Sept. 17, 1929. D. MITCHELL 1,728,247

ECHO SUPPRESSOR

Filed March 13, 1928

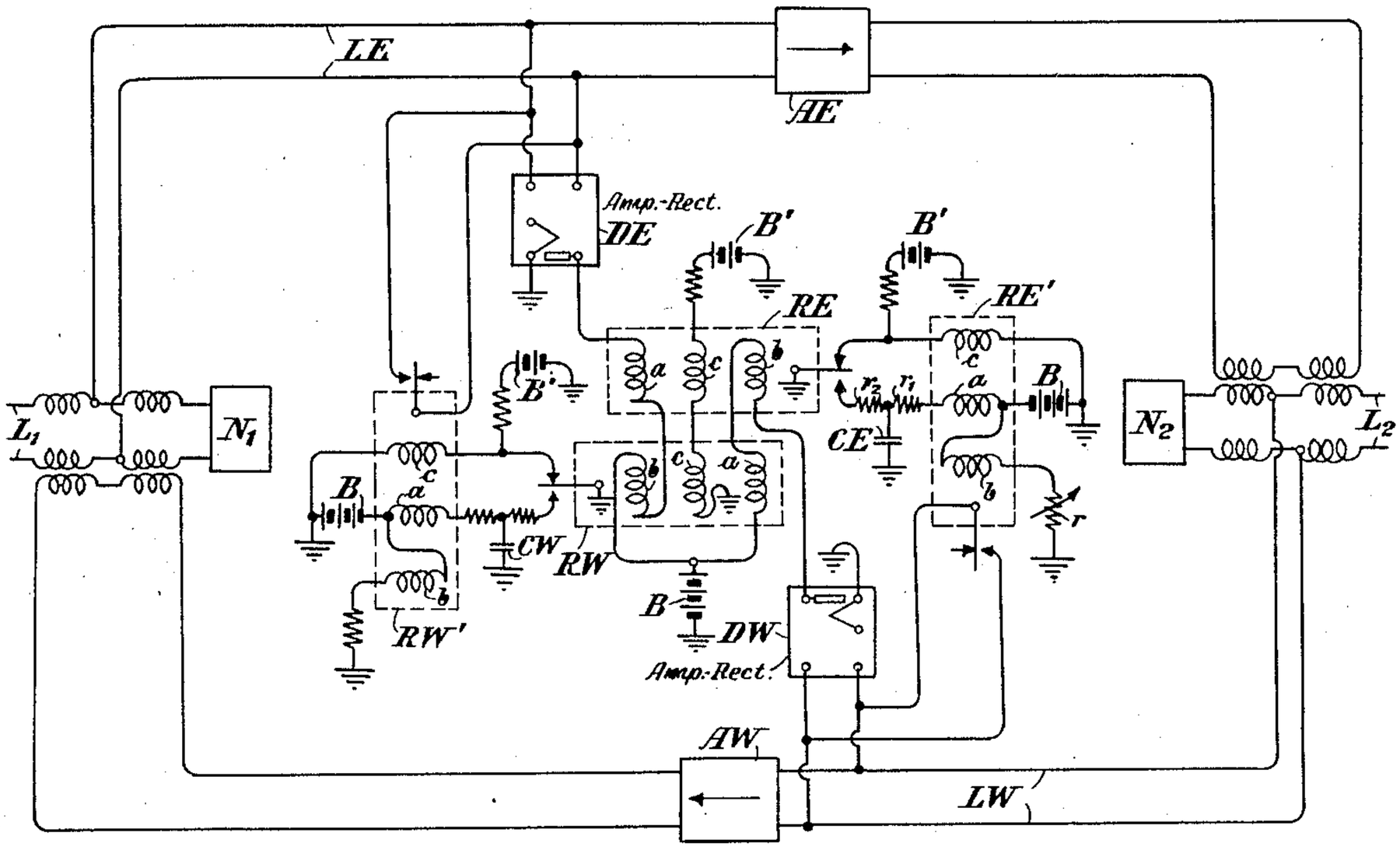

Fig. 1

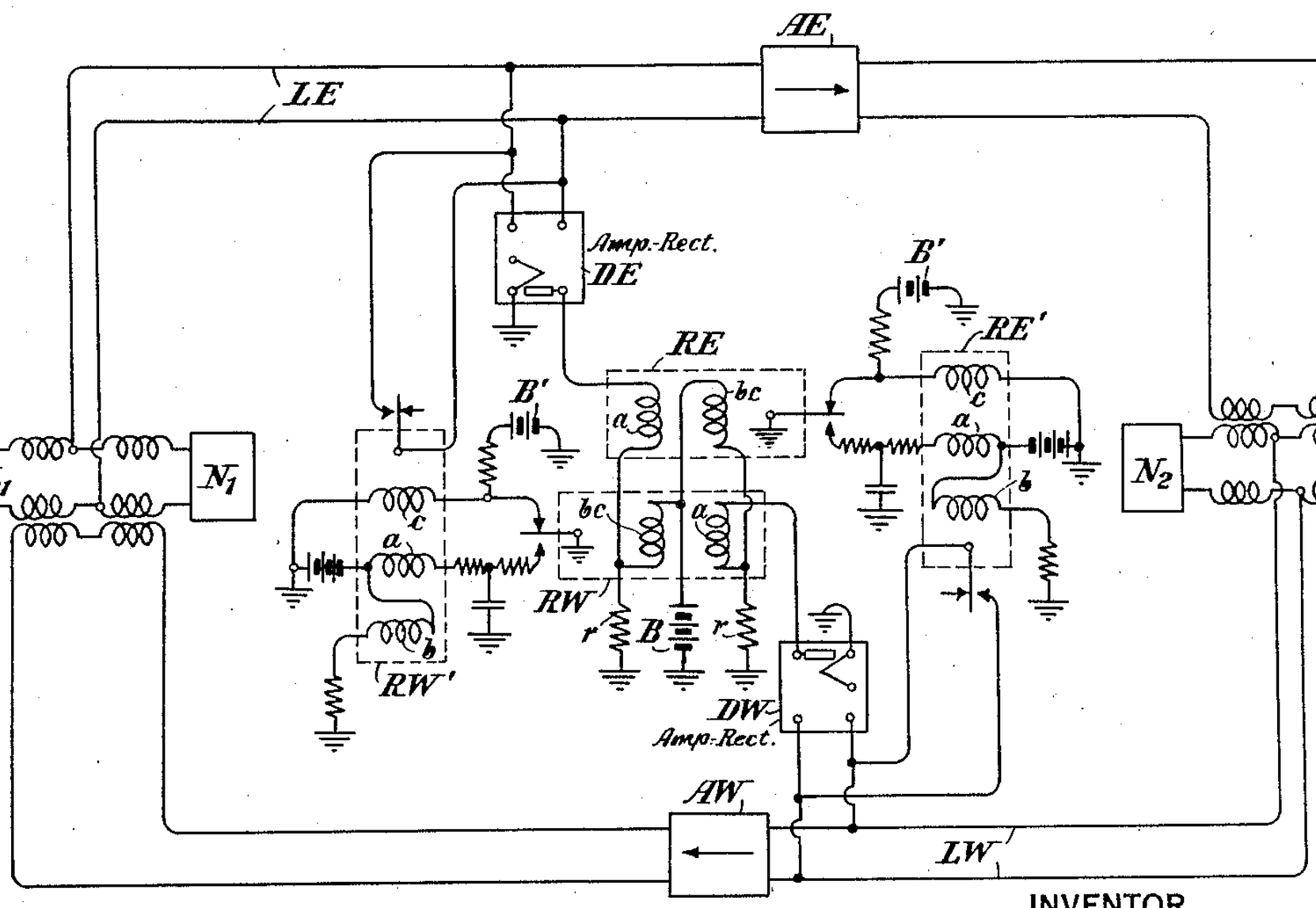

Fig. 2

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Patented Sept. 17, 1929 1,728,247

UNITED STATES PATENT OFFICE

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ECHO SUPPRESSOR

Application filed March 13, 1928. Serial No. 261,327.

This invention relates to echo suppressors, and, more particularly, to echo suppressors adapted for use in connection with two-wire telephone circuits.

In two-wire telephone circuits employing repeaters of the so-called 22-type, it has been the practice to suppress the principal, echo currents in the system by associating with each side of one of the 22-type repeaters of the circuit an echo suppressor unit to disable the repeater path transmitting in the opposite direction. With such an arrangement, it has been found that false operation occurs due to echoes having little or no delay in transmission. For example, a current passing over one side of the 22-repeater and operating the suppressor unit associated with that side would be transmitted through the hybrid coil and back over the path in the opposite direction, thereby energizing the suppressor unit associated with the second path before the first echo suppressor unit would have time to disable the second path.

It has heretofore been proposed to overcome this difficulty by interposing a delay circuit between the input of a suppressor unit associated with one side of the circuit and the input of the suppressor associated with the other side of the circuit, thereby delaying the transmission of the impulse around the circuit until the first echo suppressor unit has had time to operate. The use of such delay circuits, however, involves a considerable additional expense over and above the echo suppressor units proper.

Another scheme that has been proposed is to make the hang-over effect of the disabling relay of each echo suppressor unit dependent, to some extent, upon the length and amplitude of the operating impulse. With such an arrangement, a voice wave passing over one side of the repeater and setting the one suppressor unit into operation would, after passing into the return path to start the second suppressor unit into operation, be abruptly terminated by the operation of the first suppressor unit. Therefore, the resultant short impulse which might thus operate the second suppressor unit would not suffice to hold it operated for any length of time, and would not cause objectionable lockout of the speech. Experience has shown, however, that such an arrangement, while effective to reduce false operation to a considerable extent, accomplishes this result at the expense of the quality of the speech transmitted, since some distortion is introduced.

In accordance with the present invention, it is proposed to dispense with the use of delay circuits and still retain the fundamental relay arrangement by arranging the echo suppressor units to exercise an electrically interlocking (or opposing) control over the disabling equipment associated with the two sides of the circuit. In order to accomplish this result, the operating winding of the detector relay of the echo suppressor unit associated with each side of the circuit is connected in series with a winding of the detector relay of the opposite suppressor unit. The latter winding is connected in a reverse direction so that when either suppressor unit operates, it increases the biasing effect on the relay of the other side by an amount depending upon the magnitude of the impulse and the number of turns in the reverse winding. Thus, if one echo suppressor unit is operated, it makes operation of the detector relay of the other echo suppressor unit very difficult, due to the increased bias. Experience has shown that this interlcoking relay arrangement gives substantially the same operation as would be obtained by the use of a delay circuit. Due to the fact that the initial voice wave operates one relay and simultaneously checks the operation of the other, very quick echoes are prevented from falsely operating the apparatus before the first relay can operate, and hence a delay circuit is not needed.

The invention will now be more fully understood from the following description when read in connection with the accompanying drawing, Figures 1 and 2 of which show two different circuit arrangements embodying the principles of the invention.

Referring to Fig. 1, there is shown a 22-repeater arrangement comprising the path LE including an amplifier AE for transmitting in one direction, and a path LW including an amplifier AW for transmitting in the

opposite direction, said paths being interconnected through the usual hybrid coil arrangement with two wires lines L_1 and L_2, the said lines being balanced by the networks N_1 and N_2 in the usual and well-known manner. Both repeater paths are normally free to transmit in their respective directions, but an echo suppressor arrangement is associated with each path to block the opposite path when transmission is taking place over one of the paths.

The echo suppressor equipment associated with the path LE comprises an amplifier-detector arrangement DE of well-known type, the plate circuit of the detector of said arrangement being connected to the battery B through the operating winding *a* of a detector relay RE. The circuit of the operating winding *a* also includes a winding *b* associated with the detector relay RW of the echo suppressor unit associated with the path LW. Said last mentioned echo suppressor unit also includes an amplifier-detector arrangement DW, similar in all respects to the arrangement DE, with the plate circuit of the detector of the arrangement DW connected to the B battery through the operating winding *a* of the detector relay RW. The winding *b* of the detector relay RE is also included in series in the last described circuit. The *b* windings of the two relays RE and RW are poled oppositely with respect to the *a* or operating windings associated with each relay. Consequently, if an operating current flows from the amplifier-detector through the operating winding of the associated detector relay, a current flows at the same time through the *b* winding of the opposite detector relay to bias the latter and prevent its response to impulses transmitted over one path of the repeater through the hybrid coil to the other path. Each detector relay is also biased by means of a winding *c* supplied with a biasing current from a battery B′ through suitable resistance. The normal current through the biasing winding *c* is such as to normally oppose the action of current through winding *a*.

The detector relay RE controls a hang-over relay RE′ which performs the dual function of short-circuiting (and thereby disabling) the path LW, and of introducing a hang-over effect by which the armature of the hang-over relay maintains the short circuit for a predetermined hang-over period after the impulse which started the operation has ceased. The hang-over relay RE′ comprises an operating winding *c*, a hang-over winding *a*, and a biasing winding *b*. The operating winding *c* is energized when the armature of relay RE is removed from its back contact, thereby removing a short circuit from the winding *c* so that current can flow from the battery B′. The biasing current for the winding *b* is supplied by the battery B and is regulated by the resistance *r*, so that, under normal conditions, this biasing current is just sufficient to hold the armature of the hang-over relay RE′ firmly in its nonoperated condition. The hang-over effect introduced by the winding *a* is controlled by the charge and discharge of the condenser CE in a manner which will be described in more detail later.

The detector relay RW associated with the amplifier-detector arrangement DW controls a hang-over relay RW′, similar to RE′. This hang-over relay also includes an operating winding *c*, a hang-over winding *a* and a biasing winding *b*. The operation of the hang-over winding *a* is also controlled by the charge and discharge of the condenser CW. Likewise, the armature of the hang-over relay RW′ controls the application of a short circuit to the path LE.

The operation is as follows: A voice wave incoming from the line L_1 passes into the path LE and through the amplifier AE to the line L_2. Part of the voice energy passing over the path LE enters the amplifier-detector arrangement DE, thereby producing a unidirectional current in the plate circuit of the latter. This current passes through the winding *a* of the detector relay RE and also through the opposing winding *b* of the detector relay RW. Both relays RE and RW are normally biased by means of the current through their windings *c* so as to hold their armatures in the non-operated condition, as shown in the diagram. The current through the winding *a* of the relay RE produces an effect of such magnitude as to overcome the normal bias due to the winding *c* and to shift the armature of the relay RE from its non-operated to its operated contact. The current through the winding *b* of the relay RW produces a pull in the same direction as the normal bias due to the current in the winding *c*, and, consequently, the armature of the relay RW will be held in its non-operated position notwithstanding the fact that some of the voice energy flowing over the path LE may pass from the hybrid coil into the path LW to operate the amplifier-detector arrangement DW before relay RE′ is operated, and thereby energize the winding *a* of the detector relay RW. Obviously, this prevents any false operation of the echo suppressor unit associated with the path LW.

Returning to the detector relay RE, as soon as its armature is shifted from its non-operated contact, it opens the short circuit to ground, which normally prevents the energization of the winding *c* of the hang-over relay RE′, and said winding is at once energized to shift the armature of relay RE′ to its operated contact and thereby apply a short circuit to the path LW and to the input of the amplifier-detector DW. Transmisison from the line L_2 to the line L_1 is thereby prevented, so that echoes passing over the circuit in the

direction from the listening subscriber to the talking subscriber are blocked.

The armature of the detector relay RE, upon reaching its operated position, provides a discharge path through the resistance r_2 to ground for the condenser CE, said condenser being previously charged by the battery B through the hang-over winding *a* and the resistance r_1.

When the voice wave passing over the path LE ceases, winding *a* of relay RE is no longer energized, and the pull due to the biasing winding *c* of said relay restores the armature to its non-operated position. The additional bias introduced into the relay RW due to the current flow through the winding *b* of the relay RW also ceases, so that the relay RW is in a condition to respond to voice waves passing over the circuit LW.

As soon as the armature of the relay RE leaves its operated position upon being restored to normal, the discharge path to ground for the condenser CE is opened, and current flows from the battery B through the winding *a* and resistance r_1 to charge the condenser CE. This charging current passes through the winding *a* in such a direction as to tend to hold the armature of the hang-over relay RE in its operated position and thereby maintain the short circuit closed. As the condenser CE charges up, the current through the winding *a* decreases in accordance with the exponential law until the pull due to the biasing winding *b* is sufficient to overcome the pull due to the winding *a*, whereupon the armature of the hang-over relay RE′ is restored to its non-operated position and the short circuit is removed from the line LW. This hang-over period can be made sufficiently long to insure that any echo currents returning from east to west will have arrived at the foregoing point before the short circuit is removed.

It will, of course, be obvious that for voice currents transmitted from the line L_2 over the path LW to the line L_1, the operation of the other half of the apparatus including the amplifier-detector DW, the detector relay RW and the hang-over relay RW′, will be similar to that already described. In this case, of course, the unidirectional current from DW energizes the winding *a* of the relay RW to shift its contact. At the same time, the current passes through the opposing winding *b* of the relay RE to increase the bias of the latter, tending to hold the armature against its back contact.

In the arrangement above described, relays RE, RE′, RW and RW′ may all be exactly alike, the differences in operation being due to the different circuit arrangements by which they are connected. A modified arrangement is possible, however, as shown in Fig. 2, in which the function of the opposing winding *b* and the biasing winding *c* may be combined in a single coil. For example, the relays RE and RW of Fig. 2 each comprise an operating coil *a* and an auxiliary coil *bc*. The latter coil is so connected that current from the B battery flows through it and returns to ground through the resistance *r*, thereby producing the normal biasing action of the winding *bc* of the relay. The winding *bc* of each relay is also connected in series with the winding *a* of the opposite relay, so that plate current from a given amplifier-detector flows through the operating winding of its associated relay and the winding *bc* of the opposite relay. Consequently, when one relay, as, for example, RE, is operated by its winding *a* in response to voice currents, the biasing current through the winding *bc* of the opposite relay RW is increased, thereby preventing operation of the latter. The circuits of the hang-over relays RE′ and RW′ are identical with and are operated in the same manner as those of Fig. 1.

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 two-way communication system, a pair of paths adapted to transmit in opposite directions, an echo suppressor unit associated with each path comprising a detector and a relay operated thereby, each relay controlling means for disabling the opposite path, and an opposing winding for each relay energized under the control of the detector which operates the opposite relay, whereby when one relay is energized for operation the other relay is prevented from operating.

2. In a two-way communication system, a pair of paths adapted to transmit in opposite directions, an echo suppressor unit associated with each path comprising a detector and a relay operated thereby, each relay controlling means for disabling the opposite path, and a winding for each relay connected in opposition to its normal winding, and energized by current supplied by the detector which operates the opposite relay, whereby when one relay is energized for operation the other relay is prevented from operation.

3. In a two-way communication system, a pair of paths adapted to transmit in opposite directions, an echo suppressor unit associated with each path comprising a detector and a relay operated thereby, each relay controlling means for disabling the opposite path, an operating winding and an opposing winding for each relay, the said opposing winding of each relay being in circuit with the operating winding of the other relay, whereby when one relay is energized for operation the other relay is prevented from operation.

4. In a two-way communication system, a

pair of paths adapted to transmit in opposite directions, an echo suppressor unit associated with each path comprising a detector and a relay operated thereby, each relay controlling means for disabling the opposite path, an operating winding and an opposing winding for each relay, the operating winding of one relay and the opposing winding of the other relay being connected to be supplied with current from one detector, and the operating winding of the latter relay and opposing winding of the first relay being supplied with current from the other detector, whereby when one relay is energized for operation, the other relay is prevented from operation.

5. In a two-way communication system, a pair of paths adapted to transmit in opposite directions, an echo suppressor unit associated with each path comprising a detector and a relay operated thereby, an opposing winding for each relay energized under the control of the detector which operates the opposite relay, whereby when one relay is energized for operation, the other relay is prevented from operation, means controlled by each relay for disabling the opposite path, and means for maintaining the path disabled a predetermined time after the transmission wave passing over the other path has ceased.

6. In a two-way communication system, a pair of paths adapted to transmit in opposite directions, an echo suppressor unit associated with each path comprising a detector and a relay operated thereby, an opposing winding for each relay energized by current supplied by the detector which operates the opposite relay, whereby when one relay is energized for operation, the other relay is prevented from operation, means controlled by each relay for disabling the opposite path, and means for maintaining the path disabled a predetermined time after the transmission wave passing over the other path has ceased.

7. In a two-way communication system, a pair of paths adapted to transmit in opposite directions, an echo suppressor unit associated with each path comprising a detector and a relay operated thereby, an operating winding and an opposing winding for each relay, the said opposing winding of each relay being in circuit with the operating winding of the other relay, whereby when one relay is energized for operation, the other relay is prevented from operation, means controlled by each relay for disabling the opposite path, and means for maintaining the path disabled a predetermined time after the transmission wave passing over the other path has ceased.

8. In a two-way communication system, a pair of paths adapted to transmit in opposite directions, an echo suppressor unit associated with each path comprising a detector and a relay operated thereby, an operating winding and an opposing winding for each relay, the operating winding for one relay and the opposing winding of the other relay being connected to be supplied with current from one detector, and the operating winding of the latter relay and opposing winding of the first relay being supplied with current from the other detector, whereby when one relay is energized for operation, the other relay is prevented from operation, means controlled by each relay for disabling the opposite path, and means for maintaining the path disabled a predetermined time after the transmission wave passing over the other path has ceased.

9. In a two-way communication system, a pair of paths adapted to transmit in opposite directions, an echo suppressor unit associated with each path comprising a detector and a relay operated thereby, each relay controlling means for disabling tne opposite path, an opposing winding for each relay, and means whereby when one relay is operated the opposing winding of the other relay is simultaneously energized to prevent the operation of said other relay and thereby suppress quick echoes.

In testimony whereof, I have signed my name to this specification this 12th day of March, 1928.

DOREN MITCHELL.