Aug. 16, 1966 L. E. STAHL ETAL 3,266,718

SAMPLE VESSEL FOR CENTRIFUGE APPARATUS

Filed April 16, 1964

Fig. 2

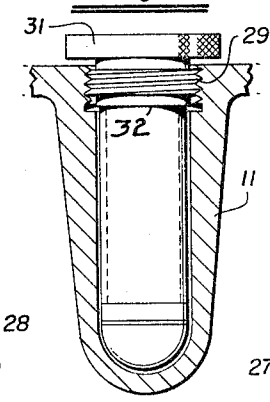


Fig. 3

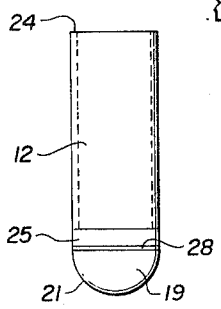


Fig. 4

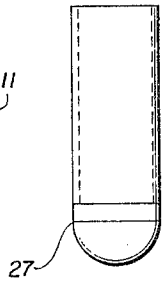


Fig. 5

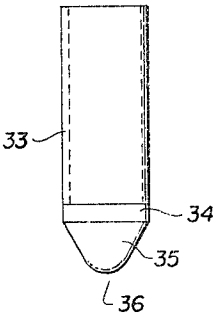


Fig. 6

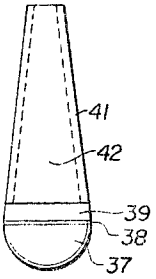


Fig. 1

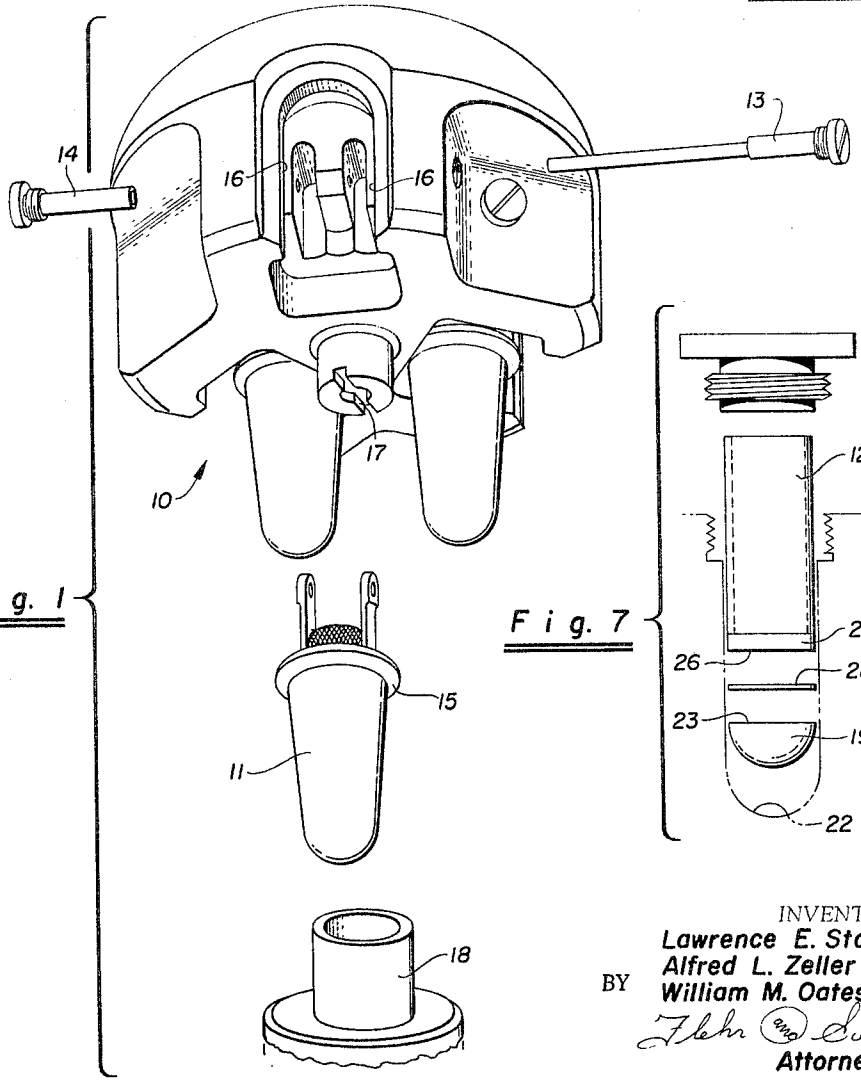


Fig. 7

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United States Patent Office 3,266,718 Patented August 16, 1966

3,266,718

SAMPLE VESSEL FOR CENTRIFUGE APPARATUS

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Filed Apr. 16, 1964, Ser. No. 360,214
6 Claims. (Cl. 233—26)

This invention relates to centrifuge rotor constructions and particularly to that portion of a rotor serving to carry matter to be subjected to centrifugation.

In centrifuge apparatus, the rotor normally includes means which serve to define a hollow receptacle adapted to receive therein a removable vessel, e.g., a test tube or the like, which carried the matter to be centrifuged. In some instances, these receptacles are formed in the rotor as bored holes. The holes are formed to receive test tubes which, in turn, carry the material being treated. In another type of rotor, so-called "swinging buckets" are employed.

In the past, in the swinging bucket rotor the sample has usually been placed in cellulose, polypropylene, or quartz tubes. These tubes then are slipped into aluminum buckets which are sealed with screw caps. The buckets are attached to the rotor yoke by pins. As the rotor spins, the buckets pivot on the pins up to a substantially horizontal position. Quartz tubes are used when the sample is to be optically analyzed while it remains in the tube.

For analyzing sample within the tube it would be preferable to make the sample-carrying tube from glass. Glass would permit inspection of sample by either visible or ultraviolet light. Furthermore glass is readily workable into precision sizes having excellent optical clarity.

Glass, however, is relatively frangible and tends to break at high rotor speeds.

Accordingly it is a general object of the invention to provide an improvement in centrifuge apparatus whereby frangible material, such as glass, can be employed to form the vessel which carries sample for centrifugation.

As disclosed herein it is observed that frangible transparent glass materials can be employed in high speed centrifuge rotors by loading the frangible vessel with compression forces to the substantially complete exclusion of tension and bending forces.

Accordingly it is another object of the present invention to arrange a centrifuge vessel whereby forces acting thereon during centrifugation are limited substantially entirely to compression forces.

It has also been observed that critical localized forces must be avoided or dissipated. Accordingly it is yet another object of the invention to provide a centrifuge apparatus employing frangible vessels constructed and arranged whereby localized critical forces acting to rupture the vessel are minimized.

These and other objects of the invention will be more readily apparent from the following detailed description of a preferred embodiment when considered in conjunction with the accompanying drawing in which:

FIGURE 1 is a perspective view, seen from below, of a centrifuge rotor of the swinging bucket style disposed in an at rest position;

FIGURE 2 is a detail elevational section view of a receptacle and sample carrying vessel;

FIGURE 3 is an elevational view of a sample carrying centrifuge vessel supported on a reaction member, all to fit within the receptacle shown in FIGURE 2;

FIGURE 4 is another embodiment of centrifuge apparatus according to the invention;

FIGURE 5 is another embodiment of centrifuge apparatus;

FIGURE 6 is an elevational view of yet another embodiment; and

FIGURE 7 is an elevational view of the vessel arrangement of FIGURE 3 being disposed into a receptacle according to FIGURE 2.

As noted, centrifuge apparatus customarily includes means defining a hollow receptacle for receiving a vessel for carrying matter to be centrifuged. As disclosed herein, in general, a solid, rigid reaction member is formed and adapted to be disposed in the receptacle and shaped to conform to the contour of the terminal wall surface of the receptacle. The reaction member is provided with an unbroken, planar surface formed thereon. The planar surface is adapted to be disposed substantially perpendicular to the axis of a sample carrying vessel. A vessel is thus provided from a length of right cylindrical material which forms the side wall. A closure member, such as a flat disc, of uniform thickness, seals the bottom of the vessel. The bottom outside surface of the disc is polished smooth and provides an unbroken surface which, when disposed in confronting relation to the planar surface of the reaction member provides a reaction interface between the vessel and the reaction member. The reaction interface thus formed serves to evenly transfer centrifugal forces from the contents and side wall of the vessel to the reaction member and subsequently to the body of the receptacle.

In the foregoing manner it is to be observed that the sample vessel is under compressive forces substantially exclusively as distingcished from tension and bending forces, thereby minimizing if not eliminating critical local disruptive forces.

The foregoing construction permits the utilization of precision bored tubing of good optical clarity so as to permit analysis of the contents of the vessel by means of visible as well as ultraviolet light.

With reference to the drawing there is shown a centrifuge rotor assembly **10** including buckets **11** which serve to define a hollow receptacle for receiving a vessel **12** adapted to carry matter to be centrifuged. Buckets **11** are attached to the rotor yoke by pins **13**, **14**. As the rotor spins, buckets **11** pivot on pins **13**, **14** upwardly to a substantially horizontal position. Buckets **11** are provided with a collar **15** which seats firmly against the retaining lips **16** formed on the rotor. At the end of each run buckets **11** gradually return to a vertical position. The rotor is attached to the drive shaft of a centrifuge apparatus in a conventional manner as by means of a driving connection received in keyway **17**. A rotor stand **18** permits removal of the buckets from the rotor with a minimum stirring of the sample.

A sample vessel assembly according to the construction shown in FIGURE 3 comprises a solid, rigid reac-

tion member 19, preferably of aluminum or other metallic substance. Reaction member 19 is formed with a hemispherical force-distributing surface 21 adapted to conform to the contour of the terminal wall surface 22 of a receptacle defined within bucket 11. Reaction member 19 is provided with an unbroken, preferably polished, planar surface 23 formed thereon.

A sample vessel 12 for carrying matter to be centrifuged comprises, according to the construction in FIGURE 3, a right cylindrical length of precision bored glass tubing serving to form the side wall of the body portion 24 of vessel 12. The bottom of vessel 12 is formed from a planar closure member in the form of a flat circular disc 25. Disc 25 has uniform thickness and a smooth, unbroken, preferably polished bottom surface 26. Closure member 25 is fixed to body portion 24 by conventional fusion technique or preferably can be fused by interposing a bonding agent which melts at a lower temperature than the glass tubing thereby avoiding possible distortion of either body portion 24 or member 25. In either event, member 25 and portion 24 are fixed to one another to seal the bottom of vessel 12.

Surfaces 23 and 26, disposed in confronting relation with respect to one another, define a reaction interface 27. Surface 23, being coextensive with surface 26, provides support throughout the entire area thereof. Thus, centrifugal forces developed in the contents and side wall of vessel 12, as well as in bottom closure member 25, transfer to reaction member 19 and subsequently to bucket 11 via the terminal wall surface 22 of bucket 11.

It has been observed to be advantageous in further relieving localized disruptive concentrations due to surface defects or impurities such as dirt particles to interpose a cushioning gasket layer 28, on the order of 0.003 inch thickness. A suitable compliant material, such as a tough plastic, for example as sold under the trademark Mylar by the E. I. du Pont Corporation, or polyethylene. Layer 28 is preferably in the form of a circular gasket of membrane dimension so that the side wall of body portion 24 will transfer its force through it to reaction member 19.

Means defining a hollow receptacle to receive vessel 12 include bucket 11 formed with a generally conforming interior surface. The sample vessel fits closely within the bucket so as to avoid side loading forces acting on the walls of the vessel which might possibly cause fracture of the sample vessel. Bucket 11 is provided at its upper end with a threaded portion 29. A knurled threaded plug 31 is formed with an annular flat surface 32 of moderately lesser diameter which, when plug 31 is screwed into bucket 11, is adapted to bear upon the upper edge of body portion 24. Prior to inserting the vessel assembly, i.e., reaction member 19 and vessel 12 (and in the case of the embodiment shown in FIGURE 3, the cushioning layer 28) a small amount of liquid of comparable density to the sample is deposited within the receptacle to preclude differences of pressure between inside and outside the vessel 12.

According to the embodiment shown in FIGURE 5, a right cylindrical tubular body portion of frangible material 33 is fused to a circular disc 34 of similar material. It is supported within the bore of a bucket 11 by means of a reaction member 35 having a right truncated conical surface of revolution formed with a spherical surface 36 at the lower end s tas to be adapted to be received and conform to the terminal wall surface of the bore of a receptacle similarly formed.

In FIGURE 6 there is shown a sample vessel of trapezoidal elevation cross section serving to provide a sector vessel having a side wall orientation of the vessel whereby sample particles will not hang up and accumulate thereon. During centrifugation when the vessel is horizontal, particles are free to move outwards of the axis of rotation and in a radial direction which leads away from the wall so as not to strike the wall surfaces. Particles near the walls tend to move generally parallel to the walls thereby avoiding stirring during the centrifuging. This type of cell construction lends itself to what is known as velocity runs in contrast to equilibrium runs whereby relative displacements of particles are noted instead of obtaining final static equilibrium of particles. The construction of FIGURE 6 includes a reaction member 37, membranaceous gasket 38, bottom closure member 39, and elongated body portion 41 forming a vessel 42. Body portion 41 has a rectangular transverse cross section and is formed by assembly and fusion of four planar trapezoidal sides of uniform wall thickness along the length of body portion 41.

Thus in the foregoing it will be readily evident that there has been provided a sample carrying construction whereby frangible materials can be employed for high speed centrifugation. Accordingly high quality optical glass can therefore be used so as to further facilitate examination of sample under visible as well as ultraviolet light.

It will be further noted that the provision of a polished unbroken reaction interface between a reaction member and a vessel constructed of precision bored tubing material closed off at the bottom by a flat disc-like member fused thereto serves to minimize if not eliminate critical localized tension and bending forces acting upon the frangible material.

We claim:

1. In centrifuge apparatus including means defining a hollow receptacle for receiving a vessel carrying matter to be centrifuged, a solid, rigid reaction member adapted to be disposed in said receptacle and shaped to conform to the contour of the terminal wall surface of the receptacle, said reaction member having an unbroken, planar surface formed thereon, a vessel for carrying the matter to be centrifuged comprising a hollow elongated body portion having uniform wall thickness along the length thereof forming the side wall of said vessel, a planar closure member of uniform thickness having top and bottom surfaces, the top surface being fixed to and sealing one end of the body portion to form the bottom of the vessel and support the contents therein, and the bottom surface of said closure member being smooth and unbroken, the unbroken surface of said reaction member being coextensive with the unbroken surface of said closure member and disposed in confronting relation thereto to define a reaction interface therebetween serving to evenly transfer to the reaction member via said interface those centrifugal forces developed in the contents and side wall of the vessel and in the closure member.

2. Centrifuge apparatus according to claim 1 wherein said body portion comprises a length of right cylindrical tubular material forming the side wall of said vessel, and said closure member comprises a flat disc of uniform thickness, the top surface of the disc being fused to one end of said tubular material to form a unitary construction thereat.

3. Centrifuge apparatus according to claim 1 including a member forming a cushioning layer of membranaceous dimension interposed at said interface between said unbroken surfaces and coextensive with the unbroken surface of the closure member to aid in distributing centrifugal forces laterally at said reaction interface.

4. Centrifuge apparatus according to claim 1 wherein said reaction member and said vessel are unattached and independently disposable into the receptacle.

5. Centrifuge apparatus according to claim 1 wherein both said body portion and said closure member are formed of transparent glass material.

6. In centrifuge apparatus including means defining a hollow receptacle for receiving a vessel carrying matter to be centrifuged wherein the receptacle as defined includes a smooth, unbroken, planar surface forming the terminal wall of the receptacle, a vessel for carrying matter to be centrifuged comprising a length of cylin-

drical tubular material forming the side wall of the vessel, a planar closure member of uniform thickness having top and bottom surfaces, the top surface being fixed to and sealing one end of the length of tubular material to form the bottom of the vessel and support the contents and side wall thereof, and the bottom surface of the closure member being smooth and unbroken and adapted to be disposed in confronting relation with and fully supported by the planar terminal wall of the receptacle to define a reaction interface therewith during centrifugation to evenly transfer centrifugal forces developed in the contents and side wall of the vessel and

in the closure member to the receptacle via the interface.

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