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[33] **Switzerland**
[31] **6391/68**

[54] **APPARATUS FOR VACUUM CASTING METAL**
9 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **164/258,** 164/256, 164/133, 164/136
[51] **Int. Cl.** **B22d 27/16**
[50] **Field of Search** 164/253, 256, 258, 63, 65, 61, 133, 136

No references cited.

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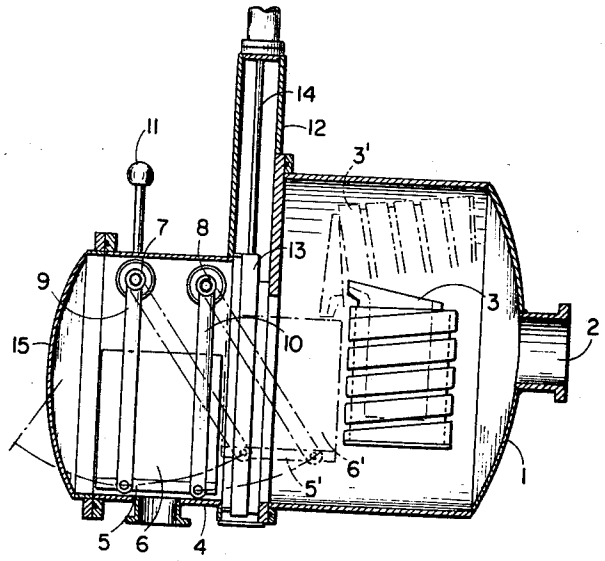
ABSTRACT: In apparatus for vacuum casting metal, means are provided for movably positioning a mold between a lock chamber and a vacuum or casting chamber. The means supporting the mold convey it in a rectilinear path between the two chambers and, preferably, transport the mold in the same horizontal plane between the two chambers.



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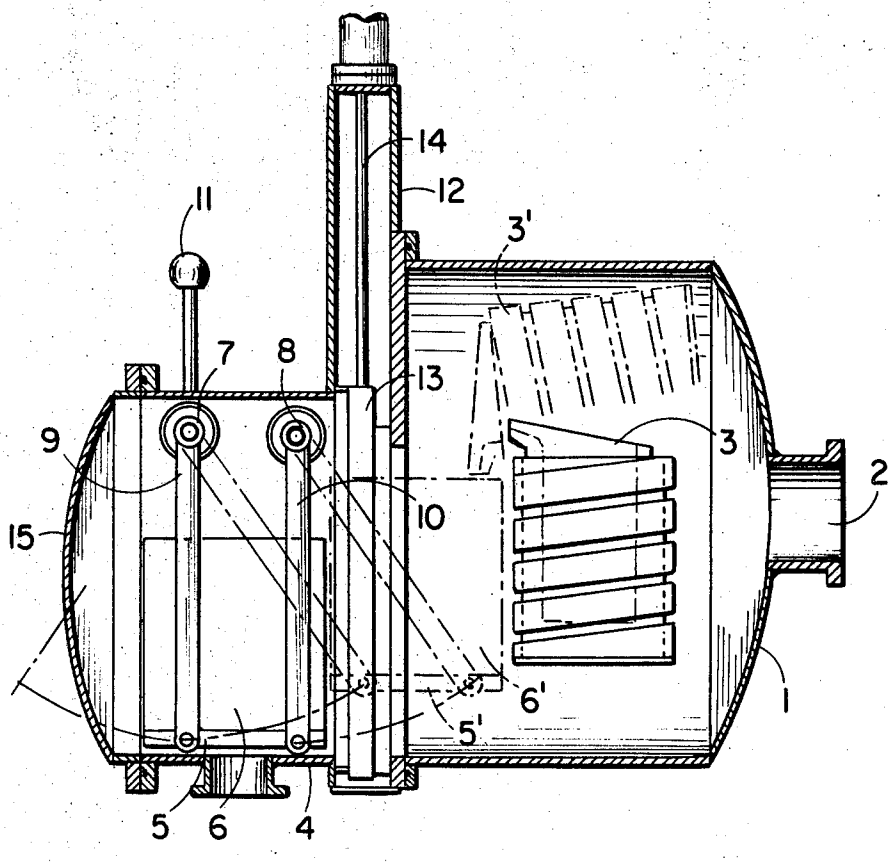

FIG. 1

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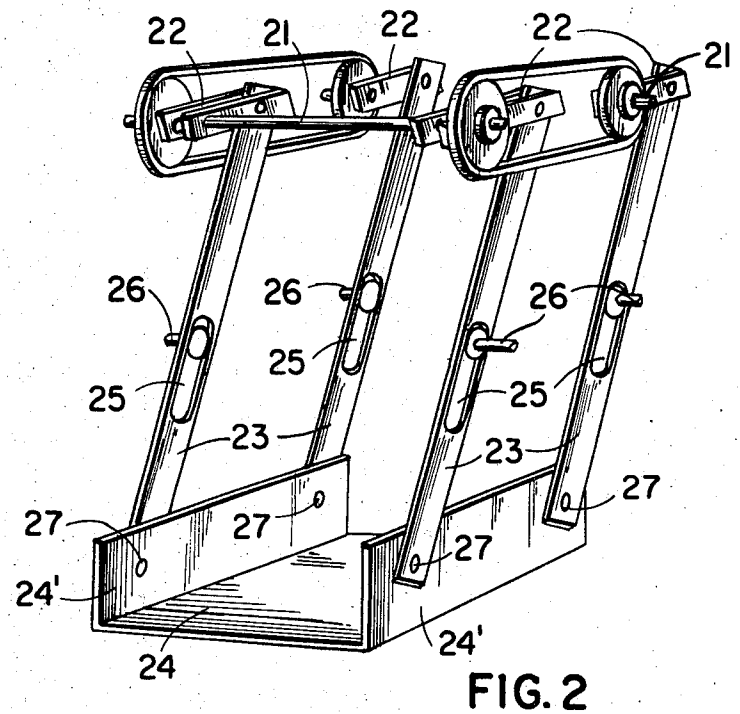

FIG. 2

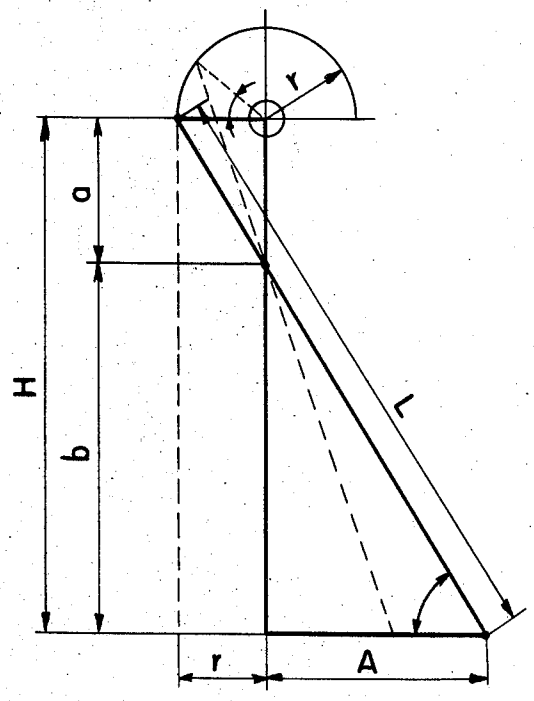

FIG. 3

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APPARATUS FOR VACUUM CASTING METAL

SUMMARY OF THE INVENTION

The present invention is directed to apparatus for vacuum casting metals and, more particularly, it is directed to a support arrangement for positioning a mod mold between a lock chamber and a vacuum chamber so that the mold travels in a rectilinear path.

In the present invention apparatus for vacuum casting of metals comprises a vacuum chamber containing a crucible for the molten metal and a lock chamber joined to the vacuum chamber and separated from it by a removable gate. The lock chamber is arranged to hold a mold which is to be positioned within the vacuum chamber to receive molten metal from the crucible. In the lock chamber a movable platform is supported for transporting the mold into the vacuum chamber when the gate is removed or opened and for returning the mold into the lock chamber after the casting operation has been completed.

In the past equipment has been used for smelting and casting under a vacuum which includes a vacuum chamber containing a tiltable crucible and a lock chamber communicating with the vacuum chamber through a gate or shutoff member. Within the lock chamber, a movable platform is located for positioning a casting mold in place within the vacuum chamber to receive molten metal from a crucible. The platform has been pivotally mounted on a vertical axis for pivotal movement between the lock chamber and the vacuum chamber. When the shutoff member is removed from the opening between the lock chamber and the vacuum chamber, the platform and the mold supported on it can be moved about the vertical axis into position for receiving the molten metal from the crucible.

Equipment of this type has the advantage that no roller bed or rails are required for supporting the mold in its travel between the lock chamber and the casting chamber. When dirt or metal spatter accummulates on the roller bed or rails, it causes an interruption in the operation and, moreover, travel along the roller bed causes vibrations in the mold, and such characteristics are disadvantageous.

While the equipment described above avoids the use of roller beds or rails, it does provide a problem since in being pivoted about a vertical axis the mold travels in a circular path from the lock chamber to the vacuum chamber. When a crucible is emptied in a tilting operation, it is known that to obtain a clean casting, the flow of the molten metal should always remain in the direction of the centerline of the casting mold. Where the crucible is tiltable about a fixed axis the mold to receive the molten metal must be moved into position through the plane of the molten metal flow from the crucible. In other words, the mold should be positioned along the line perpendicular to the tilting axis of the crucible. However, as is the case in the casting equipment described above, the mold is moved along a circular path about a vertical axis whereby its path of travel is not located in the plane of the molten metal flow from the crucible.

Therefore, the primary object of the present invention is to provide an apparatus for casting metal wherein the mold is positioned along a straight line as it is moved into position to receive molten metal from a crucible in a vacuum chamber.

Another object of the invention is to maintain the base of the mold in a horizontal position as it is moved between a lock chamber and a casting or vacuum chamber.

Still another object of the invention is to move the base of the mold through a horizontal plane as it is positioned between the lick chamber and the casting chamber.

Accordingly, in the present invention, a platform is supported with a lock chamber on a number of arms arranged to pivot about horizontal axes. Due to the manner in which the arms are connected to the horizontal axes the platform which supports a mold, as it is positioned between the lock chamber and a casting chamber, travels in a rectilinear path between the two chambers. In one preferred arrangement of the invention, the platform is supported so that it travels in a horizontal plane between the lock chamber and the casting chamber.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated and described preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a side view, partly in section, of an apparatus for vacuum casting metal embodying the present invention;

FIG. 2 is a perspective view of another embodiment of a portion of the apparatus illustrated in FIG. 1; and

FIG. 3 is a schematic illustration of one of the arms illustrated in FIG. 2 indicating its various dimensions.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1, and an apparatus for vacuum casting metals is illustrated and is formed of a vacuum chamber 1 interconnected to a lock chamber 4 by means of a valve or gate housing 12. At one end of the vacuum chamber a connection 2 is provided for evacuating the chamber. Within the vacuum chamber 1 a crucible 3 is positioned, the crucible 3 is shown in solid lines in an upright position and is tiltable about a horizontal axis so that the crucible can be moved in into position 3', indicated in dot-dash lines, for pouring molten metal from the crucible into a mold.

In the lock chamber 4, a movable platform 5, for supporting a casting mold 6, is suspended from a pair of horizontally arranged shafts 7 and 8 which are spaced apart in the direction of travel of the molds between the lock chamber and the vacuum chamber. The casting mold 6, supported on the platform 5 within the lock chamber, is shown in solid lines while the mold in it its position within the vacuum chamber for receiving molten metal from the crucible 3' is shown in dot-dash lines. Further, the arrangement of the arms 9 and 10 and their path of travel in either direction from the position of the mold 6 within the lock chamber L is shown by dot-dash lines. As it is moved from the lock chamber into the vacuum chamber the platform is lifted upwardly by the arms 9 and 10, however, it remains in a horizontal position.

The shaft 7 extends horizontally through the wall of the lock chamber and acts as the drive shaft for moving the platform 5 by means of the lever 11 secured to the shaft on the exterior of the lock chamber.

The gate housing 12 which connects the lock chamber and the vacuum chamber forms an opening between the two which is closed by the gate 13 as shown in FIG. 1. A lifting rod 14 is attached to the gate 13 and extends upwardly through the housing for removing the gate from the opening so that the platform 5 and casting mold 6 can be moved into position to receive molten metal from the crucible 3' within the vacuum chamber. In addition, at the opposite end of the lock chamber from the gate 13, a door 15 is secured to permit access to the chamber from the exterior of the apparatus.

When using the apparatus shown in FIG. 1, initially a mold is placed in the lock chamber on the platform 5 and the door 15 and the gate 13 are in the closed positions. After the gate 13 is opened the platform 5 and the casting mold 6 are moved from the positions shown in full lines within the locking chamber to the positions shown in dot-dash lines, that is, platform 5' and molds 6', within the vacuum chamber 1 and the crucible 3 is then tilted about its horizontal axis into the position 3' for depositing molten metal into the mold. The design of the crucible and of the tilting device are known and do not form a part of the present invention.

After the mold has been properly filled the arms 9 and 10 pivot about the shafts 7 and 8 and return the platform to the position shown within the lock chamber. The gate 13 is closed separating the vacuum chamber from the lock chamber, and

the lock chamber is flooded with a gas or air, whereupon the door **15** is opened and the mold can be removed from the locking chamber and replaced by another mold. With the empty mold in position within the lock chamber and the door **15** closed again another cycle of the casting operation can be performed.

In FIG. **1**, when the mold is moved on the platform between the lock chamber and the vacuum chamber it travels along a rectilinear path, however, since the arms **9** and **10** are attached to the pivotally mounted shafts **7** and **8** at their upper ends the platform is lifted vertically to a position in the vacuum chamber above its rest position within the lock chamber. On the contrary, the suspension arrangement disclosed in FIGS. **2** and **3** not only guides the platform in a rectilinear path between the lock chamber and the vacuum chamber but also assures that it remains in the same horizontal plane during its travel between the two chambers. In FIG. **1** since the platform **5** and mold **6** move upwardly as they enter the vacuum chamber the opening between the two chambers must be of a height considerably greater than that of the height of the platform and the mold. When the arrangement shown in FIGS. **2** and **3** is used the extent of the opening can be limited since the mold remains in the same horizontal plane as it is inserted into the vacuum chamber.

In FIG. **2**, a pair of horizontally arranged shafts **21** are shown, these shafts are supported within the lock chamber. A pair of spaced eccentric members **22** is fixed on each of the shafts and extends laterally from it. The upper ends of arms **23** are secured pivotally to the opposite end of the eccentric members. The arms **23** extend downwardly and are secured at their lower ends to the sidewalls **24'** of a platform **24**. Pins or similar means **27** pivotally interconnect the arms and the sidewalls providing the point of rotation between these two elements.

Intermediate the ends of the arms **23** longitudinally extending slots **25** are provided into which guide pins **26** are fitted. The guide pins **26** extend outwardly from the slots and are fixed within the lock chamber. When the lengths of the eccentric members **22** and the arms **23** are properly dimensioned, the platform is guided in a horizontal plane as it passes between the lock chamber and the vacuum chamber. As indicated in FIG. **1**, one of the shafts **21** extends through the wall of the lock chamber and is provided with actuating means for selectively moving the platform.

In calculating the lengths of the arms **23** and the eccentric members **22** the following considerations are taken into account based on the showing set forth in FIG. **3**.

The starting point for establishing the dimensions of the eccentric members and the arms is the required horizontal distance through which the platform is transported between the lock chamber and the vacuum chamber, and the height of the suspension apparatus. The dimensions to be established are the radius r, which represents the distance along the eccentric member between the shaft **21** and the pivotal attachment of the eccentric member to the upper ends of the arms **23**, and also the position of the guide pins relative to the location of the shaft and the platform.

In FIG. **3**:

A = half the working stroke or travel of the platform between the lock chamber and the vacuum chamber;

H = the vertical height or distance between the shafts **21** and the point of pivotal attachment **27** of the arms **23** to the sidewalls **24'** of the platform;

r = the dimension along the eccentric member between its point of fixed attachment to the shaft **21** and pivotal attachment to the arms **23**;

a = the vertical distance between the shafts **21** and the guide pins **26**;

$b = H - a$, or the distance from the guide pins to the horizontal plane through the points of rotational attachment **27** of the arms **23** to the other platform **24**; and

L = the length of the arms **23** measured between the points of pivotal attachment of the arms to the eccentric members **22** at the upper end and to the platform **24** at the lower end represented by the points **27**.

Accordingly,

(1) $L^2 = H^2 + (A+r)^2$

When the mold is supported on the platform within the lock chamber the arms are in the vertical position whereby $L = H + r$ and, hence,

(2) $L^2 = (H+r)^2$ therefore, from equations **1** and **2** it follows:

$$r = \frac{A^2}{2(H-A)} \quad (3)$$

Further from FIG. **3**, due to the similarity of the respective triangles formed, it follows that:

$$\frac{b}{A} = \frac{H}{(A+r)} \quad (4)$$

Based on equations **3** and **4** the following is established: it,

$$b = \frac{2H(H-A)}{2H-A} \quad (5)$$

By means of these equations the correct dimensions for the suspension apparatus can be established so that the platform and the mold supported on it, as shown in FIG. **2**, travels in a horizontal plane between the lock chamber and the vacuum chamber.

We claim:

1. Apparatus for casting metal under a vacuum comprising a vacuum chamber, a crucible disposed within said vacuum chamber and arranged to be tilted about a horizontal axis, a lock chamber contiguous to said vacuum chamber, means for connecting said vacuum chamber and lock chamber and forming an opening therebetween, said means comprising a gate forming a removable closure for the opening between said vacuum chamber and block chamber, a platform positioned within said lock chamber and arranged to support a casting mold, said platform being movably positionable between said lock chamber and said vacuum chamber for receiving molten metal from said crucible, wherein the improvement comprises means for pivotally suspending said platform about a horizontal axis in said lock chamber so that the platform is positionable in a rectilinear path between said lock chamber and vacuum chamber when said gate is displaced from the opening between said vacuum chamber and said lock chamber.

2. Apparatus, as set forth in claim **1**, wherein said means for pivotally suspending said platform comprises a pair of horizontally arranged shafts, said shafts located within said lock chamber and being spaced apart in the direction of movement of said platform between said lock chamber and vacuum chamber, upwardly extending arms secured adjacent one end to each of said shafts and adjacent the other end to said platform wherein said platform is maintained in a generally horizontal position as it is moved between said lock chamber and vacuum chamber.

3. Apparatus, as set forth in claim **2**, wherein one of said shafts extends outwardly from said lock chamber, and means being secured to the end of said shaft exteriorly of said lock chamber for rotating said shaft and moving said platform.

4. Apparatus, as set forth in claim **3**, wherein said arms being pivotally secured to said platform.

5. Apparatus, as set forth in claim **1**, wherein at least a pair of horizontally extending shafts spaced apart in the direction of travel of said platform between said lock chamber and vacuum chamber and being mounted within said lock chamber, eccentric members attached to said shafts and extending laterally therefrom, a plurality of upwardly extending arms each secured adjacent at one end to one of said eccentric members at a position spaced from the attachment of said eccentric member to said shaft and adjacent the other end being pivotally attached to said platform, and means slidably engaging said arms intermediate their points of attachment to said eccentric member and platform whereby said platform remains in the same horizontal plane during the movement between said lock chamber and vacuum chamber.

6. Apparatus, as set forth in claim 5, wherein said means slidably engaging said arms comprises a slot formed in at least one of said arms and extending in the longitudinal direction thereof, and a guide pin secured within said lock chamber and disposed in sliding engagement with said slot, whereby with said eccentric member pivotally attached to said arm as said shafts are rotated said eccentric member pivots one end of said arm about the shaft with said arm pivoting about said guide pin.

7. Apparatus, as set forth in claim 6, wherein one of said shafts extends outwardly from said lock chamber, and means being secured to the end of said shaft exterior of said chamber for rotating said shaft and moving said platform.

8. Apparatus, as set forth in claim 6, wherein said platform comprising a base portion arranged to support a mold and a pair of oppositely arranged upwardly extending side portions, and said arms being pivotally attached to said side portions.

9. Apparatus, as set forth in claim 6, wherein the required dimensions for the spacing between the points of attachment of said eccentric member to said shaft and said arm and for the dimensions between the points of attachment of said guide pin to said lock chamber and the point of attachment of said arm to said platform is determined by the formulas

$$r=\frac{A^2}{2(H-A)}$$

$$b=\frac{2H(H-A)}{2H-A}$$

and wherein:

A = ½of the working stroke or distance traveled by the platform between the lock chamber and the position in said vacuum chamber for receiving molten metal from said crucible;

H = the vertical height between the shafts and the horizontal plane including the points of pivotal attachment between said arms and said platform;

r = the distance between the point of fixed attachment of said eccentric member to said shaft and the point of pivotal attachment of said eccentric member to said arm; and

b = the vertical distance from the horizontal plane through the points of pivotal attachment of the arms to said platform and the location of fixed attachment of said guide pins to said lock chamber.