open-hearth reverberatory furnace lined with magnesite brick, as I find that silica-lined furnaces are quickly destroyed by fluxing with the sodium sulphide. Into such furnaces I introduce a charge of nickel-copper-iron matte, either solid or molten, together with coke and sodium sulphate, the latter being preferably present in the proportion of sixty per cent. of the weight of the matte and the coke in the proportion of fifteen per cent. of the matte. The sulphate is preferably added in the form of commercial niter-cake. Where, for example, a fifty-ton charge of matte is treated containing, say forty-five per cent. of nickel sulphide and thirty-five per cent. of copper sulphide, it is melted in the furnace and retained subject to the heat for some time—say four to five hours after fusion has occurred—during which time it is preferably "poled"—that is to say, treated by immersing beneath its surface poles of green wood, which evolve hydrocarbon gases and vapours, and thus aid in the reduction of the sulphate and produce an agitation of the material, which facilitates and renders more thorough the solution of the sulphides to be removed. Nearly complete solution of the copper and iron sulphides in the sodium sulphides reduced from the niter-cake is thus effected, and the molten charge may be tapped from the furnace and allowed to separate in moulds; but to get the best results I tap the different strata from the furnace separately, tapping first the solution of copper and iron sulphides floating on the surface of the bath and finally tapping the undissolved nickel sulphide, or the order of tapping may be reversed, the lower stratum of nickel sulphide being removed first. The great proportion of the iron and copper is thus separated, the nickel sulphide obtained being nearly pure. Where greater purity is desired, the nickel sulphide may be recharged into the furnace and treated again in like manner.

The skilled metallurgist will be able to modify the apparatus and also to use other solvent materials. For example, sodium sulphide may be charged into the furnace instead of sodium sulphate, in which case, as no reduction is required, the coke may be omitted or a less quantity of it employed, and even when sodium sulphate is used deoxidation may be performed by the operation of poling without the use of coke or with only a little coke.

Instead of sodium sulphide I may employ the sulphides of other alkaline metals or sulphide of manganese. —*Nickel Industry, by A. P. Coleman.*

ROCK DRILLS*

By W. L. Saunders.

The drills now in use may be classified as follows:

1. The plugger drill. This is of the hammer type. It is used in its smallest sizes for dressing stone, for trimming, cutting hitches, and for block holes. It is a hand-rotated machine.

2. The Jackhammer. A hammer drill with automatic rotation, used for sinking shafts, for down-hole work in stopes, for quarrying, for drilling in coal, and in rock and ore work wherever down-holes are required. It is held in the hand of the operator and in some mines is used for horizontal work, mounted upon some simple form of support.

3. The stoper. A hammer drill with air feed, usually used without mounting and for up-holes. It has a large field of usefulness, mainly in stopes or rooms and in driving raises.

4. The mounted hammer drill, as exemplified in the Leyner type, used mainly for horizontal, or approximately horizontal, hole drilling, for side stoping, and for driving drifts and tunnels. In this type of drill a combined stream of air and water is discharged through a hollow steel at the bottom of the drill hole.

5. The reciprocating drill, used for heavy down-hole drilling where the stopes are large, and for surface work, drilling deep holes of large diameter.

Plugger drills are largely used for pop shooting, breaking up boulders, trimming walls, and for all light work requiring holes not exceeding 5 ft. in depth. Solid or hollow steel may be used. In the latter case the exhaust air is discharged at the bottom of the hole for the purpose of removing the cuttings. This type of machine is equipped with a simple device for cleaning the holes of rock cuttings which may not have been discharged by the normal process of exhausting in the hole. This device consists of a lever, eccentric in its middle portion and located on the side of the valve chest. A portion of the lever forces a plunger against the valve, stopping the action of both the valve and the hammer piston and thus permitting live air to pass to the bottom of the hole. Where steam is used wooden handles replace the metal ones.

The Jackhammer can be operated either by steam or air, it uses hollow steels, is provided with an automatic rotation and it drills holes to a depth of 15 ft. It is essentially an all-steel drill. The cylinder, for instance, is drop forged, made of special steel, treated and hardened in the bore. Its most interesting feature is its automatic rotation.

The stoper hammer drill is so well known and so generally used that further description is unnecessary. It is but a few years since this machine was invented and its application to general mining work has been very rapid. Thousands of them are in use.

Jackhammer Records.

There is no place where this new type of Jackhammer drill shows to better advantage than in shaft sinking and in bench or foot-wall work in mines and tunnels. For shaft work two or three times the number of drills may be used as formerly. Each man in the shaft who is not engaged in mucking is a driller, the two operations being carried on simultaneously.

At the Newport mine in the Lake Superior iron country a shaft is being driven with Jackhammers. Dimensions of shaft, 11 by 18 ft. in the clear. The progress has averaged 20 ft. per week, using five drills; material, hard quartzite. During February last a progress of 107 ft. was reported, and in March 125 ft., this latter being said to be the record of performance in shaft sinking in that district.

At the Lucky Star mine in the Lake Superior district four Jackhammers are working in a shaft 12 ft. 2 in. by 14 ft. 10 in., drilling ten 6-ft. holes for sinking and twenty 5-ft. holes for squaring after blasting; material, hard diorite. The progress has averaged about 100 ft. per month.

The Norrie-Aurora shaft of the Oliver Mining Co. was sunk 64 ft. in February, employing three 8-hr. shifts of eight men, each using Jackhammer drills, the shaft being sunk, steel timbered and concrete lined. The total hours drilling was 794 man-hours, out of a total of 4,202 man-hours. In this performance the man-hours required for mucking were almost twice that of the drilling, whereas the time charged for blasing approximated that of the drilling; the timbering and lathing combined were slightly under the drilling figure. The remainder of the time was charged to squaring, cutting hitches, piping, etc. During March 105 ft. of shaft were driven and

*Extract from paper presented at Butte Meeting, A.I.M.E., August, 1913.