

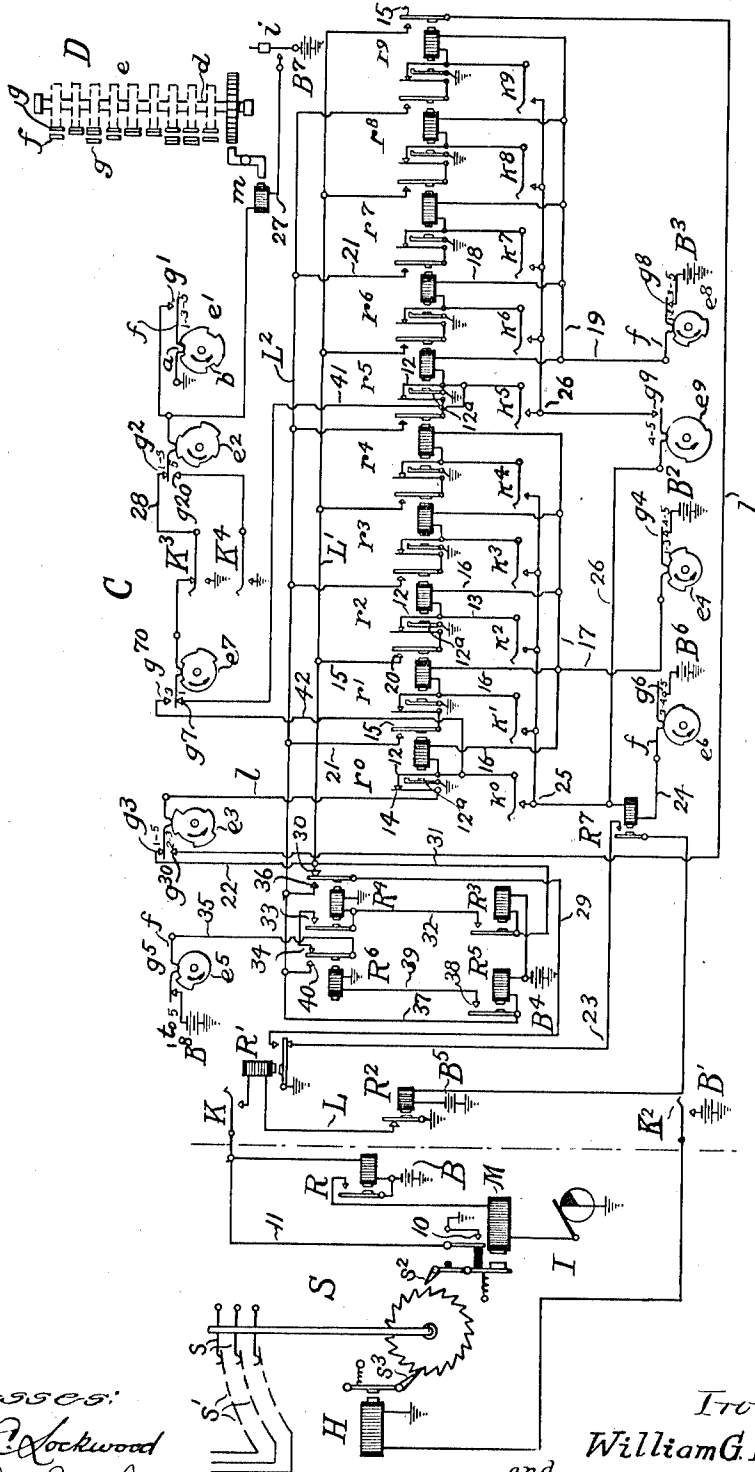
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CONTROLLING APPARATUS.

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UNITED STATES PATENT OFFICE.

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CONTROLLING APPARATUS.

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To all whom it may concern:

Be it known that we, WILLIAM G. BLAUVELT and EDWARD C. MOLINA, residing at New York, borough of Manhattan, and East Orange, in the counties of New York and Essex and States of New York and New Jersey, respectively, have invented certain Improvements in Controlling Apparatus, of which the following is a specification.

For controlling the movement of such selective apparatus as automatic telephone switches, there are used what are called "counting" devices consisting of a series of relays or like electromechanisms successively energized in the advance of a selector by current impulses sent out by it, so that its movement is measured. The current impulses are ordinarily received at the controlling apparatus by a relay or other circuit changing device, which through its front contact and a suitable local circuit successively actuates the counting or controlling relays as each impulse is received. This continues until the desired selective movement has occurred, determined, for example, by a depressed key of a set, whereupon the last counting relay energized causes the operation of a cutoff device which arrests the selective movement. After each counting relay has been energized, it is necessary that certain circuit changes be made to prepare the next relay of the series for action. So far as we are aware, this has heretofore been accomplished by arranging the controlling relays in pairs, these coöperating in some way to prepare the succeeding pair for energization and at the appropriate time operate the cutoff device. Such an expedient doubles the relays required to count a fundamental group of selective steps, this commonly being ten in practice, calling for twenty relays. It is sometimes the case in systems of this character that the group to be counted may be more than ten, as occurs when the final selector or connecting switch of an automatic telephone system has twenty substation lines terminating on each level. This still further increases the number of counting relays, so that forty may be necessary. In each of the above instances each relay has a plurality of contacts, and it will be obvious to those skilled in the art that operating troubles are thereby multiplied.

The object of the present invention is to

lessen such difficulties by reducing the number of relays. Considered broadly, this is effected in two ways—by providing in the series of counting relays but one relay for each step or impulse to be counted, and bringing about the intermediate circuit changes by a group of relays or other electromechanisms less in number than the series of counting relays and common thereto; and by utilizing said series a plurality of times to count more impulses than the fundamental group.

An embodiment of our invention, considerably simplified as to details from what might be used in practice so that the essentials may be more clearly understood, is diagrammatically illustrated in the accompanying drawing.

The invention will here be described as applied to the controlling of a telephone line selecting apparatus S. In this the brushes s are caused to advance step by step over fixed contact members s' by ratchet mechanism s^2 actuated by a motor magnet M. Current is supplied to the motor magnet by a battery or other source of electrical energy B through an interrupter I and the front contact of a relay R, the winding of which is in a main controlling circuit L from battery B through a starting key K, the winding of a controller actuating relay R' and the back contact of a cutoff relay R² to ground. A contact 10 closed by the motor magnet when energized completes a short circuit 11 for the actuating relay R'. The selector S has a pawl s^3 for holding the brushes in the position to which they are moved by the motor magnet, a release magnet H in circuit with a normally open key K² and a battery B' serving to withdraw the retaining pawl when desired.

The selector S with its motor and release magnets and the relay R are at one end of the main controlling circuit, while the keys K and K² and the relays R' and R² may be at the opposite extremity, to a greater or less extent removed from the selector, as at the position of an operator of whose equipment the controlling apparatus C forms a part. Said operator is provided with a set of digit keys or manually operable circuit controlling or contact devices, each designated by the letter k with a superscript indicating the digit from 0 to 9 which the key

represents, as k^0 , k^1 , etc. With this set of keys is associated a series of counting or controlling relays or electromechanisms r^0 , r^1 , etc., equal in number and corresponding to the keys, they each having a spring 12 joined to the associated key by a conductor 13 and an armature 12^a cooperating with said spring and being connected to ground. The counting relays may be considered as being divided into four groups, two of these consisting of the first five and the last five relays from r^0 to r^4 and r^5 to r^9 , respectively, and two consisting of the first relay r^0 , together with every alternate relay and the second relay r^1 with the remaining counting relays. Each of the counting relays, except r^0 , has one extremity of its winding united through its resting contact 14 to the armature 15 of the relay directly preceding it in the series. The opposite ends of the windings of the group comprising the first five relays are connected to battery B² through conductors 16 and 17 and a contact of a sequence switch or automatic electromechanical circuit controlling device D, to be later more particularly described. The companion group of counting relays r^5 to r^9 have their windings joined by conductors 18 and 19 to battery B³ through another contact of the switch D. A conductor l leads from the armature 15 of the last relay r^9 to the contact 14 of the first relay r^0 by way of a contact of the switch D. Of the groups of counting relays r^0 , r^2 , r^4 , etc., and r^1 , r^3 , r^5 , etc., the front contacts 20 cooperating with the armatures 15 are respectively connected to leads L² and L¹ by conductors 21, the circuit of the first relay r^0 comprising a portion of conductor l , a contact of the switch D and a conductor 22. The connection of the leads L¹ and L² to ground is controlled by the front contact of relay R¹ and two alternately actuated pairs of transfer relays or similar electromechanisms R³, R⁴, and R⁵, R⁶, the energization of which is governed by the front contact of relay R¹, their own contacts and a contact of the sequence switch. Relay R¹, which may be termed a primary cutoff relay, controls at its front contact, in connection with back contact of relay R¹, the energization of the secondary cutoff relay R² by way of conductor 23, current for the energization of relay R² being furnished by battery B⁵. The winding of relay R¹ is in a circuit from battery B⁰ through a contact of the sequence switch and conductor 24, and then in parallel through conductors 25 and 26, the latter including a contact of the sequence switch, to the keys of the respective groups of the first five and last five counting relays.

Returning to the switching mechanism D, this is an automatic device adapted to assume successive controlling positions in regular sequence, and comprises a shaft d upon

which is fixed a series of cams e , the peripheries of which cooperate with springs f to force them against or permit them to separate from contacts g . These cams, springs and contacts all appear in two places in the drawing, in dotted lines in their actual relation to the shaft d , and in full lines most clearly developing the circuit organization. In the latter case the cams and contacts are distinguished from one another by numerals affixed to their reference letters. The switch shaft with its cams may be moved from position to position by means including a motor magnet m actuating ratchet mechanism. An interrupter i applies current from a battery B⁷ through a conductor 27 to motor magnet m , and thus rotates the shaft whenever its circuit is completed at one of the contacts of the sequence switch D to ground. This ground connection may be at some external point or local to the switching mechanism itself, the cam e' controlling the latter condition and determining the correct stopping points of the switch shaft. When the spring f cooperating with this cam is separated from the contact g' , this being in the positions indicated by the numerals placed at the opposite side of the spring from the contact, a projection a of said spring lies in a depression b in a periphery of the cam, and the shaft with the associated cams is properly positioned. Upon the completion of the circuit of the motor magnet m at some point in the system, the projection rides out of the depression, and when resting upon elevations of the cam e' closes a local circuit for the motor magnet from ground through the contact g' and spring f to conductor 27, which insures the rotation of the shaft to the next position at which the cams are to stop, regardless of external conditions. The numerals applied to the contacts of the remaining cams show the positions in which said contacts are closed. The circuit connections of the sequence switch contacts will appear in the description of operation of the system. Keys K³ and K⁴ associated with the sequence switch apply ground to its motor magnet to cause its movement from and to particular positions.

We will first suppose that the operator wishes the selector brushes to travel to the point at which the apparatus will have caused the transmission of three current impulses over the main controlling circuit through the controller actuating relay R¹. She depresses the key K³, and holds it until, by a circuit from battery B⁷ and interrupter i through conductor 27, motor magnet m , contact g^2 of cam e^2 , conductor 28 and key K³ to ground, the sequence switch is advanced to the fifth position. Controlling key k^2 and starting key K are now depressed and locked down. The main controlling cir-

cuit L is completed through the starting key, and relays R and R' are energized. Relay R closes the circuit of the motor magnet M at the selector, causing it to begin its movement. Relay R' at its front contact completes two paths to the ground upon its armature—one through conductor 29, back contact 30 of the transfer relay R¹, conductor 22, contact *g*³ of cam *e*³, conductor 7, resting contact 14 and spring 12 of relay *r*⁰ of the first group of alternate relays *r*⁰, *r*², *r*⁴, etc., winding of said relay, conductors 16 and 17 and contact *g*¹ of cam *e*¹ to battery B²; and the other by way of conductor 29, back contact 30 of transfer relay R¹, conductor 31 and winding of the transfer relay R³ to battery B⁴. Relay *r*⁰, operated by the first circuit, locks itself to ground through armature 12^a, and by armature 15 joins the succeeding relay *r*¹ to lead L², which furnishes ground for the second alternate group of relays *r*¹, *r*³, *r*⁵, etc. Relay R³, energized by the second circuit, unites the grounded winding of the other relay R⁴ of the pair to battery B⁴ through conductor 32. At this time, however, R⁴ does not attract its armatures, since it is short circuited by conductors 31 and 29 through the back contact of relay R¹ and front contact of relay R'. As the pawl of the motor magnet finishes its forward stroke, it closes the short circuit 11 upon relay R', which releases, R remaining energized. The armature of relay R' in falling back breaks the short circuit of relay R¹, and the latter attracts its armatures. The making of contact 33 locks relay R¹ to battery B⁵ through the back contact 34 of transfer relay R⁰, conductor 35 and contact *g*⁵ of cam *e*⁵. The same contact and path to battery short circuit relay R³ through conductor 32 and cause its release. The armature of relay R⁴ cooperating with the front contact 36 transfers the connection of the conductor 29 to lead L². Consequently upon the second step of the selector, with the attendant opening of the short circuit of relay R' at contact 10, said relay is again energized, and the closure of its front contact applies its ground to the circuit of relay *r*¹ by conductor 29, front contact 36 of relay R¹, lead L², conductor 21, front contact and armature 15 of relay *r*⁰, resting contact 14 and spring 12 of relay *r*¹, winding of said relay, conductors 16 and 17 and contact *g*⁴ of cam *e*⁴ to battery B². At the same time this ground is effective for transfer relay R³ through conductor 37, and current from battery B⁴ energizes it.

The action of relay *r*¹ is similar to that of relay *r*⁰, it locking up and connecting the next controlling relay *r*² to the other lead L'. As in the case of relay R¹, relay R⁰ does not operate when relay R⁵ joins battery B⁴ to its winding through contact 38

and conductor 39, because of the short circuit furnished by conductor 37, contact 36 of relay R¹, conductor 29 and the ground at the front contact of relay R'. But the opening of this short circuit when R' releases leads to the energization of R⁰. By breaking back contact 34, relay R⁰ severs the locking circuit of relay R¹ and releases it. At front contact 40 it places a short circuit upon relay R⁵ through conductors 35 and 37. R⁵ is consequently deenergized and opens the circuit of relay R⁰ at contact 38. The transfer relays have thus completed a cycle of operations, and the circuit conditions resemble those under which the counting relay *r*⁰ was energized, though now the current will flow from battery B² to ground at the front contact of relay R' by way of lead L', instead of passing through contact *g*³ of the sequence switch.

Upon the operation of relay *r*² the ground at its armature 12^a is united by spring 12, conductor 13, contacts of depressed key *k*² and conductor 25 to the primary cutoff relay R⁷, which through conductor 24 and contact *g*⁶ of cam *e*⁶ receives current from battery B⁶. R⁷ closes its front contact, and when the armature of relay R' falls upon its back contact the energizing path for the secondary cutoff relay R² is closed from battery B⁵ over conductor 23. The main controlling circuit L is severed at the back contact of the last named relay. Then when contact 10 opens, as the selector finishes its final step, relay R releases and breaks the motor magnet circuit. The selector brushes are held upon the desired contacts *s*' by the retaining pawl. The operator may now free the starting key K and controlling key *k*². A depression of key K¹ supplies a ground for the interrupted current from battery B⁷ through contact *g*²⁰ of cam *e*², which traversing the motor magnet *m* drives the sequence switch to the first position. In passing through the sixth position the circuits of all the locked relays for this connection are broken at the contacts of the sequence switch and the controlling apparatus is restored to normal. When the use of the selector for this connection is completed a closure of key K² energizes the release magnet H, withdrawing the retaining pawl and permitting the brushes of the selector to be returned to their initial position.

If the conditions are such that the controlling apparatus is to count more than ten impulses, say seventeen, the operator depresses the key *k*⁶ and starting key K as previously described. The brushes of the selector travel forward governed by relay R, while the counting relays are successively energized and locked under the control of relay R' and the transfer relays. As already stated, current is supplied to the controlling

relays forming the first group, from r^0 to r^4 , from battery B^2 through contact g^4 of cam e^4 . The associate group, including relays r^5 to r^9 , receives current from battery B^3 through contact g^5 of cam e^5 and conductors 19 and 18. After the first ten impulses have been counted by the energization of the entire series of relays, the remaining seven impulses are to be counted by the first seven relays of the series, the last relay r^9 extending the ground connection at relay R' over conductor l to relay r^0 for this purpose. At the speed of operation desired, if the whole series were to remain locked until the transfer from r^9 to r^0 occurred, the latter could not be depended upon to release with sufficient promptness to insure its being in the proper position to receive the eleventh impulse. We therefore unlock the counting relays in groups of fewer relays than the whole series, in the present instance in groups of five. So when relay r^5 , which is the first of the second group, locks in the first position of the sequence switch, it places a ground upon the motor magnet circuit of said sequence switch through armature 12^a, spring 12, conductor 41, contact g^1 of cam e^1 , resting contact of key K^3 and contact g^2 of cam e^2 , causing the switch to assume position No. 3. In passing over position No. 2, the first group of relays r^0 to r^4 is released, because the circuit from locking battery B^2 is opened at contact g^4 of cam e^4 . This group is thus made ready for the first of the series of impulses above ten. In the same position contact g^3 is opened, disconnecting the first relay r^0 of the first group from the lead L' so that it may not be energized by impulses intended for the second group. During the travel of the sequence switch the energization of a second group of relays r^5 to r^9 continues, the operation of the elements being so timed that position No. 3 is reached by the sequence switch before relay r^9 is energized. During this first use of the counting series it will be evident that the primary cutoff relay R' must not be energized. This is prevented in the first position of the sequence switch, in which this first counting of the first group takes place, by opening the connection of the cutoff relay to battery B^0 at the contact g^0 of cam e^0 . During the first counting of the second group, which may be in positions Nos. 1, 2 and 3, the battery connection of said group is removed from the corresponding keys by opening conductor 26 at contact g^0 of cam e^0 . In positions Nos. 2 and 3 of the sequence switch, contact g^{30} of cam e^3 connects armature 15 of relay r^0 to contact 14 of relay r^0 , so that the eleventh impulse operates the latter. Upon the attraction of armature 12^a of relay r^0 , the motor magnet circuit of the sequence switch is grounded through

spring 12, conductor 42 and contact g^{70} of cam e^7 , resulting in its advance to position No. 5. This occurs during the operation of relays r^1 to r^4 , it merely being necessary that the fifth position shall have been attained before the sixteenth pulse is to be counted. The further operation of the system may be precisely the same as when less than eleven impulses were received, and need not be further considered.

We claim:

1. The combination with a selective apparatus including electro-responsive means for causing its selective movement, of a controlling apparatus therefor comprising a set of manually operable contact devices for determining the extent of movement of the selective apparatus, electromechanisms, one for each contact device, by which the movement of the selective apparatus toward the desired point is measured, and means under the influence of the electromechanisms for controlling selection.

2. A selector controlling apparatus comprising a set of manually operable circuit controlling devices, a series of electrical controlling devices each corresponding to a manually operable device, an energizing circuit for said electrical devices, and means common to the series for connecting the energizing circuit to successive electrical devices.

3. An impulse counting apparatus comprising a series of electromechanical contact devices, said contact devices corresponding to a series of impulses and being arranged in groups, an energizing circuit for said contact devices, and means for alternately connecting the groups of contact devices to the energizing circuit.

4. An impulse counting apparatus comprising a device actuated by the impulses to be counted, a series of counting electromechanisms, an energizing circuit for the counting electromechanisms controlled by the device, and means common to the series of counting electromechanisms for successively connecting said counting electromechanisms to the energizing circuit.

5. A selection controlling apparatus comprising controlling relays arranged in groups, an energizing circuit therefor, a relay governing said energizing circuit to actuate the controlling relays, and means for alternately connecting the groups of relays to the actuating relay.

6. A selection controlling apparatus comprising a series of controlling relays, an energizing circuit therefor, a relay governing said energizing circuit at one of its contacts to actuate the controlling relays, and transfer relays respectively operable upon different energizations of the actuating relay to connect different controlling relays to its contact.

7. A selection controlling apparatus comprising controlling relays, an energizing circuit therefor, a relay governing said energizing circuit to actuate the controlling relays, and relays interposed between the actuating and controlling relays and acting alternately to connect successive controlling relays to the actuating relay.

8. A selection controlling apparatus comprising controlling relays, an energizing circuit therefor, a relay governing said energizing circuit to actuate the controlling relays, a transfer relay operable with a controlling relay, and a second transfer relay under the influence of the first transfer relay for changing the connection of the actuating relay to a different controlling relay.

9. A selection controlling apparatus comprising a series of controlling relays, an energizing circuit therefor, a relay governing said energizing circuit at one of its contacts to actuate the controlling relays, a transfer relay operable with a controlling relay, a second transfer relay under the influence of the first transfer relay for changing the connection of the actuating relay to a different controlling relay, and a similar pair of transfer relays acting in alternation with those first mentioned.

10. The combination with a set of keys, of a single controlling relay for each key, an actuating relay for the controlling relays, and means for connecting the controlling relays in groups to the actuating relay.

11. The combination with a set of keys, of a single controlling relay for each key, an actuating relay for the controlling relays, a transfer relay energized upon the release of the actuating relay, and circuits connecting different controlling relays to the actuating relay through alternate contacts of the transfer relay.

12. The combination with a selective apparatus capable of movement and of continued movement, of a series of electromechanisms, means for successively energizing the electromechanisms to measure the movement of the selective apparatus, and means for causing a second energization of the electromechanisms to measure the continued movement of the selective apparatus.

13. An apparatus for counting electrical impulses comprising an energizing circuit, a series of electromechanisms, each provided with means for connecting the energizing circuit to another electromechanism of the series, and means controlled by the last electromechanism of the series for connecting the energizing circuit to the first of said series.

14. A controlling apparatus comprising contact electromechanisms, means for energizing groups of the electromechanisms, and means operating during the energization of

one group of electromechanisms for releasing a group previously energized.

15. The combination with a selective apparatus including electroresponsive means for causing its selective movement, of controlling electromechanisms therefor, means for energizing groups of the electromechanisms to control movement of the selective apparatus, and means operating during the energization of one group of electromechanisms for releasing a group previously energized.

16. The combination with a selective apparatus capable of movement and of continued movement, of a series of electromechanisms, means for successively energizing the electromechanisms in groups to measure the movement of the selective apparatus, means for causing a second energization of the electromechanisms to measure the continued movement of selective apparatus, and means operable during the energization of one group of electromechanisms for releasing a group previously energized.

17. The combination with a selective apparatus including electro-responsive means for causing its selective movement, of a series of electromechanisms, means for energizing the electromechanisms to measure the movement of the selective apparatus, means for causing a second energization of the electromechanisms to measure the continued movement of the selective apparatus, means under the influence of the electromechanisms for governing the movement of the selective apparatus, and means for preventing the operation of said governing means during the first energization of the electromechanisms.

18. The combination with an energizing circuit, of a series of selection controlling relays including means forming a part of the last relay of the series for connecting the energizing circuit to the first relay of the series.

19. The combination with an energizing circuit, of a series of selection controlling relays, and means for connecting the first relay directly to the energizing circuit or to the last relay of the series.

20. The combination with an energizing circuit, of a series of selection controlling relays, and a sequence switch provided with alternate contacts for connecting the first relay directly to the energizing circuit or to the last relay of the series.

21. The combination with an energizing circuit, of a series of relays successively actuated to control selection and including means for locking said relays to the energizing circuit, of means for disconnecting a portion of the series of relays from the energizing circuit while other of the series remain locked thereto.

22. The combination with an energizing circuit, of a series of relays successively ac-

tuated to control selection and including means for locking said relays to the energizing circuit, and a sequence switch having independent contacts through which the locking means of the relays are connected to the energizing circuit.

23. The combination with a series of counting relays, of means for utilizing said series a plurality of times during a single counting operation, a cutoff relay, a source of energy for said cutoff relay, and means for disconnecting the cutoff relay from the

source of energy during one of the plural uses of the counting series.

In testimony whereof, we have signed our names to this specification in the presence of two subscribing witnesses, this ninth day of November, 1911.

WILLIAM G. BLAUVELT.
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Witnesses:

GEORGE W. McRAE,
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