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(54) **Magnetic stirring apparatus and method.**

(57) A magnetic stirring apparatus is disclosed which is capable of suspending solids in a liquid medium. The apparatus comprises a vessel (22) for containing fluids and solids, a magnetic impeller (10) and a means (26) for rotating the magnetic impeller.

The impeller comprises a chamber (12) which is buoyant with respect to the fluid (24) contained by the vessel (22) and a magnet (14) placed within the buoyancy chamber (12) thereby forming a buoyant magnetic impeller.

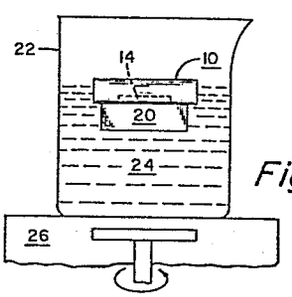


*Fig. 5*

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# MAGNETIC STIRRING APPARATUS AND METHOD

The present invention relates to an apparatus and method for stirring fluids with a magnetic impeller, and more particularly, a novel buoyant magnetic impeller which can be used to stir fluids as well as suspended solids.

While a floating "magnetic impeller" has been employed in the past, the structure and principle is different from the present invention. U.S. 4,310,253 to Sada et al., discloses magnetic particles which are covered with a material less dense than the fluid the particles are to stir, e.g., paraffin. The result is a mat of floating magnetic particles which stirs a fluid when subjected to a rotating magnetic field.

The present invention provides an improved magnetic stirring apparatus capable of suspending solids in a liquid medium with a minimum of shear force. It is particularly useful in suspended microcarrier cell culture, where low shear forces and low revolution per minute (RPM) operation are desirable.

According to the present invention there is provided a magnetic stirring apparatus capable of suspending solids in a liquid medium, comprising a vessel for containing fluids and solids, having walls, a bottom, and an opening; a magnetic impeller; and a means for rotating the magnetic impeller; characterized in that the impeller comprises a chamber which is buoyant with respect to the fluid contained by the vessel, and a magnet placed within the buoyancy chamber thereby forming a buoyant magentic impeller.

The invention provides an effective, yet inexpensive stirrer. The need for a stirrer shaft and bearing is eliminated by the use of a buoyant magentic impeller wherein the magnet is placed inside a buoyant chamber. This is different from the coated, comminuted magnetic particles in the prior art. The present impeller has a space between the magnet and the chamber walls for buoyancy. However, the magnet is not coated with a buoyant composition, and need not have a chamber made from buoyant materials.

In fact, one of the advantages of the instant design is that the buoyancy of the impeller can be adjusted by changing the density of fluid in the space between the magnet and the chamber walls. For example, if the chamber is filled with a liquid alkane it would be more buoyant in water than if it was filled with benzene. Thus, the depth of the impeller in the fluid to be stirred can be controlled.

Alternatively, if one had a fluid-filled chamber with excess positive buoyancy, one could leave the chamber fluid alone and decrease the buoyancy by adding ferromagnetic material such as iron to the external chamber walls. The magnetic attraction to the internal chamber magnet would keep the extrenal ferromagnetic material attached to the buoyancy chamber.

In the accompanying drawings:

Figure 1 is a side elevational view of the buoyant magnetic impeller with a cutaway;

Figure 2 is a cross sectional view of the impeller;

Figure 3 is a side elevational view of the impeller equipped with a paddle blade;

Figure 4 is a cross-sectional view of the impeller of Figure 2; and

Figure 5 is a schematic view of a magnetic stirring apparatus using the buoyant magentic impeller.

In a preferred embodiment for use in suspended microcarrier cell culturing, the present invention comprises, as shown in Figure 1, with a buoyant magnetic impeller 10 having a buoyancy chamber 12 and a magnet 14. The chamber is dimensioned and configured to allow placement of the magnet within the chamber as well as to provide a buoyancy space 16 about the magnet.

Attached to the outside of the chamber wall adjacent to and extending away from the magnet is a optional impeller blade 20 (see Figure 3). This blade has a negative buoyancy such that when the impeller is placed into a stirring vessel 22 containing a fluid 24, the blade extends downwardly into the fluid. Impeller movement arises from a conventional rotating means 26 which provides a rotating magnetic field.

One of the advantages of the above described impeller is that the impeller-to-bottom-wall clearance can be adjusted without relying on bearings and shafts. One can adjust the height by varying the buoyancy. For example, detachable impeller blades of varying weight can be used to compensate for fluids of diverse densities. On the other hand, the chamber space can be filled with a material, which can be solid, liquid, or gas. In fact, the chamber space could even be evacuated.

Suspension cell culturing can put high demands on a stirrer, i.e., low speed operation, minimal fluid shearing, and adequate clearance to avoid cell grinding. The present invention excels in all these areas. Without bearings and shafts, and correctly adjusted in height, cell abrasion is eliminated. When submerged in a suspension, preferably to about two thirds of the chamber height, low speed suspension without shear is a reality.

CLAIMS

1. A magnetic stirring apparatus capable of suspending solids in a liquid medium, comprising a vessel (22) for containing fluids and solids, having walls, a bottom, and an opening; a magnetic impeller (10); and a means (26) for rotating the magnetic impeller; characterized in that the impeller comprises a chamber (12) which is buoyant with respect to the fluid (24) contained by the vessel (22) and a magnet (14) placed within the buoyancy chamber (12), thereby forming a buoyant magentic impeller (10).

2. An apparatus as claimed in claim 1, wherein an impeller blade (20) is attached to the buoyancy chamber (12) and extends downward into the fluid (24).

3. A method of stirring a fluid wherein the fluid is contained by an apparatus as claimed in claim 1 or 2, and the rotating means magnet stirs the fluid by causing the buoyant magnetic impeller (10) to rotate.

4. An impeller (10) for a magnetically rotated stirrer, characterized by a chamber (12) which is buoyant with respect to the fluid (24) it is to stir, and a magnet (14) within the chamber (12).

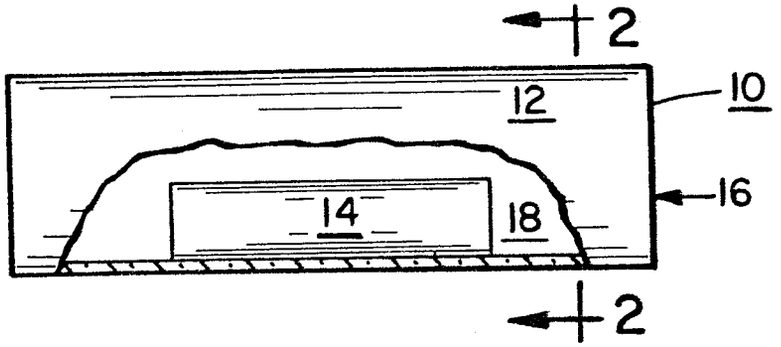


Fig. 1

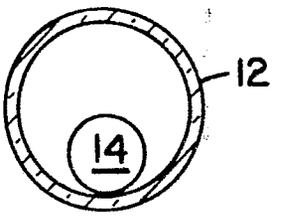


Fig. 2

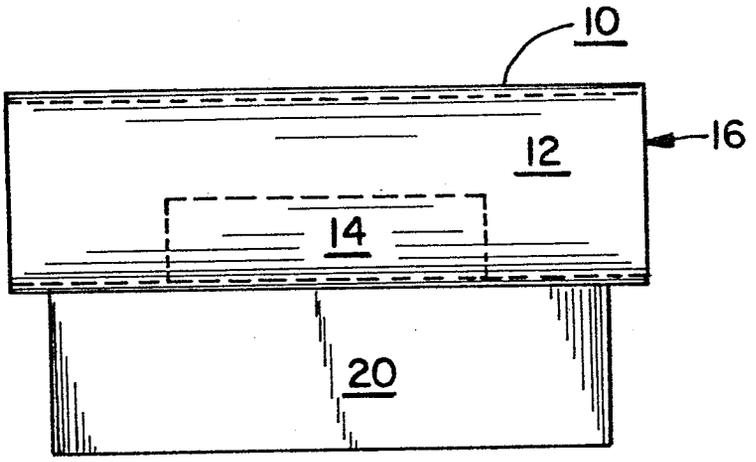


Fig. 3

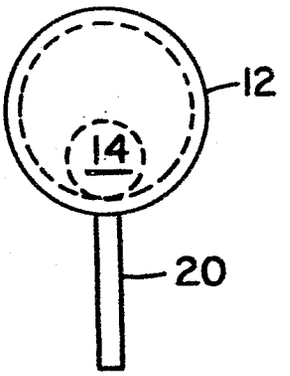


Fig. 4

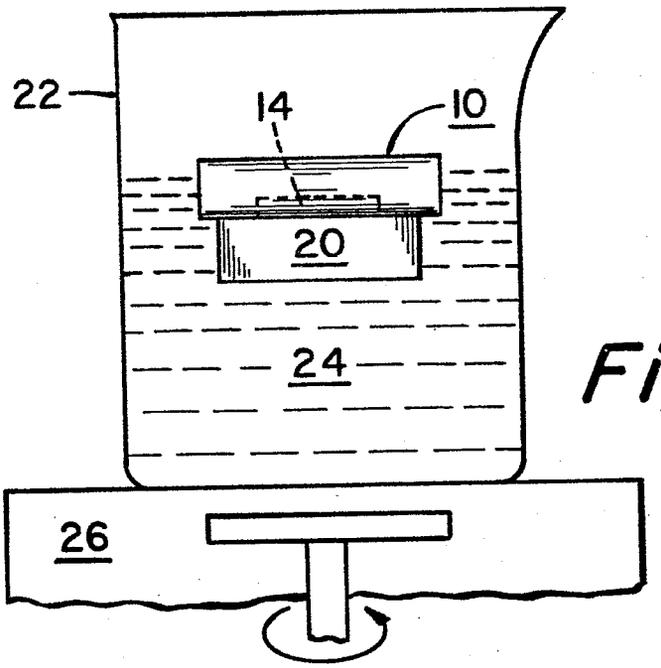


Fig. 5