GIBRALTAR copper mine starts up

First stage of new British Columbia low grade porphyry Cu-Mo producer brought into production in record time

Gibraltar Mines Ltd., Canada's newest large, low-grade porphyry copper-moly mine is now in full scale first stage production, milling 36,000 daily tons of ore. Placer Development Ltd. of Vancouver, British Columbia, financed, developed, and operates Gibraltar. The Development cost of the mine was $67,000,000. The mill started up in March 1972, and the mine was officially inaugurated on June 13.

Gibraltar is in the Cariboo district of central British Columbia. It is 38 miles north of the community of Williams Lake and 346 miles north of Vancouver. Shipments of copper concentrate from the mine through Vancouver Wharves have already started. Recently a 31,000 ton shipment valued at $7,500,000 was one of the most valuable mineral cargoes ever to clear the Port of Vancouver in a single vessel. Nippon Mining Company of Japan has contracted to buy all Gibraltar's concentrate production until the end of 1981 at a price based on the European copper price.

Gibraltar's minimum ore reserves, calculated on a cut-off grade of 0.25 percent copper, amount to 358,000,000 short tons grading 0.373 percent copper and 0.016 percent moly. This tonnage is included in four separate pits, Gibraltar East, Gibraltar West, Polyanna, and Granite Lake. The Gibraltar East pit, which is now in production, has mineable reserves of 31,000,000 tons grading 0.45 percent copper.

Exploration History

In 1917 the Polyanna group of claims was staked and some trenching was done on quartz veins. Little work was done in the area until 1957 when a 110-foot adit was driven on what is now the Gibraltar West zone. The claims covering this zone were optioned to Gibraltar Mines in 1964. Gibraltar conducted a program of I.P. surveys and diamond drilling from 1965 to 1968.

In 1964 also, the claims on the Polyanna claims were optioned to Duval Corporation which conducted extensive work including surface mapping, I.P. and drilling. These studies indicated a large, low-grade mineralized body. Later Duval invited the Placer Development subsidiary, Canadian Exploration Ltd. (Canex), to enter into a joint venture.

In early 1969 Gibraltar discovered mineralization on what became the Gibraltar East ore body. The discovery hole was 500 feet from the Polyanna border and suggested that mineralization might extend into the latter zone. Canex-Duval optioned the Gibraltar property with the provision that the Polyanna and Gibraltar properties could be commingled on the basis of established ore reserves.

A major exploration problem was the lack of rock exposures in the area. Of the four ore bodies, one is completely covered, the smallest, Gibraltar West, has a minor exposure, and the two others have small showings of leached capping. No more than 5 percent of the mineralized area is exposed. I.P. was relied on to a major extent in outlining the potential ore. However, no clear relationship was apparent between the various mineralized zones.

Finally Canex geophysics combined all the I.P. information with known drilling data and a pattern of mineralization enclosed by a distorted pyrite halo was revealed. The Gibraltar East zone fitted into the inner side of the halo and suggested that low-to-moderate I.P. response coincided with copper mineralization. A geological model was suggested which included a possible drift covered porphyry core in the center of the distorted halo. Further drilling on the Polyanna zone supported this theory, showing the Polyanna zone also on the inner side of the halo.

Step-out drilling on 800-foot centers was then conducted to the south of Polyanna. This resulted in the finding of the barren quartz porphyry core, and, on its south side, the Granite Lake ore body which was to become the second largest in the complex.

Unusual Geology

The ore bodies are contained in the Granite Mountain pluton, a coarse-grained rock intrusion into the volcanics and metasediments of the Cache Creek group. This in turn is part of a north-south trending line of batholiths which occurs along the eastern side of the Fraser River fault system. The rocks are saussuritized quartz diorite whose present silicate assemblage is comparable to the to the greenschist facies of regional metamorphism.

Regional metamorphism of the Granite Mountain pluton occurred before the intrusion of the porphyry. This in turn caused the development of the stockwork in four stages of mineralization and accompanying hydrothermal alteration. As a result, Gibraltar is considered to be somewhat unique in that it is a porphyry copper deposit which occurs entirely within a previously metamorphosed pluton.

Mine Development

A computer assisted analysis was performed to develop a program for mining the 358,000,000 tons of ore in the four separate zones. The sequence of development will insure maximum possible ore recovery at best possible mill grade and at least overall cost. The present 80,000 daily ton ore, waste, and low grade ore mining operation represents the stage one development of the Gibraltar East zone.

During the first seven months of 1971 the site was cleared, overburden stripped, and construction was started on the mill and other facilities. In August 1971 Gibraltar started stripping a thin waste rock cap from the ore body and by March 1972 it had removed 9,000,000 tons of waste rock, and a minor amount of low grade ore. At this stage several benches had been established in the ore zone and a reserve of broken ore was available for the mill which then started up.

The $67,000,000 development cost was actually 9 percent under the original estimate. A contributing factor to this favorable situation was the remarkably short development time

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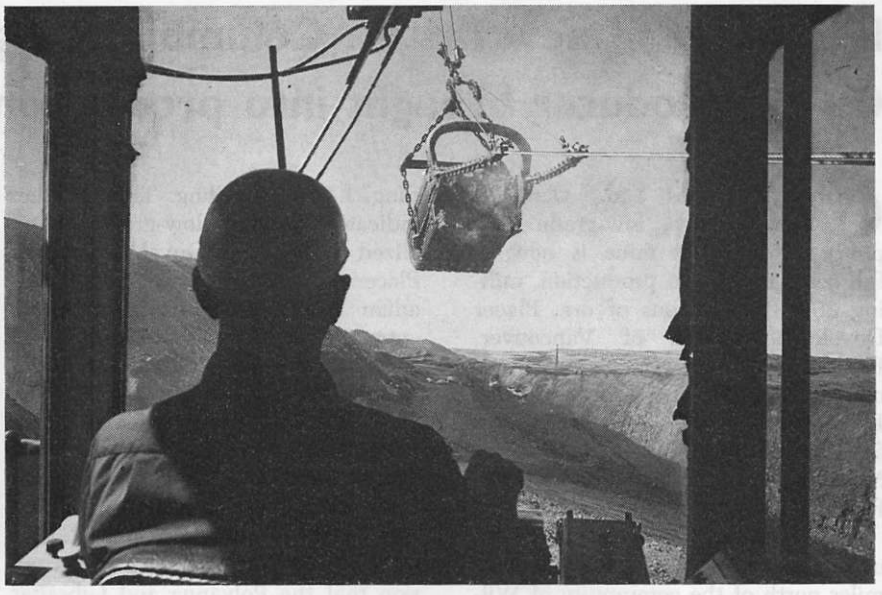
for Wyoming low sulphur coal

is stripping overburden while a Marion face shovel loads a 100-ton Euclid coal hauler.



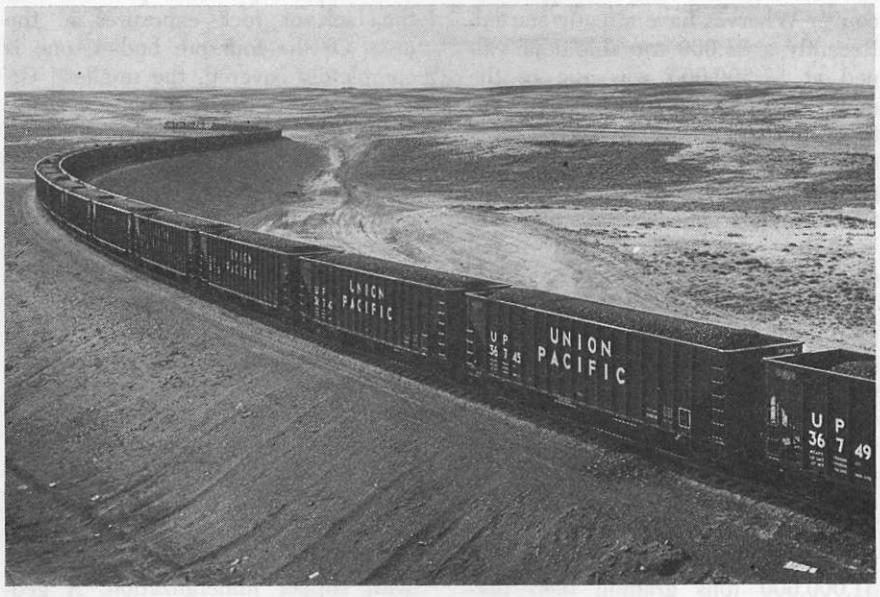
MARION 8000 dragline's 65½ cubic yard bucket removes another load of overburden at the Arch Mineral pit. Stripping will be economic down to 150 feet below surface with this equipment.

ting the finishing touches on the conveyor system while mine mouth and underground development work progresses at a fast pace. The new conveyor system was placed in operation in May and at that time Energy Development began operation of its first 95-car unit train, operating on a three-day turn-around schedule between Hanna and Sioux City. With the unit train in operation, Energy Development's output this year is scheduled to triple last year's production reaching 1,000,000 tons by the end of 1972.

With Arch Mineral starting up and the increase in production at Energy Development, southern Wyoming coal production will exceed 3,000,000 tons this year, more than doubling 1971's 1,500,000 tons. And, this is only the beginning. Arch Mineral is scheduled to start another unit train in operation this year to Kansas City, Missouri, and has commitments for production of approximately 3,000,000 tons per year when in full operation. Energy Development's long range planning calls for possible doubling of its 1972 output by 1975.

Unit Trains Low Cost Haulage

Fanning the development fires are Union Pacific's efforts to provide the low cost transportation and service necessary to make Wyoming's coal economical at the distant power plant. Over 12 miles of new railroad have been built in the past year at a cost



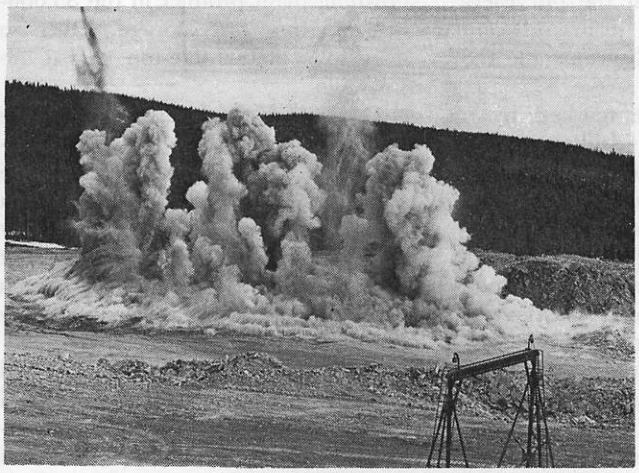
UNIT TRAIN of the Union Pacific Railroad snakes over the Wyoming prairie bound for the Commonwealth Edison power plant at Waukegan, Illinois, Round trip for the train is 2,300 miles.

in excess of $2,000,000 to serve the Arch Mineral and Energy Development operations; new schedules have been established and 165 new 100-ton coal cars have been purchased for this service.

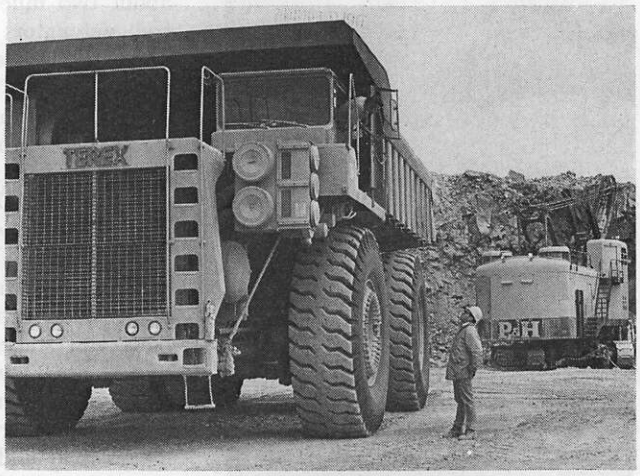
All this activity has transformed the little town of Hanna from a near ghost town of 600 or fewer to a community of almost twice that size and it is still growing. Twenty-five new homes were built last year under the direction of Energy Development for sale to employees and another 20 are scheduled to go up this year. A new shopping center is currently under construction and the community is being studied by several other businesses, including a bank.

Best of all, the boom seems to be based on a solid foundation. Arch Mineral estimates a 20- to 30-year supply of coal in the area and Energy Development reports its new underground mining operation and conveyor system is predicated on 40 years of operation. When Hanna people describe the future as being "black" they are speaking of it in glowing terms. END.

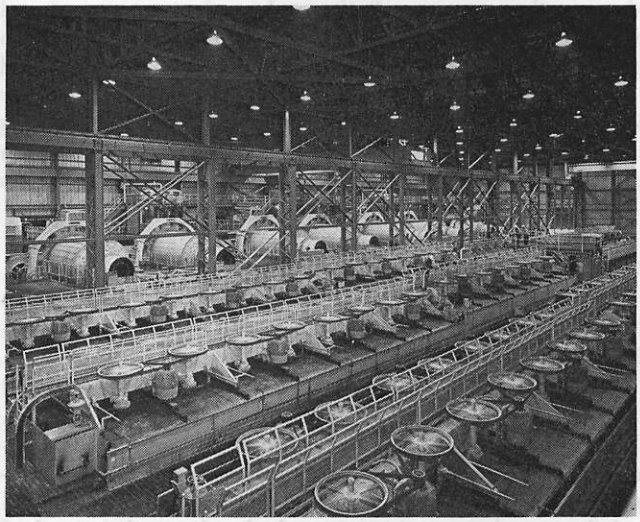
milling 36,000 daily tons



BLASTING with ANFO or slurry, each 9⅞-inch diameter hole on the 23-foot square pattern breaks 2,000 tons of ore.

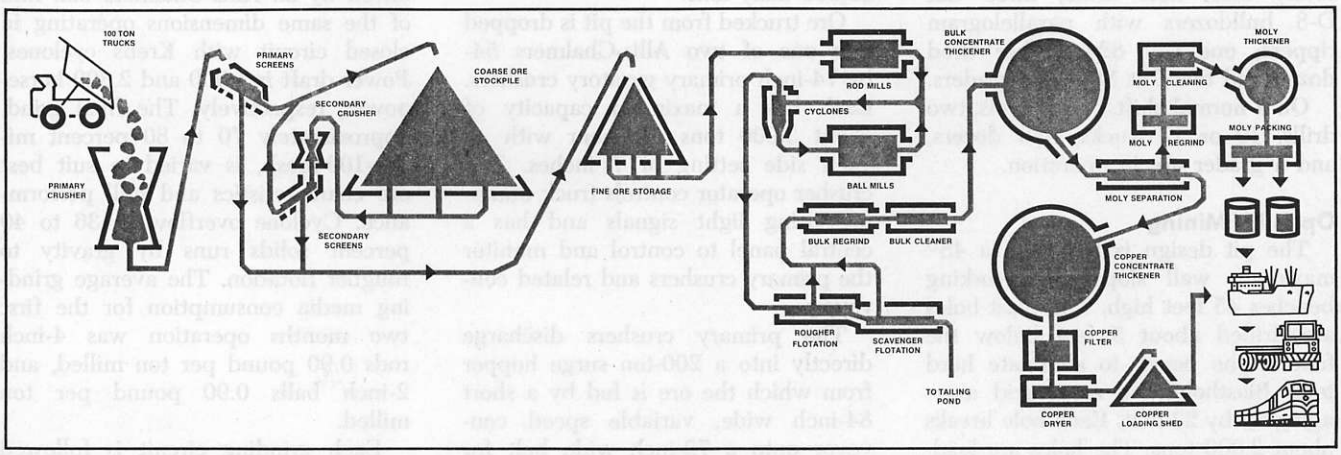


MINING with 14 cubic yard P&H 2100 shovels and big trucks (here a Terex 150-tonner), produces 80,000 daily tons of ore, and waste.

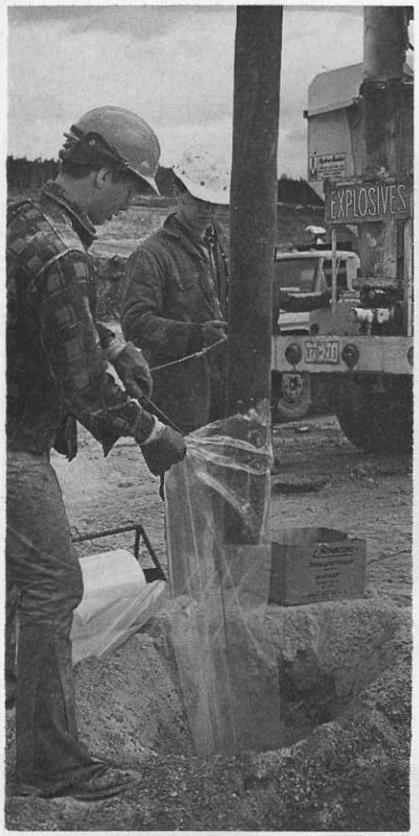


MILLING 36,000 daily tons of copper-moly ore. Rod and ball mill grinding sets in background and Denver flotation cells in front.

TRANSPORTING concentrate 14 miles to railhead in specially designed 25-ton end dump trucks. Rail transport is in 100-ton gondola cars.



FLOWSHEET, in simplified form, of ore processing at Gibraltar Mines. Fine ore is ground in rod and ball mills and a rougher concentrate is recovered which is reground in a ball mill and refloated in the cleaner circuit to produce bulk concentrate from which moly may be recovered.



EXPLOSIVES truck delivers ready mixed products to mine from a nearby Dupont plant.

for this large project—under 11 months from the start of construction to first production.

The mine operates seven days per week on a round-the-clock basis. The total pit crew, including supervisors, is 109 men making up four crews for the seven day schedule. The use of large scale, proven equipment insures low unit costs and highly efficient operation.

Major equipment includes: three P&H 2100 shovels with 14 cubic yard dippers; 13 Unit Rig 100-ton trucks; one Terex 150-ton truck; two Bucyrus-Erie 45R 9⅞-inch diameter rotary blast hole drills; three Cat D-8 bulldozers with parallelogram rippers; one Cat 824 rubber tired dozer; and two Cat Model 14 graders.

On a normal shift, two shovels, two drills, 10 or 11 trucks, four dozers, and a grader are in operation.

Open Pit Mining

The pit design is based on a 45° maximum wall slope and working benches 45 feet high. The blast holes are drilled about 5 feet below the foot of the bench to eliminate hard toes. Blastholes are on a grid averaging 23 by 23 feet. Each hole breaks about 2,000 tons. The holes are loaded with about 800 pounds of explosive giving a powder factor of about 0.4 pound per ton broken. ANFO is used in dry holes, and slurry in wet ones. The explosives are prepared in a Dupont plant situated about two miles from the pit. Electric detonators and primacord are used to initiate and propagate the blast.

Hole locations are marked by a survey crew before drillings starts and the exact location is recorded after drilling. Drill cuttings are sampled and assayed to determine the exact location of the ore and its grade. After the blast the muckpile is marked with colored plastic ribbons and stakes to differentiate between ore, low grade, and waste.

After the muckpile is marked, dozers and graders clean up the bench road and the shovel is moved in to begin loading. The shovel operator advises the truck driver by horn signals when the truck is full, and whether the load is ore, waste, or low grade. The truck then delivers the load to the crusher or the appropriate dump—depending on the haul distance the round trip is from 12 to 16 minutes.

A Napco self contained mobile drill jumbo is used for secondary blasting, trimming, and bench pioneering.

Support equipment includes dozers, graders, water trucks, and sand trucks for the roads, and a number of service trucks for the pit equipment. Service and supervisor's trucks and the shovels are equipped with two-way radio.

Crushing Arrangements

The original design capacity of the mill was 30,000 daily tons but by the time of the official opening in June the daily treatment rate had been pushed up to average 34,000 to 36,000 daily tons.

Ore trucked from the pit is dropped into one of two Allis-Chalmers 54- by 74-inch primary gyratory crushers. Each has a maximum capacity of about 3,000 tons per hour with an open side setting of 7 inches. The crusher operator controls truck dumping using light signals and has a central panel to control and monitor the primary crushers and related conveyors.

The primary crushers discharge directly into a 200-ton surge hopper from which the ore is fed by a short 84-inch wide, variable speed conveyor onto a 72-inch wide belt for transport to the primary screens. Products of the two double deck 8- by 20-foot screens are mill feed and oversize. Minus-1.5-inch mill feed is about 30 percent of the primary screen product. This joins secondary crushing plant product in the 35,000-live-ton fine ore storage. Oversize goes to a 36,000-live-ton coarse ore stockpile.

Ore withdrawn from the coarse ore stockpile is crushed in four Allis-Chalmers 13- by 84-inch hydrocone secondary crushers, each of which discharges onto a single deck 6- by 14-foot screen under the crusher which separates the minus-1.5-inch mill feed and returns oversize to the coarse ore stockpile.

Each secondary crusher is rated at 500 tons per hour of finished product. Thus the whole crusher system can produce about 3,000 tons per hour—1,000 tons primary fines plus 2,000 from secondaries. All of the screens are Allis-Chalmers Ripl-Flo type and all plant conveyors are equipped with Bando belting.

Both crusher plants are equipped with dust collection systems which discharge dust into tanks to be mixed with water and pumped to the concentrator. Central vacuum cleaning systems are ducted through both plants for speedy clean up of spills and any accumulated dust.

Grinding—Flotation

Each of the three rod mills in the concentrator is fed from the fine ore stockpile by a system of nine tube-type feeders, three variable speed collector belts, and a feed conveyor. Feed rate is set by the mill operator and then automatically maintained by a weightometer on each feed conveyor which adjusts the speed of the collector conveyors.

Grinding is in three 13.5- by 20-foot Allis-Chalmers rod mills, each followed by an Allis-Chalmers ball mill of the same dimensions operating in closed circuit with Krebs cyclones. Power draft is 1,900 and 2,300 horsepower, respectively. The final grind, approximately 70 to 80 percent minus-100-mesh, is varied to suit best ore characteristics and mill performance. Cyclone overflow at 36 to 40 percent solids runs by gravity to rougher flotation. The average grinding media consumption for the first two months operation was 4-inch rods 0.90 pound per ton milled, and 2-inch balls 0.90 pound per ton milled.

Each grinding circuit is followed by a single bank of 16 600H Denver flotation cells. The first eight cells

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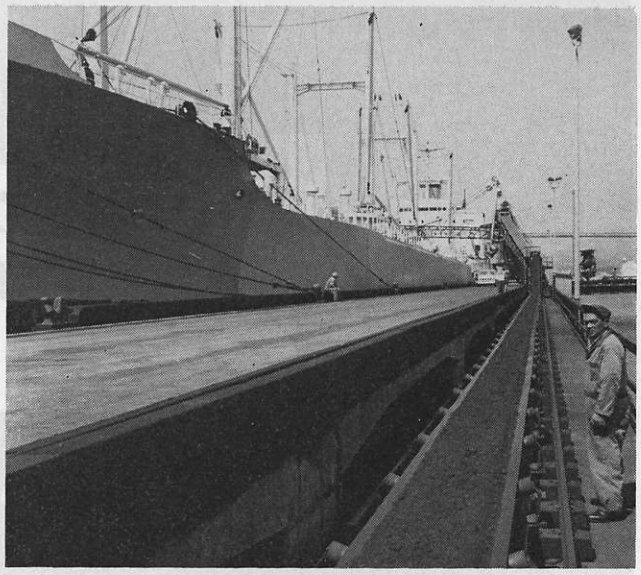
PRIMARY CRUSHER tip has built-in rock grapple to clear hang-ups. Crusher and grapple are operated from control cabin seen at top left.



CONCENTRATE loading at Vancouver Wharves for shipment to Japanese smelters who have purchased all Gibraltar output through 1981.

produce a rougher concentrate, and the last eight a scavenger concentrate which is recycled to the head of the roughers. All material which does not report to the rougher concentrate is discharged to final tailing.

The rougher concentrate is pumped to a 9.5- by 14-foot Allis-Chalmers 600 horsepower ball mill where it is reground in closed circuit with Krebs cyclones. Cyclone overflow at 10 to 15 percent solids and approximately 75 percent minus-325-mesh is fed to the cleaner circuit. The first cleaner stage is a bank of 16-DR300V Denver cells. The first eight cells produce the cleaner concentrate and the concentrate from the last eight cells along with the tailing from the second and third cleaners is returned to the regrind circuit. The tailing from the first stage cleaner is combined with the rougher tailing and discarded. Second and third stages of cleaning follow, each being done in a bank of eight DR30 Denver cells. The final copper or "bulk" concentrate is sent either to the dewatering circuit, or to the moly circuit for recovery of a moly concentrate. The moly circuit is not yet in use. It will be brought in whenever there is an economically recoverable quantity of moly present and markets for the product have been developed.

Ore Metallurgy

The ore being treated during the early stages of the operation contains chalcocite, pyrite, some chalcopyrite, and minor amounts of azurite, malachite, and cuprite. The moly content is quite variable but is currently well below average grade. As the pit reaches a greater depth the copper will be mainly in the form of chalcopyrite and the secondary copper minerals will essentially disappear.

Rougher flotation is done at a pH of about 10.0 and the cleaning stages about 11.5 Lime for pH control is added where required by an automated system controlled by monitors at appropriate points in the circuit. Proper pH control is essential to both good copper recovery and pyrite suppression. Test work and early mill performance indicate that Dow Z-200 is an effective and selective collector. Only very minor amounts of frother are required. Average reagent consumption for the first two months of operation is lime: 2.7 pounds per ton; Z-200, 0.03 pound per ton; and MIBC (methyl iso-butyl carbinol), 0.03 pounds per ton.

Copper concentrate from the third stage cleaners or from the moly circuit is thickened in an 80-foot diameter thickener prior to filtering. Thickener underflow at approximately 55 percent solids is pumped to a stock tank and then to one or both of two Dorr-Oliver-Long 8.5-foot diameter by 10-leaf disc filters. Filter cake goes to storage if under 8 percent moisture, or to a dryer if too wet. Drying, when required, is done in a 6- by 40-foot Lockhead-Haggerty rotary kiln dryer fired by natural gas. Moisture is reduced to only 5 to 7 percent to minimize dusting losses. Concentrate storage capacity is about 3,000 ton.

Tailing Disposal

Rougher and first cleaner tailing is discharged into a common sump in the floor of the concentrator. From this sump the tailing flows by gravity through a 36-inch diameter welded steel pipeline down a 0.5 percent slope for approximately 20,000 feet to the tailing pond. The additional vertical drop between the mill and the pond is accommodated by 17 vertical drop tanks from 16 to 20 feet high.

The tailing pond was built in a flat, broad basin. The starter dam was built across a narrow neck at the lower end of the basin. Sand extracted by twenty 30-inch cyclones spaced across the crest of the dam will be used to increase the height of the dam as the level of the impounded material rises.

Most of the water used in the milling process is reclaimed by a pumping system from the tailing pond. Make-up water is pumped from wells on the bank of the Fraser River. Seepage water passing through or under the dam and water from the cyclone production of sand is collected in a small seepage dam below the main tailing dam and is pumped back into the water reclaim system.

Finally the mine product—copper concentrate—is loaded into special 25-ton capacity end dump trucks which haul it 14 miles to the British Columbia Railway siding at Macalister. Four to five 100-ton gondola cars of copper concentrate are loaded daily for the 350-mile trip to Vancouver for shipping out through Vancouver Wharves to Japan. END.

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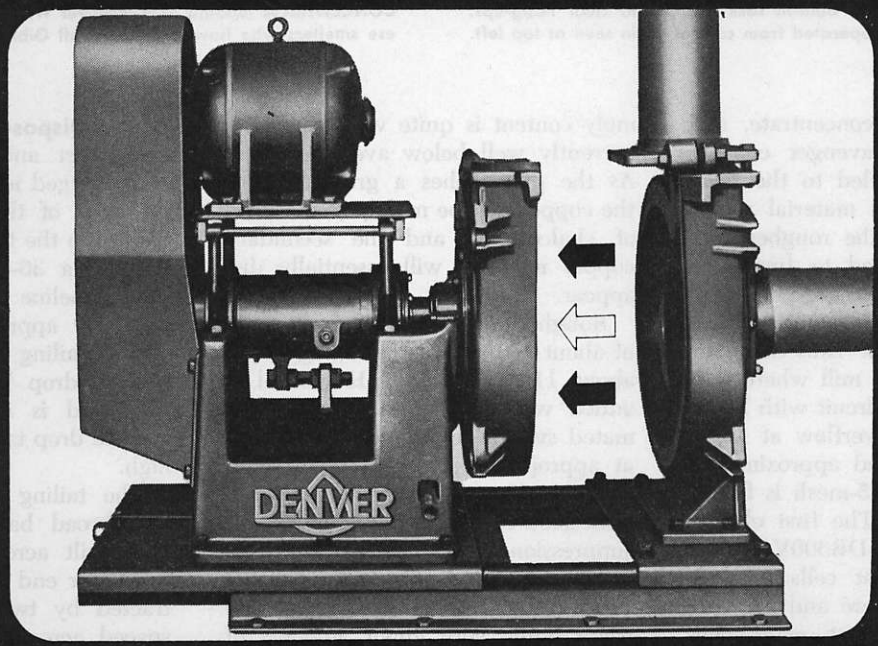

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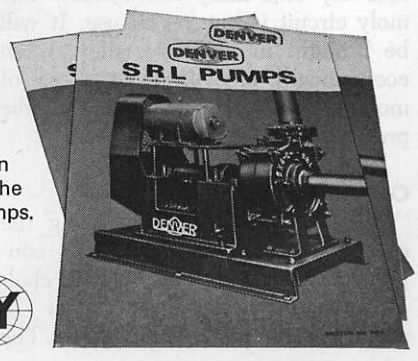

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