

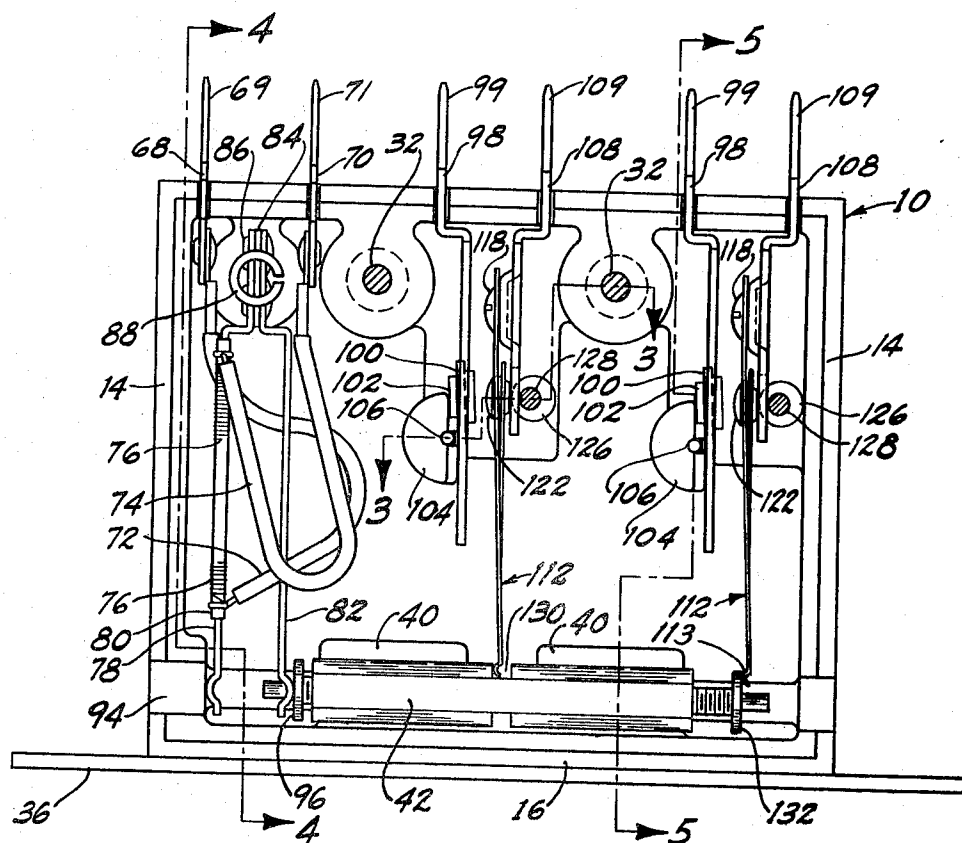
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[56] **References Cited**
UNITED STATES PATENTS
 2,498,127 2/1950 Kuhn..... 337/41 X
 2,814,686 11/1957 Wilder..... 337/41 X
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[54] **BIMETAL-ACTUATED SNAP ACTION**
SEQUENCING RELAY
 8 Claims, 8 Drawing Figs.

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 H01h 71/16
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 99, 100, 112, 113, 318, 338, 339, 340

ABSTRACT: A bimetal-actuated, snap action, sequencing relay having one-piece, self-returning, snap action switch blades of E configuration, in which the switch actuation point may be varied by the application of variable laterally opposing forces to the free ends of the long legs thereof, and in which the stationary contacts are adjustable to vary the travel of the movable contacts, the contact pressure, and return force of the blades.



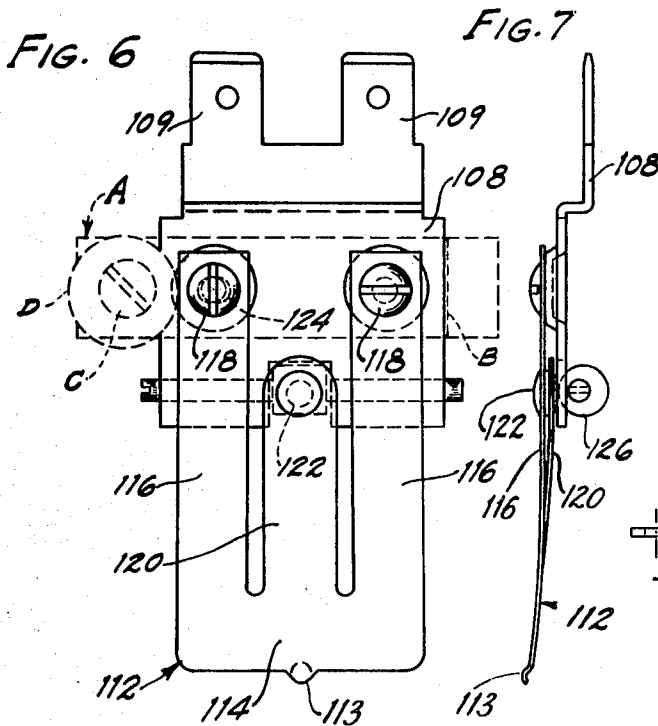
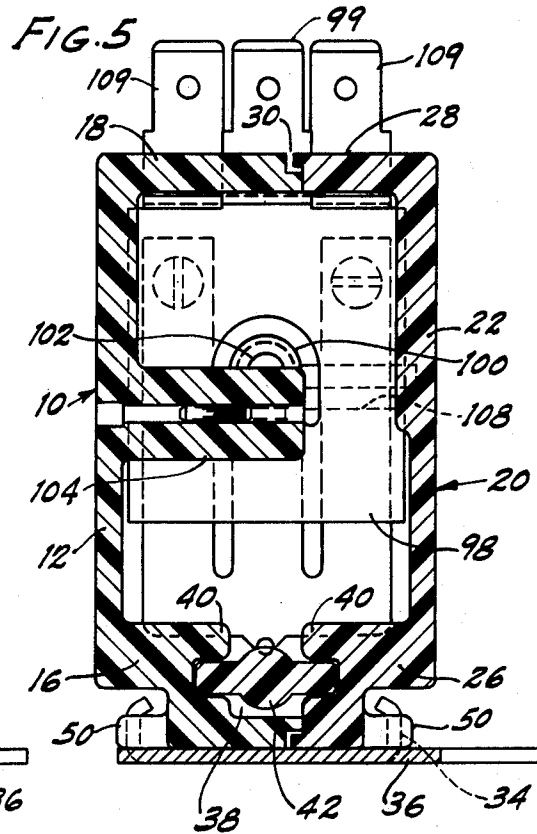
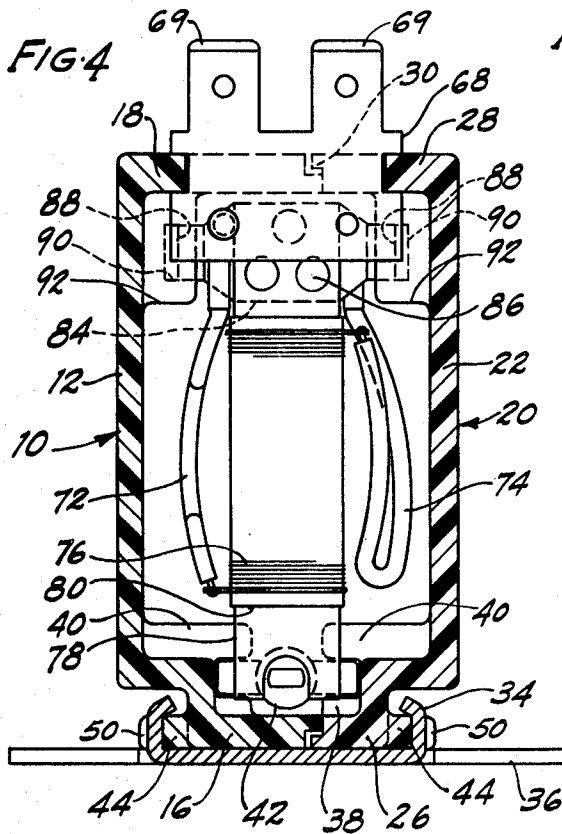
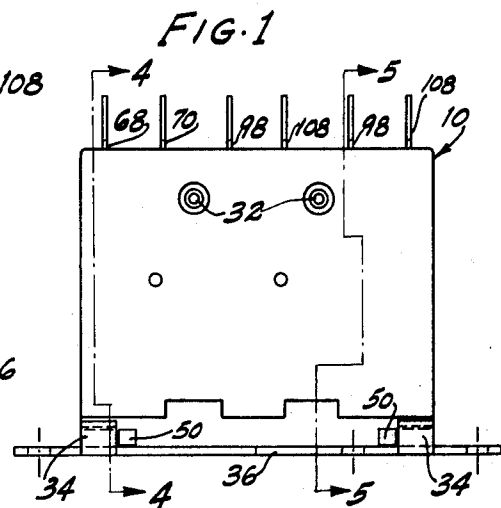
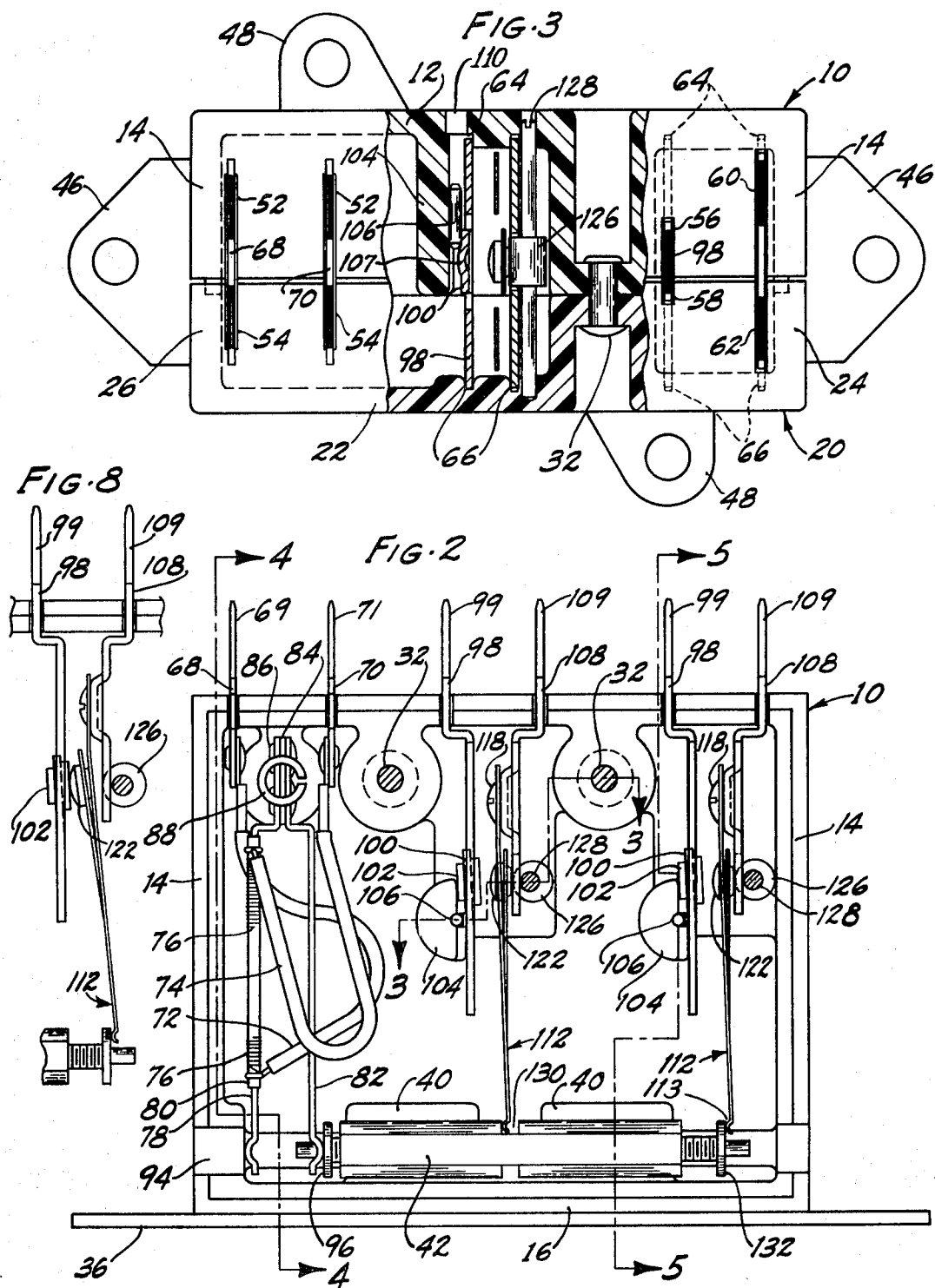


FIG. 7



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BIMETAL-ACTUATED SNAP ACTION SEQUENCING RELAY

This invention relates to sequencing relays for staging the application of a total electrical load to a circuit, and particularly to snap acting sequencing relays which are actuated by a heat motor comprising a bimetal element heated by an electrical resistance heating element.

The device has utility in sequencing the energization of a plurality of electrical resistance space heaters or in sequentially energizing electrical resistance space heaters and electrically operated air circulating blowers with a short intervening delay, thereby to preclude an objectional momentary voltage drop in a circuit which would otherwise occur if the total load were applied instantly. The device is also well adapted to use in connection with other relay devices having electrically heated bimetal actuators, thereby to effect a further staging of the application of an electrical load. In such series arrangement of multiple relays wherein the closure of contacts of one relay effects energization of the resistance heater of another, a minimum delay between the application of a load increment by each relay is, of course, assured.

An object of the invention is to provide a generally new and improved thermal relay in which a plurality of pairs of contacts are sequentially operated from one operative position to another in a snap acting manner by an electrically heated thermostatic element.

A further object is to provide a thermal relay as in the preceding paragraph which is particularly reliable in operation, of simple and rugged construction, and economical to manufacture due to fewer parts, less assembly labor, and less factory adjustment labor.

A further object of the invention is to provide a sequencing relay having a plurality of one piece, snap acting switch blades which may be critically adjusted conveniently to effect a sequential actuation thereof by predetermined progressive movements of an actuating member.

A further object is to provide means in a sequencing relay, as in the preceding paragraph, for adjustably mounting the stationary contacts so that their spacing relative to their respective cooperating movable contacts may be conveniently varied in fine incremental movements.

Further objects and advantages will become apparent when reading the following description in connection with the accompanying drawings.

In the drawings:

FIG. 1 is a side elevational view of a sequencing relay constructed in accordance with the present invention;

FIG. 2 is an enlarged inside elevational view of the casing body member with all of the internal components in assembled position;

FIG. 3 is an enlarged partially sectionalized plan view of the relay shown in FIGS. 1 and 2, the sectionalized portion thereof being taken along a line 3—3 of FIG. 2;

FIG. 4 is an enlarged cross-sectional view taken along line 4—4 of FIGS. 1 and 2;

FIG. 5 is an enlarged cross-sectional view taken along line 5—5 of FIGS. 1 and 2;

FIGS. 6 and 7 are front and side elevational views, respectively, of a subassembly including the snap acting switch blade and its terminal; and

FIG. 8 is a side elevational view of the snap acting switch blade of FIGS. 6 and 7 shown in closed position.

The relay comprises a casing consisting of a body member 10 having a rear wall 12, sidewalls 14, a bottom wall 16, a top wall 18, and a cover member 20 having a front wall 22, side walls 24, a bottom wall 26, and a top wall 28. The body and cover members are formed as castings of dielectric material such as suitable synthetic plastic material having the required rigidity. The bottom, top, and sidewalls of the body member 10 and cover member 12 are rabbeted, as indicated at 30, thereby forming an overlapping joint, and the body and cover members are rigidly connected by rivets 32 and by formed-over ear portions 34 of a stamped metal base member 36.

The bottom walls 16 and 26, respectively, of the body and cover members 10 and 20 have vertically offset adjacent portions forming a central recess 38 extending along the bottom wall of the casing. Internal, integrally cast bosses 40 extend inward from the rear and front walls of the body and cover members, covering portions of the recess 38 along its length and providing an interrupted guideway for an elongated actuating member 42. The elongated actuating member 42 is constructed as a casting of a dielectric material, such as a suitable synthetic plastic material, and is freely slidable in the interrupted guideway formed by the elongated recess 38 and bosses 40.

Exterior bosses 44 near opposite ends of the body and cover members provide ledges over which ear portions 34 of base 36 are formed, thereby to rigidly fasten the bottom walls of the body and cover members together and to rigidly connect the metal base member 36 to the casing. The metal base member 36 is provided with perforated portions 46 and 48, extending from the ends and sides of the casing, for mounting the device on support means. Portions 50 of the external bosses 44 extend outward beyond the surfaces of the bosses engaged by the ears 34 of the base member 36, thereby to provide locating stops for conveniently longitudinally positioning the base member 36 on the casing when assembling.

The top walls 18 and 28 of the body and cover members are provided with aligned transverse slots 52—54, 56—58, and 60—62, and the rear and front walls 12 and 22 are provided with aligned recesses 64—66 which are, in turn, aligned with slots 56—58 and 60—62, see FIG. 3. Fitted into slots 52 and 54 is a pair of flat conductive terminal members 68 and 70 extending interiorly and exteriorly through the slots 52—54 in the top walls 18 and 28 of the casing. Those portions of the sides of the terminal members 68 and 70 passing through the casing walls are notched to preclude their vertical movement, and the exteriorly projecting portions 69 and 71 thereof are bifurcated and perforated to receive a pair of external leads. Connected at one end to the interiorly extending portions of terminal members 68 and 70 are internal leads 72 and 74, respectively, the leads having their other ends connected to opposite ends of an electrical resistance heater winding 76.

The resistance heater winding 76 is wound around a vertically arranged strip of bimetal 78 positioned between the terminal members 68 and 70, there being an insulator 80 between the bimetal strip and the winding 76. Positioned parallel and in spaced relationship with said bimetal strip 78 is a second bimetal strip 82, see FIG. 2. Bimetal strips 78 and 82 are formed with similar opposite offset upper end portions to effect their spaced relationship and are rigidly connected together at their upper ends with the flat plate portion of a mounting member 84 between them by rivets 86, see FIGS. 2 and 4. The end portions of the mounting member 84 are formed to provide cylindrical end portions 88, see FIG. 2, which freely fit into aligned horizontal bores 90 formed in interior bosses 92 projecting from the upper portions of the rear and front casing walls, see FIG. 4. The bimetal strips 78 and 82 are therefore rigidly connected at their upper ends and are also jointly pivotally mounted in the walls of the casing.

At their lower free ends the outer surfaces of the bimetal strips 78 and 82 bear, respectively, against an internal body boss 94 and an adjustment screw 96 threaded in the left end of the actuating rod 42. The parallel spaced bimetal strips 78 and 82 are arranged with the high expansion side of strip 78 facing the low expansion side of strip 82. Ambient temperature change affecting both bimetal strips does not, therefore, effect a change in the spacing of the free ends of the pivotally mounted bimetal strips. The time required to heat and warp the bimetal strip 78 sufficiently to move the actuating member 42 a predetermined amount toward the right will, therefore, remain substantially constant irrespective of ambient temperature change.

Fitted into the recesses 64—66 in the rear and front walls of the casing and into the slots 56 and 58 in the top wall of the casing, and extending interiorly and exteriorly through the top

wall of the casing, are a pair of flat conductive members 98. The members 98 each have a single perforated terminal prong 99 extending exteriorly for connection thereto of an external lead. The wide interiorly extending portions of conductive members 98 each have a central partially detached portion 100. The partially detached portions 100 are perforated and each receives a stationary contact 102 attached thereto by riveting. The partially detached portions 100 carrying the stationary contacts 102 may be bent, thereby to adjustably position the stationary contacts. Integrally formed bosses 104 extend horizontally inward from the rear casing wall 12. The bosses 104 are semicylindrical in cross section, with their flat sides lying adjacent the partially detached portions 100 of members 98.

A horizontal pin 106 lying in a shallow groove in the flat side of each of the internal bosses 104 is biased between the detached portion 100 and the flat side of the boss. The detached portions 100 are each provided with an extruded bead 107, see FIG. 3, so that when the pin 106 is forced inward the partially detached portion 100 and stationary contact is moved toward the right with reference to FIG. 3. Holes 110 in the rear wall of the casing provide access to the pins 106. It will be noted that the vertical sides of the conductive members 98 are firmly held in the grooves 64 and 66 in the rear and front walls so that the partially detached central portions 100 may be bent relative thereto, see FIG. 5.

Also fitted into recesses 64-66 in the rear and front walls of the casing and into the slots 60 and 62 in the top wall of the casing and extending interiorly and exteriorly through the top wall of the casing are a pair of flat conductive members 108. The members 108 each have a bifurcated portion 109 extending exteriorly, thereby providing a pair of terminal prongs for attachment of leads. Connected to the interiorly extending portion of each of the flat conductive members 108 is a snap acting switch blade generally indicated at 112, formed as a stamping from thin spring-hard sheet stock and having an E configuration. The E blades 112 are arranged with their legs vertical, which legs are connected at their lower ends by horizontal portions 114. The free upper ends of the outer legs 116 are perforated and are connected to the interiorly extending portions of the flat conductive members 108 by screws 118 passing through the perforations. Attached to the free upper end of the central shorter leg 120 of each of the blades 112 is a movable contact member 122. The contact 122 is connected by a portion thereof passing through a perforation in the leg 120 and being riveted over.

The perforation in one of the outer legs 116 in each of the switch blades 112 is elongated horizontal, as indicated at 124 in FIG. 6, to permit slight lateral movement of the outer free ends of one of the legs 116 relative to the other. The application of opposing lateral forces to the free ends of legs 116, or the application of a lateral force to the free end of one of the legs while the free end of the other is held fixed, sets up a stress in the horizontal connecting portion 114. This stress causes portion 114 to warp one way or another at random from its normal free planar position if it is permitted to do so, and this warping causes the free end of central leg 120 carrying contact 122 to be moved a considerable amount from the plane of the legs 116. Under these conditions, when a lateral force is applied to the lower edge of the portion 114 in a direction opposite to the direction in which the upper part of central leg 120 has moved, the lower portion 114 is caused to snap through a planar shape to an opposite warped position, thereby causing the central leg 120 to be moved with a snap action to an opposite position with respect to the plane of the legs 116.

In order to effect a warping of the blade in the direction desired, the connecting portion of the blade 114 may be preformed slightly in the desired direction. As the lateral opposed forces applied to the free ends of the legs 116 are increased, the warping and snap action becomes more pronounced and the force required to be applied to the lower edge of the connecting portion 114 to effect a snap action through a planar shape is increased.

Referring to FIGS. 6 and 7, the blade 112 has been slightly preformed so that when lateral forces are applied to the free ends of legs 116, the blade will warp in the direction shown in FIG. 7; that is, with the free upper end of central leg 120 lying to the right of the legs 116 and with the contact 122 bearing against the adjustable stop 126. One method of applying a critical lateral force to the upper end of one of legs 116 while the upper end of the other is rigidly fixed is shown in FIG. 6. The switch blade 112 and conductor plate 108 subassembly are positioned in a fixture A, shown in dotted line, with the right-hand side of conductor plate 108 bearing against a shoulder B formed on the right-hand end of the fixture. Mounted on the left end of the fixture for rotation on a bolt C is an eccentric D with its peripheral surface bearing against the left-hand leg 116. With the right-hand leg rigidly fixed to the plate member 108 by the right-hand screw 118, and with the left-hand screw 118 in a loose condition, the eccentric D is rotated until the desired stressing is achieved and then the left-hand screw is tightened to maintain this stress. Preferably, the stress or force applied to the left-hand leg 116 is measured in force units rather than movement of the upper end of the leg, which movement is, of course, very slight.

The switch blades 112 are provided with small hemispherically formed portions 113 extending downwardly from the central portion of the lower edges thereof, which portions are engaged by the actuating member 42. Referring to FIG. 2, the leftward switch blade 112 is engaged by a shoulder formed by an interruption 130 in the surface of the actuating member 42, while the rightward switch blade is engaged by an adjustment screw 132 threadably engaged in the right-hand end of the actuating member.

Having stressed the legs 116 of the switch blade 112 to achieve the desired snap action, the required movement of switch blade portions 113 toward the right to effect a snapover of the switch blades from their positions shown in FIG. 2 to the positions shown in FIG. 8 may be varied by varying the position of the stop which limits the rightward movement of central blade 120 caused by the warping of the switch blade. The stop means for each of the switch blades comprises an eccentric 126 mounted for rotation with a shaft 128. The shafts 128 are journaled in the rear and front walls of the casing, see FIG. 3. One end of the shafts 128 has a slot therein and is journaled in a hole in the rear wall 12 of the casing, the slots in the shafts 128 therefore being accessible for rotational adjustment from the exterior of the casing. The peripheral surfaces of the eccentrics 126 engage the upper ends of blades 120 or the backs of the movable contacts 122 so that, as the shaft 128 is rotated, the condition of the switch blade with respect to the critical point at which it snaps over is varied. As the eccentrics 126 are rotated from the position shown in FIGS. 2 and 7, so as to move the contact 122 and upper end of switch blade legs 120 toward the left, the amount of rightward movement of the switch blades at point 128 required to snap them over to the position shown in FIG. 8 is reduced.

When the switch blades 112 snap through their planar shape to the opposite position shown in FIG. 8, the movement in this direction is limited by engagement of the movable contacts 122 with the stationary contacts 102 to the point wherein the switch blades will again return through their planar shape to the open contact positions shown in FIG. 2 with a snap action when the rightward force applied by the actuator member 40 is removed. The amount of rightward force required to hold the switch blades in the closed contact position shown in FIG. 8 is increased as the stationary contacts 102 are adjusted toward the right to further limit the leftward movement of the movable contacts 122.

OPERATION

In operation, when a pair of terminal prongs 69-71 at the ends of the resistance heater winding 76 are connected across a source of power, the bimetal strip 78 is heated, causing the strip to bow or warp with its left leg (in FIG. 2) pressing outward against the internal body boss 94. This warping causes

counterclockwise rotation of the entire bimetal assembly on the cylindrical end portions 88 of the mounting member 84. This counterclockwise rotation causes the rightward movement of sliding actuating member 42 and consequently the rightward movement of the projections 113 on the lower edges of blades 112.

An initial rightward movement of the actuating member 42 effects the snap action operation of the left-hand switch 122 from its open contact position, shown in FIG. 2, to a closed contact position, shown in FIG. 8, and a subsequent further rightward movement of the actuating member effects the snap action operation of the right-hand switch blade from open to closed position. The projection 113 of the left-hand switch blade is engaged by shoulder 130 intermediately of the length of the actuating member, and the initial warping of the bimetal strip 78 required to actuate the left-hand switch blade may be varied by adjustment of screw 96.

The projection 113a of the right-hand switch blade is engaged by the adjustment screw 132 so that the required further amount of warping of bimetal strip 78 to actuate the right-hand switch blade may be varied by adjustment screw 132. Inasmuch as it requires time to heat the bimetal strip sufficiently to effect the further warping thereof necessary to actuate the right-hand switch blade after the left-hand blade has been actuated, a time interval between actuation of the left and right-hand switch blades to a closed position occurs. This provision permits connecting a sectionalized, electrical load into a circuit so as to preclude light dimming, the rattling or dropping out of electromagnetic relays, or other objectionable malfunctioning of appliances in a circuit due to current inrush when the total load is instantly applied.

When the circuit connecting the resistance heater winding 76 across the power source is broken, as by the opening of a thermostat therein, the bimetal strip 78 cools, returning to its normal ambient temperature shape. As this occurs, the energy stored in the resilient switch blades 112 moves the actuator 42 toward the left and the switch blades return with a snap action to the open contact positions shown in FIG. 2.

We claim:

1. In a sequencing relay, a plurality of snap acting switches each biased in an open position, a bimetal actuator including an electrical resistance heater, a motion transmission member operatively connected to said actuator and operative to successively actuate said switches to a closed position as said bimetal actuator is heated, and means carried by said motion transmission member forming an independently adjustable operative connection between each of said switches and said bimetal actuator whereby the time intervals between successive actuation of said switches may be adjusted under operating conditions so as to insure the provision of at least the minimum required delay.

2. A sequencing relay as claimed in claim 1 in which said snap acting switches each include a flexible switch blade, a stationary contact and a movable contact carried by said flexible blades, said flexible switch blades each having a portion thereof stressed to a nonplanar form and being moved therefrom through a planar form to an opposite nonplanar form by said actuator when it is heated, thereby to effect the snap action operation of said switches from their open position to closed position, and said switch blades being limited in

movement beyond their planar form toward an opposite nonplanar form, thereby to effect the successive self-return of said switches in reverse order from closed to open position as said actuator subsequently cools.

3. A sequencing relay as claimed in claim 1 in which said bimetal actuator comprises two strips of bimetal connected at one end and coextending to free ends in parallel spaced relationship with the high expansion side of one strip and the low expansion side of the other strip facing each other, a casing, means pivotally mounting the connected ends of said bimetal strips on said casing, abutment means on said casing adapted to be engaged by the free end of one of said bimetal strips, the free end of the other strip operatively engaging said motion transmission member, and electrical resistance means for heating one of said bimetal strips.

4. A sequencing relay as claimed in claim 2 which includes means adjustably mounting said stationary contact for variably limiting the snap acting movement of said blade portion in one direction from a planar form, and adjustable stop means for variably limiting the snap acting movement of said blade portion in an opposite direction from a planar shape.

5. A sequencing relay as claimed in claim 4 comprising a casing enclosing said switch blades, and in which said adjustable stop means comprises an eccentric member for each of said switch blades having a peripheral surface adapted to be engaged by said blades, and said eccentric members each including a shaft journaled in a bore in at least one of the walls of said casing and having an end portion accessible from the exterior of the casing for adjustably positioning the eccentric.

6. In a device of the kind described, a casing comprising two open end, boxlike members joined together in fixed relationship with their side walls abutting, a plurality of spaced parallel slots in one side wall of said casing extending transversely across the joining line of said open end, boxlike members, a flat conductive terminal fitted in each of said slots and extending interiorly and exteriorly of said casing, recesses in the end walls of said casing receiving opposite edge portions of said terminal members in close fitting relationship, a generally flat, snap acting switch blade carrying a movable contact and a cooperating stationary contact connected to the interiorly extending portions of alternate terminal members, a bimetal actuator in said casing at one end of the row of terminal members, and an elongated motion transmission member operatively connected to said actuator and successively operatively engaging each of said switch blades when moved in one direction.

7. A device as claimed in claim 6 in which said bimetal actuator comprises two strips of bimetal connected at one end and coextending to free ends in parallel spaced relationship with the high expansion side of one strip and the low expansion side of the other strip facing each other, in which said bimetal strips are joined together flatwise and are connected flatwise to a member having a flat central portion and circularly formed end portions, which end portions are journaled in bores in the end walls of said casing.

8. A device as claimed in claim 6 which includes a guideway formed as a recess in a sidewall opposite to said one sidewall of said casing, and said guideway slidably receiving said elongated transmission member.

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