May 7, 1968 H. W. ANDERSEN ET AL 3,381,687

SUCTION APPARATUS

Filed Oct. 22, 1965

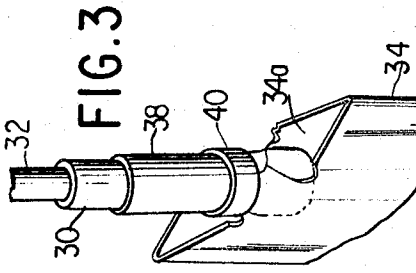


FIG. 3

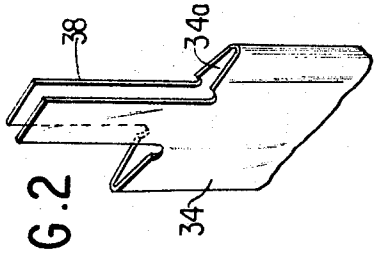


FIG. 2

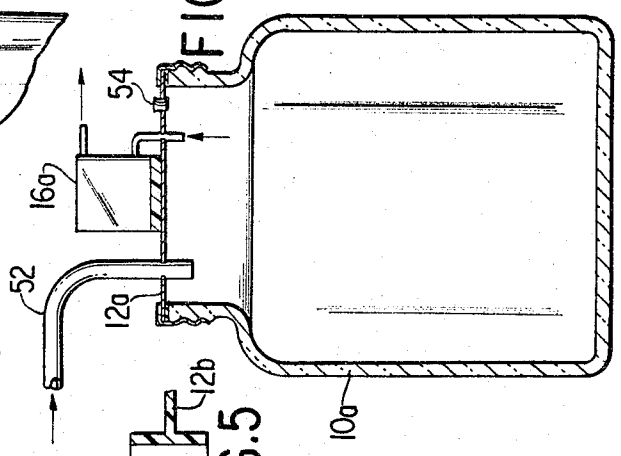


FIG. 4

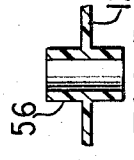


FIG. 5

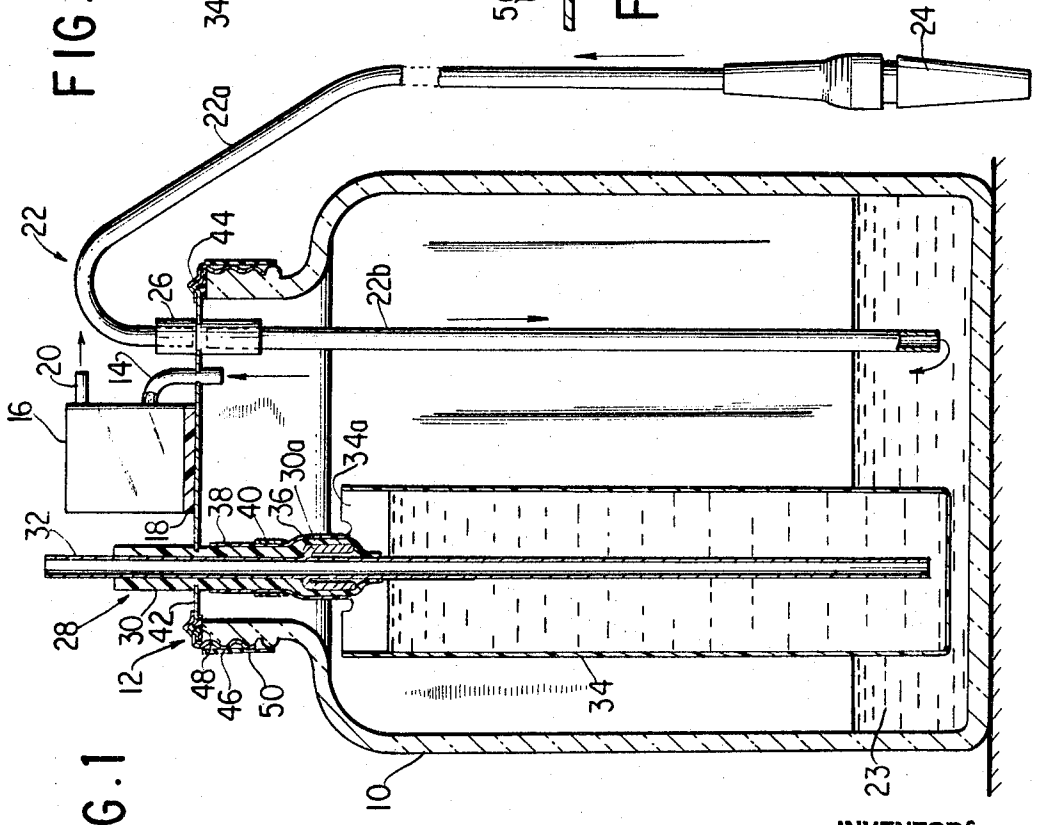


FIG. 1

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SUCTION APPARATUS

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ABSTRACT OF THE DISCLOSURE

A suction or vacuum apparatus particularly adapted for use in drainage body cavities such as the chest cavity, the apparatus including in a single unit elements constituting a water seal to prevent back flow of air to the cavity being drained, a vacuum control device for easy adjustment of the degree of negative pressure, and a pump trap preventing liquid from being drawn into the pump, the several elements being contained in, or mounted on the removable lid of, a single container, the liquid in which acts as a water seal and pump trap while a vacuum control receptacle and tube is suspended from the lid within the container.

This invention relates to a suction or vacuum apparatus and control therefore and is particularly adaptable for, but not limited to, use by the medical profession in connection with drainage of the chest cavity.

Heretofore, closed drainage of the chest cavity has been conventionally achieved by what is commonly called a "three bottle suction" system. In this conventional system a catheter leading from the pleural cavity is connected by means of a flexible tube to a rigid tube which extends below the surface of water in a first bottle called the water seal bottle. This first bottle is at a pressure below atmospheric as will be further described. The water in this bottle establishes a water seal assuring that if vacuum is lost in the system, air cannot flow freely back into the pleural cavity. The top of the water seal bottle is in turn connected to a second bottle called the vacuum-control bottle. There are three openings in the top of the vacuum-control bottle; one connects the top of the vacuum-control bottle with the top of the water seal bottle, the second connects the top of the vacuum-control bottle to the third or pump trap bottle, and the third opening holds a tube which extends from the atmosphere outside to the bottom of the bottle. The vacuum in the system is regulated by the amount of water present in the vacuum-control bottle. The higher the level of water in the vacuum-control bottle, the greater the vacuum that must be drawn by the pump before ambient room air is drawn through the tube under the water level of this bottle to prevent further rise in vacuum. The aforementioned third bottle in the three bottle suction apparatus acts as a trap bottle which prevents water from being drawn into the pump. It has two connections in its top. One connection goes to the top of the vacuum-control bottle and the second connection goes to the pump intake.

This conventional system, which is well known to the medical profession, is cumbersome in actual operation in that its use requires the untangling of a morass of rubber tubing, bottle stoppers, and bottles as well as the proper filling with sterile water of the first and second bottles.

It is an object of the present invention to avoid and overcome the aforesaid difficulties of and objections to prior art practices by combining the function of the above described three bottle system into a single unit thereby avoiding the necessity for three separate bottles and the various tubing, stoppers, and the like for making the interconnections.

Another object is to provide a suction apparatus which

is relatively inexpensive and which utilizes a simple and uncomplicated arrangement readily adapting it for use by personnel already trained in the use of conventional apparatus.

A further object is to provide certain improvements in the form, construction, arrangement, and material of the several elements wherein the above named and other objects may effectively be attained.

A practical embodiment of the invention is shown in the accompanying drawings wherein:

FIG. 1 is an elevational view, partly in section, of a suction apparatus constructed according to this invention.

FIG. 2 is a partial perspective view of the upper portion of the inner receptacle before it is affixed to its support.

FIG. 3 is a view similar to FIG. 2 showing the receptacle affixed to its support.

FIG. 4 is an elevational view, partly in section, of an alternate embodiment.

FIG. 5 is a partial sectional view of an alternate lid construction.

Referring to the drawing, FIG. 1 shows a container **10**, which may be a glass bottle, on which is mounted a detachable lid indicated generally at **12**. The lid has openings through which pass conduits of the various components for establishing and controlling the pressure within the bottle **10**. One of the openings receives a suction tube **14** leading to an evacuating means in the form of a vacuum pump **16** mounted directly on the lid **12**.

The vacuum pump may comprise an electrical vibrator which operates a diaphragm, the details of which are not shown. A resilient mounting pad **18**, made of rubber or the like, cushions the pump on the lid to absorb vibration which might otherwise be transferred to the lid. The pump **16** is adapted to evacuate the air from the bottle **10** and discharge it to the atmosphere as at **20**.

The pump suction tube **14** may be made of a flexible plastic material and of a diameter slightly greater than the corresponding opening in the lid. With this arrangement, the suction tube **14** may be compressed for insertion into the opening in the lid whereupon it will expand against the edge of the opening to form an air-tight seal.

A second opening in the lid **12** mounts connecting means, indicated generally at **22**, which leads to the pleural cavity of the chest for draining the latter. The connecting means **22** has a fitting **24** at one end adapted to be connected to a catheter (not shown) within the aforesaid pleural cavity. The other end of the connecting means **22** terminates near the bottom of the bottle **10** below the level of the liquid **23** contained therein. The liquid **23** preferably sterile water, acts as a water seal assuring that, if vacuum is lost in the bottle **10**, air cannot flow freely from the bottle back into the pleural cavity.

As shown in FIG. 1, the connection means **22** comprises a flexible drainage tube **22*a***, and a semi-rigid or rigid tube **22*b*** connected to one another by a coupling **26** within an opening in the lid **12**. The tube **22*b*** within the bottle **10** is made semi-rigid so that its terminal end will stay below the level of liquid **23** while the tube **22*a*** is made flexible so that it may be readily led to the catheter for connection thereto. The coupling member **26** is also made flexible and of a diameter slightly greater than the corresponding opening in the lid. Thus, as in the case of the vacuum pump suction tube **14**, the coupling member **26** may be compressed to fit into the opening whereupon it will expand against the edge of the opening in the lid to seal itself. The tubing **22*a*** and **22*b*** may be slipped into the coupling member **26** after the latter has been inserted in its opening in the lid.

The conduit means indicated generally at **28** comprises a sleeve **30** in which there is mounted for sliding move-

ment a control tube 32 operating in conjunction with a receptacle or vessel 34 within the bottle 10 for controlling the pressure in the latter as will be described. The receptacle 34 may be on open top bag made of a plastic film suitably supported in the bottle 10 as from the sleeve 30.

In order to mount the bag 34 on the sleeve 30, the latter has inserted therein at its lower extremity, a cylindrical ring or ferrule 36 made of a rigid material, preferably metal. This ferrule 36 is adapted to be fitted into one end of the sleeve 30, which is made of a flexible material (e.g. plastic), to expand the latter as shown in FIG. 1 and form an expanded and rigid section 30*a* on the sleeve 30. As shown in FIG. 2, the bag 34 has two strap extensions 38 adapted to be placed longitudinally around opposite sides of the sleeve 30 including that portion of the sleeve in which the ferrule 36 is contained. A closed circular ring 40 is slid down on the sleeve 30 over the strap extensions 38 to thereby secure the latter and the bag 34 to the sleeve 30. This ring 40 may be made of a resilient plastic material and of an initial diameter such that it will resiliently hold the extensions 38 on the sleeve. As shown in FIG. 1, the ring 40 is disposed in a position above the expanded section 30*a*, the latter preventing the ring 40 from slipping off of the sleeve 30.

The sleeve 30 is made of a resilient plastic material of slightly greater diameter than the opening in the lid so that it may be compressed for insertion into said opening and sealed therein as in the case of the coupling member 26 and the suction tube 14. The bag 34 may be affixed to the sleeve 30 before the latter is inserted in the opening in the lid and the control tube 32 slid into the sleeve 30 after the latter has been mounted on the lid.

The bag 34 is suitably made of a transparent and flexible plastic material sealed on the bottom and open at the top to the interior of the bottle 10 as shown at 34*a*.

The control tube 32 is adapted to slide in the sleeve 30 while maintaining an air tight seal therewith. Preferably, the tube 32 is made of a rigid or semi-rigid plastic material having a coating, e.g. silicone, to facilitate sliding action in the sleeve 30, or it may be made of a material adaptable to facilitate the sliding action such as Teflon.

The lid 12 comprises a flat circular plate 42 and a ring 44 having an inwardly projecting flange extending over the peripheral edge of the plate and including threads 46 engaging complementary threads on the neck of the bottle 10. An annular gasket 48 is provided between the lid and the neck of the bottle, as shown, to insure an air tight seal. With this arrangement it will be evident that the lid may be removed by unscrewing the ring 46 as the plate 42 remains stationary. This facilitates detaching the bottle from the lid and remaining apparatus without disturbing the setup of the latter. If desired, a resilient grip member 50, such as a circular band of rubber, may be provided around the ring so that the latter can be easily grasped and rotated, even with wet hands.

The above described device is put into operation by first admitting a predetermined amount of sterile water into the system by way of the control tube 32. This may be done by running the contents of a 250 cc. infusion bottle of sterile water by means of a conventional tube connected to the control tube 32. This fills the bag 34 with sterile water while the overflow falls into the bottom of the bottle to raise the water level above the level of the end of tube 22*b*. The vacuum pump 16 is then put into operation and the tube 22*a* connected to the catheter (not shown) in the patient's chest cavity. The vacuum or reduced pressure in the bottle 10 is thereby induced into the chest cavity through the connecting means 22. To adjust the amount of vacuum transmitted to the chest catheter, it is merely necessary to raise or lower the control tube 32 which projects inside of the full bag 34. It is evident that the higher the control tube 32, the greater absolute pressure (less vacuum) will be transmitted to the chest cavity, while the lower the control tube, the less the absolute pressure (more vacuum) transmitted. This, of course, is due to the variable head of liquid in the bag 34 sealing the interior of the bottle 10 from the surounding atmosphere.

In operation the bottle 10 is disposed to locate the liquid 23 therein below the level of the patient so that if vacuum is lost in the apparatus, the water 23 will rise in the tube 22*b* until the weight of the water equilibrates the vacuum in the chest cavity. If the water 23 were above the level of the chest cavity, it would be possible to syphon the water from the bottle 10 back into the chest cavity, a result most undesirable.

Should the patient have a great deal of drainage from his chest cavity and it becomes necessary to open and drain the bottle 10, this may easily be done by clamping the chest catheter, removing the lid 12 of the bottle as previously described, spilling out its contents, replacing the lid, and adding an appropriate amount of makeup sterile water so that the tube 22*a* coming from the patient is below the level of fluid 24 in the bottom of the glass bottle 10.

From the above description, it will be observed that this invention combines all of the advantages of the previously described conventional three bottle suction apparatus into one simple inexpensive unit. The fitting of the tubing to the lid 12 is easily made by sliding the resilient sleeve 30, resilient tube 14, and resilient coupling member 26 into the respective openings in the lid wherein they are automatically sealed air tight without requiring additional sealing means such as adhesive or the like. The unit is compact and eliminates the requirement for a complexity of tubing, bottle stoppers and bottles as well as the requirement for filling with sterile water a first and second bottle heretofore required in the three bottle suction apparatus.

FIG. 4 shows an alternate arrangement wherein the above described apparatus may be used as a suction bottle. In this arrangement the conduit mean 28 of FIG. 1 is replaced by a flexible tube 52 which is sealed within the opening of the container lid 12*a*. The opening in the lid for the connecting means 22 in the FIG. 1 embodiment may be closed off as by the stopper 54. The vacuum pump 16*a* is mounted on the lid as in FIG. 1. This arrangement may be used to provide suction via the tube 52 to any location as desired. The lid 12*a* may be easily disengaged from the bottle 10*a* for emptying the latter and also the suction tube 52 may be easily removed from its opening in the lid 12*a* as previously described.

As a further alternate arrangement, the lid, a portion of which is shown at 12*b* in FIG. 5, may be provided with short lengths of tubing 56 forming studs or bushings through which or over which the tubing (e.g. 14, 22*a* 22*b*) may be passed or attached. Thus the lid 12*c* may be made of plastic having the short length of plastic tubing 56 molded thereto to form an integral connection.

It will be understood that various alternate arrangements may be employed in place of those shown in the drawings. For example, the plastic bag 34 could be replaced by a length of tubing sealed at the bottom thereof and suitably supported in the bottle. This tube may be supported from the lid as in the case of the bag or from the bottle itself. Other constructions may be employed to accomplish the function of the conduit means to provide a variable head between the outside atmosphere and the interior of the bottle to control the pressure in the latter.

It will be understood that various changes may be made in the form, construction and arrangement of the several parts without departing from the spirit and scope of the invention, and hence we do not intend to be limited to the details shown or described herein except as the same are included in the claims or may be required by disclosures of the prior art.

What we claim is:

1. Suction apparatus comprising a container, evacuating means for establishing a reduced pressure in said

container, means connecting said container to an area in which a reduced pressure is desired, a receptacle open at its top to the interior of the container and holding a liquid within said container, a removable lid for the container, means affixing the receptacle to said lid to support the receptacle from the lid and enable removal of the receptacle from the container with said lid, and a conduit leading from a point in said receptacle to the outside of said container whereby air is drawn into said container through said liquid so that the head of the latter controls the pressure in said container, said conduit being movably mounted to permit vertical adjustment of said point.

2. Suction apparatus according to claim 1 wherein said receptacle is a flexible bag.

3. Suction apparatus according to claim 1 wherein a liquid is provided in said container, said connecting means extending below the level of said liquid so that the latter acts as a water seal to prevent air from flowing from said container to said area in which the reduced pressure is desired.

4. Suction apparatus according to claim 1 wherein said evacuating means, connecting means, and conduit means are mounted on said lid for removal therewith.

5. Suction apparatus according to claim 1 wherein said lid has three openings, said evacuating means comprising a vacuum pump and a suction tube leading through one of said openings for connecting the vacuum pump to the interior of said container, said connecting means comprising a tube leading through another of said openings, said conduit comprising a tube passing through another of said openings, said tubes being of a resiliently flexible material and of a diameter greater than that of their respective openings in the lid so that said tubes may be compressed and slid into place in their openings, thereafter forming air tight seals therein due to the resiliency of said tubes.

6. Suction apparatus according to claim 1 wherein said lid has bushings formed thereon, said evacuating means and connecting means comprising tubing attached to said bushings.

7. Suction apparatus according to claim 1 wherein said conduit mounting comprises a sleeve fixed to said container lid and the conduit includes a tube movable

in said sleeve through an opening having an air tight fit between the tube and sleeve.

8. Suction apparatus according to claim 7 wherein said receptacle is supported from said sleeve.

9. Suction apparatus according to claim 7 wherein said tube is made of a semi-rigid plastic coated with a lubricating material to facilitate sliding movement in said sleeve.

10. Suction apparatus according to claim 7 wherein said receptacle means has strap extensions, and means securing said strap extensions to said sleeve.

11. Suction apparatus according to claim 10 wherein said securing means comprises a resilient ring on the outside of said sleeve and a rigid ferrule on the inside thereof.

12. Medical suction apparatus for applying a pressure below atmosphere to a cavity of a living being, comprising a container, a detachable lid on said container, a vacuum pump on said lid, said lid having at least two openings, a suction conduit leading through one of said openings for connecting the suction side of the pump to the interior of said container, a drainage conduit leading through the other of said openings for connecting said cavity with the interior of said container, said conduits being of a resiliently flexible material and of a diameter greater than that of their respective corresponding openings in the lid such that said conduits may be compressed and slid through their respective openings into place thereafter forming air tight seals therein as the conduits tend to resume their initial diameter within their respective openings, and means mounting said vacuum pump on said lid such that the lid, vacuum pump, suction conduit, and drainage conduit may be removed from the container as a unit.

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RICHARD A. GAUDET, *Primary Examiner.*

C. F. ROSENBAUM, *Examiner.*