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(12) (19) (CA) **Demande-Application**

(21) (A1) **2,263,033**
(22) 1999/02/25
(43) 1999/11/21

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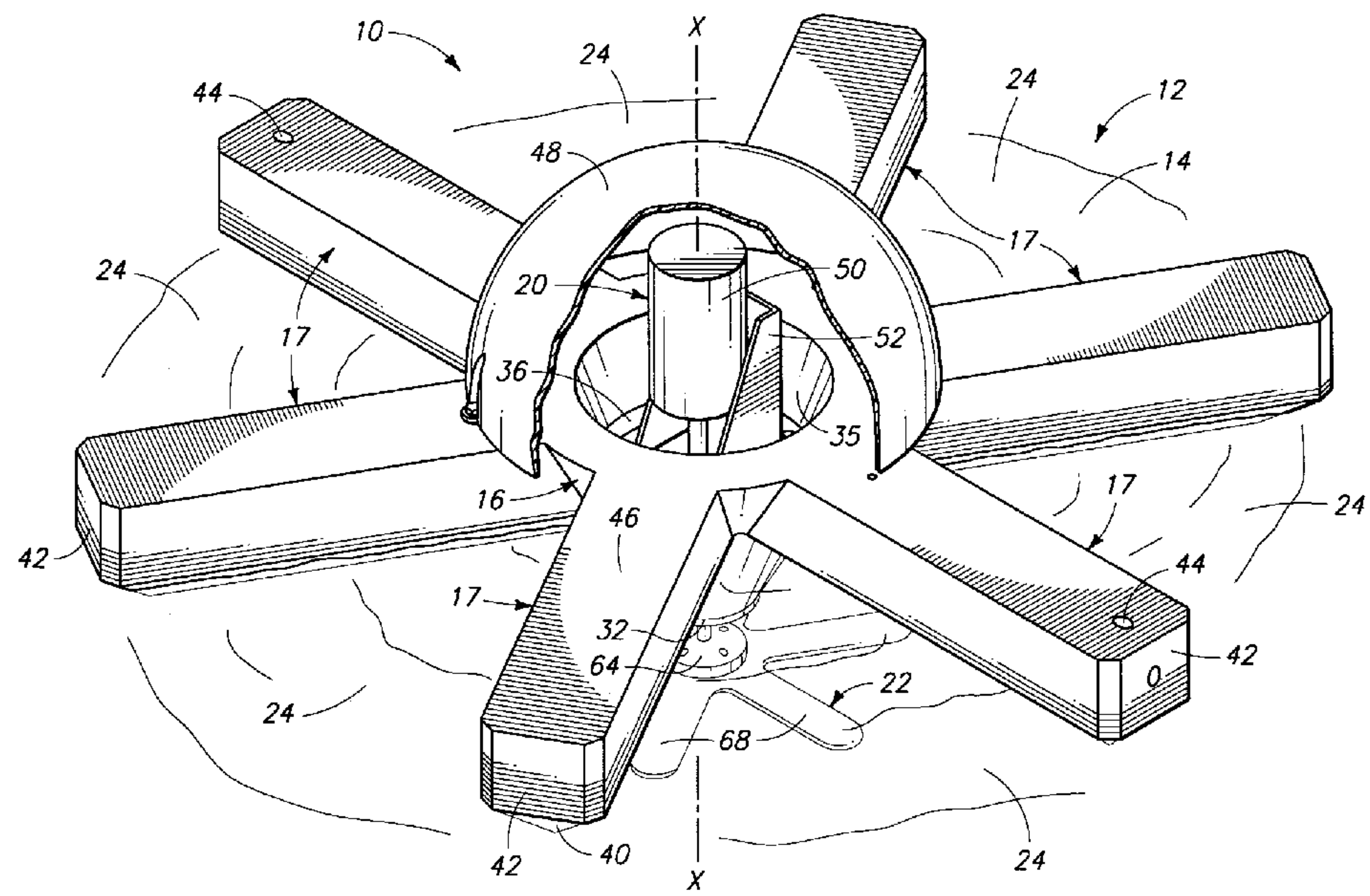
(51) Int.Cl.^{6} C02F 3/16
(30) 1998/05/21 (09/083,862) US
(54) **SYSTEME DE CIRCULATION DE LIQUIDE CYCLONIQUE**
(54) **CYCLONIC LIQUID CIRCULATION SYSTEM**



(57) A cyclonic liquid circulator is described in which a plurality of pontoons extend substantially radially from a base and with respect to a central axis passing through the base. A drive mechanism is mounted on the base that is drivingly connected to an impeller for rotating the impeller about the central axis. The base and pontoons are configured to rest on a liquid surface with the pontoons engaging the liquid and forming wedge shaped spaces between successive pontoons. The impeller is rotated by the drive mechanism about the central axis to produce a cyclonic current of liquid directed toward the base. The pontoons are configured to direct the cyclonic current radially away from the base through the wedge shaped spaces.

ABSTRACT

Cyclonic Liquid Circulation System

A cyclonic liquid circulator is described in which a plurality of pontoons extend substantially radially from a base and with respect to a central axis passing through the base. A drive mechanism is mounted on the base that is drivingly connected to an impeller for rotating the impeller about the central axis. The base and pontoons are configured to rest on a liquid surface with the pontoons engaging the liquid and forming wedge shaped spaces between successive pontoons. The impeller is rotated by the drive mechanism about the central axis to produce a cyclonic current of liquid directed toward the base. The pontoons are configured to direct the cyclonic current radially away from the base through the wedge shaped spaces.

DESCRIPTION

CYCLONIC LIQUID CIRCULATION SYSTEM

Technical Field

The present invention relates to mechanical circulation of liquids particularly in aquatic systems such as collecting ponds, waste stabilization ponds, lagoons and the like.

Background Art

It has been known that aeration of fluids in standing ponds, collection basins, and the like serves to introduce fresh oxygen into the liquid, thereby encouraging aerobic activity. Aerobic bacteria can thus function within the oxygenated fluid to break down organic materials. Otherwise, a stagnant pond will function substantially only with anaerobic breakdown of sludge. Anaerobic activity results in the release of gasses that produce an extremely noxious smell about the vicinity of the pond. Further, anaerobic activity by itself is an inefficient process for breaking down organic solids. Aerobic bacteria, on the other hand work 4 to 6 times faster than anaerobic bacteria at normal liquid temperatures of 50° Fahrenheit. Anaerobic bacteria work best at liquid temperatures of 100° Fahrenheit. Plus, the gasses normally vented to the atmosphere during anaerobic breakdown are substantially eliminated during aerobic activity.

In an attempted solution to the problem of introducing effective aerobic breakdown, aerators have been developed for placement on pond surfaces to force oxygen into the pond fluids. Some of the surface aeration equipment include impellers that are used to circulate the liquids near the pond surface. The circulating fluids will be exposed to free air at the pond surface and aerobic activity is thereby increased. More sophisticated systems force air into the pond fluids, again at or near the surface. While this further increases oxygen content, only the upper strata of the fluid material is affected and anaerobic activity still occurs in the major portions of the lower levels of the pond including the sludge at the bottom.

It is an objective of the present invention to provide a cyclonic liquid circulation system that is useful to encourage aerobic bacterial decomposition to a greater depth than presently known forms of surface aeration systems.

The above and further objects and advantages will become apparent from the following description which, taken with the accompanying drawings, exemplify a preferred mode of the present invention.

Brief Description of the Drawings

Fig. 1 is a perspective, partially fragmented view of a first preferred cyclonic liquid circulation system;

Fig. 2 is a diagrammatic view illustrating operation of the presently preferred system;

Fig. 3 is top plan view of the preferred system;

Fig. 4 is an enlarged fragmentary plan view showing details of a drive mechanism and mount; and

Fig. 5 is an enlarged sectional view taken substantially along line 5-5 in Fig 3.

Best Modes for Carrying Out the Invention and Disclosure of Invention

An example of a preferred form of the present cyclonic liquid circulator system is generally identified in the drawings by the reference numeral 10. The system 10 is intended to be placed primarily in aquatic systems (an example of which is graphically indicated at 12 in Fig. 2) that involve bodies of standing liquid 14. Examples of such systems include collecting ponds, waste stabilization ponds, lagoons and the like. The present system 10 operates to aerate the liquid 14 and thereby provide a viable environment for aerobic breakdown of organic materials. This is done by producing a cyclonic current within the liquid that will circulate substantially as shown by the arrows in Fig. 2.

Referring to a preferred form of the present circulator 10, reference is first made to Fig. 1. There, a base 16 is generally shown with a plurality of pontoons 17 connected to the base and arranged to extend substantially radially with respect to a central axis X passing through the base. A drive mechanism 20 is provided on the base with an impeller 22 connected to the drive mechanism 20 for rotation about the central axis X.

The base 16 and pontoons 17 are configured to rest on a liquid surface with the pontoons 17 engaging the liquid and forming wedge shaped spaces 24 (Fig. 3) between successive pontoons 17. The impeller 22 is configured to be rotated by the drive mechanism 20 about the central axis X to produce a cyclonic current 28 (diagrammatically shown by the arrows in Fig. 2) of liquid directed toward the base. The pontoons 17 are configured to direct the cyclonic current 28 radially away from the base through the wedge shaped spaces 24.

It is preferred that the base 16 and the pontoons 17 be integral. In the most presently preferred form, the base 16 and pontoons 17 are formed as a unit, preferably of a durable molded plastic such as linear polyethylene.

Rotation molding has been successfully used to form prototypes. This process may be used to encase an airspace 30 (Fig. 5) within the confines of the base and pontoons that will function as flotation for the circulator system 10. The airspace 30 could, if desired, be filled with a flotation foam to further assure buoyancy.

The base 16 includes a substantially frusto-conical configuration substantially centered on the central axis X and having a reduced bottom end 32 situated toward the impeller 22 and an enlarged top end 34 adjacent the pontoons 17. It is most preferable that the reduced bottom end 32 be situated below the pontoons 17 as shown in Figs. 2 and 5. It is a function of the frusto-conical base shape (at least the external wall parts extending below and between the pontoons 17) to direct current flow radially outward to the pontoons and into the wedge shaped spaces 24.

It is pointed out that the preferred frusto-conical base 16 is generally circular in cross section. However, other shapes may be used that could have an equivalent effect to direct current flow radially outward toward the pontoons 17. Therefore the term "frusto-conical" is hereby given broad meaning to include any three dimensional form that generally resembles an inverted cone. This would include, for example, a frustum of a regular pyramid.

An indentation 35 leading to a motor mount surface 36 is formed in the top end of the base 16. The motor mount surface 36 is an integral floor of the indentation 35, with provisions for mounting the drive mechanism 20. The indentation 35 is provided so the complete circulator system 10 with a drive mechanism 20 in place will present a low profile with little wind resistance and maximum stability when the unit is afloat.

It is preferred that the motor mount surface 36 be integral with the base and situated above the water line when the system is afloat. It is also preferred that the mount surface 36 be reinforced, advantageously by a stainless steel ring or "washer" 37 that may be bolted to the mount surface 36 along with the drive mechanism 20.

The pontoons 17, as indicated above, are preferably formed integrally with the base 16. They radiate from the base preferably at equally spaced angles to afford stability while the system is floating on a pond surface, and to uniformly guide current radially outwardly. To afford such stability, it is preferred that there be at least three and more preferably six of the pontoons 17, with inward ends 38 joined integrally with the base 16.

It is advantageous that the pontoons each include a V-shaped hull configuration 40 that is radial with respect to the central axis X. This particular hull configuration also helps, along with the remainder of the pontoon surfaces below the liquid surface, in directing current produced by impeller 22 radially outward.

Outward ends 42 of the pontoons 17 are closed to maintain the closed airspace 30. At least two of the opposed ends 42 include an appropriate fastening eye 44 or another appropriate anchor point which will accept a guy cable or rope (not shown) that may be used to hold the system in a fixed location on the pond surface.

The top edges of the pontoons and the base are covered by and integral with a deck surface 46 that is preferably flat and horizontal. The deck surface 46, base 16, and pontoons 17 are all preferably integrated by the molding process and are therefore formed of the same material. They also define the closed interior airspace 30 which contributes to buoyancy of the complete system 10.

In a preferred embodiment, a dome shaped drive cover 48 is removably mounted to the top deck surfaces 46, covering the drive mechanism 20. The dome 48 may be semi-spherical as shown, or be constructed to present a configuration similar to a natural structure such as a stone if the system is to be used in public areas (such as golf course water traps) where aesthetics are a concern. In either configuration, the dome 48 may be formed of the same material as the base and pontoons. The dome 48 may be releasably secured to the deck 46 by conventional fasteners to protect the drive mechanism against weather.

In general, the drive mechanism 20 may be selected from various mechanisms that will produce desired rotation of the impeller 22. In a preferred form, the drive mechanism is comprised of an electric motor that is controlled to produce a desired rotational rate for the impeller. This may be done by controlling current to the motor, or by providing a gear reduction unit; either of which are conventional and commercially available. It is desirable, however, that the output rpm be within a range of between 80 and 150 rpm, depending upon the nature of the fluid materials the impeller is to circulate. The size in terms of horsepower is preferably between .1 and 1.0 horsepower in accordance with the consistency of the materials to be circulated.

Other types of equivalent drive mechanisms may also be used. Examples include wind powered drives, battery powered motors (batteries being solar cell charged), or in some instances, gasoline, diesel, propane, or other fueled internal combustion engines.

The motor 50 is mounted by way of a mounting bracket 52 that is preferably secured by bolts directly to the motor mount 36 and steel ring 37 within the indentation 35. The bracket elevationally positions the motor well above the operational water line when the system is afloat.

The bracket 52 is preferably formed in accordance with the mounts provided on the motor 50, and is constructed using known technology of a corrosion resistant material such as stainless steel. In fact it is desirable that all parts (including fasteners) of the present system 10 be formed of corrosion resistant materials.

The output shaft of the motor 36 (or gear reducer) is preferably connected to a conventional flexible coupling 54 (Fig. 5) which, in turn, mounts an impeller drive shaft 56. The drive shaft 56 is centered on the upright axis X by self aligning bearings 58, 60 which are commercially available and constructed of corrosion resistant materials. One bearing 58 is mounted by bolts to the motor mount 36 above the water line.

The shaft 56 is rotatably journalled by the bearing 58 and extends axially downward through a hollow, tubular core 62 of the base 16. The walls of the core 62 are integral with the motor mount 36 and the reduced bottom end 32 of the base, thereby maintaining the closed airspace 30.

The bearing 58 need not be sealed to its housing and the shaft 56 since the motor mount 36 is preferably above the water line, as discussed above. In fact, it is preferred that there is not a seal between the bearing 58, motor mount 36 and shaft 56 so that any accumulated water or other fluid that might find its way into the base indentation 35 will drain through the tubular core 62.

The bottom bearing 60 may be substantially identical to the bearing 58, but mounts the shaft 56 to the reduced bottom end 32 of the base 16. The bottom bearing 60 is also used to journal the shaft 56 for rotation about the central axis X.

The shaft extends on downwardly from the bottom bearing 60 to hubs 64, 66 that secure the impeller for rotation with the shaft 56. The top one of the hubs 64 is preferably sweated, swaged, welded or otherwise secured for rotation with the shaft 56. The bottom one of the hubs 66 is provided with appropriate bolts or other fasteners for securing the impeller 22 in centered relation to the axis X. Both hubs 64, 66 may be made of corrosion resistant material such as aluminum.

The impeller 22 is preferably formed of a stamped sheet, preferably of stainless steel. It is also preferred that the impeller include six integral blades 68 substantially equally spaced about the central axis X. It is also preferable that the diameter of the impeller (between diametrically opposed blade tips) be similar to or slightly larger than the diameter at the bottom end of the base, and that the hubs 64, 66 be of diameters no larger than the reduced bottom end of the base. This is done so cyclonic current produced by the impeller will upwardly impinge on the frusto-conical walls of the base 16 and be deflected radially outwardly.

The pitch of the impeller blades 68 may vary according to the consistency of materials being circulated. It is preferable that the pitch (or angle of the blades from a horizontal plane) be at a maximum of approximately 30° and preferably between approximately 15° and 27°. It is also preferred that the rotational direction and blade pitch be consistent with natural hemispheric gravitational whirlpool effects. That is, rotation of the impeller should be matched with the natural direction of vortex rotation according to the global hemisphere in which the system is operating. Thus the impeller will be rotated clockwise in the northern hemisphere and counter-clockwise in the southern hemisphere and the pitch of the impeller will be formed accordingly.

Given the above description, operation of the preferred system may now be easily understood. Such operation will be discussed in terms of process steps for producing a cyclonic liquid flow in a standing body of liquid.

A first step involves floating the base 16 with the pontoons 17 extending substantially radially from the base on the body or pool of liquid, in such a manner that the pontoons engage the liquid form wedge shaped spaces 24 between successive pontoons. This is preferably done with the base 16 and pontoons 17 secured in a selected stationary position on the surface of the selected pool by means of appropriate guy cables or ropes (not shown) that may be connected by conventional means to the fastening eyes 44.

The motor 50 is also connected to a source of electrical energy. If the motor is to be operated by conventional alternating current, appropriate electrical wire connections are made to the current source. Conventional switching (not shown) may also be incorporated in the circuit allowing on-off control.

Conventional safety circuit breakers (also not shown) may also be used as a safety measure.

Now the impeller may be rotated about the central axis to produce a cyclonic current of liquid directed upwardly toward the base. This is accomplished simply by activating the drive mechanism 20. The impeller will rotate accordingly and the blades 68 will act to pull the liquid upwardly. The rotating blades will produce a cyclonic or vortex of current that will pull materials in the pond upwardly toward the pond surface.

The next step of directing the cyclonic current radially away from the base through the wedge shaped spaces is accomplished by the inverted frusto-conical shape of the base 16, and the radial pontoons 17. The upwardly flowing cyclonic current impinges against the base and is deflected radially outward by the frusto-conical base walls. This radial flow is encouraged by the radial orientation of the pontoons 17, within the wedge shaped spaces 24 between successive pontoons 17. The current is thus directed radially outward of the pontoons in all directions about the axis X along the surface of the pond (Fig. 2).

The radially outwardly flowing current will be exposed to oxygen in the adjacent air, and will become oxygenated, thus providing life support for aerobic bacteria which in turn thrive on organic materials carried in the current. Aerobic activity will continue so long as there are organic materials and oxygen for survival. Since the materials continue to be drawn in the cyclonic current flow, and since oxygenation will continue to occur, all organic materials drawn into the current will eventually be consumed without need for anaerobic decomposition.

The current will eventually lose its outward impetus and descend, due to the upward draw continuously produced by the impeller. The same materials will therefore migrate back to the center of cyclonic flow and be drawn upwardly again in the current where re-oxygenation will occur. In effect the current flow is axially torroidal

Because there is little or no anaerobic decomposition, no noxious gasses will be produced. Also, since aerobic bacteria work four to six times faster in the same conditions as anaerobic bacteria, smaller ponds may be used, or organic waste input may be increased.

CLAIMS

1. A cyclonic liquid circulator, comprising:

a base;

a plurality of pontoons connected to the base and arranged to extend substantially radially with respect to a central axis passing through the base;

a drive mechanism on the base;

an impeller connected to the drive mechanism for rotation about the central axis;

wherein the base and pontoons are configured to rest on a liquid surface with the pontoons engaging the liquid and forming wedge shaped spaces between successive pontoons;

wherein the impeller is configured to be rotated by the drive mechanism about the central axis to produce a cyclonic current of liquid directed toward the base; and

wherein the pontoons are configured to direct the cyclonic current radially away from the base through the wedge shaped spaces.

2. The cyclonic liquid circulator of claim 1 wherein the pontoons are integral with the base.

3. The cyclonic liquid circulator of claim 1 wherein the pontoons are oriented substantially normal to the central axis.

4. The cyclonic liquid circulator of claim 1 wherein the base includes a substantially frusto-conical configuration substantially centered on the central axis and having a reduced bottom end situated toward the impeller and an enlarged top end adjacent the pontoons.

5. The cyclonic liquid circulator of claim 1 wherein the base includes a substantially frusto-conical configuration substantially centered on the central axis and integral with the pontoons.

6. The cyclonic liquid circulator of claim 1 wherein the impeller is formed of a stamped sheet and includes 6 integral blades substantially equally spaced about the central axis.

7. The cyclonic liquid circulator of claim 1 wherein the base includes a substantially frusto-conical configuration substantially centered on the central axis and including an enlarged top end and a reduced bottom end; and

wherein the impeller includes a diameter that is at least equal to the dimension across the enlarged top end of the base.

8. The cyclonic liquid circulator of claim 1 further comprising a dome configured to cover the drive mechanism.

9. The cyclonic liquid circulator of claim 1 wherein the pontoons each include a V-shaped hull configuration that is radial with respect to the central axis.

10. The cyclonic liquid circulator of claim 1 wherein the pontoons include top deck surfaces and bottom V-shaped hull surfaces; and

wherein the base is of an inverted substantially frusto-conical configuration with a reduced bottom end and an enlarged top end; and

wherein the reduced bottom end projects below the bottom V-shaped hull surfaces.

11. The cyclonic liquid circulator of claim 1 wherein the pontoons include top deck surfaces and bottom V-shaped hull surfaces; and

a dome shaped drive cover removably mounted to the top deck surfaces covering the drive mechanism.

12. A cyclonic liquid circulator, comprising:

a base including a substantially frusto-conical configuration substantially centered on a central axis and having a reduced bottom end and an enlarged top end;

a plurality of pontoons formed integrally with the base and arranged to extend substantially radially from the base with respect to the central axis and in a plane substantially normal to the central axis;

a drive mechanism on the base;

a drive shaft extending substantially coaxial with the central axis from the drive mechanism through the reduced bottom end of the base;

an impeller mounted on the drive shaft and situated below the reduced bottom end of the base for rotation about the central axis responsive to operation of the drive mechanism;

wherein the base and pontoons are configured to float on a liquid surface with the pontoons engaging the liquid and forming wedge shaped spaces between successive pontoons;

wherein the impeller is configured to be rotated by the drive mechanism about the central axis to produce a cyclonic current of liquid directed upwardly toward the base; and

wherein the base and pontoons are configured to direct the cyclonic current radially away from the base through the wedge shaped spaces.

13. The cyclonic liquid circulator of claim 12 wherein the impeller is formed of a stamped sheet and includes six integral blades substantially equally spaced about the central axis.

14. The cyclonic liquid circulator of claim 12 wherein the base includes a substantially frusto-conical configuration substantially centered on the central axis and including an enlarged top end and a reduced bottom end; and

wherein the impeller includes a diameter that is at least equal to the dimension across the enlarged top end of the base.

15. The cyclonic liquid circulator of claim 12 further comprising a dome configured to cover the drive mechanism.

16. The cyclonic liquid circulator of claim 12 wherein the pontoons each include a V-shaped hull configuration that is radial with respect to the central axis.

17. A process for producing a cyclonic liquid flow in a standing body of liquid, comprising the steps of:

floating a base with pontoons extending substantially radially from the base on the body of liquid with the pontoons engaging the liquid and forming wedge shaped spaces between successive pontoons;

rotating an impeller about the central axis to produce a cyclonic current of liquid directed upwardly toward the base; and

directing the cyclonic current radially away from the base through the wedge shaped spaces.

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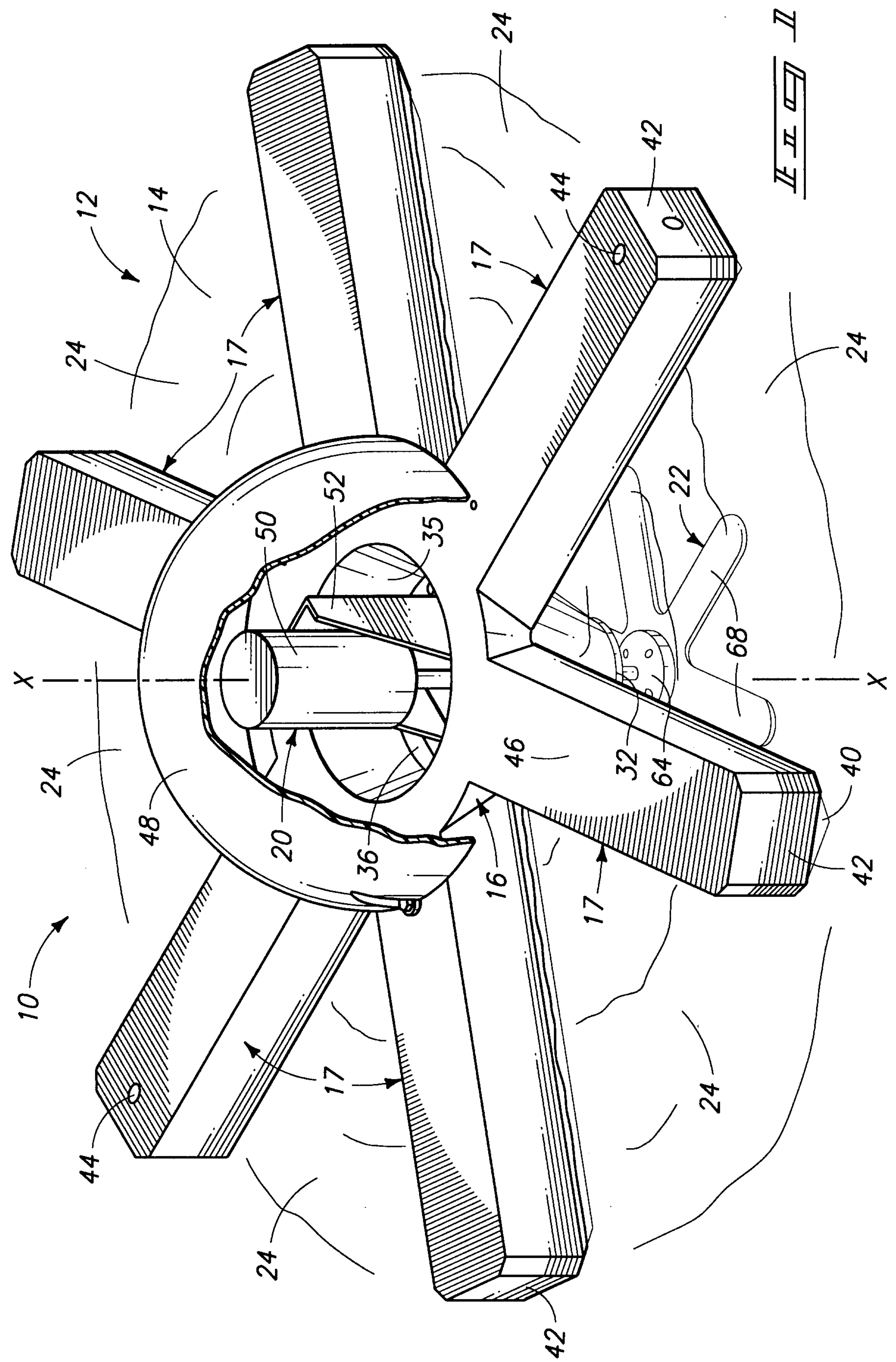

Fig. 1

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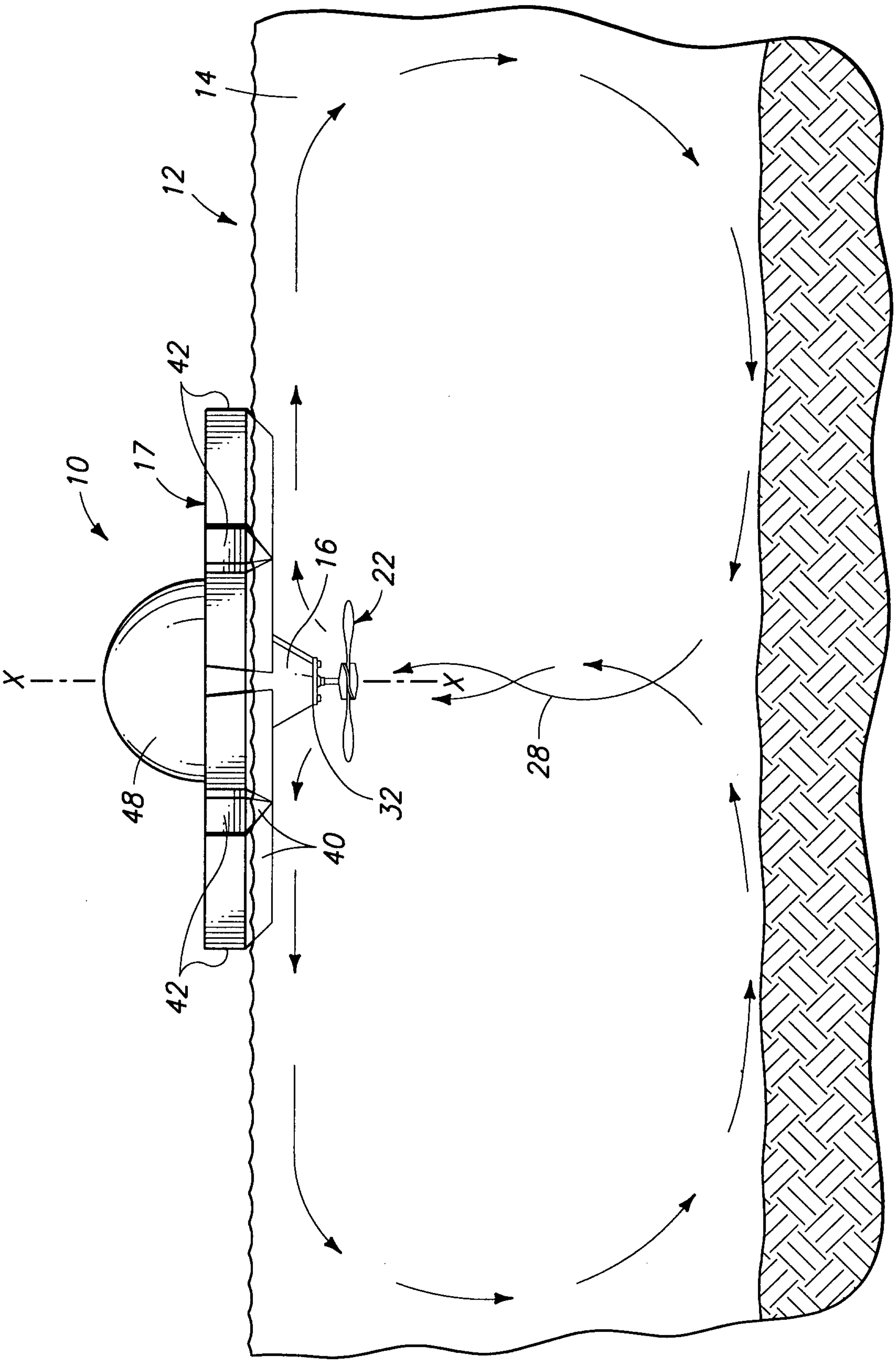

Fig. 2

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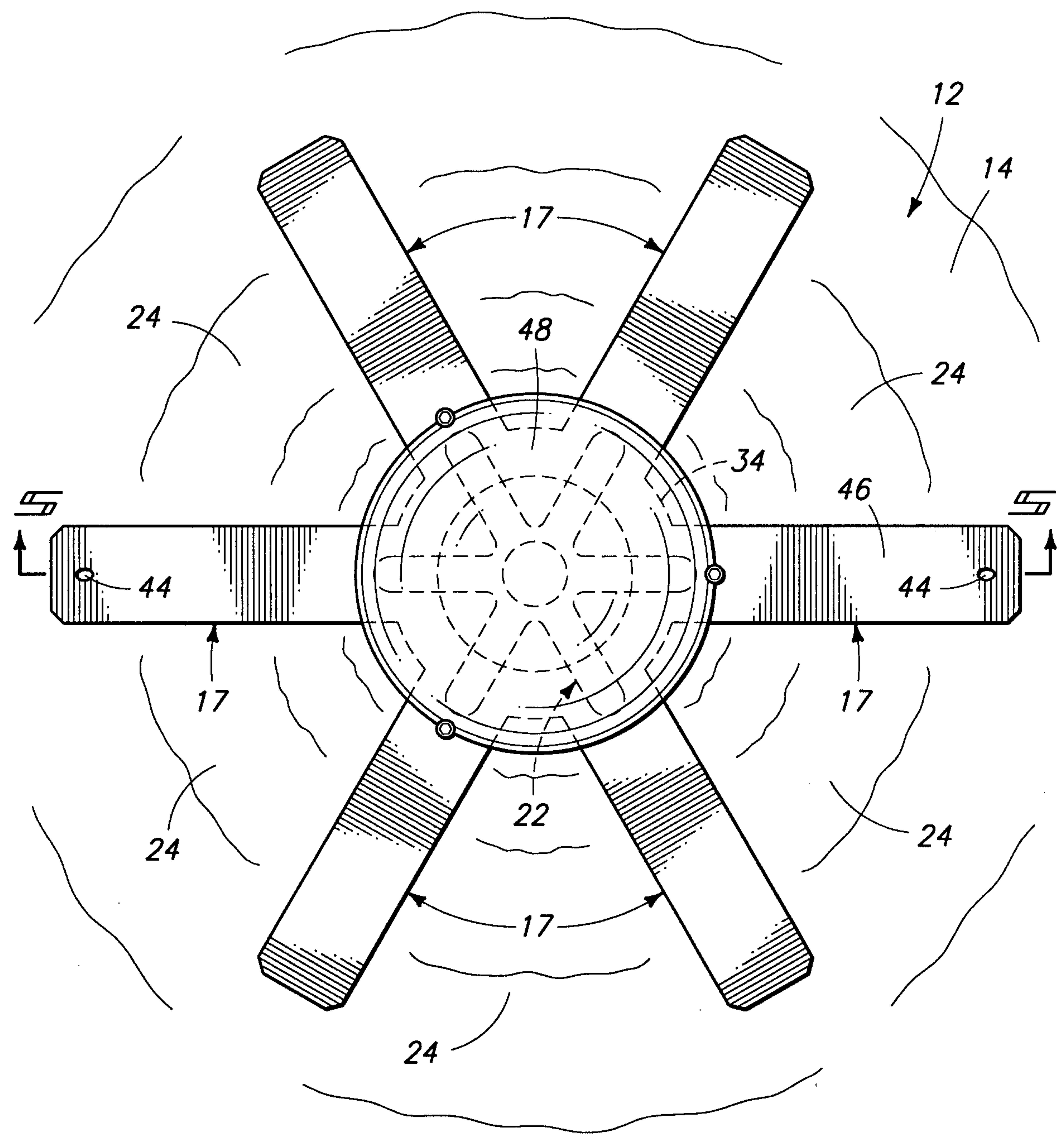

Fig 3

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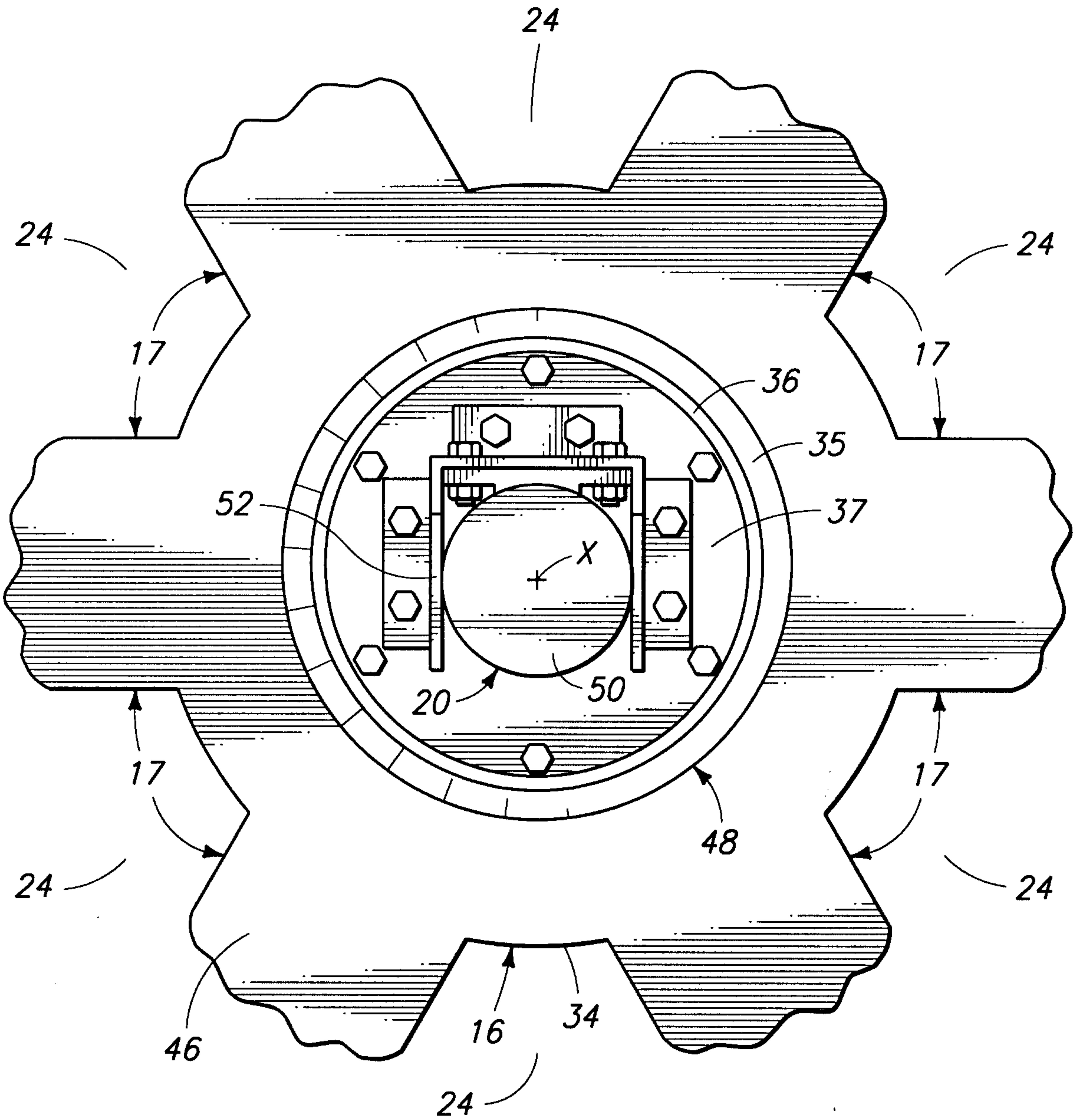

Fig 4

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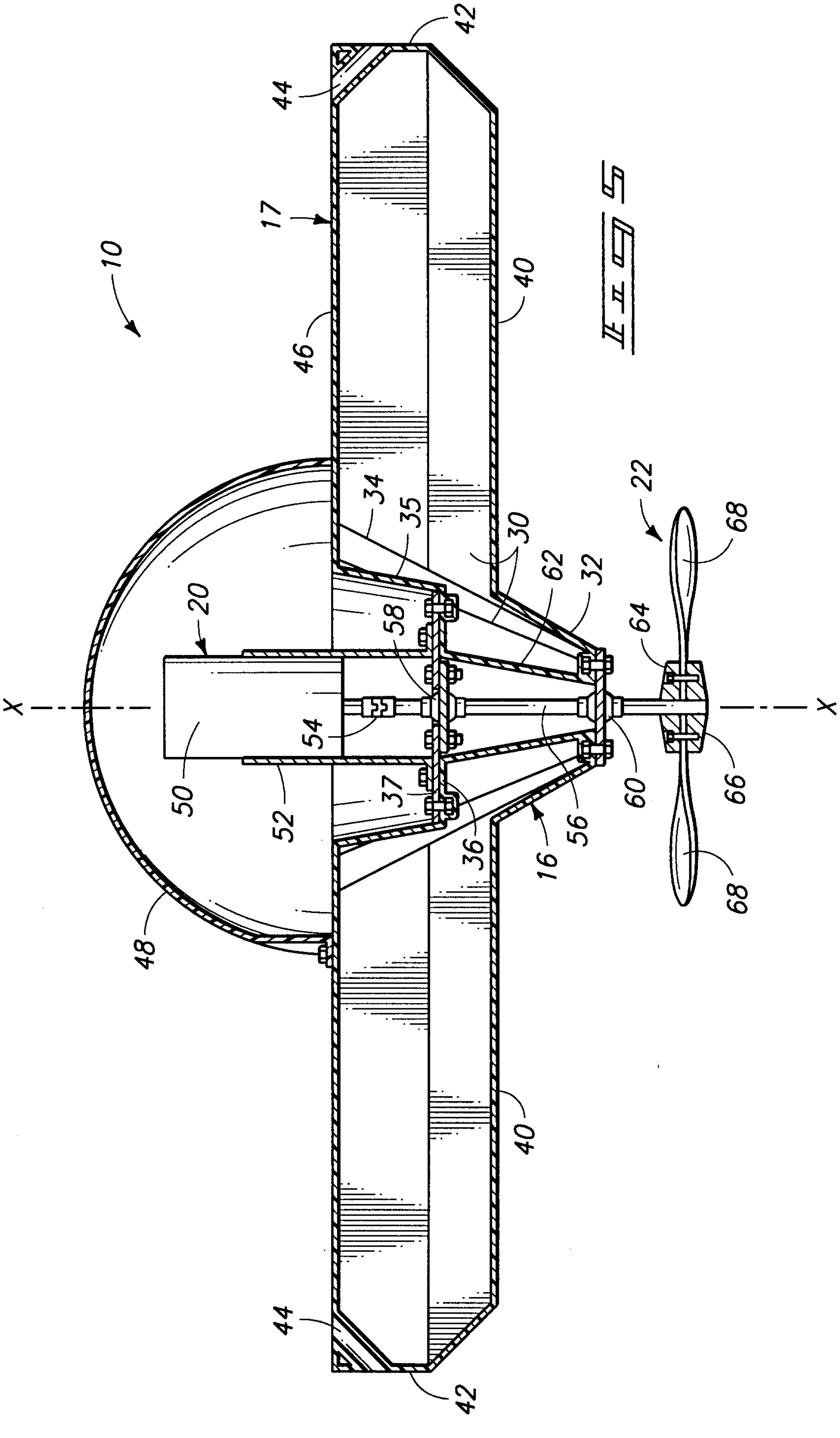

Fig 5