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LONG DISTANCE TELEPHONE TRANSMISSION

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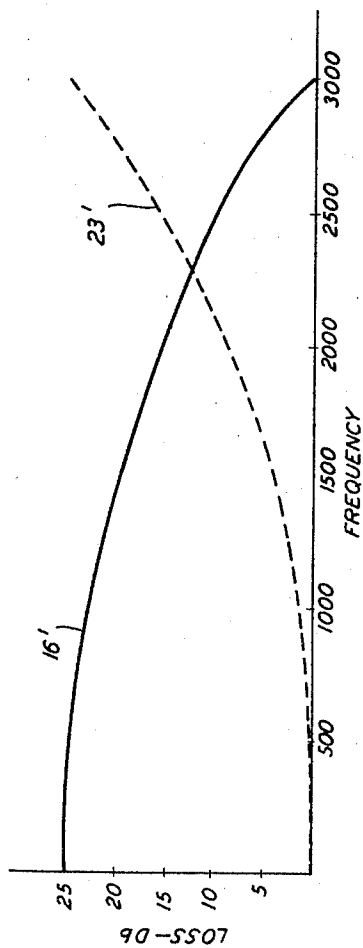
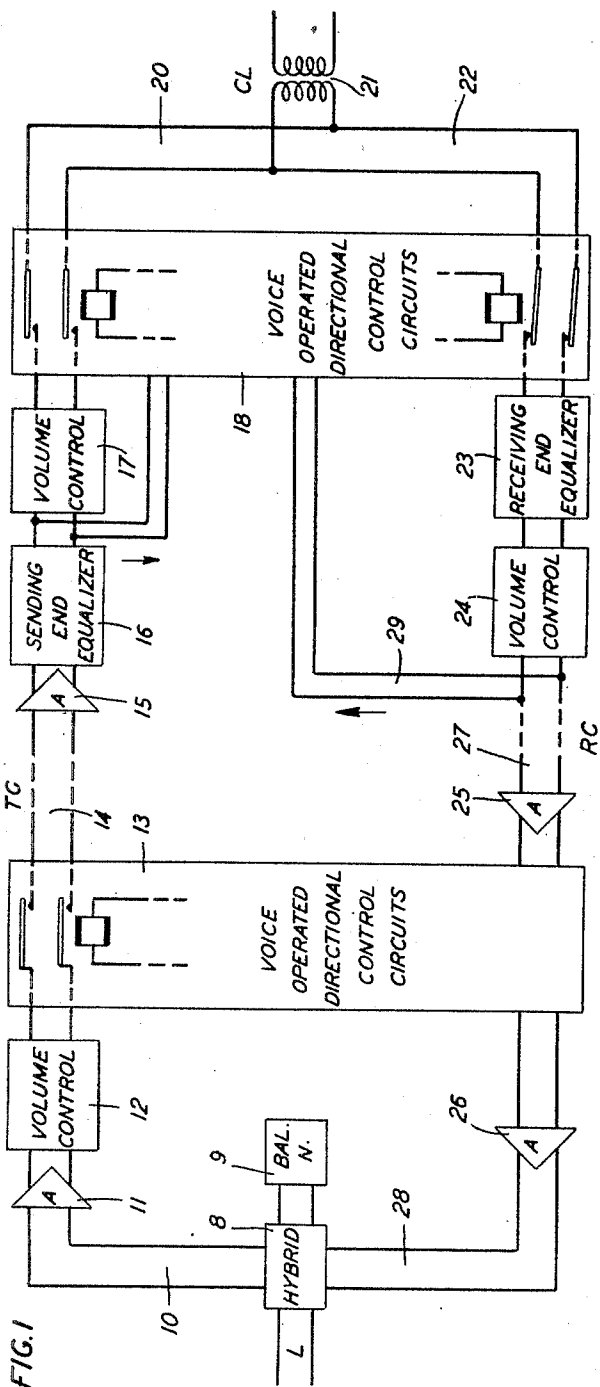


FIG. 2

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LONG DISTANCE TELEPHONE TRANSMISSION

Application filed November 4, 1930. Serial No. 493,314.

The present invention relates to transmission of speech or similar waves over a circuit, in which the attenuation, noise spectrum or some other condition requires that the waves be distorted at a receiving point to restore the waves to desired form.

Equalizers are used in such systems to compensate for the excess attenuation at some of the frequencies, generally at the higher frequencies, and for "head-end" loss which is the increase in loss at high frequencies with increase in current over that occurring at low frequencies, and to aid in overriding noise that may be present on the line. Volume control circuits also are commonly used in order to maintain constant level on an outgoing transmission path such as an ocean cable or other path of high attenuation.

Where an equalizer is used at the receiving end of such a line and a volume control is used at the input end, a discrimination may occur against certain types of voices as received.

For example, let it be assumed that a system is to be used at different times by talkers having voices of widely different frequency characteristics including both men and women. These voices of different frequency characteristics will all be distorted by the same distorting circuit, the character of the distortion depending upon the particular transmitting conditions. In general, the high frequencies will be emphasized, since this is generally the character of distortion required to overcome variable attenuation in the transmission path and also to override noise. In such cases the sending end equalizer will produce greater loss in voices in which the low frequencies predominate than in voices in which high frequencies predominate. The volume control, however, reduces voices of all character to the same volume level before transmission in order to obtain the most advantageous signal-to-noise ratio, and also, in the case of non-linear circuits having "head-

end" loss, to transmit speech from all talkers with the same "head-end" loss.

These voices of different characteristics are also acted upon at the receiving point by a distorting circuit, the function of which is to restore the distorted waves to their normal condition. In the case assumed above, this compensating equalizer will introduce greater loss to voices of high register than to voices of low register. Since the voices of all frequency characteristics were transmitted at the same volume level the result is that voices of different frequency characteristics as finally received will vary in volume level quite considerably as a result of the action of the compensating equalizer at the receiving station. Experiments have shown that the difference in level between an average man's voice and an average woman's voice as received may amount to the order of 10 or 15 db on account of the action of the receiving end equalizer.

The principal object of the present invention is to effect a compensation for the difference in level of voices of different frequency characteristics as received.

The invention provides an automatic volume control following the receiving end equalizer for reducing to the same volume level received speech of all characteristics.

Reference is made to the attached drawings for a more complete description of the invention and its construction and the manner in which it may be applied to typical transmission systems.

In the drawings, Fig. 1 shows a schematic circuit diagram of a two-way terminal circuit for a transoceanic telephone cable embodying the invention, and Fig. 2 shows curves explanatory of the action of the sending end and receiving end equalizers in the system.

The two-way terminal circuit shown in Fig. 1 is of the same general type as that disclosed in U. S. patent application of R. C. Mathes, Serial No. 487,209, filed October 8,

1930, except for differences that will be pointed out as the description proceeds.

The land line or subscriber's line L is shown arranged for two-way repeating with the cable circuit CL at the right. Transmission from the line to the cable takes place over the transmitting branch TC and receiving from the cable and receiving into the line takes place over the receiving branch RC.

The line L is provided with the usual hybrid coil 8 and balancing network 9. The apparatus in the transmitting circuit TC includes suitable amplifiers one of which is located at 11, volume control 12 which may be of the type shown in the Mathes application referred to, voice operated directional control circuit 13, these elements being located at a control station which may for example, in the case of a transatlantic telephone cable installation be at New York. A long land line 14 connects this station with the cable terminal station which may for example, be located in New England, Canada or Newfoundland. The transmitting circuit TC at the cable terminal includes suitable amplification, one amplifier being shown at 15, a sending end equalizer 16, volume control 17 and voice operated directional control circuit 18.

In the receiving circuit RC the cable terminal station includes voice operated directional control circuit 18, receiving equalizer 23 and receiving volume control 24. The long land line 27 leading to the distant control station, for instance New York, includes suitable amplifiers such as those indicated at 25 and 26 and the voice operated directional control circuit 13.

The volume controls 12, 17, and 24 may each be of the same type as volume control 6 disclosed and more fully explained in the Mathes application above referred to.

Likewise, the voice operated directional control circuits 13 and 18 may be identical with those shown in the Mathes application. It will be understood, of course, that these volume controls and voice operated circuits may be of any other suitable type, several different types being known to the prior art.

The voice operated directional control circuits are shown at 13 and 18 as comprising normally open contacts in the transmitting circuit TC and normally closed contacts in the receiving circuit RC. (The open-circuit condition is indicated by the conventional showing of a relay with open armature contacts and the closed-circuit condition is shown by a similar relay with closed armature contacts.)

In the operation of the circuit diagrammatically indicated in Fig. 1 speech waves received over the line L pass in part into the outgoing branch 10 of hybrid coil 8, are amplified at 11 and pass to the volume control

circuit 12. This volume control as is more fully disclosed in the Mathes application referred to, automatically maintains the volume at substantially constant level. For example, if different lengths of incoming toll line are connected to the line L or if different speakers at different times talk over the circuit L the voice as received in circuits 10 and 11 varies in volume level from instant to instant. The volume control 12 acts in response to these variations to increase or decrease the amount of amplification and thus maintains them at substantially constant level in the outgoing circuit.

The speech waves upon arriving at the voice operated switching circuit 13 cause the actuation of suitable relays or other means, for example, those disclosed in the Mathes application, to establish the connection of the circuit 14 through to the interconnecting line leading to the distant cable terminal. Upon arriving at that terminal the speech waves are amplified at 15 and undergo a suitable type and degree of distortion in the sending end equalizer 16 as will be more fully described later. The waves thus acted upon by equalizer 16 pass into the volume control 17 which insures that the waves outgoing to the cable CL will be at constant level. Some of the waves in the output of the equalizer 16 pass into the circuit 19 leading to the voice operated directional control circuit 18 and in a manner similar to that described in the Mathes application, they cause the establishment of the circuit leading through to the circuit 20 so that the speech is impressed upon the cable CL through the transformer 21. As is also explained more fully in the Mathes application, these waves first, however, cause the opening up of the receiving circuit RC at the switching point schematically indicated in drawing so that the waves from the transmitter do not find their way into the receiving branch. At the cessation of the speech assumed to be passing from the line L into the cable CL over the transmitting circuit TC, the transmitting and receiving circuits restore to their normal condition which is that illustrated in Fig. 1.

Speech waves received over the cable CL pass through the transformer 21 into the branch 22 and through the normally closed receiving circuit RC, this circuit being normally closed by the action of the voice operated directional control circuit 18.

The speech waves in the circuit RC pass into the receiving end equalizer 23 and volume control 24 and are impressed upon the interconnecting line 27. At this point, a portion of the speech waves is diverted into circuit 29 and used to render the circuit 19 incapable of actuating the voice operated directional control circuit 18 in the manner disclosed in the Mathes application, the nature

of these control circuits being immaterial to the present invention.

The speech waves arriving at the control station are amplified at 25 and 26 and are also illustrated as passing through the voice operated directional control circuit 13 where they are assumed to disable the switching circuits on the transmitting side in the manner disclosed in the Mathes application or any other suitable manner. The received waves then pass through circuit 28 to the hybrid coil 8 and out on the line L.

The curves of Fig. 2 illustrate typical relations between frequency and loss for the sending end equalizer 16 and the receiving end equalizer 23 respectively. The sending end equalizer 16 introduces greater loss at low frequency than at high frequency, as shown by characteristic 16'. The receiving end equalizer 23 conversely introduces greater loss at high frequency than at low, as shown by curve 23'. The difference in the amount of loss introduced by the two equalizers is dependent upon the amount of excess attenuation which the high frequencies suffer with respect to the low frequencies in passing over the system between the transmitting and receiving stations.

A subscriber on the line L possessing a voice characteristic of low register containing wave components of large energy representing a fundamental frequency of say, 150 cycles per second would have his speech very materially cut down in energy by the sending end equalizer 16 which as shown by curve 16' on Fig. 2 introduces large loss at low frequency. The waves in the output circuit of equalizer 16 would thus be reduced in level and would cause the volume control 17 to introduce considerable amplification in order to bring these waves up to the requisite level for transmission over the cable.

Waves of this character which have undergone the treatment described at the transmitter, upon arriving at the receiving station would undergo whatever distortion is necessary in equalizer 23 to restore the waves to their natural or normal and understandable condition. As indicated in the receiving equalizer curve 23' of Fig. 2, the components of principal energy in these speech waves are at those frequencies corresponding to relatively small loss in the equalizer 23 so that the waves as received are comparatively speaking, but slightly attenuated by receiving equalizer 23.

In the case of a talker with a voice of high register however, in which the components of principal energy are based upon a fundamental of say 250 cycles per second, these speech waves would be but slightly attenuated in comparison with those first considered, by sending equalizer 16. Volume control 17 would, however, send these waves out on the circuit CL at the same level as those

previously considered. Waves of this character entering the receiving station would be considerably attenuated by equalizer 23 in comparison with those first considered since the components of principal importance are at those frequencies at which equalizer 23 introduces relatively high loss as shown by the receiving equalizer curve 23' of Fig. 2. If it were not for the presence of volume control 24, the speech from the two speakers that have been considered would be received at the receiving station at quite different levels. For example, the speaker of high register characteristic might be heard at a level 10 to 15 db lower than the speaker of low register voice. Volume control 24 is, therefore, introduced following receiving end equalizer 23 to provide constant received level for all characters of talkers' voice.

The shapes of the characteristic curves of the equalizers 16 and 23 may vary quite widely in practice depending upon the transmission conditions. In general, characteristics 16' and 23' would add to approximate a straight horizontal line. To compensate for "head-end" loss in the cable, curve 23' may have less loss at high frequencies than shown. The curves may differ widely in other respects from those shown. These equalizers may correct not only for unequal attenuation over the transmitted frequency range but will also in general be designed to shape the waves so as to provide an improved signal-to-noise ratio. These networks may therefore be designed in accordance with the character of noise prevalent on the circuit. In general, however, the attenuation is greater at the higher frequencies so that the curves of Fig. 2 may be taken as fairly typical.

What is claimed is:

1. In a telephone system in which voices of different frequency spectra are sent out from a transmitting station at the same volume level, means at a receiving station for distorting the waves to aid in compensating for some transmission factor of the system, and means following said distorting means for compensating for shifts in level produced by said distorting means in voices of the different frequency spectra.

2. In a telephone system, a path for the transmission of speech or similar waves, a circuit for distorting the waves before transmission, means for impressing the distorted waves on said path at a substantially constant level, means for receiving the distorted waves from said path and for restoring them to their normal condition, and volume control means for compensating for the difference in level produced in waves of different frequency characteristics by the action of said distorting means and said restoring means.

3. In a system for transmitting speech or similar waves over a path having variable attenuation within the transmitted frequency

band, means at the input end of said path for
applying to the path at substantially the same
level speech waves of different frequency
characteristics and for emphasizing the high
5 frequency components, and compensating
means at a receiving point for effectively em-
phasizing the low frequency components of
waves as received over said path including
means for also equalizing the volume level
10 of received waves of different frequency char-
acteristics.

In witness whereof, I hereunto subscribe
my name, this 3rd day of November, 1930.

ARTHUR W. HORTON, JR.

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