May 17, 1960 H. D. TRACE 2,936,757

SURGICAL DRAINAGE APPARATUS

Filed April 19, 1957 3 Sheets-Sheet 1

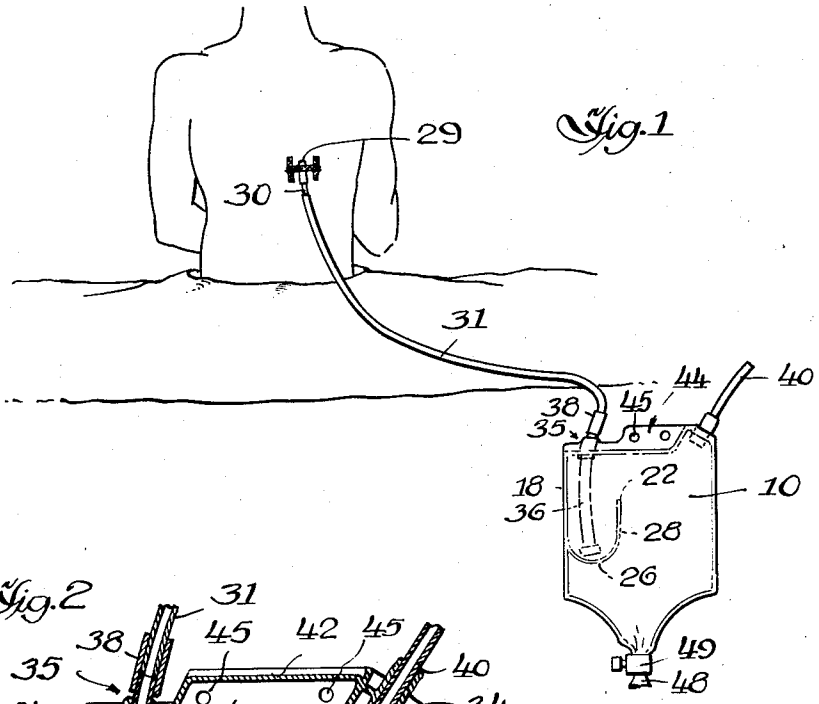

Fig. 1

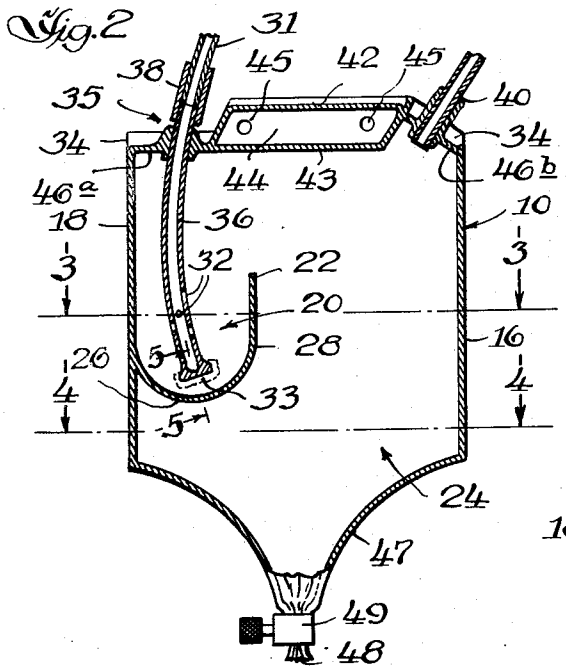

Fig. 2

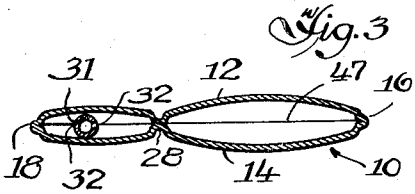

Fig. 3

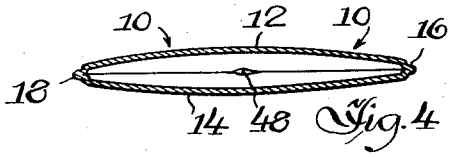

Fig. 4

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Fig. 6

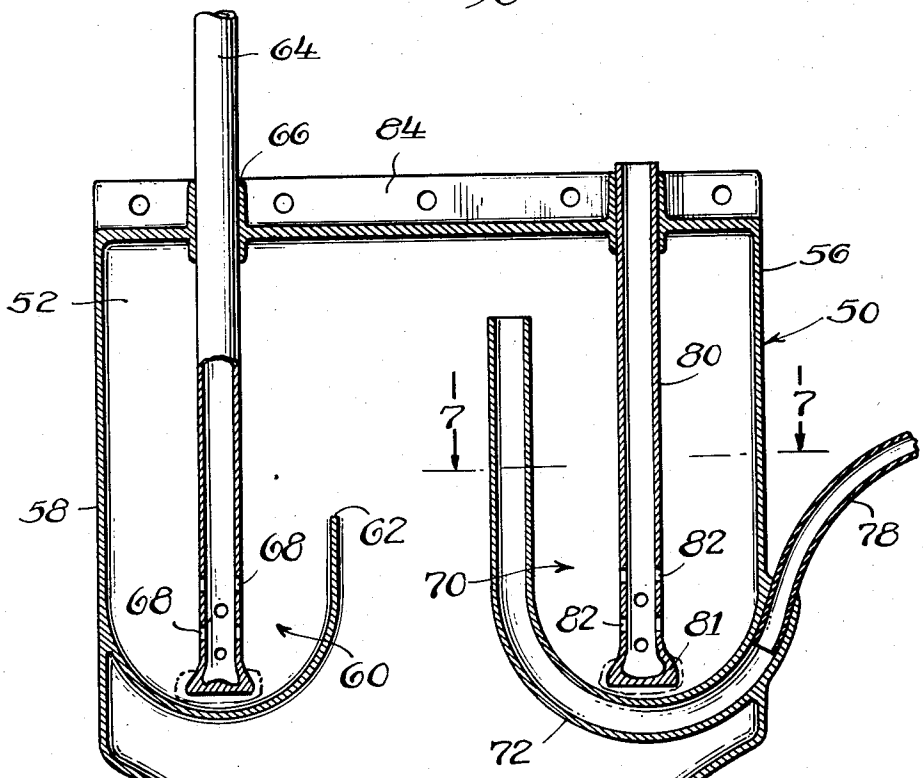


Fig. 7

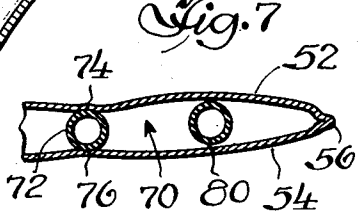
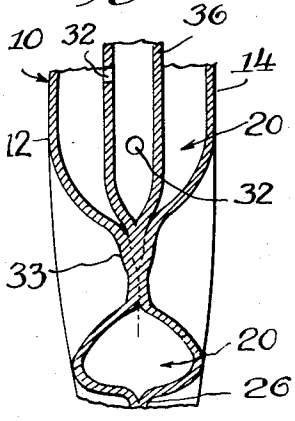
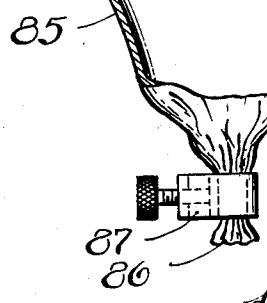


Fig. 5





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SURGICAL DRAINAGE APPARATUS

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Fig. 8

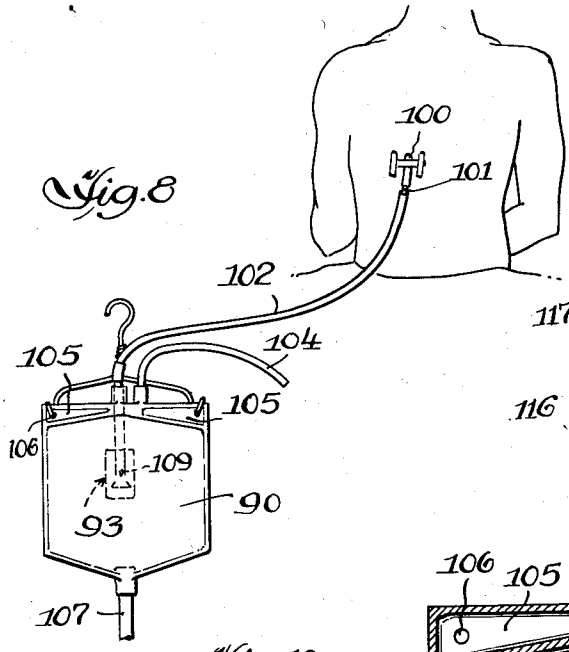


Fig. 12

Fig. 11

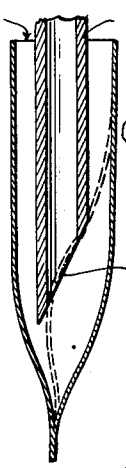


Fig. 9

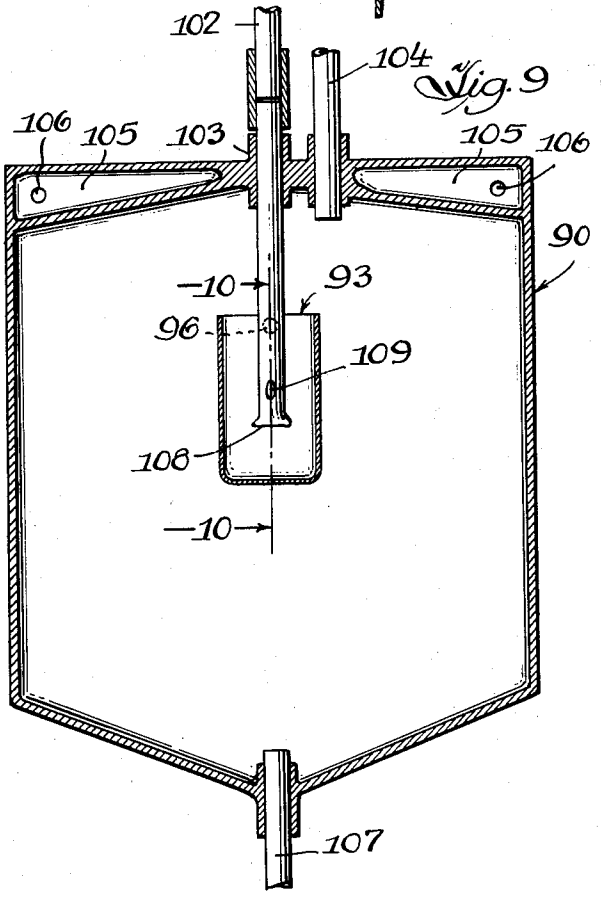
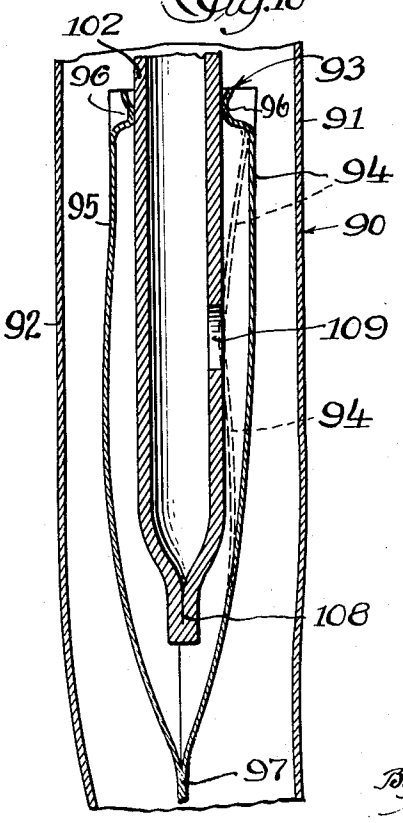


Fig. 10



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United States Patent Office 2,936,757 Patented May 17, 1960

2,936,757

SURGICAL DRAINAGE APPARATUS

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Application April 19, 1957, Serial No. 654,003

10 Claims. (Cl. 128—276)

This invention relates to drainage apparatus more particularly for surgical use, for example, for the removal of effusions and air from the thoracic cavity in surgical cases in which the pleura is opened.

In providing drainage apparatus for the removal of fluids and air from the thoracic cavity after surgery, it is necessary to provide free drainage from the cavity and nevertheless, to prevent ingress of air into the cavity when there is negative pressure therein, to avoid collapse of lung and to avoid infection. On occasions, it is necessary or advisable to maintain suction on the drainage apparatus to overcome the effects of negative pressure in the thoracic cavity. It is therefore necessary to provide such drainage apparatus with adequate traps or seals to prevent backward flow of air into the cavity, and, when suction is applied, to prevent application of excessive suction or vacuum. Hitherto it has been the practice to improvise the necessary drainage apparatus from glass bottles, for example, employing one or a series of glass bottles. The results are cumbersome, awkward and inconvenient both for use in the operating room and in post-operative care of the patient.

In accordance with the present invention I provide convenient, prepared drainage apparatus readily made of inexpensive material, ready for immediate use as required and disposable after use. The apparatus of the present invention may be readily attached in convenient locations on the operating table or the hospital bed and may be easily and conveniently transferred from one to the other as required. It provides in an integral device the necessary receivers for drainage fluids, seals or traps to prevent reverse flow of air or fluids, and means for limiting suction when suction is applied.

The invention will be more fully understood from the following description of various embodiments thereof, illustrated by the accompanying drawings, in which:

Fig. 1 is a diagrammatic elevational view, illustrating one embodiment of the invention in position to receive drainage from a patient, the drainage tube being shown attached to the catheter inserted in the thoracic cavity through the back of the patient;

Fig. 2 is a sectional elevation drawn on a larger scale of the drainage apparatus illustrated in Fig. 1;

Fig. 3 is a horizontal sectional view of the drainage apparatus, the section being taken along line 3—3 of Fig. 2;

Fig. 4 is a horizontal sectional view taken along line 4—4 of Fig. 2;

Fig. 5 is a fragmentary vertical sectional view taken along line 5—5 of Fig. 2;

Fig. 6 is a sectional elevation, drawn to a still larger scale, of another embodiment of the invention, illustrating my improved catheter apparatus adapted for provision of controlled continuous suction;

Fig. 7 is a fragmental horizontal sectional view taken along line 7—7 of Fig. 6;

Fig. 8 is a diagrammatic elevational view, illustrating another embodiment of the invention in position to receive drainage from a patient, as illustrated in Fig. 1;

Fig. 9 is a sectional elevation of the apparatus illustrated in Fig. 8, on a larger scale;

Fig. 10 is a fragmentary vertical sectional view on the line 10—10 of Fig. 9;

Fig. 11 is a fragmentary vertical sectional view of an internal flexible bag and drainage tube end constituting a modified form of the device shown in Fig. 8; and

Fig. 12 is a fragmentary detail section of a modified form of parts of the device illustrated in Fig. 10.

Referring in detail to the drawings, particularly to the embodiment of the invention illustrated in Figs. 1 to 4, my improved drainage apparatus comprises a bag or receptable 10, formed preferably of flexible thermoplastic, heat sealable, sheet material such as the polyvinyl acetate, polyvinyl chloride and vinylidine chloride polymers and copolymers. The bag 10 is formed of side walls 12, 14 of such material preferably joined along their edges 16, 18 by an electronic or heat sealing operation, as is well known in the art. Formed in the interior at one side of the bag, at a point preferably intermediate between the top and the bottom thereof, is a pocket 20 opening upwardly to form a lip 22, over which any liquid accumulating in pocket 20 may overflow to discharge into the bag chamber 24. The pocket is formed preferably by heat-sealing walls 12, 14 to one another along a line or seam 26 extending from edge 18 inward to form the bottom of the pocket, then extending upward at 28 to terminate at lip 22.

The drainage catheter 29 provided for the removal of air and effusions from the thoracic cavity is connected by a small glass or plastic tube 30 to drainage tube 31, which extends into the bag 10 and is attached to bag 10, as hereinafter described. Tube 31 enters from the top of the bag and extending into the pocket 20 to a point adjacent the bottom thereof. The tube 31 is formed with one or more lateral openings 32 disposed at a level below lip 22, the end of the tube being preferably closed by heat sealing and preferably secured in position near the bottom of pocket 20, as shown more particularly in Fig. 5. In this figure and in Fig. 2, the area heat-sealed in this way is indicated at 33.

The junction of tube 31 at its entrance into the bag 10, which is preferably near one of the upper corners of the bag, is preferably formed by heat sealing to and around tube 31 the top edges 34 of the walls 12 and 14 of bag 10, as shown at 35 in Fig. 2. If desired the portion 36 of drainage tube entering the bag may be made separate from the main portion of tube 31 and may be connected therewith by means of a sleeve 38, as shown in Fig. 2 of the drawing. A vent opening to the atmosphere is also formed at the top of the bag by heat sealing a tube 40 between the top edges 34 of walls 12, 14 of bag 10, preferably adjacent to the top corner of the bag opposite to that at which tube 31 is attached. Top margins 34, intermediate the tubes 31 and 40 are preferably heat sealed together at spaced horizontal lines 42, 43 to form a reinforced portion or tab 44 at the upper edge of the bag which may be utilized for suspending the bag from the patient's bed, or any suitable available support. Perforations 45 may be conveniently provided in tab 44 for threading a tape, cord or hook therethrough for suspending the bag. The heat sealing of the upper edges of the sides 12 and 14 of the bag 10 is completed on both sides of tab 44, as at 46*a*, 46*b*, thus completing the closure and sealing the upper edge of bag 10.

The bottom 47 of bag 10 may be formed to taper to a discharge opening 48 which may be closed by any suit-

able type of pinch cock 49. The bag 10 is then made substantially air and liquid-tight.

The operation of the improved drainage device will be apparent from the above description of the apparatus read in connection with the diagrammatic illustration in Fig. 1. As shown, drainage tube 31 is attached to the catheter 29 inserted in the chest cavity of the patient and drains into pocket 20 which is previously filled with water or any suitable liquid. Inasmuch as the openings 32 in tube 31 are below the level of overflow lip 22 of pocket 20, a liquid seal is formed, preventing air entering tube 31. As fluid draining into pocket 20 accumulates it overflows lip 22 into chamber 24, from which it may be discharged from time to time as required by opening pinch cock 48, without interrupting drainage through drainage tube 30.

In the embodiment of the invention illustrated in Figs. 6 and 7, means are provided for facilitating drainage by continuous controlled suction. The bag 50 is formed similarly to that shown in Fig. 2, as hereinbefore described. Its two side walls 52, 54 are formed of thermoplastic or heat sealable sheet material, joined at their edges 56, 58, by a heat sealing operation. The interior of the bag is provided at one side thereof with a pocket 60 opening upwardly and terminating with an overflow lip 62, formed in the same manner as the pocket 20 and lip 22 in the embodiment illustrated in Figs. 2–5 above described. Drainage tube 64 is heat-sealed into the top edges 66 of the side walls of the bag and extends into pocket 60 to discharge drainage fluid therein through lateral perforations 68 disposed at a level below lip 62 of the pocket, the construction being essentially similar to that shown for corresponding parts in the device shown in Fig. 2.

To provide for continuous controlled suction, a second pocket 70 is formed in the interior of the bag 50 adjacent to the lateral edge thereof opposite to that of the pocket 60. The bottom and inner vertical walls of pocket 70 are preferably formed by suitably curved suction tube 72, which is attached at its opposite lateral sides 74, 76, respectively, to side walls 52, 54 by any suitable heat sealing method as is well known in the art. The side walls 52 and 54 are thus sealed to the opposite sides of curved tube 72 for the entire length of the latter within the bag. A liquid-tight pocket is thus formed by the tube 72, which also functions as a suction tube, as hereinafter described. An extension tube 78 tightly connected to or sealed into the end of tube 72 may be connected to any suitable vacuum source or suction device to evacuate the air within the bag to the desired amount so as to provide a suitable degree of suction for operation of drainage tube 64.

It is important that the effective suction be controlled or limited to a predetermined amount to avoid the negative pressure within the cavity subjected to drainage reaching an amount that will cause undue discomfort to the patient or possibly have more serious effects. To secure this control a vent tube 80 opening to the atmosphere is sealed into the upper edges 66 of the bag walls, enters the bag and extends into the pocket 70, the end of the vent tube being closed and sealed to the side walls of the bag 50 by heat as indicated at 81, in the same manner as shown for the end of tube 36 in the device of Fig. 2. The interior of tube 80 communicates with the interior of bag 70 through lateral openings 82 in the side walls of the tube at various levels.

The suction applied to the drainage tube 64, which is that prevailing in bag 50, is controlled by the level of a suitable liquid, such as water, which may be supplied in pocket 70. As suction is applied through tubes 78 and 72, the level of the liquid in tube 80 is drawn below the level of the liquid in pocket 70. When the liquid level in tube 80 is drawn down to the level of the uppermost opening 82 in tube 80, air enters and bubbles through the liquid in the pocket 70, and the pressure in the bag rises. The suction that can be applied is thus limited by the difference between the level of the liquid in pocket 70 and the level of the uppermost opening 82 in tube 80.

The upper edges of the walls of bag or container 70 are sealed together to form a suspension tab 84 in substantially the same manner as tab 44, shown and described in connection with the embodiment of Fig. 2. Also, similarly to the device of Fig. 2, in that of Fig. 6 the bottom 85 of bag 50 is formed to taper to discharge opening 86, which may be closed by any suitable means, such as pinch cock 87. The bag 70 may thus be made substantially air and liquid-tight.

It will be readily seen that if it is desired to use the form of the invention illustrated in Figs. 6 and 7 without providing suction, all that would be necessary to do would be to leave tube 72 open to atmosphere. The apparatus would then operate in the same manner as the form illustrated in Figs. 1 to 4 above described.

In the embodiment of the invention illustrated in Figs. 8, 9 and 10, the numeral 90 designates a bag of the same type and material and formed in the same manner as the bag 10 of Fig. 1, by sealing the edges of side walls 91 and 92. Within the bag there is formed a pocket 93, formed of thermoplastic sheet or film material, suitably of the same character as the bag 90, but thinner, say 0.5 mm. thick.

The pocket 93 may suitably be formed of two sheets 94 and 95, sealed at their edges and bottoms, but not at their tops. The pocket 93 is hence open at the top. It is secured in position within the bag 90, suitably by securing or heat sealing the sheets 94 and 95 to the drainage or chest tube 102 near the top of pocket 93, as indicated at 96. The pocket 93, secured in this way, lies or hangs freely within the bag 90, according to the position of the latter.

As in Fig. 1, the drainage catheter 100 is connected by a small glass or plastic tube 101 to drainage tube 102, which extends into bag 90 and is attached to it at the top edge of the bag by heat sealing at 103 in the same manner as the attachment of drainage tube 31 to bag 10 in Fig. 1. A vent tube 104 is sealed in the top of bag 90, and the top margins of the side walls 91 and 92 are sealed together to form tabs 105, for suspending or otherwise supporting the bag. The tabs 105 are perforated as at 106, for attachment to a suitable suspending means.

The bottom of bag 90, like that of bag 10 of Fig. 1, may taper to a discharge opening in which a tube 107 may be sealed, this tube being open or closed by a clamp (not shown), as desired.

The drainage tube 102 enters and terminates in the pocket 93 in the bag 90 of Fig. 9. The end of tube 102 within the pocket 93 is heat sealed, as at 108. A short distance above its end, and within the pocket 93, the tube 102 has a hole on one side, as at 109.

The device of Figs. 8 and 9 is used in the same manner as that of Figs. 1 and 2. However, in the device of Figs. 8 and 9 a water seal for the end of the drainage tube within the pocket 93 is not required. The drainage tube 102 discharges freely into the pocket 93 when there is a positive pressure in the chest cavity of the patient; and when there is a negative presure, the thin, flexible material of the internal pocket 93 collapses at the opening 109 and seals it, as shown in dotted lines in Fig. 10. Since this will take place irrespective of the position of the bag 90, the embodiment of Figs. 8 and 9 has the advantage that it may be used or may fall into any position and still function satisfactorily. It does not require that it be kept in a sufficiently upright position to maintain a water seal in the pocket surrounding the end of the drainage tube.

Fig. 11 shows a modified method of providing a seal for the end of the drainage tube. Instead of heat-sealing the end of the drainage tube and forming an opening above its end, as is shown in Fig. 10, the end of the tube 102 may simply be cut off at an angle, as shown at 111 in Fig. 11. The thin, flexible material automatically

seals off the open end of the tube **102** and there is negative pressure within the chest cavity, the thin, flexible material of the pocket **93** assuming the position shown in dotted lines in that figure.

The embodiment shown in Figs. 8 to 11, inclusive, retains the same characteristics of behavior as that shown in Figs. 1 and 2. Thus, when the bag **90** is in its normal upright or approximately upright position, a seal of water or fluid derived from the cavity being drained may form in the pocket **93**. However, if for some reason the bag should be tipped into a position in which fluid drains out of the pocket **93**, the automatic valve action resulting from the thin flexible character of the material of which the pocket is formed provides an additional safety factor and prevents air or fluid returning to the chest if there is negative pressure therein.

In Fig. 12 is illustrated a modified form of a portion of the chest or drainage tube sealing device shown in Figs. 8 and 9 and in detail in Fig. 10. It differs essentially in that the lower end of the thin sheeting surrounding the end of the chest or drainage tube is not closed at its lower end to form a pocket, as is the form illustrated in Figs. 8 to 10.

Thus, in the form shown in Fig. 12, the chest or drainage tube corresponding to drainage tube **102** in Fig. 10, is designated by the numeral **115**. It is closed at its end **116** by heat sealing and is provided near its end with openings **117**, corresponding to the openings **109** in tube **102** of Fig. 10. Attached to tube **115** are sheets **118** of thin, flexible plastic film, which may be sealed together at their edges as are the edges of sheets **95** and **96** in the form shown in Figs. 8 and 10, but not at their bottoms. Thus they do not form a pocket suitable for holding fluid, but hang freely. By reason of their flexibility, on reduced or negative pressure in the chest tube **115**, they act as flap seals and close the openings **117**, thus preventing ingress of air into the chest cavity of the patient.

The sheet material of which the bags of the drainage apparatus of the present invention are formed is preferably transparent and relatively thin, so that the contents of the bag and its behavior can be observed. Normally the bags are collapsed, readily packed and require but little space. By means of the tabs provided at their upper ends they may be conveniently suspended from the operating table or from the bed of the patient in post-operative care.

The bags with the attached tubes can be readily sterilized and packed in sterile containers, if desired, so as to be ready for immediate use even in the operating room. As they are relatively inexpensive, they may be destroyed or otherwise disposed of after use. As distinguished from glass receptacles or bottles or series of such bottles which are ordinarily used for the same purpose, the apparatus of the present invention is not breakable and because of the integral or unified construction of its parts, accidental interruption of operation, such as occasionally occurs with a set-up of glass apparatus, is avoided.

Although the invention has been described in connection with the specific details of certain embodiments thereof, it is not intended that these shall be regarded as limitations upon the scope of the invention except insofar as included in the accompanying claims.

I claim:

1. Surgical drainage apparatus comprising a bag of flexible, fluid-tight sheet material, provided with a discharge opening at the bottom thereof and a restricted opening to atmosphere at the top thereof, a pocket formed in said bag below the top thereof, said pocket opening at the end forming the top of the pocket when the bag is in upright position, a drainage tube passing through the wall of the bag into the interior thereof and terminating within said pocket and opening thereinto below the top of the pocket and means provided in conjunction with said pocket for preventing flow backward into said drainage tube when there is negative pressure therein.

2. Surgical drainage apparatus comprising a bag of flexible, fluid-tight sheet material, provided with a closable discharge opening at the bottom thereof and a restricted opening to atmosphere at the top thereof, a pocket formed in said bag below the top thereof, said pocket opening upwardly and having an upwardly directed lip terminating above the bottom of the pocket and disposed at an intermediate level of the interior of the bag, and a drainage tube passing through the wall of the bag into the interior thereof and terminating within said pocket, said tube opening into said pocket below the level of said lip, said pocket being adapted to receive and retain a liquid to form a liquid seal for said drainage tube.

3. Surgical drainage apparatus as defined in claim 2 in which a closable discharge opening is provided at the bottom of said bag for discharge of accumulated drainage fluid.

4. Surgical drainage apparatus as defined in claim 2 in which said material is heat-sealable and said pocket is formed by integral attachment of opposing side walls of said bag along a line defining the bottom of said pocket and extending to said lip.

5. Surgical drainage apparatus as defined in claim 2, in which said tube is sealed at the end thereof and integrally attached to the walls of the bag within the pocket, being thereby secured in position, said tube being formed with a lateral perforation for discharge of drainage fluid into said pocket.

6. Surgical drainage apparatus as defined in claim 2, in which the tops of the side walls of the bag are joined to provide a tab as supporting and suspension means for the bag.

7. Surgical drainage apparatus comprising a bag of flexible, fluid-tight sheet material, provided with a discharge opening at the bottom thereof and a restricted opening to atmosphere at the top thereof, a pocket of thin highly flexible sheet material secured within said bag below the top thereof, said pocket having its opening in the direction which is upward when the bag is in its normal position, a drainage tube passing through the wall of the bag into the interior thereof and terminating within said pocket, said tube having an opening within the pocket, said pocket being adapted to receive and retain liquid to form a liquid seal for said drainage tube, and the material of said pocket constituting a closure means for the opening in said tube when there is negative pressure within the tube, irrespective of the presence of a liquid seal in said pocket.

8. Surgical drainage apparatus comprising a bag of flexible, fluid-tight sheet material, provided with a restricted opening to atmosphere at the top thereof, a pocket formed in said bag below the top thereof, said pocket opening upwardly and having an upwardly directed lip terminating above the bottom of the pocket and disposed at an intermediate level of the interior of the bag, a drainage tube passing through the wall of the bag into the interior thereof and terminating within said pocket, said tube opening into said pocket below the level of said lip, said pocket being adapted to receive and retain liquid to form a liquid seal for said drainage tube, a second pocket formed in said bag opening upwardly therein, said second pocket being adapted to receive and retain liquid, a second tube extending from said air opening into said second pocket, said second tube opening into said second pocket at a point spaced from the bottom thereof and below a level of liquid as retained therein, and a connection from said bag extending from a point above a point of any maximum liquid level in said second pocket to a source of suction.

9. Surgical drainage apparatus as defined in claim 8 in which a closable discharge opening is formed at the bottom of the bag for discharge of accumulated drainage fluid.

10. Surgical drainage apparatus as defined in claim 8 in which said material is heat-sealable and in which said suction connection comprises a third tube extending into the interior of the bag from one edge thereof and is integrally attached to opposite sides of the bag to form the bottom and interior side of said second pocket, said third tube opening into said bag at its upper end, which defines the upper end of said second pocket.

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