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PUMP

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FIG. 1

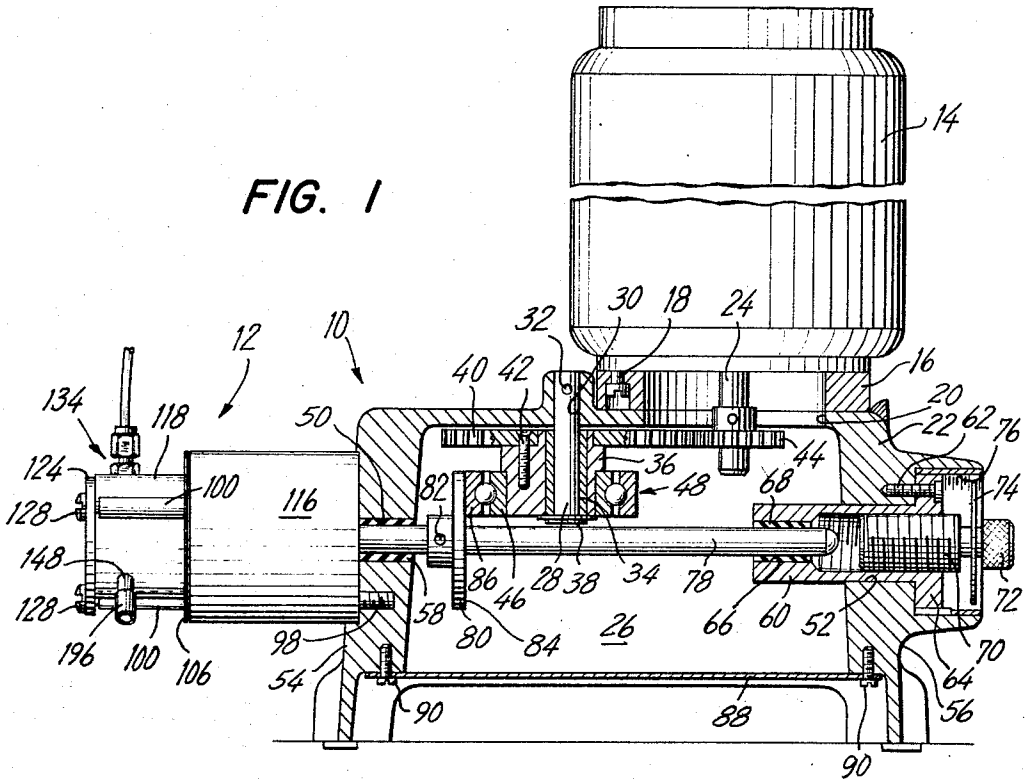

FIG. 2

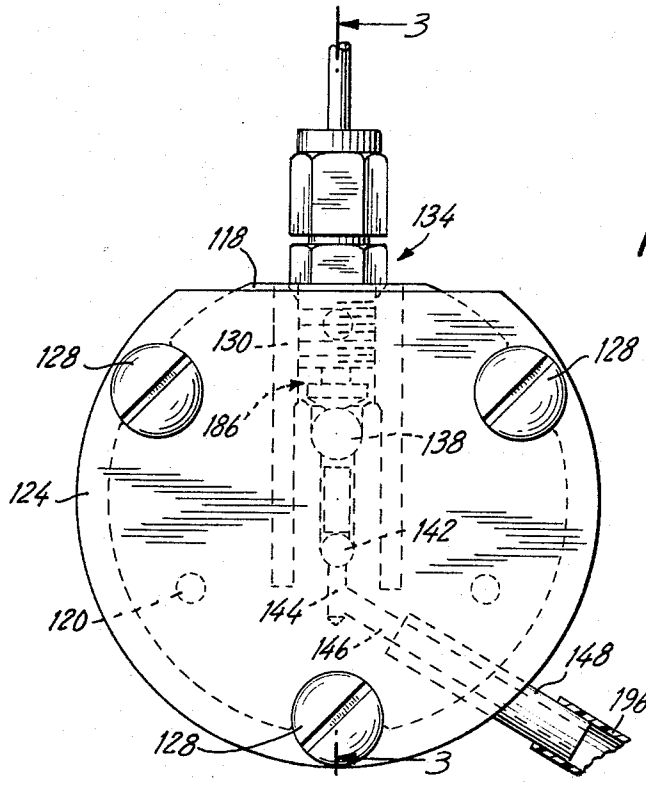

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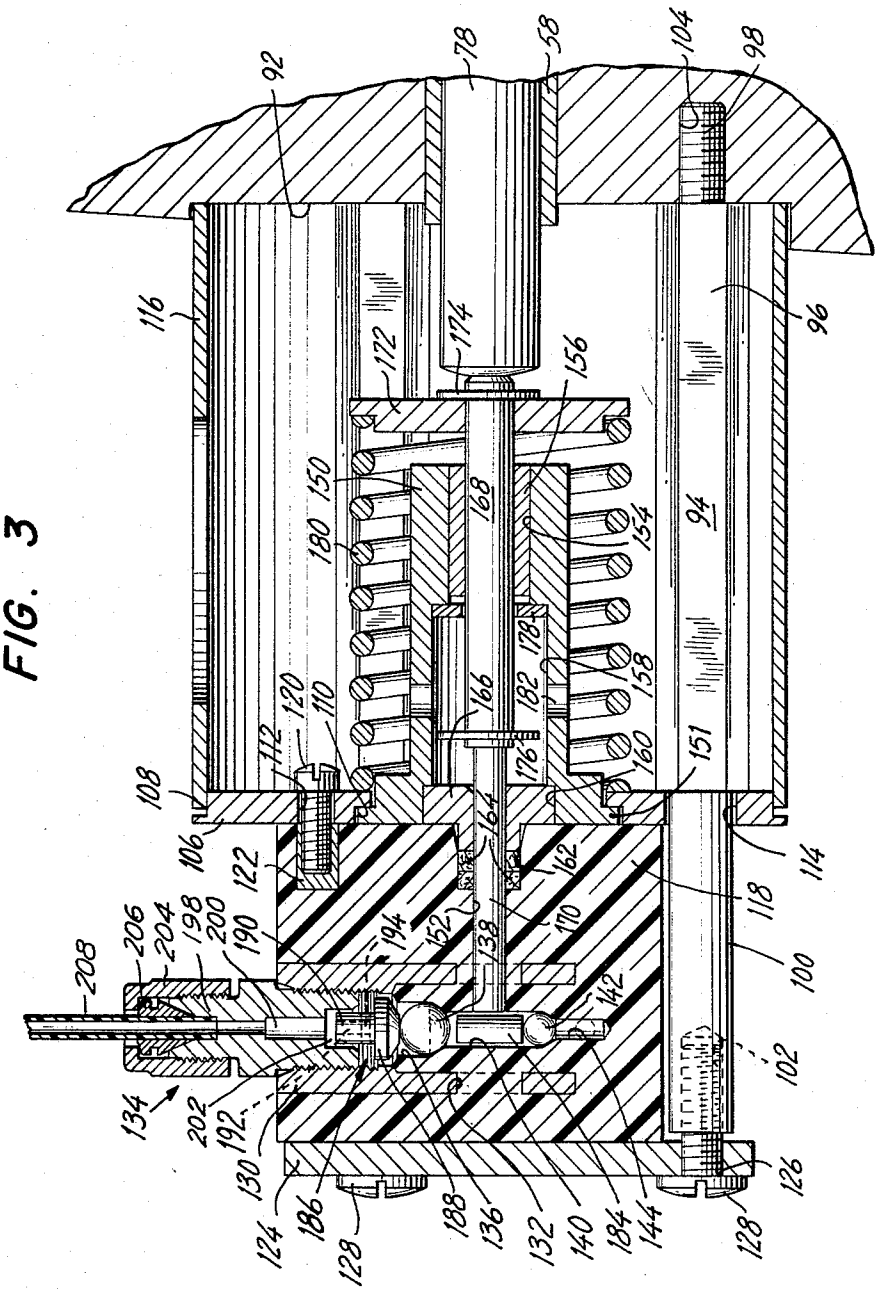
FIG. 3



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3,288,079

PUMP

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8 Claims. (Cl. 103—153)

This invention relates to fluid pumps, and particularly to positive displacement, small volume, pumps.

In the U.S. patent application of Nelson G. Kling, S.N. 361,726, filed April 22, 1964, there is disclosed a variable delivery, reciprocating pump of conveniently adjustable stroke which utilizes a relatively slow, constant speed drive motor to minimize reduction gearing requirements, while insuring constant volume delivery at each stroke adjustment.

It is an object of this invention to provide a pump of the type disclosed in the aforementioned application which is particularly adapted to the pumping of small volumes.

It is another object of this invention to provide a rugged pump having a small chamber volume.

It is yet another object of this invention to provide a pump which is particularly suited for the delivery of liquid to a chromatographic column at a constant volumetric rate.

A feature of this invention is the provision of a pump head having a chamber formed of a non-wetting plastic which is reinforced by a surrounding metal tubular structure.

Another feature of this invention is the provision of a pump head for a reciprocating piston pump having a chamber which is occupied by incompressible movable elements which do not interfere with the proper operation of the valve elements and the passageways.

These and other objects, features and advantages of this invention will become more clearly apparent from the following description taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a front elevation, partly in section, of a pump embodying this invention;

FIGURE 2 is a side elevation of the pump of FIGURE 1; and

FIGURE 3 is a detail elevation of the pump head taken along the line 3—3 of FIGURE 2.

The pump comprises a housing assembly **10**, a pump head assembly **12**, and an electric motor **14**. The motor **14** is fixed to a thermal insulating annular plate **16**, advantageously made of a phenolic plastic, by a plurality of machine screws **18**. The plate **16** is mounted over an opening **20** in the top of the pump base **22** by a plurality of machine screws, not shown. The motor has a shaft **24** which extends downwardly through the opening **20** into the hollow inner portion **26** of the base **22**. The motor is preferably of a relatively slow, constant speed type to minimize the reduction gear requirements.

A support shaft **28** is fixed within the base through a bore **30** therein by a cross-pin **32**. A sleeve bearing **34** is mounted on the shaft and a cylindrical element **36** or cam is eccentrically mounted on the sleeve bearing. The bearing and the cylindrical element are retained on the shaft by a washer supported by a snap ring **38** fixed within a groove in the lower end of the shaft.

A relatively large spur gear **40** is fixed to the cylindrical element **36** by a machine screw **42** and is concentric with the support shaft **28**. A relatively small spur gear **44** is fixed to the motor shaft **24**, and meshes with the gear **40**. The inner race **46** of a ball bearing assembly **48** is fixed to and is concentric with the cylindrical element **36**.

The base has two concentric bores **50** and **52** through the left and right ends **54** and **56**, respectively. A sleeve bearing **58** is friction fitted into the bore **50**. A cylindrical end cap **60** is fitted through the bore **52** and fixed by a machine screw **62** through its enlarged end portion **64** into the base. The end cap has a bore **66** therein of relatively small diameter into the left end portion of which is fixed a sleeve bearing **68**. The right end portion is enlarged and threaded to receive a threaded stop rod **70** having a manually graspable knob **72**. The rod **70** has an indicator **74** fixed thereto which cooperates with a tubular scale **76** to indicate the longitudinal position of the rod.

A rod **78** is mounted for reciprocation within the sleeve bearings **58** and **60**. A flanged follower **80** is fixed to the shaft **78** by a cross pin **82** and has a flat circular face **84** which will abut the outer race **86** of the ball bearing assembly **48**. A plate **88** is fixed to the underside of the base by a plurality of machine screws **90** to close the hollow portion **26**.

The pump head assembly **12** is fixed to a circular flat exterior face **92** on the end **54** of the base by three rods **94**. Each rod has a central hexagonal-sectioned portion **96**, a threaded end portion **98**, and a circular end portion **100** having a threaded axial bore **102** therein. The threaded end portions are fixed within corresponding threaded bores **104** in the base. A circular plate **106** having a peripheral shoulder **108**, an axial stepped hole **110**, three holes **112** and three holes **114**, is mounted on the three rods **94** which respectively pass through the holes **114**. A tube **116** is supported between the face **92** and the plate **106** by the shoulder **108**. A block **118** of plastic having self-lubricating, non-wetting characteristics, such as a fluorinated hydrocarbon, is fixed to the plate **106** by three machine screws **120** which respectively pass through the holes **112** and respectively engage three threaded inserts **122** moulded into the block **118**. A plate **124** having three holes **126** is mounted to the ends of the rods **94** by three machine screws **128** respectively passing through the holes **126** and into the threaded bores **102**.

A tubular metal insert **130** is moulded into the block **118**. The insert has a transverse diametric hole **132** therethrough which serves to key the insert fixedly within the block. The uppermost portion of the insert is internally threaded to receive a tube fitting assembly **134**. The remainder portion of the insert includes a core of the plastic. This core has a central coaxial bore or chamber having an upper portion **136** of relatively large diameter and a curved seat to accommodate a ball **138**, a middle portion **140** of lesser diameter and a curved seat to accommodate a ball **142**, and a lower portion **144**. A radial bore **146** passes through the block to intersect the lower bore portion **144**. The radial bore **146** includes an enlarged portion into which a nipple **148** is press-fitted.

Disposed within the tube **116** is cylindrical element **150** having a flanged end portion **151** which is captured between the block **118** and the inwardly extending flange of stepped hole **110**. The cylindrical element **150** has an axial bore therethrough which is coaxial with a bore **152** through the block **118** intersecting the bore middle portion **140**. This axial bore has a portion **154** into which a sleeve bearing **156** is fitted; a portion **158** of larger diameter, and a portion **160** of yet larger diameter. The bore **152** includes a portion **162** of enlarged diameter into which a plurality of shaft seals **164** are fitted. An annular seal plug **166** is fitted in part in the bore portion **162** and in part in the bore portion **160**. A rod having a portion **168** of larger diameter is disposed through the sleeve bearing **156** and a portion of smaller diameter **170** is disposed within the bore **152**. A flanged annular plate **172** is disposed on the rod portion **168** adjacent a snap ring **174** fitted into a groove in the rod.

A snap ring **176** is also fitted into a groove in the rod and is adapted to abut a washer **178** disposed in the bore portion **158**. A helical compression spring **180** is disposed about the cylindrical element **150** between the plate **106** and the plate **172**. The spring biases the end of the rod portion **168**, by means of the plate **172** and the snap ring **174**, against the end of the rod **78**. The snap ring **176** precludes the loss of the rod portion **168** from the cylindrical element **150**. A plurality of holes **182** communicate with the atmosphere, or at least the volume of air enclosed by the tube **116** to preclude any pumping action within the bore portion **158** by the shoulder between rod portions **168** and **170**. Snap ring **176** is provided with one or more holes (not shown) to prevent pumping action in bore **158**.

It will be seen that when the motor **14** rotates by means of the gears **44** and **40** it rotates the cylindrical element or cam **36**, which engages the follower **80** by means of the ball bearing assembly **48** to reciprocate the rod **78** against the bias of the compression spring **180**. The leftmost travel of the rod **78** is determined by the rise of the cam **36**, while the rightmost travel of the rod **78**, after the cam has dropped away from the follower **80**, is determined by the position of the rod **70**.

Disposed within the bore portion **140** of the pump chamber above the ball **144** is a cylindrical insert **184** which is smaller in diameter than the bore portion **140**, and smaller in length than the spacing between the balls **142** and **138** when they are both seated. Disposed within the bore of the metal insert above the ball **138** and below the fitting assembly **134** is a mushroom shaped cylindrical insert **186**. The insert **186** has a domed, solid head portion **188**, and a tail portion **190** having an axial hole **192** which is intersected with a diametric hole **194**.

The nipple **148** is coupled by a tubing **196** to a source of liquid. The tubing assembly **134**, consisting of a plug **198**, having a bore **200** with an enlarged portion **202** having a diameter greater than the diameter of the insert portion **194**, a cap **204**, a conical wedge **206**, and tubing **208** is coupled to a receiver of liquid. The plastic block may be made of "Teflon." The rod portion **170**, the balls **142** and **138**, the inserts **184** and **186**, and the tubular insert **130** may advantageously be made of stainless steel.

As the rod portion **170** is reciprocated to the right it enlarges the volume of the pump chamber, reducing the pressure therein. The lower ball rises from its seat admitting liquid from the source which is at atmospheric pressure. Liquid is admitted to fill the volume below the upper ball **138**. This volume is relatively small, being largely occupied by the insert **184**. As the rod is reciprocated to the left reducing the volume of the pump chamber and increasing the pressure therein above atmospheric, the lower ball is seated due to the increased fluid pressure thereon and the weight of the insert **184**. The upper ball **138** is raised off its seat together with the upper insert **186**, and liquid is expelled from the bore portion **140** past the ball **138** and the insert **186** into the bore of the fitting **134**. Should the top of the upper fitting **186** enter entirely into the enlarged portion **202** of the bore **200** and tend to obstruct the bore **200**, liquid will nonetheless be free to pass around the head portion **188**, into the diametric bore **194**, through the axial hole **192** and out into the fitting bore **200**.

As the rod portion **170** is again reciprocated to the right, increasing the volume of the pump chamber, and reducing the ambient pressure below the upper ball **138**, the ball under the increased pressure in the system coupled to the fitting **134** and the weight of the upper insert **186**, is seated, while the lower ball is again raised.

While I have shown and described the presently preferred embodiment of my invention, it will be understood that the invention may be embodied otherwise than as herein specifically illustrated or described and is not to be limited to the herein-described specific construction, except as may be required by the scope of the appended claims considered with reference to the prior art.

What I claim is:

1. A fluid pump comprising: a body made of a first material; an elongated, tubular insert of a second material, having end and lateral openings, molded in said body surrounding an elongated core of said first material which is integral with the external portion of said body through one of said ends and said lateral opening in said insert; an elongated pumping chamber in said core; a pumping cylinder projecting transversely through said block, through said first material in said lateral opening of said insert, and through said core into fluid flow communication with said chamber; and a piston disposed within said cylinder and operable for reciprocating movement in said cylinder.

2. A fluid pump comprising: a body made of a first material; an elongated tubular insert of a second material having end and lateral openings, molded in said body surrounding an elongated core of said first material which is integral with the external portion of said body through one of said ends and said lateral opening in said insert; an elongated pumping chamber in said core; a pumping cylinder projecting transversely through said block, through said first material in said lateral opening of said insert, and through said core into fluid flow communication with said chamber; a piston disposed within said cylinder and operable for reciprocating movement in said cylinder; and a tubular coupling member for an outlet conduit threadably mounted within and to the other of said ends of said insert, said chamber being in fluid flow communication with said coupling member.

3. A fluid pump comprising: a body made of a first material; an elongated tubular insert of a second material having end and lateral openings, molded in said body surrounding an elongated core of said first material which is integral with the external portion of said body through one of said ends and said lateral opening in said insert; an elongated pumping chamber in said core; a pumping cylinder projecting transversely through said block, through said first material in said lateral opening of said insert, and through said core into fluid flow communication with said chamber; a piston disposed within said cylinder and operable for reciprocating movement in said cylinder; a tubular coupling member for an outlet conduit threadably mounted within and to the other of said ends of said insert, said chamber being in fluid flow communication with said coupling member; and an inlet conduit disposed through said body and said one end of said tubular insert in fluid flow communication with said chamber.

4. A fluid pump comprising: a body made of a first material; an elongated tubular insert of a second material having end and lateral openings, molded in said body surrounding an elongated core of said first material which is integral with the external portion of said body through one of said ends and said lateral opening in said insert; an elongated pumping chamber in said core; a pumping cylinder projecting transversely through said block, through said first material in said lateral opening of said insert, and through said core into fluid flow communication with said chamber; a piston disposed within said cylinder and operable for reciprocating movement in said cylinder; a tubular coupling member for an outlet conduit threadably mounted within and to the other of said ends of said insert, said chamber being in fluid flow communication with said coupling member; an inlet conduit disposed through said body and said one end of said tubular insert in fluid flow communication with said chamber, an inlet valve ball disposed in said chamber, and an inlet valve seat formed in said chamber adjacent said inlet conduit for receiving said inlet ball for pre-

cluding the flow of fluid between said inlet conduit and said chamber; an outlet valve ball disposed in said chamber and an outlet valve seat formed in said chamber adjacent said coupling member for receiving said outlet ball for precluding the flow of fluid between said coupling member and said chamber; and a member disposed within said tubular insert between said outlet ball and said coupling member and movable therebetween.

5. A fluid pump comprising: a body made of a first material; an elongated tubular insert of a second material, having end and lateral openings, molded in said body surrounding an elongated core of said first material which is integral with the external portion of said body through one of said ends and said lateral openings in said insert; an elongated pumping chamber in said core; a pumping cylinder projecting transversely through said block, through said first material in said lateral opening of said insert, and through said core into fluid flow communication with said chamber; a piston disposed within said cylinder and operable for reciprocating movement in said cylinder; a tubular coupling member for an outlet conduit threadably mounted within and to the other of said ends of said insert, said chamber being in fluid flow communication with said coupling member; an inlet conduit disposed through said body and said one end of said tubular insert in fluid flow communication with said chamber; an inlet valve ball disposed in said chamber, and an inlet valve seat formed in said chamber adjacent said inlet conduit for receiving said inlet ball for precluding the flow of fluid between said inlet conduit and said chamber; an outlet valve ball disposed in said chamber and an outlet valve seat formed in said chamber adjacent said coupling member for receiving said outlet ball for precluding the flow of fluid between said coupling member and said chamber; a first member disposed within said tubular insert between said outlet ball and said coupling member and movable therebetween; and a second member disposed within said chamber between said inlet ball and said outlet ball and movable therebetween and also adjacent said cylinder.

6. A fluid pump comprising: a body made of a first material; an elongated tubular insert of a second material, having end and lateral openings, molded in said body surrounding an elongated core of said first material which is integral with the external portion of said body through one of said ends and said lateral opening in said insert; an elongated pumping chamber in said core; a pumping cylinder projecting transversely through said block, through said first material in said lateral opening of said insert, and through said core into fluid flow communication with said chamber; a piston disposed within said cylinder and operable for reciprocating movement in said cylinder; a tubular coupling member for an outlet conduit threadably mounted within and to the other of said ends of said insert, said chamber being in fluid flow communication with said coupling member; an inlet conduit disposed through said body and said one end of said tubular insert in fluid flow communication with said chamber; an inlet valve ball disposed in said chamber, and an inlet valve seat formed in said chamber adjacent said inlet conduit for receiving said inlet ball for precluding the flow of fluid between said inlet conduit and said chamber; an outlet valve ball disposed in said chamber, and an outlet valve seat formed in said chamber adjacent said coupling member for receiving said outlet ball for precluding the flow of fluid between said coupling member and said chamber; a first member disposed within said tubular insert between said outlet ball and said coupling member and movable therebetween; a second member disposed within said chamber between said inlet ball and said outlet ball and movable therebetween and also adjacent said cylinder; and a passageway formed through said first member including a first portion adjacent to and coaxial with said coupling member and a second portion remote from said coupling member and at an angle to said first portion.

7. A pump according to claim 1 wherein said first material has a self-lubricating characteristic and said second material has a high rigidity characteristic.

8. A pump according to claim 1 wherein said first material has a non-wetting characteristic and said second material has a high rigidity characteristic.

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