Oct. 26, 1937. J. EATON 2,097,319

SAFETY CONTROL MECHANISM

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Fig. 2.

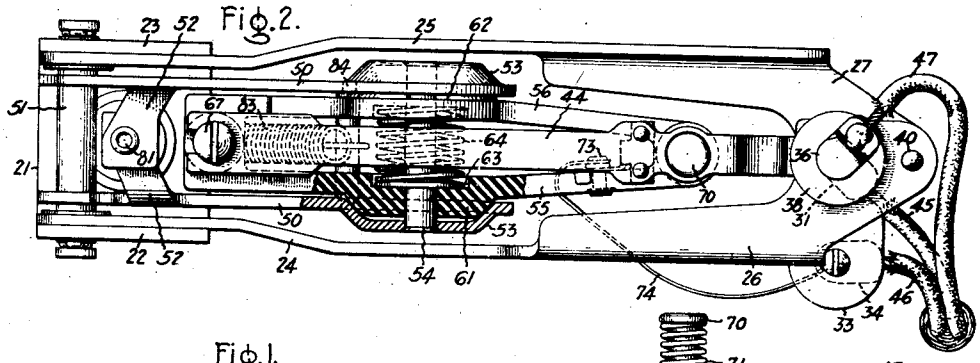


Fig. 1.

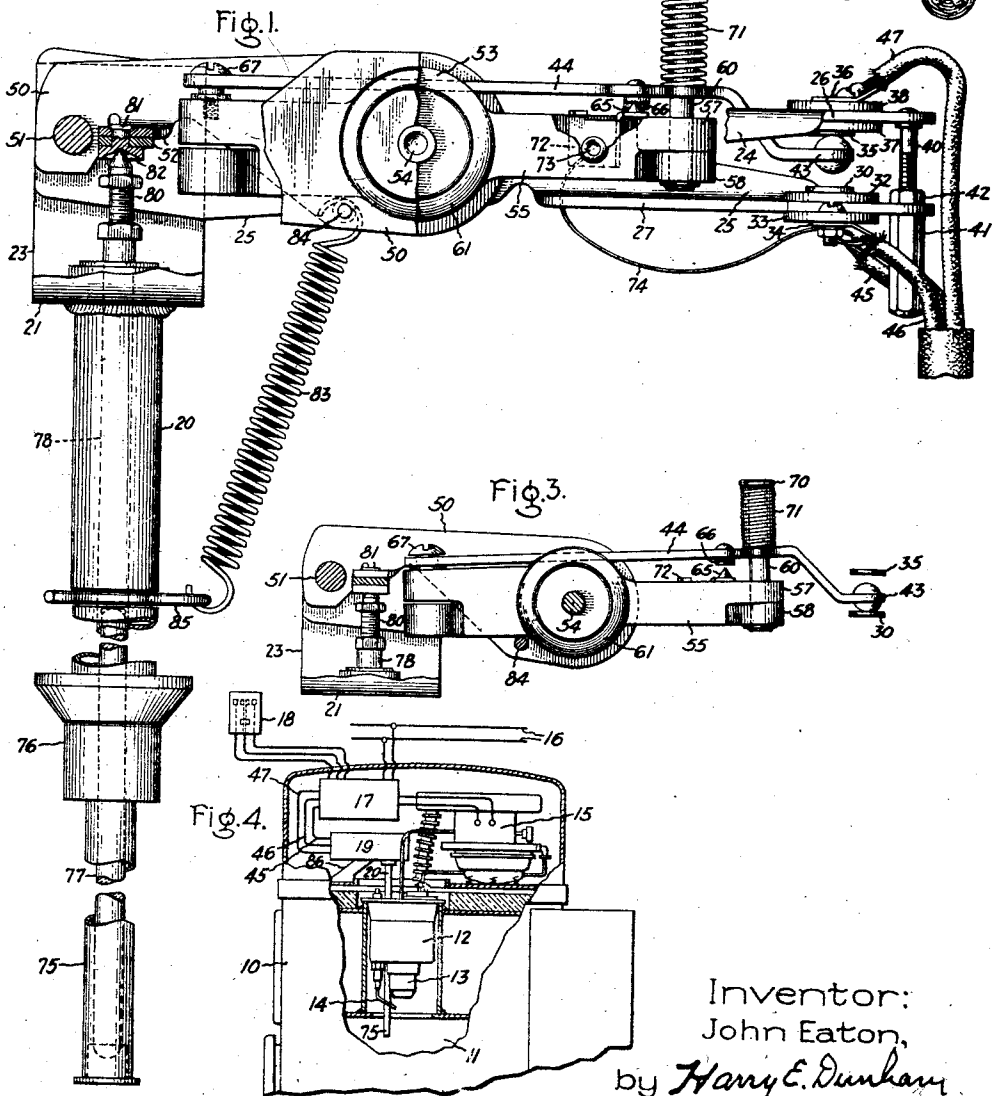


Fig. 3.

Fig. 4.

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SAFETY CONTROL MECHANISM

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Application May 21, 1935, Serial No. 22,535

12 Claims. (Cl. 200—137)

My invention relates to safety control mechanism and has for an important object the provision of improvements for insuring safe operation of electric circuit controlling mechanism, particularly of the thermal responsive type although not necessarily limited thereto.

Details of the construction and operation of one embodiment of my invention as incorporated in a flame responsive mechanism for an electrically operated fluid fuel burner apparatus are herein described in full, clear, concise and exact terms. It is to be understood, however, that my invention is not limited to the details of the construction and application of the specific mechanism herein illustrated and described since such details are set forth only for the purpose of insuring a thorough understanding of the principles underlying the invention in order that one skilled in the art may perceive other applications to which the improved mechanism is suited and may properly adapt the mechanism to various conditions of operation.

A specific object of my invention is the provision of improvements in certain aspects of the safety switch mechanism disclosed and claimed in the copending application of John G. Wemple, Serial No. 5,623, filed February 8, 1935, which application is assigned to the assignee of the present invention.

Other objects of my invention will become evident from the following description taken in conjunction with the accompanying drawing in which Fig. 1 shows the construction of a thermal responsive electric circuit controlling device incorporating my invention; Fig. 2 is an end view of the device illustrated in Fig. 1 and shows more in detail the construction of my improved friction clutch; Fig. 3 is a detailed view of certain features of the device of Fig. 1, and Fig. 4 is a diagrammatic illustration of the manner of incorporating my invention in the circuit controlling mechanism of an electrically operated fluid fuel burner apparatus.

Referring to Fig. 4, numeral 10 designates a vertical type boiler furnace having a combustion chamber 11 in the top of which is an opening for the seating of a burner head unit 12 provided with a fuel and air nozzle 13 and ignition electrodes 14. Fuel atomizing air and primary combustion air are supplied under proper pressures to the nozzle 13 by a combined blower compressor unit 15 which is energized from the electric supply circuit 16 through the automatic control apparatus represented at 17. 18 designates a room thermostat for initiating operation of the control apparatus. Details of the structure and arrangement of the elements of the burner and control apparatus above referred to may be had by reference to the following copending applications: H. S. Woodruff, Serial No. 676,651, filed June 20, 1933, for the boiler furnace 10; W. O. Lum and J. Eaton, Serial No. 691,320, filed September 28, 1933, for the burner head 12; W. O. Lum, Serial No. 553,119, filed July 25, 1931, and Serial No. 737,063, filed July 26, 1934, for the blower compressor unit 15; John Eaton, Serial No. 735,103, filed July 14, 1934, for the control apparatus 17, and W. N. Mischler, Serial No. 715,631, filed March 15, 1934, for the room thermostat 18, all of which above enumerated applications are assigned to the assignee of the present invention. A sufficient description of the operation of the burner and control apparatus above identified will be given hereinafter for a proper understanding of the present invention. It is to be understood, however, that the present invention is not limited by the details of the specific apparatus herein illustrated since such details are included herein only for the purpose of making clear the construction, application and advantages of my improved safety mechanism.

A thermal responsive control switch mechanism embodying my present invention is indicated at 19 and the details thereof are shown in Figs. 1 and 2. The supporting framework for the mechanism comprises a hollow tubular member 20 having mounted at the top thereof a U-shaped member 21 with legs 22 and 23 upon which are rigidly mounted side arms 24 and 25, respectively, which side arms extend outwardly from the legs of the U-shaped member at approximately right angles to the tubular member. The side arms are in spaced apart horizontally opposed relation to each other and the upper portion of side arm 24 is bent inwardly to provide a flange 26 while the lower portion of the side arm 25 is bent inwardly to provide a flange 27.

On the flanges 26 and 27, which are in spaced apart vertically opposed relation to each other, are provided the main circuit controlling means, the function of which will be pointed out hereinafter. An electric contact 30 is mounted on the lower flange 27 and has a connection terminal 31 in conductive relation therewith, the contact and the terminal being insulated from the flange upon which they are mounted by means of insulation washer 32 and insulation plate 33. A second connection terminal is indicated by the nu-

meral 34 and is mounted on the plate 33 in spaced relation to the terminal 31. A second contact 35 is mounted on flange 26 and has a connection terminal 36 in conductive relation therewith, these last two elements being insulated from the flange 26 by means of insulation washers 37 and 38. Spacing between contacts 30 and 35 is adjusted by means of screw 40 which is rigidly mounted on the flange 26 and extends through an opening in the flange 27 with the outer end thereof provided with an adjusting nut 41. The desired spacing is fixedly maintained by means of lock nut 42.

A movable contact element 43 mounted upon contact bar 44 is arranged for movement between the fixed contacts 30 and 35 which serve to limit the movement of the contact element in each direction. Numerals 45, 46 and 47 designate electric conductors which are fastened to terminals 31, 34 and 36 respectively and serve as means for connecting the main circuit controlling contacts 30, 43 and 35 respectively in circuit with the control apparatus 17.

Fig. 2 illustrates in detail the construction of the switch arm employed for operating the contact element 43 between the fixed contacts 30 and 35. The switch arm is made up of two sections which are relatively movable with respect to each other. One of the sections comprises a pair of lever arms 50 mounted for rotation about a pivot pin 51 which is supported by and extends between the legs 22 and 23 of the U-shaped member 21. The lever arms extend outwardly from the pivot in opposed side by side relation to each other and are rigidly braced apart by means of flanges 52 which extend inwardly from the lever arms and are joined together intermediate the arms. Inwardly facing cup-shaped recesses 53 are provided on the free ends of the lever arms and in opposing relation to each other. It is preferable though not necessary that these recesses be substantially conical in form. Extending between the lever arms and mounted thereon coaxially of the recesses 53 is a pivot pin 54 which in addition to the functions to be related hereinafter, has the function of aiding in bracing the free ends of the lever arms in rigid spaced apart relation.

The second section of the switch arm comprises a pair of members 55 and 56 constructed of molded insulation material and having flat extensions 57 and 58 on the respective ends thereof, which extensions are joined by means of a pivot pin 60 extending therethrough and fastened securely to the extension 58. This construction provides for rotation of the members 55 and 56 about the pin 60 into side by side relation with each other. At points on the members 55 and 56 equally remote from the pin 60 are outwardly facing spherical shaped bosses 61 and 62 which are designed to fit into the inwardly facing recesses 53 of lever arms 50. Bosses 61 and 62 are centrally drilled in order that the members 55 and 56 may be pivotally mounted upon the pin 54 extending between the lever arms 50. The inner faces of the members 55 and 56 are provided with recesses 63 to receive the ends of compression spring 64 which surrounds the pin 54. The ends of the members 55 and 56 remote from their pivotal junction are not joined so that spring 64 is effective to force the members apart and thereby to force the outer bearing surfaces of the bosses 61 and 62 into intimate frictional engagement with the inner bearing surfaces of the recesses 53.

As a result of the improved switch arm construction described in the immediately preceding paragraphs, there is secured a high degree of structural rigidity with improved uniformity of action of the yieldable connection between the sections of the switch arm. The braced double arm construction of the first section prevents side play or movement of that section in any direction other than in planes perpendicular to the pivot 51, while the two-member construction of the second section and the manner of joining the same to the first section insures against related movement between the sections in any direction other than in planes perpendicular to the pivot 54. Furthermore, the pressure of the spring 64 required to maintain proper relation between the two sections of the arm is less than that which would be required if each section of the arm combined only a single member, and, therefore, greater uniformity and smoothness of action of the friction clutch connection is assured with less danger of sticking due to excessive temperatures or the presence of dirt between the bearing surfaces of the clutch.

On top of the member 55 adjacent the extension end 57 thereof is provided a metallic knife-edge pivot 65 to serve as a mounting for the contact arm 44 which is provided with a bearing seat 66 for engagement with the knife-edge pivot. The free end of the member 55 is provided with a stop screw 67 having its head sufficiently spaced from the member 55 to provide for a limited rotation of the arm 44 relative to the member 55 about the pivot 65. Bar 44 has an opening on the opposite side of the pivot 65 from the stop screw 67 for the passage therethrough of an extended portion of the pin 60 which joins the members 55 and 56 together. This pin 60 is provided at its outer end with a head 70 against which abuts one end of a compression spring 71 mounted on the pin with the other end thereof pressing against bar 44 and normally operative to rotate the bar about the pivot 65 to force the free end of the bar into engagement with the stop screw 67.

Knife-edge pivot 65 is provided with a metallic mounting plate 72 having an electric connection terminal 73 to which one end of a flexible lead 74 is connected. The other end of lead 74 is fastened to terminal 34. It will thus be seen that pivot 65 and seat 66 serve as auxiliary contacts for opening and closing the circuit to contact element 43 from electric conductor 46, the circuit also including contact bar 44, plate 72, terminal 73, flexible lead 74 and terminal 34.

In the embodiment of my invention herein illustrated the operating means for the improved switching mechanism comprises a thermal responsive device the details of which are shown for purposes of illustration only since it will be evident to one skilled in the art that the switching mechanism is adapted for use with other forms of operating means with equal facility and advantages. The thermal responsive device illustrated comprises a hollow tube 75 of some material having a high coefficient of expansion, such as nichrome, which is joined in any suitable manner, such as by means of a screw connection diagrammatically illustrated at 76, to the lower end of the tube 20 which forms part of the supporting framework for the switching mechanism. Within the tube 75 is disposed a rod of substantially non-expansible material, such as quartz, which has one end in abutting engagement with the closed end of the tube 75.

Within the hollow tube 20 is a thrust rod 78 having one end in abutting engagement with the free end of the rod 77 and having on its other end an adjustable thrust point 80. The lower end of the element 81 which serves to join the bracing flanges 52 of the lever arms 50 is provided with a bearing seat 82 for the accommodation of the thrust point.

Numeral 83 designates a tension spring having one end fastened to a pin 84 which extends between the two lever arms 50. The other end of the tension spring is secured to a clip 85 mounted on the supporting tube 20 of the framework. This tension spring acts as a biasing means tending at all times to rotate the lever arms 50 in a clockwise direction, as viewed in Fig. 1, in opposition to the force exerted by the thrust point 80 against the seat 82.

The supporting framework of the switching mechanism is mounted in any suitable manner, as by means of bracket 86 diagrammatically illustrated in Fig. 4, so that supporting tube 20 extends vertically downward with the heat expansible casing 75 in position to be subjected to the heat of combustion of the fuel discharged from nozzle 13.

In operation, the control apparatus 17 is normally effective, when the burner apparatus is not in operation, to establish proper starting connections preparatory to initiation of operation of the burner apparatus as described in detail in my previously referred to application, Serial No. 735,103. Under these conditions, there being no flame within the combustion chamber of the furnace, the casing 75 of the thermal responsive device is in its contracted state causing the quartz rod 77 and the thrust rod 78 to be thrust upwardly so that the thrust point 80 is forced against the bearing seat 82 thereby tending to produce rotation of the lever arms 50 in a counter-clockwise direction, as viewed in Fig. 1. Consequently, bar 44 is forced upwardly so that contact element 43 is maintained in abutting engagement with stationary "cold" contact 35, and the bearing seat 66 of the bar is maintained in engagement with the knife-edge pivot 65 so that the bar is rotated in a clockwise direction until the free end thereof engages the head of stop screw 67. Under these conditions the circuit is closed from control apparatus 17 through conductor 47, terminal 36, contact 35, contact element 43, bar 44, bearing seat 66, knife-edge pivot 65, plate 72, terminal 73, flexible lead 74, terminal 34 and conductor 46 back to the control apparatus 17.

In response to a call for heat by the thermostat 18, control apparatus 17 is energized from supply circuit 16 and functions, as set forth in my above identified copending application, to effect starting up of the blower compressor 15 and energization of the electrodes 14 whereby fuel and air are supplied to the nozzle 13 of the burner head 12 and ignited to produce flame in the combustion chamber 11 of the furnace 10. Upon initiation of flame in the combustion chamber, the casing 75 of the thermal responsive device expands and the force exerted by the quartz rod 77 and thrust rod 78 in opposition to the action of the biasing spring 83 is decreased in accordance with increase in the temperature of combustion. Consequently, spring 83 becomes effective to produce rotation of lever arms 50 in a clockwise direction, as viewed in Fig. 1, about pivot pin 51. Members 55 and 56 also rotate in a clockwise direction, as a unit with lever arms 50, since relative movement between the two sections of the switch arm is prevented by the frictional engagement of the clutch connection bearing surfaces. Contact bar 44 rotates in a clockwise direction as a unit with member 55, the action of spring 71 being effective to maintain the auxiliary contacts 65 and 66 together and the end of the bar 44 in engagement with the head of the stop screw 67.

My improved switching mechanism can be adjusted easily by one skilled in the art so that a minimum of increase in temperature in the combustion chamber is effective to produce sufficient clockwise rotation of the switch arm to move contact element 43 from abutting engagement with the fixed "cold" contact 35 into abutting engagement with the fixed "hot" contact 30, thereby completing the electric circuit from control apparatus 17 through conductor 45, terminal 31, contact 30, contact element 43, bar 44, auxiliary contacts 65 and 66, plate 72, terminal 73, flexible lead 74, terminal 34 and conductor 46 back to control apparatus 17 to establish proper running connections for continuation of the operation of the fuel burner apparatus as set forth in my previously referred to copending application.

Initial engagement of contact element 43 and contact 30 is followed by a slight wiping action therebetween as the two sections of the switch arm continue to rotate in a clockwise direction as a unit and spring 71 is slightly compressed to permit rotation of contact bar 44 in a counter-clockwise direction about the knife-edge pivot 65 so that the free end of the contact bar is moved from engagement with the head of the stop screw 67 into engagement with the top of member 55.

With normal friction between the bearing surfaces of the clutch connection, continued heating of the tube 75 of the thermal responsive device and consequent lowering of the thrust point 80 results in continued rotation of the lever arms 50 in a clockwise direction about the pin 51 under the influence of tension spring 83. The forces exerted by the springs 64 and 71 are such with relation to each other that, under normal operating conditions, the spring 71 maintains the auxiliary contacts 65 and 66 in engagement after engagement of contact element 43 with contact 30, and the friction clutch connection between the two sections of the switch arm yields to permit relative movement between the two sections. In other words, the switch arm in effect breaks in the middle and the left-hand section thereof comprising lever arms 50 continues to rotate in a clockwise direction while the right-hand section thereof, comprising members 55 and 56, is forced to rotate in a counter-clockwise direction, with respect to the left-hand section, about the pin 54.

Upon cessation of combustion in the chamber 11 of the furnace due to shutting down of the burner apparatus in response to satisfaction of the thermostat 18, the casing 75 of the thermal responsive device contracts and the force exerted by the thrust point 80 to rotate the lever arms 50 in a counter-clockwise direction, in opposition to the force exerted by the spring 83, increases substantially inversely in proportion to the decrease in temperature in the combustion chamber. In operation the switching mechanism is so adjusted that a predetermined small temperature decrease results in sufficient counter-clockwise rotation of the lever arms 50 to effect move-

ment of the contact element 43 from abutting engagement with contact 30 into abutting engagement with contact 35, thereby reestablishing the starting connections for the fuel burner apparatus. During the reverse movement of the lever arms 50, that is movement of the arms in the counter-clockwise direction, the two sections of the switch arm at first are constrained to move as a unit by means of the friction clutch connection therebetween until the contact element 43 is prevented from further movement in the counter-clockwise direction by the fixed contact 35. Thereafter upon continued decrease in temperature within the combustion chamber with consequent continued rotation of the lever arms 50 in the counter-clockwise direction, the friction clutch connection yields to afford relative movement between the two sections and thereby contact element 43 is maintained in engagement with contact 35. Thus it will be seen that under normal operating conditions the switching mechanism provides for operation of the main circuit controlling contact element 43 from engagement with one of the fixed contacts into engagement with the other of the fixed contacts upon initiation of a change in temperature in the combustion chamber in either direction following a change in temperature in the opposite direction, and also provides for maintaining the contact element 43 in engagement with either of the fixed contacts upon continuation of the temperature change which initially produced engagement of the contact element with the particular fixed contact. Furthermore, the pivotal mounting of the contact bar 44 on the member 55 with provision for a slight relative motion between the two results in a maximum wiping action upon engagement of contact element 43 with contact 30 and a minimum of wiping action upon engagement of contact element 43 with contact 35. This difference in wiping action is a highly advantageous feature of my improved switching mechanism since, as will be understood by one skilled in the art, it is desirable to have a more rapid disengagement of the "cold" contacts upon initiation of an increase in temperature than is the case with the "hot" contacts upon initiation of a decrease in temperature.

One of the important safety features of my improved switching mechanism resides in the fact that if, at any time during rotation of the lever arms 50 in the clockwise direction after engagement between contact element 43 and contact 30, the friction clutch connection between the two sections of the switch arm fails to permit relative movement between the two sections as it should normally do under such circumstances, provision is made for completely shutting down the fuel burner apparatus. Such failure of the clutch connections to permit the relative movement may result either from excessive temperature of the elements comprising the clutch connections or from fouling or corrosion of the bearing surfaces of the clutch. Such sticking of the clutch connections at a time when they should yield to permit relative movement between the sections of the switch arm would be detrimental and even dangerous. In my improved mechanism, such sticking of the clutch connections upon continued movement of the lever arms 50 in a clockwise direction due to heating of the nichrome tube 75 or other reasons, causes the two sections of the switch arm to move as a unit while contact element 43 is restrained from further movement in the clockwise direction by the fixed contact 30. Under these conditions the compression spring 71 yields to permit disengagement of the auxiliary contacts 65 and 66, thus interrupting the electric circuit to the main circuit controlling contact element 43 to effect deenergization of the control circuit for the fuel burner apparatus.

A similar disengagement of the auxiliary contacts 65 and 66 occurs in case of continuation of the clockwise movement of the lever arms 50 past a predetermined limit. Such excessive movement of the lever arms 50 may result from either an excessive expansion of the casing 75 or breakage of a portion of the thermal responsive device, such as the casing 75 or the quartz rod 77, which would produce unopposed clockwise movement of the lever arms under the influence of spring 83. The operation of the mechanism under such conditions is illustrated in Fig. 3. If, after engagement of contact element 43 with contact 30, the lever arms 50 continue to rotate in a clockwise direction past a predetermined limit while the clutch connections permit relative movement between the two sections of the switch arm, the free ends of the members 55 and 56 engage the pin 84 which extends between the two lever arms 50. This prevents further relative movement between the two sections of the switch arm and constrains members 55 and 56 to move as a unit with lever arms 50. The resultant operation is the same as that which occurs if the clutch connections stick and prevent relative movement between the two sections of the switch arm, which is that the spring 71 is compressed and the auxiliary contacts 65 and 66 are disengaged as shown in Fig. 3.

As will be evident from the foregoing discussion, proper operation of the safety mechanism depends chiefly upon the relative forces exerted by the two springs 64 and 71. Spring 71 is so selected that the force exerted thereby is sufficient to maintain engagement between auxiliary contacts 65 and 66 after engagement of contact element 43 with contact 30 so long as the clutch connections between the two sections of the switch arm function properly under the influence of spring 64 to afford relative motion between the two sections of the switch arm. On the other hand, the strength of the spring 71 should be such that it will permit disengagement of the auxiliary contacts 65 and 66 if the frictional force exerted by the clutch connections in opposition to relative motion between the sections of the switch arm exceeds a predetermined amount for any reason or if such relative movement is completely prevented as by engagement of the free ends of the members 55 and 56 with the pin 84.

From the foregoing discussion it will be seen that the improved switching mechanism of my present invention not only provides an additional check upon the operation of the fuel burner apparatus in case the temperatures of combustion produced thereby exceed predetermined limits, but provides also an improved "fail-safe" mechanism whereby the fuel burner apparatus is completely shut down in case of mechanical failure of the thermal responsive device or in case of improper functioning of the yieldable connections between the two sections of the switch arm.

The embodiment of the invention illustrated and described herein has been selected for the purpose of clearly setting forth the principles involved. It will be apparent, however, that the invention is susceptible of being modified to suit the different conditions encountered in its use

and of being adapted for other similar applications, and I therefore, aim to cover by the appended claims all the modifications within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. Safety control mechanism including in combination, control means having a pair of relatively movable control elements provided with a yielding connection therebetween for causing movement thereof as a unit to effect operation of one of said elements into and out of a given limiting control position, actuating means therefor including a member operable in opposite directions, means interconnecting said member and the other of said control elements for operating the said one control element into said limiting position upon a predetermined operation of said member in one direction and including yieldable means providing for operation of said member in said one direction in excess of said predetermined operation to effect relative movement of said control elements.

2. Safety control mechanism including in combination a member movable in opposite directions, control means having a pair of relatively movable control elements provided with a spring connection therebetween and one of said elements provided with a slip clutch connection with said member to be operated as a unit with said member and the other control element between two limiting positions of said other element upon the initial reverse movement of said member after movement thereof in either direction and having means for stopping the slip operation of said clutch connection to effect relative movement between said control elements after a limited slip operation of said clutch connection upon a predetermined reverse movement of said member.

3. Safety control mechanism including in combination a control element movable into and out of a limiting control position, actuating means therefor including a member operable in two directions, means including yieldable force transmitting means interconnecting said member and said element operative for effecting movement of said element as a unit with said member, said element being movable into said limiting position in response to a predetermined operation of said member in one direction and said yieldable force transmitting means normally being operative for affording relative movement between said element and said member upon continuation of the movement of said member in said one direction after said element reaches its limiting position, safety control means and means operative for effecting operation of said safety control means in case of cessation of such relative movement between said members and said element at any time during such continued movement of said member.

4. The combination with an electric circuit of control means therefor including a pair of movable elements, actuating means for moving one of said elements in two directions, means including yieldable force transmitting means interconnecting said elements and operative for effecting movement of the other of said elements as a unit with said one of said elements, means for limiting the movement of said other element in one direction, said yieldable force transmitting means normally being operative to afford relative movement between said elements upon continuation of the movement of said one element in said one direction after said other element reaches its limiting position, and means operative for effecting deenergization of said electric circuit in case of failure of said force transmitting means to afford such relative movement between the members at any time during such continued movement of said one element.

5. The combination with an electric circuit of controlling mechanism therefor including a member operable in two directions, a second member pivotally mounted on said first member, means providing a friction clutch connection between said members including means providing cooperating bearing surfaces on said members and resilient means for forcing said bearing surfaces into intimate engagement, said clutch connection being normally operative upon movement of said first member for effecting movement of said second member as a unit with said first member, a circuit control element mounted on said second member, means for limiting the movement of said circuit control element in one direction, said clutch connection being operative for affording relative movement between said members upon continued movement of said first member in said one direction after further movement of said element is prevented, and means operative for effecting deenergization of said electric circuit in case said clutch connection fails to afford such relative movement between said members at any time during such continued movement of said first member.

6. Electric switching mechanism including in combination a pair of contacts relatively movable into abutting engagement, actuating means including a member movable in opposite directions, a second movable member having one of said contacts mounted thereon, means including a yieldable force transmitting device interconnecting said members for producing unitary movement of said members to effect engagement of said contacts upon initial movement of said first member in one direction after movement thereof in the other direction, said device normally being operative to afford relative movement between said members upon continuation of the movement of said first member in said one direction after engagement of said contacts, a second pair of cooperating contacts, means normally operative for maintaining said second pair of contacts in engagement, and means operatively responsive to cessation of relative movement between said members at any time during said continued movement of said first member for effecting disengagement of said second pair of contacts.

7. Electric switching mechanism including in combination a pivotally mounted member, means for rotating said member in either direction about its pivotal mounting, a second member pivotally mounted on said first member, yieldable means operative for causing said second member to move as a unit with said first member, a third member pivotally mounted on said second member, yieldable means operative for causing said third member to move as a unit with said second member, a contact element mounted on said third member, a pair of contacts fixedly mounted in spaced relation for limiting the movement of said contact element in both directions, said first yieldable means being normally operative for affording relative movement between said first and second members upon continuation of the movement of said first member in either direction after movement of said contact element is prevented by one of said fixed

contacts, and a second pair of contacts mounted one on said second member and one on said third member and normally held in engagement by said second yieldable means, said second yieldable means being operative upon cessation of relative movement between said first and second members at any time during continuation of the movement of said first member in said one direction after further movement of said contact element is provided for affording relative movement between said second and third members to thereby effect disengagement of said second pair of contacts.

8. In an electric circuit controlling mechanism, the combination including circuit controlling means operable into a plurality of positions, and means including an arm movable in opposite directions for actuating said circuit controlling means, said arm including a first section having a pair of members in fixed spaced apart side by side relation, a second section comprising a pair of members joined for relative movement into side by side relation, means for pivotally joining said sections with portions of the members of said second section disposed between the members of said first section and including resilient means for forcing the members of said second section apart and into contact with the members of said first section, and means providing bearing surfaces on the outer faces of the members of said second section for frictional engagement with cooperating bearing surfaces provided on the inner faces of the members of said first section.

9. In an electric circuit controlling mechanism, the combination including circuit controlling means operable into a plurality of positions, and means including an arm movable in opposite directions for actuating said circuit controlling means, said arm including a first section having a pair of members in fixed spaced apart side by side relation with an inwardly facing substantially conical recess provided on the inner face of each of said members, said recesses being in oppositely disposed relation to each other, a second section having a pair of members joined for relative movement into side by side relation with each other and with each of the last referred to members provided with a substantially spherically shaped bearing boss at substantially the same distance from the junction between the members, and means for pivotally joining said sections with the bosses of the members of said second section engaging the recesses of the members of said first section including resilient means for forcing the members of said second section apart to effect intimate frictional engagement between the surfaces of said bosses and the surfaces of said recesses.

10. In an electric circuit controlling mechanism, the combination including circuit controlling means operable into a plurality of positions, and means including an arm movable in opposite directions for actuating said circuit controlling means, said arm including a pair of members rigidly braced in spaced apart side by side relation to each other and mounted for rotation about a common axis, a pivot shaft extending between said members at a point remote from the axis of rotation thereof, a second pair of members rotatably and slidably mounted on said pivot shaft and pivotally joined to each other at a point remote from said pivot shaft, means providing cooperating bearing surfaces on the inner faces of said first pair of members and the outer faces of said second pair of members adjacent said pivot shaft, and resilient means disposed between said second pair of members for forcing the same apart to effect intimate frictional engagement between said bearing surfaces.

11. In a safety mechanism for heating apparatus and the like, the combination including a member movable in opposite directions about a fixed pivot point, actuating means therefor, a second member pivotally mounted on said first member, yieldable force transmitting means interconnecting said members, a third member mounted upon said second member and relatively movable angularly thereto, means forming limits of movement for said third member, and means mounted on said first member for constraining the relative movement of said second member thereto upon predetermined movement of said members, whereby continued movement of said first member in a predetermined direction about its fixed pivot point by said actuating means first moves all three members as a unit about said pivot point until the third member reaches one of said limits, then moves the first two members as a unit relatively to the third, the latter moving about the said limit as a pivot, thereafter moving the first member relatively to the second and third members as a unit, the latter moving about the said limit as a pivot until the movement of the second member with respect to the first is constrained by said movement constraining means, and finally moves the first and second members as a unit about the fixed pivot point and the third about said limit as a pivot point to effect relative angular movement between the second and third members.

12. In a safety control mechanism, the combination including three members angularly movable with respect to each other, the first member mounted for movement about a fixed pivot, the second pivotally mounted on the first, and interconnected thereto through yieldable force transmitting means, and the third member mounted on the second member and adapted to move angularly thereto, actuating means adapted to act on said first member for moving all said members, means for limiting the movement of said third member after a predetermined movement in either direction and adapted to act as a pivot for said member, a first control means carried by said third member and operable upon initial reverse movement in either direction of said actuating means, and second control means operable upon a predetermined relatively angular movement between the second and third members upon continued movement of said actuating means after the latter has been actuated to one of its limiting positions.

JOHN EATON.