July 7, 1970 R. J. EISEL ET AL 3,519,201

SEAL MEANS FOR BLOOD SEPARATOR AND THE LIKE

Filed May 7, 1968 2 Sheets-Sheet 1

FIG. 1

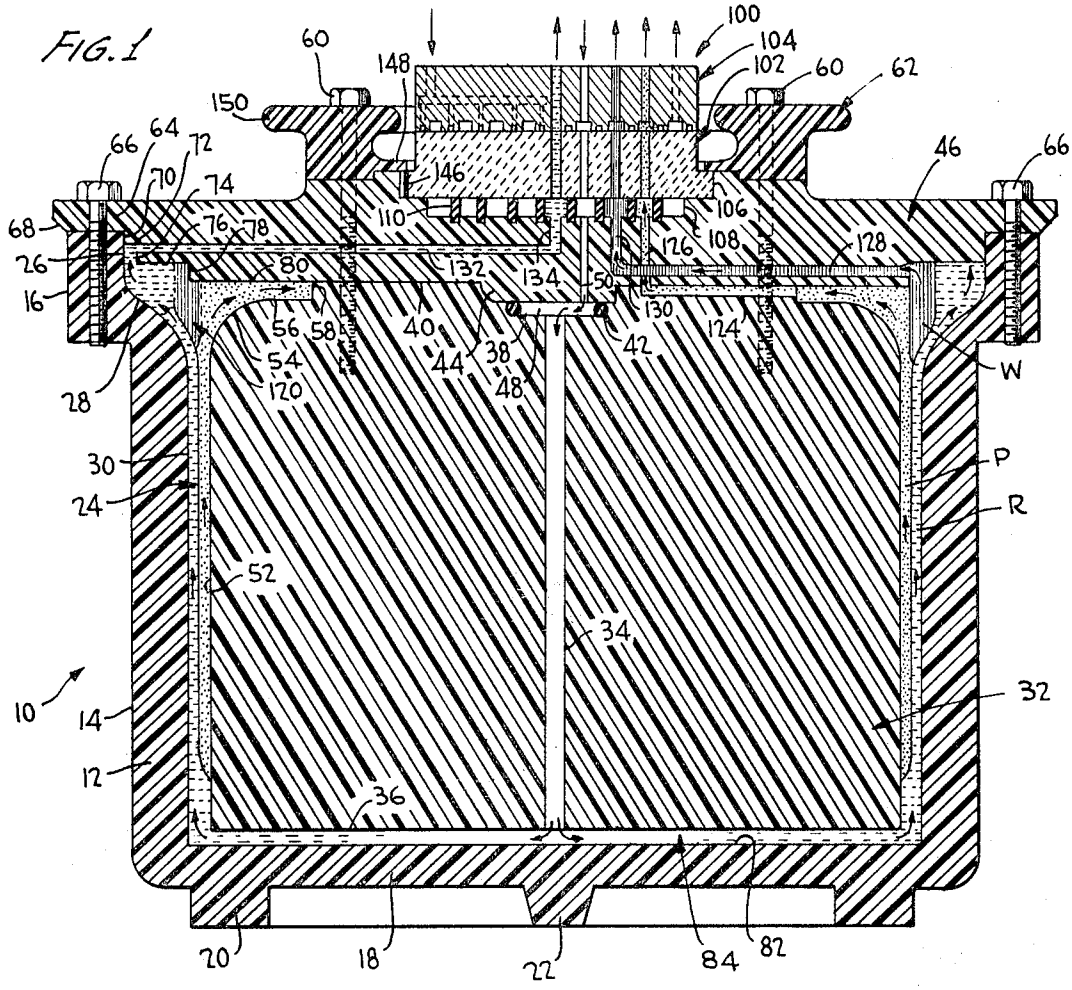


FIG. 2

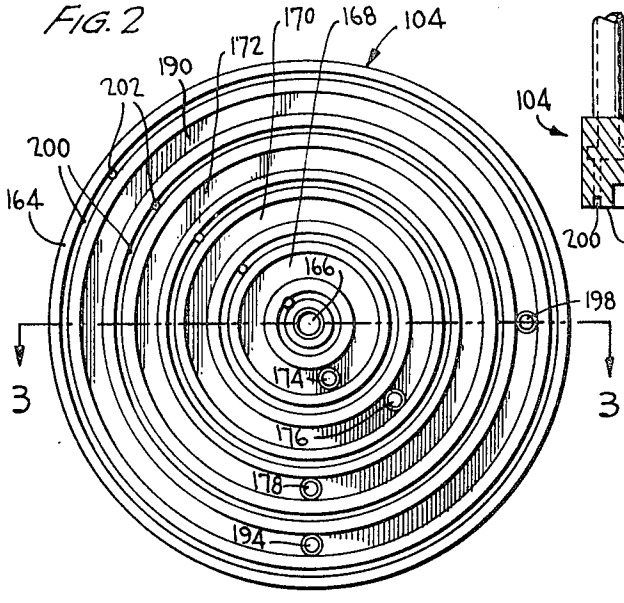
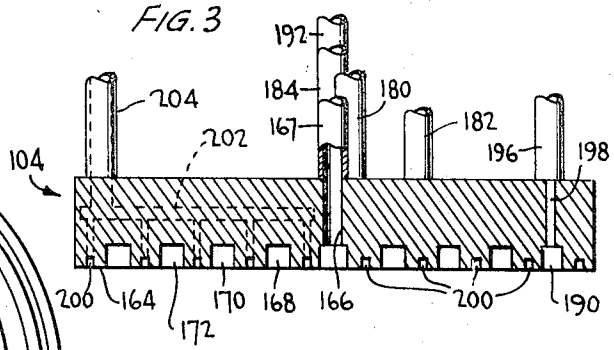


FIG. 3



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Filed May 7, 1968 2 Sheets-Sheet 2

FIG. 4

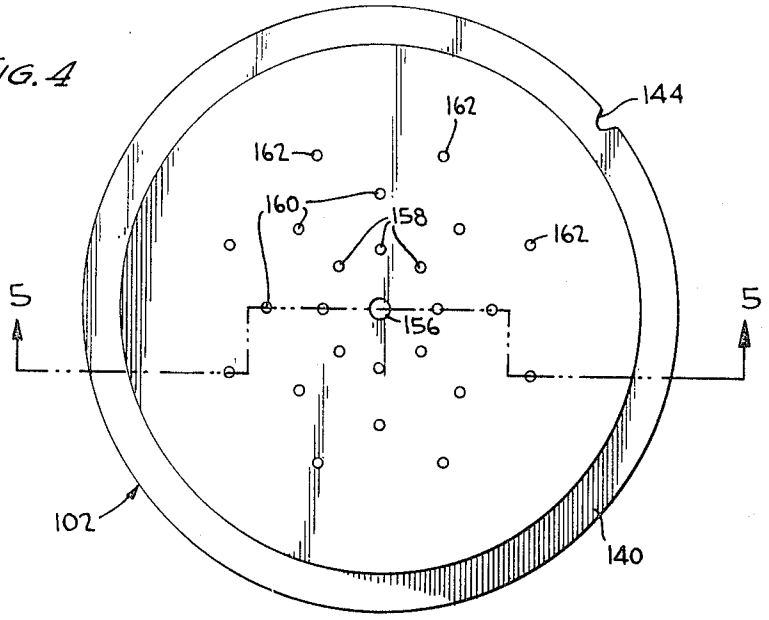
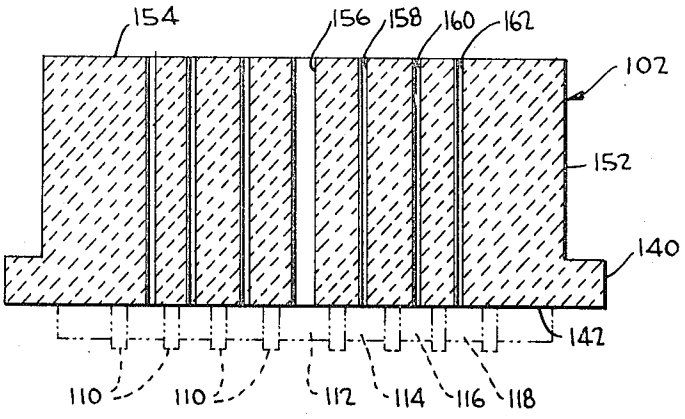


FIG. 5



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3,519,201

SEAL MEANS FOR BLOOD SEPARATOR AND THE LIKE

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Int. Cl. B04b *11/00*; A61m *5/00*
U.S. Cl. 233—21 10 Claims

ABSTRACT OF THE DISCLOSURE

Sealing means for use with a face seal having one fixed element and one rotating element particularly for use with a continuous blood flow separator. Saline under pressure is forced into groove means between the channel means at the interface of the seal means to preclude seepage of the materials in the channel means across the interface. According to a preferred arrangement the most sensitive material, such as packed red blood cells, is removed through the most direct pathway to preclude damage thereto. Preferably, the rotating element is formed of ceramic and the fixed element is formed of stainless steel.

This invention relates to a sealing means for use with a face seal having one fixed element and one rotating element. More specifically, this invention is directed to a modified and improved sealing means for use with a continuous flow blood separator of the type described in detail in copending application Ser. No. 570,792 filed Aug. 8, 1966, in the names of George T. Judson and Emil J. Freireich, and assigned to the same assignee as the instant application. The disclosure of the aforementioned copending application is incorporated herein by reference in its entirety.

The provision of a sealing means between fixed and rotating elements provides obvious difficulties. Such a sealing means has general applicability, for example, in centrifuge devices or separating means wherein a fluid is separated into a plurality of components by centrifugal force. With such devices the fluid must be fed into the bowl of the centrifuge and the separated components of the fluid must be removed therefrom after centrifugation. Since portions of the centrifuge are rotating at high speeds, and since the source of the fluid and the depository for the components are usually stationary, a sealing means must be interposed which is effective to prevent leakage between a stationary or fixed element into which the fluid is fed and from which the components are withdrawn, and a rotating element which receives the fluid from the fixed element and feeds the same to the bowl of the separator and which receives the fractional components from the separator and feeds the same to the fixed element for withdrawal from the device. The difficulties of such an operation are believed obvious.

Such difficulties are compounded when the fluid being separated is blood or any other material particularly sensitive to damage. Further, when the fluid is blood withdrawn directly from a donor, with certain of the fractional components being returned directly to the donor in a continuous separation system, any damage to the components has even greater significance since there is relatively little opportunity to monitor the same before they are returned to the donor. The aforementioned copending application discloses such a continuous flow blood separator and provides a face seal adapted to prevent leakage between the fixed and rotating elements of the centrifuge thereof. This face seal, while

generally satisfactory, has been subject to certain problems. Particularly, it has been found that in some instances the blood or fractional components thereof have a tendency to seep across the lands separating the channels defined at the interface between the fixed and rotating elements. In addition to such seepage causing a mixture of the various materials which in itself is undesirable, the high shear to which such materials are subjected during seepage across the interface has been found to damage the materials. It is this problem with which the instant invention is primarily concerned.

Other difficulties have also been encountered with the face seal disclosed in the aforementioned copending application. One of the fractional components being separated from the blood is packed red blood cells, a material which is particularly sensitive. In the face seal of the copending application, the blood itself is fed through a central axial passageway which extends through both the fixed and rotating elements, and the fractional components are withdrawn through aligned concentric channels in the fixed and rotating elements. Removal of the packed red blood cells through one of the annular channels necessitates the passage of this material through a somewhat tortuous route. It is preferred that this particularly sensitive component of the blood be handled in the most delicate manner and the instant inventive concepts modify the face seal of the copending application to effect this result.

One further difficulty found with the sealing means of the prior application results from the preferred material utilized in the manufacture of the rotating element. A synthetic resin, specifically polytetrafluoroethylene (Teflon), was initially utilized for the formation of the rotating element, but it has now been found that this material is subject to warping in use. Due to the necessity for extremely accurate mating of the fixed and rotating elements, even slight dimensional changes of the rotating element can reduce the effectiveness of the seal. The instant invention replaces the Teflon rotating element with an element formed of a material which is dimensionally stable under the conditions of use.

Although the instant inventive concepts are applicable to any sealing means wherein fixed and rotating elements are found, since the most important application of the sealing means is in a continuous flow blood separator of the type disclosed in the aforementioned copending application, the preferred embodiments hereof will be discussed in relation thereto.

Considering the foregoing, it is a primary object of the instant invention to provide a sealing means of the type described which is free from the foregoing and other such disadvantages. A basic and important objective of this invention is the provision of a sealing means which precludes lateral seepage of blood or fractional components thereof across the interface defined between the fixed and rotating elements. In this regard, the instant inventive concepts provide means intermediate each juxtaposed pair of channels in the face seal which acts as a barrier to such seepage.

Yet another important object of the instant invention is the provision of an arrangement for a face seal wherein the most sensitive component, that is, the packed red blood cells, are passed through the most direct path to preclude any damage thereto.

Further, another important object of this invention is the provision of a face seal wherein the rotating element is formed of a material which is not subject to dimensional change or warpage during use.

Other and further objects of the instant inventive concepts will either be specifically mentioned in the following detailed description or will be obvious therefrom.

Such detailed description makes reference to the accompanying drawing wherein:

FIG. 1 is a vertical cross-sectional view through a centrifuge means incorporating a face seal according to the instant inventive concepts;

FIG. 2 is a bottom plan view of the fixed or stationary element of the face seal;

FIG. 3 is a transverse cross-sectional view taken substantially on lines 3—3 of FIG. 2;

FIG. 4 is a top plan view of the rotating element of the face seal; and

FIG. 5 is a transverse cross-sectional view taken substantially on lines 5—5 of FIG. 4, showing cooperating portions of the centrifuge means in dotted lines.

Like reference characters refer to like parts throughout the several views of the drawing.

Reference may be made to the aforementioned copending application which, as has been mentioned hereinabove, is incorporated herein by reference in its entirety, to provide further background on the preferred system with which the improvements of the instant application may be utilized. In such system, whole blood is withdrawn directly from a donor, separated in a centrifuge means into red blood cells, white blood cells or "buffy coat" and plasma, with one or more of the fractional components being returned directly to the donor from the centrifuge means. Of course, various safety devices are included in the system and the use of these devices would be equally applicable to the means of the instant invention. Additionally, platelets can be withdrawn either with the white blood cells or with the plasma and subsequently separated in a second centrifuge, if desired. Further, the various operating means including pumps and the like shown in the aforementioned copending application are all applicable to use with the modified means of the instant invention.

The basic centrifuge means is designated generally by the reference numeral **10** in FIG. 1 and includes a bowl or shell **12** disposed within a casing (not shown) which is utilized to rotate the bowl and its associated elements about a central axis. The shell **12** has an upstanding cylindrical sidewall means **14** which terminates in an outwardly and upwardly directed flange **16**. The bottom wall **18** of the shell **12** is provided with an annular depending flange **20** and a central spindle **22** utilized for centering the shell **12** with respect to the outer casing.

The interior of the sidewalls **14** of the shell **12** serve to provide the outer boundary for the separation channel **24**. Starting at the top of the shell **12**, a wall portion **26** extends linearly downwardly for a predetermined distance, then merges smoothly into an inwardly and downwardly inclined wall portion **28** which in turn merges into another linearly extending wall portion **30**.

Another portion of the centrifuge assembly or separating means **10** is the center or filler piece designated generally by the reference number **32**. This filler piece is suitably suspended within the shell **12** in a manner to be more fully described hereinafter. A central bore **34** extends completely from the lower surface **36** of the filler piece **32** to the upper surface thereof. A depression **38** is provided in the upper surface **40** of the filler piece **32** and an O-ring **42** seals this depression **38** against a protrusion **44** on the cover member **46** thereby providing an enlarged cavity **48**. This bore **34** provides the input channel for the blood and the cavity **48** permits communication between the bore **34** which is axial and radially offset passageway means **50** for carrying the blood from the seal means in a manner to be described in more detail hereinafter. This arrangement differs from the construction of the separating means in the aforementioned copending application and permits the use of the axial passageway means into the seal means for packed red blood cells which are more sensitive to damage than the whole blood itself.

The filler piece **32** is cylindrically shaped for the most part and of a somewhat smaller diameter than that of the shell wall portion **30**. As such, the outer or sidewall **52** of the filler piece **32** is spaced slightly away from the wall portion **30** to thereby provide the other boundary of the separation channel **24**. This channel extends with uniform thickness substantially for the height of the shell wall portion **30**. Substantially opposite to the inclined portion **28** of the centrifuge shell, the sidewall **52** of the filler piece is radially curved as shown at **54**. This curve merges into an inwardly extending shoulder portion **56** which again turns into an upwardly extending portion at **58** to blend into the top surface **40**.

The filler piece **32** is secured to the cover member **46** by bolts or the like **60** which also function to secure a holding member **62** in the related assembly.

The top cover **46** is preferably fabricated of a clear plastic material which permits visual observation of the separation occurring within the centrifuge. This top cover member includes a flange portion **64** which abuts against the top of the flange portion **16** of the centrifuge shell **12** with bolts **66** securing these elements in related assembly. Gasket means (not shown) are included to preclude against leakage between these parts. Additionally, the flange portion **64** of the cover member **46** includes an angularly offset portion **68** designed to rest upon, and be frictionally driven by, a driving means (not shown). This manner of rotating the separating means differs slightly from the construction shown in the aforementioned application and has been found to provide better overall operation.

A short vertical wall portion **70** extends downwardly from the flange portion **64** of the top cover **46** to mate contiguously with the wall portion **26** of the centrifuge shell **12**, thereby properly positioning the cover on the shell. At the end of the vertical wall portion **70**, there is a horizontally or radially inwardly stepped portion **72** which merges with the top of another short vertical wall portion **74**. At the bottom of the wall portion **74**, there is another radially inwardly stepped portion **76** which merges with the top of a further vertical wall portion **78**. The bottom of this vertical wall portion **78** merges with the bottom surface **80** of the cover member **46** which rests on the top surface **40** of the filler piece **32**.

The attachment of the filler piece **32** to the cover member **46** is arranged such that the bottom surface **36** of the filler piece **32** is spaced slightly from the bottom inner surface **82** of the shell **12** to provide a channel **84** through which the whole blood flowing through the bore **34** can spread outwardly to the separation channel **24** and then climb upwardly therealong as the centrifuge is operated.

The seal means of the instant invention is designated generally by the reference numeral **100** and includes a lower or rotating element **102** and an upper or stationary element **104**. The lower or rotating element **102** fits within a first stepped recess or portion **106** on the top of the cover member **46**. A second stepped recess or portion **108** is also provided in the top of the cover member **46** with the stepped portion **108** being somewhat smaller than the stepped portion **106**. The stepped portion **108** contains a plurality of spaced grooves concentrically arranged around the central axis thereof with O-rings having a rectangular cross-sectional configuration being mounted within each of these grooves. All of the O-rings have been designated generally by the reference numeral **110**, but it will be appreciated that the size or diameter of such O-rings continually increases. Since the bottom of the rotating element **102** abuts against the top of the various O-rings **110**, the overall effect of such arrangement is to set off a series of channels or annular spaces between the stepped portion **108** and the bottom of the rotating element **102**. The smallest or innermost O-ring **110** defines therewithin a circular opening or channel means designated **112**, with such channel means being

axially aligned with the central or rotational axis of the centrifuge means **10**. Between this innermost O-ring and the next adjacent O-ring, a first annular channel means **114** is formed. Between the second O-ring and the next adjacent O-ring, a second annular channel **116** is formed. Finally, between said next adjacent O-ring and the outermost O-ring, a third or outer annular channel means **118** is formed. Each of these channel means serves to receive either the whole blood or the one of the fractional components as will be explained in more detail hereinafter.

To more fully understand the nature of the separation or fractionation which occurs within the centrifuge means **10**, it can be seen that the separation channel **24**, preferably having an optimum radial dimension of approximately 1 mm., extends upwardly with uniform thickness until it reaches the inclined wall portion **28** of the centrifuge shell **12**. At this point, the separation channel **24** merges into an enlarged separation space **120**. When whole blood enters the centrifuge means **10** it travels downwardly through the central bore **34**, then outwardly in the separation channel **84** and upwardly through the separation channel **24** to enter the space **120**. Such climbing action is created by a combination of the centrifugal force generated by rotation of the centrifugal shell **12**, the filler piece **32** and the top cover **46** and the action of the various pumps described in more detail in the aforementioned copending application. Due to this centrifugal force, the whole blood starts to separate as it begins to climb through the separation channel **24** and due to the difference in specific gravities of the various fractions thereof. The packed red cells are the most dense of the fractions, and these are thus packed outermost within the space **120**. The white cells are the next most dense and these are thus positioned adjacent the red cells and the plasma is the least dense and hence is disposed furtherest inwardly within the centrifuge. For purposes of illustration, blood is shown in the bore **34**, in the separation channel **84** and in the lower portion of the separation channel **24**. The packed red cells are designated R, the white cells are designated W, and the plasma is designated P. The various fractions are fully separated in the separation space **120** and the quantity of white cells is extremely small whereby, initially, there is merely an interface between the plasma P and the packed red cells R. Proper regulation of the various pumps associated with the separation system, as explained in more detail in the aforementioned copending application, adjusts the plasma-red cell interface line to space the same closer to the shell wall **26** or further away therefrom. However, after the blood has been separating for awhile, the white cells W start to build up within the centrifuge to form a "buffy coat" of the shape generally illustrated in FIG. 1. It will be seen that the white cell layer effectively "floats" between the red cells and plasma.

A first radial channel **124** communicates at one end with the separation space **120** at the wall portion **58** to receive the layer of plasma, and this radial channel **124** turns upwardly at **126** to communicate at its opposite end with the channel means **118** for removal of plasma P through the seal means **100**. A second radial channel **128** communicates at one end with the separation space **120** at the wall portion **78** and turns upwardly as at **130** to communicate at its opposite end with the channel means **116** for removal of white blood cells W through the seal means **100**. A third radial channel **132** communicates at one end with the separation space **120** at the wall portion **74** and turns upwardly as at **134** to form a portion which is co-axial with the center of rotation of the centrifuge means **10** and which communicates at its opposite end with the channel means **112** for removal of the packed red blood cells R through the seal means **100**. Thus, each of the individual fractions of the blood is transferred to its own particular channel means between the top cover **46** and the seal means **100**.

Although only a single channel has been shown communicating the separation space **120** with the individual channel means defined between the top cover **46** and the seal means **100**, it will be understood that such an arrangement is illustrative and a plurality of ports or channels can be provided to carry each of the fractional components of the blood to their respective channel means. Additionally, as will be readily understood that those skilled in the art, these fractional components are withdrawn from the separating means **10** with the aid of pumps as explained in more detail in the aforementioned copending patent application.

To understand the nature and construction of the seal means **100**, attention is directed particularly to FIGS. 2–5 which show in further detail the rotating element **102** and the fixed element **104**. The rotating element **102** is preferably formed of a ceramic material which has been found to be dimensionally stable under the conditions of use. As mentioned previously, it was found that Teflon had a tendency to warp from the heat of the blood and the operation of the device causing a reduction in the effectiveness of the seal. Manufacture of the rotating element **102** from ceramic material precludes this disadvantage. The rotating element **102** has a circular base portion **140** with a flat bottom surface **142**. The size of this base portion **140** corresponds substantially to the size of the stepped portion **106** in the cover member **46** and, as mentioned previously, when the rotating element **102** is positioned within the top cover **46**, the bottom surface **142** abuts against the top of the O-rings **110**. To prevent relative rotation between the rotating element **102** and the cover member **46**, a small notch **144** can be provided in the periphery of the base portion **140**, if desired. This notch **144** may mate with a guide pin **146** positioned at one edge of the stepped recess **106** in the top cover **46**. Further means of securing the rotating element **102** to the top cover **46** comprises the pressure plate **62** which includes an inwardly directed flange **148** which seats over the base portion **140** of the rotating element **102** as shown in FIG. 1. The bolts **60** function to secure this element to the filler piece **32** through the top cover **46** thereby securing the entire assembly together. Alternatively, separate bolts may be utilized to secure the cover member **46** to the filler piece **32** and to secure the pressure plate **62** to the cover member **46**. Further, the pressure plate **62** may merely function to assist in securing the rotating element **102** in position, with its primary function being as a handle to facilitate removal of the centrifuge means **10** from the casing (not shown) in which it is mounted in the assembly. To this end, an outstanding peripheral flange **150** may be provided on the pressure plate or handle **62**.

The rotating element **102** also includes an upstanding cylindrical body portion **152** integral with the base portion **140**, but having a cross-sectional diameter somewhat smaller than that of the base portion **140**. The top surface **154** of the rotating element **102** is planar according to the instant inventive concepts, although, if desired, mating portions of the channel means and groove means defined in the fixed element **104** and to be described in more detail hereinafter, may be provided in the top surface **154**. However, it has been found that a better seal is provided if this element has a planar top surface.

At the center of the rotating element **102**, a central bore **156** is provided which functions as a passageway means for withdrawing packed red blood cells from the channel means **112** through the rotating element **102**. The upper portion of this passageway means **156** and the lower portion of an aligned passageway means in the fixed element **104** to be described in more detail hereinafter together define a channel means for the red blood cells at the interface between these elements.

In addition to the central bore or passageway means **156** a plurality of additional bores or passageway means **158** are arranged concentrically about the central bore **156** in communication with the channel means **114** and

in communication with the channel means for the whole blood to be provided at the interface between the rotating and fixed elements as described in more detail hereinafter. Additional concentrically arranged bores or passageway means **160** are provided in communication with the channel means **116** for carrying white blood cells through the rotating element **102** and still further concentrically arranged bores or passageway means **162** are provided to communicate with the channel means **118** for carrying plasma through the rotating element **102**. The bores **158**, **160** and **162**, as will be seen from the drawing, are arranged on concentric circles of increasing diameter. These circles correspond to the mean diameters of the channel means provided at the interface between the fixed and rotating elements as will be explained in further detail hereinafter.

As mentioned previously, the fixed element **102** is formed of ceramic and thus, is not subject to dimensional change or instability during use.

As will be seen, there is a series of annular lands formed by the top surface **154** of the rotating element **102**. These lands act as boundaries between the various passageway means, and as will be explained in further detail hereinafter, cooperate with certain groove means in the fixed element **104** to preclude cross-over or seepage between the various channel means carrying the whole blood and fractional components thereof.

By referring now more particularly to FIGS. 2 and 3, the exact nature of the upper or fixed seal means **104** will be better understood. This element is preferably formed of stainless steel and has a flat lower surface **164** which is preferably lapped to a flatness of 3 light waves or less and which rests on the upper surface **154** of the rotating element **102**, this upper surface **154** also preferably being lapped to a flatness of 3 light waves or less. A central bore **166** is defined in the fixed element **104** and is aligned with the central bore **156** of the rotating element **102** to receive the packed red blood cells therefrom and pass the same to tubing **167** for removal from the separating means **10**. This use of a continuous central bore through the seal means **100** to carry the packed red blood cells functions to provide a more direct pathway for the red blood cells which, as mentioned previously, are particularly sensitive. Concentrically arranged annular channel means **168**, **170** and **172** are designed to mate with the openings at the tops of the passageway means **158**, **160** and **162** in the rotating element **102**. Bores or passageway means **174**, **176** and **178** communicate with the channel means **168**, **170** and **172** respectively at one end and with flexible tubing **180**, **182** and **184** at their opposite ends. In this manner, whole blood is passed, from a source of the same, in a continuous blood separator, from the donor, through the tubing **180** to bore **174**, the channel means **168**, the passageway means **158**, the channel means **114**, the bore **50** and the cavity **48** to the separating means. White blood cells pass from the separating means through the channel means **116**, the passageway means **160**, the channel means **170**, the passageway means **176** and the tubing **182** to any desired location. The plasma, when received from the separating means **10**, passes through the channel means **118**, the passageway mean **162**, the channel means **172**, the passageway means **178** and the tubing **184** to any desired location, generally back to the donor in a continuous blood separator.

Finally, an annular channel means **190** is provided in the fixed element **104** to define a saline-receiving channel to cool the seal means **100** and to provide an air barrier to protect the blood and other fractional components in the remainder of the seal means **100** against the entrance of air. Tubing **192** communicates through a bore **194** with this outer channel means for introduction, generally by gravity, of saline to the channel means **190** and tubing **196** communicates with the channel means **190** through a bore **198** for slow removal of saline therefrom. A clamp or the like (not shown) may be utilized on the tubing **196** to regulate removal of saline from the channel means **190**.

A mojor feature of the instant inventive concepts is the provision of groove means **200** in the lands separating the various channel means in the fixed element **104**. These groove means **200** communicate through a passageway means **202** with a tube **204**. Saline under pressure is fed through the tube **204** to the groove means **200**. The pressure of the saline in these groove means is at least as great as the pressure of the blood or the fractional components thereof in the various channel means. With a continuous flow blood separator of the type shown in the aforementioned copending application, the blood could be under arterial pressure whereby the pressure of the saline in the groove means **200** is at least this great. Preferably, saline is forced into the groove means **200** at a pressure in excess of arterial pressure. Arterial pressure is generally considered to be about 200 mm. of mercury and the pressure behind the saline in the groove means **200** is preferably from about 10–12 p.s.i. at a flow rate of about 20 ml./hr. Thus, a portion of the saline is caused to flow laterally from earh of the groove means arross the interface toward juxtaposed channel means to assist in precluding seepage of the blood and components across the interface which, as mentioned previously, may damage the various materials in the channel means and may cause mixing of the same. Leakage of the saline from the outer groove means **200** around the periphery of the seal means **100** will not cause any difficulty and will merely flow downwardly into the separating means **10**.

Reference may be made to the aforementioned copending application wherein a pivotally carried arm means is shown which cooperates with the seal means to press downwardly on the fixed element **104** during use. This arm means (not shown herein) may be readily raised to remove the centrifuge assembly when desired.

It is believed that the operation of the separating means will be readily understood from the foregoing detailed descirption. It can be seen that there is herein provided an improved construction of such separating means, and particularly the seal means thereof, which satisfies all of the objectives of the instant invention and others, including many advantages of great practical utility and commercial importance. Since many embodiments may be made of the instant inventive concepts, and since many modifications may be made of the embodiments herein before shown and described, it is to be understood that all matter is to be interpreted merely as illustrative and not in a limiting sense.

Accordingly, what is claimed is:

1. In a blood separator of the type wherein means are provided for separating blood from a source of the same into a plurality of fractional components, said blood separator having seal means associated with the separating means, said seal means including a fixed element and a rotating element having portions which abuttingly engage each other to define an interface therebetween, portions of said seal means defining spaced channel means at said interface for receiving in different channel means either blood to be separated from said source or fractional components of the separated blood from said separating means, and separate passageway means communicating with said seal means for bringing said blood to one of said channel means from said source through said fixed element, for feeding said blood from said one channel means to said separating means through said rotating element, for bringing said fractional components of said blood from said separating means to others of said channel means through said rotating element, and for withdrawing said fractional components from said other channel means

through said fixed element, the improvement which comprises:

(a) portions of said seal means defining groove means at said interface between said pair of juxtaposed channel means, and

(b) means for feeding saline solution into each of said groove means at a pressure at least as great as the pressure of said blood and fractional components thereof in said juxtaposed channel means.

2. The improvement of claim **1** wherein said blood separator includes means for continuously withdrawing blood from a donor and means for continuously returning at least one of said fractional components thereof to the donor after separation, said saline feeding means forcing saline into each of said groove means at a pressure at least equal to arterial pressure.

3. The improvement of claim **2** wherein said saline feeding means forces saline into each of said groove means at a pressure in excess of arterial pressure.

4. The improvement of claim **1** wherein said saline feeding means forces saline into each of said groove means at a pressure sufficient to cause a portion of said saline to flow laterally from each of said groove means across said interface toward juxtaposed channel means.

5. The improvement of claim **1** wherein said channel means includes a central channel means coincident with the axis of rotation of said seal means and at least two circular channel means concentric with said central channel means, said circular channel means being radially spaced from said central channel means and from each other, said groove means being provided at least between said central channel means and the first concentric circular channel means and between each additional pair of juxtaposed circular channel means.

6. The improvement of claim **5** wherein one of said fractional components includes packed red blood cells, said passageway means including an axial passageway means in said rotating element communicating the portion of said separating means containing said packed red blood cells with said central channel means and an axial passageway means in said fixed element communicating with said central channel means for withdrawing said red blood cells from said seal means.

7. The improvement of claim **1** further including portions of said seal means defining an outer channel means at said interface for receiving saline solution to cool said seal means and to provide an air barrier to protect said blood and said fractional components in the remainder of said channel means, means for feeding saline solution to said outer channel means, and means for slowly removing said saline solution from said outer channel means.

8. The improvement of claim **1** wherein said fixed and rotating elements each have a planar face portion, said planar face portions abutting each other and together defining said interface, and all of said channel means and all of said groove means being defined in said planar face portion of said fixed element.

9. The improvement of claim **8** wherein said rotating element is formed of ceramic.

10. The improvement of claim **9** wherein said fixed element is formed of stainless steel.

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