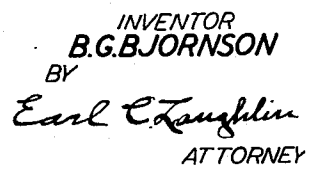


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2 Sheets-Sheet 1



May 18, 1943.

B. G. BJORNSON

2,319,717

TRANSMISSION CONTROL IN TWO-WAY SIGNAL WAVE TRANSMISSION SYSTEM

Filed May 29, 1942

2 Sheets-Sheet 2

FIG. 2

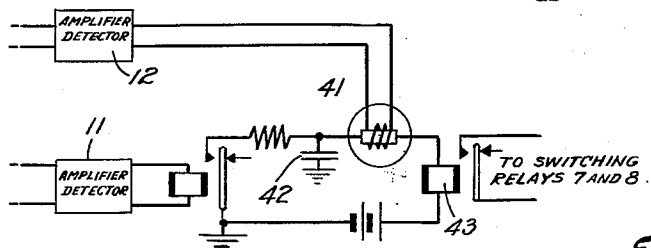
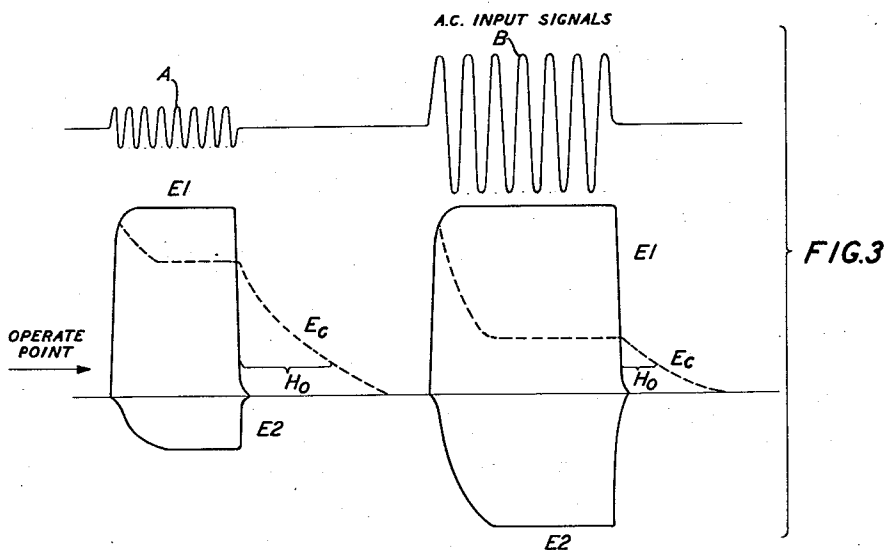
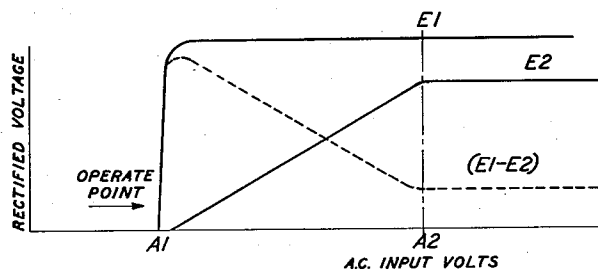


FIG. 4.

INVENTOR
B.G. BJORNSON
BY
Earl C. Laughlin
ATTORNEY

UNITED STATES PATENT OFFICE

2,319,717

TRANSMISSION CONTROL IN TWO-WAY
SIGNAL WAVE TRANSMISSION SYSTEMSBjorn G. Bjornson, Brooklyn, N. Y., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application May 29, 1942, Serial No. 444,952

5 Claims. (Cl. 178-44)

The 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.

An object of the invention is to improve such switching circuits, particularly from the standpoint of facilitating "break-in" by the signals in one direction after the signals in the other direction have obtained directional control of the system.

The invention is of particular application to, although not limited to, a control terminal for a two-way radio telephone system employing voice-operating switching circuits, so-called vodas (voice-operated device, antisinging) 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 terminal, 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 sensitivity of the transmitting and receiving switching circuits of the vodas circuit so as to prevent false operation by line noise or static, and to provide also a suitable amount of hangover in the operation of each switching circuit when the amplitude level of the control waves falls below the sensitivity setting of the circuit. The hang-over provided for the receiving switching circuit is ordinarily selected only long enough to insure the suppression of all echoes, and is, therefore, usually short, in the order of 20 to 50 milliseconds. The transmitting switching circuit is usually provided with a longer fixed amount of hang-over, in the order of 120 milliseconds, to prevent clipping of the final parts of the syllables of the outgoing voice signals.

From the standpoint of clipping, it is obviously unnecessary to apply a longer hang-over to the transmitting switching portion of the vodas circuit for an applied loud speech syllable than for

an applied weak speech syllable. This would correspond to increasing the hang-over with an increase in sensitivity of the switching circuit, whereas it is apparent that with increased sensitivity less hang-over is necessary. From this standpoint, the applied hang-over can be decreased as the input increases without resulting in an appreciable increase in clipping.

In accordance with the present invention, the transmitting switching branch of the vodas switching circuit is modified so as to provide automatically a suitable decrease in the amount of applied hang-over with increase in the amplitude of the signals applied to its input. In one embodiment this is accomplished by supplying the input signals in common to two amplifier-detectors of properly selected different input-output characteristics, having their outputs connected in opposition, and employing the resultant difference output wave to control operation of the switching relays, and to variably charge the condenser of the associated hang-over circuit to provide the desired variation in hang-over with input.

The various objects and features of the invention will be better understood from the following detail description when read in conjunction with the accompanying drawings, in which:

Fig. 1 shows schematically one modification of the invention applied to the vodas switching circuit at a control terminal of a two-way radio telephone system;

Figs. 2 and 3 show curves illustrating the operation of the circuit of Fig. 1; and

Fig. 4 shows schematically a portion of the transmitting branch of the vodas switching circuit of Fig. 1 embodying a different modification of the invention.

The two-way radio control terminal of Fig. 1 includes a voice signal transmitting branch TC leading to a radio transmitter (not shown), and a voice signal receiving branch RC leading from a radio receiver (not shown). The input of the transmitting branch TC and the output of the receiving branch RC are coupled by the usual hybrid coil transformer H and associated balancing network N in conjugate relation with each other and in energy-transmitting relation with the two-way telephone line TL which may connect directly or through a switchboard (not shown) with the telephone transmitting and receiving apparatus of a west telephone subscriber. The voice signal transmitting branch TC includes in order reading from west to east, a volume control device $\dagger$ which may be a vogad (volume-oper-

ated gain-adjusting device) of any of the well-known types, operating to compensate for the usual level variations in transmitted speech signals due to loud and weak talkers, a delay circuit 2 and a one-way transmitting amplifier 3. The voice signal receiving branch RC includes in order reading from east to west, a variable loss pad 4, which may be, as shown, of the suppressor coil type disclosed in the United States Patent to Silent, No. 1,749,851, issued March 11, 1930, adapted for switching from a low loss value to a high loss value under control of an associated switching relay, and a one-way receiving amplifier 5.

The voice signal transmitting branch TC is normally disabled at a point 6 to the east of the delay circuit 2 by a short-circuiting connection through the closed switching contacts of the unoperated switching relay 7. The voice signal receiving branch RC is normally operative due to the normal low loss condition of the suppressor coil pad 4 with its inner windings connected in series-aiding by the cross-connection through the normally closed switching contacts of the unoperated switching relay 8.

Connected across the transmitting signal branch TC at a point 9 in front of delay circuit 2 is the input of the transmitting switching branch TV of the vodas circuit. The transmitting switching branch TV includes the one-way amplifier 10 in the input, two amplifier-detector branches 11 and 12 having their inputs coupled with the output of amplifier 10 by the hybrid coil transformer H₁ and associated balancing network N₁, a direct current amplifier 13 consisting of a simple three-electrode amplifying vacuum tube, having its input connected in parallel to the outputs of the two amplifier-detector branches 11 and 12, and its output connected through the hangover circuit including the shunt condenser 14 and the series resistor 15, across the series-connected operating windings of the switching relays 7 and 8.

The amplifier-detector branch 11 comprises a three-electrode amplifying vacuum tube 16 having its control grid-cathode circuit including the grid biasing battery 17 and the grid leak resistor 18 in series, coupled by input transformer 19 to one winding of hybrid transformer H₁, and a rectifier circuit including the copper oxide rectifier 20, the condenser 21 and the biasing battery 22 in series, coupled by transformer 23 to the plate-cathode circuit including plate battery 24, of the amplifying tube 16. Similarly, the amplifier-detector circuit 12 comprises a three-electrode amplifying vacuum tube 25 having its grid-cathode circuit including the grid biasing battery 26 and the grid leak resistor 27 in series, coupled by input transformer 28 to a second winding on hybrid transformer H₁, and a rectifier circuit including the copper-oxide rectifier 29, the resistor 30, the condenser 31 and the biasing battery 32 in series, coupled by transformer 33 to the plate-cathode circuit including plate battery 34, of the amplifying vacuum tube 25. The control grid-cathode circuit of the direct current amplifier tube 13, which includes the grid-biasing battery 40, is connected through the series resistor 35 directly across the condenser 21 in amplifier-detector circuit 11, and through series resistor 36 directly across the condenser 31 in amplifier-detector circuit 12, so that the voltage produced by a charge on con-

denser 21 effectively opposes the voltage produced by a charge on condenser 31 in the control grid-cathode circuit of the direct current amplifier tube 13.

Connected across the voice signal receiving branch RC at a point 37 to the west of the suppressor coil loss pad 4 is the input of the receiving switching branch RV of the vodas switching circuit. The receiving switching branch RV includes an amplifier-detector 38 which, when the suppressor coil loss pad 4 is in its normal low loss condition with the transmitting switching delay 8 unoperated, is responsive to applied incoming voice signals from the signal receiving branch RC to cause operation of the receiving switching relay 39 in its output to break the energizing circuit for the transmitting switching relays 7 and 8, and thus effectively disable the transmitting vodas branch TV. The receiving sensitivity of the vodas branch RV is initially adjusted by any suitable means so that, when the transmitting vodas branch TV is unoperated, the receiving branch RV will not be falsely operated by the usual amount of applied line noise or static.

The manner in which the modified transmitting vodas switching branch TV accomplishes the object of the invention will be brought out in the following complete description of its operation with reference to the characteristic curves of Figs. 2 and 3.

Let it be assumed that the west subscriber associated with the line LW starts to talk. His voice currents received over the line LW will be impressed by the hybrid coil H on the voice signal transmitting branch. The impressed signals will pass through the transmitting vodag 1 which will provide the desired level compensation for strong and weak talkers, and with the level so adjusted will be divided between the input of the delay circuit 2 in the main transmission branch TC and the input of the transmitting branch TV of the vodas switching circuit.

The voice signals diverted into the branch TV will be amplified by the amplifier 10 therein, and the amplified waves will be divided equally by hybrid transformer H₁ between the inputs of the amplifier-detector branches 11 and 12, respectively, and will be amplified and detected therein to produce varying charging voltages E₁ and E₂ on the condensers 21 and 31 in the respective branches. The amplifier-detector 11 by suitable selection of the value of gain of tube 16, the control grid bias provided by the grid-biasing battery 17 and the value of the grid leak resistor 18 in its control grid-cathode circuit is arranged to operate marginally (or practically so) and to provide an amplitude limiting action. As indicated by the characteristic curves of Fig. 2, the amplifier detector 11 starts to operate when the input voltage exceeds the value A₁, and produces a varying rectified voltage E₁ on the condenser 21, such as indicated by the curve labeled E₁, the rectified voltage rising sharply to a given maximum value for input voltages slightly exceeding A₁, and remaining constant at that value for higher input voltages.

By proper selection of the gain of amplifier tube 25, the value of the grid leak resistor 27 therefor and the value of the grid-biasing battery 26, the rectified voltage E₂ produced on condenser 31 in the amplifier-detector branch 12 can be

made to vary as indicated by the curve labeled E_2 in Fig. 2, this rectified voltage varying linearly with input voltage up to a given maximum output voltage lower than the maximum rectified voltage E_1 , and remaining constant at higher input voltages. The resultant net varying voltage E_c applied to the condenser 14 in the plate-cathode circuit of the direct current amplifier tube 13, and to the operating windings of relays 7 and 8 connected across that condenser will vary in accordance with the instantaneous difference between the rectified voltages E_1 and E_2 , as indicated by the dashed-line curve labeled $(E_1 - E_2)$ in Fig. 2. The applied voltage E_c will cause the operation of relays 7 and 8. The operation of relay 8 will open the cross connection between the inner windings of suppressor coil loss device 4 in the voice-receiving branch RC thus connecting these windings in series opposing so that the loss pad 4 provides a large disabling loss in that receiving branch. The simultaneous operation of relay 7 will open the normal short-circuiting connection across the voice-transmitting branch TC allowing the main portion of west's voice signals, which meanwhile have been delayed in passing through the delay circuit 2 and transmitting amplifier 3, to pass out over the branch TC to the associated radio transmitter which will radiate them to the distant terminal of the system.

The net charging voltage E_c impressed on the condenser 14 in the output of the direct current amplifier tube 13 by west's voice signals will be proportional to the difference between the output voltages E_1 and E_2 of amplifier-detectors 11 and 12 applied to the input of that tube, indicated by the dashed-line curve labeled $(E_1 - E_2)$ in Fig. 2. As shown, this difference voltage $(E_1 - E_2)$ reaches a maximum value for an input voltage slightly greater than A_1 and is gradually reduced for higher input voltages up to the voltage A_2 corresponding to the overloading point of the amplifier-detector 12, and remains constant at a given reduced value for still higher input voltages.

When west ceases talking, the amplifier-detectors 11 or 12 will release when the level of the applied signals falls below their marginal operating points, causing the release of the direct current amplifier tube 13. The operating current applied to the winding of switching relays 7 and 8 from the output of amplifier 13 will therefore immediately fall off. These relays, however, will not immediately release but will remain operated to maintain the voice transmitting branch TC unblocked and the receiving branch RC blocked for a hang-over time interval while the discharge current of the condenser 14 flows through the windings of these relays, the length of the hang-over time interval being determined by the voltage E_c across the condenser 14 at the time amplifier 13 releases.

The variation of the hang-over time interval with the amplitude of the signals applied to the transmitting vodas circuit TV is illustrated by the dynamic characteristic curves of Fig. 3 for two square wave alternating signal input pulses A and B shown at the top of the figure, as it would be difficult to depict the variation in voltage relations which would exist in response to variations in signal amplitudes corresponding to the envelope of a speech wave. The variation with time of the opposing rectified voltages E_1 and E_2 across the condensers 21 and 31 in the amplifier-rectifier circuits 11 and 12, respectively of Fig. 1,

in response to the input pulses A and B of different amplitudes, are illustrated by the solid line curves correspondingly labeled at the bottom of Fig. 3, and the variation with time of the resultant net voltage E_c produced across condenser 14 in the output of the direct current amplifier tube 13 in response to the difference voltage applied to its input in the case of the two impulses A and B, is illustrated by the dashed-line curves in that figure. If the time constants of the two amplifier-rectifiers 11 and 12 are properly selected, the voltage E_c across condenser 14 at the end of the applied pulse will be a given amount greater in the case of the small amplitude pulse A, than in the case of the large amplitude pulse B providing a longer hang-over time interval H_o for the switching circuit TV for the former case than for the latter case. By proper choice of the elements in the circuit, it is apparent that the hang-over time may be automatically adjusted in accordance with the strength of the applied speech syllables so that only the necessary hang-over to prevent clipping is applied in each case, instead of a fixed relatively large amount of hang-over for both weak and strong speech syllables as in present vodas switching circuits. The automatic hang-over adjustment arrangement of the invention by reducing the average amount of hang-over results in quicker releases of the transmitting switching circuit of the vodas on the average and thus more frequent unblocking of the voice-receiving circuit RC during a conversation. This allows the incoming speech waves from the distant subscriber to more easily get through the loss pad 4 in the receiving circuit RC to operate the receiving switching branch RV to reverse the control of the circuit, in other words, to facilitate "break-in."

Various modifications of the circuits illustrated in Fig. 1 and described above, which are within the spirit and scope of the invention will occur to persons skilled in the art. For example, the auxiliary amplifier-detector circuit 12, instead of being employed to produce a rectified voltage opposing that produced by the main amplifier-detector 11 in the input of an amplifier tube to control the charge on a hang-over condenser in the output of the latter tube, as in the system described, may be utilized, as shown in Fig. 4, to supply heating current varying with the amplitude of the applied speech signals to the heater of a thermistor 41 in the hang-over circuit 42 of one relay 43 of the transmitting vodas switching relays, to correspondingly control the resistance in the hang-over circuit and thus the time hang-over in operation of the associated relays after the amplifier-detector 11 releases. Such a circuit arrangement may be utilized to adjust the hang-over to the optimum value for the strength of each applied signal. The thermistor may be of the usual type which provides a lowered resistance for high heating current and requires a certain time to restore to its normal resistance value when the supply of heating current ceases.

What is claimed is:

1. In combination with a two-way signal wave transmission system including at a given point oppositely-directed one-way signal transmission paths, a signal-controlled switching circuit including switching branches respectively controlled from each path, for directionally controlling signal transmission therein while preventing singing and suppressing echoes, and means to improve the operation of said circuit from the

standpoint of facilitating break-in comprising an auxiliary circuit controlled by the signals in one path for making the time hang-over in operation of the branch of said switching circuit controlled from that path vary inversely with the amplitude of the signals controlling its operation.

2. In combination with a two-way signal wave transmission system including at a terminal thereof a signal transmitting path, a signal receiving path and a wave-operated switching device connected to each path respectively responsive to outgoing signal waves to condition the terminal for transmitting only and to incoming signals to condition the terminal for receiving only, means to facilitate break-in by the signals in one of said paths after the signals in the other path have operated the switching device connected thereto to seize directional control of the terminal, comprising auxiliary means controlled by the signals in said other path for making the time hang-over in operation of the switching device connected thereto vary inversely with the amplitude of the controlling signals.

3. In combination with a two-way telephone system including at a terminal thereof a voice signal transmitting path and a voice signal receiving path, a wave-operated switching device connected to each path, the switching device connected to the transmitting path being responsive to outgoing signals therein, in the absence of prior incoming signals in the receiving path, to disable said receiving path and the switching device connected thereto, and to remove a normal disability from said transmitting path, the switching device connected to the receiving path being responsive to incoming signals in said receiving path when it is operative, to disable the switching device connected to said transmitting path, means in the latter switching device controlled by the applied signals for setting up a hang-over circuit for prolonging the operation of that device for a time interval after the controlling signals cease sufficient to prevent appreciable clipping of the outgoing signals in the transmitting path, and auxiliary means for continuously adjusting the time constant of said hang-over circuit in accordance with the amplitude level of the signals applied to said latter device, so that it provides a longer hang-over time interval in response to low amplitude applied voice signals than in response to higher amplitude applied voice signals.

4. The system of claim 1, in which the switching branch controlled from one transmission path includes a signal amplifier-rectifier having its input connected to that path, and switching relays controlled from its output, operating in response to outgoing signals in that path to disable the other signal transmission path and the branch of said switching circuit controlled therefrom, to

remove a normal disability from the first transmission path, and to apply hang-over to said switching relays effective when the amplifier-rectifier releases, the switching branch controlled from said other path operating in response to incoming signals therein when said other path is operative, to disable the branch of said switching circuit controlled from said first path, and said auxiliary circuit includes a second signal amplifier-rectifier having its input connected to said first path, and its output connected in opposition to the output of the first amplifier-rectifier, so that its rectified signal output effectively reduces the hang-over applied to said switching relays, the constants of the two amplifier-rectifiers being selected such that the net amount of hang-over applied to said switching relays varies inversely with the amplitude level of the controlling signals applied to the two amplifier-rectifiers and at any time is only what is necessary to prevent clipping of the outgoing signals.

5. The combination of claim 3 in which the switching device connected to said transmitting path comprises an amplifier-rectifier followed by a direct current amplifier and switching relays having operating windings controlled from the output of the latter amplifier, operating to insert a disabling loss in said receiving path in front of the point of connection of the switching device thereto, and to remove a loss normally in said transmitting path beyond the point of connection of the first switching device thereto, said hang-over circuit includes a capacitor charged from the output of said direct current amplifier and discharging through the operating windings of said switching relays when that output is reduced to zero, said auxiliary means comprising an auxiliary amplifier-rectifier having its input connected to said transmitting path and its output coupled in parallel with the output of the first amplifier-rectifier to the input of said direct current amplifier, so that the rectified voltage applied to the input of the latter amplifier is equal to the difference of the rectified voltage output of the two amplifier-rectifiers, the relative characteristics of the two amplifier-rectifiers being adjusted so that the net charge on the capacitor in said hang-over circuit is greater for low amplitude signals applied to the input of said first amplifier-rectifier than for high amplitude signals applied thereto and such that the time required to discharge said capacitor through the windings of said switching relays when the supply of controlling signals to said first amplifier-rectifier ceases, is only large enough to prevent objectionable clipping of the outgoing signals in said transmitting path by premature release of said switching relays.

BJORN G. BJORNSON.