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Conveyor mining in the thin vein coal fields at Excelsior, Arkansas

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CONVEYOR MINING IN THE THIN VEIN COAL FIELDS

AT EXCELSIOR, ARKANSAS

by

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CONVEYOR MINING IN THE THIN VEIN COAL FIELDS AT EXCELSIOR, ARKANSAS

Coal has been mined in this western section of Arkansas and in Sebastian County for over forty years. The first coal in any appreciable quantity was mined for railroad use. Great quantities of coal were mined for the use of the railroads throughout the Southwest, all of which was taken from the thick veins of the Hartshorne Seam. The coal underlying this section compares favorably with any in the United States as far as quality is concerned. It is semi-bituminous in character, but is known in the trade territory in the North as semi-anthracite coal, and is practically smokeless.

Since the coal mined in the early days of the industry in this section was practically all used for steam purposes, very little of it was screened, and this small amount was simply passed over gravity bar screens. This condition existed as late as the years of the World War.

At the time the thick veins were being mined, the thin veins which underlie this region were not worked because they could not be mined cheaply enough to compete with the coal from the thick seams.

In the early twenties, many discoveries of oil and gas were made in the Mid-Continent Field and throughout the Southwest, which spelled disaster for these mines that were furnishing the railroads and other industries with steam coal. The railroads of this section converted their locomotives to oil burners, and other industries converted to oil or gas burners, with the result that over 75 per cent of the steam coal market was lost.

When the steam and industrial markets were taken away from the mines of this section, the operators began to look to the purely domestic markets of the Middlewest to replace, in some measure, the markets which had been lost to oil and gas. They found that the coal from the thick veins, while excellent in quality, was too soft to ship into the northern domestic markets, as most of these markets demanded a coal properly prepared and sized and a coal which would arrive at destination with a small amount of degradation.

The coal from the thin veins (24 to 36 inches in thickness), which previously could not be worked economically, was of a harder structure, was generally better in quality, and would meet these requirements demanded by the northern markets. However, many problems had to be overcome in order to mine these thin seams profitably.

The heavy pitch of the veins, the large amount of water present, the bad roof conditions, and the quantity of gas all contributed to make mining difficult and expensive.

The old fashioned room and pillar system, which had been used in working the thick veins, was tried but was not successful except for small mines. Better success was obtained with a room and pillar system with panels driven down the pitch of the vein and with wide rooms driven along the strike of the vein. Under both these systems, the coal was undercut by modern "short-wall" mining machines and was loaded into small cars by hand at the face.

This second method did not entirely solve the problem until it was modified to concentrate the work in small sections of the mine to permit larger tonnages from a given area, with nearly 100 per cent extraction of the coal. A light-weight rather inexpensive face conveyor was developed, which contributed greatly to the success of this modified method. With these improvements, the mines have been able to produce coal at a cost that has enabled them to compete with coals from neighboring states in the domestic markets of the North.

Much experimenting has been done in this work by our company, and I shall describe such a system as is operated in the Excelsior Field in Sebastian County, Arkansas, a field that our company has been instrumental in developing within the past three years.

The Excelsior Field is located in the western part of Arkansas and is about 18 miles south of Fort Smith on the Midland Valley Railroad.

The Hartshorne Seam, which is the one mined, outcrops in this valley and dips South 9 degrees. The coal averages about 30 inches in thickness. The roof near the outcrop is extremely bad, but improves at greater depth.

Figure No. 1 is a Plan of Development of the mine, showing the long face conveyor method of mining. The simplicity of this plan is easily seen from the sketch. Some operators do not leave the second set of chain pillars on the slope between the wall and the return aircourse, but we have found that this protection is needed as we advance deeper with the workings. The cover is now from 400 to 500 feet, and we have found that this additional protection is necessary at this point. We have also found that in some cases the faces close on account of roof pressure after a wall has been worked to the boundary, and this set of chain pillars affords an auxiliary return aircourse, which is necessary in so gaseous a mine.

In each of our two mines we have four conveyor units in operation. Each unit averages over 100 tons daily, depending upon the thickness of the coal, which varies from 28 to 36 inches. This gives a daily tonnage of from 400 to 500 tons, which is a very practical output for a mine in this field.

With our production from these four units, we can regulate the production in each mine to our ability to market the coal. Our operating season generally begins early in July. We operate two conveyor units at first, and start the remaining units as the seasonal demand increases. Our season generally ends early in March, and the mines remain idle until the season begins again in July.

Figure No. 2 is a sketch showing the Plan of Conveyor Wall and the entry or road head, as it is commonly referred to. An average crew for a 300- to 350-foot face consists of the following:

1 unit foreman or wall boss

2 chunkers on entry who operate conveyor and load cars

10 loaders (this number varies to 15 men, depending upon the thickness of coal and length of face)

2 machine men

1 mucker behind machine

1 hoistman

3 entrymen

In addition to this crew, we have a regular timbering crew who work at night and take care of necessary entry timbering and other timbering incident to the operation of the mine as a whole.

With this crew, the above-mentioned tonnage is produced in a 7-hour shift. Coal is loaded but one shift in each 24 hours. The machine crew cuts at night, and the entry crew, which drives the entry and brushes the bottom, also works at night. As the hoist for the unit is located near the slope, and a complete main slope trip must be handled by the conveyor at one time, it is necessary that the entry or road head be kept advanced ahead of the long face, in order that the entire trip of empty cars may be pulled under the loading head of the conveyor and then dropped out toward the slope by gravity as they are loaded. A sheave is located in the face of the entry or road head in order to handle the trip in this manner. We use a short wall machine with a six-foot cutter bar in the entry or road head, which enables us to keep ahead with this entry development, as we use only a four-foot cutter bar on the long wall machine which undercuts the wall.

As the machine men cut at night, the coal is ready to be loaded when the day crew (composed of the unit foreman, loaders and chunkers) reach the face. On account of the roof pressure, the coal as it is undercut drops down back of the mining machine, and no shooting is necessary. It is necessary, however, to shoot the coal down when beginning a new wall. After several complete cuts have been removed, the coal begins to break without shooting.

The loaders place the coal on the chain conveyor which discharges into the mine cars at the entry on the low side of the wall. When one trip (consisting of ten $1\frac{1}{2}$-ton cars) is loaded, it is dropped out by gravity to the main slope parting. While this trip of cars is being changed, which may take several minutes if the entry is advanced any distance from the main slope, the conveyor is stopped. None of the men are idle, however, because they can be breaking their coal and getting it ready to load on the conveyor, or they can be setting props along that portion of the face already cleaned up.

The starting time at the face is 7:30 a.m., and under normal conditions the face is cleaned of its coal by not later than 1:00 p.m. When the face is clean of coal, the crew starts to move the conveyor. Props have already been set along the face where necessary, and one row has been set three feet from the face of the coal.

The crew then proceeds to move the conveyor forward against the props which have been set three feet from the coal face. These props have been set uniformly and serve as a guide for placing the conveyor pans. The conveyor is light and is easily moved; it is taken apart in order to move without disturbing the timbers already set. Since the pans, which are six feet in length, are not bolted together, moving them is a comparatively easy task. The loading head, containing the drive motor and the speed reducer, is somewhat heavier and requires a set of rollers or a pair of pull jacks to facilitate its moving. Each loader along the face is responsible for the moving forward of his section of the conveyor and the reassembling of the pans and the conveyor chain, which is standard size and detachable. Each day, after the face is cleaned up, the conveyor is moved forward the distance of the face advance, or four feet daily.

After the conveyor has been set in its new position, there remains between the props on the inside of the conveyor pans, and the face, a distance of three feet. This is sufficient space to permit the long wall mining machine to pass along the face as it cuts without having to knock out and reset any of the props set along the conveyor. The machine cuts down the face one night, then back up the next night. As the machine cuts along the face, the machine helper sets any additional props that are necessary. To move the conveyor under normal conditions requires an average of forty-five minutes.

After the conveyor has been moved, the next operation is sending props, cribbing, headblocks and other necessary timbers up the wall. This is done with the conveyor, which is easily reversed with a double throw switch. The different timbers are sent up the face on the conveyor, each loader taking off the necessary timbers as they pass his working space. The numbers and the lnegth of the various timbers have previously been determined by the unit foreman, who has taken a list of each man's timber requirements and has ordered timbers from the outside accordingly. The loaders place the timbers back of the conveyor in order to have them for the next day's operation. When this is done, the day crew is finished and the face is ready for the machine crew.

The mine operates on a 7-hour day basis, and, unless unforeseen delays or extremely bad roof conditions are encountered, the wall is cleaned of its coal, the conveyor moved, and the timbers sent up the face well within this period.

From Figure No. 2 can also be seen the method used in timbering the face. It must be remembered that our roof is not a long wall roof in the strict sense of the word, but is a roof that must be controlled in order to keep it from breaking off at the face of coal. This control is accomplished by the proper use of timbers. We have found that timber costs have greatly increased over the timber costs on room and pillar systems, but this disadvantage is offset by the other decided advantages of this system over the old.

In our mine, we have very little refuse or waste material for gob filling behind the conveyor. There is practically no draw slate and no waste from undercutting, which is done in the coal on account of the hard rock bottom. We have found, after considerable experimenting, that square cribs of pine timber set at regular intervals along the face would control the roof breaks better than any other method of timbering. These cribs are, of course, in addition to the regular straight props of pine which we set along the face as the coal is loaded from a cut.

It is necessary to set cribs on either side of the entry or roadhead to protect the haulage road and aircourse. We standardized, after many experiments, on three rows of cribs on the upper side of the roadway and two rows below the roadway. In addition to these cribs, most of the material obtained from bottom brushing is placed as a pack wall between the cribs on the lower side of the haulage road, leaving a six-foot-wide aircourse on the extreme lower side of the haulage road.

Along the wall we set approximately one crib per man each day, or one crib approximately every 30 feet. At times we put these cribs twice this distance apart, depending upon the condition of the roof. In some cases, we found that we could put the cribs further apart on the upper and lower ends of the wall and closer toward the middle, because the roof had a decided tendency to override the cribs and props at approximately the middle of the wall.

We have observed that the roof breaks occur on the various walls after every ten to fifteen cuts that are taken from the face. The timbering on the individual units depends partly on the local conditions of the top, on the various walls. It is our definite conclusion, however, that we must use cribs to properly handle and control the roof and to permit our cycle of operation, and we have had no difficulty with roof control since this system was installed. The unit foremen are charged with the responsibility of properly placing the timbers and cribs, and within a very short while learn the proper method of handling their own individual units, even though we have standardized on certain timbering methods for the operation as a whole.

The crib timbers are of pine, sawed square on two sides; they are four inches in thickness and three feet in length. The cribs are built square, and are made tight against the roof by the use of wedged cap pieces which we purchase in bundles similar to wood shingles. These wedged cap pieces are about one inch in thickness at the large end and are 8 to 10 inches in length. The loaders soon become very skillful at building cribs and can complete them rapidly.

Pine timber is also used for straight props. This is preferable to hard wood, as it has a tendency to squeeze rather than break under excessive roof pressures. The props are from 5 to 8 inches in diameter and are purchased in lengths to fit the different thicknesses of the vein (28 to 36 inches). Therefore, we do not have to cut the timbers to the proper length in the mine.

Props are set with a headblock over them. The headblock is a flat piece of soft pine from 12 to 18 inches in length and varying from 2 to 4 inches in thickness, and stands up under great weight. The props squeeze into the blocks as the face advances but do not reach the breaking point until the face has advanced a sufficient distance ahead of them. The straight props are set at whatever distance apart the roof conditions demand, which is usually about five feet. They are set uniformly along the face. Each loader is responsible for the timbering of his working space along the wall.

The coal vein lies between two strata of hard rock. The bottom rock is considerably harder than the top, which necessitates the use of more timbering than if the bottom were softer and would allow the props to sink into it as the area became worked out and the roof pressure became greater. The problem of roof control would also be easier to handle if we had sufficient waste and draw rock to fill the gob instead of having to depend entirely on timbers. In addition to the above-described cribbing and timbering methods, we use cross bars of pine across the haulage roads on the entry, in order to take care of any rock that might become loose over the haulage road. As the entry advances and the roof pressure becomes greater, we sometimes have to go back and replace these cross bars. This work is done by the regular mine timbering crew. However, we have had very little difficulty with loose rock on our haulage roads since beginning this system.

Each operation in the long wall field has its individual timbering problems and ours have been solved by the timbering methods outlined above.

Figure No. 3 shows a Section A-A of the long wall. From this sketch can be seen the relative positions of the conveyor, the straight timbers, the cribbing and the worked-out area from the face of the coal.

At times, when a roof break is in progress, we set the straight props either double or triple alongside each other, to further protect our working face by adding strength to the props at the necessary points.

Figure No. 4 shows a Section B-B of the entry roadhead. From this sketch is seen the amount of bottom brushing that is taken, part of which is used to pack wall below the entry and part of which is loaded and hauled to the outside for disposal over the rock dump. The positions of the cribs along the roadway and the method of gobbing the brushing rock on the lower side of the roadway is also shown. This sketch also illustrates the position of the air-course on the extreme lower side of the entry or roadhead.

There are no cribs set along the upper side of the roadway as the entry advances; that timbering is taken care of for the time with straight, round pine props. If cribs were set along this upper side as the entry advanced, they would interfere with the conveyor as it is moved forward each day. Each day, three cribs are set on the upper side of the entry after the conveyor has been moved. These cribs, as has been mentioned before, are used to protect the entry and haulage road when roof pressure becomes great in the worked-out area and roof breaks occur.

The bottom brushing is extremely hard and requires a heavy jackhammer air drill for drilling the bottom holes. Holes are drilled to a depth of six feet, the length of the cut taken out of the entry. We have found that this depth hole gives the best results with the 40-per-cent gelatine dynamite that is used for blasting. We drill three holes, one on each side and one in the middle, and use 1-inch drill steel, as we found that the 7/8-inch drill steel commonly used with jackhammer drills would break in this hard rock. Detachable drill bits are used, and we have found them the most practical for this work.

From the results obtained after a year and a half of operation using the long face system of conveyor mining in our thin seam of coal, four decided advantages over the old system of room and pillar work with wide rooms have been proven:

1. Operations are concentrated in small sections, thereby permitting larger tonnages to be loaded.

2. One hundred per cent extraction of the vein is obtained (with the exception of main slope pillars) which prolongs the life of the mine.

3. The ventilation of this gaseous vein is simplified.

4. Production costs are reduced.

At this time there are approximately 25 such conveyor units in operation in the Excelsior Coal Field, with additional units contemplated for next season's operation. There are also about double this number in operation in the Paris Field, a thin vein field which lies about 40 miles east of our field, which indicates that this system of conveyor mining is a complete success in the thin vein field of Arkansas.

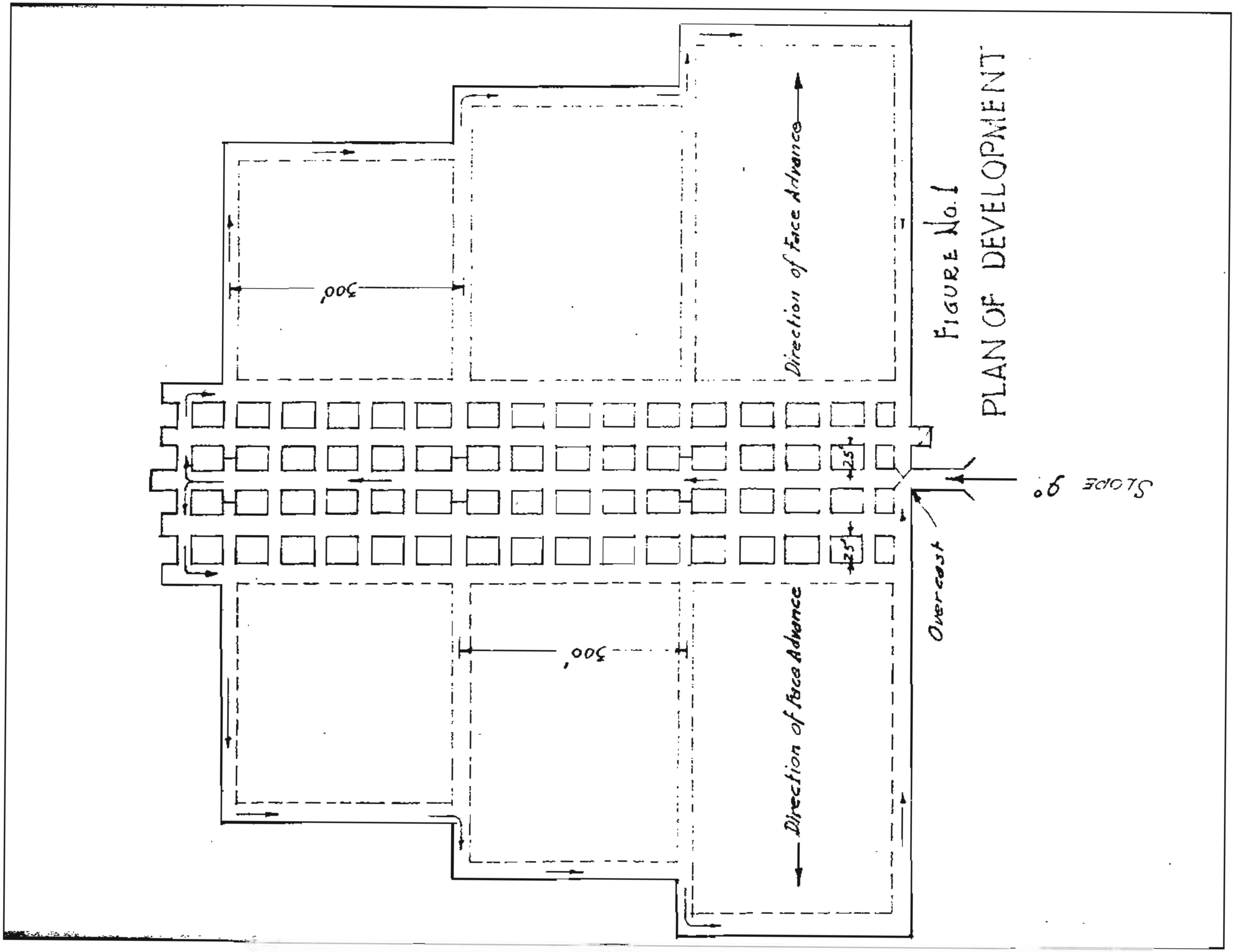
FIGURE No. 1
PLAN OF DEVELOPMENT
Direction of Face Advance
500'
Direction of Face Advance
500'
25'
25'
Slope 9°
Overcast

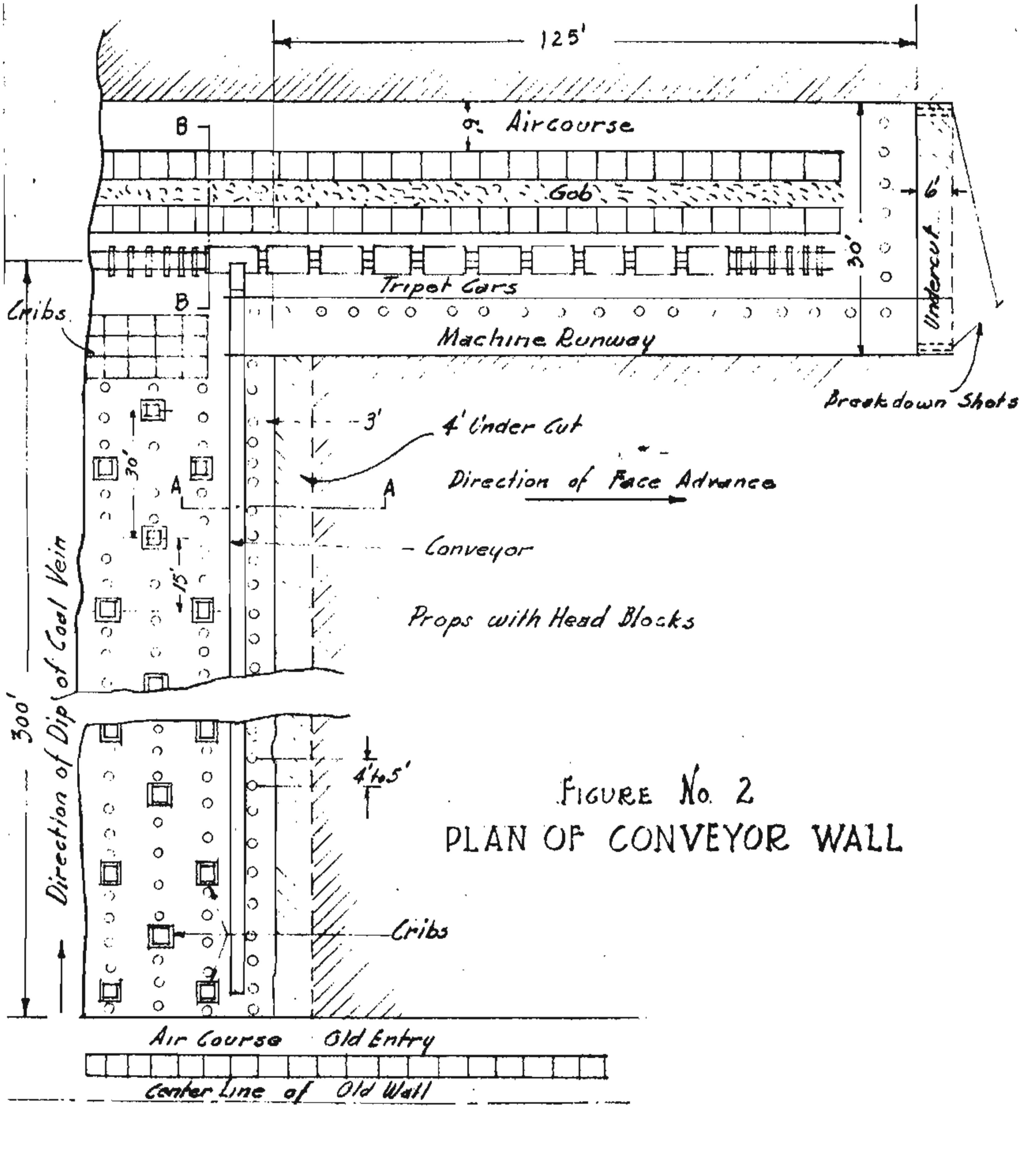

FIGURE No. 2
PLAN OF CONVEYOR WALL

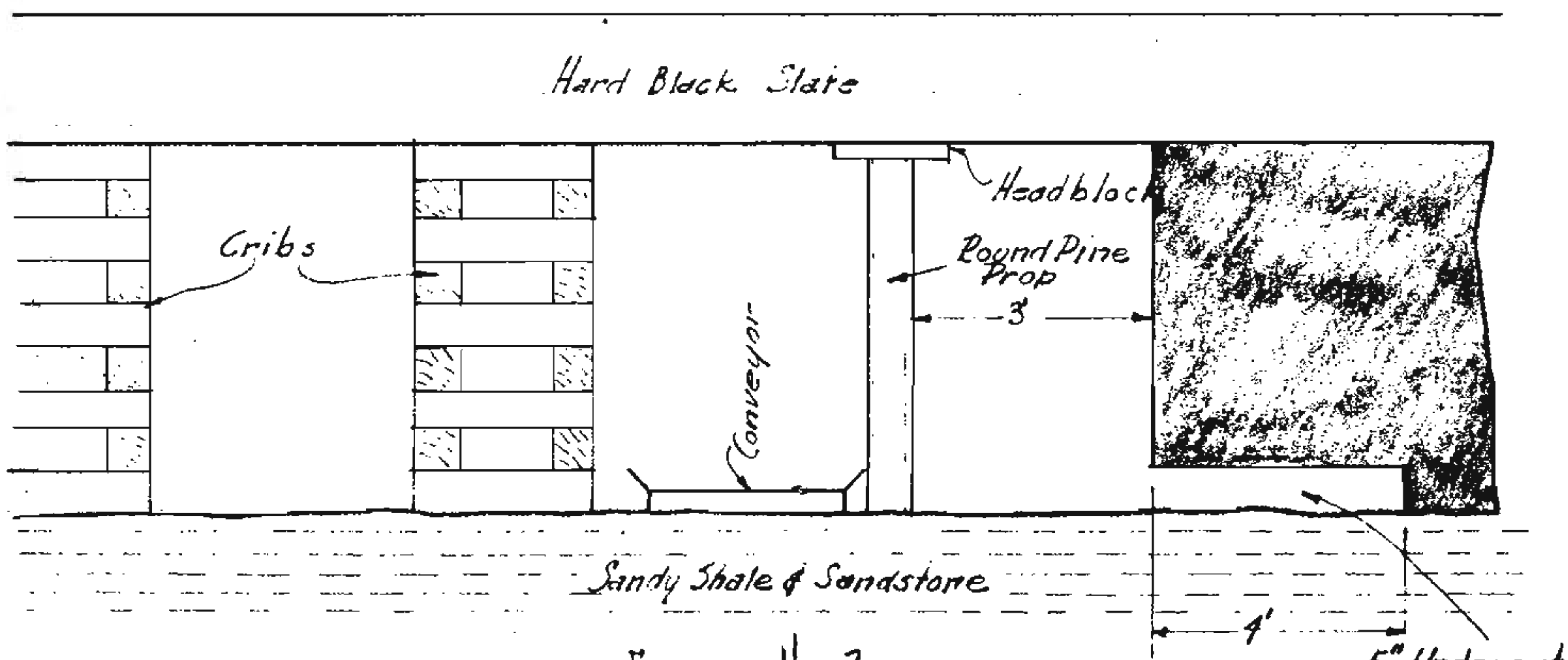

FIGURE No. 3

SECTION A-A

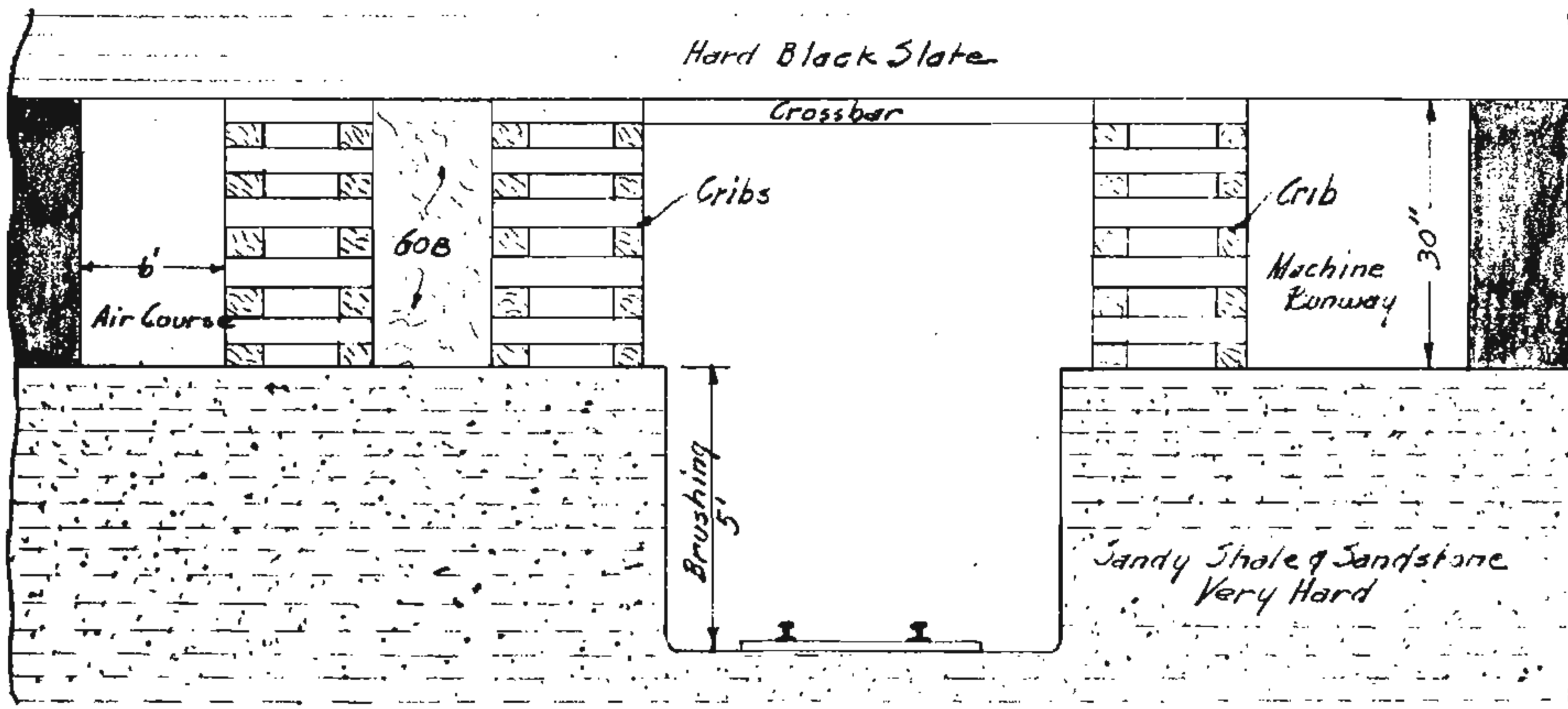

FIGURE No. 4

SECTION B-B