United States Patent [19]

Tenner

[11] **3,777,801**

[45] **Dec. 11, 1973**

[54] **CASTING APPARATUS**

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[73] Assignee: **Gravicast & Patentverwertungsgesellschaft m.b.H.**, Vienna, Austria

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Sept. 4, 1970 Austria .... A 8046/70

[52] **U.S. Cl.** **164/337**
[51] **Int. Cl.** **B22d 37/00**
[58] **Field of Search** .... 164/256, 281, 304, 164/311, 312, 335, 337, 338, 362, 363, 133, 134, 306, 259, 338 R, 338 M, 338 H; 222/1, 8–10, 11–14; 13/29, 33; 266/38, 39

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Primary Examiner—J. Spencer Overholser
Assistant Examiner—John S. Brown
Attorney—Benjamin H. Sherman et al.

[57] **ABSTRACT**

A casting apparatus is provided with a supply container for the melt which has a discharge opening leading the fluid melt into an equalization container arranged within said supply container in such a manner that the melt in the supply container surrounds the equalization container. The latter has a plug-controlled inlet which controls the flow of the melt into the equalization container. The equalization container has also an outlet having a casting nozzle therein which leads to a mold arranged outside of the supply container. The supply container is connected with a furnace in which the metal is produced.

11 Claims, 11 Drawing Figures

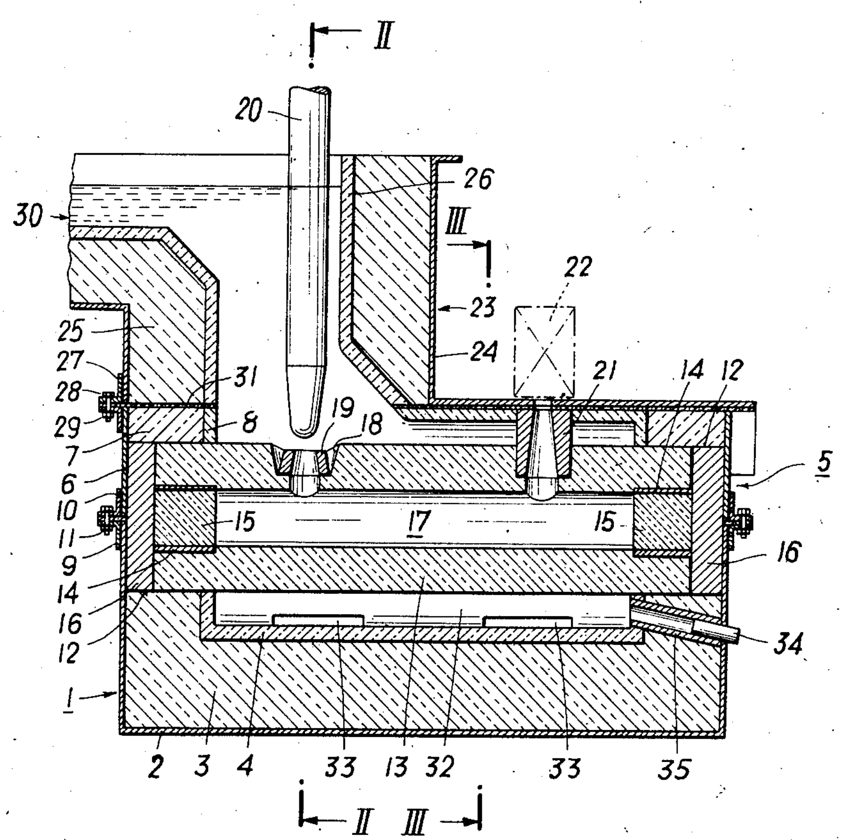
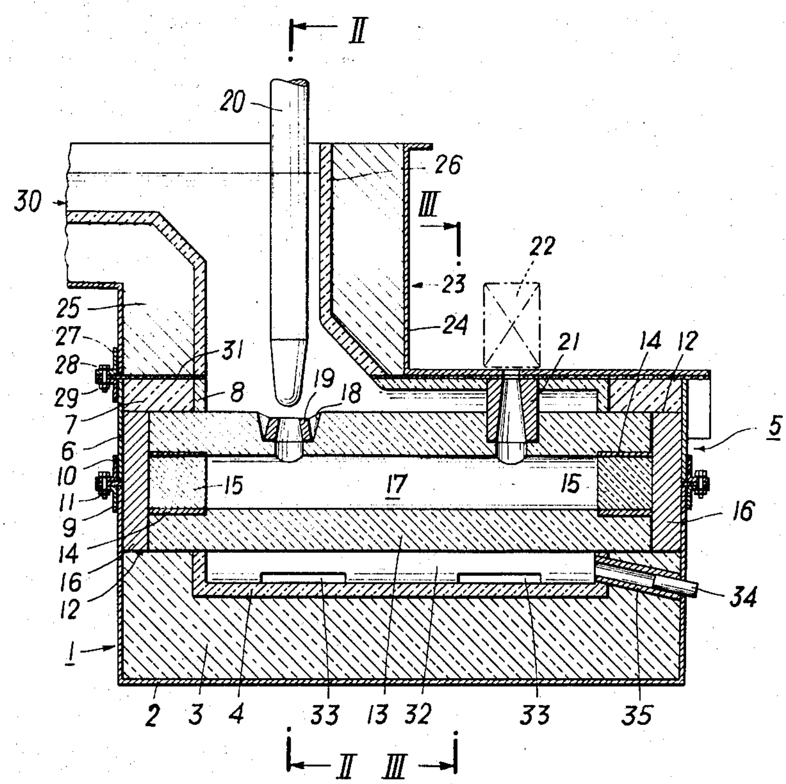


FIG. 1


II
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26
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III
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21
14
12
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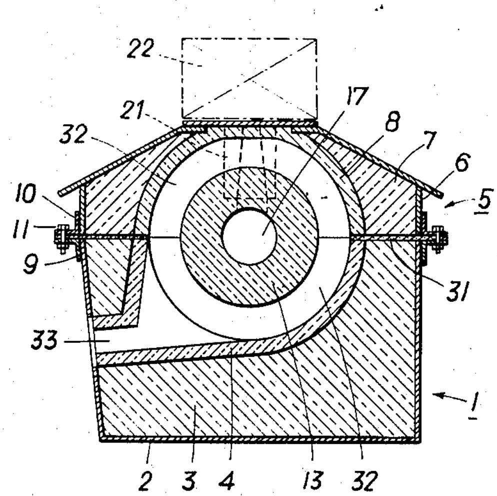
II III

FIG. 3


22
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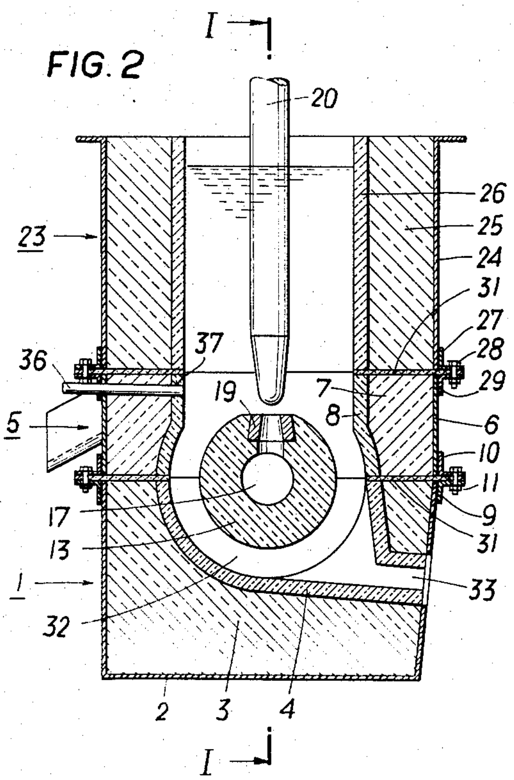
13
32

FIG. 2


I
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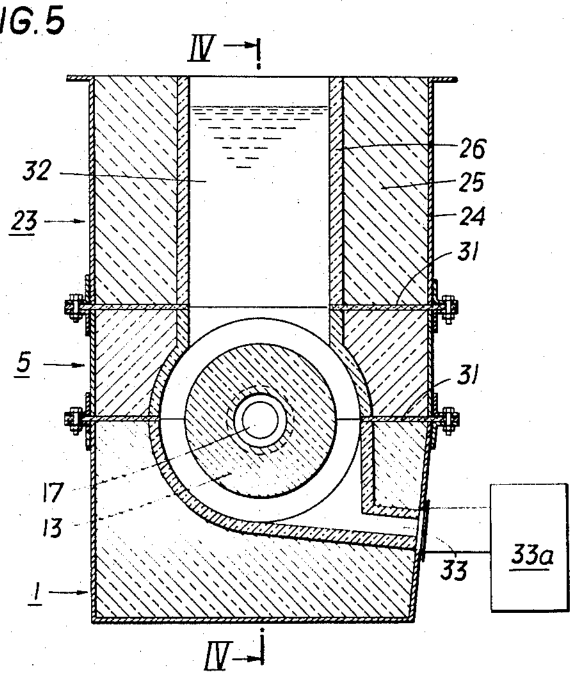
I

FIG. 5


IV
26
25
24
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32
23
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17
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1
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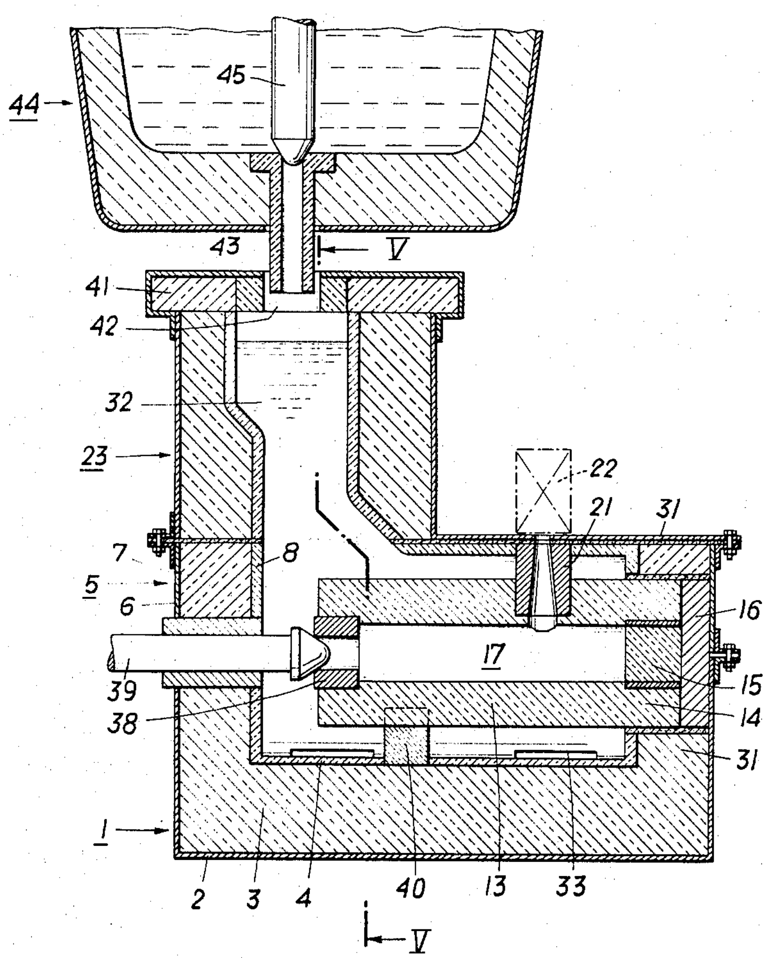
33a
IV

FIG.4


44
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43
V
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42
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23
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38
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40
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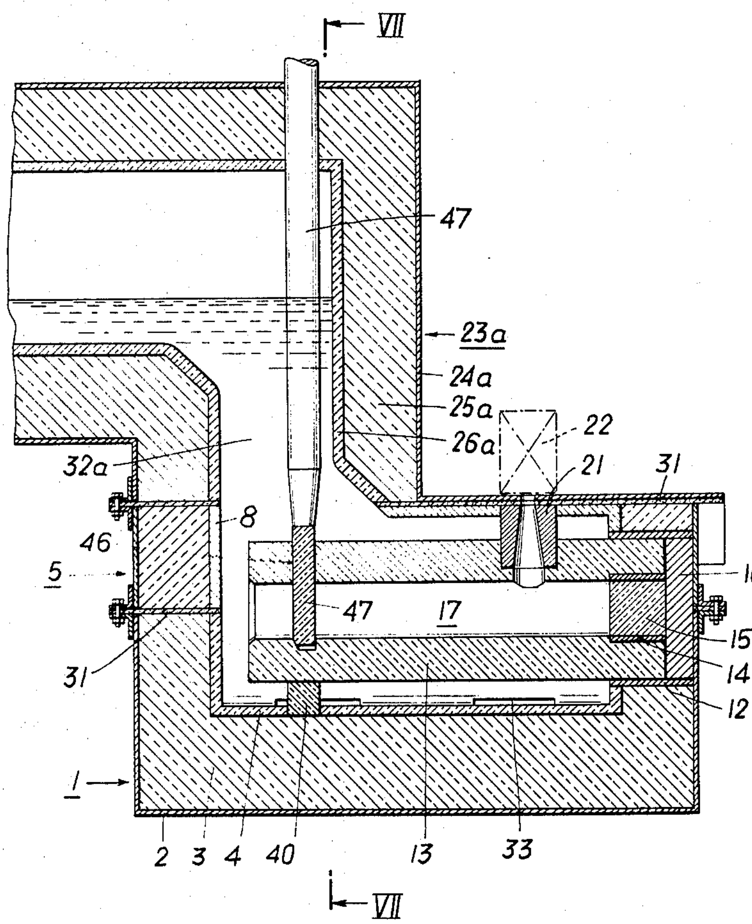
33
V

FIG. 6


VII
47
23a
24a
25a
22
26a
21
31
32a
8
46
16
5
47
17
15
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14
12
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2
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13
33
VII

FIG.7

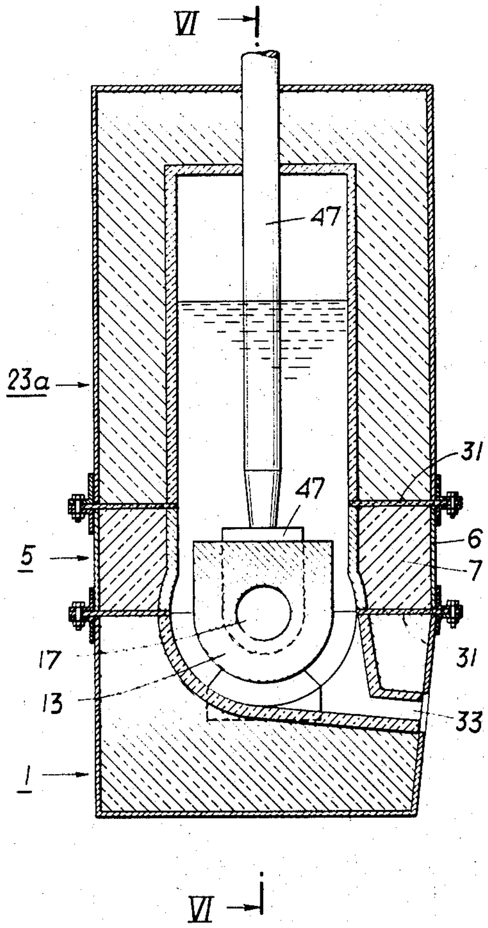


FIG.8

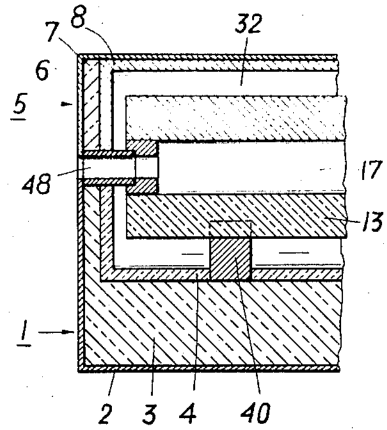


FIG.9

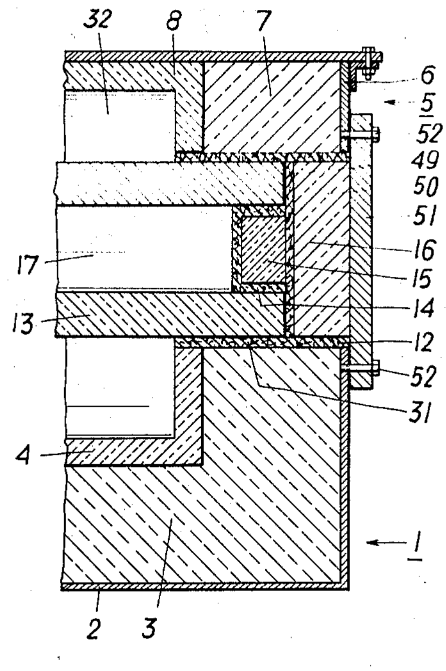


FIG. 10

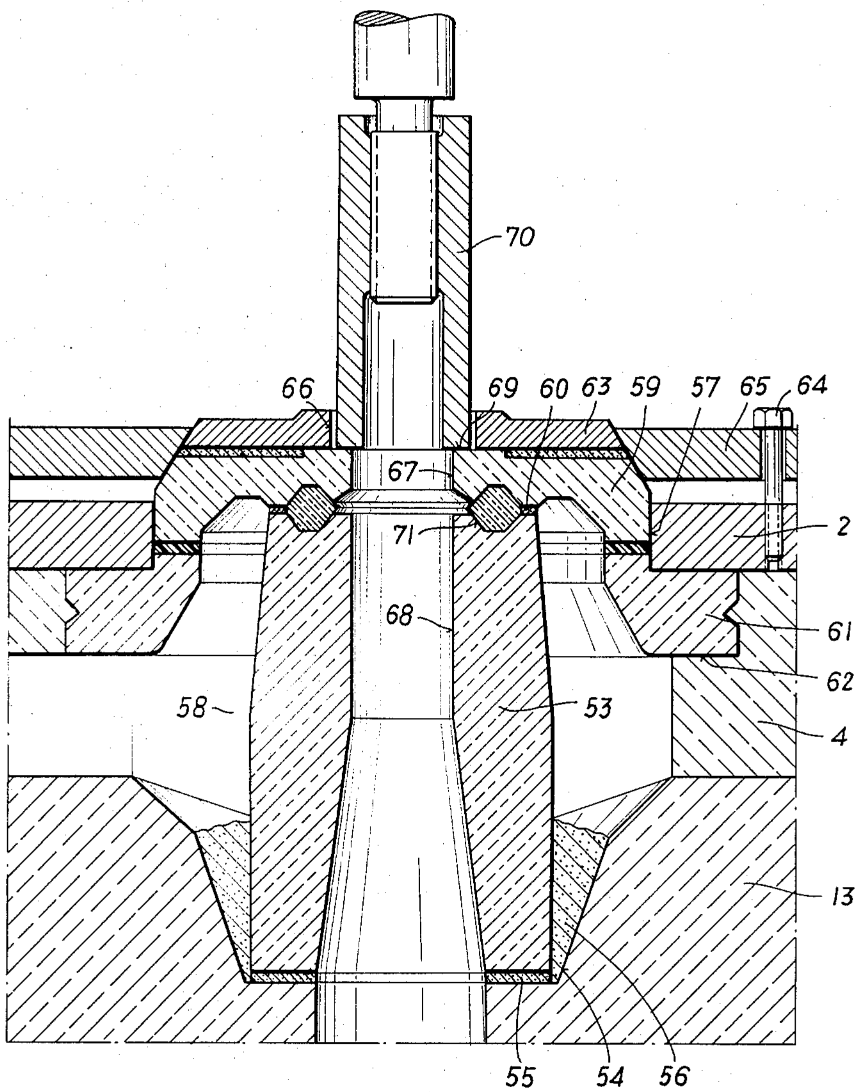
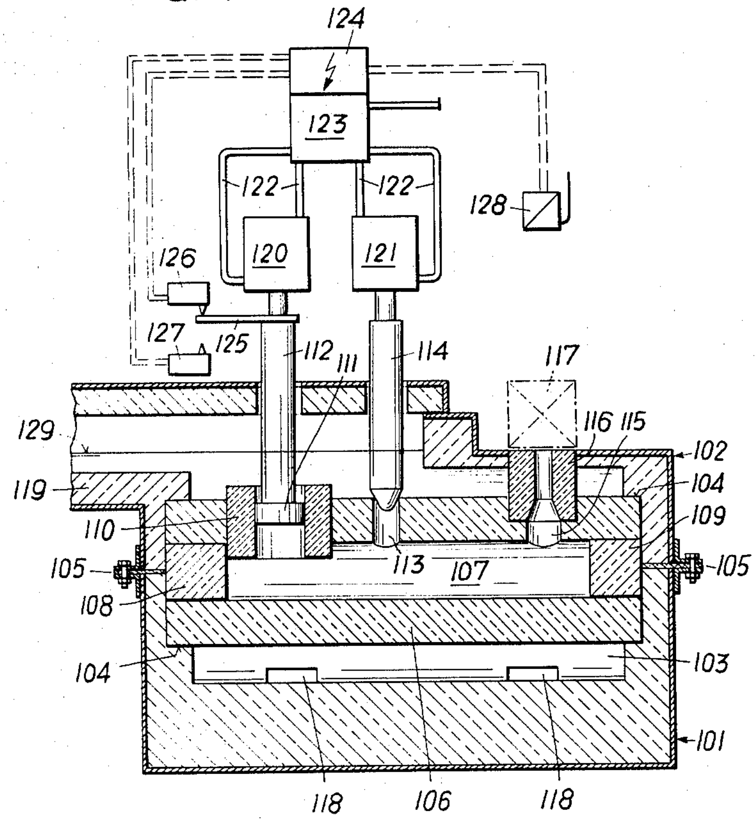


FIG. 11


124
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CASTING APPARATUS

The invention relates to a casting apparatus for melts with a supply container for the melt from which the melt flows though a discharge opening under the pressure of liquid melt to an equalization container from which a discharge aperture leads to the mold, as well as to a device controlling the flow of the melt to the mold.

It is known from the Austrian Pat. specification No. 239,979 to withdraw the melt from the lower part of a supply chamber by means of a short pipe having a closure on its outer end and being flanged to the casting vessel, thus conveying the melt by its pressure (ferrostatic pressure) into the casting vessel. For such devices it is difficult to maintain a controlled flow pattern of the melt. It is also difficult to control the temperature at the entry into the mold. It is, however, possible to place the short pipe at least partially in the furnace chamber for a heating of the crucible, but this results in an unwieldy construction as well as causes difficulties in respect of an optimal shape of the furnace chamber.

It is also known from the German Auslegeschrift No. 1,295,762 to connect by means of a conduit a high supply chamber with a relatively small casting chamber, the bottom of which is placed approximately on the same level as the bottom of the supply chamber. In this arrangement a closure is provided between the chambers for varying the speed of the metal flow. Here also the melt is conveyed by ferrostatic pressure. The insertion of the chambers into each other produces a compact construction. In this known arrangement, a separate heating system is assigned to each of the chambers causing an expensive construction and an expensive operation. Furthermore, the proposed kind of induction heating causes distortion of the flow pattern in the casting chamber since it is known that any induction heating produces its own kind of flow. Uncontrolled flow patterns are completely undesirable during the casting procedure because they affect the quality of the casting and cause waste.

It has also been proposed to connect in an L form the supply chamber to an equalization chamber and to place a stopper in the passage from the supply chamber to an equalization chamber. Such an arrangement allows control of the flow but is hardly an economical way to heat, and it becomes difficult to control the casting temperature when the melt flows into the mold.

So-called cold or hot chamber machines are used to convey the melt from a vessel to the mold or to a separate die caster, having in general a so-called gooseneck. These machines have a cylinder and a piston; from the cylinder a gooseneck duct leads upwardly or a straight duct leads sidewards to the cast or to the die caster, respectively. The cylinder has an inlet which is overlapped and closed by the piston during the working stroke. During the reverse movement of the piston the inlet is opened and the cylinder becomes filled with the melt by means of the ferrostatic pressure. The length of the working stroke is adjusted in such a way that the desired portioning can be obtained. The bent form of the goosenecks is disadvantageous for the flow techniques and is difficult to produce. Besides, the temperature control is very difficult with the known devices, for example as described in the Austrian Pat. specification No. 275,777 and the German Pat. specification No. 736,766.

It is an object of the invention to insure a controlled casting temperature and a controlled flow of the melt, if at all possible without turbulence, when the melt enters the mold, thus avoiding the drawbacks of the known constructions. The invention accomplishes this purpose with a casting apparatus of the type described above by arranging the equalization container at least up to the outlet in the supply container, thus surrounding and heating it with the melt which is in the supply container. It is useful to place the equalization container entirely inside of the supply container. The shape and dimension of the equalization container can be ideally selected according to the desired flow pattern, without being much influenced by flow conditions produced by the heating, since the melt in the supply container is set in motion by the heating (mostly by induction heating) but not the melt inside the equalization container. At the same time, it is possible for every selected shape of the equalization container to maintain a controlled temperature of the melt before it enters the die or mold, respectively. This leads to accurately controllable casting conditions and can, for instance, avoid unwanted turbulences while maintaining an accurate casting temperature which consequently leads to much better results and to a smaller rate of waste. Also, the position of the equalization container and the supply container inserted into one another leads to a compact construction with a small loss of heat and thus, compared with known devices, its operating costs are very low.

According to a further development of the invention, the apparatus is preferably so constructed that the casting nozzle is arranged substantially in the supply container and is surrounded on its exterior by the melt from the supply container, thus allowing the aforementioned good conditions to be obtained also in the area of the casting nozzle.

Preferably, the equalization chamber comprises a long tube with a straight axis, being surrounded on its outside by the melt of the supply container, and being thus heated. This leads to a very simple construction, for the tube is easy to produce and requires little melt to surround it. In the long tube the flowing melt has enough time to settle down after flowing through the device which controls the flow of the melt.

If the equalization container formed by a tube — according to the invention — is fixed at least on one end in an opening of the wall of the supply container, it is possible to attach this tube in such a manner in the wall of the supply container that the equalization container can be exchanged if this is desired. This replacement is also possible if the supply container is made of two parts and if both of the parts are connected detachably within the area of the equalization container whereby the separation planes of these parts are placed approximately at the level of the longitudinal axis of the equalization container, so that the two parts lie above or below respectively, the equalization container.

Another feature of the invention is that a displacement body may be arranged at the equalization container, which enters into the equalization chamber and is connected with a movable stopper. In this manner, it is possible to produce pressures, independently of the ferrostatic pressure and the apparatus may work for instance like a pump, or in the following more interesting manner in that after filling the mold by the ferrostatic pressure, the stopper can be closed and by means of the displacement body independently of the ferrostatic pressure, a higher desired pressure may be applied. The piston strokes of the displacement body are extremely short, insuring little wear, quick beat times, and a higher casting speed so that larger castings can be produced without major difficulties, for the diameter of the equalization chamber is relatively small.

Other features and advantages of the invention will be apparent from the following description of examples for the apparatus which are schematically illustrated in the accompanying drawings, in which

FIG. 1 shows a vertical section of a casting apparatus along the line I—I of FIG. 2,

FIG. 2 and FIG. 3 are sections along the lines II—II and and III—III, respectively of FIG. 1.

FIGS. 4 and 5 show another example of an apparatus of the invention, whereby FIG. 4 is a section along the line IV—IV of FIG. 5, and

FIG. 5 is a partial section along the line V—V of FIG. 4.

FIGS. 6 and 7 show still another example of a casting apparatus of the invention, in which FIG. 6 represents a section along the line VI—VI of FIG. 7, and

FIG. 7 represents a section along the line VII—VII of FIG. 6.

FIGS. 8 and 9 show each a section of details.

FIG. 10 shows a section of the connection of a casting nozzle with the equalization chamber, and

FIG. 11 shows a section of an apparatus having an additional displacement body.

Referring to the FIGS. 1 to 3, the illustrated embodiment of the invention comprises a supply container, the lower part 1 of which is formed by a metal box 2, a compressed or brick insulation lining 3 and a compressed or brick wear resisting inner lining 4. On this lower part 1, the upper part 5 of the supply chamber is positioned. This upper part 5 consists of a metal box 6, a compressed or brick insulation lining 7 and a compressed or brick wear resisting inner lining 8. The lower part 1 and the upper part 5 are detachably united by screws 11 and angle irons 9 and 10 respectively attached to the metal boxes 2 and 6 respectively. In each of the end faces of the refractory lining 3, 4 of the lower part 1 and in the lining 7, 8 of the upper part 5, a circular opening 12 is recessed in which a tube 13 is placed forming the equalization container consisting especially for the casting of high melting materials, of aluminiferous graphite, and being fixed by the uniting of the upper part 5 to the lower part 1. In place of aluminiferous graphite, one may use other refractory materials, for instance magnesite or sintered material. For the casting of low-melting material the tube 13 may also consist of cast material or high temperature-resistant sheet steel. The material of the tube 13 should react only tolerably or not at all to the melt as far as influencing the analysis of the melt is concerned. The tube 13 is closed on both ends by a plug 15 of refractory material which is surrounded by an insulating lining 14. The space between the end face of this plug 15 and the metal box 2 or 6 respectively, is filled with insulating material 16. Later on, more details will be described with reference to FIG. 9. The thus created space 17 inside of the tube 13 constitutes the equalization chamber, in which the flow of the casting material settles down after having passed the controlling members, so that the flow pattern can be controlled.

If necessary, the plug 15 can be withdrawn after removing the insulating material 16, and the melt within of the equalization chamber 17 may be simply drained off when closing down the apparatus. The tube 13 has a recess 18, in its wall and has mounted therein a supply nozzle 19 which can be closed and opened respectively by a plug 20 which is movable in vertical direction. Some distance from the supply nozzle 19 is arranged a casting nozzle 21 having a vertical axis. This nozzle 21 is fixedly attached to tube 13 and directs the melt with a controlled flow-pattern from the equalization chamber 17 to the mold 22. A headpiece 23 is placed on the upper part 5 and consists of a metal box 24, a compressed brick insulation lining 25, and a compressed or brick inner wear-resisting lining 26. This head piece 23 is attached by screws 28 and angle irons 27 on the metal box 24 to angle irons 29 on the metal box 6 of the upper part 5. The headpiece 23 has an inlet 30 connected to a not shown furnace so that the level of the melt in the casting apparatus and furnace is the same. Any other type of a communicationg connection may be established between the shown casting apparatus and the furnace.

The headpiece 23 and its inlet 30 can be provided with a cover, and/or a protective gas layer may be maintained above the bath level. It is also possible to protect the bath level from oxidation by a slag layer. Between the abutting faces of the different parts 1, 5, 23 and 13, layers or strips of refractory material, especially kaolin wool, may be placed. This insures a perfect sealing. The space bounded by the inner linings 4, 8 and 26 constitute the supply chamber 32, from which the casting material flows to the equalization chamber 17; analogously, the lower part 1, the upper part 5 and the head piece 23 constitute the supply container. The bottom of the supply chamber 32 is provided with openings 33 for connecting the supply chamber 32 with a not shown induction heating device. This induction heating device maintains a constant desired temperature of the melt in the supply chamber 32, and therefore also of the melt in the equalization chamber 17 which is surrounded by the supply chamber 32. The supply chamber 32 is so designed that there is sufficient space for the development of an agitation of the bath between tube 13 and the inner linings 4, 8 to obtain a uniform temperature of the bath inside the supply chamber 32. The melt in supply chamber 32 heats the tube 13 and the casting nozzle 21, thus maintaining the desired temperature of the melt in the equalization chamber 17 and in the casting nozzle 21. Therefore, it is possible to conduct the melt to the mold 22 with a controlled flow, that is to say, with a possibly turbulence-free flow and with an accurately controlled temperature. If the lower part 1 and the upper part 5 are suitably shaped, it is possible to use another type of heating in place of induction heating, for example a resistance heating or a flame heating.

The lower part 1 has an opening 35 provided with a plug 34 which is used for the emptying of the melt from the supply chamber 32 when shutting down the casting apparatus, and also for exchanging the equalization container 13. In the upper part 5, there is another opening 37 (FIG. 2) provided with a plug 36 which is used for emptying the melt from the headpiece 23 if the apparatus is shut down for a short time. Opening 37 lies above inlet nozzle 19, so that the nozzle and the part of plug 20 cooperating with the nozzle still remain below the lowered bath level. This allows an interruption of the casting procedure, for instance, with two-shift work; after the idle shift, the apparatus is immediately ready for operation, and thus avoids difficulties occurring in known arrangements which start in a cold condition, i.e. uncontrolled temperatures and a higher rate of waste.

In the embodiment of the invention shown in FIGS. 4 and 5, similar parts are marked with the same reference numerals. The tube **13** is attached at one end between the lower part **1** and the upper part **5**. The other end face of tube **13** extends into the melt in the supply chamber **32**, thus being heated and having spaced from the casting nozzle **21**, a horizontal inlet nozzle **38**, which is axially aligned with the equalization chamber **17** and being closed by a horizontal plug **39**. The tube **13** is supported on the end facing the inlet nozzle **38** by a socket **40**. In this embodiment the headpiece **23** has a cover **41** provided with an opening **42** to receive the nozzle **43** of the ladle **44**. The supply from the ladle **44** to the supply chamber **32** is controlled by a plug **45**. The plug **39** is connected with the plug **45** in a mechanical, hydraulical, or electrical manner, thus maintaining approximately a constant bath level in the supply chamber **32**. A schematically shown induction coil **33*a*** is attached to the openings **33**.

The embodiment of the invention illustrated in the FIGS. 6 and 7 differs from the embodiment already described by the lack of the inlet nozzle **38** such as shown in FIG. 4, and by the fact that the tube **13** is connected at its open end with the supply chamber **32**. Some distance from this open end, the tube **13** has in its wall a transverse slot **46** provided with a sliding plate **47** which controls the amount of flow of the melt. In this embodiment the headpiece **23*a*** forms a part of a melting furnace. Thus, the supply chamber **32*a*** forms a part of the melting furnace; a shell **24*a*** and brick linings **25*a*** and **26*a*** form also parts of the melting furnace.

Whereas the embodiment shown in the FIGS. 1 to 3 has a vertical plug for the flow passage, the embodiment shown in the FIGS. 4 and 5 has a horizontal plug with intermittent melt supply to the supply chamber. The embodiment shown in the FIGS. 6 and 7 employs a sliding plate for the supply passage.

FIG. **8** shows an embodiment with a horizontal casting nozzle **48** which can be used in any one of the previously disclosed embodiments.

FIG. **9** shows the details of the closure of the one end of tube **13** inside of the supply chamber. The closure for the other end face of tube **13** or for the discharge opening **35** may have the same construction.

The plug **15** is surrounded by a layer **14** made of insulating refractory material, particularly kaolin wool, and is inserted under pressure into the tube **13**. Afterwards, a layer **49** is placed over the end face of the tube **13**. Then, a shaped brick **50** made of insulating material is put in the portion of the opening remaining and is secured under pressure by an end plate **51**, which is held in place by screws **52** entering the lower part **1** and the upper part **5**, respectively.

The cross-section of tube **13** can also for instance be angular or elliptical, and does not necessarily have to have a straight axis, even thouth this shape has turned out to be the best for obtaining a uniform and quiet flow. Also, the outer shell of the tube **13** may be profiled if this turns out to be advantageous for reasons of heat mechanics, tension, or of construction. The outer and inner profile of tube **13** are to be selected according to the existing conditions. The supply of the melt to the headpiece **23** may be achieved by an open trough leading downwardly from the furnace. It is also possible to use a tilting ladle or other appropriate means for supplying the melt. The furnace and the supply chamber may be connected to each other and a closure device may be arranged in this connection for the intermittent feed of the melt to the supply chamber.

Of course, the apparatus described is also suitable for feeding continuous rod casting devices, especially if the melt leaves the tube **13** in a horizontal position (FIG. **8**), and if the strand is guided in a horizontal way. If necessary, the continuous rod casting mold may be directly connected to the tube **13** by omitting the nozzle **48**.

FIG. **10** shows the attachment of the nozzle **53** with its one end face to a conical recess **54** in the tube **13**, in which a heat insulating washer **55** has been inserted. The remaining conical space is filled with a compressed mass **56** or something similar. Nozzle **53** extends through a slot **58** between the tube **13** and an opening **57** in the metal box **2** of the supply chamber, and is pressed down at its upper end by means of an orifice plate **59**, urging an inserted heat insulating washer **60** against the upper face of the nozzle **53**. To insure a good insulation of the orifice plate **59** against the lining and to avoid a leaking of the melt from chamber **58**, a wear-resisting ring **61**, made for instance of "Cermotherm" (refractory sintered material) is arranged in a recess **62** of the lining **4**. This ring **61** constitutes a solid abutment for the attachment of the orifice plate **59**. Thus, the lining **4** is protected and it is easy to exchamge the nozzle **53** frequently without damaging the lining **4**.

The outer end face of orifice plate **59** is covered by a wear-resisting plate **63** and is held in place by a plate **65** attached by screws **64** to the metal box **6** of the upper part **5** of the supply chamber. This wear-resisting plate **63** protects the orifice plate **59** and the nozzle **53** against damage, for instance, during the transport of the mold. To permit, if necessary, an easy exchange of the wear-resisting plate **63**, it is provided with a central opening **66**, the diameter of which is a little greater than the diameter of the openings **67** and **68**. Thus, a circular support plane **69** is created, on which a clamp can be placed — for instance, a die **70** —, supporting the orifice plate **59** and the nozzle **53**, if the plate **65** is lifted after loosening the screws **64**, thus releasing the wear-resisting plate **63**. The wear-resisting plate **63** can then be replaced by a new one.

The wear-resisting plate **63** consists of insulating refractory material, for instance, of sintered refractory oxides which are wear-resistant or of heat- and abrasion-resistant steel. Layers of heat-insulating material, for instance, kaolin wool, are placed between the abutting faces of the wear-resistant plate **63** and orifice plate **59** respectively, between orifice plate **59** and wear-resistant ring **61** respectively, between nozzle **53** and orifice plate **59**, so as to avoid heat losses at the mouth of the nozzle. The orifice plate **59** forms with the nozzle **53** an annular groove **71** opening into the nozzle chamber and forming a horizontal recess. After being clamped in place, this groove **71** is filled with refractory material to obtain a perfect sealing and a smooth surface of the nozzle chamber. According to the type of the material to be cast, the nozzle **53** may be made of graphite, magnesite, sintered oxide or of something similar. With the apparatus of the invention, it is possible to form the entire supply chamber or a part of it by the melting furnace.

According to FIG. **11**, the casting vessel comprises a lower part **101** and an upper part **102.** The space within these two parts, **101** and **102**, constitutes a supply chamber **103.** The lower part **101** and the upper part **102** have semi-circular recesses **104** in their inner walls and are detachably connected with each other by flanges **105.** A tube **106**, constituting the equalization container is placed in these recesses **104.** The interior of the tube **106** constitutes the equalization chamber **107.** Both end faces of the tube **106** are closed by plugs **108** and **109.** A piston **111** slides in a transverse passage **110***a* of the wall of the tube **106**, and together with piston rod **112**, forms a displacement body. The passage **110***a* is formed by hollow cylindrical piece **110** inserted in the wall of the tube **106.** The tube **106** has another inlet **113** which can be closed by a plug **114** and through which the melt flows from the supply chamber **103** to the equalization chamber **107.** The tube **106** has a lateral outlet **115** leading through a casting nozzle **116** to a mold **117.** The cross-section of the equalization chamber **107** between the inlet **113** and the outlet **115** remains substantially constant (for instance, circular); furthermore, the equalization chamber **107** has a straight axis. The cross-section of the equalization chamber **107** between the inlet **113** and the outlet **115**, as well as the distance between these two openings, are selected in such a manner as to obtain a quiet flow of the melt into the equalization chamber **107** without any major turbulences.

The wall of the supply chamber **103**, which may also comprise a wall of the melting furnace, is provided with openings **118** for the connection to an induction heating device which maintains any desired temperature of the melt in the supply chamber **103.** The melt in the supply chamber **103** which surrounds the tube **106**, therefore maintains a controlled temperature of the melt in the equalization chamber **107** and in the nozzle **116** without substantially influencing the flow pattern in the equalization chamber. The supply chamber is connected by a conduit **119** to a not shown furnace.

The piston rod **112** extends into a cylinder **120** and the rod connected to a plug **114** extends into a cylinder **121.** The two cylinders **120** and **121** are connected by pipes **122** to a hydraulical or pneumatical control member **123**, which is controlled by an electrical control member **124.** The piston rod **124** is provided with a stop **125** cooperating with an upper limit switch **126** and a lower limit switch **127.** The position of the lower limit switch **127** may be varied in height and fixed according to the volume of the casting. Furthermore, there is provided an operating switch **128.**

After the mold **117** is placed in position and the apparatus is ready for operation, while maintaining a metal level **129** high enough to insure a filling of the mold **117**, the plug **114** is lifted first, until the mold **117** is filled. Thereafter, the plug **114** is lowered, thus closing again inlet **113.** Then, the piston **111** and the piston rod **112** are lowered according to the desired pressure on the melt, and according to the change of volume during the solidification of the melt. After the solidification of the melt, the mold **117** is exchanged; the plug **114**, the piston **111**, and the piston rod **112** are lifted, thus filling the equalization chamber **107** and the mold again with the melt.

This invention can be used for any type of melt; for metal melts, such as iron, steel, brass, bronze, etc., or even for plastic melts.

What I claim is:

1. An apparatus for mold casting, comprising a supply container in communication with a source of molten casting material; an equalization container supported within said supply container and provided with an inlet opening for admission of said molten casing material and further provided at a distance from said inlet opening with an upwardly directed outlet nozzle for passage of molten casting material into a mold placed over the discharge end of said nozzle; and control means for opening and closing said inlet opening to the equalization container, whereby said molten casting material may be selectively admitted into and flow through said equalization container and upwardly through said nozzle during substantial elimination of turbulence, the outer surface of said equalization container being spaced from the inside of said supply container at least along a portion of the distance between said inlet opening and said casting nozzle, whereby the molten casting material in the supply container may flow around said equalization container, thereby maintaining the molten casting material within said equalization container and said casting nozzle at a predetermined temperature while substantially eliminating turbulence in the flow between said inlet opening and casting nozzle.

2. Apparatus according to claim **1**, in which said casting nozzle bridges the space between the inside of the supply container and the outside of the equalization container, so that said casting nozzle is surrounded by the melt in said space.

3. Apparatus according to claim **1**, in which said equalization container is constituted by an elongate horizontally disposed tube having two ends and a straight axis, said inlet opening being disposed near one end of said tube, and said nozzle being disposed near the other end thereof.

4. Apparatus according to claim **3**, in which said tube is fixedly attached by insertion of at least one of its ends into an opening traversing the wall of said supply container.

5. Apparatus according to claim **1**, in which said supply container is divided into two superimposed parts along a horizontal plane intersecting said equalization container, means being provided for detachably connecting said parts to each other, and packing material consisting of wool of kaolin being provided between said parts.

6. Apparatus according to claim **1**, in which said control means for opening and closing said inlet opening comprises a plate member slidable in guide means on said equalization container.

7. Apparatus according to claim **1**, including means for connecting said supply container to an induction heating means, including openings in the wall of the supply container near its bottom and below said equalization container.

8. Apparatus according to claim **2**, in which said casting nozzle comprises a hollow body member inserted into a cavity in the wall of the equalization container and extending into an opening of the wall of the supply container where it is sealingly secured to said wall by means of an orifice plate.

9. Apparatus according to claim **8,** in which packing material made of kaolin wool is inserted between the contact surfaces of the nozzle body, the supply container wall, the equalization container and the orifice plate.

10. Apparatus according to claim **8,** including a wear-resisting plate covering said orifice plate.

11. Apparatus according to claim **8,** in which the wall of the equalization container is provided with a through passage in which a displacement member is slidably guided so as to serve for pressurizing the melt within said equalization container.

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