## CHEMISTRY OF IRON.

### Number III.

#### IRON ALONE.

Having cleared the way to the subject, we now come to iron itself. Of the 66 elements at present known, 49 are metals. Of these, the most abundant and the most useful is iron. The atom of iron is 28 times heavier than the atom of hydrogen. Perhaps a suitable substance to represent the atom of iron, will be iron itself; though the weight, or specific gravity, of a substance is a different thing from its atomic weight. In some substances the atoms are closer together than in others. The Latin name of iron is *ferrum*, and the letters Fe are adopted as its chemical symbol. In chemical formulæ Fe means one atom of iron, $Fe_2$, two atoms, $Fe_3$, three atoms and so on.

Iron is seven and seven-tenths times heavier than the same bulk of water. In other words, the specific gravity of iron is 7.7. The specific gravity of a solid that is heavier than water is ascertained by a very simple process indeed. It is only necessary to weigh the body twice, once in the air and once in water. If the body be suspended from the scales so that it will hang in a vessel of water, it will displace a quantity of water precisely equal in bulk to itself, and will be buoyed up, or have its weight reduced, to an extent just equal to the weight of its own bulk of water. If a body weighs in the air 10 lbs. and in the water 8lbs., it shows that a mass of water equal in bulk to itself, weighs only one-fifth as much; in other words it is five times heavier than water, or its specific gravity is 5.

Iron can be drawn into wire, and is therfore said to be ductile. It can be extended by hammering and is therefore said to be malleable. The several metals vary in regard to the degree of their ductility and malleability, and it is a curious fact that while one metal may be more ductile than another it may be less malleable; and while one metal is extended more than another under the hammer, it is extended less by rollers. Cooke gives the following table of the more common metals, arranged in the order of their relative ductility and malleability; those first named in the several columns being the most ductile and malleable.

| *Ductility.* | *Malleability under the Hammer.* | *Malleability under the Rolling Mill.* |
|---|---|---|
| Platinum, | Lead, | Gold, |
| Silver, | Tin, | Silver, |
| Iron, | Gold, | Copper, |
| Copper, | Zinc, | Tin, |
| Gold, | Silver, | Lead, |
| Zinc, | Copper, | Zinc, |
| Tin, | Platinum, | Platinum, |
| Lead. | Iron. | Iron. |

While iron is more ductile than either copper, gold, zinc, tin or lead, it is less malleable than any other of the metals in common use.

Iron is fusible, though it requires a very intense heat to melt it when pure. The melting point of pure iron is stated to be 2,912° above zero of Fahrenheit's scale, though the difficulty of measuring these high temperatures with accuracy prevents us from relying implicitly on these figures. Cast iron melts much more readily, the melting points of the different varieties ranging from 1,742° to 2,282°.

Ice and most other solids when heated to their melting point change at once to perfect liquids; but a few, as wax, glass and resin, pass through an intermediate state, becoming pasty before they become perfectly liquid. This state is called vitreous fusion. Iron belongs to this class of substances; when softened by heat it is said to be in a state of vitreous fusion.

## LEAD MINES—PROCESS OF SMELTING.

The deposits of lead ore in America are of vast extent. In Wisconsin, Illinois, Iowa and Missouri, they abound in what is called the "cliff limestone." According to the geological report of D. D. Owen on the Northwestern territory, there are sixty-two townships in Wisconsin, ten in Illinois and eight in Iowa, in which lead ore abounds. This metallic region extends east and west eighty-seven miles; north and south, fifty-four miles. In Missouri, as well as Illinois, the deposits of lead ore are inexhaustible, and the diggings seldom exceed 30 feet in depth. So abundant is this ore in America that 3,000,000 lbs. have been raised from a space not exceeding 50 square yards in breadth in Wisconsin; and 500 lbs. are raised daily by one miner in mines of an average production.

#### GALENA.

The common name for this ore is "sulphuret of lead." It is generally composed of lead, 86.55 parts; sulphur, 3.45 parts. This is the composition of pure galena, but lead ore frequently contains some iron, arsenic and other impurities. When a small cube of this ore is placed upon a piece of charcoal and submitted cautiously to the action of the blowpipe, it gives off sulphur fumes and yields a globule of lead. Galena is a shining ore of a gray appearance. It is easily recognized, and with a simple blowpipe and an alcohol lamp its quality can be tested in a few minutes.

Lead ore is found in the northern counties of the State of New York (where there were at one period several mines, now abandoned), Massachusetts, Maine, New Hampshire, Vermont, the Lake Superior region and at Monroe, Conn., where a small argentiferous vein occurs containing three per cent of silver. Lead ores also occur in Virginia, Tennessee and North Carolina. In Davidson county, North Carolina, it is very abundant.

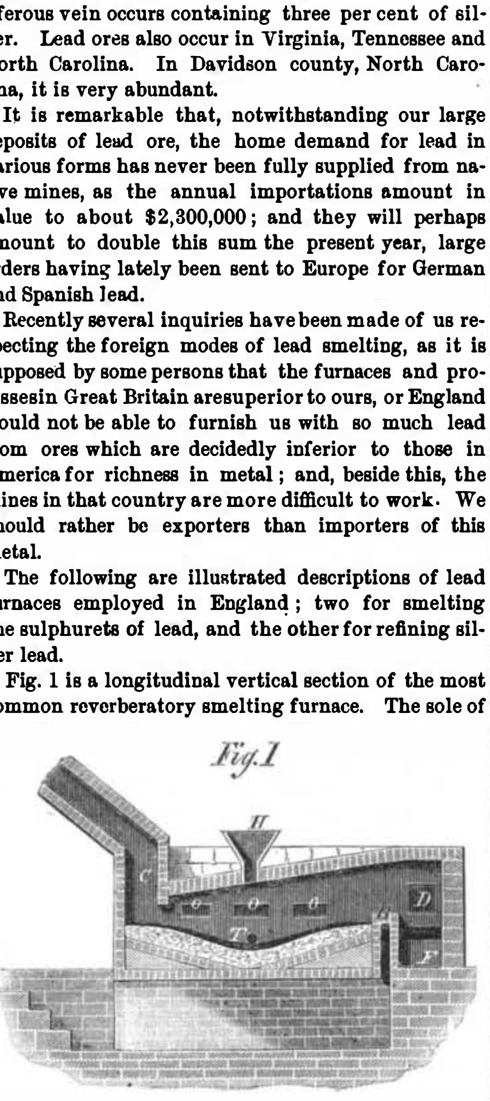
It is remarkable that, notwithstanding our large deposits of lead ore, the home demand for lead in various forms has never been fully supplied from native mines, as the annual importations amount in value to about $2,300,000; and they will perhaps amount to double this sum the present year, large orders having lately been sent to Europe for German and Spanish lead.

Recently several inquiries have been made of us respecting the foreign modes of lead smelting, as it is supposed by some persons that the furnaces and processes in Great Britain are superior to ours, or England would not be able to furnish us with so much lead from ores which are decidedly inferior to those in America for richness in metal; and, beside this, the mines in that country are more difficult to work. We should rather be exporters than importers of this metal.

The following are illustrated descriptions of lead furnaces employed in England; two for smelting the sulphurets of lead, and the other for refining silver lead.

Fig. 1 is a longitudinal vertical section of the most common reverberatory smelting furnace. The sole of

Fig. 1



the hearth is about 8 feet long and 6 feet wide, and is usually formed of fused slag, obtained from the smelted ore itself. About the center of the hearth there is a depression for the fused metal to collect in, and there is an opening to the outside for a tap hole, T, to draw off the smelted metal into a cast iron pan which is set in a niche a little under the side of the furnace. F is the firebox with the bridge wall, B, behind it; C is the chimney. The arch of the furnace is about 14 inches above the fire bridge; at the other end the arch descends to within 6 inches of the hearth, for the purpose of bringing the flame into close contact with the charge of ore. In the center of the arch is an iron hopper, H, for admitting the charge of ore. D is the door of the furnace for supplying fuel and raking the charge. On the same side are three holes, O O O, passing into the smelting hearth. These are covered with iron plates, and are only opened for the purpose of stirring the charge and supplying air as required. There are three such holes on each side of the furnace. The slags composing the sole of the hearth decline toward the tap hole, T. A charge of ore varies from 1,200 to 2,000 lbs., according to the size of the furnace. The charge is spread on the hearth with an iron rake, and, as the smelting proceeds, it is frequently stirred to expose fresh surfaces to the air and heat. After the first charge is smelted in a furnace, and the whole drawn off and the slags cleaned out, a second charge is fed in by the hopper, H. During the first two hours' operation, very little fuel is added, as the furnace retains sufficient heat for the slow action required in the earlier part of the process. Dampers are necessary in the chimney and flues, and the firebox should have one also. These are closed at first; then, after a short interval, a small portion of damper is opened, and the charge stirred with an iron rake. The smelter who has charge of the furnace works in front, and his assistant at the back openings. The first rakes the charge frequently toward the bridge wall, and the second spreads it over the hearth. Quick lime is added occasionally through the hopper to act as a flux and set the metal free. Fuel is added as the furnace requires it, and powdered charcoal or bituminous coal is thrown in among the slag to reduce the oxyd that may be formed. When the reduction of a charge of ore is complete, the lead is drawn off by the tap hole, T, and run into pigs. The whole *shift* in smelting a charge of lead occupies from five to seven and a half hours. Very rich ores require less fuel and less time to smelt than poor ores, and some metallic lead is frequently run off by the tap at an early period of the process.

[Concluded next week.]

## Mineral Wealth of the Pacific States.

The wonderful spirit for exploration and adventure, as well as for investigation into the mineral resources of this side of the continent generally, which has prevailed continuously since the Fraser river excitement of 1858, has produced highly important results.

The new mining fields, developed within the period named, in British Columbia, Washington, Oregon, and for hundreds of miles along the eastern borders of the Sierra Nevada, are already giving employment to probably 30,000 people, nearly one-half of whom are in Washoe alone. The amount of silver and gold now finding its way to this city from Nevada Territory is conceded by bankers, and ot - well informed parties, to fall not far short of $500,000 per month, and $6,000,000 is not an extravagant estimate of the annual yield of Nevada from this time forth, while it will astonish no one if, after a few years, $15,000,000 or more should come to be the average product.

But these large additions to our mining resources do not by any means determine their boundaries. Patient exploration, by experienced miners, continues along the undeveloped borders of more than a thousand miles of mineral country; and the continued discoveries of silver and gold in the Humbolt river region, as well as farther north, on the yet unexplored borders of Oregon and Washington, may almost be taken as evidence that we have as yet only found on edge of the great mineral field of North America.

These extensive developments, during the past three years, are undoubtedly among the principal causes that have created so much confidence and prosperity in this city. While the extent of our mineral resources is so largely increased, and so much greater still in prospective, the discovery of silver, and the greater success attending quartz mining enterprises, have removed many doubts formerly existing as to the permanency of our chief sources of wealth. We now see clearly what could not be so readily proved in 1855, '56, '57 and '58, that there are mineral resources yet to be developed such as cannot fail to make the opportunities for acquiring wealth on this coast better than any where else in the world, even after we can count our population by millions instead of by hundreds of thousands.—*San Francisco Bulletin.*

The London *Times* says that two of Mr. Lancaster's cast-iron guns, strengthened upon his improved system, have been severely tested during the last few days in the bombproof cell in Woolwich Arsenal, with a view of ascertaining their utmost amount of durability. The improvement consists in the gun being clad throughout with longitudinal layers or bars of wrought iron, hooped over with rings of the same metal. The test is stated to have been exceedingly satisfactory. One of the guns has so far resisted every effort to burst it. The second only gave way at the breech after having been fired several rounds loaded to the muzzle.