Aug. 29, 1950 M. TAMA 2,520,348

DISCHARGING APPARATUS

Filed Dec. 5, 1947 2 Sheets-Sheet 1

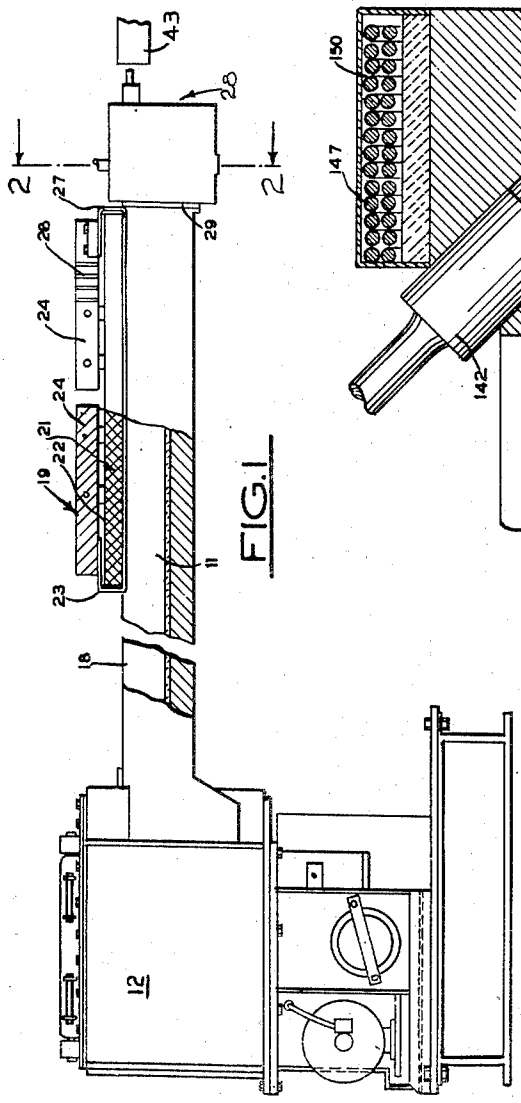


FIG. 1

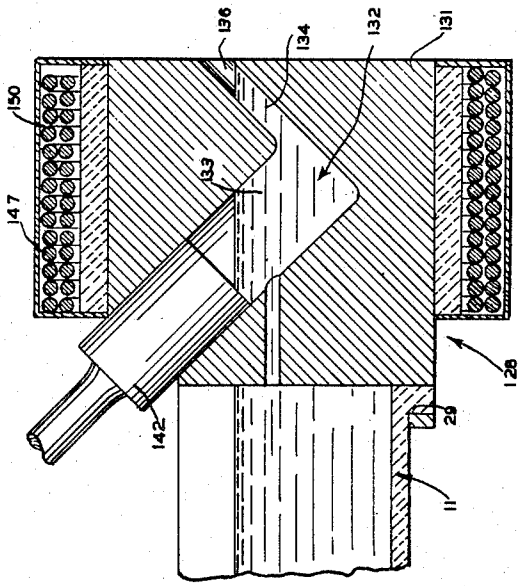


FIG. 5

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Aug. 29, 1950 M. TAMA 2,520,348

DISCHARGING APPARATUS

Filed Dec. 5, 1947 2 Sheets-Sheet 2

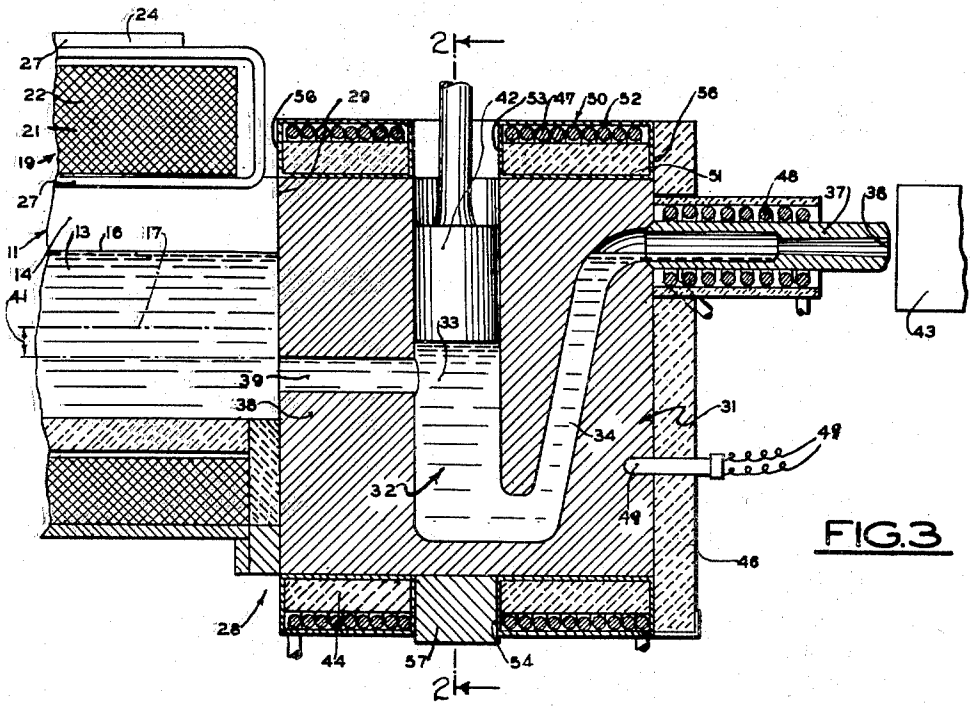


FIG. 3

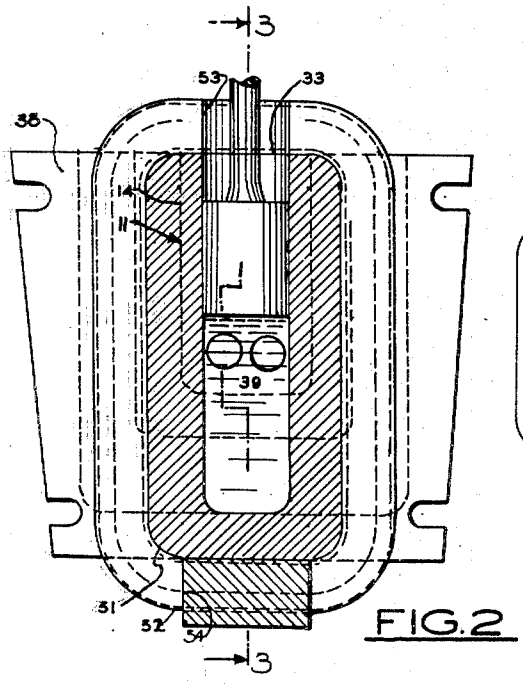


FIG. 2

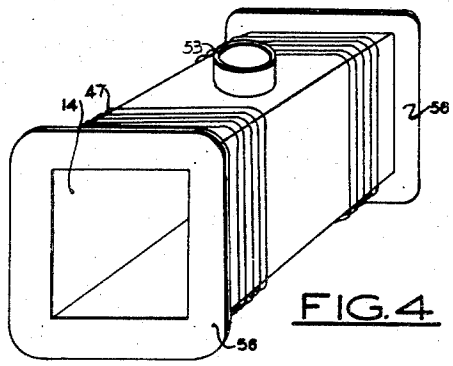


FIG. 4

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UNITED STATES PATENT OFFICE

2,520,348

DISCHARGING APPARATUS

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7 Claims. (Cl. 22—71)

1

The invention relates to a novel method and improved apparatus for die casting metals. A large variety of methods and machines is used in the die casting industry, as described for example in the book entitled "Practical Metallurgy," by Sachs and Van Horn, published 1940, by the American Society of Metals, Cleveland, Ohio, second printing 1941, pages 276 and following.

The invention aims at improving the performance of those machines which are classed as "goose neck" or "plunger type" machines. The term "goose neck" has been used for many years in the die casting industry to designate a pressure chamber which was temporarily filled with molten metal and from which the molten metal was ejected into the molds. In its original form the goose neck was open at one end while the opposite end was connected to a compressed air supply. The open extremity was first immersed into molten metal until the container was partly filled; thereafter the same extremity was tightly pressed against the mold. Pneumatic pressure exerted toward the other end forced the metal into the die cavities.

A more modern version of the goose neck of plunger type machine is shown in the weekly magazine "Steel," November 10, 1947, page 108, in an article written by Herbert Chase, under the title, "Advantages of Induction Furnaces in Zinc Die Casting Plants." In this newer machine the plunger arrangement is mounted in a stationary manner inside a furnace which usually is called a holding furnace. A piston activated by hydraulic pressure moves up and down to pump molten metal into the dies. The goose neck is heated by the molten metal container in the furnace. This has been the conventional method of heating all the plunger or goose neck arrangements of die casting machines. In these embodiments of the prior art, molten metal surrounds only the lower part of the goose neck assembly so far as it is immersed below the metal level. One of the principal drawbacks of this arrangement is the non-uniform heating of the molten metal that is to be discharged from the goose neck into the mold. Obviously, when the lower part of the exterior of the goose neck assembly alone is in contact with molten metal, the upper part will have lower temperatures. The difference is accentuated by the fact that cast iron, which is the principal material used in fabricating goose neck parts, has a very low heat conductivity. The result of the uneven temperature distribution is that the metal that is about to be injected into

2

the mold often freezes at the upper parts of the goose neck. In order to prevent this premature congealing of the metal, gas or oil flames are used to impart additional heat to the upper non-immersed part of the plunger assembly. Again, in view of the low heat conductivity of cast iron, only local heating and in most cases local overheating is achieved.

A further disadvantage of the present methods is that the goose neck or plunger assembly is in direct contact along inside and outside surfaces with molten metal. This causes excessive wear and warping of these parts, particularly if the temperature of the molten metal is allowed to run too high. A further result of the excessive contact with cast iron is contamination of the melt with iron, which is easily dissolved at higher temperatures by the metals used in the die casting industry.

Inaccessibility of vital parts is another fault of the prior art arrangement. Due to space limitations the furnace end of customary die casting machines is crowded with the furnace walls, the plunger assembly, tubes, and pipes of the fuel supply and other indispensable parts. Splashings of molten metal often cover the upper furnace walls and dissipate additional heat. In the present exemplification of the invention a launder system is employed. The term "launder," whenever used in this description and in the appended claims, is deemed to describe an open trough or conduit of refractory material suitable to convey molten metal, preferably provided with a heating system with proper temperature control instrumentation to prevent the metal from freezing.

In customary die casting machines new material is added to the holding furnace either by ladling fluid metal or by immersing solid ingots into the holding furnace. Both methods have the serious disadvantage of constantly changing the metal level. In the case of solid metal charging, variations of temperature are the undesired consequences.

A large amount of metal is held in the conventional die casting machines. This is a disadvantage because said metal is subject to oxidation and gassing.

In the arrangements of the prior art, large amounts of heat had to be supplied to the reservoir since large masses of molten metal were constantly contained therein and had to be heated. Furthermore, a great quantity of metal had to be maintained idle in these reservoirs. Moreover, due to the large size of the reservoir—it had to

be large, since it received the entire goose neck—the temperature of the metal contained therein was not uniform. Consequently it was difficult to maintain the metal ejected from the goose neck at a predetermined temperature.

Compared with the prior art, as described above, the invention tends to overcome said deficiencies and embodies in general a number of steps toward improving the performance of die casting machines. The following are some of the objects, aims and purposes to be achieved:

a. To provide methods and apparatus for continuously maintaining the temperature found to be the most adequate for the casting process.

b. To provide continuous flow of metal from the transporting launders directly to the goose neck apparatus.

c. To eliminate the holding furnace, which ties up large amounts of idle metal in present die casting machines.

d. To eliminate excessive wear and warping of the goose neck or plunger assembly.

e. To eliminate or considerably reduce the time lost in replacing worn out goose neck or plunger assemblies.

f. To provide a goose neck assembly which can be heated directly without the intermediary of a metal reservoir or holding furnace.

g. To provide electric heating of the goose neck assembly, preferably by induction methods.

h. To facilitate accessibility to the goose neck or plunger assembly.

i. To diminish splashing of molten metal in the vicinity of the molds.

j. To reduce variations of the molten metal level reaching the plunger assembly.

Further objects and advantages of the invention will be set forth in part in the following specification and in part will be obvious therefrom, without being specifically referred to, the same being realized and attained as pointed out in the claims hereof.

The invention is adaptable chiefly for the production of zinc base die castings, although other metals can also be processed therein with advantage.

In the accompanying drawings,

Fig. 1 is a schematic elevational view partly in section of a goose neck discharge device as used with a furnace and launder, in accordance with the invention,

Fig. 2 is a vertical sectional view of the goose neck discharge apparatus, taken along line 2—2 of Fig. 1, but drawn to a larger scale,

Fig. 3 is a sectional view taken along line 3—3 of Fig. 2,

Fig. 4 is a perspective view of the induction heating device used for maintaining constant temperature in the goose neck assembly, but without showing the cover and outside layer; and

Fig. 5 is a sectional view similar to Fig. 3, but embodying a modification.

In carrying the invention into effect in the embodiments which have been selected for illustration in the accompanying drawings and for description in this specification, and referring now particularly to Figs. 1 and 2, there is provided a launder, generally indicated at 11, and which is connected with a metal-melting furnace 12. The furnace may be of conventional or special design, suitable for discharging a sufficient quantity of molten metal at spaced time intervals to keep a substantially continuous flow in the launder 11.

The launder 11 is a channel type conduit having a U-shaped cross section of substantially constant area throughout at least the major portion of its length, as best shown in Fig. 1.

Molten metal 13 is transported in the interior chamber 14 of the launder and is maintained there at substantially constant level, between an upper level 16 and a lower level 17, below the latter of which the metal content never is permitted to fall during operation. The metal may not, on the other hand, rise above the upper level 16, since it might flow over the top 18 of the launder 11. The height of this level is determinable by the discharge apparatus, as explained later on.

In order to heat the launder 11, there is provided a heating unit generally indicated at 19 that forms part of a cover 21 for the top 18 of the launder 11. This cover 21 is composed of an insulating material 22, consisting for instance of "Superex" material, that is enclosed by a non-magnetic enclosure such as a stainless steel sheet 23. Electric terminals 24 are supported by the cover 21 and are preferably made of aluminum and are provided with cooling ribs 26. A resistor ribbon 27, preferably made of "Nichrome" or similar material resistant to the passage of current, is interconnected to said terminals and forms a loop surrounding longitudinally the cover 21, but spaced from the exterior of the non-magnetic enclosure 23.

The terminals 24 are interconnected to an electric source and, when a suitable voltage is applied, current passes by way of terminals 24 through the resistor ribbon 27, but due to the higher conductivity of the terminals, the latter remain cool while the resistant ribbons are heated.

A discharge apparatus, for instance an injector of the goose neck type, indicated generally at 28, is secured to an end flange 29 of the launder 11. The discharge apparatus includes a structure, for instance, a parallelepipedal cast iron block 31 that surrounds a goose neck shaped passage 32 on the interior of the apparatus. The passage 32 includes a cylindrical substantially vertical pressure chamber or cylinder 33 and a slanting bore 34 that intercommunicates with said pressure chamber 33 and includes a longitudinal portion that extends to the exterior of the apparatus 28, ending there in an orifice 36 of a nozzle 37.

The structure 31 includes a wall 38, that is detachably secured by screws or other suitable conventional means, to the flange 29 of the launder 11. A pair of adjacent, substantially horizontally disposed bores 39 extend through the wall 38 and form passages therein to provide intercommunication between the pressure chamber 33 and the interior or chamber 14 of the launder 11. The uppermost portion of said bores 39 is disposed below the lower level 17 and is spaced below the same for a predetermined distance 41; said distance 41 is sufficient to provide for free flowing of metal 13 into the pressure chamber 33 through the bores 39, when the apparatus 28 is set for receiving molten metal.

Pressure means, such as for instance a piston or plunger 42 is provided in the pressure chamber 33 for forcibly ejecting metal from the passage 32 through the bore 34 and the orifice 36. The piston 42 may be of conventional design and be operated intermittently at predetermined selectively variable time intervals by well known suitable means, for instance by hydraulic or pneumatic pressure. Pistons and operating means for the indicated purpose are well known in the art.

and it is believed to be unnecessary to describe them in great detail. At the same time it will be well understood that the illustrated piston may be substituted by other and suitable pressure means to force molten metal into the molds.

In general, the molten metal level inside the launder should be approximately the same as the lower lip of the orifice 36. When the plunger 42 is in its upper position, fluid metal will enter through the bores and by way of the cylinder 32 and the slanting bore 34 into the orifice 36 of the nozzle 37. It should at this point neither be allowed to overflow nor to stand much lower. If it overflows, premature solidification will occur in the nozzle or in the mold. If it stands too low below the entrance of the orifice 36, excessive air will be trapped and injected into the mold.

A metal casting mold or die 43 is shown adjacent the orifice 36, to receive metal ejected therefrom to be cast. The mold is tightly pressed against the orifice 36 of the nozzle 37 during the casting operation.

Insulating material surrounds the major portion of the exterior surface of the apparatus 28 and may be composed of asbestos at 44 and preferably millboard or similar insulating material at 46. The asbestos insulation 44 is disposed in a holder 50 as explained later on.

An inductor coil 47 consisting of many turns is placed around the asbestos insulation 44 and a second inductor coil 48 surrounds the major portion of the nozzle 37.

The inductor coils 47 and 48 are interconnected in a circuit to which current may be supplied from the power lines. A thermal responsive device, for instance a pyrometer 49, is inserted in the apparatus 28 and is electrically connected to a control device to provide for automatic control of the current flowing in the coils 47 and 48, to maintain a predetermined temperature for the molten metal within the apparatus 28.

Further details of the temperature control equipment are not mentioned in this specification since such devices are well known in the art. Obviously a manual control can also be used.

An important part of the invention is the electric heating coil which will now be described more fully. The goose neck assembly is made of cast iron. Heating of this block by low frequency induction at temperatures below Curie point gives the desired results of uniform temperature and easy control.

The coil 47 is made of copper wire having a coating or plating of nickel. Such a material is obtained by rolling a copper rod inside of a nickel tube. This composite material has been found to be resistant to the high temperatures prevailing in this kind of work. The coil is wound around a metallic holder 50 composed of an inner layer or bushing 51, an outer layer 52, an upper recess 53, a lower recess 54 and two flanges 56. This assembly surrounds completely the coil 47 and serves also to hold the heating device as a complete self-contained unit which can easily be detached from the goose neck assembly. This coil holder 50 is made entirely of non-magnetic material, preferably stainless steel sheet of thin gauge. The two flanges 56 limit the length of the coil. The recess 53 leaves an opening for the ram that is used to operate the piston 42. The inner layer 51 protects the coil in the inside from contact with the goose neck assembly. An innovation is the use of said bushing 51 as an entire uninterrupted metallic cylinder interposed between the primary and the secondary of an induction heating device. It has been customary heretofore to use only split bushings at this place, for fear that they would unduly overheat. This inventor has found that by properly selecting the materials and the dimensions of this bushing the splitting becomes unnecessary. A bushing of #12 gauge 18–8 stainless steel sheet has given excellent results.

The coil 47 is made of two parts connected in series and leaving the center of the goose neck assembly without surrounding coils. With such an arrangement overheating of the central part containing the piston is avoided.

The lower recess 54 surrounds a detachable stud 57 and serves to locate the coil assembly properly.

With this arrangement the entire coil assembly including the stainless steel holder can be easily removed in case a repair is needed. The goose neck assembly which in customary die casting machines has been submerged entirely in molten metal is only wetted by molten metal on one side, namely the side connected with the launder and shown on the left of Fig. 3. This is a distinct advantage since the contact with molten metal is the chief cause of deterioration of essential parts of die casting machines. Furthermore, the induction heating coil 41 gives a more uniform temperature within the goose neck assembly than the mere immersing in liquid metal.

In case of repairs, the launders can be easily detached from the goose neck assembly by opening the bolts holding flange 29.

A modified goose neck discharge apparatus is illustrated in Fig. 5, and designated generally 128. This discharge apparatus is similar to that shown in Fig. 3, but the pressure chamber 133 is disclosed inclined and the slanting bore 134 is connected thereto at right angle and forms therewith the gooseneck passage 132. The plunger 142 is also inclined. In this embodiment, there is no nozzle provided, but the end of the slanting bore 134 at the exterior of the apparatus 128 forms an orifice 136 for discharge of the molten metal into a mold.

A coil 147 is again provided and surrounded by a coil holder 150, that is made of stainless steel or other suitable non-magnetic material similar to the above described holder for the coil 47, but has no recesses. The entire coil assembly is again removable from the discharge structure 131.

This modified structure offers the advantage of easy machining of the inclined pressure chamber 133 and bore 134 during the fabrication of the apparatus and of easy cleaning thereof when not in use. Furthermore, the coil assembly may be removed from the apparatus 128 without removal of the apparatus from the launder 11.

The operation of the above described embodiments of the invention is as follows:

The launder 11 transports molten metal 13 at a level which is substantially constant and at all times above the passage provided by the bores 39 and below the top 18 of the launder, but preferably equal in height to the lower portion of the orifice 36. The exact momentary level depends on the ratio of the rate of metal received from the melting furnace and metal discharged from the launder to the ejector apparatus 28 over the same period of time. The wall 38 of the apparatus 28 completely seals the end 29 of the launder 11 and thus metal may be discharged from the launder only through the bores 39.

When the piston 42 is disposed above the bores 39 (see Fig. 3) molten metal 14 will flow through the bores 39 into the goose neck passage 33. The metal 14 is heated in the launder 11 by means of the heating unit 19 to a predetermined temperature and the metal which has flown into the passage 33 is heated there by the induction coil 47 to a desired temperature, together with the goose neck.

When the piston 42 is moved downwardly it will eject metal from the passage 33 through the slanting bore 34 and the nozzle 37, while the metal is still being heated by the induction coil 47 located around the wall structure 31 and the coil 48 surrounding the nozzle 37. The metal will be discharged into the mold 43 adjacent the nozzle orifice 36 and will have accurately the proper temperature. This temperature of the metal when it is ejected from the apparatus 28 may be varied for instance by setting the thermometer 49 in accordance with the particular molding requirements. The temperature to which the interior of the apparatus 28 is heated is maintained automatically, or by means of manual controls depending on the particular casting requirements.

Certain of the advantages of the invention have already been herein referred to. It may be useful, however, to allude particularly at this point to the fact that all of the metal flows from the launder into the goose neck passage to be heated therein to an exact predetermined temperature for subsequent ejection into a casting. This permits accurate temperature control of the metal throughout its flow, providing thus for great over-all economy of the casting arrangement.

Molten metal is caused to flow in a launder of substantially constant interior cross section, thereafter through a narrow passage and then into a wider passage of smaller cross section than the launder. The metal is finally ejected through a comparably narrow orifice, under pressure.

The gooseneck apparatus 28 is heated by an outside source, directly, which permits accurate temperature control since the heat only has to pass through the structure 31 of the apparatus 28 in order to reach the metal in the goose neck passage 33, without first having to pass another metal medium surrounding the apparatus 28. The direct heating of the goose neck apparatus moreover permits speedy adjustments of the temperature, should the requirement demand a change.

I do not limit myself to the particular details of construction set forth in the foregoing description and illustrated in the accompanying drawings, as the same refer to and set forth only certain embodiments of the invention and it is obvious that the same may be modified, within the scope of the appended claims, without departing from the spirit and scope of the invention.

It is accordingly desired that in construing the breadth of the appended claims they shall not be limited to the specific exemplifications of the invention described therein. Having thus described the invention, what I claim as new and desire to be secured by Letters Patent, is as follows:

1. In a die-casting installation a reservoir holding molten metal, a pressure chamber comprising a solid metal block having a bore entering said block from above and ending with its lower end short of the lower face of said block, said block also having a second bore and leading upwardly from the first mentioned bore towards the die, a nozzle connected at its one end to the upper end of said second bore and leading with its other end away from said block, a piston in said first bore, a launder connecting said reservoir and said block, said launder, said second bore and said nozzle being connected for a free metal flow from the reservoir to said nozzle when the piston is in its upper position and being arranged with the normal metal level of each being at one and the same level and at least one inductor coil surrounding the outside face of said block.

2. In a die-casting installation a reservoir holding molten metal, a pressure chamber comprising a solid metal block having a bore entering said block from above and ending with its lower end short of the lower face of said block, said block also having a second bore connected at its lower end with the lower end of said first bore and leading upwardly therefrom towards the die, a nozzle connected at its one end to the upper end of said second bore and leading with its other end away from said block, a piston in said first bore, a launder connecting said reservoir and said block, said launder, said second bore and said nozzle being connected for a free metal flow from the reservoir to said nozzle when the piston is in its upper position and being arranged with the normal metal level of each being at one and the same level, an inductor heating coil surrounding the outside face of said block and a heat insulating layer between said heating coil and said block.

3. In a die-casting installation a reservoir holding molten metal, a pressure chamber comprising a solid metal block having a bore entering said block from above and ending with its lower end short of the lower face of said block, said block also having a second bore connected at its lower end with the lower end of said first bore and leading upwardly therefrom towards the die, a nozzle connected at its one end to the upper end of said second bore and leading with its other end away from said block, a piston in said first bore, a launder connecting said reservoir and said block, said launder, said second bore and said nozzle being connected for a free metal flow from the reservoir to said nozzle when the piston is in its upper position and being arranged with the normal metal level of each being at one and the same level, at least one inductor coil surrounding the outside face of said block, a heating cover for said launder said cover comprising an insulating body, a strip of an electric resistor material located beneath said insulating body and means to supply current to said electric resistor material.

4. In a die-casting installation a reservoir holding molten metal, a pressure chamber comprising a solid metal block having a bore entering said block from above and ending with its lower end short of the lower face of said block, said block having a second bore connected at its lower end with the lower end of said first bore and leading upwardly therefrom towards the die, a nozzle connected with its one end to the upper end of said second bore and leading with its other end away from said block, a piston in said first bore, a launder connecting said reservoir and said block, said launder, said second bore and said nozzle being connected for a free metal flow from the reservoir to said nozzle when the piston is in

its upper position and being arranged with the normal metal level of each being at one and the same level, at least one inductor coil surrounding the outside face of said block, a heating cover for said launder, said cover comprising an insulating body, terminals supported by said cover and a strip of electric resistor material connected to said terminals forming a loop surrounding said insulating body.

5. In a die-casting installation a reservoir holding molten metal, a pressure chamber comprising a solid metal block having a bore entering said block from above and ending with its lower end short of the lower face of said block, said block also having a second bore connected at its lower end with the lower end of said first bore and leading upwardly therefrom towards the die, a nozzle connected at its one end to the upper end of said second bore and leading with its other end away from said block, a piston in said first bore, a launder connecting said reservoir and said block, said launder, said second bore and said nozzle being connected for a free metal flow from the reservoir to said nozzle when the piston is in its upper position and being arranged with the normal metal level of each being at one and the same level, at least one inductor coil surrounding the outside face of said block, and an electrically heated cover located above said launder.

6. In a die-casting installation a pressure chamber comprising a solid metal block having a bore entering said block from above and ending with its lower end short of the lower face of said block, said block having a second bore inclined to said

first mentioned bore connected at its lower end with the lower end of said first bore and leading upwardly therefrom towards the die, a piston in said first bore and at least one inductor heating coil surrounding the outside face of said block.

7. In a die-casting installation a pressure chamber comprising a solid metal block having a bore entering said block from above and ending with its lower end short of the lower face of said block, said block having a second bore connected at its lower end with the lower end of said first bore and leading upwardly therefrom towards the die, a nozzle connected at its one end to the upper end of said second bore and leading with its other end away from said block, a piston in said first bore, a non-magnetic sleeve surrounding the outside of said block, an inductor coil in said sleeve and an insulating layer between said coil and said sleeve.

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