SOUND MUFLER FOR DRAINAGE DEVICE

Inventors: Robert E. Bidwell, Melville; Leonard D. Kurtz, Woodmere, both of N.Y.

Assignee: Deknatel, Inc., Queens Village, N.Y.

Filed: Oct. 18, 1972

Primary Examiner—Richard B. Wilkinson
Assistant Examiner—P. Salce
Attorney—Roberts B. Larson et al.

ABSTRACT

Drainage device of the type shown in U.S. Pat. Nos. 3,363,626; 3,363,627 and 3,683,913. For use with vacuum, the device has three chambers: collection, seal, and manometer. In operation, a gas bubbles through a body of liquid in the manometer chamber and this is sometimes quite noisy. In accordance with the invention, the opening of the manometer chamber which is open to atmosphere is closed with a sound muffling member which does not substantially impede gas flow through the opening. The sound muffling member is preferably a member having a tortuous aperture extending therethrough, the size of the aperture being sufficient to permit the free flow of gas.

9 Claims, 3 Drawing Figures
3,782,497

1. SOUND MUFFLER FOR DRAINAGE DEVICE

BACKGROUND OF THE INVENTION

This invention relates to drainage devices. More particularly, the invention relates to drainage devices of the type disclosed in U.S. Pat. Nos. 3,683,913; 3,363,626; and 3,363,627. Still more particularly, the invention relates to such devices used with vacuum, the devices comprising three chambers: collection, liquid seal, and manometer.

During operation of these devices, a gas bubbles through a body of liquid maintained in one of the chambers. For example, atmospheric air bubbles through a body of liquid provided in the manometer chamber to regulate the amount of vacuum applied to the collection chamber. The devices are useful in maintaining clear passages and cavities under operative and post operative conditions. The noise associated with the bubbling gas is frequently annoying.

It is an object of the present invention to provide an improved drainage device. It is a further object to provide a drainage device in which the noise occasioned by its use is reduced. It is still a further object to provide a quiet drainage device provided with a bubbling gas flowmeter.

BRIEF SUMMARY

The foregoing and other objects of the invention which will be apparent to those having ordinary skill in the art are accomplished according to the invention by providing a sound muffler member for inserting into the atmosphere opening of a drainage device, the member having an external configuration corresponding to the opening such that the opening is closed by insertion of the member therein, the member having a tortuous aperture extending therethrough located in the member to provide an opening for the cavity when the member is inserted in the cavity opening, the size of the aperture being at least about 0.01 square inches and not more than 0.20 square inches.

DETAILED DESCRIPTION

There follows a detailed description of a preferred embodiment of the invention, together with accompanying drawings. However, it is to be understood that the detailed description and accompanying drawings are provided solely for the purpose of illustrating a preferred embodiment and that the invention is capable of numerous modifications and variations apparent to those skilled in the art without departing from the spirit and scope of the invention.

FIG. 1 is a sectional view through the center plane of an underwater drainage apparatus constructed according to U.S. Pat. No. 3,683,913;

FIG. 2 is a perspective view of a sound muffler for a drainage device according to the invention; and

FIG. 3 is a partial sectional view of the upper left portion of FIG. 1 showing the device of FIG. 2 in position in the drainage device.

Referring now to the drawings, there is shown a drainage apparatus 10 constructed in accordance with U.S. Pat. No. 3,683,913, herein incorporated by reference. The apparatus may be formed from two separate sections, one section being molded with all of the chambers and walls formed therein and the other sections being a flat sheet which is secured to the first section along all walls. Alternatively, the apparatus could be molded in two separate halves, the mold for each half being identical with the halves joined together along the center plane.

Referring now to FIG. 1 there is shown an underwater drainage apparatus and having a collection or trap chamber 11, a water seal chamber 12 comprising a first column 12a and a second column 12b. There is also provided a pressure regulator chamber 13 having a first column 13a and a second column formed in two portions 13b and 13c. The apparatus is completely enclosed except for an opening 14 from the collection chamber 11 which opening is adapted to be connected to the pleural cavity of the patient, an opening 15 adapted to be connected to a vacuum source, and an opening 16 which is open to atmosphere from the pressure regulator chamber 13.

One feature of the device is the provision of a pediatric collection compartment which is formed by a partition 20 in the main collection chamber 11. The angled upper end portion 20a of the partition 20 deflects the liquid entering through opening 14 into the pediatric collection compartment 21. The compartment 21 is of a relatively small cross section so that the amount of liquid collecting therein can be readily measured in increments of one cubic centimeter. In a preferred embodiment of the invention this compartment will hold 250 cubic centimeters after which additional liquid will flow over the upper end portion 20a of the partition 20 into the adjacent chamber 22 and when chamber 22 is filled the liquid will flow over the upper end of partition 23 into compartment 24.

The underwater seal chamber 12 is formed with columns 12a and 12b, these columns being separated by a partition element 26. At the upper end of column 12b there is provided an enlarged reservoir 35 which has a recessed lower end portion 36. This structure provides a water seal saver and tell tale as described in prior U.S. Pat. No. 3,363,627 herein incorporated by reference.

There is also provided at the upper end of column 12b a means for preventing the water forming the underwater seal from rising in column 12b. This means comprises a cylindrical check valve 37. There is provided a chamber which is offset with respect to column 12b and this chamber has a lower wall and upper wall having an aperture 41 therein. The edges of the chamber are secured directly to the device so that entry into chamber 38 is only through column 12b and through aperture 41. Within the chamber there is provided a cylindrical valve member 45 having a height slightly less than the length of the chamber. Normally the valve 45 rests on the bottom of the chamber. However, during conditions of high negativity within the patient's pleural cavity such that liquid from the water seal rises in column 12b to pass into the chamber, valve 45 floats and rises within the chamber to close off aperture 41, thus preventing the liquid from the water seal from rising into chamber 35. In this manner the high negative pressure which the patient has built up in the pleural cavity which the patient may require in order to fully expand the lung is permitted to be maintained. When the high negative pressure in the pleural cavity is reduced, the water within the chamber returns to the water seal at the lower end of column 12b, thus permitting the valve 45 to return to its original position and normal operation of the device is resumed. It has been found that scoring lines (not shown) across the upper
surface of valve 45 prevent the valve from sticking in the upper position closing off aperture 41.

At the lower end of the column 12a of the underwa-
ter seal chamber 12, the cavity is enlarged as shown at 12e and within this enlarged cavity there is provided an air flow meter 46. The air flow meter measures the amount of air passing from the pleural cavity through the opening 14 into the collection chamber 11 and downwardly through column 12b and upwardly through column 12a to the vacuum source. The air flow meter provides means for accurately measuring the quantity of air passing through the underwater seal and for conveniently determining whether this air flow is increasing or decreasing. This determination would be significant for diagnosing a patient’s condition suffering, for example, from a bronchopleural fistula. The meter is provided with a rear wall and a front wall having a common duct or passageway 49 formed therein. An integral connecting portion 50 forms the upper wall of passageway 49. Connecting portion 50 has a series of apertures 51a, 51b . . . 51i and beneath each of these apertures there is formed in portion 50 a separate and independent plenum chamber (not shown). The lower end of each plenum chamber connects with the common passageway 49. Disposed above and separating each of the apertures 51a, 51b . . . 51i is a partition member 53.

The air flow meter 46 is disposed within the underwa-
ter seal chamber 12 in such a manner so that the lower end thereof between the column 12a and 12b is protected with the duct 49 extending at a slight angle to the horizontal. The lower wall of duct 49 is cut away beneath the aperture 51i and its plenum chamber so that this passageway is disposed in the path of flow and directly above passageway 12e forming the end of the curved end portion of column 12b. Thus gases passing downwardly along column 12b will flow upwardly through passageway 12c into the plenum chamber and its associated aperture 51i. By inclining the passageway 49 as shown greater volumes of gases will pass through, and not the arteries in sequence. Thus, the air flow meter 46 provides a means for measuring the quantity of gases passing from the patient’s pleural cavity. For example, aperture 51i measures a volume of gas flow of from 0 to 2 liters per minute. The last aperture 51a measures a gas flow in excess of 28 liters per minute.

The pressure regulator manometer 13 is formed with a first column 13a having its upper end 16 exposed to atmosphere and a second column which comprises portions 13b and 13c. The upper ends of columns 13b and 13c are connected via passageway 54 with the vacuum source through opening 15. The purpose of portion 13b and 13c is to confine the bubbles rising through the chamber to the portion 13b so that liquid rising with the air bubbles will engage the baffle 55 which will serve to deflect the liquid downwardly into portion 13b or 13c after which the gas may continue its upward movement through passageway 54 to the opening 15.

In practice, water will flow clockwise around the part-
tion separating column 13b and 13c forming a “race-
track” like path of water. Much of the water engaging the baffle 55 will flow into portion 13c.

It can be seen that with the arrangement shown, the portion 13c provides a relatively calm body of liquid as compared with the portion 13b which may be bubbling vigorously. Consequently, the level of liquid in the sec-
ond column of the pressure regulator chamber 13 can be readily determined by noting the level of liquid in portion 13c.

In the event that some liquid does flow upwardly past the baffle 55 it will be engaged by a second baffle 56.

At the lower end of the column 13b there is provided an air flow meter 57. This air flow meter 57 is identical to the air flow meter 46 previously described except with respect to the size of the apertures therein. The aperture 58a is located directly above and in the path of flow of the passageway 13e which is the end of the lower upturned end portion of passageway 13a. The common duct 59 in the lower end portion of the air flow meter 57 is disposed at an angle of from 7° to 13° to the horizontal with best results being obtained at an angle of 10°.

The basic operation of the apparatus 10 is similar to the basic operation of the apparatus as described in prior U.S. Pat. Nos. 3,363,626 and 3,363,627 herein incorporated by reference.

An amount of liquid is introduced into the pressure regulator chamber 13 through opening 16 which will give the desired vacuum after the pump is turned on. Because of the relative sizes of column 13a on the one hand and 13b and 13c on the other hand, the water may be filled to the level of the desired degree of vacuum as once the vacuum pump is operated and column 13a evacuated, the water level will not change significantly.

The desired amount of liquid is introduced through opening 15 into the underwater seal chamber and the opening 15 is then connected to the vacuum pump.

Opening 14 is connected to the pleural cavity of the pa-
tient and the vacuum pump is started. The liquid is evacuated from column 13a and air bubbles through the pressure regulator chamber 13b to maintain the vacuum within the device at the water level set. Any liquid rising through the pressure regulator chamber with the air bubbles will engage the baffle 55 and fall downwardly into portion 13c. The liquid in the under-
water seal chamber will rise in column 12a and any air or gases within the pleural cavity will pass downwardly through column 12b and through air flow meter 46.

Any fluid (gases and liquids) coming from the pa-
tient’s pleural cavity enter the apparatus through opening 14. Liquids fall into the collection chamber 11 and gases pass through the underwater seal column 12b and 12a. Initially liquids from the pleural cavity fill the compartment 21 and subsequently overflow into compartment 22 and compartment 24.

When the pressures within the pleural cavity reach a very high negativity as, for example, when the patient attempts to expand the lungs but some blockage exists in the bronchial passages, the pressures within the col-
lection chamber 11 may be reduced below the pressure within the column 12a. Consequently, the liquid in seal chamber 12 will rise rapidly in column 12b. As de-
scribed in prior U.S. Pat. No. 3,363,627 the water seal sa-
er chamber 35 prevents this liquid from passing into the collection chamber 11. However, in accordance with the illustrated device the valve 37 operates to close off the passageway from collection chamber 11 to column 12b and thus permits the patient to maintain the high negative pressure within his pleural cavity which is necessary to expand the lungs.

When normal breathing is resumed the valve 37 will return to its open position and permit communication between the chamber 11 and column 12b within the water seal sauer chamber 35 will pass downwardly into
the underwater seal except for a small portion within the depressed part 36 which will remain to indicate to the attending physician that such a condition of high negativity had existed.

The air flow meters 46 and 57 give a clear indication of the degree of gases passing through the underwater seal and pressure regulator chamber respectively. If gas is passing through all of the apertures in the air flow meter 46 and no air flow is indicated in the meter 57, the physician is aware that the leakage in the patient's pleural cavity is completely overcoming the pump and that an emergency condition exists. The physician can determine improvement in the patient by noting decreased gas flow through meter 46 from day to day and the particular air flow meter provided according to the present invention gives an exceedingly accurate measurement of such gas flow.

As mentioned above, the gas bubbling through the device may be noisy. Whenever a manometer chamber is used to regulate vacuum, atmospheric gas bubbles through the liquid in the bottom of manometer chamber 12. The bubbling can be quite noisy, particularly at high flow rates. In accordance with the invention, it has been found that the noise of operation can be substantially reduced by providing a muffler member in opening 16.

One muffler member 70 according to the invention is shown in FIG. 2. The muffler member is plug-like in shape and has an upper surface 71 and a lower surface 72 with a tortuous aperture 73 extending therebetween. The external configuration of the member conforms to opening 16 such that opening 16 is closed by inserting member 70 therein as shown in FIG. 3. Aperture 73 is relatively large so as not to impede the flow of atmospheric air therethrough and for this purpose will generally be between 0.01 square inches. For a circular aperture, a minimum diameter of about 5/8 inch is required. In order to provide good sound muffling, however, the aperture should not be larger than about 0.20 square inches or, in the case of a circular aperture, about 5/8 inch diameter. The member is preferably fabricated from a foamed material, such as polyurethane plastic foam, and may be fabricated by drilling two slotted holes in a single piece as shown. The member may be assembled from two halves, and this is preferred where the tortuous path is too complex to be simply drilled out. It will be readily apparent that numerous variations and modifications from the device illustrated may be made without departing from the spirit and scope of the present invention.

What is claimed is:

1. A sound muffler for reducing the sound emanating from an atmospheric opening of a drainage device for draining fluids from a cavity comprising a member having an external configuration corresponding to said opening such that said opening is closed by insertion of said member therein, said member having opposite surfaces and a tortuous aperture located in said member extending therethrough from one to the other of said opposite surfaces to provide communication with said drainage device, the cross section of said aperture being at least about 0.01 square inches and not more than 0.20 square inches.

2. A sound muffler according to claim 1 wherein said member comprises foamed material.

3. A sound muffler according to claim 1 wherein said member comprises plastic foam.

4. A sound muffler according to claim 1 wherein said member includes a single tortuous aperture.

5. In a drainage device for draining fluids from a cavity having a collection chamber having an inlet opening to be placed in fluid communication with a cavity to be drained, a seal chamber having first and second columns in communication with each other at the lower ends thereof and adapted to receive a body of liquid in the lower portion of said first and second seal chamber columns, the upper end of the first seal chamber column being in fluid communication with said collection chamber, the upper end of said second seal chamber column being in fluid communication with a vacuum source, and a manometer chamber comprising first and second columns in fluid communication with each other at the lower ends thereof and adapted to receive a body of liquid in the lower portion of said first and second manometer chamber columns, the upper portion of said first manometer chamber column being in fluid communication with said vacuum source and the upper portion of said second manometer chamber being open to atmosphere, the improvement wherein the opening of said second manometer chamber is closed with a sound muffler member which does not substantially impede the flow of gas through said opening.

6. An improved drainage device according to claim 5 wherein said sound muffler member comprises the member of claim 1.

7. An improved drainage device according to claim 5 wherein said sound muffler member comprises the member of claim 2.

8. An improved drainage device according to claim 5 wherein said sound muffler member comprises the member of claim 3.

9. An improved drainage device according to claim 5 wherein said sound muffler member comprises the member of claim 4.