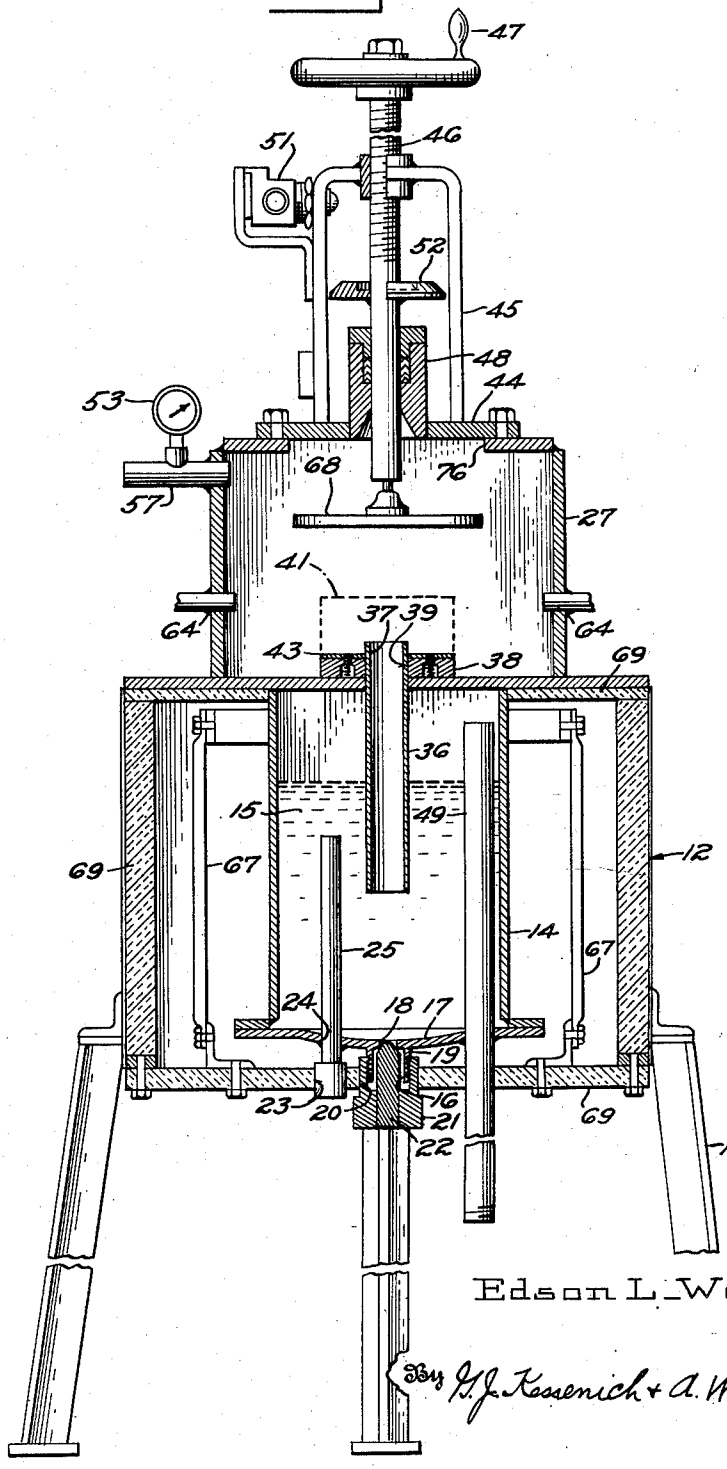
Feb. 4, 1958 E. L. WOOD 2,821,757

APPARATUS FOR THE PRECISION CASTING OF SOFT METAL MOLDS

Filed July 17, 1951 4 Sheets-Sheet 1

Fig. 1.




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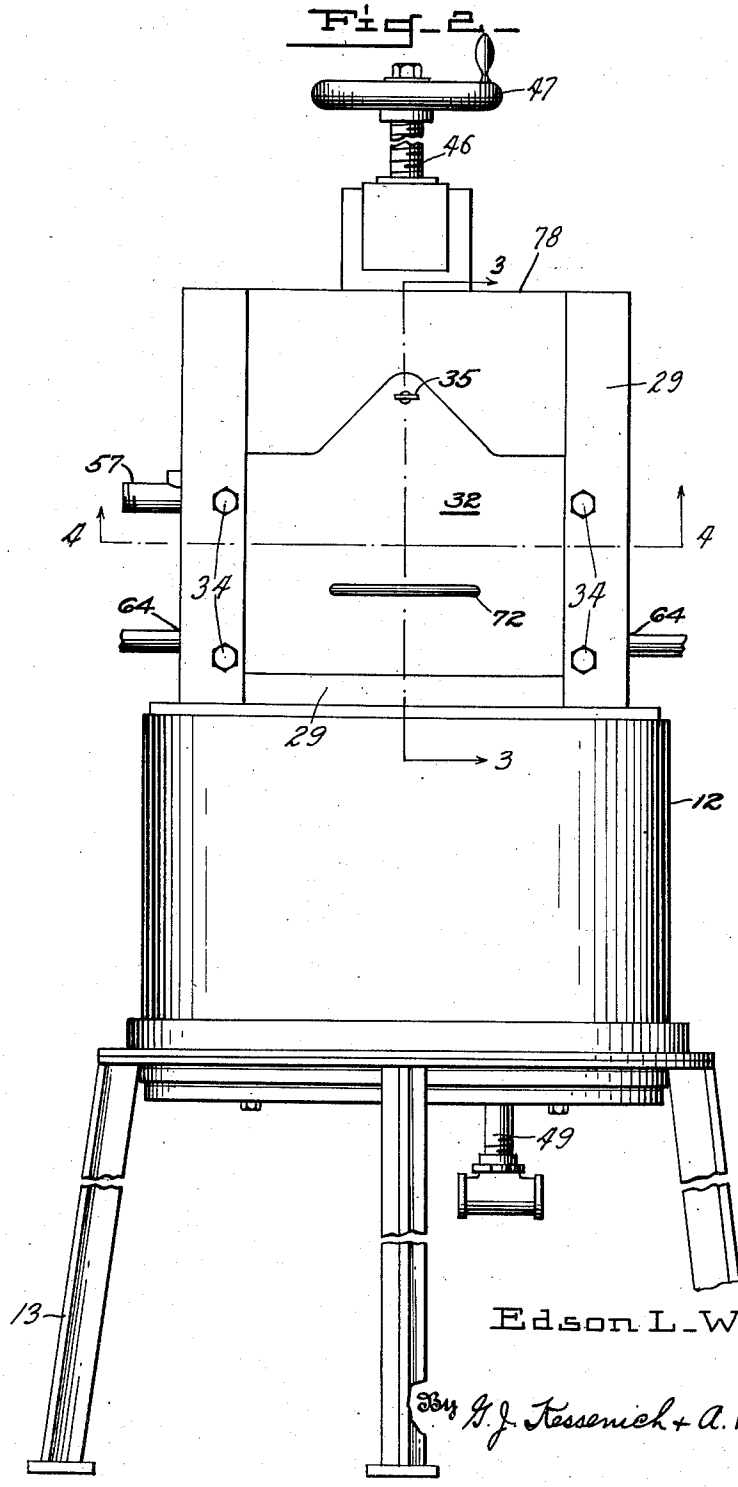
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APPARATUS FOR THE PRECISION CASTING OF SOFT METAL MOLDS

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Fig. 2.




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APPARATUS FOR THE PRECISION CASTING OF SOFT METAL MOLDS

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Fig. 3.

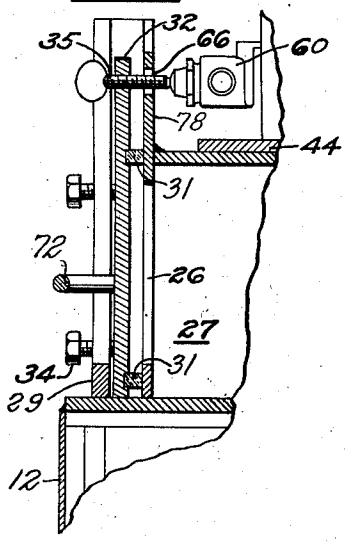



Fig. 4.

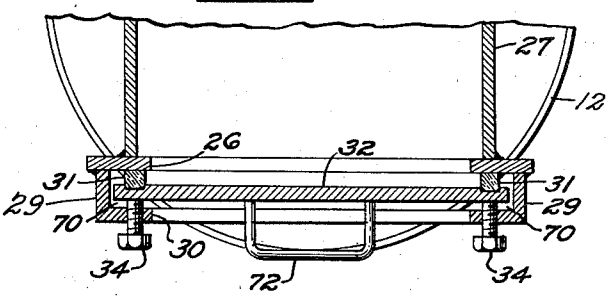



Fig. 5.

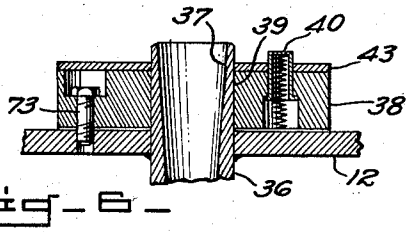
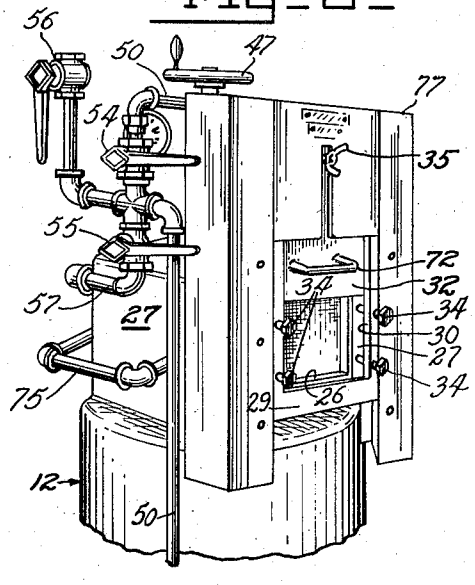



Fig. 6.




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APPARATUS FOR THE PRECISION CASTING OF SOFT METAL MOLDS

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Fig. 7.

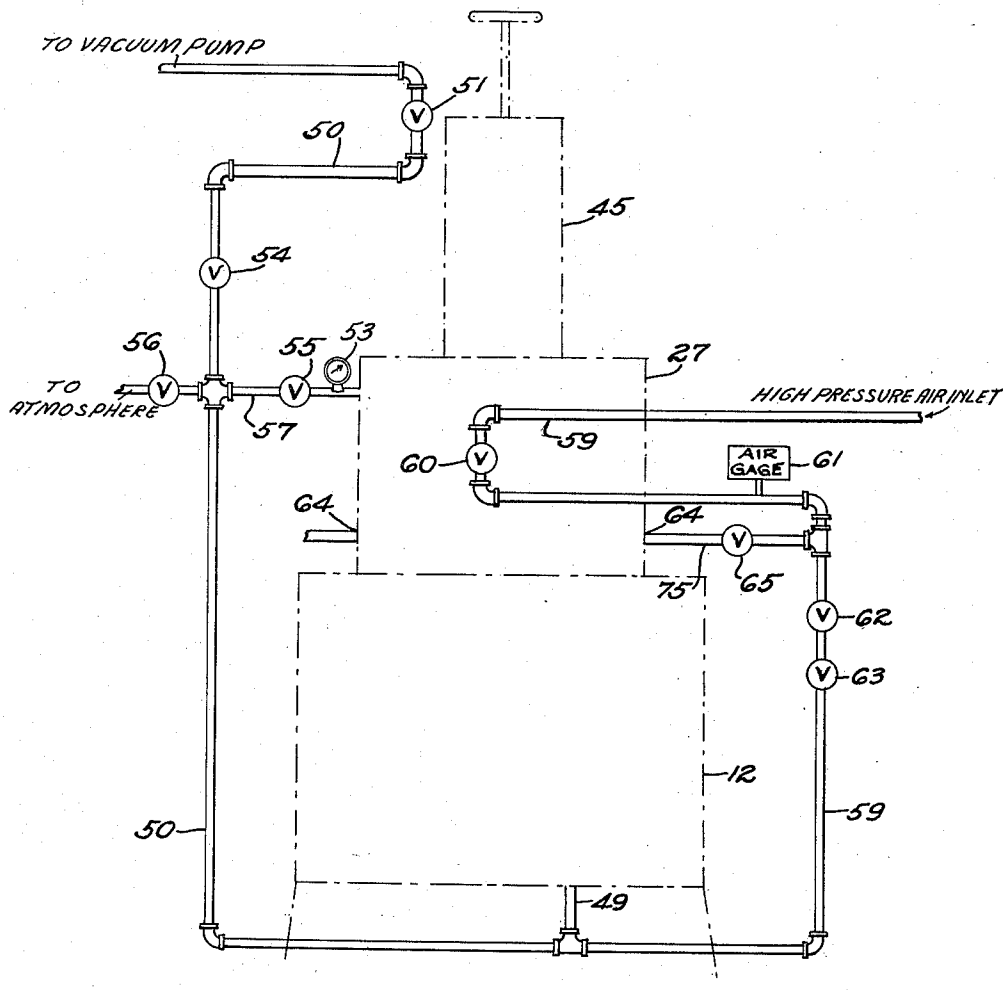
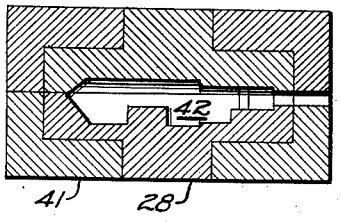



Fig. 8.




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United States Patent Office 2,821,757
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2,821,757

# APPARATUS FOR THE PRECISION CASTING OF SOFT METAL MOLDS

Edson L. Wood, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army

Application July 17, 1951, Serial No. 237,271

3 Claims. (Cl. 22—69)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described in the specification and claims may be manufactured and used by or for the Government for government purposes without the payment to me of any royalty thereon.

This invention relates to investment of precision casting and is directed more particularly to a method and apparatus for casting soft metal molds of the type wherein wax patterns are to be formed.

In the art of investment casting, a master mold of soft metal is sectionally cast so that the cavity therein will be an exact negative duplication of the exterior configuration of a master pattern. These soft metal molds are utilized for the casting of wax patterns from which refractory molds are produced for the casting of replicas of the original article.

Inasmuch as master patterns are quite often of intricate configuration, the soft metal is usually cast under pressure in order to adequately feed the corners and crevices of the master pattern. Obviously, the greater the pressure up to a certain limit, the more accurately will the mold negatively duplicate the configuration of the master pattern. However, during the pouring of molten metal under pressure there exists the possibility of air becoming entrapped therein and creating porosity, voids and like defects in the completed mold. Attempts have been made in the art to eliminate the entrapment of air in the molten metal by providing holes or vents in the chamber wherein pouring is effected. Satisfactory results, however, have not been achieved since the molten metal usually solidifies before all of the entrapped air can escape.

Accordingly, it is an object of this invention to provide an improved method and apparatus for casting soft metal molds under pressures designed to reproduce the configuration of a master pattern with far greater accuracy than heretofore and yet result in finished molds which will be substantially free from deleterious porosity and voids.

It is also important that the finished molds be of optimum soundness, free from oxides and other dross. However, since impurities of this type are invariably of lighter specific gravity than the remainder of the molten metal, they accumulate on the top surface thereof and have, heretofore, been poured along with the pure metal.

A further object of this invention, therefore, lies in providing an improved method and apparatus for casting soft metal molds wherein any impurities accumulated on the top surface of the molten metal are not automatically poured along with the rest of the metal.

Still another object of this invention resides in providing a method and apparatus for casting soft metal molds wherein the temperature of the molten metal is held within a relatively narrow range prior to and during the actual step of casting.

The specific nature of the invention as well as other objects and advantages thereof will clearly appear from a description of a preferred embodiment as shown in the accompanying drawings in which:



Fig. 1 is a view in vertical cross-section of an apparatus constructed in accordance with the present invention and adapted for the precision casting of soft metal pattern molds;

Fig. 2 is a front view of the apparatus;

Fig. 3 is a fragmentary side view of the casting chamber taken in vertical section along line 3—3 of Fig. 2 with the door held in the closed position to show the details of the frame and door construction thereof;

Fig. 4 is a fragmentary plan view of the casting taken in horizontal section along line 4—4 of Fig. 2 to show additional details of the door and frame construction;

Fig. 5 is a vertical cross-sectional view of the member arranged to support the flask in which the casting is to be made;

Fig. 6 is a perspective view of the upper portion of the apparatus showing the door held open so that the flask can be placed therein upon the support shown in Fig. 5;

Fig. 7 is a schematic view of the combination vacuum and high pressure system employed with the apparatus of the present invention; and

Fig. 8 is an enlarged vertical cross-sectional view of the flask containing a representative master pattern about which a soft metal mold has been cast by the apparatus of the invention.

As shown in the drawings, there is provided a stand 13 arranged to support a cylindrical heating chamber 12. A pressure-tight receptacle 14 for molten metal 15 is fixedly mounted within chamber 12 by suitable means (not shown) to the top closure thereof. The floor of receptacle 14 is substantially concave as best shown at 17 and is provided with a centrally located hole 18 therethrough. An exteriorly threaded hollow stud 19 depends from the underside of floor 17 in axial alignment with hole 18 and projects into a suitable opening 20 formed through the bottom of chamber 12. A sleeve 21 fits tightly up into opening 20 and is provided with an internally threaded counterbored portion 16 engageable with stud 19. A plug 22 is fixedly mounted in the base of sleeve 21 and projects upwardly through counterbored portion 16 to completely block hole 18 when sleeve 21 is fully assembled to stud 19. Such construction provides a simple and rapid means for completely draining molten metal 15 from receptacle 14 when so desired.

Chamber 12 and receptacle 14 are suitably bored as shown at 23 and 24, respectively, for the insertion of a tube 25 which extends upwardly well into molten metal 15 and is arranged to house a thermometer or other temperature recording device (not shown). A plurality of heating elements 67 are radially disposed within chamber 12 so as to surround receptacle 14 in uniform, equally-spaced relationship. Elements 67 are so designed that the temperatures thereof can be individually controlled within a narrow range in order to provide uniform heat at a constant rate. The walls of chamber 12 are suitably insulated as shown at 69 in order to minimize any heat loss therefrom. It will also be noted that floor 17 of receptacle 14 is suitably spaced from the bottom of chamber 12 in order to provide equal distribution of heat against the entire periphery of receptacle 14.

Fixedly mounted to the top of heating chamber 12 is a rectangular chamber 27 in which a desired cavity mold 28 is to be cast. The front of chamber 27 is cut away to form a rectangular opening 26 as best shown in Fig. 3. A frame 29 is secured to the front of chamber 27 and is provided with a rectangular opening 30 which coincides with chamber opening 26. Frame 29 is of right angle section and cooperates with the front face of chamber 27 to form a channel 70 in order to provide access for a door 32. A substantially rectangular gasket 31 is provided in the rear surface of door 32 in order to prevent contact

thereof with the front of chamber 27. If desired, a cover 77 may be attached to frame 9 as shown in Fig. 6 in order to protect certain mechanism (not shown) for operating door 32.

When door 32 is in its lowermost position, a pair of screws 34 mounted in frame 29 on either side of opening 30 serve as set screws to hold door 32 closed. When door 32 is raised to its uppermost position by means of a handle 72, the upper screws of each pair are arranged to be advanced sufficiently to protrude beyond the lower edge of door 32 and thereby hold such door in the open position. A thumbscrew 35 is threadably engaged in the upper end of door 32 and is arranged in the closed position thereof to pass through an opening 66 in a vertical extension 78 of the front wall of chamber 27. Thus, door 32 is prevented from being raised until after thumbscrew 35 has been retracted sufficiently to disengage from extension 78 of chamber 27

Receptacle 14 and chamber 27 are connected by a pressure tight nozzle 36 having one end thereof extending into molten metal 15 while the opposite end projects upwardly into the interior of chamber 27. Nozzle 36 is interiorly tapered at the upper end thereof as best shown at 37 in order to improve the dispersion of molten metal 15 therefrom. A plate 38 fixedly secured by bolts 73 or the like to the bottom of chamber 27 is provided with a central hole 39 through which the tapered end 37 of nozzle 36 extends. A plurality of spring-biased vertical plungers 40 are annularly disposed in plate 38 and normally project upwardly therefrom to provide a support for a sectional flask 41 containing the master pattern 42 from which the desired cavity mold 28 is to be formed. A gasket 43 secured to the top of plate 38 surrounds each of plungers 40 to form an airtight seal therefor.

Fixedly secured to the top of chamber 27 is a plate 44 having an inverted U-shaped bracket 45 extending upwardly therefrom. A clamping member 46 rotatable by means of a handle 47 on the upper end thereof is threadably mounted in bracket 45 for vertical movement through plate 44 into and out of chamber 27. The bottom of member 46 is provided with a clamping disc 68 arranged to pass through a suitable opening 76 provided in the top of chamber 27. A stuffing box 48 secured to the top of plate 44 provides an airtight seal between plunger 46 and the opening in plate 44 through which such plunger projects.

Receptacle 14 is provided with a pipe 49 which extends upwardly therein to a height greater than the level of molten metal 15. The lower end of pipe 49 projects through receptacle 14 and out of chamber 12 and, as will be later explained in more detail, is employed either as a passage through which the air in receptacle 14 and chamber 27 can be evacuated to form a vacuum therein or as a passage for introducing high pressure air to act against the top surface of molten metal 15. In the former case, a vacuum line 50 extends from a suitable pump (not shown) and connects with pipe 49. A branch line 57 intersects line 50 and enters into chamber 27. A safety shut-off valve 51 is provided in line 50 and is arranged to be actuated by a fixed collar 52 on clamping member 46. Thus, air cannot be evacuated from receptacle 14 and the chamber 27 until clamping member 46 is raised to its uppermost position wherein collar 52 opens valve 51. A suitable gage 53 for indicating the percentage of vacuum created in the apparatus is preferably provided at the point of entry of line 57 into chamber 27. Valves 54 and 55 are also provided in lines 50 and 57, respectively, to prevent passage of air therethrough when pipe 49 is being employed for the passage of high pressure air. An escape valve 56 is also included adjacent the free end of line 57 to permit venting of chamber 27 to the atmosphere.

A high pressure line 59 is also connected to the lower end of pipe 49 and extends upwardly to pass behind front



wall extension 78 of chamber 27. Line 59 is provided with a spring-loaded safety valve 60, which is arranged to be held in the open position by the end of thumbscrew 35. Thus, in the event door 32 is not in the fully closed position, thumbscrew 35 will not be able to pass through opening 66. As a result, valve 60 will not be opened and therefore will not permit the passage of high pressure air. Airline 59 preferably includes a gage 61 which measures the pressure at which the air is forced therethrough. An adjusting valve 62 and a spring-loaded valve 63 which must be held open by the operator regulates the flow of air into receptacle 14. A pair of openings 64 are provided in opposite sides of chamber 27 and a bypass line 75 connected therewith provides means through which high pressure air may be tapped from line 59. Openings 64 are in vertical alignment with flask 41 so that when air is passed therethrough, rapid cooling of cast mold 28 is effected. A valve 65 is provided in line 75 to keep air from passing into chamber 27 through openings 64 except when the cooling effect thereof on cast mold 28 is desired.

Prior to operation of the apparatus, clamping member 46 is retracted to the uppermost position thereof whereby collar 52 thereon opens valve 51. Door 32 is raised to the open position and retained therein by screws 34. The sectional flask 41 in which master pattern 42 has been embedded in the manner conventional to the art is then placed on plate 38 so that the tapered end 37 of nozzle 36 extends therein. Door 32 is then lowered and screws 34 are adjusted to hold door 32 in the closed position. Valves 54 and 55 are opened and operation of the vacuum pump (not shown) is then initiated. When the desired amount of vacuum has been attained as shown by gage 53, clamping member 46 is rotated by means of handle 47 thereon to enter into chamber 27 so that clamping disc 68 thereon contacts the top of flask 41. Continued rotation of member 46 forces flask 41 downwardly to compress spring-biased plungers 40 into plate 38. Thus, flask 41 effectively seals chamber 27 from receptacle 14. Thumbscrew 35 is next adjusted to pass through opening 66 in the front wall extension 78 in chamber 27 and operate valve 60 to open line 59 for the passage therethrough of air under high pressure. Valves 54 and 55 are then closed and regulating valve 62 is opened the desired amount. Valve 63 is then held open and air under high pressure is admitted into pipe 49. The force of such air acts against the top surface of molten metal 15 and thereby forces such metal up through nozzle 36 into flask 41 and against master pattern 42 to produce one section of mold 28.

Next the air pressure is cut off and door 32 is raised to provide access to flask 41 which is then removed from chamber 27 and disassembled into its two sections. The material in which part of master pattern 42 is embedded is then chipped away and flask 41 is reassembled and returned to its previous resting place on studs 40. However, this time flask 41 is reversed so that tapered end 37 of nozzle 36 enters into the opening formerly occupied by the embedding material. The complementary section of mold 28 is then cast in the same manner as the previous section. If faster cooling of the cast metal is desirable, valve 65 is opened and high pressure air is forced across chamber 27 past flask 41.

Thus, there is here provided a superior method of casting soft metal cavity molds for use in investment or precision casting procedures. The unique arrangement whereby the casting of the molds is carried out in a vacuum produces a mold which is remarkably free from porosity, voids, and like defects. Moreover, since the conventional step of pouring the molten metal into the pattern flask is here eliminated, the usual inclusion of impurities in the casting is here entirely avoided. Since these impurities normally rise to the surface of the molten metal, the present arrangement is such that only metal well beneath the surface is utilized. The resulting castings are therefore remarkably sound and dense in structure and relatively free

from dross. Also, the apparatus of this invention is such that the temperature of the molten metal is raised to the desired limit and is uniformly held within a fairly narrow range. As a result, the solidification of the mold casting occurs at substantially the same rate throughout the entire area thereof.

I claim:

1. In apparatus for sectionally casting soft metal molds against a master pattern in a flask, the combination of a heating chamber, a receptacle depending from the top of said heating chamber and adapted to hold a quantity of liquefied soft metal alloy, a plurality of electrical heating elements vertically disposed in radial equispaced relation to surround said receptacle and maintain the interior thereof at a substantially uniform temperature several degrees above the solidus of the liquefied metal, a casting chamber mounted directly on the top of said heating chamber, a nozzle secured in the top of said heating chamber in communication with the liquefied metal and with said casting chamber, means for seating the flask in said casting chamber over the projecting end of said nozzle, a high vacuum line extending into said receptacle and said casting chamber to evacuate the atmosphere simultaneously therefrom, clamp means for depressing the flask to seal the evacuated interior thereof from said casting chamber, a high pressure line extending vertically through the liquefied metal to direct the high velocity air passing therethrough against an interior wall surface of said receptacle whereby the subsequent diffusion of the air imparts a high degree of pressure uniformly along the entire upper surface of the liquefied metal, and valve means for closing said vacuum line and simultaneously opening said high pressure line to force a quantity of liquefied metal into the flask with sufficient rapidity to prevent any solidification thereof during passage through the portion of said nozzle extending into said casting chamber.

2. The combination defined in claim 1 wherein said vacuum and high pressure lines include a common pipe fixedly secured in said heating chamber with one end projecting downwardly therefrom and the opposite end extending upwardly through said receptacle to terminate above the surface of the liquefied metal, and means for connecting the projecting lower end of said pipe to both said vacuum and said high pressure lines.

3. In apparatus for sectionally casting soft metal molds against a master pattern in a flask, the combination of a heating chamber, a receptacle depending from the top of said heating chamber and adapted to hold a quantity of liquefied soft metal alloy, a plurality of electrical heating elements vertically disposed in radial equispaced relation to surround said receptacle and maintain the interior thereof at a substantially uniform temperature several degrees above the solidus of the liquefied metal, a casting chamber mounted directly on the top of said heating chamber, a nozzle secured in the top of said heating chamber in communication with the liquefied metal and with said casting chamber, means for seating the flask in said casting chamber over the projecting end of said nozzle, a high vacuum line extending into said receptacle and said casting chamber to evacuate the atmosphere simultaneously therefrom, clamp means for depressing the flask to seal the evacuated interior thereof from said casting chamber, a high pressure line extending through the liquefied metal to direct the high velocity air passing therethrough against an interior wall surface of said receptacle whereby the subsequent diffusion of the air imparts a high degree of pressure uniformly along the entire upper surface of the liquefied metal, valve means for closing said vacuum line and simultaneously opening said high pressure line to force a quantity of liquefied metal into the flask with sufficient rapidity to prevent any solidification thereof during passage through the portion of said nozzle extending into said casting chamber, and means for tapping said high pressure line to pass high pressure air across said casting chamber and over the flask for accelerating the solidification of the liquefied metal therein.

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