This invention relates to improvements in metal-pouring ladles, and more particularly to a novel hydraulic tilting mechanism for such ladles.

Conventional ladles employed for pouring molten metal are ordinarily provided with a handwheel which is turned by the operator in order to mechanically tilt the ladle when it is desired to pour molten metal into a mold. Unfortunately, the tilting of the ladle by such manual means is not only tedious and time-consuming, it requires considerable physical effort, especially when the ladle is full of molten metal. To overcome this shortcoming of conventional ladles, some large pouring ladles are provided with electrical tilting mechanisms designed to ease the job of the operator, but such electrically-driven ladles are not entirely satisfactory for their intended purpose. For one thing, they are relatively expensive in construction. Further, the tilting of a ladle electrically eliminates the sense of “feel” by the operator which is present with manually-operable ladles, and which is very important in obtaining accuracy and consistency in the pouring operation and to minimize spillage.

With the above considerations in mind, the principal objects of the present invention are to provide a novel and improved metal pouring ladle which is not only substantially less expensive than ladles having electric tilting means, but which hydraulic tilting mechanism provides a sense of “feel” and control comparable to that obtained with conventional manually-tillable ladles.

A more specific object of the present invention is to provide a novel pouring ladle having a hydraulically-driven tilting mechanism which is associated with and controlled by a manually-operated handwheel, said handwheel preserving the all-important “feel” which is required for accurate and consistent pouring, while said hydraulic power mechanism eliminates the necessity for physical effort in tilting said ladle and results in even greater pouring accuracy than is obtained with manually-tillable ladles.

A further specific object of the invention is to provide a manually-controlled hydraulic ladle-tilting mechanism wherein the gear ratio between said handwheel and hydraulic mechanism is such that a minimum number of turns of said wheel are required to tilt the ladle in comparison to conventional hand-operated ladles, thereby greatly conserving time and providing increased efficiency.

A further object of the invention is to provide a new and improved metal pouring ladle which is safer than conventional manually-operated ladles.

A further object is to provide a novel hydraulic ladle-tilting mechanism which is self-contained within its own frame and which can be readily used with existing hand-operated ladles.

Still further objects of the present invention are to provide a new and improved metal pouring ladle which is simple in design and construction, which is economical to operate, and which is otherwise particularly well adapted for its intended purposes.

With the above and other objects in view, which other objects and advantages will become apparent hereinafter, the invention comprises the novel hydraulically-actuated metal pouring ladle hereinafter described, and also any and all variations or modifications thereof as may come within the spirit of said invention and within the scope of the appended claims.

In the accompanying drawings, wherein is illustrated one preferred embodiment of the invention, and wherein the same reference numerals designate the same or similar parts in all of the views:

FIG. 1 is a side elevational view of the improved metal-pouring ladle;

FIG. 2 is an enlarged side elevational view of the ladle tilting mechanism; and

FIG. 3 is a front elevational view of the tilting mechanism.

Referring now more particularly to FIG. 1 of the drawing, the numeral 11 designates a conventional ladle-supporting frame or bale which is designed to tiltably support a molten metal ladle 10. Said bale 11 is provided with hooking means 13 by which it can be attached to an electrically-driven overhead conveyor or crane for transporting the ladle from the melting furnace to the pouring site, and said bale includes downwardly-extending parallel arms 12 within which aligned trunnions 15, 16 projecting from opposite sides of the ladle 10 are rotatably journaled. Conventional bales also include a hook arm 21 for releasably locking the ladle against rotation while it is being transported from the furnace, although this safety feature is not necessary in the present invention which is especially designed to prevent the inadvertent tipping of the ladle, as will be hereinafter described.

The illustrated ladle 10 is substantially cylindrical in form, being tapered somewhat toward its lower end, and has an annular rigid collar 14 from which the afore-mentioned trunnions 15, 16 project. It will be seen that said trunnion-carrying collar 14 is located substantially above the vertical center point of the ladle, thus providing a pivotal axis above the ladle center of gravity, which is true regardless of whether said ladle is empty or full. This is an important feature of the present invention because it ensures that the ladle will not accidentally tip, and also ensuring that even in the event of a malfunction in the hydraulic tilting mechanism during pouring said ladle will automatically right itself. The result is a ladle which is much safer than conventional ladles which are pivotal about an axis aligned approximately with the ladle center of gravity in order to utilize the weight of the ladle during tilting. Because of the power assist provided by the hydraulic unit, however, this is not necessary in the present invention.

In accordance with the present invention there is welded or otherwise rigidly secured to one of the depending bale arms 12 an elongated steel mounting plate 22 which may be tapered toward its upper end, as appears in FIG. 3. Mounted on the outer face of said plate is a U-shaped hydraulic fluid reservoir or tank 19 including a front wall 23 and upper and lower annular walls 20, 24. Said tank is provided with a closed top and formed on one side of said top is a pump mounting opening 27 and vent 28. A suitable submersible electric pump (not shown) is car-
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3

ried in said mounting 27, and a similar vent 29 and plugged pump mounting 30 may be provided in the opposite side of said tank top member. Ordinarily a single pump is sufficient, but the auxiliary pump mounting 30 is provided for special installations requiring dual pumps. The electric power for said pumps can be conveniently taken from the overhead hoist or conveyor.

Secured to the mounting plate 22 within the central opening provided by the U-shaped hydraulic fluid tank 19 is a hydraulically-driven torque motor 18 which is cylindrical in form and which is designed to fit snugly and substantially flush within said mount in the illustrated unit. In this respect, however, the interfitting design of said tank and motor members merely provides a neat, compact assembly and is not a critical feature of the invention. A so-called torque motor of the type illustrated is well known in the hydraulics art and comprises a pressure reaction turbine with an associated valve assembly 34 having fluid inlet and outlet lines 36–39 which permit the controlled introduction of fluid into the motor housing to rotatably drive the turbine blades therein, thereby imparting rotatable motion to the motor drive shaft 17, the direction of which will be hereinafter seen. Other suitable tank and motor designs could also be used, and the invention is not to be limited in this respect. It is contemplated, for example, that in ladles requiring a larger-capacity hydraulic fluid tank it will be advantageous to offset said tank to one side of the motor unit.

It is important, however, that the controls be located near the spout so that the operator can closely observe the pouring operation.

The torque motor 18 in the present invention is provided with a rotatable drive shaft 17 which is drivingly coupled to the trunnion 16 projecting from the side of the tiltable ladle 10. Said drive shaft 17 and trunnion 16 may be splined and interfitting, or other rotatable coupling and keying means provided. One of the important features of the present invention is that the hydraulic tilting mechanism is self-contained within its own frame and can be used with most existing hand-operated ladles, thus obtaining the advantages of said invention without discarding said existing equipment. In this respect, a set screw or other suitable device is used to separately lock the interfitting motor drive shaft 17 and ladle trunnion 16 together, and to install the tilting mechanism on an existing ladle it is merely necessary to couple said drive shaft onto one of the ends of said ladle and lock the same in place thereon. In addition, one ladle can be similarly removed and replaced with another in the present unit if necessary.

With reference now more particularly to FIG. 2 of the drawing, mounted on and projecting outwardly from the mounting plate 22 above the fluid tank 19 and motor 18 is a horizontal supporting bracket 31 carrying a rotatable shaft 32, and mounted on the outer end of said shaft is a handwheel 33. A positive displacement hydraulic valve 34 is carried on and operatively associated with said handwheel shaft 32, and leading from said valve to the opposite side of the hydraulic motor 18 and fluid tank 19 are fluid lines 36, 37, 38, and 39, said unit being so designed that every revolution of the valve 34 will turn the torque motor a predetermined number of degrees, which can be varied to best suit the particular installation.

In the operation of the novel hydraulic tilting mechanism comprising the present invention, the submersible pump 24 delivers hydraulic fluid to fluid tank 19 first actuated, and the operator manually guides the ladle-supporting frame 11 to the desired position over the mold. The operator then turns the handwheel 33 to rotate the positive displacement valve 34 so that hydraulic fluid from the tank 19 will be directed through the appropriate lines 36–39 into the side of the torque motor 18, as is well known in the hydraulic art. Said hydraulic fluid is actuated into said design, and as incoming fluid engages against a revolving plate therein said plate is caused to turn because of the pressure differential on opposite sides thereof, thus imparting rotational movement to the drive shaft 17 on which said plate is mounted. Said motor drive shaft 17 is drivingly coupled to the ladle trunnion 16, as hereinabove described, and the rotation of said motor shaft causes a corresponding rotation of the ladle. The result is that through the turning of the handwheel 33 the operator can control the hydraulic tilting of the molten metal ladle 10 during the pouring operation.

Through the actuation of said handwheel 33 the ladle 10 can be tilted forwardly at least 90° from its normal, upright position so that the molten metal therein will flow into the mold positioned therefore. In addition, said ladle is tiltable 180° in the opposite direction from its upright position for cleaning purposes and to allow the slag to drain therefrom, as must be done each time the ladle is emptied.

As hereinabove mentioned, one of the principal features of the present invention, in contrast to the electric tilting mechanisms heretofore employed, is that the manual control provided through the handwheel 33 permits a sense of “feel” by the operator which is important in order to obtain accuracy and consistency in the pouring operation and to minimize spillage. “Feel” also allows the operator to control how fast he can make the tilt rate, which is important because a particular size mold should be poured at a particular rate for the best possible casting. Moreover, and unlike conventional hand-operated ladles, the hydraulic power assist provided by the present invention makes it unnecessary for the operator to exert substantial physical forces in order to tilt the ladle, and a minimum number of wheel turns are required. In this respect, a conventional manually-operated ladle of 750 lbs. molten iron capacity ordinarily requires 70 to 80 turns of the handwheel against 30 or 40 lbs. torque in order to rotate the ladle 180°, while with the illustrated hydraulic mechanism the ladle can be completely rotated through five revolutions of the handwheel against only 2 lbs. torque regardless of the size of said ladle. The ratio of handwheel revolutions to ladle movement can be varied, of course, and the invention is by no means to be limited in this respect.

Another important feature of the present invention is that it is completely safe. In this respect, fluid pressure is maintained on both sides of the movable plate in the torque motor at all times, thus locking the same against inadvertent movement except when the valve 34 is actuated. As a result the ladle will not accidentally tip when the handwheel 33 is not being turned by the operator.

In addition, and as hereinabove mentioned, even in the event of an electric or hydraulic failure, the location of the ladle-supporting trunnions 15, 16 above the ladle center of gravity in the present invention ensure that the ladle will always assume an upright position. The result is a novel molten metal ladle wherein the danger of said ladle accidentally tipping and spilling molten metal is eliminated.

From the foregoing detailed description it will be seen that the novel hydraulically-driven pouring ladle hereinabove described has numerous advantages over the ladles heretofore employed for pouring molten metal. Principally, of course, the present invention provides a power assist which relieves the operator of the physical strain encountered with manual pouring while still maintaining the important “feel” by the operator, thus obtaining even greater pouring accuracy than is possible with said manually-tilttable ladles. In addition, the present invention is substantially less expensive than the electric tilting mechanisms sometimes used, said hydraulic unit costing only slightly more than conventional manual gearing. It is also safer than prior ladles since it cannot accidentally tip either during pouring or while standing during the pouring operation, it can be used with existing ladles, and it is relatively simple in design and construction.
It is to be understood that the present invention is not to be limited or confined to a structure identical in all respects to that illustrated in the drawing and hereinabove described. In many installations it will be advantageous to offset the handwheel 33 from the illustrated position in order to ensure that the operator has a clear view of the mold during the pouring operation, and many other variations in the illustrated design are possible. In short, what is intended to be covered herein is not only the novel ladle and tilting mechanism hereinabove described but also any and all modifications or variations thereof as may come within the spirit of said invention.

What we claim is:

1. A molten metal pouring device, comprising:
a ladle-supporting frame;
    a ladle tiltably carried by said frame,
said ladle being supported by a pair of aligned trunnions projecting from opposite sides thereof;
    hydraulically-actuated means on said frame for tilting said ladle,
said tilting means including a revolvable hand-wheel and a hydraulic motor and associated valve means with the motor drive shaft drivingly coupled to one of said ladle trunnions, whereby the tilting of said ladle is controlled through the revolvable movement of said hand wheel; and
    a hydraulic fluid source for said ladle tilting means,
said hydraulic fluid source being in the form of a substantially U-shaped tank mounted in partially surrounding relation to said motor.
2. The molten metal pouring device recited in claim 1 wherein said motor is cylindrical in shape and is mounted substantially flush with said hydraulic fluid tank.
3. The molten metal pouring device recited in claim 1 wherein said trunnions are positioned above the center of gravity of said ladle.
4. The molten metal pouring device recited in claim 1 wherein said motor drive shaft and ladle trunnion are separable coupled to permit the disconnection of said ladle from said tilting means.
5. The molten metal pouring device recited in claim 1 and including electric pump means for pumping hydraulic fluid from said tank through said valve and into said motor.
6. The molten metal pouring device recited in claim 1 and including means for preventing the tilting of said ladle except in response to turning movement of said handwheel.

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