

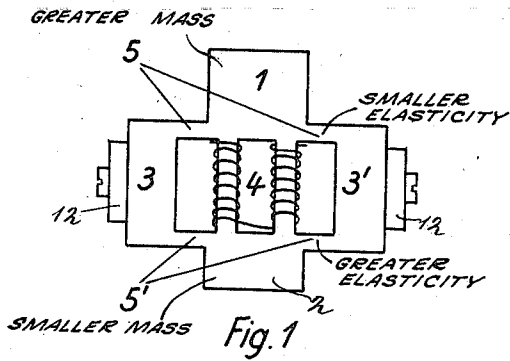
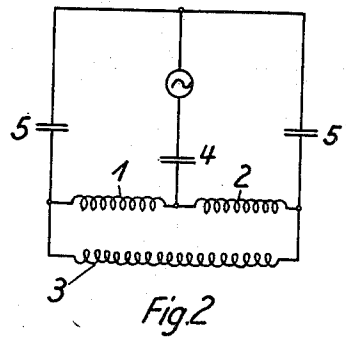
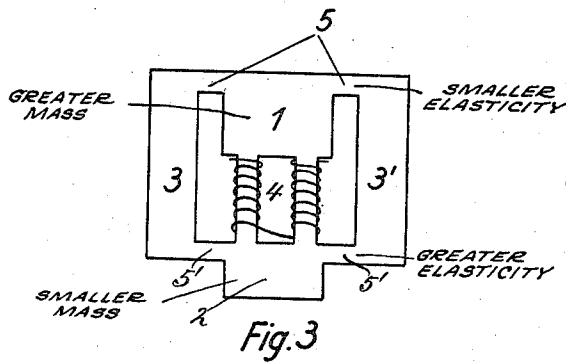
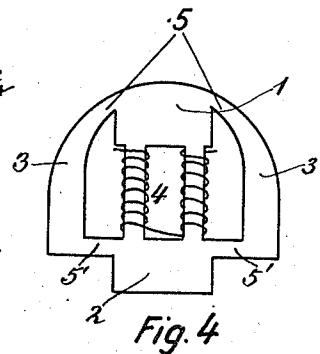
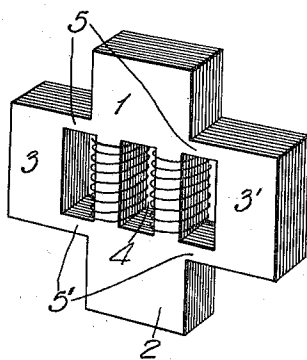
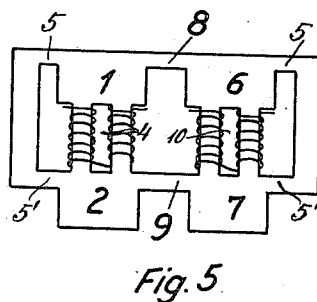
April 14, 1942.

U. JOHN

2,279,322

MAGNETO-STRICTIVE OSCILLATOR

Filed March 18, 1939



INVENTOR
U. John
BY *Musgraves*
ATTORNEYS.

UNITED STATES PATENT OFFICE

2,279,322

MAGNETO-STRICTIVE OSCILLATOR

Ulrich John, Kiel, Germany, assignor to Electro-acoustic Gesellschaft mit beschränkter Haftung, Kiel, Germany, a corporation of Germany

Application March 18, 1939, Serial No. 262,691
In Germany March 28, 1938

7 Claims. (Cl. 177—386)

The present invention relates to magneto-strictive oscillators, and in particular to such oscillators which are excited by longitudinal oscillations produced in the core structure. Sometimes such oscillations are designated as being of the mushroom type. If such an oscillator is attached in a housing or to any base on which it is to serve, the difficulty arises that by such attachments its tuning is changed. Up to the present, attempts were made to remove these defects by cushioning the magneto-strictive oscillator in its supports, for instance by interposing sound damping material such as rubber, cork, or the like. Aside from the fact that such expedients can never entirely remove the defects above-mentioned, they involve on the other hand technical disadvantages. In particular are such cushioned attachments undesirable for submarine sound oscillators, because the oscillator, due to the effect of the great outside pressure produced by the water, can easily shift in its cushioned seat and becomes subject to disturbing mechanical influences.

These disadvantages are overcome according to the present invention by shaping the magneto-strictive oscillator so that it can be rigidly mounted in its support without thereby affecting its tuning.

According to the present invention, the two masses of a magneto-strictive oscillator which are coupled by a magneto-strictive elastic element in the usual manner are besides coupled through further elastic elements with elastically unbiased masses, i. e. dead weight masses, which together with the magneto-strictive oscillator form an oscillatory system. The proportioning of the elements of this system are such that the nodal zones which is formed during the oscillation of the system become located in said unbiased masses. In these zones which do not partake in the oscillatory motion of the magneto-strictive oscillator, the oscillating system may, according to the present invention, be safely rigidly connected with its support, such as a housing or the hull plate of a ship or the like, without impairing the tuning of the magneto-strictive oscillator proper.

In the accompanying drawing, a few modifications of an arrangement according to the invention are shown as examples. In the drawing—

Figures 1, 3, 4 and 5 represent, more or less diagrammatically, several structural forms in which auxiliary masses may be connected to the

masses of the magneto-strictive oscillator for the purpose of the present invention.

Figure 2 is of explanatory nature and shows a circuit diagram (substitute scheme) representing an electrical equivalent of the mathematical relation between the masses and the elastic elements in Figure 1, and

Figure 6 is a perspective view of the embodiment shown in Figure 1 and illustrates how the laminae of the entire oscillating system are arranged.

Referring to Figure 1, 1 and 2 are the two masses of a magneto-strictive oscillator of the mushroom type, which masses are coupled by an elastic element 4. This element consists, in well-known manner, of magneto-strictive material, surrounded by an energizing winding. According to the invention, elastic suspension elements 5 and 5' are laterally attached respectively to masses 1 and 2, and these elastic elements in turn are connected together by masses 3 and 3'. These suspension elements 5, 5' and the masses 3, 3' represent in their combination an elastic system containing dead-weight masses and by which the main masses 1 and 2 of the oscillator proper are connected in addition to their connection by the magneto-strictive member 4. Further, according to the invention, the elastic suspension elements 5 and 5', that is to say, their elasticity is dimensioned so that the masses 3, 3' become nodal points of the entire oscillatory system during its oscillation. Since these masses 3, 3' remain stationary, the oscillatory system may be connected at these masses to the support 12, 12, as shown in Figure 1, without thereby impairing the natural frequency of the oscillation of masses 1, 2. In the specific case in which the masses 1 and 2 are equal, the elasticity of auxiliary elastic elements 5 and 5' must also be equal. If masses 1 and 2 are different from each other, the elasticity of the auxiliary elastic elements 5 and 5' must be inversely proportional to the masses of the main system to which the elements are connected. This way of calculating and dimensioning the elastic elements will be understood from the electrical substitute scheme of Figure 2.

Referring to Figure 2, if we assume the masses 1 and 2 of Figure 1 to be represented by the electric inductances 1 and 2 in Figure 2, and if these inductances are arranged in a Wheatstone bridge circuit, then the elasticity 4 of Figure 1 is represented by the capacitor 4 in Figure 2, and the elastic elements 5, 5' of Figure 1 are respectively represented in Figure 2 by capacitors 5 and 5'. In order to balance the bridge in Figure 2, the rela-

tions between the constants of the bridge must be such that in the bridge inductance 3, which is the equivalent of the masses 3, 3' of Figure 1, no current flows. Correspondingly, if the mechanical masses in Figure 1 which correspond with the electrical masses of Figure 2 are properly relatively dimensioned such as the electrical masses and values are dimensioned in Figure 2 to produce a bridge balance in that figure, a stationary condition of masses 3, 3' will be produced in Figure 1; in other words, the nodal point of the system will reside in these masses. The electrical substitute scheme of Fig. 2 serves to facilitate determining the relation of the magnitudes of the masses and elasticities relatively to one another, but is not intended to be necessarily an equivalent in other respects such as the spatial arrangement or location of the energy source.

In Figure 3 a modification is shown in which the auxiliary elastic suspension elements 5 which are attached to mass 1, are connected to that mass so that they are flush with its outer surface. Such a form is of advantage in case the outer surface of mass 1 is shaped as a sound radiating surface. In an arrangement such as is shown in Figure 3, it becomes easily possible to make the radiating surface of the oscillator flush with the housing. Such a flush arrangement is, however, not limited to a plane surface of the sound radiator and the casing. As shown in Figure 4, the entire system may be shaped so that the surface of the sound radiating and the auxiliary elastic suspension elements 5, 5 which connect it with the masses 3, 3', constitute together a curved or streamline-shaped body. In this case, the auxiliary elastic suspension elements 5, 5 gradually merge into masses 3, 3'. Such a form is particularly suited for oscillators which are mounted on a support which protrudes through the bottom of a vessel and which is exposed to the flow of the water.

According to a modification shown in Figure 5, a plurality of magneto-strictive systems may be joined into a single oscillator in which the masses 1 and 2 of the first system are connected by corresponding auxiliary elastic elements 8 and 9 with the masses 6 and 7 of the second system. In this case the dimensions of the constants of the constituent elements of the systems must be made so that of each two adjacent systems one taken in its entirety, becomes located within the nodal zone of the other system (or, generally speaking, of its neighboring system), whereby the other or neighboring system assumes the place of the masses 3, 3' in Figure 1 in the calculation of the constants. Such an arrangement may be particularly suitable for a group arrangement in which the systems are placed a half wave-length $\lambda/2$ apart. The above requirements are fulfilled, for instance, if the interconnected systems are equal as regards the magnitude of masses 1 and 6, masses 2 and 7, and elasticities 4 and 10, the elasticities 5 and 8 as compared with 5' and 9 being inversely proportional to the masses 1, 6 and 2, 7. If masses 1 and 6 are of greater magnitude than masses 2 and 7, the elasticities of 5 and 8 are proportionally smaller than the elasticities of 5' and 9.

In the oscillator shown in Fig. 6, only one mass 1 or 6 of each oscillatory system forms part of the sound-transmitting surface, while the other mass 2 or 7 does not participate in the sound reception or transmission but forms substantially a counterpoise for mass 1 or 6. In this respect, this embodiment resembles the oscilla-

tors of Figs. 3 and 4. The elastic element 8 in Fig. 6 has an outer surface flush with the outer surfaces of the masses 1 and 6 so that a continuous sound-translating surface is obtained.

A particular feature of the invention also resides in the manufacture of the oscillator. In order to satisfy the requirement that the auxiliary system 5, 5', 3, 3' should be connected with masses 1 and 2 without an elastic bias, the entire oscillating system is made as a whole in the form of a package of laminae, preferably of nickel, each of the laminae containing all elements of the oscillating system.

Figure 6 shows the same oscillating system as shown in Figure 1 without the support 12, 12 respectively and shows how the laminae are arranged. Each of the laminae lying in the sight has the form as shown in Figure 1. In the case of Figure 4, each of the laminae has the form as shown in Figure 4 and is arranged in a package, of which the cross-section has a streamline-shape and of which the longitudinal-section has a rectangular shape.

I claim:

1. A magneto-strictive oscillator having a sound-translating surface, in particular for submarine signalling, comprising a main oscillatory system having two main masses and magneto-strictive elastic means interconnecting said main masses, only one of said main masses forming part of said sound-translating surface to be effective in the acoustic signalling operation while said other main mass is arranged separate from said surface to form substantially a counterpoise for said first main mass, electric circuit means having a coil magnetically coupled with said main oscillatory system to transmit oscillatory energy between said circuit means and said system, and at least one auxiliary system interconnecting said two main masses separately from said elastic means and arranged separate from said coil so as to be substantially ineffective as regards said energy transmission, said auxiliary system having two elastic members connected with said two main masses respectively and having elasticities inversely proportional to the magnitudes of said two masses, and an auxiliary unelastic mass interconnecting said elastic members and forming a nodal point and supporting element of the oscillator.

2. A magneto-strictive oscillator having a sound-translating surface, in particular for submarine signalling, comprising a main oscillatory system having two main masses and magneto-strictive elastic means interconnecting said main masses, only one of said main masses forming part of said sound-translating surface to be effective in the acoustic signalling operation while said other main mass is arranged separate from said surface to form substantially a counterpoise for said first main mass, electric circuit means having a coil magnetically coupled with said main oscillatory system to transmit oscillatory energy between said circuit means and said system, and at least one auxiliary system interconnecting said two main masses separately from said elastic means and arranged separate from said coil so as to be substantially ineffective as regards said energy transmission, said auxiliary system having two elastic members connected with said two main masses respectively and having elasticities inversely proportional to the magnitudes of said two masses, and an auxiliary unelastic mass interconnecting said elastic members and forming a nodal point and supporting ele-

ment of the oscillator, the entire oscillator being laminated, each lamina containing its upper-portion of said two main masses, said elastic means, said two elastic members and said auxiliary mass.

3. A magneto-strictive oscillator, in particular for submarine signalling, comprising a main oscillatory system having two main masses and magneto-strictive elastic means interconnecting said main masses, electric circuit means having a coil magnetically coupled with said main oscillatory system to transmit oscillatory energy between said circuit means and said system, and at least one auxiliary system interconnecting said two main masses separately from said elastic means and arranged separate from said coil so as to be substantially ineffective as regards said energy transmission, said auxiliary system having two elastic members connected with said two main masses respectively and having elasticities inversely proportional to the magnitudes of said two masses, and an auxiliary unelastic mass interconnecting said elastic members and forming a nodal point and supporting element of the oscillator, one of said two main masses together with said two elastic members of said auxiliary system forming a continuous outer surface to be effective as the sound-translating surface of the oscillator, while said other main mass is arranged separate from said surface to form substantially a counterpoise for said first main mass.

4. A magneto-strictive oscillator having a sound-translating surface, in particular for submarine signalling, comprising a main oscillatory system having two main masses of different magnitudes and magneto-strictive elastic means interconnecting said main masses, only one of said main masses forming part of said sound-translating surface to be effective in the acoustic signalling operation, said other main mass being arranged separate from said surface so as to form substantially a counterpoise for said first mass, electric circuit means having a coil magnetically coupled with said main oscillatory system to transmit oscillatory energy between said circuit means and said system, and at least one auxiliary system interconnecting said two main masses separately from said elastic means and arranged separate from said coil so as to be substantially ineffective as regards said energy transmission, said auxiliary system having two elastic members connected with said two main masses respectively and having different elasticities inversely proportional to the magnitudes of said two masses, and an auxiliary unelastic mass interconnecting said elastic members and forming a nodal point and supporting element of the oscillator.

5. A magneto-strictive oscillator, in particular

for submarine signalling, comprising a main oscillatory system having two main masses and magneto-strictive elastic means interconnecting said main masses, electric circuit means having a coil magnetically coupled with said main oscillatory system to transmit oscillatory energy between said circuit means and said system, and at least one auxiliary system interconnecting said two main masses separately from said elastic means and arranged separate from said coil so as to be substantially ineffective as regards said energy transmission, said auxiliary system having two elastic members connected with said two main masses respectively and having elasticities inversely proportional to the magnitudes of said two masses, and an auxiliary unelastic mass interconnecting said elastic members and forming a nodal point and supporting element of the oscillator, one of said two main masses together with said two elastic members and at least part of said auxiliary mass forming a continuous curved outer surface of the oscillator whose center portion formed by said latter main mass serves as substantially the sound-translating surface, while said other main mass is arranged separate from said surface to form substantially a counterpoise for said first main mass.

6. In a magneto-strictive oscillator, in particular for submarine signalling, having a plurality of oscillating systems, each system being composed of two masses and a magneto-strictively elastic element interconnecting said two masses, and auxiliary elastic elements each coupling one of said masses individually with one mass of the neighboring system so that each oscillating system in its entirety forms a nodal point for the oscillations of its neighboring system.

7. A magneto-strictive oscillator having a sound-translating surface, in particular for submarine signalling, having a plurality of oscillating systems, each system being composed of two masses and a magneto-strictively elastic element interconnecting said two masses, and auxiliary elastic elements each coupling one of said masses individually with one mass of the neighboring system so that each of said systems forms substantially a nodal point for the oscillations of its neighboring system, only one of said two masses of each system having an outer surface forming part of said sound-translating surface while the other mass of each system is arranged separate from said latter surface to form substantially a counterpoise for the first mass, each auxiliary elastic element interconnecting said first masses having an outer surface flush with said outer surfaces of said first masses so as to form a continuous sound-translating surface.

ULRICH JOHN.