CHEMISTRY OF IRON.

Number VII.

SULPHURIC ACID AND IRON.

Copperas or green vitriol is a substance very well known. It is composed of sulphuric acid, iron and water. Sulphuric acid combines with iron in two proportions, and as this substance which we are considering has the first or smallest quantity of the acid, it is called the protosulphate, from the Greek, *protos*, first. The atom of the protosulphate of iron is formed by the combination of one atom of the protoxide of iron, Fe O, with one atom of sulphuric acid, SO_3, and seven atoms of water, HO. Consequently the formula is Fe O, $SO_3 + 7$ HO.

When green vitriol is heated it is decomposed, the water first passing off, and, at a higher temperature—a red heat—the sulphuric acid. Sulphuric acid was formerly made in this way, and was consequently called the oil of vitriol.

The protosulphate of iron may be made by dissolving iron filings in sulphuric acid, filtering and evaporating the solution, and setting it aside to crystallize. The crystals are sea green, transparent rhomboidal prisms, and have a strong inky taste.

The copperas of commerce is usually made from iron pyrites. When the bisulphide of iron is heated, its sulphur combines with the oxygen of the air and converts the sulphide of iron into the sulphate. That is to say, it becomes a combination of iron with sulphuric acid instead of with sulphur. Strictly speaking, the bisulphide of iron is converted into the protosulphate, which is copperas.

Copperas is very soluble in water. One pound of it will dissolve in two pounds of cold, or in three-fourths of a pound of hot water. It is extensively used in the arts; being employed for dyeing black, especially for hats; in making ink; in calico printing, and in many chemical and medicinal preparations. It usually becomes reddish when exposed to moist air; from which fact the French called it *couperose*, red, and this name has been corrupted in English to copperas.

HARDENING AND TEMPERING TOOLS AND METALS.

Number II.

Anvils and various kinds of steel dies are hardened by raising them to a low red heat, then placing them in a position with the face slightly sloping and permitting a stream of cold water to fall from an elevation upon them. When the water strikes the heated surface, it darts off at once and the metal is thereby cooled with a very hard surface, and yet it is not so liable to crack as by plunging it entire into a bath of cold water. It is scarcely possible to cool a thick piece of steel, like a die, a roller or an anvil, without cracking it if it is raised above a red heat and plunged into cold water. Such articles do not require to be tempered if properly treated in the hardening operation.

Turners' and carpenters' chisels, gouges and various tools for working in wood, are generally heated in an open clear fire, and moved backward and forward to heat them uniformly. When red hot they are plunged vertically in cold water. Some toolmakers use salt brine as the hardening liquid, others consider cold water just as good.

Very small drills are hardened by first heating them in the flame of a lamp, then whisking them rapidly through the air to cool, or dipping them into a dish containing oil.

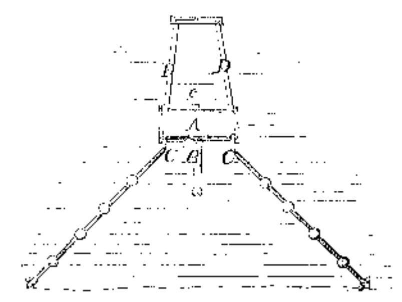
Files are hardened by first holding them in an iron vessel containing molten lead until they become red hot, then plunging them into cold salt brine. Various tools are hardened and tempered by taking each from the fire when red hot and dipping it, edge first, into cold water to a certain depth above the point. It is then lifted and held up for a second until the heat is conducted from the thicker part, which has not been cooled, down to the edge. When it assumes the blue or the straw color desired, it is plunged again into the water and cooled. Laborers' picks, hatchets, cold chisels, sculptors' chisels, &c., are hardened and tempered thus by blacksmiths. To prevent scale forming on the surface of tools while in the fire, they are covered with a paste composed of salt, charcoal and flour, which must be dried before the tools are highly heated.

In tempering knives, after they are hardened, they are laid with their backs downward upon a thick plate of heated iron or copper placed in a clear fire, and are allowed to remain upon it until they assume the proper color for the temper, when they are picked up with pliers and plunged into water.

A variety of opinions and practices prevail respecting the composition of tempering baths. A bath composed of one gallon of fish oil, one pound of beeswax, one pound of resin and two pounds of tallow, first heated and then mixed together, is employed for needles, fish hooks and some kinds of springs. Such a bath is also used for small saws. After being raised to a low red heat the saw is plunged into this bath then lifted out and partially wiped. It is then placed in a clear charcoal fire until the grease inflames, when it is cooled and thus tempered. Much experience is necessary to perform this operation, called "blazing off." In grinding and polishing several steel tools, such as saws, they are liable to lose elasticity. This is restored by careful heating and hammering. The separate parts of gun locks are fried in oil after being hardened. It is by this means that the thick and thin parts are all raised to an equal temperature and temper.

FLOATING BRIDGES.

In deep rivers and coast waters, where pillars and piers cannot be erected for building bridges or lighthouses, the accompanying figure illustrates a method by which such structures may be placed upon fixed floating foundations.



A represents a hollow cylinder or float, and any requisite number of such may be used to support a bridge or lighthouse. Each float has arms, C C, under it, to which chains and anchor weights are attached to hold the floats in position. B is a steadying rod, similar in its nature to the center board of a vessel. It is attached to and suspended directly under the float. D D are the uprights secured to the floating cylinders for the purpose of supporting trestle work and the superincumbent structure. There are valves, *e*, on the floats for pumping out water, should any find access. A series of such floats placed across a deep river will support a permanent bridge. Flying bridges for armies and the passage of heavy trains may also be constructed with rapidity in this manner. Patented by Thomas Schofield, of Grass Valley, California, March 20, 1860.

Aerial Navigation.

We find in the Smithsonian Report the following letter from Prof. Henry, of the Smithsonian Institution, to Mr. Lowe, the aeronaut, in relation to his projected crossing of the Atlantic in a balloon :—

DEAR SIR :—In reply to your letter of Febuary 25, requesting that I would give you my views in regard to the currents of the atmosphere and the possibility of an application of a knowledge of them to aerial navigation, I present you with the following statement, to be used as you may think fit.

I have never had faith in any of the plans proposed for navigating the atmosphere by artificial propulsion, or for steering a balloon in a direction different from that of the current in which the vehicle is floating.

The resistance to a current of air offered by several thousand feet of surface, is far too great to be overcome by any motive power at present known which can be applied by machinery of sufficient lightness.

The only method of aerial navigation, which in the present state of knowledge appears to afford any possibility of practical application, is that of sailing with the currents of the atmosphere. The question, therefore, occurs as to whether the aerial currents of the earth are of such a character that they can be rendered subservient to aerial locomotion.

In answering this question, I think I hazard little in asserting that the great currents of the atmosphere have been sufficiently studied, to enable us to say with certainty that they follow definite courses, and that they may be rendered subservient to aerial navigation, provided the balloon itself can be so improved as to render it a safe vehicle of locomotion.

It has been established by observations extending now over two hundred years, that at the surface of the earth, within the tropics, there is a belt along which the wind constantly blows from an easterly direction; and, from the combined meteorological observations made in different parts of the world within the last few years, that north of this belt, between the latitudes of 30° and 60°, around the whole earth the resultant wind is from a westerly direction.

The primary motive power which gives rise to these currents is the constant heating of the air in the equatorial, and the cooling of it in and toward the polar regions; the eastern and western deflections of these currents being due to the rotation of the earth on its axis.

The easterly current in the equatorial regions is always at the surface, and has long been known as the trade winds, while the current from the west is constantly flowing in the upper portion of the atmosphere, and only reaches the surface of the earth at intervals generally after the occurrence of a storm.

Although the wind, even at the surface, over the United States and around the whole earth between the same parallels, appears to be exceedingly fitful; yet when the average movement is accurately recorded for a number of years, it is found that a large resultant remains of a westerly current. This is well established by the fact that on an average of many years, packet ships sailing from New York to Great Britain occupy nearly double the time in returning that they do in going.

It has been fully established by continuous observations collected at this Institution for ten years, from every part of the United States, that, as a general rule, all the meteorological phenomena advance from west to east, and that the higher clouds always move eastwardly. We are, therefore, from abundant observation, as well as from theoretical considerations, enabled to state with confidence that on a given day, whatever may be the direction of the wind at the surface of the earth, a balloon elevated sufficiently high, would be carried easterly by the prevailing current in the upper or rather middle region of the atmosphere.

I do not hesitate, therefore, to say, that provided a balloon can be constructed of sufficient size, and of sufficient impermeability to gas, in order that it may maintain a high elevation for a sufficient length of time, it would be wafted across the Atlantic. I would not, however, advise that the first experiment of this character be made across the ocean, but that the feasibility of the project should be thoroughly tested, and experience accumulated by voyages over the interior of our continent. It is true that more eclat might be given to the enterprise, and more interest excited in the public mind generally, by the immediate attempt of a passage to Europe; but I do not think the sober sense of the more intelligent part of the community would be in favor of this plan; on the contrary, it would be considered a premature and foolhardy risk of life.

It is not in human sagacity to foresee, prior to experience, what simple occurence, or what neglect in an arrangement, may interfere with the result of an experiment; and therefore I think it will be impossible for you to secure the full confidence of those who are best able to render you assistance except by a practical demonstration, in the form of successful voyages from some of the interior cities of the continent to the seaboard. JOSEPH HENRY.

NEBULÆ.—The Earl of Rosse has communicated to the Royal Society some observations on the nebulæ, with practical details on the construction of large telescopes. The principal result of the observations seems to be a large addition to the list of nebulæ with curved or spiral branches, and many new and multiple nebulæ. A variety of objects have also been pointed out, upon which, says the noble observer, the labor of a careful scrutiny with a similar instrument, even in this climate, will be amply repaid.

THE San Juan (Cal.) *Press* states that large deposits of manganese have been discovered near Nevada.