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TRANSMISSION REGULATING SYSTEM FOR RADIO AND CARRIER TELEGRAPH SYSTEMS

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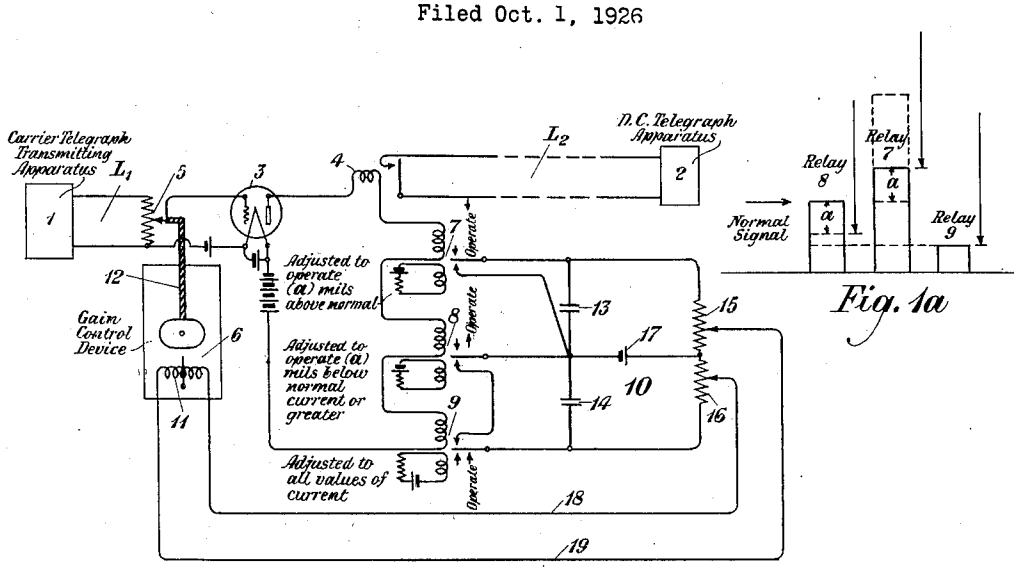


Fig. 1a

Fig. 1

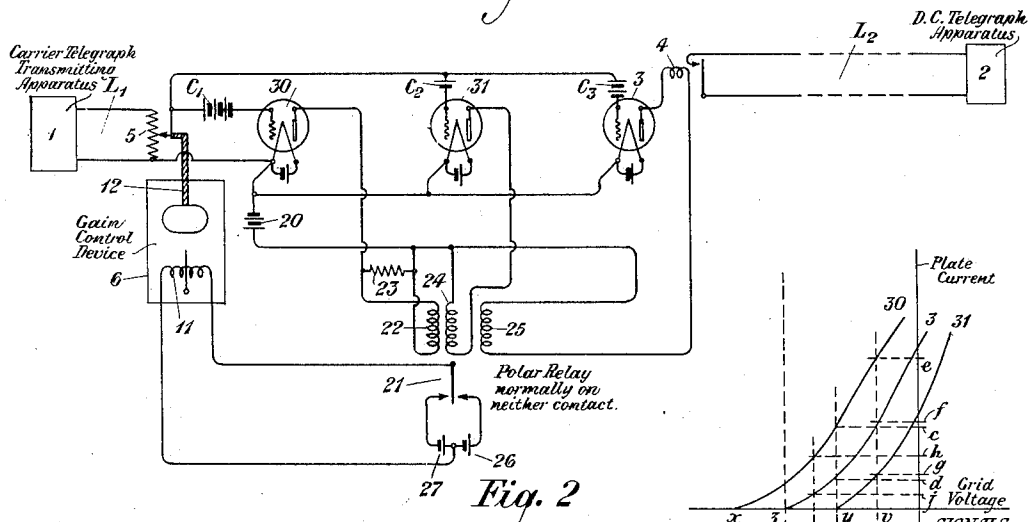


Fig. 2

Fig. 2a

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TRANSMISSION-REGULATING SYSTEM FOR RADIO AND CARRIER-TELEGRAPH SYSTEMS.

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This invention relates to a transmission regulating system for radio and carrier telegraph systems, and particularly to a system of the type in which the gain of the amplifier is varied by and in accordance with changes in the signaling current itself to compensate for changes in the line characteristics.

In high frequency telegraph systems, which term is intended to include both radio and carrier systems, it has been customary to employ means for automatically changing the gain of the amplifiers in the circuit to compensate for changes in its transmission equivalent. Heretofore it has been customary to transmit a control current consisting of a single frequency, lying outside of the band of signaling frequencies, and to utilize this control current to operate the regulating device by means of which the amplifier gain is varied. This control current, which is termed in the art a "pilot channel", utilizes a portion of the frequency spectrum that might otherwise be employed for the transmission of signals. Consequently, if the regulation of the amplifier gain can be effected by changes in the signal voltages themselves, the use of a pilot channel is rendered unnecessary and a saving will result.

The object of this invention is to control the amplifier gain in a radio or carrier telegraph system to compensate for changes in the transmission equivalent of the system, the control being effected by means of the signal voltage itself.

This invention will be clearly understood from the following description when read in connection with the attached drawing, in which Figure 1 shows schematically a form of embodiment of the invention, in which a plurality of relays responsive to currents of different strengths control a regulating device connected with the amplifier; Fig. 1[a] is a graph illustrating the operation of Fig. 1; Fig. 2 is a form of embodiment of the invention in which a plurality of vacuum tubes perform substantially the same functions as the relays in Fig. 1; and Fig. 2[a] is a graph illustrating the operation of Fig. 2.

In Fig. 1, 1 represents a carrier telegraph transmitting device connected with the line L_1 for the purpose of transmitting signals thereover to operate direct current telegraph apparatus 2 connected with the line L_2. The lines L_1 and L_2 are connected by the receiving apparatus, including the amplifier-rectifier 3 and the relay 4. The input side of the amplifier-rectifier 3 is connected with the potentiometer 5 which may be varied by means of the gain control device 6 which is controlled by the relays 7, 8 and 9, connected with the Wheatstone bridge 10. The gain control device 6, which is shown schematically in the drawing, is preferably a modification of a Leeds and Northrup recorder described in the patent to Leeds, 1,125,699, dated January 19, 1915, the modification consisting in the replacement of the pen, which is normally employed for the production of a record, with a contact point that engages the wire of a potentiometer. This type of electrical recorder is also described in Bulletin No. 871 of the Leeds and Northrup Company, published in 1921. In an arrangement of that type, the flow of current through the coil 11 in a given direction will cause the arm 12 to move in a definite direction, and the magnitude of its motion will be dependent upon the strength of the current in the coil. Likewise a reversal of the current through the coil 11 will cause the arm 12 to move in the opposite direction. The relays, 4, 7, 8 and 9 are included in the plate circuit of the amplifier-rectifier 3. Relay 4 is of the ordinary type of telegraph relay which will respond to a range of current above and below normal, and will thereby transmit a marking impulse over the line L_2 to the direct current telegraph apparatus 2 connected therewith. Relays 7, 8 and 9 are polar relays, each having one winding connected with the plate circuit of the tube 3, and having the other winding connected with a source of biasing current. Thus relay 7 is biased to operate at "a" mils above the normal signaling current, and when it operates its armature moves downward. Relay 8 is biased to operate at "a" mils below the normal current and upon operation its armature moves upward. Relay 9 is designed to operate at all values of current, and when doing so its armature moves upward. The function of the last mentioned relay will be clear from the subsequent description. The Wheatstone bridge network 10 comprises the condensers 13 and 14, resistances 15 and 16, and the source of potential 17. The operat-

ing winding 11 of the gain control device 6 is connected by means of conductors 18 and 19 with the resistances 15 and 16.

The manner in which this system operates to control the gain of the amplifier 3, in order to compensate for variations of the transmission equivalent, is as follows: Let it be assumed that the device 1 is sending signaling impulses, the marking impulses consisting of a train of waves of the signaling frequency and the spacing impulses consisting in a suppression of the signaling frequency. The impression of a train of waves constituting a marking impulse upon the grid of the tube 3 will produce a flow of current in the plate circuit thereof which will flow through the winding of the various relays. If this resultant plate current is normal, the relay 4 will operate and transmit a marking impulse to the receiving device 2. Relay 7, which operates only on abnormally high currents, will not be operated but relays 8 and 9 will operate and cause their armatures to touch their contacts. The Wheatstone bridge 10 will, however, remain balanced and consequently, current will not flow through the winding 11 of the control device 6 because no potential difference exists across the contacts of conductors 18 and 19 with resistances 15 and 16. If, however, the transmission equivalent changed so that the incoming signaling impulse produced a plate current which was "a" mils above normal, the relay 7 would operate, which would short-circuit the condenser 13 and unbalance the bridge, causing current to flow from the source 17 through the resistance 15, which would produce a voltage across the conductors 18 and 19 and cause current to flow in a predetermined direction through the winding 11. This in turn would effect a movement of the arm 12 in such direction as to diminish the plate current of the tube 3, and thus restore to normal the current flowing through the relays 4, 7, 8 and 9. As soon as such a condition is established, relay 7 will be de-energized, the short-circuit around the condenser 13 will be removed and the gain control device 6 will cease to operate. That is to say, its arm 12 will come to rest. In like manner, if the plate current drops more than "a" mils below normal, relay 8 will release and will short-circuit condenser 14, thus causing a flow of current through the resistance 16, and by virtue of the potential difference established across the conductors 18 and 19 will cause current to flow through the winding 11, the direction of which is opposite to that of the current resulting from the operation of relay 7. The arm 12 will accordingly be removed in order to increase the current in the plate circuit of the tube 3. When the current is restored to normal relay 8 will be de-energized and the device 6 will cease operating.

The object of relay 9 is to prevent the unbalancing of the Wheatstone bridge network 10 and the consequent operation of the device 6 when a spacing signal is being transmitted over the line L_1 from the distant end. Obviously, at such a time the plate current would be more than "a" mils below normal, so that the relay 8 would be released. If the contact of relay 9 were not connected in series with the contact of relay 8, the condenser 14 would be short-circuited when nothing was received from the line, and the device 6 would function by virtue of the unbalancing of the network 10. Relay 9 therefore ceases to operate when signals are not being received from the line, and opens the circuit which includes the contact of relay 8. This is clearly shown in Fig. 1[a] where relay 9 is represented as operating and remaining operated upon current of small magnitude; relay 7 will operate upon the normal current plus a current represented by "a" mils above normal; and relay 8 will operate upon current of "a" mils below normal.

In the arrangement shown in Fig. 2, in which the same reference characters have been employed as in Fig. 1, the regulation of the control device 6 is effected by means of the vacuum tubes 3, 30 and 31. The potentiometer 5, which is controlled by the arm 12 of the device 6, is connected not only with the grid of the tube 3 but also with the grids of the tubes 30 and 31. A source of plate potential 20 is connected between the filament of each tube and the plate of each tube, and each connection includes a winding of the polar relay 21. Thus the plate circuit of the tube 30 includes the winding 22 which is shunted by the resistance 23, the plate circuit of the tube 21 includes the winding 24, and the similar circuit of the tube 3 includes the winding 25 of the relay 21, and also the operating winding of the telegraph relay 4. As in Fig. 1, relay 4 serves to control the transmission of signals over the line L_2 to the receiving device 2. The polar relay 21 has its armature and contacts and sources of potential so connected with the winding 11 of the device 6 that when the armature is upon one contact current will flow through the winding 11 in a predetermined direction, and when the armature is upon its other contact, the current flow in winding 11 will be in the opposite direction. As shown in Fig. 2[a], the operating characteristics of the tubes 3, 30 and 31 are similar but they are displaced relative to each other by applying different negative biasing voltages to the grid of each tube. Thus the battery C_1 applies a negative voltage x to the tube 30, the battery C_2

applies a voltage y to the tube 31, and the battery C_3 applies a voltage z to the tube 3.

The mode of operation of this system is as follows: When a normal signal, as shown in Fig. 2^a, is applied by means of the line L_1 to the grids of the various tubes, the potentials upon the grids will be raised to y. The resultant current in the plate circuit of the tube 30 will be equal to o and at the same instant the current in the plate circuit of the tube 3 will be equal to d, while the current in the plate circuit of tube 31 is zero. The windings 22 and 25 of the polar relay 21, which are in the plate circuits of the tubes 30 and 3, respectively, are poled oppositely and the shunt 23 is so varied that the current flowing through the winding 22 will equal that flowing through the winding 25 whereby the flux produced by one winding equals that produced by the other winding and the armature of the relay 21 is unaffected. Accordingly, the winding 11 of the device 6 is not energized and no motion is given to the arm 12 which controls the contact of the potentiometer 5.

Assuming that a signal greater than normal, such as shown in Fig. 2^a, is impressed upon the potentiometer 5 by the line L_1, the grid potentials upon all of the tubes will be v and the resultant plate currents are as follows: that of tube 30 being e, of tube 3, f, and of tube 31, g. Due to the shunt 23, that portion of the current e flowing through the winding 22 will neutralize the effect of the current f flowing through the winding 25. The flow of current g through the winding 24 causes the armature of relay 21 to move to its right-hand contact, thus causing current to flow from the source 26 through the winding 11 and causing the arm 12 to vary the potential applied to the grids of the various tubes. This arm will continue to move until the potential is restored to its normal value y, whereupon current will cease to flow through the winding 24 and the currents in the windings 22 and 25 will effectively neutralize each other. The control device 6 will cease to operate and currents of normal value will flow over the line L_2 to the apparatus 2. If the signal falls below normal, the currents in the various plate circuits and in the polar relay windings are clearly shown in Fig. 2^a. There will be no current in winding 24 connected with the output side of the tube 31. The current in winding 22 in the output side of tube 30, which is represented by h, is greater than the current in winding 26 in the output side of tube 3, represented by j. The shunt 23 is adjusted to equalize the current in windings 22 and 25 for normal signals only. As thus adjusted, it will not equalize the currents for subnormal signals. The effective difference between h and j causes the armature 21 to move to its left-hand contact, thereby causing the gain control device 6 to move the contact of the potentiometer 5 in the direction to increase the signal voltage as applied to the grids of the tubes. The gain control device will continue to function until the potentiometer is moved to such point as to bring the signal strength to normal.

It will accordingly be seen that by means of the invention embodied in the arrangements shown in Figs. 1 and 2, the gain of the amplifier connected with the circuit over which high frequency telegraph signals are being transmitted may be varied in order to compensate for changes of the transmission equivalent of the circuit. While the invention has been disclosed as embodied in a wire carrier system, it is to be understood of course, that the line L_1 may be replaced by a radio link, that is to say, the sending device 1 may be connected with a transmitting antenna and the potentiometer 5 may be connected with a receiving antenna. Further variations may be made by those skilled in the art without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. In a carrier telegraph system, the combination with a source of alternating current voltage the amplitude of which may vary from normal of a plurality of thermionic rectifiers having similar grid voltage-plate current characteristics but each having a grid biasing voltage differing from the others, an electro-magnetic switching device having a winding individual to and connected with the output circuit of each rectifier, the said windings being so arranged that the device is unoperated for normal plate currents, and voltage controlling means connected with the input of said rectifiers and responsive to the operation of the said switching device whenever the alternating current voltage departs from normal, thereby tending to restore the input voltage of the said rectifiers to normal.

2. In a carrier telegraph system, the combination with a source of carrier oscillations of a medium over or through which the oscillations are transmitted, a receiving circuit connected with the said medium comprising a plurality of vacuum tubes having similar grid voltage-plate current characteristics, each tube being normally biased by a grid voltage differing from that of the other tubes, switching means connected with the output circuits of all of said tubes, the said means being unoperated when normal plate currents flow therethrough but adapted to operate upon abnormal plate currents, and voltage controlling means connected across the input of said tubes, the said voltage controlling means responding to the operation of the said switching means.

3. In a telegraph system in which a mark is transmitted by a train of waves of fixed normal amplitude and a space by the suppression of such waves, or vice versa, the combination with a plurality of vacuum tube rectifiers having approximately the same grid voltage-plate current characteristic, of a source of alternating current connected with the grid of each tube, a grid biasing source individual to and connected with the grid of each tube, the voltage of one of said sources being intermediate the voltages of the other sources, a polar relay having a plurality of windings individual to the said tubes and connected with the plate circuits thereof, the winding connected with the tube having the intermediate grid voltage being poled oppositely to the winding connected with the tube having the maximum negative biasing voltage, a non-polar relay connected with the plate circuit of the tube of intermediate grid voltage, a gain-control device connected with the armature and contacts of the polar relay, and a potentiometer variable with changes of the said gain control device to vary the potential of the alternating current applied to the said vacuum tubes.

4. In a telegraph system in which a mark is transmitted by a train of waves of fixed normal amplitude and a space by the suppression of said waves, or vice versa, the combination with a source of alternating current of a plurality of vacuum tube rectifiers having their input circuits connected in parallel with the said source, all of said tubes having substantially the same grid voltage-plate current characteristic, means to bias negatively the grid of each tube, the degree of bias of one of said tubes being intermediate that of the other tubes, an electro-responsive device having a plurality of windings each individual to a plate circuit of a vacuum tube, the winding connected with the tube of intermediate grid voltage being poled oppositely to the winding connected with the tube of lowest grid voltage, and means to equalize the currents flowing through the two last mentioned windings.

5. In a telegraph system in which a mark is transmitted by a train of waves of fixed normal amplitude and a space by the suppression of such waves, or vice versa, the combination with a plurality of vacuum tube rectifiers of a source of alternating current connected with the input circuits of the said tubes, all of said tubes having substantially the same grid voltage-plate current characteristic, means to bias negatively the grid of each tube, the degree of bias of one tube being intermediate that of the other tubes, the difference in voltage between the lowest biasing potential and the intermediate potential being approximately equal to the normal voltage of the alternating current source, an electro-responsive device having a winding individual to each plate circuit, the winding connected with the tube having the greatest biasing potential being poled oppositely to the winding connected with the tube of intermediate biasing and having means to equalize the currents in the said winding when the normal alternating voltage is applied to the grids of the tubes, and regulating means controlled by the said electro-responsive means to vary the input voltage of the tubes inversely with changes in the plate currents of the said tubes.

In testimony whereof, I have signed my name to this specification this 11th day of September, 1926.

RALPH W. DEARDORFF.