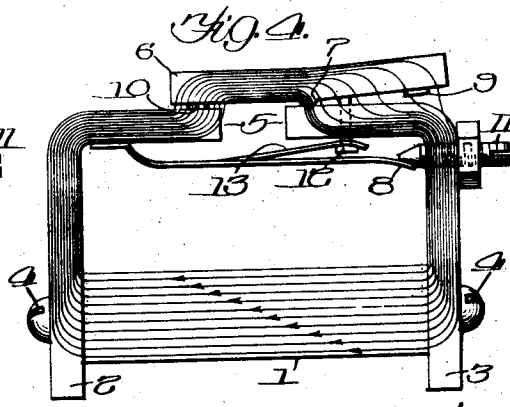
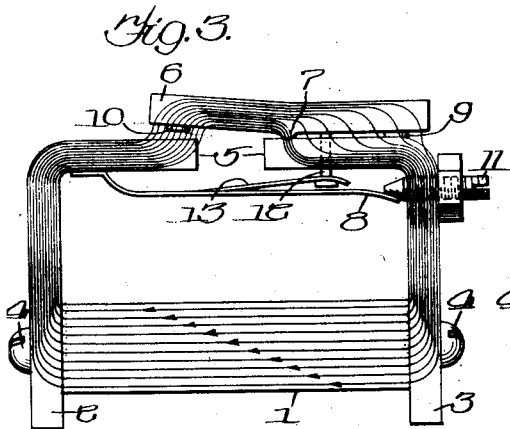
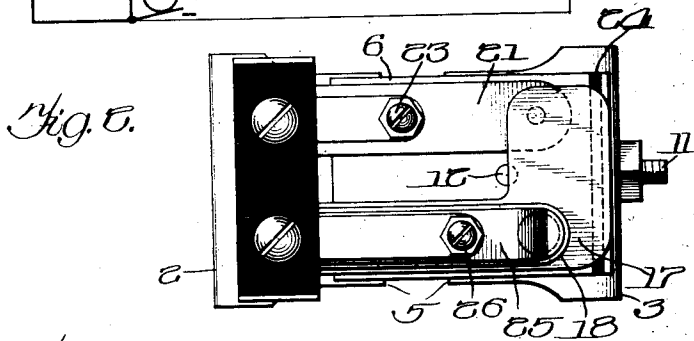
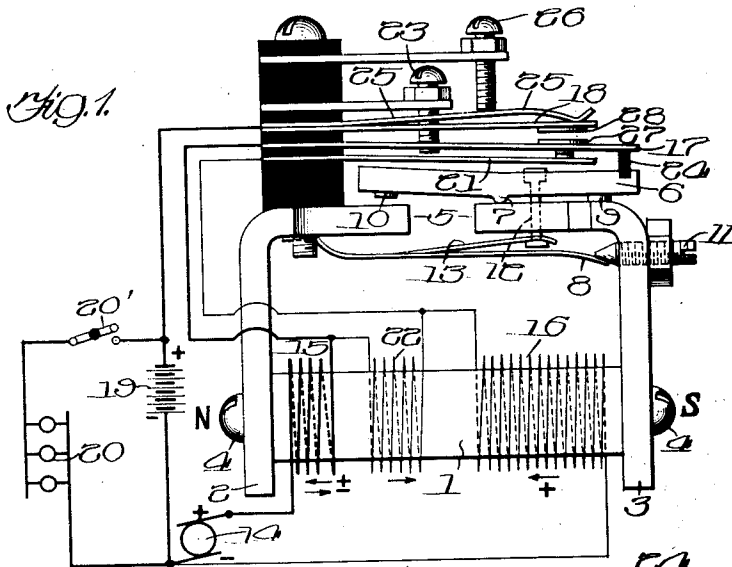


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ELECTRIC CURRENT CONTROLLING APPARATUS.  
APPLICATION FILED MAY 10, 1913.

1,108,320.

Patented Aug. 25, 1914.



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# UNITED STATES PATENT OFFICE.

ALBERT E. BERDON, OF INDIANAPOLIS, INDIANA.

ELECTRIC-CURRENT-CONTROLLING APPARATUS.

1,108,320.

Specification of Letters Patent.

Patented Aug. 25, 1914.

Application filed May 10, 1913. Serial No. 766,874.

*To all whom it may concern:*

Be it known that I, ALBERT E. BERDON, citizen of the United States, residing at Indianapolis, in the county of Marion and State of Indiana, have invented a certain new and useful Improvement in Electric-Current-Controlling Apparatus, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to apparatus for controlling electric circuits and has a number of objects and advantages in view.

The apparatus of my invention is effective in closing a main working circuit at a predetermined minimum voltage. The working circuit may, if desired, also be maintained closed as long as any current is flowing in the positive or normal direction, opening of the working circuit being permitted at a time when the current is of zero value or is very slightly reversed. If desired, the working circuit may be also opened when the current reaches a predetermined minimum value in the positive or normal direction. It need not be essential to have the current reversed in order to open the main working circuit switch contacts, though it is to be understood that the apparatus is to be adjusted to have these contacts open when the current reaches any predetermined value in the normal or positive and reverse directions. The apparatus may be adjusted to open the main or working circuit quickly and positively, when such opening is to be occasioned by reverse current, by permitting such reversed current to reduce the effective magnetism in the magnetic circuit of the circuit controlling magnet. The magnet which I employ is desirably that disclosed in my co-pending application Serial No. 766,873, filed of even date herewith.

I will explain my invention more fully by reference to the accompanying drawing showing the preferred embodiment thereof and in which—

Figure 1 is a diagrammatic view illustrating the invention; Fig. 2 is a plan view of some of the structural parts illustrated in Fig. 1; and Figs. 3 and 4 are diagrams illustrating the magnetic flux.

Like parts are indicated by similar char-

acters of reference throughout the different figures.

Referring first particularly to Figs. 3 and 4, I will first describe the magnet which preferably constitutes a part of the equipment. This magnet preferably includes no permanent magnet in its formation, the winding core 1 being preferably of soft un-laminated iron having soft iron polar extensions 2 and 3 secured to its ends by means of screws 4, these soft iron polar extensions extending laterally of the core for a sufficient distance upon each side of the core to afford proper limits to the magnet winding space and each being inturned in approaching directions upon one side of the core as indicated at 5, a suitable gap intervening between the inturned polar extension ends there to constitute a gap in the magnetic circuit. This gap is bridged by a soft iron armature 6 whose lower face is formed with a rounded fulcrum ridge 7 affording a rolling contact between the armature and one of the polar extensions 3 upon which the armature is supported adjacent the gap between the polar extensions. The fulcrum ridge 7 is located substantially midway between the ends of the armature 6 whereby the armature is caused preferably to overlie substantially all of the inseting extension of the polar extension 3 upon which the armature is mounted, the other end of the armature overlying a sufficient portion of the inseting extension of the other polar extension 2 to enable the proper passage of the magnetic flux. In the absence of sufficient tractive effort between the polar extension 2 and the armature 6, a spring 8 operates to draw the right hand end of the armature downwardly until the non-magnetic stop 9 engages the polar extension 3. When the magnetic attraction is sufficient, the force of the spring 8 is overcome to move the armature in a counterclockwise direction, the extent of movement in this direction being limited by a stop 10 of non-magnetic material adapted for engagement with the polar extension 2. The force of the spring is regulated by a horizontally adjustable screw 11 working upon the adjacent and inclined end of the spring 8. The spring operates upon the armature through the intermediation of the strut 12 swingingly connected at its upper end with the

armature and at its lower end with a spring tongue 13 projecting upwardly from and being integrally formed with the spring 8.

The flux set up within the magnetic circuit established by the elements 1, 2, 3, 6 and 7 is diagrammatically indicated in Figs. 3 and 4 by the flux lines having the arrow heads pointing a direction of flux. The fulcrum ridge 7 is integrally formed with the armature 6 and has magnetic contact with the polar extension 3, the lines of force having one distribution at the armature when the armature is unattracted and another distribution when the armature is attracted, the portions of the lower armature face being desirably angularly related to permit the armature to swing and to permit the flux to change its distribution to control the movement of the armature. When the armature is unattracted the flux upon the right of the fulcrum 7 is substantially evenly distributed between the polar extension 3 and the right hand portion of the armature but when the armature is magnetically shifted in position the air gap between the armature and the polar extension supporting the same will flare toward the right, this flaring progressively increasing as the armature continues to move in response to its magnetic attraction whereby the magnetic reluctance at its right hand air gap increases and progressively increases toward the right hand limit of the armature so as to effect a progressively increasing concentration of the lines of force toward and at the fulcrum ridge thereby progressively to reduce the magnetic pull upon the right hand end of the armature as the armature is moving to its magnetically attracted position whereby the flux across the air gap at the left hand end of the armature, as it is progressively shortened, may cause the more rapid positive closing movement of the armature, the magnetic opposition to such closing movement at the right hand end or the armature being rapidly and progressively decreased as will be understood for reasons above explained and owing also to the lengthening of the portions of the lines of force that span the progressively increasing air gap at the right hand end of the armature. Thus all the flux traverses the gap at the left hand end of the armature while the portion which traverses the gap at the right hand end of the armature progressively decreases as this latter gap is widened, a result which is rendered possible owing to the reduction of magnetic reluctance at 7 where a path is afforded for increasing flux diverted therethrough owing to the increasing reluctance at the right of the armature. In other words there is but one flux path at the left of the armature and there are two flux paths at the right hand portion of the armature, one of these latter

two flux paths including the fulcrum 7 and the other including the right hand air gap, these two flux paths thus being in shunt relation with each other and each in serial relation with the path at the left hand air gap, more flux being diverted through the first of these two shunt related paths from the second of such paths as the right hand air gap increases and more being diverted through the second of such paths from the first as this right hand air gap decreases. The spacing intervening between the fulcrum 7 and the left hand air gap is selected to enable the flux there to effect magnetic attraction as desired, the sum of the lines of force at the left hand air gap multiplied by their respective distances from the fulcrum 7 quickly becoming greater than a similar summation at the right hand air gap when the armature is being magnetically attracted. As soon as the armature moves the slightest owing to magnetic attraction a redistribution of the flux along the lines above set forth is immediately commenced and rapidly continues to insure a rapid and complete closing stroke of the armature after the initial unbalancing of the flux at the opposite ends of the armature occurs, the tendency of the armature 6 to continue the entire stroke upon which it has commenced being so strong that it will take its full movement even though the initial magnetizing force required to start the movement be largely reduced. The strip metal springs 17 and 18 carry disk-shaped contacts 27, 28, the strip metal spring 25 engaging the spring 18 near the outer peripheral portion of the disk contact 28 for the purpose of so flexing the spring 18 as to enable the opposing faces of the contacts 27 and 28 to be in exact parallelism when the contact 27 is on the point of application to the contact 28 when the spring 17 carrying contact 27 is moved upwardly by the armature through the intermediation of the insulating post 24, whereby the adjacent faces of these contacts are initially in engagement throughout to prevent undue introduction of resistance at this point of contact. The stop 26 is adjustable to enable the spring 18 to be properly initially positioned, the stop 26 operating upon the spring 18 through the spring 25. The spring 17 carries a lower contact engaging a normal contact upon the spring 21. An adjustable post 23 limits the extent to which the spring 21 may be flexed upwardly due to its own resilience when the spring 17 is lifted.

Referring now also to Figs. 1 and 2, a suitably driven direct current generator 14 of low voltage, say six volts, is in serial relation with the current coil 15 disposed about the core 1 and of comparatively few turns and negligible resistance, wound in such direction that current in the normal or

desired direction tends to produce flux in a direction corresponding to the flux set up by the pressure winding 16 (which is also disposed about the core 1 but normally in shunt of the elements 14 and 15) when the voltage is of normal or desired polarity, this condition being indicated by the arrow immediately beneath the coil 15 and the arrow beneath the coil 16 that indicate the direction of flux in the magnetic circuit afforded by the elements 1, 2, 3 and 6. The volt coil 16 is high wound with reference to the coil 15 and is designed to withstand full potential of the source of current being controlled without injurious heating. The coils 15 and 16 are cumulatively wound assuming the voltage to be of normal polarity. The coil 15 is included in a circuit that contains spring 17, spring 18 and a battery 19 which may be a three cell, six volt storage battery adapted to supply a number of six volt lamps or other load 20 with current when the switch 20<sup>1</sup> is closed, the generator 14 being included in the circuit that contains said spring 18 and battery 19. The shunt path including the pressure winding 16 is multiplied from the left hand terminal of the winding 16, one of these multiplied paths including the normal follow-up spring contact 21 and the spring 17 followed by contact 21 and the other including the winding 22, (normally short circuited by springs 17 and 21), the shunt connection effected for the coil 16 with the winding 15 by way of the coil 22 being permanent while the shunt connection of the coil 16 with the coil 15 through the springs 17 and 21 is adapted to be made and broken at these springs due to the operation of the magnet.

In describing the operation of the apparatus let it be assumed that the generator 14 is started from rest and gradually increases to its maximum speed. The generator voltage rises from zero as the generator speed increases and a circuit is initially present traceable from the positive brush of the generator through the series coil 15, the spring 17, the spring 21, the high wound voltage coil 16, to the negative generator brush.

Another circuit is initially present and may be traced from the positive brush of the generator 14 through the series winding 15 the resistance coil 22, the high wound voltage coil 16, to the negative brush of the generator. In this condition of things the normally engaged contacts of the springs 17 and 21 short circuit the coil 22, this condition remaining until the voltage of the generator rises to a predetermined value (in the example chosen say 6.8 volts by way of illustration) whereupon the magnetic flux at the left hand end of the armature 6 overcomes the flux at the right hand end of the armature and the supplementing pull of spring 8 exerted upon the armature through

the strut 12 to which may be added that portion of the pressure of the spring 17 which is not counterbalanced by the upward pressure of the spring 21. The movement of the armature 6 is positive and rapid, for the reasons herein pointed out, the armature completing its full stroke even though the force required to move it magnetically be greatly reduced. When the armature is magnetically moved it first causes engagement between springs 17 and 18 and thereafter causes the engagement between the springs 17 and 21 to be broken, the contacts of these latter springs being "follow-up contacts." Altered circuit conditions are now consequent, one circuit being traceable from the positive brush of the generator 14 through the series coil 15, the resistance coil 22, the voltage coil 16, to the negative brush of the generator, the short circuit about the coil 22 having been broken owing to the separation of the springs 17 and 21. The coil 22 now in shunt of the generator by way of coil 16 and also introduced into circuit with the coil 15, being differentially wound with respect to the coils 15 and 16, reduces the magnetizing effect of the coils 15 and 16 upon the core 1 so that if there be no current, or current of minimum value in the normal direction, or small current in an abnormal or negative direction, (according to the adjustment of the equipment) flowing in the coil 15 the spring 8 will be effective to retract the armature to its normal magnetically unattracted position. In practice this reduction of the magnetizing effect of the coil 16 amounts to forty or fifty per cent., this reduction being largely accomplished by reducing the current through the coil 16 by virtue of the ohmic resistance of coil 22 and being partly accomplished by the reduction of the effective ampere turns on core 1 by virtue of the opposing directions of current in the coils 22 and 16. The function effected by the ohmic resistance of the coil 22 is obviously accomplished whether this coil be in or out of magnetizing relation to the core 1, and this aspect of the invention is not to be limited to the winding of the coil 22 upon the core 1. The opposing magnetomotive force set up by the coil 22 is a factor which is not necessarily dependent upon the ohmic resistance of the coil 22 and this aspect of the invention is not to be limited to a high resistance for the coil 22 when it is in magnetizing relation to the core 1.

By my equipment there are obtained operating losses which are low and high over-voltage protection and also that which is of utmost importance, namely, the separation of the springs 17 and 18 when the current has been reduced to zero or the minimum or say a very small reverse value, according to the adjustment of the equipment, the

contacts being thus protected from arcing. The generator is also rendered safe from having its fields reversed due to the big reversed currents flowing in the series winding from the battery possible in some outfits.

In the magnetically unattracted (or spring actuated) position of the armature 6 with the voltage below 6.8; the generator cannot send any current through the working circuit although the battery can send 10 current through such circuit if the switch 20<sup>1</sup> be closed. With the armature in its magnetically attracted position a circuit may be traced from the positive brush of the 15 generator 14 through the series coil 15, the springs 17 and 18 (the spring portion 25 also being included in this circuit, it being in parallel with the spring 18) the positive terminal of the battery 19, the negative terminal of this battery, to the negative brush 20 of the generator. Upon increase of the generator speed beyond the speed required to impress 6.8 volts, the voltage is kept down to that of the battery voltage plus the "resistance times current" (I. R. drop) of the 25 series coil 15 and the line wiring, the main contacts remaining closed for all positive values or all predetermined positive values of current. As the speed of the generator 30 reduces gradually current through the battery reduces until the generator voltage and battery voltage are equal, at which time no current will flow to the main circuit. If the controller is properly set by the adjustment 35 of the screw 11 upon the spring 8, the armature will then open and return to its original position, it being assumed that the apparatus is to be adjusted thus to operate when there is no current flowing. In practice it has been found advantageous to enable the apparatus to operate at zero current or at one-quarter to one-half ampere maximum reverse current. When the armature begins to move to its original magnetically unattracted position it quickly 45 makes the entire stroke, contact between the springs 17 and 21 being made before contact between the springs 17 and 18 is broken. By way of example but in no wise limiting 50 the scope of the invention, values and dimensions may be assigned as follows: Current coil 15, negligible resistance, may include eighteen turns of No. 12 (Brown & Sharpe gage) copper wire. Resistance 55 winding 22 may be of twenty-two ohms resistance and have forty-four turns No. 27 "Ideal" wire. Pressure winding 16 may be of seventeen ohms having nine hundred twenty-five turns No. 29 D. C. C. copper 60 wire.

In the equipment illustrated it is possible to have current through the coil 15 reverse in direction while current in coil 16 remains in its direction, a result that would follow if spring 65 8 were set so weak that a reduction of line

voltage below battery voltage would not cause contacts 27, 28 to open, reverse current consequently flowing through the coil 15 while the voltage impressed upon the coil 16 remains normal for any value of positive 70 line voltage. The coils 15 and 16 are spoken of as being cumulatively wound and the coil 22 is said to be differential to the former coils, considering the normal relationship of the generator 14 to said winding, though 75 it is to be understood that I do not limit myself to resistance 22 which also acts as a magnetizing coil nor to a magnetizing coil which also acts as a resistance, its general purpose being to oppose the coil 16 either 80 by opposing ampere turns to the ampere turns furnished by the coil 16 or by reducing the ampere turns of the coil 16 owing to the ohmic resistance of the element 22, these two functions being both accomplished 85 by the same element 22 in the preferred embodiment of the invention.

While I have herein shown and particularly described the preferred embodiment of my invention I do not wish to be limited 90 to the precise construction and circuit arrangement shown as changes may readily be made without departing from the spirit of my invention, but

Having thus described my invention I 95 claim as new and desire to secure by Letters Patent the following:—

1. An electric current controlling device and an electric circuit controlled thereby, which circuit has a current supplying generator, said device including an electro-magnet having an energizing current winding receiving current from the controlled circuit, an energizing pressure winding subject to the pressure of such circuit, these two windings being cumulatively wound, and a third energizing winding of high resistance compared with the first energizing winding and differentially wound with respect to the aforesaid windings; and a switch having a 110 contact actuated by the magnet and serially in the controlled circuit, a normal follow-up contact engaging the first contact and by which follow-up contact the second winding is included in shunt of the generator, and an 115 alternate contact serially in the controlled circuit and engaged by the first contact before the first contact leaves its normal follow-up contact, the first two contacts having circuit association causing them, by their engagement, to shunt the third winding from the remaining windings and by their separation to bring the third winding in shunt of the generator by way of the second winding, while the latter two contacts, by their engagement, serve to establish the controlled 125 circuit.

2. An electric current controlling device and an electric circuit controlled thereby, which circuit has a current supplying gener- 130

ator, said device including an electro-magnet having an energizing current winding receiving current from the controlled circuit, an energizing pressure winding subject to the pressure of such circuit, these two windings being cumulatively wound, and a third energizing winding differentially wound with respect to the aforesaid windings; and a switch having a contact actuated by the magnet and serially in the controlled circuit, a normal follow-up contact engaging the first contact and by which follow-up contact the second winding is included in shunt of the generator, and an alternate contact serially in the controlled circuit and engaged by the first contact before the first contact leaves its normal follow-up contact, the first two contacts having circuit association causing them, by their engagement, to shunt the third winding from the remaining windings and by their separation to bring the third winding in shunt of the generator by way of the second winding, while the latter two contacts, by their engagement, serve to establish the controlled circuit.

3. An electric current controlling device and an electric circuit controlled thereby, which circuit has a current supplying generator, said device including an electro-magnet having an energizing current winding receiving current from the controlled circuit, and an energizing pressure winding subject to the pressure of such circuit, these two windings being cumulatively wound; a resistance that is high compared with the first aforesaid winding; and a switch having a contact actuated by the magnet and serially in the controlled circuit, a normal follow-up contact engaging the first contact and by which follow-up contact the second winding is included in shunt of the generator, and an alternate contact serially in the controlled circuit and engaged by the first contact before the first contact leaves its normal follow-up contact, the first two contacts having circuit association causing them, by their engagement, to shunt the resistance from the windings and by their separation to bring the second winding in shunt of the generator by way of the resistance, while the latter two contacts, by their engagement, serve to establish the controlled circuit.

4. An electric current controlling device and an electric circuit controlled thereby, which circuit has a current supplying generator, said device including an electro-magnet having an energizing current winding receiving current from the controlled circuit, an energizing pressure winding subject to the pressure of such circuit, these two windings being cumulatively wound, and a third energizing winding of high resistance compared with the first energizing winding and differentially wound with respect to the aforesaid windings; and a switch operable

by the electro-magnet and serving, when unactuated by the magnet, to open the controlled circuit and exclude the third winding from circuit relation with the first two windings and when actuated by the magnet to close the controlled circuit and bring the third winding in shunt of the generator by way of the second winding.

5. An electric current controlling device and an electric circuit controlled thereby, which circuit has a current supplying generator, said device including an electro-magnet having an energizing current winding receiving current from the controlled circuit, an energizing pressure winding subject to the pressure of such circuit, these two windings being cumulatively wound, and a third energizing winding differentially wound with respect to the aforesaid windings; and a switch operable by the electro-magnet and serving, when unactuated by the magnet, to open the controlled circuit and exclude the third winding from circuit relation with the first two windings and when actuated by the magnet to close the controlled circuit and bring the third winding in shunt of the generator by way of the second winding.

6. An electric current controlling device and an electric circuit controlled thereby, which circuit has a current supplying generator, said device including an electro-magnet having a swinging armature bridging the gap between two spaced apart portions of the magnetic circuit of the magnet and swingingly mounted between its ends at one of said magnetic circuit portions to form therewith shunt related flux paths each serially related with the flux path furnished by the other magnetic circuit portion and the remaining portion of the armature, a current winding supplied with current from said current supplying generator, and a pressure winding receiving pressure from said current supplying generator, and a switch operable by the armature of the electro-magnet and in controlling relation to said current.

7. An electric current controlling device and an electric circuit controlled thereby, which circuit has a current supplying generator, said device including an electro-magnet having an energizing current winding receiving current from the controlled circuit, an energizing pressure winding subject to the pressure of such circuit, these two windings being cumulatively wound, and a third energizing winding of high resistance compared with the first energizing winding and differentially wound with respect to the aforesaid windings; and a switch having a contact actuated by the magnet and serially in the controlled circuit, a normal follow-up contact engaging the first contact and by which follow-up contact the second winding is included in shunt of the generator, and an

alternate contact serially in the controlled circuit and engaged by the first contact before the first contact leaves its normal follow-up contact, the first two contacts having circuit association causing them, by their engagement, to shunt the third winding from the remaining windings and by their separation to bring the third winding in shunt of the generator, while the latter two contacts, by their engagement, serve to establish the controlled circuit.

8. An electric current controlling device and an electric circuit controlled thereby, which circuit has a current supplying generator, said device including an electro-magnet having an energizing current winding receiving current from the controlled circuit, an energizing pressure winding subject to the pressure of such circuit, these two windings being cumulatively wound, and a third energizing winding differentially wound with respect to the aforesaid windings; and a switch having a contact actuated by the magnet and serially in the controlled circuit, a normal follow-up contact engaging the first contact and by which follow-up contact the second winding is included in shunt of the generator, and an alternate contact serially in the controlled circuit and engaged by the first contact before the first contact leaves its normal follow-up contact, the first two contacts having circuit association causing them, by their engagement, to shunt the third winding from the remaining windings and by their separation to bring the third winding in shunt of the generator, while the latter two contacts, by their engagement, serve to establish the controlled circuit.

9. An electric current controlling device and an electric circuit controlled thereby, which circuit has a current supplying generator, said device including an electro-magnet having an energizing current winding receiving current from the controlled circuit, and an energizing pressure winding subject to the pressure of such circuit, these two windings being cumulatively wound; a resistance that is high compared with the first aforesaid winding; and a switch having a contact actuated by the magnet and serially in the controlled circuit, a normal follow-up contact engaging the first contact and by which follow-up contact the second winding is included in shunt of the generator, and an alternate contact serially in the controlled circuit and engaged by the first contact before the first contact leaves its normal follow-up contact, the first two contacts having circuit association causing them, by their engagement, to shunt the resistance from the windings and by their separation to include the resistance in series with the second winding and in shunt of the generator, while the latter two contacts, by their engagement, serve to establish the controlled circuit.

10. An electric current controlling device and an electric circuit controlled thereby, which circuit has a current supplying generator, said device including an electro-magnet having an energizing current winding receiving current from the controlled circuit, an energizing pressure winding subject to the pressure of such circuit, these two windings being cumulatively wound, and a third energizing winding of high resistance compared with the first energizing winding and differentially wound with respect to the aforesaid windings; and a switch operable by the electro-magnet and serving, when unactuated by the magnet, to open the controlled circuit and exclude the third winding from circuit relation with the first two windings and when actuated by the magnet to close the controlled circuit and bring the third winding in shunt of the generator.

11. An electric current controlling device and an electric circuit controlled thereby, which circuit has a current supplying generator, said device including an electro-magnet having an energizing current winding receiving current from the controlled circuit, an energizing pressure winding subject to the pressure of such circuit, these two windings being cumulatively wound, and a third energizing winding differentially wound with respect to the aforesaid windings; and a switch operable by the electro-magnet and serving, when unactuated by the magnet, to open the controlled circuit and exclude the third winding from circuit relation with the first two windings and when actuated by the magnet to close the controlled circuit and bring the third winding in shunt of the generator.

12. An electric current controlling device and an electric circuit controlled thereby, which circuit has a current supplying generator, said device including an electro-magnet having a swinging armature bridging the gap between two spaced apart portions of the magnetic circuit of the magnet and swingingly mounted between its ends at one of said magnetic circuit portions to form therewith shunt related flux paths each serially related with the flux path furnished by the other magnetic circuit portion and the remaining portion of the armature, and a pressure winding receiving pressure from said current supplying generator; and a switch operable by the armature of the electro-magnet and in controlling relation to said circuit.

13. An electric current controlling device and an electric circuit controlled thereby, which circuit has a current supplying generator, said device including an electro-magnet having an energizing current winding receiving current from the controlled circuit, and an energizing pressure winding subject to the pressure of such circuit, these two

windings being cumulatively wound; a resistance that is high compared with the first aforesaid winding; and a switch having a contact actuated by the magnet and serially in the controlled circuit, a normal follow-up contact engaging the first contact and by which follow-up contact the second winding is included in shunt of the generator, and an alternate contact serially in the controlled circuit and engaged by the first contact before the first contact leaves its normal follow-up contact, the first two contacts having circuit association causing them, by their engagement, to shunt the resistance and by their separation to include the resistance in series with the first winding, while the latter two contacts, by their engagement, serve to establish the controlled circuit.

14. An electric current controlling device and an electric circuit controlled thereby, which circuit has a current supplying gen-

erator, said device including an electro-magnet having a swinging armature bridging the gap between two spaced apart portions of the magnetic circuit of the magnet and swingingly mounted between its ends at one of said magnetic circuit portions to form therewith shunt related flux paths each serially related with the flux path furnished by the other magnetic circuit portion and the remaining portion of the armature, and a current winding supplied with current from said current supplying generator; and a switch operable by the armature of the electro-magnet and in controlling relation to said circuit.

In witness whereof, I hereunto subscribe my name.

ALBERT E. BERDON.

Witnesses:

A. J. WEBER,  
E. C. BROMMER.