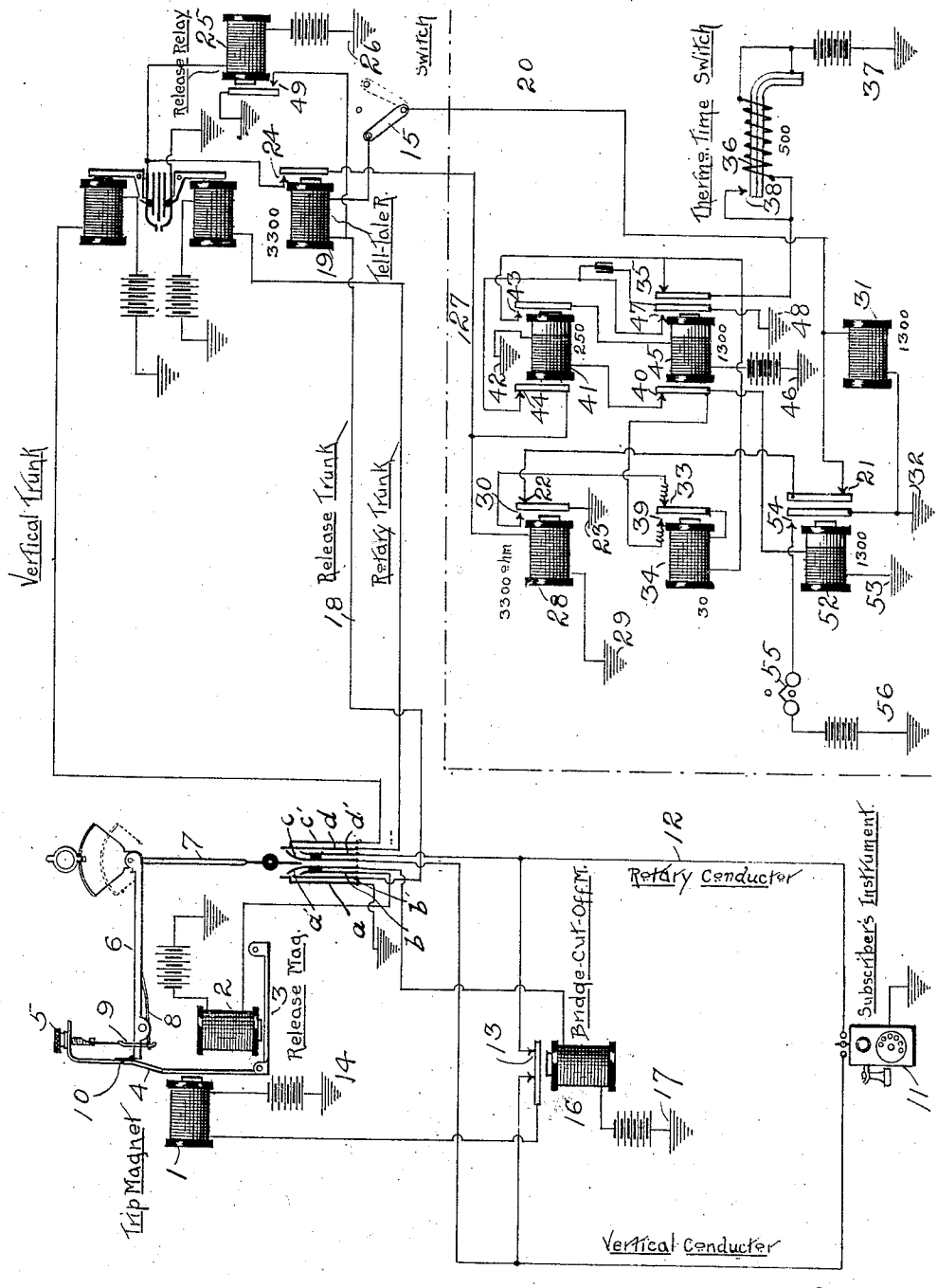
T. F. CROCKER.

ELECTRICAL APPARATUS.

APPLICATION FILED SEPT. 18, 1911.

1,037,447. **Patented Sept. 3, 1912.**



Witnesses
Calleon,
Mary F. Wean

Inventor
Thos. F. Crocker
By F. L. Walker
Attorney

UNITED STATES PATENT OFFICE.

THOMAS F. CROCKER, OF DAYTON, OHIO.

ELECTRICAL APPARATUS.

1,037,447. Specification of Letters Patent. **Patented Sept. 3, 1912.**

Application filed September 18, 1911. Serial No. 649,922.

To all whom it may concern:

Be it known that I, THOMAS F. CROCKER, a citizen of the United States, residing at Dayton, in the county of Montgomery and State of Ohio, have invented certain new and useful Improvements in Electrical Apparatus, of which the following is a specification.

My invention relates to telephone apparatus of the automatic type, and particularly to means for automatically restoring line switches and selector switches which have been accidentally or abnormally operated or which have failed to restore by the usual means, and is especially designed for use in combination with apparatus of the Keith system of telephony, invented by Alexander E. Keith, but which may be adapted to telephone apparatus of different design.

The object of the invention is to provide such automatic means for restoring abnormally operated line switches, and selector switches or those regularly operated but which have failed to restore by the usual means, which will not only be simple and cheap in construction, but will be efficient in use, positive in action and unlikely to get out of repair.

With the above primary and other incidental objects in view as will more fully appear in the specification, the invention consists of the features of construction, the means, parts and combinations thereof, and the mode of operation or their equivalents, as hereinafter described and set forth in the claims.

The drawing is a diagrammatic view illustrating so much of a telephone system of the Keith type as is necessary to illustrate the application of the present invention thereto, those portions forming the subject matter of the present invention being grouped in the lower right side of the diagram and separated from the general or Keith apparatus by a dot and dash line.

For convenience in following the circuits indicated in the diagram, sundry parts have been indicated upon the drawing by name in addition to the reference characters hereafter employed, and the resistance of the several coils has also been indicated on the drawing.

There are many conditions under which the line switches and the trunk switches of an automatic telephone system may be abnormally operated, such as grounded lines, the jarring of the mechanism during normal operation of the other parts, carelessness of workmen, gusts of wind and other accidental or unnatural means. Under such abnormal operation the plunger of the line switch plunges into the bank terminal as hereafter described, but the first selector switch will not operate to select a second selector trunk. In many automatic exchanges several persons are employed whose sole duties are to manually restore abnormally operated line and first selector switches, or as is commonly termed "off normal" switches. To obviate such conditions and to provide for the automatic restoration of the abnormally operated switches is one of the primary objects of the present invention.

In order that the present invention may be more readily understood, the characteristic features of the portions of the Keith system to which the present invention relates will be briefly described.

Referring to the diagram, the line switch illustrated at the upper left portion thereof, comprises a trip magnet 1 and a release magnet 2 arranged at right angles to each other. Below the release magnet 2 is pivoted the release armature 3. This armature carries pivotally mounted on its free end a second armature 4 extending upwardly adjacent to, and controlled by the trip magnet 1. The trip magnet armature 4 is bent at right angles at its upper extremity to accommodate an adjusting screw 5, for the purpose hereafter mentioned. Above the release magnet there is pivotally supported a plunger arm 6 to the end of which is pivotally secured, and fully insulated therefrom, a switch plunger 7 which is adapted, when released, to plunge into and close any one of a series of bank terminals, each comprising four pairs of switch blades as hereafter mentioned. Near the center of the plunger arm 6 is secured a tension spring 8 the free end of which rests in the adjusting screw stirrup 9. By the adjustment of the screw 5 the tension of the spring 8 may be increased or diminished as required. It is to be noted that the spring affords the power for tripping the switch plunger 7 into the bank terminal, and also for withdrawing the plunger from the bank terminal upon the operation of the release magnet. There is always a downward pull upon the stirrup, and when the trip armature rests in normal

engagement with the plunger arm the pull upon the stirrup is transmitted to the plunger arm on the left of its pivotal connection, tending to move the plunger arm in a counter clockwise direction. When the trip arm is disengaged from the plunger arm the spring is effective in producing a clockwise tendency and thrusts the plunger 7 into the bank terminal. The trip armature 4 is provided with a tooth or detent 10 which engages the end of the plunger arm to hold the arm elevated.

Under normal conditions of operation, when the calling subscriber turns the dial for the first digit of the desired number, the rotary line connector is momentarily grounded at the subscriber's instrument 11. This ground impulse provides an energizing circuit for the trip magnet extending from the subscriber's instrument, over the rotary line connector 12, through the bridge cut off switch 13, the windings of the trip magnet 1 and through battery to ground at 14. The trip magnet 1 thereupon energizes and attracts the armature 4, withdrawing the tooth 10 from the end of the plunger arm 6, which in response to the spring tension moves about its pivot and thrusts the plunger 7 into the terminal bank. When the plunger enters the terminal bank the two members of each of the following pairs of contacts are pressed into engagement with each other; a and a^1, b and b^1, c and c^1, and d and d^1. It is assumed for convenience of explanation that the switch wiper 15, which is a side switch wiper of the first selector switch having no other duty than that herein described, is in contact with the first bank contact, and that this contact corresponds with the bank terminal shown. When the plunger 7 plunges into the bank terminal, it closes a circuit through b—b^1 and energizes mechanism not shown which actuates the master switch causing it to move an unoccupied terminal or contact, which operation has no relation to the present case. The falling of the plunger also closes a—a^1 providing an energizing circuit for the bridge cut off magnet 16 which is grounded through battery at 17. The energizing of the bridge cut off magnet attracts the armature thereof, breaking the energizing circuit of the trip magnet 1 at 13. The closing of the contacts c—c^1 and d—d^1 by the plunger extends the calling subscriber's vertical and rotary line connectors to the trunk conductors terminating in the first selector switch.

The release of the line switch is accomplished by the return of the subscriber's receiver to the receiver hook which indirectly momentarily grounds the release trunk 18 at the first selector. As a result the release magnet 2 is momentarily energized attracting its armature 3 and in turn raising the trip armature 4 to permit the tooth 10 to engage over the end of the plunger arm 6. When the release magnet 2 demagnetizes, the armatures 3 and 4 return to normal position, withdrawing the plunger from the bank terminal and permitting the bank contacts to disengage. Such is the normal working of the Keith system shown in the drawing. However the plunger 7 is liable to be plunged into the bank terminal by some accidental means as before mentioned, at a time when the subscriber's instrument has not been operated, and therefore is not restored in the natural manner by the return of the subscriber's receiver to the hook, thereby rendering the line ineffective for a succeeding call. Under such abnormal condition the operation of the parts is as follows: The plunger 7 having plunged into the bank terminal due to some disturbance or irregularity upon the line, closes the several switches before mentioned forming the bank, energizing the bridge cut off magnet 16 to open the trip magnet circuit at 13, connecting the rotary and vertical connectors with the corresponding trunks and the release magnet 2 of the line switch with the release trunk 18, permitting current to pass through the release magnet 2 of the line switch to the tell tale relay 19, the resistance of which is approximately three thousand three hundred ohms, and thence to ground, operating the tell tale relay 19, but failing to operate the release magnet 2 because of its low resistance winding. This is the regular operation of the standard Keith automatic telephone equipment as shown in the drawing, to which the invention forming the subject matter hereof is applied.

The tell tale relay 19 is grounded through the switch 15 and common line 20 including contacts 21 and 22 to ground at 23. The tell tale relay 19 upon its operation, closes the contact 24 causing current to flow through the first selector release magnet 25 which is grounded through battery at 22, thence over the common line 27 through the relay 28 and to ground at 29. The release magnet 25 will fail to operate since it is wound to but sixty ohms resistance while the relay 28 is of three thousand three hundred ohms resistance. The energization of the relay 28 closes the contact 30 by the incidental attraction of its armature and at the same time breaks the contact 22. The opening of the contact 22 however will not affect the tell tale relay 19 which was previously grounded through this contact 22 to ground at 23, but the tell tale magnet 19 will continue grounded through the common line 20, the resistance coil 31 of one thousand three hundred ohms resistance to ground at 32, thereby causing the tell tale magnet to retain its armature in operated position and the contact 24 closed, but any other line

switch of the section which may be plunged into a terminal bank will not operate its corresponding tell tale magnet because it also would have to operate through the resistance coil 31 which is of too great resistance to permit the tell tale relay to attract its armature while said resistance coil is in the circuit. This insures the construction against possible danger of one line switch being cut off from the telephone action of another if one subscriber should release his trunk switch before the switch 15 shall have shifted to the succeeding contact, since the common line may be connected with but one line switch at a time. The resistance coil 31 of the slow acting type is maintained in the circuit until a short period after the final release as hereafter described. Upon the operation of the relay 28 and the consequent closing of the contact 30 there is grounded at 23 a circuit passing through the contact 30, the contact 33, the relay 34, the contact 35, thence through the heating coil of the thermostatic time switch 36 in the same circuit being of five hundred ohms resistance, therefore the circuit will be unbroken between grounds 23 and 37, permitting the current to flow through said circuit heating the thermostat until the thermostatic bar closes the contact 38, thereby short circuiting the heat coil of the thermostatic time switch, whereupon the entire strength of current is permitted to act upon the relay 34 causing it to attract its armature to make the contact 39 and break the contact 33. The contacts 33 and 39 are so constructed that the armature will make the contact 39 before the contact 33 is broken. The heat coil of the thermostatic time switch 36 is so wound and the contact 38 so regulated that an interval of time of predetermined length shall elapse between the closing of the circuit through the heat coil and the short circuiting thereof. In practice it has been found that an interval of from ten to twelve seconds will be sufficient.

The operation of the time switch 36 and the relay 34 closes a circuit from ground and battery 37, through contact 38 excluding the heat coil of the time switch, through the contact 35, the relay magnet 34, contact 39, contact 40, through the coil of the slow acting relay 41 and to ground at 42. This operation thus far has required a predetermined interval of time dependent upon the adjustment of the time switch 36 and contact 38. The relay 41 now operates to close contact 43 and at the same time break contact 44. The closing of the contact 43 by the operation of the relay 41 closes a circuit including the slow acting relay 45 and the time switch, the circuit passing from battery and ground 37 through the thermostat 36, contact 38, contact 35 and contact 43 to the relay 45, thence through battery to ground at 46. The relay 45 will not operate to attract its armatures however until after the thermostat cools sufficiently to open the contact 38, which will require a period of approximately six seconds. Until the operation of the relay 45, by which several contacts are controlled as hereafter mentioned, current will flow through the relay 41 which is grounded at 42, thence through the contact 40, the contact 39, previously closed by the relay 34, through said relay 34, the contact 35 and the thermostat 36, through battery to ground at 37. The line will also be closed from battery and ground 37 through contact 35, the contact 43 closed by the slow relay 41 and through the second slow acting relay 45 and battery to ground at 46, but as the battery at 37 is at one end of said line and the battery 46 at the opposite end of the line with the relay 45 between said batteries, the said relay 45 will be inoperative until the thermostat cools sufficiently to open the contact 38 which brings the resistance 36 into the circuit, whereupon the relay 45 will be energized. The slow acting relay 45 operating to attract its several armatures opens the contacts 35 and 40 and makes the contact 47. The opening of the contacts 35 and 40 breaks the circuit through the relays 34 and 41, allowing the relay 34 to release its armature which opens the contact 39 and remakes the contact 33, whereby current will again flow through the contact 30 which is grounded at 23 through the contact 33, the relay 34, the contact 43 which has not yet been opened due to the slow action of the slow relay 41, and thence through the slow acting relay 45 and battery to ground at 46, thus maintaining the attraction of the relay 45 for its armatures. The holding of the contacts by the relay 45 will be short however, as the current having been interrupted through the relay 41, by the opening of the contact 40 by the relay 45 as before mentioned, the said slow acting relay 41 will hold its armature a short time after the current has been so interrupted, continuing to supply current to the slow relay 45 through the contact 43 as described. However when the slow relay 41 releases its armature breaking the contact 43, the current supply to the second slow relay 45 is broken, but said slow acting relay will continue to attract its armatures maintaining the contact 47 closed and the contacts 35 and 40 open for a short time after the relay 41 is demagnetized to break the supply current. During this latter period after the relay 41 has been demagnetized and the supply of current to the relay 45 broken, but before the said relay 45 has released its armatures due to its slow action, the common line 27 will be grounded through contacts 44 and 47 to ground at 48 thus energizing the release magnet 25 of the first selector

through the contact 24 closed by the tell tale relay 19 to ground at 26. The energization of the release magnet 25 closes the contact 49 which grounds the release trunk 18 at 50, thereby energizing the release magnet 2 of the line switch which is also grounded through battery. The release magnet 2 thereupon attracts the armature 3 to elevate the tooth 10 above the plunger arm preparatory to returning the plunger arm and plunger to normal position upon the fall of the armature 3 at the demagnetization of the release magnet 2. When the slow acting relay 45, which has held momentarily after its supply current has been broken by the demagnetization of relay 41, releases its armatures the contact 47 is opened, thereby breaking the ground connection of the common line 27 and selector release magnet 25, which thereupon becoming demagnetized releases its armature breaking the contact 49 and removing the ground connection of the release trunk 18. This causes the demagnetization of the release magnet 2, permitting the armature 3 to fall, restoring the plunger arm and plunger to normal. This completes the cycle of operations by which the abnormally operated plunger is restored to normal. However in addition to the automatic restoring means as described, there is provided an automatic alarm which will give notice of abnormal operations of the apparatus in order that the cause of such abnormal operations, such as grounded lines, etc., may be removed. During the period that the contact 38 is closed by the thermostatic time switch a circuit is closed from the ground 37, the contact 35, relay 34 and contact 39 which energizes the slow acting relay 52 which is grounded at 53.

When the contact 38 is broken by the cooling of the thermostat as before mentioned, the relay 52 will continue to receive current from battery and ground 46 through relay 45, contact 43, relay 34, contact 39 and through relay 52 to ground at 53, as long as the slow acting relay 41 continues to attract its armature. The relay 52 is adjusted to slower action than the relay 45, hence is the last to operate. The relay 52 operates to close the contact 54 and to break the contact 21, and being slow acting retains said contacts in operated position a short time after the release impulse is sent over the line. The relay 52 serves two purposes. It affords resistance in the common line 20, and by closing the contact 54 it closes an alarm circuit from ground 32 through the said contact 54 to an alarm device 55 which may be either a light, a buzzer or a bell, and thence through battery to ground at 56. The alarm 55 gives notice that a line switch is about to be released and if it does not release, or if it does release and the plunger 7 immediately drops again as it would in the case of a grounded line, the release mechanism would complete a cycle of operations at each operation of the plunger, thereby causing the alarm 55 to give out an intermittent signal.

The automatic releasing system as herein described can be rendered common to any number of line switch trunks. The system cannot possibly interfere with regular calls by prematurely restoring the plunger since the switch 15 will shift to its succeeding position in the case of a regular call before the thermostatic time switch 36 shall have operated to close the contact 38. A release impulse cannot occur simultaneously with the operation of the plunger 7 because the tell tale relay 19 remains inoperative and does not attract its armature to close the contact 24 to cause the grounding of the release trunk, for a predetermined period of time prior to the release of the abnormally operated line switch. The automatic release system may be made common to any number of first selector trunks.

A condenser 57 may be bridged around the contact 47 to avoid a spark upon the operation of said contact.

While the automatic release system here described is illustrated in connection with the Keith system of automatic telephony and is herein described in such connection, it is to be understood that it may be applied to other systems, or may be employed for other analogous purposes, it is therefore not limited to the use and application herein mentioned.

From the above description it will be apparent that there is thus provided an automatically operating electric system possessing the particular features of advantage before enumerated as desirable, but which obviously is susceptible of modification in its form, connections, detail construction and arrangement of parts without departing from the principle involved or sacrificing any of its advantages, and it is to be understood that the invention is not limited to the particular form shown and described, and that the means and mechanism herein described represent but one mode of putting the invention into effect, and the invention is therefore claimed broadly in any of its possible forms or modifications within the scope of the appended claims.

Having thus described my invention I claim:

1. In an electrical apparatus, a main circuit, a switch adapted to close the circuit, a switch restoring magnet in said circuit adapted to open the switch, a relay also in the circuit affording such resistance as to normally prevent the operation of the switch restoring magnet at the closing of the circuit, and a supplemental circuit closed by the operation of said relay a slow acting member in said circuit adapted after

an interval of time to short circuit the resistance in the main circuit whereby the restoring magnet will be permitted to restore the switch and open the main circuit.

2. In an electrical apparatus, a main circuit, a switch adapted to close said circuit, a switch restoring magnet in said circuit, resistance in said circuit adapted to prevent the operation of the switch restoring magnet, and means including a slow acting switch energized by the closing of the main circuit for removing said resistance from the circuit, to permit the operation of the switch restoring magnet after the elapse of an interval of time from the closing of the main circuit.

3. In an electrical apparatus, a main circuit, a switch adapted to close the circuit, a switch restoring magnet in said circuit, a relay energized by the closing of said circuit by the switch, but normally preventing the operation of the restoring magnet, a supplemental circuit closed by the operation of said relay, a thermostatic switch in said circuit adapted by its operation to cause the relay of the main circuit to be short circuited, thereby permitting the operation of the switch restoring magnet.

4. In an electrical apparatus, a main circuit, a switch adapted to close the circuit, a switch restoring magnet in said circuit, a second circuit closed by the operation of the relay of the main circuit, a magnet in said second circuit adapted upon operation to close the main circuit in such way as to energize the restoring magnet, a relay also in said second circuit affording such resistance as to prevent the operation of the circuit closing magnet, a third circuit closed by the relay of the second circuit, a relay in said third circuit, and the heat coil of a thermostatic switch also in said circuit and affording such resistance that the relay will not operate until the heat coil is removed from the circuit, the said thermostatic switch being adapted to short circuit the heat coil after an interval of time from the closing of the circuit, thereby permitting the operation of the third circuit relay, which closes a succeeding circuit, a slow acting relay in the succeeding circuit which after the elapse of an interval of time acts to exclude the resistance from the second circuit mentioned permitting the second circuit magnet to operate to exclude the resistance from the main circuit enabling the restoring magnet to retract the switch.

5. In an electrical apparatus, a main circuit, a switch adapted to close said circuit, a switch restoring magnet in said circuit, resistance in said circuit normally preventing the operation of the restoring magnet, and means including a slow acting electrically controlled member for automatically removing the resistance from the circuit after the elapse of an interval of time from the closing of the circuit whereby the restoring magnet will be enabled to retract the switch substantially as specified.

6. In an electrical apparatus, a main circuit, a switch adapted to close said circuit, a switch restoring magnet in said circuit resistance in the circuit normally preventing the operation of the restoring magnet, a slow acting electrically controlled member energized through the closing of said circuit adapted by its operation to exclude the resistance from the restoring magnet circuit whereby the said magnet will operate to retract the switch, and a second slow acting electrically controlled member operating subsequent to the operation of the last mentioned slow acting member, to open the circuit to demagnetize the restoring magnet.

7. In an electrical apparatus, a main circuit, a switch adapted to close said circuit, a switch restoring magnet, a relay in the circuit with the magnet affording such resistance as to normally prevent the operation of the magnet, a second circuit, a magnet therein adapted to close an operating circuit through the restoring magnet, a relay also in said second circuit affording such resistance as to normally prevent the operation of said circuit closing magnet, a third circuit closed by the operation of the second circuit relay, a relay in said circuit and an electrically controlled slow acting member affording such resistance as to prevent the operation of the relay until after the operation of said slow acting member, whereupon the third circuit relay operates to remove the resistance from the second circuit enabling the circuit closing magnet to operate to close an energizing circuit through the restoring magnet, and means to automatically break said circuit.

8. In an electrical apparatus, a main circuit, a switch adapted to close said circuit, a switch restoring magnet, resistance in the circuit normally preventing the operation of the magnet, a second circuit having a magnet therein adapted upon operation to close an energizing circuit through the switch restoring magnet, resistance in said circuit normally preventing the operation of said magnet, and a slow acting electrically controlled member energized through the closing of the switch, and adapted by its operation to cause an energizing current to flow through the circuit closing magnet of the second circuit, which in turn will cause an energizing circuit to flow through the switch restoring magnet, and means for automatically breaking the said circuit after an interval of time.

9. In an electrical apparatus, a main circuit, a switch therein a switch restoring magnet, a slow acting electrically controlled member energized by the closing of the main

circuit switch adapted to close an energizing circuit through the switch restoring magnet after the elapse of an interval of time from the closing of the switch, and means to automatically break said circuit.

10. In an electrical apparatus, a main circuit, a switch therein, a slow acting electrically controlled restoring member energized by the closing of said main circuit switch adapted to open said switch after the lapse of an interval of time from the closing thereof, said restoring member being deënergized through the opening of said main circuit, substantially as specified.

In testimony whereof, I have hereunto set my hand this 11th day of September 1911.

THOMAS F. CROCKER.

Witnesses:
HARRY F. NOLAN,
F. L. WALKER.