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ART OF USING DIRECT METAL FROM BLAST FURNACES

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Fig. 1.

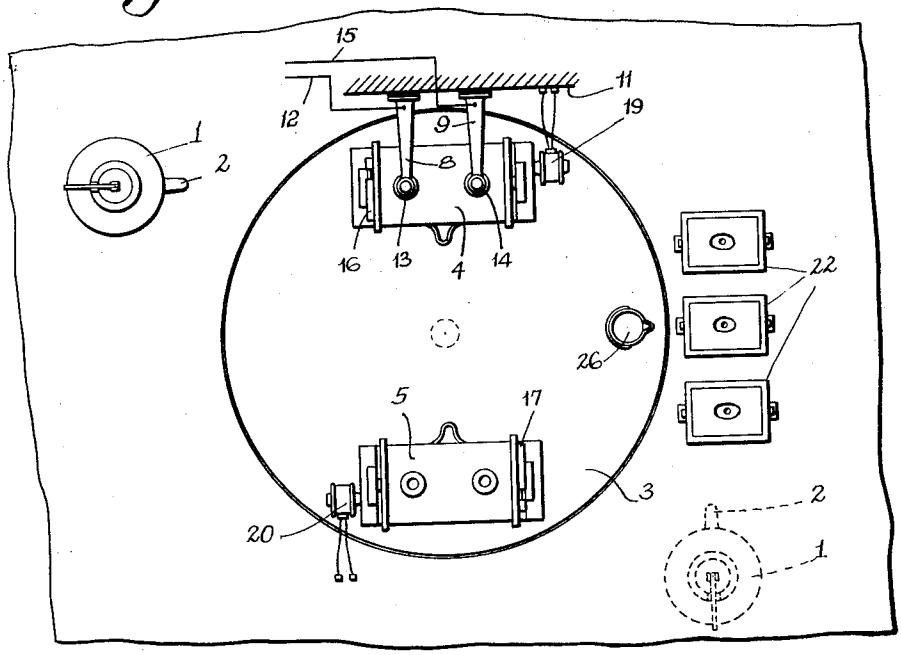
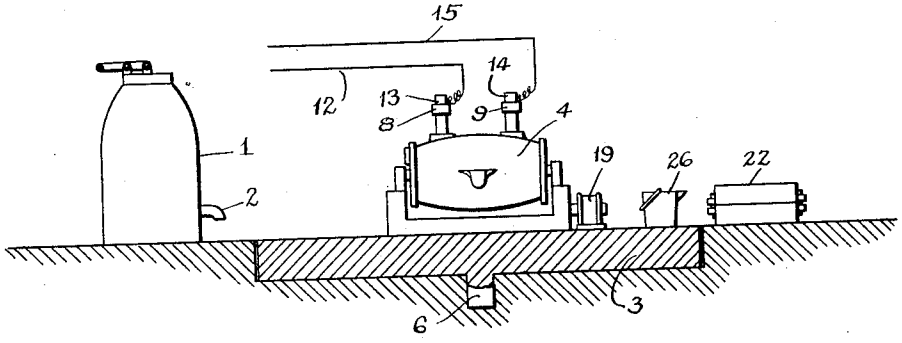


Fig. 2.



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By his Attorneys Cooke, Kerr & Cushman.

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UNITED STATES PATENT OFFICE.

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ART OF USING DIRECT METAL FROM BLAST FURNACES.

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My present invention relates to method of and apparatus for the treatment of molten metal between the blast furnace and casting molds with the interposition of an electric furnace therebetween for receiving molten metal from the blast furnace; conditioning the molten metal as to compositions and temperature in such electric furnace; and the pouring of the molten metal from the electric furnace into the molds as by way of a suitable ladle. It relates further to the use of a plurality of electric furnaces with one set of electrodes therefor and to the method of using such set of electrodes in one furnace for melting and preparing the charge while the charge in another furnace is being prepared for pouring, pouring the charge, and preparing the furnace heat for another charge.

From the very earliest times of the production of molten iron in the side-hill shaft furnace, of the fifteenth century, until the time of the modern blast furnace, "direct metal"—so-called—has been used to pour into molds for the purpose of making iron castings. In other words, instead of running out the molten metal from the blast furnace into the usual pig beds of sand, letting cool, and then remelting in a cupola, this metal has been caught in a large ladle and some of it poured into sand molds for casting without this intermediate remelting.

The reasons for the introduction of this costly intermediate step are the impossibility of regulating the composition of the iron coming from the blast furnace with sufficient nicety to give the desired physical characteristics in the castings with any degree of certainty, the open character of the metal when cast direct, and its consequent weakness when compared with the same iron when remelted and cast, and the impossibility of regulating the temperature of the metal, which may be either too hot or too cold.

The use of metal direct from the blast furnace has therefore been entirely restricted to the odd castings made about the furnace itself, as these are usually bulky and strong enough no matter what kind of iron is used, and the metal is either run into pig beds to be cooled by the air and sand, or into a casting machine to be cooled by the heavy cast iron open molds forming part of this machine, and the water sprayed upon the molten iron in them.

By remelting the pig iron—so-called from the appearance of the pig bed when the cast has been made, the individual pigs being attached to the main runner of metal called the "sow"—a considerable addition is made to the cost of the metal going into the molds for making the castings wanted, and many attempts have been made to overcome the objections to direct metal for this purpose. The most satisfactory one so far has been to run the entire tap of the blast furnace into a large preheated "mixer" or in effect an open hearth furnace, keep the bath covered with fresh fuel and keep up the temperature by the regular method of firing by oil or gas, add any missing ingredients to correct the composition, and tap out from this mixer as would be done from a cupola or air furnace in the usual foundry manner.

Again, another way is to melt pig iron and scrap in a cupola placed conveniently with respect to the blast furnace, and mix molten cupola metal with the molten blast furnace metal in a suitable ladle, so that the composition may be corrected as nearly as this is possible in the time available before pouring must be done. Both of these methods have the disadvantage that the regulation of the composition is difficult and unreliable, and there is no possibility of increasing the temperature in the last-named method. To do it in the first-named method takes considerable time, is costly and exposes the metal to oxidizing influences unless very carefully conducted, though the composition can be regulated with a fair degree of success other than this oxidation effect.

In my improved process, to be described below, I have overcome all objections inherent to other processes, and can regulate

the composition and the temperature of the metal direct from the blast furnace at will. I do this by interposing an electric furnace between the blast furnace and the molds to be poured. This serves the purpose of allowing the temperature of the molten metal of the blast furnace put into it to be raised quickly and to any desired degree. Should the metal be too hot in the first place, no current need be put on and after the regulation of the composition the metal may be tapped out into the usual carrying ladles for pouring off into molds. This raising of temperature in practice will amount to but a few hundred degrees F. as a maximum, and hence requires little time, particularly if the hearth of the electric furnace is made very shallow and the usual number of carbon electrodes for conveying the heating current is increased. The hearth of the furnace is preferably large so that with shallow depth and heavy current application a reasonably large tonnage may be handled and no danger of chilling the last portion of the blast furnace tap may ensue. In any event, the last metal, if so desired, may be cast into the usual pig beds and not used for making castings. Again, if the composition of the metal as coming from the blast furnace is correct and the temperature right, the first portion of the furnace tap need perhaps not go through the electric furnace. However, in practice it will be found highly judicious to have every portion of the blast furnace tap treated as above described, so that no chances are taken.

Referring to the correction of the composition, this is done in the following manner: It is generally known in a rough way what the composition of a furnace tap will be, as this depends upon the burden of the furnace and the operating conditions at the time. Moreover, it is easy to make a rapid chill test of the metal as it is run into the electric furnace under my process, so that with the knowledge gained by this as indicating the silicon present in the metal with reasonable closeness for practical purposes, and the ability to remove difficulties from supersaturation with carbon by adding scrap steel, there need only be added the proper proportion of ferro-silicon, ferromanganese, or other metals and alloys, to get the composition as it will be when ready to tilt the electric furnace for pouring into the foundry ladles correct in every essential. The two essential requirements of molten metal for foundry purposes—those of temperature and composition regulation—have, therefore, been met.

To carry out my process, I tap out the blast furnace in the usual manner, for example, every four hours. The entire tap, after the regular slag removal previously made, goes into a large holding ladle, or a series of them if the tap is large. Each ladle—these customarily holding about 50 tons of molten metal—goes to an electric furnace installation and a portion of the ladle metal is poured over the lip into the electric furnace hearth. In this hearth there has been placed the required quantity of steel scrap, of whatever kind may be found best for the purpose, whether in ordinary hand-size pieces or as turnings, bundles, etc. This quantity in practice is not large, possibly but five per cent of the charge, and in the course of operations will be almost white hot at the time the blast furnace iron overflows it. It will, therefore, speedily be melted down by the combined action of the intensely hot furnace metal and the electric current applied as soon as may be. The result is that the total carbon of the bath is reduced to the point desired, so that no evidence of "kish" and open structure iron may eventuate subsequently in the pouring operation and the metal when set.

Since it is desirable that the large ladles from the blast furnace be emptied of their content in ample time before the next furnace tap, the capacity of the electric furnace installation must be such that all the metal intended to be poured into castings will have been treated for temperature and composition corrections, as well as leave time to pour any balance into the pig bed and patch up the furnace ladle if necessary. Hence, several furnaces are provided, each with their own electrodes, or one set of electrodes to care for two furnaces, or two sets of electrodes to care for three furnaces, each unit placed upon a revolving table allowing treatment, pouring and preparing the hearth for the next treatment to go on at the same time. In this manner the electric current will be used without intermission other than to withdraw the electrodes from a furnace top, make the change of furnace hearth and lower them into the next furnace top again. This makes for speed, continuity of current consumption and economy. A regular succession of ladles full of molten super-heated and composition treated metal can thus be taken from the electric furnace installation to pour off all the molds made or prepared between the intervals of the blast furnace taps. This method is when desired made a continuous one, continuing night and day.

In the drawings which form part of this application is shown an embodiment of the apparatus of my invention, in which

Fig. 1 is a plan view of a blast furnace; a set of molds; and interposed therebetween a turn-table carrying diametrically mounted thereon two electric furnaces, and a set of electrodes into operable position with which either of said electric furnaces are movable

for use therewith at will; an alternate placement of the blast furnace is indicated by dotted lines, and

Fig. 2 is an elevation view in part section of the apparatus of Fig. 1.

In the drawings, the blast furnace 1 serves to melt the charge of raw metal which when properly molten is drawn out at the spout 2. The turn-table 3 carries diametrically placed thereon the two electric furnaces 4 and 5 and is rotatable on its pivot 6 in a manner and by means well known generally, but not shown. The electrode support arms 8 and 9 mounted to the support 11 and extending over the turn-table 3 carry the electrodes 13 and 14 at positions in which they are movable into one of the said furnaces 4 or 5 when it is properly positioned thereunder. Said electrode arms 8 and 9 and/or their electrodes 13 and 14 are movable vertically into or out of the furnace by suitable means not shown but well known in the electric furnace art. The electric power mains connected to the electrodes, as through arms 8 and 9, serve to supply melting or heating current to the furnace in which the electrodes are being used. The doors 16 and 17 serve, respectively, to charge the furnaces 4 and 5 therethrough and for other purposes. The electric motors 19 and 20 serve for tipping the furnaces 4 and 5, respectively, into and out of the pouring and other positions. The leads of said motors 19 and 20 are detachable and connectable through suitable means such as plugs and sockets for connecting the motors to current lead terminals properly placed with respect to the operating positions of said motors. The gang of moulds 22, 22 serve to receive the prepared charge of molten metal from the electric furnaces. The ladle 26 serves to carry the molten metal from the electric furnace and for pouring it into the molds.

In the use and operation of the embodiment of my invention, as shown in the drawings and according to the method of my invention, ore is charged in the blast furnace 1 and the molten metal carried from the spout 2 thereof, as by means of a ladle from which it is poured into the electric furnace 4 which has previously been charged with scrap metal which, when desired, is availed of as means for correcting or determining the composition of the metal to be poured from the electric furnace. When desired, the temperature of the charge in furnace 4 is brought to the required point by means of current applied from the electrodes 13 and 14. The electric furnace charge is brought to the desired composition and temperature, the turn-table is rotated to carry furnace 4 from under electrodes 13 and 14 and to move furnace 5 thereunder, said electrodes being properly raised and lowered to carry them out of furnace 4 and place them in furnace 5 at the proper times, and the melt is poured from furnace 4 to ladle or ladles 26 from which it is poured into the molds 22, 22 or other suitable receiving means.

During the charging of furnace 4 from blast furnace 1 and the pouring thereof, the electric furnace 5 has been prepared for a charge and properly charged with scrap metal as desired so that when it is moved under electrodes 13 and 14 it is ready to receive a charge from blast furnace 1 and to be prepared for pouring in turn. And likewise, during the charging of furnace 5 from furnace 1 and the pouring thereof furnace 4 is prepared whereby is completed a cycle in the continuous operation of the apparatus above described.

It is to be understood that without departing from the spirit of my invention I in some cases make the electrodes 13 and 14 movable from one electric furnace to the other in accordance with the above disclosure of my invention or any variation thereof. It is also to be understood that a greater number than two electrodes are used when temperature regulations and other conditions require.

What I claim is:

1. The method of preparing iron for pouring into molds which comprises melting a charge in a blast furnace, and pouring the melt into an electric furnace and mixing it therein with molten iron whose composition has been regulated in accord with the finished composition of the melt.

2. The method of preparing iron for pouring into molds which comprises melting a charge in a blast furnace, holding molten another charge in an electric furnace and regulating its composition therein in view of the composition of a mixture of the two charges, and pouring the melt from the blast furnace into the electric furnace and mixing it with the charge therein.

3. The method of preparing iron for pouring into molds which comprises melting a charge in a blast furnace, holding molten another charge in an electric furnace and regulating its composition therein in view of the composition of a mixture of the two charges, pouring the melt from the blast furnace into the electric furnace and mixing it with the charge therein, and controlling the temperature thereof.

4. The method of preparing iron for pouring into molds which comprises melting a charge in a blast furnace, holding molten another charge in an electric furnace and regulating its composition therein in view of the composition of a mixture of the two charges, pouring the melt from the blast furnace into the electric furnace and mixing it with the charge therein, controlling the temperature thereof, and pouring castings from the electric furnace.

5. The method of preparing metal for pouring into moulds which comprises melting a charge in a blast furnace, determining the composition thereof, preparing a charge in an electric furnace by adding molten metal to scrap metal, completing the melting of the scrap, regulating and conditioning the composition of the electric furnace charge to suit a desired result of mixing the blast furnace charge and the electric furnace charge, mixing the two charges and completing the temperature regulation with electric current.

In testimony whereof I hereto affix my signature.

RICHARD MOLDENKE.