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THE UTILIZATION OF IRON PYRITES.

The great number of specimens of this material sent to the office of the SCIENTIFIC AMERICAN for examination suggests a few words as to the characteristics and utilization of a very abundant and useful, but hitherto, in this country, much neglected mineral. That we have not put this important compound of sulphur and iron, which in Europe forms an important article of commerce, to more profitable account can be attributed only to our infancy in the art of manufacturing chemistry. We are still dependent upon foreign sulphur for our oil of vitriol, when stores of iron pyrites, containing not only sulphur but other valuable constituents, lie at our own doors. Pyrites is a term applied to various metallic compounds of sulphur, but the most abundant and well known are those of iron and copper. It is of iron pyrites or sulphide of iron that we propose to speak here, as a mineral worthy attention and study.

It was not until 1835 that the English, who used immense quantities of sulphur in the manufacture of oil of vitriol for the production of carbonate of soda from common salt, suddenly found their supplies of sulphur cut off, by an almost prohibitive duty laid on the exportation of the article by the King of Sicily, from which country most of the crude brimstone of commerce is obtained. The only available substitute was the subject of our article; and it was soon put to such useful account that, in 1861, statistics show that no less than 264,000 tuns were consumed in England. The amount used now must be vastly in excess of this, probably not less than 500,000 tuns per year.

Iron pyrites, though occurring under a variety of forms well known to the mineralogist, is still soon readily recognized, even by the inexperienced, from certain characteristic tests. How many unfortunate dupes has the bronze yellow variety deceived, in the hope that they had struck solid gold, when a few drops of hot nitric acid in the hands of the chemist, or a simple blow pipe test with charcoal, would soon have dispelled their illusion! And yet gold is not always absent. The auriferous pyrites of California, South America, and Siberia, have been profitably worked for gold. The valuable sulphur, however, in the roasting was driven off, as sulphurous acid, into the air to poison the surrounding atmosphere. Improvements are of slow growth. In our search after one valuable material, to which our attention is directed, we are apt to overlook equally valuable ones, until necessity or profit compels us to take account of them. It is but a year or two since the immense copper smelting works at Swansea, Wales, where copper is extracted from copper pyrites, have attempted to utilize the escaping sulphurous acid gas from the roasting ores. These fumes, that for generations settled down upon the surrounding country like a blight, have now been turned into a valuable commercial product.

A very common form of pyrites is that of a bright yellow mineral, which is a true bisulphide, containing iron 46·03 and sulphur 53·97 parts in 100. Iron pyrites is frequently, however, of a dark or bronze color, and sometimes resembles bell metal in its luster, this variety consisting of a mixture of protosulphide and bisulphide of iron. There is also a white variety called white pyrites, which, from its form of crystalization, is termed cockscomb pyrites. Magnetic pyrites also occurs. It is of a deep color and not very abundant. We pass over the numerous compounds formed by the combination and intermixture of other minerals, observing that when the proportion of copper is considerable, the ore is called copper pyrites, and is distinguished by its brass yellow color, the rainbow colors on its surface, and its inferior hardness.

Iron pyrites is so hard that it will strike fire with steel, whence its name, from the Greek word for fire. It was once used in the old fashioned musket, instead of flint, for this purpose. This is an easy and inexpensive test for those who would confound it with gold. Gold is too soft to strike fire in this way, and its weight, bulk for bulk, is four times as much as that of pyrites. In the utilization of iron pyrites for its sulphur, the ore is either roasted in close vessels without access of atmospheric air, when a certain proportion of flowers of sulphur sublimes; or more ordinarily it is burned in the air, for the production of sulphurous acid in the manufacture of oil of vitriol. This is done in peculiarly shaped kilns; and when once ignited, the ore keeps up its own combustion. By this plan of burning, even under the most favorable conditions, two or three per cent of sulphur remains undecomposed. But by pulverizing the ore and roasting on the floor of a reverberatory furnace, not only is all the sulphur expelled, but the residue is in a suitable condition for the extraction of its copper, and the utilization of the remaining red oxide of iron. In England, the pyrites found in the coal beds (and called "brasses"), as well as that from Wicklow in Ireland, is largely burnt for the production of sulphurous acid gas in the manufacture of sulphuric acid. The ore after burning can be utilized as a common red pigment; but where the pyrites contains from one to three per cent of copper, as it frequently does, it is returned after burning to the copper smelter. It is this small proportion of copper that makes iron pyrites so economical a source of sulphur to the oil of vitriol manufacturer, the Spanish pyrites on this account being of late largely imported and used. Ores of this character are utilized at present in England to their fullest extent, their sulphur being first extracted in the manufacture of sulphuric acid, then their copper; and finally the red residue of oxide of iron is sold to the iron manufacturer for smelting. In spite of the abundance of iron pyrites in the United States, we know of but one establishment in this country where it is partially utilized in the manufacture of sulphuric acid.

Another important manufacture, in which pyrites may sometimes be economically used, is that of sulphate of iron or copperas. When pyrites is exposed to the influence of air and moisture, it undergoes decomposition. The two constituents of the pyrites, sulphur and iron, absorb oxygen, becoming converted respectively into sulphuric acid and oxide of iron; these from their chemical affinity unite and form sulphate of iron or copperas. In the manufacture of copperas, the ore is first stacked in large heaps on a clay floor or other waterproof foundation. It is then roasted to hasten its decomposition, and afterwards moistened with water from time to time as required. The resulting solution of sulphate of iron is then caught in suitable vessels, concentrated, and crystalized. In the South Lancashire district in England, over 80 tuns of copperas per week are thus produced; and in Stafford, Vt., copperas has been made in this way for at least half a century.

We have spoken of the "brasses," or yellow pyrites of the coal measures. These are readily decomposable; and during decomposition, so much heat is sometimes liberated as to inflame the remaining pyrites and finally set the coal on fire. When this happens, the workmen are compelled, at great expense and loss of time, to flood the mine to put a stop to the conflagration. The water pumped from coal mines containing iron pyrites is sometimes so strongly charged with the acid sulphate of iron, that the iron pumps used for its removal are rapidly corroded.

There are undoubtedly many localities in this country where the pyrites is sufficiently abundant and readily decomposable for the economical manufacture of copperas, a salt which is largely used in dyeing, as a disinfectant, and for the manufacture of ink and Prussian blue. Where the pyrites contains a small proportion of copper, it may be more economically utilized, in the way already shown, for the production of sulphuric acid.

THE INFLUENCE OF CARGOES OF MACHINERY AND HARDWARE ON SHIPS' COMPASSES.

In order to determine the local deviation of a ship's compass, due to the materials entering into the vessel's composition affecting the needle, it is usual, before proceeding to sea for the first time and at certain intervals thereafter, to swing ship and compare the indications of a standard compass, located in a position out of the sphere of attraction, with those of the ordinary steering instruments in the binnacle. By this means a correction for every point is found, which must be allowed for in steering a course per the binnacle compass.

While there is little question but that every captain of a sea-going steamer is in possession of the important data thus obtained, there is in our minds considerable doubt whether a similar allowance is made for the nature and storage of the cargo. A hold full of hardware would undoubtedly affect the compasses, and cases, of arms, for example, or any other articles of iron or steel, carelessly left near the binnacle, might throw the ship miles off her course and be productive of just such a disaster as that of the Atlantic. The captain of an English vessel, the Duke of Argyll, steaming between Liverpool and Dublin, a foreign contemporary informs us, found that a box containing six sabres and three scabbards, placed at a distance of 10 feet away, exercised a sensible influence on the needle, which, when the disturbing cause was removed, oscillated from side to side for fully five minutes before it resumed its normal position. Another instance is on record of a ship being thrown some distance from her proper position through the careless placing under the compasses of a case containing a couple of small sewing machines and a few packets of needles.

These instances show that serious consequences may be due to indiscriminate stowage of cargo composed of objects of iron or steel. In fact every shipper of hardware or machinery, or passenger having in his possession such articles, should, for his individual as well as for the general interest, advise the captain and, besides, have the cases conspicuously marked as to contents, so that every precaution may be taken to avoid their influence upon the compass. It can hardly be expected that a merchant vessel will swing ship every time that she goes to sea, but at least the danger of a guide, upon which the safety of the vessel depends, becoming unreliable will be materially lessened by a careful and intelligent disposition of the metallic portion of the cargo.

NEW IRON ALLOYS.

A new process of manufacture of alloys of iron with manganese, titanium, tungsten, and silicon, and of the agglomeration of these substances for treatment in a special furnace and in movable crucibles, has recently been patented in Belgium.

Up to the present time, as our readers are doubtless aware, but one of these alloys has been to any extent industrially manufactured and employed. This is ferro manganese, which contains twenty-five to thirty per cent of manganese, with from 70 to 75 per cent iron and from 5 to 6 per cent carbon. In France and Germany, this alloy has attained some importance, and is stated to admit of the manufacture of certain qualities of cast iron with a regularity and surety not given by any other process. It has heretofore been produced either by the Prieger crucible system or by the Henderson process, both being based upon the simultaneous reduction in presence of finely divided charcoal of a mixture of the ores, pulverized, of iron and manganese. The presence of iron in the mixture determines the complete reduction of the oxide of manganese, and is indispensable to such reduction, a fact evidenced by the difficulty always encountered in obtaining metallic manganese during laboratory researches, and by the large expenditure of time and fuel usually required in effecting the reduction of the oxide. On account of the pulverulent state of the mixture, and of the poverty of the batch, which should contain an excess of charcoal, these two processes are able to produce in a given apparatus but small quantities daily of the alloy, and with an enormous consumption of fuel. The difficulty seems to have been to find a system which would answer all industrial requirements, work continuously, effect the reduction of the oxides successively and not simultaneously, and finally cause their complete fusion. A vertical apparatus, analogous to a high blast furnace, it would appear, might answer the require, ments, and it is stated that in certain localities, where ore has been found containing the proper proportion of iron and manganese, two smeltings have been produced, containing 18 per cent of the last mentioned metal. Unfortunately, however, such ores are very rare, for it is a necessity that they should be almost absolutely free from silex. Moreover, it is difficult to pass into a high furnace material reduced to a dust. The operation is productive of accidents, while it is hardly possible, subsequently, to preserve a regular working. Beyond this, the interior surface of the apparatus, incessantly in contact with the semi-reduced pulverized oxides which the blast drives into the very joints, becomes attacked with great rapidity.

The new process to which we refer in our initial paragraph and for the following description of which we are indebted to the *Chronique de l'Industrie*, appears to be based on a system of agglomeration, which permits of the introduction of the oxides no longer in a state of powder, but in the form of small bricks or lumps, containing the elements of the alloy to be produced. Many attempts, it may here be remarked, have already been made to agglomerate the rubbish of iron ore, which, in certain districts, exists in profusion, and which in its natural state is useless: but none have given satisfactory results. Lime, pitch, and fatty earth, have been successively employed, forming briquettes, which, though appearing of sufficient solidity when cold, disaggregated completely in the fire, or contained vitrifiable elements in such quantities that the ore became impoverished to an inadmissible degree. From the description of the new process, we learn that, if metal in granulated form, in the shape of filings, of iron or steel turnings, of spongy iron coarsely pulverized, or of any other *débris* of iron or steel in an analogous state of division, be mixed with ores containing manganese, tungsten, titanium, or a combination of these metals, or with quartz: the ores or quartz being finely pulverized and introduced in suitable proportions for the alloy: if this mixture be completely and regularly moistened with an ammoniacal solution, or with water slightly acidulated, and finally compressed in a mold of iron, a strong development of heat is produced; and at the end of several hours, if the mold be opened a very hard compact mass will be found, which can be broken by the hammer into fragments of desired size. These pieces resist red heat perfectly, and do not commence to disaggregate until the point of fusion of pig iron. Their proper treatment in a high blast furnace affords the means, it is stated, of obtaining alloys containing iron and manganese, in all proportions ranging from 25 to 75 per cent of the latter metal, also combinations of iron and silicon, up to 25 per cent of silicon, and finally alloys of iron and tungsten or titanium, or even triple alloys of the different metals. These results are, however, obtained only at high temperatures, with a hot blast at strong pressure, and it is stated that the apparatus ordinarily rapidly deteriorates at its lower portion. To avoid this last mentioned defect, a furnace of especial construction is employed. The shaft is formed of refractory brick as hard as possible and