

Sept. 20, 1971

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3,606,596

DRUG DISPENSING PUMP

Filed April 14, 1970

2 Sheets-Sheet 1

Fig. 1

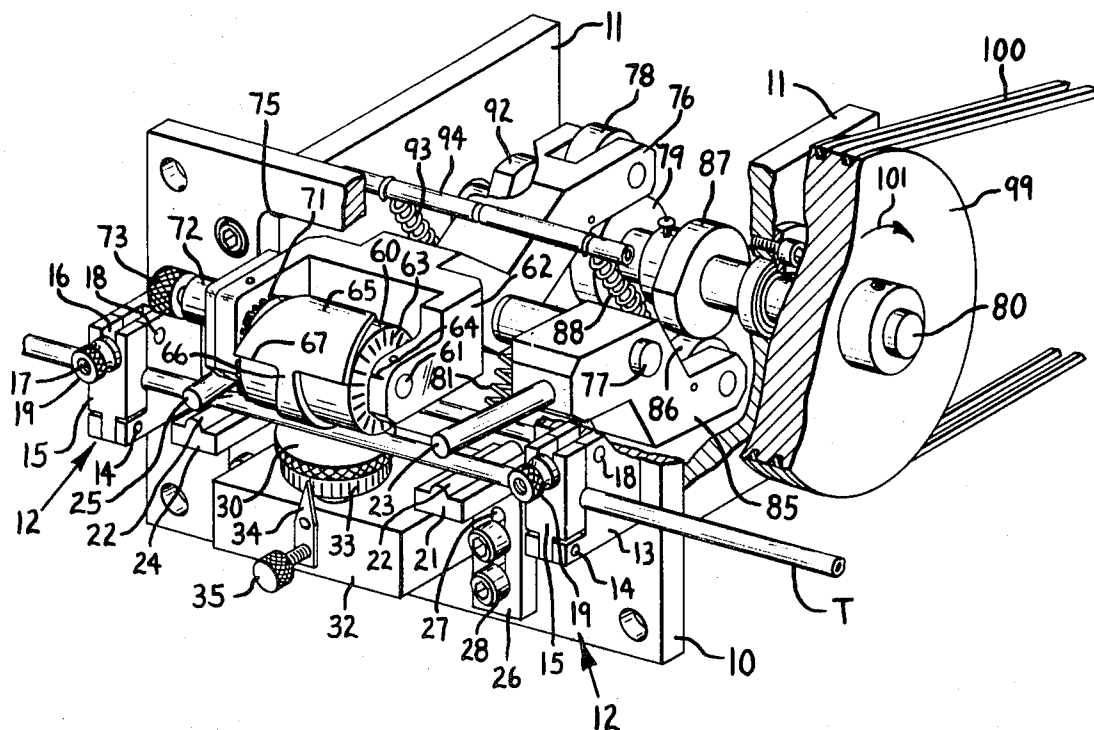
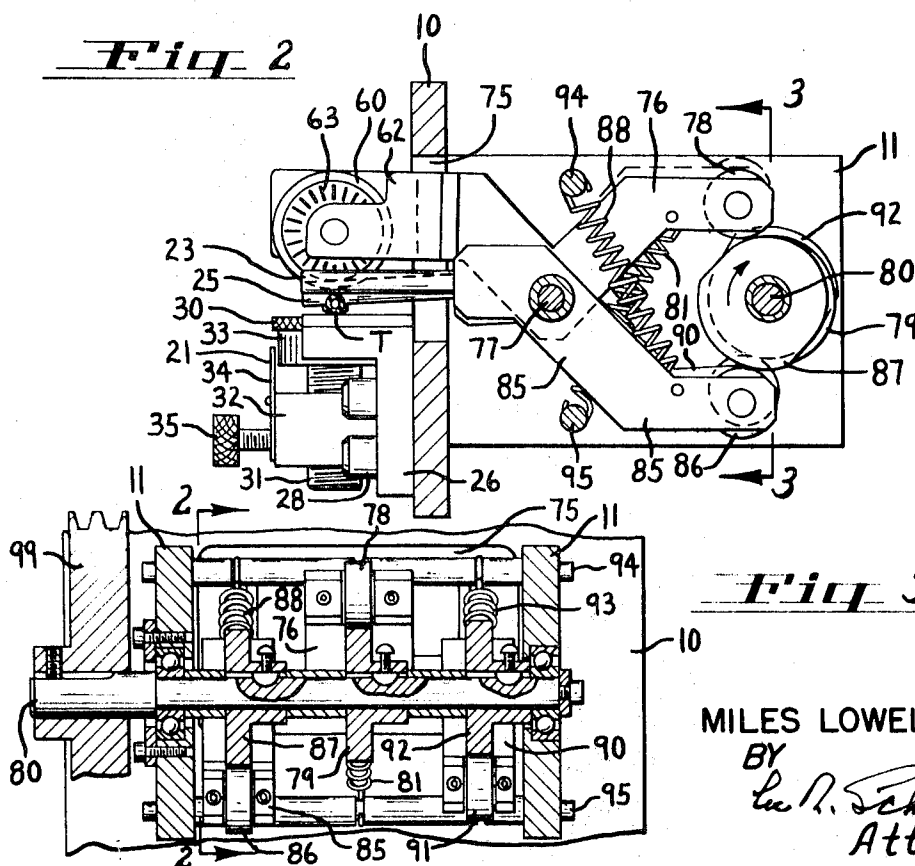


Fig 2



Fing 3

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2 Sheets-Sheet 2

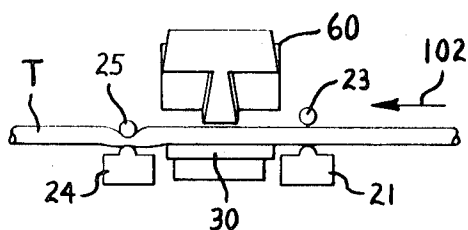
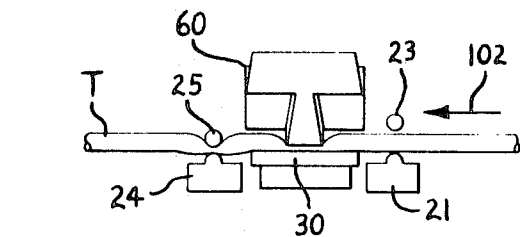
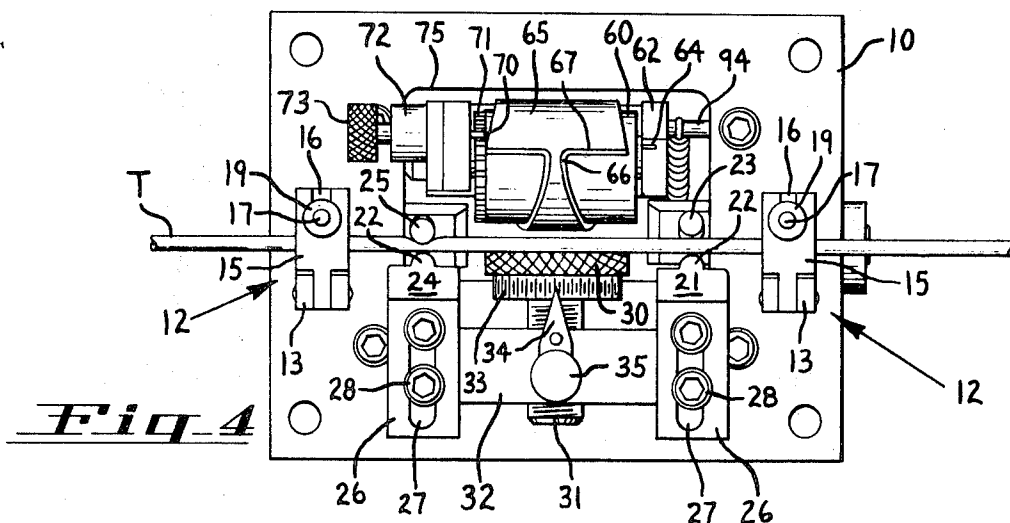


Fig 5

Fig 6

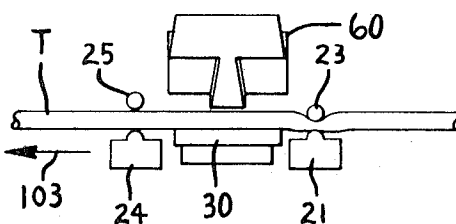
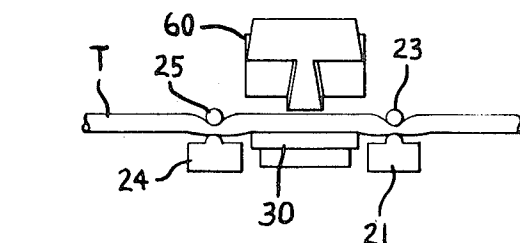


Fig 7

Fig 8

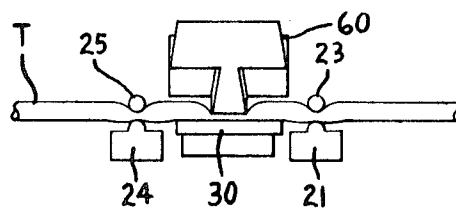
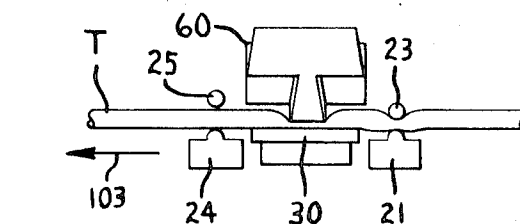


Fig 9

Fig 10

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1

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12 Claims

ABSTRACT OF THE DISCLOSURE

A positive displacement elastic tube pump having two separate adjustments for varying the rate of flow through a wide range. A portion of the tube between inlet and outlet pinch valves is alternately compressed against a platen and released by a reciprocating pressure shoe which bears against a variable length of the tube. The pressure shoe comprises a drum having a variable length effective surface acting on the tube which is adjustable by rotation of the drum. The effective length of stroke of the pressure shoe is variable by adjusting the platen toward and away from the pressure shoe. The pump is adapted to be driven by a blood pump so that when the proper dosage of medication for the blood is set on the drug pump, a change in speed of the blood pump will not alter the blood-medicine ratio.

BACKGROUND OF THE INVENTION

This invention relates to an elastic tube pump having a variable output adjustable through a wide range and has particular reference to a drug dispensing pump to be driven by a blood pump for maintaining a constant ratio between the rate of flow of the medication and the rate of flow of the blood.

For such purposes a positive displacement pump is necessary having a wide range of adjustment to vary the rate of flow and the rate of flow must be accurately determined and calibrated. Such a pump must be free of internal valves and other parts which create a problem of cleaning and sterilization. The pump must be capable of being put into operation quickly and easily without complicated connections and adjustments. For reliability in operation the pump must be of simple construction with a minimum number of working parts. Conventional pumps available on the market do not satisfy these rather exacting requirements.

Objects of the invention are, therefore, to provide an improved drug dispensing pump, to provide an improved elastic tube pump, to provide a pump of positive displacement type having variable output adjustable through a wide range which may be accurately calibrated, to provide a pump wherein the valve mechanisms and other machine parts do not come into contact with the pumped liquid, and to provide a pump of relatively simple and inexpensive construction which is reliable and trouble-free in operation.

SUMMARY OF THE INVENTION

In the present construction, the pumping action is produced by alternately squeezing and releasing a portion of an elastic tube between external pinch-type inlet and outlet valves. The tube is readily insertable into and removable from the operating mechanism.

In each pumping stroke the tube is compressed against a platen by a pressure shoe in the form of a drum having a variable length effective surface. Rotative adjustment of the drum varies the length of tube which is compressed. The effective length of the compression stroke is varied by adjusting the platen toward and away from the reciprocating drum. The combination of these two adjust-

2

ments varies the rate of flow from a maximum value to as small a value as may be desired. Both adjustments are accurately calibrated.

The pump is adapted to be driven from a positive displacement blood pump. When the proper dosage of medication is set on the drug pump, a change in speed of the blood pump will not alter the blood-medicine ratio.

The invention will be better understood and additional objects and advantages will become apparent from the following description of the preferred embodiment illustrated in the accompanying drawings. Various changes may be made in the details of construction and arrangement of parts and certain features may be used without others. All such modifications within the scope of the appended claims are included in the invention. Although the invention is described herein for the particular purpose of supplying medication to blood, it will be appreciated that the pump is not limited to this special use but is of rather general application for any purpose where its unique features are of advantage.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view, with parts broken away, showing a pump embodying the invention;
FIG. 2 is a view on the line 2-2 in FIG. 3;
FIG. 3 is a view on the line 3-3 in FIG. 2;
FIG. 4 is a front elevation view; and
FIGS. 5 to 10 are diagrammatic views in sequence, illustrating a pumping cycle.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The frame of the pump comprises a vertical plate 10 having a pair of rearwardly extending brackets 11. Pumping tube T is disposed on the front side of plate 10 and the operating mechanism is mounted on brackets 11 on the backside of plate 10. Tube T comprises an elastic rubber or plastic tube having sufficient resilience to spring back quickly to circular shape after squeezing pressure is released. Preferably, the tube T is a gum rubber tube of standard dimensions which is readily available at many scientific supply houses.

Tube T is secured in operative position by a pair of quick release clamps 12. Each clamp 12 comprises a block 13 mounted on the front side of plate 10 and having a pivot 14 for a swinging clamp arm 15. Block 13 and arm 15 are grooved to fit tube T with a firm grip. The upper end of arm 15 is notched at 16 to receive a swing bolt 17 which is pivotally mounted at 18 on block 13. Bolt 17 is equipped with a nut 19 which may be tightened on arm 15 to clamp the tube. By backing off the nut 19 a turn or so, bolt 17 may be swung upward to release clamp arm 15 for convenient removal or insertion of the tube.

Inlet and outlet pinch valves are disposed between the clamps 12. The inlet valve comprises a stationary abutment block 21 having a raised semi-cylindrical top portion 22 and a cylindrical pinch arm 23 having vertical movement toward and away from surface 22. Similarly, the outlet valve comprises a stationary abutment block 24 having a semi-cylindrical surface 22 underlying the tube T and a pinch arm 25 above the tube having vertical movement toward and away from the surface 22. The inlet and outlet valves are identical, the stationary parts 21 and 24 each being made as part of a bracket 26 mounted on the front of plate 10. Each bracket 26 contains a vertical slot 27 receiving screws 28 in plate 10 for vertical adjustment.

A vertically adjustable platen 30 is disposed between the valve parts 21 and 24. Platen 30 comprises an enlarged flat top circular head on a screw 31 having threaded engagement in a tapped vertical hole in a bracket

3

32 on the front of plate 10. The screw head is equipped with a calibration scale 33 which is rotatable behind a pointer 34. The thread on screw 31 has a coarse pitch so that the full range of vertical adjustment of platen 30 is accomplished in a single rotation of the screw. After adjustment, the screw 31 is clamped in selected rotative position by a setscrew 35.

A drum 60 forms a pressure shoe having uniform stroke, vertical movement above the portion of the tube which overlies platen 30. Drum 60 is mounted for rotation on a horizontal pin 61 in a yoke 62. One end of the drum has a calibration scale 63 which rotates adjacent an index mark 64 on the yoke.

Drum 60 has a variable length pressure shoe surface 65 for compressing a variable length of the tube T against platen 30. The axial length of surface 65 tapers from a wide portion 67 to a narrow portion 66, the widest portion at 67 having an axial dimension equal to the diameter of circular platen 30. On opposite sides of surface 65 the drum is relieved so that it will not contact the tube T. The rotative position of the drum thereby determines the length of the tube which will be compressed against platen 30 in each downward movement of the drum while at the same time the degree of flattening of the tube is determined by the vertical height adjustment of the platen.

A detent pin 70 is arranged to project between teeth 71 on one end of drum 60 to lock the drum in adjusted rotative position. Pin 70 is mounted for reciprocation in a barrel 72 on the yoke 62, the barrel containing a compression spring, not shown, which normally extends pin 70 between the teeth 71 as shown in FIG. 4. Pin 70 is retractable by a head 73 on the pin for rotative adjustment of drum 60.

Yoke 62 projects forward through an opening 75 in plate 10, the yoke being an integral part of a rocker arm 76 which is journaled on a shaft 77 extending between the brackets 11. The rear end of arm 76 is equipped with a cam follower roller 78 for actuation by a cam 79 keyed to a shaft 80 which is mounted for rotation in bearings in the brackets 11. A tension spring 81 holds roller 78 in firm engagement with the cam.

Inlet valve pinch arm 23 extends forward through opening 75 in plate 10 and is mounted on the front end of a rocker arm 85 journaled on shaft 77. The rear end of arm 85 carries a cam follower roller 86 which is actuated by a cam 87 keyed to shaft 80. A tension spring 88 holds roller 86 in firm engagement with the cam 87.

Outlet valve pinch arm 25 extends forward through opening 75 in plate 10 and is mounted on the front end of a rocker arm 90 journaled on shaft 77. The rear end of arm 90 carries a cam follower roller 91 for actuation by a cam 92 keyed to the shaft 80. Roller 91 is held in firm engagement with cam 92 by a tension spring 93. The two valve tension springs 88 and 93 are anchored to a rod 94 extending between the brackets 11 and pressure shoe tension spring 81 is anchored to a similar rod 95 as shown in FIG. 2.

Shaft 80 is driven by a pulley 99 and belts 100. Belts 100 may be driven by a blood pump or by the blood pump motor so that the speed of the present pump will always be proportional to the speed of the blood pump.

Shaft 80 may be rotated in either direction depending upon the direction of flow desired through tube T. In order to explain the valve operation in the sequence views in FIGS. 5 to 10, it will be assumed that pulley 99 is rotated clockwise in FIG. 1 as indicated by arrow 101. Before describing the valve action it will be observed that drum 60 is biased to retracted position by spring 81 and that the downward or pumping stroke of the drum is a positive actuation by cam 79. On the other hand, pinch valve arms 23 and 25 are biased to closed positions by their respective springs 88 and 93 and are opened by a positive cam action. This provides a uniform pinching force on the tube to insure complete valve closure.

4

FIG. 5 shows the beginning of the suction phase of a pumping cycle wherein outlet valve 24, 25 is closed, the tube is compressed by drum 60 which is starting to move upward, starting an inlet flow through open inlet valve 21, 23 as indicated by arrow 102. FIG. 6 illustrates completion of the suction phase wherein drum 60 has completed its upward movement and the tube portion overlying platen 30 is filled with liquid.

In FIG. 7 inlet valve 21, 23 has closed and in FIG. 8 outlet valve 24, 25 has opened and drum 60 is starting to move downward, initiating an outlet flow as indicated by arrow 103. In FIG. 9 the discharge stroke of drum 60 is completed and in FIG. 10 outlet valve 24, 25 has closed. The next event is the opening of the inlet valve 21, 23 at the start of the next pumping cycle as shown in FIG. 5.

Vertical adjustment of platen 30 varies the degree of flattening of the tube and has the effect of adjusting the effective length of the vertical stroke of drum 60 but is a much simpler form of adjustment than actually varying the excursion of the drum itself. Rotative adjustment of drum 60 varies the length of tube which is compressed by each downward movement of the drum. Maximum flow is obtained by moving platen 30 up to its upper limit of adjustment and rotating the drum to bring the long end 67 of surface 65 to bear against the tube. By lowering platen 30 and rotating the narrow end 66 of pressure surface 65 into tube contacting position, the rate of flow may be reduced to as small a value as desired. Scales 33 and 63 permit any combination of the two adjustments to be duplicated with accuracy.

In order to insert or remove tube T, the pulley 99 is rotated by hand to place the pressure shoe 60 and one or the other of the pinch arms 23 or 25 in raised position as shown in FIGS. 6 and 8. Then the other pinch arm may be raised by hand to receive or release the tube.

Having now described my invention and in what manner the same may be used, what I claim as new and desire to protect by Letters Patent is:

1. A pump comprising an elastic tube, inlet and outlet pinch valves operable on said tube, a platen supporting said tube between said valves, means for adjusting said platen toward and away from said tube, a reciprocable pressure shoe arranged to squeeze said tube against said platen, tube engaging surface portions of different length on said pressure shoe for squeezing a greater or lesser length of said tube, and means for adjusting said pressure shoe to place a surface portion of selected length in operative position confronting said tube.

2. A pump as defined in claim 1, said platen comprising a head on a screw which is rotatable for adjustment of the platen.

3. A pump as defined in claim 2, said screw having a full range of adjustment in one turn thereof.

4. A pump as defined in claim 1, said pressure shoe being rotatable on an axis parallel with said tube to effect said adjustment of the pressure shoe.

5. A pump as defined in claim 4, said pressure shoe comprising a drum having a tube engaging surface portion thereon which is tapered in a circumferential direction.

6. A pump as defined in claim 1 including quick release clamps adjacent said pinch valves securing said tube in operative position.

7. A pump as defined in claim 1 including a rocker arm and cam means arranged to impart squeezing motion to said pressure shoe, and spring means arranged to retract said pressure shoe.

8. A pump as defined in claim 1 including individual rocker arms and cam means arranged to open said pinch valves, and spring means arranged to close said pinch valves.

9. A pump mechanism for an elastic tube pump comprising a pair of quick release tube clamps, inlet and outlet tube pinch valves between said clamps, a platen for

5

supporting said tube between said pinch valves, a pressure shoe mounted for reciprocation relative to said platen for squeezing said tube, said pressure shoe comprising a drum mounted for rotative adjustment about an axis parallel with the direction of said tube, and a circumferentially tapered tube engaging pressure surface on said drum.

10. A mechanism as defined in claim 9 including individual rocker arms and cam means for opening said pinch valves and applying squeezing pressure to said pressure shoe, and spring means for closing said pinch valves and retracting said pressure shoe.

11. A mechanism as defined in claim 10, said rocker arms being mounted for oscillation on a common shaft and said cam means being mounted on a second common shaft.

12. A mechanism as defined in claim 11 including a supporting plate for said mechanism, said shafts and cam

6

means being mounted on the back of said plate and said tube clamps, pinch valves, platen and pressure shoe being disposed on the front side of said plate.

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U.S. Cl. X.R.

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