United States Patent [19]

Balas

[11] **3,900,186**

[45] **Aug. 19, 1975**

[54] **MAGNETIC CELL STIRRER**

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[73] Assignee: **Wheaton Industries**, Millville, N.J.

[22] Filed: **Sept. 12, 1974**

[21] Appl. No.: **505,226**

Related U.S. Application Data

[62] Division of Ser. No. 379,081, July 13, 1973, Pat. No. 3,854,704.

[52] **U.S. Cl.** **259/21**; 259/DIG. 46; 259/118

[51] **Int. Cl.**[2] **B01F 13/08**; B01F 7/30

[58] **Field of Search** ..... 259/116, 117, 118, 119, 259/121, 122, 125, 102, DIG. 46, 21, 22, 23, 24, 5, 64

[56] **References Cited**

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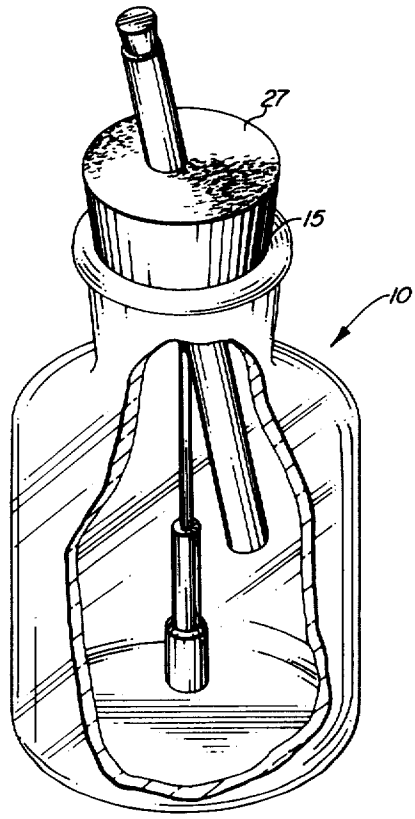
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Primary Examiner—Robert W. Jenkins
Attorney, Agent, or Firm—Eric P. Schellin

[57] **ABSTRACT**

This specification discloses several embodiments of the basic concept of providing a magnetic stirrer for a container of cells which is characterized by the inclusion of a magnet that is mounted on the lower end of a shaft which is mounted on or in a closure for an opening in the top of the container in such a manner that when magnetic forces are applied to the magnet from a rotating magnet external of the bottom of the container the magnet on the shaft is rotated, and, due either to the construction of the shaft which in most of the embodiments is flexible, or to its mounting on the closure, will move radially outwardly and upwardly in the container under the influence of the centrifugal force generated by its rotation. In the flexible shaft embodiments provision is made for adjusting the flexing amplitude of the shaft. Provision is also made for the introduction of a fluid, either gaseous or liquid, into the container through the closure and in addition to the culture or other material which is being stirred.

2 Claims, 9 Drawing Figures



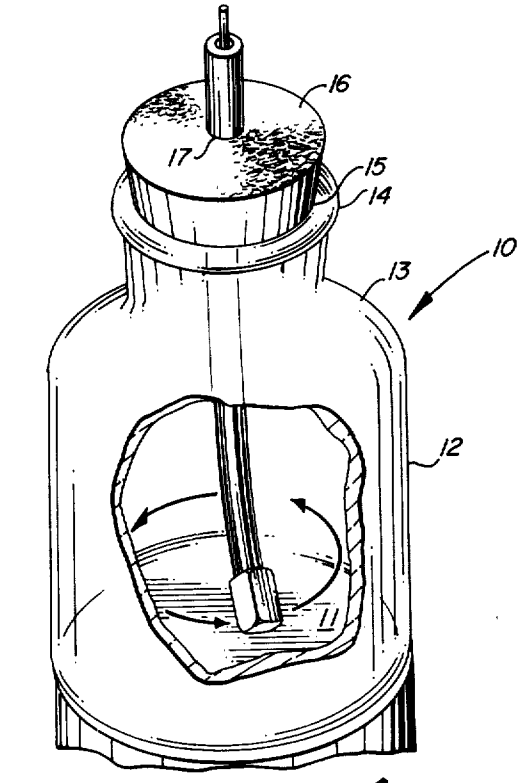


FIG-1

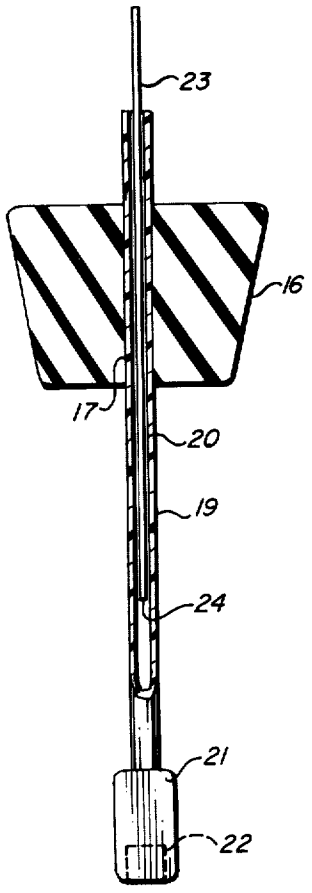


FIG-2

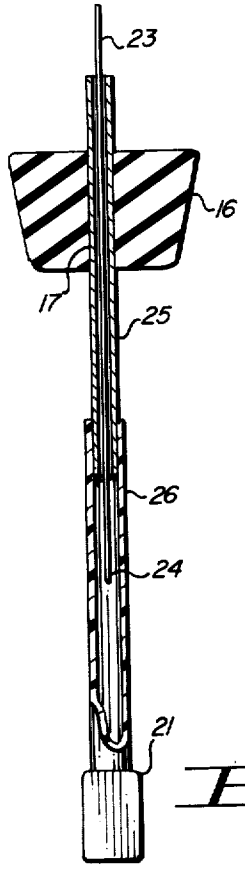


FIG-3

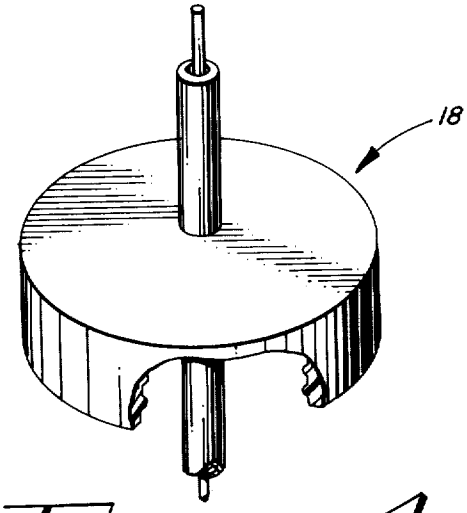


FIG-4

Fig-5

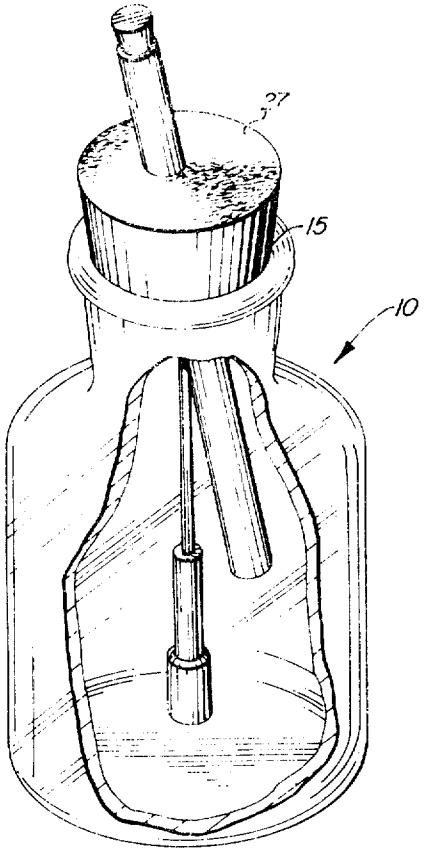
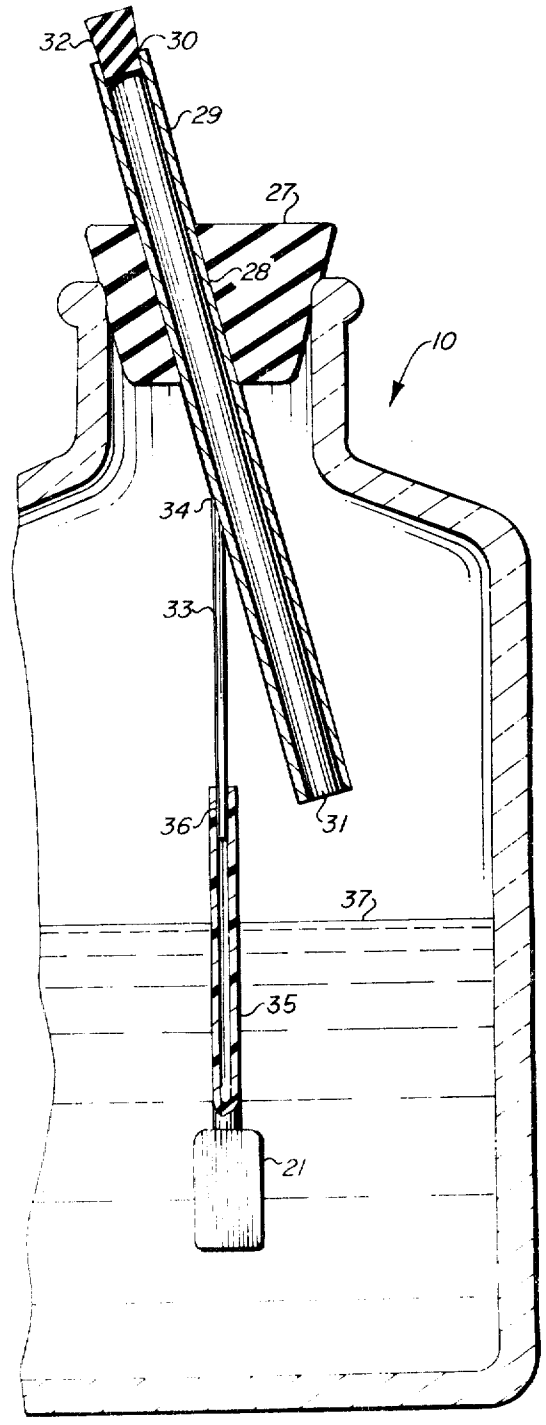


Fig-6



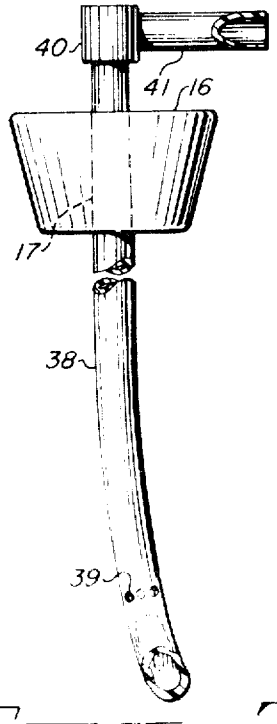


Fig-7

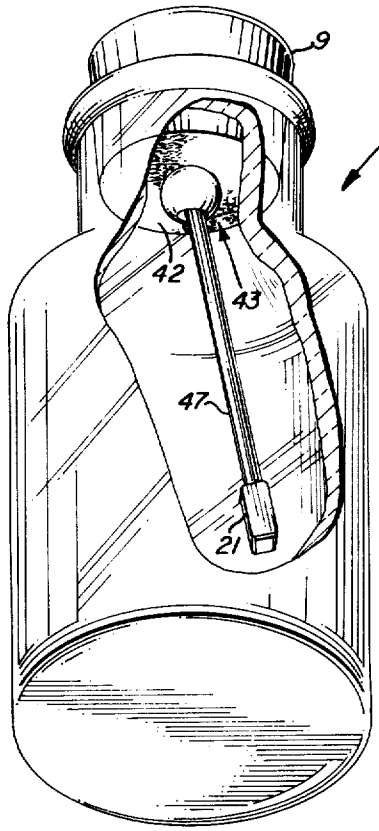


Fig-8

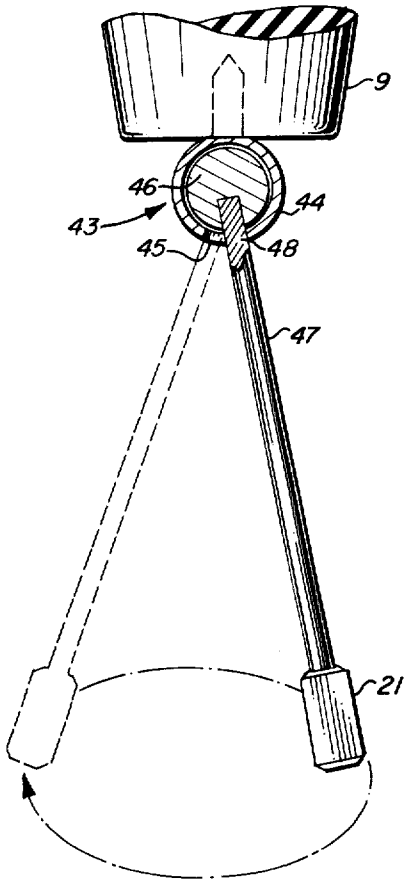


Fig-9

MAGNETIC CELL STIRRER

This is a division of application Ser. No. 379,081, filed July 13 1973, now U.S Pat. No. 3,854,704

The present invention relates to magnetic culture flasks for cell culture, for clinical mixing, fluid dispersion and the like and is concerned primarily with a magnetic stirrer which includes, as a characteristic and basic element, a flexible or rigid shaft carrying a coated magnet at its lower end.

BACKGROUND OF THE INVENTION

At the present time magnetic stirrers for cultures are known. Devices of this type which are now available comprise a flask having a flat bottom which rests on a magnetic operator. The operator includes a magnet which is rotated from a suitable power source. The flask also includes a top wall in which is journalled a vertical shaft having a magnet at its lower end, having its polarity related to the polarity of the magnetic operator so that rotation of the latter causes rotation of the magnet in the flask. In these known devices, the position of the magnetic stirrer is fixed relative to the flask bottom and walls. Thus, it can rotate only in this fixed position and the position of the magnetic stirrer relative to the flask bottom and flask wall never varies. This fixation is decided limitation on the effectiveness of the stirring action. In this journalled design sometimes the bearing jams, causing the unit to stop resulting in damage or loss of flask contents.

Also with the magnetic stirrer fixed in a position closely adjacent to the flask bottom it is impossible to stir the contents of the upper portion of the flask without disturbing any materials which may have collected on the bottom.

OBJECTS OF THE INVENTION

With the foregoing conditions in mind, the present invention has in view the following objectives:

1. To provide a magnetic stirrer for cells and the like for a container of a non-magnetic material which includes a bottom and a top opening and which stirrer comprises a closure for the opening, a flexible shaft mounted in the closure and a coated rigid magnet at the lower end of the shaft that is slightly spaced from the bottom of the container when the stirrer is assembled therewith.

2. To provide, in a container for stirring cells and the like of the type noted, a flexible shaft together with means for adjusting the flexing amplitude of the shaft.

3. To provide, in a container for stirring cells and the like of the character aforesaid, a flexible shaft having means associated therewith for introducing a fluid into the container through the closure.

4. To provide, in a container for stirring cells and the like of the kind described, a hollow flexible shaft which projects above the closure and is provided with a fitting for charging gas or other fluids therethrough with the lower end portion of the shaft adjacent to the magnet having discharge openings through which gas or other fluids is emitted into the culture; and

5. To provide in a container for stirring cells and the like of the type noted, a rigid shaft that is connected at its upper end to a closure for the container by a gimbal bearing and has a coated magnet secured to its lower end.

Various other more detailed objects and advantages of the invention, such as arise in connection with carrying out the above ideas in a practical embodiment, will, in part, become apparent and, in part, be hereafter stated as the description of the invention proceeds.

SUMMARY OF THE INVENTION

The foregoing objects are achieved by providing a flask comprising a substantially flat bottom, a wall upstanding from the bottom and a top wall including a neck defining an opening with which is associated a closure. This closure ordinarily takes the form of a stopper although a screw cap or other devices may be used. Mounted in this stopper is a flexible shaft which may be solid but is preferrably tubular. For the smaller and intermediate size flasks, this shaft may extend above the stopper an appreciable distance to provide flexibility to a required degree. An insert of appreciable rigidity, is inserted into the tubular shaft and is adjustable therein, whereby the presence and longitudinal location of the insert determines the flexing amplitude. For larger size bottles, a rigid shaft of suitable material may be mounted in the stopper and the flexible member may be secured to the lower end thereof. In this embodiment a similar flexing amplitude adjustment may be employed providing both rigid and flexible shafts are tubular.

When it is desired to introduce a liquid into the flasks, a rigid tube may be mounted in the stopper, either vertical or at an offset angle. A suspension rod has its upper end secured to this tube and the flexible shaft is attached to the lower end thereof.

When gas or other fluid substances is to be introduced into the flask a fitting is provided for introducing gas or fluid substance into the flexible tube above the stopper and the lower end of the tube adjacent to the magnet has a plurality of openings through which gas is discharged into the culture.

For a full and more complete understanding of the invention, reference may be made to the following description and the accompanying drawings wherein:

FIG. 1 is a perspective of a container for stirring cells and the like embodying the precepts of this invention and designed for smaller and intermediate sized flasks with a portion of the flask broken away.

FIG. 2 is a detailed sectional showing of the stopper, flexible shaft, and magnet.

FIG. 3 is a detailed sectional showing of the embodiment for larger size flasks which includes a rigid shaft.

FIG. 4 is a detailed perspective illustrating a screw cap which may be employed in lieu of a stopper.

FIG. 5 is a perspective of a modification by which liquids are introduced into flasks through the stopper.

FIG. 6 is a fragmentary sectional view of the embodiment of FIG. 5.

FIG. 7 is a detailed elevation of a modification for introducing gas or other fluid substance into the culture.

FIG. 8 is a perspective of a modification including a rigid shaft that is connected at its upper end to the container closure and carries a coated magnet at its lower end; and

FIG. 9 is an elevation of the stopper, gimbal bearing, shaft and magnet, with movement of the shaft and magnet being depicted in broken lens.

Before referring to the drawings, reference is made to U.S. Pat. No. 3,572,651, which discloses a spin-culture flask for cell culture and more particularly, illustrates the magnet operating mechanism for activating the magnet within the flask. Referring now to the

drawings, and first more particularly, to FIGS. 1 and 2, a container for stirring cells and the like for smaller and intermediate sizes will be described. In this connection it is noted that the intermediate sized may range between 125 and 500 milliliters in volume. The smaller sizes are those which are less than 125 milliliters, and the larger sizes are those having a capacity in excess of 500 milliliters.

A flask is referred to in its entirety at 10. It may be of any appropriate material, such as glass or plastic. Flask 10 comprises a bottom 11 which is substantially flat, a cylindrical wall 12, and a top 13 which includes a neck 14 that defines an opening 15. As shown in FIG. 1 opening 15 is provided with a closure in the form of a stopper 16 having a central vertical passage 17.

In this connection, it is noted that the present invention will be described with the stopper 16 closing the opening 15. However, it will be understood that this opening 15 might be closed by screw cap, such as shown at 18 in FIG. 4, or other suitable devices.

Rotatably mounted in passage 17 is a flexible shaft 19. While the shaft 19 may be of any material having the required property of strength and flexibility, tetrafluoroethylene polymer or tetrafluorethylene-hexafluoropropylene copolymer is indicated as a preferred material. Also, while shaft 19 may be solid, it is shown as being tubular presenting a bore 20. Mounted on the lower end of shaft 19 is a coated magnet 21. Magnet 21 comprises a bar magnet presenting a pole at 22 which is coated with a material which is inert with respect with the culture or material which is to be stirred in glass 10. Pole 22 is located closely adjacent to bottom 11 from which magnet 21 is spaced a slight distance.

In the case of the smaller size flasks such as those having a diameter less than 125 milliliters, shaft 19 may project above the upper face of stopper 16 an appreciable distance. This extent of the shaft 19 lends the property of flexibility thereto to the degree which may be required in small size flasks.

When the magnet operating mechanism of the above identified patent is operated, the magnetic force thereof is effective on pole 22 of magnet 21 to cause the latter to rotate in the manner depicted by the arrows in FIG. 1. This rotation generates centrifugal force which causes the magnet 21 to swing outwardly and upwardly and thus provide a highly effective area and space in which the stirring action takes place.

As shown in FIG. 2, an insert 23 is positioned into bore 20 of shaft 19 and presents a lower end 24 which determines the flexing amplitude of shaft 19. Thus, shaft 19 will ordinarily not flex above end 24. It is intended that by adjusting insert 23 in bore 20 the flexing amplitude may be adjusted.

It is believed that in most conditions of use of the smaller size flasks, the insert 23 will not be required. However, it may be incorporated into such smaller size flasks if so desired.

Referring now to FIG. 3, a rigid tube 25 is shown as rotatably mounted in passage 17 of stopper 16. Tube 25 may be of metal or glass or other suitable material and attached to the lower end thereof in any preferred manner, such as by an adhesive is a flexible shaft section 26. The usual magnet 21 is mounted at the lower end of shaft section 26. In operation the amplitude of flexing is determined by the lower end of shaft 25. However, should it be desired to shorten this amplitude, insert 23 may be positioned through shafts 25 and 26 until its lower end 24 is at a desired position to determine the flexing amplitude.

Referring now more particularly to FIGS. 5 and 6, a stopper 27 is used to close the opening 15 rather than the stopper 16. Stopper 27 is formed with a passage 28 which is inclined with respect to the vertical. Mounted in passage 28 is a tube 29 which is of a rigid material such as glass. Tube 29 has open ends 30 and 31 with the opening end 30 being closed when required by plug 32 or other suitable means. A rigid suspension member 33 has one end secured to tube 29 at 34. This point of connection at 34 is located on the vertical axis of flask 10. A flexible shaft 35 is rotatably mounted on the lower end of suspension member 33 as indicated at 36, the lower end of flexible shaft 35 carries the usual coated magnet 21.

FIG. 6 shows the flask 10 as including a culture or other material 37 which is to be stirred. Should it be desired to add a liquid to this culture plug 32 is removed and the liquid poured through tube 29.

FIG. 7 illustrates the modification by which gas or other fluids may be introduced into the culture. Thus, stopper 16 has the usual passage 17. Rotatably received in this passage 17 is the upper end portion of a flexible tube 38 which carries a coated magnet (not illustrated) at its lower end. Spaced from this lower end the tube 38 is formed with a plurality of openings 39. Shaft 38 projects above stopper 16 and mounted thereon is a fitting 40 from which a conduit 41 extends. Gas is introduced through conduit 41 and fitting 40 into shaft 38 from which it is discharged through openings 39 into the culture or other fluid 37.

Referring now to FIGS. 8 and 9, a modification that is characterized by the inclusion of a rigid shaft will be described. FIG. 8 shows a container 10 and a closure in the form of stopper 9. The latter presents an undersurface 42. Secured to stopper 9 at surface 42 is a gimbal bearing identified in its entirety at 43. The latter comprises a hollow sphere 44 which is formed at its lower region with an opening 45 or a required size. Universally rotatable in sphere 43 is a ball 46.

A rigid shaft 47 has its upper end anchored to ball 46 as indicated at 48. A coated magnet 21 is carried by shaft 47 at its lower end.

As magnet 21 is rotated by the magnetic operator it will swing radially and upwardly under centrifugal force. The pattern of such movement is depicted by broken lines in FIG. 9. The size of opening 45 will depend on how much movement of shaft 47 is to be accommodated.

While preferred specific embodiments are herein disclosed, it is to be clearly understood that the invention is not to be limited to the exact constructions, devices and materials illustrated and described because various modifications of these details may be provided in putting the invention into practice.

What is claimed is:

1. For use with a container for stirring cells and the like, said container including a bottom, a wall upstanding from said bottom, and an opening at the top, a magnetic flexible stirrer comprising:

a. a closure for said opening with a central vertical passage and proportioned for a tight fitting relationship with said opening, said passage being offset at an angle with respect to the vertical axis of the container and having a rigid tube received in said passage and a rigid suspension member having

its upper end connected to the rigid tube and its lower end to a flexible shaft, said connection of the suspension member to the rigid tube lying in the vertical axis of the container whereby liquid may be introduced into said container through said rigid tube;

b. a coated magnet rigidly mounted on said flexible shaft at the lower end thereof and closely adjacent to the bottom of said container when the stirrer is assembled therewith, whereby as said magnet is rotated by magnetic operating mechanism the shaft flexes into an arcuate configuration and moves upwardly and outwardly relative to said bottom by the centrifugal force generated by such rotation causing the said flexure.

2. For use with a container for stirring cells and the like, said container including a bottom, a wall upstanding from said bottom, and an opening at the top, a magnetic flexible stirrer comprising:

a. a closure for said opening formed with a central vertical passage and proportioned for a tight fitting relationship with said opening;

b. a flexible shaft mounted in said central passage with said closure between the ends thereof; and

c. a coated magnet rigidly mounted on said flexible shaft at the lower end thereof and closely adjacent to the bottom of said container when the stirrer is assembled therewith, whereby as said magnet is rotated by magnetic operating mechanism the shaft flexes into an arcuate configuration and moves upwardly and outwardly relative to said bottom by the centrifugal force generated by such rotation causing the said flexure.

d. the flexible shaft is tubular, projects above the closure and is formed with a plurality of openings adjacent to the magnet, together with a fitting on the flexible shaft above the closure and a conduit connected to said fitting for introducing gas through the fitting and into the flexible shaft.

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