Oct. 4, 1949. E. J. MOULINIER 2,483,924

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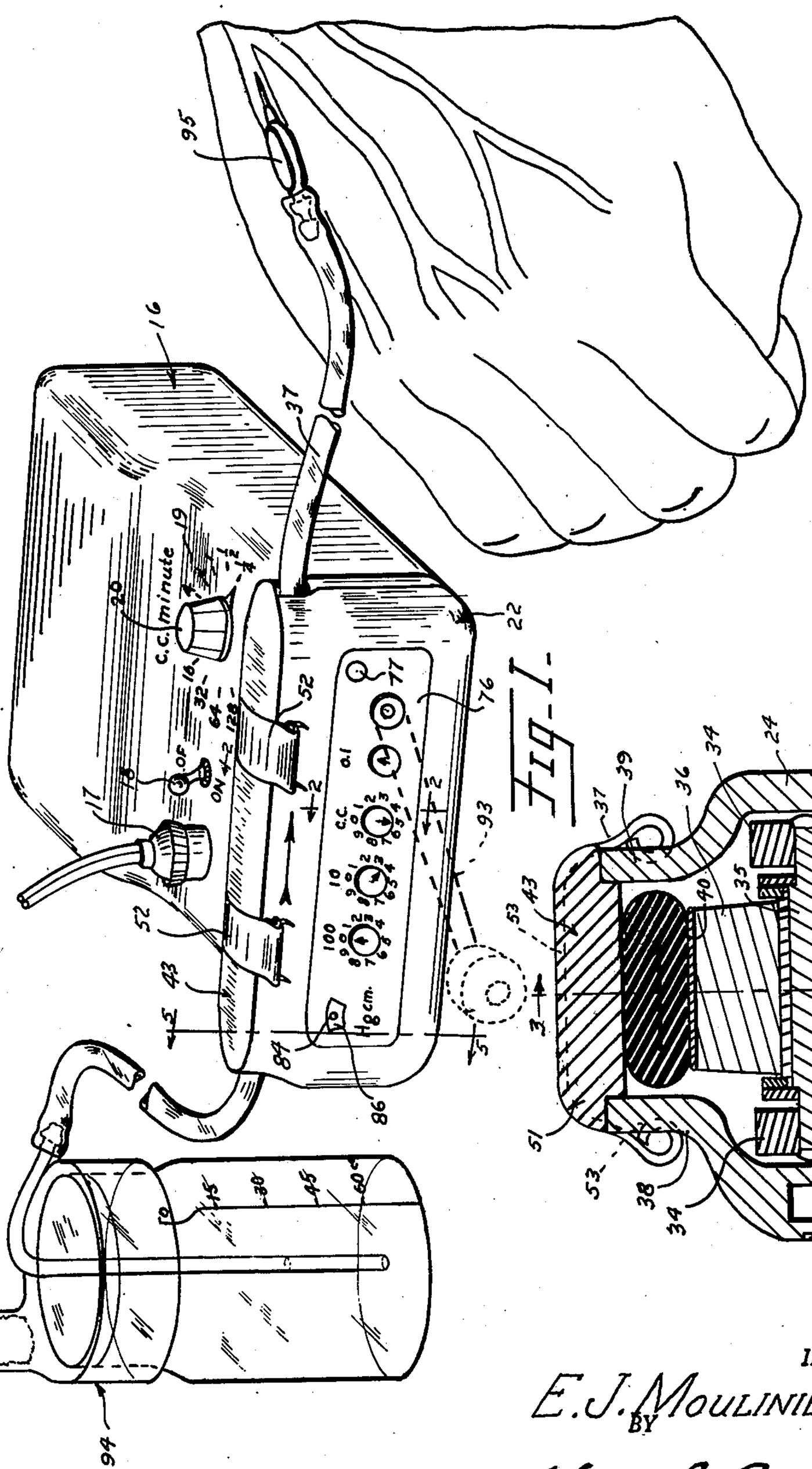

FIG. 1.

FIG. 2.

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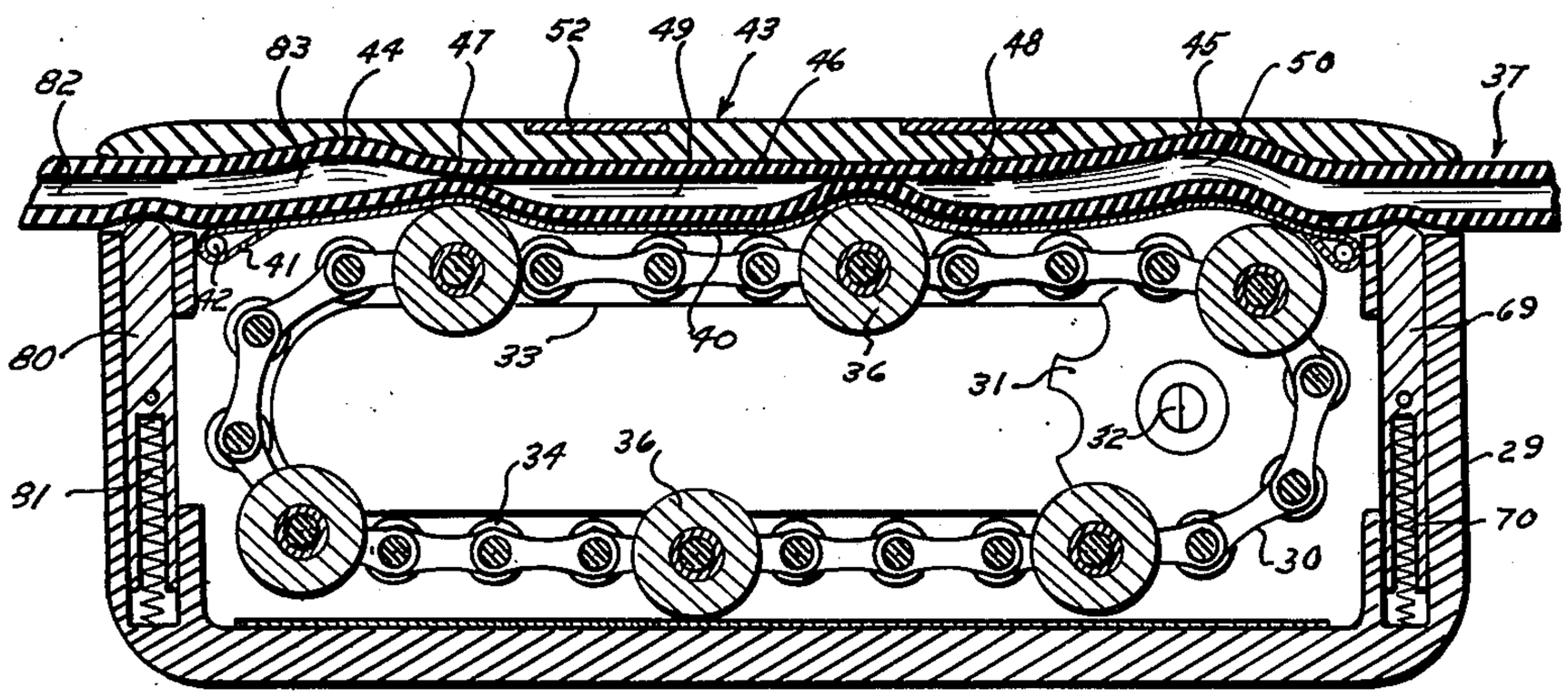

Fig. 3.

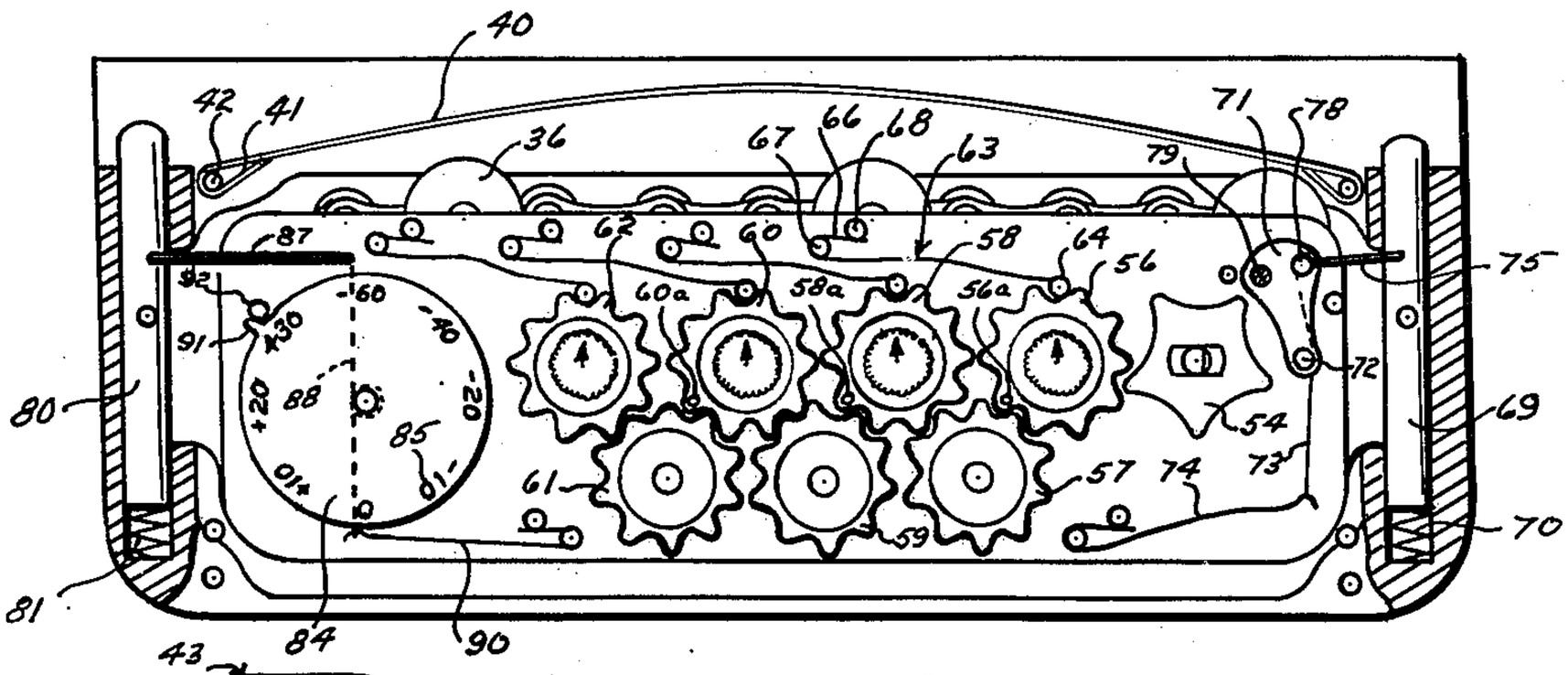

Fig. 4.

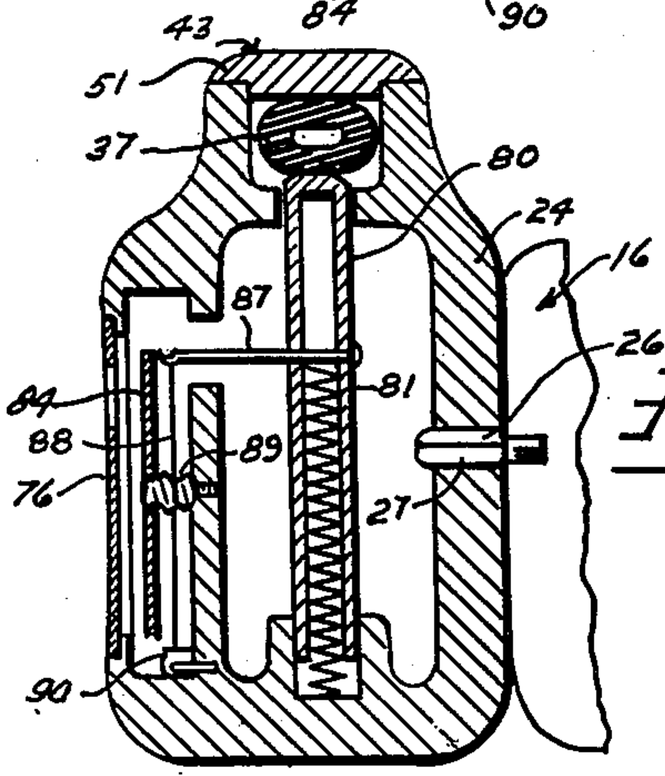

Fig. 5.

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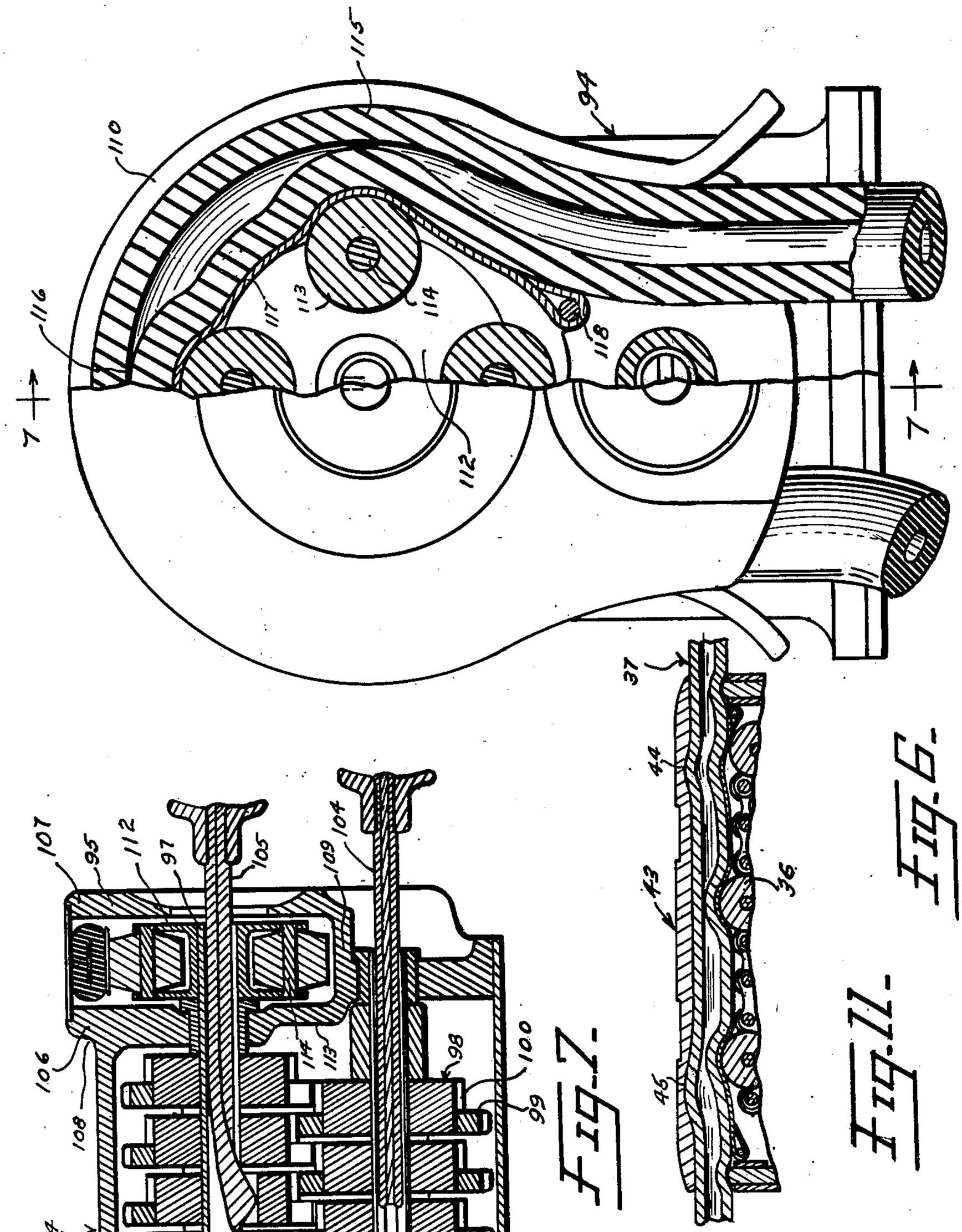

Fig. 6.

Fig. 7.

Fig. 11.

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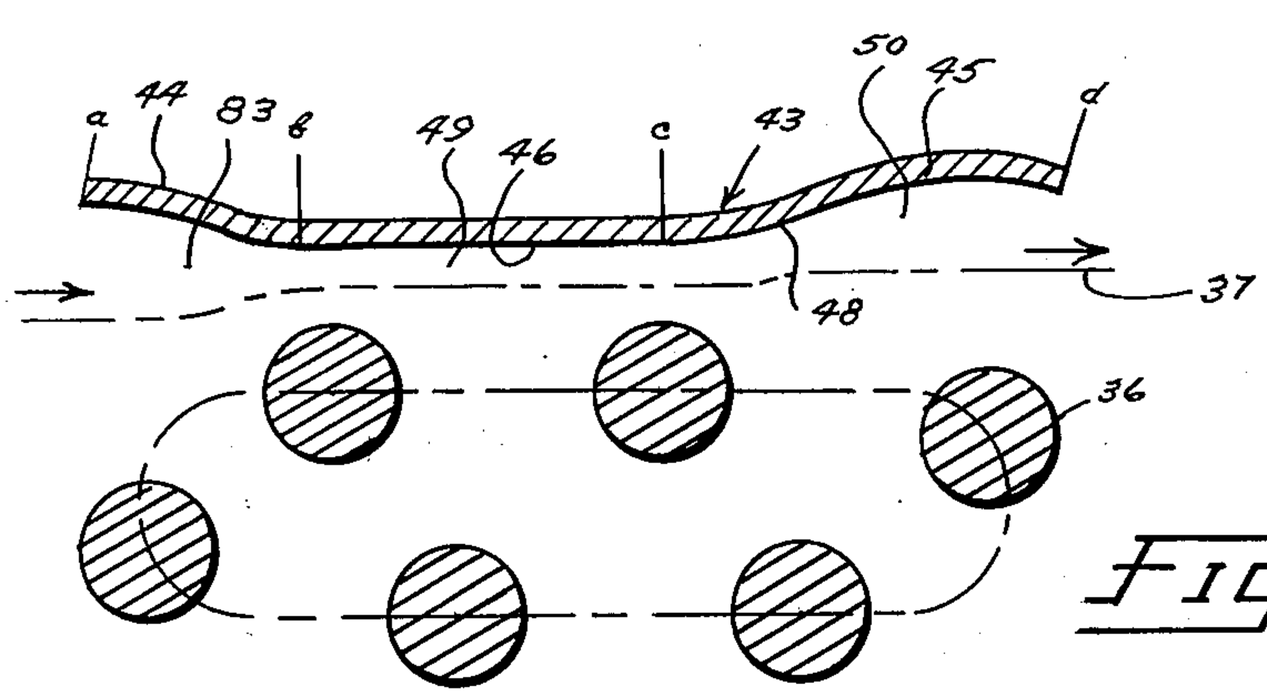

Fig. 8.

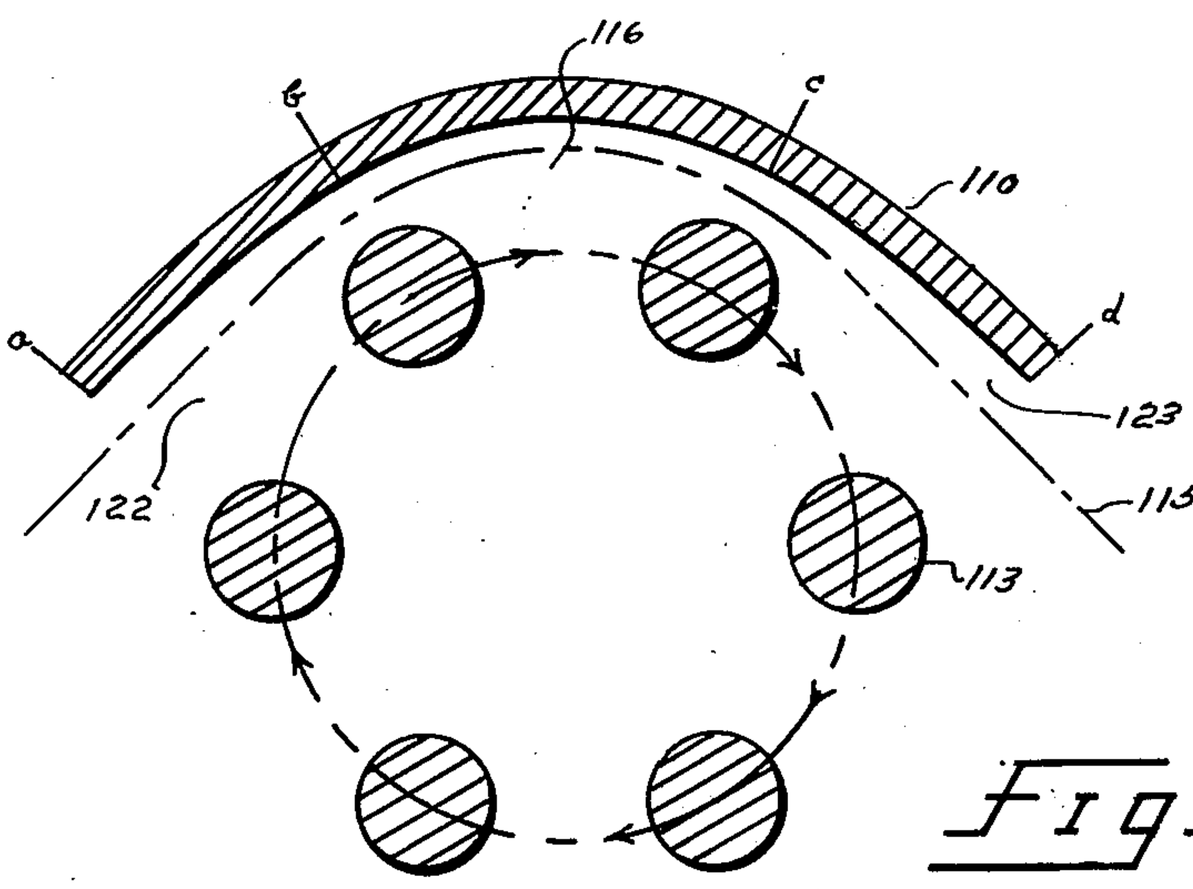

Fig. 9.

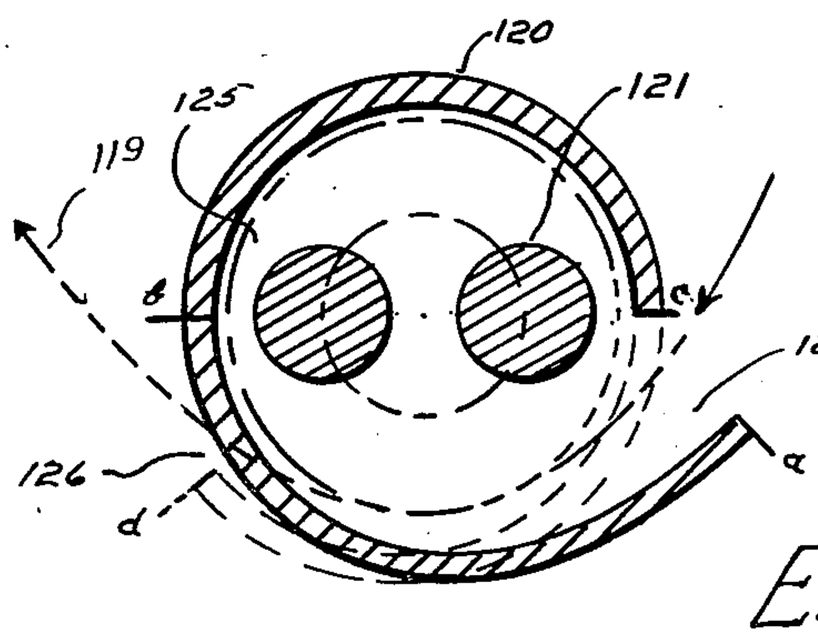

Fig. 10.

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UNITED STATES PATENT OFFICE

2,483,924

PUMP

Edmond Jean Moulinier, Paris, France

Application June 10, 1946, Serial No. 675,678

8 Claims. (Cl. 103—149)

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This invention relates to pumps designed for medical or scientific use.

An object of this invention is to provide a pump for injecting fluid into, or drawing fluid from, the body. The fluid may be whole blood, blood plasma, or other fluid which is injected into or drawn from the veins.

Another object of this invention is to provide a pump which is positive in its action and will effect steady fluid flow whereby the hypodermic needle will not be obstructed by reflux of the blood.

A further object of this invention is to provide a pump wherein the fluid moving elements thereof do not contact with the fluid so that the fluid will not be contaminated.

A further object of this invention is to provide a pump of this kind wherein the quantity of the fluid pumped can be very finely and accurately gauged, and the timing of the fluid movement can also be accurately gauged and calculated.

A further object of this invention is to provide a pump of this kind wherein the movement of the fluid can be quickly and easily reversed.

A further object of this invention is to provide a pump wherein the pumping stroke or cycle may be rectilinear, arcuate or helical.

A further object of this invention is to provide a pump acting on an intermediate portion of an elongated rubber or resilient tube for compressing the tube at at least one point, and then moving the compressed point forwardly without endwise movement of the tube and finally gradually releasing the compressed point of the liquid so that the advanced liquid will commingle with previously advanced liquid which is moved forwardly by advance of a succeeding compressed point of the tube.

With the above and other objects in view, my invention consists in the arrangement, combination and details of construction disclosed in the drawings and specification, and then more particularly pointed out in the appended claims.

In the drawings, wherein similar reference characters designate similar parts throughout the respective views,

Figure 1 is a perspective view of a pump constructed according to an embodiment of this invention, showing the pump in operative position,

Figure 2 is a fragmentary sectional view taken on the line 2—2 of Figure 1,

Figure 3 is a sectional view taken on the line 3—3 of Figure 2,

Figure 4 is a detail front elevation of the device, partly broken away and in section, with the cover removed,

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Figure 5 is a sectional view taken on the line 5—5 of Figure 1,

Figure 6 is a detail front elevation, partly broken away and in section, of a modified form of this invention,

Figure 7 is a sectional view taken on the line 7—7 of Figure 6,

Figure 8 is a diagrammatic view of the construction shown in Figures 1 to 5 inclusive,

Figure 9 is a diagrammatic view of the construction shown in Figures 6 and 7,

Figure 10 is a diagrammatic view of a further modification of this invention,

Figure 11 is a fragmentary sectional view, similar to Figure 3, with the cover reversed so as to provide a pulsating suction.

Referring to the drawings, and first to the Figures 1 to 5, and 11, the numeral 15 designates generally a motor housing wherein is positioned an electric motor of conventional construction. The housing 15 has extending from the forward side thereof a gear housing 16 wherein is positioned a gear changing mechanism of conventional construction for effecting a change of speed from the driving shaft to the driven shaft. The gear housing 16 has extending upwardly therefrom a pair of electric terminals 17 whereby the motor may be connected to a suitable source of electric current supply. A switch 18 is also carried by the gear housing 16, and the housing 16 has disposed on the upper side thereof a gear changing member 20. The gear changer 20 may be adjusted relative to the indicia 19 so that the speed of the driven shaft 21 may be varied as may be desired.

The gear housing 16 has removably mounted on the forward side thereof a pumping housing generally designated as 22. The pumping housing 22 includes a front wall 23, a rear wall 24, and a bottom wall 25. The walls 23, 24, and 25 may be formed integral with each other and a positioning pin 26 carried by the pumping housing 22 is adapted to engage in a socket 27 formed in the front wall of the gear housing 16. The pumping housing 21 also includes end walls 28, 29, which may be formed as an integral unit with the opposite side and bottom walls.

A chain 30 is disposed in the housing 22 and engages about a driving sprocket 31 which is fixed to a shaft 32 which is detachably coupled to shaft 21. The front wall 22 and the rear wall 24 of the housing 22 are formed with tracks 33 on which rollers 34, carried by the chain 30, are adapted

to movably engage. The tracks 33 are formed with substantially parallel upper and lower track portions and arcuate end portions, as more clearly shown in Figure 3. The chain 30 is preferably a wide chain and certain ones of the rollers 34 have associated with the roller pins 35 thereof a tube compressing roller 36. The rollers 35 are spaced from each other and the rollers 36 engage between the front and rear walls of the housing 22. An elongated elastic tube 37 is adapted to be extended lengthwise of the housing 22, engaging between reduced thickness extensions 38, 39, carried by the front and rear walls respectively.

The elastic tube 37 is adapted to be disposed in a substantially horizontal position and bears against a resilient or flexible strap 40 which overlies the path of movement of the rollers 36. The strap 40 is formed at the opposite ends thereof with loops 41 through which strap retaining pins 42 engage. The strap 40 is positioned between the pumping rollers 36 and the lower side of the tube 37 as shown in Figure 11.

In order to provide for movement of fluid through the tube 37 as the pumping rollers 36 move along the upper run of the track or guide 33, I have provided a combined housing or closure plate and cam member, generally designated as 43. The plate 43 is formed with an upwardly offset concave portion 44 adjacent one end thereof, and a second concave portion 45 adjacent the opposite end thereof. A straight portion 46 is disposed between the two concave portions 44, 45, and is adapted to overlie the straight upper run of the guide 33 so that the tube 37 will be compressed tight together as indicated at 47. The forward end of the straight portion 46 merges with an upwardly and forwardly inclined surface 48 which merges with the recess 45 so that there will be a gradual release or decompression of the tube in order to thereby prevent pulsations of the fluid in the delivery or decompression zone 50.

As the chain moves in a clockwise direction in Figure 3, compressed point 47 will move lengthwise of the plate 43 along the straight portion which constitutes the compressed zone 49, and when the compressed point 47 reaches the inclined surface 48 the tube is gradually released so that it will decompress in the decompressing or delivery zone 50. At the instant that a foremost roller is entering the decompression zone 50, a succeeding roller 36 is entering the compression zone 49.

The cam plate 43 is formed with opposite extending lengthwise flanges 51 which overlie the upper edges of the front and rear wall extensions 38, 39, and a pair of resilient clips 52 are adapted to engage over the plate 43 and snap in recesses 53 which are formed in the housing 22. The speed of movement of the chain 34 and rotation of the sprocket 31 will determine the quantity of fluid which is pumped.

In order that an accurate indication may be obtained as to the quantity of liquid pumped, I have provided a counter sprocket 54 which is mounted on the sprocket shaft 32. The sprocket 54 is mounted in a counter housing 55 positioned on the forward side of the front wall 23. The sprocket 54 has meshing therewith a unit gear 56 having a pin 56*a* engageable with gear 57 on one complete turn of gear 56. Gear 57 meshes with a tens gear 58 having a pin 58*a* engageable with gear 59. Gear 59 meshes with a hundred indicating gear 60 which has a pin 60*a* engageable with gear 61. Gear 61 meshes with gear 62 which

is the thousand indicator. The several sprockets 56, 58, 60, 62, are held against reverse rotation by spring-pressed pawls 63. The pawls 63 are of such construction that the wheels 56, 58, 60, 62 may be manually turned in either direction. In this manner the quantity indicating mechanism can be readily rotated to zero indication at the starting operation of the pump. The pawls 63 include a round pin 64 which is carried by an elongated spring 65, having a reverted end 66 engaged about a holding pin 67. A stationary pin 68 engages the free end of the reverted end portion 66 and constitutes a spring-tensioning pin.

In order that the user of this device may be able to determine the pressure of the delivered fluid, I have provided a pressure member 69 which is vertically slidable in the end wall 29. The pressure member 69 is adapted to engage the lower side of the tube 37 forwardly of the chamber 50 and the pressure member 69 is constantly urged upwardly by means of a spring 70. A gauge or indicator 71 is pivotally mounted as at 72 adjacent the gear or sprocket 54. The mounting 72 is rotatable relative to the housing 55 and a cord 73 is wound about the shaft or mounting 72 and has a spring 74 connected thereto which is adapted to normally swing the indicator 71 to the right as viewed in Figure 12.

A link 75 is fixed on the pressure member 69 and the opposite end of cord 73 is connected to link 75 so that vertical movement of the pressure member 69 will effect rocking of the indicator 71. The indicator 71 is swingable on the inner side of a removable plate or wall 76 carried by the housing 55 and which is formed with a window 77. The indicator 71 may include a pair of indicating elements 78, 79 so that the user of this device will be able to determine at a glance whether the pressure of the delivered fluid is normal or is above a danger point.

A second pressure member 80 is slidably carried by the end wall 28, being constantly urged upwardly by means of a spring 81. The pressure member 80 is adapted to engage the tube 37 on the intake side thereof with respect to the housing 22 and is designed for indicating positive or negative pressure in the suction zone 83 formed by the concave recess 44. A gauge wheel 84 is rotatably disposed on the inner side of the face plate 76, having indicia 85 thereon for exposure through a window 86 formed in the plate 76. The pressure member 80 has fixed thereto an arm 87 with which is engaged one end of a cord 88 wound about the rotatable pivot member 89. The other end of cord 88 is secured to a spring 90 which will effect rotation of wheel 84 in the opposite or return direction. The wheel 84 is formed with a lug 91 which is engageable with a fixed stop 92 whereby the wheel 84 is limited in its rotation. The pumping structure in the housing 22 may be manually rotated if desired by coupling a crank 93 with the shaft 32.

Referring now to Figures 6 and 7, there is disclosed a modified form of this invention. In this modified form there is provided a speed changer generally designated as 94, which is coupled to a pumping member generally designated as 95. The speed changer 94 includes a driving shaft 96 adapted to be connected to the power member, and also includes a driven shaft 97 with which is connected the pumping member 95. The speed changer 94 includes a plurality of driving gears 98 which are formed with large gear members 99 and reduced diameter gear members 100. The

driven shaft 97 has loosely mounted thereon complementary gears 101 which are similar to gears 98, having large diameter gear members 102 meshing with the reduced diameter gear members 100, and reduced diameter gears 103 meshing with the large diameter gears 99.

The drive shaft 96 is of tubular construction and has endwise adjustable therein a gear selecting key 104. The key 104 may be engaged with a selected one of the gears 98 so as to provide for rotation of the driven gears 101 at a predetermined speed. The driven shaft 97 also is of tubular construction and has endwise adjustable therein a gear coupling key 105 engageable with a selected one of the gears 101. The gears 98 and 101 are in constant mesh with each other but the rate of rotation of the driven gears 101 is determined by the endwise positions of the key members 104, 105.

The pumping member 95 includes a housing 106 which is formed of front and rear walls 107, 108 respectively. A bottom wall 109 connects the lower portions of the front and rear walls together and a substantially U-shaped detachable closure 110 formed with outturned ends 111 is adapted to close the space between the front and rear walls of the pumping housing 106. The closure 110 is only made resilient in order to remove and mount the same on the housing, and the closure 110 and housing 106 are so formed as to provide a suction zone 122, a compressed zone 116, and a decompressed or delivery zone 115. The driven shaft 97 has mounted thereon a wheel 112 which is rotatable between the front and rear walls of the pumping housing and the wheel 112 has rotatable thereon a plurality of circumferentially spaced apart rollers 113 carried by roller shafts 114. The tube 115 is compressed by one roller 113 as indicated at 116, which compresses the tube at one point between the roller 113, and a flexible or resilient pressure strap 117 which engages loosely about the wheel 112 and the roller 113, and is tied at the opposite ends thereof on pins 118. The wheel 112 may be rotated in either direction, depending on the rotation of the driving shaft 96, so that the fluid in the tube 116 may be moved in the desired direction.

As shown in Figure 10, the tube 119 may be spirally disposed in a spiral housing 120 which has rotatable therein one or more pumping rollers 121.

Referring now to the diagrammatical showing in Figure 8, the tube 37 is disposed between the pumping rollers 36 and the cam plate 43. The recess 44 constitutes the suction zone and the straight portion 46 constitutes the compressing zone, whereas the recess 45 forms the discharge or decompressing zone.

In Figure 9 the diagrammatical showing represents the pump shown in Figures 6 and 7. The numeral 122 constitutes the intake or suction zone and the numeral 115 constitutes the compressing zone, whereas the numeral 123 constitutes the discharge or decompressing zone where the fluid in the tube 116 is forced lengthwise of the tube and the fluid in the pumping zone 115 mixes with the fluid forwardly of the pumping zone.

In the diagrammatical showing of Figure 10, the numeral 124 indicates the suction zone and the numeral 125 indicates the pumping zone, whereas the numeral 126 indicates the discharge zone.

With a pump as hereinbefore described, any desired fluid may be pumped, the fluid being either liquid or gas. This device has been designed particularly as a means for intravenous injection of desired fluid and may also be used to withdraw fluid from a person. The pump may also be used in scientific laboratories for various purposes where it is desired to accurately measure the quantity of the fluid pumped and where the fluid can be pumped under any desired pressure. This device provides a continuous or steady, rather than a pulsating movement of the pumped fluid and by providing a reversible cover for the pump, the pulsating suction can be connected either to a fluid receptacle 94, or may be connected to the hypodermic needle 95, as shown in Figure 1. It will of course, be understood that with the reversible cover there may be obtained a pulsating suction from the receptacle and a steady delivery to the needle, or if the cover is reversed without reversing the movement of the rollers, there may be obtained a steady suction and a pulsating delivery. Where the cover is reversed and the movement of the rollers is also reversed, there will be a pulsating suction from the needle and a steady delivery to the receptacle.

I do not mean to confine myself to the exact details of construction herein disclosed but claim all variations falling within the purview of the appended claims.

What I desire to claim is:

1. A pump for moving fluid in a flexible duct comprising a housing, means mounting an intermediate portion of said duct in said housing, a plurality of pressure rollers movably mounted in said housing, said rollers and housing being so constructed and arranged as to provide an initial duct compressing zone, a duct compressed zone, a duct decompressing zone whereby to provide a steady fluid movement through said duct, and gauge means carried by said housing engaging said duct forwardly of said decompressing zone for indicating the fluid delivery pressure.

2. A pump for moving fluid in a flexible duct comprising a housing, means mounting an intermediate portion of said duct in said housing, a plurality of pressure rollers movably mounted in said housing, said rollers and housing being so constructed and arranged as to provide an initial duct compressing zone, a duct compressed zone, a duct decompressing zone whereby to provide a steady fluid movement through said duct, a pressure gauge carried by said housing engaging said duct rearwardly of said compressing zone for indicating fluid pressure rearwardly of said latter zone.

3. A pump for moving fluid in a flexible duct comprising a housing, means mounting an intermediate portion of said duct in said housing, a plurality of pressure rollers movably mounted in said housing, said rollers and housing being so constructed and arranged as to provide an initial duct compressing zone, a duct compressed zone, a duct decompressing zone whereby to provide a steady fluid movement through said duct, a removable duct contacting cover on said housing so formed and correlated with the movement of said rollers as to provide said compressing zone, said compressed zone and said decompressing zone.

4. A pump for moving fluid in a flexible duct comprising a housing, means mounting an intermediate portion of said duct in said housing, a plurality of pressure rollers movably mounted in

said housing, said rollers and housing being so constructed and arranged as to provide an initial duct compressing zone, a duct compressed zone, a duct decompressing zone whereby to provide a steady fluid movement through said duct, said housing including removable duct contacting cover so formed and correlated with the movement of said rollers as to provide a pulsating suction movement of the fluid in one zone and a steady delivery movement of the fluid in another zone, said cover being reversible whereby to provide steady fluid movement in said one zone and pulsating fluid movement in said other zone.

5. A pump for moving fluid in a flexible duct comprising a housing, means mounting an intermediate portion of said duct in said housing, a plurality of pressure rollers movably mounted in said housing engaging said duct at spaced intervals along the length thereof, said duct mounting means formed with upwardly offset concave portions adjacent the ends thereof to provide a pulsating suction movement of the fluid in one zone thereof.

6. A pump for moving fluid in a flexible duct comprising a housing, means mounting an intermediate portion of said duct in said housing, a plurality of pressure rollers movably mounted in said housing engaging said duct at spaced intervals along the length thereof, said duct mounting means formed with upwardly offset concave portions adjacent the ends thereof to provide a steady delivery movement of the fluid in one zone thereof.

7. A pump for moving fluid in a flexible duct comprising a housing, means mounting an intermediate portion of said duct in said housing, a plurality of pressure rollers movably mounted in said housing engaging said duct at spaced intervals along the length thereof, said duct mounting means formed with upwardly offset concave portions adjacent the ends thereof to provide a plusating suction movement of the fluid in one zone thereof and a steady delivery movement of the fluid in another zone.

8. A pump comprising in combination a housing, a flexible duct in said housing, a duct seat carried by said housing whereby an intermediate portion of said duct may engage on said seat, a flexible strap engageable with said intermediate portion of said duct, a closure for said housing formed with an intermediate straight horizontal inner side engageable with said duct opposite from said strap, said closure also formed with offset curved portions at the ends of said straight inner side, spaced duct contracting rollers in said housing engageable with said strap, and means for moving said rollers.

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