

[54] **FLUID SEPARATOR**

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210/460**

[51] Int. Cl. **B01d 35/00**

[58] Field of Search 128/214, 220; 210/406, 416,
210/436, 449, 451, 460-463; 251/7

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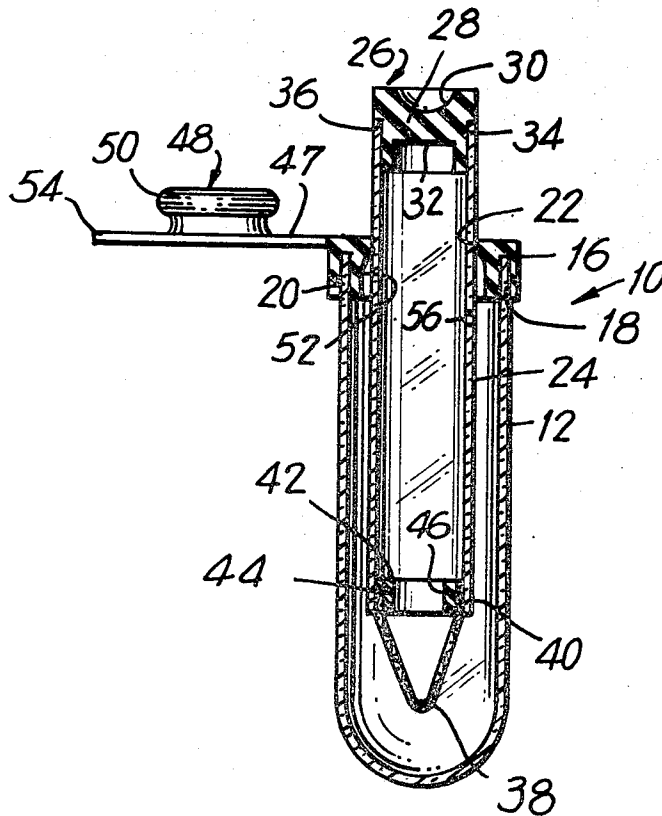
Attorney—Alex Friedman et al.

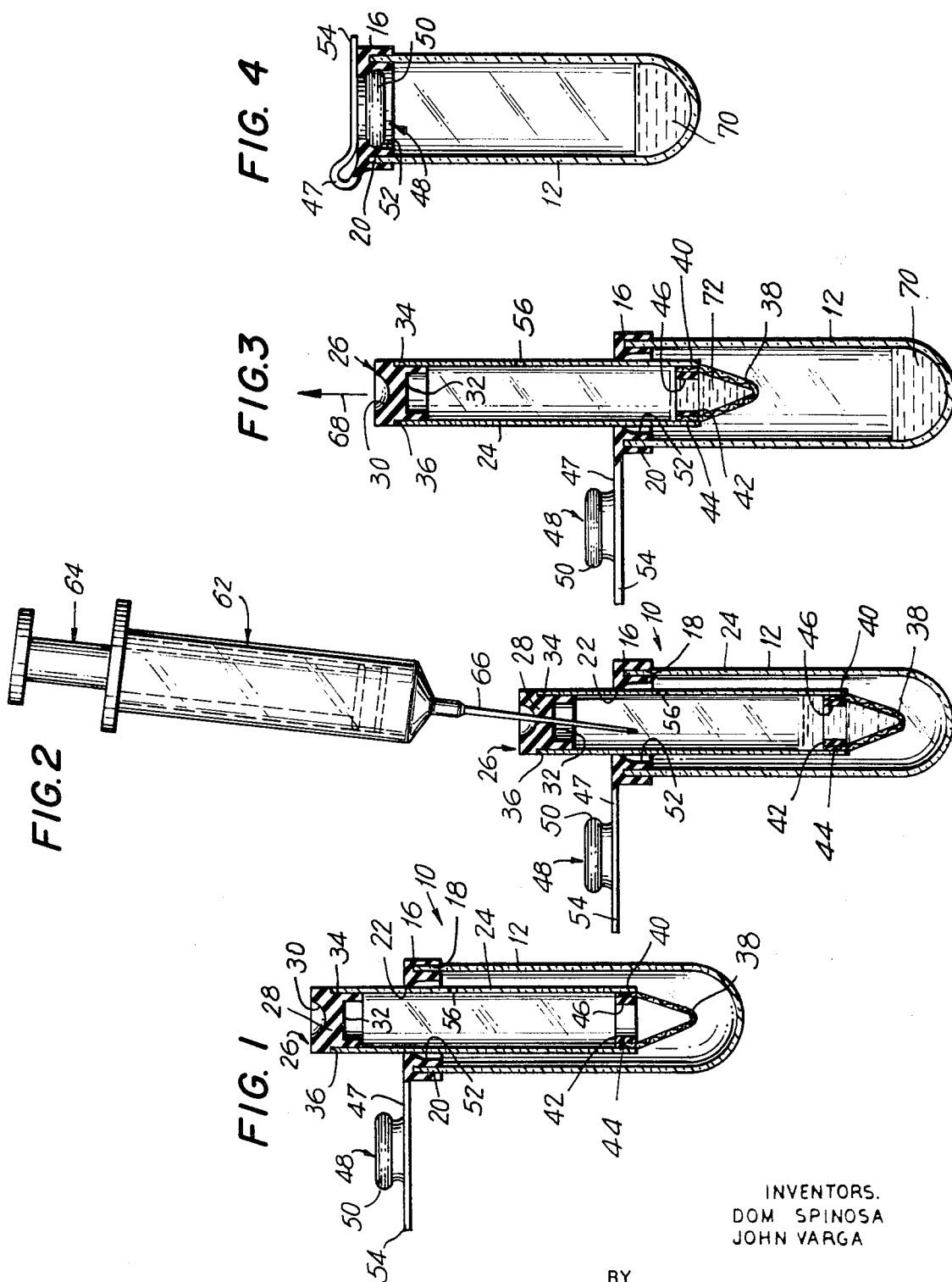
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ABSTRACT

A fluid separator having a tubular member slideably mounted in an entrance opening of an outer container by means of a first stopper. A porous filter is mounted on the inner end of said tubular member while a second stopper is provided on the other end thereof. The outer container is substantially evacuated, said second stopper being adapted to permit the passage of a hollow needle therethrough for the insertion of the fluid to be separated into said tubular member. Said filter means separates the fluid from heavier materials therein upon the withdrawal of said tubular member from said outer container.

12 Claims, 10 Drawing Figures





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FIG. 5

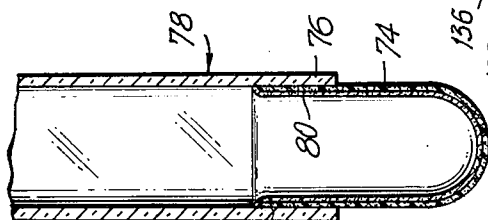


FIG. 6

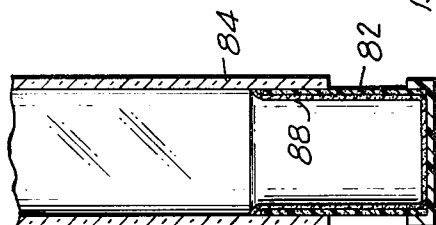


FIG. 7

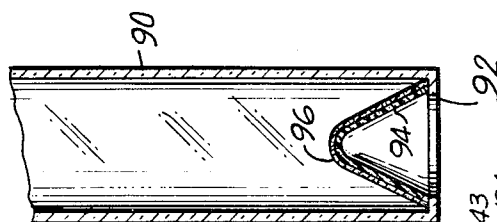


FIG. 8

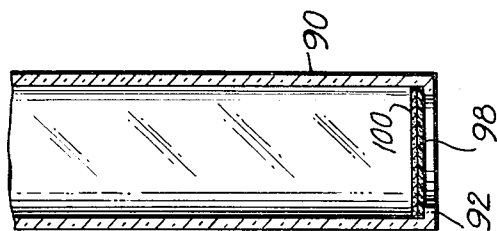


FIG. 10

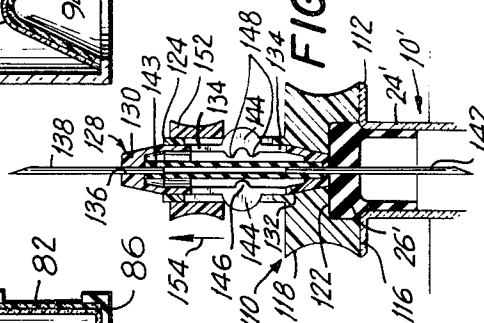
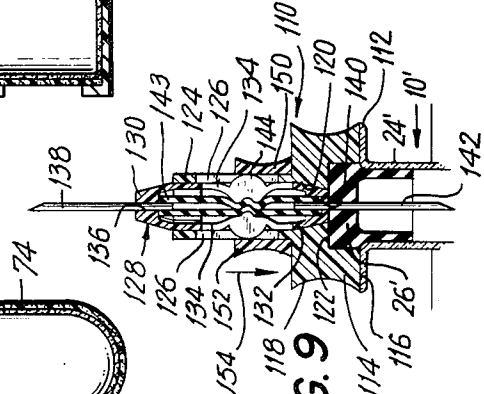


FIG. 9



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FLUID SEPARATOR

BACKGROUND OF THE INVENTION

This invention relates generally to filtering devices where it is desired to perform the rapid and efficient separation of heavier materials from fluid under sanitary conditions. One example of such a circumstance is in the separation of the heavier constituents of blood from the serum which now requires the use of centrifuge-type separators. While such filtering arrangements are effective, they have proved expensive and time consuming.

SUMMARY OF THE INVENTION

Generally speaking, in accordance with the invention, a fluid separator is provided including an outer container having at least one entrance opening, a tubular member dimensioned to pass through said outer container entrance opening and positioned in said opening so that an inner end thereof projects into said inner container, first stopper means for sealing so much of said outer container entrance opening as lies outside of said tubular member while permitting the slideable displacement of said tubular member out of said entrance opening. The outer container and tubular member are substantially evacuated, said second stopper member being adapted to permit the penetration thereof for the insertion of the fluid to be separated into said tubular member while leaving said vacuum substantially undisturbed.

Fluid separation is accomplished by slideably displacing said tubular member out of said inner container, the filtrate passing through said filter means into said outer container. The tubular member may be formed with a vent aperture through the portion of the wall thereof projecting into said outer container.

The first stopper means is formed with a central opening therethrough for receiving said tubular member, and may be formed with a cap portion coupled to the balance of said first stopper means by a flexible portion, said cap portion being adapted to seal said central opening in said first stopper means upon the withdrawal of said tubular member from said outer container.

A porous support member may be provided for supporting at least a portion of said filter means. An adapter including a flow control valve means may be provided for penetrating said second stopper means.

Accordingly, it is an object of this invention to provide a fluid separator which is simple to manufacture and utilize.

Another object of the invention is to provide a fluid separator particularly adapted for separating the heavier constituents of blood from the serum.

A further object of the invention is to provide an evacuated fluid separator wherein the fluid may be readily inserted within said separator by means of a conventional hypodermic needle or a special adapter while a portion of said fluid separator defines a retaining and storing container for the filtrate after separation.

Still other objects and advantages of the invention will in part be obvious and will in part be apparent from the specification and drawings.

The invention accordingly comprises the features of construction, combinations of elements and arrange-

ment of parts which will be exemplified in the constructions hereinafter set forth, and scope of the invention will be indicated in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the invention, reference is had to the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is a sectional view of the fluid separator according to the invention;

FIGS. 2-4 illustrate the step-step process for utilizing the fluid separator of FIG. 1;

FIGS. 5-8 are fragmentary sectional views showing alternate constructions of the filter means of the fluid separator according to the invention; and

FIGS. 9 and 10 are sectioned views of a valved adapter for applying the fluid to the fluid separator according to the invention, in the closed and open position respectively.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, the serum separator 10 depicted incorporates an outer container 12 formed substantially in the shape of a test tube and having an entrance opening 14. A first stopper 16, formed with an annular slot 18 on one surface thereof receives the rim 20 of outer container 12 in said slot in sealing engagement. First stopper 16 is formed with a central opening 22 therethrough for snugly receiving tubular member 24 which projects into inner container 12. First stopper 16 serves to seal that portion of entrance opening 14 of outer container 12 extending between the periphery of tubular member 24 and rim 20 of said outer container. The tubular member is longitudinally displaceable in said first stopper without affecting the seal between said stopper and said tubular member.

A second stopper 26 is mounted in the upper end of tubular member 24. Said second stopper is formed with a central region 28 of reduced thickness defined by cutout regions 30 and 32. The thinned region 28 is held in compression within the rim 34 of tubular member 24. The upper portion of said second stopper is of increased diameter to define step 36 against which rim 34 abuts to position said stopper on said rim. A substantially cone shaped filter member is mounted across the opening in the inner end of said tubular member and is firmly held in place against rim 40 of said tubular member inner end by an elastic rim member 42. Said ring member is dimensioned to pressingly engage the periphery 44 of filter medium 38 against rim 40 of said tubular member. Said ring member is formed with a central opening 46 therethrough to permit communication of liquid from said tubular member to said filter means which projects outwardly from said tubular member to the base of said outer container.

Mounted on first stopper 16 by means of a flexible connector tab 47 is a cap member 48. Said cap member is dimensioned to seal the opening 22 in first stopper 16 when tubular member 24 is removed. Cap member 48 is provided with an annular projecting rim 50 dimensioned to mate with a corresponding annular reentrant recess 52 formed on the internal periphery of said first stopper for retaining said cap member in position. A tongue 54 projects from said cap member for providing

a handle for manipulation of said cap member. One or more vent openings 56 are provided in the wall of tubular member 24 immediately below the point of engagement with first stopper 16, as shown in FIG. 1.

The outer container 12 and tubular member 24 are preferably formed from glass or plastic adapted to provide structural rigidity during the manipulation of the serum separator according to the invention. The first and second stoppers 16 and 26 respectively are formed of a resilient rubber or plastic. The filter medium is formed of sheet material such as Nylon, Teflon, paper or the like having a plurality of apertures therethrough dimensioned to pass a filtrate therethrough.

The operation of the serum separator according to the invention is illustrated in connection with FIGS. 2-4. Outer container 12 and inner container 24 are substantially evacuated with the tubular member projected into outer container 12 so that aperture 56 falls within said outer container. Such evacuation can be achieved by passing a hollow needle connected to a vacuum pump through the thin portion 28 of second stopper 26. Due to the compressive mounting of second stopper 26 as described above, the thin portion 26 is self sealing so that the vacuum within outer container 12 remains undisturbed upon the removal of said hollow needle.

As more particularly shown in FIG. 2, the fluid 60 to be separated is inserted within the evacuated tubular member 24 by means, for example, of a conventional hypodermic needle 62 provided with an inserting plunger 64 and a hollow needle 66. As depicted in FIG. 2, said hollow needle pierces thin portion 28 of second stopper 26 to extend into tubular member 24, thereby permitting the insertion of the fluid 60 into said tubular member. Said fluid is retained within said tubular member by filter medium 38. As described above, the self sealing characteristics of second stopper 26 permits the withdrawal of hypodermic 62 without substantially disturbing the vacuum within outer container 12 and tubular member 24.

As depicted within FIG. 3, tubular member 24 is then longitudinally displaced in first stopper 16 in the direction of arrow 68. When aperture 56 in said tubular member passes out of second stopper 16, a pressure of about one atmosphere is applied to the top surface of fluid 60 so as to force the filtrate through the apertures in filter media 38. The filtrate 70 accumulates in outer container 12, while the portion 72 of said fluid not capable of passing through filter medium 38 is retained within tubular member 56. The quantity and nature of the material passing through filter medium 38 is determined by the dimensions of the apertures in said porous filter medium.

Finally, as shown in FIG. 4, the tubular member is completely withdrawn from second stopper 16 and the opening 22 in said stopper is sealed by cap portion 48. Thus, the outer container 12 serves as a storage container for said filtrate. A valved adapter may be used in place of hypodermic needle 62 as more particularly described below in connection with FIGS. 9 and 10.

The foregoing arrangement is particularly adapted for the separation of heavier components from the serum of blood, with said serum being effectively free of blood cells if a filter having apertures of 4 to 6 microns is utilized. By selecting the filter medium, minute particles can be effectively filtered from a fluid by the fluid separator according to the invention.

FIGS. 5-8 show a variety of alternate constructions for the mounting of the filter medium to the tubular member according to the invention. A porous support member 74 is bonded, welded, heat sealed, or otherwise suitably fastened to the inner surface of rim 76 of tubular member 78. A filter medium 80 is mounted within support member 74 so as to be supported thereby along substantially its entire surface, the porosity of said support member permitting the passage of the filtrate passed by said filter medium therethrough. A support member such as support member 74 may be required where the filter medium is not of sufficient strength, for example, due to its thin gage, to support the fluid during the separation process.

The embodiments of FIGS. 6, 7 and 8 are similarly provided with support members. While the support member of FIG. 5 is tubular in shape with the bottom end thereof closed by an integral portion of said support member, the embodiment of FIG. 6 is formed with a first tubular portion 82 secured to tubular member 84 and a second cap portion 86 mounted to close the bottom end of said tubular portion. Both the cap portion and tubular portion of said supporting member are formed of said porous material and support a filter medium 88.

In the embodiments of FIGS. 7 and 8, tubular member 90 is formed with an inwardly projecting flange 92 on the inner end thereof. Specifically with regard to the embodiment of FIG. 7, a substantially conical support member 94 is mounted to said flange so that the apex of said support member faces into tubular member 90. A substantially conical filter medium 96 is supported on said support member. In the embodiment of FIG. 8, support member 98 is mounted on annular flange 92 and supports a disc-shaped filter medium 100.

Both the filter medium and support member according to the invention are preferably formed of inert materials, the porosity and mesh sizes thereof being select in accordance with the material to be filtered from the fluid.

The tubular member and filter medium may also be formed as a single member by forming a test tube shaped member of a filter material and depositing a plastic coating on all but the transverse base thereof to provide rigidity and to fill the filter apertures in this region. In each of the above described embodiments, filtration ends when the fluid level falls below the uppermost portion of the filter material.

Referring now to FIGS. 9 and 10, an adapter 110 is shown mounted on embodiment of the fluid separator according to the invention 10' fragmentarily shown therein. Fluid separator 10' is substantially identical to the embodiments discussed above, except that tubular member 24' is formed with a radial flange 112 at the upper end thereof. Further, second stopper 26' is formed with a portion thereof projecting longitudinally out of tubular member 24'. Adapter 110 is formed with a mounting member 114. Said mounting member is formed at its base with an aperture dimensioned to receive the projecting portion of second stopper 26' in sealing engagement, with the end surface 116 of said support portion in engagement with flange 112 of tubular member 24'. The peripheral surface of the lower portion of support portion 114 is formed with an annular concave groove which permits the gripping of

adapter 110 for the insertion and removal thereof from serum separator 10'. Mounting member 114 is formed with a central bore 120 therethrough providing communication to the top surface 122 of second stopper 26'. The upper portion 124 of support member 114 is substantially tubular in shape and is formed with at least one pair of longitudinally extending facing slots 126 in the wall thereof.

Received within bore 120 of support member 114 is a needle carrying member 128. Said needle carrying member consists of a pair of end portions 130 and 132 joined by a pair of flexible ribs 134. End portion 130 of needle carrying member 128 is firmly retained within the cylindrical portion 124 of mounting member 114. Said end portion is formed with a bore 136 therethrough for sealingly receiving a hollow pointed needle 138. Similarly, end portion 132 of needle carrier 128 is firmly received in the bottom portion of mounting member 114 and is similarly provided with a bore 140 therethrough for receiving a second pointed hollow needle 142. A flexible plastic tubing 143 is mounted on the inner end of each of said hollow needles 138 and 142 and extends therebetween within needle carrier member 128.

Ribs 134 of said needle carrier member are provided with outward projections 144 dimensioned to be received in and extend beyond slots 126 in mounting member cylindrical portion 124, as best shown in FIG. 10. One of said ribs is provided with a single inner projection 146 while the other of said ribs is provided with a pair of spaced inner projections 148 aligned relative to single projection 146 so that when ribs 134 are displaced centrally toward the longitudinal axis of the adapter, single projection 146 mates with and coacts with the pair of inward projections 148 to engage and seal flexible tube 143, as most particularly shown in FIG. 9.

Adapter 110 is provided with a sealing ring 150 received about mounting member cylindrical portion 124 for longitudinal displacement therealong. The peripheral surface of sealing ring 150 is provided with a concave annular groove 152 to permit gripping of said ring. When said ring is lowered in the direction of arrow 154 so that the ring is in registration with projections 144 of ribs 134, said ring engages said projection to displace said ribs inwardly so that plastic tubing 143 is closed. When, as shown in FIG. 10, sealing ring 150 is displaced in the direction of arrow 154, the ring is carried clear of projections 144 and the ribs 134 are released, thereby opening tubing 143.

Adapter 110 permits the control of the fluid into separator 10'. Further, it permits the taking of a plurality of samples since needle 138 may be inserted in a container of the fluid or in a portion of the body, while needle 142 is sequentially inserted in a plurality of fluid separators 10', sealing ring 150 being displaced to cut off the passage of fluid through the adapter while the fluid separators according to the invention are changed.

It will thus be seen that the objects set forth above, and those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above constructions without departing from the spirit and scope of the invention, it is intended that all matter contained in the above descrip-

tion or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

What is claimed is:

1. A fluid separator, comprising an outer container having at least one entrance opening; a tubular member having openings in both ends dimensioned to pass through said outer container entrance opening and positioned in said opening with an inner end thereof projecting into said outer container; first stopper means mounted in said outer container entrance opening for slideably receiving said tubular member and for sealing the portion of said entrance opening outside of said tubular member; porous filter means mounted across the opening and defining the inner end of said tubular means; and second stopper means sealing the opening defining the other end of said tubular member, said fluid separator being adapted to permit the substantial evacuation of said outer container and tubular member, said second stopper means being adapted to permit the insertion therethrough into said tubular member of the fluid to be separated without substantially affecting said vacuum, whereby the filtrate portion of said fluid passes through said filter medium into said outer container when said tubular member is longitudinally displaced outwardly of said outer container.

2. A fluid separator as recited in claim 1, wherein said tubular member is formed with a vent hole therethrough on a portion thereof intermediate the normal fluid level and the point of engagement between said first stopper means and said tubular member.

3. A fluid separator as recited in claim 1, wherein said first stopper means is provided with a central opening through which said tubular member extends, said first stopper means engaging the periphery of said tubular member in sealing relation while permitting the longitudinal displacement thereof, said first stopper member being formed with a flexible arm portion projecting therefrom and a cap portion mounted to the end of said arm portion and dimensioned for selectively sealingly engaging the central opening of said first stopper means for sealing said outer container after withdrawal of said tubular member.

4. A fluid separator as recited in claim 1, wherein said second stopper means is provided with a thinned region as viewed axially relative to said tubular member, said second stopper means being dimensioned so that a compressive force is applied to said thinned region by said tubular member when said second stopper means is inserted therein, whereby said thinned region of said second stopper means may be pierced by a hollow needle for insertion of fluid into said tubular body without substantially affecting said vacuum.

5. A fluid separator as recited in claim 1, wherein said porous filter medium is inert.

6. A fluid separator as recited in claim 1, including a ring-shaped resilient mounting member for securing said filter medium to said tubular member, said filter member being pressingly engaged to said tubular member by said ring-shaped retaining member.

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7. A fluid separator as recited in claim 1, including a porous support member extending across the opening defining said inner end of said tubular member, said filter medium being supported on the inner surface of said porous support member, whereby the filtrate passing through said filter medium passes through said porous support member into said outer container.

8. A fluid separator as recited in claim 7, wherein said filter medium and porous support member are both inert.

9. A fluid separator as recited in claim 1, including adapter means having first and second hollow needles projecting therefrom, at least one of said hollow needles being adapted for insertion through said second stopper means; a fluid passage between said first and second hollow needles; and valve means for selectively opening and closing said fluid passage to control the passage of fluid therethrough.

10. A fluid separator as recited in claim 9, wherein said second stopper means is provided with a portion projecting longitudinally beyond said tubular member, said adapter means being provided with a mounting portion for cooperatively engaging said projecting portion of said second stopper means for the releasable

securing of said adapter means to said second stopper means.

11. A fluid separator as recited in claim 9, wherein said fluid passage includes a length of flexible tubing, said valve means including a pair of displaceable valve members positioned on opposed sides of said flexible tubing for displacement relative to said tubing in a first open position and a second position at which said flexible tubing is engaged between said valve members to close said fluid passage, and means for selectively displacing said valve means between said first and second position.

12. A fluid separator as recited in claim 11, wherein said adapter means includes a support portion having apertures therethrough; said valve members being dimensioned to project through said apertures at said first position and being normally biased in said first position, said displacing means including a member displaceable into and out of registration with said apertures and dimensioned to displace said valve members into said second position when in registration with said apertures.

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