Aug. 25, 1931. W. SCHAELCHLIN 1,820,712

VOLTAGE REGULATOR

Filed Sept. 23, 1927 2 Sheets-Sheet 1

Fig. 1.

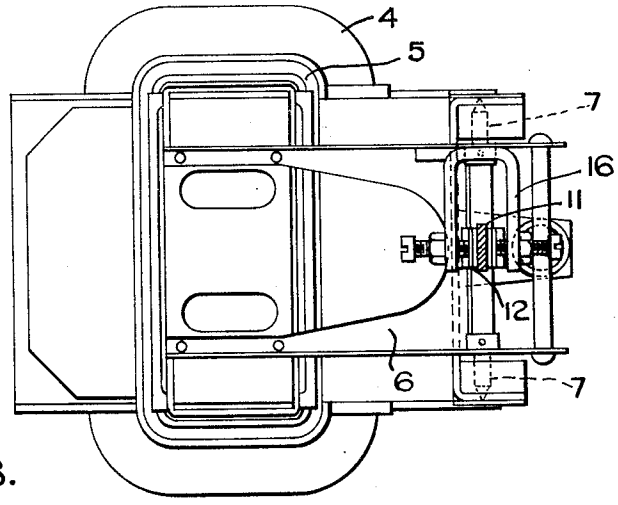



Fig. 3.

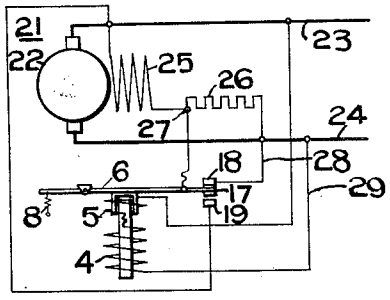



Fig. 2.




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Fig.5.

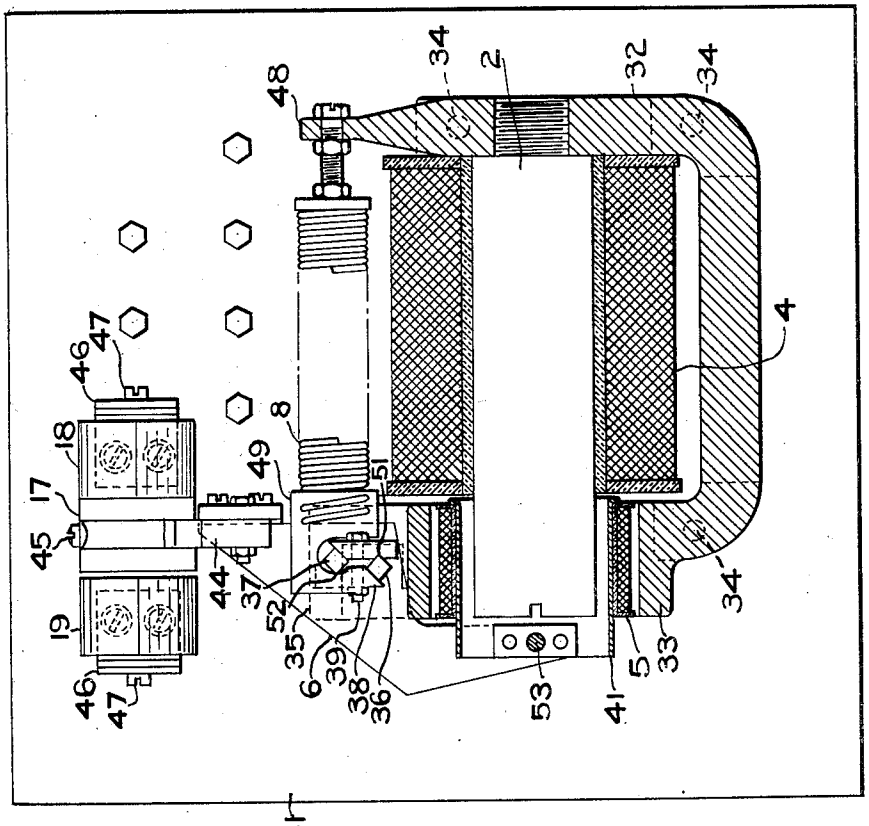
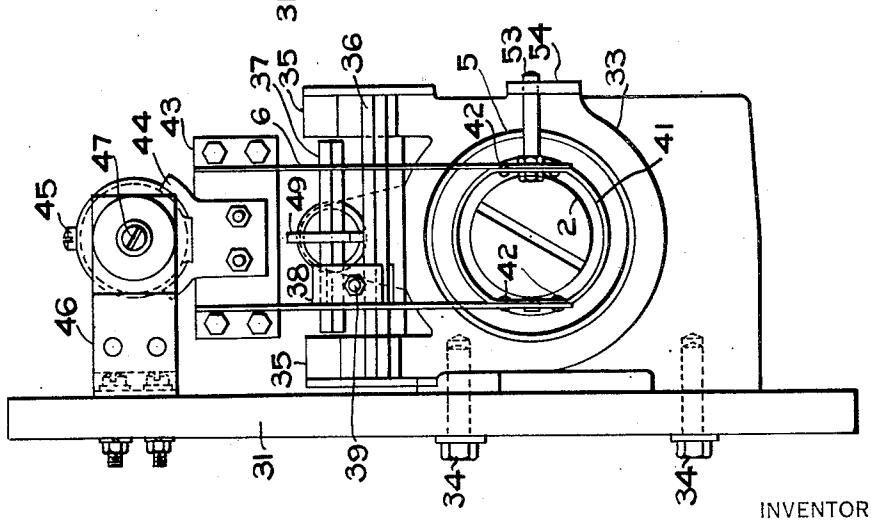



Fig.4.




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# UNITED STATES PATENT OFFICE

WALTER SCHAELCHLIN, OF WILKINSBURG, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

## VOLTAGE REGULATOR

Application filed September 23, 1927. Serial No. 221,422.

My invention relates to regulators and more particularly to voltage regulators of the vibratory type.

An object of my invention is to provide a regulator that shall be sensitive and accurate in its operation and that shall be simple in design and inexpensive to operate.

A regulator organized in accordance with my invention is applicable to many classes of service where rugged and simple construction is required, such as in railway-train-lighting service. Many regulators for such service have been utilized, but these regulators are, in general, complicated in construction and expensive to operate and not sufficiently rugged to meet the requirements for this class of service.

My invention will be better understood by reference to the accompanying drawings, in which

Figure 1 is a view of one preferred form of my regulator, partly in plan and partly in section, on the line I—I of Fig. 2,

Fig. 2 is a view, partly in section and partly in side elevation, of the regulator shown in Fig. 1,

Fig. 3 is a diagrammatic view of a regulator system employing my regulator,

Fig. 4 is a view, in end elevation, of a second preferred form of my regulator, and

Fig. 5 is a view, partly in section and partly in side elevation of the form of regulator shown in Fig. 4.

Referring to Figs. 1 and 2 of the drawings, which illustrate the preferred embodiment of my invention, a magnetic structure is provided having three portions or legs 1, 2 and 3, the two outer portions 1 and 3, together with the middle portion 2, forming two magnetic circuits. A coil 4 is provided for magnetizing the core, or magnetic structure, and is mounted upon the middle portion 2 thereof. A smaller coil 5 is provided and is connected in series relation with the magnetizing coil 4 and is mounted upon a movable bifurcated arm 6. The coil 5 is located with its conductors surrounding the upper end of the middle portion 2 of the magnetic structure and is disposed in the flux paths between the ends of the two outer portions 1 and 3 and the central portion of the magnetic structure.

The central portion 2 of the magnetic structure and the coils 4 and 5 may be rectangular in shape, as illustrated. The arm 6 is pivotally supported, at a point 7, on one side of the outer magnetic portion 3 and is connected to a vertically extending coil spring 8 for normally actuating the coil 5 and the arm 6 in an upward direction.

A support or bracket 9 is attached to the arm 6, and, as shown, it carries an upright lever 11 and a pair of flat spring members 12 and 13 that are adapted to engage stops 14 and 15, respectively. The stops 14 and 15 are illustrated as set screws mounted upon a U-shaped member 16 which is attached to, and carried by, the arm 6. The lever 11 carries, at its upper end, a movable contact member 17 which is adapted to engage fixed contact members 18 and 19. Upon engagement of the movable contact member 17 with either of the fixed contact members 18 and 19, one of the spring members 12 and 13 will be brought under tension to insure a proper contact pressure between the engaging contact members.

The regulator will be in a balanced condition, that is, the pull of the coils 4 and 5 will balance the pull of the spring 8 when the voltage being regulated is at its desired value. Inasmuch as the coil 5 is mounted within the air gap between the two portions of the magnetic circuits, a practically constant field flux will cut the conductors of the coil at all points of its travel. The pull upon the coil 5 will, therefore, be dependent upon the voltage impressed upon the regulator circuit and will be independent of its position on its line of travel.

By using a low flux density in the iron of the magnetic circuits, variations in the pull of the coil 5 will be substantially double the variations in the impressed voltage, thereby rendering the regulator very sensitive in its operation.

Referring to Fig. 3 of the drawings, which illustrates a regulator system employing the use of the regulator described, a generator 21 is provided having an armature 22 that is connected to conductors 23 and 24. The

generator 21 is provided with a shunt field winding 25 that is connected, in series-circuit relation with a resistor 26, across the terminal conductors 23 and 24 of the generator.

The movable contact member 17 of the regulator is connected to a point 27 between the resistor 26 and field winding 25. The stationary contact members 18 and 19 are connected, by means of conductors 28 and 29, respectively, to the terminal conductors 24 and 23. The regulator coils 4 and 5 are connected, in series-circuit relation, across the generator terminal conductors 23 and 24.

The operation of the regulator system is as follows: When the generator 21 is started, the regulator contact 17 is biased by the spring 8 into engagement with the contact member 18, thus short-circuiting the resistor 26 and causing the full generator voltage to be applied to the field winding 25. As the voltage of the generator rises to its predetermined normal value, depending upon the tension of the spring 8, the movable coil 5 will be attracted toward the coil 4, thus disengaging the contact members 17 and 18 and introducing the resistor 26 in the field circuit of the generator. The introduction of this resistor into the field circuit of the generator causes the voltage of the generator to again drop, thus decreasing the energization of the coils 4 and 5 and permitting the engagement of the contact members 17 and 18. The regulator will continue to vibrate, causing the repeated engagement and disengagement of the contact members 17 and 18.

If the voltage of the generator tends to rise abnormally or, if disengagement of the contact members 17 and 18 is not performed promptly enough to check the rise in generator voltage, the contact member 17 will be actuated sufficiently to engage the contact member 19, thus short-circuiting the field winding 25 and causing a further and more rapid decrease of the generator excitation than would be caused by the introduction of the resistor 26 in the circuit of the field winding.

Referring to Figs. 4 and 5 of the drawings, which illustrate a second preferred form of the invention, the regulator is illustrated as being mounted upon a slate or panel 31, with the axes of the coils 4 and 5 disposed horizontally. The coils 4 and 5 and the portion 2 of the magnetic circuit surrounded thereby are shown as being substantially circular in cross-section. The magnetic structure may be attached to the panel board 31 by any suitable means, such as screw members 34.

The magnetic core comprises the portion 2 extending through the coil windings and the portion 32 which completes the magnetic path and extends along-side of the coil 4 and is provided with an annular end portion 33 that completely surrounds the coil 5 and the left-hand end of the magnetic core portion 2.

The annular portion of the magnetic structure 33 is provided with upwardly extending bracket portions 35 upon which the bifurcated arm 6 is supported by means of the square bar 36 extending through the vanes thereof. A similar square bar 37, by means of which the arm 6 may be actuated, also extends through the vanes of the arm 6. The bars 36 and 37 are held in their illustrated positions by means of the clamping members 38 that are held together by a bolt 39.

The movable coil 5 is mounted upon a metal sleeve 41 which extends toward the left, and acts as a means for conducting heat from the coil. The sleeve 41 is flattened at portions of its circumference and is attached to the vanes of the arm 6 by any suitable means, such as rivets 42. The vanes of the arm 6 are connected, at their upper ends, by means of a transverse member 43 to which a bracket 44 is attached for carrying the contact member 17, which may be fastened thereto by means of a screw 45 extending therethrough. The stationary contact members 18 and 19 may be attached to the panel board 31 by means of brackets 46 and screws 47.

The spring member 8 is shown as attached, at its right end, to a bracket extension 48 which may be a part of the iron core of the magnet. The left end of the spring member 8 is attached to a flat hook member 49 which engages the bar 37 to actuate the arm 6 toward the right, thereby normally maintaining engagement of the contact members 17 and 18.

It will be noted that the positions of the bars 36 and 37 are such that the right side of the bar 36, that is, the point 51, which forms the fulcrum point about which the arm 6 rotates, is below and toward the right of the point 52 at the left edge of the bar 36, and which is engaged by the hook member 49 and actuated by the spring 8. The lever distance through which the spring 8 operates in rotating the arm 6 is, therefore, the vertical distance between the points 51 and 52.

As the coil 5 is attracted toward the coil 4, thus increasing the tension on the spring 8, the point 52 will be moved toward the left end slightly downwardly, that is, circumferentially about the point 51, thus shortening slightly the lever arm between these two points as the tension on the spring increases. The shortening of this lever arm, as the tension on the spring 8 increases, tends to maintain the rotating force constant, irrespective of the position of the coil 5.

A pin 53 may be attached to the arm 6 for limiting its movement by engagement with an abutment member 54.

Inasmuch as many modifications may be made in the apparatus and arrangement of parts illustrated without departing from the spirit of my invention, I do not wish to be

limited, except by the scope of the appended claims.

I claim as my invention:

1. In a regulator, the combination with a core member provided with an air gap traversed by magnetic flux of substantially uniform density, two coils connected to be jointly energized in accordance with the regulated quantity, one of said coils being fixedly mounted on said core, the other of said coils being movably mounted to operate entirely within said air gap, a contact member actuated by said movable coil, and means for normally biasing said contact member to a predetermined position.

2. In a regulator, the combination with a core member provided with an air gap, two coils connected to be jointly energized and wound about said core in axial alinement, one of said coils being movable axially along said core in a field of substantially uniform flux density, a contact member actuated by said movable coil, and means for biasing said contact member to a predetermined position.

3. In a regulator, the combination with a core member providing a magnetic circuit having an air gap therein traversed by magnetic flux of substantially uniform density, two coils connected in series relation and wound about said core in substantial alinement, one of said coils being mounted to operate entirely within said air gap and movable axially along said core, and a contact member actuated by said movable coil.

4. In a regulator, the combination with a core member providing a magnetic circuit having an air gap therein, two coils wound about said core member, one of said coils being pivotally mounted to move within said air gap, a contact member actuated by said coil, a biasing member for actuating said coil against the magnetic pull of the coil, said biasing means being so related to the pivotal mounting of said coil as to vary an effective lever arm about the pivot point inversely with variations in the biasing force.

In testimony whereof, I have hereunto subscribed my name this 19th day of September, 1927.

WALTER SCHAELCHLIN.