July 10, 1951 W. C. SEALEY 2,560,002

VOLTAGE REGULATING CONTROL AND APPARATUS

Filed July 27, 1945 3 Sheets-Sheet 1

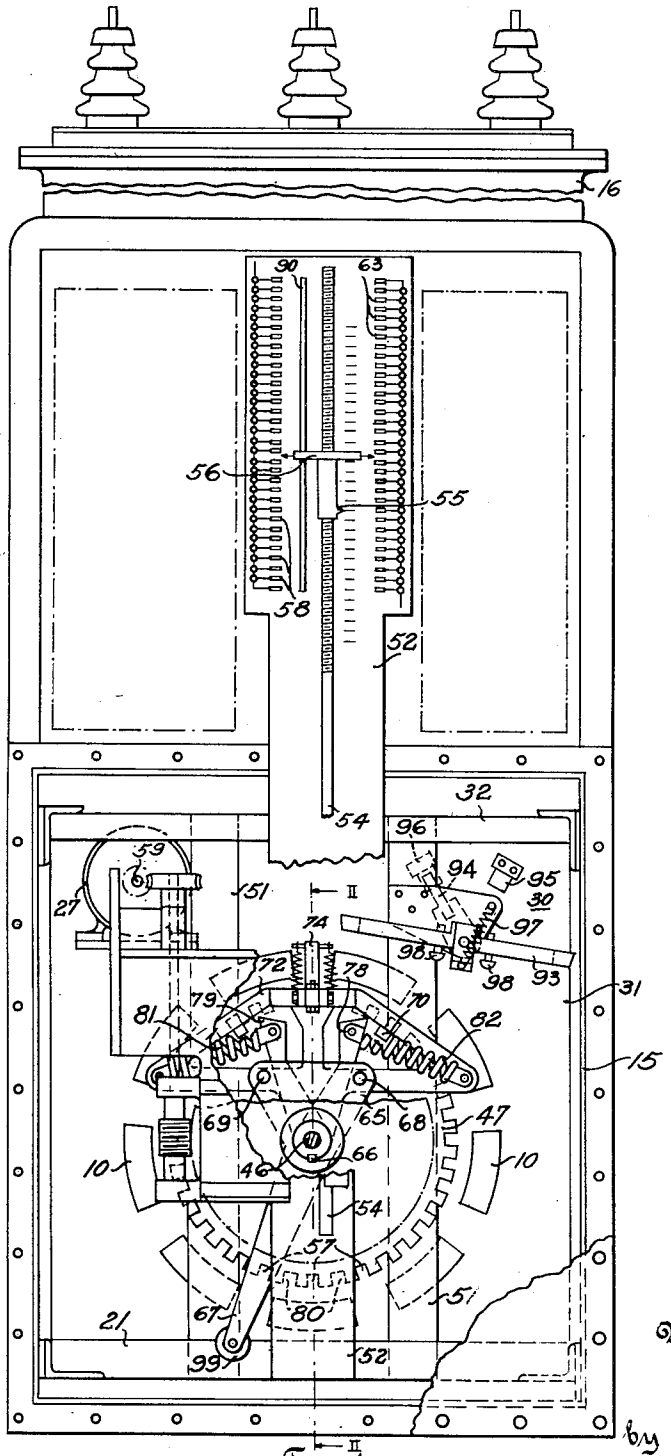

Fig. 1

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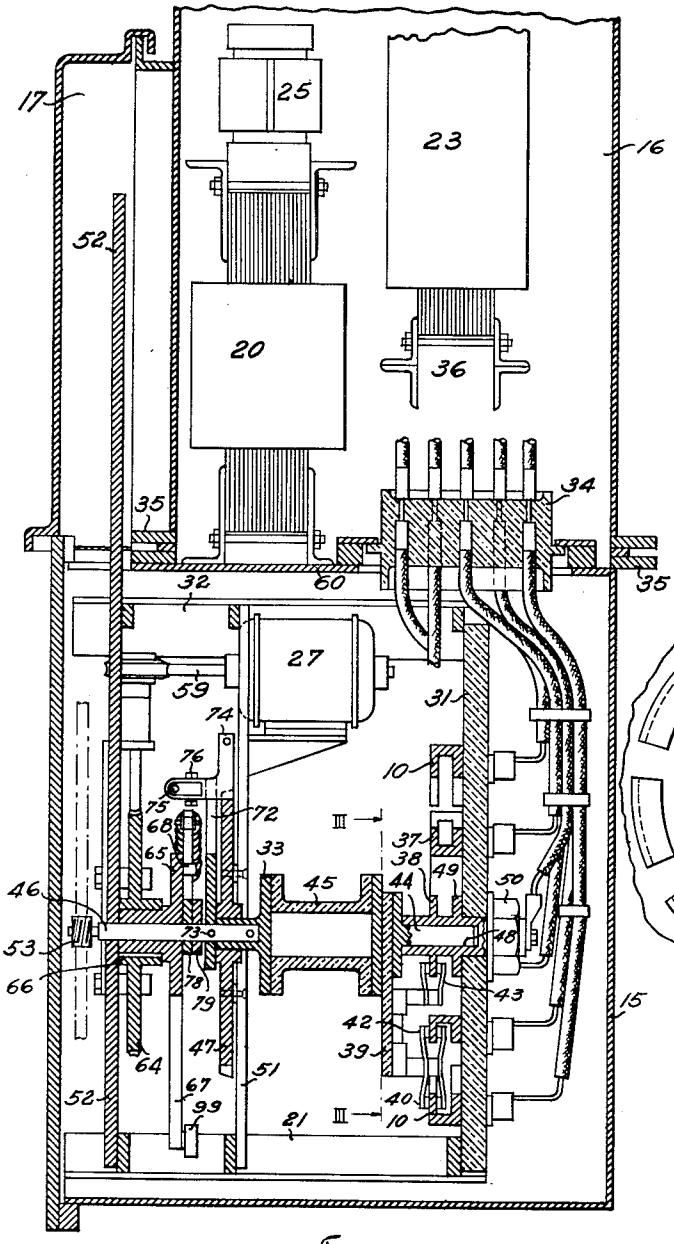

Fig. 2

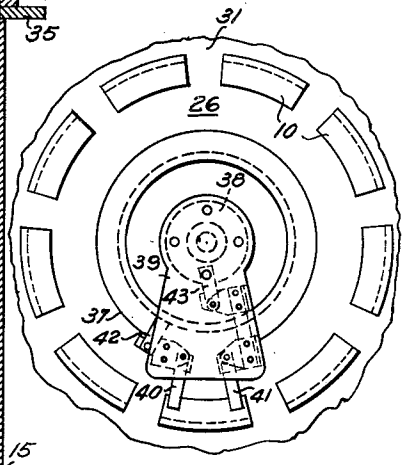

Fig. 3

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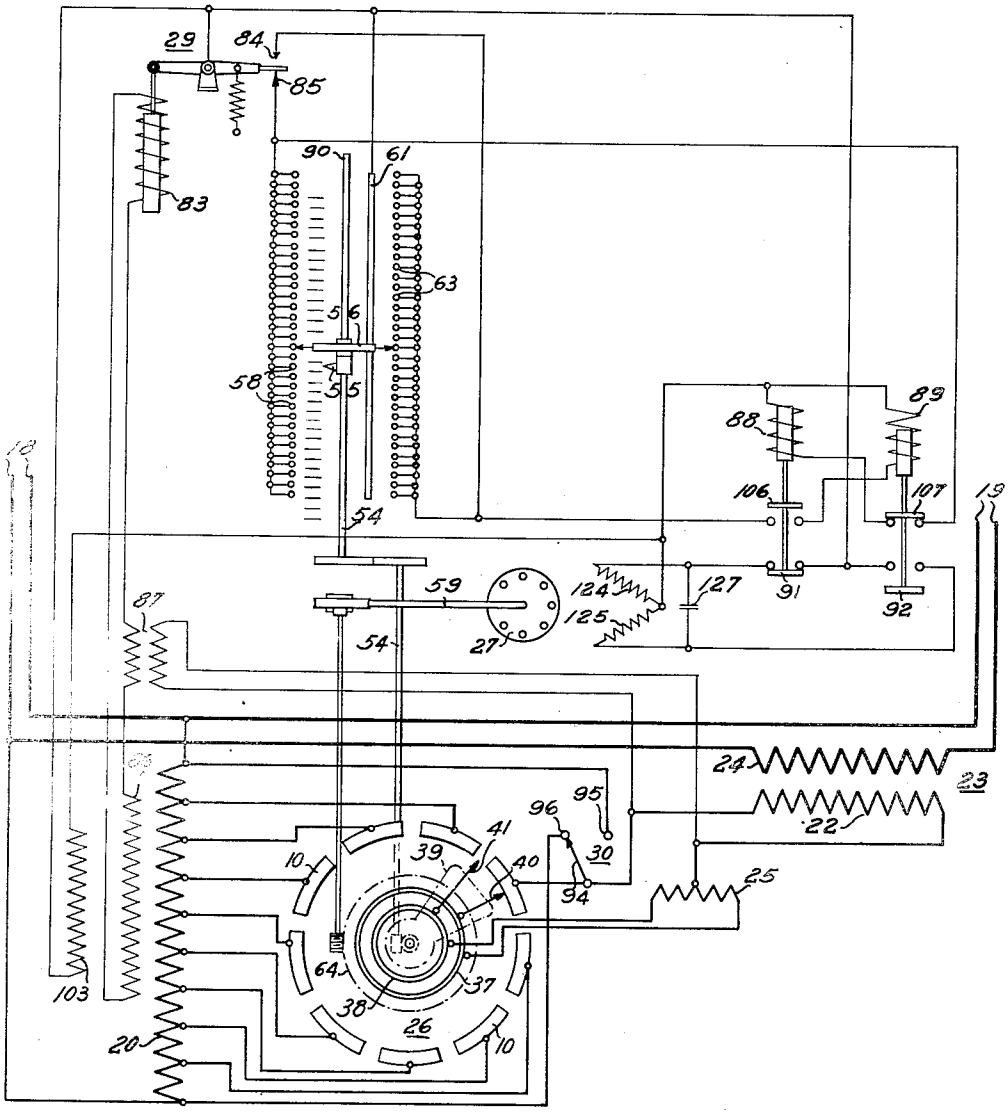

Fig. 4

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VOLTAGE REGULATING CONTROL AND APPARATUS

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5 Claims. (Cl. 175—375)

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This invention relates in general to improvements in voltage regulators and particularly to an improved tap changing system and apparatus for transformers utilized to regulate a circuit voltage.

In prior art tap changing systems of the general type disclosed in United States Patent to L. H. Hill, No. 2,177,109, October 24, 1939, Voltage Regulator, a motor controlled in accordance with the regulated voltage and operating at a relatively slow speed, applies a force to a spring operated structure to move the tap changing switch with an exceedingly fast snap action from one tap position to the next tap position. Such spring operated structure is also utilized to minimize the shock of stopping the moving contact at the new position.

If the quick moving parts of a tap changer of the above type were made lighter in weight, and therefore of less inertia, the quick break mechanism would move the tap changing switch contacts from one position to the next with such rapidity that the arc drawn at the separating contacts would not have sufficient time to be extiguished. If the speed of separation of the breaking contacts were reduced to provide more arcing time, failure to extinguish the arc and consequent burning of the contacts would ensue. Similarly, if the values of the current and voltage made and broken by the tap changing switch in regulators of the above type, were considerably increased, the same problem was presented of maintaining or increasing the speed of contact separation, but at the same time providing a greater time for arc extinguishment to occur.

It is therefore an object of the present invention to provide an improved tap changing apparatus and control system in which the above mentioned disadvantages are avoided and in which the above mentioned problems are solved.

It is a further object of the present invention to provide an improved tap changing apparatus and control system in which the time necessary for movement of the tap changing contacts from one tap position to another is decreased to permit sufficient time for the arc drawn at the breaking contacts to be extinguished, without reducing the contact separating speed.

It is also an object of the present invention to provide an improved tap changing apparatus and control system with a quick break tap changing contact that is momentarily delayed during its movement from one tap position to another.

It is also an object of the present invention to provide an improved control for a tap changer

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in which the tap changing switch is stopped in a position intermediate two adjacent tap positions, with a means for preventing such tap changing switch from staying in such intermediate position.

Objects and advantages other than those above set forth will be apparent from the following description when read in connection with the following drawings, in which:

Fig. 1 is a front elevation, with the casing partly cut away so that the tap changing compartment can be viewed, of a tap changing mechanism embodying the present invention;

Fig. 2 is a partial sectional view taken on the line II—II of Fig. 1;

Fig. 3 is a detailed view taken on the line III—III of Fig. 2; and

Fig. 4 is a schematic diagram illustrating the essential elements of the control system and apparatus embodied in the present invention.

The tap changer mechanism shown in Figs. 1 and 2 is of the general type disclosed in the above mentioned patent to L. H. Hill and comprises in general a casing 15 forming the lower or tap changing compartment, a casing 16 forming an upper or transformer winding compartment and a casing 17 forming a control compartment. The tap changing compartment and the transformer winding compartment generally contain oil or similar insulating liquid. An oil tight relation is maintained between these two compartments in order that the oil carbonized by any arcing of the tap changing switches will not reduce the insulating strength of the oil in the transformer winding compartment.

The tap changing switch generally comprises an insulating panel 31 upon which are mounted the stationary contacts 10 as shown in Figs. 2 and 3. These contacts are connected to the various taps on the winding 20 by means of conductors which are carried through the top member of the casing 15 in a gang bushing 34. The bushing 34 is suitably held in the member 60 in a manner to maintain the oil tight relation between the two compartments. The series transformer 23 is mounted on a bridge member 36 bridging over the bushing 34. The core of the winding 20 is suitably fastened to the member 60 and mounted thereon is the core and winding of the preventive autotransformer 25.

The moving contacts of the tap changing switch are carried on an insulating member 39 formed in the shape of a key hole as shown in Fig. 3. There are two movable contacts 40 and 41 and each comprises two spring held contact

pieces, one bearing on one face and the other bearing on the other face of the stationary contacts 10. The movable contacts 40 and 41 are connected respectively to current collecting brushes 42 and 43 which bear respectively on collector rings 37 and 38 of conducting material. The collector ring 38 is formed as an upstanding portion of a bearing member for shaft 44, which bearing member has a shoulder 49 clamped rigidly against the panel 31 by suitable means shown as a nut 50. The shaft 44 carries the movable contact carrying member 39 and is coupled to a shaft 46 by means of an insulating coupling 45.

Two upright members 51 are rigidly fastened to crosspieces 21 and 32 and support a notched disk 47 rigidly fastened thereto in a suitable manner as by the screws shown in Fig. 2. This notched disk 47 forms a bearing for the member 33 and the coupling 45. The shaft 46 is suitably connected at one end to the member 33 so as to rotate therewith. Mounted on the shaft 46 is a member 72 which carries the latch 74 which cooperates with the notches 57 in the disk 47 when the contacts 40 and 41 are in a tap position. The member 72 is pinned to the shaft 46 by a pin 73 so as to rotate therewith. A worm 53 is mounted on the left hand end of the shaft 46 (as viewed in Fig. 2) which functions to drive the position indicator actuating rod 54. The worm 53, the shaft 46, the member 72, the latch 74, the member 33, the coupling 45, the contact carrying member 39, the shaft 44 and the movable contacts 40 and 41 all move together with a rapid snap action.

Rotation of the motor 27 rotates the shaft 59 which is geared to a gear 64 mounted on the shaft 46 but rotating freely relative thereto. A substantially triangular shaped member 65 is suitably fastened by a pin 66 to the gear 64 so as to rotate therewith. The members 64 and 65 rotate together freely on the shaft 46. The triangular member 65 has an extension 67 thereon for operating the reversing switch 30. Also mounted on the member 65 are two stops 68 and 69 which move with the member 65 as it moves. Two arms 78 and 79 are mounted on the shaft 46 so as to rotate freely relative thereto. The arms 78 and 79 cooperate respectively with the stops 68 and 69 to apply pressure to springs 81 or 82 connected between the outer ends of the arms 78 and 79 and the latch carrying member 72.

The latch member 74 is pivoted at 75 between upstanding portions of the member 72 and the latch member 74 is biased to the position shown in Fig. 2 by means of springs, as shown in Fig. 1. The latch 74 carries a bolt 76, the head of which is engaged by the upper surface of arm 78 or 79 to disengage the latch from notches 80 or 57 in the disk 47.

Rotation of the motor 27 in a clockwise direction slowly rotates the gear 64 and the triangular member 65, thereby causing stop 69 to bear against arm 79 thereby placing spring 81 under tension. The snap action parts, including the shaft 46 and the member 72, do not move because the latch 74 is in a notch 57 in the disk 47. Further rotation of the stop 69 causes the upper surface of arm 79 to bear against bolt 76 rotating the latch 74 in a counterclockwise direction about its pivot 75, thereby releasing the latch from the notch in the disk 47. The quick break portions are snapped in a clockwise direction as viewed in Fig. 1 by means of spring 81 and are stopped at the next notch in the disk 47 by means of tension placed on the spring 82 by the arm 78 stopping against the stop 68.

As shown in Fig. 4, the voltage regulating system generally comprises means for maintaining the voltage supplied by a source of current supply 18 to a load circuit 19, at a constant value independently of changes in load. This regulation is accomplished by adding to the load voltage or subtracting therefrom the voltage of transformer 23 having one winding 24 in the load circuit and the other winding 22 which is supplied through the tap changing switch 26. The winding 22 is connected in boosting or bucking relation to the line voltage 18 dependent upon the position of the reversing switch 30.

The motor 27 is operated in one direction or the other in response to changes in load circuit voltage for raising or lowering the voltage on the load circuit. The motor 27 is reversibly controlled by contact 91 or 92 of relays 88 and 89 energized through a primary relay or contact making voltmeter generally designated as 29. The primary relay 29 is energized by a winding 86 to which is added or from which is subtracted the voltage of the winding 22 by means of a transformer 87. The motor 27 and the control circuits are energized from a suitable source of current such as winding 103.

The above description covers prior art tap changing apparatus and control of the type disclosed in the aforementioned Hill patent. Because of the exceedingly fast snap action of the quick break mechanism, the contacts 40 and 41 were snapped to their next position in a matter of about a cycle and a half of current. For normal currents and for mechanisms having a normal inertia, sufficient time was provided for extinguishing the arc drawn between the contacts 40 and 41 and the stationary contacts 10. In order to utilize lighter mechanisms with lower moments of inertia or in order to permit higher currents to be broken at the dial switch 26, the present invention provides for delaying the action of the quick break contacts 40 and 41 in between tap positions, while retaining the advantages of rapid break and make when the contacts 40 and 41 make and break at a tap position.

The illustrated embodiment of the invention includes additional notches 80 in the disk 47, each of which is positioned in between a pair of notches 57. The contacts 40 and 41 therefore are moved from a tap position with an exceedingly rapid snap action but are stopped midway between tap positions for a time sufficient to clear any arc drawn at the breaking contacts. In order to prevent the mechanisms from stopping in an intermediate position corresponding to a notch 80, a means is provided for holding in the relay 88 or 89 which has been energized. whenever the contacts 40 and 41 are not on a tap changing position. The above holding in means may comprise a single switch which is closed whenever the contacts 40 and 41 are not on a tap changing position, but this means is shown as a series of contacts 58 and 63 which are connected to a conductor 61 by means of a movable bridge 56 moved by the position indicator actuating shaft 54. This shaft 54 carries the position indicator 55 as shown in Fig. 4. The off position contacts 58 and 63 are closed only when the tap switches are not on a tap position as shown by the indicator 55.

In Fig. 4, the connections are shown for the condition in which the voltage is being raised to the correct value and the tap changer is in an intermediate position. The contact making voltmeter 29 has closed its contacts 85 thereby closing a circuit from the winding 103 through contact 85, contact 107 of relay 89, coil 88, back to winding 103. Energization of coil 88 has closed contact 91 and opens contact 106 preventing simultaneous energization of coil 89 and running the motor 27 in a direction to move the contacts 40 and 41 in a clockwise direction. The contacts 40 and 41 are shown in Fig. 4 after they have been snapped by the quick break mechanism to an intermediate position in which the latch 74 has dropped into a notch 80. As shown the contact 41 has broken with the stationary contact 10 with which it was made.

In this intermediate position the off position switch is closed whereby contacts 58 and 63 are connected to the conductor 61. Closing of the off position switches sets up a circuit from winding 103 through conductor 61, member 56, a contact 58, contact 107, coil 88 back to the other side of winding 103, thus holding closed the contact 91 independently of the action of contact making voltmeter 29. The motor 27 therefore remains energized until the contacts 40 and 41 make in the next tap position. The contacts 40 and 41 have been delayed so that sufficient time has elapsed for the arc to be extinguished, however, the speed of contact movement at the time of make and break has been maintained at a high value aiding greatly in extinguishing the arc.

Although but one embodiment of the present invention has been illustrated and described it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. In a step type regulating system, the combination of a device defining a plurality of alternate main and intermediate contact positions, a movable contact, motor means for moving said contact from one said position to the next in either direction with a rapid snap action, means for initiating operation of said motor means, means responsive to movement of said contact into any of said intermediate positions for maintaining said motor means in operation, and means responsive to movement of said contact into any of said main positions for rendering said maintaining means ineffective.

2. In a step type regulating system, the combination of a device defining a plurality of contact positions, a movable contact, means for moving said contact from one of said positions to the next with a break and make action comprising a motor and a detent mechanism for translating the relatively slow uniform continuous operation of said motor into rapid snap action of said movable contact, and means for providing continuous operation of said motor during two successive operations of said detent mechanism including initiating means for energizing said motor and circuit means responsive to movement of said contact into every other said position for energizing said motor independently of said initiating means until movement of said contact to the next position.

3. In a step type regulating system, the combination of a device defining a plurality of alternate main and intermediate contact positions, a movable contact, means for moving said contact from one of said positions to the next with a break and make action comprising a motor and a detent mechanism for translating the relatively slow uniform continuous operation of said motor into rapid snap action of said movable contact, and means for providing continuous operation of said motor during two successive operations of said detent mechanism including initiating means for energizing said motor and a motor energizing switch actuated by said motor to close when said contact is in any intermediate position and to open when said contact is in any main position.

4. In a step type regulating system, the combination of a device defining a plurality of alternate main and intermediate contact positions, a movable contact, means for moving said contact from one of said positions to the next in either direction with a break and make action comprising a motor and a detent mechanism for translating the relatively slow uniform continuous operation of said motor into rapid snap action of said movable contact, first control means for providing continuous operation of said motor during two successive operations of said detent mechanism in one direction, and second control means for providing continuous operation of said motor during two successive operations of said detent mechanism in the other direction, each said control means including initiating means for energizing said motor and a motor energizing switch actuated by said motor to close when said contact is in any intermediate position and to open when said contact is in any main position.

5. In a step type regulating system, the combination of a device defining a plurality of alternate main and intermediate contact positions, a movable contact, means for moving said contact from one of said positions to the next in either direction with a break and make action comprising a motor and a detent mechanism for translating the relatively slow uniform continuous operation of said motor into rapid snap action of said movable contact, a first energizing circuit for said motor to provide operation of said motor in one direction, and a second energizing circuit for said motor to provide operation of said motor in the other direction, said circuits including a common contact making means for initiating the energization of said motor in parallel with a common switch actuated by said motor to close when said movable contact is in any said intermediate position and to open when said movable contact is in any said main position.

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