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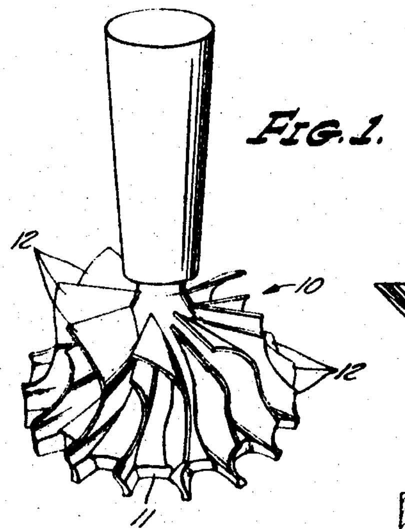

FIG. 1.

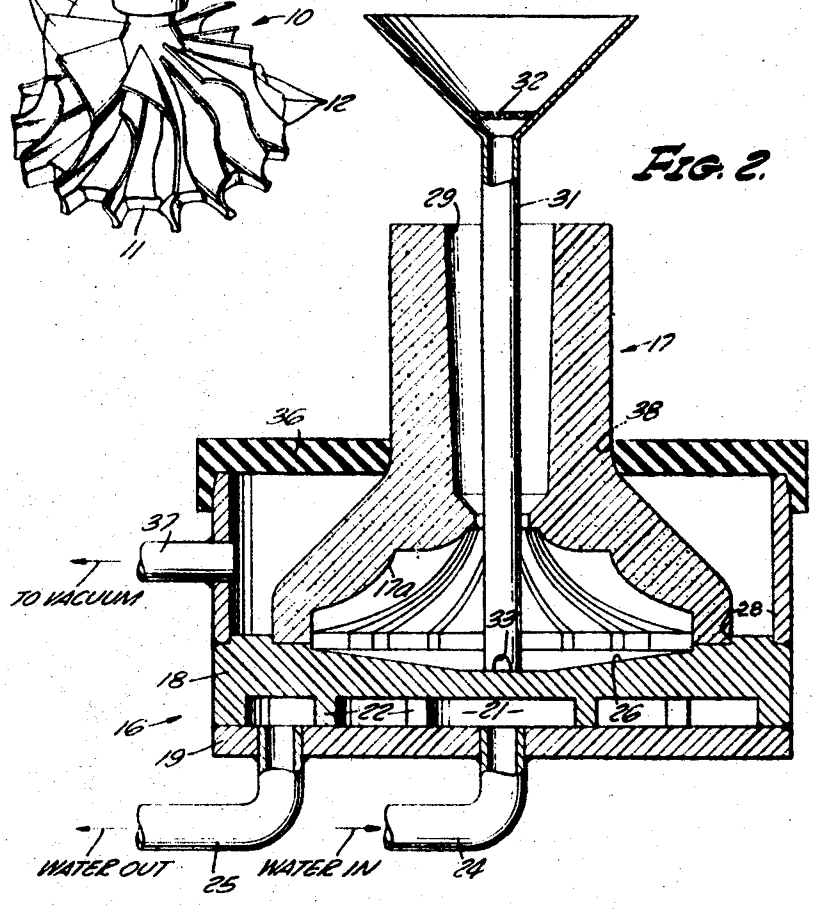

FIG. 2.

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United States Patent

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[54] **ART OF MAKING PRECISION CASTINGS**
3 Claims, 2 Drawing Figs.

[52] U.S. Cl. 164/126, 164/255, 164/65, 164/348, 164/353, 164/363, 164/133, 164/337, 249/108, 249/109
[51] Int. Cl. B22d 7/10, B22d 27/04
[50] Field of Search 164/126, 63, 65, 363, 359, 352, 353, 354, 125, 127, 133, 255, 61, 62, 122, 128, 337, 348; 249/108, 109

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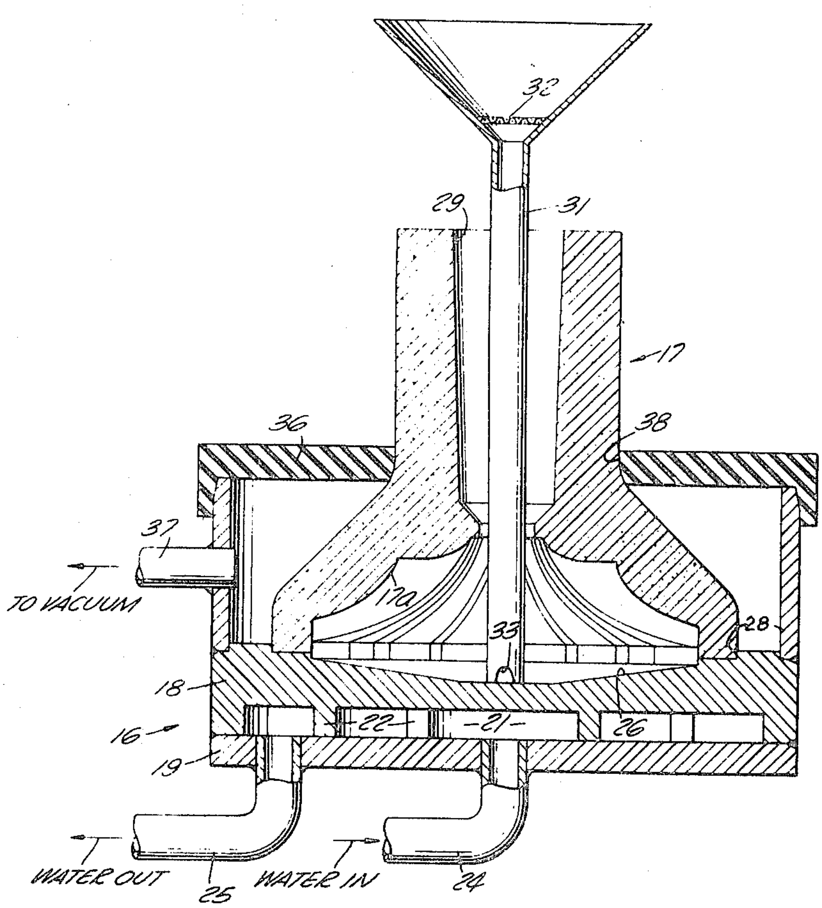
ABSTRACT: A method for casting in a founding flask in which molten metal is continuously poured below the surface of the previously added molten metal through a heated funnel which extends to the lower portion of the flask and meters the flow of molten metal into the flask. Heat is removed through the lower portion of the flask while heat is prevented from escaping through the upper portion. The exterior of the upper portion of the flask may be evacuated during the pouring of the molten metal.



ART OF MAKING PRECISION CASTINGS

This is a division of application Ser. No. 551,256 filed May 19, 1966 now U.S. Pat. No. 3,435,885, issued Apr. 1, 1969.

The present invention relates to the art of making metallic castings and, more particularly, to precision metallic castings having improved strength, ductility, and heat resistance.

In general, metallic castings are considered to be weaker than forgings because the forgings process makes the metal denser than in a casting. Up to now microscopic voids have been commonly found in castings and when the metal is forged the voids are squeezed and fused together. The microscopic voids in previous castings are believed to be formed during the cooling process.

Therefore, an object of this invention is to produce a casting having the density of a forging.

Another object of this invention is to provide an improved method for making castings.

Another object of this invention is to produce a precision casting having improved strength and ductility by preventing the formation of any shrinkage voids while the casting is solidifying.

Briefly, the present invention provides a casting mold having a cope and a drag. The drag is made of metal and has a substantially flat surface which functions as a heat sink. The cope is made of a refractory insulating material having a relatively poor thermal conductivity rate. Means are provided to ensure that when the flask is being filled the molten metal flows down through the sprue and directly to the drag and below the surface of the liquid. The molten metal is poured continuously without interruption until the flask is filled. This procedure ensures that the upper portion of the flask is last to solidify so that no slag or oxides are trapped within the metal casting but rise into the sprue. To ensure that no air pockets are formed within the flask, the pressure exterior of the flask is made lower than the pressure in the interior, causing air to pass through the cope walls which are inherently porous to air. Since the drag portion of the mold is a heat sink, the molten metal solidifies when it contacts the drag. This rapid chilling of the metal is believed to form a boundary surface between the molten metal and the solidified metal which surface is continuous and moves relatively uniformly away from the drag leaving no voids, especially of microscopic sizes, in the casting in back of the boundary surface. Although the metal solidifies, and inherently shrinks, the cope, being an insulator, maintains the metal in the liquid state long enough to fill any voids formed by the metal shrinking away from the cope walls to provide a precision, dense casting having relatively high strength and ductility.

These and other objects, features, and advantages will become more apparent from the following description of a preferred embodiment of the invention selected for purposes of illustration and shown in the accompanying drawing in which:

FIG. 1 is a pictorial view of a typical item that was cast using the teachings of this invention; and

FIG. 2 is a sectional elevation of the founding flask ready to be filled with molten metal to make the item shown in FIG. 1.

Referring to the drawings and to FIG. 1 in particular, there is shown a typical item 10 that is cast using the teachings of the present invention. The item 10 is, for example, a compressor wheel of a supercharger which is to operate at very high rotating speeds. The item 10 has a base 11 forming the hub with a plurality of blades 12 protruding therefrom. The item 10 may have any form or shape provided, as will be explained hereinafter, that the molten metal can be poured in one step into a founding flask, for example, as shown in FIG. 2 and the metal can flow into and fill all the voids within the flask as the casting solidifies.

Referring to FIG. 2, the assembled founding flask is shown. The flask has a drag 16 and a cope 17. The drag is made of, for example, mild steel and includes an upper section 18 and a lower section 19 welded together forming a passageway 21 therebetween. The lower section 19 has an inlet pipe 24 welded to the center thereof so that a suitable coolant, such as

water, enters the passageway 21. Suitable baffles 22 cause the coolant to circulate around the drag 16 and exit through an outlet pipe 25. The upper section 18 has an upper surface 26 having a slight contour as required by the item 10.

The cope 17 is made of a refractory material which has a relatively poor heat conductivity rate to ensure that practically all of the heat in the molten metal is conducted out through the drag 18, for reasons that will be explained. Since in this embodiment the item 10 is made of, for example, aluminum, the cope 17 is made of plaster of paris having a thermal conductivity rate at least 100 times less than the drag. If a metal, that has a higher melting temperature than aluminum, is used, the cope should be made of refractory material which can withstand the temperature. The thickness of the thermal conductivity rate of the cope is chosen so that very little heat passes through the walls thereof. The cope 17 has an internal contour 17*a* which is the female counterpart of the external contour of item 10. In addition, the cope is preferably expendable, i.e., the cope is broken to remove the casting. The cope 17 fits within a depressed portion 28 formed in the upper section 18 of the drag 16 so that the cope and drag are readily aligned. A sprue 29 is formed in the cope so that metal may be poured within the cavity of the flask.

In order that sound, dense, strong castings are produced, the molten metal should be poured through the sprue 29 without contacting the walls of the cope 17 and poured under the surface of the molten metal within the flask. This ensures that no oxides are trapped within the solid castings. Therefore, a funnel 31, made of, for example, a material such as mild steel which does not melt when contacted by the molten aluminum, is used when the molten metal is poured. The steel funnel 31, first, has been heated to a temperature to prevent cooling of the casting metal. Then, the hot funnel 31 is inserted through the sprue 29 until the funnel contacts the drag 16. In addition, the funnel 31 includes a suitable strainer 32 for straining out any oxides that may be floating in the liquid metal and includes a notch 33 for metering the molten metal out of the funnel to ensure that the funnel is continuously filled with molten metal, i.e., there is no interruption in the flow. An interruption in the flow of molten metal through the funnel would form a discontinuity in the casting because the metal within the mold hardens so rapidly that the following flow of metal could fall on solid metal forming hidden cracks. However, when the molten metal is poured continuously, and the bottom of the funnel 31 is kept below the surface of the liquid, the inflowing molten metal mixes with the molten metal already within the flask to form a continuous dense casting. Any oxides that may be formed flow towards the sprue and rise to the top thereof. When the flask is filled the funnel is removed. The drag 16 conducts heat away from the bottom of the mold while the cope 17 prevents heat from escaping therethrough. Thus, the portion of metal against the drag 16 solidifies first and when that portion solidifies it conducts heat from and solidifies the adjacent molten metal forming a continuous surface or interface between the molten and solid state. Since the heat has to pass through the item 10 while it is being cast, the sprue is the last portion to solidify. In order that the sprue may be the last portion to solidify, the external contour of item 10 preferably is limited such that at any horizontal plane above the drag 16 the cross section of item 10 is continuous to allow the molten metal to flow throughout and harden in the flask, as described.

To further ensure that no voids are left in the flask at the time item 10 is cast, the exterior pressure of the cope 17 is made lower than the interior. This result is achieved by placing a cover seal 36 over the drag 16, as shown, and a vacuum is drawn through a pipe 37. A quick seal is formed between the cope 17 and the periphery of a hole 38 in cover 36 and between the cover 36 and the drag. The cope 17, being inherently porous to air, allows the air in the flask to pass out through the walls of the cope so that the flask will fill completely with metal.

With the present disclosure in view, modifications of the invention will appear to those skilled in the art. Accordingly, the invention is not limited to the exact details of the illustrated preferred embodiment but includes all such modifications and variations coming within the scope of the invention as defined in the appended claims.

What is claimed is:

1. A method for producing castings using a founding flask, said method comprising:
   - pouring molten metal into said flask through a heated funnel which extends to the lower portion of said flask so that the molten metal is added below the surface of any previously poured molten metal;
   - metering the flow of molten metal through the bottom of the heated funnel to control the flow of molten metal into the flask;
   - continuously removing heat from said flask through the lower portion thereof during the pouring of molten metal into said flask; and
   - simultaneously preventing heat from escaping through the upper portion of said flask during the pouring of molten metal into said flask by providing an evacuated area above a heat-insulating cope at the upper portion of said flask.

2. A method for producing castings using a founding flask, said method comprising:
   - pouring molten metal into said flask through a heated funnel which extends to the lower portion of said flask so that the molten metal is added below the surface of any previously poured molten metal;
   - metering the flow of molten metal through the bottom of

   the heated funnel to control the flow of molten metal into the flask;
   - removing heat from said flask through the lower portion thereof;
   - preventing heat from escaping through the upper portion of said flask; and
   - forming a lower pressure exterior of the upper portion of said flask than in the interior of said flask to facilitate the escape of air from inside the flask during the pouring of molten metal.

3. A method for producing castings using a founding flask, said method comprising:
   - providing a heat-insulating cope at the upper portion of said flask;
   - providing a heat-conducting drag at the lower portion of said flask;
   - pouring molten metal into said flask through a heated funnel which extends to the lower portion of said flask so that the molten metal is added below the surface of any previously poured molten metal;
   - metering the flow of molten metal through the bottom of the heated funnel to control the flow of molten metal into the flask;
   - passing a coolant through passageways in the heat-conducting drag to remove heat from the lower portion of said flask; and
   - evacuating the area around the outside of the upper portion of said flask to facilitate the escape of gases from the interior of said flask during the pouring of molten metal.