June 22, 1926. 1,589,810

H. B. MARSHALL

VOLTAGE REGULATOR

Filed June 13, 1924

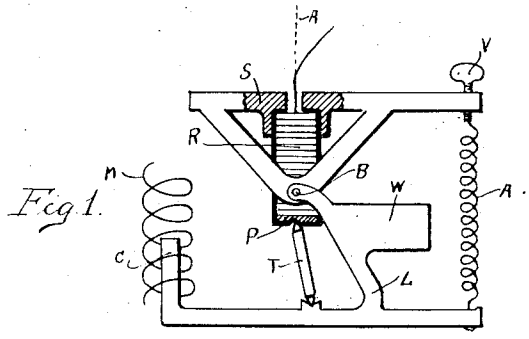


Fig. 1.

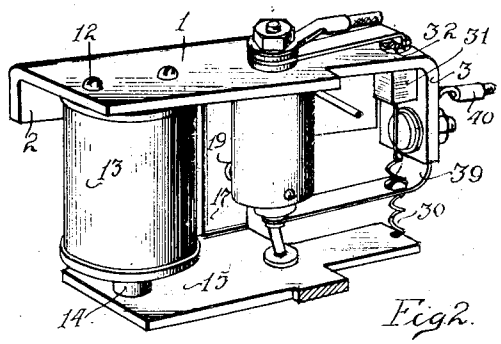


Fig. 2.

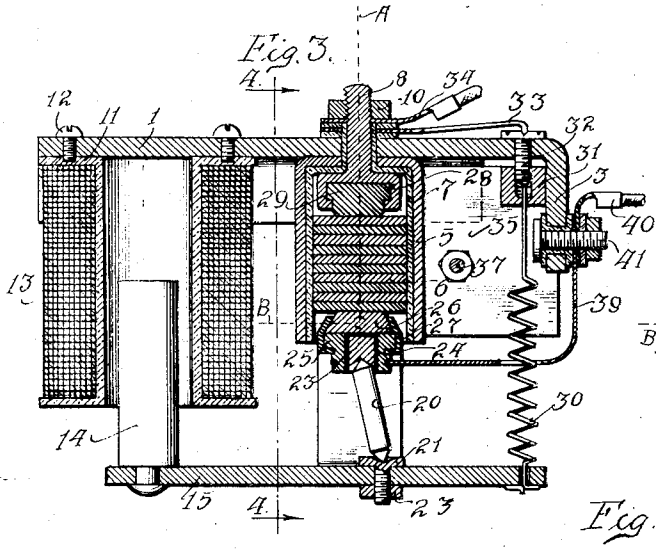


Fig. 3.

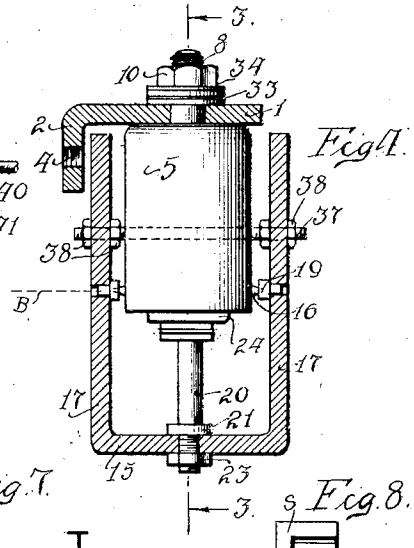


Fig. 4.

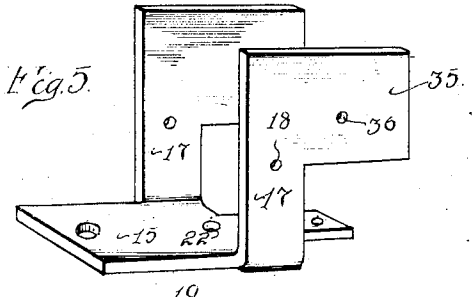


Fig. 5.

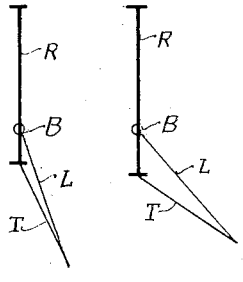


Fig. 7.

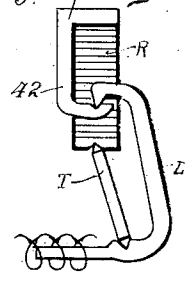


Fig. 8.

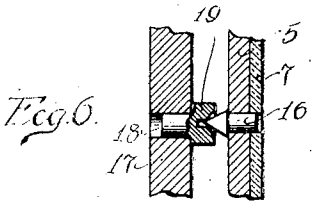


Fig. 6.

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UNITED STATES PATENT OFFICE.

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VOLTAGE REGULATOR.

Application filed June 13, 1924. Serial No. 719,880.

My invention relates to rheostats in which the resistance is varied by varying the compression of a resistance, and to electric regulating or controlling devices in which the resistance-altering compression is varied automatically in response to variations in the current flowing through a certain circuit.

In some of its general aspects, my invention aims to provide a compact, inexpensive, easily adjusted and highly effective automatic regulator for varying the resistance in response to the flow of current through a certain circuit. For this general purpose, my invention provides resistance compression means consisting of a magnetically actuated rocking member and a thrust member operatively interposed between the rocking member and one end of the resistance and both extending obliquely to the axis of compression of the resistance. It also provides simple and effective means for adjusting the regulator as a whole, for carrying current to the ends of the resistance and suitably insulating the resistance from other parts of the mechanism, provides simple and easily adjusted means for pivoting the rocking member upon its support, provides a disposition of the thrust member which will make the resulting variations in the compression of the resistance responsive to relatively small movements of the rocking member. Moreover, my invention provides simple electro-magnetic means for moving the rocking member, and provides a construction in which a series of iron parts are disposed for affording a magnetic circuit through the actuating magnet coil.

Furthermore, my invention provides an adjustable resistance or regulator of this general class in which the rocking member is substantially balanced so as to be highly sensitive, in which one of a pair of cooperating solenoid and core members is carried by the rocking member, in which the attraction of the core or the solenoid is resisted by a spring, in which the effective action of this spring can readily be adjusted with a high degree of accuracy and maintained at any point of adjustment, and in which the entire mechanism can readily be assembled to afford an exceedingly compact unit.

More particularly, my invention provides a rheostat or regulator of this general class in which the rocking member includes a pair of pivotal arms, provides cooperating pivot elements on these arms and on a stationary part of the appliance, and provides simple means for spacing these arms from each other so as to secure the desired highly sensitive pivotal engagement. It also provides a pivoting arrangement of this general class in which certain of the pivot elements are carried by the casing of the resistance and provides an exceedingly simple arrangement of the parts for facilitating the assembly and adjustment of the interengaging pivot portions. It also provides simple and effective means for making the necessary circuit connections to both ends of the compressible resistance. Still further and also more detailed objects will appear from the following specification and from the accompanying drawings, in which

Fig. 1 is a diagrammatic view showing some of the underlying features of my invention.

Fig. 2 is a perspective view of an embodiment of my invention, with the forward pivot arm of the rocking member cut away so as to show the position of the thrust member and of the lower thrust bearing.

Fig. 3 is an enlarged vertical section taken through Fig. 2 along the axis of the magnet coil and of the compressible resistance.

Fig. 4 is a vertical section taken transversely of Fig. 3 along the line 4—4 of that figure.

Fig. 5 is a perspective view of the main part of the rocking member of the embodiments of Figs. 2, 3 and 4.

Fig. 6 is an enlarged and fragmentary section taken transversely of Fig. 3 through the axis of the compressible resistance to show the mounting of the two cooperating pairs of pivot elements which are respectively carried by the rocking member and the casing of the resistance.

Fig. 7 is a diagrammatic view showing the effective angular relations of the resistance, thrust member and rocking member in two positions of the latter.

Fig. 8 is a diagram of another embodiment of my invention, namely one in which the pivotal support for the rocking member is integral with the head against which the resistance is compressed, and in which the

solenoid and core extend transversely of the thrust member.

In accomplishing some of the purposes of my invention, I employ a compressible resistance, such as the carbon pile R shown in the diagram of Fig. 1, and resist the bodily movement of this resistance in one direction by a support S against which the stationary end of the resistance bears. Then I vary the compression of this resistance by suitably moving a thrust member T which is arranged for pressing the free end of the resistance towards the said support S. To move this thrust member, I interpose it between a presser head 5 which bears against the free end of the resistance (and which effectively forms the movable end of the compressible resistance member) and a part of a lever L which forms the rocking member of my appliance. For this purpose, the rocking member has a thrust portion engaging one end of the thrust member T and disposed at one side of the axis of compression A of the resistance, the rocking member being pivoted on a pivot axis intersecting this compression axis between the stationary end of the resistance and the thrust member, thereby causing the thrust member to extend at a highly oblique angle to this axis of compression.

Mounted on the rocking member L is an iron core C which extends into a solenoid or magnet core M, thereby causing the rocking member to be moved in a direction which is clockwise in Fig. 1 when the current is flowing through the solenoid coil M. To resist such a movement of the rocking member, I interpose an adjustable spring A between the rocking member and the support, this spring being here shown as adjustable by means of a screw B. I also desirably form a weight W upon the rocking member to counterbalance the weight of the core C, so that the rocking member can be sensitively balanced.

With the parts thus arranged, it will be obvious from Fig. 1 that a movement of the rocking member in a clockwise direction will tend to swing the thrust member T more nearly into alinement with the axis of compression of the resistance (which axis is in a common plane with the pivot of the rocking member and the upper end of the thrust member) thereby reducing the distance between the upper or stationary end of the resistance and the lower end of the thrust member so as to increase the compression of the resistance, while a swinging in the opposite direction will decrease the oblique angle between the thrust member and the axis of compression and will reduce the compressing of the resistance. It will also be evident that by moving the screw V, I can readily adjust the appliance so as to vary the current flow required in the solenoid for effecting a given movement of the rocking member.

Referring now to the embodiment of Figs. 2 to 6 inclusive, this includes as the supporting member of the appliance a bracket desirably formed of flat iron and comprising a horizontal top portion 1, a downwardly directed rear flange 2 and a downwardly directed end flange 3, the rear flange 2 being provided with threaded perforations 4 for receiving screws whereby the bracket may be fastened to any suitable support. Abutting against the lower face of the top 1 of this supporting member is the closed upper end of a casing 5 which houses the compressible resistance, the latter being here shown as consisting of a pile of carbon disks 6 which are insulated from the metal casing 5 by an insulating lining 7. The casing 5 is supported from the top 1 by a terminal bolt 8 which is insulated from the said top by an insulating bushing 9 and supported by an outer nut 10.

The top 1 also has depending from it a spool 11 of insulating material, here shown as supported by screws 12, which spool carries a winding of magnet wire 13 and has a vertical bore. Extending upwardly into this bore is an iron core 14 fastened to one end of the cross-bar 15 of the rocking member of the appliance. This rocking member is pivotally connected to the stationary supporting member on a pivot axis B which desirably intersects the axis of the carbon pile (or axis of compression of the resistance) at right angles to the latter and adjacent to the lower end of the said pile. To afford this pivotal mounting, I desirably provide the casing 5 with diametrically opposite perforations disposed along the said pivot axis B, and I insert into each of these perforations the stem of a pivot pin 16 which has a conical head bearing at its back against the outside of the casing. Then I provide the rocking member with a pair of upwardly directed arms 17 spaced by a distance greater than that between the tips of the projecting pivot pins 16, and provided with a pair of alined perforations 18 in the said arms. In each of these perforations 18 I socket the stem of a pivot element 19 which has an enlarged head presenting a substantially cup-shaped recess towards the conical head of one of the pivot pins 16.

Operatively interposed between the lower end of the carbon pile and the bottom plate or cross-bar 15 of the rocking member is a thrust member 20 which desirably has conical ends adapted to afford point bearings in opposed and conically cupped thrust receiving elements associated respectively with a lower presser head 25 engaging the carbon pile and with the said cross-bar 15. For this purpose, I am here showing the lower cup-shaped thrust element as the head of a bolt 21 which extends through a correspondingly disposed perforation 22 in the

cross-bar 15 and is secured in position by a lower nut 23. Then I am showing the upper and downwardly cupped thrust receiving element as an iron block 23 socketed in an insulating cup 24 which in turn is socketed in the said presser head 25. This presser head 25 is desirably secured to the lowermost and frustro-carbon block 26 by a metal collar 27 spun over both of the said elements after the manner shown in Fig. 3, the said collar desirably also being made of iron. To receive the resulting upward thrust, I desirably flange the lower end or head 28 of terminal bolt 8 over the head of the upper carbon block 29.

With the parts thus arranged and the rocking member thus pivotally connected to the stationary casing 5, the thrust member and the carbon pile are disposed in tandem between the top 1 of the supporting member and the cross-bar 15 of the rocking member and are held in position without requiring any auxiliary fastening elements. To vary the extent of the compression of the carbon pile, I dispose the thrust member 20 obliquely to the compression axis 6 of the carbon pile this being readily accomplished by locating the axis of the thrust element 21 at one side of the said axis of compression, thereby effectively disposing the lever arm of the rocking member still more obliquely at the same side of the said axis, as shown diagrammatically in Fig. 7. When thus disposed, it will be obvious that the movement of the rocking member in a clockwise direction or one corresponding to a pull of the electromagnet on the core 1 will tend to aline the thrust member with the said compression axis, thereby decreasing the distance between the upper end of the carbon pile and the lower thrust elements 2 and causing a corresponding compression of the resistance, as also shown diagrammatically in Fig. 7.

To oppose a movement of the rocking member in its said compression-effecting direction, I interpose a tension spring 30 between the supporting member and the end of the cross bar 15 which is on the opposite side of the said axis of compression (and of the pivot axis of the rocking member) from the solenoid core 14. This spring 30 is secured at its upper end to a slide block 31 which bears against the downwardly directed end flange 3 of the supporting member so as to be kept by this flange from rotating. Threaded into this slide block 31 is a screw 32 which extends rotatably through the top 1 of the supporting member and which has the upper surface of its head provided with a series of radial notches any one of which may be engaged by the downwardly directed end of a flat latching spring 33 so as to be locked against rotation. To simplify the construction, I desirably employ the terminal bolt 8 also as the means for fastening the other end of the spring to the supporting member after the manner shown in Fig. 3, this latching spring being insulated from the stem of the said bolt by the insulating tube 9 and being interposed between a pair of insulating washers which insulate the spring both from the top 1 of the supporting member and from the circuit terminal 34 which is clamped under the nut 10.

To counterbalance the weight of the core 14 as disposed at one end of the cross-arm 15 of the rocking member, I desirably provide this rocking member with portions disposed at opposite sides of the pivot axis of the rocking member from the said core. For this purpose, I am here showing each of the arms 17 as provided with an extension wing 35. The two wings extend considerably beyond the casing of the resistance lengthwise of the rocking member, so that I can also utilize them in varying the distance between the opposed arms 17 so as to adjust the distance between the pivot bearings 19. For this purpose, I am showing the wings 35 as provided with alined perforations 36. Extending through these perforations is a threaded rod 37 carrying pairs of nuts 38 adjacent to the opposed faces of the two arms 17. In assembling the appliance, these arms can initially be sprung apart so that the pivots 19 will readily clear the tips of the pivot pins 24. Then the outer nuts 38 can be screwed up so as to draw the arms sufficiently towards each other to afford the desired delicate pivoting of the rocking member, after which the inner nuts 38 are screwed outwardly of the stem 37 so as to lock the arms in rigidly spaced relation.

To provide the desired circuit connection to the movable end of the resistance (which is here illustrated as the lower end) I desirably employ a thin and somewhat flexible metal conductor 39 which I am here showing as provided with a perforated end clamped into a corresponding groove in the lower presser head 25. This has its other end clamped to the corresponding circuit terminal 40 by a bolt 41 which extends through a perforation in the downwardly directed end 3 of the supporting member, both the bolt, the flexible conductor 39 and the circuit terminal 40 being insulated from the supporting part 3 by insulation after the manner shown in Fig. 3. When thus employed, the flexible conductor 39 desirably has a perforation considerably larger than the diameter of the spring 30 so that the spring can extend freely through it.

With the parts thus arranged, it will be evident that all of the circuit connections are insulated from the metal parts which form the supporting member, the rocking member and the thrust receiving portions. By mak-

ing the casing 5, the lower presser head 23 and the thrust member as well as the rocking member of iron, these cooperate with the solenoid core 14 in affording a magnetic circuit in the form of a loop extending through the bore of the magnet, thereby considerably increasing the efficiency of the solenoid. By forming weighted portions on the rocking member to counterbalance the weight of the core, I can employ a sensitive adjusting spring, and since there is always current flowing through the solenoid when the appliance is in use, I can maintain a sensitive balanced relation of the parts which will avoid vibration even when the appliance as a whole is subjected to jarring. Consequently, my appliance is highly suitable for use under conditions in which jarring cannot be avoided, as for example upon automobiles as a voltage regulator for the battery charging circuits. However, I do not wish to be limited to this particular employment of my invention, or to the use of its various novel features in connection with one another.

Neither do I wish to be limited to the particular details of construction and arrangement above described, it being obvious that these might be varied in many ways without departing either from the spirit of my invention or from the appended claims. For example, instead of employing the casing of the resistance as the pivotal mounting for one end of the rocking member, I may provide the pressure-receiving top with an integral arm 42 extending alongside the resistance, as shown in Fig. 8. So also, the mounting of the solenoid and of its core might be altered as shown in the same figure.

I claim as my invention:—

1. In a rheostat, a compressible resistance member having one end stationary, a rocking member pivoted on a stationary axis disposed between the ends of the resistance member, a thrust member interposed between the rocking member and the other end of the resistance member and disposed in oblique extension of the compression axis of the resistance member, and electromagnetic means for moving the rocking member in one direction.

2. A rheostat as per claim 1, in combination with spring means for resisting the movement of the rocking member in the said direction.

3. A rheostat as per claim 1, in which the electromagnetic means include a stationary solenoid and a movable core for the solenoid, the core being mounted on the rocking member.

4. A rheostat comprising a pile of compressible resistance elements, a stationary casing housing the pile and having a substantially closed end against which the pile can be compressed, a rocking member pivoted to the casing on an axis transversely intersecting the axis of compression of the pile, and a thrust member extending in oblique extension of the axis of the pile and interposed between the rocking member and the pile so as to compress the pile to a varying extent according to the position of the rocking member.

5. A rheostat as per claim 4, in which the rocking member is pivoted on an axis transverse of the axis of the pile and passing through the pile near the engagement of the latter with the thrust member.

6. A rheostat as per claim 4, in combination with means for insulating the pile from the thrust member.

7. A rheostat as per claim 4, in which the rocking member has a pair of pivot arms at opposite sides of the said casing, in combination with adjustable means for spacing the pivot arms.

8. In a rheostat of the type having a thrust member and a compressible resistance extending oblique to each other and interposed in tandem between a stationary supporting member and a rocking member, a casing for the resistance, and cooperating pivot members respectively carried by the casing and rocking member, the said pivot members comprising two pairs, one pair being mounted on opposite wall portions of the casing, the rocking member having a pair of arms disposed at opposite sides of the casing and respectively carrying the other two pivot members.

9. In a rheostat of the type having a thrust member and a compressible resistance oblique to each other and interposed in tandem between a stationary supporting member and a rocking member, a casing for the resistance, a pair of arms upon the rocking member extending at opposite sides of the casing, and cooperating elements upon the said arms and the casing for pivotally connecting the rocking member to the casing, the arms being adapted to be flexed toward or away from each other.

10. A rheostat as per claim 8, in combination with adjustable means for spacing the said arms.

11. In a rheostat of the type having a thrust member and a compressible resistance interposed in tandem between a stationary supporting member and a rocking member, a casing for the resistance, the casing having perforations in opposed wall portions and the rocking member having perforations alining with the aforesaid perforations, and two relatively cooperating pairs of pivot members respectively socketed in the perforations of the casing and the rocking member.

12. In a rheostat, a compressible resistance having one end thereof stationary, a casing slidably housing the resistance, a rocking member pivoted to the casing on an axis

transverse of the axis of compression of the resistance, a thrust member interposed between the other end of the resistance and the rocking member and extending at an oblique angle to the said axis of compression, an iron core mounted on one end of the rocking member, a solenoid into which the core extends, and means associated with the other end of the rocking member for resisting the attraction of the core by the solenoid.

13. In a rheostat, a compressible resistance having one end thereof stationary, a rocking member pivoted on an axis transverse of the axis of compression of the resistance, a thrust member interposed between the other end of the resistance and the rocking member and extending at an oblique angle to the said axis of compression, an iron core mounted on one end of the rocking member, and a solenoid into which the core extends, the rocking member having a weighted portion at its other end for counterbalancing the weight of the core.

14. A rheostat as per claim 12, in which the casing is of iron, including an iron supporting member carrying the solenoid and the said casing; the thrust member and the rocking member being also of iron and cooperating with the core, the supporting member and the casing in forming a magnetic circuit extending through the solenoid.

15. A rheostat as per claim 12, including a supporting member carrying the solenoid and the rocking member and against which the resistance is compressed, a sliding member mounted upon the supportng member for movement toward or away from the rocking member, and a tension spring interposed between the sliding member, and the rocking member, and normally latched means for moving the sliding member.

16. A rheostat as per claim 12, including a supporting member carrying the solenoid and the rocking member and against which the resistance is compressed, a screw extending through the supporting member toward the rocking member, a sliding member in threaded engagement with the screw, and a tension spring interposed between the sliding member and the rocking member, the supporting member having a portion slidably engaged by the sliding member and preventing the latter from rotating.

17. A rheostat as per claim 12, including a supporting member carrying the solenoid and the rocking member and against which the resistance is compressed, a pair of circuit terminals mounted on the supporting member, means associated with each terminal for insulating the same from the supporting member, one terminal being in conducting relation to the stationary end of the resistance, and a flexible conductor connecting the other terminal with the other end of the resistance.

Signed at St. Louis, Missouri, June 11, 1924.

HARRY B. MARSHALL.