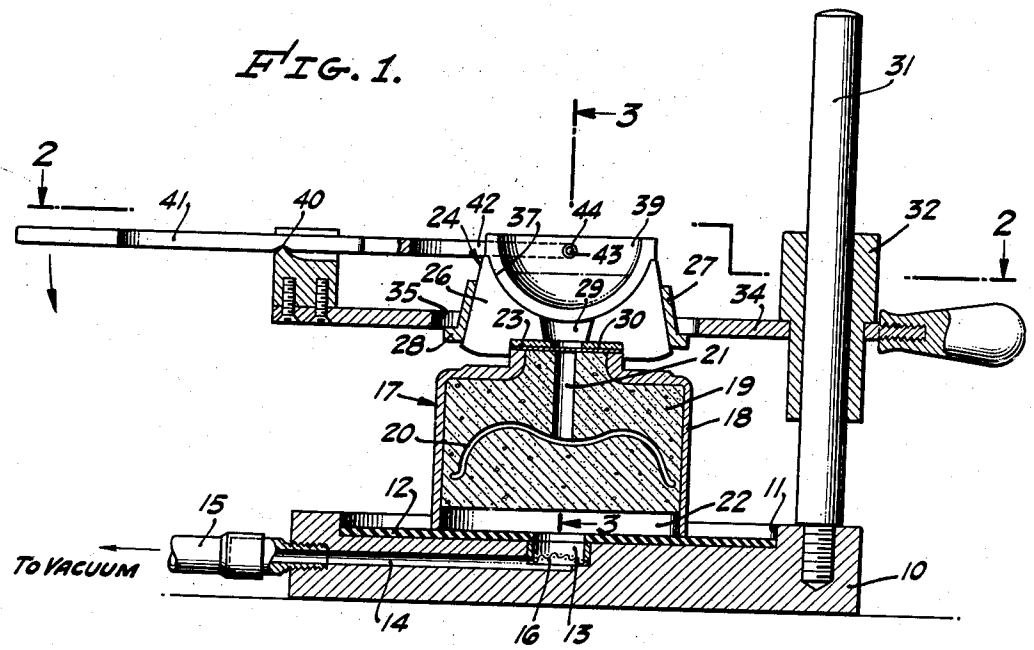
Aug. 10, 1954 W. L. SCHMITZ 2,685,718

CASTING APPARATUS

Filed Dec. 26, 1951

2 Sheets-Sheet 1

FIG. 1.



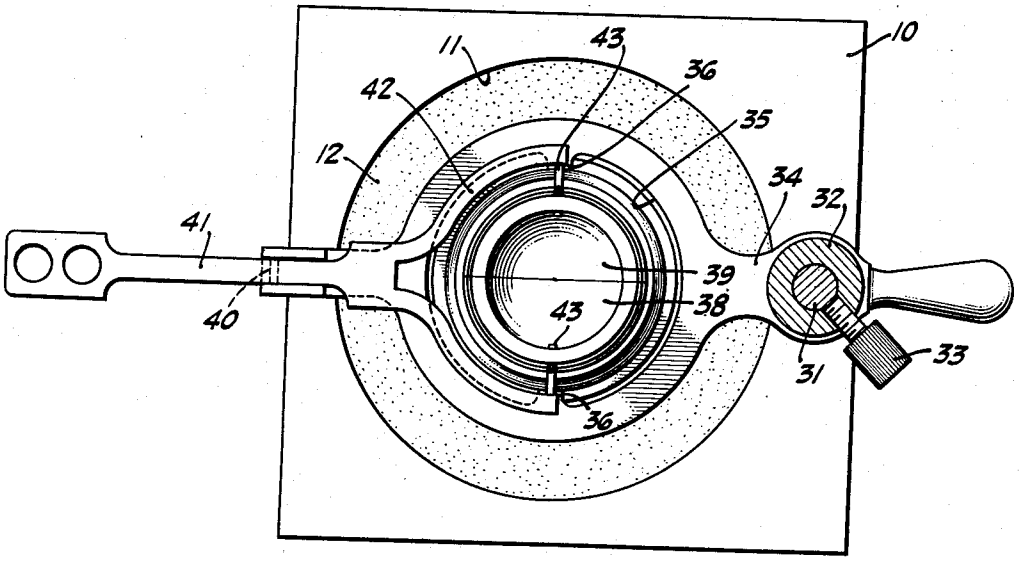


FIG. 2.

WILLIAM L. SCHMITZ,
INVENTOR.

BY Hazard & Miller

ATTORNEYS.

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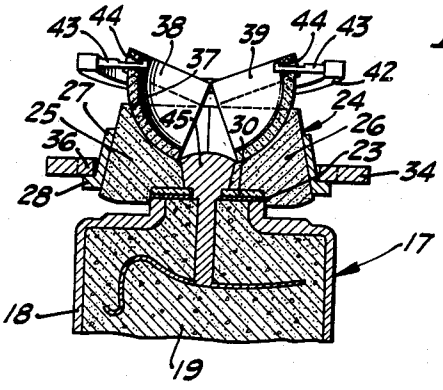


FIG. 3.

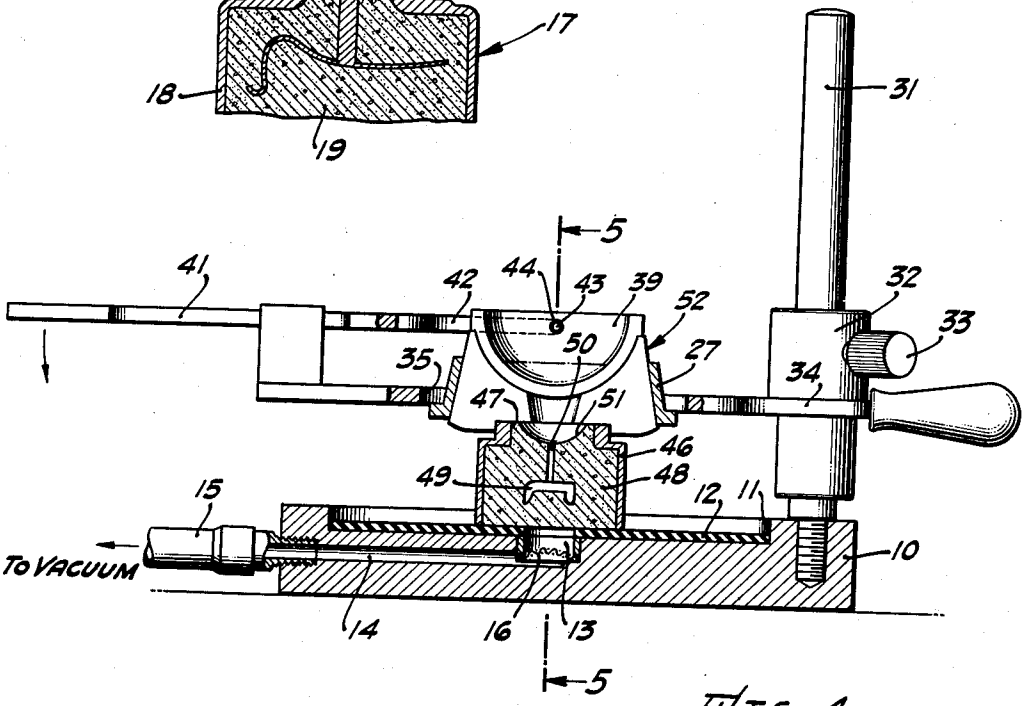


FIG. 4.

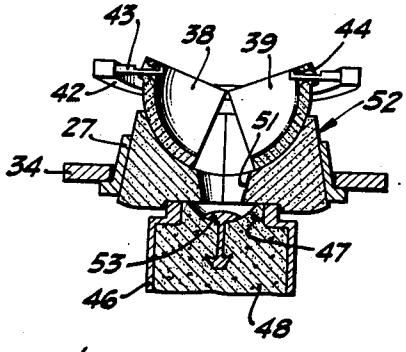


FIG. 5.

WILLIAM L. SCHMITZ,
INVENTOR.

BY Hazard & Miller

ATTORNEYS.

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2,685,718

UNITED STATES PATENT OFFICE

2,685,718

CASTING APPARATUS

William L. Schmitz, San Marino, Calif.

Application December 26, 1951, Serial No. 263,195

4 Claims. (Cl. 22—57.1)

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This invention relates to improvements in casting apparatus, and may be regarded as a further development of the invention disclosed in my copending application Serial No. 133,541, filed December 17, 1949, entitled Means and Method of Casting in Vacuo.

In the above-mentioned application there is disclosed a method of casting wherein a porous mold is formed in an impervious tubular shell and the mold cavity in the mold has a gate leading thereto from one of the ends of the shell. A thin diaphragm is positioned on the mentioned end of the shell so as to overlie the entrance to the gate and a vacuum is created within the shell through the other end thereof. The thin metal diaphragm or membrane that overlies the entrance to the gate prevents ingress of air while the mold cavity, the gate, and the porous mold material is having a vacuum created therein through the pores of the porous mold material. A funnel or sprue is positioned over the diaphragm or membrane and the material to be cast, which is usually molten metal, is poured through the funnel and against the diaphragm or membrane, rupturing or melting the diaphragm or membrane and the flowing into the mold. Entrance of the molten metal into the gate and into the mold cavity being unopposed by any substantial amount of air or gas therein a casting can be produced having high fidelity to the shape of the mold cavity.

In the application above mentioned the funnel or sprue that was positioned over the membrane was usually formed of a self-hardening moldable material such as dental investment and the quantity of molten metal poured into the mold through the funnel or sprue was sufficient in velocity and in amount to fill the entrance to the mold and form a liquid seal so as to prevent ingress of air therewith while the mold was being filled. Usually, the amount of metal poured into the funnel or sprue was sufficient in quantity as to leave a substantial button in the funnel. When the casting had been cooled and solidified, the porous cold material within the mold shell was broken and destroyed in recovering the casting. Also, the material used to form the funnel or sprue was broken and destroyed to free the solidified button so that in making a subsequent casting not only did a new mold have to be prepared, but also a new funnel or sprue.

One object of the present invention is to provide an apparatus in which the method disclosed in my copending application can be conveniently performed and wherein the funnel or sprue leading to the entrance to the gate covered by the membrane is made of separable parts which can be separated from each other to free the button therein without involving their destruction or the making of a new funnel or sprue for each casting operation.

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In castings of this type it has been found that in some instances porosity of the cast metal occurs in the casting near the juncture of the casting with the gate. This is probably due to the fact that the metal poured into the mold cavity commences to quickly cool and solidify and consequently shrink. If the gate is of sufficient size with respect to the size of the mold cavity, and if the button at the top of the gate or within the funnel is of sufficient size and can be kept molten while the metal in the mold cavity is shrinking, porosity is avoided in that the metal in the mold cavity may draw from the gate or from the molten button to compensate for the shrinkage.

Another object of the invention is to provide an improved apparatus wherein the metal to be cast can be melted and kept in a molten condition very close to the mold cavity and on flowing the metal into the mold, an opportunity is afforded to keep the button in the funnel molten so that as the metal in the mold cavity shrinks it may draw from the button and thus avoid porosity in the casting above referred to.

Still another object of the invention is to provide an apparatus for casting wherein there is a crucible divided into sections that can be held in assembled relationship over a mold while metal to be cast is being melted therein and which can be easily and quickly opened to discharge its contents into the mold therebeneath so that a minimum time loss and cooling of the metal will take place between the emptying of the crucible and the filling of the mold cavity.

Another object of the invention is to provide a casting apparatus, the parts of which can be easily manufactured and assembled and manipulated to secure fine castings. While the improved apparatus has been primarily designed for the manufacture of small castings, such as dental castings, or parts of jewelry, it is not restricted thereto but may be employed wherever dense and high precise castings are desired.

With the foregoing and other objects in view, which will be made manifest in the following detailed description and specifically pointed out in the appended claims, reference is had to the accompanying drawings for an illustrative embodiment of the invention, wherein:

Figure 1 is a vertical section through an apparatus embodying the present invention;

Fig. 2 is a horizontal section taken substantially upon the line 2—2 upon Fig. 1;

Fig. 3 is a partial view in vertical section taken substantially upon the line 3—3 upon Fig. 1, the crucible being shown in open position;

Fig. 4 is a vertical section through an alternative form of apparatus embodying the present invention; and

Fig. 5 is a view taken substantially upon the line 5—5 upon Fig. 4, the crucible being shown in open position.

Referring to the accompanying drawings wherein similar reference characters designate similar parts throughout, the improved apparatus consists of a base 10 in the top of which there is formed a depression 11. The bottom of this depression is provided with a gasket 12 preferably formed of compressible or resilient material resistive to relatively high heats such as for example silicone rubber. In the center of the base there is formed an opening 13 which is in communication with a bore 14 to which a flexible tube 15 may be connected. The tube 15 leads to a vacuum pump, not shown, so that a strong partial vacuum may be created within the bore 14 and opening 13. Preferably, the bottom of the opening 13 is covered by a screen 16.

The mold is generally indicated at 17 and consists of a tubular impervious shell 18 which may be a conventional dental flask. This shell or flask is largely filled with a porous molding material 19 such as a self-hardening conventional dental investment. The mold cavity 20 formed therein may be produced by the conventional "lost wax" method and the gate 21 that leads thereto has its entrance formed in that portion of the porous molding material 19 that is exposed in the upper end of the shell or flask 18. The lower end of the shell or flask is positioned on the gasket 12 so as to overlie the opening 13 and in the form illustrated in Fig. 1, the mold material 19 terminates at its bottom above the bottom edge of the flask 18 so as to form a chamber 22 in which vacuum will be produced.

Over the upper end of the flask there is positioned a thin diaphragm or membrane 23. This membrane or diaphragm is usually gold foil of approximately .002" in thickness. Gold foil is particularly used when the metal to be cast is gold. If other metals are employed the diaphragm or membrane is preferably formed of a metal compatible therewith. This membrane extends not only over the entrance to the gate 21 but over the entire upper end of the tubular shell or flask 18 and serves to prevent ingress of air while a vacuum is being produced in the mold cavity 20, the gate 21 and in the pores of the porous mold material 19 by means of the vacuum pump.

Over the diaphragm or membrane 23 there is a funnel or sprue 24. This funnel or sprue is diametrically divided into two opposed sections 25 and 26. It may be divided into more than two sections, such as for example three or four, along radial lines, but when only two sections are employed the funnel may be regarded as also being divided on radial lines which coincide with the diameter. These sections collectively present upwardly converging outer surfaces so as to be frusto-conical in form. They are adapted to be held in assembled relationship by an annular ring 27 having an annular flange 28. Around the opening 29 that is formed in the bottom or lower

portion of the funnel or sprue there is a recess designed to accommodate an asbestos gasket 30 that is positioned directly over the diaphragm or membrane 23.

On the base 10 there is an upstanding post 31 on which is slidable a sleeve 32 that can be held in any adjusted position such as by a thumb screw 33. This sleeve has an arm 34 rigid therewith that is widened centrally and equipped with a relatively large aperture 35. At the sides of the aperture there are inwardly extending fingers 36 that are engageable with the flange 26 so that when the funnel or sprue 24 is in position over the mold the arm 34 may be pressed downwardly into engagement with the ring 27. The ring not only holds the sections of the funnel in assembled relationship but may press them downwardly toward the membrane 23 to press the membrane firmly against the top of the flask or shell 18. The upper portions of the sections of the funnel are enlarged or widened as indicated at 37 so that the upper portion of the funnel forms a substantially hemispherically-shaped recess above the opening 29. This recess is designed to receive a crucible that is hemispherically shaped and which is diametrically divided into two sections 38 and 39.

The arm 34 provides a fulcrum 40 for a lever 41 that is bifurcated or forked as indicated at 42 at its inner end. The sides of the fork are provided with pins 43 that loosely extend through apertures 44 in the sides of the crucible adjacent its top edge. The crucible sections 38 and 39 normally assume a position wherein their lower opposed edges are in abutment as depicted in Fig. 2, but by pressing on the outer end of the lever 41 the pins 43 may be caused to lift the sides of the crucible so as to separate the bottom edges of the sections as illustrated in Fig. 3 so as to dump the contents of the crucible into the funnel or sprue.

The sections of the crucible as well as the sections of the funnel or sprue 24 are preferably formed of ceramic material resistant to damage by molten metal being metled therein or flowing therethrough so that these parts are susceptible of indefinite re-uses.

In using the apparatus above described the mold is assumed to have been previously prepared from a wax pattern. By flowing a self-hardening dental investment material in the flask or shell 18 around the pattern and around the core that produces the gate 21, the wax pattern and the core can subsequently be melted out in accordance with the lost wax process. The mold is then positioned on the gasket 12 to overlie the aperture 13 and the diaphragm or membrane 23 is positioned over the upper end of the mold. The sections of the funnel or sprue are then positioned within the ring 27 and the assembly is then positioned over the mold. The arm 34 is lowered so that the fingers 36 will engage the flange 28 and press the ring 27 downwardly. This causes the sections of the funnel to be held in assembled relationship and to press the asbestos gasket 30 into firm engagement with the top of the membrane 23. The crucible is then positioned in the top of the funnel which serves to hold the sections of the crucible in assembled relationship as depicted in Fig. 2. The metal to be melted can then be placed in the crucible and melted by the application of a blowtorch, not shown. While such melting operation is being performed, the vacuum pump may be operated to exhaust as completely as possible air from

the chamber 22. Air in the gate and mold cavity is also exhausted as completely as possible through the pores of the porous investment material 19 and the air in the pores of this material is likewise exhausted. When the metal in the crucible is molten and in a condition for casting, the outer end of the lever 41 may be depressed slightly. This causes the pins 43 to elevate the sides of the crucible from the position shown in Fig. 2 into the position shown in Fig. 3. The lower edges of the crucible sections are consequently separated and the molten metal is allowed to fall through the opening 29 against the membrane 23 overlying the gate 21. This portion of the membrane is either immediately ruptured by the added weight of the metal or melted by its heat so that without any noticeable hesitation the metal flows directly through the funnel into the gate and into the mold cavity. As the gate and mold cavity are in a high evacuated condition there is no air or gas present to retard the flow of metal with the result that a highly dense and precise casting is obtainable. The amount of metal used in the crucible is sufficient to form a liquid seal with the walls of the gate 21 so that air cannot enter the gate and mold cavity along with the molten metal. Consequently, the casting may be regarded as being produced under a differential pressure approximately equal to atmospheric pressure. As will be observed from Fig. 3, the amount of metal poured is sufficient to normally form a button 45 in the funnel which may be of substantial size. This button may be of such size that it will tend to remain molten after the metal in the mold cavity has started to solidify. Any shrinkage in the metal in the mold cavity may consequently draw from the button 45 and thus avoid porosity. A feature of the invention, however, resides in the fact that the opening of the crucible to discharge its contents exposes the top of the opening 29 so that the torch used to melt the metal in the crucible can be played immediately on the top of the button 45, thus keeping this button molten to supply metal to the mold cavity to compensate for shrinkage. In this manner, by continuing to play the melting torch on the button 45 after the crucible has been emptied, porosity in the casting can be completely avoided.

When the casting has cooled the thumb screw 33 can be loosened and arm 34 elevated. The ring 27 can be lifted from the sections of the funnel so as to allow these sections to separate. As these sections are separable from each other on radial lines they can be moved radially apart to free the button 45 and re-assembled together in subsequent casting operations. A casting operation does not involve destruction of the funnel. The casting may be recovered by breaking the investment material 19 from around the mold cavity and around the gate 21.

The construction above described is very advantageously used where the casting is in the form of a relatively broad but very thin section, such as for example a cast base for a full upper denture as illustrated. Where the casting to be produced is of relatively small volume and is highly compact in form as in the case of an inlay depicted in Figs. 4 and 5, I have found that it is possible to dispense with the membrane or foil entirely. Thus, as depicted in Figs. 4 and 5, the flask 46 is of relatively small size and has a relatively small opening 47 in the top thereof. This flask has the mold 48 formed of dental investment or similar porous material formed therein providing the mold cavity 49 and a gate 50. The top of the gate is cupped out as at 51 to receive the excess of metal and form the button. The flask is positioned on the gasket 12 on the base and the vacuum pump started to create a high partial vacuum in the porous mold material 48. This causes air in the pores of the porous investment to be continually withdrawn therefrom, and while air can enter the cup 51 the gate 50 and the mold cavity 49 while the vacuum is being pumped within the flask, the flow of air through the investment is greatly impeded as the pores in the porous investment are quite fine. Where the flask is relatively small and of the size conventionally used for making inlays, a vacuum of the order of 27" of mercury can be created in the depression 13 even though the cup 51, gate 50, and mold cavity 49 are open. In this way, in effect a reservoir of vacuum is formed in the pores of the investment within the flask 46 below the flange that defines the entrance 47. This reservoir of vacuum is many times the volumetric size of the mold cavity 49 and the gate 50.

When the metal to be cast is quickly deposited in the cup 51 it fills the entrance to the gate 50, thus forming a liquid seal against further ingress of air. The volume of air in the gate 50 and in the mold cavity 49 being relatively small as compared with the large reservoir of vacuum in the pores of the investment 48, this air becomes almost instantly dispersed in the pores so that it does not retard the inflow of metal through the gate and into the mold cavity. Consequently, where the volume of the mold cavity is comparatively small and is quite compact it is possible to dispense with the sealing diaphragm or membrane entirely.

In this form of construction the manner in which the molten metal is delivered to the cup 51 is of no great importance although I prefer to employ a ring or funnel 52 which may or may not be diametrically split. This ring or funnel serves to support the halves of the split crucible which can be lifted and separated by the lever as previously described. The use of a spit crucible directly over the mold enables the metal to be cast to be heated in close proximity to the mold cavity and as the crucible opens at its bottom it affords an opportunity for dense clean metal in the bottom of the crucible to first enter the mold and form the liquid seal without being contaminated with oxides, fluxes, or other substances which are usually flowing on the surface. Sufficient metal is poured into the mold to form the button 53 which occupies a position within the cup 51 and serves to supply metal to the casting to compensate for shrinkage. Usually, however, where the casting is small compensation for shrinkage affords no great problem.

From the above-described constructions it will be appreciated that the improved casting apparatus is highly advantageous in that when it is necessary to form the button in the funnel or ring, as in Figs. 1 and 3, the parts of the funnel may be separated around the button and used over and over again. Furthermore, the arrangement of the apparatus is such that the metal to be cast can be heated and rendered molten close to and directly over the mold so that at the instant of pouring there is no time loss or any opportunity for the metal to be cast to lose its heat. In both forms of construction a high degree of vacuum is formed in the gate and mold

cavity. In Figs. 1 and 3 the vacuum can be formed in the gate and mold cavity in advance of pouring and in the construction shown in Figs. 4 and 5, although air may be in the gate and mold cavity in a more or less rarefied condition due to the mold being heated as is customary in this type of casting, such air is quickly dispersed in the pores of the investment as soon as the liquid seal is formed at the commencement of the pouring. Consequently, in both constructions the metal flows into the gate and into the mold cavity without being impeded or retarded by the presence of air therein. The apparatus disclosed is versatile in that the same apparatus can be advantageously used for both types of castings.

Various changes may be made in the details of construction without departing from the spirit and scope of the invention as defined by the appended claims.

I claim:

1. In casting apparatus, a cup-shaped crucible vertically divided into two opposed sections, means for holding said sections in assembled relationship and contiguously arranged on the line of division so that metal may be melted in the crucible, and means for lifting said sections adjacent their rims at points arranged at approximately right angles to the line of division between the sections whereby said sections may be caused to have their lowermost portions separate to allow the molten metal to flow therebetween.

2. In casting apparatus, a mold having a gate, a funnel positioned over the mold and leading to the gate, said funnel having a recess in the top thereof, a cup-shaped crucible resting in the recess, said crucible being vertically divided into two opposed sections and contiguously arranged on the line of division therebetween so that metal may be melted in the crucible, and means for lifting said sections adjacent their rims at points arranged approximately at right angles to the line of division between the sections whereby said sections may be caused to have their lower portions separate to allow the molten metal to flow therebetween through the funnel and into the mold.

3. A casting apparatus comprising a base on which a mold may be positioned, means on the base for connecting the bottom of the mold with a source of vacuum, a post on the base, a funnel holder vertically adjustable on the post toward and away from the mold, a funnel adapted to be positioned over the mold to discharge into the gate of the mold, said funnel having a recess in the top thereof, a cup-shaped crucible disposed in the recess of the funnel, said cup-shaped crucible being vertically divided into two opposed sections contiguously arranged along the line of division therebetween, a lever pivotally mounted upon the funnel holder and means on the lever engageable with the sections of the crucible adjacent their rims at points arranged at approximately right angles to the line of division between the sections of the crucible whereby when the lever is actuated to lift the sections of the crucible the sections will separate at their bottoms and discharge the contents of the crucible into the funnel and into the mold.

4. In casting apparatus, a base, a mold receivable upon the base, a post on the base, a funnel receivable over the mold, a funnel holder vertically adjustable on the post for holding the funnel over the mold, a cup-shaped crucible fitting the top of the funnel, said crucible being vertically divided into opposed sections, a lever pivotally mounted upon the funnel holder, and means on the lever engageable with the sections of the crucible adjacent their rims at points arranged at approximately right angles to the line of division between the sections of the crucible whereby when the lever is actuated to lift the crucible the sections of the crucible will have the lower portions thereof mutually separate to empty the contents of the crucible through the funnel and into the mold.

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