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PROTECTIVE RELAY

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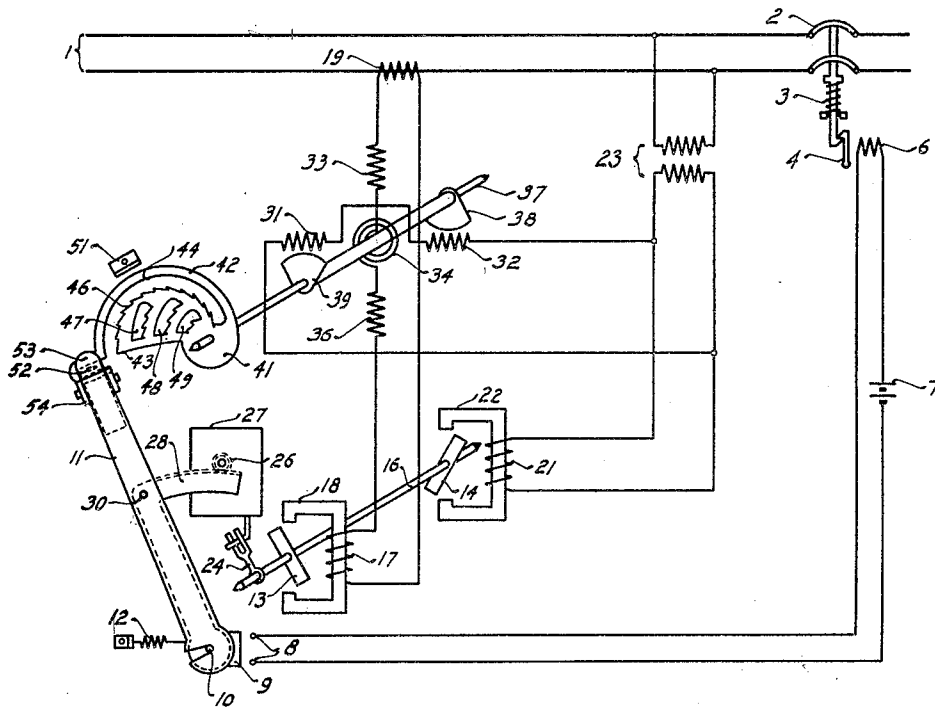


Fig. 1.

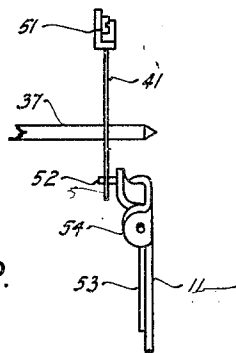


Fig. 2.

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PROTECTIVE RELAY

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This invention relates to improvements in protective relays and particularly to relays for selectively disconnecting portions of an electric transmission or distribution line in dependence on the impedance of the line in such manner that the line section directly affected by a fault is put out of operation before the unaffected portions of the line can be cut out.

The circuit breakers connecting the several portions of an electric line are usually provided with releasing coils which permit the circuit breaker to open under the action of a spring or other suitable force when the coil is energized. Various current responsive, resistance or impedance responsive devices have already been proposed to control the operation or the energization of such releasing coils. The selective relays used heretofore require an element which differentiates in the direction of the flow of energy occurring in case of a disturbance, which element may be a portion of the relay itself or may be an additional relay acting on the selective relay in such manner that the circuit breaker controlled is released only upon the occurrence of an energy flow away from the source of supply. Such differentiation in the direction of energy flow is generally necessary to obtain a proper selective action. Selective relays may also be constructed which will operate in different directions of energy flow in different ways and with different time delays dependent on the direction of the energy flow.

In either of the above cases i. e. whether operative in one or both directions of energy flow, the energy direction responsive device should operate immediately upon the occurrence of an abnormal energy flow and not only at the end of a pre-determined time. Determination of the direction of energy flow immediately before closing of the relay contacts, under some network conditions or in cases of disturbances, may give rise to erroneous operation or, in case of loss of synchronism of power stations, may lead to the undesired operation of the relay. Erroneous operation of the relay al-

ways occurs if the direction of energy flow changes during the time in which the relay is operating in either direction.

The present invention proposes a structure by which such erroneous or undesired operation of the circuit breakers may be avoided by the use of an arrangement in which the direction sensitive element of the relay operates in response to the direction of energy at the beginning of the relay action and therefore at the beginning of the variable releasing time for the relay. Such action is obtained by the provision of a relay which will automatically adapt itself to the momentary disturbance conditions if such condition changes during operation of the relay as when the impedance of the damaged network portion decreases or the direction of energy flow reverses.

It is, therefore, among the objects of the present invention to provide a selective relay which is operable differently in dependence on the direction of energy flow.

Another object of the invention is to provide a selective relay in which the direction responsive element may reverse its direction of operation during movement of the relay in any direction before reaching the end of the previous movement.

Another object of the invention is to provide a selective relay in which undesirable contact closing operations are avoided upon momentary reversal of the direction of energy flow and therefore of reversal of operation of the relay.

Objects and advantages, other than those above set forth, will be apparent from the following description when read in connection with the accompanying drawing in which

Figure 1 diagrammatically illustrates a section of an electric line employing one embodiment of the present selective relay, and

Figure 2 is an enlarged fragmentary portion of the selective relay shown in side view.

Referring more particularly to the drawing by characters of reference, the reference numeral 1 designates a section of an elec-

tric line to be protected. The line section 1 may be isolated from other sections by the opening of a circuit breaker 2 under the influence of a spring 3 upon the retraction of a latch 4 due to the energization of a releasing coil 6 which is energized from a source of current 7 upon the bridging of a pair of contacts 8.

The contacts 8 are opened or bridged by a contact member 9 mounted on a lever 11 which is operated by the co-action of a reactance responsive or impedance responsive tripping or operating initiating element and an impedance responsive or time delay element acting against a spring 12 secured to the lever 11. The lever 11 is formed with an elongated slot into which a pivot 10 extends for the purpose of permitting rotation of the lever 11 about the point 10 during at least a portion of its rotation and to permit lateral movement of the contact member 9 from the point 10 to bridge contacts 8.

The tripping element includes a pair of rotatable armatures 13 and 14 mounted on a common spindle 16. Armature 13 is rotated by the action of a coil 17 on a core 18, the coil being connected with the secondary winding of a current transformer 19 and armature 14 is controlled by the action of a coil 21 on a core 22, the coil being supplied from a voltage transformer 23. The spindle has mounted thereon an arm 24 which controls the release of a clockwork mechanism 27 driving a pinion 26 engaging with a gear sector 28 pivotally connected with lever 11 at 30 and pivotally mounted at 10 and extending laterally from the lever 11. It will thus be seen that the tripping time is dependent on the ratio of voltage to current. When the ratio of voltage to current is normal, the opposing forces of coils 17 and 21 acting on the spindle 16, through armatures 13 and 14, will prevent release of the clockwork 27 but when a short-circuit occurs, arm 24 will be so rotated as to cause release of the clockwork to cause movement of lever 11 to the right to bridge contacts 8 upon operation of the impedance responsive time delay element, as described hereinafter.

The impedance responsive element includes a pair of voltage coils 31 and 32 connected with the secondary winding of the voltage transformer 23 and current coils 33, 34 and 36 connected with the current transformer 19. A spindle 37 carries vanes 38 and 39 which are magnetized by the coil 34 surrounding the spindle which coil is connected in series with the coils 33 and 36. The spindle 37 carries a plate 41 which is formed with smooth outer curved surfaces 42 and 43 and is provided with a curved slit the one edge 44 of which is smooth while the other edge 46 thereof is serrated. The

plate 41 is also formed with a plurality of curved slots 47, 48 and 49 which are serrated on one edge thereof as shown.

The position of the plate is dependent on the rotation of spindle 37 in either direction dependent on the direction of energy flow in the line section 1. A stop 51 is preferably located adjacent edge 42 of the plate 41 to limit the movement of the plate in the one direction of rotation.

The lever 11 is provided at the upper end thereof with a knife edged pin 52 secured on a lever 53 pivoted in the ears 54 formed on lever 11. The pin 52 normally rests on a flattened portion of the plate edge 44, as shown, when the relay is at rest.

Assuming that a disturbance occurs in the line section to be protected, the action of the relay is as follows. The torque impressed upon spindle 16 by coil 17 will exceed the opposing torque produced by coil 21 and spindle 16 will rotate and will thereby release clockwork mechanism 27. Pinion 26 will produce rotation of gear sector 28 about its pivot 10 thereby moving lever 11 in a clockwise direction about pivot 10. If the flow of energy in line 1 is in the direction for which tripping of the circuit breaker 2 is not desired, plate 41 will be rotated in a clockwise direction until its further movement is prevented by stop 51. Lever 11 will continue its clockwise rotation about pivot 10 until pinion 26 disengages from gear sector 28 and then remains stationary without further effect. If the flow of energy in line 1 is in the reverse direction for which tripping of the circuit breaker is desired, plate 41 will tend to rotate in the counter-clockwise direction toward a definite position depending upon the ratio of voltage and current in the coils 31, 32 and 33, 36. Such movement is retarded by the presence of a pin 52 which slides on edge 44 while lever 11 is moving in a clockwise direction. As lever 11 moved towards the position determined therefor, plate 41 will have reached its equilibrium position and will remain stationary. Further movement of arm 11 will cause pin 52 to leave the edge 44 of the plate 41 and will cause the pin to engage in a serration of the edge 46. Pin 52 then becomes a pivoting point or fulcrum for the lever 11 and further clockwise movement of gear sector 28 rotates lever 11 in a counter-clockwise direction about pin 52 through the connection at pivot 30 and against the action of spring 12. Contacts 8 are then bridged by member 9 thereby producing energization of coil 6 and release of the circuit breaker 2.

Assuming however that the direction of energy flow changes while the above described counter-clockwise rotation of plate 41 is going on and pin 52 is sliding on edge 44; reversal of the direction of energy flow immediately reverses the rotation of plate

41 to a clockwise direction. Pin 52 will leave edge 44 and engage edge 46 and clockwork 27 will rotate lever 11 in a counter-clockwise direction as above described and would thus produce opening of circuit breaker 2. Such result is however undesired and means are provided to avoid the above action. The knife edge 52 is secured on lever 53 which is pivoted at 54 in such manner that clockwise rotation of plate 41 in contact with knife edge 52 will tilt the knife edge out of its original position to avoid locking engagement thereof with the serrated edge 46 of the plate and the pin slides on the forward side of the plate and resumes its normal position after leaving edge 43. Lever 11 then completes its clockwise movement without further effect. If it is assumed that the direction of energy reverses repeatedly and an immediate release of circuit breaker 2 is desired, the reversals of energy flow will cause plate 41 to oscillate which, by its counter-clockwise movement, will permit pin 52 to drop into slots 47, 48 or 49 whereupon pin 52 engages in the serrated edge of the slot. Such engagement causes counter-clockwise rotation of lever 11 under the action of clockwork 27 as above described which results in opening of circuit breaker 2 also as above described.

The impedance of the line section lying between the point of connection of the relay and the fault may be suddenly decreased to such value as should have caused tripping of the relay at an earlier period during the motion of lever 11. Plate 41 will then rotate in a clockwise direction toward its new equilibrium position without, however, completing its movement to the initial position corresponding to normal operation. In such case the edge 46 of plate 41 will lift pin 52 which is pivoted about the point 54 and is permitted to drop into slots 47, 48 or 49 where the pin 52 engages and causes substantially immediate tripping of the circuit breaker 2.

Although the structure and operation of but one embodiment have been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

The invention claimed is:

1. In combination with an electric circuit subject to the flow of energy therein in one and another direction, and a circuit breaker operable to disconnect a section of said circuit, of a relay comprising a timing element operable to control said disconnection operation of the circuit breaker, an element for initiating movement of said timing element, a time-delay element operable in one and another direction responsive to and in dependence upon the direction of energy flow

in said circuit and in extent in dependence upon the ratio of the voltage to the current of said circuit upon the occurrence of a fault connection therein, the movement of said time-delay element in the said one direction thereof being operable to control the duration of movement of said timing element from the moment of initiation of its movement to the moment of carrying out the same, and means actuated by said time-delay element upon movement thereof a predetermined extent in the said another direction following movement thereof in the said one direction during movement of said timing element operable to prevent said disconnection operation of said circuit breaker by said timing element.

2. In combination with an electric circuit subject to the flow of energy therein in one and another direction, and a circuit breaker operable to disconnect a section of said circuit, of a relay comprising a timing element operable to cause said disconnection operation of the circuit breaker, an element for initiating movement of said timing element, a time-delay element operable in one and another direction responsive to and in dependence upon the direction of energy flow in said circuit and in extent in dependence upon the ratio of the voltage to the current of said circuit upon the occurrence of a fault connection therein, the movement of said time-delay element in the said one direction thereof being operable to control the duration of movement of said timing element to cause disconnection operation of said circuit breaker in time in dependence upon the ratio of the voltage to the current of said circuit, and means carried by said timing element co-acting with said time-delay element upon movement thereof a predetermined extent in the said another direction following movement thereof in the said one direction during movement of said timing element for causing said disconnection operation of the circuit breaker in time in dependence upon the extent of movement of said timing element upon the occurrence of the said movement of the time-delay element in the said another direction.

3. In combination with an electric circuit subject to the flow of energy therein in one and another direction, and a circuit breaker operable to disconnect a section of said circuit, a relay comprising a timing element operable to cause disconnection operation of the circuit breaker, an element operable upon the occurrence of a fault connection in said line for initiating movement of said timing element, a time-delay element movable in one and another direction responsive to and in dependence upon the direction of energy flow in said circuit and in extent in dependence upon the ratio of the voltage to the current of said circuit upon the oc-

currence of a fault connection therein, the movement of said time-delay element in the said one direction thereof being effective to control the duration of movement of said timing element to cause disconnection operation of said circuit breaker in time in dependence upon the ratio of the voltage to the current of the circuit, and means carried by said timing element co-acting with said time-delay element upon movement thereof a predetermined extent in the said another direction following movement thereof in the said one direction during movement of said timing element for causing said disconnection operation of the circuit breaker in time in dependence upon the extent of movement of said timing element upon occurrence of movement of said time-delay element in the said another direction, the said means being operable to prevent said disconnection operation of the circuit breaker upon the occurrence of movement of said time-delay element in the said another direction in extent greater than said predetermined extent following movement thereof in the said one direction during movement of said timing element.

In testimony whereof we have hereunto subscribed our names this 25th day of November A. D. 1930.

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JOSEF STOECKLIN.

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