tons of crude ore to one ton of concentrates. Therefore the daily production of concentrates from one unit will amount to from 375 to 450 tons per day when running two shifts. The operations are being pushed to this point as rapidly as possible.

It will be necessary to install the second and possibly the third units of the concentrates before opening up Coe Hill and Blairton mines.

The ore reserves guarantee a future ore supply for the concentrator at full capacity for many years.

(To be Continued.)

EFFICIENCY IN UNDERGROUND PRACTICE*

By Andre Formis.

In consequence of the increased cost of labour and supplies in the process of mining it has become advisable to investigate the various steps in the production of tonnage with a view to reducing waste factors to a minimum. The paper submitted this evening hopes to bring out a discussion on the subject of rock-drilling, the most important of the underground operations.

Considering that the labour factor in mining is about 75 per cent. of the total cost, it is evident that the savings effected in this item are proportionately of greater importance than in the matter of the other 25 per cent. of the cost. However, owing to the nature of this larger factor it is also much more difficult to accomplish any results with it, partly on account of the evident distrust of the so-called old-time mining captains of anything suggested by a technical graduate, partly on account of the inertia of labour itself, and partly on account of the natural hesitancy of some mine managements to permit anything that may seem a radical departure from ancient and honorable customs. Yet it can be shown by actual tests, supplemented by correct cost figures—by these I mean costs based on observed and recorded facts and not pro-rated costs—that material savings are easily made without departures in any manner radical in underground practice.

In order to arrive at a correct analysis of any set of conditions it is, of course, important that the observations of these conditions be as accurate as possible. It is also obvious that a long continued set of observations is more nearly correct than a short one.

In the practice of rock-drilling many different methods are employed, many sizes and shapes of drills are used. Some of these drills are better than others; sometimes, perhaps, one only is the best for a certain class of work. Careful study and patient investigation are required to come to any definite conclusion. The selection of the drill depends on a large number of factors, the most apparent of which are:

1. Hardness of the rock to be drilled.
2. Irregularities of the rock, causing the steel to bind in the holes.
3. Diameter of drill cylinder.
4. Piston stroke if any.
5. Weight of moving parts.
6. Effective blow.
7. Total weight of drill.
8. Depth of holes to be drilled and diameter of holes.
9. Style of chuck.
10. Shape of bits.
11. Use of water in holes.
12. Hollow steel with water or air jet.
13. Wages of miners, based on company account, tonnage contract, or footage drilled.
14. Cost of power.
15. Various other factors, depending on locality, etc.

Each of the foregoing factors determines in a manner the proper drill to be used. What appears to be the proper drill having been selected, first an investigation of the amount of air it consumes should be made, second, a time study of its operation.

For the first of these studies may be used the graphic air-flow meter which has been perfected by the General Electric Company (see Bulletins No. 4004, No. 4827, and No. 4941), which measures in cubic feet the air consumed by any device connected to it. The record is made on a moving roll of paper. The interpretation of the record is simple.

The principle of operation of the meter is based on the velocity head. Consider a small pipe inserted in the airline in such a manner that the leading opening faces against the direction of flow and the trailing openings face in the direction of flow. These two pipes are connected to a vertical U-tube containing mercury. Thus the air flowing in the pipe impinges against the leading opening and sets up a pressure in the leading pipe which equals the static pressure plus a pressure due to the velocity head. The drag of the air on the trailing openings lowers the pressure in the trailing pipe. Due to the differential pressure, the mercury in the U-tube is deflected until the unbalanced column exactly balances the differential pressure. Since the leading set of openings extends approximately across the diameter of the pipe, the velocity pressure transmitted to the meter is the mean velocity pressure due to the flow of air, rather than the velocity at a single point in the pipe.

One of these meters was installed at the property with which I am connected. The meter was first used on the 1900-foot level to measure the amount consumed by a R 3 drill and a Butterfly drill No. C100. Only one drill was working on the line at a time. A recording air-gauge was also connected to the line, to ascertain the air-pressure near the drill for comparison at any instant with the graphic flow-meter records.

For a fairly accurate time study of the operations of the drill, nothing more is needed than a watch and a note book. Mr. R. T. Dana and Mr. W. L. Saunders in their work on rock-drilling have published a formula which permits of a set of short observations being used for an estimate of drilling performance. The formula is:

Time to drill one hole =(e—fd) D/f—(l—g—k) in which the quantities signify as in the table following. The table includes also the figures obtained at our mine.

e=average time to change steel	our figure,	4.00 min.
d=average time to drill one foot	our figure,	4.87 min.
l=average time to move drill	our figure,	16.00 min.
g=average time to set up drill	our figure,	12.00 min.
k=average time to blow, blast holes, etc.	our figure,	24.00 min.
D=depth of holes in feet	our figure,	8.1 ft.
f=length of feed	our figure,	2 ft.
fd=time to drill length of feed	our figure,	9.6 min.
Number of bits per hole	our figure,	4.0

Then if 540 is the number of working minutes per day shift, the number of holes per day shift=

$$\frac{540}{(e—fd)\ D/f—(l—g—k)}$$

*A paper presented at Michigan College of Mines Club, Houghton, and published in the M. C. M. Alumnus April, 1913.