April 4, 1961 R. C. INGWERSEN 2,978,557

ELECTRIC SWITCH INCORPORATING AN AUTOMATIC CIRCUIT BREAKER

Filed Feb. 21, 1958 2 Sheets-Sheet 1

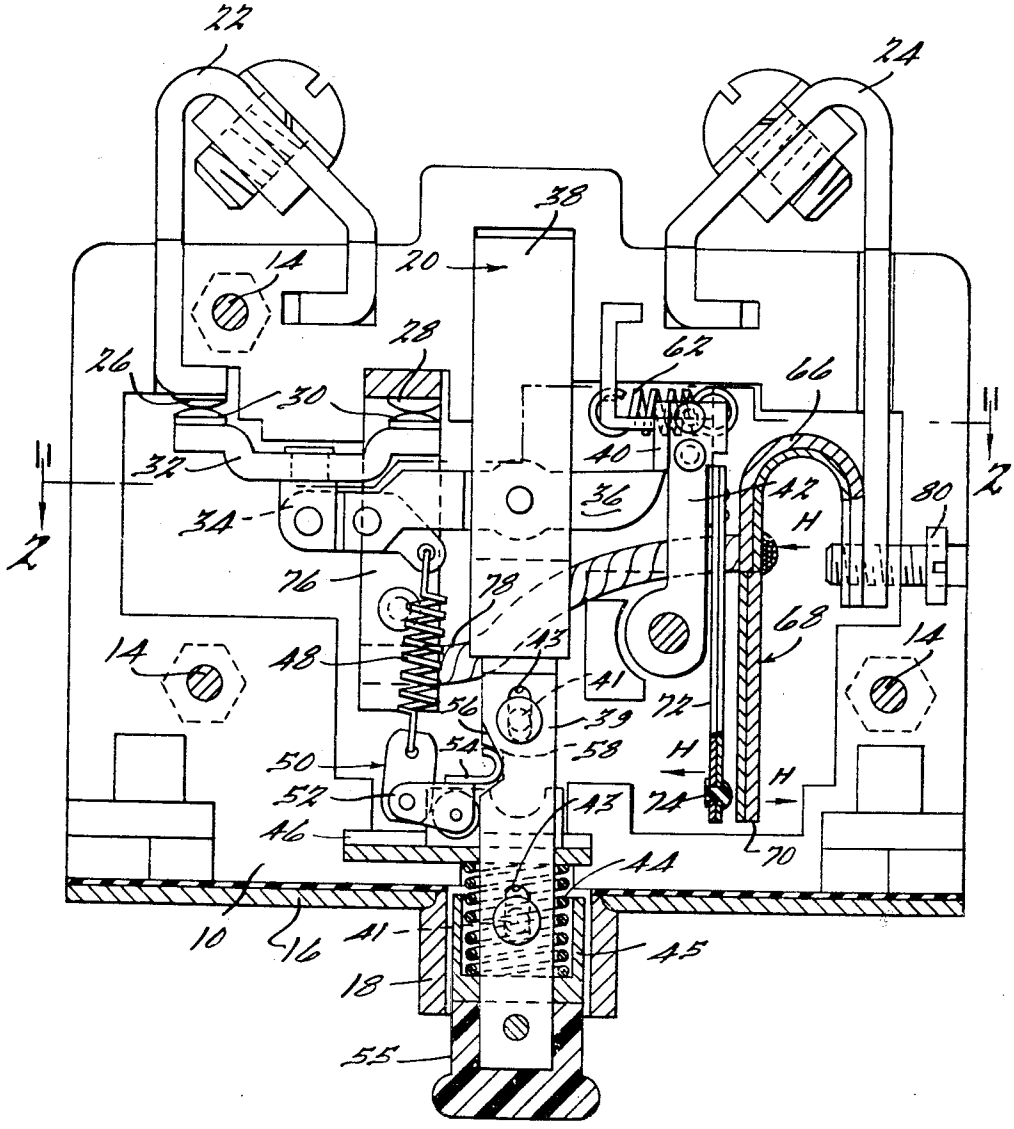


FIG. 1

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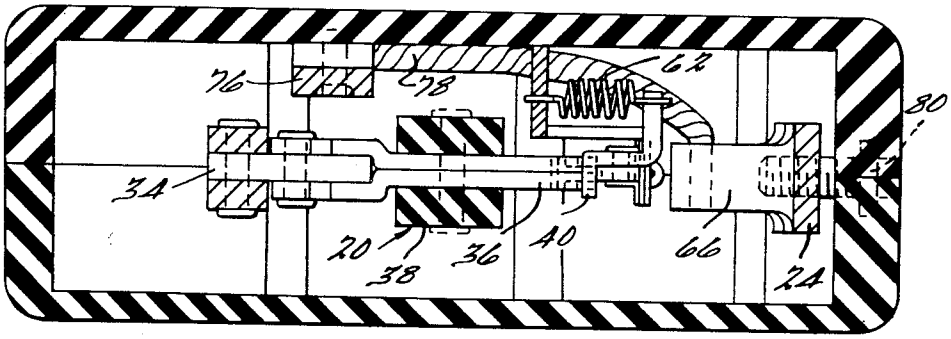


FIG. 2.

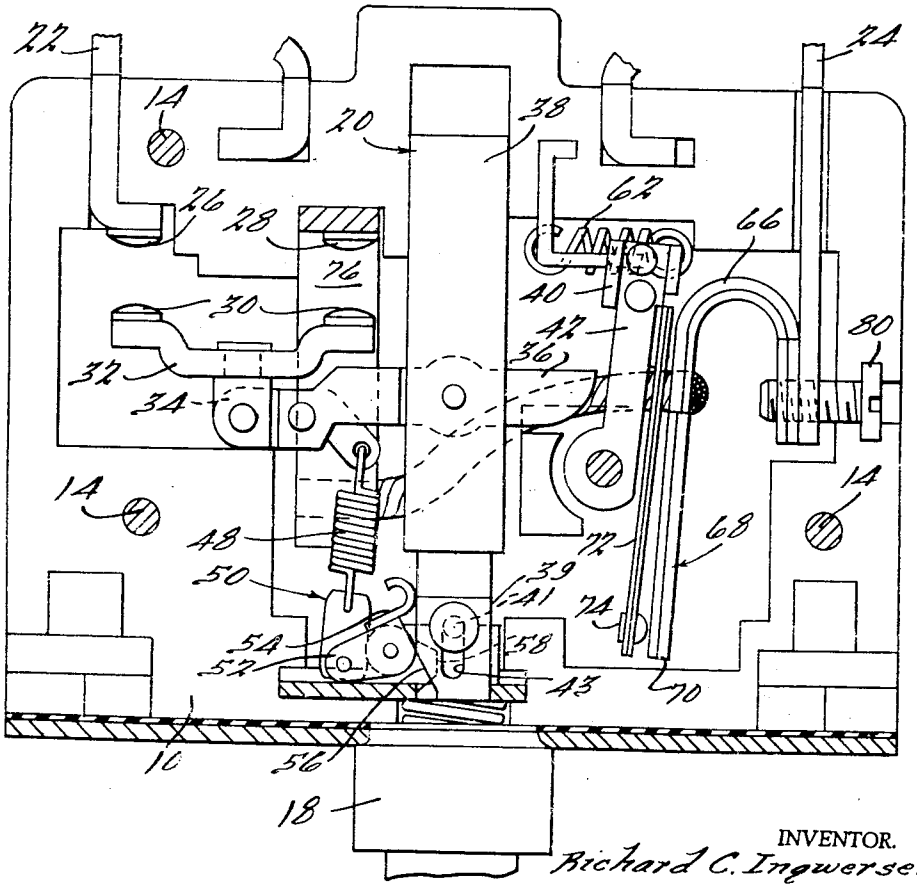


FIG. 3.

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ELECTRIC SWITCH INCORPORATING AN AUTOMATIC CIRCUIT BREAKER

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3 Claims. (Cl. 200—116)

This invention relates to an improved electrical switch of the circuit breaker type incorporating improved thermally responsive means for compensating for ambient temperature variations.

In circuit breakers of the type which open an electrical switch in response to joulean heating of an electrical element caused by a circuit overload, one problem is to minimize the effect of ambient temperature changes so that the device will operate in response to a circuit overload of a predetermined value regardless of changes in the ambient temperature.

In certain circumstances such as, for example, on high-speed aircraft where air friction may cause a relatively great temperature rise in the vicinity of a circuit breaker housed in the aircraft, it is possible that the ambient temperature rise alone may actuate the circuit breaker despite the absence of any current overload. Effects such as this must be avoided in order to achieve satisfactory circuit-breaker operation in many applications. In many instances the problem is further complicated by the requirement that the entire circuit breaker be relatively compact and of light weight. This is particularly the case when the circuit breakers are to be used in aircraft or in certain industrial installations where the available space is limited.

Accordingly, one important object of the present invention is to provide an improved electric switch incorporating a circuit breaker automatically actuatable in response to a predetermined current overload regardless of changes in the ambient temperature.

Another object is to provide an electric switch of the aforementioned type including improved means for compensating for ambient temperature changes.

Still another object is to provide an improved electric switch of the aforementioned type including an overload responsive thermostatic arrangement which is relatively non-responsive to ambient temperature variations.

A still further object is to provide an improved electric switch of the aforementioned type of relatively compact construction and including ambient temperature variation compensating means.

These and other objects are accomplished according to the present invention, one embodiment of which comprises an improved circuit breaker in which ambient temperature compensation is achieved by a thermostat arrangement including three polymetallic elements. Two of the elements are connected together end-to-end, the third being mounted separately and arranged to cooperate with the other two to provide a relatively high degree of compensation for ambient temperature changes.

The invention will now be described in greater detail in connection with the accompanying drawings of which:

Figure 1 is a longitudinal sectional view, partly in elevation, of a circuit breaker according to the present invention;

Fig. 2 is a cross-sectional view of the circuit breaker shown in Fig. 1 taken generally along the section line 2—2 thereof; and

Fig. 3 is a longitudinal sectional view, partly in elevation, of a circuit breaker shown in Fig. 1 showing the circuit breaker in its actuated, or open position.

The circuit breaker illustrated in the drawings represents a preferred embodiment of the present invention and comprises a hollow casing **10** which may be molded of plastic or like material, and is formed in two halves secured together by any convenient means, such as the screw fasteners **14** illustrated. A front plate **16** closes the casing and carries a collar **18** through which one end of an actuator plunger assembly **20** extends. A pair of terminal members **22** and **24** are fixed within the casing **10** and project exteriorly thereof for connecting the unit in an external circuit. The left-hand terminal element **22** carries a first fixed contact **26**. A second fixed contact **28** is separately mounted within the casing and is connected through various circuit elements to be described in greater detail hereinafter with the second terminal element **24**. A pair of movable contacts **30** are carried on an electrically conductive bridge **32** for travel toward and away from the fixed contacts **26** and **28**. The electrical circuit between the terminal elements **22** and **24** is closed when the movable contacts **30** are moved upwardly as viewed in the drawings into contact with the fixed contacts **26** and **28**, the circuit being completed through the movable contacts **30** and the bridge **32**. When the movable contacts **30** are moved away from the fixed contacts **26** and **28**, the circuit between the terminal elements **22** and **24** is open.

The use of two pairs of contacts provides an improved resistance to arcing without necessitating an increase in the opening travel of the movable contacts **30**, and therefore without requiring any substantial enlargement of the over-all dimensions of the device relative to similar devices having only a single pair of contacts.

The bridge **32** is centrally pivoted upon one end of a relatively short dog-leg lever **34**, which in turn is pivoted upon a contact-carrying arm **36**. The contact-carrying arm **36** is centrally pivoted upon the inner portion **38** of the plunger assembly **20**, which is mounted for vertical reciprocation within the casing **10**. The plunger assembly **20** includes an inner portion **38** and an outer portion **39**, which overlap each other and are connected together by means of a pin and slot lost motion arrangement, the pins **41** being carried by the inner portion **38** and extending through longitudinal slots **43** in the outer portion **39**.

The outer portion **39** is urged outwardly by a main spring **44** seated between a fixed wall **46** in the casing and a guide member **45**, which is fixed near the outer end of the portion **39**. A latch **54** is spring urged into a cam-shaped notch **56** in one edge of the outer portion **39**, and normally holds the outer portion **39** in its advanced position against the urging of the main spring **44**. The latch **54** operates on the same general principle as the latch arrangement described in my copending application, Serial No. 598,188, filed July 16, 1956, for, "Electric Switch Having Automatic Current Overload Protection," now Patent No. 2,838,635. It is mounted on a centrally pivoted lever **52**, the other end of which is pivotally connected to one end of a tension spring **48** called the balancing spring, which is normally tensioned between the dog-leg lever **34** and the latch lever **52**.

When the switch is in its closed position, as shown in Fig. 1, the balancing spring **48** is tensioned and urges the latch **54** into the notch **56** with sufficient force to hold the lower plunger portion **39** in its advanced position. When, however, the balancing spring **48** is relieved, the latch **54** is readily cammed out of the notch **56**, permitting the outer portion **39** to move outwardly.

The latch **54** also fits into a notch **58** in the inner plunger portion **38** to hold it in its advanced position

when the switch is closed. The inner portion 38 is urged outwardly by the action of the balancing spring 48 working through the dog-leg lever 34 and the contact-carrying arm 36. When the balancing spring tension is released, the latch 54 is cammed out of the upper portion notch 58 by the lost motion travel of the lower portion 39, so that when the inner ends of the slots 43 engage the pins 41, the inner portion 38 is free to move outwardly with the outer portion 39 to complete the opening motion of the switch.

The end of the contact-carrying arm 36 opposite from the contacts 30 normally abuts against and is retained by a catch 40, which is fixed upon a latching lever 42 pivoted upon the casing 10. An auxiliary spring 62 is connected between the outer end of the latching lever 42 and a fixed support in the casing to urge the lever 42 in a counterclockwise direction, as viewed in Figs. 1 and 2, to keep the catch 40 in engagement with the contact-carrying arm 36.

When the catch 40, as hereinafter described, is moved to the right, as viewed in Fig. 1, sufficiently far to release the contact-carrying arm 36, the contact-carrying arm 36 is free to pivot in a counterclockwise direction and does so under the urging of the balancing spring 48. As soon as the contact-carrying arm pivots sufficiently far to relieve the tension of the balancing spring 48, the sloping side wall of the notch 56 cams the latch 54 away from the plunger assembly 20, permitting the plunger assembly together with the contact-carrying arm 36 to be retracted by the main spring 44. The arrangement is such that the latch 54 may be cammed outwardly not only by the procedure just described but also by manual actuation, that is, pulling outwardly on the knob 55 which is fixed at the end of the outer plunger portion 39. When the switch is in its open position, the various elements thereof are in the positions illustrated in Fig. 3.

Most of the principles of operation and structure so far described are shown and claimed in my hereinabove identified copending application. The present invention pertains primarily to the thermostat arrangement for pivoting the latching lever 42 in response to current overloads so that the switch will automatically open as hereinabove described. This arrangement includes a pair of polymetallic thermally sensitive elements 66 and 68 connected in reverse polarity end to end. The first element 66 is U-shaped to achieve maximum deflection within minimum space, and is rigidly connected as by brazing to the second terminal 24. This U-shaped polymetallic element 66 is arranged to spread open in response to an increase in temperature, that is, its free end moves to the left as viewed in the drawings when the temperature rises. The second polymetallic element 68 is arranged in reverse polarity to the first one and is brazed or otherwise fixed to the free end of the first element 66. It is arranged so that its free end 70 moves to the right, as viewed in drawings, in response to an increase of temperature.

The second element 68 compensates to a partial extent for deflections of the first element 66 caused by variations in ambient temperature. When the first element 66 moves to the left, the second element 68 moves to the right, and the movement of the free end 70 of the second element 68 is less than it would be if the second element 68 were not thermally responsive, or were oriented differently. The compensation is not complete since the leverage action causes a greater travel of the free end 70 responsively to the movement of the first element 66 than can be compensated for by the second element 68.

Additional compensation is provided by a third polymetallic thermally responsive element 72, which is fixed at one end upon the latching lever 42 and has its free end positioned adjacent to the free end 70 of the second element 68. It carries an insulating bumper member 74 at its free end for contact with the second element 68. The element 72 is arranged so that its free end moves to the left, as viewed in the drawings, in response to an increase of temperature.

The first element 66 is connected to conduct the thermal current, and the second and third elements 68 and 72 are both arranged to compensate for the effects of ambient temperature changes on the first member 66. When the free end 70 of the second member moves to the left and pushes the bumper 74, it swings the latching lever 42 in a clockwise direction and thus releases the contact-carrying arm 36 from the catch 40 to initiate opening of the switch.

The electrical circuit from the second fixed contact 28 leads through a strap 76 and through a pigtail 78 to one end of the first thermal element 66, then through this first element 66 to the terminal 24. The first element 66 is the only one of the three elements 66, 68 and 72 through which the thermal current in the device passes. When there is a current overload in the device, the first element 66 swings the second element 68 into contact with the bumper 74, moving it to the left and swinging the latching lever 42 in a clockwise direction to pull the catch 40 away from the contact-carrying arm 36. The second element 68 acts as a lever in the operation and amplifies the travel of the free end of the first element 66 to produce a relatively large swinging travel of the latching lever 42, thereby moving the catch 40 well clear of the contact-carrying arm 36 for positive release thereof.

The tripping point, that is, the value of overload current at which the device will be actuated to open the switch, may be adjusted by means of an adjustment screw 80, the head of which is received in a slot (not separately designated) in the casing 10 and which is threadedly engaged with the terminal member 24. The screw 80 may be turned to move the terminal arm 24 together with the thermostat elements 66 and 68 toward or away from the latching lever 42, thereby to adjust the amount of flexing of the first element 66 required for tripping the device.

The thermostat arrangement is capable of operation over a relatively wide range of temperatures with a relatively high degree of uniformity. The arrangement is of relatively compact and inexpensive construction, yet is rugged and dependable in operation, providing a high degree of ambient temperature compensation.

What is claimed is:

1. In an automatic circuit breaker having a movable latch member actuatable to control the function of said circuit breaker, an actuating thermostat comprising a first polymetallic element connected in the electrical circuit of said switch for conducting thermal current and arranged to flex toward said latch member in response to a temperature rise, a second polymetallic element fixed to said first element and movable thereby toward and away from said member responsively to temperature changes, said second element being oriented to flex away from said member in response to a temperature rise, and a third polymetallic element interposed between said second element and said member and operative to drive said member to actuate said circuit breaker responsively to the travel of said second element caused by a predetermined flexure of said first element, said third element being oriented to flex in a direction to compensate for flexure of said first element caused by an ambient temperature increase.

2. In an electrical switch of the type including an automatic circuit breaker having a latch carried by a pivoted lever and movable therewith between a retaining position toward which it is spring urged and a release position, said circuit breaker also including means for opening the switch contacts when the latch is moved from its retaining position to its release position, an actuating thermostat comprising a first polymetallic element mounted at one end upon a fixed support and oriented so

that its free end moves toward said lever in response to a temperature rise, a second polymetallic element fixed at one end upon the free end of said first element and oriented to flex away from said lever in response to a temperature rise thereby to compensate partially for the effects of ambient temperature changes on said element, and a third polymetallic element fixed at one end upon said lever and positioned to be engaged by said second element, said third element being oriented to move away from said second element responsively to a temperature rise and thereby to compensate partially for the effect on said first element of ambient temperature changes, said first element being connected in the electrical circuit of said switch for conducting thermal current, said second and third elements being responsive only to ambient temperature changes.

3. In an electrical switch of the type including an automatic circuit breaker having a latch carried by a pivoted lever and movable therewith between a retaining position toward which it is spring urged and a release position, said circuit breaker also including means for opening the switch contacts when the latch is moved from its retaining position to its release position, an actuating thermostat comprising a first polymetallic element of U-shaped configuration mounted at one end upon a fixed support and oriented so that its free end moves toward

said lever in response to a temperature rise, a second polymetallic element fixed at one end upon the free end of said first element and oriented to flex away from said lever in response to a temperature rise thereby to compensate partially for the effects of ambient temperature changes on said element, and a third polymetallic element fixed at one end upon said lever and positioned to be engaged by said second element, said third element being oriented to move away from said second element responsively to a temperature rise and thereby to compensate partially for the effect on said first element of ambient temperature changes, said second and third elements being normally straight, said first element being connected in the electrical circuit of said switch for conducting thermal curent, said second and third elements being responsive only to ambient temperature changes.

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