

[54] WOUND DRAINAGE EQUIPMENT

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417/477, 306; 128/276, 214, 278, 230

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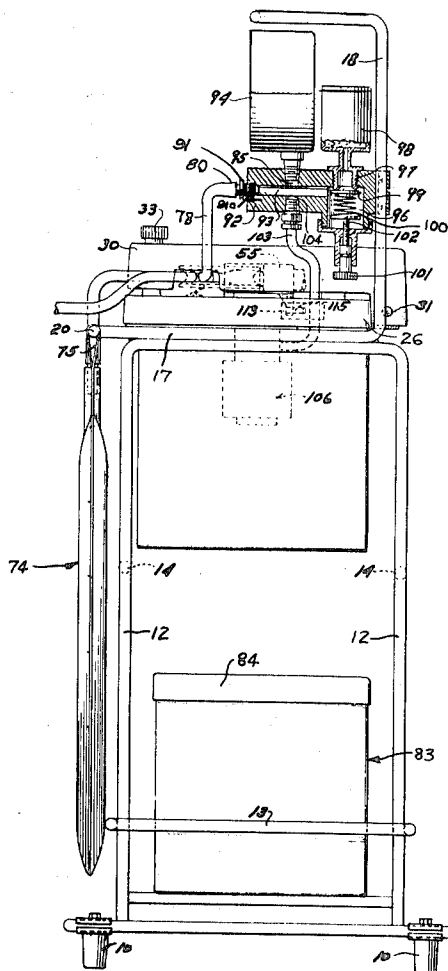
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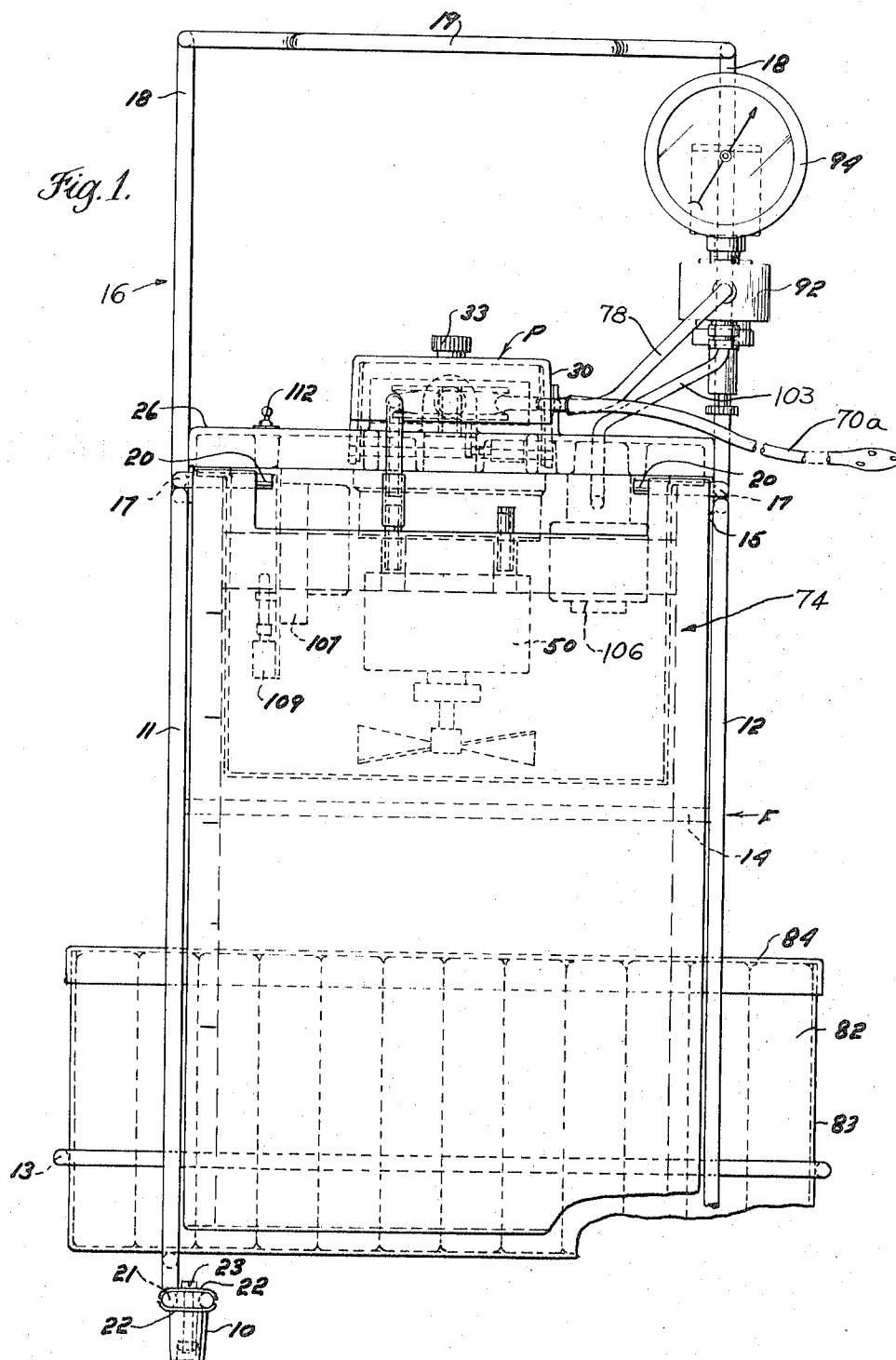
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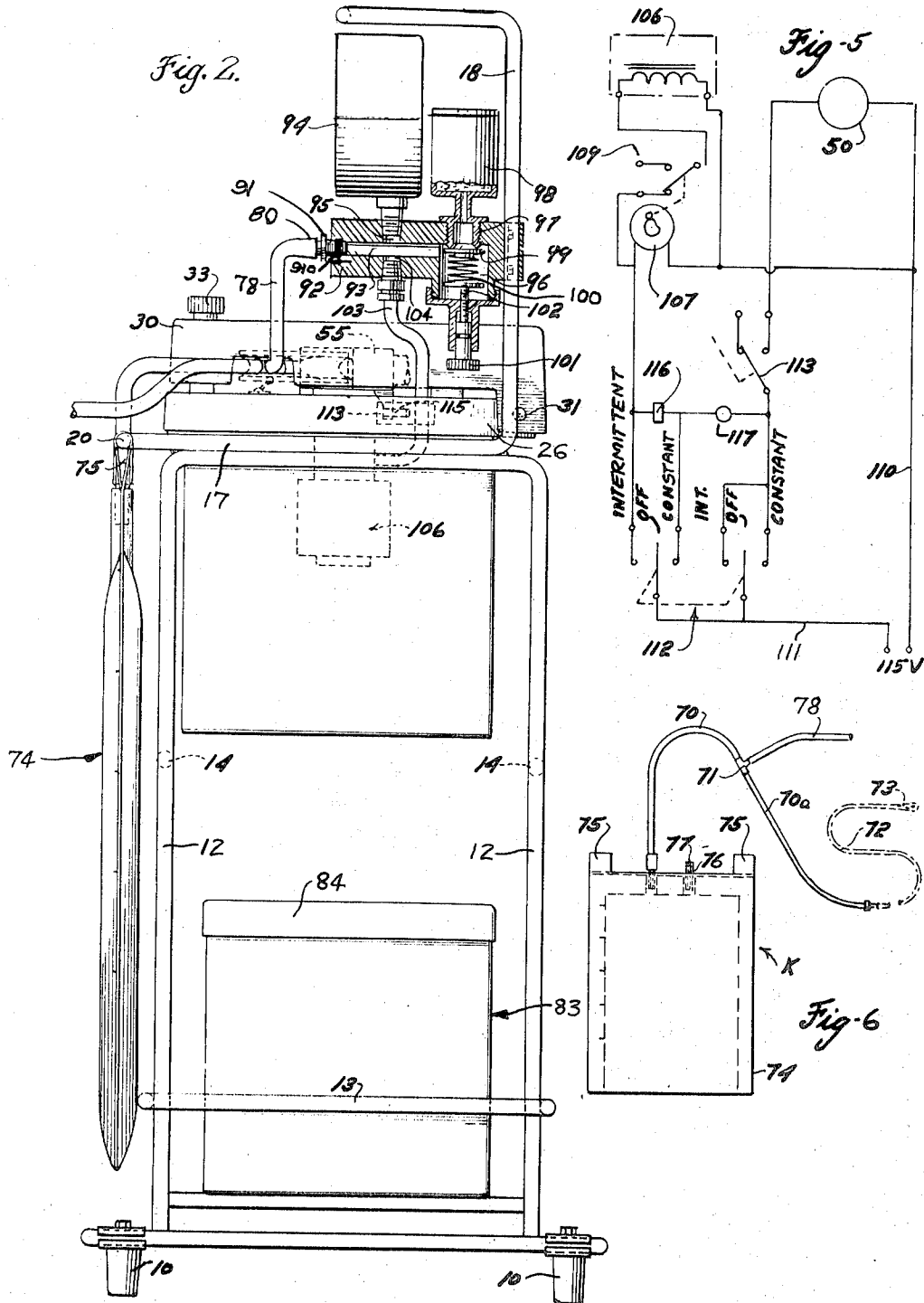
ABSTRACT

Pump provides for disposable drainage of body fluids by means of peristaltic action. Separate drainage kit comprises bag for collection of fluids. Tube leading from bag to catheter has a collapsible wall section having sufficient resilience so that periodic collapsing by rotatable pump element creates sufficient negative pressure within the tube to pump fluids to the bag. Slot loading and unloading of the tube is provided.

6 Claims, 6 Drawing Figures







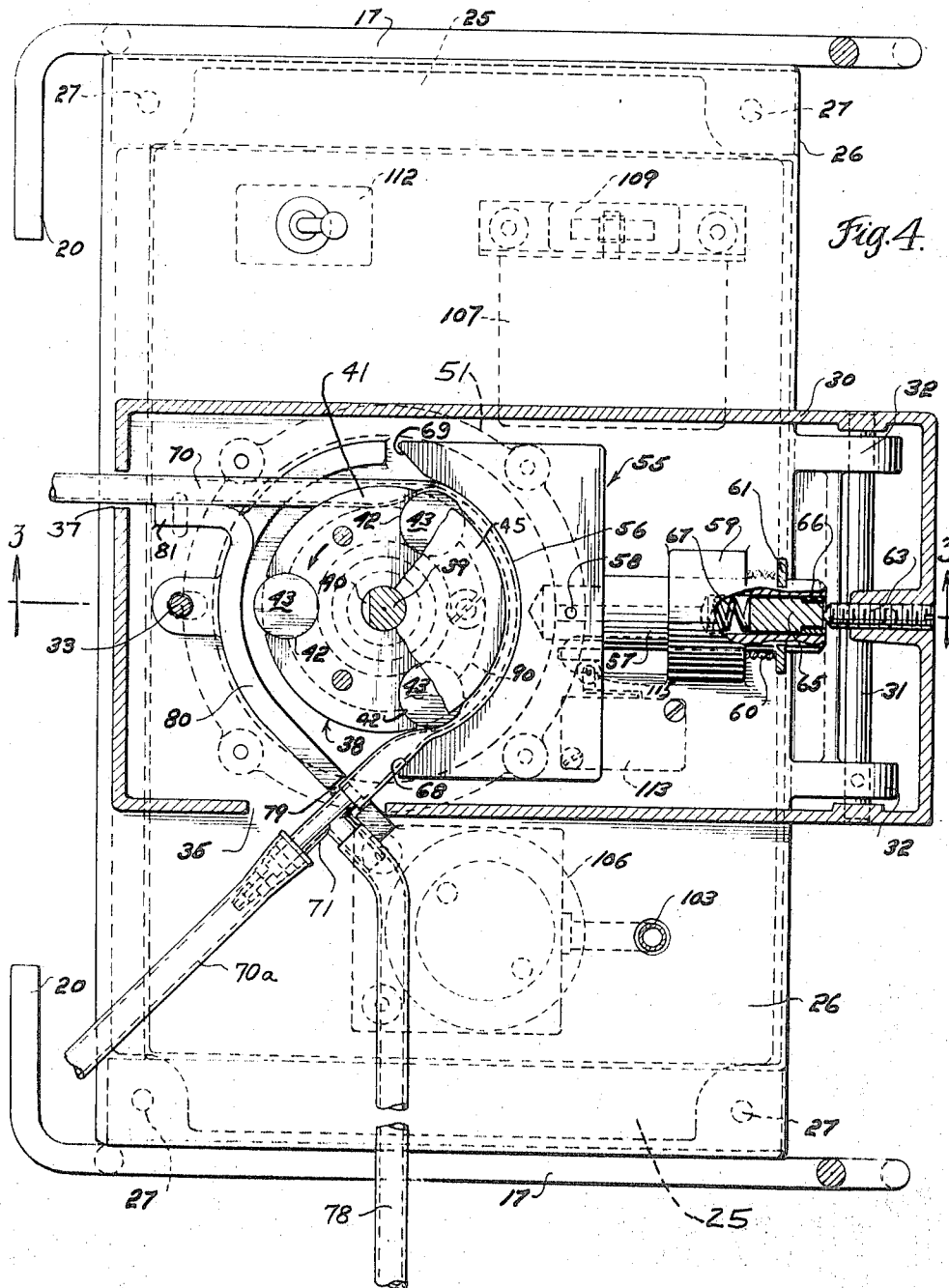
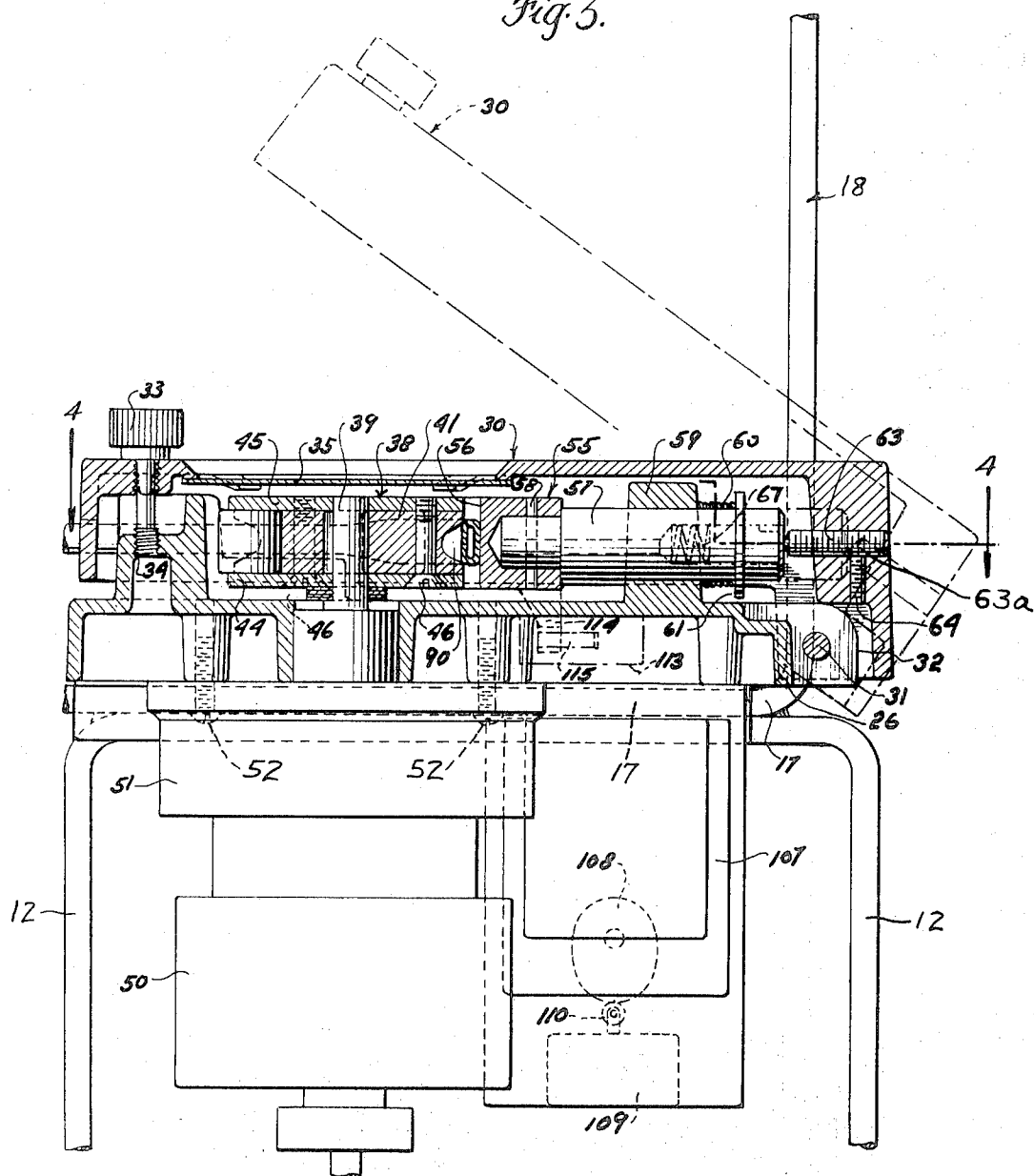


Fig. 3.



WOUND DRAINAGE EQUIPMENT

The present application is a division of application Ser. No. 850,440 filed Aug. 15, 1969 and now U.S. Pat. No. 3,675,653.

This invention relates to low suction drainage equipment useful in the medical field and is particularly directed to the provision of equipment for draining wounds or the like.

The prevention of the spread of infection to and from incisions following operations or injury requires the utmost of care and attention on the part of doctors and hospital personnel. It hardly needs to be stated that the rigorous procedures established by all modern hospitals to meet this problem are quite time consuming and keep highly trained personnel from other tasks at which their skills might be more usefully employed. Moreover, even with the strictest standards of cleanliness and care, human errors do occur as evidenced by periodic outbreaks of staph infections in hospitals throughout the country.

An important object of the invention is the provision of equipment and techniques for alleviation of the aforementioned problems. Among the special advantages of the invention is the provision of equipment which makes it practical to isolate the collected fluids from equipment which is used for the treatment of other patients and from physical contact by hospital personnel. In carrying out this object of the invention, the portions of the equipment coming into contact with the body fluid are provided as a separate sanitized, sealed unit which is intended for use for only one patient after which this sealed unit may be disposed of. By the use of the invention, it can be seen that the substantial amount of time normally spent in cleaning and sterilizing equipment can be spent on other tasks and the problems of handling the fluids to be disposed of and the hazards of spillage are minimized.

Accordingly, it is a specific object of the invention to provide a drainage set including a tube for conducting fluid from a wound and a collection bag, the tube and collection bag being formed from a flexible, fluid-tight, translucent plastic material, and provided as a disposable unit. Another important object of the invention lies in the provision of an improved pump structure which pumps the fluid through the tube of the disposable unit by peristaltic action so that the fluid conveyed and collected is completely isolated from the pump operating parts.

Another important object of the invention lies in the construction and arrangement of the disposable unit and the pump parts so that the flexible tubing may be slot or sideways loaded and removed from the pump rapidly and easily. This arrangement permits rapid replacement of the disposable unit and insures absolute sterility of the pump parts and other portions of the equipment.

Still another important feature lies in the provision of means for controlling the suction in the tube upstream from the pump in a novel and simple manner and in the provision of means associated with the suction control means for periodically back flushing a catheter associated with the disposable unit, thereby minimizing any chance that it will become clogged during drainage.

The foregoing and various other objects, advantages and special features of the invention will be fully apparent upon reference to the following detailed descrip-

tion of an illustrative embodiment of the invention and from the accompanying drawings in which:

FIG. 1 is a front elevational view of a preferred form of apparatus for carrying out the invention;

FIG. 2 is a side elevational view taken from the right hand side of FIG. 1, with certain portions of the structure being shown in section;

FIG. 3 is an enlarged view with respect to FIGS. 1 and 2 showing portions of the structure in section, the section being taken along line 3—3 of FIG. 4;

FIG. 4 is a plan view of the apparatus shown in FIG. 3, on the same scale as that Figure, with portions of the structure shown in section as taken on the line 4—4 of FIG. 3;

FIG. 5 is a schematic view of a preferred form of control circuit used in the invention; and

FIG. 6 is a detailed view of the disposable unit or kit used with the apparatus shown in FIGS. 1 through 4.

In the illustrative embodiment of the invention, referring to FIG. 1, the equipment, in general, comprises a pump unit P which is mounted on a portable supporting frame F, a disposable waste collection kit K (FIG. 6) which comprises, in general, a vented collection bag and a tube having a collapsible wall portion, a fitting adapted for connection to a catheter, and a branch line providing for controlled venting of the tube to atmosphere. Briefly stated, and as will be fully explained hereinafter, the pump P is designed to periodically collapse a length of the tube wall thereby creating a slight suction on the upstream side of the pump and advancing the fluid therein to the collection bag.

As best seen in FIG. 1, the frame F typically includes cushioning feet 10. Pairs of upright wire frame members 11 and 12 are disposed in spaced apart parallel relationship and joined by transversely extending wire frame members 13, 14 and 15. An upper frame 16 rests on the frame members 11 and 12 and comprises a single wire member bent so that it has transversely extending members 17 which are welded to the transversely extending portions of the frames 11 and 12, upstanding portions 18, and a handle 19. Inwardly bent projections 20 extend from the transversely extending portions 17 for reasons which will be described presently. The feet 10 are clamped to transversely bent looped extensions 21 of the frame members 11 and 12 by means of clamping plates 22 and a bolt 23.

The pump unit P is secured to the frame by means of angular members 25, the top flanges being shown in FIG. 4. These are welded or otherwise secured to the transversely extending portions of the frame members 11 and 12. The pump is provided with a base member 26, best shown in FIGS. 2 and 4, which is positioned on the top flanges of the angular members 25 and secured in place by means of bolts 27.

Referring now to FIGS. 3 and 4, the pump unit P further includes a cover or lid 30 which is hinged on the base by means of a hinge pin 31 which is journaled in lugs 32 integral with the base 26. A thumb screw 33 is adapted to be threaded into a threaded opening 34 in the base for the purpose of securing the cover in the closed position as it is shown in full line position in FIG. 3. A window 35, shown in section in FIG. 3, is provided in the cover in a position overlying the pump operating parts so that these parts may be inspected when the cover is closed and the pump is operating. The cover is further provided with slots 36 and 37, best shown in

FIG. 4, whose purpose will be described more fully hereinafter.

The pump further comprises a pump element 38 which is preferably mounted for rotation on a drive shaft 39. The rotary pump element may be detachably mounted on the drive shaft and for driving purposes the shaft is flattened on one side as shown at 40.

The rotary pumping element may be best seen in FIGS. 3 and 4 and preferably comprises a central disc-like member 41 on the circumference of which are provided three ring-like, transversely extending grooves with the circumference 42; roller members 43 are journaled within these grooves with the circumference of each extending well beyond the circumferential limits of the central disc 41.

The pumping element further includes a pair of side or outer plates 44 and 45 which are secured to the central disc by means of machine screws 46. The plates 44 and 45 extend outwardly to about the limits of the central disc 41 thereby covering the ends of the grooves 42 so that the rollers are locked against sideways movement. Those plates are provided with central openings which register with the central opening in the disc 41 and each is preferably provided with a flattened surface which cooperates with the flattened surface of central shaft 39 thereby keying the pumping element for rotation by the shaft. Shaft 39 is driven by a gear motor 50 having a reduction gear drive unit 51 which positively drives the shaft 39.

Screws 52 secure the unit comprising the motor and gear unit to the underside of the base member 26.

A guide element 55 having a curved backing surface 56 is associated with the rotary pumping element, as is best shown in FIGS. 3 and 4.

As is shown in FIG. 4, the guide element backing surface preferably describes an arc of slightly more than 120° and includes a flared entrance portion 68 and a flared terminal portion 69. The guide element is mounted on a shank member 57 by means of a pin 58. Shank member 57 is in turn slidably mounted in a bearing member 59 formed integrally with the base member 26. A coil spring 60 fits over the shank between the bearing member 59 and shoulder or abutment washer 61. The spring 60 yieldingly urges the shank and hence the guide element 55 to the right as these parts are viewed in FIGS. 3 and 4.

A threaded abutment screw 63 is threaded to the cover 30 and locked in axial position by means of a set screw 64. As can be seen in FIG. 3, the end of the set screw 64 fits into a slot 63a in abutment screw 63, thus preventing axial movement of the screw 63 when the set screw 64 is so positioned.

Screw 63 presses against a plunger 65 which fits within an axially extending bore in shank 57. Plunger 65 is held in place by a retainer sleeve 66. A spring 67 urges the plunger against the sleeve. The significance of this aspect of the structure will be explained hereinafter.

With the structure thus arranged, movement of the lid or cover from the closed position shown in full lines in FIG. 3 to the open position shown in phantom lines, produces a corresponding movement of the guide element 55 from the full line position in FIG. 3 into a position in which the end of the shank is moved to the position shown in broken lines. In that position, the backing surface on the guide element is well away from the ro-

tary pump element for reasons which will appear presently.

Attention is now directed to FIGS. 2, 4 and 6, which illustrate various portions of disposable drainage unit or kit K. As briefly mentioned above, this kit shown in its entirety in FIG. 6, includes a receptacle for collection of fluids collected from the wound. The disposable drainage kit preferably comprises a tube 70 having at one end a fitting 71 which is provided for connecting the tube to a vacuum regulator tube 78 and also comprises drainage tube 70a on whose end is a fitting provided for connecting to a catheter 72, the catheter being adapted to be inserted into an incision or other wound and being provided with small holes 73 in the end portion thereof through which the fluids can flow.

The other end of the tube is connected to a collection bag 74 which is provided with suspension loops 75 also shown in FIG. 2, for the purpose of suspending the bag on the inwardly bent hooks 20. A port 76 vents the bag to atmosphere and is provided with a porous filter 77.

Preferably the unit just described, including bag 74, tube 70 and tube 78, is formed of a flexible vinyl or like plastic material and all joints, including the seams of the bag, the joint between the bag and the tube 70, and the joints at the T-fitting 71, are heat sealed to insure against any leakage.

An important feature of the tube 70 is that the wall section intermediate the bag and the T-shaped fitting 71, or at least a substantial length thereof, is collapsible, and that it has sufficient life or resilience so that following collapse it soon returns to its original shape.

The unit just described comprises a package which is sterilized during manufacture and wrapped in a sterile packaging material to form an airtight sterile package 82 (FIG. 1) available for use when required. A number of such packages may be stored with the unit in a container 83 having a lid 84 and supported at the bottom of the wire frame on transversely extending members interconnecting the frame members 11 and 12.

It should be noted that although the kit just described may include the catheter 72, because of individual preferences among physicians for different types of catheters, it is preferred that the kit not include this element. However, the fitting on the end of the tube 70a is adapted to receive all commercially available catheters.

As can be seen perhaps best in FIG. 4, the collapsible part of the tube is adapted to fit between the rotary pumping element 38 and the backing surface 56 of the guide element 55 with the backing surface holding the tube in interfitting relationship with the rotary pumping element.

In threading or loading the tube into the pump, it should be remembered that when the lid is in the raised position, the backing surface 56 will be positioned well away from the rotary pumping element 38. In this position, which may be termed the loading position, the tube can be freely slot or sideways loaded between the pumping element and the backing surface. In this position, it will be apparent from FIG. 4 that the T-shaped fitting 71 fits into a notch 79 in an upstanding rim 80 which is integral with the base member 26. The end of the tube leading to the collection bag bears against a

guide wall 81 integral with the rim 80 and when the lid 30 is closed, fits through the notch 37.

When the cover is closed, the guide element 55 is moved to the left, as viewed in FIG. 4, because the pivotal movement of the cover causes the screw 63 to push the plunger 65 and thus the shank 57 on which the guide element is mounted. In the closed position of the cover, the shank has been moved so that the guide element is in the operating position in which the backing surface 56 holds the tube in interengagement with the rotary pump element. The spring loaded plunger 65 in this arrangement provides a convenient and effective means of compensating for variations in tubing wall thickness, for wear of parts, and minor maladjustments.

Reverting to the construction of the rotary pump element, it should be noted that the central disc 41 is provided with a circumferentially extending groove 90. With the parts in operating position shown in FIGS. 3 and 4, the roller elements 43 collapse or squeeze the tube 70 against the backing surface 56 while the portion of the tube intermediate the rollers 43 is not collapsed.

Referring now to FIG. 2, means for limiting the negative pressure in tube 70 will now be described. This includes a male fitting 91 mounted in a housing 92 which is secured to the upstanding frame members 18. The end 80 of tube 78 fits onto fitting 91 which in turn has a bore which communicates with a passage 93 extending well into the housing 92. Fitting 91 is provided with a check valve 91a as can be seen in FIG. 2. Check valve 91a prevents flow from line 78 to passage 93 and thus insures that fluid which could be present in line 78 will not inadvertently contaminate parts of the housing.

A gauge 94 (FIGS. 1 and 2) is connected to a branch passage 95 which leads from the passage 93. Passage 93 is also in communication with a chamber 96 which is controllably vented to the atmosphere by means of a port 97 which may be covered by a filter housed in a filter housing 98. A valve member 99 is yieldably held in a position covering the port 97 by a spring 100. An adjusting knob 101 controls a threaded adjusting screw 102 for the purpose of regulating the tension on the spring and hence the pressure differential required to open the valve to prevent the build-up of excessive negative pressures in the chamber 96 and hence in the negative pressure control line 78 and in tube 70.

It has been found desirable to provide the pump with means for intermittently venting the line 70 to atmosphere. For this purpose, a second pressure control line 103 is connected to a passageway 104 which branches off of the passageway 93. Pressure control line 103 leads to a solenoid operated valve 106.

A timing motor 107, shown in broken lines in FIG. 1, drives a cam 108 (see FIG. 3) which controls a microswitch 109 via a switch actuating roller 110. Switch 109 is arranged for momentary operation during each revolution of the cam 108 and when it is operated it energizes the solenoid of a solenoid valve 106 which thereupon vents the end of the branch line 103 to atmosphere. Whenever line 103 is thus vented, passageway 93, line 78 and all of tubing 70 is in communication with the atmosphere.

Attention is now directed to FIG. 5 which illustrates a suitable circuit for operating the pump. Leads 110 and 111 are shown connected to a suitable source of power, for example a 115V a/c source. A three position

switch 112 is mounted on top of the unit as shown in FIG. 1. Switch 112 is preferably a double pole three position switch being movable away from the central or "OFF" position to a position labelled "intermittent" or to a position labelled "constant" in FIG. 5. As can be seen from FIG. 5, a switch 113 is provided in the circuit between the switch 112 and motor 50. Switch 113 is operated by a switch actuating member 114 which extends downwardly from the guide element 55. Switch 113 has an actuating arm 115 located in the path of actuating member 114 in such position that when the guide element is in the retracted position, the actuating member is away from the arm 115 and the switch is opened. When the guide element is moved to the left as viewed in FIGS. 3 and 4, the actuating member 114 is pressed against arm 115 resulting in movement of the switch to closed position. From the foregoing it can be seen that whenever the cover is opened, the circuit to motor 50 is broken, without regard to the position of switch 112.

As shown in FIG. 5, the timing motor 107 is connected to the source of power whenever the switch 112 is in the position labelled "intermittent." The timing motor periodically closes switch 109, the latter being in series with the solenoid of the solenoid valve 106. Whenever the timing motor energizes the switch 109, as occurs at predetermined intervals with the switch 112 in the "intermittent" position, the solenoid valve is opened and the line 103, passageway 93, tube 78 and thus tube 70 is vented to atmosphere for a period of time such as ten seconds. The time period between operations of the solenoid valve 106 may vary somewhat, a typical interval between operations being about one minute.

Preferably, the apparatus also includes signal lamps in order to indicate the mode of operation employed. In the preferred embodiment, as shown in FIG. 5, a flasher device 116, which includes a flashing lamp, is connected to the power supply whenever the switch 112 is moved to the "intermittent" position. In addition, a pilot light 117 is connected to the power source when switch 112 is in either the "constant" or "intermittent" position. Thus, attendants can readily determine when the apparatus is operating and, in addition, when it is functioning in the "intermittent" mode of control.

In order to operate the pump, it is placed at the bedside of a patient and a package containing a drainage kit is taken from the box 83. As noted above, when the lid 30 is in the raised position, the guide element 55 is moved away from the rotary pumping element, that is, the parts are in the loading position. In that position, the tube 70 is fitted between the rotary pumping element and the backing surface with the branch of T-shaped fitting 71 fitting into the notch 79 the tube 78 being fitted onto nipple 91. The collection bag is suspended on the hangers 20 and the tube connected to the catheter, which is in turn inserted in the body opening requiring drainage. The lid is thereafter closed and secured by thumb screw 33.

As the lid closes, the cover moves the guide element 55 into the position in which the backing surface 56 holds the collapsible wall portion of the tube in interengagement with the pumping element. At the same time, the switch actuating element 114 which depends from the guide element 55 presses against the microswitch actuator arm 115, closing the switch 113. When the

switch 112 is moved to either the "intermittent" or "constant" position, the motor 50 is energized. Motor 50 rotates the pump element 38 via the gear unit 51 and shaft 39. The rollers 43 travel relatively to the backing surface 56 along a path which is parallel to the surface and each progressively collapses the tube wall section against the backing surface. When the pump element is provided with three rollers, as illustrated, three such peristaltic contractions occur during each revolution and these operate to propel the contents of the tube towards the collection bag by creating a slight suction on the upstream side of the pump, that is to say, on the side which is connected to the catheter and hence which leads to the source of fluid being drained.

The suction in this portion of the tube and consequently the rate of drainage of the wound should not be too great. By way of example, a maximum suction of about 15 centimeters of mercury producing a maximum rate of fluid removal of about 200 cc. per minute may be provided.

In order to regulate the suction, regulating knob 101 is adjusted to allow the valve member 99 to vent the tube 70 to atmosphere whenever the negative pressure drops below a predetermined value. Venting of tube 70 takes place via the line 79 and the passage 93 which leads to the valve chamber 96 and from there to the port 97 through the filter 98 to atmosphere.

As noted above, a check valve is provided in fitting 91 in order to prevent the flow of body fluid into passage 93. As an additional precaution, tube 79 should be relatively long, in a typical case about 2 feet, so that flow of fluids as far as the check valve practically never occurs.

The intermittently operable vacuum relief means comprising the timing motor 107, microswitch 109 and the solenoid valve 106 is brought into the operation by closure of the manually operable switch 112. The significance of this feature of the invention will be apparent if it is considered that an incision or other wound may contain particles of matter large enough to occasionally clog one or more of the openings in the catheter 72. Whenever the vacuum relief valve 106 vents the line 79 to atmosphere, the suction in the tube and hence in the catheter is broken and the fluid therein tends to flow in a reverse direction outwardly through the openings 73. This back flushing will clear the openings and will occur periodically, say every minute whenever the switch 112 is closed.

To enhance this back flushing capability of the apparatus, it is preferred that the tube 70 or at least some portion thereof be positioned somewhat above the level of the incision, thereby developing an increased pressure head and consequently an increased rate of flow in the reverse direction whenever the suction relief valve is opened.

Whenever the drainage equipment is no longer required or when the attendant observes that the bag is becoming filled, the pump is stopped by opening the lid which immediately results in the switch 113 being opened and the guide element 55 moving relatively to the pumping element until the parts are in the loading or unloading position. The entire disposable unit, including bag, tube and branch line 78 is removed as a unit and disposed.

In summary, it will be apparent from the foregoing that the apparatus provides for convenience of han-

dling and disposal of fluids drained from wounds, eliminating the time consuming and costly clean-up job heretofore required. The pump is extremely easy to load and operate and insures complete isolation of the pump operating parts from the fluid being drained.

An important criterion for equipment of this general kind is met by the apparatus of the invention, that is, a reliably controlled, gentle suction action. Moreover, the capability provided by the apparatus for periodic venting of the suction side of the drainage tube eliminates clogging of the catheter openings, thereby substantially contributing to the reliability of the apparatus.

We claim:

1. A low suction pump for use with a disposable collection bag and tube for draining body fluids, wherein said tube is provided with a resilient and collapsible wall portion, said pump comprising a pumping element having at least two roller members, a guide element having a single unitary elongated backing surface describing an arc of not more than 180° for maintaining a single passage of the collapsible wall portion of the tube adjacent said pumping element, means mounting said pumping element for periodic relative movement of said roller members with respect to said backing surface in a path which extends lengthwise of the backing surface with the roller members progressively squeezing the collapsible wall against the backing surface, the guide element and the pumping element being relatively shiftable between a loading position in which clearance is provided between the backing surface and the pumping element to facilitate sideways loading and removal of the tube and an operating position in which the tube is maintained in interengagement with the pumping element, a cover movable between a closed position for covering the pumping element and the guide element and an open position yielding access to the pumping element and guide element, and means for relatively shifting the guide element and the pumping element to the loading position when the cover is in the open position and for relatively shifting the pumping element and the guide element to the operating position when the cover is in the closed position.

2. A low suction pump as in claim 1, wherein the means for relatively shifting the guide element and the pumping element to the loading position when the cover is in the open position and for relatively shifting the pumping element and the guide element to the operating position when the cover is in the closed position further comprises a spring bias means for biasing the guide element to the loading position when said cover is moved to the open position, and for biasing the guide element against the collapsible wall portion of the tube when the cover is moved to the closed position.

3. Apparatus according to claim 2, further comprising a branch-line connected to said tube at a point upstream from the pump and back flushing means for periodically venting the branch-line to atmosphere.

4. Apparatus according to claim 3, further including a vacuum regulator for limiting the suction in said tubing upstream from the pump including a port venting said branch-line to atmosphere, a valve member covering said port, and means controlling said valve member for opening said port whenever the suction in the branch-line reaches a predetermined value.

5. A pump according to claim 4, wherein said back flushing means further comprises means for periodically opening said vent valve thereby periodically venting said drainage tube to atmosphere.

6. A pump according to claim 3, further including a signal device for indicating when the back flushing means is operative.

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