

Jan. 25, 1966

R. E. S. THOMPSON
APPARATUS FOR PRODUCING MORE THAN ONE GRADE OF MALLEABLE
IRON FROM A SINGLE HIGH CARBON CHARGE THEREOF
Filed Feb. 28, 1963

3,231,253

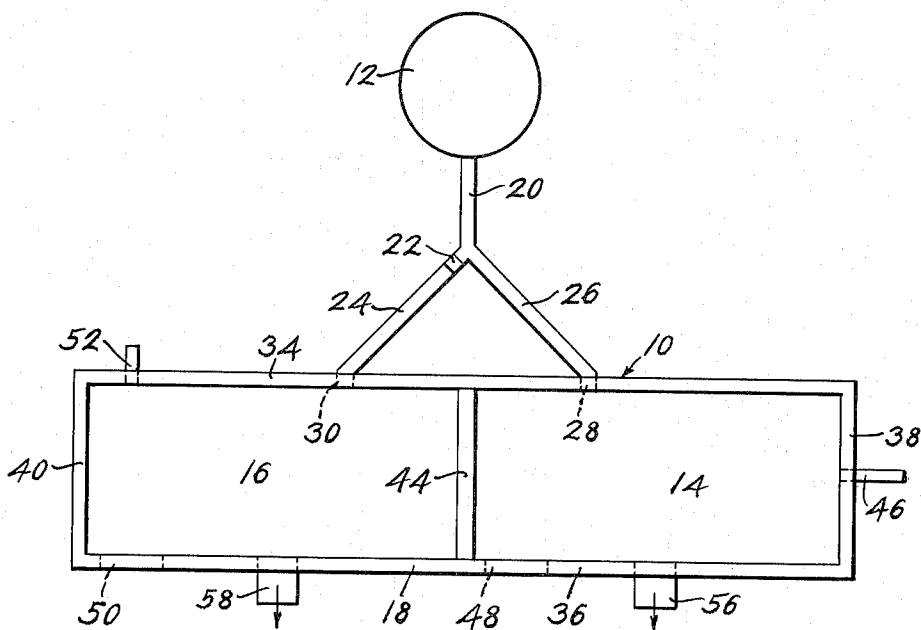


FIG. 1.

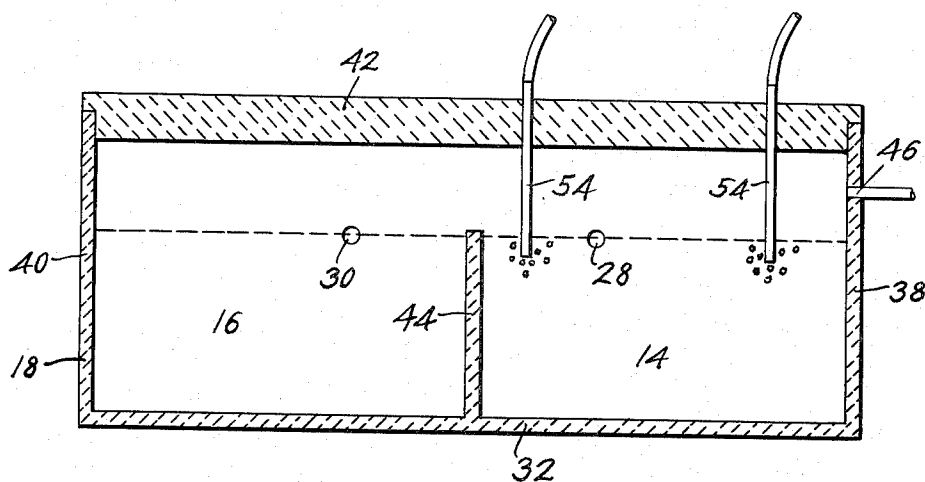


FIG. 2.

INVENTOR.

ROBERT E. S. THOMPSON

BY

Anderson, Douglas & Wymore

ATTORNEYS

1

2

3,231,253
APPARATUS FOR PRODUCING MORE THAN ONE
GRADE OF MALLEABLE IRON FROM A SINGLE
HIGH CARBON CHARGE THEREOF

Robert E. S. Thompson, Guilford, Conn., assignor to Mal-
leable Iron Fittings Company, Branford, Conn., a cor-
poration of Connecticut

Filed Feb. 28, 1963, Ser. No. 261,605
9 Claims. (Cl. 266-13)

This invention relates to malleable iron production and, more particularly, to an apparatus by means of which two or more different grades of refined iron can be produced from a single high-carbon melt.

The customary procedure in the foundry industry is to schedule production of a number of different products requiring an iron with a narrow range of carbon content. The iron is melted in a shaft furnace known as a cupola. The cupola charge is adjusted to give the required analysis except that the carbon content is higher than desired. The melt from the cupola furnace is subsequently transferred to a refining furnace where such adjustments in the carbon content as may be required are carried out to meet the particular carbon range desired. This practice requires that the products cast on each of several casting lines make use of iron having substantially the same composition.

In the malleable iron foundry industry, the problem of producing more than one grade of iron from a single or tandem (duplex) melting unit, has long existed and has been considered insurmountable. The three malleable grades covered by ASTM specifications, A197 and A47, differ mainly in the carbon content of the iron poured to produce them. The carbon content of A47, grade 35018, generally ranges from 2.15 to 2.40% that of A47, grade 32510, from 2.40 to 2.60%; and that of A197 from 2.70 to 3.00%.

The mechanical test values of these three grades are:

	Tensile strength, p.s.i.	Yield point p.s.i.	Elongation, percent
A47-35018.....	53,000	35,000	18
A47-32510.....	50,000	32,500	10
A197.....	40,000	30,000	5

The 35018 material is used in applications where strength and toughness, comparable to that of steel castings, is important. It is also generally considered to be the most dependable material for heavy (thick) section applications due to the decreased possibility of primary graphite occurrence.

The 32510 material has wide use in castings for the automotive industry and elsewhere, where a good average strong tough grade of malleable well meets all requirements.

The A197 grade is used mainly in the lighter section pipe, and other fittings where its high fluidity well serves and where the sections are so light (thin) that there is little danger of the formation of weakening primary graphite.

More recently, "ductile" iron has become a foundry product. Since its production requires a different composition, from the standpoint of carbon and other elements, the possibility of its advantageous production, along with malleable, from one melting source, is manifest.

Similarly, where high strength or pearlitic gray iron is required, great control and economic advantage would accrue to its being produced from the same melting source as malleable.

It would appear from the foregoing that an obvious solution would be to employ several hot-metal production units each of which would include both a cupola and a refining furnace that could be used for a certain grade of production; however, in most instances this is not the case because such a practice is most uneconomical. The reason for this is that a single cupola and refining furnace assembly is generally entirely adequate to supply all the hot-metal requirements for the entire foundry production and it would, therefore, involve an unnecessary duplication of expense to equip a foundry with duplicate hot-metal production facilities for the sole purpose of having more than one grade of iron available at all times.

A much more practical solution to this problem would be, of course, to provide a single hot-metal production facility capable of being used to produce more than one grade of iron from a single melt along with the attendant processing procedures by which the melt could be altered to suit varying production requirements. It has now been found in accordance with the teaching of the instant invention that the aforementioned desirable ends can be accomplished insofar as the equipment is concerned through the simple, but unobvious, expedient of compartmentalizing the refining furnace and altering the connections between the single cupola furnace so that the output therefrom can be divided and delivered to the several compartments of the refining furnace. From the process standpoint, a single high-carbon charge is fed to the cupola furnace, melted, and distributed to the several compartments of the refining furnace where the resulting fractional portions are subjected to individual treatments designed to materially alter their composition. For example, one compartment of the refining furnace would contain iron of the same composition as the original charge to the cupola in all probability. A second compartment would likely contain a medium-carbon composition produced by oxidation of the original cupola melt to reduce the carbon content thereof with a process, the details of which will be more fully set forth presently. Many foundry operations will require only a two-compartment refining furnace because high and medium carbon melts will satisfy the majority of their production needs and special alloys, low-carbon semi-steels and the like could be made in one of the compartments whenever the requirements for high or medium carbon iron were not pressing; however, there would be nothing to prevent further compartmentalization of the refining furnace to accommodate simultaneous production of more than two grades of iron and its alloys.

It is, therefore, the principal object of the present invention to provide novel apparatus suitable for use in the simultaneous production of more than one grade of malleable iron and alloys thereof.

A second object of the invention herein described is the provision of a compartmentalized refining furnace useful in combination with a single cupola furnace to produce hot-metal batches of different composition from a single charge.

Another objective of the invention is to provide a refining furnace especially designed and adapted for use in carrying out substantial variations in the composition of a melt including reduction of the carbon-content and the addition of ferro-alloys.

Still another object is to provide a hot-metal production facility for foundries that makes constantly available two or more different grades of iron yet does not require duplication of cupola and refining furnaces.

Further objects of the invention herein disclosed are the provision of apparatus for hot-metal production in a foundry that are versatile, inexpensive, easy to use, efficient, economical to operate and readily adaptable to existing facilities.

Other objects will be in part apparent and in part pointed out specifically hereinafter in connection with the description of the drawings that follows, and in which:

FIGURE 1 is a top plan view, somewhat schematic in character, showing the hot-metal production facility of the present invention; and,

FIGURE 2 is a vertical longitudinal section showing the compartmentalized refining furnace that forms a part of such a hot-metal production apparatus.

Referring now to the drawings for a detailed description of the present invention and, initially, to FIGURE 1 for this purpose, it will be seen that the hot-metal production apparatus has been indicated in its entirety by reference numeral 10 and it includes a cupola furnace 12 connected to both compartments 14 and 16 of a refining furnace 18 by means of a branched hot-metal transfer runners 20. The cupola furnace itself is a standard item found in nearly every malleable iron foundry. Into it is charged a composition capable of producing a melt having a carbon-content in the range of between approximately 2.8 to 3.0 percent. Ordinarily, the capacity of a cupola furnace is entirely adequate to satisfy the entire production requirements of the foundry. The molten metal from the cupola 12 is transferred to the refining furnace at a temperature of approximately 2780° F. by means of the runner 20 which consist usually of more or less trough-shaped pieces of refractory material. In the usual installations, the entire output from the cupola furnace is fed to a common single-compartment refining furnace where adjustments are made to meet the required carbon range.

In accordance with the teaching of the instant invention, on the other hand, branched runner 20 divides the output from the cupola furnace and delivers same to separate compartments 14 and 16 of the refining furnace. Both compartments of the holding furnace are seldom, if ever, filled simultaneously and a simple, but effective, procedure that can be used to fill only one of the compartments is to erect a temporary mud dam as indicated at 22 thus blocking of the branch 24 of the runner leading to compartment 16 while, at the same time, allowing the molten metal to flow into compartment 14 through the other branch runner 26. It should, perhaps, be mentioned that automatic metering devices can also be employed in runner 20 in place of the mud dam 22 that will eliminate the necessity for anyone attending the transfer of metal from the cupola to one of the refining furnace compartments; however, removable mud dams are entirely satisfactory for purposes of the present description without becoming involved in more sophisticated apparatus that performs this self-same function.

In the particular embodiment of the refining furnace 18 illustrated somewhat schematically herein, it includes only two compartments 12 and 14. It is to be understood, however, that the same principles to be outlined presently are equally applicable to multi-compartmented refining furnaces having more than two hot-metal reservoirs.

Next, with reference to both figures of the drawing, high-carbon or "cupola" iron enters compartments 12 and 14 through ports 28 and 30 that are located in the same horizontal plane and well above the furnace floor 32. In addition to the floor, the furnace includes sidewalls 34 and 36 as well as end walls 38 and 40, all of which are faced with a refractory lining. In addition, the top of the furnace is closed by a cover 42. The most significant feature of the refining furnace, however, is the inclusion of partition wall 44 that is, likewise, formed of refractory material and constitutes the means by which the interior is divided into separate hot-metal compartments. As illustrated, this partition wall is located midway between the endwalls however, as a practical matter, it may be desirable to have one compartment larger than the other depending on the requirements for a given grade of iron. Partition wall 44 is integrated into both sidewalls and the floor so as to form essentially fluid-tight compartments

with no access therebetween except over the top of the partition. It is quite important, that the liquids in the various compartments be sealed off from one another while, at the same time, permitting both metal baths to be treated simultaneously by flame sweeping across the surfaces thereof. Accordingly, it has proven quite satisfactory to maintain the liquid level in both compartments at the height of ports 28 and 30 that lie well underneath the cover and have the partition wall extend above the surface of the baths approximately two inches. In this way, ample space is provided between the underside of the cover and surface of the baths substantially unobstructed by the partition to allow the free passage of flame between compartments. The partition wall height above the liquid level as above stated also appears entirely adequate to eliminate cross contamination between baths.

The molten metal in both compartments of the refining furnace enters as aforesaid at about 2780° F., whereupon, a flame entering through nozzle 46 in endwall 38 is directed across the surface of both baths to bring the temperature on up to a range of between approximately 2830 to 2860° F. Compartment 14 adjacent nozzle 46 is preferably used for the production of low and medium-carbon iron from the high carbon melt taken from the cupola. This is accomplished by adjusting the flame that issues from nozzle 46 so as to insure a strong oxidizing environment. Then, by periodically removing the slag from the surface of the metal bath in compartment 14 through slag removal door 48 in sidewall 36, this particular bath is exposed to the action of the oxidizing atmosphere produced by the flame passing over the surface thereof. As a result, it is possible to effect a substantial reduction in the carbon content of the bath in compartment 14 thus producing in time either a medium or low carbon iron from the original high-carbon melt. For example, it can be shown that a charge of fifteen tons of high-carbon iron in oxidizing compartment 14 will have the carbon content thereof reduced at a rate of approximately 0.4% an hour and more if treated as outlined above.

Compartment 16 located farthest from nozzle 46, on the other hand, is utilized as the source of high carbon-iron having the same or nearly the same composition as the original melt. In order to maintain the high-carbon content of the bath in compartment 16 and prevent same from being acted upon by the oxidizing action of the flame passing over the surface thereof, it is necessary that this high-carbon bath remain covered at all times with a slag layer. The only exception to this is when minor reductions in carbon-content are necessary even in this bath, whereupon, the slag layer can be removed therefrom with paddles through slag door 50 for the relatively brief period necessary to accomplish the desired adjustments. Note also that compartment 16 is provided with a hot-metal tap 52 by means of which carbon-rich metal can be ladled from the slag-covered bath and transferred to the other compartment via branch runner 26 and port 28. Obviously, this procedure could be reversed to transfer carbon-lean hot metal to the high-carbon melt; however, this is seldom necessary and, therefore, no provision has been shown for tapping metal from the bath in compartment 14 by means of a ladle.

By maintaining the bath in compartment 16 covered at all times with a slag blanket, it becomes possible to perform a number of metallurgical operations on the bath that is kept relatively free of slag in addition to reductions in carbon-content down to about 2.3 to 2.5 percent. For example, sufficient carbon reduction to produce steels or semi-steels can be accomplished by providing lancing jets 54 entering through the side walls 34 and 36 or in that portion of the cover 42 overlying compartment 14 as shown in FIGURE 2 by means of which additional oxygen can be introduced directly into the bath. Also, various types of ferro-alloys, calcium carbide and other carbonaceous materials could be introduced directly into the melt within compartment 14

without effecting the composition of the bath in the other compartment. It even becomes possible to maintain close control over impurities such as is necessary to produce high integrity iron and ferrous alloys. Secondary slagging operations can be conducted and required in either of the two compartments. Furthermore, the adjustment of other constituents of the melt besides carbon becomes possible. For instance, by introducing lime in a nitrogen gas carrier, the sulfur-content can be controlled and an oxidizing slag step permits similar control over phosphorous.

The metal is drawn off to the casting lines through taps 56 and 58 that connect into compartments 14 and 16 respectively. Accordingly, it will be seen that the above-described hot-metal production facility for foundries together with the method employed therewith comprise a novel and worthwhile additions to the techniques and apparatus ordinarily employed in the manufacture of malleable iron castings and the like. While only a single embodiment of the invention has been disclosed, and it rather schematically, it is considered adequate to outline the novel principles involved. I realize, of course, that certain changes and modifications may well occur to those skilled in the foundry art within the broad teaching hereof; hence, it is my intention that the scope of protection afforded hereby shall be limited only insofar as said limitations are expressly set forth in the appended claims.

What is claimed is:

1. Molten metal production apparatus for foundries and the like which comprises in combination: a cupola furnace adapted to receive a charge of high-carbon iron and melt same; a refining furnace having at least two refractory lined hot metal compartments separated from one another by a partition wall, a cover forming a closure for said compartments, said partition wall extending above the liquid level of the molten metal in adjacent compartments thus preventing intermixing thereof while allowing the free transfer of heat therebetween; branched runner means interconnecting the cupola furnace in series with each compartment of the refining furnace for the transfer of molten metal thereto, said runner means connecting each compartment of the refining furnace in parallel with one another; and, oxidizing flame jet means the refining furnace in position to direct a flame across the partition wall and simultaneously raise the temperature of the molten metal in the two compartments separated by said partition wall; and, means located in the compartment containing the flame jet allowing for the removal of any slag forming on the surface of the molten metal contained therein so that said flame can sweep across the exposed surface of said slagless metal bath and oxidize same to effect a reduction in its carbon-content without substantially altering the composition of the slag-covered molten metal in the adjacent compartment.

2. The combination as set forth in claim 1 in which removable dam-forming means are selectively positioned in branches of the runner means capable of blocking the flow of the high-carbon melt from the cupola furnace into the particular refining furnace compartment connected to receive same from said blocked branch and redirecting said melt into the remaining runner branches and compartments connected thereto.

3. The combination as set forth in claim 1 in which separate hot-metal taps are provided in each compartment of the refining furnace so that the molten metal compositions contained therein can be separately utilized.

4. The combination as set forth in claim 1 in which

conduit-forming means connectable to a source of oxygen and terminating beneath the surface of the melt are provided in the compartment containing the flame jet for introducing oxygen directly into the molten metal contained therein.

5. The refining furnace comprising, a refractory-lined vessel including a floor, sidewalls and endwalls, a partition wall formed of a refractory material dividing the interior of the vessel into two liquid-tight compartments, a cover forming a closure for the vessel, said partition wall terminating in spaced relation beneath the cover and cooperating therewith to define a gap therebetween adapted to permit the free circulation of heat between compartments, a pair of horizontally-aligned inlets located in one of said outer walls of each compartment in position spaced beneath the top edge of the partition wall for direct introduction of molten metal into each compartment, a flame jet located in one endwall of the vessel above the inlets in position to direct a flame across the top of the partition wall, access means located in one of the outside walls of the compartment containing the jet positioned to permit removal of any slag forming on the surface of the molten metal contained therein, and openable melt-removal taps positioned in an outside wall of each compartment communicating the interior thereof beneath the surface of the melt for withdrawing the molten metal in said compartment.

6. The refining furnace as set forth in claim 5 in which the partition wall extends approximately two inches above the level of the molten metal in the two compartments when filled to the inlets.

7. The refining furnace as set forth in claim 5 in which conduit-forming means connectable to a source of oxygen and terminating beneath the level of the melt are provided for introducing oxygen directly into the molten metal both contained in the compartment having the jet.

8. The refining furnace as set forth in claim 5 in which access means are provided in an outside wall of the compartment remote from the jet, said access means communicating the interior of said remote compartment beneath the slag layer formed atop the melt thus providing for removal of the carbon-rich molten metal contained therein.

9. The refining furnace as set forth in claim 8 in which second access means are provided in an outside wall of the compartment remote from the jet, said second access means being located to communicate the interior thereof at the level of the slag layer therein for removal of slag forming on the surface of the metal in said remote compartment.

References Cited by the Examiner

UNITED STATES PATENTS

475,609	5/1892	Richards	266—33
702,526	6/1902	Ash	266—33
1,878,623	9/1932	Durbin	266—11
2,794,631	6/1957	Becker et al.	266—13
2,799,492	7/1957	Hobenreich et al.	266—13
2,862,810	12/1958	Alexandrovsky	266—35 X
2,875,037	2/1959	Wright	75—46
2,958,597	11/1960	Churcher	75—46
3,062,524	11/1962	Leroy et al.	266—34

WHITMORE A. WILTZ, *Primary Examiner.*

WINSTON A. DOUGLAS, MORRIS O. WOLK,
Examiners.