May 21, 1968 L. R. WORTH 3,384,353

MAGNETIC STIRRER

Filed May 31, 1967

FIG. 1.

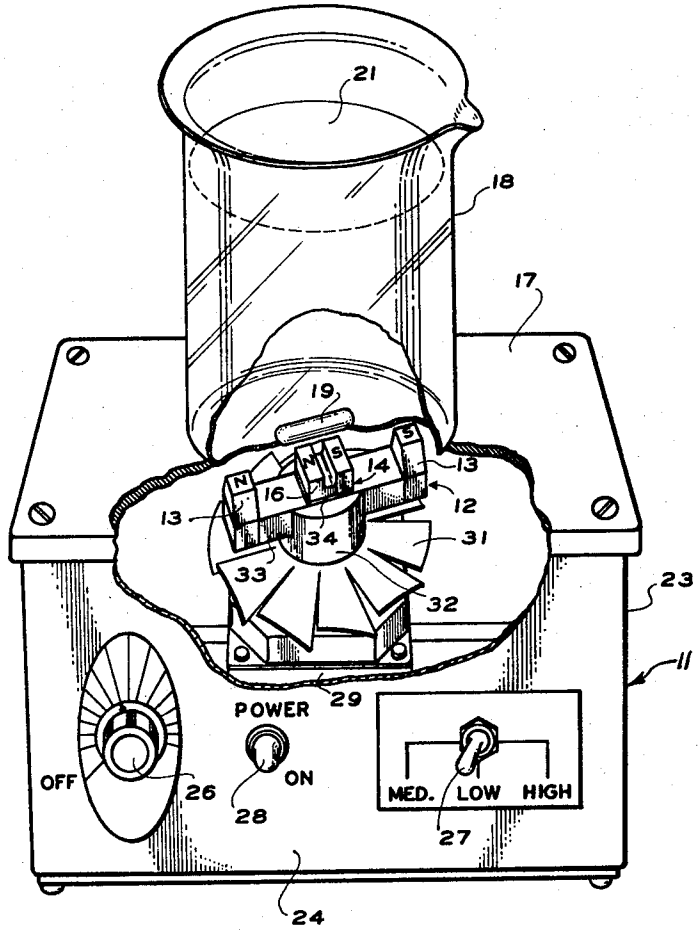
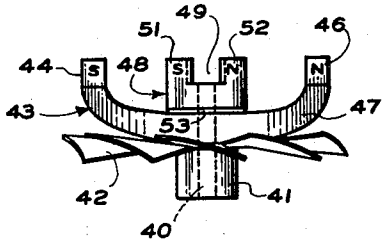


FIG. 3.



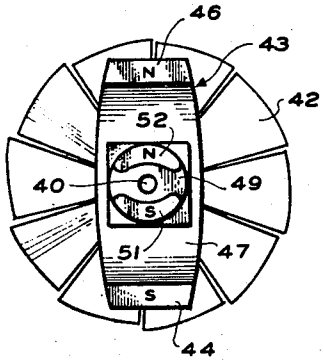


FIG. 2.

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MAGNETIC STIRRER

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ABSTRACT OF THE DISCLOSURE

A magnetic stirrer is described in which a compound magnet comprised of two magnet structures is utilized. Means are provided for supporting a liquid container having a stirring element formed of magnetic material therein within the field established by at least one of the magnet structures of the compound magnet. The rotation of the compound magnet causes a concurrent rotation of the stirring element within the liquid in the container.

This invention relates to magnetic stirrers and, more particularly, to an improved magnetic stirrer which is capable of utilization in connection with a wide range of sizes of stirring elements or bars at their maximum efficiency without sliding, drifting or jumping.

Magnetic stirrers are used to agitate fluid in a container or vessel in a manner which facilitates access to and visibility of the fluid in the container. No agitator shafts or other devices extend into the container when used with a magnetic stirrer, thereby presenting minimal obstruction at the open top of the container. The particular instances in which a magnetic stirrer may be found to be of advantage are numerous and include, for example, laboratory type procedures, such as titration, involving the mixing of various chemicals wherein it is important to control the amount of chemical being added, observe the process, and maintain a uniform distribution of the chemicals within the container.

A magnetic stirrer is generally used in connection with a magnetic stirring element disposed within the vessel containing the fluid to be stirred. The magnetic stirrer incorporates a magnet structure providing a magnetic field, and the fluid containing vessel is supported such that the stirring element therein is within the magnetic field. The magnet structure is then rotated or otherwise moved to cause a corresponding movement of the stirring element and consequent agitation of the fluid. The magnetic stirrer may incorporate a hot plate for maintaining the fluid at a desired temperature, a light or lights for providing illumination of the fluid in the vessel, and means for varying the speed of the magnet structure to provide for different degrees of fluid agitation.

Magnetic stirrers of heretofore known construction have sometimes been subject to certain limitations. One major limitation frequently encountered in prior art devices has been their inability to accommodate a wide range of magnetic stirring element sizes. Thus, a given size magnetic stirrer of prior known construction may only be usable for a limited range of vessel sizes. Previous attempts at designing magnetic stirrers to accommodate a wide range of stirring element sizes have been generally unsatisfactory in that, for many sizes, when the stirring elements are moved in a manner for peak efficiency, the elements may slide, drift, or jump out of position in the vessel due to inadequate holding ability of the magnetic field produced by the magnet structure within the stirrer.

It is, accordingly, an object of this invention to provide an improved magnetic stirrer.

Another object of the invention is to provide a magnetic stirrer capable of utilization in connection with a relatively wide range of stirring element sizes.

A further object of the invention is to provide a magnetic stirrer capable of utilization in connection with a wide variety of stirrer element sizes at their maximum efficiency without sliding, drifting or jumping.

It is another object of the invention to provide an improved magnetic stirrer generally of the type described, which is low in cost and of simple reliable construction.

Other objects of the invention will become apparent to those skilled in the art from the following description taken in connection with the accompanying drawings wherein:

FIGURE 1 is a perspective view of a magnetic stirrer constructed in accordance with the invention, and having the top broken away to illustrate internal elements, and illustrating a beaker broken away to show a stirring element therein;

FIGURE 2 is a top view of a portion of an alternative embodiment of the invention; and

FIGURE 3 is a side view of the elements illustrated in FIGURE 2.

Very generally, the magnetic stirring device **11** of the invention comprises a first permanent magnet structure **12** formed of a material such as Alnico and having a pair of first pole portions **13** of opposite polarity, and a second permanent magnet structure **14** also formed of a material such as Alnico and having a pair of second pole portions **16** of opposite polarity spaced from the first pole portions. The second pole portions are disposed between the first pole portions on a line extending between the first pole portions. The first and second magnet structures are positioned with the respective first and second pole portions of like polarity closest to each other. Means **17** are provided for supporting a fluid containing vessel **18** with a stirring element **19** therein within the magnetic field established by the first and second magnet structures. Means are provided for moving the first and second pole portions in a manner to stir the fluid in the vessel.

Referring now in greater detail to the invention, the magnetic stirrer **11** is illustrated in FIGURE 1 for use in stirring the fluid **21** in the vessel **18**. The vessel illustrated is a conventionally shaped beaker; however, vessels of other shapes and sizes may also be utilized in connection with the invention.

The stirring element **19** disposed within the vessel **18** may be of any shape suitable for achieving the desired stirring effect. The particular shape of the stirring element **11** will depend upon the shape of the vessel and the materials of which the vessel and the stirring element are comprised. Thus, if the vessel has a curved bottom, a stirring element of a generally egg shaped form, rather than the elongated rod form illustrated, may be preferable. Moreover, although the stirring element is comprised of magnetic material, it may be coated with a protective substance such as glass or Teflon, depending upon the nature of the fluid being stirred. If desired, the stirring element may include a raised portion (not shown) intermediate its ends so that the element may more easily spin in the vessel.

The magnetic stirrer **11** includes a housing **23** having the beaker supporting means or table **17** and a control panel **24**. The control panel is provided with a speed control **26**, a load mode control **27**, and a power-on light **28**. The latter is for indicating when the stirrer is operating. The load mode control and the speed control are connected by suitable electrical circuitry (not illustrated) to a driving motor **29** for the magnetic stirrer. The motor constitutes part of the means for moving the pole pieces to agitate the fluid. The load mode control is for varying the torque of the electric motor to take into account the

viscosity of the fluid being stirred. The speed control is for providing the desired degree of agitation in the fluid.

The motor **29** is for rotating the pair of magnet structures **12** and **14**, described in detail below, and has a drive shaft, not visible. The drive shaft is drivingly connected to a fan **31** for providing a circulation of cooling air, and to a cylindrical mount **32**, the latter also constituting part of the means for moving the pole pieces.

The cylindrical mount **32** is drivingly secured to the end of the motor drive shaft and supports the two magnet structures **12** and **14**. The magnet structure **12** includes an elongated bar **33** supporting the pole portions **13** at each end thereof. Each of the pole portions **13** comprises a generally elongated pole piece and the two pole pieces are disposed parallel to each other. The pole pieces are tapered toward the tips thereof, and the tips of the pole pieces lie in the same plane, a plane which extends generally parallel with the plane of the supporting table **17** and just underneath it. The elongated bar **33** is comprised of a suitable magnetized material so that the pole pieces **13** are of opposite polarity as indicated in the drawing.

The second magnet structure **14** is provided with the second pole portions **16** thereon. The magnet structure **14** comprises a generally U-shaped magnet with the pole portions **16** disposed at each tip. The magnet structure **14** is supported on the elongated bar **33**, and a non-magnetic (e.g., aluminum) shim or spacer **34** separates the U-shaped magnet structure **14** from the elongated bar. The elongated bar **33** rests in a diametrical channel or slot provided in the cylindrical mount **32**, projecting from each end thereof. The assembly of the two magnet structures may be held together by any suitable means, but it is preferable that the bond be accomplished by means of baked and cured epoxy, not illustrated.

The smaller U-shaped magnet structure **14** is oriented so that its pole portions **16** and the pole portions **13** of the magnet structure **12** are all in general alignment. In addition, the two magnet structures are positioned with their respective pole portions of like polarity closest to each other, as indicated in the drawing.

The result of the foregoing described construction is the production of two magnetic fields. The larger field, produced by the magnet structure **12**, is highly concentrated at the pole portions **13** due to the tapering shape of the pole portions or pieces, and due to the effect of the smaller magnetic field established by the magnet structure **14**. This smaller magnetic field forces the flux lines of the larger magnetic field outwardly toward the opposite ends of the magnet structure **12**.

The gap between the pole portions **13** and the pole portions **16** is selected to be sufficient to prevent the larger magnet structure **12** from excessively degrading the effect of the small magnet structure **14**. The precise positioning of the pole portions **13** and the pole portions **16** may be arrived at empirically, depending upon the range of stirring element sizes it is desired to accommodate. Thus, for example, where the magnet structure **12** is 3 inches in the horizontal direction from the outside surfaces of the respective pole portions **13**, and where the second magnet structure **14** is centered on the elongated bar **33**, being about ¾ of an inch between outside surfaces and having a centered 7/32 inch wide gap about ⅜ of an inch deep, the device is capable of accommodating bar type stirring elements in the length range from about 3/10 of an inch to slightly over 3 inches. Naturally, this geometry can be changed, if necessary to accommodate other ranges of stirring element sizes. It is preferred that the tops of all pole faces or portions be even or coplanar.

In operation, smaller size stirring elements are centered and held by the smaller magnetic field established by the magnet structure **14**. Larger stirring elements may be centered on and are held securely by the highly concentrated field established at the pole portions **13** of the larger magnet structure **12**. This particular arrangement insures that a variety of stirring element sizes may be securely locked in and held by the rotating magnet structures.

In assembling the magnetic stirrer illustrated in FIGURE 1, it is preferable that a keeper or magnetic shunt (not shown) be placed on the smaller structure **14** to reduce the effect of its magnetic field and to enable the magnet structures to be positioned more readily with respect to each other. It is preferable that the magnet structures be oriented properly (i.e., north to north) before bringing them together, and that the smaller magnet structure **14** be brought down perpendicularly to the bar **33** and that relative rotation be avoided.

Referring now to FIGURES 2 and 3, an alternative construction for part of the magnetic stirrer of the invention is illustrated. In the alternative structure, a bushing **41** and a drive shaft **40** are used to support and drivingly secure the two magnet structures described below to a drive shaft of the motor. A fan **42** is secured to the bushing **41**, as is the larger magnet structure **43**. The larger magnet structure **43** consists of an elongated magnet having its ends **44** and **46** turned to extend transversely of its middle portion **47** and parallel with each other. The ends **44** and **46** are tapered and comprise pole portions or pieces of the magnet structure **43**. The polarities are indicated in the drawing.

The smaller magnet structure **48** consists of a cylindrical or button type magnet having a slot **49** extending between the opposite poles or pole portions **51** and **52**. A shim or spacer **53** is positioned between the magnet structure **48** and the middle portion **47** of the magnet structure **43**. The shim or spacer **53** is of non-magnetic material. The entire assembly of the two magnet structures may be held together as before, that is, by a suitable epoxy, not illustrated.

The construction illustrated in FIGURES 2 and 3 provides a similar arrangement of two magnetic fields as is established by the device illustrated in FIGURE 1.

It may therefore be seen that the invention provides an improved magnetic stirrer of simple, sturdy and economical construction. The magnetic stirrer of the invention is capable of accommodating a range of sizes of stirring elements without being subject to sliding, drifting or jumping thereof. The stirring elements are securely locked in irrespective of their size, within the size range for which the magnetic stirrer is designed.

Various modifications of the invention in addition to those shown and described herein will become apparent to those skilled in the art from the foregoing description and accompanying drawings. Such modificaions are intended to fall within the scope of the appended claims.

What is claimed is:

1. A magnetic stirring device comprising, a first magnet structure having a pair of first pole portions of opposite polarity, a second magnet structure having a pair of second pole portions of opposite polarity spaced from said first pole portions, said second pole portions being disposed between said first pole portions on a line extending between said first pole portions, said first and second magnet structures being positioned with the respective first and second pole portions of like polarity closest to each other, means for supporting a fluid containing vessel with a stirring element therein within the magnetic field established by said first and second magnet structures, and means for moving said first and second pole portions in a manner to move the stirring element.

2. A device according to claim **1** wherein said moving means include a rotary support mechanically coupled to said first and second magnet structures for rotating same.

3. A device according to claim **2** wherein the axis of rotation of said rotary support is perpendicular to a line extending through said pole portions and is aligned with a space between said second pole portions.

4. A device according to claim 1 wherein said pole portions comprise generally elongated mutually parallel pole pieces having their tips lying generally in the same plane.

5. A device according to claim 4 wherein said first pole pieces of said first magnet structure are tapered toward their tips to concentrate magnetic flux thereat.

6. A device according to claim 1 wherein said first magnet structure includes an elongated bar and a pair of elongated pole pieces extending perpendicularly thereto, one at each end, wherein said second magnet structure includes a generally U-shaped magnet supported on said elongated bar, and wherein a non-magnetic spacer is disposed between said bar and said U-shaped magnet.

7. A device according to claim 1 wherein said first magnet structure includes an elongated magnet having its ends turned to extend transversely of its middle portion and parallel with each other, wherein said second magnet structure includes a button magnet supported on the middle portion of said elongated magnet and having a slot therein between opposite poles, and wherein a non-magnetic spacer is disposed between the middle portion of said elongated magnet and said button magnet.

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