Sept. 7, 1943. M. E. REAGAN ET AL 2,329,082

CIRCUIT BREAKER CONTROL SYSTEM

Filed Dec. 16, 1941

Fig. 1.

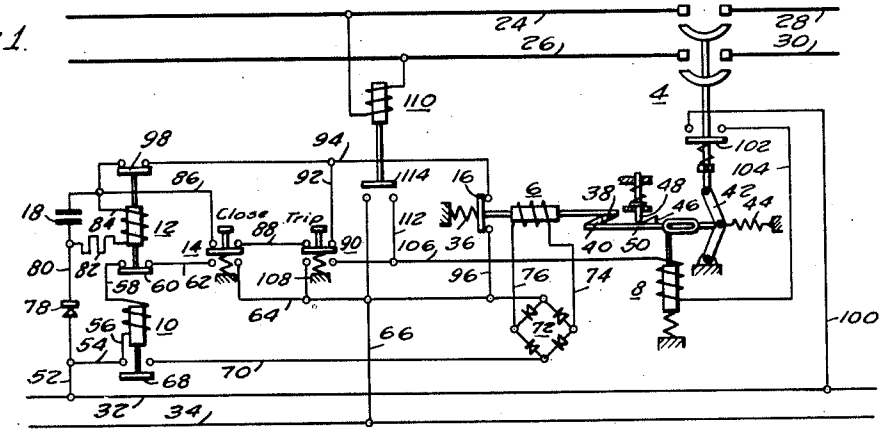


Fig. 2.

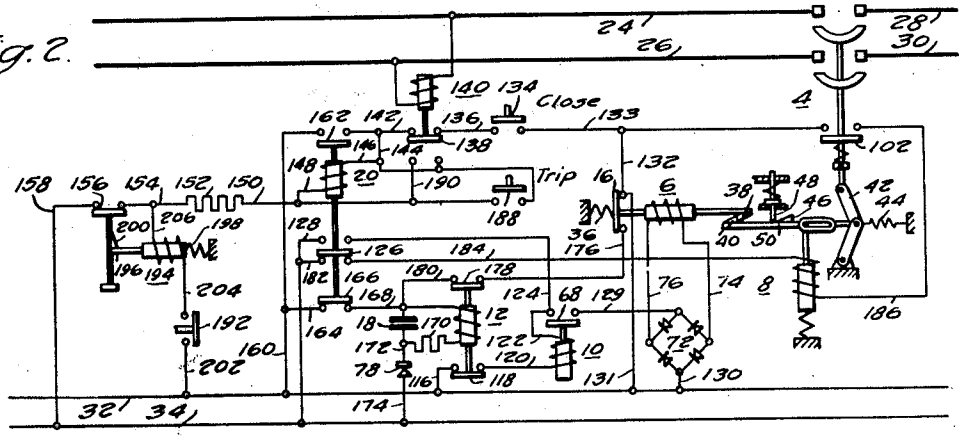
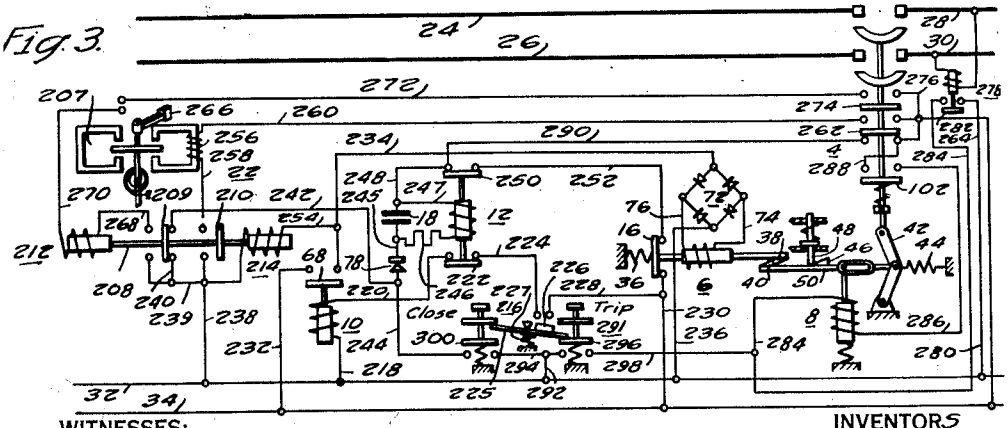


Fig. 3.



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Patented Sept. 7, 1943

2,329,082

UNITED STATES PATENT OFFICE

2,329,082

CIRCUIT BREAKER CONTROL SYSTEM

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Application December 16, 1941, Serial No. 423,191

8 Claims. (Cl. 175—294)

Our invention relates, generally, to circuit breaker control systems and, more particularly, to control systems embodying anti-pumping means and means for positively closing and latching circuit breakers.

In previously known circuit breaker closing systems in which a plurality of relays have been employed to close a circuit breaker and have been interconnected to prevent pumping of the breaker, it has been found that the relay system often releases before the circuit breaker latches in closed position, thus resulting in failure of the circuit breaker to positively close and latch.

It is an object of our invention to provide a circuit breaker control system which shall function to so control a circuit breaker as to positively close and latch the breaker, and which shall be simple and efficient in operation and inexpensive to manufacture, install, operate, and maintain.

These and other objects and advantages of the invention will be apparent from the following detailed description taken in connection with the accompanying drawing, in which like reference characters indicate like parts in the several figures, and in which,

Figures 1, 2, and 3 are each a diagrammatic view of a circuit breaker control system embodying the principal features of the invention.

In practicing the invention, in the embodiment of Fig. 1, a circuit breaker 4 having a trip-free operating mechanism including a closing coil 6 and a trip coil 8 is shown. A relay 10 controls the closing coil 6 and is, in turn, controlled by a relay 12 and a "close" circuit control device 14. The relay 12 is held energized in a circuit which includes a contact element 16 actuated to open position by the operation of the breaker operating mechanism by the coil 6. A capacitor 18 is connected in shunt or parallel relation with the winding of the relay 12 to continue the energization of the relay 10 and the closing coil 6 for an interval after the breaker has closed, thereby insuring that the breaker will be positively closed and latched before release of the closing coil 6.

The embodiment of the invention shown in Fig. 2 is a circuit breaker control system such as may be employed at automatic stations and has a master relay 20 through which the relays 10 and 12, the capacitor 18, and the closing and trip coils 6 and 8 function in a manner similar to the system of Fig. 1.

The system of Fig. 3 is an automatic reclosing system embodying the principles of the closing elements of the systems of Figs. 1 and 2, and including an automatic timing means or recloser 22 for preventing the breaker 4 from reclosing in the event that it trips within a predetermined time after any closure.

Considering the invention more in detail, with reference to Fig. 1, the circuit breaker 4 may be disposed to connect a power bus represented by the conductors 24 and 26 with a distribution line including conductors 28 and 30. A source of alternating current control power, represented by the conductors 32 and 34, may be provided. It is to be understood that it is not necessary that the control power be alternating current, and in the event that direct current control power is provided, the rectifiers referred to hereinafter may be omitted and direct connection may be made to the elements of the system to which the rectifiers supply direct current power.

The closing coil 6 of the circuit breaker 4 operates against the bias of a spring member 36 and through engaging detents 38 and 40 to move the linkage 42 against the bias of a spring member 44 to close the circuit breaker. When the circuit breaker is in closed position, a detent 46 on an arm 50, which actuates the linkage 42, will be engaged by a spring-pressed detent 48 to hold the circuit breaker in closed circuit position. The trip coil 8 of the circuit breaker when energized will function to move the arm 50 downwardly to disengage the detent 46 from the detent 48 and permit the spring member 44 to actuate the linkage 42 to move the circuit breaker to open circuit position.

An energizing circuit is provided for the relay 10 extending from the conductor 32 through conductors 52, 54, and 56, the winding of the relay 10, a conductor 58, a contact element 60 of the relay 12, a conductor 62, contact element of the "close" circuit control device 14, and conductors 64 and 66 to the conductor 34. The relay 10 controls an energizing circuit for the closing coil 6 of the circuit breaker 4 which extends from conductor 32 through the conductors 52 and 54, a contact element 68 of the relay 10, a conductor 70, a full-wave rectifier device 72, conductors 74 and 76 connected between the rectifier 72 and the winding of the closing coil 6, and conductors 64 and 66 to the conductor 34.

A normal energizing circuit is provided for the relay 12 and extends from the conductor 32 through the conductor 52, a rectifier 78, a conductor 80, a resistor 82, the winding of the relay 12, conductors 84 and 86, a contact element of the circuit control device 14 in back contact position, a conductor 88, a contact element of a "trip" circuit control device 90 in back contact

position, conductors 92 and 94, the contact element 16 actuated by the circuit breaker closing coil 6, and conductors 96, 64, and 66 to conductor 34.

The relay 12 also controls its own holding circuit extending from the conductor 32 through the conductor 52, the rectifier 78, the conductor 80, the resistor 82, the winding of the relay 12, the conductor 84, a contact element 98 of the relay 12, the conductor 94, the contact element 16, and conductors 96, 64, and 66 to the conductor 34.

A condenser 18 is connected in shunt circuit relation with the winding of the relay 12 and the resistor 82 in a circuit which extends from a terminal of the resistor 82 through the conductor 86, the condenser 18, and conductors 88 and 84 to a terminal of the winding of the relay 12. While the relay 12 is energized, the condenser 18 is also energized and held in charged condition until the energizing circuit for the relay 12 is opened by the movement of the contact element 16 to open circuit position when the closing coil 6 is actuated, at which time the condenser 18 will discharge through the winding of the relay 12 and the resistor 82 to maintain energization of the relay 12 and delay its release for an interval after its energizing circuit is opened.

An energizing circuit for the trip coil 8 extends from the conductor 32 through a conductor 100, a contact element 102 actuated by the circuit breaker 4, a conductor 104, the winding of the trip coil 8, a conductor 105, the contact element of the circuit control device 90 in front contact position, and conductors 108, 64, and 66 to the conductor 34. A voltage responsive or any other suitable protective relay 110 is connected to the power bus conductors 24 and 26 to trip the circuit breaker when the potential on the power bus conductors 24 and 26 falls below a predetermined amount. The trip circuit controlled by the relay 110 extends from the conductor 32 through the conductor 100 to contact element 102, the conductor 104, the winding of the trip coil 8, conductors 106 and 112, a contact element 114 of the relay 110, and conductor 66 to the conductor 34.

In the operation of the system of Fig. 1, the relay 12 will be normally held energized in the circuits hereinbefore described. When it is desired to close the circuit breaker, the "close" circuit control device 14 may be manually actuated to close the energizing circuit for the relay 10, which, in turn, will close the energizing circuit for the closing coil 6 of the circuit breaker 4. When the closing coil 6 actuates the circuit breaker to closed position, the contact element 16 will be moved to open circuit position to open the holding circuit for the relay 12. However, the relay 12 will not release immediately but will be held energized by the discharge of the condenser 18 through the winding of the relay 12, thus maintaining the relay 10 and, therefore, the winding of the closing coil 6 energized for an interval of time after the closing coil 6 has actuated the circuit breaker 4 to closed position to thereby insure that the circuit breaker will be positively closed and the latch members 46 and 48 will be positively engaged to hold the circuit breaker in closed position before the closing coil 6 is deenergized.

In the embodiment of the invention of Fig. 2, the energizing circuit for the relay 10 extends from the conductor 32 through a conductor 116, a contact element 118 of the relay 12, a conductor 120, the winding of the relay 10, conductors 122 and 124, a contact element 126 of the relay 20 in front contact position, and a conductor 128 to the conductor 34. The relay 10 energizes the winding of the closing coil 6 of the circuit breaker 4 in a circuit which extends from the conductor 34 through the conductor 128, the contact element 126, the conductor 124, the contact element 68 of the relay 10, a conductor 129 to the rectifier 72, the conductors 74 and 76 extending between the rectifier 72 and the closing coil 6, and a conductor 130 to the conductor 32.

An energizing circuit is provided for the relay 20 extending from the conductor 32 through the conductors 131, 132 and 133, a closed contact element 134, a conductor 136, a contact element 138 of a potential responsive or other suitable protective relay 140 which is connected to the conductors 24 and 26, conductors 142, 144, and 146, the winding of the relay 20, conductors 148 and 150, a resistor 152, a conductor 154, a contact element 156, and a conductor 158 to the conductor 34. The relay 20 controls its own holding circuit extending from the conductor 32 through a conductor 160, a contact element 162 of the relay 20, the conductors 142, 144 and 146, the winding of relay 20, conductors 148 and 150, the resistor 152, the conductor 154, the contact element 156, and the conductor 158 to the conductor 34. The relay 20 in deenergized position controls an energizing circuit for the relay 12 extending from the conductor 32 through the conductors 160 and 164, a contact element 166 of the relay 20 in back contact position, a conductor 168, the winding of the relay 12, a resistor 170, a conductor 172, a rectifier 78, and a conductor 174 to the conductor 34.

The relay 12 controls its own holding circuit extending from the conductor 32 through the conductor 131, the contact element 16, a conductor 176, a contact element 178 of the relay 12, conductors 180 and 168, the winding of the relay 12, the resistor 170, the conductor 172, the rectifier 78, and the conductor 174 to the conductor 34.

An energizing circuit for the trip coil 8 of the circuit breaker 4 is controlled by the contact element 126 of the relay 20 in back contact position in a circuit extending from the conductor 34 through conductors 128 and 182, the contact element 126, a conductor 184, the winding of the trip coil 8, a conductor 186, the contact element 102 actuated by the circuit breaker 4, and conductors 133, 132, and 131 to the conductor 32.

The relay 20 may be released by a "trip" contact element 188 which closes a shunting circuit for the winding of the relay 20 extending from one terminal of the winding relay 20 through the conductors 146 and 144, the contact element 188, and conductors 156 and 148 to the other terminal of the winding of the relay 20. Another shunting circuit is controlled by the contact element 138 of the voltage responsive relay 140 extending from one terminal of the winding of the relay 20 through the conductors 146 and 144, the contact element 133, and conductors 190, 150, and 148 to the other terminal of the winding of the relay 20.

It is to be understood that the system of Fig. 2 is such a system as may be employed at a remotely controlled automatic substation, and that the "close" contact element 134 and the "trip" contact element 188 may be contact elements controlled by a supervisory or other control system extending between a control station and the remote station at which the circuit breaker 4 is located.

A contact element 192 controls a relay 194 which is disposed to actuate a detent 196 against the bias of a spring member 198 to move the detent 196 from engagement with a detent 200 which will permit the contact element 156 to be released to move to open circuit position. The energizing circuit for the relay 194 extends from the conductor 32 through a conductor 202, the contact element 192, a conductor 204, the winding of the relay 194, conductors 206 and 154, the contact element 156, and the conductor 158 to the conductor 34. This release of the contact element 156 will break the energizing circuits for the relay 20 and will hold the energizing circuit open until the contact element 156 is moved manually back to closed circuit position.

It is to be understood that the contact element 192 which controls the relay 194 may be any contact element moved to closed circuit position by any protective device which is operated by a condition at the substation, which, when it occurs, makes it desirable that the circuit breaker 4 be maintained in open circuit position until the condition is investigated and remedied. Such a condition may be an extremely high bearing temperature on apparatus connected to the conductors 28 and 30 which are fed from the conductors 24 and 26 through the circuit breaker 4.

In the operation of the system of Fig. 2, when it is desired to put the apparatus at the substation in operation by closing the circuit breaker 4, the contact element 134 will be actuated to closed circuit position, and the energizing circuit for the relay 20 will be completed thereby. When the relay 20 is actuated, its contact element 162 will close the holding circuit for the relay 20, and the contact element 126 of the relay 20 will close the energizing circuit for the relay 10, which, in turn, will close the energizing circuit for the closing coil 6.

When the closing coil 6 is actuated to close the circuit breaker 4, its contact element 16 will move to open circuit position to thereby break the holding circuit for the relay 12. However, the relay 12 will not release immediately but will be held energized by the discharge of the condenser 18 through the winding of the relay 12. The relay 12, the relay 10, and the closing coil 6 will thereby be maintained energized for a short interval after the closing coil 6 has actuated the circuit breaker to closed circuit position to insure that the circuit breaker is fully actuated to the closed circuit position and that the latch members 46 and 48 are properly engaged to hold the circuit breaker in closed circuit position.

When it is desired to trip the circuit breaker 4, the trip contact element 188 will be actuated to release the relay 20, and the contact element 126 will cause the tripping coil 8 to be energized, thereby tripping the breaker. When the relay 20 is released, its contact element 166 will energize the relay 12, which, in turn, will close its own holding circuit and thereby remain in actuated position.

The embodiment of the invention of Fig. 3 is a circuit breaker control system which functions to automatically open the breaker in response to a fault on the conductors 28 and 30 to immediately reclose the breaker, and to prevent the breaker from closing a second time in the event that the breaker fails to remain closed for a predetermined time after the first reclosure.

The timing device or recloser comprises a timing element 207 and a relay element 208. The relay element has a pair of contact elements 209 and 210 disposed to be moved to the right-hand position, in which they are shown in the drawing, by a coil 212 and to a left-hand position by a coil 214, and are adapted to remain in the position to which they are moved by either the coil 212 or the coil 214.

A "close" circuit control device 216 is disposed to close an energizing circuit for the relay 10 extending from the conductor 32 through a conductor 218, the winding of the relay 10, a conductor 220, a contact element 222 of the relay 12, a conductor 224, a contact element 226 which is actuated to closed position by the circuit control device 216 and which is mounted on an arm 225 which is adapted to be held in the position to which it is moved by a spring member 227, and conductors 228 and 230 to the conductor 34. The relay 10 when actuated closes an energizing circuit for the closing coil 6 of the circuit breaker 4 which extends from the conductor 34 through a conductor 232, the contact element 68 of the relay 10, a conductor 234, the rectifier 72, conductors 74 and 76 extending between the rectifier 72, and the closing coil 6, and a conductor 236 to the conductor 32.

The contact element 209 in its right-hand position forms part of a holding circuit for the relay 12 which extends from the conductor 32 through the conductors 238, 239, and 240, the contact element 209, conductors 242 and 244, the rectifier 78, a conductor 245, a resistor 246, the winding of the relay 12, conductors 247 and 248, a contact element 250 of the relay 12, a conductor 252, the contact element 16, and the conductor 230 to the conductor 34. The contact element 68 of the relay 10 controls an energizing circuit for the coil 214 extending from the conductor 34 through the conductor 232, the contact element 68 of the relay 10, conductors 234 and 254, the winding of the relay 214, and conductors 239 and 238 to the conductor 32.

The timing element 207 has a winding 256 which is controlled by the contact element 210 in left-hand position in a circuit which extends from the conductor 32 through the conductor 238, the contact element 210, a conductor 258, the winding 256, a conductor 260, the contact element 262 which is actuated by the circuit breaker 4, and a conductor 264 to the conductor 34. The timer element winding 256 is thus energized while the circuit breaker 4 is in closed circuit position, and the contact element 210 is in circuit closing position. After the time interval for which the timing device 22 is adjusted, its contact element 266 will be moved to circuit closing position to close an energizing circuit for the coil 212 which extends from the conductor 32 through the conductors 238 and 239, the contact element 208, a conductor 268, the coil 212, a conductor 270, the contact element 266, a conductor 272, a contact element 274 which is actuated by the circuit breaker 4, and conductors 276 and 264 to the conductor 34.

An overload or other suitable protective relay 278, connected to the conductors 28 and 30 to respond to an overload or other fault such that is is desired to trip the circuit breaker 4, will close an energizing circuit for the trip coil 8 of the circuit breaker 4 which extends from the conductor 32 through a conductor 280, a contact element 282 of the relay 278, a conductor 284, the winding of the tripping coil 8, a conductor 286, the contact element 102, and conductors 288, 276, and 264 to the conductor 34.

Under normal conditions, the energizing cir-

cuit for the relay 12 which will pick it up and allow it to close its own holding circuit is controlled by the contact element 262 which is actuated by the circuit breaker 4. This circuit extends from the conductor 32 through the conductors 238, 239, and 240, the contact element 209 in the right-hand circuit closing position, the conductors 242 and 244, the rectifier 78, the conductor 245, the resistor 246, the winding of the relay 12, the conductors 247, 248, and 293, the contact element 262 in back contact position, and conductors 276 and 264 to the conductor 34.

Another energizing circuit for the tripping coil 8 is controlled by a manually operable circuit control device 291 and extends from the conductor 32 through the conductors 292 and 294, a contact element 296 of the circuit control device 291, conductors 293 and 284, the winding of the trip coil 8, the conductor 286, the contact element 102, and the conductors 288, 276 and 264 to the conductor 34. The actuation of the circuit control device 291 will also move the contact element 225 to open circuit position.

A contact element 300 actuated by the circuit control device 216 is provided to complete an energizing circuit for the relay 12 when the circuit breaker 4 opens in the event that the contact element 209 is not in the right-hand circuit closing position when the system is placed into operation by the actuation of the circuit breaker control device 216.

In the operation of the embodiment of the invention of Fig. 3, when it is desired to place the system in operation, the circuit control device 216 may be manually actuated to energize the relays 10 and 12. The closing coil 6 will be energized as a result of the actuation of the relay 10, and the coil 214 will move the contact elements 209 and 210 to the left-hand circuit closing position. When the circuit breaker closes, the contact element 262 will move into position to close the energizing circuit of the winding 256 of the timing element to initiate its operation, and the contact element 16 will move to open circuit position to open the holding circuit of the relay 12. The relay 12 will be maintained energized, however, by the discharge of the condenser 18 through the winding of the relay 12, and the relay 10 and the closing coil 6 will be maintained energized until the relay 12 is released after the time delay caused by the discharge of the condenser 18 through the winding of the relay 12. After the time interval for which the timing device 22 has been adjusted has elapsed, the contact element 266 thereof will be actuated to circuit closing position to energize the coil 212, which, in turn, will move the contact elements 209 and 210 to the right-hand position.

Should the circuit breaker 4 be tripped by the protective relay 278, the energizing circuit for the relay 12 will be closed by the contact element 262 on the breaker, and the relay 12 will pick up to energize the relay 10 to thereby immediately energize the closing coil 6 to close the breaker. The energization of the relay 10 will energize the coil 214 to cause the contact element 209 to open the energizing circuit for the relay 12, and if the circuit breaker trips again immediately before the timing device 22 has closed its contact element 266, the timing device will be deenergized by the movement of the contact element 262 from front contact position, and there will be no further movement of the contact element 266 to again energize the coil 212 and cause the contact element 208 to close the energizing circuit for the relay 12. The circuit breaker 4 will thus be locked out until it is again placed into operation manually by the actuation of the circuit control device 216.

It is to be understood that the relays 110 and 140 of Figs. 1 and 2 respectively are merely illustrative of one type of protective relay and that contact elements of protective relays such as the fault relay 278 of Fig. 3 may be employed instead of or in addition to the relays 110 and 140 to perform the function of controlling the circuits controlled by the relays 110 and 140.

Thus, it will be seen that we have provided a circuit breaker control system which shall function to so control a circuit breaker as to positively close and latch the breaker and which shall be simple and efficient in operation and inexpensive to manufacture, install, operate, and maintain.

In compliance with the requirements of the patent statutes, we have shown and described herein preferred embodiments of our invention. It is to be understood, however, that the invention is not limited to the precise constructions shown and described but is capable of modification by one skilled in the art, the embodiments herein shown being merely illustrative of the principles of our invention.

We claim as our invention:

1. In a control system for a circuit breaker having closing means, a first relay for energizing said breaker closing means, a second relay for energizing said first relay, means including circuit means normally energizing said second relay, means responsive to the closing of the breaker for opening the energizing circuit for the second relay, and energy storing means connected in circuit with the second relay for automatically delaying the release of the second relay when its energizing circuit is opened.

2. In a circuit breaker closing system, a first relay for energizing the closing means of the breaker, a second relay for energizing said first relay, means including circuit means normally energizing said second relay, means responsive to the closing of the breaker for opening the energizing circuit for the second relay, and a capacitor means connected in shunting circuit relation with the winding of the second relay to thereby delay the release of the second relay when its energizing circuit is opened.

3. In a circuit breaker control system, a first relay connected to energize the closing means of the circuit breaker, a second relay, a circuit control device, an energizing circuit for said first relay including the circuit control device and a front contact element of the second relay, means including an energizing circuit normally energizing the second relay, said energizing circuit for the second relay including a back contact element actuated by the closing mechanism of the circuit breaker, and a capacitor connected in shunting relation with the winding of the second relay to thereby delay the release of the second relay after its energizing circuit has been opened by the operation of the circuit breaker closing mechanism.

4. In a circuit breaker control system, a first relay connected to energize the closing means of the circuit breaker, a second relay and a third relay, an energizing circuit for said first relay including a front contact element of said second relay and a front contact element of said third relay, a first energizing circuit for the second relay including a back contact element of the

third relay, a second energizing circuit for the second relay including a front contact element of the second relay and a back contact element actuated by the closing mechanism of the circuit breaker, a control contact device, a first energizing circuit for the third relay including said control contact device, a second energizing circuit for the third relay including a front contact element of the third relay, and means for automatically delaying the release of the second relay after its energizing circuit has been opened by the operation of the circuit breaker closing mechanism.

5. In a circuit breaker control system, a first relay connected to energize the closing means of the circuit breaker, a second relay and a third relay, an energizing circuit for said first relay including a front contact element of said second relay and a front contact element of said third relay, a first energizing circuit for the second relay including a back contact element of the third relay, a second energizing circuit for the second relay including a front contact element of the second relay and a back contact element actuated by the closing mechanism of the circuit breaker, a control contact device, a first energizing circuit for the third relay including said control contact device, a second energizing circuit for the third relay including a front contact element of the third relay, and a capacitor connected in shunting circuit relation with the winding of the second relay to thereby delay the release of the second relay after its energizing circuit has been opened by the operation of the circuit breaker closing mechanism.

6. In a circuit breaker control system, a first relay, an energizing circuit for the closing means of the circuit breaker including a front contact element of the first relay, a second relay, and a third relay, a first energizing circuit for the second relay including a back contact element actuated by the circuit breaker and a contact element actuated to open circuit position by the energization of the third relay, a second energizing circuit for the second relay including a front contact element of the second relay, a back contact element actuated by the circuit breaker closing mechanism and a back contact element actuated to open circuit position by the energization of the third relay, an energizing circuit for the first relay including a front contact element of the second relay, an energizing circuit for the third relay including a front contact element of the first relay, means responsive to the actuation of the third relay for causing reclosure of the part of the energizing circuits for the second relay which is opened by the third relay a predetermined time after the actuation of the third relay, and means for automatically delaying the release of the second relay after its energizing circuit has been opened by the operation of the circuit breaker closing mechanism.

7. In a circuit breaker control system, a first relay, an energizing circuit for the closing means of the circuit breaker including a front contact element of the first relay, a second relay, and a third relay, a first energizing circuit for the second relay including a back contact element actuated by the circuit breaker and a contact element actuated to open circuit position by the energization of the third relay, a second energizing circuit for the second relay including a front contact element of the second relay, a back contact element actuated by the circuit breaker closing mechanism and a back contact element actuated to open circuit position by the energization of the third relay, an energizing circuit for the third relay including a front contact element of the first relay, means responsive to the actuation of the third relay for causing reclosure of the part of the energizing circuits for the second relay which is opened by the third relay a predetermined time after the actuation of the third relay, and capacitor means connected in shunting circuit relation with the winding of the second relay to thereby delay the release of the second relay after its energizing circuit has been opened by the energization of the third relay.

8. In a circuit breaker closing system, a first relay for energizing the closing means of the breaker, a second relay for energizing the first relay, a normally closed direct current energizing circuit for the second relay including a resistor, a capacitor connected in shunting relation with the part of the energizing circuit for the second relay which includes the second relay winding and the resistor, and means responsive to the closure of the breaker for opening the energizing circuit for the second relay.

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