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DIVERSITY RADIO RECEIVER

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FIG. 1

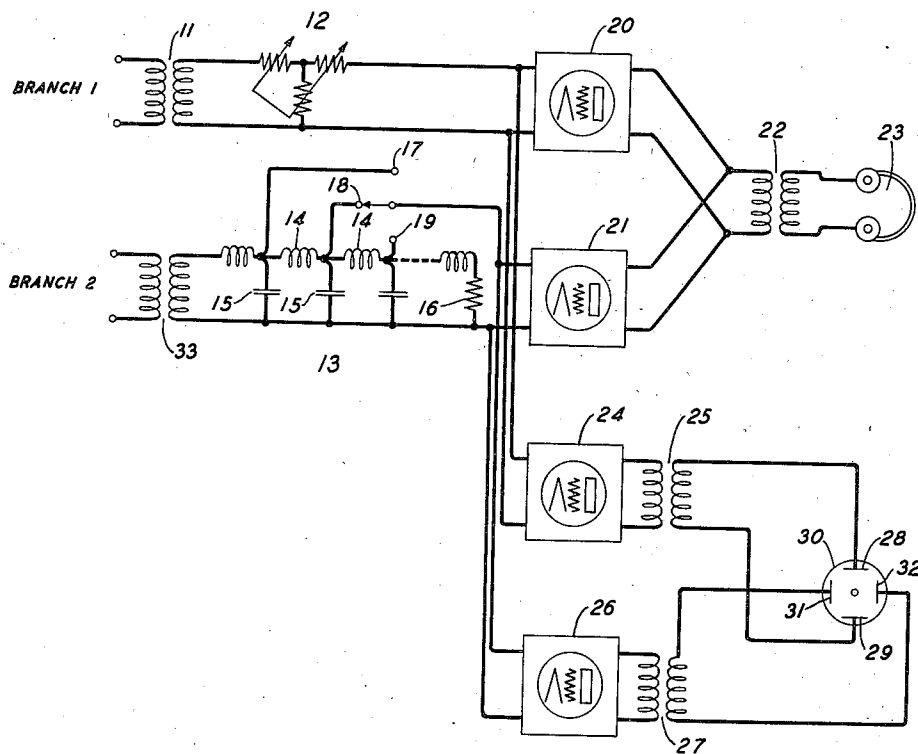
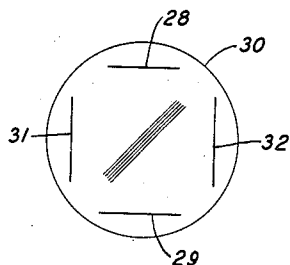


FIG. 2



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DIVERSITY RADIO RECEIVER

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7 Claims. (Cl. 250—20)

This invention relates to a method of and means for comparing or equalizing the delay in two or more audio-frequency circuits while they are transmitting complex waves.

5 An object of the invention is to compare the delay in a plurality of audio circuits carrying complex waves.

Another object is to adjust to equality the delay in two or more such circuits while they are handling traffic.

10 A further object is to provide a visual monitoring system for indicating the relative delay in a plurality of such circuits.

In receiving short wave radio signals improved reception may be obtained by the application of the so-called diversity principle in which signals received at different points, on different carrier frequencies or arriving at different angles are applied to individual receiving units having a combined audio-frequency output and a common automatic volume control. In certain receiving systems of this type the signals received by one or more of the diversity receiver units may have traversed a longer radio path than those received by some of the other units and, as a consequence, the speech currents at the outputs of the various receiver units will be delayed with respect to each other. The direct addition of these outputs does not give as satisfactory reception as would be the case if there were no delay between the diversity unit outputs. It is, therefore, of advantage to add compensating delay in all but one branch in such a manner that all frequencies in the outputs of the various units add in proper phase relation.

15 In accordance with the invention the branch having the greatest delay is paired with a branch having less delay and an adjustable delay network is inserted in the latter branch. A voltage representing a band of frequencies is derived from one of the branches and a voltage representing the same band is derived from the other branch. These two voltages, after amplification, are impressed, respectively, upon the two pairs of deflector plates of a cathode ray oscillograph. The figure formed on the oscillograph screen will then give a visual indication of the presence or absence of delay equality in the two branch circuits. The operation of equalizing the delay may be carried out while the system is handling traffic, and consists in adjusting the delay network until the screen exhibits a compact figure, approaching a straight line, which oscillates between the x and the y axes as the outputs from the two branches fade differentially. The first-men-

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each of the remaining branches and the operation repeated. The delay in all of the branch circuits will then be equalized.

The nature of the invention will be more fully understood from the following detailed description and by reference to the accompanying drawing, of which

Fig. 1 shows an embodiment of the delay equalizing system of the invention as applied to two branches; and

Fig. 2 represents schematically the figure exhibited by the oscillograph screen when equality of delay in the two branches has been attained.

In Fig. 1, branches 1 and 2 represent, respectively, the audio-frequency outputs of two branches of a diversity radio receiving system. It is assumed that the waves arriving over branch 1 will have the greater delay. The output of branch 1 is impressed upon the primary of a transformer 11, the secondary of which is connected to the input of a variable attenuator 12. The output of branch 2 is impressed upon the primary of a transformer 33, the secondary of which is connected to the input of an adjustable delay network 13.

As shown, the delay network 13 comprises a plurality of sections each consisting of a series inductance 14 and a shunt capacitance 15, terminated in a resistance 16. At the junctions of the sections a plurality of tapping points 17, 18 and 19 are provided so that the delay introduced into branch 2 may be adjusted to its required value. Other types of properly designed adjustable delay networks may, of course, be substituted for the one shown, and under some circumstances a somewhat more elaborate structure may be found desirable.

The waves in branches 1 and 2 are amplified, respectively, in the amplifiers 20 and 21, which may be of standard design and are therefore shown only conventionally. The outputs of branches 1 and 2 are finally combined at the primary of the transformer 22. Attenuator 12 is used to adjust the volume of branch 1 so that the average contributions of branches 1 and 2 are approximately equal over a long period of time. To the secondary of transformer 22 is connected a telephone receiver 23 or other reproducing system. The common automatic volume control of the diversity receiving system will keep the sum of the outputs of branches 1 and 2 essentially constant. If the transmission loss introduced by the delay network 13 changes with the setting, the gain of amplifier 21 should accordingly be adjusted so that the average output of branch 2

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at the point of combination is constant. This adjustment may be accomplished by other well-known means, as, for example, a variable attenuator associated with branch 2.

5 A voltage is tapped off of branch 1 at a point just ahead of amplifier 20 and after amplification in the amplifier 24 is impressed upon the primary of the transformer 25. A second voltage, derived from branch 2 just ahead of amplifier 21,
10 is amplified in the amplifier 26 and impressed upon the primary of transformer 27. Since the amplifiers 24 and 26 are also of standard design they are shown only in the conventional manner. The secondary of transformer 25 is connected to the two opposite deflector plates 28 and 29
15 of a cathode ray oscillograph 30, and the secondary of transformer 27 is connected to the other pair of deflector plates 31 and 32.

Assuming that branches 1 and 2 are transmitting the same speech signals of equal amplitude, but that the delay in the two branches is unequalized, the figure formed on the oscillograph screen will be of indefinite form, the cathode ray tracing a pattern resembling a tangled ball of
20 yarn. However, when the proper adjustment of the delay network 13 has been made there will be formed a compact figure, nominally a straight line making an angle of 45 degrees with the x and the y axes. Such a figure is shown diagrammatically in Fig. 2. This line will oscillate between the x and the y axes as the two outputs of branches 1 and 2 fade differentially. Adjustment of the delay network is made from time to time as required in order to keep the figure as
25 compact as possible. This operation may be carried out while the system is handling traffic, and there is thus provided a device for continuous monitoring which gives a visual indication of the relative delay in two audio circuits carrying complex waves.

The method described is very sensitive to delay differences in the two branch circuits. A setting can usually be made significant to within plus or minus 70 microseconds or less. In some instances it may be desirable to decrease the band width applied to the cathode ray tube. If, for example, the branches 1 and 2 are carrying a speech band extending, say, between 250 and 2750 cycles, it has been found helpful to restrict this to
30 a peaked band emphasizing frequencies below 1000 cycles in order to improve the contrast between a good and a bad delay setting. This band restriction may conveniently be accomplished by a proper design of the coupling transformers 25 and 27.

As pointed out above, if the system comprises more than two branches the remaining branches may be paired successively with branch 1 and their individual delay networks adjusted for delay equality with branch 1 as a reference in the manner just described. When all of the adjustments have been made the delay will be equalized in all of the branches. Or, alternatively, a plurality of oscillographs may be provided, each of
35 which is associated with branch 1 and a separate branch, so that continuous monitoring on all of the branches may be maintained simultaneously.

What is claimed is:

1. In a diversity radio receiving system one

branch circuit transmitting voice frequency signals corresponding to radio signals received over one path, a second branch circuit transmitting the same voice frequency signals corresponding to radio signals received over a different path, a
5 common reproducer associated with said two branch circuits, and means for bringing the signals in said two circuits into phase equality while the system is handling traffic, said means comprising an adjustable delay network located in
10 one of said circuits, a cathode ray oscillograph having two pairs of deflector plates, means for deriving from said one circuit a voltage representing a band of frequencies and for impressing said voltage on one of said pairs of plates, and
15 means for deriving from said second circuit a voltage representing the same band of frequencies and for impressing said voltage on the other of said pairs of plates, the condition of phase equality in said two circuits being visually
20 indicated by a narrow band of light on the screen of said oscillograph.

2. The combination set forth in claim 1 in which a variable attenuator is associated with said second branch circuit.

3. A system in accordance with claim 1 in which means are provided for keeping the average amplitudes of the signals in said two branch circuits substantially equal over a long period of time.

4. The combination set forth in claim 1 in which means are provided for restricting the frequency range of the voltages impressed upon said pairs of deflector plates.

5. A system in accordance with claim 1 in which means are provided for restricting the frequency range of the voltages impressed upon said pairs of deflector plates to a band located below 1000 cycles.

6. A system in accordance with claim 1 in which means are provided for restricting the frequency range of the voltages impressed upon said pairs of deflector plates to a band less than 1000 cycles in width.

7. In a diversity radio receiving system in which radio signals are transmitted from a source to a radio receiver over different paths whereby signals arriving over one path are delayed with respect to signals arriving over another path, a first branch carrying a band of audio frequency signals, a second branch carrying the same band of audio frequency signals delayed with respect to the signals in said first branch, an adjustable delay network in said first branch, a common reproducer associated with said branches, a cathode ray oscillograph having two pairs of deflector plates, means for impressing upon one of said pairs of plates a voltage derived from said first branch, and means for impressing upon the other of said pairs of plates a voltage derived from the other of said branches, whereby by the adjustment of said delay network the signals in said two branches may be brought into phase equality while the system is handling traffic, the condition of phase equality being indicated by the formation of a narrow band of light on the screen of said oscillograph.

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