Oct. 15, 1963 W. S. TUFTS 3,107,281

AUTOMATIC DEFROSTING DEVICE

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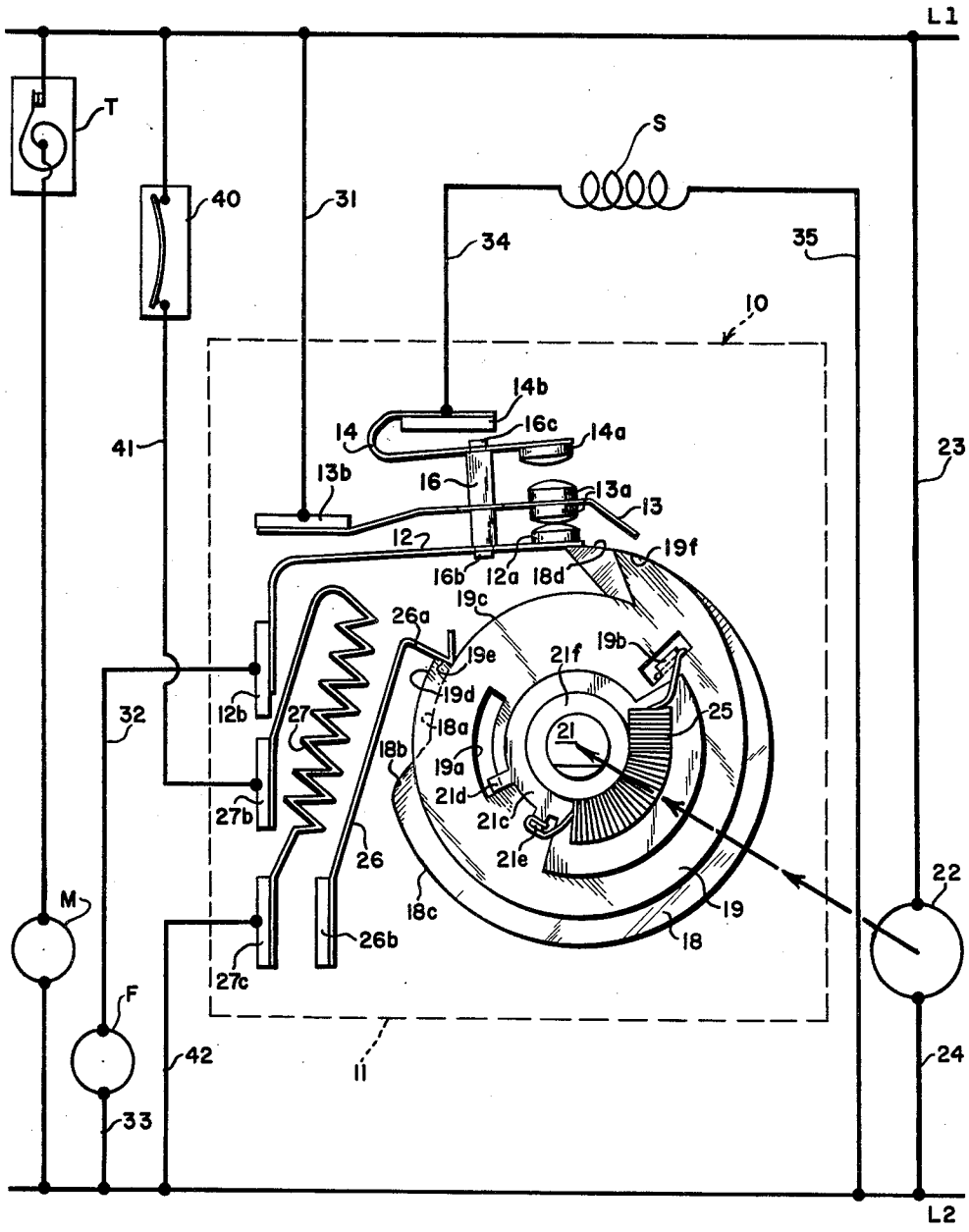


Fig. 1

INVENTOR
WILLIAM S. TUFTS

BY Roy E Ramey
ATTORNEY

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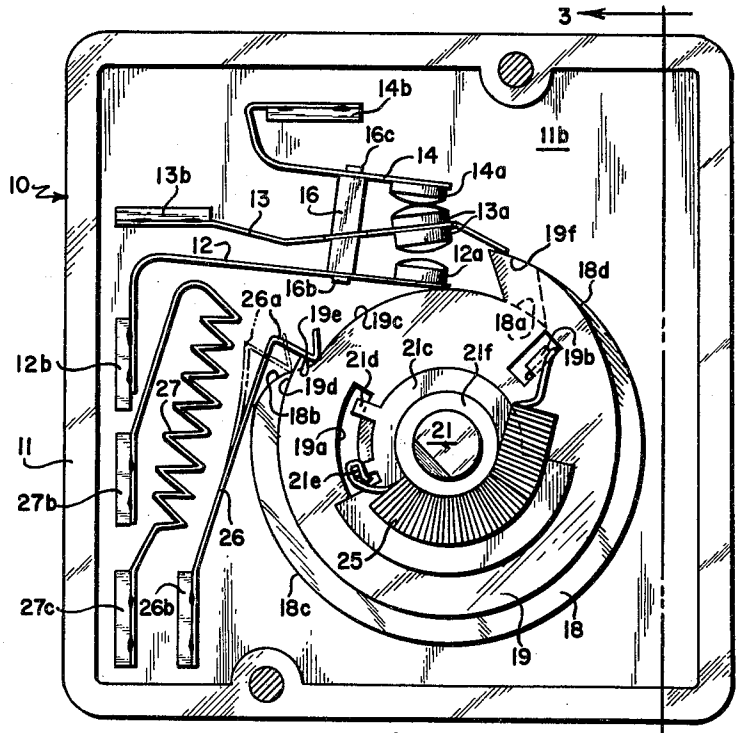


Fig. 2

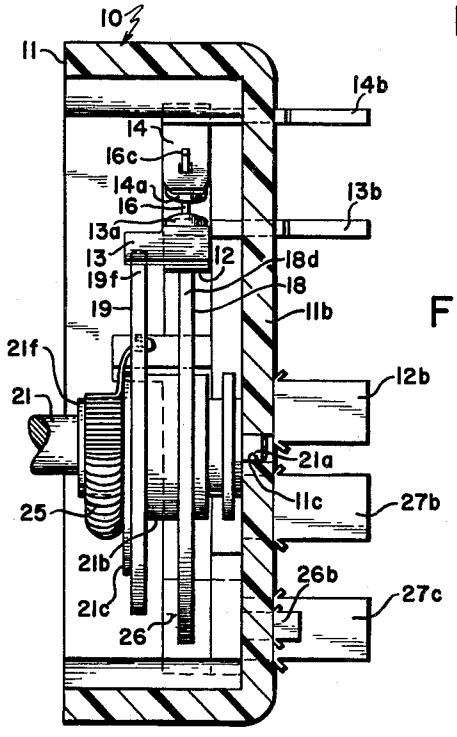


Fig. 3

INVENTOR
WILLIAM S. TUFTS

BY Roy E Ramey

ATTORNEY

Oct. 15, 1963 W. S. TUFTS 3,107,281

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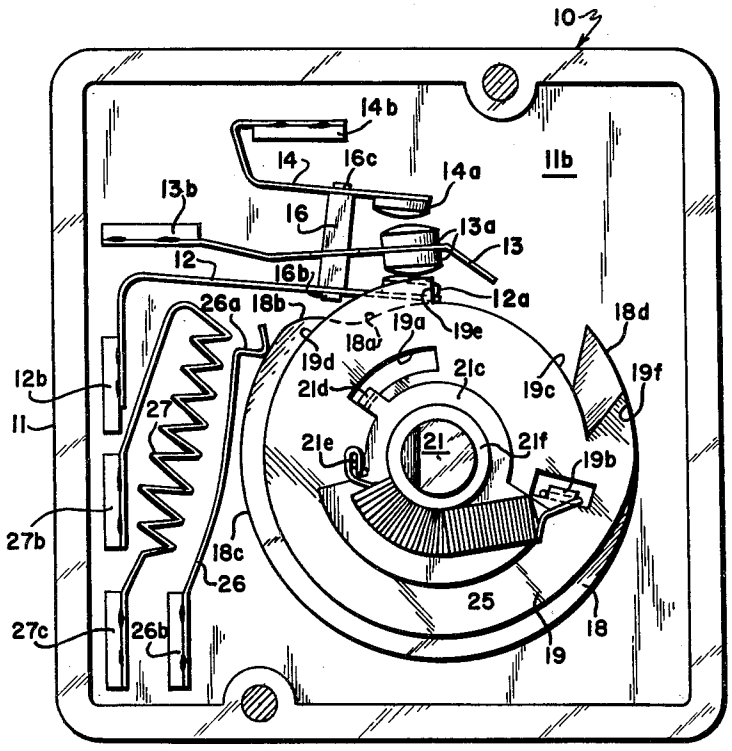


Fig. 4

INVENTOR
WILLIAM S. TUFTS

BY Roy E Ramey

ATTORNEY

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AUTOMATIC DEFROSTING DEVICE

William S. Tufts, Columbus, Ohio, assignor to Ranco Incorporated, Columbus, Ohio, a corporation of Ohio

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6 Claims. (Cl. 200—38)

The present invention relates to cam operated switching devices, and more specifically to an improved switching device particularly suited for periodically initiating defrosting cycles in the cooling unit of a refrigerator, and for terminating such cycles in response to the attainment of a given defrosting temperature in the cooling unit or, after the lapse of a predetermined period of time if the termination is not effected by the attainment of the defrosting temperature.

It is one object of this invention to provide a cam operated switch means including a plurality of switch members which are operated sequentially between two control positions by the rotation of first and second cams, respectively, for initiating and terminating defrost cycles in a refrigerator, for example, the first cam being rotated by a driving means such as a timing device, and the second cam being drivingly connected with the driving means by a lost motion connecting means including resiliently yieldable means, the second cam being held against rotation by a restraining means which releases the cam for movement to operate the switch members to the second control position in response to a given condition, such as the attainment of a defrosting temperature in a refrigerator.

Another object of this invention is the provisions of a cam operated switch means of the above mentioned character wherein the restraining means comprises a latch member, preferably formed of bimetal, which engages a shoulder in the surface of the second cam, and the means for causing the latch member to release the cam comprises an electrically energized element, preferably a resistance type heater, which is energized to heat the bimetal latch member to release the cam in response to an increase in temperature in the cooling unit to a predetermined defrosting temperature, and the first cam having surface thereon for engaging the latch member and causing it to release the second cam if the latter has not been released within a predetermined time after the defrost cycle is started.

As another object, this invention aims to provide a wholly electrically operated control device which is reliable and compact and is free of tubing for thermostatic bellows, external mechanical motion transmitting linkages, and the like, and so is adapted to be disposed in any convenient location in a refrigerator housing to which wires may be led.

Other objects and advantages of the invention will be apparent from the following description of a preferred form thereof and from the accompanying sheets of drawing forming a part of this specification and in which:

FIG. 1 is a schematic illustration of a switching device embodying the invention and shown connected in the control circuit of an electric motor driven refrigeration system equipped with an electric solenoid operated valve for directing hot gas through the evaporator so as to effect defrosting thereof;

FIG. 2 is a plan view of the device of FIG. 1, showing certain parts thereof in different positions;

FIG. 3 is a sectional view of the device taken substantially along line 3—3 of FIG. 2; and

FIG. 4 is a view similar to FIG. 2 but showing the parts in still different positions.

Although the control device of the present invention is susceptible of other forms of construction and is adapted

to other uses, it will be described hereinafter with reference to the controlling of periodic defrosting cycles of a refrigerator. Referring now to the drawings, there is illustrated therein a control device, generally indicated at 10, embodying the present invention and shown in FIG. 1 in association with the electrical circuit of a refrigeration system which may be controlled thereby.

The refrigeration system may be of the class having a refrigerant compressor which is operated by an electric motor M, and an evaporator or cooling unit, not shown, from which accumulations of frost periodically require removal. The energization of motor M is preferably controlled by a food compartment thermostat T of any well known construction, but which is here shown as being of the bimetal type.

The control device 10 comprises a box-like housing 11 which is preferably molded from a suitable insulating material, such as Bakelite or other plastic, and which serves to house a cam operated switch means for controlling the defrost cycles of the refrigerator. The switch means comprises a group of flexible electrical switch members in the form of spring leaves or blades 12, 13 and 14 mounted within the housing 11. Blade 12 has a contact 12*a* at one end thereof and has its other end secured to the rear wall 11*b* of housing 11 by means of a terminal lug 12*b* which extends through an opening in the rear wall and is fixed therein by staking. Blade 13 has, near one end thereof, a double contact 13*a* in registration with contact 12*a*, and is secured at its other end to housing 11 by a terminal lug 13*b* extending through an opening in housing wall 11*b*. Blade 14 is likewise provided at one end thereof with a contact 14*a* in registration with contact 13*a* and is secured at its other end to housing 11 by a terminal lug 14*b* extending through an opening in housing wall 11*b*.

Switch members of blades 12 and 14 are held in spaced relation by a spacer member 16 which is retained therebetween by reduced end portions 16*b* and 16*c* projecting through openings in blades 12 and 14 respectively. Spacer member 16 extends freely through an opening in blade 13, which blade may be referred to as an intermediate switch member, so that relative movement is permitted between the latter and the spaced blades 12 and 14 to open and close the contacts thereof.

Rotary, coaxial cam means, comprising a first cam 18 and a second cam 19, are provided for effecting the movement of the switch members, or blades 12, 13 and 14 to cause contact 13*a* to alternatively be in engagement with contacts 12*a* and 14*a* so as to make and break certain later described electric circuits therethrough for controlling the defrosting cycles of the refrigerator. Cam 18, the periphery of which is adapted to be engaged by blade 12, is secured to a shaft 21 for rotation therewith. Shaft 21 has a reduced end portion 21*a* journaled in an opening 11*c* in housing wall 11*b*, and is connected through suitable reduction gearing, not shown, for rotation by an electric timer motor 22 at a rate which may be in the order of one revolution per day, although any other suitable rate may be utilized. Timer motor 22 is energized through conductors 23, 24 connecting the motor between lines L1 and L2 which supply suitable electric power, such as 110 volts, A.C., to the refrigerator.

Cam 19, the periphery of which is adapted to be engaged by intermediate switch member 13 for controlling movement thereof, is mounted on an enlarged portion 21*b* or shaft 21 for rotation relative to cam 18 and relative to a flange 21*c* on the shaft. An arcuate slot 19*a* is defined in cam 19 and flange 21*c* is provided with a tab 21*d* which is in engagement with slot 19*a* and serves as a lost motion connection to limit the relative rotation between cams 19 and 18. An extension spring 25 is

connected at one end to a lug 21*e* of flange 21*c* and has its other end connected to a lug 19*b* formed in cam 19. Spring 25 is led around a drum portion 21*f* of shaft 21 and serves to yieldably connect cam 19 to the drive means for rotation with cam 18.

Means are provided to interrupt the rotation of cam 19 so that cam 18 will rotate independently thereof for operation of the switch members. To this end, cam 19 is provided with stepped surfaces 19*c* and 19*d* defining a radially extending shoulder 19*e* therebetween. A cam restraining means in the form of a flexible, resilient latch member 26 formed of bimetal material, is secured at one end thereof to housing 11 by a lug 26*b*, and is provided at its other end with a hook portion 26*a* which is adapted to engage shoulder 19*e*. When shoulder 19*e* is so engaged, spring 25 yields to permit rotation of cam 18. An electrically energized resistance type heater 27 is disposed adjacent latch member 26 and is secured to housing 11 by terminal lugs 27*b*, 27*c* fixed in openings in housing wall 11*b*, and serves to heat bimetal latch member 26 for actuation thereof to release cam 19 for rotation by spring 25 in a manner which will become apparent as the description proceeds.

The surface of cam 19, which is adapted to be engaged by blade 13, extends from portion 19*d* thereof around in a counter-clockwise direction as viewed in the drawings, and terminates in a surface 19*f* adjacent a steep shoulder forming a step between that surface and surface 19*c* of the cam. Cam 18, the surface of which is adapted to be engaged by blade 12 for controlling its movement, has a cam surface 18*a* of the same radial magnitude as surface 19*c*, and has a sloping surface 18*b* which rises from surface 18*a* to a generally circular surface 18*c* of substantially greater radial magnitude than surface 19*d* of cam 19. Surface 18*c* extends in a counterclockwise direction, as viewed in the drawings, and terminates in a surface portion 18*d* adjacent an abrupt step or shoulder between that portion and surface 18*a*.

The rotation of shaft 21 by timer motor 22 during normal operation of the refrigerator and prior to initiation of a defrost cycle will cause cams 18 and 19 to be rotated in unison, cam 19 being held by spring 25 in the position relative to cam 18 which is illustrated in FIG. 1, until shoulder 19*e* of cam 19 engages hook portion 26*a* of latch member 26. During such rotation, it will be observed that blade 12 is engaged with surface 18*d* and contact 12*a* is held in engagement with contact 13*a*, while spacer member 16 holds blade 14 with contact 14*a* thereof spaced from contact 13*a*.

The closed contacts 12*a*, 13*a* complete a circuit for the energization of an electric fan F which serves to circulate air in the refrigerator over the evaporator thereof. This circuit may be traced from line L1 through conductor 31 connected to terminal 13*b*, contacts 12*a* and 13*a*, conductor 32 leading from terminal 12*b*, fan F, and conductor 33 to line L2.

As shaft 21 continues to rotate, latch member 26 will restrain cam 19 from further rotation with cam 18, and the continued rotation of the latter will wind spring 25 about drum portion 21*f*. Such continued rotation of cam 18 will permit blade 12 to drop from surface 18*d* to surface 18*a*, whereupon blade 13 will engage cam surface 19*f* and hold contact 13*a* from further movement while contact 12*a* moves away therefrom. As contact 12*a* moves away from contact 13*a*, held by surface 19*f*, spacer member 16 will permit blade 14 to lower contact 14*a* into engagement with contact 13*a*. Accordingly, the fan energizing circuit through contacts 12*a* and 13*a* will be broken.

The now closed contacts 13*a*, 14*a* serve to complete a circuit for energizing a solenoid S of a hot gas controlling valve which is provided for directing hot refrigerant through the evaporator of the refrigerator for defrosting thereof. This circuit may be traced from line L1 through conductor 31, contacts 13*a* and 14*a*, conductor 34, solenoid S, and conductor 35 to line L2. It will be understood that energization of solenoid S, and the substantially simultaneous deenergization of fan F, will result in a rise in temperature in the cooling unit for removal of frost therefrom. During this time the cam 18 will continue to rotate as shown in FIG. 2.

A thermally actuated switch 40, which may be of any conventional construction but is illustrated herein as of the snap acting bimetal type, is located in the refrigerator so as to be responsive to the rise in temperature in the cooling unit during the defrosting operation.

When a predetermined temperature for effecting the defrosting is attained in the cooling unit, thermally actuated switch 40 completes a circuit which may be traced from line L1 through switch 40, conductor 41, heater 27, and conductor 42, to line L2, thereby energizing heater 27 to heat bimetal latch member 26. As latch member 26 is heated, it will bend to the position illustrated in dot-and-dash lines in FIG. 2 to release cam 19 for rotation with respect to cam 18 under the influence of spring 25. Such rotation of cam 19 will permit blade 13 to drop from surface 19*f* bringing contact 13*a* once again into engagement with contact 12*a* for reestablishing the energization of the circuit for fan F, and simultaneously moving contact 13*a* away from contact 14*a* for termination of the energization of solenoid S. Thereupon, the refrigeration system resumes its cooling function and, as the temperature of the cooling unit decreases toward its normal value, the thermally responsive switch 40 opens and terminates the energization of heater 27. Bimetal latch member 26, therefore, cools and resiliently engages the surface of cam 18, which it follows until it is re-engaged by the shoulder 19*e* of cam 19.

The device of this invention includes a fail-safe feature for the prevention of inordinately high temperatures occurring in the cooling unit and food compartment in the event that, for some reason such as malfunction of switch 40, heater 27 fails to cause latch member 26 to release cam 19 for movement. In the event of such a failure, and at a predetermined time after the defrost cycle is initiated, latch member 26 will be engaged by cam surface 18*b* and be lifted thereby from restraining engagement with shoulder 19*e* of cam 19, releasing the latter for rotation into its FIG. 4 position with respect to cam 18 and with respect to the switch members 12, 13 and 14. The latter are thereby returned to their normal positions with contacts 13*a*, 14*a* open and contacts 12*a*, 13*a* closed to energize fan F.

From the foregoing detailed description of one embodiment of the present invention, it will be appreciated that there has been provided thereby a particularly reliable and effective cam operated switch device which is well adapted to the controlling of refrigerator defrosting operations and which includes a fail-safe feature of operation. It will also be appreciated that the invention achieves the effective control of a plurality of circuits through the use of cams having limited rotation relative to one another, which relative rotation is controlled by a latch mechanism which is operable in one manner under normal conditions and in another manner under abnormal conditions.

Although this invention has been described with reference to specific forms of switch devices and specific uses thereof, it is understood that the invention is not limited thereto, but rather the invention includes all those modifications, adaptations, and uses as are reasonably embraced by the scope of the claims hereof.

Having described my invention, I claim:

1. Control apparatus comprising a pair of spaced contact members, an intermediate contact member disposed between said pair of contact members, said pair of contact members and said intermediate contact member being movable relative to one another to alternatively make and break first and second electrical circuits therethrough, a first rotatable cam engageable by one of said pair of

contact members to control movement thereof, a second rotatable cam engageable by said intermediate contact member to control movement thereof, means for rotating said first cam in one direction of rotation with respect to said contact members, resilient means between said cams for yieldably urging said second cam to rotate in said one direction with said first cam, restraining means for releasably holding said second cam against rotation by said resilient means, rotation of said first cam when said second cam is so restrained being effective to move said one of said pair of contact members out of engagement with said intermediate contact member and to move the other of said pair of contact members into engagement with said intermediate contact member, and electrically energized means for operating said restraining means to release said second cam for rotation with respect to said first cam, said second cam thereby being effective to move said intermediate contact member out of engagement with said other pair of contact members and into engagement with said one of said pair of contact members.

2. Control apparatus as defined in claim 1, wherein said restraining means comprises a bimetal latch member, and said electrically energized means comprises a resistance type heater adjacent said latch member.

3. Control apparatus as defined in claim 1, wherein said first cam includes means for engaging and operating said restraining means to release said second cam for said rotation with respect to said first cam.

4. Control apparatus comprising a plurality of contact members movable relative to one another to provide first and second operative positions for controlling current flow, a first rotatable cam engageable by one of said contact members to control movement thereof, a second rotatable cam engageable by another of said contact members to control movement thereof, drive means for rotating said first cam in one direction of rotation with respect to said contact members, resilient means between said cams for yieldably urging said second cam to rotate in said one direction with said first cam, restraining means for releasably holding said second cam against rotation by said resilient means, rotation of said first cam when said second cam is so restrained being effective to move said one contact member to provide said first operative position of said members, and actuating means for operating said restraining means to release said second cam for rotation with respect to said first cam by said resilient means, said second cam thereby being effective to move said other contact member to provide said second operative position.

5. Control apparatus as defined in claim 4, wherein said first cam includes means for engaging and operating said restraining means to release said second cam for said rotation with respect to said first cam.

6. Control apparatus comprising a plurality of contact members movable relative to one another to provide first and second operative positions for controlling current flow, first and second rotatable cams coaxially arranged in side by side relation and adapted to have relative rotation, said first cam being engageable by one of said contact members to control movement thereof, said second cam being engageable by another of said contact members to control movement thereof, drive means for rotating said first cam in one direction of rotation with respect to said contact members, resilient means between said cams for yieldably urging said second cam to rotate in said one direction with said first cam, said second cam having a shoulder thereon, a movable latch member for engaging said shoulder to hold said second cam against rotation by said resilient means, said first cam moving said one contact member to said first operative position of said members after a predetermined angular movement relative to said second cam, actuating means for moving said latch member from engagement with said shoulder to release said second cam for rotation with respect to said first cam by said resilient means, said second cam thereby being effective to move said other contact member to provide said second operative position, and said first cam comprising a rise thereon for engaging and moving said latch member from said shoulder upon angular rotation of said first cam relative to said second cam beyond said predetermined angular movement in the event said actuating means fails to operate said latch to release said second cam.

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