# United States Patent

**Moore**

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[54] **TEST TUBE SYSTEM FOR SEPARATING BLOOD INTO SERUM AND RED CELLS**


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[52] **U.S. Cl.** .....**210/477,** 210/482, 128/2 F, 128/272

[51] **Int. Cl.** .....**B01d 29/04**

[58] **Field of Search**.....210/455, 474, 477, 482, 446, 210/94; 128/272, 26, 2 F



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 3,608,736 | 4/1971 | Wong | 210/477 |
| 2,775,350 | 12/1956 | Jones | 210/446 |
| 3,478,889 | 11/1969 | Fessler | 210/477 X |



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[57] **ABSTRACT**

A test tube system for separating blood into serum and red cells. The system includes a first test tube, a second test tube and a connector joining the first test tube and the second test tube. The first test tube is for initially containing the blood sample and includes a sleevelike body portion that is closed at the upper end with s stopper and is closed at the lower end by a cap removably threaded on the end thereof. The first test tube has a plurality of non-wettable strands extending across the interior thereof for providing a place for the blood to clot. The connector is adapted to be threaded onto the lower end of the first test tube and the upper end of the second test tube. The connector includes a filter for the serum to flow therethrough into the second test tube.


**4 Claims, 8 Drawing Figures**

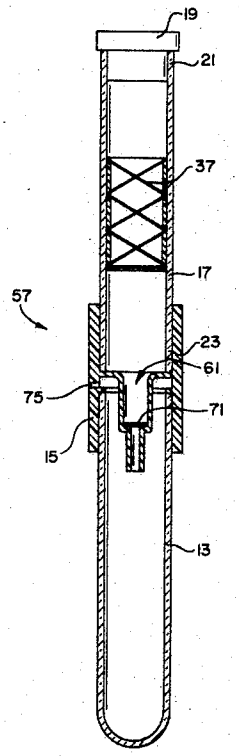

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FIG. 1

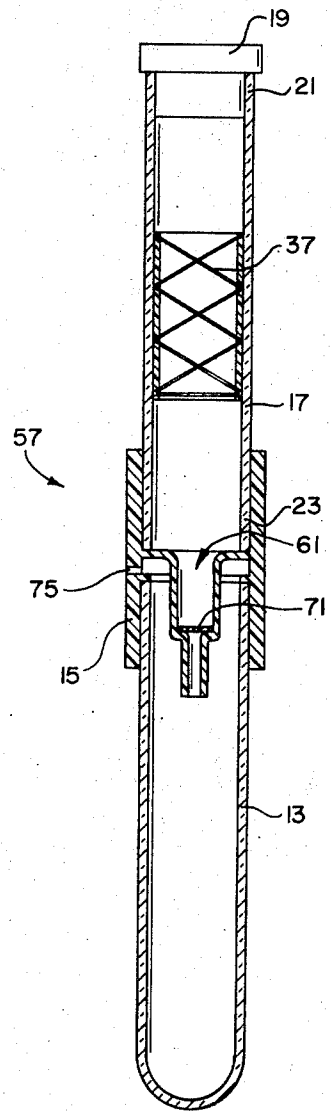



FIG. 2

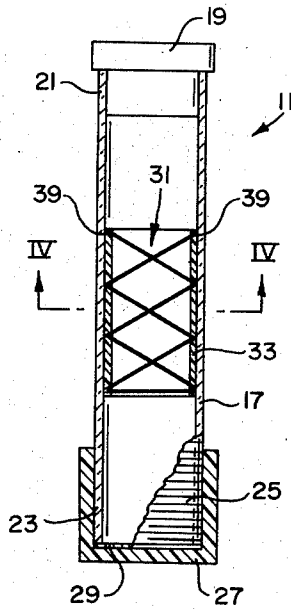



FIG. 3

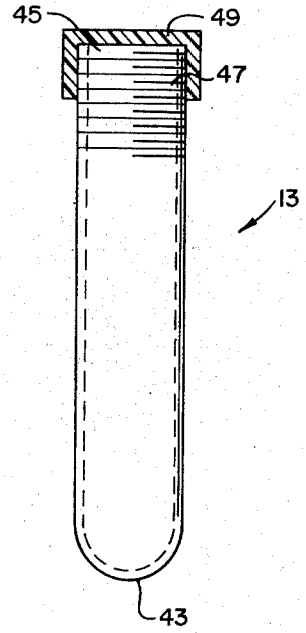



FIG. 4

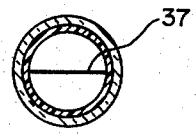



FIG. 5

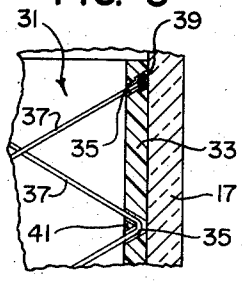



FIG. 6

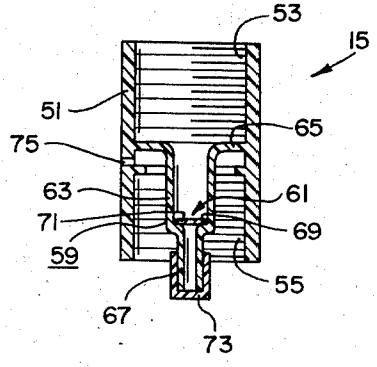



FIG. 7

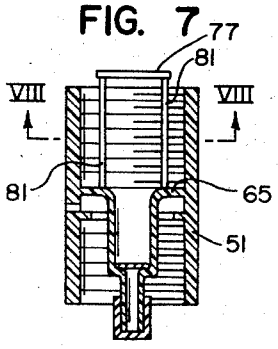
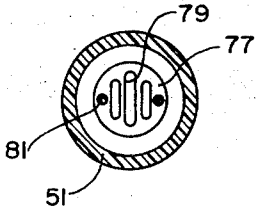



FIG. 8

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# TEST TUBE SYSTEM FOR SEPARATING BLOOD INTO SERUM AND RED CELLS

## BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to apparatus and a system for the separation of blood into serum and red cells.

2. Description of the Prior Art

In order to conduct certain tests of the blood, it is necessary to separate the clear serum from the red cells. Heretofore, to accomplish this objective, it has been the usual practice to draw the blood sample in a test tube which had a vacuum in it, and then allow the blood to clot in the test tube. Usually at this point the clotted blood adheres to the side of the tube, in which case generally the clot is loosened from the sides as with a wooden applicator stick. Then the sample is centrifuged, and the clear serum is removed, as by a pipette, or decanted off. There are many degrees of hemolysis that can affect some of the current test procedures. This hemolysis can be so slight that it is barely detectable by sight but it will greatly affect some of the studies, such as the enzyme studies of the blood. Thus, this loosening of the blood from the side of the tube will frequently cause the sample to be hemolized so that unwanted red blood cells are in with the serum. Additionally, in the removal of the serum by pipette or by decanting, many times some of the red cells will be aspirated into the serum. Also, if the serum is shipped, or occasionally, even if just stored, the red cells will liberate hemoglobin, thereby affecting several of the lab tests. In many samples of serum, fibrin strands remain and when aspirated into the various automated testing devices may result in stoppage of sample lines. In addition to this, in many tests the fibrin strands actually interfere with colormetric analysis. Also, in many instances they will interfere with antigen antibody reactions.

In general, there are two places where blood samples are taken, namely, in the physician's office or in the hospital, and the following problems are encountered:

1. Many physicians who draw samples in their offices don't have the facilities for centrifugation and don't understand the problems created when someone takes an applicator and rims down around the inside of the tube to release the blood clot and hemolize the sample. Also, some physicians simply draw the samples and don't separate it into the red cells and serum but just send it to the laboratory. Then, when it gets to the laboratory, sometimes the personnel think that they can get by and they rim the clot from the inside of the test tube, which causes the sample to be hemolized.
2. At the hospital, there are a series of tests which are performed routinely when a patient checks into the hospital. Thus, the patient generally waits a couple of hours in the admitting office. Two samples of blood are drawn, as well as a urine sample obtained. Then, the patient goes to the room. If this is diagnostic work, the decision of the doctor as to what course to take the next day depends primarily on the results of the tests of the blood sample in the test tubes. If these samples get hemolized, then the patient is delayed one day since generally the automated chemistry analyzer machine, which is quite expensive, is run only one time a day. Therefore, if the particular sample is hemolized, it will either be run at that time with the possibility of inaccurate tests, or more samples being drawn from the patient with the delay until the next day to run the samples on the machine.



In summary, the present procedures have many disadvantages, among them being the following: (1) the possibility of hemolid blood samples and the consequent inaccuracy of some of the tests; (2) the necessity for expensive equipment; (3) the length of time involved between the taking of the sample and having the results of the tests.

A search of the prior art revealed the following U.S. Pats., which neither show nor suggest the concept and structure of the present invention: Nos. 1,718,590; 1,718,593; 1,928,998; 2,176,041; 2,176,042; 2,726,656; 3,078,847; 3,448,041; and 3,462,361.

## SUMMARY OF THE INVENTION

One of the primary objects of the present invention is to provide a mechanism for obtaining serum with as little effort as possible, which is free of red cells and fibrin strands, and which is non-hemolized. In addition, the present invention is directed towards overcoming the heretofore-mentioned and other disadvantages and problems relative to previous systems and methods for separating blood into serum and red cells.

A further object is to increase the overall efficiency in the processing of blood samples.

A further object is to provide assurance that the first sample processed is the best and most economical.

The concept of the present invention to accomplish the foregoing and other objects of the present invention is to provide a test tube system for separating blood into serum and red cells which comprises first and second test tubes and connector means for removably joining the first and second test tubes. The first test tube has a sleevelike test tube body portion and means in the interior thereof for providing a place for the blood to clot away from the sides of the body portion. In its initial form used for the collection of blood, the first test tube has a vacuum in the interior thereof and the upper and lower ends are respectively closed by a stopper and a cap. The second test tube is open at the top and closed at the bottom thereof. The connector is adapted to be joined to the lower end of the first test tube (after the cap has been removed therefrom) and with the upper end of the second test tube. The connector is provided with a filter therein between the first and second test tubes and an air hole on the second test tube side of the filter. Optionally, the connector is provided with a guard above the filter. It is a further concept of the present invention that with the above test tube system that the centrifuging may be omitted and the entire separation may take place in the above-described test tube system by the following procedure: (1) The blood is collected in the first test tube in its initial form; (2) the first test tube is inverted, and the blood allowed to clot and retract; (3) the screw cap on the first test tube is removed and the connector screwed thereon; (4) the second test tube is connected to the other end of the filter connector; (5) the above-described assembly is inverted and placed vertically in a rack and the stopper of the first test tube is removed; (6) the serum is allowed to pass through the filter and

connector into the second test tube; (7) the second test tube is removed and a cap is placed on the connector; and (8) a screw cap is placed on the top of the second tube.

After the above procedure is completed, it will be understood that the serum will be in the second test tube and the red blood cells will be in the first test tube.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of the assembled first and second test tubes and the connector with the view being taken as on a vertical plane through the center line of the assembly.

FIG. 2 is a partially sectionalized view of the first test tube shown in its initial condition in which the initial blood sample is collected and with the section being taken as on a vertical plane through the centerline of the first test tube.

FIG. 3 is a side elevational view of the second test tube with the cap thereof shown in section.

FIG. 4 is a sectional view taken as on the line IV—IV of FIG. 2.

FIG. 5 is an enlarged view of a portion of that shown in FIG. 2.

FIG. 6 is a sectional view of the connector with the section being taken on a vertical plane through the centerline of the connector.

FIG. 7 is a view similar to FIG. 6 of a modified form of the connector.

FIG. 8 is a sectional view taken as on the line VIII—VIII of FIG. 7.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

In its initial form, the test tube system of the present invention comprises in general a first test tube **11**, a second test tube **13**, and a connector **15**.

First test tube **11**, in its initial form shown in FIG. **2**, comprises a sleevelike test tube body portion **17** which is preferably formed of any suitable clear material as plastic or glass. A closure preferably in the form of a rubber stopper **19** is provided to close off the open upper end **21** of body portion **17**. Body portion **17** on the lower end **23** thereof is externally threaded as at **25** to receive an internally threaded cuplike cap **27** which closes off the open lower end **23**. A gasket **29** is preferably provided in cap **27** to insure a seal tight connection. A vacuum is preferably provided in the interior of first test tube **11** so that the test tube may be filled in a manner well known to those skilled in the art, as for example, by a device which is known by the trademark "Vacutainer", that is threadedly received by an annular cuplike holder. It has a needle pointed at opposite ends with one end being inserted into the vein of the person whose blood sample is being drawn and the other end being inserted through the rubber stopper so that the vacuum withdraws the blood into the test tube. However, it will be understood that first test tube **11** may be filled with the blood sample by other means without departing from the spirit and scope of the present invention. In the interior of first test tube **11** there is means for providing a place for the blood to clot away from the sides of the body portion **17**, and this means preferably comprises the following structure: A filament **31** formed of a non-wettable plastic as nylon extends across the interior of body portion **17**. Filament **31** is preferably held in place by means of a non-wettable plastic sleeve **33** that is shorter than the length of body portion **17** and is closely and tightly fitted in the interior of the body portion **17** intermediate the ends thereof. Filament **31** is threaded through the apertures **35** in the opposite side of sleeve **33** in a criss-cross manner, as best seen in FIGS. **1** and **2**, to establish diagonal strand portions **37** extending across sleeve **33** from one side to the other and through the apertures **35** to the outer sides of the sleeve **33**. A single continuous filament **31** may be utilized or a plurality of portions of filament to establish the above-described pattern. Thus, if a single filament **31** is utilized, one end is anchored by a knot **39** with the intermediate portion of the filament extending through the apertures **35** to anchor the portions of the filament as at **41**, as best seen in FIG. **5**, and with the opposite end of the filament **31** being anchored by another knot **39**. Alternately, filament **31** may be separated into a plurality of pieces with the opposite ends of each individual strand **37** being anchored as by knots **39**. The apertures **35** along each side of the sleeve **33** are preferably in vertical alignment and are diametrically opposed to the apertures **35** on the opposite side of the sleeve so that the strands **37** are in vertical alignment, as best seen in FIG. **4**.

Second test tube **13** is closed at the lower end **43** thereof and is open at the upper end **45** thereof. Second test tube **13** is provided with an externally threaded portion **47** at upper end **45** for receiving an internally threaded cap **49** for the closure of the open upper end **45**.

Connector **15** comprises a cylindrical body portion **51** having an upwardly extending threaded socket **53** adapted to be threaded onto threaded portion **25** of body portion **17**. In addition, body portion **51** has a downwardly extending threaded socket **55** adapted to be threaded onto threaded portion **47** of second test tube **13**. When connector **15** is threaded onto the threaded portions **45**, **47** as above-described, the connector **15** joins first test tube body portion **17** with second test tube **13** to provide an assembly **57**, as shown in FIG. **1**. Connector **15** is provided with a depending nozzle-like structure **59** that defines a passageway **61** connecting the interior of first test tube body portion **17** with the interior of second test tube **13**. Nozzlelike structure **59** has an enlarged portion **63** which is integrally formed with an annular portion **65** that in turn is integrally formed with body portion **51** around the exterior of the annular portion. In addition, nozzlelike structure **59** includes a narrowed lower end portion **67** integrally formed with enlarged portion **63** at the lower end thereof. At the juncture of narrowed portion **67** and enlarged portion **63** is a shoulder **69** upon which a filter **71** rests. Filter **71** is constructed of any suitable material, as for example, a nylon mesh. A cap **73** is adapted to be removably fitted on the lower end of narrowed portion **67**, as best seen in FIG. **6**. Connector **15** is provided with an air hole **75** extending from the outside atmosphere to the interior of the connector means below annular portion **65** so that the interior of second tube **13** is vented to the outside atmosphere. In other words, air hole **75** extends from the outside atmosphere to the interior of the connector **15**

at a point which is on the downstream side of filter 71, that is, the second test tube side of the filter means.

In using the test tube system of the present invention, the blood sample is collected in first test tube 11 by the means heretofore-described. After the blood is collected, first test tube 11 will be in the form shown in FIG. 2, that is, with stopper 19 and cap 27 in place. The first test tube 11 is then inverted from the disposition shown in FIG. 2 and the blood allowed to clot and retract. The blood will tend to clot away from the sides of the sleevelike body portion 17 and will clot on the strands 37. After the blood has been allowed to clot, cap 27 is removed and socket 53 of connector 15 is threaded onto end 23. Then, with cap 73 removed, second tube 13, with cap 49 removed, is threaded into threaded socket 55 to form the assembly 57. Next, assembly 57 is inverted into the position shown in FIG. 1 and placed in a rack, not shown. Rubber stopper 19 is removed, which allows the serum to pass from first tube 11 through filter 71 into second tube 13. In this filtering process, any existing red cells, as well as fibrin strands will be separated from the serum. Second tube 13 is then removed from connector 15, cap 49 is placed on second tube 13, and cap 73 is placed on lower end 67 of the connector 15.

It should be pointed out that, if desired, as for example, in some instances with the use of the test tube system of the present invention in hospitals where there is more care taken, filament 31 and plastic sleeve 33 may be omitted. Also, in some instances it may be desirable to centrifuge the blood sample in test tube 11.

In addition, it should be pointed out that, if desired, a guard 77 may be placed above filter 71 to prevent the blood clot from falling down on top of the filter. Guard 77 is preferably disklike and has a plurality of slots 79 provided therethrough. Additionally, guard 77 is preferably supported from annular portion 65 by means of the spaced apart legs 81 which are preferably integrally formed with annular portion 65 and guard 77, as best seen in FIG. 7.

Although the present invention has been described and illustrated with reference to a preferred embodiment, it is to be understood that it is not to be so limited since changes and modifications may be made therein which are within the full intended scope of this invention.

I claim:

1. A test tube system for separating blood into serum and red cells comprising a first sleevelike test tube body portion having an upper end and a lower end, stopper means removably received in the upper end of said first test tube body portion, a second test tube having one end open and the opposite end closed, connector means removably joining the lower end of said test tube body portion opposite from said stopper means and the open end of said second test tube to establish an assembly, said connector means including structure defining a passageway connecting the interior of said first test tube body portion with the interior of said second test tube, filter means disposed across said passageway between said first test tube body portion and said second test tube, said connector means being provided with an air hole extending from the outside atmosphere to the interior of said connector means on the second test tube side of said filter means to vent said second test tube to the outside atmosphere, said first test tube body portion being adapted to receive blood for the separation thereof into serum and red cells and said assembly being positionable in a substantially vertical disposition with said first test tube body portion being above said second test tube so that the serum is adapted to flow down by gravity through said filter means into said second test tube leaving the red cells in said first test tube body portion; including means extending across the interior of said first test tube body portion for providing a place for the blood to clot away from the sides of said first test tube body portion.

2. The test tube system of claim 1 in which said means for providing a place for the blood to clot includes filament means extending across the interior of said first test tube body portion.

3. The test tube system of claim 2 in which is included a sleeve closely fitted in the interior of said first test tube body portion and being provided with a plurality of apertures therethrough, and in which said filament means includes a plurality of strand portions of a non-wettable material respectively extending across said sleeve from one side to the other and through pairs of said apertures to the outer sides of said sleeve, and means securing the ends of said strand portions to said sleeve.

4. A first test tube for containing a blood sample to be separated into serum and red cells, said first test tube comprising a sleevelike body portion having an upper end and a lower end, stopper means removably received in the upper end of said body portion for the closure thereof, cap means removably received on the lower end of said test tube body portion for the closure thereof, filament means extending across the interior of said first test tube body portion for providing a place for the blood to clot away from the sides of said first test tube body portion; including a sleeve closely fitted in the interior of said first test tube body portion and being provided with a plurality of apertures therethrough, and in which said filament means includes a plurality of strand portions of a non-wettable material respectively extending across said sleeve from one side to the other and through pairs of said apertures to the outer sides of said sleeve, and means securing the ends of said strand portions to said sleeve.

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