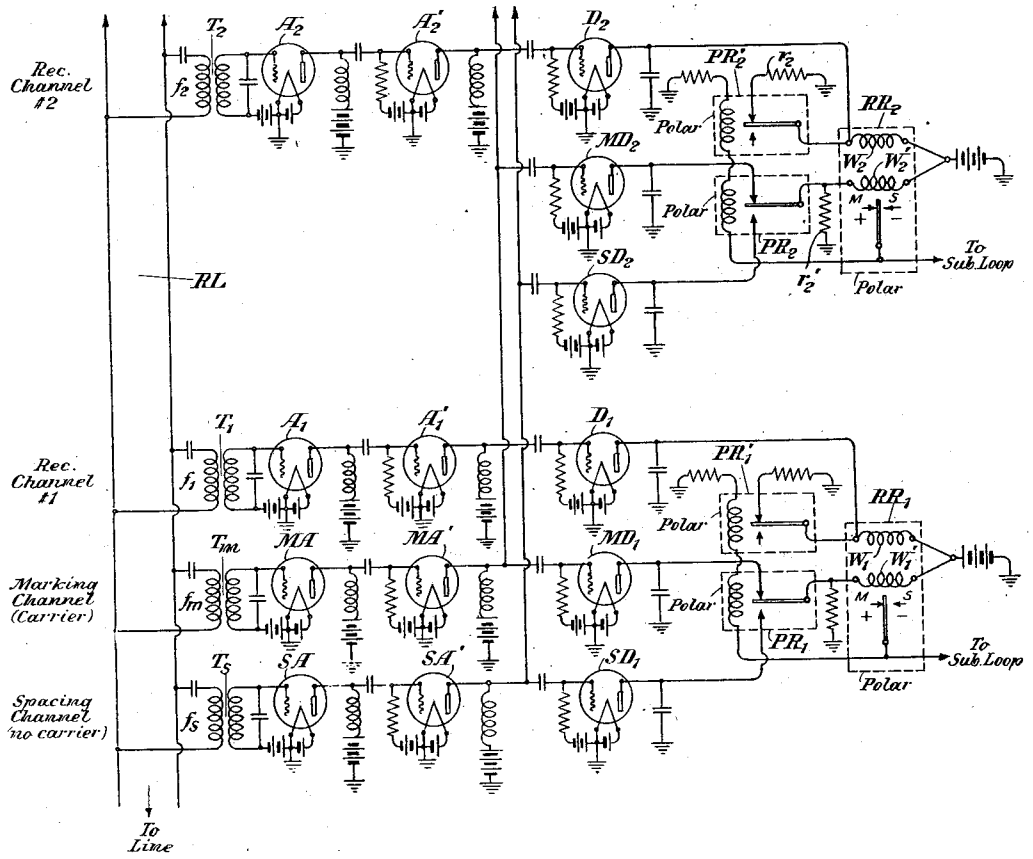
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REDUCTION OF STATIC INTERFERENCE IN CARRIER SYSTEMS

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REDUCTION OF STATIC INTERFERENCE IN CARRIER SYSTEMS

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This invention relates to wire and wireless carrier telegraph systems, and more particularly to arrangements for reducing the effect of lighting and other static interference upon such systems.

In carrier telegraph systems, lightning interference may manifest itself either (1) as an undesired pulse during the spacing or no-current interval, in which case the interference appears as a false marking signal, or (2) as an instantaneous overloading of repeaters or receiving vacuum tube apparatus by the relatively large energy of the interfering pulse, in which case the "crowding" of the vacum tubes by the superposition of the interfering pulse upon the normal carrier current of the channel reduces the current which operates the receiving relay so that a false spacing signal may appear during a marking impulse.

In order to overcome this difficulty it has been proposed to provide in addition to the regular receiving channels of the carrier system, an auxiliary "bucking" channel in which no signals are ordinarily received, due to the fact that no carrier is transmitted corresponding to this channel. When a lightning discharge occurs the auxiliary channel picks up one of the component frequencies of the lightning discharge, which is rectified to produce a pulse corresponding to the disturbing signal pulse occurring in the normal channels of the system. This pulse is transmitted through auxiliary windings to each of the receiving relays in such a direction as to tend to hold the armature of the receiving relay upon either its marking or spacing contact, depending upon which contact it rested against at the time the disturbing impulse occurred.

As the direction of the effect of the correcting impulse is determined merely by the character of the received signal (marking or spacing) at the time the static disturbance occurs, and is independent of whether the static impulse tends to hold the armature against its contact or to shift it. it is evident that if the static impulse occurs just at the time the signal is changing from marking to spacing or vice versa, the impulse from the auxiliary channel may tend to prolong the marking or spacing signal by holding the armature of the receiving relay against the contact upon which it then rests. In accordance with the present invention it is proposed to utilize auxiliary channels in such a manner as to produce effects upon any given receiving relay which are opposite in direction to those produced by the static disturbance.

In order to accomplish this result, two auxiliary channels are provided, one of which is a marking channel to which a carrier current is continuously transmitted from the transmitting station, and the other of which is a spacing channel to which no carrier is supplied. The effect of a static impulse upon the marking channel will be similar to that upon each receiving channel during the receipt of marking signals. Similarly, the effect of the static impulse upon the spacing channel will be similar to that produced upon each receiving channel during the receipt of spacing signals. By means of a reversing relay the marking channel may be connected to a suitable winding of any given receiving relay when it is receiving a marking signal and thereby produce in the relay an effect which balances out the effect of a static impulse. When the relay is receiving a spacing signal, however, the reversing relay will shift the connection to the spacing channel, thereby producing an effect in the relay opposing that of the static disturbance. In this latter, the effect of static disturbance is neutralized or balanced out in the relay in such a manner as to enable the relay to respond to a change from marking to spacing or vice versa without any prolongation of the existing signal due to the effect of the auxiliary channel.

The invention will now be more fully understood from the following description, when read in connection with the accompanying drawing, the figure of which is a circuit diagram illustrating a preferred embodiment of the invention.

Referring to the figure, the various currents of the multiplex carrier system are received in a circuit RL which may be con-

nected to either a wire line or a radio antenna. To the circuit RL any desired number of signal receiving channels may be connected, although in the ordinary wire carrier telegraph practice ten such channels are usually provided. The apparatus for each channel is similar to that of all the other channels except that the selecting apparatus of each channel is adjusted to select the particular frequency assigned to the particular channel.

In the present instance only two signal receiving channels are actually shown in the drawing, and of these a description of one, for example, channel No. 2, will suffice. This comprises a tuned selecting circuit T_2 associated with the circuit RL for selecting the carrier frequency f_2 assigned to the channel. Vacuum tube amplifiers A_2 and A_2' are provided for amplifying the carrier frequencies. A rectifying vacuum tube D_2 is also provided for translating the carrier frequency into direct current signal impulses. The grid of the vacuum tube D_2 is so biased by means of a C battery that with no carrier current present, no current will flow in the plate circuit. When carrier current is applied to the grid, however, the rectified one-way current flows in the plate circuit of the rectifier tube D_2. The operating winding W_2 of the receiving relay RR_2 is included in the plate circuit of the rectifier. A biasing winding W_2' is also provided, and by means of a suitable resistance r_2' the current flowing through the biasing winding is made equal to about one-half the current supplied from the plate of the detector D_2 when the carrier is being received.

In the system as illustrated it is assumed that carrier current is transmitted during the marking interval and that no carrier current is transmitted during the spacing interval. Normally when no signaling is taking place the carrier current is continuously on the circuit so that a steady direct current flows through the winding W_2 to hold the armature of the receiving relay RR_2 upon its marking contact in spite of the normal biasing current through the winding W_2'. Each time a spacing signal is transmitted by interrupting the carrier current the rectified current through the winding W_2 ceases and the armature is shifted to its spacing contact by the pull due to the biasing winding W_2'.

The effect of a lightning or other static interference upon the system so far described is as follows: If at the time the lightning discharge occurs a spacing signal is being transmitted so that normally no carrier would be present, the selecting device T_2 of the channel will pick up one of the component frequencies of the lighting discharge which corresponds to the frequency of the channel so that this frequency will be amplified and impressed upon the rectifier D_2 to produce a short pulse of direct current, tending to shift the armature of the receiving relay RR_2 from its spacing contact to its marking contact, thereby causing a false signal. If the lightning discharge should occur during the transmission of a marking signal, the effect will depend upon the magnitude of the energy of the static discharge at the frequency corresponding to the channel. If this energy is not so large as to overload the tubes of the system it merely tends to produce a larger rectified current in the plate circuit of the rectifier D_2 so that the effect upon the winding W_2 is to increase the pull tending to hold the armature upon its marking contact. If, however, the energy of the static discharge is very large, so as to overload the various tubes of the system, thereby producing "crowding" of the normal carrier currents of the channels, the carrier current for each channel is reduced in amplitude to make room, as it were, for the excess energy of the lightning discharge. This reduction in the carrier frequency of the particular channel now under consideration may result in a decreased current in the plate circuit of the rectifier D_2 so that the winding W_2 is no longer able to hold the armature against the pull of the biasing winding. This causes a false spacing signal.

In order to correct for these false signals, two additional channels are associated with the circuit RL, one of the channels being a so-called marking channel to which a carrier current is continuously transmitted from the transmitting station and the other of which is a so-called spacing channel and to which no carrier current is transmitted from the distant transmitting station. The marking channel consists of a selecting circuit T_m for selecting the frequency f_m assigned to this channel. The channel also includes amplifiers MA and MA', similar to the amplifiers already described in connection with channel No. 2. The marking channel also includes a detector for each receiving channel of the system. For example, the detector MD_1 is associated with the marking channel for receiving channel No. 1 and the detector MD_2 is likewise associated with the marking channel for receiving channel No. 2. These detectors are in all respects similar to the detector D_2 already described and supply to their plate circuits continuous direct currents determined by the amplitude of the received carrier.

The spacing channel differs from the marking channel in that no carrier current is transmitted thereto from the distant transmitting station and its selecting circuit T_s is tuned to a frequency f_s which is different from the frequency of the marking channel and also from the various carrier frequencies assigned to the signal receiving channels. The spacing channel includes amplifiers SA and SA' in all respects similar to the correspond-

ing amplifiers of the marking channel. Likewise, as in the case of the marking channel, detectors, such as SD_1 and SD_2 are provided for each of the signal receiving channels. No current flows in the plate circuits of the detectors associated with the spacing channel under normal conditions. If, however, a static impulse occurs, the channel selects a frequency component thereof corresponding to the frequency of the channel and thereby causes a rectified current pulse to flow in each of the detectors associated with the spacing channel.

Each receiving relay controls polar switching relays. For example, the receiving relay RR_2 controls polar relays PR_2 and PR_2' for the purpose of reversing the circuit connections to the auxiliary channel, in a manner to be described later. Likewise, the receiving relay RR_2 controls polar relays PR_1 and PR_1' in a similar manner.

The operation of the marking and spacing channels may now be understood from a description of their effect upon the receiving channel No. 2. Normally, with the marking signal being received by channel No. 2, the armature of the receiving relay RR_2 will be upon its marking contact and the polar relay PR_2 will have its armature upon its upper contact, so that the plate circuit of the detector MD_2 (which is associated with the marking channel) will be connected to the biasing winding W_2'. This increases the normal biasing current due to the resistance r_2' by an amount determined by the amplitude of the received carrier of the marking channel. In order, therefore, to maintain the normal relation between the currents flowing in the operating and biasing windings, the polar relay PR_2' is arranged to connect to the operating winding a resistance r_2 in parallel with the plate circuit of the detector D_2, the resistance r_2 being so proportioned as to draw through the winding W_2 a current in addition to the plate current of the detector D_2, said additional current having a value equal to the plate current normally supplied to the winding W_2', from the detector MD_2. When a spacing signal is received due to the interruption of the carrier frequency f_2 supplied to channel No. 2, the receiving relay RR_2 shifts the armature to its spacing contact, thereby causing the polar relays PR_2 and PR_2' to shift their armatures to their lower contacts. The polar relay PR_2 disconnects the biasing winding W_2' from the detector MD_2 of the marking channel and connects said winding to the detector SD_2 of the spacing channel. As no current normally flows in the plate circuit of the detector SD_2, the armature of the polar relay PR_2' is arranged to disconnect the resistance r_2 from the operating winding W_2 during the spacing condition so that in the absence of any static disturbance no current flows through the operating winding W^2.

As has already been pointed out, the effect of static upon the signal of any given channel depends upon whether the channel is at that moment receiving a marking or a spacing signal. If a marking signal is being received in channel No. 2, for example, the polar relays PR_2 and PR_2' will have their contacts upon their upper armatures so that the marking channel will be connected to the biasing winding W_2'. Under these conditions the current drawn through the biasing winding W_2' by the plate of the detector MD_2 of the marking channel is just balanced by the current drawn through the operating winding W_2 by the resistance r_2. The current drawn through the latter winding by the plate circuit of the detector D_2, however, is substantially twice that drawn through the winding W_2' by the resistance r_2'.

Now if the effect of the static impulse is such as to overload the tubes in the transmission circuit and cause crowding of the channels, the plate current of the detector D_2 will be decreased, and if it should be decreased to such an extent that the total current through the winding W_2 is less than that through the winding W_2', the armature of the receiving relay would be shifted to its spacing condition, thereby causing a false signal. Inasmuch as the marking channel is receiving a carrier current, however, this carrier current will be decreased in volume just as is the carrier current supplied to channel No. 2 during the marking signal. Consequently, the plate current of the detector MD_2 (and other detectors associated with the marking channel) will be decreased accordingly so that there will be a decrease in the current flowing through the winding W_2' which is comparable to the decrease in the current flowing through the winding W_2. If the marking signal should end while the static disturbance is continuing, the interruption of the carrier frequency transmitted to the receiving channel No. 2 will reduce the current through the winding W_2 and permit the biasing winding to shift the relay armature to its spacing contact notwithstanding the static impulse.

In case the condition of the transmission circuit is such that the static impulse does not overload the tubes, the effect upon an individual channel, such as channel No. 2, will be to increase the plate current of the detector tube D_2 and thereby increase the current flowing through the winding W_2. The effect upon the marking channel, however, is to similarly increase the plate current of the detector tube, such as MD_2, so that there will be a corresponding increase in the current flowing through the winding W_2'. Should the signaling channel No. 2 change from marking to spacing while the static impulse continues, the interruption of the carrier sup-

plied from the distant station will reduce the current flowing through the winding W_2 to permit the relay to shift its armature to its spacing contact. The shifting of the armature from marking to spacing during the continuance of a static impulse, results in shifting the armatures of the polar relays PR_2 and PR_2', thus establishing the circuit in condition to neutralize the effect of static during a spacing signal.

When any channel, such as channel No. 2, is receiving a spacing signal, the armature of the polar relay PR_2 shifts the connection of the biasing winding from the marking channel to the spacing channel while the polar relay PR_2' disconnects the resistance r_2 from the operating winding W_2. In the absence of any static effect, no current will flow through the winding W_2 (the plate current of the tube D_2 being substantially zero during spacing), and the current flowing through the biasing winding W_2' will be only that drawn by the resistance r_2'. If a static impulse should occur while the circuit is in spacing condition, the selective circuit T_2 of channel No. 2 would pick up a component whose frequency corresponds to that of the channel, so that a current would flow in the plate of the detector D_2 and hence, in the winding W_2. If this current should be larger than the current drawn by the resistance r_2', a false marking signal would occur were it not for the connection over the armature of the polar relay PR_2 to the plate circuit of the detector SD_2 of the spacing channel. Due to this connection, however, the static component picked up by the spacing channel causes a current to flow in the plate of the detector SD_2 and through the biasing winding W_2' to balance the static current flowing through the operating winding W_2. Consequently, the false signal will not occur. If the static impulse should continue after the spacing signal received by the channel had ceased and the marking signal begun, the current flow through the operating winding W_2 would be increased by an amount determined by the amplitude of the received carrier, thereby causing the armature of the receiving relay to be shifted to its marking contact.

It will of course be obvious that other signaling channels, such as channel No. 1, will function in a manner similar to that already described in connection with channel No. 2.

It will also 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 system, a receiving channel comprising means to select an alternating carrier current, means to detect from said carrier current a telegraph signal, and a receiving relay responsive to said signal; auxiliary channel apparatus selective of components of interfering energy differing in frequency from the carrier waves to which the receiving channel is selective; and connections from said auxiliary channel apparatus to said receiving relay and controlled by said receiving relay to produce in said relay, in response to interference, electrical effects similar to but opposing those produced on said relay by the interference effect in said receiving channel.

2. In a carrier system, a receiving channel comprising means to select an alternating carrier current, means to detect from said carrier current telegraph signal impulses, and a receiving relay responsive to said impulses; said channel producing in said relay disturbing impulses in response to interfering energy superposed on the system; auxiliary channel apparatus selective of components of said interfering energy differing in frequency from the carrier waves to which said receiving channel is selective; and connections from said auxiliary channel apparatus to said receiving relay and controlled by said receiving relay to produce in said relay, in response to interference, impulses to neutralize the disturbing impulses from said receiving channel; said neutralizing impulses permitting said relay to respond to changes of the detected signal impulses.

3. In a carrier system, a receiving channel comprising means to select an alternating carrier current, means to detect therefrom signaling impulses, and a receiving relay having an operating winding responsive to said impulses to shift the armature in one direction and a biasing winding to shift the armature in the opposite direction; an auxiliary channel comprising means selective of interfering components differing in frequency from the receiving channel; a detecting means associated with said auxiliary channel; means to establish connections from said detecting means to one of said relay windings during the receipt of marking signals; and means to open said connections during the receipt of spacing signals.

4. In a carrier system, a receiving channel comprising means to select an alternating carrier current, means to detect therefrom signaling impulses, and a receiving relay having an operating winding responsive to said impulses to shift the armature in one direction and a biasing winding to shift the armature in the opposite direction; an auxiliary channel comprising means selective of interfering components differing in frequency from the receivnig channel; a detecting means associated with said auxiliary channel; means to establish connections from said detecting means to said biasing winding during the receipt of spacing signals; and

means to open said connections during the receipt of marking signals.

5. In a carrier system, a transmission circuit, a receiving channel associated therewith and comprising means to select an alternating carrier current from said transmission circuit, means to detect signaling impulses from said carrier current, and a receiving relay; an auxiliary marking channel to which a carrier frequency different from that of said receiving channel is continuously supplied over said transmission circuit; an auxiliary spacing channel for which no carrier is supplied; said spacing channel being selective of interfering components of frequency different from those of the other channels; and means to establish connections to said receiving relay from said marking channel during the receipt of marking signals in said receiving channel, and from said spacing channel during the receipt of spacing signals in said receiving channel.

6. In a carrier system, a transmission circuit; a receiving channel associated therewith and comprising means to select an alternating carrier current from said transmission circuit; means to detect signaling impulses from said carrier current, and a receiving relay having an operating winding responsive to said impulses to shift the armature in one direction and a biasing winding to shift the armature in the opposite direction; an auxiliary marking channel to which a carrier frequency different from that of the receiving channel is continuously transmitted over said transmission circuit; said marking channel including means to select said frequency; a detector associated with said marking channel; an auxiliary spacing channel for which no carrier is supplied and having selecting means to select interference components differing in frequency from the carrier frequency of said receiving channel; a detector associated with said spacing channel; and means to establish connections to one of said relay windings from the detector associated with one auxiliary channel during the receipt of marking signals, and from the detector associated with the other auxiliary channel during the receipt of spacing signals.

7. In a carrier system, a transmission circuit; a receiving channel associated therewith and comprising means to select an alternating carrier current from said transmission circuit, means to detect signaling impulses from said carrier current, and a receiving relay having an operating winding responsive to said impulses to shift the armature in one direction and a biasing winding to shift the armature in the opposite direction; an auxiliary marking channel to which a carrier frequency different from that of the receiving channel is continuously transmitted over said transmission circuit; said marking channel including means to select said frequency; a detector associated with said marking channel; an auxiliary spacing channel for which no carrier is supplied and having selecting means to select interference components differing in frequency from the carrier frequency of said receiving channel; a detector associated with said spacing channel; and means to establish connections to said biasing winding from the detector associated with said marking channel during the receipt of marking signals, and from the detector associated with said spacing channel during the receipt of spacing signals.

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

DAVID E. BRANSON.