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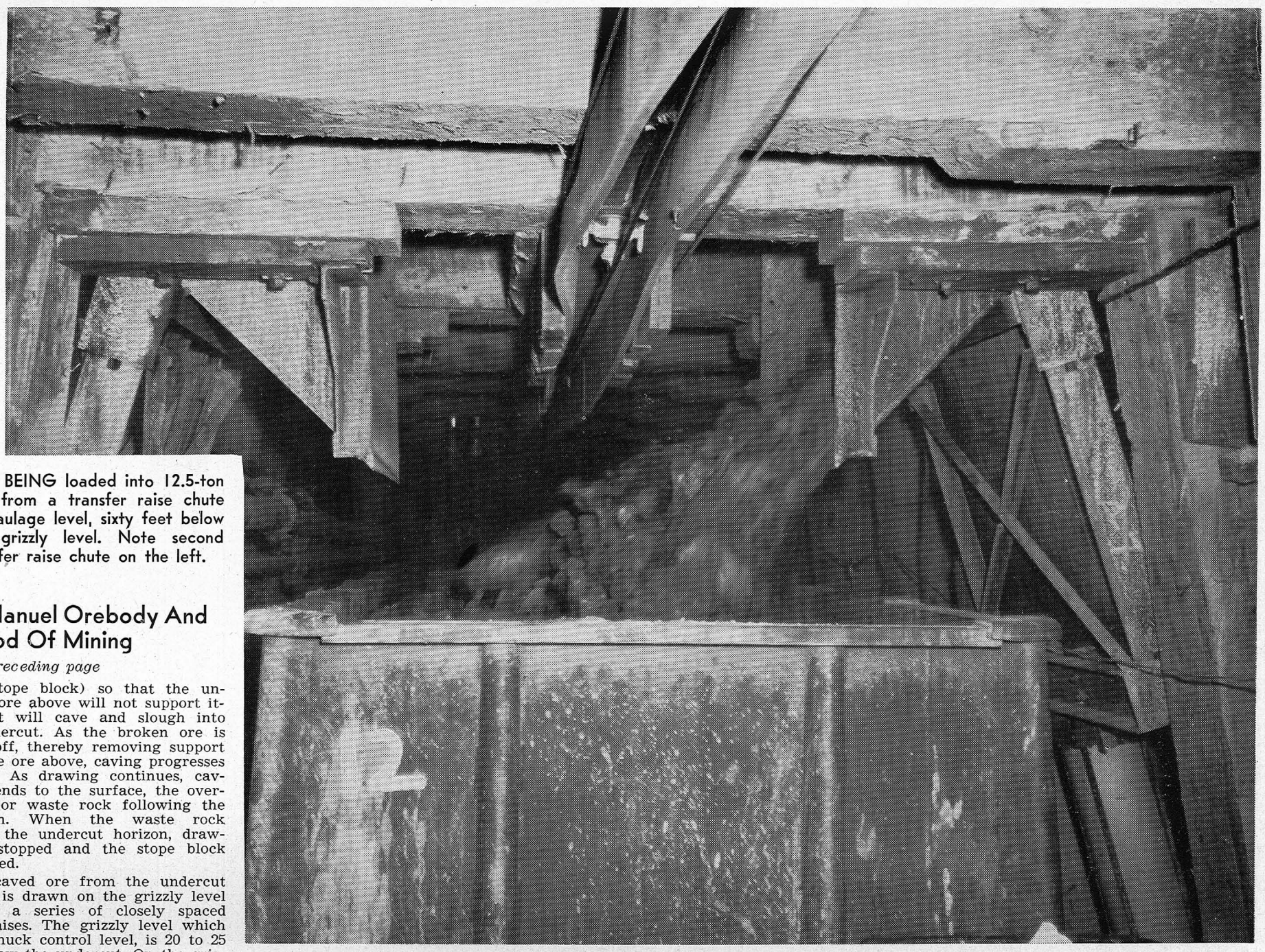


ORE BEING loaded into 12.5-ton cars from a transfer raise chute on haulage level, sixty feet below the grizzly level. Note second transfer raise chute on the left.

San Manuel Orebody And Method Of Mining

From preceding page

area (stope block) so that the unbroken ore above will not support itself, but will cave and slough into the undercut. As the broken ore is drawn off, thereby removing support from the ore above, caving progresses upward. As drawing continues, caving extends to the surface, the overburden or waste rock following the ore down. When the waste rock reaches the undercut horizon, drawing is stopped and the stope block is finished.

The caved ore from the undercut horizon is drawn on the grizzly level through a series of closely spaced draw raises. The grizzly level which is the muck control level, is 20 to 25 feet below the undercut. On the grizzly level the ore passes through the grizzlies which consist of rails spaced nine inches apart over the top of each transfer raise.

The transfer raise system funnels the ore from eight draw raises to one common loading station on the haulage level which is 60 feet below the grizzly level. A loading station serves two transfer raises, each of which when full of ore holds 65 tons. The ore stored in the raises is transported by an underground electric railroad system to the ore hoisting shafts.

Loading operations from the transfer raises to the ore cars are controlled through steel chutes and air-operated chute gates. The ore cars have a capacity of about 12.5 tons, and each train is made up of 15 to 18 cars, or 185 to 225 tons per train, pulled by a 23-ton, 250 HP trolley locomotive. When full production is reached, one of these trains will be dumped every seven minutes. The electrical power system supplying the trolley is 275 volt DC with rectifier stations so situated as to maintain full voltage throughout the haulage system.

The underground track for the haulage system is 36-inch gauge with 70-pound rail through the panels. On the main lines between the mining area and the hoisting shaft, 90-pound rail is used to accommodate the heavy traffic and higher speeds.

At the two ore hoisting shafts, 3A and 3B, on the 1475 haulage level, the trains pass through a rotary tipple which dumps three cars at a time. The cars, equipped with rotary couplings, do not have to be disconnected from the rest of the train as the tipple turns 180° and then rights itself to dump the ore into the 1,500-ton pocket or underground storage bin adjacent to the shaft.

The ore is drawn from the botom of the pocket into an 18-ton measuring pocket hopper which in turn discharges into a skip for hoisting to the surface. The bottom dump ore skips, which hold 18 tons of ore, are hoisted to the surface and discharge into a 5000-ton surface storage bin for transportation to the Plant.

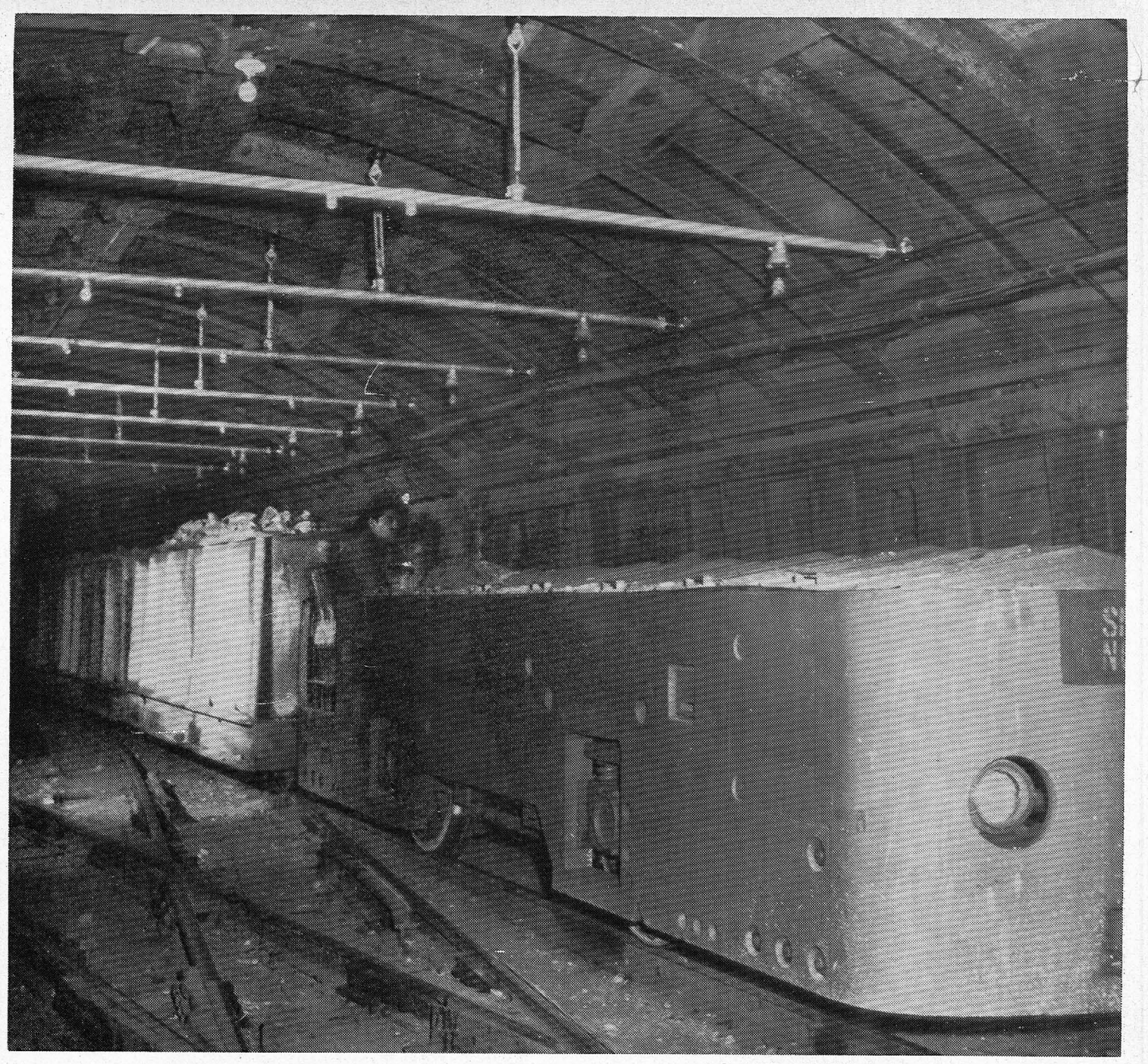
Each of the two ore hoisting shafts is equipped with a Nordberg hoist with 15-foot diameter drums and powered by two 3,000 HP electric motors. These hoists can be manually or automatically controlled. The maximum operating hoisting speed is 3,000 feet per minute. The hoisting cable is 2¼-inch diameter.

No. 1 and No. 2 Shafts were sunk early in the program, and from these shafts the first mining lift was developed. No. 1 Shaft, steel and reinforced concrete lined, now serves for downcast ventilation and will shortly be deepened for second lift development. No. 2, a timbered shaft, was sunk in the orebody to a depth below the second lift for exploration and quick development.

No. 4 Shaft, steel and concrete lined, serves as a downcast ventilation shaft and as a service shaft for men and supplies. Men are lowered and hoisted at the rate of 120 men per trip; and timber, powder, and other supplies necessary for the mining operation are lowered to grizzly and haulage levels through this shaft.

Other facilities at the mine include mechanical and electrical shops, modern timber framing shed, warehouse, and change room. The compressor house, equipped with four air compressors, provides 10,300 c.f.m. of compressed air for rock drills and other air driven tools underground and on the surface. The compressed air is carried underground through twelve-inch pipe.

Oxidized ore for smelter silica flux requirements is being mined by a small open pit operation on the orebody outcrop. Limestone and high grade silica for metallurgical use is mined from quarry sites along the San Manuel Arizona Railroad about 17 miles north of the Plant. These products are hauled to the flux crushing plant by rail in 50-ton bottom dump cars.



LOADED TRAIN with a view of the 23-ton, 250 HP trolley locomotive. This train is on the haulage level near No. 3B Shaft.

ORE BEING loaded into 12.5-ton cars from a transfer raise chute on haulage level, sixty feet below the grizzly level. Note second transfer raise chute on the left.

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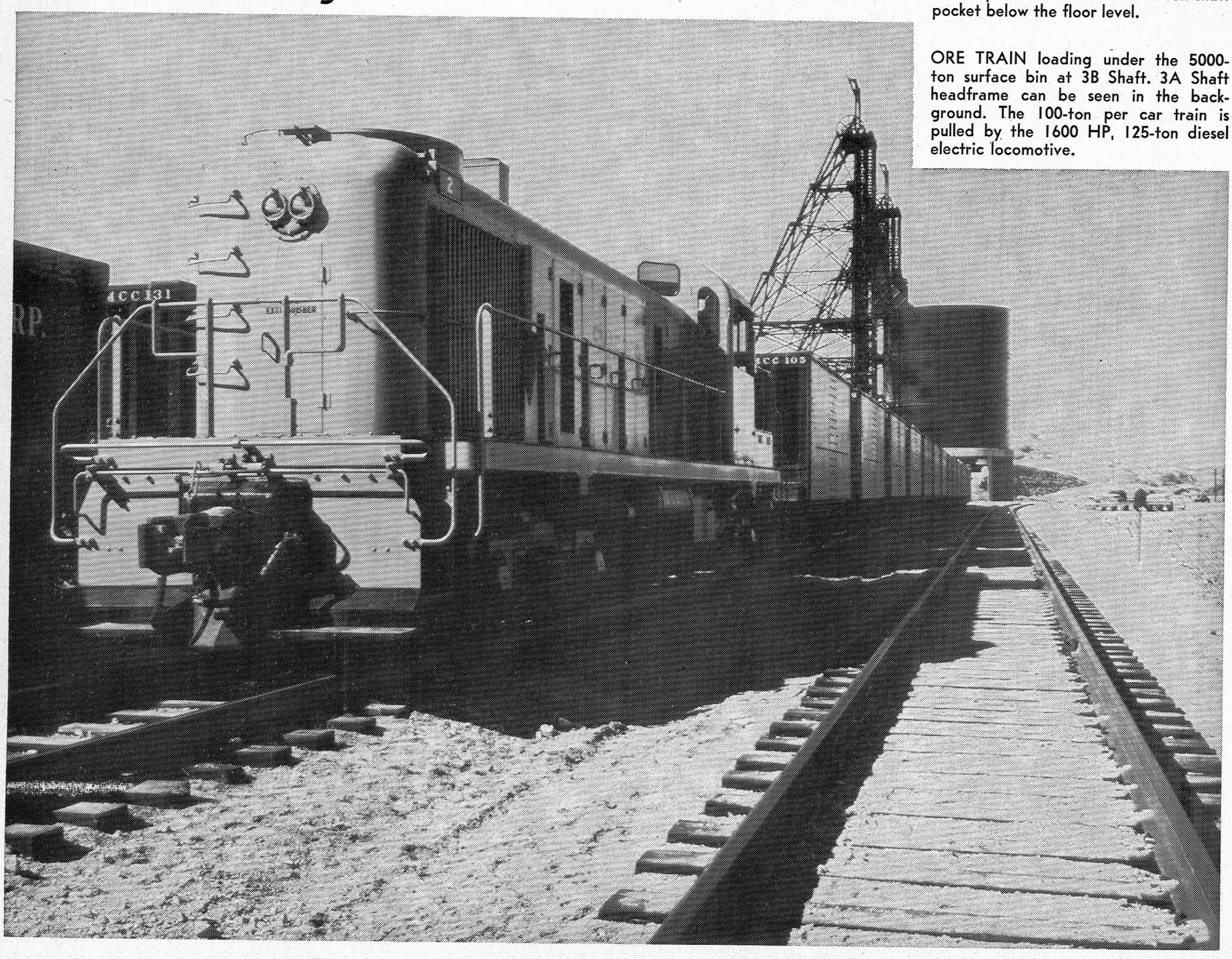
LOADED TRAIN with a view of the 23-ton, 250 HP trolley locomotive. This train is on the haulage level near No. 3B Shaft.

Rotary Dump

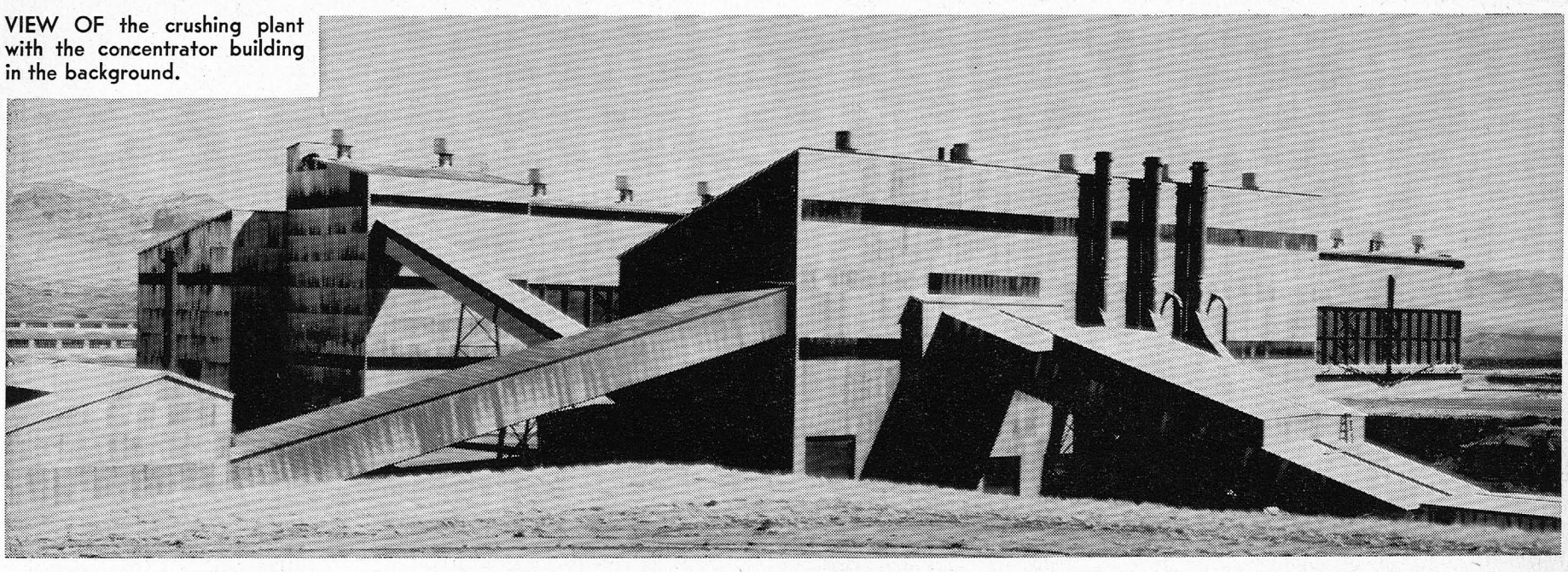
LOADED CAR in the rotary dump at 3B Shaft. The dump is starting to rotate to dump the ore into the 1500-ton shaft pocket below the floor level.

Ore Train Loading



ORE TRAIN loading under the 5000-ton surface bin at 3B Shaft. 3A Shaft headframe can be seen in the background. The 100-ton per car train is pulled by the 1600 HP, 125-ton diesel electric locomotive.

San Manuel . . . The Mill



VIEW OF the crushing plant with the concentrator building in the background.

Ore transportation from the Mine to the Plant is by rail shuttle service in 100-ton capacity bottom dump railroad cars. The 35-to-40-car train is pulled by a 1600 HP, 125-ton diesel electric locomotive. The seven mile ore transportation track is standard gauge, 132-pound rail and was constructed with liberal curves and no grade.

The mine ore is loaded from two 5000-ton bins at the collars of 3A and 3B Shafts through compressed air operated gates.

At the 10,000-ton coarse ore receiving bin at the Plant, the train is run in over the bin and four cars are dumped at a time through bottom dump air operated car gates with compressed air furnished by the locomotive.

From beneath the receiving bins, ore is fed by eight manganese steel pan feeders and two belt conveyors into two seven-foot standard Symons cone crushers at the rate of 1000 tons per hour to each crusher.

Magnets are hung at the head of each conveyor to remove tramp iron and the crusher feed passes over grizzlies where undersize material is bypassed.

The crushed ore from the primary crushers is conveyed and distributed to four secondary seven-foot Symons cone crushers, each preceded by mechanical screens to bypass the undersize material.

The final product from the crushing plant, all less than one inch in diameter, is conveyed by belt conveyor to discharge on the 54-inch belt conveyor, carrying the crushed ore at the rate of 2000 tons per hour up to the 45,000-ton capacity fine ore bin in the concentrator.

The crushing plant is designed so that all the crushers are on the same level and have the same main operating floor. A panel board on the operating floor contains meters and indicator lights for all electric motors driving equipment pertaining to the crushing operations and this, coupled with an intercommunication system, gives complete control from one point. A 30-ton overhead crane with a 5-ton auxiliary hook services the crusher floor.

In the concentrator the crushed ore discharges from the conveyor onto a 54-inch tripper conveyor running over the top of the fine ore bin for its full length. The tripper, or mechanical device for unloading the belt, travels the length of the bin distributing the ore evenly. Zipper fastening belts cover the slots through which the ore is discharged, and the zippers open and close as the tripper travels, thus preventing dust being spread throughout the concentrator.

The fine ore bins are 700 feet long by 45 feet wide and 42 feet deep and have a live load capacity of 45,000 tons. This is one and one-half days' storage for the concentrator.

The ore is drawn from underneath the fine ore bins by belt conveyors onto a gathering conveyor which feeds each rod mill at the rate of 4000 tons per day. A weightometer both registers and controls tonnage to the rod mills. Water is first added at the rod mill feed to start the wet grinding. The rod mill discharge is split to the drag classifiers operating in closed circuit with the ball mills.

The concentrator is divided into eight sections, and each section consists of one 10-foot by 13-foot rod mill and two 10-foot by 10-foot ball mills, each ball mill operates in closed circuit with a 16-foot by 35-foot drag classifier in which the ore ground to the specified size overflows to the flotation section. The oversize material from the classifier is returned to the mill for additional grinding.

Each section of the wet grinding bay has a control panel similar to that in the crushing plant, and the reagent and lime water pumps are also controlled from the same platform. The wet grinding bay is serviced by a 175-ton crane which is capable of taking out a fully charged rod or ball mill for repairs. A 10-ton crane serves for lighter, faster service.

The classifier overflow goes to distribution boxes where, with reagents added, it is distributed to 48-inch rougher flotation cells. There is a total of 480 rougher cells. The concentrate is floated from the surface, and the tailings are piped by gravity to the tailings thickeners where approximately 12,000 g.p.m. of reclaimed overflow water is returned to the mill. The thickened underflow is piped to the tailings pond.

The concentrate is pumped from the rougher flotation cells through cone classifiers in closed circuit with four 8-foot by 12-foot regrind ball mills. The reground concentrate is distributed to 144 48-inch cleaner flotation cells. The tailings from this regrind section are returned to the mill circuit, and the final copper concentrate, averaging about 28% copper, is pumped to the molybdenum thickener with the thickened concentrate going to the molybdenum plant.

Molybdenum is recovered from the concentrate through another series of flotation cells, after which the concentrate is pumped into a final thickener, then filtered, dried, and conveyed by belt conveyor to the concentrate bins. All overflow water from the thickeners joins the return water to the mill circuit.

ORE TRAIN from the mine dumping into the receiving bin at the crushing plant. The 100-ton bottom dump cars are discharging the ore into the 10,000-ton receiving bin beneath the track.

Crushing Plant

CRUSHING Plant showing control panel, mechanical screens and 30-ton overhead crane.

WET GRINDING BAY in the concentrator building showing the fine ore bins to the right; the rod mills, the ball mills, and classifiers.

ROUGHER FLOTATION FLOOR with pulp distribution box in background.

CLOSEUP OF FLOTATION FLOOR, on the left, showing the overflowing froth which carries the copper-bearing minerals. This concentrated mineral is filtered and sent to the smelter for further refinement.

TAILINGS THICKENER, below, a dewatering device for concentrator tailings. Overflow clear water returns to the mill circuit, underflow thickened tailings sand flows to the tailings pond.