Aug. 7, 1934. W. S. SPARKS 1,969,483

TELEGRAPH REPEATER

Filed Nov. 30, 1929 3 Sheets-Sheet 1

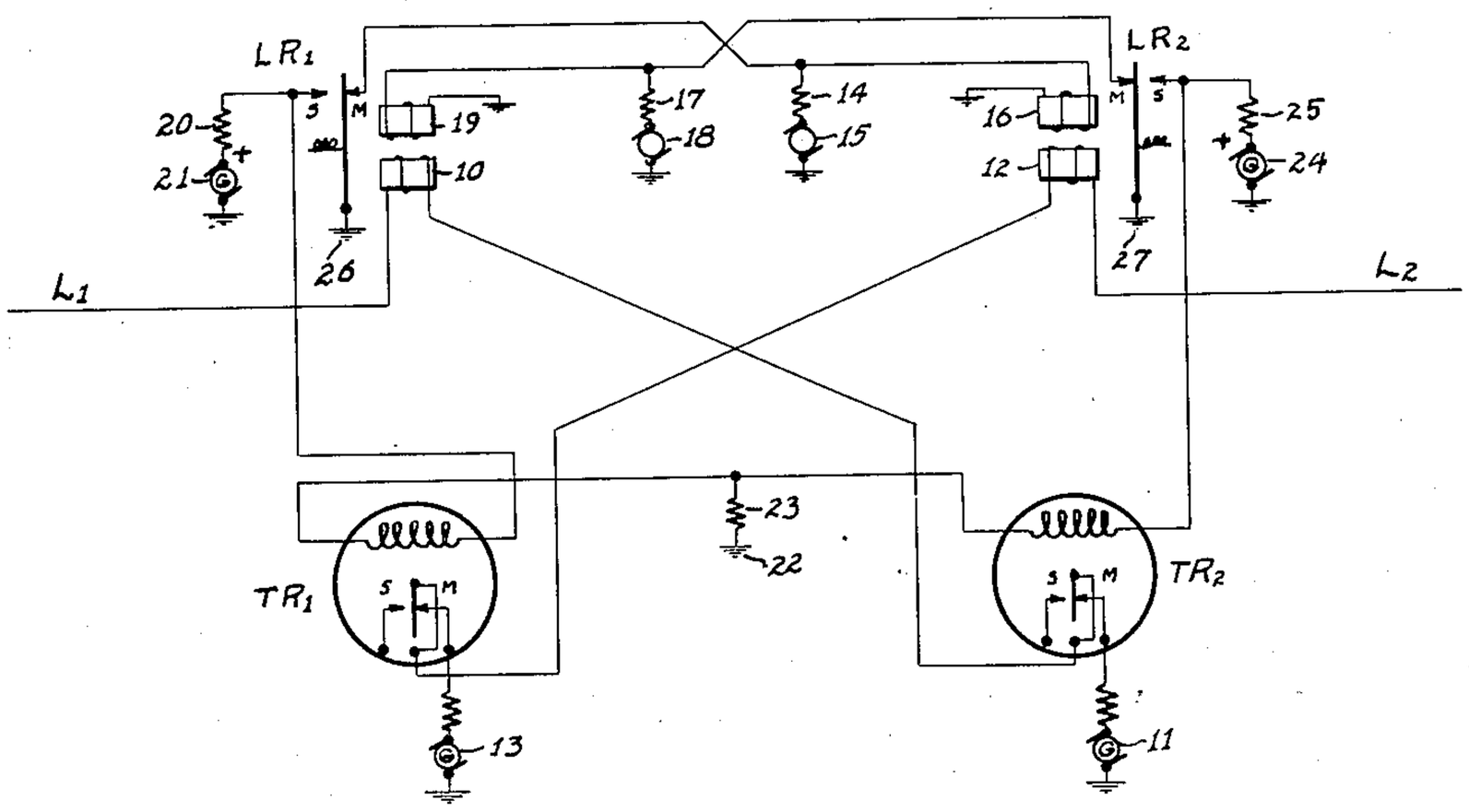

Fig. 1

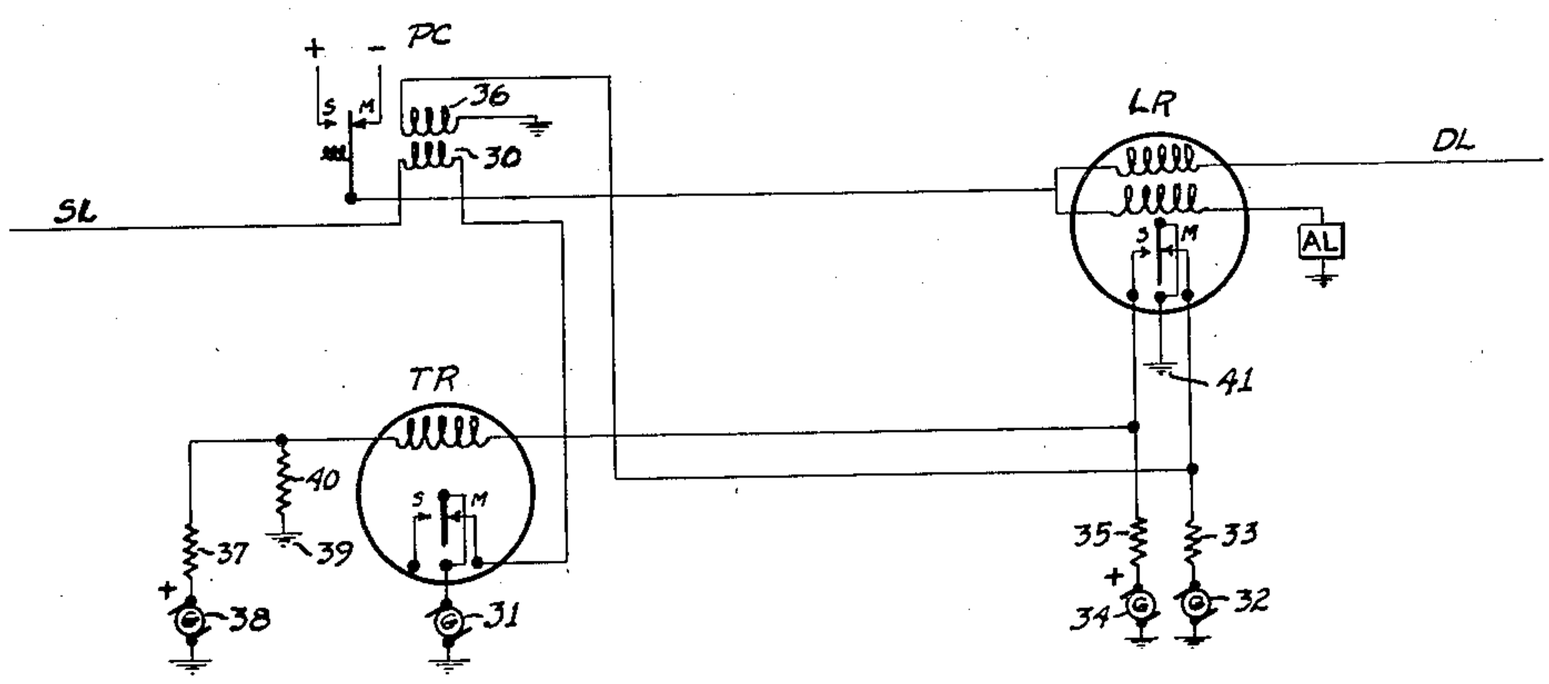

Fig. 2

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TELEGRAPH REPEATER

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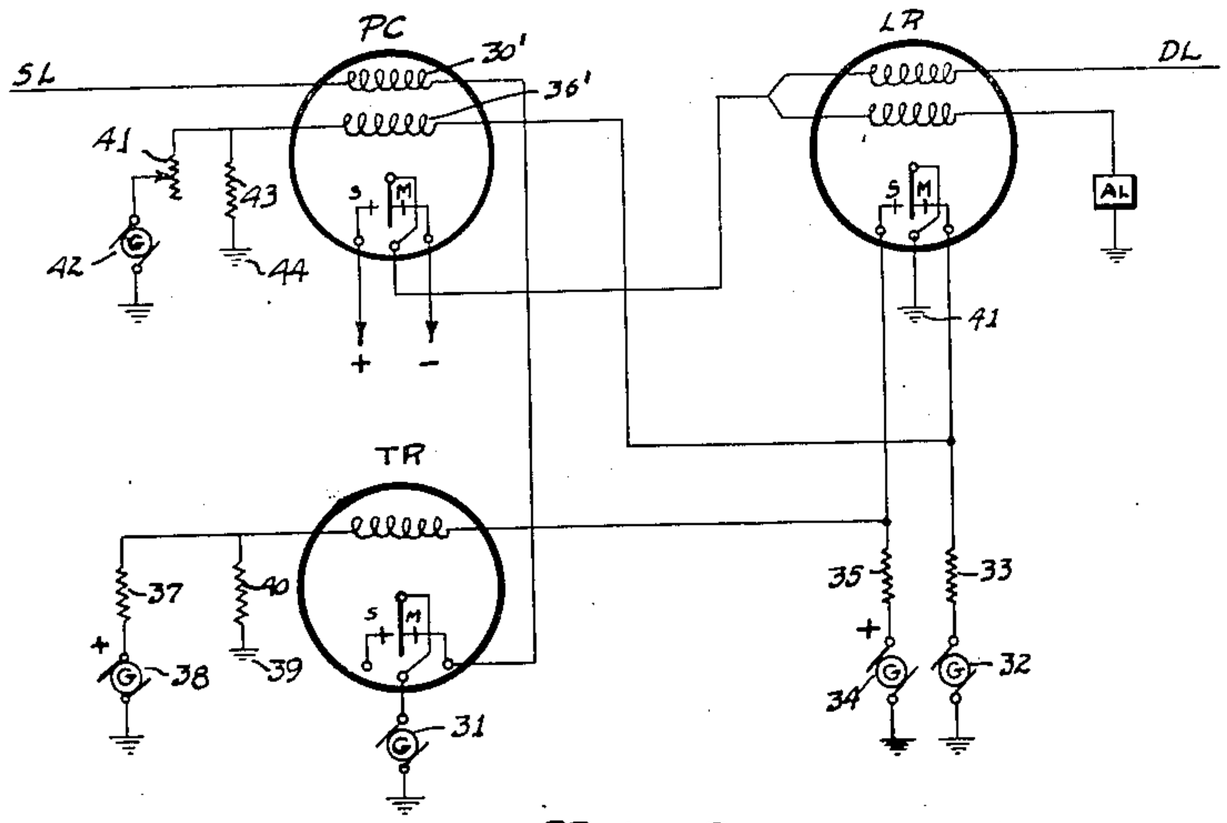

Fig. 3

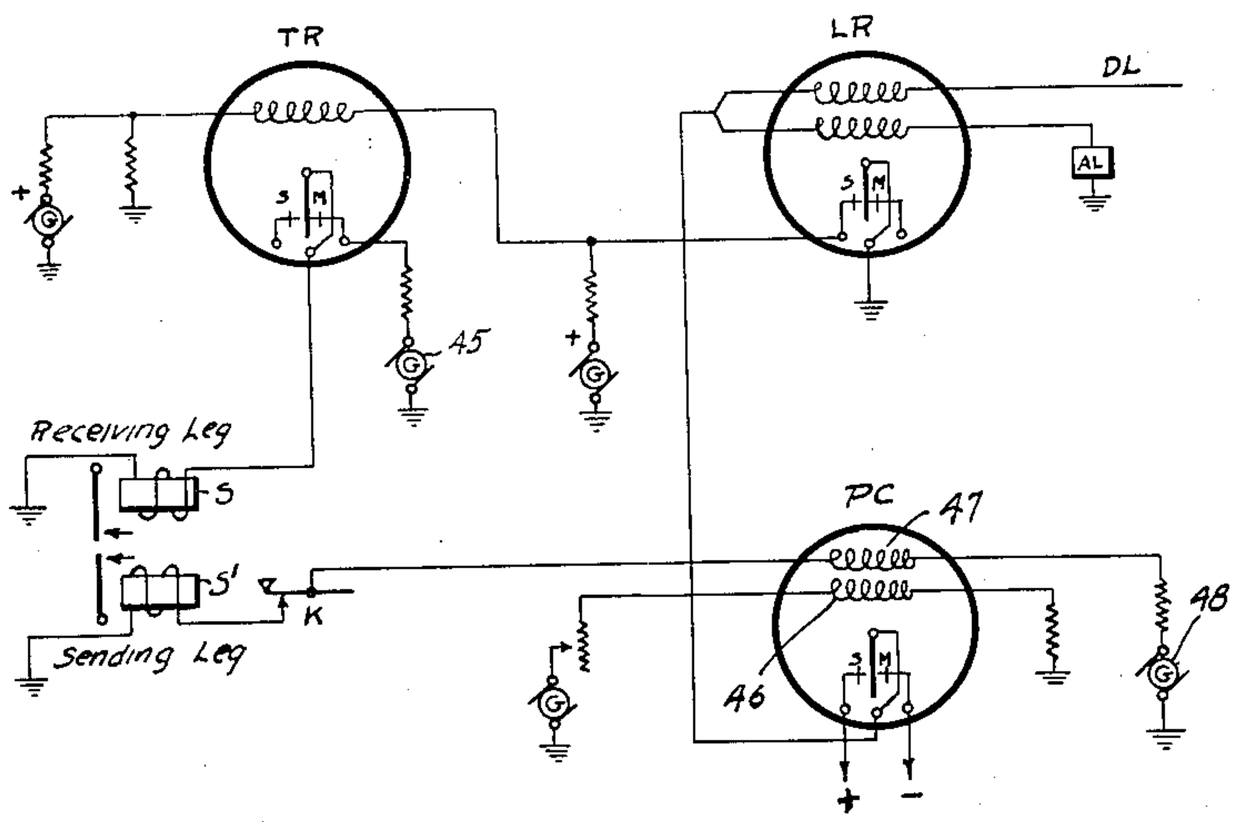

Fig. 4

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TELEGRAPH REPEATER

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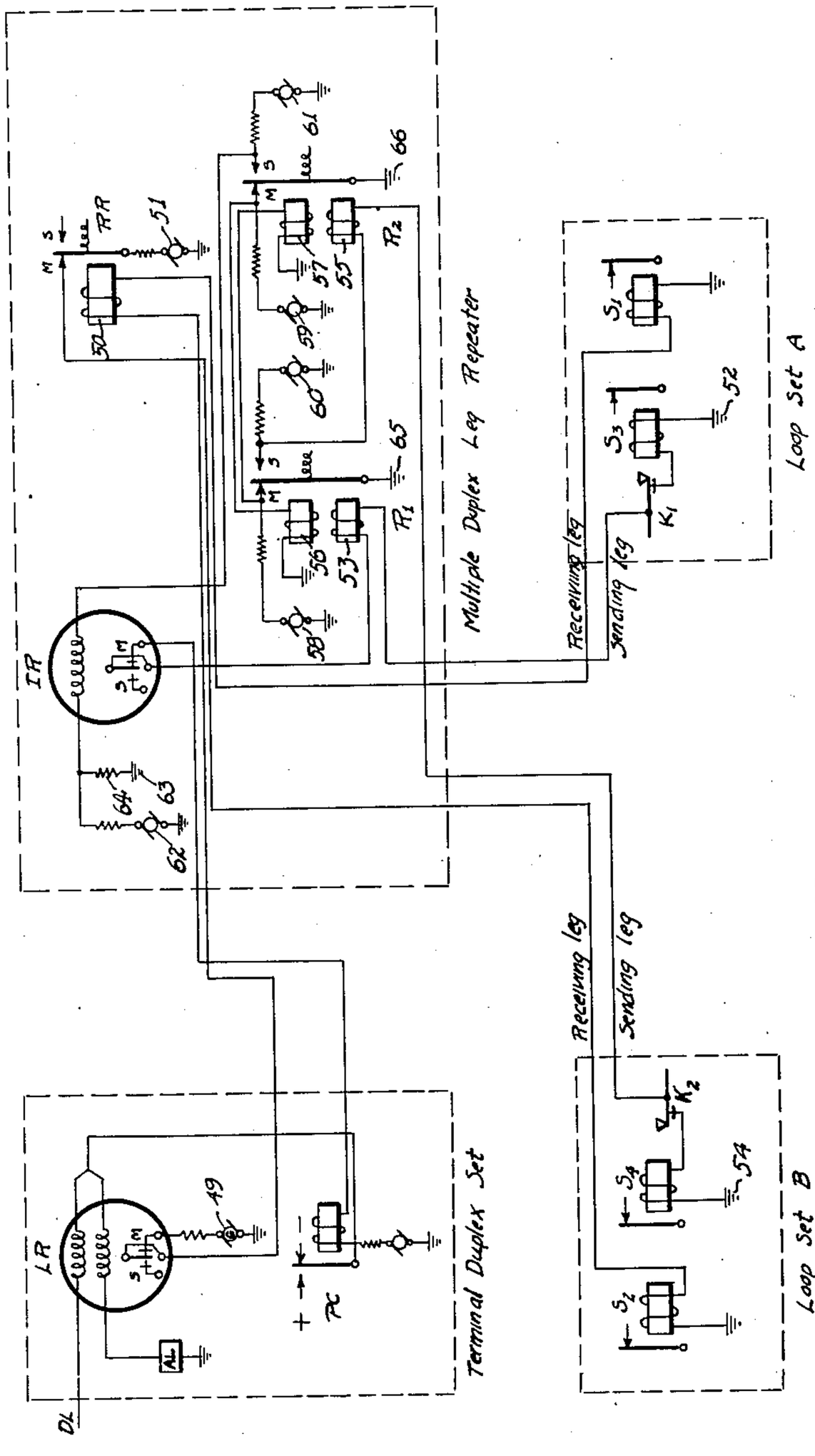

Fig. 5

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UNITED STATES PATENT OFFICE

1,969,483

TELEGRAPH REPEATER

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Application November 30, 1929, Serial No. 410,752

14 Claims. (Cl. 178—71)

This invention relates to a telegraph system and more particularly to improvements in arrangements for repeating signals in such systems. It is applicable to single line repeaters, full duplex repeaters or duplex half repeaters and is especially advantageous in connection with telegraph systems employing machine transmitting and receiving apparatus such as printing telegraph machines operating at a high speed, although it is not limited thereto.

In printing telegraph systems as commonly employed the signals are transmitted in accordance with a five or six unit code composed of combinations of marking and spacing impulses. The signals may be transmitted through the keyboard of a printing machine or by a tape transmitter or other form of storage transmitter and the marking and spacing impulses comprising each signal train are transmitted at a predetermined speed and are of equal duration. The printing mechanism operates in synchronism with the transmitting apparatus and responds to each signal combination to effect the printing of a particular letter or character.

For the sake of economy it is desirable to operate the system at the maximum speed at which the printing mechanism will satisfactorily operate, which is considerably above the speeds heretofore employed in telegraph transmission. At such speeds only a limited and definite time is available for the marking and spacing impulses to accomplish their function. Any distortion of the signals, such as the lapping over of a marking signal into the period allotted to a spacing signal or the shortening of a signal impulse of either spacing or marking character may cause the improper operation of the printing mechanism. It is essential therefore, for high speed operation that marking and spacing impulses of substantially equal duration should be transmitted to the printing mechanism.

There is a tendency, however, inherent in the usual telegraph repeater construction, due to time consumed by the various relay tongues in travelling between their stationary contacts, for the marking and spacing impulses to be repeated of slightly different length from the received impulses. This distortion of the signal impulses is accumulative and in long lines involving a number of repeating sets it becomes a source of serious difficulty.

Accordingly, it is one of the objects of the present invention to produce a high speed telegraph repeater in which the marking and spacing signals transmitted by the repeater will be of the same duration as the incoming signals.

Another object is to produce a repeater in which the repeating or retransmitting relay is equally susceptible to both spacing and marking signals and in which the reversing of current through the retransmitting relay winding is accomplished by means of a single contact of the receiving relay.

Another object is to provide a rapid and sensitive arrangement for effecting current reversals in the retransmitting or other relays of a telegraph system and in which sparking at the contacts of the controlling relay is substantially absent.

A still further object is to provide a novel locking arrangement for preventing the repeating of spacing signals back over the line from which the signals are being received and to reduce the period during which the locking winding is energized.

Other objects and advantages will appear more fully from the detailed description of invention hereinafter given.

In accordance with my invention I employ a polarized transmitting or repeating relay having a source of potential of the same polarity joined to each terminal thereof, one terminal being grounded through an appreciable resistance, and the other terminal being grounded, in response to spacing signals, through the spacing contact of the receiving relay. A locking circuit is also provided to prevent repetition of the signals into the line from which they are being received, the locking circuit being controlled entirely through the marking contact of the line relay. With this arrangement only two contacts are required on the line relay to control both the locking circuit and the reversals of current in the repeating relay. The necessity of employing double contact relays with slow acting spring contacts is thus avoided and an arrangement is provided which enables the repeated signals to be of exactly the same duration as the received signals. Moreover, the repeating relay is rendered extremely rapid in operation since the spacing current through the winding thereof is entirely removed when the marking current is applied and vice versa, so that neither the spacing nor the marking currents have any biasing force to overcome.

The repetition of marking and spacing signals of equal lengths with the received signals is accomplished by making the travel time of the tongue of the receiving relay, in a spacing direction, a part of the marking signal and the travel

time of the tongue of the repeating relay, in a marking direction, a part of the spacing signals. The constants of the system may be adjusted so that the tongues of both relays have equal travel periods whereby one exactly compensates for the other.

In order that the invention may be more fully understood, reference will be had to the accompanying drawings in which:

Figure 1 is a circuit diagram of a single line repeater embodying my invention;

Figure 2 is a circuit diagram of a duplex half repeater employing a neutral pole changing relay and embodying the invention;

Figure 3 is a circuit diagram similar to Figure 2 except employing a polarized pole changing relay;

Figure 4 is a circuit arrangement of a terminal duplex set; and

Figure 5 is an arrangement permitting the connection of a plurality of sending and receiving legs to a terminal duplex set.

Referring first to Figures 1 and 2, single lines L_1 and L_2 are shown associated with a single line through repeater, the parts of which are diagrammatically represented. The line L_1 is connected to one terminal of the winding of the line magnet 10 of the line relay LR_1, the opposite terminal of the winding of the line magnet being connected to the contact tongue of the transmitting relay TR_2. The marking contact of transmitting relay TR_2 is connected to a grounded source of potential, such as a generator 11. Likewise line L_2 is connected through the winding of the line magnet 12, of the line relay LR_2, to the tongue of the transmitting relay TR_1, the marking contact of which is joined to the grounded source potential 13.

The line relays LR_1 and LR_2 are neutral relays and the transmitting relays TR_1 and TR_2 are polarized relays, although it is to be understood that the line relays may also be polarized if desired.

The front or marking contact of line relay LR_1 is connected through a resistance 14 to a grounded source of potential 15 and also to one terminal of the locking winding 16 of the line relay LR_2, the opposite terminal of which is grounded. The marking contact of relay LR_2 is similarly connected through the resistance 17 to a grounded source of potential 18 and also to the locking winding 19 of line relay LR_1, the opposite terminal of which is grounded.

The spacing or back contact of relay LR_1 is connected through a resistance 20 to a source of potential 21 and also to one terminal of the winding of transmitting relay TR_1. The opposite terminal of this winding is connected to the ground 22 through a resistance 23. Likewise the spacing contact of line relay LR_2 is connected to a source of potential 24, of like polarity to the generator 21, through a resistance 25. The contact is also connected through the winding of transmitting relay TR_2 and resistance 23 to the ground at 22. The tongues of relays LR_1 and LR_2 are grounded at 26 and 27 respectively.

The operation of the repeater is as follows:

If a marking signal is being transmitted over line L_1 the armature tongue of each of the relays will be on its marking contact as shown in Figure 1. The locking magnets 16 and 19 will be short circuited through marking contacts and tongues of the line relays LR_1 and LR_2 respectively, and the locking windings will, therefore, be unenergized. The windings of transmitting relays TR_1 and TR_2 will be energized from the generators 21 and 24 respectively, the current flowing through the operating windings thereof in a marking direction, to the ground 22.

If a spacing signal is transmitted over line L_1 the tongue of line relay LR_1, in response thereto, will move to its spacing contact. As it leaves the marking contact the short circuiting ground 26 is removed from the locking magnet 16 and the source of potential 15 is applied thereto, thus locking the tongue of relay LR_2 against its marking contact so as to prevent the repetition of the spacing signal back over the line L_1. When the tongue of the relay LR_1 reaches its spacing contact the generator 21 is grounded therethrough and thereby in effect removed from the winding of the transmitting relay TR_1. At the same time the current flowing from the generator 24 through the winding of transmitting relay TR_2 is partially diverted from the ground 22 and flows through the winding of transmitting relay TR_1 in a spacing direction and thence to the ground 26 through the tongue of the relay LR_1. The tongue of transmitting relay TR_1 is thus moved to its spacing contact to repeat the spacing signal over the line L_2.

It will be noted that the tongue of relay LR_2 was locked on its marking contact prior to the retransmission of the spacing signal through the line magnet 12 and that the travel time of the tongue of relay LR_1, in a spacing direction, was a part of the marking signal. The travel time of the tongue of the transmitting relay TR_1, in a spacing direction was not a part of the marking signal, however, since the spacing signal was repeated over line L_2 as soon as the tongue of relay TR_1 left its marking contact.

It should be further noted that, at the instant spacing battery 24 was applied to the winding of transmitting relay TR_1 the marking battery 21 was removed therefrom so that the spacing battery had no biasing force to overcome. Hence the relay tongue was able to respond rapidly to a spacing current of low value.

The reversal of current through the transmitting relay, was accomplished through a single contact of the relay LR_1 leaving the other contact free to control the locking magnet 16. These features permit high speed operation of the repeater.

Upon the transmission of a marking signal over the line L_1 the tongue of relay LR_1 leaves the spacing contact and in so doing removes the short circuiting ground 26 from the generator 21, thereby applying this source of potential to the winding of transmitting relay TR_1 in a marking direction and thus causing the tongue thereof to move to its marking contact. The marking signal is not repeated to the line L_2, however, until the tongue of relay TR_1 reaches its marking contact, whereby the travel time of the relay tongue becomes a part of the preceding spacing signal. By adjusting the constants of the system so that the travel time of the line relays in a spacing direction is equal to the travel time of the tongues of the transmitting relays in a marking direction, the travel time of the former, applied to the marking signals, will exactly compensate for that of the other, applied to the spacing signals, and marking and spacing signals of equal durations will be repeated over the lines.

Upon contact of the tongue of relay LR_1 with its marking contact the source of potential 15 is grounded so that the current falls to zero in the locking winding 16. The removal of the locking force from the relay LR_2 is simultaneous with the

repetition of the marking signal over line L_2, since the travel time of the tongues of relays LR_1 and TR_1 is equal. This permits the maximum time to be available in which a "break" signal, transmitted over line L_2, will be effective. Thus, if the operator at the end of the line L_2, attempts to break in on the line during the period when the tongue of the relay LR_2 is locked on its marking contact, the break will be ineffective to operate the relay tongue. It will also be ineffective when the tongue of relay TR_1 is away from its marking contact. Therefore, any overlap of the energization of the locking magnet 16 on the marking signal being repeated over line L_2 will reduce the available period during which the operator at the end of L_2 may break in on the line. Since the break signal is limited to a short length by the machine transmitter, it may not be properly repeated to the line L_1, if the tongue of relay LR_2 is locked on its marking contact for any prolonged part of the marking signal being repeated to the line L_2.

It should be noted that the tongues of the relays LR_1 and LR_2 do not interrupt any inductive circuits but serve only to ground the generators 15, 18, 21 and 24. Consequently there will be no appreciable sparking at the contacts of these relays.

In Figure 2 I have shown my invention applied to a duplex half repeater. The single line SL is connected through the operating winding 30 of the pole changer PC and to the marking contact of the transmitting relay TR, the tongue of relay TR being grounded through a source of potential 31. The duplex line DL is connected through the differential winding of the line relay LR to the artificial line AL. The midpoint of the winding of relay LR is connected, in the usual manner, to the tongue of the pole changer PC. The marking contact of relay LR is connected to a source of potential 32 through a resistance 33 and the spacing contact is similarly connected to a source of potential 34 through a resistance 35. The marking contact is also connected to one terminal of the locking winding 36 of the pole changer, the opposite terminal of which is grounded. The spacing contact of relay LR is connected to one end of the winding of the transmitting relay TR, the opposite end of which is connected through a resistance 37 to a source of potential 38 and also to the ground at 39 through a resistance 40. The tongue of relay LR is grounded at 41.

The operation of the system is similar to the single line repeater. When marking signals are transmitted over the duplex line DL the tongues of all of the relays are on their marking contacts. The locking winding 36 of the pole changer is short circuited through the tongue of the line relay LR to the ground 41. The winding of transmitting relay TR is supplied with operating current from the generator 34 to the ground 39, the current being in a marking direction.

Upon the receipt of a spacing signal over the duplex line the tongue of the line relay leaves its marking contact and in so doing removes the ground 41 from the locking winding 36, thereby permitting the energization thereof from the generator 32. As soon as the tongue of the line relay reaches its spacing contact the generators 34 and 38 are connected to the low resistance ground 41, thus diverting current from the generator 34 from the winding of the transmitting relay TR and applying current from the generator 38 thereto in a spacing direction. The tongue of the transmitting relay is thereby moved to its spacing contact to repeat the spacing signal over the single line SL.

Upon the receipt of the succeeding marking signal over the duplex line, the tongue of the line relay LR leaves a spacing contact, thus reversing the direction of current through the winding of the transmitting relay whereby the tongue of the transmitting relay moves to its marking contact. Since the tongues of the transmitting and line relays have the same travel period they reach the marking contact of their respective relays at the same instant so that the locking winding 36 is short circuited at the same instant that the marking signal is repeated over the line SL, thus causing no overlap of the holding magnet with the repeated marking signal. As in the case of the single line repeater the travel time of the line relay is part of the marking signal and the travel time of the transmitting relay is a part of the spacing signal.

Signals transmitted over the single line SL are repeated to the duplex line and since the line relay LR does not respond thereto, it is not necessary to provide means to prevent the repetition of these signals back over the single line.

Figure 3 shows a duplex half repeater similar to that shown in Figure 2 with the exception that a polarized pole changer PC is employed in place of the neutral pole changer of Figure 2. The single line SL is connected through operating winding 30′ of the pole changer to the contacts of the transmitting relay. The marking contact of the relay LR is connected to one end of the locking winding 36′ of the pole changer, the opposite end of the winding being connected through a variable resistance 41 to a source of potential 42 and also through a resistance 43 to the ground 44. When the tongue of the line relay is on its marking contact, generators 32 and 42 are grounded through the tongue of the line relay and current is supplied from the generator 42 through the locking winding 36′ in a spacing direction to apply a spacing bias to the pole changing relay PC. When a spacing signal is received over the duplex line, the tongue of the line relay leaves its marking contact and immediately thereupon the ground 41 is removed from the generators 42 and 32, and current flows from generator 32 through the locking winding 36′ in a marking direction, to the ground 44, thus locking the tongue of the pole changing relay on its marking contact.

When signals are received over the single line the operating winding 30′ predominates over the biasing winding 36′ in response to marking signals to move the tongue of the pole changer to its marking contact and when the single line is opened to transmit spacing signals thereover, the biasing current supplied by the generator 42 moves the tongue of the pole changer to its spacing contact.

With the arrangement shown in Figure 3, it will be noted that the marking contact of the line relay controls current reversals through the locking winding of the pole changer and that the spacing contact controls current reversals through the operating winding of the transmitting relay.

It is obvious, of course, that two duplex-duplex half repeaters may be joined together to form a full duplex repeater.

In Figure 4 I have shown a terminal duplex set having a single receiving leg and a single sending leg. The transmitting relay TR has a single operating winding, current reversal being

controlled therethrough by the spacing contact and grounded tongue of the line relay. The tongue of the transmitting relay is connected to the receiving leg which includes a receiving instrument S. The marking contact of the transmitting relay is connected to a grounded source of potential 45.

The pole changer PC is provided with a biasing winding 46 for maintaining a spacing bias thereon. An operating winding 47 is also provided having one end connected to a source of potential 48 and the other end connected to the grounded sending leg. The sending leg includes a key K and a receiving instrument S'.

This arrangement permits signals to be simultaneously transmitted over the duplex line to the receiving leg and from the sending leg over the duplex line in the opposite direction. Signals received over the duplex line are repeated by the transmitting relay to the receiving leg and the make and break signals transmitted by the sending leg are repeated as positive and negative signals by the pole changer PC over the duplex line DL.

In Figure 5 I have shown a terminal duplex set combined with a multiple duplex-leg repeater and providing facilities for two loop sets each having separate receiving and sending legs. The terminal duplex set comprises a line relay LR and a pole changer PC. The marking contact of the relay LR is connected to a grounded source of potential 49 and the tongue thereof is connected through the winding 50 of a receiving relay RR, forming part of the multiple duplex leg repeater and from said winding to the receiving leg of loop set A. The tongue of the receiving relay RR is connected to a grounded source of potential 51 and the marking contact of this relay is connected to the receiving leg of loop set B. Marking and spacing signals received over the duplex line are thus repeated to the receiving legs of both loop sets and to the receiving instruments S_1 and S_2 thereof.

The sending leg of loop set A extends from a ground 52 through the operating winding of a recording instrument S_3, key K_1, operating winding 53 of a leg relay R_1 to the tongue of an intermediate relay IR and from the marking contact thereof thru the winding of the pole changer PC of the terminal duplex set to a grounded source of potential. The sending leg of loop set B extends from a ground 54 through the winding of a recording instrument S_4, key K_2 and operating winding 55 of leg relay R_2 to the back, or spacing contact of the leg relay R_1.

Relay R_1 is provided with a locking winding 56 having one end grounded and the other end connected to the marking contact of relay R_2. Relay R_2 is provided with a locking winding 57 having one end grounded and the other end connected to the marking contact of relay R_1. The marking contacts of relays R_1 and R_2 are connected to grounded generators 58 and 59 respectively and the spacing contacts of relays R_1 and R_2 are connected to grounded generators 60 and 61 respectively.

The spacing contact of relay R_2 is also connected to one end of the operating winding of the intermediate relay IR, the opposite end of this winding being connected to a grounded source of potential 62 and also to the ground 63 through a resistance 64.

Signals may be sent out over either one of the sending legs simultaneously with the receipt of signals over the duplex line and the signals transmitted by said sending leg will be repeated both to the duplex line and to the sending leg of the opposite loop set. For instance, if the key K_1 of loop set A is opened to transmit a spacing signal, this signal is repeated by the pole changer to the duplex line. At the same time the tongue of relay R_1 is released from its marking contact, thus removing the ground 65 from the generator 58 and causing the current to be supplied therefrom to the locking winding 57 of the relay R_2 to hold its tongue on its marking contact. When the tongue of the relay R_1 reaches its spacing contact the generator 60 becomes grounded at 65 and current falls to zero through the sending leg of the loop set B which is equivalent to the repetition of a spacing signal thereto. When the key K_1 is closed to transmit a marking signal, the tongue of relay R_1 moves back to its marking contact, diverting current from the locking coil 57 of relay R_2 and restoring current from the generator 60 to the sending leg of loop set B, to repeat the marking signal thereto.

When the key K_2 of loop set B is opened to transmit a spacing signal the tongue of relay R_2 leaves its marking contact and through removal of the ground 66 from the generator 59, establishes a locking circuit for the winding 56 of relay R_1, at the same time when the tongue of relay R_2 strikes its spacing contact current from generator 61 is diverted to the established ground and current flows from generator 62 through the operating winding of the intermediate relay IR in a spacing direction to repeat the spacing signal through the contacts thereof to the pole changer PC. The movement of the tongue of the relay IR from its marking contact also repeats the spacing signal to the sending leg of loop set A. Upon closing of the key K_2 to transmit a marking signal, the relay R_2 is energized, removes the ground 66 from generator 61, and applies the ground 66 to the generator 59, thus releasing the locking magnet 56 and reversing the direction of current through the winding of the relay IR and thereby repeating the marking signal both to the duplex line and to the sending leg of loop set A.

In this arrangement it will be noted that the marking contact of the relay R_2 controls the circuit to the locking winding of the relay R_1 and the spacing contact of relay R_2 controls reversals of current through the winding of the intermediate relay IR.

It will be noted that the leg connections within the terminal duplex set are of the same character as the legs themselves, that is they terminate in a ground or a grounded battery. As a consequence, another terminal duplex set may be substituted for one of the loop sets and the multiple duplex leg repeater thus utilized to connect two duplex circuits together at a repeating station and at the same time connect an intermediate operating station in the circuit. This intermediate operating station may be simply two legs in the repeating station office or it may be a distant office at the end of another duplex circuit. In either case the intermediate station could receive from either or both terminal stations, but could transmit in one direction only. The terminal station could work the duplex circuit both ways, of course.

The intermediate station would be connected in the way illustrated for loop set B, and the duplex set would be connected in the circuit in place of loop set A, the connections being arranged so that the pole changer would be in the receiving leg connection and the receiving relay of the duplex

set would be placed in the sending leg connection.

While a number of arrangements have been shown embodying one or more features of the invention, it will be appreciated that many other arrangements may be made embodying the invention and therefore, I do not desire to be limited to the particular circuit arrangements disclosed and described, except in accordance with the appended claims.

What I claim is:

1. A telegraph repeater set comprising a line relay, a polarized transmitting relay having an operating winding and means comprising the armature and a single contact of the line relay for obtaining current reversals through the operating winding of said transmitting relay.

2. A telegraph repeater set comprising a receiving relay and a repeating relay, said receiving relay through its armature controlling the operation of said repeating relay, and said repeating relay through its armature repeating the signals to a line, the travel time of the armature of the receiving relay in one direction being a part of either the repeated marking or spacing signals and the travel time of the armature of the repeating relay in the opposite direction being a part of the other repeated signal, and the travel time of the armature of both relays being substantially the same, whereby the length of each repeated signal will be substantially the same as that of the corresponding received signal.

3. A telegraph repeater set comprising a receiving relay, a polarized repeating relay and an operating winding for the repeating relay, said receiving relay in response to signals transmitted thereto controlling through its armature and one only of its contacts, reversal of current through said repeating relay, the travel time of the armature of the receiving relay from its marking to its spacing contact being a part of the marking signal and the travel time of the armature of the repeating relay from its spacing to its marking contact being a part of the spacing signal.

4. A telegraph repeater set comprising a receiving relay and a repeating relay, an operating winding for said repeating relay, said receiving relay in response to signals transmitted thereto effecting current reversals in said winding for controlling the operation of said repeating relay, the armature of said repeating relay starting its movement from the marking to the spacing contact immediately upon the arrival of the armature of the receiving relay at its spacing contact and the armature of said repeating relay starting its movement from its spacing to its marking contact when the armature of the receiving relay leaves its spacing contact.

5. In a telegraph system a polarized relay having an operating winding, a second relay and means comprising the armature and one only of the contacts of said second relay for controlling the reversal of current through the winding of said polarized relay.

6. A telegraph repeating set comprising two receiving relays, a repeating relay, an operating winding for the repeating relay, a locking circuit for one of the receiving relays, a source of current for said circuit, means for controlling said locking circuit comprising a shunt path for said source of current completed through the armature and marking contact of the other receiving relay and means for controlling the operation of said repeating relay comprising a low resistance return path for the operating winding thereof, said path being completed through the armature and spacing contact of the last mentioned receiving relay.

7. In a telegraph system, a polarized relay having an operating winding and means for obtaining current reversals through said winding, comprising a source of potential of the same polarity connected to each terminal of said winding, a high resistance return path for each of said sources of potential connected to one terminal of said winding and a low resistance return path for each of said sources of potential connected to the opposite terminal of said winding and means for opening and closing said low resistance return path to obtain reversals in the direction of current in said operating winding.

8. A telegraph repeater set comprising two receiving relays, a repeating relay, a locking circuit for one of said receiving relays, an operating circuit for said repeating relay, means comprising the armature and marking contact of one of the receiving relays for obtaining reversals of current in the locking circuit of the other receiving relay and means comprising the armature and spacing contact of the first mentioned receiving relay for obtaining current reversals in the operating circuit of the repeating relay.

9. A telegraph repeater set comprising a receiving relay, a repeating relay and a pole changing relay, said receiving relay responding to signals received over one line and said repeating relay repeating the signals over a second line, a locking circuit for said pole changing relay and means acting upon the receipt of a spacing signal by said receiving relay to energize the locking circuit to hold the armature of the pole changing relay on its marking contact and means acting simultaneously with the repetition of a marking signal over said second line to release said armature.

10. A telegraph repeater comprising two receiving relays, a repeating relay, a locking winding for one of said receiving relays, a grounded armature and a marking and a spacing contact for the other receiving relay, a grounded source of potential having one terminal connected to said locking winding and to said marking contact, a second grounded source of potential having one terminal connected to the winding of the repeating relay and to said spacing contact, whereby said first source of potential is shunted around said locking winding when said armature is on its marking contact and the second source of potential is shunted around the winding of said repeating relay when said armature is on its spacing contact.

11. In a telegraph system, a polarized relay, an operating winding therefor, a source of potential for applying current in a marking direction through said winding and a second source of potential for applying current in a spacing direction therethrough, a receiving relay and means controlled by a single contact of said receiving relay, acting upon the receipt of a marking signal to render said second source of potential ineffective with respect to said winding and to apply current to said winding from the first source of potential and means acting upon receipt of a spacing signal to render said first source of potential ineffective with respect to said winding and to apply said second source of potential thereto.

12. In a telegraph system, a first line section, a second local section, a polarized line relay having a single winding, means to cause said relay to repeat signals from one line section to the other, and electrical connections including a two-point

switch whereby the current through said polarized relay is reversed in direction in response to the opening and closing of said switch.

13. In a telegraph system, a first line section, a second line section, a receiving relay having a winding connected in one section, a polarized relay having a single winding adapted to transmit signals over said second section, and means to reverse the direction of current in the polarized relay under control of the receiving relay.

14. In a telegraph repeater, a Wheatstone bridge arrangement of conductors comprising four arms and a detector conductor, a line relay with its contacts in one bridge arm whereby it controls the polar sense of current through said detector conductor, and a polar repeating-relay having a single winding, said single winding included in said detector conductor.

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