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M. S. HAWLEY

2,202,906

TELEPHONE RECEIVER

Filed Jan. 11, 1938

FIG. 1

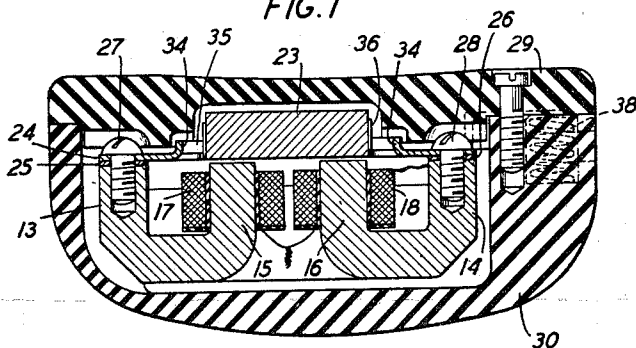


FIG. 2

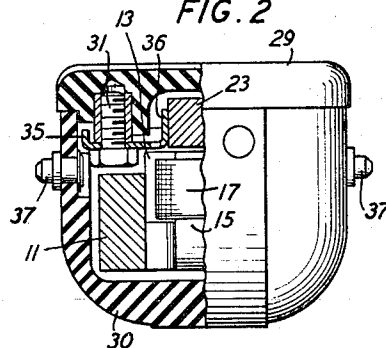


FIG. 3

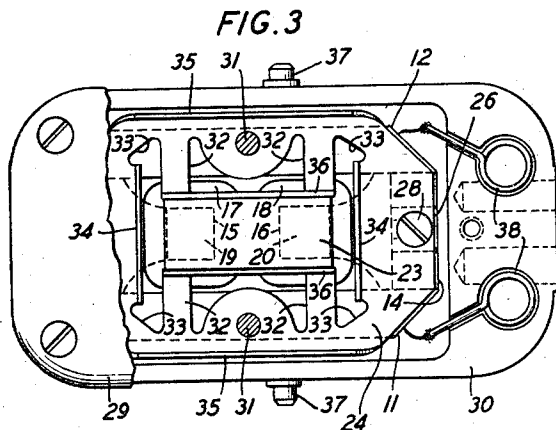


FIG. 5

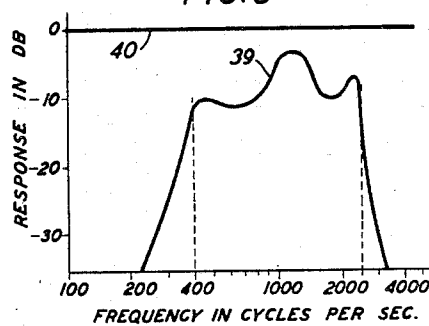


FIG. 4

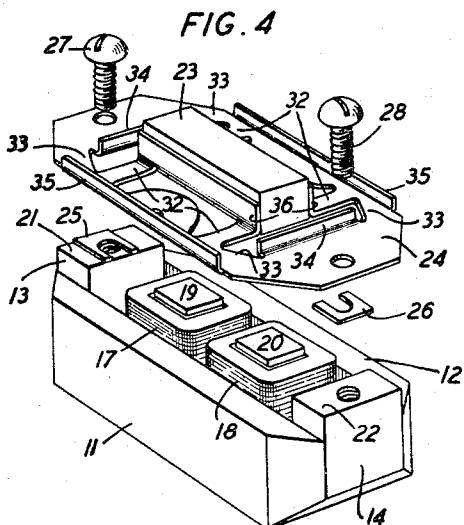
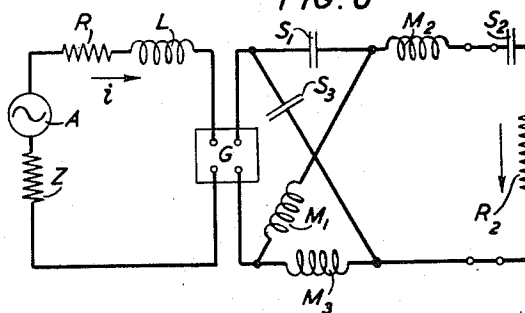


FIG. 6



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TELEPHONE RECEIVER

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Application January 11, 1938, Serial No. 184,390

4 Claims. (Cl. 179-107)

This invention relates to acoustic devices and particularly to vibration translating devices of the inertia type which are adapted to be worn in direct contact with the body of the user to serve, for example, as a telephone receiver for audiphones or as a sound pick-up transmitter.

The object of the invention is to improve the efficiency and response characteristic of devices of this type.

According to the invention the vibratory element which contacts the body of the user comprises a casing containing the necessary magnet system and signal coils and an armature adapted to move relatively to the pole-pieces of the magnet system. The masses of the magnet system and armature are connected to the vibratory cover of the casing through separate elements of such stiffness that the devices constitute for mechanical vibrations a transmission line having substantially a band-pass filter characteristic over the frequency range of interest.

In the preferred structure a pair of U-shaped pole-pieces are centrally disposed between bar magnets on opposite sides of an elongated casing. One leg of each pole-piece is secured to the end portions of the magnets and the other, adjacent legs are shaped to receive the signal coils and form pole faces opposed to the armature. The armature and magnet system are mounted in the casing in their proper relative positions by means of a single planar metallic spider member which is secured at opposite sides to the vibratory casing cover and has arms of appropriate stiffness connecting the armature and the magnet system to these points of support. The cover of a suitable phenol plastic composition is rigidly connected to the casing and its outer surface is contoured to fit the portion of the body of the user in connection with which the device is to be used such, for example, as the mastoid eminence when the device is used as a bone conduction receiver.

In the drawing:

Figs. 1 and 2 are sectional views illustrating the invention as applied to a bone conduction receiver;

Fig. 3 is a plan view of the device of Figs. 1 and 2 with the cover broken away to show particularly the mounting member for the magnet system;

Fig. 4 is an exploded view of the magnet and armature systems;

Fig. 5 is a characteristic curve illustrating the improved response at high frequencies obtained according to this invention; and

Fig. 6 is a diagram of the mechanical constants of the device shown as the analogs of a corresponding electrical system.

Referring now to the drawing, the magnet system shown in Fig. 4 comprises two permanent bar magnets 11 and 12 welded to the opposite sides of the 45 per cent permalloy pole-pieces 13 and 14. The pole-pieces are U-shaped with their adjacent arms 15 and 16 reduced in cross-section to receive the signal coils 17 and 18 and defining pole faces 19 and 20 in the plane of the clamping surfaces 21 and 22 of the other arms of the pole-pieces.

The armature 23 is preferably of 45 per cent permalloy and is supported by the spider member 24 in operative relation to the pole faces 19 and 20. The proper normal air-gap of about .003 inch is obtained by mounting the spider on washers 25 and 26 under the clamping screws 27 and 28 to permit the insertion of a suitable spacer between the armature and pole faces while the armature is being soldered to the flanges 36 of the spider. This magnet and armature assembly is secured to the cover 29 of the casing 30 by screws 31, 31 disposed on opposite sides of the armature as shown in Figs. 2 and 3.

The spider member 24 is preferably stamped from sheet beryllium copper about .017 inch and formed to have four arms 32 of suitable stiffness connecting the armature to the points of support at the screws 31, four other arms 33 of suitable stiffness connecting the magnet assembly to the same points of support and flanges 34, 34 and 35, 35 for reinforcing the member between the stiffness arms. With this type of supporting structure, both the magnet assembly and the armature are free to vibrate within the casing and the resulting reactive force on the cover is the force available for conducting the desired vibrations to the body of the user.

Since the magnet and armature assemblies are connected to the cover through separate stiffness members, it will be apparent to those skilled in the art that when the structure described is used as a receiver it is essentially a mechanical band-pass filter of the type shown in Fig. 6 in which

A is the amplifier supplying electrical power to the receiver,

Z is the internal impedance of the amplifier,

R and L are the resistance and inductance of the coils 17 and 18 of the electrical circuit of the receiver,

G is the force factor of the gyrostat mutual

(i. e. the force on the armature of the receiver per unit of current in the receiver coils),

S_1 is the stiffness of the four arms 33 of the spider 24,

S_2 and R_2 are the stiffness and resistance of the terminal impedance (the impedance of the user's head when the device is used as a bone conduction receiver). The effective mass of this impedance is usually small as compared with the mass of the casing and may therefore be neglected.

S_3 is the stiffness of the four arms 32 of the spider 24 and

M_1 , M_2 and M_3 are the masses of the magnet assembly, the casing 30 (including the cover 29) and the armature 23, respectively.

A mechanical circuit of this type gives a response characteristic of the general figuration of the curve shown in Fig. 5. In this figure the curve 39 is plotted in terms of the loss in decibels at various frequencies as compared with the response characteristic 40 which would be obtained if all the power available to the receiver were delivered to the head of the user. Inspection of this curve shows that the device operates at high and reasonably uniform efficiency over a range of about 400 to 2,500 cycles per second. It also has a very sharp high frequency cut-off and therefore attenuates the prominent, high frequency sum components of the modulation products developed in the carbon element of the mechanical type amplifiers used to drive these devices. The response characteristic shown was obtained with a device having approximately the following mechanical constants working into a terminal head impedance in which $S_2=S_3$ and $R_2=10,000$ mechanical ohms

$S_1=140 \times 10^6$ dynes per cm.

$S_3=250 \times 10^6$ dynes per cm.

$M_1=15$ grams

$M_2=8.8$ grams

$M_3=1.5$ grams

While the circuit of Fig. 6 has been said to be essentially a mechanical band-pass filter, obviously in a more conventional circuit of this type the stiffness S_3 would be connected to a point between S_1 and M_2 instead of to the input side of S_1 . As applied to the mechanical structure this would require that the four arms 33 comprising the stiffness S_1 form a connection directly from the magnet system to the armature instead of to the cover 29.

Such a structure will have a response characteristic similar to that of the structure shown except that the efficiency will be somewhat lower when the device is used as a bone conduction receiver due to the impedance of the filter being high as compared with the terminal impedance of the bone structure of the head. Since this latter impedance cannot be controlled and the mechanical constants cannot be materially reduced without loss of efficiency, these impedances can be matched only by reducing the impedance of the filter and this result is readily obtained by means of the circuit of Fig. 6 already described. It will be understood, however, that in cases where the terminal impedance is such as to permit of an impedance match, equally high efficiency may be obtained with the more conventional band-pass filter structure.

It will be apparent from the foregoing description that when telephone currents are applied to the coils 17 and 18 by means of a plug connec-

tion to the terminal springs 36 a corresponding alternating flux is superimposed on the steady flux in the magnetic circuit to vary the force of attraction between the armature and pole-pieces in the usual manner. Since both the armature and magnet system are resiliently coupled to the casing their vibrations produce, on the cover 29 of the casing, a vibratory force which may be transmitted to the mastoid eminence of the user by mounting the device in position by means of a head-band engaging the studs 37.

When the structure is used as a sound pick-up device of the throat transmitter type, for example, it will in general be found desirable to modify somewhat the constants given for the receiver in the direction of reducing the mechanical impedance of the vibratory system.

While the invention has been described for purposes of illustration with respect to a particular receiver structure, it will be understood that it is intended to be limited only by the scope of the following claims.

What is claimed is:

1. In a vibration translating device of the inertia type, a vibratory casing, a magnet system in the casing including pole-pieces and coils thereon for carrying signal currents, an armature in operative relation to the pole-pieces, and separate resilient elements forming the sole support for and connecting the magnet system and armature independently to the casing, the masses of magnet system, armature and casing and the stiffness elements being so proportioned that the response characteristic of the device approximates that of a band-pass filter.

2. A bone conduction telephone receiver comprising a casing adapted to be held in contact with the bone structure of the human head, an electromagnet and an armature in operative relation thereto for vibrating the casing and resilient supporting members forming separate resilient connections between the electromagnet and the casing and between the armature and the casing, said members being of appropriate stiffnesses with relation to the masses of the casing, electromagnet and armature to give the receiver the response characteristic of a mechanical band-pass filter having an output mechanical impedance which substantially matches the terminal impedance of the human head.

3. In a vibration translating device of the inertia type, an elongated vibratory casing, bar magnets in the casing, U-shaped pole-pieces between the magnets, signal coils on the pole-pieces, an armature in close spaced relation to the pole-pieces, and a metal spider member attached at points on opposite sides to the casing and having arms connecting the magnet system and the armature independently to said points of attachment, the arms being of such stiffness as to give the device a response characteristic which approximates that of a band-pass filter.

4. In a vibration translating device of the inertia type, a vibratory casing, a magnet system in the casing including pole-pieces and coils thereon for carrying signal currents, an armature in operative relation to the pole-pieces, and a metal spider having substantially rigid side members secured to the casing, substantially rigid end members connected to the magnet system, resilient arms interconnecting the members and separate resilient arms extending from the side members and supporting the armature.

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