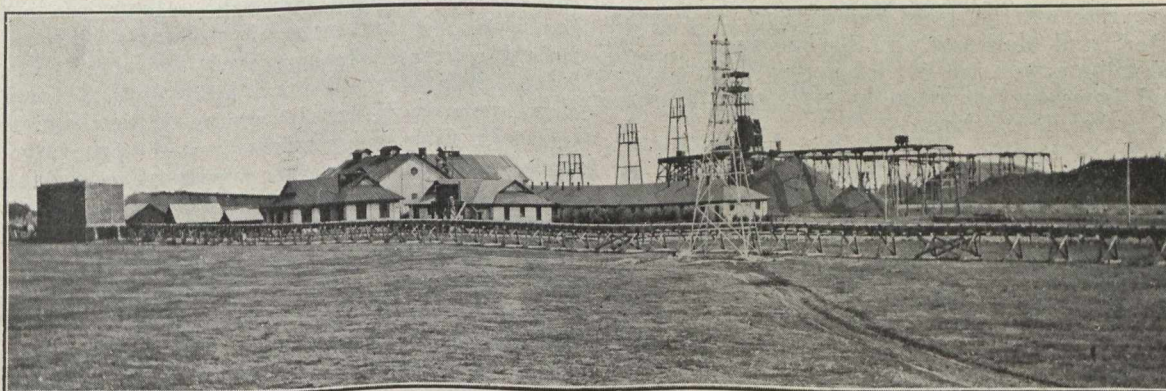


The sinking of shafts through quicksand of a hundred or a hundred and fifty feet, as has been done not only at Minnesota and Michigan iron mines, but also at coal mines in the central states, is the most precarious phase of sinking. No one who has not experienced the terrific consequences of such an undertaking can imagine the difficulties, dangers and hopelessness of trying by ordinary methods to make progress in an ocean of quicksand, where the closely timbered shaft, in spite of sheet iron, straw and braces flops out of line, twists around, or drowns out in a trice. Navigating submarines or flying in aeroplanes is nothing compared to handling quicksand. The best solution of the worst problems in sand-shafts on the Iron Ranges was the dozen concrete drop-shafts, sunk by the Foundation Company on contract, using a compressor air caisson across the shaft, in which more or less desperate characters known as sandboys (white men and negroes who follow such work around) pick and shoveled in air up to 50 lb. pressure per square inch. The contract price for these shafts was not uncommonly high, \$500 per foot. Built several feet thick of reinforced concrete; with circular cross-section, but sometimes with rectangular interior; some of them

were made, due to the amount of water and quicksand encountered. Later, Captain Thomas Caddy was engaged at a comfortable salary to put into use his experience gained at the wet, old Penobscot mine nearby, and he got the shaft down. He tried sinking two shafts at once, so that pumping could be carried out to better advantage, and he forced the short drop-section of the main shaft down through occasional hard streaks of sand and gravel by jack-screws. This was a timber-lined shaft, but with a steel cutting edge on the drop-section. Incidentally, when the shaft got deeper, a shift boss was instantly killed by someone accidentally dropping a jack-screw from surface on his head.

The Rolling Mill No. 2 shaft in the Negaunee basin, Michigan, was raised 620 ft. from underground in five months, through jasper and schist to surface in one vertical raise with no levels or stops. Later the same stoper drills were used to enlarge the shaft from 8 x 8 to 12 x 14, drilling inclined holes from below to trim off the shoulder, the enlarging progressing downwards.

At a shaft of the Tod-Stambaugh Co., near Hibbing, sunk by the Foundation Company on contract, extraordinary difficulty was had in forcing the concrete



Maas Iron Mine, Negaunee, Mich.

with walls tapering in thickness toward the top, these monolithic tubes of 100 or 150 ft. depth were sealed water-tight to bedrock without pumping a gallon of water. Enormous quantities of concrete and a considerable weight of reinforcing steel were used, as permanency was desired, and, too, the greater weight forced the cutting-edge down to better advantage. The cost of cement and steel was a large item. The Rogers shaft at Iron River, described by me in an article in the M. & S. Press of December 30, 1911, is 29 ft. in outside diameter, with a rectangular interior of 16½ x 11 ft., so that the walls vary around the circle from 3 ft. to 7 ft. in thickness.

Some queer complications arose at two or three of these sand-shaft jobs sunk on contract, and strange things were done before the shafts were finally sealed to rock.

A not unpleasant surprise was occasioned by M. A. Hanna & Co. in sinking a shaft at Crystal Falls, Mich. Having arranged for pumping a lot of water, with ample pumps, boilers, coal, etc., at the temporary plant which served for sinking, scarcely any water was found as the work went ahead. It had been feared that, as there were no other mines in the immediate vicinity, and consequently the water-level had not been artificially lowered, the sand and water customary in the district would give trouble.

At the Susquehanna mine at Hibbing, Minn., when it was first attempted to sink a shaft, several failures

tube to solid bedrock through mixed hard-pan and sand. After weeks of scarcely any progress, a great ball of concrete was made and rolled on the drop-shaft, and with the air pressure of the caisson temporarily removed to get rid of its buoyant effect of several hundred tons, a few inches at a time was gained.

A somewhat similar difficulty occurred at the Rogers shaft at Iron River, where 125 ft. was accomplished through sand in 90 days, being an average of nearly 1.4 ft. per day, which was considered excellent. But to sink the next 15 ft. three months was required, an average of 2 inches per day as the result of the labors of 50 men, working expensive shaft shifts in the compressed air of the caisson.

At the North Lake mines of the Cleveland-Cliffs Iron Co., near Ishpeming, pigs of iron were used for weights in forcing the concrete drop-shafts through hard streaks.

In the sinking of the first timber-lined shaft at the Maas mine of the same company at Negaunee, so much quicksand was pumped that a big, bowl-shaped depression formed around the shaft, which stuck up like a smoke stack in the great hole.

One company operating on the Menominee Range tried sinking a timber-lined shaft through 200 ft. of sand, to reach a big orebody proved by diamond-drilling and was over two years accomplishing it, merely to bedrock.