Feb. 20, 1934. R. W. DOEG 1,948,339

CONTROLLER

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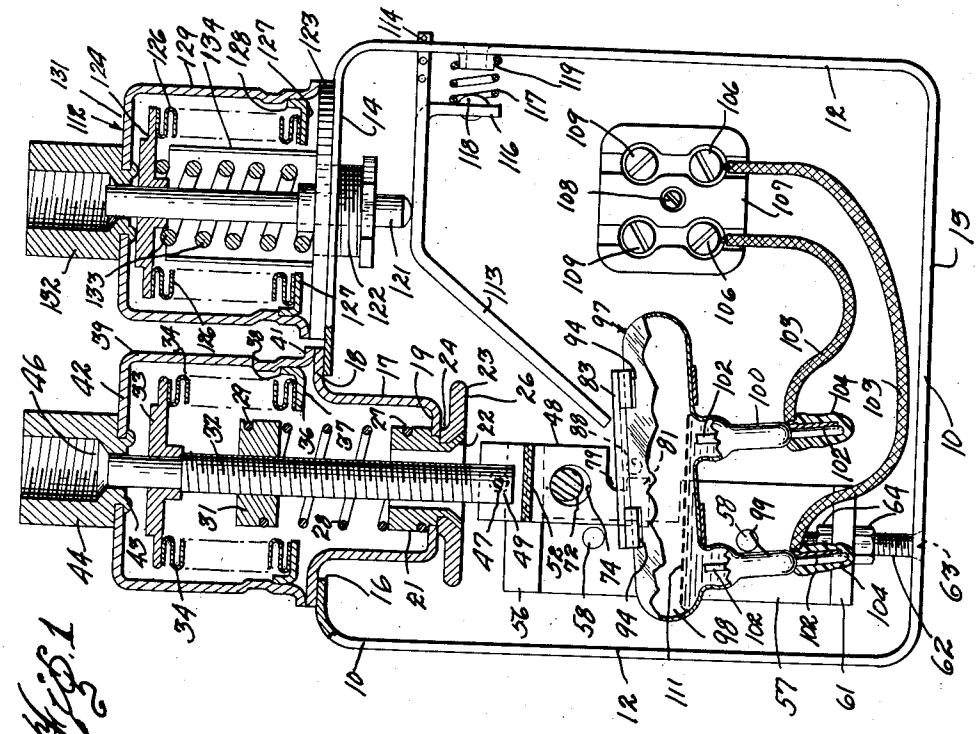


Fig. 1

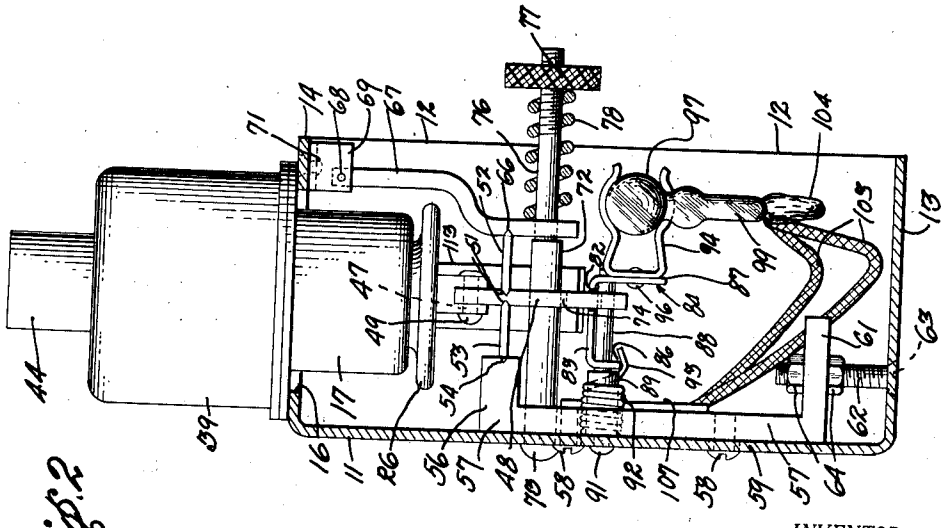


Fig. 2

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This invention relates to controllers, and has particular relation to pressure actuated electrical circuit controllers in which a mercury filled tube is employed for making and breaking a circuit between electrical conductors.

An object of the invention is to provide a structure of simplified character and design which can be manufactured at a relatively low cost by the employment of efficient manufacturing methods and machines.

Another object of the invention is to provide a controller which is capable of successful operation during long periods of time without the necessity of frequent readjustment of parts and without being rendered inoperative due to formation of electrical arcs between the terminals associated therewith.

Another object of the invention is to provide a controller which is readily adaptable for adjustment within extremely close limits in order to permit the use of the controller for any desired purpose.

Another object of the invention is to provide an electrical circuit controller capable of being employed for controlling the operation of mechanical refrigerating apparatus applicable for any use.

Prior to the invention the circuit controllers or switches employed with refrigerating apparatus or for other analogous purposes, were of a very complicated nature, and consequently were easily rendered inoperative by wear or vibration. Furtheremore, it was impossible in many instances to obtain a nice adjustment of such controllers, and consequently they were not entirely suitable for many services for which such devices were required. Switches manufactured from identical parts often could not be assembled with sufficient accuracy to render them capable of producing the same results when employed in combination with similar apparatus. When any adjustment was made, it was necessary to vary the tension or compression of a relatively large number of springs, change the length of a large number of links or levers, and in general to do a great many things of which only a few highly skilled persons were capable.

This invention is embodied in a structure consisting of any suitable pressure responsive device, as a bellows, for example, the operation of which is controlled by a single spring, that may be employed either as a resilient tension or compression member. The structure also embodies a circuit controller or switch, operable in response to movement of the bellows, and in combination with which a toggle device is employed for the purpose of increasing the normal rate of making or breaking an electrical circuit, and for controlling the maximum limits between which successive circuit making or breaking operations of the switch occur.

In addition to the aforesaid primary actuating device, a secondary actuating device operable for controlling the switch independently of the other, is provided.

For a better understanding of the invention, reference may now be had to the accompanying drawing forming a part of this specification, in which:

Figure 1 is a front elevational view of the controller in which parts of the structure are illustrated in cross section;

Figure 2 is a cross sectional view of the controller as it would be seen from the left hand side of Figure 1 with one side of the casing removed.

Referring particularly to the drawing illustrating a preferred embodiment of the invention, the controller comprises a housing 10 having a rear wall 11, side walls 12, lower wall 13 and upper wall 14. The front of the housing 12 is open as illustrated, but it may be provided with a suitable cover for the purpose of protecting the switch elements, disposed in the interior thereof, from dust or other foreign matter and from injury from falling objects, etc. The upper wall 14 of the housing is provided with a pair of openings 16 through one of which a support 17 projects. A flange portion 18 of the support, is secured in a suitable manner to the portion of the housing surrounding the opening. The lower extremity of the support is provided with an internally formed flange 19, the inner periphery of which loosely engages a circular groove or recess formed adjacent a lower edge of a collar 21. The lower extremity of the collar is provided with a flanged extension 22 which retains a disk 23 rigidly thereon. The collar 21 and disk 23 thus provide a rotatable adjusting member 26. The external surface of the collar 21 above the flange 19 is spirally grooved as indicated at 27 to receive one end of a spring 28. The spring may be rigidly secured within the groove in any suitable manner such as by soldering. The upper end of the spring 28 also is secured in any suitable manner in a spirally formed groove 29, which is formed in the exterior surface of an internally threaded ring 31. The ring is supported on a threaded rod 32, the lower end of which projects through and beyond the adjusting member 26,

while the upper end is secured rigidly in a movable head 33. One end of a bellows 34 is secured to the lower surface of the head 33 at the outer periphery thereof, while the opposite end is secured to a planular portion 36 of a flanged ring 37. A flange portion 38 of the ring, is secured to a portion of a cylindrical casing 39 adjacent the lower end of the latter, while beyond the flange 38 the casing is provided with a flange 41, which, in turn, is secured to the upper surface of the flange 18. A wall 42 formed at the upper extremity of the casing 39, is provided with an opening 43 adapted to receive a portion of a fitting 44, which is capable of connection with a conduit (not shown) communicating with any suitable source of fluid under pressure such, for example, as the low pressure side of a mechanical refrigerating apparatus. The lower end of the fitting 44 is provided with an internally formed flange 46 adapted to receive an end of the rod 32 extending beyond the head 33, thus providing a guide for the rod and bellows structure. The surface contact between the end of the rod and the flange 46 is such that fluid pressure within the fitting 44 and within the casing 39, will be of substantially an equal degree of intensity.

All of the joints between the elements associated with the casing 39 may be sealed in any suitable manner, such as by employment of solder, in order that a fluid tight chamber may be provided therein.

The lower end of the rod 32 is bifurcated as indicated at 47, in order to receive the upper end of a bar 48, and a pin 49 is employed for the purpose of providing a suitable pivotal connection therebetween. Directly below the end of the rod 32 the bar 48 is provided with an oppositely disposed pair of grooves 51 in which the adjacent sharpened ends of a pair of blades 52 and 53 are pivotally received. The opposite sharpened end of the blade 53 is received in a groove 54 formed in a laterally projecting portion 56 of a bracket 57, which bracket is secured to the rear wall 11 of the housing 10 by screws 58. The openings in the wall 11 through which the screws 58 project are somewhat larger than would be normally required, as indicated at 59, in order to permit vertical adjustment of the bracket 56 when the screws are slightly loosened. The lower end of the bracket is formed with a lug 61 through which a bolt 62, having its head 63 secured rigidly in the lower wall 13 of the housing 10, projects. When the screws 58 are loosened, the vertical position of the bracket 57 may be varied by manipulating lock nuts 64 associated with the bolt 62 and adapted to engage clampingly the opposite surfaces of the lug 61.

The opposite sharpened end of the blade 52 likewise is adapted to be received in a groove 66 formed adjacent the lower end of a bracket or arm 67. The upper end of the latter is pivoted as indicated at 68 between a pair of lugs 69 secured by a screw 71 to the upper wall 14 of the housing 10. A rod 72 projecting in a plane substantially parallel with the grooves 54 and 66 but spaced slightly therebelow, is provided with a head 73 secured rigidly in an opening formed in the back wall 11 of the housing 10. An opening 74, slightly larger than the diameter of the rod 72 and adapted to receive the latter, is provided in an intermediate portion of the bar 48. The difference between the diameter of the rod 72 and that of the opening 74 provides means for limiting the longitudinal movement of the bar 48. A threaded reduced end 76 of the rod 72 projects through an opening formed in the lower end of the bracket 67 and receives a knurled nut 77 at its outer end. A spring 78 surrounding the reduced portion 76 of the rod 72, is confined between the nut 77 and the bracket 67.

The lower end of the bar 48 is formed with a notch 79 thus providing a ledge 81 having an upper horizontally disposed surface. The ledge 81 and bar 48 are received in a notch 82 formed longitudinally of a channel member 83 constituting a portion of a switch supporting cradle 84. The ledge 81 projects beyond the extremity of the notch 82 for engagement with the lower surface of a horizontal portion of the channel member. The flanges 86 and 87 of the channel member are provided with transversely aligned openings spaced a short distance beyond the end of the ledge 81, and are adapted to receive a pin 88 on which the cradle 84 is rotatably mounted. The pin 88 is enlarged as indicated at 89 beyond the flange 86 of the channel 83 and is secured rigidly to the rear wall 11 of the housing 10 by a screw 91. One end of a spring 92 surrounding the enlarged portion 89 of the pin 88 is secured rigidly to the rear wall 11 of the housing 10, while the opposite end thereof is provided with a catch, designated 93, and adapted to engage the lower edge of the flange 86 at the end thereof remote from the notch 82.

It will be apparent that the spring tends to rotate the cradle 84 in such manner that the channel member 83 will be retained in engagement with the ledge 81.

The other flange 87 of the channel member 83 is provided with a spaced pair of resilient clamping members 94 secured rigidly thereto by rivets 96. A sealed glass tube 97, constituting an electrical circuit make and break element or switch, is positioned between and supported by the clamping members 94. Adjacent one end 98 of the tube 97 and projecting from the lower surface thereof is a spaced pair of wells 99 and 100 in which terminals 102, projecting from the interior to the exterior of the wells, are sealed. The exposed ends of a pair of insulated conductors 103 are soldered to the ends of the terminals 102 externally of the wells 99 and 100, and the splice is suitably protected by the application of sealing wax 104 or by other suitable insulating means. The opposite ends of the conductors 103 are connected by screws 106 to appropriate terminals of a terminal block 107, secured rigidly inside of the rear wall 11 of the housing 10 by a screw 108. One side of a power line, (not shown) in circuit with an electrical apparatus to be controlled, such as a motor, for example, may be connected in series with outlet terminals 109 associated with the terminal block 107.

The interior of the tube 97 is partially filled with a quantity of mercury 111, or other fluid suitable for conducting electrical energy, which is adapted to bridge the space between the contacts 102 when the end 98 of the tube 97 is sufficiently lowered, and to break such circuit between the terminals 102 when the end 98 is elevated sufficiently to permit the mercury 111 to accumulate in the opposite end of the tube.

The operation of the switch also may be controlled by a secondary controlling device 112 having a bar 113 which is adapted to be depressed under predetermined conditions to engage the end of the cradle 84 opposite the ledge 81 and to rotate the tube 97 in a clockwise direction, thus permitting the mercury to flow from the end 98 of the tube, in which event the electrical circuit

between the terminals 102 is broken. This operation does not interfere with the primary switch operating mechanism because the cradle 84 is only resiliently retained by the spring 92 on the ledge 81 and thus can be separated therefrom when any positive force is applied in opposition to the spring.

The opposite end of the bar 113 is pivotally secured by a pin 114 in an opening formed adjacent the upper end of the side wall 12. The bar 113 is bifurcated to provide a laterally projecting lug 116 disposed a short distance from the side wall 12, and a compressed spring 117 is retained between a projecting portion 118 of the lug 116, and a projection 119 extending internally of the side wall 12.

An intermediate portion of the bar 113 is engaged by a vertically disposed rod 121, which is slidably mounted in the interior of an adjusting nut 122 disposed in a threaded opening formed in the interior of an annular plate 123. The plate is secured rigidly on the upper wall 14 of the housing 10 above the previously mentioned opening formed therein. The upper end of the rod 122 is rigidly secured in an opening formed in the central portion of a head 124 to the lower outer surface of which one end of an expansible bellows 126 is attached. The lower end of the bellows is secured to an annular ring 127 having a flange 128 in turn rigidly secured adjacent the lower end of a cylindrical casing 129. The lower extremity of the casing below the portion to which the flange 128 is attached, is secured on the upper surface of the plate 123.

The upper end of the casing 129 is partially closed by a wall 131 to which a fitting 132, communicating with the interior of the casing, is attached. This fitting may be connected to a conduit communicating with the high side of a refrigerating apparatus or to any other source of fluid pressure which is likely to respond to any abnormal condition of an operating apparatus. The opening through which the fitting 132 communicates with the interior of the casing 129 is adapted slidably to receive a portion of the rod 121 projecting beyond the head 124, thus providing a suitable guide for the bellows structure. A spring 133 is compressed between the lower surface of the head and the nut 122. A tubular stop 134 supported on the upper surface of the plate 123 is adapted to limit the downward movement of the head 124.

In the operation of the structure embodying this invention, assuming, for example, that the fitting 44 is attached to a conduit communicating with the low side of a refrigerating system or with a thermostatic column of fluid responding to temperature variations in some part of the refrigerating apparatus, the pressure in the interior of the casing 39 will vary as a function of the temperature conditions within the refrigerator. Assuming the circuit to be closed, as illustrated by Figure 1, the refrigerating apparatus will be extracting heat from the interior of the refrigerator in response to the operation of a motor connected in series with the conductors 103. As the temperature of the interior of the refrigerator is reduced, the pressure in the interior of the casing 39, transmitted through the rod 32 to the stop or rod 72, is correspondingly reduced until it is possible for the spring to move the top of the opening 74 away from the rod 72 and to expand the bellows 32. At such time the grooves 51 in which the adjacent edges of the blades 52 and 53 are supported, will tend to move upwardly and out of alignment with the grooves 54 and 66. As soon as this condition prevails, the compressed spring 78 will act through the blade 52 and 53 upon the bar 48 with a progressively increasing force which tends to increase the rate of movement of the bar 48 over what it would be if the movement of the bar were controlled entirely by the spring 28. This upward movement of the bar 48 carrying the ledge 81 upwardly, tends to rotate the carrier 84 and the tube 97 upon the pin 88, thus elevating the end 98 of the tube, until the mercury 111 flows to the opposite end, and breaking the electrical circuit between the terminals 102.

Since the electrical circuit has been broken through the motor of the refrigerating apparatus, the temperature in the refrigerator consequently will be gradually increased and the pressure of the fluid in the casing 39 will be increased in proportion thereto. It is to be noted, however, that a greater pressure will be required to cause a downward movement of the bar 48 than was required to cause the movement previously described, for the reason that the downward movement is not only resisted by the spring 28 but it is also resisted by a vertical component of force of the spring 78 which is applied through the blades 52 and 53. When, however, such pressure prevails within the casing 39, a downward movement of the bar at a progressively increasing rate will follow by reason of the fact that the vertical component of the spring 78 becomes smaller as the blades 52 and 53 approach alignment. Since the spring 92 causes the cradle 84 to follow the movement of the ledge 81, the tube 97 will be rotated in a counter clockwise direction at a progressively increasing rate, thus dashing the mercury 111 into the end 98 of the tube and closing the circuit between the terminals 102. The vertical component of the spring 78 having become zero as soon as the blades 52 and 53 became aligned, the bar 48 will press upon the rod 72 with a force equal in intensity to the aforesaid vertical component, until such time as the pressure in the casing 39 has been reduced sufficiently to permit the spring 28 alone to initiate another cycle of operations of the switch.

This difference in the pressures required to cause movement of the bar 48 in opposite directions or the making and breaking of the circuit in the switch, is herein referred to as the switch differential. Such differential can be varied by manipulation of the nut 77 to decrease or increase the vertical component of force exerted by the spring 78 through the blades 52 and 53 on the bar 48. So sensitive is the mechanism that this differential may be decreased to a very small value by decreasing the compression of the spring or may be increased to a very large value by increasing the compression of the spring.

If the position of the opening 74 is such that the blades 52 and 53 are substantially in alignment at the lower extremity of movement of the bar 48, any variation in the degree of compression of the spring 78 will not affect the circuit breaking operation of the switch for the reason that the vertical component of the spring at that time is substantially zero. However, the pressure at which the circuit will be closed through the switch will be varied by a compression in the spring 78 by reason of the fact that the vertical component of the spring when the blades are deflected above the plane of the notches 54 and 56, is a positive value and hence it can be varied. If it is desired to vary the pressure at which the circuit is broken

rather than at which it is made, it is necessary only to change the position of the opening 74 in the bar 48 in such manner that the blades 52 and 53 will be aligned at one limiting position and deflected below the plane of the notches 54 and 56 in the other. If it is desired to vary the pressures at which the circuit is both opened and closed, the opening 74 in the bar 48 may be so located that the opposite limiting positions of the blades 52 and 53 will be at equal angles on opposite sides of the plane of the notches 54 and 56.

The controller may be made to operate either below or above atmospheric pressure by suitable manipulation of the adjusting member 26. Since the spring 28 is rigidly secured at one end to the adjusting member and at the other to a threaded ring 31, any rotation of the adjusting member will cause the ring 31 to move longitudinally along the threaded rod 32 thus either increasing or decreasing the tension or compression within the spring 28.

When operating the switch in response to the pressure of fluid above atmospheric pressure, the spring 28 acts as a compression member, while when operating at pressures below atmosphere, it serves as a tension member.

Assuming the fitting 132 to be connected to the high side of a refrigerating apparatus or to any source of fluid under pressure which will respond to unusual conditions of operation, when the fluid pressure in the casing 129 is increased beyond a safe value, the bellows 126 will actuate the bar 113 downwardly to positively retain the cradle 84 in such positiion that contact can not be made by the mercury 111 in the tube 97 between the terminals 102. The auxiliary mechanism may be set by manipulating the nut 122 to increase or decrease the compression of the spring 133, thus providing for permanently discontinuing the operation of any apparatus whenever a predetermined abnormal fluid pressure prevails in the casing 129.

It is to be understood that a great many varieties of equivalent elements may be employed in practising the invention, and that the application of the invention is limited neither to pressure actuated controllers nor to circuit making and breaking devices.

Such structure as may be considered within the spirit of the invention are embraced, approximately, by the scope of the appended claims.

I claim:—

1. A controller comprising a bar having a pair of oppositely disposed notches formed therein, a pair of blades having adjacent end portions pivotally supported in the notches, a bracket for rigidly supporting the opposite end of one of the blade members, a rod secured rigidly relative to the bracket and projecting through an opening formed transversely in the bar, a bracket for pivotally supporting the opposite end of the other blade, one end of said bracket being pivotally mounted in a frame and the other provided with an opening through which an outer end portion of the aforesaid rod projects, a spring surrounding the end of the rod beyond the pivotally mounted bracket and having one end abutting the latter, and adjustably mounted nut on the outer end of the rod engaging the opposite end of the spring, and means associated with one end of the bar for moving the latter longitudinally.

2. A circuit controller comprising a switch adapted to make and break an electrical circuit between a pair of conductors associated therewith, a bar for actuating the switch having an opening formed transversely thereof, a bellows responsive to fluid pressures for actuating the bar and a rod having a cross sectional dimension smaller than the corresponding dimension of the aforesaid opening for limiting movement of the bar.

3. A fluid pressure actuated switch comprising a pressure responsive member operatively associated with a source of fluid under pressure, a switch, a link connecting said member and said switch, a pair of blades having their adjacent ends engaging the link, a fixed bracket supporting the opposite end of one blade, and a pivoted bracket supporting the opposite end of the other blade, a rod extending through the pivoted bracket and having an adjustable member on its protruding end, and a spring interposed between the adjustable member and the pivoted bracket.

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