May 15, 1934. F. A. COWAN 1,958,510

MONITORING CIRCUIT

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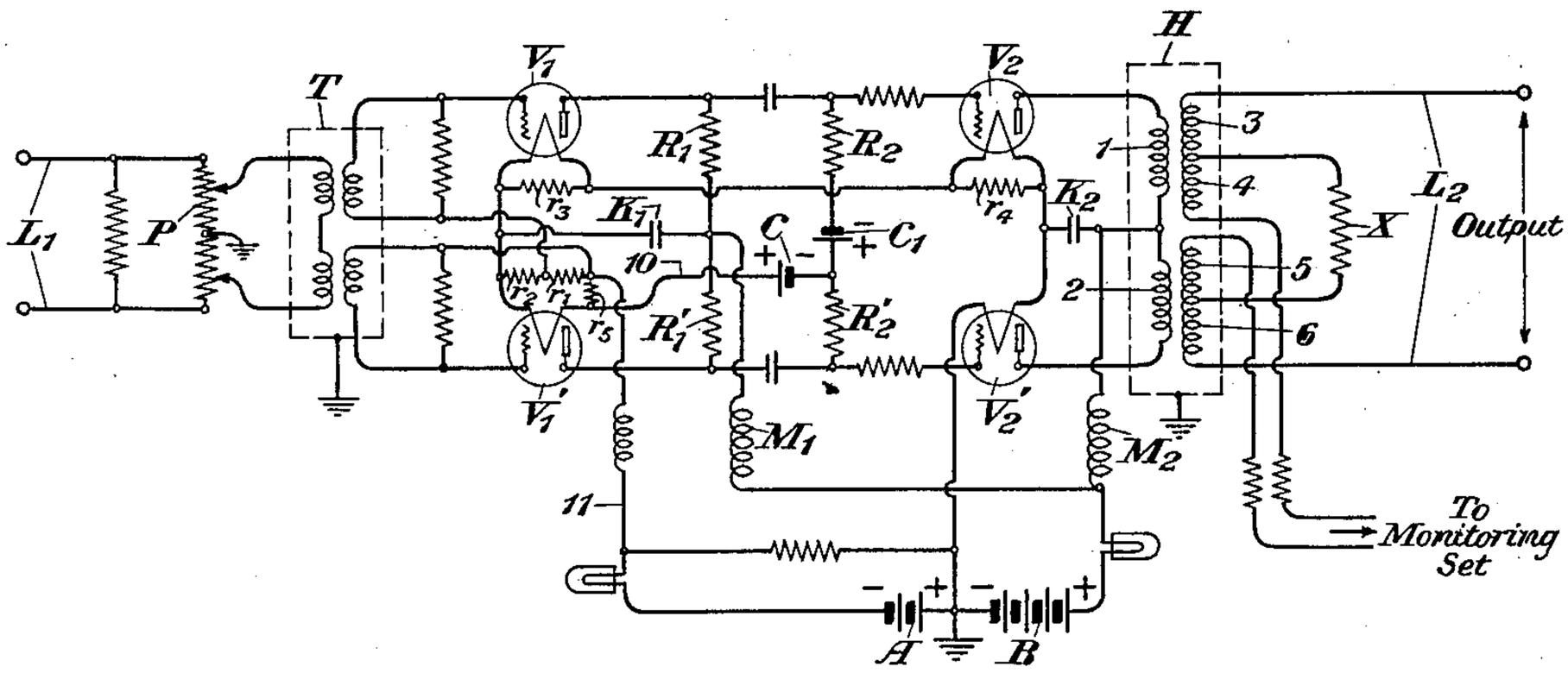

Fig. 1

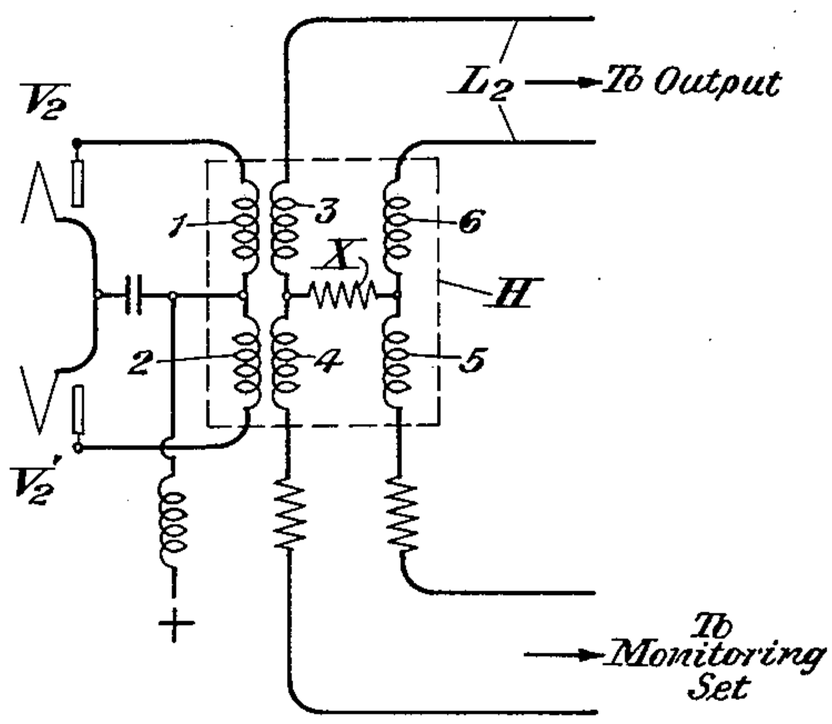

Fig. 2

INVENTOR
F. A. Cowan
BY
ATTORNEY

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MONITORING CIRCUIT

Frank A. Cowan, East Orange, N. J., assignor to American Telephone and Telegraph Company, a corporation of New York

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This invention relates to transmission circuits, and more particularly, to arrangements for monitoring the same.

In monitoring a one-way transmission circuit such as a program circuit which is divided into sections each of which is terminated in a one-way amplifier, it is desirable to connect the monitoring set for a given line section to the output side of the repeater in order that the monitoring set may detect noise originating in any part of the repeater, as well as in any part of the transmission line section. It is also desirable that the monitoring set should be so associated with the circuit that when a tone or other signal is applied to the line section which is being tested, noise from the succeeding line section will not be picked up by the monitoring set.

These objects are accomplished in accordance with the present invention by associating the monitoring set with the output side of the repeater of a given line section through a balanced circuit arrangement such that the monitoring set is substantially conjugate with respect to the succeeding line section. Preferably, the balancing arrangement includes a hybrid coil connected in the output circuit of the repeater, the monitoring set being connected to one terminal of the secondary of the hybrid coil, and the outgoing or succeeding line section being connected to the other terminal of the secondary of the hybrid coil, so that the outgoing line will be conjugate with respect to the monitoring set, but, both the outgoing line and the monitoring set may receive transmission from the repeater.

The invention will now be more fully understood from the following description when read in connection with the accompanying drawing, Figure 1 of which shows a repeater arrangement between two line sections with a monitoring connection associated therewith, and Fig. 2 of which shows the hybrid coil connection for the monitoring set of Fig. 1 in a simplified and conventional form in order to render its operation more clear.

Referring to Fig. 1, two line sections L_1 and L_2 are shown interconnected through a two-stage repeater of the push-pull type. The first stage of the repeater includes amplifying tubes V_1 and V'_1 connected in push-pull relation, and the second stage of the repeater includes vacuum tubes V_2 and V'_2 connected in push-pull relation. The line section L_1 is connected to the push-pull amplifier through a transformer T, and a potentiometer P is provided on the input side of the transformer T in order to control the gain of the one-way amplifier. The plate current is supplied to the tubes V_1 and V'_1 from the battery B through the choke coil M_1 which is connected to the junction point of resistances R_1 and R'_1 associated with the plate circuits of the tubes V_1 and V'_1, respectively. The filaments of the tubes V_1 and V'_1 are connected to the junction point of the resistances R_1 and R'_1 for alternating current transmission through a capacity K_1. In a similar manner the plate potential is supplied to the tubes V_2 and V'_2 through the choke coil M_2 which is connected to the junction point of the primary windings of the hybrid coil H, said junction point being connected to the filaments of the tubes V_2 and V'_2 for alternating current transmission through the capacity K_2.

The filament current for the tubes is supplied by the battery A with respect to which the filaments of the four tubes are connected in series. The C or grid potential for tube V_1 is obtained by connecting the grid of said tube to the junction point of the resistances r_1 and r_2 which are connected across the filament of the tube V'_1, and the grid potential for the tube V'_1 is obtained by connecting the grid of said tube to the remaining terminal of the resistance r_1. By connecting the two grids to the opposite terminals of the resistance r_1, the drop through said resistance compensates for the difference in the filament potentials of the two tubes due to the fact that they are in series.

In order that proper grid potentials may be applied to the tubes V_2 and V'_2 resistances R_2 and R'_2 are connected from the grids of said tubes to a common point from which a connection 10 extends to a resistance r_5 in the filament supply circuit 11. If desired, the grid potential thus derived from the battery A may be augmented by supplying a supplementary battery C in the connection 10. Owing to the difference in the filament potentials of the tubes V_2 and V'_2 due to the fact that they are connected in series, it is necessary that the potential applied to the grid of the tube V_2 should be more negative than that applied to the grid of the tube V'_2 in order that the grid filament drops of the two tubes may be the same. This result is accomplished by including a small supplemental battery C_1 in circuit with the resistance R_2, this battery having such potential as to just compensate for the drop through the filament of the tube V_2 and its associated resistance r_4.

By means of the circuit arrangement above described, a two-stage push-pull amplifier is obtained. This amplifier has the same potential

drops for both tubes of the same stage, notwithstanding the fact that the filaments of the tubes are connected in series. The circuit is also arranged in such manner that the second stage tubes may be biased to a different potential from the first stage tubes.

The hybrid coil H associated with the output of the repeater includes primary coils 1 and 2 and secondary coils 3, 4, 5 and 6. The resistance X has one terminal connected to the junction points of the coils 3 and 4, and its other terminal connected to the junction points of the coils 5 and 6. The remaining terminals of the coils 3 and 6 are connected to the output line L_2, and the monitoring set is connected to the remaining terminals of the coils 4 and 5, as shown.

The operation of this hybrid coil connection will be more easily understood from the diagram of Fig. 2 in which the hybrid coil and associated circuits are redrawn in a more common and conventional form. Here it will be seen that the output of the amplifier and the resistance X connected to the junction points of the secondary windings of the hybrid coil are conjugate so that no energy is transmitted from the output of the repeater to the resistance X. It will also be noted that the output line L_2 and the monitoring set are connected to the points where, in the conventional hybrid coil arrangement of the 22 repeater, the line and balancing network, respectively, are connected. Consequently, the outgoing line L_2 and the monitoring set will be conjugate so that neither can transmit nor receive from the other.

Since it is more important that the hybrid coil efficiently transmit energy from the repeater to the line section L_2 than it is that it should transmit to the monitoring set, the hybrid coil is made unsymmetrical by making the windings 3 and 6 relatively larger than the windings 4 and 5. This may be done without disturbing the requisite conditions of conjugacy if the impedances of the line L_2, the monitoring set, the resistance X, and the output of the repeater, are properly proportioned. By having the hybrid coil circuit thus unsymmetrically arranged the greater part of the energy transmitted through the repeater will be passed on to the output line L_2, and a relatively small part of the energy will be diverted into the monitoring set if the monitoring set should be inadvertently left connected in circuit while a program is being transmitted. It will be understood, of course, that should the monitoring set be open circuited, no effect will be produced upon the line because the monitoring set and the line are conjugate.

By having the monitoring set connected to the secondary side of the hybrid coil, the monitoring set is enabled to detect noise originating in any part of the repeater, as well as in the transmission line L_1. If the monitoring set were connected at some intermediate point in the repeater, or ahead of the repeater, the absence of noise in the monitoring set would not necessarily indicate that no noise was present in any part of the circuit, as noise in the repeater or in that part of the repeater beyond the monitoring set would not affect the monitoring set, and yet, would be transmitted over the outgoing line L_2.

By connecting the monitoring set through the hybrid coil arrangement above described, the monitoring operator in listening for noise on the line section L_1 and the associated repeater, will know that if any noise is heard it can only come from some point in the line L_1 or the repeater connected thereto, as noise from the line L_2 cannot be transmitted to the monitoring set through the hybrid coil, due to the conjugacy existing between the line L_2 and the monitoring set. Noise or energy incoming from the line L_2 divides between the resistance X and the plate circuits of the amplifier without being transmitted through the coils 4 and 5 to the monitoring set. A similar condition of conjugacy exists for transmission in the opposite direction so that if the monitoring operator should inadvertently leave a tone connected to the hybrid coil through the monitoring set, this tone would divide between the resistance X and the plate circuits of the repeater without passing on to the line L_2. The tone cannot, of course, be transmitted to the line L_1 due to the one-way characteristic of the vacuum tubes of the repeater.

Due to the features above pointed out, a program can be transmitted over the line L_1 and through the repeater to the line L_2 without being interfered with by the connection of the monitoring set to the circuit, and the operator may monitor on the circuit either while the program is being transmitted or during times that the circuit is not being used except for testing purposes.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated, without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a transmission circuit, an incoming line section, an outgoing line section, an amplifier interposed between said line sections, a balanced circuit connection between the output of said amplifier and said outgoing line section, a monitoring circuit connected to points of said balanced circuit which are neutral with respect to said outgoing line but which are non-conjugate with respect to said amplifier, and the parts of said balanced connection being so unsymmetrically related to said points that more energy will be transmitted from the amplifier to the outgoing line circuit than to said monitoring circuit.

2. In a transmission circuit, an incoming line section, an outgoing line section, an amplifier interposed between said line sections, a hybrid coil having two of its four sets of terminals connecting the output of said amplifier to said outgoing line, a balancing impedance connected to a third set of terminals, and a monitoring circuit connected to a set of terminals of said hybrid coil which are conjugate with respect to said outgoing line and non-conjugate with respect to said amplifier.

3. In a transmission circuit, an incoming line section, an outgoing line section, an amplifier interposed between said line sections, a hybrid coil connecting the output of said amplifier to said outgoing line, and a monitoring circuit, said repeater being connected to the input winding of said hybrid coil, and said monitoring circuit and outgoing line being connected respectively to opposite terminals of the secondary windings of said hybrid coil.

4. In a transmission circuit, an incoming line section, an outgoing line section, an amplifier interposed between said line sections, a hybrid coil connecting the output of said amplifier to said outgoing line, a monitoring circuit, and a balancing circuit, said repeater being connected to the input winding of said hybrid coil, said network being connected to the neutral points of

the secondary windings of said hybrid coil, and the monitoring circuit and outgoing line being connected to the opposite end terminals of said hybrid coil.

5. In a transmission circuit, an incoming line section, an outgoing line section, an amplifier interposed between said line sections, a hybrid coil connecting the output of said amplifier to said outgoing line, a monitoring circuit, and a balancing circuit, said repeater being connected to the input winding of said hybrid coil, said network being connected to the neutral points of the secondary windings of said hybrid coil, and the monitoring circuit and outgoing line being connected to the opposite end terminals of said hybrid coil, said secondary coils being so unsymmetrically wound that more energy is transmitted from the repeater to the outgoing line than is transmitted to the monitoring circuit.

FRANK A. COWAN.