# The Treadwell Group of Mines, Douglas Island, Alaska.

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## INTRODUCTION.

The Treadwell Group comprises five mines, four of which are situated on the northeast side of Douglas island, directly opposite the town of Juneau, and one about four miles back of Juneau. These mines are owned by four separate companies, but are all under the same general management. Those situated on Douglas island are: The Treadwell mine, owned by the Alaska Treadwell Gold Mining Co.; the Mexican mine, owned by the Alaska Mexican Gold Mining Co.; and the Ready Bullion and Seven-Hundred-Foot mines, owned by the Alaska United Gold Mining Co. The Juneau mine, owned by the

Alaska Juneau Gold Mining Co., is on the mainland. This property embodies a large number of claims and promises to be very valuable; but it has not advanced beyond the prospect-stage, and as it differs entirely from the island mines, both in geological features and methods of working, it will not be considered in the present paper.

The principal topographic features of the country surrounding the Treadwell group of mines are well shown in the half-tone illustrations, Figs. 1, 2 and 3. Fig. 1 is a view of the works of the Alaska Treadwell Gold Mining Co. on Douglas island; Fig. 2 is a view of the Treadwell open-pits or "glory-hole" looking eastward; and Fig. 3 is a view from the eastern end of the Treadwell open-pits looking toward the towns of Douglas and Juneau which are plainly seen in the distance. An ideal cross-section of the Treadwell mine, illustrating the method of removing the ore, is given in Fig. 4, and a general map of the mines of the Alaska Treadwell Gold Mining Co., the Alaska Mexican Gold Mining Co. and the Alaska United Gold Mining Co., all on Douglas island, is shown in Fig. 5.

The features that have made the Treadwell mine justly famous are the mining and milling, at a profit, of ore that does not yield an average of more than $2 per ton.

*Climate.*—Contrary to the accepted idea, the climate is not in the least severe, the winters being much milder than in New York, while the summers are never hot. During the last two winters the thermometer did not reach zero. The precipitation, however, is great, the average annual rainfall for the last three years being about 98 in. As a result of the mild climate and abundant rainfall, the entire country is covered by a dense growth of trees, consisting principally of hemlock and spruce, which makes fairly good mine timber, but poor lumber.

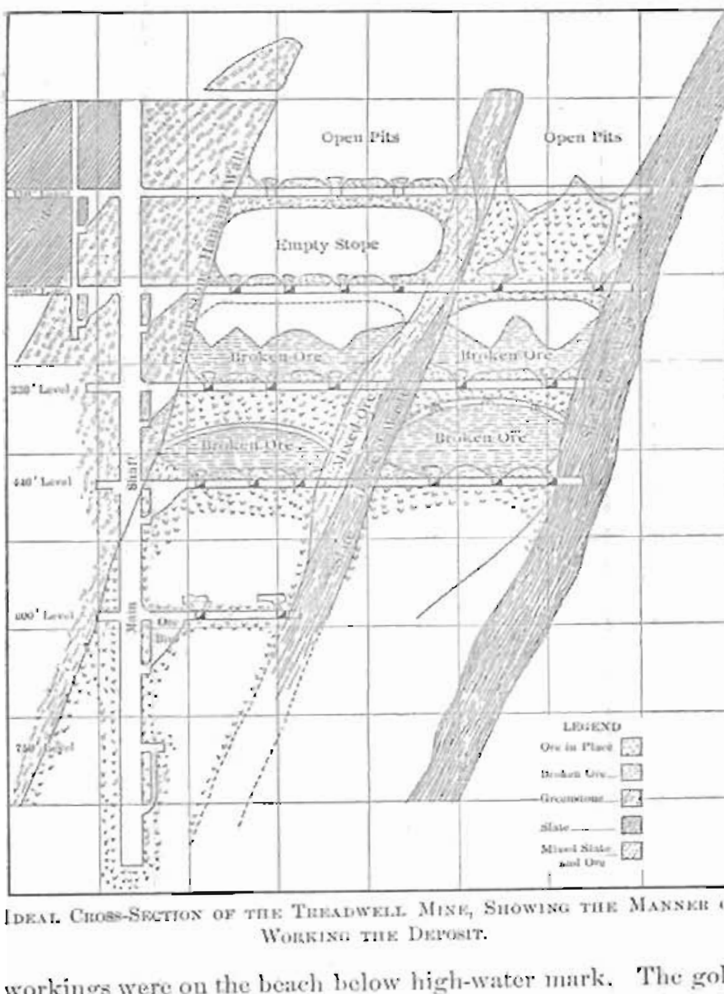
*History.*—Like every other gold-deposit in Alaska, the Treadwell mines were first worked as placer-diggings, and in this way was discovered the quartz in place, now known as the Treadwell deposit. From all accounts these surface-workings were quite rich, but were shallow and soon exhausted. It was in the summer of 1881 that gold was *first* discovered and placer-mining started. The placers in the Silver Bow basin, just across the channel, which had been discovered the previous year, proved exceedingly rich for a short period. Up to this time there had been no attempt at systematic mining in Alaska. Soon after the discovery of the placer-deposits on Douglas island, the Paris claim, which covered the site of the large surface-pit, or "Glory Hole," of the Treadwell mine was bought from French Pete by John Treadwell for the sum of $400.

Owing to the more than tropical luxuriance of the vegetation and the deposit of glacial mud which covers the surface to a depth of 20 ft., early exploration and development were extremely difficult. In 1881 the first mill, containing five stamps, was built and started crushing ore that came from a streak about 20 ft. wide, which runs along the foot-wall of the deposit. This ore is said to have milled between $8 and $10 per ton; at any rate, it was sufficiently high-grade to pay for the mill- and development-work and to leave a good surplus. It was early seen that the great bulk of the ore was extremely low-grade, and the fact was recognized that a large tonnage and, consequently, a large milling-capacity would be required to make the enterprise a success. With this idea in view a 120-stamp mill was erected and started crushing ore in June, 1885. The results of the first three years' run warranted an increase of 120 stamps, and the 240 stamps were put in operation in August, 1888. After a careful study of the results of running the 240 stamps, and of the ore-reserves in the mine, it was again decided to increase the milling-capacity by adding 300 stamps. Work was immediately started, and the 300 additional stamps were dropping in May, 1899, thus making a total of 540 stamps crushing ore from the Treadwell mine.

Soon after the opening of the Treadwell, the deposit was traced along its strike to the east, and the ore-body of the Mexican mine discovered. Unlike the Treadwell and Ready Bullion croppings, the surface-showing of the Mexican did not indicate the size of the ore-bodies that were afterwards opened up. As in the Treadwell, some fairly high-grade ore was found near the surface, but it was evidently a concentration, and did not represent the true or average value of the milling ore. It was not until 1894 that the mill of 60 stamps started crushing ore, but the result of the first year's milling was such that it was determined to increase the number of stamps to 120. This work was immediately started, and in 1896 the full mill was in operation.

After the discovery of the Treadwell and Mexican mines, there was a rush of prospectors into the district, and it was not long before rich placer-workings were found over what is now known as the Ready Bullion mine. For the most part, these

Fig. 4.




Ideal Cross-Section of the Treadwell Mine, Showing the Manner of Working the Deposit.

workings were on the beach below high-water mark. The gold was much coarser and the ground richer than in either the Treadwell or Mexican surface-workings.

Nothing was done here to open up the mine until 1894, when it was acquired by the Alaska United Gold Mining Co., which company had also gained control of the extension or the end of the Treadwell ore-body, now known as the Seven-Hundred-Foot mine.

In 1898 a 120-stamp mill was erected and started crushing ore from the Ready Bullion, and in the following year the 100-stamp mill of the "700-Foot" was put in operation, thus making a total of 880 stamps dropping on the four properties.

*Geology.*—Before taking up the subject of the underground mining in detail, it would be well to give a brief description of the geological features that bear on the economic extraction of the ore. While the geological conditions are the same in the Treadwell, Mexican and Ready Bullion mines, there are conditions due to faulting, shape and the position of ore-bodies with regard to salt water, that have a great influence on the methods and costs of mining.

The deposit lies at a slight angle to Gastineau channel. The hanging-wall of the Treadwell deposit is distant 1,000 ft. from the present shore-line, while that of the Ready Bullion lies for the most part under tidal water.

According to Prof. Becker, who undoubtedly had an excellent opportunity of studying the formation and character of the ore-bodies, this deposit represents the upper portion or "feather-edge" of an intrusion of sodium syenite, or, more logically, an albite diorite, which owing to peculiar conditions has been decomposed and silicified by solfataric or hydrothermal action, causing a concentration of gold in the native state and in the pyrites, sufficient to make it profitable mining. The country-rock in this locality is a carbonaceous slate, in which the original lines of bedding and principal cleavage coincide. It can be traced for miles both to the north and south. Its strike is N. 50° W., being practically the same as the ore-bodies and of Gastineau channel, and coinciding with one of the two fissure-systems which affect nearly the whole of the Alexander archipelago.

Following the deposition of the slate came the intrusion of the syenite. This dike is extremely irregular in shape. In the Treadwell mine it has a width of 420 ft.; going southeast it narrows down to a mere stringer until the Mexican mine is reached, where it again swells out to a width of 150 ft. From the Mexican to the Ready Bullion, a distance of 2,500 ft., it is traced with difficulty on account of faulting and the broken character of the country. At the Ready Bullion it again attains a width of 300 ft.

The next intrusion, that of the gabbro, was of fundamental importance in the formation of the ore. Accompanying and following this intrusion came the mineralization of the syenite and the deposition of the ore. The dike of gabbro forms the hanging-wall of the deposit, and varies in width from 8 ft. in the Mexican to several hundred at the Ready Bullion. In places the gabbro is badly shattered and contains numerous stringers of quartz; but these are mostly barren, and nowhere is the gabbro converted into ore. This dike can be traced the full length of Douglas island.

The third and last of the intrusions was what Becker has called an analcite-basalt. This strikes N. 20° W., cutting the slate, syenite and gabbro, and dips to the west at an angle of 86°. Preceding and during this eruption, the country-rock was evidently badly shattered, and the fissures thus formed became filled with auriferous material. In no place does the basalt dike contain ore. In the upper levels it is quite continuous, but on the lower levels each dike has split into several smaller ones, which in places enclose fragments of the syenite.

In the Treadwell, Seven-Hundred-Foot and Ready Bullion mines, and in the west end of the Mexican, the ore consists of the mineralized syenite. This ore is readily divisible into two distinct varieties. The one consists of stringers of quartz and calcite, occupying the spaces formed by the crushing of the syenite; the syenite itself being somewhat mineralized along the planes of fracture. The other consists of syenite which has been crushed and broken by dynamic agencies, and the fragments thus formed have been saturated by the mineral-bearing solutions.

In the east end of the Mexican mine,—particularly in the lower levels,—the ore consists of auriferous quartz and calcite, occupying lenticular spaces in the black slate formed by its yielding to pressure along its cleavage-planes. The value of the ore can be readily determined by the quantity of pyrite contained and its distribution,—whether uniformly or in bunches, —the latter being the best. In the upper levels the best ore lies next to the black slate foot-wall, but in the lower levels it has traveled toward the hanging-wall, and the space occupied by good ore above is here replaced by practically barren syenite.

## Mining.

*Shafts.*—The Treadwell, "700-Foot" and Mexican mines are opened by vertical shafts, but the Ready Bullion by an incline. In every instance the ground is of such a nature, except near the surface, that timbering would be unnecessary were it not required as a support for the skip-guides, ladders, pipes, etc.

Table I.—*Dimensions of Shafts.*

| Name of Mine. | No. of Comp'ts. | Vert. or Incline. | Size of Timber. | Gal. Water Per Min. |
|---|---|---|---|---|
| Treadwell...... | 4 | Vert. | 8" x 8" | 50 |
| Mexican........ | 3 | Vert. | 8" x 8" | 20 |
| Ready Bullion | 3 | Incl. | 8" x 8" | 80 |
| 700-Foot........ | 3 | Vert. | 8" x 8" | 50 |

Table I. gives the size of the main working-shafts. All of these are rectangular, and are sunk by machine-drilling. Each mine has in addition from one to three smaller shafts, sunk for prospecting, which vary in depth from 150 to 400 ft. With the exception of the No. 1 Shaft of the Treadwell, they are not used for handling ore.

All shaft-sinking is done by contract, and if possible the contract for all work on the lowest level and for the shaft is let to the same parties. These contracts include the sinking, hoisting from the shaft, driving of drifts, tramming, etc., or, in other words, the company furnishes steam, air and tools, and there its liability ends. Two machine-drills are usually employed for sinking. Two sizes have been tried, and the larger, or the new Ingersoll machine—diameter of cylinder 3⅝ in.,—has been found superior to the 3.25-in. machine formerly used. The rock is quite hard, particularly on the hanging-wall side of the deposit, and it has been found that the number of feet drilled with the large machine is fully 30 per cent. more than with the smaller one.

Both 10- and 8-hour shifts were tried, and the best progress made with the former; consequently, all shafts, as well as other underground work, are done by 10-hour shifts. The center-cut system of drilling is employed. The cut is first drilled, blasted and mucked out, then the other holes are drilled and blasted and the dirt removed in the usual manner; save that the end-holes are reserved, and fired with the cut-holes of the following round.

Although the shafts vary from 700 to 900 ft. below sea-level, and one of them is under the channel, very little water is encountered in sinking. Most of the water in the mines comes from the surface, and is caught up and pumped out, usually from the first level. The water underground does not average over 50 gallons per minute, and this is handled either by the skips or by No. 5 Cameron sinking-pumps.

Cross-head and buckets are used for sinking. The bucket is flat-bottomed, with the sides projecting 2 in., thus giving it a more secure base and permitting it to remain upright on an uneven surface while being filled.

The question of light at the bottom of a shaft has always been a vexatious one, owing to the water and blasting; but this question has been solved by using a group of three 36-c. p. electric lamps in the place of torches or candles. The wire is brought down the shaft to some convenient point, where a small reel is placed with which the lamps can be lowered or raised at will. It has been found that the best wire to use is the ordinary lamp-cord, wrapped with heavy canvas and given a good coat of P. & B. paint.

At the Ready Bullion mine the ore-body lies for the most part under water. For this reason a vertical shaft would be impracticable; therefore an incline shaft was started at a point 160 ft. from the foot-wall and sunk at an angle of 47° 53′ from the horizontal. To protect the underground workings from the sea, a pillar 300 ft. thick was left in place above the highest workings in the main ore-body of the mine. The ore was cut at a distance of 728 ft. along the incline, and the shaft continued to the 750-ft. level. In the meantime the foot-wall had become much steeper, and it was evident that if the shaft was continued at the same angle, it would soon be out of the ore. The shaft was then gradually steepened until at the 900-ft. level it has an inclination of 80°, and the shaft continues at this angle to the next lower level.

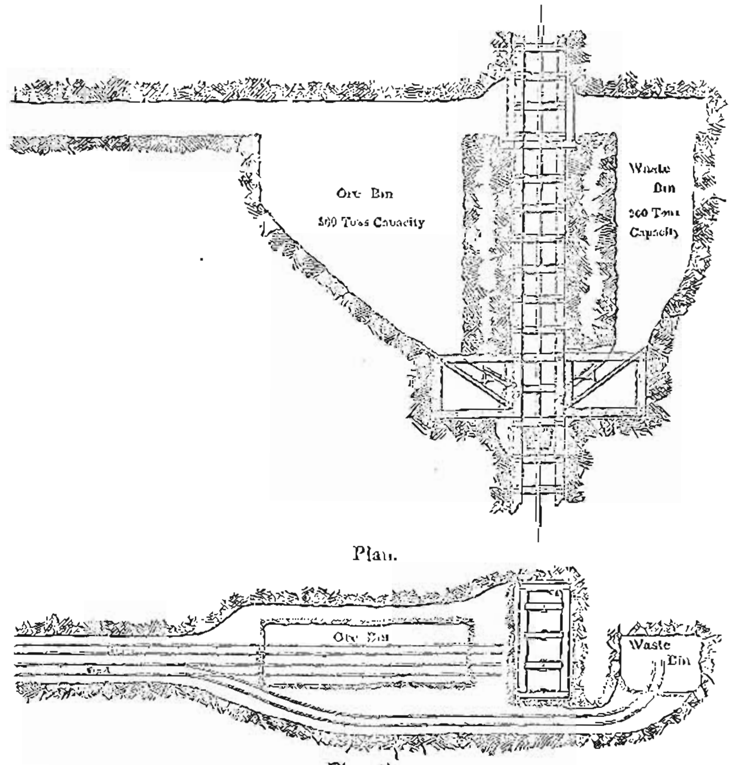
*Stations and Ore-Bins.*—Formerly, it was the custom to open up a level every 110 ft.; but below the 440-ft. level the distance between levels in the Treadwell will be 150 ft. from now on. By this method a large development-expense will be avoided.

At each level a station is cut out, the width of the shaft, from 40 to 60 ft. long and with an average height of 8 ft. In the Treadwell the main cross-cuts run parallel to the wall-plates of the shaft, and as far as possible it is aimed to have the station on the side opposite from that toward which the skips dump. When the station-level is reached in timbering the shaft, a station-set is put in. This set is 14 ft. high, and is tied in two directions by iron bolts. To protect the front wall-plate that serves for the sill of the station, a stull 10 by 14 in. is put in between the wall-plate and the edge of the station, and the two securely bolted together. In cutting out the station, a drift is run from the shaft a distance of 25 ft. It varies in height from 15 ft. in front to 7 ft. at the back, and is the width of the shaft. The main cross-cut is then started at right-angles to the station-drift. For the first 80 to 100 ft. this cross-cut has a width of 20 ft., and from thence to the footwall it is 12 ft. wide. At the hanging-wall end of the cross-cut, a station is cut for the winding-engines that operate the tail-rope haulage; and directly opposite the sinking-compartment, on alternate levels, a station is cut for the sinking-hoist. Beneath the floor of each station an ore-bin is cut out with a capacity of from 500 to 1,500 tons, according to the quantity of ore to be handled. Experience has shown that it is very convenient to have large storage capacity at the stations, and when the ore-bin is in the ore it is just as economical to cut a large as a small one.

In the Mexican and "700-Foot" mines, the main cross-cuts start directly from the shaft, and as a consequence the station-cutting is much simplified. In other respects they follow the same system as the Treadwell, with the exception that the ore-bins are smaller, and in the Mexican two bins are cut,—one for ore in front of the shaft, and one for waste, cut on the opposite side of the shaft and reached by an extension of the main cross-cut. (See Fig. 6).

In the Ready Bullion mine the above methods are used, but are changed in so far as to make them applicable to an incline-shaft, with the further exception that the main cross-cut runs to the hanging-wall. In cutting out the ore-bins two methods are employed. The old one consists of putting up a raise from the chute station to the level, and, after the chutes have been built, to cut out around the raise from the level of the cross-cut

FIG. 6.

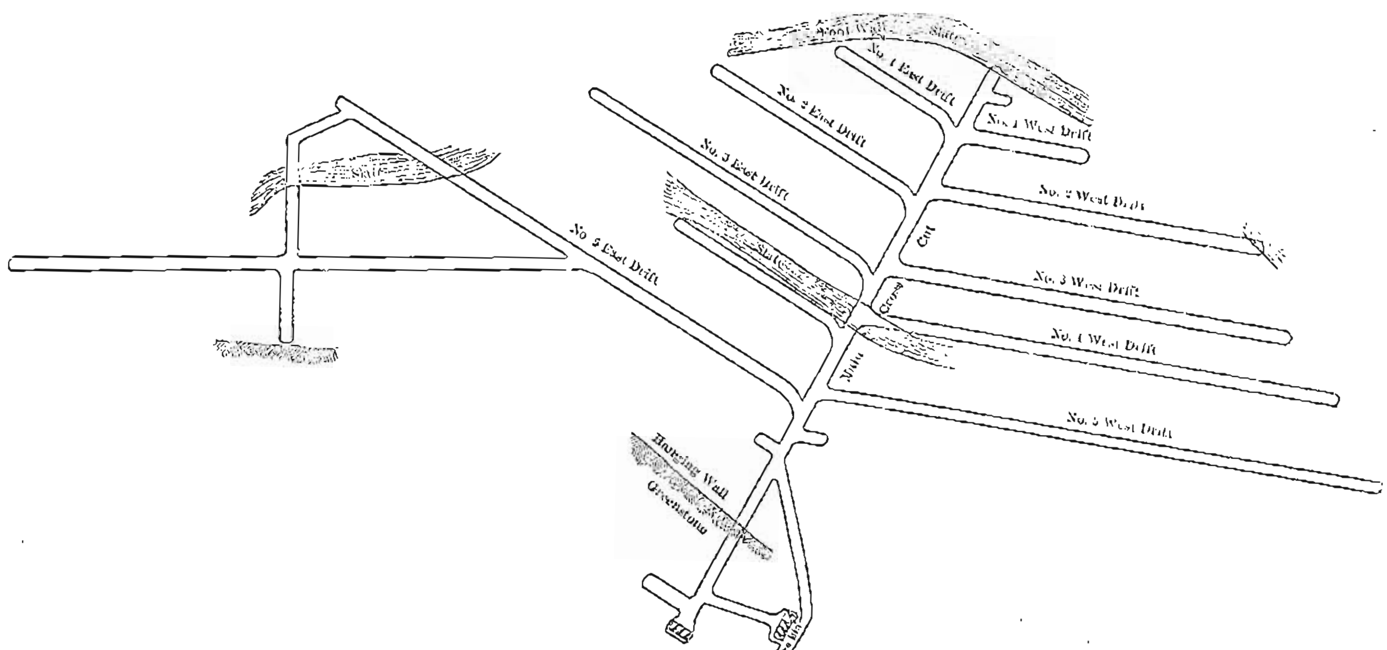



SKETCH, SHOWING THE POSITION OF WASTE- AND ORE-BINS AT THE SHAFT OF THE MEXICAN MINE.

until the bin is of the desired dimensions. By this method the rock is broken into large pieces and has to be "bull-dozed" with powder and drawn out before the work of drilling can be continued. The second method is to put up a raise from the chute-station to the small drift from the shaft at the station level, then build in the chute and stope out a room the size of the bin. The stope is carried to the level of the top of the main cross-cut, thus saving the expense of from 40 to 50 ft. of cross-cutting. At the same time it protects the timbers of the shaft from flying rock by leaving a small pillar between the ore-bin and the shaft, which can be removed when the bin is finished and the face of the cross-cut sufficiently far away to insure the shaft-timbers from being broken when the cut is blasted. The system of stoping is the same as that employed in the large stopes.

*Levels, Drifts, Cross-Cuts, Winzes, etc.*—When the ore-bin and station are completed, the main cross-cut is driven to the foot-wall. It thus serves the double purpose of determining how the level can be developed in the most economical way and of permitting a thorough sampling of the ore, so that a fair idea of its value can be obtained. The following rule is almost axiomatic in its applicability to the ore-bodies on the island: Start the first drift along the foot-wall, and keep it there. At various times the above rule has been ignored, and always with the same result. The ore-body is subject to abrupt changes in the strike and dip of the foot-wall. It is imperative that the ore be drawn from the stopes by gravity, and this cannot be applied to the ore along the foot-wall unless the chutes, and, consequently, the drifts, are kept as close to it as possible. Fig. 7 is a plan of the 220-ft. level of the Treadwell mine. On this level the slate-horse in the center of the deposit is quite small, and therefore more drifts than usual are required. On the lower levels, where the slate-horse is wider, it is left in place and forms a natural division between the hanging- and foot-wall portions of the ore-body. At intervals of 25 ft., raises are put up on alternate sides of both the main cross-cuts and drifts. These raises are 15 ft. high and are designed to accommodate the chutes for drawing the ore from the stopes. They are put up while the drift is run, and given a slope of 60° from the horizontal so that the ore will run freely in them. In the Treadwell, Ready Bullion and "700-Foot" mines, the drifts and chute-raisers are in ore; but in the Mexican, on account of the flatness of the vein, they are run in the foot-wall slate, and the chute-raises put up to the ore at an average height of 20 ft. above the track. At the same time, as the main drift and the chute-raises are being run, a second drift, called the intermediate, is driven directly above the main drift and separated from

Fig. 7.




Plan of the 220-foot Level of the Treadwell Mine.

TABLE II.—*Cost of Mining on Douglas Island, Alaska.*

(Dollars Per Ton of Ore Milled.)

| Name of Mine. | Machine-Drilling. Tool-Sharpening. Labor. | Tool-Sharpening. Supplies. | Tool-Sharpening. Total. | Labor. | Supplies. Merchandise. | Supplies. Iron and Steel. | Supplies. Repair-Labor. | Supplies. Total. | Compressed Air. Labor. | Compressed Air. Steam-Power. | Compressed Air. Supplies. | Compressed Air. Total. | Explosives. Fuse. | Explosives. Caps. | Explosives. Powder. 70 Per Cent. | Explosives. Powder. 40 Per Cent. | Explosives. Powder. Labor Primers. | Explosives. Total. | Rock-Breaking. Labor. | Supplies. | Explosives. Fuse. | Explosives. Caps. | Explosives. Powder. 70 Per Cent. | Explosives. Powder. 40 Per Cent. | Explosives. Powder. Labor. | Explosives. Total. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treadwell | .0191 | .0048 | .0239 | .2280 | .0050 | .0192 | ...... | .0242 | .0082 | .0293 | .0082 | .0457 | .0030 | .0018 | .0079 | .0656 | .0042 | .0825 | .1613 | .0097 | .0070 | .0042 | .1253 | ...... | .0099 | .1444 | .3124 |
| Mexican | .0322 | .0057 | .0379 | .2720 | .0058 | .0209 | ...... | .0267 | .0031 | .0572 | .0245 | .0848 | .0028 | .0012 | .0175 | .0822 | .0056 | .1093 | .2137 | .0057 | .0067 | .0029 | .0916 | ...... | .0132 | .1144 | .3318 |
| Ready Bullion | .0400 | .0107 | .0507 | .2521 | .0015 | .0159 | ...... | .0174 | .0029 | .0882 | .0064 | .0975 | .0027 | .0012 | .0154 | .0709 | .0063 | .0965 | .1439 | .0041 | .0064 | .0029 | .0871 | ...... | .0148 | .1115 | .2595 |

| Name of Mine. | Tramming. Labor. | Tramming. Steam-Power. | Tramming. Horses. | Tramming. Supplies. | Tramming. Total. | Hoisting. Labor. | Hoisting. Supplies. | Hoisting. Steam-Power. | Hoisting. Total. | Explosives. Labor. | Explosives. Fuse. | Explosives. Caps. | Explosives. Powder. 70 Per Cent. | Explosives. Powder. 40 Per Cent. | Explosives. Total. | Illuminants. Labor. | Illuminants. Candles. Oil. | Illuminants. Electric Light. Labor. | Illuminants. Electric Light. Supplies. | Illuminants. Total. | Total Costs. Labor. | Supplies. | Iron and Steel. | Foundry. | Electric Light. | Hauling Supplies. | Repairs. | Assay. | Power. | Personal. | Powder | General. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treadwell | .0202 | ... | .0042 | .0055 | .0359 | .0170 | .0025 | .0293 | .0486 | .0141 | .0100 | .0060 | .1312 | .0656 | .2269 | .0010 | .0072 | .0002 | .0001 | .0085 | .4766 | .0504 | .0360 | .0012 | .0003 | .0021 | .0080 | .0015 | .0586 | .0039 | .1966 | .0017 | 0.8898 |
| Mexican | .0185 | ... | .0023 | .0066 | .0271 | .0148 | .0014 | .0572 | .1034 | .0188 | .0095 | .0044 | .1091 | .0822 | .2237 | .0006 | .0130 | .0010 | .0003 | .0149 | .6465 | .0419 | .0318 | .0008 | .0013 | .0022 | .0102 | .0027 | .1144 | ...... | .1913 | .0129 | 1.0590 |
| Ready Bullion | .0825 | ... | ...... | .0005 | .0830 | .0194 | .0018 | .0882 | .1124 | .0211 | .0091 | .0041 | .1023 | .0709 | .2080 | .0004 | .0092 | .0005 | .0003 | .0104 | .5671 | .0316 | .0357 | .0006 | .0008 | .0016 | .0057 | .0021 | .1763 | ...... | .1727 | ...... | 0.9954 |

NOTE.—The costs for the Treadwell mine are from May 31, 1901, to May 31, 1902, and for the Mexican and Ready Bullion mines, from December 31, 1901, to December 31, 1902.

Tons milled: Treadwell, 682,893 tons; Mexican, 207,455 tons; Ready Bullion, 226,522 tons.

its back by a pillar of rock 10 ft. thick. This drift is the same in size as the lower one, and is so driven that it connects with the top of each chute-raise as it progresses.

At the ends of the main cross-cuts, and at intervals varying from 200 to 500 ft. along the deposit, the different levels are connected by winzes. These winzes are used as man-ways and as a medium of ventilation. It might be well to add that they are always raised from the lower level, and not sunk from above unless circumstances absolutely require it. While running the main drifts and cross-cuts close attention is paid to the grade. The standard grade in all the mines is 0.5 per cent. This grade favors the loaded car going to the station, while it does not retard it too much on its return trip. Cross-cuts are used for connecting the various drifts and for prospecting. They are the same in size as the drifts. When used for the first purpose they are at the level of the drift, but when the second object is the incentive, they are usually driven from the level of the intermediate, so that the broken rock can be stored and handled through chutes. The usual size for drifts, cross-cuts and intermediates is 10 by 7 ft. in the clear, and for raises 6 by 8 ft. in the clear, no timber being used.

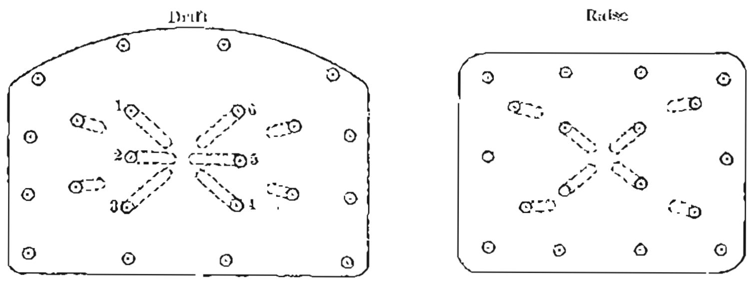
As a usual thing the rock is quite uniform in texture, and without seams or slips to break to. This makes it extremely difficult for the holes to break to the bottom. The following sketches (Fig. 8) show the scheme of drilling a round in a drift and a raise, which has resulted from several years' trials.

All work is done by machine-drills, two sizes being used. For drifting and cross-cutting the New Ingersoll, cylinder diameter 3⅝ in., is very satisfactory; and for raising, the Ingersoll-Sergeant, cylinder diameter 3¼ in., is preferable, on account of its lightness and durability.

The cut-holes from No. 1 to No. 6 are drilled 7 ft. deep, and are so pointed that they come to a common apex at the center. The next row of holes, called the relievers, are drilled 6 ft. deep and given a slight rake toward the center. The outside holes, or trimmers, are also drilled 6 ft. deep, but are given a small outward angle. The cut is first blasted with No. 1, or 70 per cent, powder; the relievers and trimmers are then blasted separately, No. 2, or 40 per cent, powder being used in each case. The position of the blasting-holes, both in the drift and in the up-raise, is illustrated in Fig. 8.

*Stoping Surface-Pits.*—By reference to the table on page 384, it will be seen that considerably more than 75 per cent of the ore mined from the Treadwell has come from the open- or surface-pits. From now on, the percentage from the underground workings will become greater each year. The main open-pit, or "Glory Hole," has reached a depth of 220 ft. below the adit level and 450 ft. from the surface, with a maximum width of 420 ft. and a length of 1,700 ft. Owing to the large slides of waste rock from the foot-wall, and the necessity of having a secure pillar of rock at the 220-ft. level to protect the underground workings from surface-water, it is impracticable to carry the pits to a greater depth. In the other mines, at present, very little ore is being taken from the surface, but at the beginning, all of them depended on the open-pits for ore on

Fig. 8.




Position of Blasting Holes.

which to start their mills. When a pit is to be opened, a raise is put up from the nearest level and connected with the surface. This raise is started from the intermediate drift, in general directly over a chute-raise. The chutes on each side then serve as a man-way for the raise in course of erection, and the broken rock is drawn off through the middle chute-raise into cars. When the raise has been connected, machine-drills are put to work cutting out a small stope at the bottom. This raise when finished has the shape of an hour-glass, the top being formed by the open-pit and the bottom by a stope, covering three chutes and from 20 to 30 ft. high, the two being joined by the raise. The object of cutting out the pit-raises in this manner is, first, to obtain chute-capacity in case of their being hung up by large pieces of rock or by blasting; and, second, to afford an opportunity to break up any large piece of rock that may have been overlooked in the pit, which would stop up the chute unless it were broken to pieces small enough to pass through it.

Machine-drilling is seen at its best in these pits. The $3\frac{1}{4}$-in. diameter Ingersoll-Sergeant drills, set on tripods, are used in all the pits at present. The average number of feet drilled per machine in 10 hours is 36.35. The holes are drilled to an average depth of 12 ft., and each machine will break 69.69 tons of ore per shift of 10 hours. When the pits were smaller, and the difficulty of setting up was not so great as at present, the average number of feet drilled was much higher, and the breaking capacity of a machine-drill was from 150 to 200 tons of ore per shift of 10 hours. The pits are worked by drilling and blasting the ore from a series of benches or terraces around the chute-raise as a center, and when the ore is blasted the broken rock rolls down to the bottom. The small pieces are then broken by sledges, and the larger ones by placing sticks of powder on the surface of the rock, tamping with a little fine dirt, and blasting. For blasting holes, No. 2, or 40 per cent, dynamite is used, while for "bull-dozing" No. 1, or 70 per cent, is the best.

When the rock has been broken to the required size, it is drawn off, through the raises and chutes described above, into cars. These cars are hauled to the station ore-bins by horses, or by endless-rope haulage, where they are dumped. The ore is then loaded into skips, hoisted to the surface, and handled in the usual manner.

*Underground Stoping.*—The future economic workings of the mines depends on no one factor more than on the success attending the carrying of the present system of stoping to the lower levels of the mines. The surface-pits are practically exhausted, and the value of the ore does not allow of timbering or any extensive method of filling. So far, the present method has proved applicable to the lowest levels, and I do not hesitate to say that it will be equally successful at any depth to which it may be desired to carry it.

It was explained above that the object of the intermediate drift is to open communication with the ore-chutes and to furnish a large facial area for the machine-drills to work upon, in cutting out or under-cutting the ground-floor for the stopes. When the intermediate has advanced about 50 ft., the work of cutting out the stope is started. This consists of mining out a chamber 7 ft. high, from 150 to 300 ft. long, and with a width varying with the width of the ore-body. In the past it has been customary to cut out the stopes with a level floor, but experience has shown that it is more economical to cut the floor so that it slopes from the parallel lines of chutes at an angle of about 30°. This does away with a large amount of shoveling, and the ore thus left is ultimately obtained through the stopes from the next lower level.

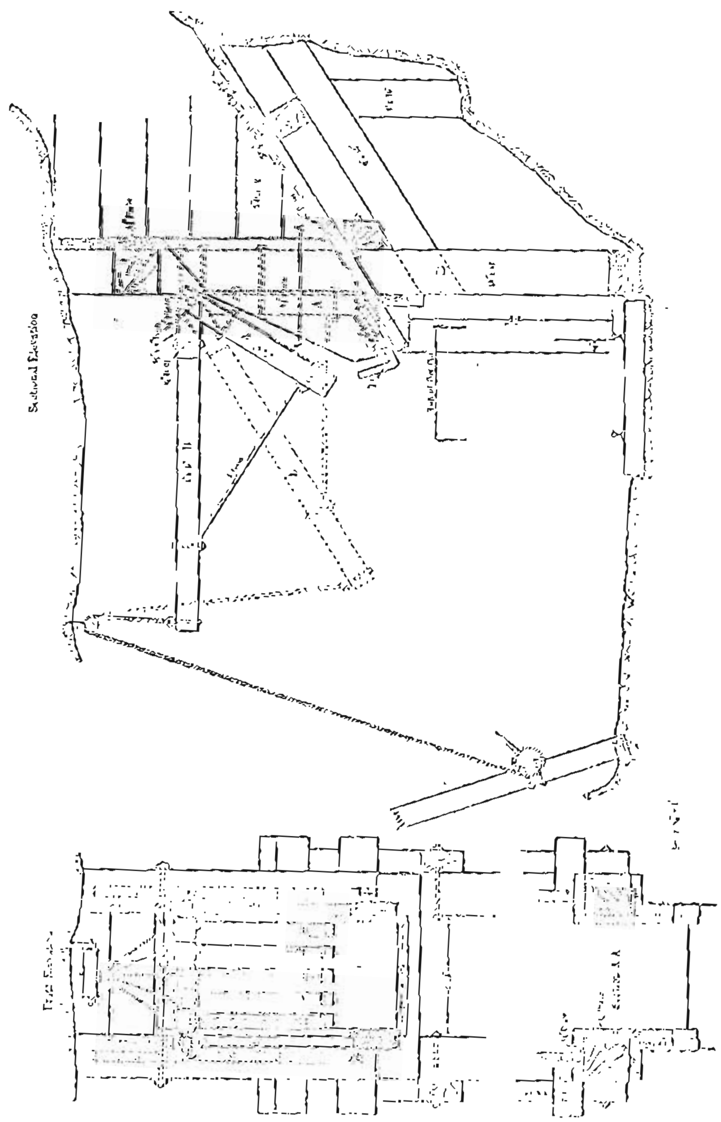
When the ground-floor has been cut out, the work of stoping upon the ore is immediately begun. The roof of the stope is arched, thus serving the double purpose of supporting the back and offering a better surface for the attack of the machine-drills. The ore is shot down in large, thin slabs, so that the shock of falling, combined with that of the blasting, breaks it up as much as possible. The pieces of rock too large to pass through the ore-chutes are broken by hand and "bull-dozed" with powder to the required size. When starting from the floor, the machine-drills cut out a trench along the center of the back to form the arch, its height varying with the character of the rock. Two sizes of machine-drills are used: the 3¼-in. and 3⅝-in. Ingersoll-Sergeant, and the holes are drilled to an average depth of 8 ft. A machine-stoping will drill an average of 28.69 ft. per shift of ten hours and break 34.96 tons of ore with the consumption of 12.53 lb. of No. 2 dynamite. The cost of breaking up the rock after it has been blasted down is a large item in the expense of stoping. One rock-breaker is usually required to each machine, and it takes 0.85 lb. of powder in "bull-dozing" for each ton of rock broken.

As no timber is used, it is compulsory that a sufficient quantity of broken ore be left in the stopes to form a solid working-floor for the miners. It has been found that one-third of the broken ore can be drawn off while the stope is being worked, and the surface of the broken ore kept within working distance of the back. In other words, by the above methods, two-thirds of the ore broken must be left in the stope, and cannot be drawn off until the stope is worked up to the next higher level and finished. In the Treadwell and Ready Bullion mines the slate-horse forms a natural division between the stopes of the north and the south ore-bodies. The walls of the ore-body are supported by vertical pillars, or ribs, 15 ft. thick, and from 200 to 300 ft. apart. For means of communication and ventilation, man-way raises are put up in these pillars and connected with the levels. At intervals of 25 ft., short drifts are run in opposite directions from the man-way raise; so that, as the working-floor of the stope advances, each of them is used successively when the workings connect with the main raise, and in turn abandoned and closed up as connection is made with the next higher one. The levels are protected by horizontal pillars from 20 to 30 ft. thick. Heretofore these pillars have been left at each level, but from now on only the pillars at every other level will be left in place; yet even with this saving, fully 20 per cent of the ore must remain in the mine in the shape of pillars and ribs to support the ground and prevent caving.

*Chutes, Drilling, etc.*—Fig. 9 shows the principal features of the so-called finger-chute which is used throughout the island when a large amount of comparatively coarse rock is to be handled. The fingers are held in place by the weight of an arm, B, and are separately hung from the rod, C C, so that the motion of each is independent of that of the others. For the purpose of raising the fingers so that the ore can be drawn, to the top of each finger is fastened a piece of rope. These pieces are brought to a common center and fastened to the main hoisting-rope, which passes over a pulley in the top of the drift and thence down to a small windlass. When ore is to be drawn, the fingers are raised to the height necessary to allow the ore to pass. When enough has been drawn, the fingers are released and fall into position, stopping the flow. If a large piece is caught on the lip of the chute, it will hold only the finger or fingers that come in contact with it, while the others drop to their normal position. To prevent fine dirt dripping into the roadway, a tail-board is put across the mouth of the chute and held in position by the angle-irons, D.

The cost of putting up chute-raise, cutting-station, and installing finger-chute complete, is as follows:

Fig. 9.



Standard Finger-Chute, Treadwell Mine.

| | |
|---|---|
| 12 ft. of raise at $9 per ft., | $108.00 |
| 80 cars of dirt at 20c., | 16.00 |
| Cutting chute-station for windlass, | 40.00 |
| 40 cars of dirt at 20c., | 8.00 |
| Building finger-chute, | 17.58 |
| Lumber, 700 ft. B.M., at $12.50, | 8.75 |
| Iron and steel, | 40.00 |
| Blacksmith-work, | 7.00 |
| Rope, | 2.00 |
| Total cost, | $247.33 |

The principal advantages gained by using the finger-chutes are dispatch in loading and freedom from blocked chutes and from spilling ore on the tracks. Their cost is prohibitive except where a large amount of coarse, dry rock is to be handled, and in the Ready Bullion and Mexican mines they have been in a great measure superseded by the common board-chute, which costs very much less. In the Treadwell they alone are used, and, as stated above, they are being put in at intervals of 20 and 15 ft., instead of 30 ft., as heretofore. The additional expense of putting in finger-chutes every 15 ft., instead of every 30 ft., is $8.33 per foot of drift. The saving in shoveling in a stope 60 ft. wide would be $12 per foot, making a saving of $3.67 by additional chutes; to which must be added the advantage of not losing time by chutes getting blocked. With chutes 15 ft. apart, the train can move with brief stops and be practically drawing from the same part of the stope. The blocked chute can be freed by one man and not delay the train more than 10 minutes. Also, in case the back of the stope should become so bad that men could not get in to work the ore into chutes, more than twice as much could be drawn from the stope with chutes 15 ft. apart.

A modification of the finger-chute is used for the skip- and bin-chutes. They are made with six fingers and are 6 in. wider than the ordinary chute. A trough is added to carry the ore from the lip to the edge of the shaft. It is 9 ft. long, 3 in. wide, with an inclination of 36°, so that the ore will run freely from the lip to the skip. Attached to the end of the trough is a hinged door made of 0.5-in. steel plate. When raised, it immediately and entirely stops the flow, and allows the trough to be filled in readiness for loading the next skip. It takes on an average 20 seconds to load a 4-ton skip and make everything clear for hoisting.

TABLE III.—*Duty of Machine-Drills on Douglas Island, Alaska.* "B."

| Mine. | Character of Work. | Average Number Feet Drilled Per Machine-Drill Per 10-Hour Shift. | Pounds Powder Used Per Machine-Drill Per 10-Hour Shift. | Average Number Tons Broken Per Machine-Drill Per 10-Hour Shift. | Average Costs Per Machine-Drill in 10 Hours. Labor, Drilling. | Explosives. | Drill-Sharpening, Repairs, Supplies, Power, etc. |
|---|---|---|---|---|---|---|---|
| Treadwell mine. | Pits | 36.35 | 15.89 | 69.69 | ........ | $2.50 | ........ |
| | Stopes | 28.69 | 12.53 | 34.96 | ........ | 1.97 | ........ |
| | Cutting out | 26.16 | 11.45 | 12.30 | ........ | 1.80 | ........ |
| | Drifting | 38.22 | 16.73 | 9.60 | ........ | 2.63 | ........ |
| | Raising | 34.18 | 14.95 | 7.60 | ........ | 2.35 | ........ |
| | Shaft sinking | 31.12 | 13.65 | 9.28 | ........ | 2.15 | ........ |
| Total | | 32.30 | 14.13 | 39.67 | $7.87 | $2.22 | $2.10 |
| Mexican mine. | Pits | 34.61 | 15.64 | 49.70 | ........ | $2.46 | ........ |
| | Stopes | 31.78 | 13.90 | 36.19 | ........ | 2.26 | ........ |
| | Cutting out | 31.40 | 13.71 | 18.40 | ........ | 2.23 | ........ |
| | Drifting | 40.83 | 17.86 | 11.40 | ........ | 2.91 | ........ |
| | Raising | 35.29 | 15.14 | 14.23 | ........ | 2.61 | ........ |
| | Shaft sinking | 41.00 | 17.92 | 20.92 | ........ | 2.92 | ........ |
| Total | | 34.59 | 15.13 | 25.52 | $7.95 | $2.46 | $2.28 |
| Ready Bullion mine. | Pits | 39.63 | 17.34 | 197.06 | ........ | $2.82 | ........ |
| | Stopes | 29.85 | 12.96 | 38.04 | ........ | 2.11 | ........ |
| | Cutting out | 26.23 | 11.48 | 17.06 | ........ | 1.87 | ........ |
| | Drifting | 30.16 | 13.19 | 10.33 | ........ | 2.15 | ........ |
| | Raising | 26.44 | 11.57 | 6.96 | ........ | 1.88 | ........ |
| | Shaft sinking | 26.80 | 11.72 | 15.21 | ........ | 1.91 | ........ |
| Total | | 28.58 | 12.49 | 28.19 | $7.03 | $2.03 | $3.02 |
| 700-Foot mine. | Pits | 36.41 | 15.92 | 55.15 | ........ | $2.59 | ........ |
| | Stopes | 29.26 | 12.81 | 35.68 | ........ | 2.09 | ........ |
| | Cutting out | 26.00 | 11.37 | 12.40 | ........ | 1.85 | ........ |
| | Drifting | 38.00 | 17.12 | 15.64 | ........ | 2.71 | ........ |
| | Raising | 33.60 | 14.70 | 8.60 | ........ | 2.39 | ........ |
| | Shaft sinking | 32.16 | 14.67 | 20.50 | ........ | 2.29 | ........ |
| Total | | 31.35 | 13.72 | 27.41 | $6.48 | $2.23 | $3.23 |
| Average Totals. | | 31.92 | 13.96 | 33.51 | $7.58 | $2.27 | $2.42 |

Table III. gives the duty of machine-drills in the different characters of work for which they are employed.

Under the heading "Pounds powder used per machine-drill per 10-hour shift" is given the actual amount of powder used for blasting the holes drilled, but it does not include powder used for bull-dozing, blasting chutes, etc. The cost of this powder is given under the head of explosives; it varies with the different mines, and from month to month in the same mine, according to the varying expense of handling and sales to outside parties.

The "Labor, Drilling" cost given is the actual expense of machine-men and helpers. The men do a great deal of the barring-down and trimming, and the above cost will vary accordingly.

The last column under "Average cost per machine-drill in 10 hours" gives the cost of drill-sharpening, repairs, power, and all other costs not included under the heads of Labor, Drilling and Explosives.

*Tramming.*—At present there are three methods of tramming in use: by hand, with the help of horses, and by endless-rope haulage.

When the tramming is done by hand, one man loads a car, pushes it to the ore-bin, dumps it, and returns to the chute. Ordinarily there are several men tramming from the same chute, and a great deal of time is lost by awaiting their turn to load; and again at the bin there is another wait until the last car is dumped before starting on the return-trip.

By using horses, the lost time is minimized by making up two or more trains of 8 cars each, so that when one train is dumping, another is loading and the third is *en route*.

While there is a marked saving in men by using horses, their first cost is considerable, a horse costing $180 delivered; and their depreciation is another factor to be considered, for they are continually meeting with accidents, which either disable them permanently or lay them off at a cost of $1 a day for maintenance.

By the use of mechanical haulage, both the lost time and cost per ton has been greatly reduced. The system is essentially the so-called "tail-rope" system in use in numerous places, but modified to make it conform with underground conditions. On the hanging-wall side of the ore-bin is situated a double-drum winding-engine, size of cylinders 7 in. by 10 in., with drums 2 ft. 8 in. in diameter. Set directly in front of and close to the engine are four posts. Two are designed to carry a sheave suspended on a horizontal axle, for guiding the upper rope and causing it to wind smoothly on the drum, while the remaining two support a roller which answers the same purpose for the lower rope. From the drum to the point where the drifts branch out, the upper rope is supported by snatch-blocks suspended from the back of the drift and by sheaves at the ends of arms securely fastened to 10- by 10-in. posts. A horizontal sheave is placed at the point where the direction of the rope is changed to allow it to enter the drift. Since this sheave is subject to severe strains, it should be held rigidly in place by horizontal 10- by 10-in. pieces securely bolted to the 10- by 10-in. posts. From this point to the end of the drift the upper rope is carried by sheaves fastened to the posts of the finger-chutes, immediately under the protruding lip, where it will be out of the way and at the same time protected from blasting. The sheaves are inclined so that the greatest strain is at right-angles to the axle, and the rope is prevented from jumping out by pegs placed across the top of the sheave. The lower rope is kept in line by a series of horizontal sheaves fastened

FIG. 10.


LOWER ROPE SHEAVE AND GUARD.

to blocks, their number depending on the crookedness of the tunnel; and it is prevented from dragging on the ground by iron rollers placed between the tracks.

The lower sheaves (Fig. 10) are placed as near the track as possible, and are mounted on pieces of 10- by 10-in. timber securely braced against the side of the tunnel. To guide the rope into the sheave the front end of the block is beveled off to the height of the rail. On the top of the sheave is a piece of wrought-iron, bent as shown in cut, its object being to prevent the rope from jumping out and also to hold the axle in a vertical position. At the ends of the various drifts, or at convenient points in them, is placed a series of sheaves, or a single sheave as the case may be, to carry the end-loop of the rope. At first was tried a sheave mounted on a truck and fastened by clamps to the rails; but this proved a failure on account of the great strain, which pulled up the track and did other damage.

For purposes of signaling, two bare iron-wires are run the entire length of the tunnel. These wires are parallel and 4 in. apart. At the winding-engine they connect with a bell and signal-light, while the current is obtained from the electric-light circuit. The signals are given by placing an iron candlestick across the two wires or by means of a special portable signal device. As the wires are bare, signals can be given from any point, which is a great convenience in case of the train jumping the track or other accident. Two trains are used on each level, consisting of seven cars, each car holding 1.5 tons. While one train is discharging at the shaft ore-bin, the other is loading. The trains are run at a maximum speed of 800 ft. per minute, and at present their capacity is 750 tons of ore per shift, or 1,500 tons per day.

*Sampling, Maps and Assaying.*—Close attention is paid to sampling and recording the assay-value of the ore. As a drift, raise, cross-cut, or other development-work is in progress, a sample is taken after each round has been blasted. These samples are taken either by the shift-boss or the foreman, and their description and location are recorded on a special tag, enclosed with the sample in the sack.

At intervals of 15 ft., and closer if there is any doubt as to the value of the ore, lines of samples—each sample being 10 ft. long and varying with the nature of the ore—are taken across the back of the stopes at right-angles to the strike. These samples are taken by cutting trenches, usually 10 ft. long, 4 in. wide across the strike of the ore, and 5 ft. apart, for the entire length of the new work. A hand-sample is taken from each car at the ore-bins, and again at the crushers a grab-sample is taken by means of large dippers, before the ore goes to the mill.

The only samples taken in the mill are from the tailings and sulphides. The tailings-sample is taken either at the tail of the vanners by means of dippers, or at the end of the tailings-launders by means of automatic samplers. The sulphides are sampled by means of the ordinary grooved sampling-rod. When the mine-sample reaches the assay office it weighs from 50 to 150 lb.

The assay office is fitted with the usual grinding machinery, two double-muffle furnaces, pulp- and bullion-scales, etc. There is an average of about one hundred samples assayed each day, and the returns from a sample are obtained the day after it is taken. All samples are assayed for gold only. In connection with the assay office are the retorting- and melting-rooms for refining the amalgam from the mills.

A complete set of maps is kept, showing in detail the underground and surface-workings of the mines, also the value and position of each sample taken and the quantity of broken ore and reserves.

*Labor.*—The nationality of the mine-laborers is shown in Table IV.

TABLE IV.—*Number and Percentage of Different Nationalities Working at the Mines on Douglas Island, Alaska.*

| Nationalities. | Per Cent. | Treadwell. | Mexican. | Ready Bullion. | Total. |
|---|---|---|---|---|---|
| Americans | 26.5 | 147 | 16 | 27 | 220 |
| Norwegians, Swedes and Danes | 25. | 104 | 60 | 41 | 205 |
| Scotch | 1. | 4 | 2 | 5 | 11 |
| Austrians and Slavonians | 24.5 | 113 | 29 | 58 | 200 |
| Irish | 3.5 | 22 | 5 | 2 | 29 |
| Germans | 3. | 13 | 7 | 4 | 24 |
| French | ..... | 2 | ..... | ..... | 2 |
| English | 2.5 | 16 | 2 | 2 | 20 |
| Italians | 3. | 6 | 8 | 9 | 23 |
| Finns | 5. | 17 | 20 | 3 | 40 |
| Russians | 1. | 5 | 3 | ..... | 8 |
| Turks | ..... | 1 | ..... | ..... | 1 |
| Japanese | 4. | 17 | 15 | ..... | 32 |
| Indians | 1. | 6 | 2 | 1 | 9 |
| Totals | 100. | 473 | 199 | 152 | 824 |

On account of the system adopted for working the mines, due to the character of the walls and vein-material, it is necessary to employ only skilled labor in the shafts, drifts, raises, etc.

About 60 per cent. of the machine-men and helpers on the island came as laborers and have learned their trade here. They are preferred by the foremen, and seem on the average to break more rock than miners who have gained their experience elsewhere.

Following are the rates of wages paid the different classes of labor employed:

| | |
|---|---|
| Machine-drillers, . . . | $2.50 per day in summer, $3.00 per day in winter; with board and lodging. |
| Machine-helpers, . . . | $2.25 per day, with board and lodging. |

| | |
|---|---|
| Mine-laborers, . . | $2.00 per day, with board and lodging. |
| Mine-laborers (Indians), . | $2.00 per day, without board and lodging. |
| Blacksmiths, . . . . | $4.00 per day, with board and lodging. |
| Tool-Sharpeners, . . . | $3.50 per day, with board and lodging. |
| Blacksmith's helpers, . . | $2.00 per day, with board and lodging. |
| Machinists and helpers in machine-shop, . . . | From $2.00 to $6.00 per day, with board and lodging. |

Labor of all kinds is plentiful, particularly so in the winter months.

*Machinery.*—Tables V., VI. and VII. show in detail the size of the principal hoisting-engines, compressors and water-wheels. Besides the above there are several hoisting-engines used underground, for sinking, tramming, etc.

All the machinery, with the exception of the hoisting-engines, is arranged so that at any time when there is sufficient water the steam can be shut off, wholly or in part, and the power be furnished by water-wheels. These wheels are either direct or rope-connected.

The steam at all the mines, with the exception of the Mexican mine where five return-tubular boilers are used, is supplied by Heine safety boilers arranged in units to suit the needs of the various mines.

Situated as the mines are, far from their source of supply, it is but natural that they support a well-equipped machine-shop and foundry, where all repairs, mine-cars, drill-parts, etc., are made.

There are no wagon-roads. The steamers deliver all supplies and machinery on the company's wharf, where it is reloaded on cars and delivered to all the principal points about the mines. For the surface-work, two 7-ton mine-locomotives, made by the Baldwin Locomotive Works, with necessary coal- and flat-cars, are used.

MILLING.

The character of the ores on Douglas island is peculiarly adapted to the simple methods of extraction in use. As explained above, the gold is contained in an altered syenite in the form of free gold, and in the sulphides, the principal gold-bearing minerals being iron pyrites, arsenopyrite, molybdenite and calcite. The ore on the surface has been subject to little oxidizing action, and, perhaps, that on the lowest level is even

TABLE V.—*Dimensions of Principal Air-Compressors on Douglas Island.*

| Name of Mine. | Make and Character of Compressor. | Steam-End. Diameter of Cylinders in Inches. Low. | Diameter of Cylinders in Inches. High. | Piston-Stroke in Inches. Low. | Piston-Stroke in Inches. High. | Piston-Speed Per Minute. Low. | Piston-Speed Per Minute. High. | Cylinder Area in Sq. Inches. Low. | Cylinder Area in Sq. Inches. High. | Mean Effective Pressure in Pounds. Low. | Mean Effective Pressure in Pounds. High. | Boiler-Pressure in Pounds. Low. | Boiler-Pressure in Pounds. High. | Indicated Horse-Power. Low. | Indicated Horse-Power. High. | Pelton Water-Wheels. Diameter of Wheel. | Diameter of Nozzle. | Head of Water. | Gauge-Pressure. | Number of Wheels. | Remarks. | Air-End. Number of Cylinders. | Diameter of Air-Cylinders, Inches. | Area of Air-Cylinders, Sq. Inches. | Length of Stroke in Inches. | Diameter of Valves, Inches. Inlet. | Diameter of Valves, Inches. Outlet. | Area of Valves, Sq. Inches. Inlet. | Area of Valves, Sq. Inches. Outlet. | Possible Speed Under Pressure. Rev. Per Min. | Revolution Run. | Maximum Drills Obtained. | At Air-Pressure of Pounds. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treadwell. | Reidler duplex. | 31 | 20 | 36 | 36 | 372 | 372 | 707.92 | 314.16 | 14.0 | 13.0 | 100 | 100 | 188.3 | 152.0 | 21′ 0″ | 1¾″ | 390 | 169 | 1 | Direct connected. | 2 | 24 | 452.39 | 36 | 6 | 6 | 28.27 | 28.27 | 65 | 61 | 30 | 80 |
| | Ingersoll single cylinder. | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 8′ 0″ | 1⅝″ | 440 | 192 | 1 | Rope driven. | 1 | 22 | 380.13 | 30 | 5 | 5 | 19.63 | 19.63 | 60 | 60 | 15 | 80 |
| Mexican. | Reidler duplex. | 30 | 18 | 30 | 30 | 350 | 350 | 706.86 | 254.46 | 14.2 | 49 | 90 | 90 | 106 | 132 | 5′ 0″ | 2⅞″ | 387 | 167 | 1 | Rope driven. | 2 | 18 | 254.46 | 30 | 5 | 5 | 19.63 | 19.63 | 70 | 65 | 15 | 70 |
| Ready Bullion. | Reidler duplex. | 31 | 20 | 36 | 36 | 372 | 372 | 707.92 | 314.16 | 11 | 43.3 | 100 | 100 | 188.3 | 152 | ... | ... | ... | ... | ... | | 2 | 24 | 452.39 | 36 | 6 | 6 | 28.27 | 28.27 | 70 | 61 | 30 | 70 |
| | | | | | | | | | | | | | | | | | | | | 3 | | | | | | | | | | | | | |

TABLE VI.—*Dimensions of Hoisting-Engines on Douglas Island, Alaska.*

| Name of Mine. | Treadwell. | | | Mexican. | 700-Foot. | Ready Bullion. |
|---|---|---|---|---|---|---|
| Location of Hoists. | New Shaft. | Old Shaft. | Man-Way. | New Shaft. | Main Shaft. | Main Shaft. |
| Number of cylinders.. | 2 | 2 | 2 | 2 | 2 | 2 |
| Diameter of cylinders in inches.............. | 15 | 12 | 10 | 14 | 12 | 12 |
| Piston-stroke in inches | 24 | 16 | 12 | 18 | 16 | 16 |
| Piston-speed per min... | 600 | 400 | 300 | 450 | 400 | 400 |
| Cylinder area in sq. in.. | 176.71 | 113.09 | 78.54 | 153.93 | 113.09 | 113.09 |
| Mean effective pressure in pounds............... | 60 | 60 | 60 | 75 | 60 | 60 |
| Boiler pressure, pounds | 100 | 100 | 100 | 100 | 100 | 100 |
| Indicated horse-power of hoist.................. | 385.2 | 164.4 | 84.4 | 314 | 164 | 164 |

TABLE VII.—*Dimensions of Mill-Engines and Water-Wheels, Douglas Island, Alaska.*

| Name of Mine. | | Steam-Engines. | | | | | | | | | | | | | | Pelton Water-Wheels. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Diameter of Cylinders in Inches. | | Piston-Stroke in Inches. | | Piston-Speed Per Minute. | | Cylinder Area in Square Inches. | | Mean Effective Pressure, Pounds. | | Boiler Pressure in Pounds. | | Indicated Horse-Power. | | Diameter of Wheel. | Diameter of Nozzle. | Head of Water. | Gauge-Pressure. | Number of Wheels. | Remarks. |
| | | H. P. | L. P. | H. P. | L. P. | H. P. | L. P. | High Pressure. | Low Pressure. | H. P. | L. P. | H. P. | L. P. | H. P. | L. P. | | | | | | |
| Treadwell. | 300 | | | | | | | | | | | | | | | 17′ 8″ | 2¾″ | 485 | 210 | 2 | Belt-connected. |
| | | | | | | | | | | | | | | | | 3′ 0″ | 1¼″ | | 210 | 2 | Direct-connected. |
| | 240 | R. 18 | L. 18 | 48 | 48 | 600 | 600 | 254.46 | 254.46 | 60 | 50 | 100 | 100 | 277.6 | 276 | 7′ 0″ | 2½″ | 460 | 200 | 1 | Rope-connected. |
| | | | | | | | | | | | | | | | | 7′ 0″ | 2″ | 460 | 200 | 1 | |
| Mexican... | | 16 | 26 | 42 | 42 | 600 | | 201.06 | 530.93 | 47 | 15 | 100 | | 175.2 | 144 | 5′ 10″ | 2⅜″ | 387 | 167 | 1 | Rope-connected. |
| Ready Bullion. | | 18 | 30 | 48 | 48 | 500 | 500 | 254.46 | 706.86 | 50 | 15 | 100 | 100 | 308 | 257 | ......... | ......... | ...... | .... | ... | .............. |
| 700-Foot | | 16 | 27 | 44 | 44 | 777 | 777 | 201.06 | 572.53 | 41 | 14 | 110 | 110 | 191 | 188.7 | 17′ 0″ | 2⅝″ | 485 | 210 | 1 | Direct-connected. |
| Total ..... | | ... | ... | ... | ... | ..... | ..... | ......... | ......... | ... | ... | ......... | | ......... | ..... | ......... | ......... | ...... | ...... | 8 | |

TABLE VIII.—*Equipment of Mills and Cost of Milling on Douglas Island, Alaska.*

Equipment of Mills.

| Name of Mill. | Crushers. Number. | Crushers. Size. | Crushers. Make. | Capacity of Ore-Bins. Cubic Feet. | Stamps. Number. | Stamps. Weight. | Stamps. Drops Per Minute. | Stamps. Height of Drop. | Feeders. Number. | Feeders. Style. | Mortars. Number. | Mortars. Style. | Number of Chuck Blocks. | Amalgamating Plates. Apron-Plates. Number. | Amalgamating Plates. Apron-Plates. Grade Per Ft. | Amalgamating Plates. Apron-Plates. Area in Sq. Ft. | Vanners. Number. | Vanners. Style. | Vanners. Size. | Motive-Power. Kind. | Motive-Power. Water-Wheels. Number. | Motive-Power. Water-Wheels. Style. | Time. Time Run. Per Cent. by Water. | Time. Time Run. Per Cent. by Steam. | Time. Time Run. Total. | Per Cent. Time Lost. | Average Tons Crushed in 24 Hrs. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treadwell "300." | 2 | "E." | Comet. | 81,795 | 300 | 1020 | 98 | 8⅝" | 60 | Suspended Challenge. | 60 | "67-A," F. and C. | 60 1" | 60 | 1½" | 45 | 120 | Frue. | 6' | Water. | 4 | Pelton. | 93.19 | ...... | 93.19 | 6.81 | 5.53 |
| Treadwell "240." | 2 | ...... | Gates. | 39,160 | 240 | 850 | 98 | ...... | 48 | Challenge. | 48 | Moren. | 48 8" | 48 | 1¼" | 40 | 96 | Frue. | 4' | Steam and water. | 2 | Pelton. | 51.44 | 40.39 | 91.83 | 8.17 | 4.80 |
| Mexican | 1 | ...... | Gates. | 31,600 | 120 | 1020 | 98 | 8¾" | 24 | Challenge. | 24 | "67," F. and C. | 24 4" | 24 | 1½" | 45 | 38 | Frue. | 4' | Steam and water. | [illegible] | Pelton. | 41.67 | 36.42 | 78.09 | 21.91 | 5.75 |
| Ready Bullion | 1 | "E." | Comet. | 19,750 | 120 | 1020 | 100 | 8½" | 24 | Suspended Challenge. | 24 | "67-A," F. and C. | 24 6" | 24 | 1¼" | 45 | 18 | Frue. | 6' | Steam. | ...... | ...... | ...... | 97.82 | 97.82 | 2.18 | 5.31 |
| 700-Foot Claim | 1 | "E." | Comet. | 23,150 | 100 | 1020 | 99 | 8¾" | 20 | Suspended Challenge. | 20 | "67-A," F. and C. | 20 1" | 20 | 1½" | 45 | 40 | Frue. | 6' | Steam and water. | 1 | Pelton. | 95.22 | 1.88 | 97.10 | 2.90 | 5.09 |

Cost of Milling (Dollars Per Ton of Ore) for Ten Months Ending September 15, 1902.

| Name of Mill. | Crushing. Labor. | Crushing. Supplies. | Crushing. Total. | Concentration. Labor. Concentrators. | Concentration. Labor. Sulphurets. | Concentration. Supplies. | Concentration. Power. | Concentration. Total. | Sulphurets. Labor. | Sulphurets. Supplies. | Sulphurets. Car. | Sulphurets. Assay. | Sulphurets. Total. | Total of All Expenses. Labor. | Supplies. | Iron and Steel. | Foundry. | Electric Light. | Hauling Supplies. | Repair. | Assay. | Power. | Legal. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treadwell, "300" | .0062 | .0046 | .0125 | .0091 | .0042 | .0095 | .0009 | .0147 | .0065 | .0007 | .0015 | .0006 | .0093 | .0560 | .0144 | .0211 | .0100 | .0041 | .0003 | .0057 | .0001 | .0061 | .0055 | .1205 |
| Treadwell, "240" | .0095 | .0040 | .0135 | .0153 | .0047 | .0029 | .0090 | .0308 | | | | | | .0720 | .0576 | .0058 | .0068 | .0040 | .0006 | .0106 | .0016 | .0658 | .0082 | .2040 |
| Mexican | .0069 | .0047 | .0116 | .0035 | .0081 | .0059 | .0090 | .0265 | .0052 | .0058 | Wharf. .0012 | .0006 | .0128 | .0720 | .0328 | .0270 | .0121 | .0027 | .0009 | .0091 | .0017 | .0090 | .0034 | .2562 |
| Ready Bullion | .0261 | .0019 | .0280 | .0147 | .0077 | .0177 | .0185 | [illegible] | .0057 | .0002 | .0032 | .0016 | .0046 | .0853 | .0300 | .0082 | .0135 | .0034 | .0012 | .0079 | .0020 | .0242 | .0050 | .3103 |
| 700-Foot Claim | .0096 | .0005 | .0101 | .0166 | .0095 | .0014 | .0056 | .0298 | .0017 | .0005 | .0019 | .0005 | .0106 | .0712 | .0285 | .0165 | .0081 | .0021 | .0001 | .0051 | .0014 | .0575 | .0062 | .1981 |

more free-milling than that in the surface-pits. By reference to Table IX. it will be seen that 48.04 per cent of the gold is caught on the plates by amalgamation, and the balance, or 51.96 per cent, is contained in the sulphurets and tailings. Table IX. shows very plainly the effect of coarse crushing on the percentage of extraction in the various places.

*Crushers.*—The crushers are located in the head-frames of the various mines, and are of the gyratory type. When the ore is hoisted out of the mine it is spilled by self-dumping skips on to a grizzly formed by 1-in. by 10-ft. pieces of iron, bolted together by 1-in. iron bars, and placed 2 in. apart by disc-shaped pieces of cast-iron. The over-size from the grizzlies goes direct to the crushers, and the under-size passes through and falls into the ore-bins situated directly beneath the crushers.

Too much stress cannot be laid upon the great effect of efficient crushing as related to the duty and output of a stamp-mill. This is particularly true on the island, where the crushing capacity is in excess of the demand and where there is abundant water-power which costs practically nothing. During the past year the duty of the mills has been increased over 1 ton per stamp in 24 hours, and without a doubt, 50 per cent of this increase has been caused by setting the crushers to break the rock 20 per cent smaller than before. An efficient crushing-plant for mines similar to the Treadwell would consist of four Gates-crushers arranged in pairs, one above the other, the upper to be of such a size that they would receive rocks 18 by 36 in., and the lower to turn out a product not larger than 1.5 in. in diameter. The rock when hoisted would be dumped on grizzlies with 5-in. spacing between bars: the over-size going to the upper crushers and the under-size falling on a second grizzly with bars set 1.5 in. apart,—over-size going to the lower pair of crushers and under-size passing into the storage-bins. The product from the upper pair of coarse crushers to be spilled on a grizzly with bars 1.5 in. apart, the over-size going to the lower crusher and the under-size and crushed product from the lower crushers falling into the bin. If the above method were used it would do away with a great deal of the bull-dozing and rock-breaking in the mines, making a very appreciable reduction in the cost of mining.

There are three different methods in use for conveying the ore from the crusher-bins to the mill ore-bins. At the Treadwell, small locomotives are used, drawing trains of six cars, each car holding 2.5 tons. At the Mexican, where the crusher and mill are practically under one roof, the 2.5-ton-cars are pushed by hand; while at the Ready Bullion the ore is handled by means of a gravity-tram operating a train of four 2.5-ton cars, the cars being returned by means of a small winding-engine located at the crusher-bin. The tracks from the crusher ore-bin are continued along the top of the mill ore-bins, so that the ore can be dumped directly from the cars into the bins.

In the 300-Treadwell and 240-stamp mills, the stamps are arranged back to back, and the bottoms of the bins are made in the shape of an inverted V, so that the ore will be equally divided and fed uniformly to the stamps on either side. In the other mills, where the stamps are arranged in a single row, the bottom of the ore-bins, from a point 8 ft. below the track, is given a slope of 45° to the open ore-chutes at the level of the cam-floor. The bins are double-boarded, and on the side next the stamps are lined with 0.25-in. steel-plate, to protect them from the scouring action of the rock. From the bins the ore is taken out by openings at the level of the cam-floor, and conveyed by chutes to the hoppers of the challenge-feeders. There is one chute and feeder for each five stamps. The 300-Treadwell, Ready Bullion, and 700-Foot mills are provided with the suspended challenge-feeders. These are preferable to the standard feeder, being more compact and very accessible for repairs. Both types are central feeders, the bumper-rod being placed next to the central stamp and guided in the usual way.

There are three different kinds of mortars in use on the island. The 300-Treadwell, Ready Bullion, and 700-Foot mills use the Fraser and Chalmers No. 67-A Type; the Mexican uses the Fraser and Chalmers No. 67, while the 240-Treadwell mill uses a special mortar made by Moran Bros., of Seattle, Wash. End- and side-liners are used in all the mills; and false bottoms are used, except in the 240-Treadwell mill, where the die rests on the bottom of the mortar. The false bottoms and liners are cast at the company's foundry, which does excellent work. The false bottoms in use consist of a piece of cast-iron 3 in. thick, and of the size and shape of the flange-portion of the die. Their object is to protect the bottom of the mortar from excessive wear.

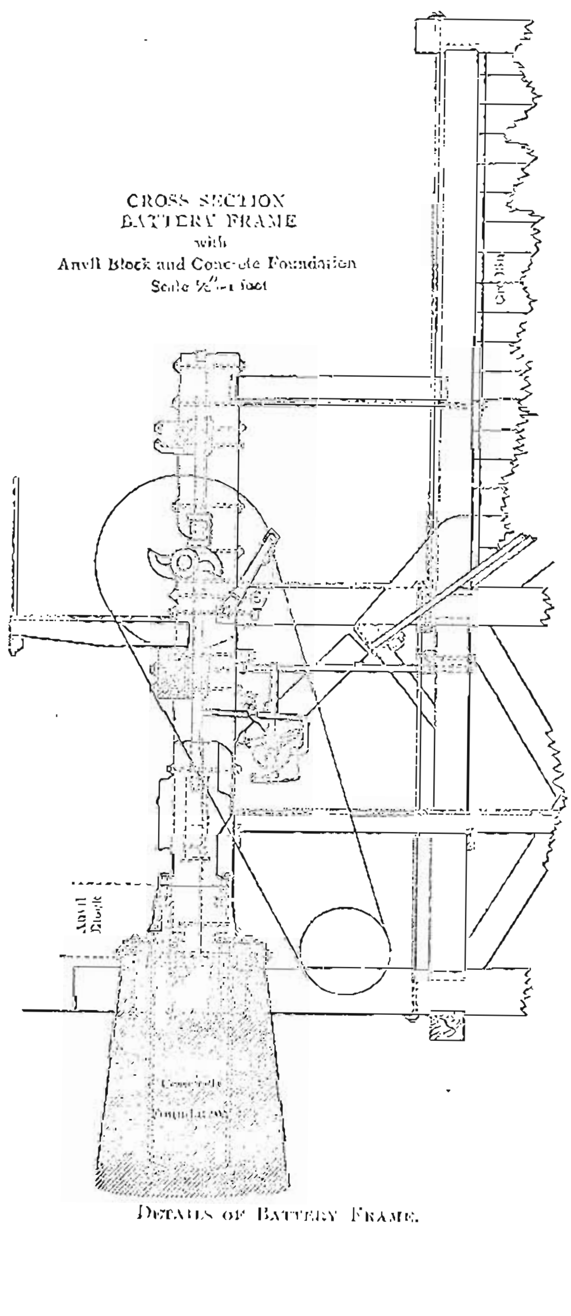
The stamps in the 300-Treadwell, Ready Bullion, Mexican, and 700-Foot mills weigh 1,020 lb., while those in the 240-Treadwell weigh when new 850 lb. The stems, tappets, boss-heads and shoes are joined in the usual manner. The Koppel shoe is used in all the mills. A shoe lasts 3 months and crushes 489 tons of ore, which means that 0.27 lb. of iron is consumed per ton of rock crushed. The dies are cast at the company's foundry and last on an average 4.49 months, crushing 732 tons and consuming 0.16 lb. of iron per ton crushed.

Interior views of the battery- and concentrator-floors of the 300-stamp mill at Douglas island are well shown in Figs. 12 and 13; and Fig. 14 shows the position of the Treadwell-Riedler compressor and the Pelton water-wheel, the latter having the cover removed.

*Battery-Foundations.*—There is no one part of a mill so essential to its efficiency as a good and lasting mortar-foundation. There are two kinds used on Douglas island. The Ready Bullion, 700-Foot, and the 300-Stamp mill at the Treadwell have concrete foundations, capped by cast-iron anvil-blocks, while the Mexican and the Treadwell 240-stamp mills have the ordinary wooden foundation.

On account of the peculiar climatic conditions prevalent on Douglas island, the life of a wooden foundation made of the best Oregon or Douglas fir has been about six years. It then commences to rot, causing the mortar-bolts to loosen, which results in an uneven wearing of the top-surface of the block. The life of the mortar-block can be prolonged from six months to a year by planing down the top and leveling it up by placing strips of rubber-belting between the old mortar-block and the mortar, but this is at best a make-shift. The rotting in every case has been confined to the surface, while the interior of the block remains sound. The blocks are built in the usual way, with four pieces of Oregon pine, 4 ft. 8 in. by 26 in., bolted together by iron bolts. The holes for the anchor-bolts are drilled into the mortar-block from above, at distances apart corresponding to those on the flange of the mortar. At a distance of 4 ft. below the top, holes are cut out to receive the

Fig. 11.




Details of Battery Frame.

nuts and washers that secure the lower end of the bolts. It is evident that when the decay of the wood penetrates to, say, a depth of 4 in., there is no longer a secure fastening for the mortar, and the mortar-block becomes useless. If a 2-in. iron rod be passed through the ends of opposite mortar-bolts and through the block, the life of the foundation will be prolonged from two to four years. The best wooden block is one built up of 2-in. plank, bolted and nailed together, and the mortar-bolts fastened as above.

*Fig.* 11 shows the character of foundation used in the newer mills. Soon after the mills were started it was noticed that the edges of the concrete next to the mortar showed signs of crumbling. The mortars were then raised and a sheet of 0.25-in. rubber-belt inserted between the mortar and the anvil-block. This lessened the crumbling, but did not stop it, and during the third year, fully one-quarter of the mortar-blocks in the mill had their anchor-bolts broken off at the point of contact of the concrete and the anvil-block. In nearly every instance, on removing the anvil-block, it was found that when the foundation was installed, instead of surfacing up the concrete to the correct level, it was allowed to set; then cement was poured in between the anvil-block and the already hardened concrete to raise the foundation to its proper height and level. This caused a plane of weakness and consequent crumbling, resulting in the breaking. The above condition might be remedied in the first instance by properly finishing the concrete, and making it 8 in. wider on either side than the bottom of the anvil-block, as shown in Fig. 11. With the above exceptions, the concrete foundation with the anvil-block has answered the purpose for which it was designed, and with a few minor changes it is preferable to the wooden foundation under the existing conditions on Douglas island.

*Power.*—Starting with the 5-stamp mill of the Treadwell, erected in 1881, the number has been increased from time to time, until at present there are 880 stamps dropping on the island, and these are distributed in the various mills as shown in Table VIII. Table VII., on page 364, gives the dimensions of the mill-engines and water-wheels at Douglas island.

During the summer months there is sufficient water to run 760 of the 880 stamps, and during the winter there is always enough to supply the batteries and vanners and run a portion of the mills.

This water-supply is obtained from a series of ditch-lines running along the mountain-sides and aggregating 18 miles in length. The main Treadwell ditch starts from a lake in the mountains 14 miles distant from the mines. It then follows the contour of the mountain-range, gathering the water from numerous small springs and streams, and delivers it to the penstocks at an elevation of 480 ft. above the mills, and at a distance of 1,500 ft. from them. On account of the heavy snowfall and low temperature in winter, the ditches are covered throughout their entire length by split lagging and boughs of trees. The snow on the mountains usually lasts until the end of April, and from then to the end of November rains are depended upon to supply the requisite amount of water.

At the Ready Bullion mine no provision has been made for a supply of fresh water for mill-use other than that for the boilers. Here salt water is pumped from the channel and used for all purposes in the mill. Experience has shown that while it is very destructive on all exposed iron in the batteries and on the vanners, it is better than fresh water for amalgamating purposes, but this advantage by no means compensates for the loss caused by its corrosive action on all exposed iron and on the vanner-belts. The coal—about 22,000 tons per year—is obtained from the mines on Vancouver island at reasonable rates. This coal is transported to the mines by means of barges, which on their return-trips carry concentrates in bulk to the Tacoma Smelter.

*Methods of Catching the Free Gold.*—The free gold is caught both inside and outside of the mortars by means of quicksilver. There is a diversity of opinion among the various amalgamators as to where, when, and in what quantities the quicksilver should be fed. Table IX. gives quantities used. The result of a series of tests in the various mills shows that the quantity of quicksilver fed in the mortars and on the plates varies directly with the gauge of the screen, and, consequently, with the coarseness of the ore. The coarser the crushing, the more quicksilver it is necessary to add to the mortars to make any saving at all.

TABLE IX.—*Detail of Clean-Up and the Effect of Coarse Crushing on the Distribution of Amalgam.*

Ten Months, 1901–2.

| Mill. | Tons Crushed Per Stamp in 24 Hours. | Oz. Quicksilver Fed Per Ton Ore Crushed. | | | Distribution of Clean-Up. Per Cent. | | | | | | | | Value Amalgam Per Ounce. | Value Bullion Per Ounce. | Value Free Gold Per Ounce Quicksilver Fed. | Per Cent. of Clean-Up in Free Gold. | Per Cent. of Concentrates. | Value Tailings Per Ton. | Gross Value Per Ton Ore Crushed. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Battery. | Plates. | Total. | Blocks. | Barrel. | Vanners. | Tanks. | Traps. | Tail-Boxes. | Ashes. | Tables. | | | | | | | |
| Treadwell "240" | 4.00 | .2098 | .0319 | .2417 | .0712 | .1938 | .0181 | .0188 | .0199 | .0151 | .0017 | .6581 | $6.12 | $18.65 | } $5.00 | 57.87 | 1.75 { | $.088 | } $1.918 |
| Treadwell "300" | 4.50 | .1261 | .0697 | .1958 | .0593 | .0962 | .0282 | .0107 | .0106 | .0128 | .0015 | .7475 | 6.12 | 18.65 | | | | .071 | |
| Mexican | 4.33 | .1794 | .0845 | .2639 | .1952 | .0793 | .0092 | .0281 | .0302 | ...... | .0037 | .6550 | 6.18 | 18.70 | 4.15 | 67.85 | 1.65 | .101 | 1.812 |
| 700-Foot | 3.97 | ...... | ...... | .2022 | .1836 | .1285 | .0111 | .0167 | .0262 | ...... | ...... | .6282 | 6.19 | 18.53 | 6.73 | 47.50 | 1.77 | .028 | 1.198 |
| Ready Bullion | 4.21 | .1316 | .0861 | .2177 | .8055 | { Blocks. Barrel. Table. } | | .0823 | .0207 | ...... | .0015 | ...... | 5.94 | 18.25 | 6.12 | 70.60 | 1.74 | .068 | 2.068 |
| Average | 4.27 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 18.59 | ...... | ...... | ...... | .076 | ...... |

Results from Ten Months, 1902–3.

| Mill. | Tons Crushed Per Stamp in 24 Hours. | Battery. | Plates. | Total. | Blocks. | Barrel. | Vanners. | Tanks. | Traps. | Tail-Boxes. | Ashes. | Tables. | Value Amalgam Per Ounce. | Value Bullion Per Ounce. | Value Free Gold Per Ounce Quicksilver Fed. | Per Cent. of Clean-Up in Free Gold. | Per Cent. of Concentrates. | Value Tailings Per Ton. | Gross Value Per Ton Ore Crushed. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treadwell "240" | 4.86 | .0849 | .0357 | .1206 | ...... | .0981 | .0216 | .0139 | .0303 | .0277 | .0011 | .8172 | $6.12 | $18.65 | } $5.80 | 45.99 | 2.00 { | $.104 | } $2.031 |
| Treadwell "300" | 5.33 | .0317 | .0532 | .0849 | ...... | .1067 | .0188 | .0257 | .0306 | ...... | .0006 | .7721 | 6.12 | 18.65 | | | | .092 | |
| Mexican | 5.73 | .2076 | .0336 | .2412 | .0221 | .0776 | .0311 | .0423 | .0101 | ...... | .0031 | .8277 | 6.48 | 18.70 | 3.63 | 48.87 | 1.71 | .105 | 1.979 |
| 700-Foot | 5.70 | .2299 | .0279 | .2578 | ...... | .0121 | .0164 | .0297 | .0382 | ...... | ...... | .8738 | 6.19 | 18.70 | 3.57 | 48.26 | 1.83 | .088 | 1.923 |
| Ready Bullion | 5.31 | .0824 | .0381 | .1205 | .0012 | .0963 | .0069 | .1936 | .0441 | ...... | .0019 | .6557 | 5.94 | 18.25 | 7.18 | 58.75 | 2.07 | .091 | 1.705 |
| Average | 5.38 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 18.59 | ...... | 48.01 | ...... | .094 | ...... |

On the other hand, the scouring action of the coarse sands on the plates necessitates frequent dressing to keep them well coated with quicksilver. It was the practice up to 1901 to keep the plates very wet, and even though the crushing was much finer an excessive amount of quicksilver was used. It will be seen from Table IX. that, although the tonnage crushed per stamp has shown a marked increase, the quantity of quicksilver used per ton is only about one-half the quantity formerly used.

The only amalgamated copper-plates used inside the mortars are the chuck-blocks. Two sizes are used at present (the 4 in. and 6 in. in height), but very little amalgam is collected from them. Formerly, they furnished 13.7 per cent of the amalgam collected, but since the fine screens were replaced they collect practically no amalgam, except during short periods in the winter when salt water is used. At these times the chuck-blocks become coated, but as soon as fresh water is again used the amalgam is scoured off, leaving the copper bare.

*Screens.*—The diagonal slot-screens which are used in all the mills are made of No. 23-gauge heavy Russian iron. Both the No. 4 and No. 5 are in use, these being equivalent to the 20- and 18-mesh wire screens, and are mounted in frames in the usual manner. Two widths are used, viz.: 9 in. and 12 in.—the former giving the better satisfaction.

A screen lasts about seven weeks in all the mills except the Ready Bullion, where it lasts only fifteen days. Salt water is used in this mill, and the corroding action seems to be intensified by the scouring of the sands in the mortar, which keeps the inside surface of the screen bright, thus always furnishing a fresh surface for the action of the water. These screens do not wear out as in the other mills, but become brittle and break.

Experiments are now in process with a make of iron-wire screen, but they have not advanced far enough for any conclusion to be reached.

*Apron-Plates.*—The motion of the battery-water, caused by the falling of the stamps, throws the pulp against the screen, and all particles fine enough pass through it and fall on the lip of the mortar. At the edge of the lip are placed two dash-boards arranged in steps to stop the rush of the water and sand, and cause it to drop in a steady flow on the apron-plates, which are placed immediately in front of the lip of the mortar, with the upper edge under the lip. This diminishes the scouring action, allowing the amalgam to collect near the upper end of the plate. The amalgam here is kept harder than at the lower end. This allows the lower end of the plate to be kept quite wet, which gives a better chance to catch the finer particles of gold that otherwise might float off.

These plates are made of the best Lake copper, $\frac{3}{16}$ in. thick, 4 ft. wide, 10 ft. long, and are given a fall of 1.5 in. to the foot. The plates are prepared in the usual manner by cleaning with a weak solution of potassium cyanide and rubbing in quicksilver until the upper surface is thoroughly amalgamated. While in use they are dressed with quicksilver twice a day, and the time taken for dressing should not exceed four minutes per day.

At the lower end of each plate is placed a wooden trough lined with copper, called the tail-box, where very little amalgam is caught. From the tail-boxes the pulp is conveyed through 3-in. pipes to the mercury-traps. These traps are made of cast-iron in the shape of a four-sided truncated pyramid, having the smaller end down. The trap is 14 in. square at the top, 15.5 in. deep, with the lower end 6 in. square. In the bottom is a 2-in. tap closed by a plug for drawing off the contents when cleaning up. Inside the trap is a block 14 by 8 in. on top, 11 in. deep and 8 by 8 in. on the bottom. The pulp from the table enters the trap through a 3-in. pipe that reaches to within 2 in. of the bottom. It then flows up through the space between the trap and the wooden block, and thence over the block into the discharge-launders.

These boxes are usually suspended under the battery-floor and from them the pulp flows through launders, where it is divided and conveyed by 3-in. iron pipes to the distributing-boxes of two vanners.

On the floor of the distributing-box of each vanner is placed an amalgamated copper-plate, varying with the size of the vanner used, those on the 4-ft. vanner being 18 in. by 3 ft. 4.75 in., and on the 6-ft. vanners 18 in. by 5 ft. 9 in. From this plate the pulp flows over the vanner, the heavy particles, including sulphurets and some free gold, being saved, while the lighter pass over the tail of the vanner into the tailings-launders, which discharge into Gastineaux channel.

*Concentration.*—By reference to Table IX., it will be seen that 48 per cent of the value contained in the ore is recovered by concentration. For purposes of concentration two sizes of Frue vanners are used: the 4 ft. and 6 ft. These vanners are so arranged that the pulp from 5 stamps is divided between 2 vanners. This style of concentrator is very well adapted to the ore, and from a study of the tables given above it would be hard, indeed, to realize a much better saving. The wear and tear on the machines is very light in all the mills, with the exception of the Ready Bullion, where the vanners get more than their share of the destructive effects of salt water in use.

When a stamp is crushing 5.6 tons of ore in 24 hours, each stamp requires 4.25 gallons, and each vanner 1.5 gallons, of water per minute. In the mills where the 4-ft. vanners are used they are overloaded. This accounts for both sizes of vanners using the same amount of water.

There is a little less than 2 per cent of concentrates in the ore. The concentrated product has a value of about $51 per ton in all the mills, with the exception of the Ready Bullion, where the concentrates assay about $35 per ton.

In connection with each mill is a storage-bin for concentrates, holding about 400 tons. These bins are situated near the mill, and when the concentrates have been collected at the vanners and shoveled into cars, they are trammed to a small hydraulic elevator which raises the loaded car to the level of the top of the bin, where it is dumped. From these storage-bins the concentrates are drawn off through chutes into special cars holding 2.5 tons, and hauled by locomotives to the wharf, where they are dumped through chutes directly into the hatches of the barges which transport the concentrates to the Tacoma Smelter, where it is treated.

Table VIII., on p. 365, shows in detail the cost of the different departments of milling as well as the equipment and running time of the various mills for the last 10 months.

*Clean-Up.*—The clean-ups in the various mills are all conducted in the same fashion, and are so regulated that they will be finished by the 15th of each month.

The first day of the clean-up is devoted to the amalgam-traps and the tank in the amalgamating-room.

To clean a trap, 5 stamps are hung up and the feed-water shut off. When the pulp has ceased to flow through the trap, the wedge that holds the wooden center-piece is loosened and the center-piece removed, first being carefully washed to cleanse it of any adhering amalgam. Then the tap in the lower end is opened and the contents of the trap allowed to flow out into a small launder, which conveys the material to a central tank. The trap is then carefully washed out, the tap and wooden center-piece replaced, and it is ready for use. It takes an average of 5 minutes to clean each trap. When all the traps have been cleaned, the contents of the receiving-tanks after being roughly washed is collected and taken to the amalgamating-barrel for further treatment. In the meantime the contents of the tank in the amalgamating-room has been removed. This is added to the product from the mercury-traps, and the total charged into the amalgamating-barrel.

This barrel is made of cast-iron, 20 in. in diameter and 4 ft. long. It is supported in a horizontal position by iron trunnions cast in the head, and is driven at the rate of 15 rev. per min. by a belt leading to one of the vanner-countershafts.

The barrel is charged through a hand-hole in the top, which can be hermetically sealed; from 300 to 500 lb. of ore constituting a charge. From 75 to 125 oz. of mercury is then added, 6 iron cannon-balls put in to act as grinders, and the barrel filled with water. The hand-hole cover is then put on, and the barrel started revolving. The charge is left in the rotating-barrel 12 hours; the barrel is then opened and the charge allowed to run out into the amalgamating-pan. This pan is made of cast-iron 4 ft. in diameter. Around the edge, with the exception of a space 8 in. wide to serve as an outlet, is a rim 2.5 in. high. The bottom is made slightly concave to resemble a Mexican *batea*. The concentrating motion of the *batea* is imitated as closely as possible. This is obtained by means of an eccentric belt, driven from one of the counter-shafts of the mill. When the barrel is stopped, the cannon-balls are taken out and put in the pan, which is immediately started. By the motion of the pan the heavy contents are concentrated in the middle, while the lighter are washed off by means of a stream of water flowing through it, the concentrated product being kept in motion, and at the same time ground, by means of the cannon-balls.

When the concentrate is cleaned of all light material, the pan is stopped and the pieces of iron, etc., removed. The amalgam is then put in a pan, the finer particles of iron removed by means of a magnet, and the other foreign material by a sponge or other means. When the amalgam is clean, it is put in small cloth bags and the quicksilver pressed out by means of a hydraulic ram, designed by one of the mill-foremen. The pressed cakes of amalgam are weighed and sent to the assay-office to be retorted and melted into bullion.

The second and succeeding days are devoted to the cleaning of the batteries and amalgamating-plates. These are cleaned at the rate of 4 batteries of 5 stamps per day. (In the Treadwell 300-stamp mill, 5 batteries are cleaned per day.)

To clean up a battery the feed is shut off and the stamps allowed to drop until they begin to pound on iron, then they are hung up. The water is then shut off, and the splash-boards, curtains, screens and chuck-blocks are removed. The water remaining in the mortar is dipped out, and the coarse sand around the top of the dies shoveled into buckets to be put back into the mortar when the clean-up is over. The lip of the mortar and the plates are then carefully hosed off (a trough being first put in the tail-box to catch any loose amalgam) and the entire surface of the plate covered by a wooden cover for steaming. A space of 0.75 in. is left between the cover and the plate by means of three slats 0.75 in. thick nailed to the bottom of the cover. Sacks or other coverings are placed over the ends and edges to prevent the escape of steam; the end of a steam-hose is then introduced through a hole in the cover, the steam turned on and allowed to remain so from 20 to 30 minutes. In the meantime a second battery is prepared, and any renewals made ready, so that no time will be lost when the mortar is cleaned out. While the plate is being steamed the chuck-block is cleaned of any adhering amalgam, recoated with quicksilver and is ready to be replaced; while the sand-distributing box on the vanners, corresponding to the batteries shut down, are taken off and the amalgam removed from the copper-plate by means of chisels. This amalgam is collected, the plates dressed in the usual manner, the distributing-box replaced, and the vanner is ready for starting. When the plate has been sufficiently steamed, the steam is shut off and the cover removed and taken to the next plate that has already been prepared for its reception. The steamed plate is then allowed to cool for a few seconds, when the operation of removing the amalgam commences. This is done by scraping the plates with sharp chisels, and as much amalgam as possible is removed without exposing the copper. The amalgam is then collected, taken to the amalgamating-room, and locked up for further treatment.

Two men now begin work on the mortar, and to protect the plates a wooden platform is placed at the head for the men to stand on. If there are no renewals necessary (but this is unusual) only a portion of the sand is taken out. If necessary, the shoes are removed by driving a wedge through the eye left in the boss-head just above the end of the shank of the shoe and forcing it out. The sand is then dug out of the mortar by means of sharp-pointed hand-picks and scoops, the die and liners removed, and the mortar thoroughly cleaned. All pieces of iron, together with the worn-out shoes and dies and liners, are taken to the amalgamating-room to be thoroughly cleaned, and the heavy sand taken to the clean-up barrel.

The liners and false bottoms are then put in and the die set on the false bottom, while the fine sand first removed from the mortar is tamped around the die to hold it in place. The shoe is then set on the top of the die with a collar of wooden shims around its neck. A 3.25-in. block is then placed on the top of the neck of the shoe, and the stamp lowered until the boss-head rests on the block. The keys of the tappets are loosened and the tappet is allowed to fall down to the finger, where the keys are tightened. If the shoe has not been removed, a 9.25-in. block is placed on top of the die and the tappets set as above. Each stamp is then successively dropped and hung up, when the shoe is firmly fixed in the boss-head. The recesses for the chuck-block, screens, etc., are washed out, and the chuck-block, screens and dash-boards put in place. The plate is then washed with a weak solution of cyanide, when quicksilver is sprinkled over its surface and thoroughly rubbed in with whisk-brooms. The quicksilver is evenly distributed by rubbing with cloths moistened with a weak solution of cyanide. Some ore is now fed into the mortar, working the feeder by hand, the water turned on, the small clean-up trough removed from the tail-box, and the stamps allowed to drop. Particular care is paid to the feeding of ore when the stamps are started, as the mortar is empty of all ground material.

The heavy sands from the mortar are treated in the clean-up barrel in the manner described above, while the amalgam removed from the plates and chuck-blocks is simply ground in the clean-up pan and the amalgam cleaned in the usual manner.

*Labor.*—Table X. gives the number, length of shifts and wages of all men working in and about the mills. During the summer, and often in the winter, months the mills are run entirely by water, and at such times the engineers, firemen and coal-passers are not required. When steam is used, the wages of firemen and coal-passers, and at the Ready Bullion that of the engineers, is divided between the mine and mill in proportion to the horse-power used by each.

Each mill is in charge of a foreman who is responsible for its condition and efficiency. He also attends to the handling and cleaning of all amalgam collected.

The duty of the amalgamators is to dress and keep the plates and chuck-blocks in good condition, to set tappets, regulate water-supply and make all renewals; or, in other words, to keep the crushing-department of the mill up to its maximum efficiency.

The feeders attend to the uniform feeding of the ore to the batteries, and assist the amalgamators in making renewals and during the clean-up. A good feeder is as valuable a man as there is in a mill.

The vanner-man attends exclusively to the running and feeding of the vanners. It is requisite that these men have considerable experience; in fact, an order has just been issued making it necessary for a man to serve first in the capacity of sulphide-puller before being put in charge of vanners.

The titles of the other men about the mills explain their duties.

*Costs.*—The details of the receipts and expenditures per ton of ore treated at the mills of the Treadwell group of mines, as well as the conditions affecting them, are given in extenso in the subjoined tables; Table XI. referring to the Alaska Treadwell Gold Mining Co., Table XII. to the Alaska Mexican Gold Mining Co. and Table XIII. to the Alaska United Gold Mining Co., the last-named company operating the Ready Bullion mine and the "700-Foot" claim.

TABLE X.—*Mill Labor.*

| Title. | Treadwell Mills. 300-Mill. No. of Men. | Length of Shift. | Rate of Wages. (a) | 240-Mill. No. of Men. | Length of Shift. | Rate of Wages. (a) | Mexican. Number of Men. | Length of Shift. | Rate of Wages. (a) | Ready Bullion. Number of Men. | Length of Shift. | Rate of Wages. (a) | 700-Foot. Number of Men. | Length of Shift. | Rate of Wages. (a) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Hrs. | | | Hrs. | | | Hrs. | | | Hrs. | | | Hrs. | |
| Foreman | 1 | 12 | $150.00 | 1 | 12 | $150.00 | 1 | 12 | $150.00 | 1 | 12 | $150.00 | .... | 12 | ........ |
| Amalgamators | 4 | 12 | 90.00 | 4 | 12 | 90.00 | 2 | 12 | 90.00 | 2 | 12 | 90.00 | 2 | 12 | $90.00 |
| Feeders | 8 | 12 | 70.00 | 8 | 12 | 70.00 | 4 | 12 | 70.00 | 4 | 12 | 70.00 | 4 | 12 | 70.00 |
| Vannermen | 4 | 12 | 65.00 | 4 | 12 | 65.00 | 2 | 12 | 65.00 | 2 | 12 | 65.00 | 2 | 12 | 65.00 |
| Oilers | 2 | 12 | 65.00 | 2 | 12 | 65.00 | 2 | 12 | 65.00 | 2 | 12 | 65.00 | 2 | 12 | 65.00 |
| Sulphide-pullers | 2 | 10 | 2.00 | 2 | 10 | 2.00 | 1 | 10 | 2.00 | 1 | 10 | 2.00 | 1 | 10 | 2.00 |
| Sulph.-shovelers | 2 | 10 | 2.00 | 2 | 10 | 2.00 | 1 | 10 | 2.00 | 1 | 10 | 2.00 | 1 | 10 | 2.00 |
| Engineers | .... | .... | 2.50 | 2 | 12 | 2.50 | 2 | 12 | 2.50 | 2 | 12 | 2.50 | .... | .... | ........ |
| Firemen | .... | .... | 2.50 | 2 | 12 | 2.50 | 2 | 12 | 2.50 | 2 | 12 | 2.50 | .... | .... | ........ |
| Coal-passers | .... | .... | 2.00 | 2 | 10 | 2.00 | 2 | 10 | 2.00 | 2 | 10 | 2.00 | .... | .... | ........ |
| Crusher-men | 4 | 10 | 2.25 | 4 | 10 | 2.25 | 2 | 10 | 2.25 | 2 | 10 | 2.25 | 2 | 10 | 2.25 |
| Repairs. | | | | | | | | | | | | | | | |
| Vanners | 1 | 12 | 100.00 | 1 | 12 | 100.00 | .... | .... | ........ | 1 | 12 | 3.00 | .... | .... | ........ |
| Carpenters | 1 | 10 | 4.00 | .... | 10 | 4.00 | ½ | 10 | 4.00 | .... | .... | ........ | .... | .... | ........ |
| Laborers | 1 | 10 | 2.00 | ½ | 10 | 2.00 | .... | .... | ........ | ½ | 10 | 2.00 | .... | .... | ........ |
| Total | 30 | .... | ........ | 34½ | .... | ........ | 21½ | .... | ........ | 22½ | .... | ........ | 14 | .... | ........ |

NOTE.—The above wages include board and lodging. Engineers, firemen and coal-passers are only employed part of the time by the mills. (*a*) Amounts of $65 or greater refer to monthly wages, and those of $4 or less to daily wages.

# TABLE XI.—*Alaska Treadwell Gold-Mining Co.*

Receipts and Expenditures in Dollars Per Ton. Also Conditions Affecting Operating Costs.

| Year. | Total Gross Bullion and Concentrate Yield Per Ton. | All Expenses Per Ton. Douglas Island. Supplies. | All Expenses Per Ton. Douglas Island. Labor. | All Expenses Per Ton. San Francisco, London, Paris, and Consulting Engineer. | All Expenses Per Ton. Total. | Profits Per Ton. Operating. | Profits Per Ton. Other. | Profits Per Ton. Total. | Per Cent. Ore From. Surface-Pits. | Per Cent. Ore From. Underground. | No. Feet. Shaft Sunk. | No. Feet. Other Dev. Work. | Pounds Powder Used Per Ton Ore. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1890-1 | $8.49 | 0.73 | 0.85 | 0.18 | 1.71 | 1.71 | 0.10 | 1.89 | 100 | ........ | ........ | ........ | 1.01 |
| 1891-2 | 2.95 | 0.65 | 0.78 | 0.07 | 1.50 | 1.45 | 0.06 | 1.51 | 100 | ........ | ........ | ........ | 0.93 |
| 1892-3 | 2.91 | 0.72 | 0.56 | 0.07 | 1.35 | 1.58 | 0.05 | 1.63 | 100 | ........ | ........ | ........ | 0.76 |
| 1893-4 | 3.21 | 0.52 | 0.75 | 0.09 | 1.35 | 1.86 | 0.10 | 1.96 | 100 | ........ | ........ | 1607 | 0.73 |
| 1894-5 | 2.60 | 0.59 | 0.71 | 0.07 | 1.37 | 1.23 | 0.06 | 1.29 | 100 | ........ | 116 | 1076 | 0.69 |
| 1895-6 | 2.97 | 0.45 | 0.65 | 0.07 | 1.16 | 1.81 | 0.07 | 1.88 | 99 | 1.0 | 50 | 1091 | 0.76 |
| 1896-7 | 2.89 | 0.75 | 0.75 | 0.07 | 1.57 | 1.23 | 0.11 | 1.34 | 95.1 | 4.9 | ........ | 2162 | 0.97 |
| 1897-8 | 2.32 | 0.57 | 0.82 | 0.08 | 1.48 | 0.84 | 0.12 | 0.96 | 89.5 | 10.5 | 158 | 2298 | 0.81 |
| 1898-9 | 2.71 | 0.48 | 0.74 | 0.07 | 1.28 | 1.43 | 0.12 | 1.55 | 85.1 | 14.9 | 48 | 3805 | 1.08 |
| 1899-00 | 2.07 | 0.44 | 0.45 | 0.03 | 0.92 | 1.15 | 0.06 | 1.21 | 67.0 | 33.0 | ........ | 3155 | 0.80 |
| 1900-01 | 1.88 | 0.54 | 0.62 | 0.03 | 1.19 | 0.69 | 0.08 | 0.77 | 47.7 | 52.3 | ........ | 4707.5 | 1.14 |
| 1901-02 | 1.91 | 0.49 | 0.78 | 0.01 | 1.28 | 0.63 | 0.05 | 0.69 | 56.0 | 44.0 | 281 | 5027.5 | 1.65 |
| 1902 | 1.85 | 0.46 | 0.54 | 0.01 | 1.01 | 0.82 | 0.05 | 0.87 | 58.3 | 41.7 | 118 | 2583 | 1.34 |

| Year. | Per Cent. Ore Milled By. Water-Power. | Per Cent. Ore Milled By. Steam-Power. | Per Cent. Indian Labor. | Average Daily Pay All D. Island Employees. | Monthly Expenses Per Ton During Year. Maximum. Month. | Monthly Expenses Per Ton During Year. Maximum. Expenses. | Monthly Expenses Per Ton During Year. Minimum. Month. | Monthly Expenses Per Ton During Year. Minimum. Expenses. | Concentrates. Per Cent. | Concentrates. Value Per Ton. | Grand Total. Tons Ore Milled. | Grand Total. Profit. | Year. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1890-1 | 79.11 | 20.89 | ........ | ........ | ........ | ........ | ........ | ........ | 2.06 | $10.65 | 220,686 | $118,298.95 | 1890-1 | |
| 1891-2 | 73.29 | 26.71 | ........ | ........ | Jan. | 2.09 | May. | 1.19 | 2.10 | 32.69 | 229,632 | 361,929.16 | 1891-2 | |
| 1892-3 | 70.18 | 29.82 | ........ | ........ | Feb. | 1.65 | May. | 1.01 | 1.89 | 41.42 | 237,235 | 385,613.79 | 1892-3 | |
| 1893-4 | 64.37 | 35.63 | 21.31 | 3.00 | Mar. | 1.73 | July. | 1.10 | 1.81 | 46.45 | 220,012 | 421,918.86 | 1893-4 | |
| 1894-5 | 71.31 | 28.69 | 15.81 | 3.19 | Feb. | 2.16 | May. | 1.11 | 1.75 | 59.74 | 241,278 | 340,581.56 | 1894-5 | |
| 1895-6 | 80.56 | 19.44 | 13.62 | 3.15 | Mar. | 1.42 | June. | 0.87 | 1.96 | 57.73 | 263,670 | 497,312.22 | 1895-6 | |
| 1896-7 | 74.66 | 25.34 | 14.47 | 3.25 | Feb. | 1.63 | May. | 1.05 | 1.92 | 48.14 | 242,027 | 323,104.95 | 1896-7 | |
| 1897-8 | 62.73 | 37.27 | 8.36 | 3.23 | Dec. | 1.60 | May. | 0.96 | 1.70 | 44.33 | 251,329 | 243,200.82 | 1897-8 | |
| 1898-9 | 68.46 | 31.54 | 12.13 | 3.13 | May. | 1.71 | June. | 1.36 | 1.96 | 48.11 | 250,108 | 386,792.84 | 1898-9 | |
| 1899-00 | 79.92 | 20.08 | 5.71 | 3.02 | Feb. | 1.73 | Oct. | 0.65 | 1.76 | 38.78 | 557,960 | 673,961.18 | 1899-00 | |
| 1900-01 | 79.29 | 20.71 | 5.38 | 3.25 | Feb. | 1.65 | Nov. | 0.75 | 1.78 | 41.92 | 457,802 | 352,558.89 | 1900-01 | |
| 1901-02 | 77.39 | 22.61 | 5.00 | 3.20 | Feb. | 1.99 | Oct. | 0.84 | 1.82 | 50.48 | 582,893 | 103,489.93 | 1901-02 | |
| 1902 | 84.93 | 15.07 | 4.8 | 3.18 | April. | 1.99 | June. | 0.90 | 1.85 | 49.79 | 508,036 | 442,518.32 | 1902- | Six months. |

TABLE XII.—*Alaska Mexican Gold-Mining Co.*

Receipts and Expenditures in Dollars Per Ton. Also Conditions Affecting Operating Costs.

| Year Ending Dec. 31st. | Total Gross Bullion and Concentrate Yield Per Ton. | All Expenses Per Ton. Douglas Island. Supplies. | All Expenses Per Ton. Douglas Island. Labor. | All Expenses Per Ton. San Francisco, London, Paris, and Consulting Engineer. | All Expenses Per Ton. Total. | Profits Per Ton. Operating. | Profits Per Ton. Other. | Profits Per Ton. Total. | Per Cent. Ore From. Surface-Pits. | Per Cent. Ore From. Underground. | No. Feet. Shaft Sunk. | No. Feet. Other Dev. Work. | Pounds Powder Used Per Ton Ore. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1894 | $2.79 | 0.81 | 1.00 | 0.13 | 1.97 | 0.82 | ...... | 0.82 | 41.37 | 58.63 | 110 | 795 | 1.07 |
| 1895 | 2.85 | 0.85 | 1.03 | 0.07 | 1.95 | [illegible] | ...... | 0.90 | 48.37 | 51.63 | 236 | 2946 | 1.08 |
| 1896 | 2.42 | 0.77 | 0.68 | 0.06 | 1.51 | 0.61 | ...... | 0.61 | 45.37 | [illegible] | 62 | 2880 | 1.21 |
| 1897 | 2.12 | 0.69 | 0.81 | 0.05 | 1.57 | [illegible] | ...... | 0.55 | 37.76 | 62.24 | ...... | 2130 | 1.18 |
| 1898 | 2.31 | 0.75 | 0.90 | 0.05 | 1.70 | 0.62 | ...... | 0.62 | 34.55 | 65.45 | ...... | 2081 | 1.25 |
| 1899 | 2.09 | 0.72 | 0.97 | 0.04 | 1.73 | 0.36 | 0.01 | 0.37 | 28.84 | 71.16 | 202 | 1910 | 1.50 |
| 1900 | 1.89 | 0.68 | 0.97 | 0.04 | 1.69 | 0.20 | ...... | 0.20 | 16.30 | 83.70 | 107 | 2087 | 1.24 |
| 1901 | 1.90 | 0.75 | 0.95 | 0.03 | 1.76 | 0.14 | ...... | 0.14 | 00.53 | 99.47 | 112 | 5829 | 1.00 |
| 1902 | 2.06 | 0.62 | 0.99 | 0.08 | 1.64 | 0.41 | ...... | 0.41 | ........ | 100.00 | 218 | 4988 | 1.32 |

| Year Ending Dec. 31st. | Per Cent. Ore Milled By. Water-Power. | Per Cent. Ore Milled By. Steam-Power. | Per Cent. Indian Labor. | Average Daily Pay All D. Island Employees. | Monthly Expenses Per Ton During Year. Maximum. Month. | Maximum. Expenses. | Minimum. Month. | Minimum. Expenses. | Concentrates. Per Cent. | Concentrates. Value Per Ton. | Grand Total. Tons Ore Milled. | Grand Total. Profit. | Year Ending Dec. 15th. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1894 | 53.33 | 46.67 | 18.75 | 3.70 | Feb. | 2.99 | July. | 1.53 | 2.02 | 85.45 | 73,141 | 59,[illegible].65 | 1894 | |
| 1895 | 57.42 | 42.58 | 19.48 | 3.47 | Apr. | 3.25 | July. | 1.62 | 2.01 | 41.64 | 70,489 | 71,[illegible].78 | 1895 | |
| 1896 | 43.39 | 56.61 | 26.08 | 3.49 | Feb. | 2.46 | Sept. | 1.31 | 2.18 | 42.49 | 101,702 | 61,[illegible].49 | 1896 | |
| 1897 | 62.68 | 37.32 | 23.91 | 3.28 | Feb. | 2.02 | May. | 1.28 | 1.81 | 37.77 | 158,005 | 87,[illegible].46 | 1897 | |
| 1898 | 55.50 | 44.50 | 16.46 | 2.95 | Feb. | 2.33 | Mar. | 1.46 | 2.07 | 84.80 | 162,437 | 100,668.07 | 1898 | |
| 1899 | 48.47 | 51.53 | 15.59 | 2.96 | Apr. | 2.14 | July. | 1.59 | 1.98 | 37.85 | 166,651 | 62,833.42 | 1899 | |
| 1900 | 42.10 | 57.90 | 11.49 | 3.05 | Feb. | 2.01 | May. | 1.41 | 1.61 | 26.07 | 166,449 | 33,821.02 | 1900 | |
| 1901 | 43.97 | 56.02 | 0.70 | 3.07 | Dec. | 1.91 | June. | 1.33 | 1.78 | 89.30 | 178,967 | 24,703.63 | 1901 | |
| 1902 | 50.60 | 49.40 | 0. | 3.12 | ...... | ...... | Sept. | 1.24 | 1.83 | 59.51 | 207,450 | 86,025.51 | 1902 | |

TABLE XIII.—*Alaska United Gold-Mining Co. Ready Bullion Mine.*

Receipts and Expenditures in Dollars Per Ton. Also Conditions Affecting Operating Costs.

| Year Ending Dec. 31st. | Total Gross Bullion and Concentrate Yield Per Ton. | All Expenses Per Ton. Douglas Island. Supplies. | All Expenses Per Ton. Douglas Island. Labor. | All Expenses Per Ton. San Francisco, London, Paris, and Consulting Engineer. | All Expenses Per Ton. Total. | Profits Per Ton. Operating. | Profits Per Ton. Other. | Profits Per Ton. Total. | Per Cent. Ore From. Surface-Pits. | Per Cent. Ore From. Underground. | No. Feet. Shaft Sunk. | No. Feet. Other Dev. Work. | Pounds Powder Used Per Ton Ore. | Per Cent Ore Milled By. Water-Power. | Per Cent Ore Milled By. Steam-Power. | Per Cent. Indian Labor. | Average Daily Pay All D. Island Employees. | Monthly Expenses Per Ton During Year. Maximum. Month. | Monthly Expenses Per Ton During Year. Maximum. Expenses. | Monthly Expenses Per Ton During Year. Minimum. Month. | Monthly Expenses Per Ton During Year. Minimum. Expenses. | Concentrates. Per Cent. | Concentrates. Value Per Ton. | Grand Total. Tons Ore Milled. | Grand Total. Profit. | Year Ending Dec. 15th. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1898 | $2.42 | 0.71 | 0.55 | 0.03 | 1.29 | 1.12 | 0.07 | 1.19 | 100 | 00 | 602 | 2112 | 2.69 | ...... | 100 | ...... | 3.31 | ...... | ...... | ...... | ...... | 2.03 | $72.00 | 19,612 | $23,412.13 | 1898 | |
| 1899 | 2.72 | 0.90 | 1.04 | 0.03 | 1.97 | 0.75 | ...... | 0.75 | 37.98 | 62.02 | 47 | 4272 | 1.32 | ...... | 100 | 9.23 | 3.08 | Apr. | 2.62 | Mar. | 1.62 | 1.92 | 38.10 | 162,107 | 121,839.75 | 1899 | |
| 1900 | 2.15 | 0.78 | 0.83 | 0.03 | 1.67 | 0.48 | ...... | 0.48 | 8.42 | 91.58 | 250 | 3552 | 1.19 | ...... | 100 | [illegible] | 3.09 | Feb. | 2.31 | Oct. | 1.40 | 2.07 | 31.57 | 179,410 | 86,418.18 | 1900 | |
| 1901 | 1.94 | 0.88 | 0.90 | 0.03 | 1.86 | 0.08 | ...... | 0.08 | 4.17 | 95.83 | 165 | 2379 | 1.28 | ...... | 100 | [illegible] | 3.05 | Apr. | 3.48 | Mar. | 1.13 | 1.97 | 33.14 | 170,672 | 14,476.61 | 1901 | |
| 1902 | 1.48 | 0.70 | 0.78 | 0.02 | 1.50 | 0.02 | ...... | 0.02 | 1.43 | 98.57 | 68 | 2787 | 1.19 | ...... | 100 | 1.00 | 3.10 | ...... | ...... | ...... | ...... | 2.01 | 32.95 | 226,522 | (Loss) 5,385.70 | 1902 | |
| **700-Foot Claim.** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1899 | $1.72 | 0.54 | 1.10 | 0.03 | 1.68 | 0.04 | ...... | 0.04 | 73.02 | 26.98 | ...... | 1621 | 1.11 | 100 | ...... | 1.87 | 3.04 | Dec. | 3.29 | May. | 1.01 | 1.91 | 87.87 | 85,035 | 3,485.88 | 1899 | |
| 1900 | 1.81 | 0.69 | 0.51 | 0.03 | 1.56 | 0.25 | ...... | 0.25 | 49.89 | 50.11 | 72 | 486 | 1.24 | 58.42 | 41.58 | 3.37 | 3.01 | Nov. | 2.31 | Mar. | 1.18 | 1.75 | 34.91 | 125,612 | 31,571.05 | 1900 | |
| 1901 | 1.50 | 0.90 | 1.05 | 0.03 | 1.97 | 0.48 | ...... | (Loss) 0.48 | 23.14 | 76.86 | 312 | 1296 | 1.08 | 51.16 | 45.81 | 1.32 | 3.11 | Oct. | 4.10 | July. | 1.80 | 1.71 | 28.13 | 89,459 | (Loss) 42,797.49 | 1901 | |
| 1902 | 1.83 | 0.52 | 0.63 | 0.02 | 1.17 | 0.16 | ...... | 0.16 | ...... | 100 | ...... | 982 | 0.78 | 81.82 | 18.18 | ...... | 3.10 | ...... | ...... | ...... | ...... | 1.84 | 48.46 | 118,511 | 19,802.61 | 1902 | |