Oct. 5, 1948. T. C. KUHLMAN 2,450,832

CENTRIFUGAL CASTING

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Fig. 1.

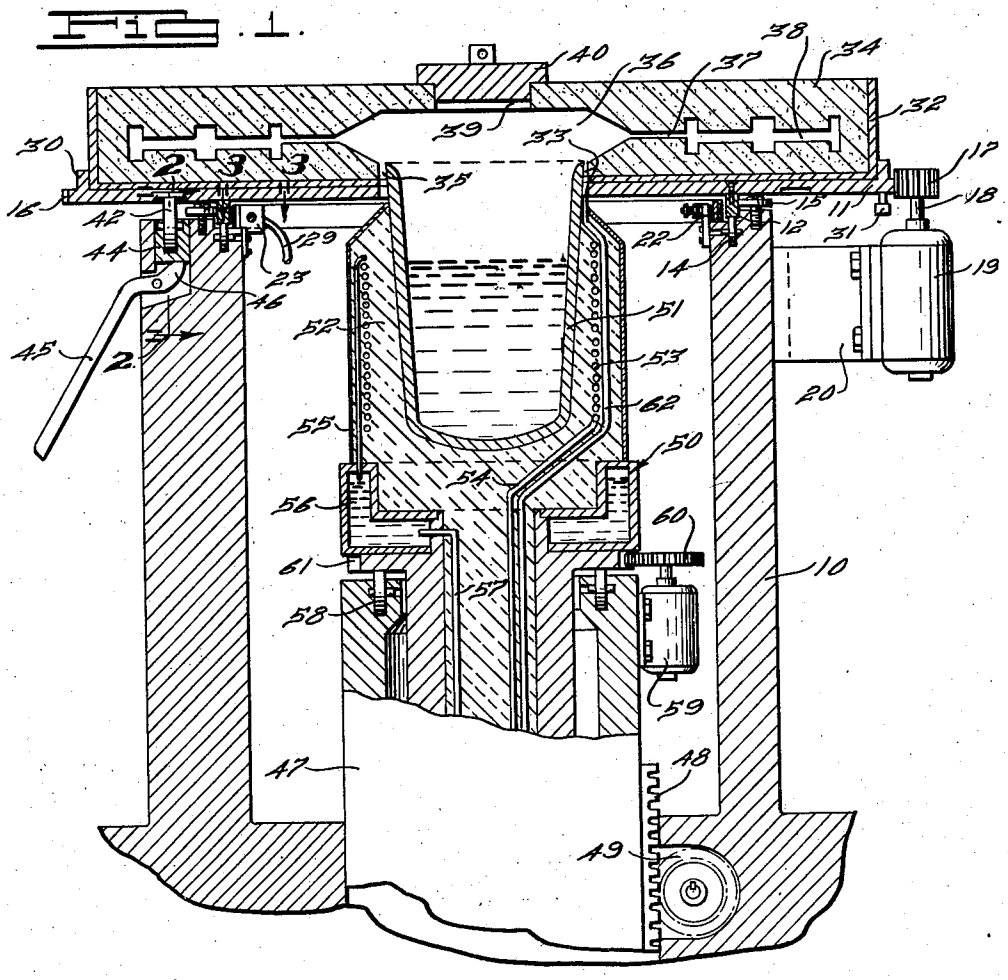
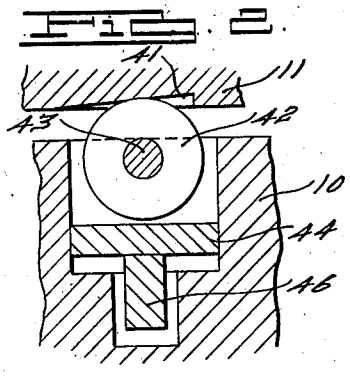


Fig. 2.



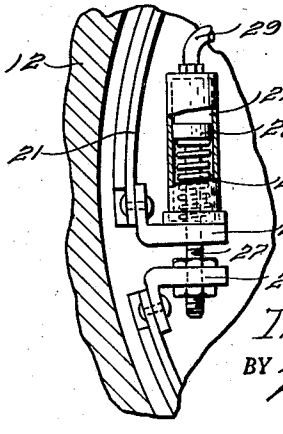


Fig. 3.

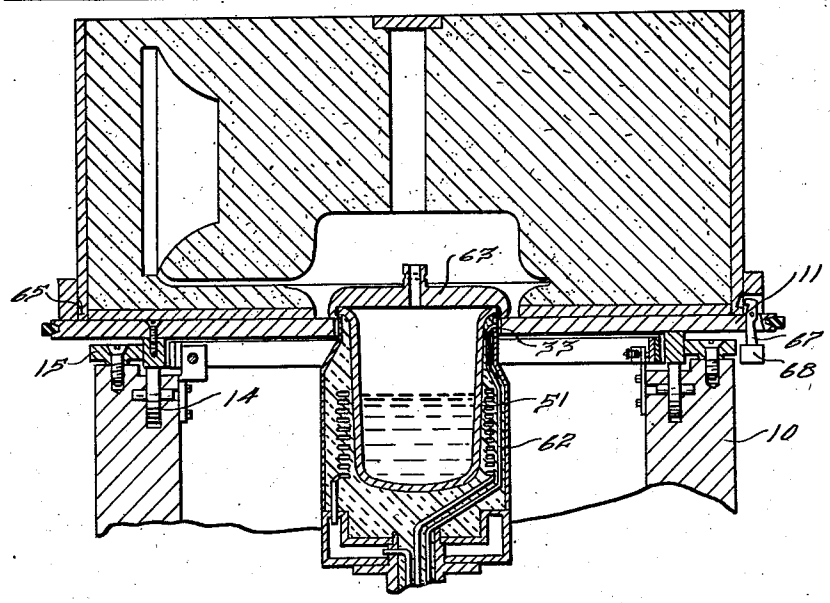
INVENTOR.
Theodore C. Kuhlman
BY Maxwell K. Murphy

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Fig. 4.



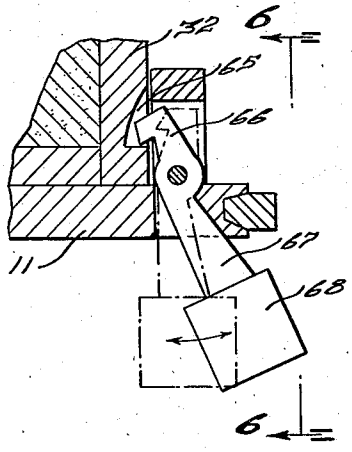


Fig. 5.

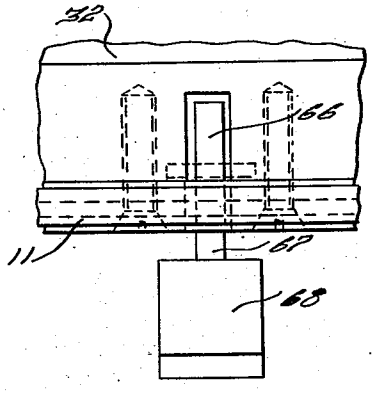


Fig. 6.

INVENTOR.
Theodore C. Kuhlman
BY Maxwell R. Murphy

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Fig. 7.

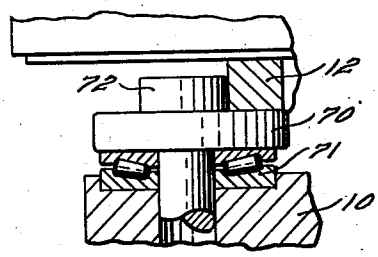


Fig. 8.

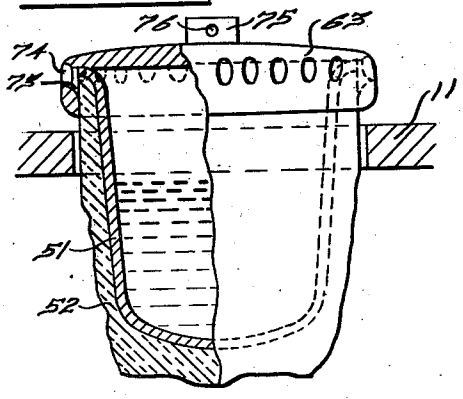
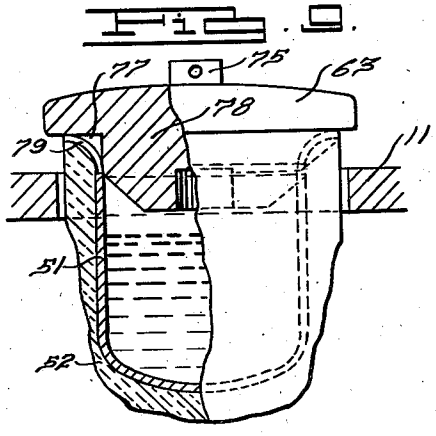


Fig. 9.



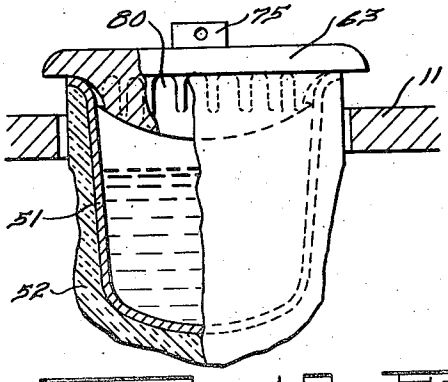


Fig. 10.

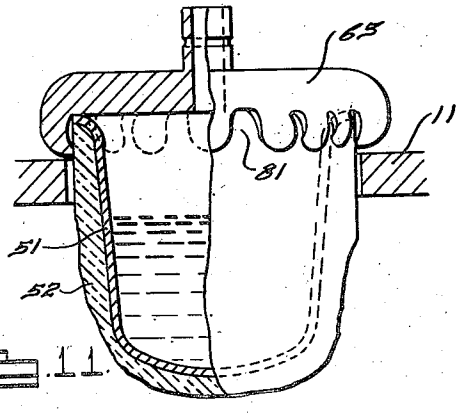


Fig. 11.

INVENTOR.
Theodore C. Kuhlman
BY Maxwell K. Murphy

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UNITED STATES PATENT OFFICE

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CENTRIFUGAL CASTING

Theodore C. Kuhlman, Detroit, Mich.

Application July 5, 1943, Serial No. 493,495

11 Claims. (Cl. 22—65)

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This invention relates to methods and means for casting metallic articles. More specifically, it relates to an improved means for producing castings of high temperature melting metals or alloys that are homogeneous, free from scale and dross, and which are ready for immediate use without machining.

The principal object of the invention is to provide an improved casting machine for casting metal by centrifugal pressure.

Another object is to provide, in connection with such a machine, means for rotating the flask thereof independently of the melting crucible and at various speeds relative thereto.

Another object is to provide means for maintaining a controlled atmosphere throughout the entire casting operation so that oxidation of the hot metal with consequent formation of scale is entirely avoided.

Another object is to provide in such a machine, a water cooled base for the crucible.

A further object is to provide in a centrifugal casting machine means for vibrating the flask during rotation such that substantially perfect pattern definition is obtained, and stresses in the cast article are greatly reduced.

A further object is to provide in such a machine means for supporting the mold platform independently of the crucible and independently of the central axis of the machine.

A still further object is to provide a self-lifting lid for the melting crucible which automatically lifts to permit the metal to flow out of the crucible and into the mold during rotation of the mold and crucible.

Other objects and advantages of the invention will become apparent from the description of the invention given below.

In general, my improved casting machine, in its preferred form, consists essentially of a revolving platform which is adapted to support the flask containing the mold. The platform is provided with a central opening through which the melting crucible or furnace extends, and the assembly is provided with means for rotating the crucible or furnace and for moving it vertically into and out of casting position.

The crucible assembly or furnace comprises a refractory lining surrounded by heat insulating material in which is embedded a water cooled induction coil. Suitable means is provided for rotating the crucible at varying speeds and for raising and lowering the crucible during rotation thereof.

Means is also provided for rotating the flask

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independently of the crucible so that the rotational speed of the flask may be varied in accordance with the diameter of the piece being cast and/or the particular alloy, and so that the rotational speed of the crucible may be brought up high enough to throw out the molten metal.

In one form of my invention, the crucible is equipped with a lid which extends over the edge thereof and is larger in diameter than the opening in the rotatable platform. In this form of the invention, during casting the molten metal is forced upwardly on the inside wall of the crucible by centrifugal force and raises the lid sufficiently to permit the metal to flow outwardly into the mold cavity. The lid is adapted to seat on the upper edge of the crucible to thereby exclude air during melting of the metal. To prevent the lid from freezing to the crucible after the metal has been cast, through solidification of traces of metal or slag that may remain on the lip of the crucible, the speed of the crucible is reduced to that of the revolving platform and the entire crucible assembly lowered. This brings the lid to rest on the platform and because both the crucible and the lid are rotating at the same speed, no scuffing or abrasion of the lid or crucible occurs.

Means is also provided in connection with my improved casting machine for filling the mold cavity with hydrogen, or other inert gas, to thereby exclude air during the casting operation.

I also provide for vibrating the mold during the casting operation, whereby the casting of alloys of relatively poor fluidity is enhanced.

Attention is now directed to the accompanying drawings which show preferred forms of my invention and in which reference characters are used to designate parts referred to in the following description.

In the drawings

Figure 1 is a vertical section of one form of my improved casting machine.

Figure 2 is a detail section on an enlarged scale of the platform vibrating means as seen when viewed along the line 2—2 of Figure 1 when looking in the direction indicated by the arrows.

Figure 3 is a similar section taken along the line 3—3 of Figure 1 and showing a portion of the brake actuating means for controlling rotation of the platform.

Figure 4 is a vertical sectional view of a slightly modified casting machine, the crucible thereof being provided with a self-operating lid.

Figure 5 is an enlarged detail view of the flask clamping device of Figure 4.

Figure 6 is a detailed elevation of the clamping

device as seen when viewed as indicated by the arrows 6—6 on Figure 5.

Figure 7 is an enlarged detail of a modified form of platform support bearing.

Figure 8 is a detail view of a crucible showing a modified form of crucible lid, parts being broken away to show sectional details thereof and

Figures 9, 10, and 11 are similar views of other modified forms of crucible lid.

Referring now to Figure 1 and related figures, it may be seen that my improved casting machine comprises a base 10 on which is rotatably mounted a platform 11. The latter is provided with an annular bearing ring 12 which is secured to the platform by cap screws 13 or by other suitable means. The lower surface of ring 12 rests on a plurality of circumferentially spaced rollers 14 carried by the base 10 and the outer periphery of the ring engages a second set of rollers 15 which are also carried by the base 15 as illustrated.

The platform 11 is provided with gear teeth 16 which engage a pinion 17 carried by the shaft 18 of a motor 19. The latter is supported on base 10 by means of a bracket 20 and is provided with the necessary switches and controls (not shown) which may be of any satisfactory commercial design.

The inner peripheral surface of ring 12 is adapted to be engaged by a brake band 21 forming part of an expanding brake mechanism generally designated by numeral 22. The band 21 carries a suitable lining and is expanded into engagement with the ring by means of a hydraulic cylinder 23 (Figure 3). The brake band is split as shown and to the respective end portions thereof brackets 24 and 25 are riveted.

The bracket 24 carries the cylinder 23 in which is reciprocably disposed a piston 26 which is operably connected with the bracket 25. A coil spring 28 operatively connected with the piston biases the latter in such direction that the brake band 21 is normally maintained in contracted condition. Pressure fluid such as air or oil may be introduced into the cylinder 23 through conduit 29 to overcome the force of spring 28 and expand band 21 into engagement with the inner surface of ring 12 when it is desired to stop rotation of platform 11. The hydraulic fluid is preferably controlled by means of a pedal actuated valve (not shown) suitably positioned for convenient operation by the operator of the machine.

The platform 11 is also provided with an annular upstanding flange 30 which has clamping means 31 for receiving and holding a flask 32. The flask is preferably of annular shape and is adapted to hold a mold 34 which may be of sand, plaster, or other material. This mold has a central opening which aligns with a similar opening 33 in platform 11. In the example illustrated the drag portion of the mold has an opening 35 through which the molten metal is adapted to flow into the sprue ring 36 thence through sprues 37 into the mold cavity 38. The cope portion is provided with an opening 39 over which a removable lid 40 seats.

The platform 11 is provided with a series of circumferentially spaced, wedge shaped depressions 41 (see Figure 2) which cooperate with a vibration wheel 42 carried by the base 10. The wheel 42 is mounted on an axle 43 which is bearinged in a reciprocable slide 44. The latter is adapted for movement to engage and disengage the wheel 42 with the platform by means of a lever 45, one end 46 of which engages the slide 44 as shown in Figures 1 and 2.

This is a very important feature of the machine, particularly when the machine is used to cast alloys of sluggish characteristics. It is accepted theory that metal is rendered molten by increasing the activity of the molecules; the greater the activity, the more fluid the molten metal. Furthermore, it is well known that the problem of making sound and homogenous castings of thin section is a difficult one. It is particularly difficult to make such castings of alloys that tend to become plastic rather than liquid under safe heating conditions. These alloys cannot be readily liquified by heating unless the temperature is raised unduly which results in scorching or burning of the metal.

I overcome these difficulties by introducing into the molten metal molecular pressure waves. These pressure waves add to the natural movement of activity of the molecules and results in a decided increase in fluidity. I have found that metal exposed to these pressure waves will flow much more rapidly; that there will be less erosion of the mold and therefore less contamination of the metal; that air and/or gas occlusions will be expelled more quickly and there is better pattern definition. Further, this increase in fluidity decreases the surface tension of the molten metal and renders it possible to cast thinner and more complicated designs. Smaller gates, sprues, etc. may be used thereby reducing waste.

Molten metal when under the influence of these waves will remain fluid longer, that is, to a lower temperature. A shrinkage takes place as the metal cools, but when vibration is present the metal cools more uniformly because the activated molecules are better heat conductors. This has also the effect of reduced stresses in the casting.

When hardening of the metal takes place it occurs more rapidly than when no vibration is present. This is important because large crystals are avoided, the rapid setting tending to keep the crystals small by providing more focal points of crystalization.

After the metal has set the intensity of the vibration is preferably increased during cooling. This facilitates creep and permits the molecules to further orient themselves, thus decreasing the internal stresses.

Reciprocably mounted in a base 10 is a member 47 which carries the crucible assembly. The member 47 is movable vertically by means of a rack 48 and pinion 49 and has a central opening in which is mounted the crucible assembly 50. The latter comprises the crucible 51 which is of refractory material and is supported in the insulating material 52. Imbedded in the insulating material and surrounding the crucible is a water cooled induction coil 53 of copper tubing. Cooling water is pumped into the coil through a conduit 54 and the outlet conduit 55 empties into a water reservoir 56 located in the base portion of the crucible assembly. An outlet pipe 57 is provided for emptying the reservoir. By providing a reservoir positioned as shown, the base and operative mechanism of the crucible assembly are prevented from overheating.

The entire crucible assembly is supported in the member 47 for rotation by means of rollers 58 and a motor 59 for driving the assembly is mounted on the member 47 as shown. The motor has a pinion 60 which engages teeth 61 on the crucible assembly. The controls for motor 59 are not shown but may be of any suitable form.

Provision is made for flooding the mold cavity with hydrogen or other inert gas during casting

by means of a pipe 62 which may be connected with a supply of gas and which opens into the opening 33 in platform 11.

In the operation of the machine as described so far, the flask 32 is filled with one or more molds. In instances where more than one article is to be cast in a single operation, several molds are placed in the flask and the space between molds filled with molding sand. The molds are preferably of truncated sector shape each having on its narrow or truncated side a sprue groove which connects with runners running from the central mold cavity. The mold or flask assembly is preferably baked to eliminate gases and is then set on the platform 11, or the sprue groove and runners may consist of a separate unit which is set centrally in the flask and the molds set and fastened against this unit, the runners in the molds to align with the runners in this unit.

The crucible 51 which is in its lowered position is then charged with metal. The charge may consist of chunks of new metal or of scraps. In cases where the duplex process is being used, the crucible may be charged with molten metal previously melted in a furnace.

The platform 11 is set in rotation by means of motor 19, and the crucible is moved upwardly into the position shown in Figure 1 and is set in motion by means of the motor 59. A stream of gas is blown into the mold through pipe 62 to eliminate the air therefrom, and this flow of gas is continued throughout the casting operation.

The speed of rotation of the platform 11 is regulated in accordance with the size and shape of the articles being cast and with the character of the alloy being cast. A relatively low casting speed by and large is desirable as it produces greater directional solidification resulting in castings of greater density. A peripheral speed of 600 feet per minute will produce excellent castings. In cases where it is necessary to feed metal to heavy sections through relatively light sections the speed may be increased to as high as 1,000 feet per minute. After the platform is in motion, the crucible is set in motion and its speed is increased such that the resulting centrifugal force causes the metal to quickly and smoothly flow upwardly and outwardly into the sprue ring 36 from where it flows through the sprues and runners into the mold cavities.

Normally, the vibrating wheel 42 is moved into contact with the platform 11 just prior to the time the metal flows out of the crucible. After the crucible has been emptied, the intensity of the vibration is increased by moving the slide 44 upwardly and the frequency thereof is reduced by reducing the rotational speed of the platform.

Preferably the charge placed in the crucible is just sufficient to fill the mold. This is advantageous in that all of the metal can then be discharged from the crucible and the slag which flows out last will rest in the sprue ring 36 where it can be easily disposed of.

The flask is rotated and vibrated until the metal has congealed and the platform is then stopped through the action of the brake mechanism. The flask is then removed and another placed on the platform in readiness for another cast.

Figure 4 shows a slight modification of the invention wherein the crucible 51 is provided with a lid 63 of such shape that it fits tightly in the mouth of the crucible and excludes the air therefrom while the metal is being melted or being

kept hot. A quartz window 64 is provided in the lid for observation purposes.

In the operation of the Figure 4 form of machine, the lid 63 seals the crucible until the metal begins to flow outwardly therefrom, then the lid is automatically lifted off its seat by molten metal. After the charge is expelled from the crucible, the lid will again seat thereon. The lid is of greater diameter than the opening 33 in the platform 11 and this is for a definite purpose which will now be explained. After the metal has been expelled from the crucible the particles of molten metal and slag that may remain around the mouth thereof might weld the lid thereto unless some means to prevent this were present. In my machine, as soon as the crucible is emptied, the crucible assembly is lowered by means of the rack and pinion 48, 49 and the lid 63 remains on the platform at the opening 33.

Figures 5 and 6 illustrate details of the clamping mechanism which secures the flask against displacement from the platform. The flask is provided with an annular groove 65 which is adapted to be engaged by the upper hooked ends 66 of levers 67. These levers are pivotally carried on the platform and have weights 68 on their lower ends such that as the platform is rotated, the weights 68 move outwardly by centrifugal force and the flask is securely locked to the platform.

Figure 7 shows a modification of the platform supporting means. In this figure a single roller is used in place of the pair (14, 15) used in Figures 1 and 4. In Figure 7, the single roller 70 is mounted in the base 10 by means of a combined thrust and anti-friction tapered roller bearing 71. The annular bearing ring 12 of the platform rests on the roller 70 which has a reduced portion 72 disposed in engagement with the outer periphery of the ring 12 for taking the thrust thereof during the rotation.

Figures 8, 9, 10, and 11 illustrate modifications of the crucible lid. In Figure 8, the lid has a concave lip 73 which is provided with circumferentially spaced holes 74. The inner surface of the lid is flat so that when the lid is in its normal position, as illustrated, an air tight seal between the lid and the crucible mouth is provided. When the lid is displaced upwardly during casting the molten metal flows outwardly through the holes 74. A lug 75 on the top of the lid is provided with a hole 76 for engagement by a lid lifting tool. The angle 73 on the inside of the lip 73 is formed such that it prevents the flowing metal from raising the lid too high so that it might become dislocated. As the lid is raised, the holes 74 rise above the edge of the crucible and the metal flowing through the holes also flows against the inner curvature of the lip and tends to force the lid down again.

In Figure 9, the lid 63 has a marginal edge portion 77 which rests on the top of the crucible mouth and an inner reduced portion 78 which has the shape of a truncated cone and fits against the inner wall. This tends to keep the lid on dead center during casting of the metal. The truncated or flat surface at the bottom serves as a convenient seat for the lid prior to its use. A lid with a spherical bottom (such as that in Figure 10) will rest on a slant and on its edge when not in use and is easily damaged while a lid with a flat bottom surface will rest level and is not so liable to be injured. The lid of Figure 9 is also provided with a recess 78' that is somewhat larger than the lug 75. This permits stack-

ing of the lids for storage and shipping. The crucible mouth is provided with grooves 78 spaced therearound such that lifting of the lid permits flow of metal out of the crucible through the grooves.

In Figure 10, the grooves 80 are formed in the lid itself and the bottom thereof is spherical in shape so that the lid will float on the molten metal as it flows out of the crucible and thus remain centered at all times. Figure 11 shows a form which combines the features of Figures 8 and 10, the grooves 81 being formed in the outer lip of the lid which fits snugly around the top of the crucible.

In all of these modifications, the lid is larger in diameter than the opening in the platform through which the crucible protrudes such that the lid is lifted off of the crucible when the latter is lowered for charging.

Having thus described preferred forms of my invention, I wish to point out that these are by way of example only, and I do not intend to restrict the scope of my invention except as set forth in the appended claims.

I claim:

1. In a machine for centrifugally casting metal, a rotatable platform adapted to support a mold flask; a central opening in said platform; a rotatable crucible assembly including a crucible adapted to extend into said opening, and means for rotating said platform and said assembly at varying relative speeds.

2. In a machine for centrifugally casting metal, a rotatable platform adapted to support a mold flask; a central opening in said platform; a rotatable crucible assembly including a crucible adapted to extend into said opening, means for moving said crucible into and out of said opening and means for rotating said assembly relatively to said platform.

3. In a machine for centrifugally casting metal, a rotatable platform adapted to support a mold flask; a central opening in said platform; a rotatable crucible assembly including a crucible adapted to extend into said opening, and a lid for said crucible, said lid being of greater diameter than said opening.

4. In a centrifugal casting machine, a platform for supporting a mold flask having a centrally disposed opening; a rotatable crucible assembly including a crucible adapted to extend into said opening; a lid for said crucible of larger diameter than said opening; means for lowering said crucible to a position below said platform such that said lid is lifted free of the crucible and rests on said platform.

5. In a casting machine as claimed in claim 4, means for rotating said platform at varying speeds relatively to said crucible.

6. In a centrifugal casting machine, a rotatable crucible assembly including a base; an insulating jacket rotatably mounted on said base; a water cooled induction coil embedded in said jacket, a refractory crucible disposed in concentric relation with respect to said coil; a water reservoir disposed below and in concentric relation to said crucible, and means for circulating water through said coil and reservoir.

7. In a centrifugal casting machine, a mold supporting platform having a central opening

therein; a crucible assembly including a crucible adapted to extend into said opening in such position that rotation of said crucible will cause molten metal to be discharged therefrom by centrifugal force; means for lowering said crucible to a position below said platform; a lid adapted to cover the mouth of said crucible, said lid being of larger diameter than said opening whereby the lid is retained out of engagement with said crucible when the latter is in charging position.

8. In a centrifugal casting machine, a base structure; a mold supporting platform rotatably mounted on the base structure; a central opening in said platform; a reciprocable member carried by said base structure independently of the mounting of said platform; a crucible rotatably mounted on said member; means for rotating said platform and said crucible at various relative speeds, and means for reciprocating said member.

9. In a centrifugal casting machine having a rotatable crucible, a lid for said crucible adapted to close said crucible from the atmosphere preparatory to casting and to be upwardly displaced by the molten metal during casting.

10. In a centrifugal casting machine having a rotatable crucible, means for rotating said crucible at various speeds whereby molten metal therein may be expelled therefrom into a mold by centrifugal force; a lid for said crucible, said lid being adapted to normally close said crucible from the atmosphere and to be upwardly displaced by the molten metal during expulsion thereof from said crucible.

11. In a centrifugal casting machine having a rotatable crucible, means for rotating said crucible at various speeds whereby molten metal therein may be expelled therefrom into a mold by centrifugal force; a lid for said crucible, said lid being adapted to normally close said crucible from the atmosphere and to be upwardly displaced by the molten metal during expulsion thereof from said crucible, and means for maintaining said lid centered on said crucible during said displacement.

THEODORE C. KUHLMAN.

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