Sept. 15, 1959 T. E. MILLARD 2,903,760

MOLD HEATING AND CASTING POT

Filed Feb. 26, 1957 3 Sheets-Sheet 1

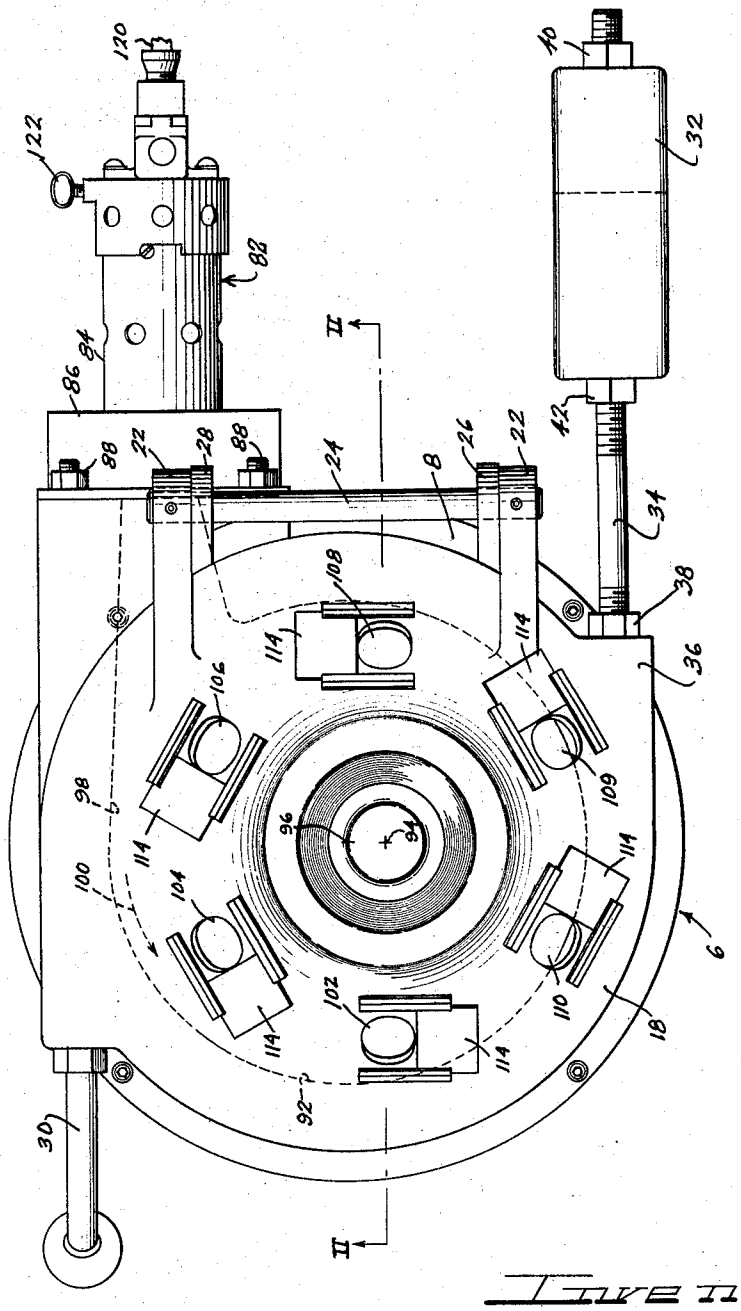


Fig. 1

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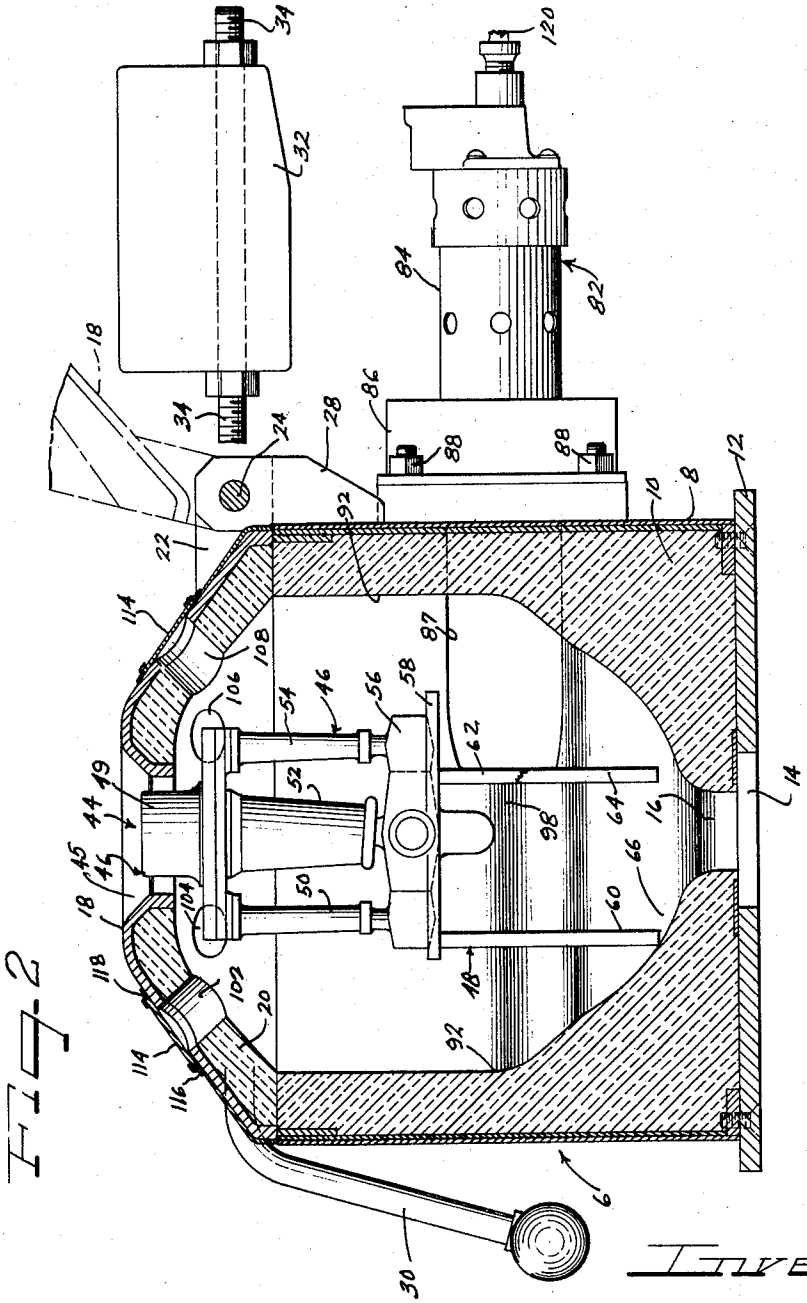


FIG. 2

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Fig. 3

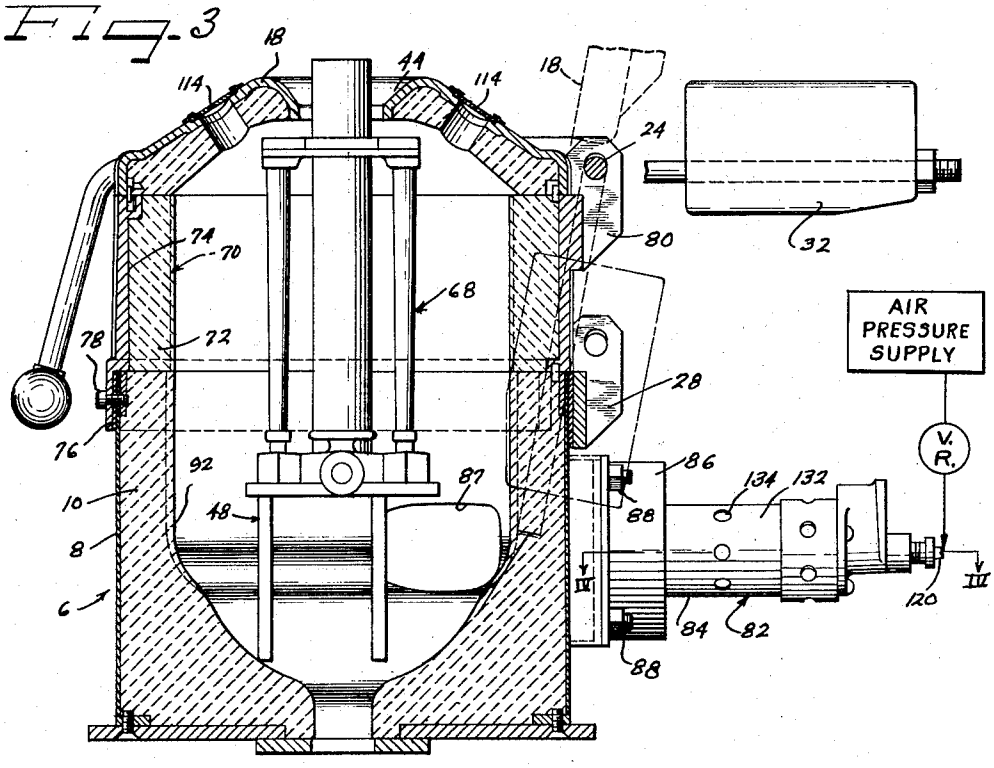
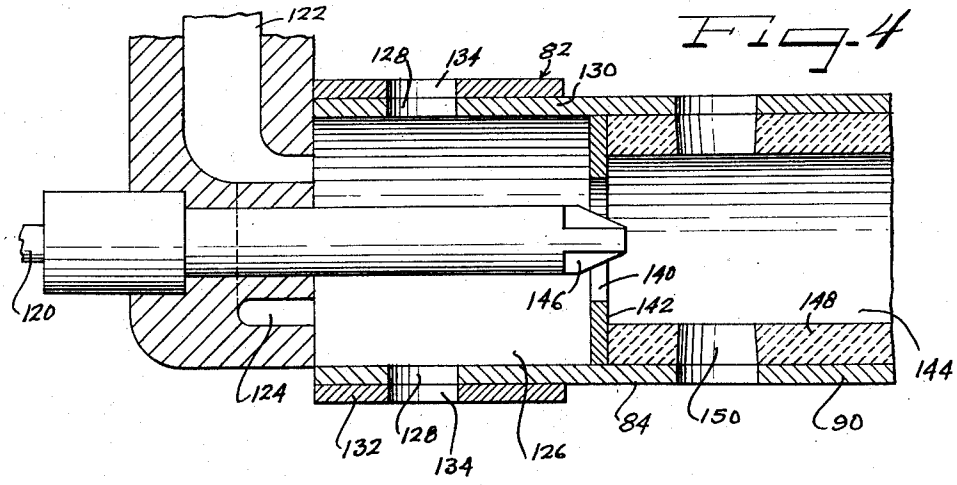


Fig. 4



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MOLD HEATING AND CASTING POT

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Application February 26, 1957, Serial No. 642,403

6 Claims. (Cl. 22—74)

The present invention relates to improvements in furnaces for containing molds and for applying a heat treatment to the molds and for containing the molds during the time they are being poured.

In the manufacture of molds of the type utilizing the present invention, the molds are first formed and then receive a heat treatment to condition them prior to pouring. The molds may be made by various methods and by way of illustration can be formed by the frozen mercury process wherein mercury is solidified in the shape of the pattern and dipped into a slurry which coats the frozen mercury to form the mold. The mercury is then permitted to liquify and run out of the mold whereupon the shaped mold remains. In accordance with the present invention, the mold is then located in a furnace where it receives a heat treatment. The mold remains in the furnace to be poured by being filled with metal.

The present invention contemplates the provision of a furnace enclosure lined with a fire resistant material and provided with an adjustable pedestal or support for supporting the mold therein. The furnace has a removable cover provided with a pour opening which is adjacent the mold and provided with adjustable vent holes for escape of gas. A vented waste opening is also provided at the bottom of the furnace. The furnace is provided with a removable insert wall section which can be added to adjust the furnace height with variance in the height of the molds so that the top of the mold will always be near the port hole. The cylindrical interior of the furnace is arranged so that the mold will be supported in an off center location with respect to the furnace. To achieve this, the furnace wall is provided with a cylindrical offset portion and a burner is arranged to direct a flame tangentially into the offset portion at a point spaced furthest from the mold. The flame will follow an encircling path around the mold to apply a uniform heat to all sides thereof. The burner applies a pulsating flame to the mold to improve the physical characteristics thereof and the pulsation rate can be altered.

In accordance with the foregoing, it is an object of the present invention to provide an improved furnace for the treatment of molds by heat.

Another object of the invention is to provide an improved furnace whereby heat may be uniformly and evenly applied to all sides of the mold.

Another object of the invention is to provide an improved mold-treating furnace where height of the furnace wall is readily adjustable so that the mold will always be readily accessible to a pour hole.

A further object of the invention is to provide an improved method for treating molds and a mold-treating furnace wherein the heated treating gases are applied with an encircling motion and the gases are deflected in such a manner as to be closer to the mold as their temperature decreases to apply uniform heat thereto.

Another object of the invention is to provide an improved mechanism and method for improving the physical characteristics of a mold by heat treatment with the

application of a pulsating heat applying medium to the mold.

A still further object of the invention is to provide mold-treating furnace having an improved support for the mold.

Other objects and advantages will become more apparent with the complete disclosure of the principles of the invention presented in connection with the description given in the specification and claims and accompanying drawings, in which:

Figure 1 is a plan view of the mold-treating furnace;

Figure 2 is a vertical sectional view of the furnace taken along the line II—II of Figure 1;

Figure 3 is a sectional view similar to Figure 2 illustrating the furnace with a removable insert or spacer added for use with a taller mold; and

Figure 4 is a horizontal sectional view taken along lines IV—IV of Figure 3.

While the drawings illustrate the preferred embodiment of the invention and illustrate the various features thereof in combination with a unit presenting an environment to which they are particularly well adapted, it is to be understood that the various features and units of the invention may be utilized in other surroundings taking advantage of their inventive principles.

In Figures 1 and 2 the furnace is shown generally at 6 having a cylindrical body formed with an outer shell 8 which may be of metal or the like. Within the shell is provided a shaped, fire-resistant material 10, which has a general cylindrical inner configuration providing an enclosure for the mold. The side wall of the furnace is supported on a base member 12 to which the wall is suitably connected. In the center of the base member is an escape opening 14, which communicates with an opening 16 in the inner, shaped, fire-resistant liner 10, and these openings provide for the escape of heating gases and for the escape of waste metal that is being poured into the mold.

The top of the furnace has a removable cover 18, which is likewise lined with a fire-resistant material 20. The cover is hinged along one side and, for this purpose, is provided with projecting brackets or arms 22 which receive a hinge or pintle rod 24 that extends through brackets 26 and 28 conected to the side wall 8 of the furnace. The cover, as thus pivotally supported, is provided with a handle 30 with which it may be opened, and it is shown in the dotted line position 18 in Figure 2 as being in the open position. For ease of opening and closing, the cover is provided with an adjustable counter-balancing weight 32 which is slidably supported on a rod 34. The rod 34 is threaded into a boss 36 in the cover, as is shown in Figure 1, and held in its position by a lock nut 38. The weight 32 is locked in its adjustable position along the rod 34 by nuts 40 and 42, which are threaded on to the bar. The cover is counter-balanced by adjustment of the weight along the bar 34 to balance its weight in the well-known manner.

In a centrally located poition with respect to the body of the furnace, there is provided a pour hole 44. Projecting up into the pour hole is the mold 46, as supported on the pedestal or support 48. The pour hole 44 has tapered sides 45 to aid in pouring, and the center section 49 of the mold also referred to as the pouring cup, which will contain the opening for receiving the molten metal, extends up into the pour hole.

The mold, which is accommodated by the furnace disclosed herein, may be of various types, but as is shown is for the purpose of casting turbine blades. The mold is shown with a central hub section 49 which receives the molten metal and passageways lead from this central section into the legs of the mold which are shown at 50, 52 and 54. These legs are connected by a base por-

tion 56, which will rest in notches in the upper platform top 58 of the pedestal 48. As shown, the pedestal is provided with legs 60, 62 and 64 which are triangularly arranged to project downwardly from the platform 58. The three triangularly arranged legs 60, 62 and 64 rest on the concave spherical floor 66 of the inside of the furnace. With the use of triangularly arranged legs and a spherical floor 66, it will readily be seen that the pedestal can be adjusted to various positions with the supporting platform 58 being variable to be positioned in different angles. Thus, if a mold 46 is used which has an upright portion not projecting upwardly at right angles from its base, the pedestal 48 can be adjusted until the mold will stand upright. As is the case with the present mold, the pedestal can readily be adjusted to insure that the central metal receiving hub 48 will be centrally located within the pour opening 44 for ease of pouring. This central location within the pour opening also permits the metal to easily overflow when the mold is filled. Metal overflowing the mold will, of course, drop down to the concave spherical floor 66 and will run out through the central opening 16.

Molds of varying heights are used and readily accommodated by the present furnace. As is illustrated in Figure 3, a mold 68 is provided which is taller than the mold 46 shown in Figure 2. In order that the furnace will accommodate the added height of the mold 68, an insert spacer 70 is sent at the top of the furnace wall 10. This spacer 70 has a lining of fire-resistant material 72 surrounded by an annular outer shell 74 which may be of metal or the like. At the base of the shell 74 is an annular flange 76 which has an inside diameter larger than the outside diameter of the shell 8 of the lower wall of the furnace so as to set thereon in telescoping relationship. Bolts such as 78 may be threaded through the flange and into the shell 8 to secure the insert 70 in place. The flange 76 is broken at the back so as not to interfere with the brackets 28, which previously supported the cover. The shell carries new brackets 80 which receive the pin 24 to pivotally support the cover 18 at the top of the extension. Thus, the insert is attached to the furnace by removing the pin 24 and the cover from the furnace, as set up in Figure 2, and inserting the spacer 70, securing it in place and attaching the cover to the top of the spacer. If the furnace were used in the manner shown in Figure 3 with the mold 46 of Figure 2, the hub 48 would not be near the centrally located pour opening 44. However, with the use of mold 48 and the spacer, the hub will be placed at a convenient pouring spot to enable the mold to be poured without spilling or spattering of the material. It will be recognized that spacers such as 70, may be provided in different sizes to accommodate molds of different sizes. With the exception of the use of the insert 70, the other parts of the furnace remain the same and like numbers are used for like parts throughout the drawings.

A burner 82 is provided for supplying heat to the furnace to treat the mold. The burner has a cylindrical body 84 with a base portion 86 which is suitably secured to the furnace wall such as by bolts 88. An opening 87 is provided in the furnace wall and the forward end, shown at 90 in Figure 4, projects through the opening to project a flame into the furnace interior. As shown in Figure 1, the burner 82 is located so that the flame will be projected tangentially against the inner cylindrical wall of the furnace. The flame and hot combustion gases will circle the inner wall surface 92 in the body portion of the furnace. This body section of the furnace is cylindrical in shape and is offset from the other circular sections of the furnace. That is, the center or axis of the floor 66 of the furnace and the pour opening 44 of the furnace are centrally located at 94 with respect to the furnace wall, as shown in Figure 1. The radial center or axis of the central body portion or of the wall 92 is located at 96, as is shown in Figure 1. Since the pedestal

48 is centrally located in the base 66 of the furnace, its center will be at 94, which is the center of the pour hole. The inner flame deflecting wall 92 will then be offset from the position of the mold 46. The burner 82 is positioned so that the flame will be first projected at the portion of the wall 92, which is furthest from the mold and this portion of the wall is shown at 98. The flame entering the cylindrical inner wall 92 tangentially at 98, will be deflected along the wall in the direction of the arrow 100. Thus, the first hot gases to enter the interior of the furnace enclosure will be furthest from the mold and will be furthest from the axial center 94, which marks the center of the mold. As the gases lose their heat they progressively move closer to the mold, following the deflector wall 92. Thus, as their temperature drops, the distance between the gases and the mold decreases so that the amount of heat imparted to the mold remains substantially constant. This will help in insuring an even curing of the mold on all sides.

As will be recognized from the drawings, the flame enters the furnace at a location furthest from the mold and the distance from the furnace wall to the mold will decrease for 180° of travel of the flame and then the distance will increase for a portion of the wall arc. This is caused by using a furnace having a cylindrical inner wall surface, which makes it possible to have the flame enter at a location furthest from the mold and thereafter progress gradually and evenly toward the mold as a function of the flame advancement around the furnace wall merely by placing the mold at an eccentric location in the furnace (or by offsetting the cylindrical wall from the mold axis). There are other advantages such as in manufacture which make a cylindrical furnace desirable. The increase of the distance from the mold to the furnace wall for a portion of the wall arc does not cause any great disadvantage since, as will be observed in Figure 1, some heat from the entering flame will radiate to the portion of mold exposed to the flame and gases as they finish their encirclement. Where the present principle of decreasing the wall distance to the mold is to be used for a full 360° of wall arc, a spiral shaped furnace wall is used as described below.

In another form, the invention may be practiced by employing a furnace having a wall which is spirally shaped with respect to the central axis where the mold or object to be heated is supported. The burner will be positioned to direct a flame tangentially against the spiral wall at the location furthest from the mold. The heated gases and flame will circle the wall, getting closer to the mold as their temperature and velocity decrease, thus affecting the mold uniformly from all sides.

The gases, on entering the furnace enclosure, will spread upwardly over the wall surface 92, and some of the spent combustion gases will pass out through the openings 102, 104, 106, 108, 109, and 110, in the cover. Each of the vent openings is provided with a sliding draft control shutter or plate, as shown by the plates 114 for the holes 102 to 110.

These shutter plates are adjustable being slidably held under guides 116 and 118 secured to the cover 18. The shutter plates are shown open in Figure 1 and closed or partly closed in Figures 2 and 3. By adjustment of these shutter plates, the amount of gases escaping can be controlled and the remainder of the gases will escape out through the opening 16 at the bottom of the furnace enclosure. Thus, by adjusting the shutter plates, the temperature within the enclosure from the bottom to the top of the furnace can be regulated. For example, by driving more heat out through the bottom opening 16, by closing the shutter plates a further amount, the temperature in the base of the furnace can be increased.

In addition, to being treated with heat, the mold receives a slight rapid jarring motion which causes more rapid heating. This jarring also acts to reduce the grain size of the molten metal poured therein and im-

prove its physical characteristics upon solidification. This vibration or jarring is provided by the burner. To obtain this end, a pulsating burner is used. The construction of the burner to obtain this effect is shown in the detailed view of Figure 4. The burner is provided with a source of compressed air fed through a line **120**. The fuel enters the burner through an annular groove **124** to pass into the mixing chamber **126**. The mixing chamber is provided with a source of primary air through the holes at **128** extending around the cylindrical shell **130** of the burner. The holes **128** for primary air are adjustable by means of a rotating sleeve **132** which contains holes **134** to be brought into a mating engagement with the holes **128**. By rotation of the sleeve in predetermined amounts, the amount of primary air supplied to the mixing chamber **126** will be regulated. The gas and primary air leave the mixing chamber through an opening **140** in a separating wall **142** between the mixing chamber **126** and the combustion chamber **144**. At this point, the mixture of gas and primary air is mixed with the primary compressed air issuing from the nozzle **146**. This mixture is spontaneously ignited in the combustion chamber **144**, which is lined with a refractory liner **148**, having a chemical additive. The chemical additive in the refractory liner will glow in a manner which gives radiant heat from a cold surface thus improving the heat transfer to the mold while aiding the flashback ignition of the burner which thereby produces the beneficial pulsations used to gain further rapid heating as well as refined grain structure of molten metal within its environment.

This flash-back action of the flame is available from a burner of the type described known as an inspirator-aspirator type burner. As an example of the type of liner that may be utilized in the burner, a mixture of sixteen parts of plaster of Paris, one part alum, one part potassium permanganate and one part salicylic acid may be compounded and used as the liner combined with a refractory fire brick.

Secondary air is provided to the combustion chamber through the openings **150** annularly arranged around the chamber. The frequency of pulsation of the burner is controlled by the air pressure of the compressed air entering through the nozzle **146**. In accordance with the principles of the present invention, the preferred range of pulsation to obtain improved physical characteristics of the casting varies with each alloy in the range of from 1,200 to 40,000 pulsations per minute. This has been found to be advantageous in cooperation with the elements as described. The heat from the burner is preferably in the range of from 1,400 to 2,200° F.

Although the operation of the furnace herein described will be apparent from the foregoing description of the details of structure, a summary of operation will be helpful in understanding the objectives and attainments of the invention. The mold **46** is placed on the pedestal **48**, which may be shifted on the cylindrical floor **66** of the furnace **6** in order that the mold will stand upright and that the hub **49** will be centrally located within the pour opening **45** in the cover **18**. For removing and replacing the mold **46**, the cover **30** can be lifted and swung to the dotted line position of Figure 2 on the hinge pin **24**. Heat is applied to the mold by means of the burner **82**, which is positioned to direct the flame tangentially into the enclosure. The flame is directed by the cylindrical wall **92** around the mold **46** by the deflector wall **92**. The wall **92** is cylindrical in shape and is offset from the position of the mold and the base and cover of the furnace so that the hot gases first issuing from the burner will be furthest from the mold, and as their temperature decreases they will be deflected inwardly to be in a position closer to the mold. The burning gases are inserted into the furnace with a pulsating frequency caused by the controllable pulsating burner and this causes a variation in the application of heat and a vibration of the gases surrounding the mold to cause more rapid mold heating and act to reduce the granular structure of the molten metal poured therein and improve its physical characteristics upon solification. As will be understood from the foregoing description, the pulsating burner may be used for curing the mold before pouring and also for treating the casting after pouring the mold if desired.

Thus, it will be seen that I have provided an improved furnace for the treatment of molds and for containing the molds for a pouring operation. The structure illustrating the preferred embodiment of the invention attains the objectives and advantages hereinbefore set forth and provides an improved method of controllably treating molds of various sizes. Molds of improved physical characteristics will result when treated by the furnace disclosed, and operation and control of the furnace is reliable and accurate.

It will be understood that while the disclosed embodiment is used for the treatment of molds or for molding, that the furnaces may be constructed for the treatment of other objects or materials such as metals or carbon parts, utilizing the features of the invention. Thus, while the description refers to molding, for convenience of the disclosure, it will be understood that while certain features of the invention operate to obtain particular new and improved effects in molding, the utilization of inventive features is not to be limited to this use.

I have, in the drawings and specification, presented a detailed disclosure of the preferred embodiments of my invention, but it is to be understood that I do not intend to limit the invention to the specific form disclosed, but intend to cover all modifications, changes and alternative constructions and methods falling within the scope of the principles taught by my invention.

I claim as my invention:

1. A furnace for molding comprising a furnace enclosure having a cylindrical interior and an eccentrically located pour opening in a cover at the top on the same axis as an escape opening at the base, a mold mounted on a mold support member centrally located with respect to the pour opening but eccentrically located within the cylindrical interior of the furnace enclosure, a pulsating burner positioned to direct a pulsating flame tangentially into the enclosure to encircle the mold, said enclosure having an offset cylindrical section for channelling the flame with the burner being positioned in the offset section furthest from the mold to direct the flame into the cylindrical furnace enclosure at the location furthest from the mold, means to selectively control the rate of flame pulsation of the burner to obtain the desired mold heat, time cycle of heating and grain refinement of a casting made therein, a vent opening in the enclosure for the escape of gases, and a removable intermediate section in the furnace enclosure to accommodate molds of different height bringing the molds near the pour opening at the mold top and locating the pouring cup centrally with respect to the pour opening in the furnace top, said cover fitting on the removable section and on the enclosure with the removable section removed.

2. A furnace for molding comprising a furnace enclosure having a heat resistant lining with a cylindrical interior offset from the center of the furnace enclosure, an escape opening at the base of the enclosure, vent openings at the top of the enclosure, adjustable closure members for the upper vent openings to control the amount of gases that escape and insure an even distribution of gases so that the escape of some of the gases will occur through the base escape opening, a removable cover for the enclosure, a removable and replacable side-wall section for the enclosure to vary the height thereof, said cover fitting on the enclosure over the side wall section or on the enclosure with the section removed, a pour opening in the cover of the enclosure for pouring molten metal into the mold, a burner positioned to direct

a flame tangentially into the offset cylindrical section of the housing at the cylindrical location which is farthest from the mold, the cylindrical wall defining a path in which the gases are deflected around the mold in an encircling wall around the mold, and means for causing a pulsation of said flame at a controlled rate, said pulsating flame vibrating the gases surrounding the mold to improve its heat acceptance and physical characteristics of the casting which is made therein.

3. A furnace for molding comprising a furnace enclosure having a pour opening at the top and a waste opening at the bottom and having a cylindrical interior, said interior including a first and a second section with the axis of the second section offset from the axis of the first section, a support member within the enclosure for supporting a mold in a central location with respect to the first section, and a burner in the furnace wall in the second section and positioned to direct a flame tangentially into the second section, the flame entering the section at a location adjacent the furnace wall spaced farthest from the mold to reduce the heat transmitted to the mold, the burner gases following the wall of the second section and being directed closer thereto as they move around the wall and lose some of their heat.

4. The method of treating a mold with heat which comprises supporting the mold in a position to receive a heat treatment, directing a flame tangentially past the mold at a predetermined distance therefrom, and deflecting the flame in an encircling motion around the mold in a decreasing radius from the mold so that as the heat content of the gases is reduced as they are moved closer to the mold to contribute a uniform amount of heat to the mold on all sides.

5. The method of treating a mold with heat which comprises, supporting the mold in a heat treating position, and directing a pulsating flame in the area of the mold to contribute heat to the mold and to vibrate the

mold with pulsating variations of the heat and the force of the gases to improve the heat absorption characteristics thereof.

6. A furnace for molding comprising a furnace enclosure having an interior the cross section of which is defined by at least two contiguous segments of cylinders of different radial centers, the center of one of said segments being offset from the center of the other of said segments in a first direction, a hingedly mounted top member for closing said enclosure, a pour opening in said top member, said pour opening being substantially directly above a first of said radial centers, a support within the enclosure adapted to support a mold above said first radial center and directly beneath said pour opening, a burner positioned to direct a flame along the wall of said enclosure, said burner being located so that the flame is initially directed perpendicularly to the straight line defined by said two radial centers and thus tangentially to the wall of said enclosure beginning at the point farthest from the mold so that the flame will follow the wall and will move progressively closer to the mold as it loses its heat in its path of travel around the mold.

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