March 14, 1944. R. VILLEM 2,344,431

MICROPHONE PHASE COMPENSATOR

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Fig. 1

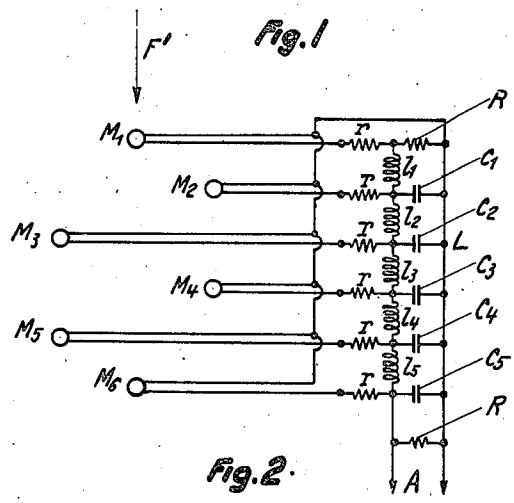
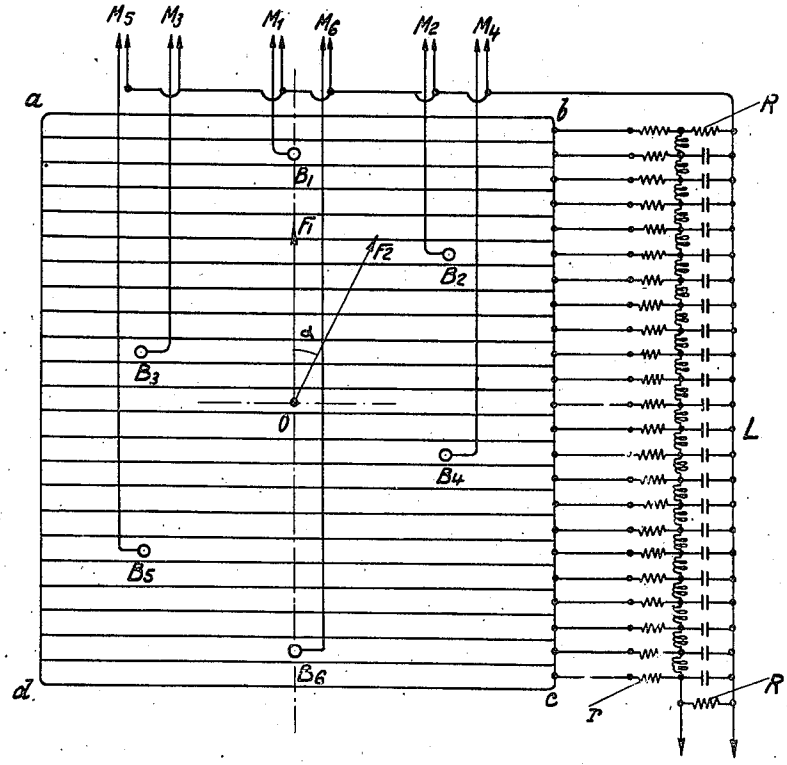


Fig. 2.



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Fig. 3a

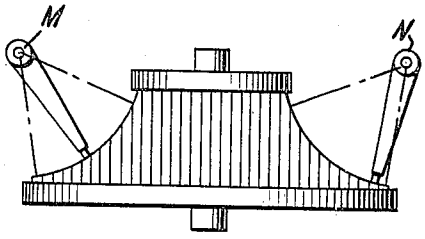


Fig. 3b

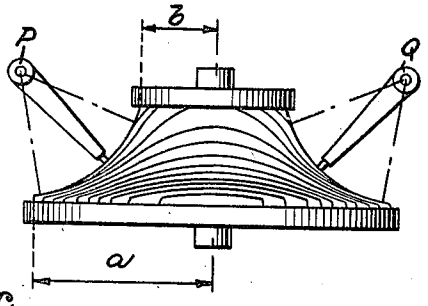


Fig. 3c

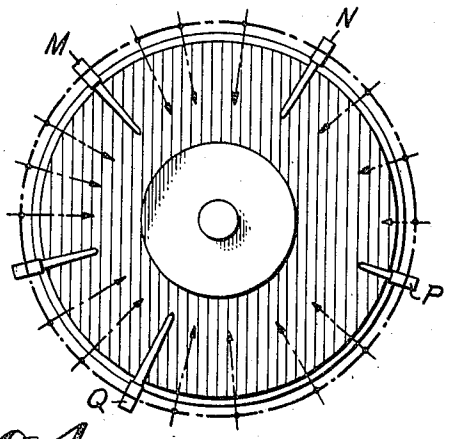
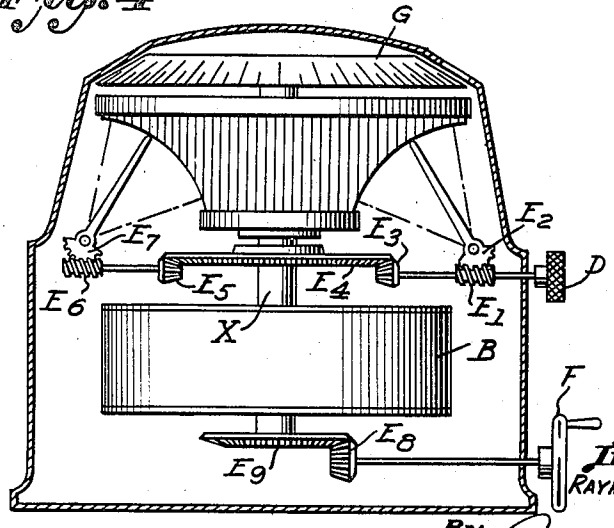


Fig. 4



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Fig. 5

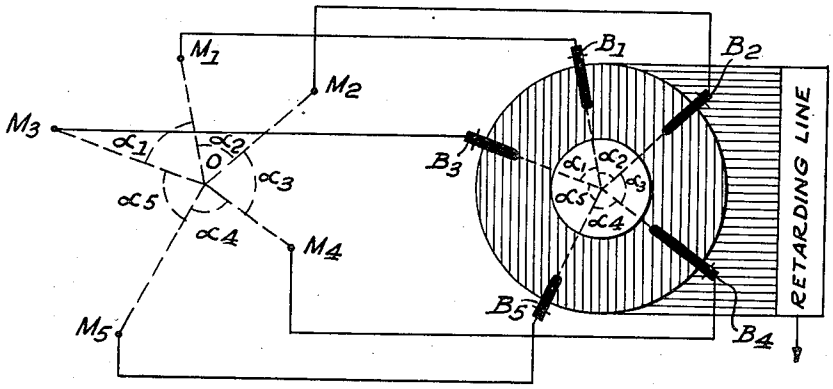
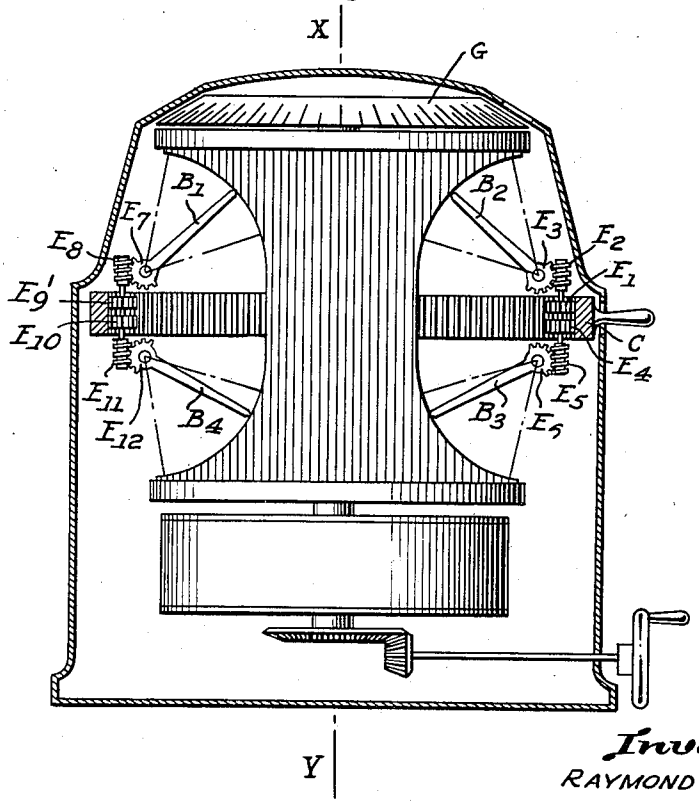


Fig. 6



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Fig. 8

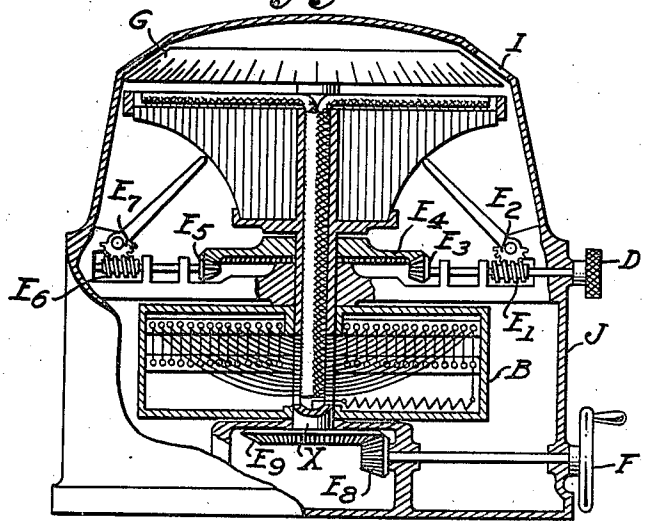
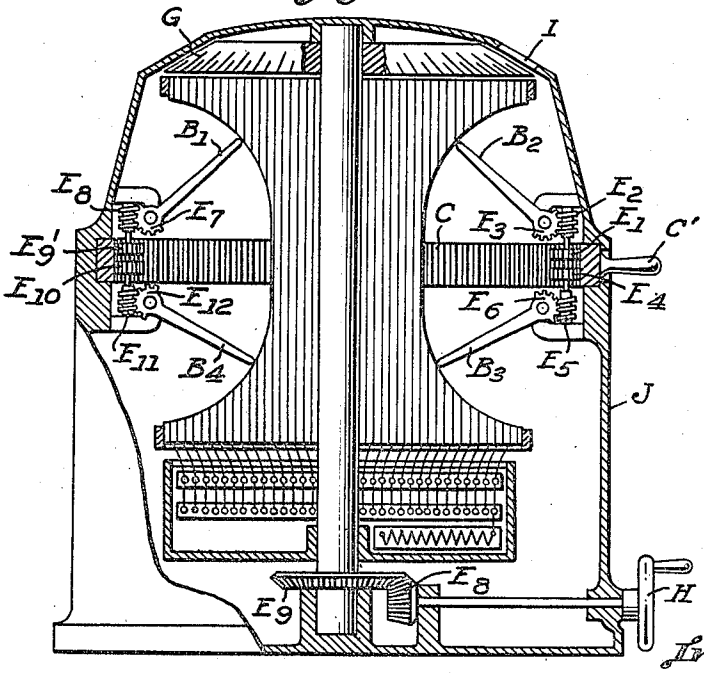


Fig. 9



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Fig. 7

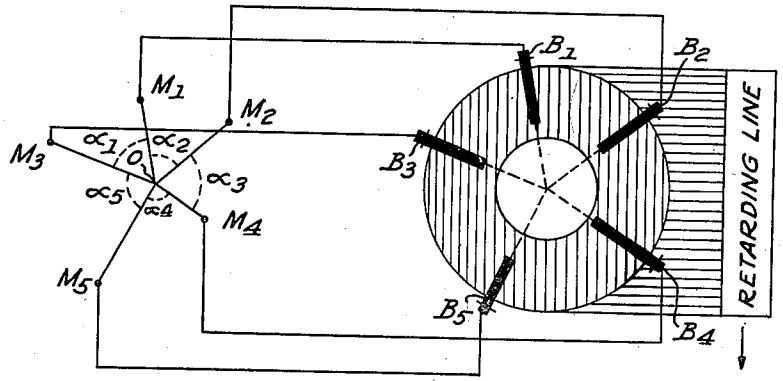
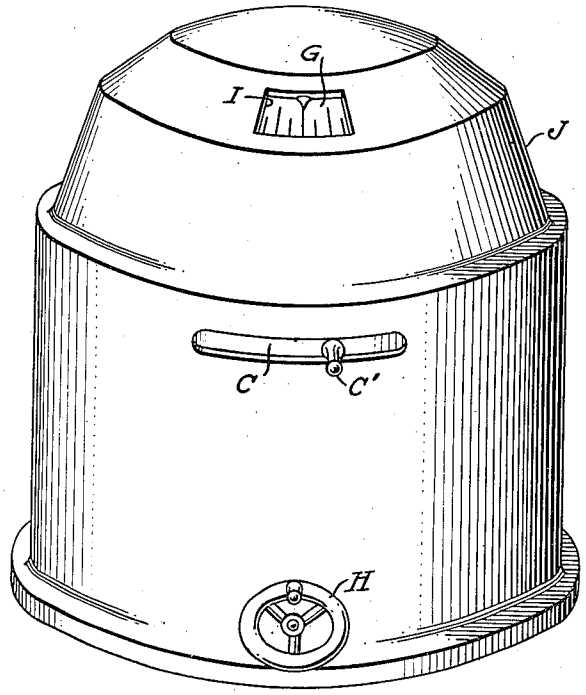


Fig. 10



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Patented Mar. 14, 1944 2,344,431

UNITED STATES PATENT OFFICE

2,344,431

MICROPHONE PHASE COMPENSATOR

Raymond Villem, Paris, France; vested in the Alien Property Custodian

Application June 25, 1940, Serial No. 342,318
In France July 18, 1939

4 Claims. (Cl. 177—386)

This invention is for improvements in or relating to a phase compensator for groups of microphones or transmitters, in particular for submarine transmission by supersonics and has for its object the mechanical embodiment of a phase compensator intended more particularly for submarine listening installations.

It is known that it is necessary in such installations to use directive groupings of microphones or transmitters in which the currents are kept in phase by the introduction of elements of artificial lines producing retardations of suitable value. In the accompanying drawings forming part hereof,

Fig. 1 is a diagram of a group of microphones with a common receiver arranged and connected as part of a phase compensator system according to the invention.

Fig. 2 diagrammatically represents a corresponding arrangement according to known art.

Fig. 3*a* is a side elevation of a current collector forming part of the invention.

Fig. 3*b* is another side elevation of the same shown rotated at an angle of 90° with respect to the position of Fig. 3*a*.

Fig. 3*c* is a top plan view of said collector.

Fig. 4 is a side elevation of the same with appropriate mechanism for controlling the brushes in contact therewith.

Fig. 5 is a circuit diagram connected to the brushes forming a system with a plan layout of the collector.

Fig. 6 illustrates a double collector system.

Fig. 7 is a similar view to Fig. 5 showing altered positions of the brushes.

Fig. 8 is a vertical section of the apparatus diagrammatically shown in Fig. 4.

Fig. 9 is a vertical section of the apparatus diagrammatically shown in Fig. 6.

Fig. 10 is a perspective view of the same apparatus as seen completely encased and viewed from the right in Fig. 6.

Figure 1 for example represents diagrammatically a group of six microphones M_1, M_2, M_3, M_4, M_5, M_6 actuating a common receiver A through successive elements of a line with retardation L composed of self-inductances and capacities.

The terminal resistances R as is known are equal to the characteristic impedance of the line and the supplementary resistance *r* reduce the interaction of the microphones.

The microphones being subjected successively to the wave coming from a direction F', which it is desired to favor, the currents supplied to the common receiver A by these microphones must all be the more retarded the earlier they are affected by the wave. The retardations given by the artificial line L must therefore decrease successively from the microphone M_1 to the microphone M_6, as is diagrammatically represented on the figure.

If the direction of the wave changes, it can be so arranged, without turning the whole of the microphones, that the various currents arrive in phase at the receiver. To this end, it is sufficient to modify the retardations given to each of them by the artificial line.

Such a result may be easily obtained, as is known, by means of a device similar to that shown in Figure 2. In this figure the rectangle *abcd* is a flat commutator, the successive blades of which are connected to the different elements of the line with retardation L. Opposite this commutator and bearing thereon, are arranged a series of brushes B_1, B_2, B_3, B_4, B_5, B_6 corresponding in number to the microphones M_1, M_2, M_3, M_4, M_5, M_6 to which they are connected.

If the successive elements of the line L have been regulated so as to relate the currents in the receiver A for a direction F_1 perpendicular to the blades of the commutator, it will be sufficient in order to favor another direction F_2 making an angle α with the first, to rotate the commutator through the same angle α with respect to the whole of the brushes, or vice versa. This compensation will be all the more precise the larger the number of blades the commutator has, that is to say, the more accentuated the subdivision of the artificial line.

One of the difficulties met with in the embodiment of these devices is to obtain good preservation of the contacts in order that no commutation noises occur during the movement of the brushes.

Another difficulty arises from the fact that in order to listen to noises in sound conducting fluids or media, the speed of transmission of which is variable, it is necessary to provide furthermore a device which permits the adjustment of these different speeds of transmission to the various retardations given by the artificial line.

The present invention has for its object to provide a compensator in which these difficulties are solved and which in particular permits of the very rapid regulation corresponding to the adaptation of the apparatus to media the speeds of transmission of which are different, such for example as submarine media of variable salinity.

The device proposed permits furthermore a fairly large number of brushes, each corre-

sponding to a microphone, to be grouped in a restricted space.

The arrangement in principle of the compensator according to the present invention is illustrated in Figures 3*a*, 3*b* and 3*c* referring respectively to two views in elevation taken at 90° from one another and a view in plan.

The commutator of partially toroidal surface is constituted by a bundle of insulated blades stuck together and held together by a hoop at their lower part.

To appreciate better the arrangement of this commutator, it may be imagined that it is obtained by starting with a bundle of blades insulated from one another and the section of which has been machined to obtain the form of revolution shown on Figures 3*a*, 3*b* and 3*c*. The commutator assembly is very rigid in construction since its section is approximately as substantial as that of a solid of equal resistance.

In dimensioning the commutator, independently of the number of blades which is regulated by the dimensions of the microphone system and the precision to be obtained, the ratio of the radii proportional to the arcuate length *a* and *b* (Fig. 2) of the contact surface of the arcuate contact surface of the commutator must be at least equal to the ratio of the distances from the point considered as the centre of the microphonic grouping to the most distant microphone on the one hand, and the nearest on the other hand.

There will be explained below the shape which it is advisable to give to the curvilinear section of this commutator.

The brushes permitting the arrival of the current from the microphones are arranged in a circle around the commutator as shown by Figure 3*c*. Only two brushes have been shown on Figures 3*a* and 3*b* so as not to complicate the drawings. The brushes pivot at the points M, N, P, Q . . . and are arranged to be fixed separately at suitable inclinations. When those inclinations have been chosen, all the brushes may be fixed relatively to one another by a mechanism similar to that illustrated in Figure 4. This mechanism enables all the brushes to be given a simultaneous angular displacement by rotating the knob D which operates the gears E_1, E_2, E_3, E_4, E_5, E_6, E_7. The operation of the mechanism will be at once understood by noting that the pulley carrying the gear E_4 is mounted idly on the shaft X. By way of non-restrictive example, in the embodiment of the principle as shown, the retardation line is located in a box B rigid with the commutator. The rotation of the latter is obtained by the crank F and the gears E_8, E_9. The accurate reading of the direction of emission or reception is ensured by an index suitably keyed onto the scale G which is visible through the window I in the casing J in Figs. 4, 6, 8, 9 and 10.

The compensator thus embodied may be adapted to any microphone system whatever.

Suppose, for example, the system is to be adapted to the microphonic base represented by Figure 5, the point O being for example considered as the centre of the said system. It is understood that the term base here means the profile plan of the actual area covered by the microphones.

The following procedure may be adopted:

1. The angles between the microphones with respect to the centre and the distances from the centre are measured and then the brush supports are arranged about their supporting ring in such a manner as to reproduce the angles and relative positions of the respective microphones.

2. The inclination of the brushes is regulated individually in such a manner that the horizontal projection of their points of contact on the collector reproduces the form of the microphonic base.

3. The brushes are made responsive to movement of the knob D effecting the general drive of all the brushes.

The electric connections of the system are shown diagrammatically on Figure 5. To simplify the drawing, the common return connection of the microphones and of the line of L retardation have not been shown except partially in Figs. 8 and 9.

The arrangement thus obtained permits of very rapidly adapting the compensator to sound conducting fluids or media, in which the speed of transmission varies.

If, in fact, the speed of transmission diminishes, the retardation to be given to the currents coming from the different microphones increases proportionally to their respective distance. It is therefore necessary that the dimensions of the image of the base, represented by the projection on the plan of Figure 5 of the point of friction of the brushes on the commutator, increases in dimensions whilst remaining similar thereto.

This result is here obtained very simply by causing the whole group of brushes to rotate through a suitable angle by means of the general actuating knob D, in Figs. 4 and 8, and shifting handle C′ of internal gear C in Figs. 9 and 10.

Hence, if the arms of the brushes in Figs. 4 and 8 are adjusted to hold the contact ends thereof in contact with the compensator in positions corresponding to the distances from the receiver the microphones are located by rotating knob D and adjusting the compensator by partial rotation of knob F until the impedances in the retardation circuit in box B causes the microphones to be in phase. Similarly, for two groups or a double group of microphones, the compensator of Figs. 6 and 9 is adjusted by partial rotation of knob H, while the contact arms B_1, B_2, etc., are adjusted for distance by shifting handle C^1 of Figs. 6, 9 and 10, which partly rotates the internal gear and through pinions E_1, E_4, E'_9 and E_{10} and worms E_2, E_5, E_8 and E_{11} in mesh with worm gear sectors E_3, E_6, E_7, and E_{12} of contact arms B_2, B_3, B_1, and B_4, respectively, will swing the latter upon their pivots to adjusted positions with respect to the collector until the microphones are found to be in phase.

In order that the correction may be sharp, it would be necessary to give to the sections of the commutator an exponential profile. To obtain the contact of the brushes on the commutator, it would then be necessary to provide for a certain displacement of the contacts with respect to the axis of the arms which support them.

In practice it will be sufficient in general to give to the profile of the commutator the form of an arc of a circle.

It will be noted that the arrangement according to the invention permits excellent contacts to be obtained owing to the fact that these operate on a surface of revolution. It will furthermore be noted that this arrangement permits, in the case of slight wear of the commutator, of taking this up by a small displacement of the

whole of the contacts, without endangering the precision of the information collected.

It will finally be noted that the system may be doubled, as shown by Figure 6, or in a general way may be multiplied if it is desired to use a very large number of microphones and if it is consequently necessary to drive simultaneously a very large number of brushes B_1, B_2, B_3, B_4. Such a control may be effected by means of the mechanism shown which comprises a toothed rim C acting on the brushes through the intermediation of gears E_1, E_2, E_3, E_4, . . . E_{11}, E_{12}, or by any other suitable means.

What I claim as my invention and desire to secure by Letters Patent of the United States is:

1. In connection with one or more detecting devices intended to be disposed in contact with an exterior surrounding fluid capable of conducting sounds or mechanical vibrations and provided with a circuit having two parallel branches connected together by at least one resistor and adapted to be connected to a receiver, an artificial line conductor comprising a plurality of resistors connected at individual spaced portions of one branch of said circuit with one of the plurality in series with the first resistor, a plurality of condenser means connected to said spaced points parallel with said first resistor and to corresponding points along the other branch, connection means upon the latter branch adapted to be connected individually to a group of said detecting devices, means for compensating the phase shifts between the currents in the different branches according to the direction and velocity of travel of the sounds or mechanical vibrations, said means including in combination a commutator or collector comprising a body of revolution exhibiting in at least one part of its profile a concave circular curvature, means for causing said commutator to rotate about its axis of revolution, segments insulated from each other occupying the active surface of the commutator with the projections of said segments in adjacent parallel planes perpendicular to the axis of rotation of the commutator having the shape of parallel bands, a group of pivoted contact members individually adapted to be connected to said detecting devices and mounted to be swingable so as to make contact with different portions of the curved surface of said collector, means for causing each of said contact members to pivot in a radial plane passing through the axis of said collector around the center of the circular curvature thereof, a connection between each of said group of resistors and a corresponding segment on said collector, and means for adjusting the contact members with respect to the collector so that the projections of the same in a plane perpendicular to the axis of rotation of said collector form a geometrical figure similar and corresponding to the relative projected distances of the corresponding detecting devices in the sound conducting fluid which are connected to said contact members and said other branch of said circuit.

2. Apparatus according to claim 1, having means for fixing each of the pivoted contact members in a predetermined adjusted position.

3. Apparatus according to claim 1, having two sets of pivoted contact members and two curved profile portions upon the collector generated from two spaced exterior generatrices, and having one set of contact members cooperating with one curved portion and the other set with the other curved portion of the collector and all of the contact members simultaneously adjustable.

4. Apparatus according to claim 1, having a hollow box or container rigid with the collector for containing the artificial line conductor and the parts thereof so as to be rotatable with said collector.

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