breakers would have an inside diameter not less than 8 ft., and the coarse ore fed in to form pebbles would be lumps from 6 in. to 8 in. cubes. In such a case it would probably prove advantageous to use a second row of ordinary tubes for the final reduction.

The capital cost for the cheapest design will depend upon the relative cost per square foot of barrel and ends. If a square foot of end costs "n" times a square foot of barrel, then the length must be "n" times the breadth. In designing a tube all the costs which are affected by the diameter must be tabulated for the various sizes and a similar set of calculations made for the various lengths and upon the above principles a determination can then be made of the best relative dimensions. I am informed that the ratio so determined will be about 4 to 1, which implies that the ends, including driving pinion, trunnions, etc., cost four times as much as the cylinder per square foot. It has, of course, been assumed that the internal capacity is a reasonable measure of the work a tube mill can be made to perform, which is in practice found to be roughly accurate.

Other considerations are of at least equal importance with considerations of prime cost, and the principal one appears to be connected with the amount of feed it is practicable to pass through the tube so that the full length may be utilized. Four hundred tons per day is quite common on the Witwatersrand, and this seems to be sufficient for the ratio of 4 to 1 with a 5 ft. 6 in. diameter tube; but it would be difficult to set a limit for the possible amount if the feed and discharge inlets are suitably arranged.

Before proceeding with the other divisions of our subject, a reference is necessary to the experiments recently carried out by the Mines Trials Committee, which has been kind enough to give permission to make use of the results obtained.

This series of experiments was carried out in the ore-dressing laboratory of the South African School of Mines and Technology by Professor G. H. Stanley, assisted by Mr. Morris Green.

Experiments were undertaken to observe and measure—

(a) The effect of varying speeds of revolution
(b) The effect of varying loads of pebbles.
(c) The effect of different "working levels" and the ascertaining of the most suitable discharge screens.
(d) The effect of varying sizes of pebbles and feed coarseness.
(e) The effect of varying kinds of tube lining.
(f) Testing the practicability of using a continuous automatically replacing lining of the pebbles themselves.

During the conduct of the trials it was further decided to

(g) Measure the fluctuation in speed and power consumption during a revolution of the tube.

The tube was a cylinder of ½ in. iron with a diameter of 77 in. inside and a length of 18 in. mounted on a heavy cast-iron spider and driven by gearing. The back was of 1 in. ribbed cast iron mounted on a shaft 7 in. diameter. The front was closed in by 1 in. iron screening, prevented from bulging out by two strong iron supporting plates. A man-hole was used for introducing or removing pebbles. The spur-wheel on the shaft was cut steel gearing with 150 teeth, pinion 20 teeth, counter shaft belt pulleys 30 in. and 20 in. diameter, motor pulley 8 in.

A 25 H.P. shunt wound motor was supplied, and the speed varied by using suitable resistances, and this gave no trouble. The calculations on power consumed do not take into account any variation in efficiency caused by changing speed, as the engineers did not consider this of importance.

Imported Danish pebbles from 2 in. to 4 in. diameter were used, and a very fine spray of water had to be directed upon them to keep down the dust. All the observations are upon the tube loaded with pebbles only.

The voltmeter and ammeter employed were carefully calibrated from time to time.

The tachometer supplied was of little use as its readings were not sufficiently "dead-beat." A stopwatch was therefore used in counting number of revolutions. Various subsidiary apparatus was used to determine levels and "angles of departure" of pebbles, etc. As the light was insufficient, no cinematograph record could be taken, as intended, but numerous diagrams were drawn from eye observations to illustrate the appearance of the moving pebbles under the various conditions. Several oscillograph records of the current consumed, and tracings of an electrically vibrated tuning fork upon smoked paper wrapped round the shaft were also taken, the latter being used to determine the variation of speed during a complete revolution of the tube.

All the observations recorded were made with the tube mill containing pebbles only, thus securing simplicity and definiteness. Any practical application of the deductions when sand and water are present requires due allowance for these factors.

Linings.—The liner used for most of the experiments was of plain concrete, and this wore away very rapidly, especially at first while it was fairly new, and the wear was not very regular. A concrete surface does not appear to have much "grip" on the pebbles, and according to the calculations made on observed figures it allowed more "slip" than even the unlined tube.

A steel bar liner, arranged alternately flat and upright in the usual manner, was found to take up pebbles well till the actual working surface consisted of pebbles. The wear in this liner was not measureable during the experiments made with it, and the working surface appeared to take up the pebbles well, giving a minimum amount of "slip."

No other kind of liner was available for experiments, but the experimental tube mill remains available for trials in this direction, if at any time such appear to be desirable.

An objection to the bar liner of the Osborne or similar types is the greater amount of amalgam held up thereby as compared with the silex liner. This may be to some extent minimized by using cement as a backing to fill up interstitial spaces, but even with great care the retention of amalgam is capricious, and may vary on the same mine from 500 to 2,500 oz. It will, however, do almost as efficient work at the first hour of starting as at the end of its life, and this compares favorably with the indifferent work done when a new thick silex liner is started up.

Upon driving a tube beyond a certain critical speed, one or more layers of pebbles may be made to adhere to the circumference, and thus form an automatic lining, which would replace itself as it wore out.

TABLE I.

Diameters and R.P.M. to Make Layers of Pebbles Continuous.

The diameters given refer to the "circle of reference" and show measurement inside tube lining less diameter of pebbles used. A layer of pebbles is said to be "continuous" when it adheres to the circumfer-