Feb. 4, 1930. H. C. SILENT 1,745,457

ECHO SUPPRESSOR

Filed Nov. 14, 1928

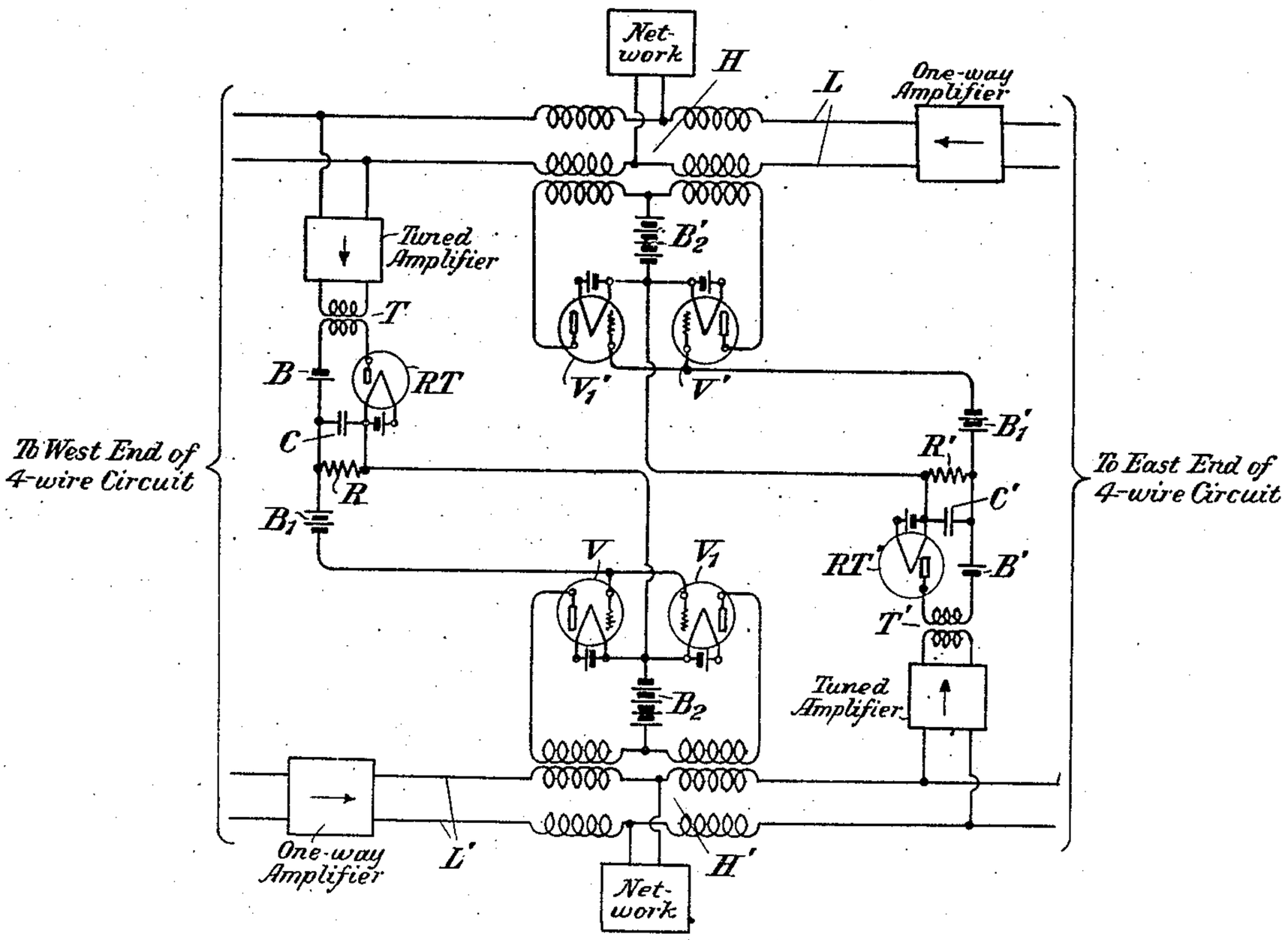

Fig. 1

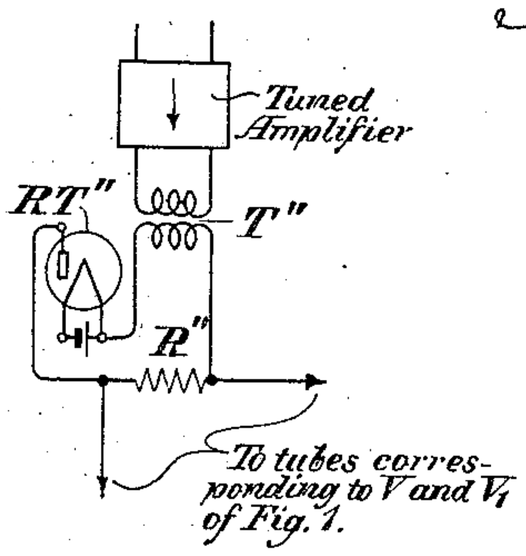

Fig. 2

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UNITED STATES PATENT OFFICE

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ECHO SUPPRESSOR

Application filed November 14, 1928. Serial No. 319,323.

This invention relates to two-way transmission circuits and more particularly to the suppression of echoes in four-wire circuits having one two-wire path adapted for transmission in one direction and a second two-wire path adapted for transmission in the opposite direction.

The object of the invention is the suppression of echoes in either path of the four-wire circuit to a degree varying directly with the amplitude of the original waves which exist in the opposite path and with which are originated the echoes that it is desired to suppress.

In accomplishing the above-stated object, the applicant provides means in each two-wire path for introducing a loss therein and means associated with said means and with the opposite path for regulating said means to produce a loss which varies directly with the amplitude of the waves in the opposite path.

The invention will be clearly understood when the following detailed description is read with reference to the accompanying drawing. Figure 1 of the drawing shows diagrammatically, and in part schematically, one desirable circuit arrangement in accordance with the invention. Fig. 2 shows diagrammatically an alternative arrangement of a part of the circuit.

With reference first to Fig. 1, there is shown a section of a four-wire circuit comprising a two-wire line L adapted for transmission from east to west and a two-wire line L′ adapted for transmission from west to east. In each of these lines, there is a one-way amplifier. In each path the applicant employs a hybrid coil involving impedances to be disclosed more fully hereinafter, and associated with each line is a tuned amplifier. Between each tuned amplifier and the hybrid coil of the opposite transmission path, certain elements are arranged as will be more fully described in connection with the following explanation of the operation of the system.

If noise or speech currents pass from east to west over the two-wire line L, the suppression in the line L′ of echoes from the west end of the four-wire circuit will be accomplished in the following manner. The noise or speech is transmitted in the manner usual in the echo suppressing arrangements old in the art through the tuned amplifier associated with line L and through the transformer T to the two-electrode vacuum tube rectifier RT, which includes in its circuits a battery B connected as shown. There is now impressed across the resistance R a voltage which is roughly proportional to the amplitude of the waves in the transmission path L. The hybrid coil H′ in the transmission path L′ has connected on one side an artificial network, schematically shown, and on the opposite side two three-electrode vacuum tubes V and V_1, having a common plate battery B_2. As is well understood in the art, the more nearly the impedance of the vacuum tubes balances the impedance of the network, the greater is the loss introduced into the line L′ by the coil H′. The applicant adjusts the network connected to the coil H′ so that it will balance the impedance of the tubes V and V_1 when the grids of these tubes are at the most negative point and the flow of plate current in the tubes at the minimum.

The voltage impressed across the resistance R by the waves in the line L with the battery B_1 connected as indicated will cause the grids of the tubes V and V_1 to become more negative, and there will be, of course, a corresponding reduction in the plate current of the tubes. This reduction of the plate current increases the impedance of the tubes and tends to balance the oppositely connected impedance of the network. Accordingly, as the grids of the tubes V and V_1 are made more negative, the loss introduced into the line L′ is increased, and it will readily be understood that this increase is roughly proportional to the amplitude of the waves in the transmission path L which have caused the voltage across resistance R and the increase of negative voltage on the grids. Conversely, a decrease of amplitude in the line L will reduce the negative voltage impressed on the grids of tubes V and V_1 and, consequently, the loss in the hybrid coil H′ will be decreased.

Instead of the arrangement described

above, an alternative arrangement may be employed as indicated in part in Fig. 2. In this case, the plate current of the tubes V and V_1 (or the corresponding tubes), instead of being normally large, is normally zero, and the network connected to the hybrid coil of line L′ is adjusted to balance the impedance of the tubes when the plate current is brought to the maximum. The elements T″, RT″ and R″, corresponding to elements T, RT and R of Fig. 1, are connected as shown in Fig. 2, and at increased voltage impressed across resistance R″, as the result of an increase of amplitude of the waves in line L, will cause the grids of the tubes to become less negative. The results will be a flow of plate current in the tubes and a decrease of the impedance balancing the network, whereby the transmission loss in line L′ will be increased.

The purpose of the condenser C is to produce a hang-over action, well understood in the art, to sustain the suppression in the line L′ until the echo has been completely suppressed.

By adjustment of the battery B, any desired threshold may be introduced into the action of the rectifier tube RT—that is, this tube may be made to function only when the amplitude of the waves in line L reaches or exceeds a given value.

It will be understood, of course, that the tubes V and V_1 may be made to operate on any desired part of their characteristic by the adjustment of the battery B_2.

It will readily be understood that the variable loss in the hybrid coil H of the line L dependent upon the amplitude of the waves in the line L′ is produced by means of the elements T′, RT′, B′, R′, C′, B_1′, V′, V_1′ and B_2′, corresponding to the elements introduced between the tuned amplifier associated with line L and the hybrid coil H′ in the line L′.

While the invention has been disclosed in one specific form which is deemed desirable, it will readily be understood that the true invention is capable of embodiment in many other and different forms more particularly adapted for forms of echo suppressor other than that disclosed in connection with the description of the applicant's novel features.

What is claimed is:

1. In a four-wire circuit having a first path adapted for transmission in one direction and a second path adapted for transmission in the opposite direction, the method of suppressing echoes which consists in introducing a loss in each path and causing the loss in either path to vary directly with the amplitude of the waves in the opposite path.

2. In a four-wire circuit having a first path adapted for transmission in one direction and a second path adapted for transmission in the opposite direction, means in each path for introducing a transmission loss therein and means associated with said means and with the opposite path for causing said transmisson loss to vary directly with the amplitude of the waves in said opposite path.

3. In a four-wire circuit having a first path adapted for transmission in one direction and a second path adapted for transmission in the opposite direction, means in one transmission path for introducing a transmission loss therein and means associated with said means and with the opposite path for adjusting said means to produce a transmission loss directly proportional to the amplitude of the waves in said opposite path.

4. In a four-wire circuit having a first path adapted for transmission in one direction and a second path adapted for transmission in the opposite direction, a hybrid coil in each transmission path, an artificial network connected thereto, a variable impedance means connected to said hybrid coil to balance said network, and means associated with the opposite transmission path for varying the impedance of said variable impedance means directly with the variation of amplitude of the waves in said opposite path.

5. In a four-wire circuit having a first path adapted for transmission in one direction and a second path adapted for transmission in the opposite direction, a hybrid coil in each transmission path, an artificial network connected therto, a variable impedance means connected to said hybrid coil to balance said network, and means associated with the opposite transmission path for varying the impedance of said variable impedance means directly with the variation of amplitude of the waves in said opposite path, said network being designed to balance said variable impedance means at the point of maximum impedance.

In testimony whereof, I have signed my name to this specification this 7th day of November, 1928.

HAROLD C. SILENT.