United States Patent [19]

Grubb et al.

[11] **3,747,842**

[45] **July 24, 1973**

[54] **CENTRIFUGE ROTOR WITH SAMPLE HOLDING MEANS**

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[73] Assignee: **Hamilton Company**, Whittier, Calif.

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[21] Appl. No.: **172,157**

[52] **U.S. Cl.** **233/26**

[51] **Int. Cl.** **B04b 9/12**

[58] **Field of Search** ..... 233/26, 27, 11, 1 R; 211/69.8, 77, 78, 120, 74

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Primary Examiner—George H. Krizmanich
Attorney—J. Carroll Baisch

[57] **ABSTRACT**

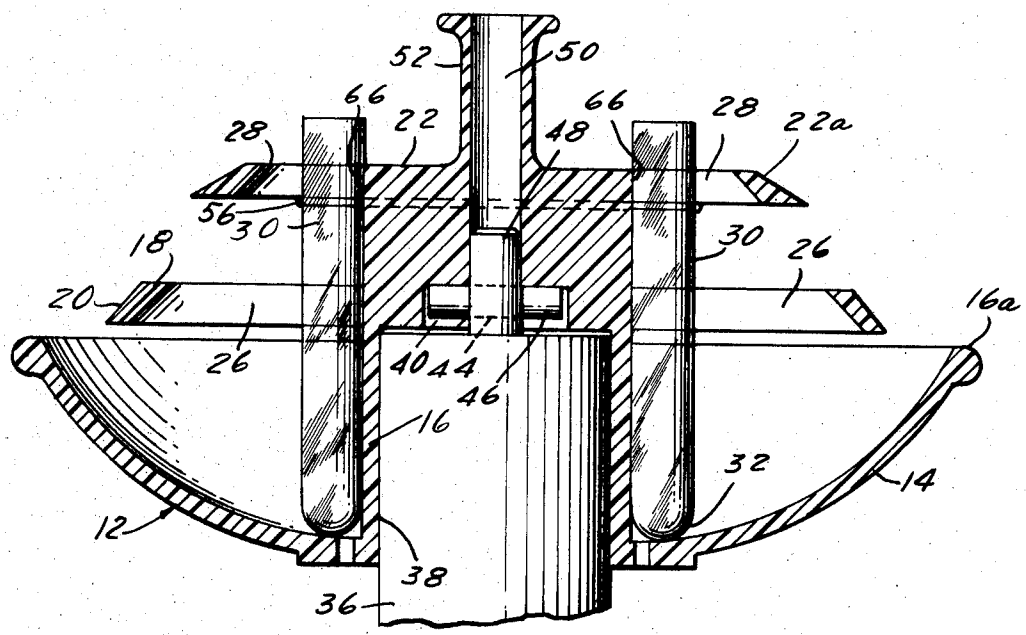
A centrifuge rotor having a hollow concave bowl with a large axial column extending upwardly above a plane of the rim of the bowl and on which there is axially disposed a flange of smaller diameter than the diameter of the rim of the bowl and spaced upwardly of the plane of said rim, the flange having a plurality of annularly-arranged and spaced, radially-extending, elongated or oval-shaped openings. Spaced above said flange is a second and smaller flange axially carried by said column and also having a plurality of radially-extending, annularly-arranged and spaced, elongated or oval openings aligned with respective oval openings of the larger lower flange.

The column is hollow and has a large recess in the lower portion with a reduced diameter recessed part extending upwardly from the upper end of said large recess. At the upper end of the reduced diameter part of the recess a pair of walls extend laterally apart to provide space for reception of a cross pin of an upstanding centrifuge drive shaft, there being a bore extending upwardly from the upper end of the reduced diameter part of the recess and through an upstanding axial stem for stabilizing reception of a part of the drive shaft above the cross pin.

The oval openings in the flanges are adapted to operably receive test tubes therein and the webs between every other opening in the smaller, upper flange have a hook with a part embedded in the webs and an arm facing radially outwardly and spaced below the underside of the webs. An elastic band of rubber, or other suitable resilient material, is carried by the hooks, the portions of the band between hooks extending across or crossing or spanning the openings intermediate the ends of said openings and closer to the inner ends of said openings than the outer ends. The band portions are spaced from the inner ends of the openings a distance less than the diameter of test tubes operably disposed in said openings, so that said band parts or portions resiliently and yieldingly urge the test tubes inwardly against the walls defining the inner ends of said openings and hold same in such position when the rotor is not operating, even when the rotor is turned upside down. However, the band permits the test tubes to pivot on the walls defining the inner ends of said openings. The lower part of said tubes are adapted to swing outwardly by centrifugal force when the rotor is rotated, the tubes extending through the openings in the lower flange which are longer than the openings in the upper flange to permit the lower part of such tubes to be thrown outwardly. The lower flange has a depending flange which limits upward movement of the test tubes when the device is operably rotated and the bowl prevents the test tubes from being thrown out of the device. The band portions or parts that cross or span the openings in the upper flange are spaced from the inner end walls of the openings a sufficient distance to permit the test tubes to be easily flipped into the inner portions of the openings of said upper flange but said test tubes are held within said openings, even when the device is inverted.

8 Claims, 6 Drawing Figures

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SHEET 1 OF 2

Fig. 1.

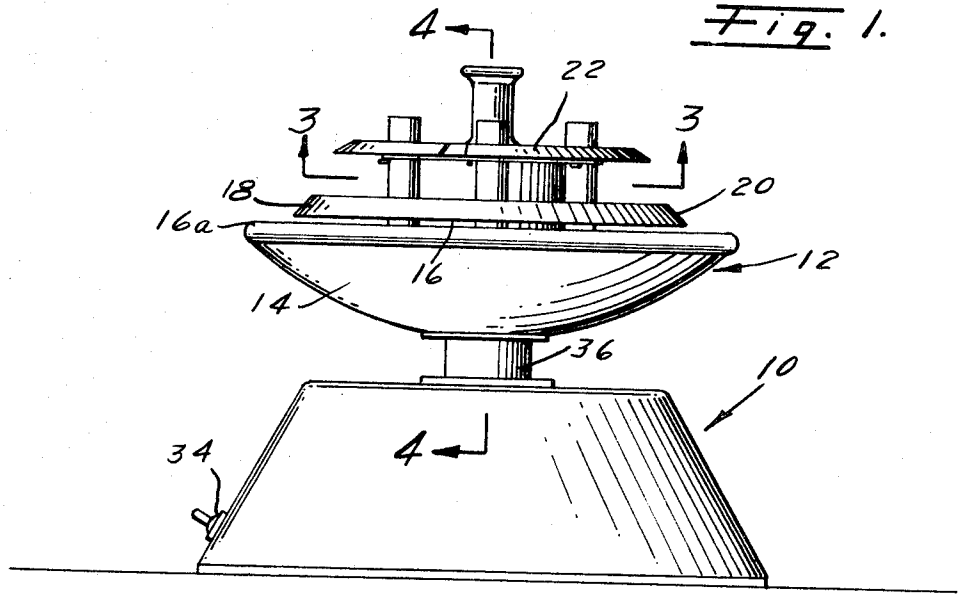


Fig. 2.

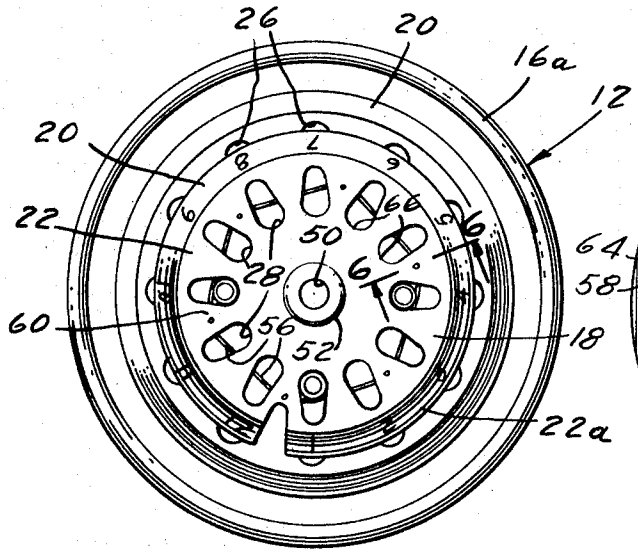
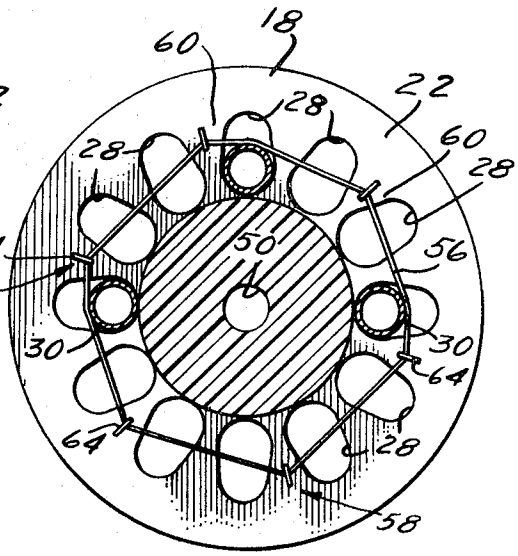


Fig. 3.



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Fig. 4.

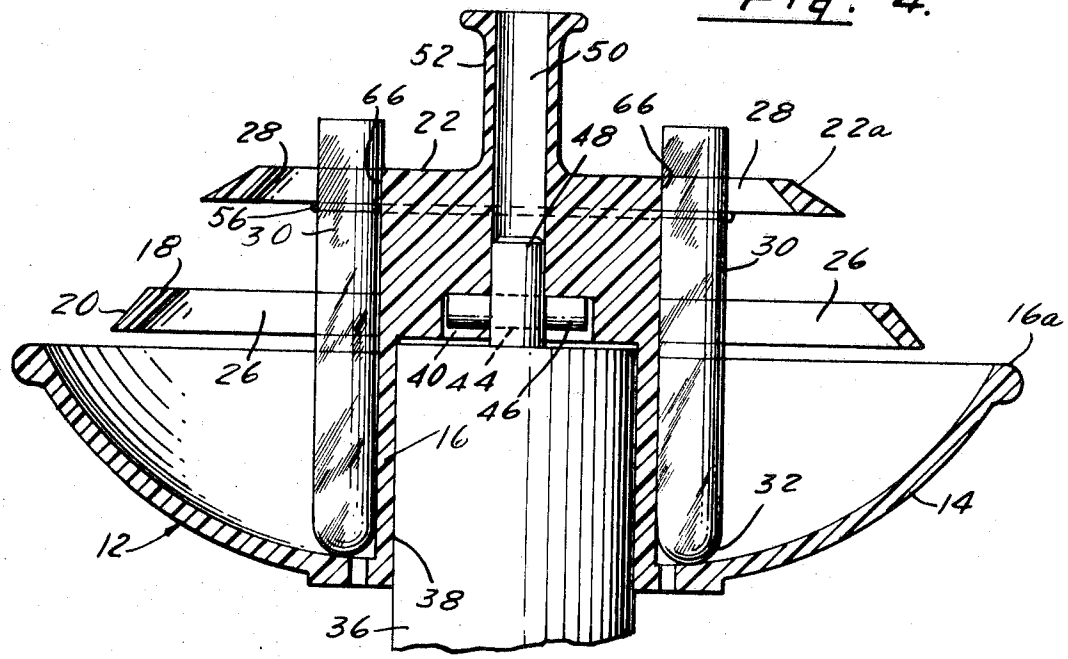


Fig. 5.

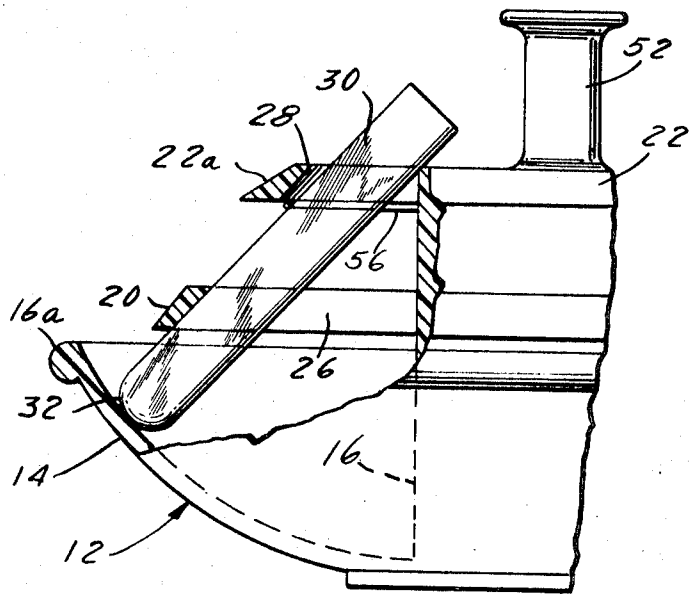
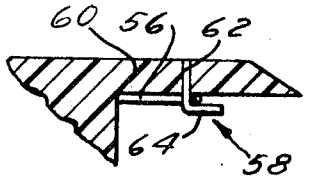


Fig. 6.



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CENTRIFUGE ROTOR WITH SAMPLE HOLDING MEANS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates generally to centrifuge rotors and refers more particularly to rotors for use in centrifuges used in making urinalyses.

2. Description of the Prior Art

Rotors for centrifuges are known but these are not equipped to hold or retain test tubes therein when the centrifuge is turned upside down.

SUMMARY OF THE INVENTION

The present invention comprises a centrifuge rotor having a hollow concave bowl with a large axial column extending upwardly above the plane of the rim of the bowl and on which there is axially disposed a flange of smaller diameter than the diameter of the rim of the bowl and spaced upwardly of the plane of said rim, the flange having a plurality of annularly-arranged and spaced, radially-extending, elongated or oval openings. Spaced above said flange is a second and smaller flange axially carried by said column also having a plurality of radially-extending, annularly-arranged and spaced, elongated or oval openings aligned with respective oval openings of the larger, lower flange.

The column is hollow and has a large recess in the lower portion with a reduced diameter part extending upwardly in the upper end of said large recess, and at the upper end of the reduced diameter part of the recess a pair of walls are spaced laterally apart to provide space for reception of a cross pin of an upstanding centrifuge drive shaft, there being a bore extending upwardly from the upper end of the reduced diameter part of the recess and through an upstanding axial stem for stabilizing reception of a part of the drive shaft above the cross pin.

The oval openings in the flanges are adapted to operably receive test tubes therein and the webs between every other opening in the smaller, upper flange have a hook with a part embedded in the webs and an arm facing radially outwardly and spaced below the underside of the webs. An elastic band of rubber of other suitable material is carried by said hooks, the portions of the bands between the hooks extending across or crossing or spanning the bottoms of the openings intermediate the ends of said openings and closer to the inner ends than the outer ends. The band portions are spaced from the inner ends of the openings a distance less than the diameter of the test tubes operably disposed in said openings, so that said band parts or portions resiliently urge the test tubes inwardly against the walls defining the inner ends of said openings and hold same in such position when the rotor is not operating, even when the rotor is turned upside down. However, the band permits the test tubes to pivot on the walls defining the inner ends of the openings of the upper flange with the lower parts of the tubes adapted to swing outwardly by centrifugal force when the rotor is rotated. The tubes extend through the openings in the lower flange which are longer than the openings in the upper flange to permit the lower parts of such tubes to be thrown outwardly. The lower flange has a depending flange which limits upward movement of the test tubes when the device is operably rotated, and the bowl prevents the test tubes from being thrown out of the device.

The band portions extending across the openings in the upper flange are spaced sufficiently from the inner ends of the openings of said upper flange to permit easy insertion of said test tubes into the inner ends of the respective openings, but since the band parts are spaced from the inner ends of said openings a distance less than the diameter of test tubes used in the device, said test tubes will be held in position in the device when the rotor is not being rotated, even when the device is inverted, so that liquid in the test tubes may be simultaneously poured out of all of the tubes without the tubes being displaced.

OBJECTS AND ADVANTAGES OF THE INVENTION

It is, therefore, an object of the present invention to provide a centrifuge rotor having means for retaining test tubes therein, even when the rotor is inverted.

It is another object of the invention to provide a rotor of this character that may be inverted to simultaneously discharge liquid within the test tubes without said tubes becoming displaced.

It is still another object of the invention to provide apparatus of this character wherein the test tubes may be easily and quickly inserted into openings provided therefor and retained in position.

It is a further object of the invention to provide a rotor or apparatus of this character wherein the means for retaining the test tubes in position permits the lower portions of the tubes to be thrown outwardly under the influence of centrifugal force.

It is a still further object of the invention to provide apparatus of this character wherein when making urinalyses a reagent may be easily and quickly added to the urine in the tubes and a reading for protein made.

Another object of the invention is to provide apparatus of this character wherein the sediment in the urine in the test tubes is thrown to the bottom under centrifugal force and the device then stopped and inverted to pour out the liquid in the test tubes so that the sediment may be removed from the test tubes and examined under a microscope.

Still another object of the invention is to provide apparatus of this character wherein the time for making protein tests and microscopic examinations is substantially reduced.

The characteristics and advantages of the invention are further sufficiently referred to in connection with the following detailed description of the accompanying drawings, which represent one embodiment. After considering this example, skilled persons will understand that many variations may be made without departing from the principles disclosed and we contemplate the employment of any structures, arrangements or modes of operation that are properly within the scope of the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring to the drawings, which are for illustrative purposes only:

FIG. 1 is a side-elevational view of a centrifuge having a rotor embodying the present invention;

FIG. 2 is a top plan view thereof;

FIG. 3 is a sectional view taken on line 3—3 of FIG. 1;

FIG. 4 is an enlarged sectional view taken on line 4—4 of FIG. 1 showing test tubes therein as positioned when the rotor is not rotating;

FIG. 5 is a partial view similar to FIG. 4 but showing the test tubes positioned under the influence of centrifugal force; and

FIG. 6 is an enlarged sectional view taken on line 6—6 of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring more particularly to FIG. 1, there is shown centrifuge apparatus including a base, indicated generally at 10, and a centrifuge rotor, indicated generally at 12.

The centrifuge rotor 12 may be of any suitable material such as, for example, a rigid plastic, of which there are various well known plastics on the market.

This rotor comprises a hollow concave bowl 14, from the bottom of which a large axial column or post 16 extends upwardly above the plane of the rim of the bowl. On the column 16 there is an integral flange 18 normal to the axis of the column 16, the flange 18 having a downwardly and outwardly-extending rim 20. Flange 18 with its rim 20 is spaced upwardly of the plane of the rim of the bowl 14 but is of smaller diameter than the diameter of the rim of the bowl, said rim being indicated at 16a.

Spaced upwardly of the flange 18 is a smaller, upper flange 22, the upper flange 22 being normal to the axis of the column and parallel to the lower flange 18, the flange 22 also being integral with the column 16.

Lower flange 18 has a plurality of annularly-spaced, radially-arranged, elongated or oval openings 26 while the upper flange 22 has a similar number of elongated or oval openings 28 which are radially arranged and in alignment with the openings 26 of the lower flange 18. These openings are adapted to operably receive test tubes 30 therein which are of well known character, being opened at the upper end and closed at the lower end by a rounded wall 32. Within the base 10 is means for rotating the rotor, said means being an electric motor, not shown, and current to the motor is controlled by a switch 34. Extending axially upwardly from the base is a post 36, the upper end of which extends into a large, cylindrical, axially-arranged recess 38 in the lower portion of the column 16, said post 36 being operably received in the recess 38.

At the upper end of the recess 38 is a reduced-diameter, axially-arranged recess 40 having a pair of oppositely-arranged walls 44 which are spaced apart and receive a cross pin 46 in a shaft 48 driven by the motor. The walls 44 provide a driving connection between said shaft 48 and the rotor. Shaft 48 extends upwardly of the cross pin 46 in a bore 50 which extends axially upwardly of the recess 40 and through a stem 52 which is integral with the rotor. Post 36 is so received in the recess 38 to permit the rotor to freely rotate but stabilizes the rotor so that it will not wobble or vibrate when it is being rotated.

Means is provided for retaining the test tubes 30 in the rotor when the latter is inverted while permitting the test tubes to be pivoted adjacent their upper ends so that said test tubes will be swung to an inclined position with the closed ends positioned outwardly under the influence of centrifugal force. This means comprises a resilient, elastic band 56 which is shown as a rubber band. Means for securing rubber band 56 in operable position comprises a plurality of hooks 58, there being a hook 58 for every other web 60 between the annularly-arranged and spaced openings 28 in the upper flange.

Each hook 58 comprises a vertical shank 62 that is embedded in a web 60 and an arm 64 that extends radially outwardly from the shank 62 and in downwardly spaced, parallel relationship to the underside of the smaller, upper flange 22. The hooks 58, thus, open outwardly and the rubber band 56 is disposed on these hooks.

The parts of the rubber band between hooks extend across or span the openings 28 intermediate their ends, said band portions being normally spaced from the inner ends or inner end walls 66 of the openings 28 a distance less than the diameter of the test tubes 30. However, said band portions are spaced from said walls 66 a sufficient distance to permit easy and quick insertion of the test tubes in the inner parts of said openings 28.

The stem 52 serves as a handle in raising or lowering the rotor and provides means to facilitate placing the rotor on the shaft 48 with the cross pin in the space between the walls 44 so that the rotor is rotated when the shaft 48 is rotated.

When it is desired to operate the apparatus test tubes are placed in the inner ends of the openings 28 so that the band portions between the hooks are stretched slightly and produce resilient pressure against the upper parts of the tubes to urge same against the inner walls 66 of said openings. It is to be understood that the band 56 is at the underside of the flange 22. The test tubes also extend through the openings 26 of the flange 18 and the band 56 functions to urge said test tubes against the column 16 so that the tubes are in an upright or vertical position when the rotor is not being rotated. The lower ends or end walls 32 of the test tubes rest on the inner surface 14a of the bowl 14.

Each of the test tubes contains a sample or specimen to be tested or analyzed and, to permit ready identification of the tubes, each opening 28 in the small upper flange is numbered, the numbers being on the beveled edge portion 22*a* of the upper flange 22, as best shown in FIG. 2.

When the rotor is rotated at a high speed to provide the centrifuge effect, the test tubes pivot on the upper edge 16a of the column 16, or pivot or rock on the inner end wall of the openings 28 of the upper flange 18, so that they take an outwardly and downwardly position, FIG. 5. The outer end walls 26a of the slots 26 in the lower flange limit upward movement of the lower end of the test tubes, and the inner surface 14a of the bowl prevents the test tubes from being thrown outwardly under the influence of centrifugal force.

When the rotor is rotated the portions of the band 56 between the hooks yields and when the rotor stops said band portions cause the test tubes to be moved to the upright position shown in FIGS. 1 and 4.

When the rotor is being rotated in the usual well known manner, sediment or solids are forced to the closed end of the test tubes and, when the samples are urine, the urine sediment or solids are forced to the lower or closed end of the test tubes.

There are two things the samples are tested for — one is for protein and a reagent is added to the liquid

specimen. A light is used to get the reading for the protein.

Thereafter, the rotor is turned upside down to dump the liquid in the test tubes. When this is done the band **56** holds the test tubes in position in the rotor and prevents said tubes from falling out of the rotor when the liquid therein is poured or dumped out.

When the liquid in the test tubes is disposed of the sediment is retained in the bottom of the tubes and this sediment is then removed from the respective tubes and placed in the areas provided therefor in the apparatus for samples for microscopic examination, said apparatus being disclosed in the application of John J. Grubb, Elwood F. Blondfield and Keichi Tomei for APPARATUS FOR SAMPLES FOR MICROSCOPIC EXAMINATION, filed Apr. 19, 1971, Ser. No. 135,332. It is to understood, of course, that this sediment from the test tubes may be alternatively placed on slides of the usual well known character for examination under a microscope.

This sediment is removed from the respective test tubes by means of pipettes such as the disposable pipettes disclosed and claimed in our pending application for DISPOSABLE PIPETTES, Ser. No. 119,784, filed Mar. 1, 1971. After sediment samples have been taken from all of the test tubes, said test tubes are removed from the rotor and disposed of. The band **56** remains in position and new, sterile test tubes are inserted into the rotor in the same manner as above described. It is to be understood that the elastic band **56** yieldingly holds the test tubes in the upright position shown in FIG. **4** when the rotor is not being rotated. Also, after the rotor has been rotated the elastic band **56** returns the test tubes to the upright position after they have been centrifugally actuated to the inclined position shown in FIG. **5**.

As above pointed out, the time required for making the tests is very substantially reduced with the present apparatus.

The invention and its attendant advantages will be understood from the foregoing description and it will be apparent that various changes may be made in the form, construction and arrangement of the parts of the invention without departing from the spirit and scope thereof or sacrificing its material advantages, the arrangement hereinbefore described being merely by way of example, and we do not wish to be restricted to the specific form shown or uses mentioned, except as defined in the accompanying claims.

We claim:

1. A centrifuge rotor for test tubes, comprising:

A. a hollow concave bowl having an axial, upstanding column with a recess therein open at the bottom, there being means at the upper end of said recess for operable engagement with upstanding drive means;

B. a lower flange axially disposed on said column, said flange having a plurality of openings therein, said openings being annularly arranged and annularly spaced apart;

C. an upper flange axially disposed on said column, said upper flange having a plurality of annularly arranged and spaced openings therein aligned with respective openings in the lower flange;

D. elastic resilient means;

E. and securing means for said elastic resilient means for securing said elastic resilient means to the upper flange and with said elastic resilient means having portions that span the openings of said upper flange with parts of said openings disposed radially inwardly and parts of said openings disposed radially outwardly of said portions of said resilient means, the elastic resilient means being positioned for easy and ready insertion of test tubes in the openings of the flanges and for retaining said test tubes in the respective openings in the flanges upon inversion of the bowl with the test tubes disposed therein.

2. The invention defined by claim **1**, wherein the elastic resilient means is disposed on the underside of said upper flange thereby permitting ready removal of said test tubes from the rotor without displacement of the elastic resilient means.

3. The invention defined by claim **2**, wherein the elastic resilient means comprises an elastic resilient rubber band.

4. The invention defined by claim **3**, wherein the openings in the upper flange are elongated radially and portions of the band cross the rubber openings intermediate the ends of said openings.

5. The invention defined by claim **4**, wherein portions of the rubber band spanning the openings in the upper flange are spaced from the inner ends of said openings a distance which is substantially half the length thereof, said portions are spaced sufficiently from the inner ends of said openings to permit test tubes to be inserted in the inner end parts of said openings, said portions of the band adapted to resiliently urge test tubes inwardly.

6. The invention defined by claim **5**, wherein there are webs between the openings in the upper flange; and there are hooks secured to certain of said webs, said rubber band being attached to said hooks which hold said band in position.

7. The invention defined by claim **6**, wherein the openings in the lower flange are elongated, said openings being radially arranged and annularly spaced apart, the outer end walls of said openings being engageable by test tubes operably disposed in the openings in said upper and lower flanges when the rotor is operably rotated, said end walls limiting upward movement of said test tubes, the lower ends of said test tubes moving upwardly and outwardly on the inner surface of the bowl, said bowl limiting outward movement of said test tubes.

8. The invention defined by claim **7**, wherein the inner ends of the openings in the upper flange provide pivot means for test tubes when the rotor is operably rotated.

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