THE REDUCTION OF CHLORIDE ORES.

For the benefit of those not familiar with the processes of reducing gold and silver ores, a brief explanation of what is meant by "free milling," an expression so often used by mining men, may not be out of place. In separating, by amalgamation, the precious metals from gangue or waste rock with which they are almost always associated, it is necessary to the success of the process to present the particles of gold or silver contained in the ore to the mercury with which they are to be alloyed, in such form that the latter can seize upon them readily. If these metals always occurred in nature in their pure metallic state, this would be a very easy matter. In free milling gold ores it is frequently only necessary to place the quicksilver beneath the stamps of the battery in which the ore is crushed, and upon an inclined copper plate over which the pulp is carried by water after it leaves the battery. The stamps, by reducing the rock to fine particles, release the minute scales and crystals of gold, which are readily taken up by the quicksilver, while the rock, for which the mercury has no affinity, is carried away as "tailings."

But silver rarely occurs in a native or pure metallic state. It is usually mixed with clorine, lead, iron, sulphur, manganese, copper, antimony and other base metals, and is found in the form of chloride of silver, argentiferous galena, in which the silver is in the form of a sulphide, and in many other compounds, for most of which quicksilver has no more affinity than it has for the common rock of the gangue. In most cases, therefore, if the silver ore was simply crushed and brought into contact with an amalgamating surface, little or none of the metal would be caught by the quicksilver and saved. Mercury has a strong affinity for metallic silver. stronger even than that of chloride, so that ff chloride of silver and quicksilver are brought together the mercury will seize the silver, forming an amalgam, and the chlorine which is released will escape as gas or unite with some other substance which presents itself and for which it has an affinity; but sulphur will not give up silver, with which it is chemically mixed, to mercury, unless the sulphur has first been driven off by fire. This process of converting chloride of silver into an amalgam is not an instantaneous one like the amalgamation of free gold, but requires several hours to be perfected, and it is hastened by the presence of other chemicals, such as sulphate of copper, sulphuric acid, and cyanide of potassium, the action of which it is unnecessary to explain here.

In order to reduce silver ores by amalgamation, it is necessary, as will be understood from the above explanation, to have the particles of metal either in a pure or chloritic state. When they are found in nature in either of these conditions they need no special treatment before being put into the mill, and the treatment of them is called "raw amalgamation." The process employed is to crush the ore to a fine pulp, and then transfer it to a large round iron tub, where it is agitated for several hours in hot water with quicksilver, some or all the chemicals I have named being added with common salt to promote the union of the mercury and the silver. If the silver in the ore is in the form of a sulphide, as it frequently is, and the amalgamation process of reduction is to be employed, the ores have to be roasted with common salt for several hours after they are crushed. Without explaining in full the chemical reactions, I may simply say that the heat volatilizes the sulphur mixed with the silver, and separates the salt into its constituents of chlorine and sodium, the first of which unites with the silver from which the sulphur has been driven off, and forms a chloride which is then ready for the amalgamating pan. The desulphurization and chlorination of an ore is an expensive process, and greatly increases the cost of reduction.

When such metals as lead, zinc, or copper are present in ores in large quantities, it is usually cheaper to reduce them by smelting, and by that process the lead and copper are generally saved and add to the value of the product. Almost any ore can be reduced by fire, if it is mixed in small proportions with cther smelting ores. In large smelting establishments like those at Denver, Omaha, and Newark, N. J., where great varieties of ores are purchased, even free milling rock can be used to advantage; but the reduction of most free milling ores by fire, without mixture with others, would be ruinously expensive if not physically mpracticable.

ON CURRENTS PRODUCED BY FRICTION BETWEEN CONDUCTING SUBSTANCES AND ON A NEW FORM OF TELEPHONE RECEIVER.*

In a communication to the Royal Society of Edinburgh of date January 6, 1879, I showed that "electric currents were produced by the mere friction between conducting substances." The existence of these currents can be easily demonstrated either by a telephone or a Thomson's galvanometer. I have since found that these currents are, for all pairs of metals which I have yet tried, in the same direction as the thermo-electric current got by heating the junction of the same two metals. They are also approximately at least, stronger in proportion as the metals rubbed are far apart on the thermo-electric scale—the strongest current, as far as I have yet observed, being got by rubbing antimony and bismuth together. These observations clearly point to a thermo-electric origin for the currents; but it is possible that they may be due partly to the currents suggested by Sir William Thomson as the cause of friction, and partly, also, to contact force between films of air or oxide adhering to the surfaces of the metals.

Having ascertained that these friction-currents are of some strength and fairly constant, I proceeded to make several kinds of machines for producing currents on this principle. One of them consists of a cylinder of antimony, which can be rotated rapidly, while a plate of bismuth is pressed hard against it by a stiff spring. When this machine is included in the same circuit with a microphone and a Bell telephone, the current got from it is quite sufficient to serve for the transmission of musical sounds and also loud speaking. The transmitter, which I have found most serviceable in my experiments, is made by screwing two small cubes of gas-carbon to a violin, and placing between them a long stick of carbon pointed at both ends, the points being made to rest in conical holes in the carbon cubes. The looseness of the contact is regulated by a paper spring. This forms an excellent and handy transmitter for all kinds of musical sounds, and also serves very well for transmitting speech.

Seeing that friction between metals clearly produces a current, it seemed natural to inquire if the converse held good, that is, if a current from a battery sent across the junction of two metals affected the friction of the one upon the other. I have tested for this in a variety of ways, and the results obtained leave me in doubt whether to attribute them to variations in the friction, or to actual sticking porduced by fusion of the points of contact through which the current passes. The most noticable effect is produced when one of the rubbing bodies is a mere point, and the other a smooth surface of metal. This led me to make a modification of the loud speaking telephone of Mr. Edison, in order to get audible indications of changes of friction produced by the passing of a variable current. It consists of a cylinder of bismuth accurately turned and revolving on centres. The rubber-point is made of a sewing-needle with its point bent at right angles, and its other end attached to the centre of the mica disk of a phonograph mouthpiece. It is evident that this is only a loose contact, which can be perpetually changed. When this apparatus is included in the circuit with the violin-microphone and three or four Bunsen cells, the violin sounds, as was to be expected, are heard proceeding from the loose contact, even when the cylinder is not rotated. They are increased, however, in a remarkable degree by rotating the cylinder slowly, so much so that a tune played on the violin can, with proper care, be distinctly heard all over an ordinary room.

With regard to the explanation of this effect, it is evident that electrolysis can in no sense come into play, as is supposed to be the case in Edison's instrument. I am inclined to look for the explanation rather in the direction of the Trevelyan rocker, although the circumstances are considerably different in the two cases. In the rocker we have the heat passing from a mass of hot metal through two points of support to a cold block, whereas, in the other case, the heat is only intense at the points of contact, the rest of the metals being comparatively unaffected. The variations n the current produced by the transmitting microphone must

*Abstract of a paper read before the Royal Society of Edinburgh by James Blyth, M. A., F.R.S.E., on May 3, 1880.