(No Model.) 2 Sheets—Sheet 1.

T. VON ZWEIGBERGK.

CONTROLLER CIRCUIT BREAKER.

No. 590,813. Patented Sept. 28, 1897.

Fig. 2.

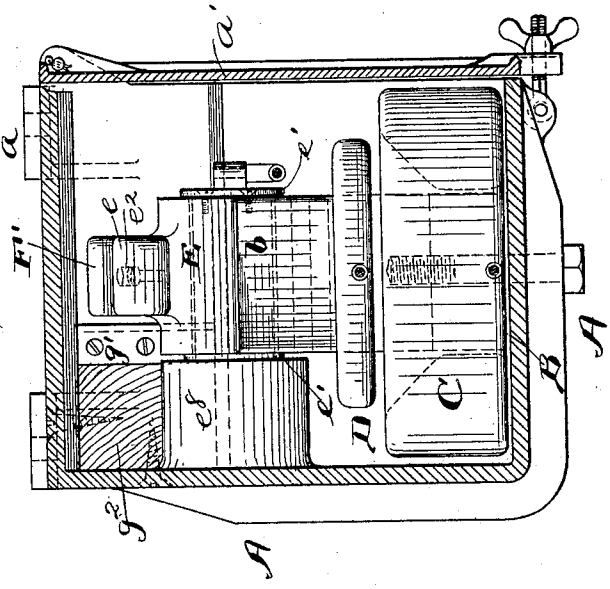
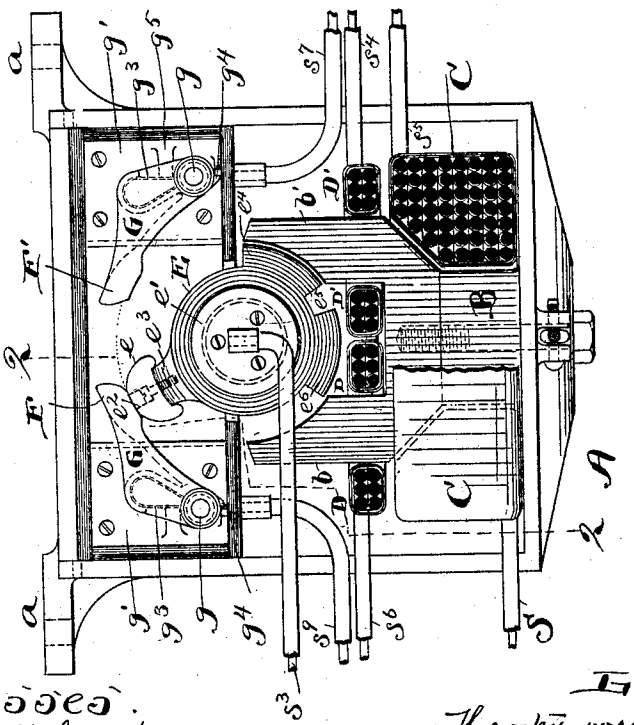


Fig. 1.



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(No Model.) 2 Sheets—Sheet 2.

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CONTROLLER CIRCUIT BREAKER.

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Fig. 3.

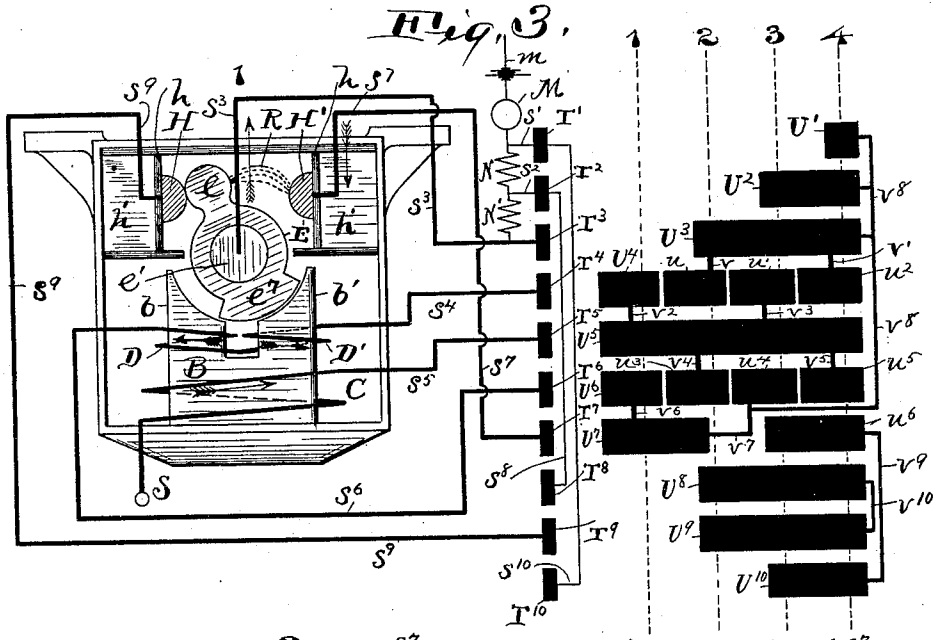


Fig. 4.

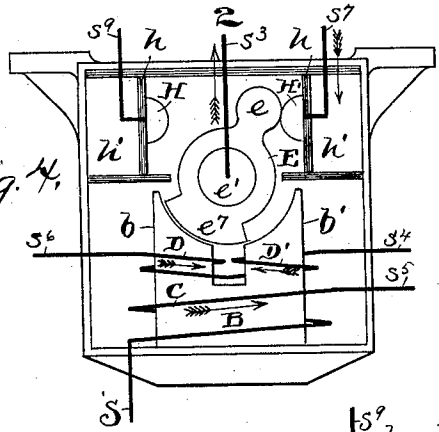


Fig. 5.

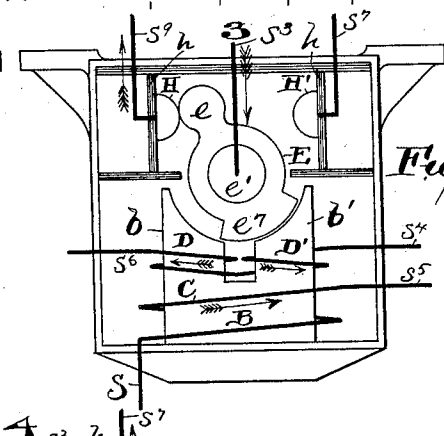
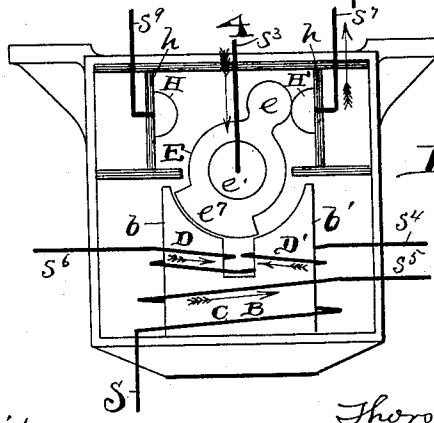


Fig. 6.



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UNITED STATES PATENT OFFICE.

THORSTEN VON ZWEIGBERGK, OF CLEVELAND, OHIO, ASSIGNOR TO THE WALKER COMPANY, OF SAME PLACE.

CONTROLLER CIRCUIT-BREAKER.

SPECIFICATION forming part of Letters Patent No. 590,813, dated September 28, 1897.

Application filed March 15, 1897. Serial No. 627,592. (No model.)

To all whom it may concern:

Be it known that I, THORSTEN VON ZWEIGBERGK, a subject of the King of Sweden and Norway, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented a certain new and useful Improvement in Controller Circuit-Breakers; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The object of my invention is to provide simple and effective means for transferring the sparking resulting from breaking a contact from a controller-cylinder, where this sparking is harmful, to some point where it is innocuous. The sparking in the controller wears away the contact plates and fingers and thus rapidly destroys the controller. The spark sometimes causes the current to arc over from a contact-plate to its finger, and thereby defeats the operator's control of his motor.

My invention obviates the spark at the controller and establishes it between surfaces so large or so easily replaced that it becomes immaterial—surfaces which can separate far enough to destroy all probability of an arc forming between them.

The invention consists of a magnetic switch adapted to be used in conjunction with a controller and operated by a current governed by the controller, which forms a shunt around the controller-contacts and after that contact has become broken by the movement of the controller-cylinder is itself opened by a further controller movement, and thereby breaks the circuit between points where the resulting spark is harmless and where the chance of forming an arc is minimized.

The combinations of parts hereinafter specified and definitely enumerated in the claims also disclose wherein the invention consists; but I do not wish to be understood as limiting myself to the particular construction specified further than those claims indicate.

The drawings clearly illustrate my invention and its method of operation.

Figure 1 is an elevation of the circuit-breaker and its case with the case-door removed. Fig. 2 is a vertical transverse section of the same, being taken on the line 2 2 of Fig. 1. Fig. 3 is a somewhat diagrammatic elevation of the same, being embodied in a cheaper form. This figure indicates also the contact-fingers of the controller and the development of the controller-cylinder. The movable part of the switch is shown in the position it occupies when the contact-fingers are in the position of contact indicated by the broken line marked 1 in the right-hand portion of said figure. Figs. 4, 5, and 6 are similar diagrammatic elevations of the magnetic switch for the contact positions indicated by the lines 2, 3, and 4, respectively, on the cylinder development in Fig. 3.

Similar letters of reference designate similar parts of each figure.

Referring to the parts by letter, A represents a box, preferably of an approximately cubical shape. This box is made of cast-iron or other desired material, and has feet *a* at its upper corners, by which it is hung from beneath a car or other support. A suitable door *a'* closes the box. In the interior of the box, projecting upward from its bottom, is the magnet-core B. This core may be cast integral with the box or otherwise carried by it, as desired. Secured to the core, preferably by bolting, is a pole-piece having the furcations *b* and *b'*. Field-coils C surround the magnet-core. Smaller coils D and D' surround the furcations *b* and *b'*, and these, because of their operation, I designate "armature-coils."

E is a metallic armature oscillatably journaled in proper relation to the pole-faces, being preferably sleeved around a large stud *e'*, projecting from a boss e^8, carried by the case. The winding of the field-coils C is continuous, while the windings on the two pole-pieces are opposed to each other, as indicated by the arrows in Fig. 3, for example. If now a direct current flows through the field-coils and armature-coils, the current around one of the pole-pieces, as *b'*, will be the same as that about the core B, while the current around the other pole-piece, as *b*, will be opposite to that around the core B. The result is that the magnetism which would be caused in the pole-piece *b* by the field-coils is overcome, while the magnetism of the pole-piece

b' is increased. The armature is therefore attracted by the pole-piece b' and oscillates toward it. If the current through the armature-coils is reversed, the pole-piece b' will be demagnetized and the pole-piece b energized by both field and armature coils, and hence the armature will oscillate toward b.

The side of the armature opposite the pole-pieces carries a contact-knob e, which I prefer to removably secure to the armature by a screw-bolt e^2 passing into a boss e^3 on the armature. Contact-pieces are held by the case at each side in suitable position for the armature-knob e to contact with them in either extreme position of the armature, and thus the armature may break or establish a circuit through itself and the contact-piece and suitable conductors leading therefrom. These contact-pieces may be made in the form of shoes F and F', as shown in Fig. 1. There each shoe is carried by a lever G, pivoted at g to a plate g', secured to the insulating-block g^2. A spring g^3 (secured to the lever and having its free end pressing against the lug g^5, projecting from the plate g') presses the shoe toward the armature, and a stop g^4 limits its movement in that direction, so that it will be in position for the armature-knob to easily slide beneath it, while sufficient pressure is afforded by the spring to insure a good electrical contact. When such an arrangement of contact-pieces is used, I prefer to form the magnet side of the armature with two segmental bosses e^4 and e^6, leaving the notch e^5 between them. The convex length of each boss is substantially the same as the concave length of the pole-face, while these bosses are formed such distance apart that the length of a boss and the notch is substantially the same as the distance between the pole-pieces. The result of this construction is that the pole-piece which is energized, say b', holds the armature in the corresponding extreme position, resisting its movement in either direction, and thus forms an electrical stop, dispensing with the necessity of a mechanical stop, while the other boss, as e^6, has its corner opposite the corner of the pole-piece b in position to oscillate the armature in the reverse direction when the current is reversed.

If desired, the construction may be cheapened by providing simple knobs H and H', as shown in Figs. 3 to 6, in place of the spring-pressed shoes. These knobs are stationarily secured by the plates h to the insulating-blocks h'. In such construction I make the segmental boss on the armature to overhang the pole-face when the knob e is against the knob H or H', so that there will be an electrical pull given by the pole-piece which will hold the armature-knob in good electrical contact with the knob H or H'. A simple way to provide for this overhanging is to make but one boss and it of a greater convex length than the concave length of either pole-face, which latter would in that case be preferably placed as close together as is convenient in construction. Such an arrangement is illustrated in Figs. 3 to 6, the single boss being indicated by the reference-letter e^7. If desired, this boss may be nothing more than the rounded end of the armature.

The construction and specific operation of the magnetic switch having been explained, I will now describe the manner in which it is operated in connection with the controller.

In Fig. 3 a motor is indicated at M, from which the line m leads to the ground or return wire. N and N' indicate resistances. The controller may direct the current through both of these resistances or only one or around them both direct to the motor. This illustrates the manner in which the controller governs the motor. The controller might be of the series-parallel type and govern two or more motors; but for simplicity of illustration I have shown but one motor, and that governed by means of a variable resistance. Four positions of the controller-cylinder are indicated in the drawings by the broken lines marked 1, 2, 3, and 4. The first of these positions is the "off" position. No. 2 is the position where the current flows through both resistances N' and N, No. 3 through N alone, and No. 4 where it passes direct to the motor. The current comes from the trolley to the conductor S and passes around the field-windings C, and thence by the conductor s^5 to the contact-finger T^5. The reference-letters T' to T^{10}, inclusive, indicate suitably-formed contact-fingers arranged in a row parallel to the axis of the controller-cylinder and adapted to contact with the plates forming that cylinder. These plates, which are secured to the controller-body in the usual manner, are indicated by the reference-letters U and u, with varying exponents. The upper three plates U' U^2 U^3 govern the motor. The intermediate plates, beginning with U^3 and ending with U^7 and including u to u^5, inclusive, serve to commutate the armature-coils and establish the circuit through them in the desired direction. The lower plates u^6, U^8, U^9, and U^{10} operate in completing the circuit from the circuit-breaker to the motor. The contact-finger T^5 is always in engagement with the contact-plate U^5. Let us now suppose the contact plates and fingers to be in the relative position indicated by the broken line 1 in the development in Fig. 3, which is one of the terminal positions of the controller—the off position. The plate U^4 is permanently electrically connected with the plate U^5, as indicated by the line v^2. The circuit thus leads to the plate U^4 and through the contact-finger T^4 to the conductor s^4, by which it continues to the armature-coils D' and D and from which the conductor s^6 carries it back to the contact-finger T^6 and the plate U^6. From the plate U^6 the circuit passes through the connection v^6, the plate U^7, the contact-finger T^7, and the conductor s^7 to the contact-piece H' or F' of the magnetic switch; but the armature of the

switch hangs by gravity in its middle position and out of contact with either of the contact-pieces. The circuit is broken at H′ or F′ and no current passes. If for any reason it should be in contact with H′ or F′, the current passes through the armature and the conductor s^3 and through the resistances N′ and N and the motor to the ground; but before the motor can have time to move under the action of this current the armature-coil D′ of the magnetic switch has caused the armature to be swung away from H′ or F′ and the circuit opened. Thus no operative current flows when the controller is in the off position, while this position always causes the armature to stand away from the contact-piece H′ or F′. Fig. 3 shows the armature just after it has swung away from H′, the current having been flowing from s^7 to s^3, as indicated by the arrows. In order that the illustration may be logical, an arc R is shown as completing the circuit, but in practice only a spark will be formed and the current will cease to flow when the armature is moved away from the knob H′. The impulse given the armature by the coils D′ may not be sufficient to swing the end *e* clear over to the knob H; but whether it does or not no circuit is formed at this time through H, and the armature comes to rest in a vertical position midway between the knobs H and H′. If now it is desired to start the motor, the controller is turned one notch to bring the contact plate and fingers into the relative position indicated by the broken line 2. Just as the contact-finger T^8 contacts with the plate U^3 the circuit is established from the trolley and plate U^5 by v^4 to plate u^3, thence via contact-finger T^6, conductor s^6, around the armature-coils in reverse direction and back by s^4 to plate *u*, connection *v*, plate U^3 to contact-finger T^3, and from T^3 through the resistances N′ and N to the motor and ground. The current thus started energizes the pole-piece *b* and swings the armature into contact with the knob H′. A shunt is thus established from U^3 via v^8, plate U^7, finger T^7, conductor s^7, knob H′, armature E, conductor s^3, and the resistances, as indicated in Fig. 4. As the contact-finger T^7 passes off of the plate U^7 as the controller comes to position 2 this shunt is broken at that point, but the armature remains in the same position, as the main circuit is already established around the armature-coils.

In position No. 3 the circuit extends from the trolley to plate U^5, thence via v^3 to *u*′, thence to contact-finger T^4 and around the armature-coils in the opposite direction from the course it took in the preceding position, thence via conductor s^6 to plate u^4, thence by the connection $v^7 v^8$ to plates U^3 and U^2. Part of the current passes from U^2 through the single resistance to the motor, a small part from U^3 through both resistances to the motor, while, the armature having been swung by the coils D′ into contact with the knob H, a part of the current shunts through the conductor s^3, the armature, the knob H, conductor s^9 to plate U^9, connection v^{10}, plate U^8, connections s^8 and s^2 to the motor. This leaves the switch in the position shown in Fig. 5.

When the controller has been turned to its terminal position, as indicated by the broken line 4, the current passes from the trolley to U^5, as always, from there via connection v^5 to plate u^5, and by the conductor s^6 around the armature-coils in the reverse direction again to conductor s^4, and from thence to plates *u* and U^3, thence via connection v^8 to plate U′ and to the motor direct, immaterial shunts being also formed from U^2 through the resistance N and from U^3 through both resistances N′ and N. The armature having been swung by the coils D into contact with the knob H′ when the fingers T^4 and T^6 passed from the plates *u*′ and u^4 to the plates u^2 and u^5, a shunt is also formed through the circuit-breaker, as indicated by the arrows in Fig. 6. The current flows through this circuit from U^3 to s^3 and through the armature to H′ and from H′ by s^7, u^6, v^9, U^{10}, s^{10}, and *s*′ to the motor, thus leaving the switch in the position shown in Fig. 6. It will thus be seen that the circuit-breaker does not interfere in the least with the governing of the motor by the controller. When the controller is turned a notch from position 4 to position 3 without the use of a circuit-breaker attachment, the only path for the current which has been flowing direct to the motor is by the previously-formed shunt through the resistance N. This sudden interposition of resistance to the whole current breaks down the current and a spark is formed between the plate U′ and the contact-finger T′. This spark is not as large as it would be if there were no shunt established through the resistance, but it is enough to be deleterious. With my attachment a shunt is formed around the contact between T′ and U′ while they are in position 4 by the circuit-breaker, which, it will be remembered, was swung into the position indicated in Fig. 6 when the controller moved to the said position No. 4. This shunt, as stated, passes from U^3 to the armature E, thence to knob H′, thence via s^7, T^7, u^6, v^9, U^{10}, T^{10}, s^{10}, and *s*′ to the motor direct. Hence when the contact-finger T′ leaves the plate U′ no spark will be formed, as the shunt through the circuit-breaker is of substantially as low resistance as the path previously provided. When the contact-fingers T^4 and T^6 withdraw from the plates u^2 and u^5 to the plates *u*′ and u^4 as the controller continues its movement toward position 3, the current is reversed in direction through the armature-coils, the armature oscillates, and the circuit is broken between *e* and H′, where the spark is harmless. This leaves the current flowing to the motor through the resistance N, both directly from the plate U^2 and from the plate U^3, via the shunt, through the circuit-breaker. When

the finger T^2 leaves the plate U^2, no spark is formed, as the circuit-breaker shunt carries the current. This shunt is again broken with a spark between H and *e* as the fingers T^4 and T^6 pass from plates u' and u^4 to plates u and u^3.

As the finger T^3 leaves the plate U^3 in passing from position 2 to the off position, a large spark would ordinarily be formed, since there would be no shunt, even through resistance, provided in this case both resistances being in series with the motor; but with my attachment a shunt through the circuit-breaker has already been formed, (via u^3, T^6, s^6, s^4, u, U^3, v^8, v^7, U^7, T^7, s^7, H′, E, s^3, N′, and N,) and this receives the current. When the fingers T^4 and T^6 pass from the plates u and u^3 to the plates U^4 and U^6, the direction of the current through the armature-coils is changed, and the circuit is thereby broken between H′ and *e*, and thus the spark takes place between these large knobs where it can do no harm. The current now stops and the controller-cylinder assumes the off position, (indicated by 1,) the armature E hanging midway between its extreme positions.

Having described my invention, I claim—

1. In a controller circuit-breaker, in combination, a magnetic switch, a controller having plates and contact-fingers adapted to govern the current through the motor, and plates and contact-fingers adapted to govern the current through said switch, said last-mentioned plates and contact-fingers being adapted to be separated by the movement of the controller at a different time from that when the first-mentioned plates and contact-fingers are separated by said movement, whereby a shunt is established through the magnetic switch around the motor-governing contact about to be broken, which shunt continues until after said contact is broken and is then itself broken by the movement of the controller, substantially as described.

2. The combination with a motor and a magnetic switch, of a controller having cooperating contact members consisting of a series of contact-fingers and a series of contact-plates, there being provision for relative movement between said two series, conductors leading from one series to the magnet of the switch, to the contact-points of the switch and to the motor, whereby some of said contact members are adapted to govern the motor, others to govern the magnetic switch, and others to properly complete a shunt-circuit through contacts established by said switch, substantially as described.

3. The combination of a controller having contact fingers and plates adapted to come into different relations, a motor, a circuit-breaker including a magnet and armature, and a circuit extending from the controller through the magnet of the circuit-breaker and back to the controller, and then dividing and extending to the motor by two paths, one of which includes a movable part consisting of or operated by the armature of the circuit-breaker, said controller being adapted in its movement to open first the direct path to the motor, and then to electrically open the path through the circuit-breaker by means of the movement of the armature caused by an electric change in the magnet, substantially as described.

4. The combination of an electrically-operatable circuit-breaker with a controller having a series of contact-fingers and contact-plates of various lengths adapted to be engaged thereby, some of said contact-plates governing a motor and others of them the circuit-breaker, the relative length of the motor-governing plates and the circuit-breaker-governing plates being such that in the movement of the controller the motor-plate fingers and the circuit-breaker-plate fingers leave their respective plates alternately, substantially as described.

5. The combination with an electrically-operated circuit-breaker, of a controller having a series of contact-fingers arranged in a row, and a series of contact-plates secured to a body which is adapted to come into different relative positions with the contact-fingers, some of said contact-plates governing the machine to be controlled, and some the circuit-breaker, the former plates being so placed that each of their contact-fingers engage with but one plate and the several contact-fingers are adapted to leave the several plates one at a time, and the latter plates being so placed that one circuit-breaker-governing contact-finger is adapted to contact successively with at least as many plates as there are machine-controlling plates, substantially as described.

6. In a magnetic switch, a magnet-core having continuously-wound field-coils surrounding it and two pole-pieces projecting from it, armature-coils surrounding the two pole-pieces in opposite directions, and an armature oscillatably journaled in suitable relation to the pole-pieces, substantially as described.

7. In a magnetic switch, a magnet-core having continuously-wound field-coils surrounding it, and two pole-pieces projecting from it, armature-coils surrounding the two pole-pieces in opposite directions, and an armature oscillatably journaled in suitable relation to the pole-pieces, combined with a controller adapted to govern a machine by breaking contacts and adapted to change the direction of a current through the armature-coils at times which are intermediate of the governing breaks, substantially as described.

8. The combination of a circuit-breaker including two contact-pieces, an armature, and coils adapted to electrically draw the armature into contact with either contact-piece by a reversal of the current through the coils, and a controller adapted to govern a machine and cause a reversal of the current through the coils, substantially as described.

9. The combination with a controller con-

sisting of coöperating contact members, of a circuit-breaker, including two contact-pieces, an armature, and coils adapted to electrically draw the armature into contact with either contact-piece by a reversal of the current through the coils, and conductors leading from said armature, from said contact-pieces and from said coils to contact members of the controller, whereby said controller is adapted to govern a machine, to reverse the direction of current through said coils and to complete a circuit through said armature, substantially as described.

10. The combination with a circuit-breaker of a controller having the plates U′, U^2, and U^3, and the corresponding contact-fingers T′, T^2, and T^3 for governing a motor, and the plates U^4, u, u', u^2 and U^6, u^3, u^4, u^5, and the corresponding contact-fingers T^4 and T^6 for governing the circuit-breaker, substantially as described.

11. The combination with a controller of a circuit-breaker interposed in a shunt-circuit around said controller, said controller having the plates U′, U^2, and U^3, and the corresponding contact-fingers T′, T^2, and T^3 for governing a motor, and the connected plates u^6 and U^{10} and U^8 and U^9 for completing the circuit through the circuit-breaker, and means for governing the movement of the circuit-breaker, substantially as described.

12. The combination with a circuit-breaker of a controller adapted to govern a motor and having the plates U^4, u, u', and u^2 and U^6, u^3, u^4, u^5 and the corresponding contact-fingers T^4 and T^6 for governing the circuit-breaker, substantially as described.

13. The combination with a circuit-breaker adapted to be operated by a reversal of current, of a controller adapted to govern a motor, and having the plates U^5 and the plates U^4, u, u', u^2 and U^6, u^3, u^4, u^5, said plates U^5 being electrically connected with the alternate plates U^4, u', u^3, and u^5, and said plates u, u^2, U^6 and u^4 being electrically connected together, and contact-fingers T^4 and T^6, said fingers being terminals of a circuit through the circuit-breaker, which circuit by a reversal of the current through it operates the circuit-breaker, substantially as described.

14. In a magnetic switch, in combination, the magnet-core B, the field-coil C, the pole-pieces b and b', the armature-coils D and D′, the armature E carrying the knob e, contact-pieces with which said knob is adapted to contact in either extreme position of the armature, and conductors connected with the contact-pieces and the knob, substantially as described.

15. In a magnetic switch, in combination, an oscillatable armature carrying the knob e, the spring-pressed shoes F and F′ with either of which said knob is adapted to contact, means for electrically oscillating the armature, and electric stops for electrically limiting the movement of the armature and providing it with a definite extreme position against movement in either direction while said armature is mechanically free to move in either direction, substantially as described.

16. In a magnetic switch, in combination, the box A, the core B and the boss e^8, the stud e' extending from said boss, and the pole-pieces b and b' extending from said core, coils C and D and D′, and the armature E oscillatably journaled on the said stud e' and adapted to make and break an electric circuit, substantially as described.

17. In a magnetic switch, in combination, the box A, the core B and the boss e^8 formed integral with the walls of said box and extending inward at substantially right angles to the same, pole-pieces extending from said core, a stud e' extending from said boss, an armature mounted on said stud, and having a rounded end adapted to stand close to the face of the pole-pieces, and means for electrically energizing said pole-pieces, substantially as described.

18. In a magnetic switch, in combination, pole-pieces b and b' having concave faces, an oscillatable armature having a rounded end and suitably journaled with reference to said pole-pieces, means for stopping the oscillation of said armature in either direction, and thus providing an extreme position, contact-pieces with which said armature contacts in either extreme position, conductors leading from said armature and contact-pieces, and means for electrically energizing the pole-pieces and thereby making or breaking a circuit through the armature and a contact-piece, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

THORSTEN VON ZWEIGBERGK.

Witnesses:
ALBERT H. BATES,
E. B. GILCHRIST.