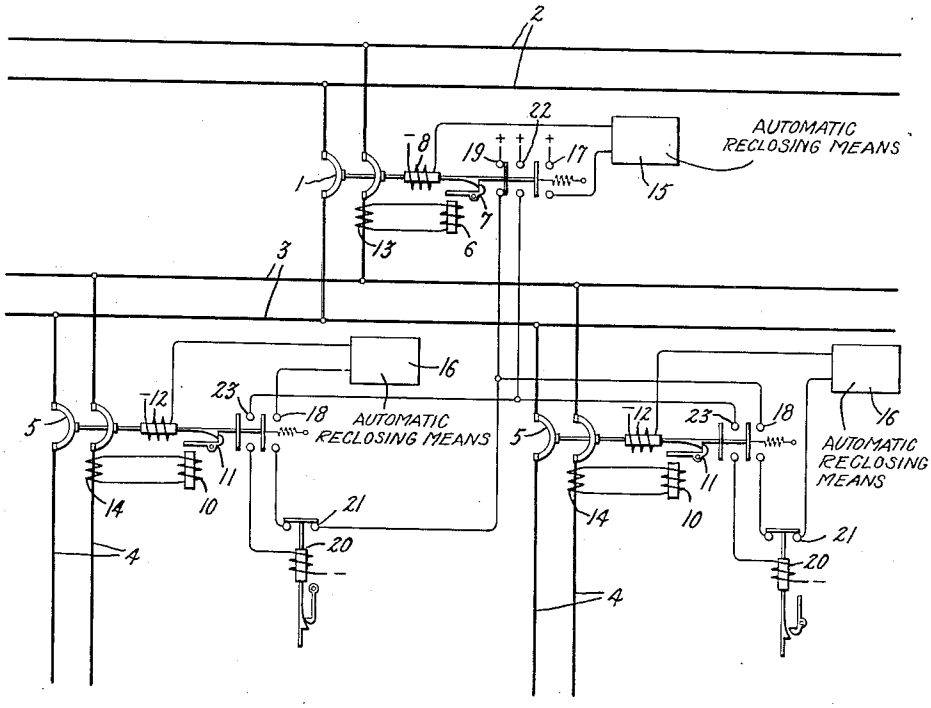
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AUTOMATIC RECLOSING CIRCUIT BREAKER SYSTEMS

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AUTOMATIC RECLOSING CIRCUIT BREAKER SYSTEM

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My invention relates to automatic reclosing circuit breaker systems, and its object is to provide an automatic reclosing arrangement for circuit breakers connected in cascade.

In the A. I. E. E. technical paper 41—128 entitled "Protection of Low Voltage Circuits by Air Circuit Breakers in Cascade Arrangement" preprinted May 1941 and presented at the A. I. E. E. Summer Convention, Toronto, Ontario, Canada, June 1941, C. H. Black and I pointed out how circuit breakers of different interrupting ratings, properly co-ordinated in design, may be used in a cascade or series connection in such a manner that, in the event of a severe fault, the main circuit breaker "backs up" the smaller breakers in series therewith so that only the main circuit breaker need have an interrupting rating equal to or in excess of the maximum short-circuit current obtainable through the series connected circuit breakers. The cascading of circuit breakers makes possible a simple means of selecting circuit breakers in order to obtain an economical yet adequate protection for relatively small installations where a complete short-circuit study might be difficult to justify and where a poor selection of protective devices would result in either an unnecessarily expensive installation or a serious hazard.

Since the interrupting rating of the main circuit breaker, when properly selected for cascade operation, is equal to or exceeds the maximum short-circuit current obtainable in the circuit and whereas the interrupting rating of the smaller breakers in series therewith may be exceeded considerably during a short-circuit, it is desirable not to put the smaller circuit breaker back into service after it has been opened by a short-circuit until after it has been inspected and serviced, if necessary. However, in order to restore service to the rest of the system supplied through the main circuit breaker, it is desirable to have it reclosed as quickly as possible. Therefore, in accordance with my invention, I provide each circuit breaker with an arrangement of apparatus for respectively reclosing it automatically when it is open and an interlocking arrangement between the main circuit breaker and the closing arrangement for each of the smaller circuit breakers connected in cascade therewith for rendering the reclosing arrangement for a smaller circuit breaker inoperative to effect further reclosures thereof after both the smaller circuit breaker and the main circuit breaker have been opened by a short-circuit.

My invention will be better understood from the following description, when taken in connection with the accompanying drawing the single figure of which diagrammatically illustrates an automatic reclosing arrangement for cascade connected circuit breakers embodying my invention, and its scope will be pointed out in the appended claims.

In the accompanying drawing, 1 represents a circuit breaker which is arranged to connect a supply circuit 2 to a load bus 3. A plurality of load circuits 4 are respectively connected to the load bus 3 by circuit breakers 5. The circuit breakers 1 and 5 may be of any suitably coordinated type. As shown in the drawing, the circuit breaker 1 is of the latched-in type and is provided with a trip coil 6 which, when sufficiently energized, releases a latch 7 so that the circuit breaker opens, and with a closing coil 8 which, when energized, closes the circuit breaker. The circuit breakers 5 are also shown as latched-in circuit breakers and are respectively provided with trip coils 10 which, when sufficiently energized, release the latches 11 which hold the respective circuit breakers in their closed positions and with closing coils 12 which, when energized, close the respective circuit breakers. The trip coil 6 of the circuit breaker 1 is connected by a current transformer 13 so that it is energized in accordance with the amount of current supplied to the load bus 3 by the supply circuit 2, and the trip coils 10 are respectively connected by current transformers 14 so that each trip coil 10 is energized in accordance with the amount of current through the associated circuit breaker 5. The cascade connected circuit breakers 1 and 5 are so selected that the circuit breaker 1 has a current interrupting rating which is higher than the rating of each of the circuit breakers 5 and which is substantially equal to the maximum short-circuit current that can flow through it. Also the trip coils 6 and 10 are so adjusted that the circuit breaker 1 is opened instantaneously when the current through it is substantially equal to the interrupting rating of the smaller circuit breakers 5, and each circuit breaker 5 is opened instantaneously when the current through it is above a predetermined value within the rating thereof.

Each circuit breaker has associated therewith suitable automatic reclosing means for effecting the automatic reclosing thereof when it is opened. Since such automatic reclosing means are well known in the art and the details thereof form no part of my present invention, I have represented such automatic reclosing means for

the circuit breaker 1 by a rectangle 15 and such reclosing means for each of the circuit breakers 5 by a rectangle 16. The operation of the automatic reclosing means 15 is arranged to be initiated by the closing of the auxiliary contacts 17 on the circuit breaker 1 when it is opened, and the operation of each of the automatic reclosing means 16 is normally arranged to be initiated in response to the closing of the auxiliary contacts 18 on the associated circuit breaker 5 if at the same time its circuit breaker 1 is closed so that its auxiliary contacts 19 are closed.

In order to prevent a circuit breaker 5 from being automatically reclosed after it has been opened by a short-circuit which is severe enough also to effect the opening and subsequent reclosure of the circuit breaker 1, each automatic reclosing means 16 has associated therewith a control relay 20 of the well known lock out type which, when in its operated position, renders the associated automatic reclosing means 16 inoperative to reclose the associated circuit breaker 5. Each lock out relay 20 is arranged to be operated when both its associated circuit breaker 5 and the main circuit breaker 1 are simultaneously in their open position. Each lock out relay 20 is also arranged so that it has to be reset manually after each operation thereof.

The operation of the arrangement shown in the drawing is as follows:

When a fault occurs on a load circuit 4 which causes a current to flow that is within the interrupting rating of the circuit breaker 5 in the faulty load circuit, the trip coil 10, associated with this circuit breaker 5, is the only one that is sufficiently energized to effect the opening of a circuit breaker. The closing of the auxiliary contacts 18 on the open circuit breaker 5 completes, through the contacts 21 of the associated lock out relay 20 and the auxiliary contacts 19 on the closed circuit breaker 1, a circuit for initiating the operation of the associated automatic reclosing means 16 so as to effect, in a manner well known in the art, the automatic reclosure of the open circuit breaker 5.

When a fault occurs on a load circuit 4, which causes the current therein to exceed the interrupting rating of the associated circuit breaker 5, not only is the trip coil 10 of the circuit breaker 5 in the faulty load circuit 4 sufficiently energized to effect the opening thereof but also the trip coil 6 is sufficiently energized by this current to effect the opening of the circuit breaker 1. The closing of the auxiliary contacts 22 on the circuit breaker 1 completes, through the auxiliary contacts 23 on the open circuit breaker 5, an energizing circuit for the lock out relay 20 associated with the open circuit breaker 5. By opening its contacts 21, the lock out relay 20 prevents any further operations of the automatic reclosing means 16 associated with the open circuit breaker 5 until the relay 20 is manually reset. The closing of the auxiliary contact 17 on the circuit breaker 1 completes a starting circuit for the automatic reclosing means 15 associated therewith which then recloses the circuit breaker 1 in a manner well known in the art so that service is restored to the other load circuit 4 on which no fault occurred.

While I have, in accordance with the patent statutes, shown and described my invention as applied to a particular system and as embodying various devices diagrammatically indicated, changes and modifications will be obvious to those skilled in the art, and I therefore aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, an electric circuit, two overcurrent circuit breakers of different current interrupting ratings connected in cascade in said circuit, the overcurrent setting of the circuit breaker having the larger current interrupting rating being adjusted to operate instantaneously when the current through the other circuit breaker reaches a predetermined value relative to the interrupting rating of said other circuit breaker and the overcurrent setting of said other circuit breaker being adjusted to operate instantaneously when the current through it increases above a predetermined value below the interrupting rating thereof, reclosing means for each circuit breaker responsive to the opening thereof, and means responsive to both circuit breakers being simultaneously open for rendering the reclosing means for said other circuit breaker inoperative.

2. In combination, an electric circuit, two overcurrent circuit breakers of different current interrupting ratings connected in cascade in said circuit, the overcurrent setting of the circuit breaker having the larger current interrupting rating being adjusted to operate instantaneously when the current through the other circuit breaker reaches a predetermined value relative to the interrupting rating of said other circuit breaker and the overcurrent setting of said other circuit breaker being adjusted to operate instantaneously when the current through it increases above a predetermined value below the interrupting rating thereof, means responsive to the opening of said circuit breaker having the larger interrupting rating for effecting the reclosure thereof, means responsive to the opening of said other circuit breaker for effecting the reclosure thereof when said circuit breaker having the larger interrupting rating is closed, and means responsive to both circuit breakers being simultaneously open for rendering the reclosing means for said other circuit breaker inoperative to reclose said other circuit breaker upon the subsequent reclosure of said circuit breaker having the larger interrupting rating.

3. In combination, an electric circuit, two overcurrent circuit breakers of different current interrupting ratings connected in cascade in said circuit, the overcurrent setting of the circuit breaker having the larger current interrupting rating being adjusted to operate instantaneously when the current through the other circuit breaker reaches a predetermined value relative to the interrupting rating of said other circuit breaker and the overcurrent setting of said other circuit breaker being adjusted to operate instantaneously when the current through it increases above a predetermined value below the interrupting rating thereof, means responsive to the opening of said circuit breaker having the larger interrupting rating for effecting the reclosure thereof, means responsive to the opening of said other circuit breaker for effecting the reclosure thereof when said circuit breaker having the larger interrupting rating is closed, a lock-out relay, means responsive to both circuit breakers being simultaneously in their open positions for effecting the operation of said relay, and means responsive to the oper-

ation of said relay for rendering said reclosing means for said other circuit breaker inoperative to effect a reclosure thereof upon the subsequent reclosure of said circuit breaker having the larger interrupting rating.

4. In combination, an electric circuit, two overcurrent circuit breakers of different current interrupting ratings connected in cascade in said circuit, the overcurrent setting of the circuit breaker having the larger current interrupting rating being adjusted to operate instantaneously when the current through the other circuit breaker reaches a predetermined value relative to the interrupting rating of said other circuit breaker and the overcurrent setting of said other circuit breaker being adjusted to operate instantaneously when the current through it increases above a predetermined value below the interrupting rating thereof, means responsive to the opening of said circuit breaker having the larger interrupting rating for effecting the reclosure thereof, means responsive to the opening of said other circuit breaker for effecting the reclosure thereof when said circuit breaker having the larger interrupting rating is closed, a manually reset relay, an energizing circuit for said relay including in series contacts on each of said circuit breakers which are closed when the respective circuit breakers are open, and means controlled by said relay when in its energized position for rendering said reclosing means for said other circuit breaker inoperative to effect a reclosure thereof upon the subsequent reclosure of said circuit breaker having the larger interrupting rating.

5. In combination, a supply circuit, a load bus, a plurality of load circuits, an individual overcurrent circuit breaker connecting each load circuit to said load bus, a main overcurrent circuit breaker connecting said load bus to said supply circuit, said main circuit breaker having a larger current interrupting rating than said load circuit breakers and having an overcurrent setting dependent upon the interrupting rating of said load circuit breakers, reclosing means for each circuit breaker responsive to the opening thereof, and means responsive to the simultaneous opening of said main circuit breaker and a load circuit breaker for rendering the reclosing means for the open load circuit breaker inoperative to effect the reclosure thereof.

6. In combination, a supply circuit, a load bus, a plurality of load circuits, an individual overcurrent circuit breaker connecting each load circuit to said load bus, a main overcurrent circuit breaker connecting said load bus to said supply circuit, said main circuit breaker having a larger current interrupting rating than said load circuit breakers and having an overcurrent setting dependent upon the interrupting rating of said load circuit breakers, means responsive to the opening of said main circuit breaker for effecting the automatic reclosure thereof, means responsive to the opening of a load circuit breaker for effecting the reclosure thereof when said main circuit breaker is closed, and means responsive to the simultaneous opening of said main circuit breaker and a load circuit breaker for rendering the reclosing means for the open load circuit breaker inoperative to effect the reclosure thereof upon the subsequent reclosure of said main circuit breaker.

7. In combination, an electric circuit, two overcurrent circuit breakers of different current interrupting ratings connected in cascade in said circuit, said circuit breakers having different overcurrent settings, reclosing means for each circuit breaker respectively responsive to the opening thereof, and means for rendering inoperative the reclosing means of the circuit breaker having the smaller current interrupting rating in response to an overcurrent in said circuit sufficient to effect the opening of both of said circuit breakers.

8. In combination, an electric circuit, two overcurrent circuit breakers of different current interrupting ratings connected in cascade in said circuit, the overcurrent setting of the circuit breaker having the larger current interrupting rating being adjusted to operate instantaneously when the current through the other circuit breaker reaches a predetermined value relative to the interrupting rating of said other circuit breaker and the overcurrent setting of said other circuit breaker being adjusted to operate instantaneously when the current through it increases above a predetermined value below the interrupting rating thereof, reclosing means for each circuit breaker responsive to the opening thereof, and means for rendering inoperative the reclosing means of the circuit breaker having the smaller current interrupting rating in response to an overcurrent in said circuit sufficient to effect the opening of both of said circuit breakers.

9. In combination, a supply circuit, a load bus, a plurality of load circuits, an individual overcurrent circuit breaker connecting each load circuit to said load bus, a main overcurrent circuit breaker connecting said load bus to said supply circuit, said main circuit breaker having a larger current interrupting rating than said load circuit breakers and having an overcurrent setting dependent upon the interrupting rating of said load circuit breakers, reclosing means for each circuit breaker responsive to the opening thereof, and means for rendering inoperative the reclosing means of a load circuit breaker in response to an overcurrent in the respective load circuit sufficient to effect the opening of both the load circuit breaker and the main circuit breaker.

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