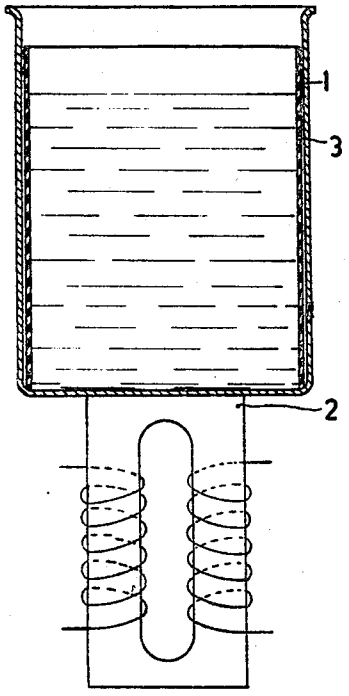
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ULTRASONIC RADIATION DEVICE

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ULTRASONIC RADIATION DEVICE

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The invention relates to an ultrasonic device and more particularly to ultrasonic apparatus for imparting ultrasonic energy to a liquid in a vessel. Devices of this type may be employed, for example, for cleaning purposes, for mixing or emulsifying two different liquids which may be miscible only with difficulty, and for obtaining biological effects, for example, for killing bacteria in liquids such as milk and so on.

In such devices the transducer for converting electrical energy into ultrasonic energy is often fastened, either directly or with the interposition of an energy transmitting body for the ultrasonic oscillations, to the bottom or to the side wall of a vessel for the liquid. Then the liquid in the vessel is excited by the ultrasonic oscillations so that the effects described above can be achieved.

In practice it has been found that, especially in the case of round, for example, beaker-shaped vessels, a strong, audible tone is often produced which is very troublesome to the user. This phenomenon may occur both with glass vessels and with metal vessels. By means of experiments underlying the invention, it was found that this audible tone corresponded to a resonance frequency of the vessel containing the liquid. By providing damping material on the outer wall of the vessel, the sound level of the audible tone could be reduced, it is true, but at the same time a large amount of useful ultrasonic energy was lost.

The invention has for its object to avoid this disadvantage and is characterized in that inside the vessel containing the liquid and near its wall, but beyond the path of the ultrasonic oscillations, from the ultrasonic radiator up into the liquid, acoustic damping material is provided.

The invention is based on the following recognition.

In order to achieve the aforesaid effects, for example, cleaning or emulsifying, it is necessary to apply enough ultrasonic energy to the liquid such that a strong cavitation occurs therein. This cavitation may be considered to be a non-linear load on the ultrasonic oscillations and subharmonics of these oscillations may be produced in the liquid. If such a subharmonic coincides with a resonance frequency of the vessel containing the liquid—in practice such a vessel may vibrate in many frequencies, so that the probability of coincidence of such a subharmonic with a resonance frequency of the vessel is very great—the vessel will be excited in this frequency. By providing acoustic damping material as described, oscillations of the said audible frequency can be prevented from reaching the wall of the vessel via the liquid. Thus the loss of ultrasonic energy is considerably smaller than in the case of direct damping of the wall of the vessel.

The invention will be described with reference to the embodiment shown in the drawing.

The single figure shows a beaker-shaped vessel **1**, which contains the liquid to be irradiated. To the bottom wall of this vessel **1** is fastened the ultrasonic transducer **2**. The ultrasonic oscillations of the transducer **2**, having a frequency of, for example 20 to 50 kc./s., propagate from said bottom wall through the liquid with a wave front extending approximately parallel to the bottom surface of the vessel **1**. A bottomless cylinder **3** of acoustic damping material, for example, some plastics such as polyethylene, polypropylene, rubber or the like is arranged near the side wall of the vessel **1**, but it is not rigidly secured thereto. The useful ultrasonic energy radiating from the bottom of the vessel **1** into the liquid is therefore not damped by the cylinder **3**, so that the desired effect on the liquid, for example, cleaning, is substantially not reduced. Since the wall of the vessel **1** is not directly damped acoustically, no additional ultrasonic energy is withdrawn from the radiator **2** for this reason. The oscillations of audible frequency produced by cavitation phenomena in the liquid, which propagate in many arbitrary directions, will strike the cylinder **3** and will be absorbed to a considerable extent so that they can reach the wall of the vessel **1** only in a materially attenuated state. In this way the said troublesome tone is suppressed. In order to obtain a satisfactory effect, it is found that a wall thickness of only a few millimetres, for example, 2.5 mm., is usually sufficient.

The vessel **1** may, of course, also have a rectangular or other shape. In this case, the cylinder **3** preferably has a corresponding shape.

What is claimed is:

1. Ultrasonic apparatus for treating a liquid in a container comprising, transducer means coupled to one wall of said container so as to vibrate said container to impart ultrasonic wave energy to said liquid along a given path, and acoustic damping means positioned within said container close to another wall thereof, said damping means being positioned wholly outside of said given path whereby ultrasonic wave energy along said given path is substantially unattenuated by said damping means.

2. Apparatus as described in claim **1** wherein said transducer means is positioned against the bottom wall of said container, said acoustic damping means comprising an open ended hollow cylinder composed of acoustic damping material, said cylinder being positioned close to a side wall of said container but not rigidly secured thereto and with its longitudinal axis substantially parallel to the direction of propagation of said wave energy.

3. Apparatus as described in claim **2** wherein said cylinder is arranged to sit on the bottom wall of said container with its longitudinal axis perpendicular thereto, the diameter of said cylinder being only slightly smaller than the correlative cross-sectional dimension of said container.

4. Apparatus as described in claim **2** wherein said container is a cylinder of a given diameter and wherein said hollow cylinder is arranged to sit on the bottom wall of said container with its longitudinal axis perpendicular thereto, the diameter of said hollow cylinder being only slightly smaller than said given diameter of the container so as to loosely fit therein.

5. Ultrasonic apparatus for treating a liquid in a container comprising, transducer means external to said container and coupled thereto so as to vibrate said container to cause ultrasonic wave energy to propagate through said liquid along a given path substantially parallel to at least one wall of said container, and acoustic damping means positioned within said container close to said wall but out of the propagation path of said ultrasonic wave energy so that any acoustic energy in the liquid reaching said wall is substantially attenuated.

6. Apparatus as described in claim **5** wherein said container comprises a first wall bounded by at least one other wall, said transducer means being positioned against a given one of said walls to impart vibrations to said liquid with sufficient power to produce cavitation in the liquid, said acoustic damping means comprising an open ended hollow thin-walled member composed of acoustic damping material and arranged so that its longitudinal axis is substantially parallel to the energy propagation path

and its walls are arranged close to the walls of said container other than said given wall.

7. Apparatus as described in claim 5 wherein said container comprises a first wall bounded by at least one other wall, said transducer means being positioned against said first wall to impart vibrations to said liquid with sufficient power to produce cavitation in the liquid, said acoustic damping means comprising an open ended hollow thin-walled member composed of acoustic damping material arranged within said container so that its wall or walls are positioned close to the bounding wall or walls of said container and substantially parallel to the direction of propagation of said wave energy in the liquid.

8. Ultrasonic apparatus for treating a liquid in a container comprising, vibratory transducer means external to said container and coupled to an end wall thereof to cause ultrasonic wave energy to propagate through said liquid in a given direction substantially parallel to the side walls of said container, and an open ended hollow member composed of acoustic damping material arranged within said container close to the side walls thereof and out of the propagation path of said wave energy so as to shield said side walls from the effects of said ultrasonic wave energy.

9. Apparatus as described in claim 8 wherein said end wall is the bottom wall of the container and wherein said

transducer means are arranged to cause said wave energy to propagate from said bottom wall through the liquid with a wave front extending approximately parallel to said bottom wall and with sufficient energy to produce cavitation in the liquid, said hollow member being arranged to sit on said bottom wall of the container so that the wall or walls thereof extend substantially parallel to said given direction of energy propagation.

10. Apparatus as described in claim 8 wherein said container and hollow member have corresponding cylindrical shapes, said container and hollow member being coaxially positioned.

11. Apparatus as described in claim 8 wherein said container and hollow member have different shapes, said container and hollow member being coaxially positioned.

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