Jan. 8, 1952 C. E. RANDALL 2,581,882

DEVICE FOR PROTECTING POLYPHASE CIRCUITS

Filed Feb. 10, 1949 2 SHEETS—SHEET 1

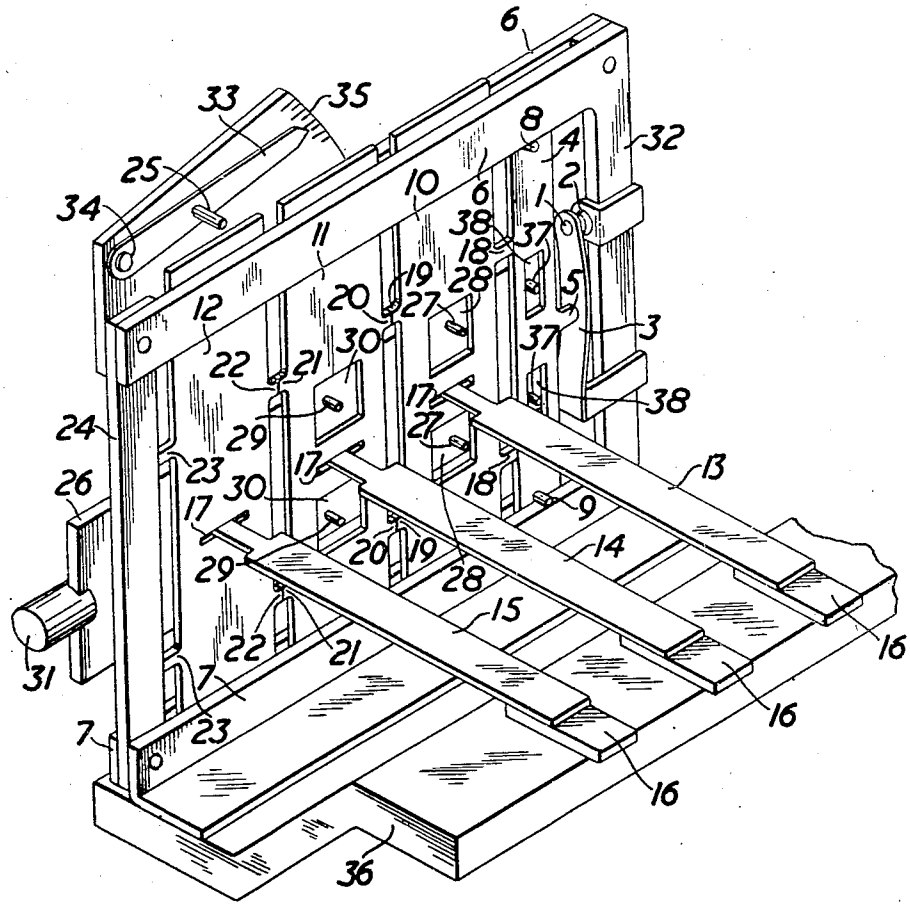


FIG. 1.

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Filed Feb. 10, 1949 2 SHEETS—SHEET 2

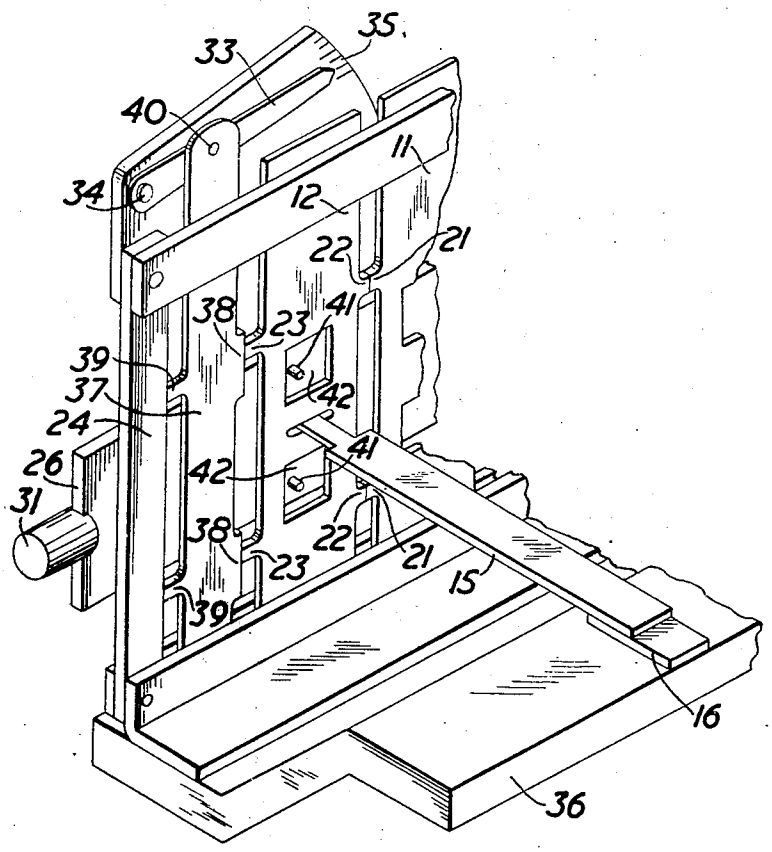


FIG. 2.

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Patented Jan. 8, 1952 2,581,882

UNITED STATES PATENT OFFICE

2,581,882

DEVICE FOR PROTECTING POLYPHASE CIRCUITS

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Application February 10, 1949, Serial No. 75,613
In Great Britain July 27, 1948

7 Claims. (Cl. 200—113)

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This invention relates to devices for protecting polyphase circuits. The object of the invention is the provision of improvements in such devices and the invention consists broadly of a device for protecting polyphase circuits against phase unbalance, comprising a plurality of elements together forming, in a mechanical series, a force-transmission means for retaining the device at a normal or non-tripped position, said elements being adapted to be individually positioned in a sense transversely to the direction of the force transmission, according to the current in the respective phases, and the mechanical correlation of said elements being such that, upon the transverse positioning of any neighboring pair relative to each other, departing, to more than a given extent, from the normal, the force transmission gives way so as to permit the device to move to the tripped position.

In order that the invention may be the more clearly understood a device in accordance therewith, together with a modification of said device, will now be described, reference being made to the accompanying drawings in which:

Fig. 1 is a somewhat diagrammatic perspective view of said device.

Fig. 2 is a similar view of the left hand end of said device showing the modification.

Referring first to Fig. 1, the circuit to be protected is a three phase circuit, and said circuit is interrupted upon disengagement of a moving contact 1 from a fixed contact 2. Said contacts 1 and 2 may for example be connected in series with the winding of a three pole contactor controlling said three phase circuit.

Said moving contact 1 is carried at the upper end of an upright leaf spring 3 and said moving contact is controlled by means of an upright pressure plate 4 which is mounted so as to be horizontally slidable. Said pressure plate 4 has a short horizontal projection 5 which engages said leaf spring, and when said pressure plate is slid to the right (according to the drawing) it presses said leaf spring to the right so that the moving contact 1 engages with the fixed contact 2. When said pressure plate is released said leaf spring presses said pressure plate to the left and simultaneously disengages said moving contact from said fixed contact.

For guiding said pressure plate 4 to move horizontally as stated, the upper end of said pressure plate is slidable between horizontal guide members 6 and its lower end is slidable between horizontal guide members 7. To restrain said pressure plate against vertical movement, it has transverse upper and lower pins 8 and 9 projecting from it, the upper pin 8 engaging the under surface of the guide members 6 and the lower pin 9 engaging the upper surface of the guide members 7.

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Normally said pressure plate 4 is held at its right hand position so that the contacts 1 and 2 are in engagement, but, upon the occurrence of either overload or voltage failure in one or two of the phases, said pressure plate is released, enabling the contact 1 to leave the contact 2, and causing the controlled circuit to be interrupted. To this end three vertical sliding plates 10, 11 and 12 are provided whose upper ends slide between the upper guide members 6 and whose lower ends slide between the lower guide members 7. These sliding plates are able to move not only horizontally, but also vertically, between the guide members. The sliding plates are controlled as to their vertical positions by means of respective bi-metal elements 13, 14 and 15 whose temperatures vary according to the current in the three phases. These elements 13, 14 and 15 are fixed at one end to fixed metal mountings 16, and their other ends are adapted to rise and fall according to their temperatures, that is according to the current value in the respective phases. These movable ends engage in horizontal slots 17 in the respective sliding plates, and thus, as the ends of the bimetal elements rise and fall, said sliding plates also rise and fall. At the same time the slots 17 are sufficiently long to enable said sliding plates to make their horizontal components of movement independently of the bimetal elements.

The sliding plate 10 has two projections 18 extending horizontally from its right-hand edge and engaging the left hand edge of the pressure plate 4. Said sliding plate 10 also has two projections 19 extending horizontally from its left hand edge, and, when said sliding plate 10 is at the same horizontal level as the sliding plate 11, these projections 19 abut, end to end, with two similar projections 20 extending horizontally from the right hand edge of the sliding plate 11. Said sliding plate 11 has also two projections 21 extending horizontally from its left hand edge, and, when said sliding plate 11 is at the same horizontal level as the sliding plate 12, these projections 21 abut, end to end, with two similar projections 22 extending horizontally from the right hand edge of said sliding plate 12. Finally said sliding plate 12 has two projections 23 extending horizontally from its left hand edge and abutting against the right hand edge of a fixed vertical member 24.

Above the sliding plate 12 is provided a pin 25 which is capable of being adjusted vertically to a position which accords to the degree of overload at which it is desired to have the device trip.

In operation, assuming the current in the controlled three phase circuit is switched off, all three of the bimetal elements 13, 14 and 15 will be equally cold and the three plates 10, 11 and 12 will accordingly be at the same level. There-

fore the projections 19 and 20 will be in engagement, and so will the projections 21 and 22. The dimensions are such that, under these circumstances the pressure plate 4 is held sufficiently far to the right to cause the contact 1 to engage the contact 2.

If now the current is switched on, and assuming that there is no voltage unbalance, the three bimetal elements will heat up equally and the three plates 10, 11, 12 will rise together remaining at the same level. The projections 19 and 20 will remain in engagement, and so will the projections 21 and 22. The projections 18 will slide up the left-hand edge of the pressure plate 4, and the projections 23 will slide up the right hand edge of the fixed member 24. The pressure plate 4 will remain unmoved and the contacts 1 and 2 will remain closed.

If now the current increases above the predetermined safe value, these three plates 10, 11 and 12 will continue to rise until the upper edge of the plate 12 engages the pin 25. This prevents any further upward movement of said plate 12, but the plates 11 and 10 will continue to rise, until the projections 21 cease to register with the projections 22, whereupon the pressure plate 4 together with the sliding plates 10 and 11 are free to move to the left until the projections 21 engage the right hand edge of the sliding plate 12, and/or the left hand edge of the sliding plate 11 engages the projections 22. This movement is sufficient to enable the contact 1 to disengage the contact 2.

If instead of overload there has been a voltage failure in one or two phases, or some other voltage unbalance had taken place, a difference of level between certain of the plates 10, 11, 12 would have eventuated so that either the projections 21, 22 or the projections 19, 20 would have ceased to register. Once again therefore the pressure plate 4 would have been free to move to the left, and the contact 1 would have disengaged.

In any event, for resetting the device after the bimetal elements have again become cold, a reset plate 26 is provided. This plate is mounted so as to be horizontally slidable in a plane parallel to the common plane of the four plates 4, 10, 11, 12, and it carries transverse pegs 27 which pass through apertures 28 in the sliding plate 10, and also transverse pegs 29 which pass through apertures 30 in the sliding plate 11. Said reset plate 26 is biased by means of a spring (not seen) to a left hand limit as illustrated, and when it is pushed to the right (by means of a finger knob 31 mounted on it) the pegs 27 engage the right hand edges of the aperture 28 and press the plate 10 to the right, and the pegs 29 engage the right hand edges of the apertures 30 and press the plate 11 to the right. The pegs are so placed that the plate 10 is moved sufficiently in advance of the plate 11 to enable the projections 19 and 20 once more to come into line (if they had disengaged) so that they will again abut against each other when the reset plate 26 is released. Equally the plate 11 is moved in advance of the plate 12 so that the projections 21 and 22 (if they had disengaged) will abut against each other when the reset plate is released.

The reset plate 26 may also carry transverse pegs 37 which pass through apertures 38 in the pressure plate 4. When the reset plate is pushed to the right these pegs 37 engage the right hand edges of the apertures 38 before the pegs 27 engage the right hand edges of the apertures 28. Thus the pressure plate 4 is kept clear of the projections 18 during the resetting operation, thereby making it easier for the bimetal elements to return the sliding plates vertically to their correct levels.

In construction the guide members 6 are shown as forming the upper member, and the guide members 7 the lower member, of a rectangular frame one of whose end members is constituted by the aforesaid member 24. The other end member of said frame, which is designated by the reference 32, serves as the support on which the contact 2 and also the leaf spring 3 are mounted.

The heating of the bimetal elements 13, 14 and 15 may be effected either by connecting them directly in the phases of the circuit to be protected, or by means of heating coils (not shown) connected in said phases.

The pin 25 is shown as mounted on an arm 33 which is pivoted at 34, so that, by moving said arm about its pivot, the raising and lowering of said pin 25 is effected. The extremity of said arm moves over, and reads against, a scale 35 which may be calibrated in terms of the current value at which it is desired to have the device trip.

The whole structure is mounted on a suitable base 36.

Referring now to Fig. 2 this shows a modification in which, instead of providing the pin 25 for checking the upward movement of the plate 12 on overload so that the plates 11 and 10 continue to rise until they are free to move to the left relative to said plate 12, an additional vertical sliding plate 37 is provided between the plate 12 and the vertical member 24. This plate 37 has projections 38 extending horizontally from its right hand edge which normally abut end to end with the projections 23 of the plate 12. Said plate 37 is normally stationary during the operation of the device, and the projections 38 are of considerable vertical depth as shown.

In operation, when the current is switched on, and assuming no voltage unbalance, the three plates 10, 11, 12 will rise together at the same level and the projections 23 will slide up the ends of the projections 38, and the pressure plate 4 will remain unmoved and the contacts 1 and 2 will remain closed. If, however, the current increases above the predetermined safe value, the projections 23 will slide clear of the projections 38, and the pressure plate 4, together with all these sliding plates 10, 11 and 12, will be free to move to the left and enable the contact 1 to disengage the contact 2.

Said plate 37 has projections 39 from its left hand edge which abut slidably against the right hand edge of the vertical member 24, and said plate 37 is vertically adjustable, and it will be seen that its vertical adjustment determines the degree of overload at which the projections 23 clear the projections 38. The vertical adjustment may be effected by pivotally connecting at 40 the upper end of said plate 37 to the aforesaid arm 33. Thus the adjustment of said arm 33 determines the vertical adjustment of said plate 37, and said arm 33 indicates, as before, on the scale 35 the degree of overload to which the device is set.

The device functions exactly as before on phase unbalance. It will be seen that, for resetting the device, it will now be necessary to provide the reset plate 26 with additional transverse pegs 41 which pass through additional apertures 42 in the plate 12. Thus when the reset plate 26 is pressed to the right for resetting, the pegs 41

will engage the right hand edges of the apertures 42 and press the plate 12 to the right. The pegs 41 are of course so placed that the plate 11 moves sufficiently far in advance of the plate 12 to permit the projections 21 and 22 to re-engage if they have been disengaged by phase unbalance, and at the same time the plate 12 is moved sufficiently far to the right to enable the projections 23 and 38 to re-engage if they have been disengaged by overload.

I claim:

1. In a protective device for electric circuits wherein a relay is used to control the circuit controlling switch in accordance with the condition of a plurality of thermal responsive elements, each of which elements is adapted to be heated in accordance with the current in a separate conductor of the protected circuit, tripping means for said relay comprising a plurality of slide members, one for each thermal responsive element, guide means for holding said members in coplanar relationship and for permitting them to move only longitudinally and laterally, a plurality of projections extending laterally from adjacent edges of said movable members to provide increased spacing between said members when the projections on adjacent members are in alignment with each other, means for connecting said movable members to said thermal responsive elements to effect longitudinal movement of said members in accordance with the value of current in their respective conductors, and means for biasing said relay to tripped position, said movable members being normally positioned with their cooperating projections in alignment to hold said relay in normal position against the force of said biasing means, whereby upon an unbalance of current in the conductors of the controlled circuit which causes the projections to be moved out of alignment at least one of said members will be moved laterally to permit tripping of said relay.

2. A releasing device for an electric switch comprising, in combination, means for normally biasing said switch to open position, a plurality of movable members guided to move in a common plane and free for movement in said plane relative to each other, said members each having laterally extending projections arranged for end-to-end engagement with similar projections on adjacent members, said members being positioned to hold said switch in closed position against the force of said biasing means when said projections are in engagement, and a plurality of current responsive elements individually connected to said movable members to effect movement thereof in parallel directions in accordance with the value of current controlling each element, whereby upon an unbalance in said values of current the projections on at least two adjacent movable members will move out of engagement to permit transverse movement of at least one of said members under the force of said biasing means to open said switch.

3. The combination with a switch having a movable element, of a fixed member, a group of slide members interposed between said fixed member and said movable switch element, said slide members bearing one against another and being of contour form such that the group is expansible or contractable for exerting or relieving pressure on said switch element by sliding any one of said slide members relative to an adjacent slide member and current responsive means for effecting sliding of said slide members individually and selectively according to unbalanced current conditions of said means.

4. The combination as in claim 3, wherein said movable switch element has stability during sliding of said slide members together, and including means for restricting the range of movement of one of said slide members to permit sliding of another relative thereto under predetermined current conditions.

5. A relay for polyphase alternating current circuits comprising the combination with thermal elements for association with different phases of the polyphase circuit of a switch having a movable element, a fixed member, a group of slide members interposed between said fixed member and said movable switch element, said slide members bearing one against another and being of a contour form such that the group is expansible or contractable for exerting or relieving pressure on said movable switch element by sliding any one of said slide members relative to an adjacent slide member, said thermal elements each having connection with an associated slide member for effecting sliding of said slide members individually and selectively according to unbalanced current conditions in the different phases of the polyphase circuits.

6. A protective device for polyphase electric circuits comprising, in combination, a switch, means for biasing said switch to a given position, force transmission means for holding said switch in another position against the force of said biasing means, said force transmission means comprising a plurality of slide members in end to end engagement and which upon a predetermined sliding movement of any one relative to the member engaged thereby effects a change in the force transmission means to permit said switch to move to said given position, and current responsive means for sliding said slide members independently of one another for relative movement thereof when they are subjected to unbalanced current, said slide members having laterally extending projections arranged for end to end engagement with similar projections on adjacent members for effecting a reduction in the effective length of said force transmission means upon movement of said projections out of engagement with each other.

7. A device according to claim 6, wherein a resetting member is provided for engaging each of the slide members after the first and moving them in the direction of force transmission, said slide members having apertures formed therein, engagement being effected by transverse projections on said resetting member which pass through said apertures in said slide members for engagement with the walls of said apertures, whereby each member is moved sufficiently far in advance of the preceding one to enable them to return to normal relative positions.

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