

July 26, 1932.

F. G. HALLDEN

1,868,706

SINGLE LINE REPEATER

Filed June 21, 1930

FIG. 1

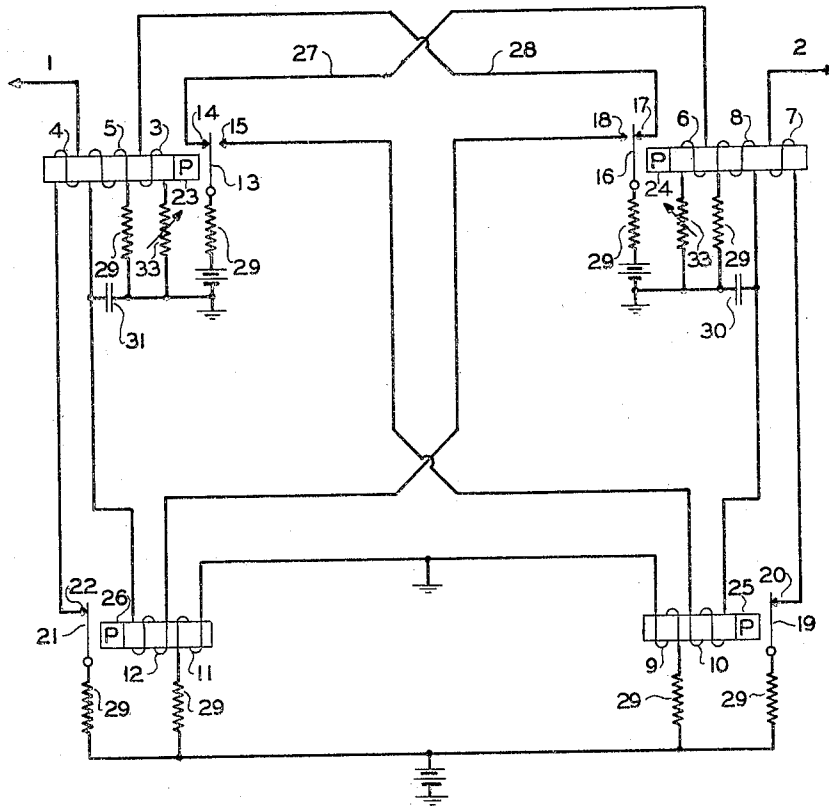
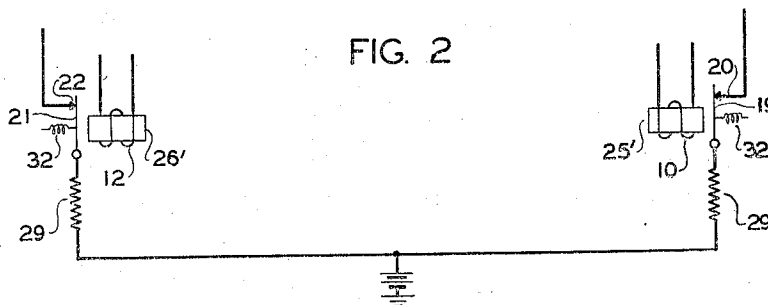


FIG. 2



INVENTOR
FREDERICK G. HALLDEN
BY
[Signature]
ATTORNEY

UNITED STATES PATENT OFFICE

FREDERICK G. HALLDEN, OF JAMAICA, NEW YORK, ASSIGNOR TO INTERNATIONAL COMMUNICATIONS LABORATORIES, INC., OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

SINGLE LINE REPEATER

Application filed June 21, 1930. Serial No. 462,793.

This invention relates to telegraph repeaters, more particularly to that type which is adapted to single line operation either with Morse or printing telegraph signals.

5 The object of this invention is to provide a simple arrangement for repeating the signals free from distortion and at high speed. Heretofore it has been a common experience to find the repeated marking signals curtailed by the travel time of the relay armatures. As the speed is increased the relay armature must necessarily spend a disproportionately longer time in transit from one contact to the other. This tends to increase 10 the signal distortion. The trouble is increased if several repeating stations are added between the sending and receiving terminals.

According to the present invention two sets of two relays each may be employed at a repeating station and in such a manner that the re-transmitted signals are not appreciably distorted, even at high speed.

Referring to the drawing:

25 Figure 1 is a circuit diagram of a repeater station embodying a preferred arrangement of four polar relays as used in the present invention.

30 Fig. 2 is an alternative fragment of the diagram showing two neutral relays in place of two of the polar relays.

Two of the relays are line relays having three windings each and two other relays, either of the polar or neutral type, are re-transmitting relays actuable from the line relays.

35 In addition to the four relays, suitable resistances 29 and 33 are provided in the several circuits to control the energizing force in the windings as well as in the line. Two condensers 30 and 31 also function in a manner presently to be explained. The alternative use of neutral relays as shown in Fig. 2 obviously eliminates the need for the biasing windings 9 and 11 because the springs 32 40 take the place of the latter.

The operation of the preferred embodiment is as follows:

45 The ampere turns in the line winding 4 of relay 23 and winding 7 of relay 24 are

adjusted to about twice the strength of the biasing current through windings 3 and 6 respectively. For greater convenience in obtaining this adjustment the resistances 33 55 are variable and are placed in series with the biasing windings 3 and 6 respectively. So also, the strength of the line winding 7 on relay 24 is about twice as great as that of the biasing winding 6. A marking signal or a closed circuit during idle time in line 60 1 tends, therefore, to hold armature 13 against its front contact 14, and during a spacing interval, at which time no current is flowing through the line 1 the biasing winding 3 acts alone in the opposite direction and throws the armature 13 against its 65 back contact 15. During the time that signals are coming in on line 1, holding winding 5 on relay 23 remains open-circuited. In the marking position of armature 13 a biasing circuit for relay 24 is maintained from 70 positive battery, through armature 13, front contact 14, conductor 27 and winding 6 of relay 24 to negative battery. Similarly, winding 3 of relay 23 is kept energized while armature 16 of relay 24 remains in the marking position, current being carried from positive battery through armature 16, contact 17, conductor 28 and winding 3 to negative battery. 75 80

The biasing windings 9 and 11 on relays 25 and 26 as shown in Fig. 1 respectively, tend to hold the armatures of these relays against their back contacts. In the alternative arrangement using neutral relays 25' 85 and 26' as shown in Fig. 2, the springs 32 accomplish the same purpose. The two operating windings 10 and 12 of these relays when energized, act with about twice the force of the biasing windings or springs and, therefore, draw up one or the other of the armatures 19 and 21 as the case may be. 90

Assuming that the operator at the far end of line 1 opens his key, then biasing winding 3 on relay 23 will not be opposed by a line signalling current through line winding 4 and armature 13 will be thrown against back contact 15. While this armature is in transit biasing winding 6 of relay 24 will de-energize, permitting the armature 16 of this relay 100

to remain against contact 17 because of the continuance of the marking signal through winding 7 and line 2 at this moment.

Next, the armature 13 will conduct positive potential through contact 15 to operating winding 10 of relay 25 and thence to holding winding 8 of relay 24 whence the circuit is completed to negative battery. Armature 19 of relay 25 breaks away from contact 20 and repeats the spacing signal through relay 24 and line 2. Relay 24 does not release, however, because at the same time that operating winding 10 of relay 25 is energized holding winding 8 builds up its holding power and acts to retain armature 16 in the marking position, prior to the deenergization of line winding 7. The spacing signal is thus repeated to line 2 through line winding 7 of relay 24 but without disturbing the armature 16 thereof.

It will be noted that in the re-transmission of the spacing signal over line 2 there is a lag represented by the travel time of armature 13 from marking to spacing contacts, because relay 25 does not operate until the circuit for its operating winding 10 has been completed by armature 13 making with contact 15. This lag corresponds with the lag in re-transmitting the marking signal as will presently be shown and hence distortion of the re-transmitted signals is negligible.

When a marking signal is again received over line 1 to energize line winding 4 of relay 23, it acts opposingly to the force of biasing winding 3 but with twice the number of ampere turns and armature 13 is drawn against contact 14. While it is in transit operating winding 10 of relay 25 de-energizes and biasing winding 9 (or spring 32, Fig. 2) acts alone in restoring armature 19 to its back contact 20 so as to re-transmit a marking signal over line 2. Before this re-transmitted marking signal builds up in line winding 7 and line 2, however, holding winding 8 of relay 24 might de-energize too quickly, but for the presence of condenser 30 which is shunted across the terminals of holding winding 8 and its associated resistance 29. This condenser becomes charged during the spacing signal and commences to discharge through holding winding 8 immediately upon the departure of armature 13 from its back contact 15. Thus, the holding force of winding 8 on relay 24 is prolonged and at no time during the reception of signals over line 1 does armature 16 of relay 24 leave its front contact 17. Relay 26 cannot operate so long as armature 16 is held stationary. Hence, at no time does the operator at the far end of line 1 lose control of the repeater unless the operator at the other end of line 2 wishes to interrupt by opening his key. In this case nothing happens during a spacing signal. With the key open in line 2, should the operator on line 1 again close his key, the con-

trol will immediately be transferred to the operator on line 2, and the repeater will act as follows:

Line winding 4 of relay 23 energizes and moves armature 13 from contact 15 (de-energizing operating winding 10 of relay 25) and against contact 14 (to energize biasing winding 6 of relay 24). Holding winding 8 of relay 24 dissipates the charge from condenser 30 and then biasing winding 6 of the same relay acts alone (because the operator's key on line 2 is open) to move armature 16 against its spacing contact 18. Operating winding 12 of relay 26 and holding winding 5 of relay 23 are energized and armature 21 breaks away from contact 22, thus opening the circuit to line 1 and repeating the spacing signal thereto. Armature 13, however, is now prevented from moving since it is held to the marking side by holding winding 5. Relays 23 and 25 then become inactive so that relay 24 may receive signals from the operator on line 2 and relay 26 will re-transmit the same.

From the symmetry of the circuits it is obvious that the repeater operates equally well to re-transmit from line to line in either direction.

It should be noted that where either or both of the lines have a high inductance the current in the line windings 4 or 7 would build up quite slowly. This can be compensated for by adding more capacity to the condensers 30 and 31 so as to prolong the holding effect of holding windings 5 and 8.

It has been previously stated that the lag in re-transmitting marking signals is equal to the lag in re-transmitting spacing signals. That the lag in both cases is equal becomes obvious when it is noted that the lag during spacing signal re-transmission comprises the time required to de-energize the line winding of the active line relay, the transit time of its armature, and the time required to energize the operating winding of the associated re-transmitting relay; while the lag during marking signal re-transmission comprises the time required to energize the line winding of the active line relay, the time required to de-energize the operating winding of the associated re-transmitting relay and the transit time of its relay armature. If the transit time of the two relays is equal, and the time required to energize the line relay winding is equal to the time required to energize the operating coil of the associated re-transmitting relay, then the lag in re-transmitting both types of signals is the same.

What is claimed is:

1. In a single line telegraph repeater, polarized input relays having line windings and biasing windings, a re-transmitting relay operable from each input relay, and means operable from one of said input relays to shift from one winding to another the magnetiz-

ing forces in the other input relay without moving the armature thereof.

2. In a single line telegraph repeater, receiving relays responsive to input line signals and unresponsive to retransmitted line signals, each said relay comprising a line winding and a normally energized biasing and a normally de-energized holding winding, a retransmitting relay operable from each receiving relay and comprising a normally de-energized winding in series with a contact of said receiving relay and also in series with said normally deenergized holding winding of the other said receiving relay, and a condenser bridged across the last said biasing winding.

3. In a single line telegraph repeater, plural-winding polarized receiving relays, retransmitting relays, armature tongues for said relays, and means controlled by the receiving relay which responds to input signals to first de-energize one of the windings of the other receiving relay, secondly to energize another winding thereof in series with a winding of one of said retransmitting relays, and lastly to retransmit through the line-winding of said other receiving relay a signal to which said relay remains unresponsive.

4. In a single line telegraph repeater a pair of relays, the first of which is a line relay responsive to input signals and the second of which retransmits under control of the first, a second pair of relays similar to the first pair but rendered inactive while the first pair is active, a normally energized biasing winding and a normally deenergized holding winding for said line relays; a circuit including the back contact of the active line relay, a winding of its associated retransmitting relay and said normally deenergized holding winding of the line relay to be rendered inactive, another circuit including said normally energized biasing winding of the last named relay and the front contact of the active line relay, and means to introduce the same lag between input and output signals whether changing from marking to spacing or from spacing to marking.

5. In a single line telegraph repeater two active and two inactive but alternatively serviceable relays, armature tongues with contacts, actuating and line connected windings therefor, one of which is normally de-energized, means rendered operative by input signals to retransmit through one of said inactive relays after rendering the latter unresponsive to changes of condition in its line winding, and a condenser arranged to discharge through one of the windings of said inactive line relay when the armature of one of the active relays moves from its spacing contact.

6. In a single line telegraph repeater two active and two inactive but alternatively serviceable relays, armature tongues with con-

tacts, actuating and line connected windings therefor, means rendered operative by input signals to retransmit through one of said inactive relays after rendering the latter unresponsive to changes of condition in its line winding, and a condenser arranged to discharge through a normally deenergized holding winding of said inactive line relay during the travel time of the armature tongue of the active line relay from spacing to marking and until the current in the line winding has built up to a point greater than the value of the opposing biasing winding.

7. In a single line telegraph repeater two polar line relays comprising three winding circuits each, two auxiliary relays, armature tongues and contacts for said relays, a line circuit which includes a winding of one line relay and a contact and armature of an auxiliary relay, a biasing circuit which includes a winding of one line relay and the front contact and armature of the other line relay, a holding circuit including a winding of one line relay which is connected in shunt with a condenser, a winding of one auxiliary relay and the back contact of the other line relay, and means to operate two of said relays while the other two relays are held inactive.

8. In a single line telegraph repeater comprising two line relays and two retransmitting relays, the method of rendering one of said line relays unresponsive to retransmitted marking signals which consists in prolonging the effect of a holding winding on said line relay by discharging a condenser through said holding winding when the armature tongue of the other line relay leaves its spacing contact.

9. In a single line telegraph repeater comprising two line relays and two retransmitting relays, the method of rendering one of said line relays unresponsive to retransmitted spacing signals which consists firstly, of de-energizing a winding normally biased in opposition to the line connected winding, secondly, of energizing another winding of said line relay with a bias in support of the line connected winding, and lastly, of de-energizing the line connected winding on retransmission of the spacing signal.

10. In a single line telegraph repeater connected to two loop circuits, a line relay in each loop circuit responsive to incoming signals thereon, a biasing winding and a normally deenergized holding winding for each line relay connected respectively to the front and back contacts of the other line relay, and two retransmitting relays each of which has a contact and armature in one loop circuit and a winding responsive to the operation of the line relay which is included in the other loop circuit.

11. In a single line telegraph repeater two active and two inactive but alternatively

serviceable relays, armature tongues with contacts, a line winding, a biasing winding and a normally deenergized holding winding, means rendered operative by input signals to retransmit through one of said inactive relays after rendering the latter unresponsive to changes of condition in its line winding, and a condenser arranged to discharge through said normally deenergized holding winding of said inactive line relay during the travel time of the armature tongue of the active line relay from spacing to marking and until the current in the line winding has built up.

12. In a single line telegraph repeater comprising two line relays and two retransmitting relays, a line connected winding, a biasing winding and a holding winding for each line relay, an operating winding for each retransmitting relay, and means responsive to the operation of the line relay which receives signals to successively modify the energizing forces in the three windings of the other line relay so as to render the latter unresponsive to retransmitted signals.

13. The invention set forth in claim 12 in which each line relay controls its own retransmitting relay so that one of said retransmitting relays is held inoperative until the direction of signal transmission is reversed.

14. A single line telegraph repeater comprising line relays responsive to incoming signals, two alternatively and opposingly energizable windings one of which is normally de-energized and line connected windings for each line relay to render the same unresponsive to outgoing signals and retransmitting relays at least one winding of which is in series with one of the first named opposingly energizable windings.

15. In a single line telegraph repeater comprising two line relays and two retransmitting relays, means to prevent distortion of the retransmitted signals comprising two line relays their armatures having marking and spacing contacts and their cores being triple wound, interconnections between the contacts of each line relay and two windings respectively of the other line relay, one of said windings being releasable when said line relay armature leaves its marking contact and operable upon re-contacting therewith, the other of said windings being operable when said line relay armature reaches its spacing contact and releasable upon leaving the same, and connections between the spacing contact of each line relay and the operating winding of its associated retransmitting relay so as to operate the latter to retransmit a spacing signal when the operative line relay armature reaches its back contact and to retransmit a marking signal with a lag behind the departure of said line relay armature from said back contact equivalent to the travel time of the armature of said retransmitting relay.

16. In a telegraph repeater two relays either one of which responds to incoming signals, two retransmitting relays each operable from one of said signal-responsive relays, an operating winding for each retransmitting relay in series with a normally deenergized holding winding of another of said relays, and a condenser to prolong the energization of said holding winding until after the retransmitted signal strength has been built up.

17. In a single line repeater, the combination of a pair of polar line relays each having a line winding, a biasing winding and a normally de-energized holding winding, an energizing circuit for each biasing winding including a contact of the other line relay, and an energizing circuit for each holding winding including a contact of the other line relay.

18. In a single line repeater, the combination of two sets of relays each set comprising a polar line relay and an associated retransmitting relay, each of said line relays having a line winding, a biasing winding, and a normally de-energized holding winding, an energizing circuit for each biasing winding including a contact of the other line relay, an energizing circuit for each holding winding including a winding of the associated re-transmitting relay and a contact of the other line relay, and biasing means for each of said re-transmitting relays.

19. In a single line repeater, the combination of two sets of relays each set comprising a polar line relay and an associated retransmitting relay, each of said line relays having a line winding, a biasing winding, and a normally de-energized holding winding, an energizing circuit for each biasing winding including a contact of the other line relay, an energizing circuit for each holding winding including a winding of the associated retransmitting relay and a contact of the other line relay, a condenser associated with the energizing circuit of each holding winding and adapted when said energizing circuit is opened to discharge through its associated holding winding in a direction to prolong the energization of said holding winding, and biasing means for each of said retransmitting relays.

20. In a single line repeater, the combination of a pair of polar line relays each having a line winding, a biasing winding and a normally de-energized holding winding, an energizing circuit for each biasing winding including a contact of the other line relay, an energizing circuit for each holding winding including a contact of the other line relay, a condenser associated with the energizing circuit of each holding winding and adapted when said energizing circuit is opened to discharge through its associated

holding winding in a direction to prolong the energization of said holding winding.

21. In a single line repeater, the method of rendering a line relay irresponsive to marking signals re-transmitted through a line winding thereof, which comprises discharging a condenser through a holding winding of said relay in order to prolong the energization of said winding until the current in said line winding has been built up to its normal strength.

22. A telegraph repeater comprising, incoming and outgoing lines, a relay controlled jointly by biasing and holding circuits and the outgoing line circuit, means to open the line outgoing circuit to repeat a signal, and means to render the biasing circuit ineffective and the holding circuit effective before the opening of the outgoing line circuit.

23. A telegraph repeater comprising incoming and outgoing lines, a relay controlled jointly by biasing and holding circuits and by the outgoing line circuit, means to close the outgoing line circuit to send a marking signal, means to open the holding circuit and then close the biasing circuit, and means for maintaining the holding circuit effective to hold the relay after the closure of the biasing circuit and until current in said outgoing line circuit has reached a value sufficient to hold said relay.

In witness whereof, I hereunto subscribe my name this 17th day of June, 1930.

FREDERICK G. HALLDEN.