Jan. 4, 1966 L. C. CLARK, JR 3,227,092

FLUID PUMP

Filed Oct. 28, 1963

Fig. 1

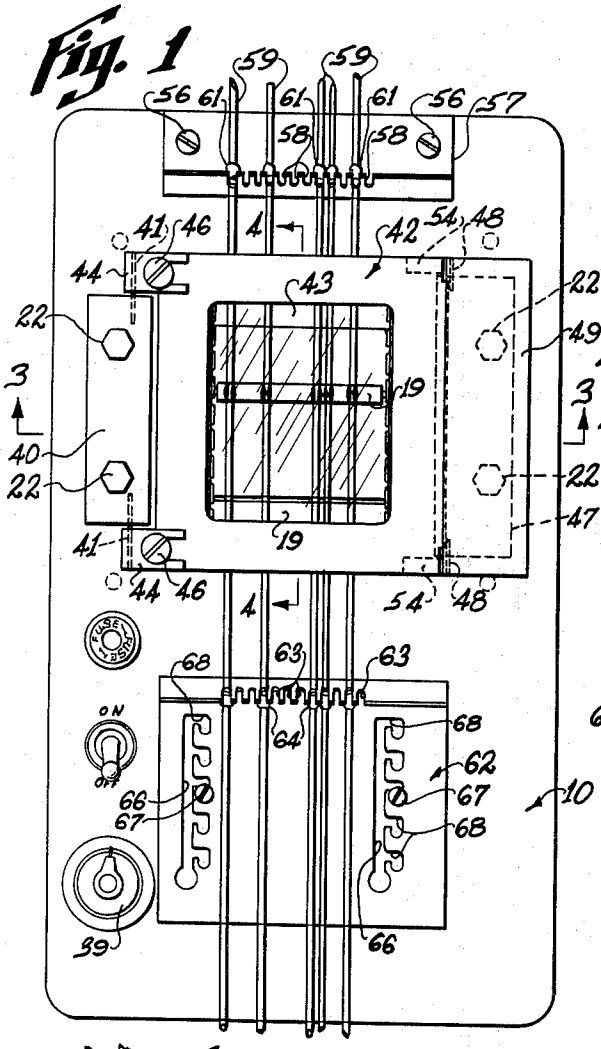


Fig. 2

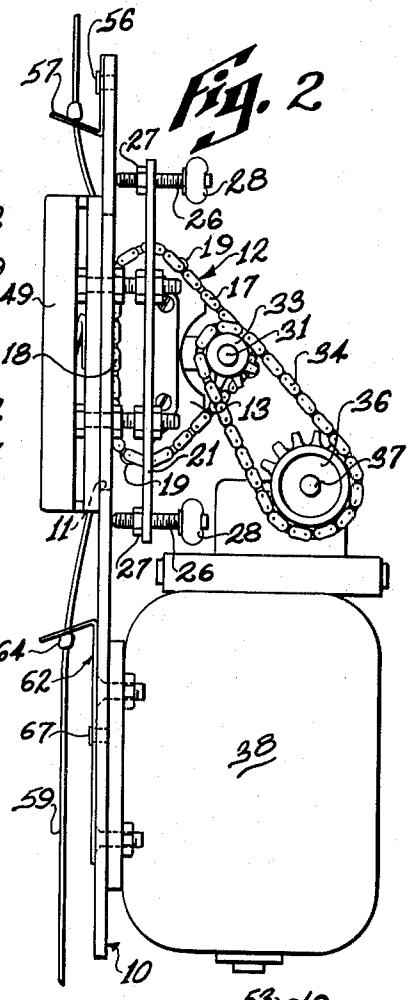


Fig. 4

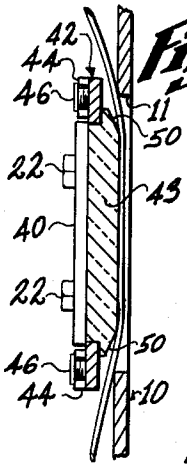


Fig. 5

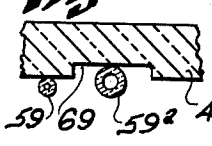


Fig. 3

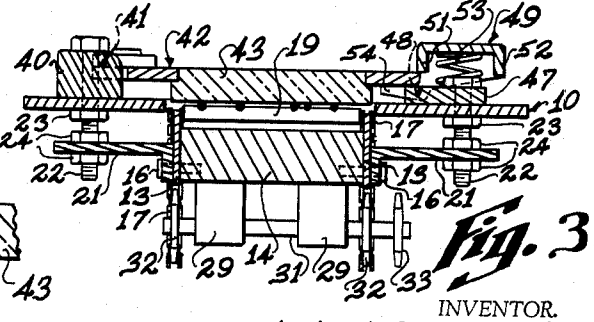
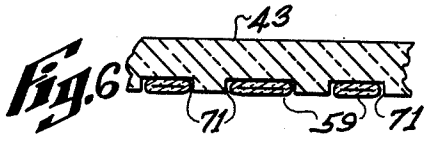


Fig. 6



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3,227,092

FLUID PUMP

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This invention relates to a fluid pump and more particularly to such a pump which functions by rolling or compressing a resilient tube longitudinally of the length thereof whereby the fluid, which may be in the form of a liquid or a gas, is propelled.

An object of my invention is to provide a fluid pump of the character designated which shall be particularly adapted for use where continuous proportioning of fluid streams is required, such as with systems for continuous monitoring in cardiovascular surgery, thus permitting accurate and continuous monitoring of both heart-lung machines and patients in regulating operative and post-operative management of the patients.

Another object of my invention is to provide a fluid pump of the character designated in which there are no exposed moving parts, thereby eliminating a hazard to personnel and clothing.

Another object of my invention is to provide a fluid pump of the character designated in which the tube being rolled or compressed to propel the fluid is under direct vision so that the movement of the fluid, or possible rupture of the tube, can be observed at all times.

Another object of my invention is to provide a fluid pump of the character designated which is adapted to be mounted in various positions, whereby it is adapted for mounting on vertical or horizontal panels, as well as on carts.

Another object of my invention is to provide a fluid pump of the character designated in which pulsations in the stream as the compressing means lifts from the tubing is reduced to a minimum to prevent regurgitant pulsating flow of fluids as the fluids are pumped past various sensors or the like.

Another object of my invention is to provide a pump of the character designated in which the amount of compressive force applied to the tubing can be varied and controlled accurately without having to disrupt the operation of the pump.

Another object of my invention is to provide a fluid pump of the character designated which shall be adapted to pump against a high head pressure and one in which the pressure within the tubing may be controlled whereby the pressure does not exceed a predetermined amount, thus adapting my apparatus particularly for non-occlusive pumping.

A further object of my invention is to provide a fluid pump of the character designated in which means is provided to apply tension to the tubing which is both adjustable and releasable with a minimum of effort.

A still further object of my invention is to provide a fluid pump of the character designated which shall be simple of construction, economical of manufacture and one which is trouble-free in operation and requires a minimum of time for assembly and disassembly.

Heretofore in the art to which my invention relates, various types of proportioning pumps have been devised. However, so far as I am aware, such pumps have been unsatisfactory due to the fact that the drive mechanism therefor is not only complicated but is mounted for pivotal movement outwardly of the pump whereby the moving parts thereof are exposed. Also, the driving mechanism must be released before the tubes carrying the fluid can be examined or replaced. Furthermore, a predetermined, accurate pressure cannot be applied to the tubes conveying the fluid due to the fact that pressure is exerted by spring-mounted members.

To overcome the above and other difficulties, I provide a fluid pump in which the driving mechanism is mounted wholly within the confines of the pump assembly whereby there are no exposed moving parts. A transparent platen is mounted outwardly of the driving mechanism whereby the tubes are positioned between the platen and the driving mechanism. The platen is held in a predetermined fixed position by hold-down means which may be released and placed back in operation with a minimum of effort and in a minimum of time. The tubes conveying the fluid are held against axial movement by releasable means which is adapted to be held in selected positions whereby the tension applied to the tubes may be varied quickly.

Apparatus embodying features of my invention is illustrated in the accompanying drawing, forming a part of this application, in which:

FIG. 1 is a front elevational view of the pump, the tubes for conveying the fluid being broken away;

FIG. 2 is a side elevational view of the apparatus shown in FIG. 1;

FIG. 3 is a sectional view taken generally along line 3—3 of FIG. 1;

FIG. 4 is a fragmental sectional view taken generally along the line 4—4 of FIG. 1;

FIG. 5 is an enlarged, fragmental view showing a modified form of my invention in which the transparent platen is provided with longitudinally extending milled-out portions for receiving different size tubes; and,

FIG. 6 is an enlarged fragmental view showing a still further modified form of my invention in which the tubes are in compressed position.

Referring now to the drawing for a better understanding of my invention, I show a supporting plate **10** which may be mounted in an upright position, as shown in FIGS. 1 and 2, in a horizontal position, or in any other desired position. A rectangular opening **11** is provided in the supporting plate **10**, as shown.

Mounted on the inner side of the supporting plate **10** is a drive assembly indicated generally at **12**. The drive assemby comprises a pair of side plates **13** which are secured to a transverse block **14** by suitable screws **16**. The side plates **13** are of a shape and thickness to form guide members for endless chain-like members **17**. That is, the chain-like members **17** surround the side plates **13** and the side plates limit lateral movement thereof whereby the chain-like members form endless drive members having a section **18** thereof projecting inwardly of the opening **11**, as shown in FIG. 2. Transverse rollers **19** are carried by and mounted for rotation relative to the chain-like members **17**. The rollers **19** are spaced equal distances from each other, as shown in FIG. 2 whereby a uniform pumping action is obtained.

Secured to opposite sides of the block **14** by the screws **16** are outwardly projecting brackets **21**. The brackets **21** are supported from the supporting plate **10** by elongated threaded members **22** which are secured to the supporting plate by lock nuts **23**. Also, suitable lock nuts **24** are provided at opposite sides of the brackets **21** whereby the driving assembly, including the transverse rollers **19**, are held at selected positions relative to the supporting plate **10** for a purpose to be described hereinafter. To further secure the drive assembly **12** in a predetermined set position, I provide threaded members **26** which pass through suitable threaded openings adjacent the ends of the brackets **21**, as shown in FIG. 2. Suitable lock nuts **27** secure the threaded member at selected positions and wing nuts **28** are provided on the threaded members **26** for actuating the same whereby quick adjustments may be made.

Bearing members 29 are mounted on the transverse bracket 14, as shown in FIG. 3, for receiving a drive shaft 31 which carries sprockets 32 that engage and drive the endless chains 17. A drive sprocket 33 is mounted on the shaft 31 in position to receive and be driven by a sprocket chain 34 which in turn passes around a sprocket 36, as shown in FIG. 2. The sprocket 36 is mounted on a shaft 37 which is operatively connected to a drive motor 38. Preferably the motor is in the form of a D.C. motor whereby the speed of rotation and the direction of rotation may be readily varied by merely adjusting a suitable rheostat indicated generally at 39.

Mounted on the supporting plate 10 at one side of the opening 11 is a bracket 40. Preferably, the bracket 40 is secured in the place by the bolts 22 which support the drive assembly 12, as shown in FIG. 3. Pivotally connected to the bracket 40 by suitable pivot pins 41 is a platen 42 having a transparent portion 43 which is in alignment with the opening 11 in the supporting plate 10. The platen 42 is adjustably and removably connected to hinge members 44 by suitable screws 46 whereby the platen may be removed or installed quickly and the position of the platen 42 may be adjusted and then locked in a set position by the screws 46. By use of a removable platen a collection of specific sizes required for a particular chemical analysis could readily be affixed. Also, the removable platens could be color coded to facilitate changing from one chemical process to another. The transparent portion 43 is so shaped that it can be readily removed from the platen 42, thereby eliminating the necessity of removing the entire platen 42.

Mounted at the opposite side of the opening 11 from the bracket 40 is a bracket 47 which is also secured in place by the bolts 22, as shown in FIG. 3. Pivotally connected to the ends of the bracket 47 by suitable pivot pins 48 is an elongated latch member 49 having depending flanges 51 and 52. The depending flange 51 is spaced from the bracket 47 to define an elongated recess therebetween, as shown in FIG. 3. A compression spring 53 is interposed between the inner surface of the latch member 49 and the bracket 47, as shown in FIG. 3, whereby the latch member 49 is urged toward locked position. That is, the depending flange 51 is urged in a direction to engage the adjacent edge of the platen 42 to thus retain the platen in locked position. Since the platen 42 engages the bracket 47, the platen 42 is held in a predetermined fixed position relative to the support member 10 while it is in locked position. An inwardly projecting detent 54 is carried by the latch member 49 in position to engage the undersurface of the platen 42 to urge the free side thereof away from the supporting plate 10 upon depressing the latch member 49. As shown in FIG. 1, the latch member 49 extends substantially the full length of the platen 42 whereby a uniform pressure is exerted thereagainst throughout its length.

Mounted on the support plate 10 at one side of the opening 11 and the platen 42 by suitable retaining screws 56 is a tube-retaining bracket 57 having an upstanding flange with outwardly opening recesses 58 therein for receiving resilient tubes 59 which are formed of a suitable flexible material, such as polyvinyl or the like. Suitable stop members 61 are secured to the tubes 59 whereby they limit axial movement of the tubes 59 relative to the bracket 57. That is to say, the outwardly opening slots 58 are of a size to receive the tubes 59 with a sliding fit but engage the stop members 61 whereby movement of the tubes 59 inwardly toward the platen 42 is limited.

Mounted at the opposite side of the opening 11 and platen 42 is a tube-retaining bracket 62 having an upstanding flange with outwardly opening recesses 63 therein for receiving the tubes 59. Also, stop members 64 are secured to the tubes 59 in position to engage the upstanding flange of the bracket 62 whereby axial movement of the tubes relative to the bracket is limited. As shown in

FIG. 1, the tube-retaining bracket 62 is provided with elongated slots 66 therein which extend generally parallel to the tubes 59 in position to receive the shank portion of retaining screws 67. Laterally disposed slots 68 communicate with the elongated slots 66, as shown, whereby the tube-retaining bracket 62 may be shifted to various positions whereby the shanks of the retaining screws 67 enter selected pairs of the laterally disposed slots 68 to thereby retain the bracket 62 in selected positions relative to the opening 11 and the platen 42. The heads of the retaining screws 67 prevent the bracket 62 from becoming separated from the supporting plate 10 as the bracket is moved relative to the screws 67. It will thus be seen that in order to vary the tension applied to the tubes 59, the operator merely moves the bracket 62 to selected positions whereby the shanks of the retaining screws 67 engage selected laterally disposed slots 68 to thus retain the bracket 62 in selected positions and thus apply any desired tension to the tubes 59. Preferably, the undersurface of the platen 42 which engages the tubes is provided with beveled end portions 50.

Preferably, the rollers 19 are of a length to compress twelve tubes 59 simultaneously. In actual practice, I find that a 1/50 hp. motor is satisfactory in every respect with systems for continuous monitoring in cardiovascular surgery. However, smaller or larger pumps can be designed wherein the power of the motor is adjusted according to the force required to compress the tubing and move the fluid.

In FIG. 5 of the drawing, I show a slightly modified form of my invention in which the transparent portion 43 of the platen 42 is provided with longitudinally extending milled portions 69, whereby the platen is adapted to receive tubes of various diameters. That is, by providing a longitudinally extending milled section 69 a tubing having a relatively great wall thickness, with either a small or large diameter, may be employed. Platens without milled sections are used for tubes having a wide range of diameters but having identical, or nearly identical, total wall thickness.

In FIG. 6 of the drawing I show the transparent portion 43 of the platen as having longitudinal grooves 71 of uniform depth but variable in width to receive tubes having the same wall thickness and the same or variable internal diameter. Such grooves prevent lateral displacement which displacement tends to reduce the accuracy of the pumping of fluid where high accuracy is desired. The grooves 71 also serve as an additional safeguard against overcompression of soft or friable tubing, such as that made from silicone rubber. That is, the grooves 71 are of a depth substantially equal the total wall thickness of a compressed tube.

From the foregoing description, the operation of my improved proportioning pump will be readily understood. The platen 42 is released by merely pressing downwardly on the outer side of the latch member 49 whereby the spring 53 is depressed. The depending flange 51 thus permits release of the platen 42 and the inwardly projecting detent 54 urges the platen 42 upwardly whereby it may be pivoted about its pivot pins 41. The tubes 59 are then inserted in the outwardly opening slots 58 and 63, as shown in FIG. 1, whereby they extend transversely of the rollers 19. The proper tension is applied to the tubes 59 by adjusting the bracket 62 relative to the supporting plate 10 whereby the shanks of the retaining screws 67 enter selected pairs of the laterally disposed slots 68. It will be apparent that any selected number of tubes 59 may be employed by merely inserting the same in the outwardly opening slots 58 and 63 as just described.

With the tubes 59 held in position by the retaining brackets 57 and 62 whereby they extend perpendicular to the rollers 19, the platen 42 is pivoted downwardly whereby it moves to latched position, shown in FIG. 3. That is, the depending flange 51 engages the adjacent

edge of the platen 42 to thus lock the same in place until the latch member 49 is released by depressing the same.

Upon energizing the motor 38, the endless chains 17 rotate about the sprockets 32 and the guide plates 13 whereby the section 18 thereof moves in parallel relation to the adjacent surface of the platen 42. The threaded members 22 and 26 are adjusted whereby the drive assembly 12 is held at a fixed predetermined position relative to the supporting plate 10. Accordingly, the rollers 19 are positioned at a fixed, predetermined position relative to the platen 42 whereby the tubing 59 is compressed accurately to its wall thickness and no further. By providing a transparent portion 43 for the platen 42, the tubing can be seen at all times while it is being compressed. Accordingly, the flow of fluid through all of the tubes can be viewed at all times, thereby making it possible to detect any malfunctioning of the apparatus instantaneously and wtihout having to disrupt the operation of the pump.

To replace a tube or disassemble the apparatus, it is only necessary to press the latch member 49 whereupon the entire platen 42 is free to pivot outwardly to free all of the tubes 59. The tubes 59 may then be quickly released by merely sliding the bracket 62 in a direction to cause the retaining screws 67 to enter the elongated slots 66 whereupon the tubes are released.

From the foregoing, it will be seen that I have devised an improved fluid pump which is particularly adapted for use with systems for continuous monitoring in cardiovascular surgery and the like. By providing a pump wherein the entire drive assembly is positioned on the opposite side of the tubes conveying the fluid from the operator, all moving parts are concealed and at the same time the tubes are in clear view and accessible to the operator. Accordingly, the driving mechanism for the pump does not have to be mounted for pivotal movement away from the tubes. Also, by providing a transparent platen which is adapted for movement toward and away from the tubes with a minimum of effort, the tubes are in clear view of the operator at all times during the operation of the apparatus and at the same time the platen may be quickly removed by merely depressing a single latch member. Also, by providing adjustable means for varying the tension applied to the tubes with a minimum of time and effort, the tubes may be assembled or disassembled in a minimum of time, thereby facilitating operation of the apparatus. Furthermore, by providing means for adjusting the position of the driving assembly 12 relative to the supporting plate 10, the position of the rollers 19 relative to the platen may be varied quickly and without having to interrupt the driving mechanism. By thus holding the platen and the rollers at a predetermined fixed position relative to each other at all times while the apparatus is in operation, the pulsations in the stream as the rollers 19 lift from the tubing 59 is reduced to a minimum, thus preventing regurgitant pulsating flow of fluids.

While I have shown my invention in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are specifically set forth in the appended claims.

What I claim is:

1. A fluid pump comprising:
(a) a supporting plate having an opening therethrough,
(b) an endless drive assembly having a section thereof extending inwardly of said opening,
(c) rollers carried by said endless drive assembly in spaced relation to each other and extending transversely of said opening,

(d) at least one tube extending across said opening and transversely of said rollers in position to be contacted by said rollers,
(e) means engaging said tube at opposite ends of said opening to limit longitudinal movement of said tube,
(f) a platen mounted alongside said section of the endless drive assembly in position to engage the opposite side of said tube from the side thereof engaged by said rollers and adapted for movement toward and away from said rollers to engage and disengage said tube, and
(g) means to hold said platen in selected positions relative to said rollers to exert a predetermined pressure against said tube while in one position and to release said tube while in another position.

2. A fluid pump as defined in claim 1 in which the endless drive assembly is supported from said supporting plate by elongated threaded members whereby the position of said endless drive assembly relative to said supporting plate is adjustable.

3. A fluid pump comprising:
(a) at least one endless drive member.
(b) rollers carried by said endless drive member in spaced relation to each other and extending transversely of said endless drive member,
(c) means to hold at least one resilient tube in position to extend transversely of said rollers and be contacted by the rollers carried by a section of said endless drive member upon movement thereof relative to said tube,
(d) a platen mounted alongside said section of the endless drive member in position to engage the opposite side of said tube from the side thereof engaged by said rollers and adapted for movement toward and away from said rollers to engage and disengage said tube,
(e) means pivotally mounting one side of said platen at one side of said section of the endless drive member, and
(f) a latch member pivotally mounted at the other side of said section of endless drive member and extending substantially the length of said other side of said platen, said latch member being provided with an elongated recess to receive said other side of the platen to hold said platen in selected positions relative to said rollers to exert a predetermined pressure against said tube while in one position and to release said tube while in another position.

4. A fluid pump as defined in claim 3 in which spring means is provided to urge the latch member into locking relationship with said other side of the platen.

5. A fluid pump as defined in claim 3 in which the endless drive member comprises:
(a) a pair of endless chain-like members connected to opposite ends of said rollers,
(b) plate-like tracks in position to receive said chain-like members whereby said chain-like members ride on said plate-like tracks, and
(c) mans to adjust the position of said plate-like tracks relative to said platen to vary the compressive forces applied to the tubes.

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