

[54] **AGITATOR FOR MOVING FLUID
SUSPENDED OBJECTS THROUGH
ABRASIVE MOTIONS**

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51/163

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241/175; 259/72, 125; 74/231

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[57] **ABSTRACT**

A self-contained agitating apparatus, primarily useful for batch processing a multiplicity of objects suspended in a fluid and contained in a vessel that is oscillated by a remote and stationary prime mover, to cause said objects to progressively move through a toroidal path and thereby roll into and out of interengagement and into and out of engagement with the vessel walls, and which action is enhanced by the presence of abrasives added to the fluid and/or batch for the purpose of deburring, polishing and the like. Secondly, the apparatus is useful for lapping objects upon a plate and by means of the above said oscillatory action, said secondary utility being concurrent with said primary utility and operative simultaneously in the one apparatus.

5 Claims, 8 Drawing Figures

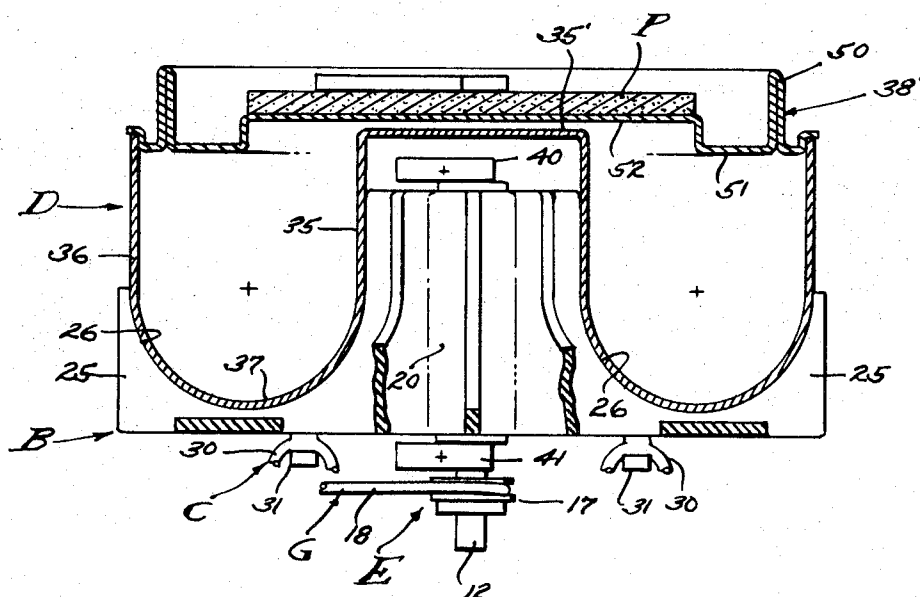


FIG. 1.

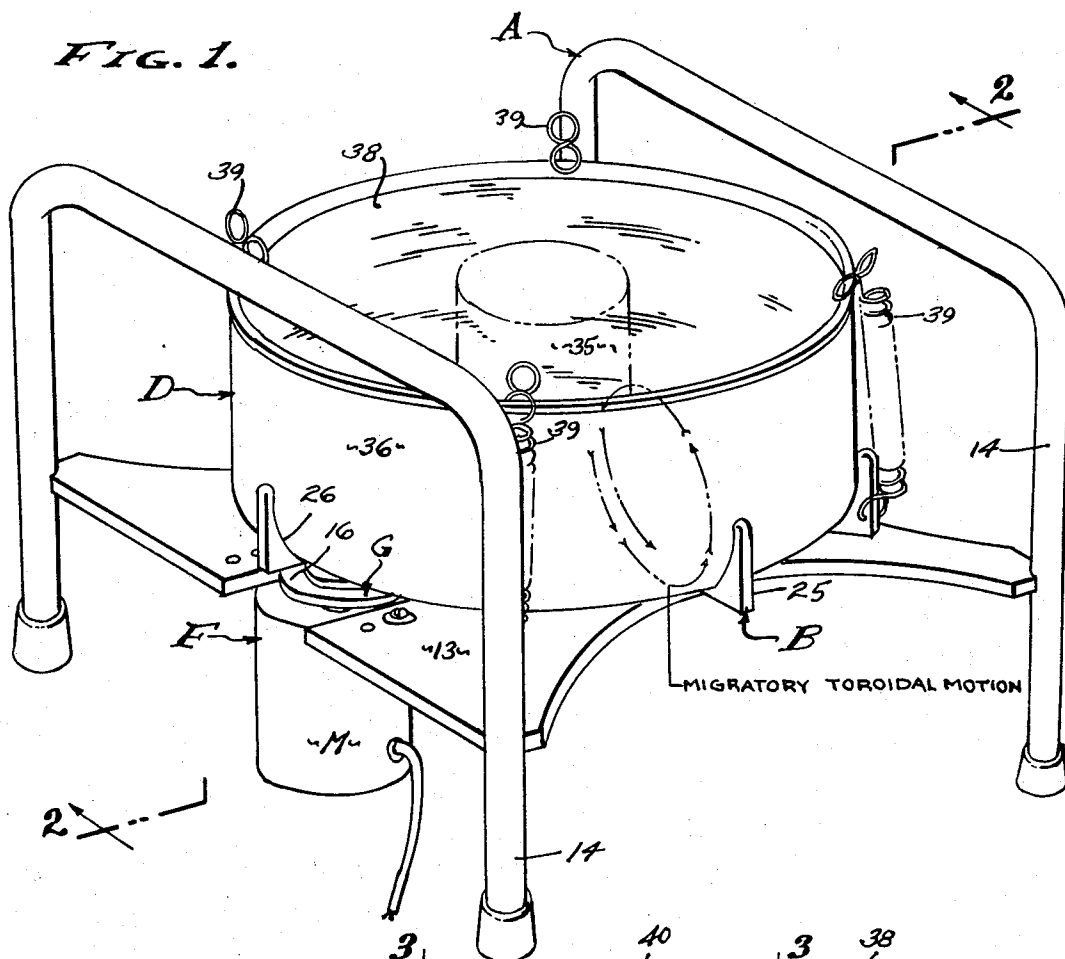
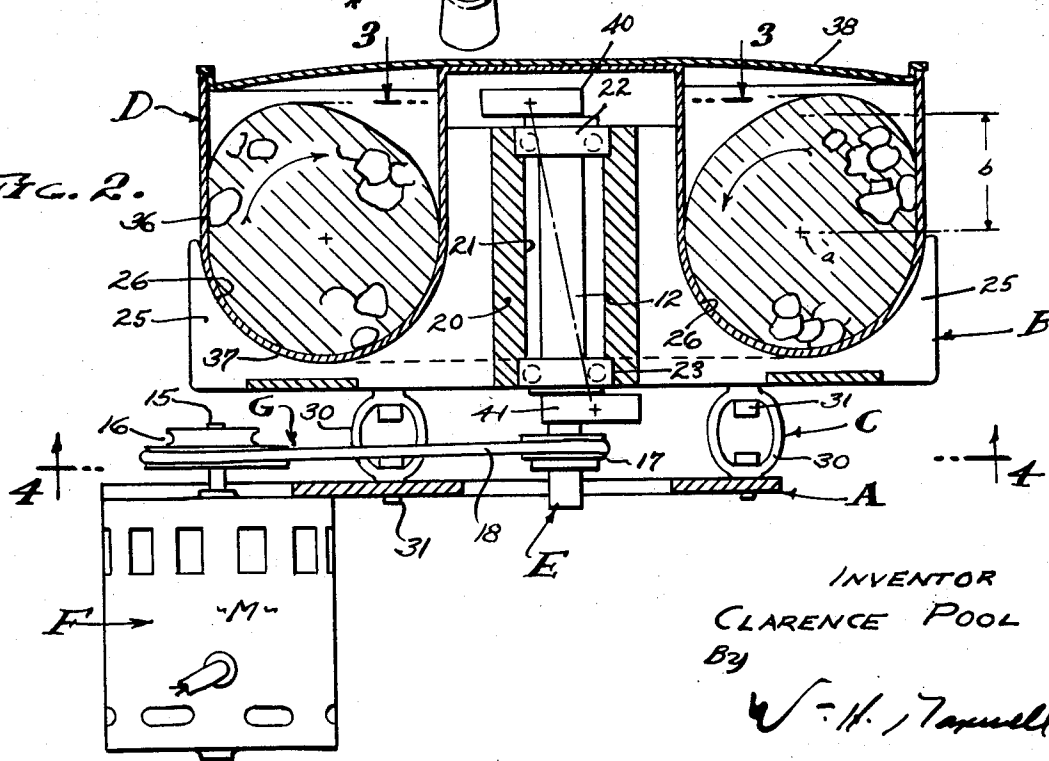
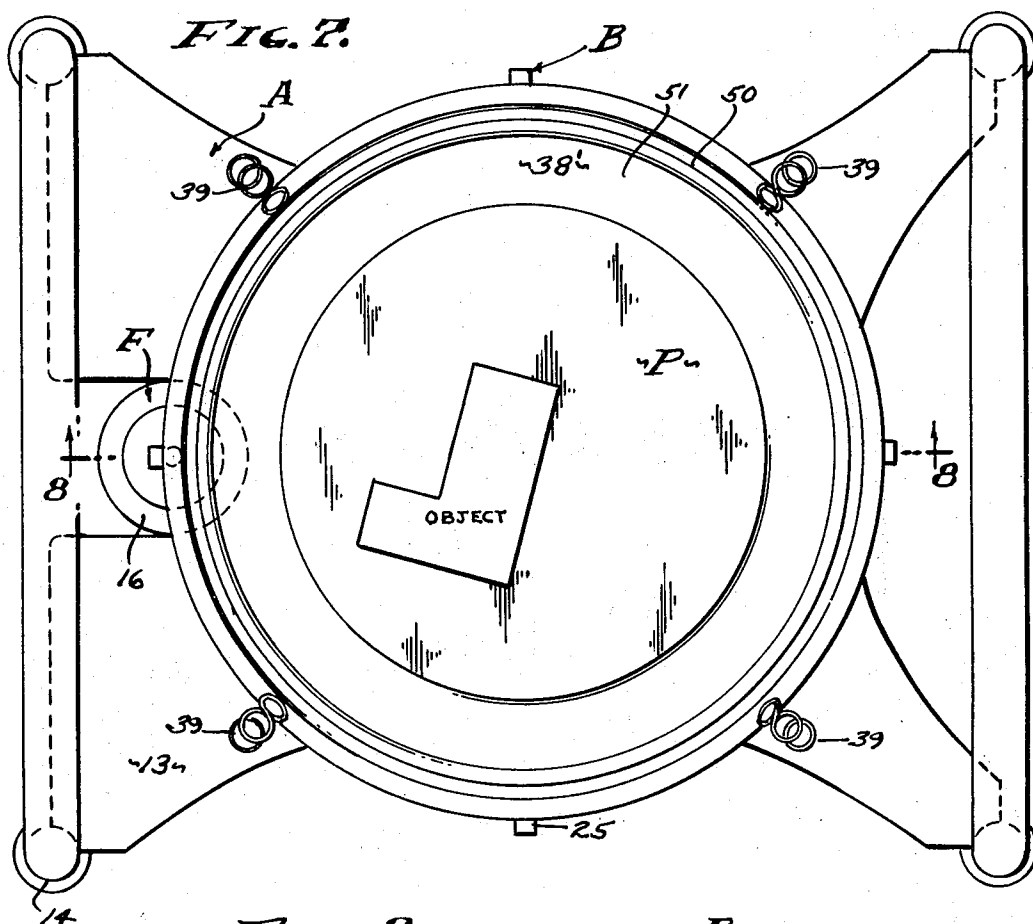
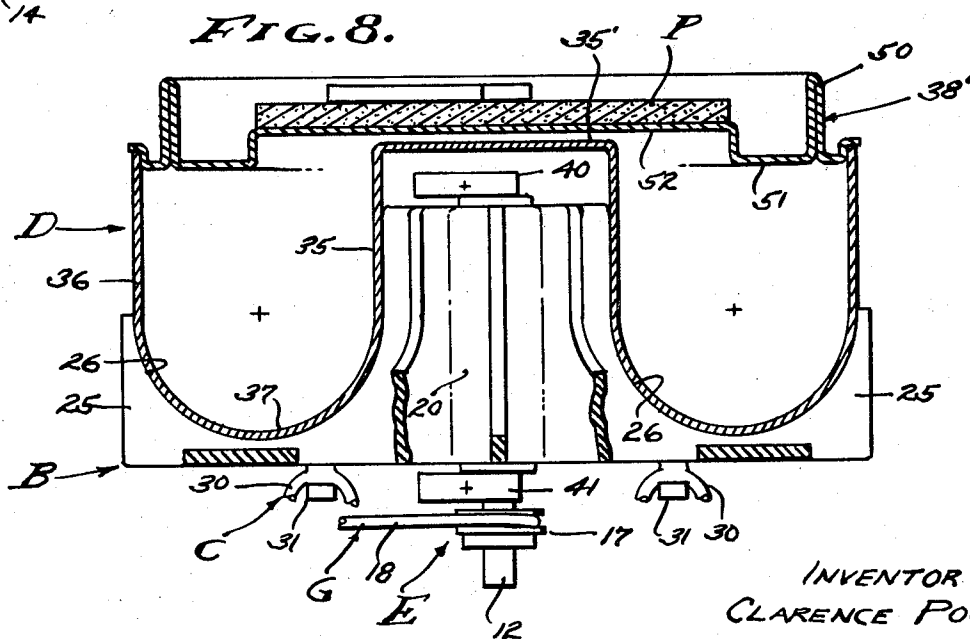


FIG. 2.



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AGITATOR FOR MOVING FLUID SUSPENDED OBJECTS THROUGH ABRASIVE MOTIONS

The present invention relates to machines heretofore referred to as polishers, vibrators and/or shakers that are powered to affect a load or mass of loose and/or fluid objects contained therein. Although such machines are continuously supplied with objects and consequently have a continuous discharge, it is fundamentally a batch process that is involved and wherein a multitude of relatively small objects are processed for polishing or deburring and the like. Depending upon the nature of objects to be processed, a carrier fluid is often employed and most often a liquid with an abrasive material suspended therein. Consequently, the mass of objects to be processed is usually mixed with a liquid carrier and abrasives, however it is to be understood that there are objects which are by themselves sufficiently fluid to be moved by the machine without the added carrier. For example, the machine of the present invention is intended for use is polishing gem stones of various description and in deburring machine parts and to affect the surfaces thereof to advantage as circumstances require.

An object of this invention is to provide an apparatus in the form of a machine unit which is capable of efficient application of power that is converted into motion so as to agitate a fluid mass directly as a result of inertial gyrations, whereby objects within the fluid mass are caused to migrate abrasively through a toroidal path.

Another object of this invention is to provide an apparatus wherein flyweights are revolved and the angular momentum thereof utilized to impart motion into a fluid mass containing objects to be processed, while minimizing structural impediments intermediate said flyweights and said fluid mass. In the present invention it is the location of gyrating weights relative to the center of gyration of the fluid mass which is of importance, and as well the lightweight construction of the containment vessel and its gyrating carriage.

It is another object of this invention to provide a gyrating carriage of minimized inertia and combined with motion damping supports which permit low amplitude high frequency motion while preventing excessive and/or prolonged displacements of the carriage. That is, the gyrating carriage has a normal frequency and range of amplitude within which oscillatory movements are most efficiently impressed upon the load or fluid mass processed thereby.

It is still another object of this invention to provide an apparatus or machine unit of the type thus far referred to that isolates the prime mover from the gyratory motions imposed upon the gyrating carriage and load or fluid mass carried thereby for processing. With the present invention an elastic transmission is provided, and together with the vibration damping supports hereinabove referred to the prime mover and surrounding frame of the unit are effectively isolated from oscillatory movements, thereby assuring longevity and quietness of operation.

It is also an object to provide a dual purpose apparatus of the character hereinabove described, wherein the primary process involved relates to the said agitation and movement of a fluid mass contained within a vessel, and wherein a second process is involved relating to lapping of objects upon the surface of

a plate incorporated in the said apparatus; the said primary and secondary processes being simultaneously operative.

The various objects and features of this invention will be fully understood from the following detailed description of the typical preferred form and application thereof, throughout which description reference is made to the accompanying drawings, in which:

FIG. 1 is a perspective view of the agitator, indicating the migratory toroidal motion impressed upon the load or fluid mass contained and processed therein.

FIG. 2 is a sectional view taken as indicated by line 2—2 on FIG. 1.

FIGS. 3 and 4 are sectional views taken as indicated by lines 3—3 and 4—4 on FIG. 2.

FIG. 5 is a diagrammatic perspective illustrating the axes and radii and gyration that are involved.

FIG. 6 is an exploded view illustrating the relationship and angular displacement of the two flyweights involved.

FIG. 7 is a plan view of the agitator shown in FIG. 1 and modified with the installation of the lapping plate which is incorporated on the cover.

FIG. 8 is a sectional view taken as indicated by line 8—8 on FIG. 7.

In the drawings I have shown a machine unit of moderate size which embodies the features of the present invention; and which involves generally, a frame A, a carriage B carried in the frame by yieldable support means C, a vessel D upon the carriage B and adapted to receive and contain a load or fluid mass of material or objects to be processed and caused to migrate toroidally, and gyrating means E to so affect the load of fluid mass to cause said migration, there being a prime mover F isolated by a transmission G from the movements impressed upon the load or fluid mass. The machine unit is essentially a lightweight apparatus, although the apparent lack of body therein has little effect upon the capability of handling a substantial load or a heavy fluid mass, since the amplitude of oscillatory motion is rather small and the frequency thereof relatively high, and all of which is directly applied to the load or fluid mass; for example approximately one-eighth inch amplitude at the center of gyration of the toroidal mass and from 1,500 to 4,000 cycles per minute in a machine having a vessel D 10 inches in diameter and accommodating a normal 8-pound load. As shown, the machine unit is motor driven and wherein the gyrating means E is rotatably operative and characterized by flyweights 40 and 41 advantageously positioned on a revolving shaft 12 for most efficient application of the effects of angular momentum and the resultant forces thereof upon the load or fluid mass being processed.

The frame A is essentially a base for the mounting of and tying together of the other elements of the machine unit. Accordingly, the frame involves a platform 13 supported by legs 14, the platform being a horizontally exposed part held spaced above a supporting surface by four corner legs 14, thereby leaving space beneath the platform 13 to accommodate the prime mover F in the form of an electrical motor M. The machine unit has a central vertical axis on which the gyrating means E is operative and about which the vessel D is formed to contain the load or fluid mass. In practice, the legs 14

are of tubular members, there being two pairs of legs and each being joined in one piece of tubing respectively, the joining sections of tubing being disposed in each instance to establish handles as shown. The operational axis of the prime mover F is laterally offset from the above mentioned central axis, the axes being parallel and the electrical motor M fixedly mounted to depend from the platform 13. The motor shaft 15 projects through and above the platform where it carries a drive pulley 16 preferably a multi-sheave pulley adapted to effect a variation in speed by selection of the desired sheave.

The carriage B that is carried by the frame A is supported from and to move independently of the frame and in a plane disposed horizontally and vertically above the platform 13. In accordance with the invention, the carriage B is a lightweight member having for its functions the carrying of the vessel D and gyrating means E so as to directly couple the operational effect of said means E upon the load or fluid mass contained in said vessel D. In practice, the carriage B is a spider member comprised of a hub 20 and radiating arms 25. The hub 20 is of substantial vertical extent and is normally disposed concentric and in alignment with the central axis of the machine unit; it being understood that operational gyrations displace the axis of the hub. The arms 25 are radial extensions of the hub and project from the hub to place and support the vessel D, with the bottom of the vessel at the lower end of the hub 20 and with the top of the vessel at the upper end of hub 20. The number of arms 25 can vary, eight such arms being shown, and each of which embraces the inner, outer and bottom walls of the vessel D which is characteristically a hollow cylinder. Thus, each arm 25 has a seat 26 with conforming configuration to the vessel shape that is supports, the arms being symmetrically and concentrically disposed about the hub 20, while the hub 20 has a vertical bore 21 therethrough and with a bearing or upper and lower space bearings 22 and 23 fixed therein to supportably and rotatably carry the shaft 12.

The yieldable support means C functions to position and damp the gyrating movements of the carriage B, means E and the load or fluid mass being processed. The means C can vary in design, a simple, direct and practical support means being the multiple deformable plastic rings 30 fastened at opposite peripheral portions to the platform 13 and carriage B respectively. The rings are vertically disposed and have enlarged portions that pass the fasteners 31 which secure the rings to the frame and to the carriage, there being several spaced rings for stability. In practice, polyurethane, nylon or other flexible material is used in forming the rings, giving suitable flexibility coupled with the cross sectional modulus of the rings, as shown, to permit deflection thereof and consequent movement of the carriage B relative to the frame A. It is preferred that the rings 30 of the support means C be fastened at the outer end portions of the arms 25 and correspondingly fastened to the underlying portions of the platform 13.

The vessel D is removably carried upon the structure hereinabove described and is shaped so as to be conducive of directing the toroidal path through which the load or fluid mass migrates. Characteristically therefore the vessel D is of hollow configuration, for exam-

ple it can be polygonal in plan view, and it is preferably cylindrical having inner and outer concentric walls 35 and 36 closed by a bottom 37 extending therebetween. The bottom 37 is disposed in a horizontal plane at the lower end of the hub 20 while the walls 35 and 36 extend upwardly to the upper end of the hub 20, the hub being substantially coextensive with the depth of the vessel D. The seats 26 of the arms 25 have embraced supporting engagement with the walls and bottom of the vessel and a feature of the vessel configuration is the semi-toroidal formation of the bottom 37 that merges integrally and tangentially with the concentric inner and outer walls 35 and 36, the radial center a of the torus establishing the approximate and theoretically ideal center of gyration when the vessel D is loaded to a level of about one radius b above the said center a . In carrying out the operational process of impressing gyrating motions to cause migration of the load of fluid mass, the said mass is usually of sufficient stiffness or viscosity to turn naturally in a more or less toroidal path, separating from one cylindrical vessel wall as it moves upwardly, and approaching toward the other cylindrical vessel wall as it moves downwardly (see FIG. 2). The vessel D is closed by a cover 38, transparent in the first form of the invention shown in FIGS. 1 and 2, and several keepers 39 in the form of hooked tension springs secure the cover 38 and vessel to the arms 25 of the carriage B.

The gyrating means E involves revolving flyweights 40 and 41 that are readily adjustable in rotative position relative to each other so as to control gyration of the bodies making up the load of fluid mass. The shaft 12 extends above and below the hub 20 and is a free turning shaft on antifrictional bearings 22 and 23. The upper flyweight 40 has its center of gravity laterally to one side of the shaft 12 and axis c and has a first center of gyration X, while the lower flyweight 41 has its center of gravity laterally to one side of the shaft 12 and axis c and has a second center of gyration Y (see FIG. 5). The flyweights 40 are adjustably locked onto the shaft 12 by means of set screws 42 and 43, as best illustrated in FIG. 6. Although a diametrically opposite setting of the flyweights is feasible for agitating the load or fluid mass into toroidal motion, further adjustment to other angular displacement settings of the two flyweights relative to each other provides for control over movement and especially circumferential migration of the load or fluid mass. Therefore and in accordance with the invention, the two longitudinally separated flyweights 40 and 41 are infinitely adjustable with respect to their angular alignment and/or displacement relative to each other. For example, the flyweights 40 and 41 are angularly displaced and separated by less than 180° and for example 165° (see FIGS. 5 and 6). Consequently, a mean chord d drawn between the centers of gravity of the two flyweights 40 and 41 is displaced from the rotational axis c by the distance of radius e thereto, thereby establishing a third center of gyration Z having an orbital path f intermediate the two centers of gyration of said two flyweights (see FIG. 5). However for another example, the flyweights 40 and 41 can be positioned laterally to one side of the shaft 12 and in angular alignment (see FIG. 8), in which case the chord d run parallel with the axis c and the center of gyration Z and orbital path f are

at a maximum radius. Still further for example, there are infinitely variable relations of said adjustment intermediate an angular alignment of the weights and an angular displacement thereof to 180°. In practice, the flyweights 40 and 41 are of equal mass and the third center of gyration Z and orbital path thereof is thereby located midway therebetween.

As best shown in FIGS. 5 and 6 the upper flyweight 40 and shaft 12 are calibrated, so that the angular position of the flyweight 40 is determinable as it is related to the angular position of flyweight 41 which is obscured beneath the vessel and platform. Therefore, flyweight 41 is locked onto the shaft 12 by the set screw 43 engaged upon a flat 43' in the shaft 12; while flyweight 40 is locked onto the shaft by the set screw 42 engaged upon the normal cylindrical periphery of the shaft. In accordance with the invention, the terminal upper end of shaft 12 is coplanar with the top face of flyweight 40 and it is marked with at least one calibration 44 that is in alignment with the flat 43'. In practice, the normal calibration 44 is positioned diametrically opposite the flat 43', and intermediate calibrations can be provided for discriminate angular positioning of weight 40.

The transmission G provides the drive from the motor M to the shaft 12. As hereinabove described, the carriage B and shaft 12 are permitted to shift relative to the frame A and motor sheave 16, and to this end the transmission G permits lateral movements of a sheave 17 on shaft 12. Shifting of the sheave 17 can be accommodated by lengthening and shortening of a drive chain or belt as permitted by a pressured idler pulley (not shown) or as is preferable in machine unit of small dimension an elastic belt 18 is employed and which permits high frequency changes in sheave position, without adverse effects.

In FIGS. 7 and 8 I have shown the secondary and dual purpose features of the present invention, wherein the cover 38' carries a lapping plate P. In this modified form of the agitator the plate P is incorporated in the cover 38' and the several keepers 39 secure the combination to the vessel D. In accordance with this modification, the plate P is a flat symmetrical stone or the like, preferably disc-shaped and disposed horizontally and concentric with the axis c when the cover is installed upon the vessel. The rim of the cover is stepped for support and is raised to establish a weir 50 from which the depressed cover wall 51 projects inwardly and then upwardly to the bottom plane of the plate P which is normal to the axis c. The vessel wall 35 is closed at its upper end by an imperforate top 35' establishing a chamber in which the flyweight 40 operates, and the cover wall has a center portion 52 disposed immediately over the top 35' and preferably with some clearance, so as to avoid abrasive contact and/or wear. With the weir 50 that surrounds the plate P abrasive laden fluids and tailings or debris are contained while the cover 35' and plate P are agitated bodily together in a generally horizontal plane. It will be observed that the forceful movements are imposed upon the cover 38' and plate P through the outer vessel wall 36 which is inherently flexible to some degree and all of which is conducive to shock isolation and smoothness of operation at the plate P.

From the foregoing it will be seen that the agitating machine unit is basically simple and of durable construction. The members thereof are for the most part metallic and of light alloys, unless otherwise required and/or as specified. For instance, the vessel D and its cover 38 are advantageously made of molded plastic. When loading the vessel, an approximation of the level b is most effective, and the presence of the load when operating the shaft 12 at speed (3,000 rpm) will ensure no damage as may be caused by vibration in the event that no load were present. LOAD Assuming that the motor M turns clockwise in plan view, so preferably does the shaft 12 carrying the flyweights 40 and 41.

The relative angular displacements of the flyweights 40 and 41 tilt the shaft 12 and causes a substantial and equal tendency toward toroidal progression of bodies in the load or fluid mass contained in the vessel D. Because the top surface of the load or fluid mass remains unconfined, frictional engagement on the load or fluid mass is through the contacting bottom and side walls, thereby imparting upward flow at the outer wall 36 and downward flow in the inner wall 35. As a consequence, toroidal movement or flow can be observed as inward on the upward exposed surface of the load or fluid mass.

Controlled positioning of the intermediate third center of gyration is attained through the adjusted angular displacement of the flyweight 40 relative to the flyweight 41, as shown, and puts the shaft 12 into an orbital gyration to cause and control a circumferential migration of the contained load or fluid mass in the clockwise direction of orbit, as effected by the frictional engagement of mass upon mass and of the vessel walls reacting upon the load or fluid mass. The above described toroidal and migratory movements of objects in the contained load or fluid mass is effectively applied in varying degree to those objects which are within the toroid of the mass. As shown in FIGS. 7 and 8, the combined cover 38' and plate P are incorporated with the agitator, and operated with or without the presence of a toroidal load or fluid mass, all as circumstances require. The flyweights are readily adjustable for effecting the desired results, or will be determined in each instance or application by the weights and stiffness of the load or fluid mass and/or objects to be moved and/or lapped.

Having described only a typical preferred form and application of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any modifications or variations that may appear to those skilled in the art.

Having described my invention, I claim:

1. An agitator for gyratably moving objects and including, a stationary frame, a vessel with a bottom and for containing the load and with a cover in supported engagement thereon, a carriage having a central hub with a shaft journaled therein and carrying an exposed sheave, the carriage being in fixed supporting engagement with the vessel, yieldable support means extending between and positioning the vessel supporting carriage upon the frame, gyrating means comprising a laterally offset flyweight fixed to the shaft, and drive means to revolve the shaft, and a lapping plate carried by said cover and centered over the axis of the said shaft.

2. The agitator for gyratably moving objects as set forth in claim 1 wherein the cover has a peripheral weir, and wherein a lapping plate is carried by said cover within the surrounding confines of said weir and centered over the axis of the said shaft.

3. The agitator for gyrateably moving objects as set forth in claim 1 wherein the gyrating means comprises a laterally offset upper flyweight fixed to the shaft and positioned substantially above the bottom of the vessel and comprises a laterally offset lower flyweight fixed to the shaft and positioned at the bottom of the vessel, and wherein a lapping plate is carried by said cover and centered over the axis of the said shaft.

4. The agitator for gyratably moving objects as set forth in claim 1 wherein the gyrating means comprises a laterally offset upper flyweight fixed to the shaft and positioned substantially above the bottom of the vessel and comprises a laterally offset lower flyweight fixed to the shaft and positioned at the bottom of the vessel, wherein the cover of the vessel has a peripheral weir, and wherein a lapping plate is carried by said cover within the surrounding confines of said weir and cen-

tered over the axis of the said shaft.

5. An agitator for moving a load of fluid objects through toroidal low amplitude vibratory motions and including, a load carrying vessel of vertically disposed hollow configuration, a carriage having a central hub with a shaft journaled vertically therethrough, the carriage being in fixed supporting engagement with the vessel, a support means comprised of a plurality of circumferentially spaced rings of deformable high amplitude impedance yieldable plastic material and each disposed between the carriage and support therefor in a radial plane relative to said shaft and fastened to the carriage and said support therefor at their opposite peripheries and positioning the vessel supporting carriage, a gyrating means comprising at least one offset flyweight fixed to the shaft, and drive means to revolve the shaft and flyweight carried thereby to gyrate the same and the carriage and the vessel impressing low amplitude movements thereupon and below the high amplitude deformation impeded by said support means.

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