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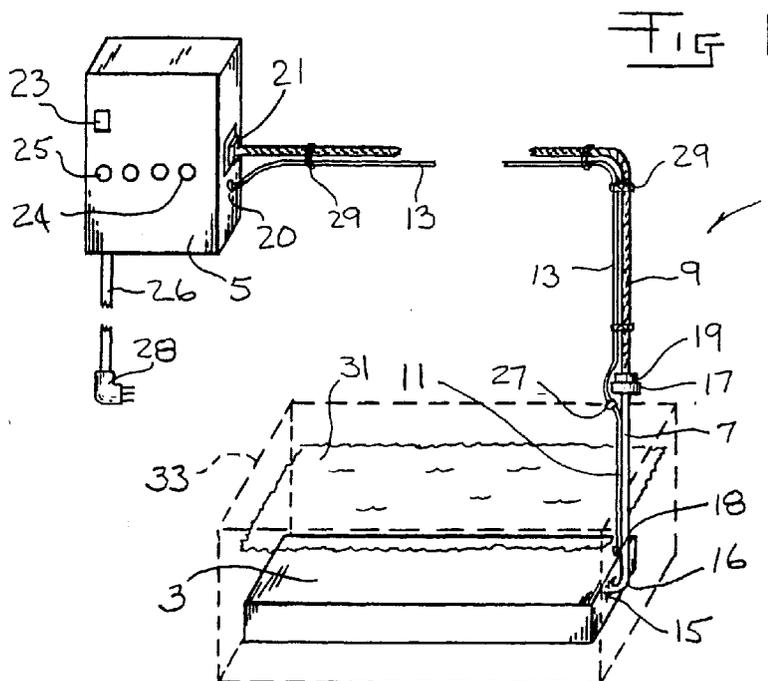
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(54) **Ultrasonic cleaning system**

(57) A portable ultrasonic cleaning system (1), comprising an ultrasonic transducer (49) contained within a submersible housing (3) to be removably placed in a liquid (31) in a bath (33) for receiving items (36) to be cleaned, a controller (5) for operating the transducer, a tubular conduit (7) attached to the housing and extending from the housing out of the liquid bath to a flexible electrical cable (9) attached to the controller. The clean-

ing system may employ a submersible low liquid level sensor (18), either as a separate submersible item in the liquid bath, or as an integral part of the transducer hardware. The low liquid level sensor may be mechanically mounted to the tubular conduit leading to the transducer housing, or it may be mounted on the housing itself. The cleaning system is especially adapted for cleaning kitchen ware.



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Description

This invention relates to the field of cleaning systems and methods, and more particularly to an improved dishwasher system which utilizes ultrasound for effectively and thoroughly cleaning kitchen and dining ware items, and which is portable for "in-sink" applications where permanent installation of ultrasound dishwasher systems is impractical or too costly.

Dishwasher systems and methods are well known in the art for cleaning food debris from kitchen and dining ware items. Ultrasonic cleaning systems have been developed to overcome the problems and deficiencies of using commonly relied upon chemical detergents or similar cleaning agents in combination with heated and/or jetted water to remove food debris from pots and pans, eating and serving utensils, dish ware, cups and glasses, etc. Such ultrasonic cleaning systems also are environmentally preferable, as they significantly reduce the quantities of chemical detergents and other cleaning substances discharged into a drain for passage to the local sewage or septic system. Additionally, ultrasonic cleaning systems have been effective to reduce the relatively high usage rate of water and detergents in commercial dishwasher systems inclusive of pre-rinse or pre-wash rinse stations and post-wash rinse stations.

Ultrasonic dishwasher systems utilize ultrasound principles, well known in the art, wherein one or more ultrasonic signal generators activate piezoelectric polycrystalline ceramic transducer arrays to provide cavitation bubbles within a water bath for vigorously scrubbing a substrate to be cleaned.

A particular ultrasonic dishwasher system designed for effectively and quickly cleaning food debris from a wide and virtually unrestricted range of kitchen and dining ware items has met with significant success for permanent installations of such systems in commercial kitchens and commercial institutions as evidenced by US 5,218,980.

It would be desirable to provide the same high technological ultrasonic cleaning systems of the prior art in a portable arrangement for a number of reasons. First, it would permit smaller restaurants and commercial institutions to have the benefits of an ultrasonic cleaning system without the expense of a permanently installed system. Moreover, since a portable ultrasonic dishwasher system would be an "in-sink" system, it could be temporarily placed in any number of sinks or water bath containers which were not designed for a permanent installation of an ultrasonic dishwasher system. Additionally, with easy removal of a portable ultrasonic dishwasher system from the sink or container, the sink or container could be used for other purposes. A portable ultrasonic dishwasher system having a flexible cable connection to its power source and controller would permit quick temporary installation and, similarly, quick removal of the system in a matter of seconds.

Depending upon the particular application, i.e. the

type of debris to be removed from the kitchen ware (e.g., pots and pans versus cups and glasses), how long the debris would typically have to dry and harden on the kitchen ware item, and the degree to which the cleanliness of the item is required (e.g., some installations require a high degree of sanitation), it may be desirable to move an ultrasonic dishwasher transducer from one sink or bath station to another. For example, a portable ultrasonic dishwasher system transducer could be temporarily installed into a dishwasher system having a post-wash sanitizing rinse station, or, if desired, it can be transferred to a pre-wash rinse station, or alternatively, the portable ultrasonic cleaning system can be transferred to a pre-wash station in advance of a conventional dishwasher appliance.

The present invention overcomes the deficiencies and disadvantages of the prior art as it relates to limitations on permanently installed ultrasonic dishwasher systems, and provides the desirable features described above. In accordance with the present invention, a portable ultrasonic cleaning system comprises an ultrasonic transducer contained within a submersible housing, to be removably placed in a liquid bath for receiving items to be cleaned, a controller for operating the ultrasonic transducers, a tubular conduit attached to the housing and extending from the housing out of the liquid bath to a flexible electrical cable attached to the controller.

A portable ultrasonic dishwasher system made in accordance with this invention can be retrofitted instantly into a fast-food restaurant or other locations to reduce labor costs greatly, as a person is no longer needed to remove debris physically from dirty kitchen ware by scrubbing. Significant cost savings in labor can be realized.

Implementing a preferred embodiment of the invention, a portable ultrasonic dishwasher system may employ a submersible low water level sensor, either as a separate submersible item in the water bath, or as an integral part of the transducer hardware. For example, the low water level sensor may be mechanically mounted to the tubular conduit leading to the transducer housing, or it may be mounted on the transducer housing itself.

For enhancing the portability of the ultrasonic dishwasher system according to the present invention, the three basic components, i.e., the transducer arrangement, the controller, and the electrical connection between the transducer arrangement and the controller, may be designed with variations as to removable plug and receptacle components at the controller, at the connection between the flexible cable and tubular conduit, or at both locations.

The controller may be provided with a casing for tabletop access or for wall mounted access, or both, the choice being left to the user or operator.

These and other aspects of the invention will be better understood, and additional features of the invention will be described hereinafter, having reference to the ac-

companying drawings, in which:

FIGURE 1 is a diagrammatic perspective view illustrating a portable ultrasonic dishwasher system employing the novel features of the present invention;

FIGURE 2 is a basic block diagram of the controller portion of the system and its connection to a transducer array and a low water level sensor;

FIGURE 3 is a cross sectional view of a container for a water bath, showing the portable ultrasonic dishwasher system transducer at the bottom of the water bath and beneath a kitchen ware item holder, or basket;

FIGURE 4 is a partial end view of the transducer housing showing one variation for the provision of a low water level sensor;

FIGURE 5 is a partial end view of the transducer housing showing a second variation for the provision of a low water level sensor; and

FIGURE 6 shows an alternative configuration for the connection between the flexible cable leading to the controller, the cable being shown in partial representation.

Figure 1 shows the basic components of a portable ultrasonic dishwasher system in accordance with the present invention. The system 1 is comprised of a transducer housing 3, a controller unit 5, a rigid water-tight tubular conduit 7 connected to the transducer housing 3 and extending upwardly to make electrical connection with a flexible cable 9, the other end of the flexible cable being connected to controller 5 through an entry access opening 21.

Preferably, the tubular conduit 7 is a rigid conduit welded at 15 to the transducer housing 3, of double walled stainless steel construction, and is provided with an elbow 16 to direct the connector end of tubular conduit 7 upwardly above the water level of the water bath 31 in a container 33, such as a sink, basin, or tank, shown in phantom in Figure 1.

At the upper end of tubular conduit 7 is an electrical receptacle 17 into which an electrical plug 19 is inserted, the receptacle 17 and plug 19 containing appropriate multiple pin and socket arrangements as is commonly known in the art of electrical interconnections. The flexible cable 9 and the tubular conduit 7 carry the electrical wiring from the controller 5 to the transducer array 49 (Figure 2) in housing 3, the tubular conduit 7 being water-tight with respect to the housing 3.

In a typical ultrasonic dishwasher system, in order to avoid damage to the transducers, a low water level sensor 18 may be provided which, when water is not present at the sensor, sends a signal to the controller 5

to turn the power off to the transducer array 49. As shown in Figure 1, a small diameter parallel tube 11 is fixed, as by brazing, to the tubular conduit 7, the smaller diameter sensor tube 11 leading to a low water level sensor 18 positioned adjacent the top of the transducer housing 3. The small diameter sensor tube 11, like the tubular conduit 7, has an electrical plug and receptacle connection 27 at its upper end for purposes of disconnecting the electrical cable 13 from the small diameter sensor tube 11 when dismantling or transporting the portable ultrasonic dishwasher system.

The cable 13 for the low water level sensor 18 is strapped to the flexible cable 9 by straps 29 for convenience, the cable 13 entering controller 5 through an access opening 20. Cable 13 may also be plug/receptacle connected to controller 5.

The controller 5 is typical of controllers for ultrasonic dishwasher systems known in the prior art and may have a main power switch 23 and various indicators 25 confirming that system power is on, that the transducer array is powered, and that a low water level has been detected. Controller 5 may have a reset/start switch or button 24 to restart the system after water has been introduced into the water bath subsequent to the detection of a low water level. All of these features of the controller are within the knowledge of the person of ordinary skill in the art and a detailed analysis or depiction of the circuitry for such basic switching and indicating devices are believed to be unnecessary and unwarranted in this description.

Power to the controller, and ultimately to the transducer array 49, is by way of an electrical cable 26 shown to have an electrical power plug 28 at its free end to be plugged into a standard 220/240 VAC 60 Hz power source.

Figure 2 shows the basic components of the electrical configuration of the portable ultrasonic dishwasher system which is not unlike that used with known ultrasonic dishwasher systems, such as that shown in US-A-5,218,980. The input power main 41 passes through a low-pass power line filter 43 in controller 5, and is then routed through to power the control panel and control electronics block 45 which, in turn, powers the ultrasonic generator 47. The output of the ultrasonic generator 47 is the signal on line 51, applied physically along flexible cable 9 and through tubular conduit 7 shown in Figure 1, leading to the transducer array 49 within housing 3. It will be understood that the block diagram of Figure 2 is representative of a basic system, and, for example to increase the power for larger transducer arrays 49, a plurality of ultrasonic generators 47 may be provided, each having an output leading to a separate transducer array 49 (not shown) in the housing 3. For example, a pair of 600 watt ultrasonic generators 47 may drive a pair of transducer arrays 49 in housing 3, the transducer arrays 49 within housing 3 being spaced to evenly distribute the ultrasonic energy, thereby presenting to the water bath 1200 watts of cleaning energy.

Also shown in Figure 2 is the low-water level sensor 18 electrically connected via cable 13 to the control panel and control electronic block 45. Upon sensing a low water level, the sensor 18 sends a signal along line 13 to cause the control panel and control electronics block 45 to turn off the ultrasonic generator 47, thereby preventing damage to the transducer array 49. As mentioned, controller 5 may have a reset button, to again apply power to the ultrasonic generator or generators 47 after the water bath has been filled to a level above the low water level sensor 18. Again, specific details as to the connection of a simple reset switch and start contactors required to carry out the low water level safety function just described is not needed for the person of ordinary skill in this art.

Figure 3 is a cross section of a container 33, such as a sink, in which a water bath 31 covers a basket 34 of kitchen ware 36 supported on, for example, a wire frame support 38 under which the transducer housing 3 is positioned. As best viewed in Figure 3, the length of the tubular conduit 7 is chosen to exceed the maximum water level expected in the sink of a kitchen or commercial establishment. Since the housing 3 is not connected to the container or sink 33, the entire housing 3 and tubular conduit 7 arrangement may be easily removed from container 33 after the platform 38 and basket 34 (along with any kitchen ware 36 therein) is removed from the container 33. The flexible nature of flexible cable 9 permits the transducer housing 3 to be removed and manipulated without disturbing the placement of the controller 5.

As was shown in Figure 1, a separate submersible tube 11 and low water level sensor 18 were attached to tubular conduit 7 as a parallel path for the electrical wiring to the sensor 18. A more convenient implementation of the sensor 18 in the system is shown in Figure 4 wherein a low water level sensor 53A is shown mounted to the lower portion of tubular conduit 7 in a water-tight attachment. The wiring from sensor 53A passes into the side of tubular conduit 7 and is sealed from water leakage in any preferred manner. The wiring 55 from sensor 53A is routed up tubular conduit 7, through connector components 17 and 19, through flexible cable 9, and into controller 5. The obvious advantage to this arrangement is that a separate tube 11, a separate connector 27, a separate wiring cable 13, a separate access opening 20 in controller 5, and straps 29 are all eliminated.

Because of the high energy level and frequency of the power sent to the transducer (or transducers), in order to avoid any false signaling to the controller that the water level is low when, in fact, it is not, cable 55 may be a shielded cable, or alternatively, cable 51 may be a shielded cable, or both may be shielded.

While the variation of the placement of the sensor in Figure 4 will prevent any portion of the housing 3 from being exposed out of the water bath while power is applied, reasonable protection for the transducer or transducers is achievable by placement of a low water level

sensor 53B on the top of the transducer housing 3 itself as shown in Figure 5. The sensor 53B is mounted on the top surface of housing 3 in a water-tight manner by the provision of a water seal 57. The wiring 55 for the sensor 53B passes through an opening 58 in the top of housing 3 and through the lower end of tubular conduit 7 and up to the controller in the manner described for the variation shown in Figure 4. Again, either wiring cable 51 or 55 may be shielded, or both may be shielded to avoid false low water level indications to the controller 5.

Figure 6 shows a controller 5 similar to that shown in Figure 1 except that the cabling utilizes the features of the variations shown in Figures 4 and 5, i.e. flexible cable 9 contains all of the wiring for the transducers and the low water level sensor of the system.

Figure 6 also shows a further aspect of the portability of the system by providing a multi-pin connector plug 61 insertable into and removable from a mating connector receptacle 63 mounted on the controller 5. If both connector components 61 and 63 of Figure 6 and connector components 17 and 19 of Figure 1 are implemented into the system, each hardware unit may be easily disconnected from the system and handled for storage or transportation to another location without being encumbered by electrical wiring connections attached to the main components of the system.

Figure 6 also shows that the controller 5 may be provided with a number of rubber feet 65, two of which are shown on the left side of controller 5 in Figure 6, and two others (not shown) which are placed on the opposite corners of the rear of controller 5. Also, the back of controller 5 is provided with an upwardly extending ear 67 having an aperture 69 therein for hanging the controller 5 on a wall fastener. Accordingly, controller 5 may be operated as a tabletop unit by sitting it on its back whereby feet 65 support controller 5 on a flat surface, or the controller 5 may be hung on a nail, screw, fastener, or other projecting object from a wall. As would be clear to a person of ordinary skill in the art, instead of a pierced projecting ear 67, a key hole or T-slot opening (not shown) in the rear panel of controller 5 may be provided for hiding the wall attachment means from the front view of the controller.

The preferred ultrasonic generator, or generators, for use in the present invention include piezoelectric transducer elements for generating ultrasonic signals within a variable frequency range on the order of about 30-50 KHz. Such signal generators are available from Ultrasonic Products, Ltd., of Birkenhead, England. A preferred generator 47 in a typical application would have a design capacity for approximately 800 watt average and on the order of 1500 watt peak power output. A scaled-up system, to accommodate larger wash sinks, would be rated at 1200 watts for a wash sink capacity of 26.74 USG or 101.22 liters.

A preferred cleaning agent comprises a nonfoaming, or low foaming, and biodegradable surfactant, such

as that marketed by Lever Industrial Ltd. of Merseyside, England, under the name Titan Intraclean SU 161, and added to the water bath to provide an approximate two percent solution.

While only certain embodiments of the invention have been set forth above, alternative embodiments and various modifications will be apparent from the above description and the accompanying drawing to those skilled in the art. For example, the portable ultrasonic cleaning system shown, described, and claimed herein need not be restricted to use in cleaning kitchen ware. Such portable cleaning systems can also be used for other cleaning tasks, such as cleaning of medical implements, automotive parts, museum display pieces, coins, and a myriad of other commercial and industrial cleaning tasks where permanent ultrasonic cleaning installations are not practical or are too costly. Additionally, although a water bath was described herein as exemplary, virtually any cleaning fluid could be used in a cleaning bath employing the portable ultrasonic cleaning system of the present invention.

Claims

1. A portable ultrasonic dishwasher system (1), comprising:

an ultrasonic transducer contained within a submersible housing (3) intended to be removably placed in a water bath (33) for receiving ware items to be cleaned;

a controller (5) for operating the transducer to produce cavitation bubbles in a water bath (31) in which the housing is to be submerged;

a tubular conduit (7) having one end (15) attached to the housing in a water-tight manner, the conduit extending from the housing and carrying electrical wiring coupled to the transducer; and

a flexible electrical cable (9) having one end attached to the other end (17) of the conduit second end, the cable connecting the conduit wiring to the controller.

2. The system as claimed in Claim 1, comprising a submersible low water level sensor (18) having electrical wiring connected to the controller.

3. The system as claimed in Claim 2, wherein:

the low-water sensor is mechanically mounted on the conduit, and

the wiring for the sensor passes through the conduit and through the flexible electrical cable.

4. The system as claimed in Claim 2, wherein:

the low-water sensor is mechanically mounted on the housing, and
the wiring for the sensor passes into the housing, through the conduit, and through the cable.

5. The system as claimed in any preceding claim, wherein, when the housing is horizontal, the conduit extends transversely to the housing for a distance sufficient for the other end of conduit to be located above the level of the water (31) in a bath (33); in which the bath is a sink having side walls and a bottom, and in which the housing rests on the sink bottom.

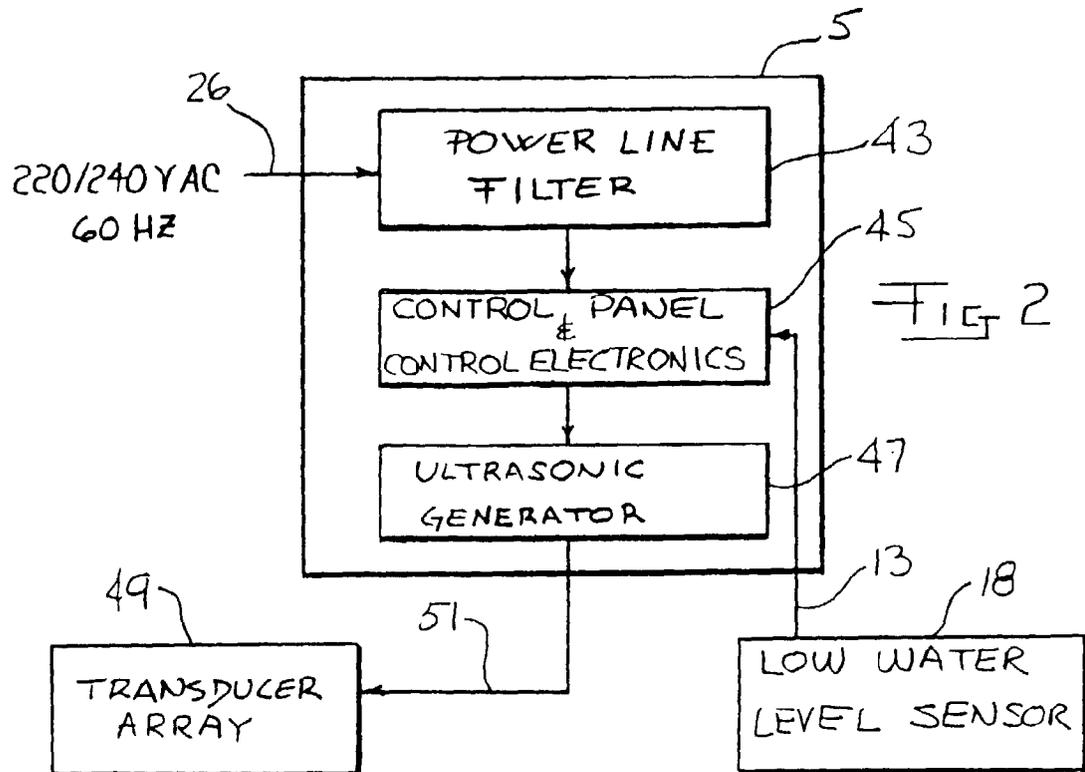
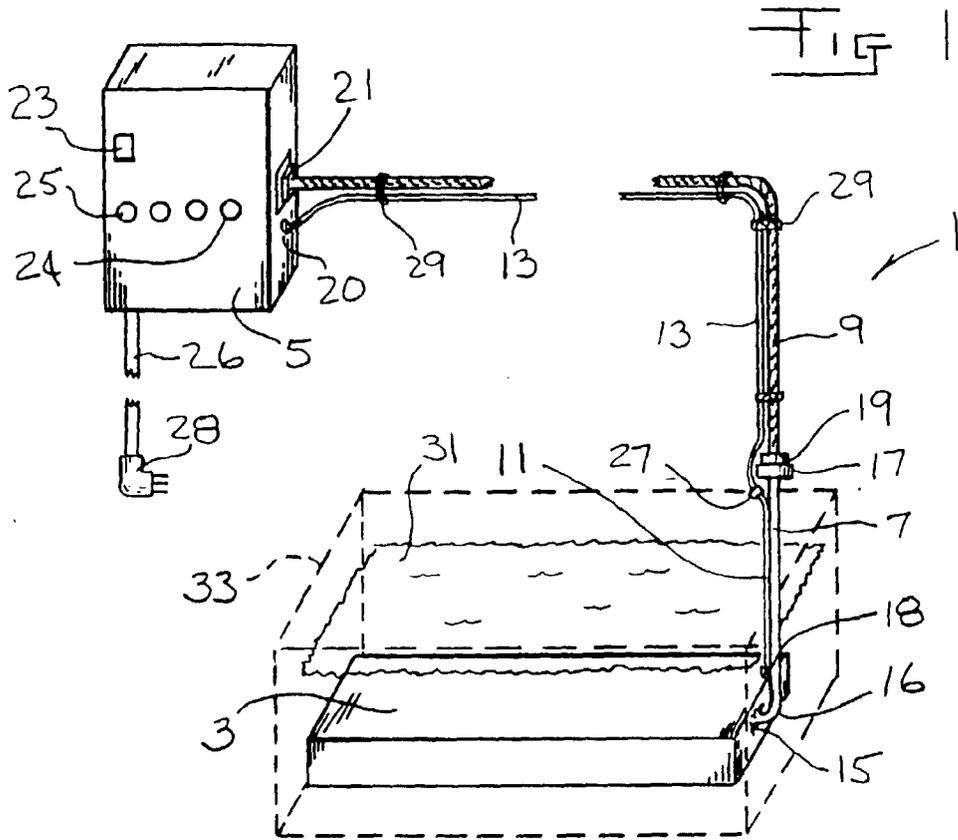
6. The system as claimed in any preceding claim, wherein the flexible electrical cable has an electrical connector at its end remote from the transducer, the connector being mechanically and electrically removable from the controller, thereby enhancing the portability of the system.

7. The system as claimed in any preceding claim, wherein the controller comprises operator controls (23, 25) positioned on a casing (5).

8. The system as claimed in claim 7, wherein the casing is adapted (67, 69) to be mounted on a wall for operator access to the controls.

9. The system as claimed in claim 8, wherein the casing is mounted by means of a quick connect and disconnect wall hanger (67).

10. The ultrasonic dishwasher system as claimed in any preceding claim, wherein the conduit extends from an end of the housing and comprises a water-tight tubular right-angle elbow portion (16) directing the other end of the conduit upwardly out of the water bath in which the housing is to be submerged.



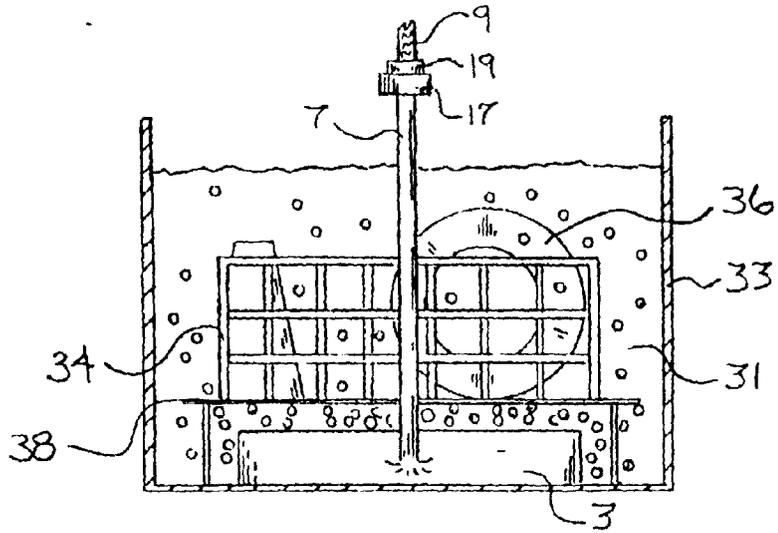


FIG. 3

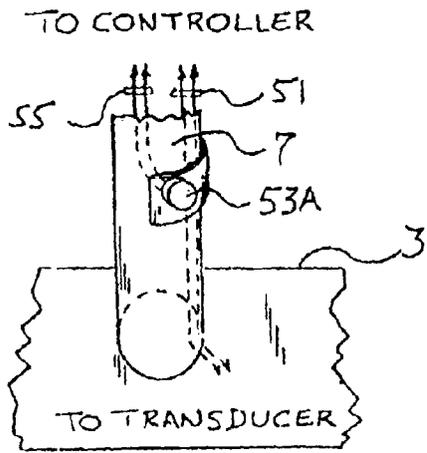


FIG. 4

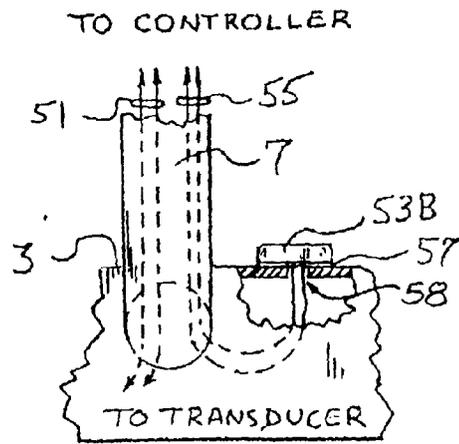


FIG. 5

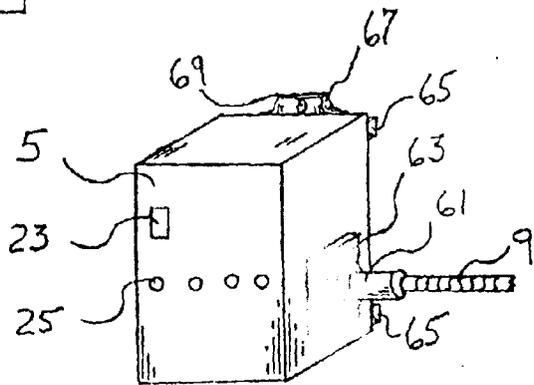


FIG. 6