

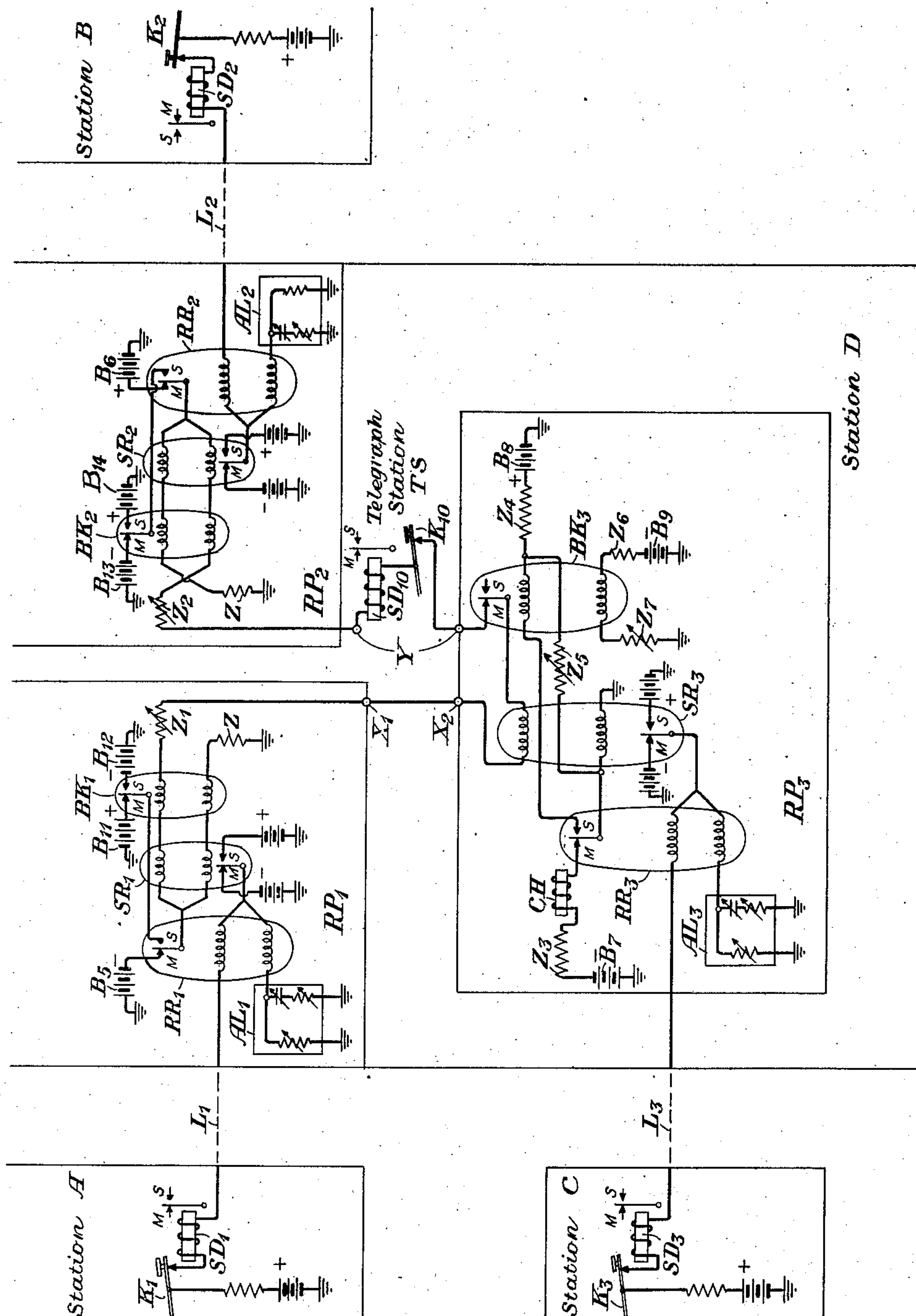
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TELEGRAPH REPEATER SYSTEM

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TELEGRAPH REPEATER SYSTEM

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This invention relates to telegraph systems. More particularly, this invention relates to repeaters for telegraph systems which are arranged to repeat signals simultaneously from any one of a plurality of stations to all of the other stations of the system.

Heretofore two telegraph stations were connected to each other by two repeaters having balanced or differential loops, one of such loops being associated with each telegraph station, each repeater serving to repeat the signals in opposite directions between the station with which it is associated and the repeater associated with the other telegraph set. When adding a third telegraph station having a balanced or differential loop, the balanced loop system being arranged to permit signaling from any one of the telegraph stations to the other stations simultaneously, it has been necessary heretofore not alone to provide a third repeater similar to the other two, but also to furnish a single line repeater as a fourth repeater. Unless the fourth or single line repeater was added to the other three repeaters of the system, it was impossible to transmit signals from any one of the stations to all of the other stations simultaneously.

In accordance with this invention it is proposed to interconnect three or more stations to each other by but three repeaters and arrange the system so that any one of the stations may transmit signals to all of the other stations simultaneously. More generally, it is proposed to interconnect three or more different telegraph stations to each other by repeaters which are equal in number to the number of telegraph stations in the system. The arrangement proposed in accordance with this invention will omit the single line repeater such as has been found necessary heretofore in such installations. The omission of the single line repeater considerably reduces the amount of equipment required for interconnecting three or more stations and, therefore, materially reduces the cost and maintenance of such systems. The proposed invention is especially useful at times when it is impossible to obtain such additional equipment.

This invention will be better understood from the more detailed description hereinafter following when read in connection with the accompanying drawing showing one embodiment of the invention merely for the purpose of illustration.

Referring to the drawing, three telegraph stations located at widely different points and designated A, B and C are shown connected to a common repeater station D by means of lines

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L₁, L₂ and L₃, respectively. Station A includes a key K₁ and a sounder SD₁, the station B a key K₂ and a sounder SD₂, and station C a key K₃ and a sounder SD₃. The line L₁ connects station A with the line terminal of a repeater RP₁ at station D. The line L₂ connects station B with the line terminal of a repeater RP₂ at station D. The line L₃ connects station C with the line terminal of a repeater RP₃ at station D. The loop terminals of repeaters RP₁ and RP₂ are connected to each other through the equipment of a telegraph station TS and through a circuit of repeater RP₃ which may be considered as the loop of repeater RP₃. The telegraph station TS includes a key K₁₀ and a sounder SD₁₀. This telegraph station may be located at the repeater station D or it may be some distance away from the repeater station D. The circuits of repeaters RP₁ and RP₂ are of the balanced or differential loop type and are the same as those heretofore embodied in repeaters interconnecting two telegraph stations such as A and B. The third repeater RP₃ at station D, however, has been modified so that it may be joined to the loop terminals of the other two repeaters at station D to enable signals to be transmitted from any one of the three (or more) stations to the other stations of the system simultaneously.

When no signals are being transmitted through the system, the keys at the various stations will be in their closed positions. The current traversing the upper winding of the receiving relay RR₁ of repeater RP₁ will be in a marking direction and this current will exceed the current in a spacing direction traversing its lower winding, thereby holding the armature of relay RR₁ on its marking contact M. There will also be a large flow of current through the upper windings of the sending and break relays SR₁ and BK₁ of repeater RP₁, and through the lower windings of the break and sending relays BK₂ and SR₂. This current will be in a marking direction and sufficient in magnitude to overcome the spacing current flowing in the other windings of these relays. Thus the armatures of relays SR₁, BK₁, BK₂ and SR₂ will be held on their marking contacts M. The marking currents just referred to will flow over a circuit which includes battery B₅, the armature and marking contact M of relay RR₁, the upper windings of relays SR₁ and BK₁, resistor Z₁, the upper winding of relay SR₃ of repeater RP₃, the armature and marking contact M of relay BK₃ of repeater RP₃, key K₁₀ and the winding of sounder SD₁₀ of telegraph station TS, resistor Z₂, the lower windings of relays

BK₂ and SR₂, the armature and marking contact M of relay RR₂, battery B₆ and ground. There will also be a flow of current in the upper winding of the receiving relay RR₂ in a marking direction and of a magnitude which will exceed the current in the lower winding of this relay which is in a spacing direction, thereby holding the armature of this relay also on its marking contact M.

The upper winding of relay RR₃ of repeater RP₃ will also receive current in a marking direction of greater magnitude than the current in the spacing direction flowing through its lower winding, thereby holding the armature of relay RR₃ on its marking contact M. The lower winding of relay SR₃ may be considered as receiving opposing currents from batteries B₇ and B₈. The battery B₇ is connected to the lower winding of relay SR₃ over a circuit which includes battery B₇, resistor Z₃, the coil CH, the armature and marking contact M of relay RR₃, and the lower winding of relay SR₃ and ground. The current from battery B₇ will be a large current of, for example, 60 ma. and it will be in a spacing direction in the lower winding. The current from battery B₈ will flow over a circuit which includes battery B₈, resistor Z₄, resistor Z₅, the lower winding of relay SR₃ and ground. This current will be of a smaller magnitude of, for example, 30 ma., and it will flow in the opposite direction tending to move the armature to its marking contact M. However, the current from battery B₇ will overcome that of battery B₈, yielding a resultant current of about 30 ma. which is in a spacing direction. At the same time current will be traversing the upper winding of relay SR₃ which is connected to repeaters RP₁ and RP₂ through the armature and marking contact M of relay BK₃ and the equipment of telegraph station TS. The current through this upper winding of relay SR₃ will be a large current of about 60 ma. and in a marking direction, and the marking effect of the latter current will overcome the spacing effect produced by the resultant current from the batteries B₇ and B₈ traversing the lower winding of relay SR₃. Consequently, the armature of relay SR₃ will be held on its marking contact M.

While no signals are being transmitted over the system and the keys of the various stations are held closed as already stated, the lower winding of relay BK₃ of repeater RP₃ will receive a current from battery B₉ which is in a marking direction. This current flows from battery B₉, through resistor Z₆, the lower winding of relay BK₃, resistor Z₇ and ground. The upper winding of relay BK₃ will be devoid of current because it is open-circuited at the spacing contact S of the relay RR₃. The dominating current through the lower winding of relay BK₃ will, therefore, hold the armature of this relay on its marking contact M.

Station C may transmit signals over line L₃ to repeater RP₃ which will repeat the signals to repeaters RP₁ and RP₂ and the latter repeaters in turn will repeat the signals simultaneously to the sounders at stations A and B, respectively. When key K₃ at station C is opened for the purpose of transmitting a spacing signal, there will be an absence of current in the upper winding of relay RR₃ so that the current in the lower winding of relay RR₃, which is in a spacing direction, will move the armature of relay RR₃ to its spacing contact S. As the armature of relay RR₃ leaves its marking contact M and is still "in the

air," the current from battery B₇ previously flowing through the lower winding of relay SR₃ will be removed from this lower winding and hence the only current through the latter winding will be that supplied from battery B₈ through resistors Z₄ and Z₅. This current, as already noted, may be a 30 ma. current, and it produces a marking effect on the armature of the relay. This increases the holding action on the armature of relay SR₃ to retain this armature on its marking contact M. When the armature of relay RR₃ reaches its spacing contact S, additional current will be supplied to the lower winding of relay SR₃ to hold the armature of relay SR₃ on its marking contact M. This additional current will flow from battery B₈, through resistor Z₄, the upper winding of relay BK₃, the armature and spacing contact S of relay RR₃, the lower winding of relay SR₃ and ground. This additional current, which may be of 60 ma., will be in a marking direction as already pointed out, so that a large resultant marking current will traverse the lower winding of relay SR₃. The armature of the relay SR₃ will, therefore, be held on its marking contact M even when the flow of current through its upper winding will be interrupted as will be explained hereinafter. The object in holding the armature of relay SR₃ on its marking contact when the key K₃ at station C is opened, is to prevent a spacing signal from being returned to station C and thereby distort and interfere with the signals to be transmitted.

Upon the closure of contact S of relay RR₃, current will flow from battery B₈ through resistor Z₄ and the upper winding of relay BK₃ and this current will be in a direction which tends to move the armature of relay BK₃ to its spacing contact S. This current, as already stated, may be of 60 ma. and it will overcome the biasing effect produced by the current through the lower winding of relay BK₃ which is in a marking direction. Consequently, the armature of relay BK₃ will move to its spacing contact S. As already stated, the opening of the marking contact M of relay BK₃ will allow the current through the upper winding of relay SR₃ to be reduced to a nullity without causing the armature of relay SR₃ to leave its marking contact M.

When the armature of relay BK₃ leaves its marking contact M, the current from batteries B₅ and B₆ traversing the circuit of the upper windings of relays SR₁ and BK₁ of repeater RP₁ and the lower windings of relays BK₂ and SR₂ of repeater RP₂ and the sounder SD₁₀ of station TS, will be interrupted. This interruption of current will cause the armatures of these relays just referred to, to move to their spacing contacts S. As the armature of relay SR₁ reaches its spacing contact S, the flow of current through the upper winding of relay RR₁ over line L₁ to the winding of the sounder SD₁ will be reduced to a nullity to convey a spacing signal to station A. The armature of relay RR₁ will remain on its marking contact M because the current through the lower winding of this relay will be reversed to a marking direction. Similarly, as the armature of relay SR₂ reaches its spacing contact S, the current flowing through the upper winding of relay RR₂ over line L₂ to the sounder SD₂ will be reduced to a nullity to convey a spacing signal to station B. The armature of relay RR₂ will also remain on its marking contact M. Thus stations A and B will receive a spacing signal simultaneously from station C in response to the opening of key K₃ at station C.

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When the key K_3 at station C is then closed to transmit a marking signal to stations A and B, the armature of relay RR_3 will then be controlled by the current in the upper winding of relay RR_3 which is in a direction to move the armature of the relay to its marking contact M. When the armature of relay RR_3 leaves its spacing contact S and is "in the air," the current in the lower winding of relay SR_3 will be obtained from battery B_8 through resistors Z_4 and Z_5 , and this current will be in a marking direction. This current will alone be sufficient to hold the armature of relay SR_3 on its marking contact M. The current in the upper winding of relay BK_3 will be interrupted by the opening of the contact S of relay RR_3 , whereupon the current through the lower winding of relay BK_3 , which is in a marking direction, will cause the armature of relay BK_3 to move to its marking contact M. Upon the closure of the marking contact M of relay BK_3 , marking current from batteries B_5 and B_6 will again traverse the circuit of the upper windings of relays SR_1 and BK_1 , the upper winding of relay SR_3 , the winding of sounder SD_{10} , and the lower windings of relays BK_2 and SR_2 . Therefore the armatures of relays SR_1 , BK_1 , BK_2 and SR_2 will be caused to close their marking contacts M. The relays SR_1 and SR_2 will repeat the marking signals simultaneously over lines L_1 and L_2 , respectively, to the sounders SD_1 and SD_2 at stations A and B. The current through the upper winding of relay SR_3 , however, will be a large current of about 60 ma. in a marking direction and it will aid the current from battery B_8 which is traversing the lower winding of relay SR_3 through resistors Z_4 and Z_5 . When the armature of relay RR_3 reaches its marking contact M, the current from battery B_7 will again be supplied to the lower winding of relay SR_3 , the latter current being in a spacing direction. Although the resultant current in the lower winding of relay SR_3 is in a spacing direction, the current in the upper winding of relay SR_3 will be of greater magnitude and in a marking direction and, hence, the armature of relay SR_3 will be held on its marking contact M.

The coil CH is inserted in series with the battery B_7 for the purpose of delaying the spacing current from battery B_7 so that this current traversing the lower winding of relay SR_3 will become effective only after the upper winding of relay SR_3 has received its marking current from batteries B_5 and B_6 . This delay feature is important, for without it the battery B_7 may exert its spacing effect upon the lower winding of relay SR_3 to move its armature prematurely to its spacing contact S and thereby distort the signals intended to be transmitted to stations A and B. Thus signals may be transmitted from station C to the repeater RP_3 at station D which then repeats the same signals faithfully through repeaters RP_1 and RP_2 over lines L_1 and L_2 to stations A and B, respectively. The sounder SD_{10} of station TS will also register the same signals.

Station A may also transmit signals to the other stations. When key K_1 is opened to transmit a spacing signal to the other stations, the armature of the receiving relay RR_1 at repeater RP_1 is moved to its spacing contact S. When the armature of relay RR_1 closes its spacing contact S, battery B_{11} will be connected to battery B_6 to repeat the spacing signal to repeaters RP_2 and RP_3 . The circuit connecting batteries B_6 and B_{11} may be traced from battery B_{11} , the armature and marking contact M of relay BK_1 ,

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the armature and contact S of relay RR_1 , the upper windings of relays SR_1 and BK_1 , resistor Z_1 , the upper winding of relay SR_3 , the armature and contact M of relay BK_3 , key K_{10} , the winding of sounder SD_{10} , resistor Z_2 , the lower windings of relays BK_2 and SR_2 , the armature and contact M of relay RR_2 , battery B_6 and ground. As batteries B_{11} and B_6 are poled in mutually opposite directions, they oppose each other and there will be no current in the circuit just described. However, the armatures of relays SR_1 and BK_1 will be held against their marking contacts M due to the reversal of current through their lower windings to a marking direction. On the other hand, relays BK_2 and SR_2 will close their spacing contacts S upon the decay of current through their lower windings. The sounder SD_{10} will repeat the received spacing signal to the telegraph station TS.

The absence of current in the upper winding of relay SR_3 will then allow the lower winding of the relay SR_3 to take control of the armature of that relay. Under the latter conditions the spacing current from battery B_7 through the lower winding of relay SR_3 will exceed the marking current from battery B_8 through that winding and, hence, the armature of relay SR_3 will be moved to its spacing contact S. The relay SR_3 will then repeat the spacing signal over line L_3 to the sounder SD_3 of station C. The armature of relay RR_3 , however, will remain on its marking contact M while signals are being received from station A. The absence of current in the upper winding of relay BK_3 will allow the lower winding of relay BK_3 to retain control of the armature of the relay and, hence, the armature of the relay BK_3 will remain against its marking contact M. As the armature of relay SR_2 closes its spacing contact S, as already noted, a spacing signal will be transmitted over line L_2 to sounder SD_2 . The closure of contact S by the armature of relay SR_2 will not change the position of the armature of the relay RR_2 , the armature remaining against its contact M.

When the key K_1 at station A is closed to transmit a marking signal, the armature of relay RR_1 will close its marking contact M, thereby connecting battery B_5 to battery B_6 over the circuit already described heretofore and hence this description need not be repeated. The large current now traversing the lower winding of relay SR_2 will cause the armature of the relay SR_2 to close its marking contact M to convey a marking signal over line L_2 to the sounder SD_2 at station B. Again the armature of relay RR_2 will become closed against its marking contact M and remain unaffected by signals from station A. The greater current now traversing the upper winding of relay SR_3 will be in a marking direction and it will be sufficient to overcome the biasing current through the lower winding of relay SR_3 which is poled in a spacing direction. Consequently, the armature of relay SR_3 will close its contact M to convey a marking signal over line L_3 to station C. Again this will not affect the position of the armature of relay RR_3 which will remain against its contact M unaffected by signals from station A. Similarly, the armature of relay BK_3 will remain against its contact M under control of marking current through its lower winding. Thus station A may send marking and spacing signals which will be repeated by relay RR_1 of repeater RP_1 to relay SR_2 of repeater RP_2 to convey the same signals to station B. In response to these signals the flow of current through the upper

winding of relay SR₃ will be changed from a large magnitude in a marking direction for a marking signal to a practical nullity for a spacing signal so that relay SR₃ may convey the same signals to station C without operating relays RR₃ and BK₃. Moreover, all of these signals will be reproduced by sounder SD₁₀ at station TS.

When the operator at station A wishes to break transmission from any of the other stations he will open his key K₁. In that event the armature of relay RR₁ will close its spacing contact S provided relay SR₁ has its armature on its contact M. Then batteries B₁₁ and B₆ will be connected to each other over the circuit including the upper windings of relays SR₁ and BK₁, the upper winding of relay SR₃, the equipment at station TS, and the lower windings of relays BK₂ and SR₂. The armature of relay BK₁ will hold its marking contact M closed due to the reversal of current in its lower winding. Also the armature of relay BK₂ will close its spacing contact S, and relay SR₂ will also close its spacing contact S. The armature of relay RR₁ will therefore be connected either to battery B₆ or to battery B₁₄, both of which are poled positively so that the receiving party will receive only positive voltage from repeater RP₂. This will effectively break transmission. When the operator at station B wishes to break transmission from any other station, he will likewise open his key K₂. In that case the armature of relay RR₂ will be connected to batteries B₁₁ and B₆, both of which are also poled in a positive direction, thereby likewise breaking transmission. Similarly the relay SR₃ will cause its armature to close its spacing contact S in response to the opening of the keys at stations A or B to interrupt transmission from station C. When the operator at station C wishes to break transmission, his opening of key K₃ will cause the armature of relay RR₃ to open its marking contact M, whereupon the armature of relay BK₃ will close its contact S to break the circuit between the upper windings of relays SR₁ and BK₁ and the lower windings of relays BK₂ and SR₂. This circuit will remain open as long as the key K₃ at station C is open. Hence the operators at stations A and B will be apprised of the breaking signal.

It will be observed that the three outlying stations A, B and C are joined together at the repeater point D. The repeater point D has three repeaters RP₁, RP₂ and RP₃ which are associated with the respective stations A, B and C. The line terminals of the three repeaters are connected to their associated stations A, B and C by lines L₁, L₂ and L₃, respectively. The loops of repeaters RP₁ and RP₂ are connected in series with the upper winding of relay SR₃ and the armature and contact M of relay BK₃ which may be treated as the loop of repeater RP₃. The relay SR₃ repeats signals from repeaters RP₁ and RP₂ associated with stations A and B to station C while relay BK₃ repeats signals from station C to repeaters RP₁ and RP₂ and thence to stations A and B, respectively. Only three repeaters are required at the repeater point D for the repeater system interconnecting the three stations A, B and C.

Although the stations A, B and C and the loop station TS are shown to include equipment for Morse signaling, it will be apparent that the equivalent at these stations may be of the teletypewriter type. Teletypewriter equipment at these stations will, of course, make a permanent

record of all signals transmitted between the various stations.

Although a station such as station C has been joined to stations A and B by the addition of a repeater such as RP₃, other stations may be added to the system by simply opening the circuit between contacts X₁ and X₂ and inserting a repeater such as RP₃ therebetween. A number of repeaters such as RP₃ may be added in series between points X₁ and X₂ so that each such repeater will repeat signals in both directions between the stations associated with these additional repeaters and all of the other stations of the system.

A single telegraph station such as TS has been shown inserted between repeaters RP₂ and RP₃ for illustrative purposes. If desired an additional number of such telegraph loops may be included in series with each other in the circuit to repeat the same signals to each of such additional stations.

The magnitude of the currents referred to hereinabove have been cited merely to aid in understanding the principles of the invention. Currents of other magnitudes may be used in the practice of the invention, as will be apparent to those skilled in the art.

While the invention has been disclosed in certain particular embodiments merely for illustrative purposes, it will be understood that this invention may be applied to other and widely varied organizations without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a telegraph repeating system for repeating signals from any one of three lines to the other lines simultaneously, the combination of two repeaters each having a line terminal and a loop terminal, a third repeater having a line terminal, a first relay and a second relay constituting the loop of said third repeater, the line terminal of each repeater being connected to one of said lines, the loop terminals of said two repeaters being connected in series with each other in a series circuit which includes the winding of the first relay of said third repeater and the armature and contact of the second relay of said third repeater, and means whereby said third repeater will send oppositely poled currents over the line associated with said third repeater to repeat signals thereto from either of the other repeaters.

2. In a telegraph system, the combination of three lines, means for repeating signals from any one of said lines simultaneously to the other lines, said means comprising two repeaters each having a line terminal and a loop terminal, a third repeater having a line terminal and a loop, the loop of said third repeater including a first relay and a second relay, the line terminal of each repeater being connected to one of said lines, the loop terminals of said two repeaters being connected in a series circuit which includes the winding of said first relay and the armature and contact of said second relay of said loop, and means whereby said third repeater will send oppositely poled currents over the line associated with said third repeater to repeat signals thereto from either of the other repeaters.

3. In a telegraph system, the combination of first, second and third telegraph sets, first, second and third repeaters associated respectively with said sets, each repeater including a line terminal and a loop, each of the line terminals of said

repeaters being connected to one of said sets, the loop of said third repeater having a first relay for repeating signals from either of the other repeaters to the telegraph set associated with said third repeater and a second relay for repeating signals from the telegraph set associated with said third repeater to the repeaters associated with the other telegraph sets, the loops of said first and second repeaters being connected in series with each other in a series circuit which includes the winding of said first relay and the armature and contact of said second relay of the loop of said third repeater, and means whereby said third repeater will send oppositely poled currents over the line associated with said third repeater to repeat signals thereto from either of the other repeaters.

4. A repeater station comprising three telegraph repeaters for three telegraph sets located at different remote points, each repeater having a line terminal and a loop, the line terminal of each repeater being connected to one of said telegraph sets, the loops of all of said repeaters being connected in a common series circuit, one of said repeaters including first and second relays, the winding of the first relay and the armature and contact of the second relay being connected

in a series circuit which includes the loop of the latter repeater, and means whereby said third repeater will send oppositely poled currents over the line associated with said third repeater to repeat signals thereto from either of the other repeaters.

5. A repeater station comprising three telegraph repeaters for three telegraph sets located at different remote points, each repeater having a line terminal and a loop, the line terminal of each repeater being connected to one of said telegraph sets, a telegraph loop circuit having a key and a sounder, the loops of all of said repeaters being connected in a series circuit which includes said telegraph loop circuit, one of said repeaters having first and second relays arranged so that the winding of said first relay and the armature and contact of said second relay are connected in series with each other to constitute the loop of said repeater, and means whereby said third repeater will send oppositely poled currents over the line associated with said third repeater to repeat signals thereto from either of the other repeaters.

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