No. 625,738. Patented May 30, 1899.

J. R. BILLINGS.

ART OF TREATING MOLTEN IRON.

(Application filed Dec. 2, 1897.)

(No Model.)

Fig. 1.

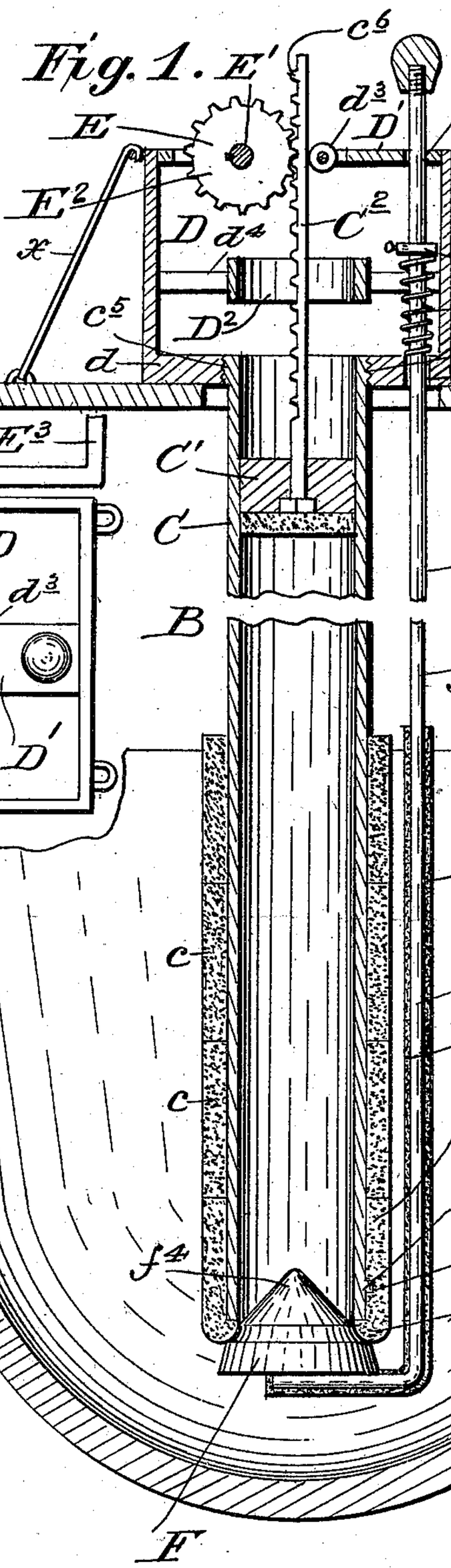


Fig. 2.

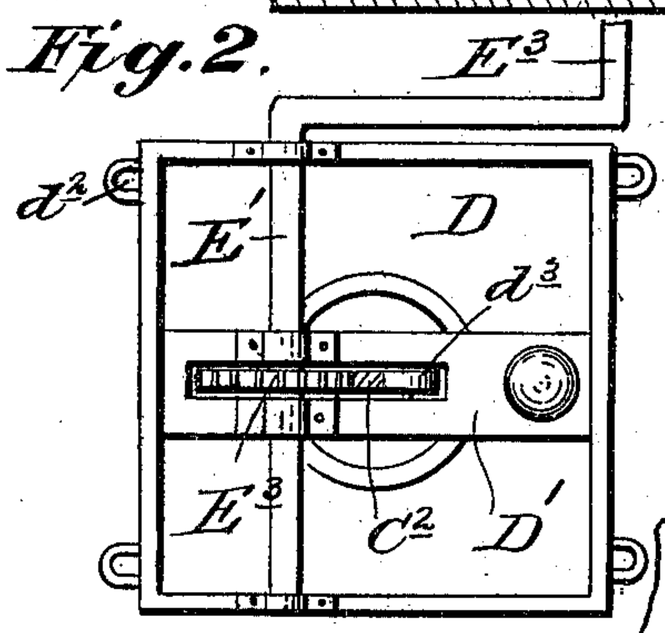


Fig. 3.

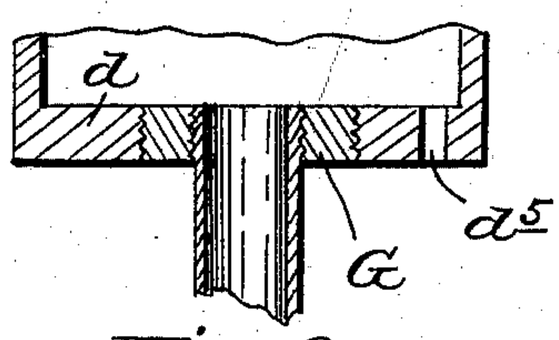
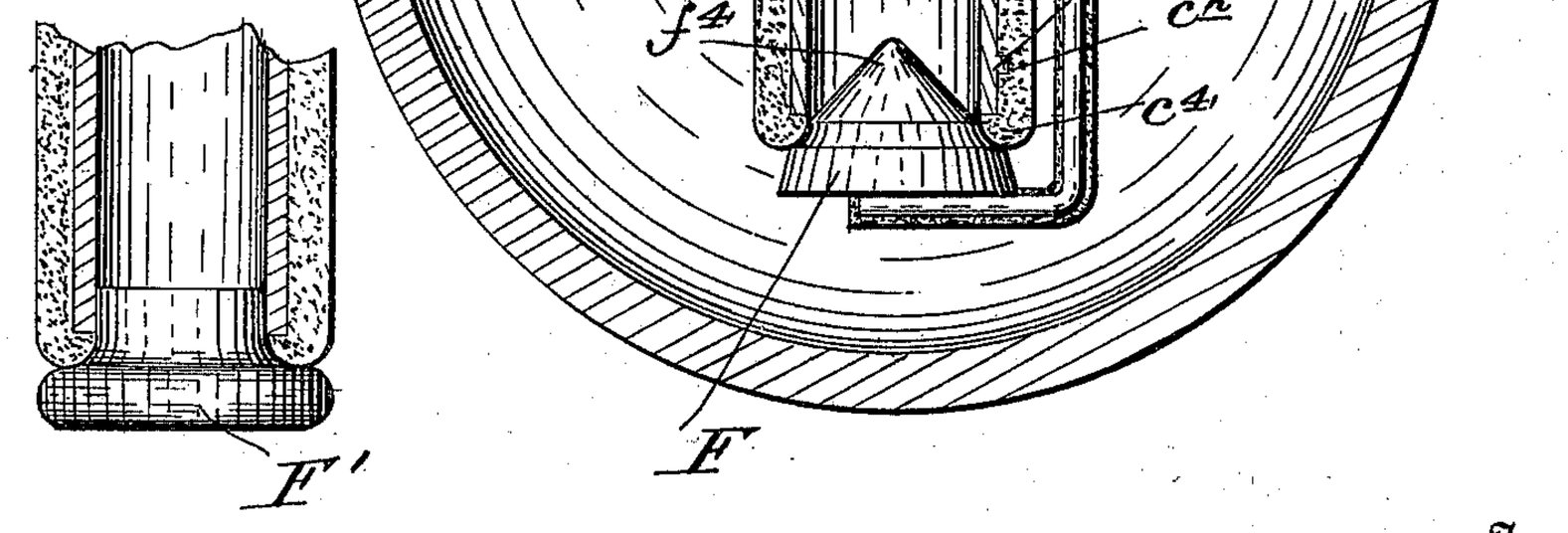


Fig. 4.



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ART OF TREATING MOLTEN IRON.

SPECIFICATION forming part of Letters Patent No. 625,738, dated May 30, 1899.

Application filed December 2, 1897. Serial No. 660,498. (No model.)

To all whom it may concern:

Be it known that I, JAMES R. BILLINGS, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in the Art of Treating Molten Iron; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to improvements in the art of treating molten iron with pulverulent or finely-divided solids, and includes both a novel method of treatment and a preferred form of apparatus whereby the treatment may be carried out.

Among the principal objects of the invention are to provide means for subjecting a body of molten iron to the action of a pulverized or finely-divided agent in such manner that the entire mass or charge will receive uniform treatment, to maintain the operation under such control that it may be regulated to suit the exact conditions or requirements of the particular charge of metal, as well as to correspond to the rate at which the chemical reaction produced by the treatment takes place, and to enable the operation to be interrupted at any moment, so that the treatment may be terminated as soon as the desired result has been obtained. At the same time by reason of the more perfect utilization of the full effects of the agent or agents the use of the invention is attended with more economical results.

Other advantages attendant upon the use of my invention will be apparent from the following description or will readily occur to those skilled in the art.

The invention consists in the matters hereinafter described, and more particularly pointed out in the appended claims.

Various methods of subjecting molten iron to the action of refining or modifying agents in pulverulent or finely-divided form have heretofore been adopted or proposed, some of which have proved to possess a valuable degree of efficiency.

It has been proposed to treat a body of molten iron or steel placed in a converter or analogous receptacle with a blast which is made to serve as a vehicle to carry into the metal pulverulent materials to act upon the same, the injecting-duct being arranged to debouch at or near the bottom of the receptacle. Obviously a blast strong enough to displace and escape through the metal and to carry the pulverized material held in suspension will also carry a large percentage of the refining or modifying agent entirely through the metal and out with the blast, so that it will be wasted. Furthermore, the blast necessarily creates a violent ebullition of the molten metal, which would defeat some of the important advantages attained by the use of my present invention, as will hereinafter appear, while the reaction set up in the presence of the blast would be modified or different from that which would take place were the blast not present.

Another method which has been proposed is to provide a converter or analogous receptacle having at its bottom a vertically-arranged tube or charge-holder, the upper end of which is open to the receptacle. This charge-holder is to be packed full and close with material in a fine state before the metal is placed within the receptacle, and after the metal has been charged therein the material in the tube is to be forced out by the use of a follower acting from below. Obviously if the pulverized material be in a loose state and be of less specific gravity than the metal, (as nearly all refining or modifying agents are,) as soon as the iron enters the converter the difference in specific gravity will cause the pulverized material to rise to the top of the metal practically all together. If, on the other hand, the material be packed within the charge-holder to such an extent that it will not rise when the metal is placed in the receptacle, then it will obviously remain in its packed form as it is forced upwardly from the charger and only that portion of the mass of metal which comes into actual contact with the cartridge or body of refining material will be acted upon by the latter. In other words, the iron will be acted upon by the refining agent only in so far as the metal acts as a

solvent of the compacted body and its diffusion and effect will necessarily be limited and slow.

Still other methods have been proposed or adopted, such as the introduction of carbon or reagents in capsules, which capsules are melted in the liquid metal and thus free their contents, or by placing a quantity of molten metal in the bottom of the ladle, then throwing in a charge of fine carbon or the like, confined in a paper or other easily-combustible case, and pouring the remainder of the charge of metal into the ladle upon the carbon. Obviously by the use of either of these methods last mentioned it is impossible to retain the pulverized material at the bottom of the mass of metal or to allow it to escape gradually and uniformly through the mass, and by none of the hereinbefore-mentioned methods nor by any other prior method known to me is it possible to produce the results attained by my present invention, among other reasons because both the temperature and the constituents of the different charges of metal vary the required treatment to such an extent that when attempted by any of the methods referred to, whereby perfect control throughout the treatment is impossible, the result is, at best, conjectured and uniformity of product a practical impossibility.

The method forming the principal part of the present invention consists in gradually introducing finely-divided or pulverulent material of less specific gravity than the metal and in a loose, free, or unconfined state at or near the bottom of a receptacle containing a charge of molten metal and permitting it to rise and become diffused uniformly throughout the mass of liquid iron. As a preferred means of carrying out this method I have shown a novel apparatus which forms another part of the invention; but it is to be understood that the method may be carried out by the use of different apparatuses.

Referring now to the drawings, Figure 1 is a transverse vertical sectional view taken through a ladle and passing axially through the apparatus constituting a part of the invention. Fig. 2 is a plan view of the apparatus. Fig. 3 is a fragmentary detail view of the bottom of the hopper, showing the manner of attaching a tube of reduced diameter. Fig. 4 is a fragmentary detail of the lower end of the tube, showing a modified form of stopper forming the closure thereof.

Referring to said drawings, A designates the ladle or other receptacle, which may be of any usual and suitable construction, being most advantageously made relatively deep and of small cross-sectional area.

B designates as a whole the introducing apparatus, consisting generally of a tube C, adapted to contain a suitable charge of finely-divided or pulverulent solids, a piston or follower C′, arranged to reciprocate therein, a hopper D, mounted upon the upper end of the tube and forming a frame upon which is conveniently mounted the operating mechanism E, whereby the piston is reciprocated, and a stopper or valve F, closing the lower end of the tube and carried by an operating-rod *f*, which extends upwardly through bearings carried by the hopper to a point accessible by the workman manipulating the apparatus. The tube C is of metal, having a smooth interior and of a length sufficient to extend from a working platform X, mounted some distance above the top of the ladle or receptacle, downwardly within the latter to a point near the bottom of the same, that portion of the tube adapted to extend within the ladle being provided with a covering of refractory material, conveniently made in the form of removable sections, as *c c*. The lowermost section c' is shown as provided with a bayonet-slot c^2, which is engaged with a lug c^3 upon the exterior of the tube, whereby the sections are held in position. In order to prevent access of the molten metal to the lower end of the metal tube when the stopper is opened, the lowermost section of refractory material is so conformed as to extend beneath and protect the extreme end of the tube, as indicated at c^4.

The hopper D is conveniently made in the form of a rectangular box-casting, the bottom *d* of which is tapped centrally, as at d', to receive the externally-screw-threaded upper end c^5 of the tube C and is adapted to rest squarely upon the platform X, so as to hold the tube in vertically-depending position.

The apparatus is conveniently held firmly to the platform against the tendency of the metal to thrust it upwardly by means of a plurality of hooks *x*, secured to the platform and adapted to be hooked into eyes d^2 upon the hopper.

In the upper part of the hopper is journaled transversely a crank-shaft E′, having keyed thereon a pinion E^2 and provided at one end with a crank-handle E^3. The pinion is arranged to intermesh with a rack c^6, formed upon the piston-rod C^2 of the piston C′, said rod being arranged to extend upwardly through a suitable bearing-aperture formed in a cross-frame member D′, which extends across the upper end of the hopper. In order to reduce the friction, that side of said bearing-aperture remote from the pinion is provided with an antifriction-roller d^3.

In the use of the apparatus the piston is withdrawn from the upper end of the tube in order to charged the pulverized material into the latter, and in order to hold the piston-rod vertical and the piston in position to reënter the tube while it is removed from the latter a guide-ring D^2 is arranged within the hopper concentrically with the axis of the tube and at a distance from the upper end of the latter slightly less than the vertical thickness of the piston, so that as the piston is withdrawn its upper end will enter the guide-ring before its lower end is fully withdrawn from

the tube. The guide-ring is conveniently supported in position by means of a plurality of radially-disposed arms d^4, extending from its periphery outwardly and secured to the sides of the hopper.

The stopper or valve-plug F, which closes the lower end of the tube, is carried upon the lower end of an operating-rod f, which is suitably bent to extend from its point of connection with the stopper laterally outward and then vertically upward along the outside of the tube and through suitable bearing-apertures d^5 and d^6, formed in the bottom of the hopper and in the cross-frame member D′, respectively, that portion of the rod which extends below the top of the ladle being protected with a coating of refractory material f'.

At a point within the hopper some distance below the cross-frame piece the operating-rod of the stopper is provided with a collar f^2, and surrounding said rod and interposed between this collar and the bottom of the hopper is arranged a coiled spring f^3, which tends to lift the rod, and thus holds the stopper yieldingly against the seat formed by the end of the tube.

In operation the pulverulent material is forced out of the tube by the downward feed movement of the piston, the stopper being forced away from its seat sufficiently to permit the material to escape by the pressure, and in order to make the distribution of the material more even upon all sides of the tube and to prevent the material from lodging or packing against the inner end of the stopper said inner end is made conical, as indicated at f^4. The upper end of the operating-rod extends a short distance above the hopper and is provided with a knob, so that the stopper may be forced open manually, should it become stuck in the end of the tube or otherwise refuse to work properly.

In carrying out my improved method by means of the hereinbefore-described apparatus the operation is as follows: A charge of molten iron having been placed in the ladle and the tube of the introducing apparatus filled with the proper material in a finely-divided or pulverulent form and its lower end held closed by the stopper, the operator mounts the platform above the ladle and passes the exit end of the tube down through the platform into the metal to a point near the bottom of the receptacle and secures the apparatus in position by means of the hooks x. The operator now forces down the piston or follower by turning the crank-handle gradually and in the proper direction. As soon as the piston begins to move downwardly the valve-plug is forced out of the end of the tube and the material escapes upon all sides of the plug. As fast as it comes into contact with the molten metal it produces a reaction which assists materially in diffusing it and spreading it outwardly away from the end of the tube, and owing to its lesser specific gravity it is at the same time caused to rise gradually toward the surface of the molten mass. The operator is obviously able to regulate the introduction of the treating agent perfectly, operating the apparatus rapidly or slowly, as required and as determined by the appearance of the charge being treated, and inasmuch as the operation may be performed directly under the observation of the operator he can determine precisely when the treatment should be terminated, thus rendering it possible to produce a very uniform product, notwithstanding the various charges treated may be quite different in their characteristics before treatment.

My improved method is obviously available for the treatment of iron with a wide variety of materials; but one of the important uses to which it is particularly well adapted is for the purpose of carburizing iron or its compounds. When carbon is introduced in this manner, not only is the iron carburized thoroughly and very uniformly throughout the entire mass, but it is also found that a considerable amount of the impurities contained in the iron are freed and separated therefrom. This is in part due to the fact that the chemical action and combustion caused by the introduction of the carbon gradually in the manner described tends to maintain the heat and keep the iron from cooling for a longer period than would otherwise be the case.

It is to be noted in this connection that my herein-described method is clearly distinguished from prior existing methods in which the introduction of pulverulent material into iron has been accomplished by the aid of a blast. The use of a blast for this purpose is necessarily accompanied with a more or less violent ebullition of the metal, thereby interfering with the inspection of the charge during treatment, as well as producing a different reaction from that produced by my method.

In Fig. 3 the bottom of the hopper is shown as provided with a reducing-ring G, inserted in the tapped aperture thereof, and a tube of smaller diameter threaded into the ring, by means of which arrangement different sizes of tubes may be used with one hopper, a piston of proper size being of course substituted for that shown.

In Fig. 4 the operating-rod which carries the valve-plug is dispensed with and the lower end of the tube is shown as closed by a stopper F′ of somewhat different form made of any suitable material and which is intended to be forced out by the charge of material when the feeding movement of the piston begins, a new plug being used for each recharging of the tube.

I claim as my invention—

1. The method of treating molten iron with metalloids of less specific gravity than the iron, which consists in gradually and positively pressing a body of the metalloid in a finely-divided condition, downwardly into the molten iron against the upwardly-directed ferrostatic pressure, protecting the main body

of the metalloid against contact with the molten iron, and allowing regulated portions of the metalloid to escape and rise freely through the molten iron, preventing during this operation any unnecessary agitation of the molten iron, such as would result from the introduction of a blast, and positively controlling the rate of feed of the metalloid thoughout the operation to correspond to the rate of reaction produced by the treatment.

2. The method of treating molten iron with carbon, which consists in gradually and positively pressing a body of the carbon in a finely-divided condition, downwardly into the molten iron against the upwardly-directed ferrostatic pressure protecting the main body of carbon against contact with the molten iron, and allowing regulated portions of the carbon to escape and rise freely through the molten iron, preventing during this operation any unnecessary agitation of the molten iron, such as would result from the introduction of a blast, and positively controlling the rate of feed of the carbon throughout the operation to correspond to the rate of reaction produced by the treatment.

3. In an apparatus for treating iron, the combination with a receptacle for molten metal, of a tube or duct extending downward into the receptacle and opening at a point at or near the bottom thereof, a mechanical conveyer for forcing pulverulent material through said tube and a stopper of refractory material held yieldingly within the end of the tube for automatically closing the discharge end thereof, said stopper being provided also with mechanical connections extending to a point accessible by the operator for positively operating it.

In testimony whereof I affix my signature in presence of two witnesses.

JAMES R. BILLINGS.

Witnesses:
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