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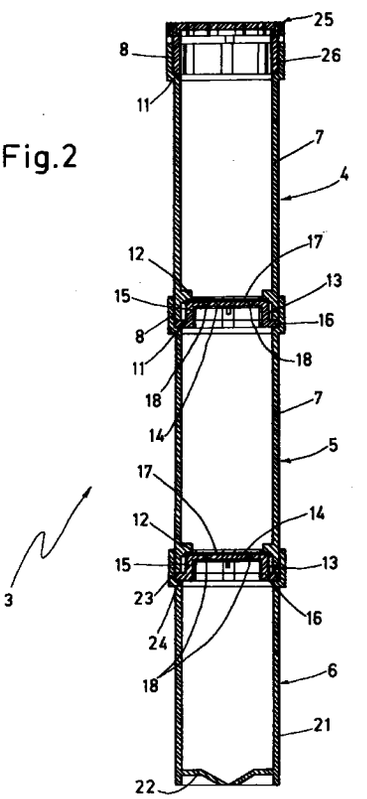
(54) Fluid filtration device

(57) A fluid filtration device (1) presenting a centrifuge (2), a test tube assembly (3), and a mechanical arm supporting the test tube assembly (3). The main characteristic of the present invention is that the test tube assembly (3) comprises a number of successive chambers (4, 5, 6), each separated from the adjacent chamber by a respective filtration membrane (17), so that the fluid introduced into the top chamber (4) is cascade filtered a number of times during operation of the centrifuge (2).

Fig.2



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Description

The present invention relates to a fluid filtration device particularly useful for laboratory analysis, and in particular to a test tube assembly containing a fluid to be separated by means of a centrifuge.

As is known, currently used filtration devices comprise a centrifuge, and a test tube assembly presenting a first tube with a filtration membrane and into which the fluid to be filtered is introduced, and a second tube into which part of the test fluid is filtered by centrifugal action. In other words, known filtration devices provide for concentrating inside the second tube the fluid portion of a smaller molecular size than the pores of the membrane, which portion is then subjected to laboratory analysis. For analyzing different molecular size portions of the same fluid, this must be filtered twice using two test tube assemblies fitted, naturally, with membranes of different filtration grades. That is, when once filtered, the concentrated portion in the second tube of the first assembly must be poured into the first tube of the second assembly and the centrifuge operated once more.

It is an object of the present invention to provide a filtration device which, in the course of one run of the centrifuge, provides for cascade filtering the same fluid a number of times.

Further aims and advantages of the present invention will be disclosed in the following description.

According to the present invention, there is provided a fluid filtration device presenting a centrifuge; a test tube assembly; and a mechanical arm supporting the test tube assembly; characterized in that said test tube assembly comprises a number of successive chambers, each separated from the adjacent chamber by a respective filtration membrane, so that the fluid introduced into the top said chamber is cascade filtered repeatedly during operation of the centrifuge.

A preferred non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a schematic view of a filtration device in accordance with the teachings of the present invention;

Figure 2 shows a section of the test tube assembly of the Figure 1 device.

Number 1 in Figure 1 indicates a filtration device comprising a known centrifuge 2 (therefore shown only schematically), and a test tube assembly 3 presenting a number of successive chambers, each separated from the adjacent chamber by a filtration membrane. In the example embodiment shown, test tube assembly 3 provides for performing two filtrations and therefore comprises three successive test tubes 4, 5 and 6. In actual use, the fluid to be filtered is introduced into tube 4; assembly 3 is fitted to a mechanical arm (not shown) of centrifuge 2; and centrifuge 2 is operated to separate the fluid portion of a molecular size smaller than the diameter of the pores of the membrane between tubes 4 and 5, and to separate, from the fluid filtered into tube 5, the fluid portion of a molecular size smaller than the diameter of the pores of the membrane between tubes 5 and 6.

With reference to Figures 1 and 2, test tube 4 comprises a cylindrical body 7 made of transparent plastic material and presenting a top end 8 with an inside diameter equal to the outside diameter of the rest of the body, so as to define an inner annular shoulder 11. At the bottom end, body 7 presents an inner annular projection 12; and test tube 4 also comprises an upside down cup-shaped body 13 presenting a base wall 14, a cylindrical lateral wall 15, and an annular flange 16 extending outwards from the bottom edge of wall 15. Body 13 is made of transparent plastic material and fitted inside the bottom end of body 7, with the exception of flange 16 which contacts the bottom edge of body 7 and presents an outside diameter equal to that of body 7.

Test tube 4 also comprises a circular filtration membrane 17 fitted between the upper face of wall 14 of body 13 and projection 12 of body 7. More specifically, the periphery of membrane 17 is pressed against projection 12 by the periphery of wall 14, which wall 14 presents a number of holes 18 for permitting the fluid filtered through membrane 17 to flow into test tube 5. In use, membrane 17 and body 13 are made, e.g. welded, integral with each other and with the bottom end of body 7.

With reference to Figures 1 and 2, test tube 5 is identical to tube 4 - and therefore illustrated using the same component numbering system - except that filtration membrane 17 of tube 5 presents smaller-diameter pores than that of tube 4. The bottom end of tube 4 is fitted inside the seat defined by top end 8 of tube 5, and flange 16 of body 13 of tube 4 rests on shoulder 11 of body 7 of tube 5.

With reference to Figures 1 and 2, test tube 6 comprises a cylindrical body 21 made of transparent plastic material and presenting a base wall 22, and a top end 23 with an inside diameter equal to the outside diameter of the rest of the body, so as to define an inner annular shoulder 24. End 23 of tube 6 is identical to ends 8 of tubes 4 and 5, so as to receive the bottom end of tube 5.

With reference to Figures 1 and 2, test tube 4 presents a fluidtight cap 25 with a tubular stem 26 inserted inside the seat defined by top end 8 of body 7.

In use, test tubes of the type indicated by 4 and 5 are available, each with a membrane 17 of a given filtration grade. For filtering the same fluid a number of times, the appropriate test tubes are selected and fitted together; and, after assembling test tube 6 into which the smallest molecular size fluid portion is eventually centrifuged, the fluid to be filtered is introduced into the first test tube. It should be pointed out that, in use, test tubes 4, 5 and 6 are all provided with a cap 25 which is removed for assembling the tubes, that of tube 4 naturally being replaced after introducing the fluid.

As is known, centrifuging comprises fitting test tube assembly 3, at an inclined angle in relation to a vertical axis of rotation, to a mechanical arm (not shown) of cen-

trifuge 2. As the arm and consequently test tube assembly 3 is rotated about said axis, centrifugal force is applied to the fluid inside test tube 4, which force produces such a pressure as to filter the fluid, so that the fluid portion of a molecular size smaller than the diameter of the pores of the first membrane 17 is fed into test tube 5. As test tube 5 receives said fluid portion, this too is subjected to centrifugal force, so that a further portion of said portion of fluid is filtered into test tube 6. It will be noted that, by virtue of the inclined angle of test tube assembly 3, each test tube is located a different distance from the center of rotation of centrifuge 2. More specifically, the distance of test tube 5 is greater, as shown in Figure 1 wherein A and B indicate the segments between the center of rotation of centrifuge 2 and the barycenter of test tubes 4 and 5. As the pressure required for filtration is known to increase, as the molecular size of the fluid gets smaller, the inclined angle of test tube assembly 3 assists cascade filtration by increasing the distance of test tube 5 and so subjecting the fluid inside tube 5 to greater centrifugal force as compared with test tube 4.

The filtration device may be fitted with microfiltration membranes (of any molecular size), in particular inorganic, e.g. ceramic, membranes; organic, e.g. polymer, membranes; or affinity membranes. It may be fitted with ultrafiltration, nanofiltration or reverse osmosis membranes (of any molecular size), in particular inorganic, e.g. ceramic, membranes; organic, e.g. polymer, membranes; membranes resistant to organic solvents; liquid membranes; or affinity membranes. Finally, it may be used for purifying the fluid by providing at least one membrane-fitted test tube with a predetermined quantity of chromatographic resin or gel (filtration, ion exchange, affinity or liquid resins), so as to obtain, after centrifuging, a purified or waste product accordingly.

The advantages of the present invention are as follows.

In particular, it provides for cascade filtrating the same fluid a number of times in the course of one run of centrifuge 2, and so obtaining fluid portions of different molecular sizes for laboratory analysis. Moreover by providing a series of test tubes of different molecular sizes (each possibly assigned a corresponding test tube colour), test tube assemblies may be formed as required by the operator. A further point to note is the modular design of test tube assembly 3 which is therefore extremely easy to assemble.

Clearly, changes may be made to filtration device 1 as described and illustrated herein without, however, departing from the scope of the present invention.

In particular, the test tube assembly may comprise a greater number of test tubes for performing more than the two filtrations provided for by the assembly described and illustrated herein; one of the test tubes may be in the form of an inverted Y with respective membranes, even of different filtration grades, along the two branch portions; and changes may be made to the manner in which the membrane and membrane supporting body are fitted to the test tube body.

Claims

1. A fluid filtration device presenting a centrifuge (2); a test tube assembly (3); and a mechanical arm supporting the best tube assembly (3); characterized in that said test tube assembly (3) comprises a number of successive chambers (4, 5, 6), each separated from the adjacent chamber by a respective filtration membrane (17), so that the fluid introduced into the top said chamber (4) is cascade filtered repeatedly during operation of the centrifuge (2).

2. A device as claimed in Claim 1, characterized in that said test tube assembly (3) is fitted to said mechanical arm at an inclined angle in relation to a vertical axis of rotation; each of said chambers (4, 5, 6) being located a different distance from the center of rotation of said centrifuge (2), and, more specifically, said distance being greater for the lower said chambers.

3. A device as claimed in Claim 2, characterized in that said test tube assembly (3) comprises in succession a top test tube (4) into which the fluid to be filtered is introduced and which is closed at the top by a fluidtight cap (25); at least one central test tube (5); and a bottom test tube (6) into which, in use, the smallest molecular size fluid portion is filtered.

4. A device as claimed in Claim 3, characterized in that said top and central test tubes (4, 5) each comprise a respective tubular body (7), the bottom end of which presents a seat for a corresponding said filtration membrane (17).

5. A device as claimed in Claim 4, characterized in that said top and central test tubes (4, 5) each comprise a respective membrane supporting body fitted integrally inside the bottom end of said tubular body (7).

6. A device as claimed in Claim 4 and/or 5, characterized in that said tubular body (7) of said central test tube (5) presents a top end (8) in which is formed a seat for housing the bottom end of said tubular body (7) of said top test tube (4).

7. A device as claimed in Claim 6, characterized in that said top and central test tubes (4, 5) present respective said tubular bodies (7) of the same shape and size.

8. A device as claimed in Claim 6, characterized in that said bottom test tube (6) comprises a tubular body (21) presenting a base wall (22), and a top end (23) of the same shape and size as the top end (8) of said tubular body (7) of said central test tube (5); the top end (23) of said tubular body (21) of said bottom test tube (6) housing the bottom end of said tubular body (7) of said central test tube (5).

Fig.1

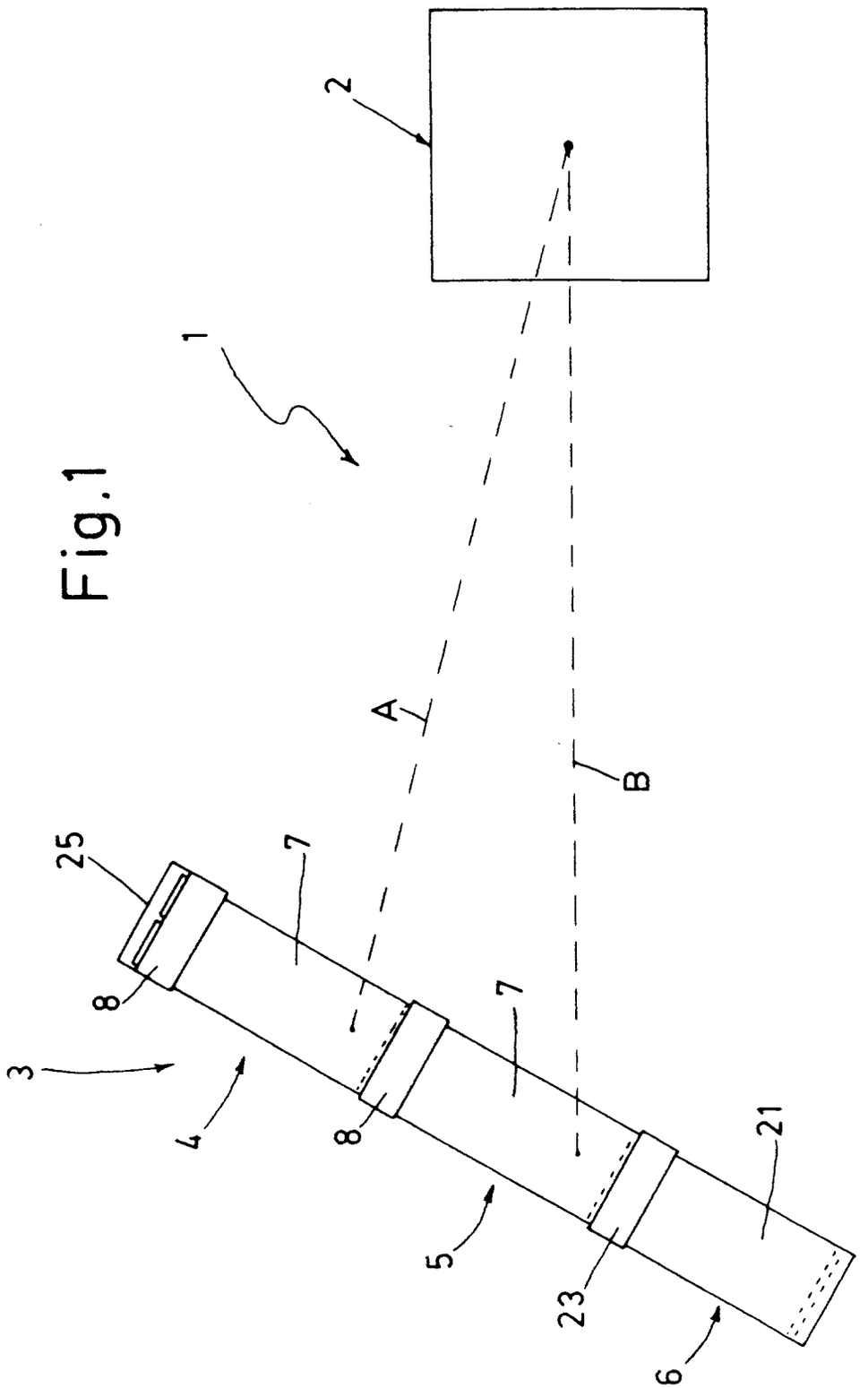
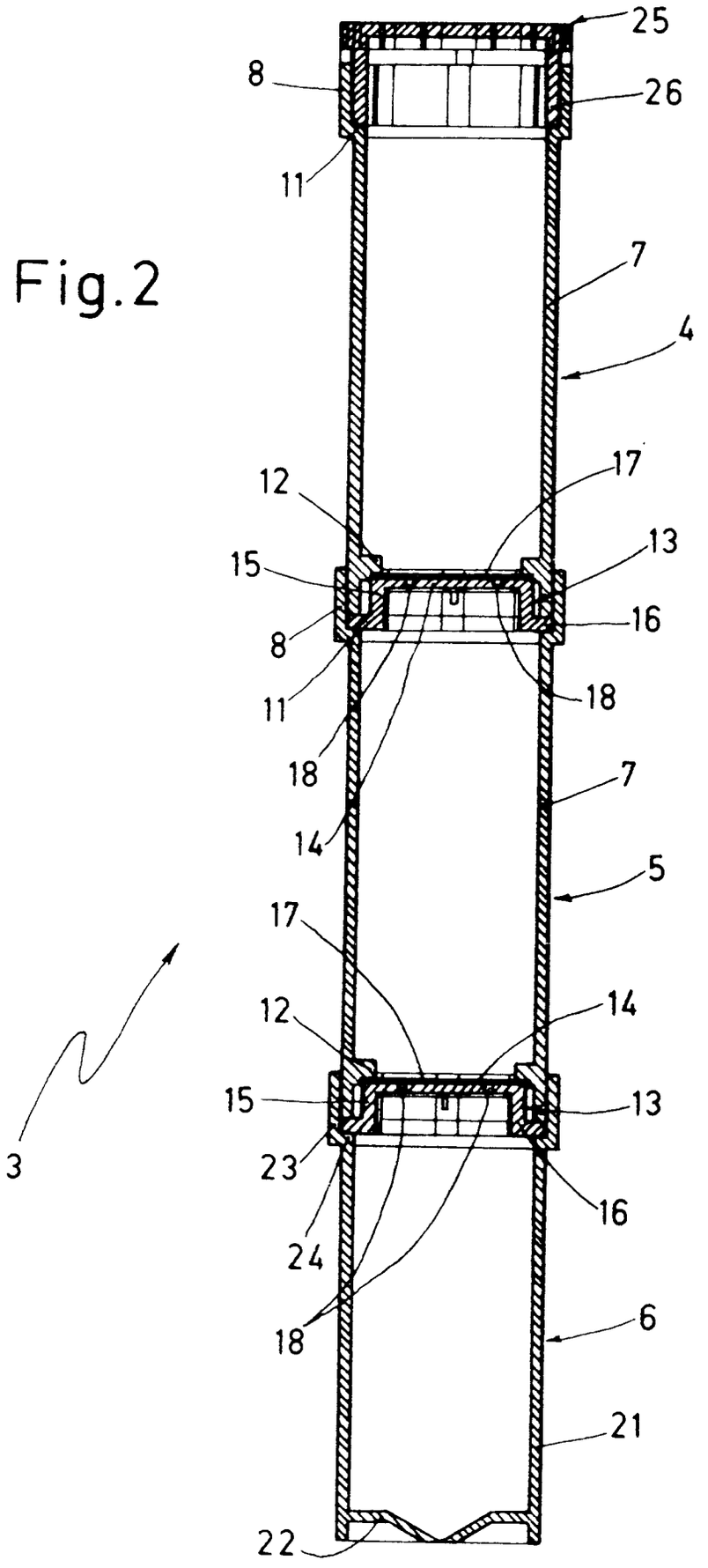


Fig.2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EUROPEAN SEARCH REPORT

Application Number
EP 94 11 7112

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US-A-3 300 051 (D.F.MITCHELL) * column 1, line 22-25 - line 66-71; claims 1,3; figure 1 *	1-8	B01L3/14 B04B7/00
A	WO-A-91 07648 (FMC CORPORATION) * claims 1-3; figure 1 *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 7, no. 122 (C-168) 26 May 1983 & JP-A-58 040 154 (MICHIZOU YAMANO) 9 March 1983 * abstract *	1	
A	US-A-4 636 361 (M.MARIAN ET AL) * claims; figure 4 *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

B01L
B04B
G01N
B01D
A61B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	4 April 1995	Cordero Alvarez, M

CATEGORY OF CITED DOCUMENTS

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