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METHOD AND APPARATUS FOR FORMING EMULSIONS AND THE LIKE

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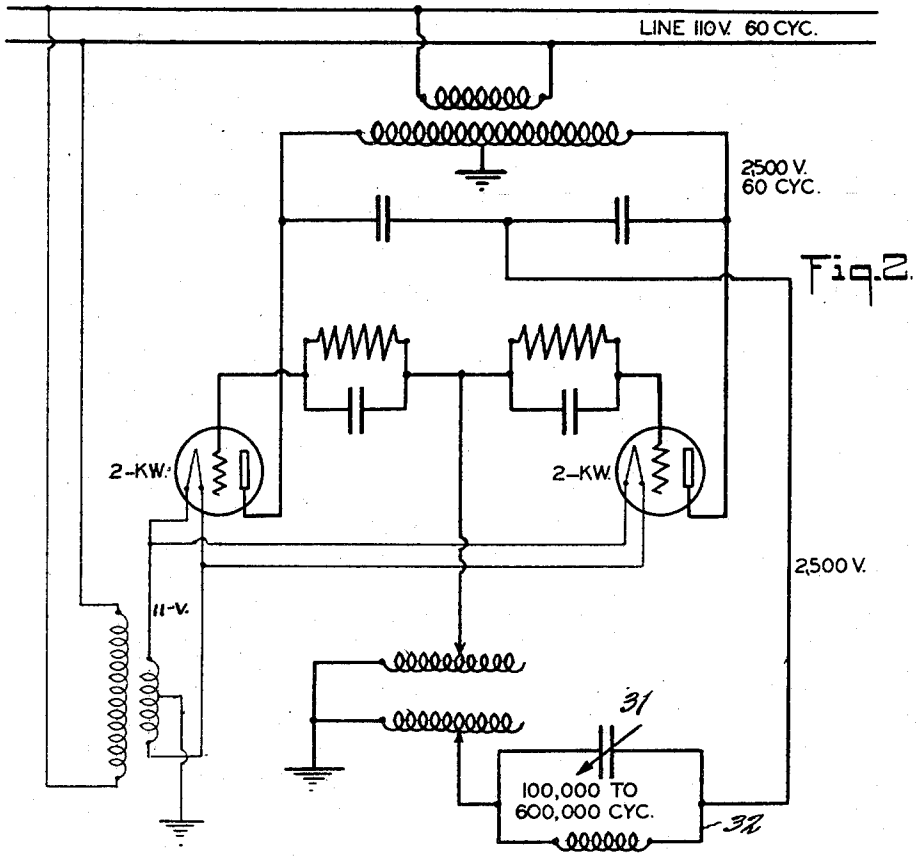
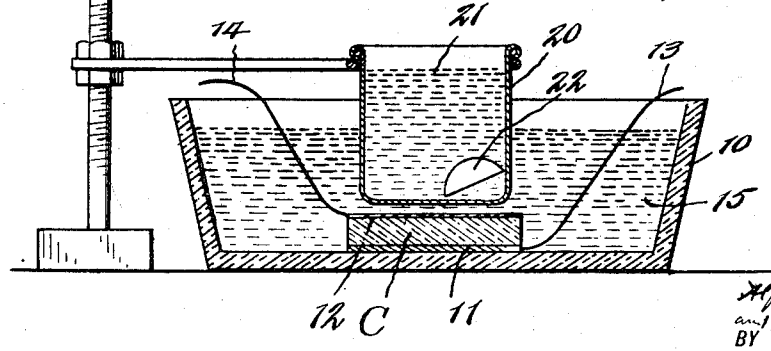


Fig. 2.

Fig. 1.



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METHOD AND APPARATUS FOR FORMING EMULSIONS AND THE LIKE

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This invention relates to methods and apparatus for forming emulsions and the like, and aims to provide an effective method and means for causing ultra-microscopic division of a liquid or solid, and the dispersion thereof through the liquid normally immiscible therewith. It may be used to produce stable emulsions between liquids which are not only immiscible, but have widely different specific gravities, to produce colloids, and to produce homogeneous stable suspensions.

In accordance with the invention, fine dispersion of a liquid or solid is caused by placing it in a liquid and passing powerful compression waves of radio-frequency through the containing liquid.

A feature of the invention consists in providing a method for producing in a liquid, powerful compression waves of radio-frequency, or "super-sonic" waves as such compression waves are somewhat inaccurately termed, because of the fact that they resemble sound waves in everything except frequency.

It has long been known that the passing of a high frequency electric current through certain crystals, causes expansion and contraction of the crystals, and this property of crystals has been used in an electric signaling. In such work, however, the oscillation of the crystals is undamped and is maintained by feeble electric impulses which sustain the natural oscillation of the crystal.

In accordance with our invention we obtain forced oscillation of such a crystal by damping its oscillation with oil and applying to it powerful high voltage electric impulses. In this way the oscillation of the crystal is made of an amplitude of much higher order than the oscillation obtained in signaling. The high amplitude oscillation of the crystal causes powerful compression waves in the liquid used to damp its oscillation and these waves may be used to set up similar waves in other liquids.

In order that the invention may be understood, we will describe in detail an apparatus for carrying it out which is illustrated in the accompanying drawings, in which:

Fig. 1 is a sectional elevation of the apparatus associated with the crystal; and

Fig. 2 is a diagram of the electric circuit used.

Fig. 1 shows an open container 10 of insulating material such as glass. On the bottom of the container is placed a lead plate 11. On this rests freely a cylindrical or disc-shaped piezo-electric quartz crystal C which may be about two inches in diameter and of from eight to ten millimeters in thickness. The upper and lower surfaces of the crystal are truly plane and parallel. On the upper surface of the crystal rests a sheet 12 of metal foil. Conductors 13, 14 connected to the plate 11 and sheet 12 lead from an oscillatory electric circuit having a tension of from 50,000 to 100,000 volts and a frequency of from 100,000 to 600,000 cycles per second. The frequency is adjusted to the normal frequency of oscillation of the crystal. To prevent the disruption of the crystal which would take place under such electric impulses, were its oscillation not damped, the container 10 is filled above the level of the crystal with a liquid 15 which serves to damp the natural oscillation of the crystal. To prevent arcing between the plate 11 and sheet 12, the liquid 15 should be a good di-electric. We have found transformer oil most satisfactory. The voltage used is as high as practical without danger of arcing around the crystal and is, therefore, a function of the thickness of the crystal.

An open container 20, smaller than the container 10, is supported above the container 10 and mounted for vertical adjustment. The bottom of the container 20, is parallel to the upper surface of the crystal. In this container is placed a liquid 21 and a liquid or solid 22 to be finely divided and dispersed through the liquid 21.

While the exact nature of the electric circuit, by means of which the high voltage and high frequency current is applied to the crystal, is not an essential part of the invention, an illustrative circuit is shown in Fig. 2. The voltages in the different parts of this circuit are indicated on this figure. The circuit contains two one-kilowatt, three-element vacuum tubes, and is of a type commonly used in radio broadcasting. A detailed descrip-

tion of it is, therefore, unnecessary. The tuning of the circuit 30, which contains the crystal C, to the normal frequency of the crystal is obtained by means of a variable condenser 31 in a circuit 32 inductively coupled to the circuit 30.

In carrying out our method by means of the apparatus which has been described, the electric circuit is first tuned to the frequency of the crystal, and the container 20 is then lowered until its lower portion is immersed in the oil 15 in the container 10. Contraction and expansion of the crystal sets up a vertical train of parallel compression waves of radio-frequency in the oil 15. The impulse of these waves sets up a vertical vibration in the bottom of the container 20 which causes a similar vertical train of compression waves in the liquid in the container 20. To obtain the maximum effect, the vertical position of the container 20 is adjusted until the distance between the bottom of the container 20 and the top of the foil 12 is equal to an even multiple of the length of the compression waves to be produced in the oil 15, so that standing compression waves are formed in the oil between the crystal and the bottom of the container 20. This condition can easily be reached by adjusting the container 20 vertically until the maximum disturbance of the liquid in it is produced. Although not essential in carrying out our process, the emulsifying effect of the compression waves in the liquid 21 may be made a maximum, by making the height of the column of liquid in this container equal to an even multiple of the length of the compression waves produced in the liquid contained in it, so that standing waves are produced in this liquid. This condition may be readily obtained by adding to the liquid 21, drop by drop, until its height is such that the maximum observed disturbance is obtained in it.

The effect of the powerful high frequency compression waves in the liquid 21 is finely to divide, and to disperse through the liquid 21, any liquid or solid placed in it. Thus if the liquid 21 be water, and a piece of wax be placed in the container, in a few minutes the piece of wax will entirely disappear and a stable colloid of creamy consistency will be formed in the container 20. The placing of any hard powdered substance in the liquid 21, will result in a more minute division of the substance and its dispersion through the liquid 21 to form the stable suspension. If the liquid 21 be water and any oil or fat be placed in the container 20, a homogeneous and stable emulsion will be formed. Even in the case of liquids of widely different specific gravity and incapable of forming emulsions, a thorough mixture having many of the qualities of an emulsion will be formed. Thus if water and mercury be placed in the container 21, there is formed an emulsion or dispersion of ultra-microscopic particles of mercury throughout the water. The mercury particles are so finely divided that the emulsion or suspension thus obtained is stable for more than a month.

What we claim is:

1. The method of forming emulsions, suspensions and colloids, which consists in passing through two adjacent immiscible substances, of which at least one is a liquid, compression waves of radio-frequency.

2. The method of forming emulsions, which consists in passing through the liquids to be emulsified compression waves formed by forced oscillation of a damped crystal.

3. The method of producing in a liquid powerful compression waves of radio-frequency, which consists in immersing the crystal in a damping liquid and causing forced oscillation of the crystal by a radio-frequency electric current of a tension sufficiently high to shatter the crystal when undamped.

4. The method of producing in a liquid powerful compression waves of radio-frequency, which consists in placing a crystal between two conductors, immersing the crystal and conductors in oil, and connecting the conductors in a radio-frequency electric circuit of a voltage just insufficient to cause arcing between the conductors.

5. An apparatus for producing powerful high frequency compression waves in a liquid, comprising an insulator, a conductor resting thereon, a crystal resting freely on said conductor, a conductor resting freely on said crystal, a body of oil surrounding the crystal and the conductors, and means for applying to the conductors a radio-frequency electric current of high voltage.

6. An apparatus for forming emulsions, suspensions and colloids, comprising a crystal, a body of oil surrounding the crystal, means for applying a radio-frequency electric current to the crystal, and a liquid container immersed in the body of oil.

7. Apparatus as claimed in claim 6 in which a crystal has parallel flat upper and lower surfaces and the container has a flat bottom parallel to the upper surface of the crystal.

8. Apparatus as claimed in claim 6 in which a crystal has parallel flat upper and lower surfaces, the container has a flat bottom parallel to the upper surface of the crystal, and means are provided for nicely regulating the distance between the bottom of the container and the top of the crystal.

9. The method of forming emulsions, which consists in immersing a crystal in a damping liquid, causing forced oscillation of the crystal by a radio-frequency electric current of a tension sufficiently high to shatter the crystal when undamped, and passing through the liquids to be emulsified the compression waves thereby created in the damping liquid.

10. An apparatus for forming emulsions,

suspensions and colloids, comprising an insulator, a conductor resting thereon, a crystal resting freely on said conductor, a conductor resting freely on said crystal, a body of oil surrounding the crystal and the conductors, means for applying to the conductors a radio-frequency electric current of high voltage, and a liquid container immersed in the body of oil.

In testimony whereof we have hereunto set our hands.

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