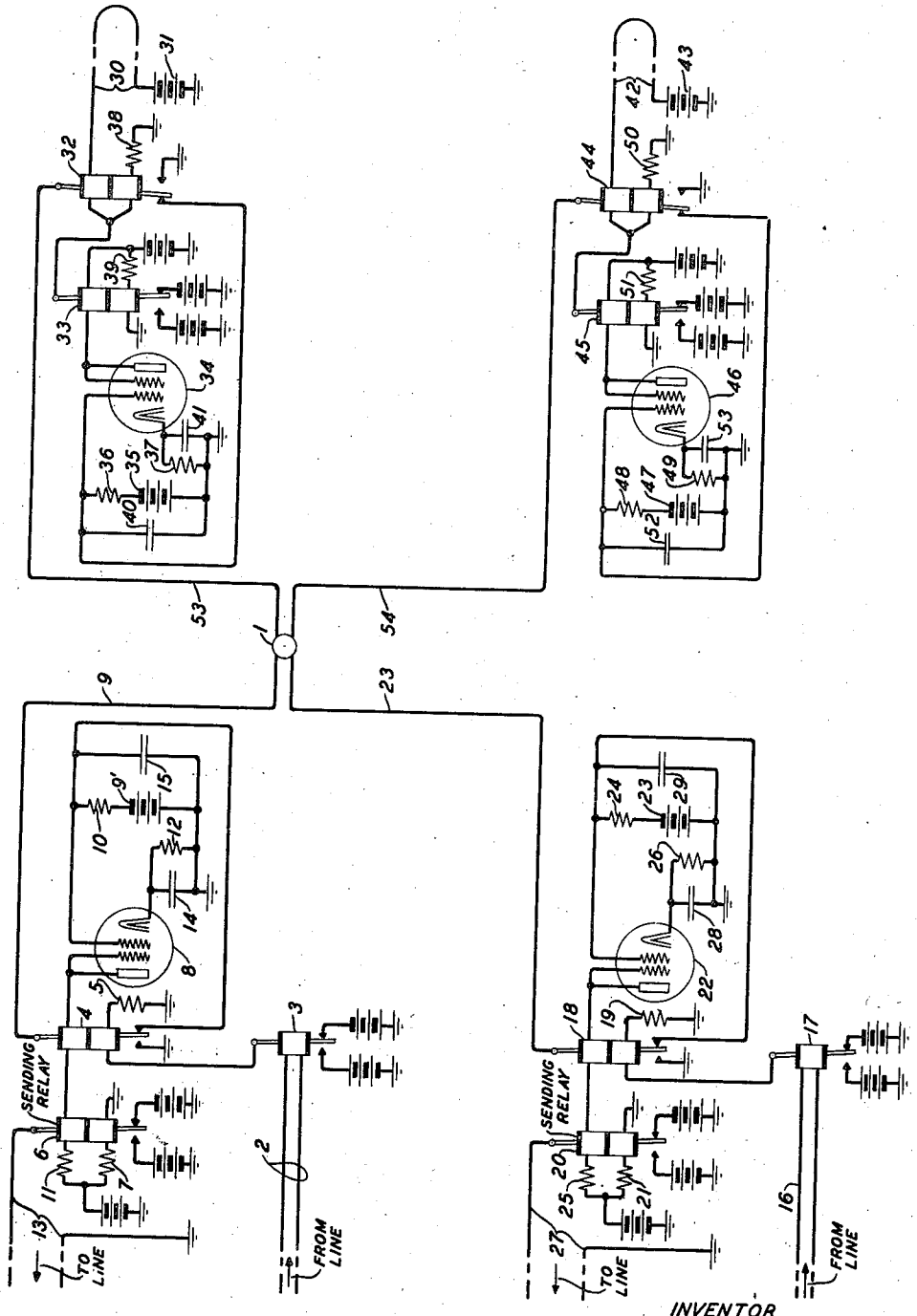
May 2, 1944. G. C. CUMMINGS 2,347,813

INVERSE NEUTRAL TELEGRAPH REPEATER HUB CIRCUIT

Filed Oct. 11, 1941



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Patented May 2, 1944 2,347,813

UNITED STATES PATENT OFFICE

2,347,813

INVERSE NEUTRAL TELEGRAPH REPEATER HUB CIRCUIT

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Application October 11, 1941, Serial No. 414,580

10 Claims. (Cl. 178—73)

This invention relates to telegraph systems and particularly to an improved inverse neutral repeater hub circuit. Inverse neutral repeater hub circuits are well known in the art and are described in detail in Patent 2,056,277, F. S. Kinkead et al., October 6, 1936.

As presently arranged the number of inverse neutral repeaters which may be interconnected into one hub is limited by one of the characteristics of the present circuits. In the present circuits each branch radiating from the common hub point extends through the armature and marking contact of a receiving relay in each branch and then through the winding of a sending relay in each branch to negative battery, of the same potential, for the marking condition. For the marking condition, therefore, no current flows in any of the branches since they are all terminated in battery of the same polarity and magnitude. When any branch sends to the other branches, the receiving relay in the particular branch is actuated so that its armature is disconnected from the path to negative battery through its respective sending relay and the armature is grounded through its spacing contact. As a result of this, current flows from negative battery connected to each of the other spokes radiating from the hub through the common hub to ground, through the armature and spacing contact of the receiving relay in the particular branch which is sending. The single spacing contact of the particular relay which is momentarily transmitting passes all of the current required to operate each of the sending relays in each of the other branches. For the steady state condition, that is to say, the condition attained when the flow of all the transient currents has ended, the total current through the single sending contact is equal to the operate current for the particular sending relay in each branch, multiplied by the number of branches. This is not the worst condition, however. The transient currents developed, particularly on the break, as the armature of the receiving relay in the particular branch which is sending separates from its spacing contact is very greatly in excess of the total steady state current, due to the fact that there is an inductance in each of the branches which is momentarily receiving.

As a result of this the number of branches which are associated together in any one hub has been greatly limited due to the contact protection problem involved.

It is an object of the present invention to increase the number of branches which may be associated together with an inverse neutral repeater hub circuit.

It is a further object of this invention to eliminate the characteristic contact protection problem inherent in inverse neutral repeater circuits.

A feature of the present invention is a space discharge device inserted in each of the branches of an inverse neutral repeater circuit.

A further feature of this invention is an arrangement wherein the effect of the inductance, due to the winding of the sending relay in each branch of an inverse neutral repeater hub circuit, upon the contacts of the receiving relay is eliminated, by interposing a space discharge device in each branch between the hub and the winding of the sending relay. These and other features will become apparent from the following description when read with reference to the associated drawing.

The drawing shows an inverse neutral repeater hub circuit comprising four branches, namely, two inverse neutral loop circuits and two inverse neutral four-wire line circuits in which a space discharge device has been inserted in each branch between the common hub and the winding of the sending relay in each branch.

The operation of the system will now be described in detail.

The common hub 1 is shown approximately in the center of the drawing. To the right of the hub are shown facilities for interconnecting two subscribers' loop circuits to the hub, through individual inverse neutral telegraph repeater circuits, each equipped with a space discharge device. At the left of the figure, two four-wire lines are shown, equipped with individual neutral telegraph repeaters, each of which includes a space discharge device. At the upper left-hand corner of the figure, four conductors are shown extending toward the left-hand margin. These conductors extend to a distant central station. The two conductors 13 are used in transmitting toward the distant central station. The two conductors 2 are used in receiving from the distant central station.

The four-wire line circuit shown at the bottom left of the drawing is identical with that shown in the upper left of the figure. At the upper right of the figure a subscriber's loop 30 equipped with an inverse neutral repeater is shown. This loop extends through telegraph receiving and transmitting apparatus, not shown, at the subscriber's premises. Similarly, a subscriber's loop 42 equipped with an inverse neutral repeater is shown at the bottom right-hand of the drawing,

The loop extends through telegraph transmitting and receiving apparatus, not shown, at another subscriber's premises.

It is to be understood that the four inverse neutral telegraph repeaters shown interconnected to hub 1 are located at the same central telegraph station.

In an inverse neutral telegraph repeater hub circuit, as is understood by those skilled in the art, any line or loop forming one of the branches of the hub may transmit to each of the other branches simultaneously. That is to say, if the distant central station, connected to the four-wire line circuit at the upper left of the finger transmits, the signals will be received by each of the other facilities forming branches of the hub. Therefore, such signals will be received simultaneously at the distant central station connected to the four-wire line shown in the left-hand lower portion of the drawing and will also be received at the two subscribers' stations. Similarly, signals transmitted by either subscriber will be received by the other subscriber as well as by the two distant central stations.

The interconnected inverse neutral repeaters are all shown in the marking condition. The armatures of all of the relays are in engagement while the marking condition prevails with the contacts as shown. No current flows in the anode-cathode circuit of any of the vacuum tubes. The reasons for this will be made apparent below.

The circuit extending through loop 2 is closed through battery of such polarity, at the distant station, that the winding of relay 3 is energized and the armature of relay 3 is actuated so as to engage with its right-hand or marking contact. Negative battery is thus connected to the armature of relay 3 and the circuit extends through the bottom winding of relay 4 and resistance 5 to ground. The effect of the current flowing through the bottom winding of relay 4 actuates the armature of relay 4 so as to engage with its right-hand or marking contact. The armature of relay 6 is actuated so as to engage with its right-hand or marking contact by the effect of current flowing from positive battery through resistance 7 and the bottom winding or relay 6 to ground. No current flows through thc top windings of relays 4 and 6 during the marking condition. The flow of current through the output circuit of vacuum tube 8 is blocked as the control grid is maintained highly negative relative to its cathode while the marking condition prevails, for reasons which will be made apparent below.

While the armature of relay 4 is in engagement with its right-hand or marking contact a circuit may be traced from ground through battery 9, resistance 10, right-hand or marking contact and armature of relay 4 and through conductor 9 to hub 1. From the hub, three other branches radiate. If the path through branch 23 is followed, it may be seen to extend through the armature and right-hand, or marking, contact of relay 18, resistance 24 and battery 23 to ground. The path through branch 53 extends through the armature and left-hand, or marking, contact of relay 32, resistance 36 and battery 35 to ground. The path through branch 54 extends through the armature and left-hand contact of relay 44, resistance 48 and battery 47 to ground. The resistances 10, 24, 36 and 48 are each of the order of 20,000 ohms. Each of the batteries shown on the drawing are of approximately 48 volts. It will be observed that the control grid of each of the vacuum tubes 8, 22, 34 and 46 is connected to the top terminal of its respective high valued resistance 10, 24, 36 and 48. It will also be observed that the positive terminal of each of these batteries is grounded. The cathode of each tube is connected to ground through a resistance 12, 26, 37 and 49. No current flows in any of the branches of the hub during marking. The grid of each tube is highly negative with respect to its cathode. The output circuit of each tube is blocked. No current flows through the winding of any relay connected in the output circuit of any tube. The armature of each of these relays is influenced only by the effect of current in its bottom winding during marking.

In the inverse neutral repeater circuit associated with a subscriber's loop circuit, such as the one shown at the upper right of the drawing, for the marking condition, the armature of relay 33 is held in engagement with its right-hand or marking contact by the effect of current flowing from positive battery through resistance 39 and the bottom winding of relay 33 to ground. While this condition prevails, a circuit may be traced from the negative battery through the right-hand, or marking, contact and armature of relay 33 to the apex of relay 32, where it divides into parallel branches. One branch extends through the bottom winding of relay 32 and resistance 38 to ground. The other branch extends through the top winding of relay 32, the top loop conductor 30 to the subscriber's station where it extends through teletypewriter transmitting and receiving equipment, not shown, and returns over the bottom loop conductor 30 to ground through positive battery 31. The effect of the current flowing through the bottom winding of relay 32 tends to actuate the armature of relay 32 so as to engage with its right-hand or spacing contact. This effect is opposed by current flowing around the loop circuit through the top winding of relay 32. The effect of the current in the top winding predominates and the armature of relay 32 is actuated so as to engage with its left-hand, or marking, contact as shown.

While the marking condition prevails, the inverse neutral repeater associated with a subscriber's loop shown in the bottom right-hand corner of the drawing is in the same condition as described for the inverse neutral repeater in the upper right-hand corner of the drawing.

When a spacing signal is to be transmitted from the distant central station connected to the inverse neutral repeater shown at the upper left of the drawing, the direction of the current flowing in loop 2 is reversed. As a result of this the armature of relay 3 is actuated so as to engage its left-hand or spacing contact. This connects positive battery to the armature of relay 3. As a result of this the armature of relay 4 is actuated so as to engage with its left-hand or spacing contact. This connects ground to conductor 9 and grounds hub 1. This grounds the control grid of vacuum tube 22, vacuum tube 34 and vacuum tube 46.

The details of the filament or heating circuit of vacuum tubes 8, 22, 34 and 46 are not shown and it is to be understood that they may be heated in any of a variety of well-known manners.

When ground is connected to the control grid of vacuum tubes 22, 34 and 46, current flows in the anode-cathode circuits of each of these tubes. The circuit for tube 22 may be traced from positive battery through resistance 25, top windings of relays 20 and 18, anode of tube 22, cathode of tube 22 and resistance 26 to ground. In the case

of vacuum tube 34 a circuit may be traced from positive battery through the top winding of relay 33, anode of vacuum tube 34, cathode of vacuum tube 34 and resistance 37 to ground. The circuit for vacuum tube 46 is similar to that for vacuum tube 34.

The effect of the current flowing through the top winding of relay 20 preponderates over the effect of current through the bottom winding of relay 20 and actuates the armature of relay 20 to engage with its left-hand or spacing contact. This reverses the polarity of the battery connected to the top conductor of loop 27 and results in a spacing signal being transmitted to the distant station. The effect of current flowing through the top winding of relay 33 preponderates over the effect of current flowing through the bottom winding of relay 33 and actuates the armature of relay 33 to engage with its left-hand or spacing contact. This reverses the polarity of the battery connected to the armature of relay 33 and to the apex of relay 32. Battery of the same polarity, namely positive battery, is connected to each end of loop 30. This results in a spacing signal being received at the subscriber's station connected thereto. The top winding of relay 32 is deenergized. The polarity of the current flowing through the bottom winding of relay 32 is reversed. Since, as described above, the effect of current from negative battery connected to the armature of relay 33 flowing through the bottom winding of relay 32 tended to actuate the armature of relay 32 so as to engage with its right-hand or spacing contact, when the polarity of the current is reversed, the armature 32 will be maintained in engagement with its left-hand or marking contact.

The operation of the inverse neutral telegraph repeater connected to conductor 54 is the same as that described for the repeater connected to conductor 53.

Current through the top winding of relay 18 augments the effect of current through the bottom winding of relay 18, to hold the armature of relay 18 more firmly in engagement with its right-hand or marking contact as signals are being received from the hub.

When a subscriber's station connected to the loop transmits, the loop is alternately opened and closed. When the loop, such as 30, is opened, the top winding of relay 32 is deenergized. The armature of relay 32 is actuated, under the influence of current through the bottom winding of relay 32, to engage with its right-hand or spacing contact. This connects ground through conductor 53 to hub 1 and results in a spacing signal being transmitted through each of the other branches of the hub to the facility connected to the respective branch, in a manner which should be apparent from the foregoing.

The circuit is arranged so that, while any branch connected to the hub is receiving, it may interrupt the sender by sending a break signal. Thus, while a subscriber's loop, say loop 30, is receiving, the subscriber may open the loop and keep it open. This causes the armature of relay 32 to be actuated to the right when the armature of relay 33 is in engagement with its right-hand or marking contact. This connects a permanent ground to the hub 1, and opens the path connecting vacuum tube 34 to the hub. Each of the vacuum tubes in the other branches is immediately unblocked as a result of ground connected to the grid of each through the hub and each tube remains in the conducting condition. In the case of a line, the armature of the sending relay such as 6 or 20 will be actuated so as to engage with its respective left-hand contact and a permanent spacing signal will be transmitted to the distant central station. In the case of a subscriber's loop, the armature of the relay corresponding to relay 45 in each of the subscribers' loops, forming part of a hub, which has been receiving, will be actuated so as to engage with its left-hand or spacing contact. This, as has been shown, deenergizes the loop and results in a spacing signal being transmitted to the associated subscriber's station.

Condensers 14, 15, 28, 29, 40, 41, 52 and 53 are employed to shape the signal elements to tend to equalize the lengths of marking and spacing signal elements by increasing the lengths of spacing signal elements to compensate for the fact that the travel time of the armature of the relay such as relay 4 in each direction would otherwise be added to the marking signal element. The effect of the condenser such as 14 is to increase the speed of build-up of the front of the wave of a space signal element to make it effective at the first possible instant. The effect of the condenser such as 15 is to decrease the speed of decay of the end of a space signal element which in effect prolongs the space signal element. The combined result is a spacing signal element which is effective earlier and of increased length than would be the case without the condensers. This compensates for the inequality which would otherwise exist in the spacing and marking signal elements due to the effect of relay armature travel time.

What is claimed is:

1. In a telegraph system, an inverse neutral telegraph repeater, a branch therein arranged for connection to a plurality of other inverse telegraph repeaters through a common neutral point, a space discharge device in said repeater and means connected to said device for rendering said device conducting or non-conducting in response to telegraph signals transmitted through said repeater.

2. In a telegraph system, a plurality of inverse neutral telegraph repeaters, interconnected by individual branches through a common neutral point, a space discharge device in one of said repeaters and means responsive to the reception of telegraph signals by another of said repeaters for controlling the flow of current through said space discharge device.

3. In a telegraph system, a plurality of inverse neutral telegraph repeaters interconnected by individual branches through a common neutral point, a space discharge device in each of said repeaters and means responsive to the transmission of telegraph signals by one of said repeaters for controlling the flow of current through said space discharge devices in the other repeaters.

4. In a telegraph system, a plurality of inverse neutral telegraph repeaters interconnected by individual branches through a common neutral point, a sending relay, a receiving relay and a space discharge device in each of said repeaters, means in any one of said repeaters for transmitting telegraph signals simultaneously to each of said other repeaters, means in each of said other repeaters for blocking its individual discharge device while the marking condition prevails, and means in any one of said repeaters, while so transmitting, for unblocking each of said

devices in said other repeaters when a spacing signal is transmitted.

5. In a telegraph system, a first inverse neutral telegraph repeater, a subscriber's loop circuit connected thereto, a first relay in said repeater having a winding in series with said loop for receiving telegraph signals from said loop, means in said repeater for repeating signals received by said relay to a plurality of other inverse neutral telegraph repeaters through a common neutral point, a second relay in said first repeater for receiving signals from any of said plurality of repeaters and repeating them to said loop and a space discharge device in said first repeater, said device having an output path in series with a winding on said second relay.

6. In an inverse neutral repeater, a relay conditioned to receive telegraph signals from any of a plurality of other inverse neutral repeaters through a common neutral point, a winding on said relay and a space discharge device having a control grid connected to said common neutral point and an anode connected to said winding.

7. In an inverse neutral telegraph system, a plurality of inverse neutral telegraph repeaters interconnected through a common neutral point, a plurality of branches radiating from said point, each branch extending from said point through an armature and a contact on a relay, to a junction formed by the control grid of a space discharge device and a resistance of relatively high value, and through said resistance to a battery of relatively low potential, the potential and polarity of the battery connected to each branch being substantially the same for each branch.

8. In a telegraph system, a plurality of inverse neutral impulse repeaters interconnected by individual branches through a common point, each repeater comprising a relay device having a control element whose potential is controllable by means of a space discharge element in said repeater to vary said repeater from a marking to a spacing condition.

9. In a telegraph system, a group of at least three impulse repeaters interconnected by individual branches through a common point, each repeater comprising a relay device having a control element whose potential is controllable by means of a space discharge element in said repeater to vary said repeater from a marking to a spacing condition.

10. In a telegraph system, a group of at least three impulse repeaters interconnected by individual branches through a common point, each repeater comprising a relay device having a control element whose potential is controllable by means of a space discharge element in said repeater to vary said repeater from a marking to a spacing condition and signal wave shaping means connected to said device.

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