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(54) **Title**: CELL FILTRATION DEVICE

(57) **Abstract**: Devices are configured to the deficiencies of the current automated systems for analyzing cell samples by being configured to eliminate expensive steps and/or components. The devices can be capable of isolating cells in solution without inflicting the cell damage associated with the vacuum or centrifuge. The devices may include at least a well member configured to be disposed in a sample well of a well plate. The well member may include an first end and an opposing second end; a first section disposed at the first end and a second section disposed at the second end, the second section defining a reservoir configured to hold a predetermined volume of a fluid; and plurality of cut-outs extending between the first section and the second section, the cut-outs being configured to allow the fluid to flow out of the well member.

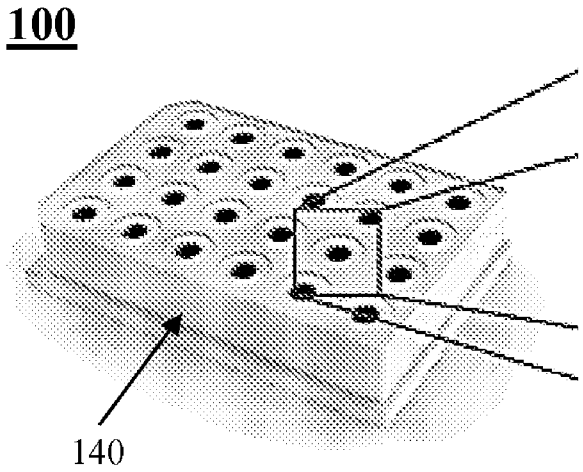

FIGURE 1

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CELL FILTRATION DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to United States Provisional Application Serial Number 61/676,357, filed July 27, 2012, which application is hereby incorporated by this reference in its entirety.

BACKGROUND

[0002] Traditionally, blood typing has been performed manually by laboratory technologists. Laboratory technologists generally manually perform a series of assays and interpret the results. This traditional method can require a long testing time and technologists that are highly skilled in these assays.

[0003] Recently, automated blood typing instruments have been introduced that are faster and more versatile. However, the current technology can be quite expensive because of many expensive moving parts, such as a robotic arm, a centrifuge, and a flow cytometer. Thus, generally all but the largest medical facilities can afford such technology.

SUMMARY

[0004] Thus, there is a need for devices that can be used with compact, less expensive, automated instruments for analyzing samples (e.g., blood typing) and be configured to replace the function of any eliminated components.

[0005] The disclosure relates to devices configured for use with automated testing or analyzing instruments. The devices are configured to eliminate expensive steps and/or components required by many automated testing instruments.

[0006] In some embodiments, the devices can be configured for testing of a sample, for example, blood typing of a RBC sample. In some embodiments, the devices may include a well member configured to be disposed in a sample well of a well plate. The well member may include a first end and an opposing second end. The well member may further include a first section disposed at the first end and a second section disposed at the second end. The second section may define a reservoir configured to hold a predetermined volume of a fluid. The well member may include a plurality of cut-outs that extend between the first section and the second section.

[0007] In some embodiments, the devices may include a plurality of support members extending between the first section and the second section, each cut-out being disposed between a set of support members. The devices may include a filter member disposed to surround the well member, the filter member at least covering the cut-out members. The support members may be configured to support the filter member. The filter member may include a hydrophilic material. The filter member may have a pore size of less than about 2.0 μm.

[0008] In some embodiments, the absorbent member may be disposed to surround the filter member and configured to absorb some of the fluid. In some embodiments, the absorbent member may be configured to be disposed adjacent to a wall of the sample well.

[0009] In some embodiments, the devices may include a depression configured to receive the well member. The depression may be configured to be disposed within the sample well.

[0010] In some embodiments, the the first section has a length and the second section has a length and the length of the second section may be longer than the length of the first section. The length of the second section may correspond to the predetermined volume.

[0011] In some embodiments, the devices may include a well member configured to be disposed in a sample well of a well plate. The well member may include a first end and an opposing second end. The well member may include a first section disposed at the first end and a second section disposed at the second end, the second section defining a reservoir configured to hold a predetermined volume of a fluid; a plurality of support members extending between the first section and the second section; and plurality of cut-outs extending between the first section and the second section and disposed between a set of plurality of support members. The cut-outs may be configured to allow the fluid to flow out of the well member. In some embodiments, the devices may include a filter member disposed to at least partially surround the well member. The filter member may at least cover the cut-out members and may be configured to substantially contain the sample within the well member during the testing.

[0012] In some embodiments, the devices may include a plurality of support members extending between the first section and the second section. Each cut-out may be disposed between a set of support members. The support members may be configured to support the filter member. The filter member may include a hydrophilic material. In some embodiments, the filter member may have a pore size less than 2.0 μm.

[0013] In some embodiments, the devices may include a well plate. The well plate may include a plurality of sample wells. In some embodiments, the devices may include a depression disposed on the bottom surface of the sample well and configured to receive the well member. In some embodiments, the devices may include an absorbent member that surrounds the filter member and is disposed between the filter member and a wall of the sample well. The absorbent member may be configured to absorb at least some of the fluid. In some embodiments, the absorbent member may include a material having hydrophilic properties.

[0014] In some embodiments, the second section may be configured to control a volume of the fluid for the testing.

[0015] Additional advantages of the disclosure will be set forth in part in the description which follows, and in part will be obvious from the description, or may be learned by practice of the disclosure. The advantages of the disclosure will be realized and attained by means of the elements and combinations particularly pointed out in the appended claims. It is to be understood that both the

foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the disclosure, as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The disclosure can be better understood with the reference to the following drawings and description. The components in the figures are not necessarily to scale, emphasis being placed upon illustrating the principles of the disclosure.

[0017] Figure 1 shows a cell filtration device according to embodiments;

[0018] Figure 2 shows an enlarged view of the cell filtration device in Figure 1;

[0019] Figure 3 shows an enlarged perspective view of the cell filtration member according to embodiments;

[0020] Figure 4 shows an enlarged front view of the cell filtration member;

[0021] Figure 5 shows an enlarged top view of the cell filtration member;

[0022] Figure 6 shows prototypes of the cell filtration member;

[0023] Figure 7 shows an orthographic illustration of the cell filtration member;

[0024] Figure 8 shows an exploded view of the cell filtration member;

[0025] Figure 9 shows a top perspective view of the well plate according to embodiments;

[0026] Figure 10 shows a bottom perspective view of the well plate according to embodiments; and

[0027] Figure 11 shows a method of using the cell filtration device in a blood-typing assay procedure.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0028] The following description, numerous specific details are set forth such as examples of specific components, devices, methods, etc., in order to provide a thorough understanding of embodiments of the disclosure. It will be apparent, however, to one skilled in the art that these specific details need not be employed to practice embodiments of the disclosure. In other instances, well-known materials or methods have not been described in detail in order to avoid unnecessarily obscuring embodiments of the disclosure. While the disclosure is susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and will herein be described in detail. It should be understood, however, that there is no intent to limit the disclosure to the particular forms disclosed, but on the contrary, the disclosure is to cover all modifications.

[0029] The cell filtration devices according to embodiments can address the deficiencies of the current automated systems by being configured to eliminate expensive steps and/or components.

The cell filtration devices are designed to remove excess fluid from a cell samples (e.g., red blood cells (RBC)). The cell filtration device can be capable of isolating cells in solution without inflicting the cell damage associated with the vacuum or centrifuge. The devices can rely upon passive fluid diffusion and hydrophilic forces to achieve fluid filtration rather than a vacuum gradient or gravitational separation. Thus, the expensive steps and components of either vacuum or centrifugation can be no longer required.

[0030] In addition, performance tests have shown that these devices can be capable of achieving an average passive fluid diffusion time of less than 20 seconds and retaining more than the 200 cells per ÂμL required for blood typing. Thus, the cell filtration devices according to embodiments can result in a low cost and more efficient solution to the current automated blood typing market.

[0031] It will be understood that the cell filtration devices according to the embodiments may be used with any blood typing system. The embodiments are described with respect to RBC samples and blood typing tests. However, it will be understood that the cell filtration device may be used with other cell samples and other tests. Also, the cell filtration devices may be used with the corresponding system for that test. The dimensions of the well member (also referred to as "filter well insert" or "inner well") and/or well plate (also referred to as "outer well" or "main well") may be adjusted to be compatible with the system.

[0032] Figures 1-10 show a cell filtration device according to embodiments. In some embodiments, the cell filtration device 100 may include a well member 110 configured to be disposed within a sample well of a well plate (see, for example Figures 1, 2 and 8). The well member 110 may be configured to hold a sample (e.g., a RBC sample) and a fluid (e.g., assay wash fluid). Figures 3-5 show the well member 110 according to embodiments. The well member 110 may be configured to contain the sample for the duration of the assay process.

[0033] As shown in Figures 3-5, the well member 110 may have a substantially cylindrical shape. In other embodiments, the well member 110 may have a different shape. The shape may depend on the wells of the well plate. The well member 110 may be a substantially hollow structure.

[0034] The well member 110 may be made of a polymer material. The material may be biocompatible. In some embodiments, the well member 110 may be made of polystyrene, for example, through plastic injection molding.

[0035] In some embodiments, the well member 110 may have a first end 210 and a second end 220 (also referred to as "lower" or "bottom") that opposes the first end 210. The first end 210 may be an open end and define an opening 212. In some embodiments, the second end 220 may be a substantially closed end and/or an open end. In some embodiments, the second end 220 may be entirely or partially closed. In some embodiments, the second end 220 may define a closed end with a bottom of a sample well of a well plate or a molded insert. The first well member 110 may have a length 202 that extends between the first end 210 and the second end 220.

[0036] In some embodiments, the well member 110 may include a body portion 230 that extends along the length 202. The body portion 230 may include a bore 232 that extends substantially along the length 202. The bore 232 may terminate at the second end 220.

[0037] In some embodiments, the well member 110 may have a wall thickness 204. In some embodiments, the well member 110 may have the same wall thickness. In some embodiments, the wall thickness 204 may be about 0.0050".

[0038] In some embodiments, the well member 110 may have a diameter 206 (also referred to as the "outer diameter") that is the same along the length 202. In some embodiments, the diameter 206 may be about 0.367 inches. In other embodiments, the well member 110 may have a different diameter along the length 202, for example, the well member 110 may be tapered.

[0039] In some embodiments, the opening 212 and the bore 232 may have a diameter 208 that is the same (also referred to as the "inner diameter" of the well member 110). In some embodiments, the diameter 208 may be about 0.267". In other embodiments, a diameter of the opening 212 and the diameter of the bore 232 may be the different.

[0040] In some embodiments, the well member 110 may include a (bottom) surface 222 that extends across the bore 232 and is disposed at the second end 220 (perpendicular to the length 202). The surface 222 may define the closed end.

[0041] In other embodiments, the well member 110 may omit a bottom surface 222. In some embodiments, the closed end may be defined by the second end 220 and the bottom of a sample well and/or a bottom of a molded insert. In some embodiments, the well member 110 may include a member configured to provide a seal between the bottom of the sample well and the well member 110. In some embodiments, the member may be disposed at the second end and substantially surround the bore 232. The member may be a silicone ring or the like.

[0042] In some embodiments, the well member 110 may include a first section 240 disposed at the first end 210. The first section 240 may be disposed to surround the opening 212 and the bore 232. The first section 210 may extend parallel to the length 202 of the well member 110.

[0043] In some embodiments, the well member 110 may include a second section 250 also referred to as "lower lip" and "bottom lip") disposed at the second end 220. The second section 250 may be configured to hold a predetermined volume of a solution or a fluid (e.g., a RBC solution).

[0044] In some embodiments, the second section 250 may be disposed to surround the bore 232. The second section 250 may extend parallel to the length 202 of the well member 110 from the second end 220.

[0045] In some embodiments, the second section 250 and the bottom surface 222 (the closed end) may define a reservoir 256 (also referred to as "well depression") configured to hold a predetermined volume of a solution (e.g., a RBC solution). The second section 250 may be configured to hold any volume of a solution. In some embodiments, the length 252 of the second section 250 may determine the capacity of the second section 250. The dimensions (e.g., the length

252 and/or diameter) of the second section 250 may be adjusted to meet the fluid volume needs of any particular application. For example, the second section may be configured to hold a volume of about 100 μL, a volume of about 187 μL, and the like.

[0046] In this way, the second section 250 may be configured to control the final fluid volume after the assay process. This can improve operation as the flow cytometer is concentration dependent. The dimensions (e.g., length) of the second section 250 may be adjusted to meet the fluid volume needs of any particular application. The well member 110 thus can be easily adaptable to ancillary tests.

[0047] Figure 6 shows prototypes 610 and 620 of a well member according embodiments with different sized reservoirs. The prototypes 610 and 620 are substantially identical but for the different sized second sections 612 and 622, respectively. The second section 612 of the well member 610 is bigger (e.g., longer length) than the second section 622 of the well member 620. The well member 610 has the second section 612 configured for a volume of about 187μL and the well member 620 has the second section 622 configured for a volume of about 100μL.

[0048] In some embodiments, the first section 240 and the second section 250 may have the same diameter. In other embodiments, the first section 240 and the second section 250 may have different diameters.

[0049] In some embodiments, the first section 240 may be smaller than the second section 250 as shown in Figure 4. The first section 240 may have a length 242 that is smaller than a length 252 of the second portion of the second section 250. In other embodiments, the first section 240 may be larger than the second section 250. The length 242 of the first section 240 may be larger than the length 252 of the second section 250. In further embodiments, the first section 240 may have substantially the same dimensions of the second section 250. The length 242 of first section 240 may be the same as the length 252 of the second section 250.

[0050] In some embodiments, the well member 110 may include a plurality of support members 260 (also referred to as "vertical supports") extending partially along the length 202 between the first section 240 and the second section 250. The support members 260 may be disposed around and surround the bore 232.

[0051] In some embodiments, the well member 110 may include a plurality of cut-outs 270 disposed at least partially along the length 202 between the first section 240 and the second section 250. The cut-outs 270 may be disposed around and surround the bore 232. The width or circumference 272 of each cut-out 270 may be defined by two opposing support members 260. The cut-outs 270 may be configured to allow a fluid (e.g., a washing fluid) to flow out of the (bore 232) of the well member 110.

[0052] There may be any number of the support members 260 and the cut-outs 270. In some embodiments, the well member 110 may include four support members 260 and four cut-outs 270, as shown in the figures. In other embodiments, the well member 110 may include a different number of

the support members 260 and the cut-outs 270. For example, the well member 110 may include two, three, five, six, etc. number of the support members 260 and cut-outs 270. The number of the plurality of support members 260 may correspond to the number of cut-outs 270.

[0053] The well member 110 may have any combination of sizes of the support members 260 and the cutouts 270. In some embodiments, the cut-outs 270 may be substantially the same dimensions (e.g. width and length). In some embodiments, each cut-out 270 may have a length 274 of about 0.052 inches. However, the length 274 of the cut-outs 270 is not limited to this length and may be of a different length.

[0054] In some embodiments, the cut-outs 270 may have a width (or circumference) 272 that is substantially the same. In this way, the spacing between the support members may be substantially the same. In some embodiments, the cut-outs 270 may be of different sizes. For example, the cut-outs 270 may have varying and different widths. The cut-outs 270 may have any combination of widths. In this way, the spacing between the supports members 260 may vary and be different.

[0055] In some embodiments, the support members 260 may be substantially the same. In other embodiments, the support members 260 may be different and vary in size. For example, the support members may have varying width.

[0056] In some embodiments, the support members 260 and the cut-outs 270 may have the same dimensions. In other embodiments, the support members 260 and the cut-outs 270 may have different dimensions. For example, the support members 260 may have a different width or circumference than the cut-outs 270. The width or circumference of the support members may be larger or smaller than the width or the circumference of the cut-outs 270.

[0057] In some embodiments, the cut-outs 270 may be disposed relative to the body 230 at predetermined angle 276. In some embodiments, the angle 276 may be about 65°. In other embodiments, the predetermined angle 276 may be different.

[0058] In some embodiments, the cell filtration device 100 may include a filter member 120 disposed to at least partially surround the well member 110. The filter member 110 may be configured to substantially contain the sample (e.g., RBCs) within the well member 110 for the duration of the assay process. In some embodiments, the filter member 120 may be fixedly disposed to the outer diameter of the well member 110, for example, by an adhesive. The filter member 120 may have at least a length that covers at least the cut-outs 270. The support members 260 of the well member 110 may be configured to support the filter member 120 in addition to supporting the body of the well member 110.

[0059] The filter member 120 may be made of a semi-permeable material. The material may be hydrophilic. In some embodiments, the hydrophilic material may include but is not limited to a polyester material. In some embodiments, the filter member 120 may include at least one layer of a hydrophilic material.

[0060] In operation, the filter member 120 may be configured to draw an assay fluid out of the well member 110 at a desired diffusion rate. For example, a filter member having a diffusion rate of about 20 seconds may have a filter size of about 1.0μm pore size.

[0061] The filter member 120 may have a pore size configured to prevent passage of the sample (e.g., RBC cells) to be analyzed across the filter member 120. The pore size may depend on the sample to be analyzed. It can be adjusted to meet the individual pore size requirements of the assay applications. In some embodiments, the pore size may be generally the largest pore size that can prevent the passage of the cells across the filter member 120, and thus the filter member 120 may be configured to allow the fastest diffusion without risk of cell sample loss. For example, RBCs generally can be as small as 2.0 μm. In some embodiments, the pore size of the filter member 120 may be less than about 2.0 μm. For example, the filter member 120 may include a pore size of about 1.5 μm or 1.0 μm.

[0062] The filter member 120 may have any thickness and any pore density. For example, for RBCs, the filter member 120 may have a thickness of about 11μm and a pore density of about 2 x 10^7 pores/cm^2.

[0063] In some embodiments, the cell filtration device 100 may include an absorbent member 130 disposed to substantially surround the filter member 120. The absorbent member 130 may be configured to absorb at least some of the fluid and draw the assay wash from the well member 110 through the filter member 120.

[0064] The absorbent member 130 may be made of any material(s) having hydrophilic properties. The absorbent material may include but is not limited to cotton materials, silicia gel derivatives, and the like. The absorbent material may be configured to produce an average diffusion rate and absorb enough fluid to withstand a number of washes required for the application without requiring a change of material. For example, for RBCs, the material may be a highly absorbent cotton that is configured to produce average diffusion rates of less than about 20 seconds and configured to withstand about six washes.

[0065] In some embodiments, the absorbent member 130 may be bonded to the filter member 120 together during the manufacturing process of the members, for example, by needle-punching. In other embodiments, the absorbent member 130 and the filter member 120 may be separately manufactured. The absorbent member 130 may be disposed to surround the filter member 120 during the manufacturing of the cell filtration device 100.

[0066] In some embodiments, the cell filtration device 100 may include a well plate 140 (also referred to as "a main plate"). In some embodiments, the well plate 140 may be any microplate or microwell plate. Figures 9 and 10 show the well plate 140 according to embodiments. It will be understood that the well plate 140 is not limited to the well plate shown in and described with respect to the figures and may be any microplate or microwell plate.

[0067] In some embodiments, the well plate 140 may be made of the same material or a different material as the cell filtration member 110. The well plate 140 may be made of a polymer material having biocompatibility. In some embodiments, the material may include but is not limited to polystyrene. The well plate 140 may be manufactured using injection-molding methods.

[0068] As shown in Figures 1, 9 and 10, the well plate 140 may include a plurality of sample wells 902. The well plate 140 may include any number of sample wells 902 and is not limited to the 24 sample wells shown. For example, the well plate 140 may include 6, 24, 96, 384, or 1536 sample wells arranged in a rectangular matrix.

[0069] The well plate 140 may be configured to compatible with existing pipette and flow cytometry equipment. The dimensions of the well plate 140 may correspond to a standard microtiter plate. The dimensions may alternatively or optionally correspond to the requirements in the Engineering Design Specifications and the standards set by the Society for Biomolecular Sciences and the American National Standards Institute. For example, the well plate 140 may have a length by width of about 5.023" by about 3.369". The inner diameter of each sample well 902 may be about 0.27" and the height of each sample well may be about 0.67".

[0070] The well plate 140 may include a first section 910 and a second section 920. The first section 910 may include the plurality of sample wells 902. In some embodiments, each of the sample wells 902 may include the well member 110, the filter member 120 and the absorbent member 130. The second section 920 may include a planar surface on which the first section 910 is disposed. The second section 920 may have a longer width and diameter than the first section 910 so as to define a "flange." The "flange" may be considered the area of the second section 920 that extends beyond the first section 910. The second section 920 may include a top surface 922 on which the first section 910 is disposed and an opposing bottom surface 924.

[0071] In some embodiments, the well plate 140 may include least one protrusion 930 disposed on the bottom surface 924. The well plate 140 may include any number of protrusions 930 and is not limited to the ten protrusions shown in Figure 10. The well plate 140 may include a plurality of the protrusions 930, such as more or less than the ten protrusions shown. The protrusions 930 may be configured to enable stacking of the plates 140. The protrusions 930 may be disposed within the flange (the area that extends beyond the first section 910) on the bottom surface 930.

[0072] In some embodiments, the well plate 140 may include at least one angled surface 940 (also referred to as "angle cutout") configured to indicate orientation and/or well number sequence. In this way, the angled surface 940 can help reduce errors. In some embodiments, the first section 910 may include at least one angled surface 940 disposed at one of the corners. In some embodiments, the first section 910 may include two angled surfaces 940 disposed at opposing corners on the same side.

[0073] In some embodiments, the (top) surface 912 of the first section 910 of the well plate 140 may include an inlet 950 configured to provide protection to the well members 140. The inlet

950 may have any dimension and may include and is not limited to 1/32". The inlet 950 may be configured to provide protection, for example, during shipping, storage, handling, and usage in the lab environment.

[0074] In some embodiments, the cell filtration device 100 may include a depression 150 configured to receive the well member 110. In some embodiments, the depression 150 may be configured to be disposed in a sample well of a well plate. The depression 150 may be configured to be disposed at the bottom of a sample well. The inner diameter of the depression 150 may correspond to the (outer) diameter of the well member 110. For example, the depression 150 may have dimensions of about 0.400" (diameter) by about 0.0625" (height).

[0075] In some embodiments, the well plate 140 may include the depression 150. Each sample well of the well plate 140 may include the depression 150. In other embodiments, a sample well of the well plate 140 may be retrofitted with the depression 150. Figure 7 shows the well plate 140 including the depression 150.

[0076] The depression 150 may be made of a polymer material. The depression 150 may be made of the same and/or different material as the cell filter member 110 and the well plate 140. In some embodiments, the depression 150 may be made of polystyrene.

[0077] In some embodiments, the cell filtration device 100 may alternatively or additionally (to the depression 150) include a member configured to provide a seal between the well member 100 and the well plate 140. In some embodiments, the member may be disposed at the second end and/or at the bottom of a sample well. The member may be a silicone o-ring or the like.

[0078] In some embodiments, the cell filtration device 100 may include the well plate 140. In some embodiments, each sample well may be configured as shown in Figures 1, 2, 7, and 8. As shown in these figures, each sample well may include the well member 110 disposed within the depression 150 provided on the bottom of the sample well of the plate 140. The filter member 120 may surround the well member 110 so as to at least partially cover the cut-outs. The absorbent member 130 may be disposed or be configured to be disposed adjacent to a wall 142 of the sample well and surround the filter member 120.

[0079] In some embodiments, at least the well plate 140 and the cell filter member 110 may be manufactured together as part of a singular mold.

[0080] In other embodiments, the cell filtration device 100 may not include a well plate 140. In some embodiments, the cell filtration device may be configured to retrofit an existing well plate. For example, the cell filtration device may be an insert configured to fit into an existing plate. In some embodiments, the cell filtration device may include the cell filtration member, the filtration member and the absorbent member according to embodiments. In some embodiments, the cell filtration device may include the depression.

[0081] In some embodiments, the cell filtration device 100 may include a molded insert including a plurality of protrusions substantially corresponding to the sample wells of a well plate. The insert maybe configured to be disposed on a top surface of a well plate and the protrusions may be configured to be disposed within the corresponding sample well. The protrusions may have a substantially open or closed bottom. In this way, an existing well plate may be easily and quickly retrofitted. In some embodiments, the molded insert may include a depression according to embodiments. The depression may be disposed on the bottom of each protrusion. In some embodiments, the bottom surface of the protrusion may be the depression and/or the depression may be disposed on top of or above the bottom surface of the protrusion. In some embodiments, the insert may additionally or alternatively (to the depression) include a member disposed on the bottom of each protrusion. The member may be configured to provide a seal between the bottom of the sample well and the bottom of the insert. In some embodiments, the member may be a silicone o-ring or the like. In some embodiments, the bottom of the protrusion with the second section of the well member may be configured to form a closed end and a reservoir. In other embodiments, the bottom of the protrusion and the bottom of the sample well may be configured to form a closed end and a reservoir. The cell filtration member, the filtration member and the absorbent member may be disposed within each protrusion as shown in and described with respect to Figures 7 and 8 and the sample well of a well plate.

[0082] In some embodiments, the cell filtration member may be configured to be sterilized or cleaned. In some embodiments, one, some, or all parts of the cell filtration member may be configured to be reused. In further embodiments, one, some, or all parts of the cell filtration member may be disposable. In further embodiments, the cell filtration member may be a single, use device.

[0083] In some embodiments, the cell filtration device may be part of a kit. In some embodiments, the cell filtration device may include any combination of the well member, the filter member, the absorbent member, the depression. In some embodiments, the cell filtration device may also include the well plate. In alternative embodiments, the cell filtration device may include a molded insert for a well plate. In some embodiments, the kit may include a plurality of the cell filtration devices.

[0084] The cell filtration devices according to embodiments are configured to substantially remove the assay wash fluid from the cell sample and configured to contain the cell sample within a specified chamber (e.g., the bore within the well member). More specifically, the cell filtration devices are configured to leverage the difference in hydrophilicity between the cell filtration member and the well plate to create a strong enough driving force to encourage passive fluid diffusion, i.e., pull the fluid from the well member to the outer hydrophilic member. In this way, the cell filtration devices can isolate the cells (e.g., RBCs) in solution so that they can be feed into a flow cytometer to determine blood type. The cell filtration devices according to embodiments can thereby allow for the

streamlining of manufacturing and material costs, drastic reduction in overall testing times and easy integration into compact systems, such as the AEGIS platform manufactured by 3Ti.

[0085] Figure 11 shows a method 1100 of performing a blood-typing method using the cell filtration devices and related operation of the cell filtration devices according to embodiments. The method may be performed using a system that includes at least pipette and flow cytometry equipment and may be performed using automated equipment. The method does not require a centrifuge or a vacuum device.

[0086] After an RBC sample 1102 is added to the cell filtration member, the reaction steps can begin. First, a hemocrit solution (e.g., a 1.5% hemorcrit solution) and reagents may be added (steps 1110 and 1120, respectively). Next, the wash steps may begin. A saline solution (e.g., 200 μL of a saline a solution) may be added to the cell filtration member (step 1130). The absorbent member may then absorb some of the saline solution (step 1140), thereby wicking or absorbing the excess assay fluid out of the cell filtration member. After the excess assay fluid 1152 is absorbed (step 1150), the sample 1102 may be analyzed (step 1160). As shown in step 1160, the remaining fluid (e.g., 20 μL) of the final suspension can be withdrawn and analyzed by a flow cytometer. The second section (e.g., reservoir) is thereby configured to prevent the absorbent member from contacting the remaining assay fluid, thus allowing precision control of the remaining fluid volume to be sent to the flow cytometer for typing.

[0087] While the disclosure has been described in detail with reference to exemplary embodiments, those skilled in the art will appreciate that various modifications and substitutions can be made thereto without departing from the spirit and scope of the disclosure as set forth in the appended claims. For example, elements and/or features of different exemplary embodiments may be combined with each other and/or substituted for each other within the scope of this disclosure and appended claims.

CLAIMS

What is claimed:

1. A cell filtration device, including:

a well member configured to be disposed in a sample well of a well plate, the well member including:

a first end and an opposing second end; and

a first section disposed at the first end and a second section disposed at the second end, the second section defining a reservoir configured to hold a predetermined volume of a fluid; and

a plurality of cut-outs extending between the first section and the second section.

2. The cell filtration device according to claim 1, further comprising:

a plurality of support members extending between the first section and the second section, each cut-out being disposed between a set of support members.

3. The cell filtration device according to claim 2, further comprising:

a filter member disposed to surround the well member, the filter member at least covering the cut-out members;

wherein the support members are configured to support the filter member.

4. The cell filtration device according to claim 1, further comprising:

a filter member configured to surround the well member,

wherein the filter member includes a hydrophilic material.

5. The cell filtration device according to claim 4, wherein the filter member has a pore size less than about 2.0 μm.

6. The cell filtration device according to claim 1, further comprising:

an absorbent member disposed to surround the filter member and configured to absorb some of the fluid.

7. The cell filtration device according to claim 6, wherein the absorbent member is configured to be disposed adjacent to a wall of the sample well.

8. The cell filtration device according to claim 1, further comprising:

a depression configured to receive the well member, the depression being configured to be disposed within the sample well.

9. The cell filtration device according to claim 1, wherein the first section has a length and the second section has a length and the length of the second section is longer than the length of the first section.

10. The cell filtration device according to claim 9, wherein the length of the second section corresponds to the predetermined volume.

11. A cell filtration device configured for testing of a sample, including:

a well member configured to be disposed in a sample well of a well plate, the well member including:

a first end and an opposing second end;

a first section disposed at the first end and a second section disposed at the second end, the second section defining a reservoir configured to hold a predetermined volume of a fluid;

a plurality of support members extending between the first section and the second section; and

plurality of cut-outs extending between the first section and the second section and disposed between a set of plurality of support members, the cut-outs being configured to allow the fluid to flow out of the well member; and

a filter member disposed to at least partially surround the well member, the filter member at least covering the cut-out members and the filter member configured to substantially contain the sample within the well member during the testing.

12. The cell filtration device according to claim 11, further comprising:

a plurality of support members extending between the first section and the second section, each cut-out being disposed between a set of support members,

wherein the support members are configured to support the filter member.

13. The cell filtration device according to claim 11, wherein the filter member includes a hydrophilic material.

14. The cell filtration device according to claim 13, wherein the filter member has a pore size less than 2.0 μm.

15. The cell filtration device according to claim 11, further comprising:

a well plate including a plurality of sample wells; and

a depression disposed on the bottom surface of the sample well and configured to receive the well member.

16. The cell filtration device according to claim 15, further comprising:

an absorbent member that surrounds the filter member and is disposed between the filter member and a wall of the sample well,

the absorbent member configured to absorb at least some of the fluid.

17. The cell filtration device according to claim 16, wherein the absorbent member includes a material having hydrophilic properties.

18. The cell filtration device according to claim 11, wherein the second section is configured to control a volume of the fluid for the testing.

19. The cell filtration device according to claim 11, wherein the first section has a length and the second section has a length and the length of the second section is longer than the length of the first section.

20. The cell filtration device according to claim 20, wherein the length of the second section corresponds to the predetermined volume.

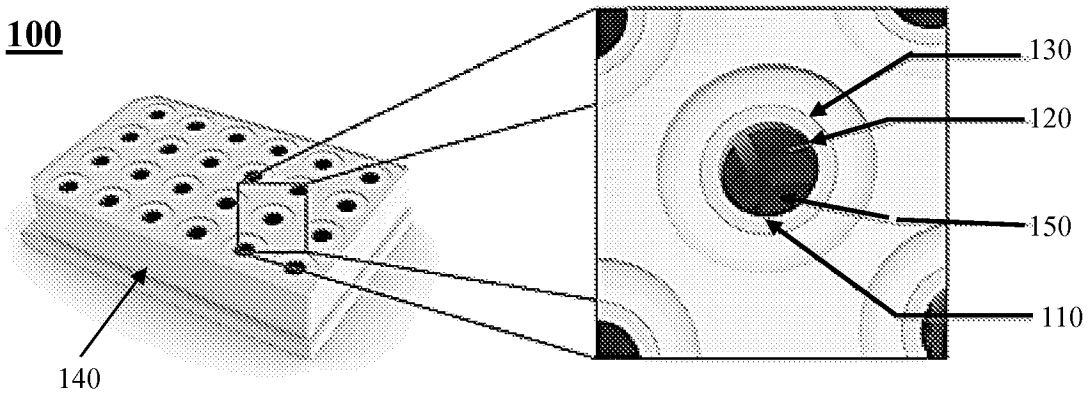


FIGURE 1

FIGURE 2

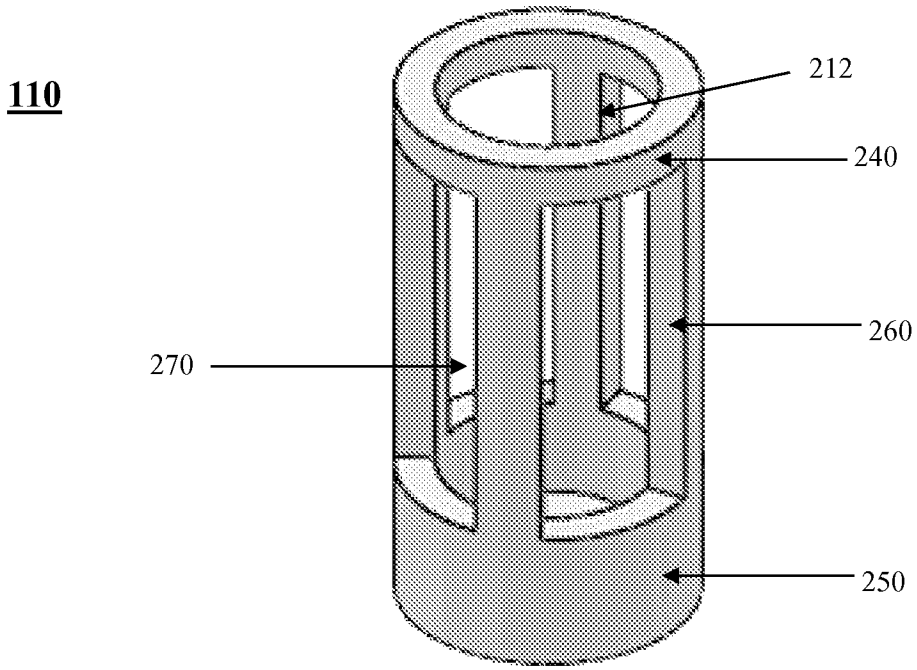
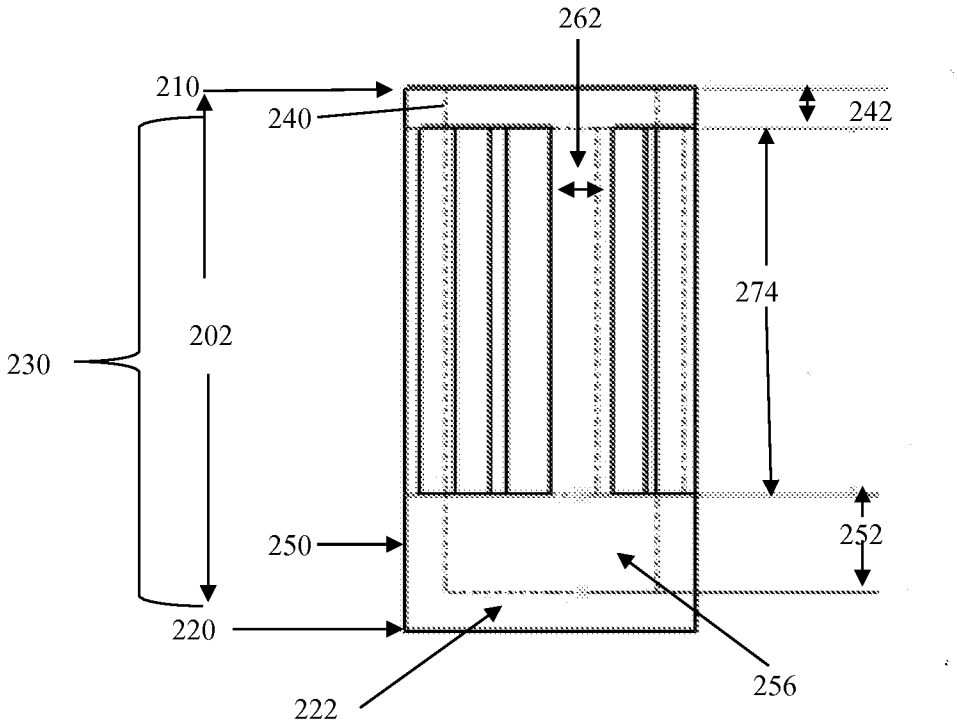


FIGURE 3



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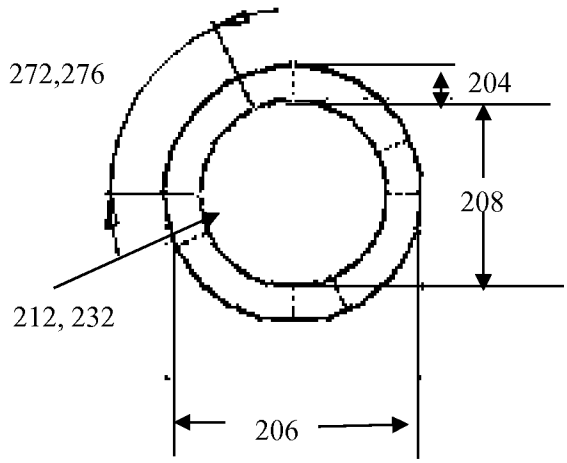

FIGURE 5

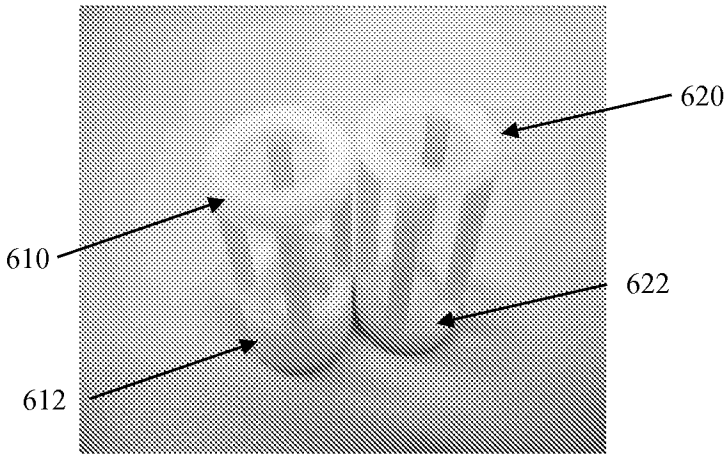

FIGURE 6

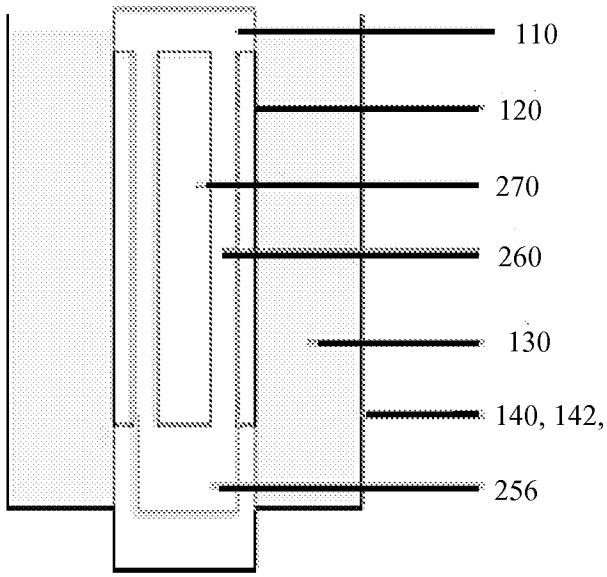

FIGURE 8

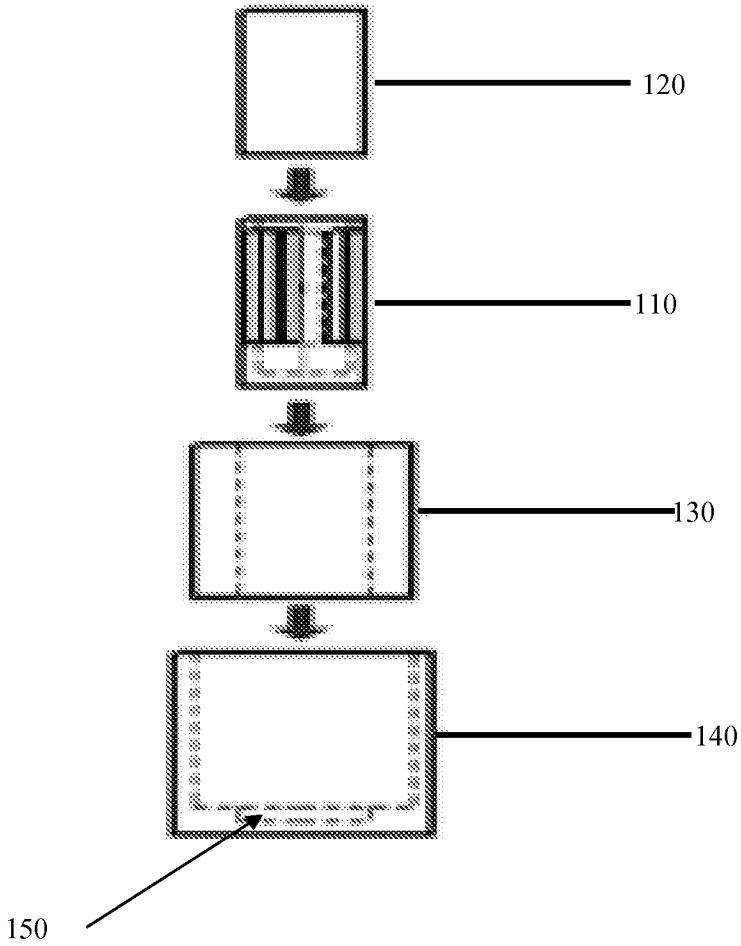

FIGURE 7

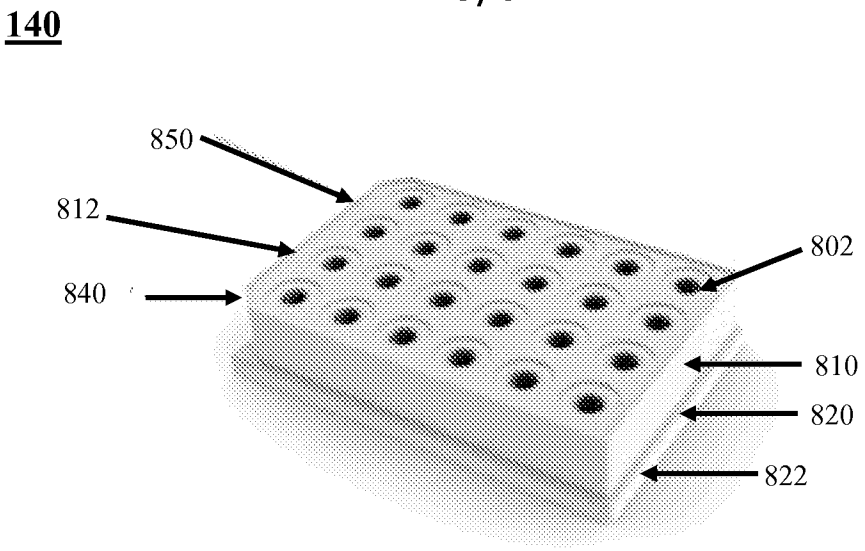

FIGURE 9

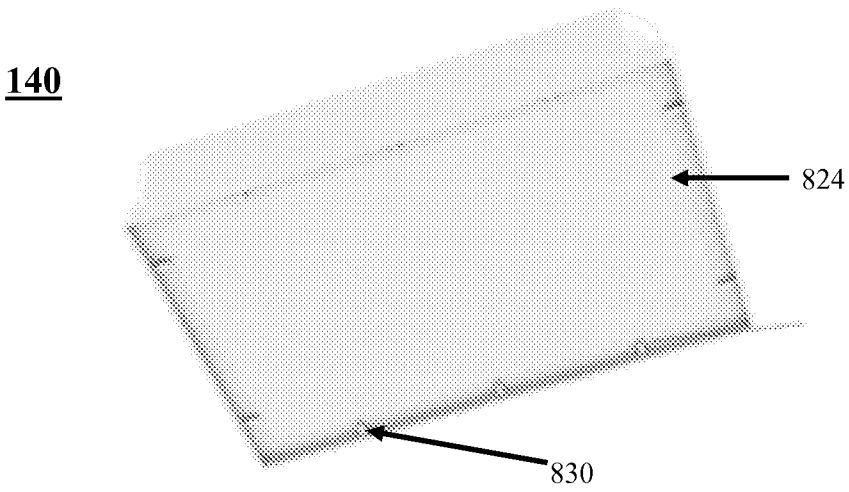

FIGURE 10

1100

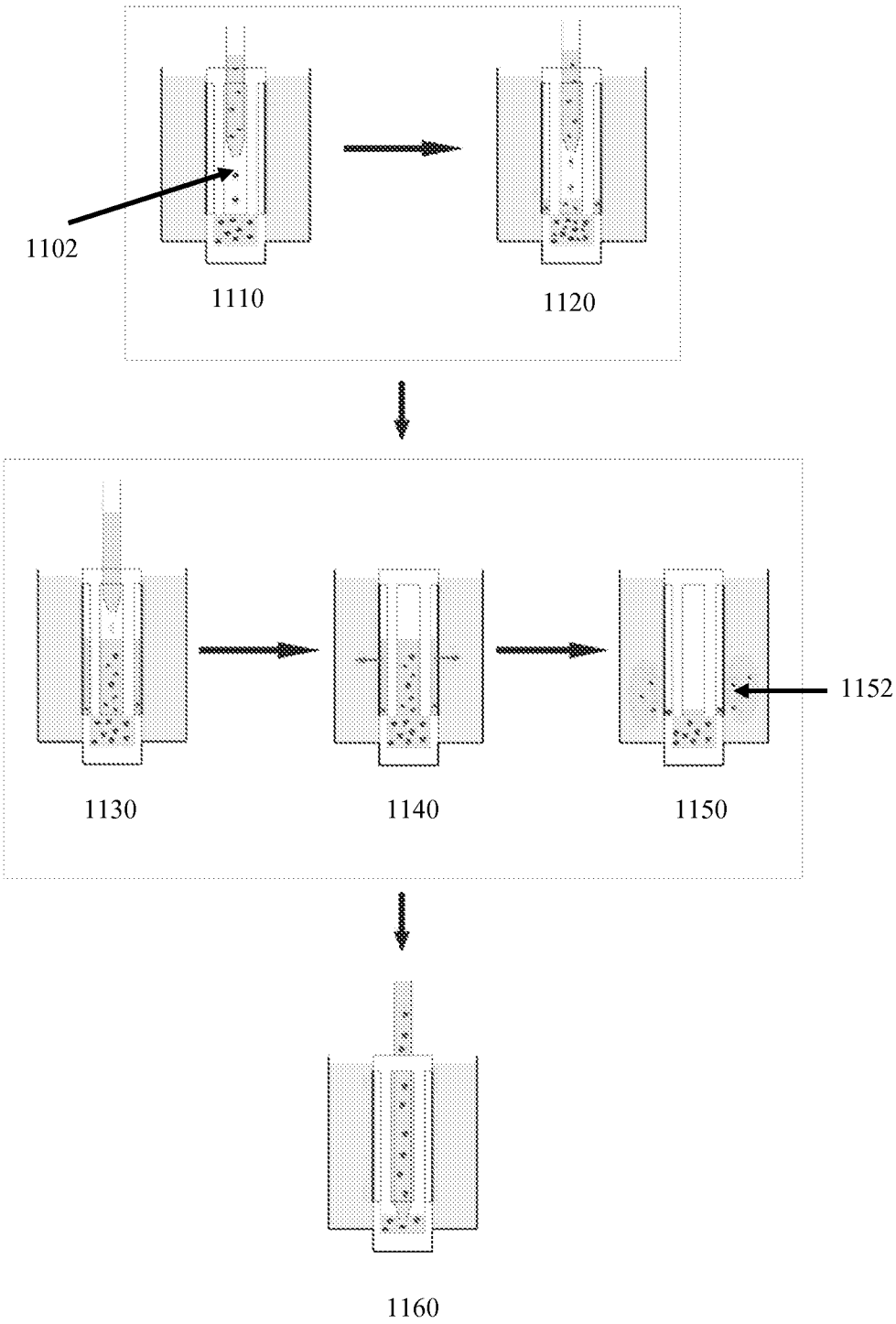

FIGURE 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/052052

A. CLASSIFICATION OF SUBJECT MATTER

G01N 35/00(2006.01)i, G01N 37/00(2006.01)i, G01N 1/28(2006.01)i

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)
G01N 35/00; B01L 300; C12M 1/12; B01L 3/00; G01N 35/02; G01N 33/53; C12M 3/00; C12M 1/34; G01N 37/00; G01N 1/28

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords:cell, filtration, well plate, cut-out, support member, filter

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2011-189270 A (SUMITOMO BAKELITE CO., LTD.) 29 September 2011 See abstract, claim 1, paragraphs [0014]-[0016], [0023]-[0024], [0033]-[0036], figures 1-5.	1-5,11-14
A		6-10,15-20
A	US 6830732 B1 (HOFFMAN, H.-J. et al.) 14 December 2004 See abstract, claim 1, column 2, lines 9-26, figures 2a-3.	1-20
A	US 2008-0003670 A1 (MARTIN, G. R. et al.) 03 January 2008 See abstract, claims 1-3, paragraphs [0039], [0044], figures 1, 4.	1-20
A	US 2003-0124715 A1 (TORTORELLA, M. D.) 03 July 2003 See abstract, claim 1, paragraphs [0008], [0011], [0021]-[0022], figures 1, 4.	1-20
A	US 2011-0165589 A1 (BIESBROUCK, G. M. et al.) 7 July 2011 See abstract, claims 1, 8-9, paragraph [0080], figure 5.	1-20

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05 December 2013 (05.12.2013)	**05 December 2013 (05.12.2013)**

Name and mailing address of the ISA/KR
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2013/052052

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