June 16, 1964 P. A. MacLEAN 3,137,481

MIXING DEVICE

Original Filed April 16, 1958

2 Sheets-Sheet 1

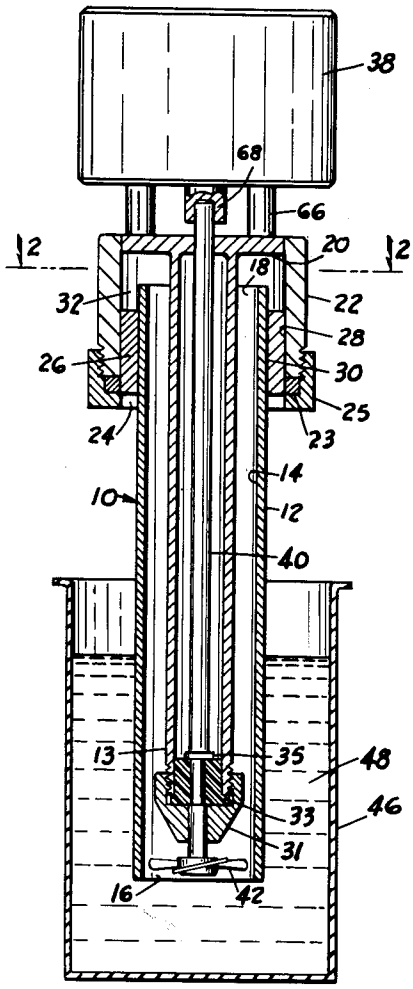


FIG. 1

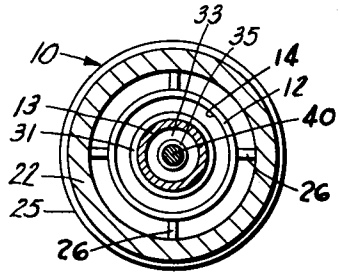


FIG. 2

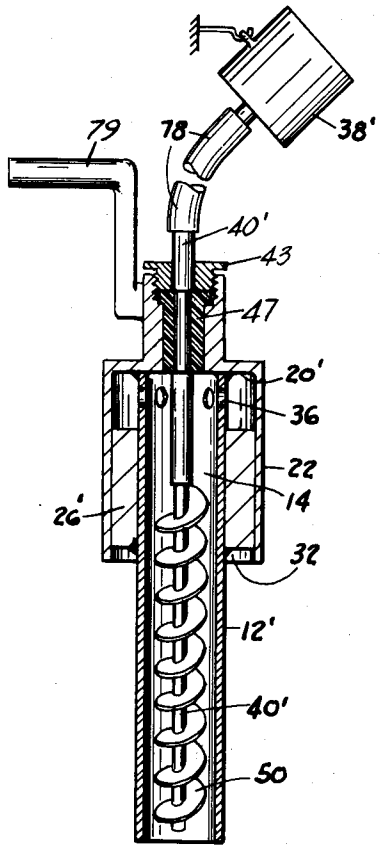


FIG. 3

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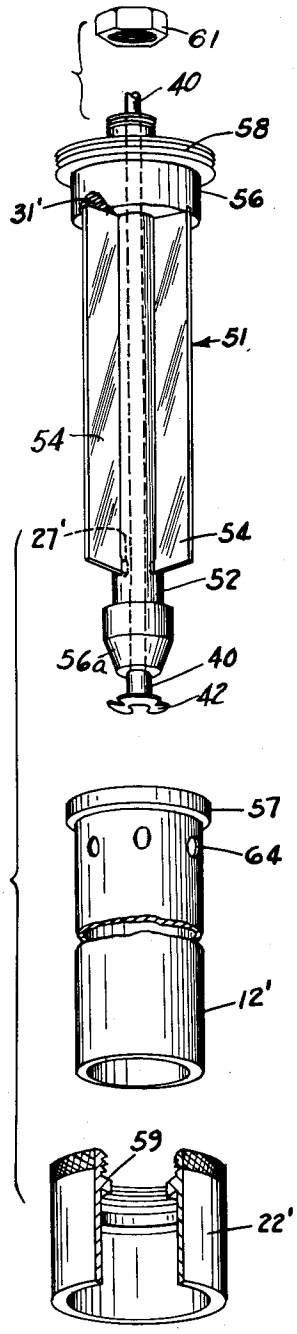


FIG. 4

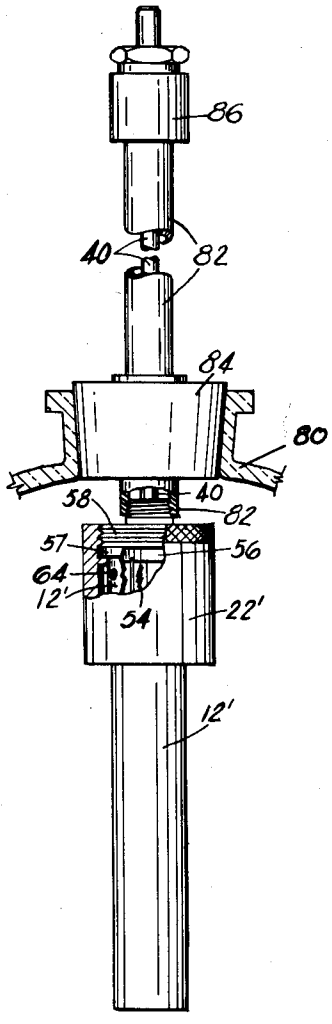


FIG. 5

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MIXING DEVICE

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Continuation of abandoned application Ser. No. 728,864, Apr. 16, 1958. This application Sept. 25, 1961, Ser. No. 140,566

3 Claims. (Cl. 259—97)

The present invention relates to an improved mixing and stirring device, adapted to mix and homogenize liquids in a receptacle and more particularly to eliminate swirling and centrifugal churning action of the liquid being mixed, against the walls of the said receptacle.

This application is a continuation of my copending application, Serial No. 728,864, filed April 16, 1958 now abandoned.

Mixing devices for liquids, such as the conventional kitchen appliance, are usually of the "egg beater" type. Such a device comprises a motor, a shaft and a mixing paddle or churning device affixed to this shaft, the said device being adapted to mix liquids in a large mixing bowl. Such a bowl must be large enough to allow for the centrifugal churning action of the mixer, and also must be of a certain minimum sturdiness, such as that of the conventional heavy molded glass or stainless steel kitchen mixing bowl, for example. That is, a fragile container, such as thin glassware would obviously be inadequate and would quickly break under the pressure of churning action and/or accidental contact with the rotating impeller. Where the liquid is retained in an elongated receptacle such as a test tube or flask, a great saving in time and a far more efficient mixing action could take place if the mixer were adapted to be inserted directly into such an elongated receptacle. For example, in laboratory work where a high degree of accuracy is desired, a loss in liquid would occur if liquids are transferred from test tubes to mixing bowl and back again to test tubes. This is unavoidable under existing devices. Moreover, the conventional mixer could not be used where the liquid level was within a short distance of the top portion of the receptacle, as the liquid would quickly overflow and be spilled in the course of the mixing action.

Briefly stated, this invention provides an easily cleaned liquid mixing device of simple construction wherein mixing is carried out within a confined chamber.

It is, therefore, a special object of the present invention to provide an improved mixing device for liquids retained in elongated fragile receptacles such as test tubes or the like.

It is a further object of the present invention to provide mixing means for liquids that eliminate to a great extent swirling and churning effects due to centrifugal force being exerted on said liquids.

Yet a further object of the present invention is to provide mixing means for liquids wherein minimum vibration is imparted to the surrounding receptacle.

A particular advantage of this invention is the provision of completely protected moving parts.

Still a further object of the present invention is to provide mixing means for liquids stored in receptacles of various shapes and sizes whereby access is readily made to said receptacles.

A particular advantage of the present invention is that it permits of thorough and convenient cleaning of the mixer. This feature is of major importance for laboratory application.

These and other objects and advantages of the present invention will be apparent from the following description and accompanying drawing, and the claims appended thereto.

In the drawing:

FIG. 1 is a cross-sectional view in elevation of a device of the present invention.

FIG. 2 is a plan view along line 2—2 of FIG. 1 (with receptacle 46 removed).

FIG. 3 is a longitudinal cross-section of an embodiment of a device of the present invention, employing an alternative impeller means and a flexible shaft drive means.

FIG. 4 is an exploded view, partly broken away, showing an alternative embodiment of the present invention.

FIG. 5 shows in elevation and partially broken away the invention shown in FIG. 4 as employed in a resin kettle.

Referring now more particularly to the drawing, there is shown in FIG. 1 a device of the present invention characterized generally by the numeral 10. Tube 12 in the embodiment here illustrated is shown as an elongated member of relatively narrow diameter, adapted to be inserted in vessels such as test tubes, beakers or flasks. However, it will be understood that this configuration is not critical and that the length and diameter of this tube will depend primarily on the type of application desired. Tube 12 in the currently preferred embodiment is formed of stainless steel tubing. The interior 14 of this tube defines a flow passage from inlet opening 16 to outlet opening 18. A wall portion 20 is disposed transversely approximate to opening 18 of this tube, the wall thus being adapted to act as a deflection surface. A second tube 22 is formed coaxially about tube 12 and extends longitudinally to enclose a portion of the upper section of tube 12. Tube 22 extends axially forward of tube 12, and abuts wall 20 to define an inverted cup-member. The abutting edge of tube 22 is tightly sealed to wall surface 20 by threaded engagement, where registering threads are formed on the inner edge of tube 22, and the rim of wall 20, by soldering, or by simple force fit.

The space between the inner wall of tube 22 and the adjacent confronting outer wall of tube 12 defines a second flow passage 32 formed concentrically about tube 12, through which, in operation, liquid will pass opposite in direction to flow through passage 14. The outlet of this second flow passage is defined by the opening 24 of tube 22.

It will be noted from FIG. 1 that tube 12 is spaced a fixed distance from the inner wall 28 of tube 22. This requisite spacing is maintained by baffle members 26 interposed between inner wall 28 of tube 22 and outer wall 30 of tube 12. Baffle members 26 are rigidly soldered to a ring 23, giving the inner tube 12 the requisite rigidity and spaced relationship to outer tube 22 and wall 20.

The primary function of the baffle members 26 is to serve as flow straightening means. It will be noted, as shown in FIG. 2 that members 26 are formed with a minimal width as seen in cross-section, thus interposing relatively little blockage to the said second flow passage while acting to prevent swirling of the liquid being acted upon.

Liquid is drawn into flow passage 14 by means of motor 38 which rotates shaft 40, upon which is mounted impeller 42, disposed proximate to the opening 16 of tube 12. Shaft 40 is positioned coaxially in tube 12, passing through an aperture formed in wall 20. In operation, tube 12 is introduced into receptacle 46 containing liquid 48. Upon rotation of shaft 40 by motor 38, impeller 42 draws liquid up into flow passage 14 with considerable velocity. It should be particularly noted, however, that impeller 42 is shrouded by the walls of tube 12; therefore, there is little or no centrifugal thrust exerted against receptacle 46. Hence, there is no spill or overflow. The liquid drawn through flow passage 14 thrusts against wall

surface 20 and is then deflected into second flow passage 32. It is then returned to receptacle 46 by the force of the liquid column forced up through flow passage 14. In the return direction, the liquid flows downwardly over the outer wall of tube 12 in flow passage 32. While flowing through flow passage 32, the liquid has imparted to it a straightening action by the action of baffle members 26. Thus all turbulence and swirling motion taking place in the region of wall 20 is largely eliminated, and the liquid descends downward into receptacle 46 flowing with relative smoothness over the outer wall of tube 12. The liquid continuously re-enters receptacle 46, as the mixing cycle is continued. Thus, the flow of liquid in the device of the present invention is almost entirely in an upward and downward direction, with little or no lateral component of motion.

In order to completely disassemble the apparatus for cleaning, collar 25 is unscrewed from tube 22 thus permitting the removal of tube 12, vanes 26 and ring 23 as a unit. Collar 31 is then unscrewed from the end of tube 13. This permits flanged polyfluoroethylene split bushing 33 to be removed together with impeller 42 and shaft 40. It will be noted that shaft 40 is provided with a reduced portion over which the split bushing 33 is positioned. A force fit split washer 35 limits the downward thrust of shaft 40 in response to the action of impeller 42 during operation. The end of shaft 40 is keyed into the motor shaft by any of the conventional coupling arrangements.

FIG. 1 also illustrates another important feature of the present invention, namely, that it is not necessary to immerse tube 12 to a maximum depth within the receptacle for the device to function adequately. Thus, the present device can be employed with relatively shallow receptacles and still function efficiently to stir and mix liquids retained therein, whereas conventional mixing devices would be entirely inoperative under such a situation. It should also be noted that the receptacle can be full almost to the top and mixing will still be possible utilizing the present device, without danger of spill.

As shown in FIG. 3, an alternate method of supporting tube 12' in spaced relationship to wall 20' and outer tube 22' is to fasten the upper portion of tube 12 against the surface of wall 20' by a soldering or brazing operation. Alternatively, the tubes 12' and 22' and wall 20' may be integrally formed by conventional metal working techniques such as by casting. In this embodiment, apertures 36 are formed in the upper portion of tube 12', serving as outlet ports for flow passage 14 and providing an access to the second flow passage 32. In this embodiment, baffle members 26' likewise serve as in the dual role of support and anti-swirl element.

It will be noted that whereas the embodiment of FIG. 1 provides but little resistance to the flow of liquid at the top of tube 12', the embodiments of FIGS. 3 and 4 employ a number of orifices 36 and 64, respectively, so that liquid is expelled therethrough under pressure resulting in enhanced mixing action.

As shown in FIG. 3, an alternate form of impeller unit is provided which comprises a spiral configuration 50 formed upon shaft 40', this spiral extending through a considerable portion of the length of tube 12'. This imparts an improved impeller action. The shaft 40' is maintained in position by split bushing 47 which is, in turn, locked in by clamping nut 43.

Shown in FIGS. 4 and 5 is yet another embodiment of the present invention, illustrating improved shaft supporting means and improved positioning of the baffle members. A unitary structure 51 is provided, which comprises a torque tube 52 having a number of baffle members 54 extending radially outward along most of the length of this tube. At one end of tube 52, there is formed a collar portion 56 and a threaded neck portion 58. In assembling the unit, shaft 40 is positioned in sleeve 52 being mounted on bearings similar to that shown in FIG. 1. Impeller 42 is securely attached to the terminal portion of shaft 40. Outer tube 22' is furnished with an internally threaded portion which registers with externally threaded neck portion 58. Prongs 27' of vanes 54 fit into registering apertures in sleeve 52. A terminal portion 31' of vanes 54 fit into registering slots of collar 56. This arrangement permits rapid assembly, dismounting and cleaning of the vanes. Inner tube 12' and collar 57 are an integral assembly which is slipped over the vane portion of sleeve 52 and is clamped against seat 59 by neck portion 58. Vanes 54 register tightly with the inner wall of tube 12', and tube 12' is provided with apertures 64 which serve as outlet ports whereby liquid entering tube 12' under impeller action can be forced into the flow passage defined by the area between 22' and 12', as explained previously. Collar 56*a* is threadably secured to the lower end of tube 52. The construction and function of collar 56*a* are the same as collar 31 which was described hereinabove with respect to FIG. 1. That is, unscrewing collar 56*a* will permit the removal of shaft 40 and impeller 42 for cleaning thereof.

It should be noted that the basic principle illustrated in the above three embodiments of the present invention is that of internal mixing, namely, that the entire mixing action takes place inside the device, not in the receptacle. The mixing action commenced by the impeller is continued by the impact of liquid particles against the walls of the flow passages and against the walls of the vanes, which promotes very effective mixing action during the entire period the liquid is traveling through the device.

It should be particularly noted that vanes structure 54 of the embodiment positioned within the inner tube as shown in FIG. 4 provides very efficient means for eliminating centrifugal swirling action. Therefore, this embodiment is particularly adapted for use with fragile receptacles, such as test tubes. Another feature of this embodiment is the great ease of assembling and dismantling the tube sections, whereby tube 12' and 22' can readily be removed for purposes of cleaning.

As shown in FIG. 1, the mixer structure of the present invention is secured rigidly to the motor rotating the shaft, by means of bolts or similar connecting members 66. For greater flexibility, connecting members 66 may be removed and motor coupling 68, shown here as rigidly coupled to shaft 40, may be coupled to an intermediate length of flexible shafting 78, whereby the device of the present invention can be used, for example, for mixing of the contents of a large number of racked test tubes, the flexible shaft portion providing maximum mobility in this application while the motor is maintained in a fixed position. In FIG. 3, motor 38' is shown coupled to shaft 40 by flexible shaft 78. Handle 79 provides a convenient means for holding the mixer.

An important advantage of this device is that it may readily be fitted through small orifices. This lends to it utility as a mixer for resin reaction kettles.

Heretofore mixers for such devices were of limited capabilities as performance was often secondary to ability to be fitted into the vessel.

In FIG. 5, there is shown the apparatus of this invention adapted for use in a sealed system utilizing a conventional resin reaction kettle 80 only, a portion of which is shown. Here the embodiment of FIG. 4 is shown coupled to an extension torque tube 82 which passes through in a tight fitting relationship, a resilient plug formed of a chemically resistant and generally gas impervious resin such as Teflon, Kel-F or other polyfluorothene resin. The plug 84 fits into the neck of the reaction vessel 80. The unit of this invention may be made sufficiently small to fit through the neck opening of a typical reaction kettle which is only 29 mm. in diameter. The torque tube terminates in a conventional stuffing box 86 through which is passed shaft 40 which is in turn coupled to a motor not shown.

While it is currently preferred to assemble the mixer of this invention using stainless steel tubes, and stainless steel for the other metal components such as the shafts and

chemically resistant plastics, as shown heretobefore, for seals and the like, it is also contemplated that the invention may be embodied in mixers formed from glass, plastics or other metals besides stainless steel. For example, a glass mixer would have utility in certain biological and bacteriological processes where the ability to sterilize the mixer would be of extreme importance. On the other hand, it is contemplated to produce the body structure disclosed as a one-piece injection molding of a thermoplastic resin such as polystyrene or nylon for applications wherein it may be desirable to dispose of the mixer because of contamination as may result from radiological applications.

The method of forming the unit will be dependent on the material chosen. The device is well adapted to molding, casting or other well known fabrication techniques.

There has thus been provided in accordance with the present invention a compact, highly efficient device, relatively simple in construction and ease of manufacture, adapted to mix liquids with minimum risk of damage to fragile receptacles, and minimum risk of spill and overflow due to centrifugal or swirling action during the mixing process. Various changes and modifications in the present device can be made by those skilled in the art without, however, departing from the scope and spirit of this invention.

What is claimed is:

1. A device for mixing liquids in a receptacle comprising:

a torque tube having an outer wall;

a second tube open at each end having an inner wall opposite said torque tube outer wall and concentric to said torque tube, to define a first flow passage therebetween said first flow passage being characterized by a substantially larger intake cross sectional area than outlet cross sectional area whereby liquids are discharged under pressure;

a wall portion disposed transversely to said second tube, proximate to one end thereof;

a third tube disposed coaxially about and enclosing at least part of said second tube and extending axially forward of said second tube to abut said transverse wall in sealed relationship thereto, the volume between the inner wall of said third tube and the confronting outer wall of said second tube defining a second flow passage concentric about said first flow passage and communicating therewith proximate to said wall portion;

a rotatable shaft axially disposed in said torque tube;

baffle members radially aligned with respect to said shaft, said baffle members extending between said inner wall of said third tube and said outer wall of said second tube;

impeller means carried by said shaft whereby rotation of said shaft, when said first tube is introduced into said liquid, will force a portion of said liquid through said first flow passage and, in turn, through said second flow passage so as to return said liquid to said receptacle; and

a bushing characterized by a low coefficient of friction interposed between said shaft and said torque tube.

2. The mixing device of claim 1 including axially movable collar means to exert pressure on said bushing for deforming said bushing so as to seal the opening between said shaft and said torque tube so as to prevent said liquid from entering therein.

3. The device of claim 1, wherein said bushing is provided with a flange adapted to extend over the edge of said tube and means to clamp said flange to said tube.

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