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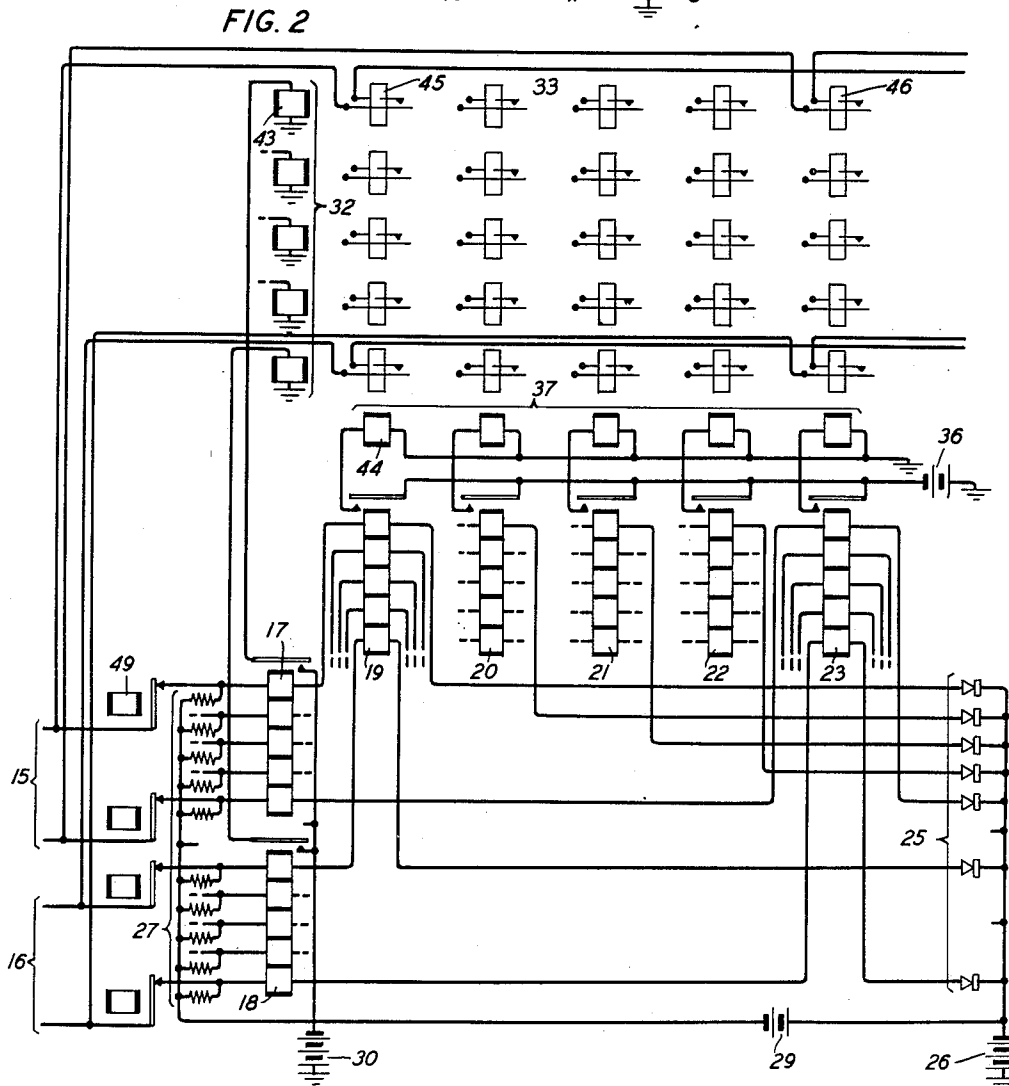
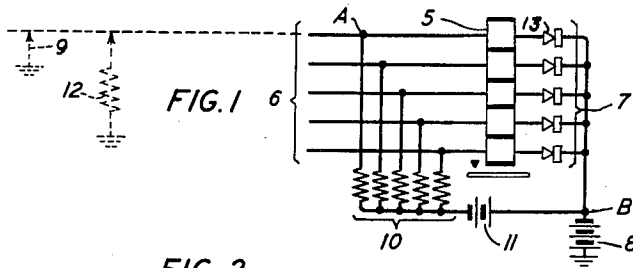
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2,193,427

TELEPHONE SYSTEM

Filed March 10, 1938

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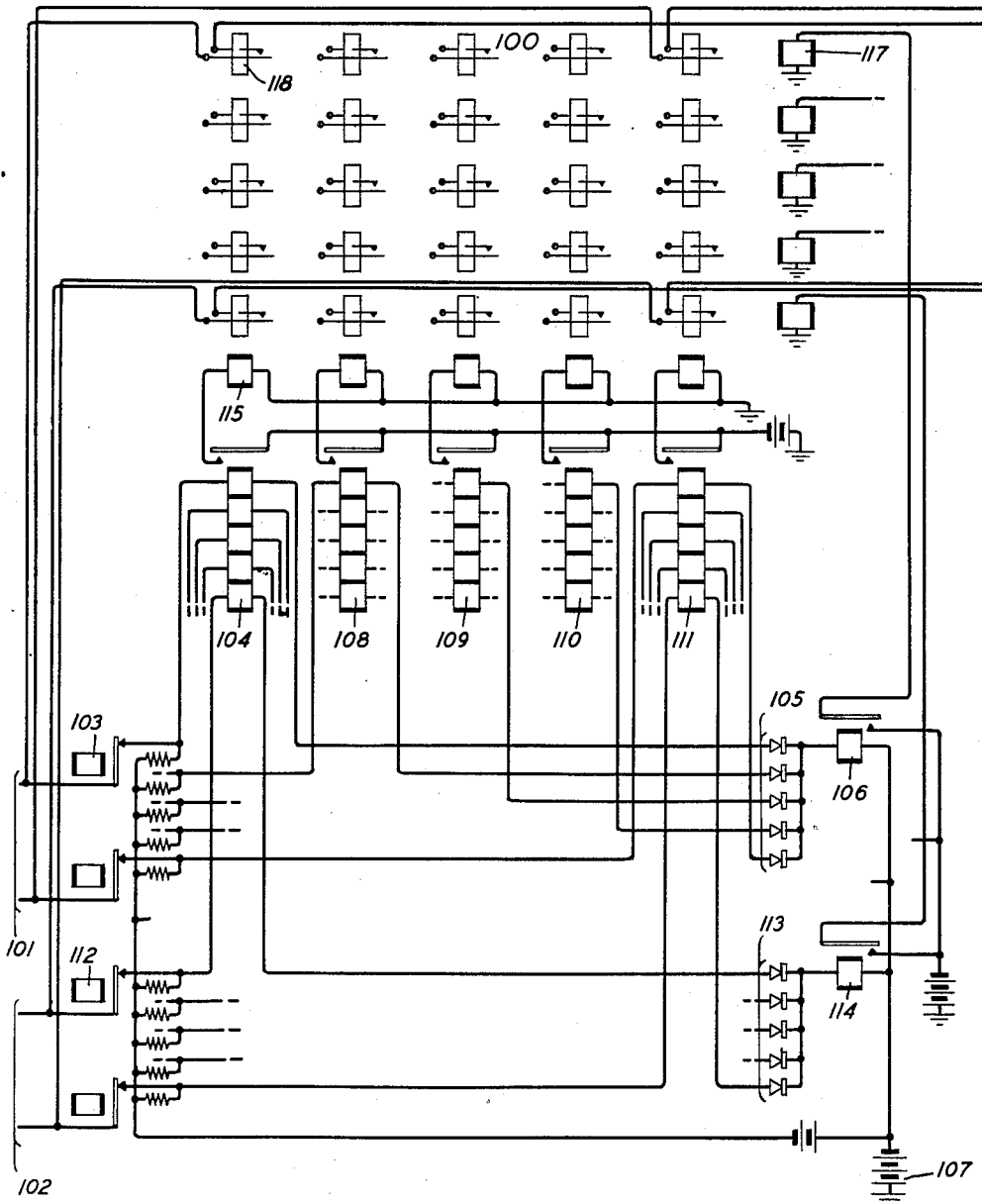
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FIG. 3



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TELEPHONE SYSTEM

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9 Claims. (Cl. 179—18)

This invention relates to telephone systems and particularly to means for controlling the marginal operating characteristics of relays in telephone systems.

5 An object is to improve and simplify relay arrangements and to reduce the cost thereof in such systems.

10 Heretofore marginal relay arrangements have been made in which accurate adjustment of the relays was required to control the operating characteristics thereof in telephone systems particularly in regard to line relay operations where the effect of leakage on the telephone line may cause false operation of such relays.

15 A feature of the applicant's invention is an arrangement in which the plurality of windings of different lines may be placed on the core of a single line relay and in which the grounding of any line causes the energization of the line relay, whereas the energization of this relay by leakage to ground on any line is prevented within a wide range of values of such leakages. The circuit arrangements for these relays may comprise rectifier elements in series with the line windings
20 and resistances and a biasing battery in shunt of the windings and rectifier elements.

Another feature of the invention is a relay arrangement whereby the lines are divided in groups, and each line is connected to a main winding and an auxiliary winding with the main winding of each group of lines carried on the core of a main relay and with the auxiliary windings from each group carried on the cores of auxiliary relays so arranged that the seizure of
30 one line in a group will operate the main relay for this group and an auxiliary relay individual to the seized line and corresponding lines in other groups.

Another feature of the invention is an arrangement whereby the operation of a main relay and an auxiliary relay causes the operation of corresponding vertical and horizontal magnets of a cross-bar switch to cause contacts at the cross-point of the corresponding horizontal and vertical bars to be operated to identify the calling line.

The invention has been illustrated in the accompanying drawings in which:

50 Fig. 1 shows a common line relay for a plurality of lines arranged in accordance with the applicant's invention;

55 Fig. 2 shows an arrangement of a cross-bar switch controlled to identify a calling line and in which the lines are divided in groups having

windings on a common main relay and an auxiliary relay; and

Fig. 3 shows an arrangement similar to that shown in Fig. 2 with a modified form of the applicant's invention in regard to the line relay
5 windings.

Referring now to the drawings and particularly to Fig. 1, 5 is a line relay common to a plurality of five incoming lines designated 6. Each of these lines is indicated by a single conductor
10 extending through an individual winding on the relay 5 and through an individual non-linear conductive element in the group marked 7 and terminating in a main battery 8 at the central office. Each of these conductors is connected
15 through a resistance in the group marked 10 and terminates in a battery 11 which in turn is connected to the main battery 8.

The operation of this arrangement is as follows: If the subscriber of any of these lines removes his receiver from the switchhook his line may be grounded, as indicated at 9 for the first line in the group 6, in any suitable manner either at the substation or through the other conductor of a pair of telephone lines. This causes current
20 to flow from this ground through the conductor and its winding on relay 5, over the corresponding non-linear conductive element 13 of the group 7 through battery 8 to ground. The characteristic of the elements involved are such that under
30 these circumstances the core will be energized to operate the armature of the relay. However, in case there is a leakage to ground as indicated, for example, at 12 for the first line of the group 6, the relay 5 will not operate. The explanation of this is that the leakage resistance 12 which is comparatively high will establish a corresponding low voltage drop across the points A and B, and therefore, due to the non-linear characteristics of the element 13 and the opposing potential of the biasing battery 11, practically no current
40 will flow in the circuit across these points through the winding of the first line. It is conceivable that when the value of the voltage drop, due to the biasing circuit comprising the resistances 10 and battery 11 is equal to or nearly equal to the voltage drop caused by the leakage resistance 12, no current at all will flow through the winding of this line. On the other hand, the leakage resistance 12 may be decreased considerably without
50 causing the winding of the first line to receive sufficient current to operate the relay as the non-linear element 13 will not change its resistance characteristic in the same proportion as the voltage across the points A, B is increased due to the
55

decrease in resistance 12. Consequently, non-operate conditions may be established for considerable variations in leakages. Similarly, any leakages on any of the other lines in the group 6 will not cause any energization of the relay 5 due to the individual non-linear conductive elements and biasing circuits. It is therefore readily seen that very reliable marginal operating characteristics may be secured by these arrangements of the relay 5 even though the leakages on the lines having windings on this relay may vary within a wide range of values.

Advantage may be taken of economical arrangements of groups of lines, and common line relays as described above in connection with cross-bar switch operation for identifying calling lines. Arrangements of this kind are disclosed in Figs. 2 and 3. Referring to Fig. 2 groups of lines 15 and 16 have been shown with the lines 15 having windings on the main relay 17 and the lines 16 having windings on the main relay 18. It should be noted that the first line in group 16 also has a winding on an auxiliary relay 19. This auxiliary relay also has a winding from the first line in group 16 and three other windings that may extend through lines having windings in intermediate main relays for three other groups of five lines each. Similarly, the auxiliary relay 20 may have its first winding connected to the second winding of the main relay 17 and its fifth winding connected to the second winding of the main relay 18. The intermediate three windings on relay 20 may extend through the second windings on three intermediate main relays. The remaining three auxiliary relays 21, 22, and 23 may have their five windings arranged in the same manner to the three succeeding windings of the corresponding five main relays. All of the windings to the auxiliary relays are wired at their opposite ends through non-linear conductive elements in the group 25 which are then connected together through the main battery 26 to ground. All of the windings in the various groups of lines and the windings of the main relays are connected through resistances at 27 which are connected together at their opposite ends to the auxiliary battery 29 which in turn is connected, as shown, to the main battery 26. This wiring arrangement is similar to the wiring for the auxiliary battery 11 and resistances 13, as shown in Fig. 1. Each main relay 17, 18 and intermediate relays has an armature connectable through contacts to battery 30 and connected individually through windings of five magnets marked 32 of a cross-bar switch 33 to ground. These magnets in the group 32 operate in the usual manner on horizontal bars in the cross-bar switch 33 of any well-known type. Similarly, the auxiliary relays 19 to 23 are provided with individual armatures connected to a common battery 36 and connectable through individual contacts to individual magnets in the group 37, each of which operates vertical bars in the cross-bar switch 33. It is common practice in cross-bar switches of this general type in the operation of horizontal and vertical bars to cause connections to be established at the corresponding intersecting points. For example, if the upper magnet 43 in the group 32 and the left-hand magnet 44 in the group 37 are operated, contacts at the cross-point 45 are operated. The contacts at point 45 establish a connection for the first line in the group 15 and the contacts at a corresponding cross-point 46 establish a connection for the last line in the

group 15. The intermediate cross-point in the same horizontal row establishes connections for the intermediate line in the group 15. Similarly, the contacts in the second, third and fourth horizontal rows are connected to lines of intermediate groups, while the lines in group 16 are connected through contacts in the fifth or last horizontal row.

The operation of this system is as follows: If a first subscriber, for example, in the group of lines at 15 calls, a circuit is established from ground over this subscriber's line through contacts of a cut-off relay 49, through the upper winding of relay 17, the upper winding of relay 19, to the upper element in the group 25, battery 26 to ground. This causes the operation of relays 17 and 19. Relay 17 closes an obvious circuit for the upper horizontal magnet 43 and the operation of relay 19 closes an obvious circuit for the operation of magnet 44. The operation of these two magnets causes a connection to be established through the contacts at 45 from the first line in the group 15. The closing of these contacts in any suitable manner may identify the calling line and initiate the establishing of a connection through a telephone system at the central office in which this equipment is located. When this identification has been made relay 49 may operate to open the connection for this line through the windings of relays 17 and 19 which now release causing the release of the cross-bar switch magnets 43 and 44, restoring this cross-bar to normal. This identification of the calling line may therefore merely be made to close a temporary starter wire connection through the cross-bar switch to initiate the establishing of a connection for a calling line through a line finder to a first selector as is well known in the art. Similarly, if any other line in the group 15 calls, the corresponding relay 17 and an auxiliary relay, for example relay 23, will cause corresponding identifying connections to be made through the cross-bar switch 33 over the contacts at the intersecting point 46. Operations similar to those described above take place when a subscriber calls in any of the other groups of lines, for the identification of the calling line through the operation of corresponding contacts at the intersecting points in the cross-bar switch 33.

It should be observed, therefore, that in this system as disclosed in Fig. 2, only two line relays are required for each group of five lines and that the arrangement is in accordance with the principles of the circuits disclosed in Fig. 1 as far as the effect of leakages on the lines on the operation characteristics of the line relays involved are concerned.

In Fig. 3 the applicant's invention has been applied in a somewhat modified form for identifying calling lines by means of a cross-bar switch 100. In this case the lines have been divided in groups of five as shown at 101, for one group, and at 102 for another group. In this case, for example, the first line of group 101 is connected through contacts of a cut-off relay 103, the upper winding of relay 104, a non-linear conductive element in the group 105 and the winding of relay 106 to battery at 107. Similarly, the succeeding four lines in this group are connected to the first winding and succeeding relays 108, 109, 110 and 111 through the winding of relay 106 to battery 107. In the group of lines 102 the first line is connected through contacts of a cut-off relay 112, the lower

winding of relay 104, an element in the group 113, winding of relay 114 to battery 107 and the succeeding lines are connected through the lower windings of relays 108 to 111 through elements in the group 113 and the winding of relay 114 to battery 107. The lines in the groups intermediate the groups 101 and 102 are similarly connected to intermediate windings of the relays in groups 104 to 111 through non-linear elements and intermediate relays similar to relays 106 and 144 to battery at 107. The relays 104 to 111 operate as shown to cause magnets to operate vertical bars in the cross-bar switch 109, while relays 106 and 114 and intermediate relays operate corresponding magnets for operating the horizontal bars in the cross-bar switch 109.

The operation of the applicant's system as applied in this Fig. 3 is as follows: If the first subscriber in group 101 takes his receiver off the switchhook a connection is established from ground through his line, over contacts of cut-off relay 103, upper winding of relay 104, an element in the group 105, winding of relay 106 to battery at 107. This causes the operation of relay 104 which closes an obvious circuit for the operation of magnet 115 and the operation of relay 106 closes an obvious circuit for the operation of relay 117. The operation of these two magnets causes the corresponding bars to close a connection at the intersecting point 118 for the first line in group 101 and thus causes the identification of this line at the central office. When the identification has been made cut-off relay 103 operates and relays 104, 106 and the magnets 115 and 117 are released causing the release of the connection at the cross-point 118 and the restoring of the cross-bar switch 109 to normal.

The arrangement in Fig. 3 as far as the effect of leakage is concerned is the same as in Figs. 1 and 2, the only difference in the wiring is that the non-linear elements are placed between the main relays 104 to 111 and the auxiliary relays 106 and 114 and intermediate relays, thus requiring only a single winding on each auxiliary relay. In this case the auxiliary relays are employed for operating the horizontal magnets in a cross-bar system and the main relays are employed for operating the vertical magnets. This is the reverse from the arrangement shown in Fig. 2 but accomplishes the same purpose. When leakage occurs, for example, on the first line in group 101, practically no current will flow through the associated winding in the main relay 104 and the auxiliary relay 106 due to the common biasing circuit and the non-linear characteristic of the first element of the group 105 for the same reason as described in connection with Fig. 1, that is, a low voltage drop is provided across the main relay winding by the biasing circuit.

What is claimed is:

1. A relay having a core, an armature, a plurality of windings on said core, any one of which will operate said armature when current of a predetermined value flows therein, non-linear conductive elements in circuit with said windings, a source for applying voltages across said windings, circuit means for causing said voltages to vary, and means for biasing said elements to prevent the flow of operating current in any winding until the voltage across said winding reaches a predetermined value.

2. A relay having a core, an armature, a plurality of windings on said core, any one of which will operate said armature when current of predetermined value flows therein, a non-linear con-

ductive element in circuit with each winding, a source for applying voltages across said windings, circuit means for causing said voltages to vary, and circuits including resistance and a source of current in shunt of said windings and non-linear conductive elements, the voltage drop across said circuits being such that any voltages applied to any one of said windings will not cause sufficient current to flow through said winding to operate said armature until said voltages reach a predetermined value.

3. A relay having a core, a plurality of windings on said core, a line connected to one end of each winding, a non-linear conductive element connected with one end to the other end of each of said windings, a source of current with one terminal connected to ground and the other terminal connected to the other ends of said elements, a second source of current with one terminal connected between said elements and said first source of current, a plurality of resistances each connected at one end to an individual line and the other end connected to the other terminal of said second-mentioned source of current, said elements being so adjusted electrically that when ground is connected to one of said lines the potential across the associated winding is of such value as to permit current to flow through said winding to energize the core to operate the relay and when a leakage occurs on said line within a wide range of values, the potentials across the windings are such as to prevent sufficient current from flowing through the windings to cause the energization of said windings to operate the relay.

4. A relay having a core, a plurality of windings on said core, a line for each winding, a non-linear conductive element for each winding, a resistance element for each winding, a main battery, an auxiliary battery, and circuits for connecting said elements, said elements being so adjusted and connected in said circuits that if any line is grounded the core of said relay will become energized to cause the energization of said relay and so that if leakage to ground occurs on any of said lines over a wide range of values, said core will not be energized and the operation of said relay thereby prevented.

5. A relay having a core, a plurality of windings on said core, a line connected to one end of each winding, a non-linear conductive element connected to the other end of each winding, a main battery with one end connected to ground, a circuit connecting the other end of said elements to the other end of said main battery, an auxiliary battery with one end connected in series aiding with said main battery to ground, resistances connected in shunt of said windings and said elements between said lines and the other end of said auxiliary battery, all of said elements being so adjusted electrically that when a predetermined voltage is applied to any line, the associated winding is energized to cause the operation of the relay and so that when voltages of other values are applied to any lines, the associated windings will not be energized sufficiently to cause the operation of the relay.

6. In combination, a plurality of incoming lines, a relay having a single core, an armature, a winding for each line on said core, a main battery, a non-linear conductive element connected between the winding of each line and the main battery, a biasing battery connected at one end in series aiding with said main battery, resistance elements each connected at one end to an incoming line

and at the other end to the opposite end of said biasing battery, all of said elements being so adjusted that when a voltage of a predetermined value is applied to a line, current will flow through the associated windings to energize said core to operate said armature and when voltages of other values are applied to a line, the associated non-linear element, the auxiliary battery and the associated resistance element will prevent current from flowing through the associated winding of sufficient value to cause said core to operate said armature.

7. In combination, a common relay having a core, lines, a winding for each line on said core, an individual relay for each line each having an individual core, a second winding for each line on the core of an individual relay, the arrangement of said windings being such that the windings of any line will operate the common relay and the associated individual relay when a voltage of a predetermined value is applied thereto, a non-linear conductive element in circuit with the winding of each line, a source of current for applying voltages across said windings, circuit means for causing said voltages to vary, and means for biasing said elements to prevent the flow of operating current in any winding until the voltage across said windings reaches said predetermined value.

8. In combination, groups of lines, a main winding and a auxiliary winding for each line, a common relay for each group of lines, the core of which carries the main winding of the lines in the group, auxiliary relays, the core of each carrying an auxiliary winding from one line in each group, the arrangement of said windings being such that the windings of any line will operate the associated common relay and the associated auxiliary relay when a voltage of a predetermined value is applied thereto, a non-linear conductive element in circuit with the windings of each line,

a source of current for applying voltages across said windings, circuit means for causing said voltages to vary, and means for biasing said elements to prevent the flow of operating current in any windings until the voltage across said windings reaches said predetermined value.

9. In combination, groups of lines, a winding for each line, a common relay for each line and having an armature controlled thereby, the core of each common relay carrying the windings of a line in each group, an auxiliary relay for each group of lines and having an armature controlled thereby, each auxiliary relay having a single winding, a non-linear conductive element in circuit with the winding of each line, a main source of current with one end connected to ground, a circuit connected from the other end of said source to one end of the windings of said auxiliary relays in parallel, a circuit connected from the other end of the winding of each auxiliary relay in parallel to the non-linear conductive elements in the group associated with the corresponding group of lines, a biasing source of current connected at one end in series aiding to said main source of current, resistance elements each connected at one end to a line and at the other end to the opposite end of the biasing source of current, all of said elements being so adjusted that when a voltage of a predetermined value is applied to a line, current will flow through the windings of the associated common relay and auxiliary relay to cause the operation of their respective armatures and when voltages of other values are applied to a line, the associated non-linear element, the biasing source of current and the associated resistance element will prevent current from flowing through the windings of the associated relays of sufficient value to cause the operation of their armatures.

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