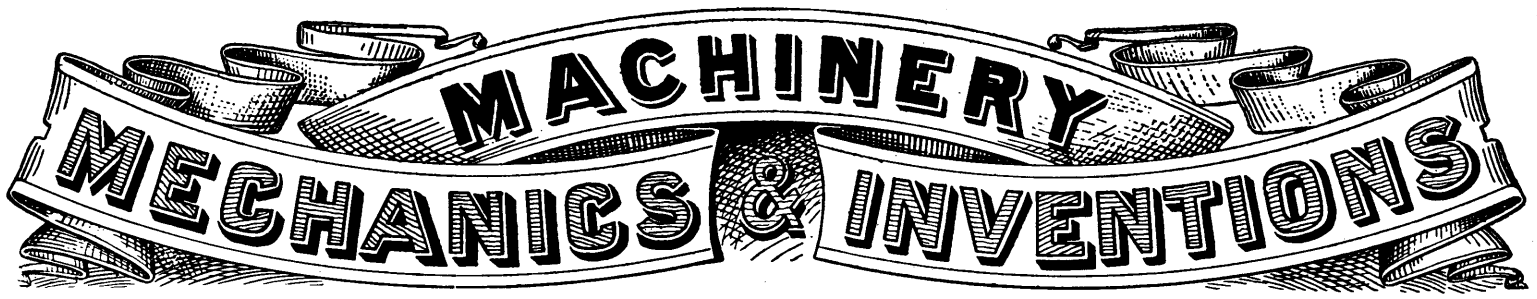

Mining Machinery with Special Reference to Ore-Dressing Appliances.

The following lecture was recently delivered by Prof. Clarkson at the International Exhibition of Mining and Metallurgy, London;

The previous lectures have taught us much relative to the vast mineral wealth of the various colonies, and have specially pointed out the necessity for improved mechanical appliances to deal with these enormous deposits. Consequently it is to be regretted, that in this series of lectures, there should be only one to deal with the very large and important subject of mining machinery. As evidence of its scope, it will suffice to point out that the title, "Mining Machinery," comprises engines, boilers, pumps, winding gear, waterwheels, and turbines, air compressors, rock drills and their accessories, ore breakers and pulverizers, machinery for amalgamating, classifying, concentrating and chlorinating, diamond and coal washing machinery, railways, elevators, and conveyors, electric transmission of power, lighting machinery, telpherage, transport, etc. Now, it is obviously quite impossible, in the short time at our disposal, to deal with more than a small section of this comprehensive subject; I have, therefore, specially selected ore-dressing machinery. In considering the particular requirements of mining machines in general, we may gain much by looking for a moment at the essentials to all successful mechanical appliances. And first in the list stands efficiency. This may be either commercial or merely scientific. The difference will be obvious to all—*e.g.*, Pancellier's combination of links may be the best appliance for drawing a mathematical straight line, but for ordinary use it could never compete with the simple ruler, and so in all. If a machine doing ten per cent. better work than another, costs twenty per cent. more in repairs, it will have to give way in favor of its comparatively less efficient rival. Simplicity will always play a very important part in the question of efficiency, and this is especially true of mining appliances. The stamp-battery furnishes an excellent illustration of an essentially simple contrivance triumphing for years over others of greater efficiency and complication. Scientific investigators may point out fundamental principles, but the work of the mechanical engineer may be defined as the art of simplifying the application of scientific formulæ to the attainment of commercial success. The second point we shall consider is the economy of material in the design of machines. This is to some extent implied by the condition of simplicity, and is rendered particularly necessary by the difficulties of transport—*e.g.*, in the present collection of machinery we have pulverizers of different types, ranging in weight from two to ten tons for the same output. What is required is a correct distribution of the most suitable material to fully meet all requirements of stress, strain, wear and tear. Frequently machines have to be made much stouter than is required by their normal work in order to meet extraneous requirements, such as excessively rough handling in transport, etc. Many American machinists seek "lightness of design" to an unreasonable extent, whereas English engineers have often gone to the other extreme. The third and last essential that we shall notice is beauty of form, and this may at first sight appear quite superfluous in mining appliances; nevertheless, its consideration by engineers in other fields has established its importance, and an improvement in this direction is promised for future mining machines. One of the first and chief things noted by investigators of old mining appliances, is the great want of any adequate consideration of the foregoing rules. Indeed, it was stated only the other day by one of the leading exhibitors of machinery, that until very recently the subject has received scarcely any scientific attention, and mining men have been quite satisfied to proceed on the old lines; however, it is to be hoped that the present exhibition will greatly help to overcome the prejudices of a notoriously conservative fraternity. It is not my intention to animadvert any particular machines, but rather to endeavor to supply information to the uninitiated, thereby increasing the educational value of the present fine collection of machines. We will therefore assume that the ore has been "brought to grass." The problem now is to extract the metals as efficiently and as cheaply as possible. We must note the special reqirements called for by the physical conditions of the country, the difficulty and expense of transport, the quality and cost of the fuel to be used, the scarcity of water, the class of labor available, and the nature of the ores to be treated. The first operation will be a careful inspection of the ore to determine its nature and value as completely as possible; which metals are present, and how much of each; do they occur in the metallic form, or in chemical combination; the relative hardness of the constituent minerals, and their ease of pulverization. Next, does the metallic mineral occur in large compact masses, or is it very finely disseminated through the rock (this will indicate to what extent it is necessary or advisable to pulverize) also the specific gravity—as a guide to "concentration." From the above, and probably other considerations, it will be possible to form a very correct idea of the best treatment and best machinery for any particular ore, and it will be now clearly seen why a pulverizer doing excellent work with one kind of ore may not be equally successful with all. The large lumps of ore must be first passed through the rock breaker, which machine has been brought to a high degree of perfection. At the present time there are only two types of mechanism used in stone breakers, viz.: the toggle joint and the eccentric, and by a little mechanical analysis these can be easily resolved into one. The only draw-back to the toggle is, that breaking only takes place during half the stroke. A successful attempt has been made to obviate this in the Gates' eccentric continuous crusher, but the great crushing force is derived in much the same manner. As the vast majority of ores are brittle and fairly hard, they may be readily pulverized in either stamp, roller, or ball mills. The modifications in design of the two latter classes of machines are so multitudinous, that it would be futile to attempt any detailed descriptions. In ball mills, one, two, or three, or a multitude of balls are placed in a suitable vessel, the whole or part of which is made to revolve, and pulverization is effected by the rolling action of the balls. The only representative in this class in the exhibition is Mr. Jordan's fine reducer. Other pulverizers have a breaking, grinding and tearing action, and are more capable of dealing with tough, soft and elastic substances. A good machine of this class is the "Cyclone Pulverizer" which has succeeded in reducing wrought iron or even india-rubber to a fine powder. High speed mills of the "Cyclone" and "Sturtevant" type require a lot of power, frequently 20 h.p., to an output of one ton per hour, and special attention must be continually paid to the bearings where a speed of from 2,000 to 3,000 revolutions per minute is attained. The essential requirements in a good pulverizer appear to be: 1. The production of a uniform sample with a minimum of slimes. What is required is a mill that will crush the bulk to pass a 60-screen and will not produce more than ten per cent to pass 100. Improvements will be effected in this direction by increased facilities for removing the particles of ore, immediately they are sufficiently reduced, thereby preventing undue battering and the consequent loss of power; removal by upward draft in dry machines is bad. . Secondly the grade or size should be adjustable. This brings us to the next consideration, viz.: the ratio of output to power expended, which should be obviously as great as possible, and varies in existing machines according to their design from 6 to 20 h.p., for an output of one ton per hour. This is a very great variation, and is governed by the question of speed, the weights to be moved, friction and the above-mentioned facilities for the rapid removal of the pulverized ore. The fourth consideration is that of weight of machine to output. This is especially important, of course, where transport is difficult. It appears to vary from 2½ to 10 tons for an output of one ton per hour. The cost of maintenance is, of course, a very important factor, and no very reliable figures can be given. In place of these, however, we may note some of the most fruitful causes of wear and tear, breakdowns and stoppages. It is clearly inevitable that a machine doing such fearfully rough work as the smashing-up of hard rock, will suffer considerably in some of its parts. These should be made light, of the simplest form, and of the most durable material, such as steel or chilled iron, and when worn out should be readily replaced with the minimum loss of time. Careful protection against grit should be afforded to the bearings, especially when a high speed is employed, and strength considerably in excess of the normal requirements should be provided to meet such emergencies as the accidental presence of a steel wedge or chisel with the ore. Formerly "wet pulverizers" were used almost exclusively, but it is satisfactory to note that "dry mills" are now coming to the front. If the "ore direct from the mine" is sufficiently pure, as is sometimes the case, it may be transferred at once to the smelting house, but in the vast majority of cases the "gangue" predominates to such an extent as to greatly impoverish the ore, thus necessitating a sorting operation before the metals can be profitably extracted. This operation of enrichment is known as "concentration" and may be popularly defined as "retaining in smaller bulk the valuable portion of the ore." Excepting the hand-sorting of some of the larger pieces, "concentration" is performed by mechanical appliances, in which either water or air is used to remove the associated "gangue." In considering the various physical properties of the associated particles of ore we shall be most struck by the great difference in the specific gravities of the metallic and non-metallic mineral—in fact, but for this variation in the weights no mechanical concentration would be possible, excepting the one or two cases subject to magnetic influence. But clearly the weights of the particles are not fixed merely by their specific gravities, but by their size and form. Everybody knows that a small piece of lead may weigh as much as a large piece of stone, consequently unless a classification according to size is made, no good concentration must be expected whatever appliance may be used. It has been pointed out under the heading of pulverizers, that although an ore may be ground to pass a twenty mesh there is sure to be an infinite variety in the size of its particles, and it is scarcely necessary to mention that it is perfectly hopeless to invent a pulverizer that will produce practical uniformity in this respect. To emphasize the importance of this classification permit me to quote from the opinions of several authorities upon the subject: "Mr. Frecheville, one of H.M.'s Inspectors of Mines, stated before the Mining Institute of Cornwall, in 1884, in reference to the unsatisfactory concentration of tin ore by jigs at the Wheal Jane Mine, that the material was discharged from the stamps into the concentrators without any classification, and under such conditions there could be no perfect dressing with a jigger, nor with any other machine, but he could see no reason why a combination of jigging and buddling introduced into Cornish mines and preceded by sizing, could fail give satisfactory results." Mr. Philip Argall (manager of a large lead works in Denver, Colorado) stated: "Classifications of the material to be operated upon, is really the secret of good dressing, no matter what method may be adopted for separating." Mr. Rennert, engineer of Johannesburg, has written that the "successful working of any concentrator will be greatly affected by proper sizing." To conclude with an extract from the famous book of Kustel! In speaking of Hunter's self-discharging percussion-table he says: "The general fault in treating these tables is overcharging with unsized ore. This may often be the cause of bringing a really good machine into discredit." This expression of opinion you will doubtless consider more than sufficient to establish the importance of "sizing;" let us, therefore, now consider the means available. The old-fashioned and still extensively used appliance is the sieve or screen, which may be arranged in an endless variety of ways. The forms of revolving screens are legion, and in addition to these, there are parallel screens, parallel-compound screens, parallel-stepped screens, screens with cams and lifting wheels, and many others, each description having its separate use, advantage, and partisans. A good dry classifier is still a want. We must pass on now to concentrates, and as time is so short we must confine our attention to typical examples of each class. Concentrating machines are either stationary, percussion, oscillating, and shaking tables, or steady-moving contrivances, and preference is always given to self-discharging continuous mechanisms. The most primitive blanket-table catches some fine Au and amalgam from stamps. Very fine Au is troublesome to save, but cannot be compared to very fine Ag. ores in this respect. Blanket stuff is comparatively poor, sometimes sixty feet long. After some further remarks the lecturer said a few words on the treatment of refractory gold ores. Probably the best treatment was a direct concentration, the following two cases excepted: (1) If the concentrates were designed for smelting on account of Pb. Ag., in which case the ore by a preceding amalgamation was saved from the unavoidable smelting loss of 3 to 4 per cent. (2) If the concentrates were intended for extraction of ore by chlorination, whereby coarse ore particles were not readily dissolved, the loss in wet concentration averaged about 12 per cent., depending, however, much upon the condition of the ore and the "gangue." This loss consisted in the finest and most unfavorably-shaped particles, of which a portion might escape amalgamation.

An Electrical Coal Mining Machine.

The transmission of power by electricity is rapidly superseding most other means, but although applied in almost every branch of mechanics above ground, it has, until now been almost unknown in mining operations, and the introduction of an electrical coal mining machine by the Jeffrey's Manufacturing Company of Columbus, Ohio, marks an important step in this connection. This concern is already well known through its "air power machines," the success of which has long been recognized, but their present venture is likely to supercede this and all others when its merits are fully established. Some description may prove of interest. The machine consists of a bed frame occupying a space two feet wide by seven feet six inches long, composed of two steel channel bars firmly