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VACUUM FURNACE USEFUL IN THE PRODUCTION OF METALS

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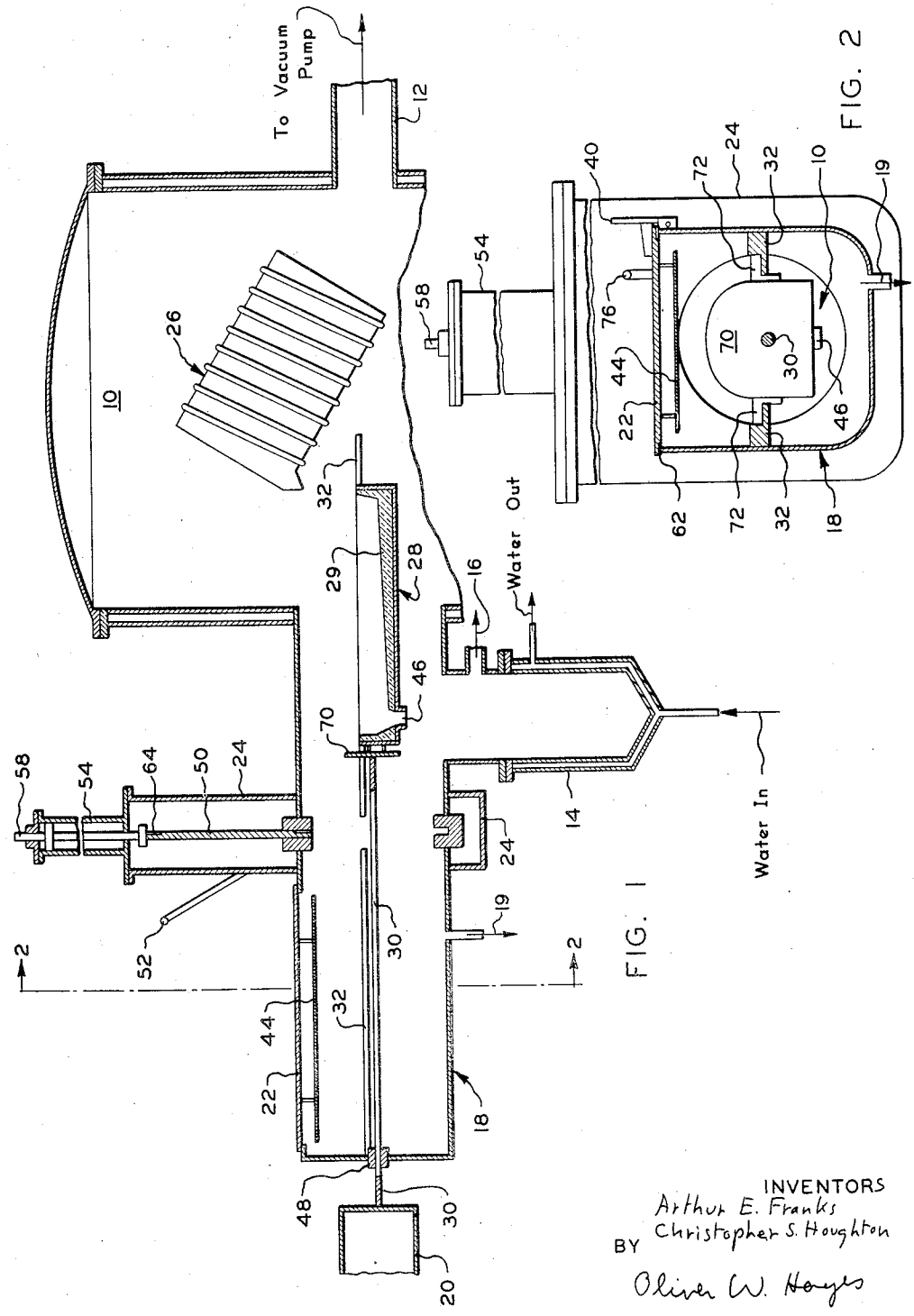


FIG. 2

FIG. 1

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VACUUM FURNACE USEFUL IN THE PRODUCTION OF METALS

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2 Claims. (Cl. 266—33)

The present invention relates to the melting and casting of metals in a vacuum and more particularly to the pouring of the cast metal into molds when using a pouring spout or launder formed of a refractory material. Ordinarily, the use of such a launder poses certain difficulties which it is the purpose of this invention to overcome. Often, when the molten metal being poured makes contact with the relatively cool launder, there is cracking and sealing of the refractory material, causing impurities to be introduced into the metal. Also, the metal may become sufficiently cooled to soldify and block passage of the metal into the mold and a costly delay in the operation will result. This is especially true if, in replacing a blocked launder, it is necessary to sacrifice the vacuum.

Accordingly, it is a principal object of the present invention to provide vacuum cast metals which are relatively free of impurities.

Another object of this invention is to provide a pouring apparatus which will minimize loss of metal by reducing the possibility of the metal solidifying within the launder during pouring operations.

Still another object of this invention is to make possible, at any time during the operation, the substitution of one launder for another without sacrificing the vacuum.

The invention accordingly comprises the apparatus possessing the construction, combination of elements and arrangement of parts which are exemplified in the following detailed disclosure, and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings wherein:

Fig. 1 is a sectional side view of a furnace with connecting loading chamber; and

Fig. 2 is a fragmentary sectional view of a portion taken along the lines 2—2 of Fig. 1.

Considered generally, the present invention deals with the melting and casting of metal under a vacuum or within a vacuum furnace for the purposes of making high-purity castings or ingots from initially high-purity metals, or for purifying metals as a result of melting the metals under vacuum and subsequently forming castings or ingots of the purified melts. More particularly, the present invention deals with that part of the operation of melting and casting which might be designated as the pouring step, wherein the metal, having been melted or purified under vacuum, is poured in to a mold. The pouring step would, of course, be carried on under vacuum conditions which would generally require a vacuum furnace with a suitable crucible and pouring mold located therein. The mold may, however, be located in a separate vacuum chamber attached or attachable to the vacuum furnace. The design and operation of one preferred such system is fully described in U. S. Patent 2,625,719, issued to J. H. Moore on January 20, 1953.

A vacuum chamber, which for convenience will be referred to as a launder loading chamber, is attached, by means of a vacuum closure, to a vacuum furnace. The vacuum closure is of such a nature that it may be opened to allow passage of the launder or pouring spout to and from the pouring position. The launder loading chamber is further provided with an evacuation means for reducing the pressure within the chamber to a low pressure on the order of 1 to 5 microns Hg abs. or less. The launder loading chamber is further provided with a mechanism, which for convenience will be called a locating means, with which to properly locate the launder at both the pouring and loading positions and to transfer the launder to and from these positions.

More particularly, the locating mechanism comprises a support means or tray on which a preheated launder is placed for transfer to and from the pouring position. The tray may be constructed of any material capable of withstanding high temperatures and in any convenient shape which will provide a secure seat for the launder. The tray is set upon or hung from a guide, preferably rails, which will insure proper transfer of the launder to and from the pouring positions. The tray is connected to a means which will transfer the tray to and from the pouring position. In a preferred embodiment, this transfer means is an air cylinder with a piston thrust of predetermined length. The air cylinder itself is preferably located outside the launder loading chamber, with the piston extending through the side of said vacuum loading chamber by means of a vacuum closure or seal, and is attached within the launder loading chamber to the tray.

In order that the preheated launder may be loaded into or unloaded from the launder loading chamber, there is provided a vacuum closure of convenient size. Preferably, this vacuum closure, which for convenience will be referred to as the loading closure, is located at the top of the launder loading chamber. To insure the vacuum-tight properties of the loading closure, a radiation shield is provided and located between the launder and the loading closure. It is preferred that the radiation shield be attached to the inner side of the loading closure so that, when the loading closure is opened to load or unload the launder, the radiation shield will swing back with the loading closure so as not to interfere with the loading operation.

Referring now more particularly to Figs. 1 and 2 wherein like numbers refer to like elements, there is shown one preferred form of the invention wherein there is provided a vacuum furnace chamber 10 arranged to be evacuated through pipe 12 which is connected to a vacuum pumping system (not shown). A second vacuum chamber 14, a portion of which may be formed by the mold itself, is provided to contain an ingot or casting mold and can be evacuated through pipe 16 which is connected to a suitable vacuum pumping system. The arrangement, up to this point, generally follows that disclosed and claimed in the aforementioned U. S. Patent 2,625,719 to Moore. A third vacuum chamber 18, extending from the furnace chamber 10, has been designated as a launder loading chamber. This chamber 18 is equipped with an evacuation pipe 19, a transfer means 20, and a vacuum closure 22 which is provided for loading and unloading of the launder 29. A closure 24 is provided which isolates the launder loading chamber 18 from the vacuum furnace 10. Positioned within the vacuum chamber 10 is an induction-heated crucible 26, shown in Fig. 1 in a tilted pouring position. The launder 29, supported on tray 28, is also shown positioned for pouring in both Figs. 1 and 2. The launder tray 28 is attached to transfer means which comprises a piston 30

which is in turn driven by the air cylinder **20**. The launder tray **28** is hung upon the guide rails **32** to insure proper transfer.

Referring now more specifically to the elements which have been outlined briefly above. The launder loading chamber **18** comprises a vacuum closure **22** through which the launder **29** is loaded and unloaded. For convenience of operation, the vacuum closure **22** is fitted with a handle **76** (shown in Fig. 2) and is also provided with dogs **40** (also shown in Fig. 2) to secure closure **22** in the closed position. To insure a vacuum-tight seal, a gasket seat **62** (shown in Fig. 2) is provided which in turn is protected from heat radiated from the launder **28** by a radiation shield **44**, attached to the vacuum closure **22** by metal struts and removed therefrom a distance on the order of two inches. In addition, the vacuum chamber **18** may be fitted with a cooling means such as water coils (not shown) to preserve the vacuum seal by preventing warping of the metal.

Within the loading chamber **18**, a launder tray **28** is is positioned to ride on the guide rails **32**. Preferably, this is done by fitting the sides of the launder tray **28** with flanges **72** which will ride on the rails **32**. The guide rails **32** are discontinued at a point before which they would be likely to interfere with the vacuum closure **24** and are again continued to extend into the vacuum furnace **10**. A front view of the tray **28** riding on the rails **32** may be seen in Fig. 2. The launder tray **28** is supplied with an opening **46** through which the spigot of the launder **29** protrudes. The tray **28** is attached by means of piston **30** through a vacuum seal **48** to an air cylinder **20**. Vacuum seal **48** is protected from heat radiating from the launder **29** by a radiation shield **70** attached to the tray **28**. The piston **30** is of a predetermined length, thereby insuring that the launder **29** will be properly positioned for pouring. Where the launder loading chamber **18** connects to the vacuum furnace **10**, a vacuum closure **24** is located which facilitates continuous operation of the vacuum furnace at a low pressure while loading and unloading of the launder **29** is carried on. Any type of vacuum closure may be used which is capable of being opened. Fig. 1 shows a preferred arrangement for closure **24** in which a sliding door **50**, provided with a gasket **64**, is shown in the open position. Sliding door **50** is attached to a piston **58** which is in turn a part of the air cylinder **54**. Operation of door **50** is initiated by the handle **52**.

In the operation of a furnace utilizing a pouring arrangement as is illustrated above, let us assume that the furnace **10** and the mold-containing chamber **14** have been evacuated and that the metal in the crucible is ready to be poured. Let us assume also that the closure door **50** of vacuum closure **24** is closed, isolating the loading chamber from the vacuum furnace, and that vacuum closure **22** is open to allow for loading. Launder **29**, which has preferably been heated to a temperature approaching the temperature of the molten metal, is placed onto the launder vehicle **28**. The vacuum closure **22** is closed and secured by the dogs **40**, then the launder chamber **18** is evacuated through the pipe **19** by an evacuaton means connected thereto. When the pressure of the launder loading chamber **18** is on the order of that within the vacuum furnace **10**, vacuum-tight door **50** of the vacuum closure **24** is raised to allow access between the two chambers. Air cylinder **20** is then operated to drive piston **30**, which in turn drives the launder tray **28** containing the launder **29** into pouring position. The crucible **26** is then tilted, pouring the metal into the launder **28**, through which it runs into the mold chamber **14**. After the pouring is completed (or, for some other reason, such as the formation of obstructions, the launder **29** must be removed), the operation is reversed to remove the launder **29** from the furnace chamber **10** to the launder loading chamber **18**. The closure **24** secures the vacuum within the furnace chamber **10** after the launder **29** has been removed to the launder loading chamber **18** by dropping door **50** of loading closure **24** into the closed position. Launder **29** is removed from the launder loading chamber **18** through vacuum closure **22** to be replaced by another.

In the preferred type of furnace illustrated in the drawings, the various structural parts are made of stainless steel or other non-magnetic metal, while the launder or pouring spout is of refractory material rammed into a stainless or mild steel shell. In the preferred operation, the launder was preheated by a gas-type heater, the burner head of which is shaped to fit within the pouring canal of the launder. The temperature to which the launder was heated was on the order of above 1200° F.

Since certain changes may be made in the above apparatus without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description, or shown in the accompanying drawing, shall be interpreted as illustrative and not in a limiting sense. Such a change could be the substitution of an atmosphere or a partial atmosphere of an inert gas for vacuum in one or more of the various chambers herein contained.

What is claimed is:

1. In a vacuum furnace, an apparatus for introducing and removing a refractory type launder during the operation of said furnace without loss of the vacuum, said apparatus comprising a launder loading chamber connected to the vacuum furnace by a vacuum-tight closure, said launder loading chamber being provided with a launder tray for supporting, and guide means for proper positioning of, said launder, a second vacuum-tight closure through which the launder can be inserted and removed, said second vacuum-tight closure being protected by a radiation shield, means for evacuating said launder loading chamber, means for transferring a preheated launder to and from the loading and pouring positions, said transfer means comprising a piston, the end of which is attached to said launder tray and which extends through a vacuum seal in the end of said loading chamber farthest away from the vacuum furnace to a cylinder which drives said piston, said vacuum seal being protected by a second radiation shield.

2. The combination of a vacuum furnace, a tiltable crucible in the furnace, means for evacuating said furnace, and a launder loading chamber attached to said furnace by means of a vacuum closure, said launder loading chamber being provided with a radiation shield-protected second vacuum closure utilized to introduce and remove a launder, means for producing a vacuum in said loading chamber while it contains a heated launder, a tray for supporting and means for transferring said launder to and from the pouring position, said transfer means comprising a movable rod attached to the end of the launder and extending through a radiation shield-protected vacuum seal to a driving means.

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