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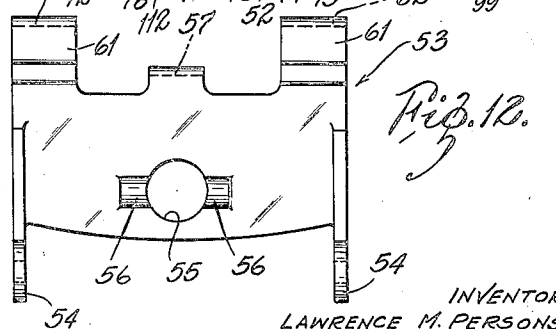
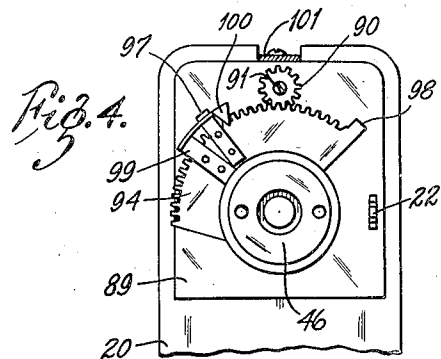
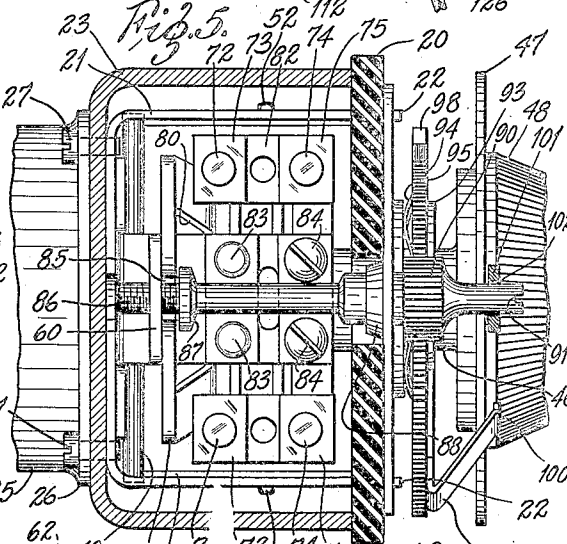
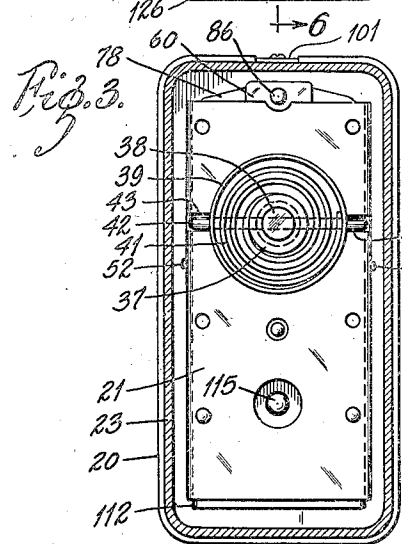
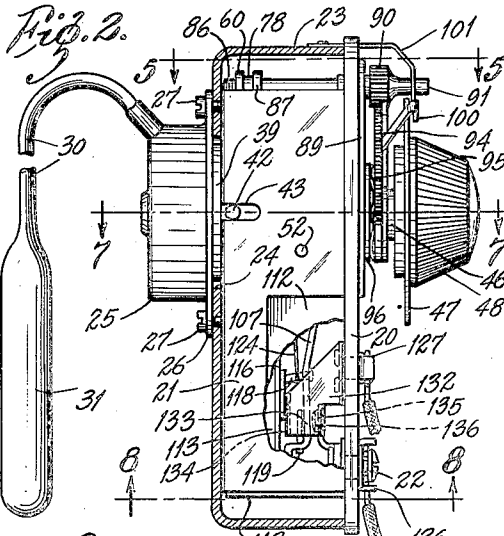
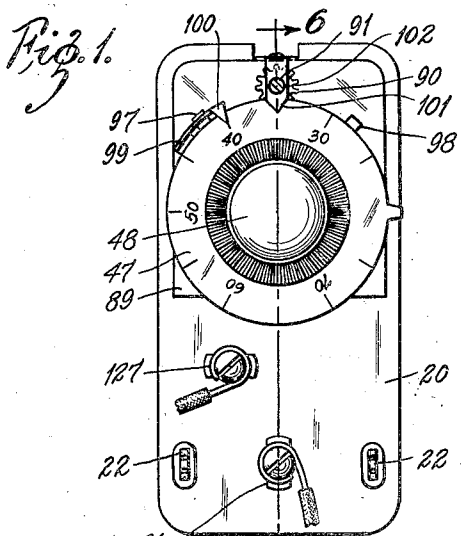
L. M. PERSONS

2,291,502

ELECTRIC SWITCH

Filed April 20, 1938

2 Sheets-Sheet 1



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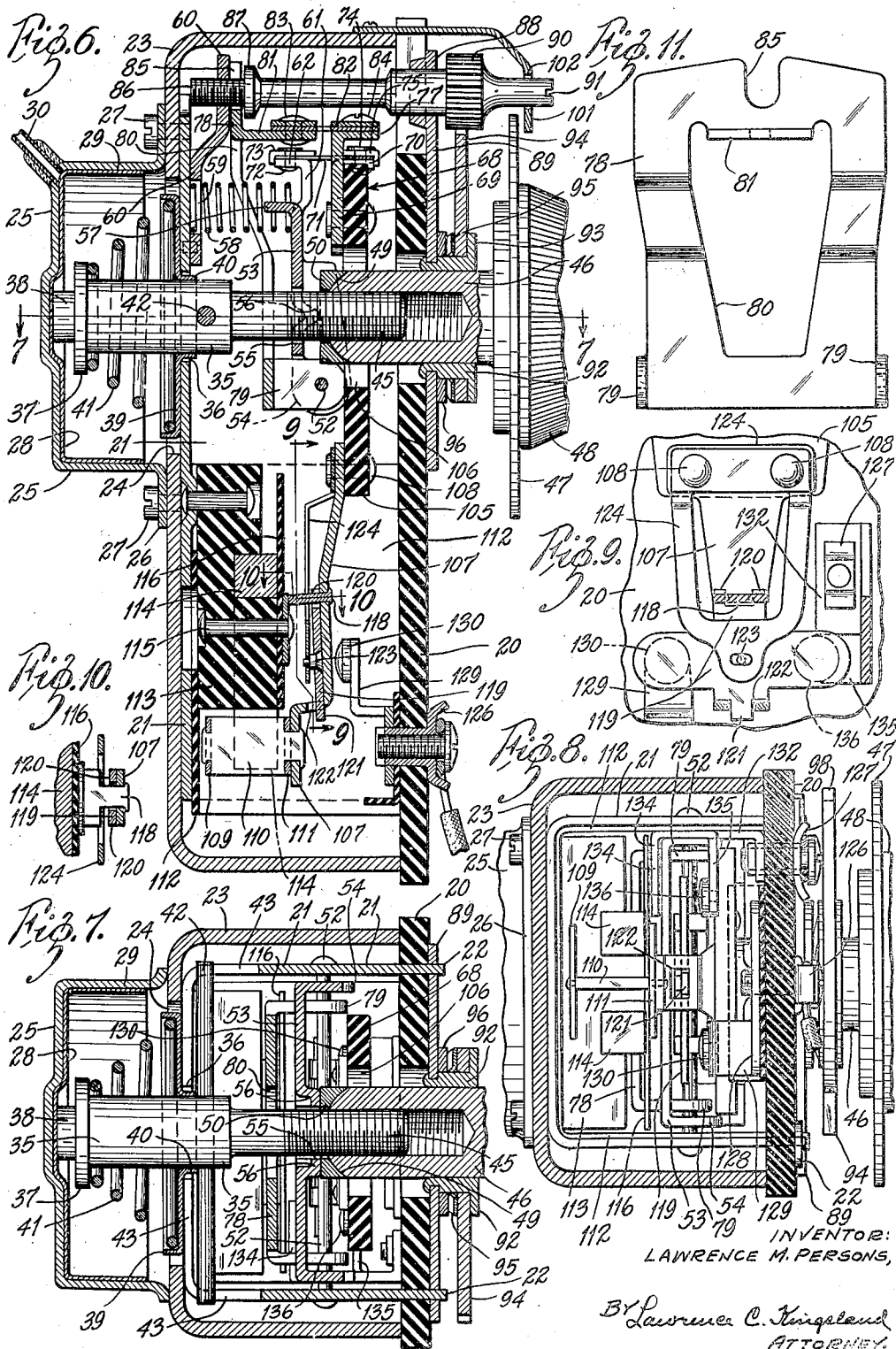
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UNITED STATES PATENT OFFICE

2,291,502

ELECTRIC SWITCH

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Application April 20, 1938, Serial No. 203,020

9 Claims. (Cl. 200—83)

The present invention relates to a mechanism including a power transmission means for transmitting and multiplying the movement from a power source to a switch or the like.

In particular, the mechanism includes a diaphragm type expanding power means acting on a compound lever system with adjustments of the connection between the lever system and the power means so as to vary the range of the mechanism, and also an adjustment of the fulcrum of at least one of the levers to effect a divided fulcrum, whereby the switch operates with a differential.

An object of the invention is to provide a simple and convenient structural arrangement whereby the diaphragm mechanism may be attached; and a simple arrangement for the power take off stud.

A further object of the invention is to provide in a switch of this kind, a particularly efficient type of pivot for the levers.

A further object of the invention is to provide a particularly simple and convenient differential mechanism.

In the drawings:

Fig. 1 is a front elevation of the device;

Fig. 2 is a side elevation looking from the left of Fig. 1 with the cover in section and the frame partly broken away;

Fig. 3 is a rear elevation with the cover in section;

Fig. 4 is a front elevation of the upper half of the device with the knob and dial removed;

Fig. 5 is a horizontal section at the top of the device, on the line 5—5 of Fig. 2;

Fig. 6 is a vertical midsection on the line 6—6 of Fig. 1;

Fig. 7 is a horizontal section through the axis of the diaphragm on the line 7—7 of Figs. 2 and 6;

Fig. 8 is a horizontal section at the bottom of the device on the line 8—8 of Fig. 2;

Fig. 9 is a vertical section at the lower middle of the device on the line 9—9 of Fig. 6, showing the outer end of the switch blade or secondary lever;

Fig. 10 is a section on the line 10—10 of Fig. 6;

Fig. 11 is a view of the differential adjusting lever; and,

Fig. 12 is a view of the primary lever.

A front plate 20 has attached thereto a main frame 21, U-shaped in cross section, as appears in Figs. 5, 7 and 8, and with which the front plate forms an open ended housing. Projections 22 at suitable points on the frame 21 pass

through the front plate 20 and are peened over to secure the frame and plate together.

A cover 23, likewise of U-shape cross section, but also closed at its ends, fits over the frame 21 and rests against the plate 22, thus enclosing the frame.

This cover 23 has an opening 24 in the back thereof. Outside the opening 24, there fits a diaphragm mechanism including a relatively rigid cup-like member 25 flanged as at 26. Screws 27 pass through the flange 26 through the cover 23 and engage in the frame 21, thus securing the diaphragm mechanism and the cover rigidly to the frame.

Fitting closely within the cup-like member 25 there is a cup-like diaphragm element 28. The diaphragm element 28 and the member 25 are welded together about their side walls as at 29. Normally the end wall of the element 28 is contiguous throughout its area to the corresponding end wall of the member 25. A tube 30 projects from one corner of the member 25 and terminates in a bulb 31. In the preferred construction the tube is of capillary size, and the mechanism is of the solid-charge type wherein the bulb, the tube and all spaces that may exist between the element 28 and the member 25 are entirely filled with a liquid that expands in response to heat changes but continues in the liquid state throughout the normal range of operation. Thus when the liquid within the bulb 31 heats and expands, it will force the diaphragm 28 (especially the end wall) away from the rigid cup member 25; and the reverse action will occur upon cooling of the liquid within the bulb.

The transmission means includes a stud 35 that is maintained in contact with the flexible diaphragm 28. This stud passes through an opening 36 in the back wall of the frame 21 and has a flange 37 therearound near the end 38, which latter end rests against the diaphragm 28. A cup-like washer 39 has a flange 40 that may pass through the hole 36 in the frame 21 and surrounds the stud 35. A conical coil spring 41 is provided between the flange 37 on the stud 35 and the washer 39. This spring normally urges the contact end 38 against the diaphragm 28.

To prevent the stud 35 from rotating, for a purpose to be described, a pin 42 passes there-through and is secured therein. This pin extends beyond the limits of the side walls of the frame 21. These side walls, as well as the back wall, are slotted as at 43, in which slot the pin 42 is guided for reciprocal movement toward and

from the front of the instrument. The slots are such as to permit such reciprocal movement but to prevent any substantial rotary movement.

The front end of the stud 35 is threaded as at 45, to receive a sleeve 46, and to the outer end of the sleeve is secured a dial plate 47 and a rotating knob 48. This sleeve 46 is rounded on its inner end as at 49, against which rounded portion there fits a spherical washer 50. It will be seen that the sleeve 46 moves in and out to follow the movements of the stud 35 as the latter follows the movements of the diaphragm 28.

A pivot shaft 52 passes through the side walls of the frame 21 near and slightly below the stud 35. A primary lever 53 has upturned ears 54 through which the shaft 52 passes. This primary lever likewise has an opening 55 through which freely passes the stud 35. On opposite sides of the opening 55 are upstanding projections 56 that engage against the washer 50.

A backturned ear 57 on the primary lever fits within a coil spring 58, the other end of which is held in position by being received in an opening 59 in a bracket 60 that has a further function to be described. The spring 58 acts to urge the primary lever forward toward the washer 50, as will be described.

The primary lever 53 at its upper end is forked, as shown in Fig. 12, giving it two arms 61, the ends of which are turned back at 62.

A long secondary lever 63 extends substantially the full length of the instrument. At its upper end it has a metal portion 64 which has at its sides frontwardly bent portions 70 located opposite the backturned portions 62 on the primary lever. A bronze strip 71 is attached between these corresponding oppositely disposed portions 62 and 70 on the primary and secondary levers. This strip is riveted to the primary lever by rivets 72 that maintain the strip 71 between the turned portions 62 and suitable washers 73. Likewise rivets 74 bind the strip 71 between the turned portions 70 on the secondary lever and washers 75.

The bronze strip 71 acts as a hinge connection between the primary and the secondary lever. Obviously, this is a frictionless connection.

The metal end 64 of the secondary lever 63 likewise has a forwardly turned end portion 77 located medially thereof, and a short distance upwardly from the strip 71. A differential lever 78 has upturned ears 79 that engage over the pivot shaft 52 (Figs. 6, 7, 11). The lever likewise has a large central opening 80 that fits around the stud 35 and the spring 58. This differential lever is provided with a forwardly turned portion 81 that may be struck out in the formation of the opening 80. A bronze hinge strip 82 is secured to the portion 81 and the portion 77 whereby the secondary lever is pivoted to the differential lever. Rivets 83 with suitable washers secure the bronze hinge 82 to the portion 81. Rivets or screws 84 secure the hinge 82 to the secondary lever.

The differential lever has a notch 85 in its upper edge that projects over the bracket 60. A screw 86 threads into the bracket 60 and passes through the notch 85. This screw has a flange 87 on the opposite side of the differential lever. The screw projects forwardly through a notch in the front plate 20 and is provided with a bearing 88 in a plate 89 attached to the front plate 20. In front of the instrument, the screw 86 has a gear portion 90, and a kerfed portion 91 thereon, by means of which it may be rotated. It

will be observed that its rotation will move the flange 87 toward or from the bracket 60.

The plate 89 has an opening through which the sleeve 46 passes. A collar 92, flanged at 93, likewise passes through this hole and is secured to the plate 89 within the hole. This collar 92 supports the sleeve 46 for its reciprocal movements. Inside the flange 93 there is mounted a gear sector 94 which rotates on the collar. This gear sector is maintained against the flange 93 by an annular leaf spring 95 that engages between a washer 96 and the gear sector.

The gear 94 (Fig. 4) carries stops 97 and 98 that limit rotation of the gear sector by their abutting the gear 90. There is also provided on the sector a pointer 99 having an index 100 that extends over the dial 47.

An additional fixed pointer 101 is attached to the cover 23 and extends over the dial. This pointer is provided with an opening 102 through which extends the kerfed portion 91 of the screw 86.

The secondary lever 63 includes a middle portion 105 formed of insulating material, and having a large opening 106 through which passes the stud 35 and the sleeve 46. The lower end of the secondary lever consists of a blade portion 107 riveted at 108 to the insulating portion 105. The bottom end of the blade 107 is turned backward and then downward, as shown in Fig. 6. To this bottom end, there is attached an armature assembly consisting of an armature element 109 and an additional armature element 111 held in spaced relation by a spacer 110. As will appear hereafter, the two armatures 109 and 111 are located on opposite sides of a horseshoe magnet.

Within the frame 21 at the switch end, there is located an insulating lining 112. Within this lining and on the back wall of the frame 21 there is secured an insulating block 113. A permanent horseshoe magnet 114 is secured embedded in the block by a rivet 115 engaging through the block and through a rigid insulating sheet 116.

The blade 107 of the secondary lever has projecting backwardly therefrom an element 118 in the shape of an inverted T, the smaller portion of which is secured to the blade 107, and which provides two confined spaces between the blade 107 and the cross element of the T.

A generally cross-shaped contact member 119 (Fig. 9) has a bifurcated upper end 120 the elements of which fit in the previously mentioned spaces between the blade 107 and the head of the T-shaped element 118. A sufficient amount of play is provided to permit the opposite end of the member 119 to pivot. This opposite end of the member 119 has a tongue 121 that passes through an enlarged opening 122 in the backwardly turned portion of the blade 107. The hole 122 permits the tongue, and consequently the plate 119, to be displaced a substantial, but limited, distance from the blade.

The contact member 119 has a rivet-like element 123 projecting from the back thereof. A light leaf spring 124 is attached to the secondary lever by means of the rivets 108. The shape of this leaf spring is shown by reference to Figs. 6 and 9. It is provided with an opening engaging over the rivet-like element 123 and, with a light tension, it normally urges the contact member 119 forwardly of the instrument until stopped by contact with the blade 107.

The T member 118 acts as a stop to limit the

movement of the secondary lever in one direction.

The contact member 119 is adapted to close across two fixed terminal contacts 126 and 127 secured to the front plate 20. The terminal 126 has a contact bracket 128 extending therefrom inside the plate 20, laterally as shown in Fig. 8, and from this lateral portion backwardly and upwardly to provide a portion 129 supporting a contact 130. The contact 130 is thus located beneath one side of the cross-shaped member 119.

The terminal 127 has a bracket 132 secured thereto inside the plate 20. This bracket is bent backwardly along the side wall inside the lining 112, and likewise projects downwardly, as shown at 133 in Fig. 2. The downwardly projecting portion 133 has legs 134 and 135 struck out therefrom, these legs projecting towards the center of the instrument as shown in Fig. 8. The leg 135 has secured thereto a contact 136 spaced opposite the contact 130 beneath the other side of the cross-shaped member 119. It will be seen from the foregoing that the member 119 may be brought toward the front of the instrument so that it bridges contacts 130 and 136, or moved toward the back of the instrument so as to break the connection between said contacts. The leg 134 may have a contact thereon adapted to close when the blade is toward the back of the instrument.

The operation

The instrument may be used as a refrigeration switch as here shown. The bulb 31 is placed in the cooling chamber, the temperature of which is to be controlled. The switch is located at a convenient and accessible point, it being connected to the bulb by the capillary tube 30. The terminals 126 and 127 are connected in series with part of the refrigeration mechanism, such as the compressor motor.

When the liquid within the bulb expands, because of increased heat, the diaphragm 28 will be moved outwardly toward the front of the instrument. It will carry with it the stud 35 which moves against the spring 41 and is guided through the openings in the washer 39 and the collar 93. This forward movement of the stud carries with it the sleeve 46, since the two are threaded together. The primary lever 53 will be caused to follow the forward movement of the stud by the action of the spring 58 which maintains the lugs 56 against the spherical washer 50, or as far forwardly as is permitted. The primary lever thus moves clockwise in Fig. 6 a slight distance.

In this movement the bronze hinge 71, between the primary and secondary levers, is likewise displaced toward the front of the instrument. This moves the secondary lever 68, the movement of which is determined by the bronze hinge 82 and the differential lever. The first stage of the movement of the secondary lever is the drawing of the portion 81 of the differential lever 78 forwardly of the instrument until the notched portion 85 of the lever 78 engages the flange 87 on the adjusting screw 86. As soon as the lever 78 lodges against this flange, further forward movement of the differential lever and of the upper end of the secondary lever is prevented. Thereafter, additional forward movement of the upper end of the primary lever 71 will produce the second stage of movement of the secondary lever, consisting of a rotational displacement of the upper end thereof, in a manner to be described. This rotation first seeks to draw the lower end

107 of the secondary lever to the right in Fig. 6. However, at the start of this movement, the armature 111 is close to the poles on the magnet 114 and therefore resists displacement. The force of this resistance is very great when applied against the force of the primary lever, because it is applied with a tremendous mechanical advantage, by virtue of the great length of the secondary lever between its lower end and the pivoted hinge 82 in proportion to the very small length between the primary lever hinge 71, at which the force of the primary lever is applied, and the secondary lever hinge 82. Since the secondary lever is somewhat resilient, there will be an actual displacement of its upper end by the primary lever, which displacement will be absorbed in the end secondary lever, deforming the same slightly but without displacing the lower end.

The third stage of the movement occurs when the force of the primary lever, plus the stored up energy in the deformed secondary lever, exceeds the resistance of the magnet. At such time the armature 111 will be drawn away from the magnet. As the power of the magnet decreases exponentially as the armature moves away from the magnet, the speed of withdrawal of the armature 111 will increase as the lever moves forwardly, once the motion has been initiated. Furthermore, as soon as the lever has been displaced a short distance, the other armature 109 approaching the magnet, will be nearer the magnet than is the first one, so that the movement of the end of the secondary lever is effected with a snap action.

As the secondary lever approaches the two contacts 130 and 136, the relatively movable cross-shaped contact member 119 will be maintained forwardly through the action of the leaf spring 124. When the member 119 closes with the two contacts, a further slight movement of the secondary lever is permitted, until the tongue 121 on the member 119 reaches the backward limit of the opening 122, and the bifurcated ends 120 strike the head of the T-shaped member 118.

The switch will stay in this position until the bulb 31 cools down. The liquid will then contract and the diaphragm 28 will move to the back of the instrument. The spring 41 will cause the stud 35 to follow this movement. The sleeve 46 will likewise be drawn backwardly, carrying the washer 50 with it. This washer, acting on the lugs 56, will pivot the primary lever 53 counterclockwise (in Fig. 6) against the action of the spring 58. This action of the primary lever will displace the hinge 71 between it and the secondary lever toward the back of the instrument. The upper end of the secondary lever will be moved correspondingly. In the first stage of this movement, the hinge 82, between the secondary lever and the differential lever, will displace the differential lever counterclockwise (in Fig. 6) until it strikes the bracket 60. In the second stage of such movement, the upper end of the secondary lever will pivot clockwise about the hinge 82. This movement of the upper part of the secondary lever tends to shift the lower part of the lever away from the contacts 130 and 136. Such movement is resisted by the effect of the magnet 114 on the armature 109. Therefore, the second stage of movement of the secondary lever consists of a storage of the energy of displacement between the upper and lower ends of the lever and this produces a deformation of the lever.

The third phase of movement occurs when the

energy thus stored, coupled with the dynamic energy of the primary lever, overcomes the resistance of the magnet. The secondary lever then withdraws with a snap action ultimately augmented by the movement of the other armature 111 into the field of the magnet.

Should the contacts 130 and 136 be welded to the contact member 119, the first part of the movement of the secondary lever will take place without moving the member 119, by virtue of the lost motion produced by the slot 122 and the connection with the member 18, thus enabling the secondary lever to get a running start which more readily breaks any such welds.

The opening movement of the secondary lever is stopped when the member 118 contacts the washer on the rivet 115.

In the foregoing cycle of operation, the stud 35 is maintained against rotation by the engagement of the rod 42 in the slots 43. It will be observed that the slots 43 are a substantial distance from the axis of the stud 35. Consequently, a relatively free fit of the rod 42 within the slots 43 permits only a small angular displacement of the stud 35. Such angular displacement is substantially less than would be permitted by a similarly tolerant engagement close to the stud itself.

In the forward movement of the stud, responsive to increase of heat in the power means, the primary lever is caused to follow the washer 50 on the sleeve 46 until it is stopped by final engagement of the contact member 119 on the secondary lever with the contacts 130 and 136. Any further movement of the stud 35 has no effect upon the primary lever and puts no strain on the instrument, since in such case the sleeve 46 merely moves away from the primary lever.

The fact that the mechanism is a solid-charge device enables a tremendous multiplication of power to be had. Consequently, the practically invariable action of the bronze hinges is particularly advantageous. A small change at the upper end of the levers would, of course, make a very large change at the critical switch end.

It will be observed that in the first stage of movement of the secondary lever, when it displaces the hinge 84 and causes the differential lever 78 to move, the pivoting of both the primary and differential levers about the same center effects a pivoting of the secondary lever without distortion of either hinge 71 or 82.

The adjustments

The principal adjustment is that obtained by rotating the knob 48 which moves the sleeve 46 in or out of the stud 35. If the primary lever begins to move the secondary lever at a certain position of the sleeve 46, the temperature at which the stud 35 places the sleeve 46 in such position may be selected by rotating the knob 48. Thus, if the knob is rotated to move the sleeve back toward the rear of the instrument, a greater movement forward of the stud 35 will be required before the sleeve is restored to its original position. Thus the switch is adjusted to move at a higher temperature. Conversely, if the knob 48 is moved to withdraw the sleeve 46 toward the front of the instrument, the primary lever is advanced so that less increase in heat in the bulb is required to shift the secondary lever.

The adjustment of the differential mechanism is obtained by inserting a screw driver in the kerfed portion 91 on the screw 86 and rotating the screw to alter the position of the flange 87.

This displaces the flange 87 toward or from the bracket 88, altering the length of the first stage of movement of the secondary lever.

If the instrument be set by knob 48 to open at 35° it will always do so. However, if the pointer 100 be set at 40°, such will occasion such displacement of the flange 87 so that an additional 5° of movement of the diaphragm is required to complete the first stage of movement of the secondary lever, it being obvious that subsequent stages take place only upon completion of the first.

In adjusting the differential, the gear 90 shifts the sector 94 and carries the pointer 100 over the dial 47 to indicate the temperature at which the switch closes. In this operation, the sector 94 rotates on the collar 92. Thus the pointer 101 indicates the opening temperature of the switch and the pointer 100 indicates the closing temperature.

What is claimed is:

1. In a mechanism of the kind described, a pair of levers, a hinge joining the two levers, a bracket, a hinge between one lever and the bracket, and means providing limited movement for the bracket in the direction of movement of the lever attached thereto.

2. In a mechanism of the kind described, a pair of levers, a hinge joining the two levers, a pivoted bracket, a hinge between one lever and the bracket, and a pair of spaced and relatively adjustable abutments on opposite sides of the bracket to permit controlled and limited movement of the bracket in the direction of movement of the lever attached thereto.

3. In a mechanism of the kind described, a lever, means to move the lever in opposite directions, a bracket pivoted about an axis parallel to the axis of the lever, a pair of spaced abutments on opposite sides of the bracket, at least one of which is adjustable, means for adjusting said adjustable abutment, and a hinge between the lever and the bracket, said hinge being displaced from the pivoted part of the bracket.

4. In a mechanism of the kind described, a primary lever, a pivot therefor, a secondary lever, means hinging the primary lever to the secondary lever, a differential lever operating on the pivot of the primary lever, adjustable abutments on opposite sides of the differential lever to permit limited movement thereof, and means hinging the secondary lever to the differential lever.

5. In a mechanism of the kind described, a frame, a primary lever having spaced and downturned ears at one end thereof, a secondary lever having at one end correspondingly spaced and downturned ears, flexible hinge strips secured between the ears of the primary and secondary levers, a third ear on the secondary lever between the first two, and projecting a slight distance beyond the first two, and means including a flexible strip joining the third ear to the frame.

6. In a mechanism of the kind described, a power means, a frame, a member on the frame and moved by the power means, means extending from the member and guides on the frame engaging the member to prevent angular movement of the member, an adjustable sleeve on the member, a primary lever, means urging the primary lever against the sleeve to follow movements thereof, a secondary lever, means hinging the primary lever to the secondary lever adjacent one end of the latter, means at the end of the secondary lever hinging the same to the frame, the length of the secondary lever from its

free end to its primary lever hinge being a large multiple of its length from the primary lever to the hinged end, switch contacts at the free end of the secondary lever, snap action means at the free end of the secondary lever, the secondary lever being resilient, and means mounting the contacts for limited movements relative to the secondary lever.

7. In a switch mechanism, a frame having front, back and two side walls, a power means including a cup-shaped member enclosing a flexible diaphragm, a stud and a sleeve threaded on one end thereof, the stud passing through the back wall, means maintaining the stud against the diaphragm, the sleeve passing through the front wall, switch mechanism actuated by movement of the stud and sleeve in response to displacement of the diaphragm, movement of the sleeve on the stud adjusting the operation of the switch mechanism, and a pin passing through the stud with guide means in the side wall co-acting with the pin to prevent rotation of the stud, but permitting axial movement thereof.

8. In a mechanism of the kind described, a frame, a primary lever having a flat surface adjacent to one end thereof, a secondary lever having a corresponding surface disposed approximately at said primary lever surface, a flexible hinge strip extending across between said levers and attached to said surfaces, an additional surface on the secondary lever spaced beyond the hinge strip, and means including a flexible strip attached to said additional surface, joining said secondary lever to the frame.

9. In a mechanism of the kind described, a frame, a primary lever pivotally attached to said frame, a secondary lever, a hinge strip connecting said primary and secondary levers, and disposed substantially tangentially to the direction of movement of the primary lever, and means attaching the secondary lever pivotally to the frame for movement in a direction substantially concentric with the direction of movement of the primary lever.

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