THE WILSON PROCESS FOR MAKING WROUGHT IRON DIRECT FROM THE ORE.

BY EDWARD M. GRANT, C.E.

The repeated attempts to manufacture wrought iron direct from the ore are so well known that it is useless to recount the history of past inventions, and, therefore, I will proceed directly to a description of the process which I have investigated.

This furnace was invented and patented by Mr. Joel Wilson, of Dover, N. J., who has spent his whole life in the iron business, in England and America, and has been working on this process for nearly twenty years. His last patent was taken out in July, 1872; and his furnace has been in operation a portion of the time during the last twelve months. The stoppages have been caused by changes made at various times in the puddling furnaces, to adapt them to this process; several hundred tuns of iron have been made by this method during that time and sold in the New York market.

I first heard of this invention in August, 1872, and in December I came north for the purpose of making a thorough investigation of its merits. I brought several tuns of hematite ore from Alabama, for the purpose of testing the working of our native ores by this process. I became so much interested in the matter that I remained in the vicinity of the works until September, 1873, when they were closed in consequence of the panic. During this time I weighed nearly all the ore and coal used in the furnace, and kept complete records of the yield in muck bar from each retort, as well as the amount of coal used in puddling, time of heats, etc. I also preserved samples of muck bar from the various charges of ores, to test the uniformity in quality of the iron produced.

The accompanying diagrams will assist an explanation of the apparatus. The ore is crushed to the size of small shot, and mixed with the proper percentage of powdered coal, and then charged in the retorts, B, through the apertures, *a a*. These retorts are built of fire brick or tile, and dovetailed together in such a manner as to hold them firmly in position. They contain from 1,300 to 2,000 lbs. of ore, according to the comparative weight and bulk of the mineral. The heat employed is produced from the gases escaping from two or more puddling furnaces, which are conducted from said furnaces through the flues, F, into a collecting chamber, G, whence the gases ascend to the level of the base of the retorts at *d d*. Here part of the heat passes under the retorts through the small flues, *h h*, into the annular space, *b b*, thence up to the top of the furnace, where they are conducted through the conduits, *c c c*, into the intermediate flues, C' C' C', and thence downward. The major part of the gases rises up through the central chamber, E, to the cap, D, thence through the conduits, *c c c*, and down through the flues, C C, uniting therein with the portion of the gases that went up the annular space, *b b*, thence down through the stand flues, H H, into the circular collecting flue, I I, which conducts the escape heat to the stack.

In this way the gases pass entirely around the retorts, heating them from the outside, while the ore is completely protected from the action of the puddling furnace gases.

After the ore in the retorts has been reduced by the action of the carbon mixed with it, and thereby freed from its oxygen, the metallic iron, in the shape of red hot particles (which flow freely, like fine gravel), is taken out at the bottom of the retorts through the apertures, *d d* (covered by the slides, *d' d'*), and received into an airtight vessel, of my own design (thus protecting the ore from oxidation from the atmosphere), and is there transferred to a hopper, opening into the puddling furnace, whence it is charged upon the hearth beneath, without losing the heat absorbed in the reducing furnace.

This reducing furnace contains sixteen of these retorts, twelve feet high, arranged in a circle about the central chamber, E; the tiles forming the retorts are two inches thick and twelve inches in hight; all parts of the furnace exposed to the action of the products of combustion are constructed of fire brick or cast iron lined with fire clay. The central chamber, E, is seven feet in diameter, and this size of the passage prevents any cutting away of the brickwork by the flame, and also produces an even distribution of the gases through the intermediate flue system, C C C. The heat which escapes from the flue, J, looking to the stack, is sufficient to raise steam for blast and rolling machinery. One of these reducing furnaces will supply three puddling furnaces with reduced ore, so as to keep them in constant operation, and the escape gases from two of these furnaces will furnish all the heat required to deoxidize the ore.

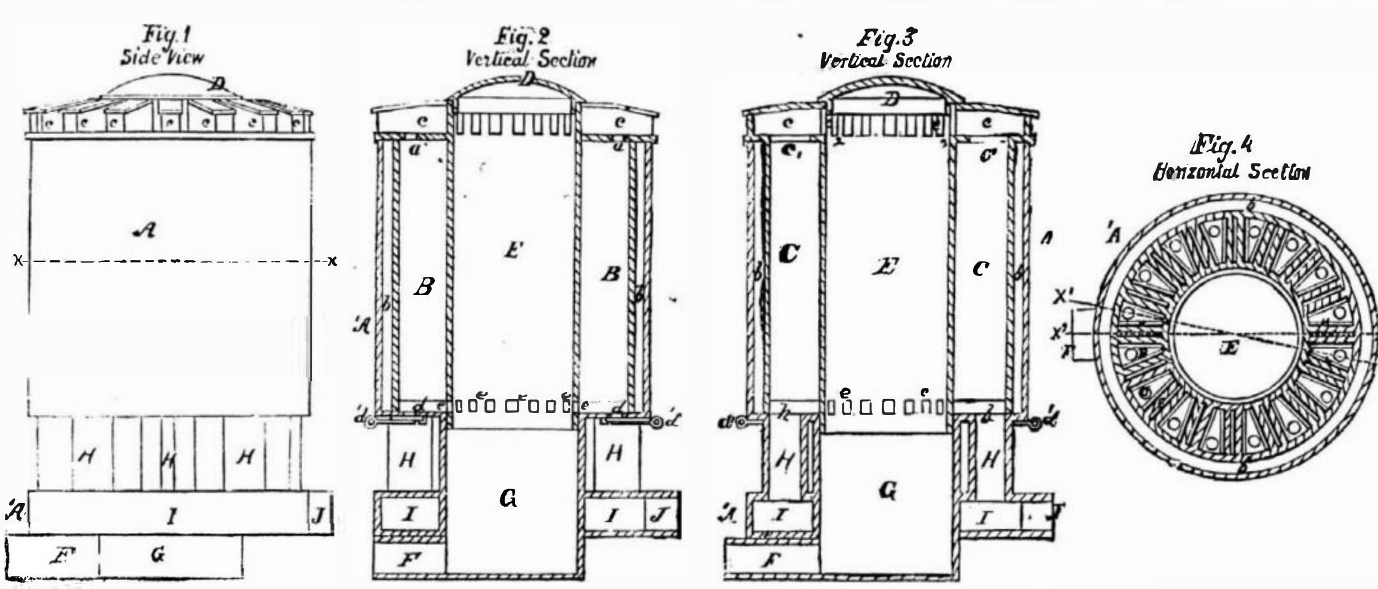
The construction of the puddling furnaces is based upon the same general principle as that adopted in ordinary bar mills; they are lengthened out, however, so as to form three bottoms, about the ordinary size; the first, next to the flue, is inclined, and upon this hearth the ore is charged; it is thoroughly heated up here, and is then moved forward upon the second hearth, by a tool designed for the purpose, where it is heated sufficiently to melt the slag produced by the fusion of the impurities of the ore; from there it is moved to the third bottom and balled up. The operation is continuous, as a second charge is placed upon the first bottom as soon as the first one is moved to the second hearth. The puddling involves less muscular exertion than that required for working pig iron, and only requires one laborer in addition to the usual puddler and helper employed in the ordinary furnace; and the yield from the puddling furnace is fully equal to the production of similar furnaces in using pig metal.

The operations of hammering or squeezing, rolling, etc., are, of course, the same as in the ordinary working of pig iron blooms. A tun of finished iron can be made with two tuns of coal, including that used for reducing purposes. The cost of these reducing furnaces is a small item, and they can be erected in any rolling mill, and the puddling furnaces modified as described, and thus render the mill owners independent of the blast furnaces.

The yield in muck bar from the ore is about the same in amount as that obtained at the blast furnace in the shape of pig iron. The Alabama ore assayed 54 per cent, and I obtained 47 per cent muck bar. Seven tuns of ore sent me from Georgia assayed about 50 per cent (being surface ore) and yielded 45 per cent. Spanish ore from Bilboa, assaying 48½ per cent, yielded 45 per cent, and many ores from New Jersey and adjacent States yielded to within two to five per cent of the assay. Magnetic and hematite ores were worked with equal facility, and they were mixed together in various proportions, fully demonstrating that mixtures of ores could be worked so as to produce any kind or quality of iron desired. The muck bar showed a uniform fracture both in color and texture, and there is no question about this process producing a quality of iron equal, if not superior, to any produced from the same ores by the old process. The degree of heat employed in the reducing furnace is not sufficient to produce any visible effect upon the bricks, and, therefore, they will endure a long period of service. The furnace is surrounded by a casing of tank iron, with a fire brick lining between the iron and the annular space, *b b*.

Ores containing an excess of impurities may be fluxed in the puddling furnace with perfect facility.

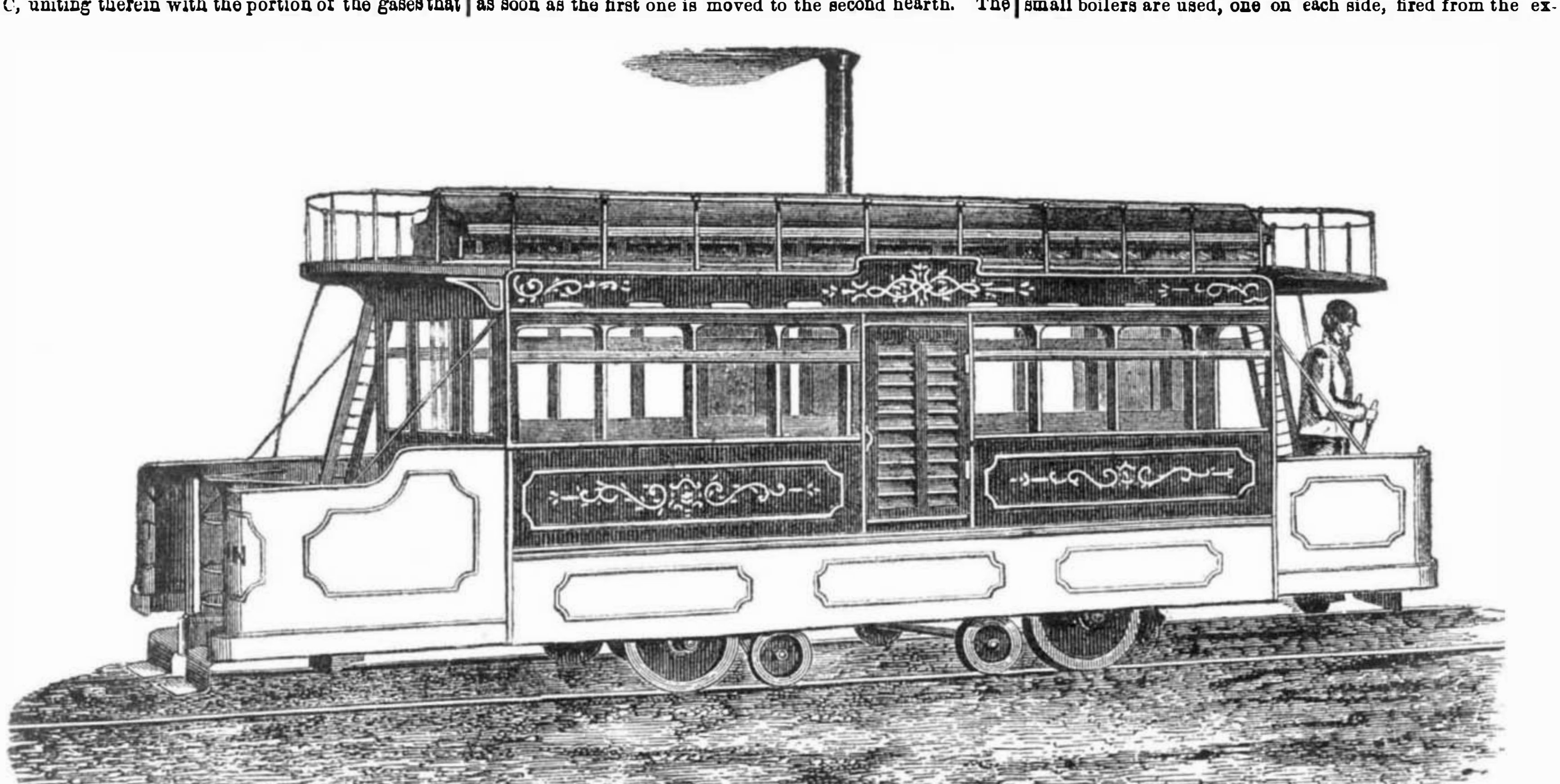
During my investigations, every facility was afforded me by the proprietors of the works; and for a good portion of the time, the operations were practically under my own direction, the inventor following my suggestions so that I might have every point tested in my own way, and to any extent deemed necessary. My conclusions were so favorable that we should have had our works in the South, upon this plan, well under way by this time, but for the unexpected stringency in the financial world, which has, of course, postponed all new enterprises.—*Engineering and Mining Journal.*



WROUGHT IRON DIRECT FROM THE ORE.—THE WILSON IRON FURNACE.

A NEW STEAM OMNIBUS AND STREET CAR.

Our engraving illustrates a new style of steam passenger cars, for street railways, the invention of Mr. Grantham, of London, where the improvement was lately tried. Two small boilers are used, one on each side, fired from the ex-



NEW STEAM OMNIBUS AND STREET CAR.

terior of the car. This novel vehicle has a double set of wheels, one set with flanges, intended for use when the machine runs on the street railway track, the other set being employed when running on common roads. Most railway cars and locomotives are useless when at the end of the track; but not so with this device. It can then steam off, independent of the track, through streets or roads, as far as may be desired. The axles of the flanged wheels are supplied with cranks and rods, and with a worm wheel and lever, under the control of the driver, who may, at any moment, raise up the flanged wheels, so that the vehicle will rest on the plain wheels, for running on common roads. The axles of the plain wheels have a screw steering device connected with them, so that the vehicle may be guided in any direction. The car is provided with seats on the top, and, as shown, has a capacity for some forty or fifty seats. But the end platforms, it appears to us, are too long. Taken as a whole, however, this device presents some good ideas, and is creditable to the inventor.

Correspondence.

Pisciculture in its Sanitary and Commercial Aspects.

To the Editor of the Scientific American:

Your reply, in your 18th of October number, to S. W. G.'s inquiry for information as to the best materials to be employed and mode of employing them in the construction of a dam for a fish pond, was read by me with very great interest, in connection with the general subject of pisciculture and utilization, especially in this form of enterprise, of small sheets of water in proximity to large centers of population.

I believe, most firmly, that a larger and cheaper supply of fish than that at present existing would be readily appreciated by every class, and prove most conducive to the more general promotion of health. Meat is good for food, but a vast quantity of meat, seemingly healthy to the utmost microscopic and scientific investigation, is really more or less the reverse, owing to the kind of food used in forcing the process of fattening, and also the habit, in order to accelerate it, of keeping the animal in a state of compulsory inactivity. We are indebted for the comparative immunity we happily enjoy from the natural, morbid consequences of consuming this, as well as many other kinds of really deleterious articles of food, to the benevolence of the *vis medicatrix naturæ*, or *vis vitæ*, to use the language of medicine. But when a man turns the age of 45 or 50 years and his vital power begins to weaken in its resistance to what is injurious, then does he begin (and continue, by an inevitable law of physical life, in accelerated ratio as his years increase) to suffer in one way or many ways, in one organ or many organs, as may be determined by congenital idiosyncrasy or acquired habit. The evil becomes deeper, more irradicable, and therefore more dangerous, by the slowness with which it grows. The remoteness of the effect from the cause throws suspicion into fatal sleep until awakened by the magnitude and seriousness of disease; the physician is called on and in vain invoked to exorcise by a drug the seven spirits which, insinuating themselves into the very citadel of life, refuse to leave until accompanied by that life which they expressly came to take away. But I must not allow myself to be carried away into inordinate length by my subject. I shall not, therefore, anticipate the answer that possibly might be urged—for assumption grows in extravagance with the extent of ignorance—derived from the easily accessible quantity of salt fish. Neither shall I touch on the admitted, because admitted, healthfulness of change of food. My object is simply to avail myself of the most potent of all arguments why our attention ought to be more generally directed to the utilization of our lakes for the propagation of fish—the commercial argument. I have been very much astonished by the reports in American papers (I am a Canadian, residing in Canada) of the wonderful financial results of a few private enterprises of this kind, notably on, I think, Long Island. One gentleman digs a pond, and builds a hatching house, at a total expenditure of $1,500, and after some two years begins to reap a clear profit of $3,000 a year, with a stock of fish on hand (I refer here exclusively to trout) valued at more than treble this sum. The reports of others are simply confirmatory of this. It is a crop that sows itself, that needs no plowing, harrowing, drilling or cultivating of the soil. The crop itself does all this. It is therefore nearly all profit. You are already beginning, with that intelligence and foresight now indigenous with you, practically to appreciate the enormous pecuniary as well as sanitary value of this industry: why should it more especially urge itself on me? Because I live within a few miles of a country—the northern bank of the river Ottawa—abounding in lakes, large and small, some teeming with the finest trout, but nobody cares to catch them; open to all, or rights may be purchased for a comparative trifle by any person, waiting for some enterprising and intelligent person to come and occupy and enrich himself as well as others. The land is, for the most part, rocky, mountainous, wild, but healthy in the extreme and picturesque. In eager exploration for minerals, the mind cannot, it would seem, appreciate the value of the living minerals which in rivers, by their glitter, attract the eye and fearlessly invite attention to their numbers and their beauty.

You have an equal share with ourselves already in our salt water fisheries. It must be because you are ignorant of the extent, perhaps the existence, of our fresh water fish that I suppose you are not already catching and exporting them. You have invaded our forests and are rapidly cutting them down and carrying them off, and profiting by the operation. I think I may safely promise your appearance with rod and bait a very warm welcome, and a very profitable result. But I must desist. I do not know if you will consider this a suitable subject for your paper; if so, I shall gladly hail its appearance in the interest of my aim, the extension of a valuable industry and the promotion of our physical well being.

These remarks embody the views of our very intelligent Deputy Minister of Fisheries, enunciated some time ago in a conversation with me. The subject is, with him, one of scientific as well as practical interest. CANADIAN.

Magnetism and the Nodular Form of Iron.

To the Editor of the Scientific American:

Those much acquainted with magnetism are familiar with the magnetic curves described by iron filings, when shaken about a bar magnet. If we lay on a bar magnet a pane of glass, and shake upon the glass some fine iron filings, and gently strike the glass, the filings will distribute themselves after a certain uniform manner in obedience to a force operating them from the magnet. If our magnet be a square bar, and we turn it one quarter of the way over, and again try the experiment, a similar distribution of the filings will ensue. What must we conclude from this? Obviously that the force of the magnet does not exert itself simply in the plane in which the filings lie upon the glass, but in an infinite series of planes, extending in every direction about it. If the magnetism were sufficiently strong to counteract or annul the force of gravitation, or the filings were free to move among themselves, they would arrange themselves about the poles of the magnet in an elongated globular form. Furthermore: If the atoms of iron of which the bar itself is composed, and which are magnetized, could overcome the force of cohesion, or were alone acted upon by the force of magnetism, they would arrange themselves in accordance with the law governing the magnetic curve. Hence, in all magnets, the atoms of which they are composed are under a strain, which is in proportion to the degree of magnetism by which they are influenced.

I deduce from the foregoing the following corollary: The best shape for a magnet is that in which the circumscribed boundary of any part of its surface will exactly coincide with the exterior magnetic curve, considering the curve to extend in every direction from the center of either pole. I also find in the above theory an explanation of the fact that iron which has been deposited from solution (as in the clay basins of Missouri) has assumed a globular shape, and is almost universally found in nodules. The atoms of iron have been deposited in obedience to the magnetic force; and being in solution and free to move, the atoms, in aggregating, have arranged themselves on the magnetic curves. While this was going forward, the nodules were probably in pairs. Subsequently, violent action has rended them asunder, causes have operated to demagnetize them, and oxidation and attrition have modified their primary form.

Louisville, Ill. C. H. MURRAY.

Coal Tar Products.

To the Editor of the Scientific American:

Allow me to add, to your list of the products of coal tar, rhigoline, which is now used in the artificial manufacture of ice. There is also a beautiful black varnish for iron, which dries quickly and produces a gloss almost equal to Japan; this is made by dissolving the pitchy residuum of coal tar in the heavy oil that distils from the same, being the only liquid which will dissolve it. This varnish is known to the trade as paraffin varnish, but this is a misnomer, as that article, although a product of coal tar, does not enter into its composition.

A few years ago I was connected with the coal tar pitch interest in such a manner as to lead to a series of experiments. In the years 1861 and 1862, I was engaged in the manufacture of a cheap quality of sealing wax for capping fruit cans. Cincinnati at that time enjoyed a monopoly in that trade, supplying dealers at all points. In the years named the price of rosin advanced (owing to the war) from $1.80 to $40.00 per barrel, and was difficult to obtain at that price: which caused the manufacturers here to look for a substitute, which was found in coal tar pitch. So well did it answer the purpose that at least fifty tuns were cast into suitable shape and sold for sealing wax, the only objection to it being the odor.

The beautiful gloss of this wax, together with its strength and the facility with which it could be cast into molds, led me to make some experiments as to its value as a material for decoration, picture frames, statuary, etc. This resulted in my securing a patent on the 5th of August, 1865, covering its use for the manufacture of a variety of useful articles. From that time until the present, I have endeavored to develope my invention, being convinced that it will be as useful as vulcanized rubber in time. I send you a blacking box, cast of the material, which please accept as a curiosity, being another link in the long chain of useful products of the unsightly and formerly despised article, coal tar.

Cincinnati, O. J. T. PEET.

THE CURABILITY OF CONSUMPTION.—This is the attractive title of a very excellent article in the *Deutsches Archiv fur Klinische Medicin*, June, 1873, by Dr. Massini. He shows, first, that true tubercular consumption is curable, as post mortems of persons dying with other diseases prove. That it is communicable he also attempts to prove, and hence he disapproves of consumptives marrying. The means of prevention are general and special. His enumeration of them includes nothing novel; but with most of the later German authorities, he is strongly in favor of elevated health resorts—pure mountain air.

ALUMINA, FROM THE CLAY TO THE SAPPHIRE.

READ BEFORE THE POLYTECHNIC CLUB OF THE AMERICAN INSTITUTE, ON DECEMBER 18, 1873, BY DR. L. FEUCHTWANGER.—CONCLUSION.

It has been stated that alumina is the oxide of the metal aluminum. We will now proceed to describe the process of obtaining this peculiar metal, and its qualities and applications.

It is an earthy metal, like cerium, zirconium, glucinum, erbium, and yttrium, and was first prepared by Wöhler in 1828: it is one of the most important metals on account of its usefulness in the arts. Its extraction from its mineral compounds, however, is not very easy, or it would ere this have been the great rival of the precious metals; in fact it possesses some qualities superior to them. Several methods have been proposed for its extraction, all of which depend upon the use of metallic sodium. Common clay, cryolite, and other aluminous minerals may be employed, but the mineral called bauxite, from France, containing about 60 per cent alumina and 40 per cent silica, is now principally employed by the large manufacturers in Europe. The process is as follows: Pulverized bauxite is mixed with powdered soda ash, and fused at considerable heat, during which process the aluminate of soda is formed, and carbonic acid escapes; the fused mass is dissolved in boiling water, and the clear solution evaporated; then the redissolved aluminate is neutralized with hydrochloric acid, whereby a chloride of sodium is obtained, and the alumina is converted into a hydrate of alumina, which, being mixed with charcoal and common salt, is formed into balls and heated in earthen cylinders, dry chlorine gas being passed through the heated mass. Chloride of aluminum and chloride of sodium are thus produced, going over into the retort, the carbon abstracting the oxygen from the alumina. Metallic sodium is now mixed with the two chlorides, and heated in a reverberatory furnace. Metallic aluminum is then found at the bottom of the melted chloride of sodium; this is now separated from the fused mass, and may be remelted, cast in bars, and then rolled out into sheets and wire. The chloride of aluminum is as yet the only vehicle suitable for the extraction of the metal; it may be easily produced by fusing the ammonio alum with charcoal and then passing a stream of chlorine gas through the mass; the chloride goes over in the form of vapor which condenses in a receiver as a solid crystaline mass. The metallic aluminum is now largely manufactured in France and England; the business has been attempted in the United States (from cryolite, by Monier and Parmele), but has not been carried to any extent.

Aluminum possesses the following remarkable properties: It is of white color, resembling silver, and is very sonorous, more so than any other metal; it is the lightest metal, having a specific gravity of 2·5 (while silver has a specific gravity of 10·53); this property renders aluminum very valuable in the arts, such as for making small weights used in chemical analysis, for dentists in the manufacture of plates for artificial teeth, and many ornamental purposes, particularly as it resists so well the action of a moist atmosphere. It even resists boiling nitric acid; this property puts it on equality with gold and platinum; but hydrochloric acid attacks it. It is, however, not blackened by hydrosulphuric acid. It is infusible in cast iron heat by exclusion of air, but burns in the same with brilliancy, and in oxygen gas the combustion is so fierce that the eye can hardly bear to look on it; it is then formed into the earth alumina. It dissolves readily in dilute caustic alkali, such as ammonia, and in dilute sulphuric acid; it is not attacked by cold sulphuric or nitric acid.

Aluminum bronze is an alloy of 1 part aluminum and 9 parts metallic copper. It has the color of gold, but becomes dull after a while, and it is as strong as iron; neither mercury nor lead, both of which generally attack other metals, has any effect on aluminum.

ALUMINA.

It has been remarked that alumina is found in Nature almost pure in the sapphire, corundum, emery, spinelle, topaz, diaspore, in the vast deposits of clay, and in all silicated minerals. In order to obtain the same pure and in a hydrate, the following process is adopted: Commercial alum, free from iron, is precipitated by a concentrated solution of carbonate of soda in excess; the precipitate is redissolved in hydrochloric acid, and again precipitated by ammonia; this precipitate is then calcined, and the result is a pure hydrate of alumina. A more simple method is by igniting the pure ammonio-alum, also by the decomposition of a solution of alum and chloride of barium. The pure alumina is colorless and tasteless, and wholly insoluble in water. If a little alum is dissolved in warm water, and some ammonia is added to the solution; the latter combines with the sulphuric acid, while the alumina unites with water so as to form a semi-transparent gelatinous mass, which is the hydrate of alumina; this has a great affinity for many coloring matters, forming the well known lake pigments.

SULPHATE OF ALUMINA

is also called porous alum, concentrated alum or alum cake. This very important substance, of extensive application in the arts, is produced either from common pipe clay, kaolin, shale, or cryolite. From clay, it is prepared by calcining the same and treating it with half its weight of sulphuric acid, until it becomes a stiff paste, which is then exposed to the air for several weeks; sulphate of alumina is produced, which is washed out with water so as to leave the undissolved silica behind; the clear solution is evaporated to a sirupy consistence and allowed to cool; it then solidifies into a white mass, and this is the cake or concentrated alum, which is extremely soluble. The alum shale is much employed for this pur-