

FIG. 2

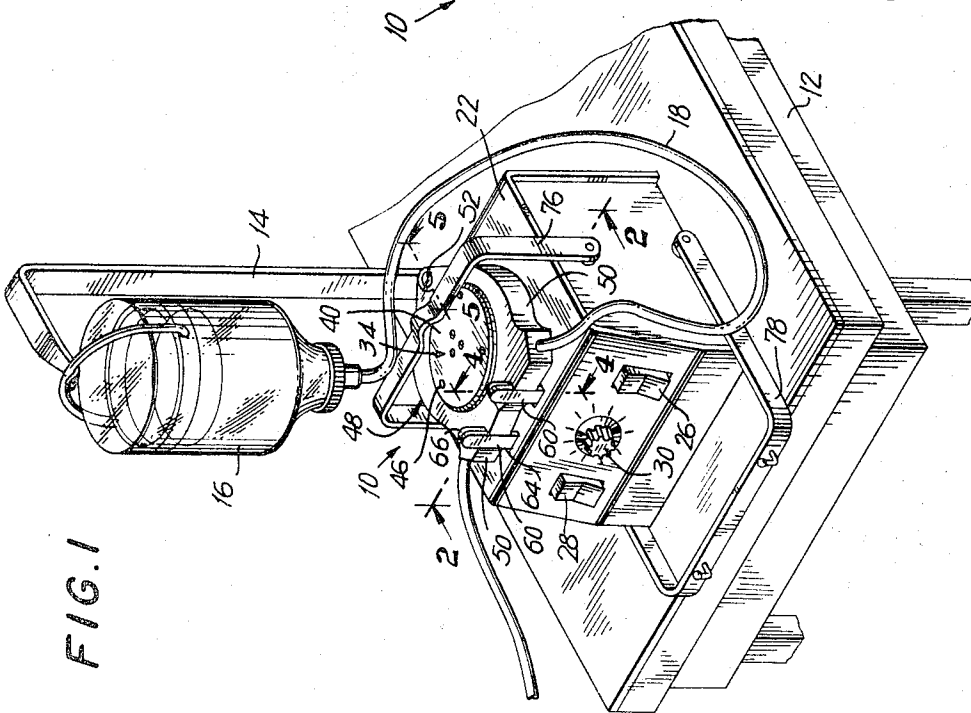
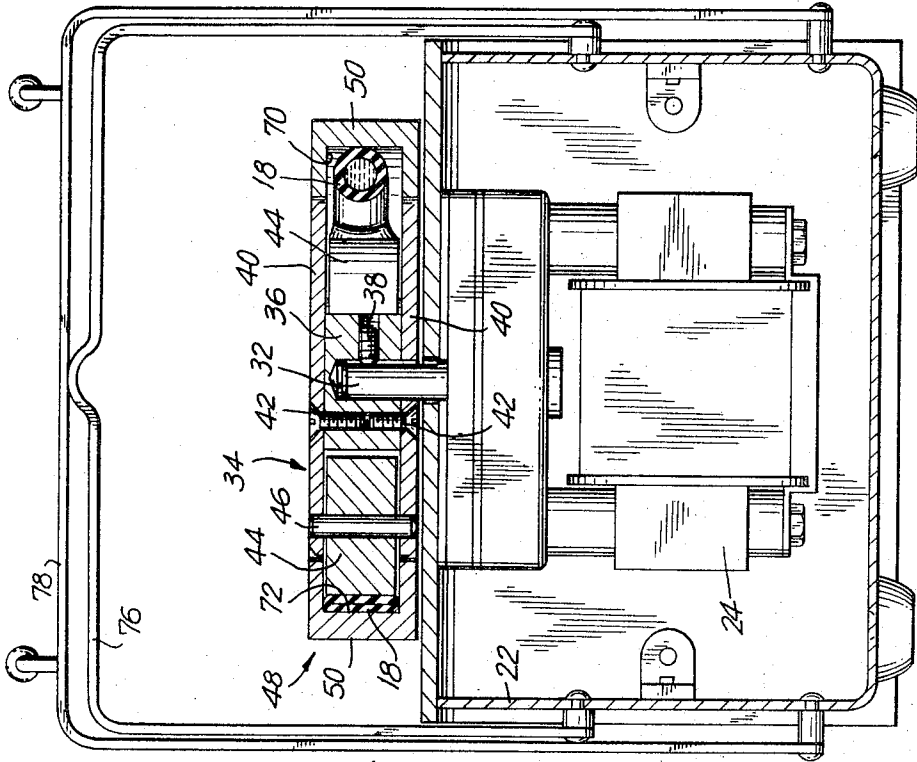
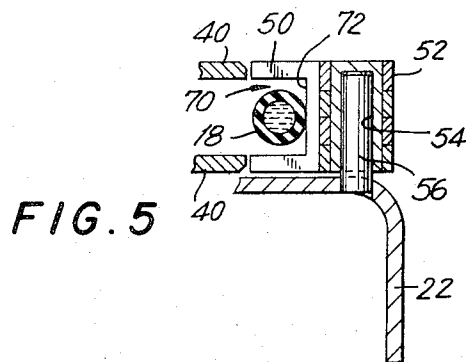
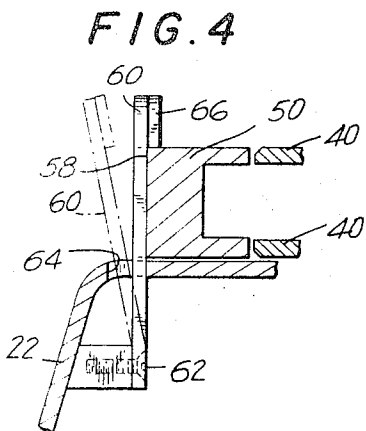
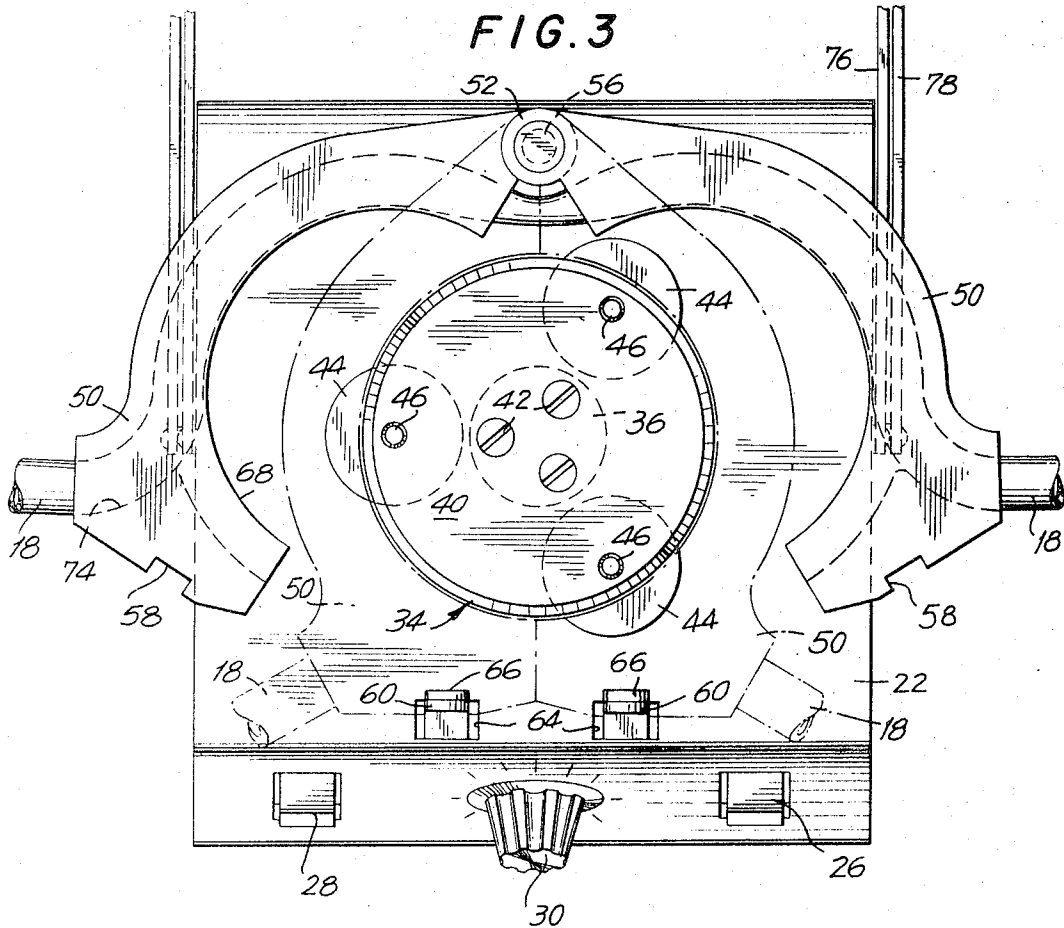


FIG. 1



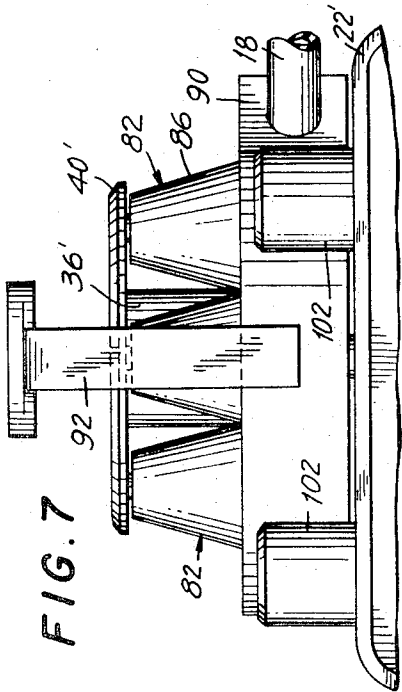


FIG. 7

FIG. 8

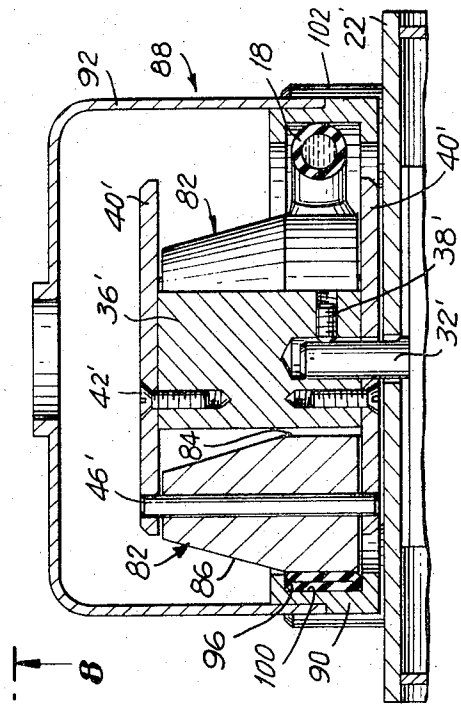


FIG. 6

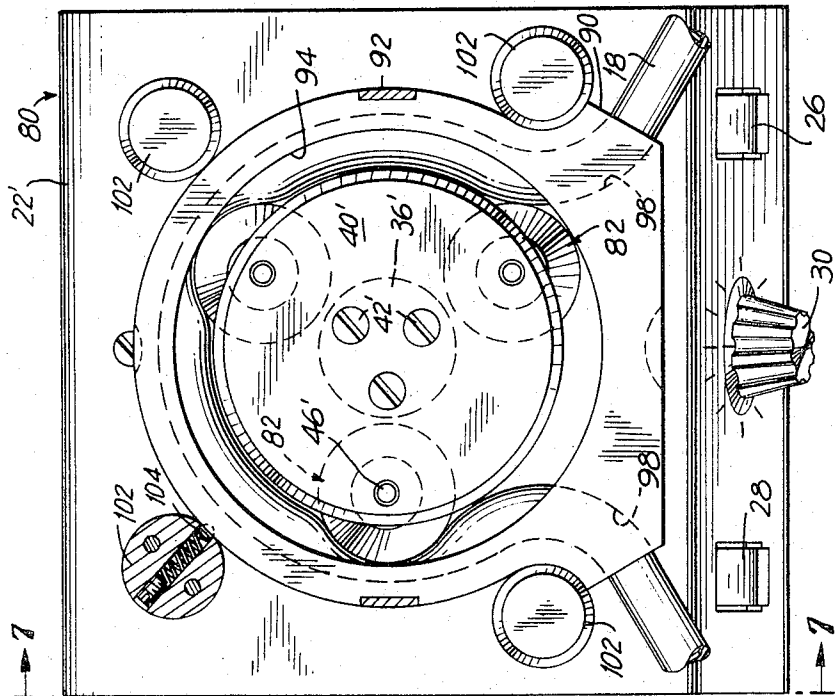
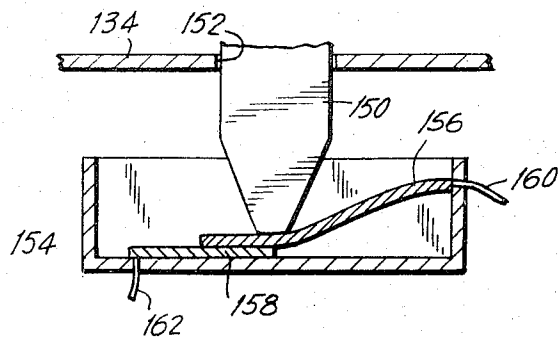
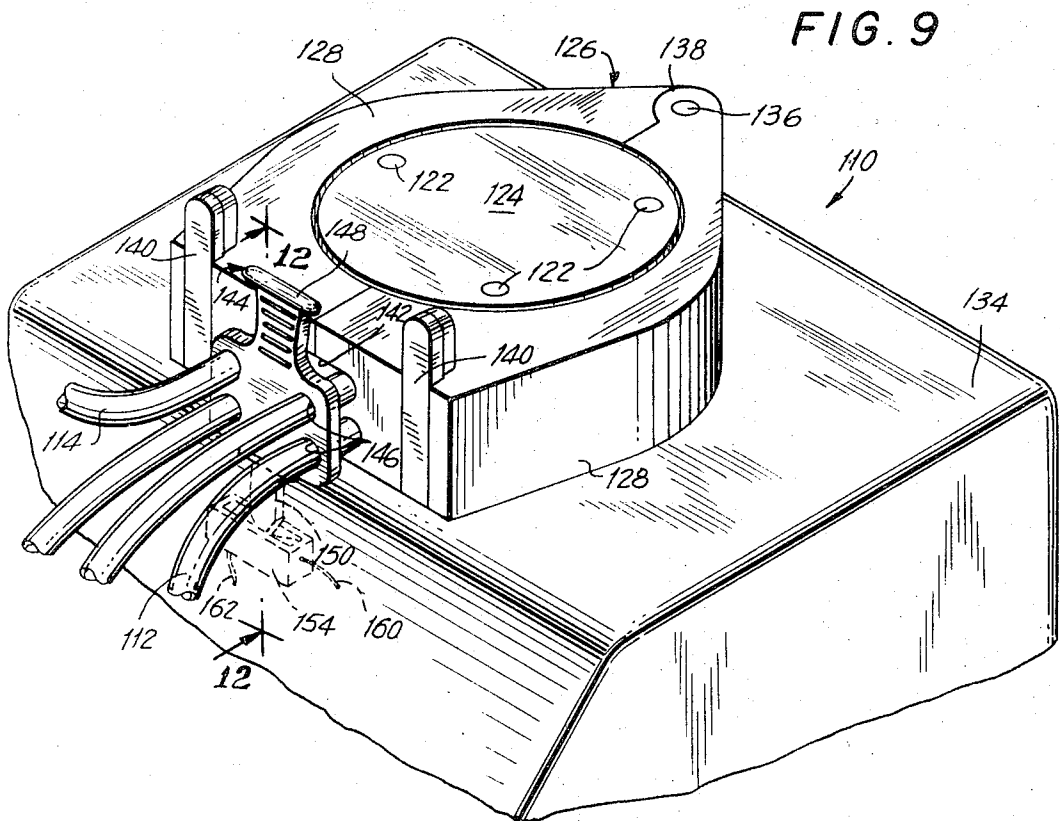


FIG. 8



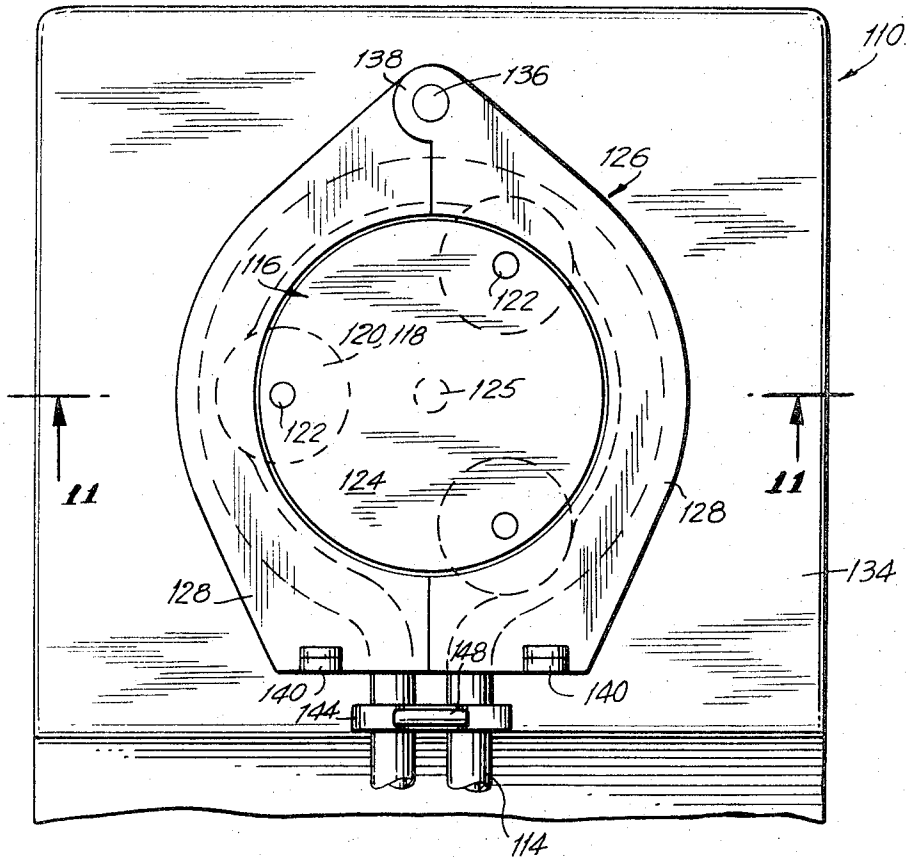


FIG. 10

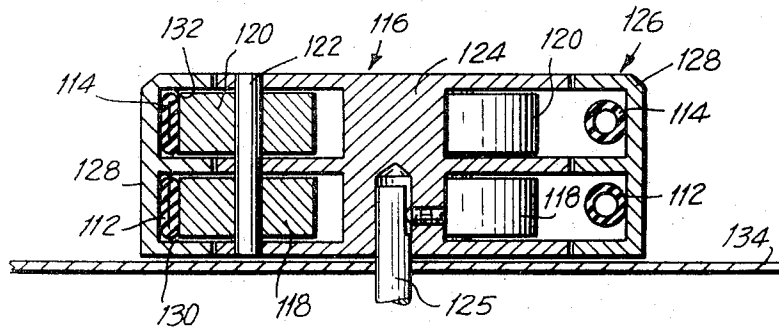


FIG. 11

MEDICAL CASSETTE PUMP

This is a division of application Ser. No. 174,019, filed Aug. 23, 1971, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to medical pumps of the type utilized for the delivery of fluids to and from patients. Examples of such applications would be procedures wherein cavities of the body are to be washed out, such as the stomach, bladder, etc., or where fluids are to be pumped from the body. Other examples in which fluid pumps are utilized in medical applications include infusion, dialysis, hemoperfusion, constant irrigation and the suction method of abortion. In such operations, it is important that the user of the pump not be exposed to the fluid to be pumped, both to maintain the sterility of fluid delivered to the patient, and to avoid contamination of or by fluid taken from the patient. The known medical pumps have required threading of the fluid transmission tube through intricate paths in the pump and have otherwise caused breaches in sterile procedures and contamination. Further, the prior art pumps required clean-up and sterilization between uses, due to the exposure of critical parts of the pump to the fluid being processed.

By providing a medical pump with a cassette for engaging a fluid transmission tube to the operative elements of the pump, the foregoing disadvantages have been avoided.

SUMMARY OF THE INVENTION

Generally speaking, in accordance with the invention, the medical cassette pump according to the invention includes a drive means, a fluid drive assembly operatively coupled to said drive means for rotation thereby about a principal axis, said fluid drive assembly including a plurality of planetary rollers freely rotatably mounted in spaced relation to said principal axis and to each other; a fluid carrying tube; and a displaceable cassette means for releasably engaging said fluid carrying tube against said planetary rollers for the displacement of the fluid therealong.

Said cassette means may consist of a pair of cassette half members hingedly joined at one end for relative pivotal displacement. Said cassette half members, when engaged together, being formed with a central opening dimensioned to receive said fluid drive assembly, at least a portion of the inner peripheral wall of said cassette defining said opening being formed with an axially facing channel for receiving said fluid carrying tube with portions of said fluid carrying tube extending laterally from said channel for engagement by said planetary rollers. The medical cassette pump may be formed with a frame means, and said cassette means may be releasably mounted on said frame means for simultaneous removal of said cassette means and fluid carrying tube.

Each of said cassette half members may be formed with a bore therethrough in the end thereof opposite the hinged connection therebetween, each of said bores communicating with said inner peripheral channel for the threading of said fluid carrying tube therethrough. Said cassette means may be pivotably mounted on a shaft upstanding from said frame means, which shaft is adapted to retain said cassette means secured to said frame means. Spring members mounted

on said frame means may be provided for retaining said cassette means in the closed operative position thereof, and said cassette means may be provided with notches for engagement with said spring members for this purpose.

Tab means may be provided with a pair of apertures therethrough through which said fluid carrying tube may be threaded to define a loop for extending about said fluid drive assembly, said loop being engageable by said cassette means against said planetary roller means. Said tab means may be provided with a finger engaging switch means, said switch means being operatively coupled to said drive means to prevent the operation thereof unless said switch means is engaged by said tab means finger.

Two sets of said planetary rollers may be provided aligned in two planes spaced along said principal axis, a pair of fluid carrying tubes being provided, said cassette means being adapted to engage one of said fluid carrying tubes against one of said sets of rollers for the separate advancement of fluid in each of said fluid carrying tubes.

In an alternate embodiment of the medical cassette pump according to the invention, said planetary rollers consist of a cylindrical portion and a conical portion extending from one end of said cylindrical portion, said cassette means being displaceable relative to said planetary rollers along said principal axis, whereby said fluid carrying tube rides along said conical portion for positioning and gradual compression until engagement by said cylindrical portion, at which point said tube is positioned for pumping.

Accordingly, an object of the medical cassette pump according to the invention is to provide a pump which is adapted to provide efficient and controlled pumping of fluids.

Another object of the invention is to provide a medical cassette pump wherein the pump is isolated from the fluids being processed.

Still another object of the medical cassette pump according to the invention is to provide a pump wherein the fluid carrying tube containing the fluid to be pumped may be readily and rapidly changed, permitting the use of disposable collection and dispensing systems.

Still another object of the medical cassette pump according to the invention is to provide a medical cassette pump which may be utilized for the simultaneous suction and delivery of fluid in a coordinated manner.

Still other objects and advantages of the invention will in part be obvious and will in part be apparent from the specification and drawings.

The invention accordingly comprises the features of construction, combinations of elements, and arrangement of parts which will be exemplified in the constructions hereinafter set forth, and the scope of the invention will be indicated in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the invention, reference is had to the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of one embodiment of the medical cassette pump according to the invention;

FIGS. 2, 4 and 5 are sectional views taken respectively along lines 2 — 2, 4 — 4 and 5 — 5 of FIG. 1;

FIG. 3 is a top plan view of the medical cassette pump of FIG. 1, showing the cassette half members in the open position;

FIG. 6 is a partially sectioned top plan view of a second embodiment of the medical cassette pump according to the invention;

FIG. 7 is a fragmented side elevational view of the medical cassette pump of FIG. 6;

FIG. 8 is a sectional view taken along line 8—8 of FIG. 6;

FIG. 9 is a fragmented perspective view of a third embodiment of the medical cassette pump according to the invention;

FIG. 10 is a top plan view of the embodiment of the medical cassette pump of FIG. 9;

FIG. 11 is a sectional view taken along lines 11 — 11 of FIG. 10; and

FIG. 12 is a sectional view taken along lines 12 — 12 of FIG. 9.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIGS. 1 — 5, the medical cassette pump 10 depicted therein is shown resting on a table 12 which also has a stand 14 mounted thereon. Hanging from stand 14 is a fluid dispensing bottle 16 to which is coupled a fluid carrying tube 18. The fluid in bottle 16 is to be pumped by pump 10 through fluid carrying tube 18 to a patient or for other purposes, the end 20 of the fluid carrying tube 18 being shown as broken, it being understood that said end would be secured to a catheter or other delivery device. The fluid carrying tube 18 could equally be connected to a collection receptical, in which case the pump according to the invention would be adapted to suction fluid from a patient or other source and deliver it to the disposal receptical.

The medical cassette pump 10 consists of a housing 22 within which is mounted a drive motor 24 best shown in FIG. 2. An on-off switch 26, and a reversing switch 28 are mounted on the exterior of housing 22 and would be operatively coupled to drive motor 24 for the purposes of turning said drive motor on and off, and for controlling the direction of rotation thereof. Knob 30, also mounted on housing 22 is provided for the purpose of controlling the speed of said drive motor and would function in a conventional manner. Provision can be made for timing and sequence controls permitting the automatic operation of the pump for periods of predetermined duration spaced by periods of predetermined duration during which the pump is at rest. The drive motor is preferably substantially noiseless, and arc-less, to permit use in an oxygen environment.

The rotative drive from drive motor 24 is transmitted to a drive shaft 32 which defines the principal axis of a fluid drive assembly 34. As best shown in FIG. 2, said fluid drive assembly consists of a central hub 36 secured to drive shaft 32 by a set screw 38. A pair of spaced plates 40 are mounted on hub 36 by screws 42 for the rotation of said plates with said drive shaft. Three planetary rollers 44 are freely rotatably mounted on plates 40 by roller shafts 46. As best shown in FIG. 3, the three rollers are circumferentially spaced about plates 40, and are equally spaced from drive shaft 38.

The three rollers are carried about the principal axis defined by drive shaft 32 in response to the rotation thereof. A cassette 48 is provided consisting of a pair of cassette half members 50. Said pair of cassette half members are joined at one end by a hinge 52 best shown in FIG. 5. Said hinge is provided with an axial aperture 54 therethrough for engaging a post 56 which projects upwardly from housing 22. Post 56 serves as an axis for the relative pivotal displacement of the two cassette half members 50, as well as serving to retain the cassette in position on the housing. Where the motor is to be of the unidirection type, aperture 54 could be closed at one end by a wall to prevent accidental reversal of the direction of fluid flow. As shown in FIG. 3, the two cassette half members may be pivoted relative to each other to open same, and may be lifted off post 56 for removal from the housing. The other end of each of said cassette half members is provided with a notch 58 which cooperates with a spring finger 60 as best shown in FIG. 4. Each of said spring fingers is mounted at one end to housing 22 by a screw 62 and extends through an aperture 64 in said housing, said aperture permitting the displacement of said spring finger to the position shown in phantom in FIG. 4 to permit the displacement of the associated cassette half member 50. A pad 66 at the end of spring fingers 60 engages the top surface of cassette half members 50 to prevent the upward displacement of said cassette half members. Each cassette half member is formed with a substantially semicircular inner periphery 68 dimensioned to extend about and receive plates 40. At least a portion of said inner periphery 68 of each of said cassette half members is formed with a channel 70. As best shown in FIG. 2, rollers 44 are dimensioned to extend into slots 70 to engage fluid carrying tube 18 against the inner wall 72 of said channel, as shown in the left portion of FIG. 2. Channel 70 is dimensioned to loosely receive fluid carrying tube 18, and to permit the flattening thereof against inner wall 72. Each of the cassette half members is provided with a curved bore 74 communicating with channel 70, as best shown in FIG. 3. Fluid carrying tube 18 is threaded through said bores and received within channel 70. The cassette is then mounted on post 56 while in the open position as shown in FIG. 3, and then, the two cassette half members 50 are brought together into the position shown in phantom lines in FIG. 3. When so positioned, each of the three rollers 44 engages a portion of the fluid conducting tube against the inner wall 72 of channel 70 to effectively close said tube. When two of the rollers thus engage the fluid carrying tube, a compartment of fluid is defined therebetween, which compartment of fluid is advanced along the tube as the fluid drive assembly 34 is rotated. Each compartment of fluid is sequentially delivered to the outlet portion of the fluid carrying tube located in one of the bore 74, while new compartments of fluid are continuously formed by adjacent pairs of rollers, transported along the section of the fluid carrying tube in the path of the rollers, and delivered to said outlet portion. In this manner, a smooth and continuous flow in either direction is produced without any of the moving parts of the pump being in contact with the fluid being transmitted.

If desired, cassette 48 may be disposable, and furnished as a unit with a disposable fluid carrying tube and either a dispensing or disposal system, which system can be sterilized as a unit, utilized as a unit and dis-

posed of as a unit. Even where the cassettes are not disposable, a plurality of cassettes 48 may be provided, each of said cassettes being threaded on a separate tube, so that upon completion of one operation, the pump may be immediately utilized for another operation by merely substituting a new cassette, which substitution is readily and rapidly achievable.

The pump is provided with a pair of handles 76 and 78 which permit the carrying of the pump, its mounting on a stand, or the self support thereof.

Turning now to FIGS. 6-8, a second embodiment 80 of the medical cassette pump according to the invention is shown. In this embodiment, drive shaft 32' has a hub 36' mounted thereon by set screw 38'. A pair of circular plates 40' are secured to said hub by screws 42'. In place of the cylindrical planetary rollers 44 of the embodiment of FIGS. 1-5, planetary rollers 82, which are freely rotatably mounted in circumferentially spaced relation on shafts 46', are formed with a cylindrical surface 84 and a conical surface 86. The cassette 88 consists of a unitary cassette member 90 and a handle member 92. Cassette member 90 is formed with an inner central opening 94, the inner periphery of which is defined by a relatively shallow channel 96. Central opening 94 in cassette member 90 is dimensioned to receive the cylindrical portion 84 of rollers 82.

Cassette member 90 is formed with a pair of curved bores 98 communicating with channel 96. Fluid carrying tube 18 is threaded to said bore and is received in the channel 96. Said channel is relatively shallow, so that portions of said fluid carrying tube 18 extend laterally out of said channel for engagement by the cylindrical portion 84 of rollers 82, as said rollers are rotated thereby. When so engaged, tube 18 is flattened and compressed between said rollers and the inner wall 100 of channel 96. The pumping operation of the embodiment of FIGS. 6-8 is thus identical to the pumping operation of the embodiment of FIGS. 1-5. Cassette 88 is mounted on housing 22' of pump 80 by means of four upstanding posts 102 which project from the top of said housing. Each of said posts is provided with a spring loaded detent 104 which engages a corresponding recess in cassette member 90 to releasably retain cassette member 88 in position. The cassette is mounted and removed by grasping handle 92 and displacing said cassette along the principal axis defined by drive shaft 32' toward or away from housing 22'. The conical surface 86 of rollers 82 permit the fluid carrying tube to ride therealong and to be gradually compressed and released, and also serves as a centering device for the positioning of the cassette.

In the alternative, rollers 82 may be substantially cylindrical but mounted for radial displacement relative to the principle axis of drive shaft 32'. In such an embodiment, the pancake shaped cassette member 90 would be positioned around the fluid drive assembly and the rollers would be displaced outwardly into the channel 96 to engage the fluid carrying tube against inner wall 100, and locked at this position. In still another embodiment, the fluid drive assembly would be formed integral with the pancake shaped cassette member 90, the combination being keyed to and removably mounted on drive shaft 32'.

As in the embodiment of FIGS. 1-5, cassette 88 may be a disposable element, and in any event, a plurality of such cassette may be utilized to permit the ready substitution of the various cassettes.

Referring now to FIGS. 9-12 of the drawings, a third embodiment 110 of the medical cassette pump according to the invention is depicted. Said third embodiment is similar in structure to the embodiment of FIGS. 1-5, but is particularly adapted for the simultaneous pumping of fluid in two separate fluid carrying tubes 112 and 114. As best shown in FIG. 11, the fluid drive assembly 116 is provided with two sets of three rollers 118 and 120, one roller of each set being mounted on a common shaft 122 for free rotation thereabout. Each of said common roller shafts 122 are secured to a hub member 124, which in turn is mounted on drive shaft 125 for rotation thereby. The hinged cassette 126 is provided with a pair of cassette half members 128, each of which is provided along a portion of the inner periphery thereof with a pair of channels 130 and 132 each of which is dimensioned to receive the corresponding pairs of rollers 118 and 120, and the respective fluid carrying tubes 112 and 114. Cassette 126 is mounted on housing 134 by means of a post 136 extending through hinge 138 joining the two cassette half portions, and by spring fingers 140.

Cassette 126 also differs from cassette 48 of the embodiment of FIGS. 1-5 in that the bores of cassette 48 are dispensed with, and replaced by open notches 142 which communicate with channels 130 and 132. This construction permits the insertion of the fluid carrying tubes without threading through the cassette, and further permits the permanent mounting of the cassette on the housing, by means of pin 136. In order to position and retain the fluid carrying tubes and to permit their easy insertion and removal from the pump 110, a tab member 144 is provided. Tab 144 is formed with four apertures 146 therethrough positioned in two aligned spaced pairs. Each of fluid carrying tubes 112 and 114 are threaded through one of the pairs of apertures 146 to define a loop in each of said tubes which extends respectively around rollers 118 and 120, so that when the two cassette half members 128 are brought together, said loops are respectively received within channels 130 and 132 and are engaged respectively by rollers 118 and 120. Tab 144 is provided with a handle portion 148 and is also adapted to serve a further safety switching function. For this purpose, tab 144 is provided with a projecting finger 150 as best shown in FIGS. 9 and 12. Said finger projects through an aperture 152 in housing 134 into a switch block 154. As shown in FIG. 12, finger 150 engages a displaceable switch member 156 against a fixed switch member 158 to close an enabling circuit, which when open, will not permit the motor to operate. Said switching circuit is connected by leads 160 and 162 to the drive motor of the pump. Displaceable contact 156 is in the form of a leaf spring, which will displace to the open position when finger 150 of tab member 144 is not present. This structure insures that the pump will only operate when the fluid carrying tubes are properly positioned. It is noted that a tab arrangement such as tab 144 may also be incorporated in a medical cassette pump according to the invention incorporating only a single fluid carrying tube, if desired. The two-tube embodiment of FIGS. 9-12 permits the coordinate suction and delivery of fluids, and would be particularly useful in washing out cavities such as the stomach and the like, and in particular, in drug or poison cases where the stomach must be washed out rapidly. Further, the two sets of planetary rollers could be mounted on separate hubs joined by a clutch mecha-

nism so that the upper set of rollers can be selectively operatively coupled to the lower set and drive shaft. Such an embodiment would permit intermediate fluid delivery while maintaining continuous suction.

Various delivery and collection systems may be utilized with the medical cassette pump according to the invention, and various features of each of the embodiments may be incorporated in other of the embodiments. Thus, the fluid carrying tubes can include a single tube as shown above, or concentric tubes one within the other. Two, three or more tubes may be coordinately driven by embodiments of the pump according to the invention. Closed disposable delivery and collection systems may be provided with the fluid receptical, fluid carrying tube and fluid passage means such as a catheter all formed as a unit. The medical cassette pump according to the invention provides a flexible efficient and sanitary pumping system which may be utilized for a wide-range of medical and other functions.

It will thus be seen that the objects set forth above, and those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above constructions without departing from the spirit and scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in the limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter

of language, might be said to fall therebetween.

What is claimed is:

1. A medical cassette pump comprising drive means; a fluid drive assembly operatively coupled to said drive means for rotation thereby about a principal axis, said fluid drive assembly including at least two planetary rollers freely rotatably mounted in space relation to said principal axis and to each other, said planetary rollers being formed with a cylindrical portion and a conical portion extending from one end of said cylindrical portion; a fluid carrying tube; and displaceable cassette means for releasably engaging said fluid carrying tube against the cylindrical portion of at least one of said planetary rollers for the displacement of said fluid therealong, said cassette means being formed with a central opening therein dimensioned to receive said fluid drive assembly, a portion of the inner periphery of said central opening being defined by a channel facing said principal axis dimensioned to receive said fluid carrying tube with portions thereof extending laterally from said channel for the gradual riding on and compression of said fluid carrying tube by the conical portion of at least one of said planetary rollers as said cassette means is displaced along said principal axis until said channel is in registration with said cylindrical portion of said planetary rollers.

2. A medical cassette pump as recited in claim 1, wherein said cassette includes an annular body having said central opening and channel therein, said body being formed with a pair of spaced bores therethrough providing communication to said channel and dimensioned to receive said fluid carrying tube.

* * * * *

35

40

45

50

55

60

65