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 [21] Appl. No. **696,428**
 [22] Filed **Jan. 8, 1968**
 [45] Patented **Mar. 16, 1971**

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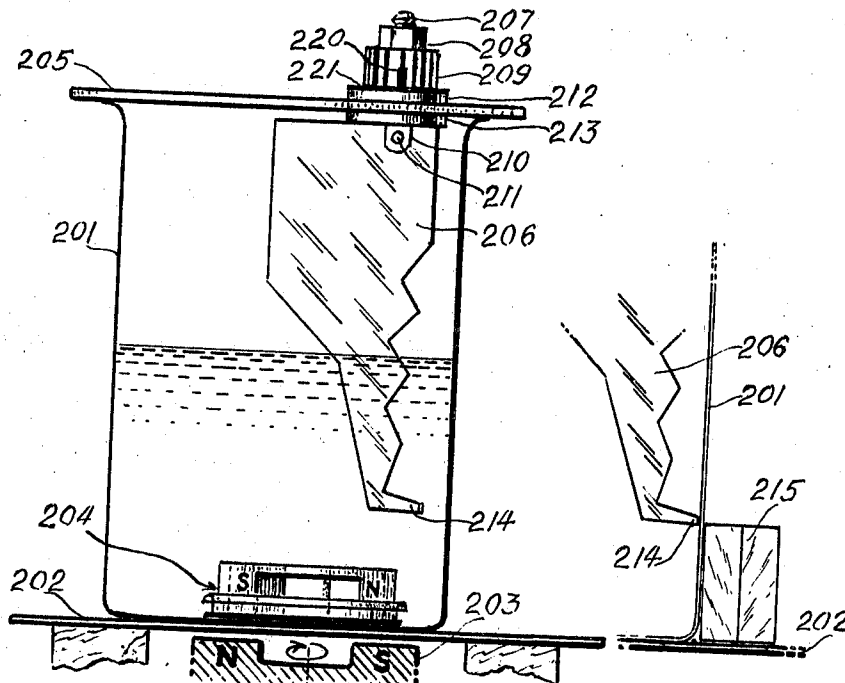
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 Attorney—Leonard Holtz

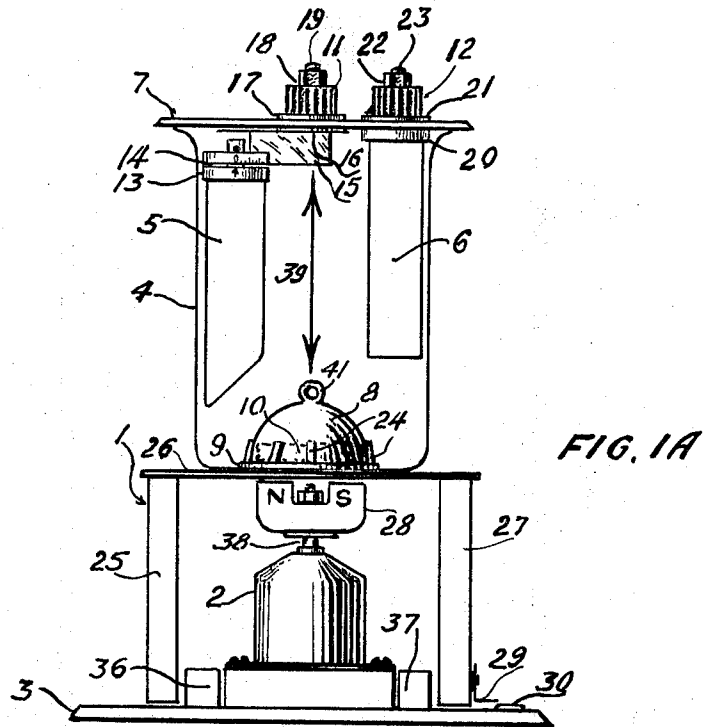
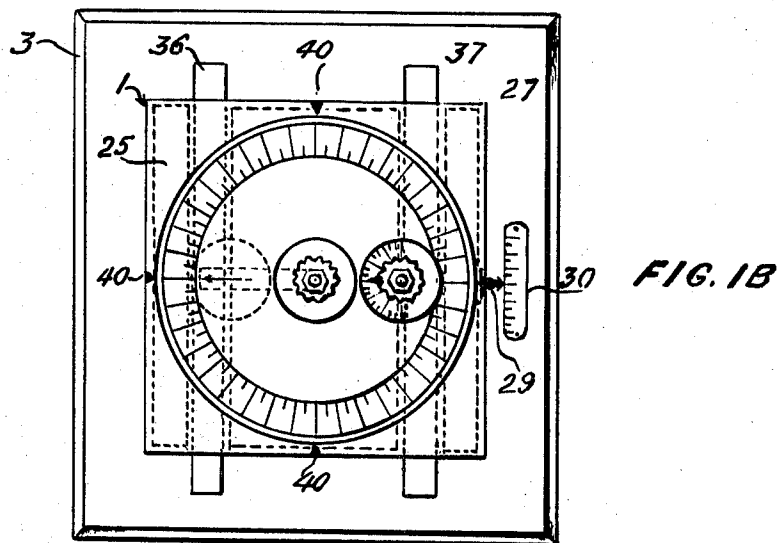
[54] **MAGNETIC STIRRERS**
 45 Claims, 48 Drawing Figs.

[52] U.S. Cl. 259/108,
 259/67
 [51] Int. Cl. B01f 7/16
 [50] Field of Search 259/102,
 107, 108, 118, 119, 121, 122, 7, 8, 23, 24, 43, 44,
 67, 66

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ABSTRACT: This invention relates to improvements in magnetic stirrers, wherein means such as, apparatus to change the relative position of the magnetic driving means and the vessel, a rotor having a substantially circular portion in its plane of rotation and adjustable baffle elements, are provided singly or in combination to enable the stirring characteristics of the stirrer to be adjustable over a wide range. Means are further provided for indexing the settings of the above variables so that any particular stirring pattern may be easily and accurately duplicated.





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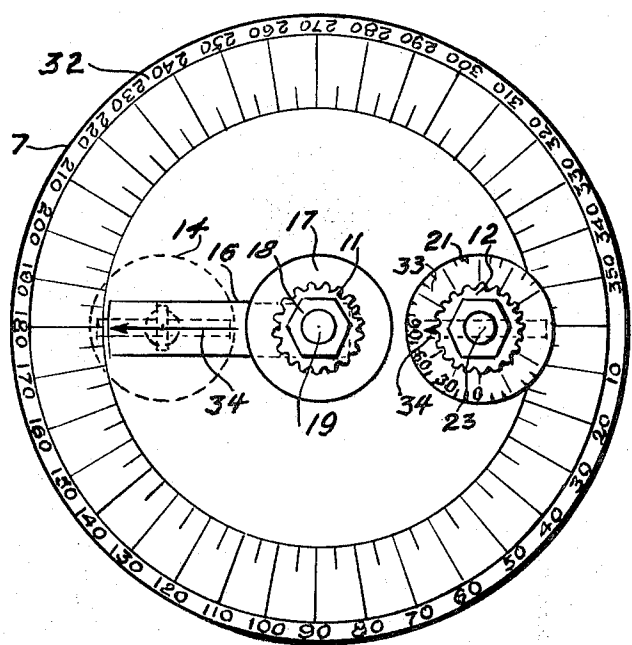
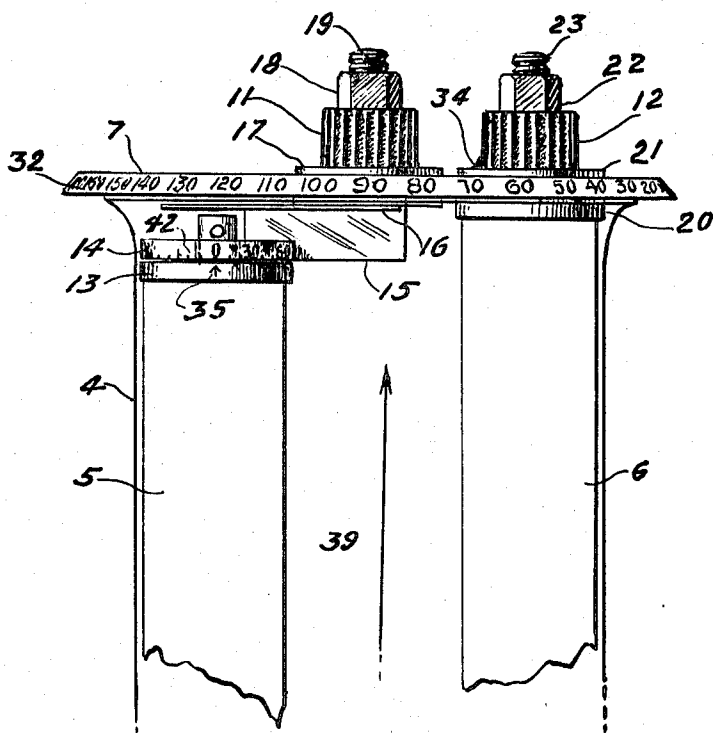


FIG. 2A



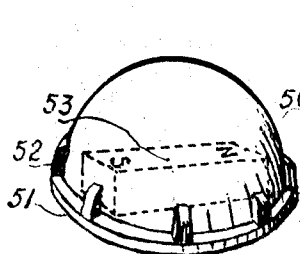


FIG. 3

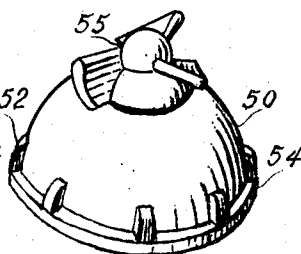


FIG. 4

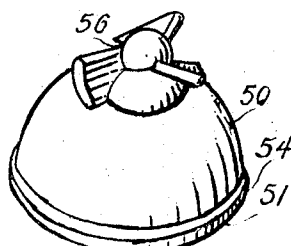


FIG. 5

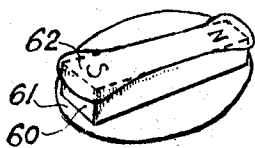


FIG. 6

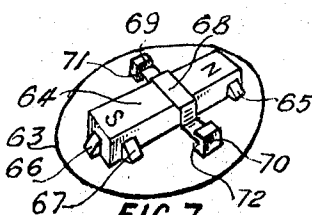


FIG. 7

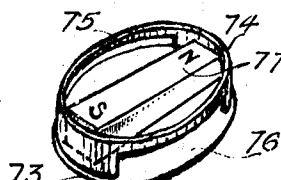


FIG. 8

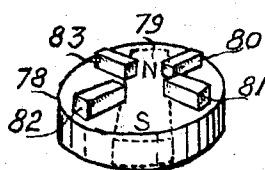


FIG. 9

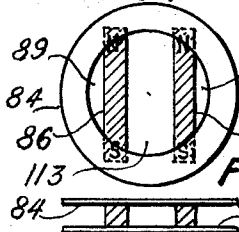


FIG. 10B

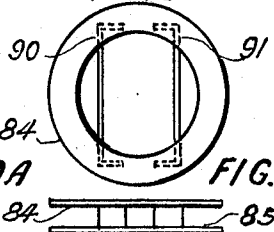


FIG. 11B

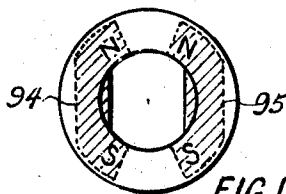


FIG. 12A

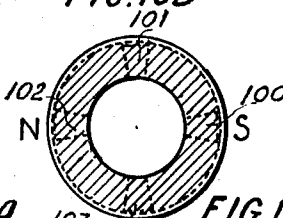


FIG. 13A

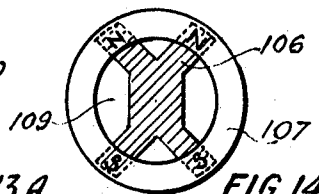


FIG. 14A



FIG. 12B



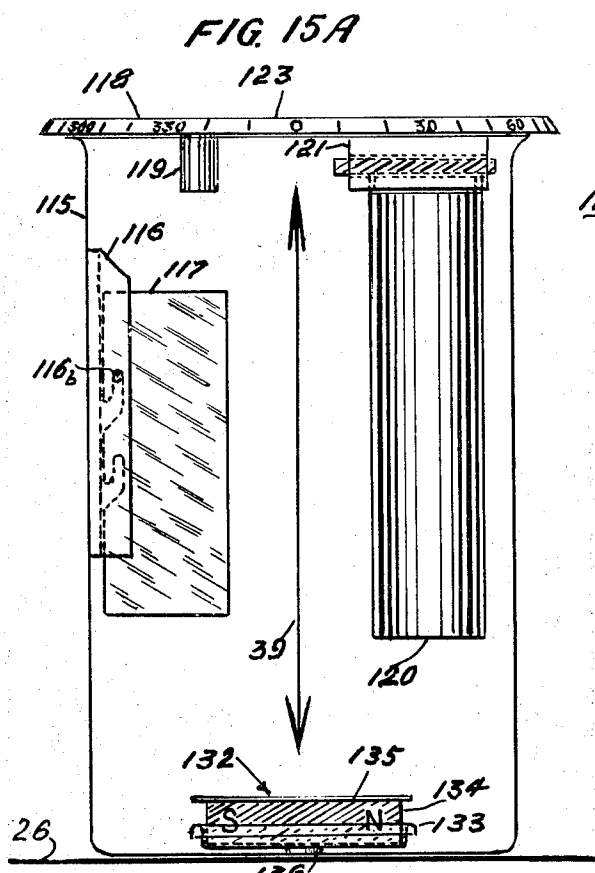
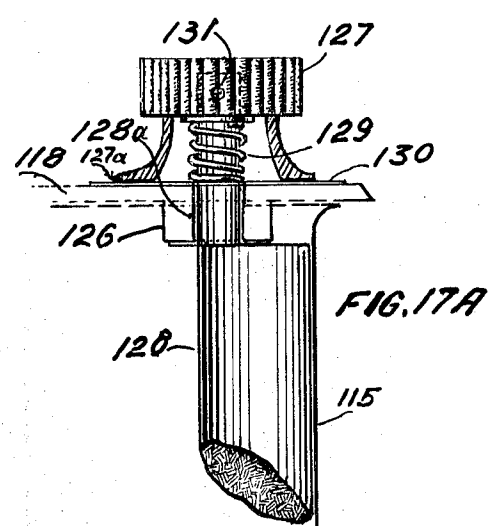
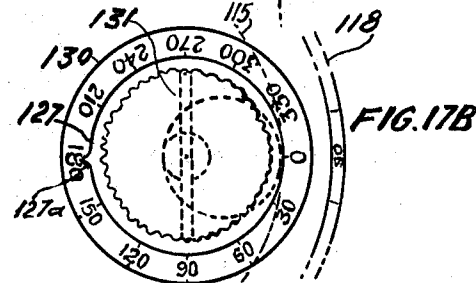
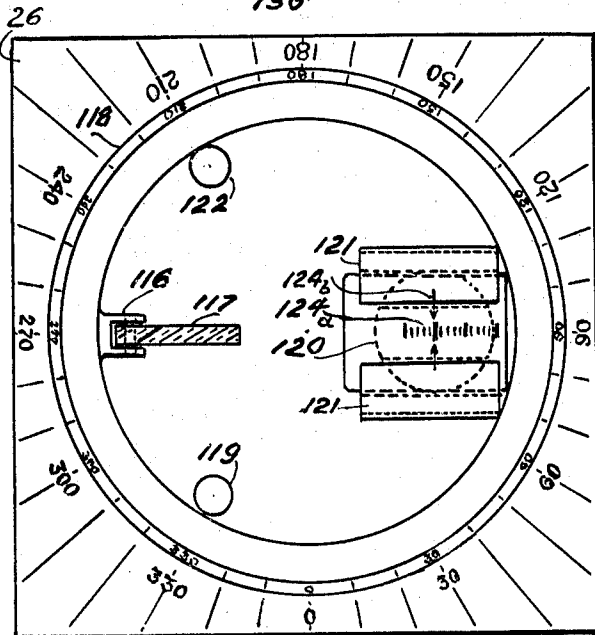
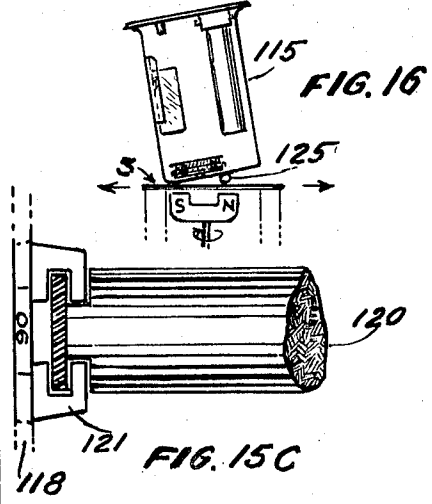
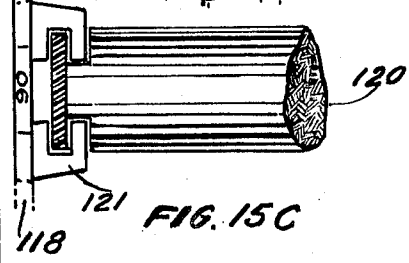
FIG. 13B



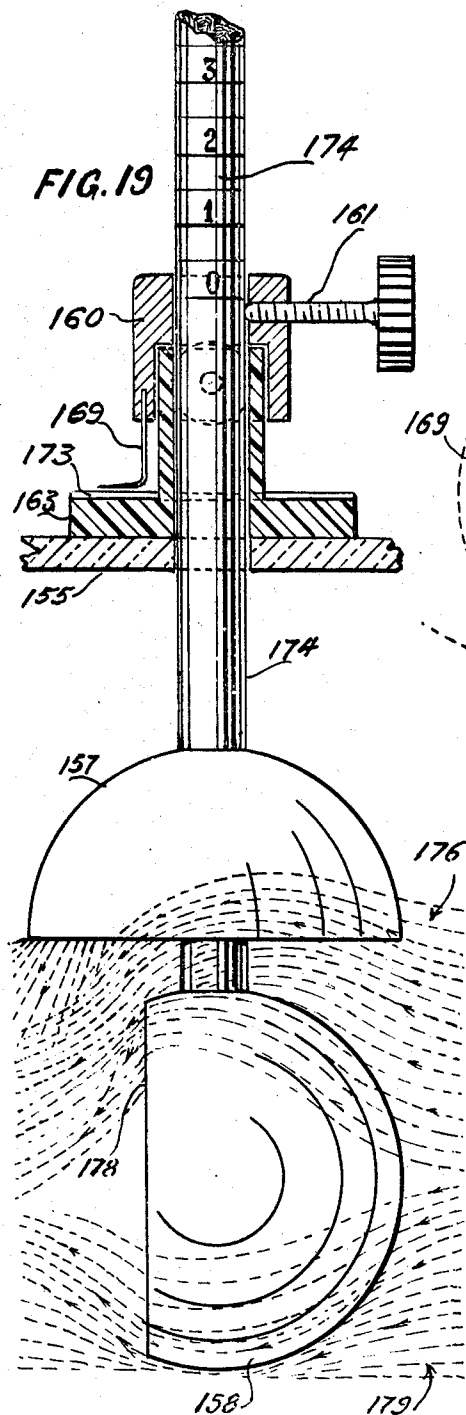
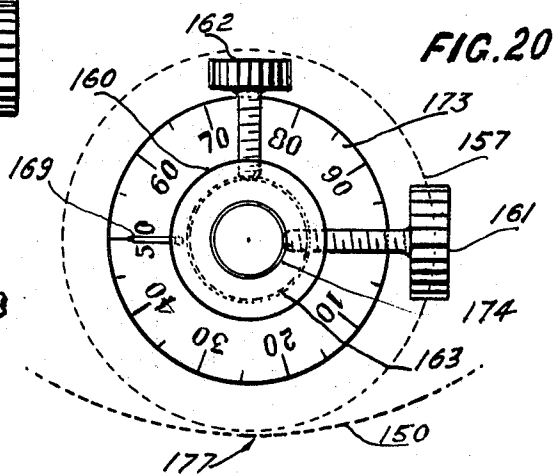
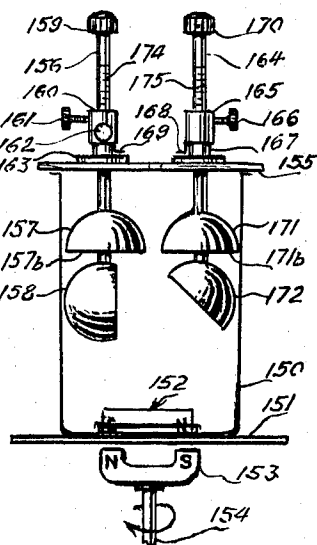
FIG. 14B

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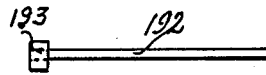
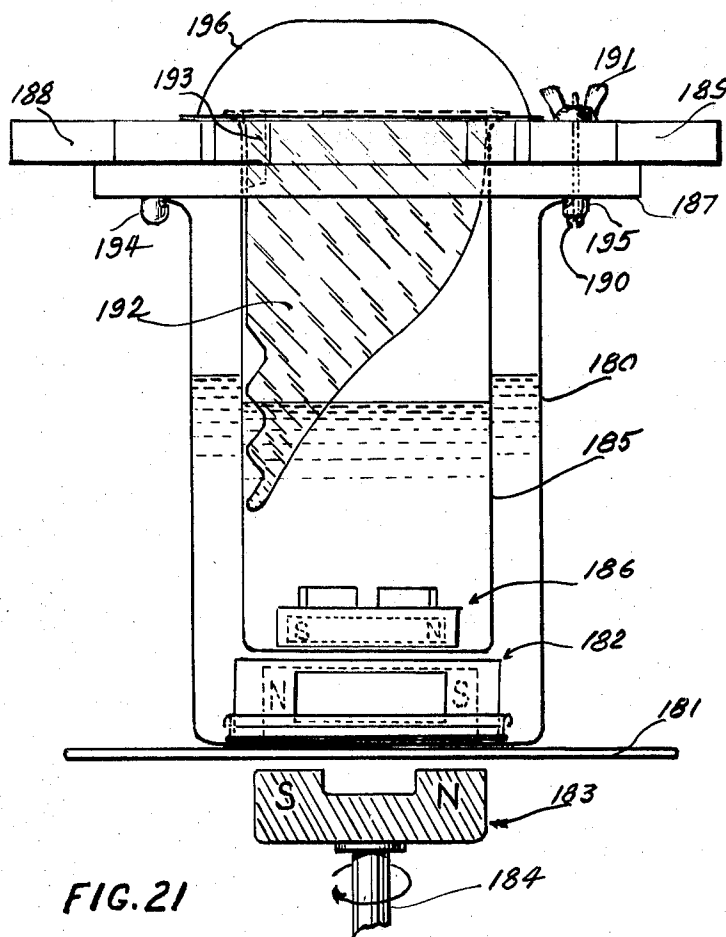
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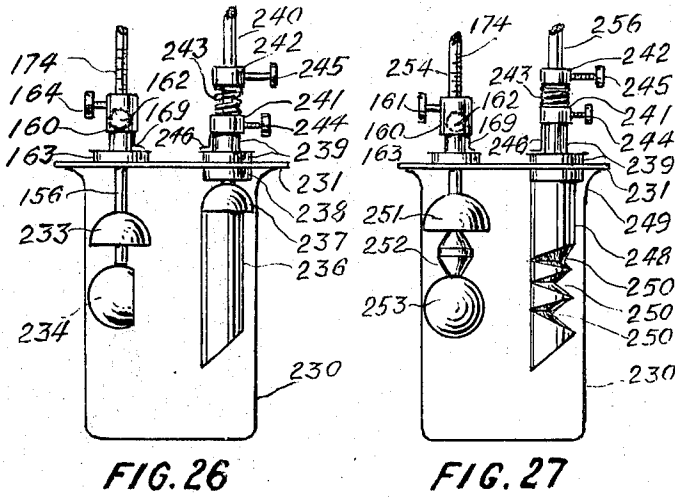
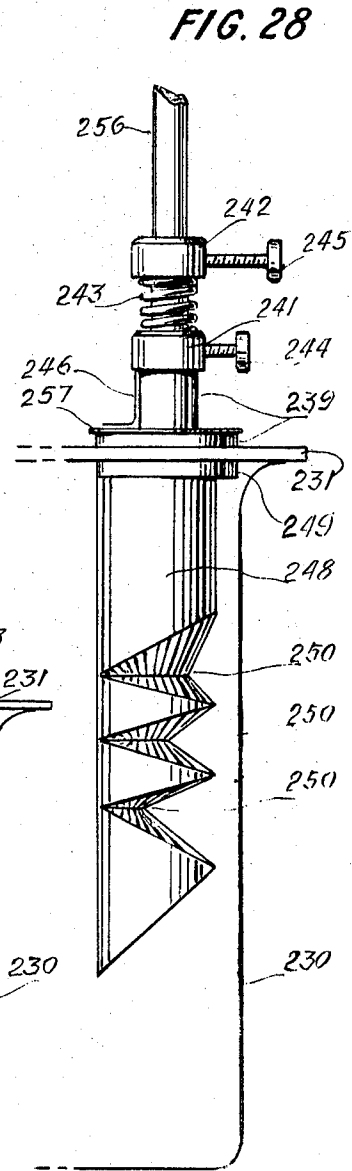
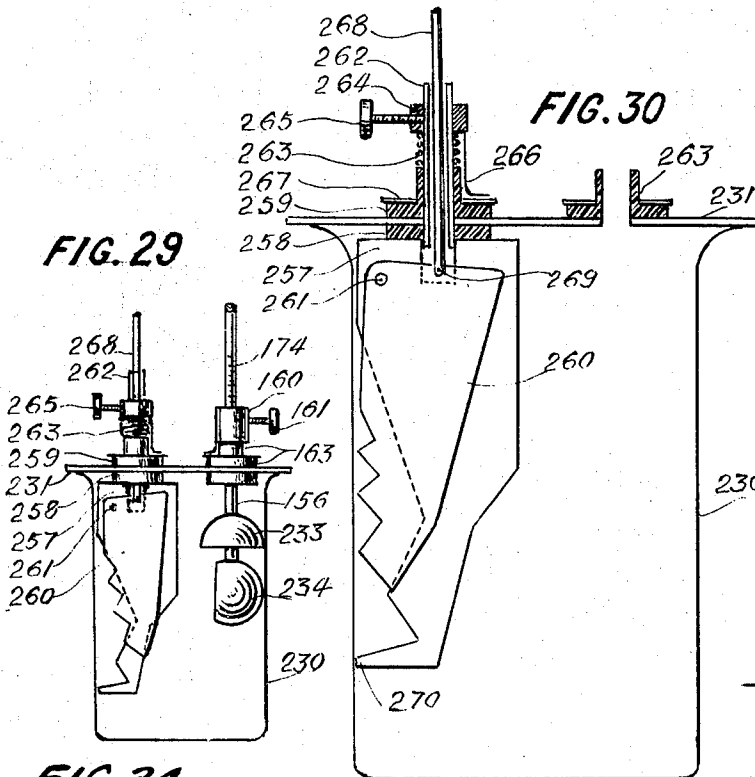
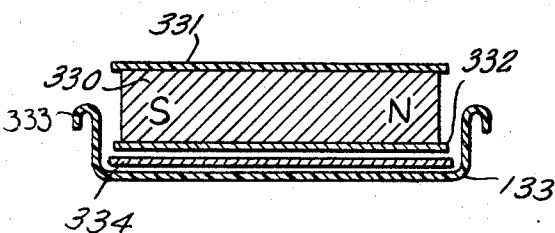


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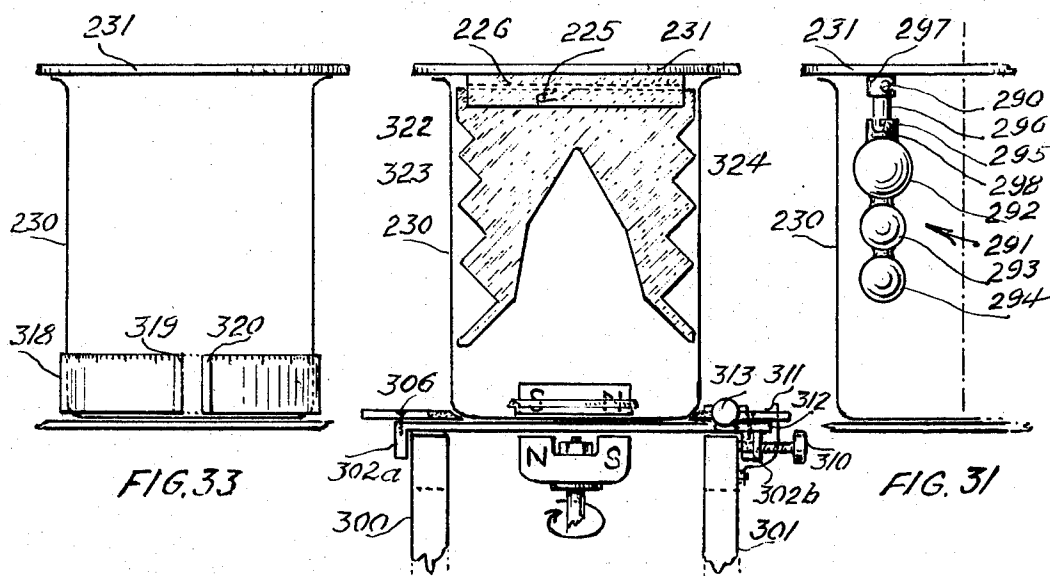


FIG. 33

FIG. 32A

FIG. 31

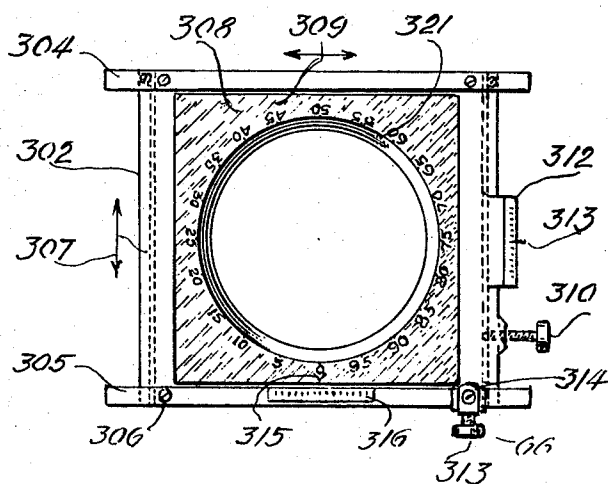


FIG. 32B

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MAGNETIC STIRRERS

FIELD OF INVENTION

This invention relates to magnetic stirrers and more particularly to improvements in magnetic stirrers which enable the stirring characteristics to be adjustable over a wide range to provide the optimum stirring patterns for a large variety of fluids having a wide range of viscosities, these stirring patterns being capable of repeated and accurate duplication.

DESCRIPTION OF PRIOR ART

Magnetic stirrers are well known in the art and are described in detail in my U.S. Pat. No. 2,350,534 issued on Jun. 6, 1944. Such stirrers are particularly useful in the chemical arts for stirring or agitating various fluids, and, as stated in my prior patent, the stirring operation may be performed in an entirely closed or sealed vessel, the contents thereof comprising any type of fluid and being under any pressure. Further, the rotor element which comprises magnetic material may be coated with teflon or any other inert material so as not to react with the fluids being stirred. The magnetic stirrer disclosed herein constitutes an improvement over the prior art magnetic stirrers, the specific improvements being described in detail herein below.

Most prior art magnetic stirrers have a limited stirring efficiency due, in part, to the small size of the magnetic rotating agitating bar (rotor). In an attempt to increase this efficiency, the speed of rotation of the bar (rotor) was increased, which, in turn caused the formation of a large, undesirable vortex pattern in the fluid. This type of stirring also does not produce a very desirable agitation of the fluid. Further, as the speed of rotation of the rotor is increased, there is a danger that the rotor will come "out of phase" with the magnetic driving member and would "dance" in the fluid. This "dancing" of the rotor may result in breakage of, or damage to, the mixing vessel even if the rotor is coated with an impact cushioning material such as teflon or the like.

In order to change the vortex pattern in the fluid and to enhance the stirring characteristics of the stirrer some prior art mechanical stirring devices have utilized baffle elements. When in use in magnetic stirrers, the presence of these baffles very often provide fluid currents which tend to cause the rotor to go "out of phase" with respect to the magnetic driving member, thereby impairing the stirring characteristics and creating the possibility of damage to the vessel.

There remains a great need for a magnetic stirring apparatus which will provide optimum stirring characteristics for practically any type of fluid. Presently when chemical reactions are carried out, for example, in the polymer field, the stirring and mixing operations used are among the least controlled and least scientifically defined steps. It would be highly desirable to be able to specify the exact type of stirring for every type of experiment with fluids, regardless of whether they are suspensions, emulsions or solutions of wide differences of viscosities. This would enable one to perform chemical combinations and other desired mixing operations under controlled and exactly duplicable conditions, thereby enabling the operator to accurately vary other variables in his operations while keeping the variables relating to the stirring step well defined. Also, when a particular chemical or any other experiment applying the stirring of fluids is described in textbooks, technical publications, and the like, it would be greatly desirable to be able to specify the exact type of stirring characteristics on a "standard" stirrer so that anyone may exactly duplicate the described experiment without doubt as to whether the fluid was properly stirred.

Another problem which presently exists in the art is encountered when stirring a fluid medium within a water jacket or other type of fluid jacket. In order to maintain the temperature of the jacket uniform, the fluid medium which comprises the jacket should be agitated. In the devices presently known in the art, a propeller is secured to a shaft which extends down between the two vessels from above the stirring apparatus. A

mechanical driving arrangement is coupled to the other end of the shaft to impart a rotary motion thereto, thereby agitating the water jacket. It would be highly desirable if a simpler method for stirring the fluid jacket was available.

SUMMARY OF THE INVENTION

Therefore, the main object of this invention is to provide a magnetic stirrer which provides optimum stirring patterns for a large variety of fluids having a wide range of viscosities, these stirring patterns being capable of being repeatedly and accurately duplicated.

It is a further object of this invention to provide a magnetic stirrer including novel stirring elements (the rotor) which will not damage the mixing vessel, even if the vessels are made of fragile materials such as glass, porcelain, or the like.

It is yet another object of this invention to provide a magnetic stirrer which utilizes adjustable baffle elements for creating an infinite variety of stirring patterns for fluids.

It is still another object of this invention to provide a magnetic stirrer for stirring the contents of a first vessel which is immersed in a water or other fluid jacket and for agitating said fluid jacket to maintain said jacket at a substantially uniform temperature.

It is still another object of this invention to provide a magnetic stirrer incorporating any combination of the features described in the above objects.

According to one aspect of the invention, a magnetic stirrer comprises means for selectively changing the relative positions of the magnetic driving means with respect to the center of the vessel of the magnetic stirrer, thereby correspondingly changing the relative position of the center of rotation of the magnetic rotor within said vessel to impart varying mixing properties to the magnetic stirrer.

According to a second aspect of this invention, a magnetic stirrer is provided which includes a rotor adapted to be immersed or partially immersed in a fluid within a vessel, at least a portion of the rotor being comprised of magnetic material. The rotor has a substantially circular periphery in its plane of rotation, and includes means for agitating said fluid. Further included is a magnetic driving means coupled to the rotor for imparting a substantially rotary motion thereto, thereby agitating the fluid within the vessel.

According to yet another aspect of the invention a magnetic stirrer comprises a variable position baffle element or elements and means for immersing said baffle element or elements in said fluid for reducing, changing, or eliminating the formation of a vortex pattern therein or for creating varied other turbulent motions, thereby making possible an infinite number of stirring patterns.

According to yet another aspect of the invention, for every stirring operation, the position of the baffle element or elements and the relative position of the vessel and magnetic driving means could be numerically read, recorded and accurately duplicated on the stirrer according to the invention.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1A is a front view of one embodiment of a magnetic stirrer incorporating the features of this invention;

FIG. 1B is a top view of the magnetic stirrer of FIG. 1A;

FIG. 2A is a top view showing in more detail the cover and baffle arrangement of FIG. 1;

FIG. 2B is a side view of the apparatus illustrated in FIG. 2A;

FIGS. 3 through 14 illustrate a plurality of rotors according to this invention;

FIGS. 10A—14A illustrating top views and FIGS. 10B—14B illustrating side views of the respective rotors;

FIGS. 15A; 15B and 15C illustrate respectively, side, top and partial side views of another magnetic stirrer arrangement according to the invention;

FIG. 16 illustrates a magnetic stirrer according to the invention utilizing a tilting vessel;

FIGS. 17A and 17B illustrate, respectively, side and top views of another arrangement for mounting on the baffle elements of FIG. 15;

FIG. 18 shows another magnetic stirrer baffle arrangement according to the invention;

FIG. 19 shows a portion of FIG. 18 in more detail;

FIG. 20 is a top view of FIG. 19;

FIG. 21 shows yet another baffle element arrangement according to the invention;

FIG. 22 shows a top view of the baffle element of FIG. 21;

FIGS. 23 and 24A are front and top views, respectively, of still another magnetic stirrer configuration according to the invention;

FIGS. 24B and 24C are partial side views of the configuration of FIG. 24A;

FIGS. 25A and B illustrate side and top views, respectively, of a more precise arrangement for adjusting the magnetic stirrer of FIGS. 23 and 24;

FIGS. 26 and 27 show still other baffle element arrangements according to the invention;

FIG. 28 shows in more detail a portion of FIG. 27;

FIG. 29 shows yet another baffle element arrangement according to the invention;

FIG. 30 shows a portion of FIG. 29 in more detail;

FIG. 31 shows still another baffle element arrangement according to the invention;

FIGS. 32A and 32B are front and top views, respectively, of a magnetic stirrer arrangement according to the invention;

FIG. 33 illustrates a device to facilitate adjustment of the position of the vessel on a magnetic stirrer; and

FIG. 34 shows a modified version of the rotor of FIG. 15A.

Briefly, the objects of this invention are carried out in the preferred embodiment shown in FIGS. 1A and 1B by providing a magnetic stirrer having a vessel platform 1 which is movable with respect to a magnetic driving means which is secured to base 3. The vessel 4 has baffle elements 5 and 6 movably mounted in the cover 7 thereof. It should be clear that the baffle elements 5 and 6 may be otherwise mounted in relation to the vessel. The purpose of these baffle elements is to create desired turbulent mixing patterns in the fluid which have defined characteristics. The optimum positions of the baffle elements will vary according to the fluid being mixed. Further provided is a rotor 8 having a magnetic bar 10 embedded therein and having a disc-shaped lower portion 9 which has a substantially round periphery in a plane perpendicular to the sides of the vessel 4. Rotor 8 also has agitating elements 24 around its periphery. In order to create the varying mixing properties of the mixer, one may adjust the position of the baffle elements relative to each other and to the vessel by means of knob 11. The angular orientation of the plates 6 and 5 within the fluid are also adjusted by means of knob 12 and adjusting member 13, respectively. The movable vessel platform 1 provides the capability of moving the center of rotation of the magnetic rotor 8 to substantially any desired position in the vessel since the rotor 8 will tend to align itself with rotating magnet 28. The outer periphery of the disc-shaped portion 9 of the rotor 8 is substantially round so that the rotor will not damage the vessel if it is forced against the sides thereof. Due to the centrifugal force built up by the rotation of this type of rotor, a thin lubricating barrier of fluid is formed between its outer surface and the wall of the vessel, thereby preventing intimate contact therebetween. This not only enhances the rotational qualities of the rotor 8 when rotating near the sides of the vessel 4, but also decreases the possibility of vessel breakage or damage due to the rotor impacting the walls of the vessel when the vessel is constructed of glass and the like. Further, if a rotor according to the invention is forced against the side of the vessel when adjusting the position thereof while it is rotating, the forces developed in a direction perpendicular to the wall of the vessel are very small, and hence, do not cause damage to the vessel.

In order to provide accurately duplicable mixing properties, the stirrer is provided with indexing means 29 and 30 for accu-

ately positioning the vessel relative to the driving means. The specific embodiment of FIG. 1 will be described in more detail below.

Referring now to FIGS. 1A and 1B, a preferred embodiment of the instant invention is illustrated which comprises a vessel platform 1 mounted on a base 3 which has a motor 2 secured thereto. Secured to the shaft 38 of motor 2 is a magnet 28. Also secured to base 3 are guide members 36 and 37. The platform 1 is slideably mounted on base 3 and includes support members 25 and 27 and an upper surface member 26 secured to support members 25 and 27. Members 36 and 37 guide the movement of members 25 and 27 along the base 3. Mounted on base 3 is a scale 30 and secured to movable member 27 is a pointer 29. Pointer 29 cooperates with scale 30 to indicate the relative position of the platform 1 with respect to base 3. Scale 30 may be calibrated in any convenient manner, such as, in millimeters, inches, etc.

It should be clear that a locking mechanism could be provided to secure platform 1 to base 3 after the relative position thereof has been adjusted. This mechanism is not described or shown herein since such mechanisms are well known to the art and a detailed description thereof is not deemed necessary for a proper understanding of the instant invention. Also, it is pointed out that a handle may be secured to the platform 1 to facilitate moving it to and fro.

It should also be clear that means may be provided for moving the upper surface 26 of the platform 1 perpendicular to the direction of the above-described motion of platform 1. This movement is not described with reference to FIG. 1 for the sake of clarity. A magnetic stirrer which is adjustable in two perpendicular directions is described with reference to FIGS. 32A and 32B.

Mounted on upper surface 26 is a vessel, such as a beaker 4, which may be made of glass or any other nonmagnetic material. Beaker 4 has an indicating arrow 39 imprinted on its surface to enable accurate alignment thereof with respect to a mark or the like on platform 1. Beaker 4 has a cover 7 which has adjustable baffle elements 5 and 6 mounted thereto. The details of the baffle elements 5 and 6 and the manner in which they are secured to cover 7 will be described hereinafter with reference to FIGS. 2A and 2B.

Within beaker 4 there is placed a rotor 8 which has a disc-shaped lower portion 9. Disc-shaped portion 9 has a substantially round periphery in a plane perpendicular to the sides of the vessel 4. Rotor 8 also has agitating elements 24 mounted around its periphery to enhance the agitating properties thereof. Rotor 8 further has a ring 41 on the top thereof to further enhance its agitating properties and to provide a convenient means for inserting and removing the rotor 8 from the beaker 4. A more detailed description of similar and other types of rotors appears herein in the descriptions of FIGS. 3-14.

It should be clear that by changing the position of platform 1 relative to base 3, one is actually changing the center of rotation of the magnetic rotor 8 relative to the center of the vessel 4. This is because the rotor 8 is not physically coupled to anything and tends to align itself with the rotating motor driven magnet 28. In the event that platform 1 is moved too far in any direction and the rotor 8 contacts the walls of vessel 4, no damage will result for the reasons mentioned hereinabove.

A rod 31 made of glass or other nonmagnetic material with fluted knobs at both ends is optionally provided for placement between the vessel platform 1 and vessel 4. See FIG. 16. In some types of mixing operations it may be desirable to have the vessel 4 inclined with respect to the horizontal direction and the rod 125 provides a convenient method for inclining the vessel 4 with respect to platform 1. It is pointed out that due to the novel construction of the rotors according to this invention, that no damage will result to the vessel 4 by virtue of the rotor contacting the vessel walls when the vessel is inclined with respect to platform 1 within certain limits.

Referring to FIGS. 2A and 2B there is shown in more detail a preferred embodiment of the baffle elements 5 and 6 and means for mounting said baffle elements to the cover 7 of vessel 4. Baffle element 6 is secured to member 20 which has a threaded portion 23 extending therefrom in the vertical direction. Secured to cover 7 is a member 21 having an angular scale 33 (calibrated in degrees, for example) printed thereon.

Member 23 extends through a hole in cover 7 and fluted knob 12 having a pointer 34 is secured to member 23 by a pin (not shown) extending through a hole in knob 12 and in member 23. Therefore, rotation of knob 12 causes corresponding rotation of member 23. The nut 22 engages member 23 for securing the baffle assembly to cover 7. By rotating fluted knob 12, baffle element 6 is correspondingly rotated since they are directly coupled together and the angular position of baffle 6 is indicated by means of pointer 34 cooperating with scale 33.

Baffle element 5 is secured to a member 13 having an indicating arrow 35 printed thereon. Member 13 is rotatably coupled to member 14 which has an angular scale 42 (calibrated in degrees, for example) printed thereon which cooperates with arrow 35. The angular position of baffle element 5 with respect to vessel 4 is adjusted by means of rotating member 13 to the desired angular position indicated by pointer 35 and scale 42.

Member 14 is further coupled to member 15 to which is further coupled an indicating member 16. Extending vertically from members 15 and 16 is a threaded member 19 which is adapted to pass through a hole in cover 7. Member 15 and threaded member 19 are secured to cover 7 by means of a washer 17, a fluted knob 11 and a nut 18 which threadably engages member 19. A pin (not shown) passes through knob 11 and member 19 to lock their relative positions. The relative position of baffle element 5 within the vessel 4 and with respect to baffle element 6 is adjusted by means of rotating fluted knob 11, which correspondingly rotates member 19 which is coupled to knob 11. On the outer peripheral portion of cover 7 there is imprinted a scale 32 (calibrated in degrees) and on indicating element 16 there is imprinted a pointer 34 which cooperates with scale 32. In FIG. 2A the pointer 16 indicates a 180° displacement between baffle elements 5 and 6. In this particular embodiment the relative position of baffle element 6 within vessel 4 is fixed, but it should be clear to one skilled in the art that the position thereof may be made variable with respect to the vessel 4 within the spirit of this invention. Therefore, it is seen that merely by rotating knob 11 the angular displacement between baffle elements 5 and 6, may easily be varied from outside the vessel. It is further pointed out that in the illustrated embodiment it is necessary to remove the cover 7 of vessel 4 in order to adjust the angular orientation of element 5 with respect to vessel 4 by means of member 13. It should be clear to one ordinarily skilled in the art that means for adjusting this angular orientation of baffle 5 from outside the vessel may be provided. Therefore, such a design is not described herein. Also, cover 7 may be rotated on vessel 4 to obtain a desired mixing characteristic. If desired, however, cover 7 may be rigidly secured to vessel 4 during operation of the mixer.

Recapitulating, the subject invention provides methods and apparatus for varying the mixing properties of a magnetic stirrer creating an infinite number of stirring patterns by: (1) accurately adjusting the location of the vessel relative to the center of rotation of the rotor; (2) accurately adjusting the positions of baffle elements 5 and 6 relative to each other; and (3) accurately adjusting the angular orientation of each of the baffle elements 5 and 6 with respect to the vessel 4. The optimum adjustments of the above variables have been found to be different for various types of fluids being stirred. Therefore, calibrated scales and indicators 29, 30 and 32, 34, and 35, 42, respectively have been provided for each of the above adjusting mechanisms for enabling accurate setting of the variables and accurate reproducibility of said settings. Also, due to

their unique construction, the rotors according to this invention tend not to go "out of phase" with the driving magnet 28.

Further provided on vessel support 26 are indicating arrows 40 for accurately positioning the vessel 4 on support 26. It is pointed out that these positioning arrows 40 (shown in FIG. 1) are useful only for one size vessel but it is understood that other locating means may be utilized by one ordinarily skilled in the art for locating any sized vessel on support member 26 and for locating said vessels in different positions on support 26. For example, a grid arrangement may be imprinted on support member 26. (See FIG. 25).

Referring to FIG. 3, there is shown a rotor similar in construction to the rotor 8 illustrated in FIG. 1A which comprises a substantially hemispherical portion 50 secured to a disc-shaped portion 51. Located about the periphery of member 50 are agitating elements 52 for enhancing the stirring properties of the magnetic stirrer. Embedded within the member 50 is a magnetic member 52 which cooperates with rotating magnet 28 (FIG. 1A) to provide rotation of the rotor. The rotor is made of glass, porcelain, Teflon or other inert material. The disc-shaped portion 51 is preferably made of a material such as Teflon which is inert to many chemicals and which in addition has a very low coefficient of friction and good impact-absorbing properties. Therefore, it will easily rotate on the lower surface of vessel 4 and will prevent damage to the vessel when the edge 54 of the disc 51 comes into contact with the sidewalls of the vessel. Magnetic member 53 normally will be a permanent magnet made of highly magnetic alloys, such as Alnico V or other sintered highly magnetic materials such as magnetic ceramics.

Referring to FIG. 4 there is shown a rotor similar in construction to that of FIG. 3 but further including a propeller or vane 55 secured to the top of the dome shaped portion 50 for enhancing the agitating properties thereof. Corresponding elements in FIGS. 4 and 3 have the same designation numerals for convenience.

The rotor of FIG. 5 also is similar to the rotor of FIG. 4 except that agitating members 52 are omitted. In some applications the agitation properties which are provided by elements 52 may not be required and the presence of only propeller 56 may provide optimum results. The choice of rotor, of course, depends upon the properties of the materials being agitated and other experimental requirements.

FIG. 6 illustrates another rotor according to this invention which comprises a magnetic member 60, normally a magnet, secured to a disc-shaped member 61. Secured to the upper surface of magnetic member 60 is a member 62 which is provided as a "bumper" to protect the vessel 4 in operation of the stirrer or in the event that the rotor should be dropped in the vessel in its inverted position. This is a very inexpensive type of rotor and provides excellent stirring properties. It is emphasized again, that by virtue of the disc-shaped element 61, damage to the vessel is prevented and various mixing properties may thereby be achieved by changing the relative position of the rotor within the vessel.

Referring to FIG. 7 there is shown another rotor similar to that of FIG. 6 which comprises a disc-shaped element 63 and a magnet 64 secured thereto by means of locating elements 65, 66 and 67 and by resilient member 68 which cooperates with slotted blocks 69 and 70 for "locking" the magnet 64 in place. In certain applications it may be required to have stronger magnets than others and this embodiment provides a simple means for interchanging magnets 64. To assemble this type of rotor, a magnet is placed on member 63 and is "located" in position by blocks 65-67. Then, resilient member 68 is placed over the magnet 64 and is slipped into slots 71 and 72 in blocks 69 and 70, respectively, to lock the magnet in place. Again, disc 63 is made of Teflon or other inert material having low coefficients of friction and which will not damage the vessel 4. Also, as in FIG. 6, a protective "bumper" Teflon or the like may be secured to the upper surface of the magnet 64.

FIG. 8 illustrates yet another rotor according to the invention which comprises a disc-shaped portion 73 and a cylindri-

cal portion 74 having slots (or other open portions) 75 and 76 therein. A magnet 77 is secured to member 73 for cooperation with the driving magnet 28. The magnet 77 may alternatively be secured to cylindrical portion 74 by a press-fit or by a bonding material. In this embodiment, agitation is provided by the magnet and the slots 75 and 76 permit the flow of the agitated fluid therethrough to further enhance the mixing properties of the stirrer. In operation, the slots 75 and 76 allow a fluid current from the outer portions of the vessel through the slots and up the center portion of the vessel.

FIG. 9 illustrates yet another embodiment of a rotor according to this invention which comprises a disc-shaped element 78 comprised of Teflon or the like and having a magnet 79 embedded therein. This rotor further has agitation bars 80—83 (preferably of square-cross sections) on the upper surface thereof. The bars 80—83 may be integral with member 78 or secured to the upper surface thereof. In practice, this rotor has been found to provide excellent stirring results.

FIGS. 10A and 10B illustrate yet another embodiment of a rotor according to this invention which comprises two rings 84 and 85. Mounted between rings 84 and 85 are magnets 86 and 87 which cooperate with the driving magnet 28 (see FIG. 1) for rotation of the rotor. The rings 84 and 85 may be secured to magnets 86 and 87 by mechanical means or by an appropriate cement or other bonding material. In this embodiment the rings 84 and 85 are preferably made of Teflon or a like substance. As in the embodiment of FIG. 8, the rotor of FIG. 10 also provides enhanced agitation qualities due to the fluid current flow from the spaces between ring 84 and magnets 86 and 87 and out through the spaces between the rings 84 and 85.

A further advantage of this type of rotor is that it may be inserted in the vessel in any orientation since it is completely symmetrical. Therefore, care need not be taken to have either the top or the bottom side up.

FIGS. 11A and 11B illustrate a modification of the embodiment illustrated in FIG. 10. Like elements in FIGS. 10 and 11 are given the same reference designation for ease of explanation. This rotor comprises rings 84 and 85 which are secured together by means of magnet holders 90 and 91. It is clearly seen how magnets such as magnets 86 and 87 of FIG. 10 are inserted into the magnet holders 90 and 91 of FIG. 11. This embodiment has the same virtues of that of FIG. 10 but further has the advantage that the magnet members are interchangeable and either more or less powerful magnets may be easily removed for ease of cleaning the rotor after use.

FIGS. 12A and 12B illustrate yet another embodiment of a rotor according to this invention. This rotor comprises rings 92 and 93 having a similar shape as rings 84 and 85 of FIG. 10. Mounted between rings 92 and 93 by means of an appropriate cement or the like are magnets 94 and 95 which are oriented with like poles in the same directions. This rotor also provides excellent agitation properties and allows the formation of fluid flow currents down from the outer portions of the vessel 4 to the center of the vessel via spaces 96 and 97 between the rings 92 and 93. Again, an advantage of this rotor is that care need not be taken in inserting the rotor in a vessel since it is symmetrical.

FIGS. 13A and 13B illustrate yet another embodiment of a rotor according to this invention. This rotor comprises ring shaped magnets 98 and 99 which secured together via members 100, 101, 102 and 103 by means of an appropriate cement, or the like. Members 100—103 further contribute enhanced agitation properties to the rotor and the spaces therebetween allow for current flow of the fluid in a similar manner as provided in the embodiments of FIG. 10, 11 and 12. It is pointed out that in certain cases it may be desirable to have only one of the members 98 and 99 comprise magnetic material and in such a case the other member would be made of Teflon or other inert materials. However, an advantage to having members 98 and 99 both magnetic is that a symmetrical rotor results with which care need not be taken when inserting same in a vessel. Secured to the outer surfaces of ele-

ments 98 and 99 are disc-shaped members 104 and 105 which are preferably made of Teflon or the like. The purpose of these members 104 and 105 is to act as a "bumper" to prevent damage to the vessel 4 and to provide a good, low coefficient of friction surface on which the rotor rotates, thereby enhancing the rotating efficiency of the rotor according to the invention.

FIGS. 14A and 14B illustrate a rotor similar in construction to that of FIG. 10 except that a differently shaped magnet member 106 is utilized. In this embodiment, a magnet 106 having a generally "x" shaped construction is secured between rings 107 and 108, said rings being preferably made of Teflon or a like material. In this embodiment the pole extensions of the magnet 106 provide enhanced agitating properties and yet allow for fluid current flow in the resulting spaces (such as space 109) between the magnet and the rings 107 and 108.

It is pointed out that in all of the above-described embodiments or rotors according to this invention, one or more "button," such as button 136 (see the rotor 132 of FIG. 15A), may be secured to the bottom surface of the rotor to enhance the rotating efficiency thereof. These buttons should be made of Teflon or any other inert material having a low coefficient of friction. Also, any of the magnets described herein may be made of highly magnetic alloys such as Alnico V or other magnetic materials such as magnetic ceramics.

Referring to FIG. 15A, 15B and 15C, there is shown another baffle arrangement for a magnetic stirrer according to the invention. There is also shown a means for indexing the rotational position of the mixing vessel 115 on the upper surface 26 of the stirrer platform (not shown) and the rotational position of the baffle elements with respect to the vessel 115. The driving magnet located below upper surface 26 has not been shown for the sake of clarity. The platform arrangement is also assumed to be similar to that shown in FIGS. 1 and 2.

The vessel 115 is located on the upper surface 26 of the stirrer platform and is provided with a baffle element 117 secured to the inner wall thereof by means of supporting means 116. Supporting means 116 may be integral with the wall of vessel 115 or may be a separate element secured thereto. Means 116 has a hollow vertical channel therein with a pin 116b being mounted perpendicular to said channel. Baffle element 117, which in this embodiment is a plate, has two grooves therein to engage said pin within said channel in a manner well known in the art. Element 117 may be inserted in the channel of means 116 in two positions: (1) upper grooves engaging pin 116; or (2) lower groove engaging pin 116b. This provides two different baffle heights for varying the mixing characteristics of the stirrer. A further description of this baffle element configuration is deemed unnecessary. It is pointed out that baffle element 117 may be made any shape which will provide desired agitating properties in the magnetic stirrer.

Placed in vessel 115 is a rotor 132 which may be any of the types heretofore discussed or the type shown in FIG. 15A. The rotor 32 of FIG. 15A includes a "cup or dish shaped" element 133 which has a lip portion which extends away therefrom and which acts as a resilient "bumper" to protect the vessel when the rotor contacts said vessel. A magnet 134 is placed in "cup shaped" element 133 and a disc-shaped element 135 or the like is secured to the upper surface of magnet 134. Element 135 may act as a bumper. The magnet 134 may be either secured to the "cup-shaped" element 133 or may be mounted so as to be freely rotatable inside the cup-shaped element 133. An embodiment wherein the magnet 134 is freely rotatable in "cup-shaped" element 133 is shown in detail in FIG. 34 and is described below. Elements 133 and 135 are preferably made of Teflon or any other resilient and inert material. A "button" 136 also made of Teflon or the like, is secured to the lower surface of rotor 132 at the center of rotation thereof to lessen the frictional forces between rotor 132 and vessel 115 to increase the efficiency of the stirrer. The use of button 136 is optional.

Vessel 115 is further provided with a cover 118 to which is secured a baffle element 120 by means of mounting means 121. On the edge of cover 118 is a scale 123 which is read in conjunction with indexing arrow 39 which is imprinted on the wall of vessel 115. Scale 123 and arrow 39 cooperate to provide a means for setting the relative positions of baffle 117 (which is secured to vessel 115) and baffle 120 (which is secured to cover 123) in an easily duplicable manner. Locating pins 119 and 122 (see FIG. 15B) and baffle mounting means 121 cooperate to position the cover 118 on vessel 115 and to allow relative rotation therebetween.

Mounting means 121 (see FIG. 15C for more detail) includes two grooved blocks 121 mounted to cover 118. It should be clear that one block having two appropriate grooves therein could be used to replace blocks 121. Baffle element 120 has a grooved out-portion at the upper end thereof which is adapted to slideably engage the grooves in blocks 121. An indexing means is provided which includes scale 124a (imprinted on the cover 118). The position of baffle 120 is adjustable with respect to the wall of vessel 115 by merely sliding it within the grooves of mounting blocks 121. The relative position of baffle 120 with respect to the wall of the vessel is then indicated by the reading of scale 124a in conjunction with arrows 124b. As can be readily seen, this adjusting procedure can be accurately duplicated at any time by one utilizing a magnetic stirrer according to the invention.

The position of the vessel 115 with respect to the upper surface 26 of the platform is determined by reading the polar scale imprinted on the upper surface 26 in conjunction with indicating arrow 39 on the wall of vessel 115. This reading is especially important in determining agitating characteristics when the rotor is caused to rotate in an eccentric manner within vessel 115 by moving the upper surface 26 a desired amount. This procedure is fully described in the description of FIG. 1. When the rotor is operating eccentrically, the rotational position of the vessel 115 will determine the relative positions of the rotor and baffle element 117 (which is fixed to the wall of vessel 115). This relative position is fixed by means of arrow 39 and the scale on the upper surface 26 of the platform. Varying this relative position vastly changes the agitating characteristics of the stirrer and the optimum setting for stirring any type of fluid can be easily obtained.

Two other adjustments are available with the stirrer of FIG. 15. Firstly, the relative positions of baffles 117 and 120 may be varied by rotating the position of the cover 118 on the vessel 115. This relative position is denoted by reading scale 123 in conjunction with arrow 39. Also, as described above, the spacing between baffle element 120 and the wall of the vessel 115 may be adjusted and the spacing is denoted by scale 124a. These two variables also greatly affect the mixing or agitating characteristics of the stirrer and the optimum settings thereof can be determined for any fluid and may be easily and accurately duplicated. It is pointed out that the scale on platform 3 may be an overlay and need not be directly imprinted thereon.

A feature of the configuration of FIG. 15 is that all mountings are contained within the vessel and there is no necessity to have holes in the cover. The adjustments in the position of baffle element 120 is made from within the vessel. Therefore, this configuration is particularly useful in applications where stirring is to be done under predetermined pressures or in predetermined atmospheres. One need only seal the cover to the vessel and no other expensive and complicated seals for shafts or the like are required.

FIG. 34 illustrates one example of a modified embodiment of the rotor of FIG. 15A wherein the magnet is freely rotatable within the "cup or dish" shaped element 133. In FIG. 34, magnet 330 may be in the form of a bar magnet (similar to the magnet shown in FIGS. 3, 6 and 7), a dumbbell shaped magnet (similar to the shape of member 62 of FIG. 6) or any other shape which is either convenient or dictated by the application. Magnet 330 is covered on each side by disc-shaped sheets 331 and 332, respectively, which are made of Teflon or other nonmagnetic, inert material. The disc-shaped Teflon

sheets 331 and 332 protrude slightly over the upper and lower flat surfaces of the magnet 330 similar to the manner in which disc-shaped member 61 of FIG. 6 protrudes over the lower flat surface of the magnet 60 of FIG. 6. The diameter of lower disc-shaped member 32 is slightly smaller than the inner diameter of the "cup or dish" shaped member 133. In this embodiment, cup-shaped member 133 is made of Teflon, glass or other inert, nonmagnetic material. In operation, due to friction or the like on the periphery of the protruding lip 333 of cup-shaped member 133 when it comes into contact with the sidewall of the vessel within which the rotor is placed, there will be a tendency for the rotor to slow down. In the embodiment of FIG. 15A, if the frictional force becomes too great, the rotor tends to go out of phase with the driving motor. However, in the embodiment of FIG. 34, the magnet 330 and disc member 332 are capable of freely rotating within the cup-shaped member 133. This reduces the possibility of the rotor coming out phase with the driving magnet, thus improving the reliability of the resulting system.

It should be clear that the materials, which make up the disc member 332 and cup-shaped member 133 must have a low coefficient of friction therebetween in order to provide the desired result. In order to improve the ease of relative rotation between the magnet 330 and the cup-shaped dish 133, a smooth thin circular disc of glass, hard plastic or stainless steel may be inserted between the bottom of the dish 133 and the disc 330. The disc 334 can also take the form of a thin, non-magnetic "thrust bearing." It has been found in practice that this configuration provides still improved results.

Another alternative, not shown, is to provide a pivot in the center of the bottom of dish 133 about which the magnet 330 can rotate. In this case, a central recess is provided in the magnet 330 to accommodate the protruding pivot in the bottom of dish 133. In this embodiment, the lower disc-shaped sheet 332 may or may not be used, as desired. Another alternative is to use a flat bottom cup or dish-shaped member 133 and an additional member, such as member 334 of FIG. 34 which has a protruding central pivot which is accommodated in a central recess in magnet 330. It should be clear that many other modifications may be made within the spirit of this invention.

Referring to FIG. 16, there is shown a stirrer similar to that of FIG. 15 which further illustrates the use of a rod 125 or the like which is placed under vessel 115 to tilt said vessel with respect to the platform 3. The arrows in FIG. 16 indicate that the platform 3 is movable in the same manner as the one shown in FIG. 1. In this embodiment, the rotor is preferably operated eccentrically in order that the poles of the rotor and driving magnet remain more closely aligned. In some instances the addition of rod 125 to tilt the vessel provides very desirable mixing characteristics without unduly complicating the structural design of the stirrer. It is pointed out that the use of rod 125 to tilt vessel 115 is made possible by the unique design of the rotors according to the instant invention. Rotor 132 of FIG. 15A is particularly adaptable for use with such inclined vessels. As was heretofore mentioned, such rotors tend not to go "out of phase" with the driving magnet as easily as the prior art rotors and such rotors will not damage the vessel 115 if it impacts the vessel. Also, the novel rotors described herein can be continuously operated against the wall of the vessel without imparting damage thereto.

Referring to FIGS. 17A and 17B, there is shown another baffle element according to this invention which enables one to adjust the spacing between the baffle element and the wall of the vessel from outside the vessel and without having to lift the cover. Like elements in FIGS. 15 and 17 are given the same reference numerals for ease of description. In this embodiment the cover 118 which is mounted on vessel 115 in the same manner as in FIG. 15, has a shoulder element 126 mounted on the underside thereof. Baffle element 128 (which is cylindrical in this embodiment) has a turned down cylindrical portion 128a which extends through aligned holes in cover 118 and shoulder element 126. Portion 128a is eccentrically located with respect to the main portion 128 of the baffle ele-

ment. A spring 129 is placed over cylindrical portion 128a and a partially hollowed knob 127 is secured to cylindrical portion 128a and a partially hollowed knob 127 is secured to cylindrical portion 128a by means of a pin 131 in a manner well known in the art. A scale 130 is secured to or imprinted on cover 118 to cooperate with extended portion 127a of knob 127 (which acts as a pointer) to indicate the rotational position of cylindrical portion 128a. This reading correspondingly indicates the distance between baffle element 128 and the sidewall of vessel 115. The purpose of spring 129 (which is in compression) is to keep tension on the cylindrical portion 128a of the baffle element so that there is a minimum amount of "wobble" or "free play" between the baffle element 128 and cover 118. Varying the position of the knob 127 also varies the relative position of baffle 128 and baffle 117 (of FIG. 15) to a minor degree.

It is pointed out that while the baffle elements 120 and 128 of FIGS. 15 and 17, respectively, were shown as rod-shaped elements, it should be clear that other shapes may provide desirable mixing characteristics with given fluids and may be substituted for the shown baffle elements within the spirit of this invention. For example, bent or twisted rods or other irregularly shaped elements may be used.

Referring to FIGS. 18—20, there is shown a portion of a magnetic stirrer utilizing another type of baffle element configuration according to the invention. FIGS. 19 and 20 are expanded views of portions of FIG. 18 looking from the rear of FIG. 18. The magnetic stirrer platform 151 is partially shown and the driving means for shaft 154 is omitted for clarity of illustration. A magnet 153 is secured to the end of shaft 154 for providing the rotating magnetic field for driving the rotor 152 which is immersed in the fluid medium in vessel 150. Rotor 152 may take the form of any of the novel rotors herein described and the one illustrated in FIG. 18 is shown merely by way of example. Vessel 150 is supplied with a cover 155 which is rotatably mounted thereon. Secured to cover 155 are shoulders (or bushings) 163 and 167 having holes therein for the insertion of the shafts of the baffle elements. The shoulders 163 and 167 may also be made integral with the cover 155 if desired. On the upper surfaces of shoulders 163 and 167 are scales such as scale 173 (shown more clearly in FIG. 20). Slideably mounted shoulder 160 and extending through the hole therein and through the hole in cover 155 is a rod 156 to which is secured baffle elements 157 and 158. These elements 157 and 158 are shown as segments of a spherical body and they provide very desirable stirring qualities. Elements 157 and 158 may be individual elements secured to rod 156 or the whole baffle element could be fabricated as one integral body by appropriately molding glass, Teflon or the like. A more detailed description of the operational qualities of these spherical segments 157 and 158 will be given below.

A shoulder 160 is secured to rod 156 by means of a screw 161 in a manner well known in the art. The purpose of this combination is to provide for adjustment of the height of the baffle elements 157 and 158 within the fluid medium. This is accomplished by means of the shoulder element 160 resting on the shoulder element 163, the rod 156 being secured to shoulder 160 at a predetermined position by means of screw 161. A scale 174 is provided on rod 156 to indicate this height. Another adjusting screw 162 is mounted in shoulder element 160 and is adapted to bear on shoulder 163 to lock the relative positions thereof. This combination is for setting the angular position of the baffle elements 157 and 158 within the fluid medium. A pointer 169 is secured to shoulder 160 for indicating on scale 173 said angular position of the baffle elements.

A similar structure is provided for the other baffle element which comprises rod 164 mounted within shoulder element 167 and having baffle elements 171 and 172 (which are also spherical segments) secured thereto. Further provided is another shoulder 165 having an adjustment screw 166 and another adjustment screw (not shown, but similar to screw 162) threadably inserted therein for making the height and angular adjustments in the position of the baffle element which

comprises spherical segments 171 and 172. A pointer 168 is secured to shoulder 165 to indicate the angular position thereof. A scale 175 is provided on rod 164 to indicate the height of the baffle element in the fluid medium. Further provided on rods 156 and 164 are knurled knobs 159 and 170, respectively, for facilitating adjustment of the positions of the baffles.

It has been found in practice that the baffle elements illustrated in detail in FIGS. 18—20 provide excellent results for stirring wide varieties of fluids. FIG. 19 illustrates (by means of the dotted lines) the fluid flow in a typical stirring arrangement. The fluid stream 176 flows in the narrow space between the wall of the vessel 150 and the portions of the spherical segments 157 and 158 located nearest thereto. This narrow space is indicated by the reference numeral 177 in FIG. 20. Part of the fluid stream 176 conforms to the curvature of the element 157 and the velocity of flow thereof is considerably slowed down. Therefore, the direction of flow of the fluid stream 176 starts to curve downward. A similar type of effect occurs when a portion of the fluid stream 176 contacts element 158. When the fluid stream 176 reaches the edge 178 of element 158 the stream is caused again to flow downward. A similar effect is exhibited by the fluid stream 179 as it flows over the lower portion of baffle element 258. In this case, the result is an upward flow in stream 179. The lower flat horizontal surfaces 175b and 171b of spherical segments 157 and 171, respectively, act as "horizontal baffle plates." As the position of the flat vertical circular surface 178 of the spherical segment 158 can be changed by turning the knob 159, this offers a very effective way to vary the mixing pattern. Further variations can be effected by selecting positions of the spherical segment 172 by turning knob 170. Varying the position of spherical segment 172 provides different fluid flow characteristics than varying the position of segment 158 due to its angular orientation in the fluid.

Referring to FIG. 21 there is shown another magnetic stirrer configuration according to the invention. This configuration is particularly useful when it is desired to stir a fluid in a water jacket or the like at a substantially constant temperature. A problem in this type of stirring procedure is maintaining the water jacket or the like at a uniform temperature. This has been done in the past by the insertion of propellers mounted on shafts which were inserted in the jacket and driven from above. This arrangement did not always provide a convenient way to achieve the desired results. The apparatus of FIG. 21 provides a simple means for solving the above-described problems.

The magnetic stirrer platform 181 is only partially shown and the driving means for shaft 184 on which driving magnet 183 is mounted is omitted for clarity of illustration. The platform 181 and driving means may be as shown in FIG. 1 or in any of the other embodiments described herein. Placed on platform 181 is an outer vessel 180 in which is placed any of the heretofore described rotors 182 according to the invention. Rotors having flat upper surfaces are particularly well suited for this application. Mounted on top of vessel 180 is a cover which is adapted for mounting another vessel such as vessel 185 within vessel 180. The cover for vessel 180 is adjustable to accept a wide variety of sizes of inner vessels 185 and includes a ring-shaped element 187 mounted on top of vessel 180. Secured to one side of element 187 is element 188 which, in this example, is a portion of a ring-shaped element. Secured to the other side of ring-shaped element 187 is element 189 which is similar in shape to element 188 except that element 189 is adjustably secured to ring-shaped element 187 by means of screw 190, spacer 195 and wing-nut 191. Elements 188 and 189 are adapted to accept the upper lip of inner vessel 185 and for supporting vessel 185 within outer vessel 180. The position of element 189 is adjustable for locking the inner vessel in place and for accepting various sized inner vessels. A cover 196 is placed over the inner vessel 185 to protect the contents thereof and a suitable rotor 186 according to the invention is placed therein. Means may be

further provided within the spirit of this invention for securing the vessel in position during the mixing operation. This securing apparatus may take the form of a clamp around vessel 180 or means for applying pressure on the cover 196.

Note that a grooved element 194 is secured to the underside of element 187 for slideable engagement with the lip of outer vessel 180. Similarly a grooved spacer is mounted on screw 190 on the underside of element 187. These grooved elements 194 and 195 secure the ring-shaped element 187 to vessel 180.

Mounted within inner vessel 185 is a novel baffle element 192 which is shown in more detail in FIG. 22. Baffle element 192 has a rectangular block portion 193 on one end thereof and is adapted to be pressfit into inner vessel 185. It should be clear to one ordinarily skilled in the art that other mounting arrangements for baffle element 192 may be devised. Note that one edge of baffle element 192 is very close to the wall of vessel 185 and that this edge further contains a "sawtooth" portion. This configuration appreciably slows down the fluid flow in the vicinity of the sawtooth (or serrated portion of the baffle element 192 and sufficiently "breaks up" the fluid stream to prevent the formation of the undesirable vortex pattern.

The outer vessel 180 may be provided with a strip-type heating element or the like (not shown) to maintain the water jacket at the desired temperature. The action of the magnetic rotor 182 sufficiently agitates the water jacket to maintain said temperature uniform. It is pointed out that baffle elements are not required in the water jacket.

It is also pointed out that sufficiently strong magnets must be used in the rotors 182 and 186 in order that enough magnetic attraction be supplied therebetween to be rotated in synchronism with drive magnet 183. In practice, however, this limitation is of no consequence since magnets of the required strengths are readily available.

The stirrer of FIG. 21 may be operated such that the rotors are operating in an eccentric position with respect to the center of the vessels. By shifting the position of the outer vessel 180 over the driving magnet 183 the degree of eccentricity may be varied and the most desirable position may be selected. This, in effect, also varies the relative position of the baffle element 192 with respect to the rotor 186 to provide different stirring characteristics. The shifting of the vessel 180 may be accomplished as shown in FIG. 1 or by any of the other methods shown and described herein. It is again pointed out that the rotors 182 and 186 may be operated so that they contact the sidewalls of their respective vessels and no damage to said vessels will result. This is due to the novel construction of the rotors according to the invention.

It is also pointed out that the particular mechanical structure shown in FIGS. 21 and 22 is shown only by way of example and that many modifications may be made thereto within the spirit of this invention by one ordinarily skilled in the art.

Referring to FIGS. 23-25, there is shown another embodiment of this invention which utilizes a more flexible baffle element configuration than shown in FIG. 21 and which illustrates a unique method for adjusting the various variables of the magnetic stirrer in an easily and accurately duplicable manner. In FIG. 23 the magnetic stirrer platform 202 is only partially shown and the driving means for drive magnet 203 is omitted for clarity of illustration. Resting on platform 202 is a vessel 201 which has a rotor 204 immersed in the fluid contained therein. The rotor 204 may take the form of any of the heretofore described rotors according to the invention. Vessel 201 is provided with a cover 205 which is slideably mounted thereon. Depending upon the particular application, the cover 205 may be fixedly mounted on vessel 201. Secured to cover 205 is a shoulder 212 through which is inserted screw 207. Screw 207 also passes through a washer 213. One end 210 of screw 207 is adapted to accept the mounting of baffle element 206 which fits in a slot (or channel) in element 210 and which is secured to element 210 by means of a locking pin 211 or the like. Baffle 206, screw 207 and washer 212 may be made in

one integral unit of glass, Teflon or the like if desired. A knurled knob 209 is secured to screw 207 by means of a pin 220 which passes through the knob 209 and the screw 207 to facilitate adjusting the angular position of baffle element 206 in the fluid medium. The completed assembly is secured to the cover 205 by means of a nut 208 which threadably engages screw 207. The hole for pin 220 is oversized to enable nut 208 to securely lock the baffle assembly in position so that there is a minimum of play between the various constituents thereof. A scale 221 is secured to or painted on shoulder 212 for cooperation with indicating marker 300 (see FIG. 24A) on knurled knob 209 for indicating the exact angular position of the baffle element. Indicating marker 300 may be a pointer secured to knob 209 (as shown more clearly in FIG. 24A) or may be merely a paint mark or the like on knob 209. A more detailed description of the means for mounting and adjusting baffle element 206 is deemed unnecessary for a proper understanding of the instant invention by one ordinarily skilled in the art.

FIG. 24A is a top view of the apparatus of FIG. 23 and shows in detail how the mixing characteristics of the inventive magnetic stirrer are set up. It should be clear from the following discussion that the so determined mixing characteristics may be easily and accurately duplicated.

Imprinted on platform 202 is an X-Y coordinate system which is used for locating the vessel 201 in the desired position. Slideably mounted on platform 202 is a locating device similar to a T-square which includes element 217 which extends across platform 202 and element 218 (secured to element 217) which slides along an edge of platform 202 to keep element 217 properly aligned. See FIGS. 24B and 24C for front and side views, respectively, of the locating device. Also secured to element 217 is block 219 which provides a surface against which vessel 201 bears during the locating process. Block 219 is utilized to more accurately locate vessel 201 since, due to the curved edge where the wall of the vessel meets the bottom of the vessel, locating the vessel by means of element 217 alone would not be as accurate.

After the desired mixing pattern is determined for a given fluid by varying the positions of the vessel and the baffle, the following procedure is utilized to record the pertinent coordinates required for reestablishment of the desired mixing pattern. First the "Y" coordinate of the point P₁ (see FIG. 24A) is obtained by moving the indicating means 217 such that block 219 bears against the wall of vessel 201. The "Y" coordinate is then read off at the upper edge of indicating means 217. In the example of FIG. 24 the "Y" coordinate of point P₁ is shown as 0.35.

Next, the angular position of the baffle element 206 is determined by reading the position of pointer 300 on scale 221. Having recorded this reading, the baffle element 206 is set at its "0" position by means of rotating knob 209. In this particular embodiment, the "0" position of baffle element 206 corresponds to the position whereby the lower extended portion 214 of baffle element 206 (see FIG. 23) just barely touches the wall of the vessel 201. This condition is shown more clearly in FIGS. 25A and 25B and is the position where baffle element 206 is perpendicular to the vessel wall. Thus, extended portion 214 of baffle element 206 cooperates with the vessel to provide a convenient "reference point." It should be clear that this reference position of baffle element 206 may be given any desired designation and the "0" designation as used in this embodiment is only by way of example. The point at which lower portion 214 of baffle element 206 contacts (or almost contacts) the wall of vessel 201 (i.e., the reference point) is easily discernable to the eye and this position is designated point P₂ in FIG. 24A. The coordinates of P₂ (i.e. X=6.2 and Y=1.75) are then recorded. Now, all of the information required to duplicate the mixing operation has been obtained for any given fluid being stirred by any given rotor at a definite rotor speed.

In order to facilitate the determination of the coordinates for point P₂, the configuration of FIGS. 25A and 25B may be

utilized. A block 215 having an arrow 216 (or other appropriate pointer) imprinted on its upper surface is positioned such that the edge of the block 215 corresponding to the head of the arrow is opposite or in alignment with the point at which baffle portion 214 contacts the vessel. The use of the block 215 minimizes the error in setting or determining the coordinates of point P₂, which error is caused by the curvature of the vessel where the wall thereof meets the base.

In order to duplicate the mixing process the reverse procedure is used. First, the baffle element 206 is placed in its "0" position. Second, the point P₁ is set utilizing indicating means 217 and then the vessel is shifted and/or rotated to get the P₂ setting, preferably with the aid of block 215. Then the angular position or baffle element 206 is set on scale 221 to the desired position and the proper motor speed is set.

Referring to FIG. 26 there is shown another adjustable baffle element configuration according to this invention. The vessel platform magnetic driving means are not shown but it should be clear that they may take the form of any platform and driving means combination herein described. Also, any of the previously described rotors may be used in this embodiment.

In FIG. 26, the combination of baffle elements shown provide excellent agitating qualities in a magnetic stirrer according to this invention. A cover 231 is mounted on vessel 230, preferably in a manner similar to that shown in FIG. 15. The locating pins 119 and 122 (see FIG. 15) are not shown in FIG. 26. The baffle element arrangement which includes spherical segments 233 and 234 is similar to the baffle element comprising elements 157 and 158 of FIGS. 18 and 19 and is therefore not described here in detail. The means for mounting spherical segments 233 and 234 to the cover 231 is also similar to that shown in FIGS. 18 and 19. Except for the spherical segments, all of the mounting apparatus in FIGS. 18 and 19 are given the same reference designations in FIG. 26. It is again pointed out that the spherical segments 233 and 234 may be secured to the rod 156 or may be made integral therewith. Either structure will operate satisfactorily, the choice being one of economy in manufacture.

The other adjustable baffle element of FIG. 26 is of a somewhat different design than heretofore described and includes a rod-shaped (or cylindrical shaped) element 236 secured to a member 237 in an eccentric fashion. Member 237 and a shoulder member 238 are secured to a rod 240 which extends through the cover 231 and through a shoulder 239 which is secured to said cover. Mounted on rod 240 are setting rings 241 and 242, between which is mounted a spring 243. Set screws 244 and 245 are threadably mounted in setting rings 241 and 242, respectively, and are adapted to bear upon rod 240. A pointer 246 is secured to the setting ring 241 to cooperate with a scale imprinted on, or secured to, shoulder 239 to indicate the angular orientation of baffle element 236. The mounting arrangement for the cylindrical element 236 is similar to that for baffle element 248 of FIGS. 27 and 28 and is more clearly seen therein. A more detailed discussion of this mounting arrangement is given in the description of FIGS. 27 and 28.

The lower portion of baffle element 236 is cut off at an angle to provide varied fluid flows when element 236 is placed at various angular position in the fluid. As can be seen, due to the eccentric mounting of element 236 on element 237, as the rod (or shaft) 240 is angularly rotated, the distance between baffle element 236 and the sidewall of the vessel 230 is correspondingly varied. The height of the baffle element 236 can also be made adjustable if desired. Spring 243 keeps the baffle elements securely in place, eliminating play therein and providing a more rigid structure. Element 236 is secured to rod 240 and bears upon the lower surface of the cover 231. Spring 243 maintains the shoulder 238 tightly bearing upon cover 231 to maintain the structure rigid.

The combination of baffle elements shown in FIG. 26 provides excellent agitating properties and, since all adjustments are made from outside the vessel, the stirring pattern may be

varied during the stirring operation. Also, this embodiment is very flexible and a wide variety of stirring patterns may be achieved.

Referring to FIGS. 27 and 28, there is shown another combination of baffle elements according to the invention. The baffle element 248 is similar to element 236 of FIG. 26 except that it is mounted directly to shoulder element 249 in an eccentric manner and that it has cut out portions 250 (similar to teeth cut therein). The surface having cut out portion 250 therein is interchangeably referred to as "serrated" or "toothed" herein. The mounting arrangement of element 248 to cover 231 is shown in more detail in FIG. 28.

The baffle element comprising elements 251, 252 and 253 mounted to rod 254 provides somewhat different agitating characteristics than the corresponding baffle element of FIG. 26 which includes spherical segments 233 and 234. For certain fluids, the baffle arrangement of FIG. 27 provides superior results. Again elements 251—253 may be made integral with rod 254 or may be merely secured thereto. The mounting of elements 251—254 to cover 231 is similar to that shown in FIG. 26 and the same reference numerals are used for corresponding elements wherever possible.

Secured to cover 231 is a shoulder 239 having a hole therein for passage of a rod 256 which is secured to shoulder 249 and cylindrical baffle element 248. Adjusting rings 241 and 242 are mounted over rod 256 and have adjusting screws 244 and 245, respectively, threadably mounted therein. Screws 244 and 245 bear upon rod 256 to lock the relative positions of the respective rings and rod 256. Spring 243 is mounted between rings 241 and 242. A pointer 246 is secured to adjusting ring 241 for cooperation with a scale 257 (shown only on FIG. 28) to indicate the angular position of baffle element 248.

The setting up procedure is as follows: First, screws 244 and 245 are loosened and, while holding rod 256 in its uppermost position, ring 242 is pushed down, thereby compressing spring 243. While spring 243 is compressed, screw 245 is tightened into ring 242 and rod 256. In this manner spring 243 causes rod 256 to be in tension and causes shoulder element 249 to bear tightly upon the lower surface of cover 231. Then rod 256 is rotated to place baffle element 248 in the desired "zero" position. Then, ring 241 is rotated so that pointer 246 (which is secured to ring 241) reads "zero" on scale 257 (shown in FIG. 28). Screw 244 is then tightened to lock the relative positions of the rod 256 and pointer 246. Now, angular adjustments may be made by turning either ring 241 or 242 since both rings are locked to shaft 256. This is a relatively simple mounting arrangement which provides very flexible operation. In the above setting up procedure for the embodiment of FIGS. 27 and 28, a convenient "zero" position for baffle element 248 is the position where it touches or is closest to the wall of vessel 230.

With respect to baffle element 248, it has been found that the addition of the serrated (or toothed) configuration 250 on one side thereof provides improved agitating qualities. As the fluid in the vessel passes between the baffle element 248 and the sidewall of the vessel 230, differing amounts of resistance is presented to various portions of the fluid flow. That is, the fluid passing between the vessel wall and the protruding portions of the serrations is exposed to the most resistance and the fluid flowing between the vessel wall and the recessed portion of the serrations 250 is exposed to less resistance. This type of baffle has been found to provide a very wide variety of turbulences for the mixing of fluids. As was mentioned with respect to the similar baffle 236 of FIG. 26, not only the angular orientation can be selected, but also the height of baffle element 248 can be made adjustable to provide duplicable mixing patterns for any type of fluid medium. Height adjusting means and angle adjusting means which are adaptable for use with baffle elements 248 and 236 are shown and described in detail with reference to FIG. 19. Alternatively, spacers may be inserted between shoulder 249 and cover 231 to vary the height of baffle 248 in the fluid.

Referring to FIGS. 29 and 30, another baffle element configuration according to this invention is shown. The baffle arrangement including spherical segments 233 and 234 is similar to the corresponding baffle element of FIG. 26. FIG. 29 is a rear view of the arrangement of FIG. 26. Since the elements are similar, the same reference numerals are used for corresponding parts and a detailed discussion thereof is omitted here.

FIGS. 29 and 30 illustrate another novel adjustable baffle element according to the invention. This baffle element includes elements 257 and 260 which are pivotally coupled together by means of a pin 261. Element 257 is secured to a shoulder 258. Member 260 (secured to member 257 by pin 261) is adapted to pivot about pin 261 in order to vary the spacing between the sidewall of vessel 230 and the member 260. Element 260 has a toothed or serrated portion on the edge thereof closest to the wall of the vessel 230 to provide similar agitating action as element 248 of FIGS. 27 and 28.

A shoulder 259 is mounted on cover 231 and is adapted to accept a hollow tube 262 which is secured to shoulder element 258 (and/or to baffle element 257) passing through a hole in cover 231 and in shoulders 258 and 259. Mounted on hollow tube 262 is a spring 263 and an adjusting ring 264. A screw 265 is threadably mounted in ring 264 to bear upon hollow tube 262. Also, a pointer 266 is secured to ring 264 to cooperate with a scale 267 on shoulder 259 (shown in FIG. 30).

Further provided is a rod 268 slideably mounted within the hollow portion of hollow tube 262. Rod 268 is pivotally secured to baffle member 260 by means of a pin 269 which passes through rod 268 and member 260. Rod 268 may be tightly fit within hollow tube 262 so that when its position is set, it will remain in position, or adjusting means such as a set-screw or the like may be used to lock the relative position of rod 268 in tube 262. It should be clear to one skilled in the art that many types of locking arrangements may be devised within the spirit of this invention. Rod 268 cannot fit too tightly in tube 262 since when adjustments are made to member 260, there is some lateral motion of rod 268 within tube 262.

The flat baffle elements of FIGS. 29 and 30 are shown in two different positions. In FIG. 30, the element 260 has its toothed edge or serrated edge positioned closer to the wall of vessel 230. This is accomplished merely by moving the rod 268 down within tube 262 to cause element 260 to pivot about pin 261 and to thereby move closer to the wall of the vessel. The adjustments of FIGS. 29 and 30 provide very different mixing characteristics and the one to be used in any particular application depends in part upon the fluid and rotor speed. A scale may be provided on rod 268 to accurately indicate its height position to enable one to duplicate mixing patterns.

The setting up of this configuration is as follows: First, element 257 is aligned such that its lower portion 270 is in the position whereby it is closest to the wall of vessel 230. This is the "zero" position in this example. It is clear that any other "zero" position may be chosen. Then the screw 265 is loosened and ring 264 rotated until pointer 266 reads "zero" on scale 267. Then, while holding hollow tube up, the spring 263 is compressed by pressing down on right 264, and while the spring 263 is compressed, screw 265 is tightened, thereby locking the relative position of ring 264 and tube 262. Again, the spring 263 keeps the structure rigid by eliminating excess play. The angular position of the baffle is now set merely by rotating tube 262 or ring 264 until the pointer 266 indicates the desired position.

This above-described baffle element configuration which includes members 257 and 260 is particularly suitable for use in the magnetic stirrer configuration of FIGS. 23, 24 and 25. The baffle arrangement of FIG. 30 is more flexible than that of FIG. 23 in that more variables are provided. Therefore, a greater variety of mixing patterns are obtainable.

The other shoulder 263 of FIG. 30 can accommodate the baffle elements 233 and 234 and their associated mounting

components (shown in FIGS. 26 and 29) or may accommodate practically any other type of adjustable baffle element discussed herein. The particular choice depends upon the fluid being stirred and the pattern desired. It is also clear, that if desired, one need not use any baffle in shoulder 263, in which case shoulder 263 is either capped or is eliminated altogether.

It is pointed out that the double-setting ring mounting arrangement shown in FIG. 28 may alternately be used to mount hollow tube 262 to cover 231 in FIG. 30. Referring to FIG. 31 there is shown another baffle element arrangement according to this invention. A slotted retaining member 290 is mounted to the cover 231 of vessel 230. The baffle element 291 includes three spheres 292, 293 and 294 having different diameters connected together to form one body 291 having an irregularly shaped surface. The spheres 292—294 may be hollow or solid. Also, they may be manufactured either separately and then attached together or they may be manufactured as one integral unit. To the upper portion of the baffle element 291 there is secured a slotted retaining member 295 similar to member 290. A rod 296 having protrusions 297 and 298 thereon is provided for mounting the baffle element 291 to the cover 231. The operation of this type of mounting arrangement should be clear to those skilled in the art. It is pointed out that the height of the baffle element 291 may be easily varied by merely changing the length of the mounting rod 296. It has been found in practice that the baffle element 291 produces excellent turbulence and provides excellent stirring characteristics when used alone, in pairs or in combination with other baffle elements.

It is not necessary to provide angular adjusting means for the baffle element 291 of FIG. 31, since its surface is symmetrical about its vertical axis. However, to achieve yet more varied stirring characteristics the retaining member 295 may be mounted offset with respect to the vertical axis of the spheres 292—294 of baffle element 291 and adjusting the angular position of baffle element 291 may be provided. In this case, by adjusting the angular position of baffle element 291, the distance between the wall of the vessel 230 and baffle element 291 is also varied. It should be clear from the foregoing discussions that the stirring characteristics will be likewise varied. Any of the various schemes described herein for adjusting the angular position of baffle elements may be adapted to the configuration of FIG. 31 by anyone ordinarily skilled in the art within the spirit of this invention.

Instead of mounting the retaining member 295 in an eccentric manner, one or two of the spheres 292—294 of the configuration of FIG. 31 could be mounted eccentric to the others. Thus, by varying the angular position of the baffle element 291 by any of the various methods described herein, the distance between the wall of vessel 230 and the eccentric spheres will be varied, thereby changing the stirring characteristics of the stirrer.

Referring to FIGS. 32A and 32B, there are shown the pertinent portions of an adjustable vessel platform according to this invention which is adjustable in two perpendicular directions. In FIG. 32A, elements 300 and 301 are support elements for the platform 302. The support elements may be similar to support members 11 and 12 of FIG. 1A (which in this example are fixed in position and not adjustable as in FIG. 1) or may be any other type of fixed support. Mounted below platform 302 is a rotating magnet 303 which is driven in the same manner as magnet 4 of FIG. 1 or by any other of the methods well known in the art. The position of the rotating magnet relative to support members 300 and 301 is fixed in the embodiments of FIGS. 32A and 32B.

Referring to FIG. 32B, there is shown a top view of FIG. 32A which shows the platform-adjusting means in more detail. Member 304 is secured to platform 302 by means of screws (as shown in FIG. 32B), adhesives, or by any other well known method. A member 305 is pivotally secured to platform 302 by pivot 306, which is shown herein as a screw. Note that member 305 is not shown in FIG. 32A for the sake of clarity.

The platform 302 has lips 302a and 302b at the ends thereof for retaining platform 302 on support members 300 and 301 while allowing for movement of platform 302 relative to members 300 and 301 in the directions of arrows 307. A plate 308 having a hole therein adapted to retain a vessel in place is movably mounted on platform 302 between members 304 and 305. Plate 308 is adapted for movement in the directions of the arrows 309.

The mechanism for locking the position of the platform 302 relative to the support members 300 and 301 includes a locking screw 310 which is threadably mounted in lip 302b. When the position of the platform 302 is set, the screw 310 is screwed in to bear upon support member 301 to lock the platform 302 in place. A pointer 311 is secured to support member 301 which cooperates with a scale 312 to indicate the position of platform 302 relative to the support members 300 and 301 (and therefore, relative to the rotating magnet 303).

The plate 308 is locked in position by means of locking screw 313 which is threadably mounted in member 314. Member 314 is secured to platform 302. When the desired position of the plate 308 is set, the screw 313 is turned in to bear upon the pivotally mounted member 305. This causes member 305 to pivot about pivot 306 and bear against the edge of plate 308 to lock plate 308 in place relative to the platform 302. When the screw is loosened, the pressure against the edge of plate 308 is released, and plate 308 may again be moved. A pointer 315 on plate 308 cooperates with a scale 316 on member 305 to indicate the position of the plate 308 relative to the member 305 and therefore relative to the platform 302 and rotating magnet 303.

The vessel is retained within the indicated hole in plate 308. Thus, by simultaneously adjusting the configuration of FIGS. 32A and 32B in the directions indicated by the arrows 307 and 309 (FIG. 32B) the vessel 230 may be set in an infinite number of positions relative to the rotating magnet 303. These positions are easily set, thus making it a simple matter to experimentally determine the exact position whereby optimum stirring characteristics are obtained for any substance being stirred. When the optimum position is found it is a simple matter to record the exact readings of the X and Y coordinates of the position of the vessel on scales 312 and 316. This enables exact duplicating of stirring operations at any future time merely by using the same size vessel, the same rotor and baffle elements, the same magnet speed and the same settings on scales 312 and 316. Also, if the baffle positions are variable, the exact positions of the baffles may be indexed as described herein and later duplicated.

It should be clear that many modifications may be made to the embodiment of FIGS. 32A and 32B to provide equivalent results by those skilled in the art and that the illustrated embodiment is shown merely by way of examples.

Referring to FIG. 33, there is shown a convenient apparatus to facilitate varying also the angular position of the vessel 230 on the surface (such as on plate 8) of a magnetic stirrer. This configuration consists of a collar 318 made of material such as Teflon or the like which is slid over the surface of the vessel 230. The collar 318 may also be made of metal, but a material such as Teflon or other plastics is preferable. Collar 318 has gripping tabs 319 and 320 protruding therefrom to enable one to easily grip the collar and to squeeze the tabs together to easily adjust the position of the vessel without having the collar slip on the vessel. The collar may have a single mark thereon to cooperate with a scale on the platform (such as scale 321 on plate 308 of FIG. 32B) to indicate the angular position of the vessel. Alternately, the scale may be provided on the vessel 230 or on the collar 318 and a reference mark provided on the platform. Varying the angular position of the vessel on the stirrer platform varies the position of the baffle elements with respect to the rotating magnet 303. This adjusting feature further facilitates determining optimum settings for stirring particular fluids. Since an index is provided, this position is also easily duplicable at any time.

Referring again to FIG. 32A, there is shown another baffle element 322 according to this invention. Baffle element 322 consists of two serrated legs 323 and 324 having a space therebetween. Only the portions of the legs 323 and 324 closest to the wall of the vessel are serrated. Note also that the depth of the serrations increases towards the bottom of the vessel. The reasons for the serrations being formed in this manner are set forth in the discussion of FIGS. 23, 29 and 30. Baffle element 322 is removably mounted in the cover 231 of vessel 230 by means of a slot in the upper portion thereof which engages with a pin 325 which in turn is retained in channel member 326. Channel member 326 is secured to the underside of cover 231. This baffle configuration has been found to provide excellent agitation and stirring characteristics. It is essentially a modification of the baffles of FIGS. 23 and 23 except that two baffles are combined into one integral structure. The two legs 323 and 324 could be identical or differently shaped, depending upon the application. It should also be clear that in any magnetic stirrer according to this invention any combination of baffle elements according to the invention may be used. Also the elements may be used singly or the same elements may be used in pairs. More than two elements can also be used.

It is further pointed out that the magnetic driving means which includes the motor 2 and magnet 28 of FIG. 1 may be adapted to impart an oscillatory motion to the rotor in the vessel 4 instead of the rotary motion described herein. Also, oscillatory motion in a vertical plane may be imparted to the rotor by an appropriate driving means. It should also be clear that the magnetic portion of the rotors may include powdered magnetic material embedded in an inert body, the powdered magnetic material being appropriately magnetized in a manner well known in the art. The magnetic material may also include magnetic ceramics. These and other variations on the embodiments of my invention should be clear to those ordinarily skilled in the art in view of the descriptions included herein.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention, as set forth in the accompanying claims.

I claim:

1. a magnetic stirrer for stirring a fluid medium within a vessel comprising:

means for supporting said vessel;

a rotor adapted to be at least partially immersed in said fluid, at least a portion of said rotor being comprised of magnetic material;

magnetic driving means coupled to said rotor for imparting motion to said rotor;

means for changing the relative position of said magnetic driving means with respect to the vessel for changing the relative position of said rotor within said vessel; and

indexing means coupled to said changing means to determine the position of said driving means relative to said vessel.

2. A magnetic stirrer according to claim 1 wherein said magnetic driving means imparts a substantially rotary motion to said rotor.

3. A magnetic stirrer according to claim 1 wherein said rotor has a substantially circular circumference in the plane of motion of said rotor.

4. A magnetic stirrer according to claim 1 wherein said changing means includes means for moving said supporting means relative to said magnetic driving means.

5. A magnetic stirrer according to claim 4, wherein said changing means includes means for moving said supporting means in two different directions.

6. A magnetic stirrer according to claim 5, wherein said changing means includes means for moving said supporting means in two substantially perpendicular directions.

7. A magnetic stirrer according to claim 4 wherein said indexing means includes means for indicating the position of said supporting means relative to said magnetic driving means.

8. A magnetic stirrer according to claim 4 further comprising means coupled to said supporting means for locating said vessel at a predetermined position on said supporting means.

9. A magnetic stirrer according to claim 1 wherein said indexing means includes means associated with said supporting means for locating said vessel at a predetermined position on said supporting means and for indicating the position of said vessel on said supporting means.

10. A magnetic stirrer according to claim 9 wherein said locating means further includes means associated with said vessel for providing a reference point on said vessel.

11. A magnetic stirrer according to claim 10 wherein said locating means includes:

- means for positioning the sidewall of said vessel at a first predetermined position on said supporting mean; and
- means for positioning said reference point at a second predetermined position on said supporting means.

12. A magnetic stirrer according to claim 11 wherein said locating means includes an X-Y coordinate system on said supporting means.

13. A magnetic stirrer according to claim 10 further comprising:

- at least a first baffle element, a portion thereof being adapted to cooperate with said vessel to provide said reference point; and

- means for positioning said first baffle element within said vessel to be at least partially immersed within said fluid.

14. A magnetic stirrer according to claim 1 further comprising:

- at least a first baffle element; and
- means for positioning said first baffle element within said vessel to be at least partially immersed in said fluid.

15. A magnetic stirrer according to claim 14 wherein said baffle positioning means includes means for adjusting the position of said first baffle element within said vessel.

16. A magnetic stirrer according to claim 15 wherein said adjusting means includes means to adjust the angular orientation of said first baffle element within said vessel.

17. A magnetic stirrer according to claim 16 wherein said baffle element includes an eccentrically mounted portion whereby adjustment of said positioning means also varies the distance between the wall of the vessel and said eccentrically mounted portion of said baffle element.

18. A magnetic stirrer according to claim 17 wherein; 9c said eccentrically mounted portion is an eccentrically mounted substantially cylindrical member.

19. A magnetic stirrer according to claim 15 wherein said baffle positioning means includes means to adjust the relative position of the axis of said first baffle element with respect of a predetermined point on said vessel.

20. A magnetic stirrer according to claim 19 wherein said baffle positioning means further includes means to adjust the angular orientation of said first baffle element within said vessel.

21. A magnetic stirrer according to claim 14 further comprising:

- at least a second baffle element; and
- means for positioning said second baffle element within said vessel.

22. A magnetic stirrer according to claim 21 further comprising second adjusting means coupled to said second baffle element positioning means for adjusting the position of said second baffle element within said vessel.

23. A magnetic stirrer according to claim 21 wherein said first and second baffle element positioning means includes means for varying the relative positions of the axes of said first and second baffle elements with respect to each other.

24. A magnetic stirrer according to claim 21 wherein at least one of said first and second baffle element positioning means includes indexing means for indicating the positions of at least one of said first and second baffle elements.

25. A magnetic stirrer according to claim 14 wherein said rotor has a substantially circular circumference in the plane of motion of said rotor.

26. A magnetic stirrer according to claim 14 wherein said baffle element includes a plate.

27. A magnetic stirrer for stirring a fluid medium within a vessel comprising:

- means for supporting said vessel;

- a rotor adapted to be at least partially immersed in said fluid, at least a portion of said rotor being comprised of magnetic material and said rotor having a substantially flat portion which has a substantially circular circumference, the plane defined by the face of said flat portion being substantially parallel to the lower surface of said vessel;

- magnetic driving means coupled to said rotor for imparting rotary motion to said rotor about an axis substantially perpendicular to the flat face of said rotor;

- at least one baffle element;

- means for positioning said at least one baffle element within said vessel to be at least partially immersed in said fluid; and

- indexing means coupled to said baffle element positioning means for indicating the position of said at least one baffle element within said vessel.

28. A magnetic stirrer for stirring a fluid medium within first and second vessels, said first vessel being at least partially immersed within the fluid medium in said second vessel comprising:

- means for supporting said second vessel;

- means for supporting said first vessel within said second vessel;

- a first magnetic rotor at least partially immersed in the fluid in said first vessel;

- a second magnetic rotor immersed in the fluid in said second vessel and magnetically coupled to said first rotor; and

- driving means magnetically coupled to said second rotor for imparting motion to said second rotor and to said first rotor.

29. A magnetic stirrer according to claim 28 wherein said first and second rotors have substantially circular circumferences in their planes of motion.

30. A magnetic stirrer according to claim 29 further comprising means for changing the relative position of said magnetic driving means with respect to said vessels for changing the relative positions of said rotors within said vessels.

31. A magnetic stirrer according to claim 28 further comprising:

- at least one baffle element; and

- means for mounting said baffle element within said first vessel, said baffle element being at least partially immersed in the fluid medium within said first vessel.

32. A rotor for a magnetic stirrer wherein at least a portion of said rotor is comprised of magnetic material, said rotor having:

- at least one substantially flat ring-shaped portion having a substantially circular circumference, the plane defined by the face of said flat ring-shaped portion being substantially parallel to the lower surface of the vessel of said magnetic stirrer; and

- an agitating portion secured to said at least one ring-shaped portion.

33. A rotor according to claim 32 wherein said magnetic material includes a magnet secured to said ring-shaped member, said magnet also functioning as said agitating portion.

34. A rotor according to claim 32 further including a second ring-shaped member secured to the other side of said magnet, thereby rendering said rotor functional also in its inverted position.

35. A rotor according to claim 32 wherein said ring-shaped portion is comprised of magnetic material.

36. A rotor according to claim 32 wherein said agitating portion is comprised of magnetic material.

37. A rotor for a magnetic stirrer comprising:
a cup-shaped member having a lip portion extending outwardly from the walls of said cup, said lip functioning as a bumper for said rotor; and
magnetic means inside said cup-shaped member.

38. A rotor according to claim 37 wherein said magnetic means inside said cup-shaped member is rotatable relative to said cup-shaped member.

39. A rotor for a magnetic stirrer wherein at least a portion of said rotor is comprised of magnetic material, said rotor having:

a substantially flat disc-shaped portion having a substantially circular circumference, the plane defined by the face of said flat disc-shaped portion being substantially parallel to the lower surface of the vessel of said magnetic stirrer; and

a substantially dome-shaped portion secured to the upper flat surface of said disc-shaped portion.

40. A rotor according to claim 39 wherein said agitating portion includes protrusions on the surface of said rotor.

41. A rotor according to claim 39 wherein said magnetic

material includes a magnet embedded in said disc-shaped portion.

42. A rotor according to claim 39 wherein said disc-shaped member is integral with said substantially dome-shaped portion.

43. A rotor according to claim 39 wherein said agitating portion includes at least one protrusion on said substantially dome-shaped portion.

44. A rotor according to claim 39 wherein said dome-shaped portion is a substantially hemispherical portion.

45. A rotor for a magnetic stirrer wherein at least a portion of said rotor is comprised of magnetic material, said rotor having:

a substantially flat portion having substantially circular circumference, the plane defined by a face of said flat portion being substantially parallel to the lower surface of the vessel of said magnetic stirrer, characterized in that said magnetic material portion and said substantially flat portion are rotatable with respect to each other.

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