Nov. 12, 1935. C. J. ANDERSON 2,020,818

PROTECTIVE DEVICE

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Fig. 1

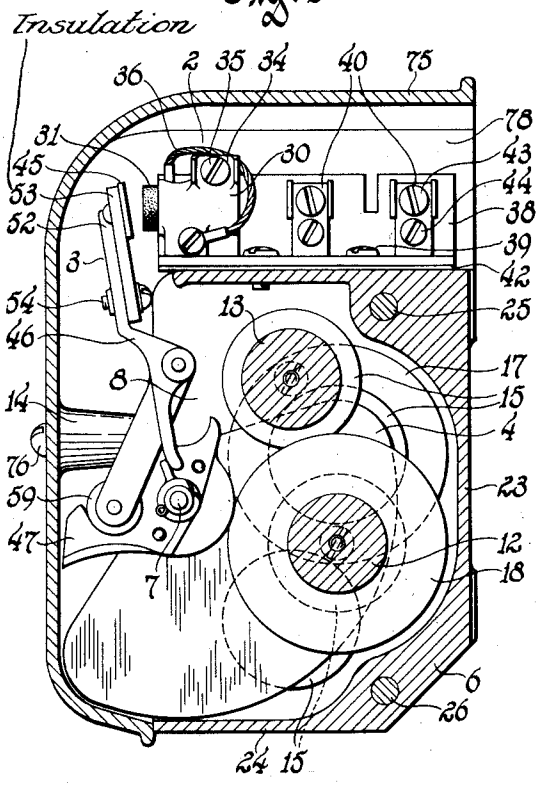


Fig. 2

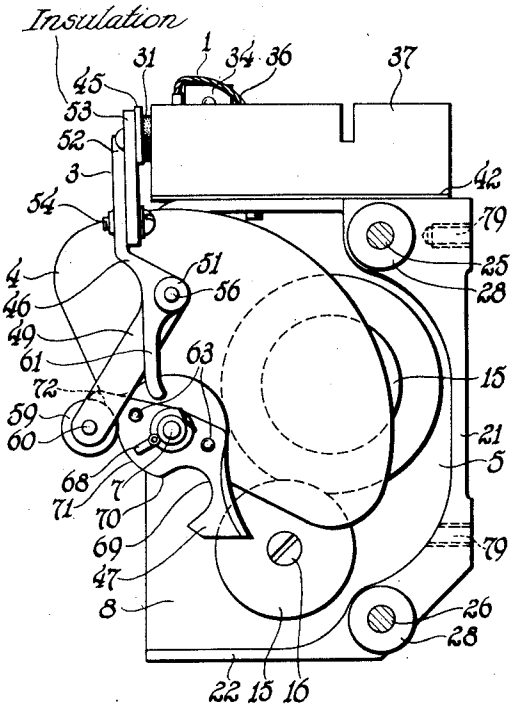
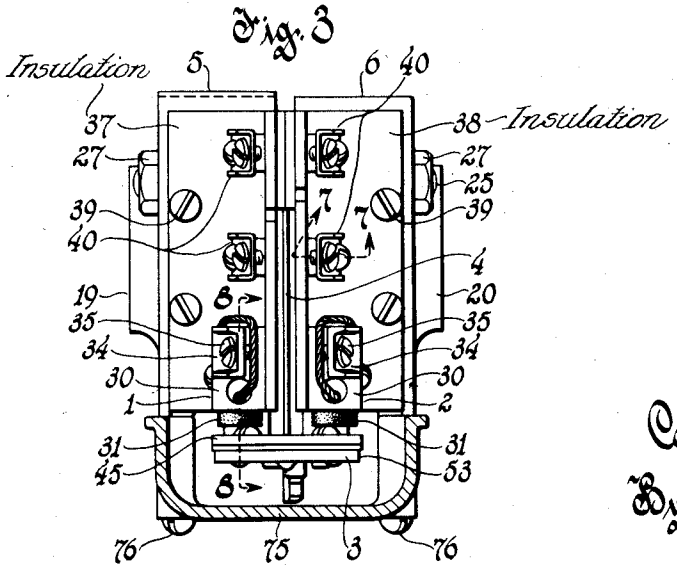


Fig. 3



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Fig. 4

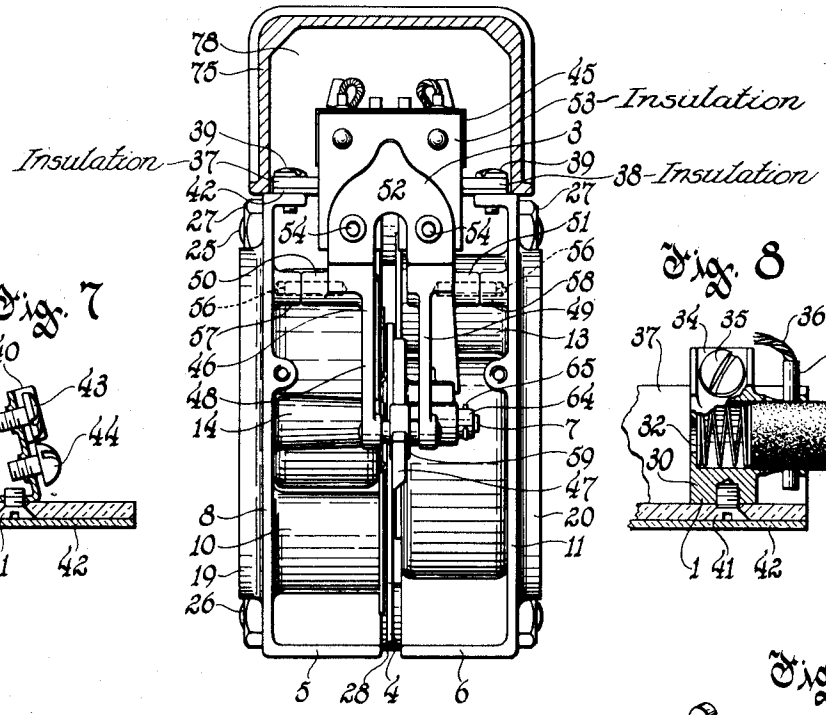


Fig. 7

Fig. 8

Fig. 5

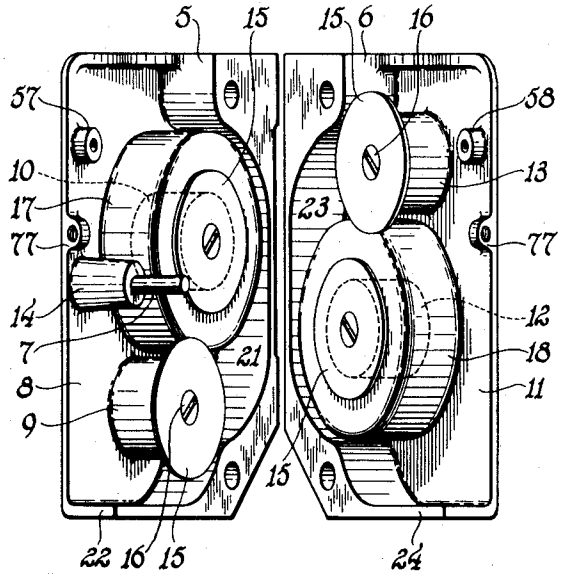
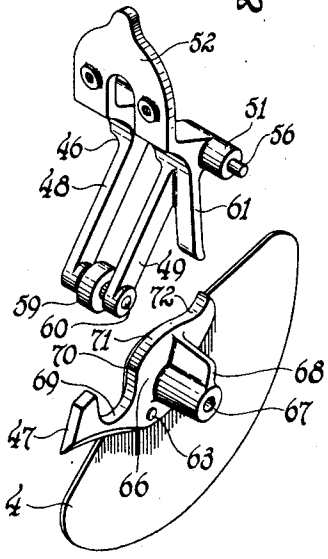


Fig. 6



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UNITED STATES PATENT OFFICE

2,020,818

PROTECTIVE DEVICE

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Application January 11, 1933, Serial No. 651,094

11 Claims. (Cl. 200—91)

This invention relates to protective devices, and more particularly to phase failure and phase reversal relays for use in polyphase alternating current circuits.

One object of the invention is to provide a compact, rugged and efficient protective device of the aforesaid character consisting of a small number of parts severally characterized by strength, simplicity and facility of assemblage.

Another object is to provide a protective device of the aforesaid character having an improved electroresponsive operating unit including magnet frames so constructed and arranged as to provide enclosing and supporting walls for the unit.

Another object is to provide an improved switch for devices of the aforesaid character and to also provide a rugged and reliable operating mechanism for the switch including a small number of moving parts.

Various other objects and advantages of the invention will hereinafter appear.

The accompanying drawings illustrate an embodiment of the invention which will now be described, it being understood that the embodiment illustrated is susceptible of modification without departing from the spirit and scope of the appended claims.

In the drawings,

Figures 1 and 2 are vertical and sectional views of a device embodying the invention;

Figs. 3 and 4 are top and front views, respectively, of the device shown in Fig. 1, the enclosing cover being shown in section;

Figs. 5 and 6 are perspective views of certain of the parts illustrated in Fig. 4, and

Figs. 7 and 8 are detail sectional views taken substantially on lines 7—7 and 8—8, respectively, in Fig. 3.

The relay illustrated includes a pair of stationary contact devices 1 and 2 and a cooperating movable contact element 3 under the control of an electroresponsive device comprising a pivoted vane 4 having magnet frames 5 and 6 arranged on opposite sides thereof. As hereinafter set forth the magnet frames 5 and 6 are provided with energizing windings for connection across unlike phases of a polyphase alternating current circuit, and under normal conditions in said circuit vane 4 is held in the position shown in Fig. 2 to maintain contact element 3 in engagement with stationary contact devices 1 and 2, whereas under given abnormal conditions of said circuit said vane is moved by gravity into the position shown in Fig. 1 to move said contact element out of engagement with said stationary contacts.

More specifically, the vane 4 comprises a vertically arranged segmental disk of aluminum or other conductive but non-magnetic material pivotally mounted upon a horizontally arranged stationary pin 7 and the magnet frames 5 and 6 are arranged in opposed relation with an air gap therebetween for receiving said vane. As shown in Fig. 5, magnet frame 5 is provided with a vertical side wall 8 having pole projections 9 and 10 on the inner face thereof, and magnet frame 6 is provided with a vertical side wall 11 having pole projections 12 and 13 on the inner face thereof. The pivot pin 7 is carried by an inwardly extending lug 14 on the inner face of side wall 8 of magnet frame 5, and as shown in Fig. 1 the pole projections 9, 10, 12 and 13 are arranged equidistant from the axis of the pivot pin 7 and in a staggered relation. As best shown in Fig. 5, each of the pole projections on magnet frames 5 and 6 has an enlarged disk 15 fixed to the inner end thereof by a screw 16, and a pair of energizing windings 17 and 18 are mounted upon the pole projections 10 and 12, respectively. As shown in Figs. 3 and 4, the outer faces of the side walls 8 and 11 of the magnet frames are provided with projecting pads 19 and 20, respectively, which provide magnetic paths of low reluctance between the pole projections on the inner faces of said walls.

The side wall 8 of magnet frame 5 is provided with inwardly projecting marginal portions forming a rear wall 21, and a bottom wall 22 and the side wall 11 of magnet frame 6 is provided with similarly shaped inwardly projecting marginal portions forming a rear wall 23, and a bottom wall 24. The magnet frames 5 and 6 are bolted together by a pair of non-magnetic studs 25 and 26, said studs being arranged within openings in the rear walls 21 and 23, and each having clamping nuts 27 associated with opposite ends thereof. As shown in Figs. 2 and 4, each of the studs 25 and 26 carries a non-magnetic spacing washer 28 which is arranged between the magnet frames 5 and 6 to maintain an air gap between the latter.

The operation of the aforedescribed electroresponsive device will now be more fully described. Assuming that the windings 17 and 18 are connected across unlike phases of a polyphase alternating current supply circuit substantially independent alternating fluxes will be produced in the magnet frames 5 and 6 which will be continuously displaced in phase. Such fluxes induce eddy currents in the vane 4 and the eddy currents induced by each magnet frame are acted upon by the flux produced in the other magnet frame to provide a torque which tends to rotate said vane in

one direction or the other, dependent upon the phase relation of the current in the windings 17 and 18. By properly connecting the windings 17 and 18 in a polyphase alternating current circuit a torque is produced which normally holds the vane 4 in the position shown in Fig. 2.

Upon failure of current in any phase of the supply circuit the torque for holding the vane 4 in the position shown in Fig. 2 becomes zero, whereupon said vane automatically moves to the position shown in Fig. 1 under the action of gravity. Also upon a predetermined general reduction of the line voltage such effective torque becomes so far reduced as to be insufficient to hold the vane 4 in the position shown in Fig. 2, whereupon said vane also moves under the action of gravity to the position shown in Fig. 1. Further, should the phase relation of the current in the supply circuit become reversed from any cause either accidental or voluntary the direction of torque on vane 4 will be reversed to drive said vane from the position shown in Fig. 2 into the position shown in Fig. 1. Upon restoration of normal conditions in the supply circuit following existence of any of the aforedescribed abnormal conditions the vane 4 is adapted to move automatically from the position shown in Fig. 1 into the position shown in Fig. 2.

As is apparent, by arranging the magnet parts in the manner above described a very rigid and compact electroresponsive operating unit is obtained. Also it has been found that arrangement of the magnet frames 5 and 6 in opposed relation upon opposite sides of the vane 4 and employment of washers 15 to provide enlarged overlapping pole faces on said frames, tends to increase the efficiency of the device. The above described electroresponsive operating device also has numerous other advantages, certain of which will be hereinafter discussed.

The stationary contact devices 1 and 2 are mounted upon the upper edges of the magnet frames 5 and 6, respectively. Said contact devices are similarly constructed, each of the same being provided with a holder 30 having a cylindrical carbon contact 31 slidably mounted within an opening therein. One of the contact devices is illustrated in section in Fig. 8, and as shown therein holder 30 has a coil spring 32 associated therewith for biasing the contact 31 outwardly. Also as shown in Fig. 8, contact 31 is held in assembled relation within the opening in holder 30 by a terminal pin 33 supported within an opening in said contact and projecting into oppositely disposed openings in said holder. As shown in Figs. 1 and 3, each of the holders 30 is provided with an upwardly extending terminal portion 34 having a binding screw 35 associated therewith, and each of said holders is connected to the contact pin 33 of its associated contact 31 by a flexible lead 36.

The contact devices 1 and 2 are mounted upon the front ends of oppositely disposed L-shaped insulating supports 37 and 38 which are fixed to the upper edges of the magnet frames 5 and 6, respectively, by screws 39. As shown in Fig. 3, each of said insulating supports also carries a pair of terminal devices 40. The contact holders 30 and the terminal devices 40 are secured to their associated insulating supports by screws 41, the heads of said screws being countersunk in the lower faces of said supports, as shown in Figs. 7 and 8. The heads of the screws 41 are insulated from the magnet frames 5 and 6 by flat insulating strips 42 interposed between said magnet frames and the lower faces of the insulating supports 37 and 38.

As shown in Fig. 3, insulating supports 37 and 38 are spaced to provide a passage therebetween for receiving terminal wires associated with the energizing windings 17 and 18. The terminal wires for said windings are not shown in the drawings, but as is apparent, such terminal wires may be passed upwardly through the space between supports 37 and 38 for connection to the terminal devices 40. As shown in Fig. 8, each of the terminal devices 40 is provided with a pair of binding screws 43 and 44, one of said screws being provided for securement of a winding terminal and the other for securement of a line connection.

The movable contact element 3 includes a contact 45 for bridging the contacts 31 of contact devices 1 and 2. Bridging contact 45 is carried by a lever 46 which is operable as hereinafter set forth by a cam 47 associated with vane 4 to move said bridging contact into and out of engagement with the contacts 31.

As shown in Figs. 4 and 6, lever 46 is provided with spaced side arms 48 and 49 having hub portions 50 and 51 on the upper ends thereof which are connected by an upwardly extending projection 52. Contact 45 is riveted to an insulating plate 53 which is secured to the projection 52 of lever 46 by screws 54. The hub portions 50 and 51 of lever 46 each have an outwardly extending pin 56 fixed thereto, and said pins are journaled within openings provided in inwardly extending bearing projections 57 and 58 on side walls 8 and 11 of the magnet frames 5 and 6. A roller 59 for engaging the cam 47 is rotatably mounted upon a pin 60 which is supported within openings in lower ends of the arms 48 and 49 of lever 46 and the hub portion 51 of said lever is provided with a downwardly projecting arm 61 which also cooperates with said cam.

Cam 47 is fixed to the right hand face of vane 4 by screws 63 and is rotatably mounted upon pivot pin 7 between the lug 14 on magnet frame 5, and a collar 64 fixed to said pin by a cotter pin 65. Cam 47 is provided with a body portion 66 having a surface on the front edge thereof for engaging the roller 59, and said cam is also provided with a projecting bearing portion 67 having a rib 68 on one side thereof for engaging the arm 61 on lever 46. The front edge of said cam member is provided with a notch 69 for receiving roller 59 and the upper edge of said notch merges at a point 70 with a convex cam surface 71. Cam surface 71 is slightly eccentric with respect to the axis of pivot pin 7 and the upper end of said cam surface joins with a concave surface 72.

As hereinbefore stated, by properly connecting the coils 17 and 18 in a polyphase alternating current circuit vane 4 is normally subjected to a torque which is adapted to move the same out of the position shown in Fig. 1 into the position shown in Fig. 2, and to maintain the same in the latter position, whereas under given abnormal conditions in said circuit said vane is adapted to move under the action of gravity from the position shown in Fig. 2 into the position shown in Fig. 1.

As is apparent, with vane 4 positioned as shown in Fig. 2, the cam surface 71 engages roller 59 to maintain lever 46 in a position wherein bridging contact 45 is held in engagement with the contacts 31 of the stationary contact devices. Also it should be noted that with the parts positioned as shown in Fig. 2 the concave surface 72 on the

cam 47 engages roller 59 to prevent counterclockwise movement of vane 4 beyond the position shown in Fig. 2.

Upon movement of the vane 4 out of the position shown in Fig. 2 into the position shown in Fig. 1 the notch 69 in cam 47 moves into a position for receiving roller 59 and during final movement of the vane into the position shown in Fig. 1 the rib 68 on said cam engages arm 61 on lever 46 to positively move said lever into the position shown in Fig. 1. Bridging contact 45 is then maintained out of engagement with contacts 31 and vane 4 is held against clockwise movement beyond the position shown by engagement of roller 59 with the bottom of notch 69.

As is apparent, upon return of vane 4 from the position shown in Fig. 1 into the position shown in Fig. 2, lever 46 is rotated in a clockwise direction to return bridging contact 45 into engagement with the contacts 31. However, it should be noted that upon initial movement of the vane 4 out of the position shown in Fig. 1 rib 68 on the cam member disengages the arm 61 on lever 46 and simultaneously the point 70 on said cam member engages the roller 59 to effect quick movement of said lever 46 into a position wherein bridging contact 45 engages the contacts 31. Upon continued movement of vane 4 towards the position shown in Fig. 2 the cam surface 71, which as hereinbefore stated is slightly eccentric with respect to the axis of pivot pin 7, serves to effect a slight continued clockwise movement of lever 46 to insure firm engagement of bridging contact 45 with the contacts 31 under the action of the contact springs 32.

The device is provided with an inverted L-shaped cover 75 having inwardly extending side walls for engaging the front and top edges of the magnet frames 5 and 6. Said cover is constructed of non-magnetic material and is secured to the magnet frames by screws 76 which pass through openings in said cover into tapped openings in lugs 77 on the side walls of said frames. As shown in Fig. 1 the cover 75 has an opening 78 at the rear thereof to facilitate wiring of the device, and as shown in Fig. 2 the rear wall of magnet frame 5 is provided with tapped bolt receiving openings 79 for securement of the device to a suitable support.

In connection with the foregoing it should be noted that the side walls of the magnet frames 5 and 6 and the cover 75 serve to enclose the various parts of the device and protect the same against injury, and to also prevent the accumulation of foreign matter within the device. Removal of the cover 75 obviously renders the parts of the switch mechanism accessible for inspection or repair. Also it should be noted that with magnet frame 5 mounted upon a support, magnet frame 6 can be readily detached therefrom for inspection or repair of the various parts.

What I claim as new and desire to secure by Letters Patent is:

1. An alternating current relay comprising a movable circuit controlling element and an electroresponsive operating unit therefor including a pivoted vane operatively connected to said circuit controlling element, and a pair of stationary field elements arranged on opposite sides of said vane, each of said field elements including a magnet frame having a side wall provided with a plurality of pole projections terminating in pole faces facing said vane, said pole faces being arranged in a staggered relation and the side walls of said magnet frames forming an enclosure for said vane.

2. An alternating current relay comprising a movable circuit controlling element and an electroresponsive operating unit therefor including a pivoted vane operatively connected to said element and a pair of stationary field elements arranged on opposite sides of said vane, each of said field elements including a magnet frame having a side wall provided with integral pole extensions projecting towards said vane, said circuit controlling element and said vane being mounted upon the side walls of said magnet frames and said side walls forming an enclosure for said vane.

3. An alternating current relay comprising a movable circuit controlling member and an electroresponsive operating unit therefor including a pair of spaced field elements and a vane movable in the space between said field elements and operatively connected to said circuit controlling member, each of said field elements including a magnet frame having a pair of projections thereon terminating in pole faces facing said vane, the pole projections on said field elements being arranged in a staggered relation.

4. An alternating current relay comprising a pair of magnet frames, non-magnetic means for securing said frames together with an air gap therebetween, a rotatable vane arranged within the air gap between said magnet frames and a switch mechanism including a pivoted contact element operatively connected to said vane, said vane and said switch mechanism being mounted upon said magnet frames.

5. An alternating current relay comprising a pair of magnet frames, non-magnetic means for securing said magnet frames together with an air gap therebetween, a vane rotatably mounted upon one of said magnet frames and arranged within the air gap between said magnet frames, and a switch mechanism mounted upon said magnet frames, said switch mechanism including an insulated stationary contact mounted upon each of said magnet frames and a cooperating bridging contact element rotatably mounted upon said magnet frames and operable by said vane.

6. An alternating current relay including a pivoted circuit controlling element, an electroresponsive operating unit therefor having a pivoted vane operatively connected to said element, and a pair of field elements arranged in opposed relation on opposite sides of said vane, each of said field elements including a magnet frame having a side wall provided with spaced pole projections terminating in enlarged pole faces facing said vane, said pole faces being arranged in a staggered relation and concentric with respect to the pivot of said vane, and a magnet winding mounted upon one of the pole projections of each of said magnet frames.

7. In an alternating current relay, the combination with a field unit including vertically arranged spaced magnet members having energizing windings mounted thereon to be supplied with alternating currents of different phase relation, of a pivoted vane arranged to swing in a vertical plane in the space between said magnet members, a pivoted contact element having a given range of movement and a cam associated with said vane for moving said contact element in one direction through a major part of its range upon initial movement of said vane out of a given extreme position and for moving

said contact element through the remainder of its range upon continued movement of said vane into an opposite extreme position.

8. In an alternating current relay, the combination with a field unit including vertically arranged spaced magnet members having energizing windings mounted thereon to be supplied with alternating currents of different phase relation, of a pivoted vane arranged to swing in a vertical plane in the space between said magnet members, a pivoted contact element movable in opposite directions between given extreme positions, a cam associated with said vane for moving said contact element out of one extreme position and through a major part of its range upon initial movement of said vane out of a given extreme position and for moving said contact element into its other extreme position upon continued movement of said vane into an opposite extreme position, and a part associated with said vane for engaging said contact element to positively move the same into its first mentioned extreme position upon return movement of said vane into its first mentioned extreme position.

9. In an alternating current relay, the combination with a switch mechanism including a movable contact element, of an electroresponsive operating unit therefor having a pivoted vane operatively connected to said element and a pair of field elements arranged in opposed relation on opposite sides of said vane, each of said field elements including a magnet frame having a side wall provided with a plurality of pole projections terminating in pole faces facing said vane, said switch mechanism and said vane being mounted upon the side walls of said magnet frames, and non-magnetic means for securing said magnet frames together and for holding the same in spaced relation.

10. In an alternating current relay, the combination with a switch mechanism including a pivoted contact element, of an electroresponsive operating unit therefor having a pivoted vane operatively connected to said element and a pair of field elements arranged in opposed relation on opposite sides of said vane, each of said field elements including a magnet frame having a side wall provided with a plurality of pole projections terminating in pole faces facing said vane, said mechanism and said vane being mounted upon the side walls of said magnet frames, non-magnetic means for securing said magnet frames together and for holding the same in spaced relation and a non-magnetic enclosing cover for said switch mechanism and said vane extending between said magnet frames and secured to the side walls thereof.

11. In an alternating current relay, the combination with a field unit including vertically arranged spaced magnet members having energizing windings mounted thereon to be supplied with alternating currents of different phase relation, of a pivoted vane arranged to swing in a vertical plane in the space between said magnet members, said vane being biased towards a given extreme position and being movable under the action of said unit into an opposite extreme position, a movable contact element biased towards open position, and a cam associated with said vane for operating said contact element, said cam providing for movement of said contact element into closed position upon initial movement of said vane out of its first mentioned extreme position and also permitting continued movement of said vane into its last mentioned extreme position while maintaining said contact element in closed position.

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