(No Model.)

2 Sheets—Sheet 1.

H. H. CUTLER.

TIME LIMIT CUT-OUT.

No. 603,594. Patented May 3, 1898.

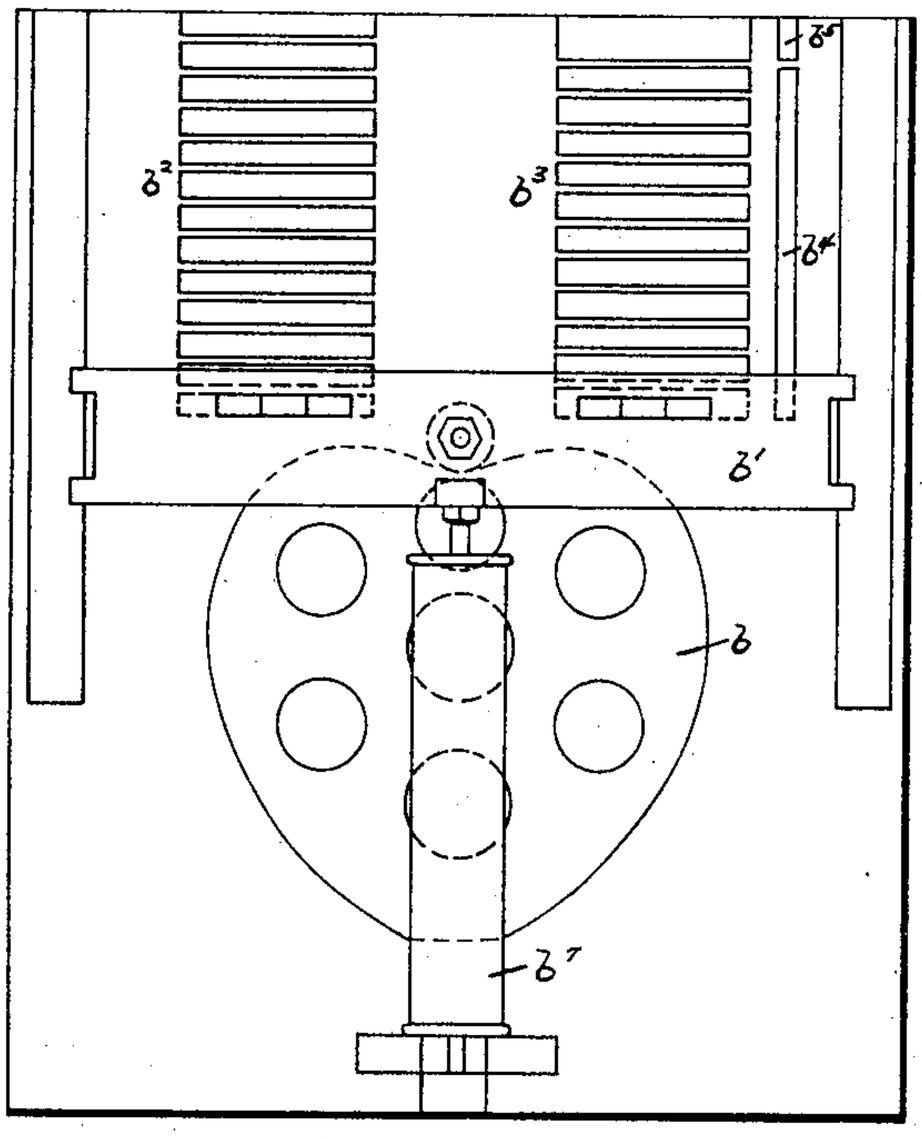

FIG 1.

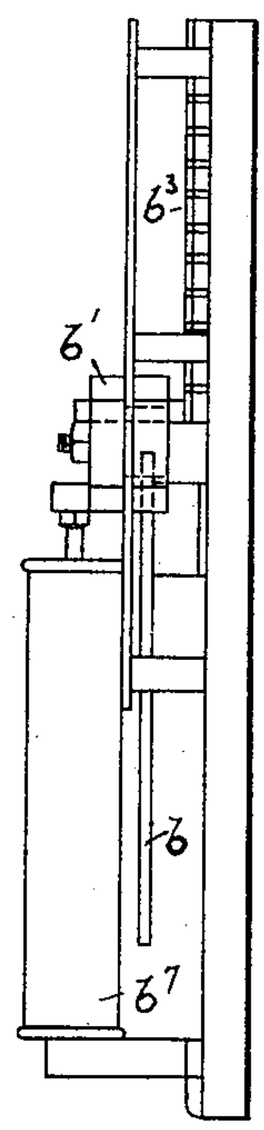

FIG 2.

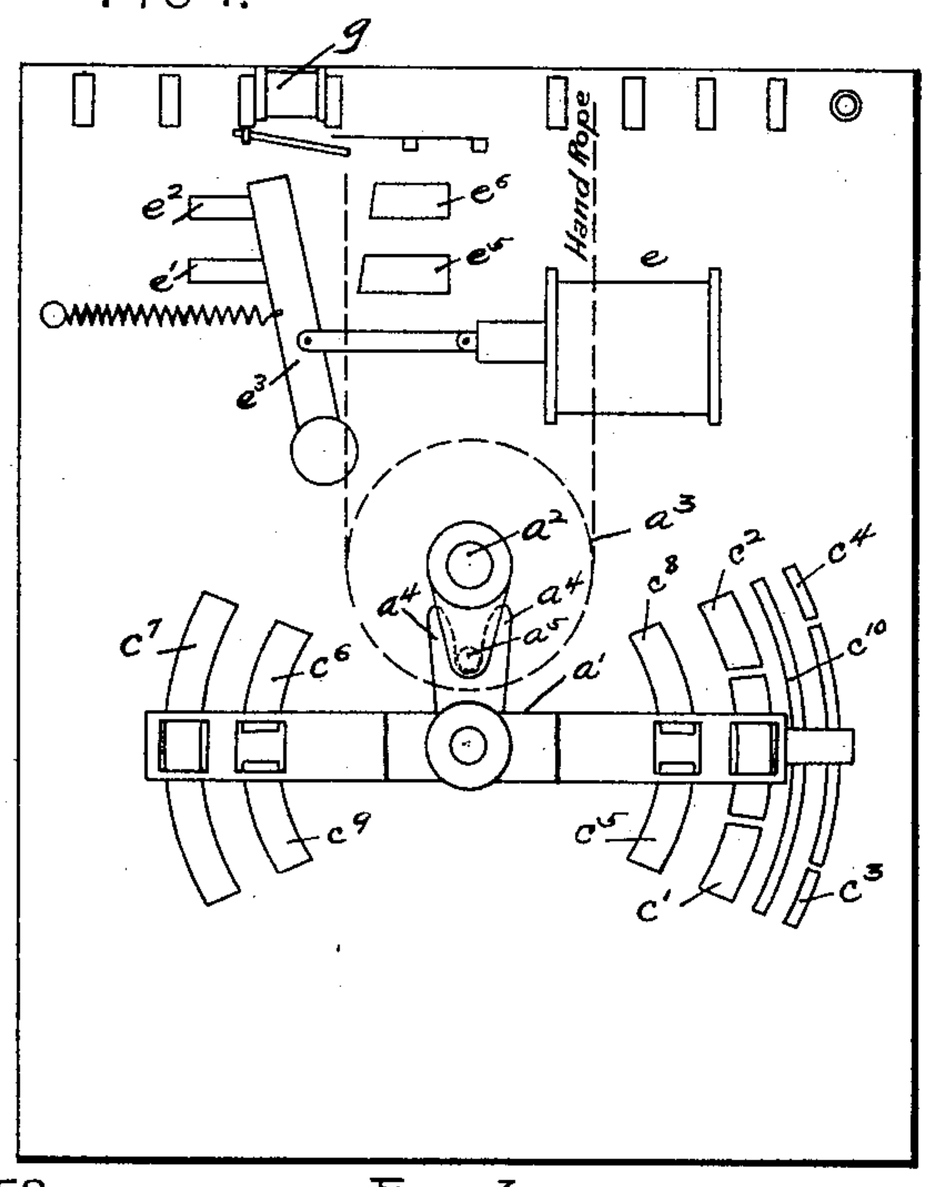

FIG 3.

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(No Model.) 2 Sheets—Sheet 2.

H. H. CUTLER.

TIME LIMIT CUT-OUT.

No. 603,594. Patented May 3, 1898.

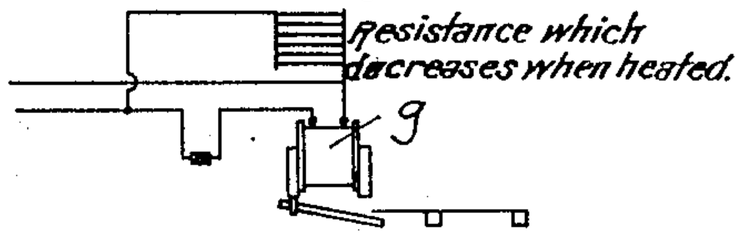

FIG. 5.

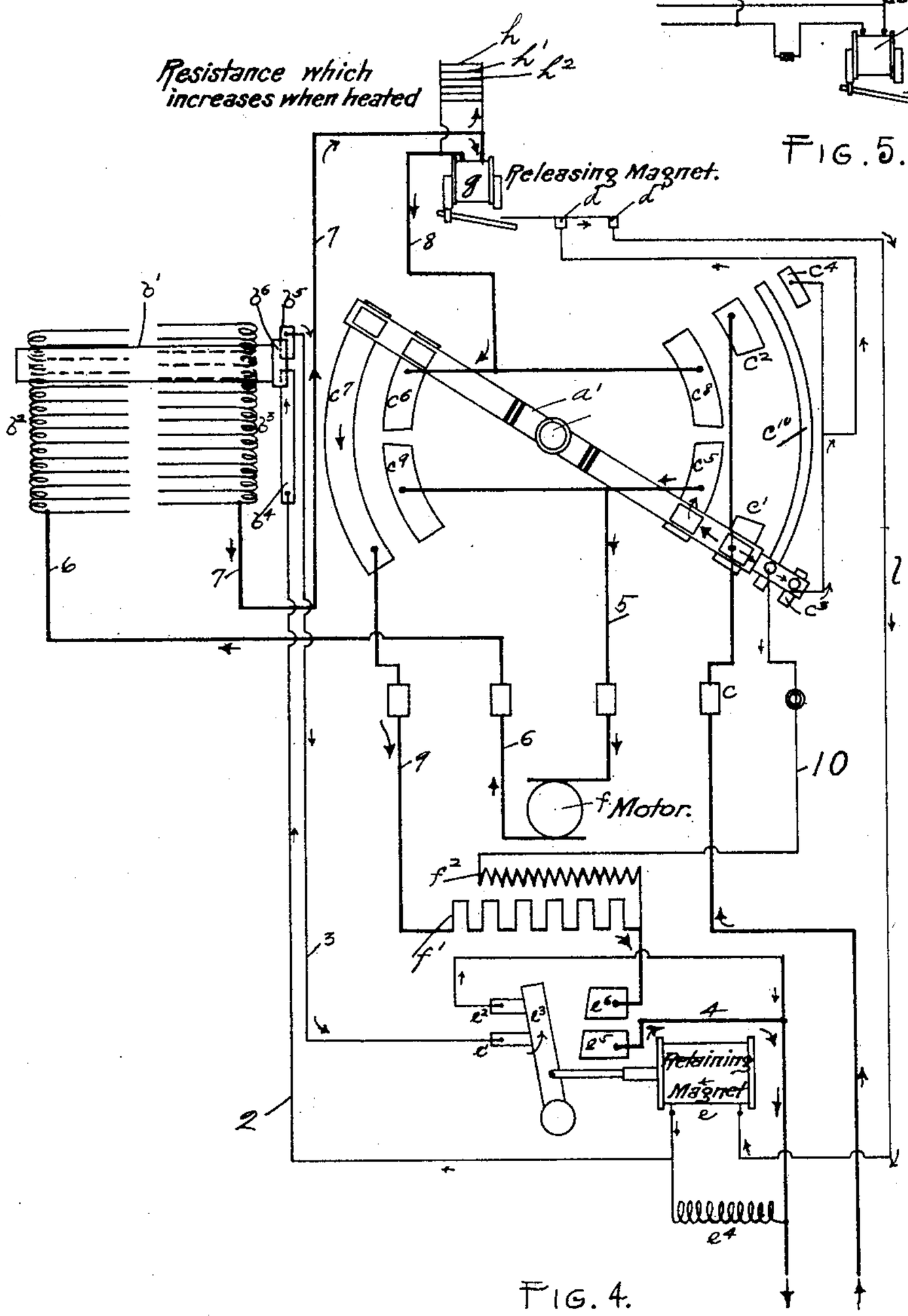

FIG. 4.

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UNITED STATES PATENT OFFICE.

HENRY H. CUTLER, OF CHICAGO, ILLINOIS.

TIME-LIMIT CUT-OUT.

SPECIFICATION forming part of Letters Patent No. 603,594, dated May 3, 1898.

Application filed July 26, 1897. Serial No. 645,970. (No model.)

To all whom it may concern:

Be it known that I, HENRY H. CUTLER, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Time-Limit Cut-Outs, 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 a time-limit circuit-breaker, my object being to provide an automatic circuit-breaker or cut-out for electric motors and other electrical apparatus and to associate the same with a device for introducing a time element into the operation of the circuit-breaker, so that the circuit will be opened only after the flow of an abnormal current for a period of time. The circuit-breaker may be arranged to open the circuit instantly upon the flow of an excessively large current.

The object of a circuit-breaker is to open the circuit upon the flow of an abnormal current, and thereby protect the electrical apparatus against damage caused by the flow of a current exceeding that which the apparatus is designed to safely carry. The damage is mainly due to the heating effect of the current, and as it takes time for any substance to heat up an abnormal current flowing for a very short time may produce no bad effect, while the same current continued for a time may destroy the apparatus. Circuit-breakers have usually heretofore been constructed so that the flow of an abnormal current instantly opens the circuit. It often happens, however, that the abnormal flow continues for a very short period of time and then returns to the normal, the short flow of abnormal current being not prejudicial to the machine, although the current would produce deleterious effects if continued long enough to permit the conductors to heat up.

It is the purpose of the present invention to provide a circuit-breaker which upon the flow of an abnormal current will not open the circuit unless the abnormal flow be continued for a predetermined period; furthermore, to arrange the circuit-breaker to instantly open the circuit upon the flow of an excessively abnormal current—that is, a current exceeding a predetermined maximum below which the time-limit operates.

In circuit-breakers a magnetic coil is provided which serves to actuate the circuit-breaker to open the circuit, and this coil I will hereinafter call the "active" coil of the cut-out. I associate with this coil a device the resistance of which varies with temperature, and consequently with the strength of the current flowing, so that a momentary abnormal current will not actuate the cut-out, while an abnormal current flowing for a period of time will alter the resistance of the temperature device, thus permitting an operating-current to flow through the active coil to actuate the cut-out. In practice I have employed one or more wires of metal—such as iron, copper, or the like—the resistance of which increases with rise of temperature, the wires being placed in shunt with the active coil, and when several wires are employed they are preferably arranged in multiple with one another. The current is thus divided between the active coil and the temperature-wires, and upon the momentary flow of an abnormal current the wires do not heat up perceptibly, and in consequence the active coil, which is wound to respond only to a current of a predetermined value, is not actuated. If the abnormal current be continued for some time, the resistance of the temperature-wires is increased, thus shunting more and more current through the active coil until the abnormal current has flowed for a time, which if longer continued would heat up and damage the apparatus when the current through the active coil becomes sufficient to operate the cut-out and open the circuit. The active coil is arranged so that even the momentary flow of an abnormal current exceeding a certain value will instantly operate the cut-out, so that excessively large currents, which would damage the apparatus by flowing a very short time, may be immediately checked.

To intensify the range of the operation of the cut-out, I may employ, in addition to the temperature device in shunt with the active coil, a series temperature device. Carbon possesses the peculiar property of decreasing in resistance as the temperature rises, and by placing in series with the active coil a car-

bon resistance the resistance of the branch through the active coil may be decreased at the same time that the resistance through the other branch is increased. The carbon resistance in series with the active coil may be employed alone, although I prefer in practice to employ the shunt temperature-wires, or where large range is desired the combination of the shunt and series temperature devices.

The time-limit cut-out is particularly applicable to electric motors used on electric elevator systems and for other purposes where it is necessary to start under load, thus requiring a large current for a short time in starting and a much less current during normal travel. The cut-out of my invention permits the flow of the large current for a time sufficient to start the motor from rest, while responding to a much smaller current if long continued, thus protecting the motor against damage from overheating.

I have illustrated the time-limit cut-out in connection with an electric elevator-controller, which also forms a feature of the invention herein.

Figure 1 is a view of the controller on the side carrying the rheostat-terminals. Fig. 2 is a side view thereof. Fig. 3 is a view on the side carrying the reversing-switch. Fig. 4 is a diagram illustrating the circuit arrangement. Fig. 5 is a view of a modification.

Like letters and numerals refer to like parts in the several figures.

Upon the front of the controller-box a is a contact-arm a'. A shaft a^2 passes through the box and carries the wheel a^3, over which passes the operating hand-rope of the elevator. Upon the contact arm or lever a' are provided two teeth or lugs a^4 a^4, between which rests a pin a^5, mounted on the shaft a^2, so that as the shaft is rotated in one direction or the other the contact-arm is rocked back and forth. Mounted upon the shaft and on the rear of the box is a cam b, which when rotated in either direction raises the contact-bar b', the ends of which carry contacts engaging the series of rheostat-contacts b^2 b^3. When the cam is moved from beneath the contact-bar, the bar descends by its own weight and is controlled by a dash-pot b^7.

One side of the supply-circuit is connected with the binding-post c, Fig. 4, which is connected with the contact-plates c' c^2. With the contact-arm in the position illustrated circuit extends thence to contacts c^3 c^4, to the contacts d d', conductor 1, magnet e, conductor 2, contacts b^4 b^5, which are connected by the brush b^6 on the contact-bar b', when the contact-bar is elevated to include all of the resistance of the rheostat in circuit. From contact b^5 circuit extends by conductor 3 through contacts e' e^2, connected by contact-arm e^3, controlled by magnet e, thence by conductor 4 to the opposite side of the supply-circuit. Between conductors 2 and 4 extends a resistance e^4. Circuit being thus closed through magnet e, the same is energized, thus moving the contact-arm e^3 into contact with contacts e^5 e^6, thus closing the same together electrically and separating contacts e' e^2. The resistance e^4 interposes sufficient resistance in the circuit of magnet e, which now extends from the magnet through the resistance to conductor 4, so that the magnet will hold its armature, although it cannot attract and move the armature when once released.

The motor-circuit extends from binding-post c, through contact c', contact c^5, conductor 5, armature f, conductor 6, resistance b^2, contact-bar b', resistances b^3, conductor 7, releasing-magnet g, conductor 8, contact c^6, through the contact-arm to contact-plate c^7, conductor 9, series winding f' of the motor, contact e^6, arm e^3, contact e^5, to conductor 4. Contact c^8 is connected with contact c^6, and contact c^9 with contact c^5. The shunt field-circuit of the motor extends from the contact-arm to contact c^{10}, conductor 10, shunt-field f^2, to contact e^6.

In starting the motor the hand-rope is pulled to move the contact-arm into the position illustrated in Fig. 4, thus closing the circuit through the retaining-electromagnet e in the manner above described to energize the same and move the arm e^3 to close the armature and field circuits. The cam is at the same time moved from beneath the contact-bar, and the latter descends to gradually cut the resistance from the armature-circuit. The movement of the arm e^3 also separates the contacts e' e^2 and cuts the resistance e^4 into circuit with the magnet e, so that the magnet will not have power to retract the armature-lever e^3, if once released. The descent of the contact-bar b' of the rheostat separates the contacts b^4 b^5 by moving the brush b^6 out of engagement therewith. It is thus impossible to energize the magnet e again sufficiently to retract the armature until the contact-bar b' is moved upward to cut all of the resistance into the motor-circuit.

Upon the flow of an abnormally small current the retaining-magnet e releases its armature to open the motor-circuit. Upon the flow of an abnormally large current the overload or releasing magnet g separates the contacts d d' by the attraction of its armature to thereby deënergize the magnet e and open the motor-circuit.

In shunt with the magnet g are included a number of wires h h' h^2, of metal or other material, the resistance of which increases with rise of temperature. In practice I preferably employ ordinary iron wires. The current thus divides between the operating-coil g and the wires, and the current flowing through the coil g during the passage of the large starting-current is not sufficient to actuate the coil to attract its armature. The flow of a much smaller current, however, if long continued will heat up the wires h h', &c., thus raising the resistance thereof and diverting an increased proportion of the current through the operating-coil to operate the

same. The time during which the abnormal current will flow before operating the circuit-opener may be adjusted by varying the sizes of the wires *h h'*. For a given current if it be desired to operate with a short time-limit the separate wires may each be small in cross-section, the combined cross-section of all the wires being of the desired value to carry the current. If a longer time-limit be desired, the individual wires may be made larger in cross-section, while the combined cross-section remains practically the same. The smaller the cross-section of the individual wires the more rapidly will the resistance increase under the flow of the abnormal current, and consequently the smaller will be the time-limit.

In order to give a greater range to the time-limit circuit-breaker, a resistance of carbon may be included in series with the operating-coil, as indicated in Fig. 5. The resistance of carbon decreases with rise of temperature. Thus, as is well known, the ohmic resistance of an ordinary sixteen-candle-power (one-hundred-and-ten-volt) lamp averages in round numbers about five hundred ohms cold and two hundred and fifty ohms hot. A filament of carbon inclosed in a lamp-globe in which the air is exhausted or a small stick of carbon in the open air may be connected in series with the active or operating coil of the circuit-breaker, while in shunt with the coil is included a material the resistance of which increases with the heat. Suppose, for example, the resistance of the active coil of the circuit-breaker to be one ohm, the cold resistance of the piece of carbon eight ohms, and the cold resistance of the shunt around these two one ohm. Now imagine eighty amperes of current flowing through this combination. This current would then for a moment divide, so that one-tenth or eight amperes would go through the active coil of the circuit-breaker and nine-tenths or seventy-two amperes would go through the shunt. Now if the circuit-breaker were set to open at eight and one-fourth amperes the instantaneous flow of eighty amperes would not open the circuit, but the circuit would be opened instantly if the circuit-breaker were set at eight amperes. After this current of eighty amperes has flowed for a very short space of time the resistance of the shunt-circuit will increase and the resistance of the circuit-breaker circuit will decrease, so that much more current will go through the circuit-breaker and cause it to act.

Suppose that a current of only twenty-eight amperes be sent through a combined circuit-breaker and time-limit device. Suppose, further, for the sake of clearness, that after this current of twenty-eight amperes has passed for some time the resistance of the shunt-circuit will have increased, through the heating effect of the current, to two ohms, and the resistance of the carbon will have decreased, through the heating effect of the current, to four ohms. Under these conditions two-sevenths of twenty-eight amperes, or eight amperes, would flow through the current-breaker, and the remaining five-sevenths, or twenty amperes, would flow through the shunt. It is clear, therefore, that a current even as small as twenty-eight amperes, if allowed to flow a sufficient length of time to heat up the time-limit devices, as pointed out, would cause the circuit-breaker to open, while a current of eighty amperes would instantaneously open the circuit. Of course, this is an extreme case, and it would probably not be necessary to put as wide a range of current on the time-limit circuit-breaker in practical operation. These figures are given to show the wide variation which it is possible to obtain.

Having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In combination the active coil of a cut-out and a time-limit controlling the same and comprising a section of an electric circuit the resistance of which varies with rise of temperature due to the current, substantially as described.

2. In combination the active coil, of a cut-out and a time-limit comprising a section of an electric circuit the resistance of which increases with rise of temperature due to the current, said section being in shunt with said active coil, substantially as described.

3. In combination the active coil of a cut-out and a time-limit comprising a section of circuit the resistance of which increases with rise of temperature, placed in shunt with said active coil and a section of circuit the resistance of which decreases with rise of temperature in series with said active coil, substantially as described.

4. In combination a retaining-electromagnet for a cut-out, a releasing-electromagnet therefor, and a time-limit controlling the releasing-magnet and comprising a section of an electric circuit the resistance of which varies with rise of temperature due to the current, substantially as described.

5. In combination a retaining-electromagnet for a motor cut-out included in a shunt-circuit, a releasing-electromagnet in the armature-circuit, and a time-limit controlling the releasing-electromagnet and comprising a section of an electric circuit the resistance of which varies with rise of temperature due to the current, substantially as described.

6. In combination an electric motor operating an elevator-car, an elevator-controlling switch a cut-out therefor and a time-limit for controlling the cut-out, and comprising a section of an electric circuit the resistance of which varies with rise of temperature due to the current whereby the cut-out permits the momentary flow of a large starting-current while responding to a small prolonged current, substantially as described.

7. In combination an electric motor operating an elevator-car, an elevator-controlling switch, a cut-out therefor and a time-limit for

controlling the cut-out and comprising a section of an electric circuit the resistance of which varies with rise of temperature due to the current, substantially as described.

8. The combination with a circuit to be controlled, of a circuit-controlling arm or element therein, an electromagnet for controlling said arm or element and a time-limit cut-out operated by the heating effect of the current and controlling the circuit through said electromagnet to thereby control said circuit-controlling arm, substantially as described.

9. The combination with a circuit to be controlled, of a circuit-controlling arm or element therein, a retaining-electromagnet for normally holding said arm or element in position to close said circuit, means for moving said arm or element when released to open said circuit and a time-limit device operated by the heating effect of the current and controlling the circuit through said electromagnet to effect the release of said circuit-controlling arm, substantially as described.

10. The combination with a circuit to be controlled, of a circuit-controlling arm or element therein, a retaining-electromagnet for normally holding said arm or element in position to close said circuit, means for moving said arm or element when released to open said circuit, a releasing-electromagnet for controlling said retaining-electromagnet, and a time-limit device operated by the heating effect of the current and controlling the circuit through said releasing-electromagnet, substantially as described.

11. The combination with an electric motor, of a cut-out having a circuit-controlling arm or element, a retaining-electromagnet for normally holding the arm in position and included in a circuit in shunt with the motor-armature, and a releasing-electromagnet included in series with the motor-armature, and a time-limit device operated by the heating effect of the current and acting upon the releasing-electromagnet to effect the release of the arm after an excessive current has flowed for a predetermined interval of time, substantially as described.

12. In an elevator-controller, the combination with a series of rheostat-terminals arranged equidistant in a straight line and situated in a vertical plane, of a contact arm or bar movable vertically across said terminals and descending by gravity, and a heart-shaped cam arranged to raise the contact-bar through equal distances for substantially equal angles through which the cam is rotated, substantially as described.

13. In an elevator-controller the combination with a series of rheostat-terminals arranged in a vertical plane on one face of a rheostat-box, of a vertically-moving gravity contact-bar, a shaft extending through said box, a heart-shaped cam thereon for raising said contact-bar, and a reversing-switch on the opposite face of said box operated by the rotation of said shaft, substantially as described.

14. In a cut-out, a retaining-electromagnet included at starting in a local circuit through a pair of separable contacts and a switch arranged to be closed only when the rheostat resistance is in circuit, means for separating said separable contacts upon the energizing of said magnet and for closing the motor-circuit and including a resistance in the circuit of said magnet, and a releasing-magnet for deënergizing said retaining-magnet, substantially as described.

15. The combination with an electric motor, of a rheostat in circuit with the armature thereof, a switch in the circuit of said motor, a magnet for controlling said switch placed in a circuit in shunt with said armature, and a switch in the circuit of said magnet operated by the movable element of the rheostat and arranged to be closed only when the starting resistance of the rheostat is in the armature-circuit, substantially as described.

In witness whereof I have hereunto subscribed my name in the presence of two witnesses.

HENRY H. CUTLER.

Witnesses:
W. CLYDE JONES,
M. R. ROCHFORD.