

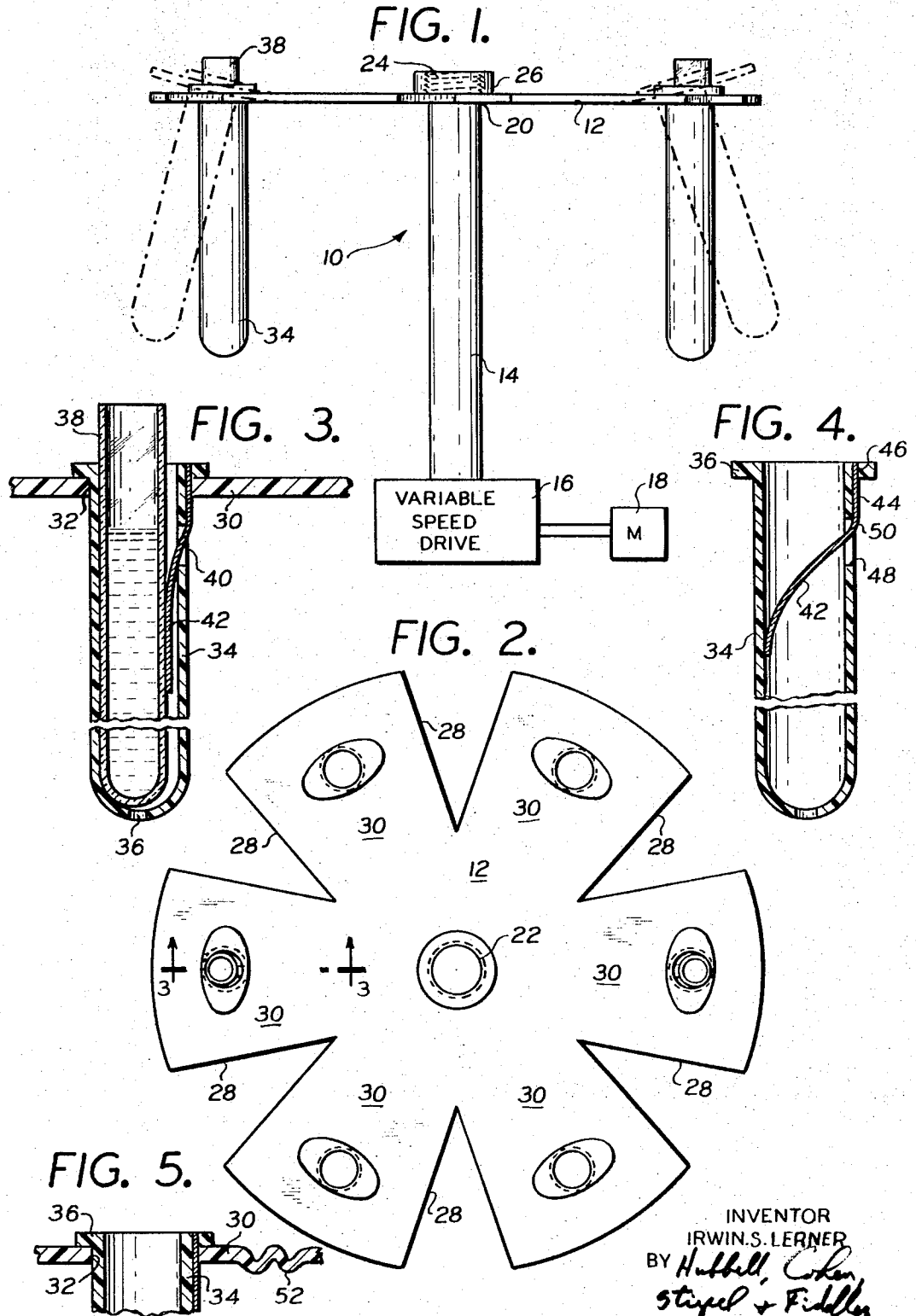
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HEMATOLOGICAL CENTRIFUGE

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FIG. 6.

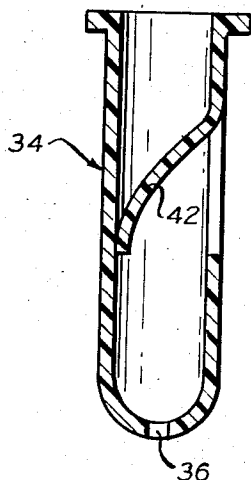
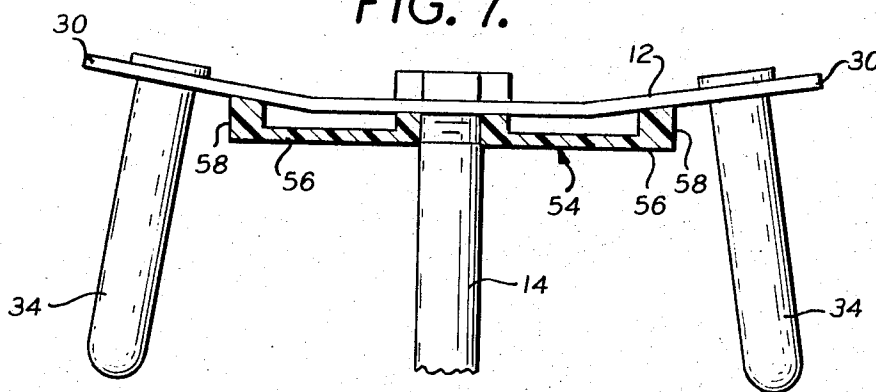


FIG. 7.



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HEMATOLOGICAL CENTRIFUGE
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This invention relates to a centrifuge and particularly to a hematological centrifuge.

It is often necessary to separate the solids from the liquid portion of whole blood. This separation is usually effected by a centrifuge. In making the separation it is desirable for the test tubes in which the blood is carried to be disposed at an angle to the axis of rotation in order for the solids to accumulate in a zone of the test tube other than the exact bottom thereof and to decrease the time of centrifugation. Such a disposition of the accumulated cells permits easy decanting of the liquid without a concomitant decanting of the cells themselves.

In the prior art, the positioning of the test tubes containing the blood samples at an angle to the axis of rotation of the centrifuge has been accomplished by disposing the test tubes on a rotor having a plurality of radially extending slots which permit a swinging of the tubes relative to the rotor, and biasing the tubes at one or several points along their lengths towards the center of the rotor (and hence the center of axis of rotation) by resilient means such as rubber bands. Upon starting up the rotor of the centrifuge, the test tubes would naturally swing out by the centrifugal force imparted thereto against the bias of the rubber bands and thereby move into an angular position with respect to the axis of rotation having been limited to the angular position by a fixed stopping device, in this case the end of the slot. While such an arrangement works, it has always been found to be inconvenient to dispose test tubes on such a centrifuge and to wrap the rubber bands around them. This operation is time consuming and has often led to test tube breakage.

It is therefore the main object of the present invention to provide a centrifuge for hematological laboratories.

Another object of the present invention is the provision of a new and improved centrifuge having means for rigidly mounting test tubes relative to the rotor and for flexing the rotor with respect to the axis of rotation of the centrifuge whereby to orient the tubes at an angle to said axis of rotation.

Still a further object of the present invention is the provision of a new and improved means for detachably holding test tubes on a hematological centrifuge.

The above and other objects, characteristics and features of the present invention will be more fully understood from the following description taken in connection with the accompanying illustrative drawings.

In the drawings:

FIG. 1 is a side elevational view of a centrifuge embodying the present invention with certain portions thereof shown schematically;

FIG. 2 is a top plan view of said centrifuge;

FIG. 3 is a sectional view taken along the line 3-3 of FIG. 2;

FIG. 4 is a vertical sectional view of a novel test tube holder employed in the present invention;

FIG. 5 is a sectional view similar to FIG. 3 showing a modification of the present invention;

FIG. 6 is a sectional view similar to FIG. 4 showing a modification of the present invention; and

FIG. 7 is a view similar to FIG. 1 showing another modification.

Referring now to the drawings in detail and particularly to FIGS. 1 to 4 thereof, the centrifuge is generally

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designated by the reference numeral 10 and includes a rotor 12 mounted on a shaft 14 which is connected to a variable speed drive 16 driven in turn by a suitable motor 18. It will be obvious that other means of achieving a variable rotational speed for shaft 14 can be accomplished than by utilization of a separate motor 18 and a separate variable speed drive 16. For instance, a variable speed motor may be employed. If the illustrated arrangement is used, the variable speed drive may take any of a number of well known forms such as a changeable gear transmission, a variable speed belt drive, or a variable speed disc drive similar to that encountered in multispeed phonograph record players and the like. The vertical drive shaft 14 may be hollow or solid depending upon the necessary strength characteristics and may be connected to the disc-like rotor 12 either permanently or detachably as may be desired. As shown herein, shaft 14 is necked down at its upper end to define an abutment 20 on which the rotor sits. The rotor 20 has an aperture 22 to permit the necked down upper end of the shaft to fit therethrough said upper end of the shaft being threaded as at 24 to threadedly receive a nut 26. Desirably, some form of keying is employed to lock the rotor to the shaft for rotation. Of course, any other suitable means of connecting the rotor to the shaft 14 may be employed.

In accordance with the present invention the rotor 12 is a circular disc-like member made of a resilient or flexible material such as, for example, various types of metals and plastics. Preferably, for the purposes of the present invention as will be understood more fully hereinafter the flat disc-like rotor 12 is made of a material having a high degree of strength and resiliency such as, for example, polyoxymethylene resins (Du Pont trademark Delrin), ABS plastics, and stainless steel. However, other steels and a number of plastics, solid, filled and reinforced, can be employed in connection with the disc-like rotor 12. The outer periphery of the rotor 12 is generally circular but is provided with a plurality of cut-outs, here shown as pie-shaped cut-outs 28 which define between them a multiplicity of flexible arms 30. Provided in each of the arms 30 adjacent the outer or free end thereof is a circular aperture 32 which is adapted to receive a cylindrical test tube holder 34 having an enlarged head 36 for limiting downward movement of the holder 34 through the aperture 32. As shown herein the enlarged head 36 is oval although other configurations could be employed. Preferably the test tube holders 34 are held in fixed relation with respect to their associated flexible arms 30 by close fits within the apertures 32 so that there can be little or no angular movement of the holders 34 relative to the adjacent portions of the arms 30.

As may best be seen in FIGS. 3 and 4, the test tube holder 34 is essentially a cylindrical body with a closed bottom. The bottom may have one or more openings to permit water from an incubation bath to enter and drain. The shape may be hemispherical as shown here or it may be flattened. The inner diameter of the test tube holder 34 is proportioned to readily receive a number of different sized test tubes. In order to accommodate a wide variety of diameters of test tubes 38, a suitable holding means 40 is provided. As shown herein the holding means 40 is a leaf spring having one end fixed to the wall of the test tube holder 34 and has a free cantilevered portion 42 that normally extends across the diameter of the test tube holder 34 (FIG. 4) at an angle to the longitudinal axis thereof. When a test tube 38 is inserted into the test tube holder, it engages the spring portion 42 and pushes it down and across the test tube holder 34 to the position best shown in FIG. 3 where the spring presses against a side of the test tube 38 and sandwiches that test tube between the spring portion 42 and the opposed wall of the test tube holder 34. While the means for securing the

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spring 40 to the test tube holder may be any of a number of suitable means such as rivets or the like, as shown herein the spring 40 has a portion 44 disposed along the outside of the test tube holder and pressed fitted into a small cavity or passage 46 in the enlarged rim or head 36 of the test tube holder, which portion 44 extends downwardly from the enlarged head 36 to a hole or aperture 48 in the wall of the test tube holder. At that point the spring is bent as at 50 and passes through the opening 48 where the test tube engaging portion 42 normally extends across the test tube holder 34. The fact that the aperture 48 is substantially larger than the spring 50 permits the portion of the spring within the aperture 48 to move across said aperture when the spring portion 42 is flexed from the position shown in FIG. 4 to the position shown in FIG. 3. The spring may take the form of a T with the crossbar portion arcuately formed to closely press internally against the holder thus retaining the spring in the holder, and the vertical member portion 42 forming the spring to work with the test tube. It will be obvious that other means may be employed in accordance with the present invention for releasably holding test tubes in the test tube holders. For example, a modified form of test tube holder is shown in FIG. 6 wherein the spring 42 is integrally formed from the wall of the test tube holder. This could be accomplished by striking up a wall portion of a metal container to form the spring 42 or in the alternative by molding the container 34 from a plastic material having suitable resilience such as, for example, polypropylene or polycarbonate.

The centrifuge 10 is constructed by assembling the variable speed drive and motor with the vertical shaft 14 and then affixing the rotor 12 thereto. The rotor 12 may be very simply stamped out of a suitable material thereby making its construction very inexpensive. In the alternative, rotor 12, depending on the selected material, may be molded or fabricated. A plurality of test tube holders 34, one for each of the apertures 32 in the flexible arms 30, are pressed into said apertures 32 for positioning on the centrifuge. Thereafter, test tubes containing suitable blood samples are disposed within the test tube holders 34 and are held therein by the springs 40 as above described.

After the test tubes are so disposed on the centrifuge 10, the motor 18 is actuated and through the drive 16 causes the shaft 14 to rotate and hence impart a rotary motion to the rotor 12. The speed of rotation may be set by adjusting the variable speed drive 16. As the rotor commences rotating, the centrifugal force acting on the test tubes and test tube holders will tend to cause the bottoms thereof to swing outwardly away from the shaft 14 as shown best in dotted lines in FIG. 1. This swinging is permitted by virtue of the self resilience of the material from which the rotor 12 is made and especially by virtue of the fact that the rotor is divided into a plurality of flexible arms 30 by virtue of the cut-outs 28 therein. Thus, the flexible arms 30 will flex under the stress of the centrifugal force acting on the test tubes and test tube holders and will bend as shown in dotted lines in FIG. 1 to thereby permit the test tubes to revolve in a position at an angle to the axis of rotation of shaft 14 which is the desired result to be achieved herein.

Referring now to FIG. 5 of the drawing, a modification of the rotor 12 is shown. The rotor is in all respects identical to rotor 12 shown in FIGS. 1 through 4, excepting that the rotor is corrugated in the area of the joining of the flexible arms 30 with the balance or the hub portion of the rotor 12 in order to make the arms 30 more flexible to give greater assurance of the bending of the arms 30 under the action of the spinning test tubes 38 and test tube holders 34. Moreover, by varying the thickness of the corrugations, the bending characteristics of the arms may be controlled. The corrugations are designated by the reference numeral 52 in FIG. 5.

Referring now to FIG. 7, a modified form of centrifuge is shown. This centrifuge may be in all respects identical

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to the centrifuge of FIGS. 1 through 4 excepting that a spider 54 is fixed to shaft 14 for rotation therewith and with the rotor 12. The spider 54 has a multiplicity of fingers 56, one for each of the rotor arms 30, with upstanding end portions 58 engaging said arms to give them an initial (non-rotational) deflection as shown in FIG. 7. With the arms so deflected by the finger portions 58, the test tube holders 34 will be positioned at rest at an angle to the vertical to facilitate filling of the test tubes and to reduce spillage as the centrifuge is started. With such an arrangement as the centrifuge commences rotation there will be no additional flexing of the arms 30 of the rotor 12 until the centrifugal force exceeds the downward spring force of the deflected arms 30. However, when the rotational speed of the centrifuge exceeds that critical speed the rotor arms 30 will commence to flex in a manner similar to the arms of the FIG. 1 embodiment. The FIG. 7 embodiment can be further modified by providing the arms 30 with a permanently set upward deflection as shown in the drawing in which event, if desired, the spider 54 can be eliminated from the construction. With a permanently set upward bend to the arms 30 the holders 34 will be carried at an angle at rest but will from the beginning of rotation commence deflecting the arms 30 upwardly from their initially deflected condition as there will be no resilient bias to overcome before deflection commences.

It will be understood that the holders 34 and the portion of the flexible rotor arm 30 to which the holders are connected can have some relative angular movement between them during the operation of the centrifuge. That is to say the means for connecting the holders to the arms could permit some free swing of the holders at the outset of centrifugation. However, in accordance with the present invention that free swinging must be sufficiently limited so that at some point the centrifugal forces operating on the holder and any test tube therein must be able to work on the rotor arm to cause that arm to flex. Thus, for example, the aperture 32 through which the test tube holder 34 is received by the arm 30 could be significantly larger than the test tube holder whereby to permit some rocking movement of the test tube holder relative to the arm. If this were the case upon energization of the motor 18 the test tube holder 34 and any test tube contained therein would swing in a radial direction relative to the wall of the aperture 32 until the test tube holder was stopped by that wall and thereafter the swinging would be resisted by the resiliency of the arm 30. As the centrifugal force is built up the arm 30 would flex an increasing amount.

While I have herein shown and described the preferred form of the present invention and have suggested modifications therein, other changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of this invention.

What I claim is:

1. A centrifuge comprising a vertically extending rotatable shaft, a radially extending resilient arm fixed to said shaft for rotation therewith, a downwardly extending container spaced from said shaft, means securing said container to said arm, and means for limiting relative angular movement between said container and that portion of said arm to which said container is connected, whereby when said shaft and arm rotate, said container will cause said arm to flex to permit said container to move angularly relative to said shaft.

2. The centrifuge of claim 1, further comprising a second arm fixed to said shaft and extending radially therefrom in a diametrically opposite direction from said first mentioned arm, a second downwardly extending container spaced from said shaft substantially the same distance as said first container, means securing said second container to said second arm, and means for limiting relative angular movement between said second container and that por-

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tion of said second arm to which said second container is connected.

3. The centrifuge of claim 2, further comprising means on said shaft for engaging said arms when said shaft is at rest for deflecting said arms.

4. The centrifuge of claim 2, wherein said arms are bent upwardly at an angle to the horizontal.

5. A centrifuge, comprising a vertically extending rotatable shaft, a horizontal disc of resilient material, means securing said shaft to the center of said disc for concomitant rotation, said disc having a plurality of peripherally spaced cut-outs defining therebetween a plurality of spaced apart radially extending arms, a downwardly extending container for each arm, means securing each container to its associated arm in spaced relation with said shaft, and means for limiting relative angular movement between each of said containers and that portion of its associated arm to which said container is connected, whereby when said shaft and arms rotate, said containers will cause said arms to flex to permit said containers to move angularly relative to said shaft.

6. The centrifuge of claim 5, wherein each of said arms has a corrugation concentric with said shaft to facilitate flexing thereof.

7. The centrifuge of claim 5, wherein said last two mentioned means are included by having an aperture in each of said arms spaced from said shaft, said apertures receiving said containers with a close fit.

8. The centrifuge of claim 7 wherein said disc is cir-

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cular and said cut-outs are pie shaped and equi-spaced from one another.

9. The centrifuge of claim 7 wherein at least one of said containers is provided with an aperture in its bottom.

10. The centrifuge of claim 7, further comprising a plurality of test tubes, one for each container, disposed in said containers, and means for releasably holding said test tubes in said containers.

11. The centrifuge of claim 10, wherein said releasable holding means is a leaf spring secured to said container at one end and having its free end bearing against the wall of the associated test tube.

12. The centrifuge of claim 11, wherein said leaf spring is integral with said container.

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HENRY T. KLINSIEK, *Primary Examiner.*