

March 29, 1949.

W. T. REA

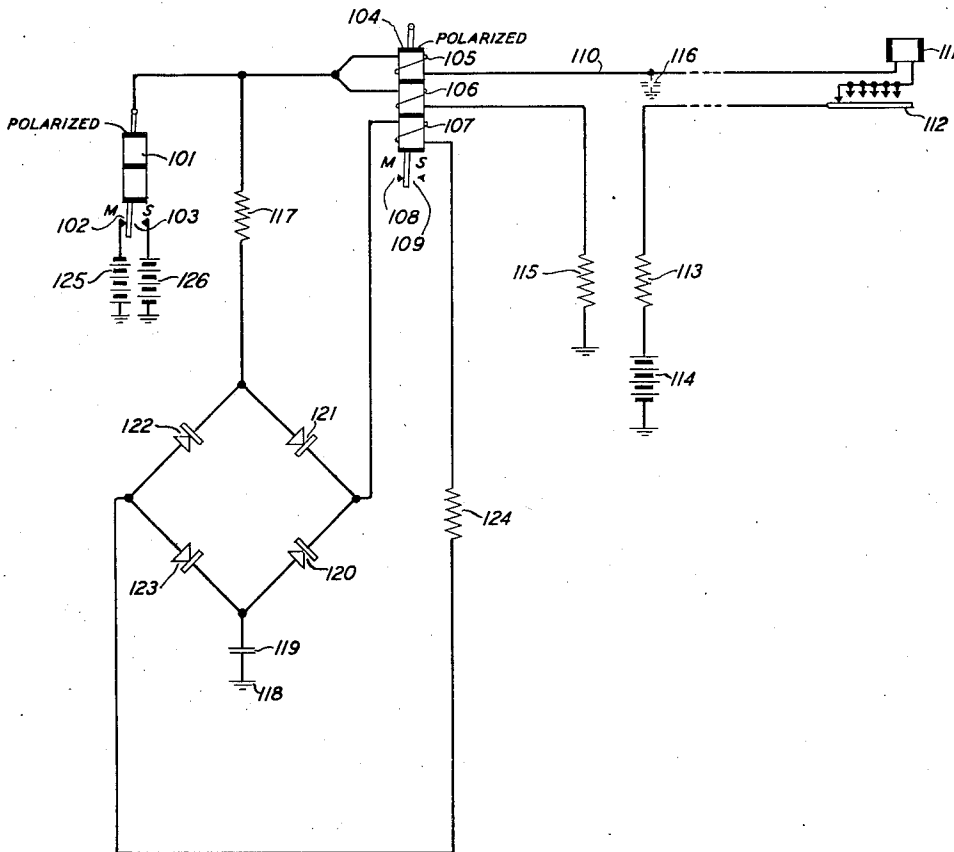
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ANTIKICKOFF CIRCUIT FOR TELEGRAPH REPEATERS

Filed May 26, 1945

2 Sheets-Sheet 1

FIG. 1



INVENTOR
W. T. REA
BY John E. Cassidy
ATTORNEY

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W. T. REA

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2 Sheets-Sheet 2

FIG. 2

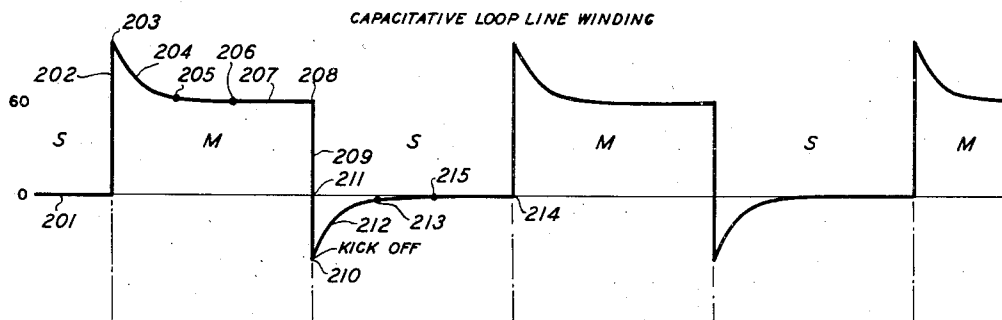


FIG. 3

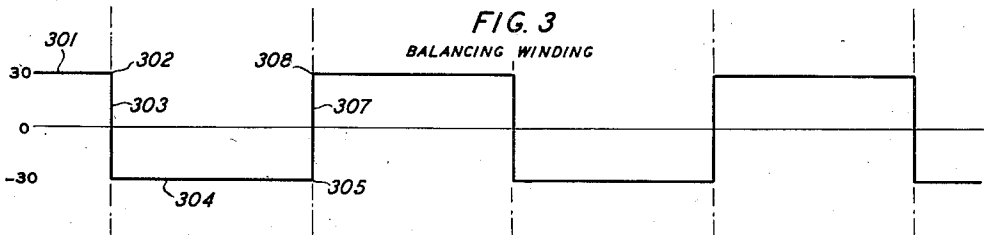


FIG. 4

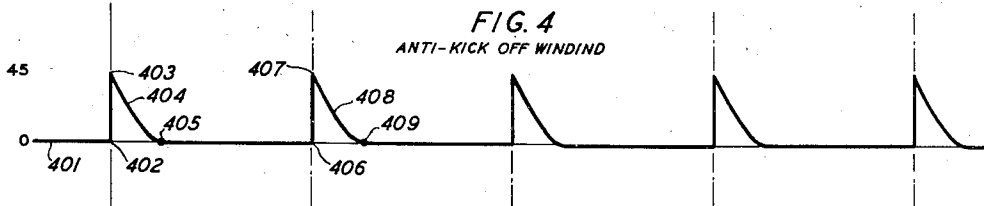
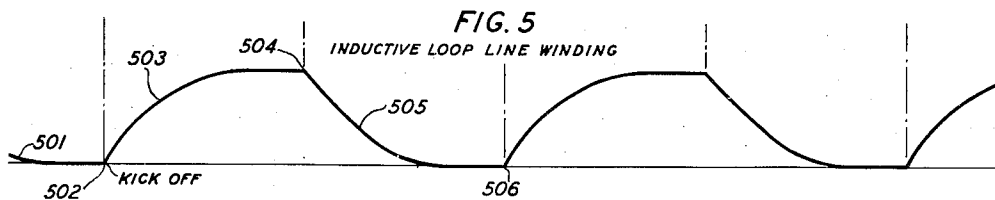


FIG. 5



INVENTOR
W. T. REA
BY John E. Cassidy
ATTORNEY

UNITED STATES PATENT OFFICE

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ANTI-KICKOFF CIRCUIT FOR TELEGRAPH
REPEATERS

Wilton T. Rea, Manhasset, N. Y., assignor to Bell
Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

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This invention relates to telegraph circuits and particularly to what is known in the art as anti-kickoff arrangement in telegraph circuits. By kickoff is meant the tendency of a magnetic device, such as a receiving relay, to respond to a capacitative or inductive discharge of a telegraph line, by disengaging its armature from a contact with which the armature should remain in engagement, for instance during the interval while a transmitting relay is transmitting pulses to a distant station. In certain arrangements it is essential that the armature of the receiving relay, at the station where the transmitting relay is located, remain constantly in engagement with its marking contact throughout the transmission to the distant station. During the transmission, the line to the distant station becomes charged. In cases where the capacitance or inductance of lines is large and the effect of the discharge back through the line winding of the receiving relay at the station which is transmitting correspondingly large, it is necessary to provide arrangements which prevent the response of the armature of the receiving relay to the effect of the discharge of the line. The arrangements which provide protection against such responses are known as anti-kickoff devices.

Depending upon the characteristics of the line extending to the distant station and the facilities connected to the line, kickoff may be caused by capacitance discharge or inductive discharge. As will become apparent below, the effects of line discharge due to capacitance and line discharge due to inductance are applied at different times in the operating cycle of the transmitting relay. There are a number of arrangements that are well known in the art designed to protect against kickoff due to capacitance discharge. So far as is known, however, no arrangement has heretofore been proposed which is effective to prevent kickoff due to both capacitance and inductive effect.

It is an object of the present invention to improve the operation of telegraph circuits. It is a more particular object of the invention to prevent kickoff due to the effect of either capacitance or inductance.

As mentioned above and as will be made apparent hereinafter, the effect of capacitance and inductive discharge manifest themselves at different times in the operating cycle of the telegraph transmitting relay. In order to be effective an anti-kickoff arrangement which neutralizes each of these effects must compensate for them at different intervals in the cycle. The

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circuit of the present invention is designed to provide a pulse of current through the receiving relay in a proper direction and at the proper time to neutralize the line discharge due to either capacitance or inductance. As a result of this, a repeater circuit equipped with the anti-kickoff arrangement of the present invention may be applied to any line with the assurance that it will be effective whether the line is subject to either capacitative or inductive discharge.

A feature of the invention is anti-kickoff circuit which is effective to prevent kickoff due to either capacitative or inductive discharge. A further feature of the invention is a rectifier bridge circuit and a condenser in series with an anti-kickoff winding on a receiving relay which is effective to supply unidirectional current pulses to the winding on transitions of the armature of a transmitting relay between batteries of opposite polarity.

These and other features of the invention will become apparent from the following description when read with reference to the associated drawings in which Fig. 1 is a circuit comprising an exemplary embodiment of the invention and Figs. 2 to 5 are diagrams used in explaining the operation of the invention of the circuit of Fig. 1.

Refer now to Fig. 1. In this figure a polarized transmitting relay 101 is operated under control of a circuit not shown, so that its armature alternately engages its marking and spacing contacts 101 and 103. Polarized relay 104 is a receiving relay located at the same repeater station where relay 101 is assumed to be located. On the receiving relay 104 are three windings, namely, line winding 105, bias winding 106, and anti-kickoff winding 107. During transmission by relay 101 toward the distant station, the armature of relay 104 is required to be maintained in engagement with its marking contact 108. The armature of relay 104 is intended to be actuated between its marking and spacing contacts 108 and 109, in response to signals transmitted from the distant station. The stations are interconnected through the loop 110 which extends through the equipment at the distant station which equipment may be any of a wide variety of telegraph equipment, but which in this particular instance is shown as a teletypewriter receiving magnet 111 and teletypewriter transmitting contacts 112, well known in the art. The loop returns to the repeater station at which relay 101 is assumed to be located and extends through resistance 113 to positive battery 114.

The biasing winding 106 is connected through

resistance 115 to ground. The anti-kickoff circuit comprises winding 107, resistances 117 and 124, the rectifier bridge comprising the four rectifiers 120, 121, 122 and 123 and condenser 119. The loop interconnecting the stations may be a loop having capacitance or inductance of large magnitude. Condenser 116 which is connected between conductor 110 and ground represents the line capacitance.

The manner in which the circuit per Fig. 1 functions will now be described in detail. First the operation of the circuit for the steady state condition will be described and thereafter the manner in which the operation of the circuit is affected by capacitative and inductive line discharges and the manner in which the anti-kickoff circuit functions to prevent kickoff for these conditions will be described.

The circuit per Fig. 1 is shown in the marking condition which is also the normal condition when the circuit is idle. When the circuit is in the marking condition, the armature of relay 101 is in engagement with its marking contact 102, under control of a circuit not shown, and the armature of receiving relay 104, for reasons to be explained, is in engagement with its marking contact 108. When the armature of relay 101 is in engagement with its marking contact 102, a circuit may be traced from grounded negative battery 125 through contact 102, winding 105, line 110, magnet 111, contacts 112, and resistor 113 to grounded positive battery 114. Batteries 125 and 114 are in series-aiding relationship and the magnitudes of their voltages are equal. A circuit may also be traced from the junction between windings 105 and 106, through winding 105 and resistance 115 to ground. For the marking condition the effect of the current flowing in line winding 105 tends to actuate the armature of relay 104 to engage with its marking contact 108. This effect is opposed by the effect of current flowing in biasing winding 106 which tends to actuate the armature of relay 104 to engage with its spacing contact 109. The effect of the current in the line winding is dominant for this condition and the armature of relay 104 is maintained in engagement with its marking contact 108.

In transmitting from the repeater station at the left of the figure toward the distant station at the right when the armature of relay 101 is actuated to its spacing contact 103, positive battery 126 is connected to one end of the loop and positive battery 114 of equal magnitude is connected to the other end of the loop. No current flows through winding 105 for this condition. The direction of the flow of current through biasing winding 106 is reversed for this condition and this effect maintains the armature of relay 104 in engagement with its marking contact 108.

In transmitting in the opposite direction with relay 101 operated to contact 102, when the transmitting contacts 112 are opened, the line current drops to zero and the armature of relay 104 is actuated to its spacing contact under the influence of its biasing winding 106.

Now to consider how the operation of the circuit is affected when the line 110 is subject to large capacitance, when the armature of relay 101 is in engagement with marking contact 102, line 110 becomes charged due to the distributed capacitance of the line represented by condenser 116. The mid-point of the line is at zero potential since the batteries at the ends of the line are of equal magnitude and opposite polarity. 75

The distributed capacitance of that part of the line nearer to battery 125 becomes charged negatively. When the armature of relay 101 first engages its spacing contact 103, the negative charge on this portion of line 110 discharges back through winding 105. The direction of the flow of current through line winding 105, due to the discharge of the line capacitance, is the reverse of the direction of the flow of current for the marking condition and the effect of the line capacitance discharge therefor tends to actuate the armature of relay 104 towards its spacing contact 109. If the surge of current exceeds the current flowing in winding 106 at that time, the relay will operate to spacing. In order to prevent this it is necessary to supply a current pulse to relay 104 which will have an effect opposed to the effect of the line discharge. Since line capacitance discharge occurs on transition from marking to spacing the compensating effect must occur at the same time.

When line 110 due to its arrangement or to the connection of a number of apparatus elements having inductance is highly inductive, the inductance seriously delays the build up of the marking current and prolongs the decay of the current for the spacing condition. The operation of the inductance delays the build up of the line current when the armature of relay 101 first engages its marking contact 102 on each transition. This tends to cause kickoff due to the fact that the opposing current in the biasing winding 106 builds up at a normal rate, which is almost instantaneously. During the interval before the current in line winding 105 has attained half of its full magnitude, the effect of the current in winding 106 is dominant and the armature of relay 104 may be operated to engage its spacing contact 109. In order to prevent this it is necessary that a pulse of current be supplied to relay 104 to tend to maintain armature of relay 104 in engagement with its marking contact 108 until the current in line winding 105 has built up sufficiently to become dominant.

It should be apparent from the foregoing that if an anti-kickoff device is to be effective to prevent kickoff on lines arranged per Fig. 1 which have high capacitance as well as on other lines arranged per Fig. 1 which have high inductance, it is necessary to supply a pulse of current to maintain the armature of the receiving relay on its marking contact on each transition of the armature of transmitting relay 101 between its marking and spacing contact and vice versa. The anti-kickoff circuit of the present invention performs this function in the following manner.

When the armature of relay 101 engages with its marking contact 102, a circuit may be traced from ground 118, through condenser 119, rectifier 120, anti-kickoff winding 107, resistance 124, rectifier 122, resistance 117, and contact 102 to negative battery 125. Assuming a direction of flow of current from positive to negative, a positive pulse will flow from left to right through winding 107 for this condition. When the armature of relay 101 engages contact 103, a circuit may be traced from positive battery 126, through contact 103, resistance 117, rectifier 121, winding 107, resistance 124, rectifier 123, and condenser 119, to ground 118. For this condition, again assuming a direction of flow of current from positive to negative, a pulse of current flows through winding 107 from left to right. Thus for both transitions of the armature of relay 101, current flows through anti-kickoff winding 107 in the same di-

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rection. The effect of this current tends to maintain the armature or relay 104 in engagement with its marking contact. Condenser 119 and the other elements of the anti-kickoff circuit are chosen to control the magnitude and duration of the pulse through winding 107 so as to overcome the effect of the capacitance or inductance of the line 110. The operation of the circuit may be better understood from reference to the explanatory diagrams per Figs. 2 to 5.

Fig. 2 is a diagram in which the magnitude of the current in the line winding 105 is plotted against time for marking and spacing signal transitions, when the line connected to line winding 105 is subject to capacitative discharge. The travel time of the armature in each direction is disregarded. Time is measured along the horizontal axis and current magnitude is measured along the vertical axis. The portion of the curve formed by line 201 indicates that the magnitude of the current in the line winding at the end period of the spacing interval, while the armature of relay 101 engages contact 103, is zero. The instant that the armature of the relay 101 engages its marking contact 102, the current rises sharply along line 202 to a peak 203 which represents an amount greater than the normal full magnitude of the current, which normal full magnitude will be considered to be 60 milliamperes. The excess over 60 milliamperes is due to the current required to charge the distributed capacity of line 110. The magnitude of the current next decreases for an interval along line 204 until it reaches point 205 at which point the magnitude of the current is slightly in excess of 60 milliamperes. From point 205 the current subsides more slowly until the normal full magnitude of 60 milliamperes is attained at point 206. This magnitude is maintained, as indicated by line 207, until the end of the marking interval represented by point 208. When the armature of relay 101 is actuated to its spacing contact 103, the magnitude of the current declines instantly as indicated by line 209, to point 210. The current passes through the zero point 211 and attains a negative peak due to the discharge of the line capacity back through winding 105 in a reverse direction. The current then rises relatively steeply as indicated by line 212 to point 213 and then more slowly until the line is fully discharged at a point in time represented by 215. The line remains fully discharged and no current flows in the line for the remainder of the spacing interval indicated at point 214, which marks the end of the first cycle and the start of the second cycle of operation of relay 101.

It was explained in the foregoing that the effect of the marking current in line winding 105 tends to maintain the armature of relay 104 in engagement with its marking contact 108. The effect of the increase in the current above the normal full magnitude, assumed to be 60 milliamperes, to the point 203, will not be adverse, since it simply tends to hold the armature more firmly against its marking contact. The effect of the negative peak 210, however, is adverse since it tends to actuate the armature to spacing.

Refer now to Fig. 3. Line 301 indicates the current through the biasing winding 106 at the end period of the spacing interval, that is, at the end of the period while the armature of relay 101 is in engagement with spacing contact 103. There is no current in the line winding 105 at this time. The current in the biasing winding 106 is in a proper direction to maintain the armature of re-

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lay 104 in engagement with its marking contact 108 during this period. On the transition to marking, indicated at point 302, the direction of the current in winding 106 is reversed, indicated by line 303. The magnitude represented by the line 301 may be assumed to be 30 milliamperes and its effect as explained is to hold the armature of relay 104 on its marking contact. The magnitude represented by the line 304 is the same as the magnitude represented by line 301 and may be assumed to be 30 milliamperes but its direction is such so as to tend to actuate the armature 304 to its spacing contact. For this condition the effect of the current in the line winding 105 is dominant and the armature of relay 104 is maintained on its marking contact. At the beginning of the spacing interval represented by point 305, the current in the biasing winding 106 rises, as indicated by line 307, to a point 308. The magnitude of this current is again 30 milliamperes. However, the magnitude of the negative peak represented by point 210 is greater on lines of high capacity and may be assumed to be 45 milliamperes. As a result of this the current in biasing winding 106 alone would not be effective to maintain the armature of relay 104 on its marking contact.

Refer now to Fig. 4. Line 401 indicates the magnitude of the current in anti-kickoff winding 107 at the end period of the spacing interval. On a transition to marking indicated by point 402, the current through anti-kickoff winding 107 rises sharply to point 403, the magnitude of which may be adjusted to any amount by a choice of constants of the anti-kickoff circuits. It will be assumed that the constants are so chosen that the magnitude of the peak is 45 milliamperes. The current subsides along the line 104 to a point in time represented by point 405, when current ceases to flow through winding 107. This condition is maintained in winding 107 until the end of the marking interval represented by point 406, at which time the current again rises to 45 milliamperes as indicated by point 407, subsiding again along lines 408 to zero magnitude at point 409. The effect of the peak represented by point 403 is not required on a capacitative loop since it just tends to aid in holding the armature to its marking contact and the current in the line winding represented by peak 203 is effective to perform this function without the anti-kickoff winding. However, after the transition from marking to spacing the effect of the current flowing during the interval from 406 to 409 aids the balancing winding in overcoming the effect of kickoff in the line winding at this time and the armature of relay 104 is maintained in engagement with its marking contact.

Fig. 5 represents the magnitude of the current in the line winding of an inductive loop plotted against time on successive marking and spacing transitions. The line 501 represents the current in the line winding 105 at the end period of the spacing interval. It is in a marking direction and approaching zero. The transition from spacing to marking is represented by point 502. The current in the line winding does not build up instantly in the manner indicated by line 202 in Fig. 2. The inductance of the line 110 opposes the build up which is represented by line 503. Dependent upon the amount of inductance in the line, the build up may be rapid or gradual. The end of the marking interval is represented by point 504. Full normal current of 60 milliamperes is not attained, if the magnitude of the

inductance is large, until near the end of the marking interval. On the transition to spacing at point 504, the magnitude of the current does not subside instantly in the manner indicated by line 209. The inductance of the line tends to maintain the current which subsides as indicated along line 505 to point 506 at the end of the spacing interval and the start of a new cycle.

Difficulty due to kickoff on inductive loops occurs at points such as 502, that is on transitions of the armature of relay 101 from its spacing contact 103 to its marking contact 102, and the reason is that the current in the biasing winding 106 changes to its full magnitude in a spacing direction almost instantly, as represented by line 303 while the current in the line winding 105 is building up slowly. The kickoff is due to the greater effect of the current in the biasing winding at the start of the marking interval, which effect is tending to actuate the armature of relay 104 to spacing and which if the inductance is large, does in fact operate the armature of relay 104 to spacing unless it is prevented by special means. Kickoff is prevented with the arrangement shown in Fig. 1, by the effect of the peak between points such as 402 and 405 on space to mark transitions. The current in the anti-kickoff winding 107 on space to mark transitions of relay 101, as indicated by peak 403, builds up instantly. Before it declines again to zero, as indicated at point 405, the magnitude of the current in the line winding has built up as indicated along line 503 to a point where it is dominant over the counter effect in the biasing winding 106.

Thus, the anti-kickoff circuit of the invention is effective on all lines whether capacitative or inductive. The kickoff circuit may therefore be standardized. It is not necessary to determine the characteristics of the line. Attention is also called to the fact that the anti-kickoff circuit is simple and relatively inexpensive.

Although the invention herein has been explained with reference to a particular preferred embodiment, it is pointed out that it may be incorporated in other embodiments and practiced in a wide variety of manners which will be apparent to those skilled in the art.

What is claimed is:

1. In a telegraph system, a telegraph circuit, having a transmitter directly connected to a polar telegraph receiving relay, a line winding on said relay, means in said transmitter for transmitting marking and spacing impulses of opposite polarity through said winding, an anti-kickoff winding on said relay, and means comprising a full wave rectifier bridge circuit, for transmitting a pulse of current through said anti-kickoff winding in the same direction for every signal impulse transmitted from said transmitter to prevent kickoff due to either capacitative or inductive effects in said line winding.

2. In a direct-current telegraph system, a tele-

graph transmitting relay, an armature thereon, a pair of opposed contacts on said relay, each of said contacts connected to an individual battery, said batteries of opposed polarity, said armature actuatable to engage each of said contacts alternately to transmit marking and spacing signals, a telegraph receiving relay, a line winding, a biasing winding, and an anti-kickoff winding on said receiving relay, said armature connected to said line winding and to said biasing winding, an anti-kickoff circuit connected to said anti-kickoff winding, a plurality of rectifiers poled in a first direction, in said anti-kickoff circuit for directing a current pulse of a first polarity in a first direction through said anti-kickoff winding to prevent kickoff of said relay due to the discharge of capacity through said line winding on a transition of said armature from the marking to the spacing condition, and a plurality of rectifiers, poled in a direction different from said first direction, also in said anti-kickoff circuit for directing a current pulse of said first polarity and in said first direction through said anti-kickoff circuit to prevent kickoff of said relay due to inductance on a transition of said armature from the spacing to the marking condition.

3. In a system in accordance with claim 2, an arrangement wherein said anti-kickoff circuit comprises four branches each including a rectifier, said branches interconnected between said armature and said anti-kickoff winding.

4. A polar telegraph repeater circuit comprising a polar telegraph transmitting relay having an armature actuatable between opposed contacts on said relay, positive and negative battery connected individually to said contacts, said armature connected directly to a line winding on a polar telegraph receiving relay in said circuit, an anti-kickoff winding on said receiving relay, a full wave rectifier bridge circuit interconnecting said armature and said anti-kickoff winding, a condenser connected to said full wave rectifier, and interconnections between said full wave rectifier and said anti-kickoff winding for impressing on said anti-kickoff winding transient pulses of the same unchanging polarity and in the same unchanging direction for both transitions of said armature between said contacts, to counteract the effect of either capacitative or inductive line discharge through said line winding.

WILTON T. REA.

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