Jan. 19, 1937. G. N. LEMMON 2,068,621

CIRCUIT BREAKER CONTROL

Filed July 15, 1933 2 Sheets-Sheet 1

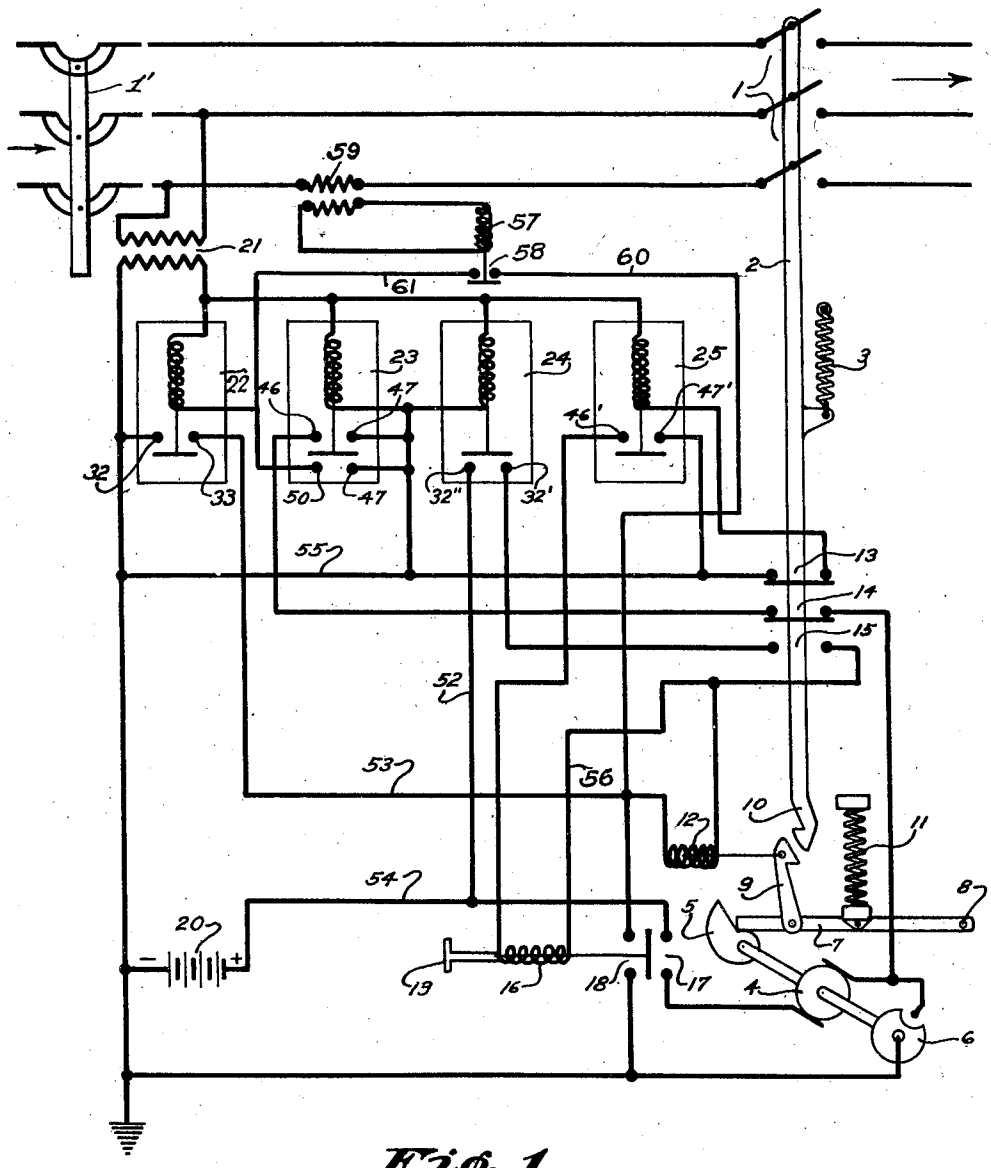



Fig. 1

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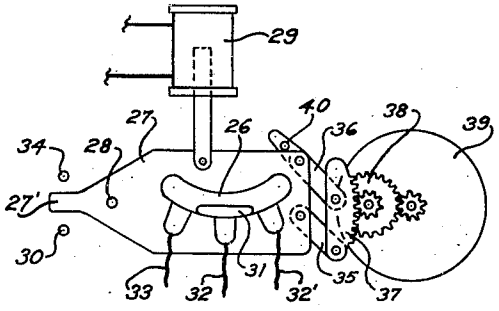



Fig. 2

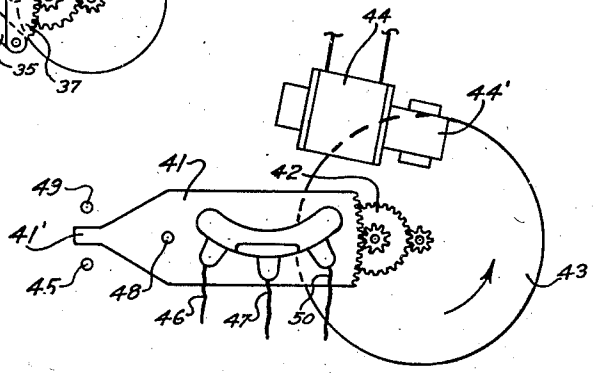



Fig. 3

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# UNITED STATES PATENT OFFICE

2,068,621

## CIRCUIT BREAKER CONTROL

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15 Claims. (Cl. 175—294)

One of the objects of my invention is to provide a simple and reliable means to operate a circuit breaker located in a main line at a remote distance from the power supply, without the need of a separate control or pilot circuit. The circuit breaker may either be of the type known as oil circuit breakers or of the type known as air-break switches.

A further object is to provide equipment to control a circuit breaker located in a main line at a distance from the power supply breaker, such control equipment acting automatically to open, reclose, re-open and lock-out the said line circuit breaker as required, and being regulated only by the conditions of voltage and current-flow in the said main line.

It is known that this general plan has been previously used by others, but it is believed that the method now disclosed is entirely new and original.

The desired objects are accomplished by employing an arrangement of relays which respond only to a pre-determined series of varied conditions in the main line, and when so responding the relays act to operate the breaker as desired. A selected series of varied conditions in the main line can be produced by opening and closing the station breaker through which power is supplied to the main line. A different series of conditions may be produced by including also the effect of overload in the line as one of the items in the series.

Referring to the drawings Fig. 1 is a diagram of one arrangement of circuit breakers, relays and auxiliaries, which employs my invention; and Figs. 2 and 3 are diagrams of some of the relays used, as will be explained later.

In Fig. 1, the line circuit breaker or switch 1 can be closed by means of the insulated member 2 against the action of the opening spring 3. A motor 4 drives the cam 5 and the cam-switch 6 counter-clockwise and at a speed which we may select as one revolution in 10 seconds. A bar 7 is pivoted at 8 and rests on the cam 5 so that the bar rises and falls as the cam 5 revolves. A hook 9 engages with a hook 10 in the lower end of 2 when the bar 7 is fully raised, and a compression spring 11 is strong enough to force 7 down against the resistance of the breaker 1 and the spring 3 when 9 and 10 are engaged. This closes the breaker 1 as the cam 5 is revolved to the position shown in Fig. 1.

A solenoid 12, when energized, disengages 9 from 10, whereupon the spring 3 acts to open 1 again. Auxiliary contacts 13 and 14 are automatically closed when 1 is open, and contacts 15 are closed when 1 is closed. A lockout coil 16, when energized, acts to open the contacts 17 and to close the contacts 18. The device is arranged so that these contacts will so remain until the push button 19 is used to re-set the lockout by opening the contacts 18 and closing 17. A battery 20 and a potential transformer 21 furnish power at suitable voltages to operate the motor 4 and also the various relays and control switches.

The relays 22, 23, 24 and 25 are the special ones upon which my invention depends. Fig. 2 shows relay 22 in diagram. A mercury-switch 26 is secured to a base 27 which is movable about the pivot 28. When 27 is rotated by the upward pull of the solenoid 29 until the arm 27' touches the stop 30, then the mercury 31 closes the contact between 32 and 33. When the base 27 is rotated by gravity until 27' is held by the stop 34, then the circuit 32—33 is open and 32—32' is closed. Attached to the end of 27 by two pivoted toggles 35 and 36 is a toothed segment 37 which engages with the pinion of the gear 38. The gear 38 in turn engages with the pinion of the inertia wheel 39. A stop 40 limits the travel of 36, and a suitable spring, not shown, tends to keep 40 against 27 as shown. It is evident that when 29 is energized 27 will be instantly lifted to its highest position, for 37 acts like a ratchet and slips past the teeth in the pinion of 38. But when 29 is deenergized and 27 drops downward then 37 engages fully with the pinion of 38, and the descent of 27 is delayed because it has to revolve the inertia wheel 39 in so doing. As a result, this relay 22 closes its contacts 32—33 instantly, but opens these contacts only after its solenoid has been de-energized for a predetermined interval. In the arrangement shown I select 2 seconds as this interval; but some other interval might be chosen as well, and the relay be adjusted accordingly.

Fig. 3 shows a relay which has a delayed action of 5 seconds in each direction. The mercury-switch has 3 contacts 46, 47, 50; and the base 41 engages continually with the pinion of the gear 42, which in turn revolves the pinion and the induction disc 43. This disc is between the poles 44' of the damped electro-magnet 44, and when 44 is energized the disc 43 is slowly revolved just as is the disc of the standard induction watt-hour meter.

As 43 is revolved counter-clockwise by 44, the base 41 is slowly raised until the arm 41' reaches the stop 45. The contacts 46—47 are then closed by the mercury which is inside the mercury switch. When 44 is de-energized, the weight of the base 41 and its attached parts tends to revolve it about the pivot 48, and the disc 43 acts as an inertia wheel and delays this motion. When 41' is against the stop 49, the contacts 46—47 are open and the contacts 47—50 are closed by the mercury. The parts are so proportioned that the desired 5-second interval is obtained in both motions of the relay. It will be noted that in Fig. 1 the diagram shows 23 as a 4-point relay, but the terminals are actually as

shown in Fig. 3, and there is only one contact terminal 47.

Relay 24 is similar to Fig. 2 except that the contacts 32—32' are the ones used, and the parts 35, 36, 37, 38, 39 and 40 are omitted. In Fig. 1 the contact 32'' designates the contact shown as 32 in Fig. 2. This relay gives an instantaneous action, with the relay contacts open when the coil is energized. If desired, an instantaneous relay of another design may be used at 24.

Relay 25 is similar to Fig. 3, with contact 50 not used, and the other contacts designated in Fig. 1 as 46'—47'.

The wiring diagram of one arrangement is shown in Fig. 1, and the chosen operating schedule required by this arrangement is as described in operations A, B, and C.

Operation A, to open 1 temporarily. Have power off the main line for 5 seconds or more, then put power on and take it off again within 2 seconds. This will open 1.

Operation B, to close 1. Apply power to the main line for 15 seconds. This will make 1 close.

Operation C, to open 1 and lock it open. Have 1 open, put power on the line for 15 seconds. This will close 1, as in operation B. Then within 2 seconds from the time 1 has closed take power off the line, and 1 will automatically open and lock itself out.

The different conditions named above seldom occur in the serial orders as given, under normal operation conditions. And so line switches fitted with this equipment are not apt to be operated accidently. In case of serious trouble on the line, however, the named conditions are apt to occur and then the line switches will automatically act to open themselves and clear the trouble.

Details are as follows:

*Operation A.*—Let it be assumed that the source of power is a generating station at the left, that the switch 1 is closed and that power flows through the line as indicated by the arrows to a load at the right. Under normal conditions power will be on the line, 9 engaged with 10, 1 held closed, contacts 15 closed, contacts 17 closed, coils of relays 23 and 24 energized, contacts 46—47 closed and all other relay contacts open. When power goes off the line, as by the opening of the breaker 1' at the generator station, 21 is de-energized and therefore so are the coils of relays 23 and 24. If power comes back in less than 5 seconds no change occurs. If power stays off for over 5 seconds contacts 46—47 are opened and contacts 47—50 are closed. When power comes back, whether in 10 seconds or two hours, the coils of 22, 23 and 24 are energized, thereby closing 33—32 and opening the contacts of relay 24 at 32'—32''.

If power stays on for 5 seconds, contacts 47—50 are opened, 22 is de-energized, and normal conditions are resumed. However, if power goes off within two seconds from the time 22 has been energized, then 24 is de-energized and closes its contacts at 32'—32'' while 33—32 are still closed, and the circuit is thereby closed from the battery 20 through 54, 52, 32''—32', 15, the trip coil 12, 53, 33—32, and so back to the other pole of the battery. Thus the coil 12 is energized, 9 is thereby disengaged from 10, and the spring 3 opens the line switch 1. This closes 13 and 14, and also opens 15.

Temporary line trouble, such as a momentary flashover, due to lightning, will cause the circuit-breaker at the generating station to open. Therefore the line has power go off, and the transformer 21 becomes de-energized. After an interval, which is generally between fifteen seconds and one minute, the breaker at the station is closed and the line becomes energized. In case the line trouble was only temporary, the overload will not be repeated at once, and the breaker will stay closed, thereby keeping the line energized and resuming service through the switch 1 to the load beyond 1, and in 5 seconds all relays have assumed normal position. This is normal operation, and despite the overload which opened the breaker at the generating station, the line switch 1 remains closed, because the contacts 33—32 and 32'—32'' are not both closed at the same time, under these conditions. On the other hand, if the line trouble is permanent, then when the station breaker is reclosed it will at once open again, thereby producing the conditions described under operation A and so causing the line switch 1 to open.

*Operation B.*—When power comes back on the line, the coil of 23 is energized and after 5 seconds 46—47 are closed, and the circuit is closed from the battery through 54—17, the motor 4, 14, 46—47, 55 and so to the battery negative. The motor 4 therefore starts to turn, 6 closes its contact and makes direct circuit back to the battery negative. Therefore the motor completes its cycle; the cam lifts 7 until 9 engages with 10; and, as the cam 5 continues to turn, the spring 11 forces 7 down and so closes 1. Meanwhile the motor circuit is opened simultaneously at 14 and at 6.

*Operation C.*—While 1 is open the contacts 13 are closed and so with power on the line 21 is energized, and the coil of 25 is energized, closing the contacts 46'—47' after 5 seconds. As soon as 1 closes as in operation B, contacts 15 are also closed, and if power goes off again within 5 seconds from the closing of 1, the coil of 24 is de-energized and the contacts 32''—32' are closed. Thus the circuit is completed from the battery through 54, 52, 32''—32', 15, 56, the lockout coil 16, 46'—47', 55, and so to the battery negative.

This operates the lockout coil 16 and opens the motor circuit at 17 so that reclosure is impossible; it also closes the contact 18 thus completing the circuit from the battery through 54, 52, 32''—32', 15, the trip coil 12, 18, to the battery negative. This operates the trip coil 12 and opens the switch 1, leaving it locked out until reset manually by 19.

It may sometimes happen that a short circuit occurs on the line so close to the switch 1 that sufficient voltage cannot be built-up on the line to energize properly the potential transformer 21. Under such conditions there would be excessive amperage in the line, and the desired results are then obtained by combining a current relay with the voltage relays and other devices. The current transformer 59 is connected directly to the relay 57, and upon excess overload the contacts 58 are thereby closed instantaneously. When power goes off, the contacts 58 open with a 2 second delay. Operation is as follows:

*Operation D.*—When power has been off the line for 5 seconds or more, with the switch 1 closed, and an excess overload suddenly comes on the line accompanied, or immediately followed, by a condition of no-voltage, then the switch 1 shall open.

With power off, the coils of 23 and 24 will be de-energized and the contacts 50—47 and 32''—32' will be closed. The contacts 50—47 do not

open for 5 seconds after power comes back and contacts 58 open with a 2 second delay, and contacts 32''—32' will not open until 21 is properly energized. Therefore, if an excess load is imposed on the line under such conditions that voltage does not build up, the relay 57 closes the contacts 58 and the tripping circuit is completed from the battery, through 54, 52, the contacts 32''—32', the switch 15, the trip coil 12, 60, contacts 58, 61 contacts 59—47 and 55 to the other side of the battery.

If voltage has been sufficient to operate the relay 24, then 32''—32' will open momentarily, but will close again as soon as power goes off the line due to opening the circuit breaker at the generating station.

In each of the various operations described above several successive steps are necessary; and it is obvious that if any one of these steps does not occur, then the resultant operation will not occur. In such case the relays tend to return to normal conditions.

One of the new features of my invention is the use of two or more relays having different periods of operation and different connections, but with their contacts in series, whereby a continuous momentary circuit through the relay contacts is completed if, and only in case, the correlated apparatus has just passed through a definite series of motions or changes within a predetermined time. This plan avoids the need for any motor driven timing devices which have to be closely coordinated with other similar equipment connected with the distant breaker at the source of power.

My relays have all the advantages of mercury-to-mercury contact and they also employ a design that readily gives a delay of several seconds. Coordination between different relays is thereby secured easily. With these relays, also, there is no problem of resetting them to normal position, since each relay always returns independently to its own normal position after a few seconds. The relays are readily arranged to give any desired time delay on either the opening or closing motions, and upon either the energizing or de-energizing of the coils.

Only a few series of actuating conditions have been described. It is obvious that many other modifications and changes in the schedule of conditions can be made without departing from the principles of my invention. It is also obvious that these principles of circuit breaker control can be used for a wide variety of purposes besides those here described in detail.

It is also obvious that this complete control consists of various interconnected relays which act in different groupings under different imposed conditions. Under one given set of conditions, the relays automatically form themselves into a group which acts in one pre-determined way. Under other conditions, the relays form into a different group, and this group acts in a different way from the first group. It is also obvious that if it is desired to obtain only the action which is produced by one group of the relays under one set of conditions, then it is only necessary to omit the relays which are not a part of the desired group. Such omission will not affect the operation of the relays which are retained and such changes do not depart from the spirit and purpose of this invention. The invention includes each of the separate operations described, as well as the complete interconnected system which properly meets whatever abnormal condition may be imposed upon it.

I claim:

1. A system of electrical circuit breaker control which comprises a source of supply, a main circuit for the distribution of power, a main circuit-breaker connected to the source and controlling the flow of current from the source to the main circuit, a line circuit-breaker in the main circuit and remote from the said main circuit-breaker, and automatic control equipment which includes devices which are operable to cause a primary opening of the line circuit-breaker if and only when the main circuit has remained de-energized for at least a predetermined time, and then been re-energized momentarily and then been de-energized again, all within a predetermined interval.

2. A system of electrical circuit breaker control which comprises a source of supply, a main circuit for the distribution of power, a main circuit-breaker connected to the source and controlling the flow of current from the source to the main circuit, a line circuit-breaker in the main circuit and remote from the said main circuit-breaker, and automatic control equipment located adjacent to the line circuit-breaker and operable to cause a primary opening of the line circuit-breaker if and only when the main circuit has remained de-energized for at least a predetermined time, and then been re-energized momentarily and then been de-energized again, all within a predetermined interval.

3. A system of electrical circuit breaker control which comprises a source of supply, a main circuit for the distribution of power, a main circuit breaker connected to the source and controlling the flow of power from the source to the main circuit, a line circuit breaker in the main circuit and remote from the said main circuit breaker, and automatic control equipment which includes devices which are operable to cause a primary opening of the line circuit breaker if and only when the main circuit has remained de-energized for at least a predetermined time, and then been re-energized momentarily and then been de-energized again, all within a predetermined interval, and which also includes devices which are then operable to close the line circuit breaker when it has been energized at one side for a predetermined time, and also operable to reopen it and keep it open if it is de-energized immediately after having been thus closed.

4. A system of electrical control which includes a main circuit and a circuit breaker connected thereto, electro-mechanical closing means to close the breaker and an electro-mechanical lockout device operable to render the said closing means inoperative, a relay which is operable when energized by power from the main circuit to close the operating circuit of the lockout device, and which is operable to open the said circuit of the lockout device with a predetermined time delay after the relay has been de-energized.

5. A system of electrical control which includes a main circuit and a circuit breaker connected thereto, electro-mechanical closing means to close the breaker and an electro-mechanical lockout device operable to render the said closing means inoperative, a relay which is operable when energized by power from the main circuit to close the operating circuit of the lockout device, and which is operable to open the said circuit of the lockout device with a predetermined time delay after the relay has been de-energized, a second

relay which is operable to close the said lockout circuit when this relay is de-energized by the de-energization of the main circuit, together with auxiliary switching equipment which is operable to energize the first relay when the breaker is open and the main circuit is energized and to de-energize the said first relay when the breaker is closed, said switching equipment being also operable in series with the contacts of the second relay to close the said circuit of the lockout device when the breaker is closed.

6. A system of electrical control which includes a main circuit and a circuit breaker connected thereto, electro-mechanical means operable to open the breaker when an auxiliary circuit is energized, and relay equipment which is operable when energized by power from the main circuit to open the said auxiliary circuit with a predetermined time delay after the relay equipment has been so energized.

7. A system of electrical circuit-breaker control which comprises a source of supply, a main circuit for the distribution of power, a main circuit-breaker connected to the source and controlling the flow of power from the source to the main circuit, a line circuit-breaker in the main circuit with automatic control equipment located adjacent to it, and containing devices which are operable to cause a primary opening of the line circuit-breaker under overload conditions in case, and only in case, the said main circuit shall have remained de-energized for at least a predetermined interval just prior to the occurrence of said overload conditions.

8. A system of electrical circuit breaker control which comprises a source of supply, a main circuit for the distribution of power, a main circuit breaker connected to the source and controlling the flow of power from the source of the main circuit, a line circuit breaker in the main circuit and remote from the said main circuit breaker, and automatic control equipment which includes devices which are operable to cause a primary opening of the line circuit breaker if and only when the main circuit has remained de-energized for at least a predetermined time and then been re-energized momentarily and then been de-energized again all within a predetermined interval, and also operable to close the line circuit breaker when it has been open and has been energized at one side for a predetermined time interval.

9. A system of electrical circuit breaker control which comprises a source of supply, a main circuit for the distribution of power, a main circuit breaker connected to the source and controlling the flow of power from the source to the main circuit, a line circuit breaker in the main circuit and remote from the said main circuit breaker, and control equipment which includes devices that are located adjacent to the line circuit breaker and are operable automatically to close the line circuit breaker when it has been open and energized at one side for at least a predetermined time, and also operable to prevent subsequent automatic reclosing in case, and only in case, the main circuit becomes de-energized immediately after the line circuit breaker has been closed as said.

10. A system of electrical circuit breaker control as described in claim 8 and operable to be opened and closed as there described, and also operable to return to normal conditions in case the line circuit breaker shall remain energized for a predetermined time interval after being so opened and closed.

11. A system of electrical circuit breaker control which comprises a source of supply, a main circuit for the distribution of power, a main circuit breaker connected to the source and controlling the flow of power from the source to the main circuit, a line circuit breaker connected to the main circuit and remote from the said main circuit breaker, and automatic control equipment which includes devices which are operable to cause a primary opening of the line circuit breaker if and only when the main circuit has remained de-energized for at least a predetermined time, and then been re-energized and overloaded, and then been de-energized again, all within a predetermined interval.

12. In combination, a circuit breaker and control equipment which includes three relays operable in coordination to cause an opening of the circuit breaker, one of said relays closing its contacts when de-energized and keeping them closed for a given interval after being re-energized, a second of said relays closing its contacts instantly when energized and keeping them closed for a given interval after being de-energized, and the third of said relays opening its contacts instantly when energized and closing its contacts instantly when de-energized.

13. In combination, a circuit breaker and control equipment which includes three relays operable in coordination to cause an opening of the circuit breaker, instantly when energized, one of said relays closing its contacts when de-energized and keeping them closed for a given interval after being re-energized, a second of said relays closing its contacts upon occurrence of overload through the circuit breaker, and the third relay closing its contacts when de-energized.

14. A system of electrical circuit breaker control which comprises a source of supply, a main circuit for the distribution of power, a main circuit breaker connected to the source and controlling the flow of power from the source to the main circuit, a line circuit breaker in the main circuit and remote from the said main circuit, and automatic control equipment which includes devices which are operable to cause a primary opening of the line circuit breaker if and only when the main circuit has remained de-energized for at least a predetermined time and then been re-energized and overloaded and then been de-energized again all within a predetermined interval, and also operable to close the line circuit breaker when it has been open and has been energized at one side for a predetermined time interval.

15. A system of electrical circuit breaker control as described in claim 14 and operable to open and close the line circuit breaker as there described, and also operable to return to normal conditions in case the line circuit breaker shall remain energized for a predetermined time interval after being so opened and closed.

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