APPARATUS FOR CASTING THIN-WALLED CAST IRON PARTS

Filed July 2, 1964 2 Sheets-Sheet 1

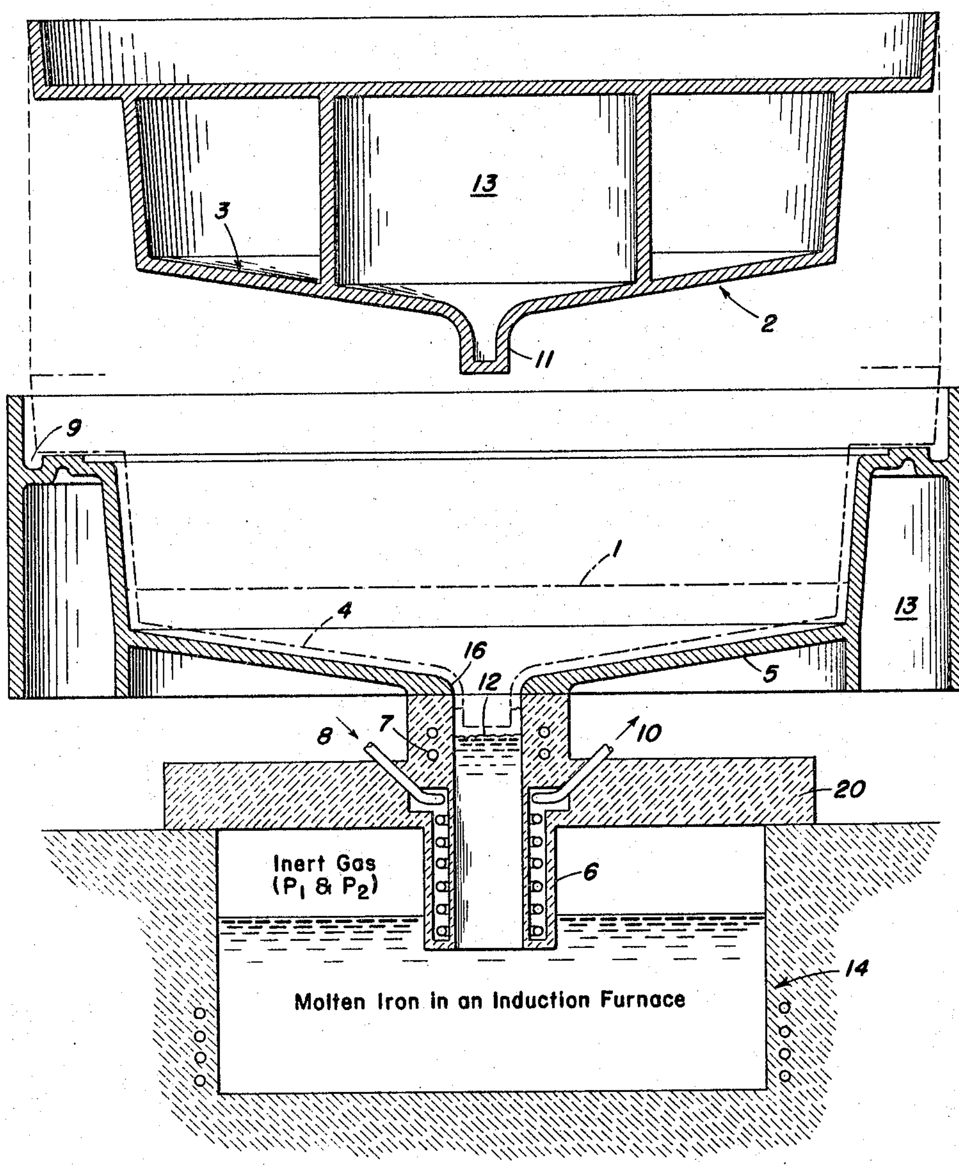

Fig. I.

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Filed July 2, 1964 2 Sheets-Sheet 2

Fig. 2B.

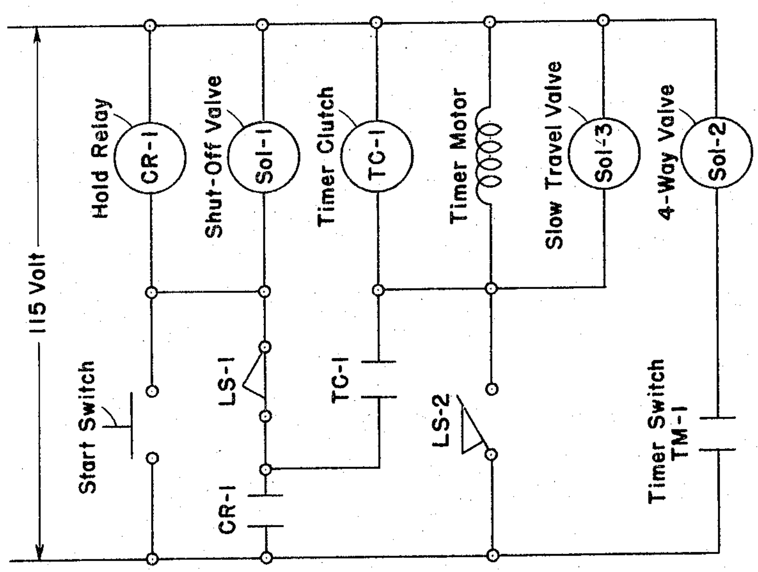
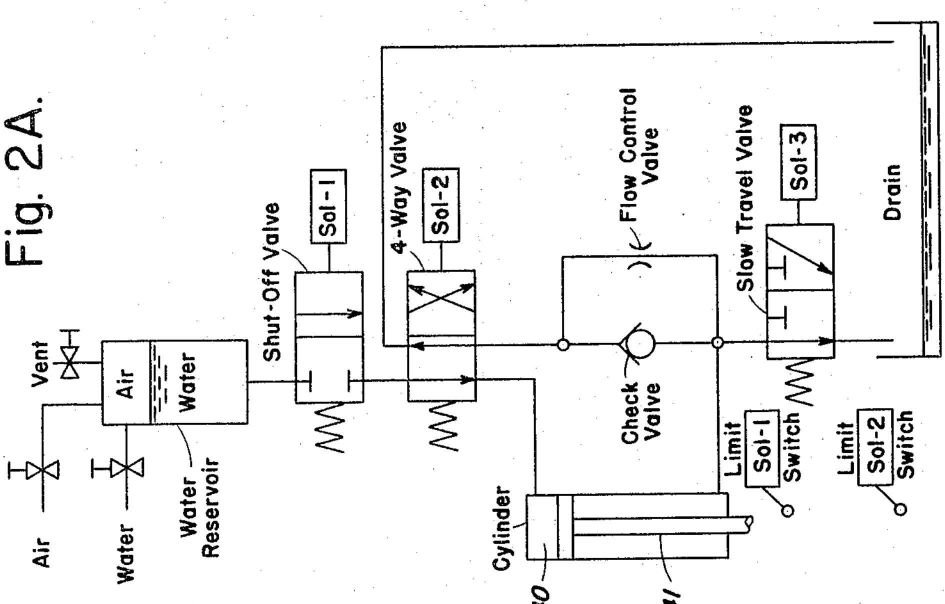


Fig. 2A.



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United States Patent Office 3,318,370
Patented May 9, 1967

3,318,370
APPARATUS FOR CASTING THIN-WALLED CAST IRON PARTS

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Filed July 2, 1964, Ser. No. 379,919
3 Claims. (Cl. 164—306)

This invention relates to a permanent casting apparatus suitable for carrying out the claimed process.

It is already known in the art in which this invention is classified that the difficulty of obtaining acceptable castings increases as the cross sectional area of the casting decreases. In particular, the occurrence of holes, as caused by misruns, slag, and sand, in thin-walled castings is far more frequent and far more serious, since such castings as sinks and bathtubs are to be enameled.

Various techniques have been suggested and tried in order to obtain satisfactory thin-walled castings. Each of these suggestions have singly suffered from one or more serious disadvantage. Thus, using regular permanent mold practices, non-uniform temperature gradients in the solidifying casting cause warping and distortion. Use of a thick coating of mold wash in the female mold, as performed in the art, results often in a roughened casting surface. Similarly, the use of pressure alone on the metal during or after its entry in the mold frequently has been found to produce unduly porous castings owing to the air or other gases being entrapped in the molten metal.

The main object of this invention is to provide an automated process for formation of light, strong, uniform, thin-walled fixtures which process produces castings requiring a minimum of secondary operations prior to enameling.

Another object of the invention is to provide a novel hydraulically operated mold which is easily automated and which when operated according to the method of the invention produces gray iron castings of unusually low section thickness with little or no scrap loss.

A further object of this invention is to provide a method of producing thin-walled castings of metal characterized by pouring a molten gray iron composition into an insulated, coated, preheated female die, rapidly closing the mold by bringing the insulated preheated male die to a point just above the molten iron, slowly advancing the male die during forming and quick opening the mold while the metal is at red heat.

Another object of the invention is to provide novel means for conveying molten iron in a furnace through a heated snorkel tube to a female die.

A further object of the invention is to provide novel means for extending the life of the snorkel tube by minimizing thermal shock.

These and other related objects, features and advantages of the present invention will be more fully understood as the description of the invention proceeds, particularly when taken together with the accompanying drawing in which FIG. 1 is a vertical sectional elevation of the novel forming apparatus of the invention. FIG. 2A is a circuit diagram of a hydraulic circuit for operating said apparatus. FIG. 2B is a circuit diagram for said apparatus.

As a preferred embodiment of the invention there has been selected apparatus suitable for the casting of bathtubs or sinks. It should be understood, however, that the present invention is in no way limited to the casting of such shapes.

Referring now to the drawing, the novel forming apparatus of the invention comprises a male die **3** (cope)

which is so maneuvered for example, by a piston in a cylinder such as shown in FIGS. 2A and 2B, that at the start of any given cycle it is in open position **2**; and a female die (drag) mounted above a pressurized melting furnace **14** connected therewith by a snorkel tube **6**, made of a refractory alloy or compound. Furnace **14** has a gas-tight lid **20**. An auxiliary heat source **7** surrounds the upper part of tube **6**. This tube can be cooled if needed by passing water which enters a cooling coil at **8** and exits at **10**. The diameter of snorkel tube **6** is such as to enable it to receive the core projection **11** on male die **3**.

Provision is made to cool both the male and female dies by passing air, steam, or water through passages **13**.

An inert gas which is non-oxidizing under the ambient conditions is maintained over the molten metal in the furnace. Suitable inert gases for the purposes of this invention include nitrogen, argon, helium, chlorine or carbon dioxide. Any means well known in the art can be used to convey the selected gas to the furnace.

The method of the invention can be illustrated by referring to the operation of the above described apparatus.

At the start of any given forming cycle, the gas pressure P_1 over the metal in the furnace is higher than the outside atmospheric pressure. This value is sufficient to keep a column of molten metal in the snorkel tube **6** above the heat source. The pressure then is increased to a value high enough to force metal up into the female die in an amount sufficient to give a full casting with minimal excess. This amount is denoted in the drawing by fill line **1** while the necessary pressure may be denoted by P_2. The level of the fill metal and the volume of the overflow trap are balanced to insure that all overflow metal, after forming, is still connected to the casting by a parting line flash which is sheared from the finished casting in a secondary trimming operation. The level of the metal in the mold is controlled by the duration and value of the fill pressure. The desired height of the metal is a function of the volume of the overflow trap which is controlled by the design and size of the part being press formed.

While this prefill operation takes place by increasing the gas pressure, the male die may either be in position **2**, which it has reached upon completion of the previous cycle; or at a point just above the metal fill line or in position **4**. However, if position **4** is used, the insulating value of the coating on the dies must be high enough to permit filling the casting before solidification occurs. To form the casting, the male die (cope) is slowly brought into the female mold (drag) to the extent that the central core projection penetrates the central opening **16** in the female mold and displaces the molten metal to the shape defined by the dies when closed. As soon as solidification is complete, the pressure is restored to P_1 to permit the level of the molten metal to fall to the level denoted by reference character **12** before opening the mold. The life of the snorkel tube is thus extended by minimizing thermal shock.

When the metal level has returned to the level indicated by **12**, the male die is quickly retracted to position **2**. The press-formed casting will then either remain in the female die or will adhere to the male die. This position can be controlled by regulating the die temperatures, the surface finish of the dies and the cycle timing. Die temperature is controlled by adjusting cycle time. For example, lengthening the time a mold remains closed lowers the temperature of the press formed part and increases its shrinkage. The cast section then locks onto the cope side of the die assembly. The preferred method is to open the mold when the casting is between 1750° and 1500° F. The casting remains in the drag side of the mold and is easily removed without any danger of cracking. Cycle time is a function of metal volume poured, cooling used, etc.

The finished casting can be removed by ejection off the male die with ejection pins or by picking up the casting from the female mold with a conventional vacuum holder. Preferably the casting should be retracted from the mold before it has cooled below black heat.

All the die surfaces which are wet by the molten metal should be coated with either lampblack, or, preferably by a multilayer coating disclosed and claimed in co-pending Ser. No. 380,047 filed this day, now Patent No. 3,266,-107. The coating described in said application consists of a base coating of a high conductivity, high ductility material used in the base layer, an inert refractory metal oxide and a plasma-sprayed overlayer of refractory oxide.

The apparatus of the invention may be automated by the use of a hydraulic system controlled by an electrical circuit such as shown in FIGS. 2A and 2B, as will appear hereinafter.

In order to begin a cycle on the machine of the invention, a start switch shown in FIG. 2B is closed to pull in a hold relay, CR–1. Solenoid **1** is also energized, thereby permitting water flow through the four-way valve into the top **40** of the cylinder, the rod **41** is operatively connected to male die **3**.

When the cylinder starts its stroke downward, a limit switch LS–1 shown in FIG. 2A, closes to complete the hold circuit, allowing the start switch to be released.

At a point above the molten metal, the descending upper die closes limit switch LS–2, energizing solenoid **3**, which stops the direct exhaust of water from the bottom of the cylinder to the drain. Instead, the exhaust water is channeled through the variable flow control valve. Limit switch LS–2 also energizes a timer motor and clutch, connected as shown in FIG. 2B.

After the desired time interval is completed, the timer switch TM–1 closes, energizing solenoid **2**, which changes the four-way valve. This provides free flow of water through the check valve into the bottom cylinder. Water exhausting from the top is directed to the drain.

As the piston starts to retract, LS–2 is opened.

At the top of the return stroke, the normally closed limit switch LS–1 opens, the hold relay, timer clutch, and motor drop out, solenoid **1** is deenergized and all motion ceases.

In successful demonstrations of the practice of the invention, the dies of the machine shown in FIG. 1 were maintained at a temperature of 700° to 800° F. and the metal pouring temperature between 2400° and 2750° F. However, this invention should not be considered as being restricted to these temperatures because the range is subject to die temperatures, coating thickness, wall thickness of casting, etc. The casting metal had the following composition: 3.70% total carbon, 2.40% silicon, 0.90% manganese, 0.08% sulphur, 0.50% phosphorus, balance iron. Castings were made with individual thicknesses of 0.020 to 0.125 inch. The surface appearance of all the cast shapes was excellent.

Having thus described and explained this invention and its mode of operation it will be understood that numerous

variations in the form and arrangement of parts shown and described may be made without departing from the nature and scope of the invention, except as defined in the appended claims.

What is claimed is:

1. In an apparatus for press-forming thin walled cast iron parts, and having;
   (a) a gas tight, pressurized holding furnace, having an opening in the top portion thereof;
   (b) a snorkel tube mounted on said holding furnace, and extending into molten metal in said furnace;
   (c) a female die mounted above said snorkel tube and having an opening in operative communication with said snorkel tube;
   (d) a male mold mounted proximate said female die, said female die and said male mold being spaced apart so as to provide a mold cavity;
   (e) means to selectively increase and decrease the gas pressure within said hold furnace and thereby force molten metal from said furnace, upwardly through said snorkel tube and into said mold cavity;
   (f) means to cause molten metal in said mold cavity to cool and solidify, the improvement comprising:
      said male mold having a central core projection position so as to project through said opening in said female die and below the level to which molten metal solidifies, and heating means to heat the molten metal within said snorkel tube and maintain the upper level of the molten iron above the bottom of the said central core projection during the molding operation, whereby decreasing the pressure in said holding furnace after solidification of the metal in said mold cavity causes the level of the molten metal to drop from a point above the bottom of said core projection to a point below the bottom of said core projection.

2. The apparatus of claim 1, wherein cooling means are provided for maintaining said core projection within desired operating limits.

3. The apparatus of claim 1, further comprising a cylinder connected to said male die and adapted to move the same in relation to said female die, a hydraulic circuit for actuating said cylinder, electric means for controlling said hydraulic circuit, said means including means for energizing said hydraulic system, means for holding said system stationary, and means for de-energizing the same.

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