

[54] **FILTERING BLOOD SUCKER**

[76] Inventor: **Robert C. Brumfield**, 73 Emerald Bay, Laguna Beach, Calif. 92657

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[51] Int. Cl. **A61m 1/00**

[58] Field of Search **23/258.5;**
128/276-278, 348, 350

[56] **References Cited**

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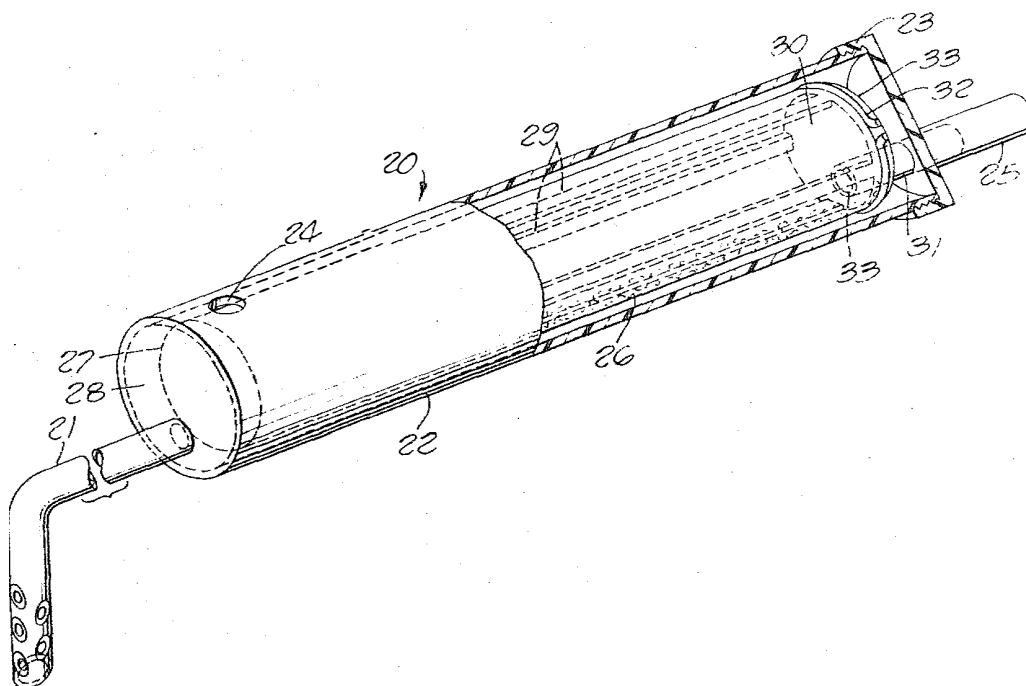
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Primary Examiner—Charles F. Rosenbaum
Attorney—J. L. Jones

[57] **ABSTRACT**

A blood sucker is connected to the suction side of a peristaltic tube pump, evacuating blood lost by a patient at a surgical site. The air evacuated through the blood sucker when in use can be filtered through a first disposable micropore filter in the sucker, prior to contacting the blood evacuated from the surgical site. The patient blood, clean air and surgical debris are also filtered through a sucker second disposable filter, whose pore apertures are sized to remove the tissue debris from the blood flowing into the sucker. Early removal of tissue debris from patient blood in the blood sucker can slow the initiation of the blood clotting mechanism. The filtered air can decrease the microscopic air contaminants in the filtered blood, which can then be returned to the patient's circulatory system. An integral plurality of flexible, parallel array blood conductive tubing provide wall stabilized, low turbulence blood flow from the sucker to a cardiotomy reservoir or the like, prior to returning the blood to the patient's circulation.

8 Claims, 10 Drawing Figures



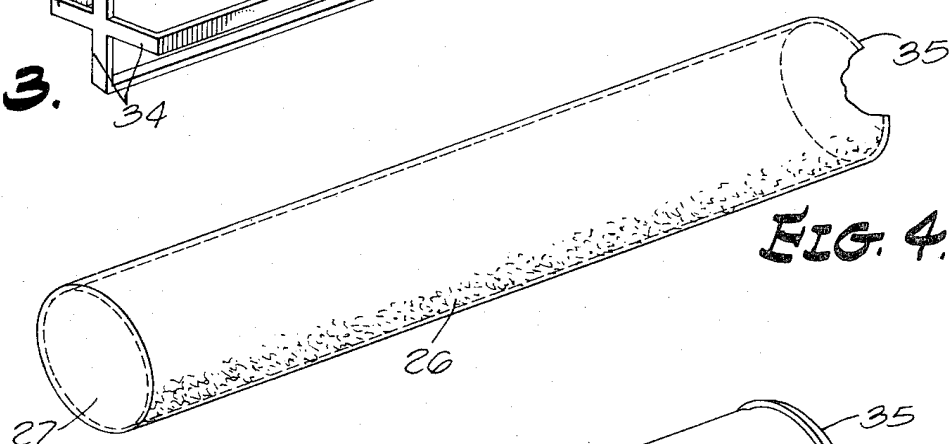
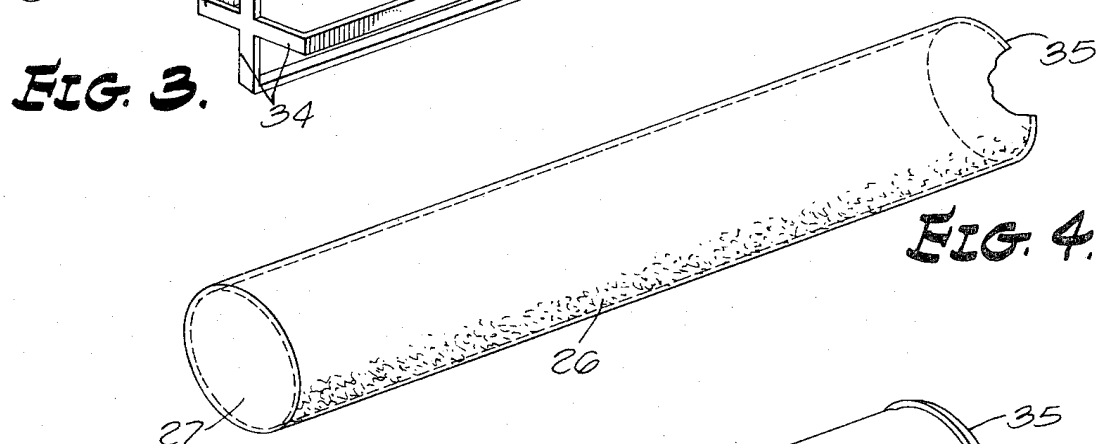
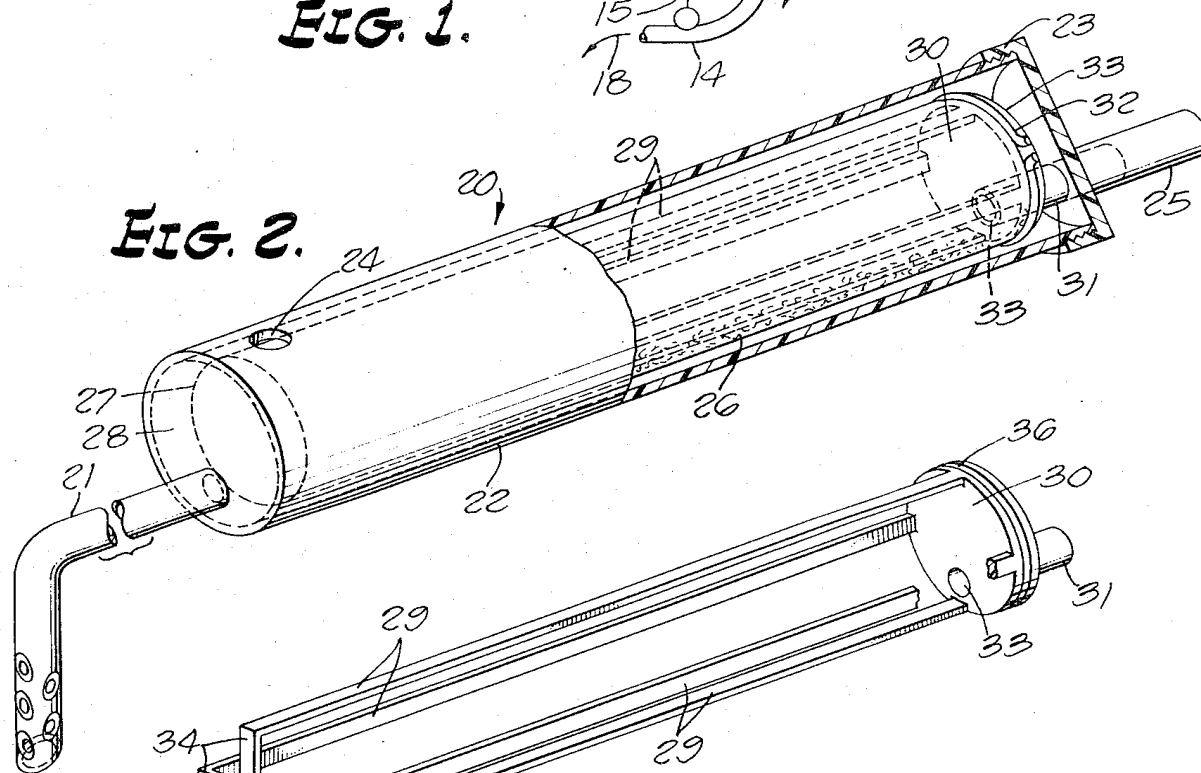
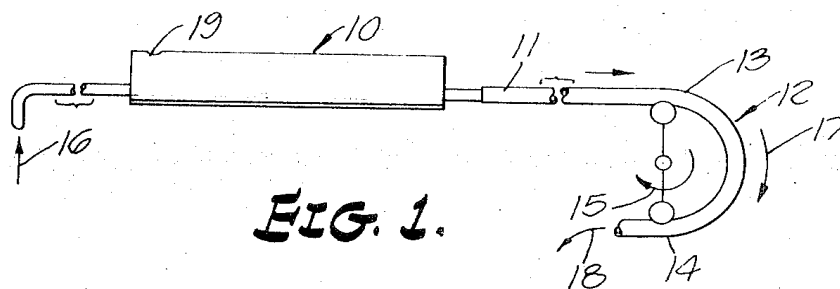
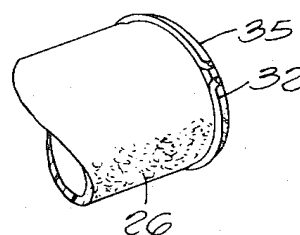
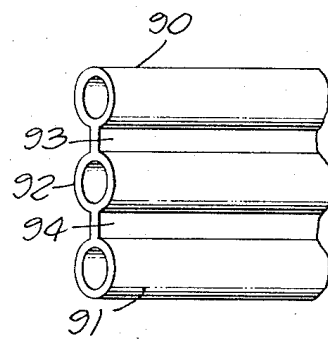
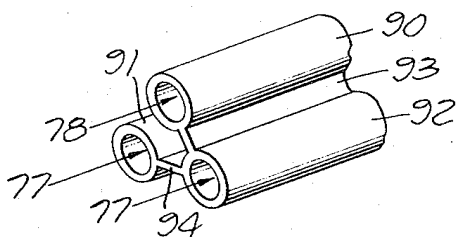
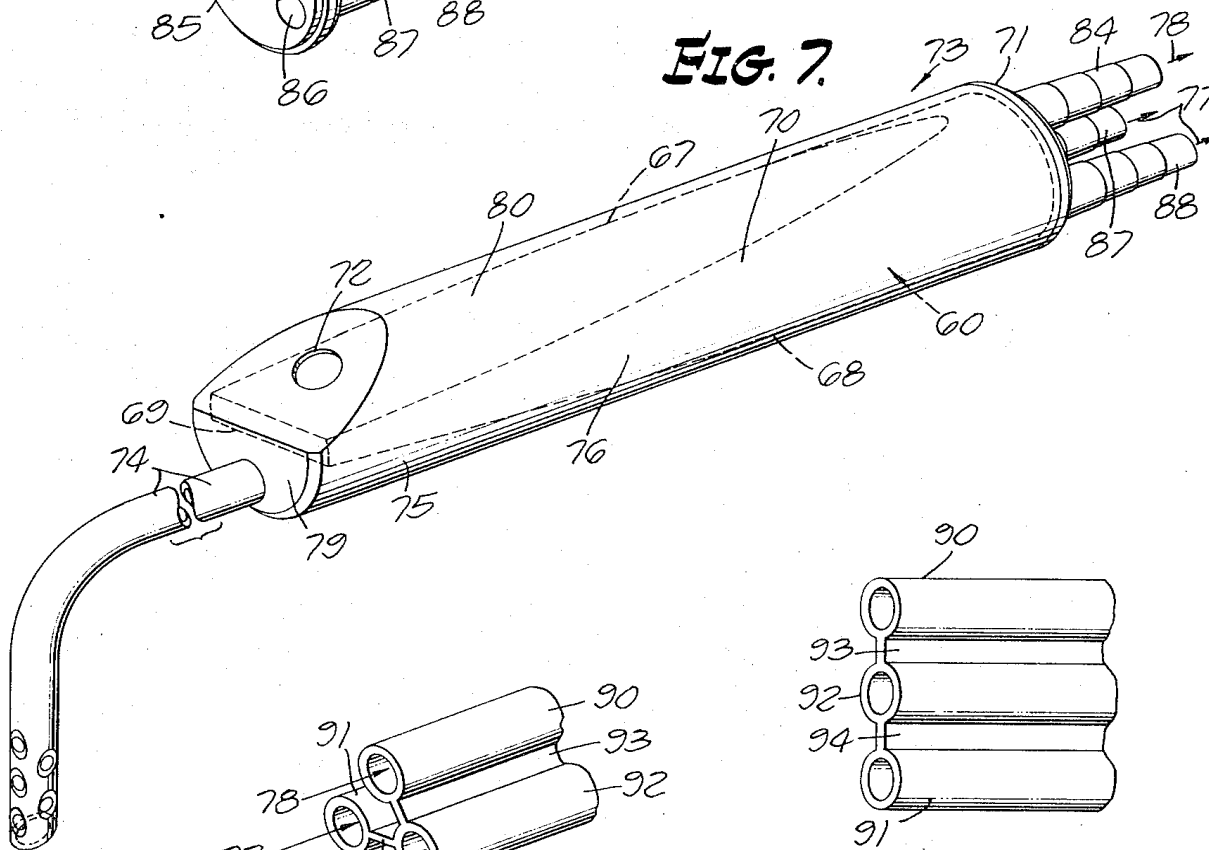
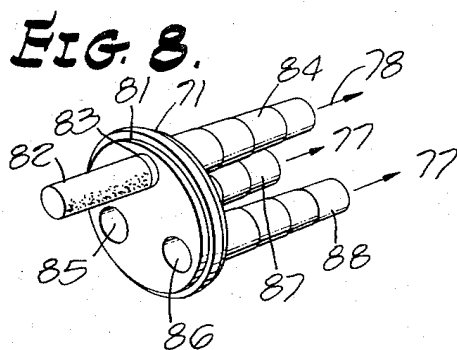
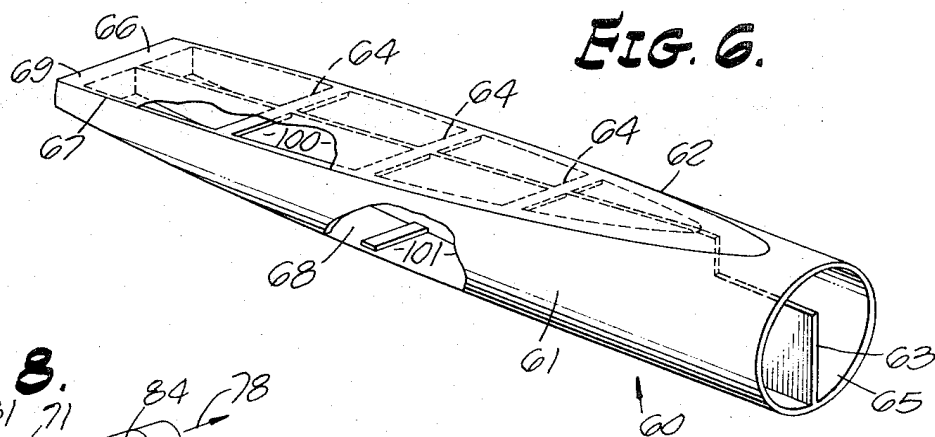


FIG. 5.





FILTERING BLOOD SUCKER

CROSS-REFERENCES TO RELATED APPLICATION

This application is related to the following applications filed earlier by the same sole inventor:

U.S. Patent application, Ser. No. 175,182 for BLOOD OXYGENATOR AND THERMOREGULATOR APPARATUS by Robert C. Brumfield, filed Aug. 26, 1971;

U.S. Patent application, Ser. No. 196,458, for BLOOD OXYGENATOR FLOW GUIDE, by Robert C. Brumfield, filed Nov. 11, 1971;

U.S. Patent application, Ser. No. 202,779, for TWO-PHASE FLUID FLOW GUIDE FOR BLOOD OXYGENATOR, By Robert C. Brumfield, filed Nov. 29, 1971; and

Docket No. 158 for LOW PRESSURE HEAT EXCHANGER FOR OXYGENATED BLOOD, by Robert C. Brunfield, filed Jan. 10, 1972. Brumfield,

Docket No. 160 for CARDIOTOMY RESERVOIR, by Robert C. Brumfield, filed Jan. 31, 1972.

BACKGROUND OF THE INVENTION

The filtering blood sucker is classified in Class 23 Subclass 258.5. The blood sucker is useful in combination with a peristaltic tube pump, evacuating blood lost by a patient at a surgical site.

There can be substantial loss of patient blood during a surgical procedure. A blood sucker is connected to the suction side of a peristaltic tube pump and evacuates patient blood lost, for early processing of the blood and its return to the patient's circulatory system. Since the recovered blood can contain surgical tissue debris, the blood can initiate the clotting mechanism. By removing the tissue debris from the recovered blood as quickly as possible by the filtering blood sucker, it is possible to decrease the risk of clot formation in the patient, with a subsequent more favorable patient prognosis.

SUMMARY OF THE INVENTION

The filtering blood sucker is connected to the suction side of a peristaltic tube pump and evacuates blood lost in a body cavity by a patient during a surgical operation. The blood sucker evacuates air through its sucker vent as the blood sucker lies operatively connected to the peristaltic pump, prior to its actual use on a patient. The surgeon grips the blood sucker and applies a finger, closing the air vent aperture and causing the sucker to evacuate blood, air, surgical tissue debris and fluids from the surgical site. The air evacuated through the sucker while operatively connected, but not in surgical use, can be filtered through a disposable microporous filter secured in the sucker, cleaning the air. Thus the blood contamination from the air is greatly reduced. The blood sucker positively contains a second disposable open pore foam filter whose pore apertures are sized to remove tissue debris from the blood flowing into the sucker. The pore apertures are sized to remove the tissue debris, without removing the formed elements of the blood and altering the homogeneity of the blood. In the sucker the pair of filters, the micropore filter for air and the second disposable foam filter for the patient's blood, are physically separated. The air enters through the blood sucker air vent and the

three-phase mixture of blood, air, and tissue debris enters through the surgical evacuating tube also on the suction side of the blood sucker. Alternatively, the blood sucker can have only a disposable open pore foam filter sleeve means for the removal of surgical tissue debris from the evacuated three-phase mixture of blood, air and tissue debris, omitting the microporous air filter.

Other objects and advantages of this invention can be found in the specification and drawings appended to this application.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic illustration of the blood sucker of this invention connected in combination with the suction side of the peristaltic tube pump.

FIG. 2 is an elevational perspective partial sectional view of one blood sucker modification incorporating an open pore foam filter sleeve.

FIG. 3 is an elevational perspective view of a filter frame of this invention useful in the blood sucker illustrated in FIG. 2.

FIG. 4 is an elevational perspective view of a filter sleeve useful in the blood sucker illustrated in FIG. 2.

FIG. 5 illustrates a further detail of the attachment of the filter sleeve to the filter frame as shown in FIG. 2.

FIG. 6 is a perspective elevational view illustrating a single use integral component of a blood sucker incorporating a microporous air filter and an open pore foam blood filter of this invention.

FIG. 7 illustrates in perspective elevational view an assembled blood sucker of this invention incorporating the disposable blood sucker insert of FIG. 6 of this invention.

FIG. 8 is a detailed view of the simple blood sucker case closure for attaching and sealing a disposable blood sucker insert of FIG. 6 into the blood sucker product illustrated in FIG. 7.

FIGS. 9A and 9B illustrate the construction of the integral plurality of blood sucker tubes, providing separation and removal of air from the blood sucker.

THE PREFERRED EMBODIMENT OF THE INVENTION

Referring to the schematic view of FIG. 1 in detail, the blood sucker 10 is shown connected by blood conductive tubing 11 to the roller pump 12, which has a peristaltic pump suction side 13 and a pump pressure side 14, as the pump rotates in a direction 15. The suction side 16 of the blood sucker 10 accepts a three-phase flow of blood, air and surgical tissue debris intake flowing through the pump in the direction 17 and venting from the pump at 18 into a cardiectomy reservoir, or the like. In operative procedure, the vent 19 on the blood sucker 10 is closed by an operator's finger to produce evacuation through the sucker 10 in the direction 16.

Referring to FIG. 2 in detail, a blood sucker 20 of this invention has a surgical evacuating tube 21 disposed on the suction side of the sucker 20 and secured to a tubular plastic case 22. The screw cap closure 23 closes the blood sucker 20. The air vent 24 penetrates the case 22 and is equivalent to the air vent 19 of blood sucker 10. The pump evacuation tube 25 is equivalent to the blood conductive tubing 11. Disposed internally in the tubular plastic case 22 is the open pore foam filter sleeve 26 having a closed filter terminus 27. The tubu-

lar case 22 has a closed case terminus 28 to which the surgical evacuating tube 21 is attached. A filter frame 29 supports the porous foam filter sleeve 26, the filter frame 29 having a frame terminus closure 30. The porous foam filter sleeve 26 covers the filter frame 29 and is secured to the filter frame closure 30 by the wire clamp ring 32. The filter frame exit conduit 31 provides a filter evacuation aperture 33 in the frame closed end 30. The exit conduit 31 is secured in the exterior evacuating means tube 25.

Further details of the filter frame 29 are illustrated in FIG. 3, wherein the filter frame members 29 are shown to be connected by a crossed set of frame members 34, and all are integral with the filter frame closure 30. The filter frame exit conduit 31 is integrally secured to the closed end 30, providing a filter evacuating aperture 33. A securing groove 36 is provided around the end 30.

The porous foam filter sleeve 26 is shown in detail in FIG. 4, having a closed filter terminus 27 and an open filter sleeve terminus 35. Further, in FIG. 5 is shown the details of the conventional wire clamp ring 32 which is secured to the porous foam filter terminus 35, securing the sleeve 26 in the groove 36 of the closed terminus 30.

Referring to FIG. 6 in detail, the single use blood sucker tubular insert unit 60 is shown to have triangular shape support sides 61 and 62 and a triangular central partition 63. A plurality of supportive ribs 64 are secured across the members 61, 62 and 63, providing a pair of oppositely disposed frame plate support areas 100 and 101. An evacuating aperture 65 forms one end of the unit 60 and a support bracket 66 forms the other insert end. On the top surface of the blood sucker unit 60 is disposed a microporous filter sheet 67 sealed on the frame plate support area 100 formed on the pair of edges of the triangular sides 61 and 62. A porous polyurethane foam filter sheet 68 is sealed on the frame plate support area 101 formed on the pair of bottom edges of the triangular shape support sides 61 and 62. The filter sheet 68 is permeable to whole blood, and filters out surgical debris and the like. The bracket 66 supports a bond 69 of the microporous filter sheet 67 and the foam sheet filter 68, providing an impervious seal through which blood does not flow.

Referring to FIG. 7 in detail, the tubular plastic case 70 encloses the blood sucker insert unit 60, and has an evacuating closure 71 secured to the case 70. An air vent 72 is covered by the surgeon's finger to place the complete blood sucker unit 73 in operation. Prior to the use of the blood sucker unit 73, room air is sucked through the air vent 72 by a peristaltic pump unit 12 or the like. The air sucked into the blood sucker 73 through the vent 72 is filtered through the microporous filter sheet 67, thus filtering out bacterial, pollen and other types of airborne contaminants from the remainder of the blood sucker unit 73. When the surgeon closes the air vent 72 with a finger, and places the evacuation tube in the patient's body cavity, the three-phase mixture of blood, air and surgical tissue debris are evacuated through the tube 74 into the blood reservoir 75 and thence into the filtered blood reservoir 76 where the filtered blood 77 and air 78 are removed through the blood sucker case closure 71. In practice the inlet blood and tissue reservoir 75 traps the surgical tissue debris, passing whole blood through the foam sheet filter 68 into the filtered blood reservoir 76. The

blood sucker insert unit 60 is dimensioned to fit snugly in the case 70, the bonded joint 69 contacts and imperiously seals the case 70 at the case terminus 79, providing a separate air reservoir 80 disposed above the microporous filter sheet 67.

FIG. 8 illustrates in detail the seal and the mechanical securing means provided by the sealing bead 81 disposed on the blood sucker case closure 71. By simply inserting the blood sucker insert unit 60 into the case 70 and pushing in the closure 71, one can make an hermetic and mechanical joint, sealing in the insert 60. A further modification of the blood sucker unit 73 is provided by the fine pore sponge cartridge 82 secured in the air aperture 83, through which the air 78 exits through exit conduit 84. The polyurethane sponge cartridge 82 is treated with a thin film of the silicone composition which induces blood-air foam collapse. Thus, any blood-air foam touching 82 is induced to collapse and air passes through the polyurethane sponge. The silicone treated sponge cartridge 82 will not readily pass whole blood, so the blood is entrained in the pair of apertures 85 and 86 and exits through conduits 87 and 88.

FIG. 9 illustrates an integral plurality of flexible, conductive blood tubing which are useful in inducing laminar blood-air slug flow in a roller peristaltic pump of the illustrated type 12. The unit tube 90 is secured to the exit conduit 84 and vents most of the air from the sucker 73. The pair of unit tubes 91 and 92 carry exiting blood 77 in the blood-air slug flow from the sucker 73. The tubes 91 and 92 are specifically diametrically sized to provide laminar slug flow as taught in applicant's earlier teaching of U.S. Ser. Nos. 175,182 and 196,458. The unit tubes 90, 91 and 92 are integrally connected by the flat continuous rubber strips 93 and 94. Thus the three tubes can be disposed parallel and flat, as shown by the fragmentary view of FIG. 9B, and placed in a peristaltic roller pump for operational blood processing.

It is basic to the filtering blood sucker of this invention that a porous filter structure is embodied which has pore structure sized to filter the formed elements of whole blood, ranging up to 100 micron average particle diameter. The porous polyurethane foam filter sheet 68 is sized to remove surgical tissue debris and the like of larger particle size, retaining these large particles on the reservoir 75 side of the foam filter sheet. In a further modification of this invention an open pore foam filter permeable to whole blood can be embodied in the case, to filter out the surgical tissue debris which enters the blood sucker.

It is desirable to provide a simple frame structure of a low cost, blood compatible plastic which can be suitably enclosed with a foam filter sleeve, filter sheet or other similar structure for the filtering of whole blood. The microporous filter paper typically has pore structure of less than 1 micron, such as 0.5 microns, or the like. The filter sheets, microporous or foam filter, can be sealed to the filter frame structures by heat sealing, cementing or the like. The porous polyurethane foam filter may be treated with a well known silicone defoaming composition to provide a very thin silicone film on the porous foam which will tend to collapse the air-blood foam on contacting the filter. Thus the blood sucker filtering unit can provide the first step in the defoaming of filtered blood and air phases increasing the

rate of blood processing for rapid return to the patient's extra-corporeal circulation.

Obviously many modifications and variations in the improvement in the filtering blood sucker can be made in the light of the above illustrations, embodiment and teaching. It is therefore understood that within the scope of the appended claims the invention may be practiced otherwise than has been specifically described.

I claim:

1. In a blood sucker having a case forming a hand-piece, said case having an inlet, an evacuating tube and an air vent, the improvement comprising:

an open pore plastic foam filter mat operatively disposed inside said blood sucker case providing pores sized to pass particles less than 100 micron average diameter, said filter mat compatible with blood, said filter mat filtering all blood, air and surgical debris passing into said blood sucker filter case, said filter mat retaining said surgical debris, said blood and air exiting through said filter mat through the sucker case exit conduit.

2. In a blood sucker having a case forming a hand-piece, said case having an inlet, an evacuating tube, an air vent, and an exit conduit, the improvement combination comprising:

an open pore plastic foam filter means operatively disposed inside said blood sucker case, said filter means compatible with blood; and,

a support filter frame positioned inside said blood sucker case providing a support structure for said filter;

said filter means and support filter frame combination adaptively filtering the whole blood-air foam and surgical tissue debris entering said blood sucker case, retaining said tissue debris in said filter and passing said whole blood and air through the exit conduit of said blood sucker case.

3. The combination with claim 2 wherein the further improvement comprises:

a porous plastic foam sheet filter means having a porous foam filter sleeve having one closed terminus and one open terminus; and,

a support filter frame having a frame supportively positioned inside said filter sleeve, said frame having one terminus closure and an evacuation tube secured to said closure, providing a fluid conductive aperture therein;

said open terminus of said filter sleeve adaptively secured coaxially on said frame terminus closure and said evacuation tube adaptively conductively secured to said blood sucker case exit conduit of said sucker case closure.

4. In a blood sucker having a case forming a hand-piece, said case having an inlet, an evacuating tube, and

an air vent, the improvement combination comprising:

a support filter frame having a pair of oppositely disposed frame plate support areas, said frame closely fitting in said blood sucker case, said frame imperiously partitioning said pair of frame plate support areas from each other;

a microporous filter sheet completely disposed over one of said frame plate support areas having pores less than one micron average diameter;

an open pore plastic foam sheet completely disposed over the second of said pair of frame plate support areas, providing pores sized to pass particles less than 100 micron average diameter;

said microporous filter sheet confronting the blood sucker case air vent and spaced therefrom, providing a separate air reservoir in said blood sucker case;

said plastic foam sheet confronting the blood sucker case evacuation tube, providing a separate reservoir for blood, air and surgical tissue debris in said blood sucker case; and,

a blood sucker case closure conductively sealing said blood sucker case exit terminus, providing an exit conduit for the blood and air filtered through said plastic foam sheet on evacuation of said blood sucker case, retaining said surgical tissue debris in said sucker case.

5. The combination of claim 4 wherein the further improvement combination comprises:

a blood sucker case closure having at least two exit conduits disposed thereon, each one of said conduits geometrically disposed providing dominantly separate air and blood evacuation through a separate conduit.

6. The combination of claim 4 wherein the further improvement combination comprises:

a blood sucker case closure having three exit conduits disposed thereon, one exit conduit sized and disposed to conduct predominantly air, and a pair of exit conduits sized and disposed to predominantly conduct laminar blood-air slug flow in exit conduits.

7. The combination with claim 4 wherein the further improvement comprises:

an open pore, sponge cartridge, having a blood impermeable sponge surface and a pore size less than 1 micron, disposed in said air exit conduit, providing a filtering air exit separating air from the blood-air foam.

8. The combination with claim 4 wherein the further improvement comprises:

an open pore polyurethane foam, having a blood compatible surface disposed thereon.

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