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ROOSEVELT TUNNEL

Speedy Progress, Methods that Save Time—Use of 100-Per-Cent. Blasting Gelatine—Novel Counterbalanced Hoist

Written for "Mines and Minerals," by R. L. Herrick

Three sets of contractors, one after another, had tackled the driving of the Roosevelt tunnel previous to February, 1908. For reasons needless to here discuss, each set in turn threw up their contract in despair of making it profitable. Some blamed the terms allowed by the Tunnel company, but with emphatic unanimity all agreed the rock was the hardest and toughest material, worth comparing with the "Hinges of Hades."

The following brief record tells the story of discouragement which begins with the breast of the tunnel, 7 feet wide and 10 feet high, advanced 88 feet by the Tunnel company. The first set of contractors began work on June 1, 1907, and drove the tunnel 18 feet farther than the Tunnel company had done; they then quit in hope of securing better terms. The Tunnel company here again took up the work on June 21, 1907, advancing it to a total length of 421 feet by August 15, 1907, before another contractor was secured. On this date the El Paso Mining Co. stepped into the breach and advanced the breast to a length of 1,226 feet in the 4 months up to December 16, thus averaging but 201 feet per month. Superintendent Brainbridge, of the El Paso Co., then drove an additional 213 feet in the 6 weeks ending February 1, 1908, thus averaging but 142 feet per month. When it is recalled that according to the terms of the early contracts, a minimum of about 260 feet per month had to be driven in order that the contractor just break even, the situation is better understood.

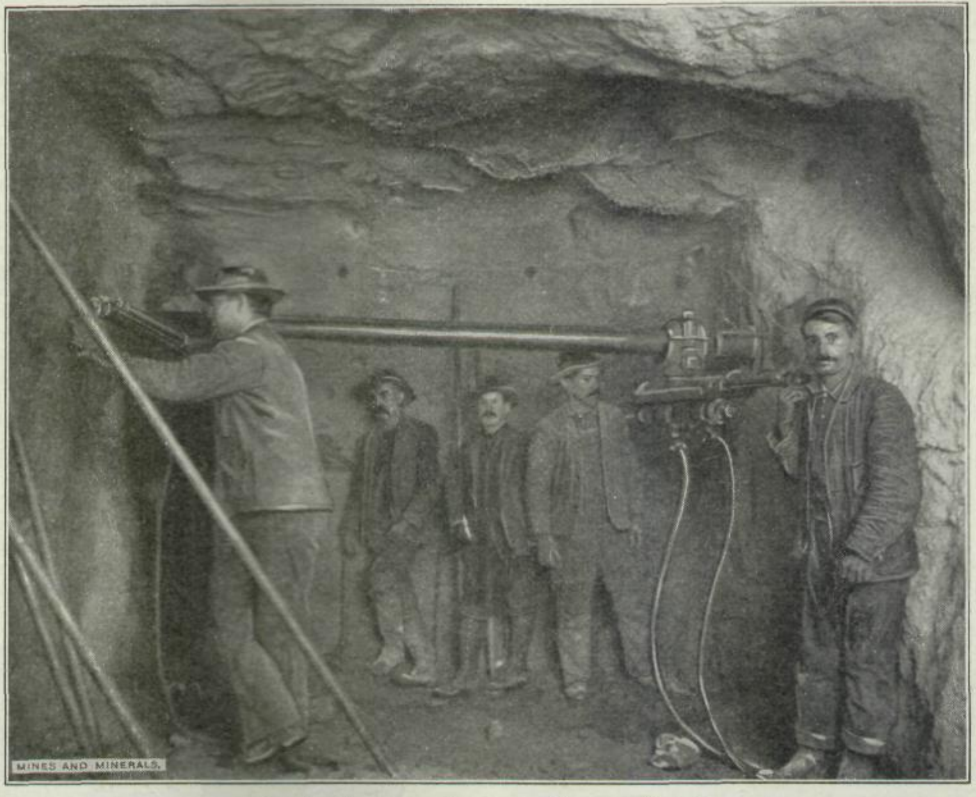


Fig. 1. Breast of Roosevelt Drainage Tunnel

Now comes the story of encouragement, the success achieved by Mr. A. E. Carlton, the well-known Cripple Creek banker, and his able superintendent, Mr. James A. McIlwee, an expert practical tunnel driver. The accompanying table is the record of the past year's achievements as recorded in monthly progress by Engineer T. R. Countryman.

At the present writing, February 1, 1909, the eventual successful completion of the tunnel draining the Cripple Creek mines is thus assured by a year's steady work by one contractor.

On January 27, 1909, the breast of the tunnel had advanced to a distance of 4,814 feet from the portal, or more than half way to the intermediate shaft sunk on the line of the tunnel, distant 7,975 feet from the portal and 6,662 feet from the El Paso shaft. The rate of progress at this time was about 14 feet per day.

Monthly Progress of Roosevelt Tunnel

1908	Feet	1908	Feet
February	211	August	300
March	303	September	351
April	262	October	287
May	268	November	360
June	187	December	334
July	203	January, 1909	435
Total for twelve months			3,501
Average			292 feet per month

A rock, whose resistant qualities are so graphically described to the visitor, and illuminated by lurid flashes of eloquence in emphatic comparisons with the hard rocks of other "regions," is surely worthy of a brief description here.

The rock in question is that designated by the government geologists as the Pike's Peak granite. Most of it thus far penetrated by the tunnel is composed mainly of coarse grains of reddish feldspars, a small amount of quartz, and is usually deficient in hornblend and other dark-colored constituents. In some parts the rock has a gneissic or schistose structure, but in the main it is characterized and one might say, made notorious, by the lack of seams or joints. As the miners say, "there is nothing to break to," a statement well borne out by Fig. 1 showing the irregular way in which the rock has been "chewed out."

Thus, while the rock itself is hard, the lack of lines of fracture and planes of seaming is doubtless responsible for the poor rate of progress made by the first contractors. The illustration shows the breast of the portal carried, roughly, 10 feet high by 7 feet wide as it was up to the period of the Carlton contract.

Immediately on taking charge, the new contractors changed the shape of the tunnel to 10 feet wide by 6 feet high above the rails. Up to this point it had been planned to lay the floor of the tunnel on stulls so as to give 2 feet clear below them for a drainage space. It was originally planned to then double track the tunnel so that it might serve for ore transportation as well as drainage.

In adopting the new tunnel section with its 3 × 6 drainage ditch, best shown in Fig. 2, the plan of using the bore for ore transportation was not necessarily abandoned. The ditch is overlaid with ties spaced on 5-foot centers which at present support only the air pipes, and the tunnel is thus far single tracked, but may be easily double tracked at any time if desired. The point here worthy of note, however, is that as the first 1,400 feet of tunnel is unprovided with a ditch, the lower end of the tracks are flooded every time the breast encounters a water flow. The tunnel grade (.3 per cent.) has of course prevented much of a setback of water toward the breast.

In an address given before the Colorado Polytechnic Society, in February, 1908, Mr. T. R. Countryman, the engineer in charge, basing his estimates on the experience of contractors previous to that date, estimated 250 feet per month for each heading worked as the probable best average rate of advance that could be maintained in the future. As has been noted in the foregoing, this average has already been exceeded by about 42 feet

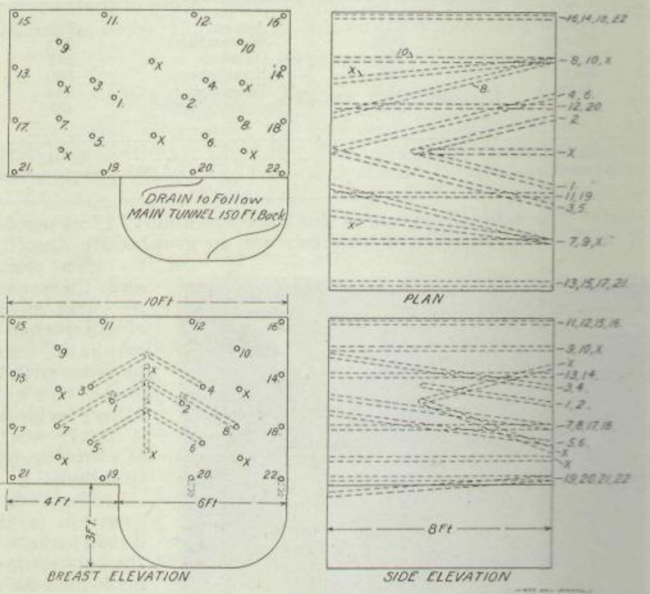


Fig. 2. Drilling in Cripple Creek Drainage Tunnel

for the 12 months of the Carlton contract. The present indications are that during the year 1909, the 300 feet advance originally estimated by Mr. D. W. Brunton will be exceeded.

The writer believes that if due weight is given to all the obstacles overcome in driving this tunnel, the rate of progress maintained entitles the contractors to consideration in the championship class. In the record of 435 feet for the month of January (rate of advance of over 14 feet per day) the championship 30-day record established by the Gunnison tunnel (449 feet) is closely approached, and that of the Ophelia tunnel (395 feet 8 inches), is exceeded. For that reason, the system of work is of timely interest.

Drilling.—After the trial of several systems of placing the drill holes, the one shown in Fig. 2 was finally proved the best adapted to the tough nature of the jointless rock.

In attacking the ordinary rock, all holes, were drilled 8 feet, except the cuts and relief cuts, Nos. 1 to 8, inclusive, which were drilled to a 10-foot depth. In extra tough ground, these lengths were each cut down 2 feet and in addition to the 22 holes used on the ordinary rock and numbered in Fig. 2, the six extra holes "X" were put in. In the good breaking ground encountered in the month of January, however, the cut holes were drilled 11 feet, and all others 9 feet deep.

At first, even with the use of from 300 to 350 pounds of 60-per-cent. dynamite, great difficulty was experienced in properly blasting the eight cut holes, sometimes several loadings of them being necessary to blow out the cut. After finally putting in the two extra cuts shown, however, even the toughest ground yielded. The system of placing the holes was evolved, not only with a view of best blasting the tough rock, but also to allow of the greatest economy of time in drilling. These ends proved to be best effected by mounting the two Leyner drills on a single horizontal cross-bar wedged against the sides of the bore as seen in Fig. 1, instead of on the usual two independent vertical columns. In this way even the maximum number of 28 holes required but two set-ups of the bar. It will be readily understood that this way of placing the bar eliminates the necessity of mucking out to the bottom before starting drilling, as when vertical columns are used.

The grade line is carried about 18 inches below the top of the bore and about 8 to 12 inches below this is placed the bar. From this, the center and corner back holes are drilled, and then by revolving the drill around and beneath the supporting bar to the position clearly shown at the right, Fig. 1, all of the remaining holes except the center lifters and bottom corners are put in.

It will be understood that the difference in the level of the drill bit between its position on top of the bar, and below the bar, amounts to about 2 feet. By using proper judgment in placing the horizontal bar, therefore, the feat of putting in 18 holes from one set-up is easily accomplished. The cross-bar is then shifted to its second position, usually about 18 to 24 inches above the floor, and the last four holes put in. In tough ground an extra center cut hole "X" is also put in from this set-up.

The bits used at the start of a hole are 3 feet in length and have a diameter of $2\frac{3}{4}$ inches. Each succeeding steel is 2 feet longer than the one before, the 11-foot cut holes requiring 6 steels to a hole, while the others require 5 steels each. The diameter of the hole bottom averages about $1\frac{1}{2}$ inches.

The number of steels has been carefully determined so that as fast as one becomes dulled, it is replaced by a sharp one. While this may seem a minor point, experience in the last 5 months has proved it a potent factor in influencing the speed of drilling, and increasing the rate of progress made in driving the tunnel.

The ditch was kept back of the breast about 150 feet and taken out at convenient intervals by placing vertical 3-foot holes spaced on 2-foot centers along the intended center line of the ditch, an ordinary tripod being employed for this work.

The water Leyner drills have enjoyed in recent years a well-earned reputation as record breakers and on this work they have proved no exception. Until recent months the No. 6 drill was employed until supplanted by the newest model, the No. 9, heavy duty. One of the chief faults previously found with Leyner drills had been the breakage of expensive parts due to the knocking of the hammer head upon its enclosing case, whenever, for various reasons, the drillman did not succeed in feeding the machine fast enough so that the hammer head always struck the steel. One of the new features of the No. 9 drill is the making of the drill case in three parts, the front head, cylinder, and back head, which are held together by the rods and heavy springs clearly shown in Fig. 3. With this construction, occasional blows of the hammer upon the case are taken up by the springs while a succession of heavy blows results in breaking a spring or in stripping the thread of the rod or breaking its bolt head rather than in breaking the case.

To one witnessing the operation of these drills for the first time and familiar only with the various types of piston drills, several features are noticeable.

In starting a hole, the rapidity of the drill's hammer blows make the bit "bite" at once at any angle and there is comparatively little or no loss of time due to the meandering of the point about a circle several times the diameter of the hole it eventually cuts after once getting a fair start.

A feature worthy of mention that is not often taken into account is the saving of time due to the elimination of a "**U**" bolt on the machine. The shank of the bit merely carries two protruding lugs which fit into the drill chuck. In changing the steel, the helper gives the dulled steel a quarter turn forward, pulls it out, inserts a sharp one and gives it a quarter turn back, all of which is done while the drillman is cranking back, turning the drill on its cone, and cranking forward into the hole again, taking in all less time than is required to loosen a "**U**" bolt. The actual time consumed in changing steel by Superintendent McIlwee's expert crew will not exceed 1 minute.

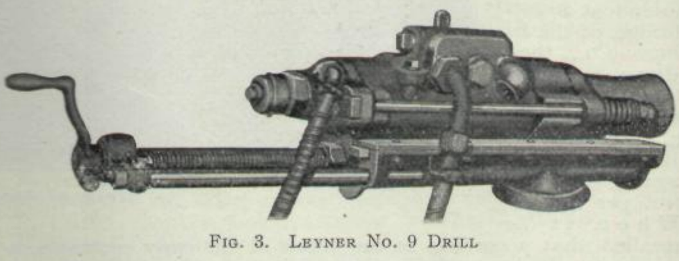


Fig. 3. Leyner No. 9 Drill

The actual drilling of an 8-foot hole is said to require about 20 minutes on an average in ordinary ground. One hole timed by the writer required 27 minutes including the time of changing steel, so this was doubtless about the average speed.

In ordinary ground the usual 22 holes amount to a total of 188 feet of work or 94 feet per drill, while in tough ground the 28 holes amount to 240 feet or 120 feet per drill. The time consumed in drilling in the first case, estimating 16 feet per hour, is about 6 hours while in tough ground allowing 15 feet per hour, drilling requires 8 hours, although ground is seldom encountered that takes that long.

Blasting With 100-Per-Cent. Dynamite.—The present method of loading the holes is a result of evolution and careful experimenting with an explosive new in the Rocky Mountain region, known as "blasting gelatine," called 100-per-cent. This has

FIG. 4. PORTAL OF ROOSEVELT TUNNEL

been made by the duPont company for more than 10 years but never extensively adopted. (See MINES AND MINERALS for January, 1909, page 232.)

The absorbent base for the nitroglycerine is gun cotton and as compared with other dynamite such as 60-per-cent., it is 40 per cent. stronger, hence the classification as 100 per cent. for it will do as much work as pure nitroglycerine. In appearance it resembles a stiff white bread dough, and is quite as plastic and compressible. In other qualities, except one, it resembles other dynamite and is as safely governed by the ordinary rules of shipping, thawing, etc. The single exception referred to is its sensitiveness. Being less sensitive than other grades, the duPont company recommends that it should be exploded with never less than quintuple caps, or double-strength electric fuses. In price it is but little more expensive than other grades, the cost being 23.5 cents per pound in carload lots, f. o. b. Denver, as compared with 15 cents for 60-per-cent. and 12 cents for 40-per-cent.

Up to September, 1908, the cut holes were loaded with heavy charges of 60-per-cent., and others with 40-per-cent. The results were unsatisfactory owing to the difficulty in properly blasting the cut holes as before mentioned. The average monthly progress for 7 months previous to this date was about 248 feet. Since September, the average progress for 5 months has been about 353 feet or 105 feet per month gain. This resulted in bringing the total progress for the last 5 months of the year to about 1,767 feet, or 33 feet more than the total for the preceding 7 months.

Mr. Carlton's cost figures show that the average cost per foot during the last 5 months is $6.64 less than the average for the preceding 7 months.

It is only fair to add, that while the 100-per-cent. powder must be credited with effecting considerable of the increased progress, the breaking quality of the rock has noticeably improved with the advance of the tunnel, as in places it was considerably more "blocky" than at first, though far from ideal. The method finally adopted for loading the holes is as follows:

The 10-foot cut holes were loaded with five $1\frac{1}{4}$ in. × 8 in. sticks of 100-per-cent. powder for ordinary ground, or seven sticks in extra tough ground. The bottom stick, or primer, carried a No. 20 blasting cap attached to the fuse. On top of this blasting gelatine were six to eight $1\frac{1}{4}$ in. × 8 in. sticks of 60-per-cent. powder. This amount of powder was rammed into the 3-inch holes so that from 4 to 5 feet were occupied by the charge and the hole was then tamped to the face.

The relief cuts used no 100-per-cent., but instead two sticks of 60-per-cent. were placed in the bottom carrying the cap and on top of this were rammed 5 to 6 sticks of 50-per-cent. The rest of the holes were usually loaded with from 10 to 12 sticks of 50-per-cent. powder. Electric shot firing was tried but owing to the difficulty with the cut holes, proved unsuccessful.

Silvanite fuse, manufactured in Denver, was favored for either wet or dry holes as being cheapest and highly efficient, although somewhat more quick burning than other makes. The fuses were cut in the following lengths:

The right-hand corner lifter (22), Fig. 2, intended to be shot last, had its fuses cut 12 feet long. The cut holes (1 and 2) shot first, were 18 inches shorter than this or 10 feet 6 inches. The next fired holes, the long cuts (3 and 4) had their fuses 2 inches longer and so on in order of the numbers on Fig. 2.

As a result of this system, the last shots, 19, 20, 21, and 22, throw the muck back from the face as far as possible, leaving a space that with a comparatively small amount of labor can be cleared sufficiently to allow the first set-up of the drills.

Immediately after blasting, the Root blower located in the shop at the tunnel portal is started up and, through the 16-inch pipe brought to within about 150 feet of the breast, the gases are rapidly sucked out. In 20 to 25 minutes after the blast, the air is clear enough to allow the next crew to go to work.

Mucking.—No attempt is made to clean the tunnel at its new breast, clear to the bottom. Instead, the top of the pile is cleared out to allow a working space next the roof of from 3 to 4 feet and this is ample to allow the first set-up of the horizontal bar. Near the end of the shift the three muckers have nearly cleaned up the pile on top of the sheets of ⅜-inch iron placed near the face before the blast. By the time the drillmen are ready for the second set-up, the pile is nearly cleaned up to their feet. The force of the explosion is such that the iron sheets must be heavily weighted down on the floor in order to receive the newly blasted rock, and not be blown some distance and badly crumpled up.

Accordingly, the iron sheets are laid in their new position and the last few cars of muck that clear the breast to the floor are shoveled on to them to act both as protecting layer and to weight them down. In hard tough rock about 25 tons are broken per round of shots while in the better breaking ground, from 30 to 35 tons is the average.

Tramming.—The tram cars have a capacity of about 36 cubic feet, holding about 2 tons, and are trammed in mule trains of 10 to 12 cars to the portal dump. As the tunnel is only single tracked, the empties brought in are kept out of the way of the loaded cars coming out as follows: Arrived at a point about 100 feet from the breast where the trains are made up, the mule is unhitched and the cars disconnected from each other. Each car is then turned over on its side next the drainage ditch and rests on the ties over it which support the air pipes and electric wires. In this way the flanges of the car wheels clear the tracks by several inches, allowing the loaded cars a ready passage out.

When the mule has hauled out the loaded cars, the empties

FIG. 5. HEAD WORKS AT INTERMEDIATE SHAFT, ROOSEVELT TUNNEL

are quickly and easily turned back on to the track by a dexterous jerk. The one nearest the face is first loaded and then pushed back past the last car lying nearest the portal. Then the next car is jerked back on to the track, loaded and pushed out to join the first and so on, till the entire train of empties has been replaced upon the track, loaded, and stands coupled together awaiting the return of the mule. The three muckers alternate in this work of replacing the cars or in assisting the mule driver to turn them over and in pushing the loaded car the short distance to the place of making up the trains. The cars are of the usual type of steel car and showed no apparent ill effects of this method at the time of the writer's visit.

The Portal Plant.—Those who joined in the celebration of starting the tunnel on May 11, 1907, will scarcely recognize the surroundings of the portal at the present time, as can be seen by a comparison of the cut on page 535, July, 1907, Mines and Minerals, with Fig. 4 of this article.

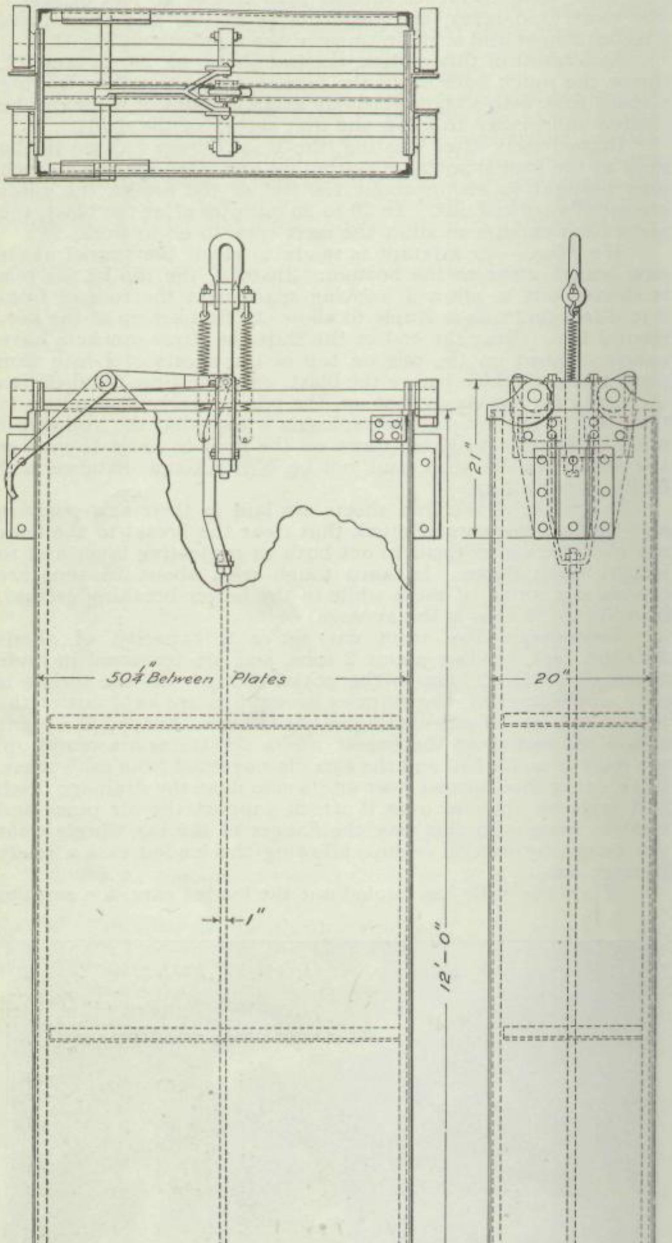


Fig. 6. Water-Tank Counterweight

It will be recalled that the portal is situated in Gatch Park, 6 miles down the cañon from Cripple Creek. The large building to the right houses the air compressor plant and the blacksmith shop, while just to the left of the portal is the transformer house with the diminutive powder house at the extreme left. The transformer house receives the power, from the Fairview substation, transmitted at 6,600 volts, which is stepped down for all the motors to 440 volts and for the lighting circuit to 110 volts.

An old model Blaisdell 18" × 12" × 12" drill compressor somewhat intermittently compresses the air to 110 pounds, driven by a 75-horsepower induction motor, General Electric type. As the elevation of the portal is about 8,000 feet, this compressor is sometimes hard pressed to keep the proper pressure on the drills with which it is connected via a reservoir by a 6-inch main.

A feature worthy of note in passing is the electric heating device for thawing powder in the little powder house. This is about 4 ft. × 5 ft., on ground plan by 6 feet high in front with a sloping roof, the whole well lined with building paper. The walls are lined with shelves holding the powder while the electric heater stands on the floor. While nothing new in principle, it is interesting as an example of the blacksmith's ingenuity under Superintendent McIlwee's direction. It consists of two rectangular frames, 12 in. × 24 in., made of 1½" × ¼" iron held apart 3 inches vertically and supported on legs above the floor. Each frame carries a row of small porcelain telephone insulators spaced on 1½-inch centers along the long sides. Across the frame between each corresponding pair of insulators extends a coil of ordinary galvanized telephone wire, all the various coils being connected in series. The coils on the bottom frame depend from their insulators and are likewise connected in series with each other and with those of the top frame.

The electric lighting circuit is connected to these coils via two fuse cartridges placed one in the powder house and one in the transformer house, while the switch that throws on the current is located for control, in the latter. The current does not heat the coils to a redness but nevertheless in about 30 minutes time the temperature of the house is raised to and maintained at a constant temperature of about 80 degrees. As the house has a southerly exposure, it is necessary to have the current turned on only from about 4 p. m. during the night up to 10 a. m. Mr. Carlton states the cost of power for this time is about 10 cents per 24 hours, a figure ridiculously low when compared with that of the former method of steam heating with Crested Butte coal costing $7.50 per ton laid down.

The blacksmith shop is well equipped and among other features has a No. 2 Leyner drill sharpener which easily handles the 150 odd steels per shift. Two blacksmiths are employed on the day shift, one sharpener, and one welder, the latter welding enough steels for 24 hours so that one sharpener alone is required on the night shift. This brings the total crew to 10 on the day and 9 on the night shift, respectively, as follows: Two drillmen at $5 per shift; two helpers at $4.50 per shift; three muckers at $3.50 per shift; one driver at $4 per shift; two blacksmiths at $5 (one only on night shift).

Careful training in systematic work and in giving attention to details has developed these crews into more efficient ones than commonly found. Their relatively high pay is accounted for by the fact that the term "shift" has no recognized length of hours. The day crew goes on at 8 a. m. and stays with the work till the muck left by the previous shift is cleaned up and a new round of shots put in and fired. The night shift goes on at 6 p. m. and does likewise. In good ground this means from 7 to 8 hours work, in tough ground from 9 to 10 hours—in which case not a complaint is heard.

A bonus system based on the progress made each month has been recently put into effect so that the project is thus made virtually a partnership enterprise.

The Intermediate Shaft.—In order to hasten the completion of the tunnel, it was orginally planned to sink an intermediate shaft on the line of the bore 10,570 feet from the portal. From the bottom of this, two headings could be driven, one to meet the heading advancing from the portal and one to cut beneath the El Paso shaft. The original plans have been carried out except that instead of locating it as first planned, a site was chosen close beside the road (as shown in Fig. 5) and thus more accessible.

The elevation of the shaft collar is 8,743 feet its depth to tunnel grade 685 feet where it is distant 7,975 feet from the portal. The shaft is 5 ft. × 10 ft. in the clear, timbered with 8" × 8" timbers hung on 5-foot centers. It was commenced August 16, 1907, and finished in the 13 months ending September 16, 1908. Sinking operations were conducted with a single-drum H. & B. steam hoist, but after the headings had been advanced about 100 feet each way, the steam boiler, engine, etc., were cut out and a 50-horsepower General Electric motor geared to the drums of a double-drum Ottumwa steam hoist.

Hoisting by electricity during sinking operations has sustained a black eye in the Cripple Creek region due to several fatal accidents resulting from the failure of the power at critical moments just before blasts. It is difficult to persuade the miners to work under such conditions and for that reason electricity was not employed until the completion of the shaft.

Ventilation.—The illustration, Fig. 5, shows the 18-inch ventilating stack extended some 15 feet above the top of the head-frame. This extends to the bottom of the shaft. At the collar it has a T connection with an 18-inch pipe leading to a No. 9 Buffalo forge blower, belted to a 5-horsepower motor. This pipe has a cut-off valve located a few inches from the vertical stack, while in the stack itself just above its junction with this pipe is another similar valve. During drilling operations in the headings below, the stack valve is open while the other is closed. The air from the drills then tends to make a sufficient ventilating current so that the stack is merely an adjunct to the up currents in the shaft compartments. After blasting, however, the stack valve is closed, the pipe valve opened, and the blower started up. Of course the compressed air pipes in the headings are turned on at this time blowing the gases of the explosion to the shaft bottom. The strong current of air from the blower pipe creates a swift upward current in the shaft which sucks out the gases. This is merely a temporary arrangement, however, till the headings have advanced far enough to allow pipes connected with the stack to be extended into them within 150 feet of the breasts without being blown down at every blast. The fan can then be used to suck out the gases directly rather than to blow as at present.

At the time of the writer's visit, the headings had been advanced some 250 feet using heavy piston drills. An opportunity was therefore afforded to make a comparison of these with the hammer drills at work in the portal heading. Recently these headings were shut down to await the arrival of four No. 9 Leyner drills. Since their installation the management expects that a speed can be made in both headings equal to that maintained in the portal heading.

In preparation for handling expected flows of water, a triplex Aldrich pump of 75-gallons-per-minute capacity, electrically driven, 15-horsepower motor, has been installed in the small station cut in the granite back of the shaft. This is merely a temporary arrangement, however, till the connection is made with the drainage ditch of the portal heading. At that time a novel scheme of hoisting will be put in operation which merits a description here.

Water-Tank Counterweight Hoisting.—This scheme contemplates the use of a water-tank counterweight whose descent along guides in the pipe and ladderway compartment shall hoist men and rock up the skipway from the tunnel below.

At the present time, water for the 12-drill Norwalk air compressor is brought from the old El Paso tunnel to the shaft via 1,800 feet of 3-inch diameter pipe. After the connection of the shaft and portal headings, the surplus water will fill the tank counterweight, already installed, and in its descent raise the loaded skip. At the shaft bottom the tank will be automatically emptied into the tunnel ditch and the water will thence flow out to the portal. By this method, the use of electric power, except possibly for starting the load will be greatly cut down and the costs thereby considerably reduced.

At the present time, an automatically dumping skip has replaced the 1,000-pound capacity bucket used in sinking. Its cable passes over one head-frame sheave to one of the hoist drums, while the other drum winds the cable passing over the other sheave and fastened to the water-tank counterweight in the ladder compartment. The hoist brakes and clutches thus control the movements of the skip and tank which may be operated either together in counterbalance exclusive of the electric motor, or controlled independently by the latter. Both skip and tank were built by the Pioneer Foundry and Machine Works of Victor, Edward F. McCool, manager.

The skip has a capacity of 35 cubic feet, and empty weighs 2,000 pounds, while full of rock weighs 5,600 pounds. The tank counterweight, illustrated in Fig. 6, is 12 feet long, 50 inches deep, and 20 inches wide, the restricted space in the small compartment being responsible for these dimensions, especially the narrow width. It holds 92.4 cubic feet or 5,736 pounds of water, while its empty weight of 2,250 pounds brings the total to 7,986 pounds. The weight of the full water tank therefore exceeds that of the full skip by 2,386 pounds. The weight of the $\frac{3}{4}$-inch plow-steel cables attached to both is about 600 pounds. In starting to hoist the skip, by letting the water tank descend, its 1,786 pounds surplus weight can be supplemented if necessary by the motor.

Arriving at the tunnel level, the discharge of the water is effected by the striking of a cam by the tank lever seen at the left top, Fig. 6. This operates the lever to pull up the circular discharge valve 15 inches in diameter and quickly empties the tank into the drainage ditch. On the down trip of the empty skip, its 2,000 pounds weight opposes that of the 2,250 pounds empty tank and 600 pounds of cable so that the peak load on the hoist is only 850 pounds.

It is estimated that by this method the loaded skip can be hoisted every 5 minutes. The pipe line was therefore constructed with the aim of bringing enough water to the receiving tank of the head-frame to serve this purpose. This tank holds just the amount of the counterweight tank whose top position is just beneath it. The turning of a valve is all that is necessary to quickly and exactly fill the counterweight. The receiving tank fills from another reservoir tank while the counterweight is making its trip.

Surface Tramming.—Instead of discharging into the usual surface bin, the skip is automatically dumped via a chute into the surface tram cars one of which is seen standing on the trestle, Fig. 5. These have a capacity equal to that of the skips. They are of the well-known type of triangular section body with side dump similar to those employed at the Portland and Golden Cycle mines, each carrying a small 3-horsepower motor. Unlike the cars of the other mines, however, they do not carry a platform and controller to accommodate an operator. Their control can be made wholly automatic, a feature for which the manufacturer, Edward F. McCool, manager of the Pioneer Foundry and Machine Works of Victor, has applied for a patent.

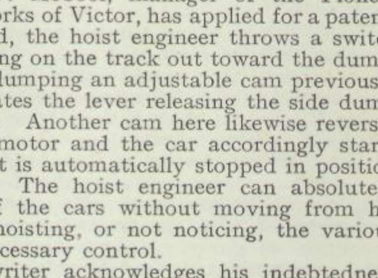
After receiving a load, the hoist engineer throws a switch which starts the car moving on the track out toward the dump. At the place desired, for dumping an adjustable cam previously attached to the rail operates the lever releasing the side dump and the car is discharged. Another cam here likewise reverses the current through the motor and the car accordingly starts back to the shaft where it is automatically stopped in position to receive another load. The hoist engineer can absolutely control the movement of the cars without moving from his place, but in case he is hoisting, or not noticing, the various cams properly give the necessary control.

In concluding, the writer acknowledges his indebtedness to Mr. A. E. Carlton, Engineer T. R. Countryman, and Superintendent McIlwee, also to Mr. Edward McCool and Messrs. Cleaver and Sharp for the data and illustrations of this article.

Improved Ejector

The ejector here shown is used for raising water from deep wells, mines, or pits, filling or emptying tanks, and for raising and transferring either hot or cold liquids.

The superiority claimed for this ejector by the makers, the Lunkenheimer Company, of Cincinnati, Ohio, lies in the tubes, which are made of a very hard grade of bronze especially adapted for the severe service to which ejectors are generally subjected. These tubes are screwed in the body, and are not loosely placed therein and held by the unions only, as is commonly done, consequently, there is no possibility of losing the tubes when the unions are removed.



The company claims great economy owing to the improved shape of the tapers inside the tubes which require a less amount of steam for a required quantity of water. It is claimed that the ejector will lift water to a greater height, will force it higher, and will take water at a higher temperature than other ejectors.

The parts subjected to wear consist only of the tubes, and these can readily be renewed at small cost when necessary. It is only necessary to turn the steam on full to operate the ejector, and after getting the flow of water established, the steam can be throttled to a very low degree.

The following tables give the amount of lift, together with the height that the ejector will force when placed about five feet above the water level.

Lift of Ejector Given in Feet. Feedwater 75° F.

Pressure, pounds	5	10	15	20	25	30	40	50	60	70	80	90	100
Lift, feet......	3	7	11	15½	21	21	20	19	18	17½	16½	15½	14½

Height (in Feet) Ejector Will Force When Placed Five Feet Above Water Level. Feedwater 75° F.

Pressure, pounds........	20	30	40	50	60	70	80	90	100
Height, feet............	18	28	36	46	57	66	74	84	92

The output of rubies in Burma during 1907 ammounted to 2,128,368 trucks, valued in Magok books at $577,325. The royalty revenue for the year was $99,245. The market for rubies was fairly good the first of the year, falling away discouragingly toward the last of the year.—*U. S. Consular Report.*