

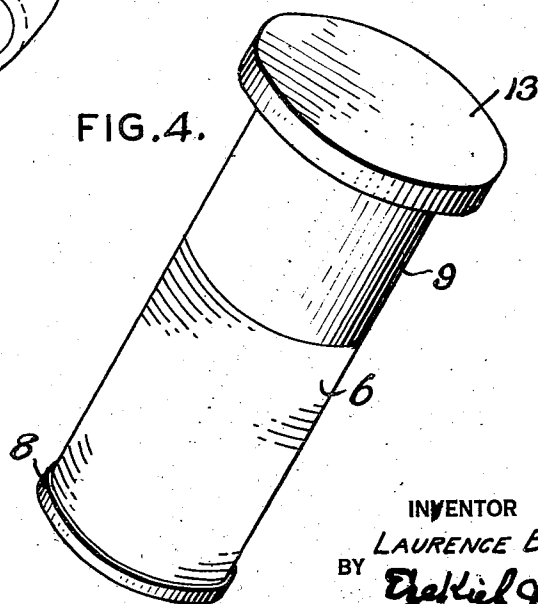
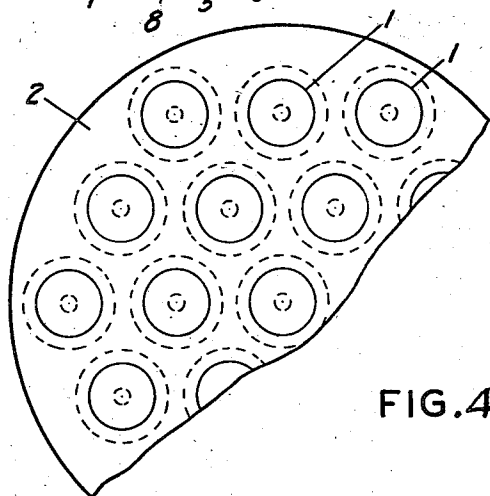
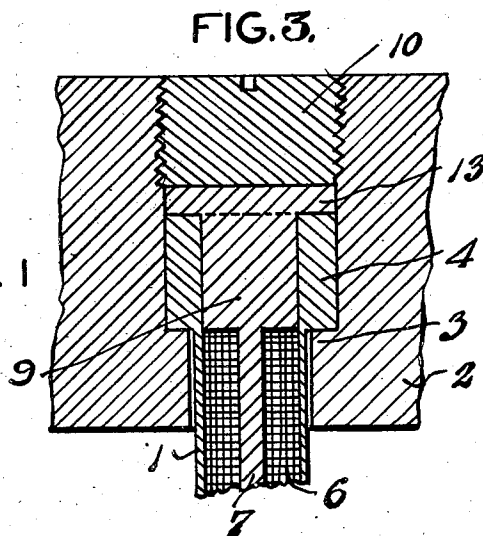
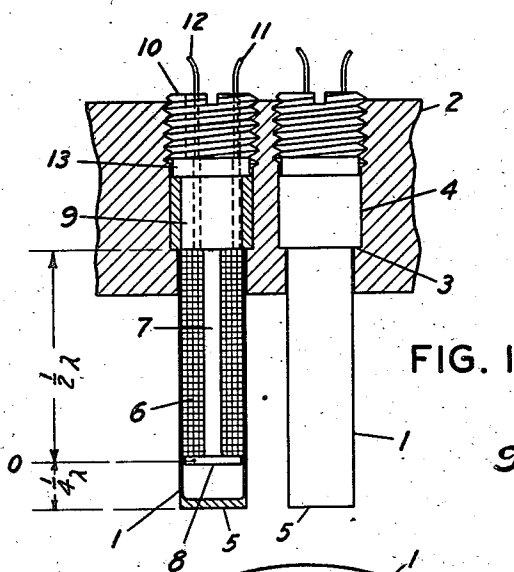
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MAGNETOSTRICTION OSCILLATOR

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MAGNETOSTRICTION OSCILLATOR

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8 Claims. (Cl. 177—386)

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The present invention relates to magneto-strictive oscillators and more particularly to oscillators for developing compressional waves of high frequencies:

In my patent application Serial No. 671,870, filed May 19, 1933, Patent No. 2,380,931, there is illustrated a so-called multispot magnetostriction oscillator whereby each unit is operated individually and independently, all of the units having an established synchronism for transmitting a plane wave in a particular direction. In my earlier application Serial No. 663,963, filed April 1, 1933, I have disclosed a method of phase shifting whereby the direction of the beam may be varied without rotating the oscillator itself. The present application relates to a construction of the oscillator which might be employed in any of the prior inventions mentioned above.

The present invention is more particularly directed to the efficient application of electrical energy and the efficient production of mechanical vibrations at very high frequencies, frequencies ranging from 20 kilocycles upwards, although the same principle may be extended to lower frequencies but in lower ranges the increase of the dimensions of the apparatus allow more leeway in design and make it unnecessary for the most part to use the principles herein set forth.

In the production of high frequency mechanical vibrations by magnetostriction means the length of the vibrating magnetostrictive elements becomes shorter as the apparatus is adapted to the higher frequencies. Not only does the vibrating element become shorter, but also on account of the load that is attached to it which includes the mass of the radiating diaphragm and the water load, the vibrating element must be made still shorter to maintain its tuning. In the system which I have employed in the present invention as well as in the inventions mentioned above, the vibrating element is held at a nodal position and the radiating end is at a position of maximum amplitude. In the present application this system is employed, but instead of making the operating part of the magnetostrictive tube one-quarter of a wave length, it is made three-quarters of a wave length or one-half wave length increments to the one-quarter wave length, that is, a wave length of three-quarters, one and one-quarter, one and three-quarters, etc., could be used.

It should further be noted that in the present invention the magnetic flux is applied in one-half wave length section and preferably the tube should be no longer than three-quarters of a wave, this dimension including the compensation which must be applied because of the added load

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of the cap. That is to say, the magnetostrictive vibrating element will not be three-quarters of a wave length of an open tube, but will be somewhat shorter, depending upon the mass which the cap adds to the tube.

In all of the above discussion the wave length is considered as being the length of the wave in the material itself which means that in the present system the oscillator is designed to operate at a definite frequency or within a very limited range about this frequency. While this oscillating frequency is usually very sharp by using magnetostrictive material that is not hard, such, for instance, as soft nickel, the tuning or resonance may be somewhat broadened.

The present invention will be more fully understood in connection with the drawing illustrating an embodiment of the same in which Fig. 1 shows a vertical view partly in section, Fig. 2 shows a plan view of a part of the oscillator and Fig. 3 shows an enlarged view of some of the details shown in Fig. 1 and Fig. 4 shows a view of a detail shown in Fig. 3.

In Fig. 1 the oscillating tubes 1, 1, etc., are mounted in a heavy plate 2. The plate 2 is perforated to provide a hole with a shoulder 3 in which the tube 1 may be placed. The tube 1 is provided with a heavy collar 4 having a shoulder corresponding to the shoulder 3 of the plate and also with a cap 5 at the lower end of the tube. The collar 4 and the cap 5 are usually an integral part of the tube. The tube 1 is provided with a thin wall and open on the inside in which is placed the electromagnetic coil 6 which is wound upon a spindle 7. The spindle 7 has at the end near the cap 5 a flange or pole 8 and at the other end a larger body portion 9 fitting within the collar 4 of the tube 1. The upper element 9 is provided with a flange 13 which fits over the collar 4 of the tube and by means of which it is clamped in place with the clamping of the tube in the plate.

The spindle 7 and the end elements 8 and 9 are of magnetic material and impress the flux set up by the coil 6 in the tube 1. The element 8 is really a pole element and this, it will be noted from Fig. 1, is positioned abutting the tube at a nodal point so that the flux circulating in the tube 1 circulates between the nodal point O and the clamping edge at the shoulder 3 a distance which corresponds to one-half wave length of the mechanical vibration in the tube.

The flux is circulated in the tube 1 in the manner as indicated above in order to obtain the correct relation of phase between flux and motion of the tube. If the node is formed as indicated at zero in the tube 1, then the motion of the tube below this point is downward at the

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same time that the motion of the tube above this point is upward. If the flux were induced for the whole length in the tube, then the tendency of the tube would be to vibrate in the whole length at one-half wave length, the natural frequency of which would not correspond to that impressed.

The tube itself is provided with a heavy mass 4 which is large in size as compared with the mass of the tube and is clamped to the plate 2 in this mass by means of the clamping nut 10 which is threaded into the plate. I have found that by using a heavy mass at the clamping part of the tube, the clamping of the tube in the plate is not very critical. If the collar 4 were not heavy, there would be serious difficulty in clamping the tube in the plate the same way each time so that it would be very difficult, even though everything were uniform, to be assured that the units produced the proper vibration.

As has been previously stated, the flux is applied to the tube over or within one-half wave length of the tube itself. The length of the tube between the point O and the cap, it will be noted in Fig. 1, is considerably shorter than the rest of the tube and, in fact, is less than one-half as long, although the tube itself from the point of the clamping shoulder to the cap end is three-quarters of a wave length. The reason for this is, as has been stated above, that the cap 5 provides such a mass to the vibrating tube that its frequency is substantially reduced.

In the illustration shown in Fig. 1 the section between the point O and the outer edge of the cap 5 represents one-quarter of a wave length, or substantially so, so that while the node occurs opposite the element 3, a maximum vibration occurs at the face of the cap 5. Both the direct current for magnetization and the alternating current for impressing the vibrations on the tube may be applied in the coil 6 through the leads 11 and 12.

Having now described my invention, I claim:

1. A magnetostriction oscillator comprising a heavy plate element, a magnetostriction tube having one end positioned in said plate, means provided in said plate and at the end of said tube whereby said tube may be clamped rigidly to said plate, an electromagnetic exciting coil within said tube and having pole faces for providing electric flux between the clamped portion of said tube and a portion adapted to be a half wave length at the frequency at which the oscillator is vibrated, said tube extending beyond the point at which the flux is applied and means providing a cap at the end of said tube.

2. A magnetostriction oscillator comprising a heavy plate, a vibrating magnetostrictive tube having a cap at one end thereof and means for clamping said tube to said plate at the other end thereof, an electromagnetic exciting coil positioned within said tube and applying magnetic flux at the place of clamping and at a point along the tube approximately equal to one-half wave length at the frequency at which the tube is to vibrate, said tube being three-quarters a wave length at the frequency at which it is to be vibrated whereby the amplitude of the tube at the cap portion is a maximum.

3. In a magnetostriction oscillator, a plate having a hole extending therethrough, a shoulder extending into said hole, a vibrating magnetostriction tube having a cap thereon and having a long external shoulder at the open end thereof and positioned to bear against the shoulder of said hole, electromagnetic exciting means po-

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sitioned in the tube having at one end a collar and a flange projecting beyond said collar at the end thereof, means including said plate clamping both said tube at said long shoulder and said electromagnetic exciting means at said collar to said plate, the electromagnetic means having at the other end a magnetic pole for impressing the flux in the tube substantially at two adjacent nodal points.

4. In a magnetostriction oscillator, a heavy plate, a hollow magnetostrictive tube open at one end and closed at the other end forming a radiating element, said tube at its open end being positioned in said plate with means clamping the tube to said plate and coil means positioned within said tube for supplying magnetic flux between the clamped end of the tube and a place near the closure.

5. In a magnetostriction oscillator, a plate having a perforation therein, a magnetostrictive tube positioned in said perforation and projecting through the face of the plate, means including said plate for clamping said tube rigidly thereto, said tube being closed at the end projecting from the plate, a magnetic spool positioned within said tube for energizing the same, means clamping said spool at one end within said tube and having a pole face at the other end positioned near the wall of the tube.

6. In a magnetostriction oscillator, a heavy plate having a perforation therein, a hollow magnetostrictive tube mounted in said perforation having a cap at one thereof and means including the plate for clamping the other end of the tube therein, and having at the desired frequency of oscillation nodal points at the mounted portion of the tube and towards the cap end a spool having a coil wound thereon, said spool of magnetic material and of a suitable length to provide pole faces at the ends opposite the nodal points of the tube thereof for impressing the magnetic flux between substantially said nodal points in the vibration of the tube.

7. In a magnetostriction oscillator, a plate having a perforation therein, a magnetostrictive tube having an outwardly projecting flange formed to fit in the perforation in said plate, means including said plate for clamping said tube therein, a magnetic spool having a coil wound thereon and provided with outwardly extending end portions, one end portion adapted to fit over the flange of said tube, means clamping said tube and spool in said plate at the flanged portions, said spool at the other end thereof extending to a position adjacent the inner wall of the tube for allowing magnetic flux to be impressed upon the tube and means forming a radiating surface closing the ends of the tube.

8. In a magnetostriction oscillator, a plate having a perforation with a shoulder therein, a vibrating magnetostriction tube having a cap at one end and a corresponding shoulder at the other end fitting in said plate with its shoulder abutting the shoulder of the perforation, said tube projecting beyond the plate, an electromagnetic spool having a flange lying over the shoulder of said tube at one end, means including the plate for clamping the tube shoulder against the spool flange and the tube shoulder against the shoulder of the perforation, said spool providing a pole face adjacent the wall of the tube at the other end, said pole face being positioned substantially at a node.

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