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FLASK FOR MAKING PRECISION CASTINGS

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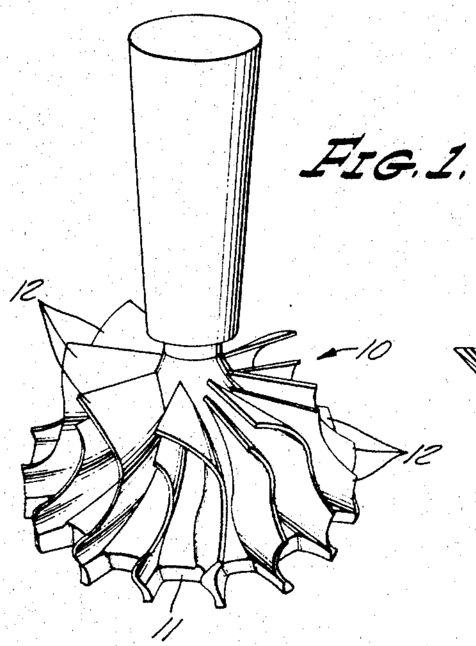

FIG. 1.

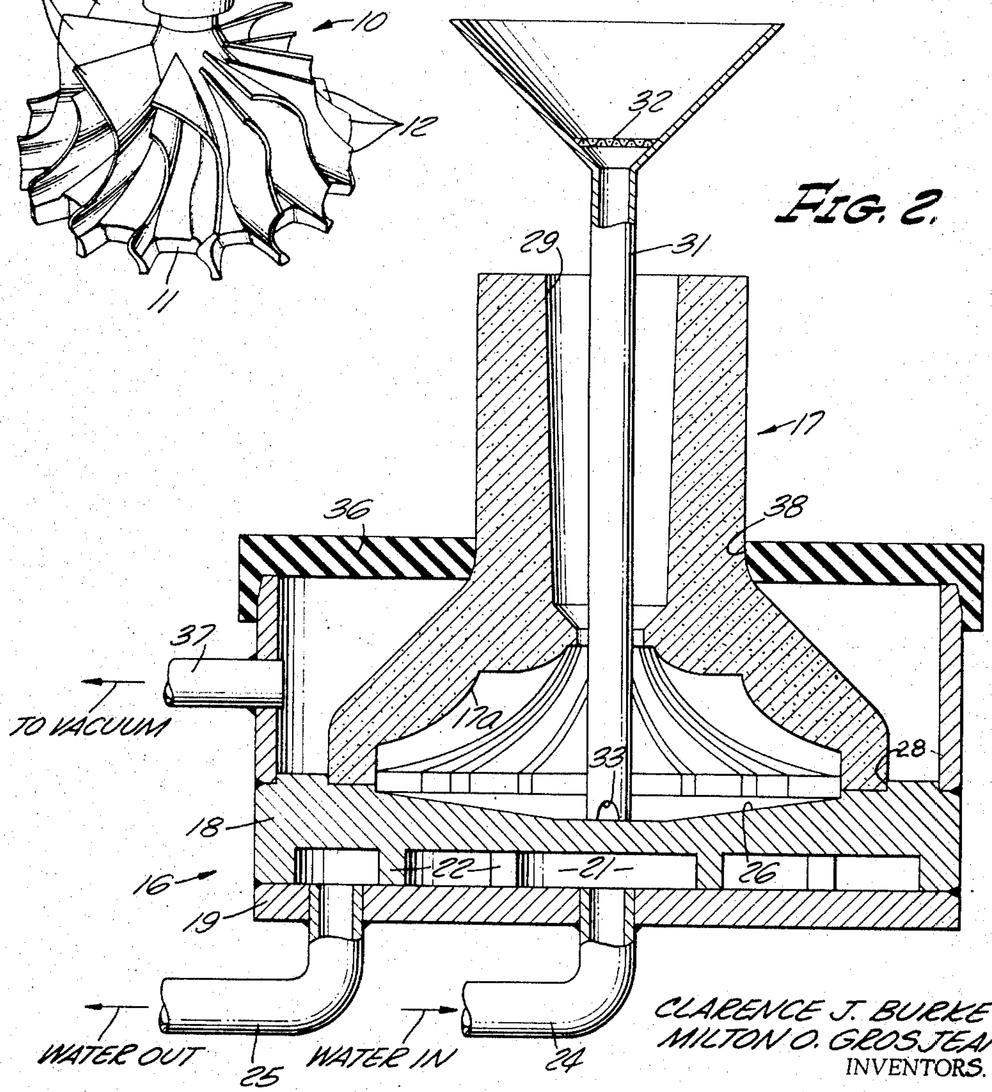

FIG. 2.

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FLASK FOR MAKING PRECISION CASTINGS

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ABSTRACT OF THE DISCLOSURE

A flask for casting precision metallic parts wherein the molten metal is continuously added below the surface of the molten pool and heat is conducted away from the bottom of the casting so that no liquid pockets are formed as the casting solidifies.

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 forging because the forging process makes the metal denser than in a casting. Up to now microscopic voids have been commonly found in casting and when the metal is forged the voids are squeezed and fused together. The microscopic voids in previous castings were 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 provide an appaartus which substantially prevents microscopic voids from forming in a casting.

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 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.

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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 liquid 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 and 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 liquid 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 liquid forming a continuous surface or interface between the liquid 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 founding flask to be filled with molten metal, said flask comprising:
a drag made of a heat conducting material,
means for conducting heat from said drag,
a cope made of a heat insulating material and having a sprue portion,
said cope being disposed on said drag with said sprue portion being disposed at the highest elevation above said drag so that molten metal flows downward to fill the flask, and
means are provided extending through said sprue portion for guiding the incoming molten metal below the liquid surface and metering the molten metal so that no interruptions are made in the flow of molten metal therethrough, to cause the oxides to float to the exterior of the casting.

2. The flask as claimed in claim **1** wherein:
means are provided for maintaining a lower ambient pressure outside of the cope than inside, and
said cope is made of an insulating material which is porous to air to cause the air within the cope to pass out through the walls thereof.

3. The flask as claimed in claim **1** wherein:

said cope and drag form a cavity which communicates with said sprue of said sprue portion and said cavity having a contour so that a cross-section thereof taken at any horizontal plane is continuous to prevent the formation of cavities between the casting and the cope.

4. The flask as claimed in claim **1** wherein:
said heat conducting material of said drag is metallic;
said means for conducting heat from said drag includes a passageway formed in said metal and having an inlet and outlet port for delivering and discharging a coolant to and from said metal, and
said insulating material of said cope has a thermal conductivity at least 100 times less than the thermal conductivity of said metal in said drag so that almost all the heat in said molten metal is removed through said drag.

5. The flask as claimed in claim **2** wherein:
said cope and drag form a cavity which communicates with said sprue of said sprue portion and said cavity having a contour so that a cross-section thereof taken at any horizontal plane is continuous to prevent the formation of cavities between the casting and the cope.

6. The flask as claimed in claim **2** wherein:
said heat conducting material of said drag is metallic;
said means for conducting heat from said drag includes a passageway formed in said metal and having an inlet and outlet port for delivering and discharging a coolant to and from said metal, and
said insulating material of said cope has a thermal conductivity at least 100 times less than the thermal conductivity of said metal in said drag so that almost all the heat in said molten metal is removed through said drag.

7. The flask as claimed in claim **3** wherein:
said heat conducting material of said drag is metallic;
said means for conducting heat from said drag includes a passageway formed in said metal and having an inlet and outlet port for delivering and discharging a coolant to and from said metal, and
said insulating material of said cope has a thermal conductivity at least 100 times less than the thermal conductivity of said metal in said drag so that almost all the heat in said molten metal is removed through said drag.

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