Sept. 26, 1950 W. A. CHARBONNEAUX 2,523,941

VIBRATORY VOLTAGE REGULATOR

Filed Jan. 26, 1946

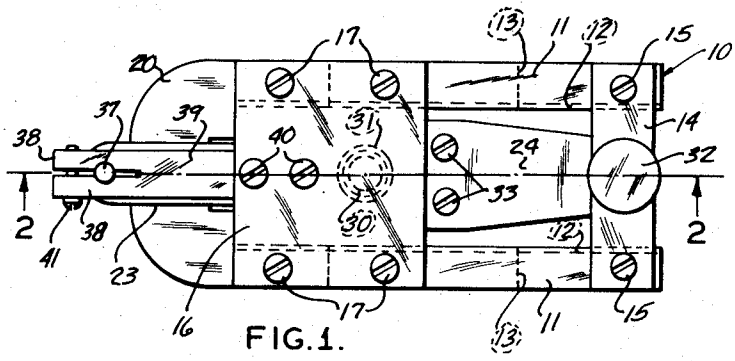


FIG. 1.

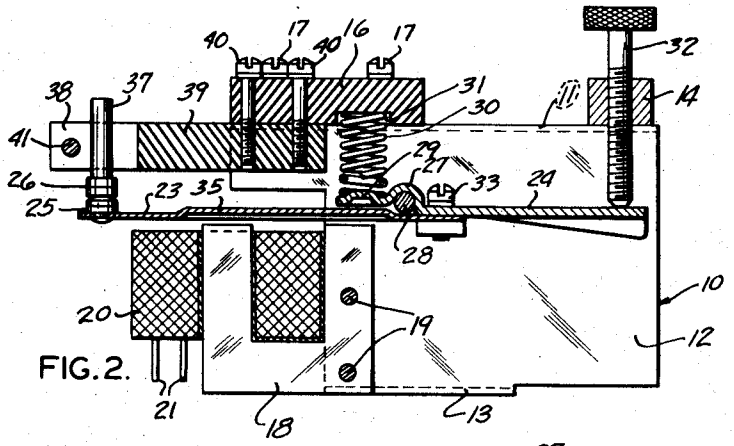


FIG. 2.

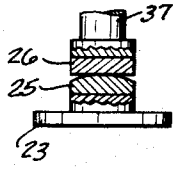


FIG. 6a

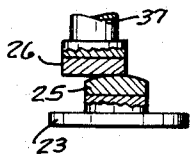


FIG. 6b

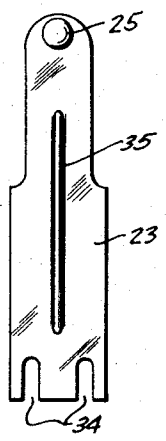


FIG. 3.

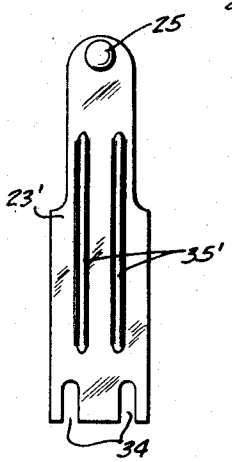


FIG. 4.

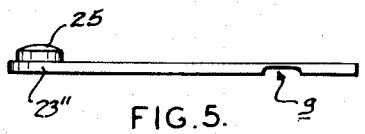


FIG. 5.

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VIBRATORY VOLTAGE REGULATOR

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4 Claims. (Cl. 200—90)

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This invention relates generally to voltage regulators of the vibrating armature type and is particularly directed to improvements in the construction and arrangement thereof whereby its operation may be more stable and reliable.

Voltage regulators of the type herein contemplated may be employed, for example, to regulate the output voltage of an alternating current electrical generator by appropriately altering the field circuit of an exciter machine which, in turn, energizes the field windings of the generator. This regulator acts periodically to short-circuit the field rheostat of the exciter machine, as is now well known and understood in the art. The periodic rise and fall of generator voltage therefore, requires a regulator which is capable of rapid and stable operation. Hitherto, voltage regulators have possessed characteristics rendering them generally incapable of uniform and stable operation under the required degree of rapid response necessary for regulating generator output voltage within close limits.

Accordingly, an object of this invention resides in improving the stability of generator output voltage regulation by a particularly novel and improved construction and arrangement of parts and elements in a voltage regulator of the vibratory type.

It is also an object hereof to provide an improved and easily manufactured voltage regulator in which the vibratory means or armature can be maintained in a relatively stable relationship with respect to the magnetic field of the solenoid associated therewith under all operating condition, thereby assuring accurate voltage regulation.

A further object may be found in the construction and mounting arrangement of the vibratory means and associated parts in a voltage regulator such that outside mechanical vibrations will have no appreciable disturbing effect thereon, thereby enabling the vibratory means to follow more closely the rapid alternating current impulses of the generating unit.

Still another object is to be found in the improved arrangement of associated movable and fixed make and break contact means which will assure uniform contact pressures and consequently make it easy to obtain voltage regulation.

Other and further objects and attendant advantages will be more fully pointed out in the following detailed description of a preferred example of the present invention, the same being illustrated in the accompanying drawing, in which:

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Figure 1 is a top plan view of the vibrating type voltage regulator constructed in accordance with the preferred practice of this invention;

Figure 2 is a transverse sectional elevational view of the voltage regulator herein preferred, the view being taken at line 2—2 in Figure 1;

Figure 3 is a top plan view of the vibratory armature means which is incorporated in the voltage regulator shown in Figure 2;

Figure 4 is a top plan view of a modified form of the vibratory armature means;

Figure 5 is a side elevational view of a further modified form of armature means; and

Figures 6*a* and 6*b* are transverse elevational views, partly in section, of the preferred form and arrangement for the make and break contacts, the views being respectively an illustration of the desired alignment for the contacts and an illustration of the degree of misalignment which can be tolerated without adversely affecting the operation thereof.

Referring now to the several views of the drawing, the presently preferred vibratory type voltage regulator may be seen to comprise a two-part frame structure **10**, each part of which includes an upper, out-turned flange **11**, side plate **12** and an out-turned base flange **13**. This two-part frame is held in assembled relation by a first cross block **14** secured to the upper flanges **11** by suitable threaded elements **15**, and by a second cross block **16** of suitable dielectric material also secured to the upper flanges by threaded holding means **17**. A solenoid unit is carried by the frame **10** near the base flanges **13** and includes U-shaped core **18** fixed thereto by means of bolts or other suitable elements **19**. One leg of this core **18** is provided with the usual coil **20** from which extend lead wires **21** for electrical connection into the power output circuit system for the generator unit (not shown) with which the regulator is associated.

The voltage regulator is characterized by an improved arrangement of a composite vibrator structure of adjustable type which is comprised of a thin spring steel vibrator arm or armature **23** and a supporting arm **24** which is arranged for pivotal adjustment in order to vary the amount of contact pressure desired between the co-operative make and break contact element **25** on arm **23** and fixed contact element **26** carried by the frame **10** as will later be described. Referring to Figure 2, it can be seen that the arm **24** formed of sheet metal is shaped to provide a saddle **27** which rests on a fulcrum bar **28**, the latter extending from side to side between the

side plates 12 of frame 10. The forward end of arm 24 adjacent the saddle 27, is embossed at 29 to provide a seat for the mounting of a resilient coiled compression spring element 30. The opposite end of spring 30 is positioned within a suitable recess 31 in the under surface of the cross block 16 thereby assuring retention of the spring in its proper position with respect to the arm 24. Arm 24 is held in position with its saddle 27 bearing on the fulcrum bar 28 by means of the spring and also by a thumb screw member 32 which bears upon the rearward end thereof as clearly disclosed, the thumb screw being threadedly received in cross block 14. Supporting arm 24 is preferably a rigid member and is further stiffened by side flanges near the end adjacent the thumb screw. The purpose in positioning the coiled spring 30 on the opposite side of fulcrum bar 28 from the adjustment screw 32 is to assure positional stability thereof during armature vibration and to compensate for wear and manufacturing tolerances in the several parts associated therewith.

The vibratory arm 23 of this composite structure is mounted on arm 24 by means of securing elements 33 which are adapted to be received in slots 34 (Figure 3) formed in the base end of this arm. In the case of the vibrator arm 23 it will be observed that a single stiffening bead 35 is suitably formed or embossed therein, while the modified arm member 23' (Figure 4) has a pair of stiffening bead formations 35', and, if desired, a further modified form of arm 23'' may be provided which is relatively thick and stiff throughout its length and width except for a short transverse section of reduced thickness *g* adjacent its point of attachment (Figure 5). In other respects, each of these arms is identical, and carries the contact element 25 at the free end opposite the base end which is secured to the adjustable supporting arm 24. The purpose of stiffening the vibratory arm is to eliminate harmonic motion in the same while it is vibrating in response to the magnetic field set up by the solenoid which, in turn, is subject to generator output voltage variation. It is further necessary to provide a stiff moving member which is not easily influenced by undesired outside mechanical vibrations. By so forming this vibratory arm with one or more stiffening beads running longitudinally thereof it is possible to select lighter gauge sheet stock for mass reduction, eliminate disturbing harmonics and prevent bowing of the arm in the middle of the span. The reduction of the arm mass will permit it to follow the rapid half-cycle alternating current impulses easily and also lessen the mechanical bounce upon impact of the contact element 25 with the stationary contact 26.

The stationary contact 26 of this voltage regulator is secured to a stem 37 which is adjustably clamped between the bifurcated end elements 38 of a supporting member 39. Member 39 is conveniently secured to the cross block 16 by threaded studs 40. A clamp screw 41 serves to draw the end elements 38 into engagement with the stem 37 after proper adjustment has been effected. In this connection the cross block 16 and member 39 secured thereto are each formed of suitable insulating material whereby electrically to isolate the contact 26 from the rest of the parts of the device which are or may be current conductors.

It will now be observed that the composite

vibrator structure of this voltage regulator possesses marked advantages over prior structures in that the vibratory armature 23 is secured to an adjustably arranged, rigid and stable supporting arm 24, the latter being arranged with its stabilizing and wear take-up spring 30 bearing on one end thereof which is opposed by the adjusting thumb screw 32 at the opposite end. The fulcrum engaging saddle 27 is held in position on the fulcrum bar 28 and hence arm 24 cannot easily move in a lateral direction or be disturbed by the vibratory response of arm 23. Furthermore, the arm 23 flexes in a zone close to its point of attachment with the arm 24 and accordingly moves in a substantially accurate path which improves the constancy of contact between the electrical contact elements 25 and 26. The final desired contacting relationship between these latter elements can be determined by adjustment of stem 37 with respect to the clamp arms 38 of member 39 and by the thumb screw 32. A further advantage of this regulator resides in the nicety of contact pressure control afforded by the location of the thumb screw 32 on the opposite side of the fulcrum bar 28 from the take-up spring 30.

In this connection an important feature of this invention is evidenced by the form and relation of the contact elements 25 and 26. Referring to Figure 5*a*, it can be seen that the fixed contact 26 has a flat face of substantial area. Contact 25, on the other hand, is formed with a pronounced crown or curvate face which, in the normal position, is concentric with contact 26. The actual zone of contact between these elements is a relatively small area but the crowning form of contact element 25 confines its zone of abutment substantially on the longitudinal center line of arm 23 regardless of lateral shifting or misalignment between the two contacts as illustrated in Figure 5*b*. As a consequence of this, the electrical contact established between elements 25 and 26 will be uniform and precise.

The foregoing detailed description is directed to a preferred form of the voltage regulator in which the construction and arrangement of the composite vibratory armature and adjustable support as well as the form and relationship of electrical make and break contact elements constitute important features. However, it should be understood that certain modifications can be made herein without departing from the scope of the invention as defined by the claims annexed hereto.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In a voltage regulator including a frame and a solenoid carried thereby for electrical connection with the source of voltage to be regulated, a fulcrum disposed on the frame, an arm member formed to provide a saddle for bearing engagement with said fulcrum, means on the frame and bearing against said arm member for retaining the latter against lateral shifting movement on said fulcrum, a vibratory armature secured at one of its ends to said arm member adjacent said saddle bearing and projecting therefrom to overlie the solenoid, a fixed contact element on the frame, a co-operative make and break contact element on said armature, and means carried by the frame and engaging said arm member for adjustably positioning the latter, whereby to predetermine the degree of contact pressure between

said co-operative make and break contact elements.

2. In a voltage regulator including a frame and a solenoid carried thereby for electrical connection with the source of voltage to be regulated, a fulcrum disposed on the frame, an arm member formed to provide a saddle for bearing engagement with said fulcrum, resilient means on the frame and bearing against said arm member for retaining the latter against lateral shifting movement on said fulcrum, a longitudinally stiffened vibratory armature secured at one of its ends to said arm member and projecting therefrom to overlie the solenoid, said armature having its zone of vibratory flexure close to its said one end, a contact element carried by said armature near its opposite end, and a co-operative contact element carried on the frame in position to be engaged by said armature contact element for make and break operation upon vibratory movement of said armature, said last mentioned contact element being adjustable relative to said armature contact element for predetermining the point of make and break operation therebetween.

3. A voltage regulator comprising a frame having a transversely extending fulcrum located medially therein, an arm provided adjacent its inner end with a saddle for rockable engagement with the fulcrum, said arm having a relatively short end-portion projecting inwardly from the saddle in the provision of a seat and a relatively long end-portion projecting outwardly from the saddle, a spring mounted in the frame and impinging against the seat, a thumb screw mounted in the frame and operatively bearing at one end against the long end-portion of the arm, a solenoid mounted in the frame in outwardly spaced relation to the short end-portion of the arm, a vibratory armature secured at one end to the under side of the arm closely adjacent to, and on the opposite side of, the fulcrum, relative to the seat, said armature extending freely outwardly beneath the fulcrum and through the magnetic field of the solenoid, a stationary contact member adjustably mounted in the frame, and a vibratory contact mounted in the free end of the armature for co-operation with the stationary contact.

4. A voltage regulator comprising a frame having a transversely extending fulcrum located therein, an arm provided adjacent its inner end with a saddle for rockable engagement with the fulcrum, said arm having a relatively short end portion projecting inwardly from the saddle in the provision of a seat, a spring mounted in the frame and impinging against the seat, an adjustment member mounted in the frame and operatively bearing against said arm, a solenoid mounted in the frame in outwardly spaced relation to the short end portion of the arm, a vibratory armature secured to the underside of the arm closely adjacent to and on the opposite side of the fulcrum relative to the seat, said armature extending freely outwardly beneath the fulcrum and through the magnetic field of the solenoid, a fixed contact member mounted in the frame, and a co-operative make and break contact element on said armature.

WILSON A. CHARBONNEAUX.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
748,442	Varley	Dec. 29, 1903
929,319	McBerty	July 27, 1909
1,103,530	Newburn	July 14, 1914
1,643,270	Greiner	Sept. 20, 1927
1,867,099	Roe	July 12, 1932
2,165,049	Hanna et al.	July 4, 1939
2,223,573	Nulsen	Dec. 3, 1940
2,238,383	Collins	Apr. 15, 1941
2,351,448	Neuner	June 13, 1944

FOREIGN PATENTS

Number	Country	Date
25,770	Great Britain	Nov. 15, 1906