United States Patent [19]

Woodger

[11] **3,800,260**

[45] **Mar. 26, 1974**

[54] **ELECTRIC SWITCHES**

[75] Inventor: **Frederick Noel Woodger,** Great Barford, England

[73] Assignee: **Cutler Hammer Inc.,** Milwaukee, Wis.

[22] Filed: **Oct. 30, 1972**

[21] Appl. No.: **302,268**

[30] **Foreign Application Priority Data**

Jan. 11, 1972 Great Britain 1123/72

[52] **U.S. Cl.** **337/49,** 200/67, 337/38, 337/39, 337/59, 337/72, 337/78

[51] **Int. Cl.** **H01h 61/00**

[58] **Field of Search** 337/36, 37, 38, 39, 46, 337/49, 53, 59, 70, 72, 73, 74, 77, 78, 86, 95; 200/67, 72, 73, 75

[56] **References Cited**

UNITED STATES PATENTS

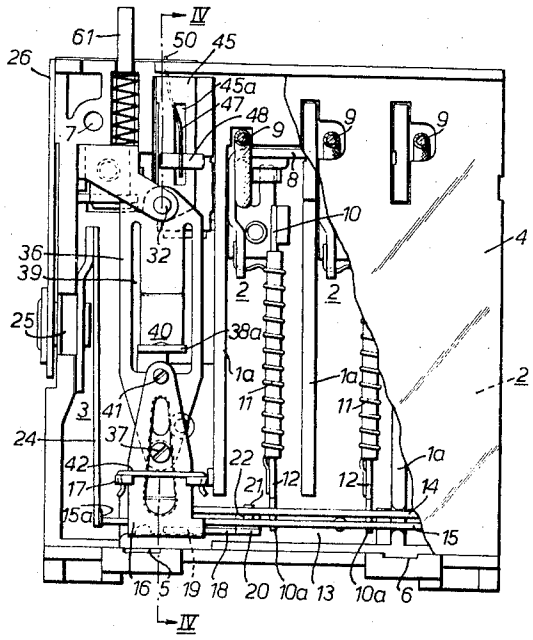
3,638,158	1/1972	Thorne	337/49
3,723,929	3/1973	Sitar	337/38
3,451,024	6/1969	Fantini	337/49 X
2,749,407	6/1956	Walton et al.	337/49 X
3,183,328	5/1965	Wheeler	337/49 UX
2,872,548	2/1959	Christensen	337/49
3,038,051	6/1962	Howard	337/49 UX

Primary Examiner—Harold Broome
Assistant Examiner—A. T. Grimley

[57] **ABSTRACT**

An electric switch comprises a movable contact carried by a snap-acting arm which is actuated by a trip lever, the trip lever being resiliently biased into contact with a fulcrum about which it may be rocked by an actuator arm to actuate the snap-acting arm. The trip lever applies actuating pressure to the snap-acting arm through a pin extending from the trip lever.

16 Claims, 12 Drawing Figures



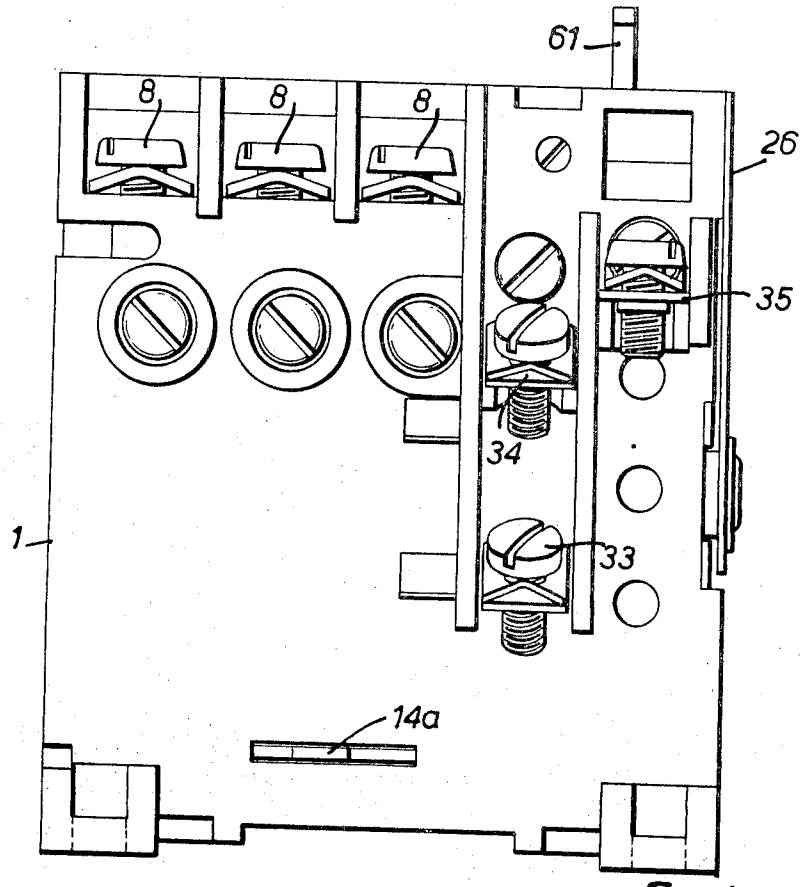


FIG. 1.

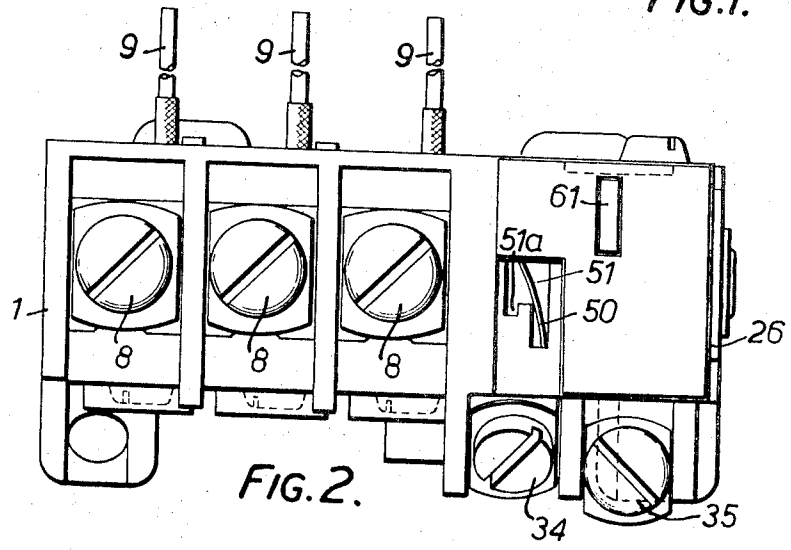


FIG. 2.

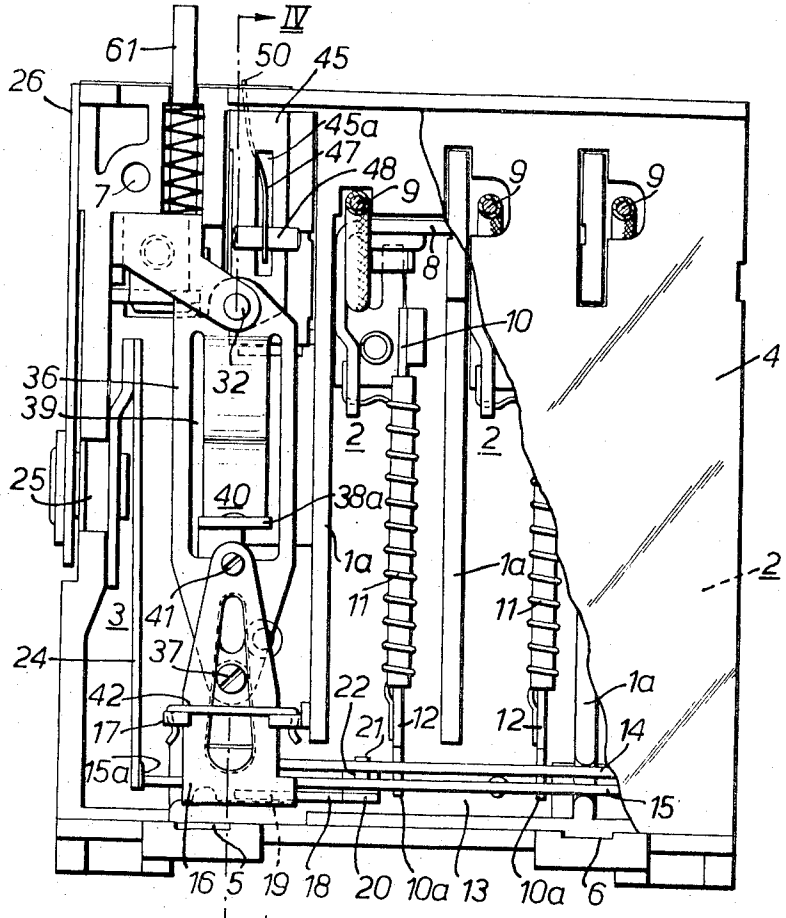

IV
61
50
45
26
45a
47
48
9
9
9
7
8
10
4
36
32
39
2
2
25
40
38a
1a
1a
2
11
11
3
41
24
37
1a
42
22
12
12
14
17
21
15a
15
16
5
19
18
20
10a
13
10a
6
IV

FIG. 3.

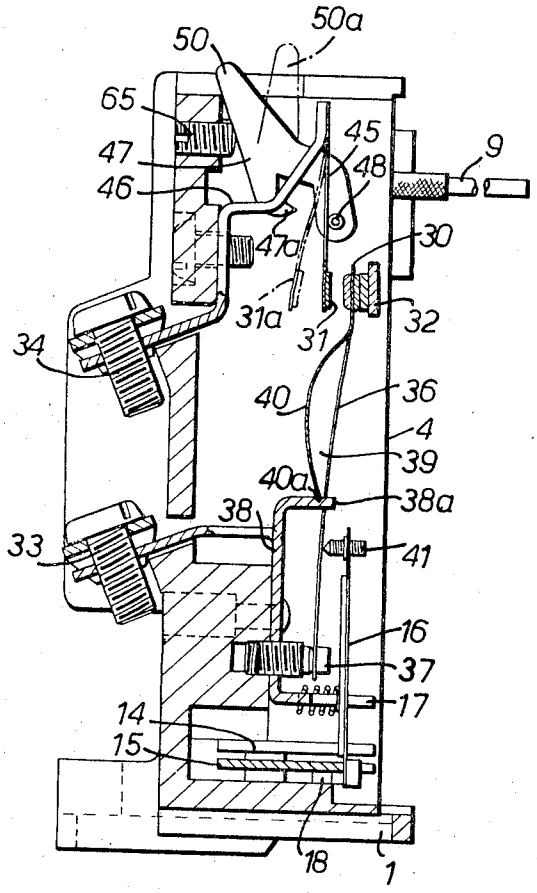

50a
50
65
45
47
48
9
46
47a
30
31a
31
32
34
40
36
4
39
40a
38a
38
33
41
16
37
17
14
15
18
1

FIG. 4.

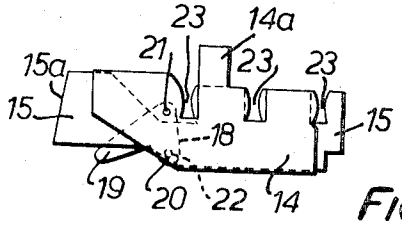


FIG. 5.

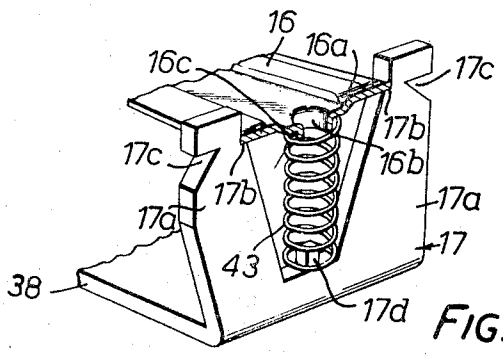


FIG. 6.

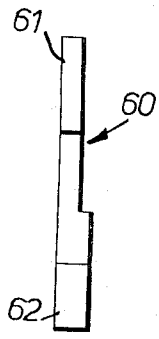


FIG. 7.

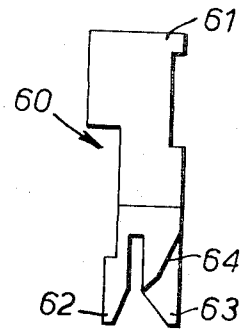


FIG. 8.

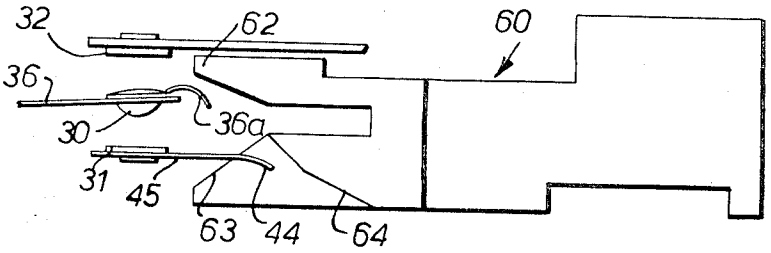


FIG. 9.

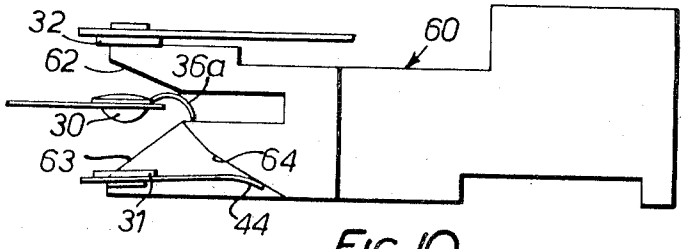


FIG. 10.

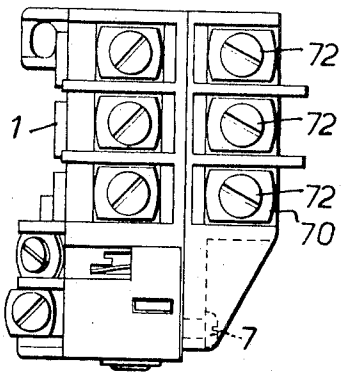


FIG. 11.

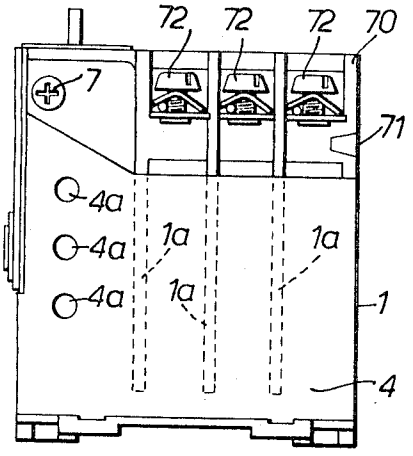


FIG. 12.

ELECTRIC SWITCHES

BACKGROUND OF THE INVENTION

This invention relates to an electric switch and particularly to such a switch in the form of an overload protection device for an electric motor.

PRIOR ART

Electric switches are known in which attempts are made to achieve sensitive actuation by employing a movable electric contact carried by a snap-acting arm. A difficulty which is frequently encountered is that in order to achieve sensitivity of actuation, the switch is very likely to be actuated in error as the result of spurious vibrations.

An object of the present invention is to provide an electric switch which is sensitive in actuation but at the same time relatively immune to spurious vibrations.

A further object of the present invention is to provide an electric switch which includes a facility for easy adjustment to compensate for mass-production manufacturing tolerances.

A yet further object of the invention is to provide an electric switch in the form of a thermal overload device for protecting a polyphase motor, which is sensitive in actuation but relatively immune from spurious vibrations, and therefore reliable in performance.

SUMMARY OF THE INVENTION

The present invention provides an electric switch comprising a movable electric contact, a snap-acting arm on which the electric contact is carried, a trip lever for actuating the snap-acting arm, a fulcrum for the trip lever, biasing means for resiliently biasing the trip lever into contact with the fulcrum, and an actuator arm movable to rock the trip lever about the fulcrum to actuate the snap-acting arm.

Preferably, a set screw is threaded for adjustment through the trip lever, the set screw applying actuating pressure to the snap-acting arm. Also, means are preferably provided for adjusting the other end of the snap-acting arm along a line perpendicular to the arm, towards or away from the trip lever.

In the case where the electric switch forms a thermal overload device for protecting a polyphase electric motor, a bimetal strip will be provided for each phase circuit of the motor, together with means for subjecting the bimetal strips to heating dependent upon the current flowing in the respective phase circuits and a trip actuator responsive to overload or unbalanced conditions in the current flowing in the motor. The trip actuator will include the movable contact, the snap-acting arm and the trip lever and actuator arm, the actuator arm being moved in response to the overload or unbalanced condition to rock the trip lever. Preferably, a pair of overlying plates will be provided, and the plates having aligned slots through which end portions of respective bimetal strips extend and being supported for sliding movement longitudinally of themselves upon deflection of the bimetal strips. In such case an abutment is also provided for limiting the sliding movement of one of the plates and the actuator arm is pivoted at spaced apart points to the respective plates for pivoting so as to rock the trip lever in the event of differential movement of the plates caused by an overload or unbalanced current condition in the phase circuits.

Other objects of the invention will become apparent from the following description of one embodiment, given by way of example only, in the form of a thermal overload device for protecting a three-phase electric motor. In the accompanying drawings:

FIG. 1 shows a bottom view of the thermal overload device;

FIG. 2 shows a front view of the device;

FIG. 3 shows a top view of the device with part of the housing cover broken away;

FIG. 4 shows a sectional view taken on the line IV—IV of FIG. 3;

FIG. 5 shows a plan view of a detail of the device, to a reduced scale;

FIG. 6 shows a perspective view of another detail of the device, to an enlarged scale;

FIG. 7 is an edge view of a component to an enlarged scale;

FIG. 8 is a side view of the component shown in FIG. 7;

FIG. 9 is a side view of the component shown in FIG. 7, in conjunction with related switch contacts and in an unoperated condition;

FIG. 10 is similar to FIG. 9 but showing the component in an operated condition;

FIG. 11 is a view similar to FIG. 2 but to a smaller scale and including a sub-housing; and

FIG. 12 is a side view, corresponding to FIG. 3, of the view shown in FIG. 11.

Referring to FIGS. 1 to 3, the thermal overload device comprises a moulded housing 1 of a thermosetting plastics material with internal partitions 1*a* forming three thermal element compartments 2 and a switch compartment 3. The open top side of the housing is closed by a single cover plate 4 held in position by two lugs on the cover plate which engage recesses in the housing at 5 and 6 and by a screw located at 7.

Associated with each thermal element compartment 2 is a terminal 8 and a terminal lead 9, the lead 9 being a rigid single-core wire. Within each compartment 2 is a thermal element comprising a bimetal strip 10 insulatingly overwound with a heater coil 11. As viewed in FIG. 3 one end of each heater coil is secured to a point 12 adjacent one end of the respective bimetal strip, the other end of the heater coil is electrically connected to the respective terminal 8, and the other end of the bimetal strip is electrically connected to the respective terminal lead 9. Thus, in respect of each terminal 8, an electrical circuit exists along the associated bimetal strip and back through the heater coil to the terminal lead 9.

As is well understood in the art, the intention is that the thermal elements should be connected by way of the terminals 8 and 9 in the different phase circuits of a three-phase supply to a three-phase motor so that each element will respond to the current flowing in the respective phase. As the current flowing through each heater coil 11 increases, the one end 10*a* of the associated bimetal strip will move to the left as viewed in FIG. 3.

The partitions 1*a* do not extend to the rear wall of the housing, so that a common transverse compartment 13 exists between the thermal element compartments 2 and the switch compartment 3. Extending in the compartment 13 is a pair of overlying plates 14 and 15 of insulating material, the plates including aligned slots through which project the ends 10*a* of the bimetal

strips. The plates 14 and 15 are supported for sliding movement, to some extent independently of each other, longitudinally in the compartment 13.

A switch mechanism (to be described hereinafter) located in the switch compartment 3 includes a trip lever 16 supported in a yoke 17 for rocking movement relative to the yoke. A trip actuator 18 comprises an arm 19 which extends behind the one end of the lever 16 from a boss 20. Forwardly extending from this boss is a first pivot pin 21 which is engaged in a hole in the plate 14 and a second pivot pin 22 which is engaged in a hole in the plate 15. FIG. 5 shows a plan view of the superimposed arrangement of the plates 14 and 15 and the trip actuator 18, from which also can be seen the general contours of the plates and the slots, referenced 23, through which project the ends 10*a* of the bimetal strips. Also seen in this Figure is an extension 14*a* of the plate 14, which projects through a slot in the bottom of the housing 1 (see FIG. 1) to serve as a trip testing operator. One end of the plate 15 presents an inclined edge 15*a* which, in operation, abuts the end of a bimetallic strip 24 (FIG. 3) carried by a boss 25 which can be turned by movement of an external lever 26. Thus, altering the position of the lever 26 results in the end of the strip 24 being aligned with a different point of abutment along the edge 15*a* of the plate 15. As will be appreciated, particularly from FIG. 5, when both plates 14 and 15 move longitudinally and together then there is no pivotal movement of the actuator arm 19. When the plate 14 moves to the left (as viewed in FIGS. 1 and 5) relative to the plate 15, the actuator arm 19 pivots towards the trip lever 16 of the switch mechanism.

The operation of the thermal overload device, as so far described, is such that if the currents flowing in the heater coils 11 exceed a predetermined maximum or if currents are unbalanced beyond predetermined limits, then the trip lever 16 of the switch mechanism will be actuated by the arm 19 of the trip actuator 18. In the case of balanced excess current, the ends 10*a* of the bimetallic strips 10 will move the plates 14 and 15 together until the end of plate 15 abuts the strip 24, after which the plate 14 will continue moving along resulting in actuation of the trip lever 16. The degree of overload current acceptable before the plate 15 abuts the strip 24 can be altered by adjustment of the external lever 26. The deflection/temperature change characteristic of the bimetallic strip 24 is chosen to be the same as that of the bimetallic strips 10 so that movement of the plate 15 towards or away from the end of the strip 24 due to a change in ambient temperature is counteracted by a compensating deflection of the strip 24. In the case of unbalanced currents in the heater coils, for example due to the condition in the protected motor known as "single phasing," the bimetallic strip 10 in the failed phase circuit will cool and deflect to the right carrying with it the plate 15 so causing the arm 19 to pivot and actuate the trip lever 16. If the unbalanced conditions exist initially on energisation of the motor circuits, then the bimetallic strip 10 in the failed phase circuit will not be heated and will remain stationary, thereby holding the plate 15 against movement to the left. The other two bimetallic strips 10 will deflect to move the plate 14 to the left and produce actuation of the trip lever 16.

The switch mechanism in the switch compartment 3 and comprising the trip lever 16 will now be described. Referring particularly to FIGS. 3 and 4, the switch comprises a contact 30 movable between two fixed contacts 31 and 32. The movable contact 30 is electrically connected to an external terminal 33 and the fixed contacts 31 and 32 are electrically connected to external terminals 34 and 35 (FIG. 1) respectively. The normal position of the movable contact is in contact with the fixed contact 32, which is rigidly fixed, to make a circuit between the terminals 33 and 35. These terminals are intended to be connected in circuit with the control gear of the motor being protected so that when the movable contact breaks from the fixed contact 32, the electrical supply to the motor is disconnected. When the movable contact breaks contact with the fixed contact 32 it moves into contact with the fixed contact 31 (the position of which is adjustable as will be hereinafter described) to complete a circuit between the terminals 33 and 34. These terminals are intended to be connected in an auxiliary circuit, for example an alarm or indicator circuit.

The movable contact 30 is carried at one end of a snap-acting arm comprising a spring blade 36, the other end of which is engaged in an annular recess immediately beneath the head of a set screw 37. This screw is in threaded engagement with a mounting means such as a rigid metal bracket 38 one end of which forms the aforementioned yoke 17. The other end 38*a* of the bracket 38 extends through an aperture 39 in the spring blade 36. Part of the spring metal from the aperture 39 is formed into an integral compression leaf spring or 'C' spring 40 the free end 40*a* of which is located in a longitudinal recess in the bracket end 38*a*.

Actuating pressure is applied to the spring blade 36 by a pointed set screw 41 carried at the end of the trip lever 16 remote from the trip actuator 18. The trip lever 16 is pivotally mounted on the yoke 17 as seen in detail in FIG. 6. The yoke comprises two upstanding arms 17*a* each having an internal land 17*b* and an adjacent external notch 17*c*. Between the yoke arms is an upstanding peg 17*d*. The trip lever 16 (only a portion of which is shown) is provided with a transverse recess 16*a* and an aperture 16*b* formed by spiking to leave a downwardly projecting annular rim 16*c*. The trip lever 16 pivots about a fulcrum comprising an elongate middle portion of a wire spring clip 42 (not shown in FIG. 6 but seen in FIG. 3) which engages the two notches 17*c* and the recess 16*a*. A coil spring 43 is located between the annular rim 16*c* and 17*d* and acts along a line intersecting the fulcrum of the trip lever to urge the latter into close contact with clip 42 and also provides damping pressure to ensure positive operation of the lever in spite of vibration of adjacent structure. The arms 17*a* engage in slots in the sides of lever 16 and these, together with the lands 17*b* prevent displacement of lever 16 under shock conditions (e.g., during transit).

As previously mentioned, the fixed contact 31 is adjustable. The contact is carried at one end of a spring blade 45 the other end of which is secured to a rigid metal bracket 46 connected to the terminal 34. The blade 45 has a slot 45*a* through which extends one arm of a lever 47 carrying a transverse pin 48 which bears against the surface of the blade. The lever passes through slots (not visible) in the bracket 46 and a hook-like formation 47*a* on the lever engages a portion of the bracket between the slots to provide a pivot for the lever. The other end 50 of the lever 47 projects through a slot 51 (FIG. 2) in the front of the housing

1 from where it can be operated to an alternative position indicated by broken lines at **50***a*, in which position the spring blade **45** is deflected so that the contact **31** is moved away from the movable contact **30** to a position indicated by broken lines at **31***a*. The housing slot **51** includes a portion **51***a* (FIG. 2) into which the lever **47** can be moved so as to be retained in the position **50***a*.

The arrangement of movable contact spring blade **36** and 'C' spring **40** is such that, with appropriate adjustment of set screws **37** and **41**, actuation of the trip lever **16** will cause the spring blade **36** to deflect over-centre when the lever **47** is in the position **50***a* and contact **31** is in the position **31***a*. Thus, the movable contact **30** will move into contact with the contact **31** and remain in that position after actuation of the trip lever has ceased, requiring manual operation of the spring blade to return it to its original position. When the lever end **50** is moved to the alternative position in the slot **51**, the fixed contact **30** is returned to its original position in which the deflection of spring blade **36** is restricted. Although spring blade **36** will initially move over-centre, after actuation of the trip lever **16** has ceased, the movable contact **30** will automatically be returned to re-make contact with the fixed contact **32** under the spring bias applied to it by spring blade **45**.

In order to re-set the switch mechanism after an overload condition, a press-button **60** is provided, made of insulating material and shaped as indicated in FIGS. **7** and **8**, FIG. **7** corresponding to the view as seen in FIG. **3**. The press-button **60** comprises a part **61** extending from the front of the housing, a forked inner end including two prongs **62** and **63** and a returned portion on the prong **63** forming an inclined surface **64**. As seen in FIGS. **9** and **10**, the press-button **60** is arranged for sliding movement adjacent the fixed contact **32**, the prongs **62, 63** being aligned with a projection **36***a* on the spring blade **36** (carrying the moving contact **30**) and the surface **64** being aligned with a projection **44** on the spring blade **45** (carrying the fixed contact **31**). When the press-button **60** is depressed, the fork prongs **62, 63** engage the projection **36***a* thereby holding the movable contact **30** away from the fixed contact **32**. Thus, during normal operation, the press-button serves as a "stop" button.

During a fault condition, that is when the movable contact **30** is in contact with the fixed contact **31**, operation of the press-button **60** causes the prongs **62, 63** to engage the projection **36***a* and move it towards the fixed contact **32**, although the prong **62** always ensures that the movable contact cannot make contact with the fixed contact **32** while the press-button is depressed. If the lever **47** is in the position **50***a* (i.e., requiring manual resetting of the switch mechanism) operation of the press-button **60** will move the spring blade **36** to just past centre so that, on release of the push-button, the contact **30** will continue moving to contact the fixed contact **32** if the fault condition has been removed. Otherwise the movable contact will return to contact the fixed contact **31**.

If the lever **47** is in the 'automatic' position **50**, depression of the press-button cannot produce premature closing of contacts **30** and **32**. Furthermore, surface **64** acts on the projection **44** to move the fixed contact **31** away from the movable contact **30**. Adjustment for the correct positioning of lever **47** when in the automatic position is provided by a set screw **65** (FIG. **4**) and adjustable to limit the travel of the lever in the position **50**.

The terminal leads **9** are connected into a sub-housing **70**, FIGS. **11** and **12**, which is secured to the main housing **1** by means of the screw at **7** (FIG. **3**) and a spring clip **71** embracing the housing **1** and the sub-housing **70**. The terminal leads **9** are terminated in respective terminals **72**.

Referring to FIG. **12**, the internal partitions **1***a* of the housing **1** are indicated in broken line and the cover plate **4** is shown with three ventilation holes **4***a* over the switch compartment **3**.

The electric switch which has been described with reference to the drawings has a sensitive actuating mechanism and includes sufficient facility for adjustment to compensate for mass-production manufacturing tolerances. Furthermore, provision is made for selecting between manual and automatic resetting of the switch by a simple device (the lever **47**) and also for the prevention of mis-use of the manual resetting facility (the push-button **60**).

I claim:

1. An electric switch comprising:
- a fixed electric contact;
- a movable electric contact;
- a snap-acting arm on one end of which said electric contact is carried;
- means mounting said snap-acting arm at the other end thereof;
- said snap-acting arm having an integral compression leaf spring having one end positioned in a recess in said mounting means;
- a trip lever for actuating said snap-acting arm and in overlapping relation thereto;
- a fulcrum for said trip lever engaging said trip lever at an intermediate point thereof;
- biasing means for biasing said trip lever into contact with said fulcrum; and
- an actuator arm movable to rock said trip lever about said fulcrum to actuate said snap-acting arm.

2. An electric switch as claimed in claim **1**, in which said biasing means acts along a line intersecting said fulcrum.

3. An electric switch comprising:
- a movable electric contact;
- a snap-acting arm on which said electric contact is carried;
- a trip lever for actuating said snap-acting arm;
- an elongate wire acting as a fulcrum for said trip lever;
- a coil spring biasing said trip lever into contact with said elongate wire; and
- an actuator arm movable to rock said trip lever about said elongate wire to actuate said snap-acting arm.

4. An electric switch as claimed in claim **3**, further comprising a recess in said trip lever, said elongate wire being seated within said recess.

5. An electric switch as claimed in claim **3**, further comprising a yoke on which the elongate wire is supported, said yoke comprising two arms extending one on each side of said trip lever, and said elongate wire having hooked ends which engage the two arms of the yoke.

6. An electric switch as claimed in claim **5**, further comprising respective lands on the two arms of the

yoke, with the trip lever resting on said lands at regions thereof opposite the elongate wire.

7. An electric switch as claimed in claim **6,** further comprising slots formed in opposite edges of said trip lever, in which slots the respective arms of said yoke engage.

8. An electric switch comprising:
a stationary electric contact;
a movable electric contact;
a snap-acting arm on which said electric contact is carried;
a trip lever for actuating said snap-acting arm;
a fulcrum for said trip lever;
biasing means for biasing said trip lever into contact with said fulcrum;
an actuator arm movable to rock said trip lever about said fulcrum to actuate said snap-acting arm; and
a pin extending from said trip lever adjacent one end of the latter for applying actuating pressure to said snap-acting arm.

9. An electric switch as claimed in claim **8,** in which said pin comprises a set screw threaded for adjustment through said trip lever.

10. An electric switch as claimed in claim **8,** further comprising means for adjusting said one end of said snap-acting arm along a line perpendicular to said arm, towards or away from said trip lever.

11. An electric switch comprising:
a movable electric contact;
a fixed electric contact;
a snap-acting arm on which said movable electric contact is carried;
a trip lever for actuating said snap-acting arm;
a fulcrum for said trip lever;
biasing means resiliently biasing said trip lever into contact with said fulcrum;
an actuator arm movable to rock said trip lever about said fulcrum to actuate said snap-acting arm and cause said movable contact to move into contact with said fixed contact; and
a push-button which may be depressed after actuation of said snap-acting arm to engage the same and to re-set said arm and which, if maintained depressed, will prevent said movable contact moving into contact with said fixed contact.

12. An electric switch as claimed in claim **11,** further comprising:
a prong on said push-button, said prong moving upon depression of the push-button to become interposed between said fixed and movable contacts; and
a cam surface on said prong which moves the snap-acting arm, whilst the push-button is being depressed, to an over-centre position for re-setting.

13. An electric switch as claimed in claim **12,** further comprising:
a second fixed contact with which said movable contact normally makes contact; and
a further prong on said push-button, said further prong moving, upon depression of the push-button, to become interposed between the movable contact and said second fixed contact to prevent contact between these until depression of the push-button is terminated.

14. An electric switch as claimed in claim **11,** further comprising:
a first position for the first-mentioned fixed contact;
a second positon for the first-mentioned fixed contact; and
a lever for moving said first-mentioned fixed contact between said first and second positions, said first and second positions being such that when said fixed contact is in the first position the snap-acting arm moves over-centre upon actuation thereof for the movable contact to make contact with said fixed contact but when in the second position the snap-acting arm is prevented from moving over-centre upon actuation thereof and instead automatically re-sets.

15. In an electric switch in the form of a thermal overload device for protecting a polyphase electric motor and having a bimetal strip for each phase circuit of the motor, means for subjecting the bimetal strips to heating dependent upon the current flowing in the respective phase circuits and a trip actuator responsive to overload or unbalanced conditions in the current flowing in the motor, the improvement according to which the trip actuator comprises:
a movable contact;
a snap-acting arm on which said electric contact is carried;
a trip lever for actuating said snap-acting arm;
a fulcrum for said trip lever;
biasing means for biasing said trip lever into contact with said fulcrum;
an actuator arm movable in response to said overload or unbalanced condition to rock said trip lever about said fulcrum to actuate said snap-acting arm;
a pair of overlying plates;
aligned slots in said overlying plates, through which end portions of respective bimetal strips extend;
means for supporting said plates for sliding movement longitudinally of themselves upon deflection of the bimetal strips;
an abutment for limiting sliding movement of one of the plates; said actuator arm being pivoted at spaced apart points to the respective plates for pivoting in the event of differential movement of the plates caused by said overload or unbalanced current condition, to rock said trip lever; and
an extension on the other of said plates, said extension being manually moved to slide said other plate and cause actuation of the trip lever, for test purposes.

16. In an electric switch in the form of a thermal overload device for protecting a polyphase electric motor and having a bimetal strip for each phase circuit of the motor, means for subjecting the bimetal strips to heating dependent upon the current flowing in the respective phase circuits and a trip actuator responsive to overload or unbalanced conditions in the current flowing in the motor, the improvement according to which the trip actuator comprises:
a movable electric contact;
a snap-acting arm on which said electric contact is carried;
a trip lever for actuating said snap-acting arm;
a fulcrum for said trip lever;
biasing means resiliently biasing said trip lever into contact with said fulcrum; and

an actuator arm movable in response to said overload condition or unbalanced condition to rock said trip lever about said fulcrum to actuate said snap-acting arm;

a pair of overlying plates;

aligned slots in said overlying plates, through which end portions of respective bimetal strips extend;

means for supporting said plates for sliding movement longitudinally of themselves upon deflection of the bimetal strips; and

an abutment for limiting sliding movement of one of the plates; said actuator arm being pivoted at spaced apart points to the respective plates for pivoting in the event of differential movement of the plates caused by said overload or unbalanced current condition, to rock said trip lever; and

a sloping end on said one plate; and means for adjusting said abutment along a long perpendicular to said plate to adjust the point on said sloping end which contacts said abutment.

* * * * *