area of 4 sq. in., the average unit pressure here is 2,190 lb. per sq. in., or eighteen times as much as under former conditions.

The finer the crushing is carried in the battery the longer sand particles remain before sufficiently reduced to escape, and the higher the ratio of fine to coarse material in the mortar-box. Hence, under these conditions the liability is for the falling stamp to have its force of impact distributed over so large an area as to produce little effect but abrasion on a bed of shifting compressible sand. These considerations serve also to explain why fine breaking before milling with heavy stamps does little good. A large number of pieces of ore of approximately equal size afford a large area to receive the blow of relatively small pressure upon each. And further, the abrasive action, above referred to, explains why stamp milling with a fine screen and a high discharge, or both combined, is inefficient through the waste of energy in converting fine sand into slime by abrasion of the particles re-arranging themselves under the stamp.[12]

As regards the desirable size to which ore should be broken before entering the mortar-box, the disadvantage of too fine crushing yielding a uniform bed has already been pointed out. The maximum limit varies with the class of ore, being less for hard ores, but in general it should be such that not more than one blow of a stamp is required to pulverize the largest piece of rock. Hence the heavier the stamp, the coarser the preliminary breaking admissible, and vice versa. With unweathered banket ore probably a maximum diameter of 1¾ in. is permissible. Larger pieces are more economically reduced by the rock-breaker and the lowering of stamp duty, owing to less actual height of drop with such a feed, is thus avoided.

In passing it may be said that the practice of placing the breakers under the control of the mine captain, who when ore is coming up freely from below avoids congestion in his bins by opening out the breakers wide, is not to be commended. The object sought is certainly achieved, but at the expense of inefficient stamp milling and greater strains on stems when the edges of the shoes fall upon large pieces of hard ore.[13] When the pieces of ore are too large to enter the feed opening of the mortar-box, and feeding consequently ceases, the results are of course even worse.

Taking the average running weight of a stamp as with a half-worn shoe and with a stem of less than its original length owing to breakage, it will be found that this weight is some 10 per cent. less than the weight of the stamp when new, and that its duty is correspondingly reduced. The obvious remedy is the use, as the shoe wears down, of compensating weights in some form or other, which have been frequently suggested and occasionally used.[14]

Since, however, greater attention has been directed to the weight of stamps through the trials on the Knights Deep referred to, the use of compensating weights has become common on the Rand, and their importance in maintaining a high efficiency and stamp duty is so considerable as to be well worth the small additional trouble and expense involved by their use. Probably the earliest form of this device was placing an old head at the top of the stem or an extra tappet above the one in use.

These devices were, however, crude, and the writer has tried various other methods, including a false head intermediate between the true head and the shoe, on the ground that additional weight is better added near the bottom than near the top of the stem. Probably the most convenient compensating weights, however, are split cast-iron discs about 4 in. high and weighing about 50 lb. or 60 lb. each, which are clamped on the stem by means of two bolts either above or below the tappet. Such a compensating weight is illustrated in the accompanying Fig. 4, and as many may be gradually added as are needed and can be accommodated.

With increased weight of stamp, the question of increased shoe and die area arises, but the considerations already advanced, showing the small amount of pressure per sq. in. of total shoe area, indicate that very large shoe and die areas are not needed for hard ores, whilst for soft ore a lower, quicker drop can be used. Some increase, however, is usual owing to the fact that the larger diameter of stems and tappets required with heavier stamps necessitates increasing the distances between stamp centres.

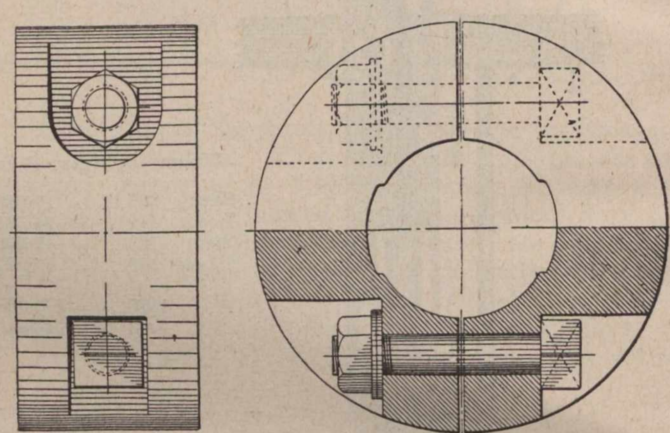

FIG. 4.

An increase is desirable when the total force of impact of the falling stamp requires a thick layer of ore on the die to avoid excessive shock. Such heavy feeding lessens the duty, because the thicker ore bed reduces the actual height of drop, and the blow is likewise cushioned so that the stamp crushes by abrasion rather than by impact. As already shown, the cushioning caused by fine particles in the mortar-box increases with the height of discharge and the fineness of the screen.

The greater the force of impact per unit of area the coarser the screen required for maximum efficiency, as otherwise a thick layer of fine ore particles would be needed to avoid pounding. Since even a heavy stamp crushes but a very thin layer over the surface of the die, it is obvious that the least thickness of ore layer necessary to take the impact of the stamp without pounding is sufficient to supply ample material for pulverization.

The prevention of irregular wear of dies is as yet an unsolved problem. At first sight it would appear that a slight cavity in the die surface due to soft metal would, when formed, be protected against further excavation by the surrounding portions of the die standing

[12] See E. A. Hersam's paper on "Economy of Power in Crushing Ore," published in the Mining & Scientific Press, of 16th Nov., 1907, p. 624; also C. de Kalb n Mines & Minerals, p. 136, Oct., 1906.

[13] See T. A. Rickard's "Stamp Milling of Gold Ores," p. 151.

[14] See Lock's "Gold Milling," p. 109; also Journal of Chem. Met. & Min. Soc. of S. A., vol. ii, April, 1898, p. 299.