Oct. 14, 1941. B. G. BJORNSON 2,258,966

CONTROL OF TRANSMISSION IN TWO-WAY SIGNALING SYSTEMS

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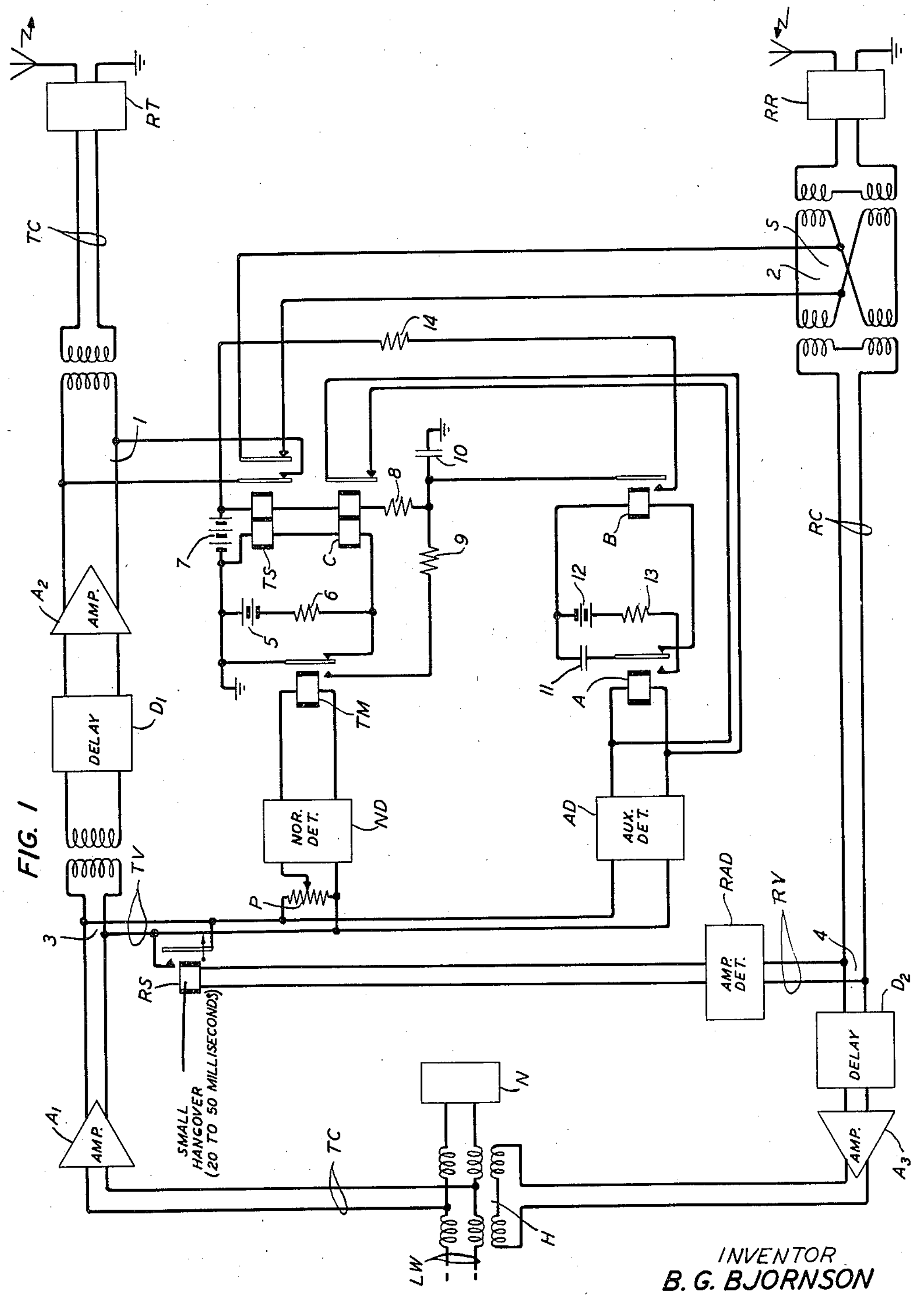

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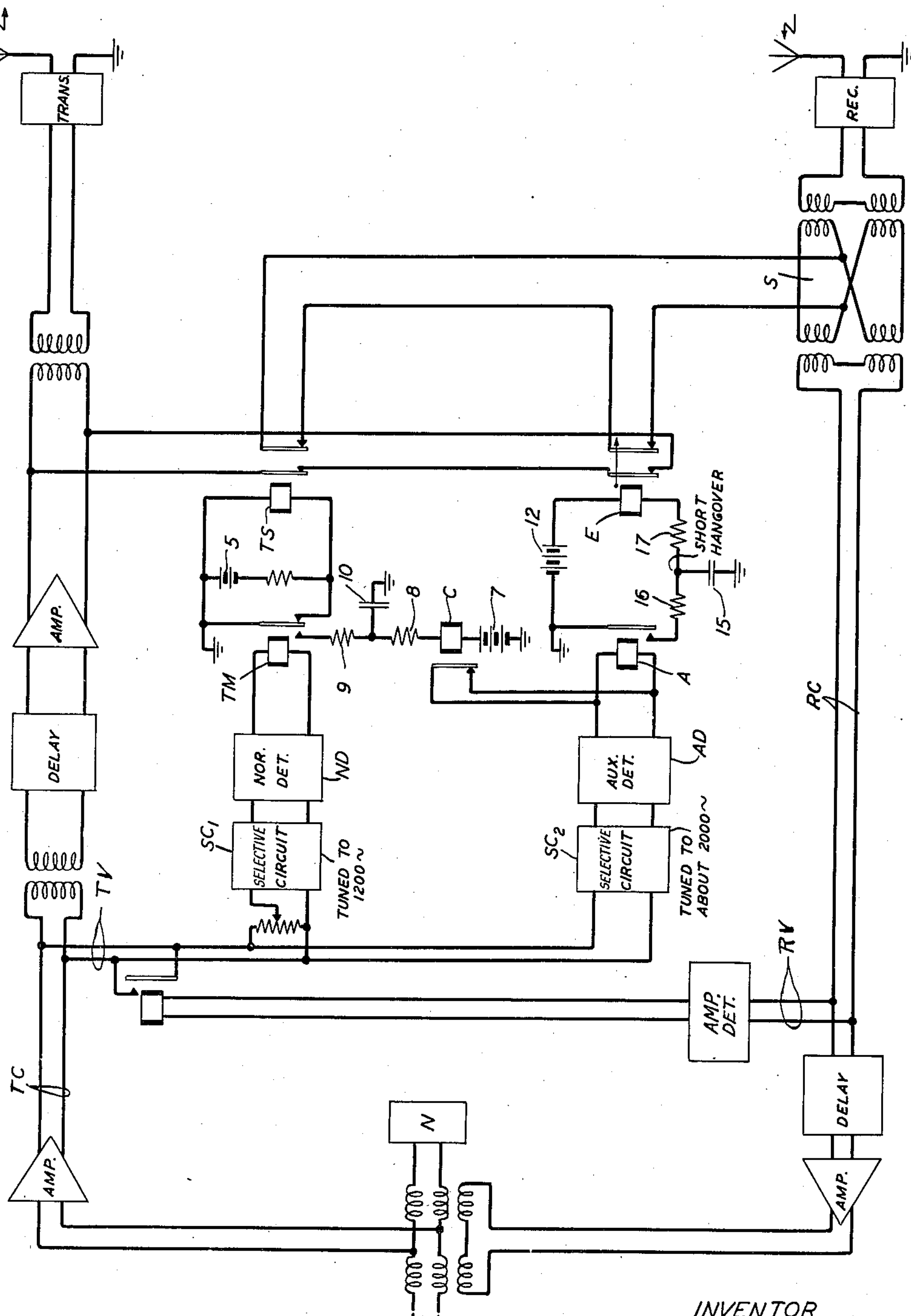
FIG. 2



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CONTROL OF TRANSMISSION IN TWO-WAY SIGNALING SYSTEMS

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This invention relates to two-way signal wave transmission systems and particularly to the signal-controlled switching circuits used with such systems to directionally control signal transmission while preventing singing and suppressing echoes.

The invention is of particular application to, although not limited to, a control terminal for a two-way radio telephone system, employing voice-operated switching circuits, so-called vodas circuits, responsive to outgoing telephone signals to condition the terminal for transmitting only and to incoming telephone signals to condition the terminal for receiving only. In the usual radio telephone terminals, the transmitting portion of the vodas circuit, which may be an amplifier-rectifier-relay circuit, operates in response to outgoing telephone signals to disable the voice receiving branch of the terminal and the associated receiving portion of the vodas circuit, and to remove a normal disability from the voice transmitting branch, and the similar receiving portion of the vodas circuit operates in response to incoming telephone signals, when the transmitting vodas portion is unoperated, to disable the latter.

To reduce quality impairment in the transmitted telephone signals caused by such switching operations, it has been found necessary to properly adjust the sensitiveness of the transmitting and receiving portions of the vodas circuit to prevent false operation by line noise or static, and to provide also a suitable amount of hang-over in the operation of each switching circuit when the amplitude level of the controlling waves falls below the sensitivity setting of the circuit. The hang-over provided for the receiving vodas detector circuit is ordinarily selected only long enough to insure the suppression of echoes so as to avoid excessive effects for operation on applied noise or static, and is, therefore, usually short (in the order of 20 to 50 milliseconds). The main function of hang-over in the transmitting vodas circuit has always been considered as the elimination of signal clippings. Also, since the ends of speech syllables are weaker and more trailing than the beginnings, a comparatively long hang-over (in the order of 120 milliseconds) has been utilized. Undoubtedly, this long hang-over reduces the number of initial clippings by holding the singing suppressor relay operated between many words.

In circuits equipped with echo suppressors, an increase in hang-over results in an increase in repetition rate. A hang-over on the transmitting vodas at a terminal of a radio telephone system, necessitating a longer transmitting echo hang-over, tends to prolong transmission lock-out periods, that is, intervals in which the subscribers at the two terminals of the system cannot hear each other. It is, therefore, desirable to avoid excess transmitting detector circuit hang-over.

The long transmitting detector circuit hang-over time (120 milliseconds) in present radio telephone control terminals was selected presumably to prevent the weak syllable endings of the poorest vodas operating talkers from being clipped. So with the fixed volume sensitivities used, for many syllables, probably most syllables, of the good vodas detector operating talkers, an excessive amount of hang-over is provided, tending to increase the probability of signal transmission lock-outs.

An object of the present invention is to reduce the probability of signal transmission lock-outs in two-way signal wave transmission systems equipped with signal-operated switching circuits for directionally controlling signal transmission.

A more specific object is to reduce the probability of signal transmission lock-outs in a two-way telephone system employing vodas switching circuits at its terminals due to excess hang-over in the switching circuits.

These objects are attained in accordance with the invention by a circuit operating to automatically adjust the hang-over of the transmitting vodas at a terminal of such a system to approximately the minimum value which will prevent signal clipping for the particular type of talker using the circuit. In one modification of the invention, this circuit operates to make the duration of the hang-over dependent on the amplitude of the applied speech currents after the release of the transmitting vodas master relay and in another to make the duration dependent both on the frequency and amplitude of the applied speech currents after the release of that relay.

The objects and features of the circuits of the invention will be brought out in the following detailed description when read in conjunction with the accompanying drawings, Figs. 1 and 2 of which show schematically a control terminal for a radio telephone system embodying different modifications of the invention.

The control terminal of Fig. 1 includes the voice transmitting branch TC including the one-way amplifiers A_1 and A_2 and the delay circuit D_1, leading to the radio transmitter RT, and the voice receiving branch RC including a suppressor coil device S, such as disclosed in Silent Patent No. 1,749,851, issued March 11, 1930, the delay circuit D_2 and the one-way amplifier A_3. The input of the voice transmitting branch TC and the output of the voice receiving branch RC may be coupled in conjugate relation with each other and in energy transmitting relation with the two-way circuit LW, which may be a telephone line connecting to a west subscriber's telephone circuit, by the usual hybrid transformer H and associated balancing network N, as shown, or in any other suitable manner.

The voice transmitting branch TC is normally disabled at a point 1 near its output to the right of delay circuit D_1 by a short-circuiting connection through the normally closed front contacts of the singing and echo suppression relay TS, and the voice receiving branch RC is normally operative at the point 2 near its input due to the series aiding connection of certain windings of the suppressor coil device S provided by the normal cross-connection of these windings through the normally closed back contacts of the relay TS.

The transmitting portion TV of the vodas switching circuit has its input connected across the voice transmitting branch TC at a point 3 in front of delay circuit D_1 and the receiving portion RV of this circuit has its input connected across the voice receiving branch RC at the point 4 near its output in front of delay circuit D_2.

The receiving side RV of the vodas comprises the amplifier-detector RAD and the switching relay RS energized from its output. It operates in response to incoming telephone signals in the voice receiving branch RC, when that branch is operative, to disable the transmitting portion of the vodas TV, for example, by closing a short-circuiting connection across its input, as indicated. The receiving portion RV of the vodas is normally provided with a short hang-over in operation, usually about 20 to 50 milliseconds, by any suitable means, to prevent its excessive operation by applied noise or static.

The transmitting vodas circuit TV includes a main switching branch, and an auxiliary branch provided for accomplishing the objects of the invention. The main switching branch includes the normal detector ND, the transmitting master relay TM operatively energized from its output and the transmitting singing and echo suppressor relay TS and the relay C, having an associated hang-over circuit, which relays are operated in response to operation of the relay TM. The auxiliary branch includes the auxiliary detector AD having its input connected in parallel with the input of the normal detector ND to the voice transmitting branch TC, a master relay A adapted to be energized by th output currents of the detector AD when relay C operates; and a switching relay B having an associated hang-over circuit, which is provided for terminating the hang-over on the switching relay TS on the release of the relay A, in the manner to be described in the following complete description of the operation of the transmitting vodas TV.

With no speech input to the transmitting vodas TV, the output of the auxiliary detector AD is disabled by a short-circuiting connection through the normally closed contacts of relay C. The relative sensitivities of the main detector ND and the auxiliary detector AD are normally adjusted, for example, by proper adjustment of the potentiometer P in the input of the former detector, so that the auxiliary detector AD is about 8 decibels more sensitive than the detector ND.

Telephone signals received over the line LW from a west subscriber will be impressed by the hybrid transformer H on the voice transmitting branch TC and transmitted thereover towards the radio transmitter RT. The portion of these outgoing signals diverted into the transmitting vodas TV, if the input of the latter is not blocked by operation of the receiving vodas RV by prior received signals in the voice receiving branch RC, will be divided between the inputs of detectors ND and AD. Although the auxiliary detector AD is more sensitive than the normal detector ND, because of the normal short circuit across the output of the former, its operation will not cause the operation of the relay A in its output until relay C in the normal detector circuit operates in response to operation of detector ND.

The operation of the main detector ND by the applied speech currents will cause the operation of the transmitting master relay TM. On the break of the back contact of the relay TM removing the normal short circuit across battery 5 and series resistance 6, current will flow from that battery through the operating windings of relays TS and C in series causing the operation of these relays. The operation of relay TS will break the normal cross-connection across the windings of the suppressor coil device S in the voice receiving branch, connecting these windings in series opposing relation so as to effectively disable that branch and will remove the normal singing suppression short circuit across the voice transmitting branch TC allowing the telephone signals, which meanwhile have been delayed in delay circuit D_1 and amplifier A_2, to be transmitted out over the branch to the radio transmitter RT which will radiate them to the other terminal of the system.

When the armature of relay TM reaches its front contact, a hang-over circuit including battery 7, resistances 8 and 9 and condenser 10 is set up for the hang-over windings of relays TS and C, the values of these elements being selected to provide a long hang-over, about 120 milliseconds, suitable for the poorest vodas operating talkers. On the break of the contacts of relay C, the normal short circuit is removed from the relay A resulting in its immediate operation by the detected voice currents in the output of detector AD. The operation of relay A will cause condenser 11 to be charged to the potential of battery 12 through resistance 13 and the front contacts of relay A.

As long as the amplitudes of the speech currents applied to the transmitting vodas TV remain over the operating point of detector ND, the circuits will remain in the condition above described with the four relays TM, TS, C and A operated and one relay, B, unoperated. The speech amplitudes at the end of a syllable will decay at a certain rate. Because of the sensitivity of the auxiliary detector AD being greater (by 8 decibels) than that of detector ND, the relay TM will always release before the relay A, the time difference in release depending upon the amplitude slope at the end of the syllable, which varies with different talkers. When the speech amplitudes fall off to the necessary degree, relay A will release. When relay A releases, the discharge of condenser 11 through the winding of relay B, the values of the elements in the two hangover circuits being properly selected, will cause the latter relay to be operated for a period long enough to charge condenser 10 through small resistance 14 to the full value of the voltage of battery 7. This reduces to zero the charging current through the hang-over windings of relays C and TS, which was supplying the slow release, and the armatures of both relays are returned to their normal contacts. When relay C releases, relay A is again short-circuited. If relay A has not released within the normal hang-over time, the release of relay C will always cause it to release so that the circuit is returned to its normal condition.

Thus, it may be seen that by proper selection of the values of the various elements of the circuit of Fig. 1 the hang-over of the switching relay TS may be made to vary in accordance with the time of the decay in the amplitude of the speech waves of the talker after the transmitting master relay TM releases, the hang-over being made just sufficient to prevent clipping. The method is based on the hypothesis that speech of amplitudes below the operate point of the switching detector is of little value.

The greater sensitivity of the auxiliary detector AD raises the question of the effects of noise on the operation. Steady noise above the operate point of the auxiliary detector AD would cause the maximum hang-over (120 milliseconds) to be applied, which would make the operation of the circuit of Fig. 1 for such a condition the same as in present practice, but as the percentage of time in which the amount of noise is that high is small, the circuit of the invention would be effective to reduce the probability of transmission lockouts for practically all condiitons.

The circuit arrangement of Fig. 2 in which the hang-over time is modified in accordance with both the amplitude and frequency of the talker's speech currents after the master relay TM releases, is based on the hypothesis that the hang-over need only depend on the high frequency components in speech assuming that the consonant frequencies predominate in this range.

In the circuit of Fig. 2, the elements having functions corresponding to those of the elements of Fig. 1, bear the same reference characters. The normal detector ND is tuned by the selective circuit SC_1 in its input to about 1200 cycles, as is the transmitting vodas detector in present vodas switching circuits, but the auxiliary detector AD is tuned by the selective circuit SC_2 in its input to a higher frequency, say 2000 cycles, and, like in the circuit of Fig. 1, although it is of higher sensitivity than the normal detector, the relay A in the output of AD cannot operate until the relay C has operated to remove the short circuit across the output of AD. The changes from the circuit of Fig. 1 will be brought out in the following description of operation of the circuit of Fig. 2.

When outgoing telephone signals are transmitted over the voice transmitting branch TC and no prior received signals are present in the voice receiving branch RC, the speech signals diverted into the transmitting vodas TV will be divided between the normal detector circuit and the auxiliary detector circuit. The low frequency components of the impressed signals selected by the selective circuit SC_1 will be detected by the normal detector ND and cause operation of the transmitting master relay TM.

On the break of the relay TM, the singing suppressor relay TS will be operated by current from battery 5, to open its normally closed back and front contacts. The opening of its back contacts will open the normal cross-connection across the windings of suppressor coil device S to change the latter to the high loss condition effectively disabling the receiving voice branch RC. The opening of the front contacts of relay TS will produce a break in the normal short-circuiting connection across the voice transmitting branch TC to unblock that branch for the outgoing telephone signals.

On the make of the relay TM, operating current will be applied by battery 7 to the relay C and the hang-over circuit comprising resistances 8 and 9 and condenser 10 will be set up for its winding. On the break of the relay C, a normal short circuit across the relay A is removed allowing its operation in response to the higher frequency components of the applied speech waves selected by selective circuit SC_2 and detected by the auxiliary detector AD. On the make of the relay A, the relay E is supplied with operating current from the battery 12 and a hang-over circuit including condenser 15 and resistances 16 and 17, is set up for its winding. The elements are selected to give the relay E a short hang-over, as indicated. The operation of the relay E to break its contacts puts another break in the normal singing suppression path across the voice transmitting branch TC and another break in the cross-connection across the windings of the suppressor coil device S in the voice receiving branch RC.

When the level of the low frequency speech components passed by selective circuit SC_1 falls below the operating sensitivity of the normal detector ND the relay TM will release causing the release of the switching relay TS to close its front and back contacts. This will not cause the voice transmitting branch TC to be blocked or the voice receiving branch to be unblocked, because of the additional break in the singing suppressor path and the additional break in the cross-connection across the windings of S provided by the open contacts of operated relay E. The voice transmission branch TC will remain unblocked and the voice receiving branch RC will remain unblocked as long as relay E stays operated, this time interval depending upon the input to the tuned auxiliary detector AD. For words ending with vowels the relay E would probably not stay operated very long after the relay TM releases. The relay TS may also be provided with a small hang-over.

It will be apparent from the above description of the operation of the circuit of Fig. 2 that the hang-over time for which the voice transmitting branch TC remains unblocked and the voice receiving branch RC remains blocked after the release of the master relay TM in the transmitting vodas circuit will depend on the hang-overs associated with the C and E relays which would depend in turn on the frequency and amplitude of the speech signals subsequently applied to the normal and auxiliary detectors which will vary with different talkers.

From the noise standpoint the circuit of Fig. 2 is similar to that of Fig. 1, that is, when the noise waves exceed the operate point of the auxiliary detector the circuit operates with a constant large transmitting vodas hang-over.

The result of employing a transmitting vodas with variable hang-over as in the circuits of Fig. 1 or Fig. 2, is to reduce the per cent time the voice transmitting branch is cleared.

A possible modification of the circuits illustrated and described which might improve the operation would be the introduction and removal of the loss in the voice transmission paths at a certain time rate. Other modifications which would be within the spirit and scope of the invention will occur to persons skilled in the art.

What is claimed is:

1. In combination with a two-way signal transmission system including at a terminal thereof signal transmitting and receiving paths and a signal-controlled switching circuit for directionally controlling signal transmission in said paths while preventing singing and suppressing echoes, means to improve the operation of said switching circuit from the standpoint of reducing the probability of signal transmission lockouts for a given amount of protection against signal clipping, comprising a circuit for producing a time hang-over in the operation of said switching circuit with cessation in the controlling signals and auxiliary means controlled by the signals applied to said switching circuit and responsive to a reduction in their amplitude level below the predetermined value required to cause operation of said switching circuit to adjust the time constant of the hang-over producing circuit in accordance with the characteristics of the subsequently applied signals.

2. The combination of claim 1 in which said auxiliary means comprises means for adjusting the time constant of said hang-over producing circuit to a value dependent on the rate of reduction in amplitude of said subsequently applied signals.

3. The combination of claim 1, in which said auxiliary means comprises means for adjusting the time constant of said hang-over producing circuit to a value dependent on both the frequently and the rate of reduction in amplitude of said subsequently applied signals.

4. The combination of claim 1, in which said switching circuit includes a transmitting portion controlled from the signal transmitting path and a receiving portion controlled from the signal receiving path, said transmitting portion including a signal detector and a chain of switching relays controlled from its output, operating in response to outgoing signals in said signal transmitting path to disable said signal receiving path and said receiving portion of said switching circuit, to remove a normal disability from said signal transmitting path, and to apply hang-over to one or more of said switching relays, said receiving portion operating in response to incoming signals in said signal receiving path, when that path is operative, to disable said transmitting portion in its input, and the last-mentioned means comprises a normally disabled auxiliary signal detector connected to said signal transmitting path, more sensitive than the first signal detector, which is adapted to be rendered operative in response to operation of a relay in said chain, and relay means responsive to the signal output of said auxiliary detector when it is operative, to control the duration of the hang-over applied to said one or more switching relays in said chain, in accordance with the amplitude of the controlling signals after the first relay in said chain releases to prevent an excessive amount of applied hang-over.

5. The combination of claim 1, in which said system is a two-way telephone signaling system, said switching circuit includes a transmitting switching portion controlled from said signal transmitting path and a receiving switching portion controlled from said signal receiving path, said transmitting portion including a speech wave detector tuned to a lower frequency in the speech range, and a chain of switching relays controlled from the detector output, operating in response to outgoing telephone signals in said transmitting circuit to remove a normal disability therefrom and to disable said signal receiving circuit and said receiving switching portion of said switching circuit, said receiving switching portion operating in response to received telephone signals in said signal receiving path, when it is operative, to disable said transmitting switching portion, and said hang-over time adjusting means comprises an auxiliary, normally-disabled signal detector tuned to a higher frequency in the speech range, and more sensitive than the first detector, connected to said signal transmitting path, which is adapted to be rendered operative in response to operation of the first switching relay in said chain, and relay means responsive to the speech wave output of said auxiliary detector to effectively apply an operating hang-over to said transmitting switching portion, the duration of which is proportional to the operating time of said auxiliary detector after the release of said first switching relay in said chain when the signal input level to the first detector falls below its operate value.

6. The combination of claim 1, in which said switching circuit includes a transmitting portion having a signal detector and a chain of switching relays controlled from the output thereof, operating in response to outgoing signals in said signal transmitting path to condition the terminal for transmitting only, said hangover-producing circuit comprises means for applying a direct current operating bias for a hang-over time interval to one or more relays in said chain when the first relay in the chain releases, and said auxiliary means comprises an auxiliary detector-relay circuit controlled by the signals applied to the input of said transmitting portion of said switching circuit, and operative when their level falls below said predetermined value to make the time duration of the direct current bias applied to said one or more relays dependent on the rate of decay in amplitude of the signals applied to said auxiliary detector-relay circuit.

7. The combination of claim 1, in which said switching circuit comprises a transmitting portion having a signal detector and a chain of switching relays controlled from the output thereof, operating in response to outgoing signals in the transmitting path to condition the terminal for transmitting only, said hang-over producing circuit comprises means for applying a direct current operating bias for a hang-over time interval to one or more relays in said chain when the first relay in the chain releases, and said auxiliary means comprises an auxiliary detector-relay circuit controlled by the signals applied to the input of said switching circuit and operating in response to the higher frequency components of said signals when the signal input level is below said predetermined value to make the duration of the direct current bias applied to said one or more relays dependent both on the rate of decay in amplitude and the frequency of the subsequently applied signals.

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