United States Patent [19]

Balas

[11] **3,854,704**

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[54] **MAGNETIC CELL STIRRER**

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

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

[51] **Int. Cl.** **B01f 7/16**

[58] **Field of Search** ..... 259/116, 117, 118, 119, 259/121, 122, 125, 102, DIG. 46

[56] **References Cited**

UNITED STATES PATENTS

2,932,493 4/1960 Jacobs 259/102

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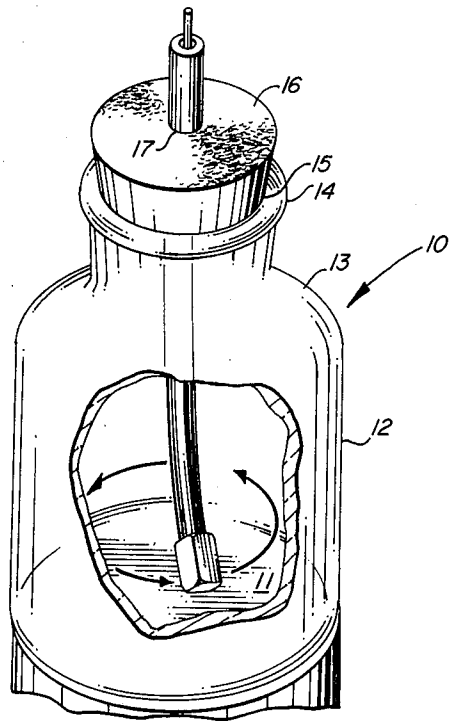
[57] **ABSTRACT**

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.

5 Claims, 9 Drawing Figures



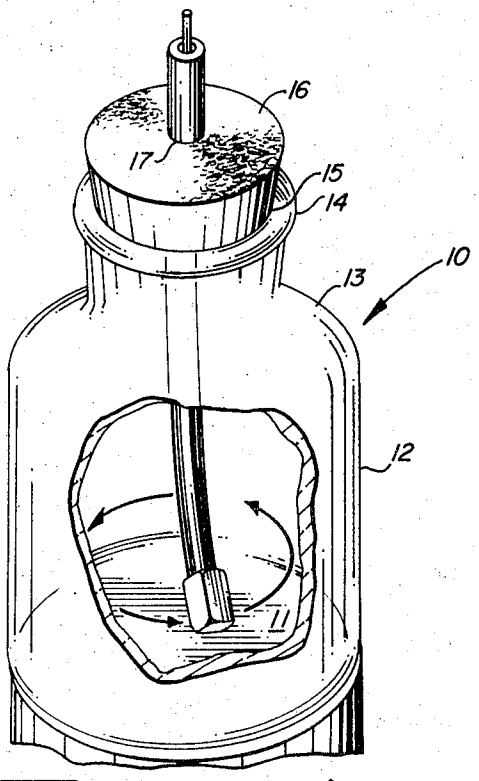


Fig-1

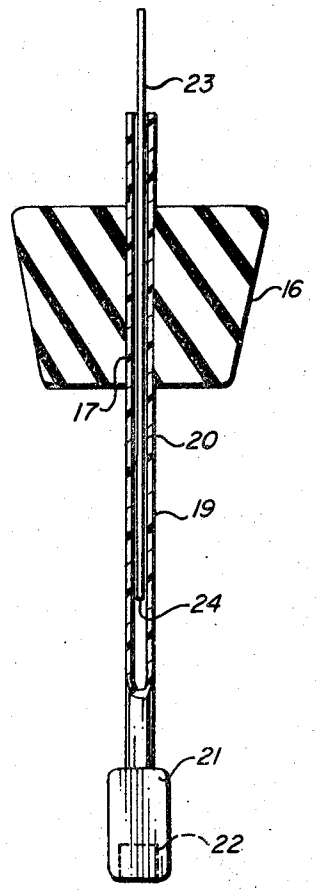


Fig-2

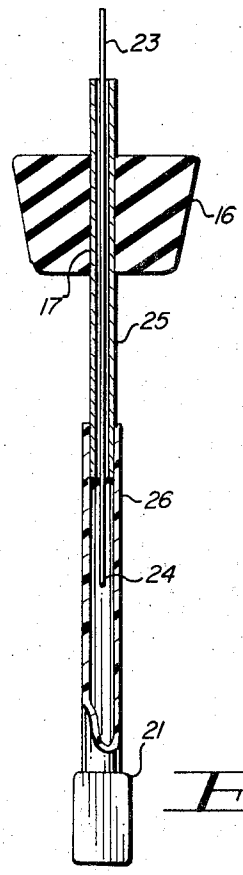


Fig-3

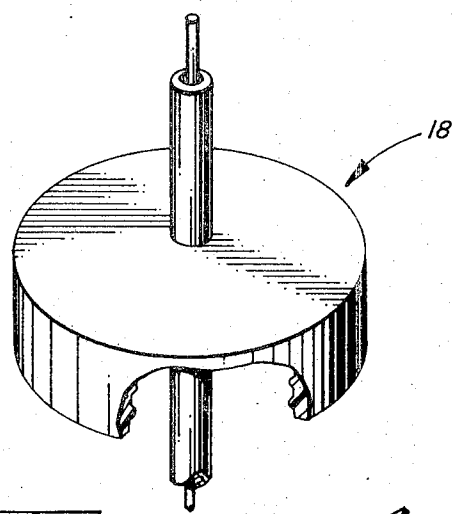


Fig-4

Fig-5

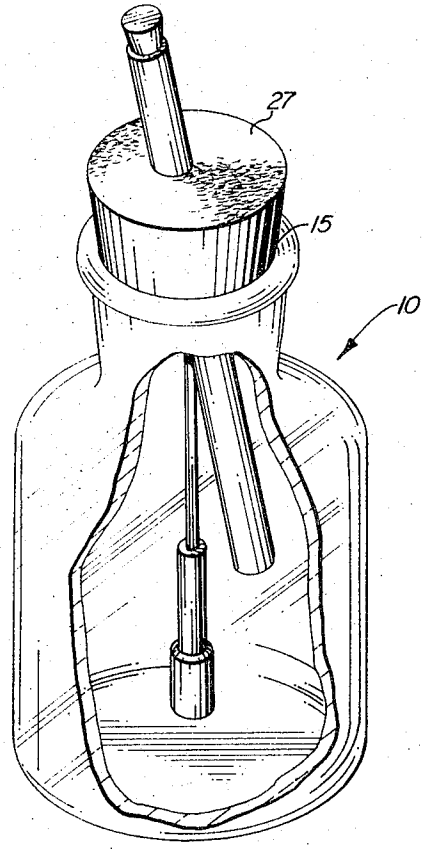
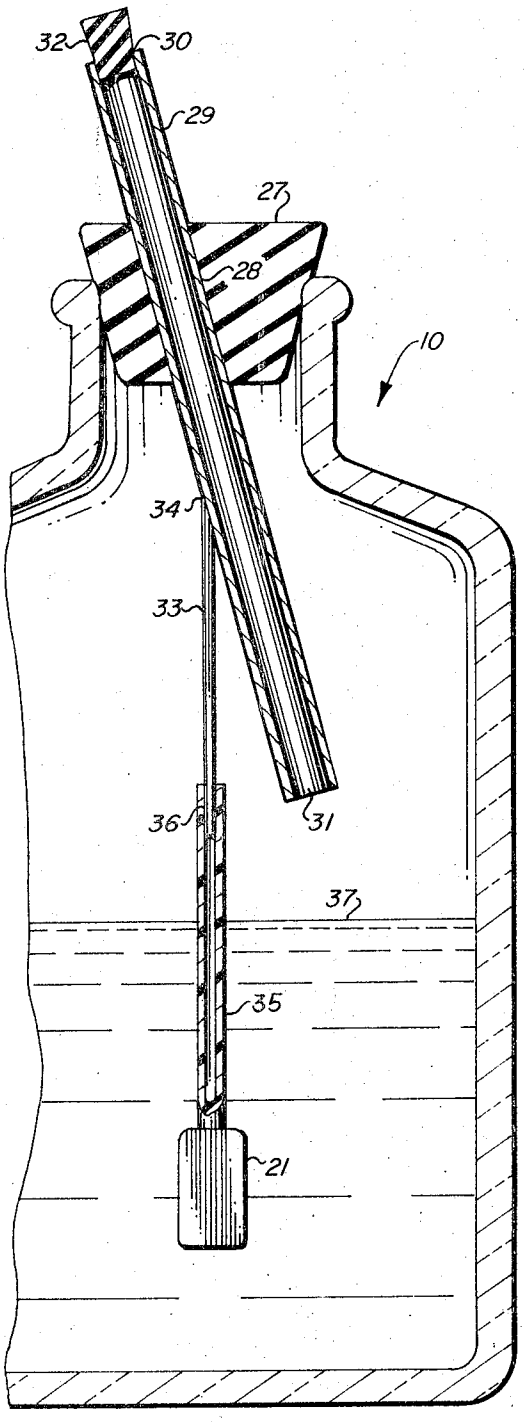


Fig-6



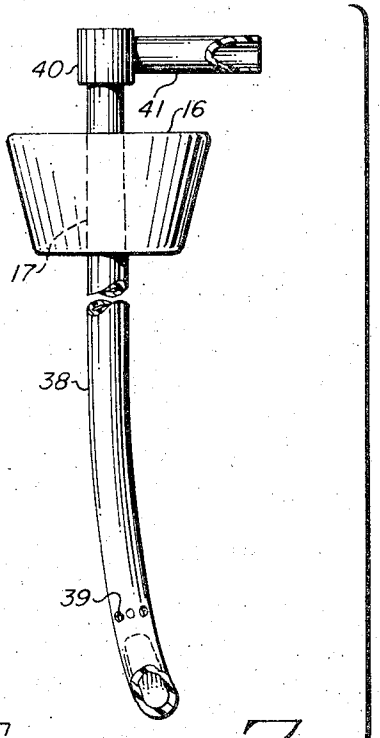


Fig-7

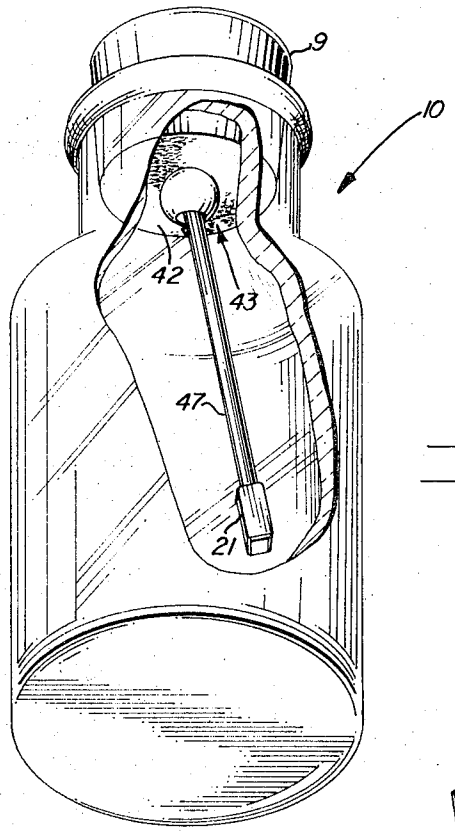


Fig-8

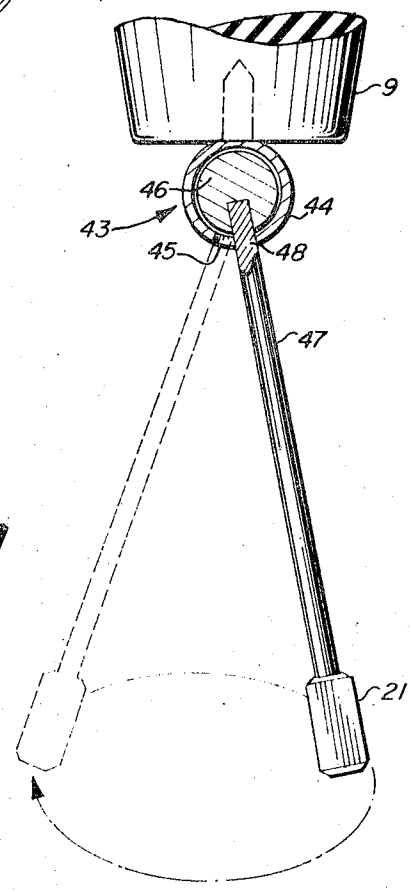


Fig-9

MAGNETIC CELL STIRRER

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 a 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 is adapted for a tight fitting relationship with the opening and 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, il-

lustrates 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 sizes 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 tetrafluoroethylene-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** of 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 formed with a central vertical passage and proportioned for a tight fitting relationship with said opening;

b. a flexible shaft (rotatably) 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.

2. The magnetic cell stirrer of claim **1** in which the closure is a stopper which fits snugly in said opening.

3. 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 vertical passage;

b. a flexible tubular shaft mounted in said passage together with an insert adjustably mounted in said tubular shaft whereby the flexing amplitude of said tubular shaft may be varied by adjusting the insert therein; and

c. a coated magnet on said flexible shaft on 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 and moves upwardly and outwardly relative to said bottom by the centrifugal force generated by such rotation.

4. 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 vertical passage;

b. a flexible shaft mounted in said passage by a rigid shaft, the lower end of which is connected to said flexible shaft; and

c. a coated magnet 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 and moves upwardly and outwardly relative to said bottom by the centrifugal force generated by such rotation.

5. The magnetic cell stirrer of claim **4** in which the rigid and flexible shafts are tubular together with an insert adjustably received in said tubular shafts.

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