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MONITORING CIRCUIT FOR TELEPHONE SYSTEMS

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FIG. 1

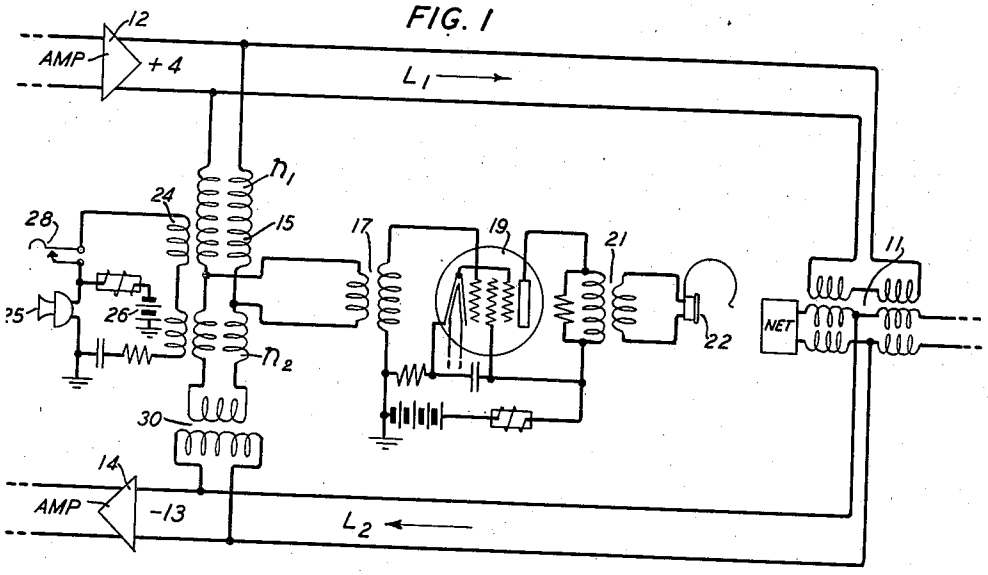
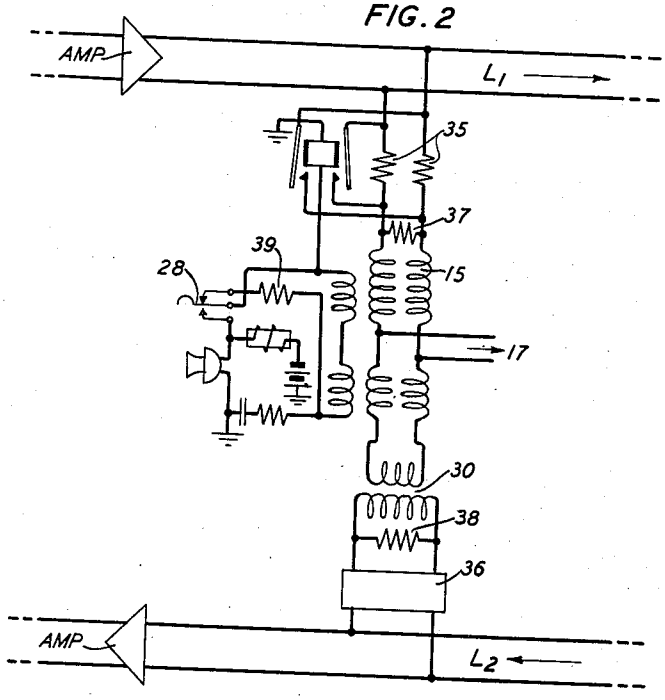


FIG. 2



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MONITORING CIRCUIT FOR TELEPHONE SYSTEMS

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5 Claims. (Cl. 179—170)

This invention relates to signal transmission circuits and more particularly to arrangements for monitoring the same. More specifically it relates to monitoring circuits connected between transmission lines operating on different transmission levels.

Its purpose is to devise a monitoring circuit which can be connected between transmission lines of different levels and still give substantially the same level of transmission to the receiver of the monitoring circuit, whether the signal comes from the one transmission line or the other.

Another purpose is to devise a monitoring and talking circuit adapted to impress speech on either or both of the transmission lines at the appropriate transmission level for each line.

Other purposes will appear from the description which follows:

The invention is applicable to four-wire circuits in which speech signaling is carried on at voice frequencies and will be chiefly described in such terms but it is also and peculiarly well adapted for multi-channel telephone systems employing four-wire terminating sets. In such a system the different channels have assigned to them definite carrier frequencies, ordinarily above the voice frequency range. In the four-wire portion of the circuit there are repeaters, modulators and demodulators. At or near a terminating set where the message for a particular channel has been brought to voice frequency, the energy levels may be substantially different for transmission in the one direction or the other, and if a monitoring set is connected across the two pairs of wires at such a point, the difference in the level of transmission introduces serious difficulties which it is the purpose of our invention to overcome.

The invention will be better understood by reference to the following specification and the accompanying drawing, in which

Fig. 1 is a diagram of the monitoring-talking circuit of the invention applied to a four-wire telephone circuit, and

Fig. 2 is a modification of the circuit of Fig. 1.

Referring more specifically to Fig. 1, there is shown a four-wire circuit consisting of the one-way lines L_1 and L_2 which are coupled to a two-way two-wire circuit by means of the usual hybrid coil arrangement 11. Line L_1 is indicated as providing transmission from west to east and in case signal-modulated carrier has been used, the signal has been demodulated to voice frequency at or prior to reaching such a point as amplifier 12. Signal from the voice frequency line for transmission from east to west is shown as taking place in line L_2 and subsequent to some such point as indicated by the amplifier 14 is modulated to its appropriate carrier frequency. Thus, while the circuit is adapted for use on carrier frequency, the portion of the circuit shown in Fig. 1 relates to the voice frequency portion alone.

Commonly on arrival at the hybrid coil 11, the signal coming from the carrier frequency portion of the system is at a relatively high level compared to the signal transmitted from the voice frequency line out to the carrier frequency portion. As an illustration, for example, a typical case would be that in which the level of transmission on L_1 would be +4 db. above reference level whereas at the corresponding point on L_2 the transmission level would be at −13 db. If a monitoring set is now connected to the two lines at the points shown in the figure, it is evident that with a symmetrical monitoring circuit the speech level from line L_1 will be 17 db. above that received from line L_2. That is, the power will be approximately fifty times as great from the one as from the other and such difference in level makes it extremely difficult to carry on suitable monitoring. Also, in case the monitoring circuit is adapted for talking, then for such symmetrical connection in the two directions it is evident that the level of speech signal coming out to the two lines will not be appropriate to the level at which these lines are operating.

For suitable operation it is required of the monitoring circuit that the level at the monitor's receiver be substantially the same regardless of whether the monitor is listening on the line L_1 at +4 db. or on line L_2 at −13 db. In addition the monitor must be able to talk over each line at approximately normal channel level for the lines. In other words, to the monitor on the low level or −13 db. side there should be little or no loss to the receiver. To the monitor on the other side, there should be 17 db. more loss than when monitoring from the −13 db. side. To talk on the +4 db. side there should be little or no loss to the line but to talk on the −13 db. side there should be 17 db. more loss than when talking on the +4 db. side. That is, the monitoring and talking connections bear inverse relationships. In accordance with our invention, then, the side that has the loss for monitoring is the side that does not have the loss for talking.

In order to accomplish the desired results, we provided a hybrid coil of the inequality ratio type which we find lends itself to the reciprocal action described. Such a hybrid coil 15 is shown

bridged between the lines L_1 and L_2, this hybrid coil being so designed that there are more turns in the transformer winding n_1 connected to L_1 than there are in the winding n_2 connected to line L_2. The particular ratio to be used will depend upon the difference in level on the two lines and for the particular example shown, where there is a difference of 17 db. between the lines, the impedance ratio between these windings is fifty to one.

Across the bridging terminals of the hybrid coil **15** is connected the primary of a transformer **17**, the secondary of which is connected to a suitable amplifying tube **19**, which is here shown as being of the pentode form. To the output of this amplifier, by means of the transformer **21**, is connected the receiver **22**.

For talking purposes there is connected across the winding **24** of the hybrid coil a transmitter **25** with suitable battery **26** and associated series choke coil. In this circuit is also included the operator's key **28**, which normally leaves the microphone circuit open.

In view of the relatively low impedance of the winding n_2 there will be a substantial lack of impedance matching between this coil and the line L_2. To avoid this impedance mismatch a repeating coil **30** is introduced having a suitable turn ratio to bring about the desired impedance matching.

When monitoring on the line L_1 most of the energy from the line is dissipated in winding n_1 and only a small part is received in the receiver circuit, for the impedance of the winding n_1 is substantially greater than that looking into the transformer **17**. Thus the speech received at the receiver **22** is not excessive. When monitoring on the line L_2 most of the energy is dissipated in the receiver circuit and little energy is dissipated in the winding n_2 for the impedance of the winding n_2 is small compared to the impedance seen when looking into the transformer **17**.

Conversely, with this system as shown, when talking to line L_1, most of the energy from the transmitter is transferred to the winding n_1 and a small portion only to the winding n_2. Thus the talking level to L_1 from the transmitter is relatively high and the talking level to L_2 is relatively low. Also with proper design, the receiver circuit with the transformer **17** is conjugate to the transmitter circuit and thus receives no energy therefrom.

There will ordinarily be a certain amount of loss for through transmission on the lines L_1 and L_2 by virtue of the bridging hybrid coil **15**. It is desirable that this bridging loss shall be kept to a negligible value and this can be attained by making the hybrid coil **15** one of high impedance. In case a coil of insufficiently high impedance is to be used, then the loss may still be kept to a desired small value by means of resistance pads **35** and **36** such as shown in Fig. 2. These pads may be allowed to remain in continuously or they may be short-circuited when the monitor talks over either line L_1 or L_2. In Fig. 2 the pad **35** with a relay controlled by the monitor's talking circuit for short-circuiting the pad is shown in detail; the same arrangement would be used for the pad **36**. The hybrid coil **15** is designed to provide a high loss between the lines L_1 and L_2 to prevent the transmission of undesirable echo currents between the lines L_1 and L_2 through the hybrid coil, tending to cause singing on the transmission circuit.

In order to obtain the most satisfactory operation of the circuit it is desirable that there should be impedance matching at the various significant points of the monitoring circuit. Thus, in looking out from the coil **15** towards L_1 it is desirable that the impedance shall appear the same as that when looking into the coil. Such a condition would not ordinarily exist when one introduces the pad **35** but it may be attained by bridging a resistance **37** across the input terminals of the coil **15**, this resistance being of such value that on looking away from the coil **15** the impedance shall appear to be the same as that of the coil itself. The same impedance matching is desirable on the side of the hybrid coil towards the line L_2 and the resistance **38** is therefore bridged across the line adjacent to the pad **36** and of proper value to give the impedance matching. It is also desirable under some conditions that there shall be impedance matching when looking into the transmitter circuit whether the key **28** is on the listening or talking position. Such matching can be obtained by the use of resistance **39** which replaces the resistance of the microphone when key **28** is in listening position.

In all cases whether one uses the circuit of Fig. 1 or the circuit of Fig. 2 the amount of power transferred from the lines L_1 or L_2 to the receiver circuit will be small and for this reason we find it desirable to introduce the amplifier **19**, as heretofore described. The transformer **17** in the input of this amplifier may be a one-to-one transformer or a step-up transformer and the transformer **21** should be step-down in order to obtain impedance matching with the receiver **22**.

What is claimed is:

1. In combination, two signal transmission lines operated at different transmission levels, a monitoring circuit comprising a transmitter and a receiver, and means comprising an inequality ratio hybrid coil associating said monitoring circuit with said lines so as to enable transfer of signal energy from either line to said receiver at the same volume level and transfer of signal energy from said transmitter to either line at the proper line level.

2. In combination, a four-wire telephone circuit comprising oppositely directed one-way circuits for opposite directions of speech transmission, one of said one-way circuits being operated on a higher level of speech energy than the other, a monitoring circuit comprising a transmitter and a receiver, and an inequality ratio hybrid transformer associating said monitoring circuit with said one-way circuits so that in monitoring either line the same level of speech energy is applied to the receiver and in talking a higher level of speech energy is applied by said transmitter to the higher level line than to the lower level line.

3. In combination, a four-wire telephone circuit comprising two oppositely directed one-way circuits for opposite directions of transmission, one of said one-way circuits being operated at a higher level of speech energy than the other, a monitoring circuit comprising a transmitter and a receiver, and a three-winding transformer coupling said monitoring circuit to said one-way circuits, said transmitter being connected to one of said windings and said receiver being connected between the other two windings, one of said other two windings being connected to one one-way circuit and the other of said two wind-

ings being connected to the other one-way circuit, the windings of the transformer being relatively proportioned so that the receiver receives less energy from the one-way circuit having the higher level than from the other one-way circuit and so that the transmitter transmits more energy to the one-way circuit having the higher energy level than to the other.

4. A four-wire telephone circuit including a transmitter circuit, a monitoring circuit, two line circuits used for opposite directions of speech transmission, one of said line circuits being operated at a higher level of speech energy than the other, and means for connecting said monitoring circuit to both of said line circuits with the same energy level obtaining at the receiver circuit regardless of whether the high or the low level line is being monitored, said means also connecting the transmitter circuit to both of the line circuits, with a higher level of speech energy being applied to the line having the higher transmission level and a lower level of speech energy being applied to the line having the lower transmission level.

5. The combination of claim 1 characterized by the fact that the hybrid coil is of high impedance so that the loss for through transmission on the two signal transmission lines is negligible.

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