CIRCA 1941-42

Benton Mine

THE BENTON GOLD MINE

NEAR GRANTS PASS, OREGON

INTRODUCTION

Students of mining engineering schools wish to obtain employment during their summer vacations but it seems to be relatively difficult for them to achieve that objective.

Early in the spring of 1940 I attempted to secure a summer job at a western gold mine. Subsequent correspondence resulted in what I considered an almost definite promise of a job. However, my trip was fruitless and I was told to begin "rustling." The manager of the mine told me never to mention that I was a student because such a statement would prevent my being hired. The foremen of all the mines visited asked for men who had experience. The three months instruction at school in drilling and blasting--secondary to the mine surveying--can not be termed experience in the true sense of the word.

A student could tell a "cock and bull" story of having worked in some mines, hoping that the foreman would not check his references but such a practice is clearly opposed to the ethics that should be inculcated in all mining engineers as set forth in the "Manual for Student Associates and Affiliated Societies" published by the Institute. The members of the Institute who are in charge of mines seem to present a paradox because they expect students to have high ethics but when they try to get jobs as lowly muckers, they are almost forced to make questionable statements if they

are to be hired.

Surely there must be a solution to the matter. Many coal and oil companies have adopted a policy of employing students during their summer vacations but to the best of my knowledge the metal-mining companies have not instituted such a program. Is that an indication that those companies do not want graduates of mining schools?

It may appear that students want jobs handed to them on the proverbial "silver platter" but such is not the case. All that is asked is a little encouragement. The present shortage of skilled labor due to the defense program may temporarily alleviate this condition but after the program is completed students probably will not be able to obtain summer employment in metal mines unless the companies change their attitude.

After a month and a half of fruitless "rustling", I obtained a job at the Benton gold mine through the influence of a friend. Most of the information forming the basis of this paper was gained while working there.

As I expect to graduate in May, 1941 I will not again be in the position of a student seeking summer employment but other students will be and unless the condition is remedied, they will have the same experience as I did.

ACKNOWLEDGEMENTS

Grateful acknowledgement is extended to E. A. Youngberg,

George Gale, and C. O. Schrader for their aid. Thanks are particularly due Superintendent Youngberg for permission to write about the mine.

LOCATION

The Benton mine is situated in the Mt. Reuben district of the Siskiyou National Forest, the claims which constitute the Benton group are found in sections 22, 23, and 27 of T 33 S, R 8 W, Josephine County, Oregon. (See Plate 1)

HISTORY

In the past the area has been known as either the Gallice, Merlin, Glendale or Rogue River district. From 1854 to 1890 the mining consisted of placer operations. Since that time quartz veins have been found which were probably the source of the gold.[1] The Mt. Reuben district experienced activity between 1891 and 1907. The J.C.L. and Benton claims were developed then by J. C. Lewis but only the latter group, consisting of seven and a fraction claims, were patented. No further work was done because the production was unprofitable until 1930 when a small crew worked a high-grade ore shoot for a short time.[2] In 1937 work was resumed with a profitable output of 45 tons per day which was to have been increased to 55 tons by a mill addition in the autumn of 1940.

TOPOGRAPHY

Josephine County is in the Klamath Mountains. The

GEOLOGIC MAP OF AREA AROUND THE BENTON MINE

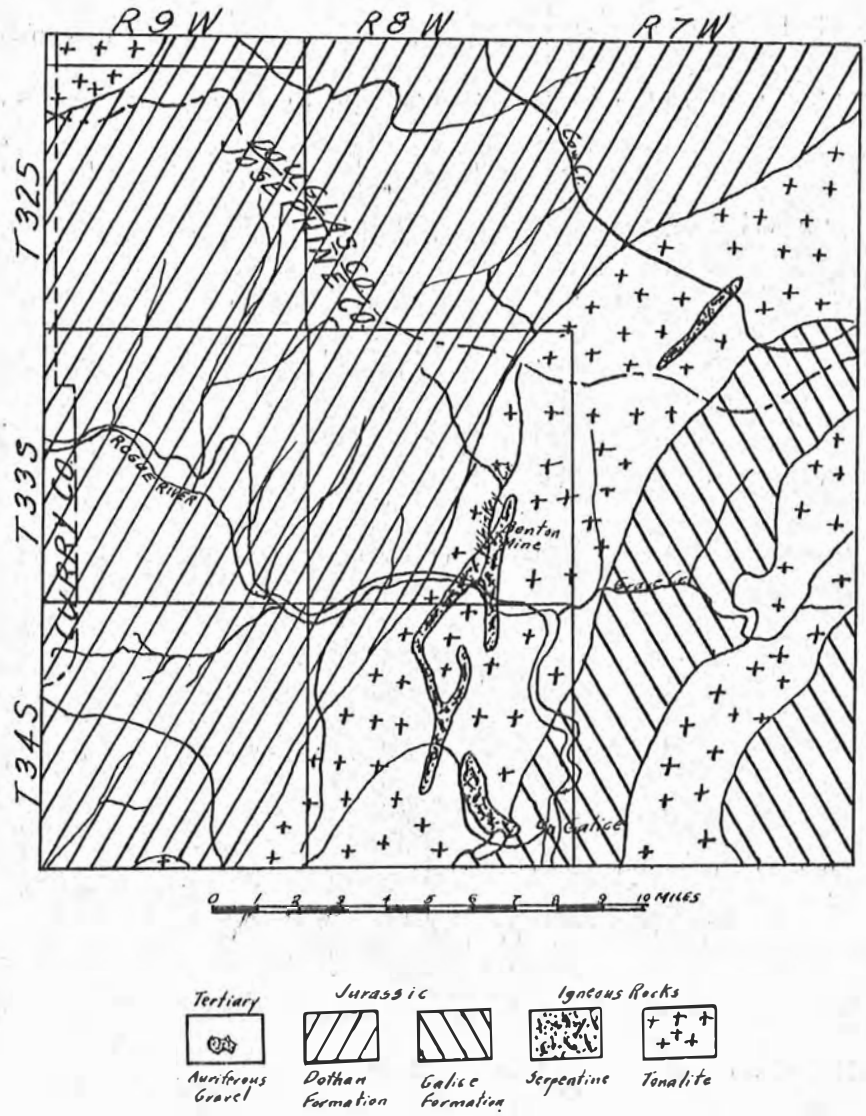


Plate I

Rogue River is the main stream of the area and flows into the Pacific Ocean; it has cut a sharp valley into the rock but there are places along its course where it has formed a broad stream bed as a result of flowing over soft rocks. The Benton claims are on Drain Creek which flows into Whisky Creek as the latter passes through the camp. The camp--bunkhouses, homes, mess hall, and mill--is situated in the bottom of a little valley.

GEOLOGY

In the Mt. Reuben district Jurassic sediments have been intruded by a greenstone which is probably a tonalite. Serpentine has been found to cut the masses of tonalite and seem to have been an important factor in the ore deposition in the tonalite but the serpentine itself holds little gold. The igneous activity is presumed to have occurred between the Jurassic and Cretaceous periods. Generally, the oxidized zone is 100 feet deep although it may be greater than 200 feet.[3]

The shearing action was general and produced narrow fissures in the greenstone but very often ceased upon reaching the contact between that rock and the serpentine. The gold in the veins probably came from the Siskiyou batholith which is south of the district.

The strike of the vein of the Benton claims follows the direction of the shear belt and varies from N 10°E to

N 40°E; the dip is 70° to the eastward. On the west side is a granodiorite and to the east is found a diorite porphyry. The ore occurs in bunches which is not unusual for that district; in places the vein splits and pinches out on one of the branches of the split. The minerals found with the gold and quartz in the vein are chalcopyrite, marcasite, sphalerite, magnetite, sericite, chlorite, calcite, and dolomite. Comminution of the ore is necessary because the gold is finely divided in pyrite which with the other sulphides constitutes 3% of the ore.

STAFF

The direction of the mining and milling operations is under the supervision of E. A. Youngberg. His subordinates are George Gale, the mill superintendent, and C. O. Schrader, who has charge of the mining. These two also survey and map the mine. The general manager has his office in Portland, Oregon.

MINE

Employment

An average of twenty-six men including the foreman work underground. Sixteen of these are engaged in drilling, two men being attached to each machine. The rest of the day crew consists of four muckers, a trammer, and a timberman. The latter is not always employed as such but may work as either a driller's helper or a mucker. Whenever it is necessary to operate the diamond drill, two experienced miners are called upon to handle the assignment. Two or

three men are employed as muckers on the night shift; they are the only workers in the mine at that time.

Description

Before mining operations were resumed in 1931 there were 5000 feet of workings which have since been extended to 12,000 feet.

The tunnels and drifts have been known by various names in the past, originally designated by states, later by numbers as at present. The practice is to indicate the levels according to the distance each is above the main or 1020 level, formerly termed the Kansas. Plate 2 illustrates portal of the main level. There are five levels, i.e., 1020, 900, 780, 700, and 500; all are joined by rills and raises. The uppermost or 500 level, previously called the Texas, cross cuts 300 feet from a hillside to the vein where drifts are run. The 900 and 700 levels are not accessible directly from the surface; one must enter one of the other three tunnels in order to reach either of these two levels. By means of a shaft which is used very little at present it is possible to descend to the 500 level from the surface.

The Georgia cross cut, driven a number of years ago, is the only working that has not touched ore. Diamond drilling has proved that it would be fruitless to extend that cross cut any farther. All other workings are in profitable ground.

To date no sinking has been done; all operations have

Portal of 1020 Level

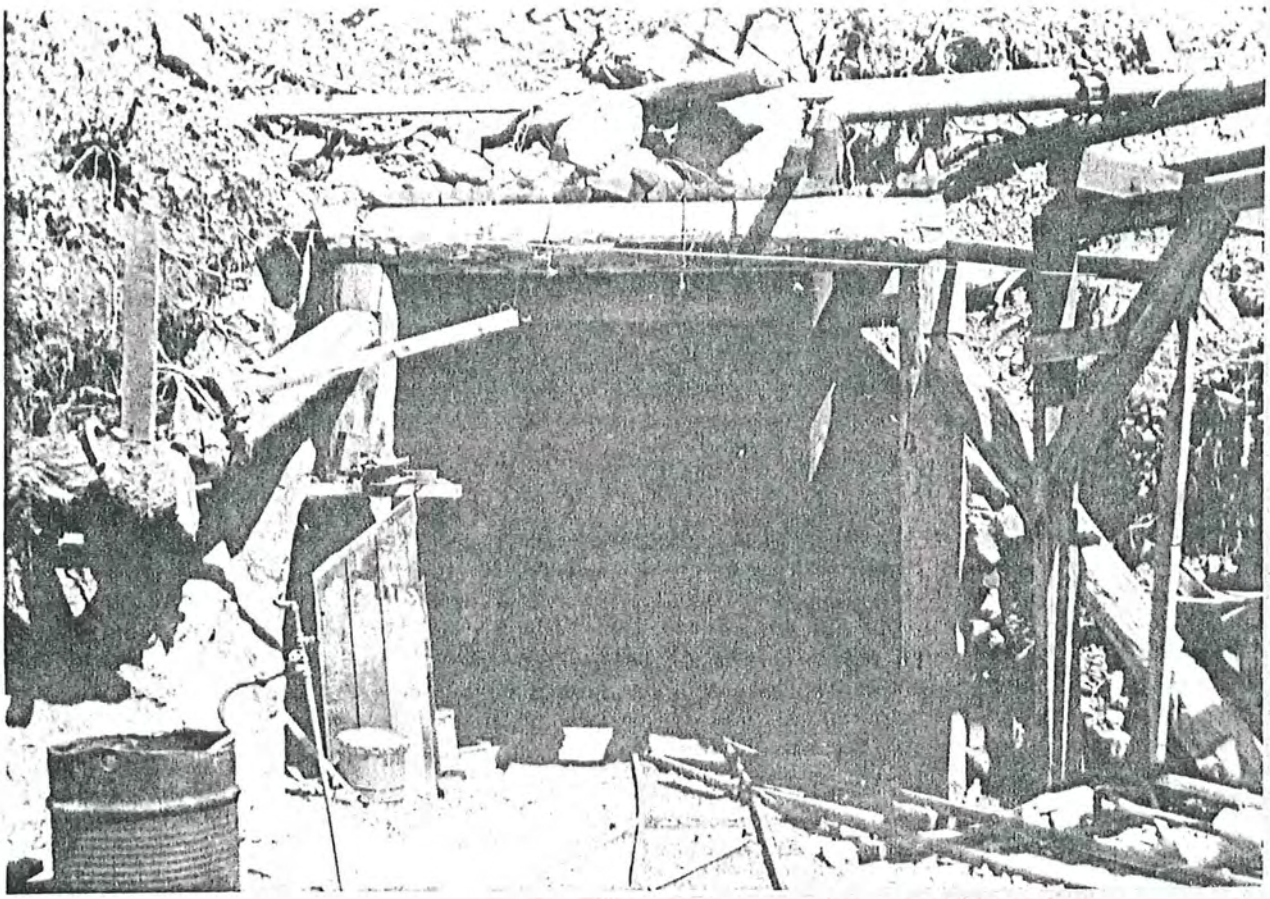


Plate 2

been kept above the main level. However, before all the upper ore has been removed, the management plans to extend the workings below the 1020 level.

Two of the raises have hoists for handling material and supplies; there are no hoists for hoisting men. The main hoist extends from the 1020 level to the 780 level; a Parke and Lacy, single-drum, 8 by 6-inch air engine lifts a three-sided skip in a wooden slide inclined slightly from the vertical. The other engine, also air driven, hoists material from the 780 to the 700 level. Racks of bits, explosives, and timber for the 500 level are transported by truck up a mountain road to the tunnel.

Ventilation

The ventilation is natural; in summer the air moves from the upper workings down to the lowest level while the opposite is true during winter. At times the night crew may find it necessary to open an air line leading to a heading in order to remove powder smoke before mucking out the round. Notwithstanding the fact that the air supply is turned off after the day crew leaves the mine, there is usually enough air under pressure in the system to blow out the smoke in a heading.

Mining Practice

Development

At present 75% of the mine operations is considered as

development. The management plans to devote 50% of the work in the future to that phase if the mine is to continue in operation.

Part of the development is accomplished by means of a diamond drill; however, it is not in operation every day.

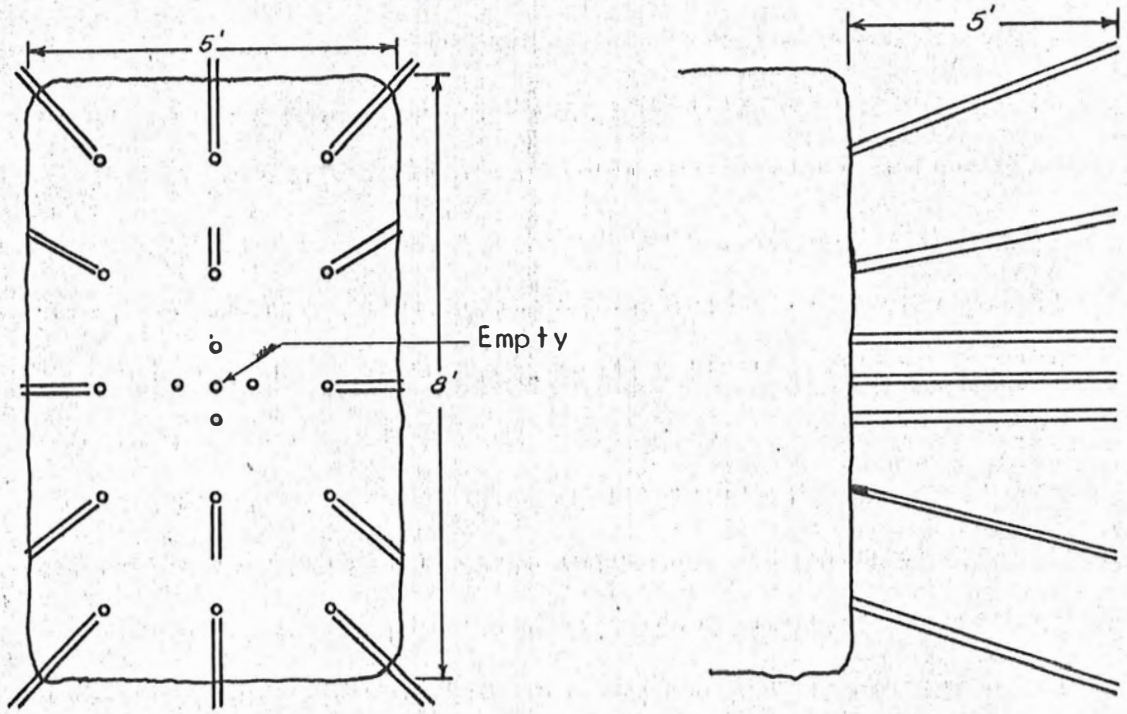
The other form of development is drifting. Three crews are constantly engaged in such work. The control of this phase is exercised by means of face samples taken after each round has been blasted. The samples are not correlated with the mill feed because of dilution of the ore in the chutes and during transportation to the mill. Samples are taken in the stopes also but they are utilized merely as checks on the progress of those workings.

Two types of rounds (see Figure 1, page 11) are used in drifts, i.e., the "burned" or burn out and the V-cuts. The former is particularly adapted to the very hard ground that is sometimes encountered. The drifts are 4 by 7 feet after placing timbers. The sets consist of posts and a cap only; sills are not used. Timbering is not extensively used because in most places the ground requires no support. The blasting practice is described in a later section.

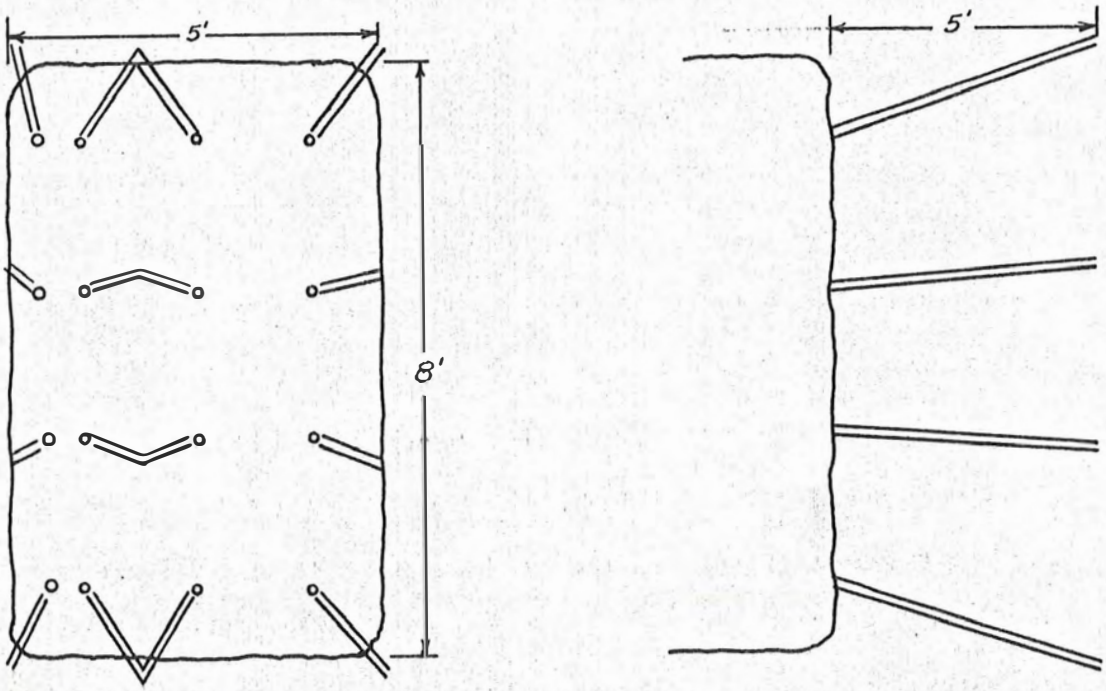
Stoping

The method of mining is a combination of the rill stope and the cut and fill systems. At 100-foot intervals along a level raises are extended upward 15 feet. Then a

DRIFT ROUNDS



Burn Out Round



V-Cut

Figure 1

4 by 7-foot rill is begun in the vein at an inclination of 45°, usually toward the north. The rill is prolonged to the next level above. A stope is also started at the lower level and after it has been enlarged to an appropriate size, waste from the upper level is brought in by way of the rill for the horizontal cut and fill operations. The latter method is employed to remove the ore in a stope. Where the vein is narrow, the practice is to muck the ore from each round into a chute and then place the waste as filling material with planks as a covering over the waste. The succeeding round is blasted down onto the planks. After the ore has been transferred to the ore chute, the planks are removed, more waste is gobbed as fill, and the planks are replaced as flooring. In wider stopes--10 to 15 feet--a number of rounds can be shot before the ore must be mucked into a chute.

The raises are extended up to the next level as are the ore chutes located on both sides of the raises. The ore chutes are offset slightly from the level to facilitate the filling of ore cars. A simple chute-gate is used; two or three boards set vertically in cleats act as a gate. When loading a car, the trammer forces the boards up and down to regulate the flow of the ore.

In all stopes above the 780 level the usual practice is for the miner and his helper to muck out a round, and

then drill and blast another. The next day they repeat the cycle. The same procedure is followed on the lower levels except that the night crew--two or three men--muck out a round. While removing a round the men sort the ore, throwing the waste aside to be used as fill. If a piece of ore is larger than 15 inches in any dimension, it is broken with a double-jack hammer. Any piece of ore smaller than that size can pass through the chute-gates and through the grizzly above the coarse ore bin at the mill.

The drilling is carried out by means of six Gardner-Denver stopers. Figure 2, page 14 illustrates the type of round used in stopes and rills. The V-cut in the latter sketch is particularly adapted to veins that have gouge on either side because the soft clayey material acts as a lubricant for breaking the first wedge or slab of a round.

More powder is used in raises and rills than in drifts. The customary practice is to insert three or four sticks in each hole, the primer being the second from the top with the cap pointing in the direction of the maximum part of the charge. In the past, 40% and 45% Atlas and Dupont gelatin dynamites were used but in August, 1940 the decision was made to standardize on 45% Dupont gelatin which is delivered in boxes of 150 sticks instead of the usual 100 per 50 pounds. The management feels that stemming drill holes is not worth the time required to fill stemming bags with

RILL ROUND

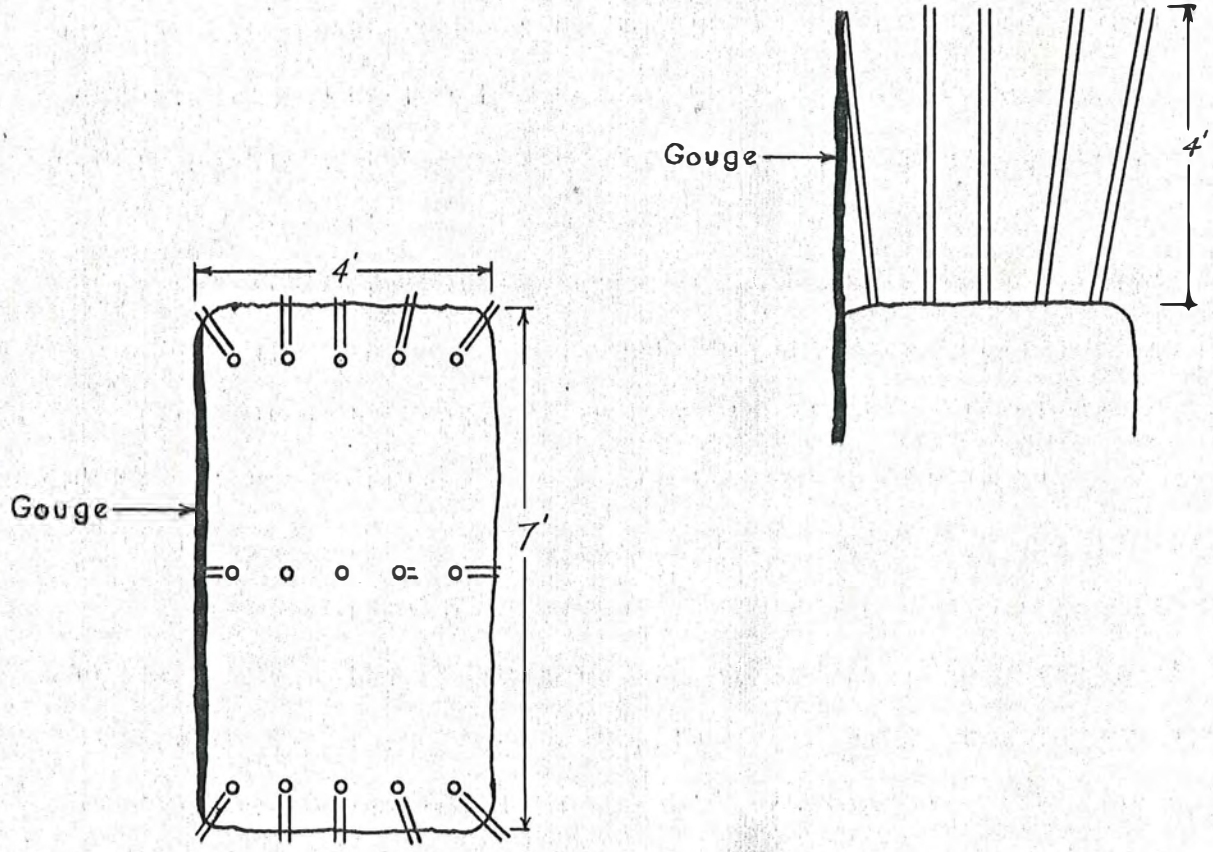


Figure 2

the necessary material. For July, 1940 the powder cost was $386 and the caps $28.70. The blasting caps are not tied to the sticks of powder but are inserted into either the ends or the sides. The fuse burns at the standard rate of 15 inches per minute. During the same month 12,000 feet of fuse were used at a cost of $76.80.

Carbide lamps provide illumination in the mine; each month approximately 350 pounds of carbide are furnished by the company.

Transportation

A gauge of 18 inches is used on the track throughout the mine. On all levels except the 1020, one-ton cars are trammed by hand. Mule haulage (see Plate 3, page 16) is used on the lowest level; two mules working alternately are for this work. A mule can haul five ½-ton cars. If the night crew is working on the lowest level, each man trams two such cars. On the right of plate 3 is shown the track leading to the dump for waste rock withdrawn from chutes on the 1020 level. The ore is trammed to the mill 700 feet distant from the main portal. Plate 4 on page 17 shows a trammer dumping a carload of ore into the coarse-ore bin.

A simple but effective switch is pictured in Plate 5, page 18. It is easily constructed by welding onto a steel plate slightly smaller than the track gauge two short pieces of rail and beveling one end of each rail by means

Mule Haulage

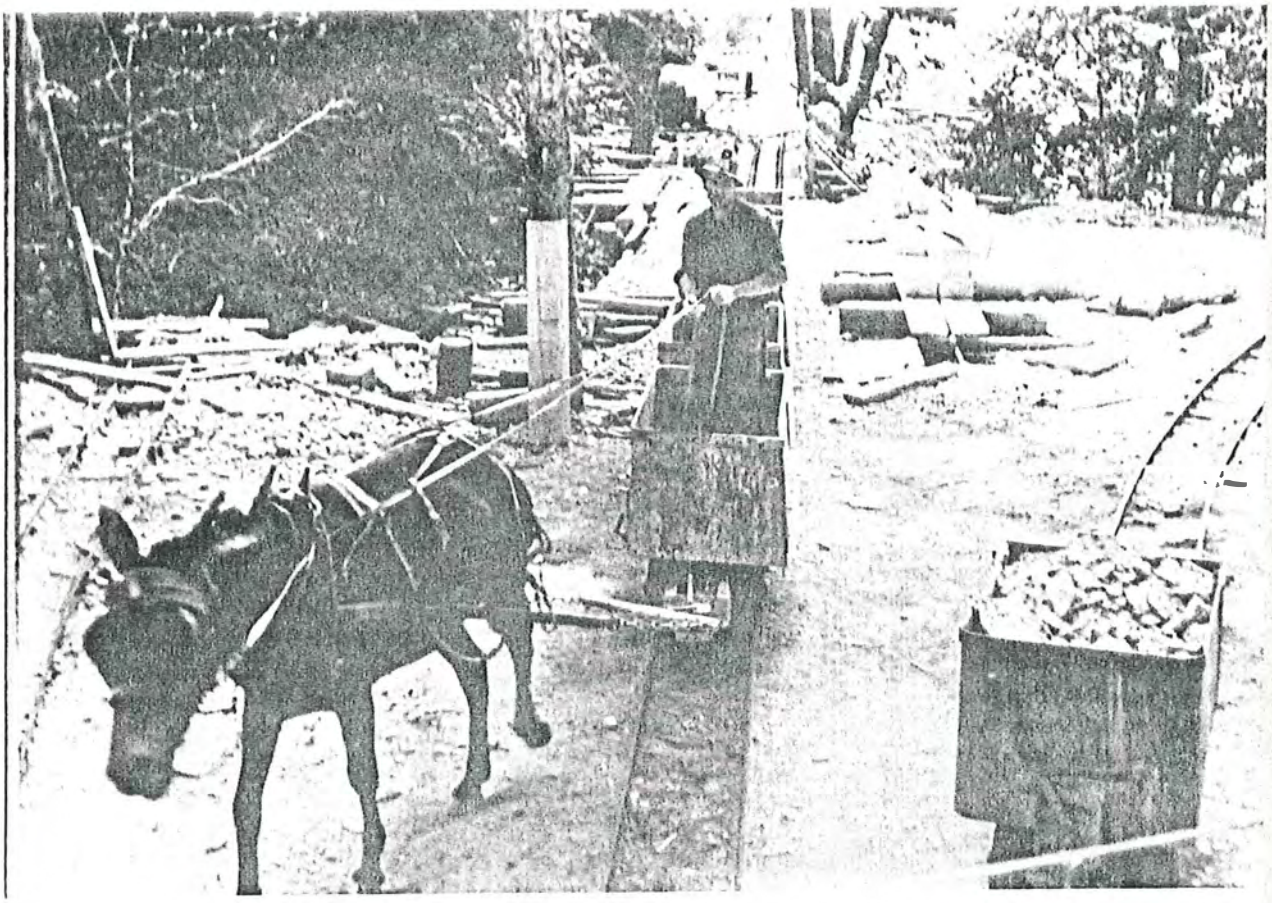
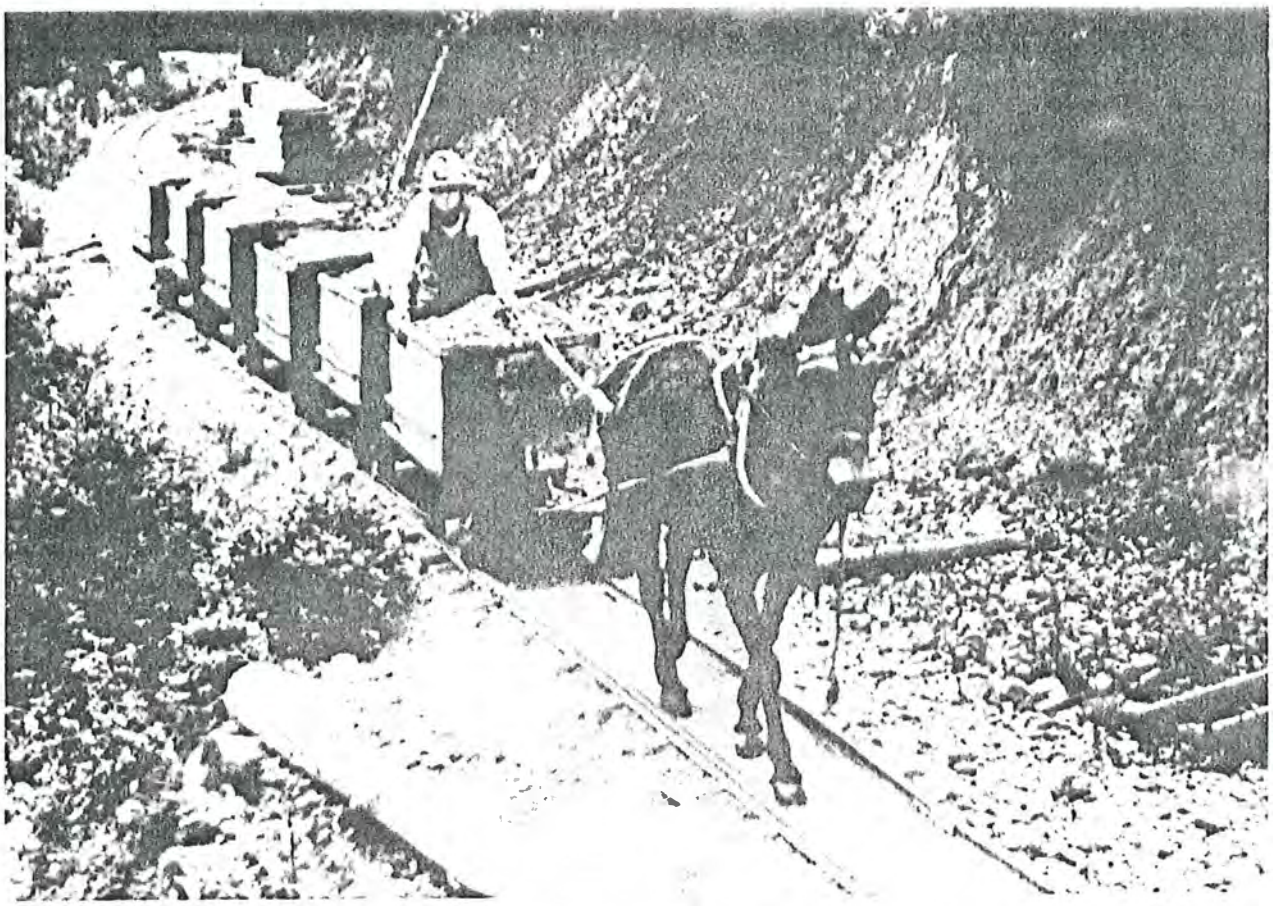


Plate 3

MULE HAULAGE TO ORE DUMP



Unloading an Ore Car

Plate 4

Track Switch

Plate 5

of a cutting torch. The switch is held in place by a pin driven into the ground or into a tie. It is easily thrown with the foot.

Drainage and Water Supply

A small dam is on Drain Creek above the point of entry into the stream of the drainage from the upper three levels. The resulting reservoir serves as a source of water for the drills and for drinking purposes in the mine. It is pumped to the three higher levels but flows by gravity to the rest of the mine. The mine water from the lower workings flows to the 1020 level and thence into Drain Creek.

Mine Shop

Quarter octagon steel is used in the stopers and round lugged steel in the drifters. A hole is normally collared with a two-foot steel and finished with a six-foot length using changes of 16 inches. Thus, each machine uses five different lengths of drill steel.

Jackbits are used throughout the mine. A detailed accounting system is used in connection with the bits. Each miner is given bits in racks having twenty-five in five successive gauges. After each use the miner returns the rack of bits to the shop together with a report listing the name of the driller, the date, the rack number, the number of bits broken, and the footage obtained with the rack. A rack contains the correct number of bits for drilling five

holes of six-foot depth. However, it is possible in the right type of ground for the miner operating a stoper to drill six holes with a six-foot depth using only four bits to the hole; seven holes can be obtained in that manner when using a drifter.

A report on each rack must be made by the shop man after he examines the rack of bits; the report includes the number of bits dulled, the number broken, the footage of the rack, the number discarded, the date out and date in, the name of the miner and the rack number.

Six gauges are used; they range from 2½ to 1-5/8 inches, the gauge change being 1/8 inch. Each bit is used approximately six times. It has been found that 1½ bits are broken per rack used. Almost all of those are of the smallest size.

Between 75 and 100 bits are reground each day with a maximum of 250 having been sharpened when the miners were drilling in hard ground. Approximately 1000 bits are hardened every fifteen days and none of them are smaller than 1-7/8 inches.

MILL

Crushing

The crusher plant consists of a 9 by 15-inch Blake jaw crusher, a 20-inch Traylor gyratory, and a belt drag classifier. The ore from the mine is stored in a 50-ton bin

from where it is withdrawn onto a shaking screen passing ½-inch. A man stationed at the screen sorts the ore and regulates the rate of feed to the jaw crusher. (See Plate 6, page 30) The fines are classified by an Esperanza classifier dragging the ore to a belt conveyor which carries the crushed ore to a 12 by 22-foot cylindrical bin having a capacity of 100 tons. From the jaw crusher the ore is carried by a belt to the Traylor gyratory set at ½ inch. The product of the secondary crusher is transported to the fine-ore bin by the belt conveyor. All this machinery is powered by a 40-hp Fairbanks-Morse motor. The crusher plant is operated on the day shift only.

Grinding

The ore is fed from the cylindrical bin to the ball mill by a short belt feeder. The feed is quite uniform in weight; nevertheless it is checked by weighing a portion each hour. The ore fed to the mill each day is 45 tons but that is an overload of 10 tons. The value of the feed is secured by assaying the combined hourly samples taken during each 24-hour period, each sample being a scoopful of the feed to the ball mill.

The grinding circuit consists of a 5 by 6-foot Williamson ball mill and a 3 by 18-foot Dorr rake classifier. The mill is V-belt connected to a 50-hp Fairbanks-Morse motor which revolves the mill at 23 rpm. Steel balls

are added to the mill in 1½, 3½, and 4-inch sizes, the amount of each added being governed by screen analyses of the classifier overflow and classifier sands. Lime is added to the sands returning to the ball mill.

The ideal grind for the ore is 70% minus 200-mesh. With the addition of another thickener the grind will probably be lowered to 60% and thus permit a greater tonnage, 55 tons. The extraction of gold by the grinding circuit amounts to 40%.

Tailings

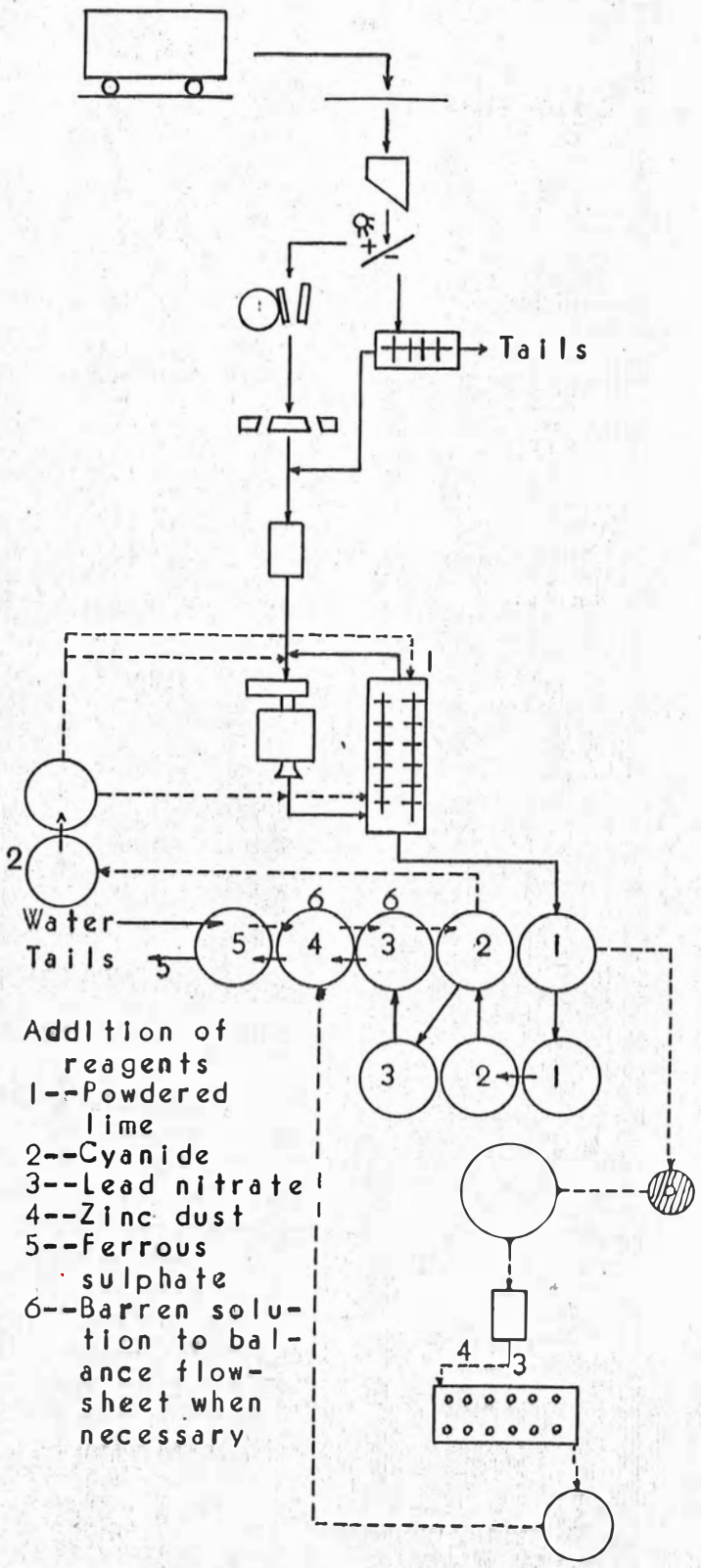
The flow of the pulp after overflowing the classifier is shown in Figure 3 on page 23. The pulp from the last or no. 5 thickener is tailings and flows into Whisky Creek. Ferrous sulphate is added to tailings to neutralize the cyanide which might have a detrimental effect upon the animal life in the stream.

Cyanidation

Figure 3, page 23, is the flowsheet of the Benton Mill. Figure 4, page 24, illustrates the flowsheet as it is since the addition of a thickener, an agitator, and a filter.

Continuous counter-current decantation in cyaniding is the method of gold recovery used in the mill. The numbers on the first flowsheet indicate the addition of various reagents. The most economical strength of the gold solution is 1.05 to 1.10 lb per ton of ore for cyanide and for lime 0.90 to 1.00 lb per ton. The tails strength can vary from

FLOWSHEET OF BENTON MILL



Run of mine

15-in. grizzly

50-ton coarse ore bin

Water spray
Shaking screen passing $\frac{1}{4}$ in.

Blake jaw crusher, 9 by 15 in.
Esperanza classifier

20-in. Traylor gyratory crusher

100-ton, 12 by 22-foot cylindrical ore bin

5 by 6-foot Williamson ball mill
3 by 18-foot Dorr rake classifier
14 by 10-foot mill solution tank

Storage tank

Dorr thickeners
#1--20 by 10 feet
#2, #3, #4, #5--16 by 10 feet

Dorr agitators
#1, #2, #3--12 by 12 feet

175-ton mill-solution orifice, excess tonnage passes to storage tank

Clarifier

Vacuum tower

Precipitation tank

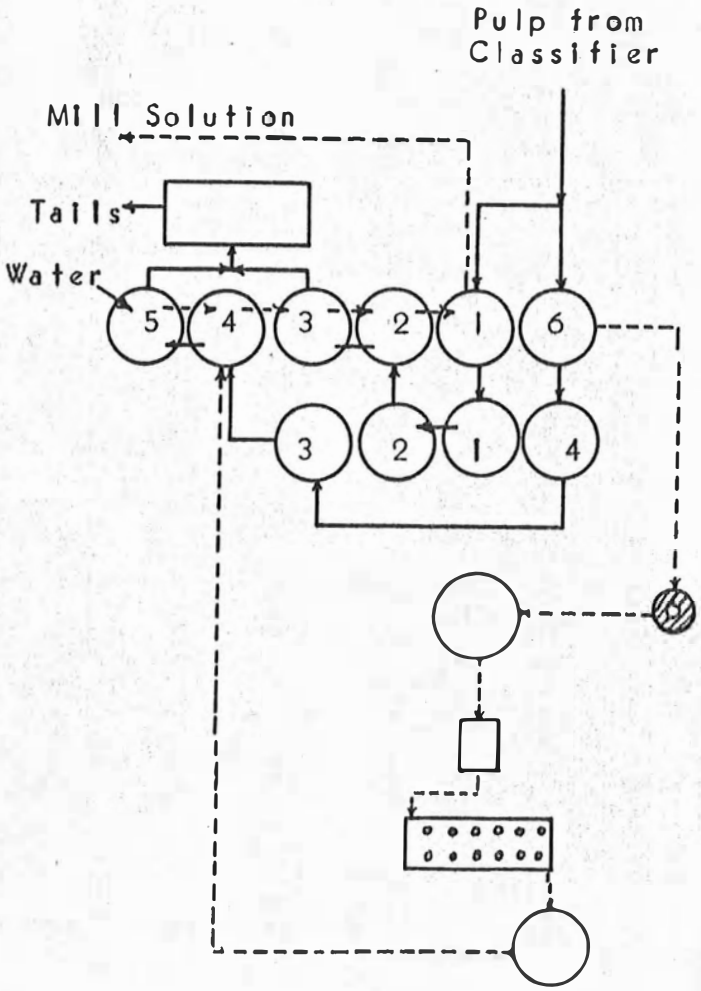
14 by 10-foot barren solution tank

Flow of ore and pulp (——)
Flow of solution (- - - - -)

Figure 3

FLOWSHEET OF BENTON MILL

With New Equipment
(#6 Thickener, #4 Agitator, Oliver Filter)



Oliver filter

Dorr thickeners
#1--20 by 10 feet
#2, #3, #4, #5--16 by 10 feet
#6--26 by 10 feet

Dorr agitators
#1, #2, #3--12 by 12 feet
#4--16 by 12 feet

175-ton mill-solution orifice, excess tonnage passes to storage tank

Clarifier

Vacuum tower

Precipitation tank

14 by 10-foot barren solution tank

Figure 4

0.40 to 0.90 lb per ton for cyanide and for lime 0.35 to 0.85 lb per ton.

During the day shift air for the agitators is furnished by a large compressor which also serves the mine; in the night the air is delivered by a single-stage Sullivan compressor powered by a 40-hp marine diesel engine.

Immediately following are values of the ore, pulp, and solution taken at various points in the mill for three months of 1940

	May	June	July
Mill heads, average assay	$12.49	$10.81	$11.08
Tails " "	1.95	1.81	1.28
Tails sands, " "	1.41	1.41	1.06
Average soluble loss	0.54	0.40	0.22
Net recovery	84.4%	83.2%	88.4%

Obviously the tailing loss was high; the reason was that the mill could not handle the tonnage being sent through it. Overloading the plant caused "mud lines" to occur in the thickeners; a "mud line" is the depth to the pulp and should be 15 inches or more. Whenever the line is within less than 15 inches of the surface, the pulp must be bypassed that particular thickener. Such bypassing eventually throws some of the gold into the tails before it has combined with the cyanide. The management believes that the additions to the plant will improve the recovery.

The canvas bags in the clarifier must be washed off every two weeks; each bag must be replaced after three weeks of service because holes have developed in it by that time. It is necessary to "milk down" the socks in the pre-

cipitation tank; if the sediment adhering to the inner surface of the socks is not manually forced to the bottom, the air pressure may be built up above the allowable. After six weeks of operation the sludge is cleaned from the socks and shipped to a smelter owned by American Smelting and Refining Company at Selby, California for refining.

For each shift one man is in charge of the mill; at intervals of two weeks the men rotate. The mill is operated continuously with cessations occurring when "clean-ups" are made and when the power plant is stopped.

Water for the mill is pumped from Whiskey Creek.

POWER PLANT

Air Compressors

Air for the rock drills in the mine is produced by a two-stage, two-cylinder--15 by 12 inches and 9½ by 12 inches--Ingersoll-Rand compressor delivering 650 cubic feet of air per minute at a pressure of 90 pounds per square inch. This machine is driven by a two-cylinder--12 by 15 inches--120-hp Fairbanks-Morse diesel engine. The compressor is operated on the day shift because the drills are used during that time only. There are two air receivers, one near the compressor at the mill and the other in the mine. The object of the latter is to catch any water that may be in the air lines.

The single-stage Sullivan compressor furnishes air, as mentioned previously, for the agitators during the two night

shifts.

Electric Power

Electricity for the camp and mill is produced by a 210-ampere, 480-volt, a-c Allis-Chalmers generator and a 24-kilowatt, a-c generator. The purpose of the latter is to replace the large generator when it is not operated. The large dynamo is motivated by a six-cylinder, 140-hp Atlas Imperial diesel engine. At two-week intervals the engine is stopped one-half hour to change oil; each month it is stopped for four hours to repair the scoop on the ball mill. A complete overhaul of the engine is made twice a year.

The 40-hp marine diesel engine operates either the Sullivan compressor or the small generator.

V-belt drives are used on all the above equipment. The large compressor has a flat-belt drive. The suction pumps for the thickeners and agitators are chain-driven by a small motor.

Shell diesel fuel is stored in 24,000-gallon tanks on the hillside above the mill. The lubricants are Standard Oil products.

CAMP

There are approximately nine houses for the men with families. One or two families live a few miles away from the camp. For the single men the company has provided eight frame bunkhouses, each of which serve as living quarters for four employees. The bunkhouses are one hundred yards

from the mill and are situated on the east bank of Whisky Creek. Plate 7 on page 29 is a view of the camp looking toward the north.

The company provides a mess hall for the men, the cost of the meals being deducted from their wages. A small canteen in the mess hall dispenses soda, candy, and tobacco. A truck is sent to Grants Pass almost every day for the mail and various supplies for the mine or mill.

A change house adjoins the row of bunkhouses affording a convenience for the employees. Ample sanitary facilities are provided. A washing machine is in the change house in order that the employees can launder their clothes.

Amusements are rather restricted but fishing and hunting are recreations that can be enjoyed in that area.

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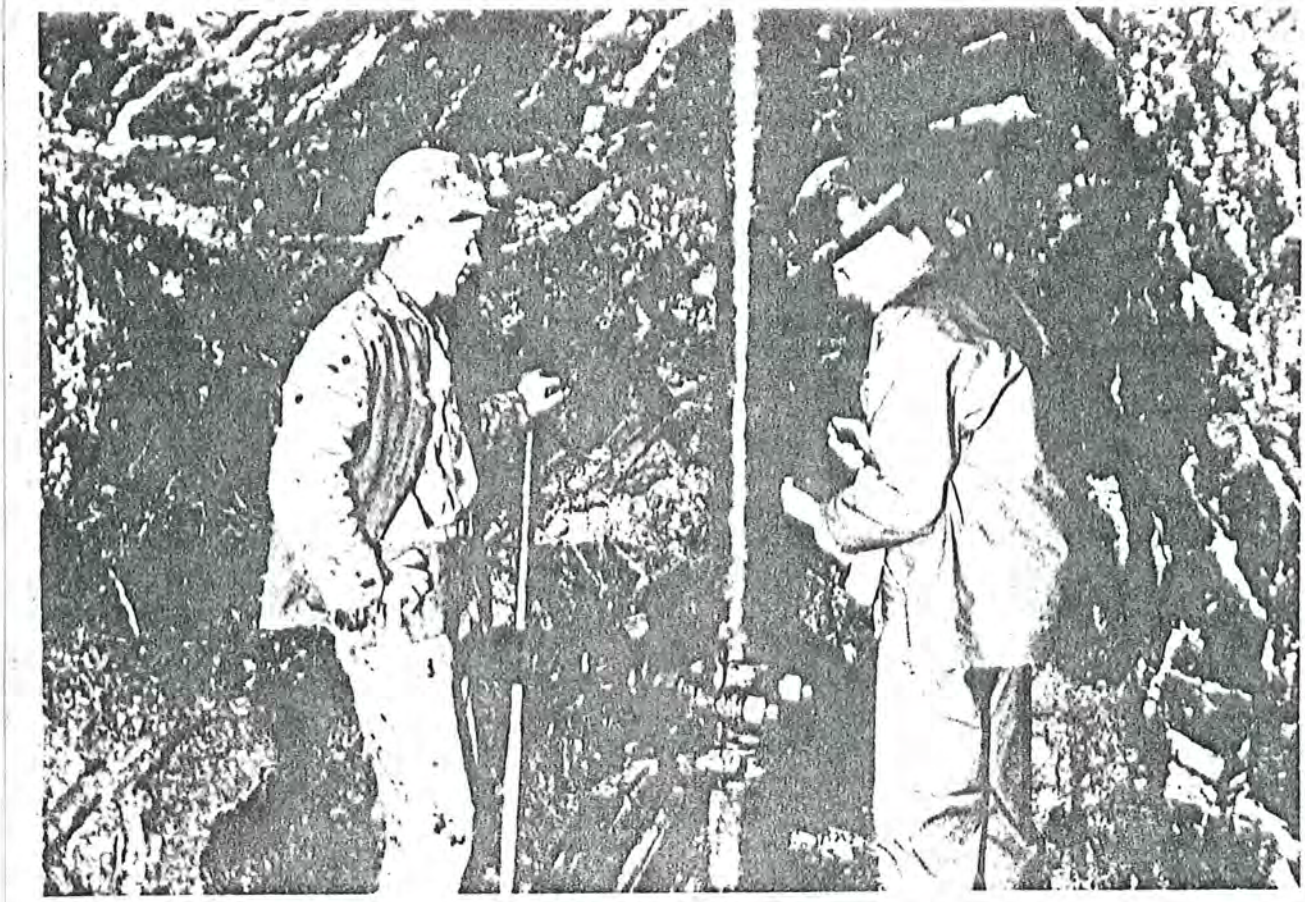
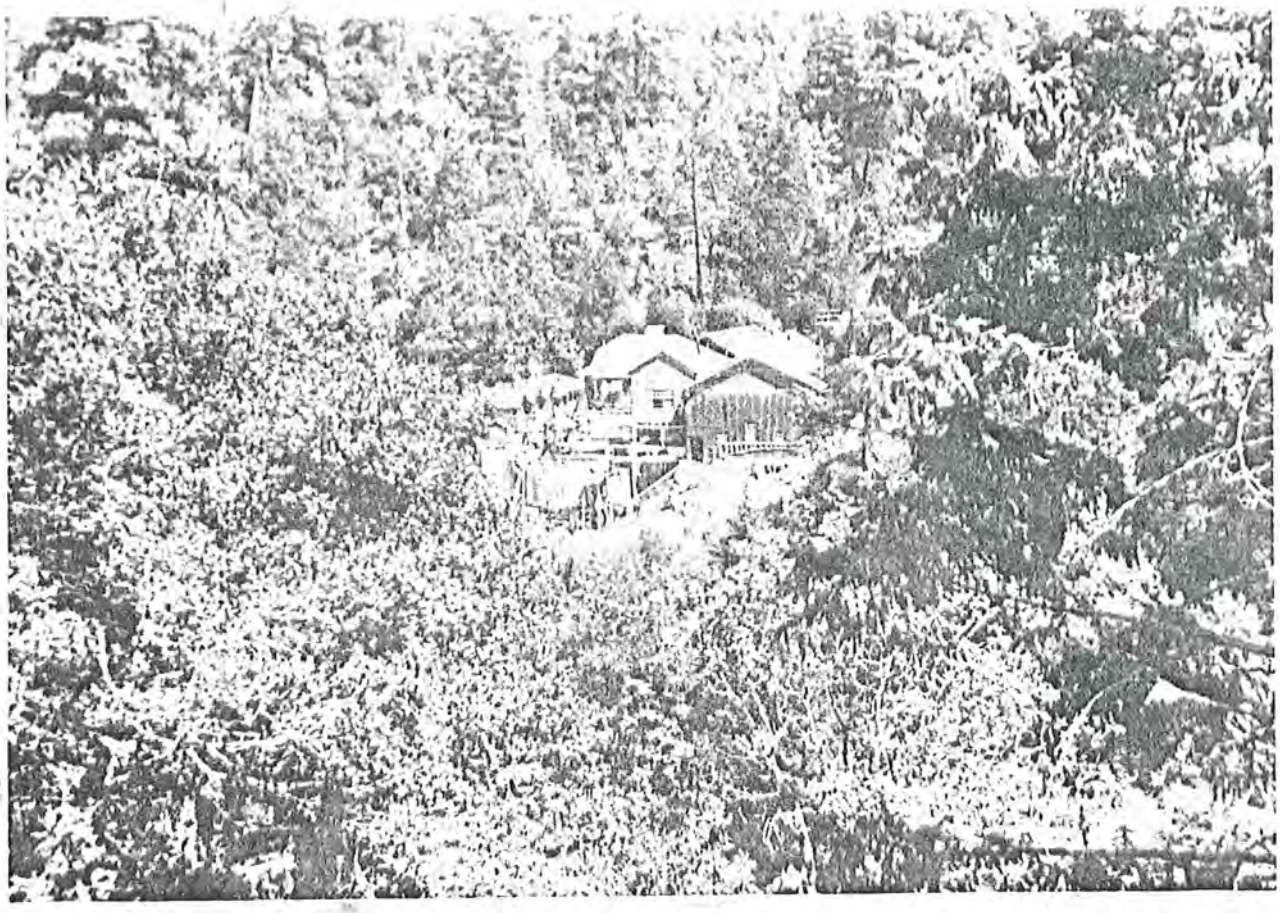
PUMPING WATER FROM A SHAFT



Benton Mine Camp

Plate 7



Sorting Feed to Jaw Crusher