

July 24, 1956

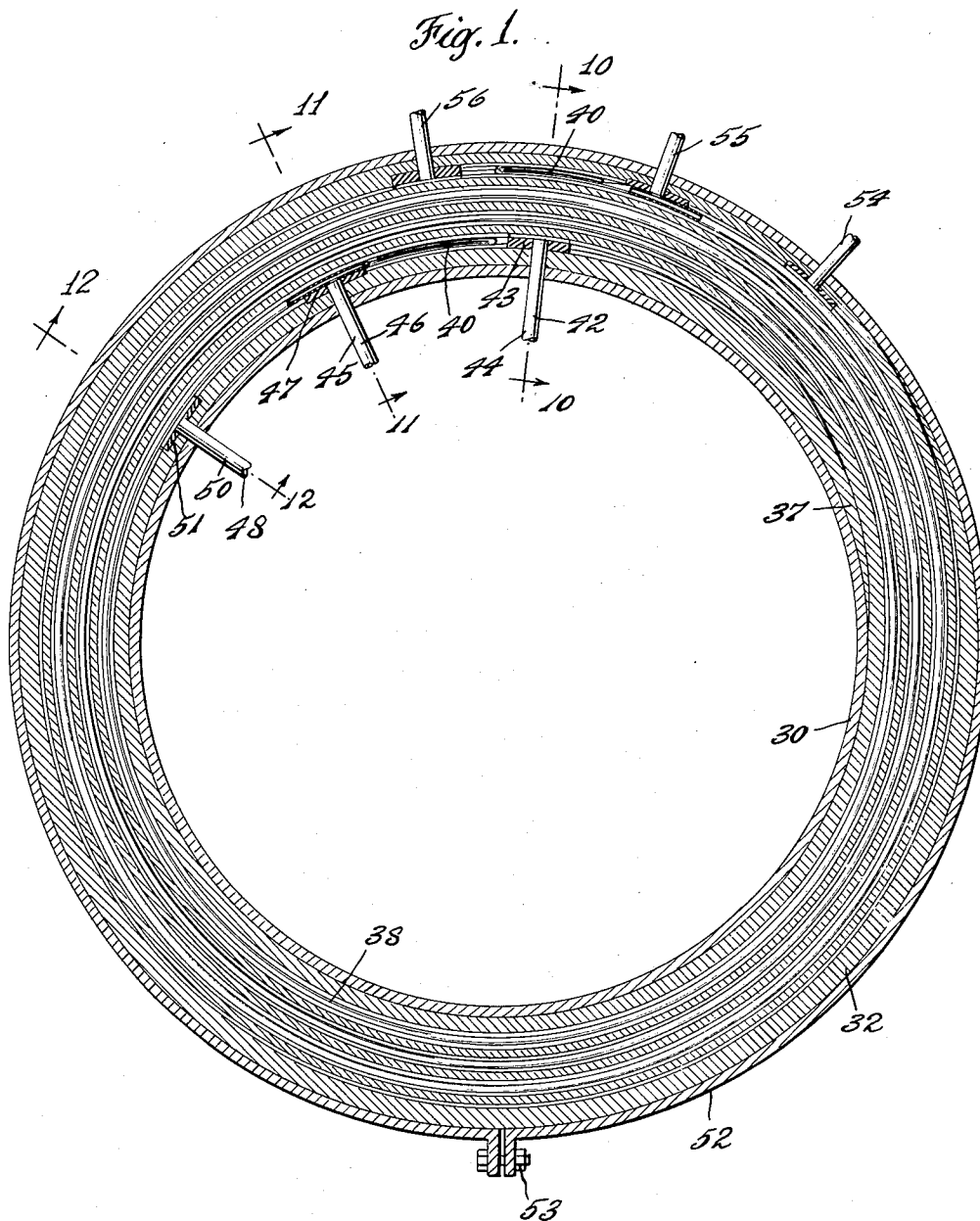
C. GOBEL

2,756,206

DIALYZER

Filed July 14, 1953

4 Sheets-Sheet 1



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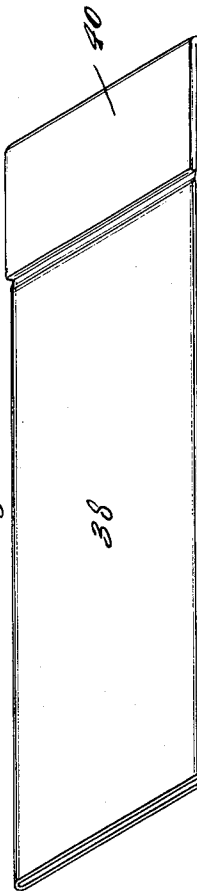
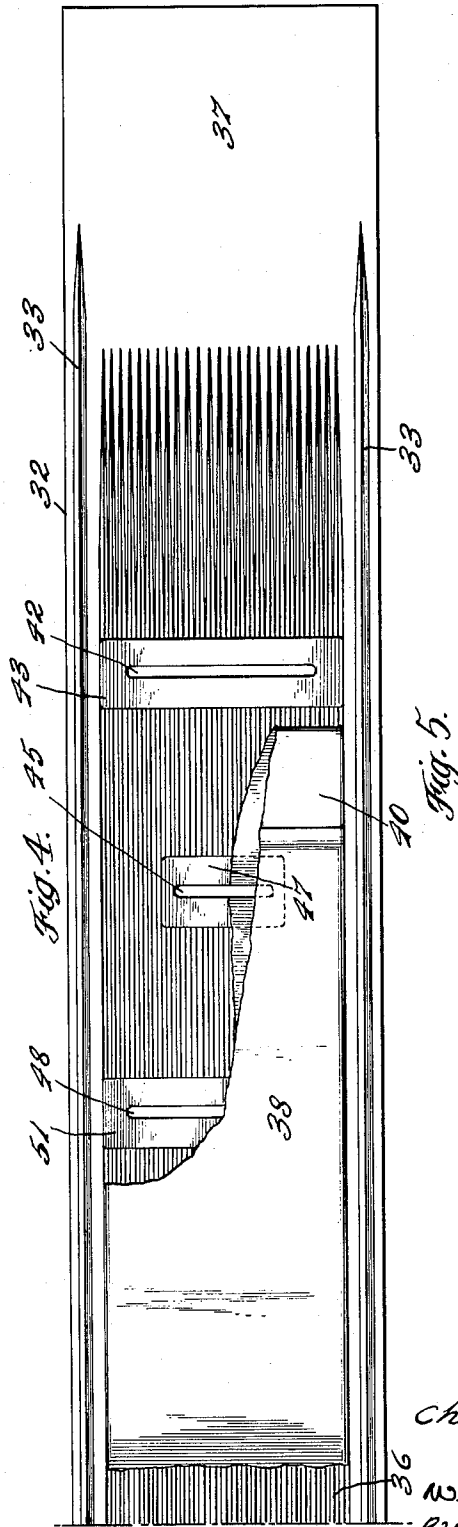
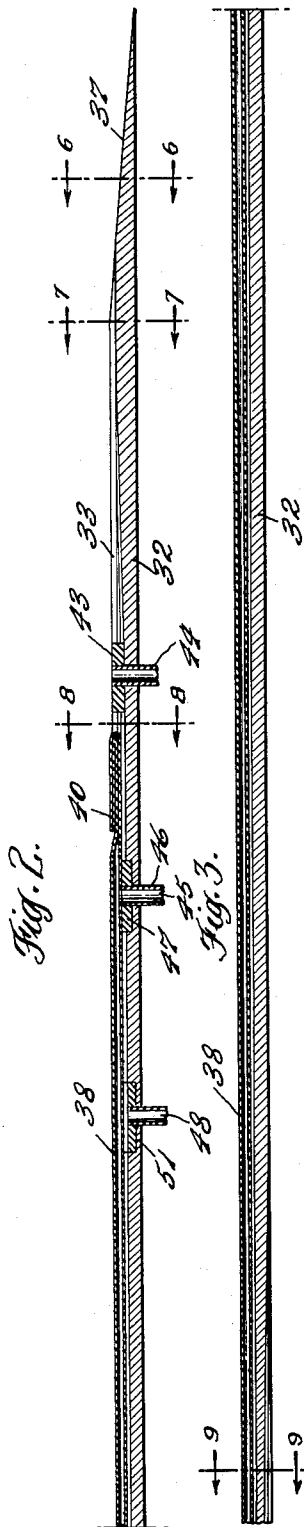
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C. GOBEL
DIALYZER

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4 Sheets-Sheet 2



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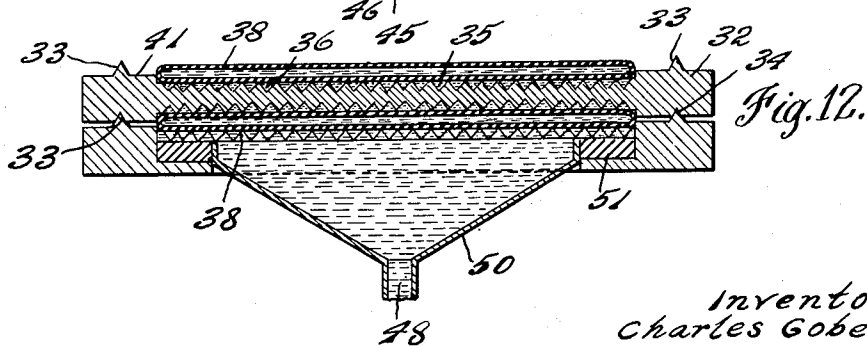
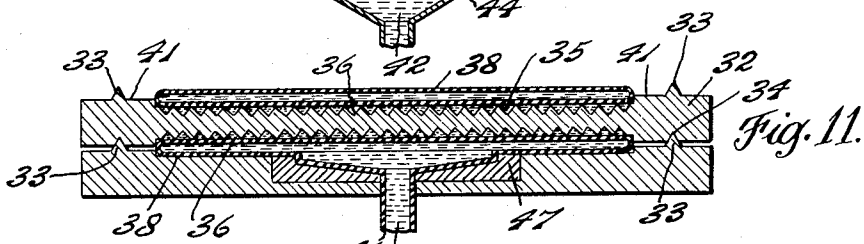
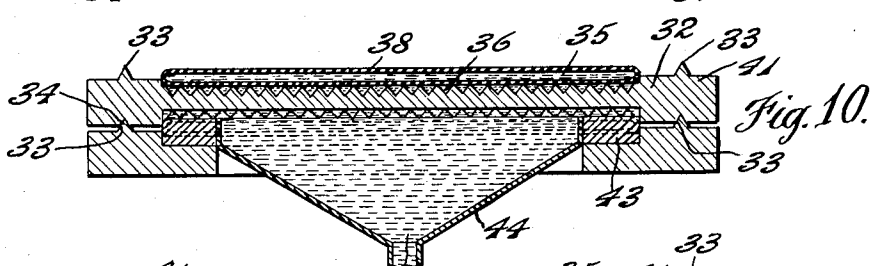
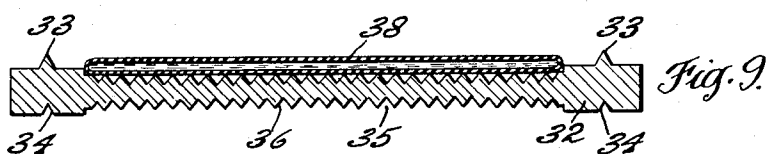
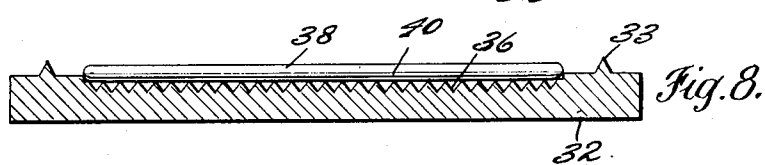
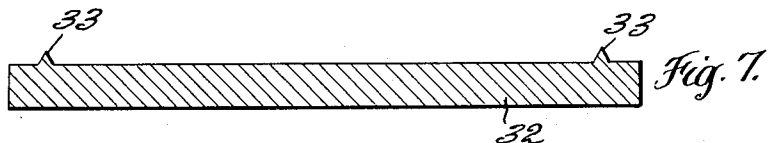
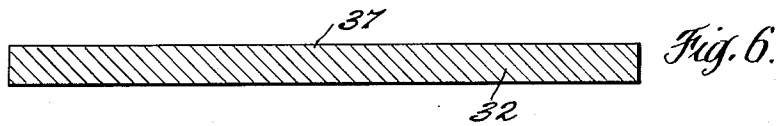
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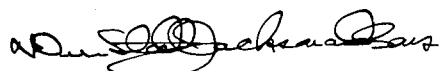
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Fig. 13.

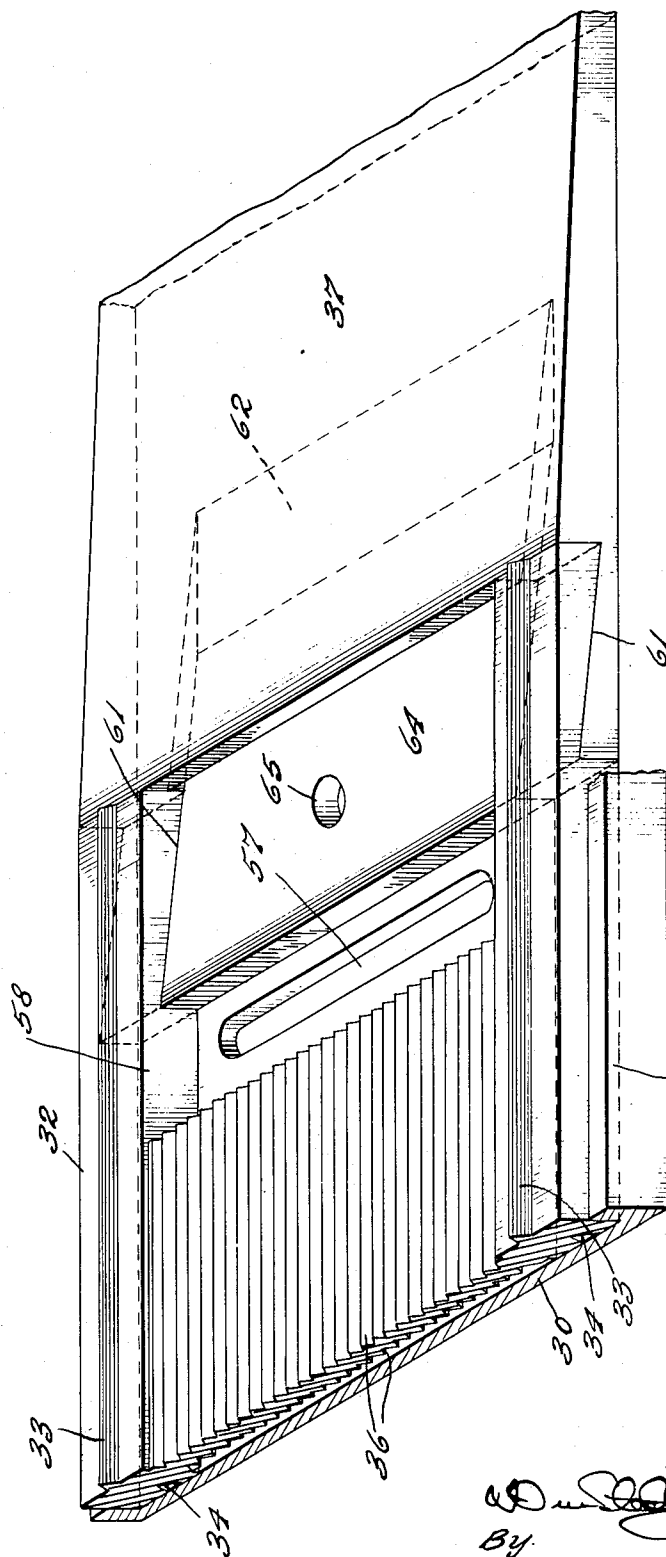
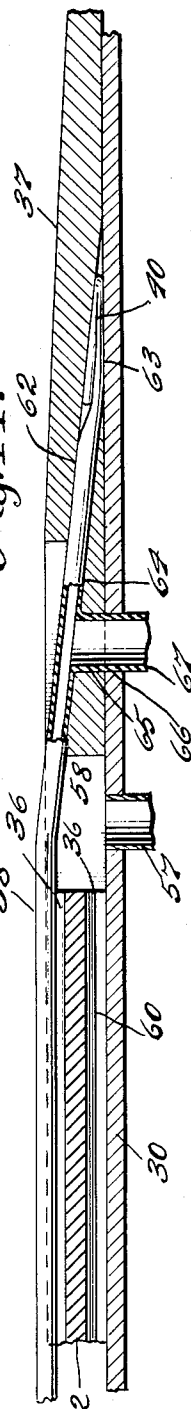


Fig. 14.



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2,756,206

DIALYZER

Charles Gobel, Philadelphia, Pa.

Application July 14, 1953, Serial No. 367,960

5 Claims. (Cl. 210—8.5)

The present invention relates to a dialyzer.

A purpose of the invention is to simplify the construction of dialyzers useful for dialyzing blood of animals, particularly humans.

A further purpose is to produce a dialyzer whose parts will stand up under repeated autoclaving without serious damage to the parts and without appreciable dimensional change which will cause increase in back pressure.

A further purpose is to wind an elastomer separator strip on a form, to seal one turn of the strip on the next at both sides, and to provide a longitudinal recess in one or both adjoining faces of the separator strip, and desirably with longitudinal grooves for flow of liquid, so that a dialyzing membrane of closed configuration, suitably a flattened tube, can extend longitudinally through the recess and be supported by the tips of the grooves.

A further purpose is to provide wedge-shaped ends of the separator strip which progressively decrease in thickness toward the ends.

A further purpose is to make connections at the ends to the interior of the dialyzer membrane and also to the space in the recess around the membrane.

A further purpose is to make the connection to the two sides of the membrane at the end suitably by providing separate connections to the two sides, one beyond the end of the membrane and one short of the end of the membrane, or to provide a single connection extending through the separator strip, passing around an extra turn of the separator strip in the recess to connect to one side of the membrane and directly connecting to the other side of the membrane.

A further purpose is to fold the end of the membrane for closure purposes and clamp it between turns of the separator strip and preferably in a pocket in the separator strip.

Further purposes appear in the specification and in the claims.

In the drawings I have chosen to illustrate a few only of the numerous embodiments in which my invention may appear, selecting the forms shown from the standpoints of convenience in illustration, satisfactory operation and clear demonstration of the principles involved.

Figure 1 is a section of the dialyzer of the invention taken transverse to the axis.

Figure 2 is a fragmentary central longitudinal section of the separator strip and membrane of the dialyzer of Figure 1, developed and showing the end at which winding begins.

Figure 3 is a view similar to Figure 2 showing an intermediate point on the separator strip and membrane.

Figure 4 is a view similar to Figure 2, but showing the top plan of the end of the separator strip and the end of the membrane, with the membrane partly broken away.

Figure 5 is a fragmentary perspective showing one end of the membrane.

Figure 6 is an enlarged section on the line 6—6 of Figure 2.

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Figure 7 is an enlarged section on the line 7—7 of Figure 2.

Figure 8 is an enlarged section on the line 8—8 of Figure 2.

Figure 9 is an enlarged section on the line 9—9 of Figure 3.

Figure 10 is an enlarged section on the line 10—10 of Figure 7, omitting the form.

Figure 11 is an enlarged section on the line 11—11 of Figure 1, omitting the form.

Figure 12 is an enlarged section on the line 12—12 of Figure 1, omitting the form.

Figures 13 and 14 show a variant of the construction near the end of the separator strip.

Figure 13 is a fragmentary perspective showing the form and separator strip adjacent to the end at which winding begins.

Figure 14 is a fragmentary longitudinal section showing the membrane, separator strip and form used in the construction of Figure 13.

Describing in illustration but not in limitation and referring to the drawings:

There is extensive need for dialyzers in the treatment of animals, particularly human beings. One important use of the dialyzer is in reconditioning the blood of an animal so that the blood can be returned to the body and will be more useful in sustaining life. In some cases the dialyzer is used to remove water soluble salts and other products of metabolism which may be impairing the function of the body. Another use of the dialyzer is to concentrate solid insoluble components of the blood and thus reduce the water content of the blood particularly in cases of edema. In either of these instances the dialyzer may perform a part of the function of the kidney, and may be described as an artificial kidney.

While the dialyzer of the invention is believed to find its widest application in performing the kidney function, it is also applicable in a wide variety of fields where dialyzers may be useful, in some cases unrelated to medicine, examples being organic and inorganic chemistry, bacteriology and industrial processes.

Dialyzers generally must conform to rigid requirements of cleanliness, and this is particularly true in the medical field, where the dialyzer should be capable of withstanding repeated autoclaving.

Dialyzers have been produced using as membranes flattened tubing of regenerated cellulose or cellulose hydrate of the character employed in the present device, connecting the membrane tubes to headers, or wrapping the unsupported dialyzer tube around a drum or in slots on a drum. Dialyzer membrane sheets have also been set up similar to a filter press between plates. These prior art devices have been difficult to control, because of pressure drop and particularly because the effect of repeated autoclaving on the parts has reduced the thickness of gaskets and the like, so that clearances for the dialyzer membranes could no longer be maintained and in some cases it was no longer possible to secure sealing pressure.

In accordance with the present invention, a separator strip, preferably of resilient elastomer such as rubber, or synthetic rubber (Buna S, Buna N, chloroprene or the like) is wound on a form, and caused to seal one turn on the next turn at the sides, leaving a longitudinal closed recess between the turns. In this recess the membrane of closed configuration, such as a flattened tube extends from end to end, with connections at the two ends to the space inside the membrane and to the space around the membrane. The ends of the separator strip are preferably of wedge configuration, so as to build up the turns at the inside and the outside without nonuniformity in diameter at different angular positions.

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The membrane desirably has folded ends clamped between the turns of the separator strip.

Grooves run longitudinally in the recess, the tops of grooves supporting the membrane, and the grooves providing for liquid flow.

Considering now the dialyzer shown in Figures 1 to 12, a form 30 suitably of metal in the shape of a cylinder, has a hollow interior and supports the separator strip. While the form may carry numerous dialyzer assemblies positioned endwise, and connected in parallel or in series, it will be sufficient to consider one dialyzer assembly on the form. For this purpose the form desirably has circumferential ribs 31 (Figure 13) of the width of the separator strip.

A separator strip 32 is wound around the form, the successive turns being wound one on another, preferably like an Archimedes spiral. Thus each turn but the innermost turn is wrapped around another turn.

In the body of the separator strip, as shown in Figures 4 and 9 to 12, the separator strip, of generally rectangular form, has tongues 33 at one face near both sides, the tongues sealing in corresponding sealing recesses 34 similarly running longitudinally at the other face at both sides, so that when two turns overlap as in Figures 10, 11 and 12, there will be an effective seal created which will be tight against leakage when the tongues and grooves mate. While only a single tongue and a single groove are shown one each side, and while the tongues both extend from the same face and the grooves both extend from the same face, it will be understood that these features are not essential to the invention, and any desired number of tongues and cooperating grooves may be employed, with the tongues located on either surface and the grooves in the other surface which make the seal. It will likewise be understood that while the tongues and grooves shown are wedge-shaped, they may assume any desired sealing contour provided when brought together a seal is obtained.

It will furthermore be understood that while tongues and grooves are preferable for the seal they are not to be regarded as essential.

In between the seals and preferably on both faces of the separator strips, suitable wide recesses 35 extend longitudinally of the separator strips and desirably also laterally for most of the width. Where the recesses 35 extend from both of the opposed faces, it will be understood that when one turn laps on the next they will cooperate to form longitudinal recess passages, partly from the outer recess in one turn and partly from the inner recess in the next turn.

In order to permit longitudinal flow of liquid notwithstanding that the membrane engages the surfaces of the recesses, the opposed recess faces desirably have longitudinal grooves 36 side by side, and suitably of general saw tooth construction.

At the initial and final ends of the separator strip, the separator strip is desirably progressively thinned or made of wedge-shape as shown at 37 in Figures 1, 2, 4, 6 and 7. In order to provide adequate sealing of the ends to relatively smooth faces of the form on the inside and of a suitable clamp on the outside, the wedge end portion at 37 is desirably made smooth on both inner and outer faces.

The space of the recesses is occupied by a membrane 38 of closed configuration, suitably a flattened tube, as shown in Figures 1, 2, 4, 5 and 8 to 12. The membrane 38 is suitably an extruded tube, the ends desirably being sealed by folding at 40 and clamping between turns of the separator strip. The folded end 40 and the normal double walled portions of the membrane 38 occupy the place between the seals at the side, in the recesses, but do not extend out far enough to interfere with the tongue and groove surfaces 33 and 34 or the flat surfaces 41 of the seals.

Several different forms of end connections are possible,

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Figures 1 to 12 illustrating one form, and Figures 13 and 14 illustrating another form. In the form of Figures 1

to 12 a passage 42 suitably of laterally elongated character extends from the recess through the wall of the separator strip. A rubber pad 43 desirably surrounds a tubular passage 44 to occupy the space between the sealing sides and extend out substantially flush with the top of the recess. The passage 42 being beyond the end of the membrane, therefore communicates with the upper side of the membrane. Access is had to the interior of the membrane by a passage 45 which passes through the inner wall of the membrane and suitably consists of a tube 46 passing through the form and the separator strip and a suitable rubber pad 47 surrounding the end of the tube and desirably cemented or otherwise sealed to the membrane.

Access may be had to the inner outside face of the membrane through a suitable laterally elongated passage 48 desirably formed by a tube 50 extending through a suitable rubber pad 51 suitably cemented to the separator strip farther from the end than the passage 45.

The outside of the coiled separator strip is suitably held in place and sealing, and inward pressure is exerted by a metallic clamp 52 surrounding the dialyzer and desirably held together under compression by clamping bolt 53.

The passages at the outside of the dialyzer are the reverse of those at the inside, passage 54 similar to passage 48 communicating with the space outside the membrane and passing through the separator strip wall and the clamp wall, passage 55 similar to passage 45 communicating with the space inside of the dialyzer and passing through the separator strip wall and the clamp wall and passage 56 beyond the folded end 40 of the membrane, communicating with the inside external surface of the dialyzer membrane.

The form of Figures 13 and 14 shows a preferred embodiment in which a passage 57 extends through the interior of the form into a chamber 58 extending across the separator strip between the sealing sides. The chamber 58 communicates with the ends of separator strip grooves 36 at both the inside and the outside of the separator strip as shown in Figure 14. There is thus direct connection with the external surface of the dialyzer membrane which is located radially inwardly, and to connect with the external surface of the separator membrane which is located radially outwardly it is merely necessary to pass around through the grooves 36 as indicated at 60 for a full turn, at which time the passages are radially outside the dialyzer membrane.

In this form suitable dovetails 61 are cut in the sealing side portions and a separate wedge-shaped or converging end piece having corresponding dovetails is affixed, desirably by cementing at the dovetails 61. The end piece has a diagonally extending longitudinal pocket 62, open at the interior at 63 against the form 30, and receiving and clamping the folded end 40 of the membrane. Between the folded end 40 of the membrane and the passage 57, the pocket inclines toward the outer wide face of the separator strip, providing a wedge surface 64, and this wedge surface has an opening 65 aligning with an opening 66 in the form, through which a connector 67 extends communicating with the interior of the membrane.

It will be evident that while the form shown is cylindrical it need not necessarily be cylindrical and may take any closed configuration, such as an ellipse or a rectangle having rounded corners.

In operation, the parts are suitably cleaned and sterilized ready for assembly of the dialyzer. Although this is not always necessary, it is preferable to use a fresh dialyzing membrane for each operation.

The separator strip is started on the form, and the membrane is also started folding the end of the membrane to seal it and clamping it in place, and extending the connections through the separator strip and the form, including the connection to the interior of the membrane. Winding then progresses making sure that the

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tongue and groove seals engage at the side, and that the membrane remains in the recesses supported by the tips of the longitudinal grooves 36. When the end of the separator strip is reached, the membrane, if too long, is cut off and then is folded over. The connection is made to the interior of the membrane and the connections are carried through the separator strip at the outside and through the clamp which is then assembled and tightened in place to tighten the seals.

After test to establish that the device is free from leakage, the dialyzer is ready for use, either as a unit of a larger device consisting of many similar dialyzers connected in parallel or in series or in some cases as a complete dialyzer.

The dialyzer is operated until the work is completed or the membrane is worn out, and then the dialyzer is disassembled, cleaned and sterilized ready for reuse.

One of the great advantages of the device is that any change in thickness, width or length of the separator strip is duly compensated for by reassembling, and the groove assures adequate flow of liquid around the outside of the membrane.

In view of my invention and disclosure variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention without copying the structure shown, and I therefore claim all such insofar as they fall within the reasonable spirit and scope of my invention.

Having thus described my invention what I claim is new and desire to secure by Letters Patent is:

1. A dialyzer including a form, a membrane extending in spiral configuration through a passage, connections at the respective ends to the interior of the membrane and to the passage, in combination with an elastomer separator strip wrapped spirally around the form, successive turns of the separator strip lapping on preceding turns, the separator strip at the sides having seals which engage and close the edge space between one separator strip turn and the next separator strip turn, and the separator strip between the edges defining the walls of the passage through which the membrane extends.

2. A dialyzer of claim 1, there being in the opposed faces of the separator strips between the seals longitudinally extending grooves side by side, the membrane being supported on the tips of the grooves.

3. A dialyzer of claim 1, in which the separator strip adjacent the ends is progressively reduced in thickness.

4. A dialyzer of claim 1, comprising walls forming a connection through the separator strip into the passage at a position short of the end of the membrane near each end, walls forming a passage through one wall of the membrane into the interior of the membrane and through the separator strip near each end of the membrane, and walls forming a passage through the separator strip beyond each end of the membrane.

5. A dialyzer of claim 1, comprising end pieces on the separator strip progressively reducing in thickness toward the ends, walls forming pockets in the end pieces receiving and holding folded ends of the membrane, walls forming passages near the ends connecting into the interior of the membrane, and means for clamping the turns of the dialyzer separator strip together.

6

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