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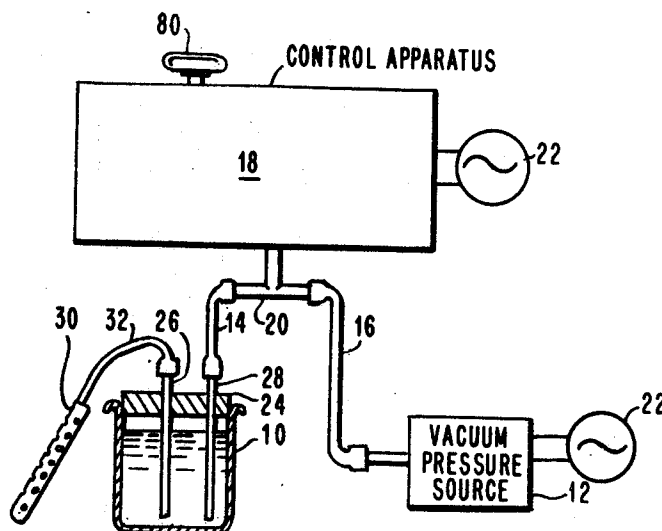
[54] EVACUATOR SYSTEM AND APPARATUS 10 Claims, 3 Drawing Figs.

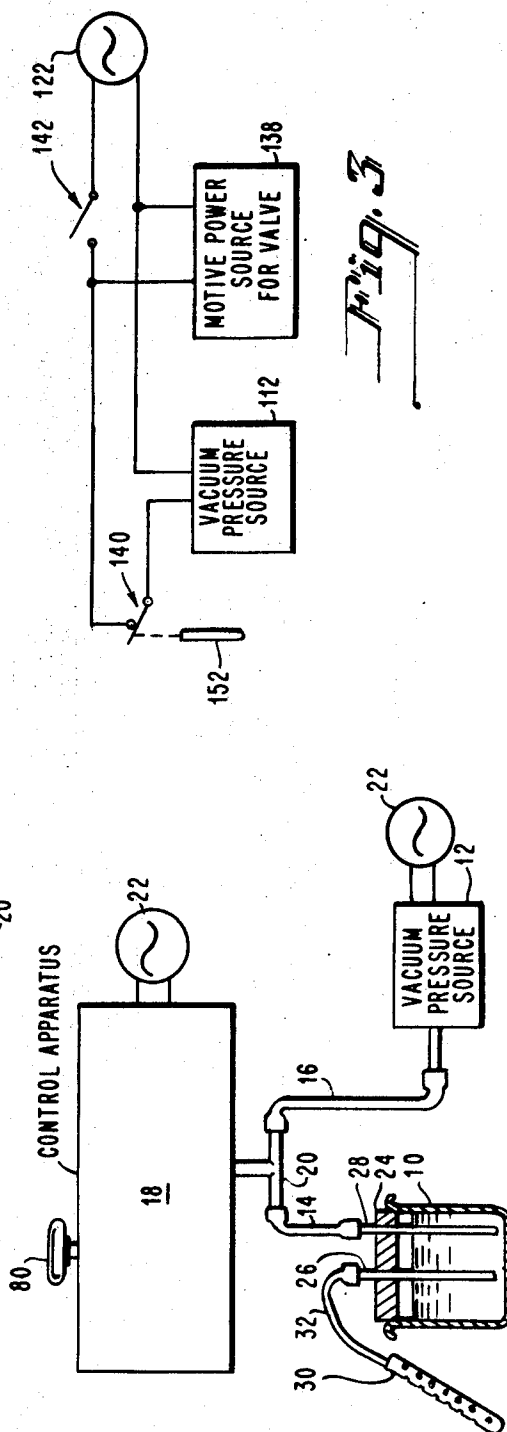
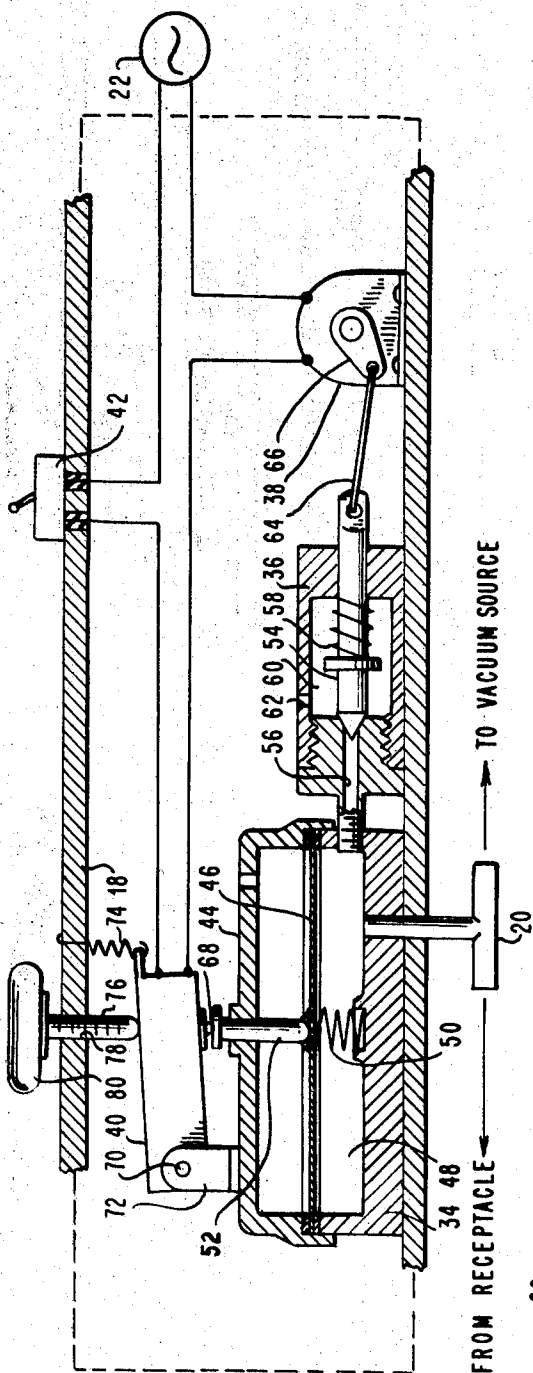
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ABSTRACT: A suction system, of the type employed in evacuating fluids from wounds or body cavities of medical patients, is provided with means for relieving suction pressure automatically in response to obstruction of the inlet to the system. The presence of an obstruction is detected in the form of an increase in vacuum pressure within the system which is sensed by a mechanical pressure transducer. The transducer in turn operates a switch which controls an electrically operated air valve adapted to introduce external or atmospheric air pressure into the system.





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EVACUATOR SYSTEM AND APPARATUS

This invention pertains generally to the control of suction apparatus, and more particularly, to the control of vacuum systems of the type which may be employed in evacuating fluids from wounds or body cavities of medical patients.

Suction systems for evacuating fluids into a suitable receptacle are known in the prior art. Such systems have been provided generally with a receptacle, such as a stoppered jar, having an inlet and an outlet, together with a catheter device coupled to the receptacle inlet, and a source of vacuum or suction pressure coupled to the receptacle outlet. The catheter may be a hollow tubular element with inlet apertures formed along the sides or at one end to admit fluids into the hollow interior. In use, the catheter is inserted into a cavity which requires fluid drainage, and vacuum pressure is applied to form a vacuum within the receptacle so as to draw fluids through the hollow catheter.

The practical application of these prior art systems has revealed that frequent cleaning of the catheter and catheter apertures is required to remove various small particles and tissue debris, which tend to block the passage of fluids to the receptacle. This procedure is undesirable generally, from the standpoint of its effect on a patient's health, as well as from its requirement for personal attention by attendants who might be occupied more gainfully with other tasks.

As an alternative to direct cleaning of the catheter itself, some attendants have been known to disconnect the vacuum source periodically for short periods of time. This procedure is effective in permitting debris to fall away from the catheter inlets under the influence of atmospheric pressure in the hollow interior. It suffers from recognized disadvantages, however, in that it continues to require personal attention by attendants, and such attention must be on a regularly scheduled basis in order to be effective. A further disadvantage of operating on any regularly scheduled or simple periodic basis is that interruptions of suction may be made, frequently, when they are entirely unnecessary due to absence of obstructions at the catheter. And, on the other hand, an obstruction may very well continue for a considerable and undesirable period of time before a scheduled cleaning or vacuum interruption is performed.

It is the aim of this invention to provide an evacuator system and control apparatus which avoids these limitations and disadvantages of the prior art.

Accordingly, an object of this invention is the provision of an evacuator system of the type described, with means for interrupting vacuum pressure in the receptacle, automatically, to clear obstructions from the catheter inlet apertures.

A further object of this invention is the provision of means in an evacuator system of the type described for interrupting vacuum pressure in the receptacle in response to blockage of catheter inlet apertures.

Still another object of this invention is to provide a self-clearing evacuator system which is simple and inexpensive to construct, is easy to maintain, and which requires a minimum number of moving parts and motive power sources.

A feature of this invention is the use of a pressure transducer which operates on electrical switch in response to detection of a selected maximum suction pressure within the receptacle of an evacuator system. The switch in turn operates an electrically controlled vent-valve which opens to vent the receptacle to atmospheric pressure and then closes again. This cycle of opening and closing continues until clearance of the catheter is signalled by the fact that suction pressure in the receptacle remains below the selected maximum value.

These and other and further objects, features, and advantages of this invention are more clearly pointed out and distinctly claimed in the following specification and claims and are fully illustrated in the accompanying drawings, in which:

FIG. 1 is a diagrammatic representation of an evacuator system constructed in accordance with this invention;

FIG. 2 is a partial cross-sectional representation of a control apparatus coupled together in accordance with this invention; and

FIG. 3 is a diagrammatic representation of an alternate embodiment of this invention.

Now, referring to the drawings more particularly, the evacuator system illustrated in FIG. 1 may be seen to comprise a "catch-bottle" receptacle 10, a source of vacuum pressure represented by "black box" 12 which is coupled to receptacle 10 by lengths of vacuum conduit 14, 16, and an adjustable pressure-control apparatus represented by "black box" 18 which is coupled to vacuum source 12 by vacuum conduit 14, 16 and T-connection 20. A source of electrical energy 22 is shown connected to apparatus 18 to provide power for operating the valve means described below. The receptacle 10 is provided with an airtight stopper 24 which includes apertures for admitting inlet pipe 26 and outlet pipe 28 into the airtight enclosure formed within the receptacle. An inlet device or catheter 30 is coupled to inlet pipe 26 by a length of flexible conduit 32, and outlet pipe 24 is coupled to vacuum conduit 14 directly.

Operation of vacuum pressure source 12 acts to evacuate air from within receptacle 10 to create a vacuum which draws fluids through catheter 30, conduit 32 and inlet pipe 26 into the receptacle. Adjustable pressure-control apparatus 18 continuously senses pressure levels within vacuum conduit 14, 16 and responds to different pressure levels in the manner described below.

FIG. 2 represents a detailed, partial sectional view of the control apparatus contained within "black box" 18. This apparatus may be seen to comprise a pressure transducer 34, an atmospheric vent valve 36, and an electrically driven motive power source 38 for operating valve 36, and a plunger-actuated electrical switch 40 for controlling operation of motive power source 38. In addition, a power switch 42 may be provided as a means to shut off supply of electrical energy to the control apparatus.

Pressure transducer 34 comprises a housing 44 and a flexible diaphragm 46 which together define an enclosed pressure chamber 48. T-connection 20 opens into chamber 48 so that the pressure within this chamber corresponds to the pressure in vacuum conduit 14, 16. A compression spring 50 biases diaphragm 46 upward against a movable element represented by transducer plunger 52, and acts against the opposite force which is exerted on the diaphragm by the effect of vacuum pressure within chamber 48.

Atmospheric vent valve 36 includes a sliding sealing member 54 which acts to seal off a vent passage 56 under the normal spring pressure of a compression spring 58. The interior 60 of valve 36 is open to ambient atmosphere conditions through vent apertures 62 which are formed in the body of the valve. Vent passage 56 may be seen to open into transducer chamber 48 at one end, and into the interior 60 of valve 36, at the other end. Thus, when sliding seal 54 is drawn back against the force of compression spring 58, to open the end of vent passage 56, atmospheric or "external" air pressure will be admitted into transducer chamber 48 through the valve.

Movement of the sliding seal 54 in valve 36 is controlled by electrically driven motive power source 38 through a coupling link 64 and a rotary eccentric arm 66. Motive source 38, accordingly, is preferably a rotary device such as a "timer" motor or similar electrical motor.

When power switch 42 is "closed" so as to complete an electrical circuit path, the supply of electrical energy from source 22 to motor 38 becomes subject to control by plunger-actuated switch 40. In this embodiment of this invention, switch 40 is of the "normally closed" type, i.e. when pressure on switch-actuating plunger 68 is released, the switch will "close" to complete an electrical circuit, and conversely, the switch will remain in "open" condition while pressure on actuating plunger 68 is maintained.

As illustrated in FIG. 2, switch 40 is pivotally mounted about an axis 70 which is coupled to a fixed position such as

support 72 on transducer housing 44. A tension spring 74 is coupled to the free end of the switch so as to bias the switch against adjustment rod 76. The adjustment rod is threadably engaged in a threaded aperture 78 and in the wall of "box" 18 and is provided with a handling knob 18 to facilitate rotation. The drawing clearly illustrates the rotation of rod 76 will advance it relative to the wall of box 18, and will tend to urge switch 40 around pivot axis 70 in a clockwise direction and against transducer plunger 52.

It may be seen now that the control apparatus which has been described, operates in the following manner: the presence of normal vacuum pressure in chamber 48, as sensed through T-connection 20, will be overcome by the force of bias spring 50 so as to maintain "upward" pressure on switch actuator 68 through transducer plunger 52. Switch 40 will be maintained in "open" position under these conditions and motive source 38 will remain inoperative in the position shown. However, an increase in vacuum pressure in chamber 48, such as might be caused by an obstruction of flow through catheter 30, will overcome the force of bias spring 50 to pull diaphragm 46 and transducer plunger 52 "downward" away from switch actuator 68. Upon release of plunger pressure on actuator 68, switch 40 will return to "closed" position and will thereby initiate operation of electrically driven motive source 38. As source 38 rotates from the position shown, sliding seal 54 of valve 36 will be drawn back against spring 58 so as to open vent passage 56 to atmospheric pressure. The resultant presence of atmospheric pressure in chamber 48 of transducer 34 will be transmitted through conduit 14 to receptacle 10, and, ultimately the interior of catheter 30. Atmospheric pressure at this point will then permit debris and other obstructions to fall away from the inlet apertures of catheter 30. The presence of atmospheric pressure in chamber 48 will have the further effect of permitting spring 50 to return transducer plunger 52 into operative engagement with switch actuator 68 so as to "open" switch 40. With switch 40 again in open position, the electrical supply to motive source 38 will be cut off and the motor preferably will return to the position shown in FIG. 2 so as to again seal vent passage 56. Electrical motors which return to a given position upon interruption of power are generally available. It is obvious that this cycle of opening and closing vent valve 36 will continue so long as suction pressure within chamber 48 continues to exceed a preselected maximum value.

Selection of the maximum suction pressure value which will initiate the described venting cycle is accomplished by means of adjustment rod 76. The position of switch 40 relative to transducer plunger 52, as determined by rod 76, will determine the length of travel required for transducer plunger 52 to relieve pressure on switch actuator 68. Since the length of travel of plunger 52 against the force of bias spring 50 will be proportional to the suction pressure in chamber 48, it is clear that the position of switch 40 will determine the vacuum pressure within transducer 34 which is required to permit the switch to close.

FIG. 3 illustrates an alternative embodiment of this invention. The FIG. shows, schematically, a transducer plunger 152, a plunger-actuated control switch 140, a motive power source 138 for controlling a vent valve (not shown), an electrically powered vacuum pressure source 112 and a power switch 142. The operation of this embodiment differs from that previously explained, in that plunger-actuated switch 140 is used here to control operation of the vacuum pressure source 112 instead of the vent valve motive power source 138. To accomplish this end, switch 140 is of the "normally open" type rather than the "normally closed" type shown in FIG. 2.

The pressure transducer and vent valve elements of this embodiment (not shown in FIG. 3) may be identical to those illustrated in FIG. 2. Thus, it may be seen that upon the closing of power switch 142 under normal conditions, the vent valve motive source 138 and vacuum pressure source 112 will operate continuously. Accordingly, in this embodiment, the vacuum conduit lines (not shown) will be periodically vented

to atmospheric pressure on a continuing and repetitive basis during normal operation. However, in response to the buildup of excess vacuum pressure in the system, withdrawal of the transducer plunger 152 will permit control switch 140 to return to "open" position. In the open position, switch 140 will halt operation of the vacuum pressure source until excessive vacuum in the system is relieved.

This invention has thus been described, but it is desired to be understood that it is not confined to the particular forms or usages shown and described, the same being merely illustrative, and that the invention may be carried out in other ways without departure from the spirit of the invention; therefore, the right is broadly claimed to employ all equivalent instrumentalities coming within the scope of the appended claims, and by means of which objects of this invention are attained and new results accomplished, as it is obvious that the particular embodiments herein shown and described are only some of the many that can be employed to obtain these objects and accomplish these results.

I claim:

1. A pressure relieving evacuator system, comprising:
 - a substantially closed receptacle having an inlet passage and an outlet passage;
 - a source of vacuum pressure having a vacuum pressure outlet coupled to the outlet passage of said receptacle and creating vacuum pressure therein;
 - a pressure transducer means, including a movable element and a pressure chamber, wherein said movable element is displaced relative to a given position in response to variations of pressure within said pressure chamber;
 - the said pressure chamber having a vacuum pressure inlet coupled to the said outlet passage of said receptacle;
 - controllable air valve means, movable under control between an open position and a closed position, said air valve means being coupled to said pressure chamber for admitting external air pressure into said chamber when in said open position;
2. The pressure relieving evacuator system of claim 1, wherein said controllable air valve means is electrically controllable, and said mechanically operated control means comprises a mechanically operated electric switch means.
3. The pressure relieving evacuator system of claim 2, wherein said electrically controllable air valve means comprises: a body member having an air passage coupled to the interior of said pressure chamber; a sliding seal member coupled to said body member for slidable displacement between a first position in which said air passage is sealed against the passage of air and a second position in which said air passages open to external air pressure; and an electric motor device having a driven rotary eccentric member coupled to said sliding seal member for displacing said seal member between said first and second positions.
4. The pressure relieving evacuator system of claim 2, wherein: the total movement of said movable element in said pressure transducer is proportional to the variations of pressure within said pressure chamber; and the position of said electrical switch means relative to said movable element is adjustable to select the total movement of said movable element which will operate said switch means.
5. A pressure relieving evacuator system, in accordance with claim 4, further including: rotatable threaded rod means coupled between said pressure transducer and said electrical switch means to threadably advance and retract said switch means relative to the said movable element of said pressure transducer, when said rod is rotated.
6. The pressure relieving evacuator system of claim 1, wherein said pressure transducer means comprises: a body member; a flexible diaphragm element coupled to said body member and forming a wall of said pressure chamber; and a plunger member, slidably mounted to said body member, having one end coupled to said flexible diaphragm element and another end mechanically coupled to said mechanically operated control means, operating said control means in

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response to displacement of said plunger upon flexure of said diaphragm.

7. A pressure relieving evacuator system comprising:

a substantially closed receptacle having an inlet passage and an outlet passage;

a controllable source of vacuum pressure having a vacuum pressure outlet coupled to the closed receptacle and admitting vacuum pressure into the outlet passage of said receptacle;

said controllable source of vacuum pressure being selectively controllable to supply or withhold vacuum pressure;

a pressure transducer means, including a movable element and a pressure chamber, producing movement of said movable element in response to variations of pressure with said pressure chamber;

said pressure chamber having a vacuum pressure inlet coupled to the said outlet passage of said receptacle;

periodically operating air valve means adapted to move periodically between an open position and a closed position, said air valve means being coupled to said pressure chamber for admitting external air pressure into said chamber when in said open position;

mechanically operated control means mechanically coupled to the said movable element of said transducer, and to said controllable source of vacuum pressure to selectively control said source in response to movement of said movable element.

8. The pressure relieving evacuator system of claim 7, wherein:

said controllable source of vacuum pressure comprises an electrically operated vacuum pump;

and said mechanically operated control means comprises a mechanically operated electrical switch means electrically connected to start and stop operation of said

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vacuum pump upon operation of said switch means in response to variations of vacuum pressure within said pressure chamber.

9. In a pressure relieving evacuator system having a substantially closed receptacle which includes an inlet passage and an outlet passage, and a source of vacuum pressure, coupled to provide vacuum pressure in the outlet passage of said receptacle, in response to an increase of said vacuum pressure in said receptacle in response to an increase of said vacuum pressure, said control apparatus comprising:

a pressure transducer means including a movable element and a pressure chamber, for producing movement of said movable element in response to variations of pressure within said pressure chamber;

the said pressure chamber having a vacuum pressure inlet coupled to the outlet passage of the receptacle;

controllable air valve means, movable under control between an open position and a closed position, said air valve means being coupled to said pressure chamber for admitting external air pressure into said chamber when in said open position;

and, mechanically operated control means mechanically coupled to the said movable element of said transducer means and to said controllable air valve means operating said air valve means between open and closed position in response to displacement of said movable element.

10. Control apparatus in accordance with claim 9, wherein said controllable air valve means is electrically operated, and said mechanically operated control means comprises a mechanically operated electrical switch means for controlling said air valve means.

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