

- [54] **PLASMA SEPARATOR**
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- [22] Filed: **Apr. 25, 1972**
- [21] Appl. No.: **247,483**

- [52] U.S. Cl. **23/259**, 23/292, 233/26, 215/47, 137/533.11
- [51] Int. Cl. **G01n 9/30**, B01d 21/26
- [58] Field of Search..... 23/258.5, 259, 292; 233/1 R, 20 R, 26; 424/101; 210/136, DIG. 23; 252/349; 128/2 F; 215/47; 137/DIG. 4, 533.11, 539

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[57] **ABSTRACT**

An evacuated tube having both ends closed has a ball type valve fixedly disposed between the ends for dividing the tube into upper and lower chambers. The valve is formed and arranged to provide a passageway between the upper and lower chambers when subjected to a force of proper intensity and direction. Upon cessation of the force, the valve closes to provide a separation between the upper and lower chambers.

29 Claims, 8 Drawing Figures

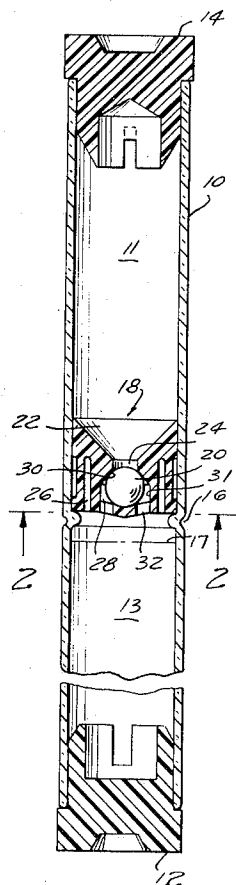


FIG. 1

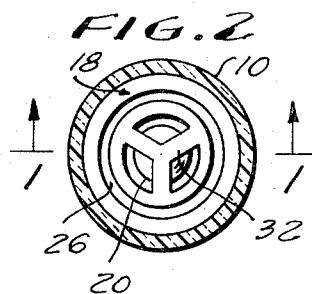
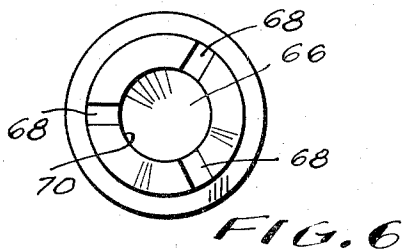
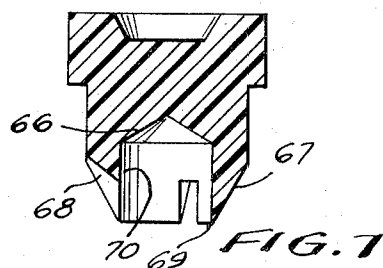
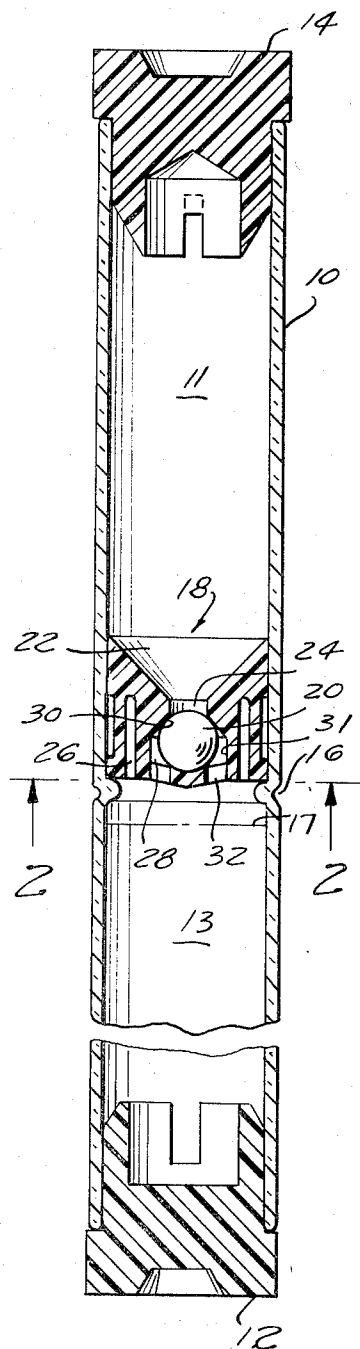
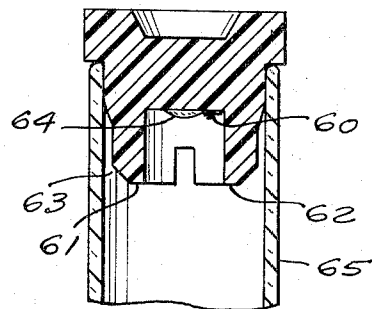


FIG. 8



PLASMA SEPARATOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to separators and more particularly to a device for separating blood plasma from cellular material.

2. Description of the Prior Art

With the development of modern pathological laboratories, it has become the common practice to send blood samples to a centralized laboratory facility for analysis. The normal procedure requires that the patient's blood sample be taken at a doctor's office or a clinic and thereafter mailed in a proper container to a centrally located laboratory to be tested. In many instances, it is desirable that the cellular material contained in a blood sample be separated from the blood plasma shortly after the sample is taken from the patient and prior to mailing. Centrifuging has become the accepted method for separation of the suspended cellular material from the blood plasma.

For proper testing of the blood sample, it is essential that pure blood plasma be made available at the laboratory and therefore the plasma must be separated from the cellular material in such a manner so as to prevent remixing of the blood constituents during mailing. Heretofore, the blood plasma was removed from the specimen tube after the blood was centrifuged to prevent the remixing of the plasma and the blood cells. A conventional syringe was used to draw the plasma from the specimen tube after which the plasma was deposited in a second container for mailing separately from the cellular material, which remained in the original container.

The use of a conventional syringe for removal of the blood plasma was extremely inefficient and time consuming since the technician had to be careful not to disturb the cellular material which remained in the bottom of the specimen tube. The blood sample was subject to contamination by contaminants present in the syringe or the second container. Another undesirable aspect of the system was that two containers were required for mailing the blood sample and on occasion, the containers would become separated and identification problems resulted.

Various devices have been developed for drawing blood plasma from the specimen tube and one such is taught by U.S. Pat. No. 3,586,064. These devices all suffered from some form of shortcoming in that they were either complicated and expensive or required considerable time for separation of the plasma. When considering the large number of blood samples processed by modern medical facilities, the time factor has become an extremely critical factor in the overall cost of blood tests.

SUMMARY OF THE INVENTION

The present invention contemplates an evacuated tube having closed ends and a valve fixedly disposed between the ends to divide the tube into upper and lower chambers. The valve includes an elastomeric body having a centrally located cylindrical opening with a cone-shaped valve seat formed around a lower end of the opening. A ball, preferably of stainless steel, is disposed adjacent the cone-shaped seat and is re-

tained against the seat by elastomeric members formed as an integral part of the valve body.

In a first embodiment, a tube is used having an opening at each end, said openings being closed with penetrable stoppers. The tube is evacuated through the lower end so that the lower chamber is evacuated first. A pressure differential is developed across the ball which causes the elastomeric members to be stretched downwardly and the ball to move down and away from the valve seat. When the ball is unseated, the upper and lower chambers come into communication so that the upper chamber is also evacuated.

The tube is filled with blood by puncturing the stopper disposed in the upper end of the tube and the vacuum in the upper chamber draws blood into the tube in a manner well known to the art. As the upper chamber is filled with blood, a pressure differential is developed across the ball causing the ball to exert a force downwardly on the elastomeric members thereby causing the ball to be unseated and the blood to flow into the evacuated lower chamber. Thus, the entire container is filled with a blood sample.

Upon subsequent centrifuging, the heavy ball is forced against the elastomeric members which stretch causing the ball to be unseated and a passage to be formed communicating the upper and lower chambers so that the heavier blood cells flow in a downwardly direction causing the lighter plasma to be displaced into the upper chamber of the tube.

When centrifuging is discontinued, the elastomeric members again force the ball into a seated position so that the ball provides a seal between the cellular material and the plasma. The seal is tight enough so that the tube may be mailed to a laboratory without fear of the plasma being remixed with the cellular material.

Heretofore, when centrifuging a tubular container of blood to separate the cellular material from the plasma, it has been a frequent practice to remove the stopper at the upper end of the container prior to centrifuging. This is done because very frequently if it is not done drops or other small portions of the blood containing cellular material hang onto the stopper or stay in crevices between portions of the rubber stopper and the glass container despite the centrifugal force applied. Then later, after centrifugation is stopped, and the stopper is removed for decanting the plasma, any such cellular material retained at the glass wall may contaminate the plasma as the plasma is poured out over the retained cellular material. One object of this invention is to provide an improved container which can be kept sealed while being centrifuged, without removal of the stopper, and which later can be inverted, shaken, handled roughly, or sent through the mail from a doctor's office to an analytical laboratory, without any of the red cells contaminating the plasma. To accomplish this, it has been necessary to invent improvements for the upper stopper also to eliminate retention of any blood containing cellular material, as will be shown and described later.

In a second embodiment, the component and assembly costs are reduced by the use of a single ended tube and a valve, having a slightly different structure. During assembly, a stainless steel ball is merely deposited in the upper chamber and is prevented from seating by the use of bosses which space the ball from the elastomeric body which ensures an opening connecting passageway between the upper and lower chambers prior

to centrifuging so that both the upper and lower chambers may be evacuated and filled with blood from the top end. The blood flows unimpeded from the upper to the lower chamber through the passageway while obtaining a blood sample from a patient.

Upon subsequent centrifuging, the heavy stainless steel ball is driven by centrifugal force through the passageway and beyond the valve seat into cavity within the elastomeric body thereby completing assembly of the valve. The ball displaces an elastomeric member and remains in an unseated position until centrifuging is terminated after which the said elastomeric member pulls the ball into a seated position to separate the upper and lower chambers in a manner substantially identical to that of the first embodiment.

The primary objective of the present invention is to provide a device that may be used to collect a blood sample from a patient, separate the blood sample into its constituents, and maintain the constituents separate while the sample is mailed to a laboratory.

Another objective of the present invention is to provide a blood plasma separator that is less expensive than those heretofore provided.

Another objective of the present invention is to provide a blood plasma separator that simplifies the procedure required for the separation and shipment of a blood sample.

Another objective of the present invention is to provide an improved closure for a blood container whereby all the cellular material of the blood will be removed by centrifugation to prevent later contamination of the plasma with cellular material, and the usual necessity of removing the stopper prior to centrifuging is eliminated.

The foregoing objectives and advantages of the invention will appear more fully hereinafter from a consideration of the detailed description which follows, taken together with the accompanying drawings, wherein two embodiments of the invention are illustrated by way of example. It is to be expressly understood, however, that the drawings are for illustrative purposes only and are not to be considered as defining the limits of the invention.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical section of a first embodiment of the present invention.

FIG. 2 is a view of the present invention taken along line 2—2 of FIG. 1.

FIG. 3 is a vertical section of a second embodiment of the present invention.

FIG. 4 is a view taken along line 4—4 of FIG. 3.

FIG. 5 is a view taken along line 5—5 of FIG. 3.

FIG. 6 is a plan view looking up at the bottom of the stopper 14 of FIG. 1.

FIG. 7 is a vertical section of the stopper 14 of FIG. 1.

FIG. 8 is a vertical section of a common prior art stopper shown for comparison.

DESCRIPTION OF THE INVENTION

The present invention will be described as a plasma separator; however, it is to be understood that the invention could be used for the separation of material suspended in a liquid, for separating emulsions or for separating fluid constituents having different specific gravities.

Referring to FIG. 1, there is shown a glass tube 10, having openings at each end which are closed by stoppers 12 and 14. Stoppers 12 and 14 are preferably resilient and penetrable by a cannula for purposes of evacuating or filling the tube. Tube 10 has a constriction 16 in the form of a reduced diameter formed at a predetermined position between the ends. The constriction is used to properly position a ball-valve 18 which is disposed within tube 10 to divide the tube into an upper chamber 11 and a lower chamber 13.

It is to be understood that the valve could be positioned in many ways well known in the art. As an example, the fit between the valve and the inside diameter of the tube may be of sufficient tightness so that once the valve is forced into a particular position during assembly the frictional forces between the valve and the tube will retain the valve at the desired position during its life including periods of centrifuging.

The valve is positioned so that it is above an interface 17 that is formed between the plasma and the cellular material of the blood after centrifuging. This is essential so that the plasma remains free of cellular material during mailing of the sample.

Valve 18 is made of an elastomeric material such as a soft inert rubber or plastic material. A ball 20 is positioned within valve 18 and is formed of one of a variety of materials having a specific gravity greater than that of blood plasma which is approximately 1.03. The material from which the ball is manufactured must be chemically inert with blood and the preferred materials are glass, ceramic or stainless steel.

Valve 18 has a conical-shaped upper surface 22 forming a funnel that is in communication with a cylindrical opening 24 formed in the center of the valve and extending therethrough. The upper periphery of surface 22 terminates in a feather edge which seals against the inner surface of tube 10 to facilitate unrestricted flow of cellular material through the valve during centrifuging and to prevent cellular material from being caught between the valve and the inner surface of the tube. An annular opening 26 is formed in the lower side of valve 18 to reduce the effect of variations of internal diameter of the glass tube 10 upon the diameter of opening 24.

Valve 18 has an internal cavity 28 defined by conical surface 30, a cylindrical surface 31 and the inner surface of spokes 32 which are connected at the center of valve 18 as shown most clearly in FIG. 2.

Ball 20 is inserted into valve 18 by pushing the ball through the opening 24 prior to the valve being inserted into tube 10. The ball is disposed within cavity 28 and is supported by spokes 32 which presses the ball against conical surface 30 to seal opening 24.

When a downward force is exerted on ball 20, spokes 32 stretch enabling ball 20 to be displaced in a downwardly direction and unseated from surface 30 thereby providing a passage between the upper chamber and lower chamber. This force may be exerted by a pressure differential between the two chambers or by centrifuging the tube.

After the valve is inserted in tube 10, stoppers 12 and 14 are placed in their respective ends and the tube is evacuated in a manner well known in the art. Evacuation of the lower chamber causes a pressure differential across ball 20 thereby causing the ball to be displaced downwardly opening a passageway to the upper chamber so that it too is evacuated.

When the tube is to be filled with a blood sample, stopper 14 is punctured with a pointed cannula connected with a patient so that blood is drawn into the evacuated upper chamber. As the upper chamber fills with blood, a pressure differential is again created across ball 20 causing it to be displaced downwardly and be unseated from surface 30. The unseating of ball 20 allows blood to flow into the lower chamber so that the entire tube is filled with the blood sample.

In order to separate the plasma from cellular material, the entire device is centrifuged so that centrifugal force is exerted in the direction of stopper 12. Since ball 20 has a specific gravity greater than blood, the ball is urged in a downwardly direction stretching spokes 32 and unseating the ball so that a passage is formed between the upper and lower chambers. The heavier red blood cells flow in a downwardly direction displacing the plasma in the lower chamber so that it flows in an upwardly direction into the upper chamber until a plasma-cellular material interface 17 is established below valve 18. When interface 17 is established, centrifuging is stopped and spokes 32 contract causing ball 20 to be seated against conical surface 30 thereby creating a permanent separation between the upper and lower chambers. A seal created by the ball and conical surface 30 is sufficiently tight so that the tube may thereafter be shipped by mail to a laboratory without the cellular material being remixed with the plasma.

FIGS. 1, 3, 6 and 7 show an improved form of upper stopper especially designed to eliminate the usual necessity of removing the upper stopper prior to centrifugation to avoid the possibility that blood droplets or other blood portions containing red cells will remain on the stopper or between the glass tube and the stopper, as discussed in greater detail above. Study of such usual malfunctions of prior art stoppers shows that blood with red cells at 64 in FIG. 8, frequently remains on horizontal portions of the stoppers as at 60, 61 and 62, and/or in small crevices where the rubber of the stopper forms an acute angle relative to the adjacent glass wall 65 of the tubular container, as at 63, even though substantial centrifugal force is employed to separate the red cells from the plasma. The stoppers 14 and 36 are designed to eliminate this difficulty while at the same time enabling the blood containers to be kept stoppered throughout centrifuging and subsequent handling prior to chemical analysis, thus keeping out dirt, air born bacteria, spores, etc..

FIG. 8 shows a very well known type of prior-art stopper inserted in its glass blood container, shown for analysis and comparison. The roof portion, which is at 90° to the long axis of the blood container and to the direction of the centrifugal force, frequently has one or more drops of blood, as shown at 64, still remaining wetting this horizontal surface. Similarly, surfaces 61 and 62, at 90° relative to the tube axis, are surfaces having a high retentivity for droplets. Blood has high wetting characteristics relative to rubber surfaces. In FIGS. 1, 3 and 7 note that these 90° surfaces have been eliminated and have been replaced with diagonal surfaces, relative to the tube axis, so that provision is made for "run-off" of the blood droplets, comparable to rain on a slanted roof. This is shown by the slanted surfaces 66, 67 and 68 in FIG. 7.

The FIG. 6 is a bottom view of FIG. 7 and shows three air channels, each also having a diagonal surface

68 for "run-off" of blood droplets. These channels aid in the evacuation of the tube 34, FIG. 3, where a plurality of such tubes may have their stoppers partially inserted, but not far enough to occlude the passageways, then be placed in an evacuating enclosure, and then have the stoppers pushed all the way into the glass tubes thus sealing in the vacuum.

Note that the stopper in FIG. 3 is shown rotated slightly, as compared with FIGS. 6 and 7, but the design is the same.

As an optional feature, the blood contacting surfaces of this improved stopper may be coated with a hydrophobic material, such as a wax, teflon or other suitable fluorocarbon, AC polyethylene available from Allied Chemical Corp., or any other preferred material which reduces the wetting action relative to blood and thus will increase the "run-off" action of blood while being centrifuged.

An additional design feature of this improved stopper is to provide a tapered or thin skirt portion on the bottom of the stopper, as at 67, FIG. 7, preferably terminating with a sharp edge, its cross section having a small included angle. The function of this feature is that when a droplet of blood "runs off" any of the diagonal or vertical surfaces down to the edge of this skirt under the influence of centrifugal force, this small included angle, constituting a sharp edge (69 and 70 in FIG. 7), substantially reduces the wetted adherence of the drop, relative to the mass of the drop, so that the centrifugal force more readily and more completely causes the droplet to be spun off this sharp edge.

Minor modifications may be made to the above-described device that fall within the inventive concepts of the invention. Ball 20 may be replaced with an element having a conical surface juxtaposed with surface 30.

The previously described device has certain characteristics that may be somewhat undesirable. The preassembled valve is normally closed when it is in the tube and opens only when a downwardly directed force is exerted on the ball. Thus, it is essential that a double ended tube be utilized so that the chambers may be evacuated from one end and filled with blood from the other end. The need for a double ended tube necessitates the use of a second stopper which adds to the overall cost of the device and also increases the assembly cost. The assembly cost is also increased by the necessity that the ball be placed within the valve prior to insertion of the valve in tube 10. A second embodiment shown in FIG. 3 is provided to overcome these somewhat undesirable features.

The device shown in FIG. 3 has an opening connecting the upper and lower chambers so that both chambers may be evacuated and filled with the patient's blood from one end of the device. A standard single ended glass tube 34 has a penetrable stopper 36 inserted in the end. A valve 38 is fixedly disposed approximately midway the tube 34 and may be positioned by the use of an annular depression such as in the embodiment shown in FIG. 1 or by the use of a tight frictional fit as previously described.

Valve 38 has a conical upper surface 40 having an opening 42 formed in the center thereof which is in communication with a cylindrical opening 43 extending through the valve. Three raised bosses 44 are formed on the conical surface 40 and are equally spaced around the surface. An annular opening 46 is

formed in the lower surface of valve 38 to compensate for variations in the inside diameter of tube 34. A cavity 48 is formed in valve 38 and is defined by a conical surface 50, a cylindrical surface 51 and the inner surface 52 of a thin wall 54 formed on the bottom of valve 38. Wall 54 has three openings 56 formed therein for communicating cavity 48 with the lower chamber of the tube as shown most clearly in FIG. 4.

During assembly of the device shown in FIG. 3, valve 38 is positioned within tube 34 and a ball 58, preferably of stainless steel, is placed in the upper chamber. Anticoagulant may be added to the tube and thereafter penetrable stopper 36 is pushed into position in the end of the tube 34. The tube is then evacuated in any suitable manner well known in the art. Both the upper and lower chambers are evacuated because ball 58 rests on bosses 44 rather than on surface 40. Bosses 44 hold ball 58 in spaced relationship to surface 40 so that an opening is formed between the ball and surface 40 to allow for evacuation of both chambers through one end. The ball has a diameter somewhat larger than opening 42 and therefore does not pass through opening 42 when placed into the upper chamber.

A double pointed cannula is inserted into a patient and the second end inserted into stopper 36 is used to fill the upper and lower chambers with blood. Both chambers are filled because bosses 44 prevent the ball from seating on the valve. After the tube is filled with blood, it is centrifuged. Because of the high specific gravity of the ball, it is driven in a downwardly direction by the centrifugal force through the openings 42 and 43 in valve 38. The ball thereafter remains in cavity 48 of the valve. During centrifuging, the ball continues to press against wall 54 causing the wall to deflect, in a downwardly direction, a sufficient distance so that the ball does not seat against conical surface 50. When the ball is not seated, an interconnecting passage between the upper and lower chambers is provided so that the heavier blood cells may flow in a downwardly direction and displace plasma which flows in an upwardly direction through the valve. When the centrifuging is completed, the elasticity of the thin wall 54 again becomes a dominant force pushing ball 58 into a seated position against conical surface 50 thereby sealing the plasma in the upper chamber from the cellular material contained in the lower chamber.

Thus, the embodiment shown in FIG. 3 reduces the component cost of the device by the elimination of a second stopper and also reduces assembly costs since the ball need not be inserted into the valve but merely may be dropped into the upper chamber, after which centrifugal force drives the ball into its proper position. Since ball 58 initially rests on bosses 44 and does not form a seal with surface 40, both chambers may be evacuated from one end of the tube and both chambers may also be filled with blood from the same end of the tube.

Thus, the present invention provides an inexpensive and uncomplicated device for taking blood samples, for separating the blood into its constituents and for shipping the separated constituents to a laboratory for analysis without the need for placing the constituents in separate containers.

What is claimed is:

1. A separator device for separating light liquid constituents from heavier solid constituents of mixtures thereof, comprising:

a hollow elongate member having at least one end adapted for receiving the mixture;
means for sealing the open ends of said hollow member; and

valve means fixedly positioned in said member for dividing the member into first and second sealed chambers, said valve means being normally closed to seal said first chamber and said second chamber from each other, said valve being responsive to a force in one direction for opening the valve so that the first and second chambers are in communication with each other while the force is applied and said valve closing to interrupt said communication after the force terminates.

2. A separator device as described in claim 1, wherein at least one of the means for sealing is penetrable with a cannula.

3. A separator device as described in claim 1, wherein the valve means comprises:

an elastomeric body having a passageway formed therethrough, said passageway including an enlarged cavity; and

a sealing element disposed in said cavity.

4. A separator device as described in claim 3, wherein said cavity is partially defined by a sealing surface formed and arranged for sealing engagement with said sealing element; and the valve means additionally includes resilient means for urging said sealing element into sealing engagement with the sealing surface.

5. A separator device as described in claim 3, wherein the sealing element comprises a spherical member.

6. A separator device as described in claim 4, wherein the means for urging the sealing element into sealing engagement comprises, resilient members formed integrally with said valve, said resilient members are disposed opposite the sealing surface and partially define the cavity.

7. A separator device as described in claim 3, wherein the hollow member is tubular and the passageway includes a cylindrical portion positioned concentrically with the hollow member, and the valve means additionally includes an annular groove formed in said valve concentric with said passageway.

8. A separator device as described in claim 1, wherein the valve means includes a conical surface, adjacent the first chamber, which forms a funnel that is in communication with a passageway that extends from the center of the conical surface through the valve means.

9. A separator device as described in claim 8, additionally comprising at least one boss formed on said conical surface.

10. A separator device as described in claim 4, wherein the means for urging said sealing element into sealing engagement comprises a thin wall formed integrally with said valve, said wall partially defining the cavity and having at least one opening formed therein in communication with the passageway.

11. A separator device as described in claim 9, wherein the hollow member comprises a glass tube having one closed end and one open end.

12. A separator device for separating mixed light liquid and heavy solid constituents of blood and establishing a permanent barrier between them, including:
a tubular container having at least one open end;

- elastomeric closure means for closing the open end and adapted to be penetrated by a pointed cannula for filling the container with blood;
- elastomeric barrier means fixedly located to separate the container into upper and lower chambers which are sealed apart from each other by said barrier means as hereinafter described;
- a passageway through the barrier means connecting the upper and lower chambers;
- a wall of the passageway comprising a valve seat;
- a resilient restraining means including at least one aperture therethrough; and
- movable valve closure means having a specific gravity greater than blood and adapted to be forced by centrifugal force from the upper chamber, down through the connecting passageway, past the valve seat and against the restraining means, which is maintained in a stretched elongated condition by the centrifugal force acting on the valve closure means so that the connecting passageway remains open and the light blood liquid component flows into the upper chamber and the heavier blood solid component moves into the lower chamber, following the completion of which, centrifugation is stopped and the resilient restraining means urges the movable valve closure means against the valve seat establishing a permanent seal between the first and second chambers.
13. The method of separation of blood, contained in an elongated container, into its lighter liquid and heavier solid constituents and transferring these constituents into upper and lower chambers separated by a sealed barrier, fixedly positioned in the container comprising the steps of:
- transferring the heavier blood constituents into the lower chamber and transferring displaced lighter blood constituents into the upper chamber by centrifugation;
 - moving a valve closure member from the upper chamber through a connecting passageway formed in the barrier and connecting the upper and lower chambers to a position beyond a valve seat means formed adjacent said passageway, by using centrifugation;
 - maintaining said valve closure member in a position beyond said valve seat by centrifugation; and
 - moving the valve closure member to a position against the valve seat means whereby the connecting passageway between the upper and lower chambers is sealed closed, by terminating the centrifugation.
14. A separator device for separating constituents of blood into heavier solid and lighter liquid portions, comprising:
- an elongated container;
 - a centrifugally operated valve means fixedly positioned in said container for separating the container into two sealed chambers and for opening and connecting the two chambers while being centrifuged and for closing and sealing apart the chambers when centrifugation terminates.
15. A separator device for separating lighter liquid constituents of blood from the heavier solid constituents thereof which comprises:
- an elongated tubular container having at least one open end; and

- closure means for said open end of said container said closure means having no surfaces on the inner portion thereof which will contact liquid contained within said container, presenting a surface parallel to the plane normal to the longitudinal axis of said tubular container.
16. As in claim 15, wherein the fluid-contacting surfaces of the closure means are made of a hydrophobic material.
17. A device as in claim 16, wherein said closure has at least one air channel in the lower sidewall contacting the interior walls of said container, said channel having an upper surface which forms an angle of less than 90° relative to the adjacent container wall of said tubular container.
18. As in claim 16, wherein the said surfaces are made of a hydrophobic material.
19. The method of separation of blood into its lighter liquid and heavier solid constituents which consists of the steps of:
- filling with blood an elongated container having at least one open end sealed by a closure member; and
 - centrifuging the container with the closure member in sealing location whereby the blood is centrifuged off the closure member and is separated into its lighter and heavier constituents, said closure member having no surface on the inner portion thereof which will contact liquid contained within said container, presenting a surface parallel to the plane normal to the longitudinal axis of said tubular container.
20. The method of separation according to claim 19 wherein said closure has a fluid-contacting surface adjacent the container inner wall contacting portion which forms an angle greater than 5° relative to the adjacent inner wall of the container.
21. The method of separation according to claim 19 wherein said closure has a skirt portion extending toward the opposite end of the container and has an edge portion at the lower end of said skirt which forms an angle less than 120° with the adjacent inner wall of said container.
22. A method according to claim 19 wherein the closure member has at least one air channel in the lower sidewall contacting the interior walls of said container, said channel having an upper surface which forms an angle of less than 90° relative to the adjacent container wall of said tubular container.
23. The method of separation of blood into its constituents of light liquid phase and heavier solid phase and establishing a permanent barrier between said phases, comprising the steps of:
- centrifuging blood contained in an elongated container having first and second chambers separated by a barrier, said barrier fixedly positioned in the container having a passageway formed therethrough so that the light liquid phase of the blood flows to the first chamber and the heavier solid phase flows to the second chamber; and
 - sealing the barrier passageway to provide a permanent barrier between the light liquid phase and the heavier solid phase of the blood constituents.
24. A method as described in claim 23, wherein the step of sealing the barrier passageway includes the step of subjecting a force activated sealing means to a pre-

determined force sufficient to activate the sealing means.

25. A method of separation of blood, contained in an elongated container, into its constituents of light liquid phase and heavier solid phase and transferring these phases into first and second chambers formed in the container by a fixed barrier disposed between the ends of the container, comprising the steps of:

opening a valve closure means having a specific gravity greater than the blood, said valve closure means being associated with the barrier separating the chambers so that the chambers are connected by the open valve means;

centrifuging the container so that the heavier solid phase is concentrated in the second chamber and the light liquid phase is displaced and flows through the open valve means into the first chamber; and closing the valve closure means after completion of the separation of the blood constituents into the light liquid phase and the heavier solid phase.

26. The method of separating blood into its constituents of light liquid phase and heavier solid phase and providing a permanent barrier therebetween, comprising the steps of:

centrifuging an elongated container in which the blood is contained, said container including first and second chambers separated by a barrier fixedly positioned in the container and having a passageway connecting the first and second chambers so that the heavier solid phase becomes concentrated in the second chamber and the light liquid phase is displaced and flows through the passageway into the first chamber; and

sealing the passageway to provide a permanent barrier between the first and second chambers by moving a closure member from the first chamber into sealing engagement with the passageway.

27. A separator device for separating blood into its constituents of light liquid phase and heavier solid phase and for establishing a permanent barrier between

the phases, including:

a tubular container closed at both ends containing the blood to be separated;

barrier means fixedly located for separating the container into first and second chambers which are sealed apart from each other as hereinafter described;

a passageway through the barrier means connecting the first and second chambers; and

force activated sealing means for sealing the passageway through the barrier means upon application of a predetermined force.

28. A separator device as described in claim 27, wherein the barrier means is formed of an elastomeric material and the sealing means comprises a closure member having specific gravity greater than blood and adapted to be forced by a predetermined centrifugal force from the first chamber into the passageway to thereby permanently seal and separate the first and second chambers.

29. A separator device for separating mixed light liquid phase and heavy solid phase constituents of blood and establishing a permanent barrier between said phases, including:

a tubular container closed at both ends containing the blood to be separated;

elastomeric barrier means fixedly located to separate the container into first and second chambers which are sealed apart from each other by said barrier as hereinafter described;

a passageway through the barrier means connecting the first and second chambers;

a wall of the passageway comprising a valve seat; and

movable valve closure means within the container having a specific gravity greater than blood for coupling with the valve seat to seal off the passageway and provide a permanent barrier seal isolating the first and second chambers.

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