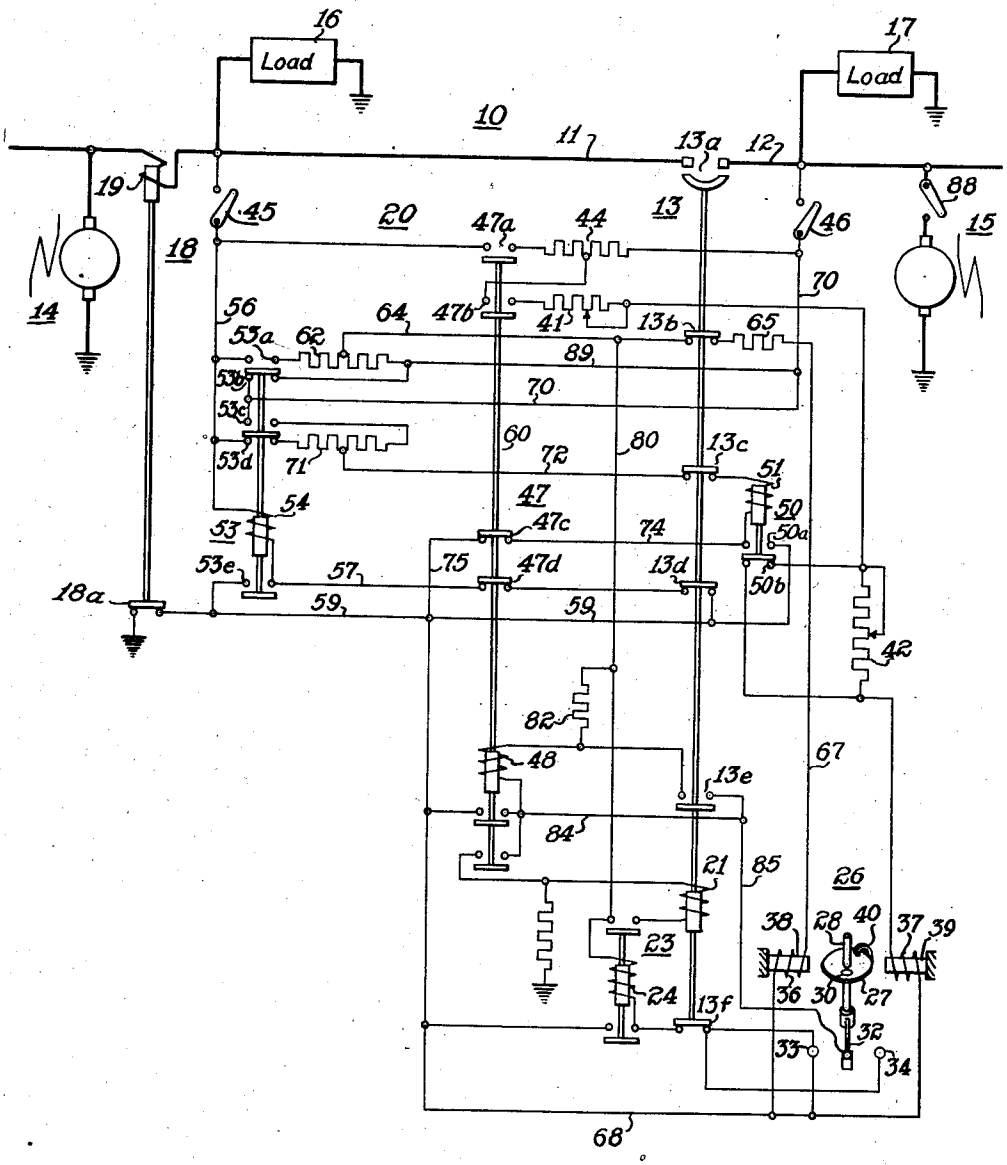
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CIRCUIT BREAKER CONTROL SYSTEM

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WITNESSES:

Wm. C. Groome

F. V. Giolma

INVENTOR

William R. Taliaferro.

BY

ATTORNEY

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CIRCUIT BREAKER CONTROL SYSTEM

William R. Taliaferro, Edgewood, Pa., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

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My invention relates, generally, to circuit breaker control systems and has reference in particular to automatic reclosing circuit breaker systems or sectionalizers for feeders for stub or multiple feed operation.

Generally stated, it is an object of my invention to provide for automatically reclosing the circuit breaker of a sectionalizing feeder in a manner that is safe as well as simple and inexpensive regardless of whether the feeder is operating as a stub or multiple feeder.

More specifically, it is an object of my invention to provide for selectively and automatically controlling the connection of the automatic reclosing apparatus for the circuit breaker to one side or another of the circuit breaker in a sectionalizing feeder, which may be arranged to operate in either stub (resistance measuring) or multiple (voltage measuring) feed, depending upon which side of the feeder is to have its load conditions measured.

It is also an object of my invention to provide for automatically changing the connections of a recalibrating relay in an automatic reclosing circuit breaker system for a sectionalizing feeder which may feed in either direction, in either stub or multiple feed, so that it will be connected to the feeder on one side of the circuit breaker, or the other, for measuring the load conditions thereof to determine whether or not the circuit breaker may be closed without exceeding the maximum safe current capacity of the system.

A further object of my invention is to provide, first, for determining which of the two sections of a sectionalizing feeder on opposite sides of a circuit breaker is operating under substantially normal conditions, and which requires to have its load conditions measured, and then provide for calibrating a load measuring device of the circuit breaker control system in accordance with either the load resistance or the voltage of the section to be measured for operating in stub or multiple feed before determining when the circuit breaker may be closed safely.

Other objects will, in part, be obvious, and will, in part, be explained hereinafter.

Direct current feeders of the usual type for feeding electrical energy in one direction only have been heretofore provided with automatic reclosing equipment for operation on stub (resistance measuring) and multiple (voltage measuring) feed reclosing, or for operation on either stub or multiple feed with automatic recalibration for either condition. Sectionalizing feeders differ from the ordinary feeders in that they are usually arranged to be energized from both ends for supplying a plurality of loads at either or both ends. Under these conditions, reclosing of the feeder breaker must be effected under a number of different conditions, depending upon both the direction in which the feeder is to supply energy, and whether or not the feeder is operating in stub or multiple feed. Since sectionalizing feeders are arranged to be fed from both ends, the automatic reclosing circuit breaker apparatus is usually calibrated for reclosing on a multiple feed or voltage measuring basis. By changing the value of the resistance in the measuring circuit, the automatic reclosing circuit breaker apparatus can be calibrated to close on a stub feed basis. Thus calibrated, however, it would be entirely unsuitable for operation if the feeder is also to operate at times on multiple feed.

Heretofore, automatic reclosing circuit breaker apparatus has been provided with measuring equipment calibrated for stub feed reclosing, and in addition a voltage relay to measure the voltage difference across the circuit breaker contacts for operating on multiple feed. Such a system operates satisfactorily only when the voltage conditions are limited to relatively high voltages on the side of the feeder having the lowest voltage. Excessively low voltages prevent the voltage difference relays from operating, which is correct, but this does not prevent the stub feed measuring equipment from functioning to close the breaker. Even though the voltage is very low, the feeder is still a multiple feeder, and yet the automatic reclosing circuit breaker apparatus is measuring as a stub feeder, which results in incorrect measuring, permitting the feeder to be closed under fault conditions or on excessive loads which result in retripping of the breaker and pumping thereof.

In practicing my invention, the closure of the circuit breaker in a sectionalizing feeder, which may be connected for feeding power in either direction, in either stub or multiple feed, is controlled in the first instance by determining through the medium of a selective control relay which section of the feeder is normally energized and which section is to have its load conditions measured. The recalibrating relay which changes the connections of the load measuring relay for stub or multiple feed is then connected to the section of the feeder which is to have its load conditions measured. The load conditions of this section may then be readily measured by the load measuring relay to determine, whether

the effective load resistance of the section is sufficiently high to limit the load current to a safe value, if this section of the feeder is operating in stub feed, or if its voltage is sufficiently high to limit the load current if it is operating in multiple feed.

For a more complete understanding of the nature and scope of my invention, reference may be had to the accompanying drawing in which the single figure is a diagrammatic view of an automatic reclosing circuit breaker system for a sectionalizing feeder embodying the principal features of the invention.

Referring to the drawing, the reference numeral 10 may denote generally, an automatic reclosing circuit breaker system for a sectionalizing feeder comprising adjacent feeder sections 11 and 12 connected by a circuit breaker 13 and supplied with electrical energy from either or both ends from sources such as the generators 14 and 15, for supplying electrical energy to loads denoted generally, by the numerals 16 and 17. An overload relay 18 having an operating winding 19 may be provided for opening the circuit breaker 13 when the current exceeds a predetermined value, and control means denoted generally by the numeral 20 may be provided for automatically reclosing the circuit breaker as soon as circuit conditions permit.

The circuit breaker 13 may be provided with main contact members 13*a* for connecting sections 11 and 12 of the sectionalizing feeder, auxiliary contact members, and an operating winding 21 for effecting closure of the contact members. Energization of the operating winding 21 may be controlled by an auxiliary breaker relay 23 having an operating winding 24.

In order to provide for determining whether or not the circuit breaker 13 may be reclosed to connect the adjoining sections 11 and 12 of the sectionalizing feeder without exceeding the maximum safe value of the current for which the system is designed, load measuring means 26 may be provided. The load measuring means may be of any suitable type such as, for example, a relay having a disk 27 of aluminum or some other suitable non-magnetic material rotatably mounted on a shaft 28, and provided with an insert 30 of magnetic material. A movable contact arm 32 on the shaft 28 is arranged for engaging spaced stationary contact members 33 and 34. Operation of the relay may be effected by means of opposed operating windings 36 and 37 which may be connected to the "normal" section of the feeder and the section which is to have its load conditions measured, respectively, to energize magnetic core members 38 and 39 which act on the magnetic insert 30, tending to rotate the disc 27 in opposite directions. A time delay action may be secured by utilizing a substantially C-shaped permanent magnet 40, having an air gap to receive the outer edge of the disc 27, whereby a drag may be exerted to retard rotation of the disc. When the winding 36 is energized, the disc rotates slowly until the arm 32 engages the contact member 33. Then when the winding 37 is later energized sufficiently, the disc rotates until the arm 32 engages contact 34.

In order to adapt the reclosing system for operation on either stub or multiple feed, provision may be made for recalibrating the load measuring means 26 in accordance with the type of feed required. Recalibrating resistors 41 and 42 may be provided in series circuit relation with the operating winding 37 of the load measuring relay, which winding is arranged to be connected intermediate a load measuring resistor 44, arranged to be connected in bridged relation with the circuit breaker 13, through suitable control switches 45 and 46. An auxiliary reclosing relay 47 having an operating winding 48 may be provided for controlling the connection of the load measuring resistor 44 to section 11, and the connection of the operating winding 37 to the load measuring resistor in response to engagement of the contact arm 32 with the contact 33.

With a view to recalibrating the load measuring relay 26 for operation on either stub or multiple feed, a recalibrating relay 50 may be provided having an operating winding 51. The recalibrating relay 50 may be arranged to vary the effective value of the recalibrating resistance, being, for example, connected in shunt relation with the recalibrating resistor 42 through contact members 50*b*, for effectively inserting it in, or removing it from, the circuit of the operative winding 37.

In order to determine to which side of the circuit breaker 13 or to which section of the feeder the recalibrating relay 50 and the operating winding 36 of load measuring relay 26 should be connected, a selective control relay 53 may be provided, having an operating winding 54. The selective control relay 53 may be provided with normally open contact members 53*a* for connecting the operating winding 36 of the load measuring relay to section 11 of the feeder under predetermined operating conditions, and normally closed contact members 53*b* for connecting the operating winding 36 of the load measuring relay to section 12 under other operating conditions. Additional normally open contact members 53*c* may be provided for connecting the recalibrating relay 50 to section 12 of the feeder under predetermined operating conditions, and normally closed contact members 53*d* may be provided for connecting the recalibrating relay 50 to section 11 of the feeder under other operating conditions.

As soon as a fault occurs, the main contacts 13*a* of the circuit breaker 13 open upon deenergization of the operating winding 21 when the overload relay 18 opens its normally closed contact members 18*a*, interrupting the circuit through the operating winding 21 between the feeder and ground. As soon as the circuit breaker opens, the overload relay 18 returns to the deenergized position, completing an energizing circuit for the operating winding 54 of the selective control relay 53 from section 11 of the feeder, through control switch 45, positive control bus 56, operating winding 54, conductor 57, contact members 47*d* of the auxiliary reclosing relay 47, contact members 13*d* of the circuit breaker, negative control bus 59 and contact members 18*a* of the overload relay 18, to ground.

If substantially normal voltage exists on section 11, the selective control relay 53 operates, otherwise it remains in the deenergized position. If it operates, contact members 53*a* and 53*c* close, and at the same time contact members 53*b* and 53*d* open. The operating winding 36 of the load measuring relay 26 is thereby connected to section 11 of the feeder through the circuit extending from the section 11 through control switch 45, positive control bus 56, contact members 53*a* of the selective control relay, control resistor 62, conductor 64, contact members 13*b* of the circuit breaker 13, control resistor 65, conductor 67, operating winding 36, and negative control buses 68 and 69 to ground, or the other side of the line.

An obvious holding circuit for the selective control relay 53 is completed through contact members 53e.

At the same time, the operating winding 51 of the recalibrating relay 50 is connected to section 12, of the feeder through the circuit extending from section 12, through control switch 46, conductor 70, contact members 53c of the selective control relay, control resistor 71, conductor 72, contact members 13c of the circuit breaker 13, operating winding 51, conductor 74, contact members 47c, conductor 75, and negative control bus 59 to ground. If section 12 is connected for stub (resistance measuring) feed as shown, no voltage is applied to the operating winding 51 of the recalibrating relay. Accordingly, contact members 50b remain closed, so that recalibrating resistor 42 remains shunted, and the load measuring relay 26 is calibrated for measuring the impedance of section 12 of the feeder for determining whether the circuit breaker 13 may be safely closed.

After a predetermined time delay, the movable contact arm 32 engages the stationary contact member 33 to establish an energizing circuit for the operating winding 48 of the auxiliary reclosing relay 47. This current extends from section 11 through control switch 45, positive control bus 56, contact members 53a of the selective control relay 53, control resistor 62, conductor 64, conductor 80, control resistor 82, operating winding 48, conductors 84 and 85, movable contact arm 32, stationary contact member 33, and negative control buses 59 to ground. The auxiliary reclosing relay 47 operates, closing its contact members 47a to connect the load measuring resistor 44 to section 11, and closing its contact members 47b to connect the operating winding 37 of the load measuring means 26 to the load measuring resistor 44.

If the load characteristics of section 12 are satisfactory, operating winding 37 causes contact arm 32 to engage stationary contact member 34 after a predetermined time delay, to complete an energizing circuit for the operating winding 24 of the auxiliary breaker relay 23. The auxiliary breaker relay 23 in turn, operates to complete an energizing circuit for the operating winding 21 of the circuit breaker 13, which operates to connect sections 11 and 12.

If no voltage, or substantially less than normal voltage exists on section 11 when the selective control relay 53 is connected thereto upon the return to the deenergized position of the overload relay 18, the relay 53 does not operate but remains in the deenergized condition. Accordingly, the connections of the recalibrating relay 50 are reversed and the relay is connected to section 11, instead of section 12, as hereinbefore described, through the normally closed contact members 53d and control switch 45. Likewise, the operating winding 36 of the load measuring relay 26 is connected to section 12, through the normally closed members 53b and control switch 46, instead of to section 11. The operating winding 37 of the load measuring relay is thereafter connected to the load measuring resistor 44 through contact members 47b of the auxiliary reclosing relay. The sequence of operation thereafter for stub feed, is substantially the same as hereinbefore described, except in that section 12 is considered as the normal or supply conductor while section 11 is considered as the stub or supplied conductor which is to have its load characteristics measured.

If, when the recalibrating relay 50 is connected to either section 12 or section 11, depending upon which of these sections is the one to which power is to be supplied, a substantial voltage exists on this conductor, such as would be the case were the switch 88 between the generator 15 and section 12 closed, this indicates that the load measuring relay 26 must be calibrated for operating on multiple (voltage measuring) feed. Accordingly, the recalibrating relay 50 operates in response to the voltage on the section, opening contact members 50b to insert recalibrating resistor 42 in series with the operating winding 37 of the load measuring relay 26 and providing a holding circuit for its operating winding 51, through the circuit extending from section 11 or 12 as the case may be, through the control switch 45 or 46, positive control bus 56 or conductor 70, contact members 53d or 53c, control resistor 71, conductor 72, contact members 13c, operating winding 51, contact members 50a and negative control bus 59 to ground.

The load measuring relay 26 is thereby recalibrated for multiple feed. When recalibrated, the operating winding 37 is so connected that the relay 26 cannot operate to effect closure of the circuit breaker 13 until the voltage of section 11 or 12 of the feeder, as the case may be, has increased to a sufficiently high value which will not permit an excessive interchange of current between sections 11 and 12 after closure of circuit breaker 13.

From the accompanying drawing and the above description, it is apparent that I have provided in a simple and effective manner, for controlling the operation of a circuit breaker in a sectionalizing feeder with the same desirable characteristics as are obtained in the case of an automatically recalibrated circuit breaker control for a standard feeder. Such recalibrating equipment is of great importance under conditions which often exist in coal mine operations where a number of direct current generators are operated for supplying energy to different points of the mine or mine trolley system under the usual conditions, so that the sectionalizing feeders operate in multiple feed, and in either direction depending on load variations. During week-ends or "no work" periods, all of the generators but one may be shut down, so that the sectionalizing feeders then operate in stub feed. Under this condition, unless the automatic reclosing apparatus of the sectionalizing feeders is recalibrated, it is impossible to reclose the feeders after a fault unless the load is reduced to zero which is usually an impossible condition. By utilizing a system embodying the principal features of my invention, adequate protection is provided and prompt restoration of service is secured under all operating conditions.

Since certain changes may be made in the above description, and different embodiments may be made without departing from the scope or spirit thereof, it is intended that all of the matter contained in the above description, and shown in the accompanying drawing, shall be considered as illustrative and not in a limiting sense.

I claim as my invention:

1. A control system for a circuit breaker disposed to provide a tie connection between a pair of feeder sections connecting a plurality of sources and loads for supplying electrical energy to the loads in either direction either in multiple or singly comprising, a control relay effective to determine which of the feeder sections is to have its load characteristics measured, load measuring means selectively connected to the section to have its load characteristics measured by the control means to determine whether the load

characteristics of said section are such that the circuit breaker can be closed without exceeding a predetermined transfer of electrical energy from one section to another, means operable to recalibrate the load measuring means if the section is to have its load characteristics measured is being supplied from another source, circuit means including contacts of the control relay for selectively connecting the recalibrating means to whichever section is to have its load characteristics measured, and means operable in response to a predetermined operation of the load measuring means to effect closure of the circuit breaker.

2. In a control system for a load measuring device which is disposed to measure either the potential or load resistance of either of a pair of sections of a sectionalizing feeder connected by a circuit breaker, a selective control relay energizable from one section of the feeder to determine which section is to be supplied with electrical energy and connect the load measuring device to the said one section when the said one section is at substantially normal voltage and to the other section when it is not at substantially normal voltage, a recalibrating resistor connected in circuit with the load measuring means, recalibrating means effective to control the effective value of the recalibrating resistor and recalibrate the load measuring device when the section to be supplied with electrical energy is at a potential due to the energization from another source, and circuit means including normally open contacts and normally closed contacts of the selective control relay for connecting the recalibrating means to the section to be supplied with electrical energy.

3. An automatic reclosing system for a sectionalizing feeder comprising adjoining sections connected by a circuit breaker and connected between a plurality of loads and sources for supplying electrical energy in either direction comprising, current responsive means to open the circuit breaker in response to a fault on either side of the circuit breaker, load measuring means disposed to be connected to the section supplying electrical energy and the section to be supplied with electrical energy in predetermined relation for determining whether the circuit breaker may be safely closed, selective control means connected to one of the sections operable to control the connections of the load measuring device to said one of the sections or to the other in accordance with the existence or non-existence of substantially normal voltage on said one section, circuit means including a resistor having an intermediate point connected to recalibrating means disposed to be connected under the control of the selective control means to the section to be supplied, said recalibrating means being effective to vary the calibration of the load measuring means in accordance with the existence or non-existence of potential on the section to be supplied with electrical energy, control means operable under the control of the load measuring means to connect the recalibrated load measuring means to the section to which power is to be supplied, and circuit means effective to close the circuit breaker under the control of the load measuring means.

4. The combination with a circuit breaker connecting adjoining feeder sections, fault responsive means for opening the circuit breaker, a load measuring device for determining the load characteristics of one of the sections, selective control means for determining in accordance with the existence or non-existence of substantially normal potential on one of the sections to which of the sections the load measuring device is to be connected, and auxiliary control means responsive to predetermined operation of the load measuring means to reclose the circuit breaker, of a recalibrating resistor connected in circuit relation with the load measuring means, recalibrating means controlling the effective value of the recalibrating resistor in accordance with whether or not a potential exists on the section to have its load characteristics measured, and circuit means including an impedance having a midpoint connected to the recalibrating means associated with the selective control means effective to connect the recalibrating means to the section whose load characteristics are to be measured.

5. The combination in an automatic reclosing system for a circuit breaker connecting the sections of a sectionalizing feeder arranged to supply electrical energy in either direction to one or more loads from one or more sources, of impedence means bridging the circuit breaker, a load measuring device having one operating winding connected intermediate the bridging impedance and an opposing operation winding, selective control means disposed to be energized from one section of the sectionalizing feeder when said one section is at substantially normal voltage for connecting the opposing winding to the section of the feeder to be supplied with energy, recalibrating control means disposed to be connected to the section of the feeder to which energy is to be supplied under control of the selective control means, and means responsive to a predetermined operation of the recalibrating control means effective to recalibrate the load measuring device for measuring the voltage of the section to be supplied with energy.

WILLIAM R. TALIAFERRO.