Nov. 11, 1969 U. F. CARTER ET AL 3,478,292

ELECTRICAL CIRCUIT OVERLOAD PROTECTIVE DEVICE

Filed Jan. 19, 1968 4 Sheets-Sheet 1

Fig. 1

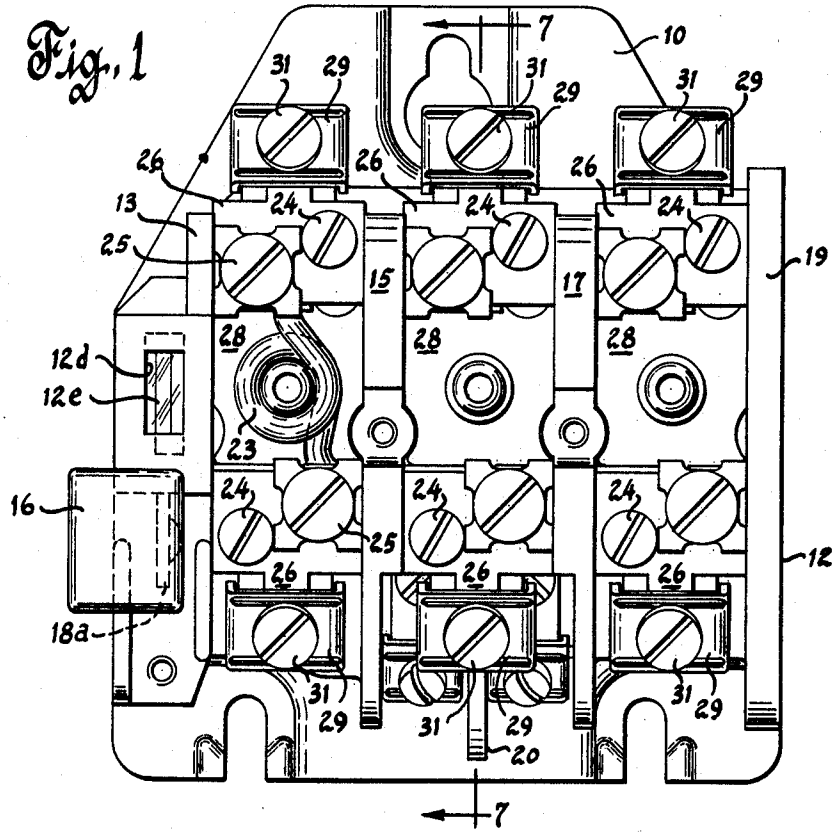
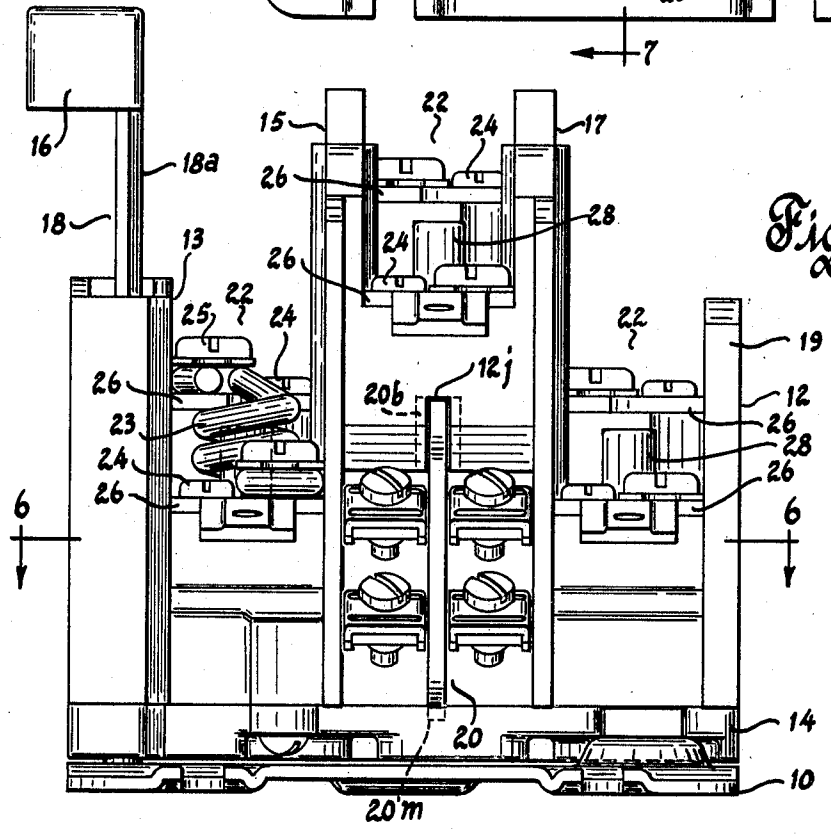


Fig. 2



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ELECTRICAL CIRCUIT OVERLOAD PROTECTIVE DEVICE

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Fig. 3

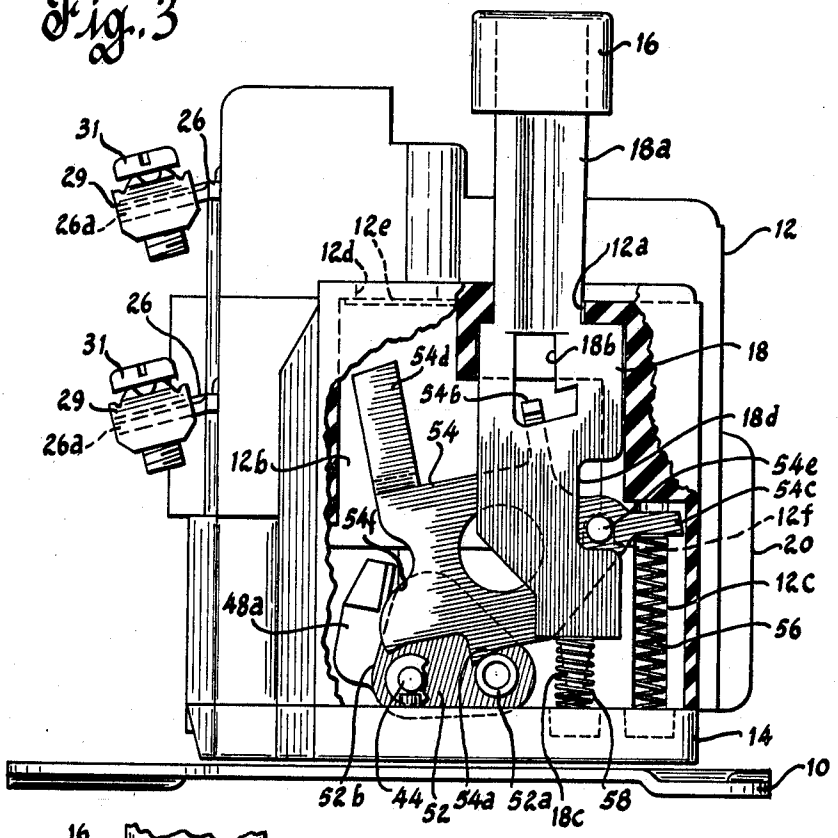


Fig. 4

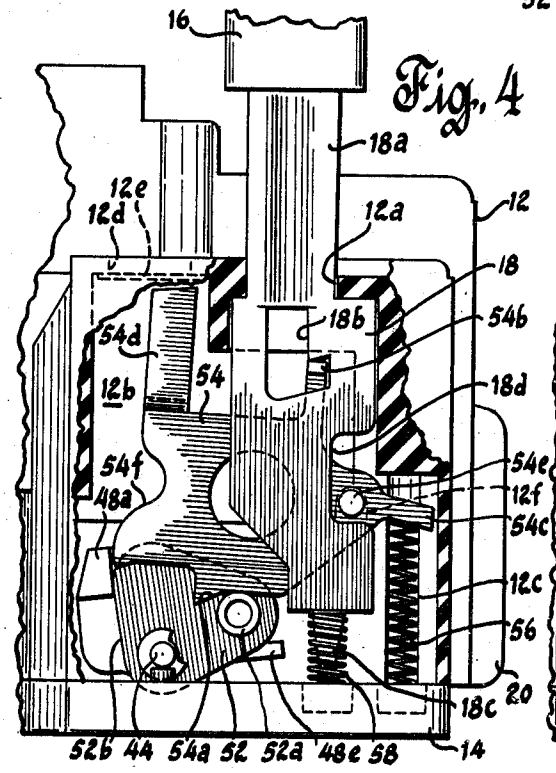


Fig. 5

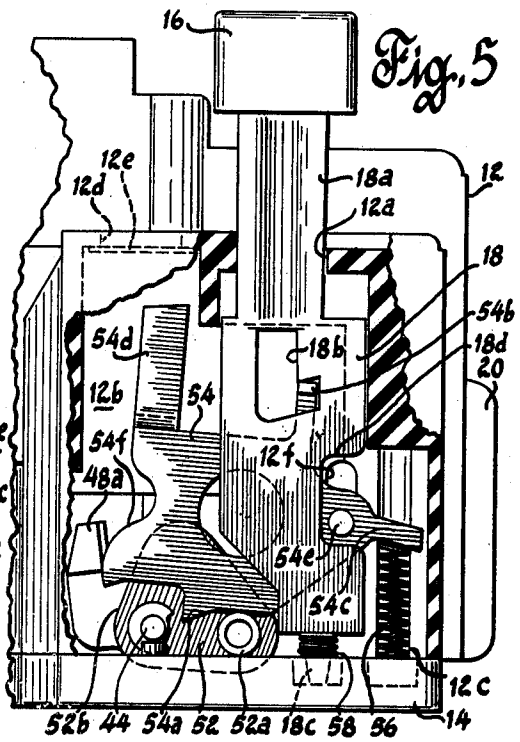


Fig. 6

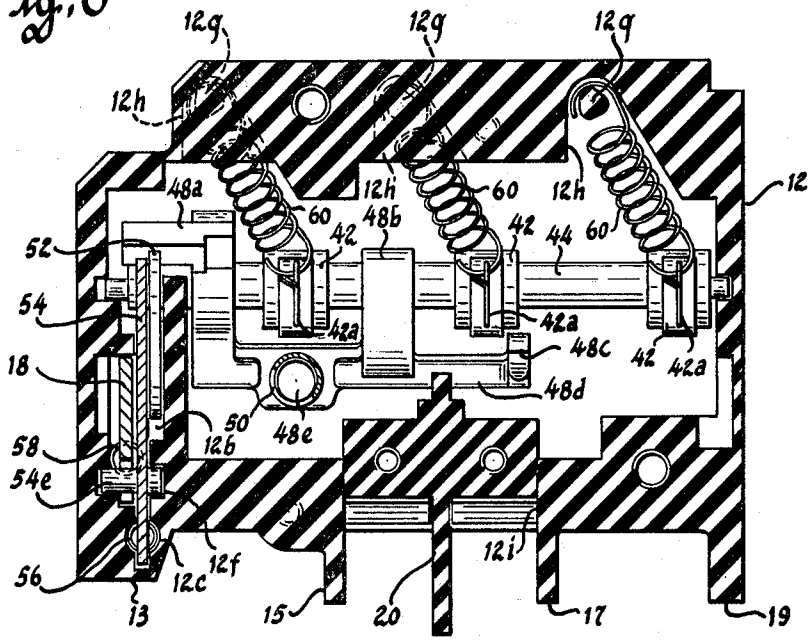
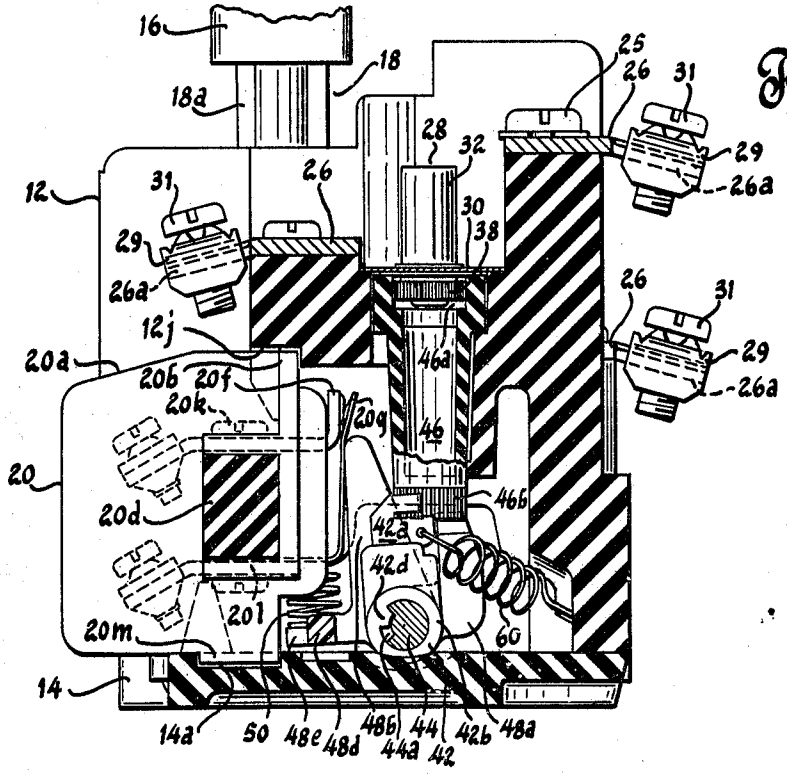

12q
12q
12q
12h
12h
12h
12h
48a
60
42
48b
42
44
60
12
52
54
18
42a
42a
48c
42
42a
48d
50
48e
12b
58
54e
56
12c
12f
13
15
20
12i
17
19

Fig. 7


16
18
18a
25
26
31
28
32
29
26a
12
31
26
30
38
29
26a
12j
20a
20b
20f
20k
20q
46a
46
20
46b
20d
42a
42d
60
20m
20l
14
14a
50
48e
48d
48b
44a
44
42
42b
48a

ELECTRICAL CIRCUIT OVERLOAD PROTECTIVE DEVICE

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Fig. 8

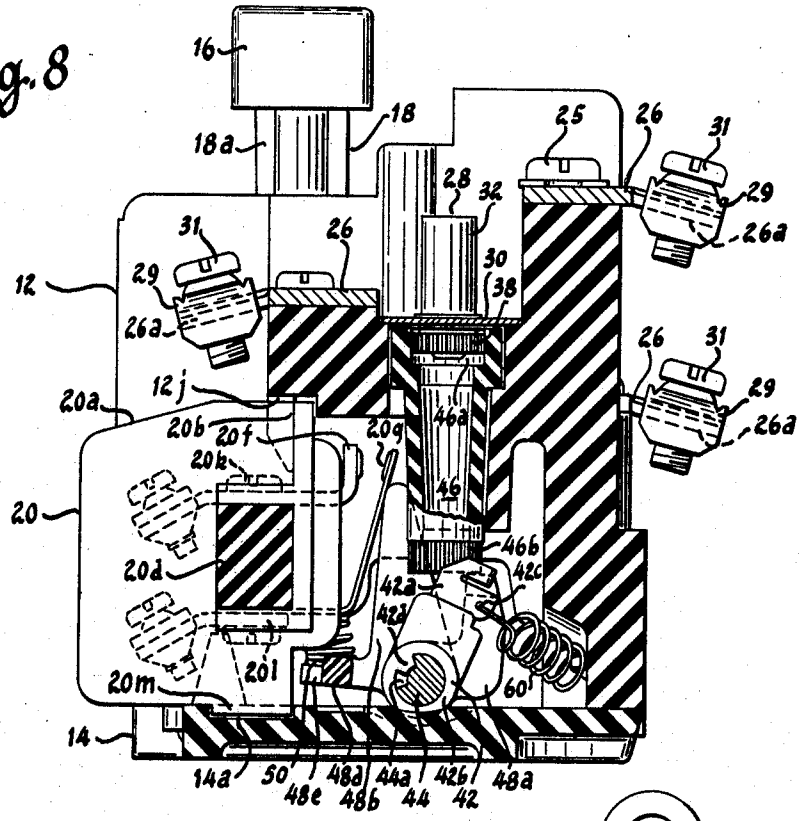


Fig. 9

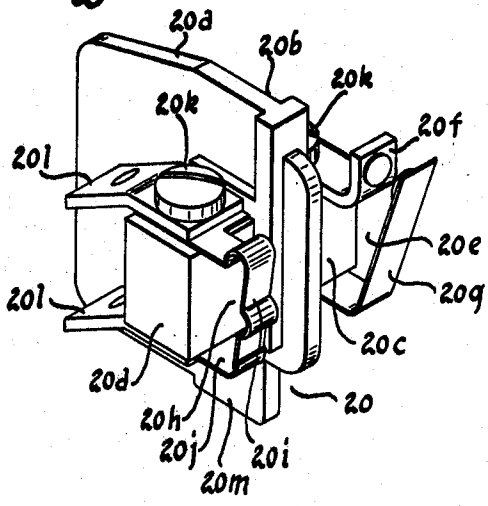


Fig. 10

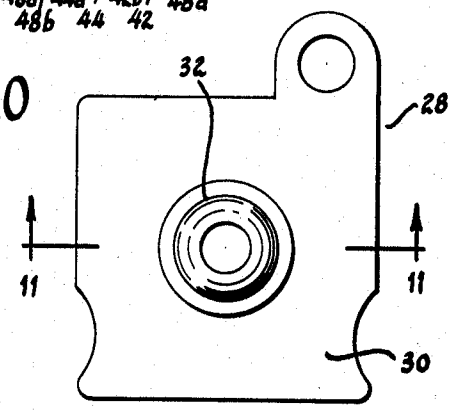
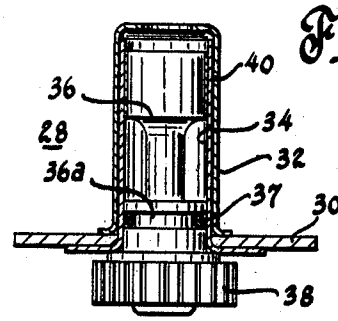


Fig. 11



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3,478,292

ELECTRICAL CIRCUIT OVERLOAD PROTECTIVE DEVICE

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Int. Cl. H01h 71/20, 73/22
U.S. Cl. 337—151 7 Claims

ABSTRACT OF THE DISCLOSURE

A manually resettable electrical circuit overload protective device of the solder film detent type. Solder film, ratchet wheel detents for one or more circuit branches are mounted in spaced relation in an insulating housing. Pawl ended levers for each detent are mounted on a common shaft within the base and have limited lost motion rotation on the shaft. The levers normally engage their associated ratchet wheel and are individually biased to independently rotate the shaft upon release of the associated ratchet wheel in response to an overload condition. A switch operating lever mounted in the housing is biased to operate one or more switches from their normal operating conditions. A third lever secured to the common shaft moves the switch operating lever against its bias to permit the switches to return to the normal conditions when said common shaft is driven by a pawl lever, and moves an indicator plate to a position affording visual indication of overload trip operation of the device. A pushbutton reset lever when depressed inwardly of the housing following an overload trip effects opposite rotation of the pawl lever shaft to effect reset of any released pawl lever on its ratchet wheel while holding the switch operating lever in tripped position.

This invention relates to an improved overload protective device for electrical branch circuit and the like.

A primary object of the invention is to provide a protective device of the aforementioned type affording positive visual indication of overload trip response.

Another object of the invention is to provide in a protective device of the aforementioned type for increased heat transfer distances between individual branch overload responsive elements for a given basic panel mounting area to minimize the heat influence imparted between such elements.

A still further object of the invention is to provide in a device of the foregoing type for "trip-free" operation which permit reset so long as an overload condition persists in any protective circuit branch, and

Still another object is to provide an improved manually operable reset mechanism insuring the aforementioned "trip-free" operation, and reset of the visual trip indication means.

Other objects and advantages of the invention will hereinafter appear.

The accompanying drawings illustrate a preferred embodiment of the invention which will now be described, it being understood that the embodiments disclosed are susceptible of modification without departing from the scope of the appended claims.

In the drawings:

FIG. 1 is a top plan view of an overload circuit protector switch incorporating the invention;

FIG. 2 is a front elevational view of the switch;

FIG. 3 is a left end elevational view of the switch with portions of the housing broken away;

FIG. 4 is a partial left end elevational view showing the switch in another operating condition;

FIG. 5 is a view like FIG. 4, but showing the switch in still another operating condition;

FIG. 6 is a cross sectional view taken along the line 6—6 of FIG. 2;

FIG. 7 is a cross sectional view taken along the line 7—7 of FIG. 1;

FIG. 8 is a view like FIG. 7 but showing the switch in another operating condition;

FIG. 9 is a perspective view of a switch sub-assembly used in the circuit protector switch;

FIG. 10 is a top plan view of a thermally responsive detent used in the switch; and

FIG. 11 is a cross sectional view of a portion of the detent shown in FIG. 10.

Referring to FIGS. 1 to 3, they show a circuit protector switch having a mounting plate **10**, a unitary insulating housing to which plate **10** is attached, and an insulating bottom cover or base **14**. The switch has a reset button **16** mounted on the stem portion **18***a* of a substantially flat reset lever **18** which is reciprocally movable in a cavity **12***a* formed in housing **12**.

An electric switch unit **20**, which is best shown in detail in FIG. 9, is mounted in housing **12** between the latter and base **14** which holds it in place. Switch unit **20** comprises an integral switch mounting and insulating member **20***a* having a substantially flat mounting and barrier portion **20***b*, and substantial cubical bosses **20***c* and **20***d* formed on opposite sides of portions **20***b*. A normally open switch **20***e* has its stationary contact **20***f* and movable spring contactor **20***g* mounted on the top and bottom sides of boss **20***c*. A normally closed switch **20***h* has its movable spring contactor **20***i* and stationary contact **20***j* mounted on the top and bottom sides of boss **20***d*. Screws **20***k* penetrating terminal plates **20**[1] penetrate alined openings and clearance openings in the stationary contact and movable contacts of the switch units to secure the same in the bosses **20***c* and **20***d*.

Housing **12** is provided with a front side opening **12***i* into which the switch unit **20** is insertable when base **14** is removed from housing **12**. As shown in FIGS. 2, 7 and 8, the forward, upper part of barrier portion **20***b* interfits in a notch **12***j* in the base, and a lower projection **20***m* on portion **20***b* extends into a complemental recess **14***a* formed in base **14** to hold the switch unit in place.

Three open stepped recesses **22** are formed in top of housing **12**. Intermediate partition portions **13**, **15**, **17** and right-hand end wall **19** provide electrical barriers between the recesses. Combination wire terminal and overload heated mounting plates **26** are secured in place in each of the aforedescribed recesses by screws **24** which take into threaded recesses. One set of such plates located at the rear of each recess are mounted at a higher level than the set at the front. The recess between partition portions **15** and **17** is at a higher elevation to provide increased electrical and heat clearance from the recesses at either side thereof and also to provide clearance for the mounting of switch unit **20** therebelow.

As best shown in FIGS. 10 and 11, overload detent **28** comprises an outer cylindrical insulating sleeve **32**, an inner cylindrical stator member **34** which extends through an opening in plate **30** and has a flange welded to the lower surface of plate **30**. Sleeve **32** is press fitted about stator **34**. A shaft **36** is mounted in member **34** and is restrained against axial movement in the latter by a C-shaped ring **37** mounted in an annular groove **36***a* that bears against the inner surface of the stator **34**. A toothed ratchet wheel or pawl **38** is non-rotatably riveted to the end of shaft **36**. Shaft **36** is normally held against rotation in stator **34** by a solidified fill **40** of an eutectic alloy solder adhering between adjacent surfaces.

As shown in the left-hand recess **22**, a helical heater coil **23** is positioned around the outer insulating sleeve

32 of detent 28 with its ends secured by screws 25 to upper and lower terminal plates 26. Terminal plates 26 have outwardly and slightly downward projecting tabs 26*a* to which are secured wire retaining members 29 by screws 31. In an actual device both of the other recesses 22 would also be fitted with heater coils 23, the same having been omitted to simplify the drawings.

With the terminals 26 wired into series in branches of the circuit to be protected the heater coils 23 will be subjected to the load current. Under overload current conditions the current generated in the heater coil associated with an overloaded branch will cause the solder film to melt between shaft part 36 and the inner surface of the stator 34 and thus release shaft 36 and wheel 38 for movement as will hereinafter be more fully described.

As aforeindicated, the center recess 22 is at a higher elevation than the other two. This affords increased spacing between the heater coils 23 and thus any one of the detents will be less subject to the heat influence of heater coils other than its own. This decreases the chances of "single phasing" effects, and permits decreasing the total panel mounting area of the protection device.

The ratchet wheels of the detents in the two outside recesses are engaged directly by pawls 42 which are mounted for a limited degree of rotation on a drive shaft 44. The ratchet wheel of the detent mounted in the middle recess non-rotatably engages a coupling member 46 within a recess 46*a* formed in the upper end of the latter. Member 46 which is hollow throughout the major portion of its length has a ratchet wheel portion 46*b* formed at its lower end which is similar to and lies in a common plane with the ratchet wheels 38. Ratchet wheel portion 46*b* also engages a pawl 42 mounted on drive shaft 44.

The pawls 42 each comprise an integral lever portion 42*a* and an apertured hub portion 42*b* preferably formed of molded nylon. A metal ratchet wheel engaging pawl portion 42*c* is preferably molded in situ in lever portion 42*a*. The aperture 42*d* extending through hub 42*b* is semicircular with a radially inwardly extending lug 42*e* that is accommodated in the substantially complemental cross section of drive shaft 44. The semicircular notch 44*a* in shaft 44 subtends a greater angular arc than does lug 42*e* of pawl 42. Thus a lost motion driving connection is provided between shaft 44 and each of the pawls 42 for a purpose that will hereinafter be described.

A switch contact operating lever 48 is rotatably journaled on drive shaft 44 by means of openings formed in lever arms 48*a* and 48*b*. Lever arm 48*b* normally engages with the spring arm 20*g* of normally open contact 20*e* of switch 20 to hold such contacts closed. Lever 48 has a third lever arm 48*c* that normally engages with the spring contactor 20*i* of normally closed contacts 20*h* to hold the latter open. Lever arms 48*a*, 48*b* and 48*c* are integrally interconnected by a portion 48*d* which has a spring retaining boss 48*e* formed therebetween arms 48*a* and 48*b*. A coiled compression spring 50 at its lower end seats around the boss 48*e* and at its upper end seats in a circular recess formed in the housing 12. As viewed in FIG. 7, spring 50 biases lever 48 in the counterclockwise direction in which arm 48*b* holds spring arm 20*g* closed and arm 48*c* holds spring arm 20*i* open.

As best seen in FIGS. 3 to 6, drive shaft 44 also has non-rotatably mounted therein a generally triangular shaped reset plate 52. Plate 52 has a short cylindrical boss portion 52*a* formed therein which is engaged by a lower edge 54*a* of an indicating plate 54 that is mounted in a narrow recess 12*b*. Reset lever 18 has a substantially L-shaped aperture 18*b* formed therein at the base of its stem portion 18*a*. A right-angle hook or tank 54*b* of the indicating plate extends into and can move about such aperture as will hereinafter be more fully explained.

A coiled compression spring 56 which seats in a cylindrical recess 12*c* formed in housing 12 bears at its upper end against a forwardly extending arm 54*c* of the indicating plate and as hereinafter explained, tends to rotate the latter, A slightly offset indicating arm 54*d* as will hereinafter be more fully explained, under typical conditions extends closely toward a window 12*d* formed in housing 12 which has a plastic lense or cap 12*e* fitted therein.

A coiled compression spring 58 at its upper end fits about a downwardly extending tang 18*c* of reset lever 18 and bears in a short recess formed in bottom base 14. A cylindrical pin 54*e* is fitted in an aperture in plate 54 and extends through a generally rectangular notch 18*d* formed in the edge of lever 18 and into a recess 12*f* formed in the inner end wall of housing 12.

As best shown in FIG. 6, each of the pawl arms 42*a* have anchored therein one end of a coiled tension spring 60 which are each anchored at their other corresponding ends about short posts 12*g* extending downwardly from the triangular shaped recesses 12*h* formed in the bottom wall of housing 12. As viewed in FIGS. 7 and 8, springs 60 each tend to rotate their respective associated pawls 42 clockwise on drive shaft 44. In normal set, or untripped condition, inturned ends of the portions 42*c* of the pawls engage with the teeth of the ratchet wheels 38 and ratchet wheel portion 46*b* and are thus restrained against rotation on shaft 44. Shaft 44, as viewed in FIG. 7, is rotationally held in engagement at its semicircular notch 44*a* with the lugs 42*d* of the pawls 42 by reset plate 52 which is held in the position shown in FIG. 3 by engagement of its boss 52*a* with the edge 54*a* of indicating plate 54. The latter plate is held in the positions shown in FIG. 3 due to the counterclockwise bias imparted thereto by spring 56.

Now let it be assumed that in use, an electrical overload condition occurs of such magnitude and duration that one of the ratchet wheel detents 28 releases to permit a ratchet wheel 38 and its shaft 36 to freely turn within a stator 34. Then the tension spring 60 will pull the pawl 42 from the position depicted in FIG. 7 to that depicted in FIG. 8. In so moving the pawl causes rotation of the shaft in the clockwise direction as viewed in FIGS. 7 and 8, and counterclockwise as viewed in FIGS. 3 to 5. Such rotation of shaft 44 causes the edge 52*b* of reset plate 52 to engage lever arm 48*a* of contactor operating lever 48 to rotate the latter on shaft 44 to a position in which the arms 48*b* and 48*c*, respectively, disengage from spring contactors 20*g* and 20*i*, respectively (see FIGS. 4 and 8).

When reset plate 52 pivots as aforedescribed, the boss portion 52*a* thereof bearing on the lower edge 54*a* of indicating plate 54 causes the latter to pivot clockise, as viewed in FIGS. 3 to 5, from the position shown in FIG. 3 to that shown in FIG. 4. In the latter position the end of the indicating arm 54*d* lies in close proximity to the lower surface of the lens 12*e* to afford visual indication from above of the tripped condition of the overload device.

Resetting of the device following subsidence of an overload condition, is accomplished by manual depression of reset button 16 to effect increased movement of reset lever 18. As can be seen from FIGS. 4 and 5, the tang 54*b* of indicating plate 54 in tripped condition engages reset lever 18 within the short-arm of the L-shaped aperture 18*b*. Thus as reset lever 18 is moved inwardly of housing 12, indicating plate 54 will be moved downwardly against the bias of spring 56 with the pin 54*e* moving in guide recess 12*f* preventing any substantial lateral movement. In so moving downwardly, the edge 54*a* bearing on the boss portion 52*a* of reset plate 52 and causes plate 52 and hence drive shaft 44 to respectively pivot from their positions depicted in FIG. 4 to those shown in FIG. 5.

The last mentioned pivotal movement will cause any pawls 42 that are disengaged from their ratchet wheels 38 and 46*b* as a result of overload tripping, to be reengaged therewith. If all solder filling between shafts 36 and stators 34 are resolidified, then the edges of portions 42*a* will engage between adjacent teeth in ratchet wheels 38 and 46*b* as shown in FIG. 7, to hold drive shaft 44

and hence retain plate **52** in the position depicted in FIG. 3.

It will be noted that during the last mentioned clockwise pivotal movement of reset plate **52** and drive shaft **44**, that a curved edge **54***f* of indicating plate engages with arm **48***a* of swtiching operating lever **48** and holds the latter against clockwise pivotal movement under the bias of spring **50**. Upon reset of all pawls **42** and release of rest button **16**, indicating plate **54** moves upward under the bias of spring **56** from the position shown in FIG. 5, and also pivots counterclockwise to the position shown in FIG. 3. During the last mentioned movement of plate **54** its edge **54***f* disengages from arm **48***a* of lever **48**, and the latter is then free to pivot clockwise, as viewed in FIG. 3 under the bias of spring **50** to afford reclosure of switch **20***g* and reopening of switch **20***i*.

It will be noted that if an overload condition persists, or if any overload detent will not reset during the aforedescribed resetting movements depicted in FIGS. 4 and 5, that upon subsequent release of button **16**, drive shaft **44** and reset plate **54** will rotate counterclockwise to their positions depicted in FIG. 4 to maintain switch **20***g* open and switch **20***i* closed. Thus the construction aforesdescribed affords a "trip-free" type of overload operation insuring that the overload responsive switches **20***g* and **20***i* cannot be reset so long as an overload condition exists.

In normal usage of the circuit protector normally open switch **20***e* would have its contacts connected in series with the operating coil of an electromagnetic contactor or the like. Thus, in untripped condition of the protector switch **20***e* would be held closed to maintain circuit to such electromagnetic contactor, and would open upon overload response of the protector to deenergize the electromagnetic contactor. Switch **20***e* could be connected in an electric indicating circuit to reclose upon overload response of the protector to illuminate a tell-tale lamp or other signaling device.

We claim:

1. In an electrical overload protective device, in combination:

(a) switching means having a movable element which is normally biased to one operating condition;

(b) a rotatable shaft;

(c) a lever keyed on said shaft for limited lost motion rotation thereon;

(d) means biasing said lever to effect rotation of said shaft in a given direction;

(e) an overload responsive element having means normally restraining it against movemet and egaging with said lever to hold it agaist rotation under the bias of its biasing means, said element restraining means n response to an overload condition releasing said element to permit rotation of said shaft by said lever;

(f) a switch operating lever rotatably mounted on said shaft;

(g) means normally biasing said switch operating lever rotatably on said shaft to hold the movable element of said switching means in another operating condition;

(h) a third lever nonrotatably secured to said shaft which engages with said switch operating lever to drive the latter out of engagement from said movable element when said shaft is rotated as aforestated;

(i) and reset means operable following overload response to engage with said third lever to first effect rotation of said shaft in the opposite direction to reset the first mentioned lever in engagement with said overload responsive element while holding said switch operating lever in its last recited position and thereafter upon release permitting said switch operating lever to rotate under its bias and effect the first mentioned operation of said movable element of said switching means.

2. The combination according to claim **1**, together with a plurality of said first mentioned levers keyed and spaced apart on said shaft, a plurality of means individually biasing said first mentioned levers to rotate said shaft, and together with a plurality of said overload responsive elements which individually engage said levers to hold them against the bias of their individual biasing means, and said levers being so keyed on said shaft that release of one overload responsive element will permit rotation of said shaft in said given direction by its associated released lever while the other levers remain engaged and restrained against movement by their respective overload responsive elements.

3. The combination according to claim **1**, wherein said reset means comprises a reciprocable lever biased to an extended position and a member biased to a normal extended position, said reciprocable lever upon movement against its bias, following overload release movement of said shaft, engaging with said member to move said member in a corresponding direction wherein it effects through its engagement with said third lever rotation of said shaft in the reverse direction and engages with said switch operating lever to hold it in tripped position against the bias of its biasing means, and said reciprocable lever upon following release movement under its bias permitting said member to reciprocably move under its own bias to pivotally disengage from said switch operating lever so the latter can move to its normal position.

4. The combination according to claim **1**, wherein said overload responsive element is a rotatable eutectic alloy solder restrained ratchet wheel and said lever has a pawl engageable with said ratchet wheel.

5. The combination according to claim **1**, wherein said switching means comprises a normally open and a normally closed switch, each having a movable element engaged and operated to the other operating condition when said switch operating lever is rotated under its bias.

6. In an electric overload circuit protector, in combination:

(a) a housing having a bottom opening cavity, three stepped recesses formed in the upper side of said member and barriers between and electrically isolating said stepped recesses from each other;

(b) a base enclosing the bottom side of said housing;

(c) a shaft journaled for rotation in the bottom wall of said base member and held in place by said cover;

(d) at least one lever keyed on said shaft for limited lost motion rotation thereon;

(e) a spring anchored in said housing and attached to said levers and tending to cause the latter to rotate said shaft in a given direction;

(f) at least one eutectic alloy solder restrained overload element mounted in one of said stepped recesses and having a ratchet wheel portion in said housing cavity and engaging with a pawl end on an associated one of said levers to normally restrain the same from rotating said shaft in said given direction;

(g) an electric heater coil mounted in said recess in concentric arrangement about a portion of said overload element and when connected in a branch of an electrical circuit affording under given overload conditions melting of solder and rotation of said ratchet wheel to release its associated lever to effect the aforestated rotation of said shaft;

(h) a switch unit mounted in a front opening in said base and comprising at least one switch having a movable element biased to one operating condition;

(i) a switch operating lever rotatably mounted on said shaft;

(j) a spring normally biasing said switch operating lever to move said movable element of said switch to another operating condition;

(k) a third lever nonrotatably secured to said shaft which engages with said switch operating lever to drive the latter out of engagement when said shaft is rotated in said given direction;

(l) and reset means mounted in another cavity in said base, and comprising an outwardly biased reciprocable lever having a portion extending above the upper surface of said base to which a depressable button is secured and a member biased to an upward position within the last mentioned cavity, said reciprocable lever upon movement inwardly of said base, following overload release rotation of said shaft in said given direction, engaging with said member to move it in a corresponding direction to effect through its engagement with said third lever rotation of said shaft in the opposite direction to reset any tripped ones of said first mentioned levers in engagement with their associated ratchet wheels and engagement with said switch operating lever to hold it in tripped position against the bias of its spring, and said reciprocable lever upon release moving under its bias to thus permit said member to reciprocably move under its bias to pivotally disengage

from said switch operating lever and permit the latter to move said movable element of said switch to its other operating condition.

7. The combination according to claim 6, wherein said stepped recess be in a row with the center one being elevated a substantial distance above the two at either side thereof to provide increased thermal and elecrical isolation between the overload responsive elements mounted therein.

References Cited

UNITED STATES PATENTS

2,972,664	2/1961	Furnas et al.	337—151 X
3,179,757	4/1965	Brandenberg	337—151 X
3,223,803	12/1965	Walters	337—151 X
3,258,566	6/1966	Arneberg et al.	337—151

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U.S. Cl. X.R.

337—146