

- [54] **POSITIVE PRESSURE LID FOR DIALYZER APPARATUS**
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[51] Int. Cl.:.....**B01d 31/00**
[58] Field of Search:.....**210/137, 494, 22, 23, 321**

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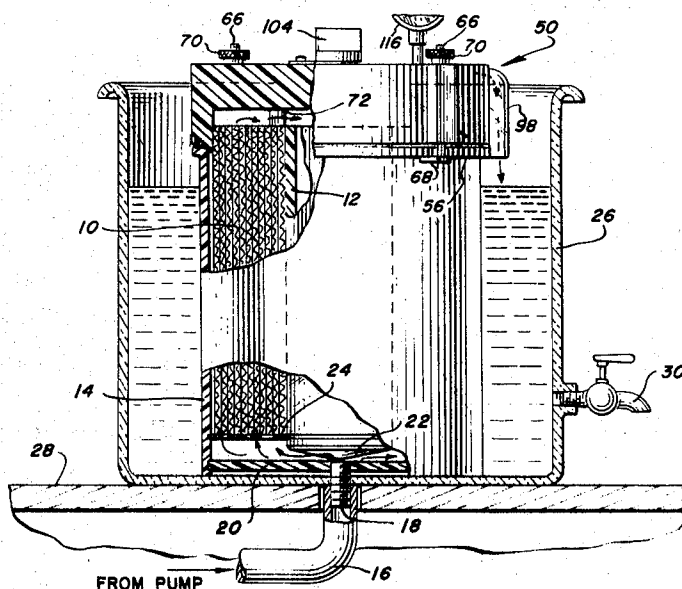
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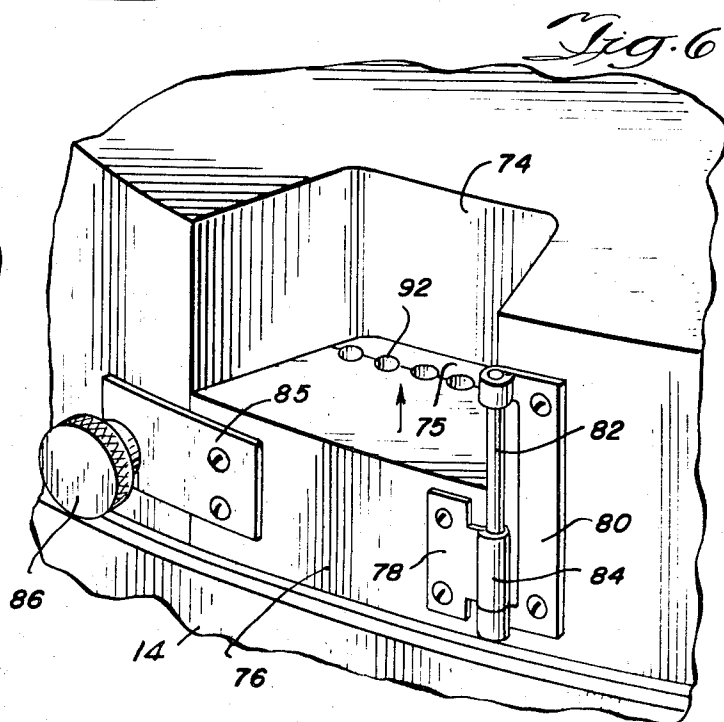
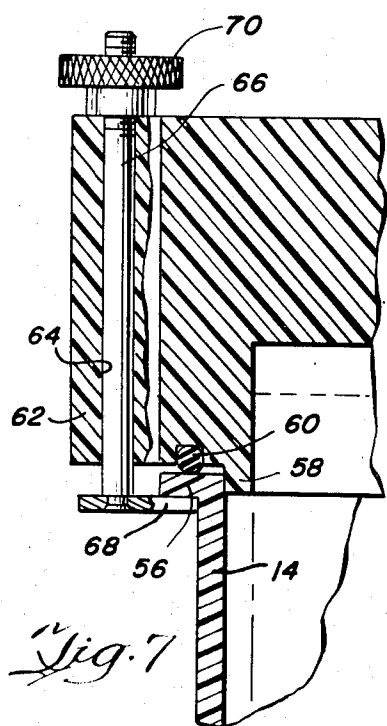
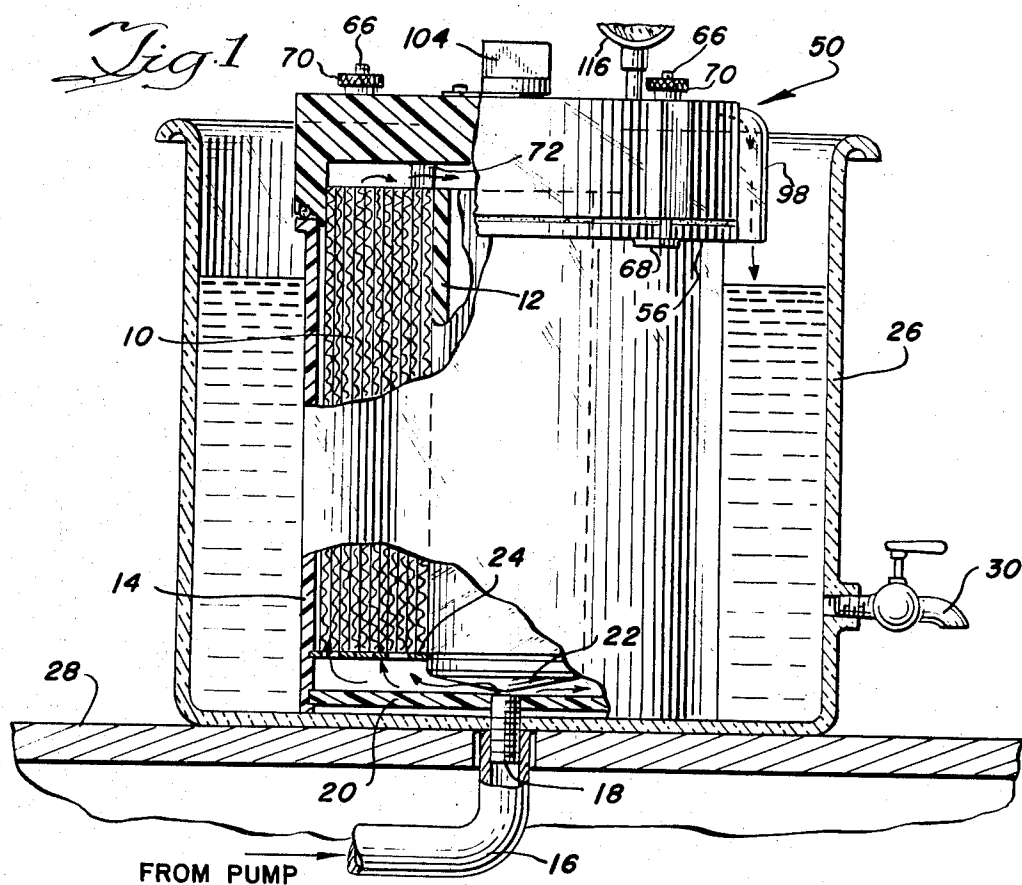
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[57] **ABSTRACT**

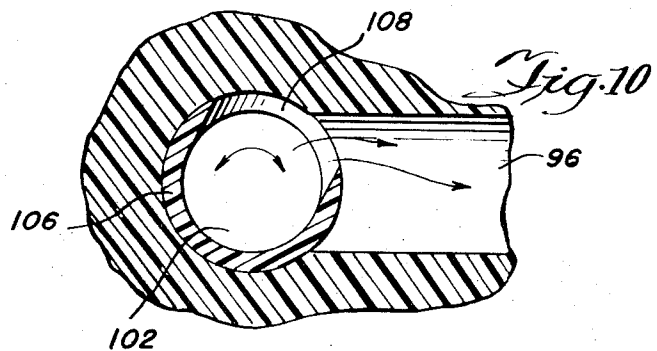
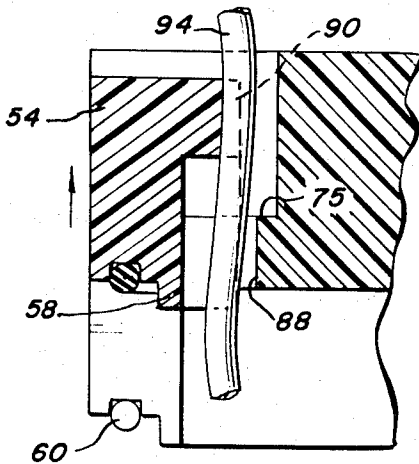
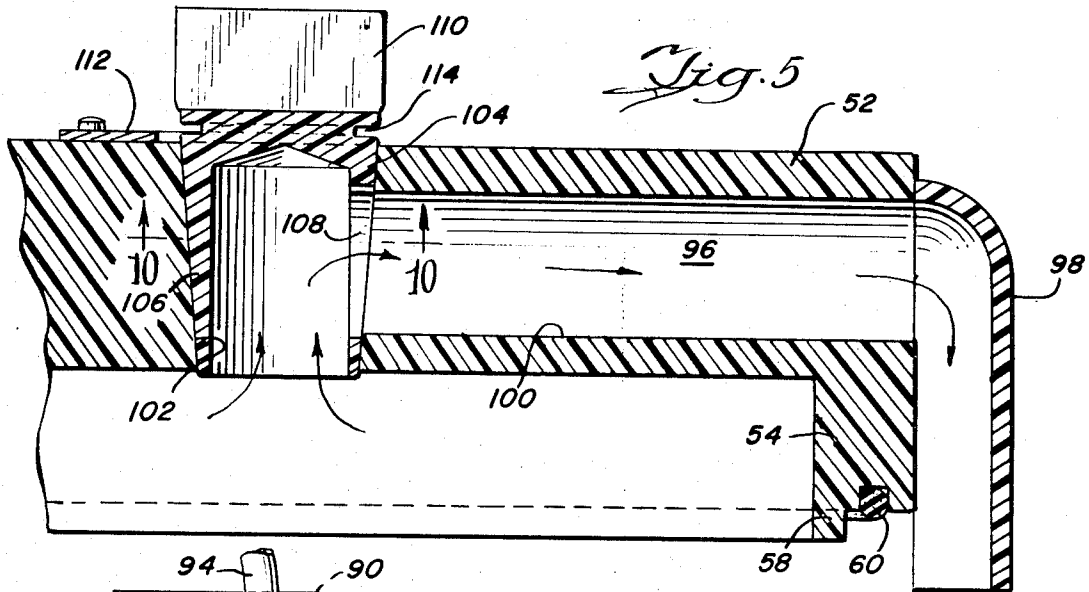
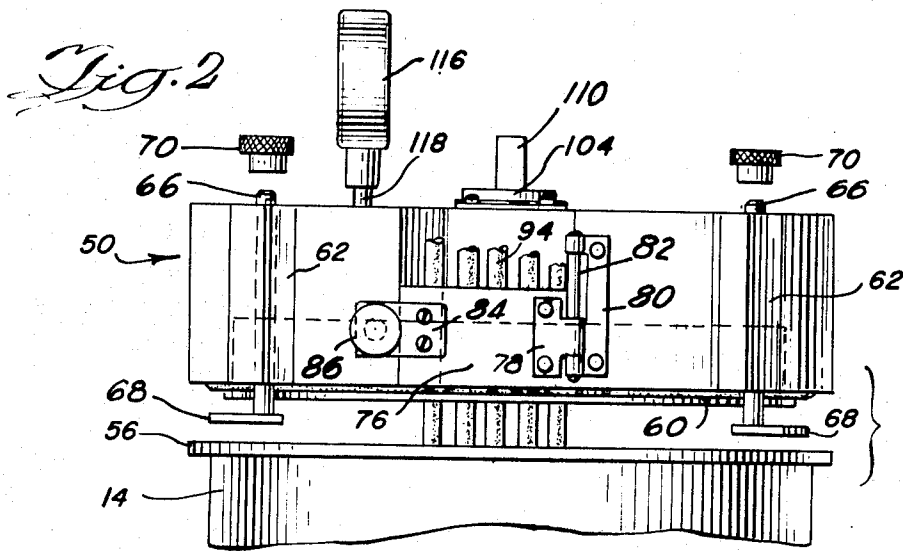
A cover for sealingly closing the dialysate chamber of an extracorporeal kidney apparatus and providing a flow duct for passing dialyzing fluid from the chamber. A valve in said flow duct to adjust the flow (volume/time) and vary the pressure within the dialyzing fluid compartment.

16 Claims, 15 Drawing Figures





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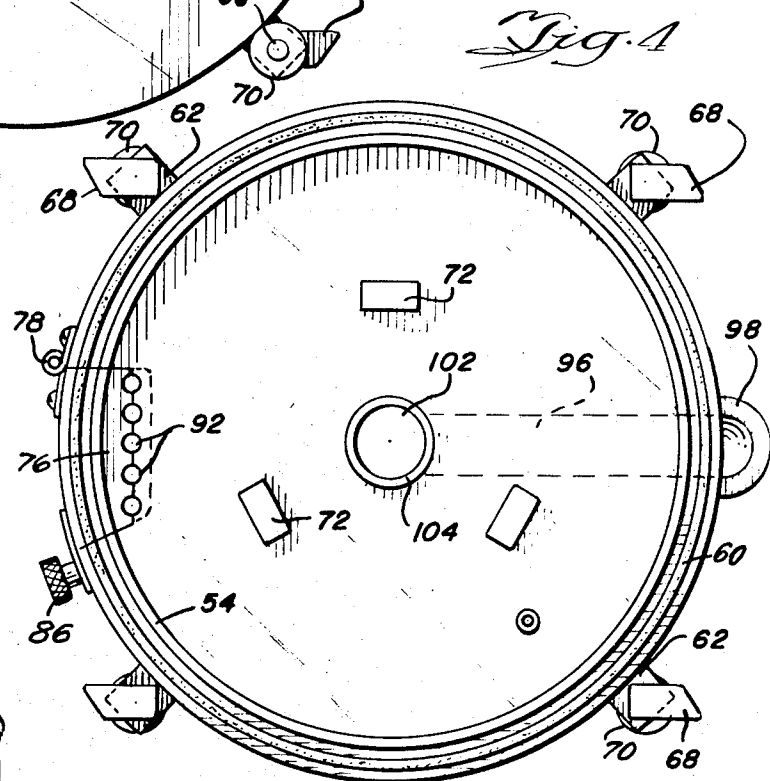
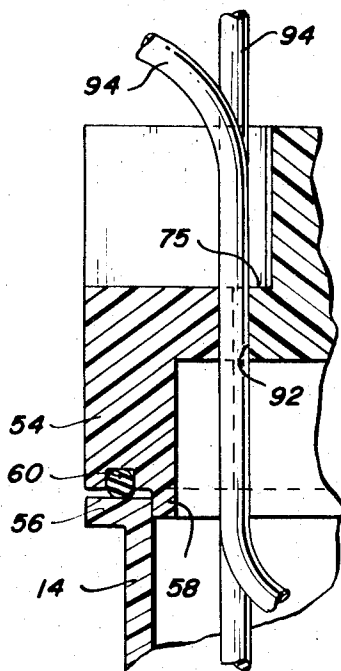
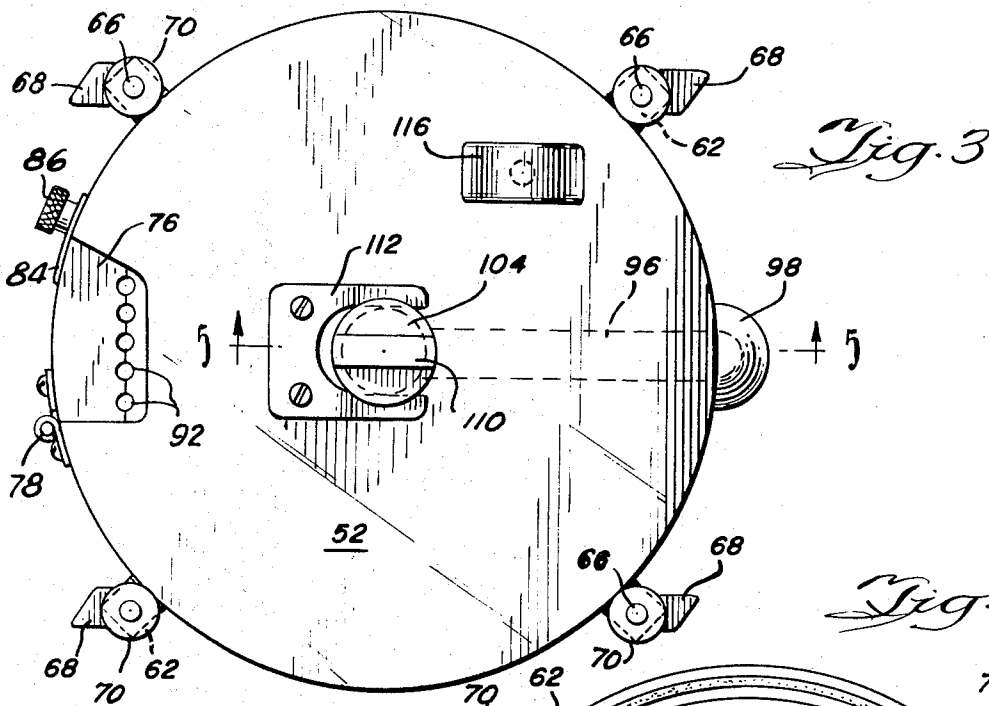


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Fig. 11

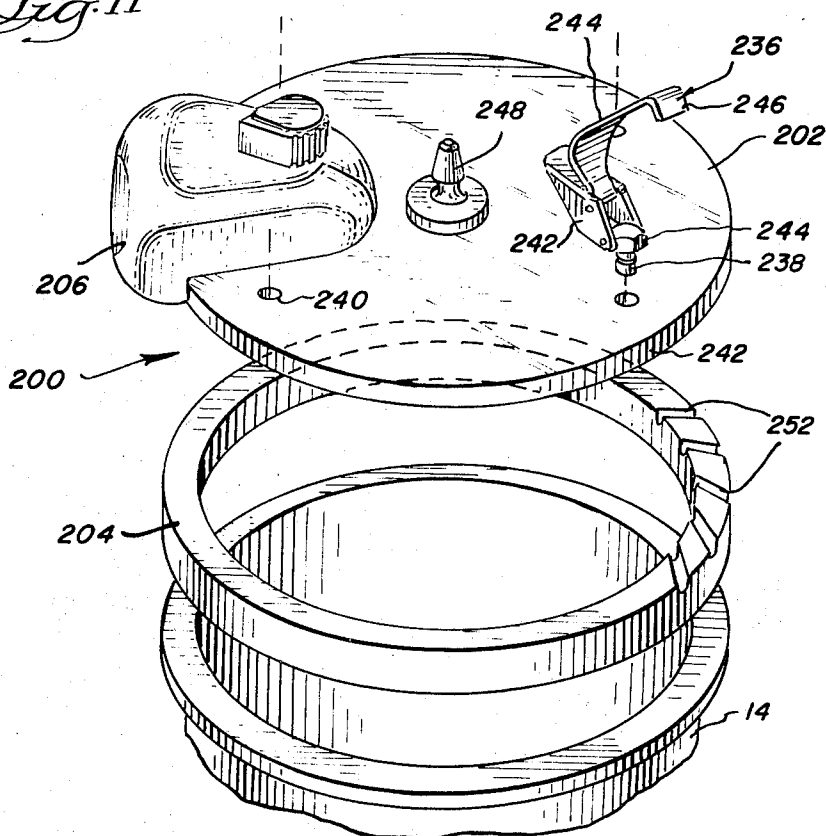
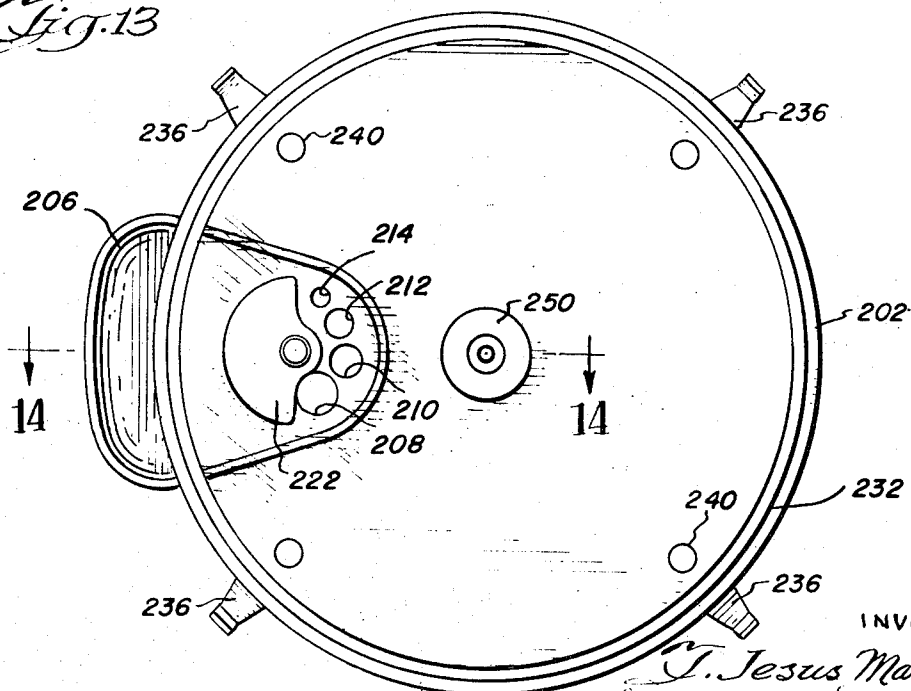
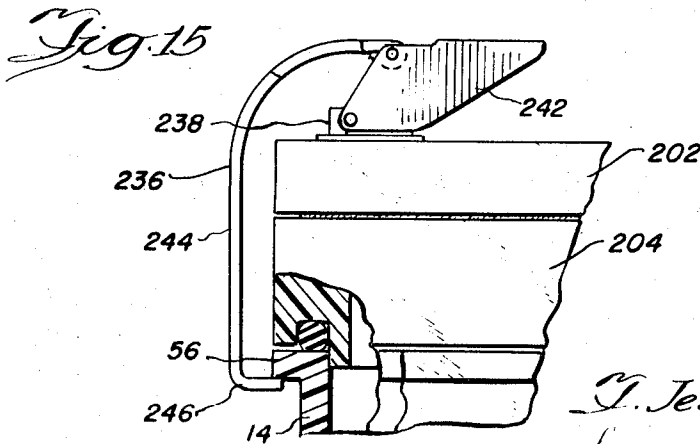
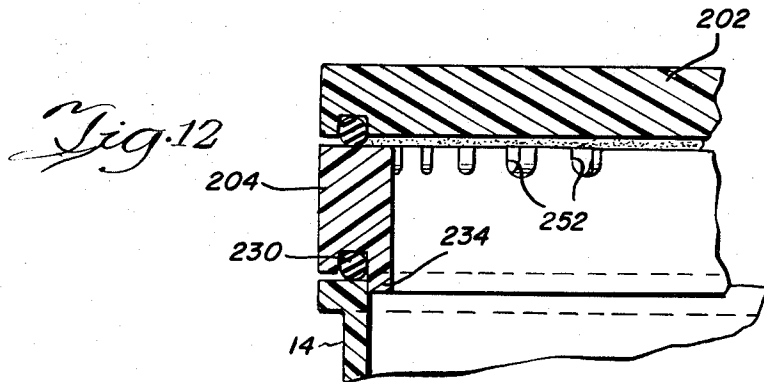
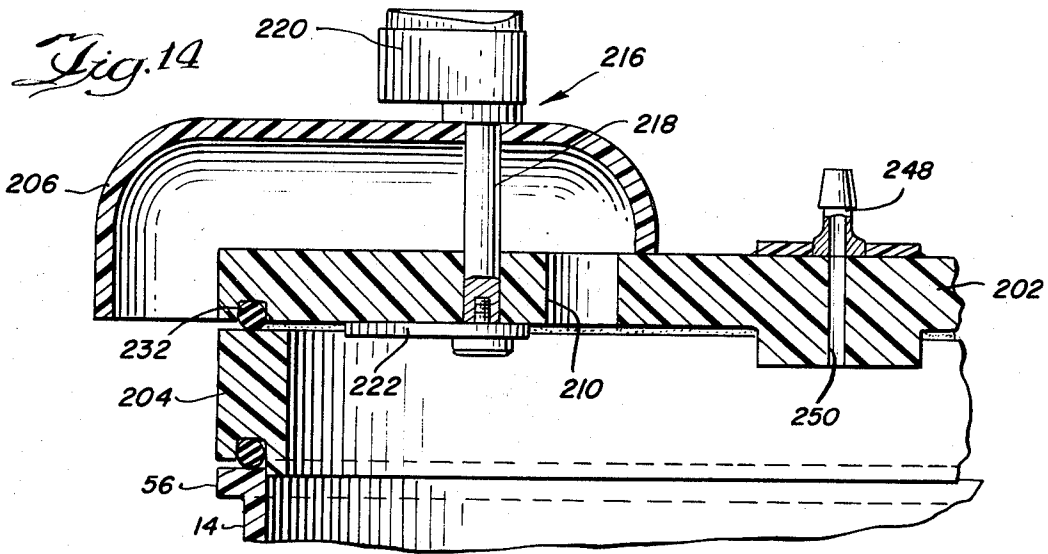


Fig. 13



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POSITIVE PRESSURE LID FOR DIALYZER APPARATUS

The present invention is within the art of artificial kidney apparatus and concerns particularly a cover member which is received on a canister or outer shell of the apparatus to enclose a dialysate chamber. More particularly, however, the cover member is sealingly received on the canister or outer shell and by provision of a valve disposed to cooperate with an outflow duct from the dialysate chamber the internal pressure may be varied.

Various forms of dialysis apparatus are well-known to the art as is the chemical phenomena upon which apparatus of this type is based. However, most of the known apparatus suffer from problems of water diffusion during dialysis, a condition which, under most circumstances, cannot be tolerated. It is this problem which the present invention seeks to overcome by management of the dialysate chamber pressure and consequently a transmembrane pressure gradient, as will be described.

Briefly, dialysis is carried out in an extracorporeal system and serves to cleanse from a biological fluid, such as blood, various organic and inorganic substances which are harmful to the system. For the purpose of this discussion the biological fluid will be considered as being blood.

One form of dialysis apparatus includes a blood flow chamber generally in the form of an elongated length of plastic tubing which may be wrapped upon a core and a dialysate chamber within which the blood chamber is disposed and through which a dialyzing fluid or wash solution is flowed. By proper support of the tubing which may be in the form of a semipermeable dialyzing membrane, for example Cuprophane which is a cellulose base membrane similar to cellophane, throughout its length the dialyzing fluid will be able to flow over a maximum amount of membrane surface area. The flow of blood and dialyzing fluid over each increment of membrane and on opposite sides of the membrane is preferably kept steady and continuous, even at the membrane surface where the requirement of flow is most important. In this connection the presentation of a stationary liquid film at the membrane surface would reduce solute diffusion efficiency.

As a consequence of a driving force (chemical concentration gradient) between the moving fluids on either side of the semipermeable membrane a passive physical diffusion of organic and inorganic substances will occur. To maintain the concentration gradient, if the dialyzing fluid is to be continuously circulated within a recirculating system, it is preferable to continuously drain a small volume of dialyzing fluid and to replenish the drained volume with fresh fluid. This is well-known.

Ultrafiltration also occurs during solute diffusion. Ultrafiltration is a phenomena which is not totally understood. Further, a complete discussion of what is thought to be the scientific principle and reasons for the occurrence of water diffusion from blood plasma is outside the scope of this invention. However, it is thought that ultrafiltration is a consequence or a function of many dialyzer characteristics. Thus, ultrafiltration is determined by, among other considerations, the transmembrane pressure gradient, area of dialyzer and perfusion flow rate, water permeability of the mem-

brane and boundary layer conditions. Of these, probably the most important consideration is the transmembrane pressure gradient.

The mean transmembrane pressure gradient, in a coil dialyzer, is of a complex nature. It is probably the summation of a multitude of pressures. Assuming that the blood path behaves like a rigid system, then pressure drop has a linear function following Poiseuille's equation:

$$\Delta P = \frac{12\mu L}{WH^3} \times Q_B \quad (1)$$

where μ is the viscosity of the test solution in dynes-sec/cm², L and W are the length and width of the dialyzer blood path in cm, H is the blood passage thickness in cm. and Q_B is the test solution flow rate in cm³/second. Then for a given set of steady state conditions the pressure drop across the dialyzer blood compartment can be approximated as the difference between the inlet and outlet pressure measurements.

$$\Delta P = P_{in} - P_{out} \quad (2)$$

The mean pressure across the blood compartment would be the average pressure between inlet and outlet of the dialyzer blood compartment

$$TP = \frac{P_{in} + P_{out}}{2} \quad (3)$$

The mean pressure across the dialysate compartment would be the average pressure between the inlet and outlet dialyzer dialysate compartment.

$$\Delta P_D = \frac{P_{D_{in}} + P_{D_{out}}}{2} \quad (4)$$

Then the true transmembrane pressure can be calculated as the difference between equations (3) and (4):

$$TP = \left(\frac{P_{in} + P_{out}}{2} \right)_{\text{blood}} - \left(\frac{P_{D_{in}} + P_{D_{out}}}{2} \right)_{\text{dialysate}} \text{ in mm. Hg.} \quad (5)$$

The blood osmotic pressure gradient, although very important, is not considered in this version of transmembrane pressure calculation.

where

IP = Transmembrane pressure in mmHg.

P_{in} = Pressure inlet (blood path) mmHg.

P_{out} = Pressure outlet (blood path) mmHg.

$P_{D_{in}}$ = Pressure dialysate inlet mmHg.

$P_{D_{out}}$ = Pressure dialysate outlet mmHg.

Following this hypothesis, one can modify ultrafiltration by manipulating transmembrane pressure. In actual tests by increasing the resistance at the dialysate outflow passage by manipulation of valving structure thereby to decrease flow the hydrodynamic pressure of the dialysate compartment may be increased. Since the pressure within the blood compartment is greater than the pressure within the dialysate compartment under atmospheric conditions an increase in dialysate chamber pressure will serve to diminish the transmembrane pressure gradient.

The amount of water diffusion would appear to be directly dependent, in part, upon the transmembrane pressure. While, as stated, the phenomena is not clearly understood there appeared, in tests, to be a dialysate chamber pressure value at which for any constant perfusion flow the volume of water diffusion became

smaller and then leveled to a relatively constant volume. Thus, for any one perfusion flow rate there appears to be some optimal pressure above which there is no significant reduction in ultrafiltration.

It is believed that this is a result of a reduced efficiency of the positive dialysate pressure in further reducing the transmembrane pressure gradient. In this connection, as the dialysate pressure is increased, a pressure increment is transmitted to the blood compartment. Therefore, control of ultrafiltration by means of pressurized dialysis is believed to be self-limiting at high dialysate chamber pressure.

A significant loss in the volume of blood during dialysis cannot be tolerated. This is because a very large percentage of chronic hemodialysis patients receive through transfusion procedures little or no blood during their therapeutic treatment. Thus, maximum blood recovery from the dialyzer is of paramount importance.

By the present invention the transmembrane pressure gradient may be reduced by pressurizing the dialysate chamber thereby to decrease the volume of water diffused from the plasma within the blood chamber into the dialysate compartment. This has been accomplished without detriment to the solute removal efficiency of the dialyzer.

In accordance with this aspect of the present invention there is provided a cover adapted for receipt upon the outer shell or canister defining the dialysate chamber of a coil-type dialyzer. However, it is to be clearly understood that the principle disclosed within this invention is applicable to dialyzers of types other than the coil type. The cover is provided with means to secure the same in a sealed manner on the outer shell or canister thereby to permit the build-up of a positive pressure within the dialysate chamber. The cover is formed with a passage through which dialyzing fluid passes from the chamber to be recirculated, as choice determines, and a valve mechanism operable in conjunction with the passage to change the resistance to flow thereby to develop or release pressure in the dialysate chamber. A pressure increase will simultaneously diminish the transmembrane pressure gradient.

In one form of the present invention the cover may be formed as an integral unit while in a slightly modified form of the present invention the cover may include a plate member of substantially flat construction and an annular ring member cooperable with the plate and serving as a mount for the latter on the outer shell or canister. The plate, as the cover described above, includes in conjunction with the dialysate outflow passage valving structure. The ring is provided with a plurality of cutouts for the introduction of one or more flexible tubes forming a part of the blood circulatory system and for connecting the blood chamber therein.

In accordance with a further aspect of the present invention, a guide block is formed within the cover to both receive and accommodate as well as to grip a plurality of flexible tubes connecting the blood compartment into the blood circulating system. In this connection the guide block is formed by a member capable of pivotal movement into and out of as well as up and down within a cutout portion of the cover and along the longitudinal axis of the cover when receiving the plurality of tubes. The block includes a plurality of

semicircular cutouts formed to cooperate with complementary cutouts within a shoulder to positively grip the several tubes in position.

In an additional aspect of the present invention there is means to measure the pressure within the dialysate chamber. To this end there is provided a port in communication with the chamber and a nipple mount adapted to connect a form of pressure measuring gauge.

There has thus been outlined rather broadly the more important features of the present invention in order that the detailed description thereof that follows may be better understood and in order that the present contribution to the art may be better appreciated. There are, of course, additional features of the present invention that will be described hereinafter and which will form the subject of the claims appended hereto. Those skilled in the art will appreciate that the conception upon which this disclosure is based may readily be utilized as a basis for the designing of other structures for carrying out the several purposes of the invention. It is important, therefore, that the claims be regarded as including such equivalent construction as do not depart from the spirit and scope of the invention.

In order that the invention may be more readily understood the same will now be described in conjunction with the accompanying drawings, in which:

FIG. 1 is a view in elevation, partly broken away and in section, of a coil dialyzer and the dialyzer cover;

FIG. 2 is a side elevation of the dialyzer cover and partially showing exploded therefrom a canister or dialyzer shell to which the cover is sealingly mounted;

FIG. 3 is a top plan view of the dialyzer cover;

FIG. 4 is a bottom plan view of the dialyzer cover;

FIG. 5 is a vertical sectional view as seen along the line 5—5 of FIG. 3 showing the flow port through the dialyzer cover and a valve member in the port;

FIG. 6 is a view in perspective of a portion of the dialyzer cover and a gate portion for supporting one or more fluid lines;

FIG. 7 is a partial vertical section through the dialyzer cover illustrating the manner of mounting on the canister or dialyzer shell;

FIGS. 8 and 9 are partial vertical sections through the dialyzer cover gate illustrating in sequence the manner in which the fluid lines are positioned and supported;

FIG. 10 is a horizontal section as seen along the lines 10—10 in FIG. 5 illustrating the port valve and that through rotation the volume of flow through the port may be changed;

FIG. 11 is an exploded perspective of a modified form of the dialyzer cover and showing a lip portion of a canister or shell;

FIG. 12 is a breakaway view in elevation illustrating the positioning of the cover on the canister or shell;

FIG. 13 is a bottom plan view of the dialyzer cover less annular ring as seen in FIG. 11;

FIG. 14 is a vertical section as seen along the line 14—14 in FIG. 13 and including in section a portion of the annular ring and canister or shell; and

FIG. 15 is a view similar to that of FIG. 12 illustrating the manner of receiving the cover, by clamping members, on the canister or shell.

A coil dialyzer of the type adapted to utilize the dialyzer cover of the present invention may be seen in FIG. 1. While the dialyzer construction and operation per se are not important to an understanding of this invention it is considered important to develop a background so that the present invention may be more clearly understood.

In an extracorporeal device, such as is shown in FIG. 1, there is passive physical diffusion of unwanted organic and inorganic substances across a semipermeable membrane as a consequence of driving force (chemical concentration gradient) from two moving fluids on opposed sides of the semipermeable membrane. To carrying out with acceptable efficiency the diffusion of substances from the blood it is desirable to provide maximum exposed membrane surface area to the flow of dialyzing fluid. At the same time, however, the membrane which may be in the form of an extended length of tube necessarily needs support throughout this length. This is particularly true in the coil-type dialyzer as is shown in FIG. 1. Therefore, as generally illustrated, an extended length of supported membrane tubing 10 is wrapped upon a core 12 within the area bounded by a canister or shell 14. The particular support structure is not shown in any detail since its construction is outside the scope of this invention. However, it is to be kept in mind that it serves to both support the membrane and allow a maximum of exposed membrane surface to the flow of dialyzing fluid.

While not shown the membrane is connected to an extracorporeal flow of blood to be dialyzed. The concentration gradient across the membrane is obtained by flowing dialyzing fluid over the opposed surface of the membrane throughout the entire wrapped length. In this connection dialyzing fluid is pumped into the area within which the wrapped membrane is disposed. To this end a conduit 16 from a pump (not shown) is threadedly coupled to an inflow spout 18 supported by a bottom wall 20 of the dialyzer assembly. By the provision of, for example, a somewhat conically shaped diverter plate 22 and annular perforated ring 24 the dialyzing fluid may be uniformly introduced into the assembly thereby to flow uniformly over the total membrane surface toward the dialyzing fluid outflow port.

In order that there may be a constant recirculation of dialyzing fluid in a closed system the fluid passed from the outflow port of the dialyzing chamber into a reservoir formed by a container 26. As shown, the reservoir container may be supported by surface 28. Any particular system for this purpose may be utilized. Such systems are well-known in the art. However, since dialysis efficiency gradually diminishes with the action of the apparatus, because of the diffusion gradient progressively falling off through operation, it is appropriate to both drain off a small portion of the dialyzing fluid and to replenish it with an equivalent amount of fresh dialyzing fluid thereby to maintain the diffusion gradient. In this connection the reservoir may be provided with an overflow determining the height of the reservoir or a tap or spout 30 within the wall of container 26.

A dialyzing fluid outflow port is formed within the dialyzer cover, generally identified by the numeral 50, which will now be described.

The dialyzing cover is illustrated as having a substantially flat upper surface 52 and generally of circular construction throughout. Depending from the peripheral region of the cover is an annular ring 54 providing a mounting surface for the cover on the canister or shell 14 which is formed with an upper out-turned lip 56.

The cover 50 may be formed of any material which may be fabricated as by molding and thereafter capable of being machined. The material of the cover should also provide a sturdy construction thereby to be a rigid assembly for a dialyzer unit. The construction also will be of the type capable of maintaining desired pressure conditions within an enclosed space. Generally, any of the commonly used metals, such as aluminum, or any of the widely used plastics, such as polypropylene, high density polyethylene, Lucite, among others, may be employed. If the cover is desirably to be transparent or translucent one of the plastic materials may be preferred.

As is illustrated, the cover 50 is mounted so that a bottom portion of the annular ring 54 rests upon the upper surface of lip 56. A further extending annular ring 58 is received within the upper opening of the shell 14 to position properly the cover. An O-ring 60 carried by the annular portion 54 serves to provide an airtight seal for the shell interior or dialysate chamber in which the dialyzing membrane is disposed. A plurality clamping assemblies including a post 62 having a central longitudinal bore 64, an elongated threaded bolt 66 which extends throughout the bore and which terminates in a foot portion 68, as well as a knurled thumb screw 70 are integral with or otherwise carried by the cover at spaced locations therearound. Preferably there may be three or four assemblies for the purpose of securely and sealingly mounting the cover 50. In assembly, the several feet 68 are received under the shell lip 56 thereby tightening the knurled screw 70 to compress the O-ring 60 between the annular ring 54 and lip 56.

A plurality of projections 72 are carried by or integral with the underside of the cover (FIG. 4). The projections serve to provide with the perforated annular ring 24 supporting confinement for the wrapped membrane 10 within the dialysate chamber.

The body of the cover 50 provides within a peripheral sector a somewhat trapezoidal shaped cutout 74. The amount of cutout within an upper portion is greater than that within the lower portion thereby to provide a shoulder 75. A guide block 76 is mounted for swinging movement into and out of the opening 74 as well as longitudinal movement within the opening between the FIG. 8 and 9 positions. The need to accommodate and provide for this movement will become apparent as the description continues. The guide block is dimensioned to be complementary with the shoulder and provide a smooth peripheral outer surface of the cover as in FIG. 6.

As is also shown in FIG. 6 a pair of hinges 78 and 80 are carried by the guide block and cover body, respectively. The hinges intercooperate by the provision of pin 82 being received within the turned extremity 84 of hinge 78. A lock plate 85 and cooperating knurled screw 86 are carried at the opposite side of the guide block to secure the latter in the closed position.

Both the shoulder 75 and the inside surface of the guide block carry a plurality of cooperating semicircular cutouts 88 and 90 forming a series of circular openings 92. These openings accommodate the tubes 94 which serve to connect the diffusion membrane into an extracorporeal circulatory blood path. The provision of a set or sets of two openings 92 permit a single or dual wrapped diffusion membrane to be connected into the system.

As has been discussed, the guide block is movable between FIG. 8 and FIG. 9 positions. This movement permits the several tubes 94 to be partially supported by the semicircular cutouts 88 and 90 (FIG. 8) whereupon the guide block is lowered (FIG. 9) so that the tubes are gripped within the openings 92. The tubes could not be otherwise gripped solely by pivotal closure of the guide block. Thus, if the tubes were to be received within the cutouts 88 they, upon closure of the guide block, would be pinched.

A port or channel 96 is formed within the cover body. This port or channel provides for discharge of dialyzing fluid from the dialysate chamber into the reservoir 26. A spout or splash shield 98 is mounted at the end of the port to direct the flowing dialyzing fluid into the reservoir 26.

The channel includes a horizontal passage 100 and a communicating vertical passage 102. A rotary valve 104 is disposed within the vertical passage and upon rotation may provide either an increase or decrease in the volume of outflow of dialyzing fluid.

The valve includes a generally cylindrical lower shaft portion 106 having an opening 108 in one wall portion of a size substantially equal to the cross-sectional size of the horizontal passage. The upper shaft 110 terminates in a hand gripping member to enable the operator to rotate the valve shaft with relative ease thereby to adjust the flow of dialyzing fluid. A U-shaped clamp plate 112 intercooperates with an annular cutout 114 in the valve shaft to allow rotation of the valve within the port 96 yet at the same time to prevent the valve from being withdrawn from the passage 102.

In operation, the cover is mounted as described and blood is caused to pass through the membrane or blood chamber. Simultaneously dialyzing fluid is introduced into the dialysate chamber and because of a maintained diffusion gradient across the membrane the diffusion of unwanted organic and inorganic substances continues. Usually the pressure within the blood chamber is in excess of the pressure within the dialysate chamber thereby creating a pressure gradient across the membrane with consequent ultrafiltration or diffusion of water to the area of lower pressure. By proper manipulation of the valve 104 a positive pressure may be developed within the dialysate chamber thereby to decrease the transmembrane pressure gradient and decrease the amount of water diffusion from the plasma. The dialysate chamber pressure may be read on a pressure meter 116 mounted by a connector 118 communicating with the interior of the dialysate chamber thereby to maintain the chamber at the desired pressure.

In a somewhat modified form of the invention, referring specifically to FIGS. 11 — 15, the cover 200 is formed of a plate section 202 and an annular ring section 204. The ring section 204 is substantially similar in

construction to the depending ring section 54 of cover 50. Similarly, the plate section 202 is substantially similar to the corresponding portion of cover 50.

The dialyzing fluid outflow port is defined by a plurality of passages 208 — 214 in communication with the dialysate chamber. By the provision of passages of varying size the volume of flow through the port and the chamber pressure may be controlled with some degree of precision. A cover or shield 206 provides an enclosure over the outflow port and serves to direct with limited splashing the dialyzing fluid into the fluid reservoir.

A control member 216 is supported for rotation by the shield 206 and the bottom surface of plate section 202. The control is defined by a shaft 218 which carries a knob 220 at one end and a curved, flat plate 222 at the other. As may be apparent proper positioning of the plate covering one or more parts of openings 208 — 214 will effect the flow volume from the dialysate chamber.

The ring 204 and plate 202 are adapted to be mounted upon the canister or shell 14 of the coil dialyzer 10. To assure proper sealing of the dialysate chamber the annular ring 204 includes an O-ring 230 which rests upon the lip 56 while a second O-ring 232 provides a seal at the junction between the annular ring and the plate 202. As with the cover 50 a projection 234 on the annular ring serves to position the cover 200 upon the shell 14.

A plurality of clamping members 236 are supported in spaced relation on the plate 202. As shown, the clamps are mounted by supporting lugs 238 which are frictionally or otherwise received within openings 240 formed in the plate 202 at approximately 90° spaced locations. The several clamps are identical in construction and therefore only one such clamp is illustrated. The clamp comprises a bifurcated body 242 having a base 242 into which the lug 238 is journaled for rotation. The clamp through appropriate mounting is also capable of pivotal movement about the lug. An arm 244 having a finger gripping end 246 is mounted on the body and capable of being pivoted about the body. Through manipulation of the body and arm the finger gripping end 246 may be received under the lip 56. Movement of body 242 from a raised pivotal position to the position of FIG. 15 serves to securely grip the lip thereby to positively mount the cover 200.

A nipple 248 supported by the plate 202 in communication with a passage 250 connecting the dialysate chamber is adapted to receive a pressure gauge, such as gauge 116, for the same purpose.

Whereas the cover 50 included a guide block 76 for gripping the several flexible tubes 94, the ring 204 in the present modification provides a plurality of channels 252 to accommodate the tubes. The O-ring 232 cooperates with the channel surfaces to grip the tubes without pinching.

From the foregoing it will be seen that in accordance with the present invention there is provided a dialyzer cover which performs the objects and provides advantages not heretofore achieved in dialysis.

Having described the invention with particular reference to the preferred forms thereof, it will be obvious to those skilled in the art to which the invention pertains, after understanding the invention, that vari-

ous changes and modifications may be made therein without departing from the spirit and scope of the invention as defined by the claims appended hereto.

Having described the invention, what is claimed is:

1. A cover for dialyzer apparatus having a dialysate chamber through which dialyzing fluid is circulated continuously thereby to be in contact over a surface within said chamber of a blood compartment adapted to confine a blood stream and formed by a membrane providing a semipermeable interface between said dialyzing fluid and blood through which because of a concentration gradient unwanted organic and inorganic substances diffuse from the blood into said dialyzing fluid, said cover comprising a body portion, said body portion including a dish-shaped member and an annular member, means on said body portion adapting said cover for receipt on said apparatus thereby to isolate said chamber from ambient conditions, means including a plurality of substantially radially disposed grooves in an upper surface of said annular member juxtaposed to said dish-shaped member when said members are received together for permitting unrestricted access of at least an inlet and an outlet tube into said chamber thereby to connect said blood compartment in an extracorporeal fluid system, means carried by one of said members to provide a seal therebetween, port means including a plurality of passages formed within said body providing a port through which said dialyzing fluid is passed, and means cooperable with said port means for varying through rotational adjustment the effective port area to adjust the volume of flow of dialyzing fluid through said port means thereby to vary dialysate chamber pressure and the transmembrane pressure gradient.

2. The cover of claim 1 wherein said passages are of varying cross-sectional diameter.

3. The cover of claim 1 comprising a shield over the end of said port means to prevent splashing of said dialyzing fluid exiting said port means.

4. The cover of claim 3 comprising a post, said post extending through said shield and said body and mounted for rotary movement, and said adjustable means comprising a plate carried by one end of said post and movable with said post thereby to adjust said volume of flow.

5. The cover of claim 4 wherein said cooperable means includes a flat plate mounted for rotation substantially in a plate including entrance to said port means thereby through movement to adjust the effective opening of the same, and means supported by said cover for moving said plate.

6. The cover of claim 1 including means carried by one of said apparatus and body to provide a fluid seal between said body and apparatus when received.

7. The cover of claim 6 wherein said sealing means is an O-ring.

8. The cover of claim 1 including means on said body adapted to mount a gauge to monitor chamber pressure.

9. A cover for dialyzer apparatus having a dialysate chamber through which dialyzing fluid is circulated continuously thereby to be in contact over a surface

within said chamber of a blood compartment adapted to confine a blood stream and formed by a membrane providing a semipermeable interface between said dialyzing fluid and blood through which because of a concentration gradient unwanted organic and inorganic substances diffuse from the blood into said dialyzing fluid, said cover comprising a body portion, said body portion being provided with a peripheral cutout of substantially trapezoidal shape and having a lower shoulder means for permitting access of at least an inlet and an outlet tube into said chamber thereby to connect said blood compartment in an extracorporeal fluid system, said means including a guide block, said guide block having a plurality of substantially longitudinally disposed grooves for cooperating with a like plurality of grooves formed in said shoulder thereby to define a substantially circular opening through which said tubes are unrestrictedly received, means on said body portion adapting said cover for receipt on said apparatus thereby to isolate said chamber from ambient conditions, port means including a plurality of passages formed within said body providing a port through which said dialyzing fluid is passed, and means cooperable with said port means for varying through rotational adjustment the effective port area to adjust the volume of flow of dialyzing fluid through said port means thereby to vary dialysate chamber pressure and the transmembrane pressure gradient.

10. The cover of claim 9, wherein one of said plurality of passages is defined by a longitudinal substantially cylindrical opening through said body and a second of said plurality of passages being defined by a transverse communicating bore.

11. The cover of claim 10 wherein said adjustable means comprises a substantially cylindrical cup-shaped element received for rotation within said opening, said cup-shaped element having an opening within one wall of a size substantially equal to the size of said transverse bore, and means in said cover for rotating said element to vary the effective port opening.

12. The cover of claim 11 including means to maintain the vertical longitudinal disposition of said cup-shaped element yet permit rotation of said element within said opening.

13. The cover of claim 9 comprising hinge means allowing movement of said guide block between a normal lowered position within said peripheral cutout to a raised position at which through pivotal movement out of said peripheral cutout said tubes may be received by said guide block grooves whereupon said guide block is redispersed in the normal position at which said tubes are positioned within said circular openings.

14. The cover of claim 9 comprising a shield over the end of said port means to prevent splashing of said dialyzing fluid exiting said port means.

15. The cover of claim 9 including means carried by one of said apparatus and body to provide a fluid seal between said body and apparatus when received on the latter.

16. The cover of claim 9 including means on said body adapted to mount a gauge to monitor chamber pressure.

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