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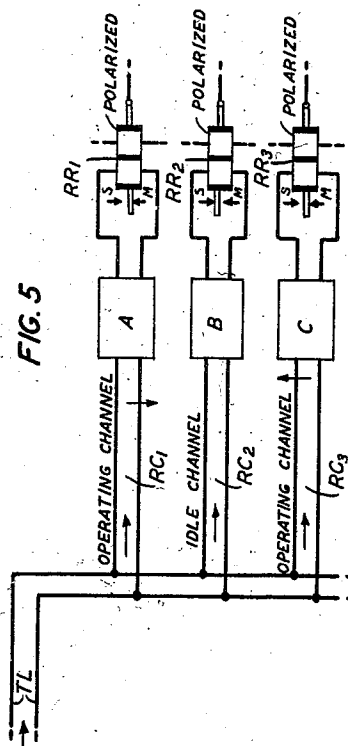
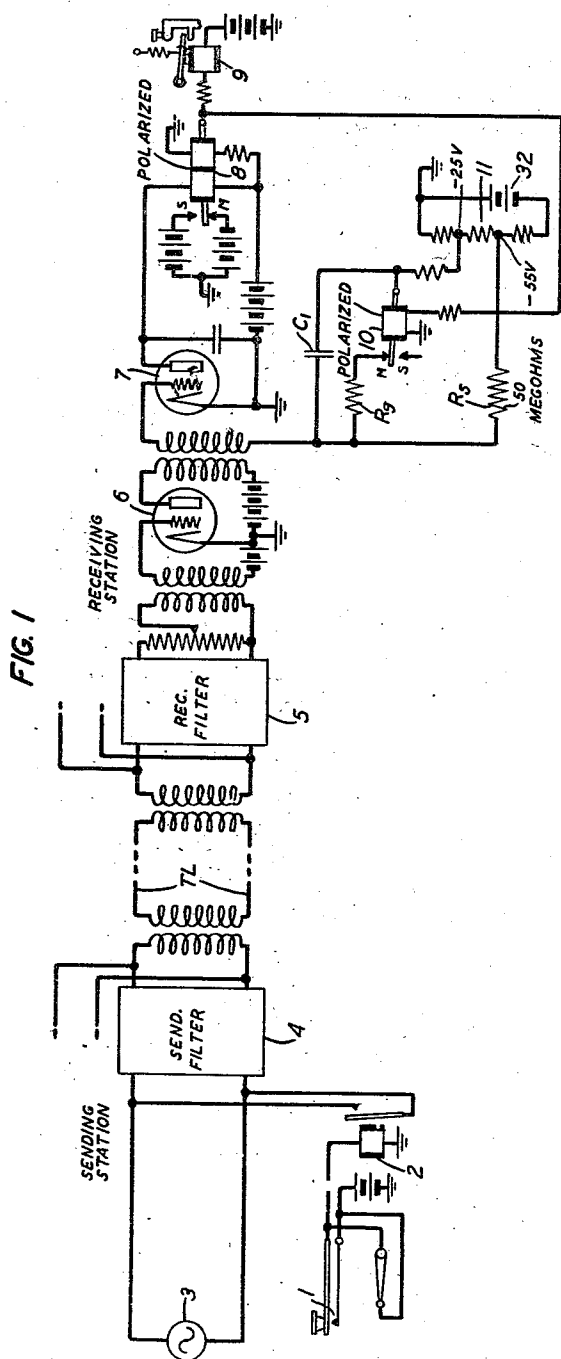
A. L. MATTE

2,307,417

RECEIVING CIRCUIT FOR SIGNALING SYSTEMS

Filed Feb. 19, 1941

2 Sheets-Sheet 1



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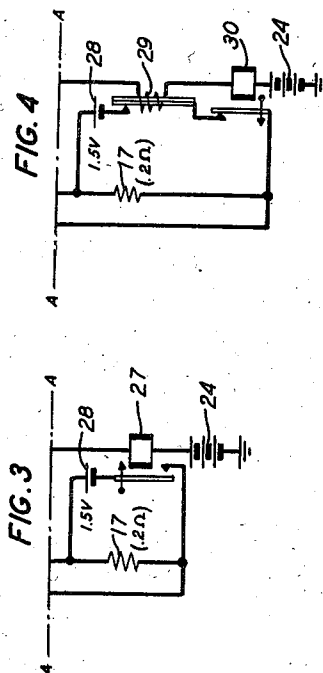
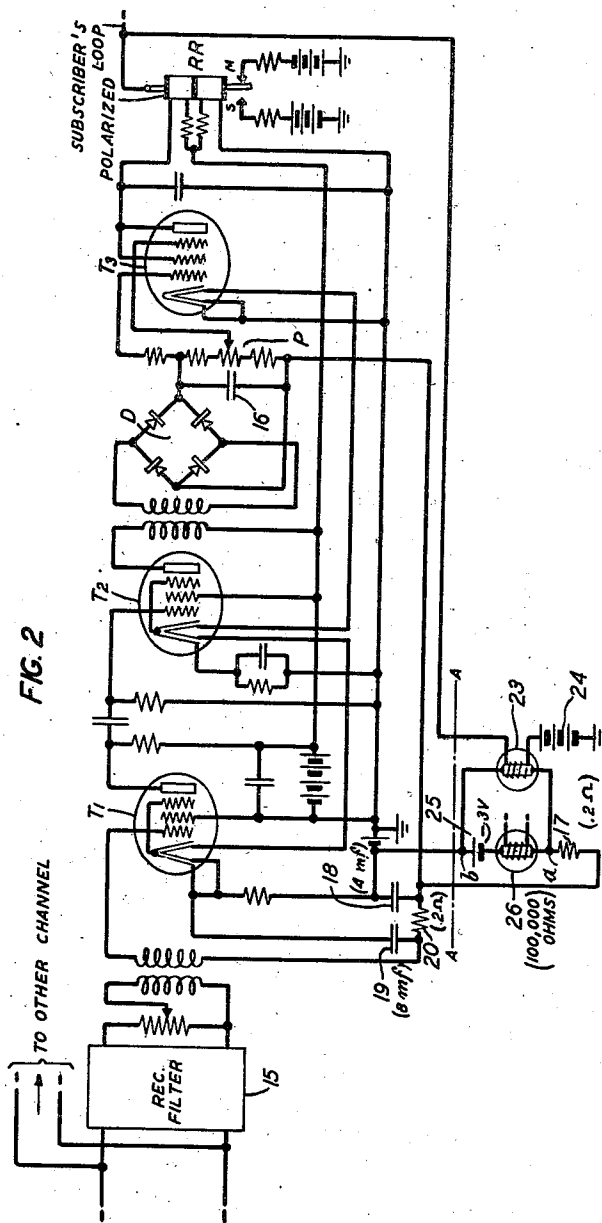
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RECEIVING CIRCUIT FOR SIGNALING SYSTEMS

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The invention relates to receiving circuits for signaling systems and particularly to such circuits employing automatic sensitivity-adjusting circuits.

In certain signaling systems employing current for indicating a positive condition and no current to indicate the absence of a signal, the sensitivity of the receiving circuit employing vacuum tube rectifier and amplifier elements and a signal receiving relay, is by means of an auxiliary automatic control made to vary directly with the loss of the line or other transmission medium over which the signals are received, in such a manner that the receiving relay is operated without bias. This is done by causing the signaling current itself to establish a variable bias on one or more of the vacuum tubes by charging a condenser paralleled by a resistance which is placed in series in the grid circuit of such tubes. If for some reason signaling ceases for some time so that no current is transmitted over the line, the condenser charge is fully dissipated and the receiving equipment tends to become abnormally sensitive to a point where it may be operated by interference originating in the transmitting medium.

One object of this invention is to prevent the condenser charge from falling below a certain limiting value under these conditions and thereby limit the receiving sensitivity to a predetermined maximum value.

It will be evident, however, that if the value of charge so chosen is too great, the receiver may be so insensitive as to fail to respond to a signal impulse when the circuit loss is near its maximum permissible value. A second object of this invention is, therefore, to select a bias value which while sufficient to offset fortuitous interference of maximum intensity is yet small enough to permit proper control of the receiver by the weakest legitimate signal pulse.

It is also apparent that, since a train of signals consists of necessity of intervals of no current as well as of current, the response of the auxiliary bias control device must be slow enough to be inoperative for the maximum interval of "no current" occurring in normal signaling. Finally, on resumption of signaling the auxiliary bias must be promptly removed and the resulting arrangements must not interfere with the proper compensating action of the receiver during regular signaling. A third object of the invention, therefore, is to provide a specified delay after a non-signaling period starts before the auxiliary bias is introduced and to provide for

its prompt and effective removal as soon as signaling is resumed.

The above method of reception finds particular application in telegraphy where it has been found that marking and spacing signals in transmission over a system are subject to distortion such that at the receiving end of the system their durations are different from those at the sending end, and vary from time to time. This type of distortion commonly called "telegraph bias" is primarily due to changes in the received telegraph currents caused by variations in line equivalent. Telegraph bias may be reduced by the use of a level compensator in the telegraph receiving circuit.

One type of level compensator used for this purpose is disclosed in the Herman Patent 1,886,806, issued November 8, 1932. It employs a condenser in parallel with a resistance in series in the grid circuit of the detector tube, whereby the signals themselves are made to produce a control grid-bias of such value as to cause them to operate the receiving relay without appreciable bias for a wide range of received levels. A compensator relay operated in unison with the receiving relay is used to prevent dissipation of the biasing charge through the control resistance during spacing intervals. However, if the spacing intervals are long enough, the charge will ultimately leak out due to imperfect insulation. In order to understand what follows it is necessary to realize that the value of the fixed negative potential (-25 volts) normally used in series with the condenser is determined by the requirements of compensation during active signaling and is not subject to arbitrary change.

Another type of level compensator, disclosed in Davey et al. Patent 2,182,841, issued December 12, 1939, employs a multigrid vacuum tube amplifier between the output of a signal detector and the receiving telegraph relay in a carrier telegraph receiving circuit, and utilizes the current flowing in the suppressor grid circuit of that tube when that grid is driven positive by the detected telegraph signals to vary the control grid bias and thus the gain of amplifier tubes in the receiving circuit in accordance with the amplitude of that current in order to provide the desired compensation for incoming signal level variations.

After a spacing signal has persisted for a fraction of a minute both such types of level compensators tend to increase the gain of the receiving circuit to a value corresponding to an uncharged condenser. This is well beyond the maximum

sensitivity attained in normal operation since regulation is obtained by varying this charge. Proper operation of the carrier telegraph receiving channels in a multichannel carrier telegraph system, in practice, makes it desirable that idle channels be left in the spacing signal condition for long periods of time. In that case, the action of the level compensator in developing excessive gain makes possible false operation of the receiving telegraph relay in the idle channel in response to extraneous interference, for example, by infiltration of message waves in the channel from adjacent operating receiving channels of the system.

Another object of the invention is to prevent such false operation of the idle carrier telegraph receiving channels in such systems and to insure that operation of the idle channel will be resumed with a sensitivity adjusted for the most probable signal level condition or other predetermined value.

The various objects specified are attained in accordance with the invention by circuit arrangements operating to limit the sensitivity of the signal receiving circuits during long non-signaling periods to a low value.

In signal receiving circuits employing a compensator relay type of level compensator, described above, this is accomplished without adversely affecting the operation of the receiving circuit during the reception of signals, by a connection between the detector grid side of the compensator condenser through a large resistance to a suitable source of negative voltage, for example, to a negative voltage tap on the grid bias voltage supply for the detector tube or to an auxiliary negative battery of the proper value, to limit the gain of the detector tube. In signal receiving circuits employing the other type of level compensator utilizing a multigrid tube, briefly described above, a similar result is accomplished by the use of an auxiliary circuit including a thermistor or a thermal or other slow-operating relay, controlled from the receiving signaling relay, to introduce into the receiving circuit an auxiliary negative battery of suitable value which is effective only during long spacing signal periods to bias one or more amplifier tubes in the circuit so as to limit their gains.

In its application to such circuits this invention consists in arrangements for establishing a minimum voltage on the grid of the compensator tube, which corresponds to a finite condenser charge and preferably one which corresponds to the average operating level. It will be shown, however, that normal compensation may extend in both directions beyond the biasing voltage obtained during such long spaces.

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

Figs. 1 and 2 disclose preferred embodiments of the invention applied to carrier telegraph receiving circuits employing respectively different types of level compensators;

Figs. 3 and 4 show alternative arrangements which may be substituted for the arrangement of the invention illustrated in Fig. 2; and

Fig. 5 shows a diagram which explains the problem for which the circuits of the invention were devised to solve.

The diagram of Fig. 5 represents a receiving station of a carrier telegraph system, including

the adjacent carrier telegraph receiving channels RC_1 , RC_2 and RC_3 connected in parallel to the incoming telegraph line TL. Each receiving channel includes in addition to a polar receiving telegraph relay RR_1 , RR_2 or RR_3 , other receiving apparatus, represented respectively by the box A, B or C, including a receiving channel filter, amplifiers, a signal detector and a level compensator, such as illustrated in the detailed circuit of Fig. 1 or Fig. 2.

In such a system, it has been found desirable in practice to leave each idle channel, for example, channel RC_2 as indicated, in a spacing signal condition during the long periods of time, which may be several hours or more, when they are not supposed to be in use. Under these circumstances, as explained above, the usual level compensator returns the sensitivity of the idle channel to an abnormally high value within a few seconds, and, inasmuch as the maximum sensitivity obtainable with such a level compensator is usually very nearly sufficient to allow operation of the channel on normal line noise and other sources of interference, it is quite probable that interfering message waves induced in the idle channel from the adjacent operating channels RC_1 and RC_3 , as indicated by the vertical arrows in Fig. 5, will be of sufficiently high level to cause operation of the idle channel to give false signals. This situation is greatly aggravated if the level of the received signals on the operating channels happens to be near its maximum value. Experience in the field shows that such false operation actually occurs in practice.

Fig. 1 shows a transmitting and a receiving channel of a carrier telegraph system connected by a telegraph line, the receiving channel employing a compensator-relay type of level compensator. The system illustrated, except for the modification in accordance with the invention to be described below is substantially like that disclosed in the Borgeson Patent No. 2,065,640, issued December 29, 1936, 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 telegraph signals controls relay 2 to close and open a short-circuiting connection across the output of a carrier wave source 3 of given frequency causing the carrier waves from that source to be chopped to form carrier modulated telegraph signals consisting of successive marking and spacing signal impulses. These impulses are transmitted through the sending filter 4 at the sending station and are then passed over the line TL to the receiving station. At the receiving station the received carrier modulated telegraph 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 amplified by the amplifier 6 and are impressed on the vacuum tube detector 7. The detected telegraph signals in the output of detector 7 will cause the operation of the polar receiving telegraph relay 8 to its marking contact m in response to a marking signal and to its spacing contact s in response to a spacing signal, to suitably control the sounder 9 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 for marking signals

and to the spacing contact s for spacing signals, and during each marking interval connects the grid leak resistance R_g in shunt to the compensator condenser C_1 which is connected in the grid circuit of the 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 pulses 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 in series therewith, is held on the detector grid due to the opening of the discharge path through R_g . A received current stronger than normal increases still further the condenser charge and hence the negative bias on the detector grid, while the received currents weaker than normal result in a smaller than normal grid bias, the over-all result being an equalizing effect in 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 7 from being affected by these changes.

The portion of the circuit of Fig. 1 described above is substantially as shown in Fig. 1 of the aforementioned Herman patent. The similar circuit of the aforementioned Borgeson patent includes in addition a resistance, large compared to R_g , between the spacing contact of the compensator relay and the grid of the detector tube, thereby effectively reducing the potential of the grid during long spaces to a value corresponding to that of a non-charged condenser. The 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 applicant's Fig. 1, which involves the invention, differs from that of the Borgeson patent in that the resistance leak R_s of high value (of the order of 50 megohms) which in the Borgeson circuit was connected between the grid side of the compensator condenser and the spacing contact of the compensating relay is in the present circuit permanently connected between the grid side of condenser C_1 and a tap on the grid voltage supply 11 of the order of -25 volts.

To explain the improvement attained by the latter connection, the operation of the circuit with the lower end of resistance R_s connected to the spacing contact of the compensator relay 10, as in the circuit of the Borgeson patent, will first be described. When a space occurs, the operation of the compensator relay armature to the spacing contact connects the 50-megohm resistance R_s in shunt with the compensating condenser C_1 in place of the resistance R_g , causing condenser C_1 to discharge through R_s , but since the latter resistance is very large compared with R_g , the effect of R_s on the total condenser charge will be negligible during active operation. However, if there is a prolonged spacing pause, the compensator relay armature remains on the spacing contact and the voltage of the plate of condenser C_1 nearest the grid of tube 7, soon acquires a potential of approximately -25 volts relative to that of the filament of tube 7. This

is within a few volts of the bias at which the receiving relay 8 just operates. It is evident that under these conditions, as explained in connection with Fig. 5, a small amount of interference such as spill-over from an adjacent receiving channel, may cause operation of the receiving relay to give false signals. The trouble is evidently due to the fact that under such a spacing condition the charge on the condenser C_1 is dissipated and the detector gain becomes abnormally high. Tube leakage tends to aggravate this condition, as may readily be seen if it is assumed that the grid-filament space of a detector tube is perfectly conducting since in that case the bias on the grid drops to zero.

The modified arrangements in accordance with the invention are intended to cause the compensating condenser to acquire during a long space the voltage it would have if signals were coming in. The desired result as shown in Fig. 1 is attained by connecting the end of the large resistance R_s , which in the circuit of the aforementioned Borgeson patent went to the spacing contact of the compensator relay, instead of to a point at a potential having a suitable value, as hereinafter explained, below that of the filament of the detector tube 7, such as to a tap on the grid voltage supply 11, as indicated. The choice of biasing voltage will be clear from the following considerations. It will be evident that if this voltage had a sufficiently high negative value an incoming signal would not overcome it, and the receiving relay 9 would not operate to marking when key 1 is closed. This would be especially the case if the line level happened to be low. It follows that the negative grid bias during a long space must not be greater than the value which will just cause the relay to close on a marking signal when the line has its maximum net loss. This may be called the "recapture" value. On the other hand as pointed out earlier, if the negative voltage during a long space is sufficiently small the sensitivity of the detector will be so great that it will operate on spurious signals. This effect will be aggravated if the line level happens to be high. The optimum voltage for biasing the compensator tube will therefore be one which apportions judiciously the relative risk of loss of control on minimum received level and false operation on maximum received level. With the embodiment illustrated in Fig. 1 a value of -55 volts has been found satisfactory, but this may vary from channel to channel and with other circumstances.

In the types of level compensator referred to herein there is, of course, an optimum condenser voltage for each level of the received signals. The grid bias established for long spaces, however, does not interfere with this requirement since resistance R_s , being very large compared with R_g , acts effectively as an open circuit during normal operation, permitting the development of a condenser charge whose value is independent of the voltage of tap 11 and which is such as to give proper compensation.

Inasmuch as the voltage of the compensating condenser C_1 during the spacing condition to attain the desired result need not be either precise or steady, since the circuit is not in use when it is inoperative, this voltage does not have to be derived from the grid bias supply circuit through a large resistance as illustrated but may be taken directly from the telegraph battery or other convenient source. Also, it is evident that the desired biasing voltage may be inserted at any

point in the grid-filament circuit other than that illustrated.

Figs. 2 to 4 show different modifications of the invention applicable to a carrier telegraph receiving channel equipped with a level compensator of the type disclosed in the aforementioned Davey et al. patent. The receiving channel and level compensator as illustrated in Fig. 2 includes a receiving filter 15 for selecting from the received carried modulated telegraph signals those within the frequency range assigned to that channel; a two-stage alternating current vacuum tube amplifier T₁, T₂ having a variable-mu tube in the first stage T₁ for amplifying the selected waves; a full-wave copper oxide detector D and associated condenser 16 for demodulating the telegraph signals from the amplified waves and suppressing the carrier components thereof; a multigrid vacuum tube T₃ coupled by the potentiometer P to the output of the detector D, serving both as a direct current amplifier for the detected signals and as an element of the level compensating circuit; and a telegraph relay RR controlled by the output current of the tube T₃ operating to repeat the marking and spacing telegraph signals.

The gains of the amplifier tubes in the receiving channel of Fig. 2 are adjusted under control of the suppressor grid current of tube T₃ to compensate for level variations of the received carrier-modulated telegraph signals, tending to produce telegraph bias, in the following manner: The suppressor grid of tube T₃ is connected to the movable arm of potentiometer P. The plate and screen are at a positive potential when the control grid of that tube is at zero potential, as in this circuit during marking signaling intervals. The suppressor grid will draw considerable current if its potential is raised any appreciable amount above zero with respect to the cathode which is near ground. This suppressor grid current flows from the potentiometer P through the resistance 17 (0.2 megohm) which with the parallel condenser 18 (4 mf.) is connected in common to the control grid-cathode circuits of the tubes T₁ and T₂. The voltage drop thus produced across the resistance 17 and condenser 18 is applied to condenser 19 (8 mf.) through resistance 20 (2 megohms), placing a negative voltage on the control grid of tube T₁ which reduces the gain of the alternating current amplifier portion of the circuit. The result of this action is to hold the voltage of the suppressor grid of tube T₃ during marking intervals to a value near zero with respect to the cathode unless the carrier current being received is not of the necessary level to raise the suppressor grid to zero with the amplifier at maximum gain. By applying approximately one-half of the direct current output signal from the bridge rectifier D on the suppressor grid of tube T₃, the half peak value of this direct current signal wave is kept approximately zero with respect to the cathode. The voltage drop across resistance 17 which supplies the control bias on tube T₁ also increases the control grid bias on the tube T₃. The net increase in the direct current output voltage of the bridge rectifier D is then about twice the amount of increase in the voltage across resistance 17. Since the changes in the control voltage drop across resistance 17 are small compared with the total bias on tube T₃, and also because the voltage of the control grid at which relay RR operates is close to the value at which the suppressor grid exercises its control, the

resulting bias of the received signal does not change appreciably with normal variations in the level of the incoming carrier signals.

In the prior art circuit of this type (Davey et al. Patent No. 2,182,841), the points *a* and *b* of Fig. 2, are connected together and the intermediate portion of the circuit forming a part of this invention are not used. In this case, during a long space, the condensers 18 and 19 will ultimately discharge, leaving the channel in a highly sensitive condition. In view of the fact that there is no compensator relay in this system, a somewhat different method of dealing with the difficulty has to be used. The arrangements disclosed in Figs. 2, 3 and 4 take care of the difficulty by introducing an auxiliary battery which is effective in biasing the amplifier tubes only during long spacing periods.

In the system of Fig. 1, the necessary delay was obtained through the high time constant of the circuit involving the 50-megohm resistance R_s. In the system of Fig. 2, the necessary delay is obtained by means of the indirectly heated thermistor 23, the heating element of which is connected between the armature of the receiving relay RR and the battery 24. The thermistor 23 will thus become heated during marking intervals and will cool off gradually during the long spacing intervals. The conducting element of the thermistor 23 is bridged around the resistor 26 and the extra 3-volt negative battery 25 provided for maintaining the condenser charge during long spaces, and when this conducting element becomes heated due to normal operation it has a resistance of the order of 100 ohms, which effectively nullifies the voltage of the battery 25 inasmuch as the latter is in series with a resistance element 26 which is made of the order of 100,000 ohms. When the thermistor 23 cools, however, its resistance rises to about 100,000 ohms and half the battery voltage appears across the terminals *a* and *b* and is thus impressed steadily upon the condenser 18 as long as the spacing condition persists. While the particular values selected for the battery and resistances can be varied, those mentioned are based on the assumption that the average condenser voltage during operation at normal received levels is about -1½ volts and that the values for hot and cold resistances for the thermistor are easily realizable in practice.

One difficulty with such an arrangement is that the cold resistance of thermistors varies rather widely with room temperature so that the voltage impressed on the condensers would not always be the same. This can be easily taken care of by employing for the resistance 26 a thermistor element substantially identical with 23 but having its heater winding idle. Temperature changes will then affect the two parallel resistances equally and the voltage impressed on the condensers will be half the auxiliary battery voltage at all room temperatures.

Fig. 3 shows a modified arrangement of the invention which may be used in connection with the system of Fig. 2 in place of the portion of the circuit shown below the dot-dash line AA, in which the thermistor elements are replaced by a relay 27 designed to have a suitable delay in operation, which when operated in response to the current from the battery 24 when the receiving relay RR is operated to its spacing contact during a long spacing signal, connects the 1.5 volt auxiliary battery 28 across the condensers 18 and 19 and the parallel resistor 17 with such poling so as to

produce the required negative biasing voltage on the control grids of the amplifier tubes T₁ and T₃ during such a long spacing period. The desired delay might also be obtained by a number of other well-known methods, such as the use of a thermal relay, a relay shunted by a non-polarized electrolytic condenser, and so forth; but all these schemes, including the use of thermistors, are subject to the objection that they tend to maintain incorrect bias conditions for some considerable time after telegraph operation is resumed. It is desirable to defer the application of the compromise bias for a period of say 10 or 20 seconds but to restore bias control to the level compensator with the first marking dot when operation is resumed.

The modified arrangement shown in Fig. 4 accomplishes the latter result by inserting two switched connections in series in the auxiliary battery circuit. One of these is controlled by the thermal relay 29 and the other by a slow-release and fast-operate relay 30, both of which are energized in series by current from the battery 24 when the telegraph relay RR is operated to the marking contact. During steady marking or normal operation the armatures of both relays are therefore pulled up and the auxiliary battery circuit is opened at two points. To insert the battery requires that both relays should release. The thermal relay 29 is the slower one, being adjusted so as not to release unless the spacing interval lasts about 20 seconds. This relay therefore determines the minimum spacing interval before the auxiliary battery is inserted. When signaling is resumed, the fast-operate (slow-release) relay 30 opens the battery circuit at once. During the interval after resumption of operation and before the thermal relay 29 has had time to open its contact, the battery connection is under the exclusive control of relay 30. To prevent this relay from connecting the battery back into circuit every time a space occurs during this interval, relay 30 is adjusted so it will not release for a period at least equal to the longest spacing condition occurring in whatever code may be used (e. g. "blank signal" in ordinary start-stop code). The relay 30 may be designed, for example, to operate in about .02 second and release in about .2 second.

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. Also, the numerical values given are merely for illustrative purposes and not as limitations and any other values which will give the required result may be used.

What is claimed is:

1. In combination with an electric signaling system comprising a sending circuit for producing pulses of electric current separated by intervals of no current respectively representing marking and spacing signals, a transmission medium subject to variable loss for transmitting said signals and a receiving circuit connected to said medium comprising a signal transmission device, a receiving relay having marking and spacing contacts, operatively controlled from the output of said device to repeat the received marking and spacing signals and automatic means for varying the bias on said transmission device to control the sensitivity of said receiving circuit so as to prevent changes in the effective length of the repeated marking and spacing signals with changes in the loss of said medium, means to prevent false operations of said relay by interference in said

receiving circuit during abnormally long spacing intervals comprising means to apply to said transmission device during said abnormally long spacing intervals only a fixed bias which will reduce the sensitivity of said receiving circuit to the necessary degree to prevent such false operation.

2. The combination of claim 1, in which said signal transmission device comprises at least one electron discharge device having a control grid biasing circuit, said automatic means comprises a capacitor in said control grid biasing circuit and means to apply a charge to said capacitor the magnitude of which is controlled by that of the signals which operate said signaling relay to its marking contact, and said means for preventing false operations of said relay comprises means for preventing the total dissipation of the charge on said capacitor during said abnormally long spacing intervals, comprising means for bridging around said capacitor a fixed biasing voltage when the spacing interval exceeds a preassigned value and means for promptly and effectively removing said fixed biasing voltage on the resumption of signaling in said receiving circuit.

3. In combination with an electrical signaling system using current for marks and no current for spaces in which the receiving circuit includes a vacuum tube transmission device, a receiving relay operated by the output current therefrom, and control means for compensating for level changes of the received current consisting of a charged condenser biasing said vacuum tube device by a charge whose magnitude is regulated by the amplitude of the received signals, auxiliary control means for preventing the charge on this condenser from falling below a certain value during long spacing intervals, said certain value being sufficient to prevent fortuitous interference from operating the receiving circuit during such long spacing intervals but insufficient to prevent the weakest marking signal from operating said receiving relay and means to prevent said auxiliary control means from affecting the compensatory action of the first control means during normal signaling operation.

4. In an electrical signaling system comprising a sending circuit to produce and transmit signals consisting of electrical current pulses interspersed with conditions of no current, a transmission medium subject to variable attenuation of a fortuitous character, and a receiving circuit including a vacuum tube control device having a control grid and a circuit therefor, capable of compensating for these variations by the generation of a variable bias on said control grid, consisting of a congruently variable charge produced by the signals themselves on a condenser shunted by a resistance in said control grid circuit and a receiving relay operated to one contact by the output of said vacuum tube device, means controlled by the receiving relay when returned to its non-operated position to shunt said condenser with a source of fixed potential after a predetermined lapse of time to prevent the aforementioned charge from being wholly dissipated by leakage, and means causing the shunt on said condenser to be promptly and effectively removed on the resumption of signaling.

5. In combination with a carrier telegraph receiving circuit including amplifying means, a signal detector, a telegraph relay controlled thereby and automatic circuit-gain controlling means for compensating for variations in level of the received carrier currents tending to distort

the repeated marking and spacing signals, means to prevent false operation of said telegraph relay in response to interference during long spacing periods when said circuit is at maximum gain comprising auxiliary means to adjust the sensitivity of said circuit so that the receiving relay will be unoperated by the maximum interference but can still be controlled by the weakest signal.

6. The combination of claim 5 in which said telegraph receiving circuit includes an electron discharge device having a control grid, said automatic circuit-gain controlling means operates to increase the negative bias on said grid for increase in the level of said currents and to decrease the negative bias on said grid for decreases in the level of said currents, and said auxiliary means comprises means for holding the negative bias on said grid during a long spacing period at a value sufficient to overcome the maximum amount of said interference.

7. The combination of claim 5, in which said detector is an electron discharge tube detector having a control grid and a circuit therefor, said level compensating means comprises a source of negative grid biasing potential, and a capacitor connected in series in said control grid circuit, a compensator relay having an armature and marking and spacing contacts, operating in unison with said telegraph relay, a resistor connected in shunt with said capacitor when said armature is on the marking contact variably charging said capacitor to control the bias on said grid during a marking signal, and said auxiliary means comprises means for causing a negative biasing voltage appreciably greater than the fixed biasing voltage applied by said source, to be applied to said control grid when said armature is held on said spacing contact for a predetermined time greater than a normal spacing signal.

8. The combination of claim 5, in which said detector is an electron discharge tube detector having a control grid and a circuit therefor, said level compensating means comprises a source of negative grid biasing potential, and a capacitor connected in series in said control grid circuit, a compensator relay having an armature and marking and spacing contacts, operating in unison with said telegraph relay, a resistor connected in shunt with said capacitor when said armature is on the marking contact variably charging said capacitor to control the bias on said grid during a marking signal, and said auxiliary means comprises means for causing said capacitor to acquire during a long spacing period a potential sufficient to overcome the maximum amount of said interference.

9. The combination of claim 5 in which said detector is an electron discharge tube detector having a control grid, said level compensating means comprises a source of negative grid biasing voltage and a capacitor connected in series in said grid circuit, a resistor and a compensator relay having an armature and marking and spacing contacts operating in unison with said telegraph relay to connect said resistor in shunt with said capacitor to variably charge said capacitor when said armature is operated to said marking contact during a marking signal, and said auxiliary means comprises an auxiliary source of negative voltage of suitable value connected to the grid side of said capacitor through a resistor of value much greater than the first resistor for preventing the complete discharge of said capacitor due to leakage during long spacing periods.

10. The combination of claim 5, in which said

amplifying means comprises at least one amplifying vacuum tube having a control grid and a circuit therefor, said level compensating means comprises a network consisting of a capacitor and a resistor in parallel in the grid circuit of said tube and means responsive to the detected signals to charge said capacitor to a potential which is proportional to the amplitude level of the detector output to vary the grid bias and thus the gain of the amplifying vacuum tube to provide the desired level compensation, and said auxiliary means comprises means controlled by said telegraph relay to effectively apply to the control grid of said tube a fixed negative voltage of suitable value only when said telegraph relay is held operated to the spacing position for a predetermined interval of time greater than that of a normal spacing signal.

11. The combination of claim 5, in which said amplifying means comprises a vacuum tube amplifier each having a control grid and a circuit therefor, said level compensating means comprises a network consisting of a capacitor and a resistor in parallel in the grid circuit of said amplifier and means responsive to the detected signals to charge said capacitor to a potential which is proportional to the amplitude level of the detector output to vary the grid bias and thus the gain of the amplifier so as to provide the desired level compensation, and said auxiliary means comprises a negative battery of suitable value and slow-operating relay means controlled by said telegraph relay when operated to the spacing position for a time greater than would be caused by a normal spacing signal to connect said negative battery in parallel with said capacitor and said resistor to produce a biasing voltage on said grid sufficient to override said interference.

12. In combination with a carrier telegraph receiving circuit comprising an amplifier for amplifying received carrier modulated telegraph signals, including a plurality of electron discharge amplifying devices each having a control grid and circuit therefor, a detector for detecting the telegraph signal components while suppressing the carrier component, a polar relay controlled from the detector output for repeating the marking and spacing telegraph signals and a level compensator comprising a capacitor and a resistor in parallel in the grid circuit of at least one of said amplifying devices, and means responsive to the detected signals to charge said capacitor to a voltage which is proportional to the amplitude level of the detected signal waves to vary the bias on the control grid of said one device and thus the gain of said amplifier so as to compensate for variations in the amplitude level of the incoming carrier waves tending to vary the duration of the repeated marking and spacing signal impulses, means to prevent false operation of said polar relay by interference currents produced in said receiving circuit during long spacing periods, due to loss of charge of said capacitor returning the circuit to maximum gain comprising auxiliary means to produce an additional negative bias on the control grid of said one amplifying device during that period sufficient to limit the sensitivity of said receiving circuit to a value corresponding to that which it would have when the carrier modulated telegraph signals are incoming.

13. The combination of claim 12 in which said auxiliary means comprises means for connecting an auxiliary negative grid biasing battery of

suitable value in parallel with said capacitor and parallel resistor when the spacing period of said polar relay appreciably exceeds that due to a normal spacing signal.

14. The combination of claim 12, in which said auxiliary means comprises an auxiliary negative grid biasing battery of suitable value connected across said capacitor and parallel resistor and means for effectively nullifying the battery except when the spacing operating time of said relay appreciably exceeds that due to a normal signal spacing impulse.

15. The combination of claim 12, in which said auxiliary means comprises an auxiliary negative grid biasing battery of suitable value connected across said capacitor and parallel resistor, a thermistor connected across said battery, means controlled by said relay for heating said thermistor during marking signal periods and for allowing the thermistor to cool off during spacing periods, the characteristics of said thermistor being such that its negative resistance value while heated is such as to effectively nullify the effect of said battery and its resistance value when cooled off to an extent which would be caused by a spacing period appreciably greater than that due a normal spacing signal will be such as to render said battery effective to produce the required negative bias on the control grid of said one amplifying device.

16. The combination of claim 12, in which said auxiliary means comprises a slow-acting relay energized by operation of said relay to the spacing signal position to connect an auxiliary negative grid biasing battery in parallel to said capacitor when the spacing period appreciably exceeds that due to a normal spacing signal impulse.

17. The combination of claim 12 in which said auxiliary means comprises an auxiliary negative grid biasing battery connected in parallel with said capacitor and parallel resistor, a slow-acting relay energized by operation of said polar relay to the marking condition to put a break in the connection of said auxiliary battery in paral-

lel with said capacitor and resistor, and releasing in approximately 20 seconds after said spacing condition starts to remove the break, and another fast-operating, slow-releasing relay operating substantially immediately when said polar relay is operated to the marking condition to put a second break in the parallel connection of said auxiliary battery across said capacitor and resistor and releasing to remove said second break in said parallel connection in about 0.2 second after said spacing condition starts.

18. In combination in a multichannel carrier telegraph signaling system including a signal transmission line for transmitting marking and spacing signal impulses of carrier current of different frequencies corresponding to different messages, and a plurality of adjacent receiving channels connected to said line, respectively selective to different carrier frequencies corresponding to different messages, each of said channels including amplifying means, a signal detector, a polar relay responsive to the signal output of said detector for repeating the marking and signal impulses and a level compensator including at least one vacuum tube having a control grid and circuit therefor, responsive to the signal output of said detector to vary the bias on said control grid to control the gain of said circuit in such manner as to compensate for variation in the level of the incoming carrier current, means in each receiving channel to prevent false operation of that channel when it is idle by message spill-over from an adjacent operating channel due to the level compensator returning the channel to maximum gain, comprising auxiliary means operative when the polar relay is operated to the spacing position for a time interval appreciably longer than that due to a normal spacing signal for applying to said grid an additional negative biasing voltage such as to limit the gain of the channel to a value corresponding to that existing when carrier signals are incoming.

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