

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
26 January 2012 (26.01.2012)

(10) International Publication Number
WO 2012/012343 A1

(51) International Patent Classification:
B04B 5/04 (2006.01) *A61M 1/36* (2006.01)

(74) Agent: O'CONNOR, Edna M.; Mail Stop: 8101F2, 10811 West Collins Avenue, Lakewood, Colorado 80215 (US).

(21) International Application Number:
PCT/US2011/044391

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(22) International Filing Date:
18 July 2011 (18.07.2011)

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, ZA).

(25) Filing Language: English
(26) Publication Language: English
(30) Priority Data:
61/365,602 19 July 2010 (19.07.2010) US

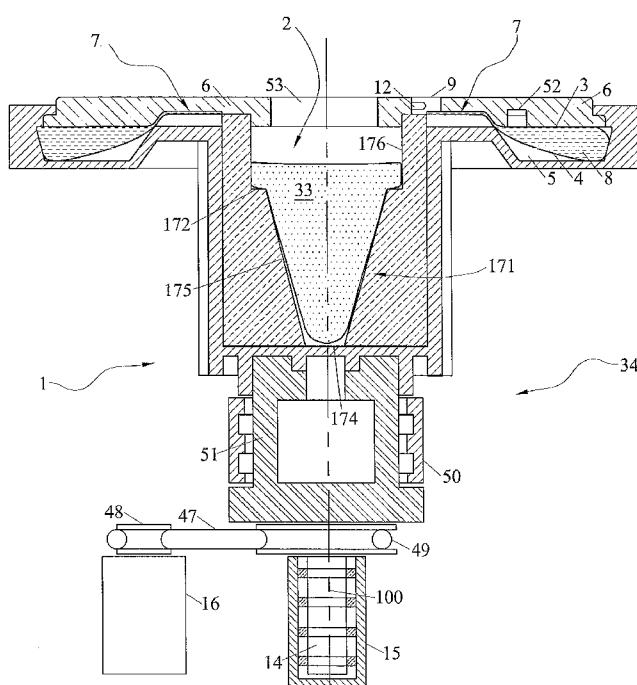
(71) Applicant (for all designated States except US): CARIDIANBCT, INC. [US/US]; Mail Stop: 8101F2, 10811 West Collins Avenue, Lakewood, Colorado 80215 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): HLAVINKA, Dennis, J. [US/US]; 7365 North Salvia Court, Arvada, Colorado 80007 (US). MERKLING, John R. [US/US]; 11171 West Exposition Drive, Lakewood, Colorado 80226 (US).

[Continued on next page]

(54) Title: A CENTRIFUGE FOR PROCESSING BLOOD AND BLOOD COMPONENTS





SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

A CENTRIFUGE FOR PROCESSING BLOOD AND BLOOD COMPONENTS**Field of the Invention**

The instant invention relates to a centrifuge for processing blood and blood components and for pooling buffy coat collections. This invention would be useful in any system with a central compartment where blood components are collected during centrifugation.

Background of the Invention

Different types of centrifuges intended for processing blood and blood components and also several types of ring bags intended for use in these centrifuges are described in, for example, WO87/06857; U.S. Patent no. 5,144,396; U.S. Patent No. 5,732,050; WO97/30715; and WO98/35757. An apparatus for pooling buffy coat collections is described in U.S. patent No. 6,656,105. In the apparatus described in U.S. Patent No. 6,656,105, the center well or central compartment or chamber to hold the platelet collection bag forms a cylindrical wall parallel to the axis of rotation of the centrifuge. This cylindrical wall provides a relatively large surface against which the platelets sediment under centrifugal force. This cylindrical wall also determines the sedimentation distance of the platelets.

Summary of the Invention

It is an object of this instant invention to reduce the sedimentation surface against a wall available for platelets in a centrifuge. This, in turn, increases the distance through which platelets must sediment before settling onto the wall. The result is that most of the platelets remain suspended in plasma or Platelet Additive Solution (PAS) when they are removed from the central chamber. Platelets in suspension are of a better quality than platelets that have sedimented onto the wall.

This present invention includes a centrifuge for processing buffy coat, comprising a rotor with a central axis of rotation, a central chamber on the rotor capable of receiving a product collection bag, and a separation chamber capable of receiving a separation vessel containing buffy coat. The separation vessel is connected to the product collection bag where separated buffy coat components can pass from the separation chamber to the central chamber. The central chamber of the centrifuge has an inner wall with a varying radius from the central axis of rotation, an upper portion, and a lower portion. When the product collection bag is received in the central chamber, the bag extends adjacent to both the upper and lower portions of the inner wall.

Another aspect of the present invention is a system for processing buffy coat comprising a bag assembly, and a centrifuge for processing buffy coat components. The bag assembly includes a separation vessel, a product collection bag, and at least one conduit connecting the separation vessel to the product collection bag. The centrifuge for processing buffy coat comprises a rotor with a central axis of rotation; a central chamber on the rotor, wherein the product collection bag is in the central chamber; and a separation chamber capable of receiving the separation vessel containing buffy coat. The central chamber of the centrifuge has an inner wall with a varying radius from the central axis of rotation, an upper portion, and a lower portion. The product collection bag extends adjacent to both the upper and lower portions of the inner wall.

In one embodiment of the invention, the upper portion of the inner wall of the central chamber described above has a greater radius than any radius of the lower portion. In another embodiment of the invention, the lower portion has a greater radius than any radius of the upper portion. Also in one embodiment, the upper portion and/or the lower portion may have a constant radius with respect to the central axis of rotation. The inner wall may also have a middle portion that is between the upper and lower portions of the inner wall that may be sloped at an angle. The radius of the lower portion of the wall may decrease or increase from its top, defined by the middle portion, to its bottom, defined by the bottom of the central chamber. The radius with respect to the central axis of rotation of the upper portion may decrease or increase from its top, defined by the top of the central chamber, to its bottom, defined by the lower portion of the inner wall. In one embodiment of the present invention, the inner wall may comprise a removable insert for the central chamber.

In one embodiment of the invention, the separated component of the buffy coat is platelets. The separated platelets are passed to the product collection bag, wherein the inner wall of the central chamber is configured such that the platelets sediment out on either the upper portion of the inner wall or the lower portion of the inner wall.

Another aspect of the present invention includes a method for separating blood composites from buffy coat in a centrifuge. The centrifuge used in the method has a rotor with a central axis of rotation and a central chamber on the rotor, and the central chamber has an inner wall. The method includes loading a separation vessel onto the centrifuge, loading a product collection bag in the central chamber of the centrifuge, loading the separation vessel with buffy coat, rotating the centrifuge at a sufficient rate such that platelets separate from the buffy coat, collecting the separated platelets in the product collection bag, and reducing the surface area for the collected platelets to contact the product collection bag.

In one embodiment of the invention, the reducing step may comprise preventing platelets from contacting the entire inner wall. The preventing step may comprise varying the radius of the

product collection bag with respect to the central axis of rotation. The varying step may comprise providing the inner wall with an upper and a lower portion, where the upper portion has a greater radius than the lower portion and where the product collection bag extends adjacent to both the upper and lower portions of the inner wall. The varying step may alternatively comprise providing the inner wall with a lower portion that has a greater radius than any radius of the upper portion of the inner wall, and extending the product collection bag adjacent to both the upper and lower portions of the inner wall.

In one embodiment of the invention, the reducing step may comprise shaping the product collection bag during the collecting step to conform the product collection bag to the inner wall of the central chamber. The shaping step may include varying the radius of the product collection bag with respect to the central axis of rotation. Additionally, the central chamber may have a top and a bottom and the reducing step may comprise decreasing or increasing the inner wall radius of the central chamber along the central axis of rotation from the top to the bottom, comprising providing the inner wall with an upper portion and a lower portion. In one embodiment of the invention, the upper portion may have a radius with respect to the central axis of rotation that is greater than any radius of the lower portion and the product collection bag extends adjacent to both the upper and lower portions of the inner wall. In another embodiment, the lower portion may have a radius with respect to the central axis of rotation that is greater than any radius of the upper portion and the product collection bag extends adjacent to both the upper and lower portions of the inner wall.

In one embodiment, the reducing step may also comprise adding an insert inside the central chamber to form the inner wall and to vary the radius of the central chamber between the central axis of rotation and the inner wall. The inner wall may be provided an upper and a lower portion where the product collection bag extends adjacent to both portions of the inner wall. The upper portion may have a greater radius than any radius of the lower portion with respect to the central axis of rotation. In another embodiment, the lower portion has a greater radius than any radius of the upper portion.

Brief Description of the Drawings

Figure 1 illustrates a cross-sectional view through a typical centrifuge in accordance with the prior art.

Figure 2 illustrates a cross-sectional view of an alternate central chamber in accordance with the invention for the centrifuge of Figure 1.

Figure 3 illustrates a cross-sectional view of an alternate central chamber in accordance with the invention for the centrifuge of Figure 1.

Figure 4 illustrates a cross-sectional view of an alternate central chamber in accordance with the invention for the centrifuge of Figure 1.

Figure 5 illustrates a cross-sectional view of an alternate central chamber in accordance with the invention for the centrifuge of Figure 1.

Figure 6 illustrates a cross-sectional view of an alternate central chamber in accordance with the invention for the centrifuge of Figure 1.

Figure 7 is a cross-sectional view of a centrifuge with a central chamber wall in accordance with the invention.

Figure 8 is a top view of a ring or separation bag for the centrifuge of Figure 1 or Figure 5.

Figure 9 is a schematic of a bag set intended for blood platelet production from buffy coat.

Figure 10 is a schematic view of a centrifuge equipped with buffy coat pooling.

Detailed Description of the Invention

The centrifuge 34 shown in Figure 1 has a rotor 1 with a central axis of rotation 100, and a central chamber 2, where, for example, the final storage, product collection or satellite bags for produced or collected separated products can be located during a centrifuging operation. The central chamber has an outer wall 61 and an inner wall 63. The satellite bags, such as bag 33 in Figure 9, are connected to a ring or annularly-shaped separation vessel 4. Furthermore, a ring or separation chamber 3 is included on the rotor 1 to receive ring or separation vessel 4. In one embodiment of the present invention, the separation chamber 3 surrounds the central chamber 2. The area beneath the ring or separation vessel 4 in the separation chamber 3 forms a chamber 5. The chamber 5 can be filled with a hydraulic fluid with the purpose of applying pressure or squeezing the ring or separation vessel 4. Centrifuge rotor 1 further includes a rotating inner lid 6 which includes a securing portion 7 for the ring or separation vessel 4. A sensor for sensing component movement is included at 52.

In Figure 1, ring or separation vessel 4 is shown filled with fluid 8 which is a composite fluid or composite buffy coat (as described below) for separation. There are three supports 9, 10, and 11 on the centrifuge rotor 1. Of these, only support 9 is shown in Figure 1, but see also Figure 8. The supports 9, 10, and 11 locate the position of ring or separation vessel 4 and also provide guide grooves 12, 21 and 22, respectively, to secure different connecting tubes or tubing or conduits between the separation vessel 4 and the satellite or product collection bags as well as a tube, tubing or conduits from the diluting fluid or buffy coat composite fluid bags as will be described below. Supports 9, 10, and 11 may be configured such that the guide grooves 12, 21 and 22 may be selectively reduced and/or increased in size to clamp or unclamp tubing or connecting tubes placed

in the grooves. For example, a portion of the support 9 could be configured to move in the direction of arrow 13 so as to function as a clamp valve. Also, one or more of supports 9, 10, and 11 may be configured to provide a welding function, which, when activated, seals and cuts the tubes positioned in the guide grooves 12, 21 and 22.

The welding function on the supports requires access to electric power in the centrifuge rotor and may also receive commands from a control system of the centrifuge. Any electrical connection occurs through slip ring connectors between the rotor and centrifuge stand where 14 indicates the centrifuge's rotor portion and 15 indicates the centrifuge stand. On Figure 1, the centrifuge motor is marked as 16. Motor 16 rotates the centrifuge rotor through driving belt 47; driving belt 47 is located between the motor's driving pulley 48 and the centrifuge's driving pulley 49. The centrifuge's rotation bearing is 50 and the centrifuge's rotating guide is 51. In the centrifuge's inner lid or cover 6, there is a central opening 53 which permits central chamber 2 to be accessible externally even when the inner lid or cover 6 is closed.

Ring or separation vessel 4, as shown in Figure 8, comprises two sheets of suitable plastic material joined together along the welded edges 17 and 18. An external ring vessel for separation of a blood composite and buffy coat is formed between the welded edges 17 and 18. Besides ring welds 17 and 18, there are additional welded points for strengthening around the holes which are intended for locating ring or separation vessel 4 on supports 9, 10, and 11. All the ring or separation vessels shown in the Figures are formed with a central opening, where the central opening primarily corresponds to the center chamber 2 opening when the separation vessel 4 is in the centrifuge 34. In Figure 8, this opening is designated 19. The ring or separation vessel 4 shown in Figure 8 has openings 109, 110, and 111 for supports 9, 10, and 11, respectively. Input tube 20 and output tube 32 are attached to the ring or the separation vessel's top and bottom sides by means of the welded sleeve couplings 24. Ports with flat securing collars 4a and 4b can be welded to the ring or separation vessel's top and bottom sides in which the connecting tubes 20 and 32 are secured by welding. Instead of being secured via the port and securing collar, the input tube 20 and output tube 32 can also be secured to each respective welded edge, *i.e.*, welding 17 and welding 18 in Figure 8.

Figure 9 shows the bag set for collecting blood platelets from buffy coat. This bag set includes ring or separation vessel 4, a bag with diluting solution 23, four connecting tubes or conduits 25, 26, 27, and 28 (the number of connecting or separation tubes can vary with the number of buffy coat collections, but generally the number is between four and six). In use, each tube 25, 26, 27, and 28 can be connected such as by welding or sterile connection to bags with buffy coat, such as bags 37, 38, 39, 40 in Figure 10. A multi-way connector 29 is connected to the diluting solution bag 23 via tube or conduit 30. Tube 20 is further connected to the tubes 25, 26, 27, and 28

through the multi-way connector 29. Tube 32 is connected from the ring or separation vessel 4 to a final storage, product collection, or satellite bag 33. A leukoreduction filter 31 may also be included. Tube 30, which extends from diluting solution bag 23 to multi-way connector 29, is arranged in the guide groove 22 in support 11 to provide a clamp valve function for control of the addition of diluting solution. Bag 23 may also contain an optional openable closer or frangible closer at 45.

The bag set shown in Figures 8 and 9 is used in the apparatuses of Figures 2, 3, 4, 5, 6 or 7, and, in Figure 10, for buffy coat pooling. In Figure 10, the centrifuge 34 is shown with an outer lid 35 open and locked in position. The centrifuge's inner lid 6 has been omitted in this figure, but see Figure 7. Also, the centrifuge rotor 1 and the ring or separation vessel 4 are drawn in a simplified manner. The centrifuge's control panel is shown schematically at 36. Furthermore, a cassette 41 mounted on the inside of the centrifuge's outer lid 35 and rotatable as shown at 42, holds blood bags 37, 38, 39, and 40 which contain buffy coat. Bag 23, containing a diluting solution, is mounted via holder 44 at a level vertically higher than bags 37, 38, 39, 40.

As shown in Figure 7, in operation, when the bag set of Figure 9 is loaded on the centrifuge rotor 1, final storage, product collection or satellite bag 33 is placed in the central chamber 2. In the prior art Figure 1, the sides 62 of the bag 33 are generally parallel to the outer wall 61 and the inner wall 63 of the central chamber.

In Figure 2, a removable insert 71 is provided for central chamber 2 to vary the radius of the inner wall of central chamber 2 with respect to the central axis of rotation 100. The insert 71 includes a top side 72, an outer side 73, a bottom 74, and a sloping inner side 75. The insert 71 has a height between the top side 72 and bottom side 74 that is less than the height of the central chamber 2. The top side of the insert 71 defines a middle portion of the inner wall of the central chamber 2. The sloping inner side 75 of the insert 71 defines a lower portion of the inner wall of the central chamber 2. The lower portion 75 of the inner wall has a radius with respect to the central axis of rotation 100 that decreases from its top, defined by the middle portion 72, to its bottom, defined by the bottom of the insert 74. The portion of the inner wall 76 above the insert 71 defines an upper portion of the inner wall of the central chamber 2. The insert 71 fits inside the central chamber 2 to shape product collection bag 33 during centrifugation as is more fully described below.

Figure 3 illustrates an alternative removable insert 81 with a sloping top side 82, inner and outer sides 85 and 83, and a bottom 84. This insert also has a height between the highest point 87 of top side 82 and bottom 84 that is less than the overall height of the central chamber 2. The inner side 85 defines a lower portion of the inner wall of the central chamber, and the sloping top side 82 of the insert defines a middle portion of the inner wall of the central chamber. The middle portion 82 is sloped at an angle greater than 0 degrees and less than or equal to 90 degrees with respect to the outer wall of the central chamber 61. The portion 86 of the central chamber above the insert 81

defines an upper portion of the inner wall of the central chamber 2. Both the upper portion 86 and lower portion 85 of the inner wall have constant radii with respect to the central axis of rotation 100.

A third alternative removable insert 91 is shown in Figure 4. This insert has parallel top side 92 and bottom 94. An outer side 93 is parallel to an inner side 95. The insert 91 has a height between the top side 92 and the bottom side 94 that is less than the overall height of the central chamber 2. The portion 96 of the central chamber above the insert 91 defines an upper portion of the inner wall of the central chamber 2. The inner side 95 defines a lower portion of the inner wall, and the top side 92 of the insert 91 defines a middle portion of the inner wall of the central chamber 2. Both the upper portion 96 and lower portion 95 of the inner wall have constant radii with respect to the central axis of rotation 100.

A fourth alternative removable insert 201 is shown in Figure 5. The insert 201 has a bottom 204, an outer side 203, an inner side 205, and a top side 202. The insert 201 extends the length of central chamber 2 from central chamber 2's opening to its bottom. The inner side 205 of the insert 201 defines an inner wall of the central chamber 2. The inner wall 205 is divided into portions. The portion 206 of the inner wall 205 defines an upper portion of the inner wall of the central chamber 2. The portion 207 of the inner wall 205 defines a lower portion of the inner wall 205 of the central chamber 2. Both the upper portion 206 and the lower portion 207 of the inner wall have decreasing radii with respect to the central axis of rotation 100 from the top of the central chamber 2 to the bottom of the central chamber 2.

A fifth alternative removable insert 301 is shown in Figure 6. The insert 301 has a bottom 304, an outer side 303, an inner side 305, and a top side 302. The insert 301 extends the length of central chamber 2 from central chamber 2's opening to its bottom. The inner side 305 of the insert 301 defines an inner wall of the central chamber 2. The inner wall 305 is divided into portions. The portion 306 of the inner wall 305 defines an upper portion of the inner wall of the central chamber 2. The portion 307 of the inner wall 305 defines a lower portion of the inner wall 305 of central chamber 2. Both the upper portion 306 and the lower portion 307 of the inner wall have increasing radii with respect to the central axis of rotation 100 from the top of the central chamber 2 to the bottom of the central chamber 2.

As described, the inserts 71, 81, 91, 201 and 301 fit inside the central chamber 2 permitting the central chamber 2 to have an inner wall with a varied radius, shaping the product collection bag 33 during centrifugation. The product collection bag 33, when received, is positioned in the central chamber 2 adjacent to both the upper portions 76, 86, 96, 206, 306 and the lower portions 75, 85, 95, 207, 307 of the inner wall of the central chamber 2. The upper portions 76, 86, 96, 206 of the inner wall have a radius greater than any radius of the lower portions 75, 85, 95, 207 of the inner

wall with respect to the central axis of rotation 100. However, the upper portion may have a greater radius than the lower portion of the inner wall such as in Figure 6 and still accomplish the goal of reducing the surface area for platelets to sediment on. An insert consistent with such a configuration is shown in Figure 6; insert 301 has a lower portion 307 of the inner wall 305 with a radius with respect to the central axis of rotation 100 greater than any radius of the upper portion 306 of the inner wall 305. In the case that the upper portion of the inner wall has a greater radius than the lower portion of the inner wall, then the middle portion of the inner wall will be sloped at an angle greater than or equal to 90 degrees and less than or equal to 180 degrees with respect to the outer wall of the central chamber.

Figures 2, 3, 4, 5, and 6 describe removable inserts. However, as shown in Figure 7, the central chamber inner wall 171 can be manufactured having a varied radius without an insert. As shown in Figure 7, the upper portion 176 of the inner wall has a constant radius from the central axis of rotation 100 greater than any radius of the lower portion 175 of the inner wall. A middle portion 172 divides the upper portion 176 of the inner wall from the lower portion 175 of the inner wall. A bottom of the lower portion of the inner wall is shown at 174. As shown in Figure 7, under centrifugal forces, a portion of product collection bag 33 extends adjacent to both the lower portion 175 of the inner wall and the upper portion of the inner wall 176.

Although only a wall configuration similar to Figure 2 is shown in Figure 7, it is understood that wall configurations similar to Figures 3, 4, 5, and 6 could be used to define the inner wall of the central chamber 2 rather than using an insert.

Before the buffy coat is separated into its components, the buffy coat in bags 37, 38, 39, 40 must be loaded into the separation vessel 4. As ring or separation vessel 4 is loaded on the centrifuge rotor 1, the product collection bag 33 is loaded into the central chamber 2 for product collection. Also, tube or conduit 30 is placed in groove 22 in support 11, tube or conduit 20 is placed in groove 21 in support 10 and tube or conduit 32 is placed in groove 12 in support 9. To begin the process of transferring or loading the buffy coat into the ring or separation vessel 4, a small amount of diluting solution will be flowed through tube 30 after opening the valve in support 11 and optional frangible 45, through multi-way connector 29, and through tubes 25, 26, 27, 28 into bags 37, 38, 39, 40, respectively. After the addition of diluting solution in sufficient amounts to bags 37, 38, 39, 40, a motor operatively connected to cassette 41 is actuated to oscillate cassette 41 forward and backwards in a pendulum movement, shown as 42, until all remaining concentrate substance in the buffy coat bags 37, 38, 39, 40 is suspended in the diluting solution. After sufficient agitation for suspension, the valve in support 10 on the rotor is opened through which tubing 20 passes from the multi-way connector 29 to drain or load the buffy coat into separation vessel 4. The process of

adding diluting solution to bags 37, 38, 39, 40, agitating, and draining the mixture of buffy coat and diluting solution through multi-way connector 29 and into tube 20 can be repeated until there is no remaining buffy coat in bags 37, 38, 39, 40. The buffy coat and diluting solution flow through tube 20 to ring or separation vessel 4.

After the buffy coat and diluting solution have been drained or loaded into ring or separation vessel 4, tubes 20 and 30 can be cut and sealed in guide grooves 21 and 22, respectively, by the welding function in supports 10 and 11. Cassette 41, holder 44, bags 37, 38, 39, 40 and 23, and all associated tubing are removed from the centrifuge lid whereby the centrifuge is closed for the centrifugation operation.

The rotor 34 is rotated at 1800 rpm or at a sufficient rpm that the less dense platelets separate from the denser Red Blood Cells (RBC) and leukocytes of the buffy coat. The built-in valve in guide groove 12 in support 9 can be opened and separation vessel 4 can be squeezed using the hydraulic fluid in chamber 5 to permit the less dense platelets and any plasma or diluting solution to be transferred through tube 32 to product collection bag 33 to be collected. While being expressed or passed from the separation vessel 4 to the product collection bag 33, the platelets can be pushed through the optional filter 31, shown on Figure 9, and collected into the product collection bag 33. The transfer of the platelets and any plasma continues until a sensor 52 indicates the interface between the platelets and RBCs/leukocytes. After the final expression of platelets, tube 32 is sealed by sterile welding using the welding function on support 9. The platelets in bag 33 will continue to be subjected to centrifugal force until the centrifuge slows to a stop.

During centrifugation, the surface area is reduced for the collected platelets to contact the product collection bag and platelets are prevented from contacting the entire inner wall. Product collection bag 33 is extended adjacent to both the upper and lower portions of the inner wall and is shaped by the contour of central chamber 2's inner wall during centrifugation. The inner wall of the central chamber has a varying radius with respect to the central axis of rotation 100 shaped either by an insert 71, 81, 91, 201 or 301 shown in Figures 2, 3, 4, 5, 56 or by the use of the central chamber inner wall 171 of Figure 7. The product collection bag is shaped by the centrifugal force to conform to the shape of the inner wall of the central chamber 2. Thus, the radius of the product collection bag is also varied by the shaping. When subjected to the centrifugal force, the platelets will form a layer farthest from the central axis of rotation 100 due to their sedimentation velocity. Decreasing or increasing the inner wall radius of the central chamber from top to bottom of the chamber either by manufacture 171 as shown in Figure 7 or by using an insert 71, 81, 91, 201 or 301 in Figures 2, 3, 4, 5 or 6 reduces surface area for the platelets to form a layer by preventing the platelets from contacting the entire inner wall.

As shown in Figures 2, 3, 4, 5 and 6, adding an insert 71, 81, 91, 201 or 301 or using of the central chamber inner wall 171 of Figure 7 to vary the radius of the central chamber between the central axis of rotation 100 and the inner wall permits the platelets to pack or sediment out along the portion of the wall with the greatest radius, including upper portions 76, 86, 96, 206 or 176 of the inner wall or, alternatively, the lower portion 307 of the inner wall. This is because the platelets will sediment out faster than any remaining less dense plasma or diluting fluid. The denser platelets under centrifugal force that have been expressed tend to move to form a layer farthest from the rotation axis. If the layer forms only in the upper portions 76, 86, 96, and 206 or, alternatively, the lower portion 307, of the inner wall, there will be fewer numbers of platelets contacting the surface area of the bag 33 than if the platelet layer extended along the entire height of the bag parallel to the central axis of rotation 100, as in the prior art Figure 1.

Platelets in plasma have a lower sedimentation velocity generally than platelets that are stored in a platelet additive solution (PAS). Generally, platelets in such an additive solution have a higher sedimentation velocity and thus may be more likely to form a film on the bag wall over its height. Thus, using the configurations of Figures 2, 3, 4, 5, 6 and 7 reduce the ability of platelets in PAS to form such a film.

CLAIMS

1. A centrifuge (34) for processing buffy coat comprising:
 - a rotor (1) having a central axis of rotation (100);
 - a central chamber (2) on the rotor (1) capable of receiving a product collection bag (33), comprising:
 - an inner wall having a varying radius from the central axis of rotation (100), comprising:
 - an upper portion (76, 86, 96, 176, 206, 306), and
 - a lower portion (75, 85, 95, 175, 207, 307), wherein, when the product collection bag (33) is received in the central chamber (2), the bag (33) extends adjacent to both the upper and lower portions (76, 86, 96, 176, 206, 306, 75, 85, 95, 175, 207, 307) of the inner wall;
 - a separation chamber (3) capable of receiving a separation vessel (4) containing buffy coat and connected to the product collection bag (33) wherein separated buffy coat components can pass from the separation chamber (3) to the central chamber (2).
 2. The centrifuge according to claim 1, wherein the upper portion of the inner wall has a constant radius with respect to the central axis of rotation.
 3. The centrifuge according to claim 1, wherein the upper portion of the inner wall has a greater radius than any radius of the lower portion.
 4. The centrifuge according to claim 1, wherein the lower portion of the inner wall has a greater radius than any radius of the upper portion.
 5. The centrifuge according to claim 1, wherein the lower portion of the inner wall has a constant radius with respect to the central axis of rotation.
 6. The centrifuge according to claim 1, wherein the upper portion has a top defined by the top of the central chamber and a bottom defined by the lower portion of the inner wall, wherein the radius with respect to the central axis of rotation of the upper portion of the inner wall decreases from the top of the upper portion to the bottom of the inner portion.
 7. The centrifuge according to claim 1, wherein the upper portion has a top defined by the top of the central chamber and a bottom defined by the lower portion of the inner wall, wherein the

radius with respect to the central axis of rotation of the upper portion of the inner wall increases from the top of the upper portion to the bottom of the upper portion.

8. The centrifuge according to claim 1, wherein the inner wall further comprises a middle portion that is between the upper and lower portions of the inner wall, wherein a top of the lower portion of the inner wall is defined by the middle portion of the inner wall.

9. The centrifuge according to claim 8, wherein the lower portion comprises a bottom and wherein the radius with respect to the central axis of rotation of the lower portion of the inner wall decreases from the top to the bottom.

10. The centrifuge according to claim 6, wherein the lower portion comprises a bottom and wherein the radius with respect to the central axis of rotation of the lower portion of the inner wall increases from the top to the bottom.

11. The centrifuge according to claim 6, wherein the central chamber comprises an outer wall and wherein the middle portion is sloped at an angle greater than or equal to 0 degrees and less than or equal to 180 degrees with respect to the outer wall of the central chamber.

12. The centrifuge according to claim 1, wherein at least a portion of the inner wall comprises a removable insert for the central chamber.

13. The centrifuge according to claim 1, wherein the separated buffy coat component is platelets, wherein the platelets are passed to the product collection bag, wherein the inner wall is configured such that the platelets sediment out along the upper portion of the inner wall.

14. The centrifuge according to claim 1, wherein the separated buffy coat component is platelets, wherein the platelets are passed to the product collection bag, wherein the inner wall is configured such that the platelets sediment out along the lower portion of the inner wall.

15. The centrifuge according to claim 1, wherein the separation chamber surrounds the central chamber.

16. A system for processing buffy coat, comprising:

a bag assembly, comprising:

a separation vessel (4),

a product collection bag (33),
at least one conduit (32) connecting the separation vessel (4) to the product collection bag(33),
a centrifuge (34) for processing buffy coat comprising:
a rotor (1) having a central axis of rotation (100);
a central chamber (2) on the rotor (1), wherein the product collection bag (33) is in the central chamber (2), comprising:
an inner wall, having a varying radius from the central axis of rotation (100), comprising:
an upper portion (76, 86, 96, 176, 206, 306), and
a lower portion (75, 85, 95, 175, 207, 307), wherein the product collection bag (33) extends adjacent to both the upper and lower portions (76, 86, 96, 176, 206, 306, 75, 85, 95, 175, 207, 307) of the inner wall;
a separation chamber (3) capable of receiving the separation vessel (4) containing buffy coat.

17. The system according to claim 16, wherein the upper portion of the inner wall has a constant radius with respect to the central axis of rotation.

18. The system according to claim 16, wherein the upper portion of the inner wall has a greater radius than any radius of the lower portion.

19. The system according to claim 16, wherein the lower portion of the inner wall has a greater radius than any radius of the upper portion.

20. The system according to claim 16, wherein the lower portion of the inner wall has a constant radius with respect to the central axis of rotation.

21. The system according to claim 16, wherein the upper portion has a top defined by the top of the central chamber and a bottom defined by the lower portion of the inner wall, wherein the radius with respect to the central axis of rotation of the upper portion of the inner wall decreases from the top of the upper portion to the bottom of the inner portion.

22. The system according to claim 16, wherein the upper portion has a top defined by the top of the central chamber and a bottom defined by the lower portion of the inner wall, wherein the radius

with respect to the central axis of rotation of the upper portion of the inner wall increases from the top of the upper portion to the bottom of the upper portion.

23. The system according to claim 16, wherein the inner wall further comprises a middle portion that is between the upper and lower portions of the inner wall, wherein a top of the lower portion of the inner wall is defined by the middle portion of the inner wall.

24. The system according to claim 23, wherein the lower portion comprises a bottom and wherein the radius with respect to the axis of rotation of the lower portion of the inner wall decreases from the top to the bottom.

25. The system according to claim 23, wherein the lower portion comprises a bottom and wherein the radius with respect to the axis of rotation of the lower portion of the inner wall increases from the top to the bottom.

26. The system according to claim 23, wherein the central chamber comprises an outer wall and wherein the middle portion is sloped at an angle greater than or equal to 0 degrees and less than or equal to 180 degrees with respect to the outer wall of the central chamber.

27. The system according to claim 16, wherein at least a portion of the inner wall comprises a removable insert for the central chamber.

28. The system according to claim 16, wherein the separated buffy coat component is platelets, wherein the platelets are passed to the product collection bag, wherein the inner wall is configured such that the platelets sediment out along the upper portion of the inner wall.

29. The system according to claim 16, wherein the separated buffy coat component is platelets, wherein the platelets are passed to the product collection bag, wherein the inner wall is configured such that the platelets sediment out along the lower portion of the inner wall.

30. The system according to claim 16, wherein the separation chamber surrounds the central chamber.

31. A method for separating blood composites from buffy coat in a centrifuge (34) having a rotor (1) with a central axis of rotation (100) and a central chamber (2) on the rotor (1), the central chamber (2) having an inner wall, the method comprising:

loading a separation vessel (4) onto the centrifuge (34),
loading a product collection bag (33) in the central chamber (2) of the centrifuge (34),
loading the separation vessel (4) with buffy coat,
rotating the centrifuge at a sufficient rate such that platelets separate from the buffy coat,
collecting the separated platelets in the product collection bag (33),
reducing the surface area for the collected platelets to contact the product collection bag (33).

32. The method of claim 31, wherein the reducing step comprises shaping the product collection bag during the collecting step to conform the product collection bag to the inner wall of the central chamber.

33. The method of claim 32, wherein the shaping step comprises varying the radius of the product collection bag with respect to the central axis of rotation.

34. The method of 31, wherein the reducing step comprises preventing platelets from contacting the entire inner wall.

35. The method of claim 34, wherein the preventing step comprises:

varying the radius of the product collection bag with respect to the central axis of rotation, comprising:

providing the inner wall with an upper portion and a lower portion, wherein the preventing step further comprises:

extending the product collection bag adjacent to both the upper and lower portions of the inner wall.

36. The method of claim 35, wherein the varying step further comprises providing the upper portion of the inner wall with a greater radius with respect to the central axis of rotation than any radius of the lower portion of the inner wall.

37. The method of claim 35, wherein the varying step further comprises providing the lower portion of the inner wall with a greater radius with respect to the central axis of rotation than any radius of the upper portion of the inner wall.

38. The method of claim 35, wherein the varying step further comprises providing the upper portion of the inner wall with a constant radius with respect to the central axis of rotation.

39. The method of claim 35, wherein the varying step further comprises providing the lower portion of the inner wall with a constant radius with respect to the central axis of rotation.

40. The method of claim 35, wherein the central chamber has an outer wall and the varying step further comprises providing the inner wall with a middle portion that is between the upper and lower portions, wherein the middle portion is sloped at an angle that is greater than or equal to 0 degrees but less than or equal to 180 degrees with respect to the outer wall of the central chamber.

41. The method of claim 31, wherein the central chamber has a top and a bottom and the reducing step comprises:

decreasing the inner wall radius of the central chamber along the central axis of rotation from the top to the bottom, comprising:

providing the inner wall with an upper portion and a lower portion, wherein the upper portion has a radius with respect to the central axis of rotation that is greater than any radius of the lower portion.

42. The method of claim 31, wherein the central chamber has a top and a bottom and the reducing step comprises:

increasing the inner wall radius of the central chamber along the central axis of rotation from the top to the bottom, comprising:

providing the inner wall with an upper portion and a lower portion,
wherein the lower portion has a radius with respect to the central axis of rotation that is greater than any radius of the upper portion.

43. The method of claim 31, wherein the reducing step comprises adding an insert inside the central chamber to vary the radius of the central chamber between the central axis of rotation and the inner wall.

44. The method of claim 43, wherein the central chamber comprises an outer wall and a top and a bottom and with the insert, the adding step comprises:

defining a lower portion of the inner wall, and a middle portion of the inner wall, an upper portion of the inner wall, wherein the loading of a product collection bag step comprises:

extending the product collection bag adjacent to both the upper and lower portions of the inner wall.

45. The method of claim 44, wherein the adding step further comprises providing the lower portion of the inner wall with a greater radius with respect to the central axis of rotation than any radius of the upper portion of the inner wall.

46. The method of claim 44, wherein the adding step further comprises providing the upper portion of the inner wall with a greater radius with respect to the central axis of rotation than any radius of the lower portion of the inner wall.

47. The method of claim 44, wherein the adding step further comprises sloping the middle portion of the inner wall at an angle that is greater than or equal to 0 degrees but less than or equal to 180 degrees with respect to the outer wall of the central chamber.

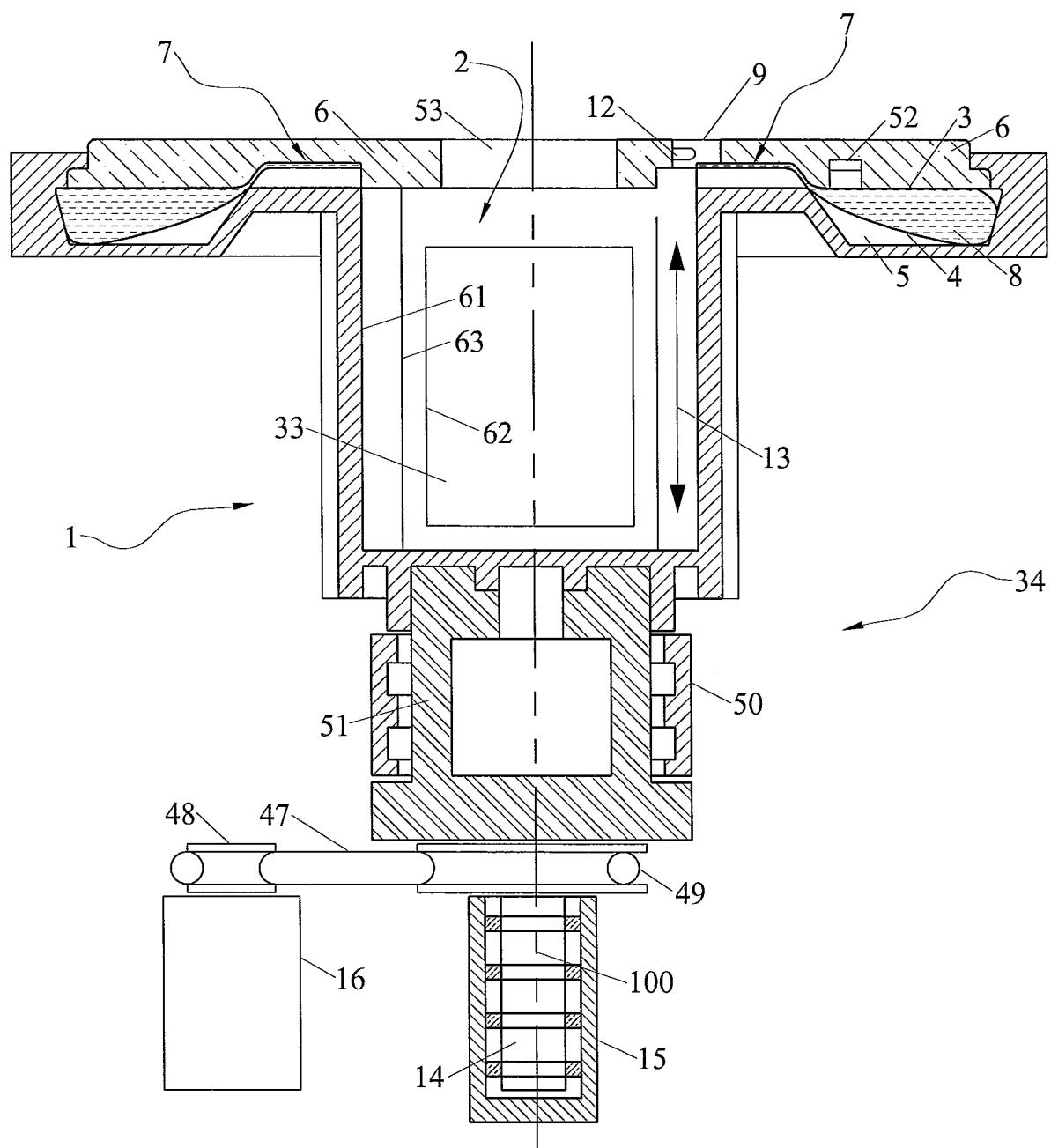
48. The method of claim 44, wherein the lower portion of the inner wall has a bottom defined by the bottom of the central chamber and a top defined by the middle portion, wherein the adding step further comprises decreasing the radius of the lower portion of the inner wall with respect to the central axis of rotation from the top of the lower portion to the bottom of the lower portion.

49. The method of claim 44, wherein the lower portion of the inner wall has a bottom defined by the bottom of the central chamber and a top defined by the middle portion, wherein the adding step further comprises increasing the radius of the lower portion of the inner wall with respect to the central axis of rotation from the top of the lower portion to the bottom of the lower portion.

50. The method of claim 44, wherein the upper portion of the inner wall has a bottom defined by the middle portion of the inner wall and a top defined by the top of the central chamber, wherein the adding step further comprises decreasing the radius of the upper portion of the inner wall with respect to the central axis of rotation from the top of the upper portion to the bottom of the upper portion.

51. The method of claim 44, wherein the upper portion of the inner wall has a bottom defined by the middle portion of the inner wall and a top defined by the top of the central chamber, wherein the adding step further comprises increasing the radius of the upper portion of the inner wall with respect to the central axis of rotation from the top of the upper portion to the bottom of the upper portion.

1/6



Prior Art
FIG. 1

2/6

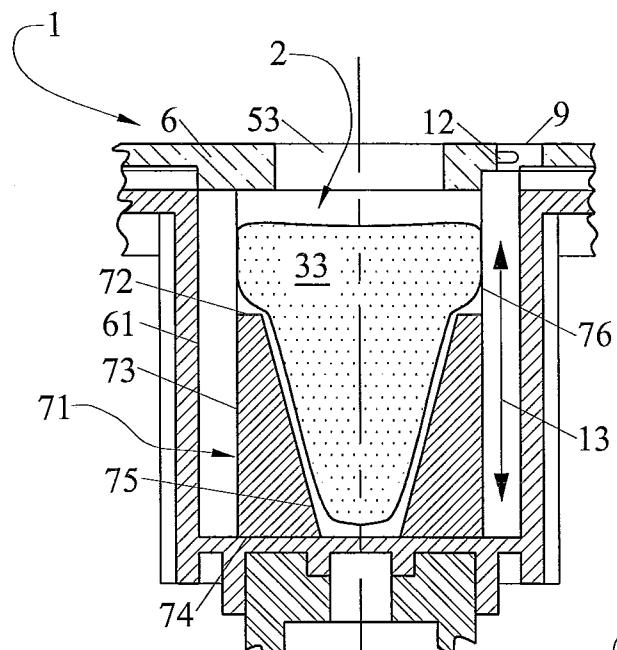


FIG. 2

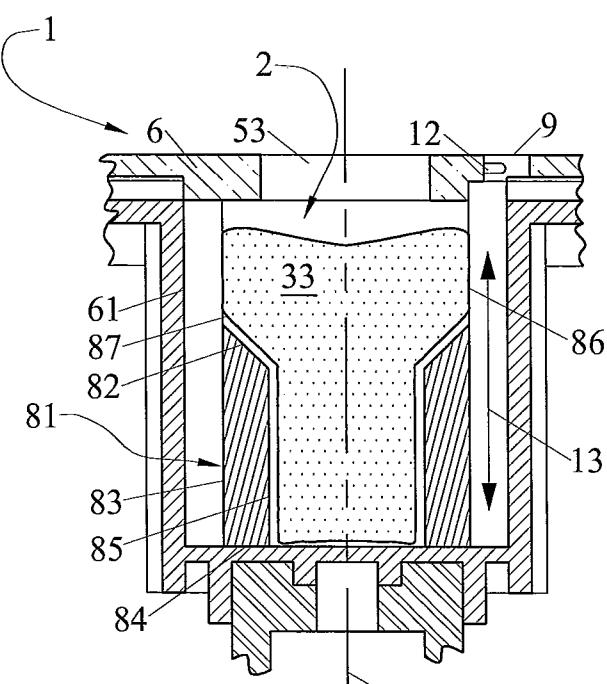


FIG. 3

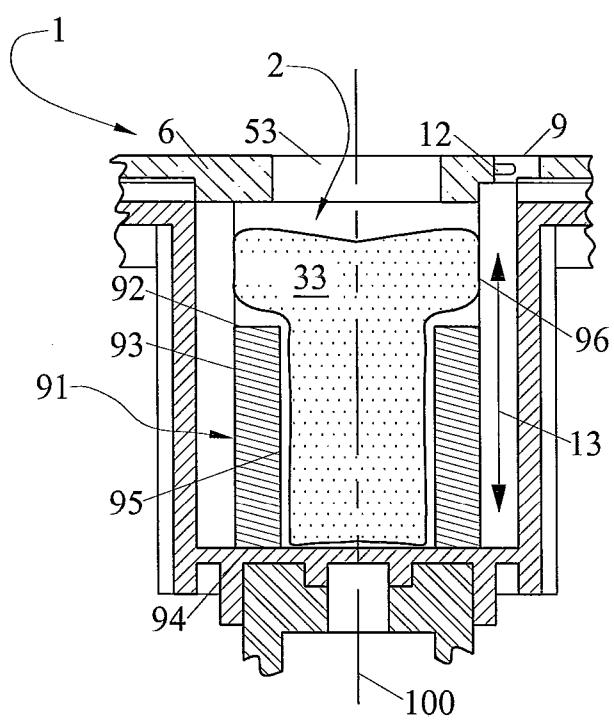
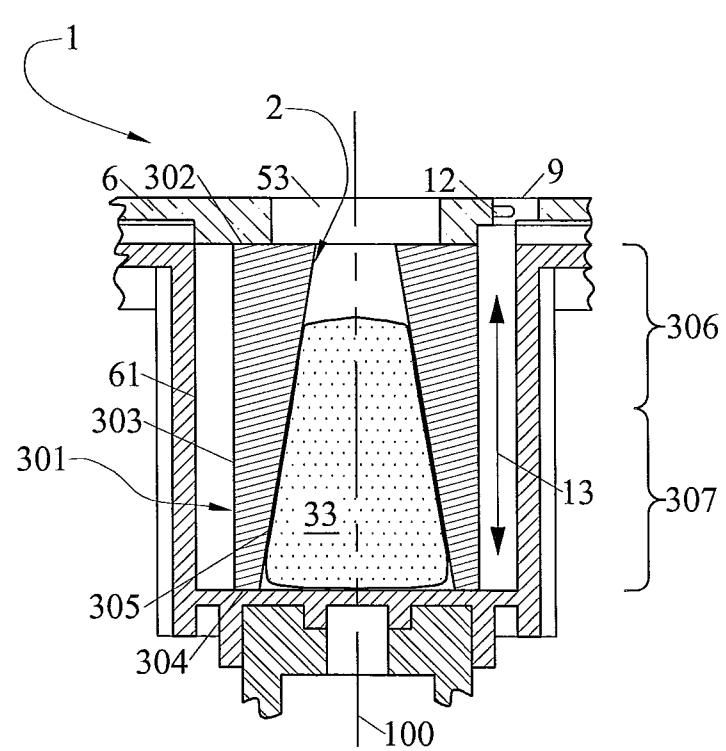
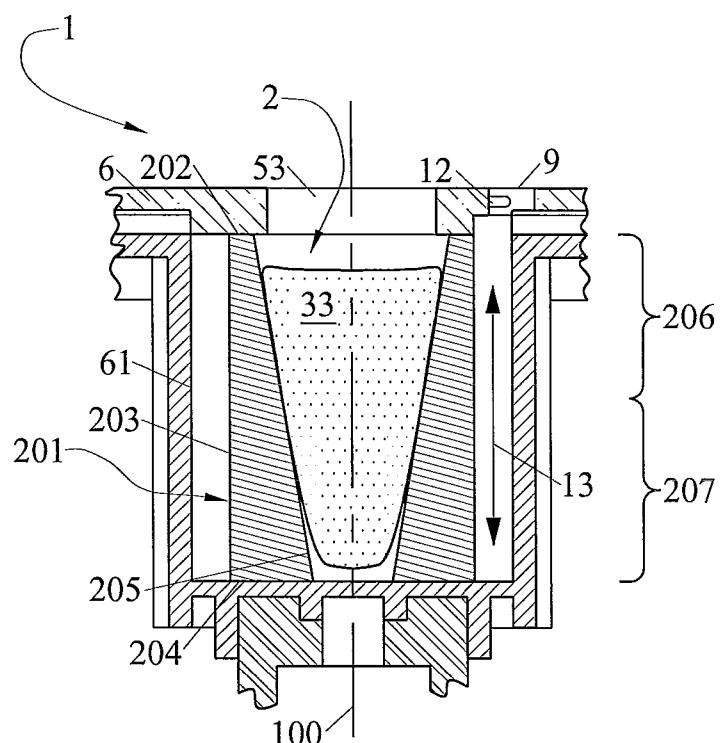


FIG. 4

3/6



4/6

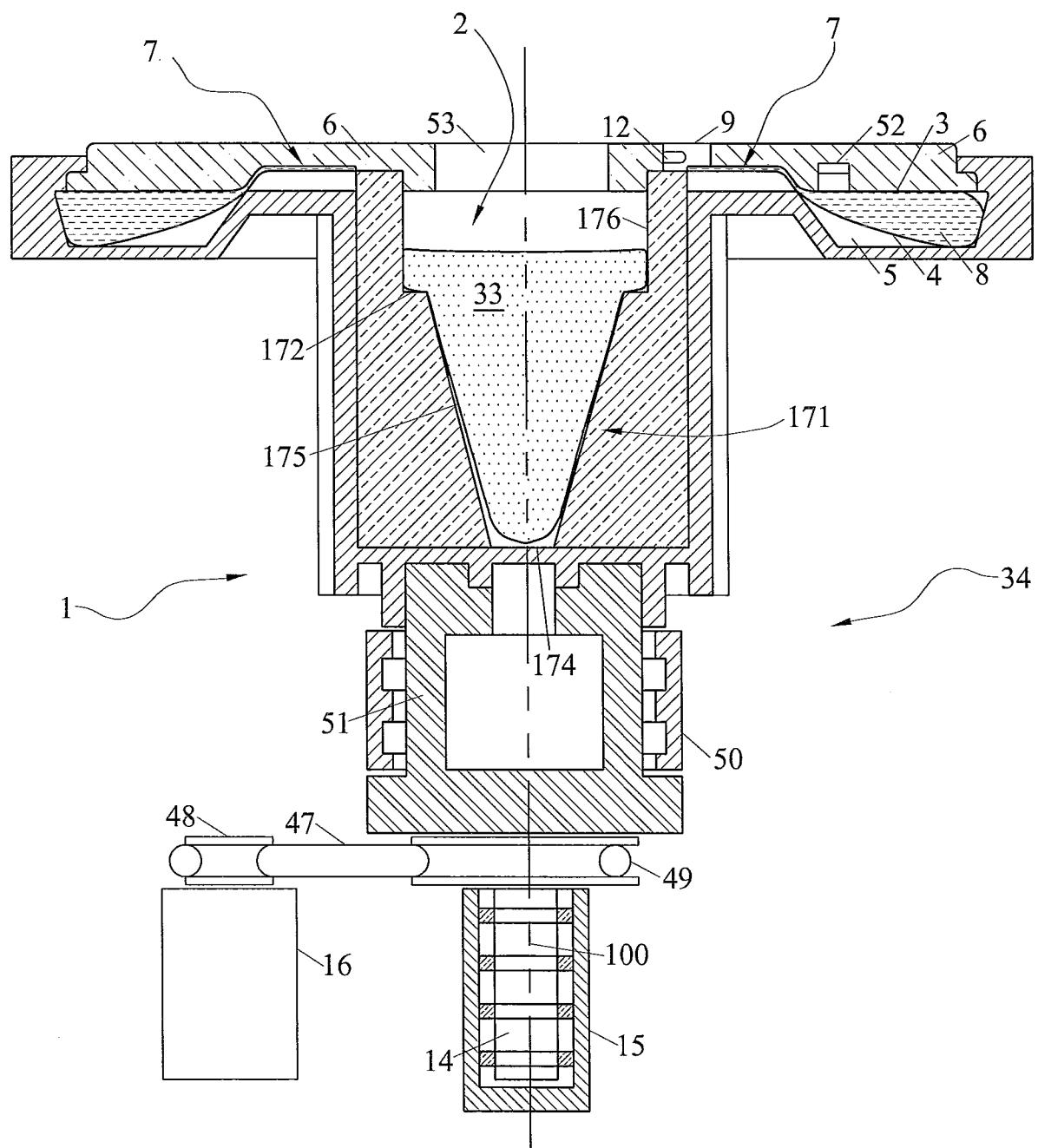


FIG. 7

5/6

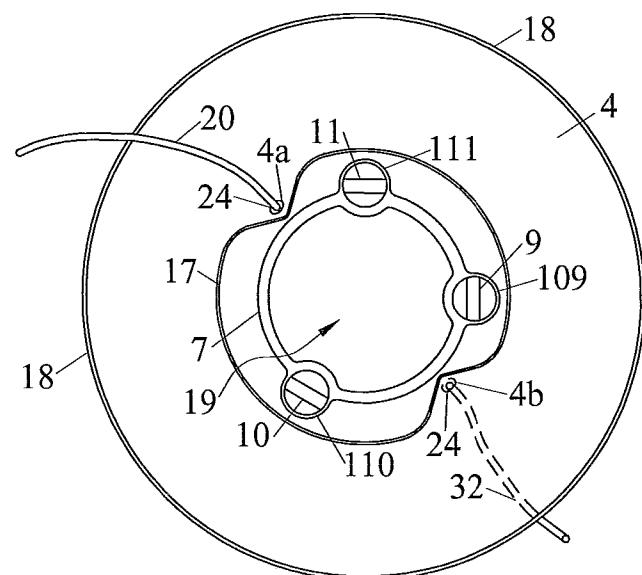


FIG. 8

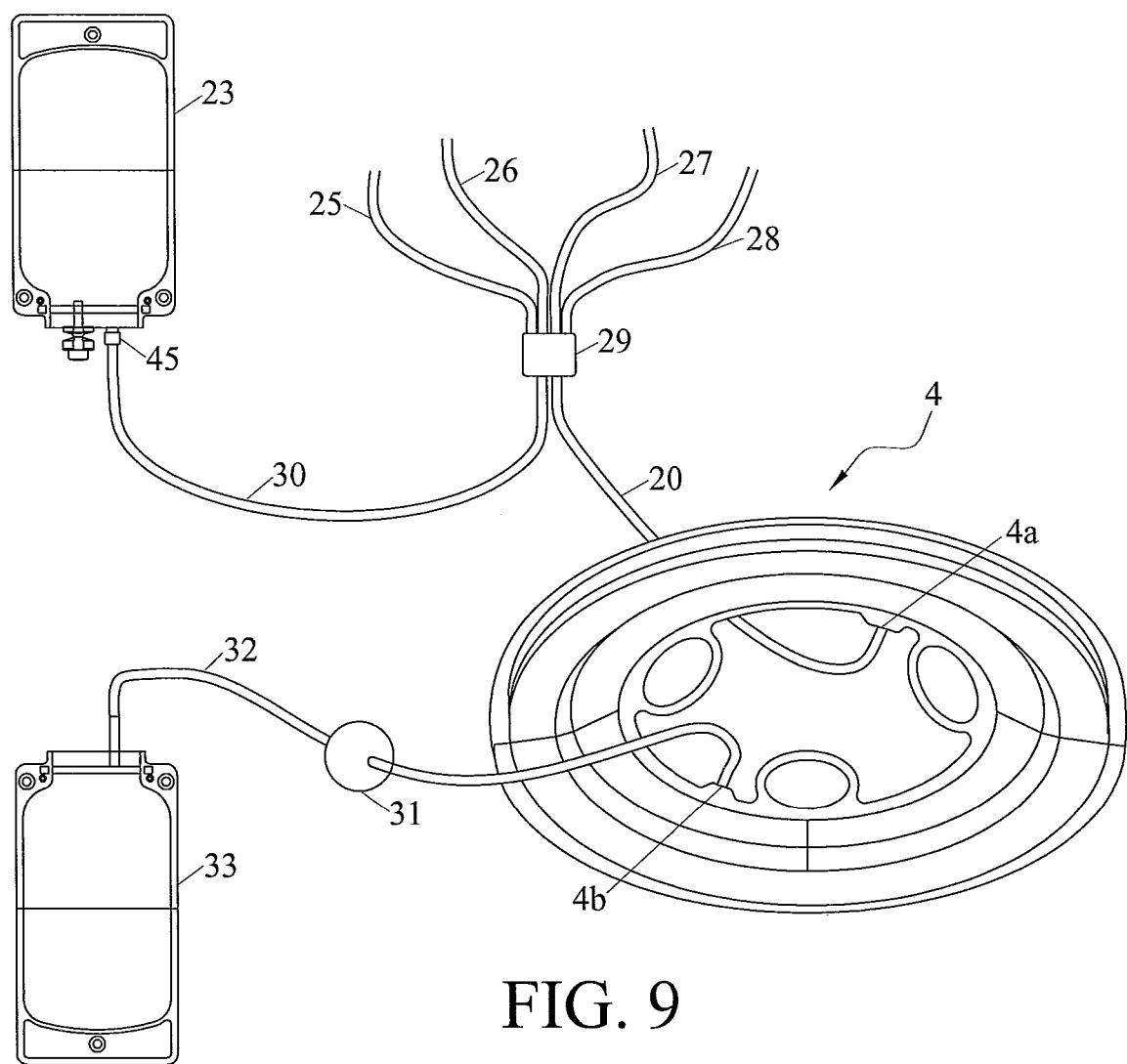


FIG. 9

6/6

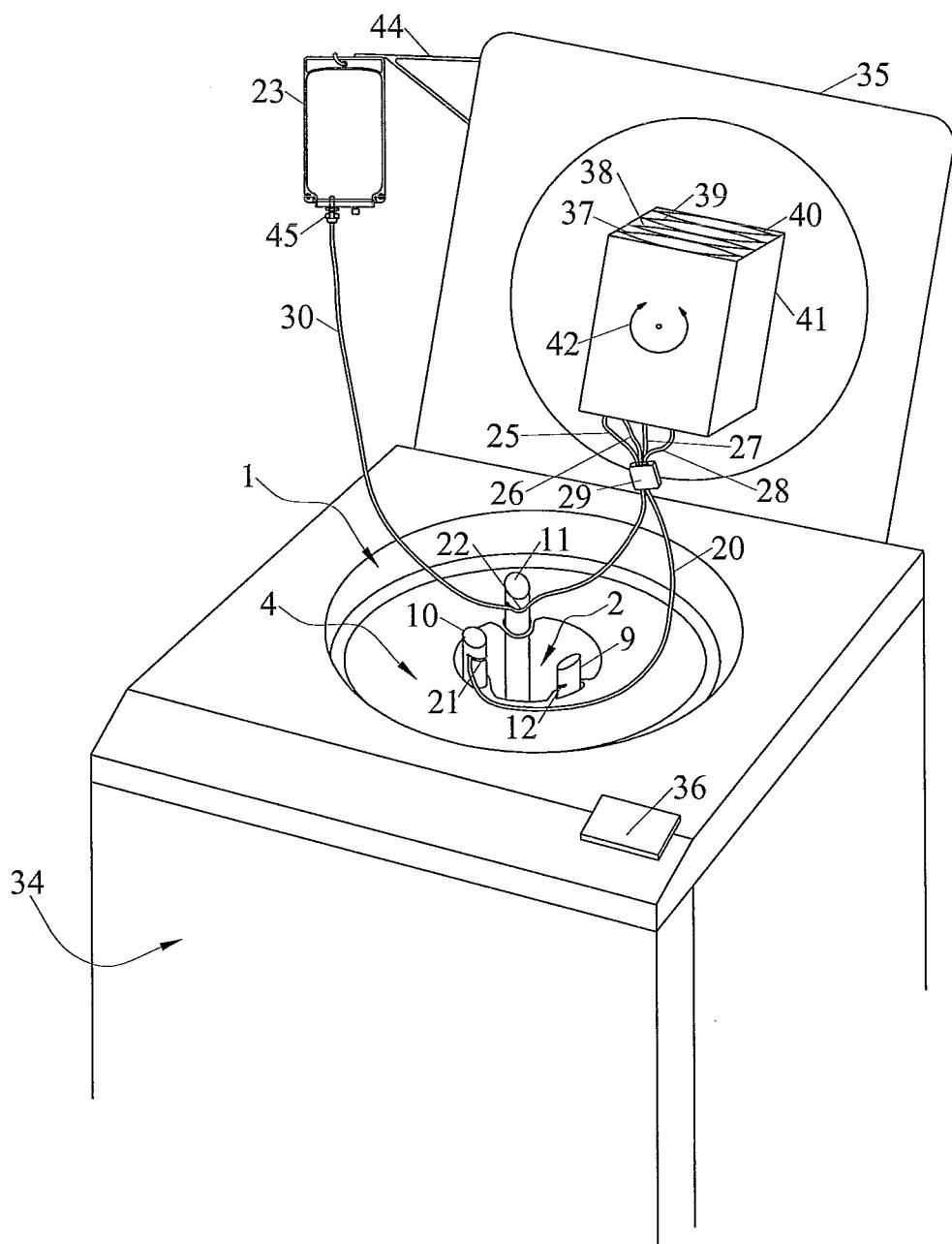


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/044391

A. CLASSIFICATION OF SUBJECT MATTER
INV. B04B5/04 A61M1/36
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B04B A61M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 656 105 B2 (HOGBERG NICLAS [SE] ET AL HOEGBERG NICLAS [SE] ET AL) 2 December 2003 (2003-12-02) cited in the application the whole document -----	1,16,31
A	WO 98/35757 A1 (OMEGA MEDICINTEKNIK AB [SE]; UNGER PETER [SE]; WESTBERG ERIC [SE]) 20 August 1998 (1998-08-20) cited in the application abstract; figures	1,16,31
A	EP 1 391 244 A2 (GAMBRO INC [US]) 25 February 2004 (2004-02-25) abstract; figures 1,3 -----	1,16,31
A	US 2009/272701 A1 (HOLMES BRIAN M [US] ET AL) 5 November 2009 (2009-11-05) figure 4 -----	1,16,31



Further documents are listed in the continuation of Box C.



See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

8 November 2011

22/11/2011

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European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Leitner, Josef

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2011/044391

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