(No Model.)

W. HAINSWORTH.

METHOD OF MAKING STEEL INGOTS OR OTHER CASTINGS.

No. 558,384. Patented Apr. 14, 1896.

Fig. 1.

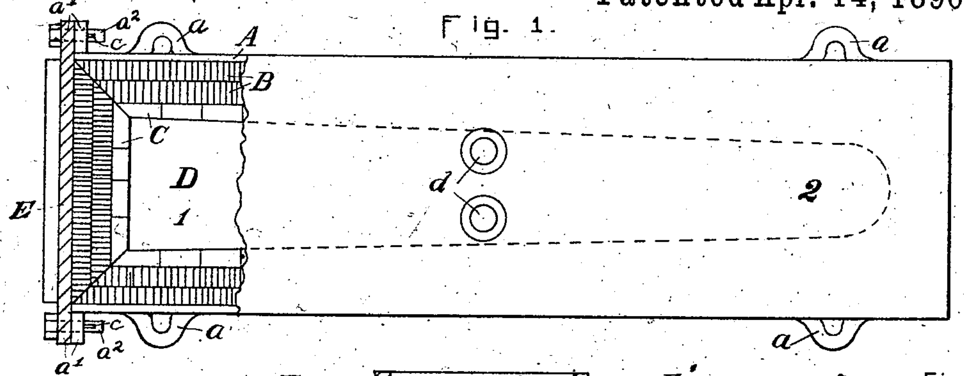


Fig. 8.

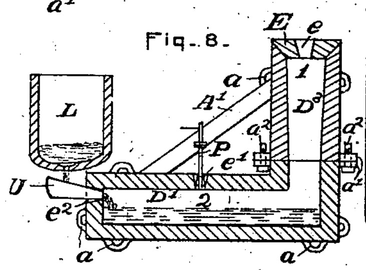


Fig. 2.

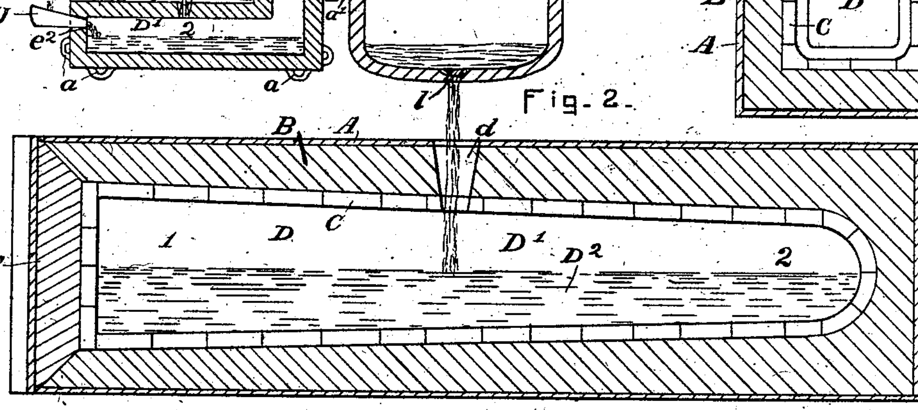


Fig. 3.

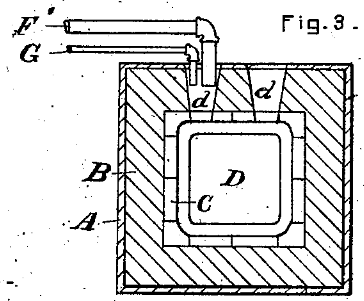


Fig. 4.

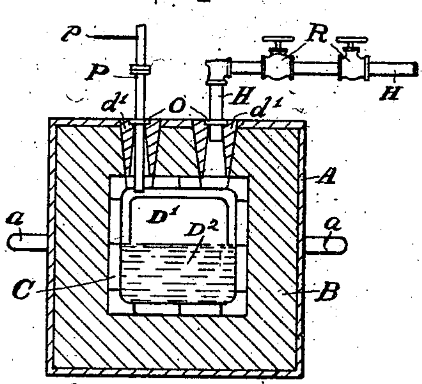


Fig. 5.

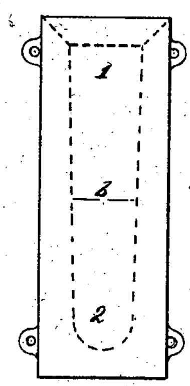


Fig. 6.

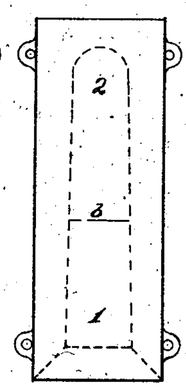
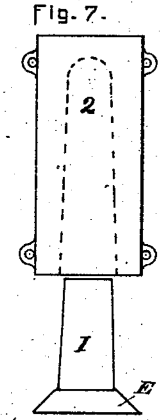


Fig. 7.



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METHOD OF MAKING STEEL INGOTS OR OTHER CASTINGS.

SPECIFICATION forming part of Letters Patent No. 558,384, dated April 14, 1896.

Application filed September 25, 1894. Serial No. 524,073. (No specimens.)

To all whom it may concern:

Be it known that I, WILLIAM HAINSWORTH, a citizen of the United States, residing at West Seattle, in the county of King and State of Washington, have invented certain new and useful Improvements in Processes of Making Steel Ingots or other Castings; 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.

My invention relates to processes of treating steel during the manufacturing of the ingot, whereby the steel will be of a better and more homogeneous quality, free from blow-holes, piping, and other defects caused by occluded gases and segregation, and whereby the ingot may be rolled by its initial heat, thereby avoiding the injurious molecular and physical changes due to the reheating. It also permits an examination and tests of the steel to be made while it is still molten, thus permitting such additions to be made as may be necessary to produce the exact grade or quality desired.

It consists, essentially, in retaining the molten steel for a time as a shallow layer within an entirely inclosed box or chamber which has been previously highly heated, preferably to a point near that of molten steel, thus, by reason of the small hydrostatic head, giving the occluded gases a better chance to escape, and then either with or without previous agitation of the metal, turning the box so as to run the steel into the ingot-mold, which is made a part of the receiver and has been similarly heated.

Figure 1 of the drawings shows a plan view of one form of receiver or mold which may be used for carrying out my process, one end being shown in section. Fig. 2 is a vertical longitudinal section showing a ladle used in charging the same. Fig. 3 is a cross-section showing a manner of heating it. Fig. 4 is a cross-section showing the receiver or mold charged and provided with attachments for examining and testing the same and for permitting the escape of the occluded gases. Figs. 5, 6, and 7 show different positions of the receiver in successive stages of the process. Fig. 8 shows in section another form of apparatus by which this process may be carried out.

The apparatus shown in the drawings and herein described are only certain forms which might be used in carrying out my invention. Numerous other forms might be used equally well, the particular form of apparatus used being immaterial.

The outer casing A of the receiver would be made of iron in any desired manner and would be provided with lugs *a* by which the whole may be readily handled by cranes or other lifting devices. The body B of the walls would be formed of any good non-conducting substance which is also capable of standing the heat. In Fig. 1 I have shown this as made of two layers of fire-brick. In the other figures, where shown in section, it is shown as consisting of a single layer, which may be fire-brick or any other suitable material. The inner lining C is formed of silica-brick or any other substance capable of withstanding the high temperature used and contact with molten steel. The interior cavity D is formed at one end, that indicated by the numeral 1, of the size and shape of the ingot to be made. This cavity or chamber is of a square or approximately square cross-section, being largest at the end 1 and tapering to the opposite end. This taper is to permit of the extraction of the ingot as soon as cooled sufficiently to retain its shape.

If a casting of any particular shape is desired instead of an ingot to be rolled, the end 1 will be made as a mold of that particular casting. I have not, however, shown herein any apparatus except that adapted to making ingots, as that will be the most important use to which my process will be put. The changes needed to adapt it to forming other shapes would be obvious to any mechanic or engineer.

That part of the chamber D which is to serve as the ingot-mold extends only to a point just short of the holes *d*, which are placed near the center of the receiver or mold, but a little nearer the larger end. These holes *d* should be placed so that they divide the chamber into equal volumes. The smaller end 2 of the chamber D serves to hold the steel while it is cooling down to the point of solidifying.

The end E of the receiver or mold is made separately and detachable from the rest in order that the ingot may be extracted. I have shown a means of attachment in Fig. 1, which consists of lugs a', bolts a^2, and key c. Other means would answer equally as well.

This apparatus would be used as follows in carrying out my method: The receiver or mold would be placed horizontally, with the holes d up, and would be heated by means of jets of gas and air introduced through one of the holes from the pipes F and G, (see Fig. 3,) the products of combustion escaping by the other hole d. This heating would be carried to a point where the interior was at a temperature about that of molten steel.

Although my process might in all its essential parts be carried on without heating the chamber quite up to this point, this is preferably done. Any other manner of heating might be used instead of gas.

When the receiver or mold has been heated to a sufficiently high temperature, it is charged with molten steel from a ladle, as shown in Fig. 2, in which the ladle is lettered L.

The quantity of steel for each charge when using the apparatus shown in Figs. 1 to 8, inclusive, should be less than half enough to fill the interior cavity. Other forms of apparatus might be devised in which this might not be necessary. The necessity for this is to prevent the escape of the steel from the holes d when the box is reversed or stood on its end. In this horizontal position, as shown in Figs. 2 and 4, the steel forms a layer or bath of a relatively slight depth. The imprisoned gases being under but a slight hydrostatic head, will escape much more readily than if the receiver were standing on its end.

After the receiver has been charged the holes d are closed by plugs d'. (See Fig. 4.) These plugs are provided with central openings, which are utilized for inserting a pyrometer P for testing the internal temperature and a pipe H for the escape of gases. The pipe may, however, be omitted. A plate of mica may be placed over one of the holes to permit a visual examination of the interior.

The mold or receiver having been highly heated and being made of a considerable bulk of non-conducting material will cause the steel to cool slowly. This permits of an opportunity to test the contents by sample before being sealed up to determine what, if any, additions may be necessary to make the steel of the required quality. These additions when determined will be made to the steel in the mold. The original charge would preferably be of a steel having a smaller percentage of carbon, chrome, nickel, manganese, or other of the ingredients which determine the quality of the steel than is wanted in the ingot, for the reason that it is easy to add these if the percentage is too small, but impossible to extract them if too large. These additions are to be made if required. The steel will be left in this shallow body until the imprisoned or occluded gases have all escaped and, if desired, until the steel is near the temperature of congelation. In the latter case the treatment may then vary slightly. The mold or receiver may be turned on end, as shown in Fig. 6, so as to run the steel into the end 1 of the ingot-mold and allowed to cool therein sufficiently to retain its shape when removed, or the receiver or mold may be turned, as shown in Fig. 5, so as to run the steel into the opposite end 2 from that occupied by the ingot-mold, where it is allowed to stay until the steel begins to congeal, when the mold or receiver is reversed, as in Fig. 6, the steel flowing into the ingot-mold, from which it is removed as soon as it is set sufficiently to retain its shape and taken directly to the rolling-mill and rolled with its initial heat—that is, without any reheating.

Ordinarily the steel will be left in the shallow bath until the gases have escaped and then will be run into the end 2, opposite the ingot-mold, where it will ordinarily be kept until it has begun to congeal, when the mold or receiver will be reversed, running the steel into the ingot-mold, where it is allowed to stay until it will keep its shape when removed, which is done by detaching the bottom and lifting the mold or receiver away from the ingot, as shown in Fig. 1. The final reversal breaks up or destroys the segregation which has been going on by mixing the cooler outer layer with the inner warmer mass, making the whole of a uniform temperature and homogeneous quality. The steel being just on the point of congealing, will quickly set and the segregation of the elements of the steel will not have an opportunity to proceed very far. This result will be obtained by either plan.

The particular object of retaining the steel in the end opposite the ingot-mold while cooling is to preserve the surfaces of the ingot-mold from being acted on by the molten steel. This object would be obtained without the double reversal by the use of a receiver of the form shown in Fig. 8. The same means are shown as those of Fig. 1 for removing the bottom E.

The ingot-mold is attached at one end of the receiving-chamber at right angles thereto. The pouring is through a hole e^2 at the opposite end by means of a spout U, which is inserted in the hole. A hole e' may be placed over the center of the receiving-chamber for the insertion of the pyrometer. The gas-escape pipe and the peep holes may be at this point or at the end hole e^2. The hole e in the bottom of the ingot-mold, which is at the top of the apparatus as it stands in Fig. 8, is for the escape of the products of combustion during the preliminary heating, the gas and air for this work being introduced at e^2. The flames would thus travel the entire length of the chambers, thoroughly and uniformly heating them up. These holes would of course be closed securely after the steel had been introduced. In this form the steel would remain as shown in the figure until ready to be poured into the ingot-mold. The whole apparatus would then be turned by a right-handed rotation into a position exactly the reverse of that shown, or so that the end E is down.

This process, by retaining the steel in a highly-heated receiver of large bulk and composed of non-conducting material, permits corrective additions to be made after charging, and by reason of the slow rate of cooling maintains a more uniform temperature in the mass, which enables it to be cooled to a lower temperature than can be done by any other process before finally running it into the mold. This mold being made as a part of the receiver, the steel is not exposed to the atmosphere by this pouring. The steel is also thoroughly mixed just before setting, thus reducing the piping and segregation to a minimum, and as a consequence producing a more uniform and homogeneous steel with a minimum of waste.

By reason of the ingot being formed in a mold which does not chill it, and thus cause the outer surface to be made too cold and stiff to be immediately rolled without being first placed in a soaking-pit or heating-furnace, ingots formed by my process have a uniform mellow heat throughout their mass and may be taken to the mill for immediate rolling. This saves the expense of operating the reheating-furnaces besides the loss on the ingots, which is usually at least three per cent. of their weight, due to oxidation.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The herein-described method of making steel ingots and other castings which consists in charging the molten metal into a heated receiver and allowing it to remain therein until the occluded gases have escaped and the metal has cooled to near the point of congelation and then, without exposing it to the atmosphere, pouring the metal into its mold, substantially as shown and described.

2. The herein-described method of treating molten steel for ingots and other castings which consists in pouring the metal into a previously heated and closed receiver, and allowing it to cool therein to near the point of congelation, adding to the steel during this time such ingredients as may be needed to produce the desired grade of steel, and then just prior to congelation, thoroughly mixing the steel and then placing it in the mold to set.

3. The herein-described method of making steel ingots and other castings, which consists in pouring the molten steel into a receiver or mold, having an interior capacity at least twice that of the ingot, and whose interior has been previously highly heated, cutting off all communication with the outside air and allowing the receiver to remain on its side for the occluded gases to escape, placing the receiver vertically with that end down which is opposite the one in which the ingot or casting is finally formed, and allowing it to remain in this position until just before the metal sets and then reversing the receiver and permitting the ingot to set therein, substantially as set forth.

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

WILLIAM HAINSWORTH.

Witnesses:
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H. L. REYNOLDS.