

March 30, 1965

D. P. ROHRER

3,175,498

SLURRY METERING PUMP

Filed Feb. 5, 1963

3 Sheets-Sheet 1

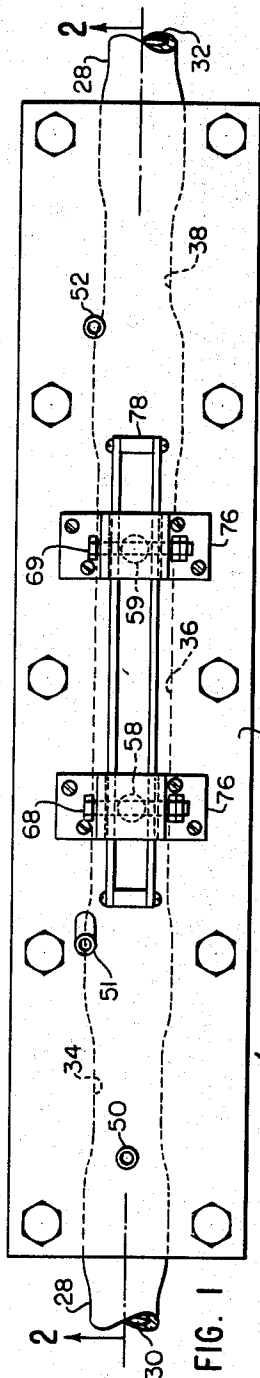


FIG. 1

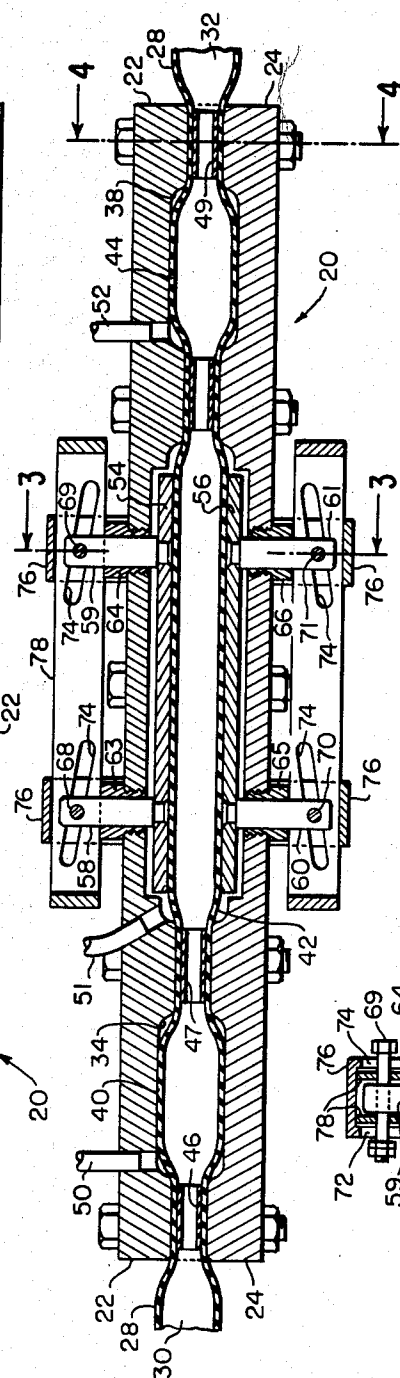


FIG. 2

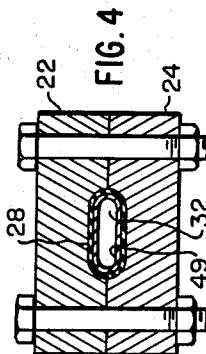


FIG. 4

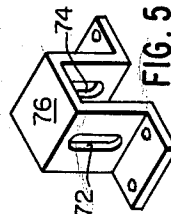


FIG. 5

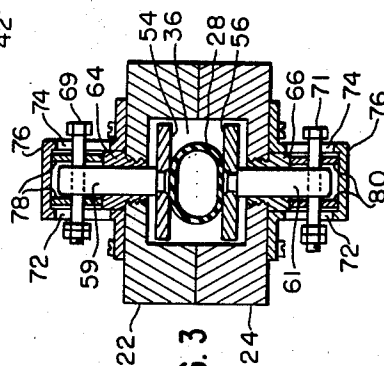


FIG. 3

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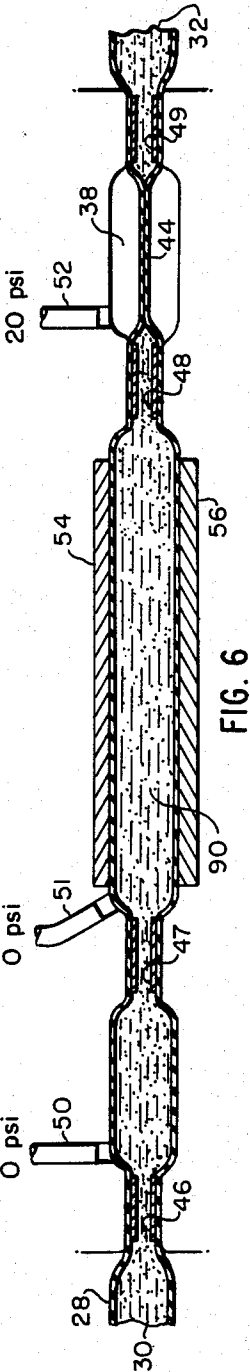


FIG. 6

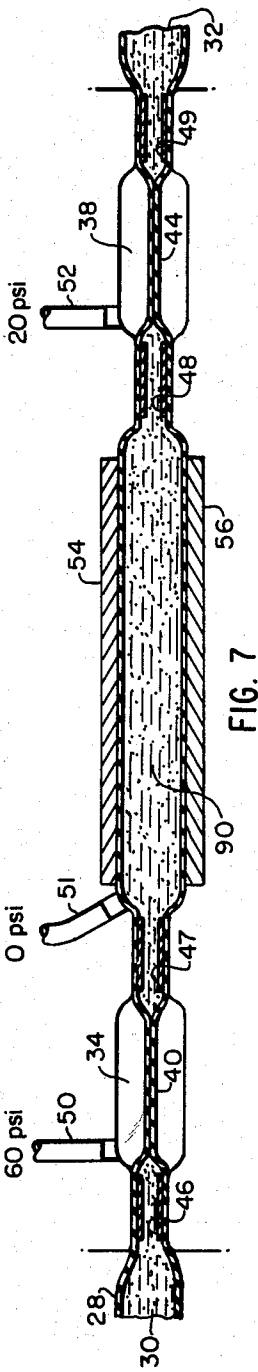


FIG. 7

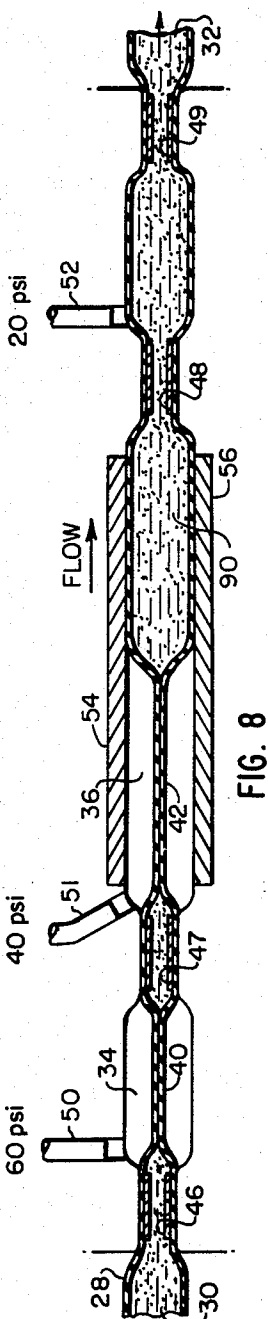


FIG. 8

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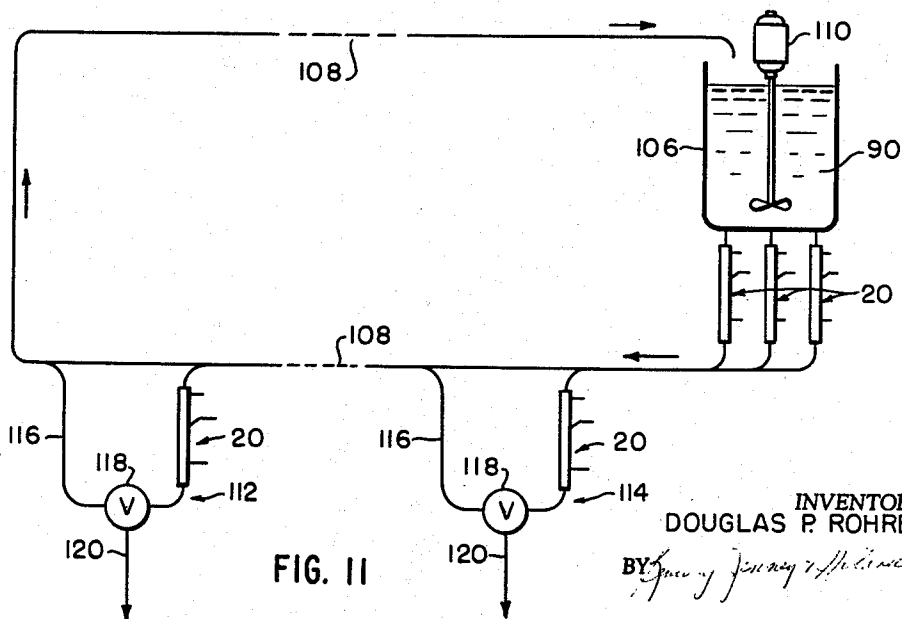
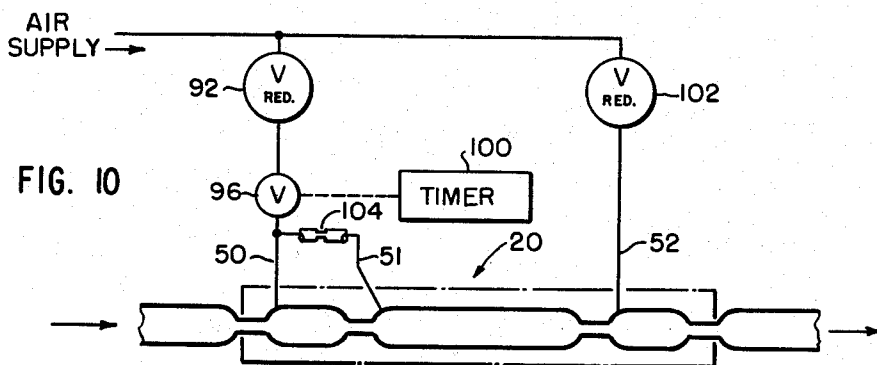
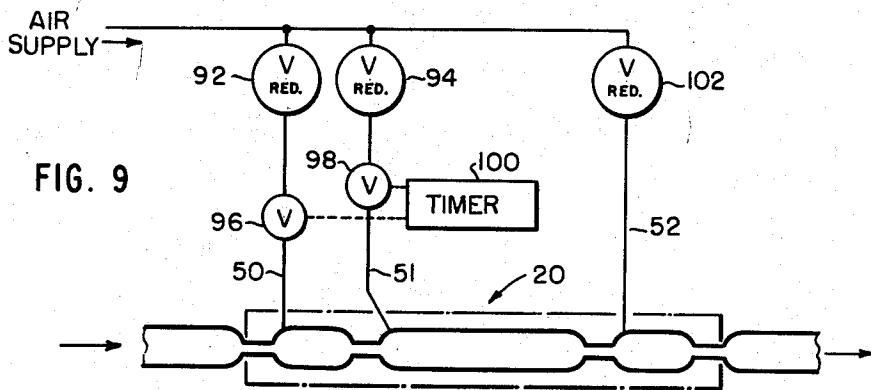
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3 Sheets-Sheet 3



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SLURRY METERING PUMP

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5 Claims. (Cl. 103—37)

My invention relates to a volumetric metering pump and in particular concerns a fluid operated volumetric metering pump. My pump is suitable for the pumping of large volumes of liquids containing solids and especially is adapted to pump and to maintain circulation of metered quantities of high density abrasive slurries.

Briefly my invention comprises a pump having a confined, sturdy, expandable, and contractible flexible elongated tubular hose element about which is clamped or rigidly secured upper and lower housing members characterized by recesses and restrictions. These housing elements when clamped in a mating engaging position divide the hose element into an inlet chamber, a delivery chamber and an outlet chamber. The hose element confined in the inlet chamber is subject to alternating cyclic relatively low and relatively high fluid pressures to effect the pulsating peristaltic-like expansion or opening and contraction or closing of the hose element within this chamber. This inlet chamber serves as a valve which is opened and closed by the application of fluid pressure. A pulsating relatively high pressure is also employed at the same time or shortly thereafter to the delivery chamber which pressure is less than that used in the inlet chamber. This pulsating action at the relatively high pressure closes the inlet chamber and forces fluid previously fed to the hose element under gravity or positive pressure conditions to be propelled in a progressive and pulsating manner from and through the hose element in the delivery chamber.

The delivery chamber has adjustable rigid plate members which are located externally of and adjacent to the hose element within the delivery chamber. These plates permit the permissive expansion of the hose element to be controlled when this chamber is being filled with the fluid to be pumped and thereby provides a means to control or meter the volume pump during each pumping cycle. The hose element in the outlet chamber is subject to a relatively constant fluid pressure which pressure is sufficient to partially or fully collapse the hose element and which pressure is a pressure between the relatively low and the relatively high pressure of the inlet and delivery chambers. The hose element in this outlet chamber is alternately forced open or expanded by the forward movement of the metered volume of fluid in the hose element within the delivery chamber occasioned by the progressive collapse and squeezing action of the relatively high pressure within this delivery chamber. This action thereby provides for the discharging from the outlet chamber of a metered amount of fluid previously confined within the hose element of the delivery chamber. The hose element in the outlet chamber is contracted and closed by the action of the constant fluid pressure in this chamber when the inlet and the delivery chamber pressure is a relatively low pressure. At this time the hose element in the latter two chambers resume their natural resilient open condition and are filled by the fluid to be pumped during the next high low pressure cycle.

The metering of desired volumes of fluid in the hose element is accomplished by adjusting the position of the rigid plate members within the delivery chamber to expand or restrict the permissive volume of fill of that hose element. Movement of the plate members inwardly toward the hose element reduces the amount of permis-

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sive fill on the low pressure filling cycle and thereby yields a reduced metered quantity of fluid on the high pressure discharge cycle. Outward movement of the plate members that is away from the hose element to the limit permitted by the confines of the delivery chamber recess provides for maximum volumetric quantities to be filled and dispensed from the delivery hose element. Thus, I have provided a fluid operated peristaltic-like volumetric metering pump capable of handling large volumes of viscous slurries and adapted to provide a pulsating metered adjustable volumetric flow of the slurry by the adjustment of the plate elements within the delivery chamber. My pumps find a special utility in circulating pumping and delivery systems wherein the slurry contains a high density solid particles in a low density organic solvent or aqueous medium, such as the ceramic slurries described in U.S. Patents 2,795,022 and 2,811,760.

It is, therefore, an object of my invention to provide a fluid operated pump capable of pumping volumetric metered quantities of fluid.

Another object of my invention is to provide an assembly for the volumetric pumping circulation and dispensing of large metered quantities of heavy slurries.

Other objects and advantages of my invention will be apparent to those persons skilled in the art from the description of my invention taken with the accompanying drawings wherein:

FIGURE 1 is a top plan view of my improved pump.

FIGURE 2 is a cross sectional view along lines 2—2 of FIGURE 1.

FIGURE 3 is a cross sectional view along lines 3—3 of FIGURE 2.

FIGURE 4 is a cross sectional view along lines 4—4 of FIGURE 2.

FIGURE 5 is an isometric view of a slotted bracket support.

FIGURES 6, 7 and 8 are schematic illustrations of my pump at various stages during a pumping cycle.

FIGURES 9 and 10 are schematic illustrations of my pump in an operative assembly.

FIGURE 11 is a schematic illustration of a slurry circulating and volumetric pumping assembly utilizing my pump.

FIGURE 1 shows a pump 20 which comprises in combination an upper elongated housing 22 and a lower elongated housing 24 securely fastened together in proper registry by a plurality of bolts about a tubular reinforced elongated woven hose element 28 having an open inlet end 30 and an open outlet end 32. The hose element 28 is characterized as a tubular passageway, the walls of which are of sufficient strength to withstand the pressures employed and which hose element may be repeatedly and alternately subjected to collapse upon the application of pressure and which has sufficient resiliency upon the release of pressure to have the wall return to an expanded normal condition or at least to an open flow condition. For the purposes of my invention a woven reinforced fire hose has proved to be a suitable hose element. Each housing 22 and 24 is characterized by three recesses of substantial depth and volume, and four restricted recesses of less depth and volume, all of the recesses being sufficient to permit the passage of the hose element 28. The housing elements upon being rigidly secured in mating engagement provide an inlet chamber 34 at the one end, an intermediate delivery chamber 36 and an outlet chamber 38 at the other end containing therein respectively an inlet hose element 40, a delivery hose element 42 and an outlet hose element 44. The hose element 28 has internally inserted therein four oval rigid steel supports 46, 47, 48, and 49 having a contour similar to but less than the restricted recesses to provide a fluid tight space between the internal

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walls of the chambers 34, 36 and 38 and the external walls of the hose element within those particular chambers. These inserts serve to prevent the collapse of the hose element in the restricted recesses. The upper housing 22 is characterized by an inlet delivery and outlet fluid conduits 50, 51 and 52 which provide fluid flow communication from a source of pressurized fluid such as an air compressor not shown to each respective chamber.

Rigid upper and lower rectangular plates 54 and 56 within the chamber 36 are disposed adjacent to and in a substantial parallel horizontal relationship to the external walls of the hose element 42 and to each other. Both plates are oppositely mounted about the hose element for inward and outward movement and both plates have the longer side longitudinally disposed along the center axis of the hose element 42. The plates are rigidly supported at each end by a pair of shafts 58, 59, 60, and 61 which shafts are slideably mounted for fluid tight reciprocating vertical movement within collars 63, 64, 65, and 66 threadably attached to the plate members. Each shaft is rigidly fastened by insert screws to a plate at the one end while the other end has a guide pin such as a bolt and a nut combination 68, 69, 70, and 71 transversely passing through the shaft in a direction substantially perpendicular to the longitudinal axis of the hose element 28. These guide pins pass through opposing vertical slots 72 and 74 in the vertical walls of four inverted U shaped support brackets 76 (see FIGURE 5). These brackets are rigidly affixed to the housing. The guide pins also pass through a pair of oppositely angularly disposed cam slots in an upper and lower cam bar 78 and 80. Each cam bar illustrated comprises a pair of parallel horizontally spaced bars secured at each end. The cam bars 78 and 80 are therefore slideably mounted within the support brackets and above the collar and on each guide pin for horizontal plate forward and rearward movement substantially in line with the longitudinal axis of the hose element 28. Movement of the cam bar in this manner permits adjustment of the vertical height of the guide pins and thus the shafts and plate members depending upon the position of the guide pin in the angular slots of the cam bars.

The upper and lower plate members in FIGURES 2 and 3 are shown in an intermediate position within the delivery chamber 36, with the plates having a length and cross sectional surface area substantially the same as or less than the hose element 42. However, as illustrated either plate above or below or alone or both may be repositioned within the delivery chamber by the displacement of the appropriate cam bars 78 and 80 in a forward or rearward horizontal direction. By proper positioning of the plates 54 and 56, the volume of fluid permitted to enter and be discharged from the hose element 42 in the delivery chamber 36 can be readily adjusted and controlled. For example, manual or motorized movement of the cam bar 78 towards the right or the outlet end 32 of the hose element 28 will permit the guide pins 68 and 69 to be repositioned in the vertical slots and in the cam slots to force the shafts 58 and 59 downwardly against the plate 54, thereby moving the plate in a parallel downward manner to reduce the permissive filling volume expansion of hose element 42. Conversely, movement of the cam bar 78 toward the left will raise the plate 54 by the vertical upward movement of shafts 58 and 59 occasioned by the repositioning of guide pins 68 and 69 in the vertically disposed slot of the support bracket 76 and in the cam slot. I have found that the frictional forces of the guide pin in the cam slot is sufficient in most operations to inhibit movement of the plates during the subsequent pumping operation and that therefore no locking mechanism of the cam bars is required.

A schematic illustration of the operation of my pump is shown in FIGURES 6, 7 and 8. FIGURE 6 illustrates my pump with the inlet end 30 open to receive either by gravity flow or positive pressure from another pump, a slurry mixture 90 having a consistency of heavy syrup and

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a density of about 200 pounds per cubic foot. During the filling time period which depends on the pressure head on the slurry and the viscosity of the slurry the hose elements 40 and 42 in the inlet and delivery chambers are under little or no pressure and in an open condition and are filled with the slurry 90. The hose element 44 is subjected to a constant pressure somewhat greater than the filling pressure of the slurry such as for the purpose of illustration 20 p.s.i. of air admitted through conduit 52 which collapses hose element 44 preventing the passage of the fluid slurry 90, during this filling cycle.

When the delivery chamber is filled with the slurry 90 to the volumetric limit permitted by the adjacent plates 54 and 56 against the hose element 42 a fluid pressure greater than the pressure in the outlet chamber 38 such as 60 p.s.i. of air is admitted through conduit 50 into the inlet chamber 34 to collapse hose element 40 and to prevent the further introduction of slurry 90 and to seal a predetermined volume of slurry within the hose element 42 as shown in FIGURE 7, which illustrates the sealing cycle. At the same time or shortly thereafter such as from one to thirty seconds the discharge cycle is started by the introduction of a fluid pressure less than the fluid pressure in inlet chamber 34 and greater than the fluid pressure in chamber 38 such as 40 p.s.i. of air into the inlet end of the delivery chamber 36 through conduit 51. This pressure progressively collapses the hose element 42 and squeezes and discharges the slurry 90 toward the outlet end 32 of the hose element 28 as shown in FIGURE 8. This slurry is impelled by a force greater than the pressure in the outlet chamber 38 and, therefore, the slurry forces open hose element 44 and is discharged in the desired volumetric quantity. Pressure is normally maintained on hose element 42 for a period of time until the entire element has collapsed at which time the pressure in the inlet 34 and the delivery chamber 36 is returned to zero or permitted to vent to the atmosphere, whereby as shown on FIGURE 6, hose elements 40 and 42 are again filled with slurry and hose element 44 closed by the air pressure within outlet chamber 38 and the pumping cycle repeated. With the slurry and the air pressures described, a hose element of 2 inches in diameter and a gravity fill with a 2 foot hydrastatic head, fill times of about 2 seconds and discharge time of 1½ to 2 seconds or a pumping cycle of about 4 seconds has been satisfactorily employed.

My pump has been described in operation in a horizontal position, however, when employed in a vertical position with the outlet chamber downwardly disposed, the inlet chamber is not required since the static head in the fluid to be pumped will cause the hose element to close at the top first, when air pressure is applied externally to the hose element since the internal fluid pressure is higher at the bottom than at the top. Further, although the pumping operation has been illustrated by the use of air, other fluids such as water, oil or other gases may be employed in a similar manner. For example a liquid may be pulsed in the desired sequence by a piston operated fluid.

FIGURE 9 illustrates one operative assembly utilizing my volumetric pump wherein compressed air of 80 to 100 p.s.i. is supplied to the inlet and delivery conduits 50 and 51 which conduits contain an adjustable pressure reducing valve 92 and 94, and electrical operative solenoid flow control valves 96 and 98 electrically connected to a multi-cam electric timer 100 to provide for the predetermined timed cyclic opening and closing of these valves in accordance with the desired pumping sequence. Air is also continually supplied to conduit 52 which contains an adjustable pressure reducing valve 102. Valves 96 and 98 may be three-way solenoid valves which permit venting of the chambers to the atmosphere through these valves.

FIGURE 10 illustrates another operative assembly wherein the inlet conduit has a restricted bypass conduit 104 to the delivery conduit 51. In this embodiment the relatively high pressure of the air supply is introduced

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upon the opening of valve 96 by the actuation of the timer into the inlet chamber which collapses the hose element in this chamber. At the same time the air in conduit 50 is permitted to bleed through the restricted bypass conduit 104 to gradually increase the air pressure in the delivery chamber above that of the outlet chamber and thereby progressively collapses the hose element and dispense a predetermined volumetric pulse of fluid. This embodiment eliminates a need for separate valves 98 and 94 and will be particularly useful where slower pumping rates are permissible.

FIGURE 11 illustrates my volumetric pumps in a circulatory system for heavy slurries. In this embodiment slurry 90 in a tank 106 is continuously circulated and pumped through a circulatory conduit 108 to inhibit the settlement of the solid material. The slurry within the tank is also agitated by a mixer 110. Three pumps 20 serve to pump slurry from the bottom of the tank 106 to the circulation conduit 108. These pumps have their pumping cycles that is the filling, sealing and discharge cycles arranged to overlap to provide a smooth continuous flow of slurry to the conduit 108. Additionally each pump is adjusted to provide for the dispensing of equal but sufficient quantities of fluid to maintain the desired flow rate, by the adjustment of the plate members within the delivery chambers of each pump. For example, the pumps can be arranged to have at any one time the condition as shown in FIGURES 6, 7 and 8. Volumetric metered quantities of slurry can be discharged to a desired filling operation or mold pattern through a filling or bypass stations 112 and 114, each of which comprises a filling conduit 116, by pump 20 in the conduit 116 with the plates adjusted to provide for the desired amount of volumetric slurry fill in valve 118 and a discharge conduit 120 leading to the mold. This assembly permits the smooth circulation of the slurry to inhibit settling and the dispensing of volumetric metered quantities of the slurry as desired.

My invention has been described and illustrated in and with certain preferred but non-limiting specific apparatus embodiments and modes of operation and at least some modification of it in detail within the capabilities of a person skilled in the art upon his consideration of these disclosures are contemplated. It is intended to secure protection by Letters Patent of all these modifications within the spirit and scope of the appending claims to the broadest extent that the prior art permits. What I claim is:

1. A volumetric metering pump which comprises in combination:

an elongated housing member having an opening at the one end and the other end and characterized by a plurality of contoured interior restrictions defining inlet, delivery, and outlet chambers at the one end, between the two ends, and at the other end respectively;

an elongated reinforced tubular hose element disposed within and throughout the length of the housing member;

support members within the hose element and at the restrictions to provide fluid-tight chambers between the external walls of the hose element and the internal walls of each chamber and to prevent the collapse of the hose element at each restriction;

means to introduce a pressurized fluid into the inlet chamber between the external wall of the hose element and the internal wall of the chamber;

means to introduce a pressurized fluid into the outlet chamber between the external wall of the hose element and the internal wall of the outlet chamber;

means to introduce a pressurized fluid into the one end of the delivery chamber between the external wall of the hose element and the internal wall of the delivery chamber;

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a pair of elongated flat plate members within the delivery chamber and opposingly mounted on either side of the hose element; and

means to adjust the inward and outward movement of the plate members substantially perpendicular to the flow of material through the hose element, thereby providing for adjustment of the volume of material dispensed from the pump in each cycle.

2. The pump of claim 1 wherein the means to adjust the plate members includes: a pair of collars secured to the housing element; a shaft member mounted within each collar for slideable reciprocating fluid-tight movement, one end of the shaft member perpendicularly secured to a flat plate member; a pair of support brackets secured to the housing and characterized by elongated slots in the walls thereof, the slots being substantially perpendicular to the flow of material through the hose element; an elongated cam bar characterized by angular slots at each end thereof; and a pair of guide pins secured to the other end of each shaft member, the guide pin passing through the slots of the respective support bracket and cam bar whereby upon movement of the cam bar forward or backward, the plate members are adjusted inwardly or outwardly to control the volume of material dispensed by the pump in each pumping cycle.

3. The pump of claim 1 wherein the housing member comprises an upper and lower elongated housing element secured in registry and characterized by oval interior restrictions and wherein the support elements are rigid oval elements of smaller size but similarly contoured as the interior restrictions.

4. The pump of claim 1 wherein the plate members are substantially parallel to each other and have a length and width substantially the same as the hose element within the delivery chamber.

5. A pump assembly which comprises in combination a volumetric metering pump which comprises in combination:

an elongated housing member having an opening at the one end and the other end and characterized by a plurality of contoured interior restrictions defining inlet, delivery, and outlet chambers at the one end, between the two ends, and at the other end respectively;

an elongated reinforced tubular hose element disposed within and throughout the length of the housing member;

support members within the hose element and at the restrictions to provide fluid-tight chambers between the external walls of the hose element and the internal walls of each chamber and to prevent the collapse of the hose element at each restriction;

means to introduce a pressurized fluid into the inlet chambers between the external wall of the hose element and the internal wall of the chamber;

means to introduce a pressurized fluid into the outlet chamber between the external wall of the hose element and the internal wall of the outlet chamber;

means to introduce a pressurized fluid into the one end of the delivery chamber between the external wall of the hose element and the internal wall of the delivery chamber;

a pair of elongated flat plate members within the delivery chamber and opposingly mounted on either side of the hose element; and

means to adjust the inward and outward movement of the plate members substantially perpendicular to the flow of material through the hose element, thereby providing for adjustment of the volume of material dispensed from the pump in each cycle;

a source of relatively high fluid pressure;

means to place the source of fluid pressure in fluid flow communication with the means to introduce a pressurized fluid into the outlet chamber including a pressure reducing valve;

means to place the source of fluid pressure in fluid flow communication with the means to introduce a pressurized fluid into the inlet chamber including a flow control and pressure valve and a restricted bypass conduit in fluid flow communication with the means to introduce a pressurized fluid to the delivery chamber thereby permitting the relatively high fluid pressure in the inlet chamber to slowly bleed into the delivery chamber; and
 a timer to alternately introduce a relatively high pressure into the inlet chamber.

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