

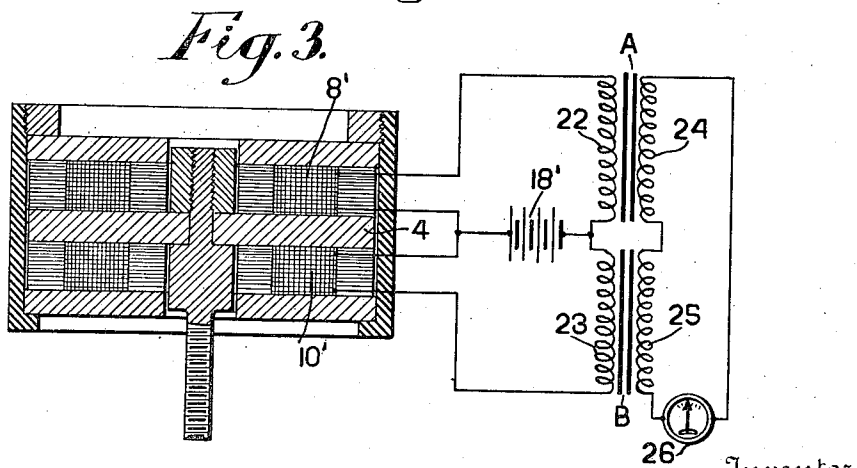
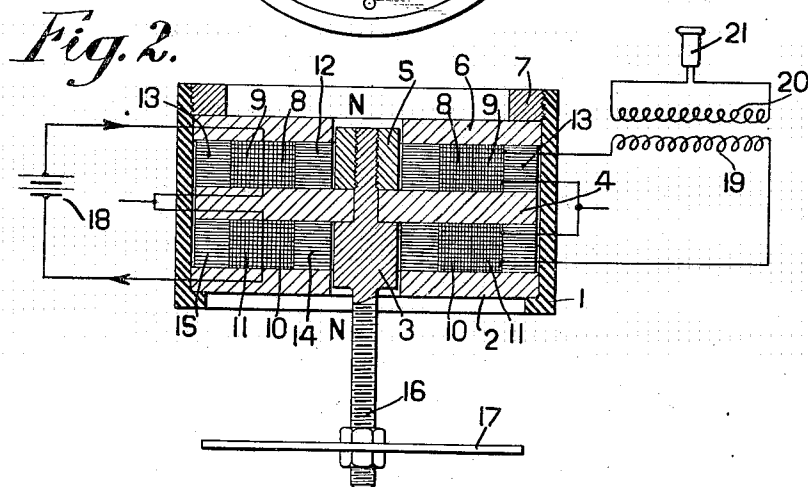
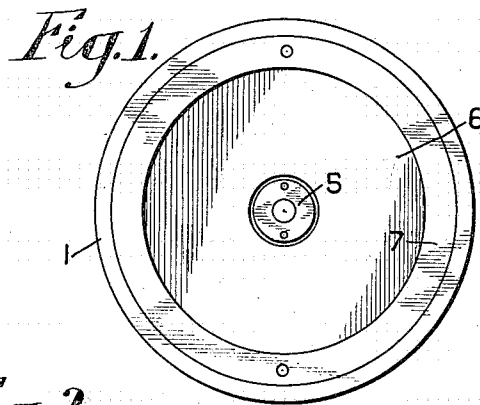
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SOUND RECEIVER

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SOUND RECEIVER

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5 Claims. (Cl. 177—386)

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A primary object of the present invention has been to devise a sound receiver which is reliable and uniform in action and one which may be readily regulated. A controlling factor in the design of the present novel form of sound receiver has been the need for the matching of a plurality of such receivers. It has long been recognized in connection with the use of hydrophones and similar devices for the reception of sounds in marine signalling and related fields that one of the greatest difficulties in the way of accurate determinations, especially in binaural reception, has been with respect to the matching of sound receivers.

In the past it has been the general practice to employ microphones to receive the sound waves due to the extreme sensitivity of these devices. Microphones, however, as is well known, are extremely difficult to match and even when matched will not remain matched for any length of time.

In recent years the practical development of vacuum-tube amplifiers which are satisfactory for use in connection with binaural reception, makes it possible to employ a receiver which is less sensitive than the microphone. The present invention has reference to a receiver of this type, which is non-microphonic and is therefore of lower sensitivity but which has a correspondingly greater uniformity of action. For this purpose the device embodying the invention is based upon the principle of the magneto-phone and a primary feature is in the development of an instrument of this type having a balanced armature.

The armature contemplated by the present invention is placed under the influence of a plurality of distinct magnetic circuits so arranged and directed that the summation of their forces on the armature when it is at rest is zero. The construction is such, furthermore, that when the armature is displaced from its neutral position, as by means of a diaphragm, only comparatively weak restoring forces will be brought into play and the natural or resonant frequency of the armature can be kept below the range of the sound spectrum that it is desired to receive. The importance of providing a natural or resonant frequency of the armature outside of the range of sounds to be received will be readily apparent. Both the intensity and phase relations of the vibrations of any type of sound receiver change very rapidly for frequencies near the resonant frequency of the receiver. For this reason it becomes highly necessary in the matching of re-

ceivers to so design them that their resonance frequencies fall either above or below the range that is to be received. The difficulty with adopting a natural frequency above the range to be received is that excessively large restoring forces will be required with the consequent reduction in sensitivity of the receiver. It will therefore be clear that the balancing of the armature by means of the opposed normal magnetic forces is an important feature of the present invention. Another advantageous feature which may be mentioned is the simplicity of construction which is such as to permit the manufacture of the major portions of the device from stampings. This not only gives rise to ease of manufacture but permits more readily the standardization of the units. Incidental and more specific objects and advantages of the invention will be apparent from the detailed description which follows and which is to be considered in connection with the accompanying drawing.

In the drawing:

Figure 1 is a plan view of the assembled sound receiver,

Figure 2 is a cross sectional view of the receiver taken along a diameter line of Figure 1, and shows in addition one form of circuit which may be employed, and

Figure 3 shows a modified construction of the device and another suitable form of circuit.

Referring particularly to Figure 2, there is shown a cylindrical casing 1 which may be made of any suitable material, preferably a non-conductor of electricity as well as magnetic lines of force, such as a phenolic condensation product. A flange formed at the bottom of this cylindrical casing serves to provide a seat for a disc 2 which has an aperture therein adapted to permit the free passage of a core 3. Formed as a unit with this core is a large disc 4, preferably made of transformer steel, and which is of such diameter as to be capable of free movement within the casing. A cylindrical nut 5, having an outside diameter equal to that of the core 3, serves to hold the three elements 3, 4, and 5, rigidly as a unit, and at the same time serves as a core equivalent to the core 3 on the opposite side of disc 4. It will be apparent that this construction is adopted primarily for the purpose of permitting ease of assembly and that any one of a number of other suitable ways might be adopted for providing a unit similar to that formed by the elements 3, 4 and 5. This unit will be referred to hereinafter as an armature.

Toward the upper end of the cylindrical casing, there is inserted a disc 6 which is similar to the lower disc 2, and has an aperture adapted to permit the free passage of the element 5. An annular ring 7 has a screw-threaded connection with internal threads at the upper end of the casing, and is for the purpose of holding the parts together as well as adjusting the normal relation thereof. Between the disc 6 and the armature disc 4, and surrounding the element 5, is an annular coil 8 of wire of any suitable material preferably a good electrical conductor. A second annular coil 9 is mounted on the outside of coil 8 and serves as a secondary winding. A similar arrangement of annular coils 10 and 11 is provided between the disc 2 and the armature disc 4. Between the element 5 and the inside of coil 8, there is provided a series of thin annular members 12, consisting preferably of laminations of transformer steel. On the outside of coil 9, between its periphery and the inside of casing 1, there is arranged a similar series of annular members or laminations 13. A similar construction comprising the two series of annular members or laminations 14 and 15, is provided between the discs 4 and 2. It will be apparent that the several series of laminations 12, 13, 14 and 15, serve to provide circuits for a magnetic flux which will surround and pass through the several coils. A stem 16 projecting from the core 3, may be connected in any suitable way to a diaphragm 17 that is adapted to receive impulses from sound or similar waves to be detected by the novel means disclosed.

In the operation of the device, a battery 18, or other suitable D. C. source of electricity, is connected in series or parallel with the two inner coils 8 and 10. The turns of these coils are preferably wound in such sense, one clockwise and the other counter-clockwise, about the core elements as to set up opposed magnetic fields. Thus the current may be made to flow in the two coils in such a direction that a north pole will be established toward each of the two outer ends of the device. This particular arrangement of the coils is not essential however since the important feature is that the two magnetic fields thus established shall exert opposite pulls upon the armature disc 4 so that the latter will normally assume a condition of balance between these opposing forces. We may assume that the lines of the upper magnetic field travel through the circuit established by the disc 6, laminations 12, armature 4, and laminations 13, while the lines of the lower magnetic field may be assumed to travel through the circuit comprising disc 2, laminations 14, armature 4, and laminations 15.

Now it will be apparent that if a sound wave strikes the diaphragm 17 to force the core 3 and armature 4 upwardly, as shown in Figure 2, the laminations 12 and 13 will be compressed so that the air gaps between these members will be reduced, and consequently the flux threading the upper magnetic circuit will be increased. On the other hand, the laminations 14 and 15 will be extended due to their resiliency so that the air gaps between these members will be increased, causing a corresponding increase in the reluctance of the lower magnetic circuit and a decrease in the flux threading this circuit. One result which is to be noted in connection with this displacement of the armature, is that the attraction created by the upper magnetic field for the armature will be increased, while the

attraction of the lower magnetic field for the armature will be decreased, so that there will be a tendency to further upset the balance which previously existed. However, all of the laminations 12, 13, 14 and 15 are, as stated, preferably made of steel so that they have considerable resiliency. It will be apparent, therefore, that the force differential created by the unbalancing of the magnetic field will be opposed by an elastic force of the laminations which have been compressed. This elastic force will preferably approximate as nearly as possible but be slightly greater than the unbalancing magnetic forces so that there will always be a tendency to centralize the armature. In this way, the centralizing or restoring forces will be relatively small so that they will interfere only slightly with the movements imparted by the diaphragm. The obvious advantage of this construction is increased sensitivity.

Considering now the electrical effects which will be produced by the assumed movement of the armature it will be apparent that the variations in the magnetic flux passing through the coils 9 and 11 will tend to induce current in these coils. Thus the increase in flux through the coil 9 will tend to induce therein an E. M. F. which will oppose the increase. On the other hand the decrease in flux through the coil 11 will induce an E. M. F. therein which will tend to oppose the decrease. Now by suitably connecting the terminal wires of the coils 9 and 11 they may be coupled in series in such a way as to add the two E. M. F.'s induced. The necessity for the employment of the secondary coils 9 and 11 instead of relying solely on the primary coils in connection with the series arrangement shown in Figure 2 will be apparent when it is considered that the induced effects in coils 8 and 10 due to the movement of the armature will be in opposite directions and if equal will produce no net results whatever. The E. M. F. induced in coil 8 in opposition to the current from the battery 18 will be offset by the E. M. F. induced in coil 10 in a direction to aid this current.

One way of insuring the proper connection between the coils 9 and 11 for adding their effects may be as follows: The coil 9 may have its windings in opposite sense to the windings of the coil 8 so that the current induced in coil 9 will be in the opposite direction from the change of E. M. F. in coil 8, and under the conditions assumed will therefore be in the direction of the current from the battery 18. Now, if coil 11 is wound in the same sense as coil 10 the current induced therein will be in the same direction as the change of E. M. F. in coil 10 which, under the conditions assumed, will also be in the direction of the current from battery 18. The reverse movement of the diaphragm and armature will of course produce directly opposite effects in the two coils so that an alternating current will be induced so long as the diaphragm is vibrated.

These combined induced currents in coils 9 and 11 may be led through a primary coil 19 of a transformer whose secondary coil 20 is in circuit with any suitable means for providing a visible or audible indication, such as a galvanometer or a telephone receiver 21. It will be obvious that any suitable amplifier may be placed in the circuit of the secondary winding of the transformer in the event that the currents directly induced are too small to produce the desired effects. The transformer 19, 20 may be omitted if the currents

induced in coils 9 and 11 are sufficient to operate the desired indicating means which may then be placed directly in series with these coils.

In Figure 3 there is shown a slightly modified construction of the foregoing type of magnetophone and in this modification secondary coils 9 and 11 are eliminated. In other particulars the construction of the magnetophone is or may be precisely the same as shown in Figure 2. The coils 8' and 10' which correspond respectively to coils 8 and 10 of the first described construction are connected in parallel with a D. C. source of electricity and are wound in such sense as to establish opposite magnetic fields acting upon the armature 4. One branch of the current from the D. C. source, such as a battery 18', passes through the coil 8' and then through a primary coil 22 of a transformer A. Another branch of the current will flow through the coil 10' and then through a primary coil 23 of another transformer B. Movements of the armature 4 will, as in the first case discussed, produce variations in flux through the two magnetic circuits threading the coils 8' and 10'. As the flux through coil 8' is increased there will be a change in the current through the primary coil 22 by virtue of an induced E. M. F. in this branch of the circuit opposing that of the source 18'. On the other hand a corresponding decrease in the flux through coil 10' will cause an increase in the current flowing through the coil 23. These changes in the current passing through coils 22 and 23 will induce corresponding currents in the secondary windings 24 and 25, respectively, of the transformers A and B and if these secondary coils are properly connected in series the two induced currents may be added. Any suitable means, such as a galvanometer 26 or a telephone receiver may be employed for giving a visual or audible indication of the current thus induced. While the coils 22, 24 and 23, 25 have been referred to as constituting two separate transformers it will be apparent that they may in reality be separate sections of the same transformer.

While two admirable forms of embodiment of the invention have been described in the foregoing sections, it will be understood that numerous changes may readily be made in either form within the scope of the claims which will be hereinafter made. Other materials than those suggested may be employed for the various parts of the device. It will be recognized that an important feature of the invention is in the ability to control the natural frequency or resonance of the armature by regulating the compression of the laminations 12, 13, 14 and 15 through the mere adjustment of the clamping ring 7. By the means disclosed it is possible to materially vary the restoring force and correspondingly change the natural frequency to hold it below any range to be detected by the diaphragm 17. The device may be employed in a variety of ways and for a variety of purposes, being particularly suited to use where uniformity and precision in action are required.

The invention herein described may be manufactured and used by or for the Government of the United States for governmental purposes without the payment to me of any royalty thereon or therefor.

What I claim is:

1. In a device for translating mechanical vibrations into electrical energy, a plurality of coils adapted to establish separate magnetic fields, a plurality of loosely mounted laminations forming

a portion of the magnetic circuit for each of said fields, means responsive to said mechanical vibrations for compressing part of said laminations so as to decrease the reluctance of said portion of one of said magnetic circuits while the remainder of said laminations tend to expand due to their resilience so as to increase the reluctance of said portion of another of said magnetic circuits, and means coupled with said magnetic circuits for detecting variations in the reluctance of said circuits produced by the movements of said armature.

2. In a vibration detector a series of coils, a D. C. source of electricity in circuit therewith, magnetic circuits of variable reluctance in the fields of said coils including a plurality of loosely mounted laminations, means cooperating with said laminations for compressing certain of said laminations while those laminations not compressed tend to expand due to their resilience so as to vary the reluctances of said magnetic circuits, and a second series of coils electrically connected in series and arranged between said first mentioned series of coils and said laminations, said second series of coils adapted to have currents induced therein in accordance with the combined variations in the reluctances of said magnetic circuits.

3. A device for translating mechanical vibrations into electrical energy comprising a disc-like armature responsive to said mechanical vibrations, a pair of flat annular coils disposed adjacent said armature and on opposite sides thereof, the axis of said coils being substantially coincident with the axis of said armature, means for passing current through said coils in opposite senses relative to each other to produce opposed magnetic fields and normally balance said armature, and means for increasing the flux in one of the magnetic fields and simultaneously decreasing the flux in another of the magnetic fields, said means comprising a plurality of loosely mounted laminations arranged on opposite sides of said armature, said laminations being adapted to be compressed together first those laminations on one side and then those on the other side of said armature by the vibrations of said armature, while those laminations not compressed tend to separate due to their resilience.

4. In a device for translating mechanical energy, a plurality of coils adapted to establish separate magnetic fields, an armature mounted between said coils, a plurality of loosely mounted laminations forming a portion of the magnetic circuit for each of said fields, said laminations being arranged in two groups on opposite sides of said armature, said armature being movable in response to said mechanical vibrations for compressing said groups of laminations alternately, while those not compressed tend to expand due to their resilience, so as to vary the reluctance of said portions of the magnetic circuits, and means coupled with said magnetic circuits for detecting variations in the flux produced by the movements of said armature.

5. In a vibration detector a plurality of flat, annular primary coils, a constant D. C. source of electricity in circuit with said coils adapted to produce magnetic flux in an annular path through said coils, a plurality of flat, annular secondary coils mounted concentrically with said primary coils in the magnetic fields of said primary coils, each of said secondary coils being arranged in the same plane as one of said primary coils so as to encircle said primary coil,

magnetic circuits of variable reluctance in the field of said coils including a plurality of loosely mounted laminations arranged in the planes of said coils, and a disc-like armature responsive to mechanical vibrations and mounted between the planes of said coils with its axis substantially coinciding with the axis of said coils, the vibrations

of said armature compressing the laminations on one side while simultaneously allowing the laminations on the other side to expand due to their resilience so as to decrease and increase, respectively, the reluctance of the magnetic circuits on opposite sides of said armature. 5

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