Nov. 5, 1974 P. OHRINGER 3,846,077

LIQUID SAMPLE COLLECTION TUBE

Filed Sept. 18, 1972 2 Sheets-Sheet 1

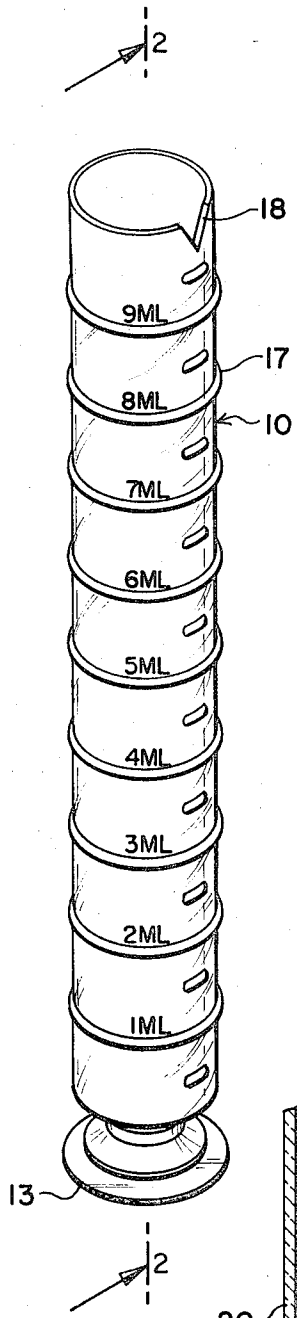

Fig. 1.

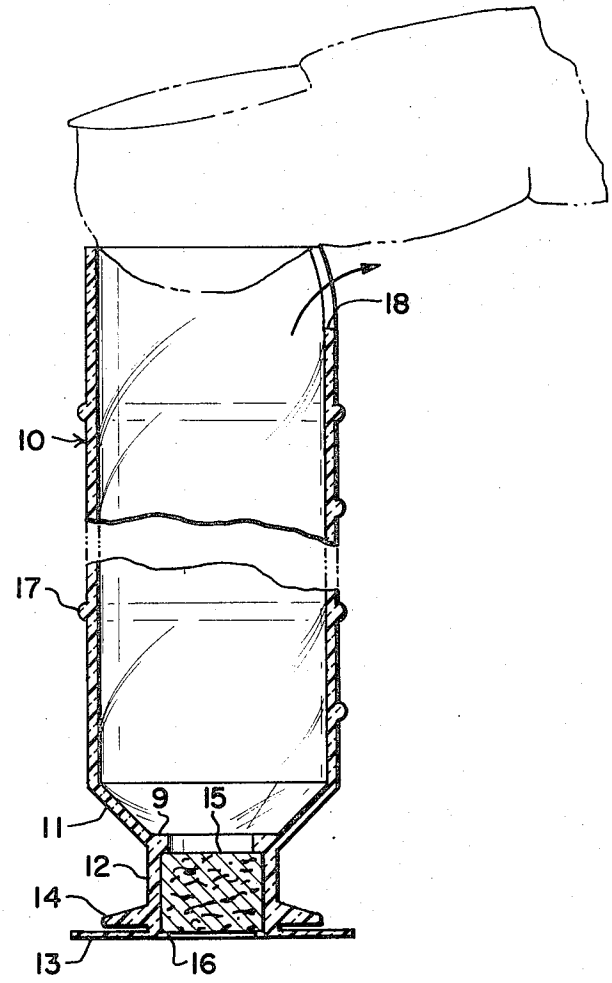

Fig. 2.

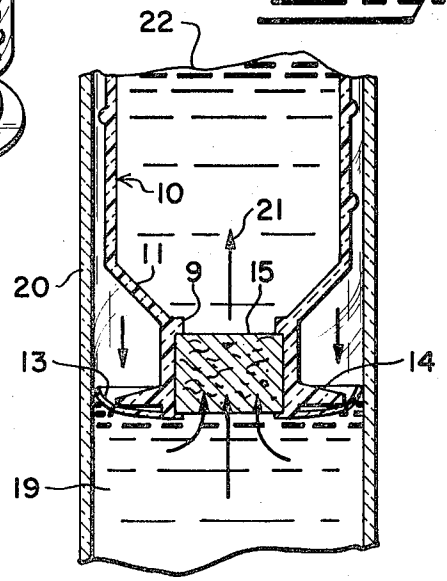

Fig. 3.

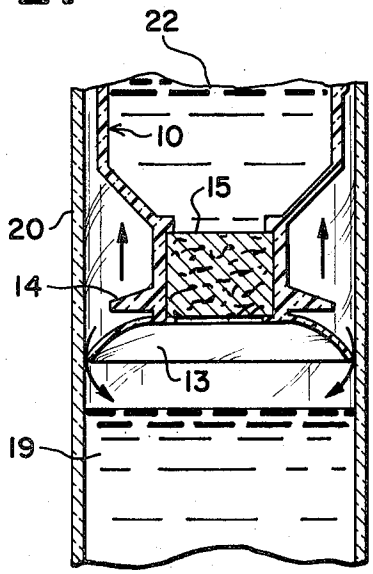

Fig. 4.

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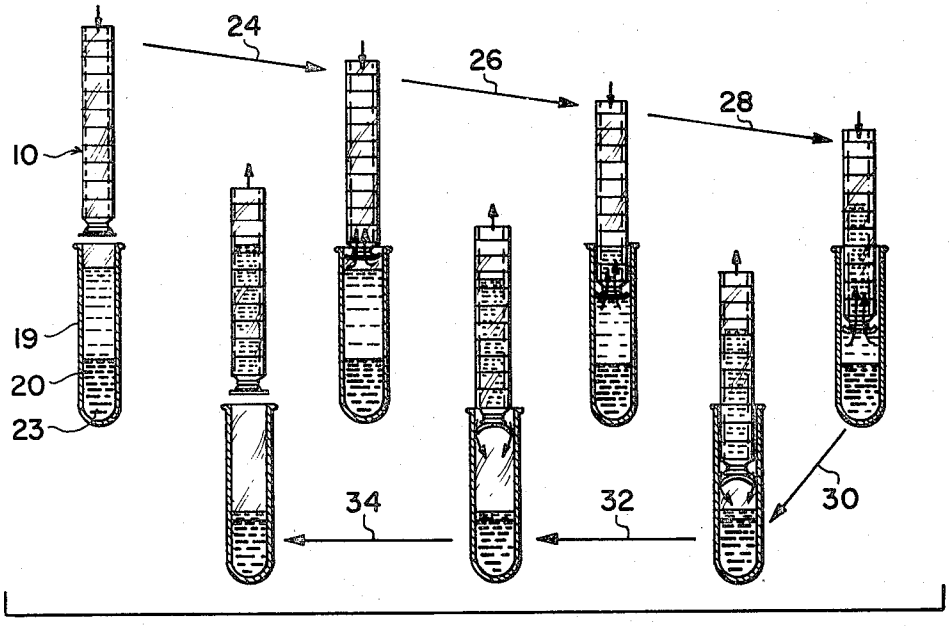

Fig. 5.

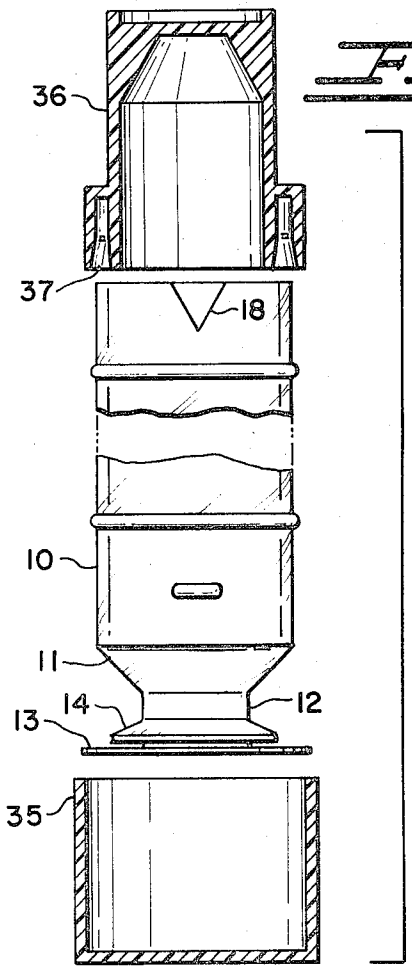

Fig. 6.

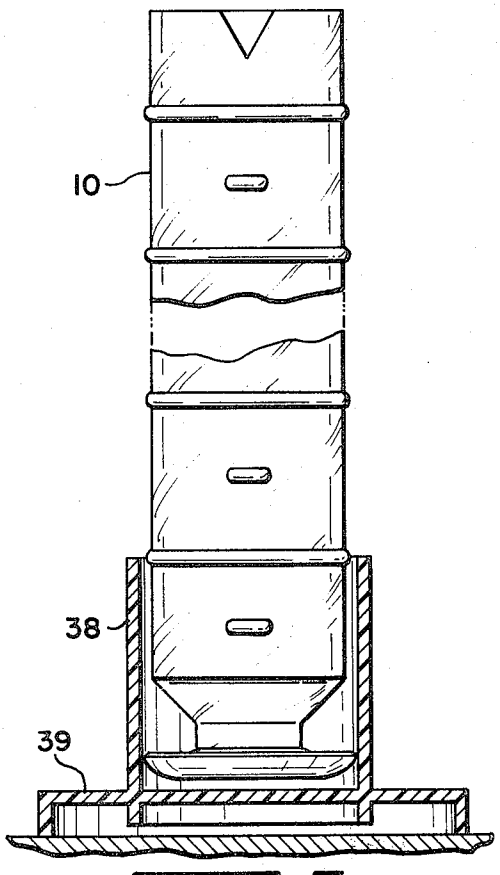

Fig. 7.

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LIQUID SAMPLE COLLECTION TUBE

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U.S. Cl. 23—259 12 Claims

ABSTRACT OF THE DISCLOSURE

A collection container for isolating a liquid sample from a specimen container consisting of an elongated cylindrical tube with an outside diameter slightly smaller than the specimen container, and having a hollow neck formed at one end of the tube. A circular disc is formed radially on the neck for slidably engaging the internal cylindrical walls of the specimen container and a shoulder is formed on the neck adjacent to the circular disc for engaging and supporting at least a portion of the circular disc. The container also includes a filter disposed in said neck aperture to limit the fluid flow from the tube.

This invention relates to an apparatus for isolating the formed elements of blood from the serum or plasma after these elements have been separated.

More specifically, this invention relates to an apparatus for filtering the serum or plasma from a separated blood sample.

When blood specimens are tested in clinical laboratories, it is frequently necessary to obtain a cell-free sample of blood serum or plasma after the serum has been separated from the suspended cellular material. The cellular material or blood cells are separated preferably by centrifugal force driving the cells to the bottom of the tube containing the blood specimen. The serum or plasma which remains in the top portion of the tube is then removed and clinically tested.

It is important to remove the serum or plasma within a short time after the blood cells are separated since these cells will begin to liberate potassium and other contaminants which may interfere with the tests to be performed. In a clinical laboratory where many hundreds of blood tests are made each day, it is also desirable to provide a quick and accurate device which can remove or isolate the serum or plasma after it has been separated from the blood cells before the blood cells liberate other contaminants.

Blood samples are generally taken in a specimen tube such as a "Vacutainer" manufactured by Becton-Dickinson Company. After these samples are delivered to the testing laboratory, they are mechanically centrifuged to separate the blood cells from the clear liquid in the sample. The serum can then be drawn off with a conventional syringe, decanted by pouring the serum off, drawn off by pipettes, or collected by using a plunger-like apparatus which is inserted into the specimen tube. Over the past few years, a great many advancements have taken place in the development of plunger-like tubes for removing the serum or plasma from the blood sample. In one such device, a capillary tube is disposed within the plunger so that the clear sample will be pushed through the capillary tube and dispensed either in a separate collection tube, or within a collection tube connected to the plunger. In another plunger-type device, needles are inserted through the plunger and a membrane connected to the opposite end of the collection tube, so that after the collection tube is inserted into the sample tube, one of the needles can be removed to entrap the clear sample within the collection tube. In a further plunger-like device of the prior patented art, the plunger includes small valves consisting of overlapping elastic material to serve as one-way valves to permit the clear sample to enter the collection tube when the collection tube and plunger are inserted into the specimen tube. This plunger-like device further includes a second one-way valve capping the opposite end of the collection tube so that when the tube is withdrawn from the specimen tube, the entrapped air in the collection tube together with the action of the one-way valves will prevent the clear sample from returning to the specimen tube. All of the plunger-like collection devices of the prior patented art suffer from the disadvantages that they are expensive to manufacture and assemble, they are difficult to withdraw from the specimen tube due to the suction, and require additional functional parts to accomplish the separation of the clear liquid from the blood sample.

Accordingly, the present invention provides an improved plunger-like liquid separation device and filter combined whereby the plunger mounted on the end of the collection tube seals only during the insertion of the collection tube into the sample tube. When the collection tube is withdrawn from the sample tube, it no longer seals so that substantially no suction is created and the clear sample remains in the collection tube without the aid of additional one-way valves to prevent the sample from being removed. In a preferred embodiment, the collection tube and plunger are an integrally formed part which include a shoulder flange mounted adjacent to the plunger so as to support the body of the plunger while it is inserted into the specimen tube. The plunger, being constructed of a very thin plastic material has no support on its front surface so that it effectively collapses when it is withdrawn from the specimen tube. A filter is also concentrically disposed within the body of the plunger at the neck of the tube so that the liquid is filtered while it passes into the collection tube and is restricted from returning to the specimen tube as the collection tube is withdrawn.

It is therefore an object according to the present invention to provide a blood serum collection tube which utilizes a one-way plunger in combination with the collection tube for isolating the serum from a blood sample.

It is another object according to the present invention to provide a serum collection tube which is simple in design, inexpensive in cost and efficient in operation.

Other objects and features of the present invention will become apparent from the following detailed description considered in connection with the accompanying drawings which disclose the embodiments of the invention. It is to be understood, however, that the drawings are designed for the purpose of illustration only and not as a definition of the limits of the invention.

In the drawings, wherein similar reference characters denote similar elements throughout the several views:

FIG. 1 is a perspective view of the collection tube according to the invention;

FIG. 2 is a cross-sectional view taken along section 2—2 of FIG. 1;

FIG. 3 is a detailed cross-sectional view of the invention of FIGS. 1 and 2 shown inserted into a specimen tube;

FIG. 4 is a further detail of the embodiment of FIG. 3 being withdrawn from a specimen tube;

FIG. 5 illustrates the sequence of operations of removing the liquid from the blood sample contained in the specimen tube;

FIG. 6 discloses the use of end caps for closing the ends of the collection tube; and

FIG. 7 shows a further end cap which serves also as a stand for supporting the collection tube.

Referring to FIGS. 1 and 2, there is shown the collection tube having a plurality of graduations 17 formed along the walls of the tube preferably in units of measure-

ment such as milliliters. At the top of collection tube **10** is formed an air escape opening **18**.

At the bottom end of collection tube **10** is formed a funnel-like taper **11** terminating in a hollow plunger. The plunger has a cylindrical neck or base **12** coupled to the end of funnel **11** and includes a cylindrically projecting shoulder **14** mounted adjacent to and partially covering a cylindrical disc or wafer **13**. In the hollow center of the plunger is disposed a filter **15** formed of a sponge-like porous material, such as foam plastic. An inwardly projecting radial flange **16** formed at the end of cylindrical base **12** partially covers filter **15** so that in a preferred embodiment, the filter will not accidentally become dislodged. At the top portion of plunger base **12** is a further inwardly directed annular flange **9** which prevents the filter from accidentally entering the collection tube.

Referring to FIG. 3, the collection tube is shown inserted into a specimen tube, such as a "Vacutainer" manufactured by Becton-Dickinson Company. The specimen container **20** includes a separated blood sample. The serum or plasma **19** is forced, as shown by the upwardly directed arrows **21**, through filter **15** to become the clear fluid **22** collected in tube **10**. The downward pressure of the collection tube also forces separated blood sample **19** to overcome the fluid resistance of filter **15** and thereby enter into collection tube **10**. The downward motion of collection tube **10** maintains plunger disc **13** in sealing contact with the internal walls of specimen container **20** since shoulders **14** immediately behind disc **13** maintain a pressure against the disc so that it serves as a sliding seal and plunger to prevent any of sample **19** from passing around the disc into the other side of the plunger. Collection tube **10** is easily inserted into specimen tubes by placing an index finger at the top of the collection tube and forcing it downward so that as the filtered specimen enters the collection tube, the air displaced by the entering fluid can easily leave the tube through opening **18** as shown in detail in FIG. 2.

Referring to FIG. 4, when a sufficient quantity of filtered specimen **22** has been collected in collection tube **10**, the tube can be lifted upward in the direction of the vertical arrows so that circular plunger disc **13** deflects in the opposite direction away from support shoulder **14**, thereby breaking the seal originally formed with the inner walls of serum tube **20** to permit air to enter around the disc and begin filling in the expanding space on top of the blood specimen. Because of the fact that the plunger contains very little or no strength to resist the withdrawal of the collection tube from the specimen tube, there is little or no suction created even when the collection tube is rapidly withdrawn so that the collected serum or plasma **22** is maintained within the collection tube by the fluid resistance of filter **15**.

The complete cycle of isolating the plasma or serum from a blood sample is shown pictorially in FIG. 5. In the first diagram on the left, collection tube **10** is moved downwardly to engage specimen tube **20** which contains the blood sample having separated cells **23** from clear plasma **19**. Moving in the direction of arrow **24**, as the collection tube with its plunger moves downwardly forming a seal with the inner walls of specimen tube **20**, air is initially forced through the filter before the plunger engages liquid **19**. In the next step after arrow **26**, fluid enters the collection tube by overcoming the fluid resistance of the filter and begins to fill the lower inside cavity of the tube. In the next step after arrow **28**, whereby a sufficient quantity of liquid **19** has been collected within the tube, the tube can then be withdrawn from the specimen container as shown after arrow **30** so that the plunger inverts within the specimen tube and breaks its sealing contact to permit air to replace the collected specimen as the collection tube is withdrawn. As shown in the final diagram following path **34**, the entire collected specimen remains within the collection tube after the collection tube is separated from the specimen tube.

Referring to FIG. 6, there is shown collection tube **10** with a cylindrical plunger cap **35** consisting of a cup-like container which is adapted to seal the end of the collection tube while further tests are to be performed on the collected specimen. Likewise, the open end of collection tube **10** can also be closed by means of cap **36** which includes an annular groove **37** adapted to fit over the cylindrical rim of the tube and completely enclose opening **18**. This will prevent air from affecting the chemistry of the contents of the collection tube if the tube and its specimen have to be stored for any length of time.

Referring to FIG. 7, there is shown another embodiment of a plunger cap consisting of a cylindrical receiving tube **38** which is closed at its bottom end and expanded by a further flange **39** which forms a stand for maintaining the collection tube in a vertical stable position. The stand and cylindrical receiving tube are preferably formed of a single integral piece of resilient material, such as plastic or nylon.

Collection tube **10** is preferably constructed from a single piece of plastic material, wherein the graduations, and the entire plunger assembly are molded in a single piece construction before the filter is inserted into the plunger. Because the collection tube of the present invention is made from a single piece of molded plastic material so that the only additional step of manufacture includes the insertion of the filter, it is very inexpensive to manufacture and therefore disposable after use because of its low cost. The plastic material may be any soft or resilient plastic, such as PVC, polyethylene or polypropylene. The diameter of the collection tube and its graduations would be preferably slightly smaller than the internal diameter of the specimen tube and plunger disc or wafer **13** would be slightly larger in diameter than the internal diameter of the specimen tube so as to form a seal when it contacts the inside walls of the specimen tube. In a preferred embodiment of the invention, the collection tube has an outside diameter of approximately .5 inch and the diameter of the plunger disc is approximately .57 inch. The edge of plunger disc **13** is approximately .01 inch in thickness and is separated from its supporting surface **14** by approximately .01 inch. The collection tube is preferably approximately 4 inches in length to accommodate up to about 10 ml. in quantity.

The filter is preferably constructed from a resilient cellular material, such as foam plastic, so that it can be slightly compressed when it is inserted into the neck or base of the tube. It can also be cemented into the tube opening if mechanical retaining means are not used.

While only a few embodiments of the present invention have been shown and described, it will be obvious that many changes and modifications may be made thereunto without departing from the spirit and scope of the invention.

What is claimed is:

1. A collection container for isolating a liquid sample from a specimen container comprising:

an elongated cylindrical tube having an outside diameter smaller than the specimen container, and including an aperture at one end communicative with said tube;

circular disc means formed radially at said aperture end of said tube for slidably engaging the internal cylindrical walls of the specimen container;

abutment means formed on said tube adjacent to said circular disc means for engaging and supporting at least a portion of said circular disc means; and

fluid resistance means disposed in said aperture to limit the fluid flow from said tube so that when said tube is inserted into the specimen container, said circular disc means will contact and be supported by said abutment means to form a seal against the internal specimen container walls and when said tube

is removed from the specimen container, said circular disc means will separate from said abutment means to release the seal from the container walls.

2. The collection container as recited in claim 1 additionally comprising a neck formed at the aperture end of said elongated cylindrical tube, said neck having a smaller diameter than said tube and surrounding said aperture.

3. The collection container as recited in claim 2 further comprising a tapered funnel joining said neck to said cylindrical tube.

4. The collection container as recited in claim 2, wherein said fluid resistance means comprises a filter partially sealing the aperture of said neck.

5. The collection container as recited in claim 1, wherein said cylindrical tube includes spaced-apart graduations formed in said tube.

6. The collection container as recited in claim 1, wherein said elongated tube includes at least one air escape opening formed at the opposite end of said tube.

7. The collection container as recited in claim 4, wherein said neck additionally comprises filter retaining means formed in the neck aperture for demountably retaining said filter.

8. The collection container as recited in claim 1 further comprising a plunger cap for enclosing and sealing said circular disc means.

9. The collection container as recited in claim 2, wherein said circular disc means comprises a flexible wafer disposed on the end of said neck and said flange means comprises a circular shoulder disposed adjacent to said wafer between said wafer and said tube.

10. The collection container as recited in claim 6 additionally comprising an end cap for closing the opposite end of said cylindrical tube, said cap including an annular channel for enclosing the cylindrical rim of said tube and the air escape opening.

11. The collection container as recited in claim 1 additionally comprising a second plunger cap having a cylindrical receiving tube closed at its bottom end, and an enlarged flange formed at the bottom end of said receiving tube for supporting said tube in a vertical position.

12. The collection container as recited in claim 1 wherein said abutment means comprises a cylindrical projecting shoulder.

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RONALD E. SERWIN, Primary Examiner

U.S. Cl. X.R.

73—425.6; 210—359