Aug. 28, 1951 G. D. CHICHESTER 2,565,591

ELECTRICAL EARPHONE DEVICE

Filed Oct. 5, 1946

Fig. 2.

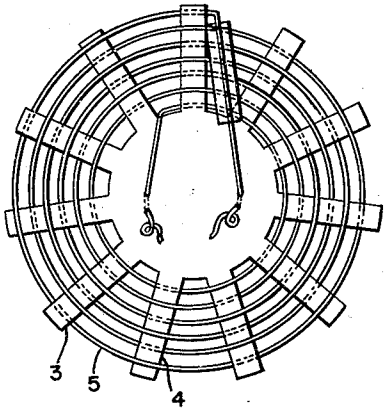


Fig. 3.

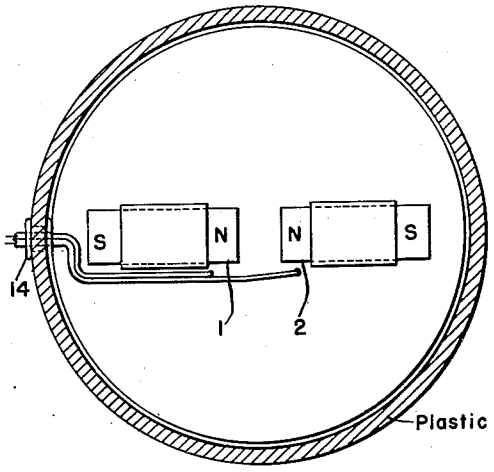


Fig. 1.

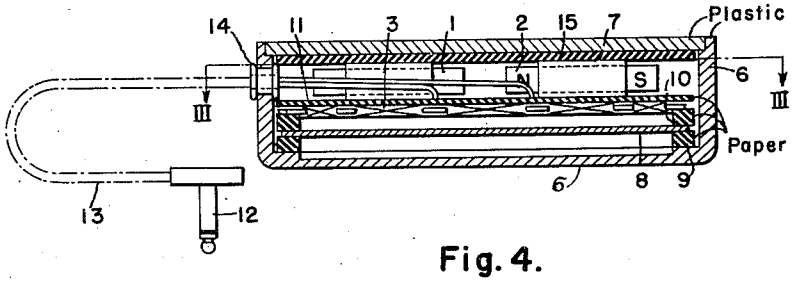


Fig. 4.

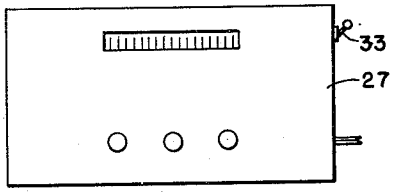
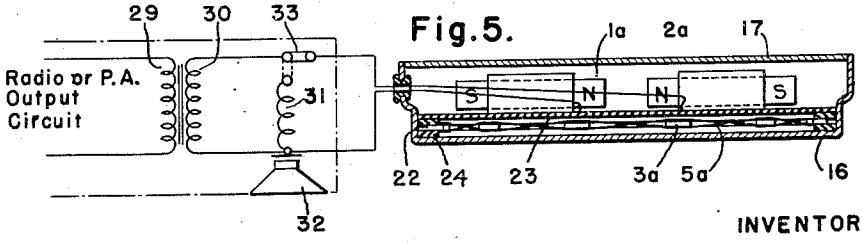


Fig. 5.



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ELECTRICAL EARPHONE DEVICE

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8 Claims. (Cl. 179—115)

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This invention relates to an accoustical device which is particularly useful as an electrical receiver or earphone, although the device is also useful in transmitting apparatus and the like.

In the past, electrical receivers have almost invariably included a disk-shaped diaphragm which would become distorted in response to magnetic field fluctuations caused by voice modulated currents and the like passing through an electromagnet coil. Such types of receivers have the outstanding objection of being somewhat cumbersome in construction, expensive to manufacture, and relatively heavy—furthermore, such types of receivers lack fidelity in reproduction due to the varying degrees of flexibility of the diaphragm at different portions thereof, and the restraining effect caused by clamping of the peripheral edge, also due to the damping effect caused by accidental touching of the vibrating diaphragm.

An object of this invention, therefore, is to provide an electrical receiving apparatus that is devoid of the above-named disadvantages of common types of receiving apparatus—more specifically, to provide a receiver that is relatively simple in construction, inexpensive to manufacture and which possesses a high degree of fidelity.

Another object of this invention is to provide an electrical receiving apparatus which includes a pair of permanent magnets arranged so that like poles are in confronting relationship.

A further object of this invention is to provide an electrical receiver which is devoid of a diaphragm of the usual type and which may employ either a metallic housing or a diaphragm-like metallic disk, the operation of which, however, is somewhat different from that of the operation of the well-known diaphragm.

A further object of this invention is to provide a hermetically sealed housing enclosing a novel permanent magnet type of receiver which may be substituted for the voice coil of a conventional type loud-speaker of a radio whenever reception at lower volume is desired.

A still further object of this invention is to provide a novel type electrical receiver which is of such construction as to emit practically no sound when used alone, but whose volume is increased by placement closely thereto, in contacting relationship, a pillow or similar device, thus providing a means for individual radio reception to allow, for example, a hospital patient to listen to broadcasts from the receiver located under his pillow without disturbance to nearby patients.

Other objects and advantages of this invention will become apparent from a study of the

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following specification taken with the accompanying drawings wherein:

Fig. 1 is a schematic electrical wiring diagram showing an electrical receiver in cross-section which embodies the principles of this invention;

Fig. 2 is a plan view of the spider included in the receiver shown in Fig. 1;

Fig. 3 is a cross-sectional view taken along line III—III of Fig. 1;

Fig. 4 is a front view of a radio receiver showing a switch for selectively connecting either the speaker or receiver in the circuit, and

Fig. 5 is a wiring diagram including a cross-sectional view of a modified form of receiver which may be substituted for the one shown in Fig. 1.

Referring more particularly to Figs. 1, 2 and 3, numerals 1 and 2 denote a pair of permanent magnets of any suitable material of high magnetic permeability, such as an alloy of aluminum, nickel and cobalt, which magnets may be in bar form, as shown, or of any other suitable shape. The magnets may be wrapped with tape to serve as insulating spacing material and are arranged so that like poles will be in confronting relationship. As shown in the drawing, the two north poles are closely spaced and face each other so as to provide a magnetic field therebetween.

A spider 3 made of any suitable material, such as paper, or other insulating material, is formed so as to have an odd number of radially extending tines or arms, such as 4, which tines serve as supports for a coil 5 which is wound somewhat in pancake form on the spider and which is woven in wave-like or basket-weave form alongside the tines. An odd number of tines, such as 11, is preferably provided for the purpose of having successive turns of coil 5 arranged so as to be located on opposite sides of any individual tine. It should be understood, however, that the coil may take other shapes, such as a spiral shape, preferably in a flat plane. Successive turns of coil 5 are shown spaced for illustration but in reality are fine wires in contacting relationship.

The housing comprises a cup-shaped portion 6 and a cover portion 7 sealed thereto so as to provide a hermetically sealed enclosure. A metallic disk-shaped diaphragm 8 is supported on a spacer ring 9 which in turn rests on an annular raised portion of the housing portion 6. If the spacer ring 9 is made of rubber, deeper tones are obtained than if it were made of hard material, such as plastic or metal, in which cases higher tones are obtained. Thus by proper selection of the spacer material, the desired pitch may be obtained. If desired, spacer 9 may be omitted altogether. Diaphragm 8 has supported

thereon an annular gasket 10 serving as a spacer element between the diaphragm and spider 3. An insulating sheet or spacer 11 is rested on spider 3. The poles 1 and 2 may rest on spacer 11. An insulating spacer or sheet 15 may be interposed between the magnets and cover 7. Such spacer may be omitted, however, if desired. A plug 12 may be used which is adapted to cooperate with a jack (not shown) in a radio receiver set. Plug 12 is connected by lead-in wires 13 to coil 5, which wires are introduced into the receiver device through a grummet 14. Thus there is provided a compact assembly wherein the parts are in close, substantially contacting relationship so as to be able to transmit motions therebetween and allow the entire assembly to vibrate or operate in unison. In operation, it appears that the diaphragm vibrates without apppreciable flexing together with the remainder of the assembly.

Figs. 4 and 5 show a modification wherein a metallic housing, instead of a plastic or insulating housing, is used, comprising a body portion 16 and a flat diaphragm-like end or cover portion 17 for enclosing the coil and magnets. The housing parts are preferably hermetically sealed together by soldering or the like in order to provide best results in reception. Hermetic sealing excludes moisture and deleterious gases from the atmosphere which may attack the insulation or magnetic parts.

A small air gap or clearance is provided between cover portion 17 and the magnets, that is, the tape or wrapping about the magnets. An annular paper gasket 22 and a sheet of insulating material 23 are interposed between the poles and spider-coil assembly. If desired, sheet 23 may be eliminated and reliance may be made on the insulating wrapping about the magnet poles. An annular insulating spacer 24 is interposed between the spider-coil assembly 3*a*—5*a* and body portion 16 of the housing. Spacer 24 may be eliminated by providing a shoulder at the periphery of portion 16 similar to the shoulder on portion 6 shown in Fig. 1. All the spacers or gaskets are preferably very thin so as to provide very close spacing between the respective elements and provide electrical insulation therebetween and for the purpose of making the entire assembly very compact in construction. If desired, the entire outside surface of the metallic housing 16—17 may be enameled, painted or otherwise coated with insulating or metallic material. The spider and the magnets may be secured together, with their intervening spacing material, as a single unit.

The theory of operation of the above-described receiver is not too well-known, however, experiments appear to indicate that the housing portion 17 does not distort or flex by different amounts at different areas of the surface under electromagnetic variations in the manner of the well-known type of metallic diaphragm, but instead it seems as if the entire housing vibrates in unison together with the enclosed parts in response to electrical current variations flowing through coil 5*a*. This conclusion is arrived at principally because no material difference appears to result from the touching of housing portion 17 with one's hands, which touching would have a serious damping effect on an ordinary type of diaphragm.

Of course, the magnetic lines of force which emanate from the like north poles of permanent magnets 1*a* and 2*a* will buck each other, consequently will diverge outwardly from the mid-point between the confronting poles and will find a return path to the opposite poles thereof through portions of the housing. The magnetic field developed by the current flow through the coil windings is toroidal in form and encircles the coil 5*a*. The interaction of the two fields provides an electromagnetic effect which apparently causes vibration of the entire assembly, which results in the emanation of sound corresponding to that of the signal current passing through coil 5*a*. The housing should be made of relatively thin metal, preferably not thicker than thirty-five thousandths inch. By making the housing of thinner material, less of the base notes of radio reception are heard. Coil 5*a* should be very tightly wound about the spider and preferably lacquered to effect stiffening of the coil to provide a spider-coil assembly having no individually movable parts so as to prevent harmonics. Such coating also makes the unit waterproof and moisture-proof.

The electrical receiver described is admirably adapted as a component part of a radio set for the purpose of allowing an individual to selectively obtain reception either from the loudspeaker of the radio set or from the receiver at will. It is also very useful in public address systems.

A convenient circuit is provided, in the case of use with a radio receiver, by having primary winding 29 of an output transformer, which is connected to the output of radio 27, for example, and which is of high electrical impedance (of the order of 550 ohms) cooperate with a secondary winding 30 of relatively low impedance (of the order of 4 ohms), which secondary winding is normally connected to the voice coil 31 of a loud-speaker 32 of the radio set. A switch 33 may be provided for the purpose of selectively connecting the secondary winding 30 either to voice coil 31 for normal radio reception, or to coil 5*a* of the above-described receiver for relatively silent reception so as to enable the operator to listen to the receiver without disturbing persons nearby, such as under a pillow.

The average voltage applied across the coil may be only of the order of 1.5 volts. Thus it will be seen that the receiver device consumes an insignificant amount of power.

If desired, the housing of either Fig. 1 or Fig. 5 may be partially evacuated and filled with an inert gas, such as a noble gas; furthermore, instead of providing a switch 33, as shown in Fig. 5, a jack may be provided which may be mounted on the side or panel of a radio set so that when a plug, such as 12 in Fig. 1, is inserted in the jack, the circuit to the voice coil of the speaker is broken, whereas the circuit to the coil of the receiver unit is made. Likewise, other variations will be readily suggested to those skilled in the art to make the above-described receiver useful for the purpose intended. It should be noted that not only pillows serve as media for enhancing the sound emitted from the above-described novel receiver, but other objects, such as flat panels, doors, desks or the like, also have somewhat of an enhancing effect when the receiver is placed in contacting relationship therewith. It will be apparent to those skilled in the art that the above-described receiver can be used in aiding partly deaf people and may be worn on one's clothing, such as on a lapel of a coat, or may be adapted so as to be worn on the ear or in the ear, as is well-known in the art. The above-

described speaker can be made smaller and is particularly adapted to be reduced in size rather easily because of its extreme lightness and simplicity of construction. An enhancing effect on the volume is obtainable by contacting the receiver with a part of the body, such as the ear.

Thus it will be seen that the above-described permanent magnet receiver provides a highly efficient, inexpensive type of receiver (or transmitter) which is particularly useful as a relatively silent means to provide individual radio reception without disturbing nearby persons by virtue of the fact that the receiver is of such construction that its emanating tones or signals are confined and enhanced or made louder by placement of a pillow or similar object in contacting relationship therewith; furthermore, I have provided a receiver whose outstanding qualities are apparently attributed to the fact that it does not involve the well-known distortion effect of common types of receiver diaphragms, but instead appears to embody the idea of an entire assembly vibrating in unison for emitting sound.

While I have illustrated and described certain specific embodiments of my invention, it will be understood that this is by way of illustration only and that various changes and modifications may be made within the contemplation of my invention and within the scope of the following claims.

I claim:

1. Electrical receiving apparatus comprising a pair of opposed permanent magnet poles of the same polarity, a metallic diaphragm disposed in spaced parallel relationship alongside said poles, and a coil wound in pancake form in a plane parallel to and interposed between that of the poles and diaphragm, said coil being wound on a spider having an odd number of radially extending tines onto which the coil is wound in wave-like form, successive windings being wound on opposite sides of any given tine.

2. Electrical receiving apparatus comprising a pair of permanent magnets having opposed poles of the same polarity, a coil disposed alongside said poles and wound in a plane parallel to that of the poles, and a metallic housing totally enclosing said poles and coil, said housing being of thin sheet metal, said coil being wound on a spider having an odd number of radially extending tines onto which the coil is wound in wave-like form, successive windings being wound on opposite sides of any given tine.

3. An electrical receiving device comprising a pair of flat permanent magnets disposed so that like poles thereof are in confronting relationship, a coil disposed along side said poles in a plane substantially parallel thereto, a thin metallic hermetically sealed housing totally enclosing said poles and coil, and a plurality of thin spacer elements for separating said coil and poles from each other and from the housing.

4. An electrical receiving device comprising a pair of flat permanent magnets disposed so that like poles thereof are in confronting relationship, a coil disposed alongside said poles in a plane substantially parallel thereto, a thin metallic hermetically sealed housing totally enclosing said poles and coil, and having at one side a diaphragm portion disposed alongside and in closely spaced relationship to said poles and having at the other side a portion of reduced diameter as compared to said diaphragm portion for enclosing said coil.

5. An electrical receiving device comprising a pair of flat permanent magnets disposed so that like poles thereof are in confronting relationship, a coil disposed alongside said poles in a plane substantially parallel thereto, a thin metallic hermetically sealed housing enclosing said poles and coil, and having at one side a diaphragm portion disposed alongside and in closely spaced relationship to said poles and having at the other side a portion of reduced diameter as compared to said diaphragm portion for enclosing said coil, said coil being wound on a spider having an odd number of radially extending tines onto which the coil is wound in wave-like form, successive windings being wound on opposite sides of any given tine.

6. An electro-acoustical device comprising a spider having a plurality of radially extending arms, a coil spirally wound on said arms in the form of a single layer in a single plane, and a pair of permanent bar magnets insulatingly supported on said spider-coil assembly and having closely spaced confronting like poles for emanating magnetic flux in opposite directions and being in a plane parallel to that of the coil.

7. In a device of the character described, a pair of bar magnets arranged with their magnetic axes in alignment and with adjacent pole faces of like magnetic polarity, a thin flat supporting member on which said magnets are mounted, a coil of a pancake type mounted adjacent said supporting member and having windings in a common plane substantially parallel to the plane of said supporting member, and a housing member formed of thin sheet metal forming an enclosure for said magnets, supporting member, and coil.

8. In a device of the character described, a pair of bar magnets arranged with their magnetic axes in alignment and with adjacent pole faces of like magnetic polarity, a thin flat supporting member on which said magnets are mounted, a coil of the pancake type mounted adjacent said supporting member and having windings in a common plane substantially parallel to the plane of said supporting member, and a housing member formed of thin sheet metal forming an enclosure for said magnets, supporting member, and coil, said housing member providing a diaphragm responsive to current changes in said coil.

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