

Jan. 31, 1967

G. G. BROWN

3,301,535

ULTRASONIC WASHING MACHINE AND TRANSDUCER THEREFOR

Filed Jan. 4, 1966

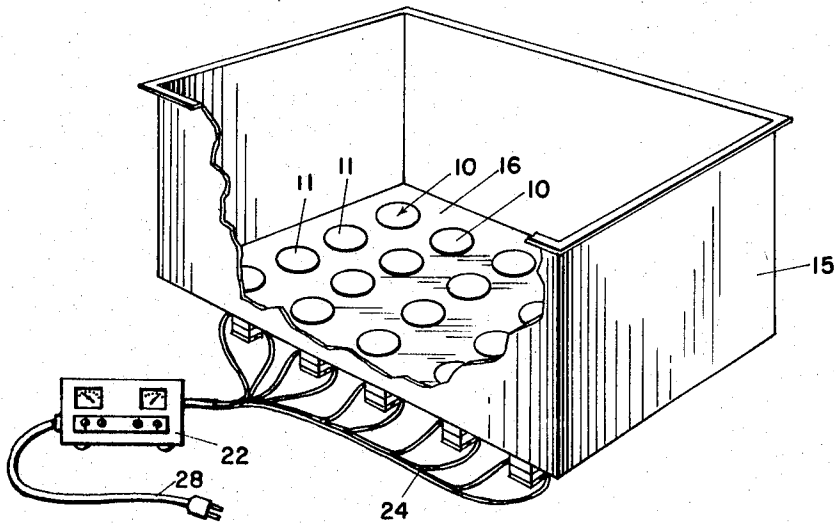


FIG. 1

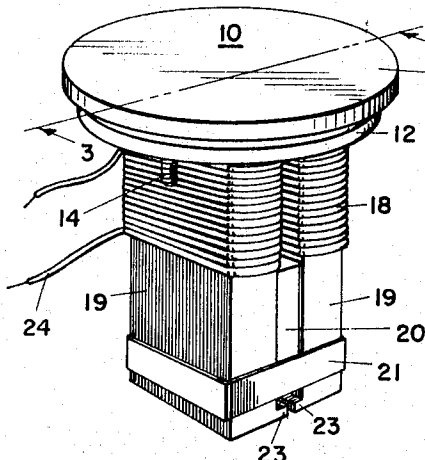


FIG. 2

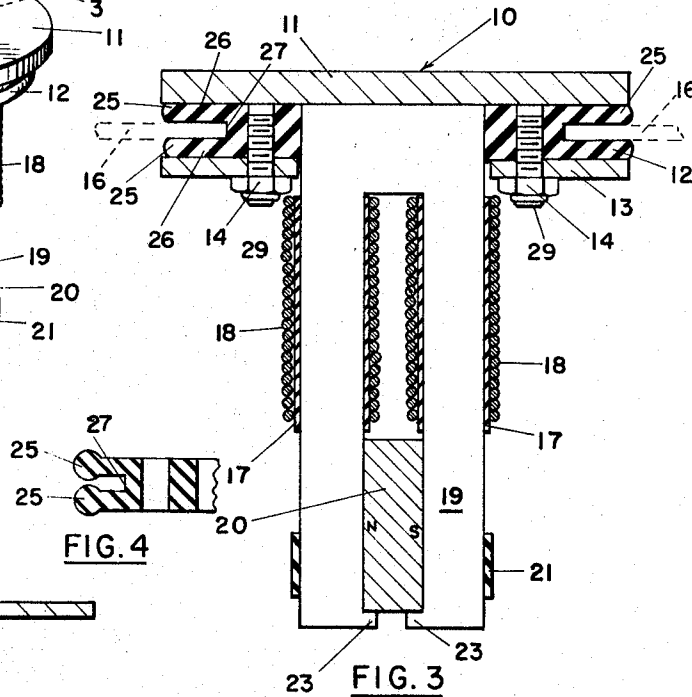


FIG. 4

FIG. 3

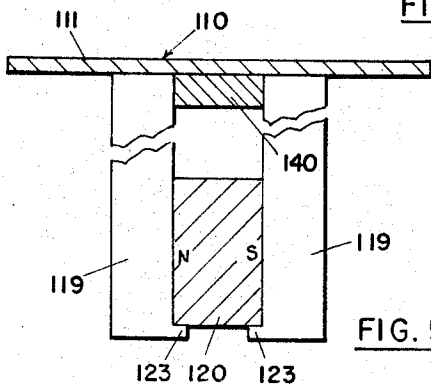


FIG. 5

INVENTOR.
GILBERT G. BROWN
BY
Charles L. Lovelock
attorney

1

3,301,535

ULTRASONIC WASHING MACHINE AND
TRANSDUCER THEREFORGilbert G. Brown, Erie, Pa., assignor to American Steri-
lizer Company, Erie, Pa., a corporation of Pennsylv-
vania

Filed Jan. 4, 1966, Ser. No. 518,676

8 Claims. (Cl. 259-99)

This invention relates to an improved ultrasonic transducer and a method for mounting said transducer in such a manner that it is mechanically and acoustically decoupled from other transducers and/or the device to which the transducers are mounted. Although this invention relates to ultrasonic cleaning devices the transducer and its resilient mounting may be advantageously used wherever a transducer or a mosaic of transducers are used to perform any of the well known processes which can be performed by ultrasonic energy. For example, agglomeration of fine particles, dispersion, homogenization, wetting of cloths in dyeing, soldering and many other well known functions.

It is well known by those skilled in the art of designing ultrasonic devices that the coupling between transducers as well as the coupling between transducers and the device to which they are attached produces such undesirable effects as in and out of phase cancellations and fortifications of the ultrasonic energy. This condition produces "hot" spots when the phase relationship is additive and dead spots when the relation is out of phase by some angle. For example, when the phase relationship is 180° there can be complete cancellation.

When transducers are attached firmly to, for example, sonic cleaner tanks, the sonic energy is bled into this metal and serves no useful purpose. However, it does usurp energy which could have been gainfully employed to produce cavitation, for example, in a sonic cleaning bath or other purpose for which the device was originally designed.

Although drawings used to describe this invention relate to magnetostrictive transducers such as are constructed of electronic grade A nickel, nickel with cobalt additives, or other magnetostrictive metals, it readily becomes apparent to those skilled in the art that this invention may be used just as advantageously with electrostrictive transducers such as are made of barium titanate, lead zirconate titanate and other materials exhibiting the piezo-electric effect.

"Ultrasonic cleaning" devices are well known in the art. The theory of ultrasonic cleaning is discussed in "The Journal of Hospital Research," volume 2, number 2, July 1964, published by the Research and Educational Divisions of the American Sterilizer Company, Erie, Pennsylvania, in an article by Gilbert G. Brown, et al.

Transducers are used to generate cavitation in liquids for ultrasonic (sonic) cleaning.

The word "ultrasonic" and sonic are used synonymously in this application since the desirable effects of cleaning, agglomeration, homogenization and other functions are produced at frequencies as low as or lower than sixty (60) cycles per second and at frequencies up even into the megacycle range. It is desired that there be no limiting frequency range applied to the claims in this invention.

A typical sonic cleaner utilizing the coupled effect wherein sonic energy is bled to the cleaning tank is clearly shown in FIGS. 2 and 3 of Patent 2,815,193, Ultrasonic Cleaning System, issued to Gilbert G. Brown on December 3, 1957.

Previous attempts to decouple transducers from their mountings have failed because the methods utilized

2

would, in some instances, decouple the transducers but would not provide a liquid proof seal.

The present invention utilizes a transducer which may be made, for example, of a stainless steel disk fixed to a laminated core made of magnetostrictive material and having an electrical coil wrapped around one or both legs of the core. The laminated core is passed through a hole in a web attached to a dual elastometric O-ring and a hole in the bottom of the cleaning tank. The transducer is clamped to the tank through the O-ring construction and a water tight seal is provided.

When the tank and transducers are assembled, the transducers are acoustically decoupled from each other and from the tank bottom. The transducers are thus permitted to work freely without interference, either from each other or from the tank bottom. The efficiency of the transducer disclosed herein is very high, noise factor is low, and there is no bleeding of sonic energy into the tank walls. Furthermore, the results obtainable in ultrasonic cleaning are substantially improved over the results obtainable with previously known transducers and transducer mountings as will appear more fully herein-after.

It is accordingly an object of the invention to provide an improved transducer.

Another object of the invention is to provide an improved combination transducer and cleaning tank.

Still another object of the invention is to provide an improved combination tank and transducer wherein the transducer is decoupled from the tank.

Still another object of the invention is to provide a means wherein the transducers are decoupled from each other.

A further object of the invention is to provide a transducer utilizing magnetostrictive properties of an electromagnetic circuit.

With the above and other objects in view, the present invention consists of the combination and arrangement of parts hereinafter more fully described, illustrated in the accompanying drawing and more particularly pointed out in the appended claims, it being understood that changes may be made in the form, size, proportions, and minor details of construction without departing from the spirit or sacrificing any of the advantages of the invention.

In the drawing:

FIG. 1 is a view partly broken away showing a tank and a plurality of transducers supported in the tank according to the invention;

FIG. 2 is an enlarged isometric view of one of the transducers shown in FIG. 1;

FIG. 3 is a cross sectional view taken on line 3-3 of FIG. 2;

FIG. 4 is a cross sectional view partly broken away of the resilient dual O-ring used in supporting the transducer shown separate and apart from the other elements; and

FIG. 5 is a view of another embodiment of the invention.

Now with more particular reference to the drawing, a tank 15 is shown by way of illustration which may be considered to be a schematic view of the tank of an ultrasonic washing machine. The tank has a bottom 16 with transducers 10 mounted on the bottom of the tank. The tank may be square, rectangular, or any other suitable shape and configuration.

The bottom of the tank has holes therein which are slightly larger than the diameter of the part of the resilient washer referred to sometimes herein as a dual O-ring 12 at the bottom of a groove 27. Each resilient washer 12 has an outer peripheral groove defined by webs 26 which connect the O-rings to the body of the washer.

The groove receives the material of the tank bottom that defines the margins of the holes therein. The transducers are energized by a high frequency electronic generator or oscillator 22 which may be connected to a suitable frequency voltage source through a cable 28 indicated. The oscillator may be of any suitable capacity and construction adapted to oscillate at a desired frequency of, for example, 20,600 cycles per second or 38,000 cycles per second.

The transducers are each made up of a plate-like disk 11 which may be made of non-magnetic stainless steel, for example, and may be, for example, three and one-half inches in diameter and one-eighth inch thick. Obviously, the disks could be made in other diameters and other thicknesses and of other suitable materials, depending upon the particular application and the resonate qualities of the system desired as determined by the particular designer or person skilled in the art.

The disk 11 is shown by way of example fixed to the U-shaped core 19. The core 19 is made of laminations of a magnetostrictive material such as, for example, pure electronic grade A nickel or any other magnetostrictive material, an alloy of nickel. The laminations may be, for example, .010 inch thick, depending upon the frequency of operation. The legs of the U may be one-half inch wide and three inches long, and the legs of the U may be spaced three-eighths inch apart. The legs may have the projections 23 on their lower ends, which projections will retain the permanent magnet 20 in position.

As an alternate construction, the core 19 could be made of two separate stacks of rectangular laminations having a permanent magnet such as the magnet 20 at the lower end and having a piece of ferrite supported between them at the upper end to complete the magnetic circuit and being integrally attached, as shown in FIG. 3.

A retainer band 21 of non-magnetic material is supported around the lower ends of the laminations to prevent them from being spread outwardly.

The permanent magnet 20 may be a ceramic magnet of the high strength variety which are familiar to those skilled in the art. It may be, for example, one and three-eighths inch wide by one and three-eighths inch long and three-eighths inch thick. It will be magnetized with its north and south poles disposed on opposite sides; that is, it will be magnetized across its lesser dimension.

Instead of a permanent magnet, suitable D.C. winding could be provided in accordance with common practice in transducers of this type.

The disk 11 will be fixed to the end of the U-shaped member by means of epoxy cement, silver brazing, or other suitable methods.

The coil 18 will be designed of proper wire size and number of turns to give the proper ampere turns and electrical impedance match desired in a manner familiar to those skilled in the art. The coils will be connected to an oscillator or power supply 22 in suitable fashion and will be supported over the legs of the laminations 19 with a coil form 17 or suitable insulating material between the laminations and the coil windings.

The washer 13 may be a plain washer made of relatively rigid material supported below the resilient washer 12 and clamped to the disk 11 by means of the studs 29 which will be welded or otherwise affixed to the underside of the disk 11. The studs 29 will extend through suitable spaced holes in the washer 13 and will be clamped thereto by means of nuts 14.

The resilient washer 12 has the groove 27 previously mentioned and has O-rings 25 attached to the resilient washer itself by means of the webs 26. The webs 26 define the sides of groove 27. Thus, when the resilient washer receives the margin of a hole in the bottom 16, it forms a liquid tight seal. The washer 13 and bottom 16 are held in the space between the O-rings 25, the O-rings are compressed between the disk 11 and the washer

13, and leakage from the tank through the holes in its bottom is prevented.

Tests utilizing the transducers disclosed herein indicate considerably improved distribution of the ultrasonic vibrations in the liquid as well as improved results in the cleaning action of the machine. Furthermore, problems of leakage from the tank are virtually eliminated.

In the embodiment of the invention shown in FIG. 5, a transducer core is shown having legs 119 made up of laminations and fixed to a disk 11 by brazing or the like. A magnet 120 is supported above projections 123 as in FIG. 3. A piece of ferrite 140 is disposed between the legs 119, and close the magnetic field. When provided with coils and suitably installed, the device of FIG. 5 functions like the device shown in FIG. 3.

The foregoing specification sets forth the invention in its preferred practical forms but the structure shown is capable of modification within a range of equivalents without departing from the invention which is to be understood is broadly novel as is commensurate with the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed as defined as follows:

1. In combination, a transducer adapted to be installed in a liquid tank and a sealing washer comprising, a relatively rigid plate-like member, actuating member fixed to one side of said plate-like member adjacent the center thereof, said actuating member being adapted to extend through an opening in the bottom of said tank, a resilient washer having an opening in the center thereof, said actuating member extending through said opening in said washer, said washer having a groove in the outer periphery thereof, said groove being adapted to receive the peripheral edge defining said opening in said tank, and sealing means to seal said washer to said disk and to said tank whereby leakage between said tank bottom and said transducer is eliminated.
2. The combination recited in claim 1 wherein said sealing means comprises two rings O-shaped in cross section, said rings being integrally attached to the outer periphery of said washer, said rings being disposed on opposite sides of said groove from each other.
3. The transducer recited in claim 1 wherein said transducer comprises said plate-like member fixed to a magnetostrictive member.
4. The transducer recited in claim 3 wherein a relatively rigid washer is disposed in engagement with said resilient washer on the side thereof remote from said disk, and means attached to said disk and extending through said resilient washer whereby said rigid washer is clamped to said disk with said rings squeezed therebetween.
5. The transducer recited in claim 1 wherein said actuating means comprises an elongated member made of magnetostrictive material, and a coil wrapped around a part of said elongated member, said coil being adapted to be connected to a source of energy of ultrasonic frequency.
6. In combination, a tank and a plurality of transducers, said tank having spaced openings in the bottom thereof, each said transducer comprising, a relatively rigid plate-like member, actuating member fixed to one side of said plate-like member adjacent the center thereof, said actuating member being adapted to extend through an opening in the bottom of said tank,

5

a resilient washer having an opening in the center thereof,
said actuating member extending through said opening in said washer,
said washers each having a groove in the outer periphery thereof,

each said groove receiving the peripheral edge defining one of said openings in said tank,
and sealing means to seal said washers to said disks and to said tank whereby leakage between said tank bottom and said transducer is eliminated.

7. The combination recited in claim 6 wherein means is attached to said disk and extends through said washer clamping said washer to said tank.

6

8. The combination recited in claim 6 wherein said means to clamp said transducers to said tank comprises threaded members fixed to said disks and extending through said rigid washers.

References Cited by the Examiner

UNITED STATES PATENTS

2,616,820	11/1952	Bourgeaux	134—184
2,896,649	7/1959	Faidley	134—184
3,113,761	12/1963	Platzman	134—184
3,198,489	8/1965	Finch	259—1

WALTER A. SCHEEL, *Primary Examiner.*

15 R. W. JENKINS, *Assistant Examiner.*