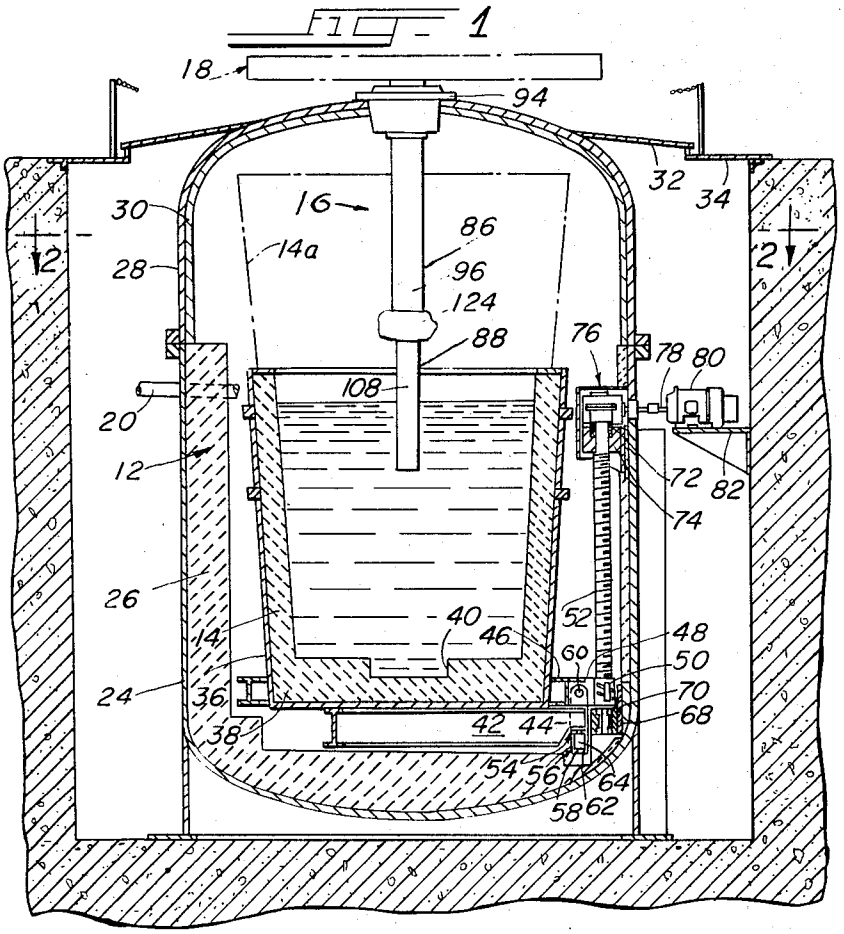
Dec. 19, 1967 J. E. CROWE 3,358,746

INJECTION-TYPE CASTING APPARATUS

Filed July 9, 1965 3 Sheets-Sheet 1

FIG - 1



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INJECTION-TYPE CASTING APPARATUS

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FIG. 2

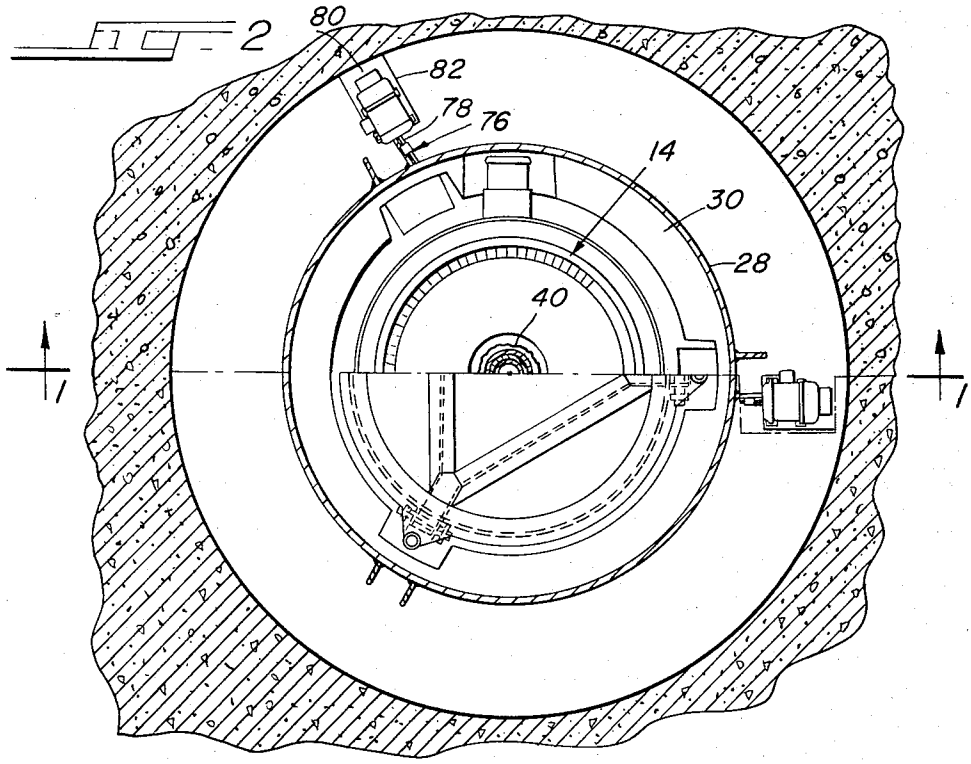
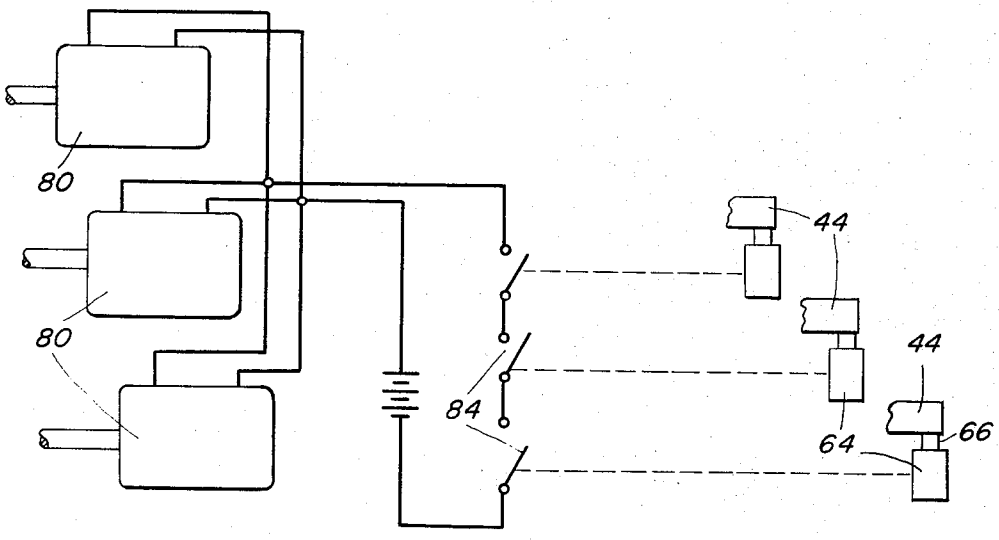


FIG. 3



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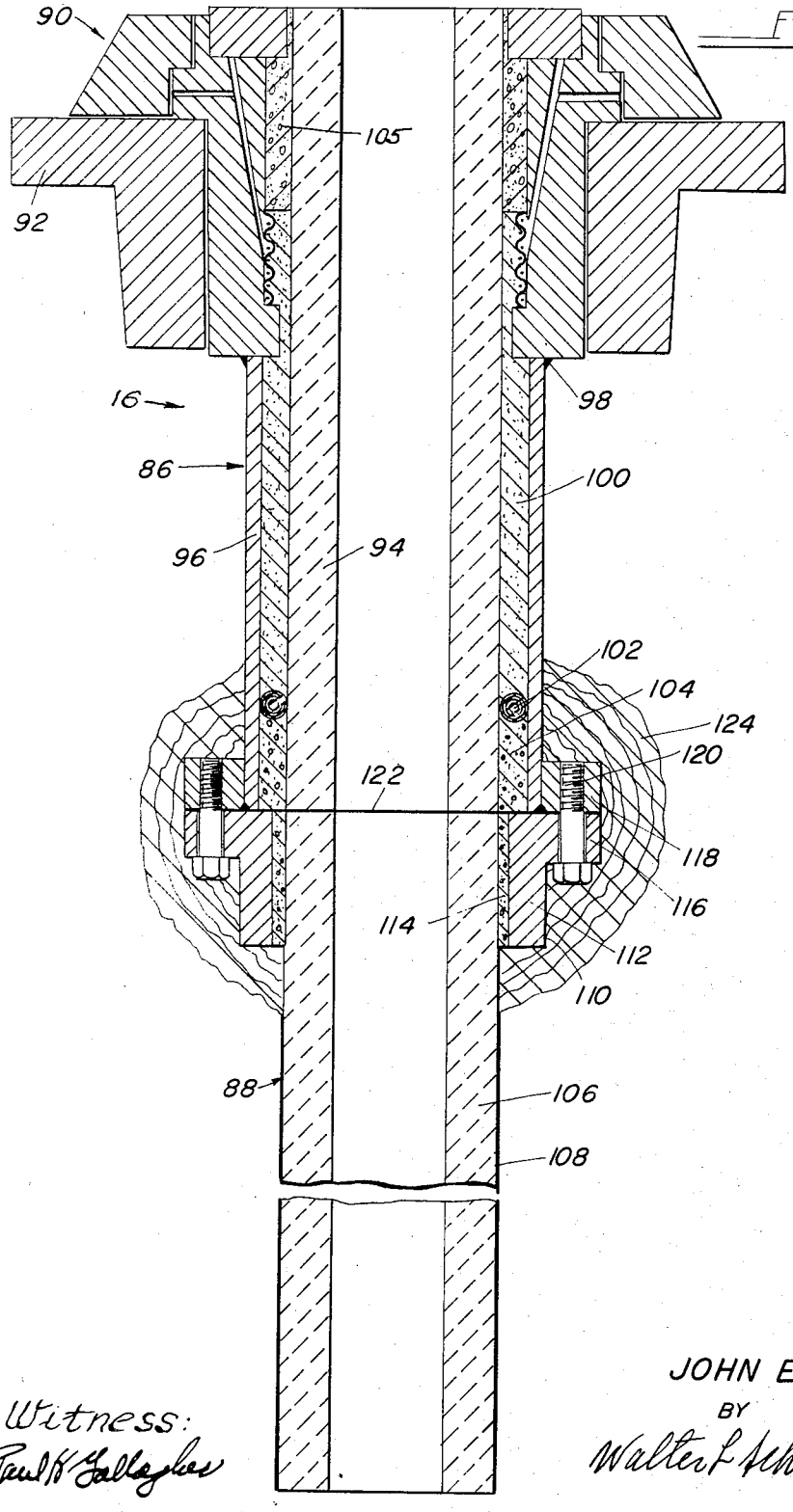
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INJECTION-TYPE CASTING APPARATUS

Filed July 9, 1965 3 Sheets-Sheet 3

FIG. 4



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United States Patent Office 3,358,746 Patented Dec. 19, 1967

3,358,746

INJECTION-TYPE CASTING APPARATUS

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Filed July 9, 1965, Ser. No. 470,704
9 Claims. (Cl. 164—306)

ABSTRACT OF THE DISCLOSURE

A pouring tube with its upper end connected to a mold extends downwardly into a gas-tight tank containing a ladle of molten metal. The tube is composite having an upper relatively permanent section and a lower expendable section the lower end of which is immersed in the molten metal. Means are provided for developing superatmospheric pressure in the tank to force the molten metal upwardly through the pouring tube into the mold. The ladle is supported by a platform which in turn is supported by a frame surrounding the lower end of the ladle and having lugs in threaded engagement with vertical screws. The frame supports the platform by means of load-cells which weigh the ladle and the molten metal, and the load-cells are operatively connected to driving motors for the screws to simultaneously actuate them and thereby raise the ladle as the amount of molten metal therein is diminished.

The present invention relates to a casting apparatus.

The invention is concerned more particularly with pressure pouring, i.e., pouring molten metal from a ladle upwardly through a pouring tube into a mold thereabove. In such pressure pouring, the pouring tube necessarily extends downwardly into the molten metal in the ladle, and in installations heretofore made, it was necessary for the pouring tube to extend to a point closely adjacent the bottom of the ladle and thus have the greater portion of its length immersed in the molten metal, at least a portion of the time during the pouring operation. Because of the hight temperatures involved, and the deleterious effects of the molten metal, the pouring tubes deteriorated fast.

A principal object therefore of the present invention is to provide novel apparatus which includes a ladle and a pouring tube extending thereinto, and construction for raising the ladle during the pouring steps so that only the lower end of the pouring tube extends into the molten metal, whereby to minimize the deleterious effects of the molten metal on the pouring tube.

Another object is to provide apparatus of the character just referred to and including means for automatically raising the ladle according to the amount of molten metal therein as determined by the weight of the ladle and molten metal.

Still another object is to provide novel construction of the foregoing general character for suspending the ladle at a plurality of points and raising and lowering the ladle evenly notwithstanding such multi-point suspension.

A further object is to provide a novel pouring tube for use in apparatus of the foregoing general character in such a way that it extends downwardly into the molten metal in a ladle, which includes an upper section that does not extend into the molten metal and is of permanent nature, and a lower section which extends into the molten metal and thereby becomes subject to the deleterious effects thereof, and which is of expandable nature, and further in which the expendable part can be easily and quickly, as well as economically, replaced with another like part for further use after discarding the expended part.

Other objects and advantages of the invention will appear from the following detailed description taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a vertical sectional view of the apparatus of the invention, and taken approximately at line 1—1 of FIGURE 2;

FIGURE 2 is a horizontal view, the upper portion of which is taken approximately at line 2—2 of FIGURE 1 and the lower half of which shows the ladle removed;

FIGURE 3 is a diagram of certain of the components utilized in automatically controlling the raising movements of the ladle; and

FIGURE 4 is a large scale sectional view of the pouring tube.

Referring now in detail to the drawings the apparatus of the invention includes a tank indicated in its entirety at 12, a ladle 14 therein, and a pouring tube 16 mounted in the tank and extending down into the ladle. Above the tank is a mold 18 engaging the upper end of the pouring tube and having an ingate communicating with the pouring tube and leading to the cavity of the mold. Air under high pressure is introduced into the tank 12, forcing the molten metal upwardly through the pouring tube into the mold, in a known manner. The manner of introducing the air under pressure into the tank is known and is indicated by a line 20 which leads from a suitable source of pressure.

The tank for convenience is deposited in a pit 22 so as to dispose the upper end of the tank adjacent floor level for convenience in placing the mold 18 in operative filling relation thereto.

The tank 20 includes a lower portion 24 which is preferably relatively fixed in position and lined with insulating material 26 in a known manner. The tank includes a cover 28 also having a lining 30 which is removably placed on the lower part and clamped thereon by suitable means for retaining the air pressure in the tank. If desired an apron 32 may be secured to the upper surface of the cover, which extends outwardly, and in conjunction with other elements 34 closes the pit around the tank.

The ladle 14 in itself may be of conventional construction, having a metal outer casing 36 and the usual refractory lining 38. Preferably the floor of the lining 38 is provided with a recess 40 for receiving the lower end of the pouring tube in the final stages of the pouring operation.

The ladle 14 is supported on a platform 42 which may be made up of suitable structural members and preferably is triangular in shape, including three ears or radial extensions 44 for supporting the platform in a manner described in detail hereinbelow. The platform may be formed by welding the various structural elements together.

Above the platform 42 and supporting it, is a frame 46 which is preferably circular in shape as viewed from above, encircling the lower end of the ladle, and made of suitable I-beam members.

This frame 46 is also provided with radially extending ears or lugs 48, in register with the ears 44 and thus being also three in number. These lugs or ears may be secured in any suitable manner such as by welding. At the outer ends of these lugs 48 are nuts 50 in the form of sleeves having substantial vertical extent for receiving screws 52 referred to again hereinbelow.

The platform 42 is suspended from the frame 46 by three connecting or suspension means indicated generally at 54, one at each of the registering ears 44 and 48. Each suspension or connecting means includes a yoke member 56 having a pair of links 58 straddling the lug 48 and pivotally mounted at their upper ends by a pin 60 extending through the lug and the links. The lower end of the links are interconnected by a saddle member or cross ele-

ment 62 upon which is a load-cell weighing component 64 having an upwardly projecting actuating element 66 directly receiving and supporting the corresponding lug 44 of the platform 42. The load-cell weighing component 64 is of known type and is operative for sensing the weight of the ladle, with the molten metal therein, for controlling the raising operations of the ladle as referred to hereinbelow.

The screw 52 is in the form of a shaft having its lower end supported in ball bearings 68 mounted in a bracket secured on the wall 24 of the tank. The upper end of the screw is similarly supported in ball bearings 72 mounted in a bracket 74 supported by the wall of the tank.

The upper end of the screw 52 is operatively connected in a speed reducer 76, the latter also being operatively connected with the drive shaft 78 of a drive member 80 which is supported by a suitable shelf 82 mounted on the wall of the pit 22. It will be understood that there are three screws 52, speed reducers 76 and drive motors 80, for the corresponding three points of suspension of the frame 46 and platform 42.

To elevate the ladle the three motors 80 are operated simultaneously and thus the frame 46 is maintained accurately level, but because of the play permitted by the pivotal mounting of the yokes 56, even if a certain degree of inaccuracy should develop in the raising of the three points of suspension of the frame, any binding will be eliminated. To assure that the three drive motors 80 will run accurately simultaneously, and none of them overrun with respect to any of the others, they are all controlled by suitable switch means so as to all be energized simultaneously, and suitable brake means of known kind may be provided for braking the motors upon de-energization of the motors to bring them to a halt accurately simultaneously.

The drive motors 80 may be controlled manually, or as indicated may be controlled automatically by sensing the weight of the ladle and the molten metal therein. FIGURE 3 indicates diagrammatically such a control means which includes the load-cell weighing components 64. These components are part of a weighing system of known kind, and they are interconnected with control means which are operative for energizing the drive motors 80 in response to variation in weight of the ladle and molten metal therein. Switch means indicated in their entirety at 84 are shown indicatively as controlled by the components 64, and in response to closing the switch means, the drive motors 80 are simultaneously energized. It will be understood, of course, that the arrangement shown diagrammatically in FIGURE 3 is only representative of a known kind of weighing control system.

One kind of pouring tube suitable for the broad purposes of the invention is shown in detail in FIGURE 4. Such pouring tube 16 is made up of an upper section 86 which is relatively permanent in nature, and a lower section 88 which is relatively expendable, the lower section being the only portion of the pouring tube which extends into the molten metal. The upper section 86 is provided with a head construction 90 which includes a flange 92 which directly engages the cover 28 of the tank, through a suitable sealing gasket, whereby the pouring tube is supported by the tank cover and extends downwardly through an aperture therein. If desired, the upper section may be a part of the cover.

The upper section includes an inner ceramic tubular element 94 which extends through the head construction 90 and leads directly to the ingate of the mold. This tubular element in itself is of known construction. Surrounding the tubular element 94 is a steel casing or tube 94 secured to the head construction 90 as by welding as indicated at 98. The annular space between the tubular element 94 and the casing 96 is filled, at least throughout a substantial portion of its length, with sand 100. In placing the sand 100 in position in this space, the tubular element 94 and the outer casing 96 together are initially placed in inverted position, i.e., inverted relative to the position shown in FIGURE 4. Then a packing rope, or other suitable packing means, 102 is packed in place in the space adjacent the then upper end of the assembly, which centers the two telescoped members. Then cement 104 is poured into the space while the packing rope supports it in position at the upper end of the assembly. After the cement is dry, the assembly is turned right-end up and the sand 100 is then poured into the space. Thereafter an additional quantity of cement 105 is poured into the space at the then upper end of the space. As a final step, the sand 100 may be cured in a known manner.

The lower section 88 of the pouring tube includes a main tubular element 106 similar to the tubular element 94 and in register therewith. This tubular element is preferably coated with an enamel glaze 108 on its outer surface. The upper end of the lower section 88 is provided with a collar 110 having an axial flange element 112 of sufficient to provide a space between itself and the tubular element and this space is filled with cement 114, similar to the cement 104.

The collar 110 is also provided with a radial flange 116 which mates with another flange 118 formed on or secured to the steel casing 96 of the upper section and the two sections are secured together by means of bolts 120 threaded into the upper flange. Preferably a gasket 122 of known kind is interposed between the sections.

Surrounding the juncture area of the two sections is a refractory material 124 put in place over the entire juncture and at least a portion of the steel casing 96, to preserve the tube at this location against the effects of the molten metal. This refractory may be put in place in the form of mud which then hardens in position. The refractory material may be on the order of about two inches thick.

The relative lengths of the sections of the pouring tube may be as desired, but preferably the lower section 88 is considerably shorter than the upper section with substantial advantage in minimizing the cost of replacement thereof. The length of the lower section will, of course, depend somewhat on the size of the ladle as well as the size of the mold and corresponding amount of metal poured in a single pouring step. For example, if in a single pouring step, the level of the molten metal in the ladle is lowered two feet, then the length of the lower section of the pouring tube would be two feet plus an additional length for convenience in positioning the ladle as well as to take care of other variations and inaccuracies.

In a practical pouring operation, and if the ladle is raised under manual control, a pouring step might be completed with the ladle in a single position, and during the time that the mold 18 is removed and replaced by another mold, the operator will start the driving motors 80 and raise the ladle an amount corresponding to the lowering of the level of molten metal therein in filling one mold. On the other hand, under automatic control, the reduction in weight of the ladle and molten metal during a pouring step, causes the driving motors 80 to be energized and the ladle raised during each pouring step, maintaining the level of the molten metal substantially constant relative to the pouring tube. In this case the variation of the level or molten metal relative to the tube will be must less than in the case of manual control which in the example given above will be in the neighborhood of two feet. In a similar case under automatic control the variation in level of molten metal may be less than one foot.

This small change in the level of the molten metal relative to the pouring tube results in a great advantage in necessitating a very short length of lower section 88 thereof with consequent substantial saving in the cost thereof in replacing it as compared with replacing the entire pouring tube. In the present instance the molten metal produces bad effects mainly only on the lower section 88 and not on the upper section 86, the metal contacting the up-

per section only in the inner surface of the inner tube element 94 and this for only a very short time, namely during the few minutes, and in some cases a few seconds, in which each individual pouring step is taking place.

Furthermore, it is within the scope of the invention to provide stationary ladle and pouring tube, and provide such a pouring tube in which the lower section thereof is of sufficient length as to extend the full depth of the molten metal. This has been found to be economical despite the fact that the expendable lower section of the tube would be considerably longer than the upper permanent section.

While I have disclosed herein certain preferred forms of the invention, it will be understood that changes may be made therein within the scope of the appended claims.

I claim:

1. Casting apparatus comprising a ladle for containing molten metal for casting, a pouring tube extending downwardly into the ladle and adapted for pouring communication with a mold thereabove, the pouring tube including an upper section of relatively permanent nature and a lower section of relatively expendable nature detachably secured thereto, and means responsive to diminution of the molten metal in the ladle for automatically effecting relative vertical movement between the tube and the ladle so that only the lower section of the pouring tube extends into the molten metal in the ladle throughout the full range of depletion of the molten metal from the ladle.

2. Casting apparatus comprising a combination, a tank, a ladle in the tank having a normal position adjacent the lower end of the tank, a pouring tube supported at its upper end by the upper portion of the tank and extending downwardly into the ladle, the pouring tube extending to the exterior and adapted for cooperation with a mold in pouring relation thereto, the ladle and pouring tube being of such dimensions and proportions that when the ladle is in its normal position adjacent the lower portion of the tank, the lower end of the pouring tube is adjacent the upper portion of the ladle, the tank being adapted for cooperation with means for producing superatmospheric pressure within the tank for forcing the molten metal in the ladle upwardly through the pouring tube and into the mold, and means responsive to diminution of molten metal in the ladle for automatically elevating the ladle in the tank to maintain the lower end of the pouring tube in the molten metal in the ladle.

3. Casting apparatus comprising a ladle containing molten metal, a pouring tube extending downwardly into the molten metal and adapted for pouring communication with an associated mold thereabove, means for developing superatmospheric pressure against the molten metal to force it upwardly through the tube into the mold, power means for effecting relative vertical movement between the tube and the ladle, and control means responsive to diminution of the molten metal in the ladle for automatically energizing said power means to maintain the lower end of the tube immersed in the molten metal as the upper level thereof is lowered in the ladle by flow of the molten metal into the mold.

4. Casting apparatus comprising a ladle containing molten metal, a pouring tube extending downwardly into the molten metal and adapted for pouring communication with an associated mold thereabove, power means for elevating the ladle, and control means responsive to diminution of the molten metal in the ladle for automatically energizing said power means to maintain the molten metal in contact with the pouring tube at its lower end as the upper level of molten metal is lowered withing the ladle by passage of the molten metal through the tube into the mold.

5. Casting apparatus comprising a tank, a ladle in the tank containing molten metal, a pouring tube extending downwardly into the molten metal, said tube extending to the exterior of the tank for cooperation with an associated mold, the ladle and pouring tube being of such dimensions and proportions that when the ladle is in normal position adjacent the bottom of the tank, the lower end of the pouring tube is immersed in the molten metal adjacent the top of the ladle, means for developing superatmospheric pressure within the tank for forcing the molten metal in the ladle upwardly through the pouring tube and into the mold, and means for elevating the ladle comprising a platform directly supporting the ladle and having a plurality of lugs extending radially from the perimeter of said platform, a plurality of vertical screws mounted in the tank and having threaded engagement with respective lugs, and means for simultaneously turning all of said screws thereby raising the platform and the ladle.

6. Casting apparatus comprising a tank, a ladle therein, a platform supporting the ladle, a frame receiving the ladle above the platform, a pouring tube extending downwardly through the tank into the ladle, molten metal in the ladle contacting the lower end of the tube, means for developing superatmospheric pressure in the tank to force the molten metal upwardly through the tube into an associated mold, and means for raising the ladle to maintain the molten metal in contact with the lower end of the tube, said raising means comprising a plurality of vertical screws having threaded connection with the frame, drive motors connected to the respective screws, connecting means for supporting the platform from the frame comprising load cells for weighing the ladle, and an operative connection between the cells and respective motors for actuation thereof thereby rotating the screws to raise the laddle as the weight of the molten metal decreases.

7. Casting apparatus comprising a ladle, a pouring tube extending downwardly into the ladle and adapted for pouring communication with an associated mold, the ladle and pouring tube having a first position in which the lower end of the pouring tube is immersed in the molten metal adjacent an upper part of the ladle, said apparatus having means for developing superatmospheric pressure against the molten metal in the ladle for forcing the molten metal upwardly through the pouring tube and into the mold, and means for progressively lowering the pouring tube into the ladle by producing relatively vertical movement between the ladle and the pouring tube, the pouring tube having an upper section and a lower section detachably secured thereto, the upper section being of relatively permanent nature including an outer steel casing exposed to the interior of the ladle and a lower section being of an expendable nature including a ceramic element exposed to the molten metal in the ladle, and a joint between the sections encompassed by an envelope of refractory material.

8. The invention set out in claim 5 wherein the raising means includes a frame surrounding the lower end of the ladle, the frame is provided with lugs having screw followers directly engaging said screws, and the frame has pivotally mounted pendant members supporting the platform.

9. The invention set out in claim 6 wherein means is provided for energizing all of said driving motors simultaneously, and braking means is provided for simultaneously braking all of said drive motors and screws simultaneously whereby to evenly raise all points of the platform supporting the ladle.

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