July 30, 1968 R. L. CARTER 3,394,880

HORIZONTAL CENTRIFUGATION

Filed July 28, 1966

Fig. 1.

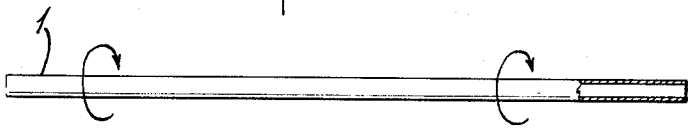



Fig. 2.

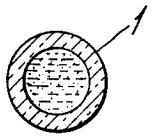



Fig. 3.

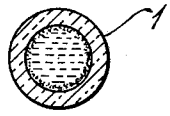
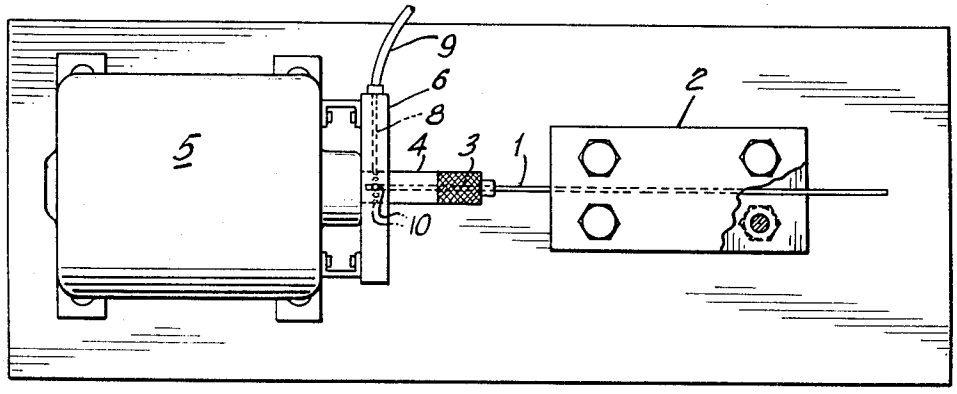



Fig. 4.



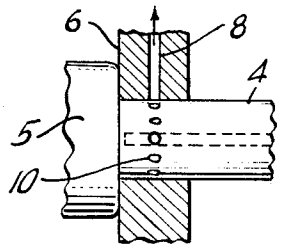




Fig. 5.

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3,394,880

Patented July 30, 1968



3,394,880

# HORIZONTAL CENTRIFUGATION

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Filed July 28, 1966, Ser. No. 568,445
4 Claims. (Cl. 233—27)

## ABSTRACT OF THE DISCLOSURE

Solid particles in a liquid suspension of particles may be separated from the liquid by introducing the suspension into a capillary tube, and rotating the capillary tube while in a horizontal position about its longitudinal axis at between 5,000 r.p.m. to about 9,000 r.p.m. and removing the liquid from the capillary tube.

The present invention relates to apparatus for conducting centrifugation in a horizontal capillary tube. More particularly, the invention relates to apparatus and a method for separating red blood cells from their suspending medium and thus providing a means for washing red blood cells.

In conducting tests for the presence of antibodies on red blood cells, it is generally necessary to wash the red blood cells to free them from serum. For example, in conducting the Coombs anti-globulin test, sensitized red cells are washed free from serum and are then agglutinated on exposure to the serum of an animal previously immunized with human globulin or human whole serum.

The Coombs test and other agglutination tests are laborious tests to conduct. Many techniques in blood testing lend themselves to automation, and it is a purpose of the present invention to provide apparatus for washing red blood cells which will serve as a portion of automated equipment for blood testing.

The present invention will be more fully understood with reference to the accompanying drawings in which:

FIGURE 1 shows a capillary tube in a horizontal position being rotated at high speed.

FIGURE 2 shows the end view of a capillary tube at rest containing a suspension of particles.

FIGURE 3 shows the end view of the capillary tube of FIGURE 2 being rotated at high speed.

FIGURE 4 is a schematic view of the mounting of a capillary tube with a means for rotating the tube.

FIGURE 5 shows an arrangement by which fluid may be withdrawn through the shaft of a motor.

When a capillary tube containing a suspension of particles is rotated along its horizontal axis, as shown in FIGURE 1, at from 5,000 to 9,000 r.p.m., the particles are forced to the walls of the tube and the fluid remains in the center of the tube. This effect is illustrated in FIGURES 2 and 3.

At rotational speeds below 5,000 r.p.m., not all of the suspended cells are forced to the walls of the tube. At rotational speeds in excess of 9,000 r.p.m., not only do the particles move to the walls of the tube, but the fluid also moves to the tube walls, leaving a slug of air in the tube.

As shown in FIGURE 4, the capillary tube **1**, is mounted horizontally in a tube holding block **2**. The tube holding block may be formed of any suitable material such as brass, steel or plastic. It is preferable to use a transparent material in order that the separation of particles in the capillary tube under centrifugation may be observed. One end of the capillary tube **1** is fitted snugly into a horizontal hole **3** drilled through the shaft **4** of the motor **5**. A chamber **6** is fitted around shaft **4**. Shaft **4** is drilled across its center to connect with hole **8** which has been drilled in chamber **6** through holes **10** as shown in FIGURE 5. Chamber **6** is fitted with a nozzle **9** to which a vacuum is attached. The speed of motor **5** is controlled by any conventional rheostat.



A sample of a particle containing suspension, such as blood, is introduced into the capillary tube **1** and one end of the capillary tube is inserted into the hole **3** in shaft **4** while the tube is supported by block **2**. The tube is rotated at a speed of between 5,000 r.p.m. to 9,000 r.p.m. For centrifuging a blood sample, the preferred rotational speed is between 6,400 r.p.m. and 7,200 r.p.m. After the 30 seconds of centrifugation, suction is applied and the liquid portion of the sample is removed. In the case of a blood sample, where it is necessary to wash the red blood cells after the removal of the serum, centrifugation is stopped, and a small amount of a washing solution, such as a saline solution, is introduced into the capillary tube. The leading edge of the washed solution displaces the red blood cells from the capillary wall and they are resuspended in the solution. Centrifugation is repeated and the saline solution is withdrawn by vacuum. Washing and recentrifugation is repeated as necessary.

The washed red blood cells are in condition for use in Coombs test, which may be performed in the capillary tube by the addition of a suitable reagent.

While the present invention is primarily intended as a rapid means for obtaining particles from small samples of particle suspensions, it will be apparent to those skilled in the art that it can also be used to obtain the liquid portion of the sample.

While the means of removing the liquid portion of the sample from the capillary tube has been described as a vacuum, it will be apparent to those skilled in the art that this may also be accomplished by applying air or other gaseous fluid, by gravity or by absorption (blotting).

What is claimed is:

**1.** A method of separating solid particles from a liquid suspension of particles which comprises introducing a liquid suspension of particles into a capillary tube, maintaining said capillary tube in a horizontal position, rotating said capillary tube about its longitudinal axis at between about 5,000 r.p.m. to about 9,000 r.p.m. and removing the liquid from the capillary tube.

**2.** A method according to claim **1**, wherein the liquid suspension of particles is blood.

**3.** A method according to claim **1**, wherein said capillary tube is rotated at between about 6,400 r.p.m. to about 7,200 r.p.m.

**4.** A method according to claim **1**, wherein the said liquid is removed by means of a vacuum.

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