

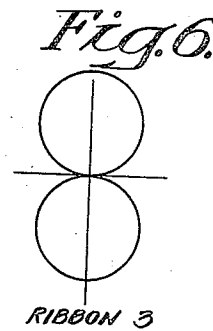
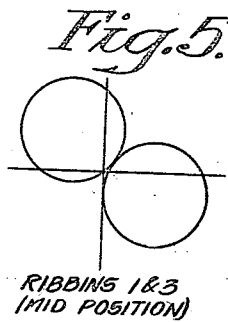
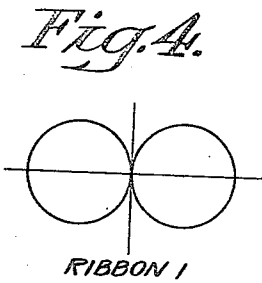
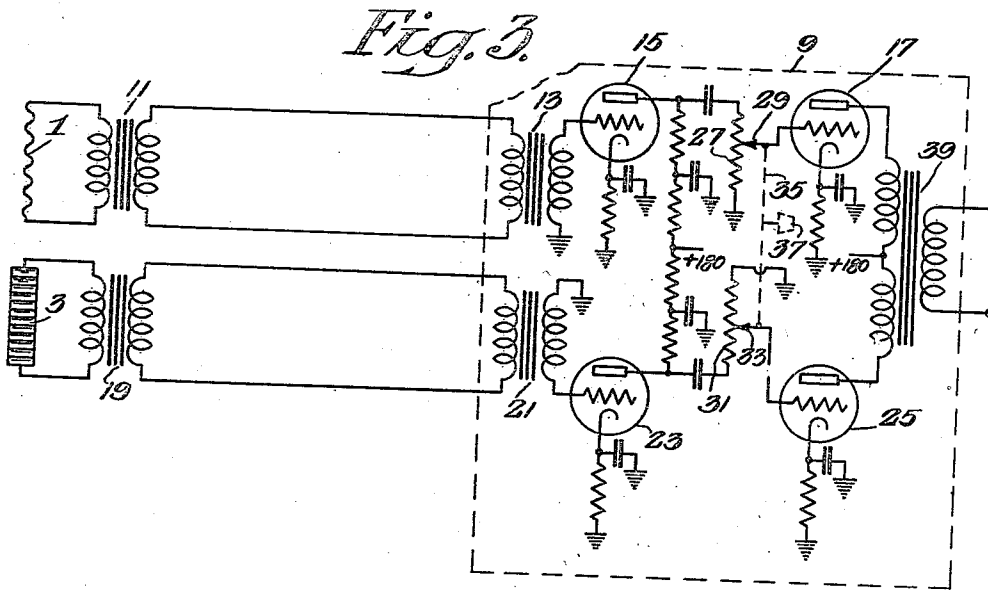
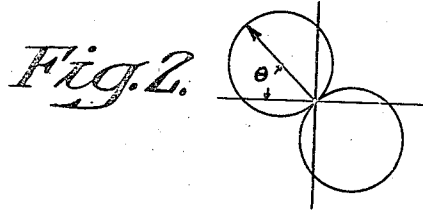
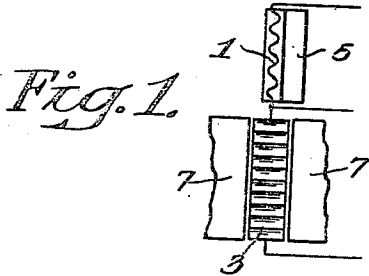
Sept. 19, 1939.

L. J. ANDERSON
ELECTROACOUSTICAL APPARATUS

2,173,219

Filed May 29, 1937

2 Sheets-Sheet 1



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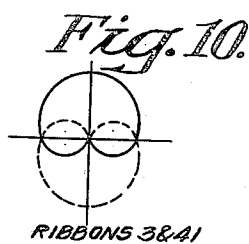
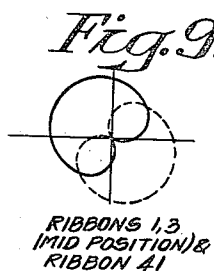
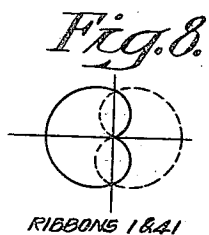
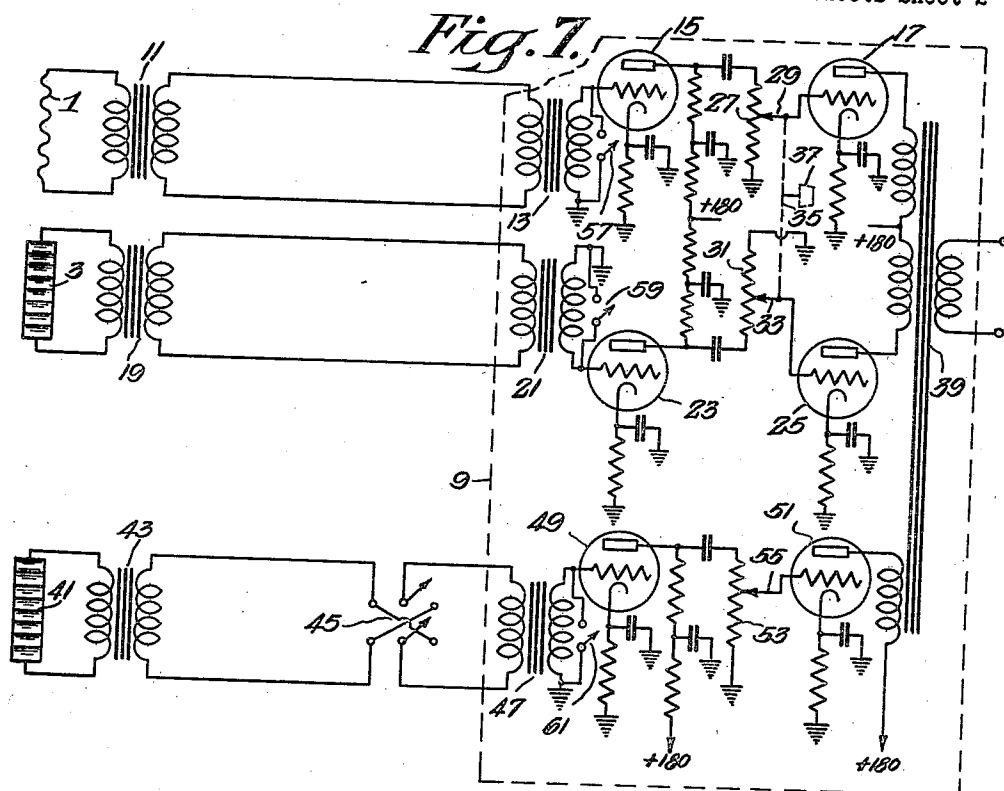
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ELECTROACOUSTICAL APPARATUS

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Application May 29, 1937, Serial No. 145,455

10 Claims. (Cl. 179-1)

This invention relates to electro-acoustical apparatus, and more particularly to microphones of the type wherein a movable conductor is mounted for movement in a magnetic field in response to either the pressure component, the pressure gradient component, or both said components of a sound wave.

It is well known that microphones of this type which are responsive only to the pressure gradient, or velocity, component of a sound wave are bi-directional, while those responsive only to the pressure component of a sound wave are non-directional. By suitably combining the two, as disclosed in the reissue patent to Olson and Weinberger, No. 19,115, a microphone is obtained which is uni-directional.

Under certain circumstances, it may be desirable to rotate the directional patterns of microphones of the type specified above, as where it is desired to present the illusion of a moving sound source, for example, while the microphone remains fixed. With the non-directional, pressure microphone, no particular problem is involved, but with the velocity microphone and with the combined pressure and velocity microphone, a definite problem is presented in view of the directional characteristics of such microphones.

The primary object of my present invention is to provide an improved sound pickup system the directional characteristic of which may be controlled so that maximum pickup will be obtained regardless of the position of the sound source with respect to the microphone.

More specifically, it is an object of my present invention to provide an improved microphone system the directional characteristic of which may be varied at will to lie along any desired axis.

Another object of my present invention is to provide an improved microphone and system as above which can be efficiently controlled from a point remote from the microphone.

A further object of my invention is to provide an improved microphone and system as above which is easily operated or controlled and which is highly efficient in use.

In accordance with my invention, I arrange a multiplicity of pressure gradient responsive ribbons at suitable angles to each other and connect their outputs to a suitable mixing device. By manipulating the mixer, the directional pattern of the microphone may be varied through any desired angle. The same result may be

achieved by associating with the pressure gradient responsive ribbons one or more ribbons that are pressure responsive and the output from which is connected to the same mixer.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description of several embodiments thereof, when read in connection with the accompanying drawings in which

Figure 1 is a fragmentary view of a velocity microphone having a pair of ribbons arranged in accordance with my present invention,

Figure 2 is a curve representing the bi-directional characteristic of a velocity microphone,

Figure 3 is a circuit diagram showing a mixing amplifier which may be employed according to my invention in conjunction with a microphone such as that illustrated in Figure 1,

Figures 4, 5 and 6 are characteristic curves illustrating how the axes of the directional pattern may be rotated by the mixing circuit of Figure 3,

Figure 7 is a circuit diagram similar to Figure 3 but including also a pressure actuated ribbon, and

Figures 8, 9 and 10 are characteristic curves for the unidirectional microphone shown in Figure 7 showing how the axes thereof are varied similarly to the curves of Figures 4-6.

Referring more specifically to the drawings, wherein similar reference characters designate corresponding parts throughout, there is shown, in Figure 1, a microphone having a pair of slightly crimped, conductive ribbons 1 and 3 serially connected and mounted for movement, respectively, between two sets of magnets 5 and 7 in a manner such that sound waves may freely strike both the front and back surfaces of each of the ribbons. It will thus be clear that the microphone is of the velocity type, i. e., of the type in which both ribbons 1 and 3 are responsive to the pressure gradient component of the sound waves. The ribbons 1 and 3 are arranged to lie in planes at right angles to each other, and if it is assumed that the characteristic curve for the ribbon 1 is shown in Fig. 4, then it follows that the characteristic curve for the ribbon 3 must be at right angles to the curve of Fig. 4, or as shown in Fig. 6.

Consider, now, the structure of Fig. 1, in which

the two ribbons 1 and 3 are at right angles to each other. For the ribbon 1,

$$e_1 = e_0 \cos \theta \quad (1)$$

where e_1 is the voltage corresponding to the angle θ (Fig. 2); e_0 is the voltage corresponding to $\theta=0^\circ$; and θ is the angle measured about a vertical axis in a horizontal plane. Similarly, for the ribbon 3,

$$e_2 = e_0 \cos (\theta + 90^\circ) \quad (2)$$

where e_2 is the voltage also corresponding to the angle θ . Adding Equations (1) and (2), we get

$$e_1 + e_2 = e_0 \cos \theta + e_0 \cos (\theta + 90^\circ) \quad (3)$$

or

$$e_1 + e_2 = e_0 (\cos \theta - \sin \theta) \quad (4)$$

From Equation (4), it will be seen that the combined voltage derived from the two ribbons may be varied depending upon the angle θ , and this variation may be obtained by means of a mixer such as that shown in Fig. 3, for example, the mixer being designed to function as follows:

(1) To connect the ribbon 1 directly to the output when the mixer control (hereinafter more fully described) is in one extreme position.

(2) To connect the ribbon 3 directly to the output when the mixer control is in its other extreme position.

(3) To maintain a constant output level for all positions of the mixer control.

The mixer, generally indicated by the reference numeral 9, includes two channels each incorporating an input transformer and a two-stage amplifier. The ribbon 1 is coupled, through an output transformer 11, to an input transformer 13 of one of the channels which includes also the amplifiers 15 and 17, while the ribbon 3 feeds into its output transformer 19, in turn connected to an input transformer 21 in the second channel which includes the amplifiers 23 and 25 arranged similarly to the amplifiers 15 and 17. Connected in the plate circuit of the amplifier 15 is a variable resistor 27 the slider 29 of which is connected to the grid of the amplifier 17. Similarly, a variable resistor 31 is connected in the plate circuit of the amplifier 23 and its slider 33 is connected to the grid of the amplifier 25, a mechanical link 35 operable by a handle or knob 37 connecting the sliders 29 and 33 physically. The arrangement is such that, as the sliders 29 and 33 are moved in one direction, the voltage fed from the amplifier 15 to the amplifier 17 will increase while the voltage fed from the amplifier 23 to the amplifier 25 will simultaneously decrease and vice versa. In practice, this may be accomplished easily by mounting the two potentiometers 27—29 and 31—33 on a common shaft operated by the knob 37, with connections to the two potentiometers such that when the slider 29 is at the maximum value of the resistor 27, the slider 33 is at the minimum value of the resistor 31, and vice versa. The outputs from the amplifiers 17 and 25 are combined in an output transformer 39 to which a suitable loud-speaker, for example, may be connected.

When the link 35 is in its uppermost position, as illustrated, the signals from the ribbon 3 will be fully attenuated and those from the ribbon 1 transmitted without any attenuation, whereupon the output from the transformer 39 will be derived entirely from the ribbon 1 and the directional pattern for the system will be as represented by the curve in Fig. 4. On the other hand, when the link 35 is in its lowermost position, the signals from the microphone 1 will be fully attenuated, those from the ribbon 3 will be trans-

mitted without attenuation, so that the output from the transformer 39 will be derived entirely from the ribbon 3, and the directional pattern will extend at right angles to the first, as shown in Fig. 6. In any position of the slider 35 intermediate its two extreme positions, the signals in each channel will be partly attenuated and the directional pattern will therefore lie between the two extreme positions represented by Figs. 4 and 6. Fig. 5 shows the direction of the pattern with the link 35 in mid-position.

In Fig. 7, I have shown a system which includes, in addition to the velocity actuated ribbons 1 and 3, a pressure responsive ribbon 41 which is in the plane of one of the other ribbons, for example the ribbon 3. The ribbon 41 is coupled through its output transformer 43, a suitable pole changing switching arrangement 45 and another input transformer 47 in the mixer 9 to a third amplifying channel including the amplifiers 49 and 51. As in the case of the two amplifier channels previously described, the amplifier 49 is provided in its plate circuit with a variable resistor 53 the slider 55 of which is connected to the grid of the amplifier 51. Preferably, the slider 55 is made adjustable independently of the sliders 29 and 33. With this arrangement, if the output of the channel including the pressure responsive ribbon 41 is held constant, it is obvious that, upon varying the combined output of the two channels including the ribbons 1 and 3 as described above in connection with Fig. 3, the uni-directional characteristic will be varied as shown in Figs. 8, 9 and 10. The reversing switch 45 will permit rotating these characteristics 180° from the solid line position to the dotted line position, as shown.

If desired, a series of switches 57, 59 and 61 may be connected in shunt with the secondaries of the transformers 13, 21 and 47, respectively, so that, upon closing these switches, the several channels will be shorted out. Thus, in accordance with my invention, the following arrangements may be provided:

(1) By closing only the switch 61, the system will act as a bi-directional velocity responsive system adjustable in the manner set forth above.

(2) By closing only the switches 57 and 59, the system will act as a non-directional pressure responsive system the output of which may be controlled by manipulation of the slider 55.

(3) By leaving the switches 57, 59 and 61 all open, the system will act as a uni-directional combined pressure and velocity responsive system which may also be adjusted in the manner previously set forth.

From the foregoing description it will be apparent to those skilled in the art that I have provided an improved microphone system which is adapted for use under widely varying conditions and, although I have shown and described but two embodiments of my invention, I am fully aware that many other modifications are possible. For example, instead of having the ribbons 1 and 3 physically and electrically connected in series, two separate ribbons may be employed, as shown in Fig. 3. Furthermore, if desired, separate individual microphones may be employed which are located adjacent each other. Many other changes will, no doubt, readily suggest themselves to those skilled in the art. Accordingly, I desire that my invention shall not be limited except insofar as is made necessary by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In sound translating apparatus, the com-

5 combination of means providing a magnetic field, a pair of movable conductors vibratably mounted in said field, said conductors lying in planes at right angles to each other, and means for variably selecting the output from each of said conductors and combining the selected portions of said out-puts.

10 2. In sound translating apparatus, the combination of a pair of channels, each of said channels including a vibratable member adapted to transform acoustical energy into corresponding electrical pulsations, said members lying in planes at right angles to each other, means for combining the outputs of said channels, and means for attenuating the pulsations in either one of said channels at will.

20 3. In sound translating apparatus, the combination of a pair of channels, each of said channels including a vibratable member adapted to transform acoustical energy into corresponding electrical pulsations, said members lying in planes at right angles to each other, means for combining the outputs of said channels, and means for gradually fading out the pulsations in one of said channels while simultaneously fading in the pulsations from said other channel.

25 4. The invention set forth in claim 3 characterized in that said vibratable members are constituted by ribbon conductors mounted in planes at right angles to each other, and characterized further in that said conductors are arranged to be responsive to the pressure gradient component of a sound wave.

30 5. In sound translating apparatus, the combination of a pair of channels, each of said channels including a vibratable member adapted to transform acoustical energy into corresponding electrical pulsations, said members lying in planes at right angles to each other, means for combining the outputs of said channels, means for gradually fading out the pulsations in one of said channels while simultaneously fading in the pulsations from said other channel, and means for short-circuiting either one of said channels at will.

6. In sound translating apparatus, the combination of a plurality of channels, each of said channels including a vibratable member adapted to transform acoustical energy into corresponding electrical pulsations, at least two of said members lying in planes at right angles to each other and another member lying in the plane of one of said first named two members, and means for attenuating the pulsations in any one of said channels.

10 7. The invention set forth in claim 6 characterized in that said vibratable members are all constituted by ribbon conductors, said first named two ribbons being arranged to be responsive to the pressure gradient component of a sound wave and said third named member being arranged to be responsive to the pressure component of a sound wave.

15 8. The invention set forth in claim 6 characterized in that said vibratable members are all constituted by ribbon conductors, said first named two ribbons being arranged to be responsive to the pressure gradient component of a sound wave and said third named member being arranged to be responsive to the pressure component of a sound wave, and characterized further by the addition of means for variably selecting the output from each of said channels and combining said selected portions into a single output channel.

20 9. In a microphone having a pair of pressure gradient responsive conductors operable in planes at right angles to each other, the method of deriving signal energy from said microphone which comprises variably selecting output signals from each of said conductors and combining said selected signals into a single output channel.

25 10. In a microphone of the combined pressure responsive and pressure gradient responsive type, the method of deriving signal energy which comprises variably selecting output signals from each of the pressure responsive and pressure gradient responsive sections, and combining said selected signals into a single output channel.

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