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MICROPHONE DEVICE

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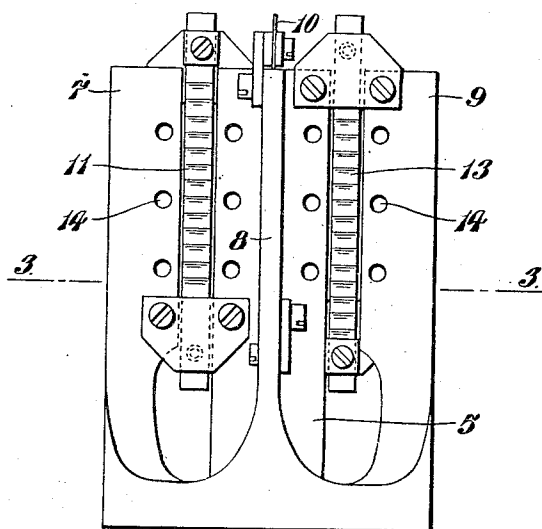


Fig. 1

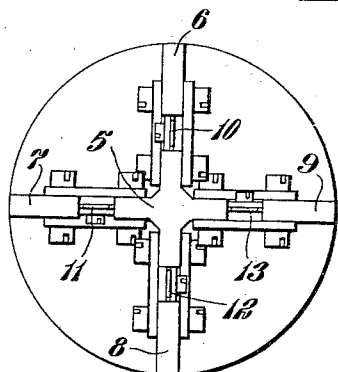


Fig. 2

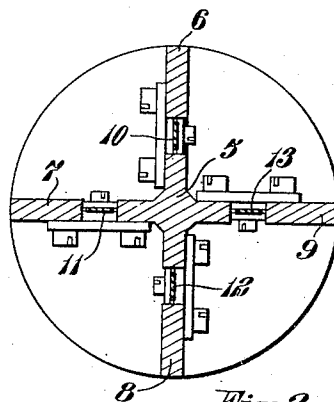


Fig. 3

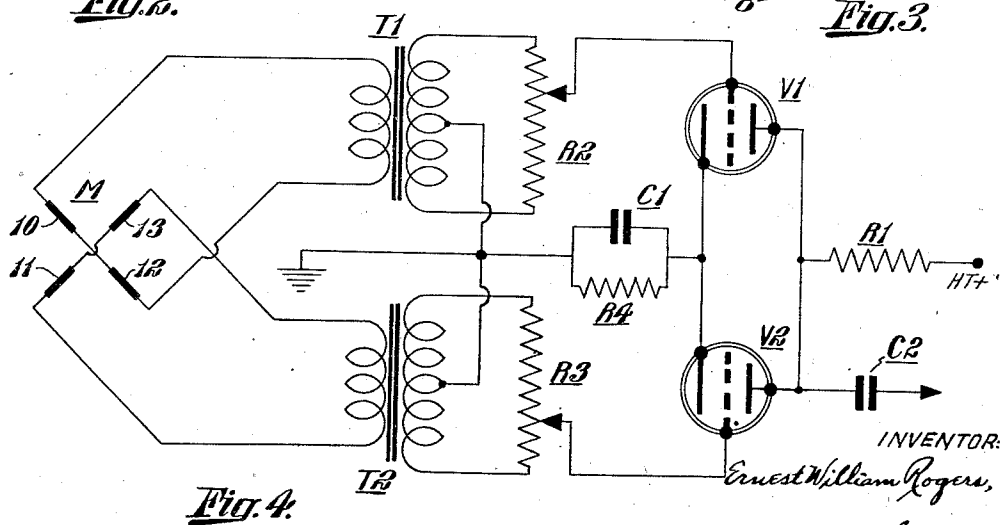


Fig. 4

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MICROPHONE DEVICE

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17 Claims. (Cl. 179—1)

This invention relates to microphone devices and has for its primary object to provide such devices and microphone systems whereby sound waves emanating from positions which are angularly displaced in relation to the location of the microphone, selectively can be received, thus permitting for example, substantially complete attenuation of sound waves from one sound source whilst obtaining satisfactory reception of sound waves from another but angularly displaced source.

Microphones according to the invention can be employed for a variety of purposes such, for instance, as a "voice pick-up" for film studio work when it is desired to eliminate pick-up of interfering sound waves from camera or other mechanism. The devices can also be used with considerable success for determining the direction of a sound source or, to be more precise, the direction of approach of sound waves, without interference from other sound waves approaching from an angularly displaced direction.

Many known forms of electro-acoustic means possess directional properties and those of the ribbon "velocity" type have quite pronounced directional characteristics. Even so, in general the response of such directional microphones is too broad to obtain in practice a sharply defined directional effect, except possibly in cases—not often occurring—where the approaching sound wave has, at least in effect, the form of a narrow beam or emanates from a point source. Furthermore, the sensitivity of these known devices to extraneous noise remains unduly high so that in cases where sound waves of large amplitude are being radiated from a close-by source, and even though such source may be located in the direction favourable for minimum microphone response, the pick-up of such unwanted sound may seriously encroach upon or even dominate over the pick-up of the wanted sound waves, thereby jeopardising if not completely annihilating the directional properties of the device. An arrangement of two separate microphone devices for sound location purposes may, in certain circumstances, give reasonably good sense of direction but the above mentioned disadvantages with respect to extraneous noise still exist, and irrespective of their electrical interconnection, phasing troubles are introduced.

Now, a microphone device according to the broadest aspect of this invention comprises, in combination as a unitary structure, two electro-acoustic means of the kind exhibiting a pronounced directional effect, said means being so relatively disposed that their respective lines of maximum sensitivity are angularly separated.

In more elaborate embodiments of the invention more than two electro-acoustic means are grouped to form a microphone device and in such

cases some of the said means may be so disposed that their respective lines of maximum sensitivity are substantially parallel. Thus for example, four electro-acoustic means can be assembled to form a microphone unit comprising one pair of such means so mounted that their respective lines of maximum sensitivity are substantially parallel whilst the other pair of means is so arranged that although their respective lines of maximum sensitivity are parallel these parallel lines are also normal to the corresponding lines of the first pair of elements.

Preferably, an arrangement is provided whereby the output of each electro-acoustic means of each group of such means having relatively parallel lines of maximum sensitivity, can be obtained separately, thus enabling a variety of phase and/or amplitude modified combinations readily to be made through the intermediary of suitable equipment which may include space discharge valve amplifying means.

One particular practical embodiment comprises four electro-acoustic means of the ribbon type arranged to form a single and compact microphone device possessing variable directional properties of a very high order of efficiency. In order that the invention more readily may be understood this particular embodiment will now be described, by way of example, with reference to the accompanying drawing, wherein—

Fig. 1 shows a side elevation of the microphone device.

Fig. 2 is a plan view of Fig. 1.

Fig. 3 is a sectional plan taken on the line 3—3 of Fig. 1.

Fig. 4 shows diagrammatically one embodiment of a mixing and amplifying circuit for the signals obtained from such a microphone device.

Referring to Figs. 1—3 it will be seen that the magnetic system of this device comprises a central common pole member 5 of cruciform section and four pole-pieces 6—9 symmetrically arranged therearound, one pole piece being disposed opposite each arm of the cruciform section but spaced therefrom to provide a "magnetic gap." In each of these four 'magnetic gaps' there is mounted a vibratory element consisting of a corrugated ribbon 10—13 respectively of aluminium or other light weight conductor, the several ribbons extending along the common pole member 5 in radial planes through the axis of the common pole member. The poles are apertured at 14 to provide a direct air path, between the opposite sides of each sound wave responsive ribbon, of dimensions small compared with the wavelength of the highest frequency to which the device is designed to respond.

It will be noted that each pair of diametrically opposed ribbons is disposed in a common plane, that is to say, all four side edges are in alignment,

whilst the two planes containing the respective pairs of ribbons are at right angles. Thus two pairs of ribbon microphone means are provided and their relative arrangement is such that the respective lines of maximum sensitivity for one diametrically opposed pair are normal to the corresponding lines of the other diametrically opposed pair.

The output from each individual microphone means is taken from the opposite ends of the ribbon and each of the diametrically opposed pairs of ribbons is adapted to be connected in parallel or in series so that their outputs are in phase and thus complementary. Suitable output transformers may be mounted upon a platform which carries the microphone device or alternatively such transformers may be attached to the device itself.

From preliminary experiments it is believed that each pair of the opposed ribbons behaves in a manner to be expected from a single ribbon located at the centre of the assembly and that co-operatively the two pairs resemble, in action, two single ribbons so centrally disposed but contained in relatively normal planes. It appears that this theory holds good for the high audio frequencies so long as the ribbons are closely spaced and in this respect it should be noted that the constructional arrangement described is conducive to close spacing of the ribbons. It should also be noted that the multiplicity of symmetrically arranged pole pieces results in a highly efficient magnet system.

One manner of utilising such a microphone device consists in feeding the two separate outputs to a mixing circuit. An example of such a microphone system is shown in Fig. 4 and comprises a thermionic valve amplifier having two valves V1 and V2 provided with a common anode load impedance R1 and separate coupling means between the respective control grids and the microphone device M. Such coupling is made by audio transformers T1, T2 across the secondary winding of each of which there is connected a potentiometer R2, R3 respectively. The valves V1 and V2 are suitably biased by providing a cathode resistor R4 across which is connected a condenser C1. The output from this mixing circuit is obtained by way of a condenser C2. Thus, separately variable attenuation of the output from each pair of ribbons can be effected by means of the potentiometers, whilst, by providing a centre tapping on the secondary winding of each transformer, as shown, and connecting this tapping point to the valve cathodes or "earth," operation of either of the potentiometers will bring about a modification of the phase relationship of the signals applied to the input grids.

The microphone device in combination with this or an equivalent mixing system can be made to behave in various ways. Thus each coupled pair of ribbons can be employed separately. Alternatively, both pairs of ribbons can be employed with their outputs in phase or 180° out of phase and with the same degree of attenuation or different degrees of attenuation. Furthermore, the output of one coupled pair of ribbons can be employed to cancel the output of the other coupled pair of ribbons.

If the device is so positioned that all four ribbons are in alignment with the direction of approach of a sound wave (that is to say the sound waves travel along the length of the ribbon) and ignoring reflections or other disturbances from nearby bodies, each pair of ribbons will be in a

position for minimum sensitivity to the said wave and very little pick-up, if any, will result, except if the sound wave approaches as a fairly broad beam, in which case the small amount of pick-up will be equal for each pair of ribbons. However such pick-up can be rendered completely ineffective by cancelling out the response of one pair of ribbons by the response of the other pair thus leaving each pair of ribbons free to receive sound waves coming from other angularly disposed directions.

The microphone device can also be so positioned for use that one pair of ribbons is located for minimum sensitivity with respect to an unwanted sound wave whilst the other ribbons will be more sensitive to such sound wave and a small fraction of their output can be employed to cancel out the pick-up from the other pair. With such an arrangement sound waves coming from a direction other than that of the unwanted sound waves will not be subjected to cancellation and consequently can be received free of interference from the unwanted sound waves.

According to a modified embodiment, means are provided whereby the output of each or more of four ribbons can be obtained separately and if desired such separate outputs can be passed to separate input channels of a mixing circuit.

In another arrangement, the outputs from the separate electro-acoustic means are paralleled and applied to a common input circuit of a valve amplifying equipment.

What I claim and desire to secure by Letters Patent is:

1. A microphone device comprising a central pole means, a plurality of outer pole means arranged about said central pole means to form a plurality of angularly separated and elongated magnetic gaps all extending substantially parallel to the axis of said central pole, and a sound wave responsive ribbon element in each of said gaps to form electro-acoustic means, said ribbon elements being located in angularly spaced planes, whereby the respective lines of maximum sensitivity of the plurality of electro-acoustic means are separated angularly.

2. A microphone device comprising a central pole means, a plurality of outer pole means arranged about said central pole means to form a plurality of magnetic gaps, and a sound wave responsive ribbon element in each of said gaps to form electro-acoustic means, said ribbon elements being located in planes at right angles to each other, whereby the respective lines of maximum sensitivity of the plurality of electro-acoustic means extend at right angles to one another.

3. A microphone device comprising a center pole member of cruciform cross section, four outer pole members cooperating with said center pole member to form four symmetrically disposed magnetic gaps, and a sound wave responsive ribbon element in each of said magnetic gaps to form electro-acoustic means, said ribbon elements being arranged along the central pole member in angularly spaced planes, whereby the respective lines of maximum sensitivity of at least two of the plurality of electro-acoustic means thus provided are separated angularly.

4. A microphone device comprising a central pole means, a plurality of outer pole means arranged about said central pole means to form a plurality of magnetic gaps, a sound wave responsive ribbon element in each of two of said gaps to form a pair of electro-acoustic means, said

ribbon elements being so disposed that their respective lines of maximum sensitivity are substantially parallel, and a sound wave responsive ribbon element in another of said gaps to form another electro-acoustic means, the latter ribbon element being so relatively arranged with respect to the said two ribbon elements that its line of maximum sensitivity is in angular relationship with the said parallel lines of maximum sensitivity.

5. A microphone device comprising a central pole means, a plurality of outer pole means arranged about said central pole means to form a plurality of magnetic gaps, a sound wave responsive ribbon element in each of two of said gaps to form a pair of electro-acoustic means, said ribbon elements being so disposed that their respective lines of maximum sensitivity are substantially parallel, and a sound wave responsive ribbon element in each of two other of said gaps to form two further electro-acoustic means, the said latter two ribbon elements being so relatively arranged that their respective lines of maximum sensitivity are substantially parallel but at right angles with respect to the corresponding lines of the first mentioned two ribbon elements.

6. A microphone device comprising a central pole means, a plurality of outer pole means arranged about said central pole means to form a plurality of magnetic gaps, and a sound wave responsive ribbon element in each of said gaps to form electro-acoustic means, said ribbon elements each extending parallel to a common line and being so relatively arranged that the respective lines of maximum sensitivity of the plurality of electro-acoustic means thus provided are separated angularly.

7. A microphone device comprising a common magnetic pole member, a plurality of pole members arranged about said common pole member to form a plurality of magnetic gaps, and a sound wave responsive ribbon element in each of said gaps to form electro-acoustic means, said ribbon elements being so relatively arranged that the respective lines of maximum sensitivity of the plurality of electro-acoustic means thus provided are separated angularly.

8. A microphone device comprising a common magnetic pole member, a plurality of pole members arranged about said common pole member to form a plurality of magnetic gaps, and a sound wave responsive ribbon element in each of said gaps to form electro-acoustic means, said ribbon elements being so relatively arranged that the respective lines of maximum sensitivity of the plurality of electro-acoustic means thus provided extend at right angles to one another.

9. A microphone device comprising a common magnetic pole member, a plurality of magnetic gaps arranged about said common pole member, and a sound wave responsive ribbon element in each of said gaps to form electro-acoustic means, said ribbon elements each extending parallel to a common axis and being so relatively arranged that the respective lines of maximum sensitivity of the plurality of electro-acoustic means are separated angularly.

10. A microphone device comprising a magnetic structure having at least two magnetic gaps, and a sound wave responsive ribbon element in each of said gaps to form electro-acoustic means, said ribbon elements being arranged side by side

and angularly displaced, whereby the respective lines of maximum sensitivity of the plurality of electro-acoustic means are separated angularly.

11. A microphone device comprising a magnetic structure having at least two magnetic gaps, and a sound wave responsive ribbon element in each of said gaps to form electro-acoustic means, said ribbon elements being arranged side by side and at right angles to each other, whereby the respective lines of maximum sensitivity of the plurality of electro-acoustic means extend at right angles to one another.

12. A microphone device comprising a magnetic structure having at least two laterally aligned magnetic gaps, and a sound wave responsive ribbon element in each of said gaps to form electro-acoustic means, said ribbon elements being laterally aligned and angularly displaced, whereby the respective lines of maximum sensitivity of the plurality of electro-acoustic means are separated angularly.

13. A microphone device comprising a magnetic system having a center pole member, a plurality of symmetrically disposed radially extending pole members each of which is spaced from said center pole member to provide a magnetic gap, and a sound wave responsive ribbon element so arranged in each of said gaps that the respective lines of maximum sensitivity of the plurality of electro-acoustic means thus provided are separated angularly.

14. A microphone device comprising a magnetic system having a center pole member, a plurality of symmetrically disposed radially extending pole members each of which is spaced from said center pole member to provide a magnetic gap, and a sound wave responsive ribbon element so arranged in each of said gaps that the respective lines of maximum sensitivity of the plurality of electro-acoustic means thus provided extend at right angles to one another.

15. A microphone device comprising a common magnetic pole member, four pole members symmetrically arranged about said common pole member to form four magnetic gaps, a sound wave responsive ribbon element in each of said four gaps to form four electro-acoustic means, the said four ribbon elements being in lateral alignment and symmetrically disposed about the axis of the common pole member, whereby the respective lines of maximum sensitivity of two of the electro-acoustic means are parallel but at right angles with respect to the corresponding lines of the other two electro-acoustic means.

16. A microphone system comprising a microphone device having a magnetic system with at least two magnetic gaps, a sound wave responsive ribbon element in each of said gaps, said ribbon elements being arranged side by side in a manner such that the respective lines of maximum sensitivity of the plurality of electro-acoustic means thus provided are separated angularly, a separate valve amplifying device for each of said electro-acoustic means, and a common load impedance provided for said valve devices.

17. A microphone system as recited in claim 16, in combination with means for adjusting the phase and amplitude of the voltage impressed upon one valve amplifier device independently of the phase and amplitude of the voltage impressed upon another valve amplifying device.

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