

Jan. 11, 1938.

H. A. PEARSON ET AL

2,105,296

HEARING AID

Filed Oct. 4, 1934

2 Sheets-Sheet 1

Fig. 1.

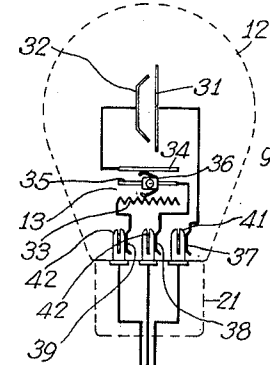


Fig. 2.

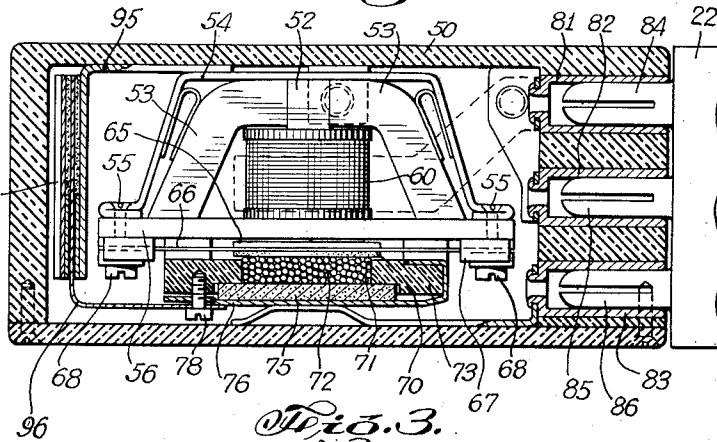


Fig. 3.

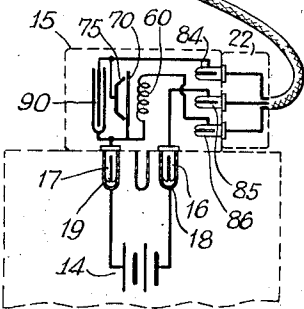
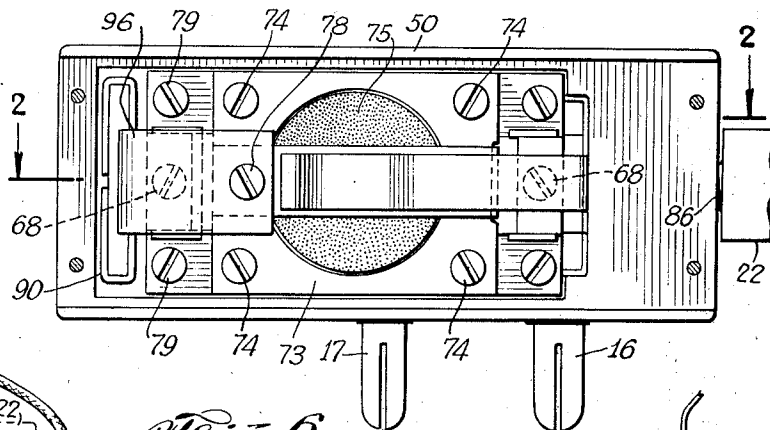


Fig. 4.

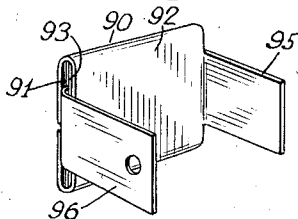


Fig. 6.

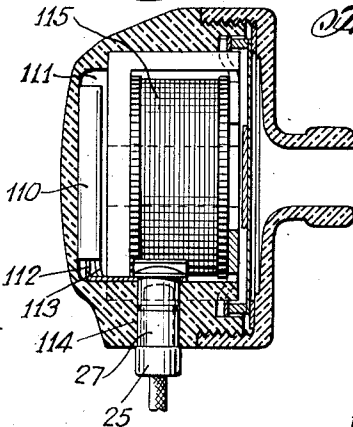
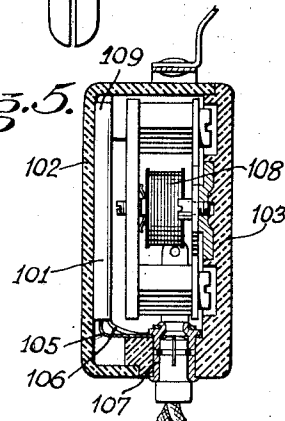


Fig. 5.



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2 Sheets-Sheet 2

Fig. 7.

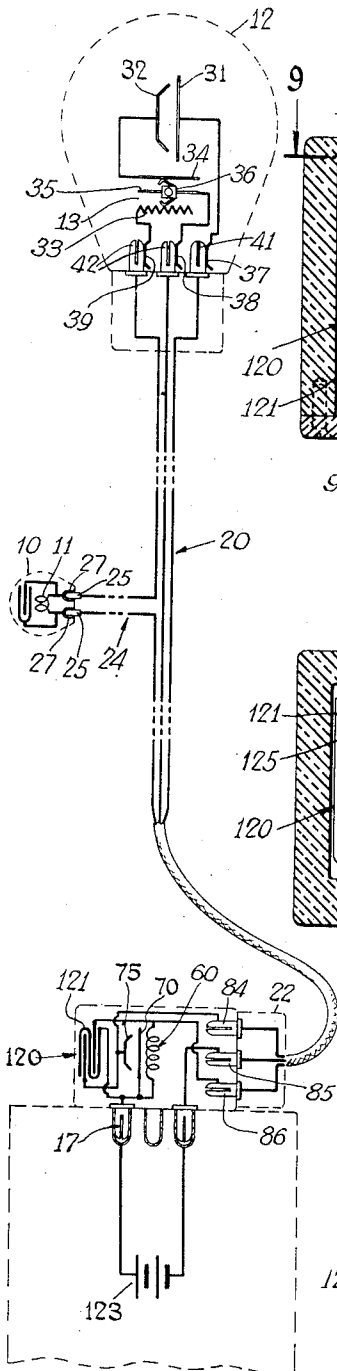


Fig. 8.

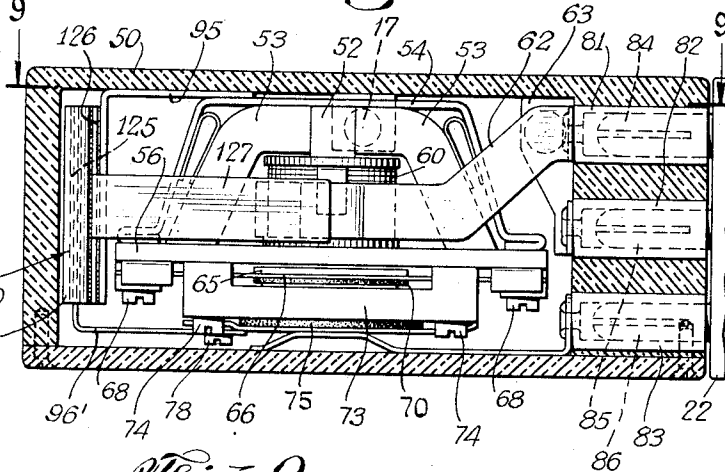


Fig. 9.

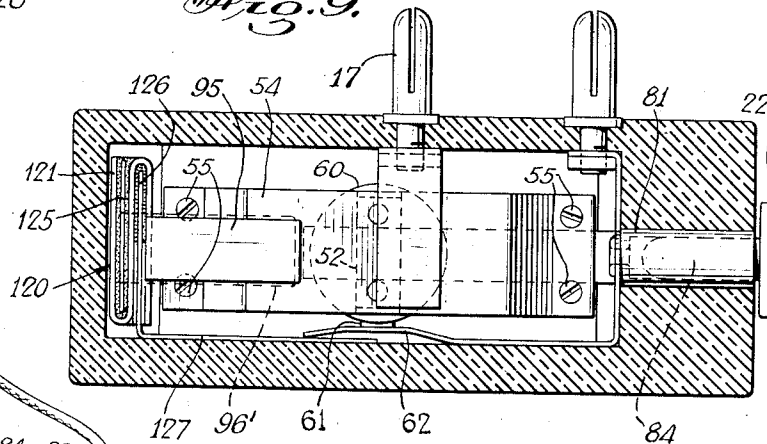
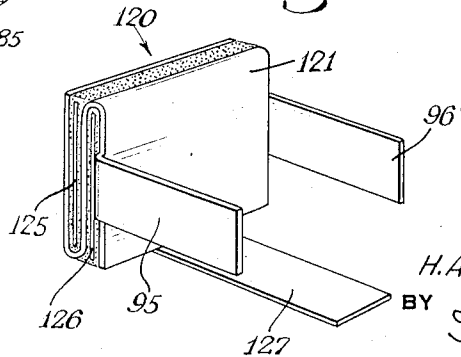


Fig. 10.



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2,105,296

HEARING AID

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Application October 4, 1934, Serial No. 746,794

4 Claims. (Cl. 179—171)

This invention relates to hearing-aid micro-
phone amplifiers and it has among its objects
improved portable microphone-amplifier hearing-
aid devices which provide increased sound am-
plification and sound intensity beyond the limits
to which heretofore microphone amplifiers used
in connection with hearing-aids had to be con-
fined in order to avoid noises accompanying the
action of the carbon particles of amplifier mi-
crophones.

The foregoing and other objects of the inven-
tion will be best understood from the following
description of exemplifications thereof, refer-
ence being had to the accompanying drawings
wherein

Fig. 1 is a diagrammatic view illustrating a
hearing-aid embodying the invention;

Fig. 2 is an enlarged horizontal sectional view
of the amplifier unit of the hearing-aid of Fig.
1 along line 2—2 of Fig. 3;

Fig. 3 is an elevational view of the interior
of the amplifier unit with the cover removed;

Fig. 4 is a perspective view of the condenser
element which is a part of the amplifier unit
shown in Figs. 2 and 3;

Figs. 5 and 6 are enlarged vertical sectional
views of a bone oscillator and a telephone re-
ceiver provided with a condenser element in ac-
cordance with the invention;

Figs. 7 and 8 are views similar to Figs. 1 and 2
showing another embodiment of the invention;

Fig. 9 is a sectional view of the amplifier unit
along line 9—9 of Fig. 8; and

Fig. 10 is a perspective view of the condenser
element of the amplifier unit of Figs. 7 to 9.

Microphone amplifiers in which weak speech
frequency currents of an input circuit are sup-
plied to an actuating winding of an electromag-
netic vibrator used in telephone receivers to im-
part corresponding vibrations to a carbon micro-
phone and generate corresponding amplified
currents in an output circuit connected to the
microphone have been a subject of much inves-
tigation and development work in the telephone
field for many years prior to the invention of
electron tubes, but this work did not succeed
and was abandoned with the introduction of
the electron tube amplifiers.

It has been known for many years past that
many people who during the first part of their
lives heard normally and at a later time, after
having acquired the characteristics of normal
persons, have through sickness or similar causes
lost their hearing to a lesser or greater degree
were in need of a hearing-aid device suitable

for concealed and inconspicuous wear and able
to restore to them the ability to hear and thus
act like normal persons. Accordingly, soon after
the invention of the telephone, efforts were
started to make a hearing-aid utilizing the tele-
phone principle.

Small portable hearing-aids that could be worn
concealed by a person of impaired hearing have
been known for many years. They consisted of
a transmitting microphone connected in series
with a small battery to a telephone receiver
worn on the ear of the person with impaired
hearing for producing in the ear channel sound
vibrations of greater strength than those that
would ordinarily reach it. Such instruments are
only of limited benefit because a microphone
actuated by sound waves can only produce current
oscillations of small magnitude and the sound
vibrations developed by the receiver can be
strengthened only to a very limited degree. The
high excitation threshold of a microphone trans-
mitter makes the intensity of the current changes
produced by it fall off very steeply with the dis-
tance so that hearing is possible only in the
immediate vicinity of the speaker.

The unsatisfactory action of such devices
brought about many efforts to provide the
deafened with an amplifier connected between
the microphone transmitter and the receiver in
order to enable sufficient amplification of the
speech currents to secure an enlarged output
from the telephone receiver. Since the excessive
bulk of the batteries and associated apparatus
made it impossible to use electron amplifying
tubes in connection with portable hearing-aid
devices suitable for concealed wear by a deafened
person essential for a practical hearing-aid, these
efforts have been concentrated on the develop-
ment of a small microphone amplifier for secur-
ing a substantial amplification of the currents
supplied to the telephone receiver by the trans-
mitter microphone of an ordinary hearing-aid.

Very serious obstacles have for many years
prevented the development of a satisfactory
practical microphone amplifier. Microphone am-
plifiers depend for their action on the variation
of the contact resistance between a large num-
ber of carbon particles. These contact variations
are very erratic and produce many disturbing
effects. Difficulties also are encountered at the
contact surfaces of the electrodes with the car-
bon particles. Much trouble was also caused by
over-modulation which occurs when vibrations
are imparted to some carbon particles with an
intensity at which they do not oscillate around

a fixed position of equilibrium in continuous contact with each other, but move freely relatively to each other and break their contact while carrying current causing sparking between the contact surfaces.

Many of these difficulties have been overcome in microphone amplifiers for hearing-aid devices disclosed in Reissue Patent No. 19,246 of July 17, 1934 which gives a substantial amount of good amplification of sound frequency current without distortion and without disturbing noises during a long useful life.

One of the essential features of the microphone disclosed in said patent resides in the relatively stiff diaphragm, preferably of steel, for imparting the vibratory movement to the movable carbon diaphragm electrode acting on the carbon granules within the microphone chamber. By making the diaphragm sufficiently stiff, the amplitude of the vibrations may be maintained within limits at which no over-modulation occurs within the microphone chamber and the disturbing noises due to the breaking of the contacts between particles while carrying current are avoided. While such amplifiers enable satisfactory amplification of speech and music without distortion and without disturbing noises, the magnitude of their amplification is limited by the requirement that the amplitude of the vibration of the movable diaphragm carbon electrode shall be limited to a relatively small value.

The magnitude of the amplifying effect depends on the amplitude of the movable contact surface acting on the carbons in the microphone chamber and the force imparted to the carbon particles. The disturbances caused by the break between the carbon balls due to an increase of the amplitude of the movable contact diaphragm and the increased force imparted to the particles made any improvement in the amplifying action worthless because the contact breaks and sparking between the carbon particles produced current disturbances which obliterated the speech current oscillations and made the reproduced speech unintelligible.

The present invention overcomes the limitations restricting the amplitude of the microphone diaphragm vibrations and permits the construction of carbon microphone amplifiers in which the vibratory diaphragm microphone electrode operates with amplitudes which produce over-modulated vibrations of the carbon particles that would ordinarily produce disturbing noises. In accordance with the invention, these disturbances are eliminated by connecting the amplifier microphone electrodes to a condenser of substantial capacity proportioned to suppress the effect of currents producing the disturbing noises due to the action of the carbon particles subjected to over-modulated vibrations.

This suppression of the disturbing currents produced by the increase of the amplitude and the forces with which the movable diaphragm electrode act on the carbon particles in the microphone chamber is preferably effected by connecting a small electrolytic condenser to the electrodes of the amplifier chamber. In the preferred arrangement the condenser element is made a part of one of the units of the hearing-aids as used heretofore. The capacity of the condenser may vary within wide limits. A condenser of 0.2 microfarad is of substantial benefit in reducing the disturbing noises. Condensers of

capacities of the order of $\frac{1}{2}$ to 1 microfarad or even more are preferable when properly combined with the other elements of the hearing-aid so as to maintain a substantial amplification effect and at the same time suppress the disturbing noises.

An essential feature of the present invention is the utilization of the large amplification obtained by the improved microphone amplifier disclosed herein for increasing the amount of power which can be applied to a small wearable hearing-inducing sound receiver for producing by bone conduction satisfactory hearing in the hearing center of a person. It has been known for many years past that many persons born with satisfactory hearing who during the first part of their lives heard normally and at a later time, after having acquired the characteristics of normal persons, have through sickness or similar causes lost their hearing to a lesser or greater degree, and become subject to maladjustment as a result of this inferiority, could be restored to their normal character by providing them with a hearing-aid device suitable for concealed and inconspicuous wear and able to make them hear well, and free them from the strain to which they are imposed by their impairment.

It has also been known that hearing-aids which impart to a deafened person hearing by means of an air-conduction telephone receiver are only of a limited benefit to most of the deafened people because the intensity of the sound produced in the ear channel is limited by the inherent delicacy of the normal hearing elements in the ear of a person. If an attempt is made to produce in the ear channel of a person sound vibrations of high intensity, the mechanical elements of the hearing organs are likely to become injured and increase the deafness rather than aid the hearing. Thus, a person of normal hearing to whom high intensity sound vibrations are imparted with a telephone receiver will not be able to hear in the way he hears normal sound, but the excessive sound vibrations will cause him a great deal of pain and noise preventing him from understanding the transmitted sound.

In imparting hearing by bone-conduction receivers, a greatly increased amount of power may be transmitted to the bone structure of the person without impairing his hearing ability. This makes it possible to operate bone-conduction receivers with sound-frequency currents of much greater intensity.

The microphone amplifier of the present invention enables the operation of bone-conduction receivers with amplified currents of a high intensity which could not be obtained with microphone amplifiers heretofore available. It also enables utilization of portable bone-conduction hearing-aids which develop sound vibrations of an intensity exceeding that permissible with air-conduction hearing-aids.

In Fig. 1 is shown a hearing-aid device exemplifying the invention comprising a hearing imparting receiver 10, having an actuating winding 11, a microphone transmitter unit 12 with a control unit 13, a battery 14, and an amplifier unit 15 with two supply terminal plug pins 16, 17 engaging the positive and negative terminal sleeves 18 and 19 of the battery, the several elements being interconnected by a flexible cord 20 having a transmitter branch with a three-terminal plug

21 engaging the terminals of the transmitter unit 12, an amplifier branch with a three-terminal plug 22 for interchangeably engaging either the terminals of the amplifier unit 15 or the battery sleeves of the battery 14, and a receiver branch 24 having two strand ends provided with plug pins 25 engaging terminal sleeves 27 of the receiver 10 leading to the actuating winding 11 thereof.

The receiver 10 may be either a bone-conduction receiver of the type shown in Patent No. 2,062,372, or an air-conduction telephone receiver of the type shown in Patent No. 1,973,410.

The transmitter unit 12 has two microphone electrodes 31, 32, and its control unit 13 has a resistor 33, a stationary contact member 34, a contact rod 35, and a sliding contact member 36 movable between a position where it makes a conducting connection between the resistor 33, the stationary contact member 34 and the contact rod 35, cutting out the resistor when moved one way, and interrupting the connection between the several elements when moved in the opposite way. One microphone electrode 32 of the transmitter is connected to the stationary electrode 34 of the control unit, and the other microphone electrode 31, the contact rod 35 and one end of the resistor 33 are connected to three transmitter terminal contacts 37, 38, 39 with which three plug terminals 41, 42, 43 of the transmitter plug 21 of the cord are in detachable contact engagement.

The amplifier unit 15 comprises a small casing 50 fitting the space above the battery 14 and enclosing a microphonic amplifier, such as disclosed in Reissue Patent No. 19,246 granted July 17, 1934. It comprises an electromagnetic vibrator having a magnetic core structure formed of a central soft iron core member 52 and two permanently magnetized core arms 53 held together by means of a metal strip 54 having its ends attached by means of screws 55 to a rigid pole plate 56, having at its center an annular pole face surrounding the pole face at the end of the central core member 52 and spaced therefrom by an annular gap traversed by the flux induced by the two permanent core members.

The central core member 52 is surrounded by an actuating winding in the form of a coil 60 having one terminal connected through the core body to the clamping strip and another terminal in the form of a contact spring 61 mounted on one side of the coil. A flat armature 65 of soft magnetic iron bridging the annular core gap is held spaced by a small gap adjacent the pole faces by means of a diaphragm strip 66 of resilient material, such as steel, which has its ends clamped between clamping plates 67 by screws 68 threaded into the pole plate. On the side opposite to the armature the diaphragm strip 66 has attached thereto a carbon diaphragm electrode 70 which lies in front of an opening 71 of a carbon chamber 72 formed in an insulating block 73 secured to pole plate by screws 74. The carbon chamber 72 is filled with small carbon balls and is enclosed on the opposite side by a carbon contact plate 75 which is held in place by means of a strip 76 having one bent-over end attached to one edge of the insulating block 73 and the other end fastened by a screw 78 to the opposite edge of the block 73.

The amplifier unit is attached to inward projections of the housing walls by means of screws 79. The two supply pins 16 and 17 of the amplifier unit are secured to the bottom wall of

the casing and arranged for detachable engagement with the battery terminal sleeves 18 and 19 to provide a good electrical as well as mechanical supporting connection between the amplifier unit and the battery. The amplifier unit has in addition three terminal sleeves 81, 82, 83 secured within the end wall of the casing 50 and arranged to engage three terminal pins 84, 85, 86 of the cord plug 22. The inner ends of the three-terminal sleeves 81, 82, 83 are connected by suitable contact strips 62, 63, 64 provided in the casing to the contact spring terminal at one end of the amplifier winding 60, the supply terminal pin 16 and to the stationary microphone carbon electrode 75, respectively, the other end of the winding 60 and the amplifier microphone diaphragm 70 being connected through the metallic magnetic core and the contact strip 62 to the other supply pin 17 of the amplifier.

The features of construction of the microphone amplifier are more fully described in the Reissue Patent No. 19,246, referred to above.

By interconnecting the transmitter, the receiver, the amplifier and the battery by the cord 20 in the way shown in Fig. 1, sound waves impinging upon the transmitter microphone 31 will produce oscillatory sound frequency currents through a primary circuit extending from the positive battery pole, through contact sleeve 18, terminal 16, plug pin 85, then through the cord lead extending therefrom to the transmitter terminal contact 38, through contact rod 35, contact rod 34, the transmitter microphone electrodes 32, 31, transmitter contact terminal 37, by way of the cord lead to plug pin 86, and therefrom by way of winding 60 and supply terminal 17 to the negative pole of the battery 14. The oscillatory currents through the actuating winding 60 impart to the armature 65 and to the carbon diaphragm 70 attached thereto vibratory motion and produce corresponding variations of the resistance formed by the carbon balls of the amplifier microphone chamber 72, generating corresponding amplified current oscillations in the secondary circuit of the hearing-aid extending from the positive terminal of the battery, through terminal pins 16, over the common circuit portion through cord pin 85, cord lead extending therefrom to transmitter contact 38, contact rod 35, contact 36, by way of resistor 33 to transmitter contact 39, plug pin 42, by way of the cord lead extending therefrom including the receiver winding 11, through the amplifier plug pin 84 and the amplifier microphone electrodes 75, 70 and amplifier supply terminal 17 to the negative pole of the battery.

In microphone amplifiers of the type described above as made heretofore, the amplitude of the movable contact member acting on the carbon particles in the microphone chambers must be limited to a value where the carbons do not cause excessive noise due to the contact interruption and resulting sparking produced by large amplitudes of the diaphragm in addition to the inherently present carbon hiss.

These limitations are overcome in accordance with the present invention by connecting to the amplifier microphone electrodes an electrolytic condenser 90 of a capacity sufficient to suppress the disturbing high frequency currents which have heretofore prevented fuller use of the amplification range obtainable with microphone amplifiers and at the same time does not appreciably divert the oscillatory currents important for the

production of the sound vibrations from the receiver winding.

The small electrolytic condenser unit 90 occupies very little space within the amplifier casing, and is shown mounted adjacent the amplifier mechanism within the interior of the amplifier casing 50. As shown in Fig. 4, the condenser unit has a capacity of $\frac{1}{2}$ microfarad, its flat sides are $\frac{5}{8}$ by $\frac{1}{8}$ inch, and its thickness is about $\frac{1}{8}$ inch. It is made of an inner metallic electrode 91 of a material, such as aluminum, surrounded by a second similar electrode 92 of opposite polarity with an intervening layer of an electrolytic substance 93, and is of the type described in Patents Nos. 1,891,207, 1,912,223, 1,815,768 and 1,963,049 which are generally available in trade. The condenser has its negative terminal lead 95 clamped under the strip 54 of the amplifier unit, and its positive terminal lead 96 is clamped by screws 78 to contact strip 76, thereby connecting the condenser to the two electrode plates 70 and 75 of the microphone chamber.

In practical experiments with microphone amplifiers, it has been found that most of the disturbing noises are produced by large oscillation amplitudes of the diaphragm electrode in the frequency range between about 300 and 800 cycles. By connecting a condenser as described above which has a high impedance for oscillations within the range up to about 1,000 cycles per second and a low impedance for frequencies above 3,000 cycles, greatly increased amplification without disturbing noises is obtained by increasing the oscillation amplitudes of the carbon diaphragm electrode 70 to values at which such increased amplitudes would have produced in prior art microphone amplifiers disturbances destroying or materially reducing the intelligibility of the transmitted speech. The amplitudes of the oscillations of the diaphragm electrode 70 is increased by proper design of the vibrator unit which imparts the oscillations to the electrode 70, for instance, by using in the vibrator unit described above a diaphragm strip 66 having a stiffness which is only above one-half of the stiffness which the diaphragm strip would require to prevent disturbing noises in the absence of a condenser unit connected in accordance with the invention.

Favorable conditions are obtained by making the condenser impedance equal to the impedance of the receiver winding connected in the output circuit of the amplifier at about 3,000 cycles per second. For instance, for a bone-conduction receiver winding having at a current frequency of 3,000 cycles an impedance of 95 ohms, a condenser of a capacity of $\frac{1}{2}$ microfarad will have at about 3,000 cycles the same impedance as the receiver. At about 1,000 cycles, which is close to the region of frequencies important for the reproduction of speech, such receiver will have an impedance of about 45 ohms and the same condenser will have an impedance of about 320 ohms. Accordingly, the use of such condenser will give no noticeable frequency discrimination in normal speech reproduction while it will secure a substantial elimination of the noise. In using under the same conditions a condenser of 1 microfarad, the condenser impedance will be equal to the receiver impedance of 75 ohms at 2,000 cycles. While such a condenser would slightly reduce the high frequency components of speech, the speech reproduction is still excellent and the noise suppression very complete.

With receivers of the same construction, a condenser of 2 microfarads gives a substantial improvement without interfering with the use.

Contrary to expectations, experiments with microphone amplifiers have shown that a high resistance connected in series with the microphone greatly increases the disturbing high frequency currents when contacts between carbon particles are broken and sparking is produced by too large amplitudes of the movable diaphragm electrode acting on the particles within the chamber. By decreasing the resistance in the circuit of the carbon chamber to low values, the wave form of the current in the output circuit is considerably improved and the disturbing noises suppressed. Since the condenser acts as a low impedance at high frequencies where the oscillator impedance is very high, its action is of great benefit in cutting down the noise producing effect of the microphone contacts.

The effect of the condenser is important not only in suppressing the currents produced by sparking between carbon particles on breaking the contacts, but is also of beneficial effect in preventing sparking or cutting down substantially its duration so that it cannot produce a harmful effect.

In connecting electrolytic condensers to the electrodes of the microphone chamber, great care should be taken to apply the terminals of the condenser with the proper polarity in the circuit extending from the battery. This is particularly important in connection with electrolytic condensers which have a greater insulating effect in one direction than in the other.

Instead of placing the electrolytic condenser within the microphone casing and directly connecting its terminals to the electrodes of the microphone chamber, the condenser may be provided as a separate unit detachable by means of plugs to the circuit leading to the amplifier microphone electrodes, or may be housed in one of the casings of the other elements of the portable hearing-aid. Thus, for instance, an electrolytic condenser of suitable size 101 may be mounted within the casing 102 of a bone-conduction receiver 103 shown in Fig. 5 and described in Patent No. 2,062,372. The electrolytic condenser 101 has its two terminals 105 and 106 connected to the terminal sleeves 107 through which connection is made to the actuating coil 108 of the receiver. The condenser, which has an insulating coating of paraffin, for instance, on its exterior surface may be held clamped in position between the cover of the receiver and an extension from the base thereof as shown at 109.

In a similar way the condenser may be mounted in a housing of a telephone receiver as shown in Fig. 6 where a small electrolytic condenser 110 is placed in a cavity 111 within the bottom of the telephone casing of a telephone receiver of the type disclosed in Patent No. 1,973,410, the terminal leads 112, 113 of the condenser being connected to the terminal sleeves 114 of the receiver to which the actuating coil 115 is connected.

The disturbing noise-creating currents are caused not only by the erratic action of the carbon microphone 70, 75 of the amplifier unit in the secondary circuit of the amplifier, but also by the similar action of the carbon contacts of the transmitter microphone 31, 32 constituting with the actuating coil 60 a primary circuit for imparting the oscillatory action to the diaphragm electrode 70 of the amplifier microphone. In the embodiment of the invention shown in Figs. 7 to

9, the disturbing effect of the carbon contacts of the transmitter microphone as well as the amplifier microphone are suppressed by connecting to the microphones of the two circuits condensers of substantial capacity, proportioned to suppress the disturbing effects without impairing the effecting of the generation of amplified sound producing currents.

As shown in the drawings, the two condensers may be made in the form of a single unit 120 having two condenser cells formed between a common aluminum electrode 121 connected to the common lead of the two microphones to the supply terminal 17 connected to the negative terminal of the battery 123 and two distinct cooperating electrodes 125, 126 of opposite polarity connected through leads 96' and 127 to the chamber electrode 75 of the amplifier microphone and to the contact spring terminal 61 of the amplifier coil 60, respectively. The condenser element formed of electrode 125 and the associated portion of electrode 121 is made and proportioned to constitute a capacity which will have an impedance of the order of the impedance of the receiver 10 at about 3,000 cycles, and a substantially greater impedance than the impedance of the oscillator 10 at frequencies of about 1,000 cycles per second. In a similar way the condenser element formed of electrode 126 and the associated portion of electrode 121 is made and proportioned to constitute a capacity which will have an impedance of the order of the impedance of the amplifier winding 60 at about 3,000 cycles, and a substantially greater impedance than the impedance of the amplifier winding at frequencies of about 1,000 cycles per second.

An electrolytic condenser in which each condenser unit has a capacity of about $\frac{1}{4}$ to 1 microfarad made in a way similar to the condenser shown in Fig. 4 will be very effective in suppressing the disturbing noises in an amplifier arrangement of the type described above. Such condenser is small in size, and can be readily mounted within the casing 130 enclosing the amplifier elements without in any way affecting the portability, lightness and inconspicuousness of the hearing-aid.

The features of the invention described above are susceptible of many modifications that will suggest themselves to those skilled in the art.

We claim:

1. In a microphone amplifier actuated by sound frequency input currents for producing corresponding amplified sound frequency currents supplied to an output circuit of a hearing-aid device or the like, an amplifier microphone having a vibratory electrode and carbon granules actuated by the vibratory motion of said electrode connected in said output circuit, a vibratory structure actuated by said input currents for imparting to said microphone electrode a vibratory motion, said amplifier microphone and said vibratory structure being proportioned and constructed to operate said vibratory electrode with an amplitude range producing through over-modulated vibrations of said carbon granules audible current impulses superimposed on said sound current oscillations, and a condenser unit connected parallel to said amplifier microphone having an impedance of the order of the output impedance at a frequency between 1,800 and 4,000 cycles and an impedance two or more times greater than the output impedance at a frequency between 600 and 1,200 cycles for suppressing said superimposed current impulses without materi-

ally impairing the intensity of the sound frequency oscillations supplied to the output circuit incident to said over-modulated vibration.

2. In a microphone amplifier actuated by sound frequency input currents for producing corresponding amplified sound frequency currents supplied to an output circuit of a hearing-aid device or the like, an amplifier microphone having a vibratory electrode and carbon granules actuated by the vibratory motion of said electrode connected in said output circuit, a vibratory structure actuated by said input currents for imparting to said microphone electrode a vibratory motion, said amplifier microphone and said vibratory structure being proportioned and constructed to operate said vibratory electrode with an amplitude range producing through over-modulated vibrations of said carbon granules audible current impulses superimposed on said sound oscillations, a condenser unit connected parallel to said amplifier microphone having an impedance of the order of the output impedance at a frequency of the order of 2,500 cycles and an impedance two or more times greater than the output impedance at a frequency of the order of 1,000 cycles for suppressing said superimposed current impulses without materially impairing the intensity of the sound frequency oscillations supplied to the output circuit incident to said over-modulated vibrations, and a housing enclosing said amplifier microphone, said vibratory structure and said condenser unit having cord leads for operatively interconnecting said amplifier microphone and said vibratory structure with said input and said output circuits.

3. In a microphone amplifier actuated by sound frequency input currents derived from a battery for producing corresponding amplified sound frequency currents supplied to an output circuit of a hearing-aid device or the like, an amplifier microphone having a vibratory electrode and carbon granules actuated by the vibratory motion of said electrode connected in said output circuit, a vibratory structure actuated by said input currents for imparting to said microphone electrode a vibratory motion, said amplifier microphone and said vibratory structure being proportioned and constructed to operate said vibratory electrode with an amplitude range producing through over-modulated vibrations of said carbon granules audible current impulses superimposed on said sound oscillations, a condenser unit connected parallel to said amplifier microphone having an impedance proportioned and correlated with respect to the impedance of said output circuit to divert said superimposed current impulses from the output circuit without materially impairing the intensity of the sound frequency oscillations supplied to the output circuit incident to said over-modulated vibrations, an inconspicuously small housing enclosing said amplifier microphone, said vibratory structure and said condenser unit, said housing having detachable terminal connections for mechanically supporting said housing on said battery, and cord leads for operatively interconnecting said amplifier microphone, said vibratory structure and said battery with said input and said output circuits.

4. In a microphone amplifier actuated by sound frequency input currents derived from a battery for producing corresponding amplified sound frequency currents supplied to an output circuit of a hearing-aid device or the like, an amplifier microphone having a vibratory electrode and carbon granules actuated by the vibratory motion of said

electrode connected in said output circuit, a vibratory structure actuated by said input currents for imparting to said microphone electrode a vibratory motion, said amplifier microphone
5 and said vibratory structure being proportioned and constructed to operate said contact member with an amplitude range producing through over-modulated vibrations of said carbon granules audible current impulses superimposed on said
10 sound oscillations, an electrolytic condenser unit connected parallel to said amplifier microphone having an impedance of the order of the output impedance at a frequency between 1,800 and
15 4,000 cycles and an impedance two or more times greater than the output impedance at a frequency

between 600 and 1,200 cycles for suppressing said superimposed current impulses without materially impairing the intensity of the sound frequency oscillations supplied to the output circuit
5 incident to said over-modulated vibrations, and an inconspicuously small housing enclosing said amplifier microphone, said vibratory structure and said condenser unit, said housing having detachable terminal connections for operatively
10 interconnecting said battery, said amplifier microphone and said vibratory structure with said input and output circuits.

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