Dec. 29, 1936. C. A. BORGESON 2,065,640

CARRIER TELEGRAPH RECEIVER

Filed March 6, 1936

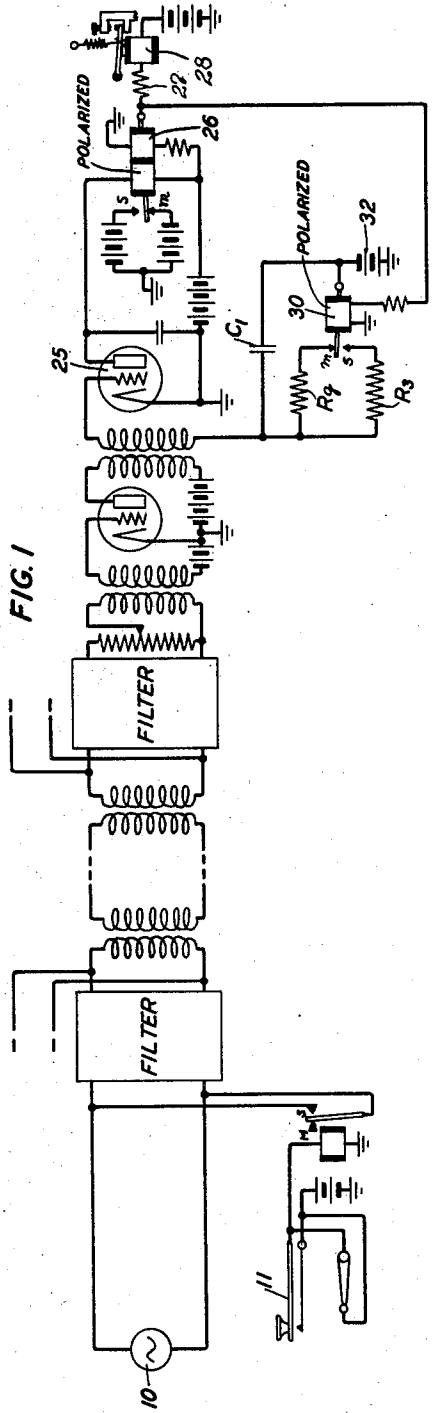


FIG. 1

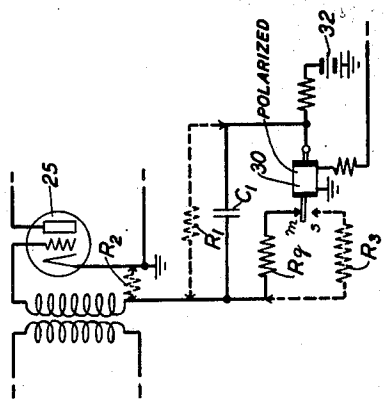


FIG. 2

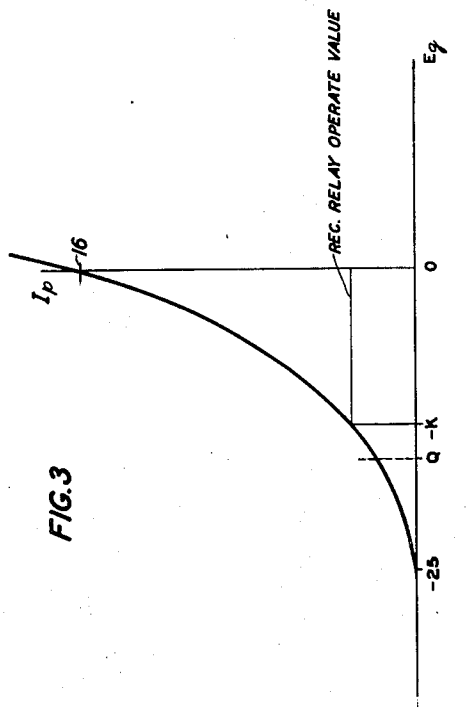


FIG. 3

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CARRIER TELEGRAPH RECEIVER

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6 Claims. (Cl. 178—88)

This invention relates to carrier telegraphy or the like and relates more particularly to apparatus used on a channel compensated against level changes. The invention involves means for preventing pulsing of a receiving relay and preventing lock-up arising during a spacing condition from various operating changes.

Transmission in telegraphy or in carrier telegraphy consists in the transmission of signal pulses which, as they leave the transmitter, are substantially square-topped. The sides of the waves after transmission over the line are sloped. Receiving apparatus is adjusted so that the time interval between transitions at the output of the receiving relay is substantially equal to the time interval between the same transitions in the original signal. The amplitudes of the signals as actually received do not remain equal. The signal amplitudes change from time to time giving rise to distortion known as telegraph bias. These changes in received signal amplitudes may arise from changes in battery voltages, changes in line equivalent and from numerous other sources.

The problem of avoiding telegraph bias has been attacked in a number of ways. So far the method disclosed in Herman patent 1,886,808 is one of the most satisfactory methods of compensation for telegraph bias and is in wide use. Compensation for bias at a receiver is provided according to the Herman patent, by the use of a compensator relay controled from the receiver relay and adapted to control the bias of a receiving detector to equalize the length of marking and spacing intervals at the receiving relay regardless of the changes in amplitude of received pulses.

The present invention is in the nature of an improvement upon the compensating circuit disclosed by Herman and is directed particularly to avoiding pulsing and lock-up of the receiving relay under extreme service conditions.

An object of the present invention is to secure an increased reliability and to improve the operation of a receiver in a carrier telegraph system or the like.

A further object of the invention is to provide means for avoiding pulsing in a carrier telegraph receiving system.

A still further object of the invention is to provide means for avoiding lock-up in a carrier telegraph receiving system.

A feature of the invention includes the provision of a resistance leak of high value connecting the spacing contact of a compensating relay to the grid side of the compensator condenser and arranged to shunt the compensator condenser which is employed for variably biasing the grid of a receiving detector to avoid telegraph bias.

In the drawing showing a preferred embodiment of this invention:

Figure 1 is a circuit diagram of a carrier telegraph channel;

Fig. 2 is a circuit schematic for consideration of the theory relative to the present invention; and

Fig. 3 is a characteristic curve of receiver operation in a carrier telegraph receiving system.

Fig. 1 shows a carrier telegraph receiving system illustrating in particular a single channel with connecting channels indicated. The system illustrated is substantially that of the Herman patent, noted above, except for a change in the compensating means.

Reference may be made to the Herman patent for a detailed discussion of the level compensator and its mode of operation. Only so much of the description will be given here as is helpful to an understanding of the present invention.

It will be understood that as the key 11 at the sending station is operated a succession of impulses of carrier waves from the source 10 is sent over the line through the channel indicated on the drawing and these impulses are impressed on the detector tube 25 at the receiving station, causing the polar relay 26 to operate, which in turn opens and closes the subscriber's loop 27 shown leading to sounder 28.

Compensator relay 30 operates in unison with the polar relay 26 and during each marking interval connects grid leak resistance R_g in shunt to the condenser C_1 which is connected in the grid circuit of the detector 25. Normally the received carrier pulses drive the grid of the detector 25 positive notwithstanding the 25-volt negative grid bias from the battery 32. During the positive pulses current is drawn through the resistance R_g throwing the grid bias more negative in proportion to the current flow through this resistance. During the spacing interval this increment of negative grid bias is held on the grid due to the charge in the condenser C_1. A received current stronger than normal increases still further the negative bias on the grid while a received current weaker than normal results in a smaller than normal negative grid bias, the overall result being an equalizing effect in grid bias to compensate changes in line equivalent.

In order to understand how the invention prevents the occurrence of pulsing, it is first necessary to understand how pulsing occurs in a system in accordance with the Herman disclosure. It is known to begin with, that if the sending key in the Herman system be left open for an abnormally long period, for example 15 seconds, the receiving relay 26 is liable to being pulsing substantially at the dot frequency.

In an endeavor to get at the cause of this pulsing phenomenon, applicant observed from actual measurements in a large number of cases that (referring to Fig. 2) the leakage resistance R_1 of the condenser C_1 is so high as to be practically infinite; and further that the insulation resistance to ground, R_2, of the plate of the condenser C_1 that is connected to the grid, while of high value (for example 84 megohms), is not nearly as high as the resistance R_1. It seems obvious that if both R_1 and R_2 were infinite, pulsing could not occur since the condenser C_1 would hold a charge indefinitely and there would be no more reason for pulsing to occur after a 15-second interval than immediately upon opening the line. It was found impractical, however, to raise the value of R_2 to a sufficiently high value to prevent pulsing from occurring after an abnormally long line interruption.

Applicant's analysis employing the circuit diagram of Fig. 2 shows the following action to account for the occurrence of pulsing. It was known from the tube and relay characteristics (Fig. 3) that if the grid could always be kept at minus 25 volts there would be insufficient space current in the detector tube 25 to operate the relay since the minimum current for operating the relay 26 corresponds to a grid voltage of minus K, considerably smaller in absolute magnitude than minus 25 volts. Pulsing could not occur merely from the condenser C_1 losing its charge for if this were the only change the grid potential would still be at minus 25 volts. What actually happens is that during a long spacing interval (R_3 of Fig. 2 being considered absent), a small leakage current flow takes place from battery 32 through the resistances R_1 and R_2 in series in a direction to neutralize any negative charge on the condenser C_1 and to build up a charge in the opposite direction. The resistances R_1 and R_2 act like a potentiometer and the potential which the grid finally reaches will depend upon the ratio of these two resistances. Since in the actual cases under observation R_1 was much larger than R_2 the grid was brought to a potential of only a few volts negative, sufficiently low negative to permit relay 26 to operate, this in turn operating relay 30 which by connecting R_g across condenser C_1 discharged the condenser and partially restored the bias on tube 25 toward its normal value of 25 volts negative. In this process the relay 26 would be released and the process would repeat itself, continuing the pulsing indefinitely.

Applicant discovered a simple and inexpensive cure of this pulsing evil in the form of a resistance R_3 which may be connected either between the plates of condenser C_1 or in the preferred form, as shown, may be connected from the grid side of condenser C_1 to the spacing contact of the compensating relay 30. The value of this resistance is preferably made slightly more than half that of the resistance R_2, or in the example under consideration, 47 megohms. With this resistance, when a long open line period occurs, a circuit exists from battery 32 to the spacing contact of relay 30, resistance R_3 and resistance R_2 in series permitting a leakage current to flow in a direction to neutralize the normal negative charge on condenser C_1 and to build up in this case a small positive charge of a value determined by the relative magnitudes of R_3 and R_2. Using resistances of the values indicated, i. e., R_2 equal to 84 megohms and R_3 equal to 47 megohms, the maximum change permitted in a positive direction of the voltage of the grid of detector tube 25 will be sufficient only to bring the grid voltage to a value of approximately 17 volts negative, regardless of the length of time the line interruption may continue. This approximate value is represented on the curve of Fig. 3 by Q and, as shown, is sufficiently removed in a negative direction from the relay operate value K to insure that the relay will remain unoperated.

Lock-up occurs when the incoming signals are too weak to overcome the negative bias of the detector grid to a sufficient extent to operate the relay 26. As noted above, strong incoming signals develop a relatively high negative bias for the grid of tube 25 by grid rectifying action and the resultant current flow through the resistance R_g. Although the voltage of the grid battery 32 may be only 25 volts, it is not unusual for the grid bias to amount to 125 volts negative, the extra 100 volts being caused by grid current flow. If there is now a sudden reduction in received level, for example, 6 decibels, and if a relatively high negative charge has been accumulated on the condenser C_1 and is allowed to remain there, it may happen that the incoming signals do not carry the grid swing sufficiently to the right in Fig. 3 to reach the value K required to operate the relay 26. Instances have been known where portions of a message sent over a line under these conditions have been lost because of failure of the receiving relay to operate. Such conditions arise, for example, from a sudden shift in line equivalent, or more often from the interchange of circuits on which widely differing levels have existed. Attendants have avoided this difficulty in the past by momentarily shorting the condenser C_1 in each of the receiving channels when lines are interchanged.

The provision of the resistance R_3, as explained above, has not only completely solved the pulsing difficulty as described, but also prevents the lock-up of the receiving relays by providing a discharge path for the condenser C_1. With a value for this resistance as indicated, the discharge time of the condenser C_1 is made sufficiently slow to permit effective operation of the level compensating action, and yet is sufficiently rapid to prevent lock-up either from sudden reduction in received signal level or from the interchange of circuits.

While, as noted above, the resistance R_3 could be directly connected across the plates of the condenser C_1, it is preferred to connect it to the spacing contact of the compensator relay so as not to discharge the condenser during the travel time of the compensator relay armature, but only during spacing intervals.

What is claimed is:

1. The combination with a signaling system in which the strength of the received signals is variable, of a three-element discharge tube receiver, a relay controlled thereby, a grid condenser, a resistance adapted to be connected in shunt to the condenser by said relay during reception of signal energy to build up a voltage on said condenser, and another resistance connected to a contact of said relay such that it is connected in

shunt of said condenser during intervals of no received signal energy.

2. The combination according to claim 1 in which the value of said other resistance is proportioned with respect to the insulation resistance to ground of the circuit on the side of said condenser toward the grid, to fix the eventual grid potential produced by leakage current flow after a long non-signaling interval at a negative value numerically greater than the value corresponding to the operate point of the relay.

3. The combination according to claim 1 in which the values of said condenser and first-mentioned resistance are high enough to give effective compensation for the variable strength of received signals and in which the value of the second resistance is made high enough not to interfere with such effective compensation but sufficiently low to provide with the condenser a time constant small in comparison with the times in which large changes in line attenuation occur, whereby lock-up of the circuit is prevented.

4. In a receiver in an electrical telegraph system, a vacuum tube having three elements, a compensating relay with marking and spacing contacts, a bias battery connected to the grid of the tube, a network in the biasing circuit of the tube, said network including a condenser connected to the relay armature and a resistance connecting the marking contact of the compensating relay to the grid and in shunt of the condenser, and means connecting the battery to the grid through the spacing contact of the compensating relay to cause the grid bias to remain sufficiently negative not to reach the receiver operating point during a spacing interval.

5. In a receiver station in an electrical telegraph system, a compensating relay with marking and spacing contacts, a vacuum tube having a grid element, a battery connected over the armature and marking contact of the compensating relay to the grid of the tube to vary the bias of the grid with variations in the level of the received signals, a network between the battery and the grid of the detector tube including a condenser and a potentiometer divider, the potentiometer divider including a resistance connecting the marking contact of the compensating relay to the grid in shunt of the condenser, and a resistance on the battery in series with the condenser and in series with said armature and a relatively high resistance connecting the spacing contact of the compensating relay to the grid to maintain the grid sufficiently negative to prevent the detector passing a pulse of current during a spacing interval.

6. In a receiver for a carrier telegraph system, a detector vacuum tube, a battery to render the grid of the tube negative, a compensating relay having marking and spacing contacts, a network in the grid circuit of the detector tube cooperating with the relay to avoid telegraph bias, said network including a condenser connected to the relay armature and to the grid of the tube, a resistance connected to the grid in shunt to the condenser over the marking contact of the relay to variably charge the condenser during a marking signal, and a high resistance connecting the spacing contact of the compensating relay to the grid lead wire and to the connecting plate of the condenser to maintain the grid bias sufficiently negative during an idle interval to prevent the detector passing a false pulse of current.

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