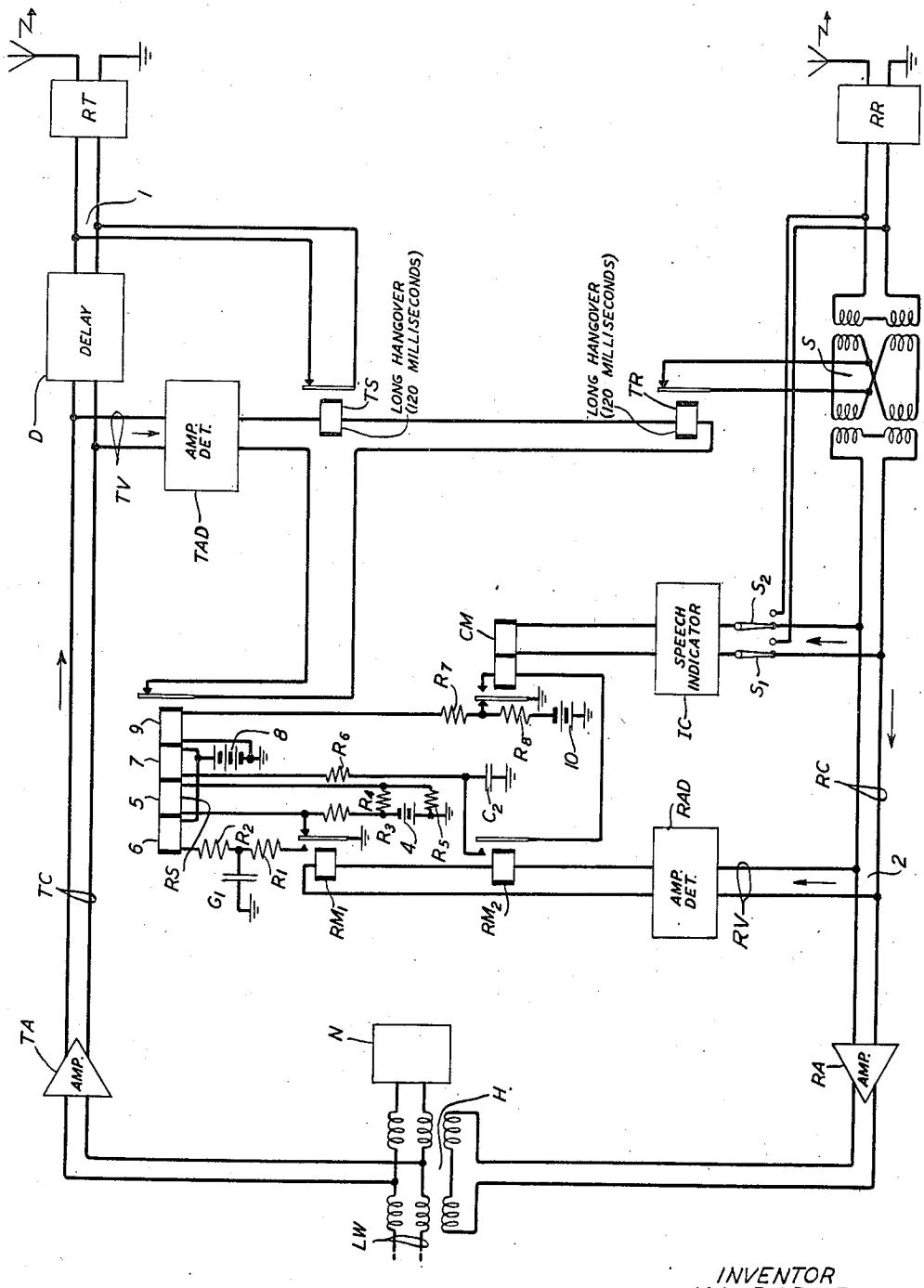
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CONTROL OF TRANSMISSION IN TWO-WAY SIGNAL WAVE TRANSMISSION SYSTEMS

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CONTROL OF TRANSMISSION IN TWO-WAY SIGNAL WAVE TRANSMISSION SYSTEMS

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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.

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 terminal, the transmitting vodas, which may be an amplifier-rectifier-relay circuit, is responsive to outgoing telephone signals to disable the voice receiving branch at the terminal and the associated receiving vodas and to remove a normal disability from the voice transmitting branch, and the similar vodas receiving circuit is responsive to incoming telephone signals, when the transmitting vodas is unoperated, to disable the transmitting vodas.

In order to reduce quality impairment in the telephone signals caused by such switching operations, it would be desirable to have the far-end transmitting and near-end receiving vodas relays operate alike on the speech signals, but due to static and other noise in the radio path the sensitivity of the receiving vodas often cannot be made as great as that of the transmitting vodas. Aside from radio noise conditions, variations in transmission in the radio path require that the sensitivities be made unequal.

Also, the transmitting vodas relays are usually provided with a long hang-over in operation, in the order of 120 milliseconds, to prevent clipping of the final parts of syllables of the transmitted voice signals. This long hang-over also makes the frequency of operation during talk spurts less so that the percentage of syllables on which there is initial clipping is reduced. The receiving vodas relays, however, cannot be given such long hang-overs without penalizing sensitivity still further in order to avoid excessive operation on static, and are ordinarily operated with about 20 to 50 millisecond hang-overs. Thus the receiving vodas is generally operated a much shorter time on speech than the transmitting vodas, resulting in a condition in which signal transmission lockouts, that is, intervals in which the telephone subscribers associated with the two terminals cannot hear each other, are readily produced. The near-end subscriber can fairly easily break through incoming speech and operate his transmitting vodas to initiate a lockout which will last as long as both subscribers hold their respective transmitting vodas circuits operated.

An object of the present invention is to reduce the probability of signal transmission lockouts in two-way signal wave transmission systems.

A more specific object is to reduce the probability of signal transmission lockouts in a two-way telephone system employing voice-operated (vodas) switching circuits at the terminals thereof for controlling the direction of transmission, caused by the near-end subscriber breaking in through received speech signals to seize control of his terminal.

These objects are obtained in accordance with the invention by circuit arrangements operating to automatically increase the hang-over of the receiving switching circuit at a terminal of such a system when incoming signals are being received. In one arrangement, this increase in receiving vodas hang-over only occurs when the transmitting vodas at the terminal is not operated by prior outgoing signals, and in another the increase in hang-over and the operation of the receiving vodas may be effected when incoming signals are being received even though the near-end subscriber has control of his terminal at that time, thus facilitating break-in.

The various objects and features of the invention will be better understood from the following detailed description when read in conjunction with the accompanying drawing the single figure of which shows schematically a control terminal for a two-way radio telephone system embodying a preferred form of the invention.

The control terminal of the drawing includes the voice transmitting branch TC including the transmitting amplifier TA and the delay circuit D, leading to the radio transmitter RT, and the voice receiving branch RC including the receiving amplifier RA, leading from the radio receiver RR. 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 connected to a subscriber's telephone circuit, by a hybrid transformer H and associated balancing network N, as shown, or by any other suitable means.

The voice transmitting branch TC is normally disabled at the point 1 to the right of the delay circuit D by a short-circuiting connection through the normally closed contacts of the

transmitting vodas switching relay TS, and the voice receiving branch RC is normally operative due to the series aiding connection of certain windings of a suppressor coil device S, such as disclosed in Silent Patent No. 1,749,851 issued March 11, 1930, provided by the cross-connection of the windings through the normally closed contacts of the transmitting vodas switching relay TR.

Connected across the voice transmitting branch TC at the point to the left of the delay circuit D is the input of the transmitting vodas TV, which includes the amplifier-detector TAD and the vodas switching relays TS and TR which, for the sake of simplicity, have been shown as energized in series directly from the output of TAD, but which, in the usual vodas circuit, would be energized by operation of one or more master relays which would be directly energized by the output currents of TAD.

Telephone signals received from a west subscriber over the circuit LW will be impressed by hybrid transformer H on the input of the voice transmitting branch TC and will be transmitted out over that branch through amplifier TA and delay circuit D towards the radio transmitter RT. A portion of these outgoing signals, diverted into the transmitting vodas TV will be amplified and detected in amplifier-detector TAD and will cause the operation of the transmitting vodas relays TS and TR. The operation of relay TS to open its contacts will break the short-circuiting disabling connection across circuit TC at the point 1, thus enabling that circuit so that the outgoing telephone signals which have meanwhile been delayed in the delay circuit D, may pass to the radio transmitter RT which will radiate them to the distant terminal. The simultaneous operation of the transmitting vodas relay TR to open its contacts will break the cross-connection across the windings of the suppression coil device S in the voice receiving branch RC, thus connecting these windings in series opposing relation, effectively disabling the voice receiving branch at that point and preventing subsequently received incoming signals from getting through to operate the receiving vodas RV to reverse the direction of transmission. The transmitting vodas relays are provided with a long hang-over in operation, in the order of 120 milliseconds, in any suitable manner, to prevent clipping of the final parts of syllables of the telephone signals by their premature release when the talker pauses.

A receiving vodas RV, including the receiving amplifier-detector RAD, the master relays RM_1 and RM_2 having their operating windings connected in series across the output of RAD, and the receiving vodas switching relay RS and associated hang-over circuits to be described, has its input connected across the voice receiving branch RC at a point 2 to the left of the suppression coil device S. The operation of the relay RS and the increase of its hang-over is controlled by operation of the master relays RM_1 and RM_2 and the control relay CM in the manner to be described.

The operation of the control relay CM is controlled by an indicator control device, represented by the box IC, which in one modification of the invention would have its input connected across the voice receiving branch RC to the left of the suppressor coil device S. The device IC may be any device which will serve as a positive indicator of incoming speech signals in the voice receiving branch RC, and will operate to cause operation of the relay CM on a large proportion, if not all, of the speech syllables received. For satisfactory operation of the circuits of the invention, it is desirable that the indicator device IC practically never operate on static or interfering noise received over the receiving branch RC from the radio link, and that it will operate as completely as possible when any speech signals are present in the voice receiving branch RC beyond the suppressor device S. Since the regular receiving vodas RV may be utilized for providing the actual disablement of the transmitting vodas TV in the manner to be described, it is not necessary that indicator device IC be fast operating, but only that it operate to cause operation of the control relay CM to provide the functions to be described, some time during the operation of the receiving vodas relay RS in response to received voice signals.

There are several different types of devices which could be used for IC. For example, the device may be such as to be selectively operated by an alternating current tone sent from the distant terminal along with and under control of the speech waves, or it may be one which will be directly operated by the received speech waves. If operation on control tone of a frequency outside the speech frequency range is desired, since complete operation of the device is not required to enable it to perform its functions, the control tone could be sent at considerably reduced amplitude from that required in the usual tone-operated vodas switching system. The device IC in that case may be a detector tuned to the tone frequency, for example, by a sharply tuned filter in its input.

Another method of operation would be by the use of control tone of a frequency within the speech band to indicate the presence of the speech waves, and to cause operation of the control relay CM. A device which would be suitable for this purpose is disclosed in Bjornson Patent No. 2,116,553 issued May 10, 1938.

There are a number of devices operated directly by speech which would provide the required operation of the control relay CM. To discriminate between the incoming speech waves and noise on an amplitude basis would require merely the use of an insensitive amplifier-detector for the device IC. Under most noise conditions when the static is not "crashy," an amplifier-detector with 10 or 15 decibels less sensitivity than the regular receiving vodas detector would rarely be operated on noise, and would be operated on the stronger speech signals to supply operating current to a relay connected in its output.

Another device which could be used for the device IC to discriminate between speech and noise is one which utilizes delayed hang-over plus a degree of discrimination on an amplitude basis, such as disclosed in Bjornson Patent No. 2,061,555 issued November 24, 1936. Such an arrangement used to provide a delay in operation of relay CM about 50 milliseconds or so after a preceding insensitive amplifier-detector-relay circuit had been continuously operated by applied waves, should provide considerable improvement in discrimination on most radio noise since the average length of a static impulse is shorter than 50 milliseconds.

Another device which could be used to provide the desired speech discrimination and control of relay CM would be a syllabic detector circuit

responsive to the syllabic variations in speech waves but substantially unresponsive to comparatively steady noise waves, which may comprise a vacuum tube detector followed by a low-pass filter having a cut-off at approximately 22 cycles. The operation of such an indicator does not need to be fast, since the suppression required to protect the transmitting vodas TV in the present system from false operation on echoes is supplied by the receiving vodas relays.

Still another type of device which would be effective to detect the incoming speech waves even through heavy static is disclosed in the copending Bjorson patent application, Serial No. 331,973 filed April 27, 1940. In that device, the combined speech and noise waves are detected and the detected waves are split up into a number of equal frequency subbands including one ranging from 25 to 80 cycles in which energy due to speech is ordinarily a minimum. Each of the frequency subbands is separately detected and the detected subband of 25 to 80 cycles is balanced against each of the other detected subbands in the windings of separate relays to balance out the substantially equal amounts of noise in the balanced subbands and cause operation of one or more of the relays due to the substantially greater amount of speech energy in one or more subbands to operate a master control relay corresponding to the control relay CM in the present circuit.

The operation of relay RM_1 in response to the output currents of amplifier-detector RAD when incoming speech signals or static are applied to the input of the latter from receiving circuit RC, when the latter circuit is operative, in breaking its back contact will cause energizing current to be supplied from battery 4 to the "throwing" winding 5 of switching relay RS causing the operation of the latter relay to break the energizing circuit of the transmitting vodas relays TS and TR. When relay RM_1 is not operated, a bias is applied to the relay RS to hold it in its normal unoperated condition by means of the potential supplied by battery 4 through voltage dividing resistances R_4 and R_5 to winding 5. When the armature of operated relay RM_1 reaches its front contact, a hang-over circuit including the condenser C_1, resistance R_2 and battery 8, is set up for the hang-over winding 6 of relay RS, the values of these elements being selected to provide a short hang-over in the order of 20 milliseconds for the relay. This small hang-over becomes effective on the release of relay RM_1 to remove ground from battery 8 through the relay armature causing C_1 to be charged up to the potential of battery 8 through the hang-over winding 6 and resistance R_2, holding relay RS operated for that interval of time. This small hang-over is provided to prevent excessive operation of the receiving switching relay RS in response to static received over the branch circuit RC from the radio link.

Relay RM_2 is operated simultaneously with relay RM_1 in response to the output currents of the receiving amplifier-detector RAD. The operation of relay RM_2 has no effect on relay RS unless control relay CM becomes simultaneously operated under control of the indicator device IC due to the presence of incoming speech waves in the input of the latter. With relay CM operated, the operation of relay RM_2 closes an energizing circuit for winding 7 of relay RS, over a circuit which may be traced from ground through battery 8, winding 7 of relay RS, series resistance R_6, closed contacts of relay RM_2, left (holding) winding of relay CM and the closed front contact and armature of that relay to ground, which aids in operating relay RC and sets up an additional hang-over circuit including large condenser C_2 and resistance R_6 for winding 7 of relay RS, increasing the total hang-over on the relay to a value in the order of 120 milliseconds.

Once this condition is set up, because of the energization of its holding winding, relay CM will not release until after relay RM_2 does, so that the long hang-over applied to the relay RS is measured from the release of relay RM_2 and not from the cessation of operate current in the (right) winding of relay CM.

The operation of relay CM by indicator device IC, besides setting up the condition for long hang-over on relay RS, also by removing the normal short on battery 10 causes the operation of relay RS directly from that battery over a circuit which may be traced from ground through battery 10, series resistances R_8 and R_7 and operating winding 9 of relay RS to ground. When relays RM_1 and RM_2 release with cessation in the supply of speech current to receiving amplifier-detector RAD, and relay CM has released with cessation of speech currents in the input to device IC, relay RS will not immediately release but will be maintained operated for the long hang-over interval (120 milliseconds) during the flow of charging current from battery 8 through winding 6 and resistance R_2 to condenser C_1, and the flow of charging current from battery 8 through winding 7 and resistance R_6 to large condenser C_2. It has been found by experiment that the increase in hang-over of the receiving vodas relay RS thus attained appreciably reduces the probability of occurrence of transmission lockout due to the local subscriber breaking in through received speech.

If it is desired to modify the circuit which has been described to facilitate break-ins by the distant subscriber, the switches S_1 and S_2, which, in the operated condition shown, connect the indicator device IC to the voice receiving branch RC at a point to the left of the suppressor coil device S, would be thrown to the right-hand contacts thus connecting the input of the device IC to that branch at a point in front of the coil S. With the latter connection, incoming speech from the distant talker, or the control tone accompanying the speech currents if a tone-operated switching system is used, may get through to cause operation of the indicator device IC and thus of the control relay CM, while the near-end talker maintains his transmitting vodas operated to block the voice receiving branch RC by means of the suppressor coil device S. The operation of relay CM will cause the receiving vodas relay RS to be directly operated in the manner previously described to disable the transmitting vodas TV by breaking the energizing circuit of the transmitting vodas relays TS and TR, thereby giving control of the near-end terminal to the voice currents of the distant subscriber. With similar switching circuits at both terminals, speech in either direction which would cause the operation of the indicator control device at the receiving terminal could always break in through speech in the other direction. The alternative connection of the input of the indicator device IC at a point beyond the suppressor device S as illustrated in the drawing, would enable the local subscriber, once he has seized control of the switching circuits at both terminals, to retain

control and thus prevent lockout of the type caused by break-in of the other subscriber.

It would be possible to adjust any of the above-described switching circuits to get considerably more total operated time of the receiving suppressing relay RS by received speech without getting an appreciable increase in noise-operated time, thus decreasing the probability of occurrence of lockout in present radio telephone channels without changing the interfering effect of noise.

Various modifications of the circuits illustrated and described 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 wave transmission system including at a terminal thereof, a signal transmitting path, a signal receiving path and a wave-operated switching circuit connected to each path, respectively responsive to outgoing signal waves to condition the terminal for transmitting only, and to incoming signal waves to condition the terminal for receiving only, means to reduce the probability of signal transmission lock-outs in said system, comprising means for effectively increasing the hang-over in operation of the switching circuit controlled from said receiving path when incoming signal waves are present therein.

2. In combination with a two-way telephone system including at a terminal thereof a voice transmitting path, a voice receiving path, and a voice-operated switching circuit connected to each path for respectively conditioning the terminal for transmitting only and for receiving only, the transmitting switching circuit having an appreciably long hang-over to prevent signal clipping and the receiving switching circuit being normally provided with a small hang-over to prevent excessive false operation on received noise waves, means to reduce the probability of voice signal transmission lock-out in said system comprising control means operating when incoming voice signals are present in said receiving path to automatically increase the amount of hang-over of the receiving switching circuit.

3. The combination of claim 2, in which the increase in hang-over provided by operation of said control means is such as to make the total hang-over of said receiving switching approximately the same as the hang-over of said transmitting switching circuit.

4. The combination of claim 2, in which said control means is directly responsive to said incoming voice signals in said receiving path and is substantially unresponsive to received noise waves therein.

5. The combination of claim 2, in which said control means is selectively responsive to control tone transmitted along with the voice signal waves from the other terminal, and is substantially unresponsive to received noise waves.

6. The combination of claim 2, in which said control means is controlled from a point in said receiving path such that it is only operative in response to the presence of voice signal waves in said receiving path to increase the amount of hang-over of said receiving switching circuit if the transmitting switching circuit is unoperated by outgoing signals.

7. The combination of claim 2, in which the operation of said control means causes said transmitting switching circuit to be disabled in addition to increasing the amount of hang-over of said receiving switching circuit.

8. The combination of claim 2, in which said system is a two-way radio telephone system including a radio transmitter and a radio receiver at each terminal and an intermediate radio transmission link, the radio transmitter and radio receiver at said terminal being connected to said voice transmitting path and said voice receiving path, respectively, said voice transmitting path being normally disabled and said voice receiving path being normally operative, the transmitting switching circuit being responsive to outgoing telephone signals, in the absence of prior incoming telephone signals in said receiving path, to disable said receiving path and said receiving switching circuit and to enable said transmitting path, the receiving switching circuit being responsive to incoming telephone signals in said receiving path, when it is operative, to disable said transmitting switching circuit, the normal small hang-over of said receiving switching circuit being such as to prevent excessive operation of that circuit by static received from said intermediate radio link, the increase in the amount of hang-over provided by operation of said control means being such as to make the hang-over of said receiving switching circuit approximately the same as that of said transmitting switching circuit, this hang-over becoming effective immediately on the cessation of applied voice signals to said receiving circuit.

9. The combination of claim 2, in which said control means is responsive to the presence of voice signal waves in said receiving path but is substantially unresponsive to the presence of noise waves therein, and the operation of said control means causes the transmitting switching circuit to be disabled, said control means being controlled from a point in said receiving path such that it operates in response to received voice signals even if said transmitting switching circuit is operated, thus facilitating break-ins by incoming voice signals.

10. The combination of claim 2, in which the hang-over of said transmitting switching circuit is in the order of 120 milliseconds, and the normal amount of hang-over in the switching circuit controlled from said receiving path is in the order of 20 to 50 milliseconds, and is increased to about 120 milliseconds by operation of said control means.

11. The combination of claim 2 in which said transmitting path is normally disabled and said receiving path is normally operative, the switching circuit connected to the transmitting path operates in response to outgoing telephone signals in the absence of prior incoming signals in said receiving path, to enable said transmitting path and to disable said receiving path and the switching circuit connected thereto, the switching circuit connected to the receiving path operates in response to incoming telephone signals in the receiving path, when that path is operative, to disable the switching circuit connected to the transmitting path, and the last-mentioned means comprises a device connected to said receiving path beyond the disabling point therein, substantially unresponsive to applied noise waves but responsive to the presence of voice waves in its input to control a relay operating to provide the increased amount of hang-over on the switching circuit connected to said receiving circuit, said increased amount of hang-over becom-

ing effective on the release of said receiving switching circuit.

12. In combination with a two-way telephone system including at a terminal thereof telephone signal transmitting and receiving paths, a vodas switching circuit including a transmitting portion and a receiving portion, said transmitting portion being responsive to outgoing telephone signals in the transmitting path, in the absence of prior incoming signals in said receiving path, to condition the terminal for transmitting only, said receiving portion including an amplifier-detector connected to said transmitting path, a plurality of master relays operatively responsive to the output currents of said amplifier-detector when waves are applied to its input, and a switching relay responsive to operation of one of said master relays to condition the terminal for receiving only, and means to improve the operation of said vodas switching circuit from the standpoint of reducing the probability of signal transmission lockout comprising an auxiliary control circuit operatively responsive to the presence of incoming signals in said receiving path, but substantially unresponsive to received noise waves, and relay means responsive to operation of said control circuit for conditioning the receiving portion of said vodas switching circuit so that the hang-over of the switching relay therein, normally small to prevent excessive operation on received noise, is automatically increased to a substantially greater value, the increased hang-over on said switching relay becoming effective when one of said master relays releases.

13. The combination of claim 12, in which said control circuit is controlled from a point in said receiving path such that it will be operated only if the transmitting portion of said switching circuit is unoperated at the time.

14. The combination of claim 12, in which said relay means when operated causes the operation of said switching relay independently, and said control circuit is controlled from a point in said receiving path such that it will be operated by the presence of received signals therein regardless of whether said transmitting portion of said switching circuit is operated at that time.

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