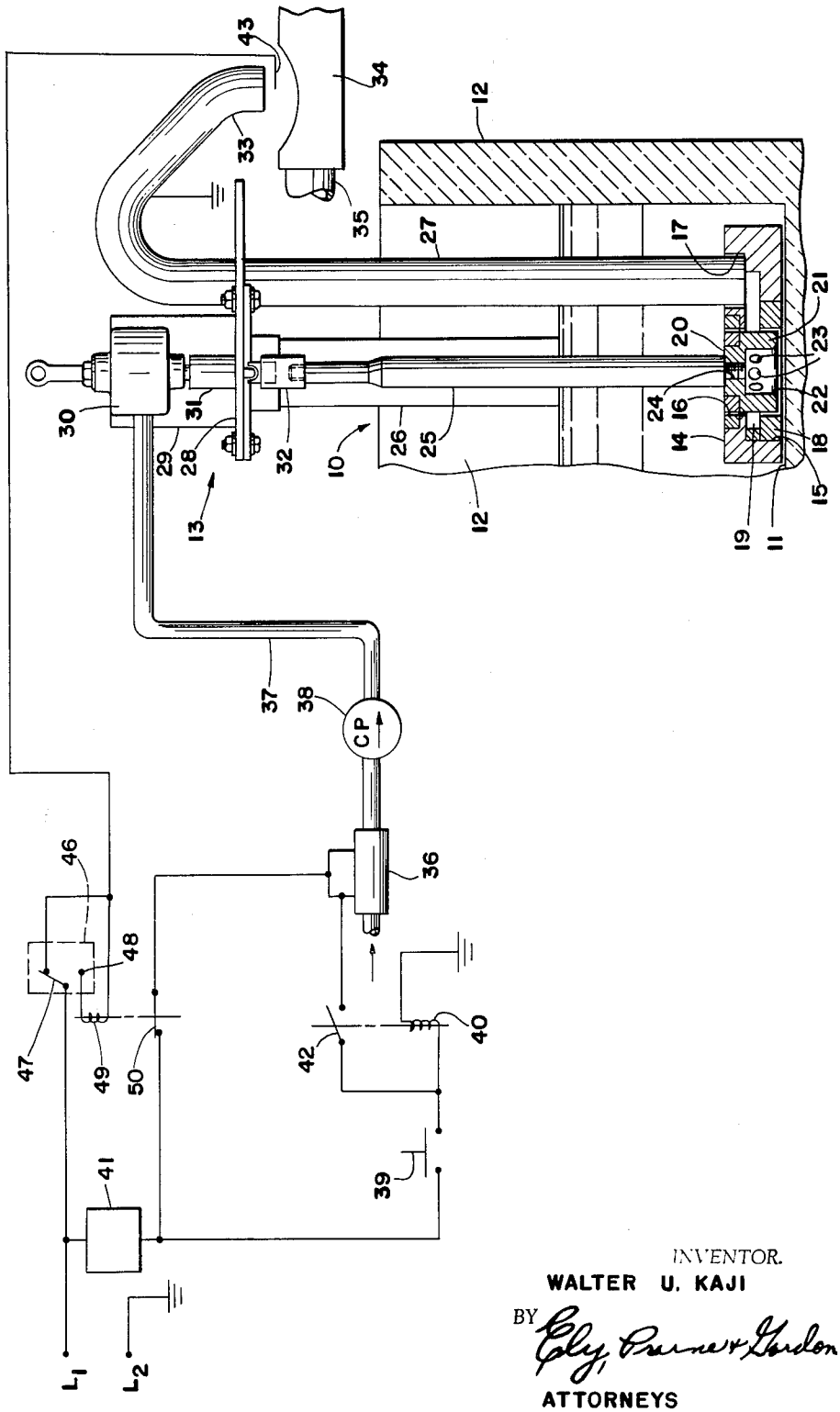
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PUMP CONTROL SYSTEM WITH TIMING MEANS RESPONSIVE TO ACTUAL INITIAL FLUID DELIVERY

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INVENTOR.
WALTER U. KAJI
BY Coly, Pennie & Gordon
ATTORNEYS

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1

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PUMP CONTROL SYSTEM WITH TIMING MEANS RESPONSIVE TO ACTUAL INITIAL FLUID DELIVERY

Walter U. Kaji, Chagrin Falls, Ohio, assignor to Metal Pumping Services, Inc., Cleveland, Ohio, a corporation of Ohio

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This invention relates to a metering pump control system and, more particularly, to a device for precisely controlling the amount of fluid delivered by a pump.

The controlled pumping means according to this invention is particularly useful in pumping successive and predetermined quantities of molten metal into a receptacle such as the shot well of a die casting machine, each such quantity corresponding to the amount of metal that is to be forced into the die cavity of the die casting machine.

Various types of equipment have been used to feed metal to die casting machine, and elaborate control systems have been devised to insure that the amount of metal charged is accurately metered. Many of these systems involve the use of a timer that begins its timing cycle in response to the operation of a pump and stops the operation of the pump when the pump has operated for a predetermined time to deliver a quantity of molten metal from a reservoir to a die casting machine.

Other systems have been devised that are responsive to the level of molten metal in the reservoir to stop the flow of metal to the die cavity when the metal in the reservoir has dropped a predetermined distance. These systems frequently employ pressure on the surface of the metal in the reservoir to force the metal into the die cavity.

Substantially all of these prior art systems employ control devices for the pumping, forcing, or drawing means that are responsive to a mechanical device for initiating the timing cycle of the system. For example, a conventional method of delivering molten metal to a die cavity from a reservoir is to open an outlet valve in a reservoir by a mechanical device such as a solenoid and permit metal to flow for a predtermined time by gravity into the shot well of the die casting machine. The time period is determined by a timing device which is started in response to the actuation of the solenoid. This device, therefore, has a timing cycle that is responsive to the operation of a valve but not to the actual flow of metal into the cold chamber of the casting machine.

A disadvantage of this system and many of the previously described systems is that the same quantity of metal does not necessarily flow from the reservoir for successive casting operations even when the valve is opened for precisely the same time increment. Obviously, the rate of flow from the reservoir changes as the level of molten metal drops. It has been proposed that the timing device should be made responsive to the metal level in the reservoir so that its cycle will be lengthened as the level drops, but such a system necessarily becomes complex since the level changes during each discharge.

An object of the present invention is to overcome many of the deficiencies of the prior art and to provide a pump system that delivers successive and precisely metered amounts of a fluid such as molten metal.

More particularly, it is an object of this invention to initiate the timing cycle of a fluid delivery device in response to the start of actual fluid delivery to the intended delivery station.

2

These and other objects of the invention will be best understood from the following description and the accompanying drawing.

The drawing is a side elevation of the apparatus partly in section.

Referring to the drawing in detail, a container **10** is illustrated. The container **10** constitutes a reservoir for molten metal and has a floor **11** and side walls **12** lined with a material having refractory properties and being resistive to attack by the molten metal. The container **10** usually constitutes an auxiliary pot to hold metal that has been transferred from the melting furnace.

A pump **13**, which may be of the type disclosed in the patent to Sweeney et al., No. 3,048,384, granted August 7, 1962, is shown in a partially submerged position in the molten metal bath and includes a pump foot body **14** which is suspended above the floor **11** of the container **10**. The body **14** is in the form of a slab and has a major bore **15**. Axially aligned with the bore **15** is a reduced bore **16**. An offset bore **17** extends partially downwardly through the body **14**. A spacer ring **18** is provided in the bore **15** and has an inside diameter corresponding to the diameter of the reduced bore **16**. The ring **18** and the foot body **14** cooperate to form a pumping chamber **19** in the foot body.

A pump impeller **20** is generally circular in form and has a depending skirt portion **21** which surrounds an axially extending internal cavity or bore **22**. Passages **23** extend through the skirt portion of the impeller and communicate with the bore **22**. The passages **23** are preferably of constant cross section and may slant backwardly with respect to the direction of rotation of the impeller. The impeller has a threaded bore **24** coaxial with the bore **22** by which the impeller is threadedly engaged on the lower end of a pump shaft **25**. The spaces between the impeller **20** and the portions of the foot body **14** and the ring **18** which form the pump chamber are such as to establish running fits suitable for the metal being pumped and these spaces form molten-metal-lubricated bearings for the impeller.

Column members **26** and **27** are provided which are engaged with the pump foot body **14**. Column **26** may be threadedly engaged with the body **14**, while column **27**, which comprises a hollow condut, is received within the offset bore **17** so as to extend down partially to meet the bore **15**.

At its upper end, column **26** may be provided with suitable metal studs, and may be bolted to a horizontal plate **28**. Mounted on the plate **28** is a vertical plate **29** which supports an air motor **30**. The motor is connected to a universal joint **31**, which in turn is connected to a metal cap **32** threadedly attached to the upper end of the pump shaft **25**.

The upper end of the hollow column or conduit **27** is bent downwardly to form a discharge spout **33**. A shot well **34** of a die casting machine (not shown) is positioned to receive a metered amount of metal from the discharge spout **33**. The metered charge of metal is forced from the shot well to the die cavity of the casting machine by a plunger **35** which is reciprocatably mounted in the shot well **34**.

The operation of the pump **13** is initiated by opening a solenoid valve **36** to admit air to the motor **30** through an air supply conduit **37**. The speed at which the pump operates is dependent upon the pressure of the air that is

supplied to the motor **30** and, since a constant delivery per unit time is necessary for metering the metal to the shot well **34**, a constant pressure valve **38** is provided in the line **37**.

When the shot well **34** is in condition to receive a metered charge of molten metal from the container **10**, i.e., when the cycle of the die casting machine is completed and the plunger **35** is in a retracted position, a starting button **39** for the pump is momentarily pressed. The starting button **39** may be manually operated or controlled by a function of the die casting machine.

Closing of the button **39** completes a circuit from a hot lead L_1 to a grounded lead L_2 to energize a coil **40** and start the timing cycle of a first timer **41**. When the coil **40** is energized, it closes a normally open switch **42** to energize the coil of the solenoid valve **36** and start the air motor **30**. Since the current passes from the hot lead L_1, through the solenoid valve **36** the now closed switch **42**, and the coil **40**, the operation of the motor **30** continues after the button **39** is released.

The air motor **30** rotates the impeller **20** to draw molten metal from the container **10** and force the metal through the pumping chamber **19** and up the conduit **27**. The molten metal is thus pumped from the discharge spout **33** into the shot well **34**. As the metal enters the well **34**, a probe wire **43** is contacted by the metal, thus completing a circuit from the hot lead L_1 through a second timer **46** and the grounded pump **13**.

When the molten metal strikes the probe **43**, the timing cycle of a timer **46** is started. When the cycle of the timer **46** has been completed, a timing switch **47** closes against a contact **48** to energize a coil **49**. When the coil **49** is energized, it opens a normally closed switch **50** and the solenoid valve is thereby closed to stop the motor **30**.

The opening of the switch **50** also deenergizes the coil **40** and causes the switch **42** to open. When molten metal no longer contacts the probe **43**, the coil **49** is deenergized, the switch **50** closes, and the timer **46** is returned to its reset position.

The volume of molten metal pumped into the well **34** is determined, therefore, by the particular time interval to which the timer **46** is set. It should be noted, however, that, after the timer **46** times out, an additional amount of residual molten metal will flow from the discharge end of the downwardly directed spout **33**. Care should be taken to include this constant volume of metal in any calculations for determining the desired time interval of the timer **46**. For simplicity, the timer may be calibrated as to volume rather than time in order to eliminate repeated calculations by the operator.

The timer **41** functions as a fail-safe device and to this end, it is set to time out shortly after the timer **46**. Any failure of the timer **46**, therefore, will not result in the continued operation of the pump **30**.

The location of the probe **43** at the entrance of the shot well **34** insures that the same quantity of metal is pumped to the well during each operation since the time required to pump the metal from the container **10** to this entrance is not a factor in the timing cycle. It should be appreciated that the time required to pump the metal from the container **10** to the entrance of the shot well **34** is not a constant that might be considered when setting the timer **46** at the start of a particular production run, but that this time becomes greater as the metal level falls. Thus, the operation of the timer **46** and the metered amounts of molten metal according to the present invention are dependent only on the rate of delivery by the pump **13** and the residual volume of metal in the spout **33**, both of which are constant.

It should further be appreciated that the control and controlled components of the present invention may be replaced with other mechanisms without departing from the scope of the present invention. For example, the metal probe may be replaced with a mechanical gate or baffle mechanism, a radiation pyrometer, or a photoelectric cell for sensing the presence and absence of molten metal flowing into the shot well **34**.

If a pump according to the above-identified Sweeney et al. patent is employed, it may not be necessary to start and stop the pump repeatedly. The Sweeney et al. patent discloses means for axially raising and lowering the pump impeller to stop and start the flow of metal from the metal reservoir without changing the speed of rotation of the impeller and its shaft. In such an instance, the solenoid valve **36** would be replaced by a control device to raise and lower the impeller.

Since, as pointed out above, various modifications may be made within the scope of the invention, the invention is not intended to be limited to the slavish imitation of the particular structure described in detail herein, except as may be required by the appended claims.

What is claimed is:

1. Apparatus for delivering accurately metered shots of a fluid from a reservoir to a receptacle comprising means for conducting fluid at a constant rate from said reservoir to said receptacle, means for controlling the flow of the fluid through said conducting means, means for timing the flow of fluid into said receptacle, and means for detecting the flow of fluid into said receptacle, said timing means being responsive to said detecting means to start its timing function only when the fluid enters said receptacle, and said flow control means being responsive to operation of the timing means for stopping the flow of fluid through said conducting means to the receptacle when said timing means completes its timing cycle.

2. Apparatus for delivering accurately metered shots of a fluid from a reservoir to a receptacle comprising a reservoir for holding a quantity of fluid, a constant pressure pump having an inlet opening in said reservoir and below the level of fluid contained therein and having an outlet opening above said receptacle, means for controlling the operation of said pump to cause said pump to intermittently deliver measured quantities of fluid to said receptacle, means for timing the delivery of fluid into said receptacle, means adjacent said receptacle and in the path of delivery of the fluid from said outlet opening to said receptacle for detecting the flow of fluid into said receptacle, said timing means being responsive to said detecting means to start its timing function only when the fluid enters said receptacle, and said controlling means being responsive to the operation of the timing means for stopping the operation of said pump when said timing means completes its timing cycle to thereby stop the flow of fluid to said receptacle.

3. Apparatus for delivering accurately metered shots of molten metal from a reservoir to the shot well of a die casting machine comprising means for conducting molten metal at a constant rate from said reservoir to said shot well, means for controlling the flow of the metal through said conducting means, means for timing the flow of metal into said shot well, means for detecting the flow of metal into said shot well, said timing means being responsive to said detecting means to start its timing function only when the metal enters said shot well, and said flow control means being responsive to the operation of the timing means for stopping the flow of metal through said conducting means to the shot well when said timing means completes its timing cycle.

4. Apparatus for delivering accurately metered shots of molten metal from a reservoir to the shot well of a die casting machine comprising a reservoir for holding a quantity of molten metal, a constant pressure pump having an inlet opening in said reservoir and below the level of molten metal contained therein and having an outlet opening above said shot well, means for controlling the operation of said pump to cause said pump to intermittently deliver measured quantities of molten metal to said shot well, means for timing the delivery of metal into said shot well, means adjacent said shot well and in the path of delivery of the metal from said outlet opening to

said shot well for detecting the flow of metal into said shot well, said timing means being responsive to said detecting means to start its timing function only when the metal enters said shot well, and said controlling means being responsive to the operation of the timing means for stopping the operation of said pump when said timing means completes its timing cycle to thereby stop the flow of molten metal to said shot well.

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J. SPENCER OVERHOLSER, *Primary Examiner.*