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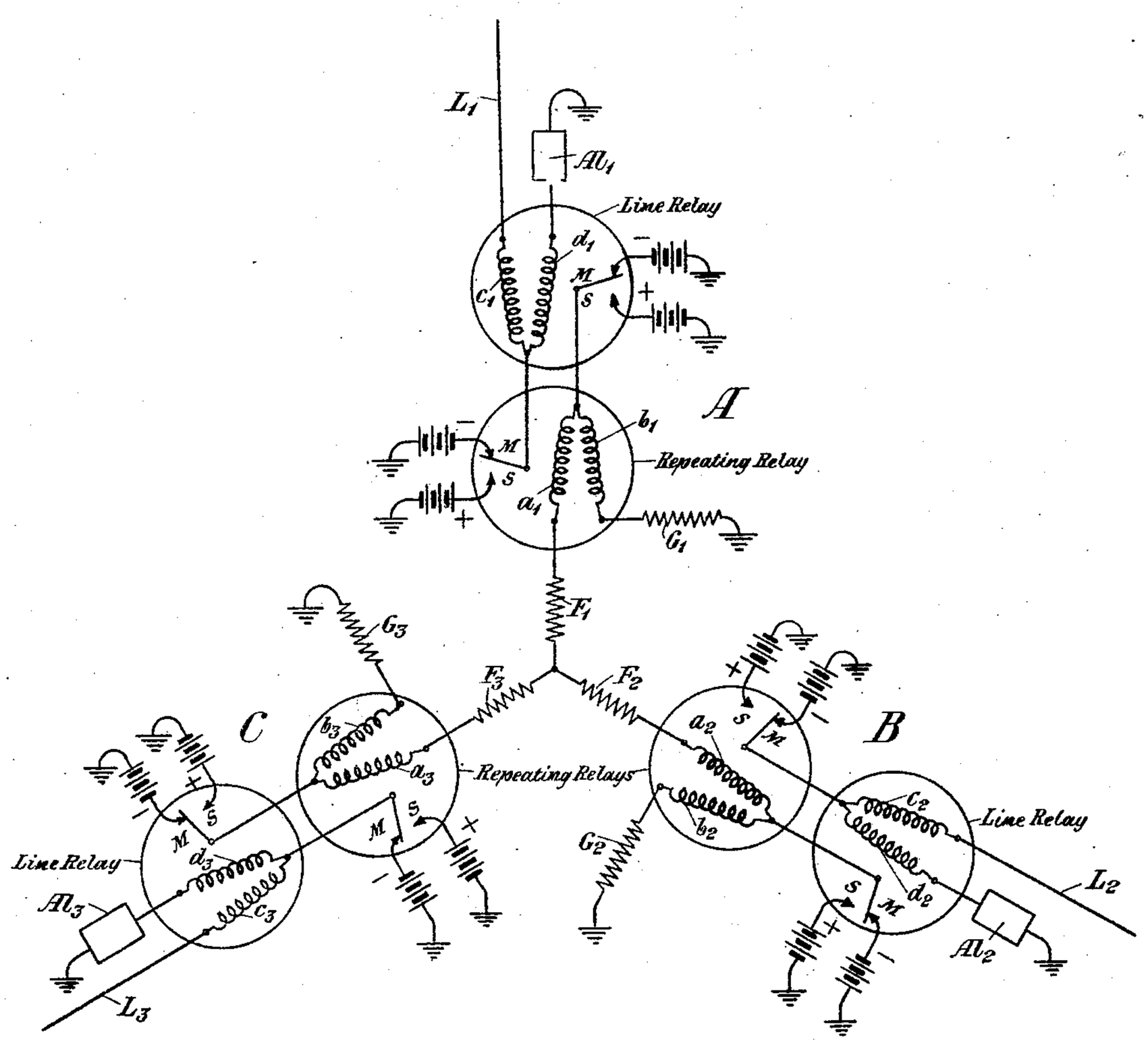

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TELEGRAPH SYSTEM.

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This invention relates to telegraph systems, and particularly to systems for interconnecting a plurality of telegraph lines to permit communication between said lines.

It has been the practice to employ local circuits operating on the polar duplex principle in connection with certain types of telegraph terminal repeater sets. When two such sets were connected together for repeating signals between two "half duplex" telegraph circuits, the system was operated on the "half duplex" principle. Whenever additional service was desired at the repeater station, it was provided by connecting additional apparatus thereat and the system was then operated on the "upset duplex" principle.

Heretofore it has not been possible, however, to interconnect three or more telegraph terminal repeater sets without employing additional apparatus which included single Morse repeaters and local circuits to cooperate therewith. The use of single Morse repeaters has been found undesirable since, besides further complicating the circuit arrangements at the repeater station, they also increased the work required in maintaining the circuits in proper operating condition.

It is therefore an object of this invention to provide a system for interconnecting three or more telegraph lines by means of telegraph repeater sets which employ local circuits operating on the polar duplex principle and to eliminate the use of single Morse repeaters therefor. Such an interconnected system, however, is not suitable for operation on the "upset duplex" principle and is not readily adaptable for additional service at the repeater station when such becomes necessary.

A feature of this invention is the provision of means permitting the interconnection of three or more telegraph lines operating on the polar duplex principle for communication of signals over said lines from telegraph stations located at the ends of said lines, said means not including telegraph repeater sets. Such an application of the invention will be obvious from the following description of the invention which is applied to local circuits operating on the polar duplex principle, the principles involved in the case of polar duplex lines being similar to those for polar duplex local circuits.

While the nature of this invention will be pointed out with particularity in the appended claims, the invention itself, both as to its objects and features, will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing showing one embodiment of the invention suitable for interconnecting three telegraph lines which are terminated in three telegraph repeater sets provided with polar duplex local circuits. It is to be understood that the invention is capable of embodiment so as to include any number of telegraph lines.

Referring to the drawing, there are shown three telegraph lines L_1, L_2 and L_3 at three telegraph sets A, B and C, respectively, which may all be located at the same telegraph station, or at different telegraph stations. However, in order to make the invention clear, it will be assumed that all three sets are located at the same telegraph station. Three line relays and three repeating relays are provided at the telegraph station, one line relay and one repeating relay for each telegraph line. The line relay at set A consists of a pair of windings c_1 and d_1 and an armature which moves between marking and spacing contacts to alternately connect marking and spacing batteries to the duplex local circuit of this set. One terminal of the winding c_1 is connected to the telegraph line L_1, and one terminal of the winding d_1 is connected to ground through a balancing artificial line AL_1, the other terminal of winding c_1 and the other terminal of winding d_1 being connected together to the armature of the repeating relay at set A.

The repeating relay of set A consists of a pair of windings a_1 and b_1 and an armature which moves between marking and spacing contacts M and S to alternately connect marking and spacing batteries to the real and artificial lines of set A. One terminal of the winding a_1 is connected to the apex of the apparatus at the station through a resistance F_1, and one terminal of the winding b_1 is connected to ground through a resistance G_1 the resistance G_1 being three times as great as resistance F_1. The other terminal of the winding a_1 and the other terminal of the winding b_1 are connected together to the armature of the line relay of set A.

The apparatus at set A is the same as the

apparatus at sets B and C and therefore the description of the apparatus at set A will be deemed sufficient to describe the apparatus at sets B and C. Assuming in this discussion that the resistances of the windings of the repeating relays are all negligible, then the resistances F_1, F_2 and F_3 are all equal in magnitude, having a value of R ohms, and the resistances G_1, G_2 and G_3 are all also equal in magnitude, having a value of 3R ohms. It is to be understood, however, that if the resistances of the windings of the repeating relay are large as compared to the resistances associated therewith, in that event the resistances of the windings are to be taken into consideration in determining the relationship between the resistances G_1, G_2 and G_3 and the resistances F_1, F_2 and F_3, respectively.

When signals are transmitted from line L_1 to lines L_2 and L_3, the armature of the repeating relay at set A will remain on its marking contact M, as will appear more fully in the description hereinafter following. When signals are being transmitted from either line L_2 or L_3 to line L_1, the armature of the line relay at set A will remain on its marking contact, as will also be shown hereinafter.

When the armatures of the line relays at sets A, B and C are on their marking contacts M, batteries of like potential and polarity are connected to the apex of the system. Consequently no current flows in the branches including the resistances F_1, F_2 and F_3, but equal currents will flow in the branches including windings b_1, b_2 and b_3 at sets A, B and C, respectively, the magnitude of the current in each case being E/3R amperes, assuming E to be the potential of each of the batteries employed in the system.

When the armature of the line relay at set A moves to its spacing contact S, a battery of opposite polarity and of the same potential as the batteries at sets B and C, respectively, is connected to the windings of the repeating relays. Current of a value of E/3R amperes will still flow through the winding b_1 of the repeating relay at set A but in the opposite direction. Since the resistances F_2 and F_3 at sets B and C are in parallel with each other in this instance, and since this parallel combination is in series with the resistance F_1 at set A, current of the value of

$$\frac{2E}{R+R/2}=\frac{4E}{3R}$$

amperes will flow through winding a_1 of the repeating relay at set A in a marking direction. The magnetic effect on the armature of the repeating relay will be determined by the difference between the currents flowing in windings a_1 and b_1 of the repeating relay, assuming that these windings have the same number of turns. The difference between these two currents is $4E/3R-E/3R=E/R$ amperes, consequently the armature of the repeating relay will remain on its marking contact while signals are being transmitted from line L_1 to lines L_2 and L_3, the value of the holding current changing from E/3R amperes for a spacing signal to E/R amperes for a marking signal. This means that the armature of the repeating relay will remain on its marking contact while signals are being transmitted from line L_1 at set A to lines L_2 and L_3 at sets B and C, respectively.

The current which flows in winding a_1 of the repeating relay at set A when a spacing signal is received from the line L_1, is 4E/3R amperes as explained above. This current divides equally between the branches leading to sets B and C. Since these branches have equal resistances and equal battery potentials, there will be a current of one-half of 4E/3R amperes, or 2E/3R amperes, flowing through windings a_2 and a_3 of sets B and C, respectively. There will still be currents flowing through windings b_2 and b_3 at sets B and C having a value of E/3R amperes, the current in windings a_2 and a_3 being in a spacing direction and the currents in windings b_2 and b_3 being in a marking direction. The spacing currents flowing in windings a_2 and a_3 at sets B and C, respectively, will overpower the marking currents flowing in windings b_2 and b_3 at sets B and C, respectively, so as to produce a spacing effect in these relays of $2E/3R-E/3R=E/3R$ amperes. Thus, when signals are being transmitted from line L_1 at set A to lines L_2 and L_3 at sets B and C, respectively, the armatures of the repeating relays at sets B and C will move between their marking and spacing contacts with equal and opposite forces, the value of the current being in each case E/3R amperes.

When signals are being transmitted from line L_1 at set A to lines L_2 and L_3 at sets B and C, the armature of the line relay at set A will move between its marking and spacing contacts in accordance with said signals, as is well known in the art. A marking signal from the line L_1 will connect the marking battery to the windings a_1 and b_1 of the repeating relay at set A, and a spacing signal from line L_1 will connect the spacing battery to these windings. As has been shown hereinbefore, the armature of the repeating relay at set A will remain on its marking contact throughout. When a marking signal is being received by the line relay at set A, there will be batteries of the same polarities and of equal potentials connected to the apexes of the repeating relays of the system, and no current will flow through resistances F_1, F_2 and F_3 at sets A,

B and C, respectively. When the armature of the line relay at set A moves to its spacing contact, the battery at set A will be of opposite polarity and of the same potential as the batteries connected to the local circuits of the system at sets B and C. Consequently, spacing currents will flow through the resistances F_1, F_2 and F_3, the current flowing through resistance F_1 being twice as great as the current flowing in either of the resistances F_2 and F_3.

When signals are being received from either line L_2 at set B or line L_3 at set C, then the armature of the repeating relay at set A will move between its marking and spacing contacts in accordance with the signals. For a marking signal, marking battery will be connected to the line L_1 at set A through winding c_1 of the line relay, and, for a spacing signal, spacing battery will be connected to the line L_1 at set A through the winding c_1 of the line relay. Because of the balance existing between the windings c_1 and d_1 of the line relay at set A, the armature of the line relay will not be affected by these signals. Thus it will be noted that the repeating relay at set A is employed for repeating signals received from either line L_2 or line L_3 at sets B and C, respectively, to line L_1 at set A.

It will be understood that while the operation of the system has been described with reference to the transmission and reception of signals over line L_1 at set A, similar events take place in the operation of the system when signals are being transmitted and received from either lines L_2 or L_3 at sets B and C, respectively.

While the system disclosed in this specification includes three telegraph lines and means for interconnecting these lines by polar duplex local circuits of three telegraph repeater sets to permit communication to take place therebetween, the invention is not limited to a system including but three telegraph lines, but may be made to include a plurality of telegraph lines, the resistances connected to the windings of the repeating relay being proportioned in such a manner that one is as many times the magnitude of the other as there are telegraph lines connected in the system.

While the invention has been disclosed in one particular embodiment which is deemed desirable, it is to be understood that it is capable of embodiment in other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. A system for signaling including a plurality of telegraph lines over which signals may be transmitted and received, said telegraph lines being connected together at the same station by telegraph sets, each of said telegraph sets including a line relay and a repeating relay, the line relay having a pair of windings, one of said windings being connected to a telegraph line and the other winding being connected to a variable artificial balancing line, the armature of said line relay repeating signals from the associated telegraph line to other telegraph lines in the system, the repeating relay having a pair of windings including resistances proportioned in accordance with the number of telegraph lines in the system, the resistance of one winding being as many times the magnitude of the other as there are telegraph lines in the system, the armature of said repeating relay repeating signals over the associated telegraph line from said other telegraph lines in the system.

2. A system for signaling having a plurality of telegraph lines over which signals may be transmitted and received, a plurality of line relays each associated with a corresponding telegraph line, the armature of said line relay transmitting signals from the associated telegraph line to other telegraph lines in the system, a plurality of repeating relays each associated with a corresponding telegraph line, each repeating relay having a pair of windings including resistances which are so proportioned that the combined resistance of the winding and its resistance is as many times the combined resistance of the other winding and its resistance as there are telegraph lines in the system, the armature of said repeating relay repeating signals from the other telegraph lines in the system to the associated telegraph line.

3. In a telegraph system, in combination, a plurality of telegraph lines interconnected at a telegraph station by telegraph sets, each line being capable of transmitting and receiving telegraph signals, and two relays associated with each telegraph line, each of said relays comprising a pair of windings, one pair of windings being differentially arranged with respect to signals transmitted in one direction and the other pair of windings being differentially arranged with respect to signals transmitted in the opposite dierction, one of said relays repeating signals from any of the other telegraph lines in the system to the telegraph line associated with said relay, the other of said relays repeating signals to the other telegraph lines in the system from the telegraph line associated with said relay.

4. A telegraph system comprising a plurailty of telegraph lines connected together by telegraph sets to permit the transmission and reception of signals by said telegraph lines, and two relays associated with each of said telegraph lines, each of said relays

comprising a pair of windings and an armature, said armature being provided to alternately repeat marking and spacing signals.

5. In a telegraph system, in combination, a plurality of telegraph lines over which communication may be established, means for interconnecting said telegraph lines to permit communication therebetween, said means consisting of a plurality of line relays each associated with a corresponding telegraph line, each line relay having two windings, one connected to said telegraph line and the other connected to ground through a variable artificial balancing line, and a plurality of repeating relays each having two windings, one connected to a point common to all of said telegraph lines through a fixed resistance, and the other connected to ground through a fixed resistance, the total resistance of one winding and its fixed resistance having a magnitude as many times the total resistance of the other winding and its fixed resistance as there are telegraph lines interconnected in the system.

In testimony whereof, I have signed my name to this specification this 20th day of March, 1926.

CHARLES LEE FARIES.