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TELEGRAPH REPEATER ARRANGEMENT

Filed March 30, 1929

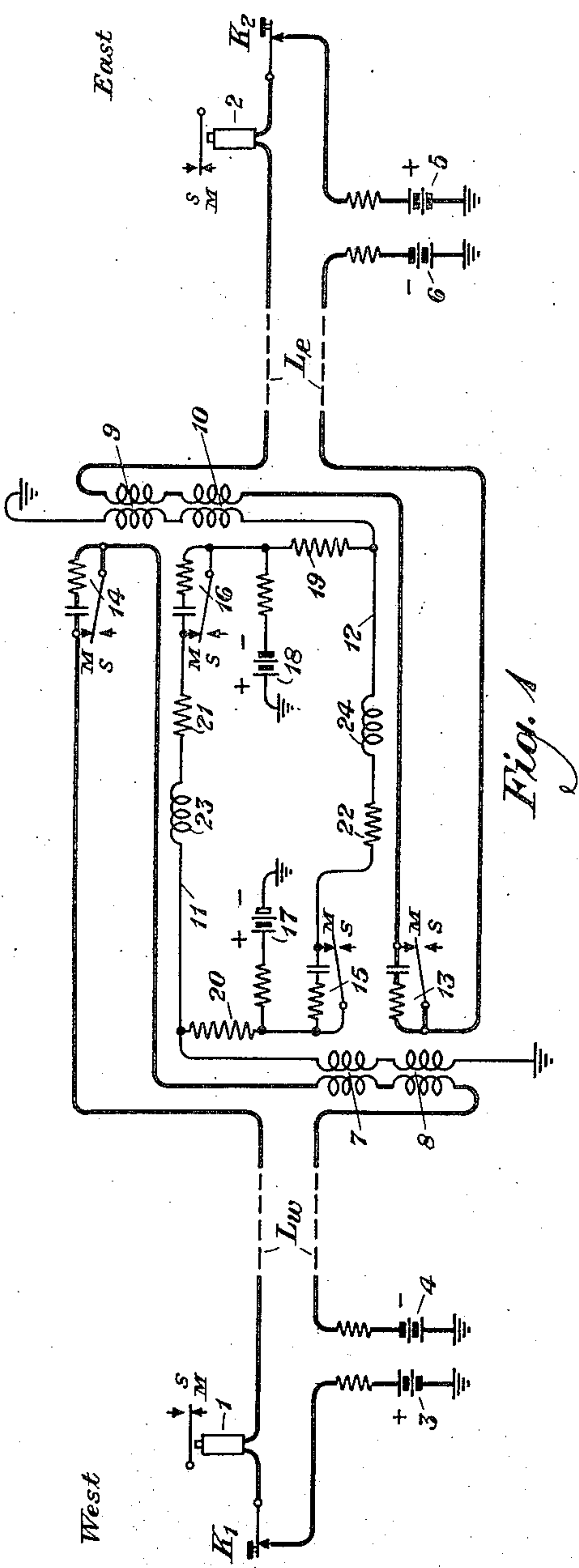


Fig. 1

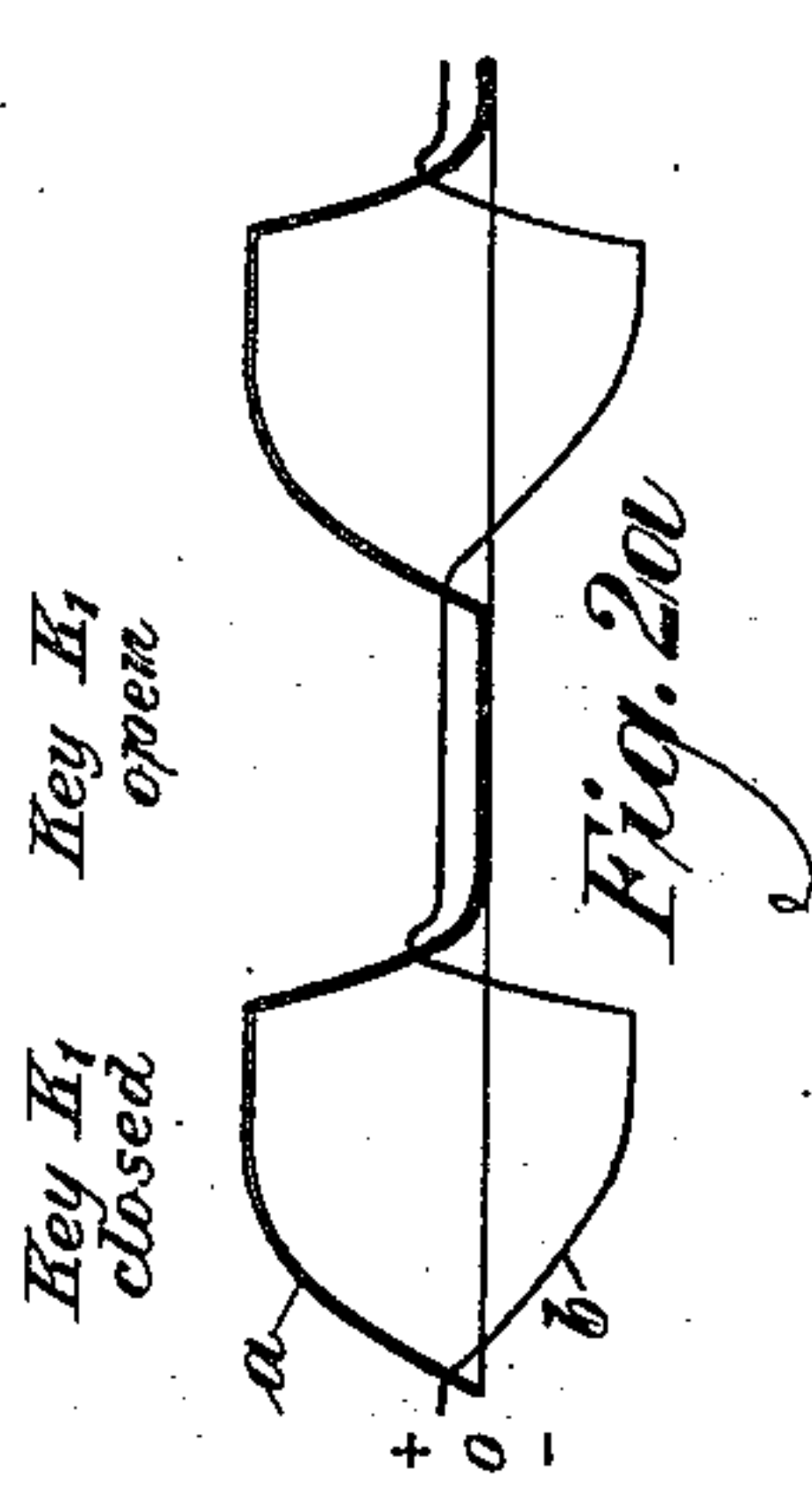


Fig. 2a

Series inductance in loop

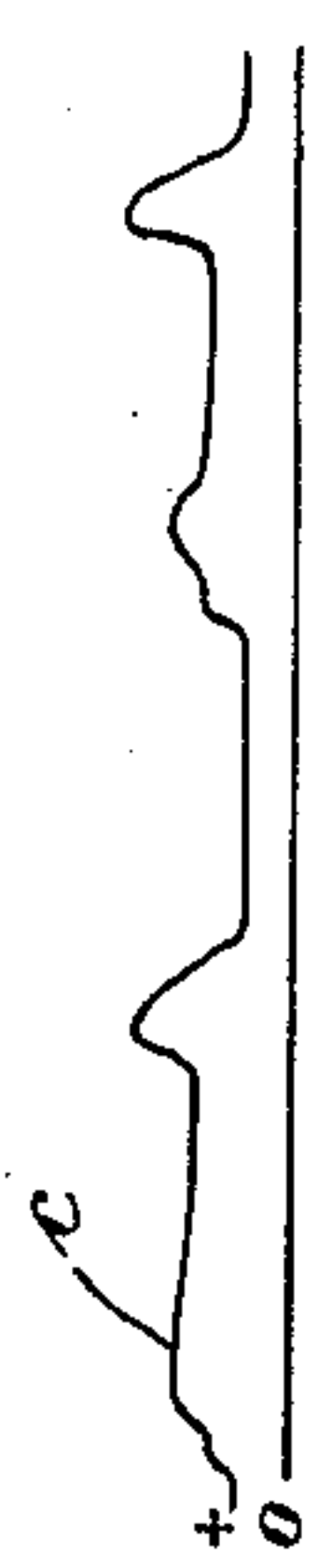


Fig. 2b

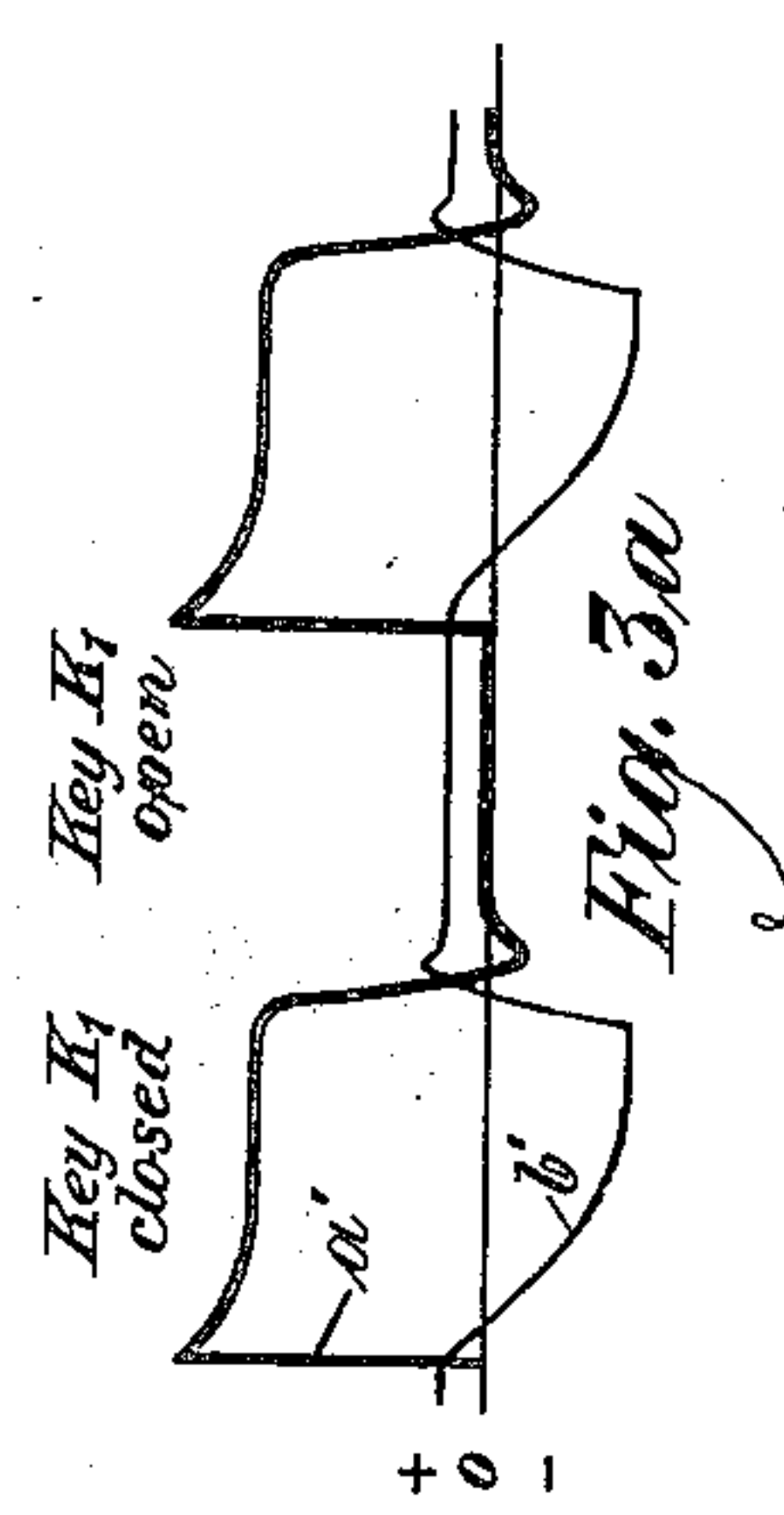


Fig. 3a

Bridged capacity in loop

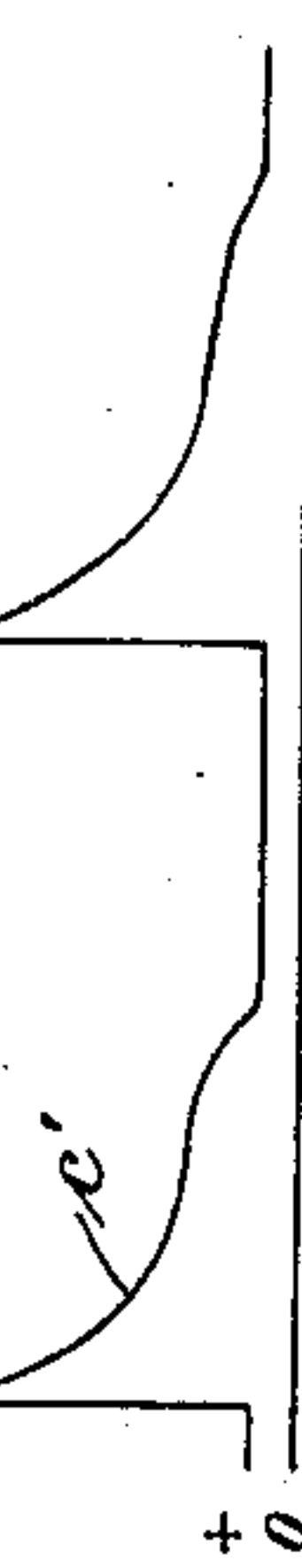


Fig. 3b

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TELEGRAPH REPEATER ARRANGEMENT

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This invention relates to telegraph systems, and more particularly to improvements in arrangements for repeating or retransmitting signals in such systems.

When a long telegraph line interconnects two distant stations it is often desirable to insert in the line repeater sets to retransmit the signals. Among the types of repeater sets commonly utilized for this purpose are those which utilize two sets of polar relays for repeating the signals. The sets of polar relays have two sets of windings, one set being included in the line or loop circuit and the other set being included in a local or auxiliary circuit. The currents in the auxiliary circuit serve a two-fold purpose. Under certain conditions the currents are utilized for "holding" purposes, and under other conditions the currents are utilized for "biasing" purposes. When the currents are utilized for holding purposes it is desirable that they should build up rapidly. When the currents are used for biasing purposes it is desirable that the rate of build-up should be slower than that in the line circuit. Due to these factors, and due to the fact that the line or loop circuits may often vary in length and electrical characteristics due sometimes to the apparatus connected thereto, it is desirable to include in the auxiliary circuit apparatus which will regulate the building-up and dying-down of the currents therein under various service conditions. In certain arrangements of the prior art such, for example, as in United States Patent 1,601,799 issued October 5, 1926, to J. Herman, are to be found means, such as a condenser-resistance network in combination with a repeater auxiliary circuit, for causing the rate of build-up of the currents in the auxiliary circuit to be slower than the build-up rate in the line circuit when such auxiliary currents are utilized for biasing purposes. The arrangements of the invention constitute a distinct improvement over former arrange-

ments of this type in that they provide not only for a slow build-up rate when utilized for biasing purposes, but also provide a rapid build-up rate when utilized for holding purposes. The arrangements of the invention furthermore constitute an improvement over prior arrangements in that they accomplish this purpose in a novel manner so that the telegraph repeater will operate satisfactorily when connected with types of lines such as composited circuits and cable circuits, with which such prior devices would not give satisfactory operation. Further features and objects of the invention will appear more fully from the detailed description thereof hereinafter given.

The invention may be more fully understood from the following description together with the accompanying drawings in the Figures 1, 2a, 2b, 3a, and 3b of which the invention is illustrated. Fig. 1 is a circuit diagram embodying a preferred form of the arrangements of the invention. In the remaining figures, the effect of the magnetizing forces in the repeater relays is illustrated by a showing of the wave shapes of the current under various conditions.

In Fig. 1 are shown two stations, a west station and an east station, interconnected by a telegraph repeater embodying the features of the invention. At the west station would be provided a key K_1 , a sounder relay 1 and the oppositely poled batteries 3 and 4. The line L_w would connect the west station to repeater apparatus. At the east station would be provided a key K_2 , a sounder relay 2 and the oppositely poled batteries 5 and 6. This apparatus would be connected by a line L_e to the repeater apparatus. At the repeater station there would be provided the relays 7 and 8 having two sets of windings. One set of these windings would be included in the line circuit L_w . The other set of windings would be included in a local or auxiliary circuit 11. The repeater circuit would also in-

clude the two polar relays 9 and 10 having two sets of windings. One set of windings for these relays would be included in the line circuit L_E and the other set of windings would be included in the auxiliary circuit 12. The spark killers 13 and 14 would be provided at the contacts of relays 8 and 9. The spark killers 15 and 16 would be provided at the contacts of relays 7 and 10. Associated with the auxiliary circuits would be the batteries 17 and 18. Included in each auxiliary circuit would be the inductances 23 and 24. Associated with these circuits are the resistances 21 and 22 and the resistances 19 and 20. It is pointed out that resistances 19 and 20 are larger than resistances 21 and 22.

The invention may be more fully understood from the following detailed description of its operation: With both keys K_1 and K_2 closed, the relays 8 and 9 would hold their armatures on their marking contacts, as shown. This will be due to the current flowing through the line circuits L_W and L_E . Under such conditions a biasing current of lesser strength than the line currents will flow through the auxiliary windings of these relays. For example, current will flow from battery 17, contact of relay 7, resistance 22, inductance 24, conductor 12, winding of relays 10 and 9 to ground. In a similar manner current will flow from battery 18, contact of relay 10, resistance 21, inductance 23, conductor 11, through the auxiliary windings of relays 7 and 8 to ground. If the key K_1 should now be opened this would cause the armatures of relays 7 and 8 to move to their spacing contacts. This would open the loop circuit L_E and the auxiliary circuit 12. It is desirable that the relays 9 and 10 should not operate under these conditions, and hence a holding current should be provided in the auxiliary windings of relays 9 and 10 at this time. This holding current is provided as follows: from battery 18, resistance 19, auxiliary windings of relays 10 and 9 to ground. This holding current would build up very rapidly and prevent the armatures of relays 9 and 10 from leaving their marking contacts. It is pointed out that with the condenser-resistance network utilized in prior arrangements in place of the combination of the inductance 24 and spark killer 15 of this invention, the discharge of the condenser of the prior arrangements would tend to prevent a rapid building-up of the holding current under such conditions. It is pointed out that the battery 18 is oppositely poled from the battery 17, and hence the current therefrom will operate as a holding current for relays 9 and 10. In a similar manner the opening of key K_2 , when key K_1 was closed, would cause the operation of relays 9 and 10 and would change the current in the auxiliary windings of relays 7 and 8 from a biasing current to a holding current.

Let us now assume the circuit to be under the conditions previously described, with the key K_1 open and the key K_2 closed. If the key K_1 is now closed, the armatures of relays 7 and 8 will return to their marking contacts. As the resistance 19 is greater than the resistance 22, the dominating current in the auxiliary windings of relays 9 and 10 will now flow from battery 17, contact of relay 7, resistance 22, inductance 24, conductor 12, windings of relays 10 and 9 to ground. This current will have a biasing effect and will oppose the current flow in the line windings of relays 9 and 10. It is pointed out that it is desirable that the rate of build-up of the current in the auxiliary windings of relays 9 and 10 should be slower than that in the line windings of relays 9 and 10. If this were not the case the biasing current might cause the relay armatures to move to their spacing contacts and cause chattering or unsatisfactory operation of the relays. To cause a slow build-up of the biasing current in these relays the inductance 24 is included in series in the auxiliary circuit. This provides a slow building-up of the biasing current and has the advantage of offering a high impedance to transient currents which may be induced in the auxiliary circuit through the coupling between the line and biasing windings of the relays. The effect of induced transients in the case of operation over composited circuits or cable circuits is found to be a serious problem with the condenser-resistance network of prior arrangements. The spark killers, such as 15 and 16, are provided in the auxiliary circuit and effectively suppress the inductive discharge at the relay contacts while at the same time not appreciably retarding the rate of build-up of the holding current.

In order to more fully understand the operation of the magnetizing forces in the relays of the repeater, such as the relays 9 and 10, reference is had to Figs. 2a, 2b, 3a and 3b of the drawings. Figs. 2a and 2b illustrate the magnetizing forces set up when the loop circuit will include series inductance. Figs. 3a and 3b illustrate the magnetizing forces set up when the loop circuit includes bridged capacity, such as to be found in a composited circuit. In Figs. 2a and 3a the wave shape of the magnetizing force due to the current in the auxiliary windings of the relays 9 and 10 is indicated by the light lines b and b' , and the force due to the line current by the heavy lines a and a' , respectively. During the closed key K_1 condition, auxiliary circuit current provides the biasing effect for the relays 9 and 10 and opposes the effect of the line current. During the open key K_1 condition, current in the auxiliary circuit provides the holding effect for the relays while there is no current in the line. As has been pointed out, it is required for satisfactory

operation that under the "closed" condition the biasing current shall not increase at a faster rate than the current through the line windings of the relays in the side to which the signals are repeated. Otherwise, relays in that side would be operated momentarily to their spacing contacts, thus mutilating the signals and causing irregular signals. Also, as has been pointed out, it is required that under the "open" condition the holding current shall take control of the relays before the line current decays to zero. Otherwise, the relay armatures might move to their spacing contacts and interfere with the signals which are being transmitted. Another way of expressing this is that the sum of the two forces indicated by the curves a , b and a' , b' , which sum is indicated respectively by the curves c , c' of Figs. 2b and 3b, must always be positive.

The manner in which the correct wave shape is obtained for current through the auxiliary windings of the relays 9 and 10 will now be described. First, assume the key K_2 to be closed and the key K_1 to be open, and that the current through the auxiliary windings of relays 9 and 10 is to be examined. This current is now holding the armatures of relays 9 and 10 on their marking contacts, and no current is flowing in the line circuit L_E since the armatures of relays 7 and 8 are on their spacing contacts. Now, if the key K_1 is closed, the armatures of relays 7 and 8 are moved to their marking contacts and current builds up in the circuit L_E and also in the auxiliary windings of relays 9 and 10, the rate of build-up through these windings depending primarily upon the value of the inductance 24 and the resistance 22. These constants have been chosen to cause the rate of build-up through the auxiliary windings to be slower than that of the current in loops containing a number of relays. This fulfills the first condition for satisfactory operation. Now, if the key K_1 is opened, the holding current will build up through the high resistance 19. The constants of the spark killers associated with the relays 7 and 10 have been chosen to minimize sparking and at the same time not appreciably retard the faster building-up of the holding current. This arrangement, therefore, fulfills the second condition for satisfactory operation.

Suppose that the circuit L_E contains a considerable amount of inductance, such as a number of subscribers' relays. The wave shape of the current in the circuit L_E may then be similar to that shown by the heavy line curve a in Fig. 2a of the drawing. If the armature of relay 8 closes the circuit after opening it for, say, several seconds, the current in circuit L_E builds up slowly, as indicated by curve a , to its steady value. When the key K_1 is opened, the armature of

relay 8 leaves the marking contact, the circuit L_E is opened and the current falls to zero in a very short time, as indicated by the curve a . It would fall to zero practically immediately were it not for the effect of the spark killer 13. Since, as indicated by the light line curve b the biasing current builds up more slowly than the line current when the line circuit is closed, and since when the line is opened the holding current is effective before the line current decays to zero, the repeater operates satisfactorily in circuits containing a number of relays.

In the case of line circuits containing bridged capacity, such as composite sets, the wave shape of the line current is similar to that given in curve a' of Fig. 3a. When the line circuit is closed after being open there is a rush of current into the bridged capacity. This current quickly attains its peak value and then gradually subsides to the steady marking value. Then, when the line is opened, the bridged capacity discharges through the circuit and through the spark killer of the line relay 8. The wave shape of the current in the auxiliary windings is, of course, the same as that given in Fig. 2a. It will be seen by inspection of curve c' that the line and auxiliary current effects in the relay are always positive, so that as regards the auxiliary circuits satisfactory operation of the repeater would be obtained in circuits containing bridged capacity.

While the invention has been disclosed as embodied in certain specific arrangements which are deemed desirable, it is understood that it is capable of embodiment in many and other widely varied forms without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. A telegraph repeater comprising relay means controlled jointly by a line circuit and an auxiliary circuit, and impedance means associated with said auxiliary circuit for causing the rate at which the current therein builds up to be slower than the rate at which said current dies down.

2. A telegraph repeater comprising relay means controlled jointly by a line circuit and an auxiliary circuit, means for applying current to said auxiliary circuit for holding purposes, means for applying current to said auxiliary circuit for biasing purposes, and means in said auxiliary circuit to cause said biasing current to building up slowly and to die down rapidly.

3. A telegraph repeater comprising relay means controlled jointly by a line circuit and an auxiliary circuit, means for applying current to said auxiliary circuit for holding purposes, means for applying current to said auxiliary circuit for biasing purposes, and an inductance in series with said last mentioned means.

4. A telegraph repeater comprising relay means controlled jointly by a line circuit and an auxiliary circuit, switching contacts in said auxiliary circuit, means for applying current to said auxiliary circuit for holding purposes, means for applying current to said auxiliary circuit for biasing purposes, an inductance in series with said last mentioned means, and a spark killer across said switching contacts.
5. A telegraph repeater comprising relay means controlled jointly by a line circuit and an auxiliary circuit, means for impressing a holding current on said auxiliary circuit when said line circuit is open, and means for causing said holding current to build up at a more rapid rate than that at which the line current dies down.
6. A telegraph repeater comprising relay means controlled jointly by a line circuit and an auxiliary circuit, means for impressing current on said circuits, and means for increasing the current in said auxiliary circuit at a slower rate than the rate at which the line current increases and for decreasing said auxiliary current at a more rapid rate than that at which said line current decreases.
7. A telegraph repeater comprising relay means including line windings and auxiliary windings, means for impressing a biasing current on said auxiliary windings when current is impressed on said line windings and for impressing a holding current on said auxiliary windings when the circuit of said line windings is open, and means for causing said biasing current to build up at a slower rate than that at which said line current builds up and for causing said holding current to build up at a more rapid rate than that at which said line current dies down.
8. A telegraph repeater comprising relay means controlled jointly by a line circuit and an auxiliary circuit, means for impressing variable currents on said circuits, and impedance means in series with said auxiliary circuit for causing the rate at which the current therein builds up to be slower than the rate at which said current dies down.
9. A telegraph repeater comprising relay means controlled jointly by a line circuit and an auxiliary circuit, means for applying current to said auxiliary circuit for holding purposes, means for applying a second current to said auxiliary circuit for biasing purposes, and an inductance in series with said last-mentioned means.
10. A telegraph repeater comprising relay means controlled jointly by a line circuit and an auxiliary circuit, switching contacts in said auxiliary circuit, means for impressing a biasing current on said auxiliary circuit when said line circuit is closed, means for impressing a holding current on said auxiliary circuit when said line circuit is open, inductance means associated with said auxiliary circuit for causing said biasing current to build up at a slower rate than that at which the line current builds up and for permitting said biasing current to die down and said holding current to build up at a more rapid rate than that at which the line current dies down, and spark suppressing means connected across said switching contacts.
- In testimony whereof, I have signed my name to this specification this 27th day of March, 1929.
- ROY B. SHANCK.

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