

Dec. 8, 1942.

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2,304,611

CARRIER WAVE SIGNAL TRANSMISSION SYSTEM

Filed Jan. 17, 1942

2 Sheets-Sheet 1

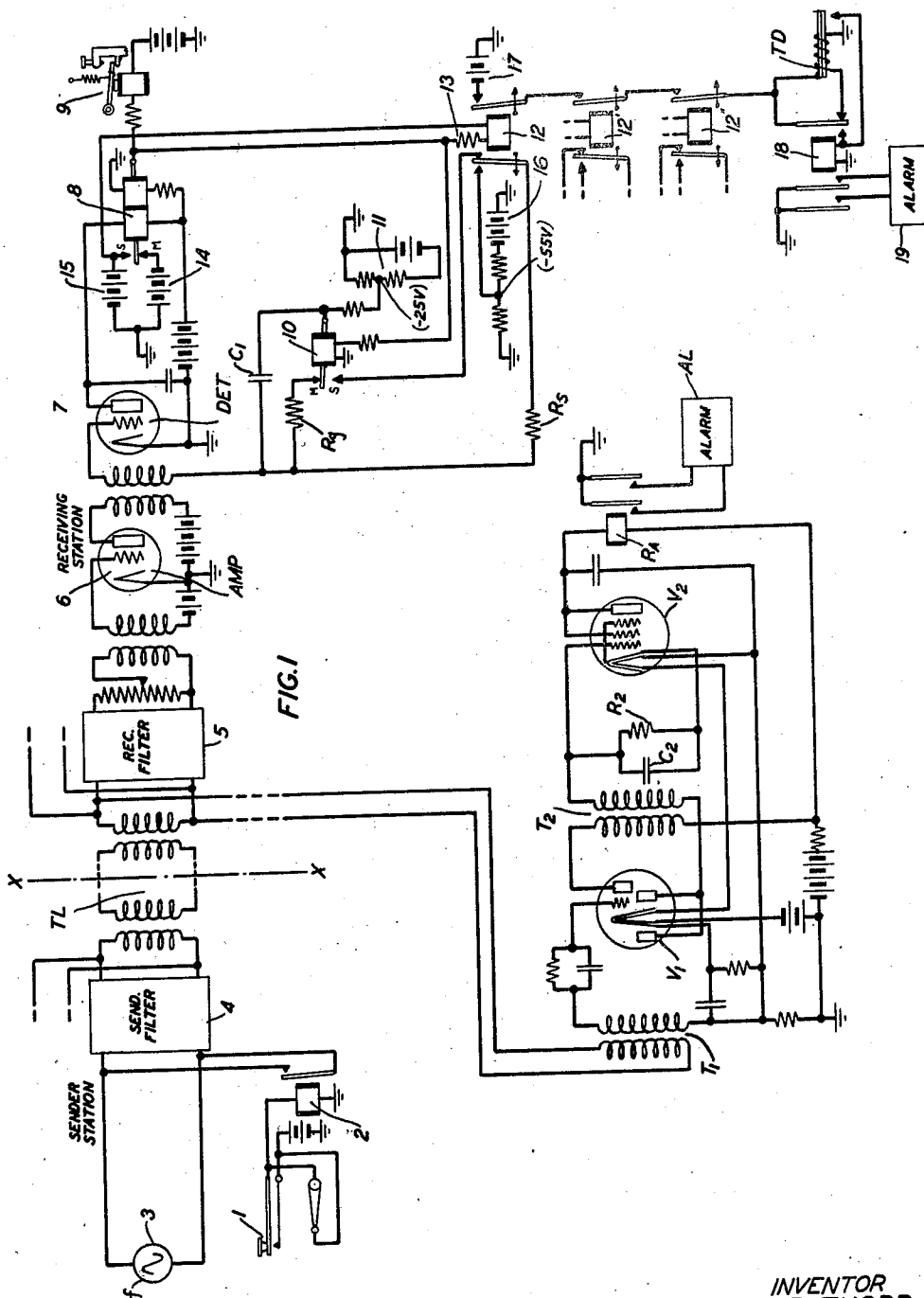


FIG. 1

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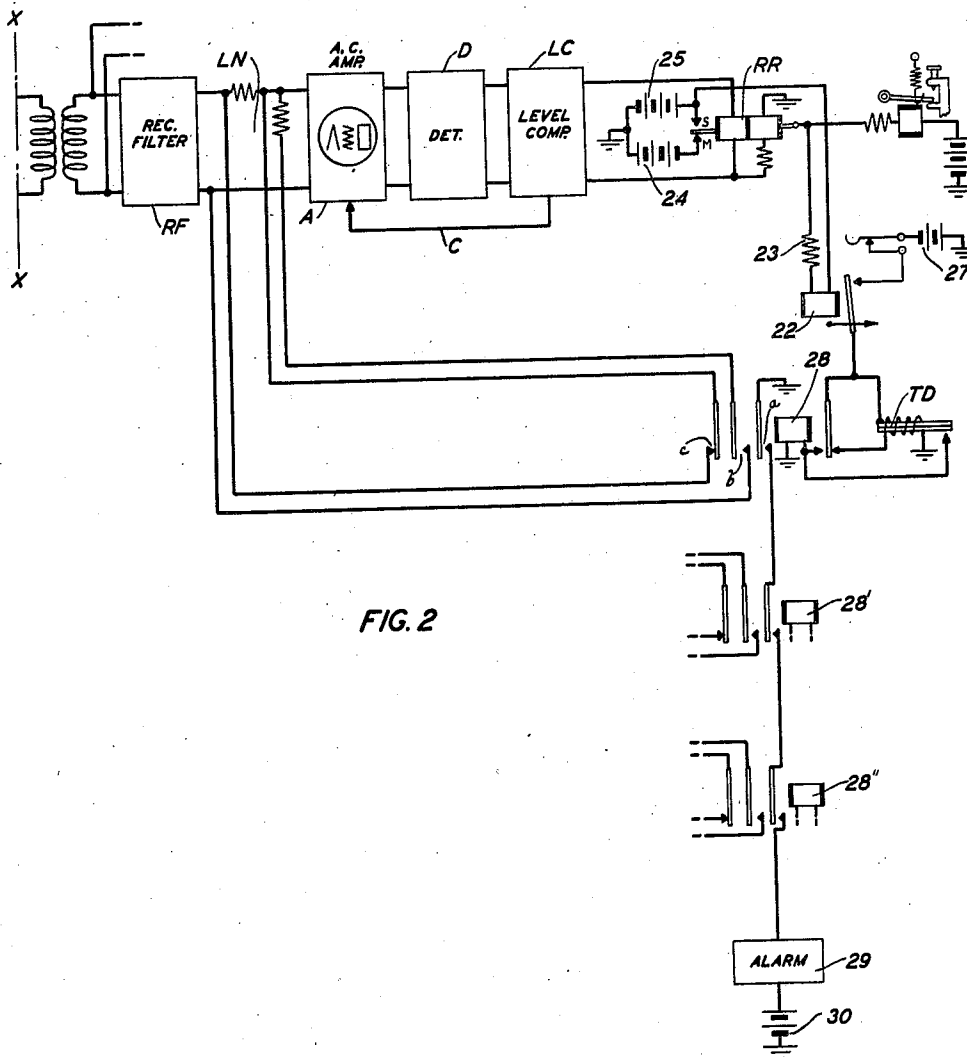


FIG. 2

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## UNITED STATES PATENT OFFICE

2,304,611

CARRIER WAVE SIGNAL TRANSMISSION  
SYSTEM

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Application January 17, 1942, Serial No. 427,132

11 Claims. (Cl. 178-66)

The invention relates to carrier wave signal transmission systems and particularly to trouble alarm and control circuits for use with such systems.

Objects of the invention are to indicate abnormal operating conditions in such systems and to automatically adjust the operating characteristics of their receiving circuits so as to prevent false signaling under certain abnormal operating conditions.

The invention is particularly applicable to carrier telegraph systems in which the transmitted signals comprise intervals of carrier current separated by intervals of no current respectively constituting marking and spacing signals. So-called level compensators are sometimes used in the receiving channels of such systems to automatically vary the gain of receiving transmission apparatus so as to reduce the type of distortion known as "telegraph bias", i. e., variations in the durations of the marking and spacing signals primarily due to changes in the received telegraph current with variations in line equivalent.

After a spacing signal has persisted in the receiving channel of such a system for a fraction of a minute, the level compensator in the channel tends to increase the gain and thus the sensitivity of the latter to a value beyond the maximum sensitivity obtained in normal operation. In practice, it is often found desirable to leave the idle channels of such a system in the spacing condition for long periods of time. In that case the action of the level compensators in developing excessive gains makes possible the operation of the receiving telegraph relays in such idle channels in response to circuit noise or message interference received from adjacent operating channels, to give false signals. The copending patent application of A. L. Matte, Serial No. 379,578, filed February 19, 1941, discloses various arrangements devised to prevent such false operation by limiting the rise in gain produced by the level compensators under such conditions to a low value.

In accordance with the invention, other circuit arrangements including a slow-release relay are provided for limiting the rise in gain of the idle receiving channel under such conditions.

In accordance with another aspect of the invention, circuits are provided for indicating to an attendant at a receiving point, for example, at a telegraph repeater or switching office, in such a system, abnormal operating conditions, such as the failure of the main carrier line, to enable prompt repair, adjustment or replacement of the

section of line or the transmission apparatus at fault.

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

Figs. 1 and 2 show schematically different embodiments of the gain control arrangements of the invention applied to carrier telegraph systems employing different types of level compensators, with associated alarm arrangements.

Fig. 1 shows one form of the invention applied to a receiving channel of a multiplex carrier telegraph system, employing the "compensator relay" type of level compensator such as disclosed in Herman patent 1,886,808, issued November 8, 1932 or Borgeson Patent 2,065,640, issued December 9, 1936. The system of Fig. 1 except for the modification in accordance with the invention to be described is like that disclosed in the Borgeson patent and reference may be made to that patent and to the aforementioned Herman patent for a more detailed discussion of the level compensator and its mode of operation.

In the system of Fig. 1, operation of the telegraph key 1 at the sending station in accordance with the telegraph signals controls relay 2 to close and open a short-circuiting connection across the output of a carrier wave source 3 causing the carrier waves of frequency  $f$  supplied therefrom to be chopped to form carrier modulated telegraph signals consisting of marking and spacing impulses. These signals are transmitted through the sending filter 4 at the sending station and then pass over the line TL to the receiving station. At the receiving station, the received signals are selected by the receiving filter 5 of the particular receiving channel illustrated in detail, which is assigned the carrier frequency of source 3, are then amplified by the amplifier 6 and are detected by the vacuum tube detector 7. The detected telegraph signals in the output of detector 7 will cause the operation of the polar telegraph receiving relay 8 to its marking contact "M" in response to a marking signal and to the spacing contact "S" in response to a spacing signal, to suitably control the sounder 9 from the associated marking and spacing batteries 14 and 15 in the subscriber's loop to repeat these signals.

Compensator relay 10 operates in unison with the polar receiving relay 8 to shift its armature to the marking contact "M" in response to a marking signal and to a spacing contact "S" in response to a spacing signal, and during each marking interval connects the grid leak resistance

$R_g$  (1-3 megohms) in shunt to the compensator condenser  $C_1$  (0.125 microfarad) which is connected in the control grid circuit of detector tube 7. Normally the received carrier pulses drive the grid of the detector tube 7 positive notwithstanding the 25-volt negative bias produced on the detector grid due to its connection to a -25 volt tap on the grid voltage supply 11. During the positive pulse, current is drawn through the condenser  $C_1$  making the grid bias more negative in proportion to the current flow through the latter condenser. Resistance  $R_g$  serves to reduce the charge on  $C_1$  during marking intervals when a reduction in level takes place and a lesser negative bias is therefore required. During the spacing interval the increment of the negative grid bias produced by the charge on  $C_1$  plus the battery voltage in series with it, is held on the detector grid due to the opening of the discharge path through  $R_g$ . A received carrier current stronger than normal increases still further the condenser charge and hence the negative bias on the detector grid, while a received current weaker than normal results in a smaller than normal grid bias. This over-all effect provides an equalizing action on the detector tube gain to compensate for changes in line equivalent so as to prevent the durations of the marking and spacing signals as repeated by the polar relay 8 from being affected by such changes.

The level compensator of Fig. 1 also includes a resistance  $R_s$  of value, say, 50 megohms, large compared to that of  $R_g$ , connected between the spacing contact of compensator relay 10 and the control grid of the detector tube 7. This resistance  $R_s$ , also disclosed in the circuit of the aforementioned Borgeson patent, was used by Borgeson to reduce the potential of the grid of the detector tube 7 during long spaces to a value corresponding to that of a non-charged condenser. This resulting bias was sufficient to accomplish Borgeson's purpose which was to prevent the grid from approaching ground potential through natural leakage thereby leading to pulsing and lock-up.

The remaining portion of the circuit of Fig. 1, which constitutes one embodiment of the present invention, was provided for preventing the receiving gain of the channel from rising during long spacing intervals to a point where chattering of the receiving telegraph relay might occur in response to noise or message wave interference from adjacent receiving channels, of high enough level. This part of the circuit includes an auxiliary slow-release relay 12 having its operating winding connected through the series resistance 13 across the armature and spacing contact of the telegraph relay 8 of the receiving channel. This connection allows the relay 12 to be operatively energized from the batteries 14 and 15 whenever the telegraph relay 8 is operated to the marking contact, and to be released by operation of the latter relay to its spacing contact. When telegraph relay 8 and the compensator relay 10 are operated to their marking contacts, the resistance  $R_s$  is connected from the control grid of the detector tube 7 to the spacing contact of the compensator relay 10 through the closed armature and left-hand front contact of operated relay 12. When the relays 8 and 10 are operated to their spacing contacts, relay 12 will release but only after a time interval determined by its slow-release adjustment, a given amount greater than the normal signal spacing interval. If the spacing con-

dition persists for a time interval greater than the slow-release time of relay 12, relay 12 releases to break its left-hand front contact thereby disconnecting resistance  $R_s$  from the spacing contact of compensator relay 10, and to make its left-hand back contact to connect the resistance  $R_s$  to a more negative potential point (say -55 volts) on the auxiliary source 16 of negative potential. This results in the biasing of the control grid of the detector tube 7 to such a point as to limit the detector gain so that the maximum amount of received noise or of message interference received by the receiving channel from adjacent operating channels, cannot cause operation of the receiving telegraph relay 8 to give false signals. The bias value selected is made small enough to permit proper control of the receiving circuit by the weakest legitimate signal impulse.

Also, the release of the slow-release relay 12 in response to operation of the receiving telegraph relay 8 to the spacing contact for a time interval a given amount greater than that due to a normal spacing signal, will close the right-hand contacts of relay 12 which are in series with the corresponding right-hand contacts of the slow-release relays 12', 12'' of each of the other receiving channels of the system, and the common battery 17 in the energizing circuit for the winding of the thermal delay relay TD. Thus, if the slow-release relays 12, 12', 12'' . . . of all of the receiving channels of the system are simultaneously released as a result of the telegraph receiving relays of all of the channels being simultaneously operated to their spacing contacts for a time interval the required given amount greater than a normal spacing signal, energizing current from the common battery 17 will flow through the closed right-hand contacts of the relays 12, 12', 12'' . . . to the winding of the thermal delay relay TD. If the spacing condition of the telegraph receiving relays of all channels and thus the release of all slow-release relays persists for an additional time interval equal to the slow-operate time relay TD due to its design, the latter relay will operate to close its contacts to provide an energizing circuit from battery 17 for the winding of the quick-operating relay 18. The relay 18 will then operate to shift its right-hand armature from the back to the front contact, and to close the left-hand contacts. The break of the right-hand back contact of relay 8 breaks the energizing connection of the winding of relay TD from battery 17 so that the latter relay will release. The make of the right-hand front contact of relay 18 will connect the energizing battery 17 directly across the winding of relay 18 so that the latter relay will be maintained continuously energized as long as all slow release relays 12, 12', 12'' . . . remain simultaneously released which will be as long as the simultaneous spacing condition of the receiving telegraph relays of all receiving channels continues. The closing of the left-hand contacts of relay 18 causes the operation of the alarm device 19 to provide a visual or audible alarm, or both, to indicate to an attendant the existence of such a condition. By suitable design of the slow-release relays 12, 12', 12'' . . . and of the slow-operate relay TD the alarm may be made responsive to a spacing condition long enough to indicate that the supply of carrier current to the channels from the main carrier line has stopped or that the apparatus therein has completely failed, and to be unresponsive to a shorter

spacing condition (longer than that of a spacing signal) such as would be caused by a temporary interruption in the received carrier current by the channels.

As an alternative to the alarm circuit controlled by the channel telegraph receiving relays, just described, a main carrier line alarm may be provided to indicate to an attendant when the main receiving line of the carrier telegraph system remains open for a predetermined time, to facilitate quick restoration of service when a line failure occurs by the patching of a spare line to the system. A simple and economical arrangement for this purpose in accordance with the invention is illustrated in Fig. 1. As indicated it comprises a high impedance bridging circuit including an input (voltage step-up) transformer T<sub>1</sub> having its primary winding connected across the common receiving line of the receiving station in front of receiving filters of the channels; an amplifier-rectifier comprising a single double-diode vacuum tube V<sub>1</sub> having its input connected to the secondary winding of transformer T<sub>1</sub>; a pentode vacuum tube V<sub>2</sub> having its control grid-cathode circuit coupled by interstage transformer T<sub>2</sub> to the diode-rectifier portion of tube V<sub>1</sub>; a resistance-condenser timing network C<sub>2</sub>R<sub>2</sub> in the control grid-cathode circuit of tube V<sub>2</sub>; an alarm relay R<sub>A</sub> in the anode-cathode circuit of tube V<sub>2</sub>; and an alarm device AL controlled by operation of relay R<sub>A</sub>.

When carrier current is being received at the receiving station of Fig. 1, the portion picked off from the main carrier line by transformer T<sub>1</sub> will be amplified by the triode amplifier portion of tube V<sub>1</sub> and rectified by the diode rectifier portion of that tube. The rectified current flowing through resistance R<sub>2</sub> of the timing network in the control grid-cathode circuit of tube V<sub>2</sub> provides a high negative potential on the control grid of that tube which reduces the plate current of the tube flowing through the winding of alarm relay R<sub>A</sub> substantially to zero. The relay R<sub>A</sub> therefore remains unoperated as long as the carrier is coming in on the line.

When the main carrier line fails, the carrier current input to T<sub>1</sub> is reduced to zero and the rectified output of V<sub>1</sub> therefore drops to zero. The charge on condenser C<sub>2</sub> gradually leaks off and the control grid of tube V<sub>2</sub> eventually acquires the same potential as the cathode of that tube. This causes the plate current to build up in tube V<sub>2</sub> to a value sufficient to operate the alarm relay R<sub>A</sub> in its plate circuit and thus the alarm device AL. The values of the capacity C<sub>2</sub> and the resistance R<sub>2</sub> in the control grid-cathode circuit of tube V<sub>2</sub> may be selected to give the desired delay so that the alarm will not operate on spacing signals of normal length even when a single channel is in service. The resistance and capacity combination in the control grid circuit of V<sub>1</sub> serves as a level compensation arrangement to take care of line variations and the difference in applied voltage due to varying numbers of channels being in service. This latter feature may not be needed, as it is necessary only that a single channel, down 8 decibels, be sufficient to bias the tube V<sub>2</sub> substantially to cut-off, so that the alarm relay R<sub>A</sub> will remain released unless the channel remains spacing for an appreciable time, say, about 15 seconds. The constants of the alarm circuit which has just been described should be selected so that an alarm will not be brought in by the maximum

amount of noise which may be received from the line.

Fig. 2 shows a modified form of the invention applied to a receiving channel of a multiplex carrier telegraph system, employing a different type of level compensator in which the gain of the alternating current amplifier (or of that amplifier and any direct current amplifier which may be used) in the receiving channel is varied in accordance with the amplitude level of the waves in the output of the detector so as to provide the desired compensation for incoming signal level variations. This level compensator illustrated diagrammatically in Fig. 2 may, for example, be such as disclosed in the Davey et al. Patent No. 2,182,841 issued December 12, 1939. That patent discloses the use of a multigrid vacuum tube amplifier between the output of the signal detector and the receiving telegraph relay in each carrier telegraph receiving channel, the current flowing in the suppressor grid circuit of that tube when that grid is driven positive by the detected telegraph signals, being used to vary the control grid bias and thus the gain of the amplifiers in the circuit, including the alternating current amplifier, in accordance with the amplitude of that current to provide the desired compensation.

The receiving channel and level compensator illustrated in Fig. 2 includes a receiving filter RF for selecting from the received carrier modulated telegraph signals those within the frequency range assigned to that channel; an alternating current vacuum tube amplifier A for amplifying the selected wave; a detector D for demodulating the telegraph signals from the amplified waves and suppressing the carrier components thereof; a level compensator LC including the backward-acting control C for adjusting the gain of the alternating current amplifier A in accordance with the level of the detected signals to provide the desired level compensation; and a telegraph receiving relay RR controlled by the current in the output of the level compensator operating to repeat the marking and spacing telegraph signals.

The alternative arrangement in accordance with the invention provided for preventing the receiving gain of the channel equipped with this type of level compensator from rising during long spacing intervals to a point where chattering of the receiving telegraph relay might occur in response to noise or message wave interference from adjacent receiving channels, to give false signals, and to provide an alarm in case of failure of the main line is as follows:

Like in the system of Fig. 1, an auxiliary slow-release relay, designated 22, has its operating winding connected in series with a resistance 23 across the armature and spacing contacts of the telegraph relay RR of the receiving channel. This connection allows the relay 22 to be operatively energized from the batteries 24 and 25 whenever the telegraph relay RR is operated to its marking contact, and to be released by operation of the latter relay to its spacing contact, the design of the relay 22 delaying the release of the relay for the latter case for a time interval longer than the normal spacing signal interval.

Suppose that the receiving relay RR is operated to its marking contact by a marking impulse in the output of level compensator LC causing the slow-release relay 22 to be operated by current from the batteries 24, 25. Then, at the end of

the marking impulse relay RR is operated to its spacing contact causing the winding of the slow-release relay 22 to be short-circuited through the closed armature and spacing contact of the former relay. Now, if the spacing condition persists for a time interval greater than the slow-release time of relay 22, which is greater than the time interval of a normal spacing signal, the relay 22 will release to close its contacts thereby causing energizing current to be supplied from battery 27 to the winding of the thermal delay relay TD<sub>1</sub>. If the spacing condition of relay RR persists for a longer time interval equal to the slow-release time of relay 22 plus the slow-operate time of the relay TD<sub>1</sub>, the latter relay will operate to close through its armature and contact an energizing circuit for the winding of the relay 28 causing immediate operation of the latter relay. The operation of relay 28 causes its right-hand armature to be shifted from the right-hand back contact to the right-hand front contact of the relay thereby disabling the energizing circuit for the winding of relay TD<sub>1</sub> from battery 27 so that relay will release, and connecting a direct energizing circuit for the winding of relay 28 from battery 27 through the made contacts of relays 28 and 22.

The operation of relay 28 will simultaneously close its left-hand contacts *a* connected in series with the corresponding contacts of similar relays 28', 28'' . . . associated respectively with each of the other receiving channels of the system, and common battery 30 in the energizing circuit for the alarm device 29; and will close its left-hand contacts *b* and open its left-hand contacts *c*. The closing of contacts *b* and opening of contacts *c* will cause the loss network LN to be switched into the receiving telegraph channel in front of the alternating current amplifier A by removing a normal short around the series resistance arm in that network and closing a normally open shunt resistance arm of the network, thereby effectively reducing the gain of the receiving channel. The values of the resistance elements in the loss network LN are selected so that the effective reduction in gain of the receiving channel will be sufficient to prevent false operation of the telegraph receiving relay RR by the amplified noise and induced interference in the channel due to the effective rise in gain produced by the level compensator LC during such a long spacing interval and will be insufficient to prevent operation of relay RR by the weakest legitimate marking signal impulse. The slow-release time of relay 22 and the slow-operate time of the thermal delay relay TD<sub>1</sub> are selected such as to prevent operation of the relay 28 to switch the loss network LN into the receiving channel if the spacing condition of the telegraph relay RR does not persist for a sufficient time interval to make the rise in gain of the receiving channel due to the action of the level compensator sufficient to allow false operation of the receiving telegraph relay by noise or message interference. Relay 28 will be maintained operated to hold the gain reducing network LN in the receiving channel, and to hold its alarm contacts *a* closed as long as the long spacing interval continues, that is, until a marking signal is received by the relay RR. When that happens, the relay RR being operated to its marking contact, relay 22 will again operate to break the energizing circuit for relay 28 returning the receiving channel to its normal high sensitivity condition and opening the alarm

contacts of relay 28. Similar arrangements for limiting the channel gain during long spacing intervals may be employed with each of the other receiving channels.

When the relays 28, 28', 28'' . . . of all of the channels are simultaneously operated, indicating that all channels have been operated to the spacing condition for a time interval a given amount longer than that due to a normal signal spacing interval, such as would occur, if the main carrier line failed, the closing of the contacts *a* of all of these relays in series will complete an energizing circuit for the alarm device 29 from battery 30, and that device will be operated to indicate to an attendant that such a condition exists.

Modifications other than those illustrated and described above which are within the spirit and scope of the invention will be apparent to persons skilled in the art. It is to be understood that the numerical values given above are merely for illustrative purposes and are not to be considered as limitations, and that any other values which will give the required results may be used.

What is claimed is:

1. In combination with a carrier telegraph signal receiving circuit including a signal detector, a telegraph relay controlled thereby for repeating the detected marking and spacing telegraph signals and a level compensator for automatically adjusting the gain of said circuit to compensate for variations in the level of the received carrier waves tending to distort the repeated telegraph signals, means to prevent false operation of said telegraph relay in response to noise or other interfering waves during long spacing intervals of said telegraph relay due to the action of the level compensator tending to increase the gain of the circuit during such intervals, comprising auxiliary means including a slow-release relay controlled by said telegraph relay, for reducing the sensitivity of said receiving circuit sufficiently to prevent such false operation when said telegraph relay is operated to the spacing condition for a time interval a given amount greater than a normal signal spacing interval and alarm means controlled by the release of said slow-release relay for indicating an excessively long spacing condition of said telegraph relay.

2. The system of claim 1, in which said auxiliary means comprises said slow-release relay which is operated in response to operation of said telegraph relay to the marking condition, and is released only when said telegraph relay is operated to the spacing condition for a time interval greater than that of the normal spacing signal interval, and other means controlled by the release of said slow-release relay for producing the desired reduction in sensitivity of said receiving circuit.

3. The system of claim 1, in which said auxiliary means produces the desired reduction in sensitivity of said receiving circuit by reducing the effective gain of said circuit by a fixed amount.

4. The system of claim 1, in which said auxiliary means produces the desired reduction in sensitivity by applying an auxiliary fixed negative bias of the proper value to said detector to reduce the gain thereof to the necessary degree in response to the release of said slow-release relay.

5. The system of claim 1, in which said auxil-

iliary means includes means for inserting a fixed amount of loss into the input of said receiving circuit, in response to the release of said slow-release relay.

6. The system of claim 1, in which said auxiliary means includes a chain of relays comprising said slow-release relay operating in response to the operation of said telegraph relay to the marking condition and releasing in response to the operation of said telegraph relay to the spacing condition, a second slow-operate relay operating in response to the release of said slow-release relay and a third relay operating in response to the operation of said second relay to restore the latter to the unoperated condition and to provide connections for maintaining said third relay operated directly by said slow-release relay only during the released time thereof, the operation of said third relay controlling the reduction in sensitivity of said receiving circuit, the release time of said slow-release relay and the slow-operate time of said third relay being selected to provide the required delay in the reduction in sensitivity of said receiving circuit after said telegraph relay is operated to the spacing condition.

7. The system of claim 1, in which said detector is an electron discharge tube detector having a control grid and a circuit therefor including a source of negative biasing potential, said level compensator comprises a capacitor and parallel resistor in series in said control grid circuit, responsive to the applied marking signals to provide a variable bias on said detector for controlling the gain thereof so as to compensate for level variations in said applied signals, a compensator relay having an armature and marking and spacing contacts, operating in unison with said telegraph relay to prevent dissipation of the biasing charge of said capacitor through said resistor during spacing signal intervals, and a second resistor of value large in comparison with that of the first resistor connected between said control grid and the spacing contact of said compensator relay for reducing the potential of said grid during long spacing periods, said slow-release relay being operated when said telegraph relay is operated to the marking condition, and being released only when said telegraph relay is operated to the spacing condition for a time interval greater than a normal signal spacing interval, a second source of negative biasing potential greater than that of the first source, and means responsive to the release of said slow-release relay to disconnect said second resistor from the spacing contact of said compensator relay and to connect said control grid to said second source through said second resistor.

8. In combination with a multichannel carrier telegraph system including a signal transmission medium for transmitting impulses of carrier current separated by intervals of no current forming marking and spacing signals, the frequency of the transmitted carrier current being different for different transmitted messages, and a plurality of adjacent receiving channels connected to said medium, respectively selective to a different one of the transmitted carrier frequencies, each of said channels including a signal detector, a polar relay responsive to the signal output of said detector for repeating the marking and spacing signal impulses, and a level compensator operating automatically under control of the received carrier signals to vary the gain of the channel so as to compensate for variation in the level of said signals, auxiliary means for preventing false op-

eration of any one of said channels when in the idle condition by interference due to circuit noise and message spill-over from adjacent operating channels due to the action of the level compensator in the channel tending to return the channel to maximum gain, comprising a separate slow-release relay for each channel, operating in response to operation of the polar relay of that channel to the marking condition, and releasing in response to operation of that relay to the spacing condition only if the spacing condition continues for a time interval a given amount longer than a normal spacing signal interval, the release of the slow-release relay of any one of the channels causing the reduction of the gain of that channel by a fixed amount sufficient to prevent false operation of the polar relay of the channel by the maximum amount of such noise and message spillover, a slow-operating relay operating in response to the simultaneous release of the slow-release relays of all of the channels for a time interval greater than the slow-operate time of said slow-operating relay and another relay controlled by operation of said slow-operating relay to disable the latter relay and to lock up said other relay with the slow-release relays of all of the channels so that said other relay is maintained operated only during the simultaneous release time of all of said relays, and alarm means responsive to the operation of said other relay.

9. In combination with a multichannel carrier telegraph system including a signal transmission medium for transmitting impulses of carrier current separated by intervals of no current representing the marking and spacing signals of transmitted messages, a different carrier current frequency being employed for each transmitted message, a plurality of adjacent receiving channels connected to said medium respectively selective to a different one of the transmitted carrier frequencies, each channel including a signal detector comprising an electron discharge tube having a control grid and a circuit therefor including a source of negative biasing potential, a receiving telegraph relay responsive to the signal output of said detector to repeat the received marking and spacing signal impulses, and a level compensator comprising a parallel capacitor and resistor in series with said control grid circuit, responsive to the applied marking signals to provide a variable bias on said detector for controlling the gain thereof so as to compensate for level variations in the applied signals, a compensator relay having an armature and marking and spacing contacts, operating in unison with the telegraph relay, to prevent dissipation of the biasing charge of said capacitor through said resistor during spacing signal intervals, and a second resistor of value large in comparison with that of the first resistor connected between said control grid and the spacing control of said compensator relay, for reducing the potential of said grid during long spacing periods, auxiliary means for preventing false operation of a channel when in the idle condition by interference due to circuit noise and message spillover from an adjacent operating channel due to the action of the level compensator tending to return the channel to maximum gain for that condition, comprising a slow-release relay operating when the telegraph relay in the channel is operated to the spacing condition, and releasing only when said telegraph relay has been operated to the spacing condition for a time interval greater than a normal

signal spacing interval, and a second source of negative biasing potential greater than that of the first source, the release of said slow-release relay causing said second resistor to be disconnected from said spacing contact of said compensator relay, and said control grid to be connected to said second source through said second resistor.

10. The system of claim 1, in which said auxiliary means comprises said slow-release relay which is operated in response to operation of said telegraph relay to the marking condition and is released in response to the operation of said telegraph relay to the spacing condition, a second slow-operating relay operating in response to the release of said slow-release relay for a given time interval, and a third relay operating in response to the operation of said second relay to disable the latter relay and to provide a connection for maintaining itself operated only during the released time of said slow-release relay, the operation of said third relay causing the reduction in sensitivity of said receiving circuit and the operation of said alarm, the slow-release time of said slow-release relay and the slow-operate time of said second relay being selected to make the operation of said third relay occur when the spacing condition of said telegraph relay persists for said time interval a given amount greater than said normal signal spacing interval.

11. The system of claim 1, in which said detector comprises a vacuum tube detector having a control grid and a circuit therefor including a source of negative grid biasing potential, said

level compensator comprises a capacitor and parallel resistor in series with said source in said control grid circuit, providing a bias on said control grid proportional to the level of the signals applied to said detector, a compensator relay having an armature and marking and spacing contacts, operating in unison with said telegraph relay to prevent dissipation of the biasing charge on said capacitor through said resistor during spacing signal intervals, and a second resistor of value large in comparison with the first resistor connected between the spacing contact of said compensator relay and said control grid, operating to effectively reduce the potential on said control grid during long spacing intervals, said auxiliary means comprises said slow-release relay operating in response to operation of said telegraph relay to the marking condition and releasing only when said telegraph relay remains operated to the spacing condition for a time interval said given amount greater than a normal signal spacing interval, and a second source of negative potential of a predetermined value greater than that of the first source, the release of said slow-release relay causing said second resistor to be disconnected from said spacing contact of said compensator relay, and said control grid to be connected to said second source through said second resistor, and the last-mentioned means comprises a chain of relays including a slow-operate relay, controlled by the release of said slow-release relay.

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