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SUPPRESSION OF INTERFERENCE IN CARRIER TELEGRAPH SYSTEMS

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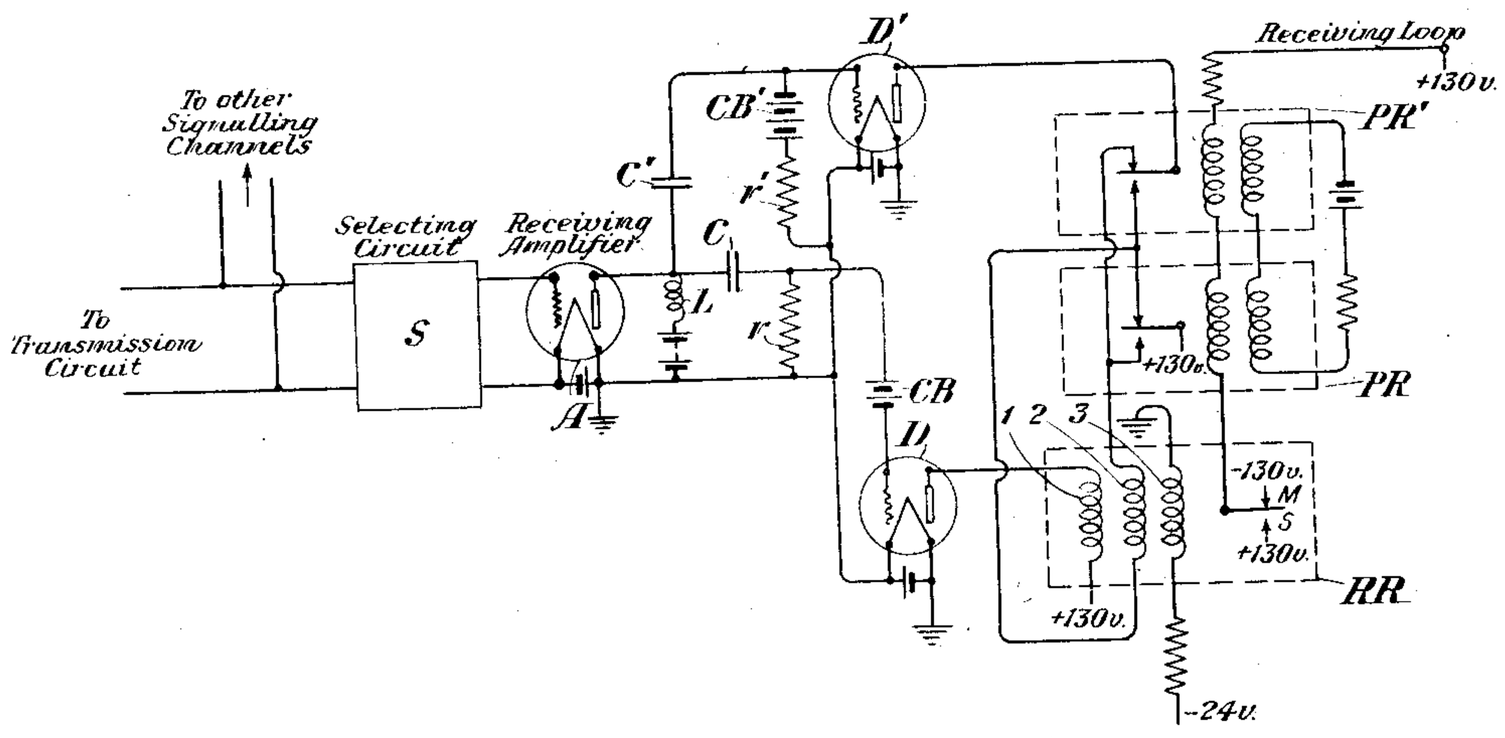

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SUPPRESSION OF INTERFERENCE IN CARRIER TELEGRAPH SYSTEMS

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This invention relates to wire or wireless carrier telegraph systems, and more particularly to arrangements for suppressing the effects of interference in such systems.

In order to overcome the effect of atmospheric disturbances, such as static discharges, upon carrier telegraph systems, it has been proposed to utilize a so-called "buck" circuit. This involves the provision of a channel, in addition to the regular signaling channel or channels, selective of a frequency in the neighborhood of the signaling frequencies. A rectifier for each signaling channel is associated with the auxiliary channel to produce, in response to the disturbance, an impulse which tends to hold the armature of the receiving relay against the contact upon which it happens to rest at the instant of the disturbance. This holding impulse is caused to flow through a winding of the receiving relay, and in order that it may always be in such a direction as to hold the relay armature on its contact, a reversing arrangement is provided for reversing the direction of flow of current through such winding as the signal changes from marking to spacing and vice versa.

The foregoing arrangement involves setting aside a frequency band for the buck circuit which cannot be used for signaling. Furthermore, in order that the arrangement may be effective, the disturbance must occur simultaneously in the band assigned to the buck channel and the band or bands used for the signaling channel or channels. In accordance with the present invention, it is proposed to overcome these limitations by using the same frequency band both for signals and for the neutralizing impulse. This is accomplished by associating with each receiving rectifier of the signaling channel an auxiliary rectifier for producing, in response to a disturbance, a momentary impulse which will flow through a winding of the receiving relay in such direction as to oppose the effect of the disturbing impulse in the relay during spacing and to assist the rectified current supplied by the receiving rectifier during marking. The proper poling of the neutralizing impulse may be accomplished as in the buck circuit by a suitable reversing arrangement. In order to prevent the auxiliary rectifier from responding to marking signals, its grid is biased sufficiently negative so that its space current is substantially zero when normal marking signals are being received.

With such an arrangement, no current will be supplied by the auxiliary rectifier during the reception of waves of normal carrier frequency amplitude corresponding to marking signals or during the zero current interval corresponding to spacing. Experience shows that the interfering disturbances are, for the most part, of much greater magnitude than the carrier current received during the marking interval. Consequently, when such a disturbance occurs it will cause current to flow in the auxiliary rectifier. This current is so poled by the reversing arrangement that it tends to hold the armature of the receiving relay upon either its marking or spacing contact, depending upon the character of the signal being received at the time of the disturbance.

The invention will now be more fully understood from the following description, when read in connection with the accompanying drawing, the figure of which illustrates a circuit arrangeemnt embodying the principles of the invention.

In the drawing, the apparatus of a single carrier channel only is shown, it being understood, however, that other similar channels may be provided in a multiplex system, either wire or wireless. The receiving channel comprises the usual selecting circuit S, which may be a tuned circuit or a band filter or other known device for selecting the band assigned to the particular channel. A receiving amplifier A is also provided for amplifying the received carrier waves, the plate circuit of this amplifier being supplied with current through the usual choke coil L. The regular rectifier or detector tube D is associated with the output circuit of the amplifier A, its grid being normally rendered sufficiently negative by means of the grid battery CB, so that when no signaling current is supplied to the grid the plate current of the detector will be zero. When, however, an alternating current is

superimposed upon the normal grid potential, a rectified plate current will flow which corresponds in magnitude to the amplitude of the received carrier wave. The potential of the grid battery CB is impressed between the grid and the filament through the usual resistance r, and a condenser C is provided to isolate the grid circuit of the detector D from the plate battery of the amplifier A.

The plate of the detector D is connected to an operating winding 1 of the receiving relay RR. The receiving relay also includes a biasing winding 3 through which a normal current flows of such magnitude as to produce a pull upon the armature of the relay, tending to hold it against its spacing contact, this pull being about one-half as strong as that due to the rectified current flowing through the winding 1 in response to a marking signal. Thus, during spacing signals when no current flows in the circuit of the rectifier D, the armature is held against the spacing contact, but when a train of carrier waves corresponding to a marking signal is received, the rectified current flowing through the winding 1 shifts the armature to the marking contact.

In order to overcome the effects of disturbing impulses, an auxiliary detector D′ is associated with the output of the amplifier A. The grid is biased by means of a C battery CB′ which is connected between the grid and the filament through a resistance r'. This resistance is provided in order to prevent the low impedance of the grid battery from acting as a shunt with respect to waves transmitted from the receiving amplifier A. Such waves will be transmitted to the grid of the detector D′ through a capacity C′ which also serves to isolate the grid of the detector D′ from the potential of the plate battery of the amplifier A.

The grid battery CB′ is so arranged as to render the grid of the rectifier D′ more negative than the grid of the rectifier CB, so that no plate current will flow in the detector D′ until an applied wave is superimposed upon its grid with a magnitude greater than the normal carrier waves received during the marking impulse. Consequently, the detector D′ produces no effect during the receipt of normal marking and spacing signals. As already stated, however, the disturbing waves are usually of greater amplitude than the normal signaling currents, and consequently, whenever such a disturbing wave is received, a current will flow in the plate circuit of the rectifier D′, as will be described in more detail later. This plate current flows through an auxiliary winding of the receiving relay RR in a direction determined by the contacts of two polar reversing relays PR and PR′. These reversing relays are connected in the loop circuit which is controlled by the receiving relay RR, and their armatures will be shifted to reverse their connections to the auxiliary winding 2 in accordance with marking and spacing signals.

The operation is as follows: Assuming that a spacing signal is being received, no carrier current will be transmitted from the selecting circuit to the receiving amplifier and consequently, no plate current flows in the detector D or the detector D′. The winding 3 of the receiving relay RR is therefore effective to pull its armature to its spacing contact so that when a space signal is sent through the loop these space signals cause the armatures of relays PR and PR′ to rest upon their lower contacts. If, with the circuit in this condition, an interfering disturbance should occur, such interfering wave, upon being impressed upon the grid of the detector D, will cause a plate current to flow through the winding 1 of the receiving relay. Since the disturbing wave will usually be of much greater amplitude than a normal marking current, this impulse through the winding 1 will be sufficient, under normal conditions, to shift the armature of the receiving relay to its marking contact. This action is prevented, however, by the fact that the disturbing wave is also applied to the grid of the detector D′, and being of large amplitude it overcomes the normal negative potential of the grid D′ sufficiently to cause a plate current to flow over the lower contact of the reversing relay PR′ through the winding 2 and thence over the lower contact of the reversing relay PR.

This current through the winding 2 is in such a direction as to oppose the current through the winding 1. It will also be sufficient to prevent the current through the winding 1 from shifting the armature, because the disturbing impulse will usually be of sufficient amplitude to overload the tube D and hence, the plate current of the tube D will not exceed its saturation value. Although a greater potential must be applied to the grid of the tube D′ in order to overcome its normal bias, than need be applied to the grid of the tube D, the actual potential applied is so great in both cases that the plate current of the tube D′ will also be a saturation current and hence, as great as the plate current of the tube D. The effect of the disturbing impulse is therefore neutralized during the spacing condition.

When a marking signal is being received, carrier waves are impressed upon the grids of the rectifiers D and D′. As already stated, the grid of the detector D′ is biased sufficiently negative so that under these conditions no space current flows in the plate of the detector D′. In the case of the detector D, however, which is biased negative to a lesser degree, a rectified plate current flows through the winding 1 of the receiving relay RR and shifts the armature of the receiving relay to its marking

contact. The polar relays PR and PR′ in the loop circuit thereupon shift their armatures to their upper contacts so that the plate of the detector D′ is connected to the winding 2 of the receiving relay in such a manner as to cause current from the plate (when flowing) to flow through the winding 2 in the opposite direction to that described in connection with the spacing impulse.

The effect of a disturbing impulse during marking is not always the same. In some instances the disturbing impulse appears to have the effect of increasing the plate current in the rectifier D. This, of course, has no effect of producing a false signal, and if a current is also caused to flow in the plate circuit of the rectifier D′ in response to such a disturbance, such plate current will assist the plate current from the rectifier D to hold the armature against the marking contact until the disturbance ceases. The difficulty arises in connection with disturbances of such a type that they cause a decrease in the plate current of the detector D, thereby having the effect of producing a false spacing signal. While the cause of this decrease in the plate current is not fully understood, it is apparently due to the action of the resistance r and the capacity C as a grid leak arrangement. The disturbing impulse may take the form of a high frequency wave within the band of the selecting circuit S, the wave being of such great amplitude as to overcome the normal negative bias of the grid of the detector and drive the grid positive so that electrons pass from the filament to the grid. Due to the negative electrons passing to the grid with each positive half-wave of the disturbing current, a negative charge is trapped upon the grid which quickly builds up, and by rendering the grid more negative tends to reduce the plate current.

Now, if the amplitude of the disturbing wave is not too great, so that the grid of the rectifier D′ (with its larger normal negative bias) is not actually driven positive during the positive half-wave, a rectified current will flow in the plate circuit of the rectifier D′ in response to the disturbing impulse. This plate current may have a value equal to that of the saturation condition of the tube, or the plate current may be smaller, depending upon the amplitude of the applied wave. In any event, the rectified current flows through the winding 2 in such a direction as to assist the plate current of the rectifier D (if any) and hence, tends to prevent the false spacing signal due to the reduction of the plate current in the rectifier D.

If the disturbing wave is of such amplitude as to actually drive the grid of the tube D′ positive so that the grid draws current from the filament, thereby trapping a negative charge upon the grid due to the action of the condenser C′ and the resistance r′ acting as a grid leak, the plate current of the rectifier D′ may be less than its maximum or saturation value. Such plate current, however, will be in such a direction as to tend to hold the armature upon its marking contact and thereby prevent the false signal even though the plate current in the rectifier D should be driven to zero.

While it would be possible for the disturbing wave to be of such great amplitude as to trap sufficient negative charge on the grids of both rectifiers so that the plate currents of both tubes would be reduced to zero, disturbances of such amplitude rarely occur, and hence, false signals produced thereby would be so few in number that they could be ignored.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a carrier telegraph system, a receiving channel including a receiving relay, means responsive to an interfering wave in said channel to produce a current impulse, and means controlled by the receiving relay to apply said current impulse to said relay so as to tend to hold its armature against the contact upon which it rests at the time the interfering wave occurs.

2. In a carrier telegraph system, a receiving channel including a receiving relay, means associated with said channel but responsive to waves of normal signaling amplitude received in said channel, said means being responsive to interfering waves in said channel of greater amplitude than normal signal waves to produce a current impulse, and means to apply said current impulse to said relay so as to tend to hold its armature against the contact upon which it rests at the time the interfering wave occurs.

3. In a carrier telegraph system, a receiving channel including a receiving relay, said relay having an operating winding and an auxiliary winding, and means normally tending to bias the armature of said relay against one of its contacts, means in said channel to supply an operating current to said operating winding in response to received carrier waves of normal amplitude, said means supplying substantially no current in the absence of received waves, auxiliary means associated with said channel and responsive to signaling waves of normal amplitude, said means being responsive to interfering waves in said channel of greater amplitude than normal signaling waves to produce a pulse of current, means to cause said current pulse to flow through said auxiliary winding in such direction as to assist said operating winding when signaling carrier waves are being received and to reverse the direction of said

pulse through said auxiliary winding when signaling carrier waves are not being received.

4. In a carrier telegraph system, a receiving channel including a receiving detector and a receiving relay, an auxiliary detector associated with said channel, said auxiliary detector being so biased as to be unresponsive to signal waves of normal amplitude received in said channel, but responsive to interfering waves of greater amplitude than normal signal waves to produce a current pulse, and means to apply said current impulse to said relay so as to tend to hold its armature against the contact upon which it rests at the time the interfering wave occurs.

5. In a carrier telegraph system, a receiving channel including a receiving detector and a receiving relay, an auxiliary detector comprising a vacuum tube having grid, filament and plate electrodes associated with said channel, said grid being so biased that no plate current will flow in response to normal signal waves but plate current will flow in response to interfering waves of greater amplitude than normal signal waves, and means to apply said plate current to said relay so as to tend to hold its armature against the contact upon which it rests at the time the interfering wave occurs.

6. In a carrier telegraph system, a receiving channel including a receiving relay, said relay having an operating winding, an auxiliary winding, and means normally tending to bias the armature of said relay against one of its contacts, a receiving vacuum tube detector in said channel having its plate connected to supply operating current to said operating winding and its grid so biased that substantially no operating current will be supplied in the absence of received carrier waves, an auxiliary vacuum tube detector associated with said channel and having its grid so biased that no plate current will flow in response to normal carrier signaling waves but plate current will flow in response to interfering waves of greater amplitude than normal carrier signal waves, and means to cause the plate current from said auxiliary detector to flow through said auxiliary winding in such direction as to assist said operating winding when carrier signal waves are being received and to reverse the direction of current flow through said auxiliary winding when carrier signal waves are not being received.

In testimony whereof, I have signed my name to this specification this 14th day of November, 1928.

ROBERT H. CLAPP.