Jan. 5, 1960 T. C. HEATH 2,920,160

REGULATOR

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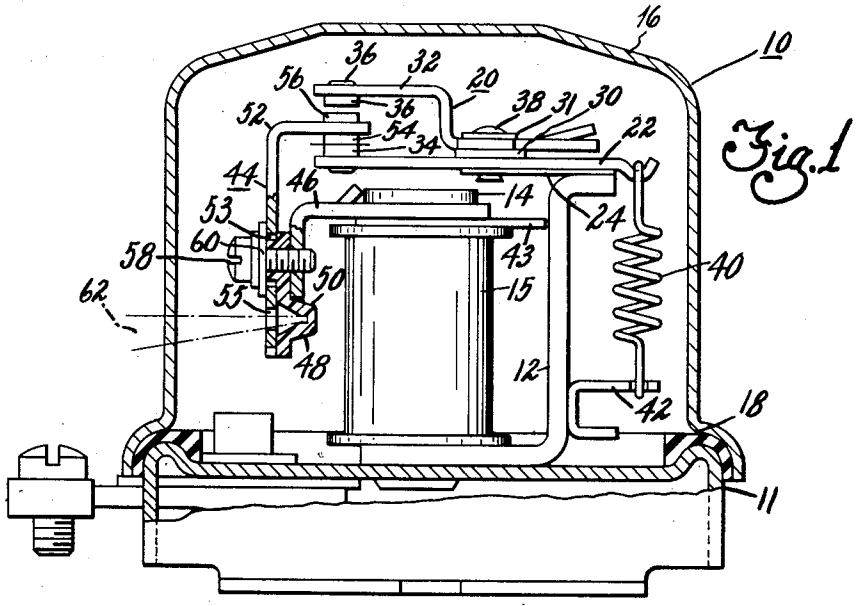

Fig. 1

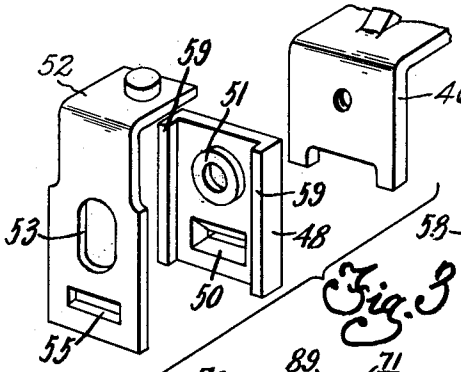

Fig. 3

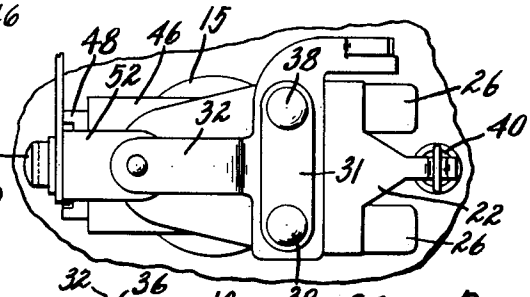

Fig. 2

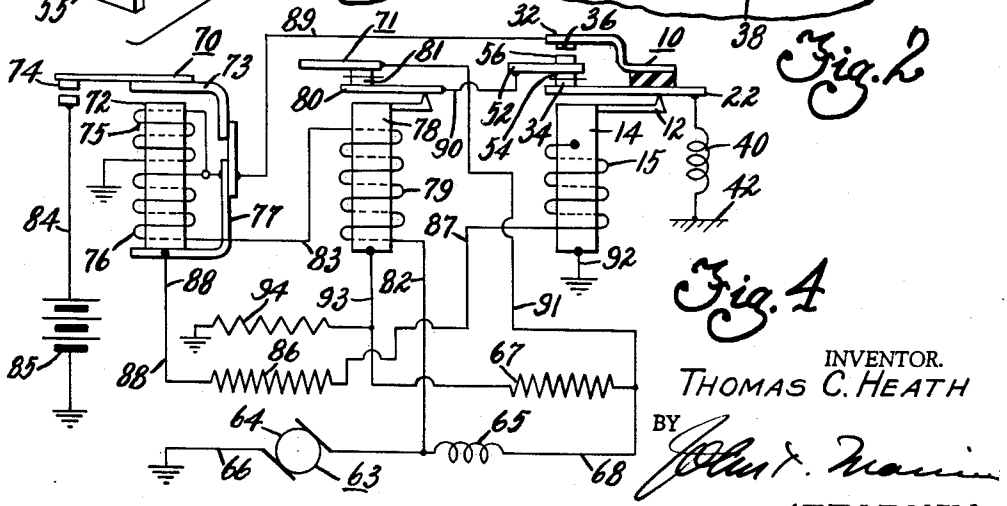

Fig. 4

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REGULATOR

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8 Claims. (Cl. 200—87)

This invention relates to regulators and more particularly to regulators that are used for controlling the battery charging circuit of a motor vehicle.

It is an object of this invention to reduce the cost of manufacture of a regulator by reducing the number of lead wires used in the regulator and by simplifying the internal electrical circuit of the regulator. This object is accomplished by providing a double contact regulator wherein two contacts are fixed to a common movable support and wherein a third relatively fixed contact is interposed between the two contacts for cooperation therewith. The two contacts are insulated from one another and one of the two contacts is electrically connected to the core of the regulator which is at ground potential. The coil winding surrounding the core also has one end connected to the core and thus directly to ground.

It is another object of this invention to provide a simple and fool-proof adjusting mechanism for adjusting the air gap between the armature and core of the regulator. This object is accomplished by providing a contact support for the stationary contact that has an elongated slot, and a tool receiving slot. The contact support is fixed to an extension of the core of the regulator by a threaded fastener that passes through the elongated slot and which is threaded into the core extension. The fastener also passes through an insulator that is interposed between the core extension and the contact support. The insulator has a prying slot that is adopted to receive the end of an adjusting tool. When the threaded fastener is not completely tightened, a prying tool is passed through the tool receiving slot in the contact support to a point where the end of the tool is in the prying slot of the insulator. With one end of the prying tool in the prying slot the contact support may be adjusted relative to the regulator core by engagement of the prying tool with the contact support.

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 embodiment of the present invention is clearly shown.

In the drawing:

Figure 1 is an end view with parts broken away of a regulator made in accordance with this invention.

Figure 2 is a top view of the armature assembly of the regulator shown in Figure 1.

Figure 3 is an exploded view showing the parts that form the fixed contact assembly of the regulator of this invention.

Figure 4 is a circuit diagram of a battery charging circuit that may be employed with the regulator shown in Fig. 1.

Referring now to the drawings and more particularly to Fig. 1 a voltage regulator generally designated by reference numeral **10** is shown. The regulator comprises a metal base **11** that carries a frame **12** and an iron core **14**. The frame **12** and core **14** are riveted or

otherwise secured to the base **11**. A coil **15** is wound on core **14** and has one end electrically connected to core **14** as shown in Fig. 4. The base **11**, frame **12**, and core **14** are all in electrical contact with one another. The base **11** also carries a cover **16** which is spaced from the base by resilient sealing member **18**. The cover is secured to the base by suitable threaded fasteners (not shown). It will be apparent to those skilled in the art that the base **11** may also support a current regulator assembly and a cutout relay assembly to complement the voltage regulator illustrated.

The frame **12** carries an armature assembly generally designated by reference numeral **20**. The armature assembly includes a spring hanger member **22** to which is welded or otherwise secured a member **24** having ears **26**. Member **24** is formed of bimetal material which when heated produces a force on armature assembly **20** directed downwardly toward the core, the magnitude of the force increasing with increasing temperature. The armature assembly further includes electrical insulators **30** and **31**, and a contact support **32**. The spring hanger **22** and contact support **32** carry respectively electrical contacts **34** and **36**. The spring hanger member **22** with attached bimetal member **24**, insulators **30** and **31**, and contact support **32** are held in fixed relationship with one another by rivets **38**.

The armature assembly **20** is secured to the upper end of frame **12** by welding or otherwise securing the ears **26** of bimetal member **24** to the frame. With this arrangement the ears **26** form a pivotal connection for the armature assembly **20** with respect to the frame **12**, the pivot point of the armature assembly being the point of attachment of the ears **26** with the top end of the frame. The armature assembly **20** is biased upwardly in a clockwise direction by a tension spring **40** that has one end looped over the end of spring hanger member **22** and has another end attached to a bracket **42** that is secured to the frame **12**. When the regulator temperature rises due to external or internal heating effects the bimetal member **24** produces a force acting on armature assembly **20** in opposition to the bias of spring **40**. This compensating effect is necessary to compensate for the reduced flux output or ampere turns of coil **15** when the coil temperature rises. The effective ampere-turns of coil **15** are reduced when the coil temperature rises because of the increase in electrical resistance of the coil which reduces the current flow therethrough for a given voltage. The compensating force produced by bimetal member **24** acts against the force of spring **40** and thus less flux is required to attract armature **20** when the bimetal member is heated.

The voltage regulator is also compensated for temperature change by a magnetic shunt member **43** that is suitably secured to core **14** and which extends to a point just short of, or touching frame **12**. The member **43** is formed of a material having a negative temperature coefficient of permeability such as nickel-steel. When the temperature of the shunt member **43** and coil **15** increases, the permeability of shunt member **43** changes to shunt less magnetic flux away from armature assembly **20**. In this manner, the shunt member **43** with its varying coefficient of permeability compensates for changes in temperature. The bimetal **24** and shunt member **43** thus provide for a two-fold method of temperature compensation for the regulator shown.

The fixed contact assembly of the voltage regulator is generally designated by reference numeral **44**. This assembly includes a metal bracket **46** that is press fitted or otherwise secured to core **14**. The assembly further includes an insulator member **48** formed of nylon or the like that is U-shaped in cross section and which has a tool receiving recess **50** and a button **51**. The assembly

also includes a metal contact support 52 that has an elongated opening 53 and a second opening 55. The contact support is slidably fitted between the sidewalls 59 of insulator 48 and carries contacts 54 and 56 that are in electrical contact with support 52 and which are interposed between contacts 34 and 36. The parts of the fixed contact assembly before being secured together are illustrated in Figure 3.

The insulator 48 and contact support 52 are held in the relationship shown in Figure 1 by a screw 58 that is threaded into support 46. The screw is threaded or press fitted in nylon insulator 48 and passes through opening 53. The screw 58 is insulated from contact support 52 by an insulating washer 60 and by button 51. The core 14 is thus electrically insulated from the fixed contacts 54 and 56 by insulator 48 and insulating washer 60. The arrangement just described provides for easy adjustment of the air gap distance between hanger 22 and the top end of core 14.

In order to adjust the contact support 52 upwardly or downwardly to effect the adjustment described, the screw 58 is first backed out slightly to loosen the connection between the insulator 48 and contact support 52. When the connection is thus loosened the end of a tool such as a screwdriver 62 is passed through the slot 55 of contact plate 52 and the end of the screwdriver is fitted into the recess 50 formed in nylon insulator 48. When the screwdriver is so positioned it may be moved upwardly or downwardly with the insulator 48 providing a fulcrum for the screwdriver. The contact plate is not impeded in its adjusting movement by screw 58 because of the clearance provided by opening 53 above and below button 51. The contact support 52 slides between the sidewalls 59 of insulator 48 which guide the support in its movement. The limit of adjustment is reached when the internal walls of opening 53 engage the button 51 on insulator 48.

It will be apparent from the foregoing that a double contacts periodically engage relatively fixed contacts 54 and 36 are insulated from each other and wherein these contacts periodically engage relatively fixed contacts 54 and 56 on contact support 52. The contacts 34 and 54 are normally held in engagement with one another by spring 40 when coil 15 is not energized sufficiently to attract armature 20 against the bias of spring 40. When coil 15 is energized sufficiently to overcome the bias of spring 40 the armature assembly 20 moves downwardly to a point where contact 36 engages contact 56 and contact 34 leaves contact 54. When the regulator is used in the circuit shown in Figure 4 the armature 20 at times vibrates so that contacts 34 and 54 become intermittently engaged and during this vibration the contacts 36 and 56 do not engage. At other times the contacts 34 and 54 are intermittently engaged due to vibrating movement of armature assembly 20 without engagement of contacts 36 and 56. The regulator thus operates by the switching action of either contacts 34 and 54 or by the switching action of contacts 36 and 56 depending upon the energization of coil 15.

A preferred circuit arrangement for use with the voltage regulator described is shown in Figure 4. In this figure, the same reference numerals as those used in Figures 1, 2 and 3 have been used to identify identical parts. As shown in Figure 4 a conventional direct current generator 63 has an armature 64 and a field winding 65. One side of the generator armature is connected directly to ground by lead 66. One side of field winding 65 is connected to an opposite side of armature 64 while the other side of the field winding is connected with a resistor 67 by a lead 68.

The regulating apparatus for the generator 63 shown in Figure 4 includes a conventional cut-out relay generally designated by reference numeral 7, a current regulator generally designated by reference numeral 71, and the voltage regulator 10 described above. The cutout relay includes an iron core 72, an armature 73, switch contacts 74, shunt coil winding 75, series coil winding 76, and a frame designated by reference numeral 77. The current regulator 71 includes iron core 78, series coil 79, armature 80, and contacts 81. The voltage regulator 10 shown in Figure 4 is identical with the regulator shown in Figures 1, 2 and 3.

The contacts 74 of cutout relay 70 are normally held open by resilient means (not shown) in accordance with conventional regulator practice. When a predetermined voltage is impressed across coil 76 the armature 70 is attracted to close contacts 74. The contacts 81 of current regulator 71 are normally held closed by resilient means (not shown). When a predetermined current passes through coil 79 the armature 80 is attracted toward core 78 to open the contacts 81. The voltage regulator 10 operates in the fashion described above.

One side of the armature 64 of generator 63 is directly connected to coil 79 of current regulator 71 by a lead 82. The opposite side of coil 79 is connected to one side of series coil 76 of cutout relay 70 by a lead 83. The opposite side of series coil 76 is connected directly to frame 77 which is in electrical contact with armature 73. The shunt coil 75 of cutout relay 70 is connected between the armature 73 and ground.

The contacts 74 of cutout relay 70 are connected between armature 73 and a lead 84 that is connected to one side of a storage battery 85. The opposite side of the storage battery is connected directly to ground as shown. The charging current for battery 85 passes through lead 82, through coil 79 of current regulator 71, through lead 83, through coil 76, through frame 77, through armature 73, through contacts 74, and through lead 84 to the battery 85. The contacts 74 are maintained open until the generator is producing a predetermined voltage whereupon the energization of coils 75 and 76 pulls the armature down to close contacts 74. The contacts 74 remain closed as long as the generator is operating.

One side of shunt coil 15 of voltage regulator 10 is connected directly to the iron core 14 of regulator 10. The opposite side of coil 15 is connected to one side of resistor 86 by a lead 87. The opposite side of resistor 86 is connected to frame 77 of cutout relay 70 by a lead 88. The armature part 32 of voltage regulator 10 is connected with armature 73 of cutout relay 70 by a lead 89. One of the two contacts 81 of current regulator 71 is connected to the fixed contacts 54 and 56 of voltage regulator 10 by a lead 90 and is also connected with core 78 of current regulator 71. The other contact 81 is connected with lead 68 and resistor 67 by a lead 91. The lower movable contact 34 of voltage regulator 10 is connected to core 14 via frame 12. The core 14 of voltage regulator 10 is connected directly to ground by a lead 92. The side of resistor 67 opposite from the side connected with lead 68 is connected to iron core 78 of current regulator 71 by a lead 93. A regulating resistor 94 is connected between the lead 93 and ground as shown, and thus is connected between core 78 and ground.

It will be observed that the shunt winding 15 of voltage regulator 10 is connected in series with resistor 86 and across the output terminals of the generator 63. This circuit may be traced from armature 64, via line 82, coil 79 of current regulator 71, line 83, series coil 76 of cutout relay 70, frame 77, lead 88, resistor 86, lead 87, coil 15, and through coil 14 to ground. The shunt coil 15 is thus always connected across the armature 64 and responds to the output voltage of the generator.

As noted hereinbefore, the voltage regulator either operates on the lower set of contacts 34 and 54 or on the upper set of contacts 36 and 56. Whether operation is on the upper or lower contacts depends on the amount of load being supplied and upon the speed the armature 63 is driven by the engine of a motor vehicle. When the voltage regulator operates on the lower set of contacts 34 and 54 the armature assembly 20 vibrates to periodi-

cally open and close these contacts. When the voltage across coil **15** is above some predetermined value the armature **20** is attracted to open contacts **34** and **54**. In this position of the armature **20** and spring hanger **22** the field **65** of generator **63** is connected in series with regulating resistor **94** across armature **64** to reduce the field current. This circuit may be traced from armature **64**, through field **65**, via line **68**, line **91**, contacts **81**, core **78** of current regulator **71**, line **93**, and through resistor **94** to ground.

When the voltage across coil **15** falls below some predetermined value the spring **40** closes contacts **34** and **54** against the attractive force of coil **15**. When contacts **34** and **54** are closed the regulating resistor is shorted out and field **65** is connected directly across generator **63** to provide for increased field current. This circuit may be traced from armature **64**, via field **65**, line **68**, line **91**, contacts **81**, line **90**, contacts **54** and **34**, frame **12**, and through core **14** to ground. It is to be noted here that the circuit for field **65** is made directly through core **14** which is grounded and via spring hanger **22** which is in electrical contact with core **14** via frame **12**.

When the voltage regulator is operating on the upper set of contacts **36** and **56** the contacts **36** and **56** are periodically open and closed by vibration of armature **20** and contact support **32**. When the voltage across coil **15** is below some predetermined value the spring **40** holds contacts **36** and **56** open. With contacts **36** and **56** in an open position the resistor **94** is again connected in series with field **65** to provide for a predetermined value of field current. This circuit may be traced via armature **64**, field **65**, line **68**, line **91**, contacts **81**, armature **80**, core **78**, line **93** and through resistor **94** to ground. When the voltage across coil **15** increases the armature **20** and contact support **32** are attracted to close contacts **36** and **56**. This reduces the field current below the value which obtains when contacts **36** and **56** are open by substantially short circuiting the field **65**. It will be appreciated that in either upper or lower contact operation the contacts are made and opened by rapid vibration of armature **20**.

When the current through coil **79** of current regulator **71** exceeds some predetermined value the armature **80** is attracted to open contacts **81**. With contacts **81** in an open position the resistor **67** is placed in series with field **65** across armature **64** to reduce the field current. When the current through coil **79** is at a normal value the contacts **81** remain closed. With contacts **81** closed the resistor **67** is shorted out and the field **65** is connected directly across the armature **64** of generator **63** to increase the field current. The contacts **81** open and close rapidly by vibration of armature **80** when the current regulator is operating.

While the embodiments of the present invention as herein disclosed constitute a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. A regulator comprising, a metal base, a metal frame secured to said base in electrical contact therewith, a metal core member carried by said base in electrical contact therewith, a coil winding on said core having one end thereof connected with said core, a first pair of fixed contacts connected together which are supported by said core and insulated therefrom, an armature assembly including second and third spaced apart contacts that are insulated from each other, means pivotally connecting said armature assembly to said frame with said second and third contacts being located at opposite sides of said first pair of fixed contacts for alternate engagement therewith, and means connecting one of said second and third contacts in circuit with said metal core.

2. A regulator comprising, a base, a coil winding assembly including a core and a coil winding supported by said base, an armature carrying a first contact overlying said core and mounted for pivotal movement with respect to said core, a contact supporting plate formed of current conducting material having a second contact positioned to engage said first contact in one position of said armature, a bracket mounted in fixed relationship to said core, a first elongated slot in said contact supporting plate, a second tool receiving slot in said contact supporting plate spaced from said first slot, an insulator member having a recess, and a threaded fastener passing through the elongated slot in said contact supporting plate and through said insulator member into said bracket, said tool receiving slot in said contact supporting plate and said recess in said insulator being in alignment with one another whereby said contact supporting plate may be moved relative to said insulator and bracket by the prying action of a tool that is adapted to be passed through said tool receiving slot and into said insulator recess.

3. In combination with a regulator having a coil winding assembly that includes a metal core and a coil winding, an armature carrying a first electrical contact located adjacent said core and adapted to be magnetically attracted by said coil winding assembly, said armature being mounted for movement toward and away from said core, a support fixed to said core, an insulator member abutting said support, a metal contact supporting plate having an elongated slot carrying a second electrical contact abutting said insulator with said second contact being located in position to engage said first contact, a fastener passing through said elongated slot and secured to said support, a tool receiving slot in said contact plate, and shoulder means on said insulator located in alignment with said tool receiving slot.

4. Adjusting mechanism for a regulator of the type having an actuating coil and a movable armature that carries a first electrical contact comprising, fixed support means, a contact supporting plate located adjacent said fixed support means and having a second contact positioned to be engaged by said first contact, means for slidably supporting said contact plate for movement relative to said fixed support means, a slot in said contact plate, and shoulder means on said fixed support means in substantial alignment with said slot.

5. A regulator comprising, an actuating coil assembly including a metal core and a coil winding, a first pair of electrical contacts supported by said core, and an armature assembly including second and third contacts secured to and separated by an insulator, mounted for pivotal movement, said second and third contacts being disposed on opposite sides of said first contacts for cooperation therewith.

6. A regulator comprising, a metal base, a frame secured to said base, a core element carried by said base, an armature assembly including a pair of contact supports separated by an insulator pivotally secured to said frame and overlying the top end of said core, first and second contacts carried respectively by said contact supports, a bracket carried by said core, an insulator member abutting said bracket, a metal contact plate carrying a third contact slidably engaging said insulator member, said third contact being disposed between said first and second contacts for engagement therewith, an elongated slot in said contact plate, a threaded fastener passing through said slot having a portion engaging said contact plate and a portion threaded into said insulator member and bracket, a second slot in said contact plate spaced from said elongated slot, and shoulder means on said insulator located in substantial alignment with said second slot whereby a tool may be passed through said second slot and into engagement with said shoulder means for adjusting said contact plate by a prying action with the shoulder means acting as a fulcrum for the tool.

7. A regulator comprising, a base, a coil winding assembly supported by said base and including a core and a coil winding, a frame secured to said base, an armature member carrying an electrical contact, a bimetal spring member secured to said frame and to said armature

member and forming a pivotal connection for said armature with respect to said frame, said bi-metal spring member supporting said armature member in cantiliver fashion over said core, a second spring having a portion fixed with respect to said frame and having a portion connected with said armature member for urging said armature member away from said core, a fixed contact adapted to be engaged by the contact carried by said armature, and a magnetic shunt member formed of material whose permeability changes with temperature supported by said core and extending toward said frame.

8. A regulator comprising, a base, a frame supported by said base, an actuating coil assembly including a core and a coil winding supported by said base, an armature assembly pivotally supported by said frame and overlying said core, said armature assembly including first and second spaced arms each carrying an electrical contact, an insulator positioned between said arms for electrically insulating one arm from the other, a pair of electrical contacts connected together and positioned

between the contacts on said arms for cooperation therewith when said armature assembly moves, spring means biasing the armature assembly away from said core and urging the contact on one of said arms into engagement with one of said pair of contacts, and adjustable means for supporting said pair of contacts from said core.

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