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CASTING IRON AND STEEL

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FIG. 1.

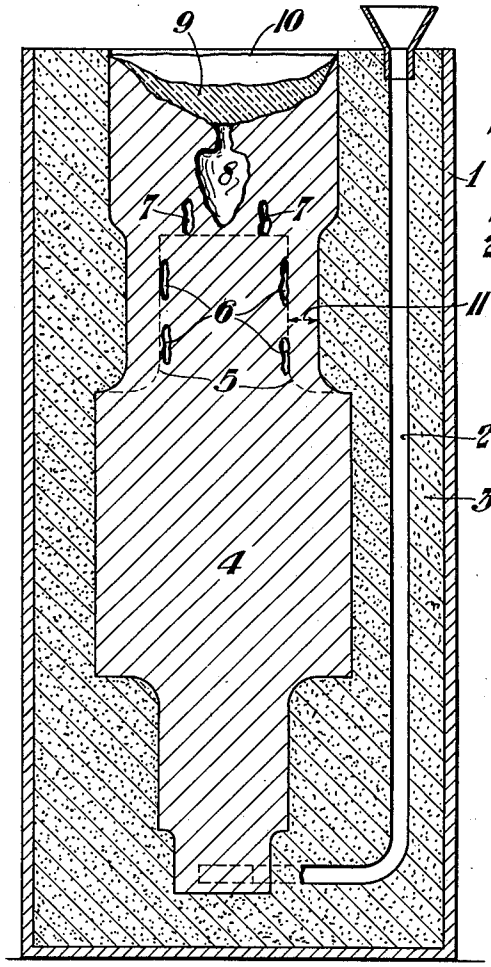
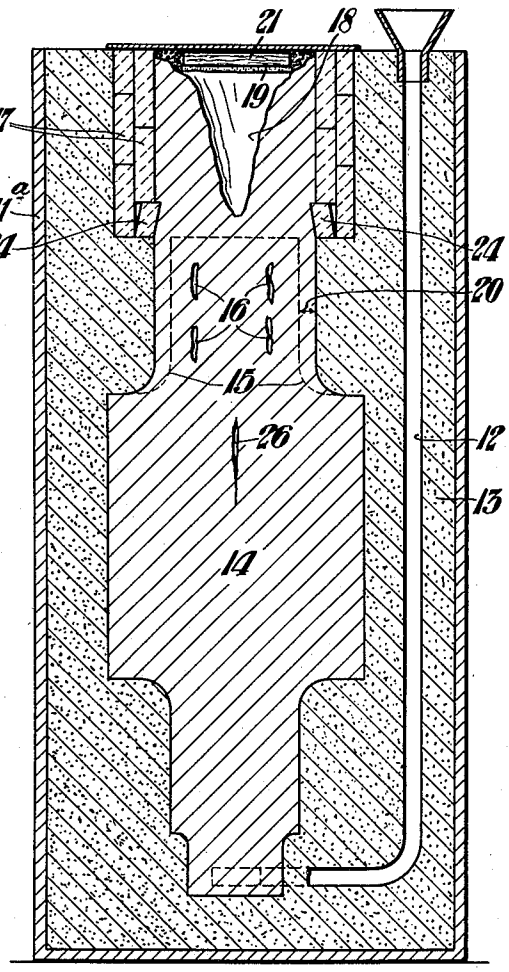


FIG. 3



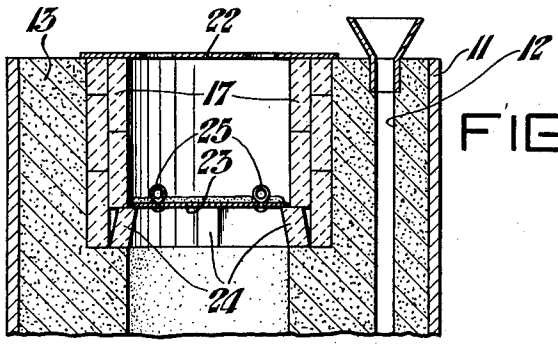


FIG. 2.

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CASTING IRON AND STEEL

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9 Claims. (Cl. 22—216)

This invention relates to the manufacture of iron and steel castings, and particularly to an improvement in the casting of articles of large cross section, such as rolls for steel mills, whereby the metal at the top of the casting is kept molten for a period longer than has heretofore been possible.

As is well known, such articles are cast in molds which are mounted in a vertical position and contain a top portion, called the sinkhead. Into a mold of this type the molten iron or steel is introduced through a gate in the bottom of the mold in a direction tangent to the circumference, so as to produce a swirling motion to the liquid steel or iron as it rises in the mold. This swirling motion causes the oxides formed on the surface of the liquid iron or steel, as well as particles of sand and other foreign material gathered by the metal, to collect at the center and thus rise into the sinkhead.

Although it is a function of the sinkhead to provide a reservoir of molten metal, which will flow downward during solidification of the metal in the mold below and thus compensate for the liquid-to-solid contraction that occurs during the solidification period, it fails to do so unless special measures are taken, for two principal reasons; namely, the wall of the sinkhead, usually composed of foundry sand contained in a metal flask, abstracts heat from the molten metal, causing it to solidify against the wall; and the metal at the top of the sinkhead, being exposed to the cooling effect of the air, forms a top crust at the surface and one or more thick bridges below. According to the practices of the prior art, it has been customary to overcome these tendencies to rapid solidification of the metal in the sinkhead, by enlarging the upper part of the mold and by using various materials placed upon the surface of the metal as soon as it has been cast.

By the process of our invention we employ an improved sinkhead and method for preventing the freezing of the surface of the metal in the sinkhead, and an improved sinkhead construction that permits heating the inner surface of this part of the mold to a high temperature just before the metal is cast. This preheating prevents the initial rapid abstraction of heat from the liquid metal, so that the amount of metal that solidifies in a given time is less than that which solidifies in the body of the casting during the same period of time. The result is a freer downward flow of metal out of the sinkhead, with such contraction cavities as do form located at harmless points. Other advantages also accrue from the application of our invention to various castings, as illustrated by the accompanying drawing.

Figure 1 is a vertical sectional drawing of a cylindrically shaped casting, made by the practices of the prior art, as it stands in its mold after solidification has become complete; and

Figures 2 and 3 are vertical sections of the same cylindrically shaped casting made in a flask similar to that shown in Figure 1, but by the method and the sinkhead of our invention.

The drawing shows the flask 1, the gate 2, the mold 3 and the casting 4, the dotted lines 5 representing the size of the upper part of the finished casting. It will be noted that the diameter of the upper part of the mold is made considerably larger than the diameter of the finished casting, to prevent the metal at this location from becoming solid before the lower part, and thus stopping the downward flow of metal. This design leaves a thick annular ring of metal 11 that must be removed by machining.

By this method of casting, the mold is filled with liquid metal to the level 10, and covered with a thick layer of insulating material 9. After solidification is complete, the metal in the sinkhead sinks, forming the pipe cavities 7 and 8, and an uncertain number of contraction cavities 6 which our investigations have shown are usually encountered at a distance of 1½ to 2 inches below the lateral surface of the casting. In machining off the annular ring of metal 11, one or more of these cavities are likely to be uncovered to form a rough, imperfect surface. The central portion of this part of the casting is also affected by smaller cavities and other defects accurately described by the terms "segregation," "coarse grain" and "dendritic structures."

Figure 3 shows the flask 11a, the gate 12, the mold 13 and the casting 14, the diameter of the upper part of the finished casting being represented by the dotted lines 15. It will be observed that the diameter of the mold is much nearer the diameter of the finished roll neck and that the annular ring of metal 20, to be machined off, is much smaller than the annular ring 11 of Figure 1.

Since the heating of a green or baked sand mold to a high temperature, approaching a red heat, causes the mold to crumble by destroying the bonding material, we overcome this difficulty by the use of refractory materials in brick form, as indicated at 17 in Figures 2 and 3. These bricks may be laid edgewise against the sand in

one course, or flatwise in one or two courses, as shown in the sketch, and are of a quality known as ladle brick. If the lining is two bricks thick, the outer courses are laid against the sand while the inner courses are laid in fire clay. Any brick possessing the requisite refractoriness may be used, the thickness of the brick inner wall depending somewhat upon the size of the casting, the larger castings requiring the thicker wall. To prevent overheating of the sand beneath the sinkhead, three or four bricks 24 in the bottom row are set at an angle with top edges, projecting into the mold to form supports for a metal shield 23, covered on its upper side with a layer of half brick, asbestos or other suitable refractory material to form an insulated covering. To permit speedy removal of the shield after the heating, it is provided with eye bolts 25.

To prepare a mold with such a sinkhead, the molding sand is placed in the flask in the usual way except that space is allowed for the brick. After the mold is formed, the bricks are placed in the sinkhead, as described above, the parts of the mold are baked and assembled for casting in the manner familiar to those skilled in the art.

To heat this sinkhead, burning gas jets are introduced through openings in the top shield 22 tangentially to the inner circumference of the sinkhead, usually about one hour before casting time. Gas is then admitted to the burner or burners at such a rate that the brick will be heated to bright redness (1700° F. to 1900° F.) at casting time, when the burners and shields are removed.

As soon as the metal has been cast in the usual manner to fill the hot sinkhead, we scoop off most of the foreign matter floating upon the surface and apply a quantity of a thermite mixture 19 sufficient to form a layer between ¼ and ½ inch thick over the central portion of liquid. Upon this layer we next apply a dried and charred wood block 21, cut roughly circular to a diameter 3 to 4 inches smaller than the hot top itself, fill about the edges of the wood block with a quantity of crushed bituminous coal, then cover the top of the sinkhead with a light steel plate, which with the coal prevents rapid burning of the wood block, by excluding air and the rapid radiation of heat. By this procedure, and with an undercutting of proper composition, we have been able to keep the top metal fluid, preventing the formation even of a crust, for extended periods of more than two hours for larger castings.

The composition of the thermite mixture is important. A mixture we have found satisfactory is marketed under the trade name "Lunkerite F," and is composed of aluminum dross, calcium carbide, and fluorspar, all finely ground and well mixed. The composition of the exothermitic mixture varies, but usually contains 2 to 3% metallic aluminum with some calcium carbide and fluoride; the remainder being alumina, Al_2O_3. When this material is placed upon the surface of the liquid steel, the aluminum and calcium carbide react with any iron oxides present and liberate heat, after which the mixture fuses to form later a very viscous slag that breaks contact of the metal with the wood block, which acts as an efficient insulator. We have also used mixtures of aluminum powder and dehydrated iron oxide in theoretical proportions to form metallic iron and alumina, adding about 1% of powdered magnesium, 3% of powdered fluorspar and powdered ferro-manganese and ferro-silicon to produce an aluminum reduced metal having about the same composition as the casting. This mixture requires a high temperature to start the reaction, and frequently fails because it absorbs heat from the liquid steel forming a crust that retards the transfer of heat to it. To overcome this difficulty, we add a small portion of magnesium powder, which first ignites at a low temperature and generates enough heat within the mass to start the reaction between the aluminum and the iron oxide which is also heated by the hot steel beneath.

In a casting, with a heated sinkhead, as described above, the top metal remains liquid and sinks to form a large cavity or pipe 18, as illustrated by Figure 3. The lateral contraction cavities 16, if formed at all, are sufficiently deep seated that they are not uncovered when the annular layer 20 is machined off. A small contraction cavity 26, or a series of such cavities, may occasionally be formed, depending upon the design of the casting, but since these are centrally located deep in the body of the casting, they do little, if any, harm. In addition to giving sounder castings, with less metal to be machined, the practice of our invention also gives less scrap, as it permits the use of smaller sinkheads.

Having thus disclosed by explanation and example the details of our invention, we desire it understood that it may have other applications and may be modified in various ways without exceeding the scope of our invention as defined by the following claims.

We claim:

1. A method of casting ferrous metal including covering the surface of the metal immediately after casting with a layer of thermite mixture containing aluminum powder, iron oxide and fluorspar, covering this layer with a dried, charred wood block and covering the block with a plate protecting it from the air.

2. A method of casting ferrous metal including placing a sinkhead on the mold to receive the metal, the sinkhead being lined with refractory brick and heated to at least 1000° F. prior to the casting of the metal, covering the surface of the metal immediately after casting with a layer of thermite mixture containing aluminum powder, iron oxide and fluorspar, covering this layer with a dried, charred wood block and covering the block with a plate protecting it from the air.

3. A metal casting sand mold preheated sinkhead preparation method, including lining the sinkhead with refractory bricks, protecting the mold sand below the sinkhead with a temporary sinkhead bottom and tangentially injecting a burning mixture of fluid fuel and air into the sinkhead to effect its preheating.

4. A method of casting metal, which comprises placing a sinkhead on the mold which is to receive the metal to be cast, introducing molten metal into the mold and sinkhead until the latter is filled, covering the metal in the sinkhead while fluid with a layer of a thermite mixture, overlying the thermite mixture with a deoxidizing and heat-insulating cover, and controlling combustion of the cover by substantially excluding air therefrom, thereby establishing a controlled maintenance of the fluid condition of the metal in the sinkhead for whatever length of time may be desired.

5. A method of casting metal, which comprises placing a sinkhead on the mold which is to receive the metal to be cast, introducing molten metal into the mold and sinkhead until the lat-

ter is filled, maintaining the metal in the sinkhead enclosed in a heat-insulating environment while protecting the metal against oxidation, and maintaining the metal in the sinkhead completely molten for a desired length of time by heat produced by an exothermic chemical reaction proceeding within the sinkhead and in contact with the molten metal while controlling the reaction speed to hold the reaction sufficiently slow while maintaining its duration for the desired length of time to maintain the metal in the sinkhead at least substantially completely molten during solidification of the metal in the mold, thereby allowing molten metal from the sinkhead to fill cavities tending to be produced in the casting as incidents to contraction of the metal during solidification.

6. A method of casting ferrous metal, which comprises placing a sinkhead on the mold which is to receive the metal to be cast, introducing molten metal into the mold and sinkhead until the latter is filled, covering the metal in the sinkhead with a layer of thermite mixture, and maintaining a controlled slow combustion of the mixture for maintaining the metal in the sinkhead molten during solidification of the metal in the mold into the casting, while protecting the metal in the sinkhead from oxidation, whereby the metal in the sinkhead may flow into cavities formed in the casting as incidents to contraction of the metal during solidification.

7. A method of casting ferrous metal, which comprises placing a sinkhead on the mold which is to receive the metal to be cast, introducing molten metal into the mold and sinkhead until the latter is filled, covering the metal in the sinkhead with a slag-producing thermite mixture adapted to form a molten slag cover for the metal, and causing a combustion of the thermite mixture while controlling its combustion rate so as to maintain the metal in the sinkhead molten until the metal in the mold has solidified into a casting for enabling metal to flow from the sinkhead into cavities tended to be produced in the casting by contraction of the metal as its solidifying proceeds.

8. A method of casting ferrous metals, which comprises placing a sinkhead on a mold which is to receive the metal to be cast, introducing molten metal to be cast into the mold and sinkhead until the latter is filled, covering the metal in the sinkhead with a thermite mixture containing material adapted to form a molten cover slag upon combustion of the thermite mixture, placing upon the mixture a dried, charred wood block of an area less than that of the mixture, completing a covering of the mixture by filling around the said block with enough coal to complete the fill, and covering the resulting reactive material with a refractory cover to exclude air from the material for controlling rate of combustion thereof.

9. A method of casting ferrous metal, which comprises placing a sinkhead on a mold which is to receive molten metal to be cast, heating the sinkhead prior to casting the metal, flowing the molten metal into the mold and sinkhead until the latter is filled, maintaining the metal in the sinkhead molten during solidification of the casting, by placing on the surface of the metal in the sinkhead a covering comprising an exothermic mixture producing reaction temperatures above the melting point of the metal, causing controlled combustion of the said exothermic mixture of the said covering maintaining the sinkhead insulated from the mold to prevent overheating of the mold, and maintaining the molten metal in the sinkhead covered during solidification of the casting to prevent oxidation of the metal.

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