This invention relates to circuit breaker systems and, more particularly, to circuit breakers for controlling parallel-transmission circuits.

Electrical transmission systems involving parallel circuits carrying balanced current and individual circuit breakers for interrupting each circuit are sometimes provided with high-speed current-balance relays which are responsive to the balanced current conditions in the parallel circuits. If a certain degree of unbalance in the current in the parallel circuits occurs, the current-balance relay functions to trip the circuit breaker controlling the circuit having the greater value of current therein. When the circuit breaker in the faulted circuit opens, the current drops to zero, and the current in the unaffected circuit would then cause the current-balance relay to trip the breaker in the unaffected circuit.

An object of the invention is to provide a plurality of circuit breakers for controlling parallel circuits embodying means for preventing tripping of one circuit breaker while the other circuit breaker is being tripped.

Another object of the invention is to provide a control system for a pair of circuit breakers protecting parallel circuits normally traversed by balanced currents in which a current-balance relay is responsive to an unbalanced current condition in said circuits to trip the breaker controlling the circuit traversed by the higher current and embodying means for preventing tripping of the other circuit breaker during the tripping time of the affected circuit breaker.

Another object of the invention is to provide a circuit breaker system for two parallel-connected circuits having circuit breakers therein in which a current-balance relay is responsive to unbalanced current conditions in the circuits to effect tripping of the circuit breaker in the circuit traversed by the higher current with switch means operated by the tripping movement of the trip device for one of the circuit breakers to prevent tripping of the other circuit breaker during the tripping time of the affected circuit breaker thus eliminating the need for auxiliary blocking relays.

The invention both as to structure and operation, together with additional objects and advantages thereof, will be best understood from the following detailed description thereof when read in conjunction with the accompanying drawing, the single figure of which diagrammatically illustrates a distribution system comprising two parallel transmission circuits to which the invention is applied.

Referring to the drawing, 11 is a common bus to which parallel circuits 13 and 15 are connected, respectively through circuit breakers shown diagrammatically at A and B. Each of the circuit breakers is provided with a tripping mechanism 17 normally restraining the circuit breakers in the closed position and operative to effect opening of the breakers. The tripping mechanism for each breaker is a latch 19 and a tripping electromagnet 21. The coil of the tripping electromagnet 21 for the breaker A is connected in a circuit extending from one side 23 a source of control energy 23-25, through auxiliary contacts 27, coil of the tripping magnet 21 for breaker A, auxiliary contacts 29, wire 31, auxiliary contacts 33 of breaker B, contacts of a switch 35 operated by the latch 19 of breaker B, line 37, contacts 39 of a balance-current relay 41, and wire 40 to the other side 25 of the control circuit 23-25. Similarly, the coil of the tripping electromagnet 21 for breaker B is connected in a circuit which extends from the line 23, auxiliary contacts 43, coil of the tripping electromagnet 21 for breaker B, auxiliary contacts 45, wire 47, auxiliary contacts 49 for breaker A, contacts of a switch 51 operated by the latch 19 for breaker A, wire 53, contacts 55 of the balance-current relay 41 and wire 40 to the other side of the 25 control circuit 23-25.

The balance-current relay 41 is shown diagrammatically as comprising a rocker 57 having bridging contacts 59 thereon for cooperating with the contacts 39 and 55. The rocker is operated by electromagnets 61 and 63. The energizing coils 69 and 71 of the magnets 61 and 63, respectively, are connected in series relation in circuits including current transformers 73 and 75 energized, respectively, by the parallel lines 13 and 15. The coil 77 of a protective relay 79 is connected in series relation in the circuit including the coil 69 of the balance-current relay 41 and current transformer 73. Similarly, the coil 81 of a protective relay 83 is connected in series relation with the coil 71 of the balance-current relay 41 and the current transformer 75. The relays 79 and 83, respectively, are provided with contacts 85 and 87, and time delay means 89 and 91.

With balanced or equal current traversing the parallel circuits 13-15, the coils 69-71 of the balance-current relay 41 are equally energized and maintain the bridging contact 59 in the neutral or central position. Upon the occurrence of a sufficient unbalanced current condition in the circuits 13-15, the circuit having the higher value current therein will energize the associated coil of the balance-current relay sufficiently to cause it to close one of the pairs of contacts 39-55 to effect tripping of the breaker in the circuit having the higher current.

Assuming an unbalanced condition due to a fault on circuit 13 in which the circuit 13 has the higher value current therein, and that the current unbalance is sufficient to cause operation of the current balance relay 41, the coil 69 will be energized by the current transformer 73 sufficiently to attract and move the armature 65 downwardly. This action causes the bridging contact 59 to engage the contacts 39 and close the previously described energizing circuit through the coil of the tripping magnet 21 for the circuit breaker A. When energized, the tripping magnet 21 for breaker A actuates the latch 19 and effects opening of this breaker.

As soon as the contacts for breaker A open, the circuit 13 is deenergized, but since the circuit 15 is energized, the magnet 63 of the current-balance relay 41 would overcame the now deenergized magnet 61 and cause the bridging contact 59 to move over and close the contacts 55 in the circuit for the tripping magnet 21 for breaker B. To prevent tripping of circuit breaker B while circuit breaker A is tripping, the switch 51 is connected in the circuit for the tripping magnet 21 for circuit breaker B. The switch 51 is biased open and is normally held in the closed position by the latch 19 when the breaker A is in the closed position. As soon as latch 19 is moved by the tripping magnet 21 for breaker A, the switch 51 opens, thus opening the circuit through the tripping magnet 21 for breaker B and preventing tripping of the latter by operation of the relay 41 while the
breaker A is tripping and before the latter starts to move in opening direction. During the opening movement of breaker A, the auxiliary contacts 49, which are also connected in the circuit through the tripping magnet 21 for breaker B, open thus preventing tripping of breaker B by means of the current-balance relay 41 until the breaker A is closed. The circuit breakers A and B may be closed by any suitable means, and when closed, the latch 19 resumes its latching position and closes the related switch 51 or 55.

The breaker B is tripped open in the same manner; that is, upon the operation of the magnet 63 of the current-balance relay 41 to close contacts 55 and energize the tripping magnet 21 for breaker B. The tripping magnet 21 operates the latch 19 to trip the breaker and, at the same time, permits opening of the switch 35 in the circuit for the tripping magnet 21 for breaker A. In this manner, tripping or unlatching of either of the circuit breakers opens the circuit to the tripping magnet of the other breaker and prevents tripping of the other breaker while the affected breaker is tripping and before the breaker moves in opening direction.

If one of the circuit breakers A or B is in the open position and an overcurrent condition occurs in the other circuit, the protective relay 79 or 83 for the closed circuit will function to effect energization of the trip device for the closed breaker. If the breaker B, for instance, is open and an overcurrent condition occurs in the parallel circuit 13, the protective relay 79 would be energized and close its contacts 85 to effect energization of the tripping magnet 21 for breaker A over the previously described circuit which includes the auxiliary contacts 27 and 29 and the coil of the tripping magnet 21 for breaker A. Similarly, if the breaker A is open and an overcurrent occurred in the circuit 15 the protective relay 83 would function in the same manner to effect energization of the tripping magnet 21 for breaker B.

It will be seen that the invention provides a current-balance relay that is responsive to sufficient unbalance current conditions in parallel circuits to effect tripping of the circuit breaker in the circuit traversed by the higher current, and which embodies switch means operated by the latches of the circuit breakers for preventing tripping of the circuit breaker in the unaffacted circuit while the circuit breaker in faulted circuit is tripping. One advantage of this arrangement is that by utilizing the latch operated switches to prevent tripping of one breaker while the other breaker is tripping the need for auxiliary blocking relays is eliminated.

Having described a preferred embodiment of the invention in accordance with the provisions of the patent statutes, it is to be understood that various changes and modifications may be made therein without departing from the spirit of the invention.

We claim as our invention:

1. In a circuit breaker system comprising parallel-connected circuits, a circuit breaker in each of said circuits, a current-balance relay common to said circuits and connected in said circuits to be operated in response to unbalanced current conditions in either of said parallel circuits to effect tripping of the circuit breaker in said circuit traversed by the higher current, and switch means responsive to the tripping operation of one of said circuit breakers connected to prevent tripping of the circuit breaker in the unaffected circuit during the tripping operation of said one circuit breaker and before said one circuit breaker starts its opening movement.

2. In a circuit breaker system comprising parallel-connected circuits, a circuit breaker in each of said circuits, latch means for each of said circuit breakers normally restraining said circuit breakers in closed positions, trip means for actuating said latch means to unlatching position, a current-balance relay, means connecting said current-balance relay in said circuits to be operated in response to an unbalanced current condition in any one of said parallel circuits to effect energization of the trip means of the circuit breaker in the circuit traversed by the higher current, and switch means operative in response to unlatching movement of the latch means of the circuit breaker in the affected circuit and connected to prevent energization of the circuit breaker in the unaffected circuit before the circuit breaker in the affected circuit is unlatched.

3. In a circuit breaker system comprising two parallel-connected circuits, a circuit breaker in each of said circuits, an electromagnetic trip device for each circuit breaker operable when energized to effect opening of its circuit breaker, a current-balance relay, means connecting said current-balance relay in said circuits to be operated in response to unbalanced current conditions in said parallel circuits, said current-balance relay when operated affecting energization of the electromagnetic trip device of the circuit breaker in the circuit traversed by the higher current, and switch means responsive to a tripping operation of one of said trip devices and connected to prevent energization of the other of said trip devices by said current-balance relay during the tripping operation of said one trip device and before said one circuit breaker starts its opening movement.

4. In a circuit breaker system comprising two parallel-connected circuits, a circuit breaker in each of said circuits, latch means for each circuit breaker normally restraining said circuit breakers in closed positions and movable to unlatching position, control circuit means, electromagnetic trip means for each circuit breaker connected in said control circuit operable by said relay to effect energization of the electromagnetic trip means of the circuit breaker in the circuit traversed by the higher current, and switch means operated in response to unlatching movement of said latch means for one of said circuit breakers connected to prevent energization of the electromagnetic trip means for the other of said circuit breakers before said one circuit breaker moves in opening direction and while said latch means is in unlatching position.

5. In a circuit breaker system comprising two parallel-connected circuits, a circuit breaker in each of said circuits, an electromagnetic trip device for each circuit breaker operable when energized to effect opening of its circuit breaker, circuit means, a current-balance relay connected in said circuit means to be energized in response to unbalanced current conditions in said parallel circuits, said current-balance relay affecting energization of the electromagnetic trip device of the circuit breaker in the circuit traversed by the parallel higher current, switch means responsive to the tripping operation of one of said trip devices and con-
connected in said circuit means to prevent energization of the other of said trip devices by said current-balance relay during the tripping operation of said one trip device and before said one circuit breaker starts its opening movement, and means operable by opening movement of one of said circuit breakers connected to prevent energization of the other of said trip devices until said one circuit breaker is closed.

6. In a circuit breaker system comprising parallel-connected circuits, a circuit breaker comprising stationary and movable contacts in each circuit, a current-balance relay connected to be energized in response to unbalanced current conditions in said parallel circuits to effect tripping of the circuit breaker in the circuit traversed by the higher current, and switch means operated in response to a tripping operation of one of said circuit breakers and connected to prevent tripping operation of the circuit breaker traversed by the lower current during the tripping operation of the one circuit breaker and before the movable contacts of said one circuit breaker move in opening direction.

7. In a circuit breaker system comprising two parallel-connected circuits, a circuit breaker comprising stationary and movable contacts in each circuit, an electromagnetic trip device for each circuit breaker each operable when energized to effect opening of its circuit breaker, auxiliary switch means on each circuit breaker operated during opening movement of one of the circuit breakers to prevent energization of the electromagnetic trip device for the other circuit breaker, a current-balance relay connected to be energized in response to unbalanced current conditions in said parallel circuits, said current-balance relay having contact means connected to effect energization of the electromagnetic trip device of the circuit breaker in the circuit traversed by the higher current upon energization of said current-balance relay, and switch means responsive to the operation of one of said trip devices and connected to prevent energization of the other of said trip devices during the tripping operation of said one trip device and before the movable contacts of the circuit breaker in the affected circuit start to move in opening direction.

8. In a circuit breaker system comprising two parallel-connected circuits, a circuit breaker connected in each of said circuits, an electromagnetic trip device for each circuit breaker operable when energized to effect opening of its circuit breaker, a current-balance relay connected to be energized in response to unbalanced current conditions in said parallel circuits, said current-balance relay having contact means connected to effect energization of the electromagnetic trip device of the circuit breaker in the circuit traversed by the higher current, switch means operable in response to the operation of one of said trip devices and connected to prevent energization of the other of said trip devices during the tripping operation of said one trip device and before the circuit breaker in the affected circuit starts to move in opening direction, switch means operable upon opening of one of said circuit breakers and connected to prevent the current-balance relay from effecting energization of the electromagnetic trip device of the other circuit breaker, and relay means connected to effect energization of the electromagnetic trip device of said other circuit breaker in response to overcurrent conditions occurring when said one circuit breaker is open.

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