G. C. CUMMINGS.

TELEGRAPH SYSTEM.

APPLICATION FILED DEC. 27, 1918.

1,367,733. Patented Feb. 8, 1921.

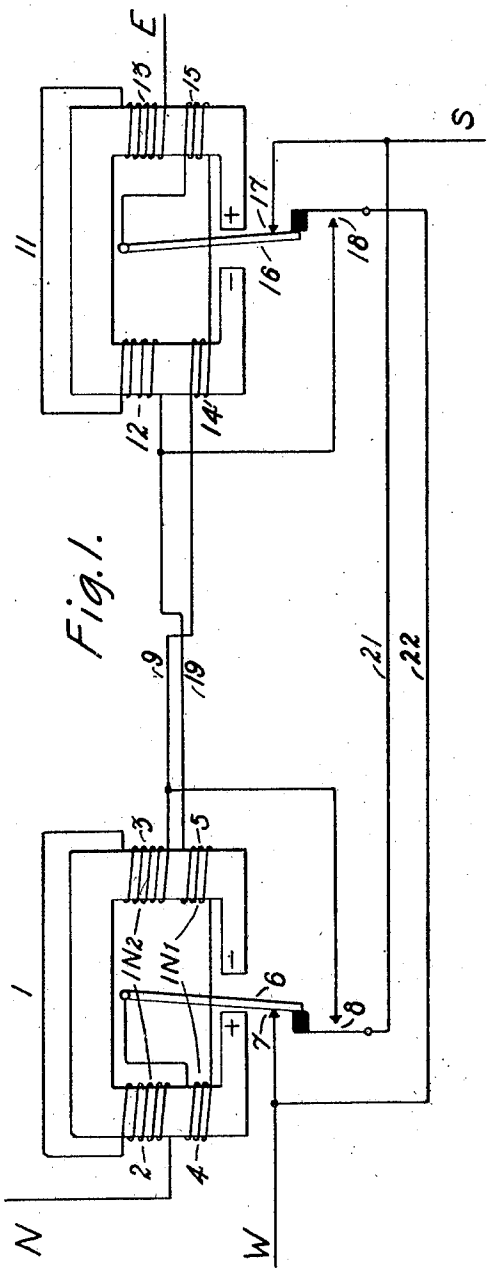

Fig. 1.

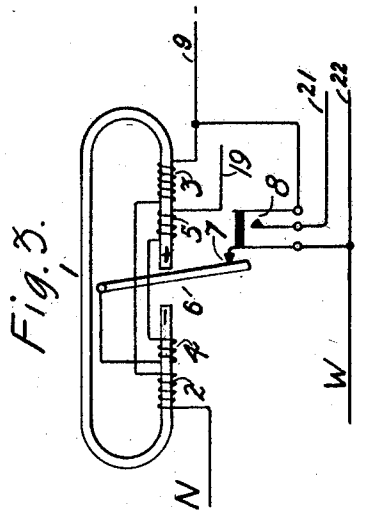

Fig. 3.

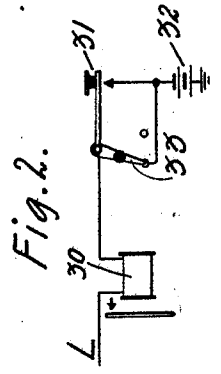

Fig. 2.

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UNITED STATES PATENT OFFICE.

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TELEGRAPH SYSTEM.

1,367,733. Specification of Letters Patent. Patented Feb. 8, 1921.

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To all whom it may concern:

Be it known that I, GEORGE C. CUMMINGS, a subject of the King of Great Britain, residing at East Orange, in the county of Essex, State of New Jersey, have invented certain new and useful Improvements in Telegraph Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to telegraph systems and more particularly to telegraph repeater systems.

The principal object of this invention is to provide improved apparatus and organization thereof to permit reciprocal repeating service between two line sections, or universal repeating of telegraphic signals between a plurality of line circuits, as between a main line and a branch line, without the necessity of employing extra sources of current supply at a repeater station.

In accordance with the present invention there is provided electro-responsive switching or relay means, characterized by a plurality of different windings and circuit controlling contacts, arranged in such a manner that repeating operations may, automatically, come entirely under the control of sending operations, and all repeating operations may be carried out through energy supplied by the regular line batteries which may be located either at terminal or way stations or at a repeater station.

This invention is illustrated diagrammatically in the accompanying drawing, and for the sake of clearness only so much of a telegraph repeater equipment has been shown as will be necessary to a clear understanding of the features of this system.

Referring to the drawing, in Figure 1 there is shown a repeater equipment suitable for rendering reciprocal repeating service between a plurality of line sections, in Fig. 2 is shown an equipment suitable for a terminal station, while in Fig. 3 is shown details of a relay structure which may be employed in the repeater system illustrated in Fig. 1.

In describing the operation of this system, the reference characters E and W (Fig. 1) indicate respective line conductors which for convenience, may be considered as extending to respective "east" and "west" stations, while the reference characters N and S indicate other line conductors which may be assumed as extending to corresponding "north" and "south" stations, respectively. The equipment shown in this figure will be understood as present at a repeater station, while the line circuits may be considered as operated on the so-called "closed circuit" plan and arranged in such a manner that the polarity of a line battery at the north station will be the same as the polarity of a line battery at the south station, thereby normally establishing accumulative current effects in the line conductor extending between these stations and routed through the circuits of the repeater equipment. In a corresponding manner, the line batteries at the east and west stations will be understood to form an accumulative series through the line circuit extending between these stations, and also routed through the repeater equipment.

Directing attention to Fig. 2 of the drawing, the normal position of the usual equipment at a terminal station is shown therein, and provides that during the time a transmitting key 31 may be idle, a line battery 32 will be connected over a key-shunting switch 33 and through the winding of a line relay 30 to a line conductor L. Since it will be understood that an equipment corresponding with the equipment shown in Fig. 2 may be present at each of the remote stations, it will be clear that on a key-shunting switch, as the switch 33, being opened preparatory to sending, say at the north station, such interruption of the line circuit will cause cessation of current in the circuit of the north-south line which may be traced through the repeater equipment by way of the windings 2 and 3 of a polar relay 1, a conductor 9, the windings 14 and 15 and the contacts 17 of a second polar relay 11, thence to the south line. Absence of current through the relay windings 2 and 3, will permit the current present in the east-west line, the circuit of which may be traced from the west line by way of contact 7 and the windings 4 and 5 of the relay 1, a conductor 19 and the windings 12 and 13 of the relay 11 to the east line, to cause the armature 6 of the relay 1 to be moved to its opposite or negative bias, thereby separating the contact 7 and closing the contact 8 of this relay 1. It will be pointed out that the arrangement of the contacts of the relay 1 is such that the contacts 8 may

close before the contacts 7 open, and vice versa, this timing relation to be the same with respect to the contacts 17 and 18 of the relay 11 is clearly illustrated by the contact arrangement shown in Fig. 3. It will be further understood that the relays 1 and 11 are to be so constructed or adjusted that the polarizing magnetism will retain the armature of each relay in whichever position it may have been moved and until it is acted upon by current through the relay windings, as will presently appear.

Resuming the description of the operations resulting from the opening of the key at the north station, as assumed, the resulting cessation of current through the windings 2 and 3 of the relay 1 having permitted the current present in the windings 4 and 5, as supplied through the circuits of the east-west line, to move the armature of this relay to its negative bias, the resulting separation of the contacts 7 will open the east-west circuit, since the relay 11 continues on its positive bias as shown, thereby causing the conductor extension 22 of the west line to remain open at the contacts 18 of the latter relay. From this description, it will be clear that opening of the line at the north station will serve directly in causing cessation of current in the south line, as a result of which, current in the east-west line may operate the relay 1 to disconnect and cause cessation of current in the latter line circuit. Accordingly, the receiving devices at the north, south, east and west stations may respond, as well understood in the art. If now a transmitting key at the north station, corresponding with the key 31, Fig. 2, is closed, as in sending a message, current will be reëstablished in the repeater circuits which may then be traced from the north line through the windings 2 and 3 of the relay 1 and the contact 8 of this relay to the south line. It will be pointed out that the characters IN1 applied to the windings 4 and 5 are for the purpose of indicating a predetermined ampere turns effect possible for these windings, while the characters IN2 applied to the windings 2 and 3 of the same relay indicate that in this system the latter windings may develop an ampere turns strength which, for convenience, may be twice the strength of the ampere turns which may be developed by the windings 4 and 5. At this time, in the assumed example, the closed position of the contacts 8 of the relay 1 establish a short circuit around the windings 14 and 15 of the relay 11 in joining the lines N and S through the windings 2 and 3 of the relay 1, as traced. Therefore, the assumed closing of the key at the north station may establish a line current of maximum strength through the windings 2 and 3, which will impart energetic movement to the armature 6 and continue to impel it, irrespective of the following closure of the contacts 7 of this relay, whereby the E—W line may be closed to reestablish current through the weaker windings 4 and 5 of this relay. In this operation, separation of the contacts 8 of the relay 1 merely removes the short circuit from the windings 14 and 15 of the relay 11, thereby inserting these windings in series with the N—S line as already traced.

In the last described operation of the relay 1, the feature relative to the contacts 7 being established before separation of the contacts 8 takes place, provides that current in the E—W line will be established in the stronger windings 12 and 13 of the relay 11 in advance of current in the N—S line becoming effective in the weaker windings 14 and 15 of the latter relay. This insures that the armature 16 of the relay 11 will continue on its positive bias during periods signaling impulses originating in the N—S line may be under transmission. Since an open and a closed position of the transmitting devices at a sending station, or the equivalent thereof, are the only operations required in telegraphic sending, it will be clear from the description given that each time the north-south line may be opened by a transmitting key, in originating a message at any station present on this line, the less powerful windings 4 and 5 of the relay 1, as energized by current in the east-west line, will move the armature 6 of the relay to disconnect the latter line circuit. In a converse manner, each closure of a key, as in sending from any station on the north-south line, will establish current through the windings 2 and 3 of the relay 1 to move the armature 6 of this relay to its left-hand position or positive bias, in which it is shown in the drawing.

It will be pointed out that the structure or adjustment of the repeater relays should be such that operating current in the weaker windings may continue until such time as the armature of the relay may have passed a central or unison point, following which it will complete its stroke through being impelled or attracted by the polarizing magnetism of the relay. This may be made clear by considering that on the instant cessation of current in the windings 2 and 3 of the relay 1 results from opening of the north-south line in sending, current in the east-west line may act in the windings 4 and 5 of this relay until the armature 6 influenced thereby shall have moved to the extent that the contacts 7 may separate to disconnect the east-west line. At this point in its travel, the armature 6 will have come into the influence zone of the negative pole of the polarizing magnetic circuit of the relay, and this force will serve to continue the travel of the armature to the final position of its stroke.

During these periods messages may be under transmission from any station on the east-west line, operations corresponding with and reciprocal of the operations already described in connection with those taking place when messages are repeated from the north-south line will become effective in repeating messages from the east-west line to the north-south line. During these operations the contacts 17 of the relay 11 serve to open and close the north-south line in phase or unison with opening and closing of the east-west line at a sending station, and throughout these operations the relay 1 continues in the position in which it is shown in the drawing. On the east-west line being opened, closure of the contacts 18 of the relay 11 serve to prepare a circuit for the east-west line by way of the conductor 22 in the form of a shunt around the windings 4 and 5 of the relay 1, thereby permitting subsequent closing of the east-west line to initially develop a maximum current strength in the windings 12 and 13 of the relay 11 to energetically impart movement to the armature 16 of this relay, which will thereupon first close its contact 17, and secondly, separate its contact 18. In addition to the contact 18 permitting an initial maximum flow of current through windings 12 and 13, the fact that these contacts shunt the windings 4 and 5 of the relay 1, insures that current of the east-west line may not be established through the latter windings before the contact 17 of the relay 11 may be closed in establishing current of the north-south line through the windings 2 and 3 of the relay 1, whereby the armature of this relay will be held in the position in which it is shown.

From the foregoing description it will be clear that in substitution of either one of the line sections or branches E, W, N or S the respective conductor or line lead may be grounded at the repeater station, under which condition repeating operations may be carried out between the remaining line branches in a manner corresponding with those already described without changes in the devices or the interconnective relation of the repeater equipment.

In case repeater service is to be employed in situations where it may be required to divide a lone line into a plurality of sections the present system may be readily applied, and to illustrate this in connection with the present disclosure let it be assumed that E represents one line section while N represents a second line section which it is desired to terminate at a repeater station. By grounding the lead W, the circuit of the E line section may be traced through the windings 13 and 12 of the relay 11, conductor 19, windings 5 and 4 and the contacts 7 of the relay 1 to earth at the lead W, while grounding of the lead S will permit the circuit of the N line section to be traced through the windings 2 and 3 of the relay 1, conductor 9, the windings 14 and 15 and the contacts 17 of the relay 11 to the earth through the lead S. Under this arrangement impulses originating in the E line section will be repeated into the N line section through operations at the repeater station corresponding with the operations already described as taking place for the repeating of signals from the east-west line to the north-south line. In a reciprocal manner, messages originating in the N line section may be repeated into the E line section. It will further be obvious that by grounding the line leads E and N at the repeater station, reciprocal repeating service may be carried out between the independent line sections W and S.

In view of the fact that the present repeater system entirely eliminates the matter of local circuits at a repeater system it may be particularly pointed out that in connection with the so-called American or closed-circuit systems described, line batteries to either supply all of the current, or to augment line batteries at distant stations on the lines may be employed at the repeater station. For the W and S lines such batteries should preferably be connected respectively in series with these lines beyond their point of connection to the repeater equipment, while for the E and N lines the batteries may be connected in series with these circuits at any point between the respective line and the junction of the lead from the contacts 18 to the conductor 19 and the junction formed by the lead from the contacts 8 to the conductor 9. It will, of course, be understood that in the substitution of earth connections for any of the lines E, W, N or S, as already described, that such earth connections may first be routed through line batteries at the repeater station and that such batteries may either serve to supply the entire line current which may be required, or they may serve only to aid other line current sources located at any remote point on the associated line.

The present system permits an instant application of the service commonly referred to as "break" signals which may be initiated by a receiving operator in order to make a request directed to the sending operator and usually relating to the message under transmission as checking or asking for repetition, etc. In describing the operations whereby break signals may become effective, let it be assumed that during an instant the east-west line may be open in a sending operation that a west operator breaks by opening a sending key on the latter line branch. Reclosing of the east sending key will fail to close the east-west line

due to the open position of the key at a west station. Therefore, the relay 11 will continue on its negative bias and the open condition of this line, as well as the open condition of the north-south line due to the continuing negative bias of the relay 11, results in the receiving devices at the sending station as well as the receiving devices at all other stations manifesting that an interruption has occurred. The sending operator may thereupon close the transmitting key to its receiving position and receive the break request from the west operator.

As a further break signal condition, let it be assumed that while a key on the east line branch may be in its open position in the transmission of a message, a break signal may be initiated by a key being opened on the north-south line. Accordingly, reclosure of the east-west line at the transmitting station will permit current through the windings 12 and 13 of the relay 11 to move the armature of this relay to separate its contacts 18 and to close its contacts 17. Separation of the latter contacts will remove the shunt path to permit current of the east-west line to act through the windings 4 and 5 of the relay 1 to cause this relay to take up its negative bias, thereby separating its contacts 7 to open the east-west line while closing its contacts 8 to shunt the circuit of the north-south line as routed through the windings 14 and 15 of the relay 11. This interruption of the east-west line apprises the sending operator thereon of a break signal, and the sending key to be thereupon placed in its closed or receiving position will permit the operator, who may be breaking on the north-south line, to take possession of the circuits and transmit signals for which the break interruption may have been initiated. The operation of break signals originating in the east-west line with respect to messages under transmission from the north-south line transpire in a manner corresponding with but reciprocal of the operations described as taking place when a station on the north-south station may break a message originating in the east-west line.

The arrangement of the relay structure shown in Fig. 3, in addition to more clearly showing the time relation of the contacts, also illustrate a preferred positioning of the relay windings whereby they may be carried on suitable cores which may form pole extensions of the member or members comprising the polarizing magnetic system.

What is claimed is:

1. In a telegraph system, a repeater station, two compound wound relays at said station, a first and a second line conductor radiating from said station and serially joined through a winding of each of said relays, a third and fourth line conductor radiating from said station and serially joined through other windings on each of said relays, means for signaling over said line conductors, and contacts controlled by said relays for reciprocally repeating signals between said line conductors.

2. A telegraph repeater system comprising a pair of relays, each having a plurality of windings, a plurality of conductors, each of which have serially connected therein a pair of windings on each of said relays, means for signaling over said line conductors, and contacts controlled by said relays for reciprocally repeating signals between said conductors.

3. In a telegraph system, a repeater station, a first and a second relay at said station, a plurality of line circuits, a first line circuit normally routed through a winding on the first one of said relays and a winding and contacts of the second relay to a second line circuit, a third line circuit similarly routed through a second winding on said second relay and a second winding and contact of said first relays to a fourth line circuit, means for signaling over said line circuits, and additional contacts in each of said relays for respectively controlling the reciprocal repeating of signals between said line circuits.

4. In a telegraph repeater system, a first and a second relay, first and second contacts controlled by said relays, an earth connection common to each set of contacts on said relays, a first line circuit routed through a first winding on each of said relays and one set of contacts on the first one of said relays, a second line circuit routed through a second winding on each one of said relays and a first pair of contacts on the second relay, means for signaling over said line circuits, and means controlled by the second set of contacts on each of said relays respectively to coöperate with the first sets of contacts on said relays in reciprocally repeating signals between said line circuits.

5. In a telegraph repeater system, a first and a second compound wound polarized relay, a first and a second set of contacts for each of said relays, a first line circuit routed through a winding on each of said relays and one set of contacts of the first relay to earth, a second line circuit routed through other windings on said relays and one set of contacts of the second relay to earth, means for signaling over said line circuits, and interconnections to respectively enable the second contacts of said relays to control short-circuiting of the associated winding and set of contacts of the other relay respectively in carrying out repeating operations between said first and second line circuits.

6. In a telegraph repeater system, a first and a second relay, each having a maximum and a minimum ampere-turns strength winding, a first and a second line conductor each

respectively routed through the maximum strength winding of one relay and the minimum strength winding of the other relay, means for signaling over said line circuits, and contacts controlled by said relays for reciprocally repeating signals between said line circuits.

7. In a telegraph repeater system, a pair of relays, each having a plurality of windings, a plurality of conductors, each of which extend through a pair of windings on each of said relays, means for signaling over said line conductors, and contacts controlled by said relay for reciprocally repeating signals between said conductors.

8. In a telegraph repeater, a first and a second polarized relay each having a minimum and a maximum strength winding, a first and a second line circuit respectively routed through the minimum strength winding of one relay and the maximum strength winding of the other relay respectively, means for signaling over said line circuits, and a plurality of contacts controlled by each of said relays for reciprocally rendering the effect of signals in case of said line circuits effective to establish similar signals in the other line circuit.

In witness whereof, I hereunto subscribe my name this 24th day of December, A. D. 1918.

GEORGE C. CUMMINGS.