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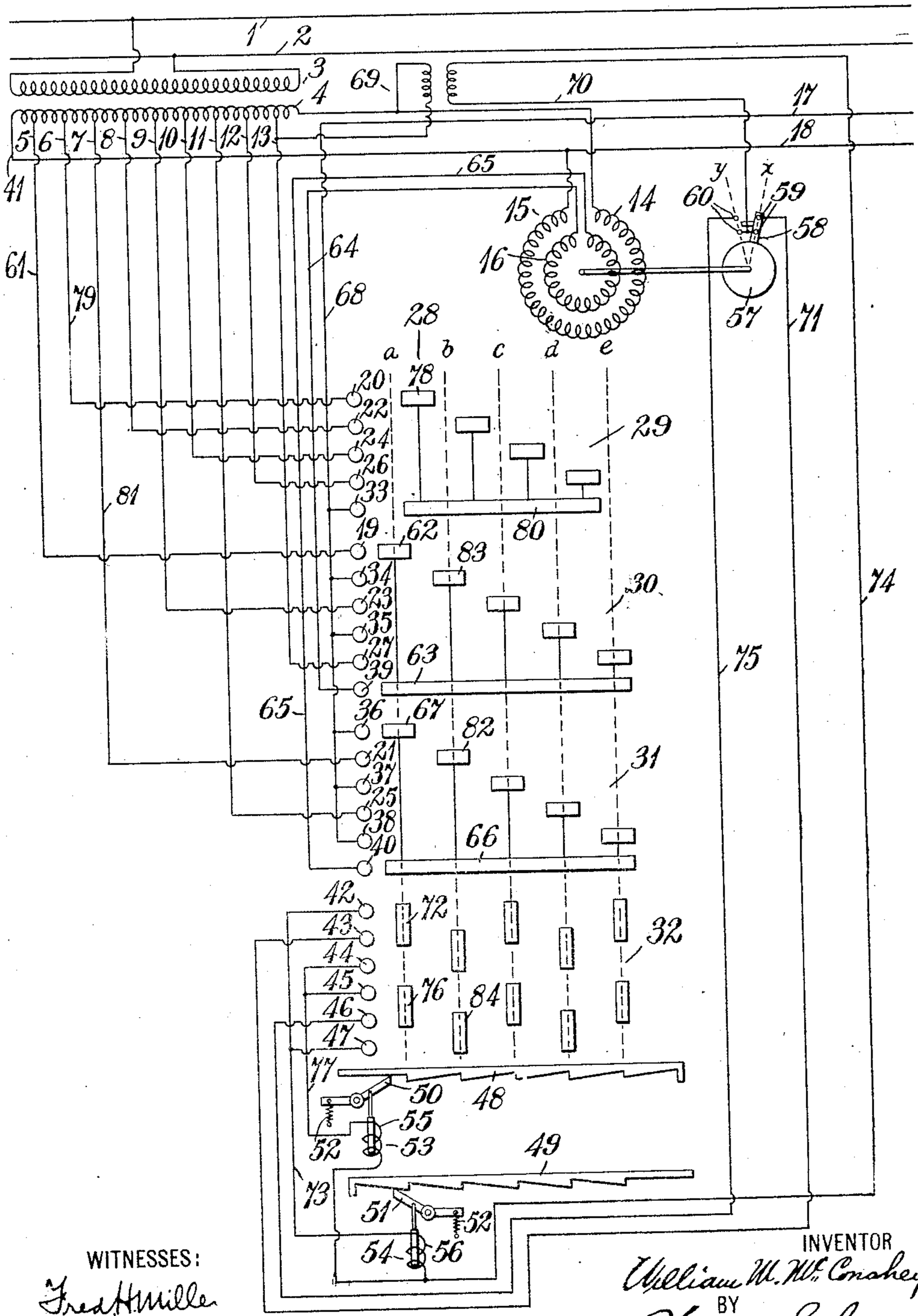
SYSTEM OF POTENTIAL REGULATION.

APPLICATION FILED JAN. 10, 1908.

968,587. Patented Aug. 30, 1910.



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SYSTEM OF POTENTIAL REGULATION.

968,587. Specification of Letters Patent. **Patented Aug. 30, 1910.**

Application filed January 10, 1908. Serial No. 410,231.

To all whom it may concern:

Be it known that I, WILLIAM M. McCONAHEY, a citizen of the United States, and a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Systems of Potential Regulation, of which the following is a specification.

My invention relates to systems of potential regulation, and it has for its object to provide a simple and efficient means for so combining a transformer having a plurality of different voltage taps with an induction regulator that a gradual voltage variation may be effected.

Alternating current transformers having secondary windings provided with a plurality of intermediate taps are often employed in connection with suitable switching devices for securing a step-by-step voltage variation or regulation. In order that the change may be relatively gradual for a wide total variation, the number of intermediate taps in the transformer secondary becomes excessive and the switching device cumbersome and expensive. Induction regulators having one stationary and one movable coil are also well known, but they are very expensive to construct for wide voltage variations.

According to my present invention, I employ a transformer having a subdivided secondary winding which is provided with a moderate number of taps and constitutes a well known regulating transformer. I also provide an induction regulator which is capable of producing a total variation of potential equal to the difference of potential existing between adjacent taps in the secondary winding of the transformer. The transformer and the regulator are so combined and their circuit connections so controlled by a suitable switching device that the electromotive forces supplied to an external circuit may be gradually varied over a wide range in either direction without producing voltage fluctuations or current disturbances in changing from one transformer tap to another.

The single figure of the accompanying drawing is a diagrammatic view of a system of regulation embodying my invention.

Referring to the drawing, alternating current energy is supplied from a suitable source at any desired voltage, through conductors 1 and 2 to the primary of a regulating transformer 3. This transformer is provided with a secondary winding 4 having a plurality of intermediate taps 5 to 13, inclusive. A primary winding 14 of an induction regulator 15 is connected in multiple circuit to the secondary winding 4 of the transformer 3, and a secondary winding 16 of the induction regulator is connected in series with one circuit conductor 17 of a variable voltage distributing circuit 17—18. Intermediate taps 5 to 13, inclusive, of the secondary winding 4 are respectively connected to contact fingers 19 to 27, inclusive, of a drum controller 28 which comprises main drums 29, 30, and 31 and an auxiliary drum 32 and is adapted to occupy a plurality of positions *a*, *b*, *c*, *d*, and *e*.

The line conductor 17 is connected to contact fingers 33, 34, 35, 36, 37, and 38 of the drums 29, 30, and 31, and the secondary winding 16 of the induction regulator 15 is connected to contact fingers 39 and 40. The line conductor 18 is connected to one terminal 41 of the secondary winding 4 of the regulating transformer 3. The above-mentioned contact fingers are all associated in operation with the contact-bearing drums 29, 30, and 31.

The contact drum 32 is engaged by a plurality of contact fingers 42, 43, 44, 45, 46, and 47, all the drums forming parts of the same movable element which is further provided with a pair of ratchets or notched strips 48 and 49 that are respectively engaged by pawls 50 and 51. The pawls 50 and 51 are normally held in engagement with the notches of the respective ratchets by springs 52 but may be released by supplying current to coils 55 and 56 of electromagnets 53 and 54. The movable member of the induction regulator 15 is provided with a rotatable disk 57 having a projecting contact arm 58 and two pairs of stationary contact terminals 59 and 60 which are bridged by the contact arm when the induction regulator occupies the one or the other of its extreme positions *x* and *y*. The circuits for the control magnet coils 55 and 56 are governed by the position of the induction regulator and by the auxiliary switch-

ing drum 32, as hereinafter explained. For the purpose of promoting clearness of disclosure, the control drums and ratchets are shown as developed into a single plane.

The operation of, and the circuit connections for, the system are as follows: Assuming that the induction regulator 15 occupies position x and that the drum controller 28 occupies its "off" position, as shown in the drawing; if the controller is now moved to occupy position a, a secondary circuit is established from one terminal of the secondary winding to the line conductor 18 and from an intermediate tap 5 through conductor 61, contact finger 19, contact member 62 of the drum 30, contact member 63, finger 39, conductor 64, secondary winding 16 of the induction regulator 15, conductor 65, finger 40, contact member 66 of control drum 31, contact member 67, finger 36 and conductor 68 to the line conductor 17. In moving the controller from its "off" position to position a, there is no opposition from the pawl 51, and it will be observed that the pawl 50 is also free to move into position a but prevents any further movement of the drum in this direction. It is now impossible to change the position of the drums while the induction regulator is being moved from position x to position y, it being possible, however, to return the drums from their position a to their "off" position when the induction regulator occupies position x and to move it forward to the position b when the induction regulator occupies position y. Auxiliary circuits are completed, the controller being in position a, from one terminal of any suitable low-voltage source, such as a shunt transformer 69 through conductor 70, contact terminals 59 (which are bridged by the contact arm 58 when the induction regulator occupies position x), conductor 71, contact fingers 43 and 42, which are bridged by contact member 72, conductor 73, magnet coil 56, and conductor 74 to the opposite terminal of the transformer 69. When the induction regulator occupies position y, an auxiliary circuit is completed from conductor 70 through contact terminals 60, conductor 75, contact fingers 46 and 45 (which are bridged by contact members 76), conductor 77 and magnet coil 55 to the conductor 74. At this point the arrangement of parts is such that the induction regulator acts in opposition to the active portion of the secondary winding 4 of the transformer and the regulating windings are so designed that the voltage induced in the secondary of the induction regulator is substantially equal to the voltage induced between any two adjacent transformer taps. Consequently, when the induction regulator occupies position x, and the drum controller position a, zero voltage is impressed upon the circuit 17—18. The voltage is gradually increased as the induction regulator is moved from position x to position y until the voltage produced is equal to the sum of that of the regulator tap 5 acting in conjunction with that of the induction regulator which is equivalent to that of the regulator tap 6. It is now possible, as already explained, to move the drum controller to position b, and in passing from the one position to the other, contact finger 20 first comes into engagement with a contact member 78 and contact fingers 19 and 36 become disengaged from contact members 62 and 67. In this way, the circuit is first established from the transformer tap 6, through conductor 79, contact finger 20, contact members 78 and 80, contact finger 33, and conductor 68 to line conductor 17.

As already explained, the voltage impressed upon the discharge circuit, when controller 28 occupies position a and the induction regulator occupies position y, is equal to the voltage of the regulator tap 6 and, consequently, no fluctuation or disturbance will take place when the line connection is established directly through the transformer tap 6 and the regulator secondary is disconnected from the circuits. When the controller 28 fully occupies position b, contact finger 20 is disengaged from the contact member 78 and contact finger 21, which is connected by a conductor 81 with the regulator tap 7, moves into engagement with a contact member 82. Contact finger 34 moves into engagement with contact member 83 so that circuit connections are now established from the regulator tap 7 through conductor 81, contact finger 21, contact members 82 and 66, contact finger 40, conductor 65, winding 16 of the regulator 15, conductor 64, contact finger 39, contact members 63 and 83, contact finger 34 and conductor 68 to line conductor 17. The induction regulator is thus connected to the transformer tap 7 but the terminals of its secondary winding are interchanged so that its electromotive force is opposed to that of the transformer and, consequently, the voltage impressed upon the line is still the same as before, being equal to the difference between the voltage of the tap 7 and that of the induction regulator.

With the regulator still in position y, and the controller occupying position b, an auxiliary circuit is established from contact finger 46 through a contact member 84, contact finger 47 and conductor 73 to the magnet winding 56. The magnet winding 56 being thus energized, releases the pawl 51 so that the controller may be returned from the position b to the position a. In approaching position a, however, contact finger 47 becomes disengaged from contact member 84 so that it is impossible to return the con-

troller to its "off" position. If the induction regulator is moved from its position *y* toward its position *x*, a voltage variation is effected and another forward movement of the drum controller is permitted as soon as induction regulator occupies this position. As the controller passes from position *b* toward the position *c*, the transformer tap 8 is connected directly to the discharge circuit and, when this position is fully occupied, the induction regulator is made to act oppositely by again interchanging the terminals of its secondary winding and connecting it in series with a circuit which joins transformer tap 9 with the conductor 17.

From the controller steps already outlined, the operation of the system may be readily understood by those familiar with the art, and I deem it unnecessary to complete a detailed description of the same. It will be observed that it is impossible to make a mistake in operating the system, and disturbances in the current, as well as in the electromotive force of the line, are entirely avoided.

Although I have illustrated a preferred form of mechanical structure for the locking mechanism which is electrically controlled, I do not desire to limit my invention in this regard, and desire that variations in circuit connections and mechanical details which do not depart from the spirit of my invention shall be included within its scope.

I claim as my invention:

1. In a system of potential regulation, the combination with a transformer having a plurality of intermediate taps, and an induction regulator associated with the transformer, of electro-responsive means for rendering the control of the transformer dependent upon the position of the induction regulator.

2. In a system of potential regulation, the combination with a transformer regulator having a plurality of intermediate taps, and a switching device for controlling the circuit connections of the regulator, of a movable coil regulator, and means dependent upon the position of the movable coil regulator for restricting the movement of the switching device.

3. In a system of potential regulation, the combination with a transformer regulator, and an induction regulator, of means for so associating the operation of the two as to effect a gradual potential variation over the entire range of the transformer regulator and means for making the control of one regulator dependent upon the position of the other.

4. In a system of potential regulation, the combination with a transformer having a plurality of intermediate taps, an induction regulator and a switching device for associating the operation of the regulators, of means dependent upon the position of one of the regulators for restricting the movement of the switching device.

5. In a system of potential regulation, the combination with a transformer having a plurality of intermediate taps, an induction regulator and a switching device for associating the operation of the regulators, of a pair of notched members, engaging pawls therefor, and electro-responsive means dependent upon the position of the induction regulator for selectively releasing the pawls.

6. The combination with a transformer winding having a series of variable-voltage taps, an induction voltage regulator, and a switching device for interconnecting said taps and said induction regulator, of means for rendering the movement of the switching device dependent upon the position of the induction regulator.

7. In a system of potential regulation, the combination with a transformer having a plurality of uniformly spaced intermediate taps, an induction regulator and a switching device for associating the operation of the transformer and the regulator, the total voltage variation effected by the induction regulator being substantially equal to the difference in potential between adjacent taps of the transformer, of means for rendering the movement of the switching device dependent upon the position of the regulator.

8. In a system of potential regulation, the combination with a transformer having a plurality of uniformly spaced intermediate taps, an induction regulator and a switching device for associating the operation of the transformer and the regulator, the total voltage variation effected by the induction regulator being substantially equal to the difference in potential between adjacent taps of the transformer, of means for interlocking the operation of the switching device and the induction regulator for effecting a gradual potential variation over the entire range of the transformer.

9. In a system of potential regulation, the combination with a transformer having a plurality of uniformly spaced intermediate taps, an induction regulator and a switching device for associating the operation of the transformer and the regulator, the total voltage variation effected by the induction regulator being substantially equal to the difference in potential between adjacent taps of the transformer, of a controller having a plurality of stationary contact fingers and movable contact bearing drums, ratchets or notched members secured to the movable member of the controller, pawls engaging the ratchets for preventing the movement of the control drums in either direction, and means dependent upon the position of the induction regulator for selectively releasing the pawls.

10. In a system of potential regulation, the combination with a transformer having a plurality of uniformly spaced intermediate taps, an induction regulator and a switching device for associating the operation of the transformer and the regulator, the total voltage variation effected by the induction regulator being substantially equal to the difference in potential between adjacent taps of the transformer, of a controller having a plurality of stationary contact fingers and movable contact-bearing drums, ratchets or notched members secured to the movable member of the controller, pawls engaging the ratchets for preventing the movement of the control drums in either direction, springs for holding the pawls in engagement with the ratchets, electro-magnets for releasing the pawls, an auxiliary contact-bearing drum operatively connected to the controller and stationary contact fingers therefor and a switching device governed by the position of the induction regulator for selectively energizing the electro-magnets.

In testimony whereof, I have hereunto subscribed my name this 27th day of Dec., 1907.

WILLIAM M. McCONAHEY.

Witnesses:
WM. P. L'HOMMEDIEU,
BIRNEY HINES.