Aug. 13, 1929. H. L. HARTZELL 1,724,197

VIBRATORY REGULATOR

Filed Nov. 29, 1927

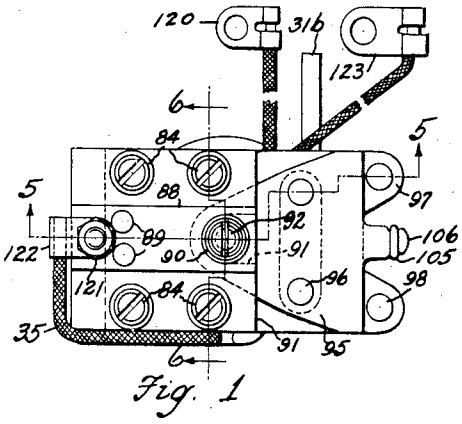


Fig. 1

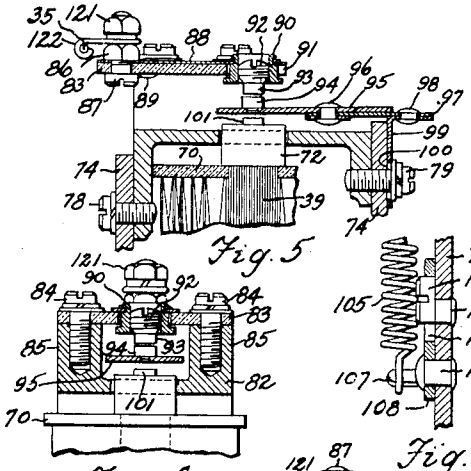


Fig. 5

Fig. 6

Fig. 8

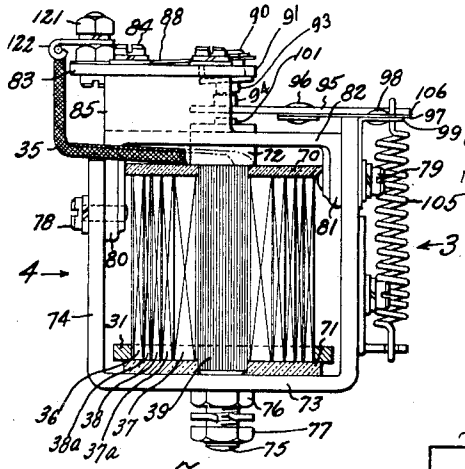


Fig. 2

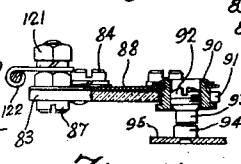


Fig. 7

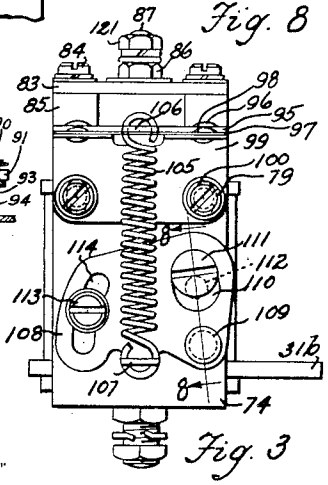


Fig. 3

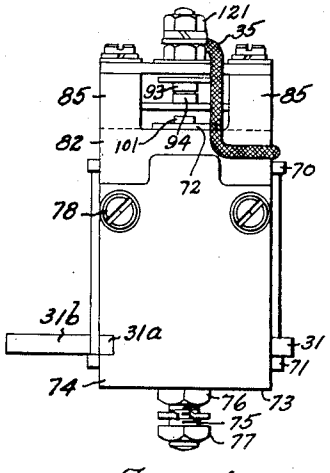


Fig. 4

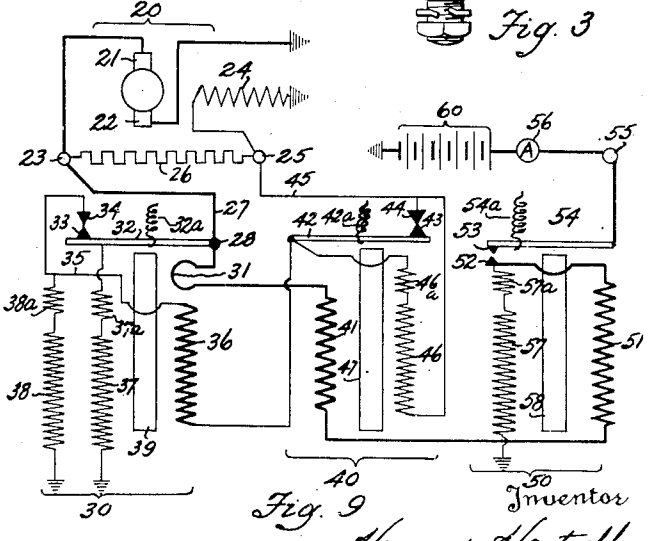


Fig. 9

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Patented Aug. 13, 1929. 1,724,197

UNITED STATES PATENT OFFICE.

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VIBRATORY REGULATOR.

Application filed November 29, 1927. Serial No. 236,464.

This invention relates to apparatus for regulating the output of a generator and more particularly to vibratory regulators for regulating the voltage or current output, or both, of a variable speed generator.

One object of the present invention is to produce at low cost a vibratory regulator having facilities for making adjustments of certain of its parts.

Another object is to provide for such relative sliding movement between the contacts of the regulator as will tend to keep the contacts clean.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of embodiment of the present invention is clearly shown.

In the drawings:

Fig. 1 is a plan view of a regulator embodying the present invention.

Fig. 2 is a side elevation, partly in longitudinal section.

Fig. 3 is an end view looking in the direction of arrow 3 in Fig. 2.

Fig. 4 is an end view looking in the direction of arrow 4 in Fig. 2.

Fig. 5 is a sectional view on the line 5—5 of Fig. 1.

Fig. 6 is a sectional view on the line 6—6 of Fig. 1.

Fig. 7 is a fragmentary sectional view of certain parts shown in Fig. 5.

Fig. 8 is a sectional view on the line 8—8 of Fig. 3.

Fig. 9 is a wiring diagram showing a battery charging system in which a regulator embodying the present invention is adapted to be used.

Referring to the wiring diagram of Fig. 9, in which is embodied the invention of John T. Fitzsimmons and Joe White described and claimed in their copending application, Serial No. 234,609, filed Nov. 21, 1927, a generator 20, which is connected by an electromagnetically operated circuit breaker 50 with a storage battery 60, is regulated both by a voltage regulator 30 and a current regulator 40. The generator 20 has a positive brush 21 connected with a positive terminal 23 and a negative brush 22 connected with ground to the battery 60. The generator shunt field 24 is connected with a terminal 25. A non-inductive, field regulating resistance 26 is connected between the terminals 23 and 25. The battery charging circuit includes the terminal 23, a wire 27 connected with a regulator terminal 28, a magnetizing coil 31 of the regulator 30, a magnetizing coil 41 of the regulator 40, a magnetizing coil 51 of the circuit interrupter 50, contacts 52 and 53, a relay armature 54, a terminal 55 and an ammeter 56.

The voltage regulator 30 comprises also an armature 32 carrying a contact 33 normally engaging a contact 34 which is connected by wire 35 with a magnetizing coil 36. The main magnetizing winding of the regulator 30 comprises coils 37 and 37ª, the latter being of relatively high resistance and made of wire having negligible temperature coefficient. The winding which has a demagnetizing effect upon the coils 37 and 37ª comprises the coils 38 and 38ª connected in series with wire 35 and ground. Coil 38ª is of relatively high resistance and of negligible temperature coefficient. While these windings are shown in separate location in the diagram it will be understood that they all surround a core 39 in the magnetic circuit of the armature 32.

The operation of the regulator will be clearly understood by those skilled in this art with the following brief description. The field controlling resistance 26 is normally short circuited by the following circuit: Wire 27, terminal 28, armature 32, contacts 33 and 34, wire 35, coil 36, armature 42 of the current regulator 40, contacts 43 and 44, and wire 45. When the generator voltage exceeds a certain amount, the armature 32 will be attracted against the action of a spring 32ª due to the combined effect of the coils 37, 37ª and coils 38, 38ª which operate cumulatively to attract the armature 32 while the contacts 33 and 34 remain closed. At the instant of separation of the contact 33 from contact 34, an instantaneous voltage will be generated by self-induction in the field coil 24 in such a direction as to cause an instantaneous surge of current in the coils 38 and 38ª in such direction as to produce flux tending to buck the flux produced by the coils 37 and 37ª. The result is that the field circuit will be quickly demagnetized to enable the spring 32ª to quickly close the contacts as soon as there has been a material reduction in the current in the field 24. It is well understood that

so long as the voltage tends to remain above a certain value, the armature 32 will continue to vibrate intermittently to interrupt and close the short circuit around the regulating resistance 26. So long as this takes place the voltage of the generator will be maintained within a certain limit. Since the current in the field 24 will be less at higher speed than at lower there will be a variation in the assistance which can be given to the coils 37 and 37ª by the coils 38 and 38ª. Hence the coil 36 is included in the circuit of the field winding 24 in order to compensate for the variations in the function of the coils 38 and 38ª. The coil 36 is connected so that its flux will at all times oppose the flux of the other coils.

The coil 31 is responsive to current so that the function of the voltage regulator may be varied at times before the current regulator comes into action.

The current regulator 40 includes in addition to the main energizing coil 41, a demagnetizing winding including the coils 46 and 46ª, the latter being of relatively high resistance and of negligible temperature coefficient. It will be noted that the coils 46 and 46ª are connected across the contacts 43 and 44 and are normally short circuited. When a certain current has been reached, the coil 41 will be energized sufficiently to attract the armature 42 toward a magnetizable core 47 against the tension of a spring 42ª. After the contacts 43 and 44 open, the coils 46 and 46ª will be energized so as to have a demagnetizing effect tending to produce a speedy release of the armature 42 almost instantly after there has been a reduction in the current in the field winding 24 resulting from interrupting the short circuit of resistance 26. It is well known that so long as the current exceeds a certain value, the armature 42 will continue to vibrate so as to maintain a field strength of the generator within a limit corresponding to which a certain current will be generated. It will be understood that windings 46, 46ª are all wound about the core 47.

The relay 50 includes magnetizing windings comprising coils 57 and 57ª, the latter being of relatively high resistance and of negligible temperature coefficient. This main magnetizing coil as well as the holding coil 51 is wound about a core 58. When the voltage to the generator exceeds a certain value, the magnetism produced by the coils 57 and 57ª will be such as to cause the armature 54 to be attracted against the tension of a spring 54ª. After the contacts 52 and 53 have been closed to establish the battery charging circuit including the holding coil 51, slight variations in generator voltage will not permit the spring 54ª to separate the contacts. However if the generator voltage falls below a certain value causing the current to flow from the battery into the generator, the magnetism then produced by the coil 51 will oppose the magnetism of the coils 57 and 57ª thereby permitting the spring to separate the contacts and preventing further discharge of the battery into the generator.

Having described the electrical system for which the present invention is adapted, I will now describe my new vibratory regulator which may be adapted for use as a voltage regulator or as a current regulator in the system shown in Fig. 9. That is to say, my invention provides a construction whereby substantially the same number and kinds of parts may be assembled to form a vibratory voltage regulator or a vibratory current regulator, the only difference being in the magnet coils which surround the coil of the regulator.

Referring now to Figs. 1 to 8 inclusive, the core 39 referred to in the diagram of Fig. 9, is provided with a knurled portion which is surrounded by the windings 31, 36, 37, 37ª, 38, 38ª, all of the windings except the partial turn loop 31 having been wound directly upon the core 39. These windings are located between insulating discs 70 and 71 and are confined between a head 72 of the core 39 and a yoke 73 of a magnetizable frame 74. The core 39 has a threaded extension 75 which receives a nut 76 by which the core and its windings are attached to the frame 74. The threaded extension 75 may be used also in cooperation with a nut 77 to clamp the regulator to a suitable support.

Screws 78 and 79 which pass through plain holes in the branches of the frame 74 and through threaded holes in the legs 80 and 81 of a non-magnetizable bridging member 82, secure the bridging member 82 to the branches of the frame 74. The frame 82 carries a non-conducting plate 83 attached by screws 84 to posts 85 integral with the bridging member 82. A nut 86 secures to the plate 83 a screw 87 and also makes an electrical connection with a leaf spring conductor 88 secured to the plate 83 also by rivets 89. The conductor 88 is attached to a metallic internally threaded bushing 90 which is received by a notch 91 in the plate 83. The bushing 90 receives a screw 92 carrying a contact 93 which is normally engaged by a contact 94 attached to a magnetizable armature plate 95. The armature plate 95 is attached by rivets 96 to a leaf spring hinge plate 97 attached by rivets 98 to a hinge spring bracket 99. The hinge spring bracket 99 is provided with slots 100, each for receiving one of the screws 79 which serve to clamp the bracket 99 against the frame 74 in various positions of vertical adjustment. Motion of the armature plate 95 toward the core head 72 is limited by the armature striking a non-

magnetizable plug 101 attached to the core head 72. The armature 95 is yieldingly urged away from the core head 72 so that the contact 94 normally engages the contact 93 by a spring 105 attached at its upper end to an extension 106 of the armature 95 and at its lower end to an extension 107 of a lever 108 which is pivotally supported upon the frame 74 by a stud 109. The plate 108 is provided with a slot 110 for receiving a screw-driver slotted disc 111 which is pivotally connected with the frame 74 by an eccentric shank 112. By turning the head 111 the lever 108 will be rotated to vary the tension of the spring 105, and the plate is clamped against the frame 74 in the desired position by a screw 113 passing through an arcuate slot 114 in the plate 108 and having threaded engagement with the frame 74.

The spring 105 tends to force the contact 94 upwardly into engagement with the contact 93 and hence tends to bow the spring 88 into the position shown in Figs. 2 and 7, thereby causing the contact 93 to be inclined slightly with respect to the contact 94 and to be out of alignment therewith. As the armature 95 moves toward the core to separate the contacts in the manner described, the contact 93 will move downwardly until the spring 88 will engage at its end the upper surface of the block 83, thereby arresting the downward movement of the contact 93. During this movement there will be a relative sliding motion between the contacts 93 and 94 tending to keep the contacting surfaces relatively clean. This feature insures a clean break of the resistance short circuit each time the contacts separate and helps to insure a dependable action of the regulator as well as longer contact life.

All of the adjustments of the regulator may be performed by the use of a screw-driver. The air gap between the armature and core may be adjusted by turning the screw 92. The spring tension may be adjusted by using a screw driver upon the screw 113 and the slotted disc 111. The hinge plate may be adjusted vertically by first unloosening the screws 79 and then tightening them to clamp the bracket 99 in adjusted position.

Other advantages of the invention result from reduction of the number of parts which is due to utilizing some of the parts in two ways, for example, the bridging member 82, which is used to clamp the branches of the frame 94 in a certain relation to the core head 72, also supports the contact 93. Thus the bridging member serves to hold the contacts 93 and 94 in alignment. The magnet frame and core members serve to electrically connect armature 32 with an external circuit. The screw threaded end 75 of the core may in conjunction with the nut 77 provide the terminal 28 shown in the wiring diagram, with which a wire 27 connecting with a generator terminal 23, is attached. One end of the partial turn loop 31 is attached at 31^a in Fig. 4 to the magnet frame 74, the other end shown at 31^b in Figs. 1 and 3, being connectible with the winding 41 of the regulator 40. One end of the windings 37, 37^a is attached to the frame 74 instead of directly to the armature as shown in the wiring diagram and the other end of these windings is attached to a terminal clip 120 which may be grounded.

The bolt 87 with which the contact 93 is electrically connected is attached by a nut 121 to a terminal clip 122 with which the wire 35 is connected. As shown diagrammatically the wire 35 is connected with one end of the series coil 38, 38^a and with one end of the coil 36. The other end of series coil 38, 38^a is connected with grounded terminal clip 120. The other end of the coil 36 is connected with a terminal clip 123 by which the instrument is adapted to be connected in the short circuit of the regulating resistance as shown in Fig. 9.

The parts of the vibratory regulator which has been described may be assembled for the purpose of constructing the vibratory current regulator 40 shown in the diagram. The only difference between the current regulator and the vibratory voltage regulator is the character of the windings which surround the magnet core and the connections of these windings with the terminals of the instrument. For example, the magnet frame or the threaded extension of the core will provide a terminal for the end of the coil 36 and the end of the coil 46^a, the ends of which are attached to the armature 42 as shown in Fig. 9. The terminal screw 87 will provide a connection for a wire leading to the coil 46 and also a connection for the wire 45 leading to the generator terminal 25.

Therefore the present invention provides for economical production of regulator sets including a vibratory voltage regulator and a vibratory current regulator, since many of the parts are common to both instruments.

While the form of embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. An electromagnetic vibratory regulator comprising, in combination, interrupter contacts, an electromagnet and a vibratory armature operated thereby for intermittently separating the contacts, a tension spring moving the armature away from the magnet, and means for varying the tension of the spring comprising a lever attached to one end of the spring and pivotally supported by the frame of the magnet and screw-driver

operated means for turning the lever and means for clamping the lever to the frame in adjusted position.

2. A regulator according to claim 1 in which the screw-driver operated means is a screw-driver-slotted disc having an eccentric shank pivotally attached to the magnet frame, the disc being eccentrically movable in a slot provided by the lever.

3. An electromagnetic vibratory regulator comprising, in combination, a U-shaped magnet frame, a center core carrying windings supported by the yoke of the frame and extending from the yoke in the direction of the branches of the frame, a non-magnetizable bridge extending from one branch to the other adjacent the ends thereof and the free end of the core to hold the ends of the branches in a certain relation to the free end of the core, an interrupter contact supported by the bridge adjacent the free end of the core and spaced therefrom, an interrupter contact mounted to vibrate between the first contact and the core, an armature supporting the second contact, a hinge for the armature, a hinge bracket having a part adapted to be clamped against one of the branches of the magnet frame, said part having an elongated hole extending substantially parallel to the core, and screws for attaching the bridge to the magnet frame, one of the screws passing through said hole in the hinge bracket in order to secure the hinge bracket in various positions of adjustment parallel to the path of movement of the vibrating contact.

4. An electromagnet vibrating regulator comprising in combination, an electromagnet and a vibrating armature, a leaf spring lever, a screw threaded bushing mounted on the leaf spring lever, a pair of interrupter contacts, one of the contacts mounted on the armature, the other contact adjustably mounted in the screw threaded bushing, and urged against the armature contact by the leaf spring lever, and a spring urging the armature away from the magnet and urging the armature contact against the other contact to cause the leaf spring to bend to thereby cause a rubbing action by one contact upon the other.

5. An electromagnetic regulator comprising, in combination, interrupter contacts, an electromagnet and a spring urged vibratory armature operated thereby for intermittently separating the contacts, an insulated plate having an aperture, a leaf spring lever mounted on said plate, a screw threaded bushing mounted on said lever, said bushing extending through and freely movable in said aperture, one of said contacts being adjustably mounted in the screw threads of said bushing, thereby permitting adjustment of the contact to and away from the armature contact, said lever and armature being so constructed and arranged as to move in opposite directions with respect to their fulcrums when the levers move simultaneously to thereby produce a rubbing action between the contacts.

6. An electromagnetic vibratory regulator comprising, in combination, an electromagnet and a vibratory armature, a bracket adjustably attached to the magnet frame, said bracket supporting the armature, a leaf spring lever; a screw threaded bushing mounted on said lever; a pair of interrupter contacts, of which one is mounted on the armature and the other having threads thereon is adjustably mounted in the screw threaded bushing, a pivoted lever adjustably mounted on the frame of the magnet; a spring for urging the contact in the armature against the other contact, one end of said second spring being attached to the armature, and the other end being attached to the lever so that the tension of the spring is changed by adjusting the lever.

In testimony whereof I hereto affix my signature.

HERMAN L. HARTZELL.