REHABILITATION OF THE INTERNATIONAL COAL MINES.
REHABILITATION

OF THE

INTERNATIONAL COAL MINES

By

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Submitted to the Department of Mining Engineering and the faculty of the Graduate School of the University of Kansas, in partial fulfillment of the requirements for the degree of Engineer of Mines.

Approved by

Department of Mining.

January 1, 1921.
To The
Professors of
Mining Engineering of
the University of Kansas who
so conscientiously built the
foundation of my adopted profession
and to those who have continued
their helpful encouragement
I gratefully dedicate
this paper.
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REHABILITATION
OF THE
INTERNATIONAL COAL MINES.

INTRODUCTION.

In the preparation of this thesis it was not the intention of the writer to make the things accomplished appear as unusual achievements or that the work is widely different here than elsewhere, but to describe, by simple mining methods, step by step the reopening of old abandoned mines from examination to successful operation of the property.

TOPOGRAPHY.

The Eagle Pass coal field is a small field, triangular shaped, outcropping in Maverick County northwest of Eagle Pass, Texas, from which town it takes its name and where all of the mines are located. The greater part of the Eagle Pass coal bed lies across the Rio Grande River in Mexico and has been worked extensively near Fuente, Coahuila, Mexico. The line of outcrop crosses the Rio Grande about 4 miles northwest of Eagle Pass and where the boundary of the International Coal Mines intersects the river. The deposit
dips to the southeast at a grade varying from 1 to 3 per cent. The shafts of the International Coal Mines are located on the southeast corner of the property.

The International Coal Mines property is bounded on the east and north sides by the Del Rio Road; on the south side by the De Bona Ranch; and on the west side by the Rio Grande River. The surface of the property, with the exception of a small portion in the northwest corner, is all under cultivation and is exceptionally good farming land. It is flat, irrigable land, lying in the onion belt of Texas and 15 or 20 acres is considered a good sized farm. Most of the tract, however, is divided into small ranches.

The structure of the formation is anticlinal in shape, the long axes of the anticline running southwest and northeast. This anticline is now being prospected for oil and the indication is very good, as there is oil on the surface of the "slush" resulting from the drillings.

GEOLOGY.

No attempt is here made to give any details of the Geology of this section, as this has been efficiently given by the Geological Survey of Texas and described by the United States Geological Survey, which offices have these records available. My aim is to give the
details of the coal deposit alone, as this will give an idea of mining methods to be successfully applied.

The deposit is interstratified with bone and muck and the occurrence of these waste materials is, in general, fairly uniform throughout the whole area.

There are two kinds of bone coal— one has no heat units whatever, while the other, according to the United States Geological Reports and a bulletin of the University of Texas, contains 10,000 or less B.T.U. Bone, bony or bony coal refers to that part of a seam in which the coal is highly charged with ash. In contrast with good coal it has a dull appearance, often resembling cannel coal, from which it may be distinguished by the difficulty in igniting. The waste bone, which lies next to the roof, is 4 to 6 inches thick and makes a good roof when the seam is high enough that sufficient height may be attained without removing this bone. After being exposed to the air it loses its dull appearance and has the semblance of a waste covered with alkaline salts. Under this strata of bone is a seam of clean bituminous coal 6 inches thick which is underlaid with a 4 inch seam of bone carrying about 8,000 B.T.U. and very high in ash and burns with a short flame. Below this lies a 2 foot seam of clean bituminous coal interstratified with two white bands of dirt, each about 1 inch thick. The coal is of a high grade, cubical cleavage, — contains very
little, if any, sulphur, and burns with a long flame.
The dirt bands are uniform throughout and easily break into small pieces. This seam is underlaid by a seam of dirt similar to that above, except that it varies in thickness from 8 inches to 18 inches and quickly disintegrates on coming in contact with air. Directly under the seam of shale is another seam of high class bituminous coal, varying from 6 inches to 1 foot in thickness. Pyrites do not occur often enough in any of the coal seams to be classed as impurities.

The formation is characterized by faults of small displacements, the greatest being a throw of no more than the thickness of the coal seam itself. Such occurrences are fairly common in this region, which shows evidence of much disturbance, a fact which causes a series of obstacles to mining. Owing to the small throws through the measures as a result of faulting and slipping, the overlying roof is very difficult to timber and make secure.

The strata is conformable. The faults are upthrow to the northwest and run in no general direction, as is known in some coal fields.

The floor of the coal seam is not a smooth surface but consists rather of a series of undulations of more or less vertical extent.

The coals are sub-bituminous and of Cretaceous Age. The coals here are lower in volatile matter and sulphur and higher in ash and moisture than the Laredo coals, the
fixed carbon being about the same. It varies from 60 to 90 inches in thickness but its dip soon brings it to so great a depth below the overlying sandstones and clays that it prevents profitable working in a wide range of territory at present. The general analysis of the coal is:

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<tr>
<td>Moisture ------</td>
<td>9.40</td>
<td>2.80</td>
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<tr>
<td>Volatile Matter--</td>
<td>33.10</td>
<td>32.80</td>
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<tr>
<td>Fixed Carbon ----</td>
<td>40.10</td>
<td>55.55</td>
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<tr>
<td>Ash -----------</td>
<td>17.40</td>
<td>8.85</td>
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<tr>
<td>Sulphur -------</td>
<td>1.30</td>
<td>.80</td>
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<tr>
<td>B.T.U. --------</td>
<td>11,150.00</td>
<td>13,160.00</td>
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MINING.

History:

The following is a brief historical sketch of the International Coal Mines Company and property up to January 1920, the time of purchase by the present owners.

Coal was first mined in the northwest boundary of the property now owned by the International Coal Mines Company fifty years ago and mining operations have continued in a small way since that time. The coal was hauled to Eagle Pass in wagons.

When the Southern Pacific Railroad was constructed
into Eagle Pass a man by the name of De Bona prospected and developed the property and proceeded to supply the Southern Pacific Railroad, and others, with coal. Through trades this part of the property became the Olmos Coal Mines Company. This portion of the property is now exhausted of coal. The remainder of the International Coal Mines Company's holdings comprises 2800 acres, 70 acres of which is fee simple, the balance being lease rights on coal.

On the southeast corner of this land Shaft No. 1 was sunk about 30 years ago and operations were continued until January 1, 1920, at which time it was permanently closed. About 1500 feet from Shaft No. 1 Shaft No. 2 was sunk about 10 years ago. Operations were continued there until the face of the workings had advanced about 1200 feet on each of the main sides of the shaft. For some time both mines were hoisting coal, the output being 400 or 500 tons per 10 hour day. Owing to a slump in the coal market and the slow demand for coal in the year 1912 it was necessary to temporarily shut down Mine No. 2. During the period of shut-down all the surface buildings and much other equipment were destroyed by fire. It was impossible for the owner to finance the rehabilitation of this mine at that time, but the cribbing that had been destroyed for about 50 feet down the shaft was replaced with new lumber which is yet in place. From observations
of the old foundations of machinery and buildings it can be seen that the construction of the tipple and other coal handling devices were much the same as the arrangements at Mine No. 1, which were obsolete even at that time.

The miners' houses, commissary, supply house, powder magazine, smith's and carpenter's shops, were for the most part modern and well equipped. The camp which was located at Mine No. 1 had a very complete water supply system and the work shops were fitted to do almost any kind of repair work that would be required in and about mines.

**Examination:**

In December 1919 the writer was asked by the management of the International Coal Mines Company to examine and report upon the possibility of rehabilitating the International Coal Mines, which property at that time had recently been purchased by its present owners, who operate the mines under the original corporation name.

During the latter part of 1919 I visited the mines, at which time Shaft No. 1 had just been abandoned, due to the fact that the air shaft had caved in from all four sides. This made it impossible to examine the workings at that time because of the absence of safety lamps and power for operating the cages. The main object of my visit at that time was to see the coal in place at different points, which was accomplished by going to the extreme northwest corner of the property. At this point a
The main drift had been worked to a distance of about 100 feet and had two cross drifts broken off from it. The character of the coal here indicated that the deposit could be worked economically because the appearance of the structure in these drifts verified what had been told me existed in the deeper workings by people who had been into the mines Nos. 1 and 2. Instructions were left with the man in charge to have steam in the boilers ready for the handling of the cages and a supply of safety lamps ready by January 15, 1920, at which time I expected to go into Mine No. 1. On that date, accompanied by two Mexicans, I descended into Mine No. 1 to thoroughly examine the conditions underground. There were no gases present and the inspection satisfactorily proved that the structure of the deposit at this point was exactly the same in character as it was at the outcrop, a distance of about 3 miles. For further proof I visited the Olmos Coal Mines, which are located a distance of 4 miles in a northeasterly direction from Mine No. 1, and found that there was no great difference in the physical make-up of the deposit, except that the dirt band was much thicker there because the Olmos Coal Mines are on the outcrop of the coal bed. Upon these facts I furnished an oral report to the owners of the International Coal Mines Company and advised the reopening of the mines, as it seemed to be a sound invest-
ment. At that time I was employed by the Central Coal and Coke Company, being in charge of the engineering work for their mines in the Arkansas and Oklahoma fields, and, having had supervision of much construction work with that company, I was well equipped with cost data which enabled me to give them estimates of costs without delay. The company fully approved the report as given and with its acceptance placed me in charge of all operations.

The first and best thing was to abandon Shaft No. 1 because of the excessive expenditures necessary to put the mine on a safe working basis. The tipple over Shaft No. 1 is a wood structure and is primitive and inadequate in every respect. It is served by a single railroad track. There is no protection for the men during bad weather, and the construction is of the crudest and most inefficient type. The cages are of the ordinary platform type, and are in a very decrepit state at the present time. In fact they should never be used again. They are not equipped for automatic loading nor unloading and are not even well adapted for hand operation.

The tipple is provided with one set of stationary screens but as there is only one loading track the screenings must be elevated to a bin and then loaded into a coal car placed on the main and only siding.

There is no provision for picking domestic lump coal nor for separating bone and other impurities from the coal.
In order to properly classify, clean and handle the coal efficiently, an entirely new tipple would be necessary in addition to the need of two more new sidings for direct loading of the fines.

It would be necessary to equip a new ventilating system, including the sinking of a new air shaft, the sinking of which, alone, would have cost $8000. The main hoisting shaft is too small and would need retimbering from surface to bottom. A dirt handling apparatus would be badly needed, as formerly the waste had been taken care of by man power, which is very inefficient where large tonnage is expected.

Owing to the lack of head room in the main entries it would be necessary to enlarge and retimber the main headings. The timbers already in place in the entries are carrying a great deal of weight and the cross-bars are bent downward in the center, which reduce the height of the original haulage ways.

The coal was mined partly by air puncher and partly by hand, or "on the solid". From the condition of the mine throughout it was evident that it had not received proper supervision. The mine had been so handicapped by former mistakes and misarrangements that it would have been impossible to put it on a proper going basis. The mine track below was in bad condition and needed new ties and, for the most part, new rails.
The entire power plant was in a general run down and dilapidated condition. The hoisting engine was too small and too slow, it being a second motion hoist and "knocked" in every connection.

From the above it can readily be seen that it would cost more to rehabilitate this mine than it would to construct and open a new one, for to have done the former would have resulted in having an old mine of which we had no knowledge of the extent nor condition of the workings, as they were for the most part inaccessible, because there were no mine maps nor plans of the workings. There was a small scale map showing location and logs of bore-holes that I afterwards found to be unreliable.

Method of Development:

It was decided to begin developing the property through Mine No. 2, which is located about 1800 feet from Mine No. 1 and, from all the information obtained from the miners who worked in both mines in former years, the two mines are connected underground. Mine No. 2, which is newer than Mine No. 1, was equipped several years ago and operated for a short time, but, as previously mentioned, the tipple was destroyed by fire and the mine was never operated again by the old company. Owing to an insufficient amount of funds the old company was not able to rehabilitate the mine. However, the railroad tracks and a twin hoisting engine were in place, the hoist, having been robbed of parts
but if replaced, was suitable for operating at a capacity of six or seven hoists per minute at a depth of 225 feet. The hoist, the shaft and yard tracks were an argument in favor of developing at this point, as this represented a big saving in money, to say nothing of the time saved that would have been required to sink a new shaft, build a new spur and set a new hoist. With this gain it was decided to make every effort to examine Mine No. 2 and get all the information concerning the conditions of the shaft bottom and entries, if possible, and with this in view two carpenters were engaged to build an old fashioned "strong-arm" windlass made from a large gas pipe and lumber for temporary use in descending and ascending into and out of the shaft.

On the morning of January 20, 1920 a carbide lamp was lowered, by means of a long cord, into the shaft down to the surface of the water below. Nothing happened, which was assurance that no explosive gas was present. A lantern was then lowered to the same depth and allowed to remain there for three hours, and not being extinguished in that length of time was evidence enough that there were no asphyxiating gases present. By this time the windlass had been completed and, with a rope 250 feet long, a piece of wood 2 x 4 inches and 2 feet long to answer as a seat or rest, I was lowered into the shaft by two Mexicans working the windlass.
The cribbing in the shaft, including walls and buntings, was in very good shape; that is, it would last about three years without giving serious trouble. The collar at the bottom of the shaft and on the east side was broken from being overloaded by carrying the weight of roof from which the timbering had been removed. The main headings run east and west. The east side had caved and the timbering on the west side was in bad shape, some sets being broken and some twisted out of line from the heavy pressure of the roof. As a result of the fire the bottom of the shaft contained a great deal of debris, consisting of partially burned timbers, scrap iron, railroad rails and pieces of machinery and it was difficult to get the depth of water or condition of the interior, however, it was estimated that the water was about 8 feet deep. It was decided to pump the water out in order that a more thorough examination could be made. While the water was being pumped out a small hoisting arrangement was erected on the ground consisting of the drum and gears of a builder's equipment, to which was connected a 5 H.P. motor that transmitted its power through a belt to the hoist. This outfit was strong enough to handle tubs having a capacity of about 30 gallons and succeeded in cleaning out the shaft to the bottom of the sump, working as the water was being lowered by the pump. As this work progressed the character
of the ribs, roof and timbering were carefully observed, disclosing the fact that the large dirt band which lies lowest in the coal seam was quickly disintegrated on coming in contact with air. These conditions existed throughout the mine, the air action undermining the coal and finally allowing caves and falls to occur. There were no large caves and the timbers were not rotted.

The atmosphere of the mine was almost void of air, but with safety lamps the greater part of the mine was examined. There were only two cross, or butt, entries turned off on both sides of the main west, and as the greater part of the coal to be mined lies on the west side of the shaft it was necessary to pay particular attention to this side of the mine. It was decided to clean the main west entry as far as it had been worked because this entry was to be the main haulage way throughout the life of the mine. The road had to be made straight, owing to the fact that it had a heavy grade and it would not be practical to zig zag by cleaning in one place and slabbing off the rib in another.

The old and only air course was on the north side of the main west and was cleaned in places where the falls were small, as this was more economical than to drive a new air course, however a new air course was opened on the south side of the main west entry in order to split the air and have at least two returns in the
main heading. No attempt was made to clean the butt entries. They were reopened by slabbing off the rib on the room side of the entries sufficiently wide to allow a new roadway and using the old entry as gobbing space. In this way many of the old rooms were reopened and there was no yardage cost for driving the entry. It is expected to reopen the first south entry as far as it has advanced to the solid working face in this manner and then continue on, more or less at random, around to the old working faces of Mine No. 1 and thus recover a great deal of pillar coal as well as some solid work that was left in the mine, also rails, timbers, pumps, etc.

In working the first north by the same method a great deal of pillar coal will be recovered from the old mines that were operated by the Olmos Coal Company, but which have been abandoned for several years.

The east side of the shaft was caved to such an extent that it was not considered profitable to clean but the same method of reopening was applied as was used on the west side. A run-around was driven east on the south side of the shaft by slabbing off the rib to allow the road to pass. This method will necessitate the caging of all the coal on one side, which is no serious disadvantage if properly handled by ample track space and caging apparatus.
Pumping:

The pumping of water out of Mine No. 2 was not the problem that confronted the International Coal Mines Company, it was the securing of machinery, as every one familiar with its purchase knows how different it was, and still is, to get delivery on machinery. After spending about two weeks getting quotations on mine pumps, without satisfactory assurance of delivery, it was decided to rebuild an old 2 inch, belt driven, centrifugal pump. The pump was rebuilt in San Antonio, Texas by the Alamo Iron Works - and to be driven direct connected to a 15 H.P. induction motor running 1700 R.P.M. The pump was successful from the start and is continuing to do good work. The body of water below to be pumped was distributed very favorably to pumping with a small pump, although it covered a large area, the underground workings being completely filled.

The shaft had been idle for 8 years without any care and naturally had many caves that dammed the water off but allowed a good drainage which kept the pump running constantly. As the cleaning of entries progressed these caves were removed and in four weeks all the water was pumped out from the west side of the mine.

After having handled all the water on the west side a more elaborate and efficient pumping plant was installed.
The pumping unit is composed of one 2 inch centrifugal direct connected and two 2 inch duplex Gardner pumps. The shaft bottom is provided with sumpage in excess of the pumping capacity.

Owing to the location of two mines that were worked out in the early days by the Olmos Mining Company, it was necessary to secure the mine from possible flooding resulting from connections that will be made as the International Coal Mines progress northwestward. The old abandoned workings are located on the "up hill side" of the International Coal Mines and the water is standing about 5 feet above the top of the coal in the old shaft. The difference in elevation of the surface of the water in the old mines and the high water level in the sump of the International Coal Mines is about 50 feet. Therefore, should a connection be made allowing the water to enter the International Coal Mines they would be flooded and the pumps submerged and rendered useless. To avoid this flooding of the pumps they were isolated from the workings by setting them as high as practicable to effect all the possible suction head; then inclosing the pumps on two sides with concrete dams left open at the top in order that the pumps may be accessible at all times for oiling and making the necessary repairs.

It is estimated that it would require about 10 days
to completely drain the two old Olmos mines. The com-
pensation for pumping will be the recovery of several
thousand tons of coal which is sure to have been left
as pillar coal just the same as in many other old mines
that were abandoned in earlier days. It is known by
old miners who worked in those mines that there was
never any attempt made at removing the pillars, which
is the cheapest coal to be produced, and at the same
time is the recovery of tonnage that would otherwise
be absolutely wasted if left in the mines.

On the east side of Mine No. 2 the formation dips
and there is no natural drainage to the sump at the
bottom of the shaft, therefore it was necessary to
install a gathering pump. The underground conditions
made it necessary to remove water from several places
during each day, hence a portable type of gathering
pump, the most useful appliance of its kind ever de-
signed for mine use, was adopted for this work. The
pump in use is made by the Fairmont Mining Machinery
Company and is gear connected and motor driven. The
motor is furnished to the manufacturers of this pump
by the General Electric Company and is a self starting
type of motor and therefore no starting rheostat is
necessary. Every part coming in contact with water is
made of acid resisting bronze.

When ordering pumps the manufacturers should be
furnished with the following data:

How many gallons you want to handle per minute.

The amount of suction lift; length and size of suction pipes.

State if you want to use one or more branches to suction.

The amount of discharge lift, length and size of discharge pipe. If other pumps use same discharge line, so state, giving approximate quantity of water passing through line.

Advise if the water contains any solids. Give character of water and state preference as to metal to be used in water end of pump.

If steam is to be used, give boiler pressure, length, size and condition of steam line and probable pressure at the pump.

If compressed air is to be used give air pressure at the pump.

If electricity is to be used, give voltage and state whether direct or alternating current. If alternating, give phase, voltage and number of cycles.

Ventilation:

No feature of coal mining is more important than proper ventilation at the working face, for on it depends the health and safety of the men working underground. Every man in a mine has a direct interest in its proper ventilation, and in case the mine is gaseous his life, as well as the lives of all other men working in the mine, may be lost if by poor ventilation explosive
gasses are allowed to collect in the workings. Therefore, it is the duty of every one working in the mine to see that the ventilation is always good.

No part of coal mining has advanced more in the last twenty years than has mine ventilation, but to equip a mine with expensive ventilating machinery is useless unless the management of the mine has the help of everybody in the mine, especially the miner. Much of the recent progress in mine ventilation has been the result of laws enacted to protect, especially, the lives and health of miners and they, above all persons, should do their part in keeping the ventilating equipment in proper condition. The carelessness of any man in a mine at any time; for example, in leaving trap-doors open, will render useless the best ventilating system, and thus lead to loss of life or lives and damage to property. Most of the states, if not all, have passed laws requiring that the volume of air circulated through a mine in a certain time shall be not less than a certain quantity for each person employed underground and an additional quantity for each animal working underground. The important features of the laws of Texas are here given and should be closely observed by the Superintendent, as to do so will result in much advantage to the miners as well as to the company.
"Sec. 2. (a) Throughout every mine there shall be maintained currents of fresh air sufficient for the health and safety of all men and animals employed therein, and such ventilation shall be produced by a fan or some other artificial means; provided, a furnace shall not be used for ventilating any mine in which explosive gases are generated.

(b) The quantity of air required to be kept in circulation and passing a given point shall not be less than one hundred cubic feet per minute for each person and not less than three hundred cubic feet per minute for each animal in the mine, measured at the foot of the downcast, and this quantity may be increased at the discretion of the inspector whenever in his judgment unusual conditions make a stronger current necessary. Said current shall be forced into every working place throughout the mine so that all parts of the same shall be reasonably free from standing powder smoke and deleterious air of any kind.

(c) The measurement of the current of air shall be taken with the anemometer at the foot of the downcast, at the foot of the upcast and at the working face of each division or split of the air current.

(d) The main current of air shall be split or subdivided (so) as to provide a separate current of reasonably pure air to every one hundred men at work, and the inspector shall have authority to order separate currents for smaller groups of men if in his judgment special conditions make it necessary.

(e) The air current for ventilating the stable shall not pass into the intake air current for ventilating the working parts of the mine.

(f) Whenever the inspector shall find men working without sufficient air he shall at once give the mine manager or operator notice and a reasonable time in which to restore the current, and upon his or their refusal or neglect to act promptly the inspector may order the endangered men out of the mine."
The fan house is a wood and concrete structure, the upper half of which is built of wood, the lower half being made of concrete which is tied to piers supporting the fan bearings and engine foundation. The house is provided with four explosion doors, two of which are placed directly over the shaft and in the roof of the building, while the other two are in the walls of that part of the house connecting the air shaft and fan house. The fan was placed at one side, out of line, so that it would not be destroyed or disabled if an explosion should take place, but would be ready for use immediately after the explosion, when it would be most needed. The merits of explosion doors and off-setting the fan from the mine opening have been proved several times at different mines.

Entrance to the air shaft proper is effected by passing through a set of double doors to prevent short circuiting the air current when a man enters the mine by way of the air shaft. At this point, hung on a board, is a map of the mine showing the courses of the ventilating current for the miners to see, in order that they may learn the paths of the currents so that if a fire or explosion should occur they will know the safest direction to take. Such training has resulted in lives being saved.
The air shaft is 10 feet square and "cribbed" with pine lumber. The timbering in the air shaft is of the square set type and lined with 2 inch by 12 inch pine planks. The method of timbering consists of a number of collars made of 6 inch by 8 inch timbers, having a vertical post (8 inch by 8 inch timber) in each corner 4 feet long, separating each collar 4 feet. Between the dirt walls and flush behind the heavy timbers were placed the 2 inch by 12 inch boards, which made up the retaining wall. The heavy sticks were first lined up and made plumb, placing as many as there was space allowed by downward progress of sinking in the shaft, by heavy wedging, first in one corner and then in another, until all the timbers were in proper alignment. This is, of necessity, a very slow and difficult task, as the dirt wall was of soft material. The plank wall was then put in place behind the heavy timbers and made secure with wedges. This was very fast work, it being only necessary to drop the boards in place, as the sets were then in proper place.

As the climate in this part of Texas is very mild, the air shaft will never become choked with ice. Masses of ice in the air shaft will prevent the free passage of air and may greatly reduce, or entirely cut off, the air current. Disastrous explosions have resulted from ice
or debris choking the air path. Airways should have as large a cross section as is practicable. Large airways with slow moving but ample currents are better than narrow air courses and fast moving currents, as the latter stir up coal dust, as well as other impurities that are harmful to breathe.

The ventilating equipment consists of a steel fan 15 feet in diameter; 5 feet wide; mounted on an 8 inch shaft having 24 inch bearings, and driven by a 26 inch by 32 inch single acting steam engine which is reversible. The mine is to be ventilated by two separate splits for the present. The cross cuts in the main entries will have to be overhauled, as the long standing of the mine has caused many of the mine timbers to break, thus allowing the roof to cave over the "gob" of old filled cross-cuts, thereby causing a great many leaks in the circulating air current. Improvised stoppings have been built and will answer the purpose until the old faces of coal are reached, at which time it is expected that all cross-cuts and air courses will have been put into first class condition.

At present the intake air passes through old workings, but the mine is not subject to spontaneous fires. It is best to ventilate old workings by allowing the return air current to sweep freely through them and if
gas is being generated it will be taken outside without injury to men or animals. In this mine the old workings generate hydrogen sulfide gas \( (\text{H}_2\text{S}) \) which heats the air current, gives off a bad odor, and is a source of annoyance to the miners. In the past miners have been permitted to shoot the coal as often as it was necessary during the working hours and the intake air was allowed to pass through old workings before reaching the miners. These two conditions have been corrected. The miners are instructed and compelled to fire their shots systematically at specified times. Also the air current is made to pass through its correct path, which allows the intake air to reach the miners first and the return air to sweep freely through the old workings. In this way working conditions were standardized.

At the mouth of the shaft a bulletin board is hung and the fire boss' record of the condition of the mine for each shift is shown, as well as individual places containing gases.

**Timbering:**

In all underground workings seasoned timber is preferable to green because it is better able to resist decay. The bark should invariably be removed from round logs, as the space between it and the wood affords an excellent breeding place for many forms of
wood-destroying insects, and the bark, itself, collects moisture and thus encourages the growth of fungi, which are the chief wood-destroying agents. Round timbers, when properly peeled and seasoned, are more durable than square timbers cut from a similar log of the same size and age, because the corners of the latter are especially liable to decay. In young and small timber, such as is generally used for mining work, the outer half of the log is usually sapwood containing starch, sugars, proteids, and other soluble organic compounds - the foods upon which decay-producing fungi thrive, which are practically wanting in the heartwood. If, in the process of squaring up, the attempt is made to obtain the largest possible square timber from a given log, the corners consist largely of this easily infected sapwood and are accordingly most liable to conditions bringing about quick rotting. It is not surprising, therefore, to find in moist underground workings, where square timbers have been in place for three or four years, that the corners of the timbers have decayed to such an extent that they can be pried off down to the heartwood with a miner's candlestick or any other sharp instrument. It is, of course, true that the outer part of a round log also consists of sapwood, but the exposed surface has not been injured or bruised by the saw.

Although round timbers deteriorate much more
slowly than square ones, they are not as easily handled in the mine, are harder to align properly, and it is much more difficult to reinforce them by the ordinary false sets.

The best method of checking the growth of fungi, and thereby increasing the durability of timber, is to poison the source of their food supply. Although there have been many processes invented for this purpose, most of those in use today depend upon the injection of either zinc chloride or creosote. The former can not be used advantageously in wet work, however, for, as it is soluble in water, it is soon leached out, leaving the timber just as susceptible to attack as before. But if creosote is properly applied it can not be washed out, no matter how much water passes over the timber, and for this reason it is the preservative generally employed in mining and tunnel work. It is, however, somewhat more costly than zinc chloride, and, as it is a liquid the transportation charges are considerably higher than on zinc chloride, which can be shipped in bulk.

The shaft bottom of Mine No. 2 had to be enlarged, both in width and length, to give more empty and loaded car capacity. Timbering the entry during the enlargement to full size was not a difficult operation. Starting at the last permanent set, which was at the edge of
the shaft proper, and proceeding toward the face, new permanent posts were placed in position as fast as the section was widened by "slabbing" and picking down the "ribs". Transverse spreader timbers were then placed between these posts with their bottom 14 inches below the joints and resting on timber ends spiked to the posts. Across these spreaders were laid two tiers of 2 inch plank, forming a floor 4 inches thick. The floor was some 2 or 3 inches below the bottoms of the caps resting on the false posts, so that it was easily laid while the false sets continued to hold the roof. Working from the end of this floor, the wedges and blocking transmitting the roof weight to the false sets were next carefully knocked out and the shattered roof picked down on the floor, from which it was later loaded into cars. By placing the permanent posts a foot or so in advance of the false posts, the timbers of the permanent set could be put in position as soon as the roof had been sufficiently removed. Lagging and wedging quickly followed, so that the roof was supported by the permanent sets shortly after the removal of the false blocking.

Timbering roof of the character such as over-burden the International Coal Mines is very expensive. The plans are to install a cement-gun for cementing the roof and ribs of all the main and cross entries as soon
as the old working faces are reached. The cement is to be put on as a coating \(\frac{1}{2}\) inch thick and is to completely cover the roof and ribs to exclude all contact of air, as air has a marked disintegrating effect on the roof as well as the band of muck underlying the upper seam. It has been proven that roofs of this character have been rendered safe and good by ceiling off the roof and coal to exclude the air. Main headings and butt entries will not need any timbering at all, except in places that are necessarily wider than regular entry width, because of the breaking off of cross-cuts and butt entries. Such places, of course, will need to be supported by heavy timbers. To successfully apply cement with a cement-gun it is necessary to pick off from the ribs and roof all loose materials, so that when the cement is applied it will have time to completely dry and set before any loose "chunks" fall off, leaving a place for air to enter and continue its work of destruction by entering into the small opening and thus forcing off the comparatively thin shell of concrete. It is a fact, too, that stoppings and overcasts could be made more efficient by the use of the cement-gun, it being cheaper and effecting a better ceiling, thereby giving a better ventilating current.

The following is the result of cement-gun tests,
and comparative costs of timbering and coating with cement-gun, which were conducted under the writer's observation:

<table>
<thead>
<tr>
<th>Description</th>
<th>Area/Volume</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Work Shot Inside</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>836' Main Slope - top and ribs</td>
<td>17747 sq. ft.</td>
<td>$218.00</td>
</tr>
<tr>
<td>Main Slope Gross Cuts - top and ribs</td>
<td>5476 &quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>Slope Partings - top and ribs</td>
<td>10945 &quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>12th East Pump Station and dam</td>
<td>4996 &quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>Total area shot</td>
<td>39164 &quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td><strong>Mixture used</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cement used - 619 sacks at .86</td>
<td>532.34</td>
<td>$128.56</td>
</tr>
<tr>
<td>Sand used - 68.77 yds. &quot;</td>
<td>224.87</td>
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<tr>
<td>Total cost material</td>
<td></td>
<td>$757.21</td>
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<tr>
<td><strong>Labor</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixing and sacking 50 shifts at 4.36</td>
<td>218.00</td>
<td></td>
</tr>
<tr>
<td>Operating gun 84 shifts at 5.00</td>
<td>420.00</td>
<td></td>
</tr>
<tr>
<td>Total cost labor</td>
<td></td>
<td>$638.00</td>
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<tr>
<td>Total cost material and labor</td>
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<td>$1395.21</td>
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<tr>
<td><strong>Cost for material - per square foot</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shot .01933</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cost for labor - per square foot</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shot .01629</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total cost per square foot shot</td>
<td></td>
<td>.03562</td>
</tr>
<tr>
<td><strong>Fan House</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cement used - 51 sacks at .86</td>
<td>43.86</td>
<td></td>
</tr>
<tr>
<td>Sand used - 5.7 yds. &quot;</td>
<td>18.64</td>
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<tr>
<td>Total cost material</td>
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<td>$62.50</td>
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<tr>
<td>Mixing &amp; sacking 4 shifts at 4.36</td>
<td>17.44</td>
<td></td>
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<tr>
<td>Operating gun 6 &quot;</td>
<td>30.00</td>
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<tr>
<td>Total cost material</td>
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<tr>
<td>Total cost material and labor</td>
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<td><strong>Cost for material - per square foot</strong></td>
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<tr>
<td>Shot .0207</td>
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<tr>
<td><strong>Cost for labor - per square foot</strong></td>
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<td></td>
</tr>
<tr>
<td>Shot .0157</td>
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<td></td>
</tr>
<tr>
<td>Total cost per square foot shot</td>
<td></td>
<td>.0364</td>
</tr>
</tbody>
</table>

Coating applied \( \frac{1}{4} \) to \( \frac{3}{8} \)" thick.
Comparative Costs of Coating With Cement Gun and Timbering and Handling Rock Falls.

Main Entries.

Cost per lineal yard for shooting slope and cross cuts, roof and ribs - 84 sq. ft.

at \( \frac{0.03562}{\text{yds}} \) ........................................... \( \$2.99 \)

Present average cost per lineal yard for timbering and handling rock falls ............. \( 21.83 \)

Cost per lineal yard for shooting equals 13.59 per cent of cost of timbering and handling rock falls.

Partings.

Cost per lineal yard for shooting with cement gun - top and ribs - 93 sq. ft.

at \( \frac{0.03562}{\text{yds}} \) ........................................... \( \$3.31 \)

Present average cost per lineal yard for timbering and handling rock falls ............. \( 26.58 \)

Cost per lineal yard for shooting equals 12.45 per cent of cost of timbering and handling rock falls.

Cross Entries.

Cost per lineal yard for shooting with cement gun - top and ribs - 54 sq. ft.

at \( \frac{0.03562}{\text{yds}} \) ........................................... \( \$1.92 \)

Present average cost per lineal yard for timbering and handling rock falls *(This figure is very conservative and probably less than actual cost.)* 4.17

Cost per lineal yard for shooting equals 46.04 per cent of cost of timbering and handling rock falls.

The Gun will also greatly reduce cost, due to the loss of coal on account of entries being blocked with rock falls, which runs from three to nine cents per ton.
Lighting:

The lighting of non-gaseous mines has never been any great undertaking, as open lights could be used, but even the best open light is a poor illuminant, and men have ever been in search of better lamps. The practice of working with a safety lamp is unjust to the workers in the mine. It is not a "safety lamp", as sad experience has taught us, to work a mine with hundreds of men and boys when the air of the whole mine is so near its explosive point as to necessitate the universal use of a safety lamp.

Gas is not generated in an appreciable quantity in the International Coal Mines, but should large feeders develop it would be no effort for the ventilating system to handle them. The amount of air will be increased until the volume of air introduced will be amply sufficient to dilute the gas to a non-explosive mixture and allow the use of open lights. It is a pitiful condition to allow men to work in a mine where the ventilation is so sluggish that the gauze in the safety lamps would be red hot from burning gas inside of them. The safety lamp was never intended by the inventor, Sir Humphrey Davy, as a source of light to be provided to work by; it was only designed as a testing apparatus to locate danger in the atmosphere of the mines.
The main haulage ways are lighted with electricity, as well as the shaft bottom, pump rooms, and places that would be dangerous for men whose lamps might become extinguished. The miners use the small carbide lamps.

Method of Working:

There are two general methods of working coal seams, as follows:

(1). Room and pillar
(2). Long wall.

However, there are a great number of methods that are modifications of the above two systems.

The principal causes affecting the extraction of coal are -

(1) Weight of overlying strata or depth of the coal seam.
(2) Strength and character of roof.
(3) Character of floor.
(4) Inclination and thickness of bed.
(5) Presence of gas in the coal or in the overlying strata.

The thickness of cover at Mine No. 2 of the International Coal Mines is 220 feet made up of shale, slate and sandstone, the thickest stratum of sandstone being 3 feet through. The roof immediately above the coal is slate interstratified with thin layers of coal and shale, which breaks down easily and chokes worked out rooms, and is very desirable as it eases weight on
adjacent pillars. This roof does not have the characteristic of arching and therefore caves will cut vertically on the rib line for a height of 40 or 50 feet and is a disadvantage to entry work, it being necessary to timber flush with the rib of the entry and is therefore very expensive.

The coal is hard and the character of the floor is soft, therefore if the pillars are not large the weight of the overlying strata will cause the floor to heave, a condition that is injurious to mining and ventilation, as air course area may be reduced and the loss of unworked portions will result.

After a careful study of the conditions, labor, etc., it was decided to adopt the room and pillar system of working. The entries are driven on 30 foot centers, each entry being 10 feet wide, leaving 20 foot pillars and no pack or gob wall is used. The rooms are turned on 40 foot centers, each room and pillar being 20 feet wide and thick respectively, and working face on. The road is carried on one side only, and close to the rib, leaving the balance of the room space for gobbing waste and only requiring one pack wall. (To build a good pack wall requires muck skill and extra time, therefore, if the road was carried in the center of the room two pack walls would be necessary.)

*A rib is the face of solid coal along the side of the workings.
Room necks are 7 yards long and 10 feet wide; depth of rooms is 275 feet and cross-cuts are 40 feet center to center. The roadway is carried on the corresponding rib in every room, and as soon as a room is finished the pillars near the road are pulled, leaving the pillars near the entry undisturbed in order that the main haulage way will remain secure until the entry has reached the boundary line, at which time these pillars are drawn together with the "chain" or entry pillars. The character of the roof is such as to not permit salvaging of mine timbers after or while the pillars are being drawn.

Mining Machines:

It is the intention of the company to mine the coal mechanically with a reciprocating and continuous cutter machine for undercutting. The reciprocating machine combines electricity and air, a small motor driving a pair of pistons in a cylinder, the confined air between them acting like a spring. The machine is manufactured by the Pneumelectric Machine Company of Syracuse, New York, and consists of the motor, gear case and cylinder - all combined into one complete compact unit of small dimensions - and much lighter in weight than the chain type of machine, though much heavier than the old fashioned air puncher machine. There are two pistons in the cylinder - one is driven
by the motor, while the other carries the cutting tool and is acted upon by the compressed air. The blow is powerful, effective, and capable of dislodging more coal with less power consumption than any other machine of the puncher type, and in addition to this the advantage of electric transmission of power is available.

The machine, being lighter, is especially adaptable to entry driving and narrow work of any kind, as well as where the roof is bad and timbering is necessarily heavy and close to the face of the working place.

It is used to good advantage in conjunction with other types of machines, as each machine is applied to the condition to which it is particularly adapted and thus secures economical results. The Pneumelectric Puncher is to be recommended for cutting coal which is loose and inclined to settle into the kerf during cutting, as it is easily disengaged from the mass of loose coal.

This machine can be furnished with motors wound for the standard mine voltages of either direct or alternating current power. Each machine is furnished with a cable, reel, tools, picks, running board, truck and shoe.

The conditions of mining encountered in the mines of the International Coal Mines Company require the use of two types of machines. At this writing none but the puncher type of machine has been tested. The other
machine to be installed is the "Arcwall" or "Turret" type of chain machine. It is similar to the short wall machine mounted on a pivoted table, enabling the cutter frame to swing in a half circle. It is carried to the face on mine track and operates without leaving the track. This type is especially suited for cutting in, above, or under a dirt band, or to cut the parting entirely out. It is advantageous for top cutting under bad roof, as no shots are required near the roof to fall the coal. It is adjustable vertically, and can cut anywhere above the top of the rail. It produces cleaner coal, with less picking, as dirt bands and seams can be entirely cut out and gobbed. The cutter bar is 7 feet long and will cut a working place 20 feet wide. The machine when working under ideal conditions will cut eight or ten places 18 to 20 feet wide in a day. The dirt bands are very hard and heavy track is being laid, as these machines will be of great strain to the track. The thickness of the dirt band is greater than the kerf can possibly be and great care will have to be exercised in order that the machine will not "climb" out into softer cutting. These difficulties will have to be worked out from experience.

Blasting Powder:

For breaking down the coal the miners are furnished with black powder and dynamite by the commissary department. The powder furnished is "B" powder (Na NO₃) of
the FF and FFF sizes, depending on the character of the coal to be broken. The powder is packed in sheet iron kegs of 25 pounds capacity. The company forbids the miners to use dynamite, as it is dangerous to transport and handle. However, in some classes of work they are permitted to use it because of the non-effectiveness of black powder, which is slower than dynamite. Its use is also permitted in wet places. The dangers of dynamite cannot be too forcibly impressed upon men working underground.

Not long ago an old Mexican miner started to work in a room that had been made idle on account of the illness of another miner. The owner of the room had carelessly placed half a stick of dynamite in a small hole in the rib and had said nothing to any one about it - the old man, after completing his work for the day, started to timber his place before going home and in so doing was picking a hitching in the rib for the crossbar when the explosion of the piece of dynamite occurred, shooting him in the face and resulting in the loss of his eyesight.

Haulage:

Mine haulage systems are very widely different as conditions govern this phase of mining. The following are the four leading systems of mine haulage:

1. Animal haulage
2. Mine locomotives
3. Endless rope
4. Tail rope.
The International Coal Mines Company is now using animal haulage, as the hauls are short and the output is not yet great enough to necessitate mechanical equipment. When the workings have advanced to a point 1800 feet from the shaft bottom a hoist capable of handling ten empty cars is to be installed above the butt entries towards the face of the main west. The loaded cars will be brought to the bottom of the shaft by gravity. It will, however, be necessary to use a mule to help the hoist drop the empty cars into the cross entries, as the grade is not steep enough to allow the work to be done by gravity. The coal will be hauled from the face of the working places to the mouth of the cross-entries by mule power, from which point the loaded cars will proceed by gravity to the bottom of the shaft under control of the rope. As a factor of safety, dog holes have been made every 50 feet in order that men traveling may have a means of escaping a wild trip or other emergency.

Mine Track:

Economical transportation of coal underground, from the working face to the bottom of the shaft, is essential to the successful operation of a coal mine. It is, therefore, necessary that proper consideration be given to gauge of track, weight of rails, size and spacing of ties, road bed, etc.
To insure the highest economy there are needed:

1. Favorable grades
2. Good trackage
3. Partings and side tracks
4. Sufficient mine cars
5. Suitable mechanical equipment
6. A carefully planned and supervised system of haulage.

All of the foregoing, with the exception of the first mentioned, are attainable by good management plus an understanding of the conditions likely to be met, and even in the first much may be done to better prevailing conditions.

In these mines methods that are considered historical in mining were found to still be in use. In some places, such as in turning rooms, wheelbarrows were used for carrying the coal to the main track. Many of the working places - (rooms) - that were worked in the early days still have the wood rails just as they were originally laid. Even today when a Mexican miner needs a pair of rails he will ask for 2 by 4 inch sticks to lay down as rails, as they do not like to use steel rails for the reason they are heavy and difficult to handle in close places.

The present workings are all supplied with steel rails and ready made ties. In the butt entries and rooms 16 pound steel rails are used, while 25 pound
steel rails are used on heavy grades and main haulage ways. The main west entry, which will be the main haulage way throughout the life of the mine, was not worked systematically, as the entry is very crooked and the track laid in such a way that the rail joints formed the necessary curves. It was very important that the track in this entry be straight as it has a heavy grade in favor of the loads. The roadway was straightened by slabbing off the ribs first on one side and then on the other until the whole length of the entry was on a tangent.

After making the grade uniform by taking up bottom and filling in low places the new ties and heavy rails were laid in place. Formerly the shaft bottom handled all the coal with a cross-over switch, but this has been removed and a double cross-over, or diamond, installed to permit the passing of loaded cars from one side to the other. The bottom parting was widened to give more room for spragging, greasing and for the mules to turn and pass around cars. After laying the new diamond switch on the bottom the double track was extended in length sufficient to accommodate five four-car trips, which will later be extended to hold three rope trips of ten cars each.

Rooms are served with tongue switches and the entries are served with split switches.
Mine Cars.

The car is the universally adopted medium for conveying the coal from the working places to the surface. As might be expected, owing to the many conditions encountered in mining, cars vary greatly in construction and in detail. Height of seam, bed top, heaving bottom, quality and use of coal, methods of payments for coal loaded, dimensions of shaft, system of haulage, etc., exercise an influence over cars.

As many considerations as possible were given to the different aspects having the most important bearing on the size and kind of car to be used in the International Coal Mines. As there were a great many old cars laying around the property that had been discarded, it was decided to use a car of the same shape, size and gauge, in order that the old irons might be utilized in building the new cars.

In mine cars, as in track work, we can find no evidence of standardization. The head of one important concern states that they have in their shop files over 2,000 drawings of mine cars of different patterns, and that they have never, as yet, built mine cars for any two companies exactly the same. (See Coal Age Vol. 8, Pg. 24).

Our mine cars were built by our mine shops, with the exception of the trucks which were purchased from
the Ottumwa Iron Works. These trucks were built according to the following specifications:

- Wheel Base - 20 inches
- Diameter of wheel - 16 inches
- Roller bearing
- Floating axle
- Track gauge - 36 inches
- Maximum load - 2 tons

The roller bearings to be inside the wheel hub instead of in the journal boxes.

The advantages of the wooden car lie in its cheapness, lack of stiffness in transportation, and the ease with which repairs can be made by unskilled labor. The bottom of the car is built of 3 inch oak, the side, flare, doors and end boards being 1\(\frac{3}{4}\) inches thick. The car is of the double flare type and has a capacity of 1 ton when loaded with coal, level, to the top of the car. The mine has heavy grades and the cars are only loaded level full to prevent spilling of coal on the track, thereby causing wrecks and derailments. To provide a means for unloading the coal from the car while dumping, an end gate is fixed to the forward end. The end gate is of the lift gate type, which has become standard for use at shaft mines, having self dumping cages. The regular drawbar for side bumpers is used, being made of iron \(\frac{3}{4}\) inch thick and 4 inches wide, and bolted to the bottom of the car with 5/8 inch by 5 inch
bolts. The hitchings are of the style commonly found in use in mines; that is, they consist of three links and a clevis on each end for coupling the cars. This coupling is used because side bumpers require long couplings, for in passing around curves of short radius there is always danger of bumpers interlocking and causing derailment. The following inquiry for mine cars is generally used:

- Capacity in tons and cu. ft.
- Single or double flare.
- Track gauge.
- Diameter of wheel.
- Spokes curved or straight.
- Axle round or square.
- Size of axle.
- Wheel base.
- Material for body, steel or wood, or both.
- Length of car, including bumpers.
- Length of body - inside measurement.
- Kind of bumpers.
- Height of car overall from top of rail.
- Width of car inside - at top.

**Hoisting:**

Hoisting in a vertical shaft does not vary a great deal in arrangement. This company is using the simple hoisting system consisting of the two ropes passing from
the drum to the sheaves which are carried by the tower of the head frame, and two cages which work in balance. This is called the balanced hoist system.

The hoisting machinery consists of a twin hoisting engine, having cylinders 16 inches by 32 inches with a flat drum 5 feet in diameter. The engine is rather old fashioned, but is a first class hoist as regards speed and power, which are the essential things in hoisting. It was built by the Ottumwa Iron Works, Ottumwa, Iowa.

The mine is equipped with two Olson self dumping cages built by the Eagle Iron Works. They are all steel cages, supplied with safety catches, dogs, etc., and weigh about 4,000 pounds each.

Dirt is hoisted in the same manner as is coal, except that the dirt is received by a special bin after passing through a system of doors located in the bottom of the coal hopper. The dirt bin has a capacity of 18 tons, which allows for storage during a break-down on the dirt dump and while repairs are being made. The bottom of the dirt hopper has a sliding door for unloading the hopper and loading the dirt car which handles the dirt from the bin to the dumping ground over an inclined track raising at the angle of about 30 degrees with the horizontal. The dirt car has a capacity of three mine cars and dumps automatically.
from both sides. It is a wood car lined inside with sheet iron, the end view of the bottom appearing in the shape of an inverted "V", making angles of 45 degrees. At the top of the incline is a tripping block in the center of the track at the dumping point which trips the latches holding the doors shut, thus allowing the dirt to pass out. The dumping point may be chosen at any convenient place along the incline, it only being required to replace the tripping block at the desired point of dumping. This is a great advantage when it is necessary to extend the incline or make repairs on it, such as are often needed. The capacity of the dumping ground is limited only by length of haul that would be economical handling.

The dirt is hauled up the incline by a 20 horse power motor. Controller is of the inclosed type, having over-load capacity and is equipped with a no-voltage release. The engine is capable of delivering a rope speed of 200 feet per minute under normal working conditions. The dirt car and dirt hoist are linked together with a 5/8 inch steel rope 600 feet long and winds over a sheave 3 feet in diameter located on the end of the dirt dump.

To lubricate and preserve the steel hoisting cables from being acted upon by fresh, salt or acid waters, and injurious elements, a dressing is applied about every 4 months.
Power Plant:

For convenience our steam power plant is located near the mine, as it is impossible at this time to exactly locate the load center. At present the company is purchasing electric power from the International Electric Company at Eagle Pass. The current is A.C. 60 cycles, 3 phase, received from a 2300 volt high tension line and is transformed to 220 volts at the mine. The power plant now consists of a battery of two 175 H.P. horizontal return fire tube boilers. These boilers are cheapest in first cost, but have lower capacity per unit of space as compared to water tube boilers. In general, they are the most difficult to keep in good operating condition when dirty or hard water is used. As the power consumption of the plant is relatively small it was more economical to install fire tube boilers instead of water tube boilers.

Uniform grey bricks were used in those portions of the settings which are well protected from extreme heat, and carefully selected fire bricks were used for the walls and arches where high temperatures exist. The life of the boiler setting is dependent upon the class of brick selected. The outside and end walls
are 13 inches thick while the center wall is 30 inches thick. The setting is partially supported by the brick walls; the points of support are made flexible for the expansion and contraction of the metal in the boilers by placing pieces of sheet metal on the top edges of the walls upon which is placed three roller bearings \( \frac{1}{2} \) inch in diameter, and on these bearings rest the lugs of the boiler. Between the walls and the boilers 2 inch air gaps were left to help take care of expansion. The brick walls are assisted in carrying the load by a frame structure built of large timbers from which is suspended the boilers and tied together by long stay bolts and buck stays.

In general, for each kind of coal there is some method of firing which will give the best results and experience and practice only show what method is best suited to the coal to be fired. In order to utilize the bony coal, which would otherwise be a waste at the mine, the fireman is supplied with sufficient help to break and mix the bony coal with an amount of clean coal such that the mixture will be consumed in the fire box. Firing under these conditions is not ideal, yet it is not the laborious task that it seems. A great deal of ash results from this method of firing, but the greater part of the ash is used underground for building road beds.
The draft is induced by a round steel stack 36 inches in diameter and 90 feet high, sitting on a brick stump and connected to the boiler by a breeching of rectangular cross section equipped with dampers for directing the draft through either or both of the fire boxes. The stack is braced with eight guy wires, four are fastened near the top and four at about the center. Each of the guys are made secure by tying to "dead men". At this time it is necessary to work only one boiler and neither boiler is in service for more than a period of one week, when it is put down, thoroughly washed and cleaned and made ready for instant operation. The steam feed line to the main hoist is a 5 inch steam pipe.

**Water Supply:**

Water is supplied to the International Coal Mines Company by an irrigating company owned and operated by the Onion Growers Association. The water is pumped from the Rio Grande by means of a centrifugal pump having a 14 inch section and a 12 inch discharge. From the pump the water is conducted by a system of irrigating ditches, cared for by the International Coal Mines Company, to the Company's reservoir, which is located near the commissary and Mine No. 1. This reservoir is an excavation in the earth, lined with cement, has a capacity of 25,000 gallons and is surrounded at the surface by a board wall 5 feet high. The water is
pumped from this reservoir to a wood tank located on a hill about 50 feet high by a 2 inch centrifugal pump running direct connected to a 5 H.P. motor. The wood tank is the distributing point for the mines and camps. The water as supplied to Mine No. 2 flows by gravity through a 2 inch pipe line from the wood tank to a sheet metal tank located near the mine, which is the source of supply for mine use, including water for mules, boilers, bath house and drinking purposes.

The water used by the boilers is treated by passing it into a chamber attached to the discharge of the boiler feed pump containing a compound called "Buckeye", which is a treatment for scale forming water. There are two ways of treating water carrying scale forming ingredients: First, by chemical means which cause such impurities as are carried by the water to precipitate. Second, by applying heat. The former treatment is applied by the International Coal Mines Company, the compound being prepared by the Buckeye Company, who took samples and analyzed the water.

The composition of boiler compounds is almost invariably based on soda with certain tannic substances, which, it is presumed, encircles scale particles and prevents their adhering to the boiler surfaces. In no case should boiler compounds be used except when the boiler is thoroughly cleaned and examined before
introducing the compound.

Wash and Change House:

A wash and change house comes next to ventilation in importance to the health, welfare and efficiency of the miners. It has been noticed that the shower bath house is very popular among the Mexican mine workers. Most of the men like to go to and from their work dry and clean. Such self respect is commendable and is encouraged by the company by their providing suitable means whereby it may be satisfied.

Mining is, of necessity, dirty work and if men, especially young men, are to be attracted to mining as an occupation a wash house at the mines is more or less inviting. A wash and change house is particularly needed because the houses of the miners, owner by the company, are not close to the mine and in nearly every instance these houses have no running water, and it is therefore very inconvenient for the men to take the required number of baths. The lack of surplus room in these cottages also makes it difficult to bathe daily in privacy, and if the miners can bathe and leave their soiled clothes at the mine the task of keeping the home clean is lessened.

Most of our miners wear only "breech-clouts" while at work in the mine and upon coming to the surface go directly to the wash house and clean and
refresh themselves. Even though the weather here is never severe the wash house is located close to the mine mouth and the men are not exposed unnecessarily to the rain or cold.

The house is built of wood and concrete. The floor is concrete and is provided with good drainage, in order that in addition to draining off the bath water the main floor of the house may also be scrubbed with ease.

The water mixer is a simple arrangement composed of cold water pipe line and a steam pipe line. This mixer does not guard against scalding accidents nor unnecessary waste of water resulting from experimentation by the user.

Tipple:

The tipple is a frame structure consisting of three bents, which are built suitable for a shaker screen, and a tower 50 feet high. The main feature of the tipple is the type of construction, which will be set forth by giving the details of one leg in the tower. The tipple is built of 3 inch lumber throughout, the tower consisting of 3 x 12 inch by 20 feet long designed as follows: Two pieces of boards, each 3 inches thick by 12 inches wide, one of which was 10 feet long and the other 20 feet long, were placed narrow edge down, flush at one end and separated by
3 inches. Butted to the end of the 10 foot stick, and 3 inches away from the one-half of the 20 foot stick, was placed another stick 20 feet long. The joint was made by inserting a 3 inch by 12 inch board 5 feet long, then bolting the three sticks together. This was continued until the leg was 50 feet long. When completed the leg had four joints. Five boards 3 inches by 12 inches by 20 feet long were required to build one leg, but required cutting in two one of the 20 foot boards, thus making the joints of the leg 10 feet apart. Each end of the legs was left open in order to bolt them to the collar of the shaft at the surface, and to the caps at the top of the tower. The tower was braced with 3 inch by 12 inch lumber and bolted to the legs.

This type of tipple has proven to be a very flexible construction, as it can easily be strengthened by adding more braces, or even increased in height if more head or winding room is necessary. It requires no fancy cuts on timbers, is easy to handle, and can be built and put up in less time than any other type of tipple; besides it costs less than any other class of wood tipple of the same dimensions.

Yard Arrangement:

On the opposite side of the lump track from the tipple is a 36 inch gauge track built in the shape of
a semi-circle, whose arc is tangent to the lump coal car. This track is elevated 7 feet above the top of the rail of the yard tracks and has a branch line that crosses the lump, slack and nut tracks, passing under the dirt incline and running to the boiler room. The semi-circle track handles the waste coming from the coal pickers on the lump car. The branch line is to serve the boiler room bunkers and handles the bony coal from the coal pickers on the lump car and the clean coal that supplements the bony coal in the bunkers of the boiler room. Under the incline track and over the track which serves the boiler coal bunkers is a hopper that has a capacity of 8 tons of coal for boiler purposes. After the dirt has been cleaned out the boiler coal is dumped into the dirt hopper, and with the help of the dirt car on the inclined road the coal is hauled and dumped into the storage bin from where it is taken by means of a side dumping car to the bunkers in the boiler house. The parts of the elevated road passing over the lump, slack and nut tracks are so arranged that they have to be raised in order to spot empty coal cars and to allow the loaded coal cars to pass out. This is accomplished by a system of pulleys and the dirt hoist, which is so located as to do all the heavy work or lifting, such as pulling empty and loaded coal cars, lowering and
raising steam and water pipe lines in the shaft, smoke stacks, swinging and lowering heavy timbers into the shaft, etc.

Ashes and refuse from the boiler room are handled by loading into a mine car which runs on a surface track laid for this purpose. The car after being loaded is caged at the landing during intermission of hoisting - then hoisted and dumped into the dirt hopper, from where it is carried to the dirt dumping ground in the regular manner.

It is seen that all the arrangements have been laid out with the view to doing as much of the heavy work as is possible mechanically.