The Geological Survey

OF

ARKANSAS

Coal Mining in Arkansas
PART I

BY A. A. STEEL, B. S. in C. E., E. M.

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State Geologist

LITTLE ROCK
DEMOCRAT PRINTING & LITHOGRAPHING CO.
1910

LETTER OF TRANSMITTAL

To the Chairman, Governor George W. Donaghey, and Members of the Geological Commission of Arkansas:

Gentlemen: I have the honor to submit to you herewith, Part I of the report on Coal Mining in Arkansas.

Respectfully yours,

A. H. Purdue.
State Geologist.

University of Arkansas,
Fayetteville, Arkansas.
December 22, 1910.

THE GEOLOGICAL COMMISSION

HIS EXCELLLENCY, GEORGE W. DONAGHEY,

GOVERNOR OF ARKANSAS.

JOHN N. TILLMAN,

PRESIDENT UNIVERSITY OF ARKANSAS.

HON. F. H. PHILLIPS,

COMMISSIONER OF MINES, MANUFACTURES, AND AGRICULTURE.

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PREFACE

The following report upon Coal Mining was prepared by A. A. Steel, Professor of Mining in the University of Arkansas. Professor Steel is a man of thorough technical training as a mining engineer, and has had wide practical experience in mines. His unselfish interest in the work will be understood when it is stated that Part II was prepared without compensation, as there were no funds at the disposal of the Geological Survey. Several things as originally planned for the report had to be omitted, from lack of expenses money for the necessary investigations.

A scientific report should provide information for all persons interested in the subject considered, and this report, therefore, describes many things already familiar to persons engaged in coal mining in Arkansas. Aside from the interest in the mere recovery of the coal from the ground, most persons connected with the coal industry of the world are even more interested in the question of labor supply and the welfare of the miners. For this reason, some information is given about the miners and their homes.

The progress of the coal industry and of the State at large requires the production of the best quality of fuel at the least cost. With this object in view, suggestions have been given for improving the condition of the coal mined and for avoiding useless expense in mining it. The best results can be obtained only by the coöperation of the mine workers and the mine owners. The report includes a full discussion of the relations between these two parties to the mining industry, and gives suggestions for securing greater harmony.

The State shows its interest in the mines by enacting laws regulating their operation. A discussion of this subject is, therefore, necessary in a state report upon coal mining. This report gives an outline of the existing laws, and points out the changes which are believed to be most desirable for the better protection of the miners and for the greater welfare of the industry.

Within the bounds of Arkansas, the supply of coal is much less than is popularly supposed. A rough estimate indicates that about half of the easily accesible coal is already mined. By far the largest part of our coal reserve lies beneath Sugarloaf and Poteau mountains and can be mined only with difficulty, and at great cost. At the present modest rate of production, our entire coal supply can last less than 350 years. Five times the present rate would be a conservative estimate for the State's annual output a quarter of a century hence. So that it is reasonable to prophesy that our coal supply will not last longer than 100 years.

Inasmuch as some of our essential natural products are limited, the State should stand guardian over them for posterity. While the people of the present should not be deprived of their use, it is but a duty of the public to prevent waste of these precious heritages. To justify ourselves in the wasteful use of Nature's gifts upon the belief that the ingenuity of man will always supply the demands of the future without hardship, is race egotism that begets vandalism. It would seem that the organization upon which the duty of conservation naturally falls is the State Geological Survey. Full details are given for the application to the Arkansas mines of all those practicable methods for reducing the maste of coal that can be applied under existing conditions.

Those of our citizens who work in the coal mines are of even greater concern to the State than is the coal they produce. With this in view the following report includes a full discussion of the best means of safeguarding our miners from accidents and disease.

It is thought advisable to present the results of the work in two parts. Part I deals with all phases of the coal-mining industry in Arkansas. It is untechnical and should be intelligible to students, professional men, and all others who may be interested

in coal mining, but who have had no actual experience in it, and it will give coal-mining men, who are not familiar with the industry in Arkansas, what general information concerning it they would care for. Part II is more technical. It deals with the conservation of the expense of mining coal, of the coal itself, and of the lives and limbs of the miners.

Part I contains information that it was thought should be given to the Thirty-eighth General Assembly of Arkansas, and for that reason a limited number of copies were distributed in 1910. The remaining copies printed at that time are bound together with Part II.

The Survey is indebted to so many persons for courtesies and assistance extended to Professor Steel in the preparation of this report, that it is impossible to name them here. Practically all the operators gave him access to all their records. Without exception, the foremen and superintendents freely gave the time needed to show him about the mines and always gave him the greatest freedom to go about as he wished. The majority of the miners interviewed were very kind in explaining the details of their work. Assistance in the calculations and drafting was furnished by R. E. Shipley, Ben F. Allen, J. H. Collins, J. R. Stallings, and Arthur King, students in the department of Geology and Mining, University of Arkansas; Miss Juanita Moore, secretary of the Survey, assisted in the calculations and did the stenographic work.

A. H. PURDUE,
State Geologist.

ERRATA

Page

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381. Fifteen lines from top, for "asmospheric" read "atmospheric".
381. Nineteen lines from top, for "vesssel" read "vessel".
383. Three lines from top, for "inculding" read "including".

Coal Mining in Arkansas

BY A. A. STEEL.

CHAPTER I.

GENERAL CONDITIONS RELATING TO THE ARKANSAS COAL AND COAL MINES.

This chapter is intended to give persons unfamiliar with coal mining, some idea of the way the coal is obtained from the ground in Arkansas. Parts of it may, therefore, seem elementary to coal-mining men. An effort has been made to indicate the more technical words by single quotation marks, the first time they appear, whether they are used in standard technical writings or are merely local miners' terms. All such words and most of the other technical words used in coal mining are defined in the glossary at the end of Part I. In Chapter II will be found an untechnical description of the details of mining. Some of the methods used are the result of recent changes, but are, of course, familiar to the coal men of this State, although differing from the details of mining in other districts. The geology of the Arkansas coal-field, and the present condition and location of the beds, are fully described by Authur Collier in Bulletin 326 of the United States Geological Survey, which bulletin can be obtained by application to the Director of the Survey at Washington.

GEOLOGICAL HISTORY OF ARKANSAS COAL.

Origin of the coal. So far as now understood, the combustible matter of the coal was originally formed by plants of ancient kinds, growing in swamps, such as those of southern Louisiana or eastern Virginia. By falling into water, the vegetable matter was preserved from ordinary decay and soon changed into a condition resembling peat. After a certain time this peaty material was covered, generally by mud, as sometimes now happens to similar deposits in the delta of the Mississippi. Additional sediment was washed in as the country was more or less gradually submerged, until the original vegetable matter of the Arkansas coal was covered by some thousands of feet of mud and sand. This mud and sand in the course of time changed respectively to shale, which the miner calls 'slate,' and to sandstone. While covered in this way, the peat also changed to coal.

Variation in the beds. Since the original swamp was not everywhere equally deep, and since the vegetation grew more rapidly or decayed less in some parts than in others, the thickness of the coal is far from uniform over the entire field. The swamp also shifted its position at different times, and the growth of vegetation ceased occasionally, while thin layers of mud were washed in.. Therefore, no one bed of coal is continuous over the whole coal-bearing area, and there are often one or more partings of dirt or rock known as 'middle band' or 'band rock' between the parts or 'benches' of the thicker seams. At least a thin bed of coal was formed over most of the Arkansas coal-area just after the sand which now forms the Hartshorne sandstone was put down, at which time the sea became shallow and filled with mud and vegetable matter. This Hartshorne sandstone is a thick, easily recognized stratum of rock, and indicates the most favorable place for prospecting, because the greater part of the coal in the State is just above it. This bed is known as the Hartshorne coal. Smaller swamps were formed at two or three levels or 'horizons' above this, with as much as 1,000 to 1,200 ft. of shale and sandstone between the resulting coal seams. In outlying parts of the main coalfield, and as far away as the northwest part of the State, thin beds of coal, mined for local use, were deposited considerably before the Hartshorne coal, and as much as 2,000 feet beneath its horizon.

Age of the coal. All of the Arkansas true coal was deposited during the great coal-forming period called by geologists, the Pennsylvanian period. Much later, in Tertiary time, there were extensive peat swamps over much of that part of the State which is now low and flat. This material, however, has not been completely changed to coal, but has only reached the stage of lignite, which contains so much water that it is not now commercially valuable for direct burning, although the beds are very thick, and used to a slight extent for making gas.

Folding. Since the coal was buried, the region has been raised and lowered at different times. During this process, the rock layers including the coal seams, which were originally practically flat, have been gently folded up into anticlines and down into syclines. As a result they are now seldom level, but have a dip or 'pitch' occasionally as much as 18 degrees from the horizontal, but generally less than 6 or 7 degrees or 10 ft. in 100 ft.

Faults in the coal. During the folding, a good many crushed places and small rolls or wrinkles were formed in the coal bed. These are very troublesome and are all called 'faults' by the miners. There are also a few true faults which the miners sometimes call 'throws.' These throws are long fissures in the rock along which there has been movement, so that the coal upon opposite sides is not now at the same level. In one case, it has been dropped as much as 300 ft. These large faults are few and far apart, and, at the worst, they would simply separate the individual mines, if the position of the coal be determined by proper tests before the mines are opened. In places, failure to locate them before sinking shafts, has caused great loss of money.

Erosion of the rocks and coal. While the region has been above the sea, the original rocks of the coal-bearing formation have been attacked by weather and streams, until much of the country has been reduced to about the level of the Arkansas River by the wearing away of some thousands of feet of rocks. The present surface is below the higher part of the old anticlines of the coal bed. Consequently, much of the coal has been carried away by erosion. Since the land surface is hilly, the broad line, along which the main coal seam cuts the surface, or the 'outcrop' is very irregular, although most of the coal is now in the synclines or 'basins' as they are called by the miners. Some of the highest mountains in the field, such as Sugarloaf, Poteau, and Magazine, are immediately over these basins; so that one could incorrectly imagine that the weight of the mountain had caused the coal seam under it to sink.

CHARACTER AND EXTENT OF THE COAL BEDS.

Extent of the coal deposits. The Arkansas coalfield lies in the valley of the Arkansas River between the western border of the State and Russellville. It has roughly the shape of a Roman capital L with its base along the Oklahoma line. It is about 33 miles wide and 60 miles long, but it is only in the eastern and western parts of this area that the Hartshorne coal is probably thick enough or sufficiently free from partings to be of economic importance. Still, some 300 to 320 square miles will probably contain coal which may be mined. In places, the coal is over 8 ft. thick, and when clean and of good quality, it has been mined where no thicker than 18 in. The Hartshorne seam will probably average about 3 ft. thick, and assuming this thickness over 310 square miles, that part of this bed which lies in Arkansas once contained something like a billion and a quarter tons of coal. The small amount of coal above and below the Hartshorne horizon may be nearly equivalent to that already mined, which was about 26,800,000 tons up to the end of 1909. At an average 'recovery' of 80 per cent in mining, the State will therefore yield only about 850,000,000 tons, but at the present rate of mining, this will last for 350 years. The rate of mining will probably increase.

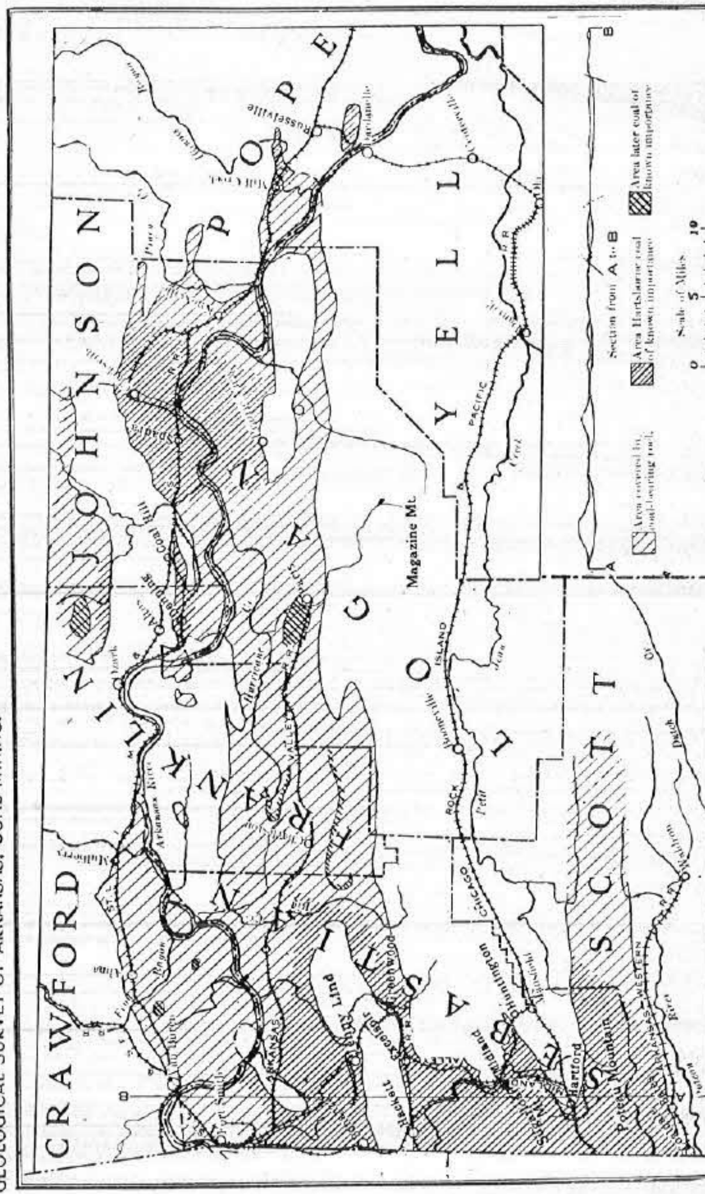
Plate I is an outline map of the Arkansas coalfield, redrawn from the geological map in Mr. Collier's report.* It shows the counties, railroads, larger towns, and the coal-mining camps. On this map is indicated the area underlain by the Hartshorne sandstone. This is the area ordinarily spoken of as the coal-bearing area. The exact limits of the Hartshorne sandstone under Magazine Mountain and the eastern part of Poteau Mountains were not worked out by Mr. Collier, because the coal bed in these places is supposed to be of no value. A little coal has been mined from beds that are below the horizon of the Hartshorne sandstone. These are of importance cheifly south of Dardanelle. Unfortunately, the locations of these beds were not worked out sufficiently to be shown on the map. They are relatively unimportant.

Upon this map is indicated the area in which the Hartshorne coal is of known importance. Coal can not be mined from every acre of this area because there are many small tracts in it that contain only faulty or thin coal. They are often too small to map, and the exact location of many of them will not be known until all of the good coal has been mined. This faulty coal occupies a considerable proportion of the areas of the mines

*Bull., U. S., Geol. Survey, 326.

PLATE I.

GEOLOGICAL SURVEY OF ARKANSAS, COAL MINING.



Outline map of the Arkansas coalfield.

already opened. Since the best part of the coal seam is opened first, there will be a larger proportion of faulty coal in the remaining parts of the Hartshorne seam. The amount of this faulty coal has been guessed at in placing the ultimate recovery of the coal at the low figure of 80 per cent.

The map also indicates the more important areas of the coal beds lying at a considerable distance above the Hartshorne horizon. These beds are of considerable importance, only at Paris, near the center of the coalfield.

Attention should be called to the fact that the largest part of the unmined area of thick Hartshorne coal lies beneath Sugarloaf and Poteau mountains. These tracts constitute by far the largest portion of the Arkansas coal reserves, estimated above. Unfortunately, most of this coal is under from 1,000 to 3,000 ft. of rock and can not be profitably mined until the price of coal is largely increased. It will, therefore, not be long until the scarcity of Arkansas coal becomes severe. It is hoped that there will be an opportunity to estimate as closely as possible the time that the relative cheap supply of coal will last. The newer workings of the mines, which are approaching the base of Sugarloaf Mountain, indicate that there is danger that the coal under it will be badly mixed with slate. This will reduce the reserve of good coal. The deeper coal is, however, harder than the more shallow coal.

Portion of the coal worked. In Arkansas, if the parting of a coal seam is hard and over 16 in. thick, and also if the top or bottom bench of coal is thin or impure, only the thicker or better part of the seam is mined, and one or more of the benches are left. It will be nearly impossible to mine this abandoned coal after the mines have fallen in, and it may be considered as permanently lost.

As yet, it is unprofitable to extensively mine both benches of a seam containing a parting, unless there are 3½ ft. of bituminous coal or 2½ ft. of semi-anthracite coal. In this case, the parting must generally be not more than 2 or 3 in. thick. At Russellville, however, one seam is mined that aggregates only 24 to 30 in. of coal, and is divided by 16 in. of waste; but this coal is very valuable, the parting is extremely soft, and most of the other conditions are favorable.

Clean beds of coal are mined rather extensively, even where only 20 or 24 in. thick, provided other conditions are favorable; but usually the limit of profitable mining is 28 to 32 in. The thinner beds, which have not been disturbed, constitute a reserve which will be mined in the future, when the thicker seams promise to be exhausted. As yet no coal is mined at a depth of more than 480 ft. below the surface of the ground.

Character of the coal. The coals in the eastern part of the field have about seven to nine times as much fixed carbon as volatile combustible matter, and are rated as semi-anthracite. These are sold for domestic use at but little below the price of the Pennsylvania anthracite. Those in the western part of the field contain but three to six, generally five, times as much fixed carbon as volatile combustible, and the coals are bituminous. They are less smoky than most bituminous or soft coals.

The heating value of the coal, which lies between 13,700 and 14,700 British thermal units, and its specific gravity (average 1.35) place it among the best coals in the United States. Its moisture and ash are also low, but it contains a little more sulphur than other high grade coals. This sulphur, combined with iron as pyrite or 'fool's gold' often occurs as large nodules or layers, which the miners call 'sulphur balls' or 'sulphur bands.' These are noticeably heavier than the coal, and can be easily picked out by the careful miners.

The chief objection to the Arkansas coals is their softness, for the coals from the Hartshorne horizon in Arkansas are very much softer than those of corresponding composition in other fields. This increases the amount of small coal or 'slack' produced in mining, and also makes it more dirty and disagreeable for domestic use. The coals at the other horizons are harder, but do not contribute much to the total output. Some of the coal would make good coke, but as there is no demand for coke, none is made in this State. The slack of all the Arkansas coal which has been tested can be made into briquets, or artificial lumps, with an unusually small percentage of binding material, but good lump coal is still so cheap that the briquets can not, as yet, be manufactured at a profit. In quite a number of the seams there are layers, generally near the top or bottom of the benches, which contain a good deal of rock or dirt in thin sheets mixed

with the coal. This makes 'bony coal' which does not burn well and must be picked out by the miner, although it is often hard to distinguish underground except by its position in the bench.

Roof and floor of the coal beds. The roof and floor of the coal seams now being mined are generally good, and in some places, very strong indeed. In places, however, a few inches of rock just above the coal is so loose that it falls down as soon as the coal is mined. This is called 'draw slate,' and may be either hard shale or soft earthy material called 'black jack' or 'rashing.' The soft material contains much combustible matter, and may once have been soil or vegetable mold.

Hight of working places. The combined thickness of the coal, its partings, and the draw slate over it, determine the hight of the place in which most of the miners have to work. Where only one bench of a coal seam is worked, or the seam is clean, this hight ranges from 2 ft. 10 in., to 4 ft. 6 in., except in rather extreme cases. The least hight in the double-bench seams is about 3 ft. in some of the semi-anthracite mines near Clarksville, where the parting is only 3 in. thick. The hight is seldom more than 8 ft., which is rather common in some of the soft coal districts where the parting may be as much as 12 or 14 in.

In a few places, where the partings are soft and easily handled and near the middle of the seam, three benches of a coal seam are worked together. Such seams have generally from 6 to 7 ft. of coal and 12 to 14 in. of waste. But usually, when the seam is much divided, it contains so much bony coal that not more than one bench can be mined.

Firedamp. Unless they are very near the surface, most coal seams give off more or less marsh-gas or 'firedamp' (methane). This is colorless and odorless and was formed as the woody substance of the plants changed to coal. It is lighter than air and collects in the upper parts of the mine workings when it is not driven away by an air current, and often burns the miners who carry a light into it. When mixed in proper amounts with the air, it explodes violently if ignited.

Because of this firedamp, practically all the mines employ one or more 'fire-bosses' who go through all the working places in the mine in the early morning and test them for gas with a 'safety lamp.' The gas, if present, burns inside the wire gauze of the lamp without setting fire to the gas outside. If any fire-damp is found, a 'dead-line' of marked powder kegs is put across the place, and the miners are expected to stay out until the gas has been removed by the proper officials, who turn an air current into the place. As compared with mines in other states, the Arkansas mines are not as yet deep enough to have much of this gas.

When the fine dust of certain kinds of coal is mixed with air, as by blasting, it burns so rapidly that it may explode when heated very highly, which may be done by the flame of blasting powder. These dust explosions are especially common in Oklahoma, but are quite rare in Arkansas, because of a difference in the coal.

Owing, therefore, to the good roof and few explosions, the death rate from accidents in the Arkansas coal mines is much lower than the average of the United States, and but for the carelessness bred by this security, it would be even less.

STRIP-PITS.

Since the coal will soon decay when exposed to the weather, it is not found at the surface of the ground, but along its outcrop it practically always stains the subsoil deep black and the coal

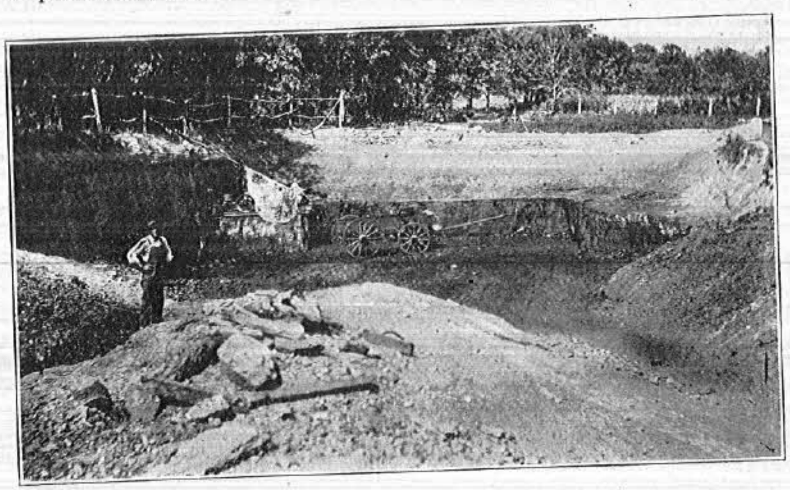


Fig. 1. Strip-pit of J. L. Cross, near Huntington.

itself can be located by auger holes or shallow pits. If there is a soft shale cover, and the coal is fairly flat, so that it does not soon get too deep, considerable coal can be mined in 'strip-pits' by removing the covering with plows and scrapers, and loading the coal into wagons. Figure 1 is a photograph of such a strip-pit. Generally the deeper shale, which is harder, is first shaken up by blasting before it is plowed. Drills are made by forging a chisel-shaped edge, about 2 in. long, on the end of a long octagonal bar of tool steel. With these 'churn drills' a row of holes about 6 ft. deep and 12 ft. apart is drilled in the shale about 8 ft. back of a vertical face. The shale is thoroughly loosened or 'shaken up' by firing about 25 pounds of common black blasting powder in each hole. In order to get this much powder into the hole and especially to concentrate it at the bottom where it is most effective, each hole is first 'sprung' by discharging a single stick of dynamite in the bottom of it. This pulverizes the shale near the bottom of the hole and throws the dust out through the top, which is left entirely open. After the powder is poured into the chamber thus formed, and the fuse inserted, the hole is thoroughly 'tamped' by ramming earth into all of the remaining space. Under ordinary conditions, it will pay to strip until the hard shale is about four times as thick as the coal.

The thickness and cleanness of the coal, and the direction of its dip, can be determined from the outcrop. Before opening the mine deeper, a few prospect holes are drilled with a well-drilling machine, to determine the average dip and thickness of the bed and the presence of any important throws.

SLOPE MINES.

Slopes. If the railroad tracks can not be conveniently brought to the outcrop, or if the seam is nearly flat, the mine is usually opened by a 'shaft' or vertical pit from the surface of the ground to the coal. Otherwise, an opening 8 to 14 ft. wide, called a 'slope' is driven into the coal from the outcrop, directly down the dip of the seam. The entrance to such a slope is shown in Fig. 2. This figure also shows the ventilating fan in the rear. If the coal is 'low' (by which the miner means that the seam is thin), some of the slate over the coal is shot down or 'brushed' to make more room; but even then the

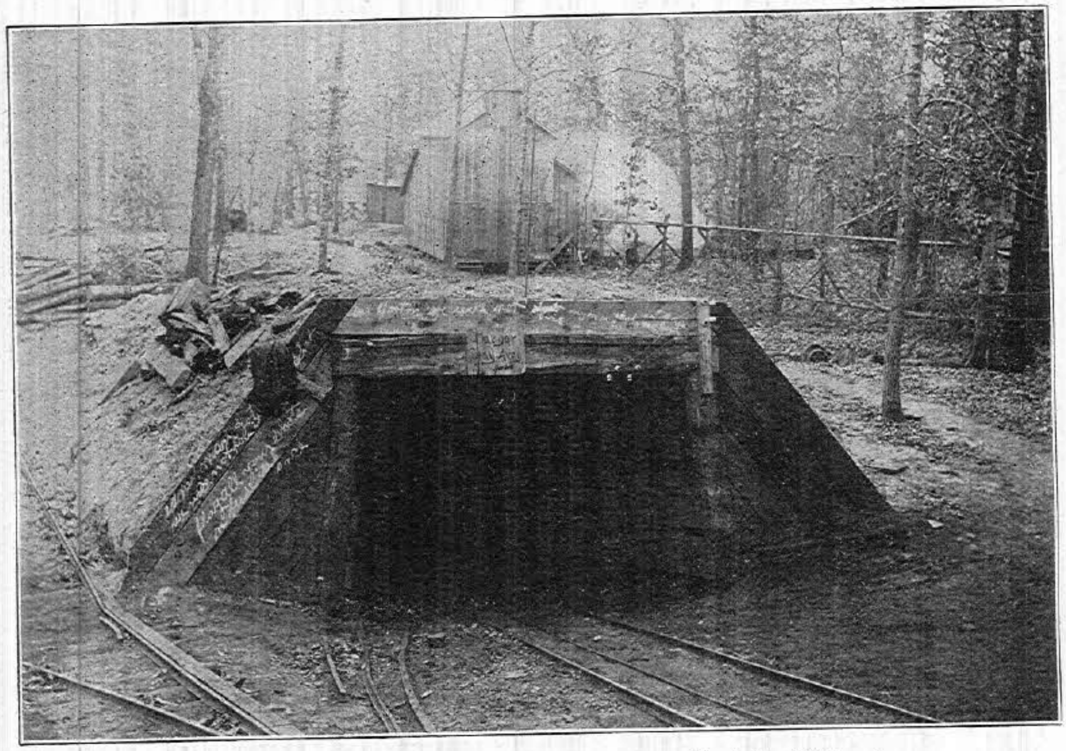


Fig. 2. Mouth of a slope, Mine No. 2, Branner Coal Co., Midland.

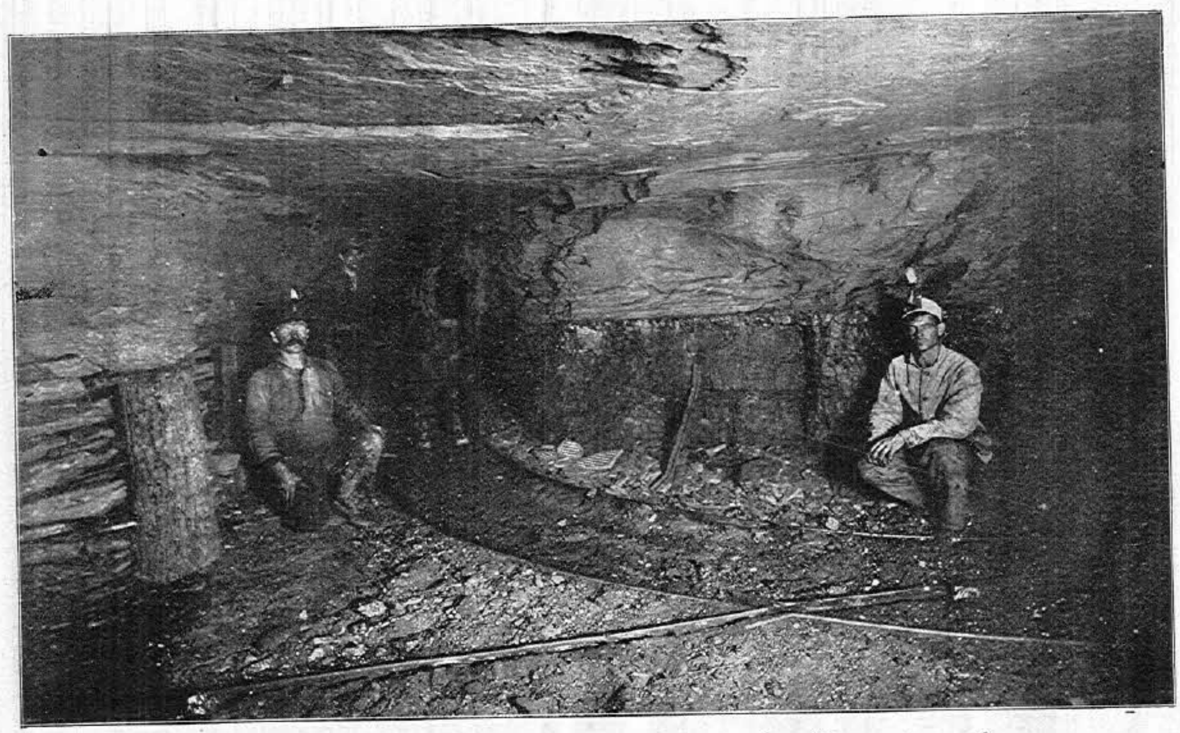


Fig. 3. The beginning of an entry in low coal. (By courtesy of *The American Lumberman*).

hight is seldom more than 5 ft., and the miners must generally stoop while walking in the slope. Figure 3 shows the brushing in an entry. A track of 16- or 20-pound steel rails and of three-foot gage is laid in the slope, and trains or 'trips' or three to 20 small mine cars, each holding three-fourths to two tons of coal, are pulled up the hill by a steel wire rope wound upon the drum of a hoisting engine. The dip of the coal and grade of the slope must be enough for the empty cars, which weigh from 600 to 1,200 pounds each, to pull the rope back after them.

Entries and rooms. At intervals of about 300 ft., other passageways in the coal are driven to the right and left from the slope in such a direction along the seam that they are nearly level. They are called 'entries,' and a light steel track is laid in them. If the coal is low, they are brushed to a hight which is usually 4 ft. 6 in. above the rail so that a mule 14 hands or 4 ft. 8 in. high can just walk between the ties of the track and not strike the roof. Figure 3 shows this brushing and the general appearance of an entry. Figure 19, on page 49 shows another view of an entry with very wide brushing. After the entries have gone a short distance from the slope, 'rooms' are 'turned' into the coall every 36 ft. along the upper side of the entry. These rooms, from which most of the coal is obtained, are only about 8 ft. wide at the beginning or 'neck,' but at a distance of 10 or 12 ft. from

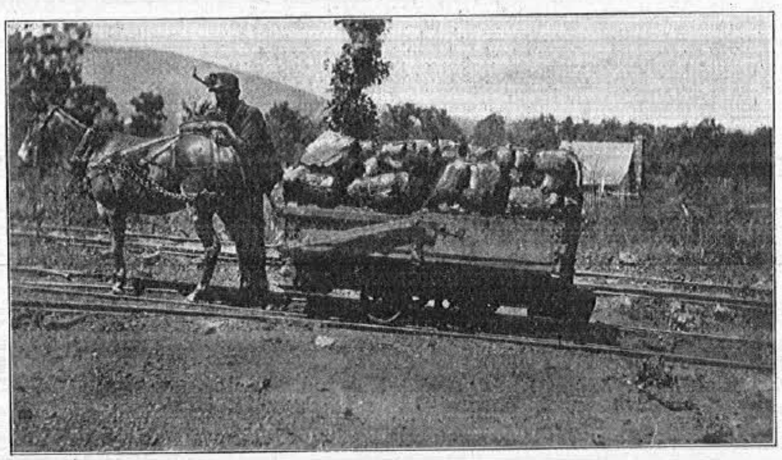


Fig. 4. Pit car load coal. Dallas Coal Co., Burma.

the entry, they are gradually widened out to 24 or 30 ft. This leaves from 6 to 12 ft. of solid coal between the rooms as a pillar to support the roof. In Arkansas, the rooms are seldom more than 250 ft. from the entry to the extreme end or face.

Hauling coal. The coal from all these workings is taken out to the slope in pit cars such as that shown in Fig. 4. There is a switch in the entry track at the neck of each room which is not completely worked out. Figure 5 shows the side of a room

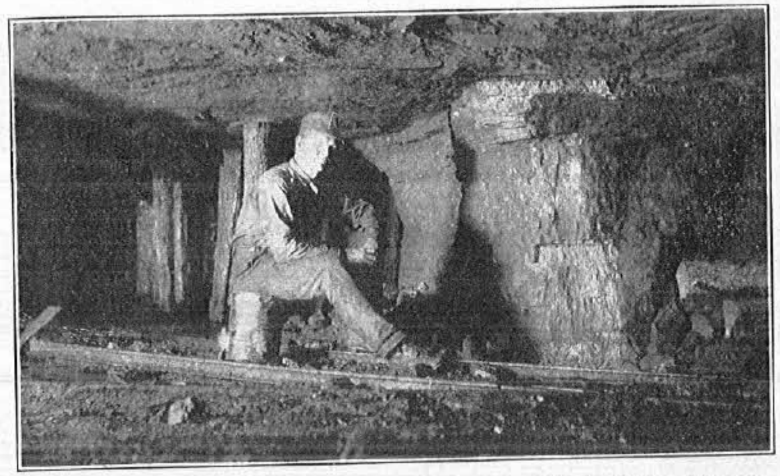


Fig. 5. Side of a room neck and props in a room. Mine No. 2, Denning.

neck, but the switch is not very distinct. In the room, the miner himself lays a track of steel or wood as he digs out the coal, so that the car can be brought right to the face from which the coal is blasted. In the entries, the cars from the rooms are made up into trips generally of three large cars or five small ones. A single mule hauls these trips down the gentle grade to the beginning of the entry, where there is a wide place with a short length of double track. This is called the 'parting.' Here the driver leaves the loaded cars on the main track and takes the same number of empty cars from the side track, below the 'loads,' back through the entry to the rooms. If the coal is 'high' enough, he takes the cars, one at a time, to the face of the rooms with the mule. If the coal is low, the miner helps the driver push the smaller empty cars up the room while the mule waits, as the roadway in the room is seldom brushed to a hight sufficient to admit a mule.

At the entry partings, the loaded cars are coupled into 'rope trips' by the driver. When there are enough cars for a trip, the mule driver waves his light to signal to the 'rope-rider' who rides up and down the slope with a train of cars. He lets a train of empty cars down into the parting, fastens the rope to the loaded trip, and signals by electric bell to the hoisting engineer, who winds up the rope and so pulls the loaded cars out into the entry and up the slope.

VENTILATION.

Ventilation. To get rid of the little gas that is always present, and to furnish pure air for the men and mules, a strong current of air must be forced through the mine. For this purpose, 'slope air-courses' are driven usually on both sides of the main slope. They are just like the main slope except that they are sometimes wider and are rarely brushed. At the mouth of these air-courses, is placed a large steam-driven suction fan. A small fan is shown in Fig. 2. The fan draws a strong current of air up the air-courses and down the slope. The current from the air-course opposite the fan is carried over the slope in a passage blasted out of the rock above, and separated from the

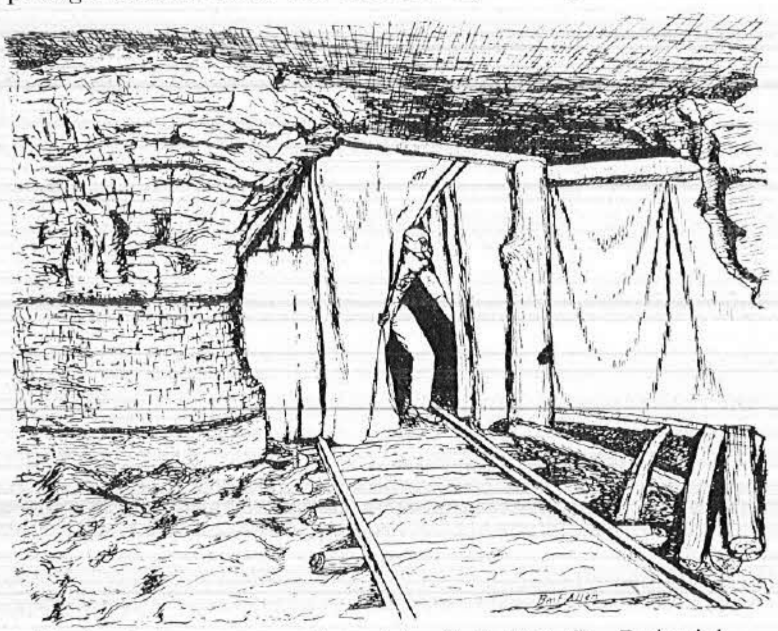


Fig. 6. Curtain across a dip switch. Paris Coal Co., Paris, Ark.

slope by a tight wooden tunnel through which the cars pass. This construction is called an 'overcast.'

From the face of each entry, the gases and impure air are drawn out to the slope air-course by another passage just like the entry, except that it is seldom brushed. This is along the lower side of the entry opposite the rooms, and a 'chain pillar' usually 12 ft. wide is left between them. In Arkansas, this passage is generally called the 'back entry,' but sometimes the 'smoke room' or simply 'air-course.' As the entries are driven forward, they are connected at intervals of 30 or 40 ft. by 'crosscuts,' 'break-throughs,' or 'dog-holes.' All but the last of these are carefully closed, generally by tight board 'stoppings.'

As soon as a room is widened out, it is connected to the adjoining room by a crosscut through the pillar, and the air current is made to pass through this break-through by hanging a 'curtain' of two overlapping strips of canvas across the entry. The mule can pull the cars through this without delay and even though a little air may blow through it, enough will go to the room face to keep the gas from collecting there. Figure 6 shows an elaborate curtain across the 'dip-switch' through which cars are taken to the back entry. This also shows the extent of the brushing in low coal.

Ventilation by splitting. The general arrangement of a slope mine is, therefore, like that shown in Plate II, which represents the appearance of a slope mine soon after it is opened, if the roof were lifted off, omitting timbering, etc. The direction of the air current is shown by the arrows. The east side of the mine is ventilated by the system called 'splitting.' It will be noted that at each entry the air current is divided or split. Most of the air goes on down the slope, but part of it goes into the entry and on through the rooms as shown by the arrows in the Second East Entry of Plate II. Curtains are stretched across each entry at intervals to keep the air current in the rooms until the last one in reached. From this room the air passes along the entry to the last entry crosscut and then out through the back entry to the slope air-course. Here it unites with the main return current and goes to the fan. At all but the longest entry, a 'regulator' is built in the back entry. It is a rough wooden stopping from which a few boards have been removed to allow enough air to blow through to ventilate this entry, but not enough to rob the longer entries of their share.

It will be noticed that if fresh air is to pass into each entry, it must cross the return air current passing up the slope air-course. Therefore, when a mine is ventilated by splitting, an overcast must be built at each entry, except the last one, to carry the return air over the 'split' of fresh air going into that entry.

Ventilation by coursing. The other side of the plate shows the 'coursing' system of ventilation. While the slope air-course is being extended as shown on the map, the air current passes down the main slope to the last crosscut, through this to the slope air-course, and up to the air-course of the lowest entry, as shown by the arrows. Ordinarily, however, if a mine is ventilated by coursing, the entire current required for one side of the mine passes down the main slope to the last entry air-course, which it follows to the last entry crosscut as shown in the Second West Entry. It returns by the entry to the inside curtain which throws the air into the rooms. The current then goes from crosscut to crosscut through the rooms, back to the slope air-course, which takes it to the air-course of the entry above. Through this entry, the same air is circulated as in the first entry. It then passes out to the air-course again and so on through all the entries in succession. As soon as possible the rooms are 'holed through' into the air-courses above (see room 3, Second East Entry), so the ventilating current does not have to go all the way out to the slope air-course to reach the air-course of the next entry.

By coursing, no overcasts are required except the one over the main slope, but there must be a tight door at each entry at the places marked in Plate II. Figure 7 is a photograph of a mine door. The white patches are due to a fungus which rapidly destroys mine timbers. After the first room is holed through the door is usually placed at the inner end of the parting, and to save delay in hauling, a boy is hired to open and close it for the driver. Fortunately, the law requires that these 'trappers' be over 14 years old, and of course the work is very light. The trappers all want to be drivers when they are 16 so they often help the driver.

Fig. 7. Mine door. Mine No. 5, Denning.

As soon as the first room beyond the parting is holed through, the slope air-course is no longer needed for coursing ventilation, and the stoppings at the entry chain pillars can be removed to give an unobstructed passage up to the first entry. It is, therefore, used as a traveling way or 'manway' by the miners who thus avoid injury from the rapidly moving trips of cars in the slope. It can also be used as an 'escape way' when the main slope is blocked, provided the stopping at the first entry and the fan house are fitted with small doors through which the miners can pass to the surface.

Whenever the face of a room or entry gets so far beyond the last crosscut that a 'pocket of gas' collects in it, the air current is carried in by a temporary partition reaching from beyond the last crosscut as far in as necessary. These partitions are called 'brattices' or 'brattishes' and are generally made by stretching strips of canvas, 'brattice cloth,' along a row of wooden posts wedged against the roof. They are arranged according to the two plans shown in rooms 13 and 15 of the First West Entry, Plate II. The cloth is seldom very tight against the roof, so that a good deal of the air leaks through and goes straight across the room. The brattices are also generally disarranged by blasting, so it is considered better to make break-throughs closer together and not use brattices except in cases like room 13, where another crosscut can not be made because the miner in room 12 has not yet driven his room far enough ahead. The brattices are put in by the fire-bosses and their helpers, who are the only persons allowed to go into a gassy room. The helpers are called 'brattice-men.'

When the entries are just starting, and before the partings are complete, they are always ventilated by coursing with curtains in place of doors. Plate II shows this arrangement for ventilating two new entries and the slope.

Advantages of the coursing system of ventilation. Ventilation by coursing has the advantage that when the rooms are holed through from one entry to the air-course above, the fire-boss and the mine foreman, or 'pit boss' can pass from entry to entry without each time going out to the slope air-course, which is often far from the nearest of the rooms in which the miners are working. As it does no harm to continue the rooms until they cut the air-courses above, no surveying is needed to prevent this, and at small mines, a surveyor will not be necessary. A manway is more easily provided. No expensive overcasts are required and there are no regulators to be adjusted. All of the current not lost by leakage passes each working place, instead of the weaker current of a single split. It is, therefore, easier to keep the places clear of gas by brattices when this is necessary, and the lamp smoke is more promptly blown out of a room. For this reason, many of the miners think ventilation by coursing is better than by splitting.

When ventilating by splitting, however, passageways with locked doors and as close together as required can be provided for the fire-boss, although at some additional cost. The heavy pillar between the back entry and the room faces below it, has sufficient advantage to pay for the cost of surveying needed to regulate the length of the rooms.

Disadvantage of the coursing system of ventilation. The coursing system has the disadvantage of requiring many doors, with trappers to see that they are kept closed, and the wages of a trapper for three of four months will equal the cost of an overcast. By coursing, all of the air current has to go through the entire mine and therefore travels much farther than if divided

into splits, each passing through only one entry. Also if the same amount of fresh air is forced through a single passage instead of several combined, its velocity must be several times greater. Therefore, the resistance of the air is much greater, so more power is needed to drive it; and the pressure is greater, which increases the loss by leakage through the stoppings. With straight overcast ventilation, there are no unlocked doors to be left open. With coursing on the other hand, there is danger that all the air will be cut off from the entries below, if any door is left open, unless pairs of doors are used, which is not done in Arkansas.

The great disadvantage of coursing lies in the fact that the air supplied to the last entry has previously passed through all other parts of the mine, so the miners working there get the lamp smoke and impurities from all the other miners; and if the amount of gas in the mine suddenly increases, there may be enough to cause an explosion by the time the air current reaches the light of the last miner. In case such an explosion does occur, it may travel through the entire mine and not merely through the gassy split. It is for this reason that the Arkansas law requires that there be a separate split of air for each 40 miners.

Plate II shows a number of different ways the partings and the rooms are arranged in the Arkansas coal mines, though of course not all of these are found in any one mine.

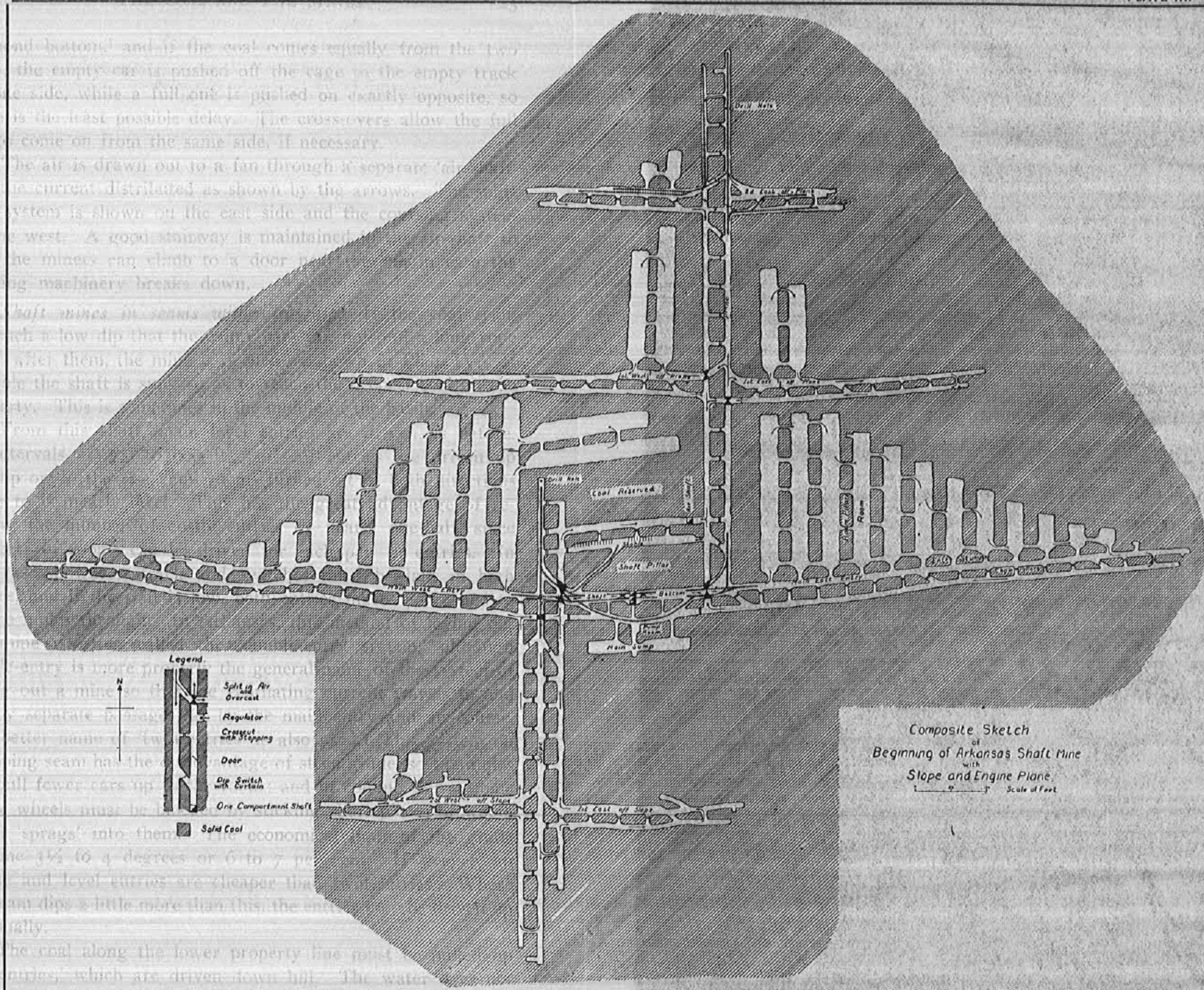
Drainage. More or less water enters the mines either slowly from small seams in the roof and coal, or more rapidly from a few distinct cracks in the roof. At some of the mines, a good deal of water soaks in from old strip-pits, or from caved rooms that have been driven too near the surface. While the slope is not being extended, all the water collects in that part of it which is below the last entry. From this it is thrown to the surface by a steam, electric, or compressed-air pump. If the slope is long and has a gentle dip, two drill holes from the surface are put down near the pump and the water is discharged directly through one of them. The other hole is used for the steam pipe or electric wires. In some cases, the water is discharged through a pipe along the main slope and the power brought down through the air-course. While the slope is being extended, most of the water is collected in a special 'sump' excavated in the coal below the last entry. Some water enters the slope below this sump and collects at the face where the men are working. In a few cases there is so little that it is bailed out by hand, but usually a small portable pump is used to raise it to the sump, from which the large pump sends it to the surface. In this way the water in the largest pool at the face is never more than 3 or 4 in. deep.

SHAFT MINES.

If the coal outcrops beyond the limits of the property or can not be reached by a railroad switch, the mine must be opened by a shaft. The cars are hoisted up this shaft upon elevators or 'cages' which run in two compartments, so that all the dead weight is balanced and power is needed only to hoist the coal and get up speed. From the bottom of the shaft, main level entries are driven to the right and left.

Shaft mines on seams with considerable dip. If the seam has a considerable dip, the coal below the main entries is brought up to one of them by a slope. The rope by which the cars are pulled up the slope generally passes through a drill hole to an engine on the surface. From this slope, entries are turned both ways as in a slope mine. From the other main entry, a set of passages is driven in the coal straight up the dip toward the outcrop. In one of these, a track is laid to form an 'engine plane' or more simply a 'plane.' Entries are turned off on both sides of the plane and its air-courses, as from a slope; but in this case, the empty cars are pulled up the plane by a rope and switched back into the partings, and the loads are pulled out of the partings and let down the plane, dragging the rope after them. Until at least two entries are turned, the cars are handled on the plane by mules, so when an engine is brought into use, the rope passes to the surface through a drill hole between the second and third entries. As the plane is extended, a sheave or 'bull wheel' is placed behind the last entry and the rope carried up and around it and back to the original drill hole. Plate III is a composite sketch of such a shaft mine on a steep pitching seam, before the development has proceeded far.

There are many ways of arranging the shaft bottom, but unfortunately only one can be shown. This is called a 'double



Composite Sketch of Beginning of Arkansas Shaft Mine with Slope and Engine Plane.

diamond bottom,' and if the coal comes equally from the two sides, the empty car is pushed off the cage to the empty track on one side, while a full one is pushed on exactly opposite, so there is the least possible delay. The cross-overs allow the full car to come on from the same side, if necessary.

The air is drawn out to a fan through a separate 'air-shaft' and the current distributed as shown by the arrows. The splitting system is shown on the east side and the coursing system on the west. A good stairway is maintained in the air-shaft so that the miners can climb to a door near the fan in case the hoisting machinery breaks down.

Shaft mines in seams with little dip. If the coal seam has such a low dip that the empty cars can not pull a long rope down after them, the mine is opened as shown in Plate IV. If possible the shaft is sunk so as to reach the deepest coal on the property. This is sometimes in the middle of the basin.

From this shaft, main level entries are driven as before. At intervals of 400 to 600 ft., pairs of entries are driven up the dip or 'to the rise,' and rooms turned off in both directions so as to be nearly level. This has the great advantage of reducing the number of costly entries by nearly one-half, since two sets of rooms can be driven for each pair of entries. In this case, however, track and switches must be laid in both entries, and if the coal is low, both entries must be brushed to let the mules through. In Arkansas, this method of laying out the mine is often called the 'double-entry system,' although double-entry is more properly the general name of the system of laying out a mine so that the ventilating current travels in and out by separate passages, as by the main entry and air-course. The better name of 'twin-entries' is also used. This system on a dipping seam has the disadvantage of steep grade, so the mules can pull fewer cars up to the room; and in coming down, some of the wheels must be blocked by sticking short pieces of wood, called 'sprags' into them. The economical limit of the grade is some 3½ to 4 degrees or 6 to 7 per cent. If steeper, an engine and level entries are cheaper than twin-entries. Where the seam dips a little more than this, the entries may be driven up diagonally.

The coal along the lower property line must be pulled up 'dip entries,' which are driven down hill. The water does not drain away from these and the miner who drives them is paid extra 'water yardage' on account of the discomfort of working in a pool of water.

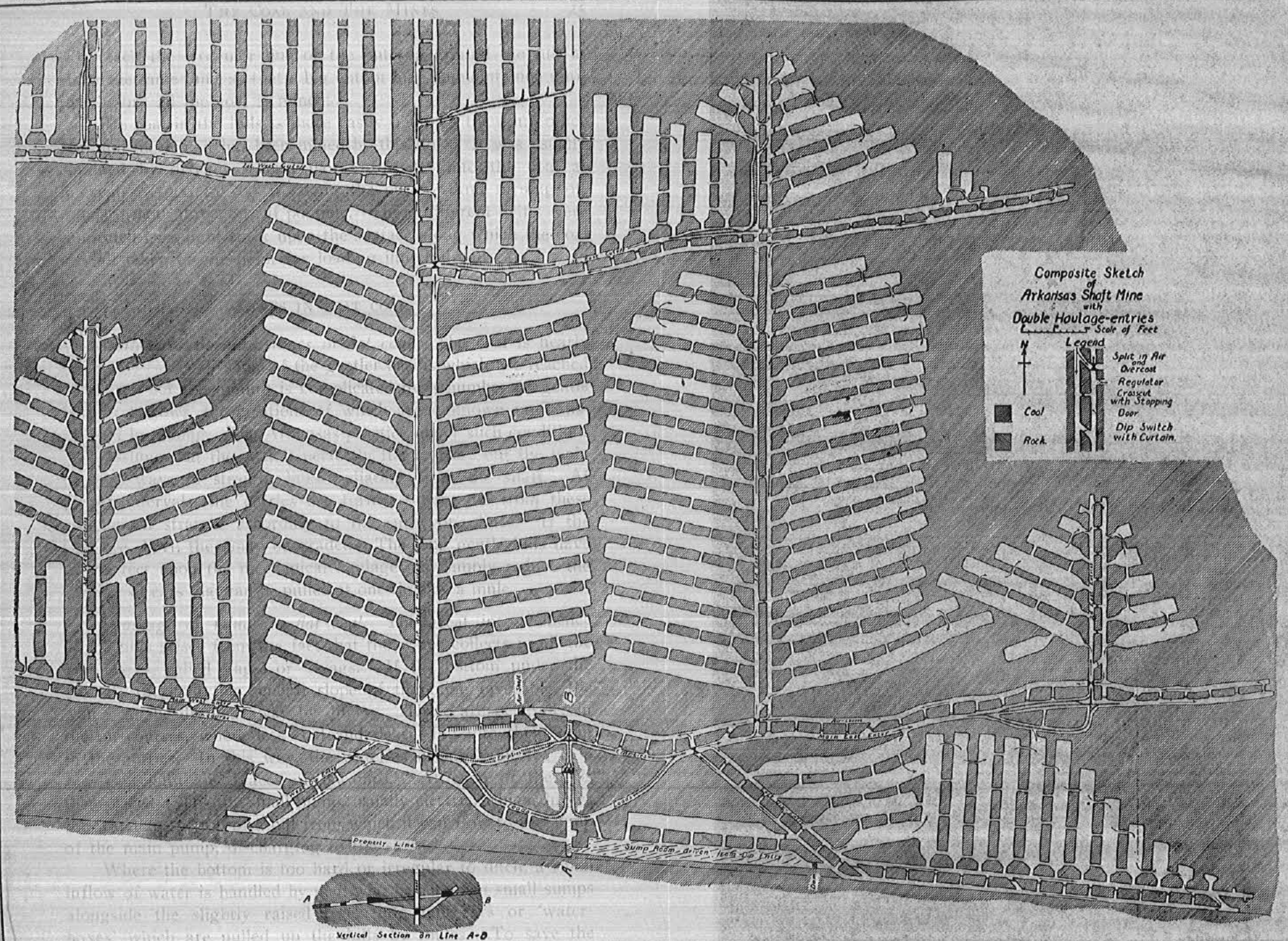
The mine shown in Plate IV is laid out for motor haulage on the main level and up the First West Entry to the 'cut-off entries' driven to intersect the others as soon as they are too long for economical mule haulage. It shows the twin-entry plan of mining coal.

The arrangement of the shaft bottom shown is adapted from that of one of the best laid out mines in the State. At the end of the main entry, the motor is uncoupled from its train of loaded cars and runs rapidly ahead to get a trip of empties for the return. As soon as the motor has passed, the switch is thrown to turn the loaded cars running on behind down toward the shaft out of the way of the empty trip. After the 'flying switch' is made, the loads run by gravity to the shaft, and are released one at a time to run on to the cage and bump the empties off on the other side. These empties are hoisted up the steep hill (shown in the section) by lugs or pushers on an endless chain, called a 'car haul.' From the top of this, they run down 'empty tracks' to be oiled and made up into empty trips ready for the motor. This arrangement saves all the hard work at the shaft bottom, but pays only at a large mine.

A number of different styles of partings are also shown and some expedients for saving entries and especially crosscuts between the entries.

DRIFT MINES.

When the coal seam is nearly flat and in a hill above the level of the valleys, it is usually opened by 'drifts.' These resemble slopes except that they are level. Mine No. 5 at Huntington is the only large drift-mine in this State. At this mine, a large oval patch of coal rises gently into a low ridge crossing the general line of outcrop. The main opening of the mine is a drift, which passes through the old workings of an abandoned small mine, and will eventually cut this tongue of coal off from the main body in the basin. This drift is parallel to the property line, and therefore runs very slightly down hill. From it, several sets of twin-entries are driven up hill, not directly, but so arranged that the main drift and all the entries


Composite Sketch
of
Arkansas Shaft Mine
with
Double Haulage-entries
Scale of Feet
N
Legend
Split in Air and Overcast
Regulator
Crosscut with Stopping
Door
Dip Switch with Curtain.
Coal
Rock.
Main East Entry
Property Line
Air Shaft
A
B
Vertical Section on Line A-B

will reach the irregular line of the outcrop around the hill at about the same time, so that a big output may be maintained until just before all the coal is mined.

The coal in the hills is more easily obtained than any other coal and most of it has been mined by this time. It was usually obtained by driving several pairs of drifts into the coal at intervals of 300 to 500 ft. along the outcrop and turning off rooms in both directions, if possible. These different drifts were connected by a light track upon the surface along which the coal was all taken to one point for loading into railroad cars.

MINES IN FLAT COAL.

Method of opening mines in flat coal. The coal is nearly flat in the center of some of the gentler basins which are reached by shafts, but the mining is complicated by a number of gentle hills or hollows, the positions of which are unknown until discovered in mining. The Arkansas practice under such conditions is to assume that the coal is perfectly flat and lay out the main haulage ways in straight lines radiating from the shaft. At proper intervals, the entries are turned square off from these and driven straight according to the surveyor's lines. If the hills are short, they may be graded. The long gentle hills have little effect upon the mechanical haulage and simply reduce the number of cars that can be pulled at one time by a mule.

Drainage of mines in flat coal. The great inconvenience of the hills arises from the fact that the water collects in all the low places, called 'sags' or 'swags.' If the bottom under the coal is soft, and the general slope of the mine favorable, the water can be drained away by ditches. These are generally in the air-courses, where less coal and debris fall into them than in the entries. In this way, the water is usually collected in a few especially low places or 'swamps.' At each of these is then placed a separate small pump, usually electric, which throws the water to the top of a hill from which it can flow to the sump of the main pump, discharging to the surface.

Where the bottom is too hard or irregular to ditch, a small inflow of water is handled by men who bail it from small sumps alongside the slightly raised track into tank-cars or 'water-boxes' which are pulled up the hills by mules. To save the expense of these 'bailers,' to handle larger quantities of water, and to avoid interference with the hauling of coal, several of these sumps at Mine No. 2, Denning, are connected by branching pipes with the suction of the main swamp pump. There are convenient valves so that water is never drawn from more than two sags at once. The pump-man soon learns about how long each one can be opened without drawing in air. Such a system is a little troublesome to design, but works very well.

MINOR FEATURES OF THE MINES.

Cut-off entries in flat coal. After the hills and hollows of these basin mines are located by the working of the mine, it sometimes happens that an entry from one haulage road can be turned so as to cut off several entries from another main road, and still continue at a favorable grade. The shortened entries are continued as before, but the coal is now taken out through the 'cut-off' entry and need not be hauled over the hills in the unfavorable entries. Also, the water can be allowed to stand in the low places in the abandoned parts of the entries until it flows over the hills. In an extreme case the mechanical haulage is extended into such a cut-off entry and it may, after a while, be possible to allow the entire low district on the other haulage-way to fill with water.

Cut-off entries in dipping coal. In the steeper mines, entries are sometimes lost by the crushing of the pillars. In this case, it is customary to drive a cut-off up through a room of a lower entry and so continue the first entry beyond the cave. This is very hard on the mule working in the cut-off, but is generally the cheapest way of mining the coal ahead of a lost entry.

When a number of lower entries are lost, a cut-off slope is sometimes used to reopen them. When this slope can start from a level entry leading to the shaft, it is very satisfactory, since it costs no more to operate than the original inside slope, and saves a long run by the 'gathering mules.' The main cost is that of sinking the slope.

Diagonal rooms. At a few mines, the seam dips more than 7 or 8 degrees, at which angle it is difficult to get the cars into the rooms, and the loaded cars run out too rapidly for safety even when all the wheels are blocked and slide upon wooden tracks sprinkled with dirt. At such mines, the level entries are turned off the slope closer together and the rooms are driven diagonally upward. At one mine with a dip of about 12½ degrees, the rooms make an angle of only 35 degrees with the entry, which gives them a grade of some 7 degrees or 12 per cent. In such rooms, one rail of the track is higher than the other, and the car is kept from slipping off by a guard-rail inside the upper rail. Such rooms are not quite as convenient for the miners and the cost of the entries is greater since they are closer together for the same length of room.

SMALL MINES.

At many places, there are small patches of coal separated from the larger mines by creeks or the accident of property lines. These are often leased to practical miners who generally employ less than 10 men, so their mines are not subject to the more severe mine laws. When a large company works the adjoining land, these leases are given to the best miners in that company's employ. They are generallly furnished with cars, rails, and other equipment, and sell the coal to the company at less than the market price. Such a working is often jokingly called "The Chosen-Friend Mine."

Where the coal seam is rather flat, these small mines are generally opened by driving rooms straight down the dip from the edge of the strip-pit, which has been worked as far as stripping is profitable. Each of the rooms is a 'pigeon-hole' but the term *pigeon-hole* is also used for any sort of small mine. Figure 8 is reproduced from a photograph of a row of such pigeon-holes, and shows also the 'spike-team' for hauling up the large cars.

When these rooms become too long, pairs of them are brushed if necessary, and changed into drifts. If the dip is greater, the pigeon-holes are necessarily short and a slope is sunk instead. Rooms are turned off from this to the right and left, and there are no regular entries. When the rooms become too long, and another slope is inconvenient, a pair of rooms some

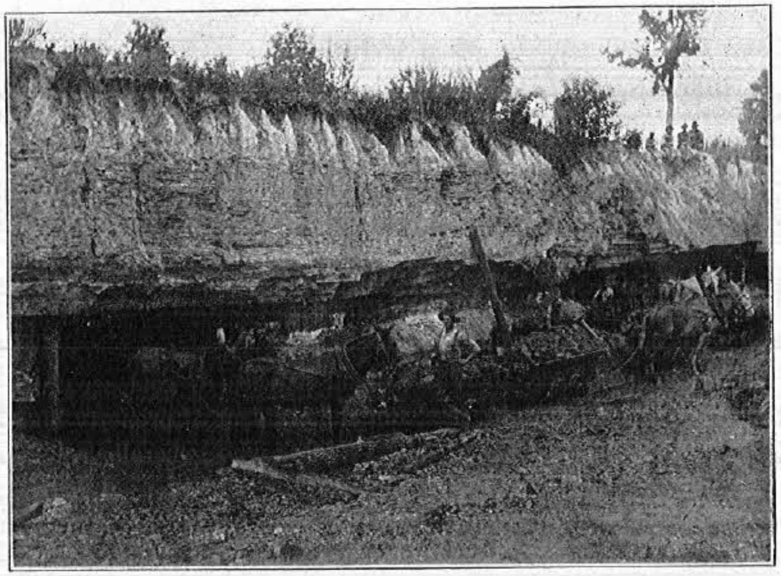
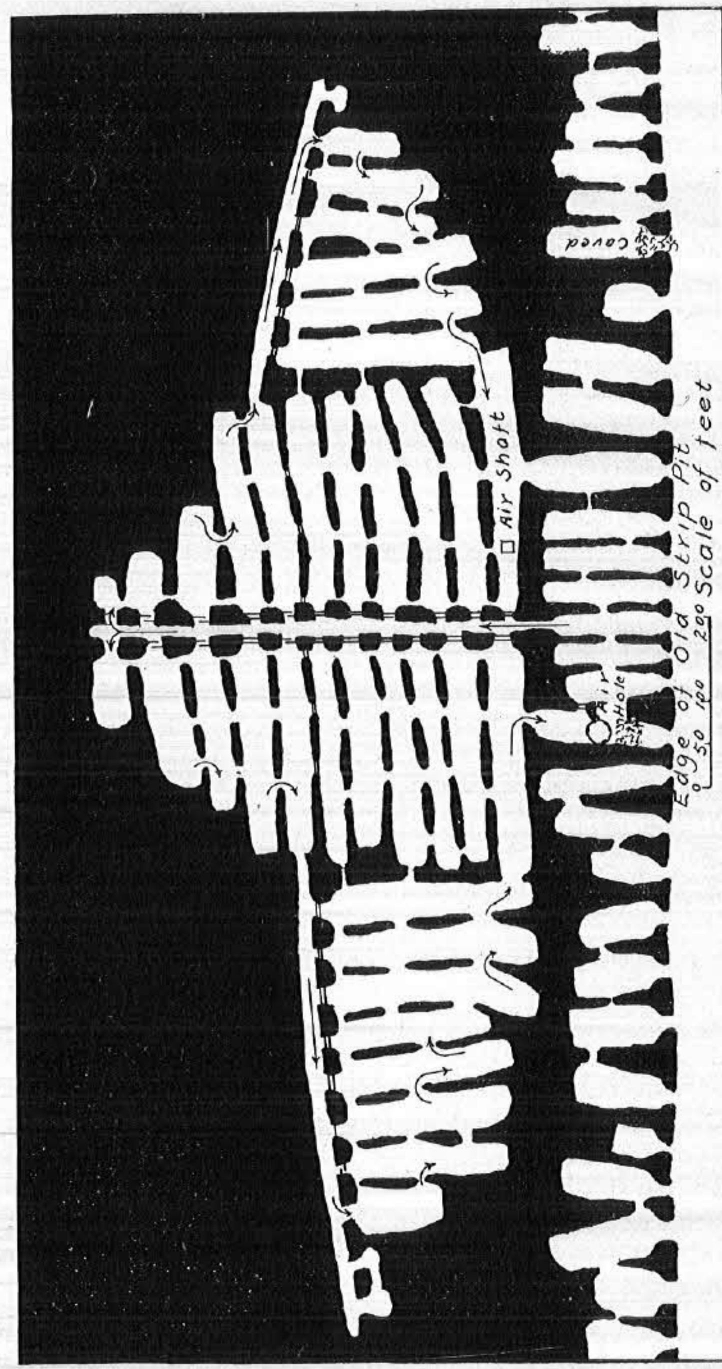


Fig. 8. 'Pigeon-holes' at Huntington.

distance down the slope is continued to the right and left as the first entry in the usual way. In this case, an air-course is seldom driven below the entry, and the rooms are ventilated by passing the air current into the face of the entry and out through the break-throughs between the rooms. A tight curtain is, therefore, maintained at the neck of each working room except the last, and as soon as the room is worked out, a tight stopping is built at the neck. This 'single-entry' system of ventilation is not very effective, and is prohibited by law at the larger mines. Plate V is a sketch of the arrangement of such a little mine.



Plat of a small mine ventilated by the single-entry system.

The coal is pulled up the gentle slopes by the mules, and hoisted with a horse 'whim' at the steeper ones. Figure 9 shows the standard Arkansas style of home-made whim. When ready to let the trip down the slope, the top man sets the brakes and withdraws the pin (generally the axle of an old pit-car) which attaches the rope drum to the shaft of the hoist. The drum, controlled by the brake, is then free to run backwards while the horse stands still.

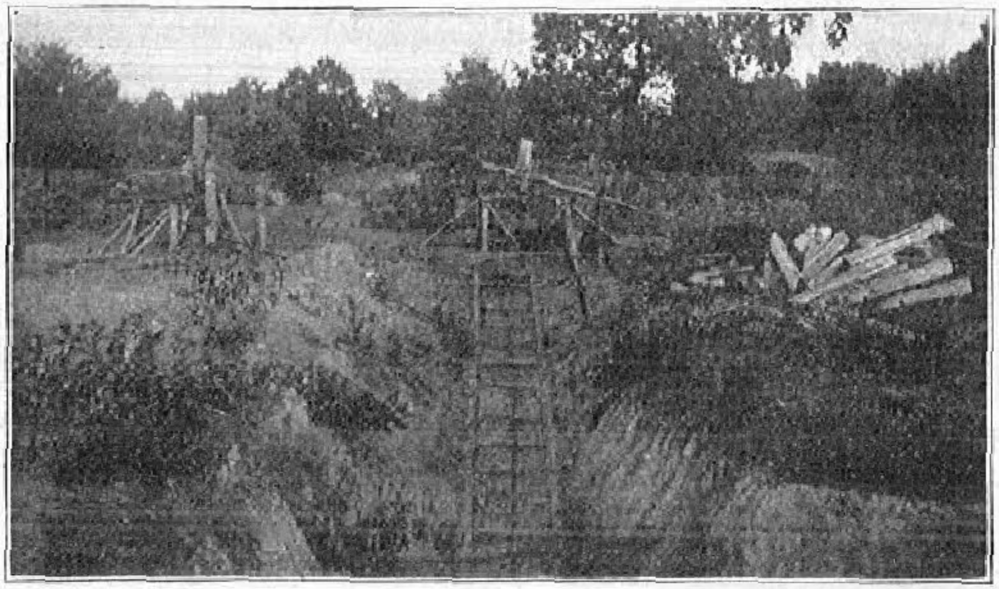


Fig. 9. Home-made horse whims.

These small mines are so near the surface that they contain no gas, and many of them rely upon natural ventilation only. This is most effective in winter when the mine is warmer than the outside air. At this time, also, there is the greatest demand for the coal. To lessen the smoke which fogs the poorly ventilated rooms, many of the miners work with small acetylene cap-lights or burn the soft paraffin wax—called 'miner's sunshine'—instead of the ordinary smoky mixture of lard-oil and rosin-oil.

When the natural ventilation is not sufficient, many of these small mines are ventilated with a furnace. This is nothing but a home-made set of grate bars beneath a short air-shaft. A coal fire upon this grate warms the air in the shaft and causes a strong air-current to pass up with the smoke of the fire. The air current enters at the main opening and is circulated around the mine as needed. Its strength can be varied by the size of the fire. There are none of the so-called improved ventilating furnaces in the State, since wherever such a furnace would be useful, the mechanical fan is used and is much better.

MINE NO. 17, JENNY LIND.

The irregularity of the actual coal mines is illustrated by Plate VI, which is a map of Mine No. 17 of the Western Coal & Mining Co. at Jenny Lind. This mine was opened upon the general plan shown in Plate III, with a slope and engine plane leading to the main shaft. Because the coal to the east of the shaft proved unfit to mine, the workings are now badly one-sided. As the entries were extended to the west, it was found that just south of the line of throw the coal seam became nearly flat. This made it necessary to turn off several intermediate entries from the main haulage entries, which are named 'New *N*' and 'Little *N*.' At the extreme western limit of the mine, the coal becomes irregular, and the entries are sharply turned. Just north of the line of throw, the coal again dips. The dip is rather steep at first but gradually diminishes until entry '*Y*' is reached. At this point, the coal becomes practically flat and is in the center of a basin, beyond which it will again rise.

The throw shown on the map has dropped the coal down to the north some 30 ft. where the main slope crosses it; to the

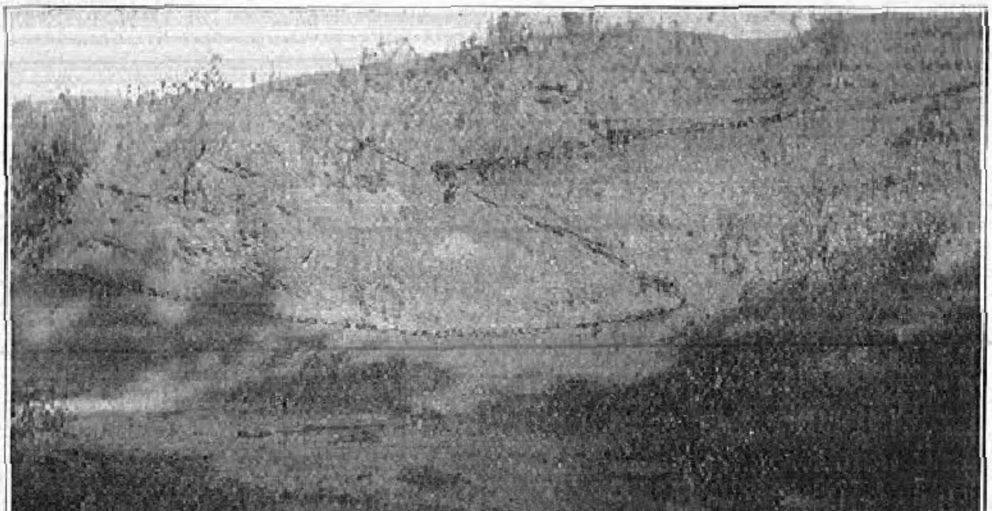
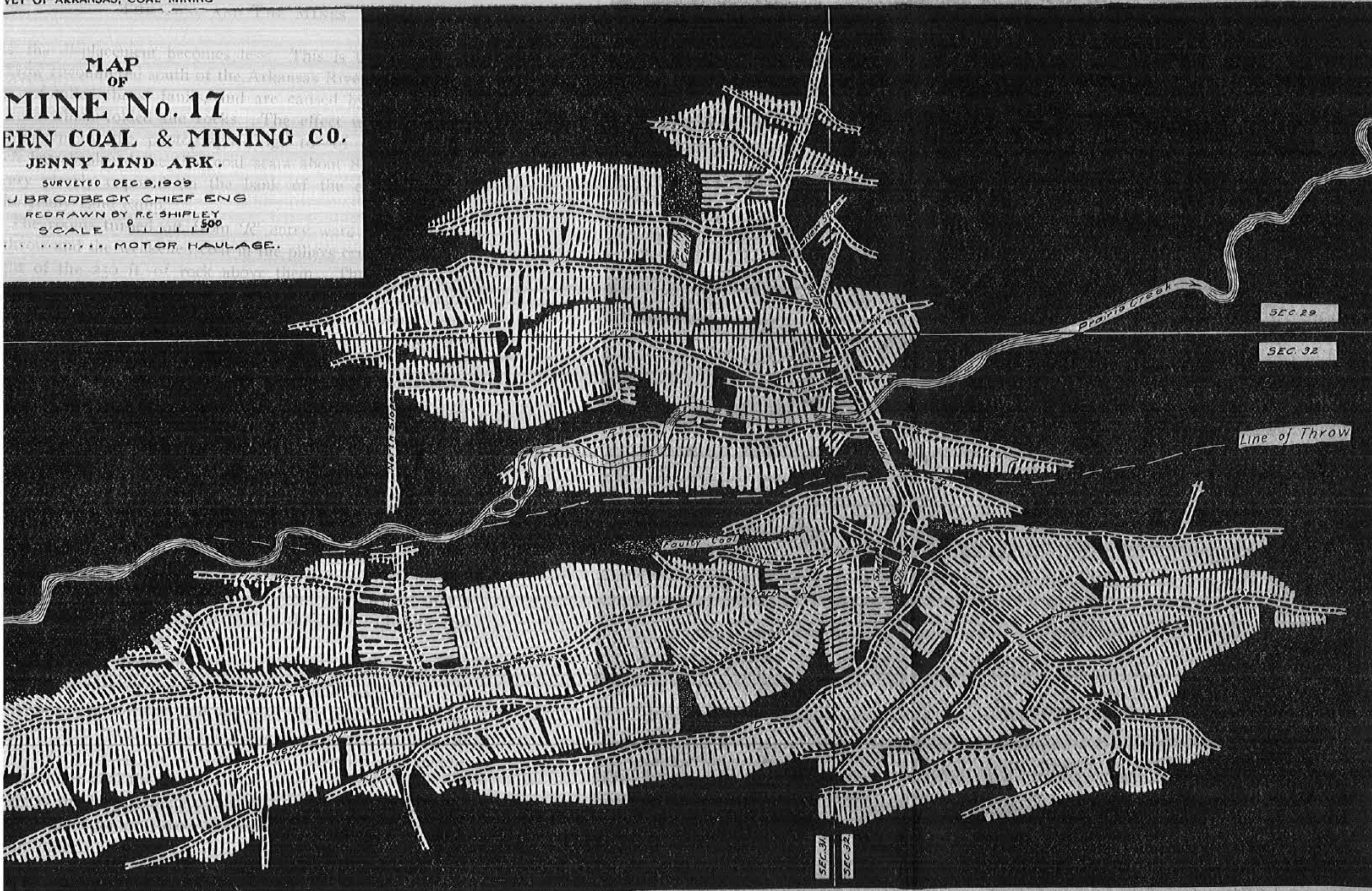


Fig. 10. Small thrust fault at Jenny Lind.


MAP
OF
MINE No. 17
ERN COAL & MINING CO.
JENNY LIND ARK.
SURVEYED DEC 9,1909
J BRODBECK CHIEF ENG
REDRAWN BY R.E SHIPLEY
SCALE 0 500
.... MOTOR HAULAGE.
SEC. 29
SEC. 32
Prairie Creek
Line of Throw
Faulty Coal
New Slope
SEC. 31
SEC. 32

west, the displacement becomes less. This is the typical form of throw encountered south of the Arkansas River. Geologically, they are called thrust faults, and are caused by the horizontal pressure which folded the rocks. The effect upon the coal is best shown by the photograph—Fig. 10—of a similar fault which has displaced the thin coal seam about 8 ft. This fault is very clearly exposed on the bank of the creek just west of the Jenny Lind camp.

The rooms turned off from '*R*' entry were driven clear to the throw and the weakened coal in the pillars crushed under the weight of the 250 ft. of rock above them. This crushing has already spread to the '*R*' and '*V*' entries and is threatening to close the '*X*' entry. For this reason, the 'North Slope,' some 3,000 ft. east of the main slope is being opened from the 'Little *N*' entry and the '*X*' entry, working both up and down. After this slope is completed, entries at regular distances along it will be turned off to the west, and the coal raised by an electric hoist to the motor line in 'Little *N*' entry. The main slope will then be abandoned as an outlet for the coal.

The caving of the '*R*' and '*V*' entries and rooms opened a number of cracks in the creek bed and admitted more water than the pumps could handle. The slope and all the workings driven from it were slowly flooded by this water. At the time of the writer's visit, most of it had been pumped out, and because it was found impracticable to close all the cracks in the creek bottom, an 8-in. drill-hole had been put down from the surface, and a large electric pump was being erected in the slope to handle this increased inflow of water.

The map also shows the larger patches of faulty coal, and will give some idea of the irregularity of their occurrence and the consequent annoyance and expense they cause. Some of the entries have been stopped because the miners working in them would not keep the dirt from an unusually soft middle band out of the coal they loaded.

This is the largest mine in the State and the underground workings extend for over 9,000 ft. east and west. At practically all of the other mines, the entries are numbered as in Plates II, III, and IV. At Mine No. 17, the alphabet has already been exhausted in naming entries.

LONGWALL MINES.

In the Spadra district, the 'longwall' method has been experimented with and modified from time to time, but up to the present time, the final method to be used has not been decided upon. Many of the thin seams of coal in the outlying districts, which are mined only for local use, are worked by a primitive longwall method. The method is best developed at the Baldwin mines near Fayetteville, Washington County. Here the coal, which is 10 to 14 in. thick and of high grade, lies perfectly flat very near the top of Robinson Mountain and some 500 ft. above the valley. At this place, a little more than 100 acres of coal have been protected from erosion by a bed of hard sandstone some 15 ft. thick. Immediately below the coal is a bed of shale or fire clay which is rather soft, where the coal is mined.

The coal is mined in 10-acre tracts. Each of these is opened by a single drift, but adjoining mines are connected as soon as possible so that there is a little natural ventilation in the winter, at which time the mines are worked by the farmers living in the valley. The general plan is shown in Fig. 11. The main drift is driven straight into the mountain. After this has advanced some 40 ft. into good salable coal, a so-called room, 40 ft. wide is started both ways from the drift. When this has advanced too far to shovel the coal to the main drift, a roadway is opened along the middle, by shooting down the softer shale and sandstone between the coal and the hard 'cap rock.' This brushing usually gives a passageway only 3 ft. high. All of the coal is pushed out by the miners. The rock from the brushing is piled into strong walls on each side of the roadway, to assist the props in supporting the roof. The coal is secured by digging out the clay from beneath it and wedging the coal down as shown in Fig. 12, which is redrawn from photographs. Even after the dirt is dug out, the miners have only some 15 in. of hight in which to work, and in this space the coal is shoveled and pushed to the roadway. After the room is sufficiently advanced, this 'underclay' is shoveled back and left behind the miner.

As soon as the main entry can be extended far enough after the first pair of rooms is turned off, a second pair is turned off, and so on. At some of the mines, when the first rooms reach

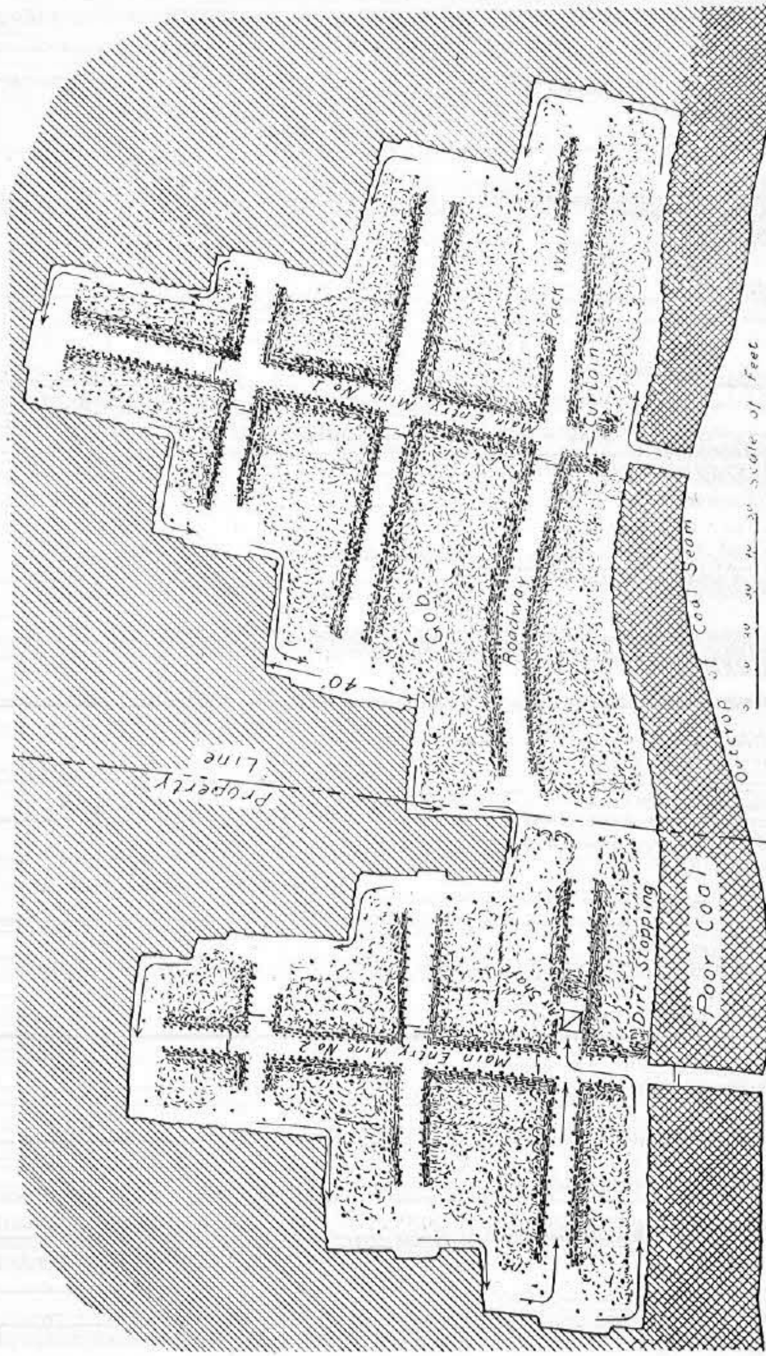


Fig. 11. Plan of longwall mines, Leith, Washington County.

Fig. 12. Method of digging coal at Baldwin mines, Leith.

20 ft. in length, the main drift is continued as a room 40 ft. wide, with a brushed roadway through the middle. Care is taken to put no clay into a wide passageway along the poor coal next the outcrop and around the entire face of the mine, to a small air-shaft above the drift. The air goes along this passageway from one of the drifts. On account of the space taken by this passage and by the roadways and walls of roof rock next them, the clay nearly fills the remaining space, and the roof can sag only a short distance before it is perfectly supported, even though the mine becomes large. On account of the thinness of the cover, the sagging roof helps but little in breaking down the coal, but the bottom does not squeeze up and the roadways are not affected. The props are used to keep up the loose rock next the coal. This longwall method will be used more extensively in the future in other parts of the State.

At Paris, two of the mines are equipped with machines to dig out the hard clay under a low-coal seam to give hight enough for working; but the general plan of the mining is like that shown in Plate IV. The details will be discussed in Chapter II.

CHAPTER II.

DETAILS OF MINING.

DETAILS OF DRIVING ENTRIES.

Cutting. Except in the small semi-anthracite coal mines, all the entries and slopes are driven by a single method, which is called 'cutting.'

Figure 13 shows in plan the normal condition of a narrow entry in single bench coal, after all the loose coal has been loaded out. The drill-holes are charged ready for blasting in the night or the 'shots are prepared,' as the miners say. The narrow part, which is generally 4 ft. wide, is called the 'heading.' The V-shaped notch alongside of this is the 'cutting,' and is dug out by the miner, who kneels on the bottom and uses a light short pick. The cutting is from 4 to 6 ft. long and only sufficiently wide to crawl into far enough to reach the end. It is made in 2 to 4 hours, depending upon the skill of the miner, and the hardness of the coal.

Drilling holes. In the soft coal of Arkansas, all holes for blasting are drilled with a 'breast auger.' This is made of a flat bar of steel twisted into a spiral, like a carpenter's auger. The cutting end of this is split and spread by the blacksmith at intervals, and bent to make a pair of cutting edges. The hole drilled by them is consequently larger than the spiral and is generally about two and one-fourth inches in diameter. The outer end of the spiral is welded to a round rod of steel, bent to form a pair of cranks for turning it. The rounded end of this stem fits into an iron plate supported against the miner's body As the miners sharpen the drills with a file every day, the widened part is soon worn off and the bit must be sent out to the blacksmith again. After the hole is put in, the small amount of fine coal, which remains in it is removed by a scraper, which is a light iron rod with a small lip at the end of it.

Charging holes. A case to contain the powder to be put into the completed hole is made by rolling a 15-inch strip of cheap brown paper sidewise around a smooth wooden stick 1½ and 2 in. in diameter, called a 'firing-pin.' The free side

of this paper is pasted down by first rubbing the paper with cheap soap. It is then pulled off the pin and filled with coarse black powder from a 25-pound sheet-iron keg.* One end of a piece of blasting-fuse is stuck into the powder and the paper tied around it. This 'cartridge' is gently pushed to the bottom of the hole by a 'tamping bar,' which is a ¾-inch rod of steel 8 ft. long, with a head large enough to almost fill the hole. To keep the powder from blowing out, the hole is tamped full of clay, fine slate, or even coal dust. For convenience, this material is first made up into 'dummies' by putting it into paper cases like that made for the powder, but only 8 in. long. The first of these is pressed in gently, to avoid accidently lighting the powder; but all the others are packed as hard as possible by striking them with the bar, while the fuse is held tight with the other hand so that it will not be kinked or cut. There is a notch in the head of the tamping bar to fit around the fuse.

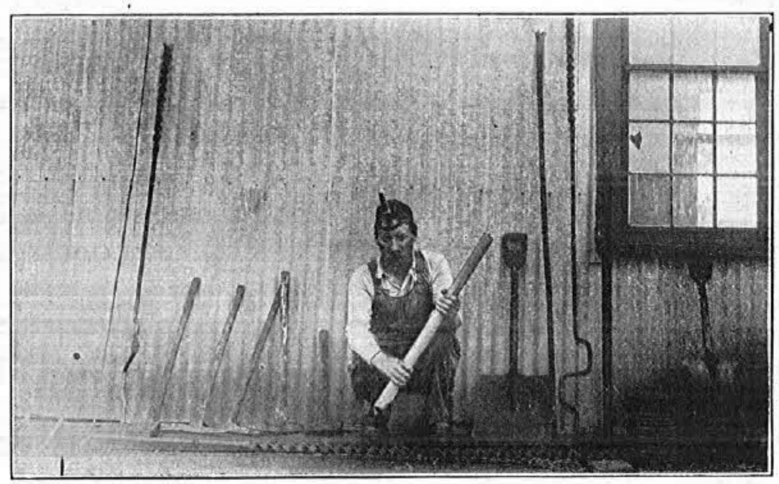


Fig. 15. A group of miners' tools.

Miners' tools. Figure 15 represents a group of miners' tools. There are three augers, the large coal shovel, and the smaller rock shovel, which is next the window. The firing-pin is leaning against the window casing, and the tamping bar with the notch on the bottom is beside the long auger, and the scraper beside the

*At Hartford the miners use 12½-pound powder jacks.

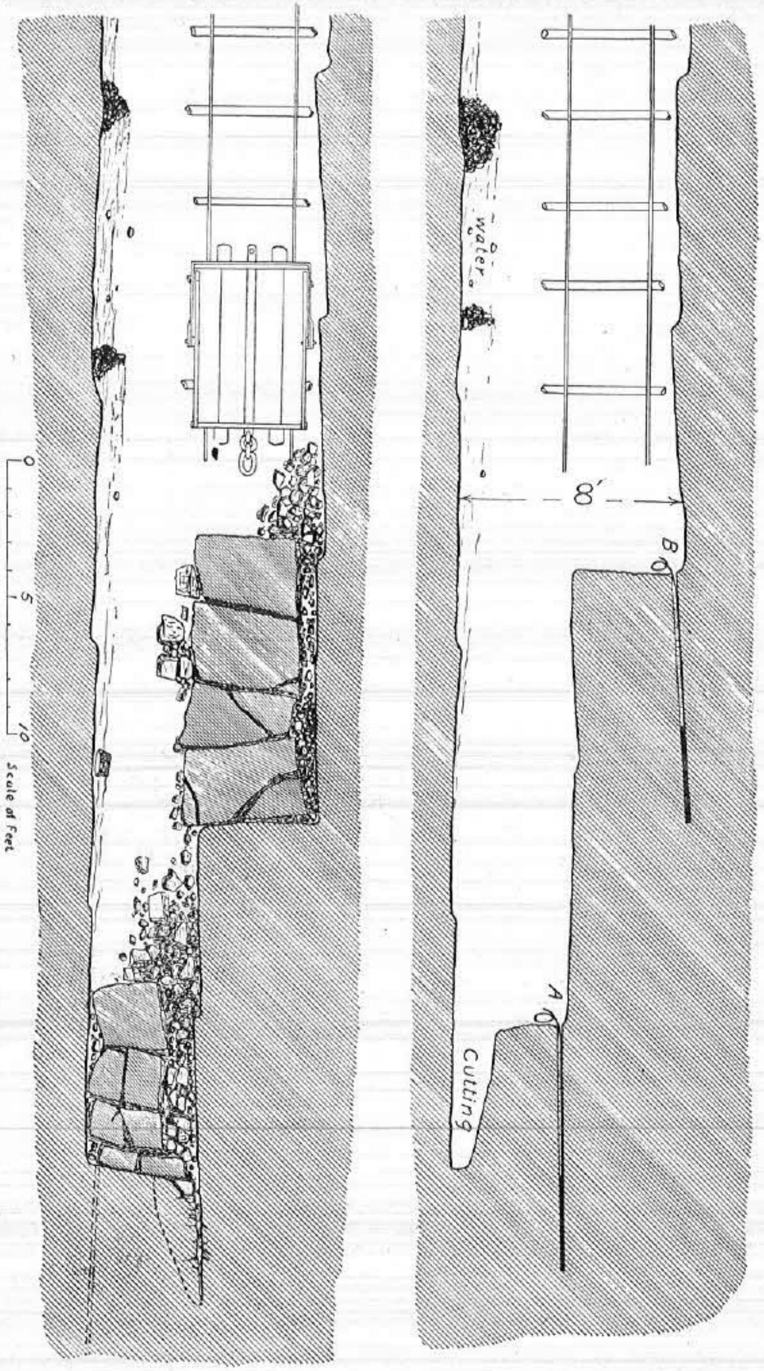


Fig. 13 and 14. Plan of entry in single-bench coal before and after blasting.

short one. The miner holds the cartridge ready for the fuse and wears the typical pit cap and lamp. There are also a corrugated iron powder keg, picks and a sledge. No breast plate for the auger is shown, but some idea of it can be had from Fig. 31, p. 63, which shows the end of an auger sticking out of a hole just over the miner's head.

The cutting shot. One charge of powder, the 'cutting shot,'—A, Fig. 13—is placed about half-way between the roof and floor on the side of the heading opposite the cutting. The hole is drilled 8 to 10 ft. deep, and 2 to 4 ft. 'on the solid,' which means that it goes this far beyond the end of the cutting.

When the powder explodes, all the coal between it and the cut is blown into the cut and heading. The coal which is too tight to be blown out is shattered and cracked, sometimes even beyond the end of the drill-hole, as shown in Fig. 14.

The shattering of the coal greatly reduces the labor of making the next cutting, which is on the other side of the heading in the position shown by the dotted lines, and follows the hole just blasted. For the purpose of so shattering the coal, more powder than necessary to loosen it is always used. The amount or powder is reckoned by the number of inches in the length of the cartridge. A 1½-inch cartridge has about one pound of powder for each 17 in., and a 2-inch cartridge, which is more commonly used, one pound for each 10 in. The ordinary 9-foot shot with 5½ ft. of cutting, is generally charged with from 36 to 42 in. or 3½ to 4 pounds of powder. Except in the low coal, two men work in each entry and are known as 'buddies.' One of the pair is usually a skilled pickman who does the cutting or 'head work,' while his partner does most of the shoveling or 'back work.' Most of the miners get in a cutting every day, so two men should drive an entry 5 or 6 ft. per day. The rate per month of 20 working days is seldom more than 75 ft.

Back shots. After the cutting is far enough ahead, the miner puts in the 'back shot.'—B—which is usually 9 or 10 ft. long, and throws out a strip of coal 4 to 5 ft. wide with 30 in. or 3 pounds of powder. The less skillful mines generally blows this back coal down so as to nearly fill the heading, and since he must be able to get at the cutting early to finish it before the end of the day, he must keep the heading well in advance of the back shot or there is no room into which to shovel the coal from the cutting shot. As the car can not be brought nearer than the back shot, these miners have much extra labor in shoveling the heading coal back to the car, or 'turning out' the coal. Under these conditions, there is very little air current in the heading, and gas is liable to accumulate and burn the miner when he takes in his light. For this reason, some foremen require that the back coal be first cleaned up before any one goes into the heading.

On the other hand, the skillful miner can so gage his powder that the coal is merely well-loosened for easy picking down, as shown in Fig. 14. But he runs the risk of leaving the coal too tight to get, so light shooting can only be done when the coal seam is rather uniform. When the light shot is successful, the miner need shovel the coal but once before he can load it into the car, but occasionally he can not get at the heading till after the back coal is cleaned up. In this case, he loses time unless there are plenty of cars. Figure 19, p. 49, shows the appearance of the heading and cutting in an entry in low coal, after all the coal has been cleaned up.

Grade of entries. The entries in the dipping seams are supposed to be driven at a 'water grade' or to go up about 6 in. in 100 ft., at which grade the mules can haul in as many empty cars as they can haul out loaded ones. At this grade the water flows out fairly well, and if the bottom is hard and smooth, the miner keeps the lower side of the entry at a slight angle to the edge of the pool of water which stands behind little piles of coal in the entry, as shown in Fig. 13 and 14. Unfortunately, many miners are used to driving entries perfectly straight and pay no atention to gentle rolls in the floor, but turn rather sharply only when the grade is badly off. For this reason, the Arkansas entries are often very hilly and sometimes more crooked than necessary. The back entry is driven to keep the length of the crosscuts uniform if possible, and is often zigzag.

Sights for entries. When the coal is in general flat, the entries of the better managed mines are driven 'on sights' put in by the superintendent or a special surveyor. For sights, two very small holes are drilled into a solid spot of a shale roof, in the line desired for the center of the track, and about 4 ft. apart. Horseshoe nails with holes punched through the heads are driven solidly into the holes in the roof, and strings with stones tied to them are fastened to the nails. The nails are then bent slightly to one side or the other until the strings are exactly in line with the surveyor's instrument. Every day or two, one of the entrymen is supposed to stand behind the outside string and light up the other by holding his lamp at arm's length in front of him. He can then sight across the two strings to a light in the breast of the entry, which his partner moves to the right and left until it marks the desired position of the center of the entry. The next cutting is then varied a little if necessary to keep the entry in the right place.

If the roof is bad and liable to fall, the nails may be driven into timbers. If the roof is sandstone, the nails are driven into wooden plugs set in slightly larger holes. There is some little expense of 'lining up the mine' or setting new sights at intervals, but the chief difficulty is to compel the miners to pay attention to the sights. For this reason, attempts to drive the rooms also on sights have been generally abandoned, and only a few of the entries are driven on sights.

Entries in double-bench coal. When there are two benches in the coal seam, they are sometimes so tightly stuck to each other that they can be shot out as though one. Usually, however, the middle band is so soft or loose that the holes will not always 'break top and bottom.' In this case, the heading is driven in the easier bench, and generally the back shot of that bench is fired next. If the top bench is left, it is then shot down by two light shots on each side of the entry, fired just after the back shot has loosened the coal below, or sometimes not until the coal from the back shot has been shoveled out. Since the solid coal along the side of an entry or room is always called the 'rib,' such shots along it are known as 'rib shots.' In rare cases, one 'center shot' brings down all the top coal. If the bottom bench is left, two rib shots are always used. These rib shots are fired alternately first on one side of the entry and then on the other, and each shot is about half its length ahead of the last. This makes a kind of cutting for the next shot, and the entire block of coal is pushed partly into this space, and so shaken loose from the bottom or from any hard middle band above it. In a few cases, the benches are not so easily separated. Then the cutting is made in only one bench, as usual; but the other bench is shot out of the heading before it is widened, so that a single back shot will widen both benches.

Gob entries. In case there is a considerable quantity of waste between the benches of coal, there would be a little delay and expense in hauling it out. To avoid this, the entries in Arkansas are often driven 12 to 14 ft. wide by putting in another row of back shots behind the first row, or on the other side of the heading. This widening of an entry is called 'slabbing it.' The track is then laid next the upper side of the entry, and the waste piled along the lower rib.

Since heaps of waste material left in coal mines are called 'gobs,' an entry with waste left in it is a 'gob entry.' Figure 16 is the plan of such an entry. It shows also a room neck and a crosscut from the air-course, and the way the bottom bench is usually taken up. If the middle band is so soft as to be easily shoveled off the lower bench without blasting, it is usually cleaned out of the heading before the back shots are fired. Where quite hard, it is always left until the bottom shots are fired. These, if properly charged, shake the rock loose from the bottom bench, and break it up for easy picking without mixing coal and rock. Figure 17 is a cross section of a gob entry showing the ordinary heap of waste, and, by the dotted line, its occasional excessive amount.

As gob entries are necessarily wide, the roof is weak, and generally at least one row of props is set alongside the track. These props look like pieces of ordinary split oak cordwood with the ends sawed off square. The bottom of the prop is first set upon the floor and a 'cap piece' about 4 in. wide, 15 in. long, and 1 or 2 in. thick, is held against the roof while the prop is set under it at a small angle from the vertical. The prop is then securely wedged into place by driving it plumb, with an ax or sledge. The props are shown best in Fig. 5, p. 15, and Fig. 19, p. 49. If the roof is unusually weak, as where the coal is near the surface, it is supported over the roadway by 'cross-bars.' These are logs 6 or 8 in. in diameter, reaching from side to side of the road, and placed as close together as is necessary. The ends of the cross-bars may be held up by resting them on a little shelf of coal, if it is hard. The notches that are cut into the coal to sup-

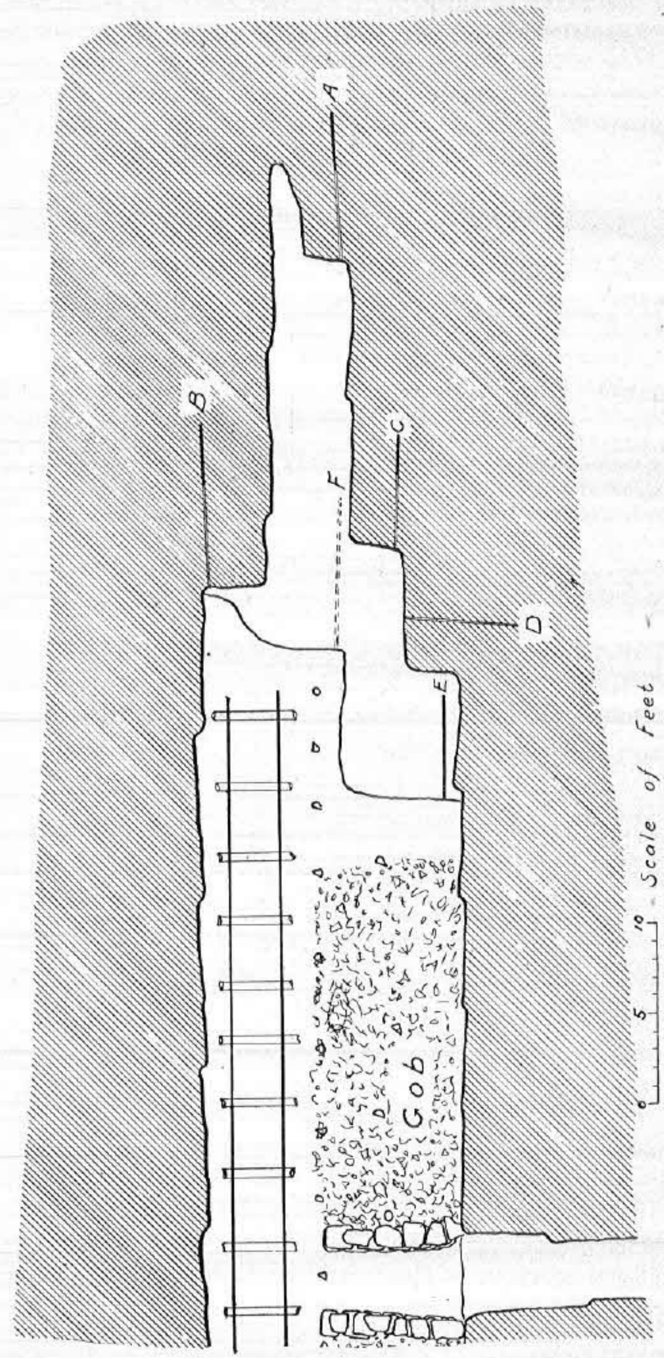


Fig. 16. Plan of an entry in triple-bench coal, Huntington.

Fig. 17. Cross-section of a gob entry at Huntington.

port the cross-bars are called 'hitches.' Very often the coal is too soft or the entry too wide for hitches, and an upright post or 'leg' is set under one or both ends of the cross-bar. Figure 17 shows such a cross-bar with a hitch at one end and a leg at the other.

Rock augers. When the coal seam is too thin to give the hight required for a mule, the entries are usually made higher by brushing them or blasting down the rock over the roadway. The roof at all of the mines in Arkansas where brushing is done is so hard that the holes must be put in with some kind of a 'post-drill.' The commonly used style is that shown in Fig. 19. These are called 'machines' or at times 'Hardsocg drills,' since that firm supplies most of the drills used in this coalfield. The strong auger is fed forward as it is turned by screw threads upon its stem, from which it can be detached for sharpening. The nut or 'boxing' for this feed-screw is supported at any desired hight by any pair of the notches in the post. The general length of the post can be changed to fit the usual hight of the place in which it is to be set, by slipping the 'boot' or pointed pipe at the bottom up and down on the stem. The final fitting for each place is made by the jack-screw at the top, which clamps the entire post into position. If the rock is a little harder than that worked as shown in the Fig. 19, and the drill difficult to turn, a threaded box with beveled cog-wheels in front of it is substituted for the plain nut; and the crank, which has greater leverage on account of the gears, is close to one side of the post, so that the bending strain upon the long feed-screw is reduced. Upon one side of the feed-screw is a channel or keyway engaging a projection or feather on the larger of the beveled cog-wheels so that the bar must rotate with the wheel, but is free to be fed forward by the action of the screw thread.

In still harder rock, a ratchet drill most frequently of the Nixon make is used. The rather indistinct photograph reproduced in Fig. 18 shows this drill in position for putting in a brushing shot near the end of an entry. An iron post with a jack-screw at the end is supplied with the drill to hold it against the rock, but in this case, the miner has, as usual, set up a temporary prop as a substitute for the regular post. The drill operates in the same way as a machinist's ratchet used for drilling holes in metal. When the drill is rotated by the ratchet

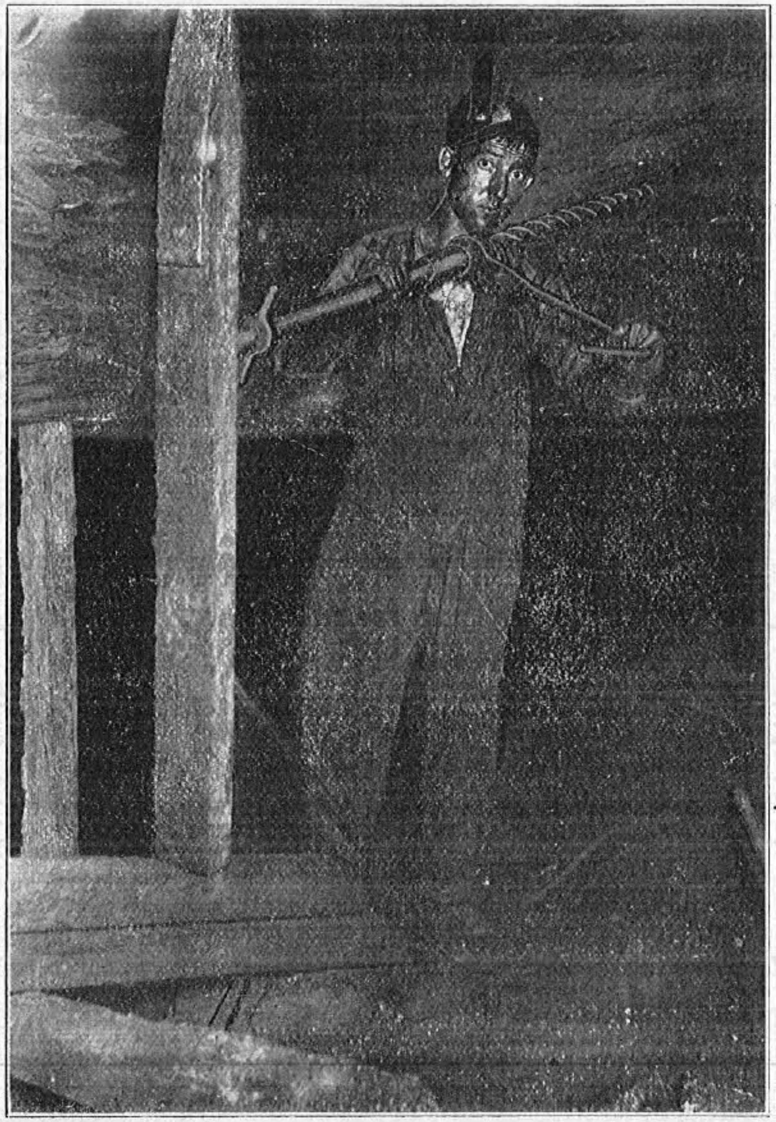


Fig. 18. Ratchet drill putting in a brushing shot in an entry. Mine No. 5, Denning.

handle, the thread bar in the pipe opposite the auger is screwed forward at a rate depending upon the hardness of the rock.

Brushed entries. The holes for blasting down the roof are drilled upward at a slight angle to reach a little more than the required hight above the rail. A single row of shots over the center of the track is enough to break the entire width, and each shot breaks the rock to a sufficient hight for some distance beyond the end of the hole. The rock is usually blasted with black powder, which causes the hole to 'run ahead' farther. Sometimes a stick of dynamite is added to break the rock into smaller pieces if it is hard.

Brushed entries are nearly always wide to provide room in which to pile the waste rock, and that part of the roof which is not to be shot down must be securely propped. A line of 'breaking-props' only 12 to 16 in. apart is set along the edge of the brushed part of the entry to break off the slabs of slate loosened by the shot. These are shown in Fig. 19. If the rock is very hard, a row of triple props, as shown in Fig. 20, p. 51, is sometimes used.

Figure 3, p. 13, is a photograph of a brushed entry in unusually low coal. At the left are shown the heavy breaking-props and the carefully piled waste rock. Figure 19 is an ideal

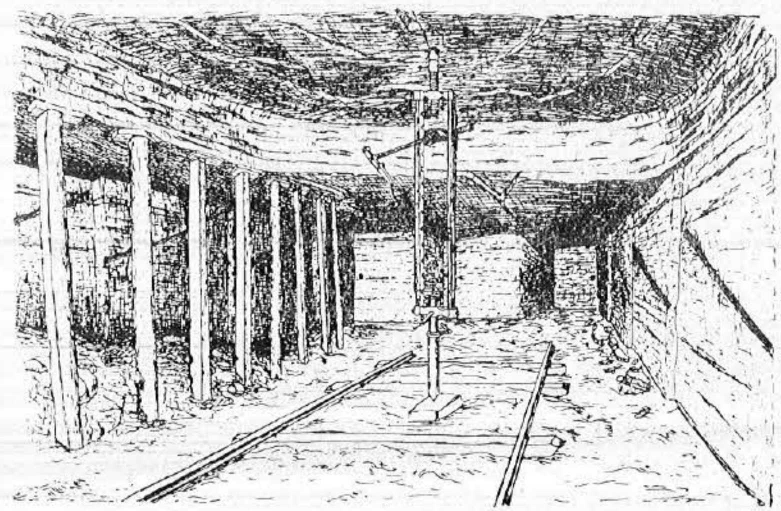


Fig. 19. Ideal view looking toward the head of a gob entry in low coal, as at Denning.

view of a brushed entry in higher coal. This shows also the heading and the cutting. The block of coal to be removed by a back shot is shown upon the left side of the picture, but is somewhat obscured by the drill. A machine used for drilling the hole for the brushing shot is shown in position, and the end of the last brushing shot can be seen in the roof in front of the machine. (For the sake of clearness, the width of the brushing machine has been shown wider than usual and the gob space behind the breaking props is correspondingly narrow.) The rock removed from the roof is carefully stacked up as in Fig. 3, only when there is but little room in which to put it. Quite frequently the roof slate is piled along the roadway in the middle of the entry only, so the air, coming from a crosscut behind it, is carried on to the face of the entry before returning. This greatly helps the ventilation.

Entries at Spadra and Russellville. If, as at some of the semi-anthracite mines, there is enough waste to fill all the space, a 'gob wall' of the larger flat stones is built along the outer edge of this waste, to maintain the passage for the air current. Figure 20 shows the plan and section of such an entry, and also the method of driving it in the hard unexplosive coal. This is the method used in the rooms at these mines. The slanting shot is more heavily loaded than the others, and is fired first, generally breaking the coal as shown. The next day the shots A, B, C, and D, will all be fired. The hole, D, is in the bottom bench and reaches only a foot or so 'into the solid' under the top bench, and is not heavily charged. On the following day after this coal has been loaded into cars, the shot E, a rib shot in the bottom bench under shot B, and possibly another 'opening shot' will be fired. If the middle band is hard rock, that bench which most easily separates from the band-rock is shot first. If both benches are loose, the thicker one is shot first.

Bottom brushing. Instead of shooting down the roof, or 'top brushing,' room for the mules in the entries in low coal can be made by digging into the floor, or 'taking up bottom' as it is usually called. This is also known as bottom brushing. In Arkansas, this is done only when the roof is hard sandstone which can not be drilled by any kind of auger drill.

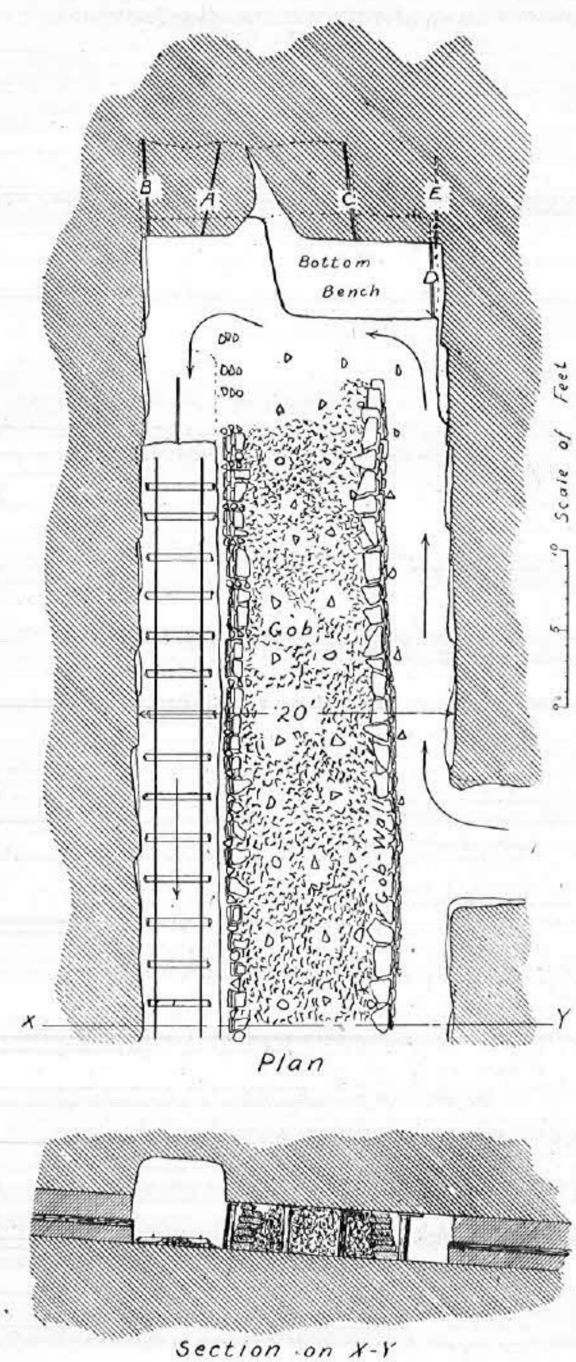


Fig. 20. Plan and section of a brushed entry with gob walls, at Spadra.

DETAILS OF WORKING ROOMS.

Terms used to describe shots. In the soft coal districts, the method of shooting the coal in the rooms varies greatly with differences in the coal seams, and in the skill of the miners. If the hole for blasting is so drilled into the coal that it is parallel to the free face of the coal like the back shots in entries, the shot is said to be 'balanced.' The outer end of the hole is called the 'heel' and the inner end is the 'point' or, less often, the 'toe.' The perpendicular distance from the face of the coal to the hole is called the 'width' of the shot, and the distance along the hole is the 'length.' Some shots are wider at the toe than at the heel and are called 'gripping shots.' A 'splitting shot' is one put into the center of a large solid lump of coal, which has been previously thrown out of its original position by a shot not strong enough to loosen it thoroughly.

Blown-out and windy shots. If there is no free face alongside the hole, or if the shot is so wide the powder can not break the coal, the tamping and more or less of the coal around the heel are blown out like shot from a gun. Such 'blown-out shots' are dangerous to any one in the mine at the time, since they stir up a great deal of dust and then set fire to it by the long hot flame of the burning powder. If the dust is very inflammable, it burns so rapidly that it has the effect of a larger explosion;

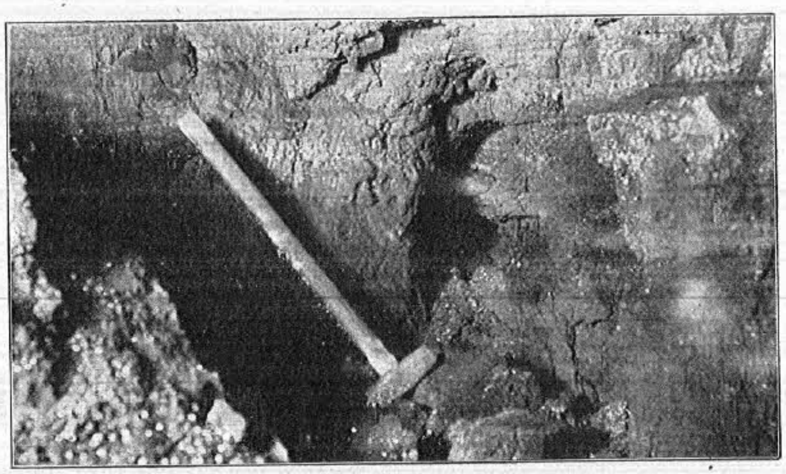


Fig. 21. Blown-out shot at Mine No. 2, Chant, Okla.

and if the mine is dry, this stirs up more dust, so the explosion may spread through the entire mine with constantly increasing violence. Figure 21 is a photograph of a blown-out shot which started a disastrous dust explosion at Chant, Oklahoma.

Usually the blown-out shots in Arkansas cause only a slight concussion, and are one of many kinds of 'windy shots;' but the rush of air is often sufficient to blow out a few stoppings, etc. The force of the concussion is greater and a general explosion is more probable if the blown-out shot has been tamped with coal dust instead of clay or other incombustible material.

Windy shots also occur whenever more than enough powder to do the work is exploded, and much force and flame strike the dusty air after the coal is all blown out of the way. Splitting shots are especially dangerous, and when shots are strongly gripping and heavily loaded, there is also danger that only the heel will be broken and a windy shot produced. Such a shot was fired between shots D and A in the face of the room shown in Fig. 27, p. 59.

Joints in the coal. At many of the mines of this State, there are joints in the coal. These are always in two sets not equally marked and dipping in opposite directions. The dip of the joints varies greatly in different parts of each small mining district, but all of the slips have a direction or strike between north and northwest which is quite uniform throughout the coal-bearing region, and is quite independent of the amount and direction of the dip of the coal seams. They do not extend from one bench of coal into another, nor into the roof or floor, and often dip at different angles in the two benches of a double seam. They are at irregular distances apart and can seldom be seen before they are opened by blasting. The miners call them 'slips' or 'faces,' and they represent the vertical 'cleat' in the coal of some other regions. Figure 17, p. 46, shows the general cross-section of such a lot of joints. Figure 39, p. 86, shows how they open under pressure, and Fig. 31, p. 63, shows how they open after shooting.

When the shot-holes are drilled into the coal parallel to these slips, the shots must be narrow, or the powder may only loosen the slip and cause a blown-out shot. A shot like C in Fig. 24 would probably blow out. When the shots are placed across the slips, there may be a strong slip near the inner end of the tamping in the hole. Then, if the shot is balanced, only the toe breaks. This produces a windy shot like that shown at B, Fig. 22, to avoid which these holes are rather strongly gripped

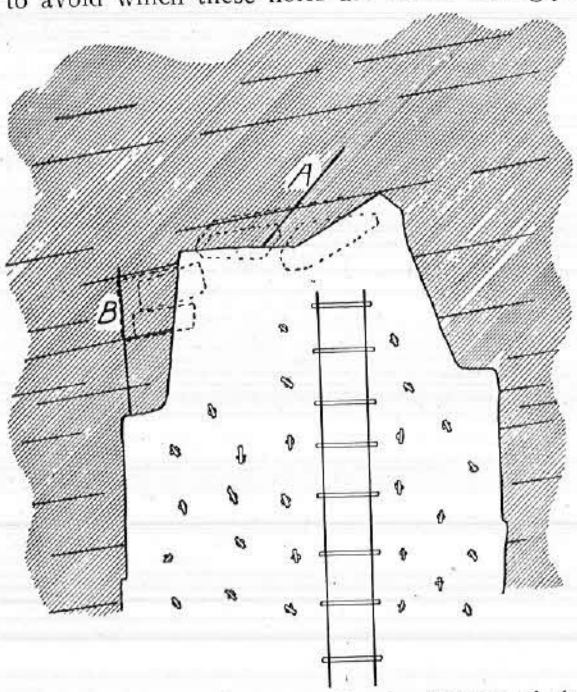


Fig. 22. Plan of the face of a room showing failures of shots caused by strong slips.

as in Fig. 23. The powder sometimes kicks back along these joints and leaves a portion of the hole unaffected as shown at A, Fig. 22.

Ordinarily, however, the presence of slips is an advantage, because they lessen the amount of powder required to loosen the coal. The coal is not so badly shattered, and has less tendency to fly across the room and break out the props, when slips are present than when there are none. When the joints are even slightly opened, the coal is easily mined by picking loose the narrow end of the wedge-shaped pieces of coal between them until the entire wedge falls out. When the seam is thick, these masses may, however, fall and catch the miner. A few accidents each year are caused in this way.

Placing of shots when slips are present. In advancing a room face, the miner tries to arrange his shots so that each one will leave the face in good shape for another one, or 'make a good chance for it.' This generally requires a number of gripping shots, and is fairly easy when the joints have a convenient direction. Figures 23 and 24 show two general systems of placing shots, when the joints are nearly parallel to the direction of advance. In Fig. 23, the holes cut across the slips. This

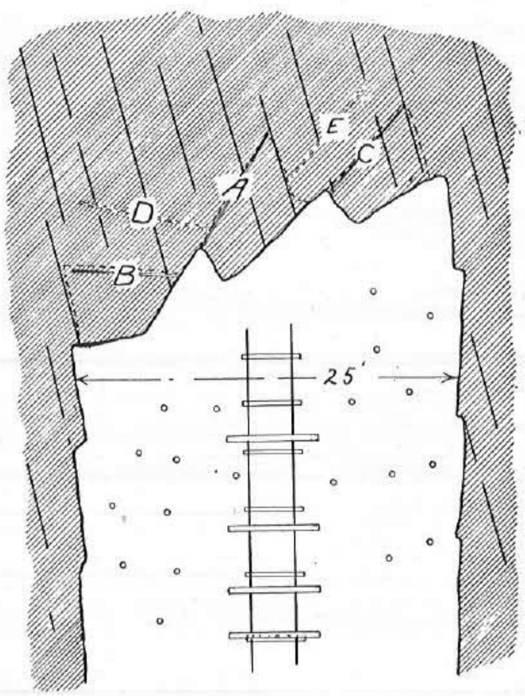


Fig. 23. Plan of the face of a room showing method of placing shots across slips which are parallel to the room.

plan was formerly much used when the miners tried to get lump coal only, but now since the companies have been compelled by law to pay the miners as much for slack as for lump coal, the tendency is to shoot the coal entirely out, so no picking will be needed. Much coal will then fly some distance from the face, and with holes like those in Fig. 23, this coal will fly down the room next the rib. This leaves the coal far from the car and also breaks out many props. Therefore, the arrangement shown in Fig. 24 is the more common. This throws all the

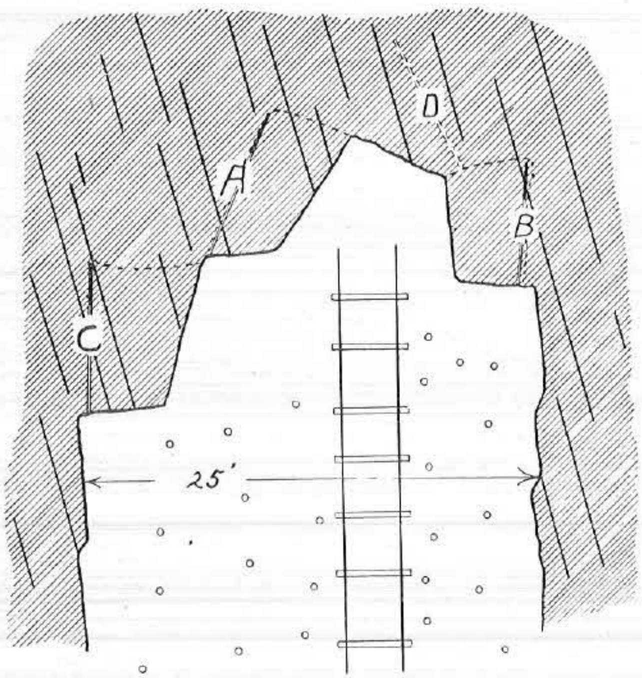


Fig. 24. Plan of the face of a room, showing careless method of placing shots parallel to the slips to throw coal towards the track in the center of the room.

coal toward the track, into a space in which props are seldom needed. It does not produce as good coal, but that affects only the profits of the company. The blasting is more dangerous to the man who fires the shots, but as fewer props are knocked out, it is less dangerous to the miner who puts in the holes and does not have to blast them. The first opening in front of the track is made by a series of gripping shots as shown in Fig. 22, in which shot A is the second of such a series.

When the slips run across the room, there is commonly little trouble in arranging the shots; but when an unusually open slip is in just the right place, it spoils an opening shot, as shown in Fig. 22.

At Coaldale, the slips dipping to the west are unusually well marked and do not cut square across the entries. The shots may then break beyond the cutting, or not as far, depending upon which side of the heading the cutting is made. This is shown in Fig. 25 and 26 which show the effect of these slips upon two successive cutting-shots. The miners, therefore, put in the

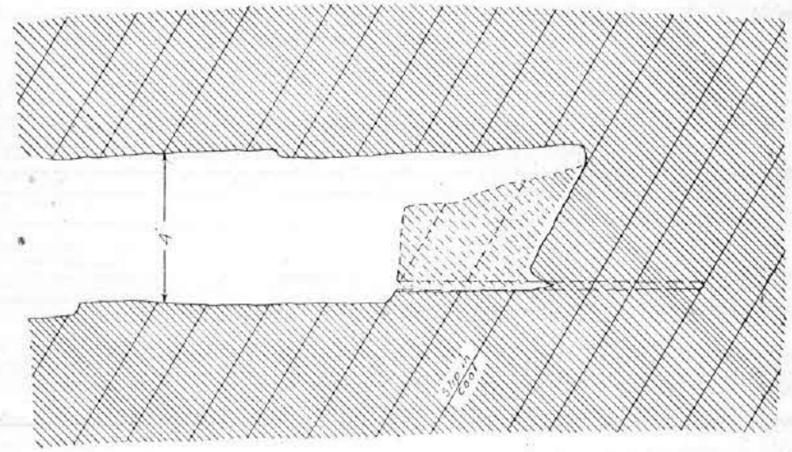


Fig. 25. Plan of an entry-heading at Coaldale, showing the effect of a strong slip inclining backward from the end of a cutting.

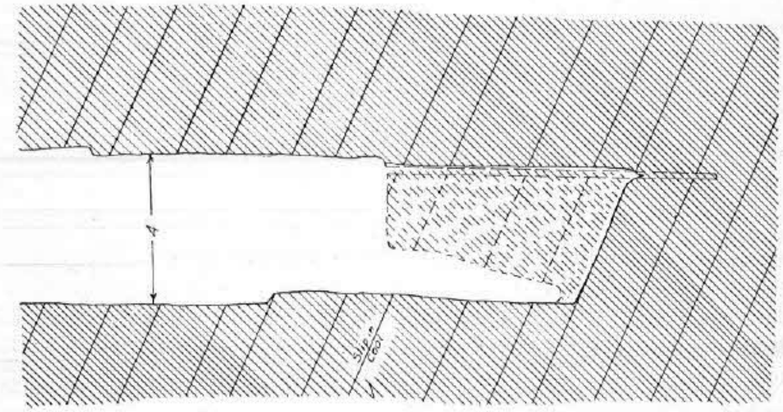


Fig. 26. Plan of an entry-heading at Coaldale, showing the effect of a strong slip inclining forward from the end of a cutting.

cutting shots farther into the solid on one side of the heading than on the other. In the rooms at Coaldale, the slips are generally handled as shown in Fig. 23.

Mining of shots. If there are no noticeable slips and a gripping shot will only break the coal at the heel or outer end, some of the soft middle band or dirt beneath the coal is picked out before blasting, so that the solid part of the shot will be narrower at the toe than at the heel. Such shots are said to be 'mined.' Both the opening and the soft band in which it is made are called 'minings.' It so happens that nearly all the coal of Arkansas except that at Spadra, contains either a soft mining or an abundance of slips. When this mining is thin, the miner first cuts out 2 or 3 in. of the dirt as far as he can easily reach with his pick, and when the mining must be more than 10 or 12 in. deep, he widens it by 'snubbing,' which means picking down the lower layers of coal. On account of the labor needed, this mining is rarely done. Figure 27 shows an extreme case.

Cutting in rooms. Occasionally very tight gripping shots are helped by a cutting or 'shearing' as shown in Fig. 28. Usually, however, the miners put in a gripping shot to crack the coal and then another short shot next day to throw it out and open up the face. If the minings shown in Fig. 27 were omitted, it would represent such a room. If the second hole, A, Fig. 27, is too deep, a windy shot is caused by the powder blowing out through the crack. Cuttings in the side of the entry should nearly always be made in turning a room neck, to avoid danger to the shot-firer. Crosscuts when required to be made should first be shot through the heel of what could be made a rib shot, as shown on successive days at D, Fig. 16, p. 45, and A, Fig. 28.

Deficient coal. The coal is sometimes stuck tight to hard top or bottom rock, and is difficult to shoot loose. This is called 'frozen coal,' or 'stuck top' or 'stuck bottom.' At a few mines, the coal in places is in distinct layers or 'seamy.' When the powder is in one of these seamy places, it sometimes blows out through a seam, so the coal is hard to get without two more shots. The miners call this 'squeally coal' from the noise the shots make. Large masses of pyrite or 'sulphur balls' prevent the shots from

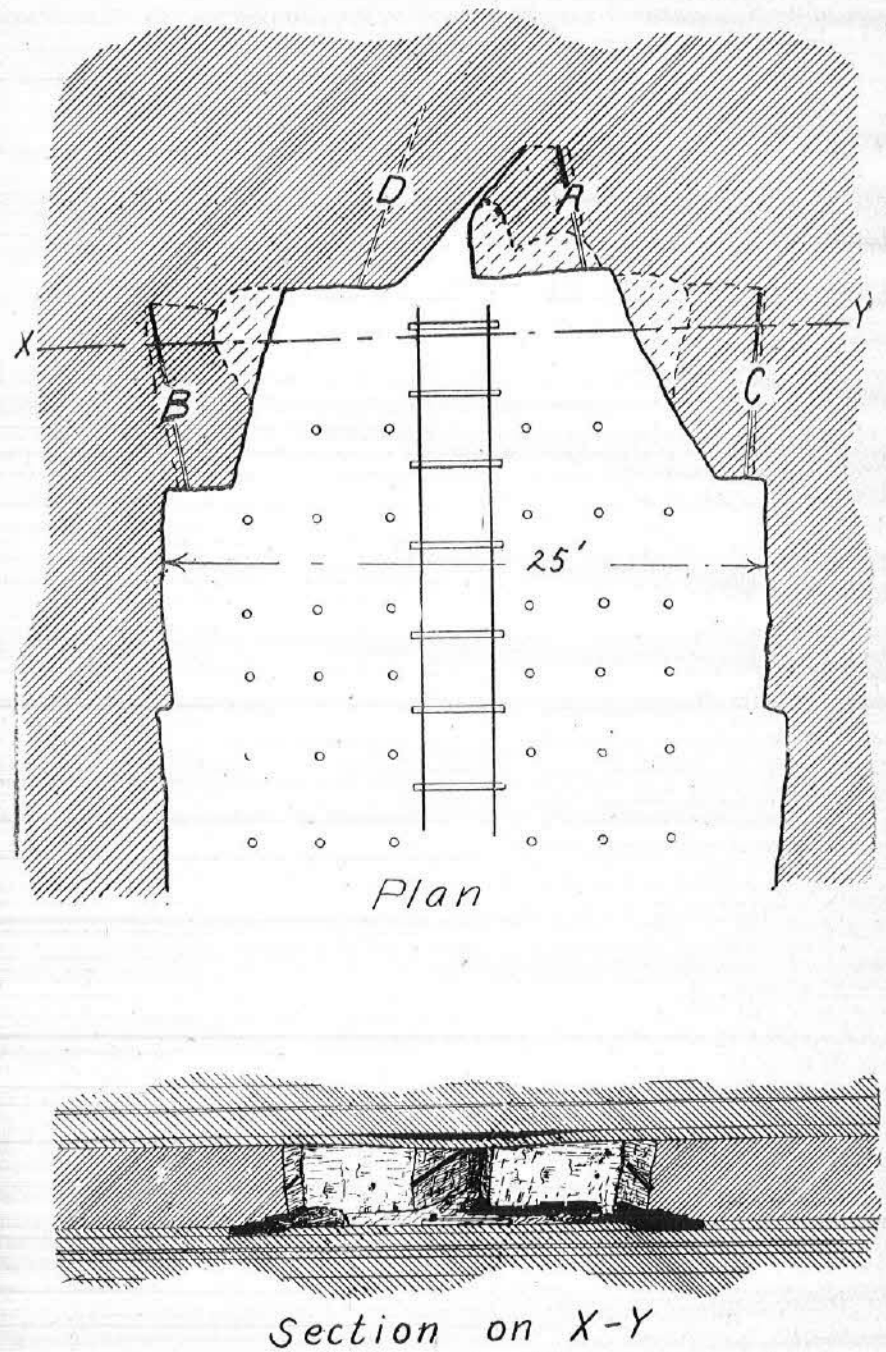


Fig. 27. Plan and section of a room in which the coal has been 'mined' before blasting.

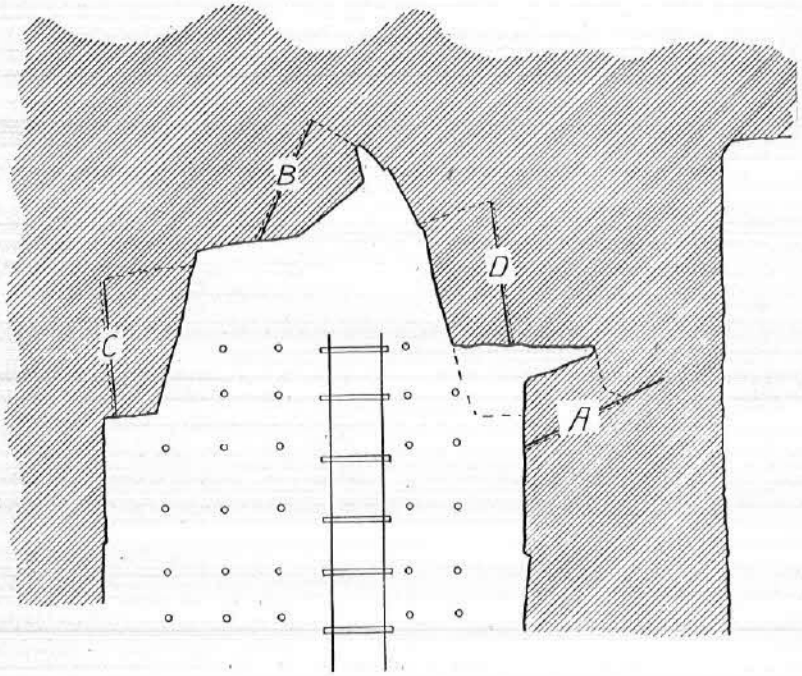


Fig. 28. Plan of a room in which strong coal has been cut before blasting. This shows also the second shot of a crosscut or break-through.

breaking the coal, but are especially objectionable because they can not be drilled by the breast auger, and a miner must sometimes try several places before he gets a hole in deep enough.. These conditions, as well as low coal, generally make 'deficient coal,' for the digging of which the miners get extra pay.

Good-shooting coal. In parts of the Denning field, especially, the coal is hard and more elastic than the average of this State. If, in addition to this, the slips are close together, less than the usual amount of powder then shakes the coal loose, and it is very easily picked down, in case the lumps can not be pulled loose by hand. Little slack is produced. Such coal is known as 'good-shooting coal,' and the practice of 'shooting it off the solid' in the ways described, without any pick work to prepare the shots is less objectionable. Fig. 29 shows the result of a fairly successful shot in such coal. The hole was drilled just to the left of the shovel handle and the explosion of the

Fig. 29. The result of a shot in good-shooting coal at Mine No. 5, Denning.

powder opened up the slips, as shown. In this case a little more powder would have given a better result. The figure also shows the gray streak of band rock, some of the miner's tools, and the typical cap and lamp. Some of the Denning coal is too seamy for good shooting, and the variation is often abrupt.

Woody coal. Unfortunately, much of the Hartshorne coal in Arkansas is inclined to be what the miner calls 'woody' because in extreme cases, its texture is much like that of somewhat rotten pine wood. The point of a sharp pick sinks into it quite readily; but when an effort is made to pry off a chip by raising the pick handle, the coal merely crumbles enough to release the pick and very little progress is made. In such coal, the shock of a blast sets up little vibration and does not open the seams and slips. Instead, a large mass of coal is often pushed several inches from its position and remains wedged between the roof and floor almost as firmly as ever. Fig. 30 shows such a displaced mass of coal and also the two benches in the coal. All such coal should be undermined as shown in Fig. 27 before it is blasted, especially where a slight decrease

Fig. 30. The result of a heavy shot in coal free from slips. Slope No. 2, Russellville.

in the distance between the roof and floor will cause the coal to wedge tight after shooting.

Where there is a soft mining band in the coal, as in Fig. 30, or under it, some miners do mine the coal more or less when the shots are wide. Where there is no extremely soft mining, this pick work is almost never done. Some miners claim that it is harder to mine this inelastic coal than the 'lively' coal of other regions. Most of those who have ever undermined ordinary hard coal admit, however, that the softness of the Arkansas coal makes it unusually easy to pick, and the reason for not doing it, is simply the greater ease of putting in enough powder to

blow out the coal without pick work. The softness of the coal makes the drilling of shot holes remarkably easy when compared with the labor of drilling the lively coal. This tempts the diggers to put in more shots instead of mining their coal. As a compromise, many pit bosses request the miners to use only narrow shots. The soft Arkansas coal is especially suitable for undermining by the chain type of machine, as will be discussed later.

WORKING COMPOUND COAL SEAMS.

Working double-bench coal seams. When the coal is in two benches of nearly the same size, separated by a loose middle band, the operators generally require, as far as possible, that the upper bench be mined by some one of the methods shown in Fig. 22 to 28. The bottom bench is then loosened by three light shots, first in the center and then next each rib. After the top coal is loaded out, the dirt is cleaned off the lower bench, immediately if it is soft, or after it is broken up by blasting the bottom coal, if it is harder. If the roof is good, this plan of shooting the top coal first is the safest as well as the cleanest way, for there is less danger from falls of coal.

Figure 31 is an ideal view of a room worked in this way, when there are three benches in the coal seam as at Huntington.

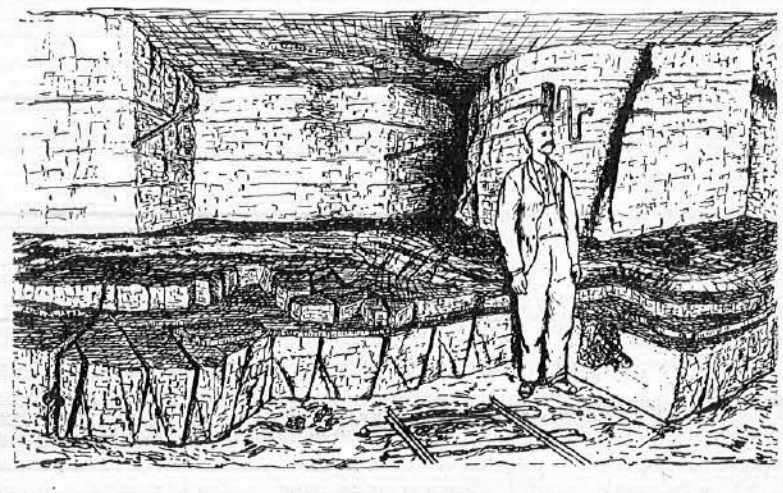


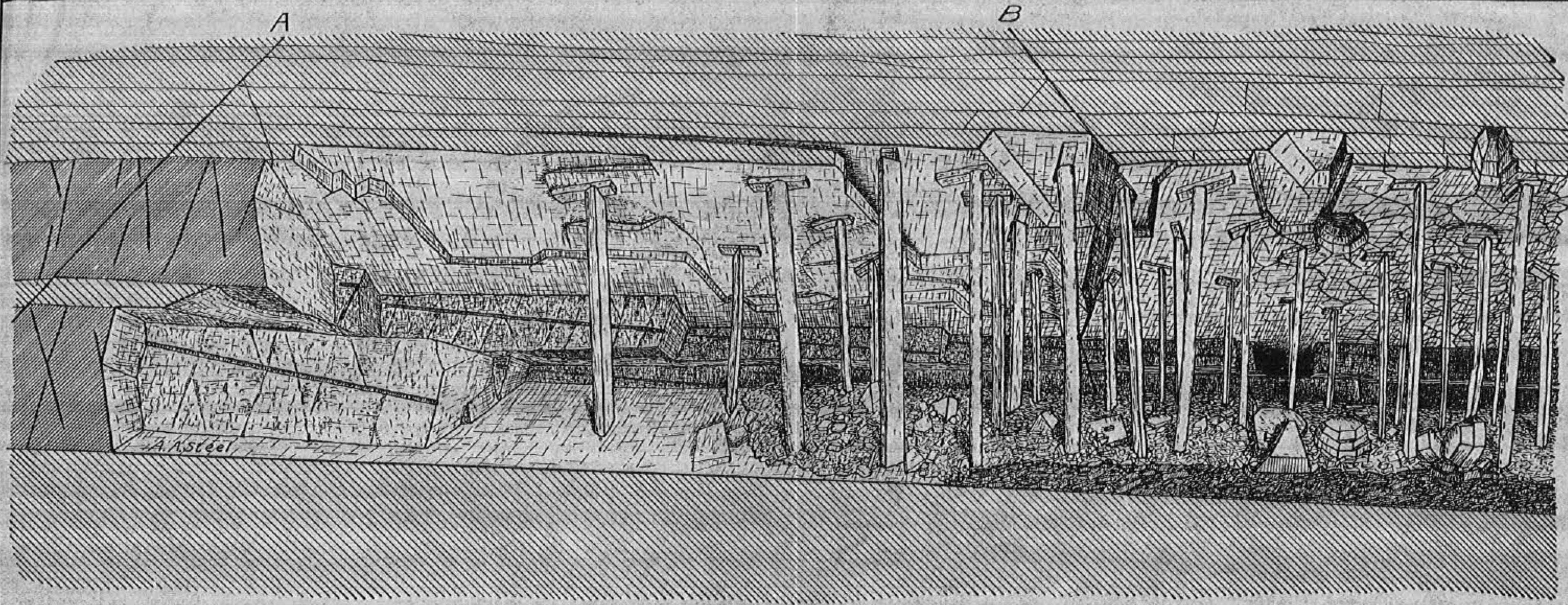
Fig. 31. Ideal view of the method of working rooms at Huntington so as to produce the cleanest coal.

The little heaps of loose coal and slack always found in the rooms have been omitted for the sake of clearness. This gives the room too neat an appearance. In this room the main dirt band is soft and easily handled, but the bottom band is hard slate and has been broken up by blasting the bottom bench of the coal. The effect of a good shot in opening up the joints in the coal has been exaggerated to show the joints more distinctly, but the way the hard band rock is knocked loose is the ordinary result of proper blasting. The figure shows how the opening shots are arranged in the upper bench and the result of wedging up the 6-in. coal. The miner's auger just behind his head shows the position of the next shot in the top bench.

Shooting bench-and-bench. If there is little difference in the thickness of the two benches of the coal, the more skillful miners prefer to shoot the coal so that each bench is alternately half the depth of the holes, or 3 or 4 ft., in advance and behind the other. This has the advantage that nearly any sort of hole breaks the coal; also, it is the safest if the roof is poor, because the final props can be kept nearer the face. The miners do not like to set temporary props between the roof and bottom bench, which may be necessary if the top bench is shot far in advance of the bottom one. It has the disadvantage that much of the middle band must be picked out piece by piece as the coal is loaded, and the fine pieces of the dirt are sure to be mixed with the coal. This method is called 'shooting bench-and-bench.' Plate VII shows a longitudinal section of a room worked by this method.

Shooting the bottom bench first. Some few miners prefer to shoot the bottom bench out first if it is thick enough. This system gets the top coal out in large sound pieces and generally requires the least powder; but it produces the dirtiest coal and is on the whole the most dangerous, unless the top bench is too thin to shoot well alone.

Top bench frozen to the roof. At some mines, the top bench coal is only 6 to 10 in. thick, and the bottom must be shot out first. When the thin top bench is stuck to the roof, the parting is easily picked down and thrown back. When the upper bench it not more than a foot thick and stuck tight to the roof, it is customary to shoot it with only enough powder to jar it loose,



Ideal section of a room worked 'bench-and-bench,' showing different kinds of roof.

so that it can be readily wedged down. If enough powder is used to throw the coal down, only a little patch near the shot is broken, and all the rest of the top bench is left as firmly attached to the roof as ever. In one of the mines at Russellville, the top bench of hard semi-anthracite coal is only 7 in. thick and tightly fastened to the solid roof. At this place, two shots, each containing only 2½ in. or ¼ pound of powder, are sufficient to loosen a strip of the top coal 8 ft. wide across an 18-foot room. Figure 30 shows a little of such a thin top bench which has been left by the firing of only one shot in the lower bench coal since all the over-hanging coal was taken down.

Loose top-coal. Sometimes there is a smooth seam or parting in a single bench of coal near the top. If the coal above this slip is strong, it will hold up clear across the room, even though it is not stuck to the roof. It is customary to get such top-coal by cutting it loose next to the pillars and allowing the coal in the middle of the room to fall by itself. It is more certain to fall easily, if it stands long enough to swing loose like the slate shown in Plate VII and Fig. 27. The miners, therefore, wait as long as they think it safe before they 'shear' the roof coal loose and, unfortunately, many are hurt while working under it, although seldom fatally. Any draw slate in the room will fall with the roof coal. Such a band of top coal is shown

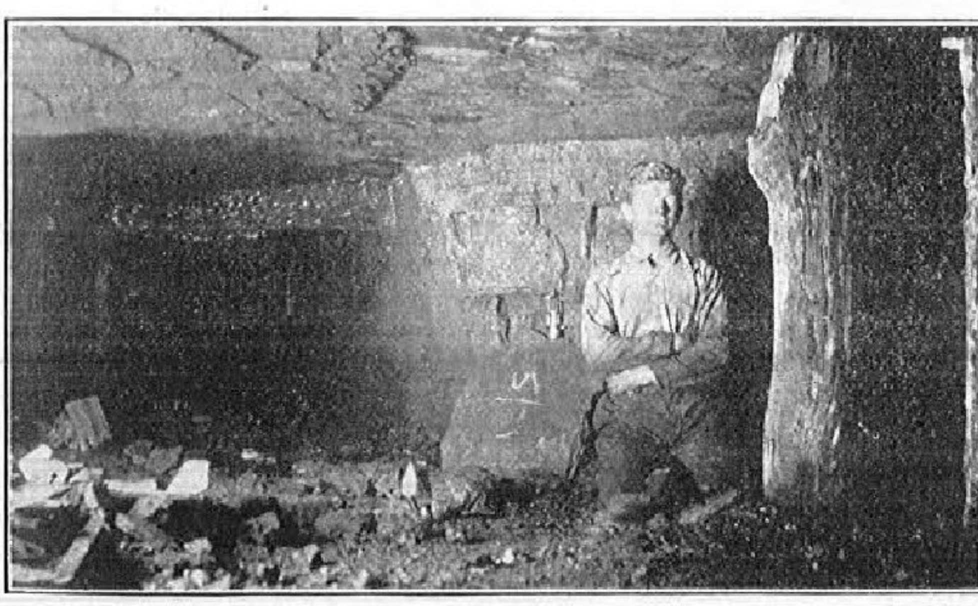


Fig. 32. Top-coal in a room at Mine No. 2, Denning.

in Fig. 32, which also shows a little brushing in the entry at the mouth of the room.

Wedging up bottom. At Mine No. 17, Jenny Lind, there is a smooth seam in the bottom bench 20 in. above the floor. The shots are generally put in the dirt parting between the two main benches, and break the top and 'top bottom' together. The 'small bottom' below the lowest seam is sometimes cracked by the shot but is usually undisturbed. It is quite full of slips and contains no hard bands. The miners, therefore, find it cheaper to wedge up this bottom than to shoot it, and of course the coal is better, if it is only wedged.

Use of sprags in blasting at Coaldale. At Coaldale, the same method would seem advisable. Here only the upper 5 ft. of coal seam is mined. In this, are two narrow soft dirt streaks, but no distinct shale parting; and at 2, 4, and 24 in. from the bottom are perfectly smooth and free seams along which the coal separates. Below the upper 5-foot bench of coal which is mined, is a layer of very soft dirt or 'rashing' 3 or 4 in. thick; below this is a few inches of sulphury coal, or the '6-inch seam,' and then the main parting of several inches of shale, clay, and bony coal. The bottom bench varies much but is said to average about 18 in. thick.

The roof is very soft and must be kept securely propped. For this reason, the rooms are only 18 ft. wide, and because the coal dips between 12 and 14 degrees, they are driven up diagonally with a track along the lower rib. Over the roadway, at intervals of 2 or 3 ft., are set light cross-bars from a hitch in the coal at one end to a 'leg' at the other.

In the entries, the bottom coal is always mined separately, but in the rooms, the miners load the holes heavily in an effort to break the coal clear to the bottom. Since the coal shoots very easily, this overloading causes it to fly badly. The steep dip of the rooms gives added force to blows against the props. The bottom dirt must, therefore, be removed, and the props set in a hole dug 3 or 4 in. into the bottom coal. They are set in these nearly vertically; so, as long as the bottom is secure, the blows of the flying coal will wedge the top over and make the props more nearly perpendicular between the roof and floor. This sets them tighter and prevents the loosening of the roof.

The props must, however, be set so close to the face of the room that the blasting of the coal often knocks them out. Therefore, to prevent all possibility of the props being knocked out and the roof falling, the miners are required to set one to three 'sprags' against each shot. As used here, a sprag is a long and heavy prop, the lower end of which is set well into the floor coal in front of the drill-hole, and 12 to 15 in. from the coal face, while the top is wedged against the roof next the coal face. As many wedges as possible are driven between the roof and the sprag to make it more secure. Figure 33 shows the

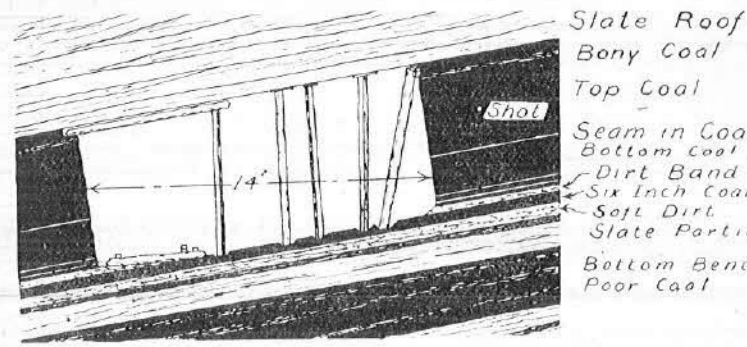


Fig. 33. Cross-section of a room at Coaldale, showing seams in the coal and the method of setting sprags and cross-bars.

different parts of the coal seam at Coaldale and the method of setting props, cross-bars, and sprags. The shot always either breaks the sprags or knocks out the bottom, but this pretty well stops the larger masses of coal, which then roll gently down against the nearest props without disturbing them. The shot-firers are not allowed to load and fire any holes which are not properly spragged.

The heavy blasting also loosens some of the dirt below the bottom coal. During the time the coal was shoveled up from this dirt, so much of the dirt was mixed with the coal that it became unsalable and the mine was once compelled to shut down. To avoid this, at the last short 'run,' each digger was required to have all of the exposed bottom dirt shoveled back out of the way before the shot-firer would light his shots. Although there was no great objection to this severe discipline, it would seemingly be better to accomplish the same result by using only light charges of powder and shoveling the loosened coal of the upper part of the seam off the clean bottom. The bottom would then have to be wedged up, but it is so loose and full of slips that this labor would be little if any greater than that required for the setting of sprags.

If the bottom were left for some distance from the face of the upper coal, too much roof would be left without support. For this reason it would be necessary to see that the bottom is taken up and props set, after each shot. In this case, the support for the roof would be as good as that afforded by the present method, and the roof would not be so greatly weakened by the shattering effect of the heavy blasting.

GENERAL METHODS OF BLASTING.

Number of shots per day in each room. Each shot gives off some combustible gas and stirs up dust, and in order to lessen the danger of starting dust explosions, the miners in the soft coal mines very seldom put in more than two heavy shots at once. These are generally some distance apart, so that the coal will be distributed along the face. In all the plans shown in the figures, shots A and B may be fired one day, shots C and D the next, and so on.

Two large shots, if successful, give the miner all the coal he can load in one day, for besides turning out the coal and shovelling it into the car, he must pick the coal down, set props, help the driver with the cars, prepare shots for the next day, pull down draw slate, throw this and any other waste back upon the piles of gob, and occasionally lay track.

Shot-firers. Because of the great loss of life if an explosion should occur while all the miners are in the mine, nearly all the soft-coal mines have two or more 'shot-firers,' who light the shots at their own risk, after all the other men are out of the mine. As the work is easy, requiring only 2 to 4 hours, and the pay is good, there is seldom difficulty in getting shot-firers. Unfortunately, a few of the miners are not as careful to avoid putting in dangerous shots as they would be if they had to do the firing themselves; but the shot-firers are allowed to skip any shot they think dangerous.

When the dust of the mine is explosive, many shot-firers load the cutting shots themselves so that they can tell just what effect

the shot will have, and avoid dangerous shots. In this case, the miner merely prepares his cartridge and dummies, and leaves these with the tamping bar next to the hole he has drilled. This extra work is seldom thought necessary by the shot-firers who work in Arkansas. At some of the Oklahoma mines all shots are loaded by the shot-firers, who go around the mine in pairs to assist each other.

In Arkansas, the shot-firers are required to charge the few holes in which there is much water. If the hole is wet, the digger smears his powder cartridge well with soap. If the shot-firer then works rapidly, the hole will be charged and tamped, and the powder exploded before it is injured by the water. If the coal gives off gas, some miners plug the end of each wet hole so that the pressure of the gas will keep out the water until the shot-firer charges the hole. Whenever possible the diggers prefer to charge their own holes, and often complain that the shot-firer does not tamp them properly. Another reason why they object to leaving this work to the shot-firer is that careful shot-firers will often fill up the end of holes that are dangerously deep or will not use all of the powder the miner puts in the cartridge if they think the amount excessive. This changing of the shot does not give the digger as much easily shoveled coal as he wants, or else requires a little extra pick work.

To save time, the shot-firers require the miners to flag their shots or to fasten a piece of paper upon the fuse of each shot, so they can be readily found. Each miner also puts up at the room-neck or crosscut, through which the shot-firer enters his room, a piece of blasting paper on which is marked with greasy coal dust a large figure indicating the number of shots in the room. The shot-firer pulls this down and if another one is not put up in its place next day, he does not then go into the room.

Precautions in firing shots. The fine coal dust and explosive gases, produced by blasting, follow the ventilating current from room to room in the mine. To prevent the ignition of this mixture by the flame of a succeeding shot, which may blow out, the shot-firers begin blasting at the 'last of the air' of each split, which means the working place nearest the return airway. They then work toward the intake, or 'fire against the air.' This permits those shot-firers who charge the shots to work in pure air. It also causes the shot-firers to be most quickly reached by the current of fresh air or by a rescue party, in case of a small dust explosion which is chiefly limited to the rooms full of dust and smoke. A severe dust explosion will spread both ways through all the dry parts of a mine, and consume most of the oxygen in it, and the shot-firers run a great risk of suffocation, regardless of the way the shots are fired.

In case experienced shot-firers are caught by such an explosion and not immediately disabled, they grope their way to the nearest pool of water and lie down close to it until reached by rescuers. The water dissolves some of the poisonous powder gases and much of the carbon dioxide of the afterdamp. These are removed from the air and the proportion of oxygen is therefore increased next to the water. Since they are lying still, the shot-firers can live for hours under these conditions. If the explosion attracts attention at the surface of the mine, the officials can tell about where the shot-firers are by knowing the time at which they usually finish each entry. The current of fresh air is therefore first directed to that part of the mine by means of temporary canvas stoppings put up as rapidly as the fresh air they direct into the mine permits the rescue party to enter.

The danger to the shot-firers is further reduced by lighting the shots in but one room at a time and waiting until these explode before lighting any others. In this case, the shot-firers put in the time charging the holes. To avoid the risk of injury from a shot which may break through the pillar separating adjoining rooms, and also to escape the concussion of the slightly windy shots, the careful shot-firers leave one room between that in which the fuses are burning and the one in which they are working. This is commonly done by not lighting the shots in the first room until the holes in the second room also are charged. Then the fuses in the first room are lit and the shot-firers charge the holes in the third room. After this is finished and the shots in the first room have gone off, the fuses in the second room are lit and the shot-firers charge the holes in the fourth room, and so on. This plan is a little easier than that of going directly from the first room to the third and charging the holes in the second room after those in the first one have exploded.

In case the fire of a windy shot in the first room spreads through to the second, it may light the exposed heavy charges of powder the miner has prepared. This will add to its violence and increase the chances of a general dust-explosion. Therefore, the common method of charging shots in two rooms before any are lit is safer because there is no exposed powder in the rooms on either side of that in which the shots explode. The supply of powder belonging to the miner is kept in iron kegs of not more than 25 pounds capacity or occasionally in small iron 'powder jacks,' or special buckets. In addition these are enclosed in a strong wooden box and the whole is kept in the neck of the room or an old entry crosscut far from the actual working face. This powder is therefore ignited only in cases of severe general explosions.

Carelessness in firing shots. In contrast with the careful methods outlined above, most of the Arkansas shot-firers use little care. In order to reduce the time required to get to all of the shots, each of the reckless shot-firers goes through certain entries alone while his partner is firing shots in others. With the ordinary coursing system of ventilation common in the Arkansas mines, the 'last of the air' is near the entrance to each entry. If then the shots are fired 'against the air,' the shot-firer has to walk out from the last working place through an entry full of smoke. Each shot-firer, therefore, goes to the end of the entry through the rooms in which the miners have already charged the holes. He finds all the shots and cuts the ends of the fuses so that they can be lit with a minimum of delay. Those in the entry air-course are lit as soon as reached. All the others are then fired 'with the air,' as rapidly as possible while the shot-firer runs through the rooms in an effort to 'beat the smoke out.' In the less dangerous mines, he will even light shots which he knows will blow out a stopping or two because he expects to reach a place of safety before the fire in the fuse reaches the powder. The entries nearest the 'last of th air' are fired first, so there is less danger of an explosion spreading through the mine. There is in cases some danger to the other shot-firers but the routes of the men are laid out to reduce this. Where such methods are possible, there is little necessity for the employment of shot-firers.

In order to have more time in which to beat the smoke out when firing shots in this careless way, these shot-firers request that the speed of the ventilating fan be reduced to decrease the velocity of the air current and its cloud of smoke. Some careful shot-firers make the same request because a reduction in the velocity of the air is supposed to cause the dust suspended in the air current to settled out and so reduce the danger of a dust explosion. The velocity of the air current is very low in most of the Arkansas mines at all times and the writer is of the opinion that the little dust which might settle out is a negligible factor in comparison with that stirred up by blasting and the concussion of a windy shot. Slowing down the fan increases the proportion of firedamp in the air and the practice should be prohibited when shots are fired against the air as they should be.

Decreasing number of shots. The average amount of coal dislodged by each shot is increasing from year to year, and the number of shots fired per day is decreasing, until, at present, many miners put in only one heavy shot in the afternoon, instead of the former two or three light ones. The heavy shots are both wider and longer than those formerly used, and in order to put them in, the miners buy augers averaging 2 ft. longer than those used in the same district eight or ten years ago. The amount of powder in each shot is increasing even more rapidly than the amount of coal brought down by it, so that in 1909, 13 per cent more powder per ton of coal was used than in 1905. This change reduces the miner's labor and is largely the result of the law which compels the company to pay as much for crushed coal and slate as for good lump coal. The heavy shots greatly increase the danger of explosions due to windy shots.

LONGWALL MINING AT BALDWIN.

Details of pick mining at Baldwin. The details of getting the coal at the longwall mines of Baldwin are pretty well shown in Fig. 12, p. 36. The miner can not even crawl into the workings, but must drag himself at full length. He lies upon his side and picks out the hard clay or soft shale from under the coal, by horizontal blows of a pick weighing about 2 pounds. From time to time the cuttings are raked out with the pick and shoveled upon the piles of the gob shown in the rear. When

the cutting is 18 in. or 2 ft. deep, the coal is wedged down by driving above it two or three long steel wedges like that shown sticking above the coal. This brings out the coal in large, nearly cubical blocks, with less than 5 per cent of slack, since the coal is naturally blocky. Before powder became so cheap, all coal was undermined in this way. The miner lay upon his side no matter how much hight there was. His shoulders and elbows were soon calloused, and old miners do not complain of the position. Except where the coal was thin and blocky, it was customary to bring it down by very light shots, but this only required from one-fourth to one-eighth the amount of powder which is now used, and made but little slack.*

Width of rooms at Baldwin. The low space at Baldwin is a great annoyance in shoveling the coal out to the entry so the large lumps are pushed rather than shoveled. At one room visited, the extreme distance from the side of the room to the track in the center was 30 ft., but the miners usually prefer to have the sides of the rooms only 20 ft. from the track. If the room is narrower than this, the labor of extending the roadway is too great for the amount of coal obtained.

Building pack-walls at Baldwin. The track and brushing are kept as near the face as possible, so the car will be nearer and more easily loaded. Enough room must be left between the face and the first breaking-prop next the roadway to get out the coal, and the pack-walls can be carried up as far as the brushing. After the rock is shot down, the miner throws it back from the roadway as far as necessary, and does not begin to build the wall until the edge of the dirt pile gets too close to the track. Then as fast as the wall is raised, dirt and as much fine material as possible is packed in behind. Practically the entire space for 5 or 6 ft. on each side of the road is packed full by the time the last stones of the wall are wedged in under the roof. The shots over the road generally break out the rock in flat slabs, which are very easily piled up. Unfortunately,

*Information has been received that a mine has been recently opened at Excelsior where the coal is 30 in. thick, but the rashing under it is so soft and the coal so blocky that the regular miners consent to get it out without the use of powder, by mining and wedging. They do this for the low price of 80c a ton, loaded upon the pit car. The writer has as yet been unable to visit this mine.

the appearance of these rock walls is not very well shown by the illustration.

MACHINES.

Punching machines at Paris. At Paris, some of the coal is only 20 or 21 in. thick, and it is difficult to get a sufficient number of miners to work in it. Since the shale under the coal is too hard to be dug out by hand, as at Baldwin, Ingersoll-Rand 'punchers' like that shown in Fig. 34 are used to dig out shale

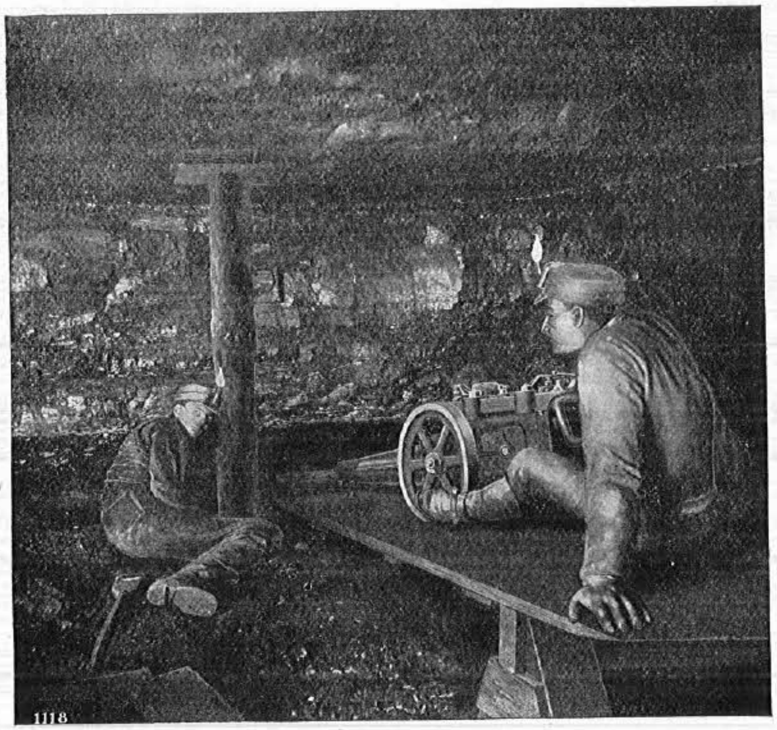


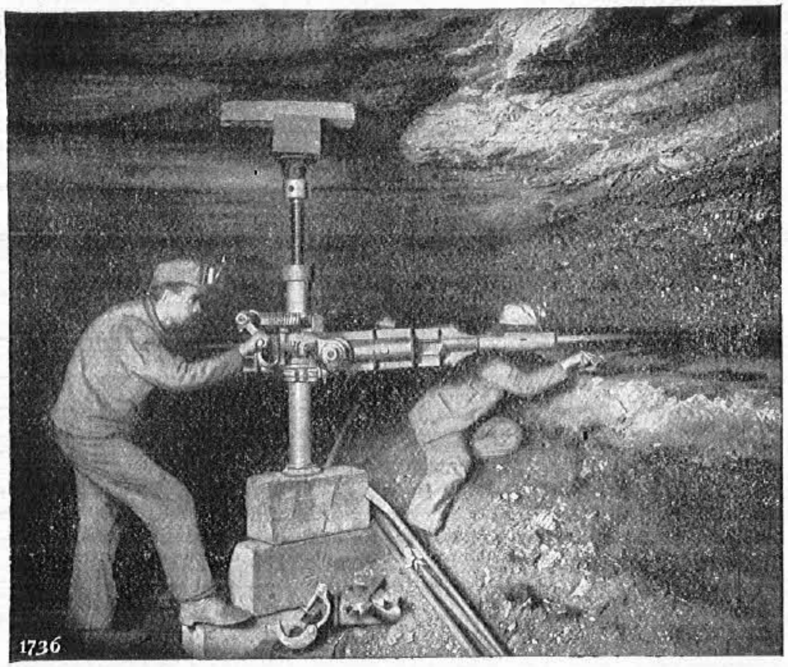
Fig. 34. Ingersoll-Rand puncher, as used at Paris. (By courtesy of the Ingersoll-Rand Drill Co.)

enough to give sufficient hight for the miner. The double-pointed pick is driven forward with great force by compressed air and returned, some 280 times per minute. The block under the wheel takes the recoil of the machine. With these machines 10 in. of the shale bottom is taken up and the coal is undermined to a depth of 4 ft. Figure 39, p. 86, shows rather clearly how

much clay is removed. Some of the coal has been taken from the pillars by the pit boss after the machines were stopped during the suspension of mining. The shale is supposed to be dug out in such a way that the floor under it will be smooth. Since the mining is not as high at the inner end as at the beginning, this leaves 3 to 6 in. of shale hanging to the coal. This is easily removed when the coal is loaded out after it has been dropped by light shots. As the clay is picked loose by the machine runner, his helper scrapes it out of the cut with a long handled shovel and throws it back out of the way of the 'loader' who loads the coal, sets props, and has general charge of the room. The machine runner goes from room to room and is paid by the number of feet of cutting made. Since it was obvious that machines were required for the successful operation of this mine, the miners did not especially oppose their introduction.

Post punchers. A modification of the punching machine was used to make a mining in the soft dirt band at Russellville. It is called a post puncher and two views of it are shown in Fig. 35. The upper view shows the machine at work cutting out a dirt parting in the coal as was done at Russellville. The lower view gives a better idea of the machine and shows it at work undermining the coal. It also shows the improved style of post. These machines worked well enough but were abandoned on account of the strong opposition of the miners, and the consequent difficulty of getting men to operate the machines properly or to consent to blast and load the coal prepared by digging out the middle band. There was complaint that the machines jarred the roof too much, but this was probably not well founded.

Chain machines. In addition to the compressed-air punching machines, there are 'electric machines' or 'chain machines.' A type of these very similar to that shown in Fig. 36 is now in use at Spadra, for longwall mining. These machines contain an electric motor, geared to a sprocket chain or 'cutting chain.' The idle sprocket of the chain is held by a flat 'cutter bar,' which reaches into the cut beneath the coal. This is shown at the right of the motor in Fig. 36. Every second link of the chain is a block of steel carrying a sharp projecting pick point which is detachable for sharpening. These points scrape and chip out the coal against which the rapidly moving chain is



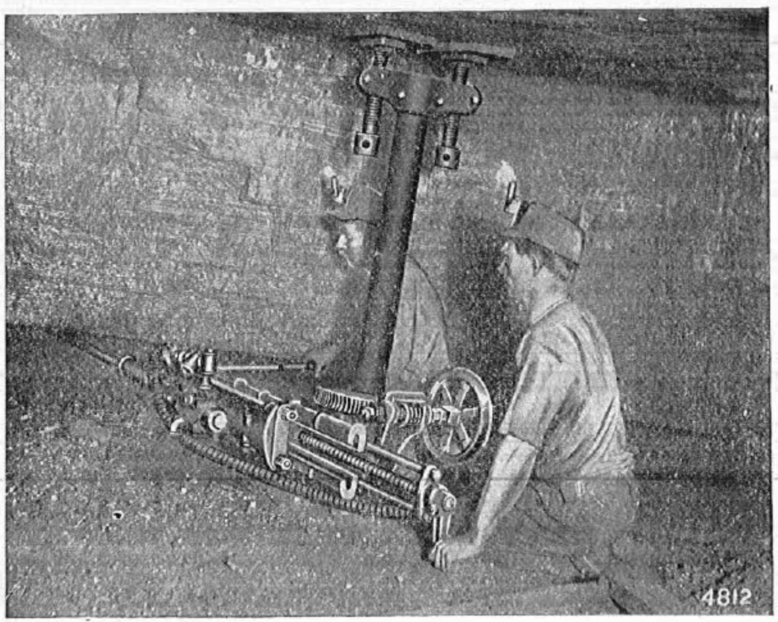


Fig. 35. Two views of the Ingersoll-Rand post-puncher. (By courtesy of the Ingersoll-Rand Drill Co.)

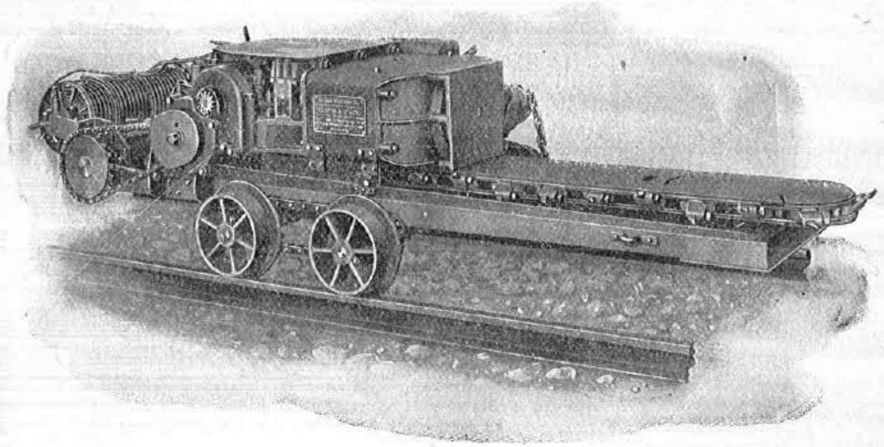


Fig. 36. "Sullivan 'Class CE-6' Low Vein Continuous Coal Cutter, on Self-Propelling Truck."

pressed. After the cutter bar has dug its full length into the coal, the machine drags itself along the face of the coal and the

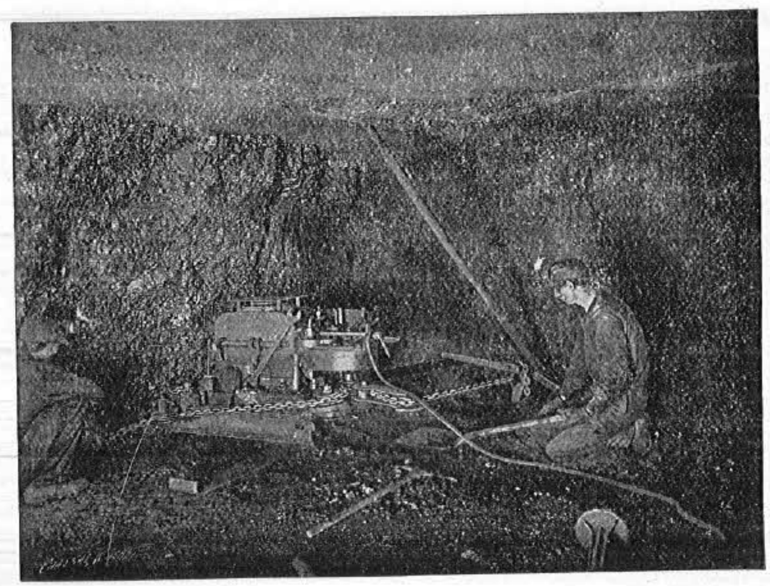


Fig. 37. "Sullivan 'Class CE' Continuous Cutting Electric Coal Mining Machine, crossing a room face in a single operation, without withdrawing the machine from the coal or moving jacks."

picks rapidly undermine the coal across the entire face of the room. This process is shown in Fig. 37.

The dragging of the machine is accomplished by pulling in the feed chain shown in front of the machine, near the floor, in Fig. 37. This feed chain can be pulled by the machine either backward or forward and fast or slow as the machine runner wishes. The chain can be readily fastened in any part of the room by properly placing the 'jack.' This is a pipe with a 'pig foot' upon the lower end and a point on the upper end. A link of the chain is caught in the pig foot and the point of the jack is fastened in any little nick in the roof, so that the jack resembles a light prop leaning toward the machine. By this chain a skillful runner can rapidly move his machine to any part of the room and load it upon the truck or unload it. In this way the heavy machines can be handled with very little exertion. The truck for the machine runs on the regular mine track and can be driven by the motor of the mining machine. It is, therefore, easy to take the machine from one room to another. In the longwall mines, the machines move continuously from one end of a long face to another and the truck is seldom needed. The power is supplied from the flexible cable wound on a reel shown on the rear of the truck, Fig. 36.

The cut made by the machine is shown at the right of Fig. 37. It is not as high as that made by a puncher and resembles a horizontal saw cut 4 or 5 in. wide and 5 or 6 ft. deep. The electric drive of these machines makes the problem of distributing the power to them much simpler than supplying compressed air to the puncher. If conditions are satisfactory they are more rapid. They are not satisfactory where the bottom of the coal contains many large sulphur balls, or where the floor is very uneven, but such conditions are rare in Arkansas. They can not cut out a soft seam of dirt under the coal if it contains much sand or grit, which would wear the cutter chain too rapidly, For this work punchers are better. The post-punchers are better for mining out a thick parting.

At Spadra, they were very succesful in mining the coal, reducing the proportion of slack produced, and preventing the mixing of coal and slate and the shattering of the lump coal by heavy blasting. There was, however, constant trouble with the miners' local union, which was not favorable to the use of mining

machines. At the present writing, the machines are being operated by non-union labor with reported success.

In 1908 and 1909, another of the Spadra mines was equipped with continuous electric coal cutters of the Jeffrey type, but the tipple at this mine was burned before the machines were well tested. The Jeffrey machines differ from the Sullivan type chiefly in the replacement of the front and back parts of the feed chain by steel cables wound upon separate small drums.

Chain machines that were moved along the face of the room by hand were in successful use at Denning for many years until removed on account of the opposition of the Union. Machines have been experimented with in several other places.

SUPPLY OF CARS TO THE MINER.

The turn. If the miner is given all the cars he wants, he sometimes loads all the loose coal he has, or 'gets a clean up.' When several miners in an entry are cleaned up each day, they say 'the turn is good.' The 'turn' means the number of cars each miner receives each day. Ordinarily, the empty cars must be given to all the miners in turn, which explains the origin of this use of the word. Since there must be enough 'diggers' to keep the drivers and other 'company men' busy all day, the diggers seldom get as many cars as they want, and only a few rooms are cleaned up.

Overloaded cars. It follows that the miners, who are paid by the ton mined, put as much coal as possible on each car. After the car is about level full, the miners set a row of large lumps of coal all around the top and shovel in more coal. Such a car is shown in Fig. 2 and is said to be 'chunked up.' When the turn is poor and there is plenty of coal in the rooms, the miners tend to overload the cars by excessive chunking up, so there is usually a weight limit upon the cars. If any miner exceeds the limit, he is not paid for the excess weight. The price of mining this excess coal is paid to the local union.

FALLS OF ROOF.

Propping. By the common law, the miner is responsible for the safety of his own working place, and the operator of the mine is required merely to furnish each miner with all the props he needs. Nearly all rock loosens gradually, or piece by piece, and the single pieces are seldom large enough to break a prop immediately after they loosen. Thus, if the props are set close enough together, there is very little danger from falls of roof. As soon as the rock begins to settle, the effect upon the props can be noticed. When a prop first begins to 'take weight,' it becomes tightly fastened between the roof and floor and 'sounds high;' that is, when struck by a pick, it gives out a more musical sound than a loose prop. As the weight increases, the prop begins to crush through the cap board, but is still strong and solid. The most highly strained corners of the prop then splinter off, and finally the entire prop slowly bows until it begins to crack, as shown in Fig. 38, p. 85. The strength of the prop is then gone, and if there are no other props to carry the load, the roof will come in more or less rapidly. Small pieces and slabs of rock fall from time to time, and the roof as a whole gradually settles, although it may take some months before it reaches the floor.

When the props begin to take weight, the miner generally sets more props to hold the roof up until the face of the room had advanced so far that a fall of the roof does not interfere with the mining of the coal. The rock over the coal seams is usually 'shelly,' and loosens in wide slabs, from the thickness of roofing slate up to 6 or 8 in. Such a roof is shown at the left of Plate VII. When a loose slab of the roof is struck by a pick handle, it sounds hollow or 'drummy.' If it is thin, the miner pulls it down; otherwise, he sets a prop under it. As a result, the props are irregularly placed and some rock falls nearly every time a prop or two is knocked out. When not immediately propped up, the weight of the hanging rock will tend to open the seam above it over a large area, until it sags or 'swings' clear across the room. Some tough slabs of the right thickness may bend down 4 or 5 in. in the middle of a ten-foot span without breaking, as shown in Fig. 27, p. 59. This action often concentrates the weight of a large amount of rock upon a single prop, which may break with fatal results to the miner. If there are loose slabs over the roadway, it is protected by cross-bars, as shown in Fig. 33.

Even when the roof is dangerous, very few miners will set up props unless the roof sounds drummy or shows bad cracks.

During several weeks spent in the Arkansas mines, the writer saw only two rooms which were properly and systematically timbered. During the intervals of waiting for cars, the miners working in these rooms set props at equal distances in straight rows as shown in Fig. 27 and 28, even though the rock above is perfectly solid at the time. The roof, therefore, has no chance to get loose and dangerous. Since so many props are set and the roof remains tight, there are no rock falls, even if a few props are knocked out by flying coal from heavy shots. These careful miners, therefore, seldom have to clear up a big 'fall of rock' before they can get at their coal after blasting. They are also safe from concealed weaknesses in the roof.

Water slips. In most of the mines, there are occasional slanting cracks reaching up into the roof as shown at A and B, Plate VII. Because water generally drips out of these and because the rock strata have often slipped or moved along them, they are called 'water slips.' When a steep joint in the rock intersects one of these, as at A, Plate VII, the wedge-shaped mass of rock next to the water slip is very dangerous. These blocks are generally heavy enough to cause a severe or fatal accident if they fall upon a miner, and although they may be very loose, they are usually too hard and heavy to sound drummy except at the extreme edge. They come at irregular intervals, and if the water slip is beyond the block, as at A, Plate VII, and concealed by a little coal, the miner does not know that the loose block is there. While he is working at the face, the little coal at the corner of the block, which is all that supports it, may give way and the block fall without warning. This danger can be certainly avoided only by keeping the props very near the face. Props close to the face are objectionable because they do not leave the miner sufficient space in which to shovel his coal, and because the props are knocked out by blasting. If the top bench of the coal seam must be mined first, these water slips are especially dangerous, because permanent props can not be set close to the face. In other coalfields, cross-bars are set between the face of the coal and the nearest props to give the miner sufficient room in which to work. This is not done in Arkansas because the dangerous roof is not common, and because the coal is often too weak to properly support the inner end of the cross-bar.

It is fortunate that the water slips all cross a room in the same general direction. As soon as one water slip has been found, an intelligent miner takes pains to see that the face of his room is never parallel to the direction of the slips, and that the props are so placed that there are no unsupported strips of roof having the direction of a possible loose wedge of rock. Since the water slips extend from room to room, many of the miners look for them in the adjoining room which is more advanced than their own, and so can tell where to expect them and what their direction will be. On account of the danger caused by these water slips, many miners will not work in mines in which they are common.

Potty roof. In some places, the soft mud that covered the beds of carbonaceous material now forming the coal seams, was dried by the sun and cut up by many intersecting shrinkage cracks, such as may be seen in the bottom of any dried-up mud-puddle. The size of the blocks depends upon the thickness of the layer of mud. Where the blocks were large and the mud-cracks became filled with a less sticky material, the blocks which now form the roof of the coal tend to fall out, with little warning. Because these blocks resemble large inverted iron pots or tubs, the miners call a roof containing them 'potty' or 'tubby.' Since the loose pots are seldom drummy, they are dangerous, and props must be set very close together wherever they occur. Fortunately, they can generally be easily seen because the roof flakes off until the bottoms of the mud-cracks are exposed, as at the right of Plate VII. Fortunately, also, potty roof is rare in Arkansas and seldom extends over more than one or two rooms in a mine.

Blocky roof. At several mines, the hard rock above the coal is cut up by the rock joints common everywhere. If the lower layer of the roof is thick and hard, these blocks do not sound drummy and are dangerous. Some of the miners call such a jointed roof potty, but most of them use the better term, 'blocky.' The center of Plate VII shows one type of blocky roof. Fortunately the blocks are in most places large enough to be supported by at least one prop, as they are ordinarily set, and the splintering and bending of the prop gives the miner ample warning of danger. The blocks seldom loosen until some

weeks after the coal has been mined, so the face of the room where the miner usually works is safe, except when water slips are cut. The falls in the roadway in the older parts of a room occur mostly just after the shots go off, when there is no one in the room. There is, however, some expense in clearing this rock up and many foremen pay the miners for setting cross-bars over the roadway wherever the roof is blocky.

If only the layer of the roof next the coal is blocky, no attempt it made to keep it up, and it is all wedged down as 'draw slate.' Draw slate is properly all the rock above the coal, which will fall when the coal is blasted, and should not include any of the rock under which props are set, or any rock under which a miner would dare to work. When the roof is blocky, however, the miners must secure the rock until the inner joint is reached, since a wide block is sometimes loosely held up by a little coal at the face of the room, even though it has not sagged noticeably. This support is usually a temporary prop so placed that it will be blown down together with the coal which holds the block of rock fast. Most of the draw slate is soft dirt or weak slate which is readily pulled down, if it does not fall as soon as the coal is removed, and is not dangerous.

BASIS OF PAYMENT TO THE MINERS.

The miners are generally paid 62c. a ton for all the coal they load. When a car is loaded, the miner hangs upon it a little tin 'check' with his 'check number' on it. The coal in each car is carefully weighed by the company's 'weigh-boss' and the 'check-weighman' hired by the miners. The weight is credited to the check number on the car. The men are paid extra for mining any kind of 'deficient' coal.

Besides this, they are usually paid $2.25 per yard for driving entries and $1.12½ per yard for room-necks, and break-throughs that are cut before blasting. They get from 5c. to 9c. per yard for each inch of rock brushed from a yard of roadway 5 ft. wide, and generally 28c. for setting each cross-bar, when such are necessary.

Twice a month, the pit-boss and a helper, who is generally the fire-boss, must go through and measure the yardage of each miner. In the rooms, the mark from which progress is measured is only a chalk mark or cuts on a prop next the road, because the pay for a foot is generally small. In the entries, a cluster of five small holes is drilled into the coal on one side, and measurements taken from the center hole. These measuring marks are universally called 'stamps' and are moved up by the pit-boss from time to time, as the face gets beyond the reach of the tape line. There seems to be no tendency to dishonesty on the part of the miners in the way of attempts to move the stamp backwards and so apparently increase their yardage.

At many mines, nothing is paid for handling the middle band. At a few mines, especially where the middle band is hard, the price paid for mining the coal varies with the thickness of the band rock, and at others, the miners are paid so much for each inch of rock for every 15 sq. ft. removed. They are always paid for handling all but the first few inches of draw slate which falls from the roof. This is generally 2½c. an inch for each yard 5 ft. wide. This is not enough to pay the miner for the labor of cleaning it up, and he prefers to keep it from falling by sufficient props. It is quite an expense to the companies, however, and makes them more anxious to supply the miner with plenty of props.

All the company men are paid by the 8-hour day or fraction thereof. This is generally $2.56 per day for men underground and $2.02½ for laborers on top.

SQUEEZES.

Small rooms and small pillars. In many Arkansas mines, the rooms are turned square off the entry and driven straight up hill, regardless of the curves. When the pillar is too thin, as determined by the distinctness with which pick blows can be heard through it, the room is turned away from the one beyond, or stopped; or if the crosscuts through the pillars are too long, the rooms are turned the other way, or widened. This practice makes the width of the pillars very uncertain and the rooms irregular, as shown on the left side of Plate II.

To save the cost of cutting crosscuts between rooms, many pit bosses ask the miners to widen the room and shoot through the pillar as shown in Plate II. When in addition, the rooms are made too wide, very little of the pillar is left. This weakening is locally called 'robbing' the pillars.

How squeezes start. When robbing is carried too far, the pillars crush and let the roof slowly down. When the roof is very strong, it does not break but carries the weight over to the next pillar, which, in turn, crushes, until this 'squeeze' may extend through a large part of the mine, even 'riding over' a pillar 40 ft. wide. When the pillars are very strong, they are sometimes squeezed down into the shale beneath. This shale acts like clay, and squeezes up in the roadways. Figure 38 is re-

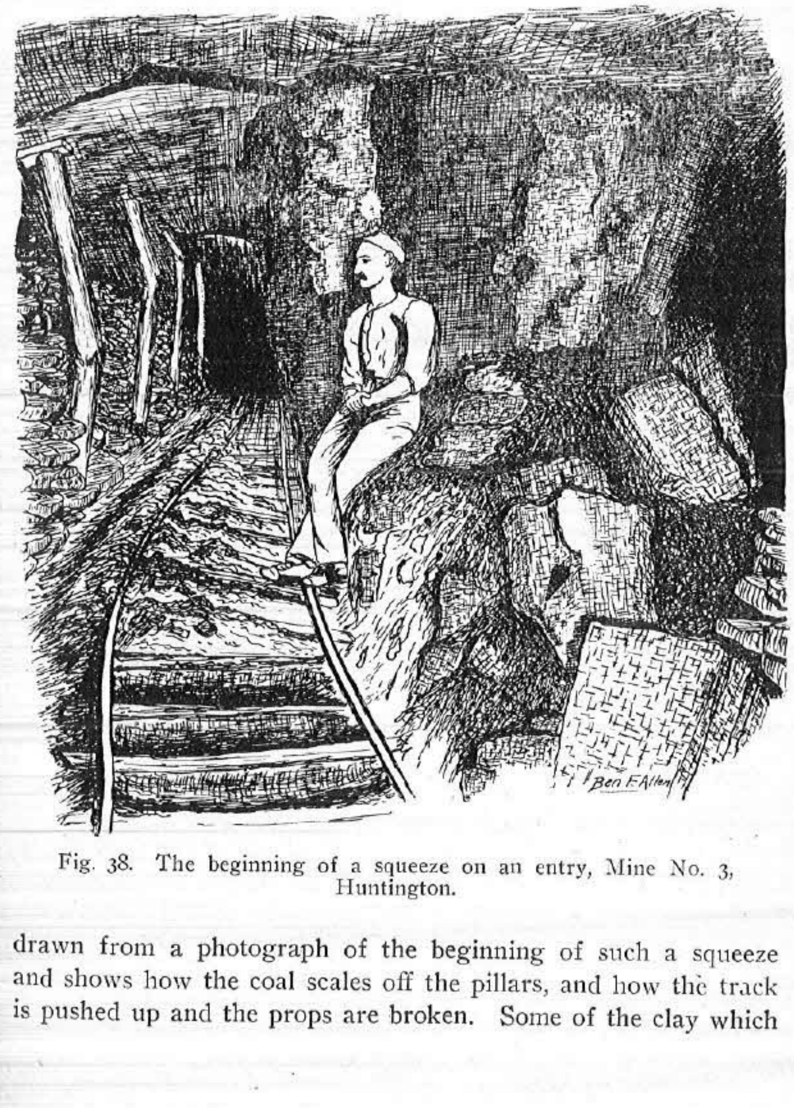


Fig. 38. The beginning of a squeeze on an entry, Mine No. 3, Huntington.

drawn from a photograph of the beginning of such a squeeze and shows how the coal scales off the pillars, and how the track is pushed up and the props are broken. Some of the clay which was squeezed up between the ties has been removed. The roof settles very slowly and there is no very great danger in passing such places, since a little crackling noise precedes the fall of a chunk of coal or a small piece of roof. When the roof is very strong, the crushed pillars can be very easily loaded out and the coal is merely broken into pieces and not shattered as by blasting. Figure 39 shows such a pillar; but unfortunately, the most

Fig. 39. The effect of a squeeze upon a pillar of hard well-jointed coal. Also the unmined clay left beneath the pillar. Paris Coal Co., Paris.

thoroughly loosened coal has been removed, because it was the easiest of all for the pit boss to get during the suspension.

Checking squeezes. When the room pillars first begin to work under a squeeze, the entries sometimes can be saved by building cribs of short props and setting heavy logs called 'trees' in the room-necks, as shown in Fig. 40. In many entries, such trees are set every two or three feet along the track.

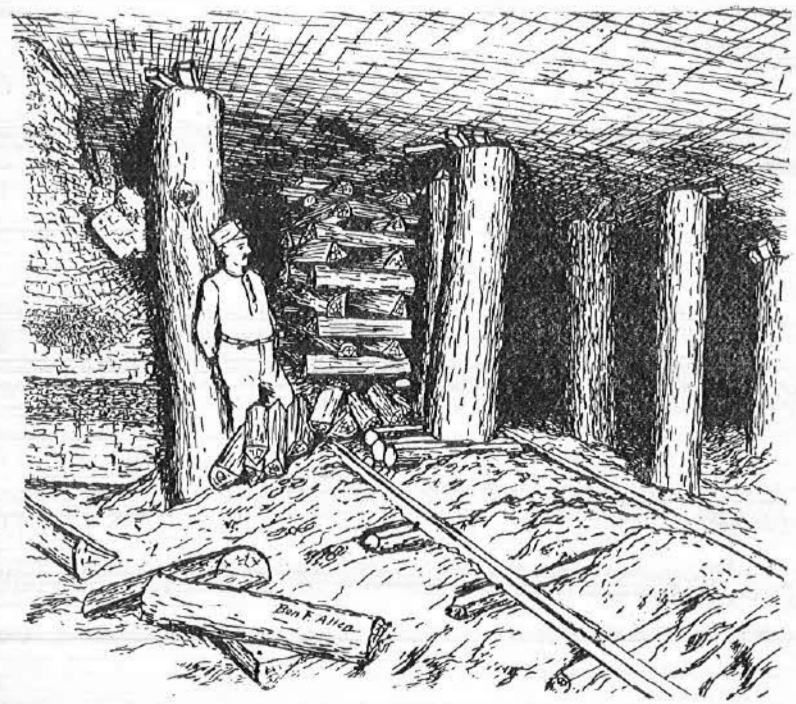


Fig. 40. Timbering used to check a squeeze and the raising of the track caused by the squeeze. Bolen-Darnall Mine, Hartford.

The photograph, from which the figure is redrawn, was taken in the Bolen-Darnall Mines, where the squeeze, beginning in 1905, had spread to the main slope in June, 1909, and prevented mining for two weeks in July of the latter year, while three shifts of men were working to check it. The squeeze extended over some 12 or 15 acres at the end of a thick lens of very strong sandstone just above the coal. The figure shows the opening of an entry which had to be stopped up with timbers for some distance, to save the pump room as well as to check the squeeze. The abandoned entries higher up were also heavily timbered with cribs, and the slope lined with 'trees.' For quite a distance in the main slope, the bottom heaved up as much as 3 ft. This heaving of the bottom, which is called 'creep,' caused additional annoyance by carrying in the bottoms of trees that had been set in the slope before the squeeze became serious.

After the timbering was put in, the squeeze apparently stopped. The track was taken up, the clay loaded out, and the track relaid.

At a nearby mine, a squeeze was checked at an entry by building a wall of solid masonry 3 ft. thick along the entry rib. This served also to prevent the loss of the ventilating current through the crushed pillars.

Effect of the strength of the roof upon a squeeze. At Central No. 4 Mine, almost adjoining the Bolen-Darnall, a small squeeze spread over only two rooms, when a pillar varying from 12 to 18 ft. in width caused the roof 300 ft. thick to break. A large crack was noticed on the surface three days later. In this case, however, the roof was all a fairly soft shale. Such squeezes do little damage in the mine but are bad if they come to the surface in a creek bed or other places from which water can enter. The rooms are generally driven at intervals of at least 36 ft. from center to center, regardless of the character of the roof. If the roof is poor, the miners make the rooms narrower than usual. The pillars are then left wide and strong, and squeezes are unlikely. If a squeeze does start, a weak roof will easily snap off at the first strong pillar the squeeze reaches. This stops the spread of the squeeze. If, however, the roof is so strong as to need little or no propping, the miners, who often have the full consent of the pit bosses, will make the rooms 35 or 40 ft. wide, so as to blast the coal more easily. The pillars are then fewer and often smaller than those left under a weak top. As soon, therefore, as so large an area is opened up that the hard roof can not carry the load across the entire mine, a squeeze is almost certain to begin, unless the mine is so shallow that the weight of the overlying rock is small. There is less trouble if the distance between the rooms is made so great that wide pillars will be left even though the rooms are as wide as the miners find convenient. Such squeezes will be hard to stop when once started, and larger pillars rather than smaller ones should be left beneath a strong roof. At Denning, the roof is nearly ideal, in that there is a strong but thin sandstone just above a little shale. The rooms are therefore safe, but the sandstone is so thin that it readily breaks under a squeeze because all the rest of the roof is soft shale. This prevents the spreading of squeezes.

This sandstone 'cap rock' also indicates when to expect coal in drilling prospect holes.

Effect of squeezes. When the squeezes are unchecked, the entries and rooms under the ordinary shale roof are filled with loose slabs of slate. After the rooms are completely filled, there is very little weight on any one place, and the entries may be reopened by setting light timbers, generally a cross-bar and two legs, under the slabs of slate a foot or so beyond the last uncrushed pillars, and removing the rock beneath as far in advance as is safe. Another cross-bar is then set to support another set of roof slabs, which carry the load a little in advance. In rare cases, light poles are driven forward over the cross-bar to support very loose rock in front, until room is made for another set of timbers. The better pieces of rock are set to one side and used to build walls along each side of the entry, to help support the roof and keep rocks from falling upon the track. This is expensive at best, generally costing at least \$6.00 to \$10.00 a yard. The ventilating current goes through the loose rock into the surrounding rooms, or directly to the return air-course. Therefore, unless the seam has quite a steep dip, it is better to reopen a squeezed entry by driving a cut-off from another entry. The squeeze seldom extends through the short rooms at the head of an entry, so the driving of an entry is easily continued after the cut-off reaches it. Some superintendents prevent the squeeze from spreading as the entry is continued by omitting one room, which leaves a strong pillar to stop the squeeze. In most cases, there is time to save the rails in the rooms and entries after a squeeze starts.

MINING THE PILLARS.

In most districts, robbing the pillars means mining them, but in Arkansas, this is called 'pulling the pillars.' It is not often done, since they are left too narrow in the first place to make it easy. The method most used is shown in the First West Entry, Plate II. When the room is full of waste rock, a 4-ft. 'slab' is taken off one side of a wide pillar and a track laid in this space up to the end of the room if possible. Figure 40-A shows the process of thus slabbing a pillar at Mine No. 1, of the Branner Coal Co., at Midland. At this mine a thin bottom bench of coal was left in the rooms but this is mined beneath the pillars. The remaining part of the pillar is then mined retreating toward the entry. The roof is secured by many props and the weight makes the coal easy to loosen. That portion of the room pillars which lies between two room-necks and between the entry and the first room break-through is called the 'entry stump.' The pillar between the entry and its air-course is the 'chain-pillar.' The pulling of pillars is generally begun at the far end of a finished entry. The narrow part of a room pillar is mined first. Then

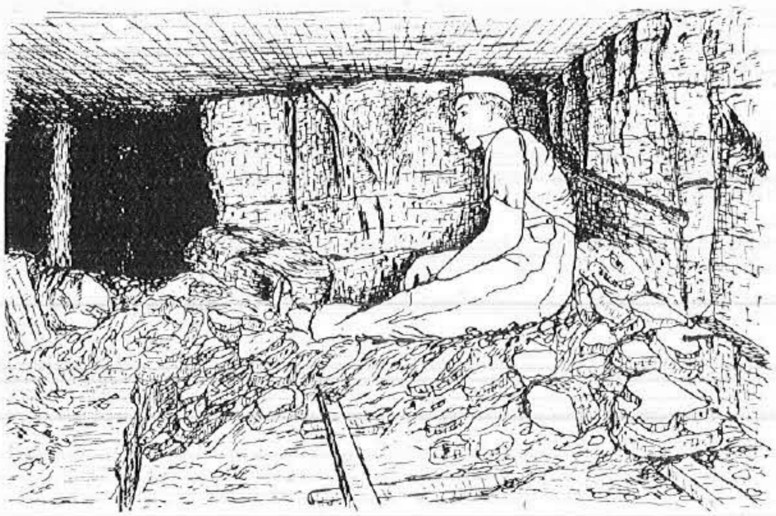


Fig. 40-A. Slabbing a room pillar, Mine No. 1, Branner Coal Co., Midland.

Fig. 41. A small part of an entry stump left in drawing pillars. Branner Coal Co., Midland.

the 'entry stump' and that part of the chain pillar opposite it are mined together, retreating toward the slope. Next to cross-cuts, or where the weight becomes too great, small pillars of coal are abandoned to give temporary support to the roof. Figure 41 shows one of these with the roof over the old entry fallen in around it.

In a few mines, the rooms are laid out for pulling the pillars from a track along the side of the room, by the standard method. This is shown in the Second East Entry, Plate II. It is rather common to pull the larger entry stump and the most of the chain pillar, provided that there is a demand for coal and the roof is good. The chain pillars are rarely mined in gob entries because the waste has to be shoveled to one side before the coal can be reached. The entry stumps are the most accessible of all the pillars. When mining them, the diggers are less apt to mix slate with the coal than if they had to shovel the slate out of the way. This slate trouble is aggravated by the mine-run law which practically compels the operators to pay the miners as much for fine slate as for good coal.

HAULING THE COAL.

Pit mules. The hauling of the coal presents little novelty. The mules are trained to 'gee' and 'haw' and turn around without lines, and also to 'get up a step' and stop, so that the cars may be coupled and switched. The driver rides on the last car of the trip, and the mules have to get along in almost absolute darkness. Indeed, if left alone anywhere on the entry, most of them will go through the dark to the parting, where they are in the habit of standing while the driver is waiting for cars.

The mules are always taken out of the slope mines at night, but are not always hoisted out of the shaft mines. If left in, they have a dry stable with a special split of pure air for ventilation. They generally are well cared for. At no mine in the State is any driver allowed to abuse his mule. This is in pleasing contrast to some other districts. If a mule is kicky, it is usually sold to avoid injury to the driver.

Some mules have worked underground for many years, and they are said never to die, but eventually are disabled or killed by accidents. They are very skillful at keeping out of the way of cars, but many are killed by collisions when several haul to the same parting, and the drivers are careless. At some of the mines, there are steep hills in the entries and the drivers neglect to block the car wheels. The mules must then run very fast to keep out of the way of the loaded cars. This they do in safety except at the curves where they are often injured.

Spike teams. When the entry is too long for one mule to handle all the cars, it is customary to have two mules and drivers following each other in and out. When the entry becomes too long for this, an 'inside parting' is made as far in as possible. Single mules then haul the cars to this parting, from which trips of twice as many cars as before are hauled out by two mules going tandem as a 'spike team.' Figure 8, p. 28, shows a number of spike teams used to pull single cars up the steep hills. The inside parting is also called a 'swing parting,' and if a single mule hauls the coal to the entry parting, it is called a 'swing mule' as distinguished from the others, or 'gathering mules.'

Mechanical haulage. When the coal has to be hauled in considerable amounts for any great distance underground, some mechanical haulage system is installed. When this main haulage road is nearly level, an electric locomotive with overhead trolley carrying 250 volts is used. There are four of the larger mines in the State equipped with one or more 7 to 13-ton electric locomotives, which haul the coal from about ½ to nearly 2 miles. Figure 42 shows one of these motors at the beginning of a side track, waiting for the other motor to pass it with the empty cars. This figure also shows the timbering used to protect an entry where the roof is loose.

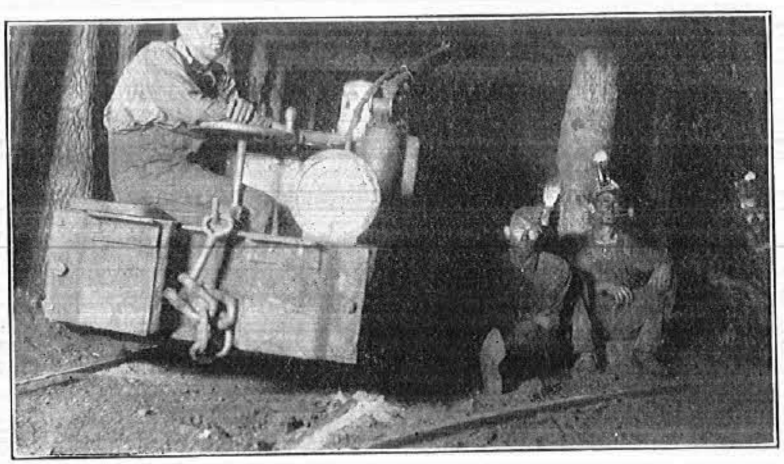


Fig. 42. An electric motor waiting for another motor and a trip of empty cars to pass. Mine No. 17, Jenny Lind.

When the seam dips, it is rarely possible to haul the coal from more than one entry over a level road; but most of the mines are then equipped with slopes or engine planes upon which the coal is hauled by a rope, and the cars returned by gravity. If there are hills in both directions, or some level places along the road, the cars must be hauled both ways. For this purpose, two of the larger mines use the 'tail-rope' system of mechanical haulage. With this arrangement, a wire rope leading to a hoisting engine upon the surface, pulls the long trip of loaded cars up or down the hills from any one of the 'rope partings' inside the mine. To the last car of this trip is fastened the tail-rope, which is thus pulled out with the trip. The tail-rope passes around a bull-wheel just inside of the parting and out to a second drum on the main engine, and is used to pull an empty trip back to the inside parting, when the engine is reversed. As couplings are provided in the tail-rope, the empty trips, with the main rope following, may be taken to any one of the partings. Mine telephones are used to notify the coupler when the loaded trips are ready, so that he will know where to send the empty trip. The tail-rope system is more expensive to maintain and operate than an electric system of the same capacity, but is independent of grades, and the haulage roads can run in any direction from the shaft bottom.

SURFACE ARRANGEMENTS.

Tipples at the soft coal mines. At the surface of each mine is a more or less complicated 'tipple' or building, containing arrangements for weighing the coal and sorting it into various sizes, if that is required, and for loading it into railroad cars. The coal may be weighed in the pit cars which are then merely run over a platform scale, as at some of the slope mines, but more commonly it is dumped into a 'weigh pan' or 'weigh basket' of any one of a number of different kinds. At a few of the soft coal mines, the coal is dumped into railroad cars immediately after weighing, and sold as mine-run. Only one side-track is

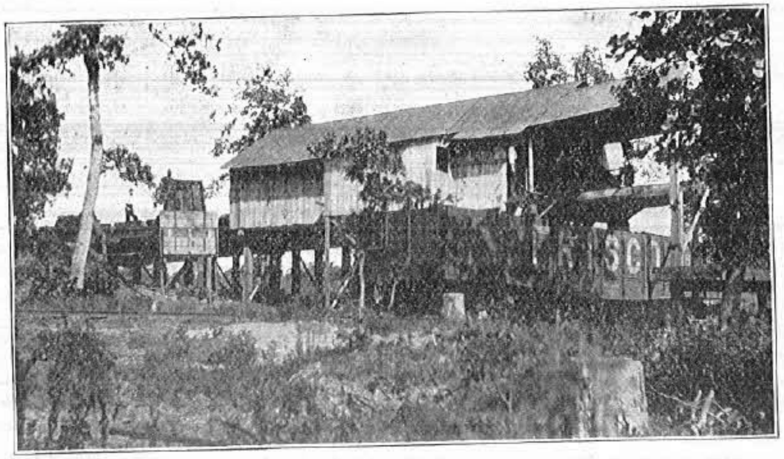


Fig. 43. Northwest side of tipple at drift mine of Dallas Coal Co., Burma.

then needed for the railroad cars and the tipple is called a 'one-track tipple.' Figures 43 and 44 show two views of a well designed one-track tipple at a drift mine. Figure 43 shows the coal falling from the pit car into the railroad car, and also shows a car which has been dumped into the little bin at the left, from which the coal is reloaded into wagons to be sold locally. Further to the left is shown the beginning of the waste dump. Figure 44 shows clearly how the tracks for loaded and empty cars slope to facilitate the handling of the cars. Unfortunately, at the time this

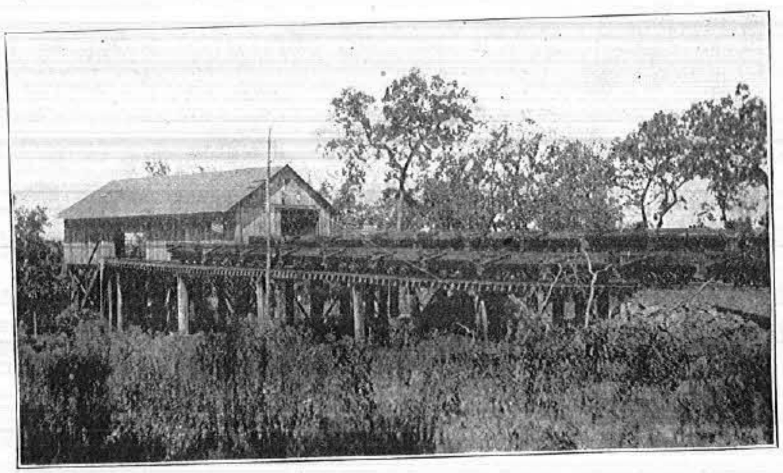


Fig. 44. Southeast side of tipple at drift mine of Dallas Coal Co., Burma.

picture was taken, the mine was idle and both tracks were full of empty cars.

At most of the soft coal mines, the coal, after being weighed, is dumped upon an inclined bar-screen with spaces of 1⅛ in. between the bars. The lump coal slides on over the bars into one railroad car, while most of the fine coal or slack falls between them into another car. This forms the standard arrangement of a two-track tipple. When orders for mine-run coal are filled, the screen is covered with flat iron plates and all the coal passes over it just as it comes from the mine. If less of the fine coal is to be removed, only a part of the screen is covered. When the miners were paid upon a lump coal basis, the weigh basket was placed at the lower end of the bar-screen which was of a specified size, and only the coal which passed over the screen was credited to the miner. A correspondingly higher price was paid for mining this coal, however. Tipples with screens require a greater hight from the dumping place to the track level. The bar-screens do not take out all of the slack and when a fancy grade of lump coal is prepared, the coal is passed over a shaking screen of some sort.

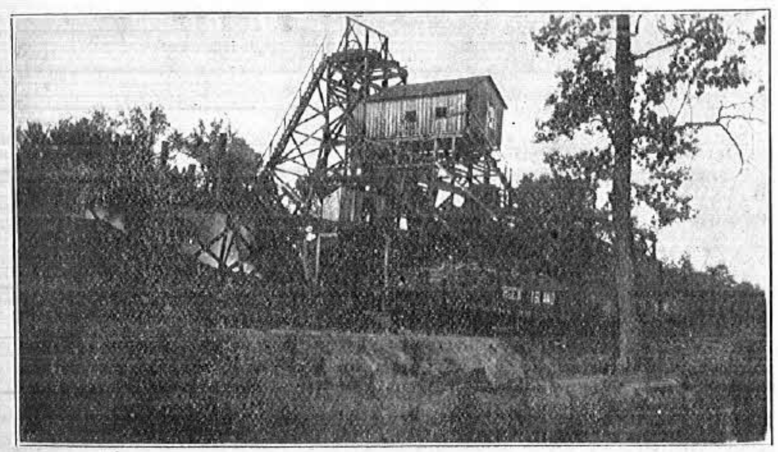


Fig. 45. Tipple and boiler pond. Coronado Mine, near Huntington.

Figure 45 shows one of the best designs of the high two-track tipples with a fixed screen as used at shaft mines equipped with self-dumping cages. These cages automatically dump the coal from the pit car into the weigh-pan. This tipple is so arranged that when a car load of waste is hoisted, the iron sheet upon which coal would be dumped is raised like a trap door, and the rock falls through into a bin beneath. At any convenient time during the day, the rock is drawn from this bin into a special rock car and dumped on the waste pile on the left. Most of the tipples have no waste bin, and rock from the mine is dumped from the pit car directly into the rock car, which takes it to the waste pile. The hoisting is, therefore, frequently delayed while the rock car is being emptied and returned. At nearly all of the tipples, there are arrangements by which some of the slack coal can be easily taken to the boiler house.

Some of the soft coal mines supplying the household trade make 'fancy-lump' coal, clean nut coal, and slack. At some of these, the coal is first dumped upon a coarse screen which removes everything less than 2 in. in diameter. That which passes through this screen is then further separated into nut coal and slack. This slack is smaller than the standard size. At other mines that make three sizes of coal, the coal is first passed over a standard screen to take out most of the slack, and then over a coarse screen which takes out the rest of the slack and the nut coal. The screens are given a shaking motion, and are of various kinds. Some are in the form of revolving drums or trommels. A three-track tripple is required for the production of nut-coal, in addition to the lump and slack. Figure 46 shows the old

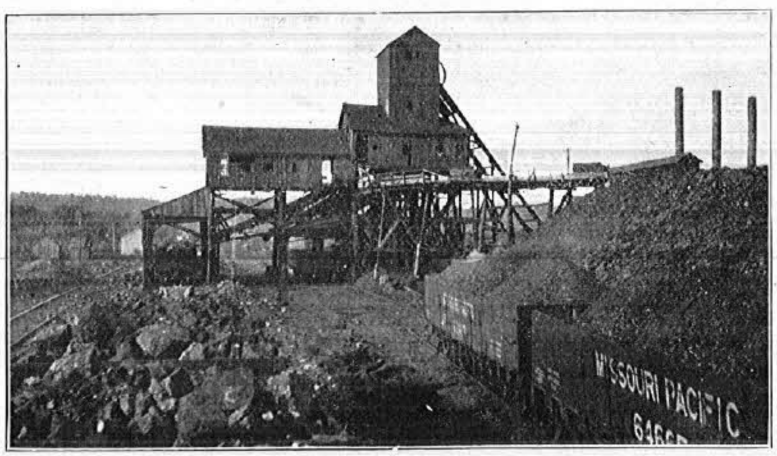


Fig. 46. Tipple at Mine No. 17, Jenny Lind.

three-track tipple at Mine No. 17, Jenny Lind, with slack coal falling into the car nearest the shaft. After it had passed over the slack screen, the nut coal was formerly taken out of the lump coal by a shaking screen over the track which was in the center. Before the photograph was taken, this intermediate screen had

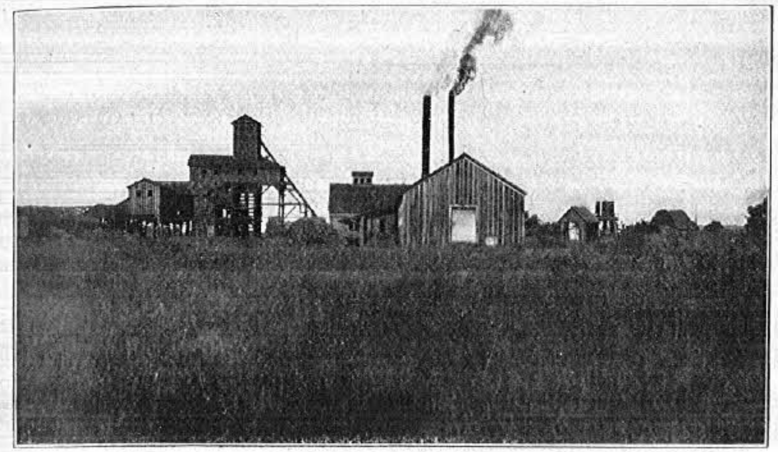


Fig. 47. Tipple and surface buildings at Mine No. 18, Jenny Lind.

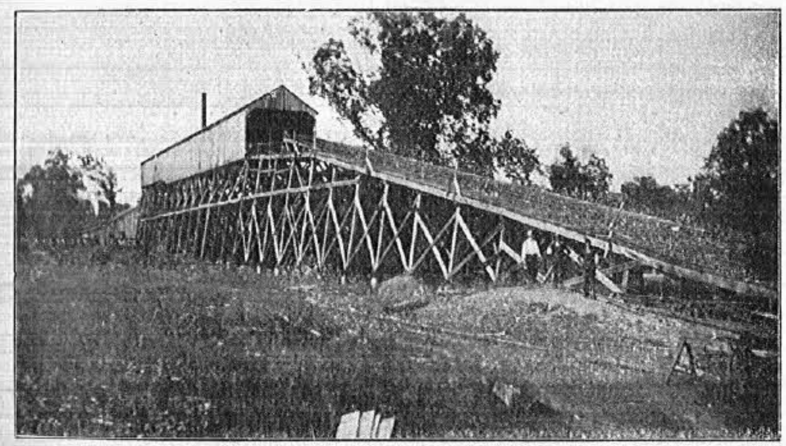


Fig. 48. Tipple at Mine No. 2, Greenwood.

been replaced by a shaking iron trough, and the center track removed. Most of the newer tipples are completely boarded up. Such a tipple with the round-topped fan house in the rear, and the other surface buildings is shown in Fig. 47. The nearest building is the blacksmith shop and machine shop and is exaggerated in size because it was so near the camara.

Figure 48 is a view of a very complete tipple of a slope mine on low dip coal. The lower track for the empty pit cars can be seen at the end of the shed. This is a two-track tipple, but no good photograph could be obtained of the screening arrangements. Figure 49 shows a very cheap but effective two-track

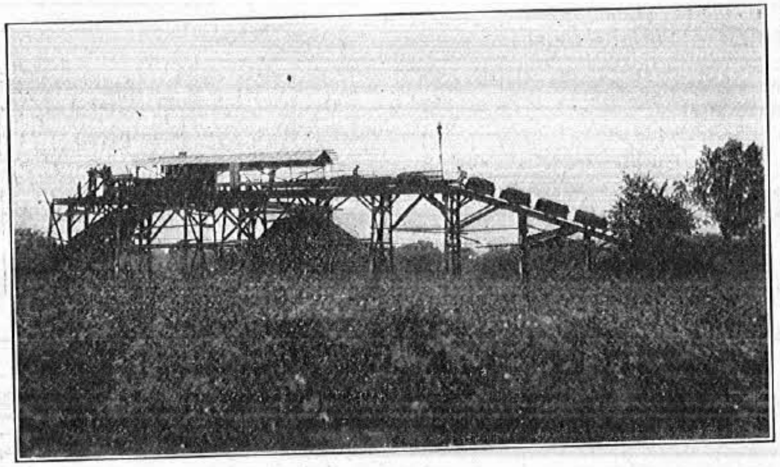


Fig. 49. Tipple at Mine No. 135, Bonanza.

slope tipple, large enough to handle a four-car trip. The trestle is built of logs cut from the leased land, and the tipple is equipped with second hand machinery furnished by the owner of the coal land. The actual cash investment by the lessees was, therefore, almost nothing.

Where necessary at the soft coal mines, slate is picked out of the lump coal while it is stopped upon the screen. This delays the hoisting, and reduces the capacity of those large mines whose output is determined by the dumping arrangements. There are also a number of slate pickers in the railroad cars. These men also act as car trimmers, and properly arrange the pile of coal in the center of a well filled car. At a few of the mines, there are no slate pickers except those in the cars. No attempt is made anywhere to pick slate out of the slack.

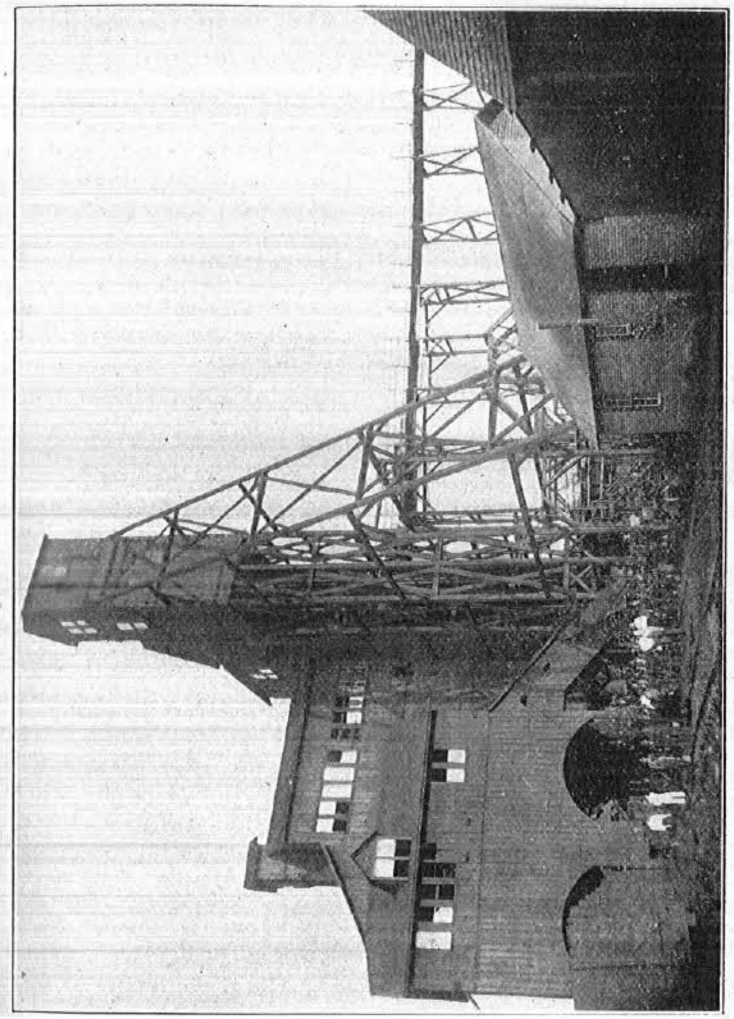


Fig. 50. Breaker of the Southern Anthracite Coal Co., Russellville.

Semi-anthracite breakers. The semi-anthracite coal must be broken into smaller lumps and carefully sized before it can be sold, and a good deal of slate must be picked out. This requires a large surface plant which is called a 'breaker.' Figure 50 shows one of the best of these. Generally the coal from the mine cars is dumped over a wide bar-screen from which the lumps pass to a crusher. These lumps then join the fine material from the mine, and pass over a series of nearly flat shaking screens of boiler plate, punched with round holes. These screens are shown in Fig. 51. The largest size of coal commonly shipped is called 'grate

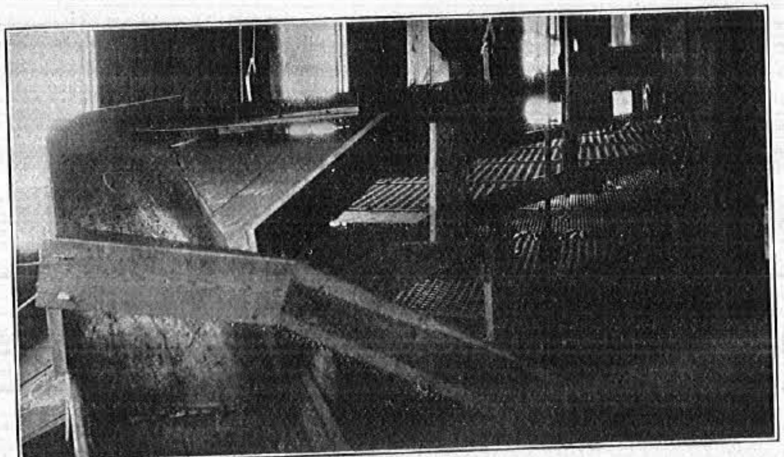


Fig. 51. Screen used in preparing semi-anthracite coal for market. Ducksnest tipple, Spadra.

coal.' This includes all lumps which pass between the bars 6 or 7 in. apart and can not pass through round holes 2¾ to 3 in. across. 'Egg coal' is the next smaller size, and includes all which goes through the first screen and over the second one, in which the holes are about 2 in. across. The next size is 'No. 4,' which is used in heating stoves and brings the highest price. At most of the mines, enough 'pea coal' is removed from all finer than No. 4 to supply the boiler, and at some a still smaller size, 'buckwheat coal,' is made and the pea coal is sold. There is no uniformity in the sizes of screen openings. Since the slate in Arkansas is just as smooth as the coal, the ordinary mechanical slate pickers, which depend upon the lagging of the slate as the mixture passes down a chute, can not be used. The only

mechanical device available is a set of square bars with their edges set upwards, and so placed that the coal passes over them, while pieces of flat slate turn up on edge and fall through. This has the disadvantage of losing flat pieces of clean coal. The great bulk of the slate must be picked out by hand. Boys can generally do this more rapidly than men, but it is difficult to get them to attend to their tasks so men are employed to pick slate. The smallest size cleaned is No. 4 and this requires the most labor. As so many cars would be needed to receive the different sizes of coal, all of the smaller sizes are temporarily stored in bins, from which the cars are readily loaded as required by orders. This saves the delay and cost of the frequent shifting of cars which would otherwise be necessary.

To reduce the amount of slack produced in crushing the coal, J. F. Sauerman of Russellville designed a crusher with a jaw set with long steel picks, which splits the coal rather than crushes it. These machines have quite generally replaced the ordinary toothed rolls for breaking coal throughout this State, and are being rapidly introduced in other states.

WASHING SLACK.

Since the fine slate can not be picked out of the slack by hand at a profit, the Central Coal and Coke Co. has built

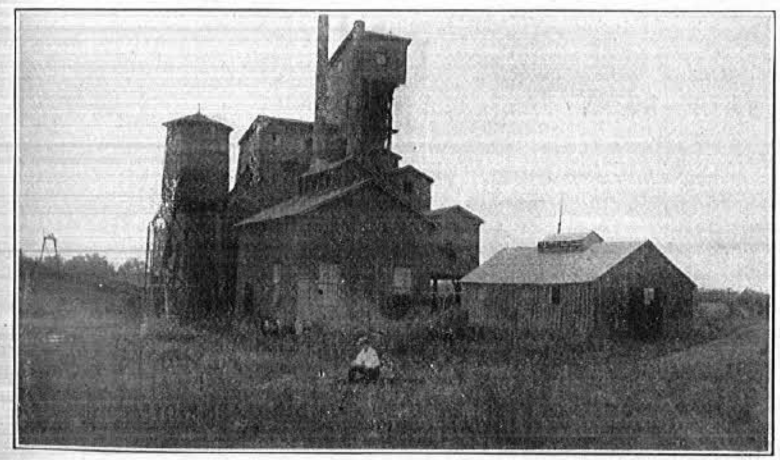


Fig. 52. Slack washer. Central Coal and Coke Co., Doubleday.

a slack washer at Doubleday, near Hackett. This is shown in Fig. 52. The slack is automatically unloaded from the cars and elevated to a storage bin at the top of the building. From the bin it is fed at a uniform rate to a number of 'jigs' of the Stewart pattern. These are strong frames with a flat wire screen bottom, upon which the mixture of coal and slate rests, while the whole is rapidly agitated up and down in a tank of water. Since the slate is a good deal heavier than the coal, it sinks more rapidly in water. When a mixture of slate and coal is kept mobile by the currents of water, the slate soon settles to the bottom. The fine slate then works through the screen into the tank, and the larger pieces of slate form a layer next to the screen and keep the fine coal out of the tank. At intervals, a little of the coarse slate is emptied through the screen to prevent the layer from getting too thick. In the meantime, the clean coal passes over the edge of the shaking frame at the side opposite the inlet; then it goes successively to a settling tank, elevator, and storage bin over the loading track. The washer removes all the impurities in the coal, and also some of the very fine coal dust which does not settle out of the waste water. The product is therefore a very desirable boiler fuel and brings a good price, but as there is much loss of coal in washing and the process is expensive, only the slack that can not otherwise be sold is washed.

CHAPTER III.

THE MINERS.

THE COURTESY OF THE MINERS.

A visitor to the Arkansas mines is quickly impressed with the general intelligence and ability of the miners. Nearly all of them speak English. The great majority were most courteous to the writer, cheerfully answered what must have seemed to them 'fool's questions' concerning their work, and gave all the information desired about the details of mining. Many even took the time to guide him to some other working place that he might see a reported peculiarity of the coal or meet a miner of more local experience, or one who was looked upon as an authority upon the points of mining. At noon-time they all offered to share their dinners with the stranger. A few miners were met who feared that the 'Survey man' was hired by the operator or some imaginary enemy of the Union to spy upon them.

SOURCES OF INFORMATION ABOUT THE MINERS.

The high class of the Arkansas miners and the importance of the labor supply in coal mining led to the making of systematic inquiries regarding the miners and labor problems in general. From the miners' point of view, the best information regarding their grievances and desires was obtained from the older miners and especially the secretaries of the local unions, most of whom are well posted and intelligent. A few members of the miners' 'pit committees' proved to be well informed and conservative. Generally, however, they are the most troublesome and unreasonable men in the crew, since they are elected upon the supposition that the chief duty of the pit committee is to quarrel with the pit boss and superintendent. In one or two instances, their answers did not correspond with facts observed in the mine, and as far as possible these men were avoided.

Views of the employers were obtained from the foremen, superintendents, and operators. Many unusual conditions were confirmed by both parties. One or two instances of unreasonableness upon the part of the operators were noted.

Information regarding the home life of the miners, the character of the camps, sanitary conditions, and general matters was obtained chiefly from the resident physicians and by personal observation. Data as to the nationalities were obtained from the foremen, office force, and when possible from the secretaries of the local unions. The earnings of the men were obtained from personal examination of the pay-rolls and other records. This gave also some idea of their regularity of working. Questions regarding their financial habits were asked of the office force.

THE HOMES OF THE MINERS.

Houses owned by the miners. There are great variations in the different camps, but leaving out exceptional cases, from 60 to 65 per cent of the mine workers are married and 20 or 25 per cent of the whole force own their homes. The majority of the companies try to attract the miners that save their money and build homes, for they are the more skillful and steady workmen and so increase the output of the mine. In general, tracts of an acre or two of the unused surface land over the coal are leased to certain steady men for one dollar a year. These men build their own cottages, which are most frequently of the cheap type of the company camps, and raise vegetables and a little corn upon the land they have fenced. This gives them work for the idle days, which are most frequent in the spring, when the market for coal is poor. These men generally keep a cow and some pigs.

Unfortunately, there are some companies which do not grant leases on small lots. In such cases, the miners can farm only the big yards at the company camps. They may be ejected from these at any time and lose their gardens. Near most of such camps, there is good farm land belonging to other parties. Many of the miners buy or rent 5 to 20-acre tracts of this and farm more extensively.

In the well organized and more permanent towns at some of the mines, the miners own town lots, upon which they build houses. Such houses range from the $150 shacks to the modern bungalow cottages, and two-story houses costing $2,000 or more. Probably one-half of the houses owned by miners are upon town lots and one-third upon leased land. The others are on farms owned by the miners. Because there is no fire protection, the

miners seldom build houses costing more than $500. In Spadra where there is always a long spring shut-down, nearly one-fifth of the miners farm rather extensively and many others work at some other trade during the idle season. Over the entire coal-field, about ten per cent of the married men cultivate two or more acres.

General requirements of a coal camp. Generally a coal miner is married or lives with his parents. The companies opening new mines are therefore supposed to provide houses for the miners. At camps away from the towns, there is also a boarding-house built by the company and rented to some woman, who boards visitors, new miners, and a few unmarried miners. A few miners' wives also take in boarders. By agreement with the miners, the companies usually collect the board-bills for all the landlords. In the semi-anthracite districts, a change-house with shower baths is provided at most of the mines by the company. Nowhere are there the free bunk-houses which are always provided at the metal mines, where so few miners are married.

The company houses. The almost universal custom requires the miners to pay $2.00 a month for each room, regardless of the character of the house. The miner wants from 2 to 6 rooms, generally 3 or 4. The company houses are of shed construction; that is, the outside walls are built of 1-in. boards set vertically and nailed together by heavy battens outside the cracks. The

Fig. 53. Part of a company camp, No. 4 Mine, Hartford.

common 'good' house is lined with building paper, and neatly ceiled and painted inside. The three room T-shaped house with porch is probably the most common. The second house in Fig. 53 is of this style. The type shown in Fig. 54 is said to be a little cheaper. The four-room houses are less frequent and are

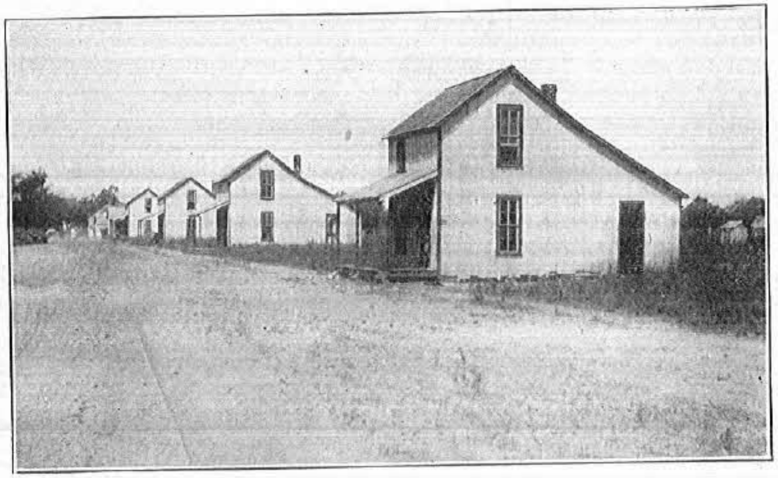


Fig. 54. Part of a company camp, No. 3 Mine, Huntington.

commonly square with a hipped roof and porch, like the third house in Fig. 53. The cheapest style of four-room house has a high gable roof over two rooms, and a lean-to, without separate ceiling, over the other two. On account of the greater cost per room of the two-room houses, they are often of rough unpainted boards outside and are rarely ceiled, but are lined with wall paper upon cheese cloth. These are occuped by an inferior class of miners and are rare. At one camp not owned by the company, two-room houses of the cheapest construction, and in very bad state of repair are now rented for $3.00 per month, instead of $4.00.

Since the weather is seldom very cold and then only for brief spells, the houses are open underneath to keep them dry in summer and to lessen decay. Because of the warm climate, there is little demand for plastered houses. Several rather expensive plastered houses, with more windows than usual, were built at Midland. A few were rented to town people at higher

prices, but the miners would pay no more than $2.00 a room and demanded the houses at that price.

The ordinary houses, if built in small numbers, cost from $50.00 to $90.00 per room, the price varying with the number of rooms and kind of construction. If they could be rented steadily at $2.00 per month for each room, they would yield from 25 to nearly 50 per cent gross income per annum. This is possibly the reason that the miners are not always encouraged to build their own houses. The insurance rate and depreciation are very high, however.

Vandalism. At most of the camps, as soon as a house has been vacant more than one night, every pane of glass is broken. The windows have very small panes to reduce the cost of replacing them. In a week or two the sash goes out as well as the glass and the doors sometimes follow. This is supposed to be done by the inevitable bad boy, but in most cases he has at least the tacit consent of his parents, if not their active encouragement. There is no apparent reason for this attitude except possibly a desire to provide work at the company's expense for the man who replaces the windows. Of course, only a few of the parents are of this objectionable sort. It is recommended that the windows be so designed that the entire sash can be removed for safe keeping, as soon as the house is vacant. When the plastered houses at Midland became empty, the boys not only broke the windows, but knocked off the plaster as high as they could reach and as thoroughly as possible without too much work. It is reasonable to suppose, therefore, that if a miner wants a plastered house in the future, he must build it himself.

Besides causing ill feeling, this vandalism prevents the companies from putting more than one window in a room, except the kitchen. It also results in their building few houses, with the hope that none will be vacant. As is usual with mankind, the miners as a whole suffer for the faults of a few.

It is a pleasure to be able to record one exception to this general spirit of malicious destruction. At Montana, near Spadra, the Scranton Anthracite Coal Co. built a number of attractive four-room cottages as shown in Fig. 55. These had as many as four windows in some of the rooms and rented for

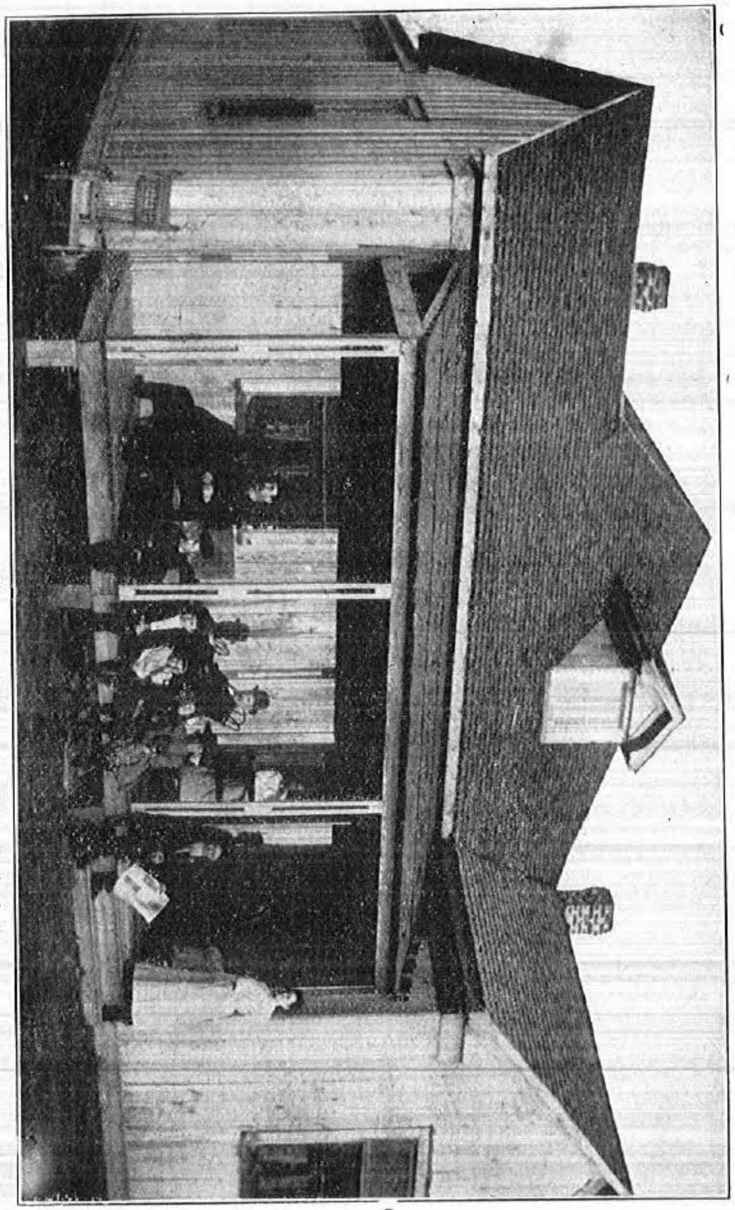


Fig. 55. Company house at Montana. Miners in 'idle day' clothes.

$10.00 a month. After the mine was closed on account of the mine-run law, all these houses stood vacant. Though no special precautions were taken to guard these houses, two years later very few, if any, of the windows had been broken. Figure 55 also shows a representative miner's family as they appear on 'idle days' or week days upon which the mine is not working.

General appearance of the company camps. As there is no fire protection, all the company houses are quite a distance apart. This has also a sanitary advantage. The camps are located upon high, well drained land, if any such place is within half a mile or so of the mine opening. Some are very cheerless and uninviting. Figure 54 is a view of the least attractive part of the most unpleasant large camp seen. Besides the discomfort of the dusty main road just in front of the houses, the water supply at this place is very deficient. This camp is, however, at Huntington where the majority of the miners own their own attractive homes or soon find a better place to rent. The houses shown are, therefore, occupied chiefly by Mexicans.

None of the camps shaded by some of the original fine oak trees could well be photographed. Figure 53, No. 4 camp at Hartford, is one of the more attractive open camps. The photograph, which was taken after the extreme heat and drouth of 1909, does not give a good idea of it. Figure 56 represents about an average camp. It was taken after some 10 weeks suspension of

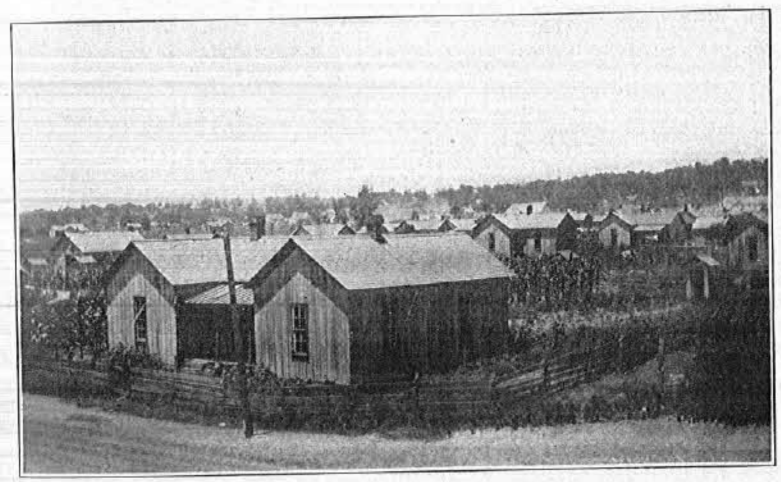


Fig. 56. No. 2 Camp, Denning.

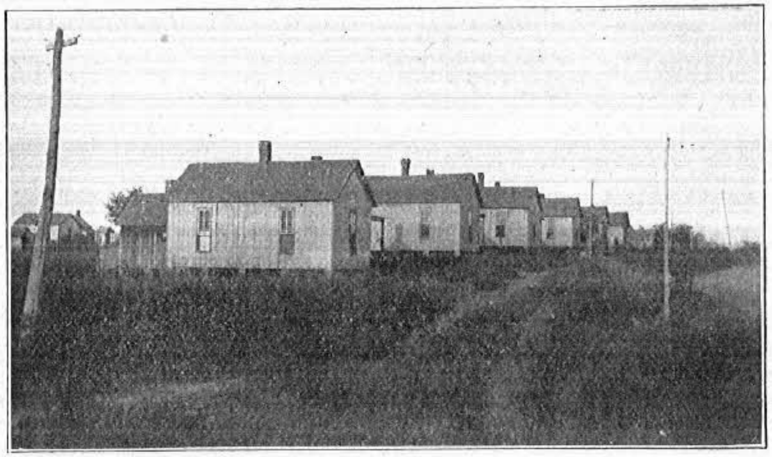


Fig. 57. Part of the company camp at Jenny Lind.

mining, and shows the extent of the gardens. Figure 57 shows the less attractive side of a row of T-shaped, three-room houses.

Besides raising vegetables, many of the miners or their families take great pains to plant flowers and improve the appearance of their homes. This is true of the majority of those who own their own houses, but some of the company houses are

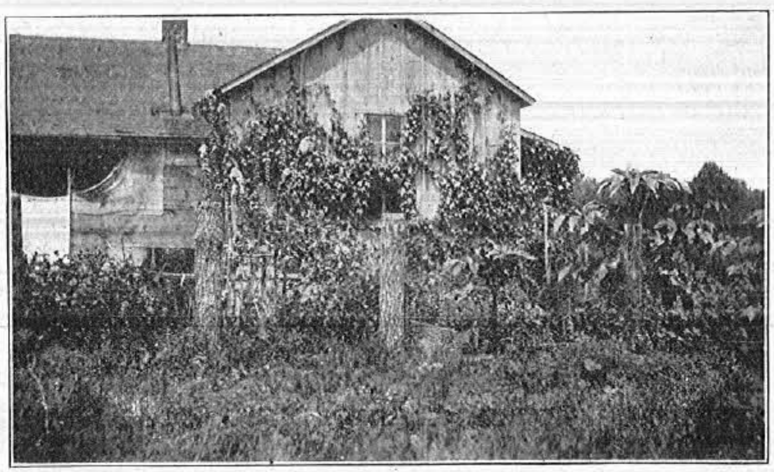


Fig. 58. Flower garden around a company house in Fidelity Camp near Greenwood.

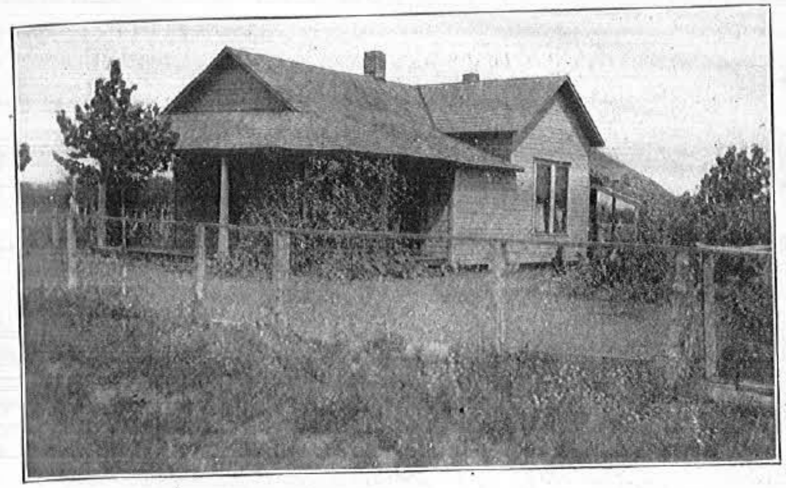


Fig. 59. A well cared for company house at Fidelity Camp near Greenwood.

made very attractive at those camps where the miners have no opportunity to build. Figures 58 and 59 show two such places, and give a better idea than words, of the high class of citizens some of our miners make. The figure gives no idea of the brilliant colors surrounding, what in one case would otherwise have been only a company shack. The dilapidated appearance of the house is due to an attempt to wall in the porch with brattice cloth.

WATER SUPPLY.

Deep wells. In most of the coal camps, the ground-water is very near the surface and is unwholesome. For this reason, nearly all of the companies drill deep wells into some stratum of sandstone to supply drinking water. Generally, this water contains enough iron to give it a taste disagreeable to a stranger, and it is slightly hard. It is, however, very healthful, and the people soon get used to the taste. The wells are commonly equipped with a bucket and chain as shown in Fig. 60. A form of vandalism is to fill these wells up with stones, valuable articles like fire brick belonging to the company, or even rubbish. To prevent this, some wells have pumps which afford protection but are expensive to maintain.

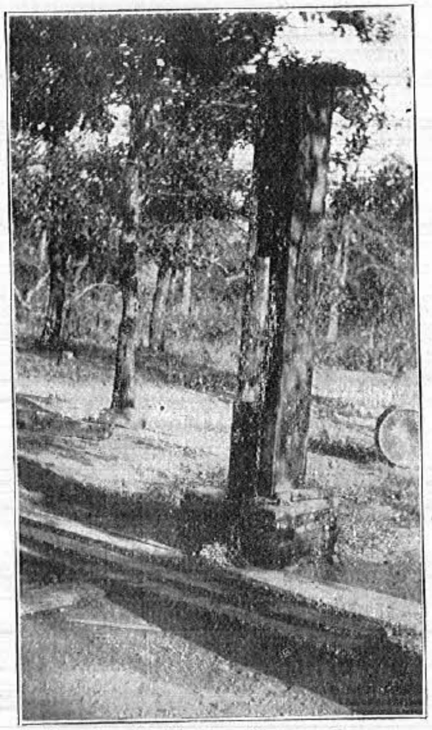


Fig. 60. Drilled well near Burma.

Soft-water supply. The miners bathe every day after returning from work, and in addition to the drinking water, most of the camps are supplied with soft water for laundry and bathing purposes. This is called 'scrub water' and is piped from the tank which also supplies the boilers. It is drawn from ordinary yard hydrants placed at intervals along the streets. This scrub water is obtained from the mine or from the surface pond, which is built to catch rain water. The miners all prefer to have the soft water piped to their homes, because it is easier to carry drinking water, which is needed in less quantity.

Drinking unwholesome water. A few of the more ignorant and careless families drink this filthy water, provided it is clear. Some of the miners think the iron water from the deep wells is unwholesome. They dig shallow wells or try to get a 'spring' by blasting a hole in the rock of a creek bed, where they often get a stream of water from the creek. This is strained

through a little sand between the rock layers and contains most of the microbes of the creek. There is such a well carefully curbed up within a few feet of the good well shown in Fig. 60. As often as it is filled up by the operator, it is cleaned out by a new-comer. This bad water is a cause of typhoid fever.

Unusual water-supply conditions. The deep wells are sometimes drained by the mine workings, as at No. 3 camp shown in Fig. 54. Here the people are required to depend upon two dug-wells in the shale. The water is apparently good enough, but there is an insufficient quantity and it is soon all dipped up. Figure 61 shows a number of women waiting for

Fig. 61. Shallow wells at No. 3 Camp, Huntington. This also shows the common type of four-room house built for the miners.

water to trickle into the well. There is another well where the man is standing, but at the time the photograph was taken, the creek water in it was manifestly unfit to drink.

At Spadra, there is no shallow water and the deep water tastes so strongly of iron and sulphur that it can hardly be used. A few houses have cisterns or rain water barrels, but many of the miners must buy water at 50c. a barrel. This is about the cost of hauling it from some open wells 2 or 3 miles away. The inadequate water supply no doubt does give some grounds for the complaint that Spadra is very unhealthful, and the resulting scarcity of men may have helped a little to increase wages there.

Where there is a company store or large office building not near a dusty tipple, wholesome water is collected in cisterns, but this is seldom more than enough for the office and store employees living near, and the water is often under lock and key, during the dry season.

Under normal conditions, the Fidelity camp near Greenwood has probably the best water supply. In the mine, there is a strong spring of pure soft water which is pumped to camp, and serves as both drinking and scrub water. However, as soon as the pumps are stopped by a suspension of mining or accident, the town is without water. A combined deep well and prospect hole was being drilled at the time of the writer's visit.

SANITATION.

General unhealthful conditions. The general sanitation of the coal camps is a difficult problem. The climate is warm and the valleys wide and poorly drained, so the malaria mosquito flourishes. On account of the rather poor soil, the growth of weeds is not especially luxuriant; but, except in very dry years, there are plenty of weeds immediately surrounding the houses to afford lurking places for the mosquitos in the day-time. The ground beneath the weeds has the musty smell of fallen leaves and weeds that have died from want of sunlight. These weeds attract the mosquitos from their breeding places. Such conditions are new to most of the miners from other states, and, unfortunately, they do not fear the mosquitos which are less annoying than ticks and chiggers. The houses are very seldom screened.

All dish-water and other slops which are not fed to the pigs are thrown upon the ground near the houses, and afford breeding places for flies. At some places, the pigs are allowed to roam at large, and are then a possible sanitary advantage by consuming garbage. But they cause so much annoyance that the owners of the pigs are generally required to keep them penned. The pens are ideal breeding places for flies.

Each house has the ordinary outdoor water-closet. Except in the organized towns, these closets are rarely if ever cleaned and never disinfected. They are entirely open, as if for the especial convenience of the flies. According to statements of physicians, there is always some typhoid at every camp. All the

mine water is sure to be more or less infected, and the outhouses can furnish plenty of germs for the flies to distribute. While the closets are far enough from the houses to avoid offense. they are sufficiently near for the flies to easily visit the miner's table at every meal and infect his food.

The prevailing ailments are malaria and typhoid. There is also some dysentery. When working in poorly ventilated mines, the men suffer from headaches. Pneumonia, rheumatism, and consumption are less prevalent than in the northern camps. The physicians say that the conditions of life among some of the foreign miners are such that one wonders how any of them can live, and that their remarkable power of resistance is all that saves them. The fact that they will not stay in bed even with a temperature of 103 degrees from typhoid, helps to spread the contagion.

Dysentery. The dysentery in the mining camps is partly due to the heat, but is caused chiefly by improper food. For this reason, only the most robust children grow up and the infant mortality is great. But on account of the abundance of fresh air, it is much less than among the working people of the crowded cities. These troubles can be helped only by educating the house-wives. This is the more difficult on account of a prejudice against educated people, which is strongest among the most ignorant of the miners. The great majority of the miners can afford good food, and most of the English-speaking miners are free from dysentery.

The prevention of typhoid fever. To check the typhoid, it is recommended that shallow surface wells near possible sources of polution be prohibited. In the few places where it has not already been done and is feasible, deep wells should be drilled. When necessary, a complete engineering study should be made of the problem of water supply. It will be very difficult to educate all the people against drinking impure scrub water, from the boiler pond. A double set of hydrants to supply both drinking water and scrub water is ineffective, and the miners object to hard sanitary water alone.

On account of the tight nature of the soil and the moist climate, deep privy vaults fill with water and in spite of disinfection become breeding places for millions of mosquitos, even in the higher and better drained locations. The closets should, therefore, be arranged to be easily cleaned and thoroughly sprinkled with lime at least twice a month at dwellings, and once a week at boarding-houses. They should be provided with tight receptacles and should most certainly be closed with a door strong enough to prevent the pigs from getting at the filth and scattering it broadcast over the camp. These doors should be kept in repair and might be made tight enough to keep out most of the flies. Formaldehyde is the best disinfectant, but is hopelessly expensive, on acount of the large quantity needed. Bichloride of mercury decomposes too rapidly. Copperas is quite cheap, but not much more effective than air-slacked lime, which can be used in large quantity on account of its cheapness. To encourage its use, all closets should be kept provided with a supply. If lime is freely used, the closets need not be so frequently cleaned, but it is feared that the main reliance for sanitation must be placed upon the scavenger. Special disinfection should be practiced in case of known sickness from typhoid. The hog-pens should be removed to places beyond the camp.

Reduction of the malaria. The malaria mosquito does not fly far from its breeding place except when carried by the wind. As the prevailing winds are from the south, all new camps should be to the south of the sluggish streams and ponds, and as far from them as convenient. The number of mosquitos can be greatly reduced by keeping the weeds well mowed over the entire camp. To keep out the mosquitos as well as the flies, the miners should be encouraged to cover the windows with cheap mosquito netting, and they should be furnished with strong wire-screen doors. The return of these in good condition should be insured by a cash deposit. When the miner calls for this deposit, the windows can be taken away as already suggested.

The mowing of the weeds and the scavenger work should be paid for by the companies as a charge against the rent-roll. The money spent for this would give a handsome return in improved healthfulness. This would bring an increased number of miners and a lower wage scale.

Company doctors. It was formerly the custom to charge all the employees of the company a doctor fee which secured all necessary medical attention; but by arrangement with the Union,

the payment of the doctor's fee is now optional. This fee is only $1.00 and is paid by the less healthy miners and those with large families, provided the doctor has a good reputation. The stronger miners do not need a doctor except when they are hurt, in which case they call in any one they wish. At the larger camps, the doctor fees and outside practice are sufficient to attract able physicians; but at some of the smaller mines, the doctors are inefficient, and the companies are guilty of yeilding to a demand for an 'older doctor' by engaging men with no medical education whatever.

Union hospital at Clarksville. With a general payment by the miners, good medical treatment can be obtained at small cost. Dr. W. F. Smith of Clarksville has organized a Union hospital for the Spadra district. The three local miners' unions voted to pay 50c. a month for each member and about 400 miners contribute. All the miners and their families get medical treatment, which includes board, nursing, and surgery at the hospital when necessary. In addition, there is a free dispensary for treatment of minor wounds and sickness. The hospital has 12 beds and there is an average of five patients in it all the time. There were 128 patients during the two years 1908 and 1909, and about 150 visits per month to the dispensary. Injuries, and all sickness except obstetrical cases and contagious and venereal diseases are treated. The fee would be about sufficient if 500 miners contributed. The hospital at Clarksville is available for outside patients who pay. This is in the less healthful Spadra district.

HOME LIFE OF THE MINERS.

Furniture. Nearly all of the houses owned by the miners and three-fourths of those in the company camps are comfortably furnished. Many of the rented houses are very well furnished. Certain of the miners do not wish to invest their savings in a house which ties them down to a single camp, and instead buy good furniture and portable conveniences for their families. Upon this, the miner can borrow money when necessary. As an extreme case, the writer saw a fine piano and other expensive furniture going into one of the houses shown in Fig. 54, p. 106. To those miners who wish to improve the looks of the houses, the companies furnish paint for the ceiled houses, or cheap wall paper for those that are papered. The miner can select his own colors. Attractive lace curtains, carpets, and the cheaper musical instruments are quite common; but mosquito bars and screen doors are seldom seen. A few of the married miners, who are habitual drunkards, or poor and irregular workmen, have only large boxes for tables, smaller ones for chairs, and very dilapidated kitchen outfits. Some sleep upon dirty bedding on the floor and live most wretchedly.

Mining is dirty work and the miners must bathe every day. So far as known, they never use portable bath-tubs but almost always use a common small laundry tub half full of hot water. The resulting puddle on the floor is cleaned up by the women folks. The women also wash the miner's pit-clothes before they become unsanitary.

Income of the miners. As will be explained later, the net monthly income of the diggers, or men who mine the coal in rooms or entries at so much per ton, is about $69 a month on an average. The more skilled and industrious men earn more, say $100 to $150 per month. The top men probably average $47 and the company men under-ground, $53 a month.

By agreement, the miners are paid every two weeks. If money is due them, they may at any time get orders on some store. If a miner who is not settling up to quit, draws cash at other times than pay-day, he is charged 10 per cent for the accommodation. There is rarely any reason why the miner can not save a little cash from pay-day to pay-day, to procure such articles as can not be bought on store orders. Still, at one mine where no objection is made to discounting money for the miners, 11 per cent of the pay-roll is discounted. Few of the miners discount everything they earn, so the number who discount some of the earnings each two weeks may be estimated at 15 per cent of those working at this mine. This means that this proportion of the miners are habitually short of funds and ordinarily live from hand to mouth. At this mine, nearly 10 per cent of the men discount everything they earn. These are the poorest miners or irregular workers and do not earn as much as the good miners who discount nothing. Toward the close of a wage contract, even the most shiftless miners try to save a little money in anticipation of a long suspension of mining after the contract expires.

Purchase of supplies. The miners are not now obliged to trade at the store of the company by which they are employed, and the company store must meet the general competition of the independent dealers. The companies having stores of their own do not issue store orders between pay-days except upon their own stores. If the company is small and has no store, the miner can get an order good at whichever one of a large number of stores he specifies. The value of the order is deducted from his pay and given to the store, which pays the mining company 10 per cent for collecting the account and protecting it from loss. The 10 per cent which the operators charge the miners for cash between pay-days, induces them to take store orders which are accepted at full value by the stores. Some coal companies with stores refuse to give the miners cash except in case of sickness or other emergency. It is then done by the cashier as a personal favor and without charge. The improvident miners working for these companies get cash with which to buy whiskey between pay-days, by selling their store orders to others. Store orders can always be bought at the large camps at 85c. or 90c. on the dollar. They are sometimes as cheap as 75c. on the dollar. At all the camps except Jenny Lind, there are competing stores which are close at hand. Some of the larger companies having stores in several states, can buy goods in large quantities. Such stores are well managed and get the general outside trade.

For lack of training in household management, the living of the miners is often unnecessarily expensive. This is common with many of the poorer people everywhere. The majority of the miners buy at a single store in very small lots, and any comparison between stores is based upon prices only. The more intelligent of them are better managers. Many of them club together to do shopping in rather a wholesale way at Fort Smith, or send to the catalog houses for supplies. As yet, there are no coöperative stores in this State managed by the Union. This ought to be a good opportunity for the miners to save a possible 5 per cent on their purchases but there have been two many failures and swindles.

The miners' children. While many of the children are neatly dressed, the general surroundings of a mining camp are not clean enough to justify spending much time on clothes.

Some sort of school facilities are provided by the public. In some instances, school houses have been built by the companies. As a rule, the schools are too far away, too crowded, and the terms too short for the best results. Nearly all of the teachers are well paid for the short time they are employed, and seem to a visitor to be quite efficient, but they need more facilities and have too many pupils each, for effective teaching.

The foreign-born miners, even those who are themselves illiterate, seem much more anxious that their children get some schooling than are the American-born miners. The recent compulsory education law may help this condition.

DRINKING.

Abolition of saloons. By local option, there are no saloons in any of the mining camps. In many cases, this was brought about by skillful political work in locating the first smaller districts, from which the saloons were removed by majority petitions signed by the farmers as well as their wives. Subsequently, these were combined and voted the remaining towns dry. The last of the camps to be made dry was Bonzana, where the saloons were voted out in 1909. The miners at Russellville constitute such a small percentage of the people that they have very little influence, and that county has been dry for over 20 years. At nearly all the camps, a considerable majority of the miners are now in favor of keeping out the saloons, although they themselves drink. The miners can get all the liquor they wish by express from Fort Smith, and the great extent of this mail-order liquor business in good evidence that 'blind tigers' and other illegal methods of selling whiskey are scarce. At some places, a few of the miners make a colorless drink called 'Choctaw beer,' or 'choc.' It is made of malt, hops, and sugar. Little of this is sold, however. The express business has led to the drinking of relatively more whiskey and less beer, but the miners club together and order kegs of beer. A few get cases of bottled beer. They rarely deliberately order enough to make themselves drunk, and the supply soon runs out. All persons agree that the amount of drunkenness and disorder has greatly decreased since the public saloons disappeared. There is said to be illegal selling of intoxicants at Spadra, but elsewhere by general consent of the miners, the law is well enforced.

With the saloon, went also the houses of prostitution, and there is now no obvious immorality at the mining camps. The general morality of the miners is above the average.

Amount of drunkenness. Most of the foremen were asked about the drunkenness of the crews. The general average of the estimates thus collected shows that, outside of Spadra, an average of 5 or 6 per cent of the crew is out every day because of drunkenness. At Spadra, nearly 25 per cent of the places are vacant each day; but this is partly on account of irregular working of the mines, and the employment of the miners at other work. Probably 20 or 25 per cent of the miners throughout the coalfield get drunk on pay-days, and possibly 50 or 60 per cent upon Labor Day, New Year's, and other holidays.

The amount of drinking varies greatly with the personal influence of the superintendents and their pit bosses. At one large camp, the general drunkenness of pay-days has been reduced from 25 per cent ten years ago, to something like 1 per cent at present. This is chiefly due to the personal influence of the officials. Prohibition, the weeding out of drunkards from the crew, and other causes have also aided.

A still more striking instance of the effect of the personality of the officials was noted at one small camp where after New Year's Day, 1910, only one miner in a crew of a little over 100 men, was unable to go to work. At an adjoining mine the pit boss, who was very able in a technical way, complained that nearly 25 per cent of his crew was out every day on account of drunkenness.

At one camp, the general opinion of the doctor, bosses, merchants, and some of the drinking miners themselves, is that more than half of the men at all the mines get helplessly drunk every pay-day. Here the earnings of the miners are less than the average of the State, but the general surroundings are more pleasant than at many camps. There has always been a scarcity of labor at this place, and many of the men who have been shipped in are merely waiting to save enough money for a 'road stake' upon which to leave. Whiskey interferes with this saving, so the drunkards stay and the temperate men leave. An unusually large proportion of these men are Italians. The Italians at other camps have a good reputation.

NATIONALITIES OF THE MINERS.

At the smaller mines, the pit boss and officials of the Union know every individual man; but at the larger ones only estimates of the number of men of each nationality could be obtained. Many pit bosses do not distinguish illiterate Lithuanians from Slavonians and Hungarians, although the first come from Russia and the others from Austria-Hungary. They go under the general slang name of 'Hunks' or 'Bohunks.' Special inquiry was occasionally needed to distinquish between Americans, and Scotch, Welsh, and English; and at one or two places, Germans and German-speaking Austrians were combined.

All the day-men, or direct employees of the company, such as drivers, trackmen, and general roustabouts, must speak English to readily understand orders. In a room, however, the miner is practically supreme, and the only need for English is to ask for props, and powder, and to talk to the pit boss while he is masuring yardage, draw slate, etc.

Of some 4,700 coal mine employees in the State, the different nationalities make up the percentage given in the following table:

Nationalities of the coal miners in Arkansas.

Nationalities	per cent	Nationalities	per cent
Americans		English	1.0
White	66.6	Belgians	0.9
Negro	2.0	French	0.8
Italians	5.8	Bohemians and similar peoples	0.5
Scotch	5.0	Hungarians	0.5
German-Austrians	4.2	Mexicans	0.4
Germans	3.0	Lithuanians	0.3
Irish	2.8	Swedes	0.3
Slavonians	2.2	Russians	0.1
Welsh	2.0		
Poles	1.3		

White Americans. American-born whites make up about two-thirds of the crews. Of these 20 or 25 per cent are natives of Arkansas. The other Americans are generally experienced

coal diggers from other states, chiefly Alabama, Pennsylvania, Indiana, Tennessee, and Kentucky. The natives of Arkansas are not used to mines and those underground are generally young; but of the top laborers, three-fourths or more are Arkansas men. A considerable number of the English-speaking miners have studied more or less with the correspondence schools, and the majority of the fire-bosses and pit bosses have finished such courses. Through these men, the technical knowledge of all the miners is increased. Many of the men are generally interested in geology, ventilátion, and general mining problems, and ask intelligent questions whenever the opportunity offers. No figures as to number of correspondence students could be obtained from the schools.

Negroes. From all the camps except those about Huntington and Russellville, the negroes have been driven out by the white men, who feared their competition. At the Southern Anthracite Company's mine at Russellville, all the negro diggers are in two 'nigger entries' separate from the white miners. These entries have negro drivers. There is one other negro driver hauling coal from the white miners, and upon the surface there are three negro workmen. At all the other mines, the few negro diggers are given places according to the order of their names on the list of waiting miners, and are, therefore, scattered throughout the mine. There is some opposition from the whites to the negroes who dig coal by the ton; but for heavy day-work, such as handling the cars, there seems to be no objection to the employment of negroes. The negroes who dig coal are generally quite satisfactory to the management, for they are anxious for work and do little complaining about shortage of cars, deficient coal, or the measurements of the pit poss. In the same way, the negro drivers try to get as many cars to the white diggers as possible, and, provided there are only a few of them, are accommodating about helping the miners with their cars. When they are numerous, negro day-men are inclined to loaf unless some one else sets the pace, as when they must cage all the cars that are sent to the shaft. The few negroes who are willing to work in the mines are quite steady workers. The negro diggers are accustomed to consider the company a friend as against the white miners and are therefore a source of weakness to the Union.

Italians. The Italians are the most numerous of the foreign miners and make up 5.8 per cent of the men; but they are so generally scattered throughout the district that they are the predominating foreign element at only two camps. At one of these places, their drinking is troublesome; and at both, they are inclined to be unruly and to strike over little details, even though this is in violation of their agreement with the operators. At the other places, they are satisfactory workmen. They are chiefly from the north of Italy and are pretty fair citizens. Although nominally Catholic, they pay little attention to church festivals. They desert the Union readily, and are dirty around their homes.

Scotch. The Scotch are the next in number among the foreign miners and make up 5 per cent or more of all the number. They are collected at Huntington, although there are a few in nearly every camp. As a rule, they are more skilled than even the Americans, and are less reckless and more inclined to save their money. They are not unreasonably quarrelsome, but insist upon their rights, and together with the northern-born Americans are the main strength of the Union. They stick to their side of an agreement, are the last to give in during strikes, and do not threaten. Of course they are welcome at all the mines.

Austrians. There are now 4.2 per cent of German-speaking Austrians among the Arkansas miners, but the number is rapidly increasing. Many are coming across the ocean direct to Arkansas instead of working from camp to camp as do the other foreigners. They are all Catholics, and where in large proportion as at Jenny Lind, they tie up the mine by staying out at church festivals. Especially is this true during Lent and on St. Barbara's Day (December 4th).

These Austrians are fond of beer, but rarely get drunk and never disturb any one else. At Jenny Lind, they have organized drinking clubs which are supplied with beer in kegs. This comes by wagon from Fort Smith. They sometimes stay at these clubs till 2 a. m., but are able to work upon the following day. They occassionally invite their American friends to these meetings, but never accept invitations from the Americans. When an Austrian, who has recently come from Europe, builds his own home, he plans to keep boarders. A small room at one end of the house is the private bed-room of the family. At the other end is a kitchen and in the middle is the largest room. At night, eight or twelve unmarried miners sleep in this room on cots along the wall. In the day time, it is the dining-room, and on idle days the general loafing place for smoking and drinking. When they first come to this country, their habit is to boil together everything they eat. This is served in a single large bowl from which they all eat. Very soon, however, they learn the more dainty habit of individual plates, and the more appetizing, if less healthful frying of the food.

Since the Austrians are clever, industrious, and peaceable, they are much desired in spite of the occasional celebrations. At first they do not understand shooting out the coal without first undermining it, and may put in some very dangerous shots. It is recommended, therefore, that they be not employed in mines with explosive dust, or in gassy parts of mines, until they have had some American experience. They are now considered a source of weakness to the Union because, as yet, they seem disposed to accept, without complaint, any reasonable settlement offered by the pit boss on measuring day; and do not demand increases in the scale of pay. It is feared that when they once begin to quarrel with the companies, they will lose all restraint and resort to violence, as they have done in other states.

Germans. About 3.0 per cent of the men are supposed to be Germans although some of these may be Austrian. There are more Germans at Bonzana than elsewhere, but they are found at most of the camps. As is well known, they are fond of beer. They have no striking peculiarities as miners. There are a number of German pit bosses in the State. Many American-born miners of German descent work at Paris.

Irish. The figures show that the Irish with 2.8 per cent are next in number, but many of them are undoubtedly American-born. There are only 15 or 20 regularly working at all mines outside of Spadra, and of these, a number are pit bosses and superintendents. At Spadra, however, they make up about 25 per cent of the crew, and are chiefly from the anthracite region of Pennsylvania. They are said to be responsible for nearly all of the labor troubles that originate with the miners in the unruly Spadra district. They drink much whiskey, which brings disorder among themselves as well as trouble with the companies.

When sober, they are splendid workers, but are inclined to be reckless.

Other good foreign-born miners. The Welsh and English are good miners and splendid citizens, but so far as distinguished, make up only 2 per cent and 1 per cent respectively of the crews. The other foreign miners of the better class are the few Belgians, French, and Swedes. The only criticism against them is the difficulty of talking to the few, mostly Belgians, who have not learned English.

Slavonians. Of the illiterate foreigners, the Slavonians make up 2.2 per cent of the entire mine force. They are most numerous at Denning. Besides getting drunk at the church festivals, they are all drunk for three or four days whenever there is a wedding among them, but are otherwise steady workmen. They can not read their statements, and their ignorance of English annoys the pit bosses. They are not very intelligent and are unsanitary in their way of living. At all places except Denning the nationalities together are organized into local labor unions on the basis of the mines at which they work; but at Denning the Slavonians and a few Poles have a so-called 'Polish local' of their own, which is distinct from the two English-speaking locals of the district.

Other illiterate foreign-born miners. Altogether there are 1.3 per cent of Poles. Those at Hartford discount their wages and get drunk as often as they have a few days earnings to their credit. They work very irregularly, and are undesirable to both the company and the Union. At Denning, the Poles are said to be more temperate than the Slavonians. In the mines of Arkansas, there are small numbers of Hungarians, Bohemians, and others from Austria-Hungary, and, at the time the statistics were collected, only three Russians. The miners of these nationalities are less satisfactory than the Germans, but are too few to have much influence upon labor problems. Altogether they constitute only 1.3 per cent of the mine workers.

Mexicans. There are 0.4 per cent of Mexicans, nearly all of whom are in a single colony at Huntington. They are more intelligent and have a better knowledge of machinery than the average Mexican who has not left Mexico, but very few speak

English. They are physically weaker than the other races, so are not greatly desired. They are a weak element in the Union, have no idea of sanitation, and are friendly to those who speak Spanish, but keep much to themselves.

Day-men. Since most of the day-men are Americans, the percentage of foreigners among the contract diggers is greater than the figures given, by a little less than one-half. For example, about 8.5 per cent of the diggers are Italians, although only 5.8 per cent of the whole crew are Italians. Only 50 per cent of the diggers are Americans. Including the Scotch, English, Welsh, etc., there are some 65 per cent of the contract miners from English-speaking countries.

IRREGULAR WORKING.

Short time at the mines. Owing to the fact that there are more coal mines in the United States than are necessary to supply the demands for coal, the diggers do not expect to work much more than 20 days per month on an average, although the work is quite steady in the winter time. Occasionally the mine is in operation only a part of the day making what are called 'short runs.' The idle days and short runs cause a loss of time and wages to the miners and of output and profit to the operators. The short runs are expensive to the operators because the fire-bosses, shot-firers, and a few other employees get pay for a full day, so if the output is less the cost per ton for the labor is greater than usual. The short runs are most frequently caused by a shortage of empty railroad cars. At times the operator begins hoisting coal in the hope that the cars asked for will be delivered before all of the 'empties' already at the mine will be loaded. When the cars do not come the short run results. Others are caused by accidents to the hoisting plant or other equipment. In prosperous times the railroads can not obtain all the cars they need and the mines do not receive enough for full day runs.

When the mine is to work, the whistle is blown the evening before, so the miners know they are to come out. At times, they do not go down the mine unless assured that more empty coal cars will be supplied before the few on hand are loaded. The car shortage is especially trying at the mines upon the small independent roads. Nearly all of their own cars must be sent upon foreign roads to reach the markets, and when cars are in great demand these roads do not return them, but pay the per diem charge instead. In time of severe shortage, the mine can operate only a few days a week.

Irregular miners. By agreement, a digger can not be discharged if he lays off less than three full days in succession. Therefore, if the miner has been dissipating, does not feel well or thinks the weather too bad, he stays at home. A few are so shiftless that they scarcely work more than the required one day in each three. Many who go down more frequently will soon quit if any little thing in the room goes wrong and so work but a part of the day. Some superintendents claim that the miners will stay at home for slight excuse, if they have plenty of money or provisions ahead. On the other hand, the miners say that they are more likely to stay at home if the conditions of the mine are such that they can not earn much money by going out. Which of these is the true condition probably depends upon the individual miner. There is no doubt, however, that a chance to earn good wages will attract a better class of miners and so reduce the amount of laying off, provided the trouble makers can be kept out.

Extra work. The week days upon which no coal is hoisted are called 'idle days' and are used by the company in repairing the main roadways. The extra work is given in turn to the competent day-men who are asked to work by the pit boss on the day before they are needed. Because of the idle days, there is almost never any work done on Sunday. During the busy season, the repair work is done at night. In a few cases, work like sinking a new slope is done on both a day and night shift. For this double-shift work, the contract miners receive 28c. a yard extra, because the man working on the opposite shift does not always leave the place in good condition. In other cases, the sinking of a slope, etc., which interferes with regular work, is done only upon night shift for which the miners receive no extra pay.

GENERAL SENTIMENT AMONG THE MINERS.

Socialism. The miners are well posted upon current events. They spend many of the idle days talking with their fellows or reading the labor journals and newspapers. Most of the labor papers, to which the miners subscribe as a duty, are socialistic in policy, and a considerable number of the miners think they are socialists. Generally a 'socialist' digger expects more money than the driver or the boy who tends the door. His idea of socialism is, therefore, merely an arrangement by which the workmen shall receive also the share of the proceeds of the industry which now goes to the operator and the landowner. Many of the apparent socialists are foreign-born miners who have not been in this country long enough to understand fully the conditions, and who have been misled by false statements and appeals to class hatred indulged in by a few of the agitators. Some of these so-called leaders are the lazy, unskilled, or dissipated miners who merely serve to bring socialism into disrepute. Many of the real socialists are splendid miners who own their own homes and have saved considerable money. It is clear that these men are actuated by the highest motives. There are also a great many miners who are perfectly willing that their employer shall make as much profit as possible as long as he pays the miner full wages for his labor.

A few coöperative mines have been started. One of these, having seven members, is still doing well; but it is on a strict business basis and the efficient superintendent owns more of the stock than any of the others. In the same way, several little mines have been run by companies of two to four of the better miners. Where these have prospered, the owners soon lose interest in the miners and become members of the Operators' Association formed to resist the demands of the Union.

The real coöperative mines opened up in Arkansas have always failed, because every member wished to be superintendent or pit boss, or else was continually trying to elect a different set of officers. Occasionally, some of the members accused the others of doing less than their share of the work. In no case has such a mine lasted long enough to suffer from the difficulty of selling coal under the present strong competition.

The square turn. In those mines where the diggers are poorly supplied with cars, they demand that in general fairness, the same number of cars be given to each man. This is called a 'square turn.' In some cases, they demand a square turn even when they know that many of them will have all their coal loaded before the day is over. After these men have quit, the driver has little to do, and if the condition is general, the hoisting of coal is stopped before the good miners are much more than half through. The much better plan is to allow the good miners to get an extra car at intervals so that the miners who can get a clean-up during the day are through about the same time. Only the stronger pit bosses can do this, however, since so many miners object to a plan which enables a very good miner to earn more money than the average.

Favoritism. Some clever superintendents have a trick of putting all the agitators together in one or two entries where the coal is easy to mine and giving these men more than their share of the cars. This favoritism allays the energy with which the favorites demand an equal turn for all and generally make it easier to get along with them; but it is unfair to the quiet and often efficient miners that are left in poorer places. It was at one time the custom to put the undesirable miners in an entry where conditions were so unfavorable that they would quit. Such places were known as 'strangers' homes' and have been abolished by the requirement of the Union that places be assigned to the men in the order of application and as the places become available. At present, the undesirable men must be gotten rid of by tricks, or by shutting down the mine for so long a time that they leave the camp along with the good miners.

Before the days of the Union, a few of the best day-men were given all of the idle-day work. In cases, there was really unwarranted favoritism, so by agreement the companies are now required to divide this work equally among all the day-men who are competent. When, for example, one or two drivers are needed on a number of idle days, it is a fair rule that requires the work to be given to all the drivers in turn; but when it comes to cleaning up roads, building doors and such work, some drivers are nearly worthless. The rule as enforced ignores the question of competency. As an extreme case, the Union tried to compel the superintendent of one mine to give an equal share of this repair work at $2.56 a day to door boys who regularly earned only $1.13 a day.

Limitation of the output of the miners. There is an unfortunate attitude among the miners which causes them to attempt to limit in various ways the earnings of their fellow miners. In order to enforce the 8-hour day, the Union has made a very proper rule which allows none of the miners to work more than eight hours in any one day; but the other rules are less reasonable. For example, all of the diggers are required to be out of a mine within two hours after the hoisting of coal is stopped, even though the run stops only two or three hours after work has started and the miner has much work he can do in his room. No diggers are allowed in their places in idle days. At Jenny Lind, it is the custom for the entry-men to clean up the rock from the brushing shots at night. They are, therefore, required to stay out one day to make up for this, although the mine may be running only two or three days a week.

At times, the limitation of the earnings of the men is an inconvenience to the company, as when it prevents men who are driving a much needed slope or entry from working upon idle days. Such a rule is sometimes excusable and prevents undue favoritism in giving this extra work to friends of the pit boss. The miners will, however, limit the earnings of each other, even when it causes a loss to some of the men not earning extra money. Such a condition occurs each time an inner parting is made or an old parting extended in a narrow entry. In shooting down some coal from the side of the entry and widening it where the parting is to be made, some diggers are employed from the list of those waiting for places. This work obstructs the haulage-way and all the men regularly working in the entry are forced to lay off until the change is complete. Since the pit boss is anxious to reopen the entry, he will give the diggers working on the parting all the cars they want from the number that regularly would go to all the working places on the entry. Since full price is paid for the parting coal and it is very easily mined, these diggers can earn $15.00 to $20.00 a day. But should they do so, they would be heavily fined for accepting more cars than the other miners. The time the other men have to remain without work is, therefore, increased. In one instance, the men who loaded too much coal at the parting were compelled to remain idle for two days, although the labor agreement prevented the pit boss from putting new men in their places. The result was that all of the regular crew of the entry had to be idle two days longer just to discipline three men who had earned too much money.

Unnecessary employees. An equally unfortunate spirit appears in the desire to compel the operators to employ as many men as possible. This is often given as the reason why the miners demand the employment of shot-firers; but they also want shot-firers to reduce danger to themselves, and to fire their shots in case they wish to go home before the regular quitting time. This spirit does, however, lead them to demand employment of a trapper at each door, even though the driver who hauls coal through it may have so few cars to handle that he has ample time to open and close the door himself. For the same reason, the miners have prevented the companies from having work done in the mine upon idle days, by those men who are employed by the month. The miners demand instead that some of their number be employed to do this work, and this demand has been granted by the Arbitration Board selected to settle disputes between the operators and the miners. This spirit sometimes works a hardship upon the miners themselves, as at Mine No. 17, Jenny Lind, where the men refused to use steel track in their rooms unless company men were hired to lay it. This demand was refused by the company, and the miners have continued to use wooden track, although steel track is used at the new adjoining mine owned by the same company. It is cheerfully laid in the rooms by the miners, because it so greatly reduces the number of wrecks of heavily loaded cars with which the miners have to contend.

There is also a growing tendency to permit each man to do but one kind of work. This rule requires the employment of both a rock-man and a timberman, instead of one general man. When an entry reaches the property line or bad coal, and most of the rooms are finished, there is not enough coal coming from the remaining rooms to keep a driver busy. When possible a driver then works part of the time in another entry, but this is not always convenient and would give the miners irregular service any way. It used to be the custom to furnish two or three miners with a mule and give them a contract to mine the coal remaining in these few rooms and haul it to the parting.

Such contracts are not now permitted by the Union because diggers are not allowed to work also as drivers. The result is that the entry is stopped as soon as the cost of hauling becomes too great, and the operator loses the remaining coal upon which he has already paid 10c. to 30c. a ton for driving the entry, air-course, etc., and laying track. These little patches of coal can seldom be mined after the first mine is abandoned, and are thus permanently lost to the world.

Annoyances to the operator. These acts are interpreted by most of the operators as merely a desire to increase the expense of the company and reduce profits. A more typical instance of this lack of coöperation is the habit the miners have of laying off in a body at every possible excuse, such as the death of a child. Generally, so few men come to work on such occasions that the mine can not be operated profitably and the pit boss can not give these few men work. The next time still fewer come. At times 25 per cent of those who wished to lay off, go to the funeral, but more frequently only a few intimate friends of the family do and the others merely loaf. During a season of slack orders, the miners know that if they can tie up the mine on one certain day, it will give them work on what would otherwise be an idle day, so they inconvenience the company without injuring themselves. But in cases, they carry the plan of laying off whenever there is an excuse to an extreme. In one instance during a busy season following a shut-down, 300 miners laid off one day, on account of the death of a man that had belonged to the Union three years previously. Only 5 of the 300 attended the funeral. The intelligent miners were as much disgusted as the operator.

After the passage of the mine-run law, there was a great tendency to mix fine slate with the coal, as the diggers were paid as much per ton for this as for the clean lump coal. During the season of great demand, this caused complaint against the operators and made it more difficult to meet the competition in some markets, but it was chiefly the consumer who suffered. As the demand for coal decreased, the smaller companies having dirty coal were forced into bankruptcy and the miners were thrown out of work. This taught many of the miners a valuable lesson. The more clever superintendents and pit bosses explained to the miners that as far as clean coal was concerned the interests of the miners and operators were the same. The result was a considerable improvement during 1909; but there are always some men who will not play fair and they load out as much dirt as possible, relying upon their fellows to keep the average product clean enough to sell. The good miner then feels as though he was doing useless labor if he tries to clean his coal. The same feeling and the fear of ridicule from their careless fellows, have forced practically all of the good miners to be quite indifferent to the amount of slack they make in shooting their coal.

One very unfortunate attitude of most of the miners is their opposition to mining machines. It seems that in cases, the companies can remain in business under present competitive conditions and continue to pay present wages only by using machines. These do not save labor especially, but greatly improve the quality of the coal. The problem of machine mining will be discussed at length in Part II.

Officials. Many of the sensible miners do not now want the position of pit boss on account of the quarrelsomeness of the men; and, because of the increasing lack of coöperation between the miners and the operators, there is trouble in finding experienced foremen, who will be entirely loyal to the companies' interests. The pit bosses are commonly selected from among the sons of the older bosses, or from the more able fire-bosses. The fire-bosses are selected from the ranks of the miners. They have a good deal of responsibility, and must be steady men who have had much experience as miners. The work is generally light and the hours are such that the fire-boss has a good opportunity to study in the afternoons. He is the only employee subject to discharge at any time without interference from the Union. This tends to develop a desire to do careful work and a resulting loyalty to the company. The work of inspecting the mine for firedamp makes the fire-boss familiar with the entire mine. He also regularly assists the pit boss on measuring day, and so learns the administrative side, also. He is often an informal assistant to the pit boss before he is given full charge of a mine.

The superintendents have generally been pit boses of better education and more ability than the average. They are often taken from the mine of another company. A few superintendents

have first served in the office, then in charge of surface work, etc. If their tastes run to the actual problems of mining, they are very successful. So far as known, all the superintendents with a college technical training are financially interested in the companies operating the mines of which they have charge. Several of the smaller companies are owned by former miners, and of course these men act as superintendents of their own properties. In general, it seems necessary to have as a member of these small companies a clever coal salesman as well as a good mine superintendent. A few men are quite successful in both ways.

Many of the surveyors are young technical graduates, but such men as a rule remain only a short time, on account of the low salaries. At many mines, either the pit boss or the superintendent does the surveying.

THE UNION.

Organization of the miners. Until April 1, 1910, all of the mine employees except the office men and bosses belonged to District 21 of the United Mine Workers of America and all of the mines were strictly 'closed shop.' The constitution of District 21 is printed in full at the end of this chapter. It is admirably designed to further the objects of the Union, and to prevent discord as far as possible. Special interest attaches to the preamble and to the following portions: Article III, Section 10; Article IV, Section 11; Article VI, Section 1; Article VIII, Section 3; Article XII, sections 1, 5, 7, 8, 9, 10, 11, 13, 20, and 25; and Article XIV, Section 1. The local unions make their own by-laws.

Unless the mines are very small, there is a local union for each mine or each small group of mines belonging to the same company. At one local in Russellville and possibly others, it is a part of the regular program to discuss the details of the trade and the safe ways of handling gas and reducing danger. At most places, however, the locals are concerned only with administrative problems, wages, and the ways of obtaining concessions from the operators. The relations between the Union as a body and the operators are discussed in Chapter V.

Effect of the Union. To a certain extent, the tendency of the Union is toward the dead level of equality. At first it merely specifies the minimum wages to be paid, but this tends to make it more difficult for the especially good men to get extra pay; and after a time the man who receives extra pay is annoyed. If any man receives more than the usual pay the miners generally demand that all men doing that class of work receive this increased pay. For this reason it is almost never granted directly, but must be in the form of fictitious overtime.

At many locals, it is the custom to levy after each accident special assessments upon all the members in order to assist any miner who is injured and needs money, or to pay funeral expenses of those who die. In a very few places, such contributions are voluntary. So far as known, this help, the aid to study at Russellville, and the maintenance of the hospital at Clarkeville are the only unselfish activities of the Union.

Difficulties in maintaining the Union. The Union has been in control of the labor market for about seven years. It was organized and is maintained in the face of great difficulties. Some of the foreign races are very hard to hold together, and there is a strong tendency on the part of the southern white laborer to accept without question the opinions of the mine operators. Natural conditions also tended to make these people improvident, so they seldom have the accumulated savings needed to carry them through a long strike. In the other southern states, the presence of negro labor is a further source of weakness. It is probably only because of the scarcity of negroes in the Arkansas mining districts that the Union has succeeded at all, for Arkansas is the only genuinely southern state in which the United Mine Workers are well established. Among its other advantages, the Union has aroused the interest of these men in economic problems, and the consequent desire for more information will be a source of education.

There is a great deal of trouble with the officers of the Union. Although the constitution is very skillfully formed to prevent this, quite a percentage of the treasurers of the locals run off with the funds. Their bondsmen are miners and even if they have not previously left, and are able to make the shortage good, they usually beg off. The accounts are not audited by skilled outside men, and many of the minor officials misappropriate a percentage of the money by connivance of the other officers, or by deceiving them. Quite a few of the petty officers

are professional labor agitators, and merely want an easy way of earning a living. Many of the miners never attend meetings of the locals and an inner circle is often formed to run things as they wish, and to get favors from the superintendents. The superintendents naturally do not put themselves out in the interest of harmony in the Union. It is generally assumed that strike benefits are never as large as the sums contributed to the so-called 'defense fund' and this causes criticism of the officers. The legitimate expense of the Union in salaries and expense of national and district officers, the cost of conventions, and such things, are heavy, so the miners complain.

During 1909, the companies belonging to the Operators' Association collected from the miners of Arkansas and paid to the treasurers of the local unions nearly $93,000, or 4.56c. per ton of coal mined during that year. The average labor cost per ton of coal may be taken as $1.10. So upon the average, the miner paid a little more than 4 per cent of his earnings in cash to the Union.

In addition, the crew of diggers at all but the smaller mines pay about $3.30 a day to the check-weighman. Assuming that the soft coal mines run only 200 days during the year, and the Spadra mines only 175 days, the cost of the check-weighmen to the miners reaches a total of about $20,000 per year more, or 0.8 per cent of the earnings of the miners. The companies are all quite willing that the miners should employ a check-weighman and realize the necessity of having one. They therefore grant the request of the Union, and cover up this expense by deducting coal from the miner and crediting it to the check-weighman who is paid like any miner. At the big mines, this expense per miner is very little and the check-weighman is employed only where there are 30 or more miners. At the small mines, however, the cost is considerable. The companies insist that all other assessments to the Union be in cash. In some extreme cases, these amount to nearly 20 per cent of the miners' earnings, and there is complaint.

There are of course the expected clashes of opinion between the conservative and radical elements over questions of policy toward the operators and general Union problems. An extreme case of this sort occurred at Spadra at the first meeting of the joint local, after machines were introduced. Some of the miners directly concerned said they would stick to their agreement, and give the machines a fair trial at the tentative scale of wages. The radicals, chiefly from the other mines, wished to fight the machines in every way, regardless of promises. The debate soon changed to a free-for-all fight with the result that those who wished to properly run the machines were pretty well disabled.

As an outcome of all these irritations, nearly all of the miners are more or less opposed to the way the Union is now conducted; but they support it because they realize the need of its protection, and hope for better management in the future.

A surprising number of the men are, however, disgusted with the whole idea of the Union. The miners were never oppressed in this State as in some others because there was nearly always need for attracting skilled miners to Arkansas. Many of the better miners hate the idea of limiting wages, the unfair treatment given some of the operators, the stopping of work for trivial causes, the resulting idleness of the mines and loss of work, etc. Some of the miners have a personal enmity towards some of the leaders, who are often quarrelsome and unreasonable to those who oppose them. This soon changes to enmity against the Union. Others begrudge the cost of the Union. If, therefore, the local peace officers would really maintain order, several of the mines could be run non-union in spite of the hated name of scab.*

In some places, the locals are accused of not initiating all men who apply for membership and offer the initiation fee. This prevents their working at the mines and drives out miners that, from the point of view of the Union, are undesirable. This is supposed to be in violation of Article VII, Section 1, of the district constitution. To the credit of the Union, it must be said that it is done in surprisingly few cases.

At Spadra the locals do raise the initiation fee to prevent the joining of a sufficient number of miners to supply the demand. When therefore a trivial strike is declared against one

*As this report goes to press, information is received that two of the companies at Spadra are operating their mines with non-union labor. At one of these, where the men and property are well guarded, the effort seems quite successful. At the other the expensive tipple was burned down. It is claimed that this was purposely done by sympathizers of the Union, and the tipple is being rebuilt.

operator, all the miners in the district can get work at other mines, if the operator does not quickly yield.

On account of the surplus of miners during the last two years of 'hard times,' it is generally believed that the Union was maintained only by the 'check off' agreement by which the companies deduct from the pay of the miners all Union dues, fines, and assessments, whether the miner is willing or not.

CONSTITUTION OF THE UNITED MINE WORKERS OF AMERICA.

DISTRICT 21. MARCH, 1909.

PREAMBLE.

"There is no fact more generally known or more widely believed than without coal there would not have been any such grand achievements, privileges and blessings as those which characterize the twentieth century civilization, and believing as we do, that those whose lot it is to daily toil in the recesses of the earth, mining and putting out this coal which makes these blessings possible are entitled to a fair and equitable share of the same therefore, we have formed 'The United Mine Workers of America,' for the purpose of more readily securing the object sought by educating all mine workers in America to realize the necessity of unity of action and purpose, in demanding and securing by lawful means the just fruits of our toil. And we hereby declare to the world that our objects are:

"FIRST. To secure an earning fully compatible with the danger of our calling and the labor performed.

"SECOND. To establish as speedily as possible and forever, our right to receive pay, for labor performed, in lawful money, and to rid ourselves of the iniquitous system of spending our money wherever our employers see fit to designate.

"THIRD. To secure the introduction of any and all well defined and established appliances for the preservation of life, health and limbs of all mine employees.

"FOURTH. To reduce to the lowest possible minimum the awful catastrophes which have been sweeping our fellow craftsmen to untimely graves by the thousands; by securing legislation looking to most perfect of ventilation, drainage, etc.

"FIFTH. To enforce existing laws; and where none exist, to enact and enforce them, calling for plentiful supply of suitable timbers for supporting the roof, pillars, etc., and to have all working places rendered as free from water and impure air and poisonous gases as possible.

"SIXTH. To uncompromisingly demand that eight hours shall constitute a day's work, and that not more than eight hours shall be worked in any one day by any mine worker. The very nature of our employment, shut out from the sunlight and pure air, working by the aid of artificial light (in no instance to exceed one candle power), would, in itself, strongly indicate that, of all men, a coal miner has the most righteous claim to an eight hour day.

"SEVENTH. To provide for an education of our children by lawfully prohibitinng their employment until they have attained a reasonable satisfactory education, and in every case until they have attained fourteen years of age.

"EIGHTH. To abrogate all laws which enable the operators to cheat miners, and to substitute laws which enable the miner, under the protection and majesty of the State, to have his coal properly weighed or measured, as the case may be.

"NINTH. To secure by legislation, weekly payments in lawful money.

"TENTH. To render it impossible, by legislative enactment in every state, for coal operators or corporations to employ Pinkerton detectives or guards or other forces (except the ordinary forces of the State) to take armed possession of the mines in case of strikes or lockouts.

"ELEVENTH. To use all honorable means to maintain peace between ourselves and employers; adjusting all differences so far as possible; by arbitration and conciliation that strikes may become unnecessary.

CONSTITUTION.

ARTICLE I.

Name, Object, and Jurisdiction.

"Section 1. This organization shall be known as the Twenty-first District of the United Mine Workers of America.

"Sec. 2. The objects of this union are to unite all mine employes who produce or handle coal or coke, in or around the mines and to ameliorate their conditions by methods of conciliation, arbitration or strike.

"Sec. 3. This district shall have its jurisdiction over the Local Unions in Arkansas, Oklahoma and Texas, which shall be governed in all trade matters by this Constitution.

ARTICLE II.

Officers.

"Section 1. The officers of this District shall be one President, one Vice President, one Secretary-Treasurer, and three Excutive Board Members, who shall constitute the Executive Board; also a Board of Auditors consisting of three members.

"Sec. 2. The salaries of all officers shall be fixed at each annual convention.

"Sec. 3. The President's salary shall be for this year $100 per month and all legitimate expenses; the SecretaryTreasurer's salary shall be $95 per month and all legitimate expenses; the Vice President's

salary shall be $3.50 per day and all legitimate expenses while in actual service. Members of the Executive Board and Auditing Committee shall receive $3.50 per day and all legitimate expenses, when employed by the President to work for the United Mine Workers of Arkansas, Oklahoma and Texas.

"Sec. 4. Any member in good standing in the organization shall be eligible to hold office, providing he has been a member of a Local Union in the District for one year, and does not hold stock in any coal company or mines, or any political office, except legislative office.

ARTICLE III.

"Secton 1. The President shall preside at all conventions of the District; he shall sign all official documents when satisfied of their correctness, and with the consent of the Executive Board, he shall fill by appointment all vacancies occurring in the offices where there is less than six months to serve.

"'Any vacancy occurring in any of the offices of the Executive Board other than President or Vice President, elective offices, in excess of six months whether caused from death or otherwise, he shall immediately call an election to fill such vacancy;' and in like manner he is empowered to suspend or remove any District officer for insubordination, for just and sufficient cause, and with the consent of the Executive Board, appoint, from time to time, such organizers and workers, as in his opinion may be required to serve to the best interests of the organization. All organizers appointed must be U. M. W. of A., bona fide members. He shall send out in circular form to all Locals, six weeks previous to the District Convention, such recommendation as he may deem wise to be acted on at District Convention so delegates to same Convention may have the advice of their representative Locals on such recommendations. He may attend in person or send a District officer to visit Local Unions and any other place connected with the United Mine Workers of America, when convinced that such services are required.

"Sec. 2. Duties of the Vice President: The Vice President shall act as General Organizer and shall be under the direction of the President, and in the absence of the President shall assume all the duties and responsibilities of that office and shall succeed to that office in case of the death or removal of the President.

"Sec. 3. Duties of the Secretary-Treasurer: The Secretary-Treasurer shall have charge of and preserve all books, documents and effects of the District office. He shall record the proceedings of all conventions and of the meetings of the Executive Board and shall keep copies of all important letters sent out by him. He shall receive and receipt for all moneys, pay all bills and current expenses, when attested by the President. He shall prepare and submit to all Locals a quarterly statement showing salary and expense of each officer and employe in separate items, and report all moneys received and disbursed, and perform such other duties as may be assigned to him. He shall give a bond in the sum of thirty thousand dollars ($30,000) secured by a reliable security company, for the safe keeping of all moneys entrusted to him, which must be approved by the District Executive Board, and deposited with the President. But shall not have more than two thousand dollars ($2,000) subject to his order at any one time. All other funds must be deposited by him subject to the order of the Executive Board. He shall, quarterly, send to all Locals in good standing the password. It shall be the duty of all parties receiving said password in writing to destroy it at once and no one shall transmit it without the proper authority. He shall employ such assistance as may be necessary to conduct the affairs of his office and have all district printing done subject to the approval of the President and Executive Board members.

"Sec. 4. Duties of the Executive Board: The Executive Board shall constitute the District Board of Conciliation and Arbitration, execute the orders of the District Convention, and between Conventions shall have the power to direct the workings of the Union and shall have the power to suspend or remove the District President for insubordination or other just and sufficient cause. The Board shall be convened by the President, or by request of three members of the Board and they shall have power to draw upon and use the defense fund of the District only in case of strike or lockout; also to levy or collect assessment when necessary. It shall hold in trust for the United Mine Workers of America all money deposited subject to the order of the Executive Board, but under no circumstances shall said money be drawn except upon a written order of a majority of the Board members.

"Sec. 5. The District officers in settling disputes shall make a synopsis report of the evidence in said disputes and their decisions on the same which shall be filed with the District Secretary, whose duty it shall be to compile the same and send out a monthly report to all Local Unions, to be kept on file as a guidance for their officers.

"Sec. 6. The District officers and District Executive Board shall send in a written report of all violations of the District law and agreements, by either operators or miners, to the Secretary-Treasurer who shall compile the same for future reference.

"Sec. 7. No District officer or representative shall enter into an agreement with operators whereby a Local is affected other than what is agreed upon at Joint Conference without first obtaining consent of the Local affected. The District officers shall have power to meet such new conditions as may arise with the consent of the Local Union affected.

"Sec. 8. Duties of the Auditing Committee: The Auditing Committee shall meet quarterly, they shall carefully inspect and audit the books, accounts pertaining to the Secretary-Treasurer's office, and shall make a report of their findings to the Locals of the District. And the books of the Secretary-Treasurer shall be closed the last day of the month previous to the month the annual Convention is held. They shall meet one week prior to the annual Convention and make their report prior to the ratification of the election of officers. They shall also serve as Tellers and Credential Committee, and shall report at the District office one day prior to opening of District Convention to examine list of delegates' credentials to Convention.

"Sec. 9. The term of all elective officers shall be one year, beginning April 1, 1908.

"Sec. 10. There shall be selected by each Local Union a person for the purpose of collecting the statements of the employes each pay day and tabulate them and make a report to the Local Union at the end of each month.

ARTICLE IV.

"Section 1. The revenues of this District shall be derived from the Local Union, viz.: Twenty cents per capita per month, fractional members pro rata. The funds shall be used to pay the District officers, Organizers, Office expenses and cost of securing better legislation for the benefit of the miners. The Strike or Defense Fund shall hereby be created by an assessment of one per cent of the gross earnings after powder and blacksmithing has been deducted. Said fund shall be used for no purpose other than strikes, lockouts or suspension.

"(Note). The word lockout or suspension shall not apply to members who are thrown idle on account of mines being abandoned or shut down. Said funds shall after a period of six weeks be distributed to all members out of employment at the rate of $3.00 per week per member.

"Sec. 2. No Local or Locals shall be exempt from paying per capita tax, or assessment unless they have been idle for one month. In all cases where Local Unions desire exoneration from dues, such request shall be signed by the President, Secretary and Mine Committee and approved by the President and Secretary of the District and a report shall be made each week, giving the number and names of idle men, in the place of the regular monthly financial reports, as long as members remain idle.

"Sec. 3. The Local Secretary shall fill out and forward to the District Secretary-Treasurer on or before the 25th of each month, a report of all members in good standing in the Local Union on the 1st day of that month, together with all taxes and assessments due to the District office for the same.

"Sec. 4. Should satisfactory evidence be produced that any Local Union Secretary has failed to report monthly the full membership of his Union to the National and District Secretaries, together with the payment of dues and assessments on the same number of members that have paid to the Local Union, said Local Union shall be suspended from the privileges of benefits until such deficiency is made good.

"Sec. 5. In the filling of the monthly report the Local Secretary shall report to the District office on blanks furnished for that purpose, the amount of money paid in and the number of members reported to the National Secretary, the amount of money and number of members reported to the District Secretary-Treasurer and shall sign a certificate showing that the report is for the full number of members in good standing in the Local.

"Sec. 6. Any member defrauding the organization of dues or asessments, by failing to receive a check number will be fined five dollars ($5.00).

"Sec. 7. The revenues of this District shall not be used for the payment of expenses incurred by any Committee or members appearing before the legislative bodies of Arkansas, Oklahoma and Texas, unless officially authorized by the District President.

"It shall be the duty of the District President to appoint a committee of not more than three to appear before the Legislative bodies of the above named states to represent the miner's interests in encouraging the passage of mining legislation. Said committee shall act in conjunction with the legislative committee of the State Federation of Labor.

ARTICLE V.

"Section 1. The District Secretary-Treasurer shall issue a call for the Annual Convention six weeks prior to the date set for the Convention, and shall furnish printed credentials with duplicates to each Local and all Locals shall place the names of all delegates from said Local on the same credentials, properly signed and sealed, and the duplicate shall be sent to the District office six days prior to the date of the Convention.

"Sec. 2. The District Convention shall be held annually at such place as may be determined upon by the preceding Convention. Special Convention may be called by the District President, acting under the advice of the Executive Board, but one-fourth of the membership to be determined at regular meetings and only members present and voting in favor of said call shall be counted, to call a Special Convention.

"Sec. 3. Representatives to District Conventions shall be elected directly from Local Unions and shall have one vote for fifty members or less, and an additional vote for each fifty members or majority fracton thereof, but no representative shall have more than five votes and no person shall be eligible as a representative who is not a miner or mine laborer, or employed by the organization, and is a bone fide member of a Local Union in the District.

"Sec. 4. Representation shall be based upon the average membership of the Local Union for the last three months upon which payment of per capita tax has been made previous to the month in which the District Convention is held.

"Sec. 5. That no District officer other than the President and Secretary-Treasurer shall be allowed to attend any Convention other than the regular District Convention unless said Local Union employing said officer shall pay said officer for said work.

ARTICLE VI.

Strikes.

"Section 1. When trouble of a local character arises between the members of Local Unions and their employer, the Mine Committee and officers shall endeavor to effect an amicable adjustment, and, failing, they shall immediately notify the officers of the District and said District officers shall immediately investigate the cause of complaint and failing to effect a peaceful settlement upon a basis that would be equitable and just to the aggrieved members finding that a strike would best subserve the interests of the locality effected, they may with the consent and approval of the District officers order a strike.

"Any Local Union striking in violation of the above provisions will not be recognized or sustained by the District officers. Before final action is taken by any District upon questions that directly or indirectly affects the interests of the mine workers of another District, or may require a strike to determine, the President and Secretary of aggrieved District shall jointly prepare, sign and forward to the National President a statement setting forth the grievance complained of, the action contemplated by the District, together with the reasons therefor, and await the decision of the National President and be governed thereby; and in all cases the Mine Committee and employes and all parties involved must continue to work pending an investigation and adjustment until a final decision is reached in the manner above set forth.

"Sec. 2. Any Local Union, Committee or member acting in violation of Section 1 of this Article shall be liable to expulsion or fine, subject to the discretion of the District Executive Board.

ARTICLE VII.

Membership.

"Section 1. The membership of this Union shall consist of all miners and mine laborers, and other workmen, skilled and unskilled, working in and around the mines, who perform labor for which a scale of wages is made. (Except mine foreman and top bosses who have the right to hire and discharge), who shall sign a collective and continuous order authorizing Local Unions to check-off all dues, fines and assessments; and shall pay the following initiation fee:

"The initiation fee for the practical miners shall be $10.00. For non-practical miners, $50.00. For top laborers, $10.00. Any top laborer desiring to go into the mine shall pay an additional fee of $40.00.

"Sec. 2. Miners' and widows' sons and orphans under the age of sixteen shall pay the sum of $2.50 and receive half turn of the mine. Miners' sons from 16 to 21 years of age shall pay $10.00 initiation fee and shall receive full run [turn] of the mine; (provided), that where the State law prohibits the employment of boys under sixteen they may be admitted over sixteen and under eighteen on the initiation fee of $2.50. This shall only apply to miners' and widows' sons and orphans.

"Sec. 3. Boys, other than miners' or widows' sons under sixteen years of age shall pay the sum of $10.00 initiation fee. All applications, other than miners' sons, over sixteen years, shall comply with Section 1 of this Article, and in no case shall any Local Union donate any part of the initiation fee back to the members.

"Any Local Union violating this section shall be fined $50.00, same to be collected by District Executive Board and placed in the District defense fund.

"Sec. 4. Any member or members of the organization misrepresenting the age, relation, occupation or experience of any person making application for membership in any Local, shall be considered guilty of a misdemeanor and shall be fined in the sum of ten dollars ($10.00) for such offense. Any member so fined and refusing to pay the same shall be expelled and his name published in the United Mine Workers' Journal. The membership so received shall be null and void and the fee returned.

"Sec. 5. No member shall accept compensation from any one he takes into the mines to work with him. Anyone found guilty of such offense shall be fined for the first offense the sum of $50.00, for the second offense he shall be expelled.

ARTICLE VIII.

Cards.

"Section 1. No person, a member of the organization, who holds a due or transfer card showing him to be a member in good standing, shall be debarred or hindered from obtaining work on account of race, color, creed or nationality. Any Local Union violating this action shall be fined twenty-five dollars ($25.00), and said fine so collected shall be deposited in the defense fund.

"Sec. 2. Any member leaving one mine and securing employment in another, shall deposit a Transfer Card, bearing his name and occupation, with the Check-Weighman or Pit Committee of the Local Union governing the mine in which he received employment, and he shall be a member of the Local Union issuing the ecard until the said card is deposited with another Local Union.

"Sec. 3. All Local Unions shall set aside one meeting in each month at which agreement and Constitution shall be read and discussed.

"Sec. 4. No Transfer Card shall be issued to any member when the Local is three months in arrears to the National or District for dues and assessments.

"Sec. 5. The Secretary-Treasurer shall perpare and send out a monthly statement of all Locals three months or more in arrears for dues or assessments, and no Local Union shall refuse to accept a Transfer Card from any Local Union unless it appears on said list as being in bad standing or falsified as to the occupation of the holder. All dues, assessments and fines shall be collected by the check-off system or its equivalent.

"Sec. 6. Any member leaving one locality and securing employment in another who has not a Transfer Card, must agree to the initiation fee being retained until Transfer Card has been produced, before being permitted to work. Should he fail to produce a Transfer Card within fifteen days, he shall forfeit the initiation.

'Sec. 7. Any boy receiving employment at which a man's wages is paid, shall pay full dues and assessments.

ARTICLE IX.

Application and Reinstatements.

"Section 1. Any member of the United Mine Workers of America leaving the mine for other vocations in life must pay all dues and assessments created by the Local District and National organization in order to retain membership, but shall not visit or be eligible to hold any office or have a voice or vote in the Local, and shall be a silent member. But in case he should at any time desire to work in or around the mines, and having secured employment, he shall be restored to full membership.

"Sec. 2. Any member becoming three months in arrears shall be suspended and must make application as a new member.

ARTICLE X.

Password.

"Section 1. Any member charged with having abused the use of our password or in any way divulged the action of his or any other Local contrary to this Constitution, if proven guilty, shall be expelled.

ARTICLE XI.

Election of Officers.

"Section 1. All nominations for the District officers shall be in the hands of the District Secretary not later than ninety days prior to the expiration of the term of office. Local Secretaries shall be required to post notice at least one week before the nomination, and the Secretary shall ascertain the acceptance of the nominees, and inform said nominees by what Locals was nominated and shall furnish them with a prepared ballot for each actual paid-up member in the Local not later than sixty days prior to the expiration of said term of office.

"Sec. 2. The address of all candidates shall be on ballots and no name shall appear more than once on any ballot.

"Sec. 3. All members of Local Unions shall cast their votes for the candidates of their choice, said ballots shall be cast, counted, sealed and recorded in the presence of the Local officers and forwarded to the District Secretary not later than thirty days prior to the expiration of the term of office, and they shall record the vote on returning sheet opposite the names of candidates for which said vote or votes have been cast. No member shall be allowed more than one vote for one candidate, nor shall the Secretary record the vote of any member that is not present at the time the election is held. The correctness of the returning sheet must be attested to by the President and Secretary of the Local Union and forwarded to the District Secretary, in envelopes marked election returns at the same time the ballots are sent.

"The Recording Secretary of Local Union shall send under separate cover returning sheet and ballots in all elections, by express or registered mail.

"The envelopes are to be opened and the votes counted by the Tellers only, and in no case shall votes be counted that the envelopes have been opened previous to reaching the Tellers. In the event of no election, the two candidates receiving the highest number of votes shall be referred back to the Local Unions who shall hold a second election and forward the result to the District office in the same manner as above stated.

"Sec. 4. The National Board Member, President, Vice President, Secretary-Treasurer, District Executive Board Members and Auditors shall be elected by a majority of all votes cast; the election to be governed by this Constitution; election to be not later than ninety days prior to the expiration of office.

"Sec. 5. Any member guilty of electioneering or influencing in any manner the election or rejection of any candidate for National or District office, shall upon proper testimony be convicted and deposed. This, however, shall not prevent any member from making charges against unworthy candidates. Such charges, however, must be sustained by proper evidence, signed and sworn to before a notary public.

"Sec. 6. Secretaries of Local Unions shall, under penalty of suspension from office, notify their members one week prior to the date set for the election of District officers, and should it be proven there has been more votes reported on returning sheets than were actually cast by the members present at the meeting where the vote was taken, or that the votes have been counted for candidates other than those that have been constitutionally nominated, the whole vote of the Local shall be thrown out. The returning sheets, after the election, before being destroyed by the District Secretary, shall be kept six months.

"Sec. 7. There shall be one day set aside for the election of District officers, same to be designated by the District President and the Secretary-Treasurer.

"Sec. 8. It shall be the duty of the Recording Secretary to send official notice at once by registered mail to District Secretary-Treasurer that election returns have been sent. If from any cause any Local Union has not voted, it shall also become the duty of the Recording Secretary to serve notice on District Secretary-Treasurer of same, setting forth their reasons for not casting vote, and it shall be the duty of the District Secretary to notify the Auditors and Tellers of same before final vote has been counted. The Tellers, upon receiving official notice that election returns have been sent in shall refrain from announcing final count until ballots have been found and counted, or Local Union furnished with ballots and returning sheets to cast the vote again.

ARTICLE XII.

Miscellaneous.

"Section 1. No miner shall be permitted to enter the mine on idle days for the purpose of working except by permission of the Mine Committee and Executive Board, same to be [given] in urgent case in slopes and slope airways. Any miner doing so shall be fined ten dollars ($10.00) for each and every offense and the amount of the fine sent to the District office and deposited in the Defense Fund. Day hands may do work on idle days, provided he shall not produce coal, but all day work to be equally divided among the day hands. A day laborer accepting work on idle days shall only receive the scale of wages adopted for said class of work. The company soliciting a day man for any class of work other than the regular work for which he was employed shall pay him the scale of wages governing his regular employment.

"Sec. 2. Local Unions, individual members and all other persons are hereby prohibited from using the name of our organization for the purpose of furthering their interests.

"Sec. 3. Local Unions, when electing officers or changing officers of the Local shall notify the National and District officers within five days after such changes are made.

"Sec. 4. No Local shall in any way deprive a member on account of his absence from being eligible as a delegate to any convention when he is on duty serving the organization.

"Sec. 5. Any member or members of the organization creating a condition which prevents the carrying out of the Joint Agreement in any locality or mine, shall be fined ten dollars ($10.00) each for such offense, and refusing to pay same, shall be expelled, said fines to be paid over to District Treasurer. Any District officer knowing of such violation and not doing his duty and not enforcing this Section shall upon proper testimony, be fined ten dollars ($10.00) for each and every offense.

"Sec. 6. All check-weighmen employed by the members of the United Mine Workers shall be members of the United Mine Workers six months prior to their election, except newly organized Locals, and voted for and elected at a regular or special or joint meeting of the Locals or Local effected, by those who maintain them and shall be accepted by the company whether an employe of said company at the time of the election or not. Notice of election of check-weighman shall be posted in some conspicuous place at the mine where check-weighman is to be employed, at least three days before the time set for such election. It shall be the duty of such check-weighman to keep a record of all men employed in and around the mine, report monthly on blanks furnished by the Secretary-Treasurer for the purpose, the amount of coal hoisted, amount of powder used, gross earnings, per capita earnings, and such information as he shall collect. Under no consideration shall a check-weighman be considered an officer of the Local Union. The term of which a check-weighman shall serve shall be left to the discretion of those who employ him, but [he] shall be removed for cause, at any time, after a fair and impartial trial by the Local Union employing him. The above will not prevent any Local officer from acting as check-weighman.

"Sec. 7. No member shall be fined or expelled without first being given a fair and impartial trial, and shall have the right to an appeal. All accusations against members, officers of Local Unions or officers of the District shall be made in writing with accuser's or accusers' names attached thereto and placed in the hands of the President of Local Union of which the accused is a member, and the accused shall be furnished with a true copy of all charges and specifications made against him at least one week prior to the trial.

"Provided, however, that in case a man working under the jurisdiction of a Local Union, who has not deposited a transfer card and is charged with an offense, the Financial Secretary shall have withheld from his wages an amount sufficient to pay his fine until the party or parties under charges shall be tried.

"Sec. 8. Any member found guilty of contracting or accepting as compensation for his labor less than the scale of price shall be fined twenty-five dollars ($25.00).

"Sec. 9. Any member of any Local Union found guilty of hiring laborers in the mine shall be fined fifty dollars ($50.00).

"Sec. 10. Any member abusing a committeeman, check-weighman or any officer of the organization when discharging their duties, according to the agreement and constitution, shall be fined ten dollars ($10.00) for such offense. Also any officer, check-weighman, or committeeman abusing any member of the organization when uncalled for shall be subject to the same fine.

"Sec. 11. Any member of the United Mine Workers of America who shall enter any regular or special meeting in a state of intoxication shall be fined not less than one dollar ($1.00) nor more than ten dollars ($10.00) and said moneys turned in to the Defense Fund.

"Sec. 12. Any mine worker belonging to any Local Union in District 21, who is now or may be in the future a member of any detective association shall be barred a seat in any Local Union, but shall not be relieved of dues and assessments.

"Sec. 13. Each Local Union shall elect three Financial Trustees whose duty it shall be to accompany the Local Treasurer and draw check-off and other moneys belonging to the Local Union; see that all dues, per capita taxes and assessments due the National and District are promptly forwarded to the National and District offices and the balance shall be deposited in some bank in the name of the Local Union. The Treasurer shall be required to give bond for all moneys in his possession; provided that any Local Union whose Treasurer can give a sufficient bond this section shall not apply.

"Sec. 14. All fines shall be considered as dues and shall be collected in the form that they accrue and be paid into the Local Union where the members so fined belong, unless otherwise provided for.

"Sec. 15. No member of the United Mine Workers in District No. 21 shall be allowed to collect financial assistance on a Transfer Card or letter of recommendation, unless right to collect such assistance is endorsed by the District President.

"Sec. 16. Any member of the organization withholding any official documents from the Locals or persons whom it was intended for, shall be removed from office or fined ten dollars ($10.00). The same shall apply in not answering documents when required.

"Sec. 17. Any member proven guilty of pawning his Transfer Card for money shall be expelled from the organization and his name published in the U. M. W. of A. Journal.

"Sec. 18. Any Local Union calling any Board member to settle any grievance before representing any grievance to proper parties specified by agreement will pay all expenses incurred by said Board Members.

"Sec. 19. Any member, or Local in this District, violating any part of the Constitution where there is no special penalty attached shall be fined ten dollars ($10.00).

"Sec. 20. No Local Union members or Local officials shall send letters around the District publishing any officer, officers, member or members without making specific charges in the Local Union the officer or members belongs [to] and then no letter can be sent through the District only by or through the District Secretary-Treasurer. Any Local Union or member violating this Section shall be fined $25.00.

"Sec. 21. In case of any question of a Local nature arising, or formulation of a price on any Local condition that the contract doesn't make specific provision for, and such question has been passed upon by the Local Union or their representatives, and failing to adjust such questions in conformity with their positions, the District official shall be permitted to reverse the position taken by the Local Union until the entire matter has been pased upon by the Executive Board. Should the Local Union or its representatives enter such protest to said District officials, in order that their position may be defined, and when a decision has been rendered by the Board, the District President shall defend the decision of the Executive Board to the highest tribunal of our organization. The President or Vice President failing or refusing to comply with this Section shall be suspended from office, not less than thirty days.

"Sec. 22. All Local Unions must affiliate with State Federation of Labor. All per capita tax to State Federation shall be collected and paid through the District Secretary-Treasurer, who shall forward the same to the Secretary of Federation in the various states. The District Secretary-Treasurer shall receipt all Local Unions for all per capita tax collected for such State Federation.

"Sec. 23. No District officer shall recognize any grievance that has been brought to his notice by an individual member or render any decision until he has consulted with Local Union affected.

"Sec. 24. No District officer or District organizer shall organize a new Local Union in any locality where a Local is located without first consulting the old Local in regard to the same.

"Sec. 25. No sub-lease shall be recognized by any Local Committee or Local officer or District officer that makes doubtful the paying of the scale rates of prices or conditions of the present state or interstate wage contract. Any members of our organization leasing a mine and throwing other members out of employment shall forfeit their right to membership in our organization.

"Sec. 26. Any member carrying news to any person or persons outside of the hall shall be fined not less than $5.00. This shall not include mine committees.

"Sec. 27. Where evidence can be conclusively established that a Board Member has made application for another position, and it is proven, he shall be immediately deposed for the District Board.

"Sec. 28. Any officer or member of District 21 appearing before any Legislator directly or indirectly or by petition protesting in any way against the passage of any Mining Legislation which has been adopted by a majority vote of the miners organization or in Convention of by the State Federation, or in caucus called by the District President shall be fined $50.00 and his action reported to all Locals by the District Secretary, said fine to be paid into the District Defense Fund.

ARTICLE XIII.

Rulings.

"Section 1. Where any part of the Constitution shall in any way conflict with either the National or District Agreements, the Agreements shall have precedence in all cases.

"Sec. 2. No Local Union shall impose a fine on its members for not attending picnics or parades.

"Sec. 3. No man shall be elected check-weighman who is not a practical miner.

"Sec. 4. No member shall be eligible to hold a District or National office in this District until he shall have worked in or around the mines in the District at least twelve months prior to his nomination.

"Sec. 5. This Constitution can be amended or abrogated by a majority vote of the members of the Local Unions by referendum vote. A majority of the Executive Board or one-fourth of the membership of this District may at any time demand that any part of the Constitution be submitted to the Locals to be voted on."

CHAPTER IV.

THE WORK AND WAGES OF THE MINERS.

The exact earnings of the men working in the coal mines of Arkansas has been a subject of some dispute. A knowledge of the earnings of the employees is necessary for a proper understanding of the frequent labor quarrels afflicting the coal-mining industry. Since the public, as the innocent third party, always suffers from such quarrels, it is believed that the determination of the average earnings of the miners is worth the expense incurred by collecting the figures at the different mines. Before giving the wages of the men, it seems proper to give an outline of the conditions under which they perform their labor.

CONDITIONS AND NATURE OF THE MINERS' WORK.

Darkness. The first impression given to some persons by the word *mine* is its darkness. The coal and slate are so very black that the coal miners must be provided with a stronger light than other miners and even then the coal mines are darker. The ordinary open light used by the miner varies from 1½ to 3 candle-power, instead of being less than 1 candle-power, as stated in the preamble of the constitution of the Union. Nevertheless, the light is not good and is a contributing factor in causing accidents from moving cars, and possibly also from falls of roof. It does not seem in any way to affect the sight of the miners which, if anything, averages above that of men in other occupations in spite of the irritation of the dust. It is fortunate that all of the Arkansas mines are sufficiently free from gas to permit the use of open lights. These throw a strong light upon the roof instead of the shadow cast by a safety lamp. This light reduces the loss of life from falls of rock, the great danger to which the miners are exposed.

Smoke. The mining laws and the agreement between the companies and the men require that, with the exception of the rope-riders, no miner shall burn anything in open lamps but pure lard-oil, which does not smoke very much. This will not burn in a draft or strong ventilating current and is expensive, so is not known to be used anywhere except in some 'country-banks' remote from the main field, where the miners use home-made lard-oil. Instead, the miners use various mixtures of lard-oil, or cotton-seed oil, and a cheaper oil, such as that obtained from the distillation of rosin. These are cheaper, burn more readily, and are not explosive, but they produce objectionable amounts of smoke.

The result is that the rooms are quite full of ordinary floating lamp-black, such as comes from a smoky kerosene-lamp. In places where the cheap oil is burned and the ventilation is poor, the smoke is so thick that from a distance of 25 ft., a pit-lamp shows as a mere blur of light and nothing near it can be distinguished. In most of the mines it is difficult to take photographs except on idle days or in the main intake of the air current.

Even the 'sunshine' wax and the best of oil give a little smoke, which the miner must inhale. It is the writer's opinion that this smoke is the main cause of the blackening of the lung tissue observed in the autopsies of all men who have mined coal for 10 years or more in America. It also affects the nose and throat slightly. The acetylene lamps give the best and cheapest light, and produce no smoke at all, but on account of the annoyance of changing the carbide chamber about once every two hours, they are used only at a few of the mines having no artificial ventilation. As a general rule, therefore, all the underground men, except those near the bottom of the main downcast shaft, must work in the smoke.

Water. Mines are supposed to be wet and disagreeable, but on account of the usual tight shale roof in coal mines, there is but little trouble from dripping water. No miners were seen wearing rubber coats, as is so common in the metal mines. By agreement with the men, the entries and traveling-ways are to be as dry as possible. Some mines still have a few wet and sloppy entries, but the condition of the roadways is constantly improving, and very few men need now work all day with wet feet as was formerly nearly always the case. Some miners work in shallow pools of water in dip rooms and dip entries, but they are paid extra for this, and no men afflicted with rheumatism or weak lungs need work in a wet place. Where enough water to wet the miner's clothes drips from the roof, as in rooms near the surface of the ground, the man is generally paid extra. It should be remembered that on account of the warm climate of the Arkansas coalfield, the mine water is at 60 to 65 degrees F. which is not cold, and has little effect upon the miners' health. Wetness is therefore not a serious inconvenience to the miners of Arkansas.

Dirt. Coal is also supposed to be dirty and dusty. Some entry-men are annoyed by dust while making their cuttings, but the coal is generally damp and there is little discomfort in loading it. This is noticed when the coal is dumped into the railroad cars. Moreover, to any one used to it, the coal dust is no more disagreeable than any other dust. But owing to its blackness, it is very noticeable, and one of the miners' sayings to a new man is, "You will never be a good miner until you can eat your bread without seeing the finger marks on it." This applies to the underground lunch, for the miners always bathe as soon as they get home. This bathing has a sanitary advantage which somewhat offsets the disadvantage of the inhaled dust. Another saying is to the effect that a negro wearing black clothes, and using black towels, would be less dirty than the white man working at a slightly dusty job. The greasy black lamps, however, do certainly make a 'dirt' when mixed with coal dust and much rubbing is required to clean one's hands.

Cramped working places. The low hight of the working places is somewhat injurious, although the experienced miners do not object to it unless required to push cars up into rooms where the hight is less than 3 ft. 6 in. In the room, the miner rests on his knees or sits down while at work, and stretches out to rest by lying at full length. By agreement, no more is paid for mining low coal than for high coal unless it is lower than 2 ft. 10 in. Many men actually prefer to work in low coal if it is loose and shoots better than the high coal; and the companies working low coal have as abundant a supply of labor as the others. There are, however, some miners, especially the older ones, who do not like to stoop over, and it is certainly tiresome to visitors who go from place to place in the low-coal mines. The miners all object to coal over 8 ft. high on account of the difficulty of setting props and examining the roof.

Nearly all of the company men work most of the time in places 4 ft. 6 in. high or over, but of the diggers, a considerable number are in cramped places. The illustrations in Chapter II show the problems of mining low coal and may give a wrong impression of the general hight of the coal. Figures of the number of diggers at each mine were tabulated according to the hight of the coal. The results show that 32 per cent of the diggers in this State work in places over 6 ft. high. Here they need never bend over. Such a place is shown in Fig. 31, p. 63.

Forty per cent of the miners work in places of medium hight or from 4 to 6 ft. These happen to be mostly between 4 and 5 ft., as shown in Fig. 29, p. 61, and Fig. 32, p. 65. The miners soon learn to walk readily and rapidly in places 4 ft. 6 in high. Their knees are bent and the body thrown forward and they take long swinging steps. The hands are generally clasped over the small of the back to balance the body. A small burden, like a dinner bucket, is carried at the side in one hand, which is supported at the wrist by the other hand, which is crossed over the back.

The other 28 per cent of the diggers work in low places which range from 16 in., at Baldwin, Washington County, to 4 ft. high. Of these all but 50 or 60 miners are in places from 2 ft. 6 in. to 4 ft., as shown in Fig. 30, p. 62, and Fig. 39, p. 86.

Labor and skill. The actual labor of digging the coal is not light. It has about the variety and is a little harder than that of carpenters who work on ordinary small dwellings. The modern system of shooting off the solid requires intelligence and skill to place the holes to the best advantage and properly judge the amount of powder necessary. Better shooting and greater energy distinguish the good miners, who earn much money, from the general average. Those that earn very little are either lazy or are recovering from sprees which also reduce the number of days worked.

Since shot-firers have become so universal, the tendency of the less experienced miners is to pay little attention to the placing of the holes and to use increasing amounts of powder. This is to be sure of getting plenty of coal regardless of the danger or the proportion of slack, and is fast putting the work upon the level of unskilled labor. Many men now use 30 or 36 in. of powder in all holes which are of the same depth regardless of the width of the shot. In the older days of pick mining, considerable manual skill and practice were necessary to undermine the coal rapidly with a hand pick. A little of this skill is still required for making a cutting in an entry, but skilled pickmen are rare, and coal mining can hardly be called a trade any longer.

Bad air. A few of the mines have good ventilation, but bad air is so common that it must be more or less injurious to the health of the miners. So far as known, none of the mines in this State give off either of the poisonous mine gases, deadly white-damp (carbon monoxide), or less injurious stink-damp (hydrogen sulphide). Black-damp (either carbon dioxide or nitrogen) and firedamp (methane), which are given off by the coal and rock, have no direct effect upon the men, but simply deprive them of the full proportion of the necessary oxygen of the air. The amount of oxygen in the mine air is further reduced by its tendency to unite with coal dust, decaying mine timbers, etc. The firing of shots sets free poisonous gases, both carbon monoxide and oxides of nitrogen. There is further contamination from the smoky lamps, from the decay of timbers and animal waste, and from the breath of the men and mules.

The Arkansas law upon the subject of ventilation is fairly adequate, but has never been universally enforced, and the indifference of the miners to this matter is remarkable. When the ventilating current is strong, the miners generally burn a cheaper grade of oil, which increases the amount of smoke. At other mines free from firedamp, the air current can not be noticed and the air is sometimes so bad that lights will not burn. The miners must then wait until the next day before they can work. In other places where the lights burn dimly, those miners who will work suffer from headaches. Men suffer no immediate injury or inconvenience from lack of oxygen, until the amount is very much less than that needed for the lights ordinarily used. The headaches must, therfore, be due to gases remaining from the shots fired the evening before.

At those mines having poor air and where shots are fired at noon, the miners quite generally suffer from headaches. It is an advantage to the miner, especially in low coal, to blast twice a day; and if the mine is ventilated by a complete system of overcasts with a separate and adequate split of air for each entry, the miners can entirely avoid the powder smoke by their usual custom of collecting in the entry to eat their lunches. To change the air entirely, in 30 minutes, with double rooms 40 ft. wide and of an average length of 75 ft. and half full of gob as is common in coal 4 ft. high, will require a split of only 100 cu. ft. of air per minute for each man which is now required by the law. The advantage to the companies as well as to the men is so great that it is earnestly recommended that these conditions be brought about. In some places, the Union has refused to allow any of the miners to blast at noon. In some cases, this works an injury to the miners as well as to the companies, since the rule is enforced at some mines that have ventilation entirely adequate for double shooting. If bad air be prevented by proper ventilation, and by prohibiting the sale of inferior oil, the work of the miner would not necessarily be unhealthful.

Temperature. The temperature of the mines is remarkably uniform summer and winter, and nearly all the diggers in this State work in places where the temperature varies little from 60 degrees. This is a great comfort as compared with the lot of other workmen who generally suffer from either extreme heat or cold. At the bottom of the shafts, a few men are exposed to a strong draft of cold air during the occasional very cold days of winter. For this there is no remedy except a reversal of the fan, which would give them warm, but impure and possibly explosive, air. When these bottom men are not busy enough to keep warm, they sometimes warm themselves at the steam pump, which is usually in a place sheltered from the draft. In other places, they improvise stoves from old powder kegs, but the gases and smoke from these pollute the main air current going to all the other men in the mine. It is recommended that a sheltered room be provided for the bottom men, and that at all those mines having steam pumps, it be heated by steam in winter.

Top men. Not all the comforts and discomforts so far discussed apply to the top men. They get more coal dust than the other men, but otherwise the work is not unusual. Unless they are skilled, they get but little more than common laborers' wages.

Accidents. The top men run little more risk than ordinary street laborers, but the underground work is precarious. This greater accident rate is possibly the chief drawback to the occupation of mining. From 1905 to 1908, inclusive, there were within the State 48 fatal accidents at the mines which during this time employed about 5,000 men. Seven of these men were shot-firers who all understand that they take a great risk. This makes the fatal accidents among the other workmen at the rate of 2.06 per annum for each 1,000 men employed. During this time, 150 men were injured suffiicently to lose time. This is at the rate of 7.53 men per annum for each 1,000 employed. Both of these rates are increasing rapidly as a result of the carelessness encouraged by the mine-run law passed in 1905. All the statistics available may be found on p. 274.

A death rate of 2.06 per annum for each 1,000 men employed means that the average miner would not be killed by an accident in the mines of Arkansas until he had worked in them for 480 years, assuming of course that he did not previously die from other causes. Taking 30 years as the average time a miner works in a mine, about one in 16 is killed by an accident at the mines. This is somewhat greater than the proportion of other workmen killed by accidents. It must be remembered that the miner is also subject to all the usual accidents on idle days and after working hours, so it is safe to say that he runs about 50 per cent greater risk of fatal injury than men in other trades. Since so few miners insure their lives, the insurance companies have no special mortality tables.

If 7.53 men in each 1,000 are hurt each year, the average miner gets hurt only once in 13 years. It is not surprising therefore that a miner gets careless after working for 6 or 8 years without injury, and so neglects to prop his roof, which is the great source of danger.

So far as can be learned, from 1 to 4 shot-firers are killed each year. Since there are now only 40 regular shot-firers in the State, this makes the rate at least 25 to 100 per 1,000 per annum, which is probably below the truth. This means that a man can fire shots for only 16 years on an average before getting killed. Shot firing is generally done by reckless, unmarried men, who are tempted to run the known risk for a year or two by the high wages and light work. Other shot-firers are experienced, careful men, who know all the best ways of getting through explosions and thoroughly understand the shooting of the coal. Such men are practically never killed if the miners permit them to leave the dangerous shots unlighted. The common windy shots seldom do more than knock the shot-firers down, and if they are hurt at all, they are killed outright by severe explosions suffocated in the choke-damp following a dust explosion. After they are rescued when nearly suffocated, life must be restored by artificial respiration.

A study of the relative frequency of the different causes of accidents is instructive. Of the 34 miners exclusive of shot-firers killed during 1906, 1907, and 1908, 21 or nearly 62 per cent were killed by falls of rock or top coal; 4 or 11.5 per cent were crushed by cars; 3 or 8.8 per cent were killed by burning firedamp or gas explosions; 2 or 6 per cent by shaft accidents; 1 or 3 per cent by a powder explosion; and 3 or 8.8 per cent by other accidents. The 6 shot-firers, who were killed, constituted 15 per cent of the total number killed at the mines. Of the non-fatal accidents, 44 per cent were due to falls of roof; 30 per cent to miscellaneous causes; 17 per cent to burns by gas and powder. This indicates that a larger proportion of the accidents from roof falls are fatal than from other causes. The little pockets of gas are apt to cause serious but non-fatal burns; and many men are injured by cars, though only a few are killed by them.

The general death rate in all the coal mines of the United States during the last few years has been between 3.31 and 4.86 per annum per 1,000 men employed. This is much greater than the Arkansas rate of 2.36 including the shot-firers. The greater safety of the Arkansas mines is due to a generally better roof and the freedom from explosive dust and large quantities of gas. At some of the mines with solid sandstone roof, accidents except from machinery, are practically unknown. At one or two places, the roof is bad.

So few coal miners carry old-line life insurance that no special class is made for them. They are grouped with miners of all sorts and must pay a large extra amount for protection. This extra cost is made necessary by the excessive risk from pneumonia in the metal mines, as well as the accident risk.

Some means of reducing the number of accidents will be mentioned in connection with proposed changes in the wage contract and the mine laws. Others will be deferred to the technical discussion, in Part II.

EARNINGS OF THE MINERS.

Disagreement as to amount. By the agreement between the Union and the Operators' Association, the daily wages of all the company men are fixed at the prices given later. In a few cases, skilled trackmen receive more than the scale price of \$2.56 per day, but in general there is no difference of opinion as to the amount the day men receive. There is, however, always a great difference in opinion as to the daily earnings of the diggers, who are paid by piece work. The Central Coal and Coke Co. keeps track of this by counting the number of men to whom coal has been credited each day, and at the semi-monthly pay-day adding these numbers to give the total man-days of work. This, divided into the total sum paid to the diggers for that period, gives the average earnings per man per day. These are adjusted to allow for short days, and the result is strictly correct as to gross earnings. No other company keeps any record of the average earnings of the men.

All of the detailed pay-roll statements issued to the miners are handed to one of the local Union officials, who makes out a list of the deductions to be made by the company and paid to the Union. He also copies the totals for statistical purposes. From these, the daily earnings are supposed to be figured, but the totals are sometimes divided by the number of working days during the period, without allowance for the idle days of the mine. Only rarely is any allowance ever made for short days or for the days the miners stayed at home or went on a drunk. If the miners never changed from one mine to another except on pay-day and the work was accurately done, this method would give the average gross annual income, from coal mining, of all the men in the Union. No distinction is made between the day-men and the diggers who earn much more money. The results occasionally published as the average earnings per day worked are much too low and no record of the pit expense can be obtained from the miners' statements. On the other hand, quite a number of the operators will give only the earnings of a few skilled men, some of whom may average over \$12.00 per day.

For these reasons, the Survey was requested by both operators and miners to get impartial figures as nearly exact as possible.

Method of obtaining the average earnings of the miners. To explain just how the figures were obtained, it will be necessary to state that all the companies keep a pay-roll ledger from which the miners' statements are copied and which shows just how much each miner receives for each kind of work, and the amount of powder, Union fees, rent, groceries, etc., charged against him. They also keep a daily 'coal bulletin' which is a large card with all of the miners' check numbers printed upon it, and having several blank spaces under each number. In one of these spaces the weighman enters the weight of each car load of coal as the 'check-puller' calls off the proper check number. The check number is entered upon the pay-roll ledger with the miner's name, and the bulletin, therefore, shows exactly how many cars each miner sent out each day.

At a few mines, the weight of each miner's coal from the bulletins is entered each day opposite the miner's name upon the pay-roll ledger, or upon the coal book. At these places, it was an easy matter to count the number of days upon which the miner worked. At the other mines, it was necessary to go through all the coal bulletins and count the number of days each miner was credited with coal.

It frequently happens that when the miner leaves at night, he has a loaded car at the neck of his room, at the shaft bottom, or upon one of the partings. The next day, this car is hoisted and its weight is entered upon the bulletin under the loader's check number, although he may not go near the mine that day. When therefore the miner has only one car on a day following others upon which he has several cars, it is assumed that he did not work that day. In many cases, this conclusion was confirmed by a blank space on the day following. Where the cars are large and the miner is working in deficient coal or a narrow entry, a single car with another left on the parting would represent a single day's work and this rule would be unfair. In such cases, there are generally many such days and special inquiry was made of the pit-boss regarding the miner concerned. In all cases, the best judgment was used. In case the miner spent much time cleaning up a fall of rock on a single day, this would show upon the pay-roll as a special credit. In some cases, no help for an occasional injustice was apparent. Those miners who work irregularly are generally out several days, and the steady men with a single one-car day were assumed to have lost no time.

Records which show the number of hours in each day's run of the mine were always available, and the time of the miners was adjusted to represent full eight-hour days instead of counting the few six- and seven-hour runs as full days. This will be objected to on the ground that the Union allows the diggers to work for two hours after the drivers are called off, if the eight hours are not sooner completed. Very few miners do this, however. On the other hand, probably between 10 and 20 per cent of the miners work only 4 or 6 hours of the 8, even when the mine runs all day. This is especially true at slope mines, where the miners can go up at any time and at those shaft mines where the turn is good and miners get cleaned up and do not have to wait long for an empty cage.

Because the pit bosses and driver bosses so universally complain about the miners leaving before quitting time, it is believed that the time lost in this way will offset any error due to not counting days on which the miners are credited with only one car load of coal, or any time they may work after the hoisting of coal ceases. To reduce the last error, the attempt was made to select those semi-monthly periods during which there was the least proportion of short days, and in many instances, no short runs were included and all the days were nominally 8 hours long. Where a choice was possible, those semi-monthly periods covering many days of work were selected to get better averages. At a few mines, those men who worked only two or three days were omitted. Only the records for a short time previous to the visit were examined, but care was taken to avoid the rush months before the suspension of 1910. At three mines the January, 1910, pay-rolls were used. All the others were during the last half of 1909. It is assumed that by taking one pay at each mine at random, the average will be fair. It is known that at one mine by a change of administration shortly after the period for which the pay-roll was studied, the earnings of the miners were increased nearly 20 per cent. This is the only error of this kind noted.

Pit expenses. By contract, the miner's powder is delivered to his room by the company, and he is required to buy it from the company at the agreed price of $2.00 a keg. At all of the mines, therefore, the amount of powder sold to each miner is shown upon the pay-roll ledger together with his gross earnings. At many mines the company has no general store and sells nothing else to the miner but his other pit supplies, which include oil for light, fuse, cartridge paper, and soap. At other mines, these items are kept separate from groceries, etc. The miner does not have to buy all these supplies from his employer, but since they are furnished right at the mine at a standard price he usually does so. By various ways, it was determined that they bought about 90 per cent of their miscellaneous pit supplies from the companies. This ratio was therefore used in figuring the total cost of the mine or pit supplies. In practically all cases where no record of the fuse, etc., could be obtained, the ratio between the cost of powder and other supplies could be obtained at a neighboring mine where the physical conditions were the same. The small supplies cost generally from one-fourth to one-half as much as the powder. The charge for sharpening tools or blacksmithing is uniformly three-fourths of 1 per cent of the gross earnings. The cost of the tools is estimated at from 50c to 75c a month by the miners. The cost of pit supplies is not as exact as the gross earnings of the miners but the error is thought to be less than 2c a day either way from the average figures given.

In figuring the net earnings of the miners, only those expenses which are peculiar to the occupation were deducted. This includes the expense for tools, light, and blasting material, but does not include overalls or any money paid to the Union.

Number of mines included. At all the mines but two, every aid and courtesy in finding records was shown by the office force and in no case was any attempt made to influence the results. At the various offices of the Central Coke & Coal Co. full access was given to the books, but after checking the results upon the monthly statement at one of the mines, no personal inspection of the books was made except to get the pit expense and the earnings of the entry-men separately. The average gross earnings and expenses were accepted without question. At one of these mines, the separate record of entry-men was not obtained for lack of time. At the mine of the Patterson Coal Co., the bulletins corresponding to the last average month's run had been destroyed, and it was necessary to assume that the miners worked on an average of 14½ days out of the 15 days, run during the month. This mine was not included in figuring the average, but the result was found to be only 6c per day greater than the general average.

Aside from the exceptions mentioned, the writer personally copied the figures from the pay-rolls and counted the days from the bulletins. The data were obtained at all of the mines so far as known, which worked to any extent between July and December, 1909, with the exception of a few very small country-banks and the mines of the Franklin Coal Co., the Dodson & Melton Coal & Lumber Co., and the Little Rock Fuel Co., all near Denning; the Harper Coal Co. at Bates; the Star and the Standard Coal companies at Paris; and Clarke & McWilliams at Spadra. Inquiry from the miners and others indicate that at these mines which employ all together less than 250 diggers, the earnings are greater than the average of the others, since at only one mine were the estimates less. The men generally do better at the small mines especially at the pigeon holes than at the large ones, on account of the better turn.

The figures are averaged upon the basis of the number of individual men at each mine, regardless of the number of days each man worked. The total number of diggers on the list is 2836.

The original adjustment of the scale. It soon became apparent that the original scale was quite fairly adjusted among the different mines except at Spadra, and that the men could do about as well in low coal as in high coal, provided they all received about as many cars as they wished. Except in the matter of turn, the other inequalities have been caused by the change from the screened-coal to the run-of-mine basis of payment. This change has been of advantage to the miners working in the higher and softer coals and against some of those in the harder and generally lower coals. The former uniformity was natural at the time prices were regulated simply by the necessity of maintaining a full crew of men, for under this rule those mines, at which the men earn more money than the average, would get a surplus of diggers and could reduce wages slightly, while the other mines would have to increase them to keep their crews. The only artificial condition was due to occasional unreasonable store requirements, or to the differences in the camps and towns. Since the coal mines have been controlled by the Union, the increases in wages have been on the percentage basis and have not greatly disturbed the relation between the different mines.

Advantages of the entry-men. The change from the screened-coal to the mine-run basis has entirely unbalanced the relation between the earnings of the entry-men and the room-men. Formerly, the yardage price was adjusted so that the entry-men, by working harder, could earn a little more money than the room-men, but not as much as at present. The difference was due to a desire to have the entries pushed when necessary so as to quickly develop the mine. A part of the yardage is required to pay for the extra labor and discomfort of making the cutting. Under the present rate of earnings, this labor would be fully covered by about 75c. per yard in average coal, but it commonly costs $1.12½ per yard. The difference between this and the $2.00 or $2.25 commonly paid, was supposedly due to the less proportion of lump coal which it was possible to get in the narrow entries. When, however, the companies were forced by law to pay as much for slack as for lump coal, this disadvantage of narrow work ceased.

At each concession obtained by the Union, a uniform percentage increase was made in the scale for coal and for yardage. This increases the net earnings of the entry-men in greater proportion than it increases those of the room-men, and from a study of the pay-rolls, the difference in the earnings of the two groups of miners is now very apparent. For these reasons, the earnings of the room-men and entry-men were kept separate at all the mines but two.

The earnings of the different groups of miners. The 2,836 diggers of all classes, whose records were studied, received on an average $4.54 for each 8 hours in the pit, and their net earnings after deducting the cost of pit supplies, blacksmithing, etc., averaged $3.90 per day with a possible error of 2c. per day either way. The average earnings of 648 entry-men were $5.95 gross and $5.31 net per day with a possible error of 3c. in the net daily earnings. The average daily earnings of 1,961 other diggers working in the same mines were only $4.12 gross and $3.52 net per day. These figures are possibly 5c. too high, since at one of the mines where the earnings of the room-men and the entry-men were not separated, the men make less than the average of the State which is increased 5c. per day when this mine is omitted from the calculation. Fifty miners were engaged in pulling pillars in the State and earned on an average $5.23 gross per day and $4.58 net. At Paris, the four machine runners cutting out the clay at the scale price per foot made $3.83 per day and their helpers $3.41 and they were not very skilled. The 17 loaders who handle the coal after it was undermined by machines earned $4.02 gross and $3.77 net.

Owing to the unusual conditions at Spadra, the few entry-men there earn per day an average of $7.45 gross or $6.54 net and the room-men $4.99 gross or $4.32 net. Omitting Spadra only, the net earnings of the other entry-men and room-men in the State are 18c. and 7c. per day respectively less than the average figures given above.

To indicate the difference caused by a poor turn, we can omit from the calculation two large adjoining mines where the scale and physical condition of the coal are very favorable to the miners, but where the turn is poor. This increases the gross earnings of the room-men 14c. and the net earnings 12c. per day but affects the entry-men only 8c. and 5c. This shows how much less the turn affects the entry-men than it does the room-men. When the turn is poor the entry-men make the entries narrower and get more yardage than when the turn is good.

If we omit those four mines at which the turn is poor and the miners earn little, and also all the mines of the Spadra district where the earnings are high, the results of the pay-roll study show that the entry-men earn on an average $6.13 gross and $5.50 net per day. The room-men earn $4.68 gross and $4.08 net per day. These figures may be taken to represent what the miners should earn under the 1908 scale.

At quite a number of the mines, the amount of money the entry-men earn from the coal they produce was taken separately.

The results show that 505 entry-men earn on an average $3.39 per day from the coal and $2.53 from yardage, both gross. The total earnings of these men were $5.92 gross and $5.27 net per day, which is very near the average of all the entry-men in the State. At these same mines, the 1,400 room-men earn $4.21 gross and $3.84 net per day.

Effect of changes in the scale. If the scale should be increased 16 per cent as first demanded by the miners in the spring of 1910, these 505 entry-men would get $6.87 per day gross or $6.22 net. This would be an increase of 18.02 per cent in the net earnings, since they would not need to use any more powder, etc., than before. The corresponding room-men would then earn $4.89 gross and $4.51 net, or get an increase of 17.78 per cent in their net earnings. The difference in the net earnings in favor of the entry-men would then increase from $1.43 per day or 37.24 per cent, to $1.71 or 37.91 per cent. This shows how a uniform increase in the scale such as has been granted in the past, gives an increasing proportionate advantage to the entry-men.

If, on the other hand, the scale on coal and day work only should be increased 16 per cent, the entry-men would get $6.46 per day gross, or an increase of only 8.86 per cent. Their net earnings would be increased to $5.81 per day or 10.02 per cent. This would reduce their advantage over the room-men to only $1.30 per day or 28.82 per cent which is more reasonable. The actual reduction in the advantage of the entry-men would, however, not be quite as great as these computations indicate, because at many mines the entry-men could widen the entries to get more coal per yard, and so earn relatively more from the high priced coal, and less from the yardage.

It might be well to remark that each increase of 1 per cent in the entire scale would increase the average net earnings of all the diggers in the State by 1.15 per cent, because the pit expenses would remain the same, while the gross earnings are increased 1 per cent.

If it is assumed that the net earnings of the entry-men ought to be 125 per cent of the present net earnings of the room-men (or $4.80 per day, for the 505 entry-men whose yardage earnings were figured separately), the gross earnings of these men should be reduced about 47c. per day. If the scale upon coal remained the same, as assumed, this would mean a reduction of 18.5 per cent in the yardage scale. In order that the average earnings of the men remain unchanged, an increase of 2.7 per cent in the entire scale should follow, or the entry yardage should be reduced 15.8 per cent and the coal price alone increased 2.7 per cent. This would make the net earnings of the room-men $3.95 per day, and of the entry-men $4.95. To bring about the same proportion without changing the yardage scale, would require an increase in the coal scale of over 80 per cent. To give the entry-men 133 per cent of earnings of the room-men without changing the average of the earnings of all the men, would require a reduction in the entry scale of 5 per cent and an increase in the coal rate of 0.9 per cent, making the net earnings of the entry-men $5.17 per day, and of the room-men $3.88 per day.

Which of these ratios is more fair should be settled by the miners and operators.

The ratio of the normal net earnings of entry-men and room-men throughout the State is so nearly the same as that at the mines where the yardage earnings were obtained separately, that the same ratio of reduction in yardage and increase in coal would apply everywhere.

The results of these pay-roll calculations are summarized in the table on the following page.

Monthly earnings. A coal digger expects to work only 20 days per month and this is counted full time. During the last two years, the mines outside of Spadra have run only about 18 days a month on an average, not counting the months when the mines were closed by the suspension, or those mines which were

Daily Earnings of Coal-Diggers of Arkansas in 1909.

GROUPS OF DIGGERS	No. of Men	Gross	Net
ALL DIGGERS—			
General Average	2836	$4.54	$3.90±.02
Average Spadra district	237	5.92	5.15
Average omitting Spadra only	2599	4.41	3.82
Normal average omitting Spadra and four mines with poor turn	1633	5.10	4.43
ENTRY-MEN—			
All entry-men, average of	648	5.95	5.31±.03
Average at Spadra	89	7.45	6.54±.01
Average omitting Spadra only	559	5.72	5.13±.03
Normal average omitting Spadra and four mines with poor turn	399	6.13	5.50±.03
ROOM-MEN AND PILLAR-MEN—			
General average	1961	4.12	3.52±.02
General average corrected for one mine omitted	....	4.07	3.48±.02
ROOM-MEN—			
Average at Spadra	148	4.99	4.32±.01
Average omitting Spadra only	1813	4.05	3.45
Normal average omitting Spadra and four mines with poor turn	1234	4.68	4.08±.02
PILLAR-MEN—			
General average	50	5.23	4.58±.02
EARNINGS FROM COAL AND YARDAGE—			
Separate earnings of entry-men from coal	505	3.39	
Separate earnings of entry-men from yardage	505	2.53	
Total earnings of these entry-men	505	5.92	5.27
Total earnings of room-men in same mines	1400	4.21	3.84
EFFECT OF CHANGE IN SCALE—			
Earnings of 505 entry-men, 16% increase in scale	....	6.87	6.22
Earnings of 1400 room-men, 16% increase in scale	....	4.89	4.51
Earnings of 505 entry-men with 16% increase on coal only	....	6.46	5.81
Earnings of 505 entry-men if yardage is reduced 18½%	....	5.45	4.80
Earnings of 505 entry-men if yardage is reduced 15.8% and coal increased 2.7%	....	5.60	4.95
Earnings of 1400 room-men, same conditions	....	4.32	3.95
(This makes net earnings of entry-men 25% more than room-men, without changing the average net earnings of all the men.)			
Earnings of 505 entry-men if yardage is reduced 5% and coal is increased 0.9%	....	5.82	5.17
Earnings of 1400 room-men, same conditions	....	4.25	3.88
(This makes net earnings of entry-men 33% more than room-men without changing the average net earnings of all the men.)			

closed for several months on account of bankruptcy or lack of market. The steady diggers could therefore earn about $68.00 net per month as an average. The net monthly earnings of the room-men were $61.00 and of the entry-men $91.00 after deducting 75c. a month for tools. The day-men underground work on idle days, or work overtime, and their average month may be taken at 21 days. The firemen, engineers, and pump-men often work 30 days a month, so the same 21 days average time will apply to the top men. This makes the monthly earnings of the bottom men at $2.56 a day equal $53.00, and of the top men at $2.02½ or more, equal $42.00 for laborers, or $65.00 to $79.00 for engineers; an average of, say, $47.00.

These monthly wages should be compared with the $60.00 to $75.00 a month earned by skilled Arkansas carpenters, $140.00 per month earned by railroad engineers of all classes, and $88.00 per month earned by railroad firemen. The work of the well paid carpenter demands more skill than that of the miners, but is not so dangerous. The other building trades work less steadily. The work of train-men is considerably more dangerous. The miners should get more than the $30 to $40 a month earned by the common surface laborers, who receive $1.25 to $1.75 per day of 10 hours.

At Spadra, the work is fairly steady, except during the long spring shut down, when the miners have a chance to do other work. The day-men have no advantage over those in other districts, and the supply seems adequate, but during the busy season, the entry-men get $97.00 per month net, working only 15 days of less than 8 hours each. The room-men get $64.00 or $65.00.

The general average net income of the diggers over the entire State is about $69.00 per month. The average income including day-men as well as diggers of all the members of the Union, is about $63.00 with proper allowance for the number of day-men and room-men in each district. At Baldwin, the farmers dig coal 3 or 4 days a week in the fall and winter, when they can not farm. They make about $1.75 a day or, say $30.00 a month, which is a striking contrast to the earnings in other districts of the State.

CHAPTER V.

RELATIONS BETWEEN THE MINERS AND THE OPERATERS

Introduction. The two great problems in profitable coal mining are the finding of a market for the coal and the securing of an adequate supply of efficient labor at feasible rates. For this reason a full statement of the scale of wages paid under Arkansas conditions is given in this chapter, mainly for the information of operators in distant coal-mining regions. The subject is somewhat technical but is given here in connection with the income of miners which is a matter of interest to the people of Arkansas. The earnings of the miners are of course determined by the contract with the companies.

The operators and miners have generally been able to agree upon the general scale of wages, but there has been a great deal of quarreling over the little details of the agreement and a constant effort to exact concessions without yielding anything in return. Much of this strife arises from a failure upon the part of both the operators and the miners to see both sides of each question. There are also many slight concessions which one party or the other can readily make and which will greatly benefit the other. In the interest of harmony between the operators and their employees, the writer has undertaken as a disinterested third party to point out some of the desirable concessions and the unreasonableness of some of the demands The general prosperity of the coal-mining industry will certainly be increased by anything which tends simply to lessen the quarreling between men who must work together to produce the coal.

INTERSTATE AGREEMENT AND CONTRACT.

The Operators' Association. At the request of the miners, the operators of most of the large mines of Missouri, Kansas, Oklahoma, and Arkansas have formed the Southwestern Interstate Coal Operators' Association for the purpose of arranging labor agreements with the officials of the Miners' Union. The Operators' Association receives a small sum of money from each member for each ton of coal mined by him, which money is used to pay administrative expenses and the salaries of the labor

commissioners and their assistants. Just before the suspension of 1910, the members of the Operators' Association paid an assessment of 5 mills for each ton of coal mined. The ordinary assessment is only 2 mills and the average is about 2½ mills. This may be compared with the cost of maintaining the Union for which the miners pay 45.7 mills per ton of coal mined in Arkansas not including the necessary expense of the check-weighman. The constitution of the Operators' Association is printed in full below.* Articles II and III are of the most interest.

The supposed advantage to the miners in having an organization of the operators is the greater convenience of arranging a general agreement and the fact that this agreement will expire at all the mines at the same time. Otherwise, if a strike were declared against one operator only, he could turn over his contracts to another operator whose mines were running and receive a slight commission for the sale of the coal, which would enable him to continue the strike much longer. When all the mines are tied up at once, the public is deprived of coal as soon as the stocks of coal are exhausted. The miners hope that under these conditions pressure will be brought to bear upon the operators to force them to grant the miners' demands, generally by successive compromises which eventually yield to the miners their full demands. The operators are in such active competition with each other during most of the time that as soon as the price of coal goes up as it will after a general suspension, some of the operators wish to sign up with the Union and begin to

*CONSTITUTION OF THE SOUTHWESTERN INTERSTATE COAL OPERATORS' ASSOCIATION. Revised Nov. 15, 1910.

ARTICLE 1.

"The name of the Association shall be 'Southwestern Interstate Coal Operators' Asociation.'

ARTICLE 2.

"The objects of this Association are to negotiate, enter into and make effective agreements which shall fix the wages of employees and conditions of employment in and about the coal mines in the 14th, 21st and 25th mining districts, as established by the United Mine Workers of America; and to compile and publish, for the use of such members, statistics of coal industries in said districts.

ARTICLE 3.

"Section 1. Any person, firm or corporation, operating a coal mine in the territory described in article 2, shall be eligible to membership in sell coal. One operator after another deserts the Association for this reason and finally they all vote to yield and none of them have ever held out long enough to win any important dispute except a temporary reduction in wages from 1904 to 1906. During the hard times of the spring of 1908, the Union failed to win any increase in the scale of prices, but the operators very quickly renewed the previous agreement for two years, even though they had determined to obtain some concessions from their men. There seems to be some danger that when the operators are forced to effectively unite to settle labor disputes, they may also be able to unite to regulate the price of coal, and the public will pay a still greater price for labor disputes.

Most of the operators of the small mines sign up with the Union under the same agreement as the members of the Association, but are often forced to grant special concessions in wages. Since their output is not enough to prevent a general rise in the price of coal, it is very seldom that the Union does not allow them to operate after signing up. The profits they make during the suspension are an inducement to the operators of the larger mines to grant the miners' demands.

Union districts. The states covered by the Southwestern Interstate Coal Operators' Association together make up districts 14, 21, and 25 of the United Mine Workers of America. All of the local unions of Arkansas and all of those of Oklahoma except those in a little area in the northeastern part, belong to District 21. This district is also supposed to include all of Texas, but as yet there are very few local unions in Texas.

this Association and entitled to a voice and one vote at its meetings; but every member shall be entitled to an additional vote for each one hundred thousand (100,000) tons of coal, or majority fraction thereof, produced annually by such person, firm or corporation.

"Sec. 2. For the purpose of determining the number of votes to which each member is entitled, the annual tonnage of mine-run coal produced by each member between June 1st of each year and May 31st of the following year, shall be ascertained from reports, verified by affidavit, to be made to the Association on or before June 10th of each year.

"At all meetings of the Association, any member shall have the right, by accredited agent or written proxy, to cast the number of votes that said member is entitled to, ascertained as aforesaid, provided that the votes to which each member is entitled (whether such vote is cast in

Districts 14 and 25 each include several sub-districts covering the separate fields in Missouri and Kansas. The state line is not generally recognized in grouping the locals but District 14 is mostly in Kansas and District 25 in Missouri.

Joint conventions. The leaders of these three districts of the Union and the scale committee of the Operators' Association meet in joint convention to arrange the general conditions governing the relations between the miners and the operators. The result is known as the 'interstate agreement' and is the same in all of the districts. Besides this, they arrange a local scale of wages and special conditions of employment for each of the districts or sub-districts. This is called the 'contract.' After the agreement and contracts are formulated, they are ratified by a convention of representatives of all the local unions and by the members of the Operators' Association, and signed by the respective leaders.

The interstate agreement and contract. The last general agreement was adopted May 25, 1908, and terminated March 31, 1910, since which time the mining has been suspended at practically all of the mines in the State.* The agreement is here printed in full and that part of the contract which has general

*A new agreement was signed September 19, 1910, for a period ending March 31, 1912. The general basis of this was an increase of yardage, dead work prices, and day wages of 55.5 per cent of the 1908 price, and an increase in the price of mining from 62c. per ton of mine-run coal to 65c. per ton and the equivalent increase for higher priced coal. The miners also gained some advantages in the conditions and granted the operators the right to use old rooms for air-courses without payment of yardage.

person or by proxy) shall be ascertained from his own production of coal.

ARTICLE 4.

"Application for membership must be made to the Secretary in in writing, stating the location of mine or mines then operated by the applicant, and must be accompanied by the membership fee for the first year, and the applicant's proper proportion of the last previous or pending assessment.

ARTICLE 5.

"No individual who is an official or representative of more than one coal mining interest shall be entitled to the privileges of the Association unless each separate interest shall hold membership in good standing in the Association.

ARTICLE 6.

"The membership fee shall be $10.00 per annum, to be paid after the first year, on June 1st of each year.

application to Arkansas, omitting the local conditions embodied in it and the portions which refer to Oklahoma only. This is followed by a general summary of the different scales of wages which were obtained from the various officials of each mine. These are the scales under which the miners earned the wages given in the last chapter.

JOINT INTERSTATE AGREEMENT OF OPERATORS AND MINERS.

Adopted at Kansas City, Mo., May 25, 1908, for the period closing March 31, 1910.

GENERAL CONDITIONS.

ARBITRATION.

SECTION I.

"1. Whereas, the benefits to be derived from an industrial contract depend altogether upon the fidelity with which it is carried into effect, and,

"2. Whereas, it is our earnest and sincere desire that any agreement made and executed by and between the representatives of the miners in Districts 14, 21 and 25 and the representatives of the Southwestern Interstate Coal Operators' Association be observed and carried out in its intirety, and that all controversies arising under the contract shall be definitely settled;

"3. It is Therefore Mutually Agreed, That in case of any local trouble arising at any time through a failure to agree between the foreman and any employee, the pit committee and the foreman are empowered to adjust it, and in case of their disagreement or failure to act within two days, it shall be immediately referred to the superintendent of the company and the District President of the U. M. W. of A. in whose

ARTICLE 7.

"To provide any further funds necessary to pay the expenses of the Association, a ratable assessment shall be made based on the monthly production of mine-run coal of the members. On or before the 10th day of each month each member shall make a verified return to the Secretary of the amount, in tons, of mine-run coal produced by such member in the next month preceding the date of the return; and the Secretary from said returns shall calculate the amount due from each member according to the assessment made by the Association. The Secretary shall forthwith give notice to each member of the amount due from him or it, and each member shall promptly pay the amount shown to be due.

district the controversy arose, or such person as either may designate to represent him, and should they fail to agree it shall then be referred by either party to the Commissioner of the Southwestern Interstate Coal Operators' Association and the District President of the U. M. W. of A. in whose district the question arises, or such persons as they may designate for its adjustment.

"4. In case there should be a disagreement between a District President and the Commissioner of the Southwestern Interstate Coal Operators' Association, the case shall be referred to the President of the Southwestern Interstate Coal Operators' Association and the International President of the United Mine Workers of America for a final decision or adjustment. In the event that the President of the Operators' Association and the International President of the United Mine Workers of America fail to agree, they shall have authority to select a person to decide the question in dispute, the mines to continue in operation.

"All settlements and decisions rendered hereunder shall be final and binding on all parties concerned, except where local decisions set aside the written terms of the joint agreement.

EIGHT HOUR DAY.

SECTION II.

"1. For all classes of labor eight hours shall constitute a day's work. The going to and coming from the respective working places is to be done on the employee's own time. All company men shall perform whatever labor the foreman may direct. An eight-hour day means eight hours work at the usual working places, exclusive of noon time, which shall be one-half hour for all classes of day labor. This shall be exclusive of the time required in reaching such working places in the morning and de-

ARTICLE 8.

"Any member who shall fail to pay his annual membership fee, or any assessment made as provided for in Article 7, for thirty days after such membership fee or assessment is payable, shall thereby forfeit his membership, and the Secretary, on being advised by the Treasurer of such default, shall strike the name of such delinquent member from the roll of membership, and thereupon notify each member of his action; and shall also report to the Association, at its next meeting, the name of every member so in default, and that the name of every such member has been stricken from the roll of membership.

ARTICLE 9.

"Every member, by joining the Association, obligates and pledges himself to maintain and observe all contracts entered into with mine-parting from the same at night. The operator may refuse to allow any day man to work on any day at which he fails to be at his working place at the starting time.

PENALTIES FOR LOADING IMPURITIES.

SECTION III.

"1. In order to insure the production of clean and marketable coal, it is herein provided that if any miner or loader shall load with his coal sulphur, bone, slate, black-jack or other impurities, he shall for the first offense be notified by weighman and check-weighman on the miners' bulletin; for the second offense he may be suspended for one day or be fined 50 cents; for the third and each subsequent offense occuring in any consecutive 30 days, he may be suspended for three days or fined $1.00; provided, if in any case it is shown that a miner or loader maliciously or knowingly loads impurities, he shall be subject to discharge.

"2. It is further agreed that if any miner or loader has been fined, suspended or discharged and claims that an injustice has been done him, the matter shall be taken up for investigation and adjusted in the manner provided for in Section 1 of this agreement.

"3. It is further agreed that all moneys collected from fines, as provided for in the foregoing paragraphs of this Section, shall be deposited to the joint account of the Secretary-Treasurer of Districts 14, 21 and 25 of the U. M. W. of A. and the Secretary-Treasurer of the Southwestern Interstate Coal Operators' Association, and disposition of said fund shall be made on the joint account of said Secretary-Treasurers.

"4. It shall be the duty of the pit committee and mine foreman at the end of each day's work to inspect the dirt loaded in coal during said day and render decisions hereunder.

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workers. Any violation by a member of any such contract shall be cause for his expulsion from the Association; but no member shall be expelled for this cause until charges have been made and proven against him; but if such charges are made and proven, the guilty member may be expelled by a majority vote at any meeting of the Association, or by a majority vote at any meeting of the Executive Committee hereinafter provided for.

ARTICLE 10.

"The annual meeting of the Association shall be held on the second Tuesday of June in each year at a place to be designated by the Executive Committee. Special meetings may be held on the call of the President,

HIRING, DISCHARGING AND TIME TO BE PAID FOR.

SECTION IV.

"1. The management of the mine, the direction of the working force, and the right to hire and discharge are vested exclusively in the operator, and the U. M. W. of A. shall not abridge these rights. It is not the intention of this provision to encourage the discharge of employees or the refusal of employment to applicants because of personal prejudice or activity in matters affecting the U. M. W. of A. If any employee shall be discharged or suspended by the management and it is claimed that an injustice has been done him, an investigation, to be conducted by the parties and in the manner set forth in Section 1, shall be taken up promptly and if it is proven that an injustice has been done, the management shall reinstate said employee and pay him full compensation for the time he has been suspended and out of employment.

"2. In order that no disputes will arise, it is hereby agreed that the foregoing paragraph of this section shall be construed that day men shall receive the scale wage for the work at which they were employed when suspended, and miners $2.81 per day.

"3. When the foreman, as provided for in paragraph 1 of this section, directs an employee to do labor, the scale of wages being lower than his regular scale, he shall be paid the wage scale as paid for labor from which he was transferred, during time employed.

SUSPENSION OF MINING.

SECTION V.

"1. In case of either local or general suspension of mining, either at the expiration of this contract or otherwise, the engineers shall not

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or on the call of two of the Vice-Presidents and Secretary, or on a written request signed by any ten members of the Association.

ARTICLE 11.

"At any meeting of the Association a quorum shall consist of the majority of the voting strength of the Association as fixed in Article 3. The Secretary shall give notice of all meetings by mailing to each member at his usual postoffice address a letter in which the date and place of the contemplated meeting shall be distinctly stated, and such notice shall be mailed not less than ten days prior to the date of the meeting; provided, in case of emergency of which he shall be the judge, the President may call a meeting by three days' telegraphic notice to each member.

ARTICLE 12.

"The officers of the Association shall consist of a President, one Vice-President at Large, one Vice-President from each of the States of Kansas, suspend work, but shall, when mining is suspended, fully protect all the company's property under their care, and operate fans and pumps and lower and hoist such men or supplies as may be required to protect the company's property, and any and all coal required to keep up steam at the company's coal plants. But it is understood and agreed that the operator will not ask them to hoist any coal produced by non-union labor for sale on the market. Should the interest of the engineers be directly involved in any issue at the expiration of this contract, and any engineers cease from work, the United Mine Workers of America will provide competent men to perform the emergency work above recited at the scale price in effect at the time of the suspension, subject to any subsequent settlement. The operator, at his option, to retain only such engineers as are required, but with the understanding that all of the engineers employed at the time of the suspension shall be entitled to an equal division of the work.

LOCAL DEMANDS.

SECTION VI.

"1. There shall be no demands made locally by either operators or employees which are in conflict with this agreement, or any District agreement, and there shall be no provisions imposed violating the same.

"2 If any mine or any substantial part of a mine is laid idle or shut down in violation of this contract by any operator or any agent of any operator, such operator shall pay to the mine workers employed in said mine, who are thereby laid idle, the sum of one dollar per day for each of such mine workers for each day or part of a day which said mine is so laid idle, which sum shall be added to the regular pay account of

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Oklahoma, Missouri and Arkansas, and a Secretary and Treasurer; but the last two offices may be held by one person. The President and Vice-Presidents shall serve without compensation.

ARTICLE 13.

"The officers of the Association named in Article 12 shall be elected at the annual meeting, and shall hold office until their successors are elected and qualify. If the Association at any annual meeting fails to elect said officers, they may be elected at any subsequent special meeting.

ARTICLE 14.

"The President shall preside at all meetings of the Association; shall approve all expenditures of the funds of the Association; and, except as otherwise provided, shall call all meetings of the Association.

ARTICLE 15.

"In case of the illness, absence, disqualification or disability of the

each of said mine workers and be paid him with such regular account.

"3. If any mine or any substantial part of a mine is shut down or laid idle in violation of this contract by any local union, member or members of any local union, pit committee, check-weighman, or other or different officer or officers or committee of the U. M. W. of A., said operator may withhold for his or its own use from any fund checked off by him or it from the wages of the employees at said mine and otherwise payable by said operator to the officers of the local union having jurisdiction over the workmen at said mine, a sum equal to fifty cents per day per man for all the United Mine Workers who are so idle at said mine for each day or part of a day such mine or substantial part thereof is so shut down or laid idle.

"4. Any question or disagreement as to any such shut-down or the laying idle of any mine being in violation of this contract and the rights of the injured party to the indemnity or penalties hereby prescribed shall be determined and finally settled as other disagreements are provided to be settled, by Section 1 of this agreement. But no indemnity or penalty above provided shall be withheld or paid to the party entitled thereto until any disagreement concerning the same has been so finally determined.

PAYMENT OF WAGES.

SECTION VII.

"1. The operators agree to pay twice a month, the dates of payment to be left as at present; and these payments are to be made at the office nearest to the mine wherein or at which the employees are employed; provided, however, that this office shall be located not more than two miles from such mine.

President, a Vice-President shall perform his duties. For this purpose, the Vice-President at Large shall be first, the Vice-President of Kansas shall be second, the Vice-President of Oklahoma shall be third, the Vice-President of Missouri shall be fourth, and the Vice-President of Arkansas shall be fifth.

ARTICLE 16.

"The Secretary shall keep a record of the proceedings of all meetings of the Association and the Executive Committee hereinafter provided for, and shall countersign all notices of meetings, and send the same as hereinbefore provided to the members of the Association.

"The Treasurer shall receive and be the custodian of all the moneys of the Association and shall pay out the same only on voucher approved by the President. He shall give a bond in an amount to be fixed by

"2. Any employee wishing to leave the service of an operator shall upon giving the mine foreman three days' notice of his intention to do so, receive all money due him within twenty-four hours after he has left the service of an operator; provided, that not more than 10 per cent of the employees shall avail themselves of said right in any one week.

CHECK-OFF.

SECTION VIII.

"1. The operator will recognize the pit committee in the discharge of their duties as provided for in this agreement, and agree to check off all dues, assessments, fines and initiations from all miners and mine laborers when desired. In order to protect the companies, the U. M. W. of A. agree, when the companies so demand, to furnish a collective and continuous order authorizing the company to make such deductions. The companies agree to furnish the miners' local representatives a monthly statement, showing separately the amount of dues, assessments, fines and initiations collected. In case any fine is imposed, the propriety of which is questioned, the amount of such fine shall be held by the operator until the case is taken up and a decision reached.

"2. All deductions for dues, assessments, initiations and fines shall be made through the company office upon statement made by the check-weighman or a duly authorized representative of the Local Union. It is understood that powder, oil and smithing shall have prior claim, and not to exceed one-half of the regular initiation fee shall be collected in any one pay.

"3. It is agreed that the miners may employ a check-weighman to see that coal is properly weighed and a correct record made thereof, and when such check-weighman is employed the companies shall furnish him a check number, and he shall credit to his number such portion of each miner's coal as he may be authorized to do by the Local Union.

DRIVERS.

SECTION IX.

"1. Drivers shall take their mules to and from the stables, and the time required in so doing shall not include any part of the day's labor; their time beginning when they reach the change at which they receive empty cars—that is, the parting drivers at the shaft bottom and the inside drivers at the parting—and ending at the same place; but in no case shall a driver's time be docked while he is waiting for such cars at the points named. The inside drivers, at their option, may either walk to and from their parting or take with them, without any compensation, either loaded or empty cars to enable them to ride. This provision, however, shall not prevent the inside drivers from bringing to and taking from the bottom regular trips, if so directed by the mine foreman, provided such work is done within the eight hours.

"2. When the stables are located outside the mine the companies agree to deliver the mules at the bottom of the shaft in the morning and relieve the drivers of the mules at the bottom of the shaft at night.

"3. When the day men go into the mine in the morning they shall be entitled to two hours' pay whether or not the mine works full two hours; but after the first two hours the men shall be paid for every hour thereafter, by the hour, for each hour's work or fractional part thereof. If, for any reason, the regular work can not be furnished the

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the Association or the Executive Committee, conditioned as the Association or Executive Committee may provide. The premiums on such bond shall be paid by the Association.

ARTICLE 17.

"There shall be an Executive Committee of eighteen members. The President and Vice-President at Large, and the Vice-Presidents of each State shall be ex-officio members of the Executive Committee, and the President shall be the chairman thereof.

"The Secretary of the Assocoation shall serve as Secretary of the Executive Committee.

"Three of the other twelve members shall be elected by the members of the Association operating mines in each of the States of Kansas, Oklahoma, Missouri and Arkansas.

"Seven or more members of the Executive Committee sitting at the chief office of the Association at Kansas City, Missouri, shall constitute a quorum, and any question before said committee shall be decided by a vote of the majority of a quorum thereof.

ARTICLE 18.

"The meetings of the Executive Committee shall be held on the call of the President, or on the call of any five members. Five days' notice, stating the time and place of the meeting, shall be given in writing to every member of said Committee; provided that the President, in any instance where he may determine an emergency exists, shall have the power to call a meeting of the Executive Committee by telegraph on two days' notice.

ARTICLE 19.

"The Executive Committee shall have and possess all power and inside day laborers for a portion of the first two hours, the operators shall furnish other than the regular labor for the unexpired time.

EQUAL TURN.

SECTION X.

"1. The operator shall see that an equal turn is offered each miner and that he be given a fair chance to obtain the same. The check-weighman shall keep a turn-bulletin for the turn-keeper's guidance. The drivers shall be subject to whomever the mine manager shall designate as turn-keeper in pursuance hereof.

MEASUREMENTS.

SECTION XI.

"1. It is agreed that measurements of entries, brushing, room turning and deadwork shall be made semi-monthly, and payment in full shall be made for such work in the same manner as other work is paid for.

CONDITION OF THE MINE.

SECTION XII.

"1. The company shall keep the mine in as dry condition as practicable, by keeping the water off the road and out of the working places. When a miner has to leave his working place on account of water, through the neglect of the company, they shall employ said miner doing company work when practicable and provided that said miner is competent to do such work, or he will be given another working place until such water is taken out of his place.

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authority that the Association possesses, except to elect officers or amend the Constitution and By-Laws. The Executive Committee shall keep a record of its proceedings, and make a report thereof to the Association. Said Executive Committee shall not, however, have any power to repeal or abrogate any action taken by the Association.

ARTICLE 19-A.

"There shall be a General Scale Committee of the Association, composed of the members of the Executive Committee, ex-officio, and twelve other members, three of whom shall be elected by the members of the Association operating mines in each of the respective States of Kansas, Oklahoma, Missouri and Arkansas, and said respective States shall also elect an alternate for each elective member of said Committee. Said alternate shall have the right to meet with the Committee, and also the right to participate in the deliberations of said Committee, and each

DOCTOR.

SECTION XIII.

"1. No deduction shall be made for doctors unless such deduction is authorized by the individual employee.

PROVISIONS FOR INJURED.

SECTION XIV.

"1. The operator shall keep sufficient blankets, oil, bandages, etc., at each mine, and provide such suitable conveyance as is available to properly convey the injured persons to their homes after an accident.

DEATHS AND FUNERALS.

SECTION XV.

"1. In the event of an instantaneous death by accident in the mine, employees shall have the privilege of discontinuing work for the remainder of that day only. Work, at the option of the operator, shall be resumed the day following and continued thereafter. In case the operator elects to operate the mine on the day of the funeral of the deceased, as above or where death has resulted from an accident in the mine, individual employees may, at their option, absent themselves from work for the purpose of attending such funeral, but not otherwise. And whether attending such funeral, or not, each member of the U. M. W. of A. employed at the mine at which the deceased was employed, shall contribute fifty (50) cents and the operator twenty-five dollars ($25) for the benefit of the family of the deceased or his legal representatives, to be collected through the office of

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alternate, in the absence of the principal, shall have the right to vote for and in place of his principal; but on all questions coming before the General Scale Committee the vote must be unanimous of all members present at the Committee.

"Said General Scale Committee shall have power to represent the Association and fix the term and conditions governing the employment of labor and all interstate conferences with the mine workers, and shall meet on the call of the President of the Association.

"The General Scale Committee shall keep a record of its proceedings and make a report thereof to the Associaation. Said General Scale Committee shall not, however, have power to repeal or abrogate any action taken by the Association.

ARTICLE 20.

"The members of each of the States of Kansas, Oklahoma, Missouri, and Arkansas, shall annually elect a Local Scale Committee of seven the company. In the event that the mines are thrown idle on account of the employees' failure to report for work in the time intervening between the time of the accident and the funeral or on the day of the funeral, then the company shall not be called upon for the payment of the twenty-five ($25) dollars above referred to.

"2. Except in cases of fatal accdients, as above, the mine shall in no case be thrown idle because of any death or funeral, but in the case of the death of any employee of the company or member of his family, any individual miner may, at his option, absent himself from work for the purpose of attending such funeral, but not otherwise.

POWDER.

SECTION XVI.

"1. The price of powder during the life of this contract shall be $2.00 per 25-lb. keg.

"2. There shall be no other explosive than black powder used for shooting coal in the mines except upon the mutual consent of the pit boss and the mine committee who may allow the use of other explosives in entries and slopes or places regarded as deficient and faulty.

RAILROAD CARS AT MINES.

SECTION XVII.

"1. When an adequate number of empty railroad cars are at the mines at the starting time in the morning to work one-quarter day, and the operator has assurance from the railroad company that more cars will be placed at the mine before the empty cars already at the mine are loaded, then all employees shall go to work.

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members. Each Local Scale Committee shall have power to deal with all local questions and conditions affecting the employment of labor arising within its State, and shall have power to fill vacancies in its own membership. Four members of each Local Scale Committee shall constitute a quorum for the transaction of business; but on all questions coming before such Committee the vote must be unanimous of all members present.

ARTICLE 21.

"The Executive Committee, in its discretion, may employ a commissioner or commissioners, and define the duties of said commissioner or commissioners. Said Committee shall also make provision for the collection of statistics which shall show the production of coal in the territory embraced in this Association, and shall report such statistics to the annual meetings of the Association, together with any other informa-

"2. Whenever any operator may desire to mine and stock his coal, either in bins or on the ground, the employees shall go to work whether there are any empty railroad cars at the mine or not.

NEW MINES.

SECTION XVIII.

"1. Where the development of a new mine is begun during the period covered by this agreement, scale of wages covering the labor at such new mine will be the same as in other mines in the neighborhood.

"2. Where a mine is being developed in a new part of the field where new conditions are encountered, a scale of wages and rates will be made by the Commissioner for the operators and the District President for the miners.

CLASSES OF WORK.

SECTION XIX.

"1. The erection of head frames, buildings, scales, machinery, railroad switches, etc., necessary for the completion of a plant to hoist coal, all being in the nature of construction work, are to be excluded from the jurisdiction of the U. M. W. of A. Extensive repairs to and rebuilding of the same class of work, shall also be included in the same, provided that any or all members of the U. M. W. of A. who may be employed at such work shall not be asked to work in conflict with the terms of this agreement.

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tion concerning coal industries that will, in the judgment of the Committee, be of interest to the members.

"These articles may be amended by two-thirds vote of the Association at any regular or called meeting; provided the text of every proposed amendment shall be presented to the members at least ten (10) days prior to the meeting at which it is voted upon.

ARTICLE 22.

"At meetings of the Association and Executive Committee, the following order of business shall be observed, unless otherwise voted:

ORDER OF BUSINESS.

1. Roll call.
2. Reading of Minutes of previous meeting and their approval.
3. Report of Standing Committees.
4. Report of Special Committees.
5. Report of the Secretary and Treasurer.
6. Unfinished Business."

"2. It is further agreed that the reloading of coal that has been mined and unloaded on the ground shall be exempt from the jurisdiction of the U. M. W. of A.

DUTIES OF PIT COMMITTEE.

SECTION XX.

"1. The duties of the pit committee shall be confined to the adjustment of disputes between the pit boss and any member of the U. M. W. of A., working in and around the mines, arising out of this agreement or any District agreement made in connection therewith, when the pit boss and said miner or mine laborer have failed to agree.

"2. In case of any local trouble arising in any mine through such failure to agree between the pit boss and any miner or mine laborer, the pit committee and the pit boss are empowered to adjust it, and in the case of their disagreement, it shall be referred to the superintendent of the company and the District President of the U. M. W. of A., or such person as he may designate to represent him; and should they fail to agree, it shall be referred to the Commissioner of the Southwestern Interstate Coal Operators' Association and the District President of the U. M. W. of A. for adjustment; and in all cases the mines, miners, mine laborers and parties involved must continue at work pending an investigation and adjustment, as provided for in Section 1.

"3. If any day man refuse to continue at work because of a grievance which has or has not been taken up for adjustment in the manner provided herein, and such action shall seem likely to impede the operation of the mine, the pit committee shall immediately furnish a man or men to take such vacant place or places at the scale rate, in order that the mine may continue at work, and it shall be the duty of any member or members of the United Mine Workers who may be called upon by the pit boss or pit committee to immediately take the place or places assigned to him or them in pursuance thereof. Provided that this paragraph shall not prevent the enforcement of the other penalties herein provided for.

"4. The pit committee, in the discharge of its duties, shall under no circumstances go around the mine for any cause whatever, unless called upon by the pit boss or by a miner or company man who may have a grievance that he can not settle with the boss. Any pit committeeman who shall attempt to execute any local rule or proceeding in conflict with any provision of this contract, or any other made in pursuance hereof shall be forthwith deposed as committeeman. The foregoing shall not be construed to prohibit the pit committee from looking after

the matter of membership dues and initiations in any proper manner. The pit committeemen shall be elected to serve for one year unless deposed for cause.

"5. Members of the pit committee employed as day men shall not leave their places of duty during working hours except by permission of the operator, or in cases involving the stoppage of the mine.

SECTION XXI.

"1. This contract shall continue in full force until the expiration of two years from March 31, 1908.

OBLIGATIONS.

SECTION XXII.

"1. All the provisions and terms of this contract are hereby mutually agreed to by and between all the operators, members of the Southwestern Interstate Coal Operators' Association and all the miners of Districts 14, 21, and 25, and are signed by the representatives of the parties hereto who have been duly authorized to execute the same on behalf of the Southwestern Coal Operators' Association and on behalf of Districts 14, 21, and 25 of the U. M. W. of A. respectively.

"2. That the next Interstate Joint Conference meet in Kansas City, Mo., not later than March 1, 1910, and earlier if meeting can be arranged by Presidents of Districts 14, 21 and 25, U. M. W. of A., and President, Secretary and Commissioner of the Southwestern Interstate Coal Operators Association.

"In behalf of the Southwestern Interstate Coal Operators' Association.

JAMES ELLIOTT,
President.

CHAS. S. KEITH,
Vice-Pres.-at-Large.

J. H. HIBBEN,
Secretary.

"In behalf of the miners.

P. R. STEWART,
President District No. 21.

GEO. COLVILLE,
President District No. 25.

ALEX. HOWAT,
President District No. 14."

DISCUSSION OF THE AGREEMENT.

Section I provides for a board of reference for the settlement of disputes and has generally worked satisfactorily, except when the miners strike before referring their grievances to it.

Section II of the agreement, which defines the time of day work of all classes, seems to be satisfactory, and changes need only be made in the event of a general change of scale.

Section III, which gives penalty for loading impurities, might well be made more stringent. As this penalty now is, some of the younger miners load out slate on purpose so as to get a three-day lay-off, which, with the two more days regularly allowed and idle days, will give them a week or more for a hunting trip without allowing the pit boss to put some one else in their places. Only a few men do this but the majority of the miners do not object to a lay-off now and then and do not fear the penalty for loading out slate.

An effective slate clause should specify that if required by the company, a single piece of easily separated impurity shall be enough for a penalty, and that the pit committee shall have no jurisdiction over the amount of impurity which can be loaded out without a penalty; and further that any miner loading out 50 pounds of impurity to the ton in any car shall be subject to immediate discharge at the option of the pit boss, but only after the impurities have been weighed in the presence of the checkweighman. If a fair sample of the slack of any car of coal shall have 5 per cent more slate than the average slack of the mine, the miner may be subject to immediate discharge. This proportion of waste to be determined by floating the coal in a solution of zinc chloride or other heavy solution which has a specific gravity 0.10 greater than that of the clean lump coal. A test to be made whenever required by the pit boss.

If it were not prohibited by law, it would seem fair to arrange cash penalties in proportion to the weight of the impurities, and on the basis of the actual agreed total cost of picking it out of the worst car, multiplied by the number of cars loaded by the miner during the day.

Section IV actually gives all of the men who are discharged the right to appeal for re-instatement. This is necessary to protect the leaders of the Union but is often greatly

abused. In some cases, the foreman does not have control over the day-men even. At other mines, new diggers can not be employed except with the approval of the Union. Paragraph 2 provides for the wages to be paid for the time lost by discharged men who are reinstated and paragraph 3 provides that men who are transferred to other work shall not get less than their regular pay. The district contract gives them an increase of 28c. a day. There is no objection to these parts of the section.

Section V requires the engineers to remain at work during suspensions and has generally been observed for at least the first four months of a suspension.

Section VI prohibiting local strikes or shut-down is very good but is not enforced.

Section VII specifies two pay-days per month, and is generally satisfactory. More frequent pay-days with the necessary measurement in the mine will take too much time of the mine foreman and of the office force.

Section VIII requires the companies to 'check-off' Union dues, etc., from the wages of the miners, and is necessary to maintain the Union, although it seems unfair to the companies and some of the men. The Union should be required to initiate any man paying the fee and taking the Union obligations.

Section IX merely provides for the measurement of the time the drivers shall work. It need only be modified in case of a change of scale and is inserted to prevent disputes.

Section X, requiring an equal turn, should be modified in favor of the miners as suggested on p. 224.

Section XI simply requires a measurement of yardage for each pay day.

Section XII, requiring the company to keep the roadways dry, and Section XIV, requiring provision for first aid to the injured, are often neglected by the operators.

Section XIII makes the payment of a doctor's fee optional. It would seem better to require a general and smaller fee which might be greater for the men with families, and in return to allow the miners to select the doctor. It is feared, however, that the miners would object to this, and it is not a favor to the companies.

Section XV, regarding deaths and funerals, requires contributions from the miners and operator to the family of any miner who is killed if the mine continues in operation. The second part, requiring that the miners remain at work unless they attend the funeral of any member of the family of any miner, is entirely proper, but in this State at least, it is nearly always violated.

Section XVI, paragraph 1, fixes the price of powder at $2.00 per 25-lb. keg. This provides a margin to pay the operator for handling it and delivering it to the miners' rooms. The price is a little high in the hope of reducing the excessive use of powder in order to lessen the danger to shot-firers. the bad effect upon the roof, and the production of slack. To be effective in this way the price should be much greater. The advance in the price could be used to provide a fund for relief of injured miners or returned to the miners in the form of a higher price for mining the coal. It should be noted that this last plan was put into effect in the Pennsylvania anthracite mines many years ago. It was very satisfactory at the time but after a number of years led to the accusation that the operators were unfairly extorting money from their men and was used to influence public opinion against the operators. Paragraph 2 allows the operator to prevent the destructive shattering of the coal by injurious explosives. In other States, it is violated by the room-miners who buy dynamite from the entry-men who need it for blasting rock. Fortunately this practice is almost unknown in Arkansas.

Section XVII is a necessary agreement to enable the operator to begin mining coal before the supply of empty railroad cars for a full day's run has been delivered. It saves a delay in the use of cars and so reduces the car shortage, but occasionally requires the miners to go into the mine for only two hours work.

Section XVIII is a necessary agreement regarding the opening of new mines. It has led to some dispute as to which was the nearest similar mine when the scale at various nearby mines has been different. It should therefore be more specific.

Section XIX, paragraph 1, exempts other mechanics erecting new tipples and the equipment, from the control of the Mine

Workers' Union. Paragraph 2 allows the companies to gather up slack from the ground during general strikes. It is all that prevents an enormous waste of the surplus slack.

Section XX, paragraphs 1 and 4 define the duties of the pit committee. Paragraph 4 should be more strictly enforced than it is because in many cases the members of the pit committee interfere in the settlements already made between the miners and the pit boss. Paragraph 5 prevents members of the pit committee who are employed as day-men from leaving their places without permission for purposes of committee meetings. This is necessary to prevent the tying up of the work of parts of the mine, but has in many cases the effect of limiting the membership of the pit committee to the contract diggers. Paragraph 2 of this section again provides for the settlement of disputes by the reference board. Paragraph 3 requires the pit committee to provide men to take the places of day-men who strike in violation of the agreement. In many cases the pit committee does this, but there is a necessary delay while men are being found, so the requirement is chiefly useful to persuade the drivers and others not to go out upon so many useless strikes. The diggers as well as the company are inconvenienced by these strikes.

Section XXI defines the period of the agreement.

Section XXII pledges its observance.

CONTRACT FOR DISTRICT NUMBER 21*, U. M. W. OF A.

Adopted at Kansas City, Mo., May 25, 1908. For period ending March 31, 1910.

PRICES FOR MINING IN ARKANSAS, AT COAL HILL, ALIX, DENNING, BONANZA, JENNY LIND, GREENWOOD, EXCELSIOR, HACKET CITY, MONTREAL, BURMA, MIDLAND CITY, HUNTINGTON, HARTFORD AND BATES.

"1. All coal in Arkansas, at the option of the operator, to be mined and paid for on a sliding scale in proportion to the percentage, or weight, of lump coal contained in the whole, based on the present prices and size of screens where such are established.

*Portions applying to Oklahoma only have been omitted.

"2. The price for mine-run coal per ton shall be 62 cents.

"3. For screened coal, per ton, 90 cents.

"4. The operators are to have the option of paying on a screened-coal or mine-run basis. When the coal is mined on screened-coal basis, the screens used shall not be more than six feet wide, have bars not more than sixteen feet long, and 1⅛-inch space between the bars." [This is known as a standard screen.]

"5. This rate applies to all coal more than 2 feet 10 inches high, except where there is a special agreement or local condition.

"6. Where miners at Coal Hill, No. 18 Jenny Lind, and Denning, Arkansas, have been pushing cars both ways, the company shall assist the miner one way when necessary.

THE McCURTAIN PUNCHING MACHINE SCALE.

"7. Cutting in rooms (including room break-throughs) shall be 12½ cents per ton mine-run, to be divided three-fifths to cutter and two-fifths to helper.

"8. Cutting in entries and all other narrow work except room break-throughs shall be sixteen and one-half cents divided three-fifths and two-fifths as above. No yardage.

"9. Loaders in rooms (including room break-throughs) shall receive forty cents per ton mine-run; loaders to furnish powder and do all work ordinarily done by pick miners in room, except cutting.

"10. Loaders in entries and all other narrow work (except room break-throughs) shall receive forty-five cents per ton. No yardage. Loaders to furnish powder and do all work ordinarily done by pick miners in entry work except cutting.

"11. The loading rate of the McCurtain machine scale shall be extended over those mines in Arkansas which now carry 62 cents per ton mine-run tonnage rate. Where punching machines are installed in Arkansas, the McCurtain cutting rate to be adopted.

"12. Where chain machines are installed, in Arkansas, the rate for runners and helpers shall be established by the Commissioner of the Operators and the District President of the Union, and in case of their failure to agree, the matter will be taken up in the manner provided for other controversies.

ENTRY YARDAGE, ETC.

"13. Entry yardage and deficient work will be the 1903 rate. [This is an advance of 12½ per cent over the non-union rate.] The

same rules and customs defining deficient work in District 21 shall be in force during the life of this agreement. [This probably includes brushing, etc., where there is no special agreement.]

"14. All break-throughs in Arkansas when required to be cut through, to be paid at the 1903 rate.

"15. Price for moving all draw slate and rock exceeding two inches in thickness, 2½ cents per inch per running yard for each five feet in width, and all over and above to be paid accordingly. This applies to all mines except where there is a special contract.

INSIDE DAY WAGE SCALE.

	Per day
Timbermen	$ 2.56
Track layers	2.56
Track layers' helpers	2.36
Trappers	1.13
Bottom cagers	2.56
Drivers	2.56
Trip riders	2.56
Pushers	2.56
Water haulers and machine haulers	2.56
All other inside day labor	2.35
Spragging, coupling and greasing, when done by boys	1.75
Shot-firers, under normal conditions	3.00

"The fire-boss shall receive $3.04 per day and shall be subject to discharge by the management of the mine without appeal; if competent, shall be given other work.

"The fire-runner shall receive not less than $2.56 where such is employed.

"Electric hoist operators:

	Per day
For boys	$ 2.00
"'Boys' means those of maximum age of 19 years.	
Electric slope engineers	2.56
Motormen	2.56
Pump men (inside)	2.56
Head machinist	3.10
Machinists	2.75
Day wages for digging coal	2.81
Machine runners	3.00
Machine helpers	2.75
Shaft sinkers	3.04

OUTSIDE DAY WAGE SCALE.

First blacksmiths	$ 3.00
Second blacksmiths	2.75
Blacksmiths' helpers	2.36
Carpenters	2.43

"Provided that all carpenters now receiving more than $2.30 shall be advanced 5.9 per cent.

All other outside day labor	$ 2.02½

"Provided that any class of outside day labor now receiving $1.91 or more per day shall be advanced 5.9 per cent. These provisions only apply to outside labor not otherwise enumerated.

SCALE FOR ENGINEERS.

Engineers, first-class, 500 tons and over, per month	$79.00
Second-class, 300 to 500 tons per month	73.00
Third-class, 300 tons or less, per month	65.00

"The minimum rate for tail rope and slope engineers shall be $2.38 per day, or $62.00 per month; provided, further that the maximum rate for tail rope and slope engineers shall be $2.70 per day or $70.00 per month. Twenty-six days to constitute a month's work and nine hours to constitute a day's work. All over-time in excess of nine hours to be paid for at a proportionate rate per hour.

"The mining prices, inside and outside day wage scale (except engineers) provided for in this contract is based upon an eight-hour work day.

SCALE PRICE FOR BLACKSMITHING MINERS' TOOLS AND MACHINE MINE TOOLS.

"1. Three-fourths of one per cent on gross earnings for blacksmithing of miners' tools, and three-eighths of one per cent on gross earnings for machine coal loaders' tools.

"2. All sharpening and repairs of tools to be done as promptly as possible.

GENERAL CONDITIONS.

"1. It is agreed to renew the contract expiring March 31, 1908, for District 21, except where local and district provisions and conditions already agreed to by miners and operators conflict with the general interstate provisions that may be agreed to by miners and operators at this conference. All joint decisions made in connection with the aforesaid agreement are confirmed.

"5. No person employed underground shall use an inferior grade of lard oil, and the use of any other except lard oil is prohibited. Rope riders in mine slopes are excepted.

"7. Where coal is screened before being weighed it shall be dumped on flat sheets and passed over the screen specified in the Pittsburg Agreement, and there shall be no obstruction on said screen.

"8. All company men shall receive an equal share of all work when competent to do such work.

"9. The gas men shall place marks at last inside break-throughs, showing clearly whether there is any standing gas in working place. Should there be standing gas, he shall place gas mark at room neck in addition to mark at inside break-through; but should working place be clear, he shall place marks so indicating this at coal face. No miner shall be permitted to brush out gas.

"10. Miners shall have the right to send out their dull tools on top of loaded cars and the company shall deliver the same to the blacksmith shop for sharpening, and no man be allowed to carry tools up or down shaft. In slopes the company shall deliver the same to parting or bottom. The company shall not be responsible for tools.

"11. Any underground employee not on hand to go down to work at the hour for commencing work, shall not be entitled to go below except at the convenience of the company.

"12. When an employee is sick or injured he shall be given a cage at once. When a cage load of men come to the bottom of the shaft, who have been prevented from working by reason of falls or other things over which they have no control, they shall be given a cage at once. For the accommodation of individual employees less than a cage load who have been prevented from working as above, cage will be run mid-forenoon, noon and mid-afternoon of each working day. Provided, however, that the foregoing shall not be permitted to enable men to leave their work for other than the reasons stated above.

"13. The sinking of slopes and driving narrow work through faults shall be left to Local Union and mine management for adjustment.

"14. All double shift places to be paid twenty-eight cents per yard extra.

"15 All wet entries, rooms, slopes, slope air-courses and all other work connected with the slopes shall be left to the Local Union and superintendent or manager for agreement of price.

"16. Frozen or seamy coal, stuck top or bottom, shall be deficient work, and shall be paid for extra, the same to be determined by mine committee and pit boss. If they fail to agree the miner shall be given an average place in the mine.

"17. There shall be no deduction for school purposes except authorized by the individuals.

"18. For the health and safety of the miners' lives, air-courses shall be kept up with the entries as near as possible, and cross-cuts shall be driven every forty feet; where gas exists, they shall be driven every thirty feet. No room shall be turned inside the last cross-cut.

19. "The present conditions in regard to double and single work shall prevail.

20. "Any employe absenting himself from work two days, and not reporting for work on the morning of the third day, shall forfeit his right to his working place, unless excused by mine foreman, but shall be given another place on turn; provided, however, this shall not apply in case of sickness.

21. "Where a fall occurs in any working place the company shall make preparations to clean up same within four hours from time of notice; failing to do so the miner or miners affected shall clean up same, company paying at the rate of $2.56 per shift.

22. "Price for moving all draw slate and rock exceeding two inches in thickness, 2½ cents per inch per running yard for each five feet in width, and all over and above to be paid accordingly. This applies to all mines except where there is a special contract.

23. "Where rooms are driven up narrow on account of bad top, the yardage shall be same as that in air-courses, measurements to be made from the entry; and when room is widened out one-half room turning shall be paid. Where bottom is taken up entry yardage shall be paid. This does not apply in rooms that have been widened out, then narrowed up and re-necked, but in these cases the prices shall be 1906 rates.

24. "When a car leaves working place it is in charge of the company, and average weight shall be paid for broken cars. Such cars shall be reported by the man that dumps the coal. The company shall keep all cars in good repair.

25. "All coal four feet and over where it comes down to under a thickness of three feet four inches, shall be declared deficient work. This applies to Arkansas and Oklahoma.

26. "Where cars are delivered at working face, all timber and rails shall be delivered there.

27. "Where powder is taken into the mine in kegs, it shall be delivered to the working place; otherwise it shall be handled according to the methods in vogue at the various mines.

28. "When any employe shall be requested to fill the place of another employe, as specified herein, he shall receive the wages of the employe whose place he takes, plus 28 cents; provided, further, that it is not compulsory on any man who may not wish to take such place.

29. "The District President of the U. M. W. of A., the Commissioner of the Southwestern Interstate Coal Operators' Association, and the State Mine Inspector shall be a committee of three to determine at what places shot-firers shall be employed in Arkansas.

30. "In behalf of the Southwestern Interstate Coal Operators' Association,

JAMES ELLIOTT,
President.

CHAS. S. KEITH,
Vice-Prest. at Large.

J. H. HIBBEN,
Secretary.

"In behalf of the miners,

P. R. STEWART,
President District No. 21.

FRED W. HOLT,
Secretary District No. 21."

The more important local prices based on an advance upon the 1902 prices, and special agreements, most of which are not printed in the 'contract,' are given below.

MINING.

Spadra. At Spadra, the agreed price for screened coal per ton is $1.02 from Sep. 1 to Feb. 28, and 92c from Mar. 1 to Aug. 31; for mine-run coal, per ton, 87½c. For all coal under 3 ft. in hight, the miner is paid 5c. per ton additional to the above prices for each 3 in. less of coal. He receives 10c. per ton extra for all coal from rooms over 150 ft. long.

Russellville. At Russellville, the price for hand-picked coal free from slack, slate, sulphur, bony coal, and black jack, is $1.12½ per ton from Sep. 1 to Feb. 28; 97c. per ton from Mar. 1 to Aug. 31; or $1.04½ per ton for the entire year. For bottom coal only, when it is more than 15 in. high, $1.30½ is paid. This is the average price at 5c. a ton extra for each 3 in. less than 3 ft. high. If bottom coal is less than 15 in., it is deficient and 10c. per ton extra is paid when both benches are mined. The miners receive 10c. per ton extra for coal coming from rooms more than 150 ft. long.

Paris. At Paris, for mining 'hand-picked or forked coal free from impurities,' $1.05 per ton is paid. This coal as mined now contains over 25 per cent of slack and this is practically a mine-run price. The coal is usually 28 to 30 inches high and is declared deficient if not over 24 in. high. The companies pay 10c. per ton for coal from rooms over 150 ft. long.

Excelsior. At Excelsior, where the coal is low, the price for the first 100 ft. of room driven horizontally, is 75c. per ton; for the second 100 ft., 80c. per ton.

Hackett. At Hackett, on account of a deficiency of 2 to 4 in. in hight, the miners get 70c. per ton.

Machine scales. At Spadra, $3.00 per day was paid for running chain machines, and 70c. per ton, for loading the coal after it was cut, and for taking care of the room. At Paris, 14c. per linear foot of face in rooms, and 16c. in entries was paid for cutting out with a punching machine 10 in. of hard clay under the coal to a depth of 4 ft. Eight or 9c. of this was paid to the machine runner, and 6 or 7c. to his helper. After the coal which is only 22 in. high was cut, the loaders received 75c. per ton for shooting it down, loading it into pit cars, and taking care of the room.

ENTRIES, AIR-COURSES, AND CROSSCUTS.

Prices paid for 'cutting' and handling coal only, in entries and other narrow places are in addition to the regular tonnage rate as follows:

At Spadra

20-foot gob entries or air-courses, per yard	$1.12
16-foot " " " " " " "	1.25
12-foot " " " " " " "	1.50
10-foot " " " " " " "	1.75
8-foot entries or air-courses, per yard	2.00
All crosscuts between entries and air-courses, per yard	2.00

At Jamestown

20-foot gob entries or air-courses, per yard	1.12
12-foot " " " " " " "	1.25
6-foot entries or air-courses, per yard	1.75
All crosscuts in entries	2.00

At Russellville

18-foot gob entries worked by 2 men, per yard	1.12½
8-foot entries worked by 1 man, per yard	1.68

This includes brushing to 4 ft. and building gob-wall for air-course next rib.

A special air-course which becomes the first room crosscut, costs, per yard	1.12½

At Paris

All entries regardless of width, per yard	1.79
After coal is undermined by machines, per yard	1.00

At Denning

Entries, air-courses and entry crosscuts	1.68¾

At Jenny Lind and Bonanza

The main entry, per yard	2.08
The back entry, per yard	1.97
The crosscuts, if driven from the main entry, per yard	2.08
If driven from the air-course, per yard	1.97

These differences are supposed to be due to the delay caused to the main entry-men by the starting of rooms and alterations in the track.

At Hackett, Excelsior, Bates, Burma, Montreal, Huntington, Greenwood, and smaller Camps

The entries and air-courses, per yard	2.25
Crosscuts between entries, per yard	1.68

At Hartford

For main entries 12 to 15 ft. wide, per yard	2.25
For entry crosscuts	1.68

For back entries 20 ft. wide driven as a 'smoke room,' no yardage paid, except the regular price for brushing.

At Coaldale

Entries and air-courses, per yard................ 2.50
Entry crosscuts, per yard...................... 1.68

In general, the Union requires the same yardage for driving a cut-off entry through old room pillars as for an entry in solid coal, but this includes cleaning up gob in the rooms and setting large props or trees in them. By decision of the arbitrators, full yardage is demanded for old rooms which are continued as entries or for all rooms from which more than one room has been turned as in flat coal seams. Attempts have been made to collect yardage on any room parallel to an entry or which may be afterwards used to carry the ventilating current.

At Hartford only, no yardage except brushing is charged upon entry air-courses which are driven full width as 'smoke rooms.'

BREAK-THROUGHS OR ROOM CROSSCUTS.

At Spadra, the companies are required to pay $2.25 for all break-throughs however they are made. This is supposed to be at the rate of $1.12½ per yard.

At all other districts, break-throughs are supposed to be paid for only when cut, but at Denning especially, yardage is claimed whenever the first shot does not blow through the pillars. Where the entry yardage is $2.25 or $2.50, cut break-throughs cost, per yard, $1.68½; at practically all other places, $1.12½; the first crosscut is always paid for. At Huntington, break-throughs in the upper bench only cost, per yard, $1.59.

ROOM TURNINGS.

At Paris, a special double room turning with the first crosscut and the connection between the room-necks cost commonly $9.00, or when first cut by machine $2.80. At all other places as far as known, the room turning is, per yard, at the rate of $1.12½. At Denning, it is called 2 yards, or costs $2.25. At all other places, it is called 3 yards, or costs $3.37½.

SLOPES.

The price for sinking slopes at Spadra, per yard.........$6.00

At other places, the price is left to local agreement. Generally it is the standard price of entry yardage and brushing, plus the cost of the extra hight and width of brushing required, plus the water yardage of 50c. or $1.00. A final 25c. or 50c. a yard is added for the extra labor of shoveling the coal uphill and for the danger from runaway cars. The cost is thus fixed at $3.50 per yard at Russellville, $4.50 at Greenwood and Denning, and $6.00 at many other places. At Jenny Lind mine, No. 18, the $1.00 a yard more than entry yardage and brushing is still paid although the slope has passed the center of the basin and is now going gently upwards in perfectly dry coal.

The slope air-courses are sometimes sunk, in which case the price is that of the main slope less the cost of some of the brushing not needed. They are usually, however, driven uphill from each crosscut from the main slope. The crosscuts are 40 ft. apart and the coal is either turned out with a shovel or run out on a temporary track. The yardage by this method is the same as for air-courses and the crosscuts between them, and is $1.25 to $2.00 less than that paid for the slope. At Russellville, the full slope price of $3.00 per yard is paid.

Yardage of generally $1.69 to $2.25 is paid for rooms which must be narrowed to 9 ft. on account of a patch of bad top.

BRUSHING.

There seems to be little basis in reason for the prices paid for brushing. There is often a fixed price per entry with a price for extra brushing per inch. In several places, there is a straight price per inch. In other places, the brushing price per yard varies by steps and is not uniform per inch. These prices reduced to the basis of one inch for each yard of roadway brushed from 5 to nearly 7 ft. wide are as follows:

Denning, Hackett, Jenny Lind, and Bonanza, per inch, per yard .... 8c.
Fidelity ....4c. to 8c.
Spadra .... 7c.
Top brushing at Burma............................ 7c.

Bottom brushing at Burma, 5 ft. wide.................. 5½c.
Bottom brushing at Burma, 3 ft wide.................. 2c.
Russellville ....5½c. to 8c.
Paris .... 5c.
Bottom brushing at Bolen-Darnall Mine at Hartford, 40c.
per yard for 18 in. or per inch...................... 2c.
Extra brushing when required............ ...... 4½c.

When the coal below the dirt band is good, the cost of the first 18 in. is only 20c. per yard of entry.

There is no brushing scale at the mines having high coal, and in general the brushing price is highest at those mines having a low price on entry yardage which makes the combined result more fair. At some places, however, it takes some hours to drill a hole for a brushing shot and then the rock may have to be sledged before it can be handled, while at another and possibly nearby mine where the prices are identical, the hole is drilld in a few minutes and the soft slate comes down for a long distance ahead and in slabs easily handled. The greatest cost per yard is $2.38 at Hackett where the price is high and the coal low.

DRAW SLATE.

When less than 2 in. thick, draw slate is generally not paid for. When thicker, the general scale is 2½c. per in. for each 15 sq. ft.

At Montreal and Burma, draw slate over 4 in. thick is paid for across the width of the room at the rate of 56c. per yard of room for draw slate 4 to 8 in. thick, and 84c. per yard for draw slate 8 to 12 in. thick. Over 12 in. is settled locally. This is from 1¼c. to 3c. per in. 15 sq. ft. as the rooms are commonly driven.

At Denning, the standard price is paid for draw slate in rooms, but in air-courses, it is paid for at the rate of

25c. per yard of air-course for draw slate 3 to 6 in. thick.
50c. per yard of air-course for draw slate 6 to 9 in. thick.
75c. per yard of air-course for draw slate 9 to 12 in. thick.
$1.00 per yard of air-course for draw slate over 12 in. thick.

Over 12 in. should generally be held up by props.

At Paris, the miner is paid for draw slate by increasing the price per ton of coal mined.

For draw slate 1 to 5 in. thick, 5c. per ton of coal.
For draw slate 5 to 10 in. thick, 10c. per ton of coal.
For draw slate 10 to 15 in. thick, 15c. per ton of coal.

This is equivalent to 1½c. to 7c. an in. of draw slate covering 15 sq. ft. of top. The thickness of the slate handled is such that 1¾c. per in. per 15 sq. ft. is the most common result of this scale.

At Russellville the miners are paid 2½c. extra for handling each inch of bottom rock for each 15 sq. ft., when it is over 2 in. thick and shoots out with the coal.

At a few mines with high coal easily mined, there is an agreement that draw slate must be handled free, but when very thick the pit boss usually pays the miner a dollar or so extra for cleaning it up at intervals. At many mines where the thickness of draw slate is uniform, it is customary to pay those miners who have the draw slate for an hour or more of time each day for cleaning it up.

GOB WALLS

At Spadra, the miners demand $1.12½ per yard for building gob walls to maintain a passage for air through the entry gob at each crosscut.

DIRT BANDS.

Dirt bands are not paid for at most of the mines with dirt bands because the coal is high and easily mined. At Spadra and Russellville, the middle band is paid for by increasing the price of coal from all places with band rock over 4 in. thick.

Between 4 and 8 in., per in., per ton of coal............ 2c.
Between 8 and 16 in., per in., per ton of coal............ 2½c.
Between 16 and 20 in., per in., per ton of coal............ 3½c.
Between 20 and 24 in., per in., per ton of coal............ 4½c.
Between 24 and 30 in., per in., per ton of coal............ 5c.

This makes the price of coal when the band rock is 24 in. the maximum now handled equal to $1.78 per ton. The band rock is measured between the loose seams. This scale is equivalent to 4c. to 11c. per in. per 15 sq. ft., in 39 in. coal, the common hight; and to 3½c. to 6c. per in. per 15 sq. ft. in 28 in. coal, the lowest mined.

If there is not enough room to gob all of the dirt band as in entries, room necks, etc., it is loaded out at a quite uniform rate of 28c. per car load, level full regardless of the size of the car.

Bony coal is supposed to be picked out at a few mines at from ½c. to ¾c. per in. per ton of coal mined. This amounts to 2c. or 3c. per in. per 15 sq. ft. at those mines.

DEFICIENCIES.

Wet places. Water yardage of 50c. to $1.00 is paid for practically all wet places driven to the dip. Fifty cents per yard is demanded of all wet places at Spadra even when going to the rise. When there is much 'rain' in a room at Paris, about 10c. a ton of coal is paid extra which is about 50c. per yard of room for each digger in the double rooms.

Sulphur. Sulphur (pyrite), when in sufficient amount to interfere with breaking the coal in blasting or with drilling holes, is paid for generally as agreed to between the pit boss and miner. At Spadra, the miner gets 10c. per ton extra for all the coal mined each day that a sulphur band 2 in. thick shows in the face. This is reasonable if the band is long, but the same price is demanded for a sulphur ball only 4 in. long, and 2 in. thick, which amounts to about 50c. for picking out each ball of sulphur.

Frozen coal, etc. When the coal is stuck tight to hard top or bottom, the miner gets about 25c. or 28c. per yard of entry extra and the equivalent in the rooms, but there is seldom any fixed scale of payment. Where it is frozen to both top and bottom, the price may be as high as $1.00 a yard extra.

Seamy coal where very hard is paid for at as high as $1.12½ a yard of room or entry at the few places where it occurs.

Faulty coal, where rock crumpling or rolls in the roof cut the coal to ¾ of its height, is paid for extra at some mines at the rate of $1.12½ per yard of entry or narrowed room, and at the rate of $6.00 a yard at Spadra. This last price is absurd. Where there is no coal at all, the Spadra scale for a faulty entry is only $7.00 a yard and the cost of loading out the rock. At

other places, this work is let by the fairer method of a special contract which varies with the hardness of the rock, or else the entry is driven by day work.

DISCUSSION OF THE GENERAL PROVISIONS OF THE CONTRACT.

Most of the general conditions in the contract need no comment. Owing to the form in which this was printed, the order of the paragraphs has been changed slightly and the paragraph numbering has been extended beyond paragraph 18. Paragraph 5 requiring the miners to burn nothing but pure lard-oil is universally violated, and should be amended together with the law so as to allow the miners to use any light that does not give more smoke than pure lard-oil.

Paragraph 19, requiring the working conditions at the mine to remain unchanged, should be amended by the addition of the words:

"Unless agreed to by the pit committee and pit boss or board of reference. It is further provided that if for any reason the operator shall change any part of the mine to a condition more favorable to the miners, he shall be allowed to restore the former conditions at any time without protest."

Paragraph 21 allows the miners to clean up rock falls at the rate of $2.56 per day. To this should be added:

"The miner is required to work steadily at this and may be furnished as many cars as are necessary regardless of the turn."

Paragraph 22, requires payment for draw slate at 2½c. for each inch of thickness for each 15 sq. ft. removed, for all draw slate over 2 in. thick except where there is a local agreement to the contrary. At all mines, payment should be made for draw slate over 2 in. thick as a matter of safety, but the price named in the agreement is excessive, since it amounts to 54c. per cubic yard. This is too much for easily handled dirt and makes the miner very careless about allowing rock to come down with the coal. There is also a tendency for the miner to include as draw slate falls of rock from some distance back from the face. It is also suggested that for convenience of measuring and to avoid disputes, the price per in. should be on the basis of the running yard of narrow entry, gob entry, or of room as in the other districts covered by the Southwestern Interstate Coal Operators' Association, where the price is also less. The scale in force at Burma, Arkansas, is recommended for general application.

For the sake of greater clearness, it would be a little better to substitute the expression 'shooting coal' for 'mining coal' in all cases as is done in one of the other district contracts.

DISCUSSION OF THE SCALE.

General fairness of the scale of wages. It is the general opinion even among most of the operators that skilled track layers can seldom be had for the price named in the scale and that the day men are not overpaid. Except at Spadra, the same opinion applies to the price paid to the room-men and to those few entry men working under hard conditions, such as two men in a narrow entry. As indicated by the surplus of men at all of the mines, the pay of nearly all classes of diggers has been excessive during the last two years. Under ordinary conditions, this would have meant that the miners would have had to share the depression in the coal trade by a reduction of wages as well as by the present short time and the difficulty of getting new work after losing their places. More of the mines would then have been able to run in competition with fuel-oil and coal from other fields. Normally, however, there has been but little surplus of men and this is the best argument for the fairness of the price under the climatic and other conditions of Arkansas. The surplus entry-men have found work in the rooms while waiting for places in entries.

High wages at Spadra. The details of the yardage, etc., were once adjusted so as to equalize the earnings of the men in all parts of the coalfield, and in this way were as fair at one mine as another. At present there is some tendency to declare a strike just while the coal is high and so frighten the smaller companies into granting any concessions demanded. This works best at Spadra where after one company has given in, an attempt is made to compel the other companies, one after another, to grant the same price. The present high wages at Spadra are therefore entirely artificial. A few companies have resisted and run at a loss on account of a short crew, or have shut down. Some that have granted all the demands have gone into bankruptcy as a result.

Among the unreasonable demands at Spadra may be mentioned the price of \$1.12½ for building a yard of gob-wall. This

is only a rough pile of flat slate to keep the debris of a gob entry from obstructing the air current coming from a crosscut, and can be built in 15 or 20 minutes. It is really less trouble than stacking up the brushing in many of the high gob entries, which work is not paid for except as a part of the entry and brushing yardage. The price of \$6.00 a yard for going through slightly faulty coal is also out of all reason and the demand of 10c. a ton extra on the coal for sulphur is now carried to the greatest absurdity. Even the 87c. a ton for mining is too high.

Scale of yardage. Some men can not do well in an entry and prefer rooms. It is generally thought, however, that the entry-men receive more than is fair and that the yardage should be reduced by ten to twenty per cent. The common saying is that the Union is run by the entry-men for their own advantage, but that they pay some regard to the wishes of the room-men in order to get their support, while the interests of the day-men are not considered.

As conditions now stand, it is recommended that the price for entries vary with the width. Whenever entries or other narrow work must be cut on account of explosive dust, the necessity for speed of advance, or to preserve strong pillars, the present price of \$1.12½ a yard for the cutting alone seems reasonable. The averages of the figures given by the miners over the entire soft coal region show that a yard of cutting can be made in 1.85 hours. At \$1.12½ a yard, this gives the miner 61c. per hour which is net, because he saves enough powder by cutting to more than pay for his light and tool sharpening expense. The price is even a little greater than 61c. an hour since many shots break a little beyond the cutting, but against this is the labor of turning out the coal.

If then the entry is so wide that the digger can get all the coal he can load, he should get no extra yardage for the coal, and in places where the entries are driven room width of 18 or 20 ft. and not cut, no yardage should be paid except as a premium for rapid progress. So far as known, this is allowed only at Hartford. This rule will also allow rooms to be driven parallel to the entries, and rooms to be changed into entries without the present absurd claim for yardage.*

*The new agreement grants the operator this right.

In general, where the roof is strong, it would seem fair to give the entry-man $1.12½ a yard for making the cutting and to let him drive the entry as wide as he wishes. For two men in high coal this is generally 14 ft. When the entry is narrowed to 8 ft. for the sake of rapid progress and is driven by two men, the present maximum price of $2.25 per yard is not too high, but for a single man in an entry, the 18½ per cent reduction in the average yardage as discussed on p. 168, or $1.75 per yard would be fair, as compared with the room miners' earnings.

The extra labor of making the first 6 ft. of a crosscut is only that of the cutting, since the main supply of coal comes from the entry and the miner losses nothing on account of lack of coal. Since, however, the crosscut is long, there is some labor in turning out the coal and a reasonable price would be about an average of the $1.12½ a yard for cutting and the price of the entry. This approximates the original price of $1.50 a yard since increased 12½ per cent.

Where break-throughs between rooms are not cut, no pay should be given. It is recommended, however, that except when the cover is less than 100 ft., the pillars be of some thickness to prevent squeezes, and this would require longer break-throughs. The price of cutting would be $1.12½ per yard with nothing extra for lack of coal. For break-throughs over 12 ft. long, the miner should be allowed about 20c. per ton each time the coal is turned. For a 5-ft. crosscut in coal 5 ft. high, this would be 60c. a yard in addition to the cutting for each yard beyond the first four. Even then, however, the average will be less than the $1.68 now paid at a few mines.

Slope yardage is to be left to local agreement. Some superintendents report that this means that the company has to pay whatever the "Local" agrees to demand, and that this figure depends simply on how necessary the slope is to the company. The rule given in the statement of the contract prices seems to be the fairest way of figuring the slope yardage. In no case should the extra price over entry work be paid when the slope is level and nearly dry.

Deficient work. No rule can be laid down as to deficient work. The more forceful superintendents will not consent to a scale for this but settle each case fairly with the man involved. This plan is to be much commended. Mr. F. J. McGuire at Fidelity uses an admirable method which is to allow a miner working in deficient coal as much money per day as he made during the last pay period, provided of course that he does good honest work, which is checked up by the pit boss. If the miner shirks, another man is put in his place, and the lazy miner awaits his turn for a vacancy elsewhere. This method generally requires a personal acquaintance with every digger. The pit committee is not allowed to interfere. It should be more generally remembered that the companies can collect fines to the limit of the money due to the Union at so much a day for all unwarranted strikes. The companies have a further right to require the miners to elect an entirely different pit committee, whenever the pit committee interferes with a settlement between the pit boss and any miner unless the miner especially calls in the pit committee. These things are not done, however, as often as they should be.

INFLUENCE OF THE MINERS' UNION.

The necessity for the Union. It is generally admitted that the Union is needed, and as yet the operators as a whole have not seriously opposed the check-off system, without which the closed shop could not be maintained. Before there was a union, the chief hardship to the men was due to the favoritism of some of the pit bosses or superintendents. It is also regretted that at some mines a direct advantage to the company was obtained by giving all of the better paying places to men that ran up big store bills, and discharging men that patronized mail-order houses. In a few places, the miners were definitely required to trade at the company store, and some miners were even discharged for publicly reading labor papers to their illiterate fellows. If any miner received an unfair measurement at that time, he had no alternative but to quit work. Owing to the scarcity of good men, however, this cheating was probably seldom intentionally done.

The general advantages of the Union. All of these former hardships have been removed by the Union. The Union or at least the Union idea is always present to afford protection to the men in the event of a possible oppression by an association of the operators. It has also secured the passage of the mining law of 1905 which, among other things, provides for the accurate weighing of the coal and should improve the ventilation of the mines. To a very slight extent the Union assists the mine inspector in his effort to enforce the ventilation law.

The Union has probably increased the general intelligence of the foreign element among the miners by inducing them to take more interest in general affairs, and has entirely stopped the custom of bribing the drivers with oil or money to give some miners more cars than others. *The Mine Workers' Journal* makes a practice of publishing the names of miners who leave a camp with unpaid board bills, and such men are not given a transfer card. They are generally, therefore, obliged to change their names, when applying for another initiation. In this way, the Union as a body stands for greater honesty.

Concessions obtained from the operators. By strikes or threats of strikes, the Union has secured for the miners two pay-days a month at the cost of a little increase in the administrative expenses of the companies. They have also required the companies to keep the mine more nearly dry, and have made the compensation a little more fair in some cases, by providing for extra payment for mining the more difficult coal. They have obtained compensation for the handling of draw slate which has made the work more safe, because it gives the companies a great pecuniary interest in providing every miner with all the props he can be induced to set.

The Organization is also looked up to by the men for having been partly instrumental in securing an increase in wages. As a general economic question, this may be of doubtful advantage to the miner, since it has certainly assisted in causing the closing of several mines which were unable to meet the competition of natural gas and fuel oil.

General disadvantages of the Union. Among the general disadvantages to the coal-mining industry attributed to the Union is the tendency to increase class hatred, which may lead to anarchy and has certainly done much to destroy the spirit of coöperation between the men and the companies. It also

provides many opportunities for graft and is an expense to the men, costing them nearly 5 per cent of their wages.

The Union often requires that a company man loading out a fall of rock or doing any such work shall get no more cars than the room-men. The room-men have so much other work that they do not need many cars, and without more cars a rock man can often not work fast enough to keep warm in the strong cool breeze of an entry. It naturally greatly increases the cost to the company, and is often a hardship to many men who are prevented from working in their rooms by the fall of rock. In this way the conditions of company car loading and car loading by the diggers are often so unlike that this rule has no justice at all even from the point of view that considers the company as of no more importance than a single miner. In any case, the mine belongs to the company and the company should have a right to favor itself.

As a general theory, the Union is supposed to be of great advantage to the operators also, in that it secures a stable labor supply so as to put competition between the operators on the basis of the physical conditions in the mine and the ability of the management, and to enable the companies to make long time contracts without the fear of strikes and increased labor costs. This was the result in Iowa at least, but in Arkansas it is certain that the long biennial suspensions have alone more than offset any advantage to the operators on this score. They have cost one of the largest companies during the last seven years over $1,000,000 in 'stand by' expense; that is, office and administrative costs, taxes, pumping, etc., which go on during suspensions when no coal is sold. In the matter of avoiding unexpected strikes, the particular set of local unions in Arkansas has failed miserably in spite of the efforts of the higher officials. Indeed, the men are becoming more inclined to strike over trivial causes from year to year.

Arbitrariness of the Union. In relation to the operators, the great mistake of the Union is its arbitrariness. The fact that no member of the Union except the fire-boss can be discharged without appeal has led to absurd abuses. At present, the miners think they have a perfect right to use the most offensive language toward any operator or his representative. If the pit boss succeeds in soundly thrashing an insulting miner, no action is taken except possibly a suit in the criminal court. There are, however, some excellent pit-bosses who are not expert at rough and tumble fighting and many of the operators are very slight men physically. Nevertheless, if the operator of a mine should discharge an employee for physical violence or for insults not fit to print, there is either an immediate strike or an appeal to the arbitration board. If any justification for the quarrel on the part of the miner can be found, this board will order him reinstated in his position with full payment for the time lost. The result is that some of the actual operators of the mines hesitate to go near their own properties for the purpose of adjusting a dispute. The arbitrators did recently decide that a company operating a mine in Oklahoma could not discharge a miner who was legally convicted of selling whiskey in a company house in defiance of the State law.

In the same way, the miners drive their rooms any size they wish and regardless of the orders of the pit boss. Sometimes, therefore, the pillars are insufficiently thick and the company is put to great expense on account of a squeeze. At other times, the pillars are so large that an unnecessary amount of coal is wasted in them. The miners pay no attention to sights or grades given by the engineer unless they are compelled to do so by the personality of the superintendent or pit boss. There is no punishment whatever for shooting the coal to slack and practically no punishment for loading out dirt and slate.

The men will allow the operator no supervision over their blasting and there is no way to prevent the miners from blowing up the mine by improper shots. The only protection the shot-firer has is his nominal authority to refuse to light dangerous shots. If, however, he does this, the men sometimes complain at once to the superintendent and demand his discharge or they fine the shot-firer.

The effects of such an attitude were illustrated at Mine No. 4, Hartford, on Jan. 8, 1910. The officials of the Local Union had been annoying the shot-firers and threatening to fine them for skipping so many shots. That evening, Shot-firer J. W. Mitchell became angry and declared that he would fire every shot upon his side of the mine even though he blew up the whole mine by doing so. Sure enough he lit two dangerous

shots in a single room and caused a severe local dust explosion. The conditions of the mine were such that this explosion did not blow up the whole mine as the poor fellow feared. In fact his partner fired a few shots in a distant entry after he felt the concussion of the explosion, and even after he decided that he, himself, had better get out of the mine, he neglected to notify the superintendent at once. This increased the delay of the rescue so, when found by the superintendent, Mr. Mitchell had been dead for some time. He was standing with his head in his hands against a pile of waste. His body was not marked but he had been overcome by the gases from the explosion before he could get out. This man was only one of many who have lost their lives on account of the unreasonableness of the Miners' Union.

VIOLATIONS OF THE AGREEMENT BY THE MINERS.

The greatest objection to the Union is the constant violation of its agreements. The Union has no corporate existence and can not be sued for damages. All the better officers and leaders do attempt to live up to their contract, but are unable to hold in line the rank and file of the Union, who can not resist the temptation to annoy the companies. Tying the mine up on account of funerals has been discussed.

To prevent injury to the cars and annoyanace at the self-dumping cages, most of the companies have imposed a weight limit on the cars. Any coal in excess of this amount is not credited to the loader, but since the company does not expect to get it for nothing, it pays to the Union the price for mining it. Ordinarily, therefore, the miner does not overload his car unless he has plenty of coal and puts on a hundred pound or so 'for the Union.' At one of the Huntington mines, however, the Local Union has voted in direct violation of their agreement to require the check-weighman to keep track of the amount of excess coal each miner sends out and to pay this back to the miner from the money given to the Union. As a result the miners load out from three to six times the normal amount of the excess weight of the coal. This causes some expense to the company for repairs to pit cars and for cleaning out the sump below the shaft. The large lumps of coal falling down the shaft annoy the cagers by splashing water upon them and frequently cause serious injury. The proportion of overweight at this mine is three times the normal amount and shows how much more the miner is interested in himself than in the Union.

Probably there is more difficulty from the drivers than from any other group of employees. They have frequently all quit work and violated their agreement to simply appeal to the arbitration board, because they accused the pit boss of violating his agreement by not giving them all an equal turn at idle day work, regardless of their ability to do this work. The drivers who are supposed to be favored are compelled to strike with the others.

Another trivial cause of strikes is an unfairness of the turn. This unfairness is sometimes accidentally caused by wrecks or failure of the drivers to carry out the orders of the pit boss. Sometimes it is due to a bad distribution of the crew of diggers and drivers. In any case, the diggers should appeal and not strike. At one mine, the diggers are not well united and only those in one or two entries quit at a time. Their cars are then distributed among the remaining diggers, and the next day the pit boss laughs at them.

At other times, one or two men get up a sudden strike on account of a supposed unsafe condition of the mine, and refuse to work until the mine inspector comes. Technically this is not a violation of the agreement, but generally the condition is an old one and at the worst affects only one or two working places, in which case work at all other places should go on as before. In many instances, the mine inspector finds nothing wrong and is as angry as the operator.

One of the worst forms of these strikes is that caused by the wandering trouble makers or 'hobo miners,' who get elected to offices in the Local and in the busy season agree to get an increase in the scale if the men stand by them. After the strike is well started, the hobo gets work at another camp and allows the town boys and the company to suffer. If the strike is won, he and his friends profit by it next year.

When the superintendent accuses the men of violating the contract by striking, they retort that they are not striking but are all sick. They add, however, that they will not get well

until a certain man gets his place back or the company grants their demand.

To illustrate the number of one class of violations of the agreement, it may be stated that there were during the last contract period of 1908 to 1910, twenty-one different strikes which tied up the mines in violation of the agreement for periods of from one-half day to one hundred and twenty days. This does not include the delays caused by funerals, etc., but were all the result of quarrels with the mine officials. These strikes resulted in a loss of 705 days to the operators, and in 121,895 days' work lost to the miners. Eleven of these strikes lasted over one week and therefore resulted in permanent loss of business to the companies, besides the annoyance and expense of the little delays. The chief coal contracts are for so many tons per week. If the coal is not supplied by the company concerned, it is then bought elsewhere. These longer strikes cost the miners about 120,000 days' work; and taking the average net earnings of all classes of men at $3.40 per day, these long strikes cost the miners some $400,000. When the figures are corrected in detail for each strike to allow for the increased work after the strike, the net loss to the men was at least $350,000. The total earnings of the miners of the State during the 22 months, figured on the above basis, was something over $5,000,000; so the loss was about 8 per cent of the earnings of the miners. Some miners therefore think that the Union is indeed an expensive luxury.

If the actual miners are chiefly responsible for the violations of the Union agreement, the leaders alone are responsible for the passage of the disgraceful mine-run law which has been such a handicap to the coal-mining industry of this State especially.

PROPOSED CONCESSIONS.

For all these reasons, there is a constantly growing opinion that the Union is the curse of the industry and many of the operators, even some of the more liberal ones, are coming to the conclusion that the Union must be destroyed in order that they may escape from its oppression. Other persons, however, are of the opinion that by slight concessions on each side, the Union and the operators could work together in a very satisfactory way. It is in the hope that this may be accomplished that the following suggestions are offered.

Non-union mines. Each small district or camp must be either wholly non-union or entirely union, as desired by the men. The so-called 'open shop' with voluntary membership in a union, leads to constant friction in the mine and among the miners' families. Those companies having several mines can possibly arrange which of their mines are to be non-union so as to suit all classes of the miners. At other places, it is a matter that might be left to the superintendent and the men. No attempt should then be made to destroy the Union or to use compulsion against the non-union men. A few of the non-union men will be the best class of miners, but the bulk of them will be poorer than the average and mining costs will be equalized.

Incorporation of the Union. Since this idea is impracticable, it is thought that it is best to have a 'closed shop' if the Union will incorporate itself as is done in England, so that a real contract with some legal strength can be entered into. The present so-called contract is not worth the cost of printing so far as its legal value to the operators is concerned. The value of the company's property and good will in the market enables the Union to enforce its reasonable demands by a strike.

Control of the crew. To permit the owners to profitably operate their properties, the pit boss should have complete control of the crew, and for the sake of harmony should have the unquestioned right to discharge any man he wishes, even for no other reason than personal dislike, if he thinks he can get a better man in his place. This privilege will not be abused, since the pit boss must maintain a full crew, but when the worst offenders are dismissed, the remaining men will be more careful to do things according to orders. An efficient superintendent will see that the pit boss shows no man undue favors.

Protection of Union officials. The objection to the uncontrolled discharging of men is that some of the less scrupulous officials will discharge those men that are active in the Union, even if they do nothing at all improper. It is for this reason that the agreement, Sec. IV, Paragraph I, provides that the men shall not be discharged without the right of appeal.

The best feasible solution of this question of how to give the companies full authority to hire and discharge men without injury to the Union, would seem to be that of separating the employees into two classes, ordinary mortals and officials of the Union; the first class to be subject to discharge when in the judgment of the pit boss it is necessary, and to have no appeal except to the law of supply and demand in the labor market. The officials are to be discharged only for cause, but these causes should include failure to report for work for three consecutive days except for good reason, and persistent loading out of slate as at present, but more rigidly enforced. In addition they should be subject to discharge for making too large a proportion of slack, persistent failure to properly timber working places, or to drive rooms or entries properly on sight or to grade as required, for refusal to keep room or entries the proper width, for neglect in closing doors, for laying off one-fourth of the time without excuse, or for making slow progress (say less than three-quarters of the average rate), for abusive language to the officials, disobedience to orders, or for anything definitely detrimental to the interests of the employers and not required by the Union. The officials should have the right of appeal in case they think they have been unjustly treated.

This favored class would include all local and district officials as the Union is now organized, but no new man should be recognized as an official until he has continuously worked for the company, subject to immediate discharge, for at least a month, if married, or for two months, if single. The Union is not to be restricted in the selection of its check-weighman. If any man has served as check-weighman continuously at any mine for six months, he shall be given any place applied for ahead of all new men waiting for work, but not ahead of the regular crew temporarily out of places. He can then be at once elected to any other office. Those men, who have served as officers of the Union at other mines at the time these were shut down, should be entitled to protection for six months at other mines if the local so requests, and shall get places ahead of other strangers.

This will require all the officers of the Union to be skilled efficient miners or day-men and will eliminate the professional trouble maker who is generally worthless as a miner. Any man particularly valuable to the Union can be retained as check-weighman which position requires considerable intelligence. The officials of the Union will not have much advantage over the men, and the pit bosses should show no prejudice against the Union. Many pit bosses and superintendents are strongly in favor of a sensible Union and would certainly do the best they can.

The right to hire and discharge employees. In case of objection to the plan of favoring the Union officials, it is urged that the long list of causes for discharge, given above, be added to Sec. IV of the agreement. Good miners will not be discharged for trivial offenses on account of their scarcity.

No restrictions except as outlined above should ever be placed upon the hiring of men by the companies. It should be understood that new places will be assigned to the members of the regular crew in order as they finish their old places. When, for any reason, the output of the mine is reduced by stopping work in one or two entries, the superintendent should be free to choose, from among these men, those whom he wishes to remain and take places in turn in other parts of the mine. Under the present rule of giving places to new men in the order in which their names occur upon the check-weighman's list, the pit boss is often obliged to hold some places back until the undesirable man at the head of the list is drunk or out of town. Such tricks are not pleasant.

Small concessions by the operators. The greatest complaint against the companies, charging failure to carry out their agreement, is in the matter of supplying good air and in keeping the roads dry. This is only in certain cases and the miners generally say that conditions are improving, from year to year, but all companies should at once make the drainage and ventilation of their mines as perfect as possible. There has been a little complaint about unfair measurements of draw slate and yardage, and undoubtedly some injustice is occasionally done to some of the more ignorant miners in this way, but the pit boss occasionally also makes mistakes in favor of the men. There are of course many entirely groundless complaints in addition to these.

The selection of proper bandages and supplies for first aid treatment to the injured according to Sec. 12 of the agreement is generally left to a pit boss rather than to a surgeon, and many absurd remedies are furnished, but generally according to the requests of the miners themselves. In many cases, this agreement is ignored entirely. The miners consent to this, and when asked about it, they maintain that the company should prevent all accidents regardless of the carelessness of the men. The training of first aid corps as is done in the Pennsylvania anthracite region is suggested.

The turn. At many mines, the most valuable concessions to the men would be to give them a good turn. Many superintendents do make an effort to give the diggers a good turn or plenty of cars.

The first reason that it is not universal is on account of the demand from the men that a digger be put in every possible place, especially during slack times. This results in overcrowding the entire mine so there are not cars enough to go around and the same total pay is divided among more men.

The second reason is that a good turn increases the earnings of the room-men more rapidly than those of the entry-men, and there is some fear that the entry-men may demand an increase in the yardage scale, a more favorable width of entry, or some other concession in order that they may maintain their advantage. This is very unlikely, however, and a strong superintendent can easily resist this demand. In the interests of the company as well as of the miners, he should also resist the demand to crowd the mine with diggers.

A third reason for a poor turn is that it often happens that the crew of diggers is so short or incapacitated as a result of drinking that they can not supply enough coal to keep the drivers busy or to maintain the output of the mine. As a consequence the superintendent opens up so many entries that he is reasonably sure of his output every day, and on normal days the men get very few cars apiece. This reason is important only where the crew of diggers contains a large proportion of irregular and drinking men. It can be corrected by discharging the worst offenders among the diggers, and this authority should be granted by the Union at once. If the Union refuses this, it would probably be better to give the men a good turn at the expense occasional half-day runs or of shutting the mine down entirely after the big holidays. Short-day runs increase the expense of the shot-firers and fire-bosses chiefly.

A fourth reason for the poor turn is that a clause in the agreement requires all 'working conditions' to remain as at present. Since it is often a great advantage to the company to have two men in a room in certain parts of the mine, the superintendent is obliged to keep two men in every room at all times to avoid establishing an injurious precedent, and as a result, some of the entries are so crowded that it is impossible to put enough drivers in them to take away all of the coal that the miners could load. The other entries must then be held back to keep a square turn among the miners. It is believed that each operator should have full power over the working conditions in his own mine as was the case before the organization of the Union. Since he must maintain his crew, the working conditions can not be made too unfavorable or all of the miners will seek work elsewhere. It is, however, very unlikely that the Union will ever grant the operators this authority, because in June, 1910, the operators offered to increase the entire scale of wages 5.55 per cent in return for the privilege of determining their own working conditions. This offer was refused by the miners who continued their strike for three months longer. Nevertheless, at many mines where two men work in each room, the entries are so laid out that the turn is very good, and an effort should be made to make it so in other mines.

A fifth and often very important reason for a poor turn arises from the fact that if the miner has all the cars he wants and is ambitious to earn much money, he hurries with the loading. Under these conditions, he naturally picks out the slate less carefully and since the mine-run law compels the company to pay for this slate just as if it were coal, the companies have little protection except in giving the miners a poor turn. At one mine, the output and consequently the turn which the miners receive is reduced about ten per cent by delays on the surface, while the slate is being picked out of one pit-car load of coal before another can be hoisted. The loading of slate with the coal should be prevented by better discipline under all conditions, but until the miners submit to this, they have no right

to object if the operator makes the turn just as poor as he can without loss to himself, because this is the only punishment for loading slate that can not be resisted by the Union. It is so unfair to the miners who load only clean coal that they should be willing to coöperate with the company in penalizing the careless miners in return for receiving a good turn.

The sixth objection to a good turn is that when the miners get many cars, they spend less time setting props, and the number of accidents increases. The miners can, however, be required to set sufficient props by changing the agreement and especially the State law as suggested in Chapter VI.

When the miners all get exactly the same number of cars per day and none of the miners get all their loose coal cleaned up, the daily rate of advance of the rooms is uniform, whereas if all the miners got as many cars as they wanted, the good miners would load much more coal than the poor ones and therefore advance their rooms more rapidly with attendant disadvantages. This seventh objection is not at all important, however, because with even a square poor turn, many of the rooms fall behind because of the irregular attendance of the miners. As previously stated, the operators should be allowed to discharge the slow men or to put them all in a single entry by themselves.

The eighth and most universal objection to a good turn is that it enables many miners to get a clean up, before the end of the day, and the coal comes slowly near quitting time, so that the drivers and other day-men who handle the cars can not do as much work as they should. For a similar reason, there is little or no work for the day-men next morning, until the room-men have replaced knocked out props, cleaned up falls of rock, and have loaded their first car. When the cars are large, this is more important, and if most of the men had been cleaned up the evening before, the minimum delay in the morning would be about 30 minutes. This alone would cost the company one-sixteenth of the pay-roll of a large part of the day crew or with the delay in the evening, it would cost the companies from 3c. to 6c. per ton of coal mined. This objection makes it entirely impossible to clean up all the diggers and mine the coal advantageously. The more experienced superintendents, who have given thought to this problem, estimate, however, that about one-third of the miners can be cleaned up and the others given nearly as many cars as they want at an increased expense to the company of less than 1c. to 2c. per ton of coal mined, as compared with the very poor turn. This may increase the net earnings of the room-men as shown by the actual figures obtained from the mine pay-rolls from only $2.58 per day net which is an average at the four mines with a poor turn to $4.08 per day which is an average of the other mines, omitting Spadra where the earnings are so excessive. This is an increase of 58 per cent in the net earnings of the miners, and is equivalent to an increase in the scale price of 50 per cent, and might cost the companies 1c. per ton of coal.

Besides the great advantage to the miners, a good turn has many incidental advantages to the companies. For example, fewer entries need to be worked or maintained to give the same output of coal. This facilitates the supervision of the drivers and so reduces loafing and there is a direct saving in the cost of timbermen and rock-men and in the interest and depreciation upon the track and interest upon the cost of the entries not yet needed. If the turn is increased from three cars to five cars, this may amount to 3.8c. per ton at some mines for which data are at hand. This argument will not apply when a good turn can be obtained only by changing from two men in a room to one all over the mine, but such a change is seldom necessary.

When all of the men get many cars, there is no complaint about giving some of them more cars than the average, provided of course that each of them gets all the cars he wants occasionally. This is a great advantage when some work is needed in a hurry. At some mines at least there will be less trouble with the men if they are given a good turn.

A good turn may be maintained by deciding upon what the output of the mine shall be as determined by the amount of capital available for investment, by the amount of coal required for profitable contracts and the general market demands, and by the amount of unmined coal to be obtained from a single opening, etc. After the mine has been opened to this capacity and the plant and day crew adjusted accordingly, the number of working places can be kept uniform, by opening up new entries only a little faster than needed and not putting

in men at every possible place. This will require a pretty good knowledge of the character of the coal bed in different parts of the property and some advance development to allow for variations and faults in the coal.

The cost of a good turn may be reduced by putting the slow miners, who should be subject to discharge anyway, in one or two special entries by themselves in which entries only the same proportion of the diggers should be cleaned up. If the room-men are slow and the entry is advanced at the average rate, the number of working rooms in the entry is greater and a large number of slow miners can provide the same total amount of coal from an entry as a smaller number of fast miners. When a mine is nearly worked out, there will be an advantage of driving some entries slowly so as to bring all of the entries in the last group to the boundary of the property at the same time.

It is recommended, therefore, that the companies make as much effort as possible to get the coal away from the miners as fast as they can load it so that they can earn good wages. For this purpose, the first sentence of Sec. X of the agreement should be modified to read:

"The operators shall as far as possible endeavor to furnish the miners nearly as many cars as they desire. If less than one-quarter of the men in the mines are cleaned up on an average, the miners shall receive an equal turn. If the company is able to furnish as many cars as wanted to one-third of the men or more in each entry, there shall be no requirement of equal turn among the entries, and the company shall be allowed to change diggers from one entry to another if desired, provided that there be no difference in the two places except in the matter of the turn. An effort shall be made to furnish each miner as many cars as he may need for the same number of days in each month. In no case will the miners require an equal turn with the company men."

The following provisions should also be added to this section:

"If any miner quits before the regular quitting time, and before his room is cleaned up, he shall loose his right to his equal turn for one week and shall receive cars only at the convenience of the company, provided that an empty car shall have been offered to him at least one-half hour before quitting time, on the day he quits early.

"The pit boss or his representative shall be required to stop the miner's turn if his room is not timbered as agreed upon between the pit boss and the pit committee, whenever such a room is reported to him."

(The fire-boss can easily report these bad rooms.)

If the companies give the miners a good turn, as suggested, and do not discriminate against the reasonable Union leaders, and if the Union strictly adheres to the spirit of its agreement, it is believed that the present ill feeling between the operators and the Union will subside.

CHAPTER VI.

MINING LAWS OF ARKANSAS.

ABSTRACT OF PRESENT LAWS RELATING TO COAL MINES.

Most of the provisions of the mining laws of the State are adequate and require no comment. The subjects covered by the laws relating to coal mining are given in the outline below.

Mine maps. Sections 5337 and 5338 of Kirby's Digest of the Laws of Arkansas, as amended by Act 225, 1905, require the operator* of each coal mine to file with the mine inspector and the clerk of the county an accurate map of his mine workings and property, each year or whenever a mine is abandoned, or if he fails to do so the mine inspector is authorized to have the map prepared at his expense.

Ventilation. Section 5340 of Kirby's Digest, and sections 7, 8, 10, and 17 of Act 225, 1905, provide that all openings to the surface used for the removal of coal shall be the intake of the air current which shall be not less than 100 cubic feet per minute per man measured at the foot of the intake, that the air current shall be so split that there shall be not more than 50 employees working on each split of air, that there shall be not less than 200 cubic feet of air passing each working face per minute, and that the mine inspector be required to measure the air at all working faces in making his inspection.

Where gas has been found in the mine, a fire-boss must examine each working place and all abandoned places adjacent thereto, if accessible, each morning before miners are allowed to enter, and he is required to keep a record of the condition of all places and mark out all dangerous places upon a blackboard. Any appliance can be used to produce the air current, but furnaces must be arranged to prevent fires. In room and pillar mines, two entries must be driven parallel to each other for ingress and egress of air with crosscuts between, at intervals of 40 ft. along the entries, or of 30 ft. if gas is present. The inspector was required to send written notice of the last

*Operator is used throughout this chapter to include any person, firm, or corporation in possession of the mine.

change in the law to all operators. Needed modification of the law will be suggested.

Section 11 of Act 225, 1905, provides that no oil except pure lard-oil shall be used for lights by any underground employees except rope-riders. Because of the impossibility of enforcing this, the law is a dead letter.

General Safety Provisions. Section 5339, provides for an adequate escape-way distinct from the ordinary entrance and exit of the mine.

Section 5341 provides that bore holes be kept 20 ft. in advance of all workings approaching abandoned workings containing water or gas.

Section 5342 requires all shaft mines to be provided with proper signals, a proper hood over the cage, proper guides for the cage, proper brakes for the hoisting engine, and proper safety catches on the cage. It also provides that no props or rails shall be lowered in a cage while men are ascending or descending in the shaft, and that when men are upon one cage, the opposite cage shall be empty. (Means for testing the safety catches will be suggested.)

Section 5343 prevents the employment of boys under fourteen years of age or under sixteen years unless they can read and write, or females of any age, underground; and requires the employment of competent persons over eighteen years of age to operate the engine by which men are hoisted or lowered in either shafts or slopes; and allows only the persons employed for the purpose to ride upon any loaded cage or slope trip; and allows only eight persons and only one of each family to ride upon any single cage or car, which must not be lowered or hoisted more rapidly than 500 ft. per minute while men are riding on it.

Section 5344 provides for proper gates and fences around mine openings, proper safety devices for steam boilers, and provides that when underground engine planes, etc., are used for traveling ways they shall be provided with refuges at intervals of not more than 30 ft.

Section 5345 provides for the investigation of all fatal explosions or other accidents by the mine inspector, and for notifications to the coroner or some justice of the peace of the

county, of any loss of life or any serious personal injury caused by any accident at any mine.

Section 5351 forbids the injury of any apparatus at the mine which is necessary for its security, and provides the penalty.

Section 5352 requires the operator to deliver a sufficient number of props to the miner's room. (Modification of this and a requirement to compel the miner to set the props is suggested on p. 235.)

Section 12, Act 225, 1905, requires the mine operator to keep at the mine sufficient bandages, stretchers, medicines, etc., to care for injured persons.

Section 18, Act 225, 1905, requires the companies to call out the miners in time of high water, at all mines which may be in danger of flooding, and provides a severe penalty.

Section 5350 as amended by Section 4, Act 225, 1905, provides for the recovery of damages by a miner or his heirs when the miner is injured by willful violation of the mine laws.

Mine Inspection. Section 5346 provides for the appointment of an Inspector of Mines by the Governor and specifies that he shall be a practical miner of 7 years' experience and shall receive a salary of $2,000 a year.

Section 5347 outlines the duties of the inspector and specifies the very brief report he is to make and requires that he shall not restrict the working of the mines unnecessarily.

Section 5348 requires that the operator give the inspector all facilities for inspecting the mine and provides the penalty for failure.

Section 5349 provides that the mine inspector shall have the operator of any mine which is worked contrary to the provisions of the laws or which is unsafe for the workmen, enjoined by the judge of the circuit court, from further operation of the mine until the defects are remedied.

Section 16, Act 225, 1905, requires the prosecuting attorney of the district to take charge of all complaints of violations of the law upon notice from the mine inspector.

Section 5354 provides for penalty to the mine inspector for neglect of duty and for all others who violate any provision of the mining laws.

Section 15, Act 225, 1905, provides the mine inspector with blanks and stationery.

Section 5358 specifies the general penalty against both the mine operator and his agent for violations of the law.

Weighing Coal. Section 5353 provides for the employment of a sworn weighman, for recording the amount of coal mined, and requires the mine operator to allow the miners to employ a sworn check-weighman.

Section 5356 as amended by Section 6, Act 225, 1905, requires the mine owners to provide proper scales for weighing the coal, requires the mine inspector to test them once a year, and as much oftener as may be required by the written request of the mine operator or any two or more of the miners.

Section 9, Act 225, 1905, requires every mine operator to keep on hand 500 pounds of United States standard testing weights for use of the mine inspector for testing the scales.

Section 5357 required the owner to pay for the coal without screening except under a specific agreement, or contract outlining the method of screening. It also gave the operator the right to deduct the weight of impurities loaded out by the miner.

Act 219, 1905, is the so-called mine-run law which denies the rights which were granted to the operator by the above sections.

Miscellaneous. Section 5359 gives the workmen a lien upon the output and equipment of the mine to secure the payment of their wages.

Section 5355 requires that the operators of mines and other industrial establishments shall be required to give the names of their agents and employees to assessors, sheriffs, and tax collectors, acting in their official capacity.

Section 13, Act 225, 1905, provides that the operator of each mine of whatever size shall make a sworn annual report to the mine inspector of the amount of coal mined each month of the year ending July 1st.

Section 12, Act 225, 1905, provides a penalty.

DISCUSSION OF MINING LAWS OF ARKANSAS.

Better ventilation. The sections of the law governing the ventilation of the mines are defective in specifying both the results required and the method of accomplishing them. The clause governing the distribution of the air current through all parts of the mine is also entirely inadequate. The following suggestions are, therefore, offered as an amendment to the sections of the law governing the ventilation of the mines:

When the temperature of the outside air is more than 28 degrees F. all outlets for coal should carry an intake current of air. In colder weather the direction of the ventilating current may be left to the option of the operator. The air current shall be so divided that in general not more than forty men shall work in one split of the air current except in opening up a new portion of the mine, in which case one only of the splits may supply as many as sixty men until it is convenient to provide an additional split. Each split of the air current shall have not less than 100 cu. ft. of air per minute for each man working in it and 600 cu. ft. per minute for each mule, measured in the main airway within 200 ft. of the working place most distant from the main intake. The mine inspector shall be required to measure the air current in each split within 200 feet of the most distant working place at each inspection and record the results in a well-bound book. An air current at least equal to 1,000 cu. ft. per minute shall be conducted to within forty feet of the face of each working place at all times or to within thirty feet if the mine gives off considerable quantities of gas. Sufficient air must reach the actual working place to keep it free from all standing gas of any sort. Except where several splits are combined, all airways must be of sufficient size to reduce the linear velocity of the air to 150 ft. per minute, or less. At all mines where any firedamp has been detected, a competent person or persons shall be employed as fire-boss, to inspect the mine each day, immediately before the miners go to work. If any dangerous accumulation of gas can be detected by the ordinary safety lamp, no miner or driver shall be permitted to work in that split of the air current until the gas shall have been removed by the proper officials. The fire-boss shall properly mark out all dangerous workings and also the entrance to the entry containing the gas and shall post these places on a suitable blackboard at the pit mouth, and record them in a well-bound book. He shall leave a mark showing his visit each day in each working place. All bodies of standing gas shall be removed by directing a current of air into the working place, in such a way that the gas shall not again collect during the day. Any adequate means of accomplishing these results may be used by the operator.

All permanent stoppings required to maintain the ventilation shall be substantially built of masonry, preferably reinforced concrete, from floor to roof, when they are more than 1,500 ft. from the last crosscut. All other stoppings shall be at least as permanent as those made of two thicknesses of boards and a complete layer of tarred canvas. Explosion doors may be left in the stoppings where desired, but must be self-closing.

All overcasts and undercasts shall be provided with thin wood and tarred canvas partitions so arranged that they may be immediately blown out by a severe explosion. The other parts of the overcast shall be substantially built and so arranged that the explosion partitions can be at once replaced by sheets of canvas, in order to restore the ventilation with the least delay.

These provisions will be sufficient, since in order to accomplish the ventilation so required, it will be necessary at all but the smallest mines to have efficient fans and the double-entry system of ventilation. Under the old law it is necessary to reverse the fan during nights to prevent the accumulation of ice in the shaft. This has a bad effect upon the roof of the mine, in proportion to the number of reversals. In most cases it is also probable that the cold draft has a worse effect upon the cagers and all other persons working in the main intake current than the increased safety from explosions justifies. When standing gas is present, the fan should not be reversed except on idle days on account of the danger of blowing gas out upon the lights of the bottom men, and the fire-boss must use care in sweeping out bodies of gas standing in the rooms. The present law has been interpreted to prohibit all intakes of air except the main slope or hoisting shaft. This often impairs the ventilation with no advantage whatever.

The quantity of air stated is the generally accepted minimum amount and the wording used will require adequate distribution of the air. This is often lacking under the present law which in the absence of gas really required only 200 cu. ft. of air per minute for fifty men, since most of the air current may leak through neglected stoppings between the main intake and the working places.

The provision as to splits is intended to place each regular entry upon a separate split of air and so do away with doors and trappers. The provision for one larger split is for convenience in opening up new entries, or turning new entries off and old one continued through faulty coal, etc. To pass 1,000 cu. ft. of air per minute within forty feet of each working place will require a sufficient number of crosscuts, but when it is advisable to reduce the number of crosscuts to save leakage along

a main air-course, any other means such as sufficient brattices, or gob-walls can be used. Such a current will of course provide a sufficient amount of pure air for the men. This wording of the law will also allow some leakage in the temporary stoppings near the end of an entry or the division of the air current among a number of crosscuts to reduce the friction.

The provision requiring that no men work upon any split in any part of which gas is present might have been modified so as to allow men to work on the intake side of the gas where there is no chance of being burned. This is not advisable because the fire-boss may be careless about marking out all of the places beyond the gas, and men frequently go beyond the safe zone to get tools, etc., and may therefore be burned when the gas is swept out. The provision for separate splits protects the miners in all the other entries.

The requirement that the gas be blown out by regular brattice men will prevent the miners from getting burned in trying to 'brush out' the gas, and will avoid the danger of another accumulation occurring before the next examination by the fire boss. These stringent rules for handling gas will make it advisable to maintain a sufficient air current to keep the working places free from gas except when stoppings are blown out by windy shots. In this case the miners have to stay out of the entry until the stoppings are replaced.

The details as to the stoppings and overcasts in addition to the requirements of separate splits are to facilitate the rescue of shot-firers in case of an explosion. Concrete stoppings will cost $4 to $8 apiece, and are not justified except where required to resist a considerable air pressure, which is only at a long distance from the last crosscut. The distances are selected so as to require the replacement of wooden stoppings more than four or five years old. In practice it will mean that in all cases where the entries are expected to be more than 1,500 ft. long, the temporary canvas stoppings will be replaced in groups by concrete as fast as the entry is extended, until it is within 1,500 ft. of its intended final length. The present practice of relying upon mere piles of waste rock for stoppings is very objectionable. The necessity for concrete stoppings under this arrangement can be entirely avoided with great resulting advantage to the ventilation by establishing new lines of overcasts along an air-course through the rooms at intervals of 1,000 feet, along the entries. This will replace the timber overcasts by the time they begin to rot and will be necessary only in the large mines.

It is entirely impracticable to make masonry overcasts strong enough to resist a severe explosion. Fig. 62 is a view of the effect of a dust explosion upon a heavy masonry over-

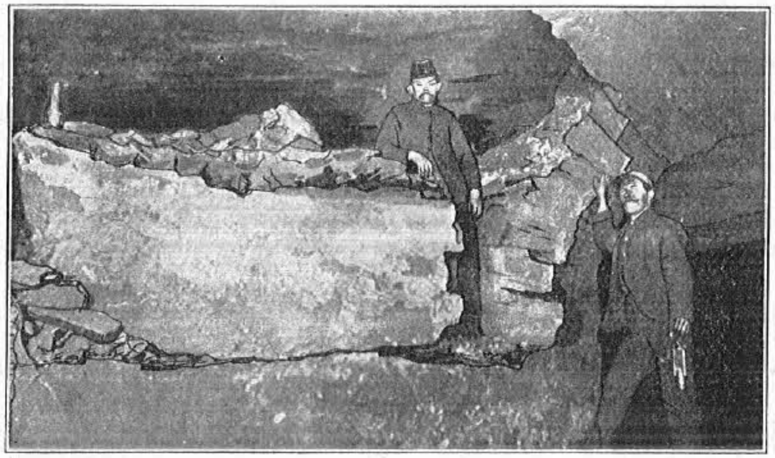

Fig. 62. Masonry overcast destroyed by a dust explosion. No. 2 Mine, Chant, Oklahoma.

cast. This overcast was supposed to be explosion proof. It merely delayed the restoration of the ventilation. The plan of explosion doors will make it possible to restore the ventilation with the least possible delay. The plan of a separate split for each entry will make it possible to reëstablish the ventilation in the entries in any order and with much greater safety and rapidity. This will greatly increase the chances of getting to the shot-firers before they suffocate from the after-damp of a slight dust explosion. In Part II of this report will be given an outline of a means of improving the ventilation at the least cost, and of avoiding the necessity for maintaining stoppings along main planes and slopes, and also a design for an overcast with explosion doors.

Pure oil. To insure the burning of nothing but good oil, the law should be equivalent to this:

The sale of any oil producing more smoke than pure lard-oil or pure cotton-seed oil, for burning in the open lights of any miners except rope-riders is prohibited. Upon written complaint of any person, the mine inspector shall test the oil submitted to him by burning it in a pitlight with a new wick under such conditions that the amount of smoke deposited upon glass can be compared with that deposited by a standard sample of oil burned under the same conditions. If the oil is noticeably inferior, the mine inspector himself shall secure another sample and repeat the test, and if the oil proves inferior on second test, the prosecuting attorney shall take the necessary steps to collect the fine of $.... for each such barrel of oil in the stock of the seller. No miners except the rope-riders will be allowed to add any substance to the standard oil used for burning in open lights.

Minor matters. Upon a complete revision of the law, many unimportant changes in the provisions for minor safety matters might be suggested. For instance, it might be well to require that all safety catches upon cages used for hoisting men, shall be tested once a year by attaching a cage carrying a loaded car of coal to the hoisting rope in such a way, as by a hemp rope, that the cage can be readily dropped to the bottom of the shaft unless the catches work. This is not a perfect test for safety catches but is readily applied, and under such a law, the operators will save money by maintaining the safety catches in good condition and so protecting their cages from destruction. It will, however, be unnecessary to make this test if the inspector is thoroughly competent, since he can judge the condition of the catches almost as well by a mere examination.

Mine props. Section 5352 providing that miners be furnished with sufficient props could well be modified to read:

The operators shall be required to furnish the miners with all necessary mine timbers and to deliver them at the point at which the miner receives his empty car. All timbers shall be of the customary good quality. At each parting or siding from which cars are distributed to the miners by gathering drivers or pushers, there shall be at all times a sufficient supply of 'cap pieces' and of props of all the lengths in common use in that part of the mine and varying by 2-inch intervals from the shortest to the longest. These props shall be kept in distinct piles or bins, which shall be clearly marked with the length of the prop in them. The person delivering the cars to the miner shall bring to him what props he requests with the next car delivered after his request. Timbers of unusual sorts shall be delivered to the miner as promptly as practicable. Nothing in this section shall be construed to prevent the operators from requiring the miners to account for all props delivered to them or from in any way reducing the waste of props which are not set in position. A record in a bound book shall be kept of all props sent to each gathering parting and of those delivered to each working place.

A committee of the miners and the pit-boss and superintendent of the mine shall determine what shall be considered a safe interval between the rows of props and between the face of the coal and the nearest prop, for each kind of working place, and a copy of this agreement shall be sent to the Chief Mine Inspector. Each contract miner shall then be required to set props regularly at least this close together and as much closer as he may think necessary for safety under unusual conditions. The pit-boss shall prevent the miner from loading coal as soon as practicable after he learns that the place is not so timbered. Disagreements as to the standard distances shall be referred to the mine inspector or to an arbitration committee selected by the pit-boss and miners. The pit-boss and his representatives without interference from the miner shall alone be the judge of the manner in which the timbering conforms to the requirement, and at each inspection of the mine the mine inspector shall examine the timbering in at least five of the newer rooms selected as he sees fit, and if the timbering does not conform to the agreement the operator shall be fined at least $.... at each inspection not to exceed once a month. In case a fine has been assessed, subsequent inspections shall cover only those props set since the date of inspection which led to the fine.

The provision that there be a supply of timbers at each gathering parting is believed to be without precedent, but will greatly reduce the delay in providing the miners with timbers and lessen the confusion among the drivers, and the drivers will then have no excuse for not bringing props to the miners. It will also reduce the expense to the companies after it is once started, since the props can be taken to all the partings upon an idle day and there will be no delay caused by looking for props at the shaft bottom where the delay is more expensive. Each miner should be required by the pit boss to move unused props up to the face of his room as it advances, and the company should be allowed to prevent the miners from burying the props of the wrong length in the gob rather than moving them ahead, or to require that they be stored in piles for taking out. The record will be worth its cost in saving waste and will show the facts as to props in case of any accident.

The provision that the pit boss shall stop the working of any place that is not properly timbered is carried out with good results in Indiana. In practice the fire-boss can also act

as a timber inspector, and can direct the boss driver to stop the miner's turn until the props are set. The clause defining the proper timbering is planned to encourage the miner to set props regularly without waiting for the roof to become dangerously loose. Many miners say that they would do this if everyone else did, but they do not wish to seem unnecessarily careful. As worded it does not relieve the miner of his responsibility, and there can be no logical interference from the Union in case the more careless miners need to be disciplined. This will be unlikely since the first suggestion in regard to systematic timbering here outlined was received from a miner.

Systematic timbering is required by law in most of the European countries, where the accident rate is low as compared with the United States. More than half of our accidents are caused by falls of roof, and if the rooms are systematically timbered, there will be very few such accidents except as the props are knocked out by excessive blasting. In Great Britain, an act of Parliament prohibits all shooting off the solid, so that the props when once set are not knocked out. As a discreditable contrast, Arkansas has passed the mine-run law which has virtually eliminated all other methods of mining and even all ordinary care in shooting off the solid. The effects of this practice upon the props and the roof are discussed in Chapter VII.

First aid supplies. Section 12, Act 225, 1905, requiring the operators to keep on hand a sufficient stock of supplies for first aid to the injured could well include in addition the words:

The selection of these supplies shall be left to any graduate doctor of medicine agreed upon by the miners and the pit-boss.

Firing shots. Next to the falls of roof, careless blasting of coal is the greatest source of danger, and many states have passed laws forbidding the firing of certain kinds of shots. Since the mine inspector can not inspect the shots of all the miners every day, these laws are ignored. Since it is also to the financial interest of the companies to reduce the frequency of explosions caused by blown-out shots, and the injury to the roof resulting from shots that are too heavy, the most feasible law for reducing these dangers seems to be a section reading:

Where the shot-firers are employed, they shall not be under the jurisdiction of any organization of the miners and shall be subject to discharge without appeal, and any person other than an official of the company who in any way annoys the shot-firer on account of his refusal to fire any shot whatsoever, or who interferes in any way with the hiring or discharging of any shot-firer, shall be guilty of a misdemeanor. The officials of each mine shall formulate general rules governing the character of shots permitted, which rules must be approved by the mine inspector at each visit, but the operators shall be permitted to make any additional restrictions for the safe blasting of coal.

Since it is necessary to maintain a full crew, rules made for the firing of shots will not be unreasonable, and the committees of the miners can at all times protest to the pit boss and appeal to the regular arbitration committee that adjusts disputes between the miners and operators. When the shot-firer is not under the jurisdiction of the Union, he will be free from all threats of fines on account of his caution and will be treated with the respect shown to the bosses who do not belong to the Union. There should be some agreement by which discharged shot-firers should be reinstated into the Union upon payment of back dues in an amount not to exceed the regular initiation fee, but this is only necessary as long as the present closed shop condition continues, and should not be included in the law.

Mine inspectors. The present mine law requires the single mine inspector to measure the air at every working face in every large mine in the State at least once in three months and in general to do an amount of work beyond the capacity of eight or ten men. The inspector is therefore required to depend upon the assistance of the miners and other friends. There have been many methods by which the appointee of the Governor has been selected, and some of these have proved unsatisfactory. Very few if any of the operators object to the additional expense needed to increase the safety of their mines, but they do not wish to spend more money than their competitors. For these reasons more mine inspectors are needed. A comprehensive report from the mine inspector is also desirable, especially one relating to the detailed causes of all fatal and disabling accidents. The following suggestions are offered as a beginning:

There shall be employed one Chief Mine Inspector and at least two deputies one of whom shall reside in the vicinity of Clarksville or maintain an office there and inspect only those mines north of the Arkansas River. The other two shall reside at different convenient points in Sebastian County, as at Fort Smith, Greenwood, Huntington, or Hartford, and divide the work as directed by the Chief Mine Inspector. The Chief Mine Inspector shall receive a salary of $2,000 per annum and all necessary expenses, for which he must submit subvouchers. The assistant mine inspectors shall receive salaries of $1,500 per annum and all necessary expenses approved by the Chief Mine Inspector, and sworn to by the assistant mine inspector.

The Chief Mine Inspector shall be appointed by the Governor to serve for two years or until his successor is appointed, and the assistants shall be appointed by the Chief Mine Inspector to serve until their successors are appointed.

To aid in the selection of competent mine inspectors there shall be an Examining Board, consisting of the State Geologist as chairman and five other members selected by him. One of these members shall be an expert mining engineer, one of them a mine superintendent, one a hoisting engineer or a master mechanic of a mine, and two of them practical miners or mine foremen. Each member of the board shall be allowed $.... per day and expenses for each day he is occupied by the examination which shall not average more than 5 days for each examination. The Board shall be furnished with all necessary blanks and stationery. All examinations shall be held in the city of Fort Smith, Arkansas. There shall be an examination during January or February of each even numbered year, and as often in addition as an appointment of an inspector is necessary and there are no eligible candidates. The time and place of each examination shall be published in newspapers and journals selected by the State Geologist so as to give at least one month's notice to the mining public. The examinations shall be prepared and conducted as determined by the Board, so as to secure the selection of competent men only. Four members of the Board shall constitute a quorum, and part of the work may be done by correspondence if this is more convenient.

All candidates shall present to the Examining Board satisfactory evidence of good moral character, temperate habits, and good health, and shall upon the application blanks state fully their experience in coal mining and their education. In deciding which men shall be eligible to appointment, education and experience shall be considered in a manner to be decided by the Board.

The examination for Assistant Mine Inspector shall cover the subjects of mine maps, mine ventilation, and the measurement of the air current, character and effects of mine gases, mining machinery and appliances, the blasting of coal and rock, the causes of mine accidents, and questions of practical mining, and the mining laws of the State. The examination for Chief Mine Inspector shall test in addition the candidate's knowledge of the English language and his ability to write a report upon some technical matter relating to mine inspection.

All persons who take the examination shall be notified of the result by mail and a list of all who have passed shall be sent to the Governor shortly after his election and whenever else he may so desire, and all appointments and re-appointments shall be made from this list. All persons who have passed the examination for Chief Mine Inspector shall also be eligible for the position of assistant mine inspector and any person who has passed two successive examinations shall be eligible without further examination as long as he meets the other requirements. A list of eligible persons shall also be given to the Chief Mine Inspector upon his appointment and he shall select his assistants from this list. All mine inspectors shall devote their entire time to that work and shall have no financial interest whatever in any coal mine during their term of office.

Every coal mine in the State employing ten men underground at any one time shall be thoroughly examined by one of the mine inspectors at least once every ninety days and as much oftener as may be necessary in the judgment of the Inspector. This inspection shall include the determination of the number of men and mules working upon each split of air; the tracing out of the course of the air current upon the mine map and a verification of the location of each overcast required; a measurement of the air current in each split at some convenient point near the most distant working place; a general study of the mechanical appliances of the mine and of the system of propping the roof and blasting the coal; and any other examination which the Inspector may deem necessary to secure compliance with the laws and the proper safety of the men. All fatal accidents shall be personally investigated by a mine inspector as soon thereafter as practicable and complete statistics shall be collected each three months giving the average number of men employed at each time for each class of labor when running; the number of days upon which the mine was operated; the total tonnage of coal mined; and the total amount of the pay-roll, including superintendent and office force in Arkansas, for each calendar month. Where possible, the Mine Inspector shall endeavor to collect data as to the age and cause of death of all former mine workers who die from other cause than accidents in the mine.

The Mine Inspector shall have authority to deputize any person to see that the speed of the fan is not lessened after his visit or that any changes that he may require are carried out within the time specified. He shall interfere as little as possible with the operation of the mine and shall make no unreasonable requirements or order changes not necessary to the health and safety of the employees, but he shall not be restricted to the letter of the mining laws.

All operators shall be required to furnish all reasonable aid to the Inspector, and all information needed for the preparation of the Mine Inspector's report. The statistics of each individual mine shall be held confidential by the Mine Inspector. All injuries to employees sufficiently serious to prevent their working shall be promptly reported to the Mine Inspector with full details as to the cause and circumstances of the accident, and as nearly as possible the age, experience, and nationality of the injured person.

The Chief Mine Inspector shall be responsible for the enforcement of the law and shall prepare a report for each calendar year giving the number of mines of each type in operation; the average number of days operated; the average number of men of each class employed; the total

production and the total pay-roll of each county; a complete report upon all accidents; whatever data is available as to the causes of other deaths; an account of all mine explosions; and any other information of general interest. There shall be also an administrative report showing the date of each inspection of each mine; the number of mines visited; the results of the measurement of the air; the warnings of violations of the law given; and the prosecutions conducted, etc. Five hundred copies of this report shall be published by the State, and for its preparation the Chief Mine Inspector shall be allowed the aid of a draftsman and of a stenographer at a cost not to exceed $200 per annum.

Each mine inspector shall take the oath of office required of other officers of the State and may be removed for cause at any time by the person appointing him. If any financially responsible person shall send to the person making said appointment an affidavit charging the Inspector with neglect of duty, drunkenness, dishonesty, or other gross misconduct, the Inspector shall be removed from office. This shall be done by the person making the appointment as soon as the charges have been investigated and substantiated, or immediately if the charges are accompanied by a bond of $4,000 to be forfeited to the Inspector in case the charges are disproved, provided that the bond has been approved by the Judge of the county in which the Inspector resides. In case of injustice, the Inspector may by suit at court collect from the maker of the charges or his bondsmen, damages to the extent of the Inspector's salary for the remainder of a two years' term and a sum sufficient to cover necessary court expenses and attorney fees, as ordered by the court in which the case is tried. In case the charges are sustained after trial, the State shall pay for the court expenses and attorney fees and loss of time undergone by the maker of the charges.

It is believed that such a law will secure the selection of the most efficient inspectors available and will give the inspectors all necessary authority. These two are the essentials of good mine inspection. The expense to the State will be considerably increased but it is believed it is the least amount consistent with thorough enforcement of the law and the preparation of a creditable report. Good inspection is necessary to protect the lives and the health of the miners and to safeguard the better operators from their unscrupulous competitors.

In general, administrative details will have to be added to the suggestions here offered, and in cases the mere substance and not the wording of the clauses has been given. The above mentioned few changes in the laws and the repeal of the mine-run law are especially urged as the beginning of the improvement of the mining conditions. It is thought well to omit for the present drastic provisions for mine refuge stations, rescue apparatus, and such matters, since disastrous explosions are practically unknown except when firing shots. The Mine Inspector will have authority to establish regulations regarding fire proof stables and such matters. As soon as the National Bureau of Mines has finished its draft of a uniform and adequate law for all of the states, it should be adopted by the State of Arkansas, with what changes may be needed to suit local conditions.

Since so few of the miners carry any life insurance whatsoever, their families are left destitute in case of their death by accident, and they themselves suffer from want in case of disabling accidents. Most of these accidents are due to the carelessness of the miners themselves and it seems unfair to assess either the State or the operators to provide them with accident indemnities. If such a measure is ever deemed advisable, it is earnestly recommended that the fund needed be raised as a tax upon the powder used, to be paid by the miners using the powder in the form of an increased cost per keg. Part of this may be made up by the operators giving the miner an increase in wages or by the State contributing some of the money in proportion to the amount of powder saved by the careful miner. This would decrease the present excessive use of powder, which is perhaps the greatest single cause of mine accidents. A less sum of money, therefore, would be adequate for the indemnity. It is quite apparent, however, that the administration of such a fund would be very difficult and expensive, and it is believed that no action should be undertaken by the State until the number of men employed in the mines become much greater, as it doubtless will in the future.

CHAPTER VII.

THE MINE-RUN LAW

STATEMENT OF LAW.

Introduction. In addition to the laws which were discussed in the last chapter and which were passed in the interest of the health and safety of the miners, we have the so-called mine-run law which was passed in 1905. The real nature of the law is not very generally understood and its importance merits a full discussion.

It should be understood that what the writer has to say about this law is the result of his own unbiased study of all the conditions affecting the coal-mining industry in the State, and of a desire to benefit it as much as possible. In the course of the work necessary for this report, he received many favors from both the miners and the operators, and has formed many personal friendships among both. It is felt that the writer is as nearly unprejudiced in his opinions as is possible for any one to be. No figures have been intentionally exaggerated and no conditions have been overdrawn.

Statement of the law. The mine-run law in full is as follows:

ACT 219.

"AN ACT to provide for the weighing of coal mined in the State of Arkansas, as it comes from the mine, and before it is passed over a screen of any kind.

"Be It Enacted by General Assembly of the State of Arkansas.

"SECTION 1. It shall be unlawful for any mine owner, lessee, or operator of coal mines in this State, where ten or more men are employed underground, employing miners at bushel or ton rates, or other quantity, to pass the output of coal mined by said miners over any screen or any other device which shall take any part from the value thereof before the same shall have been weighed and duly credited to the employee sending the same to the surface and accounted for at the legal rate of weights as fixed by the laws of Arkansas, and no employee within the meaning of this Act shall be deemed to have waived any right accruing to him under this section by any contract he may make contrary to the provisions thereof, and any provisions, contract, or agreement between mine owners, lessees, or operators thereof, and the miners employed therein, whereby the provisions of this Act are waived, modified or annulled, shall be void and of no effect, and the coal sent to the surface shall be accepted or rejected; and if accepted, shall be weighed in accordance with the provisions of this Act, and all right of action shall not be invalidated by reason of any contract or agreement; and any owner, agent, lessee, or operator of any coal mine in this State, where ten or more men are employed underground, who shall knowingly violate any of the provisions of this section, shall be deemed guilty of a misdemeanor, and upon conviction shall be punished by a fine not less than \$200 nor more than \$500 for each offense, or by imprisonment in the county jail for a period of not less than sixty days nor more than six months, or both such fine and imprisonment; and each day any mine or mines are operated thereafter, shall be a separate and distinct offense, proceedings to be instituted in any court having competent jurisdiction.

"SEC. 2. This Act shall be in force and effect on and after the first day of April, 1906, and all laws and parts of laws in conflict with this Act are hereby repealed."

The nature of the law. Before this law was passed, the contract with the miners, which has not been changed,* gave the companies the right, if they wished, to pass the coal over a standard specified screen. All of the lumps over 1⅛ in. each way, and quite a little of the finer coal went over this screen into a weigh basket at the end, and its weight credited to the miner, and the miner was paid on a lump-coal basis. The contract also allowed the company to pick out the lumps of slate or other impurity in the coal at any time before it was weighed. Both of these privileges are specifically denied by the mine-run law, which requires the weighing of the coal just as it comes from the mine. Such coal is called mine-run coal.

It should also be noted that the law breaks all previous contracts providing for this screening and sorting of the coal, even though they were signed in good faith previous to its passage. Most laws forbid future contracts only.

Nominally the law seems fair, in that it allows the companies the right to reject any inferior car load of coal after it has reached the surface, but the coal can not then be rejected except at a prohibitive expense to the companies. By the time the coal has reached the surface, it has cost the companies the full proportion of all the underground expenses, such as driving the entries, and hauling and hoisting the coal, even though nothing is paid to the miner for it. This expense is often nearly

*The contract of September 19, 1910, merely specifies a scale for payment upon the lump-coal basis as well as the mine-run basis.

half the total cost of mining, never less than one-fourth. At all those mines which are equipped with self-dumping cages, which includes practically all of the shaft mines, an attempt to inspect the coal before it is dumped would cause prohibitive delay. In no case before the coal is dumped can any idea be formed of the amount of slate or slack in the coal except that which shows on the top. The expense of rejecting the coal after it is dumped would be very great on account of the delay caused by getting it out to the waste pile without any of it getting on the screens or into the railroad cars in the usual way.

This explanation in itself makes clear the unfairness of the law. In this chapter, the further injustice of this law will be pointed out. An effort will also be made to show how weak are the arguments used to secure its passage, and how far-reaching has been its detrimental effect upon the coal-mining industry of Arkansas and upon the State at large.

The passage of the law an accident. It is believed that on account of its technical nature, many of the leglsiators who voted for the mine-run law did not fully understand its nature, and that others who favored it had promised the leaders of the Miners' Union that they would support this measure before they appreciated its evils. The passage of the law was therefore an unfortunate accident. Experience has shown that it is in many ways detrimental to the mining industry and of little or no advantage to the miners. It is hoped that every member of the Legislature will carefully study its actual effects; and it is believed that such a study can not fail to result in its repeal.

The need of a mine-run scale of prices. Mine-run coal is cheaper because the companies are not worried about finding a separate market for the slack in it, and at times many consumers wish to buy it. At a few tipples, after the slack and lump coal have once been separated for weighing, it is inconvenient to load them both into the same railroad car to sell as mine run. For this reason the operators desire to have a mine-run scale upon which they can pay the miners for coal of this sort. They can load occasional cars of mine-run coal by simply placing iron plates over the screen so that all the coal goes on into the weigh basket and then into a car which would ordinarily receive only the lump coal. If, however, much mine-run coal is to be loaded and the miners get so careless that the customer complains about the large amount of slack in the coal, the operator should have the privilege of changing his tipple so that he can pay his miners in proportion to the amount of lump coal they mine.

ARGUMENTS IN FAVOR OF THE LAW.

Payment for the slack. The great argument used by the advocates of this law was that the miners gave to the companies a valuable product, the slack coal, for which they were not paid. That this argument is not valid will appear from the following:

At the time the law was passed, the coal for which the miners of this State were paid was supposed to average 30 per cent slack. From the government reports, the proportion was probably less than 30 per cent but this was the figure accepted as an average by the Union. In each 100 tons of coal sent out, there were then 70 tons of lump coal. Under the scale of prices then in effect, the men were paid 90c for each ton of lump coal; that is, they received $63.00 for the 100 tons, even though they got nothing for the slack. Under the alternative mine-run scale, they would get 62c for each of the 100 tons, whether lump or slack. This is only $62.00 for the 100 tons or $1.00 less than they would receive on the lump-coal basis of payment. This simple arithmetic shows that the screened-coal basis of payment gives the miner full value for his coal, provided that it is up to the standard of quality and there is no foundation for any other claim. The same method of figuring would show that if the coal contained more than 70 per cent of good lump coal, the miner would be paid a premium for his extra care in mining it.

That the screened-coal basis of payment recompensed the miner in full, is shown by the results at Mine No. 2, Denning. Here the coal is of such unusually high quality that it can be shot from the solid with a less proportion of slack than in most mines; but in order to encourage the miner to use care in placing his shots, the company has gone to the expense of first weighing the coal as required by the mine-run law and crediting the miner with it. The coal is then screened and the lump coal reweighed and credited to the miner at the old price of 90c per

ton. If at the end of the two weeks, the price for this lump coal at 90c per ton is greater than that of the mine-run coal at 62c per ton, the miner is paid the difference as a premium. Otherwise, he gets the full mine-run price. Under this arrangement, however, the men have much less incentive to do good work than if they did not have the mine-run basis of payment to fall back upon. The result is that the lazy men shoot the coal to bits and the incompetent ones make no effort to improve so as properly to mine the coal. Still, out of 203 diggers on the pay-roll for January, 1910, 134 or 66 per cent, earned the premium; that is, they received more than 62c. a ton for all the coal including the slack in it. It is instructive to note that the careful miners who received the premium averaged $4.20 per day net, while the others averaged only $3.83, a difference of about 10 per cent. The careful entry-men earned from the coal alone 15.3 per cent more than the lazy ones, and the good room-men 11.18 per cent more than the poor ones. As this is the only mine in the State using such an arrangement, no other figures are available.

Maintenance of the screen. The second argument in favor of the passage of the law was, "The screen is a robber." By this is meant that the bars of the screen would become bent and permit large slabs of coal to pass through. It is regretted that one or two of the companies were very careless about the condition of their screens many years ago, but this injustice was very promptly corrected by the Miners' Union upon its organization in 1903. For years the screens have never been seriously defective and when slightly out of order they have been promptly repaired. In fact the miners' committee inspected the screens each time the scales were tested, and whenever any bar became bent the committee required that it be straightened before any more coal was weighed. The operators now generally ralize that it is actually to their own interest to maintain the screen in good condition since screened coal for domestic use has always been worth more than 90c. a ton above the price of slack coal.* The companies would, therefore, lose money

*Various attempts have been made to save a high priced nut or pea coal from the miners' coal which went through the screen, but the expense of doing this and the resultant poorer quality of the slack made this impracticable. The idea was therefore given up voluntarily by the operators in the early nineties.

by getting good lump coal mixed with the slack. The removal of the smaller lumps of coal which should pass over a standard screen is of no advantage to the consumer and does not raise the price of lump coal. When the operators make a special grade of lump coal from which all of the slack is not removed, the difference in price is less than 90c per ton; but in this case, the miners are paid on a mine-run basis and the area of the screen is reduced. There is, therefore, little likelihood of poor screens in the future.

Coal not uniform. At a very few mines, there is trouble because the coal in some places is seamy or faulty, and under the best of treatment yields a less proportion of lump coal than the average. At some such mines, it is still customary to pay the miner working in this poor coal extra for it, and on the screened-coal basis, he could be credited with the lump weight of the average pit car of coal from the mine, for each well filled car he sent out. Where applied, this rule was entirely satisfactory to the men, as is the present plan of allowing the average weight for each car load of coal which has been wrecked while in the care of the operator. This objection to paying for the coal in proportion to the amount of lump coal it contains, is thus seen to have little weight. In fact, it is now seldom urged by the friends of the mine-run law.*

The slack left in the mines. A more just argument against paying for mining coal in proportion to the amount of lump coal it contains is that, when they were so paid, the miners did not load out all of the coal, but left some slack in the mine as a permanent loss of a natural resource. Where the miners were paid for hand-picked or forked coal, as at Paris, this was true; but in the State as a whole, only a very little slack was ever left, for the reason that the coal is loaded with a shovel and shoveled up from the smooth floor. It is as easy for the miner to shovel into the car the little slack that is left after the lumps are loaded, as to put it back out of his way. Whenever the

*This condition is now fully provided for by the 'contract' between the miners and operators. Paragraph 16 of the General Conditions reads as follows:

"Frozen or seamy coal, stuck top or bottom, shall be deficient work, and shall be paid for extra. The same to be determined by mine committee and pit-boss. If they fail to agree the miner shall be given an average place in the mine."

screen was covered with iron plates at intervals to fill orders for mine-run coal, some of the top men would make a chalk mark in each car as it was emptied so that the miners would know that they were being paid on a mine-run basis. They then loaded out any convenient slack left in their rooms. This reduced the waste on the screened-coal basis. A study of the mining methods shows that only one or two per cent of clean coal was ever left in the mines as slack.

Even if we grant that a good deal of coal was wasted, this could have been corrected by requiring payment for all classes of coal at any scale of prices to be agreed upon, say 35c. a ton for the slack and 75c. a ton for the lump coal. The prices are equivalent to 90c. a ton for lump coal only, or 63c. a ton for mine-run coal, on the original basis of 30 per cent of slack.

Mine-run laws in other states. As an excuse for the mine-run law, we are told that it exists in other states. It is true that some states have just as bad a law as Arkansas, but many of the older laws simply provide for the payment of all classes of coal as suggested, at any price agreed upon* or require a written agreement for payment on a lump-coal basis.† Few of them prevent the removal of slate, although some provide for a method of determining the percentage of impurities in the coal.‡

As will be shown later, the injury in Arkansas by such a law as the one we have is much greater than in any other place, except at some of the mines in Oklahoma, where the conditions are similar. The fact that the other states have similar laws is no reason why it should remain on the statutes of Arkansas after its evil results have been so clearly demonstrated by the experience of the last four years.

Reduction of the labor of the miners. The mine-run law requires that the miner be paid for his coal regardless of its quality. It takes less labor and less skill to shoot the coal out carelessly than to mine it in such a way as to get a large proportion of good lump. The mine-run law therefore gives the miner the same pay for less work and this is the real reason

*See Laws of Illinois, Act approved June 3, 1897.
†See Laws of Iowa.
‡Bituminous mining laws of Pennsylvania, Act approved June 13, 1883.

why some of the miners favor it. If it is claimed that the production of good coal requires too much work, why not for the same reason prohibit the contracting masons from allowing those of their men that are paid by the thousand brick laid, to point or otherwise finish the joints? Or, why not prohibit the plasterers from troweling his work smooth, or compel the cabinet-maker to leave his furniture unplaned? In each case, labor would be saved and people could get along. Such examples show the folly of attempting to change methods of work by law. Besides determining the manner of weighing the coal, the mine-run law has changed the method of mining it. This change has caused the injury to the quality of the coal, which in turn causes a hardship to the public.

Increase of wages. Many of the miners had been led to believe that the passage of the mine-run law would increase the amount of money they could earn each day, as well as their pay per unit of real work performed, but in general this has not been the case. This will be explained in detail when pointing out the injury the law has had upon the welfare of the miners.

THE INJUSTICE OF THE LAW.

The State, an instrument for breaking contracts. The mine-run law is unjust and morally wrong. It definitely breaks all contracts entered into by the miners to mine coal in a proper manner, and for a fair price. This effect is shown best at Paris, where miners were paid the high price of $1.05 a ton for undermining the coal, breaking it down, loading the large lumps by hand, loading the smaller lumps by the use of a fork, and doing the incidental work of taking care of the room. This plan should make but a little slack and most of that should be left in the mine. It yields the maximum amount of valuable hand-picked coal.

At all the Paris mines, the men are now paid upon the mine-run basis as required by law. Where there are no machines, they are still getting $1.05 a ton for the coal as agreed in the contract. While they all claim that their coal is still hand-picked as called for by their contract, the kind sent out by some of the miners yields 35 to 40 per cent of slack when it

is passed over a standard screen, instead of practically no slack as it should. For this slack, the miner gets the same $1.05 a ton as for the lump, although it sells for as little as 65c. a ton, or has to be thrown away for lack of market.

The miners' contract still specifies that at all the mines, the operators shall have the right to pay his miners for their coal at the agreed price, upon either a mine-run or a screened-coal basis as he wishes. It was signed in good faith by the operators and also signed by the miners, who on signing it did not protest against the screening of the coal. The right to screen the coal before paying for it is so just and so necessary for the profitable production of good coal that the dissatisfied element among the miners could not hope to deprive the operators of it by striking. This class therefore secured the passage of this law to relieve themselves of their contract.

Class legislation. The law is also wrong because it is class legislation in that it directly attacks only those employers of labor who operate coal mines. The coal-mining companies, while not faultless, have treated their employees as well as any other group of industrial companies, and in weighing the coal, they have for years treated the miners with entire fairness. At most mines, the men have sufficient confidence in the company weigh-boss to remain at work even when their representative can not be present. At many small mines a checkweighman is rarely present. Therefore, why the injustice of punishing the coal companies more than any other class of corporations who pay their men by piece work?

Besides injuring one class of employers more than others, the law is further unfair in that it definitely injures the skilled and experienced miner while it benefits the indifferent and lazy one. It also lessens the work of a few unscrupulous miners at a dreadful risk to the shot-firers. The only miners whose work is much lessened are those working in the soft and generally high coal, and to benefit them, the miners working in the hard coal should not be injured.

Instead of a fruitless attempt to raise wages by legislation in defiance of the law of supply and demand, it would seem more fair to forbid the companies to deduct the Union dues, assessments and fines from the wages of their men, many of whom consent to this reduction only because the Union will not allow them to work upon any other condition.

THE INCREASED PRODUCTION OF SLACK.

Proportion of slack increased. The law has made the companies powerless to regulate the amount of their coal which is shot into slack, with the result that the proportion of slack is constantly increasing. Affidavits of the companies, an examination of their shipping books, and the results of test runs made by the superintendents, show that those few mines which made as little as 21 per cent of slack on the old screened-coal basis now make 31 per cent; those which then made about 25 per cent now make from 35 to 40 per cent; those which then made about 30 per cent now make over 40 per cent; and those that made about 34 per cent in the old days now make 50 per cent. This shows an increase in the proportion of slack of about 50 per cent of its original amount. It will be shown later that this excessive production of slack causes a waste of one of our natural resources; and besides, it causes a big loss to the operators and a hardship to all of the consumers of coal.

Amount of slack formerly left in the mines. After it was clearly shown that this increase in the production of slack has really occurred, the friends of the mine-run law claimed that this extra slack is simply that which was formerly left in the mines. But abundant figures show that within one month of the passage of the mine-run law, the increase in the slack was as little of 2½ or 3 per cent at several of the mines now showing large increases. It reached the maximum amount of 7 per cent at the Bolen-Darnall mine at Hartford. Here much fine dirt formerly dug out from under the coal had accumulated in the rooms and some of it was loaded out as soon as the law required the company to pay for it. Of the general increase or 3 or 4 per cent in the slack following the passage of the law, possibly three-fourths was slack formerly left in the mine, but of this slack, a large part was worthless dirt as at the Bolen-Darnall. The estimate that the former waste was only about 1 or 2 per cent of the weight of the coal is therefore just.

Progressive increase in the proportion of slack. Most of the miners had not actually urged the mine-run law, and for some time after its passage, they continued to mine the coal in

the old way, so the immediate increase in the production of slack was slight. From the force of evil example, however, more and more of these good miners adopted the careless methods and the carelessness will continue to increase as long as the law is in effect. As a result of the change in the method of mining, the excessive production of slack has steadily increased until this excess is now four times as much as it was in the first few months of the application of the mine-run law. The best proof of the fact that the shattering of the coal will continue to increase is the experience of Kansas, where a mine-run law was enacted as long ago as May 8, 1897.

Complete shipment records were obtained from one of the Kansas companies which has maintained a quite uniform production of over 500,000 tons per annum from 1894 to 1909. By 1905, the proportion of lump coal had been so reduced that its high price compelled the railroads to buy railroad lump. This mine-run coal from which only 25 per cent of its weight of slack has been removed. After this date, the slack shipments do not show how much slack was produced, but the shattering of the coal has continued to increase. The actual results from 1894 to 1904 are given in the following table:

Proportion of Different Sizes of Coal in Kansas.

YEAR	Per cent Lump Coal	Per cent Nut Coal	Per cent Slack Coal	Ratio of Increase of Slack
1894	59.21	15.03	*25.96	
1895	57.79	14.61	*27.60	1.00
1896	57.65	15.81	*26.54	
1897	55.43	16.61	27.96	1.05
1898	56.04	14.04	29.92	1.12
1899	57.20	14.89	27.91	1.05
1900	56.12	15.51	28.37	1.06
1901	53.37	14.53	32.10	1.20
1902	51.73	13.95	34.32	1.28
1903	50.38	13.95	35.67	1.33
1904	45.91	15.94	38.15	1.43

*Average 26.70.

It will be noted that the amount of lump coal produced has shown a decrease from year to year, while the amount of slack increased from an average of 26.70 per cent previous to the mine-run law, until it had become 38.15 per cent as long ago as 1904.

During the interval covered by this table, there was no change in the manner of screening the coal, or in the character of the unmined coal, or in any of the conditions except for the organization of the Union in 1903. This shows conclusively how rapidly a mine-run law and the loss of control over the men due to the strength of the Union, leads to the development of carelessness in mining.

By 1907, the slack problem in Arkansas had become so serious that the railroads dependent upon the Arkansas mines were forced to buy coal containing a good deal of slack. After this time, the shipping records did not show exactly the relative amounts of slack and lump coal produced. After about a year, however, one company kept a separate record of the amount of slack obtained from the railroad lump and from the true lump coal. These records are not so satisfactory as they should be since but little straight lump coal was produced at the mines making much slack. There was also an uncertainty due to the fact that some cars contained slack from both kinds of coal. The results are as shown in the table below.

Percentage of Slack at Arkansas Mines.

For year ending Apr. 1..........	1906	1907	1908	1909	1910
Average of per cent of slack at three mines	28.10	28.00	?	36.04	42.32
Per cent of slack produced at one of these mines...............	26.42	26.10	?	39.32	41.87

This table makes it clear that the proportion of slack made has increased steadily from the passage of the mine-run law until the present; but the Kansas mines have a longer and more exact record.

Method of producing the slack. A study of the mines shows why the production of slack will increase. At Bonanza and Hartford especially, there is a band of soft dirt under the coal, and at many other places, there is a band of the same soft dirt in the coal. This can be picked or scraped out sufficiently to prepare a shot properly in from one-half to three-quarters of an hour. This removal of the dirt makes it possible to shoot out the coal with the minimum proportion of slack. It also saves powder and reduces the danger, for which reasons it is still done by some of the experienced miners; but the work is unpleasant and at least one-half of the miners make no pretense of doing it at all, because they know that any block of coal can be loosened by blasting, provided enough powder is put behind it. To be certain of enough, they generally add a little more than enough powder, because, even though the coal is thereby reduced to a heap of slack, the mine-run law requires that they get full price for it. Also the slack is easier to shovel and does not require loosening with a pick, before it can be loaded.

The heavy blasting tends to throw the pieces of coal some distance and it is further crushed into slack by striking the roof or floor and the props. The careless miners place their shots so as to throw the coal toward the track and so reduce the labor of loading it. To do this, they ignore, if necessary, the natural cleavage planes of the coal which makes still more slack in blasting it loose.

Many of the miners are fine men and do not wish to be known as 'slack makers' but they find it hard to withstand the gibes of their fellows, and are therefore becoming more and more careless. From year to year, the common length of the augers sold to the miners is increasing. This shows the tendency to put in fewer and heavier shots than formerly. It means heavier blasting and more slack each year. As the younger men who are now entering the trade do not understand the old careful way of mining, the proportion of miners skilled in the best methods is bound to decrease; and the proportion of slack produced in mining the coal will correspondingly increase, unless the men have some incentive to do better work.

Efforts of the operators to get lump coal. At present some of the superintendents are arranging to get lower side-boards upon what new cars they need, and to give the miner fewer cars per day. Then in order that the miner may make good wages, he must mine enough lumps to chunk up his car so as to increase its capacity. Some superintendents are even thinking of removing the doors from the cars so that the miners will have to mine lumps to hold the coal in the car. Both of these plans will work a hardship upon the good miners as well as upon the careless ones, and the second one is only a desperate last resort, for it may increase the accidents upon slopes.

Figure 4, p. 14, is the side view of a car of coal which shows the lumps used to chunk it up. It does not, however, show the slack in the middle of the car. A much better idea of the way the coal looks when mined can be obtained from Fig. 8, p. 28, which shows the cars coming out of the 'pigeon hole,' operated during the suspension of 1910. This gives a fair view of the entire car and shows how many lumps will be needed to stop up the end.

Decrease in the sale value due to slack. Since we have sufficiently shown that a constantly increasing proportion of good lump coal is shot into slack as a result of the passage of the mine-run law in 1905, it may be interesting to see how this affects the operators.

Since slack coal is worth so much less than lump coal, the natural result of an increase in its proportion is to decrease the average value of the coal. The average prices of the different sizes of coal have not been published, but from information given by companies, wholesale dealers, and others, it is known that the price of the slack coal is from 95c to $1.50 per ton less than that of the lump coal from which the full amount of fine coal has been removed. The average difference is at least $1.15 a ton. Now the mine-run law has increased the slack on an average from the normal 30 per cent to at least 45 per cent. It has therefore reduced the value of 15 per cent of the output of the State by $1.15 a ton. On the normal output of 2,500,000 tons,* this loss amounts to $430,000 per annum in round numbers.

This figure is correct even though much of the coal is sold as modified lump, since modified lump is cheaper than ordinary

*This figure is intermediate between the output of 2,377,000 tons in 1909 and the maximum of 2,670,000 tons in 1907. It about equals the capacity of the mines now working, and is used throughout this chapter as a basis of figuring losses due to the mine-run law.

screened lump by an amount sufficient to make it uneconomical to mix screened coal and slack bought separately.

This heavy loss to the operators has not benefited the consumer in general. The average price of slack has not been reduced, because a reduction beyond the present price does not increase the amount of sales and is of no value to the operators. The price of slack is fixed by the competition of fuel oil, and by its relative value as compared with lump coal. The greater part of the slack has been forced upon the railroads by the high price of lump coal. Another portion has been made salable in competition with lump coal, by the expensive process of washing. In general, the output of lump coal is restricted after the slack market has been supplied, until the price of lump coal has so increased as to make it advisable to mine the lump coal and throw away the slack. Some of the loss has been made up by an increased cost of lump coal, but this only transfers the cost to the consumer.

Loss of slack. The large production of slack has not only lowered the price of coal but has also made it necessary to load some slack out on the surface of the ground. When the slack is loaded out upon the prairie, there is a loss of at least 5 per cent* even if it is gathered up again. No general figures as to the amount of coal dumped upon the ground at all the mines are available, but during 1909 a single company accumulated 24,222 tons. The 5 per cent loss amounted to 1311 tons. Some of the slack dumped on the ground is not gathered up until the biennial suspension of mining, and after two years' exposure to rain and wind, the loss is very great. Much of it is never gathered up and is permanently lost, not only to the operators but to mankind. The annual loss to the State must even with our present limited output, be several thousand dollars a year. This is in addition to the cost of storing the slack. Unless restricted, this loss will increase as the mining industry is extended.

THE DECREASE IN THE QUALITY OF THE COAL.

Shattering the lump coal. The mine-run law injures the companies by also reducing the quality of the output and hence

*The only exact figures available show a loss of 11.5 per cent from one pile of 9,978 tons. The superintendents do not generally weigh the slack before it is wasted and guess that the minimum loss is 5 per cent.

its cash value. The heavy careless shooting not only reduces the proportion of lump coal but also greatly weakens those lumps which are not entirely broken up. As a result, they readily slack off on standing and are easily broken by handling. It will therefore not endure railroad shipment as well as it should. When domestic lump coal is loaded out by a careful retail dealer, the lumps are forked out and the coal remaining is sold at slack prices. In this way, it is possible to tell accurately how much slack is found in the coal. An affidavit of Mr. Geo. McLean of the Merchants' Transfer Company of Little Rock, states that several years ago, the Arkansas coal which he sold left from 3 to 5 per cent of slack, whereas in 1908, it left from 10 to 16, generally about 15 per cent. This is coal which left the mines as clean, fancy lump and was screened in the same way as before the mine-law went into effect. The experience of Mr. McLean is that of all dealers and consumers, and shows how much the coal is shattered by the excessive shooting.

This shattering so affects the coal that it produces an unnecessary amount of slack when an attempt is made by the consumer to break up the larger lumps. If a lump of properly mined coal is struck with a pick, it will break cleanly into a few pieces, but if Arkansas coal as now mined is treated the same way, it either crumbles where struck or if hit hard enough falls into small pieces with a large amount of slack. This fact was tested at Spadra by the writer who compared the breaking of the shattered lumps and of lumps from coal that had been undermined by mining machines, and shot only sufficiently to 'drop it down.' Arrangements were made to have a weighed amount of each kind of coal crushed and the percentage of slack produced from each determined, but this could not be done before the end of the mining season.

Increase of slate in the coal. There is a further injury to the operators, because the mine-run law compels the companies to pay the miners as much for slate as for coal. Some little protection is afforded by the agreement with the Union which allows a few of the worst offenders to be laid off for from one to three days, but they can only be penalized for loading out slate that is in large enough pieces to be picked out by hand from the lump coal. The companies are not allowed to put another man in the place made vacant, so the laying off of the men is an expense to the company because it reduces the output of the mine. Since it is generally impracticable to inspect the slack coal for slate, the miner gets a premium for shooting all of the dirt band and slate into small pieces and of course the coal goes also. Nevertheless, much slate in large sizes gets into the lump coal, although the companies have from two to six extra pickers at each large mine in their efforts to produce salable coal.

No exact figures of the increase in the slate in the larger sizes of coal can be obtained, because no tests are made, but the superintendents frequently receive complaints from consumers, and some of them have been obliged to stop those entries in which the middle band is the thickest. This increases mining costs by reducing the output, and causes increased waste of coal, but has become necessary on account of the mine-run law.

With regard to the slack coal there are abundant figures showing the increase in the proportion of slate which is mixed with the coal as a result of the increasing carelessness of mining. The fact that this slate evil will increase is best proved by the results obtained at the slack washer. As soon as the mine-run law was passed, it became necessary for the Central Coal and Coke Co. to build a slack washer at Doubleday, Arkansas, to remove the waste slate from that proportion of the slack coal which could not otherwise be sold. This company has kindly furnished the writer with the number of tons of coal washed and the amount of material removed from it each month since washing started in July, 1906, until the suspension of mining of 1910. This is summarized in the following table.

Results of Washing Slack Coal at Doubleday.

PERIOD	Percentage of Loss in Washing	Percentage of Slate in Slack*	Ratio of Increase of Slate
July, '06-Mar. 31, '07.....	19.04	11	1.00
Apr. 1, '07-Mar. 31, '08...	24.74	16	1.45
Apr. 1, '08-Mar. 31, '09...	26.40	18	1.64
Apr. 1, '09-Mar. 31, '10...	31.25	23	2.09

*The normal ash in this coal is only 5 to 9 per cent and is not removed in washing. Of the loss in washing, 8 per cent is clean coal which floats off as a fine powder in the wash water or is attached to pieces of slate or sulphur. The rest of the loss is chiefly slate unnecessarily mixed with the coal. The slack from some of the mines has less slate in it than this, but that from others has probably more, so this experience is not greatly different from the average.

To show the increase in the proportion of slate, the percentage of the first season is taken as normal. This shows the progressive increase in the amount of fine slate mixed with the coal and that it is now twice as great as it was during the first year after the passage of the mine-run law. The amount can be expected to increase as long as this law is in effect.

An effort to calculate what the amount of dirt in the slack coal would be if the miners shot to pieces all of the dirt band in the mines supplying this washer, indicates that they are already putting in nearly the equivalent of 75 per cent of the entire dirt band. Some of the dirt, however, comes from the soft bottom or from the draw slate. The writer has been in mine rooms where the middle band is 6 to 8 in. thick and very soft, but where there was nothing but a few large pieces of draw slate in the piles of waste. The dirt from the middle band had been loaded out with the coal and sold to the company, instead of being left in the room, according to contract. Fortunately, other miners are still quite careful to load only good coal.

The slack from the Spadra mines is used by the zinc smelting companies who find it necessary to analyze it for computing the retort charges. The results of their analyses for several years show a rapid and steady increase in the percentage of ash left by the slack. Since the middle band at Spadra is hard slate and not soft dirt, this indicates a very rapid increase in the carelessness of blasting.

The slack from other mines is occasionally analyzed by the large consumers or by the operators who have to specify the quality. These analyses all show large and increasing percentages of slate in the slack. An estimate based upon all of the figures available and the output of the mines represented indicate that the enactment of the mine-run law has caused an average increase of slate in the slack equal to about 10 per cent the weight of slack. Only the larger pieces of slate can be picked out of lump coal and much of the slate in it is nearly small enough to go through the screen. If it is assumed that the amount of slate left in the lump coal is only 2 per cent of its weight more than formerly, the average increase in slate in the coal of all sizes is 5.6 per cent. For convenience in calculation the figure of 5 per cent will be used since it is certainly not too great.

Reduction in value caused by slate. The government coal contracts based upon the heating value of the fuel and the amount of ash in it, reduce its purchase price in proportion to the loss in heating value caused by the addition of impurities. If the ash in the coal exceeds the amount specified in the accepted bid by more than 2 per cent of the weight of the coal, a deduction is made in the price because the extra ash reduces the efficiency of the furnaces, interferes with the draft, increases the labor of firing, and causes other annoyances. An excess of ash in the coal equal to 23 per cent of its weight as shown by the results at the washer is so great there is no way of estimating the penalty from the tables in the government contract specifications.

Even if we assume that the mine-run law had no immediate effect, the increase in the proportion of slate removed at the washer subsequent to the full operation of the law is 12 per cent of the weight of the slack.

Such an increase would cause its entire rejection under a government contract but the ash penalty would be at least 75c. a ton if the table of these penalties were extended far enough to include an increase in the ash equal to 12 per cent of the weight of the coal. If we take the average value of the slack at the mines at 85c. a ton, the loss in heat value would cause a further reduction of 10c. a ton, so the slack would very properly be rejected in favor of other coal.

In 1908, the average mine value of the Arkansas coal of all sizes was $1.68 a ton. The 5 per cent extra slate in the coal reduced its value by 35c. per ton at the mine, figured under the government specifications.*

Fortunately, for the operators, but not for the consumers, the coal of Arkansas is not bought subject to analysis. Prices of coal are regulated according to competition among the companies, and the price the year before. Hence the average prices do not change quite as rapidly as the cost of produc-

*If the coal contained 10 per cent of ash in 1908, 5 per cent additional reduces its heating value 5/90 or 5.55 per cent or 9c a ton. The average of the penalty for a high increase of ash in slack and a low increase in the lump coal is much greater than the penalty for an average increase in ash contents. The average ash penalty for a 10 per cent increase in the ash of the slack (or 45 per cent of the coal) and for a 2 per cent increase in the ash in the rest is at least 26c. a ton for all the coal as nearly as can be estimated by the incomplete tables of the government specification. If it all increased in ash only 5 per cent, the penalty would be but 12c. a ton.

tion does. The price received at the mine is nearly always the same no matter where the coal is sent, except in the case of big special contracts. For this reason, an increase in mining costs is largely taken up by the loss of profit to those companies having an established market. When the price of production increases, the coal is sold below cost at many places where there is a fixed price regulated by the cost of oil and coal from competing districts. At other places, the market is simply surrendered to the competing fuel. Since the price can not be raised in distant markets, it follows that the Arkansas consumer is about the only consumer who feels the increase in cost of mining. As the mining cost increases without sufficient increase in the selling price, those companies whose coal is more difficult to mine go out of business. Still, however prices are fixed, either the operator or the consumer suffers by this decrease in value of the coal, which is at least 35c. a ton on the average. Consumers gladly pay 60c. to 70c. a ton more for washed slack than for unwashed slack, but this is not all due to the mine-run law, since there was some slate in the slack before. The lump coal is reduced in value by the shattering as well as by the slate. A loss of 35c. a ton in the value of the Arkansas coal is $875,000 a year at the normal output. This sum might as well be paid to the operators for better coal as thrown away in decreased efficiency of steam boilers and the extra expense of handling clinkers and dirt.

Loss of market. In competitive districts the quality of the coal is of great importance, and the changes in the price of one coal as compared with the price of another indicate the money value of a decrease in quality. In the eastern part of the State, Arkansas coal is in strong competition with Illinois coal. Tests of Arkansas and Illinois coal made by the government experts at St. Louis in 1904 show that the Arkansas coals had at that time about 20 per cent more heating value than Illinois coal. They also had considerably less ash and sulphur, which are the injurious ingredients. In 1904, it was therefore possible to sell Arkansas coal at a higher price than was received for Illinois coal at places where both kinds of coal were available. The Arkansas coal is now so shattered and mixed with slate that consumers at competitive markets pay from 35c. to 50c. a ton more

for Illinois lump or mine-run coal than for the same sizes of Arkansas coal. The value of Arkansas coal is thus shown, by the judgment of the consumers, to have decreased more than the 35c. a ton determined by the tables in the government specifications. The difference is due to freight paid on slate and the shattering of the lumps.

If the comparative value of a coal decreases, the consumers in competitive regions buy a competing coal instead. The deteriorated coal can then be sold only at points so much nearer the mines that the difference in freight rates will enable the producer of this coal to lower the price sufficiently to make up for the difference in quality. Thus as the comparative value of a coal decreases, its market area contracts.

Thirty-five cents a ton is a conservative estimate of the decrease in value of the Arkansas coal as a result of the influence of the mine-run law. This 35c. a ton will pay the additional freight rate on coal from Little Rock to Memphis. Allowing 10c. a ton for transferring part of the coal from one railroad to another, the remaining 25c. a ton will extend the distance the coal can be hauled by 60 miles. Directly toward the competing coal fields the distance is less, because as the Arkansas coal pays more freight the competing coal pays less; but where the coal from both fields goes along parallel lines the extension of the market area would be much greater.

An addition of a 60-mile strip around the area, supplied with coal chiefly by the Arkansas-Oklahoma coalfield, would more than treble this area. The increase in the coal sales would be chiefly in the territory now supplied by Illinois and Alabama coal and would benefit Arkansas more than Oklahoma. An exact computation of the effect of an increase in the quality of Arkansas coal would require a complete knowledge of freight rates and market demands at all competitive points.

A rough estimate shows that it would increase the output nearly 100 per cent. Such an increase in the output of Arkansas coal would result in an improvement in the quality of competing coals or a little decrease in their price. The profit of mining the Arkansas coal would also have to increase a little before a sufficient number of new mines would be opened to supply such an increased demand. The reduction of costs of mining which would follow the repeal of the mine-run law would, however, bring this about without an increase in the present sale price of the coal. These price factors, however, disturb any calculation as to the increase in the output which would follow the restoration of the former good quality of the coal. It would certainly be at least 50 per cent of the present output.

If the mine-run law had not been passed, the coal-mining industry of Arkansas would have promptly recovered from the set-back caused by the over-production of fuel oil in 1904. In 1905, the production was again increasing rapidly. Now most of the Texas fuel oil has been replaced by Alabama coal instead of coal from the Arkansas-Oklahoma field which formerly supplied that territory. The loss of market which followed this law can be again seen by noticing how much more rapidly the production of coal has increased in the competing states of Illinois, Alabama, and Kansas as compared with Arkansas and Oklahoma. Unfortunately no complete statistics later than 1908 are available. This problem is complicated by the production of fuel oil in Oklahoma, but the phenomenal industrial development of Texas and Oklahoma has more than offset this. The Arkansas coalfield supplies a much smaller proportion of the coal used in Arkansas, Louisiana, Oklahoma, and Texas than it did in 1905 and 1907. The loss of this business will continue to increase until the industry is relieved of the burden of the mine-run law.

The good effect which an increase of 50 per cent in the output of the coal, would have upon the general prosperity of the coal-mining region of the State is obvious.

INCREASE IN MINING COSTS.

Cost of handling slack. The mine-run law not only causes a tremendous decrease in the revenue of the coal companies, but increases the expense of mining marketable coal. When the operators can not sell the slack, it must be shoveled out of the railroad cars at a cost of 10c. a ton. When it is gathered up again, there is a further cost of 14c. a ton. The total of 24c. a ton is a direct expense and in addition is the loss of the wasted slack and the lessened value of the slack which has been exposed to the weather. The total amount of slack stored on the ground each year is not known, but the Central Coal & Coke Co. alone

had, on March 12, 1910, 24,222 tons of slack stored at Huntington and Doubleday. At 24c. a ton, the handling of this slack cost $5,813. The Bache-Denman Coal Co. had 9,978 tons of slack stored, and the annual expense to all the companies may be estimated at $10,000.

Cost of mining slate. Since the mine-run law went into effect, the Central Coal & Coke Co. has washed practically 144,000 tons of dirt out of a small part of its slack. The appearance of the pile of dirt near Hackett as it was in September, 1909, is shown in Fig. 63.

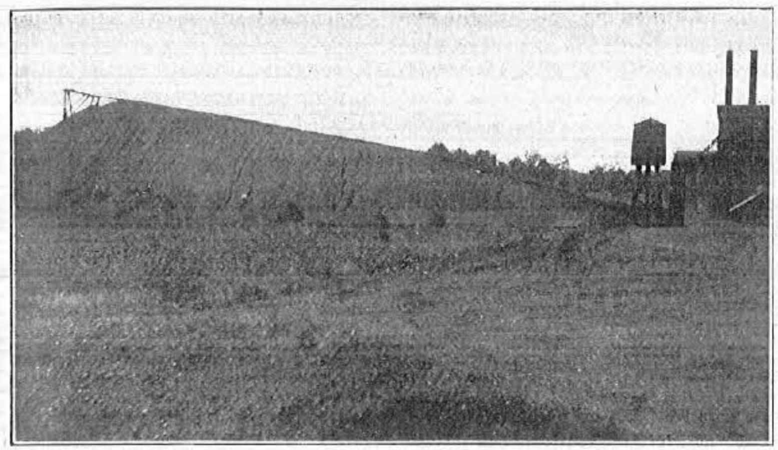

Fig. 63. Pile of slate washed from slack coal at Doubleday, September, 1909.

During 1909, 28,800 tons were added to this unsightly mountain. This useless dirt cost the company 62c. a ton, paid to the miners who sold it as coal, and as much more for hauling, hoisting, and loading it at the mine, and in freight. This was, therefore, an expense of at least $35,000 per year, of which half or more was due to the increase in the amount of slate made possible by the mine-run law.

This is a good illustration of the increased cost in an isolated case. A better idea of the entire cost to the State can be obtained on the basis that the mine-run law has increased the amount of slate in the coal upon an average of 5 per cent of its weight. This is certainly a conservative estimate. On an output of

2,500,000 tons, this cost is at least $137,500 for mining and handling, not allowing anything for those expenses which are not affected by the number of tons produced from each mine. There is the cost of mining the additional slate which is picked out of the coal by slate pickers. No idea of the amount of this can be formed.

When the slate is removed from the coal by washing or hand-picking, the cost of mining it is a direct loss to the operator. The slate remaining in the coal causes a loss in the form of a reduced selling price in competitive markets for the coal containing it. The nearby consumer who must buy his coal in Arkansas anyway pays at least a portion of the cost of mining the slate by paying full coal prices for a mixture of coal and slate.

Cost of removing slate. The washing of the slack at Doubleday costs one company several thousand dollars a year. In addition to this, there is the cost of the 'slate pickers,' or hands required to pick the large pieces of slate out of the coal; for the law not only compels the companies to pay the full mining price for this slate but also prevents them from docking the miners, or even the Union as a whole, to meet the expense of picking out some of it so that more coal can be sold. The larger part must of course remain in the coal. A study of the crews and outputs of each mine shows that the actual expense of trying to remove the slate, averages three-quarters of a cent per ton at the mines outside of Spadra. This does not include the expense of handling cars and the other work of car trimmers. Of this, the largest part or about one-half a cent a ton is due to the mine-run law for there was much less trouble before its passage. This makes a cost of $12,500 a year to the operators. At Spadra the cost of picking slate is 8c. a ton or about $16,000 a year, but only a possible $5,000 of this is due to the mine-run law, for it has always been necessary to clean this coal from sulphur and bony coal. Both of these expenses will increase from year to year unless the attempt to maintain the quality of the output is given up or the mine-run law is repealed.

Cost of explosions. A further slight increase in the costs is due to the increasing frequency of destructive 'windy shots,' or dust explosions, resulting from the excessive use of powder. Doors and stoppings blown down by them must be replaced, and

the cost of a single general explosion is often great. At many mines, it is already necessary to pay the shot-firers extra on account of the extra risk they run. The actual total cost can not be estimated, but it is probably offset by the profit upon the additional powder sold to the miners. This profit is nominally 75c. per keg, but the company has to pay for a powder clerk, the delivery of the powder to the miners' rooms, and various general expenses, so the net profit is small.

The increased danger of explosions disturbs the peace of mind of the mine owners and all the officials. There is much worry attending the loss of life and efforts at rescue. It is generally the superintendent or pit-boss who is injured or killed by going down into the deadly gasses or under a shattered roof to rescue the shot-firers before they suffocate. This has been the experience elsewhere and the prospect is not pleasant.

Cost of draw slate. The excessive use of powder and the blowing out of props greatly increases the expense of draw slate and falls of rock. At most of the mines, no separate records of the costs of draw slate are kept; but at such mines as keep the records, the costs are shown to have increased steadily except for the little drop during the last year, which resulted from a corresponding drop in the consumption of powder. The costs at three mining camps including seven different mines, averaged on the basis of a uniform output, are given in the following table. At all of these mines the cost has increased almost exactly in the same proportion. The figures are representative.

Cost of Draw Slate.

PERIOD ENDING MARCH 31	Cost per Ton for Bad Roof	Ratio of Increase
1904	$.0108*	
1905	.0116*	1.00
1906	.0114*	
1907	.0227	2.00
1908	.0398	3.52
1909	.0447	3.95
March to December, 1909	.0411	3.63

*Average $.0113.

The cost of draw slate, at all mines keeping a separate record of it, lay between 1c. and 7c. per ton of coal mined in 1909. It will average between 2½ and 3c. a ton over the entire State. The proportion of this due to the mine-run law is at least 2c. a ton as an average, and with a normal output would cost the companies $50,000 a year.

Increase in general expenses. It can be conservatively estimated that the loss of market resulting from the mine-run law has reduced the running time of the mines by at least 10 per cent of the former time, or 11 per cent of the present time. If the output of the mines now in operation should be increased by 11 per cent, the fixed expense, such as interest, taxes, administration, pumping, etc., would not be increased at all. The decrease of 10 per cent in the output has therefore resulted in an increased fixed expense of 11 per cent for each ton now mined. The fixed expense is from 25c. to 40c. per ton, omitting exceptional mines, although the sale price of coal at many mines is not sufficiently above operating costs to pay them. A much greater increase in the market demand would follow the restoration of the old conditions, but this would lead to the opening of new mines. It seems just therefore to estimate the loss as at least 10 per cent of 25c. on each ton or $62,500 on the normal output of the State.

At least one mine, that of the splendidly managed Scranton Anthracite Coal Co., is definitely shut down pending the repeal of the mine-run law, on account of the great increase in unsalable slack. Nine other large mines have been closed on account of bankruptcy or lack of market. Some one has to pay for watchmen at these mines and for keeping down the water or removing it at some future time. The lost interest that the money spent in opening these mines should be earning must also be paid. This makes another charge against the mine-run law of between $40,000 and $60,000 annually. Both of these costs are absolute dead-losses without any benefit to anyone.

INJURY TO THE MINERS

Increase in the use of powder. The miners themselves are beginning to suffer as a result of the mine-run law. The most pernicious injury to the miners is the increase in the number of

accidents. As this results mainly from the excessive use of powder, a few exact figures as to the increase in the consumption of powder may be interesting. When the coal is properly undermined, it can be dropped down and broken up sufficiently by very light charges of powder for easy handling with a pick. The Enterprise Coal Co. at Spadra operated two mines. From June 1 to November 20, 1908, the coal at one of these was undermined by a machine and then shot down, while at the adjoining mine, the coal was shot off the solid in the present careless way. From figures taken from the pay-roll by the writer, it was found that during the entire period of the operation of the machines, 151 kegs of powder were used to shoot down 13,316 tons of coal, or 88.17 tons per keg. From February, 1908, to January, 1909, in the adjoining mine where the conditions were identical except for the difference in the mining method, 16,987.28 tons were shot off the solid by 1,115 kegs of powder. This is only 15.23 tons of coal to a keg of powder. This means that 5.8 times as much powder is now used as would be needed if the coal were first undermined as was once the universal custom.

At Paris, where the coal is undermined by machines but is thinner, one keg of powder was used for 48.4 tons of coal during the season ending April 1, 1910. There is no exactly similar adjoining mine, but the other mines in the district use four times as much powder for shooting the coal off the solid, even though the coal is thicker and should require less powder.

Even before the mine-run law was passed, the miners generally mined the shots only slightly, if at all. Nevertheless, the consumption of powder has greatly increased. Because of lack of records, it was impossible to get exact figures from all of the mines which have been in operation from before the passage of the law to the present. Exact figures were, however, obtained from ten such mines and others which were in operation for only a part of the period. Approximate figures showing the same results were obtained from three others, so there are only three large soft coal mines omitted. In these mines, the conditions are such that the increase will be more than the average. The increase has been much greater at Spadra, but unfortunately no figures could be obtained because of lack of records.

One of the mines for which figures were available is the Denning No. 2 at which two-thirds of the miners receive a premium for being careful. The consumption of powder here has as a consequence increased only 3 or 4 per cent. This mine is omitted from the calculation. One mine, where for several reasons there was but little increase in the waste of powder, is included, even though it brings down the average rate of increase. Owing to the form of the figures, it was necessary to average them on the basis of an equal output of coal at each mine. The results are given in the following table.

Consumption of Powder in Ten Large Mines.

PERIOD	Tons of Coal per Keg of Powder	Kegs per Ton of Coal	Ratio of Increase	
Oct. 1, '05 to Mar. 31, '06	30.31	.03299	1.000	
Apr. 1, '06 to Sep. 30, '06	28.41	.03519	1.067	1.030
Oct. 1, '06 to Mar. 31, '07	29.54	.03385	1.026	
Apr. 1, '07 to Sep. 30, '07	28.49	.03510	1.064	1.028
Oct. 1, '07 to Mar. 31, '08	29.18	.03427	1.039	
Apr. 1, '08 to Sep. 30, '08	26.34	.03796	1.151	1.111
Oct. 1, '08 to Mar. 31, '09	26.96	.03709	1.124	
Apr. 1, '09 to Sep. 30, '09	25.03	.03995	1.200	1.156
Oct. 1, '09 to Mar. 31, '10	27.12	.03687	1.118	

The decreased consumption of powder during the winter is general. This may be due to greater caution on the part of the shot-firers who are more likely to skip heavy shots in the winter, when there is greater risk of a dust explosion. The increased output may also account for this and for the slight improvement in the summer of 1907. It is much regretted that the figures were not obtained for the summer preceding the mine-run law, but estimating it at .03416 kegs per ton of coal, the ratios in the last column are obtained. The larger part of the decrease just before the last suspension is due to the change at the Central No. 2 Mine at Huntington, where much of the coal was obtained from the drawing of pillars. At several mines, however, the miners were more careful owing to their efforts to keep the slate out of the coal and prevent the mine from shutting down for lack of a market.

The table shows that the consumption of powder has increased progressively since the passage of the mine-run law until it was 13 per cent greater in 1908 than in 1905. This excessive consumption of powder will of course continue to increase in normal years until the mine-run law is repealed. If only the mines at places where the coal is easily undermined, as at Bonanza and Hartford, are considered, the consumption in 1909 was 20 per cent greater than in 1905.

A study of the results at Denning show how much of the increased use of powder is directly due to the mine-run law. Here at No. 2 Mine, the consumption of powder has increased about 4 per cent even though only one-third of the men are careless. If all the men had been careless, the increase would have been the 12 per cent to be expected.

Further, at Mine No. 2, the pay-roll data were obtained separately for the good miners who made less than 30 per cent slack, and for the poor miners who made more than 30 per cent. This shows that the good men used on an average one keg of powder for 28.2 tons of coal of all sizes, and the others one keg for 24 tons. This shows an excessive use of powder by the careless men of 12 per cent. In the case of the entry-men, the difference was 26 per cent. As previously stated, the good miners also earned 10 per cent more than the poor ones which means that they mined more coal, but the poor miners actually used 3.2 per cent more powder each day in the rooms, and 6.9 per cent more in the entries. Reduced to the basis of the same number of tons per day on an average, this would mean that the poor entry-men actually used 1.5 pounds of powder each day more than the good men. This is the effect of the mine-run law everywhere.

Effect of heavy shots. To illustrate one of the effects of heavy shooting on the roof, the discussion of the mining at Coaldale may be repeated. Here there is a smooth seam in the coal, 10 in. above the bottom. When ordinary narrow shots properly loaded are fired in the upper part of the bed, that bench is only nicely loosened and the coal below the seam is not affected. This requires that the bottom be wedged up, and the miners therefore put wide shots in the top bench and overload them so that special timbers have to be used to keep the flying coal from knocking out the props. In this way, the bottom bench is not only cracked loose along the line of the drill hole, but also is thrown out from the face.

Overloaded holes strike a severe blow upon the roof in the same way, and weaken it if they do not actually crack it. Every succeeding shot still further jars the roof and even the solid rock, for quite a distance away. The result is that, when the roof once begins to sag, it loosens over a wide area, and falls, sometimes while the miner is setting a prop under it.

A little reflection will show how much more a heavy wide shot will affect the roof, than the same amount of powder in two light shots. Fig. 64 is added to illustrate this. At present many

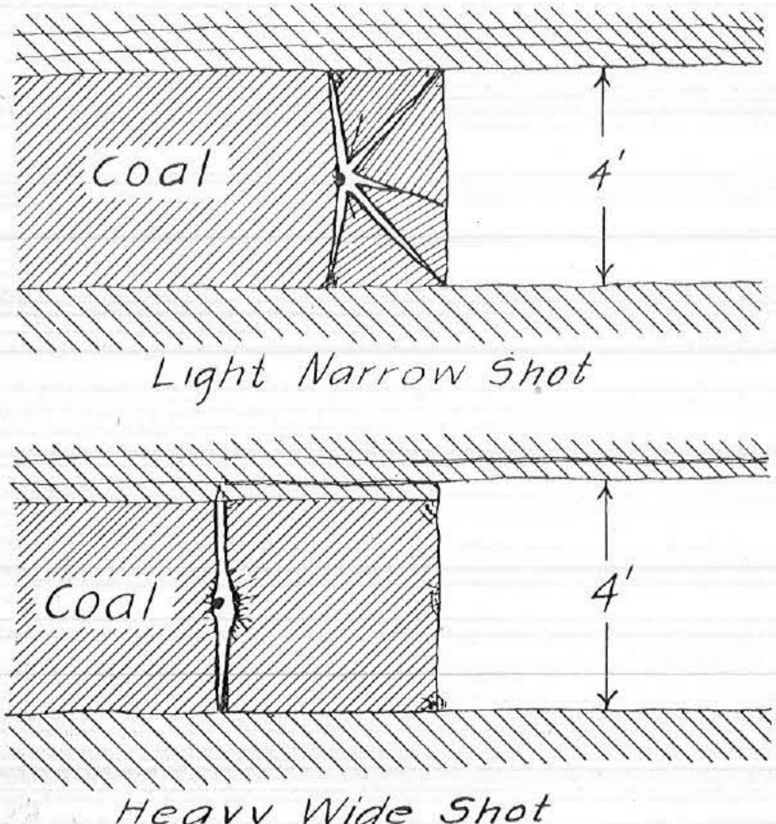

Fig. 64. The effect of wide and narrow shots upon the roof of a coal mine.

of the miners put in only about half as many shots as formerly, to get out the same amount of coal. All of them are using fewer shots. This change in the blasting does not show in the figures for the consumption of powder, and it is safe to say that at present the blasting of the coal is at least three times as severe as it was in 1905.

The heavy shooting also sends the coal flying against the props. At a mine at Spadra, the writer saw some large pieces of coal which had been thrown by the blast of the afternoon before a distance of 40 ft. They had knocked out the props so as to leave an open lane down one side of the room. Besides knocking out props, such shooting cracks or otherwise weakens some of them in a way which the miner does not notice until the roof falls. The worst trouble is the increasing tendency of the miner to set his props as far from the face as possible, so as to save the labor of replacing them. He therefore works in an unprotected space. This wide space also gives the roof a chance to loosen and get drummy, which throws an added strain upon the places where the tough slabs have been weakened by the direct blows of the powder. The roof gets an additional jar each time a heavy mass of flying coal hits a strong prop.

The heavy and wide shots now used are dangerous to the shot-firers, and many miners have begun to ignore all ordinary precautions for safety in blasting. At a mine near Hartford, the writer saw a large mass of coal similar to that shown in Fig. 30, p. 62, which had been shot out of its position, but was still tightly wedged between the roof and a roll in the floor. The miner was very frank and when asked how he would go about picking this coal down, he laughingly set his auger in position for drilling a splitting shot through the center of this chunk of coal and said, "With two feet of powder." Then he added, "I always find an auger when I start to look for a pick." He knew that in most of the states such splitting shots are forbidden by law on account of the danger of a general dust explosion. He also knew how easy it would be to shovel up the slack such a shot would make and was one of the few that admitted that he did not care what became of the company's property or of a shot-firer who would be foolish enough to light such a shot. Such an attitude is fortunately exceptional as yet, but the distressing feature of the situation is that such carelessness is bound to become the prevailing custom unless the shameful law by which it is encouraged, is repealed.

Accidents in the mines. So far as they are available, the records of the accidents in the Arkansas mines show the increases in the number due to falls of roof and the firing of shots, which might be expected from the increased severity of the blasting. No record seems to have been kept of the accidents in Arkansas mines previous to 1905, and the records for 1909 are not yet available. There is some uncertainty about those for 1907, for the exact figures are available only for half the year, during which ten men were killed. A complete record of the accidents in the mines of the Operators' Association during 1907 was available. If 13 men were killed in all of the mines of the State, the ratio of the number of accidents in the associated mines and the others would be the same in 1907 as in other years. This figure is therefore used in the table although it is obviously too low. All of the data available are given in the following table.

Accidents in the Mines of Arkansas.

YEAR	Tons of Coal Mined	Average Number of Men Empl'd	ACCIEENTS: Fatal	Serious	Minor	Total	Deaths Due to: Shot Firing	Falls of Roo
1905	1,934,673	5192	8			42		
1906	1,864,268	4298	13	6	25	44	4	6
*1907	2,670,438	5085	13	12	27	52	2	7
1908	2,078,357	5337	14	17	29	60	1	8
1909	2,377,257	4700	15	19	40	74	2	9
†1910	small		9	18	30	57	4	5

YEAR	Accidents per 1,000 Men: Fatal	Total	Accidents per 1,00 0,((Tons of Coal Mined: Fatal	Total	Fatal Accidents in the United States: Per 1,000 Men	Per Million Tons Coal
1905	1.91	10.02	4.1	21.2	3.60	5.69
1906	3.02	10.23	9.1	23.6	3.31	5.08
*1907	2.56	10.22	4.8	19.8	4.85	6.95
1908	2.62	11.24	6.9	28.9	3.60	5.99
1909	3.19	15.74	6.3	31.1	....	....

*Arkansas accident figures for 1907 are incomplete and too low.

†Accident figures for 1910 were compiled from the operators' reports to T. A. Freeze, State Mine Inspector, after the first part of this report was in press. During this year the mines were closed 5½ months by a strike, and operated irregularly and with short crews during the fall. Note that all fatal accidents were due to blasting or falls of roof.

The mines were much less steadily operated in some years than in others so the figures as to the number of deaths reported per 1,000 men employed are misleading. The fairest figure for comparative years is that per 1,000,000 tons of coal mined. This shows how low the figure for 1907 is. Assuming that ten men were killed during the first half of the year as well as the second, the rate becomes 7.5 which is too high since the first half of the year had a much less output than the second.

The high fatality rate in 1906 is due to the fact that four men were killed by windy shots instead of the usual one or two.

During the years of 1906, 1907, and 1908, for which figures are available,* 52.5 per cent of the fatal accidents were due to falls of roof, 17.5 per cent to firing shots, 10 per cent to crushing between cars (chiefly drivers), 7.5 per cent to firedamp, 5 per cent to accidents in shafts, and 7.5 per cent to other causes. The figures for the non-fatal injuries are not so detailed, but show that 44 per cent were caused by falls of roof and 17 per cent by gas explosions. Of the causes listed, burning by gas and accidents with cars are quite generally much less fatal than the others.

Imperfect as these figures are, they well illustrate the effect of the mine-run law. The heavy shooting following the passage of the law has progressively increased the amount of rock falling in the rooms to triple that of 1905; this is shown in the table on p. 267. It is therefore directly responsible for at least half the deaths due to this cause in 1908. Charging the law with only one-sixth of the deaths from this cause in 1906 and with half of them in 1908, makes a total of 7 deaths on this account, not including those of 1909. If the shots were properly prepared, there would be much less danger in firing them than in handling the powder while they are being prepared. All the fatal accidents due to firing shots in 1907 and 1908 and probably at least half of those in 1906, happened to regular shot-firers. Nearly all of these deaths are due to the heavy and careless loading of the shots encouraged by the mine-run law, and at least four of the seven may be charged against it.

*Figures for the 6½ months of 1910, during which the mines were operated show that 55% of the fatal accidents were due to falls of roof, and that 45% of them happened to regular shot-firers as a result of dangerous shots. No men were killed in other ways.

As conditions now exist, this killing of shot-firers is often little short of murder on the part of the unscrupulous miners who knowingly overcharge the holes with powder. The laws of the State should not encourage murder.

One of the results of the passage of this unnecessary law in 1905 has therefore been the death of 11 of our miners in 3 years. At present, it is responsible for over half the number of deaths due to falls of roof and three-fourths of those due to the firing of shots or at least 40 per cent of all the deaths from accidents in and around the mines.

This estimate of the proportion of deaths due to the mine-run law is shown to be conservative by the fact that the number of deaths per 1,000,000 tons of coal mined has increased more than 40 per cent since 1905. During this time there has been no change in conditions of mining except the carelessness permitted by the mine-run law and a decline in the output of the mines. Such a diminished output causes the less experienced coal miners to seek work in other occupations and should therefore cause a decline in the death rate. The death rate has failed to fall as it should, and it never can fall much until this law is repealed.

Decrease in the daily earnings of many miners. A carload of mixed slack and lump coal now brings the digger only 62c. a ton. Those skilled diggers that work in hard or good-shooting coal could without great difficulty so mine the coal that it would contain such a large proportion of lumps that the average value would be 70c. to 80c. per ton on the old screened-coal basis. If then the condition of the mines is such that the miners can not all get more cars every day than they needed for loading all their carefully mined coal, they can not earn so much money now as they could before the mine-run law went into effect. Now the miner often sits down and waits for cars, when formerly he spent the time preparing the coal for the next shot.

The Denning pay-roll figures show that if the good miners at No. 2 had been paid on a straight mine-run basis, as was done at all other mines, they would have lost $1,441.85 during the month of January, 1910. This is 12½ per cent of their gross earnings, or an average of over 50c. per day each. If the mine-run law had not been enforced, the earnings of the careless or unskilled miners in Mine No. 2, Denning, would have been reduced by only 3½ per cent or 15¾c. per day each or $211.02 for all of them. This loss to the poor miners is only 14.6 per cent of the gain to the good miners. Except in a few places at Mine No. 5, the condition of the coal is the same in all of the Denning mines. The conditions are much worse at those mines where the coal is easily undermined or where the turn is poor. At Bonanza, the miners say they earn in the rooms from 25c. to 75c. a day less than formerly. At Jenny Lind, it is from 50c to $1.00; and at many other mines, it is considerable.

The men working in these mines frankly object to the mine-run law and many other men not directly injured by it admit that it is wrong; but even those that do not blindly follow their leaders are forbidden to sign a petition for its repeal or to appear before a legislative committee by Section 28 of Article XII of the Constitution of the United Mine Workers of America, District 21, which reads:

> "SEC. 28. Any officer or member of District 21 appearing before any Legislator directly or indirectly or by petition protesting in any way against the passage of any Mining Legislation which has been adopted by a majority vote of the miners' organization or in Convention of the State Federation of Labor, or *in caucus called by the District President,** shall be fined $50.00 and his action reported to all Locals by the District Secretary, said fine to be paid into the District Defense Fund."

The $50.00 fine and the publication of the miner's name at all the locals practically expels him from the Union, and under the present closed shop rule, expulsion from the Union means the impossibility of earning a livelihood by working in the mines. This clever little trick of the Union leaders in preparing the constitution is therefore the only reason for the impressive unity of the miners in favor of this absurd law.

It is conservative to estimate that the wages of about half of our diggers are reduced by an average of about 25c. for each day they work. This is a total of about $75,000 per annum, which is very much greater than the total gain to the careless men. The figures of the U. S. Geological Survey show no consistent increase in the amount of coal produced in Arkansas per day by each man employed at the mines, up to 1908. Since many of the mines where the coal is low and other mining conditions are difficult have gone out of business and because many difficult

*Italics ours.

entries in other mines have been stopped on account of lack of demand for coal, the production per man should have increased if there had been no loss of wages. The loss in wages is partly offset by the decrease in the labor required to shoot the coal as compared with that required to mine it, but it is a direct loss in the form of lack of opportunity to work for the extra money.

Loss of earnings to all the miners. The miners as a body are injured financially more than they realize by this law. The reduced profit to the operators has made it so difficult for them to grant the increase in wages demanded by the miners in March, 1910, that the strike continued for over 5 months. The miners say, "Raise the price of coal to the consumer." But that would simply mean the loss of market to fuel oil and competitive coal. The passage of this law further hurts the miners as a body by causing ill feeling on the part of the operators, who are therefore less likely to grant favors voluntarily. Instead of giving the miners a better turn, they must give them a poorer turn or fewer cars because the good turn encourages the loading out of slack.

A less obvious but direct injury to the miners results from the great decrease in the production of the coal which is caused by this law. In the entire United States, the coal miners are only injured in as far as the coal is replaced by fuel oil; but the Arkansas miners in whom the Legislature should be especially interested suffer directly as the coal business of eastern Arkansas is transfered to Illinois and Alabama. If it were not for this loss of business, the mines now operated and consequently the present crew, would work a possible 20 days per month instead of 17; and the annual earnings of the miners now in the State would be increased at least 11 per cent, or an average of $7.00 apiece per month. Assuming that the mine should work 12 months a year with no loss of time by strikes, this would amount to about $300,000 net per annum to the men now in the State. The repeal of the law would therefore benefit them more than the winning of a most bitterly contested strike, even though they would have to work a little harder. Any increase in the output beyond this 11 per cent would result in the coming in of new miners, following the reopening of the mines now closed and the opening of new mines. The work thus supplied to the new miners would be an advantage to them, but is best classed as a benefit to the State at

large rather than as a benefit to the miners now working in the Arkansas mines.

Loss of skill. The miners are further injured by the mine-run law because under its operation they are losing their old-time skill, which will make it impossible for them to get employment in fields where it is necessary to do pick work. This lowering of the standard of skill also throws the occupation open to any man with a strong body. As soon, therefore, as the artificial conditions due to the the Union break down, the wages of the coal miners can not be maintained as much above the pay of common laborers as at present. The bringing in of such a lot of inferior workmen is sure also to be the end of the Union, since unskilled labor has never been successfully held in line during a long strike.

There is now no incentive for the new men to learn how properly to shoot the coal and as a result the mine-run law means stagnation in the progress of our miners toward increased efficiency.

INJURY TO THE CONSUMER.

Cost of slate. As usual, the consumer suffers from industrial troubles. Those consumers near the mines are compelled to pay an increased price for coal of inferior quality. This extra cost serves to reduce the loss to the operators by the same amount, and on account of the low value of the great amount of slack, the average selling price of all the coal is decreased.

Most consumers including the railroads themselves have to pay freight upon the useless slate. The average cost of the freight on Arkansas coal is probably $1.50 a ton. We have seen that the mine-run law has added at least 5 per cent of slate to the coal. In the 2,500,000 tons normal annual output, this slate will weight 125,000 tons and the consumer pays $187,500 annually to get this from the mine to his unloading switch.*

There is in addition, the labor of handling 5 per cent more of fuel and 50† per cent of ash. When drayage is paid on the coal, this is a big expense, but no figures are available for calculating

*The benefit to the railroads is much less than this sum since they make but a small profit in handling coal.

†This is figured on the basis of 10 per cent ash in the original coal, before the law was in effect.

the total amount. The labor of handling the extra slate and ashes often costs nothing and merely causes more work to the fireman as in the case of the private dwellings, railroad locomotives, or small power plants; but the capacity and efficiency of all boilers is reduced. This reduction increases costs, as by a reduced ton-mileage of every locomotive or increased actual coal consumption per pound of steam produced. Since the slate has no heating value, more tons of so-called coal have to be bought to get as much heat as formerly.

By comparison with the price paid for other coals and figured on the basis of the government contracts, the loss in the quality of the coal is at least 35c. a ton as was previously explained. This costs the consumers of Arkansas coal $875,000 a year at the normal output.

It may be well to call attention to the fact that the State itself is a large consumer of Arkansas coal. During the mild season of 1909, the different State institutions used 10,362 tons of coal, which cost $35,000 delivered. Upon this, they lost $3,625 due to its bad quality, $650 more for freight on the 5 per cent unnecessary slate it contained, and about $200 for drayage on slate. This bit of class legislation, therefore, cost the State treasury directly about $4,506.*

In the interest of economy in State expenditures, the mine-run law should be repealed at once.

Increase of smoke. There was a time when the Arkansas coal commanded quite a premium on account of its high heating value, its low ash and sulphur, and the small amount of smoke it produced. It was, therefore, used throughout the State and in in most of Louisiana and Texas as well, especially by the railroads. Since the railroads have been compelled to take with the lump coal all of the screenings but 25 per cent of the weight of the coal, the amount of smoke has been constantly increasing. The future discomfort to the railroad passengers which will result from the continued deterioration of our coal was well illustrated during the summer of 1910, when all the locomotives on branch

*Actually the loss to the State is much greater since it buys mostly slack. In this the slate has increased more than 10 per cent as a result of the change in mining methods caused by the mine-run law. Much of the coal bought by the State was washed slack for which the 60c. to 70c. a ton extra was paid for the removal of the slate. In this calculation the State is figured as a consumer of average coal.

lines burned smoky coal from other states while the supply of Arkansas coal was cut off by the suspension of mining. The smoke and the increasing difficulty of keeping up steam caused by the slack and slate have reduced the advantages of the Arkansas coal, and have already greatly restricted the field in which it is used by the railroads. The complaints are so great that as our coal gets dirtier, the railroads are putting an increasing number of oil-burning locomotives into service for passenger trains in spite of the great expense for maintenances of boilers. The Rock Island railroad company is considering abandoning Arkansas coal in favor of Alabama coal, even upon the division which crosses the Arkansas coalfield.*

The increased dirt and discomfort of handling the coal has lessened its use in dwellings in favor of other coal, and the general poor quality of the slack has lead to a great increase in the consumption of formerly inferior smoky coals. As a result, our cities become dingy with smoke and our State unattractive to strangers.

Injury to the firemen. Since the law was passed at the request of the mine workers, its effect upon other workmen should be considered. It injures all firemen handling Arkansas coal by increasing the labor of shoveling coal by 5 per cent, and of handling the ashes by 50 per cent. The trouble with clinkers is greatly increased by the addition of the slate, and this most disagreeable work is now at least twice as great as it was before the mine-run law was put into effect. In addition, the railroad crews have a great deal of trouble to maintain their schedules and are in constant difficulty with their superiors. Since this and the increased cost of the equivalent coal increases the cost to the railroads, they hardly feel like raising the pay of the firemen. What justice is there in a law which decreases the labor of one group of workmen and increases that of another? Why should the general coal consuming public be made to suffer by the operation of a law which really benefits no one?

*Since the above was written it is reported that all of the Rock Island passenger locomotives burn Alabama coal, even when passing the Arkansas mines at Hartford.

INJURY TO THE STATE AS A WHOLE.

The special disadvantage in Arkansas. The coal of Arkansas is of such a quality and occurs in such a way that a mine-run law is especially objectionable to this State as compared with most of the others. The Arkansas coal has quite generally a band of dirt separating the two benches of coal or else a layer of soft dirt either above or below the coal. Unless the companies have a right to prevent it, many of the miners will load this out as coal with the disastrous result shown. Except in the nearly exhausted Denning field, most of the Arkansas coal which is now being mined is rather soft or 'woody' and does not readily shoot off the solid. It should therefore receive great care in mining.

Moreover, much of the Arkansas coal is non-coking in character, and the slack has relatively much less value even for steam purposes than the lump coal. On the other hand, the free burning lump coal is especially satisfactory for domestic use. In Alabama and southern Colorado, the slack coal is used for making coke and except for the slate in it has just as much value as the lump coal. Indeed some lump coal has to be crushed to supply the market for coke. This allows the competitors of the Arkansas operators to send clean lump coal to drive the Arkansas coal out of Louisiana, southern Texas, and even the eastern half of Arkansas. The same is true of West Virginia, whose competition by cheap water transportation is severe in some places.

On account of the soft dirt band in or beneath the coal, it is unusually easy to prepare the shots in the proper way, and many of the miners would do so, if given an incentive by an opportunity to earn more money by this extra work.

In no other states, do these conditions exist to any great extent except at a few places in the Oklahoma field. The only advantage that Arkansas has over Oklahoma is the less explosive nature of the coal dust, but recent experience has amply proved that even the Arkansas coal dust can be made to explode and kill the shot-firers, as already shown.

Loss of business caused by the law. The unfair treatment of the men who have spent their money developing the Arkansas coal mines, the impairment of the value of the fuel supply of the State and its increase in price, will tend to discourage the investment of more money in industrial enterprises in Arkansas. The

removal of the mine-run law will therefore be an effective aid in the efforts being made by the energetic commercial clubs to build up the manufacturing interests of the State.

If this mine-run law had not been passed, the Arkansas coal-field would have been able to supply the greater part of Arkansas with superior coal and the production would now have been 50 to 75 per cent greater than it is. Even at the lowest figure, this would mean that $2,000,000 more would be spent per year in Arkansas, instead of going to Illinois and Alabama. The larger part of this $2,000,000 would be paid for mine labor. This would increase by an equal amount the business of the Arkansas merchants, mechanics, and others who furnish the miners with supplies. They therefore suffer from the mine-run law to the extent of the loss of profits upon this business. The loss of business to the merchants to a certain extent reduces the volume of business handled by the railroads and the injury thus spreads as an endless chain throughout the State. We have previously pointed out that the operators and miners already in the State lose $362,500 of the $2,000,000 because of the increased number of days the mines are idle through loss of market. The loss to the merchants certainly equals $362,500; so the $2,000,000 can be added to the losses of the operators, miners, and consumers as an actual loss to the State without danger of counting the same loss twice. The direct loss to the coal industry will be tabulated as only $1,600,000.

Among the general injuries to the State is the annoyance and loss to those users of coal who have had to substitute other coal for the once superior Arkansas coal. They would burn the $2,000,000 worth of coal which is the measure of the loss of market caused by the mine-run law. The discomfort to the public at large due to the increased amount of smoke has already been noted. In addition, there would have been an advantage to the consumer due to a superior fuel and to the community on account of less smoky cities.

WASTE OF RESOURCES.

Loss due to shattering of the coal. The full value to the State would of course be received for this extra coal, which would be put to a good use, but the mine-run law causes a great permanent loss of our valuable coal. The heavy shooting causes an unknown but large percentage of the coal to fly all over the room. Much of this lands in inconvenient places, or upon the piles of draw slate found in the rooms and is never picked up by the miner because this is not so easy as to shoot more coal from the face of the room. The weight of coal thus lost is certainly equal to the 1 or 2 per cent in the slack which was formerly lost in being discarded by the miners. It is largely good lump coal of greater value than the slack. This loss can not be prevented by the management of the mine as long as the mine-run law gives the miner full authority to shoot the coal as he pleases.

Unmined areas of coal. There is another very great loss due to the necessity of abandoning many isolated patches of coal which can not be profitably mined because of the mine-run law. These patches include (1) those parts of the operating mines where the dirt band is of such a nature that the miner will now mix so much of it with the coal that the product can not be sold; (2) those places where the coal contains an unusual amount of bone or sulphur which the miner will not now sort out; (3) those parts where the coal is seamy or otherwise so faulty that greater care would be needed to get a profitable proportion of lump coal; (4) those parts where the roof will not stand the heavy shooting now customary; (5) those parts that are too thin to work with profit under present mine-law conditions. After the rest of the coal in the mine is worked out and the mine allowed to fill with water and cave in, it will be practically impossible ever to mine these patches, even when coal becomes scarce and expensive everywhere. An immediate repeal of the law and the resulting better dicipline would make it possible to save the greater part of this coal.

In the older days, it was customary to continue some entries through the most of these places looking for good coal beyond, but the operators can not now afford to do this and even some good coal is lost.

There are also places in the coal seams in which there is no considerable amount of coal but these are generally avoided in opening the mines. In portions of nearly all the mines, there are patches in which the coal is destroyed by movements of the rock, but these are generally quite small. All of the areas of unmined coal show upon the maps of the mines and make up about 15 per cent of the area of the coal developed in the mines now working. Many were seen in the mines by the writer, and the cause for the stopping of the entries was generally asked of the pit boss. As a result of this study, the writer estimates that the mine-run law causes a loss in the way of abandoned patches of coal of between 8 and 12 per cent of the entire output. What proportion of this loss is due to carelessness caused by the mine-run law, and what to the reduced profit on deficient coal, can be estimated only by an examination of every patch abandoned since 1905.

Additional mining waste. The mine-run law has reduced mining profits until the net value of the unmined coal is now so small that the operators can not afford to go to any extra expense to reduce the waste of coal due to cheap mining methods. The coal now wasted in mining is chiefly in the unmined parts of compound seams, in unmined pillars, and in the working places lost by squeezes or caves caused by cheap mining. A careful study of mining costs shows that, at an additional expense of 10c a ton, enough coal can be mined from these places to increase, by 15 per cent, the proportion of coal recovered from the areas which are now mined.

Such a resulting reduction in waste would be made possible by repealing the mine-run law, for this would increase the mining profits more than 10c a ton. The entire reduction of waste might not immediately follow, but a saving equal to at least 10 per cent of the coal now mined would follow the pulling of the more convenient pillars in the mines. This merely requires an increase in the recovery of the coal from the present 60 per cent to 66 per cent. This mining of the pillars would be started at once to supply any largely increased demand for Arkansas coal. Such an increase in the demand would follow the improvement in quality made possible by a repeal of the law. It would also lead to the opening of new mines so laid out that the waste of coal in them would be much less than it is in the older mines.

Cost of the waste. It is conservative to estimate, therefore, that the mine-run law causes at present a waste of coal in the areas which are mined equal to 10 per cent of the output of the coal. We have seen that it also prevents the mining of a large area of less perfect coal, and causes an additional loss equal to about 10 per cent of the output on this account. The total underground waste of the coal caused by this law is therefore equal to 20 per cent of the present output. In 1908, Arkansas produced 2,078,357 tons of coal with a mine value of $3,499,470 or practically $3,500,000. The loss in that year was therefore equivalent to 415,000 tons which should bring to the State $700,000. On the basis of a normal output of 2,500,000 tons annually, the loss would be 500,000 tons or about $840,000.

We have seen that the mine-run law is the cause of an excessive production of slack. In order to make some of this slack salable, 6,000 to 8,000 tons of it are lost every year at the slack washer. In spite of this washing, more slack is produced than can be sold and the mine-run law is directly responsible for the resulting waste of surplus slack. Much of the slack is unloaded in the most convenient places as upon the sides of railroad embankments or into the creeks from which places it can never be recovered. Even when the slack is stored on the prairie and gathered up during a long strike, there is a large loss in weight and in heating value as a result of its exposure to the weather. No exact figures as to these losses can be obtained but by the spring of 1910 some 39,000 tons of slack had been dumped upon the ground and the permanent loss must have been equivalent to another 6,000 tons of coal. Fig. 65 shows a small portion of a single one of these piles of surplus slack. The entire pile below the heavy line in the back ground is slack dragged away from the track by slip scrapers. There is a similar pile on the other side of the track. Other piles were formed at nearly all of the mining camps.

These obtrusive piles of slack constitute the most direct and obvious loss of coal caused by the mine-run law. Fig. 66 is a view of one of them taken in December, 1910, only three months after a coal famine caused by the long suspension of mining. It shows clearly how rapidly the mine-run law causes the accumulation of unsalable slack. The total waste of slack not gathered up is about 12,000 tons per annum. This figure is chiefly interesting as showing how negligible this waste is when compared to the great waste the mine-run law causes in the mines. The loss of slack is rapidly increasing. It now costs the operators $7,500 a year.

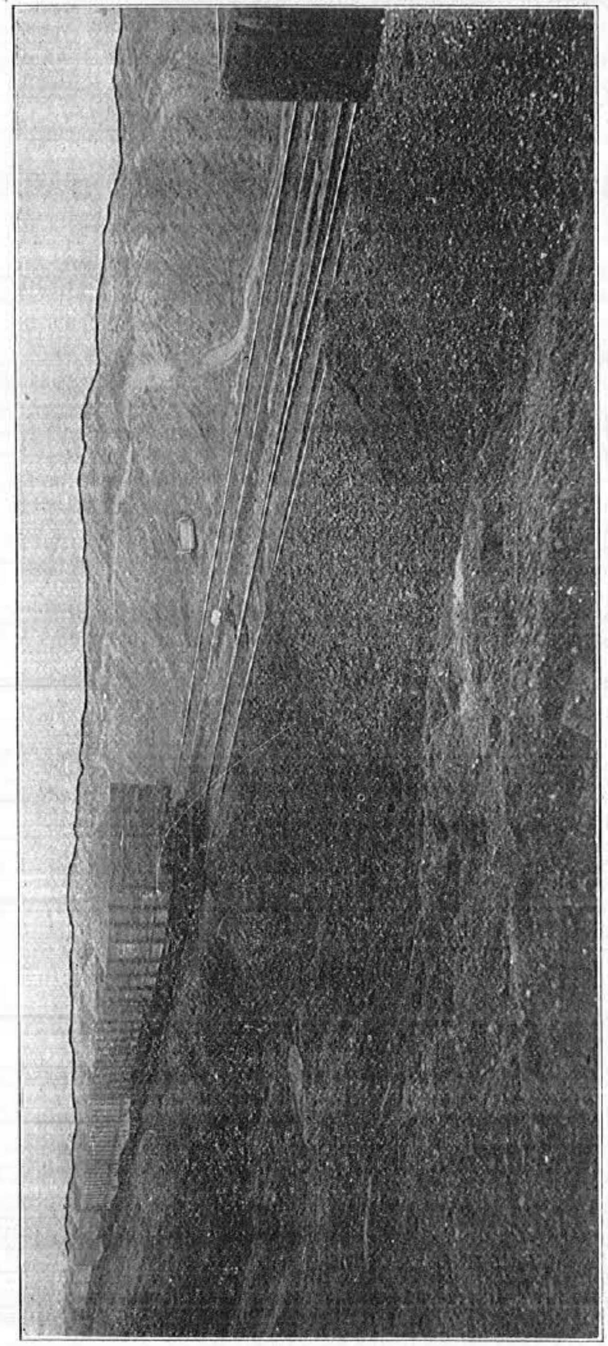

Fig. 65. A portion of the pile of slack dumped upon the ground at Doubleday during 1909.

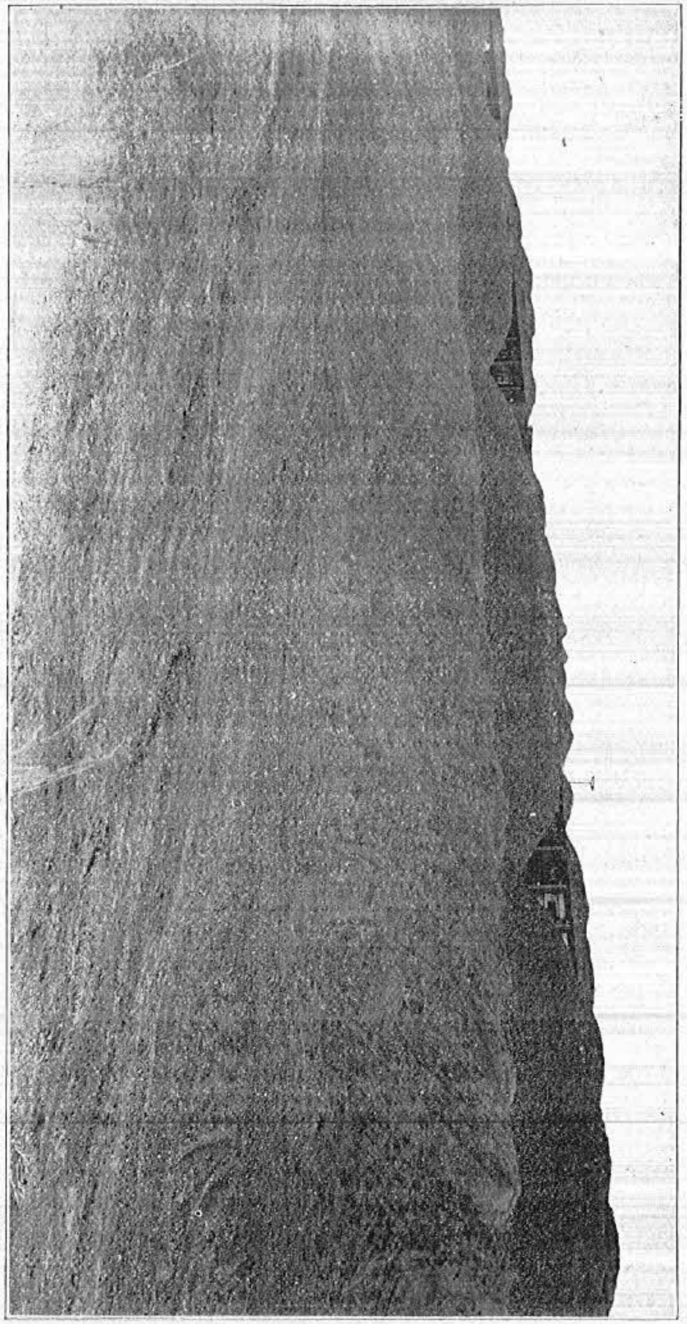

Fig. 66. Portion of a single pile of surplus slack accumulated between the resumption of mining in September, 1910, and December, 1910.

But besides the present money loss due to this wasted coal is the more serious matter of the future scarcity of coal. Arkansas has much less coal than has commonly been assumed, and there is probably not even a billion tons of true coal left in the State so far as we can now estimate it. It would seem better therefore if the laws were framed so as to reduce this waste of coal rather than to compel so great a waste as over 20 per cent of the annual output.

SUMMARY.

Explanation of the law. It was explained that the law requires the operators to pay just as much for slack coal as for lump coal, and that it definitely broke the contract between the miners and the operators. It really requires the operators to pay the miners full value for all slate and other impurities in the coal because it is wholly impracticable to reject bad car-loads. It was also explained that the law was passed through a misunderstanding of its real nature and importance.

Weakness of the arguments in favor of the law. It has been shown that there was no good reason for the passage of the mine-run law. The miner received full value for his labor under the screened-coal basis of payment, and was paid so much extra for the lump coal that he received the full equivalent of the price now paid including the slack.

We have also seen that the screen did not cheat the miners except in rare instances, and that the miners could easily require that it be maintained in good condition.

It was pointed out that there need be no difficulty in compensating the miners who work in places where lump coal could not be readily obtained.

Figures were presented to show that on the average not more than 1 or 2 per cent of coal was lost on account of the slack that was left in the mine, and this loss is not so great as the present loss, due to scattering the more valuable lump coal all over the room by the heavy shooting now practiced. Both of these losses can be avoided by paying the miner a less sum for the slack than for the lump coal, but this can only be done by screening the coal; and that is not permitted by the mine-run law.

Attention was called to the fact that most of the screen laws in other states are fair and it is contended that the existence of bad laws in Kansas and a few other states is no valid reason why Arkansas should be burdened with a similar law, which is especially injurious under the conditions existing in this State.

As was shown, the hope held out to the miners that the law would increase their earnings has in general proved a snare and delusion; and that, aside from the entry-men, who were already receiving the best pay, only a few of the miners have been able to earn more per day, while many have earned much less than formerly.

It is admitted that the law does reduce the labor of the miner. It is easier now to shoot out a dollar's worth of slack than it used to be to mine a dollar's worth of good coal; but it is emphatically claimed that this is no just reason for the passage of such an injurious law. We have seen that there is no other valid reason.

Injustice of the law. The law is unjust and wrong. The State was made the innocent agent in breaking a fair and just contract made in good faith.

The law directly attacks no other class of employers of labor than the coal operators and is therefore class legislation.

It benefits a small number of miners and injures many other miners. While it decreases the labor of some of the careless coal shooters, it greatly increases that of the firemen of the State, especially the locomotive crews. These are injustices to the men affected by this law.

Further, the law was intended to benefit the miners at the expense of the employers and is therefore unjust, especially since the operators have for years treated the miners fairly in the matter of weighing the coal.

Inferior quality of the coal. The passage of the law has caused a decrease in the quality of the coal and consequently a decrease in its value and a resultant loss of market. It has been shown that the amount of slack made by the miners has progressively increased from less than 30 per cent as an average in 1905 to 45 per cent or more in 1909 and that this increase is due almost entirely to more careless methods employed by the

miners. These changes in the work of mining were described at length to show what might be expected in the future.

It has further been shown that careless shooting has so shattered the lump coal that it can not be broken up for firing without making a great deal of slack; and that over three times as much slack as formerly is now made in shipping and handling clean lump coal.

Many figures were submitted showing the great increase in the amount of slate mixed with the coal, due to the heavy shooting encouraged by this law; also to the fact that the companies are compelled to pay the miners for slate, without an effective way of penalizing them for mixing slate with the coal. The increase already amounts to 5 per cent of the weight of the coal shipped, and the proportion of slate will continue to get larger. The government tables and the relative selling prices in competitve markets show that this addition of slate has already caused a decrease in the value of the coal of at least 35c. per ton.

It was shown that the great deterioration in the value of the Arkansas coal is in itself responsible for a loss of market in Louisiana, Texas, and eastern Arkansas, of between 50 per cent and 100 per cent of the present output; and that the repeal of the law would increase the running time of the mines now in operation by at least 11 per cent, and also lead to the opening of new mines.

Increased accidents to the miners due to changes in mining methods. We have seen that under the mine-run law, the work of the miners is made easier than formerly. This advantage is, however, more than offset by the large increase in the number that are killed or injured each year as a result of the law.

As early as 1908,* the mine-run law was directly responsible for 40 per cent of the fatal accidents to coal miners. Incomplete statistics for 1909 show that the law was responsible for the death of seven of our miners during that year alone. This great increase in mortality has been the direct result of a change in coal mining methods induced by the operation of the law.

*Figures just obtained show that it was responsible for 55% of the total accidents of 1910.

Exact figures prove that the miners are now using 12 to 15 per cent more powder per ton of coal mined than they did in 1905 and that this is a progressive change. Data from Mine No. 2 at Denning proved that this change is wholly due to the mine-run law.

It was explained that the miners are now putting in fewer and wider shots and using longer augers than formerly. As a result, the severity of the blasting has increased even more rapidly than the consumption of powder per ton of coal produced.

The severe effect that this has upon the roof beneath which the miners work was proved by exact figures from cost records. These show that nearly four times as much rock now falls from the roof as formerly. Statistics of the fatal accidents to miners show that up to 1908 52.5 per cent of them were caused by falls of roof. The increased amount of rock which falls from the roof is certainly responsible for half of the lives lost in this manner. In other words, 26.25 per cent of the fatal accidents in 1908 were the result of the increased danger from the roof which was caused by the careless blasts. This in turn was the result of the mine-run law.

The extra danger the heavy blasting causes to the shot-firers is obvious, and the extra danger caused by the mine-run law is responsible for the deaths of three-fourths of the shot-firers now killed in the mines. Of the fatal accidents to miners, 17.5 per cent were accidents to shot-firers. Three-fourths of these accidents were 13.12 per cent of the total number, so by 1908 the mine-run law caused 13.12 per cent of the fatal accidents in the mines by deaths to shot-firers.

It was seen that a total of nearly 39.37 per cent of the fatal accidents were due to the mine-run law even as soon after its enactment as 1908. The total number of accidents per 100,000 tons of coal produced has shown an increase of even more than 40 per cent of the number in 1905. This again shows the effect of the law. In 1910 four miners were killed in firing shots and five were killed by falling roof. The mine-run law therefore caused the death of six of our miners in the six and one-half months' run of 1910. Increasing numbers of them will be killed each succeeding year until the law is repealed.

Other disadvantages to the miners. The law decreases the earnings of the miners. The loss in earnings to some of the miners as a result of the lower value of the coal they mine, amounts to $75,000 per annum. The men can not petition for the repeal of the law because the constitution of their Union prohibits this. This loss to the miners is but partly offset by the increased daily earnings of other miners who are able to load out a greater quantity of the poor coal than they did of the good coal.

The reduced running time of the mines has caused the miners now in the State a loss of about $300,000. Many of them are already beginning to think the permission to load out slack and slate is not worth this much to them as a body.

Several mines are already definitely shut down as a result of the mine-run law. This makes it more difficult for the miners to secure places in which to work. The law has also made it more difficult for the miners to obtain favors from the operators.

A result of the law is a large loss of skill on the part of the miners. In the long run, the miners will suffer still more as the law reduces the work to the level of mere rough labor, when the Union will fall to pieces and the relative wages of the miners are sure to decrease.

Financial cost to the producers and the consumers of coal. To a certain extent, the increased costs of mining are made up by increased cost of coal to the consumers, so no attempt is made to separate the losses of the operators and the consumers. If they are studied together, duplication of losses due to the mine-run law is avoided. The operators have had to carry most of the increased cost of mining and the loss due to the increased production of slack. Some of them have already become bankrupt while others have had to close their mines. On the other hand, the consumers bear the chief burden of a decrease in the quality of the coal which has followed the passage of the mine-run law. As the operators successively shut down their mines, the cost of coal to the nearby consumers will increase. This can only be prevented by a repeal of the mine-run law. The losses are computed upon the basis of a normal output of 2,500,000 tons of coal per annum, which is much less than the full capacity of the mines now opened, and but little more than the output of 1909. For convenience all known losses are here tabulated.

Annual Cost of Mine-Run Law to Operators and Consumers.

Increased cost of mining coal.	
Increase in fixed expenses due to shorter running time	$62,500
Increased cost of draw slate	50,000
Cost of picking out some of the slate	18,000
Maintenance of idle mines	50,000
Decreased value of the output.	
Decrease in value due to the extra 15 per cent of the coal which is shot into slack	430,000
Decrease in value of the coal on account of shattering of the lumps and increase in slate (at 35c. a ton)	875,000
Cost of freight upon the extra amount of slate in the coal	185,000
Sum	$1,670,500

There is in addition the cost of washing slack to prevent the loss due to wasted slack from becoming much greater than it is; also the annoyance and worry which the careless method of mining coal and the extra accidents cause the operators.

Besides the direct financial loss to the consumers of the coal, the increased amount of clinkers it produces in burning causes a hardship to all the firemen of the State, and the extra smoke is a discomfort to the general public.

The State itself must be counted as a considerable consumer of coal and already loses $4,500 annually because of the poor quality resulting from the effect of the mine-run law.

Of the losses caused to the operators and consumers, the miners get only about $205,000 a year, which is paid to them for handling draw slate and for mining slate or picking it out of the coal after the companies have paid for it. We have seen elsewhere that their loss on account of idle time alone is much greater than this, so the great loss to the operators causes no permanent gain whatever to the miners as a whole.

The total annual cost of the mine-run law to the operators and consumers is in round numbers $1,500,000 which means that if the law were repealed, it would be possible to supply coal of

such a quality and price to the consumers that they would save the equivalent of 60c. a ton without additional cost to the producers. If the consumers paid the same price as at present, there would be a saving of 7½c. a ton in freight and the operators would get 52½c. a ton more. The most probable distribution of the advantage of a return to the old methods of mining would be to give the miner an increase in pay amounting to 5c. per ton; to increase the profit of the operator by 7½c. per ton; to save the consumer 7½c. in freight and 5c. in price for coal; and to furnish him with coal worth in heating value 35c. a ton more than that he now buys.

It should be noted that the younger miners do not know how to mine coal in the old way, while the older ones have lost some of their skill. These factors will delay the benefit which we have outlined above as a result of the repeal of the mine-run law. Still the longer the law remains in force, the longer it will take to recover from its effects.

Injury to the State at large. The final objection to the law is its injury to the general welfare of the State.

It has been shown that Arkansas is injured above all the other states by such a law on account of the restricted demand for slack coal, and because of the exceptional physical character of our coal-beds.

It has been pointed out that the law retards the development of our great resources, because it shows a spirit of unfairness toward the investors and lessens the advantage which should result from a superior fuel supply.

Through loss of market for the coal, it lessens the direct money income to the State by at least $2,000,000 per year. There is no need to enlarge upon the effect which this would have upon all lines of business in the coal region.

It has been shown that the mine-run law is the cause of a dead waste of over $848,000 worth of coal annually, and coal is one of our most vital natural resources.

In conclusion, we repeat the list of direct money losses caused to the State each year by this absurd law.

The loss to the present producers and consumers of coal	$1,670,000
The net* loss to the mine workers now in the State.	100,000
Additional loss to the coal industry alone due to loss of market	1,600,000
Absolute waste of our resources	850,000
Total	$4,220,000

The astounding sum of money includes no duplication and does not consider the great loss to the railroads, merchants, and other interests incident to the decline of the coal-mining industry.

In addition to the money loss, this law already costs the lives of seven of our miners every year, sacrificed to the greater ease of shooting out the coal, instead of mining it.

This is surely sufficient to make it clear that the repeal of the law prohibiting the screening of the miners' coal before weighing it, is the most important service to the State that the Legislature now has an opportunity to perform.

*The increased receipts of the miners due to the mine-run law include $50,000 per year for handling draw slate, $18,000 for picking out the extra slate, and $137,000 for mining the slate which the law compels the operators to pay for. Some of the miners earn more money per day which may amount to $25,000 per year. The total gain is about $280,000. The miners as a body lose $300,000 on account of increased idleness and $75,000 on account of the decreased daily earnings of many of them. The net loss is, therefore, $95,000 besides the hardship of waiting for places and of securing work.

CHAPTER VIII.

GENERAL CONDITION OF THE MINING INDUSTRY

MARKETS FOR COAL.

Lump coal. Except in the well developed industrial centers of the United States, the railroads are the chief consumers of coal. This is especially true in Arkansas, because the market area is so well supplied with cheap fire-wood and has such a mild climate that the household trade in coal is light. Also, there is little industrial development. On the other hand, several main line railroads with heavy through traffic are dependent upon the Arkansas and Oklahoma coal for fuel, and this coal when properly mined is unusually valuable as an efficient and nearly smokeless locomotive fuel. The railroads, therefore, use almost all of the lump coal produced in the State, although quite a percentage of some of the harder coal from the thin seams is sold at good prices for domestic use, in the larger cities of Arkansas and neighboring states. Under special conditions, some coal has been shipped as far as Canada, and one lot was sent to San Francisco for use in testing a western-built battleship.

The Arkansas semi-anthracite coal of the larger sizes is used entirely for domestic heating purposes under the name of 'Arkansas anthracite' and is in but little demand during the summer. It is shipped regularly as far as Lincoln and Omaha, Nebraska, and all the nearer northern cities it competes with Pennsylvania anthracite with an advantage in freight.

Slack. The ordinary slack coal is used in industrial plants, and much of it must be shipped a long distance to find a market. Almost all of the slack of the semi-anthracite coal of Arkansas is used as a reducing material in the retorts of the zinc smelters. A little of the very small sizes of coal is used for steam at the mines and elsewhere. A very close separation of the different sizes in the finer slack will be needed before it can be burned under boilers, and as yet no boiler furnaces have been constructed for its use, except at a single one of the mines.

Mine-run coal. Many industrial plants, and the heating plants of the larger buildings use the higher priced mine-run coal instead of slack for raising steam. This is largely on account of its greater freedom from slate and the less annoyance from clinkers. It also burns more freely with poor draft and so raises the capacity of the furnaces. During the last few years there has been an increasing use of mine-run coal instead of lump coal in domestic heating plants. This is due to the increase in price of lump coal, which has followed the passage of the mine-run law, and to the fact that the lump coal has been so shattered that a large part of it breaks into slack before it reaches the consumers' bins. Much of the rest of it falls to pieces soon afterwards. While more expensive it has therefore but little advantage over mine-run coal.

The unity of the Arkansas and Oklahoma coalfields. Many companies own mines in both Arkansas and Oklahoma, since the coals are either generally similar or have special advantages that determine which of the two coals is best for any particular use. The two states, therefore, constitute a single competitive district as far as markets are concerned. The competition between the different operators is, however, very severe. This has led to the bankruptcy of many of the weaker companies, and prevents their coöperation toward improving the mining methods and the quality of the product.

Coöperative selling. Competition used to be especially destructive at Spadra, and was one of the causes which led to the granting of even some of the unreasonable demands of the Spadra miners. The conditions have recently been greatly improved by the organization of the so-called 'selling agency.' This is incorporated under the name of the Clarksville and Spadra Coal Co. Some of the stock in this company is owned by the Clarksville bankers and merchants, but most of it is owned by the coal operators. The majority of the operators in the district, whether interested in the company or not, have contracted to sell their entire output to it. The agency sells as much coal as possible in competition with the independent companies, and other coal fields. It buys this coal at a little below the selling price from all of the contracting operators, in proportion to the actual capacity of their mines. This proportion is determined by buying the coal from them in such an amount that

each mine can operate at full capacity the same number of days per month, as nearly as may be.

Besides securing to all the companies a uniform price for the coal, this agency has been a great advantage in securing a market for all sizes of coal. Formerly one company would have on hand an excess of large size grate coal while unable to fill orders for nut coal. At the same time another company might have a big demand for grate coal and no market for nut coal. The selling agency has adjusted the prices of the different sizes of coal in such a way that the average demand is in proportion to the output of each size. This has increased the total sale. The agency also solves the question of a fair distribution of railroad cars in time of shortage, and in this way is a great help to the railroad, the officials of which merely ask the agency where to send the cars. By having a large supply of coal, the agency can take larger contracts than individuals, and since the coal comes from several mines, the supply is less liable to be cut off by petty strikes, not authorized by the leaders of the Union.

Coöperative selling is of course cheaper than individual selling, and the small fee charged the operators leaves a saving, although it enables the selling company to distribute a small profit to its stockholders. The agency has been very ably managed. The individual operators do not interfere in the management, although they give it what aid they can in developing new markets, and what advice it asks for. Since some of the stronger operators have not contracted their output to the agency, it is in no sense a monoply and the consumer does not suffer.

A similar organization would be quite advantageous to the smaller operators in the soft coal district of this State. The slack from the thinner single bench coal seams often commands a few cents per ton more than the average price of slack, on account of its greater freedom from slate. The small operators, however, have difficulty in securing large contracts, because of the difficulty of guaranteeing a sufficient supply in case of a sudden increase in the demand. Coöperative selling of the slack would, therefore, benefit the consumers as well as the small operators. The small operators have little difficulty in selling their lump coal and the larger operators need less aid in disposing of their slack.

LOSS OF MARKET.

During the last two or three years, the coal industry has been depressed by a loss of market in addition to the high cost of mining. Part of the loss of market is temporary and due to the industrial depression of the whole country; but in addition to this result of hard times, the once great domestic demand for the high grade Arkansas coal in Kansas City has recently been destroyed by the introduction of natural gas. Natural gas has also practicaly destroyed the entire market at Fort Smith, Texarkana, and a few other smaller places.

The great over-production in petroleum in Texas entirely prevented the sale of steam coal in Texas during 1904 and 1905, but this competition is not now so troublesome. The fuel oil production in Oklahoma keeps down the price of steam coal in that region where the Oklahoma and Arkansas coal is not in competition with coal from other districts.

The market for Arkansas coal is still further restricted by unfair freight rates. The State of Oklahoma has set the freight rate upon coal at a very low figure. Since this does not apply to interstate business, the Arkansas coal is severely handicapped in the western Oklahoma markets, where most of the coal used in that state is sold. Some years ago the Arkansas freight rates upon coal were fixed by the Railroad Commission at about three-fourths of the present rates. These rates did not apply to Illinois or Alabama coal and gave the Arkansas operators a big advantage in the eastern and southern parts of the State. The courts declared this rate confiscatory. Such special freight rates do not seem fair to the other commonwealths and are not to be recommended even if feasible. A low rate, independent of state lines, is preferable. As the rates are now adjusted, however, the Illinois coal is unjustly favored, since the price per ton-mile for hauling Illionis coal seems to be less than that charged against Arkansas coal, by an amount in excess of that justified by the longer haul.

Along with the loss of market for slack coal, due to fuel oil competition, came the increasing production of slack as a result of the mine-run law. This raised the price of screened lump to such a figure that the railroads were forced to take coal containing all of the slack in excess of 25 per cent of its weight

as mined. This, together with the increased amount of slate, and the shattering of the lump coal, has largely destroyed the superiority of the Arkansas coal as a locomotive fuel. Therefore much of this main market has now been lost to competing coal and fuel oil.

The more careless mining of the coal, together with the greater expense of mining, has also caused a loss of a great deal of the domestic business in competitive coal markets. The market for the lump coal of the semi-anthracite mines is still good, but the output of these mines is limited by the amount of slack required by the zinc smelters.

METHODS OF DEVELOPING THE MARKET.

The competition of both oil and gas, especially the latter, will rapidly decrease, owing to the increasing cost of these fuels and the development of new uses for them, unless new fields are discovered. In the meantime, however, it may necessary to make still greater concessions in the price of coal.

Briquetting. The slack coal can be very readily briquetted or made into lumps by the use of pitch binder, since an unusually small percentage of binder is required for the Arkansas coal as compared with other coals. In some ways the briquets are superior to lump coal, but with us, their quality is injured by the great amount of fine slate in most of the Arkansas slack coal. Besides, the American public has not yet learned to appreciate briquets. Therefore, they must be sold for less than the price of lump coal. Also, the cost of the pitch for binding material is high in Arkansas. For these reasons, there is generally not enough margin between the sale value of slack and briquets to pay for their manaufacture in this State.

The best commercial plan for making briquets seems to be to locate the factory in some large city* where binder is cheap and where the briquets can be sold without reshipment. This would realize the full advantage of the lower freight rate upon slack coal as compared with the rate upon lump coal or upon briquets, and would also save wear upon the briquets. The plant could not be operated steadily during the early summer

*Information has been received that such a plant has recently been erected at Kansas City, Mo. The commercial result and mechanical details are unknown.

because of lack of market, but that is the season when there is the least surplus of slack.

The greatest difference in value between slack and lump coal exists in the case of the semi-anthracite coal from Spadra and Russellville. This is mined by so many small companies that no one of them has a sufficient amount of slack to justify the erection of a briquetting plant. It would be possible, however, for an independent briquetting company at a large city, such as St. Louis, to buy slack from all of the mines on long time contracts. The most valuable size of the semi-anthracite coal is No. 4, which is sold for use in magazine stoves or base burners. Briquets so small can not be profitably made, but the smaller commercial sizes of briquets of this coal are admirable for furnace use. An addition of Spadra or Russellville slack will greatly improve briquets made from the more volatile or smoky coals. A complete commercial investigation of the briquetting possibilities at a number of large cities seems advisable, but must be done by a coal salesman. Afterwards, the necessary scientific data can be secured. In the meantime, the cost of briquets of Arkansas coal can be taken as about $1.00 per ton more than the price of the slack from which they are made, provided that the plant is large and well designed and that good pitch can be had for about $12.00 per ton. Some allowance must be made for the fact that if the mines are relieved of a sufficient amount of slack to enable them to supply the railroads with clean lump, the market value of the slack must be increased. Since both of these results will have a great benefit upon the coal-mining industry, the briquetting should be done by the operators.

Improvement in quality. The most obvious method of regaining the lost market is to improve the quality of the coal. This can be done by the repeal of the disastrous mine-run law, the effects of which were shown in the last chapter, and by restoring reasonable control of the mining methods to the owners of the mines. This was the last thing contended for by the operators during the long strike from April 1 to nearly October 1, 1910. It prolonged the strike for three months, and the operators were finally forced to agree even to hire the men in the order that their names appear upon a list of applicants kept

by the Union. There seems little hope, therefore, that the former discipline of the mine crews can be re-established until after a still greater depression and the closing of more mines.

Mining machines. Even under the best of discipline, the old style mining of the coal is impossible on account of the loss of skill on the part of the miners; but the percentage of slack can be somewhat reduced and the mixing in of slate can be prevented. Proper control of the mine crews will also permit the introduction of coal-mining machines. At most of the mines of the State, the physical conditions are admirably suited for the use of mining machines of one type or another. As compared with shooting off the solid, mining machines do not save labor, and for the same daily wages to the men, they will increase the cost of the coal by about the cost of the maintenance of the machines and the power. In a few cases, an increased percentage of recovery of the coal will pay a portion of the expense by reducing the average cost of driving the entries, but in most cases the profit from the introduction of the machines would come chiefly from the improved quality of the coal. When properly undermined, as by machines, the coal can be obtained in good solid lumps with very little slack, except the small amount made by the machines themselves in those few cases in which the cutting must be made in the coal and not in the soft material under it. In any case, practically all of the slate can be kept out of the coal which has been undermined.

The nearly universal experience in other coalfields is that these improvements in the quality of the output will show a profit in favor of mining machines even though the wage scales for mining with machines is no less than for shooting off the solid, and the operators must bear the entire expense of the maintenance of the machine plant. This is only the case if the proper type of machines has been selected and the plant is well managed. The physical conditions in many of the Arkansas mines are exceptionally favorable for the use of mining machines. In addition, the softness of the coal and the poor demand for slack, make the commercial results of shooting the coal off the solid especially disastrous at most of the coal-mining districts of Arkansas. It is quite certain that mining machines would be profitable at many of the Arkansas mines if given a fair trial.

The machines would be of further advantage in curtailing the expense of handling dirt and draw slate, since the roof would not be so badly shattered and props would not be knocked out, if the present heavy blasting were done away with. It is agreed by all persons who have investigated the subject that the decrease in the number of accidents, caused by shooting the coal and by falls of the roof, would much more than offset the few accidents caused by the machines themselves.

The only reasons, therefore, why the machines are not used almost everywhere, are lack of capital and experience, and the opposition of the men. This opposition is partly due to the prejudice of the less intelligent workmen against machinery of all sorts that they themselves can not operate. Where the loaders are paid upon a lump-coal basis they welcome the machines, because of the large proportion of good lumps in machine-mined coal. But where they are paid upon the mine-run basis, they often find it no more work to shoot out the coal and load the slack and shattered lump, than to break up and load the firm masses of coal, obtained by merely rolling out the coal with powder after it has been undermined. This is especially true where the coal is soft and easily drilled for blasting. On a mine-run basis, therefore, mining the coal by machines is an advantage to the loader chiefly in reducing the amount of blasting. This lessens the annoyance of replacing knocked-out props and makes it unnecessary to set the props so carefully, since they are not subject to heavy blows. It also reduces the amount of draw slate which must be handled, and makes the work much safer. The chief money advantage to the loader is the saving of about 80 per cent of the powder ordinarily used. This saving is 5c. to 16c. per ton of coal produced, but is seldom sufficient to equal the cost of undermining the coal.

It follows, therefore, that the mine-run basis of payment is largely responsible for the opposition of the miners to the mining machines. But it is chiefly this basis of payment that makes the adoption of machines necessary to maintain the quality of the coal.

The machines serve to definitely divide the mine crew into two classes, the few skilled men who can operate the machines, and the less skilled laborers who timber the rooms and blast and load the coal. It, however, requires as much skill to shoot and load the

coal which has been properly mined as it does to shoot it off the solid with an excessive amount of powder. Therefore, the machines have no bad effect upon the average skill of the miner. From the point of view of the miners, machines are objectionable, since they develop a class of highly skilled machine runners who may previously have been machinests instead of miners, and who are less likely to go out on long strikes in the interest of the unskilled laborers.

Even though the men oppose the machines, it must be said that the leaders of the Union recognize the great increase in the prosperity of the coal-mining industry which has in certain districts followed the introduction of mining machines. To their great credit, they therefore, do not oppose machines, even though these increase the difficulty of holding the men together. This acceptance of machines was explicitly stated in decision No. 21 of the arbitrators, selected to settle disputes between the miners and operators under the last agreement. This decision was rendered at Pittsburg, Kansas, July 16, 1909, and was signed by Mr. James Elliott, President of the Southwestern Interstate Coal Operators' Association, and by Mr. T. L. Lewis, President of the United Mine Workers of America. It contains the following unqualified statements:

"It is not in harmony with the object and spirit of the joint movement to prevent the installing of machines or labor-saving equipment in coal mines, neither is it in harmony with the principles of the United Mine Workers as we understand them to prevent the use of labor-saving appliances in or around the mines.

"The joint agreement for District 14 [also for District 21] recognizes the right to place machines in the mines, as there is a wage scale provided."

It should be noted that the word *machines* meaning machines for undermining the coal is distinct from labor-saving equipment, although both are allowed.

This decision is, however, not fully accepted by the men, and many misstatements to the effect that mining machines are devices to beat the miners out of their jobs are even printed in the newspapers. For this reason, a brief statement of the influence of labor-saving machinery upon the working men may be advisable.

Apparently most of the writers upon economic subjects take for granted the advisibility of labor-saving machinery, and merely answer the common objections to them. For this reason, no concise discussion of the subject by a recognized authority is available. Most of the economists who have studied the problem seem to agree that workmen, highly skilled in a special trade, suffer more or less when they are replaced by epoch making machines, which do the same amount of work with much less labor or with labor of much inferior grade. But labor as a whole does not suffer, because the decrease in the cost of production generally results in such a greatly increased output that more men are employed than before, which is a great advantage to the large class of less efficient working men; and because all working men share with the entire community the great benefit resulting from the cheapening of the product.

"It is a recognized economic axiom that the wages of labor are paid out of the product of industry, and in so far as the introduction of machinery increases the product of industry, it means higher wages and better labor conditions." *(Ely, Seligman, Bullock, Hadley.)*

When the displaced labor is not specialized, the hardship of finding work elsewhere is very much reduced, and the cheapened product or the increased development of the industry more than compensate for the temporary loss of work. When the saving in labor is but little, and men experienced in the trade are required to operate the machines or do other parts of the work, and especially when the labor is strongly organized, the most common effect of the introduction of machinery is merely to increase the output of the product, with no change in the wages. Often there is a decrease in the number of hours in a day's work or a reduction in the labor performed in a day without a decrease in the daily pay of each man. These are the conditions in regard to labor in the coal mines of Arkansas. It may be well to repeat that coal-mining machines do not cause a reduction in the number of men employed in producing each ton of coal. There are generally the same number of men in the rooms and several machine crews in addition, together with the electricians and machinists needed to maintain the general plant. This extra labor is about offset by an increased output per room. They are slack-saving machines rather than labor-saving machines.

In order to expand the market for coal, and on account of the recent change in the methods used by the miners, mining machines are becoming almost as necessary as steam hoists.

These have displaced a great many men formerly in charge of small horse-driven hoists. Indeed, at one time, the hoisting of coal in England gave employment to large numbers of women, who were themselves displaced by the horse-driven hoists. These poor creatures received only 6c. per day of 14 hours, and they carried the coal on their backs up ladders in the shafts, with no machinery except the baskets. No one would now think of giving the work back to them. On account of the great advantage to the industry, there is now no objection to the installation of steam hoists. In the same way, the use of mining machines is inevitable. If they are not accepted by the present coal miners, they will be operated after repeated contests with the companies, by crews recruited from the mechanical trades.

Therefore, even if the machines did really displace a few of the miners temporarily, there should be no opposition to them. Indeed, the miners, in their own interest, should do all they can to encourage the installation of machines, because the resulting increase in the output of the coal would require large additions to the present total force of miners, and so make it easier for them to secure steady work. This increase in the production of the Arkansas coal would certainly follow the improved quality of properly mined coal, as compared with coal shot off the solid. This would give the Arkansas coal full command of many of the present competitive markets. The general public would be benefited by the increased business and also by the better quality of the fuel.

It may be of interest to note that there is little or no opposition among the men to the introduction of the newer types of labor-saving machinery, such as electric motors and other mechanical haulage systems, which displace many mules and drivers. This lack of opposition may be due to the fact that such machinery is known to be recessary to permit the continued working of the mine, after the coal near the shaft is exhausted; or to the fact that the driving of a mule is less specialized work, and the drivers have little difficulty in securing equally satisfactory work elsewhere. The drivers have thus become used to the substitution of power haulage for mules, while the diggers are still afraid of the results of mining machines. It may also be that it is so easy to replace the drivers bv new men that they do not dare to object as a body. At any rate, all opposition to machinery at the coal mines is directed against the machines for undermining the coal to accomplish the work formerly done by pick miners, but now nearly universally neglected.

THE HIGH COST OF MINING.

Dipping coal seams. Except in the State of Washington where the coal seams are much folded and broken up, the cost of mining in the Arkansas-Oklahoma field is greater than in any other important coalfield. This is partly due to the fact that the coal seams are not flat so that the usual, nearly level, twin-entries cannot be used. This fact nearly doubles the cost of entry yardage. The expense of this doubling of yardage is relatively higher than in other fields on account of the unbalanced scale of prices of labor, and the unusual cost of driving entries in Arkansas. The dip of the seams increases the cost of haulage since the entries are rarely maintained at the right grade, and are more crooked than in flat seams. Also, it largely prevents the use of electric motors for hauling coal underground, because of the difficulty of hauling from more than one entry with the same motor. These factors increase the cost of underground transportation.

High cost of labor. All the other physical conditions are at least as favorable as the average. The main cause of the high cost of mining the coal is the high scale of wages paid to the miners, per unit of work. The wages of both the day-men and the contract miners at Spadra are about twice those in the Pennsylvania anthracite region. As the cost of supplies is not greatly different in the two regions, the operating costs at Spadra should be a little less than twice those in Pennsylavnia. They are in fact quite a little more than twice as great where the conditions of the mines are similar. This excess over the amount expected is due to the petty contentions of the men, and the fewer number of days per year the mines are in operation.

About 15 per cent* of the wages paid represents increases gained by the Union and may be considered partly artificial.

*The formal increase was 12½ per cent in most piece work, which means 14 per cent increase in net earnings as explained on p. 168. The Union also secured a reduction in the hours of day-men from 10 to 8 hours per day. In addition, many extra payments have been secured, so the average result is about 15 per cent increase in wage costs.

Nearly one-third of this goes to maintain the Union. Another large proportion of the high wages was granted even before the organization of the Union. At this time, coal mining was a comparatively new industry in an old-settled community, where most of the labor was profitably employed in other occupations, chiefly farming. There was no considerable amount of negro labor available, and at first no cheap European labor. Therefore, it was necessary to pay high wages to attract skilled miners from the other states fast enough to supply the increasing demand of a rapidly growing enterprise. These prices have been maintained by the miners even during the recent times of depression.*

A further reason for the high wages is the less healthful climate and the general unsanitary and disagreeable conditions of the mining camps. These conditions were discussed in Chapter III, and need not be repeated here. There seems to be no compensation in the way of a reduced cost of living in Arkansas except in the matter of less need for warm clothing and for winter fuel than in colder regions. The standard of living among the miners has been greatly raised during the last decade, and with this comes a demand for higher wages.

In common with most other coal miners, those in Arkansas suffer from the summer idleness. This is especially severe in the Spadra district because that coal is practically all used for household heating. The domestic consumption of the soft coal is such a small fraction of the output, that the conditions for steady mining should be better than in any of the states supplying a heavy domestic trade. Figures in the government reports, however, seem to show that they are as bad as in any other part of the United States. This is true even in Sebastian County where the least proportion of domestic coal is produced. It is believed that this is due to the great ease of opening up new mines and the small capital required. As a result, the mines are not operated steadily even in winter time. The shortage of cars may also be greater than in other states.

Suspensions of mining. Another hardship to the industry is caused by the biennial suspensions during which the miners

*The Union consented to a reduction in 1904 due to the reduction in demand for coal which followed the temporary, but great, overproduction of fuel oil in Texas.

and operators dispute over a new wage contract. This is entirely due to the Union, and many of the miners are disgusted with it as a result. Efforts are, therefore, being made by the Union leaders to avoid this. It is hoped that they will be successful. If not, the Union is likely to go to pieces, in which case the miners probably would suffer on account of the ill feeling which has been caused by labor disputes.

COST OF MINING COAL.

It is frequently claimed that the coal-mining business is very profitable, since the miner gets 62c. or 87½c. a ton for mining coal, which is sold at an average price of $1.68 per ton. The price paid for shooting and loading coal is, however, but one of the items of the cost of the coal. Cost data were freely furnished by all the companies but two. This was with the understanding that costs at specific mines would not be published. In very few cases was information obtained as to the cost of administration; or cost of selling the coal; or interest on the investment and depreciation of the plant; because these had no technical interest, and in many cases were unknown to the bookkeepers. At many of the smaller mines, no detailed costs are kept and the total costs were not copied. Even where operating costs are kept in detail, the subdivision is different at the mines of different companies. For this reason, the general figures of costs can be divided only into a few groups.

There are two important classes of mines as far as costs go, those paying the standard price of 62c. per ton for 'mining' and those paying more. The first class includes practically all of the mines of Sebastian, Franklin, and Scott counties, where the coal is soft and used largely for industrial purposes. The second class includes the much smaller production from the districts supplying coal chiefly to the household trade.

COSTS OF MINING COAL IN SEBASTIAN COUNTY.

Cost of narrow work in Sebastian County. In Sebastian County* and similar fields, the shooting out and loading of the coal, not including the firing of the shots, costs 62c. per ton

*Sebastian County is used throughout this discussion to include similar mines in other counties.

when the coal is not 'deficient.' In addition, the shooters are paid extra for all narrow work and brushing, for deficient coal, and for bad roof. This 'dead work' costs from 6c. to 30c. per ton of coal, depending upon the agreed scale of payment and the physical conditions of the mine. The cost is generally between 8c. per ton, the minimum, for the high coal, and 25c. per ton, the maximum, for the low coal, if the seams have the common dip and the ordinary good roof.

The cost of the entries and air-courses, and the crosscuts between them, varies from 3c. to 18c. per ton of coal produced, and is generally from 4c. to 14c. It may reach 20c. when the main slope and air-courses are being pushed and the coal is low. The cost of brushing is nothing in the mines where the coal is everywhere more than 4 ft. 6 in. thick, and may reach 7c. per ton where the coal is only the limiting 2 ft. 10 in. thick, below which more than 62c. per ton must be paid for 'mining.' The cost of room-necks varies from 0.2c. to 0.6c. and is generally between 0.25c. and 0.4c.

Aside from differences in the scale of wages, these costs depend chiefly upon the thickness of the coal seams. If the entries were all the same distance apart in the different mines, the amount of coal produced from a hundred yards of entry would vary according to the thickness of the coal. If then the cost per yard of driving the entries did not change, the items of cost just given would increase in proportion to the decrease in the hight of the coal, being twice as much in a 3-foot seam as in a 6-foot seam. The cost of opening up 100 yards of entry in the low coal is, however, greater than in the high coal, because the cost of brushing per yard increases rapidly as the coal seam gets thinner. In the low coal, the rooms must also be shorter than in high coal and more entries must, therefore, be driven in the same area. For these reasons, the cost per ton of coal of opening up the entries and rooms increases quite a little more rapidly than the hight of the coal decreases.

The cost of the break-throughs between the rooms varies with the width of the pillars as well as with the hight of the coal. This width is determined by the strength of the coal and its depth below the surface, but chiefly by the policy of the management of the mine. The cost of the break-throughs ranges from 0.3c. to 3c. per ton.

Cost of deficient coal. There is a very little deficient coal n these counties, but the cost which is often nothing, may amount o 6c. per ton; from ½c. to 1c. per ton is common. The cost f draw slate depends entirely upon the character of the roof. n a few mines it is nothing, and at one of those where it is ept separate the cost is as much as 7c. per ton. It is genrally from ½c. to 3½c. per ton of coal produced. This cost rill increase as the miners use shots that are fewer and heavier ian those now used, which are already twice as heavy as they rere some years ago.

Cost of bottom labor in Sebastian County. Besides the costs or diggers, there is a large expense for day-men. This varies om 25c. to 40c. per ton of coal and is commonly 30c. to 37c. er ton. In many cases, this expense is merely divided into ie cost of bottom labor and the cost of top labor. At a few ines, the cost of supplies needed for the different kinds of ork is very properly included with the cost of labor. The ost of bottom labor, as far as known separately, ranges from ‌c. to 27c. per ton, and may be taken as 18c. to 22c. at most ines.

Of this cost, that of the drivers is the largest item, and cluding the labor of mechanical haulage, this amounts to from . to 11c. per ton of coal. This is a little greater in the thinner al seams than in the thicker ones because of the smaller cars d the smaller mules which reduce the output per driver. also increases if the dip of the coal increases, since pushers e needed to help the miners handle the cars in the rooms, the coal is too low for the mule, and the dip is steep. The in cause of the variation is the length of the entries, or, ughly, the age of the mine after the full output has been ched. The more normal cost of haulage varies from 7c. ton in the thick seams, where the entries are generally g, to 8½c. in the thin seams, where pushers are often reired.

There is also a cost for trackmen and a general repair ng. This cost increases with the age of the mine, and may from 0.3c. to 5c. per ton, depending entirely upon the physical nditions. The cost of shot-firers is generally from 1½c. to per ton at those mines which employ them, which includes

practically all of the mines producing soft coal. The cost of the cagers, couplers, greasers, and other men at the bottom of the shaft, is generally from 1c. to 2c. per ton of coal produced. This cost is influenced by the arrangement of the shaft bottom and by the capacity of the mine. At those mines which do not have shafts, there is a corresponding expense for rope-riders, switchmen, and the extra track work in the slope. The cost of the trappers or door boys is rarely kept separately, but is included with the cost of haulage or the labor cost of ventilation. It is generally in the neighborhood of 1c per ton.

There is also the general underground labor cost, made up of the pay of the pit boss, the fire-boss, pumpman, etc. At the smaller mines, the pit boss and the fire-boss do nearly all of this work, and generally the cost is nearly independent of the output of the mine and its physical condition. It is, therefore, one of the items which is especially reduced by increasing the output of the mine. It is as low as 2c. per ton at some of the larger mines, and as high as 9c. per ton at the small ones, and is usually between 2½c. and 5c per ton.

Cost of top labor in Sebastian County. At the surface of the ground, a number of men are needed to weigh and dump the coal, pick slate, handle railroad cars, attend to the boilers, run the engines, repair cars, etc. Where the mines have but little mechanical equipment, the blacksmith and his helper do little more than sharpen the miners' tools. The ¾ of 1 per cent of the gross earnings of the diggers, which is the amount they are charged for blacksmithing, then about equals the cost of the blacksmithing. Where there is much general repair work, the cost of the extra blacksmithing is paid by the company. The total cost of the top labor varies chiefly according to the output of the mine, since the general conveniences are not greatly different at the large and small mines. As far as figures are available, the extreme range is between 6c. and 20c. per ton. It is generally from 7c. to 15c. per ton.

The labor cost of dumping the coal upon the screens is very little at the shaft mines with self-dumping cages, and as great as 6c. per ton at some of the small slope mines. It is generally from ¼c. to 1c. per ton. The wages of the hoisting engineers amount to from 0.2c. to 3c. per ton. Omitting ex-

:eptional mines, they are generally from ½c. to ¾c. The cost)f the boiler attendance varies considerably, according to the ımount of water to be handled as well as the amount of power ·equired. The last item depends upon the capacity and size)f the mine. The boiler-room labor generally costs from 2c. o 4c. per ton of coal mined. The cost of picking slate out of he coal averaged ¾c. per ton in 1909. The cost of loading oal in the railroad cars is fairly uniform at from 1c. to 1½c. ›er ton. The cost of the general repair work is seldom more han 1c. per ton, but in exceptional cases reaches 3c. per ton.

General expenses of mining in Sebastian County. To these tems of top and bottom labor should be added the general cost ›f superintendence, bookkeeping, etc., which amounts to from ½c. to 14c. per ton, depending mostly upon the output of the nine. It is generally from 1c. to 3c.

Most of the larger companies own their coal land, but to epay the purchase price, they charge the coal with a royalty ›f 5c. per ton. The smaller operators lease the coal land and ›ay a cash royalty of usually 8c. to 10c. per ton. In a few ases, it is as low as 5c. and in one case it is as high as 15c. 'he operators of the little mines on the very thin seams of coal f Washington County, pay the extreme royalty of 1c. per bushel r 25c. per ton.

Cost of boiler coal in Sebastian County. A good deal of oal is used under the mine boilers. At a few mines, this cost ; eliminated by dividing the total of all the other items of ost by the number of tons shipped. But the general practice is › figure the cost, as has been done here, by the number of ›ns of coal hoisted or the total upon the miners' bulletins. Only few figures could be obtained as to the cost of boiler coal, ut it is from 1½c. to 4c. per ton of coal produced. The figures f the production of the coal given to the government for *Iineral Resources,* indicate that in both 1907 and 1908, 3.2 er cent of the coal produced in Sebastian County was used t the mines, chiefly for making steam. Assuming 70c. a ton s the average value of slack at the mines, this amounts to 2.2c. er ton of coal mined which may be taken as the average cost f the boiler coal.

Cost of supplies in Sebastian County. The final operating cost is that of supplies. This includes timber, rails, cars, piping, repairs for pumps and other machinery, oil, waste, etc., as well as the mules and their feed and harness. At many mines, these costs are distributed among the general items, together with the labor costs given above, but at most mines the cost of timber (of all sorts) is kept separate from that of other supplies. This is only a small fraction of a cent at one of the low coal mines with a solid sandstone top, and is a little over 3c. a ton at the mines with the unfavorable tops. It is usually about 1½c to 2c. a ton. The other supplies may cost between 4c. and 12c. and are usually between 5c. and 10c. a ton.

Fixed expenses in Sebastian County. The sum of all of these costs makes up the operating cost of producing the coal which cost practically ceases when the mine is shut down for a long time. There is in addition a heavy overhead charge which must be added before the real cost of the coal can be determined, in order to figure the profit, if any. These costs include taxes; insurance; law suits; the expense at the general offices of the large companies; the cost of the suspensions of mining; the cost of selling the coal; interest upon the investment; the depreciation of the plant and buildings; and the sum which must be set aside to repay the cost of opening the mine during its lifetime, or the amortization of the property.

The depreciation of the machinery and buildings is often assumed to be cared for by the cost of maintaining them in a working condition. This cost is of course very low during the first year or two before the tipples begin to rot. Depreciation should, therefore, be covered by a fixed per cent of the cost of the plant distributed over the tonnage produced during the year.

The most commonly overlooked cost is that of amortization. This cost arises from the fact that when the coal is all mined out, only a hole in the ground and changes in the surface of the land are left to represent the money paid for opening the mine, putting in the railroad tracks, building foundations, and dams for boiler ponds, etc. Also, the machinery and houses have only a very low second-hand value when the mine is worked out. The mines are exhausted in from 3 to 25 years and as a rule from 10 to 25 per cent of the first cost of opening and equipping the mine should be charged against the coal mined each year.

The capacity of the mine has little influence upon the amount of the fixed charges per ton of coal, since the mines with larger capacity represent a larger investment than the small mines, and require a larger staff of salesmen. At a little mine, the owner is often pit-boss, sales agent, bookkeeper, and the rest of the general staff; and a very cheap plant will be sufficient to hoist 100 tons of coal per day. Thus the total cost of fixed expenses is small when the output is small. When the capacity reaches something like 500 tons per day, there is a saving in the administrative expenses per ton as the capacity increases, since the general staff then increases slowly.

The accessibility of the coal makes a large difference in the overhead cost, and each new mine is opened at a greater cost than the previous ones in the same camp. The cost of amortization is reduced somewhat in such cases by first acquiring the right to mine a large tonnage of coal, and thus assuring a long life to the mine. The interest and depreciation are, however, greater than at the older mines of the same capacity.

These overhead or general costs are approximately constant from year to year, which is the reason they are often called fixed charges. The greatest variation in the amount per ton of coal mined is, therefore, caused by differences in the number of days per year that the mines are operated, and this depends upon the market demand. It is for this reason that, rather than keep the mine idle, the operator will take contracts during hard times at prices showing but little operating profit, and so be able to pay at least a part of the fixed charges while he is waiting for better times.

These fixed charges so far as known are between 22c. and 37c. per ton of coal produced, and 25c. and 30c. may be taken as an ordinary amount.

Summary of costs of mining coal in Sebastian County. The general range of costs in the soft-coal mining-districts of Arkansas may be summarized in the following table. The costs are

given in cents per ton of coal hoisted from the mine and exceptional mines have been omitted.

Items.	Low.	High.
Shooting and loading the coal	$0.6200	$0.6200
Cost of entries, air-courses, and crosscuts between them	.0400	.1400
Cost of brushing	.0000	.0600
Cost of room turnings	.0025	.0040
Cost of break-throughs between rooms	.0030	.0250
Cost of deficient coal	.0050	.0100
Cost of draw slate and rock	.0050	.0300
Total cost of dead work	.1200	.2200
Cost of drivers and general haulage labor	.0700	.0950
Cost of trappers	.0075	.0100
Cost of timbermen, trackmen, rockmen, and general repair work	.0400	.0600
Cost of shot-firers	.0150	.0200
Cost of cagers, etc.	.0100	.0200
Cost of underground supervision	.0250	.0500
Total cost of underground labor	.1900	.2400
Cost of coal dumpers	.0025	.0150
Cost of weighing coal	.0025	.0150
Cost of engineers	.0050	.0070
Cost of firemen and coal wheelers	.0200	.0400
Cost of picking slate	.0000	.0150
Cost of loading into railroad cars	.0100	.0150
Cost of general repair men	.0050	.0300
Cost of outside foremen and miscellaneous labor	.0300	.0800
Total cost of top labor	.0800	.1500
Cost of superintendent, office force, watchman, etc.	.0100	.0300
Cost of boiler coal	.0100	.0300
Cost of mine timbers	.0150	.0250
Cost of other supplies	.0500	.1000
Royalty	.0500	.1000
Cost of overhead charges	.2500	.3000
Total cost of coal omitting exceptional mines	$1.3000	$1.7000

Adavantages of thicker seams of coal. It should be noted from this discussion that many expenses increase as the coal seam gets thinner. Under the present scale and identical physical conditions, the theoretical cost of narrow work, brushing, laying track, etc., in coal 7 ft. high, is some 7c. per ton less than in coal 4 ft. high. In practice the difference is still greater. In mines of the same area, the difference in the cost of hauling coal is also considerably greater in the low coal mines. As a result, the thinner seams of coal are worked as yet, only where the top is better than the average and the dip less, so that other costs will be reduced to make up for the increases mentioned. In many cases, however, the coal of the thin seams is cleaner and harder than in the thick ones; and it commands a higher average price in the market, by reason of its freedom from slate and greater hardness. The small proportion of low priced slack increases the average selling price of the coal produced. In other words, where the quality of the coal and other physical conditions are the same, and where railroad transportation is available, the thick coal seams are mined first. As a result, a large proportion of such coal in favorable positions has already been exhausted, and there is little further opportunity of opening up slope mines in high coal, except where the dip is steep or the roof bad, or the coal seam much separated by partings,

COST OF MINING COAL AT SPADRA.

The costs at Spadra may be summarized in the following table:

	Low.	High.
Cost of mining per ton hoisted	$0.8750	$0.8750
Cost of entries and entry crosscuts	.1300	.2100
Cost of brushing	.0300	.1200
Cost of room turnings	.0100	.0200
Cost of room break-throughs	.0100	.0250
Cost of handling rock parting over 4 in. thick	.0000	.0600
Cost of deficient thickness	.0000	.1500
Cost of sulphur	.0200	.0300
Cost of draw slate and rock	.0700	.1100

	Low.	High.
Cost of gob walls	$0.0040	$0.0100
Cost of water yardage (wet places)	.0150	.0200
Total cost of dead work	.2500	.5000
Cost of drivers and car pushers	.1500	.2200
Cost of timbermen, trackmen, etc.	.0600	.1500
Cost of shot-firers	(none employed)	
Cost of cagers	.0400	.0600
Cost of underground supervision	.0800	.1200
Cost of pump runners	.0400	.0800
Total cost of underground labor	.3000	.5000
Cost of slate pickers	.0700	.0800
Cost of all other top labor	.0500	.1200
Total cost of day labor	.2000	.3500
Cost of superintendent and office force and general expense	.2500	.5000
Cost of boiler coal	.0300	.0400
Cost of props	.0300	.0600
Cost of supplies	.0600	.1100
Total operating cost	$1.9000	$2.6000

On account of the expensive tipples and the long shut downs, the overhead cost at Spadra must be quite high, but no figures could be obtained. The dead-work cost is quite accurate, as are the totals of the bottom labor and top labor. The items of the day labor cost are approximated by studying the organization of the crews and the mine capacities, and allowing for idle day costs, etc., in such a way as to make the totals approximate those shown by the actual cost records. These items are, therefore, not as trustworthy as desired. Almost no exact data as to the cost of supplies other than props could be obtained, but these will not differ greatly from the costs at the soft coal mines.

Comparative conditions at Spadra and in Sebastian County. The higher costs at Spadra are due chiefly to the higher scale of wages paid to the miners. This extra price is largely due to the increased proportion of idle time, the less healthful camps, the poor water, etc., and to the greater hardness of the coal as compared with the conditions at the mines of the first group. To an unknown extent, the higher cost is due to the exactions of the Union and to lack of unity among the operators. The

ERRATUM

After "Total cost of underground labor", (p. 319), insert:

	Low	High
Cost of dumping and loading into railroad cars......	.0150	.0400
Cost of weighing coal	.0150	.0500
Cost of engineers	.0400	.0600
Cost of firemen	.0300	.0800

costs are further increased by the low hight of the coal as previously outlined. The hardness of the coal and the band rock also increase the cost of mining. The last two items account for 10c. a ton of the extra price regularly paid for shooting and loading the coal, and at one mine reach a total of 22c. a ton. The band rock also requires heavier shooting, which increases the cost of the draw slate. The increased amount of draw slate, together with the band rock, requires a great expense for slate pickers, which has been increased by the operation of the mine-run law. There is likewise more trouble from sulphur in the coal and faulty places in the seams of coal than in the soft-coal fields. The cost of the preparation of the coal into the different trade sizes is also much greater, both in labor and cost of maintenance of the increased equipment.

The only considerable physical advantage in the field at Spadra as compared with other camps, is the general gentle dip of the coal seams, which usually allows the driving of twin-entries. The extra price obtained for the coal is a great commercial advantage.

MINING COSTS AT RUSSELLVILLE.

At Russellville only two companies are operating, and the publication of the cost data is inadvisable. As shown by the scale of mining prices, the minimum cost of shooting out the coal, is, on account of the low hight, 17c. a ton more than at Spadra. And on account of the considerable amount of coal thinner than the standard, the mining cost is often increased by as much as 26c. a ton, making a total of $1.30½ in some rooms. The day-work cost is a little greater than at Spadra on account of the steep dip. At one of the mines, the cost of handling middle band is also much greater. On the other hand, there is no expense for sulphur, and the yardage and draw slate costs are much less than at Spadra, while the coal commands a higher price.

METHODS OF DECREASING THE COST OF MINING.

Lower labor costs. A decrease in operating costs by a simple reduction in wages is not to be recommended, but mutual concessions which will give the miner the same annual income and still enable the companies to get cheaper coal, were discussed

at length in Chapter V. If the mines are operated many more days per year than at present, the real income of the miners will be much greater even though they earn a little less per day. This is better for the men than the present system, and will attract a larger number of first-class miners to the State than are now here. This increase in the number of miners would incidentally obviate the shortage of men during the busy season. There are not enough men available in the winter-time because the number of men at the mines is a rough average of the summer and winter demands. There is a surplus of men in summer and some of the miners seek work elsewhere. If the mines worked steadily, there would be less discontent among the men, and fewer strikes and petty exactions than now. At present it is necessary to pay much more per ton for mining coal than in some of the competing districts. If the men had steady employment this difference would be smaller than at present. Steady work would attract men willing to work steadily. At present, many of the men prefer to work only a few days per week at a high price per day, even though they do not earn as much per week as the steady men in other districts. These miners will follow the tramp element to the districts where irregular work at high unit prices is the rule. A more contented and steadier crew would mean lower labor costs, on account of the increased output for the same number of day-men. Of course any concession in wages per unit of work, would give the operators just that much additional advantage in the competitive markets.

Any method by which the mines can be operated more days per year is therefore of great advantage to both the operator and the miners. At Russellville, this is accomplished by one company by large concessions in the price at which the coal is sold in the early summer, as compared with the price in the fall. The reduction in price of the coal is partly borne by the miners, who receive 15c. per ton less for the coal in summer than in winter. The company reduces the price of the coal by considerably more than this in the early summer and steadily advances the price as the demand increases, until the normal winter price is reached. Such a policy induces the retail dealers to buy the coal early, and store it in their own bins. Some of their customers do the same. The men realize the advantage the steady work gives them. The result is that this company has one of the best and most contented crews in the State, even though the average scale of prices is considerably less than that at Spadra.

The softer coals which are mined in the western part of the field can not be so readily stored in the consumers' bins. If all the companies should make these general concessions in the selling price, the increased demand at each mine would be much less than it is when only one company lowers the selling price. This is true because of the limited storage room available among the dealers and consumers.

Storage of coal. The more effective method of securing steady operation is a large scale storage of coal near the mines. At present large quantities of bituminous coal are stored at the ports of Lake Superior, so that the large copper mines can take advantage of the cheap Lake freight rates in the summer, to accumulate enough coal to supply their needs during the winter, when the Lake traffic is stopped by ice. To prevent injury to the quality of the coal, it is stored under roof and the expense is considerable. Some of the low volatile Arkansas coals could probably be stored nearly as well as the coal from the Appalachian field, but some of them are quite liable to spontaneous combustion. Whether or not the Arkansas coal would catch fire could be tested only by actually storing the coal. The companies do not wish to go to the expense of providing the storage room, until they are sure that their coal is suitable for storage. Still other varieties of coal are known to break up into small pieces quite rapidly, even when only exposed to damp air, and therefore can not be stored in the ordinary way.

Previous experiments in storing coal. It so happens that at both Spadra and Russellville where the storage of coal would be most advantageous, the coal will store very well even when exposed to the weather. At some of the mines in Spadra, piles of slack coal have burned, but at the zinc smelters this slack is regularly stored in sufficient quantity to supply the demands of the smelter throughout the idle period of the mines. This is piled in the open air upon the surface of the refuse of the ore from which the zinc has been extracted, and the hight of the piles does not exceed 8 feet. It is therefore believed that

the burning of the slack at Spadra was caused by the cinder foundation upon which it was piled.

At one of the mines in Russellville, a large quantity of coal was stored in a shed in anticipation of the suspension of mining, pending an adjustment of the wage scale. This shed and most of the coal burned. It is claimed by some that the fire was lighted by some incendiary. But the coal was piled above a hot steam pipe which would greatly increase the chance of spontaneous combustion. At Spadra, it was once common to drive the entries during the summer so as to get ready to produce a larger amount of coal in the winter. The coal from these entries was successfully stored in open piles upon the ground. This practice has now been abandoned on account of the expense of storing the coal without any adequate arrangement, and because the cost of supervision, ventilation, etc., made the entries driven in summer very expensive. Since the entries were then not driven in the winter, and rooms were not worked in summer, different sets of miners were generally required for each half of the year, so this plan was of no advantage to the men and they would make no concessions in the scale of wages.

Possible methods of storing coal. The above mentioned practice demonstrated the possibility of storing the Spadra coal without its deterioration. Mr. Joseph Meytrot, now of Russellville, prepared a preliminary design of a covered storage bin of several thousand tons capacity, with mechanical means for filling it with coal and loading the coal in the cars without direct labor. The first cost of the plant worked out at about $1.00 per ton of capacity. Interest and depreciation upon this would amount to a cost of about 20c. per ton of coal stored. The Dodge or other system open air storage in piles such as those used in Pennsylavnia would be even cheaper. With suitable storage at Spadra, the chief cause of the labor troubles and the high wage scale would be eliminated.

So far as known, all coals, even those which go to pieces in the air, can be stored under water with no deterioration whatever except that a little slack is produced by handling. In the few cases where this method has been followed, the coal has been dumped from cars upon trestles into cement-lined pits filled with water. The coal is removed by various mechanical appliances. In many parts of the Arkansas coalfield, the ground is practically level, and there is a tight clay shale a short distance below the surface. Storage pits in this material could be very easily excavated and would be practically water tight without a lining. A detailed design and estimate of costs of storage at some of the mines of the larger companies, is therefore advisable, as a possible alternative to the opening up of an additional mine when an increased supply of coal is needed for the winter demand. While the coal is in storage, interest must be paid upon the cost of mining it, but the royalty and general charges need not be paid at once. This interest will be quite small, but must be included in estimates of the cost of storage.

Incidental advantages of storing coal. Besides the advantage to the operator in the way of a better labor supply and possibly of less price per unit of labor, steady work with a full crew will greatly increase the output per year, with proportionate decrease in all fixed charges, notably pumping, ventilation, maintenance, supervision, interest, etc. There would also be less cost to both operators and the miners from car shortages, since the coal can be dumped into the storage pit whenever the supply of cars runs out. It could of course be reloaded as soon as the extra cars could be obtained. These incidental advantages might possibly pay for the cost of storage, and it is suggested that an effort be made to negotiate a sliding scale with the miners, with a lower basic price than the present price for mining. This would be increased in a certain proportion for each day the mine is idle in excess of a certain number of days per month. This scale would be in effect only during the summer-time when the miners suffer from short time. In the winter they should receive the present price for mining.

Future labor supply. As the coal-mining industry in Arkansas becomes older, and the condition of the camps becomes adapted to the climate, there will be a better supply of trained labor. The labor costs will then become more nearly equal to those of other fields, which now have a great advantage. The result probably will be brought about by more rapid increases in the wage scale in the other coalfields than in Arkansas. Such a readjustment will of course be a great advantage to the industry in this State. Its coming can be hastened by improving the sanitary conditions and general attractiveness of the camps

as outlined in Chapter III. The storage of the coal would be more effective, however, and would give a more immediate return to the individual company making the expenditure.

Other reductions in cost. A considerable reduction in the cost of mining coal would follow the repeal of the mine-run law in a manner indicated in Chapter VII. In many cases, costs can be reduced by improvements in the mechanical plant and mine equipment. This is usually most noticeable at the small mines working patches of coal, which are more favorable than the average, but of small size and often overlooked by the large operators. It is often impossible at the small mines for lack of capital.

Costs can generally be reduced by more intensive development of the mines so as to give a predetermined maximum capacity of 600 to 1,500 tons per day, and by equipping all parts of a new mine upon the basis of this anticipated capacity. This method is especially available to the companies operating several mines, and able to open new ones when the market conditions justify it. In some cases, the rapid development of the mine is restricted by the Union rule which prevents the working of the entry-men upon the days when the room-men and most of the day-men would be laid off on account of poor demand for coal. In other places, the rapid development is hindered by gas, which prevents the putting on of double shifts in the entries. Some methods of decreasing the time required for development to a maximum capacity will be suggested in the technical part of this report.

At some mines, a high cost of operation could have been reduced by more preliminary prospecting, so that the mines could have been more advantageously opened, or a greater capacity secured. More than the customary amount of prospecting is desirable in nearly all cases.

At many mines, the cost of haulage can be reduced by a moderate expenditure upon the tracks and cars. This is often the most obvious saving, but may require additional capital, additional supervision, or the bringing in of high priced trackmen.

Apparently quite a saving can be made by changes in the methods of laying out many of the mines so as to directly reduce the cost of yardage per ton, and also to avoid squeezes and other indirect costs. It would be especially easy to save a little on the purchase price of the coal land and the entry cost, by increasing the percentage of coal mined. These technical changes will be discussed fully in Part II.

THE ORDINARY WASTE OF COAL.

The waste of coal in Arkansas is unusually great, even for wasteful America. What may be called the ordinary wastes of coal, or the kinds of waste common to most American districts, are excessive, and there are many additional wastes due to unfavorable geological conditions.

Pillars. The largest item of the ordinary waste is the coal lost in the pillars, which are left to support the main mass of rock above the coal, and which are not often mined in Arkansas. The recovery of this coal is largely prevented by the small size of the original pillars, and the resulting squeezes and caved rooms. This causes a loss of most of the pillars even when an attempt is made to mine a few of them. There is further difficulty because the miner will not consent to keep the track along the pillar on one side of the room, but lays it in the center of the room so as to reduce the labor of turning out the coal with his shovel. The result is that the pillars upon both sides of the room are partly buried by heaps of gob and therefore not readily accessible. The coal can be obtained by slabbing the pillar and laying a new track in the space thus obtained. Even this method is made inadvisable at many mines, on account of the mine-run law, which compels the operator to pay full mining price for any fine slate the miner loads out from these old waste piles.

Loss of entries. The squeezes cause a further loss of coal by causing the abandonment of all the unmined coal in those entries which are caved shut, so near the anticipated limit that it does not pay to drive a cut-off from another entry to get this coal. Part of this loss is due to the fact that the coal seams of Arkansas are rarely flat and it is unusually difficult to cut off an abandoned entry. Whenever an entry is stopped for any reason, even when it has reached the boundary line of the property, some of the coal in a few of the last rooms is abandoned, as soon as the output of that entry becomes too small to keep

a mule and driver reasonably busy. This is largely due to the recent refusal of the miners to accept a contract, both to mine this coal and to haul it to the main slope. Such contracts are common in other states, so this loss is greater than in most other coalfields.

Loss of coal in abandoned parts of mines. On a still larger scale, there is a loss of coal when large sections of a mine are so nearly worked out that the coal coming from one or two entries will not pay for the maintenance and ventilation of that section of the mine, which is then closed. In the same way, much good coal is lost in the corners and other distant parts of a mining property when the mine is finally abandoned. This loss is unusually large in Arkansas because of the large number of separate small mines. Some of this coal can be recovered through future adjoining mines, but most of it will be permanently lost because of the danger of approaching too near the abandoned mines, especially when no survey of the mines is available. In any case there may be large errors in the survey of either the old or the new mines. Such errors are nearly always shown when the parts of two mines intersect while both are in operation. They are due to the fact that the ordinary working of a mine does not require exact surveying. For these reasons, a very wide zone will be left around all old mines. In many cases, the abandoned patches lie between the old mine and the outcrop or unworkable areas of the coal seam. There is still further difficulty in later mining these patches of coal on the boundaries of abandoned mines on account of the adverse ownership, and the difficulty of paying royalty upon only a portion of the output of the new mine.

Waste due to interlaced ownership of land. There is a further loss of coal due to the accidents of ownership. Parts of the legal subdivision may extend over areas of good coal beyond geological displacements of the coal seam or strips of low-grade coal too wide to profitably cross. Except for adverse ownership, this coal could easily be mined by the operator working the coal on the same side of the barrier but in another legal subdivision. The coal under the adjoining tract of land may be worked out and the mine abandoned before the geological barrier is discovered, so no arrangement by which the other land owner can mine this detached coal can be made, even if both parties could agree upon terms.

When the mining right needed for a new mine is bought or leased from a number of individuals, the owner of a single small division of land may ask such high prices that the coal will not be mined by the operators who mine the coal from adjoining land. After this surrounding coal is exhausted and the mines abandoned, it will be commercially impossible to sink a pair of deep shafts to open up this small patch of coal, until the value of coal in the ground has much increased. By this time, these patches may be forgotten. If not, a wide zone around the margin must be left as a protection from water in the old mines, so the loss may be considered permanent. As yet, the price of mining rights has been so low that there has been but little trouble on this account. The land in the coalfield is largely owned in small patches, with occasional defective titles and many undivided interests. An unusual amount of loss will be caused by this fact unless at some future time laws can be passed to prevent it.

There is already a little increase in the cost of mining due to interlaced ownership of land by the larger companies who have at times purchased it checker-board fashion hoping to secure the rest later. In those places where the coal seam is of standard quality this will merely delay the mining and cause no loss except in the case of small patches. Up to the present time the companies, except those at Spadra, have been able to agree upon a mutually profitable exchange of land or readjustment of boundaries.

UNUSUAL WASTES OF COAL.

Besides these wastes, which are of more or less importance in all of the coal-mining states, there are many others due to local geological conditions. Similar conditions exist in other places, but it is very seldom that any one coalfield has as many special sources of loss of coal as the Arkansas field.

Losses due to irregular entries. The dip of the coal seam varies frequently. The entries of the mines are turned off the slope at a standard distance measured along the coal seam. When they are properly driven to grade, the vertical distance

between the entries remains constant as they get longer. If then the dip of the coal seam increases, the horizontal distance between the entries decreases, and the rooms between them get short where the change is great. Some entries must then be stopped, and the coal worked by longer rooms from the entry below. When the dip is great, these rooms are often too long to be worked without extra payment for handling the cars, and if the prices are such that the company can not afford this, rooms must be stopped with a loss of some coal beyond them.

When the dip gets much less than it is at the slope, the horizontal distance between levels increases and the rooms get too long to work. Usually, before the rooms are too long to work, the dip is so much decreased that dip rooms can be driven down from the entry above. Finally, intermediate entries can be opened up without great loss of coal.

Coal is lost quite frequently by carelessness in driving entries. On account of rolls in the floor and an attempt to keep it straight, an entry may run badly up hill until it is so close to the entry above that it can not be profitably worked. If the entry below is correctly driven, the rooms beyond the entry which is stopped would have to be of double length to get all of the coal. On account of the extra expense of the long rooms, the coal is lost instead of being mined.

Irregularities in the coal. As already noted in Chapter VII, much coal is lost on account of irregularities in the coal seams. In some places, these are patches or strips of the coal seams which have been so crumpled, crushed, or mixed with waste that the coal has no value. The only loss, therefore, is that caused by the failure of the companies to extend the entries through these places to get the good coal beyond. The patches of good coal are more certain to be lost if they are of limited extent, and near the boundaries of the property or the limits of the area to be worked from the given openings. The wider the known strip of poor coal, the greater is the expense of crossing it, and the greater the amount of good coal that must be abandoned beyond it. The less the profit in mining coal and the poorer the financial condition of the companies, the less likely are they to develop these detached areas of good coal. Indeed, at present, some companies make it a rule to stop entries as soon as they strike faulty coal, without waiting to determine the size of the faulty area. There is also the loss in a few unfinished rooms on each of these stopped entries. Some of this coal may be recovered if the condition of the industry is soon improved, but after some time the entries leading to the barrier of poor coal will fall in and the loss will become permanent.

The coal seam in places may be thinner than usual or have a thicker parting or a poorer top. The coal is then called 'deficient' and an extra price must be paid for mining it. If the cost of mining is increased sufficiently to destroy any possible profit from mining this coal, it will be abandoned, although it may be of excellent quality. Long neglect of the approaching entries makes the loss permanent. These deficient areas also serve as barriers, preventing the mining of better parts of the coal seam beyond them.

Both of these losses are sometimes greatly increased by unfortunate contentions of the miners, and by the difficulty of handling the extra dirt which is caused by the mine-run law. Together they constitute a very important loss.

Losses due to the dip of the coal seams. In coal seams that are nearly flat, entries can be driven in any direction. When bad coal in a flat seam is found, all the entries are stopped as soon as they intersect it, until one entry passes the area of bad coal. Branch entries are then turned off from this entry, to get the good coal left behind the patch of bad coal. If the barrier of poor coal is too long to be worked around in this way, a single pair of entries may be driven through it and branch entries turned off in each direction to get the good coal beyond the poor coal. In this way, the extra expense is not great enough to make the mining of the good coal beyond the areas of poor coal unprofitable. Even the moderate dip of the Arkansas coal makes the working of these branch entries so expensive that it can only be done to recover large areas of coal. The waste of good coal caused by the barriers of poor coal is therefore greatly increased by the dip of the Arkansas coal.

Since the coal seams of Arkansas dip, level entries can not follow the property line. There is, therefore, some coal between the property line and the lowest level entry that can

be turned off from the slope. It can be mined only by dip entries, as shown in Plate IV, opposite p. 24, or by dip rooms. If there is much water, the cost of water yardage and the extra expense of hauling the coal up hill may prevent the profitable mining of this coal, especially if the normal profit is very small. Except for troubles caused by adverse ownership, this coal could generally be worked from the next mine below, so the final loss need not be great.

Loss in unmined benches of coal. In many places, the different benches of thick seams of coal are separated by thick partings. If one single bench of coal is thick enough to mine it is now worked separately. If the abandoned bench is above that part of the seam which is worked, as at Bates, the coal will be destroyed when the mine caves in. If it is beneath the coal mined and of little thickness, or if it is separated by a weak parting, it can not be mined after the working above it becomes filled with broken rock caving in from the roof. This is the condition at Hartford. Near Burma and at Coaldale, a rather thick bench of coal is left below a thick or strong parting. When coal has become scarce and high priced, this may possibly be mined, but at a greatly increased expense compared with the present cost of getting it.

The loss of coal in these abandoned benches is about as great as any of the other unnecessary wastes, and is probably greater than in any other state except possibly Colorado. This loss is now being reduced, and at Huntington quite a little of the lower bench coal has been mined from the floors of old rooms in the upper bench which have not yet caved. No more of the lower bench is being abandoned at Huntington.

Loss due to need of protecting the surface. On account of the low value of the farming land and the generally hilly surface above the coal, there will be little objection to the complete mining of the coal with a consequent settling of the surface. In this respect the conditions in Arkansas will allow a much more complete extraction of the coal than can be made under high priced and nearly level farming land, as in Illinois. There will always be some loss of shallow coal beneath streams.

REMEDIES FOR WASTE OF COAL.

Change in the ownership. The loss of coal by adverse ownership of land can be remedied only by fundamental changes in the law in the direction of giving coal companies the power of buying mining rights by condemnation under proper restrictions. This is essentially a legal problem and need not be further discussed. To permit the profitable mining of the deep coal under the high mountains it may be necessary to allow the condemnation of a right-of-way through the old mines along the outcrop of the coal.

More careful mining. The losses due to irregular entries are largely caused by carelessness and are therefore avoided by the more careful mine officials.

Increase in value of the coal. Practically all of the other losses are preventable by known methods and are due to commercial considerations. The chief factors are the small profit in mining and the cheapness of the coal in the ground. The latter condition generally makes it more profitable to open up a new mine than to work the less easily obtained coal in the old mines. Of late years, undeveloped coal lands have rapidly increased in value and the easily mined coal has been getting scarcer. This results immediately in a slight effort to increase the proportion of coal utilized, but has not yet led to any great improvement except in the mining of the lower bench of coal at Huntington. As the outcrop coal becomes exhausted, an increased amount of capital will become necessary to open up mines. This will tend to increase the percentage of coal recovered. Also, as the price of coal advances, the extra cost of mining a larger proportion of the coal will become less in proportion to the entire cost.

This future effect will of course not save the coal now being wasted. It is certainly to the interest of the operators of the Arkansas coal mines as well as of the public to postpone the coming of high prices of coal. It seems better, therefore, not to wait for high prices before reducing the waste of coal. On account of the relatively small amount of coal in the State of Arkansas as compared with other states, a high cost of Arkansas coal would for a long time transfer the coal-mining industry to other fields. Such a condition is dangerously near,

because the most important of the coal reserves of the State are those under Sugarloaf and Poteau mountains, and other relatively inaccessible places.

Wider pillars. It is believed that much of the coal now wasted can be mined at a profit under normal conditions. Already some of the operators are finding that as their mines get deeper, larger pillars must be left to prevent costly squeezes or caving in of the workings. Where the pillars are of considerable size, they can be cheaply mined except under streams and ponds. To reduce the cost of this work, some minor changes in the system of driving rooms will be needed. These changes and the more feasible methods of mining the pillars under Arkansas conditions, will be briefly outlined in Part II, although the more common methods which are used in other fields are well known to most of the operators. One of the chief reasons for leaving small pillars is the cost of driving crosscuts through the pillars to ventilate the rooms. Some methods will be suggested for reducing this expense.

An error is often made by assuming that smaller pillars are needed under a hard sandstone roof. The immediate roof merely determines the safe width of the room, since as soon as the area opened up becomes large enough, the pillars take the full load regardless of the character of the roof. When they once begin to crush under a hard sandstone top, the squeeze will generally extend to the solid coal and cut off all of the entries. On the other hard, a pure shale top can be readily broken by any good pillar not already overloaded, and the entries are often saved even if a squeeze starts. For this reason it would be better to leave the pillars beneath a strong sandstone roof until all the rooms in the entire mine or section of the mine are completed. On the other hand, pillars beneath a pure shale roof can often be mined as soon as the room alongside is completed. Under slightly stronger top, the pillars can be pulled as soon as the entry is finished, retreating toward the main slope in the way now done which is described in Chapter II. If the pillars are to be mined, the entries should be narrow.

Narrow entries. The loss of the entries in any case can be largely reduced by keeping them narrow. This should always be done if the roof is poor and is now done by some companies under nearly all conditions. The narrow entries will stand so much longer that much coal can be recovered from unmined areas, even after a long interval during which there have been no tracks in the entries. When a mine is opened in the future at some distance from the outcrop of the coal seam, it will often be advisable to drain the old mines between it and the outcrop. This will be most likely when the new mine is under a mountain. If then, these old entries are still open, much of the coal in pillars and poor areas may be recovered. To remove all the rock convenient rock bins should be provided at the tipples.

Longwall mining. It is believed that in the Spadra field and prospective Prairie View field, all new mines should be operated upon the longwall system, since the character of the roof and the coal with its strong band of rock parting, represent almost ideal conditions for longwall mining. By this system no pillars are needed except around the shaft, and the extraction can easily exceed 90 or 95 per cent of the coal in the ground. The working face of a longwall mine is best kept roughly circular. There is often some loss of coal in the corners of the land owned, but this is very small. Experiments with longwall machines are now being conducted, and a rather complete study of the alternative methods of longwall mining will be made for Part II of this report.

Longwall retreating. For most of the thicker seams of coal, the method of mining by rooms and then mining most of the pillars will be much cheaper than first driving entries to the boundaries and mining the coal by longwall retreating. This must, therefore, be considered as the only feasible way of working the coal although the loss is unavoidably a little greater than the loss by longwall retreating. The latter method must, however, be used for the thick coal seam deeply buried beneath Poteau and Sugarloaf mountains. A discussion of the problem of mining this deep coal will be given in Part. II.

Mining machines in compound seams. In many places, it is feasible to mine all of the coal in the compound seams by first digging out the parting with mining machines. Where the parting is very soft, the extra cost will be little, and will usually be paid for by the increased tonnage per yard of entry. In many other cases, it will be more than made up by the increased amount of good lump coal obtained instead of the present mixture of dirt, slack, and shattered lump. There is also the advantage of a slightly greater output for the same amount of development. The chief reason why machines are not more freely used is the opposition of the miners which was discussed fully on p. 304. Estimates of the cost of machine mining will be made in the technical portion of this report, together with a discussion of the type of machine best adapted to the various conditions of different seams.

Longwall advancing and retreating. A study will also be made of the possibility of mining the lower part of a double seam of coal by longwall advancing and getting the rest by longwall retreating. This is successfully done in other countries, where the coal has greater value, and seems feasible at some of the Arkansas mines.

Modified leases. As yet, practically all of the coal-mining leases contain no reference to mining methods, nor any requirement as to the proportion of coal which must be saved. This fact makes the waste of coal a matter of no financial concern whatever to those operators that do not own the mining right. At other mines, even where the coal is owned by the operating company, the ability of the superintendent is judged entirely by the low cost at which he can get out a ton of coal, measured on a mine-run basis. If then he has no financial interest in the company, he has no direct incentive to strive for more complete extration or even a conservation of the quality of the coal. These improvements may increase the cost per ton mined. The superintendents neglect them even though they would pay well by increasing the amount of total profit obtained from the mines.

The cost of driving the entries and air-course, laying track, and turning the rooms, is strictly in proportion to the area of the coal land developed, so the cost per ton is decreased by mining a larger proportion of the coal. This cost is never less than 10c. per ton of coal produced and is often much more. For this reason the operators that lease the coal land, do not waste much more of the coal in the ground actually opened than the amount wasted by those operators that own the coal land. But the lessees and a few superintendents do waste a large amount of the coal by failure to mine any deficient coal; or to drive entries across strips of faulty coal; or to mine under bad roof, as long as there is any better or more easily available coal anywhere in the ground leased or owned by an absentee corporation. The total loss in the State from this cause is relatively small, only because such a small proportion of the output of the coal comes from leased land.

The coal lands in other states, notably in West Virginia, are frequently owned by large companies, and all leases, based upon a fixed royalty per ton of coal mined, fully specify the method which shall be used in mining, and the dimensions of all pillars, etc. This is possible in a district where the waste has been reduced by the standard method of mining. As yet none of the ordinary methods of mining in use in Arkansas are adapted to a reasonably complete extraction of the coal. It would be difficult, therefore, to negotiate a lease upon the basis of a specified better system of mining, even if the owner of the land were sufficiently posted upon mining methods. But it is urged that all future leases require the mining of all possible areas of coal with payment by the owner of the land for driving exploratory entries through faulty strips of coal not previously tested. A lease should also require that, except under a very strong sandstone roof, all pillars be pulled as completely as possible immediately upon the completion of the entry. It should further require that the main slope or plane be protected by very wide pillars between it and the first room, so that squeezes started by pulling the pillars on the finished entries, will not cut off the main slope. In any case, a minimum width of at least 15 ft. should be required for the pillars between rooms. An inspection of the operator's pay-roll will show the size of the pillars, by giving the yardage paid the room men for break-throughs, and the execution of the agreement could be readily enforced. If the pillars are sufficiently wide, they can be mined even some years after the rooms have been completed, and are not lost to the owner of the land even if the lessee does not mine them. To maintain access to this coal, all such leases should forbid the driving of wide gob entries.

State control of mining methods. When the coal land is owned by the operator, it is generally supposed that he has a right to mine the coal as he sees fit, provided no one else is injured by his method. It is believed, however, that when the limitation of the coal supply of the United States becomes better known, the states will assume more or less control over their coal, and prevent its waste by prescribing the methods of mining it, as is now done by the large leasing companies. This is the only way by which the waste of coal can be reduced to a minimum. It is the especial duty of the State to consider the welfare of its future inhabitants, for this is seldom a matter of any concern to the present citizens and coal operators.

For the purpose of controlling the waste, the plans of opening new mines with the full records of preliminary prospecting, might be submitted to some State Board for approval. The expense of this engineering advice might well be borne by the State as a partial compensation to the companies for the extra expense of reducing the waste of coal. As an extreme alternative, the companies might be required to pay a heavy fee for the service, and could leave the entire formulation of the plan of mining to the State Board, which would then serve as a consulting engineer. If all the companies were treated alike, none would have any competitive advantage, and the extra cost of the coal would then be borne by the immediate consumers. This hardship to the consumer would be so small in proportion to the gain of the future users of the coal that the State would be justified in imposing this upon them in order to delay the time when no coal would be available. As a partial compensation to the operators, single interests owning, say, 60 per cent of any tract of coal land, should be permitted to buy the rest at prices fixed by appraisement proceedings, or by the State Engineering Board.

Such control of coal mining is already being advocated in other states. It will most promptly become necessary in the anthracite coalfield of Pennsylvania and in Kansas, and its practical operation wherever established should be carefully studied.

A further step in the interest of conservation would be to prevent the opening of new mines when the capacity of those already supplying that particular grade of coal is in excess of the demand for it. This would incidentally cheapen the cost of mining the coal, and greatly benefit the workmen by securing a steadier operation of the mines, but might require some storage of coal either by the consumers or by the operators.

Any reduction in the cost of mining by such a method will benefit the consumer, since in the long run, the sale price of the coal is regulated by the cost of mining it. As yet the formation of a monopoly in coal mining has not even been attempted anywhere in the United States, except in as far as the anthracite mining business is controlled by the railroads which bring the coal to market. This need not be feared as a result of restricting the opening of new mines. A precedent for this restriction of new enterprises of a semi-public nature has been established by the frequent refusal to permit the building of railroads, uselessly duplicating existing lines. The shipping public profits by this, in that the cost of railroad transportation need be only enough to support one efficient road instead of two or more inferior ones. The large number of railroads engaged in carrying anthracite coal to the sea-board could very well be replaced by two or three with controlled rates.

Technical discussion. Until interference by the State is definitely required, it is hoped that the superintendents and foremen of the operating mines will soon be able to organize a technical society for the interchange of ideas of mutual advantage, and especially to report experiments planned to reduce the waste of coal, with full cost data. The spirit of coöperation among technical men is one of the greatest reasons for the rapid progress in technical methods made during recent years, and nearly all of the Arkansas operators seem perfectly willing to give the other operators some of the benefit of their experience.

GLOSSARY OF COAL MINING TERMS.*

Afterdamp.—The mixture of gas left in a mine after an explosion, chiefly carbon dioxide and nitrogen.

Against the Air.—In a direction opposite to that in which the air current moves. *To fire shots against the air,* to fire shots in such an order that the shot-firer travels against the air.

Air.—The current of air which circulates through and ventilates a mine.

Air-course.—A passage through which air is circulated. Particularly a long passageway driven parallel to the workings specially to carry the air current. *Entry air-course,* a passage for air parrallel to an entry. In Arkansas usually below the entry on the side opposite the rooms. Often called in Arkansas *back entry. Slope air-course,* air courses parrallel to the slope on one or both sides of it.

Air-shaft.—A shaft used expressly for carrying the air current.

Airway.—Any passageway through which air is circulated. Rare in Arkansas.

Anemometer.—An instrument for measuring the velocity of an air current.

Anthracite.—Coal containing a small percentage of volatile matter. Sometimes used in Arkansas for coal ordinarily called semi-anthracite and containing a little more volatile matter than the usual 2.5 to 6 per cent., which is the ordinary maximum of anthracite.

Anticline.—A fold in the rocks with the convex side upward. The arch part of a fold.

Apron.—A hinged extension of a loading chute. More commonly called *lip* in Arkansas.

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*This glossary is largely condensed from the compilation in the *Coal and Metal Miner's Pocket Book.* An effort has been made to indicate the local variations in the use of terms but this is not complete. All expressions not current in technical literature have been marked "(Arkansas)" although they are often used in other states, especially in the Interior Coalfield. Specific British terms have been omitted as far as possible, and also metal mining terms and definitions of terms having a different meaning in metal mining, such as *breast* and *cap.* A few terms relating to deep drilling have been included.

Backlash.—(1) The backward suction of air-currents produced after a mine explosion.

(2) The reëntry of air into a fan.

Back shot.—A shot used for widening an entry placed at some distance from the head of an entry.

Back Work.—(Arkansas) Loading coal, laying track, and other work of driving an entry not done at the extreme face.

Bailer.—A person who removes water from a mine working by dipping it up with a bucket.

Balanced.—Said of a shot for blasting coal when the drill hole for the powder is parallel to the face of the coal which is to be broken by it.

Balk.—A sudden thinning of a coal seam. Rare in Arkansas.

Band.—A seam or the stratum of slate or other refuse in the coal. Commonly called *middle band* in Arkansas; also *dirt band, sulphur band*, or other band as the case may be.

Bank.—(1) The top of a shaft.

(2) A coal mine, especially a small one.

Barney.—A small car used on inclined planes to push the mine car up the slope.

Bar Screen.—A device for separating different sizes of coal, and consisting of a number of parallel inclined bars at regular distances apart along which the coal slides by gravity.

Basin.—(1) A coalfield resembling a basin in form.

2) The lowest part of a folded coal seam. That part in a syncline.

Bearers.—Pieces of timber 3 or 4 ft. longer than the width of a shaft, which are fixed into the solid rock to support the shaft timbering at intervals.

Bearing.—(1) The course by a compass.

(2) The points of support of a beam, shaft, or axle.

Bearing in.—The depth of an undercut, mining or holing from the face of the coal to the end of the undercut.

Bed.—(1) The level surface of a rock.

(2) A stratum of coal, ironstone, etc.

Bell.—Overhanging rock of bell-like form, not securely attached to the mine roof. *Pot* is the common Arkansas term.

Bench.—(1) A portion of a coal seam which is separated from the rest by a band of shale or other impurity. Rarely that portion of a seam of coal separated from the rest only by a smooth seam.

(2) A natural terrace marking the outcrop of any stratum.

Bench and Bench.—(Arkansas) That plan of mining coal in a room which requires the blasting of the two benches of coal alternately each a little beyond the other.

Bench Mark.—A mark whose elevation is exactly known or assumed as a reference point by a surveyor.

Bevel Gear.—A gear-wheel whose teeth are inclined to the axis of the wheel.

Blackdamp.—Carbon dioxide. Less exactly any gas that will neither burn nor support combustion

Black Jack.—(1) Crude black oil used to oil mine cars.

(2) Soft black, carbonaceous clay or earth associated with coal.

Blast.—(1) To loosen or throw out coal or rock by the use of dynamite, powder, or other explosive.

(2) The sudden rush of fire, gas, and dust of an explosion through the workings and roadways of a mine.

Blasting Barrel.—A small pipe used in blasting to affort a passage for the squib through the tamping.

Block Coal.—Coal that breaks into large cubical blocks.

Blocky.—(Arkansas) Breaking down in thick blocks. Applied to the roof of a mine working.

Blossom.—The decomposed outcrop, float, surface stain or any indication of a coal bed or mineral deposit.

Blow.—A dam or stopping is said to blow when gas escapes through it.

Blower.—(1) A sudden emission or outburst of gas in a mine.

(2) Any emission of gas from a coal seam similar to that from an ordinary gas burner.

(3) A type of centrifugal fan used largely to force air into furnaces.

(4) A blowdown ventilating fan.

Blown-Out Shot.—A shot that has blown out the tamping without breaking any of the coal except that around the auger hole.

Blue Cap.—The blue halo of ignited firedamp which shows above the yellow flame of a safety lamp when it burns in air containing small quantities of firedamp. The percentage of firedamp can be roughly measured by the hight of the cap.

Board-and-Pillar.—Practically the same system of mining as that called *room-and-pillar.*

Bone.—Coal intimately mixed with slate or rock. More commonly called *bony* or *bony coal* in Arkansas.

Bonnet.—(1) The overhead cover of a cage.
(2) A cover for the gause of a safety lamp.

Boss.—(1) A person in immediate charge of a piece of work. *Pit Boss,* mine foreman. *Driver Boss* or *boss driver,* a person in charge of the drivers in a mine. In Arkansas sometimes called the *coal rustler. Fire-boss,* an underground official who examines the mine for firedamp, and has charge of its removal.
(2) (Arkansas) A coal mine employee not under the jurisdiction of the miners' union.

Bottom.—(1) The landing at the bottom of the shaft or slope.
(2) The lowest point of mining operations.
(3) The floor, bottom rock, or stratum underlying a coal bed.

Bottom Pillars.—Large pillars left around the bottom of a shaft; a *shaft pillar.*

Box.—(1) The part of a wheel which fits the axle.
(2) The threaded nut for the feed screw of a mounted auger drill. More commonly called *boxing.*

Brattice.—(1) A temporary partition used for directing the ventilating current into any part of a mine working.
(2) (Arkansas) The permanent partition used to close any passageway against the air current. More properly called a *stopping.*

Brattice Cloth.—Canvass or burlap used for making brattices and stoppings.

Brattice Man.—A person who assists the fire-boss in constructing brattices.

Brattish.—An Arkansas variation of *brattice.*

Breaker.—In anthracite mining the structure in which the coal is broken, sized, and cleaned for the market.

Breaker Boy.—A boy who works in a *coal breaker.*

Breaking Prop.—(Arkansas) One of a row of props of sufficient strength to cause the rock above the coal to break and so limit the area of top brought down by a brushing shot.

Break-through.—A narrow passage cut through the pillar to allow the ventilating current to pass from one room to another. Also called a *cross-cut,* or *room cross-cut.* Larger than a *dog hole.*

Break top and bottom.—To loosen the coal in both benches of the seam with a single shot.

Breast.—A stall, board, or room in which coal is mined.

Breast Auger.—An auger supported by a *breast plate* against the miner's body. Used for drilling holes in the soft Arkansas coal.

Breast Plate.—A slightly curved iron plate fastened to the end of a coal auger to enable the miner to press the auger forward with his body.

Briquets.—Fuel consisting of slack or coke breeze with usually some binding material, which is pressed into lump form; also called *'coalettes'* and *'eggettes.'*

Brown Coal.—Lignite, a fuel intermediate between peat and bituminous coal.

Brush.—(1) To mix air with gas in a mine working by swinging a jacket, etc., to create a little current.
(2) To shoot or wedge down some of the rock over a roadway to increase the hight or head room.
(3) Less often *to take up bottom* for the same purpose.

Brushing.—The rock or slate removed from the roof of a roadway. *Bottom brushing,* rock or clay taken up from the bottom of a roadway.

Buddy.—A partner. Each of two men who work in the same working place of a coal mine. Sometimes spelled *butty.*

Buckwheat.—Anthracite coal which will pass through a mesh of ½ in. and over a mesh of 3/16 in. to ¼ in. Prepared in Arkansas only at one mine near Russellville.

Building.—A built up pillar of rock to support the roof of a mine.

Bulkhead.—(1) A tight partition or strong stopping.
(2) A pile of timber laid close together with alternate layers crossing each other. A solid *crib* used to support a very heavy roof.

Bulletin, or *Coal Bulletin*.—A large card having spaces beneath the miners' checknumbers in which the weight of each car load of coal each miner sends out is entered.

Bull Wheel.—(1) Two large wheels and a reel upon which the rope carrying the boring rods is coiled when drilling holes by machinery.

(2) (Arkansas) Any underground sheave wheel. Particularly the wheel around which the tail rope is passed beyond each terminal of a tail rope haulage system.

Bump Knocker.—Local term at Spadra for a person who picks down portions of machine-mined coal which have not been shot down by blasting.

Buntons.—Timbers placed horizontally across a shaft or slope to carry the cage guides, pump rods, column pipe, etc.; also, to strengthen the shaft timbering.

Butt.—Coal surface exposed at right angles to the face; the *"ends"* of the coal. Not common in the Arkansas mines.

Butt Entry.—A gallery driven at right angles with the butt joint. Not used in Arkansas.

Cage.—A platform on which mine cars are raised to the surface.

Cage Guides.—Vertical rods of pine, iron, or steel, fixed in a shaft, between which cages run, and whereby they are prevented from striking one another, or against any portion of the shaft.

Cager.—The person who puts the cars on the cages at the bottom of the shaft.

Cage Seat.—Scaffolding, sometimes fitted with strong springs, to take off the shock, and on which the cage drops when reaching the pit bottom.

Caking Coal.—Coal that agglomerates on the grate, when burned.

Cap.—(1) A piece of plank placed on top of a prop.

(2) The pale bluish elongation of the flame of a lamp caused by the presence of gas.

Cap Board.—Same as *cap* (1).

Cap Rock.—(1) The loose rock lying on top of the bed rock.

(2) (Arkansas) A hard layer of rock, usually sandstone, a short distance above a coal seam.

Cap Piece.—Same as *cap* (1). Usually a piece of wood split from a log.

Carbon.—A combustible elementary substance forming the largest component part of coal. *Fixed carbon*, that part of the carbon which remains behind when coal is heated in a closed vessel until the volatile matter is driven off.

Carbonaceous.—Coaly, containing carbon or coal. Especially shale or rock containing small particles of carbon distributed throughout the whole mass.

Car Haul.—An endless chain arranged to raise the cars automatically up a hill from which they travel by gravity.

Cartridge.—Paper or waterproof cylindrical case filled with gunpowder, forming the charge for blasting.

Car Trimmer.—A person who adjusts the load in a railroad car.

Casing.—Tubing inserted in a bore hole to keep out water or to protect the sides from collapsing.

Cave, or *Cave In*.—The caving-in of the roof strata of a mine, sometimes extending to the surface.

Center Shot.—A shot in the center of the face of a room or entry. Used only when the coal can be shot directly up or down.

Chain Pillar.—A pilllar left to protect the entry and air-course, and running parallel to these passages.

Chairs.—Movable supports for the cage arranged to hold it at the landing when desired.

Chance.—(1) The opportunity a shot has to break the coal.

(2) The opportunity to put in a shot in a good position.

Charge.—(1) The amount of powder or other explosive used in one blast or shot.

(2) To put the explosive into the hole, to arrange the fuse, or squib, and to tamp it.

Check.—(Arkansas) A piece of tin bearing a stamped number. This is placed upon the pit cars to indicate which miner loaded them.

Check-number.—(Arkansas) A number assigned to each miner by which his coal is identified, and under which its weight is entered on the coal bulletin.

Check-off.—(Arkansas) A method of collecting union dues, fees, and fines by withholding them from the miner's wages.

Check-puller.—A person who takes the miners' checks from the cars and calls the number on them to the weighman.

Chestnut Coal.—Anthracite coal that will pass through a hole 1⅜ in. square and over a hole ¾ in. square. In Arkansas, coal that passes through a 2 in. round hole and over a 1 in. round hole. This is larger than the Pennsylvania size, and is prepared at only one mine.

Chock.—A square pillar for supporting the roof, contsructed of prop timber laid up in alternate cross-layers, in log-cabin style, the center being filled with waste. Commonly called *crib* in Arkansas.

Choke-damp.—Any kind of *black-damp.*

Chunked-up.—Built up with large lumps of coal to increase the capacity of a car.

Churn Drill.—A long iron bar with a cutting end of steel, used in quarrying, and worked by raising and letting it fall. When worked by blows of a hammer or sledge, it is called a "jumper."

Chute.—(1) A narrow inclined passage in a mine, down which coal or ore is either pushed or slides by gravity.

(2) The loading spout of a tipple or bin.

Clanny.—A type of safety lamp invented by Dr. Clanny.

Clean-up.—(1) To load out all the coal a miner has.

(2) An opportunity to clean up.

Cleat.—(1) Vertical cleavage of coal seams, irrespective of dip or strike.

(2) A small piece of wood nailed to two planks to keep them together, or nailed to any structure to make a support for something else.

Cleavage.—The property of splitting more readily in some directions than in others.

Clinometer.—An instrument used to measure the angle of dip.

Coal Cutter.—A machine for holding or undercutting coal.

Coal Dust.—Very fine powdered coal suspended in the airways of a mine.

Coal Measures.—Strata of coal with the attendant rocks.

Coal Smut.—The blossom of coal.

Cog.—A *chock.*

Coke.—The fixed carbon aud ash of coal sintered together. That part of a caking coal which is left after the volatile matter has been driven off by heat.

Collar.—(1) A flat ring surrounding anything closely.

(2) Collar of a shaft is the first wood frame of a shaft.

(3) The bar or crosspiece of a framing in entry timbering.

Colliery.—The whole plant, including the mine and all adjuncts.

Company Man.—A man employed by the day and working directly under some boss. Distinguished from the miners or diggers who are paid by piece work on contract.

Continuous Coal Cutter.—A coal mining machine of the type that cuts across the face of the coal without being withdrawn from the cut.

Cores.—Cylinder-shaped pieces of rock produced by the diamond-drill system of boring.

Counter.—A secondary haulageway in a coal mine. Not used in Arkansas.

Counter Gangway.—A level or gangway.

Country Bank.—(Arkansas) A small mine supplying coal for local use only.

Coursing, or *Coursing the Air.*—Conducting the ventilating current through all parts of the mine one after another by means of doors and stoppings.

Creep.—The gradual upheaval of the floor of the mine workings due to the sinking of the pillars into a tender floor.

Crib.—(1) A structure composed of horizontal timbers laid on one another, or a framework built like a log cabin.

Cribbing.—(1) Close timbering, as the lining of a shaft.

(2) The construction of cribs of timber, or of timber and earth or rock to support the roof.

Cross-bar.—(Arkansas) A horizontal timber held against the roof to support it, usually over a roadway; a *collar.*

Crosscut.—A small passageway driven at right angles to the main entry to connect it with a parallel entry or air-course. Also used in Arkansas instead of a break-through, especially for the first break-through connecting two rooms or for break-throughs which must be cut.

Cross-over.—A curved piece of track connecting two parrallel tracks.

Crush.—A *squeeze.*

Culm.—Anthracite-coal dirt.

Curb.—(1) A timber frame intended as a support or foundation for the lining of a shaft.

(2) The heavy frame or still at the top of a shaft.

Curtain.—A sheet of brattice cloth hung across an entry in such a way that it prevents the passage of the air current but does not hinder the passage of mules or mine cars.

Cut.—(Arkansas) To shear one side of an entry or crosscut by digging out the coal from floor to roof with a pick.

Cutter Bar.—The structure supporting the cutting chain of a chain mining machine.

Cutting.—(Arkansas) The opening made by shearing or cutting.

Cutting Chain.—The sprocket chain which carries the steel points used for undermining the coal with chain mining machines.

Cutting Shot.—(Arkansas) A shot put in beside a cutting so as to blast some coal into it and to shatter the coal beyond for aid in making the next cutting.

Cut-Off Entry.—(Arkansas) An entry driven to intersect another and furnish a more convenient outlet for the coal. Also called *cut-off.*

Cutter.—A term employed in speaking of any coal-cutting or rock-cutting machines; the men operating them, or the men engaged in underholing by pick or drill.

Cutter-Bar.—That part of a chain mining machine that supports the cutting chain and extends under the coal.

Dagger.—(Arkansas) A T-shaped iron used to force an auger into the hard semi-anthracite coal of Arkansas. The bottom is placed in a hole dug in the floor while the miner drilling the hole presses his breast against the crossbar. The end of the auger fits into any one of a number of recesses in the stem of the dagger.

Dam.—A timber bulkhead, or a masonry or brick stopping built to prevent the water in old workings from flooding other workings, or to confine the water in a mine flooded to drown out a mine fire.

Damp.—Mine gases and gaseous mixtures are called damps. See also *Afterdamp, Blackdamp, Firedamp, Stinkdamp, Whitedamp.*

Davy.—A safety lamp invented by Sir Humphrey Davy.

Day.—Light seen at the top of a shaft.

Day-Man.—(Arkansas) A coal mine employee paid by the day as distinguished from those that are paid by the piece and by contract. In Arkansas, also called *"company man."*

Day Shift.—The relay of men working in the daytime.

Day Work.—(Arkansas) All work other than that done by the piece or contract. Such as repairing roads, handling cars, etc. In Arkansas, also called "company work" and does not include work for which the men are paid by the month.

Dead.—The air of a mine is said to be dead or heavy when it contains carbonic-acid gas, or when the ventilation is sluggish.

Dead.—(1) Unproductive.

(2) Unventilated.

Deal-line.—(Arkansas) A row of marked empty powder kegs or other danger signal placed by the fire-boss to warn miners not to enter workings containing gas.

Dead Work.—Exploratory or development work not directly productive. Properly, brushing, taking-up-bottom, handling draw slate, etc. In Arkansas, often used to include yardage costs for driving entries, cross-cuts, etc.

Deficient Coal.—(Arkansas) Coal more difficult to mine than the standard, and for which the miners are paid an extra price.

Detaching Hook.—A self-acting mechanical contrivance for setting free a winding rope from a cage when the latter is raised beyond a certain point in the head-gear; the rope being released, the cage remains spspended in the frame.

Diggers.—(Arkansas) Men who are paid by the ton of coal produced. *Miners* in the stricter sense. Originally these men *mined* or *undermined* the coal. The term is now applied to the men who merely *shoot out* the coal.

Dip.—(1) To slope downwards.

(2) The inclination of strata with a horizontal plane.

(3) The lower workings of a mine.

(4) (Arkansas) Being driven down hill, as dip entry, dip room, etc.

Dip-switch.—(Arkansas) A *slant* or piece of track connecting the back-entry or air-course or a dipping vein with the main entry or gangway.

Dirt Fault.—A confusion in a seam of coal, the top and bottom of the seam being well defined, but the body of the vein being soft and dirty.

Dog.—(1) An iron bar, spiked at the ends, with which timbers are held together or steadied.

(2) A short heavy iron bar, used as a drag behind a car or trip of cars when ascending a slope to prevent their running back down the slope in case of accident. A *drag*.

Dog-Hole.—A little opening from one place in a mine to aonther, smaller than a break-through.

Doors.—Wooden doors in underground roads or airways to deflect the air-current.

Door Tender.—A boy whose duty it is to open and close a mine door before and after the passage of a train of mine cars. In Arkansas, called *trapper*.

Double-diamond Bottom.—(Arkansas) An arrangement of track at the shaft bottom consisting of two parallel tracks (one to each compartment of the shaft) with a double cross-over track between them and repeated on each side of the shaft.

Double Entry.—(1) A system of ventilation by which the air-current is brought into the rooms through one entry and out through a parrallel entry or air-course.

(2) (Arkansas) A pair of entries in flat or gently dipping coal so laid out that rooms can be driven from both entries; *twin entries*.

Double Shift.—(1) Two sets of men at work, one set relieving the other.

(2) To employ two shifts of men, or to *work double shift*.

Downcast.—The opening through which the fresh air is drawn or forced into the mine; the *intake*.

Drag.—(1) The frictional resistence offered to a current of air in a mine.

(2) See *Dog*.

Draw.—(1) To 'draw the pillars,' to mine out the pillars, or to *pull* or *rob* them after the rooms are worked out. Called *pull* in Arkansas.

(2) An effect of creep upon the pillars of a mine.

Draw Slate.—(Arkansas) Loose slate, dirt, or rock that falls from the roof of mine-working when the coal is shot out.

Drawing an Entry.—Removing the last of the coal from an entry.

Drawn.—The condition in which an entry or room is left after all the coal has been removed. See *Robbed*.

Drift.—In coal mining, a gangway or entry above water level, driven from the surface in the seam.

Driving on Line.—Keeping a heading or breast accurately on a given course by means of a compass or transit. In Arkansas called "*driving on sights*."

Drummy.—Sounding loose, open, shaky, or dangerous when tested.

Dummy.—(Arkansas) A short paper case filled with fine rock for use as tamping drill holes.

Dump.—(1) A pile or heap or ore, coal, clum, slate, or rock.

(2) The tipple by which the cars are dumped.

(3) To unload a car by tipping it up.

Ear.—The inlet or intake of a fan.

Egg Coal.—Anthracite coal that will pass through a 2¾ in. square mesh and over a 2 in. square mesh. The Arkansas screens have 3 in. to 3½ in. and 2 in. or 2½ in. round openings.

Empties.—Empty mine or railroad cars. Empty railroad cars are called "*flats*" in Arkansas.

Empty Track. A track for storing empty mine cars.

End, or End-On.—Working a seam of coal at right angles to the principal or face cleats.

Engine Plane.—A passageway having a steep grade along which cars are raised and lowered by a rope attached to an engine; a *plane*. In Arkansas, limited to planes down which coal is lowered. If coal is hoisted, the plane is known as a *slope*.

Entry.—A main *haulage road, gangway*, or *airway*. An underground passage used for haulage or ventilation, or as a manway. (Arkansas) Commonly limited to haulage ways sufficiently level to permit the hauling of coal by mules. *Back entry*, the air-course parallel to and below an entry. Distinguished from *straight entry, front entry*, or *main entry*. *Dip entry*, an entry driven down hill so that water will stand at the face. If it is driven directly down a steep dip it becomes a *slope*. *Gob entry*, a wide entry with a heap of refuse or gob along one side. *Slab entry*, an entry which is widened or *slabbed* to provide a working place for a second miner. *Double-entry*, a system of ventilation by which the air-current is brought into the rooms through one entry and out through a parrallel entry or air-course. *Cut-off-entry* (Arkansas), an entry driven to intersect another and furnish a more convenient outlet for the coal. *Single-entry,* a system of opening a mine by driving a single entry only, in place of a pair of entries. The air-current returns along the face of the rooms, which must be kept open. *Tripple-entry,* a system of opening a mine by driving three parallel entries for the main entries. *Twin-entries,* a pair of entries close together and carrying the air current in and out, so laid out that rooms can be worked from both entries.

Entry-man.—A miner who works in an entry.

Entry Stumps.—Pillars of coal left in the mouths of abandoned rooms to support the road, entry, or gangway till the entry pillars are drawn. In Arkansas these pillars are called entry stumps even when the rooms are first driven, before any pillars are pulled or the rooms abandoned.

Escape-way.—An opening through which the miners may leave the mine if the ordinary exit is obstructed.

Explosion.—Sudden ignition of a body of firedamp or of coal dust.

Eye.—(1) Circular hole in a bar for receiving a pin and for other purposes.

(2) The eye of a shaft is the very beginning of a pit.

(3) The eye of a fan is the central or intake opening.

Face.—(1) The place at which the material is actually being worked, either in a room or heading or in longwall.

(2) The end of a drift or tunnel.

Faces.—(Arkansas) Inclined joints in the coal.

Face-on.—When the face of the breast or entry is parallel to the face cleats of the seam. Not used in Arkansas.

Fall.—A mass of roof or side which has fallen in any part of a mine.

False Set.—A temporary set of timber used until work is far enough advanced to put in a permanent set.

Fan.—A machine for creating a circulation of air in a mine.

Fancy-lump-coal.—(Arkansas) (1) Soft coal from which all slack and *nut coal* has been removed.

(2) (Arkansas) Semi-anthracite coal of larger size than *grate coal.*

Fan Drift.—A short tunnel or conduit leading from the top of the air-shaft to the fan.

Fault.—(1) Strictly a fracture in the rock along which there has been movement so that single beds of rock or coal are not at the same level in both sides of the fracture. In Arkansas, this is called a *"throw." Normal fault,* the ordinary type of fault or throw by which the rock layers upon the side of the fissure toward which it dips have been slipped down from the position they occupy on the other side. This leaves a strip along which each bed of rock or coal is wanting for short distance and is the reverse of a thrust fault. *Thrust fault,* a displacement of the rocks along a fissure in such a way that the end of a layer of rock on one side of the fissure overlaps the end of the same layer over the other side. This is believed to be caused by horizontal pressure and is the common type of fault found in the coal mines south of the Arkansas River.

(2) (Arkansas) Any area of a coal seam in which the coal is not of a good quality, generally caused by a crushing of the coal, or a mixture of dirt with the coal or a substitution of dirt for the coal at the time the coal was deposited. Also called *dirt faults,* or *rock faults.* The coal in them is called *faulty coal.*

Feather.—A slightly projecting narrow rib lengthwise on a shaft, arranged to catch into a corresponding groove in anything that surrounds and slides along the shaft.

Feather Edge.—The thin end of a wedge-shaped piece of rock or coal.

Feed.—Forward motion imparted to the cutters or drills of rock-drilling or coal-cutting machinery, either hand or automatic.

Feeder.—(1) A runner of water.

(2) A small blower of gas.

Fiery.—Containing explosive gas.

Fire.—(1) To blast with gunpowder or other explosives.

(2) A word shouted by miners to warn one another when a shot is fired.

Fire-boss.—An underground official who examines the mine for gas and inspects safety lamps taken into the mine, and removes accumulations of gas.

Firedamp.—A mixture of light carburetted hydrogen (methane, Chap. 4), and air in explosive proportions; often applied to methane alone or to any explosive mixture of mine gases.

Firing Pin.—(Arkansas) A wooden cylinder upon which the blasting paper is formed in a case for the *cartridge* or *dummy*.

First of the Air.—(1) (Arkansas) That part of the air current which has just entered a mine working place; the *intake air*.

(2) (Arkansas) The working place of a mine or split which is nearest the intake, or receives the first of the air.

Fixed Carbon.—That part of the combustible matter of coal which remains after all the volatile matter is driven off by heating the coal in a closed vessel.

Flat.—(1) A district or set of workings separated by faults, old workings, or barriers of solid coal. Not common in Arkansas.

(2) A siding or station underground; a *parting*.

(3) (Arkansas) A railroad car of the gondola type for shipping coal.

Floor.—(1) The stratum of rock upon which a seam of coal imediately lies.

(2) That part of a mine upon which the miners walk or upon which the road bed is laid.

Fork.—A wide fork with many tines used for separating lump coal from slack when the coal is bad.

Frame Set.—The legs and cap or cross-bar arranged so as to support a passage mined out of the rock or coal seam; also called *framing* or *set*.

Frozen Coal.—(Arkansas) Coal which strongly adheres to the rock above or below it.

Fuse.—(1) A hollow tube filled with an explosive mixture for igniting cartridges. No longer made.

(2) Contraction for *safety fuse*, which see.

Gage Door.—A wooden door fixed in an airway for regulating the supply of ventilation necessary for a certain district or number of men. Called *regulator* in Arkansas.

Gallery.—A horizontal passage. Term rare in Arkansas.

Gallows Frame.—The frame supporting a pulley over which the hoisting rope passes to the engine.

Gangway.—The main haulage road or level. Commonly called *entry* in Arkansas.

Gas.—See *firedamp*. Any firedamp mixture in a mine is called *gas*.

Gate.—An underground road connecting a stall or breast with a main road. Not used in Arkansas.

Gateway.—(1) A road kept through the *goaf* in *longwall* mining.

(2) A gangway having ventilating doors.

Gathering Mule.—The mule used to collect the loaded cars for the separate working places, and to return empties.

Get a Clean-up.—To have an opportunity to *load out* all the coal a miner has loosened.

Goaf.—That part of a mine from which the coal has been worked away, and the space more or less filled up with waste. Rare in the United States.

Gob.—(1) Common American term for *goaf*.

(2) Any pile of loose waste in a mine.

(3) To leave coal and other minerals that are not marketable in the mine.

(4) To stow or pack any useless underground roadway with rubbish. *Gob entry*, a wide entry with a pile of brushing, middle band, or other *gob* along one side. *Gob fire*, spontaneous combustion underground of fine coal and slack in the gob. *Gob road*, a roadway in a mine carried through the goaf. *Gob room*, space for leaving gob. *Gob wall*, a rough wall of flat stones built to prevent the piles of gob from obstructing the passageway for air.

Gobbing Up.—Filling with waste.

Good Shooting Coal.—(Arkansas) Coal that can be shot *off the solid* with a large proportion of solid lump coal and little *slack*.

Gouging Shot.—(Arkansas) A gripping shot or opening shot used to make the first opening in a straight room face, or to start a break-through.

Grade.—(1) The amount of fall or inclination in ditches, flumes, roads, etc.

(2) A filling made in improving a roadway.

(3) To prepare a roadway of more uniform slope.

Grate Coal.—Coal which will pass through bars 3¼ to 4¼ in. apart and over round holes 2¾ in.; also called *broken coal*. Arkansas bars are 7 in. apart and the holes 3 in. to 3¼ in. in diameter.

Greaser.—(1) A person who oils or greases the mine cars.

(2) A slang name for a Mexican.

Grip.—To turn into the side of a working place.

Gripping Shot.—A shot so placed that the point or inner end of the hole is considerably further from the face of the coal to be broken than is the heel or outer end of the hole.

Grizzley.—A coarse screen made of parallel inclined bars along which the larger fragments slide by gravity; a *bar screen*.

Half Set.—One leg piece and a collar.

Hauling.—The drawing or conveying of the product of the mine from the working places to the bottom of the hoisting shaft, or slope.

Head Block.—(1) A stop at the head of a slope or shaft to stop cars from going down the shaft or slope.

(2) A *cap piece*.

Head Frame.—See *gallows frame*.

Heading.—(1) A continuous passage for air or for use as a manway; a *gangway* or *entry*.

(2) A continuous passage between two rooms, breasts, or other working places.

(3) (Arkansas) The narrow part of an entry near the working face.

Head Piece.—A *cap*; a *collar*.

Head Work.—(Arkansas) The cutting and other work done at the face of an entry.

Heaving.—The rising of the floor of a seam where the coal has been removed.

Heel.—The beginning or outer end of a blast hole, or the coal near this which will be loosened by the blast.

Heel of Coal.—A small body of coal left under a larger body as a support.

Hewer.—A collier that cuts coal; a *digger*. Not used in Arkansas.

High.—High coal is the miners' name for coal of a thick seam.

Hitch.—Notch or nick cut in the rock for holding cross-bars, beams, or timber etc., for various purposes.

Hogback.—A roll occurring in the floor and not in the roof, the coal being cut out or nearly so, for a distance.

Hole.—(1) To undercut a seam of coal by hand or machine.

(2) A bore hole.

(3) To make a communication from one part of a mine to another.

Holing.—(1) The portion of the seam or underclay removed from beneath the coal before it is broken down.

(2) A short passage connecting two roads.

Holing Through.—Driving a passage through to make connection with another part of the same workings, or with those in an adjacent mine.

Hood.—See *bonnet*.

Horizon.—That position in a series of rock formations occupied by any particular stratum.

Horseback.—(1) Natural channels cut or washed away by water in a coal seam, and filled up with shale and sandstone. Sometimes a bank or ridge of foreign matter in a coal seam.

(2) A mass of country rock lying within a vein or bed.

Horse Gin.—A gearing for hoisting by horsepower.

Horse Whim.—A vertical drum worked by a horse, for hauling or hoisting.

Hydraulic Cartridge.—A contrivance for wedging down coal by the pressure of a number of pistons driven forward by hydrostatic pressure.

Hydrocarbons.—Compounds of hydrogen and carbon.

Inbye.—In a direction inward toward the face of the working, or away from the entrance.

Incline.—Short for inclined plane. Any inclined heading or slope road or track having a general inclination or grade in one direction.

Indicator.—(1) A mechanical contrivance attached to hoisting, hauling, or other machinery, which shows the position of the cages in the shaft or the cars on an incline during its journey or run.

(2) An apparatus for showing the presence of firedamp in mines, the temperature of goaves, the speed of a ventilator, pressure of steam, air, or water, etc.

Inset.—The entrance to a mine at the bottom, or part way down a shaft where the cages are loaded.

Inside Parting.—(Arkansas) A side track or parting some distance from the beginning of a long entry, at which cars are left by a gathering driver. Also called a *swing parting.*

Inside Slope.—A slope on which coal is raised from a lower to a higher entry, but not to the surface.

Inspector.—A government official whose duties are to enforce the laws regulating the working of the mines.

Intake.—(1) The passage through which the fresh air is drawn or forced in a mine commencing at the bottom of a downcast shaft, or the mouth of a slope.

(2) The fresh air passing into a colliery.

Into the Solid, or *On the Solid.*—Said of a shot which goes into the coal beyond the point to which the coal be broken by the blast.

Jack.—(1) A jack-screw attached to a pointed pipe and used for holding an electric coal mining machine in position while at work.

(2) A pointed iron pipe wedged beneath the roof in a coal mine to hold the feed chain of a continuous electric coal cutter. Also called a *pipe jack.*

Jack, or *Powder Jack.*—A tin bucket with pouring spout in which powder in quantities of 5 to 12½ pounds is carried into the mine.

Jars.—In rope drilling, two long links which take up the shock of impact when the falling tools strike the bottom of the hole.

Jig.—(1) Self-acting incline.

(2) A machine for separating ores or minerals from worthless rock by means of their difference in specific gravity; also called a *washer.*

Jigging.—Separating heavy from light particles by agitation in water.

Joints.—(1) Divisional planes that divide the rock in a quarry into natural blocks. There are usually two or three nearly parallel series, called by quarrymen end points, back points, and bottom joints, according to their position.

(2) In coal seams, the less pronounced cleats or vertical cleavages in the coal. The shorter cleats, about at right angles to the face cleats and the bedding plane of the coal.

(3) (Arkansas) Any cleavage surface in a coal seam.

Jugglers.—Timbers set obliquely against the rib in a breast, to form a triangular passage to be used as a manway, airway, or chute. Practically limited to Pennsylvania.

Jump.—An upthrow or a downthrow fault.

Jumper.—A hand drill used in boring holes in rock for blasting.

Keeps.—Wings, catches, or rests to hold the cage at rest when it reaches any landing.

Key.—An iron bar of suitable size and taper for filling the keyways of shaft and pulleys so as to keep both together.

Kerf.—The undercut made to assist the breaking of the coal.

Kick-back.—(Arkansas.) To break the coal on both sides of the auger hole which contains the powder, usually along a joint in the coal.

Laborer.—(1) A man hired by the contract miner to assist him. Prohibited by the Union in Arkansas.

(2) Mine laborer, a man working for day wages in or about a mine; a *company man* distinguished from *digger* or *contractor.*

Lagging.—(1) Small round timbers, slabs, or plank, driven in behind the legs and over the collar, to prevent pieces of the sides or roof from falling through.

(2) Long pieces of timber closely fitted together and fastened to the drum rings to form a surface for the rope to wind on.

Lamp Men.—Cleaners, repairers, and those having charge of the safety lamps at a colliery. Not employed in Arkansas.

Lamp Stations.—Certain fixed stations in a mine at which safety lamps are allowed to be opened and relighted by men appointed for that purpose, or beyond which, on no pretense, is a naked light allowed to be taken.

Lander.—The man that receives a load of ore at the mouth of a shaft.

Landing.—(1) A level stage for loading or unloading a cage or skip.

(2) The top or bottom of a slope, shaft, or inclined plane.

Lap.—One coil of rope on a drum or pulley.

Larry.—(1) A car to which an endless rope is attached, fixed at the inside end of the road, forming part of the appliance for taking up slack rope.

(2) See *barney*.

(3) A car with a hopper bottom and adjustable chutes for feeding coke ovens.

Last of the Air.—(1) (Arkansas) That part of the air current which has passed through all the workings of the mine or split; the *outtake air*.

(2) (Arkansas) The working place of a mine or split nearest the outtake of the air, or which receives the last of the air current.

Latches.—(1) A synonym of switch. Applied to the split rail and hinged switches.

(2) Hinged switch points, or short pieces of rail that form rail crossings.

Launder.—Water trough.

Leader.—A seam of coal too small to be worked profitably, but often being a guide to larger seams lying in known proximity to it.

Leg.—(Arkansas) A prop used to support a horizontal timber such as a cross-bar.

Length of Shot.—The depth of the hole in which the powder is placed or the size of the block of coal to be loosened by a single blast measured parallel to the hole.

Lift.—(1) The vertical hight traveled by a cage in a shaft.

(2) The *lift of a pump* is the vertical distance from the level of the water in the sump to the point of discharge.

(3) The distance between the first level and the surface, or between two levels.

(4) The levels of a shaft or slope.

Lifting Guards.—Fencing placed around the mouth of a shaft, which is lifted out of the way by the ascending cage.

Lignite.—A coal of a peaty character, and a brown streak and containing much water.

Lime Cartridge.—A charge or measured quantity of compressed dry caustic lime made up into a cartridge and used instead of gunpowder for breaking down coal. Water is applied to the cartridge, and the expansion breaks down the coal without producing a flame.

Lines.—Plumb-lines, not less than two in number, hung from hooks driven in wooden plugs. A line drawn through the center of the two strings or wires, as the case may be, represents the bearing or course to be driven on. Called *sights* in Arkansas.

Lining Up a Mine.—Placing the sights for driving entries or rooms nearer the working face by surveying.

Lip Screen.—A small screen or screen bars, placed at the draw hole of a coal pocket to take out the fine coal.

Lively Coal.—(Arkansas) Brittle and generally hard coal which may be chipped off in good sized pieces while being undermined or sheared with a pick.

Loaded Track.—Track used for loaded cars.

Loader.—(1) One that fills the mine cars at the working places.

(2) (Arkansas) The man who loads coal at a certain price per ton after the coal has been undermined by machines. He also shoots the coal down and takes care of the working place.

Load Dropper or *Car Dropper.*—(Arkansas) A person who allows ears of loaded cars to run down a gently inclined track one at a time.

Load Out.—(Arkansas) To load into a car which will be taken out of a mine and emptied.

Loads.—Loaded mine cars.

Longwall.—A system of working a seam of coal in which the whole seam is taken out and no pillars left, excepting the shaft pillars, and sometimes the main-road pillars. *Longwall advancing*, mining the coal outward from the shaft pillar and maintaining roadways through the worked out portion of the mine. *Longwall retreating*, first driving haulage road and airways to the boundary of a tract of coal and then mining it in a single face without pillars back toward the shaft.

Loose End.—Coal prepared by cutting, or that coal which is certain to be loosened by a shot.

Low Coal.—(Arkansas) Coal occurring in a thin seam or bed.

Lump Coal.—(1) All coal (anthracite only) larger than broken coal, or, when steamboat coal is made, lumps larger than this size. In Arkansas called "*fancy lump*."

(2) (Arkansas) All coal passing over a standard bar screen, or *screened coal;* or any kind of coal containing less of the smaller sizes than such coal. *Railroad lump coal* has a less proportion of the slack removed and may contain all of the slack in excess of 25 per cent or in cases 15 per cent of the weight of the coal as mined.

Machine.—(1) A machine for undermining or shearing coal by power. *Pick machines* or *punchers* are driven by compressed air and strike the coal direct blows as with a hand pick. *Chain machines,* locally called *electric machines,* scrape out a cut in the coal by means of sharp points attached to a rapidly moving sprocket chain.

(2) (Arkansas) An augur attached to some kind of a post and fed forward with great force as it is rotated. Used in Arkansas only for drilling holes in shale. Also called a *post drill* or *ratchet drill.*

Main Rope.—In tailrope haulage, the rope that draws the loaded cars out.

Manager.—An official who has control and supervision of a mine, both under and above ground, and generally also of the sale of the product.

Man-hole.—(1) A refuge hole constructed in the side of a gangway, tunnel or slope.

(2) A hole in cylindrical boilers through which a man can get into the boiler to examine and repair it.

Manway.—A small passage used as a traveling way for the miner, and also often used as an airway or chute, or both.

Marble Drill.—(Arkansas) A prospecting drill containing a ball valve or marble by which the current of water with the cutting is made to rise in the drill; a drill of the type made by the Cyclone Drilling Machine Company.

Match.—(1) A charge of gunpowder put into a paper several inches long, and used for igniting explosives.

(2) The touch end of a squib.

Measures.—Strata.

Middle Band.—(Arkansas) A stratum of rock or more usually soft dirt near the middle of a coal seam.

Mine.—(1) Any excavation made for the extraction of minerals.

(2) To undermine the face of coal before it is wedged or blasted down.

(3) (Arkansas) To obtain the coal in working places in any way.

Miner.—(1) One who mines.

(2) A worker in a coal mine who is paid a certain price for each ton of coal he digs or blasts from the solid seam.

Mineral Oil.—Petroleum obtained from the earth, and its distillates.

Mining.—(1) In its broad sense, it embraces all that is concerned with the excavation of minerals and their complete utilization.

(2) (Arkansas) The excavation made in undermining a coal face.

(3) (Arkansas) A soft band of dirt in or beneath a coal seam in which a preliminary excavation can be readily made.

Mining Engineer.—A man having knowledge and experience in the many departments of mining.

Mining Retreating.—A process of mining by which the bed is untouched until after all the gangways, etc., are driven, when the mineral extraction begins at the boundary and progresses toward the shaft.

Mother Gate.—The main road of a district in longwall working.

Motive Column.—The length of a column of air whose weight is equal to the difference in weight of like columns of air in downcast and upcast shafts. The ventilation pressure in furnace ventilation is measured by the difference of the weights of the air columns in the two shafts.

Mouth.—The top of a shaft or slope, or the entrance to a drift or tunnel.

Naked Light.—A candle or any form of lamp that is not a safety lamp.

Narrow Work.—(1) All work for which a price per yard of length driven is paid, and which, therefore, must be measured.

(2) Headings, chutes, cross-cuts, entries, etc

Natural Ventilation.—Ventilation of a mine without either furnace or other artificial means, the heat being imparted to the air by the strata, men, animals, and lights in the mine, causing it to flow in one direction, or to ascend.

Neck.—A *room neck* is the narrow entrance to a room next to the entry, or a place where the room has been narrowed on account of poor roof.

Needle.—(1) A sharp-pointed metal rod with which a small hole is made through the stemming to the cartridge in blasting operations.

(2) A hitch cut in the side rock to receive the end of a timber.

Nick.—To cut or shear coal after holing. Not used in Arkansas.

Nicking.—(1) A vertical cutting or shearing up one side of a face of coal. Known as a *cutting*, or *cut* in Arkansas.

(2) The chipping of the coal along the rib of an entry or room which is usually the first indications of a squeeze.

Night Shift.—The set of men that work during the night.

Nip.—When the roof and floor of a coal seam come close together, pinching the coal between them.

Nogs.—Logs of wood piled one on another to support the roof. See *chock*. Known as *cribs* in Arkansas.

Normal Fault.—The ordinary type of fault or throw by which the rock layers upon the side of the fissure toward which it dips have been slipped down from the position they occupy on the other side. This leaves a strip along which each bed of rock or coal is wanting for a short distance and is the reverse of a thrust fault. Also called *tension fault* or *gravity fault*.

Notched.—(Arkansas) Framed to fit in position and hold together more securely as a 'notched set of timbers.'

Nut coal.—An abbreviation for chestnut coal, which is anthracite coal passing through a 2 in. round opening and over a 1 in, round opening. In Arkansas soft coal districts applied to all smaller lumps of coal separated from slack and fancy lump coal.

One-track Tipple.—A tipple having but one railroad track beneath it and used for preparing but one kind of coal.

On Sights.—Following sights placed by a surveyor.

On the Solid.—(1) Applied to a blast hole extending into the coal further than the coal can be broken by the blast.

(2) That part of a blast hole which can not be broken by the blast.

Open Cast.—Workings having no roof. Commonly called *open cut*.

Open Cuttings.—Any surface excavation.

Openings, An Opening.—Any excavation on a coal or ore bed, or to reach the same; a mine.

Opening Shot.—In shooting off the solid, the first shot fired in a straight face of coal. Called also *wedging shot* or *gouging shot*.

Operator.—The individual or company actually working a colliery.

Outburst.—A *blower*. A sudden emission of large quantities of occluded gas.

Outbye.—In the direction of the shaft or slope bottom, or toward the outside.

Outcrop.—The portion of a vein or bed, or any stratum appearing at the surface, or occurring immediately below the soil or diluvial drift.

Output.—The total amount of the product of a mine.

Outtake.—The passage by which the ventilating current is taken out of the mine; the *upcast*. Rare in Arkansas.

Overburden.—The covering of rock, earth, etc., overlying a mineral deposit that must be removed before effective work can be performed.

Overcast.—A passage through which the ventilating current is conveyed over a gangway or airway.

Overwind.—To hoist the cage into or over the top of the headframe.

Pack.—A rough wall or block of coal or stone built up to support the roof.

Packing.—The material placed in stuffing boxes, etc., to prevent leaks.

Pack Wall.—A wall of stone or rubbish built on either side of a mine road, to carry the roof and keep the sides up.

Panel.—(1) A large rectangular block or pillar of coal measuring, say, 130 by 100 yds.

(2) A group of breasts of rooms separated from the other workings by large pillars.

Parting.—(1) Any thin interstratified bed of earthy material in a coal seam.

(2) A side track or turnout in a haulage road.
Entry parting, the parting at the beginning of an entry in a slope mine. *Inside* or *swing parting*, a parting some distance from the mouth of an entry, from which the cars are hauled out by a special mule or team. *Rope parting* or *motor parting*, a parting on which trips of cars are collected for hauling out by a rope haulage system, or electric motor.

Pea Coal.—A small size of anthracite coal. In Arkansas coal which passes through a round hole 1 in. across and over a hole ½ in. across.

Peat.—The decomposed partly carbonized organic matter of bogs, swamps, etc.

Pentice.—A few pieces of timber laid as a roof over men's heads, to screen them when working in dangerous places, as at the bottom of shafts.

Picker.—(1) A small tool used to pull up the wick of a miner's lamp.
(2) A person who picks the slate from the coal in an anthracite breaker.
(3 A mechanical arrangement for removing slate from coal.

Picking Chute.—A chute in an anthracite breaker along which boys are stationed to pick the slate from coal.

Pick Machine.—A machine used to undermine or shear coal by heavy blows of short steel points attached to a piston driven forward and back by compressed air. Commonly called a *puncher*.

Pigeon Hole.—(Arkansas) (1) A room driven directly into the coal seam from the edge of a strip pit.
(2) Any small poorly equipped coal mine.

Pig-foot.—(1) An iron clamp shaped like a pig's foot used to attach the 'jack' to the feed chain of a continuous electric coal cutter.
(2) A pipe jack with a pig-foot at one end.

Pillar.—A portion of the coal left to hold up the rock over a mine.

Pipe Jack.—An iron pipe with a clamp or pig-foot upon one end and a curved point upon the other. It is wedged between the floor and roof of a mine room to hold the feed chain of a continuous electric coal mining machine.

Pit.—(1) A shaft.
(2) The underground portion of a colliery, including all workings. Used in many combinations, as pit car, pit clothes, etc. *Pit lamp* or *pit light* is the open lamp a miner wears upon his head as distinguished from a *safety lamp*, *acetylene lamp*, or *electric light*. *Pit room*, the extent of the opening in a mine; pit space. The *pit boss* has charge of the surface work at the mine as well that in the mine. *Pit committee* (Arkansas) a committee of three mine workers elected by the Local Union to confer with the pit boss or superintendent in case of disputes between them and any miner.

Pitch.—Used for inclination or dip.

Place.—The part of a mine in which a miner works by contract is known as his "place" or "working place."

Plane.—An inclined road along which coal is hauled by a rope attached to an engine. In Arkansas limited to planes down which the loaded cars run by gravity while the empties are pulled up by the engine or the extension or such a working on which cars must be hauled both ways.

Plant.—The shafts or slope, tunnels, engine houses, railways, machinery, workshops, etc., of a colliery or other mine.

Plenum.—A mode of ventilating a mine or a heading by forcing fresh air into it.

Point.—The inner end of a shot or auger hole for a shot.

Pocket.—(1) A thickening out of a seam of coal or other mineral over a small area.
(2) A hopper-shaped receptacle from which coal or ore is loaded into cars or boats.
(3) A small mass of mineral.
(4) (Arkansas) A *pocket of gas* is a small accumulation of gas.

Post.—(1) Commonly used in the metal mines instead of *leg*. which is the coal miner's term.
(2) The support fastened between the roof and floor of a coal seam used with certain types of mining machines or augers.

Post-drill.—An auger supported by a post.

Post-puncher.—A coal mining machine of the puncher type supported by a post.

Pot.—A rounded mass of roof slate resembling in shape an iron pot and easily detached. It is separated from the others by old mud cracks.

Potty.—(1) Containing pots.

(2) (Arkansas) Applied to any roof in a coal mine which falls down in thick blocks.

Pricker.—(1) A thin brass rod for making a hole in the stemming when blasting, for the insertion of a fuse.

(2) A piece of bent wire by which the size of the flame in a safety lamp is regulated without removing the top of the lamp.

Prepare a Shot.—(1) To shear or undermine the coal so that it can be readily blasted loose.

(2) (Arkansas) To make a cartridge for a blast.

(3) (Arkansas) To charge a blast hole.

Prop.—A wooden or cast-iron temporary support for the roof. *Breaking prop* (Arkansas), one of a row of props of sufficient strength to cause the rock above the coal to break and so limit the area of top brought down by a brushing shot.

Propping.—The timbering of a mine.

Prospect.—To examine land for the possible occurrence of coal or other valuable minerals by drilling holes, ditching, or other work.

Prove.—To ascertain, by boring, driving, etc., the position and character of a coal seam, a fault, etc.

Puddle.—Earth well rammed into a trench, etc., to prevent leaking.

Pulling Pillars.—The common expression used in Arkansas for mining the coal in the pillars of a mine; *robbing pillars.*

Pump Station, or *Pump Room.*—An enlargement made in the shaft, slope, or entry, to receive the pump.

Puncher.—A *pick machine* used to undermine or shear coal by heavy blows of sharp steel points attached to a piston driven forward and back by compressed air.

Pusher.—A person regularly employed to push mine cars from one place to another. He usually assists the diggers to push cars up into steep rooms.

Pyrites.—Sulphide of iron. Called *sulphur* by the miners.

Rashing.—Soft scaly slate or earth beneath a coal seam, often containing much carbonaceous matter.

Recovery.—The proportion of coal in the ground which is extracted.

Refuge Hole.—A place formed in the side of an underground plane in which a man can take refuge during the passing of a train, or when shots are fired.

Regulator.—An obstruction placed in an airway and containing an opening which can be made larger or smaller to regulate the quantity of air current sent to any part of a mine.

Rests.—Supports on which a cage rests when the loaded car is being taken off and the empty one put on.

Return.—The air-course along which the vitiated air of a mine is returned or conducted back to the upcast shaft.

Reverse Fault.—See *thrust fault.*

Rib.—(1) The side of a pillar.

(2) The side of any entry or other working place.

Rib Shot.—A shot next to a rib.

Ride Over.—(Arkansas) A squeeze *rides over* a pillar when it extends into the workings beyond the pillar.

Rider.—(1) A thin seam of coal overlying a thicker one.

(2) A person who rides with the trains of cars, as *rope-rider, trip-rider.*

Ring.—(1) A complete circle of tubbing plates around a circular shaft.

(2) Troughs placed in shafts to catch the falling water, and so arranged as to convey it to a certain point.

Rise.—The inclination of the strata, when looking up hill. *To the rise,* directly up hill in a dipping coal seam.

Rise Workings.—Underground workings carried on to the rise or high sides of the shaft.

Roll.—An inequality in the roof or floor of a mine.

Rob.—(1) To mine the pillars of coal, to *pull* or *draw* them.

(2) (Arkansas) To leave the pillar too narrow for sufficient support.

Roll.—An inequality in the roof or floor of a mine.

Roller.—A small steel, iron, or wooden wheel or cylinder upon which the hauling rope is carried just above the floor.

Rolls.—Cast-iron cylinders, either plain or fitted with steel teeth, used to break coal and other materials into various sizes.

Room.—A wide working place in a mine, formed by the removal of coal and having no special purpose.

Room-and-Pillar.—The system of working the coal out in rather wide rooms with pillars of solid coal between them. The common American term for *pillar-and-breast; broad-and pillar; pillar-and-stall,* etc., used indifferently for all relative sizes of rooms and pillars.

Rope.—A steel rope used for hauling trains of cars in a mine.

Rope-Rider.—A person who rides with the trains of cars attached to a rope for engine haulage. Also called *trip-rider.*

Rope Trip.—A trip of cars handled by a rope.

Rubbing Surface.—The total area of a given length of airway; that is, the area of top, bottom, and sides added together, or the perimeter multiplied by the length.

Run.—(1) The sliding and crushing of pillars of coal.
(2) The length of a lease or tract on the strike of the seam.
(3) The interval of time during which a mine is in operation.

Safety Catches.—Appliances fitted to cages to prevent them from falling to the bottom of the shaft if the rope breaks.

Safety Fuse.—A cord with slow-burning powder in the center for exploding charged blast holes. Commonly called *"fuse."*

Safety Lamp.—A miner's lamp in which the flame is protected in such a manner, usually by a wire gauze, that an explosive mixture of air and fireclamp can be detected by the mixture burning inside the gauze, without danger of igniting the mixture outside of the lamp.

Sag.—A depression in a coal seam, rope, mountain range, etc.

Sand Pump.—A sludger; a cylinder provided with a stem (or other) valve, lowered into a drill hole to remove the pulverized rock.

Scale.—The rate of wages to be paid, which varies under certain contingencies.

Scoop.—A large-sized shovel with a scoop-shaped blade.

Scraper.—(1) A tool for cleaning the dust out of the bore hole.
(2) A mechanical contrivance used at collieries to scrape the clum or slack along a trough to the place of deposit.

Screen.—(1) A mechanical apparatus for sizing materials.
(2) A cloth brattice or curtain hung across a road in a mine, to direct the ventilation. *Standard screen,* the screen for removing some of the slack from coal before it is weighed. The standard screen specified in the agreement betwen the operators and miners of Arkansas is a screen 6 ft. wide and 16 ft. long, composed of continuous bars ⅝ in. wide with spaces between them 1⅛ in. across.

Screened Coal.—(1) Coal which has passed over any kind of a screen and therefore consists mainly of the larger sizes.
(2) Specifically coal which is weighed and credited to the miner after passing over a standard screen.

Scrub Water.—(Arkansas) Sof t water supplied to mining camps for bathing and laundry purposes.

Sealing.—Shutting of all air from a mine or a part of a mine by stoppings.

Seam.—(1) Synonymous with *bed,* etc.
(2) A plane in a coal bed at which the different layers of coal are easily separated.

Seam-out.—To merely blow out a soft stratum in the coal, or escape through a seam without loosening the main mass of coal. In Arkansas, called *squeal out.*

Seamy.—Full of seams so as to be difficult to blast.

Second Working.—The operation of getting or working out the pillars formed by the first working.

Self-Acting Plane.—An inclined plane upon which the weight or force of gravity acting on the full cars is sufficient to overcome the resistence of the empties; in other words, the full car, running down, pulls the other car up.

Set.—(1) To fix in a place a prop or sprag.
(2) A train of mine cars, called a *trip* in Arkansas.

Set of Timber.—The timbers which compose any framing, whether used in a shaft, slope, level, or gangway.

Shackle.—A *U*-shaped link in a chain closed by a pin; when the latter is withdawrn the chain is severed at that point.

Shaft.—A vertical hole through the strata from the surface of the ground to a coal seam and used for hoisting coal or the passage of an air current, or for an escape way.

Shaft Pillar.—Solid material left unworked beneath buildings and around the shaft, to support them against subsidence.

Shale.—(1) Strictly speaking, all argillaceous strata that split up or peel off in thin laminæ.

(2) A laminated and stratified sedimentary deposit of clay, often impregnated with bituminous matter. Called *slate* by the coal miners.

Shearing.—Cutting a vertical groove in a coal face or breast. Called in Arkansas a *cut* or *cutting*.

Sheave.—A wheel with a grooved circumferance over which a rope is turned either for the transmission of power or for winding or hauling.

Shelly.—A name applied to coal that has been so crushed and fractured that it easily breaks up into small pieces. The term is also applied to a laminated roof that sounds hollow and breaks into thin layers of slate or shale.

Shift.—(1) The number of hours worked without change.

(2) A gange or force of workmen at one time upon any work, as the day shift, or the night shift.

Shoot.—To break rock or coal by means of explosives.

Shooting-off the Solid.—Obtaining the coal by mere blasting without undermining or shearing it. The common Arkanass' method of working rooms.

Shore Up.—To stay, prop up, or support by braces.

Shot.—(1) A charge or blast.

(2) The firing of a blast.

(3) Injured by a blast.

Balanced shot, a shot so placed that the hole containing the powder is parallel to one face of the coal to be broken. *Blown-out shot,* a shot which merely throws out the tamping without loosening much coal. *Cutting shot*, a shot arranged to loosen the coal prepared by the cutting and to scatter the coal in advance to facilitate the making of another cutting. *Gouging shot* (Arkansas) a gripping shot or opening shot used to make the first opening in a straight room face, or to start a break-through. *Gripping shot,* a shot which is farther from the face of the coal at the point than at the heel; also called *wedging shot*. *Opening shot,* the first gripping shot fired, in a straight face of coal. *Slitting shot,* a shot put into a large mass of coal detached by a previous blast. *Windy shot,* a shot which causes a concussion in the air, usually by an excessive amount of powder behind an easily loosened mass of coal.

Shot-firer, or *Shot-lighter.*—One of two or more persons hired to fire the shots in the more dangerous mines after all the other men have left the mine.

Shutter.—(1) A movable sliding door, fitted within the outer casing of a Guibal or other closed fan, for regulating the size of the opening from the fan, to suit the ventilation and economical working of the machine.

(2) A slide covering the opening in a door or brattice, and forming a regulator for the proportionate division of the air-current between two or more districts of a mine.

Side Chain.—A chain hooked on to the sides of cars running on an incline or along a gangway, to keep the cars together in case the coupling breakes.

Siding.—A short piece of track parallel to the main track, to serve as a passing place.

Sight.—(1) A bearing or angle taken with a compass or transit when making a survey.

(2) Any established point of a survey.

Sights.—Bobs or weighted strings hung from two or more established points in the roof of a room or entry, to give direction to the men driving the entry or room.

Sill.—The floor piece of a timber set, or that on which the track rests; the base of any framing or structure.

Sing.—The noise made by a feeder of gas issuing from the coal. Rarely used in Arkansas.

Singing Coal.—Coal from which gas is issuing with a hissing sound.

Single-entry System.—A system of opening a mine by driving a single entry only, in place of a pair of entries. The air-current returns along the face of the rooms, which must be kept open.

Sink.—To excavate a shaft or slope; to bore or put down a bore hole.

Sinker.—A man who works at the bottom of a shaft or face of a slope during the course of sinking. Known in Arkansas as *shaft sinker* in a shaft.

Siphon.—A closed pipe for raising water over a low hill to a lower position on the other side, operated by gravity.

Skip.—(1) A mine car.

(2) A car for hoisting out of a slope.

(3) A thin slice taken off from a breast or pillar or rib along its entire length or part of its length. Called *slab* in Arkansas.

Skirting.—Road opened up or driven next a fall of stone, or an old fallen place. Also called *slab* in Arkansas.

Slab.—(1) Split pieces of timber from 2 in. to 3 in. thick, 4 ft. to 6 ft. long, and 7 in. to 14 in. wide, placed behind sets or frames of timber in shafts or levels.

(2) Pieces of wood sawed on the sides of a log.

(3) A skip taken off the rib of an entry, or room.

Slack.—(1) Fine coal that will pass through the smallest sized screen. The fine coal and dust resulting from the handling of coal, and the disintegration of soft coal. In the soft coal districts of Arkansas, this includes all coal which will pass between bars 1⅛ in. apart. In the semi-anthracite district it includes all coal which passes through a ½ in. round hole.

(2) The process by which soft coal disintegrates when exposed to the air and weather.

Slant.—(1) An underground roadway at an angle between the full rise or dip of the seam and the strike or level.

(2) Any inclined road in a seam.

(3) The short inclined crosscut connecting the entry with its air-course to facilitate the hauling out of the coal. More commonly called a *dip switch* when the coal seam is not level.

Slate.—(1) A hardened clay having a peculiar cleavage.

(2) About coal mines, slate is any shale accompanying the coal, also sometimes applied to bony coal.

Slate Picker.—(1) A man or boy that picks the slate or bony coal from anthracite coal.

(2) A mechanical contrivance for separating slate and coal.

Sliding Scale.—(1) A mode or regulating the wages paid working-men by taking as a basis for calculation the market price of coal, the wages rising and falling with the state of trade.

(2) (Arkansas) A method of paying for the coal in proportion to the amount of lump coal it contains.

Slip.—(1) A fault.

(2) A smooth joint or crack where the strata have moved upon each other.

(3) (Arkansas) A joint in the coal upon which there may have been no perceptable movement.

Water slip, a slip from which water flows.

Slope.—(1) A plane or inclined roadway, usually driven in the seam from the surface.

(2) Any inclined haulage-way upon which the coal is hauled by power, whether it reaches to the surface or not. Distinguished from a *plane* down which the coal is lowered. *Rock slope,* a slope driven through rock strata. *Slope air-course,* a passageway parallel to the slope used for the passage of the air-current.

Small Bottom.—A local term used at Jennp Lind for the smaller part of the bottom bench of the coal seam. This is below the *top bottom* and separated from it by a smooth seam.

Smoke Room.—(Arkansas) An entry air-course driven room width.

Snubbing.—(Arkansas) Increasing the hight of a mining by picking down the lower layer of coal.

Socket.—(1) The innermost end of a shot hole, not blown away after firing.

(2) A wronght-iron contrivance by means of which a wire rope is securely attached to a chain or block.

Solid.—(1) Coal which has not been undermined, sheared, cut, or otherwise prepared for blasting. Used in the expression, '*Shooting off the solid.*'

(2) That part of the coal which can not be thrown out by a single shot or the coal beyond the *loose end*. Used in expressions describing holes drilled for blasting as, '3 ft. into the solid,' or 'on the solid.'

Sollar.—A wooden platform fixed in a shaft, for the ladders to rest on.

Sounding.—(1) Knocking on a roof to see whether it is sound or safe to work under.

(2) Rapping on a pillar so that a person on the other side of it may be signaled to, or to enable him to estimate its width.

Spike-team.—(Arkansas) A tandem team of mules hauling coal.

Spiles.—A temporary lagging driven ahead on levels in loose ground. Short pieces of planking sharpened flatways, and used for driving into watery strata as sheet piling, to assist in checking the flow.

Splint Coal.—A laminated, course, inferior, dull-looking, hard coal, producing much white ash, intermediate between cannel and bituminous coal.

Split.—(1) To divide an air-current into two or more separate currents.

(2) Any division or branch of the ventilating current.

(3) The workings ventilated by that branch.

(4) Any member of a coal bed split by thick partings into two or more seams.

(5) A bench separated by a considerable interval from the other benches of a coal bed.

Splitting Shot.—(Arkansas) A shot put into a large mass of coal detached by a previous blast.

Spoon.—A slender iron rod with a cup-shaped projection at right angles to the rod, used for scraping drillings out of a bore hole.

Sprag.—(1) A short wooden prop set in a slanting position for keeping up the coal during the operation of holing.

(2) A short round piece of hard wood, pointed at both ends, to act as a brake when placed between the spokes of a mine-car wheel.

(3) (Arkansas) Heavy slanting props wedged against the coal to prevent it from flying when blasted.

Spragger.—One who tends to the spragging of cars, as at the shaft bottom.

Sprag Road.—A mine road having such a sharp grade that sprags are needed to control the speed of the car.

Spring Latch.—The latch or tongue of an automatic switch, operated by a spring at the side of the track.

Spring Pole.—An elastic wooden pole from which boring rods are suspended.

Spring.—To enlarge a blast hole by the explosion of a small quantity of dynamite in it, in order to make it contain more explosives.

Squealy Coal.—(Arkansas) Seamy coal from which the powder often seams out with a squealing sound.

Squeeze.—An extensive and slowly spreading crushing of the mine pillars and settling of a strong roof.

Squib.—A straw, rush, paper, or quill tube filled with priming of gunpowder, with a slow match on one end, used for lighting a blast by the use of a needle or blasting barrel.

Stamp.—(Arkansas) A mark from which the pit boss measures the length of the working place for figuring yardage.

Standing Gas.—A body of firedamp known to exist in a mine, but not in circulation; sometimes fenced off.

Steamboat Coal.—In anthracite only, coal small enough to pass through bars set 6 to 8 in. apart, but too large to pass through bars from 3 to 5 in. Comparatively few collieries make steamboat coal except to fill special contracts or orders. This size is called grate coal in Arkansas, and forms the chief output of the semi-anthracite mines.

Stem.—The heavy iron rod to which the bit is attached in deep drilling by the rope method.

Stemming.—(1) Fine shale or dirt put into a shot hole after the powder, and rammed hard.

(2) Tamping a shot.

Sticky Coal.—(Arkansas) Coal strongly adhering to a hard stratum of rock above or below it; *frozen coal.*

Stove Coal.—In anthracite only; two sizes of stove coal are made, large and small; large stove, known as No. 3, passes through a 2¼ to 2 in. mesh and over 1⅞ in, to 1½ in. mesh; small stove, known as No. 4, passes through a 2 to 1⅜ in. mesh and over a 1⅛ in. to 1 in. mesh. Only No. 4 is made at most of the mines at Spadra; only No. 3 at Russellville.

Stow.—To pack away rubbish into goaves or old workings.

Stratification.—An arrangement in layers.

Stratum.—A layer or bed of rocks, or other deposit.

Streak.—The color of the mark made when a mineral is scratched against a white surface.

Strike (of a seam or vein).—The intersection of an inclined seam or vein with a horizontal plane. A level course in the seam. The direction of strike is always at right angles to the direction of the dip of the seam.

Strip.—(1) To remove the overlying strata of a bed or vein.

(2) To mine a deposit by first taking off the overlying material.

Strip-Pit.—A coal mine worked by stripping.

Studdle.—A piece of square timber placed vertically between two sets of timbers in a shaft.

Stump.—The pillar between the gangway and each room turned off the gangway. Sometimes the entry pillars are called *stumps.*

Sulphur.—(1) One of the elements.

(2) Iron pyrites, occurring in coal seams.

Sulphide.—The combination of sulphur and a base.

Sump.—A catch basin into which the drainage of a mine flows and from which it is pumped to the surface.

Sunshine, or *Miners' Sunshine.*—(Arkansas) The trade name of a soft grade or paraffin wax with a low melting point. It can be burned in an ordinary pit lamp with a nail (usually copper) in the wick and gives little smoke.

Swing or *Swing Loose.*—(Arkansas) To gradually loosen over a considerable area and sag. Said of the rock over a mine working place.

Swing Parting.—(Arkansas) A parting some distance from the mouth of an entry. The loaded cars are left here by the gathering driver to be taken out by a *swing driver,* with a *swing mule* or a *spike team.*

Swag.—An Arkansas form of sag.

Swamp.—A depression or natural hollow in a seam; a *basin.*

Switch.—(1) The movable tongue or rail by which a train is diverted from one track to another.

(2) The junction of two tracks.

(3) A movable arm for changing the course of an electrical current.

Syncline.—A fold in the rock with the concave side upward; a *basin.* The trough of a fold in the rocks.

Tail-rope.—(1) In a tail-rope system of haulage, the rope that is used to draw the empties back into the mine.

(3) A wire rope attached beneath cages, as a balance.

Take Up Bottom.—(Arkansas) To remove rock from the floor of a roadway to increase the hight; *bottom brushing.*

Take the Air.—(1) To measure the ventilating current.

(2) Applied to a ventilating fan as working well, or working poorly.

Tally.—(1) A mark or number placed by the miner on every car of coal sent out of his place, usually a tin ticket. By counting these, a tally is made of all the cars of coal he sends out. Called a *check* in Arkansas.

(2) Any numbering, or counting, or memorandum, as a tally sheet.

Tamp.—To fill a bore hole, after inserting the charge, with some substance which is rammed hard as it is put into the hole.

Telegraph.—A sheet-iron trough-shaped shute, for conveying coal or slate from the screens to the pockets, or boilers.

Temper Screw.—In rope drilling, a screw for gradually lowering the clamped (upper) end of the rope as the hole is deepened.

Tension Fault or *Gravity Fault.*—See *normal fault.*

Three-track Tipple.—A tipple having three railroad tracks beneath it and used for preparing three kinds of coal.

Throw.—(1) A geological fault or displacement of the rock.

(2) The vertical distance between two edges of a faulted bed or coal or rock.

Thrust.—A *squeeze.*

Thrust Fault.—A displacement of the rocks along a fissure in such a way that the edge of a layer of rock on one side of the fissure overlaps the edge of the same layer over the other side. This is believed to be caused by horizontal pressure and is the common type of 'throw' found in the coal mines south of the Arkansas River. Also called *reverse fault.*

Tipper, or *Tipple.*—An apparatus for emptying cars of coal or ore, by turning them upside down, and then bringing them back to the original position, with a minimum of manual labor.

(2) (Arkansas) Any device for emptying mine cars. Tipple is the common name.

Tipple.—The dump trestle and tracks at the mouth of a shaft or slope, where the output of a mine is dumped, screened, and loaded.

Toe.—The inner end of a shot. Also called *point.*

Top.—Mine roof. *Top coal,* the upper part of a coal bed separated from the rest by a seam or parting. *Top bottom* (Arkansas), the upper part of the bottom bench of a coal bed.

Train, or *Trip*.—The cars taken at one time by mules, or by any motor, or run at one time on a slope, plane, or sprag road, always together. *Trip* is the term used in Arkansas.

Tram.—A mine car, or the track on which it runs.

Trammer.—One who pushes cars along the track. In Arkansas known as a *pusher*.

Trapper.—A boy employed underground to tend doors.

Tree.—(Arkansas) A thick log used as a prop in heavy ground.

Trip.—The mine cars in one train. See *train*.

Tripple-entry System.—A system of opening a mine by driving three parallel entries for the main entries.

Trommel.—A drum, consisting of a cylinder- or cone-shaped sheet-iron mantle (generally punched with holes) that revoles; used for washing or sorting ores.

Trouble.—A dislocation or fault; any irregularity in the bed.

Truck System.—Paying miners in food instead of money.

Tub.—(1) A mine car.

(2) An iron or wooden barrel used in a shaft, for hoisting material. Called *car* or *bucket* in Arkansas.

Tubbing.—Cast-iron, and sometimes timber, lining or walling of a circular shaft.

Tunnel.—A horizontal passage driven across the measures and open to day at both ends; applied also to such passages open to day at one end, or not open to day at either end.

Turn.—(1) The hours during which coal, etc., is being raised from the mine. Called *run* in Arkansas.

(2) To open rooms, headings, or chutes off from an entry or gangway.

(3 The number of cars allowed each miner. *Good turn*, many cars for each miner.

Turnout.—A siding or passing on any tram or haulage road.

Turn Out.—(Arkansas) To shovel coal towards the track for more convenient loading.

Twin Entries.—A pair of entries close together and carrying the air current in and out, so laid out that rooms can be worked from both entries. Often called in Arkansas *double entries*.

Two-track Tipple.—A tipple having two railroad tracks beneath it and used for preparing two kinds of coal.

Undercast.—An air-course carried under another air-course or roadway.

Underclay.—A bed of fireclay or other less clayey stratum, lying immediately beneath a seam of coal.

Undercut.—*Undermine, hole*, or *mine*. *Mine* is the common Arkansas term.

Upcast.—The shaft through which the return air ascends.

Upthrow.—The side of a fault or *throw* upon which the displacement has been upwards.

Vein.—A tabular mass of mineral, deposited from liquid solutions, often applied incorrectly to a seam or bed of coal or other mineral.

Vent.—(1) A small passage made with a needle through the tamping, which is used for admitting a squib, to enable the charge to be lighted.

(2) Any opening made into a confined space.

Ventilation.—*Circulation*. The asmospheric air circulating in a mine.

Volatile Combustible.—That part of the combustible matter of coal which is driven off when the coal is heated in a closed vesssel, chiefly compounds of hydrogen and carbon.

Walling.—The brick or stone lining of a shaft.

Wall Plates.—The two longest pieces of timber in a set used in a rectangular shaft.

Washery, or *Coal Washer*, or *Slack Washer*.—Machinery for separating by the aid of water the impurities from coal.

Washer.—A *jig*.

Water-Box.—A square open wooden tank car used for removing small amounts of water from low places in a mine. Also the tank car used for sprinkling roadways to settle the dust.

Water Cartridge.—A waterproof cartridge surrounded by an outer case. The space between being filled with water, which is employed to destroy the flame produced when the shot is fired, thereby lessens the chance of an explosion should gas be present in the place.

Water Gage.—An instrument for measuring the pressure per square foot producing ventilation in a mine.

Water Grade.—(1) The inclination of an entry which is just sufficient to drain off the water or 6 in. to 12 in. in 100 ft.

(2) A grade determined by keeping the working place nearly parallel to the edge of the pool of water standing

upon its floor. Water grade is sometimes incorrectly called *water level.*

Water-slip.—(Arkansas) A crack or dislocation in the roof of a coal mine from which a considerable water flows.

Water Yardage.—(Arkansas) Extra payment to the miners who work in a wet place either by the yard of progress or the ton of coal mined or rarely the day of time.

Weather.—To crumble by exposure to the atmosphere.

Wedging.—The material, moss or wood, used to render the shaft lining tight.

Wedging Shot.—(Arkansas) An *opening shot.*

Wedging Down.—Breaking down the coal at the face with hammers and wedges instead of by blasting.

Weigh Basket, or *Weigh Pan.*—Any receptacle in which the coal is weighed after it is dumped from the pit cars.

Whim.—A winding drum worked by a horse.

Whip.—A hoisting appliance consisting of a pully supporting the hoisting rope to which the horse is directly attached.

Whitedamp.—Carbon monoxide (CO). A gas found in coal mines, generally where ventilation is slack. It is extremely poisonous.

Wind Gage.—An anemometer, for testing the velocity of air in mines.

Windy Shot.—(Arkansas) A shot which causes a concussion in the air, usualy by an excessive amount of powder behind an easily loosened mass of coal.

Wings.—See *rests* and *keeps.*

Work.—(1) To mine.

(2) To crumble and yield under the action of a squeeze. Applied to pillars or roof of a coal mine.

(3) To be slowly closing under the action of a squeeze. Applied to portions of the mine workings.

Workable.—Any seam that can be profitably mined.

Worked Out.—When all available mineral has been extracted from a mine, it is worked out.

Working Cost.—The total cost of producing the mineral.

Working Face.—See *face.*

Working Home.—Getting or working out a seam of coal, etc., from the boundary or far end of the mine toward the shaft bottom.

Working Place.—The place in a mine at which the coal is being actually mined.

Workings.—The openings of a colliery inculding all roads, rooms, levels, dips, airways, etc.

Woody.—(Arkansas) Having the consistency of partially decayed wood.

Yardage.—(1) Price paid per yard for cutting coal.

(2) The extra compensation a miner receives in addition to the mining price for working in a narrow place or in deficient coal. Usually at such a price per yard the working is advanced.

Yield.—The proportion of a seam sent to market; the recovery.

The Geological Survey

OF

ARKANSAS

Coal Mining in Arkansas
PART II

BY A. A. STEEL, B. S. in C. E., E. M.

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LITTLE ROCK
DEMOCRAT PRINTING & LITHOGRAPHING CO.
1912

LETTER OF TRANSMITTAL

To the Chairman, Governor George W. Donaghey, and Members of the Geological Commission of Arkansas:

Gentlemen: I have the honor to submit to you herewith, Part II of the report on Coal Mining in Arkansas.

Respectfully yours,

A. H. PURDUE.

State Geologist.

~~University of Arkansas,~~
Nashville, Tennessee.
July 6, 1912.

Coal Mining in Arkansas

PART II

INTRODUCTION

In recommending changes in Arkansas coal-mining methods, three objects are to be kept in view. In the order of their importance to the State at large, these are, first, a reduction in the number of accidents to the miners and in the amount of sickness among them; second, a reduction in the loss of coal and improvement in its quality as placed upon the market; and, lastly, a decrease in the cost of mining the coal. These objects all come under the head of conservation and may be called the conservation of the health and safety of the miners, the conservation of the coal, and the conservation of the expense of mining it.

An increase in the cost of mining coal and, therefore, in its cost to the consumers, is generally recognized as the price of increased safety. Therefore, some safeguards to the miners will be suggested here, even though they increase the cost of the coal. Such changes will but little more than place Arkansas abreast of neighboring states in which the competing coal-mines are situated and in which the coal-mining regulations are steadily being made more stringent. At the best, there will still be accidents as long as miners, operators, and mine inspectors are human and careless, and as long as some of the causes of accidents are as obscure as at present.

The complete recovery of the coal in mining will increase the cost of the coal and, in many cases, the danger to the miners also. There are, however, many changes which, it is believed, will reduce the waste of coal without additional danger to the miners, and without an increase in the final cost to the mine owner. This discussion will be restricted to such methods, because it is useless to recommend others until a constitutional and practicable method of state supervision of mining has been devised. Economies in mining will be considered that do not increase the danger to the men, do not cause greater waste of coal, and do not reduce the wages of the individual miners.

Many changes in mining methods and equipment will result in a saving of money as well as a saving of the coal or the lives of the miners. These changes might, therefore, be discussed in order of the extent of variation from present methods, but it is thought best to group them in accordance with the main object of each change, with repetition when necessary. As the least restricted by the others, the welfare of the miners is considered first. The conservation of the coal must then be considered before the methods of reducing mining costs can be fully discussed.

CHAPTER IX

CONSERVATION OF THE HEALTH AND SAFETY OF THE MINERS

MINING LAWS.

Kinds of accidents. Mine accidents, especially in the United States, are caused chiefly by the carelessness of the victims, who take needless risks, sometimes through ignorance of the danger, but more often for the sake of saving time, labor, or expense. Variable proportions of the remaining accidents are caused by the carelessness of the mine operator or his officials, by the carelessness of the fellow employees of the victim, or by the hazard of the industry.

The hazard of the industry. The hazard of the industry of coal mining is shown by the accidents that are unexpected or whose causes are unknown. These accidents are as yet unavoidable and are a part of the price the community pays for its coal. They are being reduced in number as our knowledge is increased by constant study and investigation. This work is done mostly by the various state and government organizations and the technical associations of mining men. To reduce these accidents, such study should be liberally supported.

Carelessness of the operators. The accidents due to carelessness can be largely prevented by the constant education of all persons connected with mining, as to the cause and prevention of accidents, and by enacting and enforcing laws preventing carelessness. Sickness among the miners can be reduced in a similar way. The existing laws and especially the heavy cost of the damages exacted for accidents have largely checked the carelessness of the operators. As the causes of accidents and sickness become better known, the hazard of the industry can be reduced by amending the mining regulations from time to time to throw the burden of preventing accidents upon the operators if possible. The cost will then come upon the consumer of the coal as it should. Rigid enforcement of such regulations will protect the miner from the carelessness of the operators.

Carelessness of the miners. Most of the states of this country also have laws designed to protect the miner from the carelessness of himself or of his fellows. The strict enforcement of similar laws largely explains the low accident rate of Great Britain and other European countries. In this country, there is unfortunately a feeling that a man should be allowed to run any risk he wishes regardless of those dependent upon him for support. In the mines, this is often extended to permit a careless miner to jeopardize his mates. This attitude causes the miners to resent any but the most obvious regulations governing their own conduct. Owing to the political power of the miners, most mine inspectors dare not enforce any of the more paternal regulations. Nevertheless, it seems advisable to try to secure the proper laws, and then begin to educate the miners and the public sufficiently to allow the laws to be enforced.

Sickness among the miners. The enforcement and enactment of laws preventing sickness is still more difficult because of the greater obscurity of the causes. The example of some of the energetic state and city boards of health is very encouraging. The special problems of the mines must await the solution of the more general health problems of the State.

Changes in the laws. The most necessary changes in the Arkansas mining laws have been fully discussed in Chapter VI, Part I. The great increase in the accidents following the change in mining methods induced by the mine-run law was indicated on page 274. It is hoped that the recommendations in Chapters VI and VII can be immediately carried out. Then, as soon as the industrial situation warrants it, the more stringent regulations here mentioned may be successively enacted into law. If done slowly to keep pace with neighboring states, this will cause no hardship to the mining industry.

SLIGHT IMPROVEMENTS IN HEALTH CONDITIONS.

Smoky lights. The injury caused by the burning of smoky oil was pointed out on page 153. Better light is greatly needed to reduce the accidents from falls of roof, and the matter will be discussed under that head.

Dust. Most of the dust of the coal mines is caused by the drying effect of the ventilating current. To prevent this, the air current should be warmed and moistened to mine conditions as soon after it enters the mine as possible. This will also prevent dust explosions and will be fully discussed on page 410. In the very few mines in which the coal is naturally dry, the miners will be obliged to inhale a little dust while shoveling coal or making the cutting. The coal dust is not as irritating as street dust containing grit and organic matter, and the miners would rather breathe it than take the trouble to sprinkle the coal pile. Sprinkling alone will not protect the miner from dust while making a cutting. Respirators would protect the miner if kept in good condition, but the discomfort is so great that the miners would not wear them except under most rigid supervision. The best procedure is, therefore, to take measures to reduce the injury caused by the dust by maintaining the general health of the miners. Physicians say that no local treatment is advisable.

Dry roads. By agreement between the Miners' Union and the operators, the traveling-ways of the Arkansas mines are now nearly all so well drained that the miners need not get their feet wet in going to work. Experience has shown that the draining of the entries gives a good return in the increased output of the mules and drivers and the better condition of the feet of the mules. The draining of most entries is a simple matter except in low places or swamps of the coal seam, where the water must be pumped. When necessary, it would be well to change the hours of the pumpman so that he can get to these places as soon as the fire-boss has inspected them, and get the water out before the miners come in. All the smaller depressions should be drained and the ditches maintained in good condition so that the entries will not be even muddy.

Sanitation. All of the Arkansas mines are without any underground toilet conveniences. If the ventilation is poor, an offensive odor results. This odor alone has not been proved to be injurious. Even with the best of ventilation, however, this carelessness will pollute the mine-water and general surroundings. Some miners use the clearer mine-water for drinking purposes, and nearly all of them get it upon their hands and so into their mouths in small quantities. This promotes the spread of water-born filth diseases, such as typhoid fever. Much more serious is the danger of hook-worm and the allied miners' worm, which causes the disease called ankylostimiasis. This has already become serious in some of the German mines.* The eggs of these worms hatch soon after they are discharged from the intestines. Under the conditions of warmth and damp of the mines, the tiny immature worms live for a long time and travel some distance. They can enter the body and infect another miner whenever they come in contact with his skin. The disease is not fatal but decreases the strength and vitality of the miners.

Even though it will be impossible to induce all the miners to use them, privies should be provided in every entry. With a separate split of air for each entry, they should be placed at the last of the air so as to create no nuisance. Since the back entry will then carry the return air-current, the best place is in the back entry just outside of the last dip switch. The waste should be kept out of the mine-water and disinfected once or twice a month by copperas, which costs only 2c. or 3c. a pound. All waste matter should be well sprinkled with copperas and deeply buried each time the toilet is moved forward. At some of the metal mines, steel toilet cars are provided. They can be sealed and at intervals taken to the surface and cleaned with o hose.† With the ordinary surface arrangements of a coal mine, there will be no advantage in taking waste to the surface. It can just as well be buried underground.

Drinking water. At the entrance to every mine, there should be an abundant and convenient supply of the most wholesome drinking water available, and the miners should be encouraged to carry this into the mine. Any good springs found in the mine should also be arranged for the use of the miners.

Tiresome walking. Primarily to prevent accidents from cars, the miners should be carried to and from their working places as discussed on page 441. This will relieve the workers of the large mines from the exhaustion caused by a walk of a mile or more, often in a stooping position and over a rough road. They will begin their day's work in better condition, and also be more inclined to set necessary props at once. It will often pay by attracting more good miners to the large mines.

*Ankylostimiasis. Its Cause, Treatment, and Prevention. London: The Colliery Guardian Co., Ltd. 32 pp. Illustrated.

†Anaconda Toilet Cars. *Mines and Minerals,* Feb. 1910, Vol. XXX, p. 410. Also used at Goldfield, Nevada.

Good explosives. No dynamite or other nitroglycerine explosive should be fired under such conditions that the men will have to breathe the gases. The gases from black powder are not so injurious, but even this should not be fired during working hours except in places having an air current strong enough to carry the smoke away at once. If safety explosives are used during working hours, the miners should be supplied with blasting caps of ample strength, given but a few at a time and cautioned to keep them as dry as possible, so that the explosive will be properly detonated. The safety powder should be selected to give as harmless fumes as possible. These precautions are especially necessary wherever two shifts of men are at work. If the mine is very wet, the more poisonous gases are quickly dissolved in water. When work must be rushed, sprays or water may be used to quickly clear the working places.

Strong drafts. With splitting ventilation, none of the miners will be subjected to a strong chilling draft except the few who work in the main intake. When larger air-ways are provided, the injury to these men will also be reduced. Such arrangement will lessen the temptation to burn smoky oil. Sheltered rooms should be provided for waiting and for eating lunch wherever there is a strong chilling draft at the foot of a shaft in winter time. If the air-current is moistened and warmed to mine conditions as soon as possible after it enters the mine, the draft will be less injurious.

At a few mines the slope is unnecesarily heated by a long steam line to the pump. As a result, the miners are overheated in walking out and likely to take cold upon reaching the open air. Such pipes should be kept off the regular traveling-way, or better still, the more economical electric pump should be installed.

INCREASED VOLUME OF AIR.

The present condition of mine ventilation. As stated in Chapter VI, the ventilation of the Arkansas mines is seldom sufficient for the most healthful conditions. They should be ventilated by splitting as now required by law. In addition, larger air-ways should be provided, and the leakage through the stoppings should be reduced in order that a strong current of pure air may reach each working place with the greatest certainty and at the least expense. Each split should have a sufficient current to rapidly drive away any body of gas. The leakage through the stoppings is largely the result of the unfortunate law which requires, in gassy mines, a crosscut every 30 ft., instead of specifying the amount of air to be delivered within 30 ft. of each working place. The miners see that the crosscuts are driven because they get paid for driving them, but in many mines, the driving of crosscuts actually reduces the efficiency of the ventilation.

Avoiding stoppings in dipping coal. The law should be modified as suggested on page 231. In the meantime, the small air-ways and the need of tight stoppings may be avoided by the plans shown on plates IV and VIII. Plate VIII is intended to represent half of what may be called a single panel of coal dipping too steeply for twin haulage entries. The triple entry may represent a slope from the surface or any inner slope or plane off a main level entry leading to a shaft at the left. The double entries of this panel will be driven as far as it pays to use mule haulage, and the slope as far as it pays to work by a single rope. The plate also shows plans for leaving room pillars at the least expense and then robbing them.

The course of the ventilating current is rather obscurely shown by the small arrows. The air enters by the slope and both of its air-courses. The air from this half of the panel returns through the line of double rooms nearest the slope. There is an overcast and regulator at each well-advanced entry and a permanent stopping at the neck of one of the air-course rooms and in the entry air-course between the slope and the overcast. If the roof is of very strong sandstone, these rooms may be as wide as the miners care to make them. If the roof is of average strength, they should be held to the minimum room-width allowed by agreement with the miners, and they should be systematically timbered. Under a very poor roof, they must be narrower, and yardage must be paid according to the local conditions. In general, there will be no great need of rushing this work. The pillar between the two rooms is small to avoid payment of yardage on the required crosscuts. These rooms and the main slope are amply protected by the heavy pillars formed by omitting one or more rooms on each side. These pillars cost only interest on

the yardage of the entry past them from the time of driving the entry till the time of driving the omitted rooms. This is paid for by security against squeezes.

The present law requires the overcasts, so doors can not be substituted. Moreover, the cost of the overcasts is soon repaid by the saving in wages of trappers. The cost of forcing sufficient air through all these workings to adequately ventilate them by a single split would be prohibitive anyway. Additional overcasts are shown at the head of the main slope. Stoppings may be substituted and one overcast used as at present, but the better ventilation is worth the cost of the extra overcasts. If the slope starts from the surface, two separate fans are better than the extra overcasts.

Advantages of special air-course rooms. If the roof is good, this plan costs no more than the present one of returning the air through the slope air-course, and it has the following advantages: The heavy combined air-current is carried in passages of some three times the present cross-section. The power required is therefore only about one-ninth as much, and the air pressure and tendency to leakage are correspondingly reduced. Only two permanent stoppings are required for each lift instead of eight or nine. These can be made of permanent concrete at the cost of installing and maintaining wooden ones in the eight or nine slope crosscuts. The leakage through slope crosscuts, which is the most serious, is therefore eliminated entirely. The separation of the intake and return air-ways is a secure pillar of coal interrupted by the minimum number of openings. This reduces the damage from windy shots, and enables the rescue party to carry the ventilation down the mine in one-fourth the time, in case all stoppings are blown out by a dust explosion. The stoppings between the slope and its air courses may be of the most temporary character. After the air-course rooms are connected, the slope stoppings may be removed and the slope air-course will form an ideal traveling-way for the miners. It will carry an intake air-current and be accessible from the slope at short intervals.

Additional lines of overcasts. When entries become long, the leakage of even a single split becomes serious, because the stoppings must be placed every 36 ft. and are loosened by the shocks of heavy blasting and occasional windy shots. This can be reduced by a second line of overcasts connecting pairs of protected rooms as shown on Plate VIII. As long as coal is hauled along the first entry, the small amount of air coming from the lower entries can be returned through the first entry air-course. By the time two or three lower entries are thus connected, the upper entry will have reached its limit and by placing a stopping at its entrance, the main entry as well as its air-course can be used as a return. This avoids the need of the entry stoppings and reduces the resistance by increasing the size of the air-way. The second entry will next become the return air-way, and pillar robbing can be started at the end of the first entry. The ventilating current will then return from the first entry through the last room of the second entry. The plate shows No. 5 as the idle return entry and robbing in progress on 2, 3, and 4. As long as no more than two splits of air-current are required for pillar robbing no stoppings will be needed in the entries being robbed.

As soon as an entry is ventilated by this new line of overcasts all the stoppings between the two overcasts can be replaced by a single stopping placed where the regulator was. Both the entry and its air-course can then carry an intake current with a reduction in the resistence. On Plate VIII, the temporary stoppings still needed are shown by single lines. The masonry ones are shown by double lines. This plate represents a portion of a mine sufficiently opened to provide working places for 100 men. With crosscuts 6 ft. wide and 30 ft. apart, or 36 ft. center to center, it requires only two hundred temporary stoppings and seventeen additional permanent ones. Under the plan of ventilation in use at present, a mine of the same size would require over five hundred stoppings in the entries. Of these, three hundred would have to resist greater air pressure than any of the temporary stoppings under the modified plan, and have, say, twice as great a leakage. Even without allowing for increased leakage as the stoppings get old, these results indicate that a second line of overcasts will avoid three quarters of the leakage of a mine of this size. This will require seven additional overcasts, which would cost between $1,200 and $1,500. It will save an unknown amount in repairs to stoppings. Replacing of the stoppings on the first 1,500 ft. of seven entries would cost nearly half this amount.

Avoiding stoppings in flat coal seams. On Plate IV, the second west entry shows the simplest method of avoiding leaky stoppings where the coal is so flat that twin haulage entries can be used. This may be called a twin single-entry system. The first break-through between the rooms provides one of the air-courses, and the room-necks serve as crosscuts. This can be used whenever the cover is so thin that the pillars between room-necks need not be more than 30 ft. wide. As soon as these single entries become so long that the leakage at the room-neck is serious, crosscuts may be driven between the haulage-ways. These will be so few that the leakage through them will not be serious. This change improves the ventilation and actually saves money.

As soon as the twin entries are worked out to the next cut-off entry, both of them can be used for return air while the cut-off and its air-course bring in fresh air. In this way, the resistance can be cut down. In a large mine, it will be necessary to drive the main level haulage-ways as two separate pairs of entries separated by a solid pillar of coal.

For the future deep mines in the basins, the pillars between rooms must be thicker to prevent squeezes. In this case, leakage through the crosscuts can only be avoided by very expensive stoppings or a modification of the law, but in any case frequent cut-off entries will make the renewal of stoppings unnecessary and will reduce the air pressure against them.

CHANGE HOUSES.*

Requirements of change houses. For the general health of the miners, more sanitary camps as outlined on page 114 are the greatest need. Of almost equal importance is the use of proper change houses. These are especially important in the cold weather when the miners come up from the mine tired and sweaty and have to go in the icy weather some distance to their houses. Some wear old coats over their pit clothes, but there is generally no place to store them at the mine, and the miners rather run the risk of cold than carry their heavy wraps on the

*This discussion was published in *Mines and Minerals*, June, 1912.

long walk underground. Where the miners have been induced to bathe and change clothes at the pit mouth, the amount of pneumonia among them has shown a remarkable falling off.*

Miners will not use change houses unless they are attractive. The buildings must therefore be well ventilated, lighted, and warmed, and be easily cleaned. It is strongly recommended that there be a separate room in which the early miners can wait until time to go down the mine. Since all the miners will change their clothes at about the same time, a good deal of floor space is needed and there will be plenty of room for large lockers in a single tier. To dry the miners' towels, shoes, and pit clothes, warm dry air must pass through each locker. To check the spread of lice, the partitions between lockers should be tight and the separate locker rooms arranged to be filled at intervals with the vapor of some insecticide. Near the baths should be a space in which the miners can dry themselves before returning to the locker room.

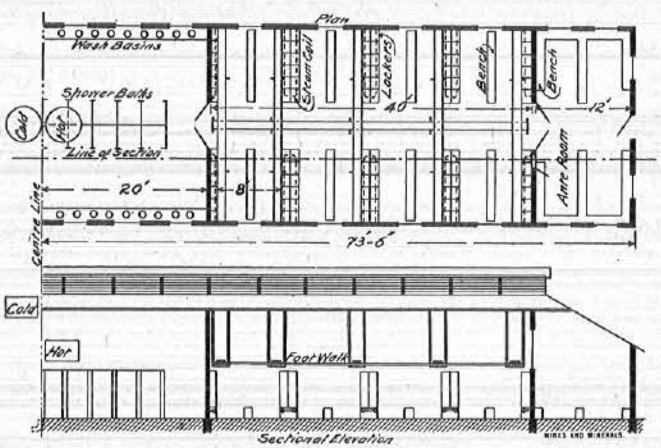
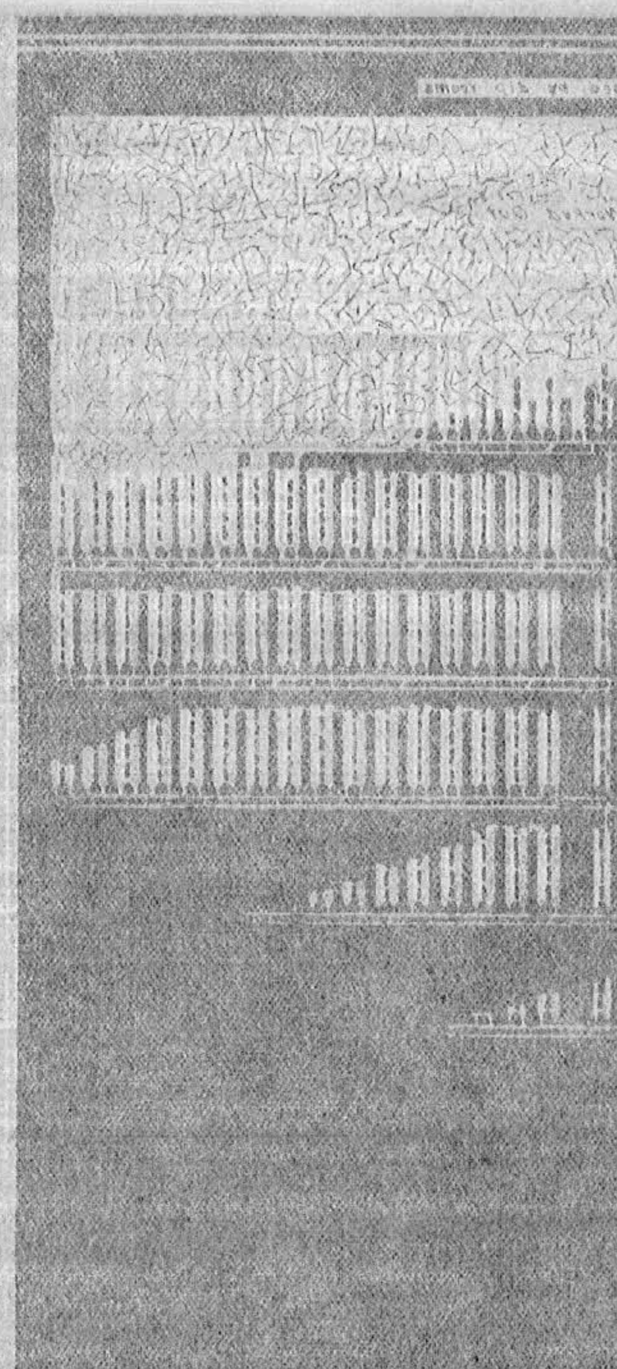


Fig. 67. Suggested change house.

Suggested arrangement of a change house. Figure 67 is a suggested plan for one-half of such a change house to accommodate 192 men. The entire floor is to be cemented and to slope about ¼ inch to the foot toward the central drain under the baths. All lockers and benches are supported on iron pipe legs, 15 to 18 in. long, and the lower 6 ft. of the walls plastered with

*Engineering and Mining Journal, Feb. 18, 1911, p. 386.



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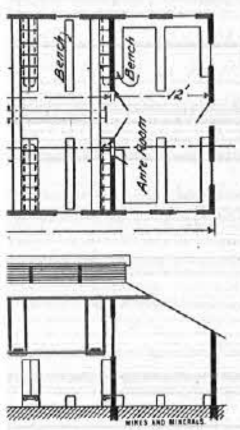

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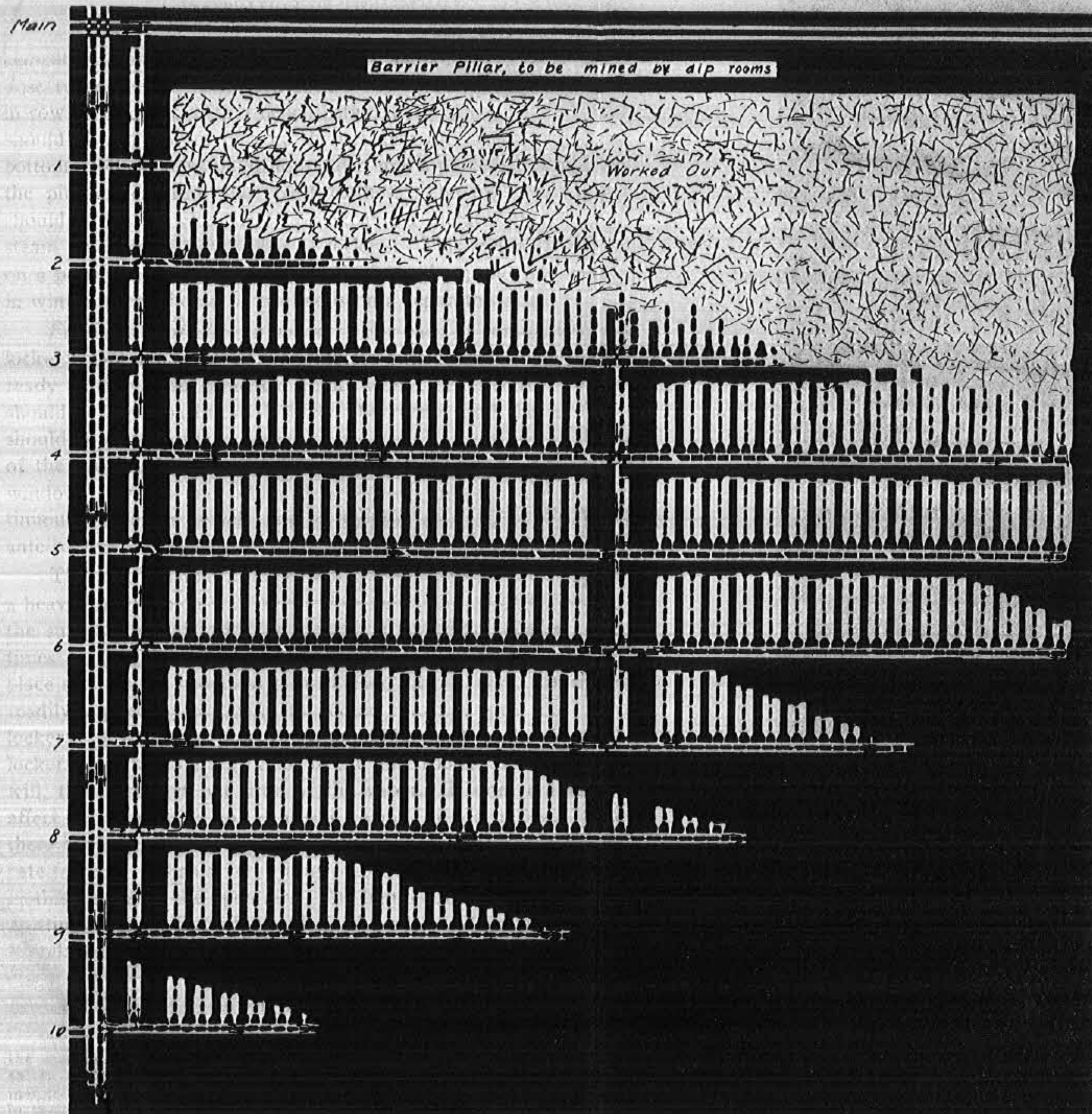

Suggested plan of ventilation for mines in dipping coal.

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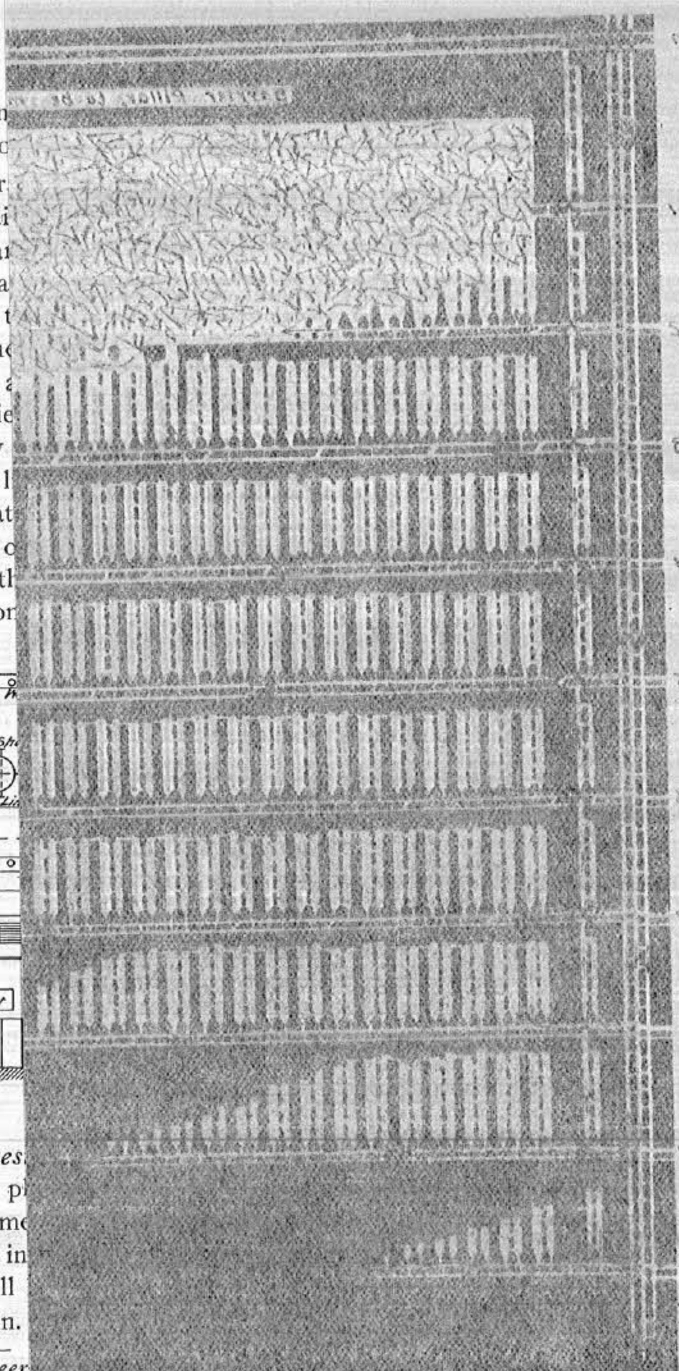

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*Engineer

cement on metal lath. The entire floor should be washed with a hose twice a day. The lockers are shown 12 by 18 in. inside, in rows 8 ft. apart, with a bench between the rows. Each locker should have a pair of narrow shelves near the top and near the bottom, clothes hooks on all four sides, and a partition to separate the pit clothes from the street clothes. The top and bottom should be heavy wire screen or expanded metal with a line of steam pipe beneath each row of lockers. This steam should be on a portion of the day in all kinds of weather; and for heating in winter, there should be wall coils on a separate circuit.

Fumigation of change houses. For ease of fumigation, the locker room should be tight; complete outside covering of some ready roofing with cemented joints would be effective. There should be tight partitions between the rooms, and the windows should be close to the eaves to insure privacy as well as tightness of the cemented part. Good air can be insured by opening the windows inwards and fitting the ridge of the roof with a continuous ventilator which can be opened and closed from the ante-room.

The only feasible insecticide is carbon disulphide.* This is a heavy liquid which boils at 115 degrees F. and rapidly saturates the surrounding air with its vapor. The vapor is nearly three times as heavy as air and fills up the bottom of any enclosed place such as the proposed cement lined locker room. It can be readily applied by throwing the liquid into the open top of the lockers. For this purpose, there should be plank walks above the lockers, leading to a high door to the ante-room. The attendant will, therefore, get but little of the vapor. It does not readily affect a human being and causes a warning headache long before there is danger of fainting. It does not injure the hands or delicate fabrics. It has a very disagreeable odor but this soon leaves clothing hung in the open air. The liquid could be applied after quitting time on Saturday and all the odor will be gone before Monday if the ventilation is restored on Sunday. Before applying it, the steam heat below the lockers should be cut off. The greatest objection to carbon disulphide is its inflammability. The

*Hydrocyanic acid is cheaper and in sufficient quantities kills even the eggs of insects. It is, however, such a deadly poison that it can be safely used only by a skilled chemist. Formaldehyde has been recommended but is not effective, costs too much, and leaves a penetrating odor in the clothing.

mixture of its vapor and air is explosive and ignites at a low red heat, much more readily than either firedamp or gasoline. All fire must therefore be kept away from it.

Paul Hayhurst, Professor of Entomology, University of Arkansas, states that fleas, lice, and most other insects can be killed by vapor of carbon disulphide if 1 to 1½ pounds of it are applied to each 100 cubic feet of space containing grain, clothing, etc. For open rooms only one-tenth of this quantity is needed. The locker room sketched here, large enough to accom-accommodate ninety-six miners, will require only 7 to 10 pounds of carbon disulphide for each fumigation, if the room is filled to a depth of 7 ft. Commercial carbon disulphide can be obtained through a local druggist in lots of ten gallons or more, at about 10c. a pound. The cost will, therefore, be only about 1c. for each man. It does not kill the eggs, and, to prevent all breeding of lice or fleas, the clothing would require fumigation about once every two weeks. The few mature insects brought in with the street clothes will not spread seriously. If necessary, the locker room could be fumigated occasionally, while the men are at work and the street clothes are in the lockers. It is only for a short season each year that the fleas are annoying.

Change houses have been so arranged that the miner can hang all his clothes upon a rope or light chain, hoist them up out of reach, and lock them there. This is cheaper than the lockers but not as neat and does not admit of ready fumigation.*

Water supply for change houses. To prevent waste of hot water, each shower should be fitted with a single valve accessible from the outside. The temperature of the water will be regulated by the attendant. The hot water tank should be maintained at a constant temperature. If under only a slight pressure and heated by coils containing exhaust steam, it can be kept at the ordinary boiling point without boiling and waste of heat. The hot water can be drawn off at the top of the tank and cold water let in at the bottom from the slightly elevated cold water tank. Both tanks must have drain pipes to remove mud, settling from the ordinary soft water supply of the mine.

The miners are usually willing to pay enough for a good change house to hire the attendant. He should, however, be

*Coal Age, Jan, 27, 1912.

hired by the mine foreman so that he will not try to coax the men to put up with a little dirt. The operator should furnish hot water and lights and maintain the building.

BETTER DISCIPLINE.

For the prevention of accidents, the first thing needed is better discipline. At present the mine foreman is allowed no control of the methods of digging coal or propping the rooms. He, therefore, can not give any instruction to the miners that are inexperienced or new to the district, nor can he exercise any restraint whatever over any miner that wishes to run a risk. The drivers and other day-men are in general perfectly willing to take orders about matters affecting the company's interest, but if the foreman suggests any change in the way of handling cars or mules so as to reduce the danger to the workmen, they look upon it as an unwarranted interference. The most certain security is the enactment of laws preventing the miner from risking his life and that of his fellows, and in the enforcement of such laws.

As a more practical and immediate relief, it is urged that the local Unions adopt regulations governing safety at each of the mines. All persons who violate the rules should be rather severely fined and the money used as the Union wishes. It might be well to use it as a fund for the relief of injured miners. The mine foreman and pit-committee together can enforce the rules, and if necessary the most reckless men can be discharged. The Union has already prevented crowding on the cages.

GAS BURNS.

The frequent burns from gas are generally due to poor discipline and the impatience of the miners. These can be most certainly prevented by keeping all men out of that split of air-current which contains gas, until the gas is out, or generally until noon. As another inducement to prevent the miners from brushing gas out of their rooms, the company should provide plenty of brattice men to get the gas out of the way before the miners become impatient. These men should have plenty of material, and the air-current should be so split that there will be no objection to carrying the air behind long brattices.

The fire-boss and superintendent should instruct all the brattice men in safe methods of blowing gas out of rooms. A few of the more frequently violated rules may be repeated here:

1. The fire-boss shall see that no person working with gas has an open lamp with him even though it is unlighted and supposed to be used only in walking out.

2. Safety lamps should be kept in the fresh gas-free air at all times while brattices are being built, except when testing for gas. The Davy lamp used for testing should be sheltered from all drafts.

3. If the ventilation of more than one or two places has been interrupted for more than a few minutes by leaving a door open or blowing down a stopping, it should not be restored until the fire-boss is certain that there are no open lights on the return side of these workings.

4. After restoring such interrupted ventilation, he should inspect the cut-off working places by following the air-current.

5. He should then carefully examine all quiet air spaces near curtains or doors and at falls before pronouncing the workings safe.

6. If any man whose working place has been marked out is found in his entry before he is told to go there by the fire-boss, he should be discharged. This does not prevent the fire-boss from using these men as helpers if they are competent.

7. When building brattices to carry the air-current from the nearest crosscut toward the working face, as much space as possible should be left between the brattice and the rib. If possible, the cloth should be fastened to the rib side of the props, so that the resistance to the air-current caused by the brattice, will be as small as possible.

8. When brattices must be built to remove gas, the air-current should be strong enough to make it unnecessary to use special pains to keep the brattice tight. As long as crosscuts are not more than 40 ft. apart and the mines are no more gassy than those now open, the air-current should be sufficient to keep all workings free from gas when it is simply directed toward the face by a brattice. Before extending such a brattice, the air-current should be increased by opening the regulator or by speeding up the fan.

Rules 9 to 12 will apply to those mines ventilated by a separate split for each entry as all the mines should be.

9. In dipping coal with no rooms turned off from the air-course, the air-course should be used as a return, so that fire-bosses and brattice-men may easily follow the air-current to any body of standing gas without entering the return from it.

10. Under no circumstances should any persons except brattice-men be allowed to work on the return side of any body of gas, however small.

11. If possible, all persons except the brattice-men should be kept out of any entry in which standing gas is present.

12. If standing gas is found in more than one working place on a single split of air, the gas nearest the intake of fresh air should be completely removed, before the brattice-men proceed to the following body of gas.

13. If the mine is small and ventilated by coursing, and gas is frequently found, enough fire-bosses or brattice-men should be employed to remove all bodies of standing gas by directing an air-current into them before any of the regular day crew is admitted to the mine. The gas-men should follow the air-current through the mine and remove all gas as soon as it is found.

14. Under present conditions, at large mines ventilated by coursing, it is thought necessary to remove small bodies of gas while men are working upon the return side of them. In this case, the fire-boss should see that there are no open lights in any working place on the return side of a body of gas and in the same entry. The body of gas nearest the return air-current should then be removed by slowly extending the air-current towards it in such a way as to dilute the gas as much as possible. The remaining bodies of gas should then be removed in the same manner. At best, this method is risky and the condition requiring it should be removed as promptly as possible.

Practically all the fire-bosses understand the minor precautions to be taken in removing gas and they need not be given here. It is earnestly recommended that the fire-boss dead-line all places in which there is enough gas to give a distinct cap in a Davy lamp and that the present practice of marking some places "Little gas—be careful!" should be abandoned.

CARELESS HANDLING OF POWDER.

Handling powder with open lights. Many inexcusable accidents are caused by the habit of leaving an open light upon the miner's cap while he is preparing his shots or raking the powder out of a missed hole. Many states attempt to stop this by legislation, but under the American notion that every man has a right to be reckless, it is impossible to enforce such laws. The practice can only be stopped by better discipline and the prompt punishment of all offenders. If the miner persists in handling powder with a light on his cap, electric or acetylene lights should be used because they do not drop sparks. Some miners also open their powder kegs by running a pick through them and do not cover up the hole. The rather open powder box is then all that protects this powder from any chance spark or mild dust-explosion.

Amount of powder in the mine. The larger the quantity of powder each miner has in his powder box, the more serious will be the resulting burn. In a few cases, the explosion of the powder of a careless miner has caused other deaths by starting dust or gas explosion. Large quantities of powder increase the danger of both gas and dust-explosions. Under the present plan of handling powder, few of the miners ever have much more than 25 pounds of powder in their working places at any one time. At a few mines, the powder is handled in powder jacks holding half a keg of powder or less. They can be easily and securely closed and are less apt to cause spilling of powder. To reduce the quantity of powder in the mine, small powder jacks should be used everywhere.

Missed shots. If missed shots are not picked out, the miner runs the risk of a burn in handling the coal containing this powder after it is loosened by another shot. The shot-firer is also in danger because the substitute shot can not be so well placed or may ignite the powder of the missed hole and cause a severe windy shot. For these reasons, the nearly hopeless task of preventing the miners from opening missed holes is not worth the effort.

For picking out a missed shot, the miners should use a copper tool. In coal containing any considerable amount of pyrite (sulphur), copper tipped tamping bars are safer, although the danger of steel tamping bars seems very slight under the present practice of making up the powder into cartridges before it is charged.

Hang-fires. In gassy mines, the shot-firers are often paid extra to go back and extinguish any blowers of gas which may have been lighted by the shot. It is only under these conditions that there is any tendency to go back too soon in case of a misfire. In one mine of this State, squibs are used under these conditions because they are less likely to hang fire. It would be much safer for the shot-firer not to go near a missed shot for an hour or more, but, since they will be sure to take risks, a squib used in a good copper barrel may be better than the almost universal fuse (safety fuse) in spite of other objections. In any case, the men should be induced to wait until the smoke has cleared away so that they need not go clear to the face. If the miners fire their own shots, or if each entry has a separate split of air, a separate fire-runner should be employed where there is danger

of lighting gas blowers. He should not go into the entry until the smoke has cleared out of the first working place, and should follow the smoke through the entry. This will avoid most of the danger of hang-fires.

THE EXCESSIVE USE OF POWDER.

The effect of lowered cost of powder. From the time that the value of labor became so much greater than the cost of powder, the miners have been using an increasing amount of powder to loosen their coal. This tendency has been greatly stimulated by the unfortunate mine-run law, which has removed all incentive to use powder carefully. Its effects upon the falls of roof and dust explosions have been fully explained on page 271 of Part I of this report. To reduce the number of accidents from this cause, it will first be necessary to repeal the mine-run law. Until this is done, any discussion of the reduction of underground accidents seems a waste of time.

Even under mine-run conditions, the excessive blasting is possible only because of the low price of powder. It can, therefore, be checked by an increase in the price of powder as outlined on page 192, Part I. Owing to the force of public opinion, this can not be done by the operators even if the extra price of powder is returned to the men in the form of increased wages. Owing to difficulties of administration, it can not readily be done by the State. It can, however, be easily carried out by the Miners' Union. A heavy tax upon each keg of powder used will enable the Union to collect a strike fund in proportion to the earnings and recklessness of the diggers, and the diggers are financially benefited by the Union much more than the day-men.

Relief fund from a tax on powder. A still more logical use for the money is as a fund for the relief of sick, aged, or injured miners, or of those dependent upon miners that are killed or disabled. The Union already has an organization fitted for the administration of this fund, and practically all of the operators are willing to contribute an equal amount to such a fund for the sake of getting out better coal. The money would be collected from the pay-roll by the company as are the Union dues. With an equal amount donated by the company, this should then be deposited in some bank to be drawn out only by check signed by both the operator and the officials of the local Union.

If the price of powder were raised only $1 per keg, the fund would amount to some $200,000 a year in Arkansas.* If this were equally divided among the victims of fatal and serious accidents, each one would get about $6,000. Such an increase in the price of powder will reduce the accidents to the old figure of 60 per cent of the present rate or less, and many of the seriously injured miners finally recover completely and will need only temporary help. With no extra administrative expense, $12,000 would then be available for relief of each fatal injury.

Money can not compensate for a miner's life. It is supposed to no more than replace the financial value of a man to his family. That of the average mine worker in Arkansas is not greater than $3,000† or one-fourth of the money available. It seems proper, therefore, that all of the operators' share of this fund should be otherwise used for the benefit of the miners, or paid to the general funds of the State. After mining machines have been generally installed, a contribution of $1 per keg of powder by both operators and miners may not amount to so much, but the accidents will be greatly reduced in number and there will be little temptation to use too much powder.

Many skilled and steady miners contribute to their families an income much greater than the proceeds of $3,000 cash. The compensation should therefore be based upon the average earnings of the victim of the accident. It should be invested in a 15-year annuity for the widow and annuities for each orphan until he has reached the age of 14 years. The total of these annuities might be made equal to a little more than half the

*The coal produced in Arkansas in 1909 was 2,377,257 tons. The consumption of powder is from one keg for 12 tons to one keg for 35 tons. The large mines use about one keg for each 25 tons, and the average is not far from one keg of powder for 23 tons of coal, which would make a total of 100,000 kegs of powder per year. During this year, 15 men were killed at the mines and 19 were seriously injured. The $200,000 fund would therefore have yielded about $5,900 for each miner.

†The average mine worker earns about $63 a month ten months a year. In addition to the cost of his own board, his family does not ordinarily get much more than half of this, or $315 a year. He probably works in a mine not more than 28 years after he is married. The average money obtained by the families of old as well as young miners will then be $315 a year for 14 years. Three thousand dollars will provide this amount if the money left after each payment draws 6 per cent annual interest.

miner's annual income for the three years preceding the accident, or more if there is plenty of money. Injured miners should receive something like half their average wages, and if permanently injured, an annuity for life. To insure permanence, these annuities should be purchased from some insurance company at the time of the fatal accident. The funds of all the mines should be available to provide for any accident at a small mine.

WINDY SHOTS.

Even when they are not fatal to the shot-firer, windy shots injure the miners as a class by loosening doors and stoppings until the ventilation is impaired. They also make it necessary to employ reckless shot-firers that are more likely than careful men, to kill themselves and blow up the mine. The financial burden of these results falls almost entirely upon the operator. Therefore, windy shots can be best prevented by giving the operator complete control of the work of the shot-firers, who should be allowed to skip any shot they wish without abuse from the miners. In the more dangerous mines, a shot-inspector ranked as a boss should be employed. These men should go through the mine at short, irregular intervals and consult with the miners as to the position and loading of the shots they intend to put in, and should especially instruct the new miners who are not yet familiar with the shooting qualities of the coal.

Such a shot-inspector should either approve all shots or accompany the shot-firer upon his rounds. The two should tamp all shots and proceed as described on page 69. If the proper dummies are provided, it is but little work to securely tamp the holes and this tamping will not be neglected by any man who understands the danger of blown-out shots. The miners will, therefore, have little just cause for complaint on the score of careless tamping.

To further safeguard the shot-firers, or the miners firing their own shots, all the operators should be required by law to deliver to the miners' powder boxes, suitable clay or earth for tamping. Unless this is done, the temptation to use the coal cuttings for tamping will be too great for the miner to resist.

The danger of windy shots can be greatly reduced by properly preparing the shots by mining, or by shearing. Under present labor conditions, this requires the use of mining machines, which will be discussed in the next chapter. Even then supervision will be needed to see that the shots are not overloaded or improperly placed. With chain machines, it will be necessary to see that the undercut coal is properly snubbed before the main shots are fired.

Windy shots can also be largely prevented by the proper use of safety explosives. These must, however, be properly used. They have some disadvantages, such as a greater shattering effect in our fragile coal, the danger in handling the sensitive caps needed to detonate most varieties, deterioration of some varieties by cold or damp, and their greater cost. They are nevertheless recommended for use in the mines having explosive dust such as those south of Poteau Mountain. Elsewhere in this State black powder can be used with safety if it is properly handled, and it is simpler to prevent the spread of a dust explosion than to use unaccustomed explosives. We again repeat the statement that dynamite is not a safety explosive, and there is no excuse for using it in coal.

COAL DUST EXPLOSIONS.

Means for controlling dust explosions. A few dust explosions in Arkansas have been started by the explosion of loose powder or small pockets of gas, but the common cause is some kind of a windy shot. Besides eliminating windy shots, steps should be taken to prevent the resulting dust explosion or retard its spread. The entire subject has been ably discussed by George S. Rice in Miners' Circular No. 3, of the U. S. Bureau of Mines. All mine superintendents are urged to obtain a copy of this circular by request to the Director of the Bureau of Mines, Washington, D. C.

Mr. Rice shows that only dry dust explodes and that plenty of water furnishes the simplest method of preventing the spread of a dust explosion. But it is necessary to wet the dust thoroughly in all parts of the mine. After the dust has been thoroughly dried, it can not be quickly moistened. Therefore, the water should be applied continuously and the air-current of the mine prevented from drying it up. These results are most readily obtained by keeping the air current so moist that it causes all

parts of the mine to sweat or at least allows the dust to become wet from the natural dampness of the mine.

Humidity in the air. Mr. Rice explains that as air is cooled, the amount of invisible water vapor it can carry is diminished. If, therefore, the outside air in summer-time is sufficiently supplied with moisture, some of this moisture is deposited in drops upon all parts of the walls of the mine with which the warm air comes in contact, because the temperature of the coal and rocks of the mine does not change much during the year. In the winter-time the cold outside air contains very little water and it rapidly dries out the mine dust as it warms up on entering the mine. These facts explain why the mines sweat in summer and are so dry in winter.

Whenever the outside air does not contain substantially as much water as it will hold at the mine temperature, water should be added to it. The moisture in the air can at all times be learned by placing in it two thermometers just alike except that the bulb of one is covered with a fabric kept wet by water. The greater the difference in the readings of the thermometers, the more water the air needs to saturate it. The exact amount of water needed can be determined from the tables which come with the instrument. This instrument is called a psychrometer and can be purchased through any of the dealers in mining instruments. One of them should be kept at every large mine. The air will be moist enough whenever the reading of the wet bulb thermometer is as high as the temperature of the return air from the mine.

In order that the air can carry enough water, it must be at least as warm as the rocks of the mine. It may be raised to the mine temperature and at the same time moistened by a sufficient number of sprays of warm water. In severe weather, there will be trouble from the freezing of the pipes and the spray, and a great deal of water will be needed.

Steam jets. It is cheaper and easier to use jets of exhaust steam, which will both warm and moisten the air. No more steam will be used than that needed to raise the air to a little above mine temperature and the steam jets will cause no uncomfortable heat if they are small and not pointed directly at a passerby. If a number of small jets are used, the air will mix with the steam before it has a chance to heat the roof unduly. If the steam is turned toward the roof or wall, this can be protected by light lagging.

It should be noted that the drying effect of the air-current will extend throughout a mine as rapidly as the moisture nearer the intake is gone. On the other hand, air deposits moisture only while cooling and as soon as the warm air of summer reaches the temperature of the mine, it ceases to deposit water. The sweating only extends into the mine as the dripping coal near the intake gets warmer and this change is slight. Therefore, to quickly dampen the mine by means of the air-current, steam jets must be placed at more than one place in the path of a long ventilating current. The writer has noticed, however, that coal dust gets very wet if stored in cellars, the bottom of piles of coal, abandoned mine workings, or other damp places free from a current of drying air. Therefore, jets near the face will not be necessary unless the dust is made very rapidly as by heavy shooting in a dry mine. This point can be determined by experience at each mine.

Mist. The heating effect of steam is not great unless it is condensed to water. Therefore, except under exceptional conditions, more steam will be needed to heat the air than is required to moisten it. The condensed steam remains as a thick mist until it settles upon the walls of the mine workings. This will make the hauling of the coal past the steam jets both disagreeable and dangerous, and some means must be taken to prevent the mist from interfering with the hauling of coal.

Mr. Rice suggests using water jets to slightly moisten the air during the day time and steam jets at night in case the coal must be hauled past the jets. Warm water will make some mist as well as steam, and at best only as much water will be taken up by the air as it will hold at that temperature. Since even a little steam will warm the air slightly, more water can be introduced by steam jets without a fog than by water. In very cold weather, water jets would freeze unless far from the mouth of the mine with expensive pipes. For these reasons, it seems better to omit water sprays in winter, and merely cut down the amount of steam in the day time, until the mist is not objectionable.

Where there are steam pipes in one compartment of the down cast shaft, they warm the air considerably and quite a little steam can be added at the top of the shaft without causing a mist at the bottom. During the night, an excess of steam can be used to make up for the shortage during the day. This can be obtained from the exhaust of the fan engine supplemented by some steam direct from the boilers if necessary. This sufficient quantity of steam will of course melt all accumulations of ice and make it unnecessary to reverse the fan at night. The mine will not dry out too much in a single day.

The mist may be eliminated by the plan of first warming the air by passing it over steam pipes until the stqam jets will just saturate the air and finish warming it without condensation. At a large mine, however, this will require several thousand dollars' worth of radiators. This mist can also be avoided by superheating the steam until the steam needed to supply moisture to the air will bring in enough heat to warm the air to mine temperature. For outside air at 10 degrees F. with a humidity of 80 per cent, this would require 1,200 degrees of superheat, which is also impracticable. The mist can be quickly settled by the Cottrell process.* This consists of passing the air-current containing suspended particles between electrodes charged with static electricity. Grounded plates and heavily charged wires are used, and the drops of water become charged and fly to the plates. A charge of several thousand volts is needed, and this would require a special shed outside the mine and a plant more expensive than the radiators needed to heat the air.

The suspended drops of water can be thrown out by centrifugal force by driving the air at high velocity through a spiral passage. This is done in some forms of steam separators, but the velocity there used is 6,000 feet per minute or more, and it is quite impracticable to give the entire ventilating current of the mine this velocity. Other steam separators cause the drops of water to cling to metal surfaces by causing the steam to pass projecting points. B. N. Wilson, Professor of Mechanical Engineering, University of Arkansas, has suggested that this principle might be used in the mine by stretching wire screens from the

Mining and Scientific Press, Aug. 26, 1911, Vol. 103, p. 255. *Engineering and Mining Journal*, Oct. 14, 1911, Vol. 92, p. 763.

roof to the floor on alternate sides of the air-course as shown in Fig. 68. The air-current will be sufficiently stirred so that all

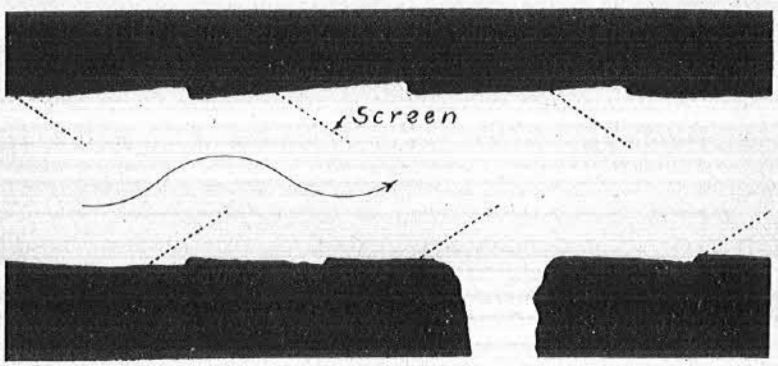

Fig. 68. Arrangement of screens for precipitating mist.

parts of it will soon come into contact with the screens, and pass through them without much extra resistance. As the mist passes through the screen some drops of water cling to the metal; other drops unite with each other and so become heavy enough to settle quickly. Light galvanized wire screen (hardware cloth) of about 4 mesh is recommended. It is regretted that no funds are available for the purpose of determining the efficiency of this apparatus and affording data as to the number of screens necessary. They are very cheap and screens can easily be added in the mine until the air is cleared. This appears to be the most feasible method for quickly settling the mist.

Objection to the mist can be avoided by placing the steam jets where the fog will not interfere with the workmen. If the air is to be moistened at the main intake, some intake may be provided in addition to the main outlet for coal. If the mine is large, additional intakes will be necessary anyway and the problem presents little difficulty. With the plan of ventilation shown on Plate VIII, these steam jets can be placed at intervals along the first lift of the old slope air-courses now used as intakes. The mist may then be settled by screens according to Professor Wilson's suggestion, before it reaches the first haulage road. A wooden brattice along the side opposite the jets will enable miners to pass, if they use this as a traveling-way while the main haulage-way is in use. A curtain across the main haulage-way will

reduce the amount of cold air entering through it. A little steam can be used in the main haulage-way without annoyance. If the mine is ventilated by a separate split for each entry, the air generally passes through the old workings of the entry first. A few steam jets could then be placed at the entrance to the old rooms of each entry. By the time the air-current of such a mine reaches those entries having no old workings, it would be so warm that the air could be moistened sufficiently with little or no condensation of the steam to a mist. Piping for such steam jets will be expensive but this system is much cheaper as well as more effective than that of piping all parts of the mine for sprinkling with a hose, as is required by law in Oklahoma. The pipes could also be left bare to partly warm the air by radiation and so reduce the mist. The small slope mines ventilated by coursing can be moistened by the exhaust from the steam pump. This can be distributed along the air-courses leading to the two lower entries and so throughout the mine.

It is thus seen that objectionable mist can be avoided at little expense.

Oppressive atmosphere. As yet none of the Arkansas coal-mines are so deep that they are uncomfortably warm. Therefore, the miners will not be inconvenienced by the humidity of sprayed air. At the most the conditions will be the same as they now are in the summer-time. Some of the recently published lurid rhetoric about saving the miners from dire disaster of working in a moist mine is no argument against steam jets. As the mines get warmer, stone dust will have to be substituted for water to check dust explosions.

Falls of roof caused by sprays. The most common objection to spraying the air is that it causes the roof to fall. This is unquestionably true if the roof is such a pure clay that it will absorb water indefinitely. Even then it is doubtful if the number of accidents will be increased because in any case the rooms will become moist in the summer-time and the same amount of rock will fall. All of this is likely to fall on the miners except that in the few working places finished before the roof became wet.

Most of the falls of rock in old entries and traveling-ways are caused by the wetting of roof that has dried out from its naturally moist condition and thus cracked open to let moisture get behind the slabs. These falls, which are the heavy and dangerous ones, will be largely reduced by keeping the mine constantly moist. It is believed that falls are also caused by the changes in temperature of the mine workings. The fact that a uniform moist air current does not injure the mine roof was demonstrated by the Consolidation Coal Company of West Virginia and this argument against sprays has little weight.

Requirement of steam jets by law. It seems, therefore, that steam jets should be installed in all the mines in Arkansas. If experience proves that they do not injure the roof, their universal adoption should be required by a law, providing that the ventilating current of the mine shall be so warmed that it is within 5 degrees of the temperature of the return air and shall have a humidity of over 90 per cent of saturation before it reaches the first active working place upon each split of the air.

Water sprays. On warm and very dry days, the air of a mine should be moistened only, and the extra heating caused by steam will be objectionable. For this purpose a few sprays of water will be sufficient. They can also be used to rapidly cool the air even when it is wet. The same apparatus can be used for the steam jets in winter. As a preliminary arrangement, a line of pipe may be installed along each side of the main intake slope or shaft bottom about opposite the center of the coal seam. To prevent spoiling the pipe for other use, two or three holes for the jets, say 1/16 inch in diameter, can be drilled in each coupling of the pipe. These may be placed as far apart as the ordinary length of pipe, and the sprays received upon bits of sheet iron fastened to the coal. Valves should be placed at intervals to cut off as much of the end of the pipe as may be necessary when using water. A valve at the exhaust of the pump or fan will regulate the amount of steam to be used. Experience will show how much the pipe must be extended or how many holes should be plugged with wood. Special nozzles for mine sprays are now on the market.

Amount of water and steam needed. To illustrate the amount of water and steam needed to warm and moisten the incoming air to saturated air at mine temperature, we may consider the case of a medium-sized mine with an output of 1,400 tons of coal in eight hours and requiring 50,000 cu. ft. of air per minute. We will assume the mine temperature at 60 degrees F., which is about the Arkansas mine temperature.

If the moisture is supplied in the form of a water spray, a good deal of heat will be required to evaporate the water so that it can enter the air as vapor. If the incoming air is warm, it can supply this heat in cooling to 60 degrees F., provided that it is not so dry, that too much water will be required. If the warm incoming air at any given temperature has just the right humidity, it can be both cooled and moistened to saturated air at 60 degrees F. by the evaporation of a certain amount of water. The table below gives in round numbers this humidity and the weight of water required for several temperatures.

Humidity of outside air at given temperature and pounds of water at 60 degrees F. needed to produce 50,000 cu. ft. of saturated air at 60 degrees F.

Outside temperature	Per cent of humidity	Water needed
65	79.2	2.3 pounds
70	63.8	4.2 "
80	39.8	8.5 "
90	24.6	12.6 "
100	15.2	16.5 "
110	9.5	20.5 "

The humidity of this air at the higher temperatures is so low that this condition will seldom if ever occur in this State. The table shows, however, that the amount of water required to saturate the air is in the extreme case only 2.5 gallons per minute. This can be supplied by a one-inch pipe with a fall of only 3 feet in 100 feet. Under a 50-foot head this will require only 9 jets 1/16 inch in diameter.

If the air contains more water than the amounts given in this table, it will become saturated before it is cooled to mine temperature by the evaporation of the water of the jets. It can only be cooled further by warming the water of the jets. In practice, it can therefore not be cooled quite to mine temperature and we will assume that it is to be cooled to 65 degrees F. and that sufficient air will be used to make 50,000 cu. ft. when saturated with moisture and at a temperature of 65 degrees F. If the water is introduced as a fine spray, it can be assumed that the water is warmed and the air cooled until both reach the same temperature. If enough water is sprayed into the air to cool it at once, no part of the water will remain heated above 65 degrees F. The quantity of water at 60 degrees F. required by this plan to cool the air entering the mine at various temperatures and humidities is given in column 3 of the table below.

If the particles of water could be made to travel against the air-current, they would continue to cool the air and warm themselves until they all reached the temperature of the incoming air. The amount of cooling water so required is given in column 5 of the table.

It is quite impracticable to apply cooling water in this way, but by applying it slowly to the incoming air by a number of jets some distance apart, the water of the first spray can be raised to nearly the temperature of the incoming air and that of only the last to no higher temperature than that of the cooled air. The minimum quantities of water required by this method are given in column 4 of the table. Actually a little more than this amount of water will be needed even if the jets are small and far apart, and directed against the air-current.

Pounds of water at 60 degrees F. required to cool 50,000 cu. ft. of air measured at 65 degrees F. to 65 degrees F.

Outside air		Cooling water required		
Temperature	Humidity	If heated to 65° F.	Each spray heated to temperature of passing air	Each spray heated to temperature of incoming air
70	85	830	700	450
	90	1,450	1,225	750
	100	2,750	1,950	1,375
80	70	4,450	2,200	1,125
	80	6,250	3,150	1,575
	90	8,000	3,850	2,025
	100	9,800	4,350	2,475
90	70	11,400	4,650	1,900
	80	13,900	5,200	2,325
	90	16,450	5,725	2,750
	100	18,950	6,200	3,150
100	70	20,000	6,300	2,525
	80	23,550	6,900	2,950
	90	27,050	7,400	3,375
	100	30,500	7,850	3,800

The outside conditions will be seldom worse than 70 per cent humidity at a temperature of 100 degrees. This may be assumed to take about 7,500 pounds of water per minute. This will require about 750 jets ⅛ inch in diameter under a 50-foot head and will require about a 5-inch pipe. It seems, therefore, commercially impossible to so cool the air that there will be no sweating in the mine at all. Even a small amount of water will be beneficial and at least the amount given in the table on page 417 should be used to start the sweating immediately.

The difference in the amount of water required to cool wet air and dry air arises from the fact that the evaporation of a pound of water spray has a greater cooling effect than two hundred pounds of water heated 5 degrees, and because the moisture of warm air has such a large proportion of its total heat.

If the outside air at any given temperature is drier than the figures given in the table on page 417, or if, for any humidity, it is colder than the temperatures there given, heat in addition to the water spray will have to be added to bring it to the condition of saturated air at 60 degrees. If heat is furnished by dry steam, the amount needed is given in the table below. The third column gives the steam needed to saturate the air with moisture. This is merely cooled from the boiling point to 60 degrees. The next column gives the additional steam which will be condensed to mist at 60 degrees F. For any given temperature, the steam required increases as the humidity decreases, and the amount for any other humidity can be readily figured by noticing the rate of change for the humidities given. For low temperatures, the amount of moisture in saturated air is so small that the influence of humidity is almost negligible.

Dry air at 60 degrees or warmer can be brought to the condition of saturated air by adding warm water or a mixture of mine-water and steam. There will then be no mist. The last column of the table gives the negligible amount of water required in connection with steam, for dry air at 60 degrees F. Dry air at higher temperature will need very little steam in addition to the water given in the table on page 417.

Pounds of dry steam needed to warm 50,000 cu. ft. of air to 60 degrees and saturate it with moisture.

Temperature	Humidity	Steam as vapor	Steam as mist	Total steam	Pounds of Water
60	100	0.0	0.0	0.0	0.0
60	90	4.0	0.0	4.0	0.2
60	80	7.5	0.0	7.5	0.3
60	70	12.0	0.0	12.0	0.5
60	60	16.0	0.0	16.0	0.7
60	50	19.5	0.0	19.5	0.8
50	100	12.2	8.0	20.2	0.0
50	90	15.1	7.5	22.6	
50	80	17.9	7.0	24.9	
50	60	23.7	7.0	30.7	
50	40	29.5	6.5	36.0	
40	100	21.5	15.0	36.5	
40	90	23.5	15.0	38.5	
40	80	25.5	14.5	40.0	
40	60	29.5	14.5	44.0	
40	40	33.5	14.0	47.5	
30	100	28.0	22.0	50.0	
30	80	30.5	22.0	52.5	
30	60	33.0	22.0	55.0	
20	100	32.5	30.0	62.5	
20	80	34.0	30.0	64.0	
20	60	35.5	30.0	65.5	
10	100	35.0	38.0	73.0	
10	80	36.0	38.0	74.0	
10	60	37.0	38.0	75.0	
0	100	37.0	46.0	83.0	
0	80	38.0	46.0	84.0	
0	60	39.0	46.0	85.0	
—10	100	39.0	54.0	93.0	
—10	80	39.5	54.0	93.5	
—10	60	40.0	54.0	94.0	
—20	100	39.5	62.0	101.5	
—20	80	40.0	62.0	102.0	
—20	60	40.6	62.0	102.5	

The exhaust of a common slide valve engine may be assumed to contain 25 pounds of dry steam for each horse-power for each hour it runs. A temperature of 10 degrees F. above zero with a humidity of 60 per cent is as severe as may be expected for even a day or two at a time in Arkansas. This would then require all the exhaust steam of 180 horse-power of engines. This is available at any mine of this size, which, in addition to the fan, should have a good plant for power haulage and mining machines. If exhaust steam is used, a good steam separator must be placed just before the first jet to take out the water condensed in the engine. This water can be drawn off continuously into the air along with a little steam if the pipe is so large it will not be sprayed. It will then heat the air slightly.

Assuming 30 pounds of steam per hour as a boiler horsepower, the same air would require at night 150 boiler horsepower if all engines were stopped. One pound of Arkansas slack coal should evaporate 6.5 pounds of water. This would then require, in an extreme case, the burning of about 700 pounds of coal per hour. At large mines, a fireman is now employed each shift anyway and the coal would cost about $4.50 a day, 16 hours a day. The night temperature will not average below 40 degrees any month. This will require only 40 to 45 pounds of steam per minute, which should be largely supplied by a fan engine. If made especially, it will cost about $2.50 each winter night at the larger mines, or $150.00 a year. This is a small price to pay for freedom from dust explosions.

RECOVERY OF MINES AFTER EXPLOSIONS.

Rescue apparatus. Until dust explosions have been stopped by the combined effects of more careful blasting, safer explosives, and thorough wetting of the mine, provision should be made for the most rapid rescue of shot-firers. For this purpose, oxygen helmets and electric safety lights should be immediately available, and men should be trained in their use at the government rescue stations. It is only necessary to have one outfit for joint use for all the mines in each camp. This will be more likely to insure that the apparatus be inspected at intervals and so cared for. The operators should unite to send some mine foreman to McAlester, Oklahoma, for training, and on idle days should pay the regular wages to fire-bosses and certain experienced miners while they are trained to use the apparatus. It will be best to select those men who volunteer for rescue parties and who own their own homes and are thus more likely to be in camp when needed.

Restoring ventilation. After-explosions of gas are not likely to follow dust explosions in any of the Arkansas mines, so immediate steps should be taken to restore the ventilation at once. All shot-firers should time themselves frequently and report to the foreman and superintendent so that they may know where the shot-firers are by knowing the time at which the explosion occurs. In those mines having a separate split of air for each entry and therefore an unbroken pillar of coal below each entry air-course, the air-current can be taken directly into any single entry by placing temporary stoppings in all openings between the travelling-way and the return air-courses. It is not even necessary to repair the overcasts to reach any one entry. Other entries may merely be cut off by temporary stoppings. An additional stopping in the main slope will be necessary to carry the air to an entry opposite the fan. By having a solid pillar of coal between the main air-courses, as shown on Plate VIII, the time required to reach the beginning of any entry is only one-fifth or less of the time required to close a crosscut every 30 or 40 ft.

To place these stoppings with the least possible delay requires a proper organization and the presence at all times of sufficient supplies. This matter is fully discussed in "Suggested Rules for Recovering Coal Mines After Explosions and Fires," by W. E. Garforth.*

In this country, the chief criticism regarding the conduct of rescue operations is lack of preparation in advance and the fact that all responsible officials present at the time often go together in the most advanced party, and, if they are overcome, no one remains to direct the work. To restore the ventilation with the least possible delay and without breathing apparatus, the most advanced party should consist of but one mine official accompanied by one or rarely two healthy, temperate, and experienced volunteers. They should carry with them only sufficient material for one hastily placed stopping. As far behind them as the distance to the next stopping, at least, there should be two other men who do nothing but keep themselves ready to render aid to the advanced party if any of them are overcome by afterdamp,

*Published by C. Van Nostrand Company, New York. Price $1.50.

and to afford means of communication to the other parties. After a stopping is placed or nearly finished, these supports can carry down the materials for the next stopping while the advanced party is waiting for the air to clear. Dangerous quantities of poisonous afterdamp can be most easily detected by watching the behavior of a caged bird carried with the advance party. As long as the bird is not overcome, there is little danger to the men, and, by having the bird, the advance party will lose less time hesitating to advance even when a safety lamp will burn. The bird may be a canary and should be kept at every mine.

The advance party should be followed as closely as convenient by several other men who will place tighter canvas stoppings outside of the temporary ones, repair the most dangerous places in the roof, and clear temporary passageways around the worst obstructions so as to reduce the delay and danger of carrying out unconscious men. Parallel passageways as on Plate VIII are a great aid in passing obstructions. Men will also be provided to carry in all supplies needed by this force and by the advance party. The placing of brattices should be in charge of a regular brattice man, and some mine official should have supervision of this work. A third responsible official should remain constantly at the pit mouth to send messengers and see the supplies are at hand.

OVERCASTS WITH EXPLOSION WALLS.*

After one entry has been explored, the overcast giving access to the next entry should be repaired. The overcasts are also indispensable to enable ventilation to be safely restored in two entries at the same time. Explosion-proof overcasts can be made only by driving tunnels above some solid rock stratum, and from behind solid pillars of coal. There will be no feasible way to remove the waste without an opening to be afterwards closed by a stopping. In many mines, the overlying strata are so weak that an explosion would cause a heavy rock fall at such an overcast. The ventilation of this rock tunnel will be difficult and an effective rock tunnel is forbidden by the law requiring a crosscut every 30 ft. For these reasons, it seems best to protect the main structure of the overcast by providing ample relief passages for the pressure caused by an explosion.

*This description was published in *Mines and Minerals,* April, 1912.

Figure 69 shows a design for such an overcast to carry a 10-foot air-course over a parting 14 ft. wide. It will be noticed

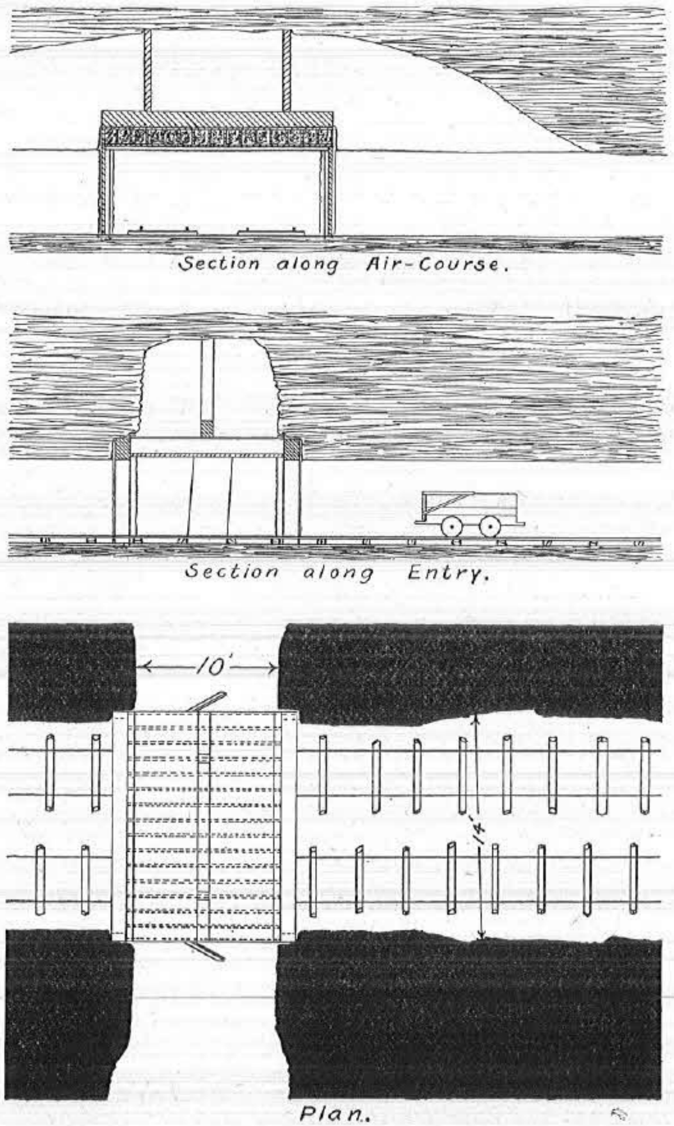

Fig. 69. Protected overcast with light walls.

that the main frame of this overcast is sheltered as much as possible by solid coal or rock. For this purpose, both the entry and

the air-course should first be driven a foot or two narrower than the intended width and then widened by pulling down all loose coal and dressing the walls smooth with a pick. These smooth walls will reduce the size of the air-course needed. The width of the overcast can be further reduced by making the cut in the rock higher than is at present customary. All spaces between the timbers and the coal or rock should be packed solid with strong cement mortar.

To proportion the members of the overcast for equal strength, the roof and the main frame are designed just strong enough to support a quiet downward load of 20 pounds per square inch, or nearly a ton and a half per square foot, in addition to its own weight. The posts are made as wide as the collars to give sufficient bearing area. This gives them much surplus strength as columns and will make them more secure against blows from derailed cars.

The table below gives the size of collars and the size and spacing of the joists for overcasts of various sizes, to resist 20 pounds per square inch downward pressure, if fair yellow pine is used. It should be noted that short overcasts will be much cheaper than the long ones for the same strength. If a beam

Dimensions of Timbers of Overcasts.

Width of air-course in feet	Width of entry in feet	Size of collar in inches	Size of legs in inches	Size of joists in inches	Spacing of joists in inches
6	8	6 by 10	6 by 10	2 by 10	20
	10	6 by 12	6 by 12	2 by 10	20
	14	12 by 12	8 by 12	2 by 10	20
8	8	6 by 12	6 by 12	2 by 12	16
	10	8 by 12	8 by 12	2 by 12	16
	14	12 by 14	12 by 12	2 by 12	16
10	10	10 by 12	6 by 12	2 by 12	12
	14	12 by 16	12 by 12	2 by 12	12

of about the same size of the collar be placed above the overcast and braced against the roof by two props at one-fifth the length of the beam from the ends, the overcast will not fail from upward pressure until the force equals 80 pounds per square inch. This construction is especially advisable if the entry carries the intake air-current. In this case, the main shock of the explosion will generally be from the entry toward the air-course. A smaller beam and more props would be cheaper for the long overcasts. If a cheaper overcast is desired, a 10 ft. by 14 ft. overcast to resist only half as much pressure will require collars 10 in. by 12 in., and 2 by 12 joists spaced about 22 in. center to center.

Figure 70 shows two suggested details for framing the roof. Both of these have about the same ultimate strength as the beams, but will yield somewhat by crushing of the wood before the

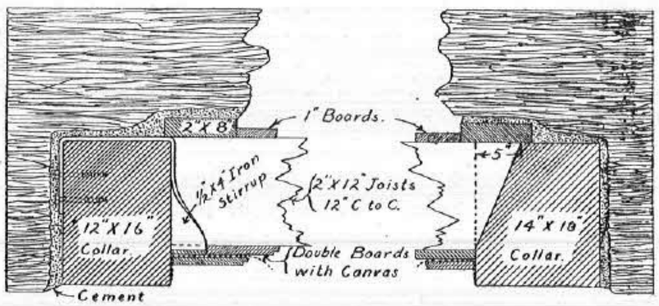

Fig. 70. Details of overcast with light walls.

beams will break. The iron stirrups are a more nearly standard construction for buildings but are more expensive. The beveled notch in the beam can be used only if the collar is made from 2 to 4 in. wider than the dimensions given in the table. It is also necessary that roof rock be so strong that the beams can not be forced apart. Because the joists must be held down by wedging against the rock, it will be necessary to frame the overcast a foot or so below its final position and to jack it up after the joists are in place. Cement should be packed in above the collar to make a tight joint before the 2 by 8 is put in.

To lessen the grip of the explosive blast, both top and bottom of the roof should be covered with smooth boards. To prevent leakage, either the top or bottom covering should be double with tarred canvas between the layers. The resistance of the overcast to a sudden shock can be greatly increased by weighting it with stone and sand between the joists. This should be well packed in.

Each side wall of the overcast can be made of two layers of inch boards with tarred canvas between. These may be supported at the top by a 2 by 4 strip nailed to the roof just firmly enough to resist ordinary windy shots. If necessary, doors for the convenience of the fire-boss may be placed in these partitions if they are made self-closing by leaning the hinges, and if they open against the air-pressure. In case these walls are totally destroyed, and the roof remains substantially intact, the side walls can be replaced by brattice cloth and ventilation restored in a few moments. Even if the entire overcast is destroyed the smooth nitch in the coal and roof will make it much easier to build a canvas overcast on a wooden frame than in the case of any style of masonry overcast.

The extra cost of such an overcast is chiefly in the extra labor of preparing the entries. This will be repaid by reduced maintenance. This overcast is very much cheaper than a rock tunnel and just about as effective because it can be restored as easily as the stoppings leading to a rock tunnel can be replaced. Its disadvantage is the fact that it will rot, and, if a long life is needed, concrete might be better, but the concrete should be provided with equally large explosion doors.

All mine fans should be placed at some distance from the mine opening so that the force of an explosion can be relieved through explosion doors without destroying the fan. This practice is already common.

ACCIDENTS FROM FALLS OF ROOF.

Mine props. It is universally acknowledged that sufficient timbering will largely prevent falls of roof in the working places. This requires that the props be not shot out by blasting off-the-solid and this in turn requires that the coal be undermined as by machines, or that sprags be placed against the face of the coal to protect the props from flying coal. This last practice is used at Coaldale and was described on page 66. It is not as effective as undermining, because the roof is still subject to the shock of heavy blasting.

The sufficient roof support is best secured by systematic propping with extra propping when necessary. This should be required by law as suggested on page 235. The full discussion there need not be repeated. It has been thought that there would be some advantage in so placing the props that they are staggered, or alternated in succeeding rows across the room. This, however, gives the shortest distance between props along the diagonals; and, for the same total number of props set, leaves a greater unprotected space along the face where the miner has to work. Rows parallel to the room track and at right angles to it are therefore recommended. If the props are set close enough together, only a few rocks, relatively small ones, can fall without giving warning by the props taking weight. If the props can not hold the weight, the working place must be made narrower.

Narrow entries. To prevent falls of rock in entries and traveling ways, sufficient rock-men should be employed to pull down all slabs of loose rock in all such places and, where necessary, to timber or retimber them.

In order not to weaken the roof any more than absolutely necessary, no entries should be wider than 10 feet except at partings, or for double tracks, or for carrying an air-current too great for a narrow entry. For double track and strong air-current, two entries should generally be used instead of one. In most places, the entries need not be wider than 8 or 9 feet.

In no case should gob entries be driven. They are necessarily wide and so weaken the roof. If brushed, the roof generally becomes dangerous as soon as the props rot, and these props can not be renewed. In all cases they are likely to cause car accidents by obstructing the rails, or by tempting the miners to take insecure positions to avoid a passing trip. They also interfere with the renewal of defective stoppings. If the slate is carefully corded up by skilled rock-men, the gob is less objectionable, but this increases the cost of the entry. It is generally thought that by leaving the gob in the entries, the operator saves the entire cost of hauling it out and dumping it; but it is forgotten that gob entries require extra timbering, greatly increased expense for maintenance per entry, and still worse retard the rate of driving entries, and so reduce the output of the mine until extra entries have been opened. This still further increases the cost of the care of the mine. In spite of these objections to gob entries, a change in the law will be required to prevent new ones.

BETTER LIGHT.

Acetylene lamps. Next after systematic timbering and careful blasting, good light is needed to protect miners from falls of roof. The main shaft bottom and entry partings of most of the larger mines are already lighted by electricity, but the chief danger is in the working place. Here the acetylene lamp seems to be the solution of the trouble. To encourage the use of carbide lights, the operators should sell the lamp and carbide to the miners at the lowest possible rate.

Recently lamps have been designed small enough to be attached to the miners' caps and they are being rapidly introduced. Besides better light, the carbide required is much cheaper than even the inferior grades of lamp oil, and, unless the flame is too high, they do not smoke at all. These small lamps are objectionable because the carbide and water must be renewed every two hours. When the miner works by himself, he often keeps the old style lamp burning low to give light while he is renewing the carbide. The change in position of the lamp also causes some trouble as does the sediment of the mine water used in the reservoir. Still, the carbide lamp requires no more of the miner's time than the open oil lamp.

The use of more than one light. As a remedy for all the disadvantages of the carbide lamp, it is recommended that each miner have two or more lights; one of these may be a small cap light to be used in handling cars or other work requiring both hands and a change of position of the miner. Another one should be a larger lamp supplied with a sharp hook or chain so that it can be readily fastened to either side of a prop or to the face of the coal in order to throw a light in any direction. This will give a good illumination of the miner's working place and require little attention. The larger lamps can well be provided with the two-jet burner to permit the miner to use a larger flame without smoke. This should be interchangeable with the stronger single-jet burner. For general illumination, especially of the roof, the reflector of these larger lamps should be so small that the shadow is but little larger than that of the body of the lamp.

The third light will be exactly similar to the second and will be used instead of the miner's cap light at the working face. The cap light will then be used only when the miner walks; and it must be fitted with a valve to shut off the water supply at other times. If two fixed lights are used, the miner can see in all parts of the workings without shadow and will have greater freedom of movement. The miners will soon get the habit of carrying one of these large lights in their hands or fastening it to the front of the car when traveling. This is the way in which most of the metal miners of the West handle their candles.

Suggested modification of the cap light. Some carbide lamps are arranged with a valve for regulating the flow of water. These are a convenience in starting and stopping the light and enable the miner to fill the reservoir with water some time before he needs the light. Sediment in the water and changes in the position of the lamp and depth of water in the reservoir change the rate of flow and require adjustment of the valve. Others have a pipe leading to the bottom of the carbide chamber and so arranged that an increase in the pressure of the gas checks the flow of water. Changes in position of the lamp may cause a sufficient increase in pressure to force carbide residue up this tube. Both of these troubles can apparently be overcome by the arrangement shown in the annexed sketch, Fig. 71. This arrangement is not known to be patented. To the end of the water tube is screwed a cup, closed for convenience of construction, by a screw plug. The water enters the lower part of the cup through small openings of any sort in the wall of the tube. It can not flow upward out of the cup unless the lamp is vigorously shaken or the gas pressure is less than the water pressure. The gas pressure can be regulated by the manufacturer by changing the length of the tube which will alter the head of water upon the cup. The valve is used to start and stop the light. Small obstructions in the tube can be removed by rapidly working the rod in it after the valve is unscrewed. If necessary, the cup can be taken off by the miner.*

Electric lights. For mines having an electric plant, and employing an electrician, electric cap-lights with storage battery will soon become standard.† The recently perfected tungsten light will furnish a three-candle power light for 12 to 14 hours

*Literature upon Acetylene Mine Lights can be obtained from the Maple City Mfg. Co., Monmouth, Ill.; Scranton Acetylene Lamp Co., Scranton, Pa.; and John Simmonds Co., New York.

†See *Mines and Minerals,* Vol. XXXII, p. 79 and p. 91. Sept., 1911.

with a storage battery weighing only 2 pounds, or about as much as a miner's side can, or cadger. These lamps require no attention from the miner and are absolutely free from smoke. They can be readily made as safe as the ordinary safety lamp, and should supercede safety lamps for all purposes except testing for gas, because they are the only safety lamp throwing any light upon the roof. Three-candle power and absence of smoke will

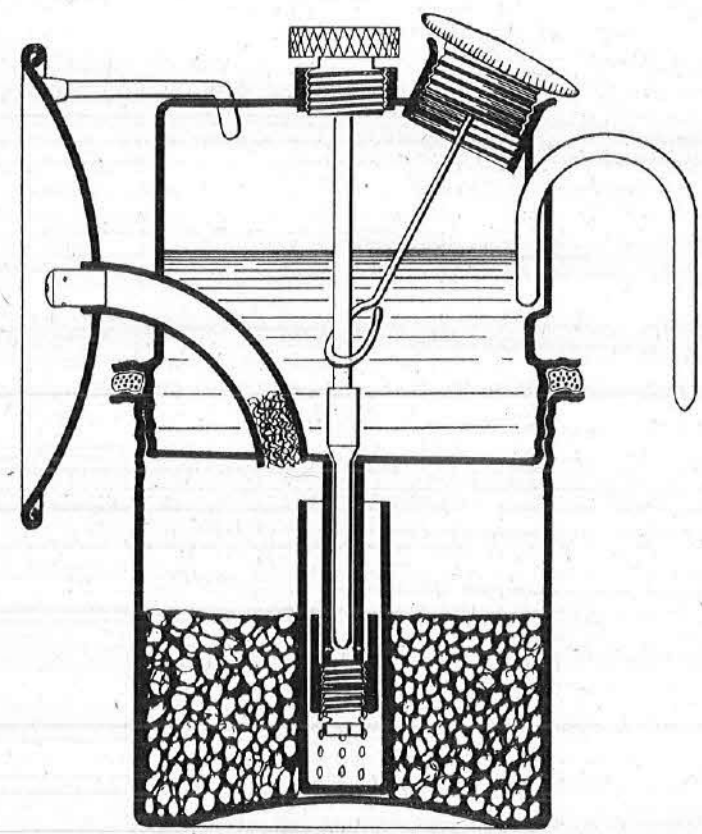

Fig. 71. Suggested design for a carbide cap-lamp.

give much better light upon the roof than even the common pit lamp. They are also unaffected by draft. With such lights, the increased efficiency of the labor will make it profitable to supply the lights free to the day-men and charge them only for breakage. The batteries are being improved constantly to reduce weight and inconvenience of acid solutions. Their maintenance including wages of the electrician who charges the batteries has already been reduced to from 2c. to 3c. per day.

At the smaller mines a dynamo for charging the lamps can be attached to the fan engine. Such a plant sufficient for 200 lights and consisting of a dynamo, switch board, and charging racks for the batteries, will cost about $175. The lights themselves with storage battery and connections complete can be obtained for $6 to $7.50 each depending upon the number purchased.

MINE FIRES.

Prevention of fires. Severe mine fires can best be fought by men equipped with oxygen helmets and under the supervision of the officials of the United States Bureau of Mines. The best method of handling mine fires is prevention. As yet the Arkansas mines show few large blowers of gas, and the coal has a low percentage of volatile matter and is not so readily ignited as other coal. As a result mine fires are more easily prevented than in other states. The number of fires can be reduced by the more careful use of powder so as to reduce the frequency of large flames after the gas has been liberated by breaking the coal, and the chance of a powder flame coming in contact with a gas blower at some other part of the working face. Safety explosives are an advantage.

In case there are any gas blowers at all, the mine should be paroled after each blast. This is now done in many cases by the shot-firers, but on account of the smoke in the rooms, they do not always find the small blowers burning with a colorless flame. Such fires are not likely to become serious for some hours and are generally found in time by the fire-boss next morning. So far as known the serious fires have started on the evening before an idle day or Sunday. For this reason and to restore disarranged ventilation as soon as possible, it would seem well to have the fire-boss inspect all gassy mines the night after shots are fired whether the mine is to work next day or not.

Small mine fires. In case of small fires, certain precautions should be observed in fighting them. The velocity of the air-current passing the fire should be reduced without reducing the speed of the fan or impairing general ventilation. With a separate split for each entry this can be done by partly closing the regulator. If the fire is in an entry, it will ordinarily be better to short-circuit the air by opening a stopping as close to the fire as possible. If it is in a room, the break-throughs leading to the room should be closed by temporary stoppings. In this way, there will be no chance for the accumulation of dangerous bodies of firedamp to be lighted by the smoldering fire or the miners' lights as soon as the ventilation is restored. To protect the men from the poisonous gases given off by the fire, they should approach it with a line of brattice cloth carrying just enough fresh air to drive the smoke and steam away but not enough to fan the fire. The air-current can be easily obtained at the opened stopping. In this way, the fire fighters are not injured by the fumes. Until the fire is all cleaned up, no man should be allowed to work on the return side of the fire. For this purpose, separate splits for each entry with return through the air-course is practically required.

Sufficient props and crossbars should be placed along the line of attack to protect the men from the falls of roof likely to be caused by the heat, and to assure a line of retreat.

For the convenience and comfort of the men a hand-driven force pump is much better than throwing water upon the fire by powder cans. This should be provided at the more firey mines together with tank cars for bringing water; after the visible fire is cooled, much more air can be used to drive away the gases while the loose coal is being loaded out. It will then be best to make the inlet for fresh air wide enough to cover the greater part of the working place. More props should be set as soon as the spread of the fire has been stopped and before any attempt is made to dig out the bottom of it.

Fire-proof structures. The stables, underground engine-rooms, and shaft bottoms should be as nearly fire-proof as possible. At the small mines, the timbering should be heavy and slow burning and all inflammable litter should be kept away. Hay and straw for the mules should be placed in a separate room not traversed by a strong ventilating current. If the mine is to have a life of more than 12 or 14 years, it is just as economical to make these structures of concrete and to support the roof of the shaft bottom by steel mine supports. Wherever possible, places in which inflammable material is stored, should be lighted by low voltage electric lights, or by portable electric lights worn by the men. The mules have better health and can be shod more carefully if they are hoisted to the surface every night and at all mines having large enough cages all underground stables should be abolished.

To protect the miners from surface fires, the fan house should be 100 or 150 ft. from any other building and should be of brick or corrugated iron construction. To prevent tipple fires from spreading down the mine, the fan should be easily reversible. At a short distance down the main shaft, there should be light easily closed doors. As a result of fire experience in buildings, wooden doors covered on both sides by heavy tin with clamped seams and rivets are recommended. They should be held open by hemp ropes extending up into the tipple far enough to be always dry and sure to be burned off before fire has spread past the doors. The doors will then close even though no one can approach the shaft top. The mine inspectors should see to it that these safety doors are never propped open. With these simple precautions the men in a mine will be safer against fire than persons working in frame buildings. The greatest danger is from gas after the ventilation stops but the men will leave the mine before there is much accumulation.

Alarm systems are not recommended. In the dampness of a mine, they are very likely to get out of order in spite of constant care. They may therefore fail in an emergency and the men, who would otherwise leave the mine or be warned by messenger, may lose their lives by depending upon the alarm.

FALLING OF MEN.

All openings to shafts both at top and bottom should be guarded by substantial gates. These can be made to open and close automatically at the shaft bottom. The gate at the ground level should be opened only by hand and so arranged that it will not stay open except when the cage is at the landing. A simple scheme for this purpose is shown in Fig. 72. This is intended for a substantial lifting gate so counter-balanced that it can be readily raised, but still tending to close of its own weight. At the top of its lift, it is held by the latch *A*. This is so propor-

tioned that it tends to assume a horizontal position but is free to rise, as the gate passes, by sliding in a link at the end of the rod *B*. While the gate is open, the latch is held by the rod *B*, which is supported against the side of the cage through the bell crank and bar *C*. As soon as the cage is moved, the gate is released and later the weight on rod *B* pulls *C* out of the way of the cage. The gate can be held open by other means in case it is necessary to get to the shaft while the cage is not at the landing, but it will not be left open after ordinary use.

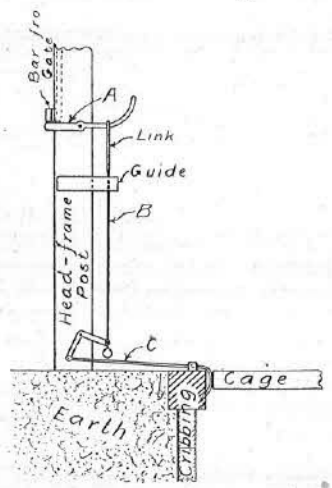

Fig. 72. Shaft gate.

All stairways and walks around the tipple should have strong railings upon both sides, and as far as possible there should be sufficient hight so that men can pass without striking their heads or stooping. The stairways in the escape shafts should be so railed and arranged that the miners can go up and down them in the dark if necessary.

To reduce the risk of stumbling, all ladders and stairways should be kept in perfect repair and there should be no steps of unusual hight.

ACCIDENTS FROM MACHINERY.

Guards. All mining machinery should be provided with all possible safeguards. These consist of shields over all gears, rapidly moving saws, wheels, or any machinery not enclosed by railings. Ample room for attendants should be provided so that they need not go too near any machine. These methods have been worked out by mechanical engineers for the larger industrial companies, and accounts can be found in technical literature.*

*Complete statement in "The Mechanical Engineer and Prevention of Accidents," by Jno. Calder. *The Journal of American Society of Mechanical Engineers*, Feb. 1911.

Rope carriages for slope tipples. At most of the slope mines, it is necessary for the coupler on the tipple to throw the hoisting rope upon the knuckle sheave, with an iron hook each time an empty trip is sent down the mine. This is fatiguing work and requires considerable skill to avoid injury. At the No. 2 slope of the Russellville Anthracite Coal Company this is avoided by carrying the rope upon a car above the empty track and on a level with the track for the loads. This car is pulled to the knuckle by holding the rope in a clamp which is released by the attendant at the right time. The car is then returned by gravity. There is still some danger and this arrangement takes even more time than the dangerous hook.

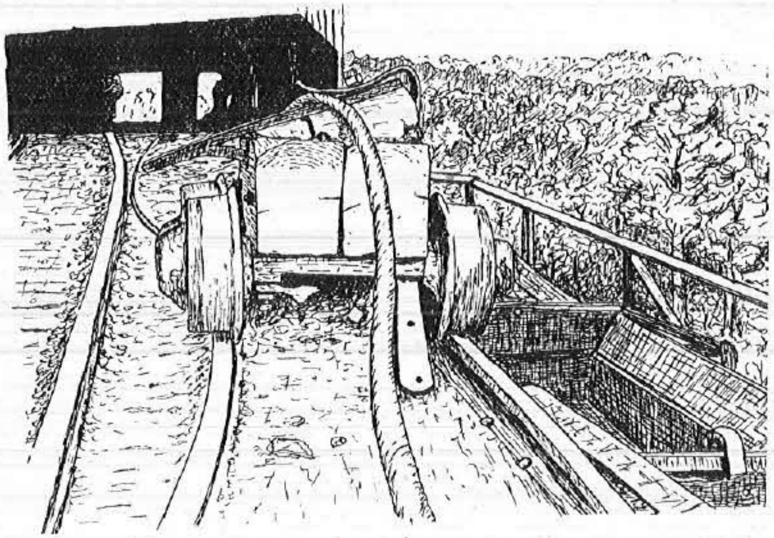

Fig. 73. Rope carriage at the Hiawatha Mine.

A better plan is in use at the Hiawatha Mine at Coaldale and the mine of the Harper Coal & Coke Company at Bates.* Fig. 73 is redrawn from a dim photograph of the rope carriage in use at the Hiawatha Mine. This shows the car on the side track with the hoisting rope thrown into the spring clamp on top and ready to be attached to the empty trip ahead of the cars shown. As the trip is lowered, the car runs forward. Most of the way, the left hand wheels run upon the near rail of the loaded track as shown

*This description was published in *Mines and Minerals* for April, 1912.

in Fig. 74. When the knuckle is reached, this rope carriage is held by a firm stop, while the rope slides down the iron bar on top and drops down upon an iron inside the rail of the loaded track, and slides over onto the knuckle pulley, as the trip swings on to the straight track. The carriage is prevented from tipping over, as the rope slides off, by the tongue on the right hand side, which enters a slot in the stop. When the loaded trip comes up, it strikes the end of the rope carriage and pushes it back until it turns out of the way on the side track. After the loaded trip has been spragged, the coupler detaches the rope, pulls it back far enough, throws it into the clamp of the carriage, and jumps down to the empty track and attaches the rope to the empty trip. Then if the grades are right, he need merely to pull back the stop and the trip starts off without more attention.

The rope carriage must be high enough so that the rope will not strike the frame work of the upper track. If too high, there

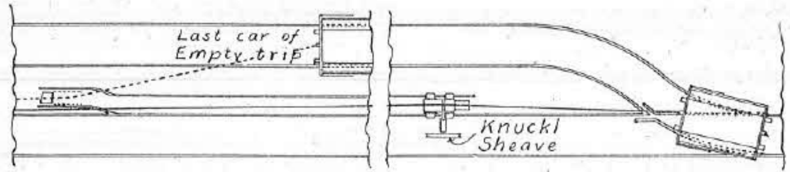

Fig. 74. Track for rope carriage.

is danger that the carriage will be jerked off onto the empty track. This danger is reduced by placing the extra rail for the slope carriage as near the empty track as possible, by weighting the other side of the car, and by decreasing the angle of the rope from the carriage to the trip. This angle is sufficiently small upon all gently sloping tipples. On the others, it can be increased by placing the switch between the empty and loaded tracks farther from the trucks.

The carriage should reach the knuckle just as the rope has swung over to the first rail of the straight track. To insure this, the side track for the rope carriage is placed just as far from the end of the usual empty trip as the frog between the loaded and empty tracks is from the knuckle. It is said to be better to have the carriage strike the top too soon so the rope will slip in the clamp, rather than too late so the rope may slip off and catch at the edge of the rail.

To prevent the carriage from turning over endwise, the front wheels should be as far forward as possible and the stop as high as it can be without striking the rope. If the rope rubs on the extra rail for the carriage, the only harm is the extra wear on the rope.

With this arrangement, the knuckle sheave can be in the exact center of the slope track and only the empty track need be curved. The sheave should be rather low, and heavy iron straps should be provided to guide the rope from the arm of the carriage to the sheave.

The rope carriage here shown can be applied to any existing tipple at very little expense. The extra time and strength it saves the coupler can be profitably spent in better inspection and oiling of the pit cars and in assisting to drop loads to the dump.

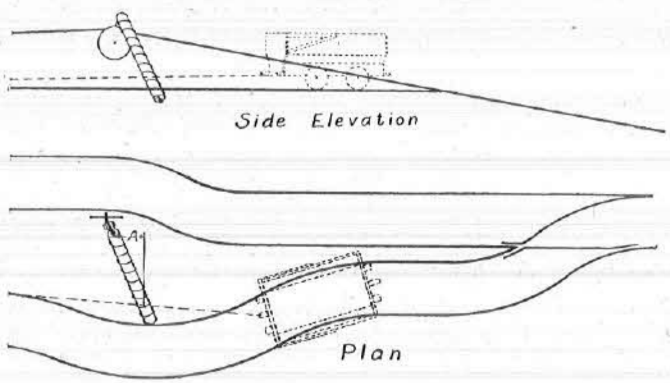

Fig. 75. Spiral for raising rope to knuckle sheave.

The slope carriage at Bates carries an upright arm so pivoted that it can not swing toward the empty track, but so arranged that, as the cars swing over to the straight track, this arm carries the rope over to the center of the knuckle sheave. This carriage has little advantage over the one shown and is more complicated. It takes a little more time to put the rope on it and it is very likely to be jerked off the track at the knuckle.

Spiral for raising the rope at slope tipples. At one or two slopes in this State, the rope is carried most of the way up to the knuckle sheave by a screw-like arrangement as shown in Fig. 75. Ordinarily these do not carry the rope all the way to the sheave and the coupler has to throw the rope the rest of the way by pulling it with a hook. To insure the most certain action it is best to place the knuckle sheave outside the track and put an extra curve in the empty track and to raise the rope some distance above the rail. Such an arrangement will always work and be free from derailments, and does not require the coupler even to place the rope upon a carriage. It will, however, require more expensive changes in existing slope tipples, is more expensive to maintain than the carriage, and is troublesome to design and construct.

The drawing shows a screw made of a one-inch square iron rod riveted spirally around an eight-inch steam pipe. The detail, Fig. 76, shows a possible method of construction. The pipe is fastened by riveted arms to a two-inch square shaft turned at the ends. For simplicity in designing the bearings, the spiral should be attached to a timber parallel to its axis as shown. The

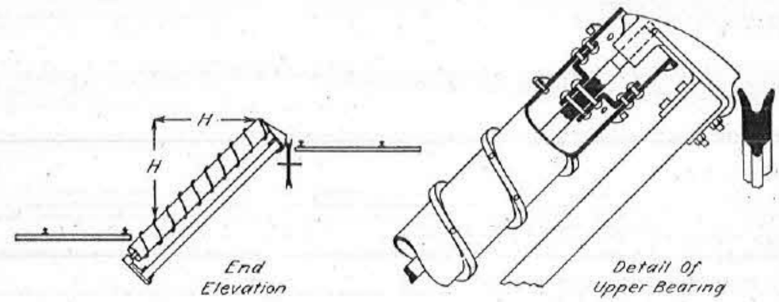

Fig. 76. Details of spiral for raising rope.

support of this timber depends upon the general design of the tipple. The lower bearing is a simple thrust-bearing but the upper one must carry a heavy wing to guide the rope from the highest point of the pipe to the knuckle sheave. In order that the rope may bear equally upon the pipe and the spiral, the horizontal distance between the ends of the pipe at right angles to the center line of the tipple should equal the vertical distance.

For best results, the spiral should make the same angle with the axis of the screw that the rope does. If this is done, the rope is supported evenly on its lower side by the spiral. It is also necessary that the rope reach the top of the spiral at about the time the end of the trip has swung over upon the main track. To bring this about, the total length of the spiral, above the point at which the rope first touches it, must equal the distance the rope travels from the time it touches the spiral until the trip is upon the main track.*

This distance, which may be called L, depends upon the grade of the tracks and the vertical distance between them at the knuckle. When too great, it can be reduced by keeping the empty track so far away from the loaded track that the rope will not touch the spiral until the trip has nearly reached the frog between the tracks.

The length of the spiral depends upon the number of turns it makes around the pipe. This is increased by placing the pipe more nearly at right angles to the rope. This reduces the offset A shown on the plan and measured from the point at which the rope first touches the spiral to the point at which it leaves it. If the spiral is to be parallel to the rope at the point of contact, and if the rope is to reach the top after it has traveled a distance L, the offset A is given by the formula:

$$A = \frac{L}{2} - \sqrt{\frac{L^2}{4-2H^2}}$$

In this, H is the vertical distance the rope must be lifted and A and L are as just defined.

The position of the spiral upon the pipe can be marked out for the blacksmith by wrapping around the pipe a piece of paper cut off at the angle the spiral is to make. This angle can be laid off by measuring on the side of the paper a distance equal to 1.414 times H, and, at right angles to this, the distance A and completing the triangle by joining the ends of the two legs. This triangle may be made to any scale and applied to the pipe as often as necessary. The computation can then be checked by measuring the length of the spiral to see if it equals L.

If trigonometrical tables are available, the angle of the spiral called S may be obtained more simply from the formula:

$$\text{Sine of } 2\,S = \frac{2\sqrt{2H}}{L}$$

The horizontal angle P, that the projection of the spiral upon the plan makes with the perpendicular to the direction of the

*Actually the spiral should be a trifle shorter since the rope rests upon the spiral at a distance from the axis greater than the outside of the pipe. The correction is small and varies with the diameter of the rope and the amount of wear upon the pipe. It is an error upon the safe side.

rope, is then given by the relation tangent $P = \sqrt{2} \cdot$ tangent S. This is readily laid out on the drawing board. H can be taken as the difference in elevation between the two tracks at the knuckle.

Safety switches for slopes. For the protection of the men in the mine and to prevent the destruction of cars that escape from the empty track, a switch just above the slope mouth should be held by a spring in such a position that all descending cars will be turned to the repair track unless the attendant holds the switch for the slope. The Arkansas mines do not have such a safety switch because the coupler's attention is required at the knuckle sheave while he should be attending to the safety switch, and no one else is at hand to look after it. An automatic arrangement such as described would therefore not only relieve the coupler of the dangerous part of his work, but would also permit the operation of a safety switch without additional expense. This switch can be closed by a wire from the position most convenient for the coupler. It should be required by law as in many other states.

ACCIDENTS FROM CARS.

Better light. Many accidents to drivers are caused by collisions between different mule trips and by mules going in the wrong direction. These can be largely avoided by having a good light attached to the first car of the trip or hanging to the collar of the mule. The only practicable light for this purpose is the electric light with storage battery. They should be at once introduced in all mines having a direct current electric plant. Wherever two or more mules haul to the same parting, they should be supplied even when a special dynamo for charging the batteries must be purchased. Lights of three candle power are now made for this purpose and cost from $9.00 up. The maintenance is about 2c. or 3c. a day. Such a light will pay for itself in a very short time by reason of the saving of time by the driver and the much larger amount of work a mule can do if it is not obliged to flounder around in the dark.

Accidents from hills in roadways. In many of the Arkansas coal mines, there are short steep hills in entries which are generally level. The drivers soon get into the habit of making the mules run down these, instead of spragging the cars and going at an ordinary speed. In order to keep out of the way of the cars, the mules will get to running down such hills faster and faster. The result is a bad wreck whenever the cars strike a chunk of coal or any other obstruction. There are also wrecks when the mule stumbles or tries to dodge the trip. Generally the mule is hurt rather than the driver, but the driver is sure to get hurt if he is caught in many wrecks. Usually, there is no excuse for such hills, and the entries should be driven at grade. Generally, the expense of removing hills or avoiding them in the first place will be more than repaid by the better output and longer life of the mules, even if the safety of the driver is not considered. This phase of the question will be discussed in Chapter XI.

When entries must be driven around squeezes or patches of faulty coal, hills may be necessary. They are also necessary for twin-haulage entries, and in nearly flat coal generally. Such hills are usually long and the drivers are much more likely to sprag their cars on them. This should be insisted upon by better discipline. If the hills are so steep that more than three sprags to the car are necessary, the general layout of the mine should be changed to avoid them even in the rooms. This will be discussed later.

If there are hills in cut-offs or rooms, requiring more than two sprags to the car, all cars should be fitted with brakes that can be operated without danger while the car is in motion. This is necessary because the grades will change in short distances and some cars will run stiffer than others. As a result, the cars are either excessively spragged and wear out the mule, or they are in places insufficiently spragged, causing danger, or the driver is forced to the dangerous practice of taking out spraggs or putting them in while the trip is in motion. Often all three conditions occur on the same run. With a good brake, the miners in rooms or the drivers need put in only enough spraggs for the flattest part of the hill, and safely and easily control the speed of the cars by the brake. As yet no brakes are used in Arkansas. The extra cost per car is only $1.50 for single brakes, and $3.00 for double brakes, and will often pay in additional output from the mine. If brakes are used, care must be taken to see that they are maintained in good condition.

Bumpers. When cars are full and entries low, or when cars are chunked up, the drivers are compelled to ride on the bumpers. Even when cars are empty, they ride between them to save time in switching. For the protection of the driver, the cars must be kept apart by bumpers. The thick corner bumpers now in use are more safe and convenient for the driver, although harder upon the cars than center bumpers. They should, however, be made a little longer than at present, say not less than 8 or 9 inches beyond the extreme ends of the car body. They should also be wide. This change is impracticable in those mines already opened by small shafts. In existing slope mines, it presents little difficulty and all new shafts should be made large enough to accommodate long cars.

Obstructions on the track. To reduce accidents, the tracks should be kept clean, all gob entries eliminated, and plenty of room maintained at the side of the track to receive any lumps of coal the driver may wish to throw off the track. It is better for the efficiency of the mule to fill the space between the ties with good road material. Hard brushing from the mine is sometimes available, but it will generally be necessary to bring in cinders or other material from the surface. This will have a slightly beneficial effect in also avoiding accidents caused by stumbling mules, and will prompt the company men to keep the roads cleaner.

The spilling of coal can be greatly reduced by less chunking up of the cars. This is best accomplished by giving the miners plenty of cars or a good turn. Some miners will arrange the chunks upon lightly loaded cars in such a way that some coal is very likely to fall off, and enable the loader to claim an average weight for the "broken car." The pit-bosses should occasionally inspect the loading of the cars to check this cause of unnecessary accidents to drivers. It may even be well in all cases except actual bad wrecks reported by the driver, not to allow payment for the spilled coal but to credit all coal gathered from the roadways to the general funds of the Union. Under present conditions, this is too likely to lead to unfairness, one way or the other.

Where a poor turn is unavoidable, it seems better to limit the hight of the loaded car rather than its weight. This is less troublesome to the miner, and the car is less likely to spill coal on the roadway or down the shaft. The simplest method of enforcing this rule is to pass the cars under a bar swinging like a gate, and so set that it will be opened by all cars of excess hight. An agreed amount of coal should then be deducted from the check number on the car and credited to the Union. If this agreement can not be made, the cars can be passed under a strong fixed bar that will knock excess coal off. This exacts an additional penalty because some coal below the bar will go with the projecting lumps. In fairness, the coal knocked off must be credited to the Union. It can not be refunded to the miner as excess-weight deductions sometimes are.* It will, however, be necessary to make note of the cars that are broken before reaching the bar, and there is an expense in gathering up the coal. Obstruction of the track and delays may be avoided by placing the bar over a good-sized pit beneath the track.

If it were not for the mine-run law, the falling of coal could be almost entirely prevented in the high-coal mines by making the car bodies higher to give the same capacity with less chunking up. This can not well be done in the low coal, and under present conditions, high cars will increase the percentage of slack produced.

Better tracks and switches will also reduce accidents slightly, but this is primarily a matter of greater economy in hauling coal.

Accidents with rope haulage. Accidents on rope-haulage ways can be reduced by keeping the speed as low as possible. This requires that the trips be made as long as can be handled by the engine and rope, and that delays between trips be reduced as much as possible. When the output is small, there is no excuse for running the trips so fast that there are frequent long waits for coal. To increase the length of trips, stronger rope and better couplings and in some cases more cars will be needed. These pay anyway in the reduced number of wrecks. The practical limit of the number of cars per trip will then be determined by the capacity of the terminals at the top and at the different levels.

There is little danger to the trip riders as long as the speed can be kept down to 8 miles an hour. At higher speeds, better track and better running gear on the cars become increasingly

*See page 215.

necessary to prevent derailments and the shaking off of coal. With these greater speeds, a high-priced trackman should be employed occasionally to line up the track. It is believed that at high speeds, the rope rider will be safest if on the car next the rope both up and down.

At the head of all slopes, there should be a derailing switch that must be held in position by some man each time a trip is to be lowered. It should be far enough from the top that the entire trip will pull on the rope before the first car passes the switch.

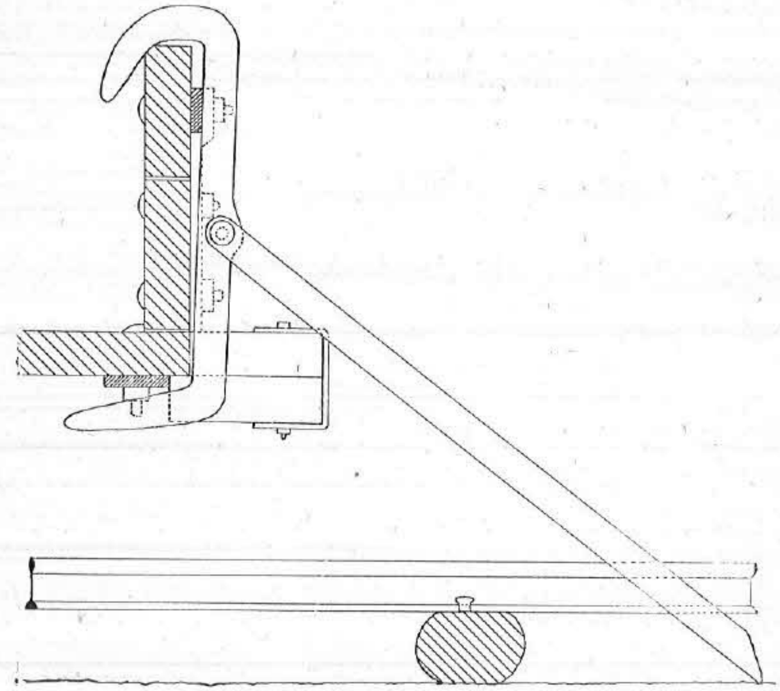

Fig. 77. Trip dog used at Bates, Arkansas.

While slopes are being sunk, a similar safety switch should be placed below the last working entry to protect the men at the face. If the grade is steep, this should be connected to a side track so graded that the runaway cars will wedge against the roof and not run on down over the ties.

Safety dogs on the end of the trips are not always used because they often fail to stop the trip but merely turn under the last car.

At the mine of the Harper Coal & Coke Co. at Bates, Arkansas, a dog like that shown in Fig. 77 is in use. It is said to have been designed by I. R. Packard. The top is hooked over the car more easily than the ordinary dog is fastened to the edge of the coupling. It is not in the center of the car and is pretty certain to throw the car into the rib. It can not turn under the car without first tearing the end out, which will not happen at the low speed of the beginning of the runaway. It can be made by the mine blacksmith and the expense is not great. It is rather heavy and should, therefore, be made of crowbar steel to give sufficient strength with a minimum weight.

Experience has shown that for both main slopes and shafts it is safer as well as cheaper to install ropes having a factor of safety of about 5, and to discard these ropes as soon as the wires of the outer layer are worn so that a small number of them are broken. Such discarded ropes can then be further used in inside slopes having a small capacity and low speed of hoist. If larger ropes are used, they are likely to be used too long and there is no easy way of judging the wear inside the rope. Jerks in starting trips on slopes can not be avoided by even the most careful engineers, and the rope generally breaks as the trip is starting, without serious results.

Accidents with electric haulage. The entire subject of electrical accidents in coal mines has been so fully discussed in Miners' Circular No. 5, issued by the Bureau of Mines, that little need be said here. The main thing seems to be to impress upon the men the fact that electricity is dangerous and should be left alone. Where men must pass under a trolley wire, the wire should be protected from accidental contact by a secure wooden guard.

Accidents to men walking in haulage-ways. To avoid these accidents, all power and mule trips should carry a light, and the present law requiring refuge holes every 40 ft. should be enforced, and also amended to require that they be kept free from all rock, coal, or other refuse; and that the rib for a yard on each side of the hole be kept whitewashed. In ordinary entries, the room necks will serve as refuge holes. As mentioned before, gob piles should be kept out of entries used as traveling-ways. Wherever the old air-courses are no longer required to carry the return air, they should be kept in good order as independent traveling-ways.

ACCIDENTS FROM MISSILES IN SHAFTS.

At shafts having self-dumping cages, the bottom men are in danger of injury from falling coal. This can be prevented by stopping the excessive chunking up of cars. The danger can be reduced by building a secure hopper at the top, so that no coal can fall down outside the compartment of the dumping cage. By watching the falling of the coal, the hopper at the top can often be changed to reduce the amount of coal that falls down that compartment even with excessive chunking up. A substantial partition should then be built between the compartments from the top to the bottom of the shaft. At the bottom, there should be a gate regularly opened only by the descending cage. This gate should be so strong that it will keep cars from running into the sump.

SUMMARY.

In this chapter, we have attempted to show that the mining laws should be amended to protect the health of the miners as well as to prevent accidents to the men. To enforce proper precautions upon the part of the miners, the entire responsibility should be placed upon the operators and the miners should be prevented from interfering with the enforcement of the rules made by the operators and mine inspectors.

The general health conditions may be improved by avoiding smoky lights, dust, muddy roads, strong drafts of cold air, and long walks in low entries, by securing the best kinds of explosives, and by properly firing them and removing the smoke as rapidly as possible. The mines should also be provided with proper drinking water and sanitary conveniences. Modern change houses are strongly recommended.

Better ventilation is needed and can best be secured by several strong splits of air rather than by coursing a single split through the entire mine. Loss of air before the working places are reached requires increased size of air-ways and reduction in the number of stoppings used. Plate VIII shows a suggested plan for accomplishing these results.

For the prevention of accidents, better discipline is essential. The powder should be more carefully handled; the amount of powder used in blasting coal should be reduced by a strict control of the shot-firing, and wherever possible, by undermining the coal by machinery before it is blasted. It is suggested that the price of powder be largely increased and that the increased price paid for powder be used as a relief fund for the victims of mine accidents. An equal tax should be placed upon the coal operator to go to the general funds of the State. This would provide money for more rigid state inspection and for the general sanitation of the mining camps.

Rules for handling gas in the safest manner are suggested. To check the common dust explosions, more careful use of powder is necessary, safety explosives are advisable, and the mine should be kept moist. For the last purpose, steam for both warming and moistening the air-current is strongly recommended. The advantages of the method are pointed out and the means for reducing its disadvantages are suggested. This is followed by calculations showing the amount of steam and water that will be needed under various conditions, and the horsepower of boilers and the expense necessary to keep the air in good condition.

The best methods of controlling mine fires and of recovering mines with the least delay and danger are outlined. To reduce the accidents from falls of roof, the legal requirement of systematic and extra proppings is necessary. Better light, less powder, and narrow entries will help reduce such accidents. Besides protecting the miners from falls of roof, better lights are needed to prevent smoke, to light the front of all trains of cars whether pulled by power or by mules, and to increase the efficiency and comfort of the men. Electric or acetylene lights are recommended and described.

The danger of the falling of men should be lessened by railings at shafts and stairways, and the falling of coal down shafts should be prevented by a strict load limit upon cars and the best possible dumping arrangements. Guards and safety devices are outlined for the reduction of accidents from moving machinery.

To protect the men from car accidents, better lights, cars, track, and bumpers are advisable. Obstructions upon the track should be reduced by care in loading and handling cars and by

the abolition of gob entries. With rope haulage, the speed should be as low as possible and strong hitchings and cars are necessary. Refuge holes or separate traveling-ways for men should be maintained. Safety switches are needed upon slopes and the men should be taught to fear electricity. The example should be set by placing all possible guards around electric apparatus.

Without neglecting minor precautions, it is urged that special attention be paid to the chief causes of accidents. These are the falls of roof, the heavy blasting, and accidents from cars and gas. It is also urged that more attention be paid to the prevention of sickness among the miners.

Most of the suggestions here given involve some expense to the operators or else extra work upon the part of the miners themselves. In the long run, the expense falls upon the consumers of the coal. It is for the sake of the consumers that the coal is mined and it is for them that the miners toil. Why then should they complain at the cost of the health and safety of the men who supply them with coal? No users of coal should be so heartless as to begrudge the few cents per ton of coal needed to minimize the suffering and hardship caused the miners and their families by sickness and injury.

Conditions in the different mines vary and general regulations will be inadequate under some circumstances, and needlessly drastic under others. Legislation can not keep exactly abreast of knowledge of mine safety. For these reasons, legislation is a last resort and it is gratifying to note the tendency of a large number of operators to forestall the passage of rigid laws by introducing safer methods and appliances as rapidly as they are devised. It is for such operators that the suggestions here given were prepared. At some future time, the consumers of coal may become sufficiently humane and sufficiently conscious of their own interest in the matter to give preference in the purchase of their coal to those operators that pay the most attention to the health and safety of their employees. When this attitude is well established, safety laws will be unnecessary.

The miner may think it a hardship to be careful, but the widow caused by his carelessness will find it a much greater hardship to honorably provide for herself and children. The miner who survives an accident but loses his eyes or limbs will be quick to prefer careful mining to the hardships that so often follow the shirking of this duty. Before they complain of safety regulations, those miners that are too lazy to be careful without regulations should think of the possible results of their carelessness to others. This thought should also make both miners and operators willing to bear the tax upon powder that will prevent many accidents and provide for the victims of the accidents that are unavoidable.

CHAPTER X

CONSERVATION OF COAL

CONDITIONS OF COMPUTATIONS.

The general remedies for the loss of coal have been given on page 332. The detailed computations to be given here are made upon the supposition that the mine-run law will be repealed, and that the miners will not resist those changes of mining methods, that do not decrease the daily earnings of individual miners. The scale prices of the 1908 wage contract will be used since these form the basis of the costs given in Chapter VIII. As long as the scale is increased or decreased by a uniform percentage, no change is made in the relative costs of different methods as compared with each other. When methods of mining for which there are no scales are studied, scales will be suggested which are expected to yield to the miners the normal earnings given on page 170. The scales for some proposed special kinds of work are figured from the Arkansas room tonnage scale by using the ratio which exists between the tonnage and special scales in certain other districts of the Southwest.

The value of the coal in the ground will be taken as 10c. per ton. This includes the value of the land and cost of opening the mine with interest, charged against the coal that may be recovered during the life of the mine. In some cases of thick coal purchased cheaply and opened at slight expense, the charge is less than this. But the value of the mining right has increased lately and the expense of opening mines is increasing rapidly. The cost of opening some of the newer mines at Spadra has exceeded this, not including interest. The difference between the market value of slack and lump coal is taken as $1.00 a ton for the softer coal and $2.50 for the Spadra coal.

Most of the mining methods hereafter described make it possible for the operators to mine a larger proportion of coal than at present and to do this at a profit. Other improvements along the same lines will suggest themselves to the superintendents. Some methods fully described are not the best that have been devised, but they will cause the least disturbance in labor conditions. Others have been preferred to plans yielding a slightly better extraction because they require much less departure from present plans. In many cases, only that plan which shows the greatest net profit has been discussed. Much time has been spent in an effort to devise plans for materially reducing the waste of mining under certain special conditions. When more careful mining proved more costly than present methods, no mention of the new plans has been made. Careful mining is less profitable in the case of small mines cheaply opened and having a top of thick unyielding sandstone. Wherever wage scales and thicknesses of coal are such that deadwork costs are low, the more complete mining becomes less profitable than usual. The methods discussed here have not been hastily worked out.

NECESSITY OF SAVING THE COAL.

The operators are strongly urged to adopt more complete methods of mining the coal whenever this is possible. In the first place, it is often profitable from a mere commercial point of view. Further, those in possession of nature's gifts of coal may be compelled by law to use that gift for the greatest good to mankind. It may be urged that the coal belongs to the so-called owners, and that the public has nothing to say as to its use. This argument has little practical importance, because public opinion is rapidly approaching the point of regulating the control of nature's gifts by drastic legislation when necessary, and in the final contest, the people will rule this country rather than those holding title to its natural resources.

No legislation for the prevention of waste of coal mining is proposed in this report. One of the chief reasons is that no practicable method of State supervision has suggested itself. This conservatism will not prevent the passage of laws upon the subject, if the operators continue to recklessly waste the coal. Unless such legislation is prevented by voluntarily checking the waste of coal, the operators may suddenly find themselves put out of business by laws of such an ill-advised nature that none of the coal mines can be profitably operated under its provisions.

A still more weighty reason for saving of the coal is the future welfare of the race. The world's supply of coal is limited. Substitutes for coal will doubtless be worked out, but for many purposes these substitutes will be expensive and unsatisfactory. The scarcity of fuel is, therefore, sure to retard progress and cause suffering. The present wanton waste of coal will in the future cause an incalculable hardship to mankind. By increasing the severity of the struggle for existence, it may mean death instead of life to untold millions of our people. The wasting of coal is, therefore, a crime against humanity and should be stopped at once.

LOSS OF COAL IN PILLARS IN SHALLOW MINES.

Loss of pillars in shallow mines. In the future, all mines working coal at slight depth must be opened upon thin coal seams, because the thicker coal is already exhausted near the outcrop. This reduces the actual loss of coal in each pillar left unmined, but it does not affect the percentage loss. Where the coal is so low that the roof in the room must be brushed, or pushers must be employed, the thinness of the seam will greatly increase the cost of mining the coal. If, then, the roof is so brittle that entries can be readily protected from squeezes in the rooms, it seems best to make the room pillars just as small as possible and to abandon them.

Narrow entries in shallow mines. In this case, it is essential to fully protect the entries. This is best done by making both of them narrow, by providing good pillars between room-necks, and by leaving a pillar between the air-course and the faces of the rooms below it. The narrow entry entails the expense of loading out the brushing. The good stump pillars merely require vigilance to see that the miners live up to their agreement to keep the room-neck 8 or 9 ft. wide for 3 yd., and that the first crosscut between rooms be kept 30 ft. from the entry. The pillar below the air-course can be obtained at the negligible expense of measuring the rooms from the surveyed entry and the cost of driving the slope a little longer for each lift.

Cost of coal with wide entries. To illustrate the various costs and results, we may take the case of a mine opened on a seam of coal 2 ft. 10 in. thick without room brushing. According to present practice, the entries will be 18 ft. wide; the main entry will be brushed to a total hight of 5 ft. and the brushing gobbed. If the dip is considerable, there will be a brushed dip switch every 150 ft. The back entry and rooms will not be brushed and the cars will hold about 1,200 pounds. The rooms will be about 150 ft. long holed into the air-course above, and leaving a considerable block of coal at the head of each pillar. The rooms, if single, will be 36 ft. from center to center. The pillar will average about 9 ft. thick and there will be three break-throughs and about 2 yd. of each must be paid for. There will be a 5-foot crosscut each 35 ft. along the entry, and the chain pillar will be 12 ft. thick.

The yardage of entries, crosscuts, room-necks, and break-throughs, the cost of brushing, ties, entry and breaking props, stoppings, switches and track laying, will amount to about $117.08* for each 12 yd. along the entry. If the pillars between room-necks are made small, the first mining will yield 600 tons for a length of 36 ft. along the entry and width of 198 ft. from air-course to air-course.† After the entry is finished, the chain pillar will be buried in gob and the amount of coal to be obtained from the pillars on each side of the air-course will be so small and so mixed with slate that they will not likely be mined. The stumps of the room pillars are readily accessible, but can only be mined at a profit by giving a pair of men a contract to both mine the coal and haul it to the slope. This is now forbidden by the Union, so that under present conditions very little if any of this coal can be recovered. The entire output may then be

*24 yd. of entry and air-course at $2.25 per yd.	$ 54.00
4 yd. of crosscut at $2.25 per yd.	9.00
1 room-neck	3.37
6 yd. of break-throughs at $1.68 per yd.	10.08
14 yd. brushing in entry and slant at $2.08 per yd.	29.12
1 stopping	3.00
3-cent ties, each 3 ft. is 1c per ft., 72 ft. plus 6 ft. slant	.78
1 room switch and ¼ dip switch at $3.50	4.37
Laying track in main entry at 6c per ft.	2.16
3-cent breaking props, each 16 in., and other entry props	1.20
Total	$117.08

†Area:

Irregular end of room, 15 ft. long, average 14 ft. wide	210	sq. ft.
Room-neck, 10 ft. by 8 ft.	80	"
Room widening, 12 ft. by 10 to 27 ft.	222	"
Room, 115 ft. by 27 ft.	3105	"
3 break-throughs, 9 ft. by 5 ft.	135	"
2 entries, 18 ft. by 36 ft.	1296	"
1 crosscut, 12 ft. by 5 ft.	60	"
Total	5108	sq. ft.

At 24 cu. ft. per ton, this is 603 tons.

taken at 600 tons and the direct theoretical cost of opening up the rooms will be 19.5c. per ton of coal mined.

Theoretical cost with narrow entries. If, on the other hand, there are full sized stump-pillars and a 15-foot pillar below the air-course and the entries are only 8 ft. wide, the pillars between the rooms can be made so small that they will generally squeeze in after the rooms have been finished a short time. They may be assumed to average no more than 5 ft. wide between cross-cuts. The first mining will then yield 590 tons from a strip 36 ft. by 193 ft. After the rooms are finished, the track can be relaid in the back entry, and the pillars readily mined without danger of mixing in the gob. Since the air-course pillar is unbroken, practically 100 per cent of it can be mined and also a little coal from the ends of the room pillars below. Between 80 and 90 per cent of the chain and stump pillars can be mined. Six men can be employed at this work. The pay-roll records show that with only a fair turn, the Arkansas miners will average 8½ tons of coal apiece from the pillars each day. If then the entry has been driven to such a distance that two mules were required to take the coal away from the room miners, one mule will be kept busy hauling coal from the pillar miners. As the work retreats toward the slope, a single mule can be used in two entries on opposite sides of the slope. The hauling cost of this coal will, therefore, average no more than that of the room coal.

Eighty-five per cent of the stumps and chain pillars and all of the air-course pillars will yield 160 tons additional coal and the total yield from 12 yards of entry will be 750 tons.* The cost of opening up the workings will be less only by the cost of a little yardage for break-throughs and the cost of the entry props and breaking props not now needed. It will amount to about $110.00 for 12 yd. In addition, there will be the expense of handling the brushing. If it weighs 160 pounds per cubic foot, has a thickness of 26 in. and an average width of 7 ft., the brushing in the main entry and dip switches will amount to 75,000 pounds for each 12 yd. of entry. It will cost about 20c. a ton to haul, hoist, and dump the brushing and 28c. per 1,200 pounds to load it. This amounts to $24.50 per 12 yd. of entry. To mine the pillar coal will require the relaying of the track in

*Because the entries are narrower, the first mining will not yield quite 600 tons, even though the rooms are wider.

the back entry and of the switches at each slant. This will amount to about $3.00 for each 12 yd. of entry. Extra props will be needed for the pillar coal; at 1c. a ton this will cost $1.60. The total cost will then be $139.10 or 18.5c. per ton. No pushers will be needed to handle cars for the pillar coal, but this slight saving will be ignored.

The cost of first opening up the rooms will be $134.50 and will amount to 22.8c. for each of the 590 tons produced at the first working.

Advantages of narrow entries. The direct expenses listed amount to 19.5c. a ton under the old plan. With narrow entries and better recovery of coal, they amount to 18.5c. per ton. The narrow entries also have other advantages. If the men are given plenty of cars, the narrow entry can be driven in two-thirds the time it takes to drive a wide one and only two-thirds as many entries will be required for the same number of working places. Since the yield per yard of entry is 25 per cent more, the number of advancing entries needed is still further reduced and only about half as many entries will be needed. The number of retreating entries will be one-third as many as the number of advancing entries. There will then be about five-sixths as many yards of entry to maintain. No notched cross-bars will be needed and very few others. There will be no gob to clean off the track and no breaking props to replace, so the cost of rock men per yard of entry will be small. It is safe to estimate that the cost of maintenance of the mine underground will be only one-fourth as much with narrow entries as with wide ones. This saving will vary from 2c. to 4c. per ton of coal.

There is a further advantage in the shorter time required to reach full production and in the interest charge on the cost of opening entries not now needed. At 10 per cent per annum, this will amount to about 1c. per ton, if the mine is operated 200 days a year and has a capacity of about 500 tons per day. Against this is the fact that the coal first mined costs 3.3c. per ton more than coal could be obtained for, if it were mined without reference to the later working of the pillars. Upon this the operator must pay interest until the pillar coal is mined. In low coal, the entries will be short and it may be assumed that they will reach their limit in two years. It will take about half as long to rob it

back and the total life of the entry will be three years. The average time between the first and second minings will be a year and a half. At 10 per cent per annum, this charge will be about 0.48c. per ton of room coal. It will be only 0.38c. per ton of all the coal ultimately obtained from the entry.

These direct savings in operating costs, therefore, amount to from 3c. to 5c. a ton, which is certainly worth while. Since the coal is worth 10c. a ton in a mine opened for the present method of mining, there is a great saving due to the better recovery. If by improved methods, 750 tons are obtained from an area of 36 ft. by 193 ft., some 770 tons would be obtained from a patch 36 ft. by 198 ft. This is 170 tons more than is obtained by present methods. This value would amount to 2.3c. a ton on the basis of the increased output. The recovery is increased from 68 per cent to 87 per cent of the coal in the ground.

Actual yardage costs. All the computations are based upon the theoretical yardage costs. These are always too low because the entry-men are credited with various extras, and because the yield is reduced on account of the waste of coal in the gob, the loss of rooms, short rooms, and the occurrence of faulty patches in the coal. Cost records of the companies show that under the conditions assumed, the cost of opening entries would be 30c. a ton or more, rather than 20c. This increases the saving per ton due to a higher percentage of extraction. If double-necked rooms are used, the recovery of coal under the present method is a little greater than with single-necked rooms because of the fewer room pillars left, and the profit from better mining is slightly reduced. The difference is small, however.

As the coal gets thicker, the cost of handling brushing decreases more rapidly than does the yardage cost. If a 5-foot seam at little depth were available, the same figuring on the basis of rooms only 150 ft. long gives a saving of 2c. per ton in yardage costs alone, due to making the entries narrow and increasing the extraction. If the rooms are 250 ft. long, the saving will be about 1.4c. The total will not differ greatly as the thickness of the seam varies as long as brushing is necessary.

PILLARS IN COAL MINES.

Strength of coal pillars. As the mines get deeper so much coal must be left in the room pillars that it becomes economical to mine them. The load upon the mine amounts to a little more than 1 pound per square inch for each foot of depth below the surface. The load upon the pillars is increased in the proportion of the total area of mine workings divided by the area of the pillars. The strength of the pillars depends primarily upon the strength of the coal, and is generally assumed to vary in proportion to the area of the pillars. The margins of the pillars are, however, weakened as a result of the heavy blasts fired against them when the room coal is blasted out, and by the slacking of some coal when it is exposed to the air. As a result, a pillar 12 ft. wide is actually more than twice as strong as a pillar 6 ft. wide. The pillars are greatly weakened by a layer of soft clay or rashing in the coal, above it or below it. Pillars in high coal are also supposed to be weaker than pillars in the same quality of low coal. Pillars in dipping coal are weaker than in flat coal. This is especially noticeable if the pillars are parallel to the strike of the coal bed. If the coal is rather sharply folded, the pillars on the flanks of the basin will quite completely crush before those in the basin begin to take much weight.

The actual strength of the pillars per square inch of area can be rather exactly obtained by carefully surveying all the pillars in an area in which a squeeze starts. The load upon these pillars will be given by the weight of cover within a line drawn half-way between the crushing pillars and the sound ones outside the area of the squeeze. From this, the maximum resistance of the coal per square inch can be figured. After a squeeze has started, more or less weight will be concentrated upon the surrounding pillars until the roof or the pillar yields. For this reason, the average computed strength of pillars that yield under an old squeeze will be less than their real strength.

It is regretted that lack of funds has made it impossible to secure any exact figures in this way. Approximate data of the size of crushed pillars in a number of mines were obtained from a study of adjoining workings mined under the same pit-boss. From these, it appears that the weaker coal, such as that at Huntington and Hartford, has a resistance of only 500 to 700 pounds per square inch. The coal at Paris seems to have no more strength, but in this case the load upon the coal is increased by strains in the rock due to recent folding and by the weight of

Short Mountain. The stronger seams of soft coal will carry 1,000 to 1,200 pounds per square inch of pillar. The strong coal at Russellville with a soft clay parting holds in the neighborhood of 1,500 pounds at a considerable dip. No squeezes were observed at Spadra and it is likely that the pillars there will sustain 2,500 pounds per square inch. These figures will be used in subsequent computations.

Breaking the roof. To hold up the roof, a sufficient area of coal must be left in the pillars, but if the pillars are to be safely mined, each individual pillar must be large enough to cause at least the lower part of the roof to bend or break. This size depends upon the strength of the roof, and the thickness which must be broken to relieve the pressure. No opportunity was presented for studying the breaking of a sandstone roof, but sufficient and confirmatory data were obtained from three different mines with a pure shale roof, to show that the rather hard Arkansas shale or "slate" will shear off when the load on the section cracked is between 50 and 60 pounds per square inch, and that the settling and, therefore, the cracking of the roof will under ordinary conditions cease when the shale has fallen in to a hight of 50 to 75 times the hight of the caved working. The strong silicious sandstone of Arkansas will probably sustain a load of 1,200 to 1,500 pounds per square inch before it will shear off. The total force on the pillar should be figured for the thickest individual layer of sandstone above the coal.

Avoiding long break-throughs. The great disadvantage of wide room-pillars is due to the yardage cost of the long break-throughs required by law each 30 or 40 ft. A portion of this expense can be avoided by the plan shown on Plate VIII. Each second pillar is a strip of coal thick enough merely to resist blasting alongside of it. In it the break-throughs can be made as often as desired without expense. It will serve only to carry the air to the room faces and to relieve the props a little by holding up the lower layers of the roof.

If there is a separate split of air for each entry, the extra resistance to the air-current will be of little importance. There will, however, be a necessary expense for temporary canvas or dirt stoppings at each break-through. This will be about $1.00

per break-through. To secure the best results with the present system of pillars, stoppings should be used, so it is hardly fair to charge this expense against the new plan.

Long crosscuts will be needed between each wide pillar and its stump. If they are to be mined, an additional crosscut will be needed next the air-course pillar to begin the mining. Even if the pillars are not mined, but left only strong enough to support the roof, it is apparent that, as depth of mining increases, it will be cheaper to drive one long crosscut through every second pillar than it is to drive several through twice as many pillars of moderate width.

The size of pillars required. If the pillars are to be successfully mined, they must not only support the load, but must also be strong enough to break the roof. The resulting extra expense may be charged against the pillar coal. The tables below show the size of the pillars under a shale roof required for each purpose, at different depths, and with different strengths of coal. They are figured from the data given above. The strength of the small pillars between large ones is ignored and each large pillar is strong enough to support and to break the roof along its full length. If the roof is broken as shown on Plate VIII, the pillars need not be quite so large, but the distribution of pressure on the pillars is too uncertain for computation. Because of the greater proportionate strength of wide pillars, the width given in the table is excessive at the greater depths.

Width of pillars in feet required between pairs of 30-foot rooms.

Depth in feet	For weak coal		For medium coal		For Spadra coal	
	To support roof only	To break and support roof	To support roof only	To break and support roof	To support roof only	To break and support roof
100	16	28.5	6	11	3	5.0
200	43	76.0	13	23	6	10.0
300	96	171.0	21	38	9	15.5
400			32	57	12	21.5
500			46	81	16	28.5
600			64	114	20	36.0
700			90	159	25	44.0
800			128		30	53.5
900					36	64.0
1000					43	76.0
1100					50	89.0
1200					59	105.2

Width of pillars in feet required between pairs of 24-foot rooms.

Depth in feet	For weak coal		For medium coal		For Spadra coal	
	To support roof only	To break and support roof	To support roof only	To break and support roof	To support roof only	To break and support roof
100	13	25.5	5	9	2.0	4.0
200	35	68.0	10	20	4.5	9.0
300	78	153.0	17	34	7.0	14.0
400			26	51	10.0	19.0
500			37	73	13.0	25.5
600			52	102	16.5	32.0
700			73	143	20.0	40.0
800			104	204	24.5	48.0
900					29.0	57.0
1000					34.5	68.0
1100					41.0	80.0
1200					48.0	94.0
1300					56.0	110.0

Width of pillars in feet required between pairs of 18-foot rooms.

Depth in feet	For weak coal		For medium coal		For Spadra coal	
	To support roof only	To break and support roof	To support roof only	To break and support roof	To support roof only	To break and support roof
100	10	22.5	3.5	8	1.5	4.0
200	27	60.0	8.0	18	3.5	8.0
300	60	135.0	13.0	30	5.5	12.0
400	160	360.0	20.0	45	7.5	17.0
500			29.0	64	10.0	22.5
600			40.0	90	12.5	29.5
700			56.0	126	15.5	35.0
800			80.0	180	19.0	42.0
900			120.0	270	22.5	51.0
1000					26.5	60.0
1100					31.5	70.0
1200					37.0	83.0
1300					43.0	97.5
1400					51.0	114.5

Protecting the entries. To protect the entries from squeezes after the room pillars have been mined, they should be made narrow and be protected by ample pillars on both sides and the room-necks should be kept small. The maximum length of the stump pillars between room-necks is limited by the present Arkansas law to 30 ft. if gas is present. A 30-foot pillar between the air-course and the rooms below is then as wide as is effective.

The cost of crosscuts each 30 ft. is so great that it seems best to limit the chain pillar to the present standard of 12 ft.

To get some idea of the depth at which such an arrangement will protect the entries after the room pillars are mined, it will be necessary to make assumptions as to how the pressure is distributed over the pillar. It will be necessary for lack of other data to consider the roof no stronger than shale. Then if we assume that the pressure is uniform all over the pillars, we get the maximum depth of 250 ft. for weak coal, 600 ft. for coal of medium strength, and 1,500 ft. for the Spadra coal. If we assume, as is more likely, that the direct load is uniformly distributed, but that the force required to break the roof varies uniformly from nothing at the lower edge of the air-course pillar to the necessary maximum at the edge of the first room break-through, the depth becomes 200 ft. for soft coal, 500 ft. for coal of medium strength, and 1,300 ft. for strong coal.* These can more safely be taken as maximum depths under a roof consisting of practically pure shale for a thickness of at least 500 ft. next to the coal.

MINING PILLARS IN DEEP MINES.

Comparative costs of careful and careless mining of coal of medium thickness and medium depth. As long as the pillars are not more than 40 ft. wide, they can be mined by slabbing off one side to make a place for the track, and mining back the 30 ft. remaining. This is the method shown on Plate I, and the miners are glad to do this work and to lay their own track at the regular room-scale. If the rails are of steel and are not lost, the expense of this track is then the cost of the switch at the bottom or $3.50 and the cost of the ties, about 1c. per foot of track. The extra

*The chain pillar is equal to a continuous strip of coal a little over 10 ft. wide. Room stumps will average, say, two-thirds solid coal or equal a continuous strip 20 ft. wide. The coal is then 60 ft. wide in a width of 88 ft. At a depth of x feet, the weight in pounds per square inch is $\frac{88x}{60}$, which is 1.47x. The shearing stress for each inch of length uniformly distributed is $\frac{50 \times 12 \times x}{88 \times 12} = 0.56x$. At the edge of the stump, the pressure in pounds per square inch will be twice this or 1.12x. Then $1.47x + 1.12x = 500$ for weak coal, and x equals 195 ft.

For medium coal, $2.59x = 1200$; and x equals 461 ft.

For strong coal, the depth is so great that all the roof will not be broken before the workings are filled. If 500 ft. must be broken, we have $1.47x = 2500 - 1.12$ times 500, and x equals 1320 ft.

cost is in narrow entries, the extra length of break-throughs, and the extra props needed.

We will take for study the case of medium strong coal, 3 ft. 6 in. thick and under about 300 ft. of cover. There is a good deal of such coal in the western part of Sebastian County. If the roof is at all good, a 95 per cent recovery of the room pillars should be possible because there are no crosscuts to interfere with the support of the roof. If the dip is such that 250-foot rooms are possible, but not twin haulage entries, the workings will be best laid out as given below, under the present plan of getting out some of the coal at the least first-cost. The main entry and also the dip switch, each 250 ft., will be brushed 18 in. to admit a car of 2,000 pounds capacity. The entries will be about 12 ft. wide and gobbed. The chain pillar will be 12 ft. wide with 5-foot crosscuts, each 35 ft. The rooms will be 250 ft. long and 30 ft. wide and triangular blocks of coal will be left at the faces after they are holed through to the air-course above. Each second pillar will average only 4 ft. wide and have five break-throughs, say 5 ft. wide, shot through without yardage cost. The alternate pillars will then have to average 21 ft. wide to prevent squeezes and will require only one 5-foot break-through for which the track will be turned. The stump must be left full size.

Figuring the coal at 24 cu. ft. in place equal to a ton, the average of Arkansas coal, an area 286 ft. from air-course to air-course and 85 ft. along the entry, and covering a pair of rooms and a pillar of each sort, should then yield 2,300 tons of coal. The entire cost of getting in the entries and opening the rooms including the long break-throughs will be $244.90* or 10.6c. per ton of coal.

*56⅔ yd. of entry at $2.25 per yd.	$127.50
2.4 crosscuts, 4 yd. each, at $2.25 per yd.	21.60
18 in. brushing at $1.44 per yd. for 28⅓ yd. entry and 1.7 yd. of slant	43.20
2 room-necks at $3.37 each	6.74
1 break-through, 7 yd., at $1.68 per yd.	11.76
Laying track in main entry	5.10
2 room switches and ½ of a dip switch, and a curve for break-through	8.75
2.4 stoppings at $3.00	7.20
4 temporary stoppings at $1.00	4.00
Ties for entries	1.70
Ties for rooms	5.00
Breaking and entry props at 3c each	2.35
Total	$244.90

If the workings are laid out so as to facilitate the mining of pillars, the entries will be only 8 ft. wide and without gob, and a pillar averaging 30 ft. wide will be left between the squared room faces and the air-course. Each second pillar will be 38 ft. wide instead of 21 ft., and both break-throughs will be driven in the first opening. Other arrangements will be as before. We may assume that none of the 4-foot room pillars will be recovered, but that 95 per cent of the wide room-pillars and air-course pillars can be mined and 85 per cent of the stump and chain pillars. An area of 308 ft. from room face to room face and 102 ft. along the entry will then yield 2,400 tons of coal from the first working and 1,900 tons from the pillars. The cost of first opening this up will be $359.50,* or 14.9c. per ton of coal first mined.

The opening up cost of the coal first produced is 4.3c. a ton more with careful mining than with careless mining. To offset this cost, we have the saving, due to the narrow entries, in wages of rock-men and timber-men and in other maintenance charges. In addition to the laying of track already figured, this cost actually amounts to from 3c. to 5c. a ton, and the saving will run from 2c. to 3c. a ton. The narrower entries will also be driven considerably faster, but since less coal is obtained per yard of entry the interest saving from this fact will be small and may be neglected under ordinary conditions. After pillar mining has begun, fewer entries will be needed, but this is included in the reduced cost of maintenance. The total extra cost of the coal first mined is then 1.3c. to 2.3c. a ton.

If the roof is sufficiently flexible, the room pillars can be mined at once so the cost of the first coal becomes greatly reduced. We will, however, assume the less favorable case in

*68 yd. of entry at $2.25	$153.00
3 crosscuts, each 4 yd., at $2.25	27.00
2 room-necks	6.74
2 break-throughs, 12⅔ yd. each, at $1.68	42.56
Brushing ⅖ of a 5-yard dip switch, 34 yd. of entry at $1.44	51.84
Loading and hauling brushing at 48c a ton, or $1.21 per yard, 36 yd. of entry and dip switch	43.56
Laying track in main entry	6.00
2 room switches, part of dip switch, etc	8.75
Ties for 204 ft. of entry	2.04
Ties for 500 ft. of room	5.00
3 stoppings at $3.00	9.00
4 temporary stoppings at $1.00	4.00
Total	$359.49

which it is necessary to leave all the pillar coal until the limit of the entry is reached. The limit may be taken as half a mile to be reached in normal working of the mine three and a half years after the entry is started. It will then take as long to rob all the pillars and the operator must under these conditions pay interest upon the extra cost of the coal first mined for about five years on an average before he gets the profit from the pillar coal. At 10 per cent per annum, compound interest, this amounts to from 0.8c. to 1.4c. per ton of coal first produced, or from $19.00 to $33.60 for the block of coal considered.

The pillar coal can be mined at an additional expense of relaying the dip switches and track in the back entry, and a switch and ties for the track along the pillar. At first, the old ties can be used but we will assume that they must all be replaced. This offsets wear and interest upon the steel rails. The pillar coal will also require extra props. This extra cost may be figured at 1c. a ton more than that of the room coal. For the same block of coal, these extra expenses amount to $34.00.* As many men as desired can be set to work upon the pillar coal. Therefore, the driver can be kept busy at all lengths of retreating entry and the cost of hauling coal from the pillars will be less than from the rooms. This can hardly be figured because it depends upon the ability of the pit-boss more than anything else.

The mining of the pillar coal will then raise the total output from the area occupied by two rooms to 4,300 tons and the cost to from $412.50 to $427.10, including interest upon the extra cost of the first opening. The final cost of opening up the coal after the slope is down is, therefore, from 9.5c. to 9.9c. per ton. This shows a direct saving of from 0.7c. to 1.1c. or an average of say 0.9c. a ton. To this is to be added the saving of 2c. to 3c. a ton upon the entire output due to cheaper maintenance.†

The recovery is increased from 65 per cent to 94 per cent of the coal in the area opened up. The careful mining would,

*Props for 1900 tons of coal at 1c per ton	$19.00
Relaying air-course track, and proportion of dip switch	8.00
Ties in air-course and alongside pillars	3.50
Switch for pillar track	3.50
Total	$34.00

†It should be noticed that on the coal first obtained the saving was figured only as reducing the interest upon the extra cost of this. It is not included in the cost of opening up the coal just given.

therefore, yield 1,325 more tons of coal than the careless mining from the area of two rooms and their pillars, which produced a total of 4,300 tons. At 10c. a ton, this represents a profit of 3.1c. additional.

The total gain from the careful mining under ordinary average conditions is then 6.5c. a ton. The interest charge against the coal first produced will average about 0.6c. per ton upon the entire output of the mine. For each 20,000 tons of coal produced per year, this will require an investment of $1,200, if it is capitalized at 10 per cent per annum. This represents the additional investment for each 100 tons nominal daily output. It will earn an average of about 108 per cent per annum.

If the mine is large, and so laid out in panels that the full capacity of the mine is not reached much before the pillar mining is in full swing, the greater output per yard of entry will greatly reduce the capital required to open the mine, because only about seven-tenths as many yards of entry need be driven before the full capacity is reached. The entries may also be driven more rapidly, so the time required for opening the mine will not be more than half as great. Both the investment and the interest upon it are then reduced. The exact calculation of the amounts is laborious and will vary greatly in different mines. It may be as high as 4c. a ton, if the investment is large.

In the favorable case that the room pillars can be robbed as soon as the rooms are finished, we get a first output of 3,500 tons at the first mining at a first cost of $376.50* or 10.7c. per ton. There will then be no interest charge whatever and the final profit will be increased half a cent a ton without additional investment. As we have already seen, this mining is perfectly feasible at depths up to about 500 ft.

Except for labor troubles, it would be possible to keep the room track next the rib, and mine the pillar without extra cost at all. This is more advantageous in case of the smaller pillars.

In a few cases with favorable roof, it may be possible to mine as much as 75 per cent of the stump pillar and say 50 per cent of the big room-pillars if the entries are cluttered with gob

*Cost as before	$359.50
Laying track around stump, and ties for pillar	6.00
Extra props	11.00
Total	$376.50

and no air-course pillar is left. There would be trouble from the spreading of squeezes and the loss of rails. If these costs are ignored, there will be a recovery of 82 per cent of the coal at an entry development cost of 8.6c.* a ton. The increased recovery by the safer method will then cost 1.1c. per ton of coal mined. The saving in maintenance is now a little less because the difference in yards of entry is less. There is, however, the full saving due to better roof. This may be taken as 2c. a ton as an average. The interest on coal first opened is, as before, half a cent per ton of total output, because in this case room pillars can be mined at once. It is included in the cost of the better recovery. The total saving by the more careful laying out of the mine and better recovery is then only 0.9c. a ton. This will represent 18 per cent interest on the extra investment needed to accomplish it and will also be much safer and more certain.

Comparative costs of careful and careless mining of coal of medium thickness and considerable dip. At most mines with dipping coal only 3 ft. 6 in. thick, the rooms would be driven only 150 ft. long to save the expense of pushers. If all other conditions are as before, the coal can be opened up by careless methods at a cost of 16.4c.† per ton. This will yield 1,475 tons of coal or a recovery of 64 per cent.

*The output would be 3000 tons. The cost of opening:

As before	$244.90
Cost of extra props for pillar coal at 1c per ton	7.00
Cost of relaying switch for pillars	3.50
Extra cost of track around stump, about	2.00
Ties for 125 ft. along pillar	1.25
Total	$258.65

†An area of 186 ft. by 85 ft. will contain 2,300 tons of coal 3 ft. 6 in. thick at 24 cu. ft. to the ton. This mining will cover an area in square feet as follows:

Entries, 24 ft. by 85 ft.	2,040 sq. ft.
2.4 crosscuts, 5 ft. by 12 ft.	144 "
2 room-necks, 81 sq. ft.	162 "
2 room widenings, 9 to 30 ft. wide and 21 ft. long	819 "
2 rooms, 60 ft. by 113 ft. additional length, leaving an average of 7 ft. of coal at the inner corners	6,780 "
4 break-throughs, 5 ft. by 4 ft.	80 "
1 break-through, 5 ft. by 21 ft.	105 "
Total	10,130 sq. ft.

This gives 35,455 cu. ft. or 1,477 tons if the coal is 3 ft. 6 in. high. Costs below next page.

The careful mining will give a first output of 1,525 tons of coal at a cost of 22.8c. per ton.*

Mining the pillars later will increase the output of the block of the rooms to 2,900 tons† and give a recovery of 94 per cent.

*An area of 208 ft. by 102 ft. will contain 2,090 tons of coal. The square feet of workings will be:

Entries, 16 ft. by 102 ft.	1,632 sq. ft.
3 crosscuts, 5 ft. by 12 ft.	180 "
2 room-necks, 81 sq. ft.	162 "
2 room widenings	819 "
2 rooms, 30 ft. by 120 ft each	7,200 "
4 break-throughs, 5 ft. by 4 ft.	80 "
2 break-throughs, 5 ft. by 38 ft.	380 "
Total	10,453 sq. ft.

This will give 1,525 tons of coal.

The cost will be as follows:

68 yd. entry, at $2.25 per yd.	$153.00
2 crosscuts, 4 yd. each, at $2.25 per yd.	18.00
Brushing in 34 yd. entry and ⅖ of 5-yard dip switch, at $1.44 per yd.	51.84
2 room-necks at $3.37	6.74
2 break-throughs, 12⅔ yd. each, at $1.68 per yd.	42.56
Loading and hauling the brushing at $1.21 per yd.	43.56
Laying track in main entry	6.00
2 room switches, part of dip switches and curves for crosscuts	9.00
Ties for entries	2.04
Ties for rooms	3.00
3 stoppings at $3.00	9.00
3 temporary stoppings at $1.00	3.00
Total	$347.74

†Large pillars, 110 ft. by 38 ft.	4,180 sq. ft.	
Air-course pillars, 30 ft. by 102 ft.	3,060 "	
Total	7,240 sq. ft.	
Small stump, 9 ft. by 25 ft., 225 sq. ft.; and 21 ft. by an average of 25 ft. and 4 ft., 302 sq. ft.; sum	527 sq. ft.	
Big stump, 527 sq. ft. plus 30 ft. by 32 ft. in the middle	1,487 "	
Chain pillar, 12 ft. by 87 ft.	1,044 "	
Total	3,058 sq. ft.	
95 per cent of 7,240 sq. ft.		6,878 sq. ft.
85 per cent of 3,058 sq. ft.		2,600 "
Total		9,478 sq. ft.

This will yield 1,380 tons.

The cost will be:

56⅔ yd. entry at $2.25 per yd.	$127.50
2.4 crosscuts, 4 yd. each, at $2.25 per yd.	21.60
28⅓ yd. entry and 1.7 yd. slant brushing at $1.44	43.20
2 room-necks at $3.37	6.74
1 break-through, 7 yd. at $1.68 per yd.	11.76
Laying track in main entry and curve for break-through	5.10
2 room switches and a half of dip switch, say	8.75
2.4 stoppings at $3.00	7.20
3 temporary stoppings at $1.00	3.00
Ties for entries	1.70
Ties for rooms	3.00
Breaking and entry props	2.35
Total	$241.90

The cost of opening up the workings and mining the pillars will be 13.0c. per ton of total output.*

The saving on maintenance will be greater with short rooms than with long ones, because more entries are needed for the same capacity. It may be taken as at least 3c. a ton. The net extra cost of the coal first produced as the entries are opened is then 3.4c. per ton. The interest on this, as before, will be 2.2c. a ton on the first output of 1,525 tons. This will amount to 1.1c. on the entire output of 2,900 tons.

The saving in extra coal obtained will amount to 3.2c. per ton.† The net saving by careful mining under these conditions is then 8.5c. per ton. It will cost an investment of 1.1c. on each ton of annual capacity capitalized at 10 per cent, or $2,200 per each 100 tons nominal daily capacity. This will yield 77 per cent interest per annum.

If the room pillars can be mined as soon as the rooms are driven, the cost of the coal first obtained will be 17.1c.‡ per ton. Since we have assumed a pure shale roof this can be done, the interest charge on the first coal disappears, and the total saving is 9.6c. per ton. No extra investment will be needed, but it will simply be necessary for the foreman to see that all rooms are driven on sights, etc.

Comparative costs with bottom brushing. If the floor is soft, it becomes possible to take up bottom in the rooms and use cars holding, say, 3,000 pounds. The miners at Burma and Dallas consent to do this work at 31c. and 40c. a yard. In this case, the rooms will be 250 ft. long regardless of the dip. It will be necessary to take up another strip of bottom along the pillar

*Cost:

As before	$347.74
Extra props	13.80
Pillar switch	3.50
Relaying back entry track and switches	8.00
Ties in air-course	1.02
Ties along pillar	1.50
Total	$375.56

†The increased recovery is 30 per cent. Thirty per cent of 3,090 tons is 927 tons. This is $92.00 for each 2,900 tons mined, or 3.2c per ton.

‡The big pillar will yield 580 tons and the total of first mining will be 2,105 tons. The cost will be:

As before	$347.74
Extra props	5.80
Extra cost of track around stump pillar, and ties	6.00
	$359.54

at the same cost. To secure space for this waste, the first skip taken off the pillar can be made a little wider than 10 ft. and the track can be placed next the rib. The cost of loading out entry brushing is reduced on account of the larger cars to 38c. a ton or less. Other costs will be as before. With lower scale, the cost of opening up the first coal then becomes 12.8c* per ton in the case of wide entries, and 16.6c.* per ton in case of narrow ones. This difference is less than before and the interest charge upon the extra cost of the first coal is thus slightly reduced. The additional cost of taking up bottom along the pillar makes the final cost of the coal obtained by careful mining 11.2c. per ton.†

The direct saving in opening up expense from the careful mining is thus increased from 0.9c. to 1.6c. per ton by bottom brushing. This follows from the fact that the coal from a 38-foot pillar is obtained at the same additional brushing expense as from a 30-foot room. There is also the saving in loading brushing.

In case the roof and bottom are both hard, the cost of brushing in the rooms will be as high as $1.44 per yard. This will pay at least with a long mechanical haulage. As before, this will obviously increase the saving, more than the smaller change did.

Comparative costs with twin haulage entries and long rooms. In case the coal seam is flat enough to permit the use of twin haulage entries, no air-course pillar can be used, and both entries will be brushed. If the rooms are 250 ft. long, 30 ft. wide, and 12-foot gob entries are used, and the pillars are alternately 4 ft.

*Wide entries. Output, as on page 463, 2,300 tons of coal.

Cost, as on page 463, foot note	$244.90
166 yd. brushing in 2 rooms at 31c per yd.	51.46
Total	$296.36

Narrow entries. Output, as on page 464, first coal, 2,400 tons.

Cost, as on page 464, foot note	$359.49
Less saving on handling brushing at 38c, instead of 48c a ton	9.07
	$350.42
Add cost of room brushing, as above	51.46
Total	$401.88

†Cost:

As before	$401.88
Extra brushing, 83 yd. at 31c per yd.	25.73
Other extra cost of mining pillars, as before	34.00
Average interest, as before	23.00
Total	$484.61

The output will be 4,300 tons as before.

and 21 ft. as before, two rooms and pillars on each entry require a space of 85 ft. along the entries and 536 ft. across them. This area will contain 6,640 tons of coal and will yield 4,510 tons at a cost of $325.30.* This is 7.2c. per ton.

If the entries are driven 8 ft. wide and all the brushing is loaded out, and if each large pillar is left 38 ft. wide, the block containing four rooms and pillars will be 102 ft. along the entry, and 528 ft. across it. This will contain 7,850 tons of coal. The first working will yield 4,525 tons at a cost of $471.25†, which is 10.4c. per ton. The extra cost is practically balanced by the saving in maintenance charges, so interest may be neglected.

When the big pillars of one pair of entries are mined next the completely caved gob of an older pair of entries, it will be necessary to drive a new break-through and leave, say, 4 ft. of

*Square feet of workings:

Entries, 24 ft. by 85 ft.	2,040 sq. ft.
2.4 crosscuts, 5 ft. by 12 ft.	144 "
4 room-necks, 9 ft. by 9 ft.	324 "
4 room widenings, 9 ft. to 30 ft. by 21 ft.	1,638 "
4 rooms each 30 ft. by 220 ft., (250 ft. less 30 ft. entrance)	26,400 "
10 break-throughs, 5 ft. by 4 ft.	200 "
2 break-throughs, 5 ft. by 21 ft.	210 "
Total	30,956 sq. ft.

30,956 sq. ft. of 3 ft. 6 in. coal will yield 4,514 tons, and the recovery will be 68 per cent.

Cost:

56⅔ yd. entry at $2.25 per yd.	$127.50
56⅔ yd. brushing at $1.44 per yd.	81.60
2.4 crosscuts, 4 yd. each, at $2.25 per yd.	21.60
4 room-necks, at $3.37 each	13.48
2 break-throughs, each 7 yd., at $1.68 per yd.	23.52
Laying track in entry and curves for break-throughs	12.00
4 room switches, at $3.50 each	14.00
Ties for entries and rooms	11.70
Props in entry	4.70
2.4 stoppings at $3.00 each	7.20
8 temporary stoppings in rooms at $1.00 each	8.00
Total	$325.30

†Square feet of workings:

Entries, 16 ft. by 102 ft.	1,632 sq. ft.
3 crosscuts, 5 ft. by 12 ft.	180 "
4 room-necks at 81 sq. ft. each	324 "
4 room widenings at 409½ sq. ft.	1,638 "
4 rooms, each 30 ft. by 220 ft.	26,400 "
10 break-throughs, 5 ft. by 4 ft.	200 "
2 break-throughs, 5 ft. by 38 ft.	380 "
Total	30,754 sq. ft.

This will yield 4,524 tons.

See costs below next page.

coal to protect the miner until the regular settling of the roof has started. This requires the driving of two additional long break-throughs for pillar robbing in each block. These will be shorter by the width of the skip, or, say, only 27 ft. long. The additional coal at 95 per cent of the room pillar and 85 per cent of the stump and chain pillars is 2,810 tons. The cost of mining this will be \$70.32* in addition to the cost of opening.

The cost of the entire 7,335 tons will then be \$541.60 or 7.4c. per ton. This shows a nominal cost of two-tenths of a cent greater than that of the careless mining. The recovery is, however, 93 per cent. The additional 22 per cent of 7,850 tons is 1,727 tons. At 10c. a ton, this represents a saving of 2.4c. a ton on the entire output. With the 2.5c. a ton saving on maintenance of entries, the entire profit is then 4.5c. per ton.

Comparative cost with twin entries and short rooms. If the rooms of the twin entries are only 150 ft. long, we get with wide

*Square feet of pillars:

2 small stumps, each 525 sq. ft., as before	1,054 sq. ft.
2 large stumps, each 1,487 sq. ft., as before	2,974 "
Chain pillar, 12 ft. by 87 ft.	1,044 "
Total	5,072 sq. ft.

85 per cent of 5,072 sq. ft. is 4,311 sq. ft. This is 628 tons.

Tonnage:

As above	628 tons
1 large pillar, as before	1,100 "
1 large pillar, less 4 ft. by 38 ft., or 20 tons	1,080 "
Total	2,808 tons

Cost:

2 break-throughs, 9 yd. each, at \$1.68 per yd.	\$30.24
Extra props for 2,808 tons of pillar coal	28.08
2 switches for pillars, \$3.50 each	7.00
Ties for pillar track, 500 ft.	5.00
Total	\$70.32

Cost:

68 yd. entry at \$2.25 per yd.	\$153.00
68 yd. brushing at \$1.44 per yd.	97.92
Loading and hauling brushing from 68 yd. at \$1.21 per yd.	82.28
3 crosscuts, each 4 yd., at \$2.25 per yd.	27.00
4 room-necks at \$3.37 each	13.48
2 break-throughs, 12⅔ yd. each, at \$1.68 per yd.	42.56
(The inner break-throughs can not well be driven until robbing begins.)	
Laying track in both entries	12.00
4 room switches at \$3.50 each	14.00
Ties for entries and rooms	12.00
3 stoppings at \$3.00 each	9.00
8 temporary stoppings at \$1.00 each	8.00
Total	\$471.24

entries from an area of 85 ft. by 336 ft. 2,750 tons of coal out of the 4,165 tons in the ground, at a cost of \$317.30 or 11.5c. per ton.*

The recovery will be 66 per cent.

With narrow entries, we get 2,720 tons of coal from the first mining of an area of 102 ft. by 328 ft., which contains 4,880 tons. The cost will be \$463.25 or 17.0c. per ton.†

The extra cost of the first coal mined will then be 5.5c. per ton. In this case, the maintenance costs are high and the saving may be taken as 3c. per ton. This leaves a net extra cost of 2.5c. The interest for 5 years will be 1.3c. per ton or \$35.35 on the entire block.

The pillars will yield 1,755 tons additional coal at an additional cost of \$57.80.‡ The total output will then be 4,475 tons,

*Square feet of workings:

Area as before		30,956 sq. ft.
Less 4 room heads, 30 ft. by 100 ft.	12,000 sq. ft.	
Less 4 break-throughs, 5 ft. by 4 ft.	80 "	
		12,080 "
		18,876 sq. ft.

This is 2,752 tons.

Cost:

As before		\$325.30
Less ties for 400 ft. of track	\$4.00	
Less 4 temporary stoppings	4.00	
		8.00
		\$317.30

†Square feet of workings:

Area, as before		30,754 sq. ft.
Less 4 room ends, 30 ft. by 100 ft.	12,000 sq. ft.	
Less 4 break-throughs, 5 ft. by 4 ft.	80 "	
		12,080 "
		18,674 sq. ft.

This is 2,722 tons.

Cost:

As before		\$471.24
Less ties for 400 ft. of room track	\$4.00	
Less 4 temporary stoppings	4.00	
		8.00
		\$463.24

‡Tonnage:

As before	2,808
Less 95 per cent of the ends of two pillars, 38 ft. by 100 ft., or in tons	1,052
	1,756

Cost:

2 break-throughs, as before	\$30.24
Extra props for 1,756 tons of coal	17.56
2 switches for pillar track	7.00
Ties for pillar track, 300 ft.	3.00
	\$57.80

at a cost of \$556.39, including \$35.35 for interest, or 12.4c. per ton. The interest alone amounts to 0.8c. per ton.

The final recovery will be 92 per cent, and the extra saving 26 per cent. On the entire block of 4,880 tons, this is 1,268 tons and the profit \$126.80, or 2.8c. a ton.

With the saving in maintenance of entries at 3c. a ton, the entire gain is 4.9c. a ton. The loss in interest may, as before, be eliminated by mining the room pillars as soon as the rooms are completed.* The total gain will then be 6.0c. a ton.

Comparative cost with wide pillars and twin gob-entries. In the case of twin entries and short rooms, the cost per ton of loading out the brushing is so great that instead of using narrow entries, it may be cheaper to drive the entries to their limit and then mine as much as possible of the wider room pillars and stumps, and to abandon the chain pillars entirely. If necessary, the rooms may be made narrower, say, 24 ft. wide, and the same 38-foot room pillars left to secure the entries from squeezes. The 30-foot rooms and 38-foot wide pillars may be used at depths less than 200 ft. without fear of squeezes caused by the wide entries. This may be compared with the present careless mining using 30-foot rooms and 21-foot large pillars, which, as we have seen, yields a recovery of 66 per cent of the coal at a cost of opening up the rooms equal to 11.5c. a ton. With 38-foot pillars instead of 21-foot pillars, the first mining with wide entries will produce 2,840 tons of coal from an area of 102 ft. by 336 ft. at a cost of \$381.00 or 13.4c. a ton.†

*If the rooms are choked with gob, the same new track along the pillar will be necessary. In this case, there will be an expense in laying the track around the stump pillar, but this will be less than the cost of switches and what good ties are already in the rooms may be saved. Ninety-five per cent of the big pillars will yield 1,210 tons. The cost of extra props will then be only \$12.10 and the dead-work cost of mining the pillars may be taken as \$52.35. The output will then be 3,930 tons, at a cost of \$515.59, or 13.1c per ton, as against 11.5c per ton with wide entries. This extra cost is made up by saving in maintenance.

†Square feet of workings:

Area as with narrow entries	18,674 sq. ft.
Add 4 ft. on each entry, 102 ft. long	816 "
Total	19,490 sq. ft.

This amounts to 2,842 tons.

Cost:

As in case of narrow entries	\$463.24
Less loading of brushing	82.28
	\$380.96

The extra cost of the first coal produced is then 1.9c. per ton. The interest will amount to 1.0c. a ton for there is no saving on maintenance. On the 2,840 tons first produced, this is \$28.40. The mining of, say, 80 per cent of the stumps and 90 per cent of the pillars will yield 1,600 tons additional at an extra mining cost of \$56.25.* The total output will then be 4,410 tons out of 5,000 tons in the block at a cost of \$465.65, including interest. This is 10.5c. per ton. The recovery on this basis will be 89 per cent. The extra saving is 23 per cent of 5,000 tons or 1,150 tons. At 10c. a ton, this represents a saving of 2.6c. per ton on the entire output. On this plan, the total saving is 3.6c. per ton for there is no saving in maintenance. The narrow entries are more profitable as well as safer than wide ones.

As a fairer proposition, we should compare the cost of mining with wide entries and no pillar mining, with the cost of mining coal with wide entries and rooms only 24 ft. wide between pillars alternately 4 ft. wide and 38 ft. wide, assuming that 80 per cent of the stumps, 90 per cent of the wide room-pillar, none of the narrow room-pillar, and none of the chain pillar, can be mined later.

With careless mining, we get a recovery of 66 per cent at a cost of opening the rooms equal to 11.5c. per ton. Under the new condition, the space of two rooms will be 90 ft. along the entries and 336 ft. across them and will contain 4,410 tons. The

*Square feet of pillars:

2 large and 2 small stumps as before	4,028 sq. ft.	
80 per cent of 4,028 sq. ft.		3,223 sq. ft.
1 large pillar, 38 ft. by 115 ft.	4,370 sq. ft.	
1 large pillar, 38 ft. by 111 ft.	4,218 "	
	8,588 sq. ft.	
90 per cent of 8,588 sq. ft.		7,730 "
Total		10,953 sq. ft.

This is 1,596 tons.

Cost of mining pillars:

Break-throughs and track, as before	\$40.24
Extra props on 1,600 tons of pillar coal	16.00
Total	\$56.24

first mining will yield 2,340 tons at a cost of $352.85* or 15.1c. per ton. The extra cost compared with the cheapest possible mining is then 3.6c. per ton. The interest for five years at 10 per cent is 2.0c. On the 2,340 tons, this is $47.00.

The pillars will yield 1,540 tons additional at an extra mining cost of $55.65.† The total output is then 3,880 tons and the cost, including interest, $455.50 or 11.7c. per ton. The only saving over the careless mining is then in the better recovery, which is 86 per cent instead of 66 per cent. This yields a profit of $88.20 or 2.2c. per ton or 2.0c. per ton after deducting loss on opening.

*Square feet of workings:

2 entries, 12 ft. by 90 ft.	2,160 sq. ft.
2.6 crosscuts, 5 ft. by 12 ft.	156 "
4 room-necks, 81 sq. ft. each	324 "
4 room widenings, 21 ft. long and 9 to 24 ft. wide	1,386 "
4 remaining parts of rooms, 24 ft. by 120 ft.	11,520 "
2 break-throughs, 5 ft. by 38 ft.	380 "
6 break-throughs, 5 ft. by 4 ft.	120 "
Total	16,046 sq. ft.

This will yield 2,339 tons.

Cost:

60 yd. of entry, at $2.25 per yd.	$135.00
60 yd. of brushing, at $1.44 per yd.	86.40
2.6 crosscuts, 4 yd. each, at $2.25 per yd.	23.40
4 room-necks, at $3.37 each	13.48
2 break-throughs, 12⅔ yd. each, at $1.68 per yd.	42.56
Laying track in entries	10.80
2 curves for break-throughs	2.00
4 room switches, at $3.50 each	14.00
Ties in entries and rooms	7.80
Props in entries	5.00
2.6 stoppings, at $3.00 each	8.40
4 temporary stoppings, at $1.00 each	4.00
Total	$352.84

†Square feet of pillars:

2 small stumps, each 30 ft. long, 19 ft. wide for 9 ft., then narrowed to 4 ft.	824 sq. ft.
2 large stumps, same size as small stumps plus 30 by 32 ft. (additional width)	2,744 "
Total	3,568 sq. ft.

80 per cent of 3,568 sq. ft.	2,854 sq. ft.
90 per cent of 38-foor room pillars as before	7,730 "
Total	10,584 sq. ft.

This will yield 1,542 tons.

Cost:

Extra props for 1,540 tons	$15.40
Break-throughs and track as before	40.24
Total	$55.64

With such large room pillars, however, more of the pillar coal should be recovered. If we assume 95 per cent of the room pillars and 85 per cent of the stump as before, the total recovery becomes 3,970 tons.* The cost of mining the pillar coal is $56.60. The total is $456.50 or 11.5c. per ton which is the same as the first cost with careless mining. The recovery becomes 90 per cent as compared with 66 per cent for careless mining. The gain is 24 per cent and amounts to $106.00 or 2.6c. per ton on the entire output.

The saving in maintenance of the narrow entries and the greater strength of the entries together with the possibility of mining the pillars as soon as the rooms have been finished makes it very profitable to drive the entries narrow and load out the brushing. This is also much safer for the men.

Comparative costs with weak roof. If the roof is not firm, 30-foot rooms are inadvisable and it will be necessary to require that the rooms be kept down to 24 ft. or less. This case is not so favorable for mining the room pillars because the size of pillar required to merely support the roof is then smaller than before and the extra size of pillar required to break the roof is of greater relative importance. For study, we may take the extreme case of rooms only 18 ft. wide under 300 ft. of shale. According to the table, the large room-pillars must then be 30 ft. wide to break the roof and 13 ft. wide to merely support it. In the unfavorable case of rooms 150 ft. long and no brushing in rooms, the mining with wide entries gives a theoretical yardage cost of 12.5c. per ton for opening up the entries and rooms, and the recovery will

*Square feet of pillars:

Stumps, as before	3,568 sq. ft.	
85 per cent of 3,586 sq. ft.		3,033 sq. ft.
1 pillar, 38 ft. by 115 ft.	4,370 sq. ft.	
1 pillar, 38 ft. by 111 ft.	4,218 "	
Total	8,588 sq. ft.	
95 per cent of 8,588 sq. ft.		8,159 "
Total		11,192 sq. ft.

This will yield 1,633 tons.

With room coal, 2,340 tons, this makes a total of 3,970 tons.

be 65 per cent.* With narrow entries and immediate mining of room pillars, which is possible with such a roof, the cost of the first coal will be 14.2c. per ton. The final recovery, at 95 per cent of the room pillars and 85 per cent of the stump and chain pillars, will be 92 per cent. If 3c. per ton extra is allowed for hauling the coal from the stumps, the final cost of mining with narrow entries is 12.7c. per ton, with a nominal loss of 0.2c. a ton.†

With such a poor roof the cost of maintenance of wide entries will be very high, and the saving due to narrow entries may be taken as at least 4c. or 5c. per ton. The profit from the

*With wide entries, the area for a single unit is 53 ft. by 336 ft., which contains 2,595 tons of coal. The square feet of workings will be:

2 entries, 12 ft. by 53 ft.	1,272	sq. ft.
1.5 crosscuts, 5 ft. by 12 ft.	90	"
4 room-necks, 81 ft. each	324	"
4 room widenings, 21 ft. by 11 ft.	924	"
4 fooms, 18 ft. by 120 ft.	8,640	"
2 break-throughs, 5 ft. by 13 ft.	130	"
6 break-throughs, 5 ft. by 4 ft.	120	"
Total	11,500	sq. ft.

This will yield 1,676 tons, and is a 65 per cent recovery.

Cost:

35⅓ yd. of entry, at $2.25 per yd.	$ 79.50
6 yd. of crosscuts, at $2.25 per yd.	13.50
35⅓ yd. of brushing, at $1.44 per yd.	50.88
4 room-necks, at $3.37 each	13.48
2 break-throughs, 4 yd. each, at $1.68 per yd.	13.44
Laying track in entries, 106 ft., say	6.00
4 room switches, at $3.50 each	14.00
Ties in entries and rooms	7.00
Props in entries	3.00
1.5 stoppings, at $3.00 each	4.50
4 temporary stoppings, at $1.00 each	4.00
Total	$209.30

This is 12.5c per ton.

†With narrow entries, the block is 70 ft. by 328 ft., and contains 3,347 tons. The square feet of workings will be:

2 entries, 8 ft. by 70 ft.	1,120	sq. ft.
2 crosscuts, 5 ft. by 12 ft.	120	"
Complete rooms as before	9,888	"
2 break-throughs, 5 ft. by 30 ft.	300	"
6 break-throughs, 5 ft. by 4 ft.	120	"
Total	11,548	sq. ft.
2 room pillars, 30 ft. by 115 ft. ......6,900 sq. ft.		
95 per cent of 6,900 sq. ft.	6,555	"
Total	18,103	sq. ft.

This will yield 2,639 tons. The pillar coal makes up 955 tons of this. See costs below next page.

27 per cent better recovery will be 2.8c. per ton. The total gain is then 7.7c. to 8.7c. a ton.*

Effect of change in conditions. As with all illustrations with the shallow coal, the saving due to narrow entries will increase as the hight of the coal increases, until no more brushing is needed. The saving due to yardage will then decrease, but the saving in recovery and in maintenance will remain. At less depth the size of the room pillars may be reduced. This lessens the advantage of mining them until it becomes profitable to make very small room pillars and merely protect the entries, as in the case of the shallow mines studied.

*If the room pillars could not have been mined at once, the room coal would have cost 20.6c per ton and the interest on the extra cost over the saving in maintenance would have been more than 1c a ton on the whole output.

Cost:

46⅔ yd. of entry, at $2.25 per yd.	$105.00
46⅔ yd. of brushing, at $1.44 per yd.	67.20
Handling brushing, at $1.21 per yd. brushed	56.46
8 yd. crosscuts, at $2.25 per yd.	18.00
4 room-necks, at $3.37 each	13.48
2 break-throughs, 10 yd. each, at $1.68 per yd.	33.60
Ties	7.40
Laying track in entries	8.40
4 room switches, at $3.50 each	14.00
2 stoppings, at $3.00 each	6.00
4 temporary stoppings, at $1.00 each	4.00
Room cost	$333.54
Laying track around 2 stumps, at $2.00	4.00
Ties along pillars	3.00
2 break-throughs, 30 ft. less 9 ft., 7 yd. each, at $1.68 per yd.	23.52
Extra props for pillar coal	9.55
Total first cost	$373.61

This is 14.2c. per ton.

Stump pillars:

2 small stumps, each 30 ft. long, 9 ft. wide for 13 ft., then narrowed to 4 ft. at 30 ft.	591	sq. ft.
2 large stumps, same size as small stumps, plus 26 ft. by 30 ft., extra width	2,151	"
Chain pillar, 60 ft. by 12 ft.	720	"
Total	3,462	sq. ft.

85 per cent of 3,462 sq. ft. is 2,943 sq. ft. This is 429 tons.

The total will be 3,070 tons. There will be no extra cost of mining except the props at 1c a ton. The output per entry will be small, so that 3c a ton will be allowed for extra expense of hauling the stump coal, say, $17.00 for both props and haul. The total cost of 3,068 tons will then be $390.61, or 12.7c per ton. The final recovery is 92 per cent. The gain is 27 per cent. On 3,347 tons, in the block of four rooms, this is 903 tons, or at 10c a ton, $90.30. On 3,068 tons recovered, this amounts to 2.8c per ton.

As the depth of mining increases, the proportion of coal which must be left in the pillars increases. The loss of coal and expense of mining the pillars will increase if they are more than 40 ft. thick. It is, therefore, best to first reduce the size of the room. The table on page 461 shows that in soft coal with rooms held down to 18 ft. in width, pillars more than 40 ft. wide will be needed at a depth of 370 ft. Under these conditions, the profit from more complete mining is obviously greatly increased, because the careless mining requires room pillars 17 ft. wide, and only some 60 per cent of the coal could be recovered.*

Actual yardage costs. The foregoing discussion of mining under the various conditions likely to be found in this State is necessarily academic. It nevertheless shows that under all such conditions more complete mining will pay even though the coal land is leased. Fairly complete cost data were kindly supplied by companies operating mines on coal seams of about the thickness here considered. In all of these the dead-work exclusive of slopes, amounts to considerably more than the entire cost of opening the rooms theoretically figured. In fact, the mere yardage costs run from 120 per cent to 220 per cent of the theoretical cost. A safe average would be 150 per cent. This excess is due to patches of bad coal, uncompleted rooms, grading in the entries, water yardage, and excessive allowance of yardage by pit-bosses to pay for various deficiencies in the coal.

The greater the yardage cost, the greater the profit from a more complete mining of the coal. In general the saving in maintenance will equal the cost of mining pillar coal, and the profit from increasing the recovery from 60 per cent or 65 per cent to 90 per cent will amount to roughly one-half the dead-work cost, as this is usually figured by the bookkeepers.

Pillars in very deep mines. A possible mining of the smaller pillars by the standard method of laying the room track alongside the pillar and using it to pull back the pillar is cheaper than the method of relaying the track in the space provided by taking a skip or slab off the side of the pillar. It has not been considered,

*The block of four rooms, 18 ft. by 150 ft., is 57 ft. by 336 ft., and contains 2,790 tons. The area of workings exceeds that just figured in the previous foot-note by the 4 ft. greater length of two entries 12 ft. wide and two break-throughs 5 ft. wide, through a 17-foot pillar instead of a 13-foot pillar. This contains 20 tons and the output is 1,696 tons, or 60 per cent of the coal in the block.

because it is nearly impossible to get the miners to lay the track along the rib, unless the room must be kept narrow on account of bad roof. If the track is not laid along the rib in the first place, the handling of the gob makes it very expensive to relay the track there unless a skip is first taken off the pillar. The Arkansas crosscut law introduces a further labor complication in immediate mining back of the pillars, because this makes it advisable to leave only one large pillar for each two rooms. This could, however, be met by having a crew of pillar-men entirely distinct from the room-men. For the very deep mines, such a great percentage of coal must be left in the pillars that they must obviously be mined if the mine is to be worked at a profit.

The wide pillars can best be mined by laying a track in a slabbed space to within 18 or 24 ft. of the end of the room, and then carrying a working room-width across the end of the pillar. The track in this place will then be taken up and another cut made across the pillar nearer the entry. To protect the track and the miner, and to secure a line of retreat, it will be necessary to have a considerable stump between this working and the caved area beyond the end of the pillar. The amount of coal so lost will depend entirely upon the character of the roof and the strength of the coal. If a large pillar is needed, the working can be kept narrow while advancing across the end of the pillar, and part of the coal between it and the gob may be mined on the retreat. This method will require that the company deliver and receive the cars at the first turn, or there will be runaway cars, because the miner can not handle a spragged car on the level part of the track. If the cars have good brakes, this will not be necessary unless the dip is quite steep.

If the pillars are not more than 60 ft. wide, a larger recovery might be possible by splitting them with a narrow working upon which yardage would be paid. This is, however, practically prevented by the Arkansas crosscut law and need not be further considered.

As depth increases, the relative size of pillars must be still further increased. This leads to longwall retreating, which will be discussed later. Unless the coal is thick, this will give place to longwall advancing.

PREVENTION OF SQUEEZES.

Squeezes caused by small pillars. Coal is lost as a result of squeezes, because the squeezes cut off entries or room-necks leading to unmined areas of coal. If uncontrolled, they will also destroy the coal of the pillars before they can be mined. Under present conditions, most squeezes start because the pillars left in the first mining are too small. The small pillars are the result of the high cost of crosscuts every 30 ft., and the failure to increase the size of the pillars as the mine gets deeper. We have shown that the large pillars and narrow entries needed to prevent the squeezes are profitable when the work is so laid out that the pillars can be mined. Many of these squeezes can be prevented by blasting down a hard stratum of sandstone just above the coal, and so causing the roof to break and take the accumulated strain off the pillars. The first round of holes can not penetrate more of the roof than the thickness of the coal seam unless special jointed augers are used, but if the first holes are drilled in a slanting direction, it is often possible to get in at the edge of the fallen rock and drill another round of very deep holes. The loose rock will then afford effective support to the roof, and this method is often cheaper than the attempts to check squeezes by timbering.*

Mining of pillars in panels. When the roof is brittle, there is no danger of starting a squeeze by mining pillars, and the work can be done in any manner, provided that the entries are protected. Where there is strong sandstone in the roof, it becomes difficult to mine room pillars without causing the squeeze to spread over the adjoining entry. It is then best to leave the pillar mining until the entry has reached its limit and for this reason the entries should be short or the interest and maintenance charge will be too great. Long entries increase the cost of mule haulage, and it is likely that when single mines in Arkansas cover more ground than at present, a number of slopes or engine planes with power haulage will be used to cut off the entries in the dipping coal. In the deep coal of less dip in the western part of the State, cut-off entries will be used as is now done in mines with twin haulage entries. Both of these methods are in effect a

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panel system of mining, and the robbing back of pillars can soon begin. In order to secure the greatest benefit of roof weight, and to avoid squeezes in the entries, the breakline between the substantial room pillars and the mined out area should be as nearly straight as possible. Plate VIII shows the most approved method of working out a single panel. By this arrangement, no coal need be hauled up-hill by mules.

The coal of adjoining panels can be left until the roof of the first panel is down and all danger of squeeze is over, but the main slope or cut-off entry must be protected by a strong barrier pillar. These are best formed by omitting rooms next to the slope as shown on Plate VIII. Enough of such rooms should be omitted to insure a sufficient output of coal during the final retreat to keep the minimum day crew busy. The width of the pillar between the slope and nearest room does not have to be uniform, but may increase as depth increases. The main level haulage-ways can be protected by omitting frequent pairs of rooms, or all of the rooms on the upper side, and by leaving a solid pillar below. This pillar can best be mined on the retreat by diagonal dip-rooms.

In parts of the State, the roof is so strong that barrier pillars would have to be very thick. In such places, it will be unsafe to mine any pillars until after the completion of all the rooms in the section of the mine served by the slope, engine-plane, or cut-off entry. The pillars must then be mined retreating toward the main outlet for the coal. If the shaft is sunk in the lowest part of the property, all the coal can be hauled down-hill and this presents no difficulty. If the coal is hoisted out of the panel a straight retreating breakline can not be maintained unless the pillar coal is hauled up to the entry above. This can best be done by a crab locomotive*, if the dip is great. If the property is very large and the shaft can not be sunk to the deepest part, it will pay in the long run to sink the main slope to the lower boundary through a panel 800 to 1,000 ft. wide, which will not be touched until all the pillars in the panels to the right or left have been mined. All coal from the other panels can then be brought down to the foot of this slope. The final panel can be

*A gathering locomotive carrying a hoisting drum with a light steel cable long enough to reach to the face of a room from the air-course above.

mined toward the shaft by long horizontal rooms separated by wide pillars. Each pillar will be mined back as soon as the room below it is completed. The same method can be used where the coal has so great a dip that it is regularly mined by level rooms. In this case, if the final retreat is up the panel, the small hoist used to pull up the empty cars for room coal can pull the pillar coal to the entry above.

Where both the floor and roof are strong and a straight breakline is maintained, the weight of the roof should largely break out the coal without shooting, and the tendency to squeeze can be used to advantage. The pillars can be protected from a squeeze during a long shut-down, by blasting down the roof as described. If the holes are drilled into both the roof and floor over a width of 100 to 150 ft. and as deep as possible, the space of the coal seam will be well filled with broken rock, and the roof will be effectively supported for an indefinite time, if this should be necessary. The break will then occur at the side of the blasted area next to the gob.*

MINING OF ADDITIONAL BENCHES OF COMPOUND SEAMS.

There is a further loss of coal in Arkansas in unmined benches of compound seams. The mining of this coal costs the removal of the intervening parting. The miners will do this for 2½c. an inch over each 15 sq. ft. whether it is in the roof or the floor. The profit, if any, results from the mining of the extra coal without a charge for entries and first cost of opening the mine. These entry costs depend upon the thickness of the bench at present mined. In most cases, the bench varies from 3 ft. to 4 ft. and under present methods the cost of opening up the rooms to the stage of completed room-track, costs 18c. to 24c. a ton. With improved methods of mining, they will be 12c. to 18c. a ton. The value of the coal in the mine may be taken as 10c. a ton. The net value of the coal in the unmined parts of the coal seams is then 31c. a ton with the present layout of the mines, or 25c. a ton if the pillars are mined. One inch of coal will contain .052 tons for each 15 sq. ft. At 25c. a ton, this is worth 1.3c. and will pay for about half an inch of dirt that has to be paid for. This means that 10 inches of bottom coal will pay for

*_Coal Age,_ Vol. I, p. 481, Jan. 20, 1912.

the removal of 5 inches of parting plus the parting handled free.

If the parting is free from grit, as at Hartford, the conditions are ideal for cutting it with chain machines. These will remove 4 inches of the parting, if it is below the bench mined, and this thickness can be added to the thickness of parting handled free, making a total of 6 inches, usually.

Under present conditions, it is the custom to use large pit cars as long as the room brushing does not exceed 3c. an inch per yard, including bottom coal. Each inch of additional hight of working is then worth 3c. per yard of room in saving of brushing expense. The rooms are commonly five or six times as wide as the brushing. At the least, therefore, each 15 sq. ft. of coal or parting taken from the room floor is worth one-sixth of 3c. or .5c. for each inch of thickness. The value of 1 inch of coal over 15 sq. ft. then becomes 1.8c. and the cost of handling parting only 2c. an inch. One inch of good second-bench coal then makes it worth while to pay for the handling of 0.9 inches of parting. The result is about the same if the miner is paid say 6c. per inch for the rock brushing, and simply gets the coal for mining it from the roadway.

Whenever, therefore, the second bench of coal becomes much thicker than that portion of the parting which must be paid for, it is decidedly profitable to mine it. If the pillars are not mined, the profit is still greater, for then one inch of coal will pay for 1.05 inches of parting. To both of these figures, 4 inches of parting may be added, if machines are used.

For considerable benches of top or bottom coal separated by too thick a parting to be handled at a profit, important modification of mining methods will be needed, and this discussion is best postponed until such special methods are taken up.

MINING MACHINES.

Different types of machines. The use of mining machines is essential to prevent the shooting of so much of the soft and brittle coal into low grade slack. Of the two general types of punchers and chain machines, the advantages of the punchers are: The blasting of coal cut by the puncher is safer than the blasting of coal cut by chain machines, if this is carelessly done, and the coal may be obtained in slightly better and more convenient condition. The punchers can be used to dig out a hard or gritty underclay or a parting; and they can be much more easily worked around sulphur balls and rolls in the floor. On the other hand, the cost of the plant per unit of capacity is more, the machine man can cut less coal with a puncher and even though he is paid twice as much per ton as the runner of a chain machine, he earns less per day. If the blasting is carefully done, the coal cut with chain machines is obtained in just as good condition with no greater danger, and an electric power plant is more convenient at the mine than a compresed air plant. For these reasons, the chain machines will have an advantage at most of the Arkansas mines.

All of the leading makers of chain mining machines are now turning out machines of the continuous cutting type. These operate on the principle of the one shown on page 77. The different makes vary chiefly in the method of pulling the machine across the face and of controlling its direction. These are superior to the older type of machines laboriously handled by means of crowbars, and they are now rapidly superceding them. Full information regarding these machines will be furnished by their makers.*

Layout of the mine for continuous coal cutters. In using such machines, it is a great advantage to cut a wide face at once. If the roof will so permit, the rooms should have two necks and two tracks as shown in the Second West Entry of Plate II. If the tracks are placed as in Room No. 7, and there is not too much gob, the room face can be made 50 to 55 ft. wide without inconvenience to the loaders. Ordinarily, each track will be next the rib and double rooms will be about 40 ft. wide. Even in entries and crosscuts, or rooms which must be narrow on acount of bad top, the continuous cutters have a great advantage in loading and unloading from the track and general ease of handling. The first cut of a crosscut can be readily made by swinging the machine around under the rib before or after the room face is cut.

The head of the pillars less than 40 ft. wide can be readily cut by first pulling the machine to the far side and making the

*Jeffrey Manufacturing Co., Columbus, Ohio; Morgan-Gardner Electric Co., Chicago; Sullivan Machinery Co., Chicago.

cut back toward the track. These continuous cutters require less space than the old type, between the nearest props and the face, and if necessary props can be taken out in front of the machine and reset after it has passed. In pillar work, props should generally be set immediately behind the machine. If the pillars are wide and mined by extending the track in a working crossing, the end of the pillar, the machine work does not differ from that in rooms.

It is necessary that the loaders behind the machine get an equal turn. This has sometimes been interpreted to mean that the places be all cut in turn if the loaders are not laying off. If there are narrow places in the mine such as entries, pillar skips, or rooms kept narrow on account of bad top, it is much fairer simply to give the diggers the same number of cars for the week, and to cut the narrow places oftener than the wide ones. For best results, it is also necessary to have enough places to keep the machines always busy. Both of these results are obtained by assigning two working places to each pair of miners, who will work as partners in first one room and then the other, and so lose no time waiting for the machine to get through. This arrangement of two double rooms for each pair of miners or two single rooms for each miner does not decrease the output of the entry, because for the same tonnage, the rooms advance only half as fast and there will be twice as many working rooms in the entry if the speed of advance of the entry remains the same. The only expense will be interest on trackage and yardage. To increase the output of the entry, the width of the entry should be so adjusted that each entry will be cut and blasted every day, and the coal produced will keep two or three men busy in the pair of entries.

Blasting of machine-cut coal. If the coal is more than eight to twelve times as thick as the cut made by the machine, and if there is any sort of loose seam in the coal, it should be "snubbed" by first blasting down the lower part by light shots just below the seam. Such blasting produces the best grade of solid lump coal with the minimum of danger. If, in addition, there is a good current of moistened air well divided into splits, there is no reason why the blasting should not be done at any time. For good progress in the entries, if the coal be snubbed by blasting, shots must be fired at least twice a day. The entry can be cut in the afternoon and snubbed at night. Next morning this coal can be loaded, cartridges prepared and the incidental work done, so that the main lot of coal can be blasted at noon and cleaned up in time for another cutting. If, as should be the case, the entries are the last places on the split of air, the blasting can be done at any time, and one entry snubbed at the time of the main blasting in the other entry. In most cases, all the entry coal must be shot down at once. Each room will be snubbed the same day it is cut, and blasted the next day. In the meantime, the other room of the pair of miners will be cleaned up and left ready for the machine.

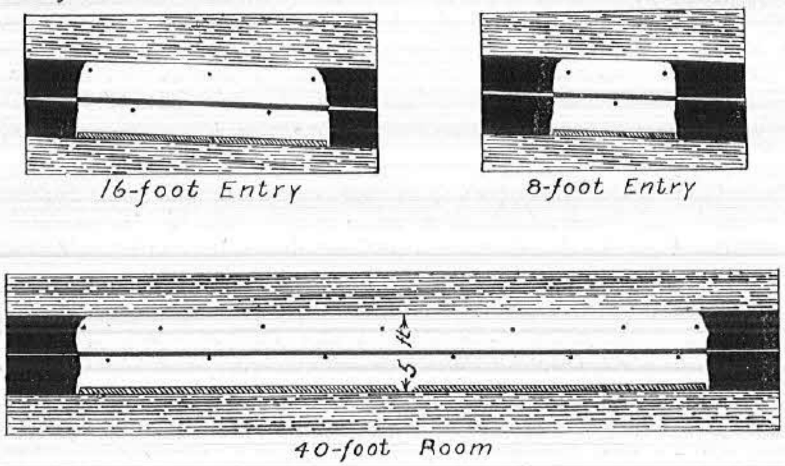


Fig. 78. Arrangement of shots in machine-cut rooms and entries.

In many mines the coal is snubbed by hand wedging. This will not work well in the soft Arkansas coal, unless there is a good free seam. In case the snubbing shots are not desirable, all the coal must be shot down at one time. For this work it seems best to use a number of light shots, so that the coal will be well broken up without shattering. Generally, three shots in the face of a room will bring down all the coal, but those shots must be heavy and the coal is likely to remain in a very large mass. Figure 78 shows suggested plans for the shots in an entry and a room. Such shooting will take less powder than the fewer big shots, but more time and fuse, and to secure the best results it is urged that all the shooting be done by the operator, who

will furnish his own powder. The miners will allow a differential for the shooting.

A good turn for the loaders. If each miner or pair of miners has two working places, there will always be plenty of coal and the men can not run out of coal no matter how good the turn is. The day-men will then be busy till quitting time, and there is no reason why the turn should not be as good as the men want. This is the great advantage of machine mining as far as the men are concerned. With machine mining, there is no trouble about keeping the room face in good condition and the men will not object to working in pairs. If the rooms each have two tracks, the cars can be brought alternately to first one track and then the other and the driver can keep a car always in the room without any extra switching. With long rooms or flat rooms the cars can be handled both ways by the company at much less than the present expense if driver or pusher can take an empty car in on one track and a loaded one out on the other. If the coal is low, it is better for all concerned to provide three places for each pair of loaders, so that there may always be places to cut and coal to load.

Output of loaders and machines. If given plenty of cars and two working places, the loaders in rooms and wide entries can get out an average of twelve tons of coal a day. In the narrow entries, they can load 10 tons per day if no brushing is needed. In the hardest coal of the State, each machine can cut 100 ft. of face 6 ft. deep and move from place to place, provided that no time is lost waiting for places to cut and the men do not loaf. In the softer coal, each machine can cut 200 ft. per day. In places like Hartford, Bonanza, and Excelsior, where there is a soft rashing under the coal, the machines can cut still more, but an extra labor will be needed to handle the cuttings and help move the machine from room to room and this introduces complications.

Number of machines in each entry. Ordinarily all the working places in a single entry will be cut by one machine if the coal is soft, and by two machines if it is hard. Intermediate conditions will require two machines part of the time and one part of the time. One of the machines and its crew of loaders will be transferred from entry to entry as fast as the extra places become available. Extra machines will be used if the room pillars are mined as soon as the rooms are finished. At intervals, the extra machine may be stopped to allow the room work to catch up with the pillar work. There must be enough places in each entry to keep the machines busy.

The number of rooms in an entry can be increased by increasing the distance between the entries so that it will take longer to finish the rooms after they are opened, or more easily by speeding up the entry. Work in the entry on idle days violates the principle of an equal turn and is prohibited by the constitution of the Union. When necessary, a night shift can be employed and the entry made so narrow the day crew can shoot and clean up the coal in time for a cut to be made again just before quitting time. While one entry is being cut, the day crew will be preparing the shots in the other entry. This can be done before the cutting, as well as after it. This double shift work requires extra payment for yardage and the employment of enough drivers scattered through the mine to haul all the night coal to the partings. The rapid driving of entries could be most simply done by contract at so much per yard of entry of specified width, the contractor to haul the coal to the parting. This is prevented by the constitution of the Union, Article XII, section 9, and also by the fact that good machine runners do not like to load coal, and good loaders will not know how to manage a machine to best advantage.

When the mine is small and it is desired to develop territory rapidly, the best plan seems to be to operate the machinery steadily on two shifts. The coal can be loaded from the rooms and hoisted in the daytime only, but the entry loading can be double shifted and the machines will be available to cut the entry as soon as the coal is loaded out. If the ventilation permits shooting at any time, the speed of driving can be increased by narrowing the entries until they can be cut earlier each succeeding day and cut twice every few days. The speed of the entries can be reduced at any time by widening them until the cutting is omitted every few days. This is so simple that it is best to have rooms long enough in the first place.

Proper length of rooms. The method of first approximating the proper length of rooms may be given by illustrations. We may assume that the width of the entries is so adjusted to the entry crew that a 6-foot cut will be made each day in each entry or crosscut, and that the crosscuts are 12 ft. long and 36 ft. apart center to center. The entries will then go 4 ft. 6 in. a day. We may further assume that the double rooms are 40 ft. wide and the pillars alternately 4 ft. and 40 ft. thick. One pair of rooms will then be started each 27.5 days.

If the coal is 5 ft. high, two men will advance a pair of rooms a little less than a foot and a half a day, and 20 ft. of face will have to be cut daily for each pair of rooms. If three men are employed in the two entries, the entries will be about 12 ft. wide to keep them busy with one cutting a day. If the coal is as hard as that at Spadra and only 100 ft. can be cut per day, 75 ft. of cutting must be done in rooms. This requires that 3.8 pairs of rooms, as an average, be cut per day. Each pair of rooms must then last 3.8 times 27.5 days, or 104 days. If advanced 1.5 ft. per day, this will require that the rooms be 156 ft. long. If, as is more likely in high coal, the coal is so soft that 200 ft. can be cut in a day 8.8 pairs of rooms must be working and the rooms will be 363 ft. long. The use of two machines in the hard coal would have the same effect. As the coal gets thinner, the entry-men must spend time brushing, so the width of entry will not increase. The rooms advance more rapidly for the same output but more feet of room must be cut each day for each room, fewer pairs of rooms are required, and the length of the rooms will not change. The 150-foot rooms will, therefore, be suitable for the hard coal at Spadra if one machine is used, and 360-foot rooms if two machines are used.

If the entries are shot more than once a day and advanced 6 ft. a day including the driving of crosscuts, the entries will be 9 ft. wide at the same output per man or 8 ft. allowing for extra time required for blasting, track-laying, etc. At this speed a new pair of rooms will be started each 20⅔ days. The rooms will be advanced 1 ft. 6 in. a day and if the coal is soft about nine pairs of rooms will be cut per day. The rooms must be 280 ft. long. For the hard, low coal, allowing the same width of entries, one machine will require rooms 127 ft. long, two machines 280 ft., and three machines 433 ft. After the machines have been in operation for some time, the length of the rooms may be changed as required, when new entries are started.

Scale of wages for machines. In hard coal, the daily output per machine should be 25 tons per foot of thickness of coal. For soft coal, it should be 50 tons. At Hartford or Bonanza, it will be still greater, if there are two helpers to each machine. The output per entry, if the length of the rooms does not change, differs from that produced by shooting off the solid in proportion to the speed of advance of the entries. This also fixes the number of machines for each entry.

It is perfectly obvious that the labor of cutting the coal is in proportion to the number of square feet of coal cut regardless of the thickness of the coal. It is, however, very much easier to keep a record of the amount of coal cut and the payment should be made on a tonnage basis and this should vary with the thickness of the coal. It should also vary with the hardness of the coal. In general the mines of the Sebastian county type should have a lower rate per square foot cut than those of Spadra. The Denning field is intermediate. The Sebastian county coal is so soft that the cutting rate should be lower than in adjoining states even though the general wage scale is higher here. The soft coal greatly reduces the time lost in changing bits, because they need be changed less often, and also the actual time of cutting the coal. On the new basis of 65c. a ton for shooting off the solid, it is suggested that coal of a standard thickness of 5 ft. or more should be cut for 5c. a ton to be divided between the runner and helper in the proportion of 2.75c. and 2.25c. This is on the supposition that there are two places for each pair of miners and enough places to keep the machine fairly busy. Under these conditions, if the runner is reasonably expert, the pair can earn $12.50 per day, or the runner $6.875 and the helper $5.625. This is ample allowance for loss by absence of diggers, thin patches of coal, etc. On the same basis, the scale for coal, say 3 ft. 6 in. to 5 ft. thick, would be 6c. a ton, and for coal 2 ft. 10 in. to 3 ft. 6 in., 8c. a ton. For Spadra coal, the price would be double this or, as a general rule, 15c. a ton. At Bonanza and Hartford, two helpers should be employed, and the total price paid would be some 5.5c. per ton, giving the runner 2c. and each of the helpers 1.75c. a ton. These scales are maximum rather than minimum, and are not intended as a starting point for concessions.

The loaders have the advantage of plenty of coal at all times and a good turn, greater safety, and a saving in powder amounting to at least 5c. per ton. If the coal is cut by chain machines, the loaders must often first snub it. This requires the drilling of extra holes and extra fuse not needed for punchers. In Illinois, it is customary to pay 7c. a ton for snubbing the coal when it is done by hand. Since the shooting rate is about the same as in Arkansas and the Illinois coal a little harder, the same price should be paid in this state. The scale for loading coal without snubbing has already been fixed at 47c. per ton. When the coal is carefully snubbed, the price of shooting and loading will then be 54c. a ton. With high and soft coal, the total price will be only 60c., giving a differential under the most favorable conditions of 5c. a ton. With lower coal, the cost of cutting should increase, and the differential decreases slightly until the coal becomes so thin that snubbing is not necessary.

At Spadra, the mining eliminates most of the extra labor due to the greater hardness of the coal, and saves the miner so much more powder that this makes up for the greater difficulty of drilling holes as compared with Sebastian county. At present prices, the cost of handling the standard 4-inch rock band is 8c. a ton. This would make the cost of loading normal Spadra coal 55c. a ton after cutting. With 7c. for snubbing, and 15c. for cutting, the total cost will be 67c. At this price, the crews would earn good daily wages equal to the best now paid in Sebastian county, but owing to the unpleasant surroundings and short working time at Spadra, a smaller differential in favor of machines is desirable. This can best be done by an increase in the price for snubbing the coal and picking out the rock, and so should be paid only in case the coal is carefully mined. For cutting, snubbing, and loading, 70c. or 75c. a ton might do as a trial scale.

In all mines, it should be understood that the machine runners will be allowed to load out coal at the standard rate at any time they have cut all their places, and from any room containing coal but no loaders. With proper adjustment, this will be necessary only when the loaders are out a good deal of the time.

To facilitate it, the loaders should be required to snub all places as soon after they are cut as posible, whether or not the spare place has been cleaned up.

The entry yardage in other machine districts is from three-fifths to two-thirds that of the solid shooting yardage. In all cases, the machine relieves the miner of the task of making the cutting, which, under the old scale, was worth $1.12½ a yard. (New scale $1.19.) It also relieves him of the labor of turning the coal out of the heading, and saves a large proportion of his pit expense. If the entry is wide, the turn good, and the blasting regulations such that the entry-men are provided with plenty of coal, the only excuse for yardage except brushing is to hurry the progress of the entry, and it should be divided equally between the machine men and the loaders. If the conditions of entry work are hard, the two-thirds price is right, but the loaders should get more than the half of this, say half the present yardage for entries less than 10 ft. wide. In all cases, it seems best to pay the cutters a little more per ton for entry coal rather than yardage; for high coal from 6c. to 10c. a ton would be reasonable in 8-foot entries. This will be only 20c. a yard, but will pay the runners 40c. for moving the machine, which is ample with the new type of machine, handled by its own power.

Profit from machines in Sebastian county. In general the differential in favor of machines may be counted upon to pay for power, maintenance, interest, and care of the machines. A mine producing 1,400 tons of coal per day from a seam 5 ft. thick will require only six machines in constant use and say two in reserve. If the mine is new, it will cost about $22,000 to install an eight-machine plant of the best type, including boilers and power plant. Interest, depreciation, and maintenance may be taken at 20 per cent of this or $4,400 per annum. The wages of one electrician at $100 a month and extra pay for a mine foreman able to look after a machine mine, say $25 a month, will amount to $1,500 a year. If slack coal is worth 60c. a ton, the cost of the 200-horsepower required, including wages of one fireman, will be $4.75 per day or $950 a year of 200 working days. The extra 200-horsepower boiler will not take all the fireman's time, but with the ash wheeling and incidental work, nearly the full time of one man will be required. Even in the soft coal,

it will be necessary to employ a skilled blacksmith to sharpen bits. It will not take all his time and perhaps $2 a day or $400 a year may be charged to the machines. The yearly charge against machines will then be $7,250 or only 2.6c. per ton. This is much less than the probable differential under any scale.

The general saving will result from a reduction in the cost of draw slate amounting to from nothing to 6c. per ton or an average of 3c. The smaller number of wroking entries causes a reduction in the delay and cost of development equal to some 2c. per ton. There will also be a reduced maintenance charge even beyond that caused by narrow entries and wide pillars. An important saving will result from a reduction of at least one-third of the present amount of slack. In the soft coal mines, this will increase the value of about 15 per cent of the output by about 95c. a ton. This is 7c. a ton on the entire output. The increased freedom from slate will reduce the expense of slate pickers and increase the sale value of the coal by 5c. a ton. This would vary greatly acording to the source and character of the dirt and the ability of the pit-boss. The indirect profit of the machines will thus be at least 15c. a ton and is ample profit upon them.

Profit from machines at Spadra. At Spadra, for 39-inch coal and a mine with an output of 800 tons per day, ten machines would be required for regular operation and three spare machines or thirteen in all. The first cost will be $35,000. The interest and maintenance at the same rate as before will be $7,000. One man will hardly be able to take care of so many machines in this hard coal, and it will be advisable to hire a machine boss as well as an electrician. This cost may be taken as $2,400 a year, without allowance for time of a pit-boss. The cost of fuel and the time of one and a half firemen will be $7 a day or $1,400 a year. The sharpening of bits will take the time of one blacksmith and helper, or about $5.50 a day or $1,100 a year. The cost of operating the plant is then $11,900 a year or 7.4c. a ton. This is offset by the greater differential from the cost of shooting the hard double bench coal off the solid.

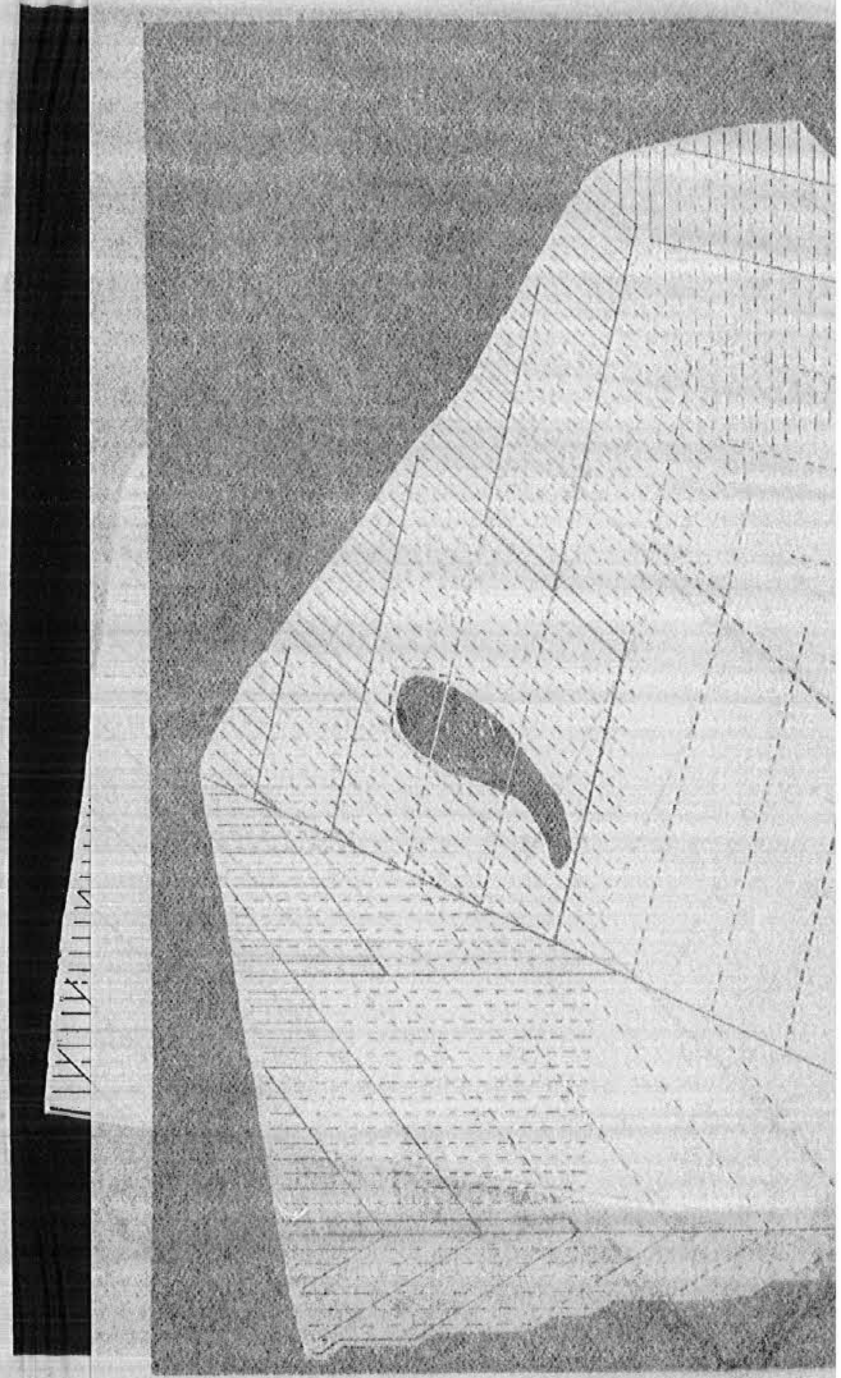
At Spadra, the indirect saving is much greater. The roof is such that the draw slate expense will nearly disappear if the coal is cut before blasting. This will give an average saving of

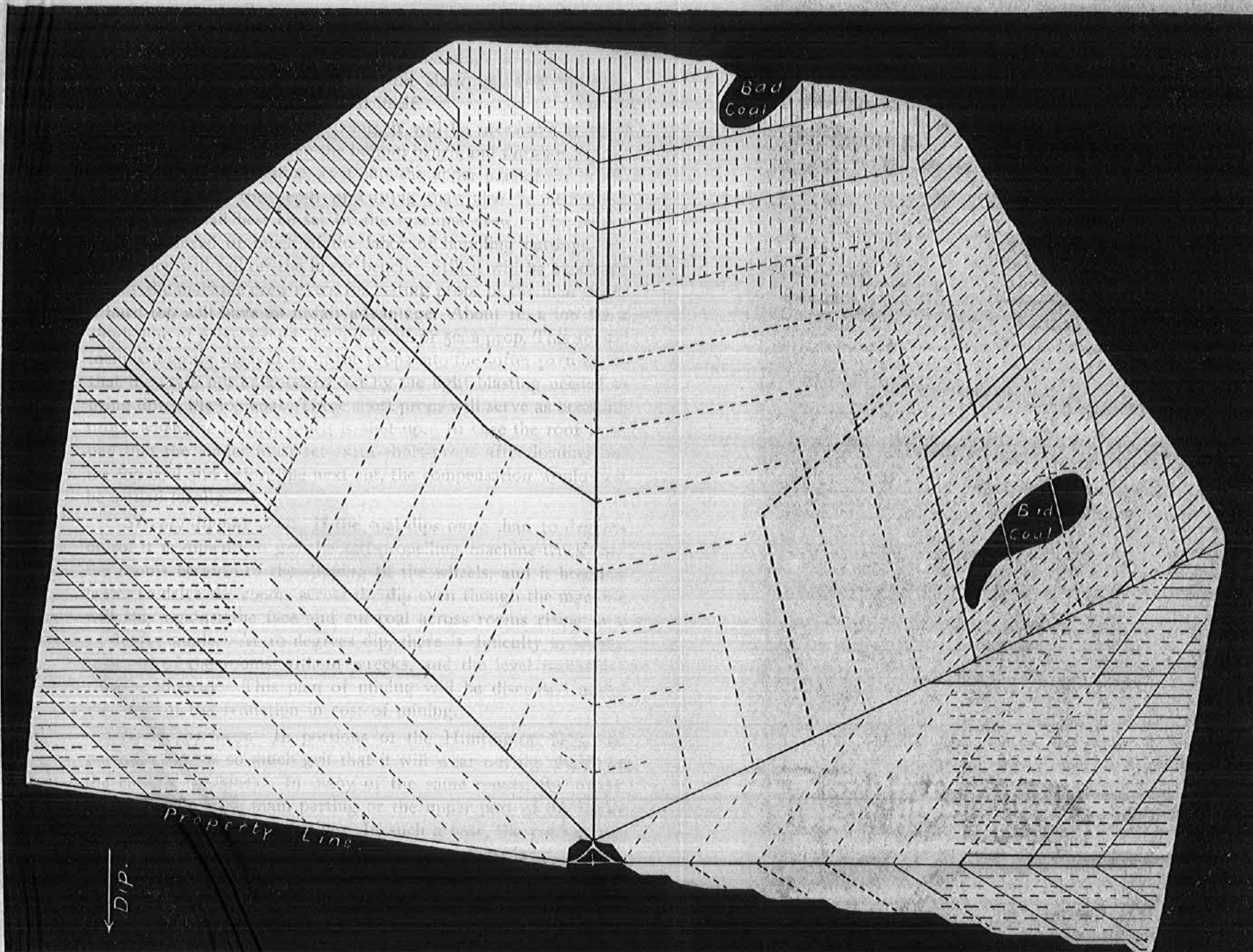
7c. a ton at least. Most of the rock band can be thrown back in large pieces by the miner if the coal is first cut. This will make an additional savings in the cost of slate picking of 6c. a ton. Under Spadra conditions, the machines will more than make up for the great increase in slack caused by the mine-run law. The difference in value of slack and lump coal at Spadra is as great as $2.50 a ton, so the saving from 15 per cent extra lump coal will be a little more than 16c. a ton on the entire output. The total indirect saving is then at least 29c. a ton, and machines should be used even without any differential.

MINING MACHINES FOR UNUSUAL CONDITIONS.

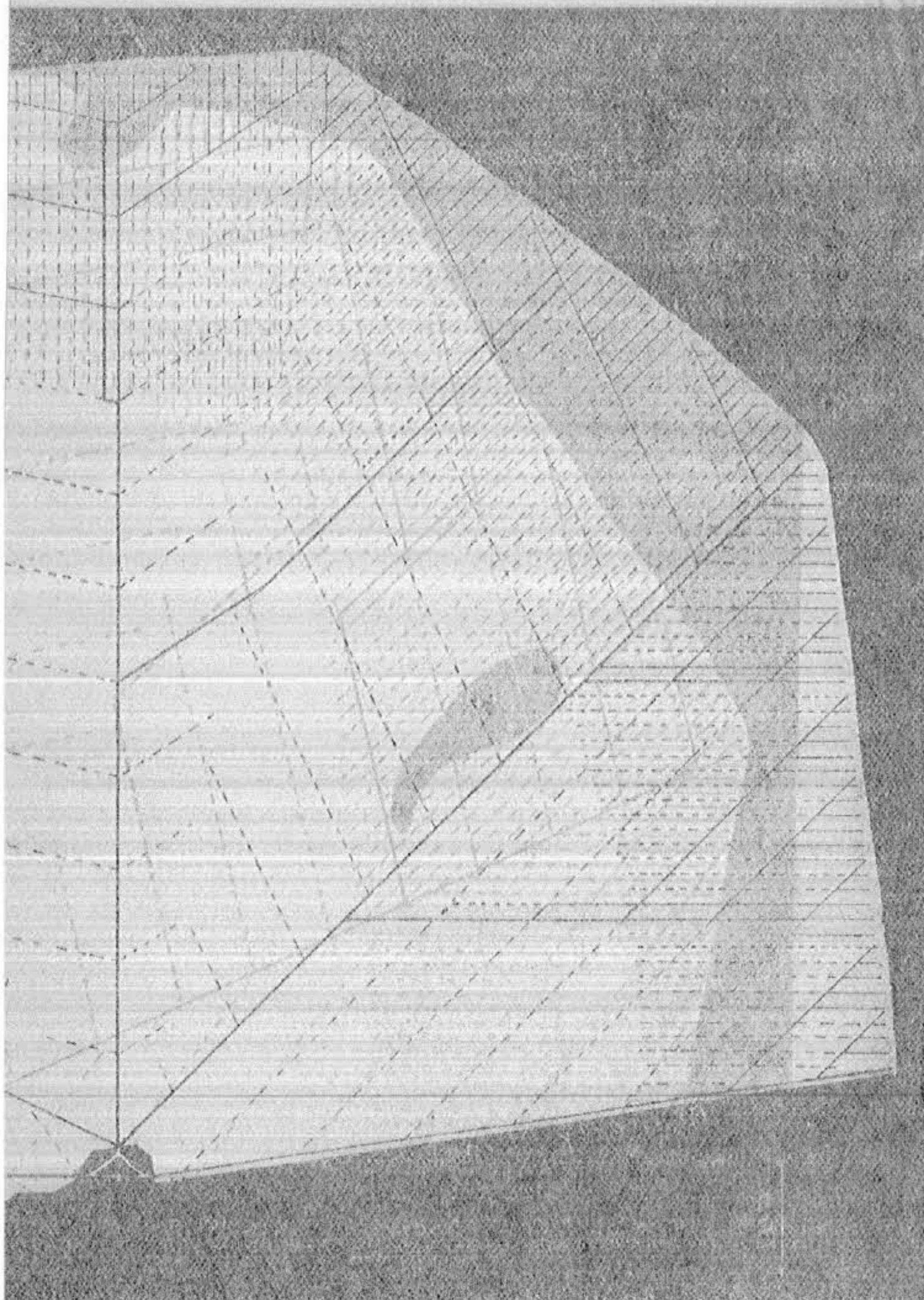
Double-bench high coal. If the coal seam contains a parting, it is of course better to make the cutting in it than in the good coal beneath, and so reduce the production of slack and enable the machine to keep some of the dirt out of the coal. When the dirt band is softer than the coal, there is an additional advantage in cutting it. If the roof is strong, the top coal sufficiently high (over 2 ft.), and the parting free from destructive grit, the dirt can be cut out without difficulty by the continuous-cutting chain-machines. These can be used at Mine No. 17, Jenny Lind, at Greenwood, and at some of the Huntington and Prairie Creek mines. For this work, a special high truck is used holding the machine nearly as high as the top of the bottom bench. About 5 ft. of the bottom bench must be left as a working platform. After the cut is made, the cuttings will be gobbed and the top bench shot down and loaded out. At all the mines mentioned, the upper part of the muck can be cut and the rest loaded out before the lower bench is disturbed by shooting. If the parting is hard, it can be broken by blasting the bottom bench. After the parting is out of the way, the outer 6 ft. of the lower bench will be loaded out leaving enough of this for a platform for the machine. Props will then be set close to the edge of this lower bench.

The machines will eliminate the fine draw slate caused by heavy blasting, and nearly all the dirt can be kept out of the coal if it is mined in the manner outlined, and if the miners do not load out dirt on purpose. Running the machine in the top bench will be quite convenient for the crew and the costs will be as





Longwall mining with gentle dip and poor roof.



before. There will be an additional advantage in keeping out the dirt and a greater reduction in the slack, as compared with cutting the lower part of the coal itself.

In case the roof is not strong, it will be necessary to set a row of short props between the bottom bench and the roof, immediately behind the machine, as it cuts the upper part of the muck. When necessary, the depth of cutting may also be decreased. These props had best be set by the machine crew. The helper will be relieved of much of the labor of handling cuttings, because they will fall off the lower bench. Still it will be necessary to pay the machine crew extra for setting props or the men under a hard top will have an unfair advantage. About 1c. a ton for a single line of props would amount to 4c. or 5c. a prop. This should include digging the bottom of the props into the softer partings so that they will not be knocked out by the light blasting needed to bring down the top coal. These short props will serve as breaking props when the bottom bench is shot up. In case the roof is so bad that the loader must set extra short-props after loading out the top coal and before the next cut, the compensation would best be settled locally.

Steeply dipping coal. If the coal dips more than 10 degrees or so, it is difficult to get the self-propelling machine-truck into the rooms because of the slipping of the wheels, and it becomes better to drive the rooms across the dip even though the machine will stay against the face and cut coal across rooms rising at a 14-degree angle. At 10 degrees dip, there is difficulty in letting cars out of the rooms without wrecks, and the level rooms are cheaper anyway. This plan of mining will be discussed under the head of the reduction in cost of mining.

Gritty partings. In portions of the Huntington field, the parting contains so much grit that it will wear out the chains of the electric machines. In many of the same rooms, the 6-inch coal just below the main parting or the upper part of the lower bench is bony and of no value. In such a case, the cutting can readily be made in the bony coal unless it contains large sulphur balls.

It has been suggested that the thick parting at Huntington, together with the 6-inch coal and the small parting, be cut out completely with a punching machine, and that all the cuttings be gobbed by the machine runners so the loaders will have no temptation to load out dirty coal. This can be done most easily by placing the puncher upon the lower bench of coal left for the purpose, because the post punchers can not remove so much rock at one cutting. With a hand-operated puncher, it is practically impossible to make the back of the cut as high as the front, and some of the dirt will have to be separated from the top bench after it is blasted. The result will probably be dirtier coal than that produced by the cheaper chain machines.

Partings near the top of the coal. If the dirt band is high in the coal, as at Fidelity and Russellville, or if it is too gritty to be cut by a chain machine, it can best be cut by the post punchers. The cut should be made just beneath the top bench of the coal to insure the most complete separation of the dirt after blasting. The output of the post punchers is so small that it will be necessary to pay the runners about 18c. per ton for coal 5 ft. high. This is the chief disadvantage of post punchers. In coal of moderate hardness, they are expected to cut 90 ft. of room face 4 ft. 6 in. deep in an eight-hour day.

The only successful device for using electric distribution of power for punching machines is with the "Electric Air" device, the patent of which is controlled by the Ingersoll-Rand Drill Co., of New York. This is successful with post punchers, but the two short lines of air hose connecting with the pulsator interfere with the free movement of a puncher operated in the ordinary way. Those punchers having the motor mounted on the machine are very heavy if they have sufficient power. Compressed air lines to the power house are better than these electric devices for common punchers.

The Jeffrey Manufacturing Co., Columbus, Ohio, has recently brought out the Jeffrey-O'Toole type of coal mining machine described in *Mines and Minerals*, March, 1912, and in *Coal Age*, January 20, 1912. This machine remains upon a track in the center of the place while a long cutter bar swings around in a half circle, cutting out a crescent-shaped block of coal about 18 ft. from tip to tip and 4 to 8 ft. wide. For entries, the cutter is not swung all the way around. For wide rooms, two tracks and a 10-foot, or possibly a 12-foot, arm can be used. This machine can be adjusted to cut the partings in this State which are

so close to the roof that the ordinary chain machine could not be operated on the lower bench. The writer has had no personal experience with this machine. It is shown in Fig. 79.

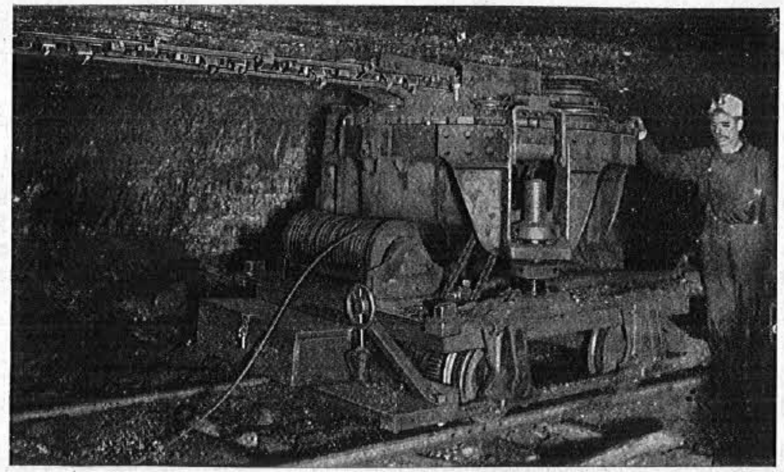


Fig 79. Jeffrey-O'Toole mining machine. (By courtesy of the Jeffrey Mfg. Co.)

Thin coal. So far as known, none of the mines of Arkansas have many rolls in a hard floor, or both sulphur in the lower part of the coal and grit in the floor under it. For this reason, chain machines rather than punchers will be used in high coal and the chief use for punchers will be for digging out a hard clay under thin coal. This is often the cheapest way to obtain the necesary hight of working place. The punchers are now used for this purpose at Paris and will be needed when additional mines are opened on the low coal seams of Prairie View and Excelsior. The scales at Paris are based definitely on the number of square feet of coal undermined. In rooms, the scale is 14c. per foot of face undermined to a depth of 4 ft. In the 21-inch coal, this amounts to 40c. per ton. It is equivalent to 14c. a ton for 5-foot coal and seems reasonable when compared with scales in other districts. The runners earned only $3.83 a day, which is not sufficient. They were not very experienced, but it is probable that this scale is too low for such hard clay. In other mines, it might be ample.

Combined use of chain machines and punchers. Where the coal dips too steeply to permit driving rooms to the rise, the rooms may be driven level and cut with chain machines. This will work in seams quite a little steeper than any as yet known in this State. In case the rooms are level, engine-planes must be driven straight up the dip. If the mine is gassy, solid shooting in the engine-planes becomes dangerous and machines may be considered indispensable. For this purpose the only successful machine is the post puncher, made by a number of companies. It can be used to both undermine and shear the entries so that, if narrow, they can be driven very rapidly. If electric chain machines are used in the rooms, the engine-planes in the entire mine can be driven by a single electric-air post-puncher. The workings will generally be so laid out that development work need be done in only two entries at a time unless the output is very large. There will be a sufficient number of narrow places close together to keep one machine busy in each entry and there will be no trouble with the special crew. The scales can be easily adjusted on the yardage basis.

For rapidly driving entries in flat seams, the same combination can be used, and an 8-foot mining or shearing put in each day; but there will be a great delay in shifting the machine from entry to entry, so probably not more than two pairs of entries could be cut in a single day.

General advantages of mining machines. The proper use of mining machines of any type does much to conserve the value of the coal. If the blasting is carefully done, the machines make it possible to load out good sound lump coal with the least possible production of slack and the greatest freedom from dirt and slate. Even if the blasting is carelessly done, the percentage of slack and the injury to the lump coal is less than caused by any but the most careful blasting off the solid. The slate is so easily separated from the machine-mined coal that even the careless miners will pick out more than they will from coal shot off the solid. Under all conditions, the machines are an advantage in these respects.

The reduction in the production of slack is an immediate financial gain to the operator, and in the long run it is a great advantage to the entire community including the miners. The

more sound condition of the lump coal and its freedom from slate, increase its sale value somewhat, and so is an advantage to the producers; but the chief gain will be to the consumers who are the general public. The greater value of the coal and its greater hardness will extend the market area of the Arkansas coal, and thereby increase its production, which is a general gain to the State.

LONGWALL MINING.

General advantages. Wherever longwall mining is used, from 85 per cent to 95 per cent of the coal in the area mined is recovered. Except under special conditions, the recovery is generally nearly 95 per cent. Longwall mining is, therefore, the most certain method of reducing the waste of coal. The coal so obtained is also in the best possible condition, because almost none of it need be blasted out of tight corners next to pillars, or shattered by opening shots in room faces and entries. This system is also especially favorable to the use of mining machines.

Under a good roof, the method of longwall advancing can be used quite profitably wherever the firm rock from middle bands and draw slate, together with brushing obtained from the roadways, is sufficient to provide substantial pack walls. If the character of the coal and band rock is similar to that at Spadra, the longwall method will pay even though the roof is not strong. Wherever the total thickness of the coal seam is so small that the roadways in the rooms can be brushed at a profit, the longwall method will pay very well even though the roof is weak.

Longwall mining under weak roof. If the roof is weak, the standard method of longwall advancing requires the driving of roadways or gates at about right angles to the face and at intervals of 40 ft. to 45 ft. along the face. Each interval is then called a room. In many places the longwall face is driven in all directions from the foot of the shaft. Where the dip is slight, this is feasible, but in most parts of the Arkansas field, the coal has considerable dip, and to avoid annoyances from water it is best to work to the rise only. If the coal is low or the gates quite steep, it will be necessary to drive haulage-ways cutting the gates off so that the miner need push his car only 150 ft. Otherwise, it will be necessary to pay him 10c. a ton extra for all coal coming from a greater distance than 150 ft. If the cars are brought in or taken out by mule or motor, the miners will handle them one way for a distance of 250 ft. without extra charge. If the gates are nearly perpendicular to the face, the fewest gates will be required for the same interval along the face. The more nearly the haulage-ways are placed at right angles to the gates, the less the length of haulage-way required, but for convenience in building them, the haulage-ways must make a considerable angle with the working face and can not always be put square across the gates.

In the gates, the cars are handled separately and grades are of little importance until they exceed 8 per cent or 10 per cent in favor of the loads and 2 per cent or 3 per cent against the loads. Where the cars are handled in trains, especially by mules, the grades should be in favor of the loads and should not exceed 3 per cent or 4 per cent. Grades of 0.5 per cent or 1 per cent are better, especially where the run is long and little of the time of the driver is spent in gathering single cars.

Upon these principles, the best layout for a longwall mine on a coal seam with a soft top and dipping not more than 5 degrees seems to be the nearly standard method shown on Plate IX. The heavy lines represent the lines of motor haulage and abandoned roadways are shown as broken lines. Several arrangements of shaft pillar can be made, but the plan shown will permit the coal from the upper part of the mine to be taken to either side of the shaft and so facilitate caging from both sides. The motor roads will cut off the mule roads before the maintenance becomes costly and before the mule haul exceeds 700 to 1,000 ft.

In order to keep the gates short, the mule roads must be so close together that there will be but few gates from each road and a single mule can do the work for several roads. If the roadways are good, cars for all the places off each road can be handled in a single trip. This obviates the necessity for partings, which must be heavily timbered, and are a general annoyance in longwall work. In practice, the driver will leave the loaded trip next to the motor road, go to the next road above, take all the empty cars standing there to the miners, and get loaded cars

for the return. By the time the miners have turned out the coal for another car, the motor will have replaced the loads with empties. The motor trips will not be long and the motor can be light, but the track must be surfaced well enough to allow the pushing of the trains as well as pulling.

While the mine is small, the mining machines and loaders will be thickly spaced around the face and each mule will serve but few roads. As the mine gets larger, the output will rapidly increase as more men and machines are added, until the capacity of the shaft or tipple is reached. Then the interval between loaders may be increased as the working face becomes longer, until there will finally be only one loader for several rooms. The final limit is reached when the speed of advance of the face becomes so slow that the gate roads and working space can not be maintained. The remaining coal of such an exceptionally large area can then be worked as another panel, or through another shaft.

Cost of such a system at Spadra. At Spadra, the standard 4-inch band rock from a 40-foot room will yield material enough to make a pack wall about 30 in. wide on each side of the room roads. This should be built for something like 75c. per yard of roadway in addition to the cost of handling the rock. More material must be provided for the wall. If the roadways are brushed 18 in., a mule can be used to haul in the empty cars and large cars can be used. The roadways must have ample width and the brushing obtained from them will give enough additional material for the pack walls. At the standard price of 7c. per inch, this brings the cost of brushing to $1.25 a yard or the entire cost of the roadway to $2.00 a yard. If there is a cut-off roadway each 250 ft. with extra brushing and pack walls costing say $3.00 a yard, the theoretical yardage cost is 16.4c. per ton.* This compares very favorably with the present costs of entry, air-course, crosscuts, room-necks, and break-throughs. The track expense will be about the same and there will be a large margin for the extra timbering, and the cost of cribs at

*Gates 40 ft. apart will keep the distance along the face within 45 ft. A room 40 ft. by 250 ft. will contain 1,350 tons of coal 39 in. high. Ninety-five per cent of this is 1,280 tons. It will require 83 yd. of gate road at $2.00 a yard and about 18 yd. of main haulage-way at $3.00. The total is $210 or 16.4c per ton.

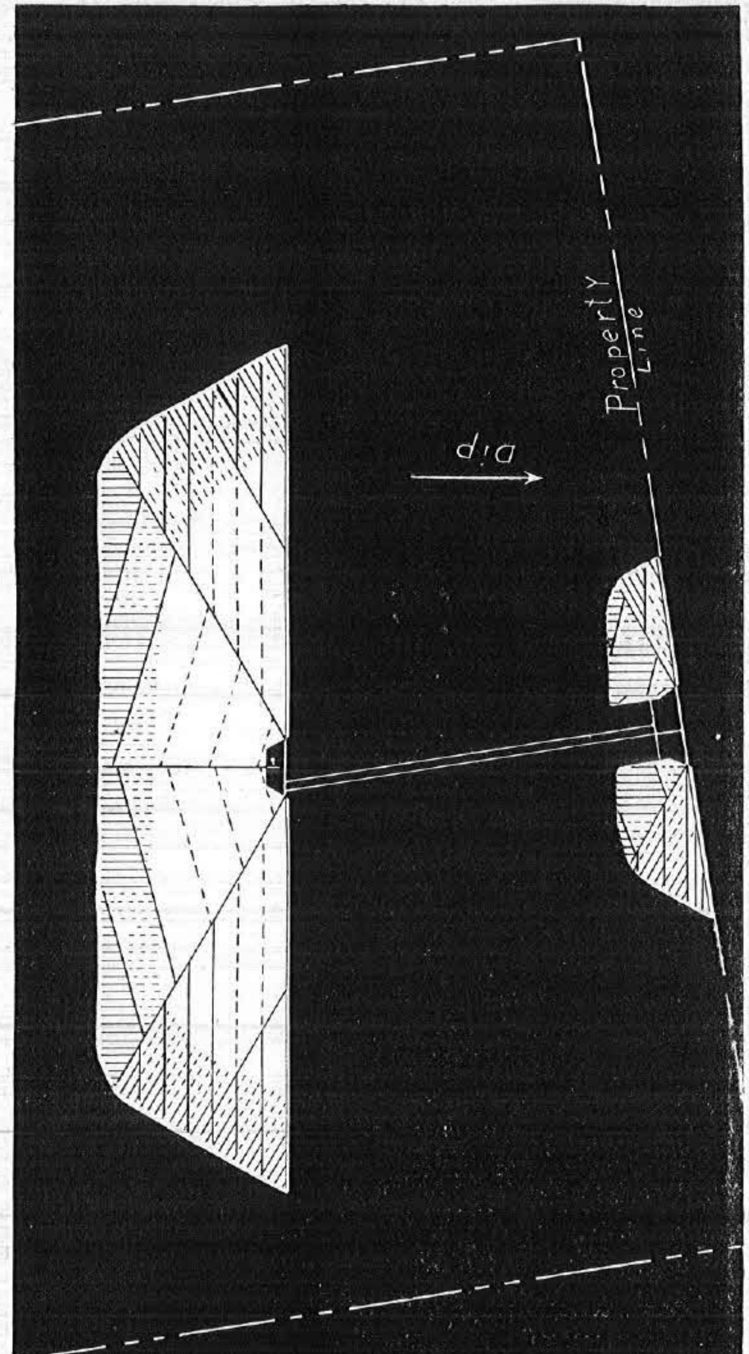
switches. The extra cost of hauling due to scattered work is offset by the saving caused by bigger cars. There will be important gains from increased capacity of the mine, and better recovery of the coal.

If the band rock is thicker than the standard minimum, the hight of working is greater and more material is available for pack walls. As a result, less brushing will be needed and the cost of yardage for longwall greatly decreases. On the other hand, thick band rock increases the expense of room and pillar work by the expense of loading rock out of entries and room-necks. It is therefore, evident that the advantage of longwall increases with the thickness of the band rock. The cost of handling the rock at the face will be the same with either system.

Longwall in thin coal seams. In the case of thin coal at considerable depth as in the Prairie View field and the deeper part of the coal seam near Hackett and Bonanza, it will be necessary to open up considerable bodies of coal from a single shaft. This will require a long haul and the use of cars of a fair size and brushing in the rooms. Under such conditions, the great advantage of longwall mining will be self-evident without computations. With room-and-pillar work, brushed entries have to be driven at close intervals. Besides brushing, they involve the heavy charge for yardage and crosscuts and there is the expense of room-necks and room break-throughs. With longwall, a single roadway, driven at about the expense of the brushing of one entry, serves instead. The better output per acre still further cuts this expense down. The gate roads cost but little more than the room brushing.

Longwall for coal of considerable dip. If the dip of the coal is greater than here assumed, the longwall mining had best be done by the method shown in Plate X. The cost figures will be about as before. This plate also shows the methods of laying out the work in panels and of working coal below a shaft located most conveniently upon the surface. To push the work in the corners, more men may be employed there as, for example, a pair of men for each two rooms instead of a pair for each three or four rooms. The machine will then once in two or three cuts be hauled across the top of the panel upon a track in the haulage road instead of cutting continuously from one end to the other. After every cut,

PLATE X.



Longwall method for coal dipping between 3 degrees and 12 degrees.

the machine will be hauled back along the bottom of the panel to the starting point.

Longwall for high dip. If the dip of the coal is high as at Bates and Coaldale, the most feasible longwall method is that of driving the gate roads at a water grade and collecting the cars by small engine-planes and motor hoists. The general plan is shown in Plate XI which indicates the special method of mining both benches of a compound seam with a thick parting. The first working by longwall advancing will be discussed in that connection.

Faulty patches and longwall mining. It is obvious that all of the longwall methods so far mentioned are admirably adapted to working around patches of bad coal. It will be a simple matter to stop the working as soon as the coal is poor and then circle back in the good coal behind. The opening for the air current may be retained around such patches of coal or most of the air may be sent around by the haulage roads. The only expense will arise from the cost of extending the haulage roads through them if they are so long that the coal behind can not be mined from another road. This is much less than the cost of driving the entries and air-courses through bad coal in room-and-pillar work and there need be no loss whatever of good coal behind faulty patches.

Longwall mining under good roof. Where the roof is strong and the coal fairly high as at Spadra, no gate roads are required, but the cars may be run directly along the face of the coal as shown in Fig. 80. It will be necessary to place the roadway at intervals of say 200 ft. and all the miners of the set or barrie must run their cars out at the same time. The coal will be run down the face to the roadway below and the miners will then go up to the roadway above for more cars. This system is very flexible because the space for each loader can be varied according to the number of men in the mine from day to day. If any man of the group is not ready to load a car, he need not go up for an empty car, but can pick down coal and set props while the other loaders are each filling a car.

The machine requires 3 ft. 6 in. next to the face and the track 4 ft. 6 in. additional. This space of 8 ft. can be safely left unsupported in front of the machine. Immediately behind the machine, 14 ft. will be unsupported if the cut is 6 ft. deep, but the track can be immediately moved over 3 ft. by company men and more props set outside of it to reduce the unsupported width to 11 ft. including the cut. In many cases, the roof will stand this and the weight will simply help break down the coal. As

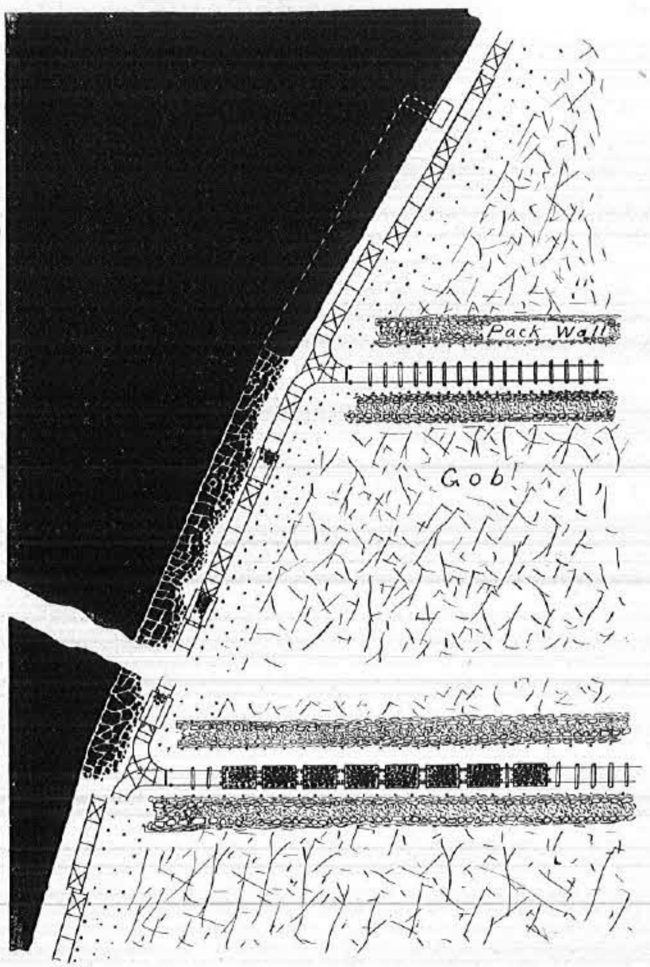


Fig. 80. Longwall mining with good roof.

soon as possible, the loaders will push the track over the other 3 ft. or half the cut and set another row of props close together behind the track, reducing the space to 8 or 9 ft. again. The rear props had best be pulled by the company men who shift the

track and set props behind the machine. If done by a prop-pulling machine, there is little danger. If the roof is good enough, the track can be moved 6 ft. at a time, after the coal is loaded out.

If the roof is not quite so strong as this method requires, props may be set between the track and the face after the machine passes. These will be in the way of the loaders but the fact that all coal can be shoveled directly into the cars with no turning out compensates for this inconvenience. As soon as the coal is loaded out, an additional line of props may be set 4 ft. from the face, the props next the track removed, the track moved over, and the props immediately reset behind it. After the machine has passed, the track may be moved over at once or it may be left until the coal is loaded out and then moved 6 ft. past two lines of props. Under this plan, the greatest width of roof unsupported for any length of time will be only the depth of the cut. Immediately behind the machine, there will be a width of 4 ft. greater. While the track is being shifted, 7 ft. 6 in. of roof will be unsupported. This is entirely safe at most of the Spadra mines.

For convenience, the tracks to the face should be so placed that the coal between them can be cut in a single day. This will vary from 150 to 250 ft. Enough loaders should work in each section or barrie to load out the coal on another day, and, to prevent delays, there should be two sections for each machine and each set of loaders.

This plan is well adapted to flat seams and also to dipping seams provided that the dip is not so great that it is unsafe to push spragged cars along the face. The workings for steep dip are outlined in Fig. 81. The cars can be handled upon the main plane by a rope and in the nearly level entries by mules. As the entries get too long, they can be cut off by inclined motor haulage roads. The coal above the highest entry can be let down to it through ordinary gates until the face has advanced far enough for another entry. If desired, the mine may be extended by a slope below the shaft, because most of the water can be kept from the face by ditches along the entries. No short gates will then be needed, but a sump will have to be maintained in advance of the lowest point of the face.

The entries will have to be brushed and secured by wide pack walls and if the dip is high, cribs may be needed along the upper side. In some cases, they may require timbering, but these charges will be so much smaller than the dead work expenses for room-and-pillar mining that no computations as to financial advantages of this type of longwall are necessary.

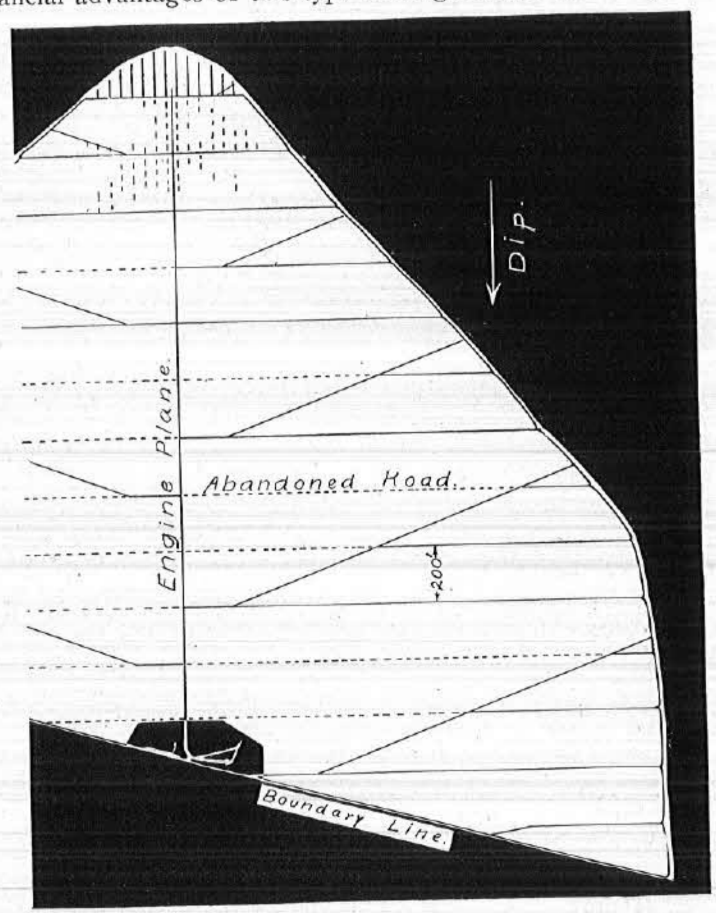


Fig. 81. Longwall mining with good top and steep dip.

In case of faulty patches in the coal, the face in the good coal must be advanced beyond them. During this interval, there will be an extra expense and delay in handling cars both ways on the same track and in moving machines past such places. The air current can be carried around the areas of poor coal, and generally the mule entries can be driven through them without a special air-course. They will cause a greater annoyance than if there are gate roads all along the face, but the expense of driving the regular room-and-pillar entries through faulty patches will be almost as great.

Longwall with portable track along the face. If the roof is too weak for a continuous track along the face, only enough space may be left to pass the machine, and props may be set immediately behind the machine and close to the face. The coal can then be loaded out by extending a track along the face in

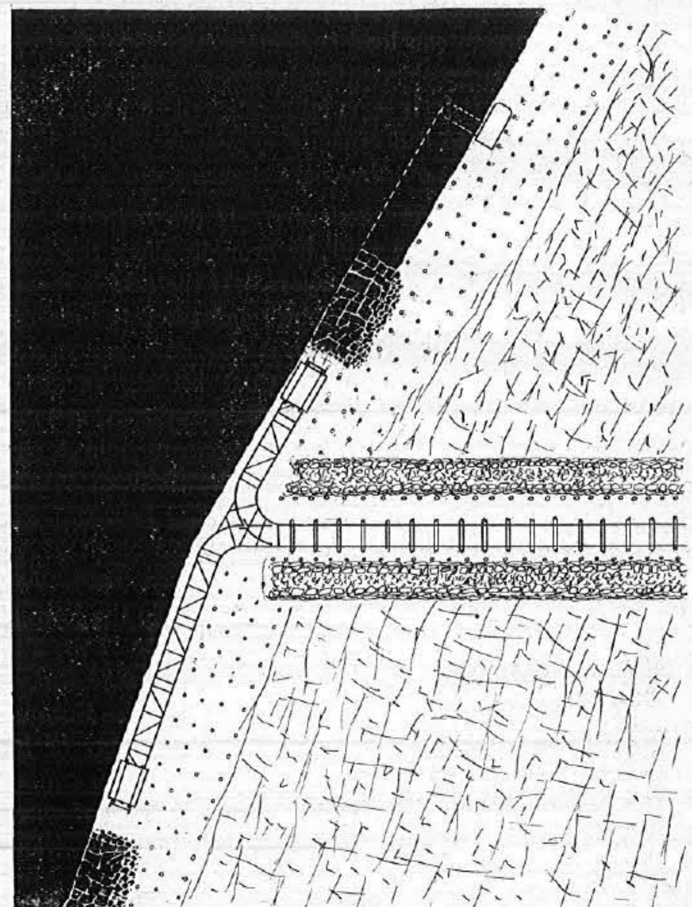


Fig. 82. Longwall mining with portable face track.

the space from which the coal has been loaded. For this purpose, short lengths of ready-made portable steel track are recommended. As soon as the coal is all loaded out, the track may be stacked up in any convenient place. Portable curves and short track may be used in entries. Fig. 82 shows the general arrangement.

This method can be used only upon grades so low that the empty cars can be pushed uphill. Its great disadvantage is the fact that but two men can load coal in each section of the mine, and to maintain a large output, the entries must be close together and the mine large. It is especially adapted to old mines that have been developed to full capacity by placing gate roads close together and by turning out the coal between them by hand.

Longwall mining with conveyors. If the roof is good and the coal so thin that cars can not be brought along the face, the coal can best be removed by conveyors. If the coal is more than 24 in. high, it can be cut by machines and there is little trouble in using the conveyors. The system is best described in a paper read by J. F. Thomas before the Coal Mining Institute for America in June, 1907, and entitled "Mechanical Conveyors as Applied to Longwall Mining." This is reprinted in *Mine and Quarry,* No. 3 of Vol. II, published by the Sullivan Machinery Co., Chicago. In the *Engineering and Mining Journal,* May 18, 1907, Vol. 83, page 958, may be found another account of American practice. In the same journal for April 7, 1906, Vol. 81, page 652, is an account of English practice and in the journal for August 11, 1906, Vol. 82, page 267, is an account of the Belgian practice. In *Coal Age,* Feb. 24, 1912, Vol. I, page 643, is an account of several types of English conveyors. In Europe, the conveyors are sometimes operated by hand and may be of the shaking type. In America, they are ordinary scraper conveyors. No full account need be given here. The occurrence of extensive and frequent faults in the coal will be the greatest hindrance to the use of conveyors because conveyors require a uniform advance of a straight face. The other great objection is the fact that the loading of the coal can not well be done by contract but must be done by day labor.

One of the greatest advantages of conveyors is their independence of grades. The special field for conveyors seems to

be in the steep and low coal south of Poteau Mountain. For this purpose, the conveyors should be placed as shown in Fig. 83. The main slope and its air-course may first be sunk a sufficient distance to give a longwall face with sufficient capacity. The conveyors will then be placed in the air-course and worked outward. These conveyors should be about 250 ft. long and at the lower end of each, a roadway with brushed bottom is needed so that the conveyor can dump directly into the cars. This roadway will be extended by hand mining as an ordinary double entry. The lower entry or air-course will be top-brushed. This entry will then be used as a run-around parting to get cars beyond the

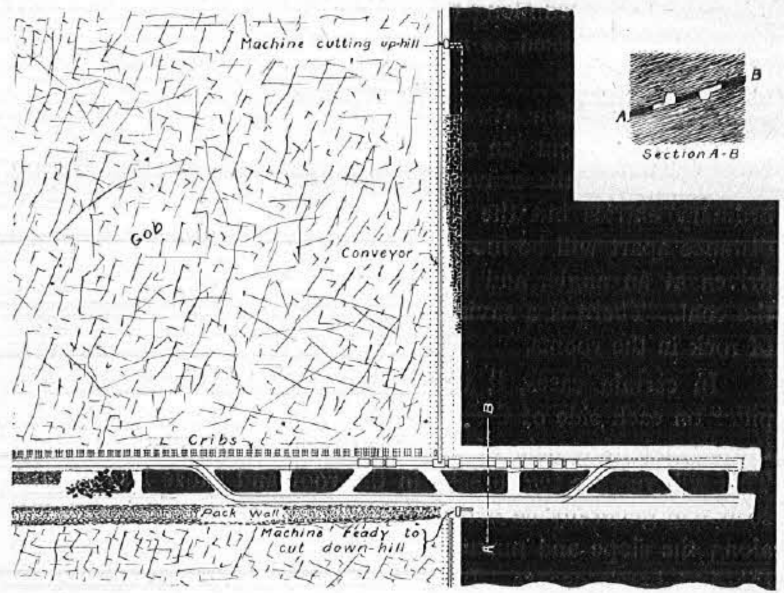


Fig. 83. Longwall face conveyors with steep dip.

conveyor. They can then be loaded on the way out. The coal alongside the conveyor will be cut, shot, and loaded as rapidly as possible, and the conveyors kept approximately in line. The machine can cut downhill and wait alongside of the track until the coal is loaded out. If the machine is of the reversible type, it will start up as soon as it is overhauled and the last of the coal loaded out. Until more coal has been cut and blasted, the crew of loaders will be occupied setting props and moving the conveyor.

The entries must be driven wide enough to leave room on the side for the machine. For this, the roof will be strong enough in the solid coal. It will be best to take the mule through a crosscut and to keep the brushing as narrow as possible. The chain pillars between the entries will be left until crushed by squeeze, and can then be loaded directly into cars alongside and replaced by a pack wall or cribs as may be needed. This will protect the ends of the conveyors and the men handling cars. The brushing must be done on the night shift when the rock can be hauled back to be used as pack walls. If the dip is steep, cribs will be needed along the upper side of the roadway and the brushing can be used as a lower pack-wall supported by a line of props.

It has been demonstrated in Pennsylvania that the saving in labor of turning out the coal much more than makes up for the labor of moving the conveyor. The entries will cost more than ordinary entries but the cost per ton will be less because the distance apart will be more than is possible when the rooms are driven at an angle, and because of the complete extraction of the coal. There is a saving in room brushing and the handling of rock in the rooms.

In certain cases, it will be better to leave a considerable pillar on each side of the slope and start the longwall face from the second of a pair of rooms turned off the entry partings. This will require two breaks in the roof and cause loss of coal, so it will generally be better to leave only narrow strips of coal along the slope and maintain the passageway by brushing after the first break occurs. In this case the narrow pillars of coal serve as pack walls for the slope.

WORKING COMPOUND SEAMS BY LONGWALL.

General method of working. At Bates under the present conditions, only the lower 36-inch to 42-inch bench of the compound coal seam is mined. Above this is a parting of slate, clay, and bony coal 30 in. thick, and above it 42 in. of good coal with a single 4-inch parting. As a result of experience in Europe, it seems that the only commercially feasible way of mining the entire seam is to mine the lower bench by longwall advancing and the upper bench by longwall retreating. The lower bench may be mined by the conveyor system just outlined or by the plan shown in Plate XI. If it were not for labor questions, the conveyor system would be much more satisfactory because it leaves so few irregularities in the floor upon which the upper bench must settle. The settling of the upper bench will serve to break the coal up ready for loading out without blasting. This breaking will be assisted by the weight of the roof upon the edge of the coal during retreat. The effect is shown in all mine squeezes.

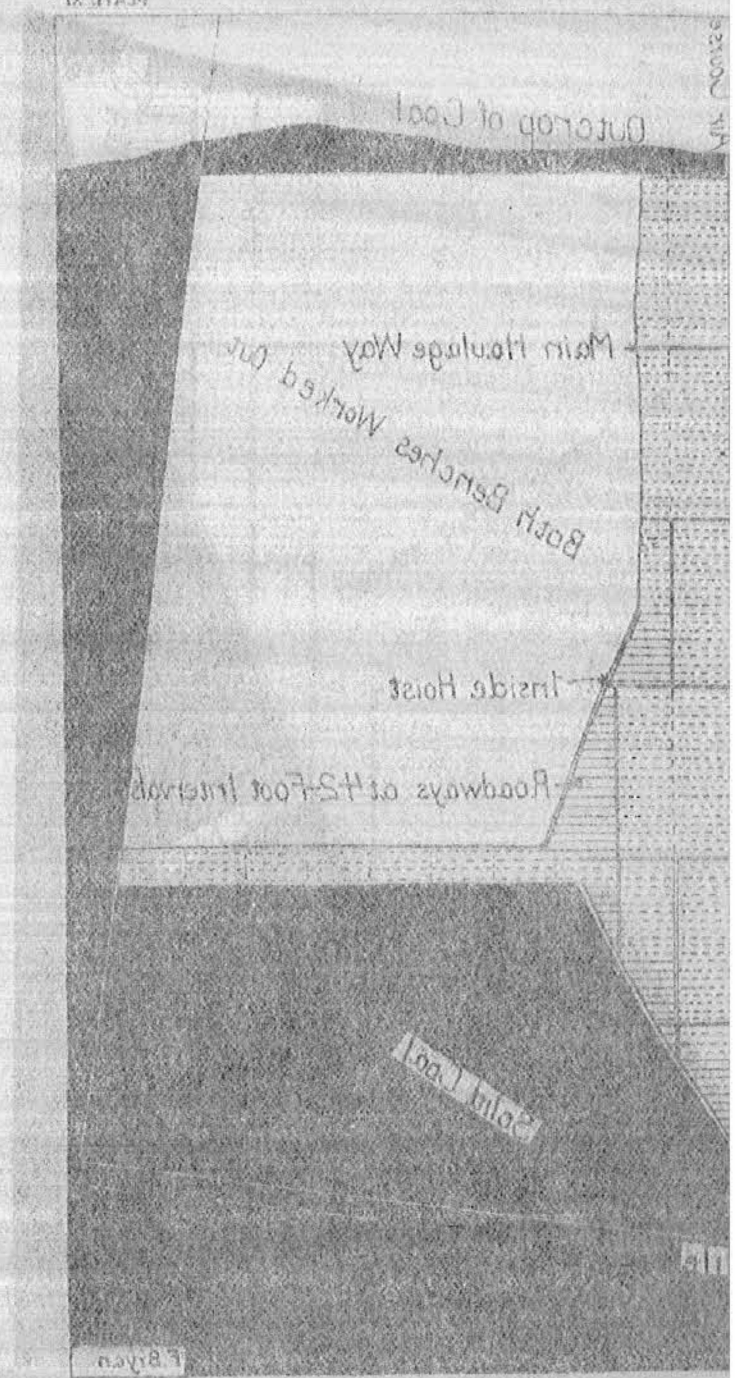
Mining the lower bench. In the system shown on Plate XI, it is assumed that the sinking of the lower working-place and the building of solid pack walls for the slope are carried on by double shift or double crew with payment for yardage. As rapidly as possible, other miners are set to work on single shifts widening out the walls of the slope so that the working maintains a V-shape. At intervals of 40 ft. to 45 ft., level roadways are brushed and cribs or pack walls built alongside. The cars from the slope as well as the short rooms are at first handled by the main rope or a special sinking engine.

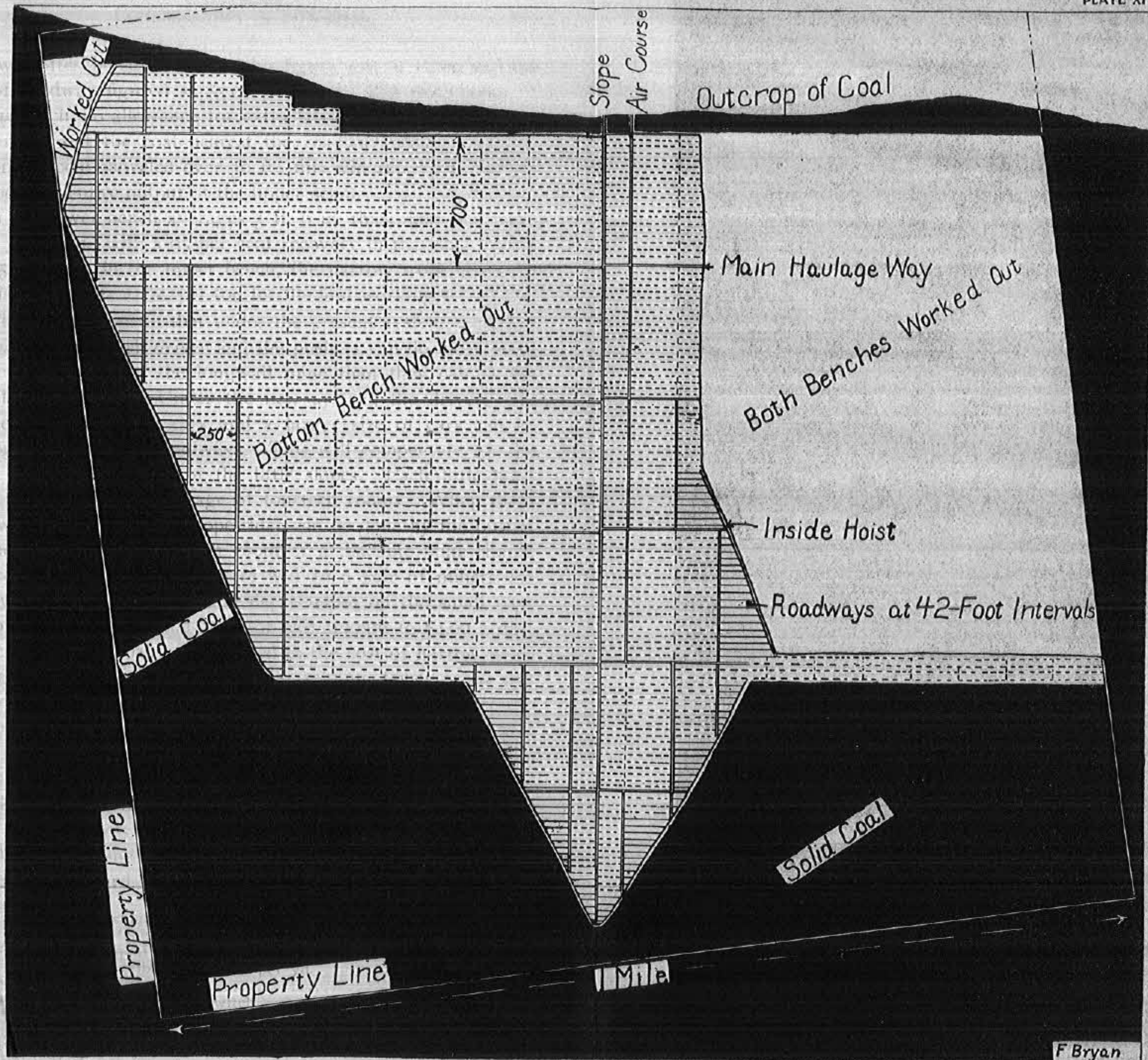
As soon as these room roads are so long that the roof is down between the slope and the working face, another little slope is built, and brushed, and the cars are hauled up this by a small electric hoist to a parting above. As soon as the roadways have reached a length of 250 ft., a second slope will be started and a new hoist put in, so that the miners need not push the cars more than 250 ft. one way. A pusher will be employed to bring in the empty cars, and to assist the miner with the loaded cars if necessary. The roads will be brushed up to the coal above and one or both of the upper benches over the road may then be removed. Most of the brushing can be used as a pack wall along the lower side, supported by props below. It is recommended that cribs be used above the road.

From the top of the small slopes is a well brushed and supported roadway for mule haulage to the partings at the main slope. As soon as the number of rooms off any little slope becomes so great that the switching of the cars can not be done by a single rope-rider, the little slopes should be cut off by another main haulage road. As many of these main haulage roads will be turned off from the slope as may be necessary to supply the desired output. The sinking of the main slope will then be stopped until a later time. When sinking is resumed, a roadway in the well-settled mined-out district should be used as the main haulage road, rather than one right at the edge of the solid coal above which the roof will be broken to a great hight. As the main haulage roads settle on the light cribs, all the upper coal above them should be mined. If the roof above is more solid than the coal, all the upper bench coal can be shot down from the roadways at once. For this work, nothing need be paid, except the regular tonnage rate, because this coal will be very easily mined. If done later, it should be shot down by company men.

Mining the upper bench. As soon as the roadways reach the limit of the coal to be mined from this slope, or the property line, a cut between roadways will be made through the parting and the upper bench. The props will then be pulled and mining stopped until the roof settles. In the meantime, the remaining coal in the roofs of the room roads will be removed. As soon as the workings between roads close, the upper bench can be mined back toward the main slope and the coal taken through the roadways already driven, to the little hoists in their former places. After the coal next the roadway is shot down and loaded, the cribs on the high side can be knocked out and thrown back. There will then be no obstruction in the floor next the roadway.

Costs. To figure costs, it is necessary to assume some reasonable scale of wages. The present scale for brushing is $1.00 per yard up to the clay seam in the parting. This amounts to from 5c. to 8c. per inch. The brushing is so soft that it does not need to be shot, and often falls as far as the coal above, so that 5c. per inch per yard seems to be ample for brushing and piling the waste along the lower side. For the full 30 in., this will amount to $1.50 a yard. The miners must be paid for building the cribs along the upper side. Cribs of three sticks, 42 in. long each way piled 42 in. high should be built for 60c. (Cribs 4 ft. high are built for 56c. in Missouri.) They will require thirty-three props costing 3.5c. each, or $1.15 per crib. This makes the cost of the line of cribs $1.50 a yard. Smaller





Longwall advancing in the bottom bench and retreating in the top bench, steep dip.

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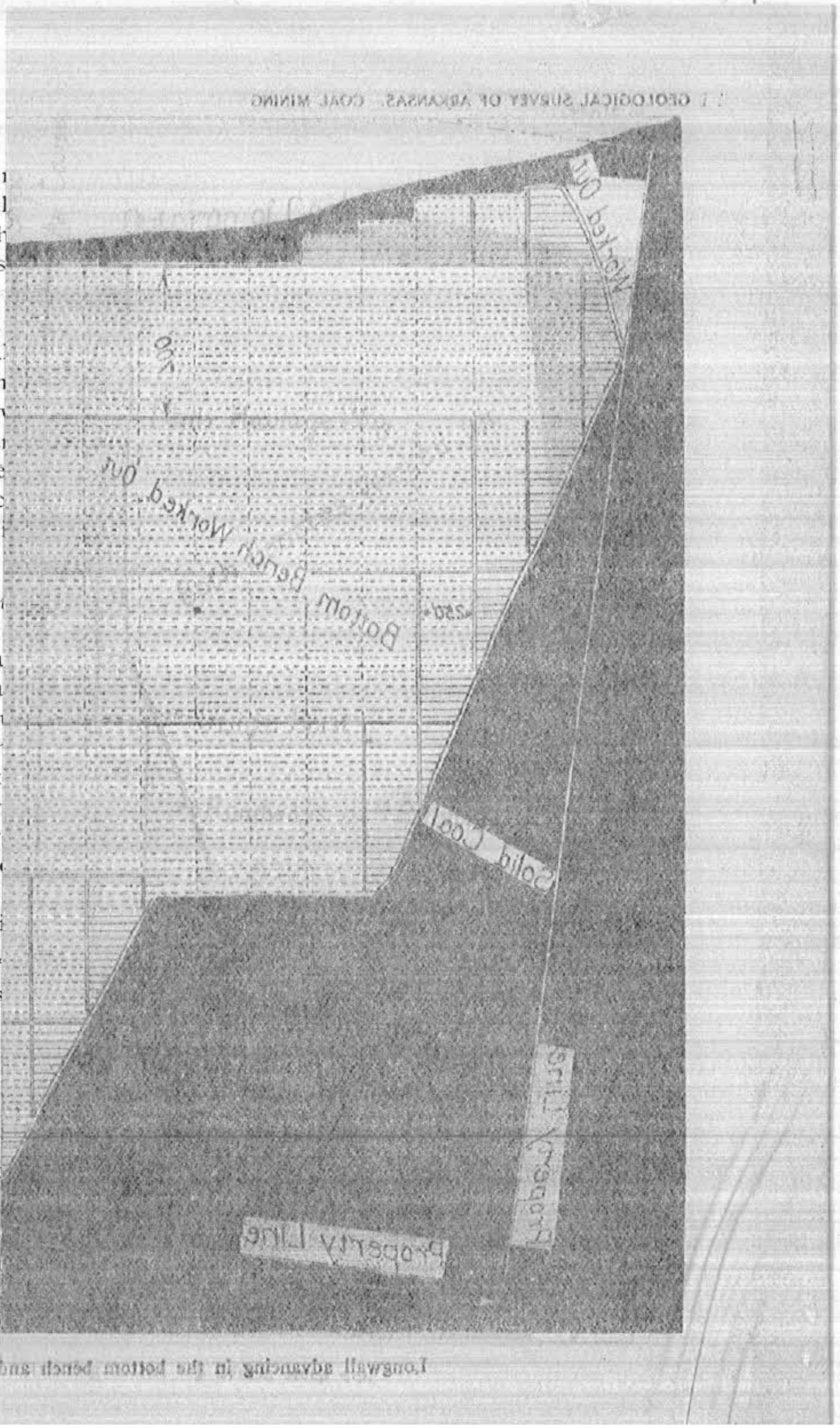


cribs will often be sufficient but this figure will be taken and the cost of roadway figured at $3.00 per yard. For the mining of the top bench, no allowance for extra labor need be made except for turning out the coal nearest the roadway above. At 10c. per ton for coal shoveled over 30 ft., this will amount to 3c. per ton upon the entire output of the upper seam.

If the lower bench averages 3 ft. 6 in. thick, and the upper bench 3 ft. 6 in., with a 95 per cent recovery in the lower bench and 85 per cent in the upper bench, the narrow work after the slope is sunk, costs 21.2c. per ton for the first working.*

The dip is so steep that under the present system, a pusher is employed with each driver and the pushers can do more work in the level rooms of the longwall mine than they can in the present steep rooms. Under the new system, the drivers will lose no time gathering cars and a larger size of cars can be used on the high level roadways. This will compensate for the wages of the rope-riders of the little slopes. Each little hoist should be good for an average of fourteen rooms. When there are fewer, the work of the rope-rider can be done by the pusher and the hoist operator. Each room of a machine mine should produce 12 tons of coal. (There will be a pair of miners for each two rooms.) Interest and depreciation on the small rope and hoist and wages of the operator will amount to $4.00 a day, or 2.4c. per ton of coal. This added to the cost of narrow work gives a sum of 23.6c. In the regular mining, fewer props will be used, because the longwall props may be pulled. The present clay roof is fully as expensive to maintain in the entries as will be the shale above the top bench using longwall.

At present, the rooms are 20 ft. wide and driven at an angle with the entry at distances of 45 ft. along the entries. The length of the rooms may be taken at 250 ft. Pillars are only 8 ft. thick and some crosscuts are blown through. Others are cut at $1.68 per yard. All the crosscuts of a room may be taken

*A room 42 ft. wide and 250 ft. long requires 83 yd. of room road and 14 yd. of little slope or 99 yd., assuming enough cribs along each side of the slope to equal continuous cribs on one side.

99 yd. brushing and cribbing at $3.00 per yd.	$297.00
99 yd. ties	3.00
14 yd. of track laying and one switch	7.50
Total	$307.50

At 95 per cent recovery, the room will yield 1,450 tons of coal and the cost will be 21.2c. per ton.

to cost \$10.00. The rooms and entries are brushed at \$1.00 a yard. The cost of narrow work and ties is 27.7c. per ton.* There is thus an apparent immediate saving of 4.1c. per ton. Actually, it is difficult to drive the present rooms across the 12½-degree dip to the full length of 250 ft. and the yardage per ton is greater than that figured above. There is a slight extra expense due to the falling of soft top across the room face and in loading out extra brushing from falls or roadways. Since the rooms are turned off at such long intervals, there will be but few rooms in an entry and the cost of hauling and general maintenance will be high. The longwall plan gives the full output in a shorter time. For these reasons, the saving by longwall will be more than 4.1c. per ton.

Eighty-five per cent of the top bench will yield 1,300 tons of coal additional. At 3c. per ton for turning out the coal and 2.4c. for small hoists, the cost of this coal will be \$70.20. The entire 2,750 tons of both benches will cost for development, turning out and hoisting to the main entries \$411.60 or nearly 15c. per ton. The ultimate saving will then be 12.7c. a ton. The total recovery of the coal will be about 90 per cent as against about 35 per cent as at present. If the value of the coal in a developed mine be taken as 10c. a ton, this represents an additional profit of 7.2c. per ton on the increased output. The total of 20c. per ton will go far towards making the improved system of mining profitable in this steep coal. It is a sufficient argument against the present wasteful method.

*Two entries 8 ft. wide, 45 ft. long; 1⅓ crosscuts 12 ft.; one room; one room-neck; and five break-throughs will yield 833 tons of coal. The costs will be:

30 yd. of entry and air-course, at \$2.25 per yd.	\$ 67.50
30 yd. of brushing, at \$1.00 per yd.	30.00
16 ft. of crosscuts, at \$1.68 per yd.	8.96
1 room-neck, at \$3.37	3.37
Room break-throughs	10.00
Room brushing, 83 yd., at \$1.00 per yd.	83.00
Ties, 340 ft.	3.40
1 switch and track laying	7.50
Loading out brushing at 28c. per 1,800 pounds, from entry and room-neck	17.63
Total	\$231.37

This is 27.7c. per ton. Actually \$2.50 a yard is paid for driving entries at Bates, but this seems unreasonable and the more common \$2.25 a yard is used as before.

LONGWALL TO SAVE A THIN LOWER BENCH.

Between Huntington and Burma and possibly east of Hartford, only the upper bench of coal is mined and a thinner bottom bench is left beneath a thick strong parting. There seems to be no plan by which both benches can be mined at a profit at the present time. If the upper bench is mined out clean by longwall mining, the lower bench can be mined as soon as the scarcity of coal makes it profitable to mine such thin coal. The second mining must be done by the longwall method and the fact that the roof has already settled once will facilitate the work except for the maintenance of roadways. It is, therefore, strongly urged that these upper benches be mined by longwall, which has been shown to be at least as cheap as the present method and to give a better recovery from the upper bench now being mined.

LONGWALL RETREATING.

General plan of the mine. The thick coal under the high mountains like Sugarloaf must be mined by longwall retreating. The details of the work are sufficiently well known and will vary with the nature of the roof. They will not, therefore, be discussed. The main objection to longwall retreating is the cost of development. In Arkansas, this is especially serious because the coal will have to be brought to shafts near the foot of each mountain and all the development must be from one side. The cost of development for longwall retreating can best be reduced by mining the coal in panels.

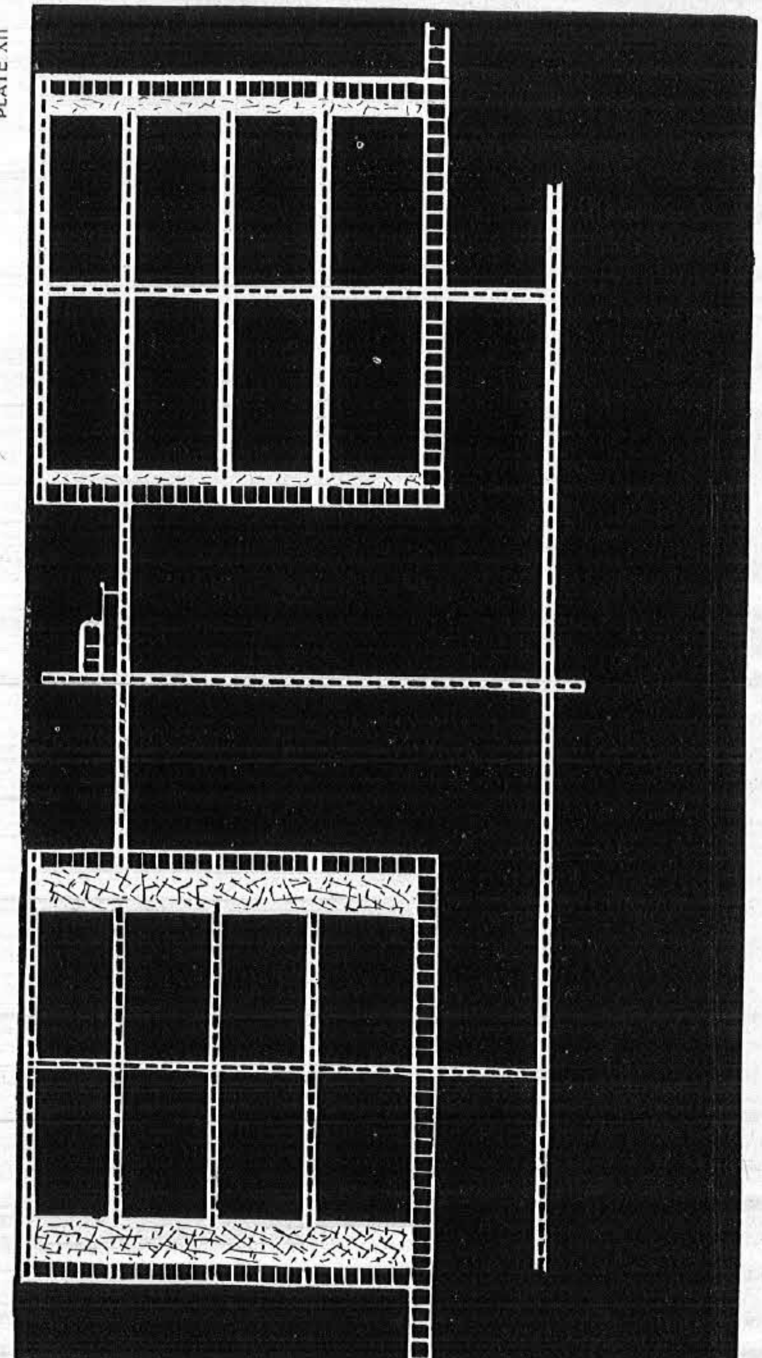
The roof is probably strong and the coal can be mined by keeping a track along the face. Two panels 1,000 ft. on a side will yield a sufficient output if mined by machines. Entries should reach the face each 250 ft. and the general plan is shown on Plate XII. To reduce the time of development and to ventilate the mine without depending upon the tightness of the stoppings, the pair of entries next the top of the shaft panel should be driven as soon as the main slope reaches them. Double entries must be driven along each side of the panels connecting the ends of the panel cross-entries. The chain pillar for these entries and the pair of entries at the bottom of the panel should be as wide as possible. Forty feet will be assumed. If the mining of the panel be stopped at the nearest of the entries, the outer entry will be in solid coal and should resist the squeeze. It will then remain open for ventilation and can be used as the opening face or roadway of the adjoining panel. To further hasten the development, it is advisable to drive the working along the near side of the panels down-hill as well as up-hill even though it is cheaper to drive them up-hill. All of the engine-plane and most of the working on the far side can be driven up-hill.

As soon as the full production of the first pair of panels is available, the next pair in the top tier can be opened up. This may be hastened by driving the lower marginal working directly from the first panel while the main entry is being extended to the new engine-plane. This work can be done in the most economical way and the expense charged against yardage for the coal of the first panel. As soon as the end property lines are reached, a new tier of panels may be started next below. For these, the former main haulage-way becomes the upper cross entry. The special slope driven for ventilation must be extended from tier to tier of panels.

When only one tier of panels is left, no main haulage-way need be driven and the engine-planes become slopes sunk from the former main haulage-way to the lower property line. The lower tier of panels can, therefore, be mined on the retreat making them twice as long down the dip and mining only the side away from the main slope. A lower boundary line not parallel to the strike will thus be easily followed. The cross entries of the panels will follow the strike and the lengths of face between them can be varied as the dip changes and as experience indicates. Finally the panels along the main slope will be mined two at a time retreating up toward the shaft. There will be a slight loss of coal in the pillars along the margins of the panels and next the main slope.

Time required to develop the mine. To reduce the time of paying interest on the cost of sinking the shafts and the general expenses, all development should be done on two shifts. If the crosscuts are only 12 ft. long and 36 ft. apart, and the entries are kept down to 7 or 8 ft. in width, the slope and its air-course should be sunk at the rate of 200 ft. per month, and the level entries at the rate of 250 ft. working twenty-five double shifts a month. The workings in the 40-foot pillars around the margin

PLATE XII



Longwall retreating.

of the panel will be delayed by the long crosscut and go only 150 ft. per month.

The last point of the panel to be reached will be the farther lower corner, and because of the delay of the workings with wide chain pillars, this will be reached first by way of the lower cross-entry of the panel. This work will take about thirteen months after the shafts are down.* It will take about one month longer to finish the working across the bottom of the panel and within fourteen months, the full output should be reached. The extra pair of slopes from the air-shaft should be driven from below as soon as possible.

Extra cost of development. We may assume 6 ft. as the most likely thickness of the coal under the mountains, and the mine will produce enough coal to meet all the payroll except yardage as soon as the first pair of cross-entries are turned off from the main slope.† No brushing will be required and the slope should be sunk for not more than $4.00 a yard. Including the cost of crosscuts at $1.68 a yard and 25c. a yard for double shifting, the slope and its air-course together will cost $10.00 a yard. The engine-plane and its air-course driven up-hill and the pair of level entries will cost $5.50 per yard of advance. The extra-long crosscuts at $2.25 a yard will make the pair of working at the end of the panels cost $12.30 per yard of advance when driven down-hill. Up-hill or across the bottom, the cost will be

* 250 ft. of main slope at 200 ft. per month	1¼	months
500 ft. of upper entry at 250 ft. per month	2	"
750 ft. of wide-pillar end-working at 150 ft. per month	5	"
1,000 ft. of lower cross-entry at 250 ft. per month	4	"
Total	12¼	months

Or, allowing for delays, thirteen months.

†Besides the diggers in slopes, one man will be needed to act as superintendent, foreman, and engineer, at a salary of at least $150 a month. On the day shift, there will be one fireman, one car trimmer and general surface man, one weighboss and top foreman, one blacksmith and general mechanic, two engineers, two bottom men who will lay track and build brattices when not caging, and one rope-rider. At night the cars can be left on the bottom, and only one third-class engineer and fireman will be needed at the surface and the slope engineer and a rope-rider in the mine. This will make a payroll of about $950 a month, allowing for extra labor, but not office expense. The two slopes with crosscuts will yield 865 tons of coal per month. One hundred tons will be used at the mine and the rest sold. Being entry coal, it will not bring more than 70c. a ton more than the cost of shooting and loading. At first the loss on day labor will then be $415 a month. When the new entries are begun, only an extra mule is needed and the output of coal will be three times as great, and will meet the payroll.

$8.00 per yard. In estimating the total extra development, the ordinary entries and track across the panels need not be included because an equivalent charge would be necessary in developing a room-and-pillar mine. The total additional investment in yardage for the first two panels is then $40,000.*

In addition to the cost of yardage, interest must be paid upon the cost of the shafts for a longer time before full production is reached. The cost of sinking and equipping the shafts will depend entirely on their depth and the nature of the rock, but the item of interest upon the expense together with loss on payroll at first may be taken as $10,000. The total cost is, therefore, about $50,000 more than that of opening a room-and-pillar mine. While the first panels are being mined, the second pair will be opened and so on. The cost of opening the panel is not returned until the last two are mined and the interest upon this extra investment remains as an annual charge upon the coal. The annual output of 1,200 tons per day 200 days a year will be 240,000 tons.† Interest at 10 per cent per annum will then amount to a little more than 2c. per ton. The output of the mine can be increased by opening up more panels or making the panels larger but this will not greatly affect the interest charge because the development cost increases in nearly the same proportion.

Cost of extra yardage. Besides the interest upon the extra development expense, the cost of mining by longwall retreating will exceed that of ordinary room-and-pillar mining by the extra cost of the narrow workings around the panel and the engine-plane through it. To reduce this, the panels after the first two, can be made longer. The exact size will depend upon the relation

* 433 yd. double main slope at $10.00 per yd.	$ 4,333
867 yd. double engine-plane at $5.50 per yd.	4,767
667 yd. double main entry at $5.50 per yd.	3,667
333 yd. double cross entry in shaft pillar at $5.50	1,833
667 yd. marginal slope at $12.50 per yd.	8,200
1,333 yd. marginal working at $8.00 per yd.	10,667
83 yd. double air-course at shaft at $5.50	458
2,000 yd. main haulage track at $1.50	3,000
1,600 yd. of track between panel entries at $1.00	1,600
360 extra stoppings at $3.00	1,080
Total	$39,605

In round numbers, this is $40,000.

†This allows an average of one loader loading 12 tons per shift for each 40 ft. of face. The panels will last about two years, giving time enough to develop a new set of longer panels.

to the property lines but they can be assumed to average 1,500 ft. on the strike by 1,000 ft. on the dip, and to yield 375,000 tons of 6-foot coal. If driven upwards, the extra workings will cost $8.00 per yard. In the center of the property, each marginal working serves two panels and the one across the bottom takes the place of an ordinary pair of entries costing $5.50 a yard. It may be fair to charge each panel as an average with one end working and the full cost of the bottom working. After the mine is fully developed, rails can be obtained from the older panels and the cost of the extra narrow work will be about $10,000,* including interest.
This amounts to 2.7c. per ton.

Comparative results. The increased cost of narrow work and capital charges will then make coal obtained by longwall retreating cost about 4.75c. a ton more than coal mined at shallow depth by room-and-pillar. Against this is the profit from better recovery and the reduced cost of mule haulage. With panels, 1,500 ft. long, no mule entries will exceed 750 ft. By leaving a track in both cross-entries of the pair, the empties may be taken in on the lower track and left for the miners below. The mule can then take out the loaded cars of the barrie above along the upper entry. The work of the engine-plane is equally simple and the general mechanical haulage will not cost more than that of any large mine. It may be possible to reduce the number of cross-entries and save greatly on yardage. It is thus apparent that the careful mining of this deep coal will soon be commercially feasible. It should not, however, be undertaken except after thorough prospecting and then only by companies with ample capital and controlling a large area of coal land.

Deep coal under poor roof. If the roof over the deep coal should be of such a nature that neither tracks nor conveyors can be used along the retreating face, the entries must reach the face at intervals of 40 or 60 ft. Under present conditions, this will be a prohibitive expense, especially so long as crosscuts between entries are required by law every 40 ft. Such coal if there is

*2,500 ft. of marginal working at $8.00 per yd.	$ 6,667
1,000 ft. of engine-plane at $5.50 per yd.	1,833
100 stoppings at $3.00	300
Track laying, incidentals, and interest	1,200
Total	$10,000

any in the State will remain as a small reserve against the time of national scarcity.

MORE CAREFUL HANDLING OF COAL.

Avoiding wear on soft coal. All the Arkansas coal is easily broken up, especially after it has been heavily blasted. For this reason, all unnecessary handling should be avoided. In the mine, unnecessary handling is chiefly caused by the need of turning out the coal long distances. Besides the wear on the coal, the necessity for much shoveling tempts the miner to make as much slack as possible in the shooting. Narrow rooms with track in the center are an advantage in this regard. The cutting of the entries by machines also makes it possible to keep the entry track close to the coal, and there need be no turning out of heading coal. The longwall method with a track along the face is especially favorable, and even the face conveyor, dropping coal into the car, is better than turning it out even once and then shoveling it into a car.

At the surface, the most general place of smashing coal is in the old-style weigh-basket. To avoid the serious loss of double payment to the miners for all coal that hangs in the weigh-basket, the bottoms are necessarily given a steep slope and the coal strikes violently against the door. The Pittsburgh type of weigh-basket already in use at a few mines completely avoids this. When closed, this presents to the coal a smooth gently sloping iron trough, turned up at the end to bring the coal to rest. To dump, the bend is lowered and opened so that all the coal slides gently out upon the screen. They are not much more expensive than the other type and are more easily operated and less apt to get out of order. The main objection is that they require 4 or 5 ft. more head room between the dumping device and the top of the screen so that they can not be used in some of the tipples already built.

Very few tipples are arranged with chutes for lowering the coal into the railroad cars. The simplest device is the closed steel box about 2 ft. square and nearly long enough to reach to the bottom of the car from the lip of the screen. This is made to telescope in three or four sections largest at the bottom and is normally kept full of coal. As fast as more coal is supplied in

the top, the bottom is raised by the car trimmer and the coal rolls gently out upon a conical pile. The spout can be given an inclination of about 45 degrees to reduce the shock upon the first coal of each pile. It is not very expensive and if properly counterbalanced it is easily operated by one man and saves a good deal of the labor of trimming the load with a shovel. It is especially necessary for the preparation of fancy domestic-lump coal, but will reduce the breakage upon all lump coal and so extend the market area and prevent some complaints.

Unnecessary production of slack in semi-anthracite tipples. In the Spadra district, much of the coal must be prepared for the domestic market by breaking to grate size or less. This is usually done by passing the coal through a Sauerman crusher. At a few of the older tipples, the mine-run coal is dumped directly into the crusher from the cars. The result is that the wet slack promptly chokes the crusher and much of the grate, egg, and stove coal is needlessly crushed to slack. At a very little cost, a 7-inch bar-screen can be placed before the crusher to throw the fine part of the mine-run coal to the chute below the crusher. In a few cases, this will require the raising of the dumping platform, but even that expense is soon repaid by the greater sale value of coal not crushed to slack.

At some of the newer Spadra and Russellville tipples, the coal must pass through a great many appliances before its final separation. This causes unnecessary wear. Revolving screens, with spokes and bands inside, and elevators, are especially bad. Generally the coal will be sized sufficiently if it is passed over a shaking screen of less than the customary length. A little undersized material may get into the commercial coal but the quality of the commercial coal can be better maintained by the use of lowering chutes to the bins and cars and by placing lip screens at the loading chutes from the bins.

Many tipples have an unnecessary number of elevators and conveyors, which wear out the coal. The best arrangement of the tipple seems to be to dump the coal up on a sheet that can be raised to pass rock but which ordinarily discharges into a weigh-pan. From the weigh-pan, the coal goes straight to the short 7-inch screen with a discharge gate controlled by a crusher attendant who will let the over-size into the crusher without choking it. At the small mines, the crushed coal joins the undersize and passes directly onto a set of shaking screens. The screens are followed by diagonal bars to take out flat slate. From these, the different sizes of coal go past slate pickers and on to the car or bins. No elevator is necessary except to return the undersize from the lip screens to the main screens. Shaking conveyors attached to the screen can be used to carry the egg coal to the far end of the last bin which need not be very high. Doors can be left in these conveyors to distribute the coal and they can be arranged for easy lowering and raising to reduce the drop as the bins are filled. The rarely required "fancy lump coal" can be prepared by raising the first bar-screen to throw mine-run coal directly to the main screens. The fancy lump instead of grate coal will then go over the upper screen to the car. Larger tipples can have separate sets of screens for the fine coal from the mine and for that coal which has passed through the crusher.

There is a further loss by burning at the mine-boilers coal of high commercial value. Some of the slack ordinarily sold to the zinc smelters can be screened to yield a well-sized product that will burn with forced draft. The value of the slack to the smelters is not decreased by reduction in size of the particles.

There is considerable waste at Sapdra in the form of flat pieces of coal which slide through the diagonal bars together with the flat slate. The coal is not slippery enough to permit the use of any of the common types of mechanical slate pickers depending upon the retardation of the slate. Therefore, the flat coal must be thrown out. The loss can be avoided by mining machines producing coal free from slate, or by the establishment of a single washery, which will handle this product together with the fine coal from all of the mines of the district.

SUMMARY.

In this chapter, many figures have been presented to show that the present great loss of coal in the pillars can be profitably prevented. In all cases, narrow, secure entries are more economical than the dangerous gob-entries commonly used. In very shallow mines, it is not profitable to leave the pillars between the rooms wide enough to be afterwards mined, but it is

profitable to so securely protect the entries that the abandoned room-pillars can be made much smaller and the entry pillars can be mined.

Under all conditions of coal seams, the room pillars of all but the shallow mines can be advantageously made larger than at present and the coal almost completely recovered by mining the pillars later. Under some conditions, the coal first mined will cost more than that obtained by the present wasteful methods and additional capital is required to get the extra profit from mining of the pillars. This profit arises from the saving in the costs of opening the rooms due to the greater output per yard of entry, and the saving in the cost of land and the opening of the mine due to the greater percentage of coal recovered. The cost of the narrow entries is repaid by the reduced cost of maintenance unless the roof is so strong that there are no expenses caused by falls of roof. In any case, the better recovery reduces the cost of maintaining tracks and ventilation because fewer working entries are needed for the same output.

Detailed calculations are made for deep and shallow coal 2 ft. 10 in. high and for coal of medium depth and 3 ft. 6 in. high with all sorts of arrangements of workings and lengths of rooms to meet the varied conditions. For the sake of uniformity, we have assumed that, with careless mining, the minimum width of pillar to support the roof is used between each pair of rooms and that the other pillars are mere strips for ventilation. This is cheaper than the present plan of making all the room pillars of the same size. It saves either an expense for crosscuts or an expense caused by squeezes and does not alter the general results. It is then shown that the advantage of better mining holds for other thicknesses of coal and is increased by any increase in actual yardage expenses over the theoretical yardage.

The standard plans are suggested for the protection of the main passageways of the mine from squeezes caused by the mining of pillars. Calculations are given to show under what conditions it will pay to handle thick partings for the mining of additional benches of compound seams now wasted in room-and-pillar mines.

The advantage of mining machines is shown to lie in the greatly improved quality of coal which results from the substitution of machine mining for the present wasteful method of shooting off the solid. Figures are given to show the profit which will result from the use of machines under the various standard conditions, and methods are given for the use of machines in exceptional mines.

No discussion is needed to prove that longwall mining recovers a very large percentage of coal from the area worked. Figures are therefore given to show under what conditions longwall mining can be profitably substituted for the more wasteful room-and-pillar mining. Description is given of the modifications of longwall for unusual conditions. The use of longwall in certain compound seams is shown to be remarkably profitable and longwall is urged for all compound seams. Longwall retreating is the only possible way to mine the high coal under the high mountains. Computations are given to show that if the mine is properly laid out in panels, this method will be profitable as soon as the demand for coal makes it advisable to open up this deep coal.

Finally the useless production of slack by the careless handling of coal is condemned.

Under nearly all conditions existing in this State, the waste of coal can be prevented without extra cost to the operators and the present waste is little short of criminal carelessness.

CHAPTER IX

CONSERVATION OF EXPENSE

THE MINE PLANT.

The design of the mechanical plant. At all but the little mines equipped with second-hand machinery, more money should be spent upon the design of the mechanical plant. At the small mines, this can best be done by purchasing the engine from a good firm that will design the details and send out a skilled mechanic to have charge of the erection at the expense of the mining company. He will see that the engine has good foundations, that the machinery is properly lined up, that the steam connections are safely and efficiently made, and all such matters are attended to. The larger mining companies have their own master-mechanic or engineer. As a general rule, it is best to buy the special plant of the mine from firms dealing in mining machinery exclusively. It is then more likely to be adapted to the conditions. Cheaper engines are an endless expense on account of the constant need of repairs and the innumerable delays they cause. A little extra investment in better plant is good economy. Engines of good design, material, and workmanship generally inspire their attendants to take care of them and attract a better class of engineers. The majority of the steam hoists that have given good satisfaction in Arkansas were made by the Litchfield Foundry & Machine Co., Litchfield, Ill. Other good engines were made farther east.

Some of the larger makers of mining machines build the electric apparatus needed in all mining machinery and even the generating sets. Nearly all of them build the motors needed for such special work as coal cutting machines. Others equip their hoists, pumps, and fans with motors built by large electric firms and do not install power plants. Both of these plans are satisfactory, but mining machinery, especially locomotives, built by the larger electric firms have not been well adapted to mine conditions. It is often difficult to change the wheels of a locomotive without head-room or a repair pit.

Slope ropes and rollers. Most of the mines of the State operate the slopes and engine-planes without rollers. The ropes are rather heavy and cheap, have seven wires to the strand, and rub on the oak ties. To keep the rope out of the dirt, the rollers would have to be not more than 25 to 30 ft. apart and the full time of one man will be needed to take care of them. It is, therefore, much cheaper to wear out a few more ropes during the life of the mine. This works well with steep dips or short runs. When the length of the rope and the grades are such that the empty trip can no longer drag down the heavy rope, the next change is to substitute a smaller rope of better quality and much less weight. This reduces the load on the hoist and wears longer, and may even be advisable at the start. It should be tested in each mine because of the variation in the amount of grit to wear the rope. Finally, in slopes that are long or have less than 3 degrees inclination, rollers are necessary to reduce the friction of the rope. Experience of the copper mines of Michigan indicates that the best results are obtained from plain oak cylinders mounted on steel shafts with good bearings secured to heavy ties.

Rather than attempt the task of maintaining crowd sheaves to take the rope into the entry partings, it is far better to use several pieces of *T* rail firmly spiked to strong ties. The rope wears out faster but enough extra rope can be bought so that when one short length is worn out, it can be cut off. Before the second piece gives out, the rope is reversed to equalize the wear. A piece may then be cut off the other end when that gives out. By the time the fourth length is worn out, the entire rope will be worn out and the extra cost is only the two short lengths cut off. Against this, is the saving of many wrecks. Some mines use oak blocks instead of rails but the rope soon cuts into the spikes and the wear is just as great. The rails should be rather heavy, long, well-curved so as not to tear loose, and set close together to reduce wear on the rope. They should be as high up as possible and set near the inside rail so as to catch the rope.

Larger sheaves. Most of the drums of the hoists are large enough, but in many engine-planes and haulage systems, the bull wheels and angle sheaves are much too small. Large sheaves are especially important for the seven-wire-strand ropes used on

slopes, for they are not as flexible as the ordinary hoisting ropes and small sheaves cause dangerous, concealed wear inside the rope. At angles in slopes and haulage planes, the curve in the track should have as long a radius as possible so that the cars will not be derailed by the pull of the rope inside the curve of the track. The rope is best carried around the curve by many rather large drums set close together. These are best made of wood and kept covered with oak lagging that can be easily renewed in the mine. The bearings are best supported by cross pieces bolted between solid square props. The lower bearing should be kept free from dirt and have an oiling pipe reaching over to one of the props. Oak timbers between the drums will keep the rope from slipping down to the lower bearing. Iron sheaves may be substituted for the wooden drums but are more expensive and much harder on the rope.

Mine cars. With short mule haulage and poor tracks, the cars now in use are generally as satisfactory as any. The cars made by the Engineering Works, of Van Buren, Arkansas, have given general satisfaction and are usually bought finished. Some mining companies, especially those operating in several states, buy their cars of the Watt Mining Car Wheel Co., of Barnesville, Ohio. Usually on account of high freight and cheap local oak lumber only the iron parts of these cars are shipped in. They can be finished in the mine carpenter shop, where they are rebuilt as often as needed. A wooden car commonly costs \$30 to \$36. The body is rebuilt every 6 to 9 months, and the wheels last five years. There is no excuse for allowing the stock of cars to get so low that complete cars must be rushed in.

The size of wheels should be adjusted to the capacity of the car and the length of the wheelbase should be proportioned to the length of the car. No general rules can be given. If the mine-run law is repealed, the hight of the cars should be determined only by the convenience of loading, the higher the better for transportation. If the roof is poor and crossbars are needed in entries or rooms, the high narrow steel car bodies are of advantage. They are hard to load and to empty for the capacity. As long as corner bumpers are used, the cars should have diagonal iron straps on the bottom.

To support the flare boards of the wooden cars, a diagonal brace is commonly attached to the iron strap around the open end of the car. The weak place is then at the bottom of the sides where only the stiffness of the two straps keeps the walls from spreading. It is strongly recommended that the two straps be welded together at this place so that the angle will be formed by a single iron twice as thick as a single strap. It will then be eight times as stiff as one strap or four times as stiff as the two straps acting separately. The weight of the car will not be increased and much of the trouble due to tight doors will be avoided without the annoyance of a tie rod across the end of the car. Where center bumpers are used, the brace should be bent edgewise and attached to the ends of the planks across the end of the bumper. Fig. 84 shows both plans, omitting the bumpers for the sake of clearness.

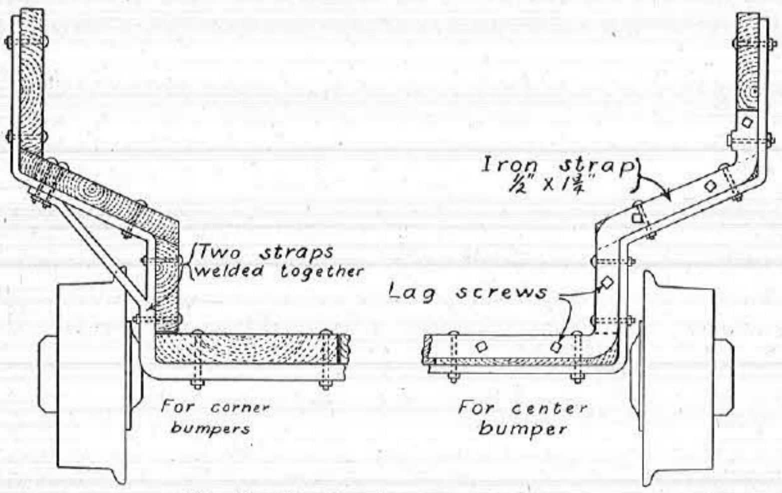


Fig. 84. Bracing for front of pit car.

Where the dip of the track varies as in rooms or entries driven on sights, brakes on the cars are essential for both economy and safety. As the mines get larger, some improvements in the cars will be profitable. These will include roller bearings and revolving axles with one loose wheel and greater capacity.

The most necessary present improvement is better hitchings and stronger center straps to hold the hitchings. At the Fidelity Mine at Greenwood, the very convenient hitchings shown in

Fig. 85 are used. It is reported that these hitchings were designed by W. H. Barrett, the manager. They are very easily connected and will not jar loose. The hitchings and cars are alike at both ends. The net section can be designed to be everywhere of the same cross-section as the center strap of the car.

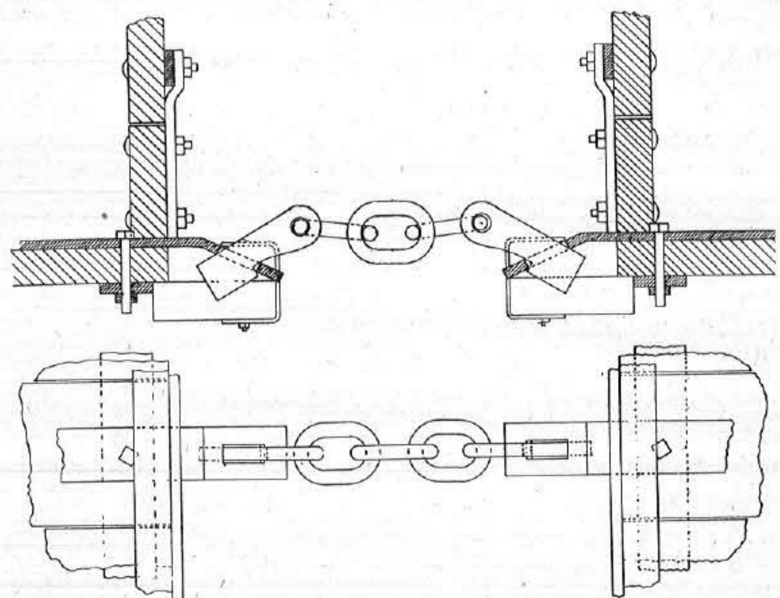


Fig. 85. Improved car hitchings used by the Fidelity Fuel Co., Greenwood.

Larger cars. Large cars are a great advantage in transportation. If the mine has self-dumping cages and a properly graded bottom, the large cars have no disadvantages and the limit is placed by the hight of the seam. With ordinary slope tipples, cars holding over 4,000 pounds of coal are hard to handle and are advisable only in case the mine is equipped for mechanical haulage for some distance.

Ordinarily the size of the car is limited by the necessity of loading it in low rooms and pushing the empty car up steep low rooms. Besides the advantage of hauling coal in larger cars, the high room-road makes it possible to take the cars up the room with a mule and the miners do not object to rooms 250 ft. long. The miner also finds it easier to load the cars. Long rooms obviously reduce yardage costs greatly. The method of estimating the yardage that it is economical to pay for bottom brushing may be illustrated by a couple of examples. If the coal is 3 ft. 6 in. thick and the rooms 150 ft. long, the cost of opening up the rooms is 16.4c. per ton with a 64 per cent recovery.* With a 94 per cent recovery, it will be 14.1c. per ton.† If the rooms are 250 ft. long, the costs will be 10.6c. and 9.7c. per ton respectively.‡ The long rooms require some extra time on the part of the driver but no pushers are needed and 3,000-pound cars can be used instead of 2,000-pound cars. The saving in hauling coal will be at least 25 per cent of the cost with small cars and may be taken as 2c. per ton at least. The gain from long rooms and bottom brushing is then 7.8c. per ton with present wasteful methods, or 6.4c. per ton with greatest possible recovery. If the rooms are 30 ft. wide, 13 tons of 3 ft. 6 in. coal will be produced for each yard of bottom brushing. With the saving of 6.4c. per ton, it is then profitable to pay anything less than 83c. a yard for bottom brushing. With the poorer extraction and saving of 7.8c. a ton, the limit is $1.01 per yard of bottom brushing. If the rooms are only 25 ft. wide, the profitable brushing price is 70c. or 85c. per yard. About 16 in. of brushing will be needed and in order to pay, it will have to be done for from 4.5c. to 7c. per inch per yard, depending upon conditions. Inasmuch as actual yardage costs exceed theoretical costs, the margin for taking up bottom exceeds the amounts given. The advantage greatly increases as the mine becomes larger. The cost of brushing may be reduced by making the gage of the track less.

If the coal is only 2 ft. 10 in. high, the rooms must be brushed anyway or they can not be driven even 150 ft. without extra payment to the miners. It seems fair, therefore, to credit the cost of taking up bottom to the difference in entry costs for 125-foot rooms and 250-foot rooms. The theoretical cost of opening up the coal according to present methods with 125-foot rooms will be 20.4c. per ton, not counting break-throughs or room tracks, which do not change with the length of the room. With 250-foot rooms, the same expenses amount to 14c., a gain or 6.4c. a ton. The saving in hauling caused by 3,000-pound cars instead of 1,200-pound cars will amount to at least 5c. per ton if the mine is large. If the rooms are 27 ft. wide, as assumed, they produce about 9½ tons per yard, and the operator can afford to pay $1.08 per yard for brushing or 4c. per inch per yard. In general, however, the longwall method would be better for such low coal.

*See second foot-note on page 467.
†See foot-notes pages 468 and 469. This includes 1.1c. per ton interest.
‡See pages 463 and 465.

GENERAL DESIGN OF MINE TIPPLES.

A great deal might be written upon the subject of the design of tipples, but the most general criticism seems to be an unnecessary expense and inconvenience. In many tipples, some of the timbers are unnecessarily large and solid. In the same tipple, other timbers may be barely strong enough. In slope tipples, it is customary to make the posts too big and the stringers too small. These wastes can best be eliminated by designing all members just strong enough to hold the load and then making them all ten to fifteen times as large. The braces take but little material and should have ample strength. Since the stresses in them can seldom be computed, it seems safe to make them about half the size of the main members. The high shaft-tipples designed in this way will be subject to considerable vibration from the self-dumping cages. All joints should, therefore, have substantial fish-plates to make them as rigid as possible. With each brace and cross-strut, there should be a strong tension rod with lock nuts easily accessible so that any man can take up all the slack at intervals. At the smaller mines, it seems unnecessary to paint the tipples as protection against the weather. They first rot at the joints or near the ground. If creosoted timber becomes available, it should be used for the lower members. A covering of galvanized iron often holds water next the timber and increases the rot, or it gets knocked off. It seems best, therefore, to replace the lower timbers when necessary. The large timber sometimes used is more apt to be of inferior pine and will rot faster than smaller timbers, and even with big timber, the bracing works loose and the tipple will shake.

If the tipple is to have a long life, it can advantageously be completely covered so as to be always dry, but this covering must be complete and is expensive to maintain. For deep shafts for large areas of coal, steel tipples carefully designed by an engineering firm are far more economical.

At all tipples, the slate pickers, weigh-bosses, and others not actively moving about should be protected from cold weather.

In the winter time, the shed over the scales at least should be comfortably warm. At many tipples, the men improvise stoves out of powder kegs. This wastes coal, causes a great risk of fire, and is very expensive on account of the time the men lose in keeping the fire going. Good stoves are an improvement but the best device is a radiator supplied by exhaust steam, which is usually wasted.

All of the men who work in a single place should be protected from rain to avoid delays as well as discomfort, and all of them should have plenty of room, plenty of light, and secure footing in order to enable them to work efficiently. But all this can be obtained without enclosing the entire tipple.

Many shaft tipples have the dumping platform too low. The extra hight is not very costly and 40 ft. is ample for a Pittsburgh weigh-pan and the fixed screens required by a two-track tipple. Shaking screens require less hight. All tipples with fixed screens should be so planned that shaking screens can be added if the market should make it advisable to supply a grade of coal entirely free from slack. The output of some of the mines working compound seams is cut down by delays in hoisting caused by the necessity of picking out slate. This is best avoided by making a double chute from the screen to the car with a swinging door so that the coal can be sent first to one side and then to the other. Space for this can be provided at all new tipples.

For fire protection the boiler house should be at least a short distance away from the tipple. A few barrels of water can be advantageously set around the tipple, but are useless unless kept full of water at all times.

LABOR SAVING DEVICES.

Dumping arrangements. Many of the safety devices described in Chapter IX are also labor saving, such as rope carriages, the improved trip dog, and better stairways, etc. The amount of money to be spent upon special labor saving devices is largely determined by the output of the mine. If there is a very small power plant, the single fireman can easily wheel all his slack and ashes and would almost as soon be busy at this as to sit around. If there are many boilers, a good track and self-dumping cars are very profitable. Above all, the designers should avoid complicated machinery requiring more time of the attendant than is needed to do the work with primitive arrangements.

At shaft mines, self-dumping cages are nearly universal, but at some of the larger slope-tipples, end dumps are still used. When these limit the output or require extra men cross-over dumps are much more economical. Such dumps have been failures at old tipples for lack of proper grades for the track and because the tipple is so low that the dumping plate and screen can not be given sufficient inclination. The arrangement should rather exactly follow the maker's drawings.

Handling dirt. At all mines, there should be some simple way of dumping dirt necessarily loaded out. At many mines, the hoisting or dumping of coal must be stopped while the top men push a car load of waste over the worst kind of a track. At old tipples, where little dirt is hoisted, it may not be worth while to change the general arrangement, but there is no excuse for some of the poor tracks that are in use. Figure 86 shows an extreme case. At this place, even if the car does not run off the track, a great deal of time is lost in pushing the car up steep hills or preventing runaways down others. A half day's work by a good track-man and helper will generally put the dirt track into such shape that one man can handle the car and two men can do

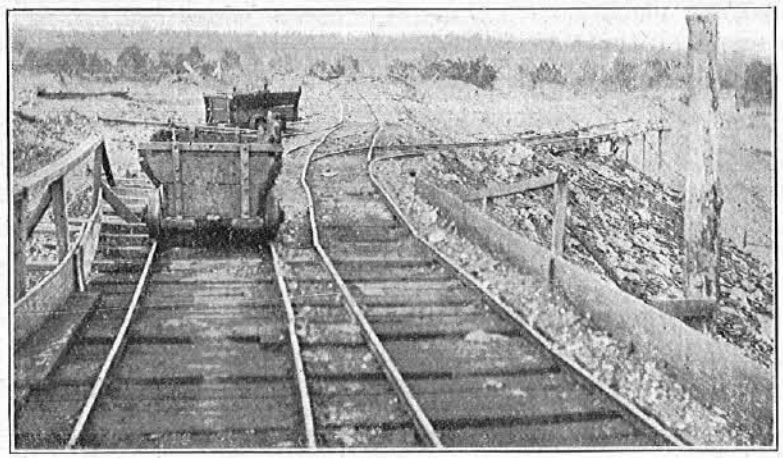


Fig. 86. The kind of waste track to avoid.

it rapidly. If dirt is hoisted in pit cars, it can be dumped by one man if the track ends in a low gooseneck on a trestle and if there is a chain and lever for raising the rear of the car. A steeper gooseneck delays the handling of the empty car and it racks the axles too much. Figure 87 shows a suggested arrangement.

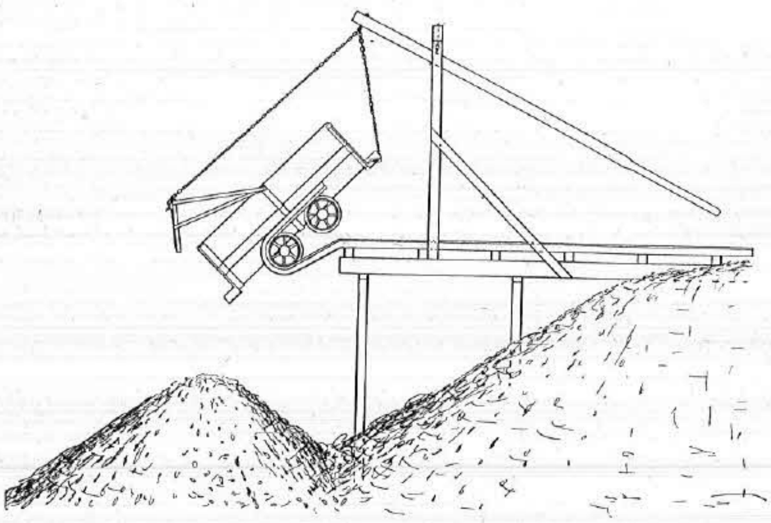


Fig. 87. Arrangement for dumping waste.

If the mine hoists much dirt, it is economical to put in a rock bin just below the dumping sheet above the screen or weigh-pan. By raising the dumping sheet on signal from below, the rock will fall into the bin. Rock can then be hoisted and dumped as rapidly as coal and there is the minimum delay. The bin should be large enough to hold several carloads of rock so that it can be emptied at any convenient time. With a bin, it is convenient to have a special gable-bottom rock-car that will dump on both sides of a short trestle with the least delay. If the dumping place is distant or up a hill, the car can be handled by a light engine and dumped automatically. At any mine, a little work with a watch will show how much such a bin will save. The time of all the top and bottom men and engineers must be counted while they are idle waiting for rock dumping. If the hoist or tipple limits the output of the mine, the effect of a diminished output upon general expenses must be included.

Faster weighing. Wherever the output is large, the weighing is greatly facilitated by spring scales with a large dial. The weigh-boss need not then put down his pencil and will have time to weigh the coal both before and after screening, if this is desired and if the weigh pans are so arranged that he can see both dials from one place. Where the coal is weighed in the cars, either in the mine or on the surface, long scale platforms and spring dials make it possible to weigh the coal without stopping the cars, but the scale must be kept in adjustment and accurately set level. All new tipples should have sufficient head room to make it possible to use double weighing at the least possible expense if this should become profitable under a more reasonable labor contract.

Sump guards. Of the small changes in equipment, one of the most profitable seems to be the installation of guards to keep the cars out of the sumps. When the bottom is level for caging from both sides, these may take the form of a stout timber across the track next the sump and at such a hight above the rails that it will be struck by the bumpers of the car. This can be hung by a chain at each end, passing over grooved wheels to a light timber across the cageway. Then when the cage descends, the guard timber is raised high enough to clear the car. If properly arranged, this can be pulled from in front of a car it has just stopped, without a wreck. The device was seen at the Coronado Mine at Arkcoal, and is so simple that no drawing seems necessary.

If the bottom has a grade so that cars can run down-hill onto the cage from one side and off at the other, the most convenient arrangement is a double stop on each track so interlocked that when the one next the shaft is open, the one a little more than a car length behind is closed and the reverse. In this way, only one car at a time can run down to the shaft. A pair of pivoted arms or wings in front of the wheels like those of a crossover dump is the most effective stop. These should act against springs to reduce the shock upon the car and avoid spilling coal. The near pair of arms can be swung away from in front of the car by the descending cage but it seems better to have this light task done by the bottom man, who is needed to signal the engineer. An equipment of this type is manufactured by the Mining Safety

Device Co., of Bowerston, Ohio, and illustrated descriptions can be obtained from them. For the greatest convenience, the tracks should have a grade of about 1½ per cent and the clamp for holding cars on the cage should have ample strength to stop the cars.

Besides avoiding the expensive delays caused by cars in the sump, these guards save a great deal of time and strength of the bottom men, who can have the car under way at the moment the cage is expected without fear of running it into the sump if the cage does not come. Fewer bottom men will be needed and if the output of the mine is large, the small first cost of such a device is soon repaid.

Sump cleaning. At some mines, a good deal of coal falls down the shaft and fills up the sump. If in addition, the shaft sump can not be drained, there is considerable expense in cleaning it out. Under these conditions, a wooden box with a perforated bottom and weighted to cause it to sink may be placed in each sump. A movable frame of boards must be placed above the edges of the box so that coal will not wedge between the shaft sides and the box. When the box is nearly full of coal, the boards may be removed, and the chains at each corner of the box fastened to the cage. By raising the cage, the box is drawn up sufficiently to be supported on temporary timbers above the sump. The cage will then be loosened and pulled up out of the way while the coal in the box is shoveled into a pit car. The men need not get wet and but little time need be lost.

Load-limit. To reduce the damage to cars, the number of wrecks, and the expense of cleaning up tracks and sumps, all the pit cars should have a conservative load-limit and the miners should be given a sufficient number of cars per day to reduce the temptation to overload the cars. This load-limit should be enforced as outlined on page 443.

BETTER GRADES AND TERMINALS.

Entry grades. At most of the mines of the State, much money is lost by careless management of the hauling. If the coal dips at the usual high angle, very little can be gained by an attempt to drive the entries on sights, and they should be driven strictly at grade except under special conditions. The grade is

best checked by the track layer. For this purpose, he should be provided with a straight-edge, half as long as the ordinary rail and having at each end a forked iron shoe that will hold the straight-edge upright on the rail. One shoe will be thicker than the other by the amount the track should rise in the length of the straight-edge. In using this device, the new pair of rails is spiked to the ties. Then the thick shoe is placed on the end of the previous rail and the new pair swung across the floor until the level shows no inclination on the top of the straight-edge. The center of the rail is secured in position and the straight-edge moved forward to give the level of the other end of the rail. To avoid sharp bends in the track, the floor may be raised or lowered slightly at the rolls. If the track approaches either of the ribs, the entryman can swing his cutting shot accordingly. If he has been so careless that the track at proper grade can not be laid in the entry, he should be required to correct the error by shooting out the near rib. This will rarely be necessary.

The grade of the track should be such that the same effort is required to pull the empty cars in and the loaded cars out. This is most easily determined by trial. The grade increases as the cars get stiffer and becomes less as the weight of the empty cars per ton of coal carried increases. It will not be greatly different from one-half of one per cent, except with small stiff cars. If the straight-edge is 9 ft. long, this requires a shoe 0.54 of an inch (or a little more than half an inch) thicker at one end than at the other. At intervals, the straight-edge should be tested by reversing it and measuring the distance the low shoe must be raised to again bring the top level. This hight should be double the difference in the thickness of the shoes.

With grades adjusted in this way, the mule is always working at full capacity whenever it is hauling a complete trip. The mule can then do much more work in a day without becoming exhausted. In many mines, the loaded trip will just about run out by itself and one mule can haul in three big empty cars. With proper grades, the mule can haul six cars with the same effort required to haul in three cars, but must pull both ways. In case of mules or teams hauling from swing partings, this just halves the cost. With gathering mules, on a short run, the percentage of time spent in switching and hauling single cars is so great that the saving from long trains is less. But good grades will often save the need of a second or third mule in the entry. The saving increases with the length of the haul and it is obviously more important to look after the grade for long entries than for short stub entries. At several mines, the hills are so bad that the mules are quite worn out hauling but one or two cars to the trip. In many cases, the saving may easily be one-half of the present cost of hauling coal or, say, from 2c. to 10c. a ton on the entire output. The direct cost is almost negligible.

If the dip of the coal increases as the entries leave the slope, the entries that are driven exactly at grade will approach each other. The dead-work costs are then increased because the rooms are short until finally it is more economical to stop every second entry and mine the coal beyond by driving long rooms from the other entries and paying a little extra for the coal from the ends of these rooms. The length of the long rooms which are cheaper than driving an intermediate entry and two short rooms can be readily computed. As will be shown later, the rooms except in very high coal are much too short for the greatest economy. As a result, the intermediate entries should be dropped as soon as this will make the long rooms come within the 100 ft. extra length in which the miner will run out the coal for 10c. a ton extra. It costs little more for the driver to pull the empty car into a long room than it does to pull the empty car into a short one. Ten cents per ton on the inner 100 ft. of a 350-foot room raises the price of digging coal only 3c. per ton. This is generally much less than the cost of driving a pair of entries.

If the dip of the coal becomes less as the slope is left, the rooms get longer farther from the slope. After a time, it becomes necessary to turn off an intermediate entry. The dip is then sure to be rather gentle so that this intermediate entry can be started from a room. The hauling will be expensive and this stub entry should lead to a swing parting in the level entry. Because of the extra expense of the haul in the stub entry, the economical length of rooms will slightly exceed those at which it would pay to drop the intermediate entry as the dip increased, but it will not be less than 100 ft. longer than existing rooms.

At very few mines will the dip change enough seriously to affect the length of the rooms. This changing of room length is the only objection to driving entries at grade and is not serious.

Shaft bottoms. At least two men are needed at the shaft bottom. As long as the output of the mine is so small that they can easily cage all the cars, labor saving arrangements are of no commercial value, but the track and switches should be kept in such a condition that there will be the fewest possible derailments. As the mine gets bigger, it becomes very important to give the tracks at the bottom, grades in favor of the loads, so that the attendants need do little hard labor in handling cars. This requires that the empty car be pushed off on one side of the cage and the loaded car be run on from the other. If the empty track be given a sharp grade, the empty can be bumped off by the load, and no attendant will be needed to handle empties except the greaser and coupler, who prepares the empty trips. In all such cases, a sump guard is necessary, and if the cars are heavy and handled rapidly, it will be advisable to arrange a stop for the loaded cars in addition to the device for clamping the car to the cage. This may take the form of a stop against the car bumpers, to be raised into position by the entering loaded car after the empty has left and to be lowered again by the raising of the cage. The apparatus can be readily designed, but is necessary only at very large mines and the spilling of coal must be guarded against.

If the shaft is so well centered that the coal can be supplied equally to the two sides, it is cheaper to have one track for loaded and one for empty cars on each side of the shaft. This causes an awkward bit of grading to give the differences in grade for the two tracks and requires a long run-around to equalize exactly the output from the two sides of the mine. In general, it is the most feasible improvement upon the present plan of double diamond bottom shown on Plate II.

If the mine is large and has a moderate dip, it may be more economical to arrange a bottom with both loaded tracks on the same side as shown on Plate III. This makes a bottom more convenient for the men and avoids confusion of coming and going trips, but an automatic car-haul is a nuisance and should not be installed as long as the cars can be handled by men or mules with about the same crew. At a few shafts in the center of a coal basin, it is possible to so design this type of bottom that the empties can be taken around the shaft by the regular haulage motors. It has an additional advantage of avoiding double tracks for car storage. Many other types of bottom can be designed to suit the capacity and dip of the mine, but the main requirements are ample capacity for storage and grades of 1 per cent to 1½ per cent, down-hill for both loads and empties.

Entry partings for slopes. As now designed, the empty track at the beginning of all entries off of slopes is put on the low side of the parting to make sure that the empty car will pull down the rope so far that it can be readily attached to the loaded trip. This also has the advantage of a steep hill to stop the empty trip in the right place without signaling to the engineer. If the dip is slight or the roof poor, these conditions are intensified by using run-around partings with the empty track below.

Either plan requires that the mule pull the empty trip up a steep hill to the main-entry track. In all cases, this is extra work, and if the track and grade are good everywhere else, it limits the number of cars that can be handled by a single mule. A still greater objection to this kind of parting is the fact that a second empty rope-trip can not be run into the parting until the driver has taken out all the empties, and a loaded mule-trip can not be conveniently left on the other track as long as a rope trip is standing there. As a result, the drivers lose time if anything at all delays the rope, and the hoisting of coal stops if the drivers are delayed even for a short time. These delays are very expensive and also annoying to the men, who wish to make a good showing and do not like to sit around waiting.

All these objections may be overcome by the arrangement shown in Fig. 88. The empty track will be given a sufficient grade to drag in the rope until it can be attached to the other trip. The empty track should then continue down grade for some distance to a short safety hump. This will be only as long as a single car and will not impede the mule seriously, but will serve to stop a slowly moving trip. After taking off some cars, the driver can easily pull the remaining part of the trip down to the hump before he uncouples the mule trip from the inner end and there will nearly always be room for another empty trip if the rope-rider wishes to leave one there. In the same way, the loaded track should have such a steep grade in favor of the loads that the driver can easily push a mule trip down it. If then the

driver finds a loaded rope-trip standing at the outer end of the parting, he can leave his mule-trip behind it and go on about his work. As soon as he finds the rope trip gone, he runs the mule trips ahead into position. If then the number of drivers is adjusted to the capacity of the slope, all trifling delays will equalize each other and the joint output of rope and mules will be much increased.

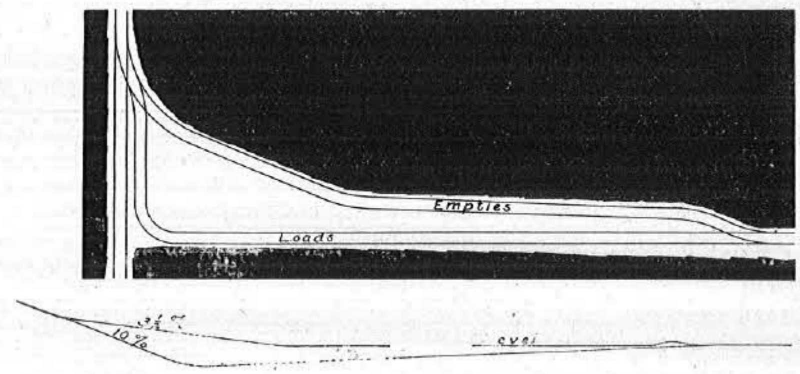


Fig. 88. Suggested plan and profile of an entry parting.

With this arrangement, the engineer must stop his rope at the right place. This requires marks on the rope and a signal by the latch thrower. The giving of signals as to where the trip is to go is now generally done and is good practice. The extra cost of the parting and additional cars is in proportion to the increased length of the parting and is repaid by increased output. The grade can be arranged at all mines so steep that slopes must be used instead of twin haulage entries and motors.

Motor partings. The use of motors for mine haulage is so new that the necessity for adequate terminals is not always appreciated. The combined capacity of the partings at which the trips are made up should exceed the number of cars in the trip. When possible, each parting should hold an entire trip. Where the grade of the main haulage-way allows it and where the mule haulage-roads necessarily have hills as in most motor mines, the cheapest arrangement requires only two tracks both with considerable down grade. The motor pulling in the empties can with proper grades make a slow flying-switch, and the empties will run on into the parting until spragged by the brakeman. The motor can then be coupled onto the loads.

If two partings are served by the same motor trip, one parting will be in a branch entry and the empties for the second parting are uncoupled before the first flying-switch is made. They are then taken into the second parting, and the loads from the second parting back into the loaded track of the first parting to be coupled onto the trip standing there. This two-parting arrangement is often very convenient for the mule haulage and it is important to have the grades and length of parting such that there is always a supply of cars for the drivers as outlined for entry partings. Besides the expense of arranging suitable grades, the flying-switch parting requires that the mules pull either the empties or the loads up a considerable hill. It also requires the motor to pull the loads up the slight grade which is necessary to keep the empties going after the motor is cut off. Without this grade, the flying-switch must be made at a dangerous speed. This little grade may limit the capacity of the motor, but in most cases the motors will have ample capacity to handle the full output in short trips.

Where grades can not be arranged, three-track partings are good. The motor then pulls the empties onto the side track and returns on the idle track to the head of the loaded track and pulls out the loads. It is often possible to put one of the tracks in the air-course and to use the idle track for a motor road to another parting as shown in the Main East Entry of Plate IV. Instead of using a three-track parting, the empties may be left on one parting and the loads taken from another just beyond, as in the First East Cutoff of Plate IV.

The handling of the motor is still simpler if the trip is pushed ahead of the motor one way. This requires very good cars and track and if the speed is at all high, it is decidedly dangerous, and is not recommended.

BETTER TRACKS.

Fish-plates. Many wrecks are caused by the poor track even when there are no bad grades. Wrecks are expensive and should be prevented. At very few mines are fish-plates used in the entries. As a result, the ends of the rails slip apart as soon

as the tie to which they are fastened becomes old or is kicked out of place. The cost of fish-plates is very little and it costs less to put them in than it does to spike the ends of two rails to the same tie. To take up the track, it is best to knock the nuts off two of the bolts with a sledge and leave a pair of fish-plates fastened to one end of each rail. The gain from fish-plates can only be determined by trial, by comparing the number of wrecks in entries with fish-plates and the number in the other entries. The importance of fish-plates increases with the size of the cars, the number of cars in a trip, and the length of the entry.

Leveling track. If the entries have a hard inclined floor, much of the trackman's time will be saved by providing him with oak wedges of the thickness needed to raise the lower end of the tie to the level of the other end. After these wedges are adjusted lengthwise under the tie, they should be nailed in position and the track will be permanently level.

Switches. For the sake of saving the track-man's expensive time and to insure good switches, it is economical to buy complete ready-made switches with light riveted steel ties from some of the dealers. If the mine blacksmith and trackman are both unusually expert and have plenty of time, as at a small mine, it will be cheaper to make the switches at the mine. Otherwise buy them.

Good switches are especially necessary where the dip is steep or variable. Under these conditions, the miners can hardly help letting the loaded cars down from the rooms so rapidly that they frequently jump the track at the switch. If the dip is so great that wooden sand-rails and four sprags do not check the car, a change in the layout of the mine is required for good results. At less dip, brakes on the cars can control their speed. Where there is sufficient head room, the entry track should be so raised that the inner rail of the switch can be depressed and in many cases it will be an advantage to depress the rail on the high side of the entry near the switch points.

At a few small mines, wooden turn-tables are used in place of switches. If both the miner and driver are expert, the loaded car can be swung rapidly over these, but the cars are always severely racked by the process and about half the time the driver is delayed picking up the coal knocked off. In many cases, the men have to lift the car around by main strength. Besides taking time, this work is so laborious that it is certain to reduce the efficiency of the men. In one mine, the time lost in handling ten cars was noted. The results showed that for very low coal and 150-foot rooms, the pay for the lost time of the driver would amount to a little more than $5.00 at each turn-table. This would pay for putting in the best kind of switch.

Track ballast. If the coal is high or the entry long, the ties should be well covered with the best material available in order to preserve the condition of the track and give the mule a good path. If the entry is used as a main haulage road, it will generally pay to bring in cinders or rock from the surface unless the mine waste is unusually good. Where the coal is low, the rooms short, the brushing rate high, and the entry unimportant, the present practice of making the mule walk between the ties in a low entry is the most economical. Except under these conditions, the gain in brushing the entries high enough for the mule to walk on the ties is important. For illustration, we may assume coal 3 ft. 6 in. high with rooms to the rise 250 ft. long and a recovery of 95 per cent. If the brushing costs 7c. per inch per yard and the haulage costs about 10c. per ton, it will pay to brush the outer half of the entry if the efficiency of the mule is increased by only a trifle more than half of one per cent.

BETTER SYSTEM OF HANDLING CARS.

The output of the drivers can often be increased by more perfectly systematizing their work. An attempt to secure data as to the delays in switching, making up mule trips, etc., soon made it apparent that the various drivers had very different methods of handling the cars in making up trains. The variation is too great to be explained by the difference in equipment and it is suggested that the boss drivers time all the different operations, note where the greatest delays occur, and change the system accordingly. In general, it is better to have the mule do a little extra shifting of cars, if this saves time which would otherwise be lost in waiting for the miners to run out their cars. The boss driver can easily compare the delays by counting slowly to himself instead of looking at a watch. This is one of the principles of "scientific management."

At most of the mines having long entries, it is customary to use two gathering mules following each other to the entry parting, as long as they can keep up with the turn. An inner or swing parting is then put in and a spike team used to pull the cars out. Ordinarily it will be more economical to put the inner parting in sooner and to use at first but one spike team for two opposite entries. This is especially economical when the grades are so laid out that the spike team can handle long trips. The saving caused by using four mules and three drivers amounts to $2.46 a day. This will pay for the two inner partings in a very short time. It is of course safer for the men than having two gathering mules following each other. Before the swing parting is put in, there should be enough extra rooms developed and ready to start, so that the spike team will be busy immediately. As the output of the gathering mules decreases, the team driver can assist the gathering drivers until enough more rooms are developed and ready to work to occupy the time of a spike team in each entry hauling from a parting farther in.

GATHERING LOCOMOTIVES.

The long rooms, which will be shown to be economical, so increase the output of each entry that it is possible to employ a gathering locomotive in each pair of entries. This entails no great additional expense at those mines having an electric plant for other purposes and, therefore, requiring the services of an electrician. The gathering locomotive is especially profitable in those mines where the coal is so low that mules can not enter the unbrushed rooms, and in those mines where the entries are long. The crew of the gathering locomotive receives but little more wages than the pair of pushers needed for the long rooms. The fact that the motor can push the cars as well as pull them reduces the time lost in making up trains. The brakes on the motor obviate the necessity of spragging cars, save wear on the cars, and reduce the delays by wrecks and the danger attending the running of loaded cars out of steep rooms. The great saving arises from the greater speed of travel, and the longer trips hauled. The motor can safely run 600 ft. to 800 ft. per minute as against 250 ft. for a mule and can handle in a single trip cars enough for every place in the entry. In high coal, there is an additional saving in the possibility of using larger cars. Properly designed motors can be used in entries too low for mule haulage and they save some brushing expense. This will be important in the Prairie View field of low, valuable coal. On the other hand, the gathering motor requires more expensive switches and better room tracks.

To illustrate the convenience of a gathering locomotive, we may assume that the entry parting is graded as recommended for mule haulage. The motor coming out with a loaded trip can make a slow flying-switch and go in with enough empties to supply all the places. Half of these will be left in the entry just outside of the first room being mined. The others will be dropped outside the middle room, which we will call No. 10. The motor then runs up into room 10 and the miner releases his loaded car, which follows the motor down to the entry. The brakeman throws the switch and the motor pushes load 10 past room 11 and gets load 11, which stops on the entry. While the motor is in room 11, the brakeman pushes an empty past the switch into room 10 and the motor pushes this empty up to the face of room 10 after it returns from room 11. Loads 10 and 11 are then pushed past room 12 and left. While the motor gets load 12, the brakeman puts an empty beyond the switch into room 11. This is continued until the load in the main entry is picked up by pushing in half the loaded trip. The empty for the entry must be pushed in by the entry man from the last dip switch. After half the trip is collected this way, it is left inside room 10 while the motor returns to room 1 and gathers the cars from 1 to 10. The two sections of trip are then coupled together and run out. If the motor can push the entire loaded trip up the entry grade, load 1 can be collected first, but this offers little advantage and there must be a greater length between the face of the entry and the last room in order to hold the entire trip. If desired, one-third the trip can be collected at a time. By the plan outlined, the brakeman is always at hand to throw switches and has plenty of time to couple up the cars. The motor need wait for a coupling to be made only while pulling up the empty trip and hitching onto the full loaded trip. The stopping, starting, and backing is so much quicker with a motor than with a mule that no argument is needed to prove the saving of time.

The motor need work on two sides of a slope only while the entries are short and near the bottom of the slope where there is no confusion in crossing the rope. In this case, no flying-switch is made but the motor merely drops the loaded trip at the slope, runs on over the vacant track of the opposite parting, and pulls in the empty trip standing there. Before the motor returns, the rope will take away the loads left in the first entry so the motor can get back. If desired, one motor can work in entries at different levels by laying a track between them in the slope air-course, but in general, it will be cheaper to increase the output of a single entry by lengthening the rooms.

No figures need be given to prove the great labor economy of a gathering locomotive and they should be used as soon as four mules or pushers can be displaced by one motor, provided that an electric plant is already at hand. This can be done when there are only two men in each of two entries. This condition is soon reached if the rooms are driven to a proper length. In mines with twin haulage entries the motors have so much more capacity than mules and can so easily go from entry to entry that their use is economical almost immediately if the mine has much capacity.

CRAB LOCOMOTIVES FOR DIP ROOMS.

The development of the combined crab locomotive and gathering locomotive makes it possible to drive dip rooms at a profit in the steep dipping coal. This just divides the entry cost unless brushing is required. With rooms not exceeding 250 ft. in length, the miner then runs in his empty car and the brakeman pulls down the hoisting rope of the motor, and the labor expense is no greater than that of handling cars in rooms to the rise with a driver or a pusher. The plan is feasible only in dry mines, and has but little advantage over long rooms.

GASOLINE LOCOMOTIVES.

Recently locomotives with gasoline engines of the automobile type have been introduced into coal mines. It is well known that most of the smoke and smell of an automobile is caused by improper cylinder lubrication and this can be avoided. The main part of the exhaust gas will then consist of harmless nitrogen from the air and the nearly harmless carbon dioxide. The carbon dioxide can be completely absorbed by passing it over slacked lime which is cheap. There still exists the possibility of deadly carbon monoxide. Much search in the literature and considerable correspondence failed to secure the report of a single careful analysis of the exhaust gas of an automobile, but the combustion in the cylinder is such that there is little danger of producing carbon monoxide and no injurious results have as yet been experienced. The gasoline tanks are so arranged that they can be filled only outside the mine, and there is no danger of shocks from a trolley wire and no expense in the maintenance of an electric system. The speed is also more economically controlled. Gasoline locomotives would be especially desirable for gathering work because they avoid the delays and heavy maintenance charge attending the use of the portable cable needed when using an electric motor beyond the trolley. The very slight odor can be quickly removed by adequate ventilation. In fact, the gasoline haulage locomotives would go far toward requiring good ventilation at all times. Those companies which have used these motors all report the greatest satisfaction and they are certainly worthy of trial. As yet, none are advertised for use in low coal.

ELECTRIC PUMPS AND FANS.

In Chapter IX, we have shown that besides producing better coal, mining machines will be profitable and, therefore, offer a means of saving expense. Either these or electric locomotives require an efficient electric power-plant. All distant machinery should then be driven by motors because of the cheap and efficient electric distribution. With a power plant, all pumps should be driven by motors. They are especially useful for draining the little sags in mines in the basins of the coal seam. The mines are frequently connected with other mines or have special shafts. It is then economical to put in ventilating fans at a distance from the boiler plant and motors should be used to drive them. In the deep mines opened up in panels, much air leakage can be avoided by putting boosting fans underground, and so reducing the pressure across the stoppings. All of these distant motors without exception, but especially the fan motors, should be

equipped with automatic starting boxes. If then the main current is cut off for a minute, the distant fans and pumps can be immediately started as before from the power house without the delay and cost of a long trip to each motor. Self-oiling bearings are already in general use. Electric lights with storage batteries should be attached to all mules if the mine has an electric plant.

SPECIAL ELECTRIC PLANT.

Inside slopes and engine planes will also be operated by electricity if the power is available but they do not need automatic starting boxes. At the very large mines of Germany and where central power plants are available in this country, electricity is used for all power purposes. To equalize the load, special complex plants are used.* Under Arkansas conditions, they seem unnecessary and the ordinary high-grade steam plant takes care of the violent fluctuations caused by motor haulage and a number of electric slope hoists underground.

Where condensing water is available in large quantity, it is very economical to put in steam turbines generating electric power from the exhaust of steam hoists and haulage engines. As long as the production of slack exceeds the market demand, the modern gas-producer power-plants are not advantageous.

LOADING MACHINES.

Recently machinery has been used for loading coal, but all the types as yet in use, except conveyors for longwall mines, require that the coal occur in a single rather high bench with no dirt partings.†

It is also necessary for the coal to be of such a nature that it can be shot down into rather small lumps without excessive production of slack. Either of these reasons will prevent the use in the Arkansas coal mines of the present types of loading machines and no further discussion is necessary.

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*Rushmore and Pauly, Large Electric Hoisting Plants. *Transactions, American Institute of Electrical Engineers,* Vol. 29, pt. I, p. 291.

Sykes, Wilfred, Electric Mine Hoists. *Transactions, American Institute of Electrical Engineers,* Vol. 29, pt. I, p. 249.

†Whaley, Wm. *Mines and Minerals,* Nov., 1910, Vol. 21, p. 206.
Hamilton, Wm. E. *Mines and Minerals,* Dec., 1905, Vol. 26, p. 197.

LARGE CAPACITY.

Capacity desired. Up to a certain point, the cost of coal is greatly lessened as the capacity increases, but large capacity means a larger investment and either a short life for the mine or the mining of a large area of coal through a single opening. If the coal is near the surface and cheaply opened, the size of the area is best kept small to reduce the cost of underground haulage, and it is best to plan for a life of only about ten years, and to develop the mine accordingly. During this time, the common wooden construction will not require extensive replacement.

If the mine is deep, the sinking and equipping of the shaft for a sufficient capacity is expensive and a longer life should be insured by the purchase of sufficient coal land. In this case, the high cost of timber makes it cheaper to build steel tipples rather than to renew the wooden ones. Then to reduce the interest charge a still larger capacity is necessary.

A careful study of these factors should determine the most desirable capacity for the mine, and new mines should be opened only when there is good reason to think that the demand for that particular kind of coal will insure fairly steady operation. A capacity of less than 500 tons per day is rarely advisable except at very small mines and a capacity of more than 1,500 tons in 8 hours requires special arrangements for loading into railroad cars and shifting the cars. These are the limits for ordinary mines.

Development of large capacity. After the desired capacity has been determined, every factor should be adjusted accordingly. Where the hauling is done entirely by mules, the pit cars rarely hold more than two tons of coal. If the coal is low, this load is reduced, but if a large capcity from low coal is essential, the length and width of the cars and the size of the shaft may be increased, or the rooms may be brushed to admit higher cars. The size of the car, the number of cars to be hoisted per minute, and the depth of shaft determine the size of the hoist, which should be ample. A small second-hand hoist is advantageous for the early development. The hight and hardness of the coal determine the size of the mining-machine plant required for the given capacity. The proposed area and plan of the mine fix the size of fan needed, but in many cases, a smaller fan may be used at

first. These initial power requirements, with a small allowance for pumping, determine the number of boilers required, but the boiler house should be arranged for the easy addition of more boilers as the steam requirements for pumping, haulage, and ventilation increase. A pre-arranged plant is much more economical than the replacement of one piece of equipment after another as fast as it is desired to increase the capacity.

After the plant is in place, it is advisable to open up a sufficient number of working places in the shortest possible time. At first, two shifts should be employed in all entries. As soon as the first room of any entry reaches its full length, that entry may be continued single-shift until finally double-shift is used only in the main entries, slopes, or engine-planes from which entries are to be turned. During development, there is additional profit from the safer narrow entries, because they go faster. When full output is reached, the main slope or plane should be continued until at least one pair of cross-entries has been turned after all the other entries have been running for some time on single shift. Otherwise, the output of the mine will decrease as the output of each entry becomes less, after the rate of driving the entry is decreased by dropping the second shift. After the normal production is reached, the main slope need be pushed only as fast as needed to maintain the output by opening new entries as required.

While the required number of places is being opened, enough cars and drivers should be provided to always keep the coal away from the miners. The size of partings and the capacity of the main haulage must in the same way be kept up so that the mules are busy. After sufficient capacity is reached, more rooms should be opened until the turn is low enough to insure fairly clean coal and steady work for the drivers. Care must be taken not to overdo this, especially in machine mines, or there will be loss of money in maintenances of entries, unnecessary scattering of the day men, and additional pay for deadwork demanded by the miners in the effort to earn good pay each day.

At a great many of the mines of the State, the capacity is needlessly low because of failure to remedy the condition which keeps it down. Cars and other equipment can either be sold, or used in a new mine, and the only expense of an abundance of cars is the interest upon the investment. The maintenance charge is reduced by the possibility of sending a car to the repair shop before it is completely disabled. It is remarkable what a great number of factors are allowed needlessly to reduce the output of the mines. The most common condition is complaint of lack of places for the men, while the main slope or engine-plane is idle and no effort is being made to open new entries. This is especially wasteful in case the same company has several mines in the same camp. It is then far better to shut down some of the mines and increase the capacity of others, if the full production of all the mines can not be sold.

Maintaining full capacity to the end. As the main slopes approach the boundary line, provision must be made for opening up another main entry to take its place. These main entries should be so laid out and so pushed that the full production of the mine can be maintained almost to the time of complete exhaustion. Unless care is taken, it frequently happens that coal is left in such positions far from a shaft that it can be mined out only slowly, or is left in the ground when the mine is abandoned. No general rule can be given for avoiding this except that after the full production is reached, no main entry should be driven unless the one that is to be ultimately the longest is driven at the same time.

In each main entry, care must be taken to maintain a big output to the end. If the cross-entries are long and the main entry is regularly driven only at intervals, it is possible to push the main entry to its limit and then start several cross-entries at once. A corresponding number of more advanced entries will then be stopped in succession until the lengths of the cross-entries are so adjusted that the last group of entries in sufficient number to supply the full output of the main entry will be finished at the same time. If the main entry is steadily advanced in normal work, it should be pushed by double shift to reduce the time interval between the starting of the cross-entries. Then the cross-entries near the end can be driven by double shift until the output is so increased that some of the more advanced entries can be stopped until the last group is adjusted to reach the limit at the same time. This adjustment of the entries is less important where they are served by a motor that can be used on another

run. If the dip of the coal is not too great, the direction of the twin haulage entries can be adjusted to make it possible for several to reach the boundary at once without change in the method of working.

To save the expense of hauling coal in a cross-entry with but little output, it is essential that several rooms at the end of the entry be finished at the same time. This can be easily accomplished by continuing to drive the entry without increasing the force of drivers until several rooms are developed at the end and can be started together. There should be enough of these rooms to keep at least one driver busy, or a driver and pusher if the rooms are long. In case of the last group of entries off a single main entry, the total output is maintained because the more rapid development recommended will increase the number of entries available.

CHANGES IN THE MINE WORKINGS.

In Chapter X, we have described many changes that will enable the operators to produce more coal at less cost than is possible by present methods. To the extent that they reduce cost, they conserve the expense. In discussing other changes, it will be necessary, to a certain extent, to consider but one change at a time, and we will assume that gathering motors, and other improvements are not yet introduced. In considering the opening of any new mines, all of these improvements should be studied together and the mine workings arranged from the beginning for their use.

LONGER ROOMS.

One of the most common of the unnecessary expenses is caused by the short rooms. The miners very properly object to running their cars out of rooms exceeding a certain length. As a result, the rooms are not driven longer than this. The distance was originally determined in pick mines where the yardage rate for entries was relatively low, and in flat high coal where twin haulage entries could be used. Owing to the high scale of payment, the frequent crosscuts, and especially the dip of the coal permitting rooms on only one side of the entry, the yardage expense in the Arkansas mines is unusually high, so that the old adjustment of room length is not the best.

The saving from the longer rooms follows from the fact that more coal can be obtained from the rooms without any additional cost for opening them up. This additional coal causes an increased cost for handling the cars in the long rooms and long rooms have some other disadvantages. The most economical length of rooms can be determined by calculating the different costs for rooms of different lengths and noting the length of room for which the total is the least. Conditions vary greatly, and all that can be done is to indicate the general result by a few illustrations. In calculating yardage, the most general scale will be used and no allowance made for the extra yardage caused by faulty coal, etc.

It is ordinarily customary in the dipping coal for the miners to run out the cars a certain distance at the regular mining rate. They will generally run the coal out an additional 100 ft. for 10c. a ton extra. If the rooms are brushed or naturally high enough for a mule to bring in the empty car, the limiting distance is commonly 250 ft. If the coal is less than this, the miner usually helps the driver or a special pusher to run in the empty car and the limiting distance is 150 ft. Ordinarily, the expense of the longer rooms is then due to the extra time it takes the pusher and the extra payment to the miner.

The amount of the first expense per ton of coal produced from the entire room is readily computed by dividing the extra payment by the total output of the room. As an alternative, it is often cheaper to handle the coal by company labor. It is obvious that it will not be profitable to pay 10c. a ton extra for mining coal in the face of the room wherever the total entry costs are less than 10c. a ton.

To compute the cost of pushing the empties, we may consider that the pusher goes only 200 ft. per minute or about 2¼ miles per hour. If done by the driver, the mule stands idle and the cost of the mule must be included. Under the old scale, a special pusher at $2.56 a day costs .533c. per minute. In a minute, he can push a car 100 ft. and return so the cost of pushing cars will be .533c. per 100 ft. The cost, the depreciation, care and feed of the mule, allowing for idle days, amount to a little

more than 50c. a day and the time of the driver and mule costs .646c. for each 100 ft. of round trip pushed. It should be noted that the delays in switching cars, making up trips, and hitching the mule are constant regardless of the length of the room. Only the time of pushing up the empty car and walking out depends upon the length of the room. The delay in waiting for the miner to run out his car can be avoided by properly arranging the work. The total variable cost of pushing the cars into the rooms for rooms of different lengths may be figured for the average distance from the entry to the face for each length of room.

Cost of long rooms in coal 2 ft. 10 in. high. If the coal is only 2 ft. 10 in. high, the cars will hold only about 1,200 pounds and the cost of pushing them 100 ft. and returning will amount to 1.777c. for each ton of coal produced. If the workings are laid out as outlined on page 455 for the greatest possible recovery of coal, 75 tons of coal will be obtained from the 36 ft. of entries past a single room, 160 tons from the mining of the entry pillars, and 515 tons from the room 150 ft. long. Each additional 25 ft. of room will yield 91½ tons of coal. The cost of deadwork may be taken as $139.10 for a room 150 ft. long and about $1.25 for ties and temporary stoppings for each additional 25 ft. The various costs are then as given in the table below, assuming that the driver helps the miner. If a special pusher is needed, the cost of the extra length of room is a trifle less.

Partial costs in coal 2 ft. 10 in. high.

Length of room	Total coal produced	Pushing empties	Mining extra coal	Yardage	Sum of these per ton	Difference per ton
150	750	$ 6.87		$139.10	19.46c.	
175	841	9.40	$ 9.15	140.35	18.89	.57c.
200	933	12.34	18.30	141.60	18.46	.43
225	1,024	15.69	27.45	142.85	18.16	.30
250	1,116	19.46	36.60	144.10	17.93	.23

From this table, it will be seen that the increase in room length from 150 ft. to 175 ft. shows a profit of more than half a cent a ton on the entire output of the mine. This may be more forcibly expressed by saying that the additional 91 tons of coal are obtained at an additional cost of only $12.93 or 14.3c. per ton as against the 19.4c. per ton paid for all the coal from the shorter rooms. This means that the first 91 tons of extra coal costs 5c. per ton less than the coal produced by the former method. It is profitable to drive the rooms in low coal as far as the miners will consent to work at 10c. per ton extra.

Cost of long rooms in coal 3 ft. 6 in. high with gob entries. Unless the conditions are very favorable, rooms will be driven only 150 ft. long in coal 3 ft. 6 in. high. Under the present system of minimum width of pillars and no mining of the pillars, we have figured on page 467 that from a pair of rooms 150 ft. long and the entries past them, there will be obtained 318 tons of entry coal and 1,159 tons of room coal. Each additional 25 ft. of the two rooms will yield 220 tons of coal. The cost of ties and stoppings and the entry cost for the pair of rooms will be $241.90. Each additional 25 ft. will cost about $1.50 for ties and stoppings.

The cars will hold about 2,000 pounds of coal and the cost of pushing in the empties by the driver will be 0.646 per 100 ft. round trip for each ton of coal. Allowing the miner 10c. per ton of coal for helping push the cars more than 150 ft., the cost for different lengths of rooms are as given below.

Partial cost in coal 3 ft. 6 in. high with gob entries.

Length of room	Coal produced	Pushing empties	Mining extra coal	Yardage	Sum of these per ton	Difference per ton
150	1,475	$ 5.61		$241.90	16.77c.	
175	1,695	7.92	$22.00	243.40	16.12	.65c.
200	1,915	10.58	44.00	244.90	15.64	.48
225	2,135	13.60	66.00	246.40	15.26	.37
250	2,355	16.97	88.00	247.90	14.98	.28

This shows a decided gain in driving the rooms as far as the miner will do it for 10c. a ton extra.

Cost of long rooms in coal 3 ft. 6 in. high with wide pillars. If the mine is laid out for the mining of pillars, the yardage costs are less and the saving is not so great. The exact theoretical calculation is complicated by the interest charge against the coal first mined. This lessens with increased length of room and may be roughly taken to offset the cost of ties and stoppings for the extra coal. On that basis, the costs are as given in the table below.

*Partial cost of long rooms in coal 3 ft. 6 in. high with pillar mining.**

Length of rooms	Coal produced	Pushing empties	Mining extra coal	Yardage	Sum of these per ton	Difference per ton
150	2,905	$ 8.90		$375.56	13.23c.	
175	3,262	12.40	$ 35.70	375.56	12.99	.24c.
200	3,619	16.50	71.40	375.56	12.81	.18
225	3,976	21.15	107.10	375.56	12.67	.14
250	4,333	26.40	142.80	375.56	12.57	.10

This table shows that even with pillar mining, it is profitable to increase the length of the rooms.

Handling loaded cars by the company in high coal. Entry costs in high coal with rooms already 250 ft. long will be so low that it will not pay to give the miners 10c. a ton to make the rooms longer. It will, therefore, be necessary for the company to get the loaded cars from the faces of rooms more than 250 ft. long. In most of the mines with high coal, the rooms have but one track, and the miner expects to receive an empty car very soon after he has run out the loaded car. Under these conditions, the pusher will have to walk up into each of the long rooms to get the car, and there will be a delay of a half a minute to a minute in starting each car out and going from room to room. This delay will cost from .26c. to .53c. per car and may be taken as .42c. as an average. Both the mule and the pusher will, however, go at least 250 ft. per minute while going, and the cars will hold an average of 3,500 pounds of coal. The extra cost of handling cars per ton of coal will then amount to .24c. for the delay and .49c. for each 100 ft. round trip the two cars are pushed. To calculate yardage costs, we may assume a final recovery of the coal equal to 94 per cent and may omit all room expenses except

*The workings for a pair of rooms 150 ft. long will yield 264 tons of entry coal, 1,261 tons of room coal, 802 tons of coal from entry pillars and 578 tons of coal from the room pillars. Each additional 25 ft. of the pair of rooms will yield 357 tons of coal from the rooms and the pillars between them. The cost of opening the rooms and pillars is $375.56 as already figured.

*Partial costs of long rooms in 5-foot coal.**

Length of rooms	Coal produced	Cost of handling cars	Cost of opening	Sum of these per ton	Difference per ton
250	6,143	$18.40	$255.00	4.45c.	
275	6,643	26.00	255.00	4.33	.22c.
300	7,143	34.24	255.00	4.04	.19
325	7,643	43.09	255.00	3.90	.15
350	8,143	52.55	255.00	3.78	.12
375	8,643	62.63	255.00	3.68	.10
400	9,143	73.62	255.00	3.59	.09
425	9,643	85.51	255.00	3.53	.06

the room-necks and first long break-throughs. The cost of different length of rooms are then as figured in the table below.

From this table, it appears that the most economical length of room exceeds 425 ft., but that above 375 ft., the advantage is small.

In still higher coal, the dead-work costs are less and the advantage of long rooms diminishes. As a general rule, the extra cost of handling coal in rooms 25 or 50 ft. longer than now in use may be taken as about one-fourth to one-half the entire cost of hauling coal. If this sum is less than the cost of entry yardage, room-necks, and other development expenses, it will pay to lengthen the rooms.

*The block of two rooms and pillars will be 308 ft. across the entries and 102 ft. along them. Ninety-four per cent of this will yield 6,143 tons of coal. The two rooms and 95 per cent of the 38-foot room pillar will yield 500 tons of additional coal for each 25 ft. of additional length of room. The rooms will produce 5,000 tons of coal from 250 ft. and the hauling of the empties for this an average distance of 125 ft. will cost .368c a ton or $18.40. The additional room coal requires the hauling of cars both ways. The cost is figured for the average haul of the extra coal.

The cost of opening up the two rooms is as given below:

68 yd. of entry, at $2.25 per yd.	$153.00
3 crosscuts, each 4 yd., at $2.25 per yd.	27.00
2 room-necks at $3.37	6.74
2 long break-throughs, 12⅔ yd. each, at $1.68 per yd.	42.56
Laying track in main entry	6.00
Room switches, dip switches, etc.	8.75
Ties for entry	2.04
3 stoppings	9.00
Total	$255.09

Cost of handling cars in long rooms in low coal. If the coal is so low that the empties must be pushed into the rooms, the miner must handle the cars at least one way unless a special helper is hired to assist the driver. In this case, the running out of the coal entails no great loss of time because the two men can bring an empty into one long room and step through the break-through into the next room and run out the loaded car in it. With the present requirement of equal turn for all miners, this can always be done except when some of the miners are laying off. Ordinarily, about one-sixth of the miners may be out and one-sixth of the time the pushers must go through an intervening room. Going through the rooms saves the delay of going from room-neck to room-neck along the entries.

If the mines are laid out as recommended with the pillars alternately wide and narrow with no intermediate break-throughs in the wide pillars, it will be necessary for the pushers to return to the entry for each second room, but even then it will be much cheaper to handle the cars by company men than to pay the miner 10c. a ton extra for handling them in long rooms. If profitable, the rooms can be made more than 100 ft. longer than the present practice requires.

To illustrate the gain from the long rooms and the employment of a special pusher, we may take the case of coal 3 ft. 6 in. high, pillars alternately wide and narrow laid out for pillar mining. In this case, the pushers will have to make six trips the length of the room and go through one break-through for each two car loads of coal. The delay of going from room to room and starting out the cars may be taken to average a minute per car more than the delay of taking cars only one way. This allows for the few vacant places. The cars will hold a ton of coal and the men will go 200 ft. per minute while pushing the car. The coal and yardage cost will be as before and the costs are shown in the table below.

Partial costs of handling cars by company in long rooms in 3 ft. 6 in. coal.

Length of rooms	Tons of coal	Handling cars*	Yardage costs	Sum of these per ton	Difference per ton
150	2,905	$ 8.90	$375.56	13.23c.	
175	3,262	21.75	375.56	12.18	1.05c.
200	3,619	36.03	375.56	11.37	.81
225	3,976	51.74	375.56	10.75	.62
250	4,333	68.88	375.56	10.25	.50
275	4,690	87.45	375.56	9.87	.38
300	5,047	107.45	375.56	9.56	.31
325	5,404	128.88	375.56	9.32	.24
350	5,761	151.74	375.56	9.14	.18
375	6,118	175.03	375.56	9.00	.14
400	6,475	200.78	375.56	8.90	.10

These show that the costs continue to decrease until the rooms are more than 400 ft. long, and that the gain is important until the rooms get 300 ft. long. By making the rooms 300 ft. long instead of only 150 ft., about 3.7c. per ton can be saved on the entire output of coal. This saving will be greater if the pillars are not robbed, or if the coal is lower than 3 ft. 10 in., because the yardage cost per ton is then so much greater. This also shows how very much better it is to handle the cars for the miners than to pay them 10c. a ton for doing it themselves. In one case, the gain from making the rooms 250 ft. long instead of 150 ft. is nearly 3c. a ton. In the other, it is only .66c., where all other conditions are the same.

Long double rooms. If the cars are handled both ways by the miners, they can not object to working in pairs in double rooms with only one car in the room at a time, especially where the coal is cut by machines. In this case, the pushers or drivers can always bring in the empty car, cross over at the room face, and run the loaded car out on the other track. In high coal, this will take but little more time than it takes the driver to walk out without a car and less than it takes for the driver to wait for the miner to run out the coal. In low coal, a second pusher must be hired, but he can do much more work in double-track rooms than

*The cost for 150 ft. is as before. Each additional 25 ft. yields 357 tons of coal. The driver and pusher together cost 1.066c per minute and the cost of pushing per ton is then 1.599c. or 1.6c per 100 ft. from the entry, plus 1.0c constant delay. The first 357 tons of coal is pushed 162 ft. 6 in. on an average, and each succeeding lot is pushed 25 ft. further at an increase in cost of 0.4c per ton.

in single-track rooms, and the expense of handling cars will be less than we have just figured. It is obvious that if the rooms can be made double, they should be lengthened under nearly all conditions. The only exception is the case of coal so flat that twin haulage entries can be used, and so high that the miners will push the cars one way 250 ft. and the expense of opening the entries per ton of coal is very low. These are the conditions under which the standard length of 250 ft. for rooms was established, and they are unfortunately rarely found in Arkansas.

If the rooms are laid out for no mining of pillars as at shallow depths, the saving from long rooms increases because the entry charge increases as the percentage of coal recovered decreases. The gain in the case of shallow mines in low coal is so great that no calculations seem necessary.

DESIRABLE LENGTH OF ROOMS.

Advantages of long rooms. We have shown that in all cases where the miners will not help with the cars for more than 150 ft., it is economical to pay them 10c. a ton more for mining the coal beyond 150 ft. and to make the room 50 to 150 ft. longer. This is sometimes done at present, but in all cases, it is cheaper to deliver and receive the cars at the faces of the rooms than it is to pay 10c. a ton to the miner. This will make it possible to save money even in high coal, by extending the rooms 100 ft. or more, to 350 ft. By making wide rooms with two tracks in a room, the extra expense of handling cars by company men is still further reduced, and nearly half the present entry cost can be saved by doubling the length of the rooms. In many cases, such a saving will exceed 10c. a ton, the present greatest profit on the coal. In case gathering locomotives or gasoline locomotives are used, the expense of hauling in long rooms will be reduced, and they can be made still longer than with mule haulage.

The caving of long rooms. One of the common objections to long rooms is the statement that they are likely to be lost by caving in, but a careful study of the mines shows that only a very few rooms fall in, and they generally fall in next the face, where the props have been shot out or have never been set. Even if the rooms did fall in, the chief loss in the rails covered by the fall, for it costs only $10 to $12 to turn off the room from one of the adjacent rooms driven past the fall. This objection has, therefore, very little weight.

Suggested length of rooms. A more serious objection to long rooms is the congestion on the entry. Longer rooms mean more working places per entry and a larger output from each entry. This has the incidental advantage of making it more advisable to keep the entry tracks in good repair, but the natural limit of the length of rooms is that which, when room No. 1 is just finished, will occupy all the time of one driver and one pusher. Then as the entry gets longer, some rooms may be stopped as soon as they are opened. Then, when a sufficient number of these rooms are opened, another pusher or driver may be put in the entry. Before a second mule is put on, there should be enough pushers to relieve the driver of all switching of cars. When the second driver is put on, the pusher will serve the newly started rooms and the drivers will do the switching. When the pair of entries is just starting, a single pusher can be employed to help the miners in both entries, and if the grades are right, he can run the cars to the parting. A pusher for each entry will next be employed; then a single mule and driver to help the two pushers in the two entries; and finally in each entry two pushers, two drivers, and three mules if the entries are long enough. Each time another company man is put on, a number of rooms will be started at once and in this way the hauling of coal will be always at its greatest efficiency. Figure 89 shows the suggested stage of leaving the rooms. A single pair of men

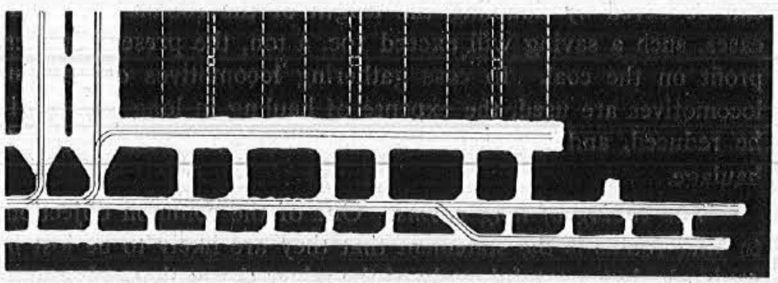


Fig. 89. Entries prepared for starting several rooms at once.

can develop as many rooms as wanted far in advance of the last working room if desired, and the slight additional yardage of

break-throughs is quickly returned, by the increased output of the drivers after an additional driver is put on. At present, the drivers work harder and harder until an extra man is employed. Then the two men at first do but little more than one did.

The length of the room No. 1 that will just keep a single company man busy can be figured if all the data are at hand, but it can more easily be determined by noting the percentage of the day each driver spends in gathering the cars after the trip haul is deducted, and figuring up how many more rooms would be needed to keep him busy all day. If, for example, five more rooms are needed, the extra length of room should be five times the average difference in lengths of adjoining rooms. If the length is much shorter than the economical length as figured from yardage costs, at least one other man should be fully occupied in the two beginning entries before room No. 1 reaches its limit. The rooms can be lengthened, without confusion in hauling, by driving the entries more slowly, but this requires more entries for the same output and greatly increases maintenance and capital expenses.

BEST LENGTH OF ENTRIES.

In slope mines, the entries are kept short by opening new mines along the outcrop. This requires a complete power plant and tipple. If the market justifies the increased output, it is more economical to build one good tipple and electric power plant. The side slopes can then be supplied with an electric hoist and a fan driven by a motor. The coal must be brought to the main tipple by motor haulage. The opportunities of opening such a system of mines have now disappeared.

In the deeper mines on steep dipping coal, the entries can be shortened only by inside slopes or engine-planes from the main level entries. The expense of operating the rope and the connecting haulage road may be taken as equal to that of ten mules and drivers if interest on the investment is included. The cutoffs are justified only if they replace this number of mules. The mules are replaced only in case the entries are so long that two or more mules are required to do the work that one could do in a short entry. An extra mule in the entry is justified only where half of the time of the first mule is spent in pulling the trips after they are made up. If the rooms are so long that more than one mule is busy gathering the cars near the entry, a third mule is needed when each of the first two spend one-third of their time hauling full trips. The first conditions occur with short rooms and the second with long ones. With the present short rooms, each mule makes a trip in from 12 to 30 minutes. Taking 25 minutes as the general maximum time, and allowing 1 minute for delay at the parting, and 250 ft. per minute as the speed, the mule spends half the time pulling a trip if he goes 1,400 ft. along the entry after the trip is made up. The distance to the last room is then about 1,600 or 1,700 ft. On the same basis, the third mule or swing parting should be put in at 2,000 or 2,500 ft. which checks practice fairly well. If then the output of the mine is such that ten ordinary entries will be needed, they should not exceed 1,700 ft. and inner slopes should be sunk at intervals of 3,000 to 3,500 ft., provided property lines do not interfere.

If the dip of the coal is uncertain, or rolls and faulty patches are frequent, the entries should be shorter. As the rooms are made longer, there will be a larger output per entry and more congestion for the same length. Therefore, the distance between slopes should be slightly reduced, as the length of the rooms is increased.

REDUCING THE COST OF MAINTENANCE.

The cost of maintenance of a coal mine can be reduced by leaving proper pillars, by decreasing the final length of the entries, by abandoning each entry as soon as possible, by avoiding wide gob entries, and by a reduction in the number of entries made possible by longer rooms, larger percenatge of extraction, and greater speed of driving entries. In a large mine, the rapid working out and abandonment of the entries means that the mine must be opened in panels. The coal in the panel nearest the shaft is naturally the cheapest and must be opened first to insure the full output as soon as possible. This will give a false idea of the cost of the coal and it is strongly urged that the development of the most distant panel be pushed as soon as full production is reached. If this development is charged to the coal at once, it will partly offset the cost of hauling from the distant panel. As soon as the most distant panels are mined, the barrier pillars can be attacked, and the amount of main entry to be maintained will constantly decrease.

In the small slope mines, the mining of the pillars of the first entries and their immediate abandonment requires in most cases only a strong pillar to protect the main slope.

THE GENERAL PLAN OF THE MINES.

Hauling in break-throughs. Little improvements in the layout of the smaller mines can be suggested, and when large mines are opened, the plan of work will doubtless be so carefully considered by other engineers that suggestions will not be necesary.

If the roof of the mine is very strong, the entry cost can be very largely reduced by the plan shown at the top of Plate IV. By this plan, an engine-plane may be driven straight up the dip and a single pair of level entries started to the right and left. From these entries, rooms can be driven on sights, to the rise, and parallel to the engine-plane. Every other pillar may be left only 4 ft. or 5 ft. wide with break-throughs each 30 ft. or 40 ft. as required by law. The other pillars will be 30 ft. to 40 ft. wide and strong enough to securely support the roof. At intervals of 250 ft. (or 150 ft. if the coal is low), break-throughs are made in the wide pillars. A track will be laid in the break-through nearest the engine-plane from a switch in the plane. This will be extended across the first pair of rooms and switches put in where it crosses the room tracks. This cross track at the right grade will be used in driving the crosscut through the next wide pillar, etc. In this way, the rooms are cut off with no yardage except that which would anyway be required for break-throughs. The plan is used in parts of the Coronado Mine, and is not opposed by the Union.

The grades are easily maintained, and if the panel is large, partings next the plane may be made by slabbing not more than one wide pillar at a very small expense. If brushing is necessary, that it best done by day-men or by special contract, while the room-men continue to push the rooms and break-throughs. The engine-plane need advance no faster than the rooms and should be driven as a room without yardage except brushing, but this will be opposed by the miners. If driven as an entry, the miners in it will have time to do all the brushing in the break-throughs. The ventilation will be by the longwall method. The intake air will be split at the head of the engine-plane and passed through the room faces on each side of the panel and returned through the air-courses of the original level entries.

When the property line is reached, the large pillars can be readily mined through the same openings, retreating down the engine-plane. Since there is practically no yardage cost except for the single pair of level entries and the engine-plane, the pillars may be made full width for easy mining with only a negligible interest cost. The panels may also be made as large as permitted by economical haulage.

If the mine is large and the roof not too solid, the pillars may be robbed in panels. Coal below the shaft must be mined by first sinking the slope to the bottom of the panels and leaving a sufficient slope pillar to make it possible to mine the pillars down the dip. By increasing the size of the pillars between the pairs of narrow rooms, this plan grades into the longwall retreating already described.

Where the roof is very poor, narrow room-necks are needed to reduce the maintenance of haulage-ways, but in the majority of the Arkansas mines, the plan of continuous rooms as outlined above will be quite feasible. Under weak roof, the main pillars between the rooms must be given ample width and the tracks crossing the rooms may have to be timbered as for a squeeze. This arrangement of hauling through break-throughs is the cheapest plan of using short rooms.

Mines in steep basins. Where mines are opened in narrow basins with much of the coal too steep for the use of twin haulage entries, it is generally advisable to run the main entries square up the dip from the shaft in the basin, and to place an engine on this plane as soon as two or three level entries have been turned off from it. If the mine is small and the flat of the basin is so wide that the cars can not be let down to the shaft bottom, the cars from the engine-planes can be handled on the flat by mules. If the mine is large, one or more motors can be used for this purpose as well as to bring the cars from the engine-planes of other panels.

In the small mines, a single pair of twin haulage entries will be driven up the center of the basin from near the shaft. From

these entries, rooms will be driven toward the outcrops of the basin. If the roof permits, they can be cut off at proper intervals by haulage break-throughs as just outlined. Otherwise, they will be cut off by entries at grade from the engine-plane. In this case, all the pillars below the first level entry can be pulled as a single panel if the roof permits. If the flat is wide, twin haulage-entries can be started from the rooms at proper intervals along the main entry in the basin.

If the mine is to be large, it is better to avoid the swamp entry by driving the main haulage-entry slightly off the axis of the basin with the rooms on one side dipping slightly down-hill. A line of crosscuts in the axis of the basin will provide drainage, the slight dip at the mouth of the room will cause no inconvenience, and the main haulage road will be dry.

Unless the axis of the basin pitches at a considerable angle, the coal below the shaft is most easily mined by two pairs of twin haulage entries driven at grade from the shaft, with dip rooms between. It will be cheaper to pull single cars up this slight dip than it will to pull the trips up a wet dip entry in the swamp. If the mine is large, dip rooms of too great length may be avoided by using the hoist of the next engine-plane on the flank of the basin to pull cars up a short slope from another pair of entries nearer the swamp.

Mines in flat or irregular basins. Small mines in flat basins are the simplest of all to mine, but if the mine is large, provision must be made in the first plan of the mine for some form of mechanical haulage. If but little of the coal has a dip too great for twin-haulage entries, electric motors will be best for the main haulage. To open the mine properly, there must be a sufficient amount of prospecting to make it possible to construct a fairly accurate contour map of the coal seam.

Unless the surface features prevent, the main shaft will be placed somewhere in the axis of the basin and a main haulage road will be laid off along the basin. The twin entries for mule haulage will be nearly at right angles to this and will be cut off at intervals of about 1,500 ft. by motor roads with a small grade in favor of the loads. To connect these roads with the least yardage expense, a main motor entry will be started directly uphill on each side of the shaft. When the dip becomes greater than is desired for motor haulage, this road will fork to the right and left and continue as a *Y* at the desired maximum grade. From this *Y*, easy curves can be made to connect with the level haulage roads on the outside. To get the motor upon the roads inside the *Y* will require expensive grading or a steep hill at the curve. It will be better, therefore, to have the mules bring the cars from the space within the *Y* to partings in the arms of the *Y*. The general course of these entries can be laid out in advance by plotting the grade contours. The dividers may be set for the scale length of entry needed to rise from contour to contour, and one end of this set at the point on the map where the entry cuts a contour. The other end is then swung until it intersects the contour above. Actually the entries will not occupy the exact position indicated on the map, but the general layout will be the same, and the maximum grade required for the entry to reach any given point can be determined.

If there is a large area of coal below the shaft, level motor roads can be started as often as necessary from the main road in the axis of the basin. Any considerable area of steep coal can be mined by level mule entries from an engine-plane above the upper motor road. In most cases, the motor can be brought up on a diagonal road and the plane avoided. The ordinary motor roads can be given a grade where necessary on account of irregularities. In a regular wide basin, they need not be exactly parallel, but the direction can be gradually shifted to intersect the property lines at a better angle.

In all such large mines, it is very advisable to push the main road up from the shaft as rapidly as possible and to mine the coal first above the highest cut-off. Then as soon as the mule roads are finished the pillars can be mined back with no possible danger of a squeeze and with the least amount of open space in the mine.

The tail-rope haulage system is advisable only where there are grades too steep for motors and not continuous enough to enable the trip to drag the rope behind. The typical use is for crossing considerable hills or hollows in case the basin is irregular, or the shaft can not be sunk in the center of the basin. For tail-rope haulage, the main roads should be as straight as possible regardless of grade. At most big mines, motors will be advisable for the level haulage, even where tail-rope haulage is used for the

hills. The yardage cost often interferes with the driving of motor roads up hills at an angle to the dip.

MINES IN STEEP-DIPPING COAL.

General plan of the mine. In Arkansas, there is a good deal of coal of such steep dip that it is expensive and dangerous to run the cars down the rooms even when wooden sand-rails are used. In some mines, the rooms are driven diagonally across the dip. This is not very effective and greatly increases yardage costs because the entries must be closer together for the same room length. In such cases, some saving can be made by also giving the entries a big up-grade so they are more nearly at right angles to the rooms. This increases the cost of haulage.

Instead of using these methods, it is far better to run the rooms nearly level and gather the cars by small engine-planes off of a few main level entries along which the cars are taken to the slope by electric motors. This plan is shown on Plate XIII. The method is very convenient and has been much used in the West, but failed in Oklahoma because the pillars in the soft coal were left so narrow that they rolled over. Under the existing crosscut law, at least every second pillar must be kept narrow, but the width of the rooms can be held down to 24 ft. or less and every second pillar should be 40 ft. wide.

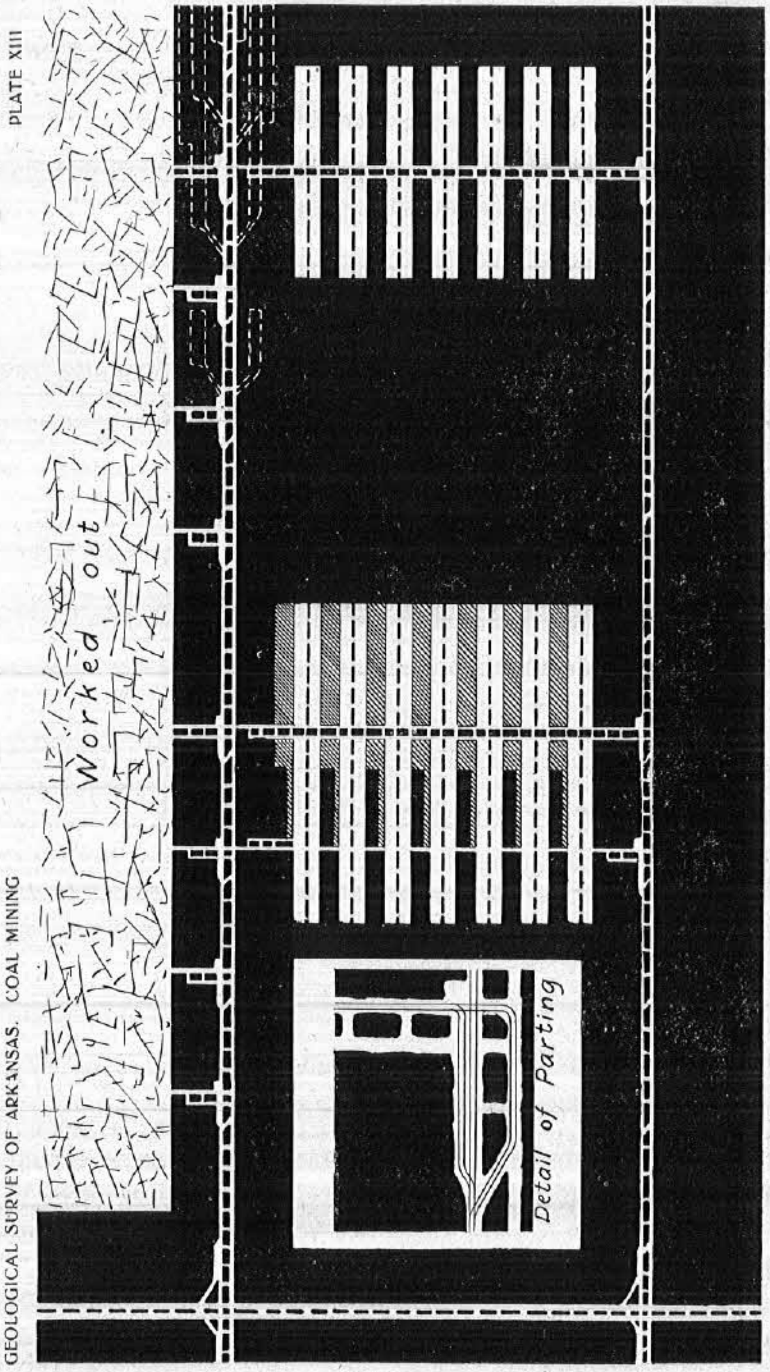
The track will be near the lower side of the room with space below it for all the waste of compound seams. This material can be used to level up the track in high coal. In low coal, bottom brushing can be done to level the track. In all cases, the room men should be required to lay the track at such a grade that the cars must be pushed both ways and can be easily handled by one man. In order to keep the small hoist busy, it is best to complete the plane before any rooms are started. The crosscuts can be spaced to serve as necks for the rooms and the pillar workings on the air-course side. All rooms may be started full width because the room pillars must be adequate to prevent squeezes, and no real room-necks will be needed.

Both the main entry and its air-course will carry a current of fresh air, and a separate split can be sent up through each small plane. The amount can be adjusted by a regulator at the top, and this air can be sent through the rooms by maintaining a curtain opposite each little pillar.

Mining the pillars. As soon as the rooms are finished, the pillars can be mined by taking a good sized skip off the bottom and pulling back all the rest except a narrow strip to hold up for a time the gob above. The main entries may be protected above and below by omitting one or more rooms. If necessary, the pillars can be reënforced by shooting the roof and floor of the nearest room. The greatest strain will come on the entry above the robbed pillars, but this entry need be maintained only a short time after the rooms below are finished. At considerable depth, the workings may in general retreat and the pillars of the entry above can be promptly mined. In this case, the room above the pillar of the lower entry can be reënforced readily by rock shot from the roof. These entry pillars can be mined by horizontal rooms connected with the main entry by inclined roads. The room farthest from the entry may be finished first, and the pillar beyond pulled before the next room is started.

In most cases, at the less depth, it will be possible to pull the pillars immediately. It is then advisable to drive the original planes a long distance apart and rob back the first room pillars only on the side away from the main slope. The hoist can then be moved over to the line of break-throughs in the big pillars, and the other room pillars robbed toward this new plane at the same time the rooms are being advanced on the other side until the plane is moved again. In this way, the capacity of the small plane will be nearly maintained. The saving in yardage will be great, but twice as many partings on the entry will be necessary and a little more money must be invested in preliminary work. The hatched area of Plate XIII, shows the pillars which have been mined and the broken lines indicate the workings in the entry pillars.

Method of development. To keep the motor busy, all the engine-planes of the entry should be developed before the room mining is started. If the continuous cutting electric machines are used in the rooms, as can readily be done at all the dips known in the State, this development work can be rushed by the use of the electric-air post-puncher. There will be sufficient places rather near together to keep one machine busy on each



Method of mining steep dipping coal.

entry. In a machine mine, the rooms will advance at an equal rate and the punchers will be concentrated occasionally on a single line of break-throughs. This can be driven part way down from the room above for ventilation and to save moving of the machines.

At most of the mines in high coal, it will be possible for a mule to drag the empty car up the engine plane, but the loaded cars had best be let down by fastening an old wire rope to a strong prop at the top of the plane and fastening the car to this rope by a screw clamp. The screw can be loosened just enough to let the clamp slide over the rope to lower the car. In low coal, the cars are best brought up by a light hoisting rope passing over pulleys and pulled by a mule walking in the entry.

Handling cars on the planes. In most places, the dip is not sufficient to interfere greatly with switches along the plane. Under these conditions, the cars can be handled in trains. The hoisting rope must, however, be so light that it can be readily pulled down the plane by the rope-rider and it will rarely be possible to handle more than three cars in a trip. Even this introduces delays in shifting cars and in general it would seem better to handle but one car at a time. The miners, according to their agreement with the operators, will handle the cars in level rooms both ways for 150 ft., but must not have to wait for a car. Under these conditions, there should be attached to the hoisting rope, two chains, one about 10 ft. long and the other 25 ft. The empty car can be attached to the long chain and stopped when the other hook is opposite the loaded car waiting at the switch. The load is then attached to the short chain and pulled out on to the entry while the rope rider holds the long chain down in the cut in the curved rail while the wheels pass over it. The empty is then let down on the empty track and detached. The rope rider can signal the miners to run out their cars as needed. In longer rooms, the miners will push the cars one way, but it seems cheaper under these conditions to handle the cars both ways for the miners and let them wait for the empty until it can be brought up from the entry, and to handle the cars on the plane in trains.

The partings at the foot of the plane are most conveniently arranged as shown on the plate. The empty may be dropped off the end of a motor trip, run over the sidetrack. Any empty standing here may be pushed into the end of the entry until there are enough for the last plane. The old dip switches may be used for loaded track and no yardage is needed. The rope will be pulled down far enough to be attached to the empty trip, the operator of the little hoist can see that there are no collisions with the entry motor, and the loaded cars are easily attached to the end of the outgoing trip.

If the dip is steep, it is better to handle the cars on a slope carriage or barney. For this purpose, it is recommended that a long carriage be used with two platforms. The empty will be put on the upper track and pulled up past the room so that the load can be put on the lower track. The barney is then lowered until the empty can be taken off. The miner or pusher is always ready to help the rope-rider and there will be the least amount of delay in changing cars or waiting for cars. An iron counterpoise can be run on an inside track depressed at the passing place. It should be heavy enough to pull up the carriage and the empty car and light enough to be raised by the loaded car. No electric power plant will then be needed. A single-deck slope-carriage will work just as well, provided that the cars come equally from rooms on both sides of the plane and that the miners lay off in pairs only, and will wait for their cars. The last will be unlikely and there will be a big expense for pushers. The large carriage is more convenient for the rope-rider. All the slope carriages should have a device for holding them opposite the tracks.

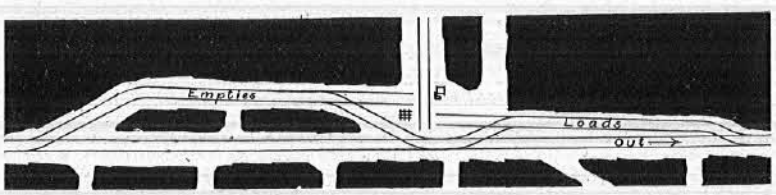


Fig. 90. Station for double-deck slope-carriage.

Figure 90 is a sketch of the station at the bottom of the plane. A similar arrangement with tracks on the same level can be used with switches provided that the cars are turned around again at the slope. This can be done by dropping them from the motor on the parting on the far side of the slope, but there are no apparent advantages in this style of parting, over the one in Plate XIII.

Best length and number of planes. Each little slope should be so long that the engine-plane will be kept nearly busy. It is advisable to give it surplus capacity in order to provide a good turn and to keep the pushers busy. If the arrangement of rooms, the speed of the travel, and the delays in switching cars are known, this length is easily computed. The delay will be determined by the arrangement and the number of men. Two minutes per car may be assumed. We may also assume that the speed will be 600 ft. per minute, that there are on the two sides of the plane four rooms for each 100 ft. and that each room yields four cars per day. Then in addition to the 60 or 75-foot pillar next the entry, 1,000 ft. of slope will be required if three cars are handled at a trip. If only one car is handled at a time, as will generally be advisable, and if there is no reduction in the delay, the distance is 700 ft. A smaller hoist handling one car at 400 ft. per minute will need 600 ft. of plane. The daily outputs from each plane will then be about 320 tons, 224 tons, and 192 tons respectively. If machines are used with a pair of miners in each pair of rooms, the output will be increased slightly and the planes will be shorter.

These figures show at once that only a few planes will be needed and the output can all be handled by one or two motors on a single pair of entries. Unless the planes be put in breakthroughs, it will be necessary to have at least two sets of planes in process of development while the first set is producing room coal.

Comparison with present methods. As compared with the driving of rooms up the dip, the method here outlined has the disadvantage of requiring a little more capital for the initial development. It requires more machinery and, therefore, a different type of mine foreman. It is a slight departure from present methods.

The advantages of the method are: A good extraction at a low interest charge because the pillars can soon be mined; the entry yardage is greatly reduced; there are no wrecks and overworked mules; the haulage is much cheaper; the hoisting is mainly from one level and cheaper; and finally, it is the only satisfactory way of using mining machines in the moderately steep coal. It is in a way the system of twin haulage entries applied to steep coal.

Steep seams at greater depth. This steep-dipping coal soon reaches a depth at which even 40-foot pillars will fail. For thick coal, it is then advisable to use a system of longwall retreating from the property line to the main slope. Entries, driven double for ventilation, will divide the face into panels some 250 to 300 ft. along the dip. Between these entries, conveyors discharging at the lower end may be placed along the retreating face. Some special piece of machinery can be attached to the lower part of these conveyors, for carrying the coal to the cars, passing on a parting in the wide entry at right angles to the face conveyors. This is necessary to insure a heavy output without the expense of maintaining a double-track entry beyond the end of the face conveyor.

It will be some time before such coal is opened and before the problem of labor for conveyors is adjusted. Until then no more discussion of this problem seems necessary. The thin seams of steep dipping coal are best mined by conveyors by longwall advancing as discussed on page 512 of Chapter X.

PROSPECTING.

Before any mine is opened, the coal along the outcrop or in adjoining mines should be carefully studied. In many cases, the outcrop is exposed by a nearly continuous line of strip pits. Where these are not present, the outcrop should be fully located by drilling holes to cut the seam just below the belt of weathering. The results should be mapped and will show whether or not many faulty patches or dislocations may be expected in the area under consideration. This will give some idea in advance as to the number of deep drill holes which may be needed properly to locate the seam and determine the best location of the shaft and preliminary plan of the mine. More deep holes may be drilled if the first holes indicate that this is necessary. The drill holes alone will give sufficient information as to the average thickness of each bench of coal and the thickness and general character of all the partings. If the work is carefully done and the cuttings of different parts kept separate for analysis, the drill will also show how much bony coal may be expected.

It is also advisable to determine the presence or absence of frozen top, bottom, or band-rock; the number and position of

loose seams in the coal; the presence or absence of small rolls in the roof and floor; and the general character of the roof and floor. These greatly affect the cost of mining and the quality of the coal produced. If there are a sufficient number of surrounding mines, this information can be easily obtained. If there are no deep accessible workings, a number of test pits are needed around the outcrop. Where the roof, floor, or band-rock is hard, these workings should extend some distance into unaltered coal, and unless a distinct band of rashing can be found at the separation of coal and rock, frozen coal is to be feared. Where there are rolls along the outcrop, they are liable to be numerous in the basins. If it is necessary to secure information as to frozen coal and seamy coal at depth, core drills are necessary. Most of the Arkansas coal is so soft that it will not yield cores with the ordinary small diamond drill used for prospecting. It is, therefore, advisable to use some form of drill like the Davis calyx drill made by the Ingersoll-Rand Drill Co., of New York. Such a drill will yield a core of any size desired. Such cores will often show the presence or absence of short rolls because at only a few parts of a roll will the roof and floor of the coal be parallel.

For ordinary prospecting in soft rock, the common marble drill of the type made by the Cyclone Drill Co., Orrville, Ohio, is most used and is best. For shallow holes, these drills may be home-made. For very hard rock, the drill needs to be sharpened so frequently that it is expensive to uncouple the rods of a marble drill, and it is much cheaper to drill through the hard sandstone with an ordinary rope drill such as is used for sinking oil wells. As soon as the hard rock is penetrated, the rod drill of either type can be substituted to get a better record of the coal. The combination of rope drill and Davis-cutter drill is recommended for holes of large diameter.

If the prospecting shows that there are any unusual conditions not found in adjoining mines, such as bony coal, frozen coal, sulphur bands, or steeper dip, it is absolutely necessary to secure enough data to make it possible to settle the "local conditions" with the Miners' Union before any money is spent in opening up the mine. If the prospecting shows unfavorable conditions, the mine should not be opened until there is an outlook for a good demand for coal at a profitable price.

STORAGE OF COAL.

Several reasons for the storage of coal in Arkansas have been given on page 324. Besides these, it is quite essential to store coal at Spadra and Russellville in order to prevent the complete loss of the market, because of inability to deliver coal when it is ordered.

In the Transactions of the American Institute of Mining Engineers, volume 42, page 314, R. V. Norris has given all possible data upon the storage of anthracite coal in the air, and the discussion need not be repeated. He strongly recommends mechanically operated plants, designed especially to reduce the breaking of the coal. This breaking causes a heavy loss, even with the hard Pennsylvania anthracite coal, and will be worse with the softer semi-anthracite coal of Spadra and Clarksville. Breakage is especially severe if the coal is dropped any distance, or if it is drawn from the bottom of a high pile while it is under pressure. Freezing need not be feared in Arkansas.

A few of the softer coals of Arkansas can be safely stored in the same way, but, with most of them, there is danger of spontaneous combustion or of falling to slack, and the larger sizes at least must be stored under water. All tests show that no noticeable changes occur in coal under water and the only loss will be breakage in handling. The chief objection to storing coal under water in most places is the annoyance of frost, which interferes with reloading and with unloading of wet coal from the railroad cars. The mild climate of Arkansas obviates the first difficulty and if the work is properly done, the coal will be drained before it freezes in cars sent north.

By dropping the coal into water, the main source of breakage is avoided. If any mechanical plant is used for reloading, the shoveling types working from the bottom of the pile are best.* They can be easily used in a plant designed for hand loading and are recommended. Other machines handling grab buckets can be used without drawing off the water, but they cause too much breakage. For reloading slack, the large steam-operated slip scraper, pulling the coal up an incline to the car, is cheaper to install and is recommended. The best arrangement for storing

*_Mines and Minerals,_ Sept., 1908, Vol. 29, page 76.
Engineering News, June 20, 1912, Vol. 67, page 1176.

lump coal under water seems to require a pond that can be readily drained. This can be crossed by a series of trestles from which the coal can be dumped into the water by gable-bottomed cars. With a proper layout of these trestles, the cars can be hauled from the tipple by mules and automatically dumped without stopping, and the expense of putting the coal in is very small. The coal can be reloaded into small cars running under the dumping trestles. A hoist is necessary to pull the car up an incline to the railroad cars, and several reloading tracks can be served by one small hoist, or the cars may all be pushed to the foot of the incline. The track can be relaid as the coal is removed. The hoist may be a contractor's donkey engine on skids, but if near the tipple, it will be cheaper to supply steam from the main boiler plant to a small hoist.

To reduce the expense of grading, the ponds can be made less than 150 ft. wide and as long as desired, following contours. The waste dirt may be heaped up between the ponds and no retaining walls will be necessary. The ponds may be emptied one at a time as needed and the coal allowed to drain for as long a time as is desirable before it is loaded. The dam may be of earth with a concrete outlet for draining. In most places, natural surface water can be made to fill the pond and no cement bottom will be necessary. To insure clean coal, a bed of slack may first be put down. For convenience in shoveling, a cement floor is much better. It can be put in for 75c. a square yard. To keep mud off the coal, the natural drainage should be run past the ponds until it is nearly clear, or if water is scarce, it should be run into a settling pond before reaching the coal ponds. The main storage pond may occupy the widened bed of a low-banked stream. The waste earth can be used as a high dam above this, and the lake formed by it will serve as a settling pond. An overflow channel can then be made around the waste bank along one side of the storage pond. If the settling dam is high enough, other long shallow storage ponds may be built at higher levels parallel to the first one. Valves and concrete culverts will be needed for filling the storage ponds as desired. The general arrangement will then be as shown on Plate XIV.

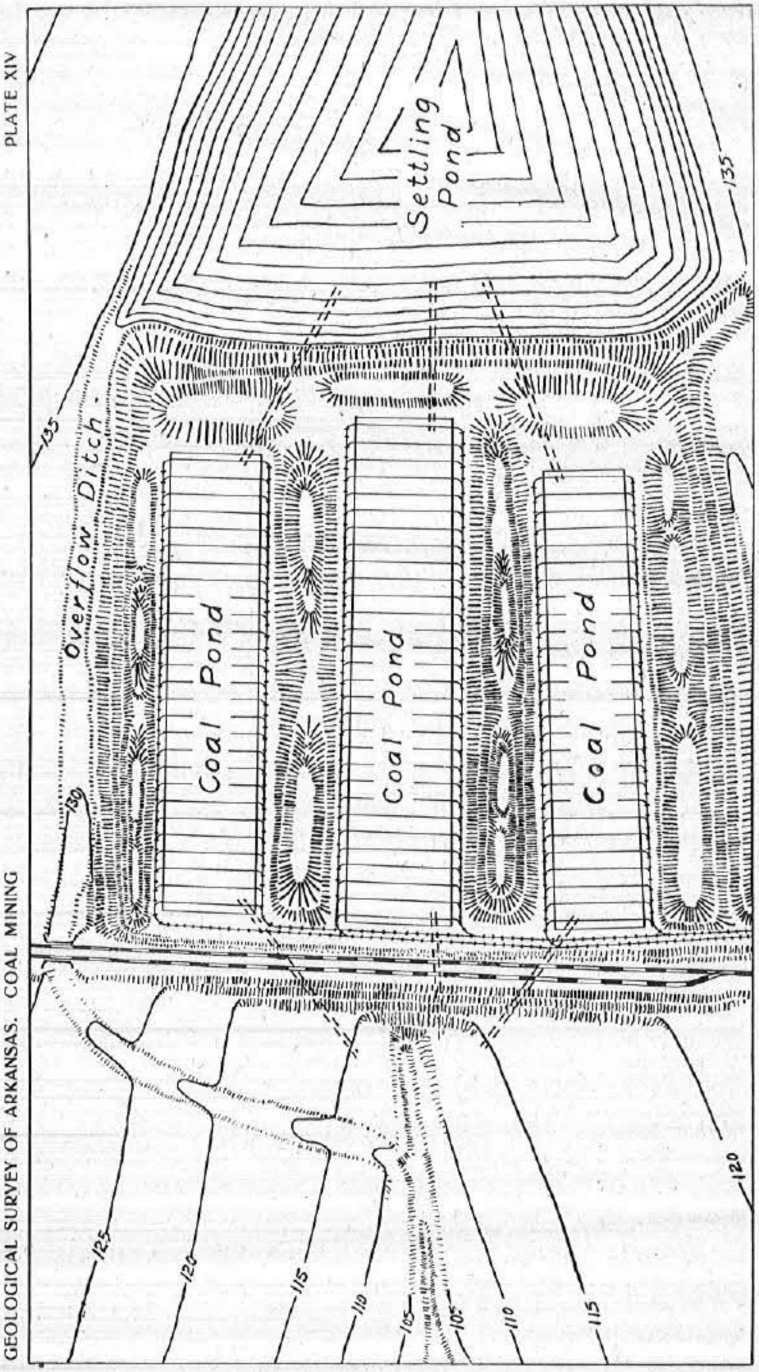
The coal may be dumped into water without shock. The wear of dumping it into low gable-bottomed cars will be less than that of dumping it into railroad cars, if a proper chute is used. The extra wear of storage is then only that caused by shoveling up the coal and dumping it into cars. Nearly all the slate may be removed during the shoveling in day-light by paying a little extra per ton for the slate picked out. The incline to the cars may be high enough to admit the use of a bar screen. These precautions will make it possible to supply coal of standard quality or better from the storage ponds.

The first cost will depend upon the nature of the land surface. In favorable locations, the grading will cost less than 10c. per ton of capacity. The cost of the trestle and track will depend upon the depth of the pond. If the trestles are high, they need not be so close together. If we assume that the trestles are 20 ft. high and 20 ft. apart, each foot will allow the storage of about 10 tons of coal and their cost will not exceed 20c. per ton of capacity. The total first cost will then be 30c., and interest and depreciation at 20 per cent per annum will be 6c. a ton if coal is stored only once a year. The reloading can be done by the cheapest class of labor and will not cost more than 8c. per ton for shoveling, or 14c. for all labor together. This is repaid by the steady operation by the mine and consequent reduction in fixed charges, and by the difference in value of the coal in summer and winter. A profit should be supplied by lower wages accepted by the miners in return for steady work. The cost of a storage plant should be compared to half that of opening another mine because it will increase the annual capacity 50 per cent.

The average depth of the coal pile will vary greatly. At 18 ft., a single acre will store about 20,000 tons. Storage should be provided for nearly 100 days output and the larger mines will need 7.5 acres of storage room. If the ponds are 150 ft. wide, the total length must then be about 2,000 ft., and the greatest haul of the coal in small cars will be 1,000 ft. with best conditions and three ponds.

MINE ACCOUNTS.

Accurate cost records are desirable for the following purposes: (1) To determine exactly the average cost, per ton of coal, of each item of payment for which there is a special scale price in the agreement with the mine workers. (2) To determine the total cost of the different kinds of openings and struc-



Suggested arrangement of ponds for storing coal.

tures in the mine, per ton of coal and per unit of structure. (3) To learn the effect of variation in local conditions, such as thickness of coal, the kind of roof, and the amount of draw slate, based on the tonnage of coal produced under those conditions. (4) To judge of the efficiency of the work of each group of men paid by day labor, and to check any tendency to extravagance in employing labor.

The costs first mentioned are generally entirely beyond the control of the operator and are of use only in drawing up a labor agreement and can, therefore, be most easily dispensed with. Some of the items are often needed for other purposes and can be cheaply determined by two methods. First, the yardage book of the mine foreman can have a number of names on a page and have ruled columns for each item of dead work, and for the total Ordinarily, only the total for each man need be copied upon the payroll ledger, and whenever the totals of each item for the mine or entry are desired, they can be taken directly from the foreman's book by merely adding up the figures. To reduce the size of the book without cramping the space, the pages of the book should be ruled differently for entry-men and for room-men. Spaces should be left for the actual measurement, as, so many square yards of rock of such a thickness. The office force can then make the calculations of the total.

It is necessary to make out a complete statement of payroll items to give to the miners. These statements can as well as not be made in columns beneath printed heads. They can then be made as a carbon copy of the same entries transferred from the present style of yardage book to the ledger, and the individual items can then be obtained for the entire mine by merely adding the columns. This second method of getting payroll items has the incidental advantage of giving a check on the entries in the ledger because the sum of the columns in each page must equal the sum of the column for total yardage. There can also be no undetected errors in copying the miners' statements. The ledger is most convenient if of the loose-leaf form, and the pages for room-men and entry-men should be different to save bulk and expense. There seems to be no possible excuse for keeping a special office yardage-book, into which the records of the foreman's book are copied.

There is a great advantage in keeping a record of the number of diggers in the mine each day. This should be done by the weigh-boss who can receive reports from the drivers in case the coal bulletin does not show conclusively whether or not the diggers were in the mine. Separate records should be kept for entry-men and room-men and for those men working double or single or in entries of different widths. Such a simple record will make it possible to compute the average daily earnings of all the contract miners of each group. The weigh-man can make a record for each man's attendance upon the bulletin and this can be copied into the daily coal-book. At the end of the two weeks, the number of days worked can be entered upon the payroll along with the total tonnage.

The second lot of costs are important in adjusting the general layout of the mine, and are readily obtained by proper summations of the different pay-roll items. It is very advisable not to make these according to any system but to prepare reports only as desired by the superintendent at intervals. In order to do this, the mine foreman's report of supplies and day labor must distribute the cost of ties, props, and labor of maintenance among the different sorts of workings. The superintendent should know the average cost per yard of complete entry of each sort in use, including switches and room-necks; the cost of crosscuts, break-throughs, etc.; the cost of a switch, overcast, permanent or temporary stopping; the cost of maintenance of old and new entries, and all such things; and the cost of haul per unit of distance under different conditions. In order to keep these records, it is necessary that the yardage measurements of the pit-boss be checked against the totals determined by surveys. If the miner has been bothered by any unusual condition, it is quite customary for the pit-boss to allow the entry-man a little extra yardage to avoid the establishment of a precedent. Rather than do this, it is better to state on the yardage book just why the extra amount is allowed, and not to spoil the yardage record for calculations.

The third lot of cost data is almost never kept. For this purpose, it is necessary to know in what part of the mine each miner works. This can be very simply done by assigning check-numbers to the miners in such a way that all the men in each entry will have numbers close together and by changing the

miner's check-number each time his place is changed. The output from any entry may then be quickly determined by adding the semi-monthly output of coal from the records in the miners' coal-book. It is very important in some cases to figure these extra costs against the coal obtained from that locality. Unless this is done, much coal may be mined at a loss, which will reduce the average earnings of the mine. This information is also necessary for the intelligent planning of extensions of the mine into places where unfavorable conditions are known to exist. It will often serve to show the need of more prospecting, or a change in the length of rooms or direction of the rooms, as the dip changes. These records are vital for forecasting the probable cost of coal from distant parts of the mine and for comparison with the known conditions of competing mines.

The record should be so kept that the information can be obtained whenever desired, but there is no need of compiling the separate costs except under special circumstances, and the extra bookkeeping will not be very expensive. All of these costs are best figured upon the basis of the bulletin weight of coal hoisted, rather than upon the weight of coal shipped. The cost of boiler coal and shortage will then appear as perfectly proper items of cost and will not be concealed. It will also make it possible correctly to average and sum the costs based on local outputs.

The fourth group of records gives the most direct return. Each mine foreman should be provided with blanks for a day-labor report in detail. On this should be written the number of men regularly employed about the mines, such as firemen, rope-riders, etc., a detailed statement of the work of each man of the miscellaneous crew, and the reason for any additional expense. Such reports will give the foreman a feeling of responsibility and will enable the office force to figure at any time the cost of maintaining the roof of any particular main slope or entry, and the cost of laying track, keeping track in condition, and the cost of stoppings and so forth. The boss drivers at the larger mines should report the output of each individual driver, the number of wrecks, and the reasons for delay. This will have a good effect upon the drivers, and will reduce the danger of slighting the track work in order to keep down the cost of track-men. To be effective, these reports must be carefully studied and the office force should compile monthly reports of the cost per ton of haulage on the different entries and main haulage lines, and of the different items of maintenance. Pains should be taken to see that the sum of the reported outputs of the individual entries checks with the total of the mine. Such records will show the real cost of making switches and other machinery in the blacksmith shop and so check much waste of money. It throws extra work upon the mine foreman, but enables the more able men to prove their superiority and will, therefore, make the position more attractive to them. It will also show the cost of each individual squeeze, mine fire, and other accident. They are absolutely essential wherever mining machines are operated on day's pay.

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