Oct. 8, 1940. C. R. HANNA 2,217,406

VOLTAGE REGULATOR

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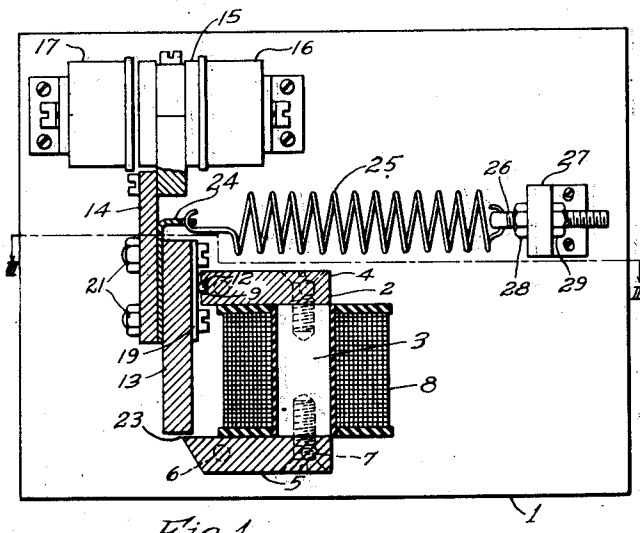


Fig. 1.

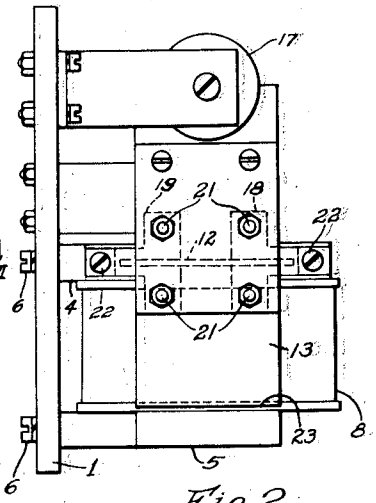


Fig. 2.

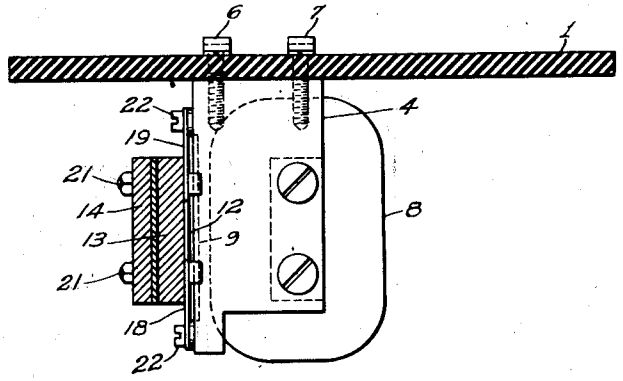


Fig. 3.

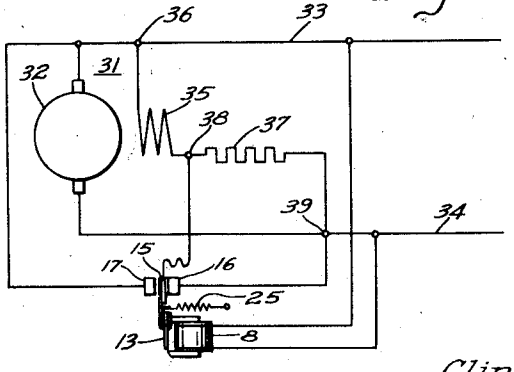


Fig. 4.

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VOLTAGE REGULATOR

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Application January 9, 1937, Serial No. 119,805

4 Claims. (Cl. 175—336)

My invention relates to regulators and particularly to vibratory regulators for governing an electrical quantity, such as voltage, of an electric generator or circuit.

Among the objects of my invention is the provision of a regulator that is rugged in construction and possesses high current carrying capacity, that is light in weight, and that requires but a small amount of power to operate it.

Another object of my invention is the provision of a regulator that operates at high speed and is quickly sensitive to slight changes in variations in the regulated quantity from its desired value.

A further object of my invention is the provision of a regulator of the above indicated character in which a moving arm is provided as a portion of the magnetic circuit and is so arranged as to provide an air gap of substantially constant length independent of the position of the armature within its normal range of movement.

Other objects and advantages of my invention will be apparent from the following description of one preferred embodiment thereof, reference being had to the acccompanying drawing, in which:

Figure 1 is a partially sectional side elevational view of a regulator constructed in accordance with my invention,

Fig. 2 is an end view of the regulator illustrated in Fig. 1,

Fig. 3 is a view taken along the line III—III of Fig. 1, and

Fig. 4 is a diagrammatic illustration of one application of the regulator to control the voltage of a generator.

Referring to the drawing, a panel 1 of insulating material is provided upon which are mounted the various parts of the regulator including a core structure 2 having a winding leg 3 to the ends of which are attached laterally extending portions 4 and 5 that are attached to the panel 1 by any suitable means such as by the screws 6 and 7 (see Fig. 3). A winding 8 is provided between the core legs 4 and 5 about the winding leg 3 by means of which the core is energized in accordance with the regulated quantity. A notch or slot 9 is provided in the outer end of the laterally extending core leg 4 in which a small rod or wire 12, such as piano wire, may be partly inserted, the outer portion of the wire extending beyond the face of the end of the leg 4 to engage an armature member 13 of magnetic material to provide a rocking surface or pivot point about which the armature is adapted to move.

An arm 14 is attached by any suitable means to the upper end of the armature 13 and carries a contact member 15 at its upper end that is movable into and out of engagement with a fixed contact member 16 mounted on the panel 1, or into and out of engagement with a fixed contact member 17 also mounted on the panel 1.

The armature 13 is mounted upon the core structure by means of T-shaped flat spring members 18 and 19, best shown in Figs. 2 and 3, that are positioned between the armature 13 and the outer end of the core leg 4. The members 18 and 19 are positioned, as best shown in Fig. 2 with the cross portion of the T's extending toward one another and fastened to the armature member 13 by suitable means, such as bolts or screws 21, the outwardly extending portions being attached to the core member 4 by means of screws 22. The flat spring structures 18 and 19 are sufficiently rigid to hold the armature 13 rigidly against longitudinal movement while permitting a free flexing or movement of the armature about the wire 12.

The lower end of the armature terminates adjacent the outer end of the lower laterally extending core leg 5 providing an air-gap at 23 between the armature 13 and the core leg 5.

As illustrated, the armature 13 is mounted in a position substantially parallel to the winding leg 3 of the core structure and its lower end terminates so as to overlap the end of the core leg 5, the adjacent surfaces of the opposite sides of this air-gap being substantially parallel, so that an air-gap of substantially constant length exists within the normal range of movement of the armature 13, independently of the position of the armature.

A finger 24 is provided on the armature assembly to which one end of the coil spring 25 is attached, the other end being attached to an eyelet 26 the stem of which extends through an opening in a bracket 27 and is provided with adjusting nuts 28 and 29 for adjusting the tension of the spring 25. The method of mounting of the armature 13 by means of the flat spring members 18 and 19 so as to rock on the outer surface of the wire 12 provides a free moving armature having a substantially frictionless pivot.

Referring to Fig. 4, a generator 31 is provided having an armature winding 32 connected to circuit conductors 33 and 34, and a field winding 35 that is connected between a junction point 36

on the conductor 33 and through a resistor 37 to a junction point 39 on the conductor 34. The movable contact member 15 of the regulator is connected to a junction point 38 between the field winding 35 and the resistor 37. The regulator contact member 16 is connected to conductor 34 and the contact member 17 is connected to the conductor 33. The regulator winding 8 is connected to be energized in accordance with the voltage extending between conductors 33 and 34.

The tension of the spring 25 is adjusted to accord with the voltage desired to be maintained between conductors 33 and 34. This spring normally biases the contact member 15 into engagement with the contact member 16 to shunt the resistor 37 from the circuit of the field winding 35. As the voltage of the generator armature 32 increases, the current through the generator field winding 35 and the regulator also increases until the energization of the winding 8 increases sufficiently that the pull on the armature 13 becomes sufficient to overcome the pull of the spring 25, thus moving the armature 13 in a counter-clockwise direction about the pivot 12 against the pull of the spring 25 to separate the contact member 15 from the contact member 16. This inserts the resistor 37 in circuit with the field winding 35 between conductors 33 and 34, decreasing the energization of the generator and causing the voltage thereof to decrease. The decrease in the energization of the winding 8 causes the pull on the armature to decrease sufficiently that the force of the spring 25 moves the armature 13 in a clockwise direction and causes engagement of the contact member 15 with the contact member 16. The regulator is sufficiently sensitive that the repeated engagement of the contact member 15 with the contact member 16 and separation therefrom takes place at such a rapid rate that the voltage between the conductors 33 and 34 does not vary appreciably from the desired value.

If the generator is operated at such a high speed that the residual magnetism is sufficient to cause the energization of the winding 35 to maintain the generator voltage above the desired value with the contact members 15 and 16 out of engagement, the pull on the armature 13 will be continue until the counter-clockwise movement thereof is sufficient to cause the contact member 15 to engage the contact member 17 and short circuit the field winding 35. The continued vibrations of the regulator will, under this condition, cause repeated engagement of the contact member 15 with and separation from the contact member 17 instead of with and from the contact member 16.

It will be appreciated that the particular construction of mounting of the armature 13 on the core structure 2 provides a substantially frictionless pivot while giving rigid support to the armature against longitudinal movement and thereby permitting the use of a relatively small air-gap between the end of the armature 13 and the core leg 5. The variable overlap between the end of the armature 13 and the winding leg 5 is such as to provide a constant pull on the armature for a constant excitation of the core structure. Because of the short range of movement of the armature 13 and the constant length of the air gap 23, the magnitude of the armature pull is substantially independent of the position of the armature within its range of movement. Also, since the spring 25 is relatively long, so that its pull on the armature is substantially constant within its range of movement, it follows that the magnitude of the magnetic force necessary to move the armature is likewise substantially independent of the position of the armature within its range of movement.

Many modifications may be made in the apparatus illustrated and described without departing from the spirit of my invention, and I do not wish to be limited otherwise than by the scope of the appended claims.

I claim as my invention:

1. In a relay, in combination, a core structure of magnetic material comprising a winding leg and two legs extending laterally from the ends of the winding leg, a slot in the end of one of said laterally extending legs and a wire partially inserted in said slot and extending therefrom to provide a rocker surface, an armature of magnetic material and resilient means for biasing said armature into engagement with said rocker surface, one end of said armature terminating adjacent the other of said laterally extending legs to provide a substantially uniform air-gap therebetween within the normal range of movement thereof, means for biasing said armature to a position to provide a relatively small overlap between the end of said armature and said last named core leg, and a winding on said winding leg for actuating said armature against the force of said biasing means.

2. In a relay of the contact making voltmeter type, in combination, a core structure of magnetic material comprising a winding leg and two legs extending laterally from the ends of the winding leg, an armature of magnetic material hingedly supported on one lateral leg, resilient means for biasing said armature into engagement with said one lateral leg, one end of said armature terminating closely adjacent the inner side of the outer end of the other of said laterally extending legs, the end surface of the armature being substantially parallel to the side of the leg, and overlapping said side a substantial amount in all positions within the range of travel of the armature to provide an air gap between the closely adjacent surfaces having substantially uniform length within the normal range of movement thereof, which range of movement is substantially less than the minimum overlap, means for normally biasing said armature toward the position of minimum overlap between the end of said armature and said last named core leg, and a winding on said winding leg for actuating said armature against the force of said biasing means.

3. In a regulator relay of the contact making voltmeter type, in combination, a core structure having a winding leg and a pair of legs extending laterally therefrom, one of said laterally extending legs being provided with a rocking surface, an armature member of magnetic material engaging said rocking surface and flat flexible means between the aforenamed laterally extending leg and said armature and attached thereto for supporting the armature against said rocking surface to prevent longitudinal motion thereof while permitting the rocking of said armature upon said surface, one end of said armature terminating closely adjacent the inner side of the outer end of the other of said laterally extending legs, the end surface of the armature being substantially parallel to the side of the leg, and overlapping said side a substantial amount in all positions within the range of travel of the armature to provide an air gap between the closely adjacent surfaces having substantially uniform length within the normal range of movement thereof,

which range of movement is substantially less than the minimum overlap, and a winding on said winding leg energized in accordance with the quantity to be regulated.

4. In a relay, in combination, a core structure comprising a winding leg and a pair of laterally extending legs, an armature, means for pivotally mounting said armature upon one of said laterally extending legs to provide against longitudinal motion while permitting the pivotal movement of said armature with respect to said core, one end of said armature terminating closely adjacent the inner side of the outer end of the other of said laterally extending legs, the end surface of the armature being substantially parallel to said side of the leg, and overlapping said side a substantial amount in all positions within the range of travel of the armature to provide an air-gap in the magnetic circuit of the core between the closely adjacent surfaces having a substantially constant length and variable cross-section within the permitted range of movement of the armature, which range is less than one-half the minimum overlap.

CLINTON R. HANNA.