

Sept. 7, 1943.

L. J. ANDERSON

2,328,941

ELECTRO-ACOUSTICAL APPARATUS

Filed Feb. 29, 1940

2 Sheets-Sheet 1

Fig. 1

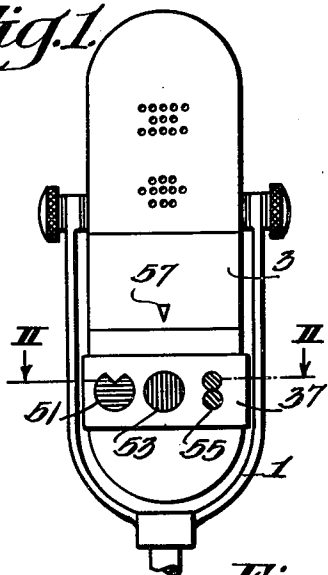


Fig. 2

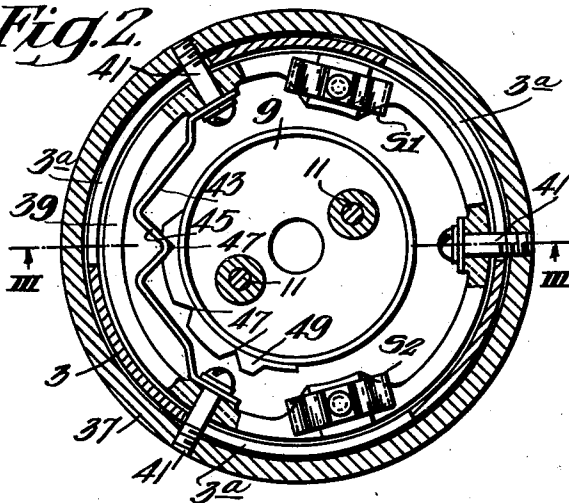


Fig. 3

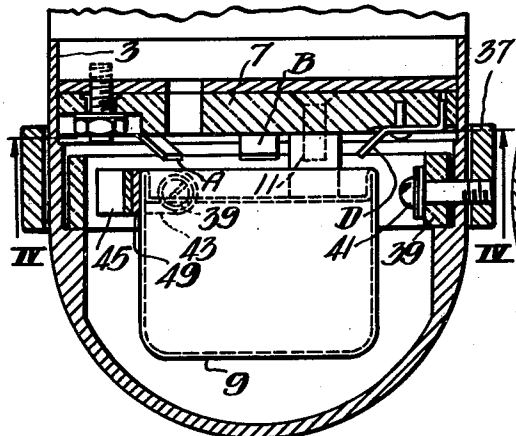


Fig. 4

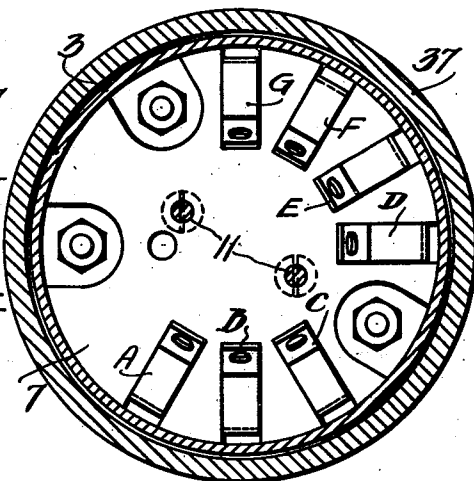


Fig. 5

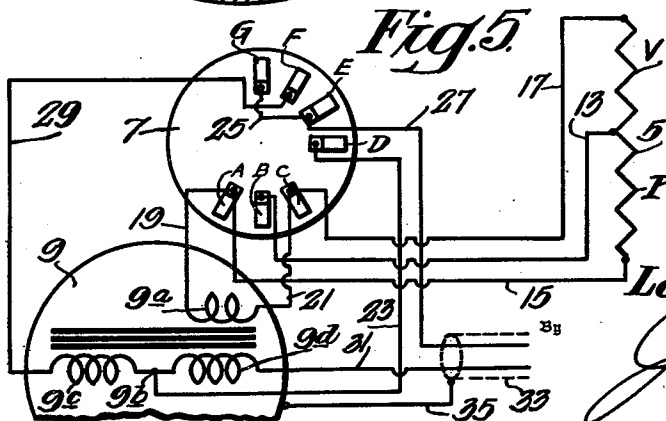
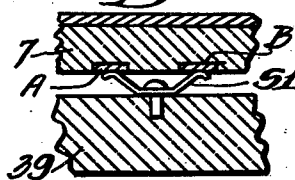


Fig. 6



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2 Sheets-Sheet 2

Fig. 7.

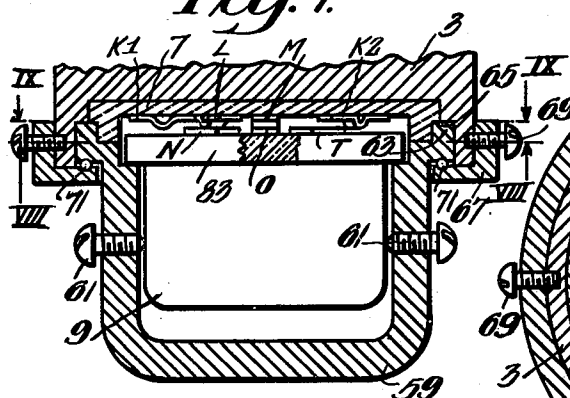


Fig. 8.

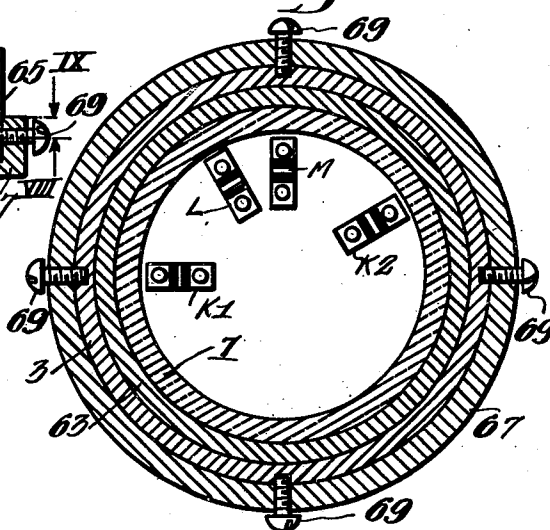


Fig. 9.

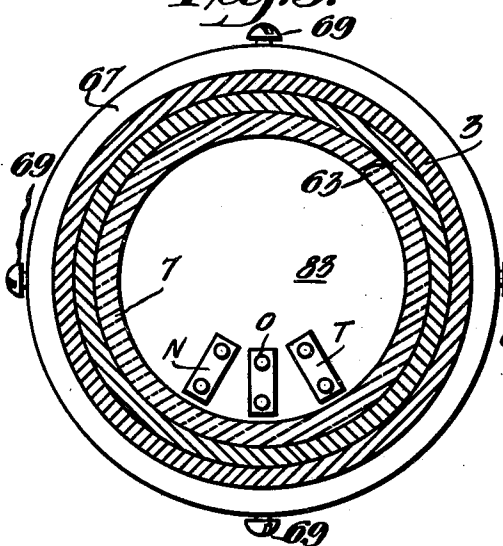


Fig. 10.

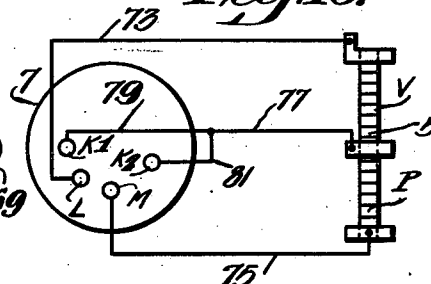
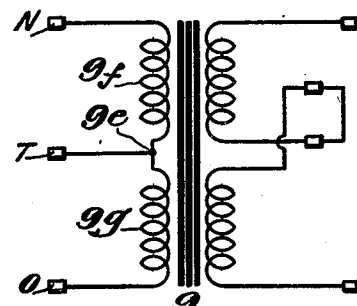


Fig. 11.



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UNITED STATES PATENT OFFICE

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ELECTROACOUSTICAL APPARATUS

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13 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 the sound wave are bi-directional, while those responsive to only the pressure component of the sound wave are non-directional. By suitably combining the two, as disclosed, for example, in the re-issue patent to Olson and Weinberger, No. 19-115, a microphone is obtained which is unidirectional.

Under varying circumstances, it is desirable to employ one or the other of these types of microphones, and the primary object of my present invention is to provide a single microphone as aforesaid which may be readily adjusted to operate either as a unidirectional microphone, a bidirectional microphone or a non-directional microphone.

More particularly, it is an object of my present invention to provide a novel microphone of the type set forth which may be readily adjusted to operate either as a microphone responsive to the pressure gradient component of the sound wave, a microphone responsive to the pressure component of the sound wave, or a microphone which is responsive to both said components.

Another object of my present invention is to provide an improved microphone as above described which is simple in construction, which is comprised of a minimum number of parts, and which is highly efficient in operation.

According to one form of my invention, I mount in the casing which houses the ribbon elements or other moving conductors of the microphone a terminal plate to which the ribbons are connected and also connect thereto the primary winding of a suitable transformer which is also housed within said casing. The secondary winding of this transformer is provided with a suitable tap and this winding and its tap are connected to other terminals on said terminal plate. Rotatably mounted on the casing of the microphone is an annular control member provided with a pair of sliders adapted to bridge certain of said terminals, depending upon the position of the control or ring member on the casing, and the arrangement is such that, in one position, the velocity section of the ribbon is

short circuited and the pressure section of the ribbon is connected to the primary winding of the transformer with the whole secondary winding operative. In another position of the ring member, the pressure section of the ribbon is short circuited and the velocity section is connected to the primary winding of the transformer, the whole secondary winding again being operative. In the third position of the ring member, both the velocity section and the pressure section of the ribbon are connected to the primary winding of the transformer, and only a portion of the secondary winding is rendered operative through the tapped connection thereto. In this way, the output impedance of the microphone looking into the secondary winding of the transformer is always constant regardless of which of the ribbon sections may be connected to the primary winding of the transformer.

In another form of my invention, instead of using the annular control member, or ring member, I mount the transformer in a rotatable housing at the bottom of the microphone casing and provide the transformer housing with a terminal plate to which its windings are connected, the primary winding of the transformer in this form of my invention being tapped. By rotating the aforesaid rotatable housing to any one of three predetermined positions, suitable connection may be made between the ribbon sections of the movable conductor and the primary winding of the transformer such that either the velocity section alone is connected to the primary winding through the tapped connection thereto, the pressure section alone is connected to the primary winding of the transformer, also through said tapped connection, or both said sections are connected to the whole primary winding. In order to maintain a constant output impedance, the secondary winding of the transformer may be suitably controlled by external switching means to shift the transformer turn ratio depending upon the connections to the primary winding.

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 two embodiments thereof, when read in connection with the accompanying drawings in which

Figure 1 is a front elevation of one form of my invention,

Figure 2 is an enlarged sectional view thereof taken along the line II—II of Fig. 1.

Figure 3 is a sectional view taken along the line III—III of Fig. 2.

Figure 4 is a sectional view taken along the line IV—IV of Fig. 3.

Figure 5 is a circuit diagram showing the connections of the vibratile conductor of the microphone and of the transformer to the terminal plate.

Figure 6 is a detailed sectional view showing the cooperation of one of the sliders or bridging elements on the control member of this form of my invention with terminals on the terminal plate.

Figure 7 is a fragmentary sectional view of another form of my invention.

Figure 8 is a sectional view taken along the line VIII—VIII of Fig. 7.

Figure 9 is a sectional view along the line IX—IX of Fig. 7.

Figure 10 is a wiring diagram showing the connections of the movable conductor to the terminal plate of this form of my invention, and

Figure 11 is a wiring diagram showing the connections to the transformer windings.

Referring more particularly to the drawings, wherein similar reference characters designate corresponding parts throughout, I have shown, in Fig. 1, a yoke member 1 upon which is swivelled a casing 3 within which is mounted a movable conductor 5, such as a crimped ribbon mounted for vibration in the air gap of a suitable magnetic structure, all in well known manner. The conductor 5 may be comprised of two separate ribbons or of a single ribbon clamped at its center so as to provide the serially connected ribbon sections V and P, the section V being accessible on both sides by sound waves and therefore responsive to the pressure gradient component of the sound wave, and the pressure section P having a suitable pipe therebehind (as shown for example in the above identified Olson et al. reissue patent) whereby it is responsive to the pressure component of the sound wave.

In the lower portion of the casing 3, there is mounted a terminal plate 7 provided with a plurality of spring terminal members A, B, C, D, E, F and G, a suitable coupling transformer 9 being secured to the terminal plate 7, as by means of screws or the like 11. The common end of the ribbon sections V and P is connected through a lead 13 to the terminal strip B. The other end of the ribbon section P is connected through a lead 15 to the terminal strip A, and the other end of the ribbon section V is connected through a lead 17 to the terminal strip C, the primary winding 9a of the transformer 9 being connected through leads 19 and 21, respectively, to the terminal strips A and C. It will thus be seen that the whole ribbon or conductor 5 is connected in series with the primary winding 9a of the transformer and that, by bridging either the terminals A and B, or B and C, either the pressure section P will be short circuited, or the velocity section V will be short circuited, depending upon which terminals are bridged. Accordingly, it is possible to adjust the microphone so that either the voltage generated by the section V will be applied to the primary winding 9a, the voltage generated by the section P will be applied to the primary winding 9a, or the sum of the voltages generated by the serially connected sections V and P will be applied to the primary winding 9a, depending, respectively, upon whether the

terminals A—B are bridged, whether the terminals B—C are bridged, or whether the terminals A, B and C are left open.

The secondary winding of the transformer 9 is provided with a tap 9b which divides the secondary winding into two sections 9c and 9d, the tap 9b being connected by a lead 23 to the terminal strip D. The terminal strips E and G are bridged by a lead 25, the strip E being connected to one side of a suitable power line through a lead 27. The terminal end of the secondary winding section 9c is connected to the terminal strip F through a lead 29, and the terminal end of the secondary winding portion 9d is connected to the other side of the power line by means of a lead 31, a shield 33 around the leads 27 and 31 being grounded to the casing of the transformer 9 by means of a lead 35.

From the foregoing, it will be obvious that when the terminal strips D and E are bridged, the secondary winding portion 9d is connected to the line through the lead 27, terminal strip E, terminal strip D, lead 23, and lead 31, the secondary winding portion 9c remaining open circuited. On the other hand, when the terminal strips E and F are bridged or the terminal strips F and G are bridged, both secondary winding portions 9c and 9d are connected to the line, in the former case through the lead 27, terminal strip E, terminal strip F, lead 29, and lead 31; and in the latter case through the lead 27, lead 25, terminal strip G, terminal strip F, lead 29 and lead 31.

For effecting the various connections set forth above, I provide on the casing 3 a rotatable control member 37 in the form of an annulus or ring which is connected to a second ring 39 of insulating material by means of a plurality of screws or the like 41 which pass through a like number of circumferentially spaced slots 3a in the casing 3. The ring member 39 is provided with a pair of conductive bridge members S₁ and S₂ which are in circumferentially spaced relation, the member S₁ being adapted to coact with the terminal strips A, B and C, and the member S₂ being adapted to coact with the terminal strips D, E, F and G. The ring 39 also carries a spring member 43 formed with a V-shaped detent 45 which is adapted to cooperate with a plurality of V-shaped notches 47 in a plate 49 secured to the casing of the transformer 9, the detent 45 and the notches 47 cooperating to releasably lock the ring members 37 and 39 in adjusted position.

The control or ring member 37 is free to be moved circumferentially on the casing 3 within the limits permitted by the slots 3a. When the control member 37 is moved to a position such that the bridge member S₁ is out of contact with the terminal strips A, B and C, and the bridge member S₂ bridges the terminal strips D and E, then both of the ribbon sections V and P retain operative connection with the primary winding 9a of the transformer and only the secondary winding portion 9d is connected to the line, as above described. Thus, the microphone is set for unidirectional operation. If the control member 37 is moved to a position such that the bridge member S₁ bridges the terminal strips A and B and the bridge member S₂ bridges the terminal strips E and F, then the pressure section P of the ribbon 5 becomes short circuited and inoperative to apply voltages to the primary winding 9a, leaving only the velocity section V operative for this purpose. At the same time, the secondary

winding portions 9c and 9d are both connected to the line, and the microphone is conditioned to have a bidirectional characteristic. Similarly, if the control member 37 is moved to a position such that the bridge member S₁ bridges the terminal strips B and C and the bridge member S₂ bridges the terminal strips F and G, the velocity section V of the ribbon 5 becomes short circuited, both of the secondary winding portions 9c and 9d become connected to the line as above described, and only the pressure section P is operative to apply voltages developed thereby. Hence, in the latter case, the microphone is conditioned to be responsive only to the pressure component of a sound wave and has a non-directional characteristic.

To facilitate ascertaining at a glance the operating condition of the microphone at any time, the ring member 37 may have applied thereto a series of indicia 51, 53 and 55. These are preferably, and respectively, curves simulating the cardioid characteristic of the unidirectional microphone, the non-directional characteristic of the pressure microphone, and the bidirectional characteristic of the velocity microphone, and they may be further differentiated by coloring each of them differently (for example, blue, red, and green), as indicated in Fig. 1. These, or any other similar indicia, may cooperate with a pointer 57 on the casing 3 and will be so related thereto that the characteristic appearing under the pointer readily indicates the operating condition of the microphone.

In Figs. 7 to 11, there is shown another modification of my invention wherein the transformer 9 is housed within a housing 59 to which it is secured for movement therewith as a unit, as by means of screws 61 or the like. The housing 59 is formed with an upstanding flange 63 which is confined between a shoulder 65 formed on the casing 3 and an annular member 67 of L-shaped cross section which is secured to the casing 3 by the screws 69. The housing 59 is free to rotate in the ring member 67 and the casing 3, and preferably rides on antifriction bearings 71.

The terminal plate 7 of this form of my invention is provided with a plurality of spring terminal strips K₁, K₂, L and M, the terminal end of the velocity section of the ribbon 5 being connected to the terminal strip L by means of a lead 73, the terminal end of the pressure section P of the ribbon 5 being connected to the terminal strip M by a lead 75, and the common ends of the ribbon sections V and P being connected to the terminal strips K₁ and K₂, respectively, by the common lead 77 and the leads 79 and 81. The casing of the transformer 9 is also provided with a terminal plate 83 on which are the three terminal strips N, O and T. The primary winding of the transformer 9 in this form of my invention has a tape 9e which divides the primary winding into the portions 9f and 9g. The tap 9e of the primary winding is connected to the terminal strip T on the plate 83, the terminal end of the primary winding portion 9f is connected to the terminal strip N, and the terminal end of the primary winding portion 9g is connected to the terminal member O.

The adjustment of this form of my invention is very similar to that described above in connection with the modification shown in Figs. 1 to 6. All that is necessary is to turn the transformer housing 59 one way or the other to obtain the desired connections between the terminal members N, O and T and the terminal strips K₁, K₂, L and

M. When it is desired to operate the microphone as a bidirectional, or velocity, microphone, the transformer housing 59 and the transformer 9 are turned to a position where the terminal T is connected to the terminal strip L and the terminal N is connected to the terminal strip K₁, in which case the velocity section V of the ribbon 5 becomes connected to the portion 9f of the primary winding of the transformer through the leads 73, 79 and 77. To set the microphone for operation as a pressure, or nondirectional, microphone, the housing 59 and transformer 9 are turned to a position such that the terminal member T is connected to the terminal strip K₂ and the terminal N is connected to the terminal strip M. In such case, the pressure section P of the ribbon 5 is connected to the portion 9f of the primary winding through the leads 77, 81 and 75. On the other hand, when it is desired to operate the microphone as a unidirectional microphone having the well known cardioid characteristic, the transformer housing 59 and the transformer 9 are turned to a position such that the terminal member O is connected to the terminal strip M and the terminal member N is connected to the terminal strip L. In such case, it is obvious that the full primary winding becomes connected to the whole ribbon 5 through the leads 73 and 75. In any case, regardless of the relation of the terminal members N, O and T with respect to the terminal strips K₁, K₂, L and M when there is a connection between them, the output impedance of the transformer 9 will always remain the same because the tap 9e is so chosen as to maintain the proper number of turns in the primary winding when only either the pressure section P or the velocity section V is connected thereto. As in the case of the first described modification of my invention, the housing 59 may be provided with the curves or other suitable indicia 51, 53, 55 to indicate the operating condition of the microphone.

From the foregoing description, it will be obvious to those skilled in the art that I have provided a novel microphone switching arrangement by means of which the selected operating condition for the microphone may be quickly and easily obtained. Although I have shown and described but two embodiments of my invention, it will be obvious to those skilled in the art that many other modifications, as well as changes in those described, are possible. For example, to facilitate detecting at a distance the particular curve 51, 53 or 55 which at any time indicates the then operating condition of the microphone, a suitable light source may be provided in the lower part of the casing 3 to illuminate these indicia. Other changes and similar additions will no doubt readily suggest themselves to those skilled in the art. I, therefore, desire it to be understood that I do not wish my invention to 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 a sound pick-up system, the combination of a casing, a pair of electro-dynamic translating units therein each including a vibratile element, one of said elements being responsive to the pressure gradient component and the other to the pressure component of a sound wave, said elements being adapted to develop voltages upon vibration thereof in response to said components, a coupling transformer including a primary winding, and control means movably mounted on said casing for selectively connecting to said primary

winding either one or both of said elements at will, said control means including means for selecting and rendering effective predetermined portions of the secondary winding of said transformer in accordance with the selected one or both of said elements connected to said primary winding.

2. In a sound pick-up system, the combination of a casing, a pair of electro-dynamic translating units therein each including a vibratile element, one of said elements being responsive to the pressure gradient component and the other to the pressure component of a sound wave, said elements being adapted to develop voltages upon vibration thereof in response to said components, a terminal plate in said casing, a plurality of terminals on said plate, a coupling transformer, said elements and the primary winding of said transformer being electrically connected to said terminals, and control means movably mounted on said casing for selectively coupling either one or both of said elements to said primary winding at will whereby to apply said voltages to said transformer.

3. The invention set forth in claim 2 characterized in that said control means comprises an annular member surrounding said casing and slidably mounted thereon.

4. The invention set forth in claim 2 characterized in that said control means comprises an annular member surrounding said casing and slidably mounted thereon, and characterized further by the addition of one or more sliders carried by said member and adapted to coact with said terminals upon moving said member to predetermined positions to effect connection between the selected one or both of said elements and said primary winding.

5. The invention set forth in claim 2 characterized in that said transformer is provided with a tapped secondary winding, characterized further in that said secondary winding and the tap thereon are connected to certain of said terminals, and characterized still further in that said control means includes a slider adapted to bridge certain of said last named terminals in pairs, said terminals and said slider being so arranged that when either of said elements alone is selected, for operation, said slider is effective to render the whole secondary winding of said transformer operative, and when both said elements are selected for joint operation, said slider is effective to render only a portion of said secondary winding operative.

6. In a sound pick-up system, the combination of a casing having a reference indicium thereon, a pair of electro-dynamic translating units therein each including a vibratile element, one of said elements being responsive to the pressure gradient component and the other to the pressure component of a sound wave, said elements being adapted to develop voltages upon vibration thereof in response to said components, a coupling transformer, control means movably mounted on said casing for selectively connecting to said transformer either one or both of said elements at will, and separate indicia complementary to said indicium associated with said control means for visually indicating in conjunction with said indicium the operating condition of said system.

7. The invention set forth in claim 6 characterized in that said indicia comprises curves simulating the directional characteristics of said elements when acting either singly or jointly.

8. The invention set forth in claim 6 characterized in that said indicia comprise curves simulating the directional characteristics of said elements when acting either singly or jointly, and characterized in that each of said curves is differently colored.

9. In a microphone having a casing within which is carried a vibratile element adapted to be operated in response to either the pressure gradient component of a sound wave, the pressure component of a sound wave, or both said components, control means including a ring member rotatably mounted on said casing for selectively adjusting the microphone to any one of said operating conditions at will, and means associated with said first named means for indicating the operating condition of the microphone, said indicating means comprising a plurality of curves each simulating the directional characteristics of the microphone corresponding to a different operating condition thereof and a pointer on said casing for cooperation with said curves.

10. In a sound pick-up system, the combination of a casing, a pair of electro-dynamic translating units therein each including a vibratile element, one of said elements being responsive to the pressure gradient component and the other to the pressure component of a sound wave, said elements being adapted to develop voltages upon vibration thereof in response to said components, a coupling transformer including a primary winding, and control means including a housing movably mounted on said casing for selectively connecting to said primary winding either one or both of said elements at will, said transformer being housed within said housing and being movable therewith as a unit.

11. In a sound pick-up system, the combination of a casing, a pair of electro-dynamic translating units therein each including a vibratile element, one of said elements being responsive to the pressure gradient component and the other to a pressure component of a sound wave, said elements being adapted to develop voltages upon vibration thereof in response to said components, a coupling transformer including a primary winding, and control means including a housing rotatably mounted on said casing for selectively connecting to said primary winding either one or both of said elements at will, said transformer being housed within said housing and being movable therewith as a unit, and said control means also including means associated with said primary winding for selecting and rendering effective either only a portion of said primary winding or the whole of said primary winding in accordance with the selected one or both of said elements connected to said primary winding.

12. In a sound pick-up system, the combination of a casing, a pair of vibratile elements therein one of which is responsive to the pressure gradient component and the other to the pressure component of a sound wave, said elements being adapted to develop voltages upon vibration thereof in response to said components, a terminal plate in said casing, a plurality of terminal strips on said plate, said elements having connection with said terminal strips, a housing rotatably carried by said casing, an output transformer housed within said housing and secured thereto for movement with said housing as a unit, said transformer including a tapped primary winding, a second terminal plate on said

transformer, and a plurality of terminals on said second named plate, said primary winding and the tap thereon being connected to said last named terminals, and said last named terminals being adapted to coact with said terminal strips for coupling either one or the other of said elements to a portion of said primary winding through said tap, or both said elements to the whole primary winding, depending upon the position of said transformer and said housing on said casing.

13. In a microphone having a casing within

5 which is carried a vibratile element adapted to be operated in response to either the pressure gradient component of a sound wave, the pressure component of a sound wave, or both components, control means including a member rotatably mounted on said casing for selectively adjusting said microphone to any one of said operating conditions at will, and means exterior of said casing associated with said first named 10 means for indicating the operating condition of the microphone.

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