2 Sheets—Sheet 1.

L. D. CHAPIN.

Manufacture of Iron.

No. 223,481. **Patented Jan. 13, 1880.**

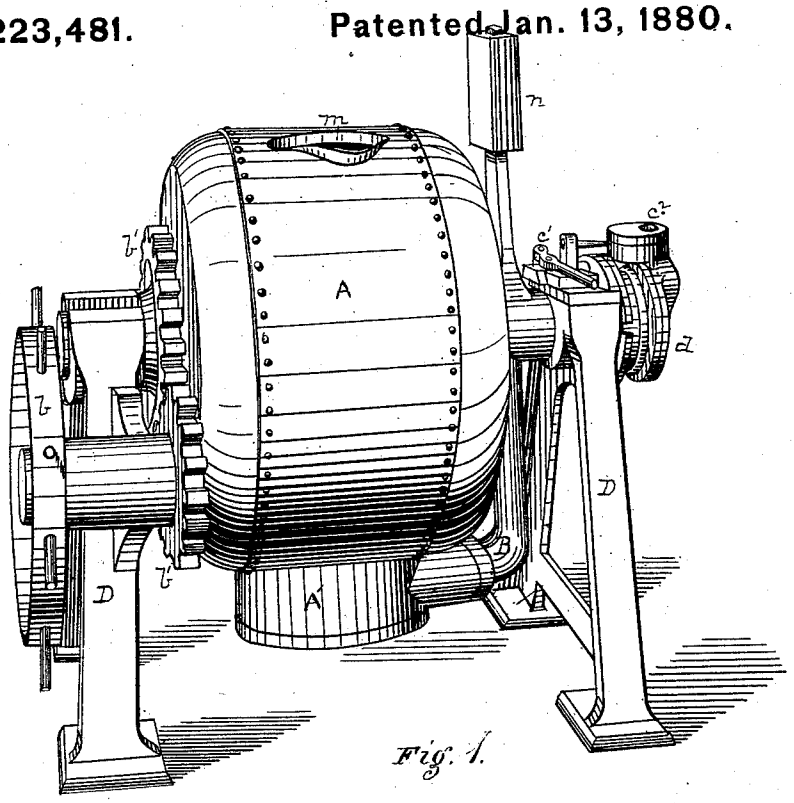


Fig. 1.

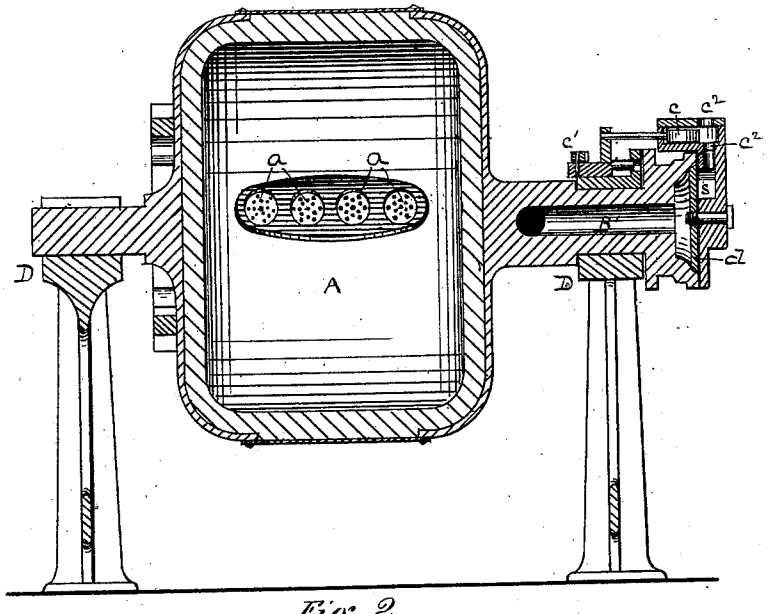


Fig. 2.

Witnesses
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2 Sheets—Sheet 2.

L. D. CHAPIN.

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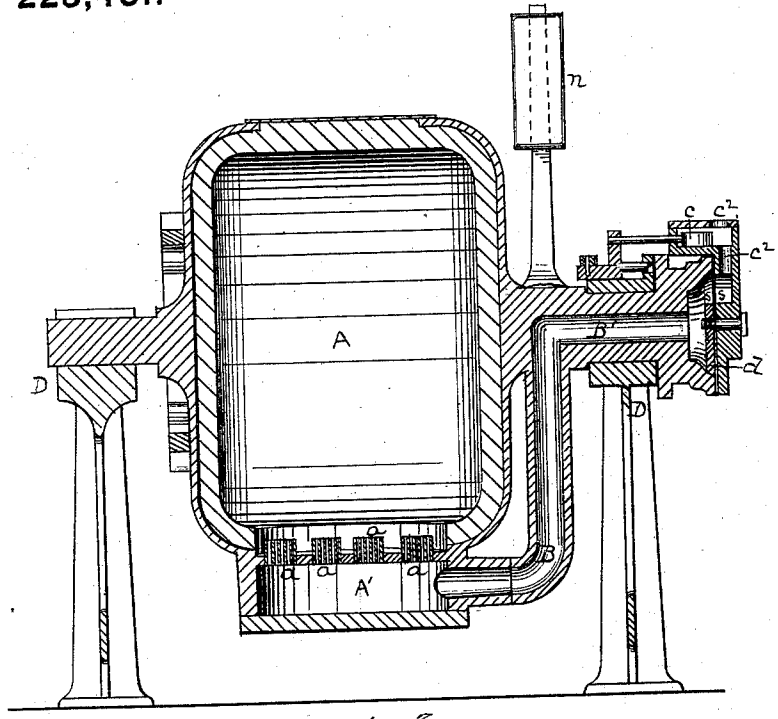


Fig. 3.

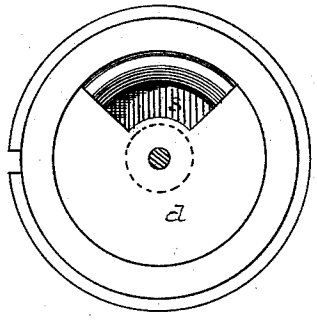


Fig. 4.

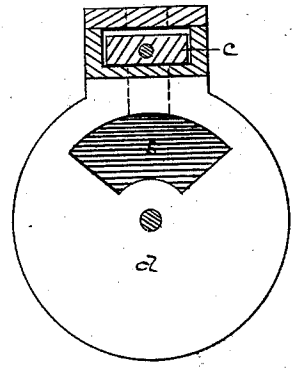


Fig. 5.

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UNITED STATES PATENT OFFICE.

LUCIUS D. CHAPIN, OF CHICAGO, ILLINOIS.

MANUFACTURE OF IRON.

SPECIFICATION forming part of Letters Patent No. 223,481, dated January 13, 1880.

Application filed August 1, 1878.

To all whom it may concern:

Be it known that I, LUCIUS D. CHAPIN, of Chicago, county of Cook, State of Illinois, have invented or discovered a new and useful Improvement in the Manufacture of Iron; and I do hereby declare the following to be a full, clear, concise, and exact description thereof, reference being had to the accompanying drawings, making a part of this specification, in which—like letters indicating like parts—

Figure 1, Sheet 1, is a view, in perspective, of one construction of apparatus suitable for use in working my invention. Fig. 2 shows a longitudinal vertical section of the same in one position or adjustment. Fig. 3, Sheet 2, is a like view of the same, but in another position or adjustment; and Figs. 4 and 5 are views, to a somewhat enlarged scale, of the valve devices employed to regulate the air-blast.

My improvement relates to the manufacture of common wrought-iron (but of superior quality) direct from the pig-iron without boiling or puddling, or with the use of so little boiling or puddling agency that the same is an inconsiderable element; and the nature of it consists, in general terms, in the combination of the air-blast-purifying process in an oscillatory or rotary converter and the reverberatory-furnace balling process in the making of wrought-iron direct from the blast-furnace or remelted pig, the said two processes being used consecutively in conjunction and in separate vessels, substantially as hereinafter described and claimed.

In carrying out my invention I take pig-iron of any desired quality, either as it comes from the blast-furnace or as remelted; but, for facility of description, I will first refer to the use of common pig-iron, of ordinary or average quality, as it comes from the blast-furnace and without remelting. In treating such iron I make use of a converter, A, of any suitable form or construction, preferably of a cylindrical or barrel shape, made with closed ends, arranged to revolve or oscillate on an axis horizontal, or nearly so, substantially in the manner common in the Danks furnace; but I provide for the supply of air in jets under pressure through tuyeres *a*, properly arranged in a tuyere-box, A, on what, for practical purposes, may be termed the "bottom" of the converter.

The length of the converter, as well as its diameter, may be varied at pleasure; but the tuyeres should extend along the so-called "bottom," in order that the air-blast may be caused to operate as thoroughly as possible through the entire, or nearly the entire, mass of molten metal.

Preferably I make the converter large enough to contain any desired amount of iron; but I generally use less than one-half its capacity.

The air under pressure may be introduced from any suitable pump or reservoir to the tuyere-box and tuyeres through a pipe, B, and hollow journal B′, and the amount of air supplied may be regulated by varying the adjustment of a slide or other suitable valve, *c*, operated by a hand-lever, *c′*, or in other equivalent manner, so as to open or close, wholly or in part, the air-ports c^2, which lead from the reservoir or pump; or the same result may be secured automatically by disk-valves *d d*, the ports *s s* of which, when the tuyeres are down, as in Fig. 3, register so as to be fully open, but slide past each other, and to that extent automatically cut off the supply, as the converter is oscillated in either direction; but for the purpose indicated other known form or construction of automatic valve may be substituted for that described as the mechanical equivalent thereof.

The molten metal being run into the converter, the air-blast is let or turned on, and an oscillatory or rotary motion is imparted to the converter during the operation of the blast, so that the molten metal shall be more completely acted on by the air, and also so that when the temperature becomes too great the quantity of air admitted may be lessened; and, if desired, the tuyeres may be brought above the level of the molten metal. In this way—that is, by bringing the air-blast to act throughout the entire mass of the iron, and by automatically or otherwise varying the air-supply as the temperature varies—I provide for the use of the air-blast in removing the various impurities of the iron, since it is a well-known fact that different impurities are more quickly eliminated at different temperatures; and the object of the blast is chiefly to remove or eliminate the impurities ordinarily present in the cast-iron, particularly phosphorus, carbon, sulphur, and silica.

Any suitable means may be employed to give to the converter the proper or desired mo-

tions in its bearings D, such as a hand-wheel, *b*, and gearing *b'*, or other desired arrangement of hand or steam or other power appliances. The converter has also the usual charging and drawing-off hole, *m*, and a weight, *n*, is added to counterbalance the extra weight resulting from the presence of the tuyere-box, tuyeres, &c. When necessary the hole *m* may be closed, other suitable vent for the gases being in such case provided.

The rotating or oscillating of the converter is kept up, with perhaps occasional interruptions, according to the temperature and the amount of iron under treatment, but for the most part faster or slower, while the blast is blowing, and both are continued during the proper period for the purpose named, but in ordinary cases for, say, ten minutes, more or less. The iron is then nearly at "nature," as it is called, and I approach more or less nearly that point, as may be desired; but preferably I stop or arrest the operation a little short of that point, such point being determined, as well as other points or stages in the elimination of impurities, by the color of the flame or by other means known in the art.

In order, now, to complete the conversion of this material into wrought-iron, I finish bringing it to nature, and for this purpose resort to any one of several methods of balling, each of which involves the use of mechanical motion imparted to the molten mass until the mushy particles, lumps, or granulated masses shall have become agglutinated, and thus formed into puddlers' balls or "puddle-balls," so called. In one of these ways I run the contents of the converter off into a puddling or other reverberatory furnace, stir it while subject to the ordinary furnace-heat with the ordinary mechanical appliances, and ball it up in the usual way of balling under like conditions, which will take a period of from ten to twenty minutes, more or less. Ordinarily in this part of the process there will be no boiling or puddling operation performed, as that term is known in the art; but at the same time it may be practicable to arrest the treating of the molten mass in the converter at a lower stage, and to a very limited extent puddle or boil the same after it has been run into the puddling-furnace; and I provide for this modification of my process simply in order that I may be protected in the use of my invention, even though a small or limited amount of puddling or boiling may be performed in connection therewith. As soon as the ball is formed it is transferred to the squeezers, cam, hammers, or rolls, and worked into muck-bar in the usual way.

Another mechanical means of giving motion to the metal after coming from the converter is by the use of a circular tilted basin of a suitable size, fitted up with the proper appliances for effecting its rotation on a nearly perpendicular axis, fast or slow, as may be found desirable. The metal is run from the converter into such basin, and suitable means are to be added by which the metal in the basin shall be kept in a proper state, one suitable means being the introduction of a supply of blast-furnace or other gas, heated air, or other like agency through a pipe in the center of the basin, terminating in a series of goose-necks downwardly bent, so as to deflect the hot air or gas onto the surface of the iron; also, for the same purpose, a flame may be made to pass over the basin after the manner of an ordinary puddling-furnace. After the charge has been introduced into the basin it is to be covered, if not already protected, by a roof or cover, so as to prevent the undue loss of heat by radiation; and the bottom and sides of the basin may be protected as against radiation by a shell or larger basin suitable for the purpose. Then by rotating the basin fast or slow, as may be desired, the granulated or spongy bunches or balls of metal formed as the material comes to nature will be gathered into a puddle-ball, which is to be removed and operated on as before; but so much of my invention as relates to the construction of such a basin and to the use of it as a puddler will form the subject-matter of a separate application.

As a third equivalent, the Danks or other similarly-operating furnace having a reverberatory action may be used in this last stage of the operation—that is to say, the material may be run from the converter, after being purified, directly into the Danks or other like furnace, brought to nature, and balled in the manner well known in the art; but while mentioning these different ways of applying mechanical power in balling, I do not limit myself thereto, but include other equivalent mechanical means suitable for the purpose involving the reverberatory action of heat on the metal and motion imparted to it.

In the use of different qualities of pig-iron in this operation the skill of the iron-worker must be employed in varying somewhat the amount and force of the air-blast in effecting the purification of the iron. The rules governing such variation are so well known in the art that they need not be stated at length.

I do not limit myself to any particular form or construction of the converter, except that it shall be vibrating or oscillating on an axis horizontal, or nearly so, during the whole or greater part of the time when the blast is in operation, so that the entire mass of iron shall be thoroughly and effectually purified by such agency.

The particular advantages I claim as the result of this process are, first, the dispensing with the ordinary puddling or boiling operation, which is well known to be long, tedious, costly, and slow; second, the production of a superior quality of wrought-iron with a greatly-reduced amount of labor, and consequently greatly-reduced expense.

For most purposes it is believed that the oscillating motion is preferable, and the regular oscillatory motion may be effected by the ordinary crank-motion, or by any movement which will effect a stroke in one direction and

allow a return-stroke by the same or other mechanical means.

While I have described the running of the molten metal direct from the blast-furnace into the converter, it is obvious that the pig-iron may be remelted in a cupola or other suitable furnace and run from thence to the converter; and it will be within the scope of my invention to melt a portion or the whole of the pig-iron in the converter itself.

It will also be within the scope of my invention, in so far as relates to the use of the converter, to run the purified metal therefrom direct into a sand bed. In such case, if the treatment with air has been carried nearly to the extent of bringing the iron to nature, the product of the sand bed will be porous pig having some of the features of iron-sponge, and this product can be charged into an ordinary puddling-furnace, remelted, and puddled or boiled, and brought to nature in a comparatively short time, so as to save a great part of the entire work and time and waste of puddling or boiling. If the air-treatment is discontinued sooner, a little longer time will be required in puddling or boiling; but in any case the time and labor of the whole process will be greatly lessened. This purified porous pig may also be charged into a cupola, remelted, and run off into a superior quality of pig-iron, to be subsequently reused for any of the ordinary purposes, particularly such as require a purified or refined pig.

It may be stated as a further advantage that I combine the rapid purifying action of an air-blast under conditions which permit the regulation of the temperature for the purpose of purifying the metal and bringing it more or less nearly to nature with the more certain and accurate operation of balling by motion imparted to the iron under a reverberatory heat. While each of these operations, separately considered, is old in the working of metals, they have not to my knowledge ever been used consecutively in conjunction. Hence it is essential to the complete working of my entire process that the metal be first purified and brought to nature, or nearly so, by the action of the air-blast blowing through the molten mass, while the same is kept more or less constantly in agitation by motion imparted to the converter, and then that it be balled under a reverberatory heat or flame and by the aid of motion imparted to the material, substantially as described.

I am aware that within the meaning of the patent law it is not new to treat molten iron by an air-blast through the iron and a reverberatory heat or flame on the iron, both operating simultaneously on the same charge in the same vessel; but the first part of my improved process differs from this in the fact that, as described, the iron, after being purified and brought nearly to nature in one vessel by the use of an air-blast, must be transferred or run into a separate vessel or working-chamber for the further and subsequent operation of completing the conversion into metallic iron and balling.

I am also aware that it has been proposed to make metallic iron in condition for use without further treatment by the use of the air-blast alone blowing through the molten mass; but the second part of my process differs from this in the fact that I arrest the purifying and converting action of the air-blast a little before the iron comes to nature, or comes into the condition of metallic iron, and run off the mass into a sand bed, so as to produce a porous product somewhat akin to iron-sponge, and which requires further treatment before becoming what is commonly known as "wrought-iron." And these differences thus enumerated I find to be important, useful, and essential in securing the results I have in view.

I claim herein as my invention—

1. The method of making wrought-iron by subjecting the molten metal simultaneously to the oscillatory or rotary action of the converter, in which it is inclosed, and to the action of an air-blast until it is sufficiently purified and approaches nature, occasionally intermitting or varying one action or the other, as described, if so required, and then transferring the same to a separate furnace or balling-chamber and balling it under a reverberatory heat or flame, substantially as set forth.

2. In the process of making wrought-iron, the method of preparing the iron for subsequent reworking by subjecting it to the simultaneous action of an air-blast and the rotary or oscillatory action of the converter, in which it is inclosed, occasionally intermitting or varying one action or the other, if required, and arresting the action of the blast on the iron as it approaches nature, running it off into a sand bed, whereby to make a porous pig capable of being brought to nature with little or no puddling or boiling, substantially as set forth.

In testimony whereof I have hereunto set my hand.

LUCIUS D. CHAPIN.

Witnesses:
O. W. BOND,
GEORGE H. CHRISTY.