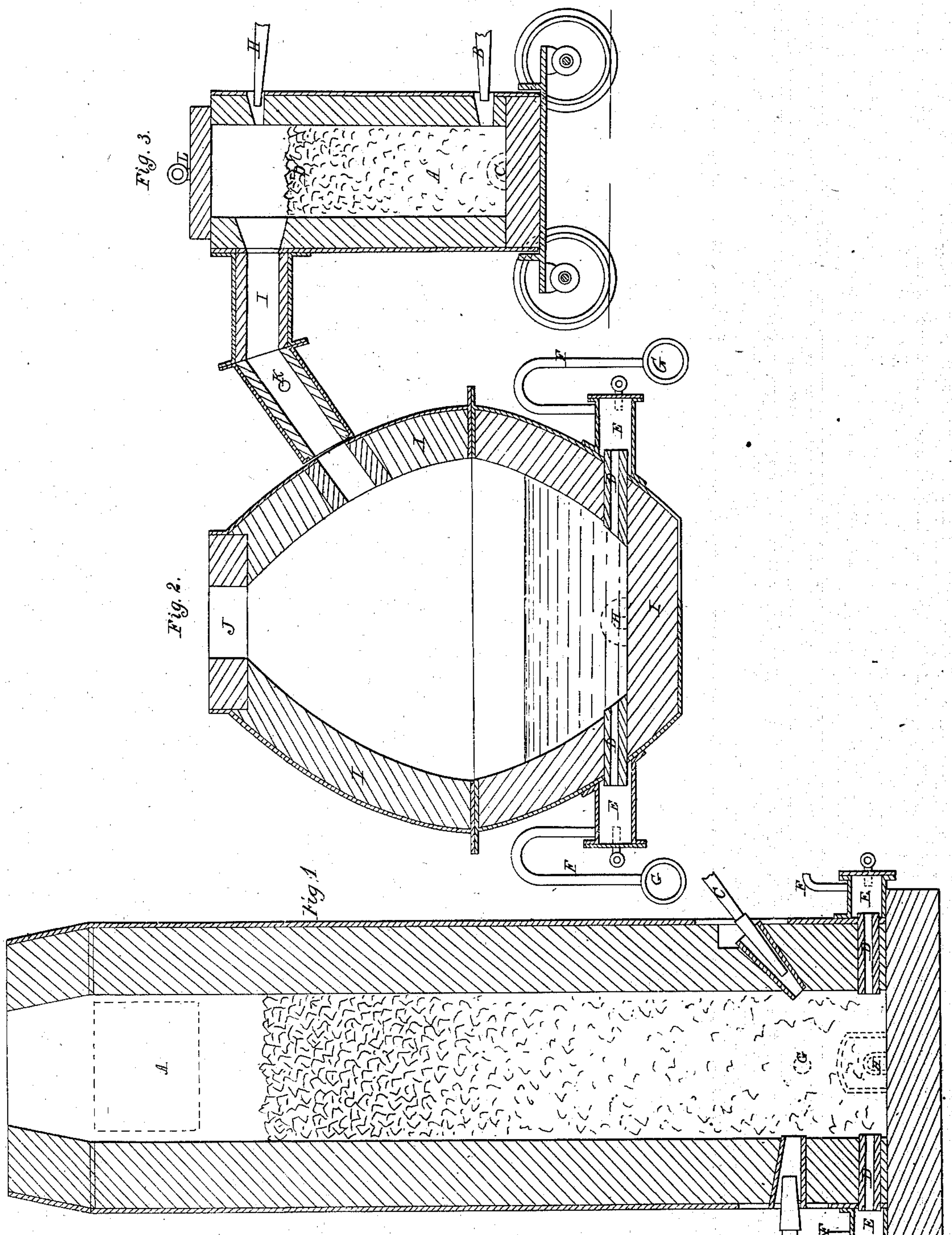
G. PARRY.

MANUFACTURE OF IRON AND STEEL.

No. 47,506. Patented Apr. 25, 1865.



Witnesses:

A E Beach

C L Topliff

Inventor

Geo. Parry,

By Munn & Co

Atty

UNITED STATES PATENT OFFICE.

GEORGE PARRY, OF EBBW-VALE IRON WORKS, ENGLAND.

IMPROVEMENT IN THE MANUFACTURE OF IRON AND STEEL.

Specification forming part of Letters Patent No. 47,506, dated April 25, 1865.

To all whom it may concern:

Be it known that I, GEORGE PARRY, of Ebbw-Vale Iron Works, in the county of Monmouth, furnace-manager, a subject of Her Britannic Majesty, have invented Improvements in the Manufacture of Iron and Steel; and I do hereby declare that the following is a full and exact description of my said invention.

This invention has for its object the production of a superior bar or wrought iron to that obtained in the ordinary manufacture of iron, as well as the production of cast-steel in large masses of a superior quality to that obtained by the direct decarbonization of crude pig-iron, as now carried out. To accomplish these objects, I take wrought-iron which, from having previously undergone the puddling process, has been purified by the expulsion of sulphur and phosphorus; or I take wrought-iron scrap and introduce it, together with coke or other fuel and proper fluxes, into a blast-furnace similar in form to that ordinarily used for melting pig-iron, but so arranged with respect to the tuyeres as to insure the maintenance of a much higher temperature in the furnace than is required for merely melting the iron. By this means I am enabled to effect the rapid and economical carbonization of the wrought-iron under treatment. When thus carbureted, I run out the iron from the converting or blast furnace into any suitable form, and submit it to the puddling process, by which means a further portion of sulphur and phosphorus is removed, and the iron is increased in strength and value. This iron may, if thought desirable, be again carbonized and puddled again for the third time.

In the accompanying drawings, Figure 1 shows in vertical section the furnace which may be employed for converting or carbonizing wrought-iron. A is the opening for charging; B, a tuyere blowing horizontally; C, a smaller tuyere inclined downward at an angle of about thirty to forty-five degrees. D D are tuyeres placed near the bottom of the furnace for blowing air through the metal when required, (two of which only are shown in the drawings.) E E are blast-boxes for supplying the tuyeres D D, and which are connected with the blowing-engines by pipes F F.

In carbonizing the wrought-iron, I propose to make it take up two per cent. or thereabout of carbon from the coke, when it will be ready to undergo the subsequent treatment of puddling, which will convert it into what I term "purified wrought-iron." Sufficient fuel having been supplied to the furnace for the purpose of getting up the heat, I charge the furnace with about seven hundred weight of coke (with sufficient lime to flux the ash of the coke) to every ton of wrought-iron, applying these materials in successive quantities of from one and a quarter hundred weight to one and a half hundred weight of coke to four hundred weight of iron, which will be found a convenient quantity for each charge. The converting-furnace being filled and the blast put on, the furnace should be kept nearly full during the continuance of the operation, or the iron will not have taken up a sufficient dose of carbon, and unless this be done the subsequent treatment of the iron in the puddling-furnace will be useless, the presence of a certain amount of carbon in combination with the metal being necessary to produce the "boil," without which no efficient refining of the iron will take place. With a small furnace two and a half feet square, rounded at the angles, and from ten to fifteen feet high, blown by one horizontal tuyere having a nozzle of two and a half inches diameter, and one inclined tuyere of one inch and a quarter diameter, with a pressure of blast of two pounds and a half to three pounds on the square inch, I have been enabled to carbonize and run out one ton of iron per hour.

In carrying out this part of the process I prefer to blow down into the iron through one or more tuyeres, C, (not using the lower tuyeres, D D.) The nozzles of these tuyeres C may be changed for others of larger or smaller bore in a few seconds, when required, the exact amount of blast required being soon ascertained by a little practice, and the want of a sufficient blast being indicated by the carbonized iron, when run off, not being sufficiently fluid. G is the cinder-hole at the back of the furnace, and H the tap-hole. With converting-furnaces of larger dimensions the number of both horizontal and inclined tuyeres must be increased, so as to diffuse the blasts of air more uniformly over the enlarged area of the furnace. The whole of the tuyeres may be inclined downward with nearly the same effect, if thought desirable, but must be put at a lesser angle of dip. I prefer, however, the mode of blowing, as above described. There is little or no loss of metal in carrrying out this carbonizing process when clean wrought-iron is employed, the small quantity of iron oxidized, and which passes off with the slag, being replaced by carbon. The minute portion of silicon in this carbonized wrought-iron, as compared with that contained in crude pig-iron, does not admit of slag being formed to any extent when air is blown into it while in the fluid state; but the oxide formed would pass out at the top of the furnace as a dense brown smoke and entail a loss, were it not that the column of incandescent fuel above reduces it to the metallic state and intercepts it. I find that a height of furnace from eight to ten feet is sufficient to effect this reduction and prevent the loss of metal by sublimation. When the charge of scrap or puddled iron has been subjected to the blast a sufficient time to bring down, say, a ton of the carbonized metal, I tap the furnace and run the metal into molds, as is usually done with pig-iron intended for puddling, and I otherwise treat it in a similar manner to iron prepared for puddling—that is to say, I now submit the carbonized, wrought, or scrap iron to the operation of puddling in an ordinary puddling-furnace, and by that means cause it to give up or part with the impurities remaining therein after the first puddling process. The metal I remove as puddled balls, which may then be submitted to the ordinary rolls, for the purpose of being reduced to the form of merchant or other bars. This completes (in general) the process of making my "purified wrought-iron," which may be subsequently converted into cast-steel in the manner presently to be described, or applied to other uses. When, however, a still purer quality of iron is required, I repeat the converting or carbonizing process, and then subject the metal to the puddling process, as before.

I would here remark that by taking the thoroughly-puddled iron from the furnace in small balls or pieces the cost of rolling the same into bars and cutting those bars up by shears into pieces suitable for undergoing a second carbonization, or for conversion into hard or soft steel, will be avoided. The pieces of wrought-iron intended for carburation should not be too large—not much exceeding the size of a railway-bar cut up into lengths of four to six inches. Cinder-iron, of which nearly the whole of the railway-bars laid down have been manufactured, becomes, by sufficient carburation in the converting-furnace and subsequent puddling, equal in value to the best brands of mine-iron, and may be used for the like purposes, or be converted into cast-steel. Thus the iron rails now in use, as they successively become worn out, may by this invention be converted into durable cast-steel rails.

In order to convert bar or scrap iron into cast-steel, I introduce into the converting or blast furnace a smaller proportion of coke or fuel than is required for manufacturing the purified wrought-iron. The proportion may be so regulated as to communicate to the wrought-iron the desired degree of carbon known to exist in the various classes of cast-steel, from hard cast-steel to soft cast-steel, and I run this steel out of the furnace into ingots or into any desired forms.

In the manufacture of cast-steel from wrought-iron I use the same kind of converting-furnace as that described for making the more highly-carbureted metal; but I reduce the quantity of coke to about five hundred weight to every ton of wrought-iron used when making a hard steel, and to about four and a half hundred weight when producing a soft steel, the proportions varying somewhat according to the quality of the coke or other fuel used.

In making hard steel I prefer using the tuyeres B and C, Fig. 1, without the tuyeres D D; but I increase the size of the nozzle of the blowing-down tuyere C, making it about one and a half to one and three quarter inch in diameter, so as to discharge more blast into the metal at the bottom of the furnace than is required when preparing the carbureted iron for the puddling process. The proper quantity of air required will be found by a little practice, for if too little be blown down the steel will prove deficient in fluidity.

In making soft cast-steel I prefer using two or more of the tuyeres D D, together with the ordinary tuyere, B, of the blast-furnace, with or without the tuyere C. The tuyeres D D being below the surface of the fluid, converted wrought-iron or molten steel must be supplied with blast of sufficient pressure to force through the head of metal, and I find that three pounds to the square inch is enough for every six inches of depth of metal. The state of the metal in the bottom of the furnace may be partly judged of by passing a small rod of iron into it through the tuyere C, or more exactly by tapping out a small quantity of it. If too hard, the blast should be slackened on the tuyere B, the blast on the other tuyeres being either continued unaltered or somewhat increased. If found too soft, a portion of hard steel or any pure pig or carbureted iron may be run into it through the tuyere C, where also any manganesic or other desirable alloy may be passed in (by moving the blow-pipe back) just previously to tapping the furnace. It is best not to run the steel direct from the furnace into the molds, but first into a funnel, from whence it may be passed out with greater regularity on removing the funnel-stopper, as is usually done when large castings of steel are made from the accumulated pourings of numerous crucibles. The steel may also be mixed or alloyed with any other metals or substances in this funnel, instead of in the furnace. The molds may be placed on a turn-table, which is made to revolve beneath the funnel, thus bringing each mold in succession beneath the orifice of the funnel to be filled, and the funnel made large enough to receive the contents of two or more converting-furnaces, if required. Instead, however, of making soft steel in the converting-furnace, as just described, I prefer to produce it at two operations. Thus I first make a hard steel in the converting-furnace, and then run it out into another furnace or receiver, where I reduce it to the required degree of softness by passing air through the fluid metal from below, as first pointed out in the specification of an English patent granted to Mr. J. G. Martien, dated September 15, 1855, No. 2,082, for the treatment of crude pig-iron; or I blow air down on the surface of the metal, as practiced in the old refineries, and should the steel now be found too soft for the purpose required, I harden it by the addition thereto of a proportion of the hard steel in a fluid state from the converting-furnace.

Fig. 2 represents in sectional elevation the furnace or receiver into which I run the hard steel from the converting-furnace. I would here remark that it may be convenient to make this furnace of sufficient capacity to hold the runnings of two or more converting-furnaces, as by that means large masses of cast-steel may be readily produced. E E are two blast-boxes, of which there are several, placed round the furnace. They are made either cylindrical, to hold but one tuyere each, or are widened out around the furnace, so as to hold a greater number. G G is the main blast-pipe, which passes round the furnace and feeds the blast-boxes by the pipes F F. D D are two of the tuyeres for blowing air through the molten metal, and H the tap-hole for discharging it when reduced to the required degree of softness. This furnace or receiver may be made of two truncated cones of sheet-iron joined at the base, (or better of a curved or parabolic form, as shown in the figure.) and lined with fire-resisting material, which is shown at I I I. The charge of hard steel or carbureted wrought-iron is run in a molten state into the furnace through the opening J at the top after the blast has been turned on.

The furnace may conveniently be heated by means of a gas blow-pipe, shown in vertical section at Fig. 3. A is the fuel-chamber of this blow-pipe, charged up to the line D with breeze or small cokes, cinders, or refuse from the fires, together with a portion of lime to flux the clinker and ash, and which runs out at the cinder-hole C. B is a blast-pipe for generating the gas, and H another for effecting the combustion of the gases while passing through the pipe I to the furnace, Fig. 2, or the blast of air for consuming the gases may be introduced at K directly into the pipe I. This gas-furnace is lined with fire-brick and closed with a brick cover, L, or it may be surmounted by a charging-hopper. The pipe I is also lined with loam or other bad conductor of heat. This gas blow-pipe is mounted on wheels for the convenience of removing it from the furnace, Fig. 2, when desired. After a few minutes' blowing into the receiver (the exact time requisite being very accurately ascertained by the workman after a little experience) the steel will have become sufficiently softened, and may be tapped and run out into a funnel and dealt with as before described.

Previously to tapping the furnace, alloys may be run in at the top J, or, what is better, the alloying material may be poured into the funnel as the steel is running. It may also be hardened when made too soft by the addition of hard steel, or of any pure pig or carbureted iron (which may also contain the alloy) in the same manner.

In the manufacture of cast-steel direct from crude pig-iron, as lately introduced, by removing a portion of the carbon, sulphur and phosphorus remain behind, and it is difficult to get crude pig-iron free from these injurious elements. In this process for manufacturing cast-steel by adding carbon to wrought-iron, (which had previously been puddled,) nearly all the pig-iron produced in this country becomes available for the manufacture of cast-steel in the converting-furnace, the greater proportion of the sulphur and phosphorus originally contained in the iron having previously been eliminated in the puddling process.

From some years' experience in the analysis of irons I have always found that the effect of puddling is to reduce the quantity of sulphur to about one-third, and of phosphorus from one-forth to one-fifth of that originally contained in the pig-iron. It will thus be seen that when such purified iron has been sufficiently carbureted in my converting-furnace and again puddled, the impurities above named become almost entirely removed, and the iron is fitted for conversion into best cast-steel by this invention.

I have found it desirable, when using sulphury coke in the converting-furnace, to add as much lime as the ash will bear as a flux, but not such an excess as to thicken the cinder and clog up the furnace. The coke should also, when in a dry state, be immersed in brine or a solution of carbonate of soda for a few days previous to use. The brine or carbonate of soda, when thus intimately diffused through the whole substance of the coke, will effectually seize the sulphur and carry it off in the slag, and thus prevent the contamination of the metal. Carbonate of soda or any other cheap alkali (in a dry state) may also be introduced at the top of the furnace with the charges; but the use of alkalies for seizing the sulphur of the coke forms no part of my invention.

When the kind of wrought-iron called "puddled steel" is used in the converting-furnace for conversion into cast-steel, the proportion of fuel expended will be less than that given above. The same remark also applies when hot-blasts are employed. In the latter case the tuyeres, which are placed above the surface of the metal, may be of the kind well known as "water-tuyeres;" but with cold-blasts, brick or refractory fire-stone tuyeres are best. The tuyeres placed below the surface of the metal are conveniently made of very thin sheet-iron, (black plate,) slightly tapering, having good fire sand or clay (silicious underclays of the coal measures) rammed around them, or as small a proportion as possible of the fat or aluminous clays mixed with powdered white sandstone, as well as for the lining of the furnaces.

Having now set forth the nature of my invention of improvements in the manufacture of iron and steel, and explained the kind of apparatus I employ in carrying the same into effect, I wish it to be understood that I do not claim such apparatus as any part of my invention; but

What do I claim is—

The processes above described, whereby I am enabled to produce purified wrought-iron and hard or soft cast-steel in large masses in an economical manner.

In witness whereof I, the said GEORGE PARRY, have hereunto set my hand and seal this 20th day of June, 1864.

GEORGE PARRY. [S. L.]

Witnesses:

JAMES SMITH,

HENRY V. TAYLOR.

Clerks to Messrs. Seeretan, Woodhouse & Colborne, Solicitors, Newport. Mons.