CRUSHING AND AMALGAMATION IN MODERN STAMP-MILLING.

By R. M. Aitken, Metallurgist, Reefton.

The subject of stamp-milling is one about which much has been written, and as the present methods of working and the machinery in use have been so often and minutely described in all details, it will only be necessary in this paper to touch upon the most important parts of the process.

It does seem strange that notwithstanding all the numerous and ingenious inventions for the rapid pulverisation of the ore, and the easy extraction of the precious metals, the stamp mill still continues to hold its own, and is almost universally employed. This no doubt is partly owing to the simplicity of the machinery, the cheapness of the treatment, and its apparent adaptability to the various classes of ores; but the main reason must be on account of the important changes of development through which it has passed. Take for instance the grading by grizzlies, the use of rock-breakers and automatic feeders, the many mechanical improvements effected in stampers, cams, and mortar-boxes, and the increased attention given to wearing-parts and screening; these have all tended to lessen the wear-and-tear, simplify the working, increase the efficiency of the mill, and thus reduce the working-costs per ton. Yet in spite of all these numerous improvements it needs no hesitation to assert that the milling plants of to day are far from perfect; they are undoubtedly more elaborate, more complex, and more costly than formerly, but the methods of crushing and amalgamation are practically the same.

It is not my intention to find fault, or condemn the present method of working without giving reasons for the same, or suggesting some means of remedying the defects; but it is probably time that the matter received some consideration when we find the main principles of crushing being practically ignored to allow of inside amalgamation being practised, and little or no attempt made to properly amalgamate the free gold on outside plates. Perhaps to some men the treatment appears so simple that it has not been made the subject of such study as it fully deserves, or possibly the successful introduction of leaching and other after-processes has caused many metallurgists to lose sight of the desirability of crushing the ore, sizing the pulp, and arranging their tables to obtain a more perfect amalgamation. The improper crushing of the ore, want of sizing, and injudicious use of mercury may not only cause poor battery amalgamation but must seriously affect the working of the after-processes such as concentration, chlorination, and cyanidation; and it seems highly probable that the low extractions so often obtained from these processes may be traced directly to the initial methods of crushing and amalgamation.

The main objects of crushing are to use rock-breakers, stampers, and screens that will produce the largest possible output—crushed to the requisite fineness—for the best and proper extraction of the contained metals, consistent of course with cost, without rendering the pulp unsuitable for amalgamation, concentration, or any other processes that are to follow. But this is not the case in our modern mills where we find the efficiency of many being seriously interfered with by having mortars made suitable for inside amalgamation, by increasing the depth of discharge, reducing the speed of the mill, and dropping stampers in unsuitable rotation to assist this method of saving. It has been stated that this double use of the crushing-machine is the one distinctive feature which has enabled the stamp mill to hold its own against newer inventions for pulverising ore, and to compete with better, but more complicated, amalgamating-machines. This may be so, but at the same time it has given a general and foolish idea that rapid pulverisation can only be secured by impairing amalgamation. Although the practice is almost universal it must be considered one of the most serious errors in stamp-milling—even with free milling ores—and if the properties of mercury and the use of the battery are understood, very little reasoning will show that crushing and amalgamation in the one machine is detrimental to one or both operations.

The mills of Colorado and California in America afford an excellent illustration of the two extreme methods of gold-milling. In the former, the stamps drop slowly from twenty-five to thirty beats per minute, while in the latter a rapid pace of ninety to over a hundred drops is maintained. The theoretical work done in each is about the same, as the height of drop in the one is 16 in. to 20 in., and in the other 4 in. to 6 in.; but in practical work the latter will crush two and a half times that of the former. The great difference is, that in Colorado the ore contains a large percentage of pyrites, and excessive pulverisation was considered necessary to break the close intimacy between the finely divided gold and its associated pyrites. This was attained by a slow drop and a deep discharge, the cushion of water deadening the blow of the stamp, and the design of the mortar being wide and roomy to cause a weaker splash and allow the heavier particles to resettle. But in California, the idea was to induce rapid pulverisation with heavy fast-dropping stamps, narrow mortars (diminishing opportunities of resetting), and shallow discharge to increase the force of the splash and accelerate the exit of the pulp through the screen.

The modern method of wet crushing has practically resolved itself into a standard one, and, although varying to some extent in different mills, it may briefly be described as follows: The ore from the mine before passing into the ore-bin is separated according to size by grizzlies, and the larger lumps broken down by rock-breakers. From the bins it is automatically fed into the mortars, the centre stamp of each battery being so arranged as to control the working of the self-feeder. In the mortar it is crushed to a suitable degree of fineness, and a portion of the free gold extracted by inside amalgamation before passing through the screens. To enable the use of inside copper plates the mortars are made more roomy, and the depth of discharge, speed of the mill, &c., regulated so as to prevent any unnecessary scour taking place. On leaving the box, the pulp (coarse and fine together) is run slowly over one long amalgamated copper-plate table to save the free gold, at the foot of which is placed an amalgam-trap to arrest any escaping particles. The table is about the same width as the front of the mortar-box, with a grade carefully adjusted to ensure an even flow of the pulp. At this stage amalgamation is considered complete, and sizing of the pulp is sometimes done before concentration and chemical