Dec. 29, 1959 J. NEUHAUS ET AL 2,919,215

APPARATUS FOR VIBRATING LIQUIDS

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Fig. 1

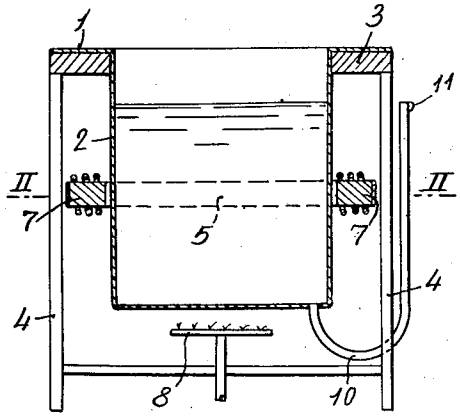


Fig. 2

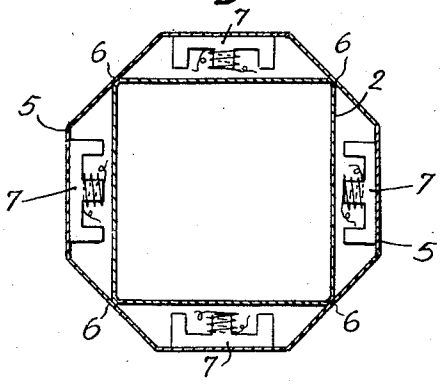


Fig. 3

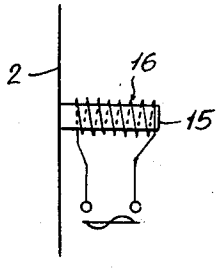


Fig. 4

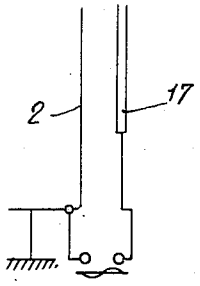
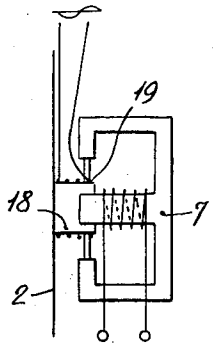


Fig. 5



INVENTORS:
JEAN NEUHAUS,
JANOS KEMENY
AND BELA RANKY
BY:

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Fig. 6

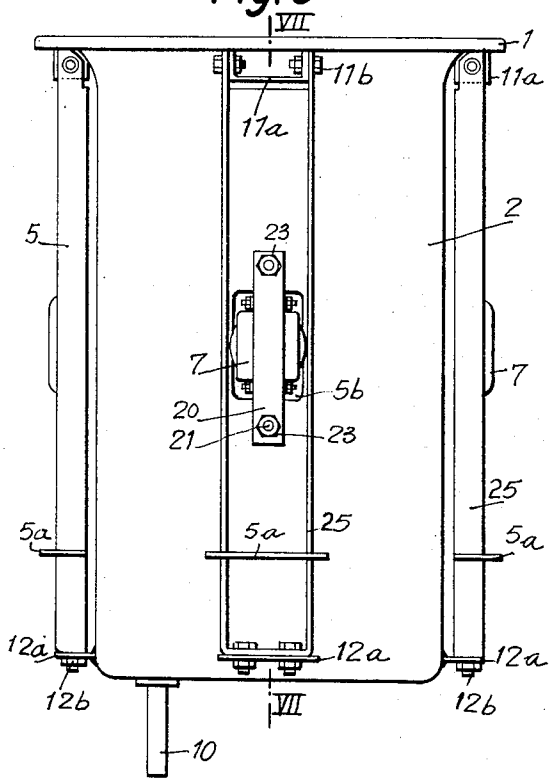


Fig. 7

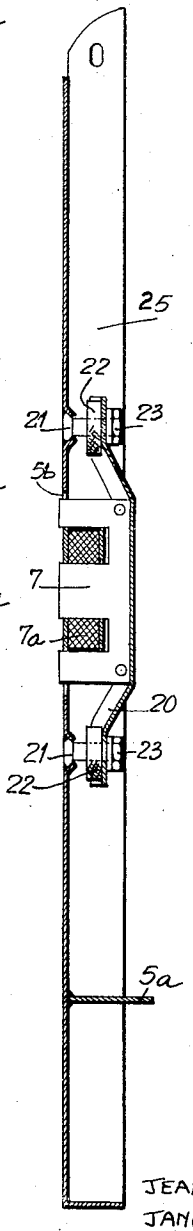
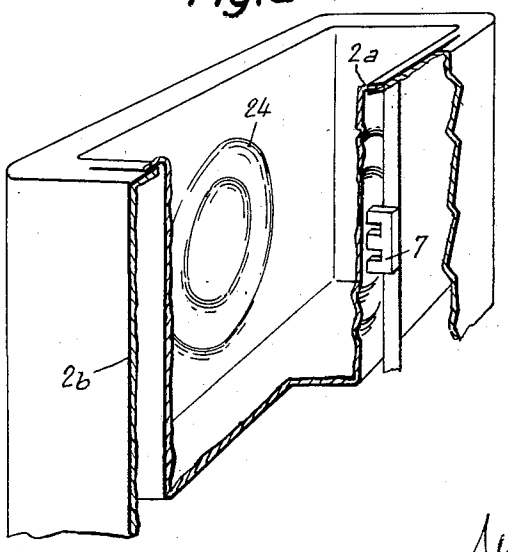


Fig. 8



INVENTORS:
JEAN NEUHAUS,
JANOS KEMENY,
AND BELA RANKY
BY:
Mudall & Hume
atys

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APPARATUS FOR VIBRATING LIQUIDS

Jean Neuhaus, Neuilly-sur-Seine, Janos Kemeny, Bry-sur-Marne, and Bela Ranky, Clichy, France; said Neuhaus assignor to Thermofrigor, Société Anonyme, Casablanca, Morocco

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Claim priority, application France February 21, 1952

3 Claims. (Cl. 134—1)

The present invention relates to apparatus for vibrating liquids, in which vibrations are transmitted to the liquid through the whole or a part of the walls themselves of the vessel containing the liquid.

Generally, those vibrations are obtained by mechanical means.

In accordance with the present invention, the vibrations of the walls are obtained by the fact that those walls, or the elements of which they are made, are traversed by lines of force of magnetic or electric fields having periodically variable intensities.

In this manner, one obtains an improvement in the efficiency of transmission of the energy particularly in the case of low frequencies. Indeed, in that case, the wave lengths are great relatively to the dimensions of the vessels and the use of the walls themselves, on the one hand, avoids the short-circuits which are produced in the case of submerged vibrators, and on the other hand, provides a transmitting element having a surface which is as large as possible.

If low frequencies are used, for example, 50 to 100 cycles per second, that is to say, frequencies which are generally used by vibrators supplied with alternating current of a frequency of 50 cycles per second, a practically stationary vibratory system is obtained. The walls and the liquid form a complete vibratory system having several degrees of freedom, that is to say, several resonance frequencies.

In accordance with the present invention, the system formed by the receptacle and the liquid on the one hand, and the emitters of the said fields on the other, are preferably given such characteristics that their frequencies are in resonance.

Thus, one can tune either one of the fundamental frequencies of the vibratory system formed by the vessel and the liquid to the frequency of the fields (for example, by varying the level of the liquid), or the frequency of the fields to one of the fundamental frequencies of the vibratory system formed by the vessel and the liquid.

If, for emitting the fields, one uses electromagnets supplied with alternating current having a periodicity of 50 cycles, the frequency of variation of the fields is 100 cycles. If the vibratory system is to be tuned to that frequency, the vessel must be given relatively small dimensions (10–20 litres for exampie) with the usual sheet metal thicknesses (about 0.5–1 mm.). In order to make the vessel larger while preserving resonance, the thickness of the walls would have to be increased which would make the apparatus less sensitive.

In order to avoid that difficulty, it is possible in particular to rectify the alternating current by suppressing one alternation and the frequency of the exciting force is then brought back to 50. Thus, the dimensions of the vessel in resonance with that frequency, can be materially increased and furthermore the noise of the apparatus is more acceptable to the human ear.

If the walls form one of the elements of the magnetic circuit, they must be of a ferro-magnetic material. That

in some cases can be a disadvantage. In that case, one can make the non-ferro-magnetic wall integral with a part of ferro-magnetic material closing the magnetic circuit of the electro-magnet or subjected to the action of a coil traversed by an electric current the intensity of which is subject to periodic variations.

One can also use one or more of the walls of the vessel as one of the elements of an electrical condenser the charge of which is subject to periodical variations.

One can also mount on one or more of the walls an electrical conductor through which passes a current the intensity of which is subject to periodical variations and which lies in a magnetic or electromagnetic field.

The applications of the present invention are very numerous. Among those applications one can mention in particular washing machines, emulsifiers, baths for cleaning metals, galvano-plastic devices, vibrators for use in the manufacture of foodstuffs, etc.

By way of example, but in no limiting sense, there have been shown in the accompanying drawings:

Figure 1, a vertical section through a washing machine in accordance with the invention.

Figure 2, a horizontal section through that washing machine; taken on the line II—II in Figure 1;

Figures 3–5, three modifications of a detail of the machine in accordance with the invention;

Figure 6, a side view of the vessel of a third washing machine in accordance with the invention;

Figure 7, a section taken on the line VII—VII of a part of Figure 6;

Figure 8, a perspective view partially in section through a fourth washing machine in accordance with the present invention.

The washing machine shown in Figures 1 and 2 comprises an iron vessel **2** of square horizontal section, the upper edge **1** of which rests on a frame **3** mounted on a support **4** having four feet. A gas burner **8** provides the necessary heat. A octagonal frame **5** is fixed on the corners of the vessel **2** and carries four electro-magnets **7**. One of the elements of the magnetic circuit of those electro-magnets is constituted by the vertical wall itself of the vessel **2**. If those four electro-magnets **7** are fed with the same alternating current, the walls oscillate at a frequency twice that of the alternating current. The vibrations of the walls are in phase and the walls are drawn in at the same time. For tuning the exciting forces of the electro-magnets **7** and the vibrations of the vibratory system formed by the vessel **2** and the liquid which it contains, one can regulate the level of the liquid in the vessel **2** by means of a pipe **10** by vertically displacing its end **11**. When resonance is achieved, the end **11** is fixed at the height of the liquid level in the vessel **2**. Numerous spurts of water then occur from the free surface of the liquid particularly near the walls of the vessel **2**. For washing clothes, the latter have only to be immersed in the suitably prepared liquid. The liquid level in the vessel **2** remains constant, the pipe **10** acting as an overflow.

If the current used for excitation of the electro-magnets **7** of two opposite walls of the vessel **2** in an alternating current 90° out of phase relatively to that used for the other two electromagnets, the opposite walls will be pulled in while the others are not.

When a rectifier is used for reducing the frequency and it is desired that the two pairs of walls should oscillate in opposite directions, two oppositely connected rectifiers have to be used, one for each pair of electromagnets.

The present invention is not limited to the washing machine described above. Thus, for example, if the walls of the vessel **2** are of ferromagnetic material as in Figures 1 and 2, that can be a disadvantage. For example, as indicated in Figure 3, there can be fixed to

the non-ferro-magnetic wall **2** a ferromagnetic part **15** disposed in the field of a solenoid **16** through which passes an alternating electric current. Also, as shown in Figure 4, the wall **2** could be used as one element of a condenser the other element of which is shown at **17** and the charge on which is subject to periodic variations. It is also possible, as indicated in Figure 5, to fix to the wall **2** a sleeve **18** on which is wound a conductor **19** supplied with alternating current and disposed in a magnetic field.

The washing machine shown in Figures 6 and 7 comprises a vessel **2** the edge **1** of which has lugs **11***a* while the lower edge has lugs **12***a*. To these lugs **11***a* and **12***a* are fixed supports **25** by means of screws **11***b* and **12***b*. Those supports form screens **5***a* for protecting the electromagnets **7** against the hot gases of the burner **8**. The supports are provided with openings **5***b* substantially at the centre.

The electromagnets are formed by a packet of plates **7** and a coil **7***a*; each of these electromagnets is carried by a stirrup **20** which is fixed to the base of the support by screws **21** the heads of which are welded to the support **5**. On these screwthreaded rods are provided knurled nuts and locking nuts **23**. The ends of the stirrup **20** are held between knurled nuts **22** and locking nuts **23**.

By suitably adjusting the position of the knurled nuts **22**, the air gap of the magnetic circuit defined by the plates **7** and the wall **2** can be adjusted and the force of attraction thus modified.

The operation of that washing machine is otherwise identical to that of the washing machine shown in Figures 1 and 2.

It is to be noted that the vessel need not be of square cross section as in the examples described above. It can be round or rectangular as shown in Figure 8. The vessel or container shown in Fig. 8 is formed with double walls **2***a* and **2***b* and the inner wall portions of the walls **2***a* are not strictly plane but formed with depressions at **24**, here shown to be circular and coaxial with the electromagnets **7**, only one of which is shown in Fig. 8. The depressions **24** allow not only the period of the vibration of the unit formed by the vessel and its contents to be varied but also allow the elimination of certain internal stresses in the plates forming the vibratory wall **2***a*.

The operation of that washing machine is analogous to that of the washing machines described above.

What is claimed is:

1. Vibration apparatus comprising, in combination, support means; container means mounted on said support means and adapted to contain liquid to be vibrated and having at least one wall portion including ferro-magnetic material, said container means with liquid therein being adapted to vibrate within a certain frequency range, the actual frequency within said range depending upon the amount of liquid in said container means; vibration producing means mounted on said support and cooperating with said wall portion including ferro-magnetic material for vibrating said container means together with the liquid contained therein at an actual frequency within said frequency range; and means operable for varying the level of the liquid adapted to be contained in said container means for adjusting the frequency of vibration

of said container means with said liquid therein to a frequency resonant with said actual frequency within said frequency range, whereby resonance can be established between the frequency of said vibration producing means and the adjusted frequency of said container means with the liquid therein.

2. Vibration apparatus comprising, in combination, support means; container means mounted on said support means and adapted to contain liquid to be vibrated and having at least one wall portion including ferro-magnetic material, said container means with the liquid therein being adapted to vibrate within a certain frequency range, the actual frequency within said range depending upon the amount of liquid in said container means; electrical vibration producing means mounted on said support and comprising electromagnetic means supplied with alternating current of a frequency of 50–60 cycles per sec., said vibration producing means cooperating with said wall portion including ferro-magnetic material for vibrating said container means together with the liquid contained therein at an actual frequency within said frequency range; and means operable for varying the level of the liquid adapted to be contained in said container means for adjusting the frequency of vibration of said container means with said liquid therein to a frequency resonant with said actual frequency within said frequency range, whereby resonance can be established between the frequency of said vibration producing means and the adjusted frequency of said container means with the liquid therein.

3. A method of treating solid matter by applying a vibrating force having a predetermined frequency of vibration to container means containing said solid matter immersed in a liquid within said container means which container means together with the liquid therein is adapted to vibrate at a natural frequency within a certain frequency range, the actual natural frequency of vibration within said range depending upon the amount of liquid in said container means, said method comprising the steps of adjusting the amount of liquid within said container means in such a manner as to adjust the actual natural frequency of vibration of said container means and said liquid therein to a frequency resonant with said predetermined frequency of said vibrating force applied to said container means; and vibrating said container means with said solid matter immersed in said adjusted amount of liquid therein by applying to said container means said vibrating force with said predetermined frequency of vibration.

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