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H. NYQUIST ET AL

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ECHO SUPPRESSOR

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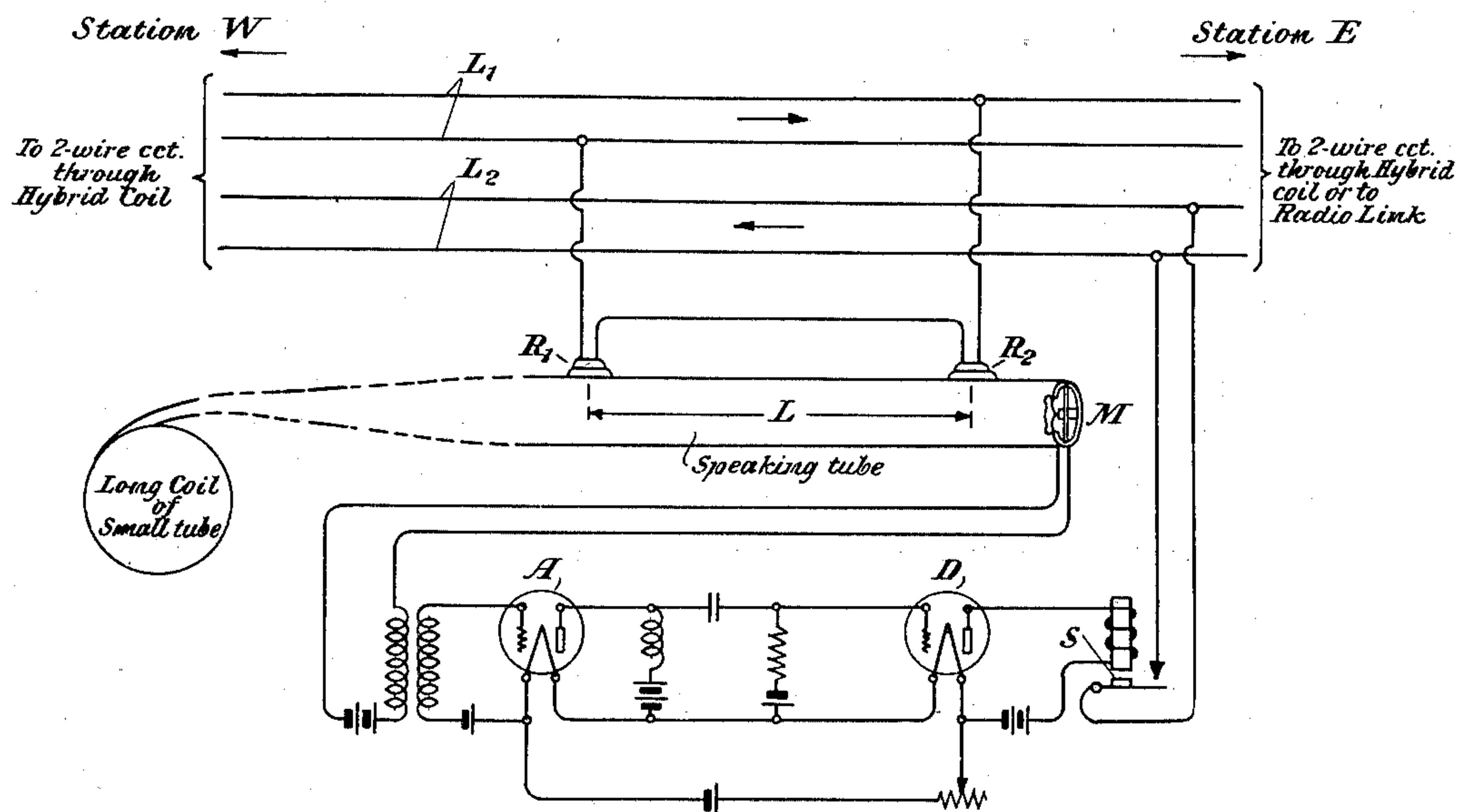


Fig. 1

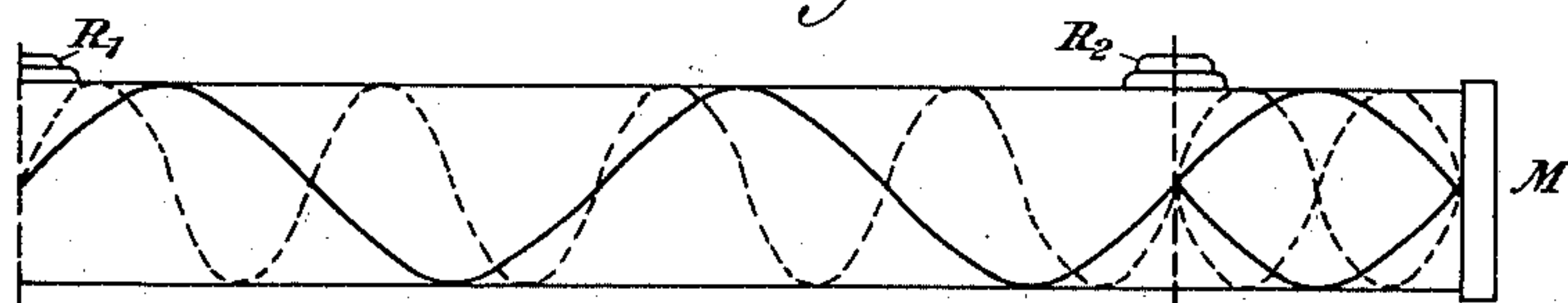


Fig. 2

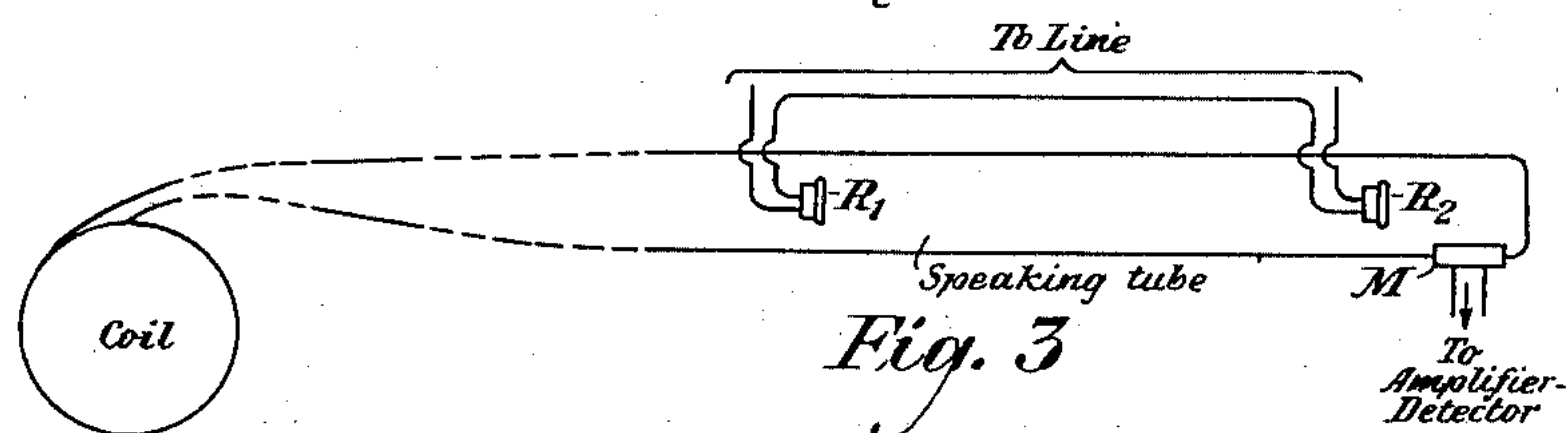


Fig. 3

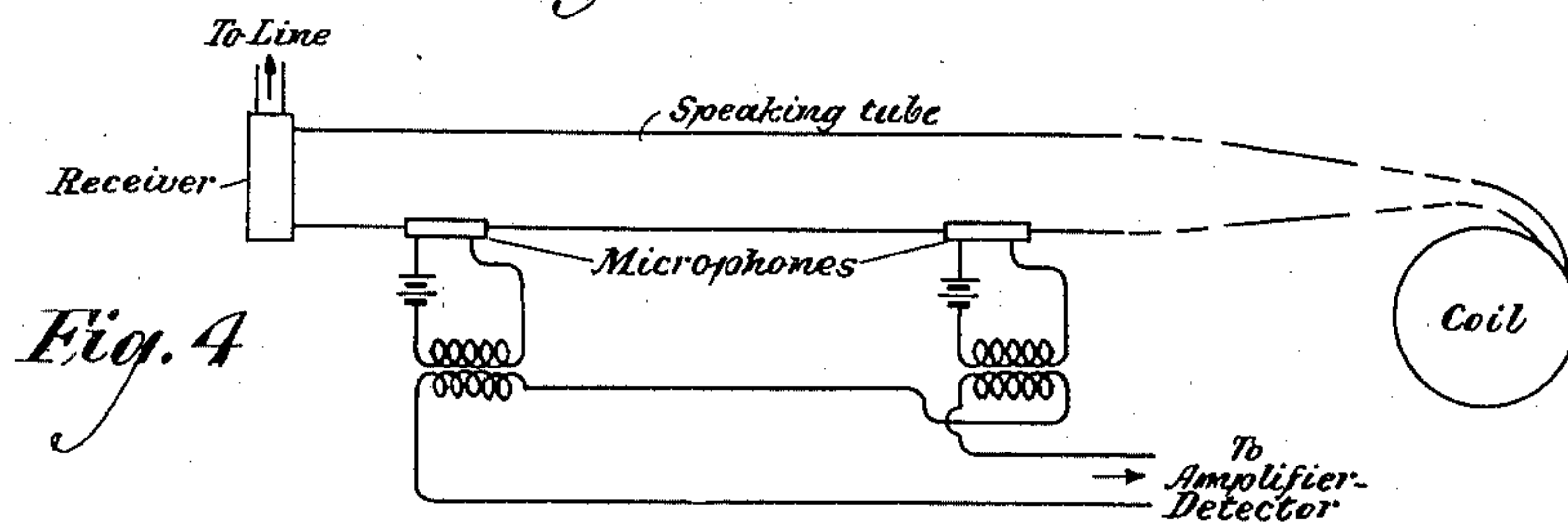


Fig. 4

INVENTORS
H. Nyquist & K.W. Pfleger
BY *g e f o h*
ATTORNEY

UNITED STATES PATENT OFFICE

HARRY NYQUIST, OF MILBURN, AND KENNETH W. PFLEGER, OF ARLINGTON, NEW JERSEY, ASSIGNORS TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

ECHO SUPPRESSOR

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This invention relates to the four-wire sections of two-way telephone systems, and more particularly to voice-operated devices associated with the circuits for preventing echoes therein:

The four-wire sections of two-way telephone systems have one path adapted for transmission in one direction and another path adapted for transmission in the opposite direction, and these two paths are connected at each end of the circuit, in the case of all-wire systems, through a hybrid coil to a two-wire line, which line is approximately balanced by a suitable network. In some systems the transmission is in part over a radio link, and in such cases the four-wire section may be connected at one end to a two-wire line through a hybrid coil and at the other end to radio apparatus for transmission over and reception from the radio link.

Since the balance of the two-wire line and the associated network is not perfect, there is the likelihood that currents flowing in one of the transmission paths of the four-wire circuit will be reflected back from the two-wire line over the other transmission path, producing "echoes". In order to suppress these echoes voice-operated means have been devised which respond to voice currents in one path and function to short-circuit or otherwise disable the opposite path. For a full disclosure of echo suppressor arrangements as applied to all-wire circuits, reference may be had to an article by A. B. Clark and R. C. Mathes in the Journal of the American Institute of Electrical Engineers, June, 1925, pages 618 to 626.

If the transmission lines of the telephone system run parallel to power lines or are subjected to other interference, the current responsive devices for disabling one path of the four-wire circuit may be falsely operated by the interfering currents in the voice channels.

The object of the applicants' invention is to provide a voice-operated echo suppressing arrangement which is free from operation by one or more frequencies and their harmonics, but will respond readily to all other frequencies within the range contemplated.

In general, the applicants employ the well

known amplifier detector-device for controlling a switch to short-circuit one transmission path, and use a speaking tube and a suitable arrangement of telephone receivers and transmitters so positioned with respect to the speaking tube that the waves corresponding to the frequency to be barred and to the harmonics of that frequency will be cancelled out and will have no effect on the amplifier-detector, as will be more fully disclosed herein-after.

In the applicants' companion application filed as of even date herewith, there are disclosed the broad idea of balancing out certain frequencies in the input to the amplifier detector and a specific arrangement for practicing the idea, this arrangement involving the use of a telegraphophone or an equivalent device. In the present application there is disclosed a different and simple arrangement for accomplishing the same object to which the companion application is directed.

The novel features and the advantages of the present invention will be more clearly understood when the following description of one embodiment thereof is read with reference to the accompanying drawing.

Figure 1 of the drawing shows diagrammatically and in association with two lines adapted for transmission in opposite directions a desirable speaking tube arrangement for protecting the voice-operated apparatus against operation by one or more frequencies and their harmonics.

Fig. 2 of the drawing shows by wave curves how in the speaking tube of Fig. 1 a single wave and one of its frequencies are cancelled out before they can affect the input to the amplifier detector.

Figs. 3 and 4 show alternative arrangements of the telephone receivers and transmitters with respect to the speaking tube of Fig. 1.

Like characters of reference in the several figures of the drawing designate corresponding elements.

With reference to the details of Fig. 1, the telephone lines L_1 and L_2 are understood to be the two paths of a four-wire circuit forming part of a two-way telephone system, as in-

licated and briefly discussed above. Line L_1 is adapted for transmission from station W at the left to station E at the right, and line L_2 is adapted for transmission in the opposite direction. It is understood, of course, that these voice paths are associated at one end directly and at the other end either directly or over the radio link to a two-wire line through the usual hybrid coil, as clearly disclosed in the above identified article.

The voice-operated device shown comprises a vacuum tube amplifier A, a vacuum tube detector D associated therewith, and a relay S controlled by the operation of the detector for short-circuiting the line L_2 in response to voice currents in the line L_1 . It is to be understood, of course, that for the suppression of echoes in the opposite direction similar apparatus is provided to short circuit the line L_1 in response to voice currents flowing in L_2 . If, now, interfering currents, such as currents from power lines having a certain frequency, flow in the line L_1 , they may operate the amplifier detector A—D and the associated switching device to produce a false short-circuiting of the line L_2 .

In order to prevent the operation of the echo suppressor by currents of one or more given frequencies or their harmonics, the applicants arranged a speaking tube, the receivers R_1 and R_2 , and a microphone M as shown in Fig. 1. The receivers R_1 and R_2 are positioned in the side-wall of the speaking tube and are connected across the line L_1 and in series one with the other so as to give sound waves 180 degrees out of phase. The receivers are separated by a distance L , which is determined as described hereinafter. In response to current flow in the line L_1 sound waves are produced in the speaking tube through the receivers and are transmitted through the air within the tube to the microphone M at the right end of the tube. The waves, of course, will also travel to the left, but they are absorbed at the left end of the tube without reflection by means of a device which acts like a tube of infinite length, this device consisting of a long coil of small tube. The main portion of the tube should be sufficiently large in diameter so that there will be negligible attenuation and the velocity of all frequencies will be approximately the same.

The distance L between the receivers R_1 and R_2 is determined in accordance with the wave length or wave lengths corresponding to the frequency or frequencies against which protection is desired. This distance L must be such that the interfering fundamental frequency or frequencies and the harmonics transmitted from the receiver R_1 will reach the microphone M just out of phase with the interfering waves transmitted from the receiver R_2 . Given the proper connection of

the two receivers indicated above, the distance L must be a multiple of the wave length corresponding to the fundamental interfering frequency or a common multiple of the wave lengths corresponding to the two or more fundamental interfering frequencies. When these conditions are met, the interfering waves will be cancelled out at the right end of the speaking tube and will not affect the microphone M.

The case of protection against two interfering frequencies and their harmonics being considered, for instance, the distance L must equal $\lambda_1 m$, which is equal to $\lambda_2 n$, where λ_1 and λ_2 are the wave lengths of the fundamental interfering frequencies and m and n are whole numbers. The numbers m and n should be as small as possible for two reasons: In the first place, sudden changes in the load on the power wires may cause a short interval of time to elapse during which the microphone receives waves from R_1 and R_2 which are unequal in magnitude; in the second place, the length of tubing should be reduced to the minimum.

Even when the length of the tube is reduced to the minimum, this length may be necessarily rather great. Let it be assumed, for instance, that protection is desired against interference from two power lines, one carrying 60-cycle current and the other 25-cycle current. A 60-cycle sound wave is approximately 18 feet in length, and a 25-cycle sound wave is approximately 43.2 feet in length. At their minimum values m must equal 12 and n must equal 5, and, accordingly, a tube 216 feet in length is required. It will be understood, of course, that if protection against only the 60-cycle current is desired, a tube 18 feet long will suffice. Similarly, protection against 25-cycle current only will call for a tube length of 43.2 feet.

It will be readily understood, of course, that if the reduction of the length of tubing is not an important consideration, the tube length indicated above may be multiplied by any whole number.

The cancellation of the waves corresponding to the interfering frequencies and their harmonics will be more clearly understood from an examination of Fig. 2 of the drawing. In this figure the distance between R_1 and R_2 equals 2λ and the unbroken curves represent the fundamental waves sent through the tube to the microphone M from the receivers of R_1 and R_2 . Due to the spacing of the two receivers these waves are 180 degrees out of phase and cancel each other at the microphone end of the tube. Likewise, the second harmonic of the frequency represented by the unbroken curve is represented by the broken curve. It is seen that this harmonic, like the fundamental, is cancelled out at the microphone end of the tube.

It is, of course, not essential that the ar-

5 rangement of two receivers and a microphone shown in Figs. 1 and 2 be employed. The requirement is that, in association with the speaking tube, there be employed an arrange-
 10 ment of telephone receivers and transmitters, or the equivalents, so connected and so positioned with respect to the tube that the waves corresponding to the frequency or frequencies against which protection is desired and to the
 15 harmonics of that frequency or those frequencies will be cancelled out of the input to the amplifier-detector or other controlling means.

15 The receivers R_1 and R_2 , if two receivers are employed, are not necessarily connected in series with one another, but any connection giving the phase separation of 180° for the chosen frequency or frequencies will be suitable.

20 Figs. 3 and 4 of the drawing show arrangements, for example, which differ from that shown in Figs. 1 and 2, but will give the desired result, assuming, of course, that the requirement stated above as to the distance L
 25 is observed.

In Fig. 3, the receivers R_1 and R_2 are mounted within the tube, and the microphone M is positioned in the side wall of the tube.

30 In Fig. 4, a single receiver is mounted at one end of the speaking tube, and two microphones are mounted in the side wall of the tube and are spaced with reference to the wave length or wave lengths corresponding
 35 to the frequency or frequencies to be barred, and are connected in series opposing relation to give the desired cancellation in the input to the amplifier-detector.

40 While the invention has been disclosed in certain specific arrangements which are deemed desirable, it is to be understood that it may be embodied in other and widely different forms within the true scope of the invention as defined in the appended claims.

What is claimed is:

45 1. In association with two telephone lines adapted for transmission in opposite directions, controlling means responsive to currents in one of said lines, switching means controlled thereby for disabling the opposite
 50 line, a speaking tube, means for converting the electric waves in the said one of the telephone lines into sound waves in said speaking tube, and means for converting the sound waves in said speaking tube into electric waves
 55 in the input of said controlling means, said converting means being so arranged and positioned with respect to said speaking tube that waves of one or more given frequencies and the harmonics thereof are cancelled and have
 60 no effect on said controlling means.

65 2. In association with two telephone lines adapted for transmission in opposite directions, controlling means responsive to currents in one of said lines, switching means controlled thereby for disabling the opposite

line, a speaking tube, means for converting the electric waves in the said one of the telephone lines into sound waves in said speaking tube, means for converting the sound waves in said speaking tube into electric waves in the input of said controlling means, said converting means being so arranged and positioned with respect to said speaking tube that waves of one or more given frequencies and the harmonics thereof are cancelled and have no effect on said controlling means, and means at one end of said speaking tube for absorbing the sound waves therein without reflection.

3. In association with two telephone lines adapted for transmission in opposite directions, controlling means responsive to currents in one of said lines, switching means controlled thereby for disabling the opposite line, a speaking tube, means for converting the electric waves in the said one of the telephone lines into sound waves in said speaking tube, means for converting the sound waves in said speaking tube into electric waves in the input of said controlling means, and means for cancelling out in said speaking tube the waves of one or more given frequencies and the harmonics thereof.

4. In association with two telephone lines adapted for transmission in opposite directions, controlling means responsive to currents in one of said lines, switching means controlled thereby for disabling the opposite line, a speaking tube, means for converting the electric waves in the said one of the telephone lines into sound waves in said speaking tube, means for converting the sound waves in said speaking tube into electric waves in the input of said controlling means, means at one end of said speaking tube for absorbing the sound waves therein without reflection, and means for cancelling out in said speaking tube the waves of one or more given frequencies and the harmonics thereof.

5. In association with two telephone lines adapted for transmission in opposite directions, controlling means responsive to currents in one of said lines, switching means controlled thereby for disabling the opposite line, a sound propagating medium, means for converting the electric waves in the said one of the telephone lines into sound waves in said sound propagating medium, and means for converting the sound waves in said sound propagating medium into electric waves in the input of said controlling means, said converting means being so arranged and positioned with respect to said sound propagating medium that waves of one or more given frequencies and the harmonics thereof are substantially cancelled and have no effect on said controlling means.

6. In association with two telephone lines adapted for transmission in opposite directions, controlling means responsive to cur-

rents in one of said lines, switching means controlled thereby for disabling the opposite line, a sound propagating medium, means for converting the electric waves in the said one of the telephone lines into sound waves in said sound propagating medium, means for converting sound waves in said sound propagating medium into electric waves in the input of said controlling means, said converting means being so arranged and positioned with respect to said sound propagating medium that waves of one or more given frequencies and the harmonics thereof are substantially cancelled and have no effect on said controlling means, and means at one end of said sound propagating medium for absorbing the sound waves therein without reflection.

7. In association with two telephone lines adapted for transmission in opposite directions, controlling means responsive to currents in one of said lines, switching means controlled thereby for disabling the opposite line, a sound propagating medium, means for converting electric waves in the said one of the telephone lines into sound waves in said sound propagating medium, means for converting sound waves in said sound propagating medium into electric waves in the input of said controlling means, and means associated with said sound propagating medium for substantially cancelling the waves of one or more given frequencies and the harmonics thereof.

8. In association with two telephone lines adapted for transmission in opposite directions, controlling means responsive to currents in one of said lines, switching means controlled thereby for disabling the opposite line, a sound propagating medium, means for converting the electric waves in the said one of the telephone lines into sound waves in said sound propagating medium, means for converting the sound waves in said sound propagating medium into electric waves in the input of said controlling means, means at one end of said sound propagating medium for absorbing the sound waves therein without reflection, and means associated with said sound propagating medium for substantially cancelling the waves of one or more given frequencies and the harmonics thereof.

In testimony whereof, we have signed our names to this specification this 8th day of October, 1927.

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HARRY NYQUIST.

KENNETH W. PFLEGER.