June 28, 1938. S. BALLANTINE 2,121,780

SOUND TRANSLATING SYSTEM

Original Filed Feb. 26, 1935

Fig. 1.

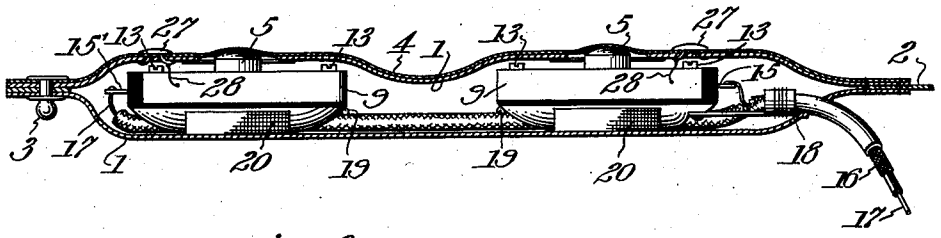


Fig. 2.

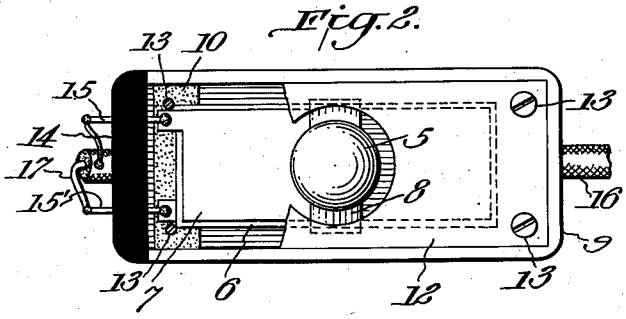


Fig. 3.

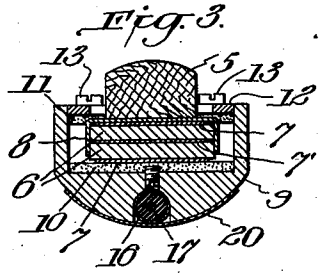
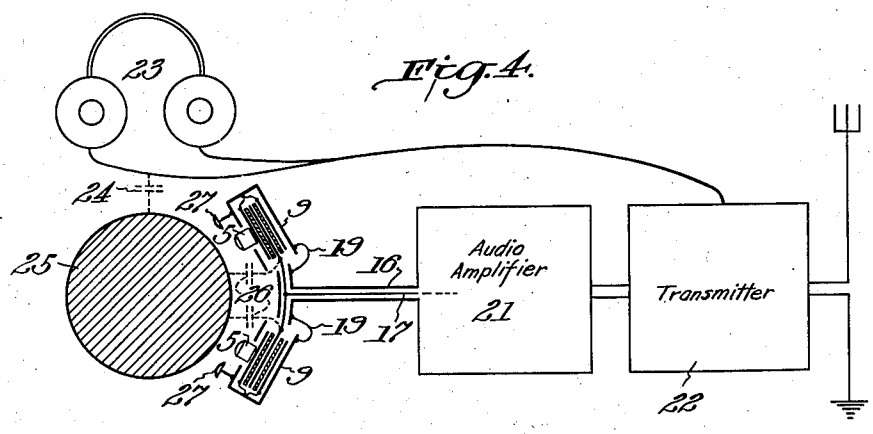


Fig. 4.



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SOUND TRANSLATING SYSTEM

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Application February 26, 1935, Serial No. 8,392
Renewed February 20, 1937

10 Claims. (Cl. 179—78)

This invention relates to sound translating systems and particularly to systems which include a high impedance microphone working into a high gain amplifier.

In my copending application Serial Number 6,246, filed Feb. 12, 1935, I have described and claimed a novel type of microphone which is worn around the neck and actuated by the vibrations of the throat which are set up by the voice. The active elements or mechano-electrical transducers are Rochelle salt crystals and, in comparison with the usual carbon microphones, the impedance of the throat microphone is very high and the conversion efficiency is quite low. The mechanical vibrations of the throat are not a true copy of the sound waves which are set up in air by the voice but the microphone may be combined with a frequency selective amplifier to obtain an output which, in magnitude and in frequency-energy distribution, is a fair duplication of the output obtained when a carbon microphone is actuated by sound waves in air. Such a combination of a throat microphone and a compensating amplifier is described and claimed in my copending application Ser. No. 6,245, filed Feb. 12, 1935. The microphone-amplifier system is preferably so designed that it may be substituted for the carbon microphone of a radio telephone transmitter, and such a system is especially useful on airplanes as the throat microphone does not respond to sound waves in air and thus excludes engine and other disturbing noises.

The new throat microphone and compensating audio amplifier have proved very satisfactory when worked into a telephone line and into some types of radio transmitters, but difficulties were encountered under some conditions, for example when the system was worked into a radio telephone transmitter unit of the type including a head set that permits the operator to listen in to his own speech signals. In telephone parlance, this operation is known as listening to the "side-tone". In some instances, the output from the transmitter was much less than was expected, and in other cases continuous oscillations were set up and "singing" resulted. These are the characteristic indications of a feed-back of energy from a high voltage level stage of an amplifier to a preceding stage or to the unit which works into the amplifier. Investigation of the problem identified the feed-back as taking place between the head set and the microphone in which crystal microphone units were not completely shielded. The high audio amplification brought the electrical power level at the headset to a value enormously greater than that at the microphone, with the result that the intense external electrical field to which the imperfectly shielded microphone was exposed produced, electrostatically, a microphone output comparable to that generated by the mechanical vibration of the crystals.

Objects of the invention are to provide methods of and apparatus for preventing false actuation of a throat microphone by electrical fields in which the same may be located. Objects are to provide methods of and apparatus for reducing the electrostatic pickup from external fields when using a throat microphone of high impedance.

A further object is to provide a sound translating system including a throat microphone having an incompletely shielded transducer, a radio telephone transmitter having a headset to permit the operator to listen in on the side-tone, and circuit arrangements supplementing the shielding of the transducer to reduce the pickup from electrical fields in which the microphone may be located.

These and other objects and advantages of the invention will be apparent from the following specification when taken with the accompanying drawing, in which:

Fig. 1 is a longitudinal sectional view through a throat microphone embodying the invention;

Fig. 2 is a front view, with parts broken away, of a single unit;

Fig. 3 is an enlarged transverse section through a unit; and

Fig. 4 is a diagrammatic view of a complete transmitter in which the microphone may be incorporated.

The microphone illustrated in Fig. 1 may be of the type which is described in detail in my prior application Ser. No. 6,246. The support for the microphone is a narrow band or sheath 1 formed of a flexible material such as glove leather, and an elastic band 2 which has appropriate means for connection to the snap fastener 3. The front wall of the casing has two openings which are covered by a thin membranous material 4, such as thin rubber or glove leather, and the actuating buttons 5 of the microphone extend through the openings.

Each microphone unit comprises an assembly of two Rochelle salt crystals 6 having outer electrode foils 7 and an electrode foil 7' between the crystals. The plates 6 are cut and related in such manner, as described in Letters Patent No. 1,802,782, Sawyer, as to develop electrical voltages between the inner and outer electrodes when the assembly is bent.

The button 5, of balsa wood or other light material, is secured over the center to the crystal unit by a stirrup 8, and the unit is mounted in a metallic housing or shell 9 for bending or vibratory motion in response to the mechanical vibrations imparted to the button. The ends of the unit are spaced from the bottom of shell 9 by strips 10, and similar strips 11 are placed above the unit for clamping engagement by the cover plate 12 when the latter is drawn down by the screws 13.

One end of the housing is closed by a block 14 of insulating material in which leads 15, 15' are supported. The leads 15 of each unit are connected to the outer electrodes 7 and to the metallic sheath 16 of a flexible cable that has an inner conductor 17. The inner foil electrodes 7' are connected to the conductor 17 by the leads 15'. The cable thus formed by conductors 16, 17 is anchored to a stirrup 18 that is fixed to one of the shells 9 to relieve the connections from mechanical strain. The outer insulation is stripped from the portion of the cable within the leather casing 1 and the sheath 16 is grounded upon the shells 9 by soldered spots 19. The cable lies in channels formed in the shells 9 and is held therein by strips 20 of adhesive fabric.

The construction, as so far described, has been successfully operated for telephone and radio telephone transmission of speech when the microphone was actuated by mechanical vibrations of the larynx and the microphone was worked into a compensating audio amplifier of the type having a response which rose with frequency. But the operation was unsatisfactory when the system was worked into a radio telephone transmitter having headphones for listening to the side-tone. As shown in Fig. 4, such a transmitter includes the throat microphone, an audio amplifier 21 such as described in my application Ser. No. 6,245, a transmitter 22, and headphones 23. The imaginary condenser 24 represents the electrostatic capacity coupling between the headset and the body of the wearer, indicated at 25, and condensers 26, 26 represent the coupling between the body and the microphone. The direct coupling between the headset and the microphones is usually small compared to these paths.

These couplings to the microphone arise, of course, from the incomplete shielding of the microphone. In the illustrated construction, for example, there are several points of the circuit which are exposed to external fields, as follows: (1) the holes in plates 12 for the entrance of the buttons 5; (2) the space occupied by the insulating block 14; (3) the exposed high potential leads 15' and associated terminals and connections. While it may be possible, at least in theory, to decrease these exposures and the resultant couplings, it is not always convenient mechanically to provide a complete electrical shielding in the microphone structure.

I have discovered experimentally that the pickup from external electrical fields may be very much reduced by employing the operator himself as additional shielding for an incompletely shielded throat microphone. This additional shielding may be provided automatically by grounding the body of the operator to the microphone shield when the microphone is placed in position on the neck.

A very convenient construction for obtaining an automatic grounding of the operator is shown in Fig. 1 as two metallic buttons or rivets 27 which are fastened through the leather covering 1 and electrically connected by leads 28 to the respective metallic housings 9. The outer faces of the buttons 27 are preferably slightly rounded to form smooth surfaced bosses that are almost flush with the covering 1, the faces projecting just enough to insure contact with the skin. The outer faces of the buttons may be plated with gold or they may be formed of a non-corrodible metal.

This method of supplementing the shielding of a microphone has worked out very well in actual practice, since it is automatic and requires no thought by the operator. The additional shielding effect is sufficient for all practical purposes as oscillations have been prevented at the highest side-tone level that the ear can tolerate. The shielding action of the operator's body is also effective to prevent external pickup from sources other than the side-tone. One such source of disturbance is the radio frequency radiation field of an antenna, and this may be quite troublesome in open cockpit airplanes due to the proximity of the operator to the antenna. The introduction of radio frequency voltages into the audio amplifier may result in the production of audio frequency currents by rectification in the amplifier stages, and this may set up an oscillating system. I have found that this action is prevented when the buttons 27 are used to ground the operator upon the metallic shielding that, of itself, is not sufficient to prevent a disturbing pickup of radio frequency energy.

It is to be understood that the invention is not restricted to the particular microphone construction herein illustrated since the same problems arise when any incompletely shielded microphone of high impedance is worked into high gain circuits.

I claim:

1. In the operation of a throat microphone having a high impedance mechano-electrical transducer located in and incompletely shielded by a metallic housing, the method of supplementing the shielding to prevent pickup from external electrical fields which comprises establishing an electrical connection between the metallic housing and the surface of the operator's body.

2. In the operation of a sound translating system of the type including a throat band having therein a metallic housing affording an incomplete shielding for a mechano-electrical transducer of high impedance, the method of grounding the operator's body which comprises mounting metallic pieces on the throat band for contact with the operator's body, and electrically connecting the metallic pieces to said housing.

3. In the operation of a radio telephone system including a throat microphone working into an audio amplifier and transmitter, the method of reducing electrostatic pickup from external fields which comprises grounding the operator's body to the microphone.

4. In the operation of a radio telephone system including a throat microphone working into an audio amplifier and transmitter, and headphones connected to said transmitter to permit the operator to listen to the side-tone, the method of reducing electrostatic pickup from external fields due to the headphones which comprises grounding the operator's body to the microphone.

5. A throat microphone comprising an incompletely shielded vibration-responsive microphone of high impedance, a flexible band of non-conducting material enclosing the microphone and adapted to support the same on the operator's

throat, electrically conductive members exposed on said band for engagement with the operator's throat, and electrical connections between said members and the microphone.

6. In an electrical communication system, an incompletely shielded microphone of high impedance adapted to be worn in contact with the body and actuated by the vibrations thereof due to the voice, a telephone receiver headset to be worn by the operator, a transmission network connecting said microphone and said headset, and means for reducing the capacitive feedback from said headset to said microphone, said means comprising an electrical connection between the operator's body and the low-potential side of the microphone.

7. In a sound translating system, a microphone of high impedance adapted to be worn in contact with the body and actuated by the vibrations thereof due to the voice, a metallic housing providing an incomplete shield for said microphone, a telephone receiver headset to be worn by the operator, a transmission network connecting said microphone and said headset, and means for reducing the capacitive feedback from said headset to said microphone, said means comprising an electrical connection between the operator's body and the said metallic housing.

8. A microphone adapted to be worn in contact with the body, said microphone comprising at least one vibratory sensitive transducer, a metallic housing incompletely enclosing said transducer, a non-conductive covering for said transducer, means for supporting said covering upon the operator's body to position said transducer for actuation by the vibrations thereof, a metallic member mounted on said microphone so as to contact electrically with the skin when the microphone is worn, and an electrical connection between said metallic member and said housing.

9. A microphone adapted to be worn in contact with the neck, said microphone comprising at least one vibratory sensitive transducer, a metallic housing incompletely enclosing said transducer, a leather covering for said transducer, means for supporting said covering upon the operator's body to position said transducer for actuation by vibrations of the throat, a metallic member mounted on said leather covering to contact electrically with the skin when the microphone is worn, and an electrical connection between said metallic member and said housing.

10. In a throat microphone, a pair of piezoelectric transducers, a metallic housing incompletely enclosing each transducer, an operating member secured to each transducer and extending through the associated housing, a non-conductive casing enclosing said housings, and adapted to be worn on the neck to position said operating members for actuation by the mechanical vibrations of the throat, metallic members mounted on said casing adjacent each housing to contact with the skin when the microphone is worn on the neck, and electrical connections between said metallic members and the housings adjacent thereto.

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