

March 10, 1959

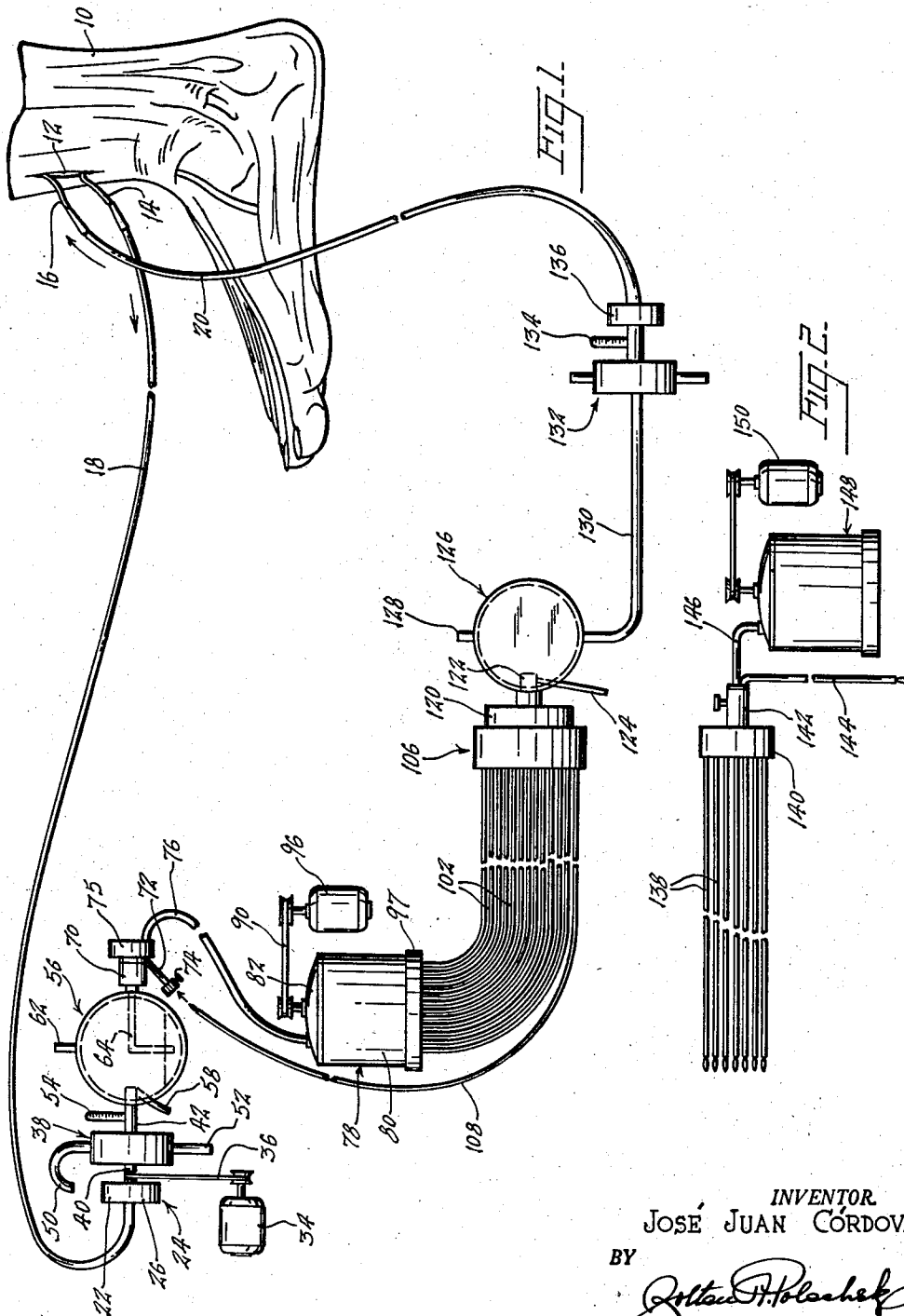
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2,876,769

APPARATUS FOR OXYGENATING, CENTRIFUGING AND
CHANGING THE TEMPERATURE OF BLOOD

Filed Oct. 11, 1955

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

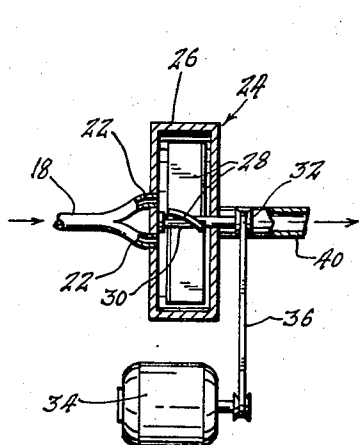


FIG. 3.

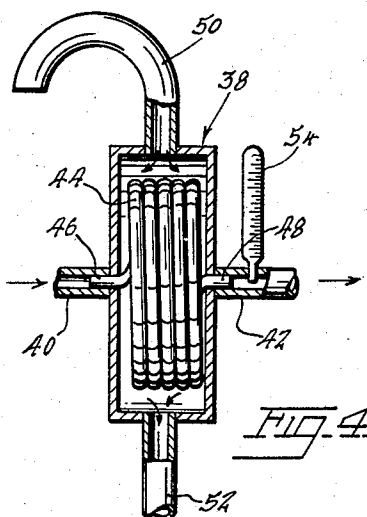


FIG. 4.

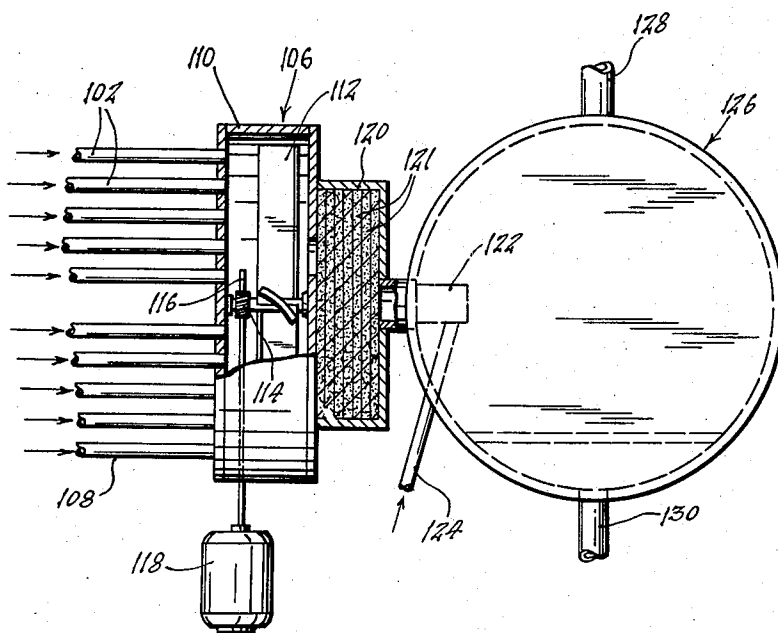


FIG. 5.

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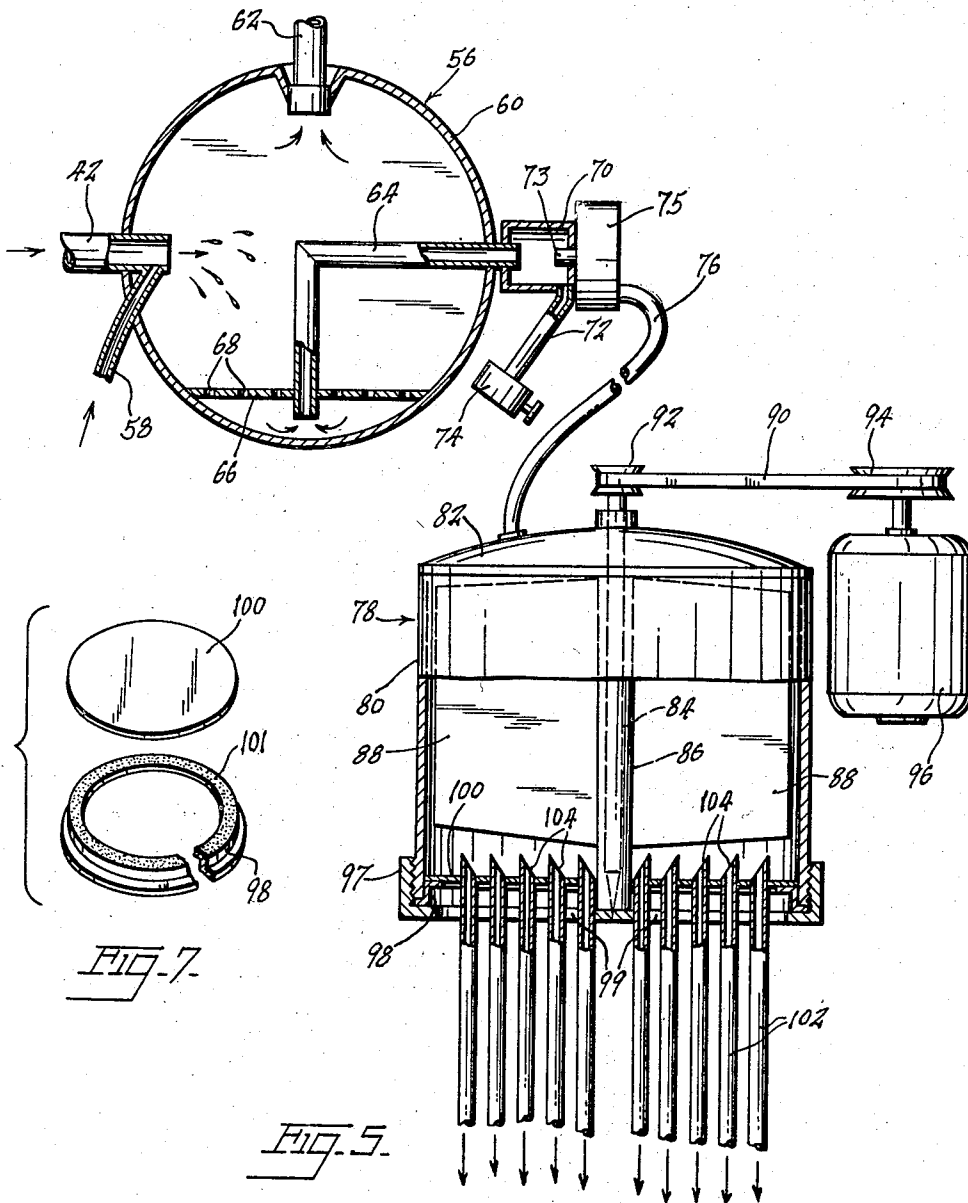
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Filed Oct. 11, 1955

3 Sheets-Sheet 3



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APPARATUS FOR OXYGENATING, CENTRIFUGING AND CHANGING THE TEMPERATURE OF BLOOD

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Application October 11, 1955, Serial No. 539,768

7 Claims. (Cl. 128—214)

This invention relates to a new medical, therapeutic and anesthesiological method of and apparatus for treating diseases, ailments and general loss of efficient functioning of the body. More particularly, the invention relates to a method and apparatus of the type and for the purpose stated, so designed as to include temporarily in the circulatory system, a succession of stages or stations, disposed exteriorly of the body, in which the blood is warmed or cooled, whichever desired, above or lower than the normal body temperature, in the latter case producing an anesthetic effect; is oxygenated; is passed through a centrifuge to disassociate various, differing components of the blood through the provision of a centrifugal spectrum, and separate normal and abnormal, that is healthy and diseased components, with the healthy components to be returned to the blood system of the body following filtering and return to a normal or other body temperature. In this method the abnormal components are suctioned selectively from the centrifugal spectrum of the blood and may be transferred to the second centrifugal device; in any case, they are always suctioned off and eliminated from the blood circulatory system.

In other words, the system is basically formed by a central or first centrifugal device in direct or indirect connection with two circuits; one for suction and return of the normal components of the blood and the other for suction and elimination of the abnormal components of the blood.

This new medical method effects the healing of disease by suctioning off the pathogenic agents and also causes anesthesia by direct cooling of the blood.

In accordance with the invention, a selected vein or artery of the circulatory system of a human or lesser animal is cut, and to the extremities of the vein, resulting from cutting thereof, there are connected a pair of tubes, one extending to the inlet end of the apparatus constituting the invention, and the other extending from the outlet end of the apparatus. The apparatus provides a closed cycle which, in effect, becomes part of the circulatory system, during the time that the blood is being acted upon by the apparatus, and as the blood passes through this cycle, exteriorly of the body, it is drawn, forced, or otherwise caused to flow through successively following stations, each of which has its own individual function to perform with respect to pumping of the blood through the apparatus, warming, cooling or filtering the blood, atomizing the same, oxygenating the blood, disassociating by centrifugal action the various components, and effecting, if desired, the addition of new components calculated to have the desirable therapeutic action upon the blood.

A further object of importance is to permit the selective insertion of needle-like end portions of lead-off tubes into the centrifugal separator, so that the selective location of said tubes at a predetermined distance from the axis of rotation of the centrifuge, after analysis of the spectrum, will permit only selected components into

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which the blood is divided by centrifugal action to be taken from the centrifuge and led back to the circulatory system.

A further object is to permit other, needle-like elements to be attached to and communicate with the centrifugal device, penetrating a membrane provided in said device, with said other needle-like elements leading to a second centrifuge. In this way, a primary disassociation of the several component parts of the blood can be effected, with said parts being led to a second centrifugal device for further separation, and/or the addition of antibiotics or other curative or conditioning chemicals or compounds, after which the blood can be then returned to the blood stream of the body, or suctioned to its elimination.

For further comprehension of the invention, and of the objects and advantages thereof, reference will be had to the following description and accompanying drawings, and to the appended claims in which the various novel features of the invention are more particularly set forth.

In the accompanying drawings forming a material part of this disclosure:

Fig. 1 is a diagrammatic view showing the apparatus in use.

Fig. 2 is a diagrammatic view showing a portion of the apparatus that can be used selectively with the apparatus shown in Fig. 1.

Fig. 3 is a fragmentary sectional view through the main impeller pump.

Fig. 4 is a sectional view through the means for raising or lowering the temperature of the blood as it passes into the apparatus.

Fig. 5 is a somewhat diagrammatic sectional view of the portion of the apparatus wherein the blood is atomized and oxygenated, and also, following its being atomized, subjected to centrifugal action.

Fig. 6 is a view partly in side elevation and partly in section of the outlet end of the apparatus shown in Fig. 1, illustrating a second pump and filtering means in association with a second atomizing device.

Fig. 7 is an exploded perspective view of the membrane of the centrifuge and its associated support ring.

Referring to the drawings in detail, designated at 10 is the leg of a patient, and to connect the apparatus into the circulatory system, an incision 12 is made in said leg, and a vein or artery cut, with the cut ends 14, 16 being connected to the inlet and outlet tubes 18, 20 respectively of the apparatus.

As shown in Figs. 1 and 3, the tube 18, at its outlet end, divides into branches 22, opening into an impeller pump 24, which is used to pump the blood through the apparatus, so that excessive strain is not imposed upon the heart. The pump 24 includes a casing 26, having a series of radial blades 28 secured to a shaft 30, carrying a pulley 32 about which is trained a belt driven by a motor 34, the belt being designated by the reference numeral 36.

The blood to be treated, after passing out of the pump 24, passes to a temperature control means generally designated at 38, through a connecting conduit 40. The means 38, at its outlet end, is in communication with a discharge tube or conduit 42.

Within the casing of the temperature control device there is provided a coil 44, the inlet end 46 of which is extended into the connecting conduit 40, while the outlet end 48 thereof is extended into the outlet conduit 42. The blood thus passes through said coil, and surrounding the coil is a liquid or gas, such as water, freon, etc. which either heats or cools, whichever is desired, so as to correspondingly elevate or lower the temperature of the blood. The liquid or gas is circulated through the casing of the temperature control device, passing into said cas-

ing through a tube 50 and out of the casing through a tube 52.

In the conduit 42 there is provided a clinical thermometer 54, which can be observed to determine if the blood, after passing out of the casing of the temperature control device, is at the proper temperature. If it is not at the proper temperature, means can be utilized to raise or lower the temperature of the circulating liquid or gas within the casing. It will be understood, in this connection, that a suitable thermostatic device can be employed in association with the thermometer, adapted to control operation of a heating or cooling means, so that said circulating liquid or gas will be at all times maintained at a uniform, preselected temperature.

After the blood has been heated or cooled to the desired temperature, it passes through the conduit 42 to an atomizing and oxygenating device generally designated at 56. This has been shown in detail in Fig. 5, and includes a circular casing into which the conduit 42 opens.

Within the casing, the conduit 42 is in communication with the outlet end of a tube 58 through which oxygen is forced under pressure. The tube 58 is reduced in diameter relative to the conduit 42, and enters the conduit at an acute angle thereto. As a result, oxygen forced through tube 58 is directed under pressure into the stream of blood flowing into the casing 60 of the device 56. This breaks up the blood into small globules, in effect atomizing the blood simultaneously with the mixing of the oxygen therewith.

That oxygen which is surplus, following intermixing with the blood, flows out of the casing 60 through a pressure relief valve 62.

The atomized blood, having the oxygen fully intermixed therewith, gravitates to the bottom of casing 60, and flows out of the casing through a right-angled outlet tube 64. The inlet end of the tube 64 is disposed adjacent the bottom of the casing, the blood flowing by gravity to the bottom through a plate 66 having perforations 68. In the bottom of the casing 60, the blood reforms into a fully liquid state, and is forced upwardly through the tube 64, passing into a short, cylindrical chamber 70 which communicates with a suction tube 72 having a manually operable valve 74 associated therewith.

Connected in communication with the discharge end of the tube 64, within the chamber 70, is a tube 73 connected to the inlet of suction pump 75. The outlet of the suction pump 75 is connected to a tube 76, entering the upper end of a centrifugal separator 78. The centrifuge includes a cylindrical, upstanding, large diameter casing 80, closed by a cover 82, to which the tube 76 is connected.

Extending axially of casing 80 is a shaft 84, journaled in the upper end of the casing. Secured to the shaft 84 is a sleeve 86 to which are attached radially, outwardly extending vanes 88.

The shaft 84 is driven by a belt 90 passing around a pulley 92 secured to the upper, projecting end of shaft 84, and also trained about a drive pulley 94 mounted upon the shaft of a drive motor 96.

Threaded onto the lower end of the casing 80 is a bottom plate 97, said bottom plate having segmental bottom openings 99 around the axis of rotation of the shaft 84. The lower end of shaft 84 is pointed, and is journaled in a conical recess provided centrally in the bottom plate.

The bottom plate is adapted to support within the casing a membrane support ring 98, shown in detail in Fig. 7. The support ring 98, as shown, may be of approximately Z-shaped cross section, having an outwardly directed bottom flange clampably engaged between the lower end of the casing 80 and the peripheral portion of the bottom plate 97. The support ring has an upturned top flange, and cemented to said top flange, by means of adhesive or cement 101, is the marginal portion of a membrane or diaphragm 100.

A series of tubes 102 have beveled inlet ends 104, so as to pointedly tip the inlet ends of said tubes. The tubes are inserted selectively through the openings 99, and by reason of the pointed ends thereof, puncture the membrane 100, so as to dispose the inlet ends of the tubes in communication with the chamber of the centrifugal separator. As a result, when the separator is in operation, the blood entering the same through the tube 76 is forced radially, outwardly of the axis of rotation of the shaft 84, and will divide into various components, to provide a centrifugal spectrum which can be analyzed to determine which of said components should be permitted to flow freely back into the circulatory system of the body, which should be removed completely by reason of the presence therein of harmful bodies or by reason of the existence of other undesirable characteristics, and which should be returned to the circulatory system of the body after being properly conditioned, as for example, through the addition or dispersal therethrough of antibiotics or other curatives and therapeutic compounds.

It will be seen that the tubes 102 need not be inserted through the membrane until after the centrifugal action has been obtained, meanwhile the blood flows through the by-pass tube 108. Then assuming for example that all the separated parts of the blood can be returned forthwith to the circulatory system, tubes 102 can be inserted in such positions as to remove all the separated components of the blood. Alternatively, the tubes can be inserted into selected parts or divisions of the spectrum, so as to remove only a selected portion of the blood.

The tubes 102, as shown in Fig. 1, lead the separated components of the blood to a mixing pump generally designated at 106, in which the previously separated components of the blood are mixed before being returned to the circulatory system.

As shown in Fig. 1, one of the tubes, designated at 108, can by-pass the centrifugal separator completely, being engaged in the valve 74, with the pump 106 creating a suction in conduit 72 so as to cause the blood to in part by-pass the centrifuge. In this way only a sampling of the blood, to be subjected to centrifugal action for the purpose of analysis of the several component parts thereof, can be led to the centrifuge.

In any event, the pump 106 includes a casing 110, and rotatably mounted in said casing is a series of radial blades 112, secured to and extending outwardly from a shaft journaled at its opposite ends in the casing. The shaft has a pinion secured thereto, in mesh with a worm 114 mounted upon a shaft 116 extending into the casing 110 and driven by a motor 118.

Secured to the output side of the pump 106 is a filter casing 120, containing a series of plate-like filter elements 121 and after the blood has been intermixed by vanes 112 in the pump casing, it passes through the filter plates or elements 121, and flows outwardly from the filter casing through a conduit 122. Connected in communication with the conduit 122 is a second oxygenating device including a tube 124. The blood is atomized within the oxygenating device, generally designated at 126, with surplus oxygen passing outwardly through a pressure relief valve 128. The atomized blood, as it reforms into a liquid, gravitates to the bottom of the device 126, passing outwardly through a conduit 130. Then, the blood flows into a temperature control device 132 similar to the device 38, so as to be returned to a normal temperature or, for that matter, otherwise treated to put the same at a selected temperature before return to the circulatory system.

A thermometer 134 is employed adjacent the temperature control device 132, for the purpose of ascertaining whether the blood has been heated or cooled to a desired temperature. Thereafter, the blood passes through a pump 136, and is forced thereby into the return tube 20, connected to the vein or artery extremity 16 for return to the circulation system.

In some instances, all the blood acted upon by the centrifuge 78 is not to be returned directly to the circulation system.

Under these circumstances, the centrifuge 78 may divide the blood into normal and abnormal components, with the normal components to be returned forthwith to the circulation system and the abnormal components to be further acted upon or, for that matter, removed completely. Thus, a series of needle-tipped tubes 138 is utilized, and these can be selectively inserted through the membrane 100 so that all or some of the components into which the blood is divided by the centrifugal separator 78 will pass into the tubes 138 instead of into the tubes 102. The blood flowing into the tubes 138 is intermixed by a suction pump 140, passing into a chamber 142 provided with a manually operable valve, and said valve may be so designed as to permit all or some of the blood flowing into the chamber 142 to pass into a drainage tube 144 for complete removal from the circulation system. Alternatively, all the blood may flow into a tube 146, and in still other instances, some may pass into tube 144 while the remainder passes into tube 146.

Tube 146 opens into the upper end of a centrifuge generally designated at 148, similar in all respects to the centrifuge 78, and having a shaft driven by a belt passing around pulleys one of which is a drive pulley carried by a motor 150.

Within the centrifuge 148, the blood is again divided into predetermined components, and if desired, antibiotics or other curative or therapeutic compounds may be introduced to the centrifuge through tubes 138. The shaft of the centrifuge, for example, can be hollow and perforated, so that said antibiotics are directed outwardly through perforations provided in the shaft. Then, some of the tubes 102 could be connected to the output of the centrifuge 148, with the blood being returned to the circulation system in the manner previously described or could be drained by insertion of the tubes 138 in closed circuit with drainage tube 144.

It will be seen that a wide variety of uses can be encompassed by the method and apparatus illustrated and described. Treatments for any of a large variety of conditions can be effected, or if desired, simple analysis of said conditions, aiding in diagnosis, is quite possible. The centrifugal separator can be arranged in series, not only in a series of two but in a series including additional separators. Successive separation stages can thus be resorted to, with, for example, the first stage accomplishing an initial division of the blood into components differing from one another by reason of weight, while in successive stages in which centrifugal action is employed, antibiotics can be employed, with said antibiotics being of specific weight so as to find a way to selected, divided components of the centrifugal spectrum. Then again, the centrifugal separators can be employed to remove abnormal blood components from normal blood components, and various other uses may suggest themselves during regular employment of the apparatus.

A simple removal of diseased blood components can also be effected, and new blood inserted into the blood stream to take the place of that removed, the device being in this instance used for transfusions. Still further, where certain components of the blood, on analysis of the centrifugal spectrum, are found to be weak or lacking in resistance to disease, additives can be inserted therein during passage of the blood through the apparatus.

The apparatus, still further, may be used for controlling temperature elevations within the body, removing embolisms by filtering, controlling blood pressure, etc.

While I have illustrated and described the preferred embodiment of my invention, it is to be understood that I do not limit myself to the precise construction herein disclosed and that various changes and modifications may be made within the scope of the invention as defined in the appended claims.

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

1. Apparatus for the therapeutic treatment and conditioning of the blood comprising conduit means connectable at opposite ends thereof to the cut ends of a blood passage of the body, for connecting said conduit means into the circulation system of the body, thereby to circulate the blood exteriorly of the body, at least one temperature control device connected in said conduit means and adapted for adjusting the blood temperature to a selected degree, at least one pump connected in the conduit means for pumping the blood therethrough, centrifuge means connected in said conduit means adapted for dividing the blood into different components of a centrifugal spectrum, for analysis, selective removal, and treatment of selected components of the blood, and means connected in said conduit means for atomizing and oxygenating the blood, said pump, centrifuge means, and means to atomize and oxygenate the blood being connected in series within said conduit means, the conduit means including inlet and outlet tubes at opposite ends of said series, the temperature control device including a coil connected in the conduit means at opposite ends of the coil, for flow of the blood through the coil, a casing surrounding the coil, and means connected in communication with said casing for circulating a liquid therethrough having a temperature to which the blood is to be adjusted, the temperature control device further including a thermometer at the output side of said coil, to provide a visual check of the temperature to which the blood temperature has been adjusted, said means for atomizing and oxygenating the blood comprising a casing, said blood being arranged to flow from the temperature control device into said casing, a tube extending into communication with the conduit means within the casing at an angle to the path of the blood flowing into the casing, said tube being adapted for the forcing of oxygen thereinto, for atomizing the blood while intermixing the oxygen therewith, and an outlet tube within the casing, said outlet tube having an inlet end disposed adjacent the bottom of the casing, with the atomized blood flowing by gravity to the bottom of the casing for passage into the outlet tube, said casing including a perforated plate adjacent the bottom of the tube through which the gravitating blood is adapted to pass.

2. Apparatus for the therapeutic treatment and conditioning of the blood comprising conduit means connectable at opposite ends thereof to the cut ends of a blood passage of the body, for connecting said conduit means into the circulation system of the body, thereby to circulate the blood exteriorly of the body, at least one temperature control device connected in said conduit means and adapted for adjusting the blood temperature to a selected degree, at least one pump connected in the conduit means for pumping the blood therethrough, centrifuge means interposed in said conduit means and connected to said pump and adapted for dividing the blood into different components of a centrifugal spectrum, for analysis, selective removal, and treatment of selected components of the blood, and means connected in said conduit means for atomizing and oxygenating the blood, said pump, centrifuge means, and means to atomize and oxygenate the blood being connected in series within said conduit means, the conduit means including inlet and outlet tubes at opposite ends of said series, the centrifuge means including a casing having an inlet at its upper end into which the blood is directed, said outlet tube being connected to said centrifuge inlet, said centrifuge means including a shaft rotating therein and vanes extending radially, outwardly of the shaft, and a membrane extending across the bottom of the casing and arranged to be perforated for flow of the separated components of the blood through selected perforations of the membrane.

3. Apparatus for the therapeutic treatment and conditioning of the blood comprising conduit means connectable at opposite ends thereof to the cut ends of a blood passage of the body, for connecting said conduit means into the circulation system of the body, thereby to circulate the blood exteriorly of the body, at least one temperature control device connected in said conduit means and adapted for adjusting the blood temperature to a selected degree, at least one pump connected in the conduit means for pumping the blood therethrough, centrifuge means interposed in said conduit means and connected to said pump and adapted for dividing the blood into different components of a centrifugal spectrum, for analysis, selective removal, and treatment of selected components of the blood, and means connected in said conduit means for atomizing and oxygenating the blood, said pump, centrifuge means, and means to atomize and oxygenate the blood being connected in series within said conduit means, the conduit means including inlet and outlet tubes at opposite ends of said series, the centrifuge means including a casing having an inlet at its upper end into which the blood is directed, said outlet tube being connected to said centrifuge inlet, said centrifuge means including a shaft rotating therein and vanes extending radially, outwardly of the shaft, and a membrane extending across the bottom of the casing and arranged to be perforated for flow of the separated components of the blood through selected perforations of the membrane, said casing including a bottom plate having openings and disposed below said membrane, and a support ring clamped between the plate and the adjacent end of the side wall of the casing, the membrane being secured at its periphery to said support ring.

4. Apparatus for the therapeutic treatment and conditioning of the blood comprising conduit means connectable at opposite ends thereof to the cut ends of a blood passage of the body, for connecting said conduit means into the circulation system of the body, thereby to circulate the blood exteriorly of the body, at least one temperature control device connected in said conduit means and adapted for adjusting the blood temperature to a selected degree, at least one pump connected in the conduit means for pumping the blood therethrough, centrifuge means interposed in said conduit means and connected to said pump and adapted for dividing the blood into different components of a centrifugal spectrum, for analysis, selective removal, and treatment of selected components of the blood, and means connected in said conduit means for atomizing and oxygenating the blood, said pump, centrifuge means, and means to atomize and oxygenate the blood being connected in series within said conduit means, the conduit means including inlet and outlet tubes at opposite ends of said series, the centrifuge means including a casing having an inlet at its upper end into which the blood is directed, said outlet tube being connected to said centrifuge inlet, said centrifuge means including a shaft rotating therein and vanes extending radially, outwardly of the shaft, and a membrane extending across the bottom of the casing and arranged to be perforated for flow of the separated components of the blood through selected perforations of the membrane, said casing including a bottom plate having openings and disposed below said membrane, and a support ring clamped between the plate and the adjacent end of the side wall of the casing, the membrane being secured at its periphery to said support ring, said conduit means including a series of tubes having inlet ends adapted to perforate the membrane at selected distances radially, outwardly of the axis of the shaft of the centrifuge means, for leading the separated components of the blood from the centrifuge means.

5. Apparatus for the therapeutic treatment and conditioning of the blood comprising conduit means connectable at opposite ends thereof to the cut ends of a blood passage of the body, for connecting said conduit means

into the circulation system of the body, thereby to circulate the blood exteriorly of the body, at least one temperature control device connected in said conduit means and adapted for adjusting the blood temperature to a selected degree, at least one pump connected in the conduit means for pumping the blood therethrough, centrifuge means interposed in said conduit means and connected to said pump and adapted for dividing the blood into different components of a centrifugal spectrum, for analysis, selective removal, and treatment of selected components of the blood, and means connected in said conduit means for atomizing and oxygenating the blood, said pump, centrifuge means, and means to atomize and oxygenate the blood being connected in series within said conduit means, the conduit means including inlet and outlet tubes at opposite ends of said series, the centrifuge means including a casing having an inlet at its upper end into which the blood is directed, said outlet tube being connected to said centrifuge inlet, said centrifuge means including a shaft rotating therein and vanes extending radially, outwardly of the shaft, and a membrane extending across the bottom of the casing and arranged to be perforated for flow of the separated components of the blood through selected perforations of the membrane, said casing including a bottom plate having openings and disposed below said membrane, and a support ring clamped between the plate and the adjacent end of the side wall of the casing, the membrane being secured at its periphery to said support ring, said conduit means including a series of tubes having inlet ends adapted to perforate the membrane at selected distances radially, outwardly of the axis of the shaft of the centrifuge means, for leading the separated components of the blood from the centrifuge means, said tubes having beveled tips at their inlet ends to provide pointed end portions on the tubes for perforating said membrane at selected locations upon the membrane.

6. Apparatus for the therapeutic treatment and conditioning of the blood comprising conduit means connectable at opposite ends thereof to the cut ends of a blood passage of the body, for connecting said conduit means into the circulation system of the body, thereby to circulate the blood exteriorly of the body, at least one temperature control device connected in said conduit means and adapted for adjusting the blood temperature to a selected degree, at least one pump connected in the conduit means for pumping the blood therethrough, centrifuge means interposed in said conduit means and connected to said pump and adapted for dividing the blood into different components of a centrifugal spectrum, for analysis, selective removal, and treatment of selected components of the blood, and means connected in said conduit means for atomizing and oxygenating the blood, said pump, centrifuge means, and means to atomize and oxygenate the blood being connected in series within said conduit means, the conduit means including inlet and outlet tubes at opposite ends of said series, the centrifuge means including a casing having an inlet at its upper end into which the blood is directed, said outlet tube being connected to said centrifuge inlet, said centrifuge means including a shaft rotating therein and vanes extending radially, outwardly of the shaft, and a membrane extending across the bottom of the casing and arranged to be perforated for flow of the separated components of the blood through selected perforations of the membrane, said casing including a bottom plate having openings and disposed below said membrane, and a support ring clamped between the plate and the adjacent end of the side wall of the casing, the membrane being secured at its periphery to said support ring, said conduit means including a series of tubes having inlet ends adapted to perforate the membrane at selected distances radially, outwardly of the axis of the shaft of the centrifuge means, for leading the separated components of the blood from the centrifuge means, said

tubes having beveled tips at their inlet ends to provide pointed end portions on the tubes for perforating said membrane at selected locations upon the membrane, there being two centrifuge means identical to one another, for connection of a series of tubes to one of the centrifuge means to lead the separated components of the blood to a second centrifuge means, from which other tubes extend, thereby to effect a series of blood separations by centrifugal action.

7. Apparatus for the therapeutic treatment and conditioning of the blood comprising conduit means connectable at opposite ends thereof to the cut ends of a blood passage of the body, for connecting said conduit means into the circulation system of the body, thereby to circulate the blood exteriorly of the body, at least one temperature control device connected in said conduit means and adapted for adjusting the blood temperature to a selected degree, at least one pump connected in the conduit means for pumping the blood there-through, centrifuge means interposed in said conduit means and connected to said pump and adapted for dividing the blood into different components of a centrifugal spectrum, for analysis, selective removal, and treatment of selected components of the blood, and means connected in said conduit means for atomizing and oxygenating the blood, said pump, centrifuge means, and means to atomize and oxygenate the blood being connected in series within said conduit means, the conduit means including inlet and outlet tubes at opposite ends of said series, the centrifuge means including a casing having an inlet at its upper end into which the blood is directed, said outlet tube being connected to said centrifuge inlet, said centrifuge means including a shaft rotating therein and vanes extending radially, outwardly of the shaft, and a membrane extending across the bottom of the casing and arranged to be perforated for flow of the separated components of the blood through selected perforations of the membrane, said casing including a bottom plate having openings and disposed

below said membrane, and a support ring clamped between the plate and the adjacent end of the side wall of the casing, the membrane being secured at its periphery to said support ring, said conduit means including a series of tubes having inlet ends adapted to perforate the membrane at selected distances radially, outwardly of the axis of the shaft of the centrifuge means, for leading the separated components of the blood from the centrifuge means, said tubes having beveled tips at their inlet ends to provide pointed end portions on the tubes for perforating said membrane at selected locations upon the membrane, there being two centrifuge means identical to one another, for connection of a series of tubes to one of the centrifuge means to lead the separated components of the blood to a second centrifuge means, from which other tubes extend, thereby to effect a series of blood separations by centrifugal action, one of said centrifuge means having, in advance of its inlet end, a drain tube, for draining off abnormal components of the blood.

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