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ULTRA HIGH FREQUENCY VIBRATOR

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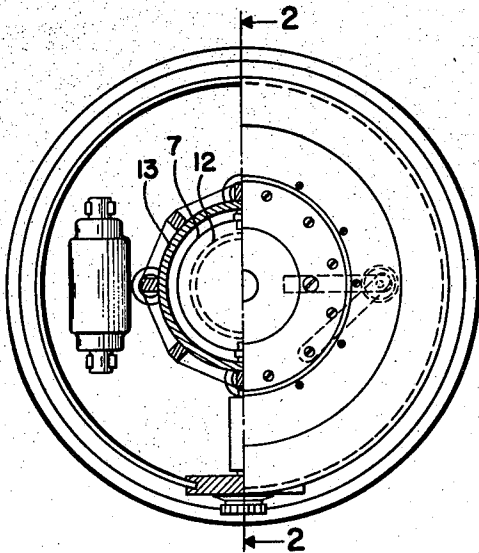


FIG. 3

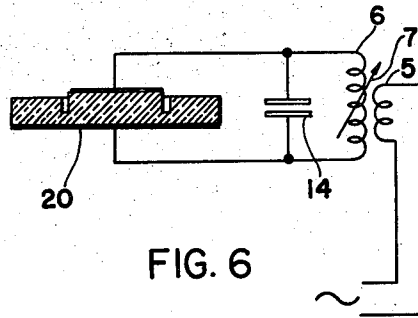


FIG. 6

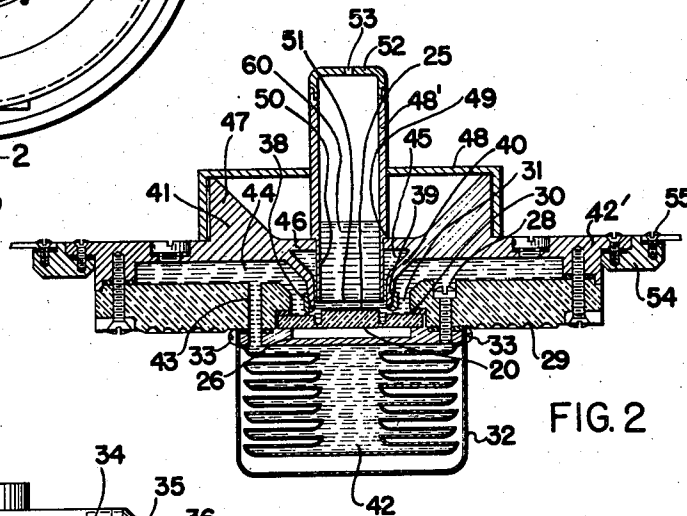


FIG. 2

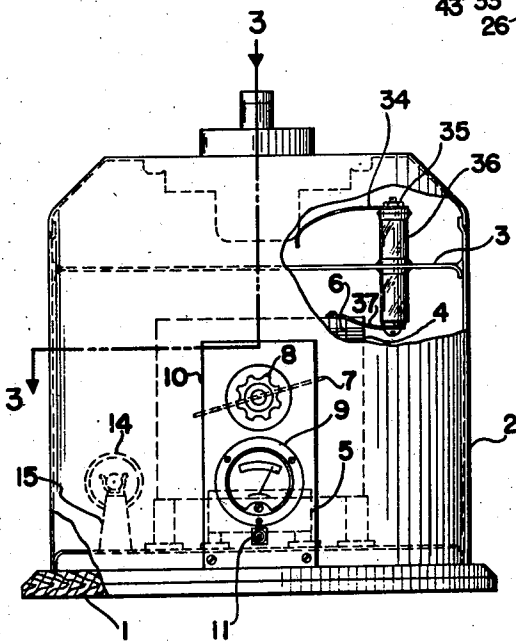


FIG. 1

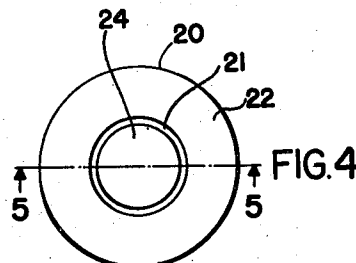


FIG. 4

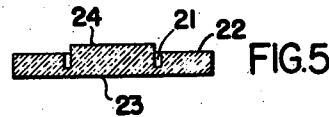


FIG. 5

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ULTRA HIGH FREQUENCY VIBRATOR

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6 Claims. (Cl. 259-72)

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The present invention relates to an ultra high frequency vibrator used principally for vibrating liquids. More particularly in the present invention a small volume of liquid is vibrated within a container which is particularly adapted to fit into the vibrator and have an intimate acoustic coupling with the vibrating surface.

The vibrator in the present invention may be formed as a piezoelectric crystal of quartz, or other suitable piezoelectric materials may be used producing vibrations over a uniform surface which is covered with a liquid film forming acoustic contact with a very thin membrane. The membrane may also be covered with a liquid in which the container holding the liquid substance to be vibrated is placed. The device is preferably operable at very high frequencies with comparatively high power and it may be built in varying sizes for vibrating small test samples or larger quantities for industrial production purposes.

The invention will be more fully described in the specification attached when taken in connection with the drawings showing an embodiment of the invention in which:

Fig. 1 shows a plan view of the device with fragmentary portions broken away;

Fig. 2 shows a section taken on the line 2—2 of Fig. 3.

Fig. 3 shows a section taken on the line 3—3 of Fig. 1;

Fig. 4 shows a detail of the piezoelectric operating element;

Fig. 5 shows a section on the line 5—5 of Fig. 4; and

Fig. 6 shows a circuit diagram of the device of Fig. 1.

In the arrangement in Fig. 1 the unit as assembled may comprise a wooden base 1 on which stands a casing or cover 2 which is preferably made of copper or other shielding material. A copper shield partition 3 within the casing 2 separates the upper part of the casing from the lower part in which the tuned power oscillating circuit is positioned. This comprises a transformer 4 with an inner primary coil 5 and an outer secondary coil 6 within which is positioned a copper vane or disc 7 whose position is adjusted by the external knob 8 until a maximum current is indicated on the secondary current meter 9. Both the tuning dial knob 8 and the meter 9 are mounted on a metallic panel 10 at the front of the device, the panel also containing the input plug 11 to which the desired high frequency current is conducted. The transformer 4 is a step up transformer so that the voltage within the de-

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vice is at a much higher potential than that brought to the device from the outside.

As indicated in Fig. 3 both primary and secondary coils may be wound on insulating forms 12 and 13, respectively, which may be made of plastic or other suitable material. The secondary of the coil is shunted by a vacuum or mica condenser 14 of a very high voltage rating. This condenser is mounted on suitable insulating supports 15 extending from the base of the case.

The vibrating unit itself is shown in section in Fig. 2. This comprises a piezoelectric crystal vibrating element 20 which has an annular groove 21 in its top face and a substantial heavy ring portion 22 by means of which the crystal is firmly clamped in place. The crystal preferably is of quartz but other suitable piezoelectric material may be used. While the frequency of operation used may be considered high for compressional wave vibration, a frequency of 500 kc. has been found satisfactory.

The bottom face of the crystal is coated with a conductive electrode 23 of gold or other highly conductive material. The center 24 of the crystal element preferably has a surface parallel to a thin diaphragm 25 which is positioned just above it and separated only from the top of the crystal by an oil film of very little thickness. The electrode 23 on the bottom face serves as one electrode of the system while the thin diaphragm 25, which may be of Monel metal or the like, serves as the top electrode acting through the oil film. The lower clamping member 26, which is recessed at the center to leave the bottom of the piezoelectric crystal free, except at the edges, serves as the conductive connection for the bottom electrode. This lower clamping element is held in place by means of screws 28 inserted from the top of an insulating supporting plate 29 of Lucite, Mycalex, or other suitable material. The screws 28 draw the lower clamping plate 26 tightly against the lower surface of the insulating plate 29 and hold the rim of the crystal element tightly against a shoulder 30 recessed in the sides of the plate adjacent the central opening 31 in the plate. An outer casing 32 is attached by means of screws 33, or otherwise, to the sides of the clamping plate 26. This cover 32 is made of copper or other suitable conductive material and serves as a conductive path to the crystal electrode through the spring contact 34 connected to the rod 35 insulated through the glass bushing 36. It also serves to conduct heat away from the crystal. At its lower end the rod 35 connects through the conductor 37 to the secondary 6 of the trans-

former. The top electrode 25, comprising the Monel metal thin disc, is retained in place by means of metallic sleeve 38 with an inwardly extending flange extending over the rim of the disc or diaphragm 25. The ring 38 threads onto the end of the cylindrical tube 39 and clamps the diaphragm between the flange of the ring and the end of the tube. Both the ring and tube are conductive and preferably are made of aluminum alloy or some such similar light conductive metal.

The cylindrical tube 39 is flared outward conically at 40 and merges into a supporting structure 41 which has a heavy flange ring 42' by means of which the element 41 is clamped tightly to the rim of the plastic or Lucite element 29 making a full liquid seal. As will be noted, liquid seals are also provided between the piezoelectric crystal element and the top clamping shoulder 28 as well as between the Lucite element 28 and the lower clamping ring 26.

A liquid bellows element 42 is attached to the bottom of the clamping ring 26 at its outer edge by welding, soft solder, or any other suitable method. A passage 43 is also drilled through the insulating plate 29 connecting the inside of the bellows with the chamber 44 formed between the element 41 and the insulating plate. This chamber 44, the inside of the bellows, and the entire surface of the crystal element is filled with oil, preferably a good insulating oil. A second chamber is formed above the diaphragm 25 within the hollow cylinder 39 and its flared out conical portion 40. This second chamber 45 is filled with a liquid which may be the same as the insulating oil in the chamber 44.

The supporting structure 41 is provided with an inwardly extending horizontal flange 46 and also with an upwardly extending wall 47 adapted to receive a cylindrical cover 48 over its top and side surfaces. The inwardly extending flange 46 serves as a support for the container 48' which is provided with a shoulder 49 adapted to rest against the flange 46. The top part of the cover 48 is perforated also to make a free fit for the container 48'. The container 48' is removable and preferably is provided with a thin lower wall 50 and a thin bottom diaphragm 51. The container also may be covered by a cover 52 with one or more vent holes 53.

The top diaphragm 25, which serves as the second electrode, is electrically connected through the supporting plate or structure 41 which may be grounded to the case through a supporting ring 54 which is held to the case by means of a set of screws 55. The other transformer terminal, therefore, will also be grounded to the casing 2.

In the operation of the device the structure is tuned to the desired frequency by adjusting the knob 8 until the current meter reads a maximum. Under these conditions a maximum power is being consumed in the vibrator circuit which comprises the transformer, the shunting condenser and the crystal oscillator. The vibrations generated by the crystal oscillator will be transmitted through the thin oil film between the top surface of the crystal and the diaphragm 25 and through the short liquid path beneath the bottom 51 of the container 48' effectively providing an acoustic coupling for transmitting acoustic vibrations to the liquid 60 within the container 48'.

It will be noted that the lower surface or electrode of the piezoelectric crystal is not immersed in a liquid medium but that only the upper surface is in contact with the liquid medium thus

providing a free release at this surface of the crystal in air, gas or vacuum surroundings. The bellows, with its oil filled chamber 42 connecting with the chamber 44, provides for expansion of oil produced by heat generated in unit. It will also be noted that vibrational energy may be transmitted not only through the bottom of the container but also through the side walls by means of the liquid contact of the chamber 45.

The device herein described may be used for testing purposes by putting samples of the substances to be tested within the container 48'. These preferably should be liquid but other types of materials, such as plastics, semi-plastics, or even solids, may be similarly tested by immersing the materials in the container.

Having now described my invention, I claim:

1. An ultra high frequency vibrator comprising a piezoelectric crystal having a rear surface and a front surface, a gas confining container covering said rear surface whereby said rear surface may be exposed to a gas or vacuum medium, said front surface covered with a liquid medium and a container in intimate contact with the liquid medium.

2. An ultra high frequency piezoelectric crystal vibrator having a conducting electrode attached to one face of the vibrator and another electrode comprising a thin conductive membrane insulatedly mounted with respect to the first-mentioned electrode near the other face of the vibrator and having only an oil film between it and said other face of the vibrator, and a container positioned adjacent said membrane and a second liquid medium acting between said membrane and said container.

3. An ultra high frequency vibrator comprising a piezo electric crystal plate, a conductive electrode positioned in parallel relation to said plate, near one face thereof, having only an oil film between the electrode and said face of the plate, means on the other side of said electrode from said plate forming a liquid chamber over said electrode having means supporting a container and said container having the bottom thereof immersed in said liquid chamber.

4. An ultra high frequency vibrator comprising a piezoelectric crystal plate having a top surface and a bottom surface and a thin compliance rim, a gas confining container covering said bottom surface whereby said bottom surface may be exposed to a gas medium, an oil chamber formed on top of the piezoelectric crystal plate, a conductive electrode positioned parallel to the piezoelectric crystal plate near said top surface and having only an oil film of said chamber between the electrode and the plate, a second oil chamber formed over said electrode, a container having the substance to be treated positioned in said second chamber over the electrode and means for supporting said second container in said chamber.

5. An ultra high frequency vibrator comprising a piezoelectric crystal plate, an electrode at the bottom surface of said plate, said plate being clamped at its edge and free around the rest of the surface of the plate, an oil chamber formed above the plate, an expandable bellows element positioned beneath said bottom electrode and having a passageway to said chamber, a membrane forming a thin electrode positioned directly over the plate having an oil film between it and the plate, a second chamber formed over said membrane and a container adapted to be posi-

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tioned within said chamber, said container adapted to contain material to be vibrated.

6. An ultra high frequency vibrator comprising a piezoelectric crystal plate having a thin compliance ring, means clamping the piezoelectric crystal plate beyond said thin compliance ring, one of said clamping members comprising a large plastic non-conductive plate, the other a conductive flanged ring making electrical contact with a bottom electrode of said plate, a liquid chamber formed over said plastic plate, a cover covering said liquid chamber, a thin membrane, means provided within said cover for supporting said thin membrane, said cover and membrane being of conductive material and said membrane being parallel to said plate and serving as an electrode therefor, a thin film separating said mem-

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brane from said plate and means formed within said cover comprising a second liquid chamber over said membrane and a container supported within said second chamber.

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