

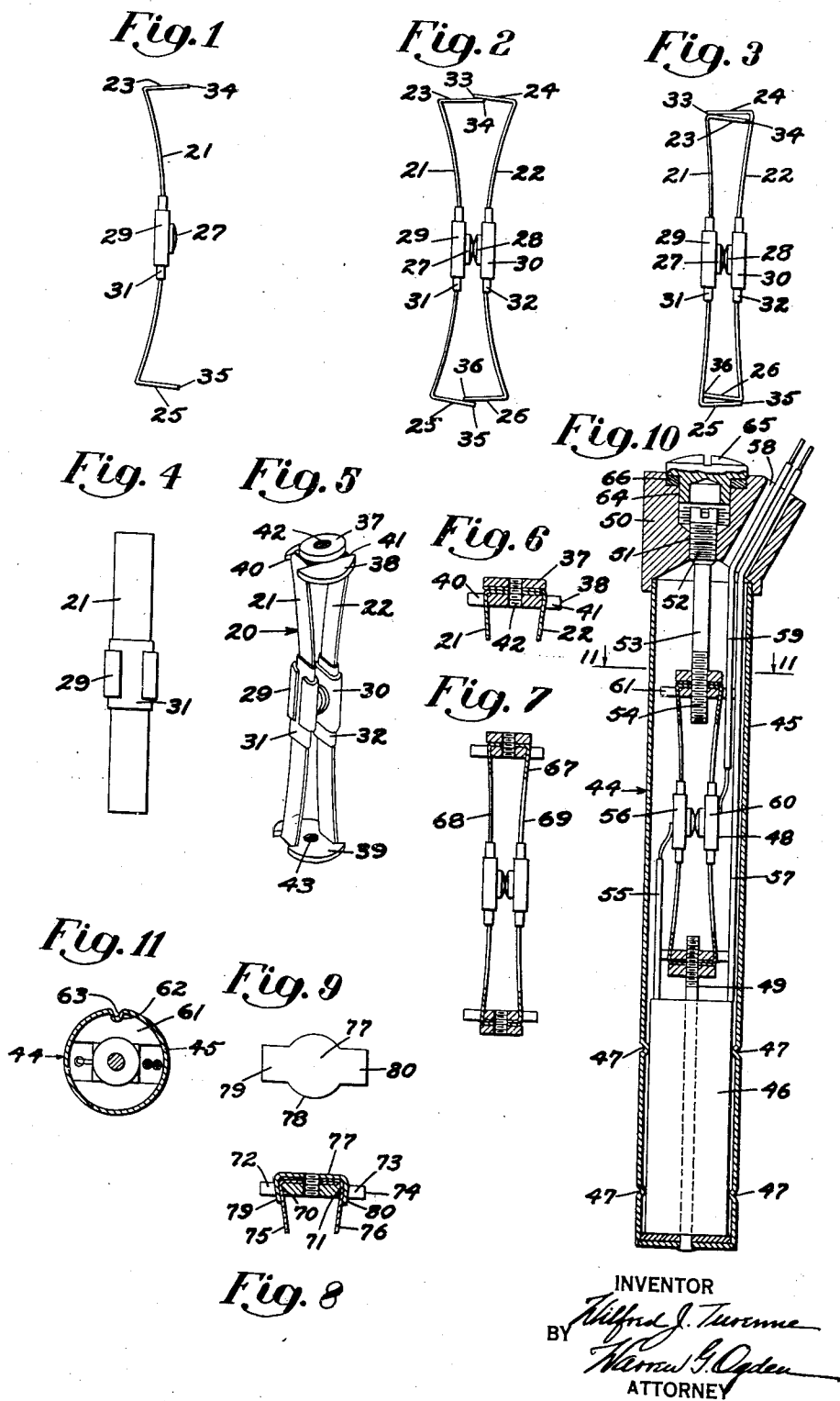
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W. J. TURENNE

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SWITCH

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SWITCH

Wilfred J. Turenne, Danvers, Mass.

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15 Claims. (Cl. 200—137)

My invention relates to a switch and more especially to a switch adapted to open and close an electric circuit in accordance with thermal or other changes in a device associated with the switch. My switch is a finished article of manufacture and may be handled as a unitary article for assembly with other parts of the instrument in which it is to be used.

utility, and one of the principal objects of the invention is to bring about a relatively simple, unitary and self contained form of switch which may be adapted, without change, to a wide variety of uses.

Another object of the invention is to bring about a unitary form of switch which, while having improved operating characteristics, will occupy less space than those previously known and used.

A further object of the invention is to bring about a unitary form of switch in which greater uniformity of action is obtained, in the making and breaking of the contacts at predetermined settings, than has heretofore been possible.

In certain specific aspects it is an object of the invention to bring about greater uniformity of movement of a pair of spring controlled switch points or contacts and to prevent, or at least to reduce to minimum, vibratory movements of the springs, and thus the contacts, due to any external vibratory or other shock or jar to which an instrument with which the unit is associated may be subjected, during its use.

A feature of the invention resides in a novel structure and method for imparting increased tension to the spring elements of the switch, and thus contacting pressure between the switch points beyond that which has heretofore been possible in switches embodying spring elements of comparative size and form.

A further feature of the invention resides in an improved arrangement for connecting the spring ends to one another and to any device with which the switch is to be used.

To these and other ends, the invention resides in the novel features and combinations of parts to be hereinafter described and claimed.

In the drawing:

Figs. 1, 2 and 3 are side elevational views showing one form of the improved switch, during certain steps in the construction of the same;

Fig. 4 is a front elevational view of one of the springs entering into the construction of the switch;

Fig. 5 is a perspective view of the completed switch;

Fig. 6 is a longitudinal sectional view of one of the ends of the switch shown in Fig. 5;

Fig. 7 is a side elevational view of a modification of the invention;

Fig. 8 is a longitudinal sectional view of another modification of the invention;

Fig. 9 is a plan view of a part entering into the structure of the modification shown in Fig. 3;

Generally speaking the invention relates to that type of switch in which a pair of substantially parallel bowed flexible bars, subjected to varying pressure or tension at their ends, are caused to move relatively to one another in a direction transversely of their lengths, by variations in such pressure or tension, and by this movement, to open or close a pair of electrical contacts associated one with each bar. A switch of this character, but greatly improved by my present invention as to sensitivity, is shown in my prior patent for a thermostatically controlled iron, granted April 28, 1925, No. 1,535,751, therein consisting of a strip or bar of invar bent centrally of its length to form a somewhat U-shaped construction having two legs which, intermediate their ends, bow inwardly towards one another and by thermal changes control the movements of co-operating pairs of electrical contacts attached to the legs.

In certain aspects the present invention relates to a form of thermostatic switch particularly adapted for use in highly sensitive thermally controlled instruments and, as will appear from the detailed description hereinafter, the invention may be carried out in connection with a single strip of suitable material bent between its ends to form a pair of strips which are drawn together in a manner to secure the greater sensitivity, or it may be carried out through the use of two separate strips of material, similarly secured together at both of their ends. In either case the strips entering into the construction of the switch form leaf springs which are inwardly bowed between their ends, and by a novel means of tensioning before assembly in the instrument I make use of the inherent flexibility of these springs and the tendency thereof to return to and remain at a condition of least stress or strain, to control within an extremely narrow range of temperature the opening and closing movements of a pair of electrical contacts connected thereto in suitable manner.

The usual switch of the type contemplated is specially designed to fit into and to be constructed as a part of the specific device with which it is to be used, and therefore is of limited

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Fig. 10 is a longitudinal sectional view of a thermostatically controlled heater having the improved switch as a part thereof, and.

Fig. 11 is a cross-sectional view taken along line 11—11 of Fig. 10.

Referring now to the drawing, in which I have illustrated my invention by showing some preferred embodiments of the same, and with particular reference at present to the form of the invention shown in Figs. 1 to 6 inclusive, the reference numeral 20 (Fig. 5) indicates, in general, the improved switch which, in this instance, includes a pair of leaf springs 21 and 22, rigidly connected together at their ends and bowing inwardly towards one another intermediate their ends. The springs 21 and 22 are substantially identical and prior to assembly each consists of a single strip of flexible substantially non-expanding material, preferably invar, having a thickness and width to give the desired degree of stiffness, the springs between their ends having a normal concave bow-like shape, as shown in Fig. 1. The extreme ends of the springs are bent, or otherwise directed towards the convex sides thereof, to form flanges 23, 24, 25, and 26, while substantially half way between the ends of the springs are electrical contacts or switch points 27 and 28, which, in this instance, are attached to the springs by means of metallic clips 29 and 30, the clips being insulated from the springs by suitable insulating material, such as mica, herein indicated by the reference numerals 31 and 32. Preferably the side edges of the clips are crimped tightly around the edges of the springs with the contacts extending towards one another on the convex sides of the springs.

During the assembly of the switch the springs 21 and 22 are first brought into the position shown in Fig. 2 wherein the convex sides of the springs oppose one another, the flange 24 slightly overlapping flange 23, while flange 25 slightly overlaps flange 26, it being noted that the flange 24 lies outside of flange 23, while the flange 25 lies outside of flange 26, switch points 27 and 28 at this time being in contact.

The springs 21 and 22, as shown in Fig. 2, are not under tension but each has its normal or natural curvature. The radius of curvature of the bowed portions is relatively small so that the springs, at the ends, are widely separated and it will be further noted that at this stage the flanges on the ends of each spring diverge from one another outwardly towards their ends.

Pressure is now brought to bear on the springs at their ends to cause each of the latter to flex or bend inwardly towards the opposing spring end, and to bring the flanges into overlapping relation throughout their lengths, the relative positions of the springs at this stage being as shown in Fig. 3. The flange 24 now overlaps flange 23, at one end of the unit, while the flange 25 overlaps the flange 26, at the other end of the unit. Since the electrical contacts 27 and 28 prevent relative movement of the springs at the centers thereof, the springs are somewhat flattened and have a radius of curvature much greater than normal, the tension imparted to the springs, due to the resistance thereof to this bending or flexing movement and their tendency to resume their normal shapes, urging the electrical contacts 27 and 28 into tight engagement, when the opposing spring ends are held against separation.

Primarily the flanges at the ends of the springs serve to connect the ends of the springs together,

in a manner to be hereinafter set forth, but in the present instance they have the added function of imparting added tension to the springs, beyond that imparted thereto by the relative flexure of the springs towards one another as described above. For this purpose the flanges bear such an angular relation to the bowed parts of the springs that when the latter are flexed into the positions shown in Fig. 3 the adjacent overlapping flanges lie at an angle to one another.

The change in the angular relation of flanges 23 and 25, on spring 21, brought about during the bending or flexure of the spring is such that the flanges, towards their outer or free ends, are now inclined towards one another, while flanges 24 and 26, on spring 22, towards their free ends, are likewise inclined towards one another. As a result the outer free end 33, of flange 24, is substantially in contact with the adjacent inner end of flange 23, while the outer free end 34, of flange 23, is spaced from flange 24. In similar manner the outer free end 35, of flange 25, is substantially in contact with the inner end of flange 26, while the outer free end 36, of flange 26, is spaced from flange 25.

The flanges are now flexed in a direction such that each of the outer free flange ends moves longitudinally of the unit away from the center thereof, there being a slight displacement of the springs relative to one another, until the flanges are parallel and the adjacent overlapping flanges in contact throughout their lengths. This may be conveniently accomplished by clamping each pair of overlapping flanges together, the flanges being welded, or otherwise attached, each to its overlapping flange, in order to hold the flanges against separation and to prevent the ends of the springs from moving apart. As each flange is brought into contact with the adjacent overlapping flange, the angular movement of the flanges is such as to force the bowed parts of the springs towards one another and to force the contacts 27 and 28 into tighter engagement. For example the clamping pressure on flange 23 swings this flange upwardly at its outer end 33, as viewed in Fig. 3, and as this swinging or flexing movement is resisted by the bowed intermediate part of spring 21, to which the flange is attached, tension is added to spring 21 in a direction tending to increase the bowed curvature thereof.

In order to reinforce the unit at its ends, and to provide a convenient arrangement for the assembly thereof in a thermostat or other device, reinforcing discs 37 are applied to the ends of the unit, in the form described the discs being attached to the outer faces of flanges 24 and 25, and if desired discs 38 and 39 may be assembled within the unit and attached to flanges 23 and 26. Preferably discs 38 and 39 are somewhat larger in diameter than discs 37 and are slotted at 40 and 41 for the reception of the bowed intermediate parts of springs 21 and 22. If preferred the discs may be assembled on the unit prior to the welding of the flanges and the discs may be welded to the flanges at the same time that the latter are welded together. After the discs are assembled on the unit, and welded or otherwise attached to the flanges, the ends of the unit are drilled and tapped at 42 and 43, for the reception of suitable threaded elements by means of which the unit may be assembled within a thermostat or other device. As shown in Fig. 5 the threaded openings 42 and

43 are at the centers of the discs and lengthwise of the unit.

The switch assembly, as thus described, is in the form of a unit which is self contained and may be readily embodied in thermostats, or other devices wherein it is desirable to control the opening or closing of an electric circuit. Owing to the fact that the bowed parts of the springs, in their final shapes approach parallelism, it will be apparent that very little elongation of the switch is necessary to separate the contacts, and that the switch is thus highly sensitive to small linear changes produced by variations in tension applied to the ends of the switch by an external mechanism.

As an example of a suitable use to which the unit described above may be put, and in order that its mode of operation may be fully understood, the improved switch will now be described in connection with a thermostatically controlled electric heater, it being understood, however, that the description thereof in connection with this particular instrument is for illustrative purposes only.

In Figs. 10 and 11 the reference numeral 44 indicates, in general, an electric heater suitable for immersion in water or other liquid, the heater including an elongated cylindrical casing 45, of material having a reasonably high coefficient of expansion, there being an electrical resistance heating unit 46, in the lower end of casing 45, the heating unit being of any suitable type and held in place by indentations 47, formed in the wall of the casing and extending inwardly therefrom. Within the casing 45, and above the heating unit 46, is a switch 48, of the type described above and shown in Fig. 5, a rod 49, of invar or other non-expanding material, being threaded into the lower end of the switch and extending downwardly through the heating unit 46 to the bottom of the casing, to which it is attached. Mounted on and closing the upper end of the casing 45 is a cap 50 having, in the lower end thereof, an axially directed opening 51, threaded to receive the enlarged threaded upper end 52, of an adjusting screw 53, the lower reduced threaded end 54, of the screw, being threaded in the upper end of switch 48. One of the leads 55, of the heating unit 46, is connected to contact 56, of switch 48, while the other lead 57 passes from the heating unit upwardly through the casing and outwardly through opening 58, in cap 50. A wire 59, connected to the contact 60, of switch 48, passes upwardly through the casing and outwardly through the opening 58. It will be understood without further description that the switch 48 is thus in series with the heating unit 46.

In use the heater may be immersed in a body of liquid and the outer ends of the wires 57 and 59 connected in any usual manner to a power line, or other source of supply of electricity, which, since the switch is normally closed, passes through the heating unit 46, causing the latter to heat in well known manner, the heat being dissipated through the casing 45 to the surrounding liquid. As the temperature of the liquid rises, the casing 45 expands and, since the rod 49 and the springs of switch 48, are made of invar, or other substantially non-expanding material, and their expansion negligible, these parts are placed under tension, this tension tending to straighten the bowed springs of the switch 48, and thus to separate the electrical contacts thereon. When the tension, produced by the casing 45, becomes

great enough to overcome the tension inherent to the springs of the switch, the contacts 56 and 60 are separated and the circuit opened. As the liquid, and thus the casing 45, cool, the casing contracts, reducing the tension on the ends of the switch 48, until the springs bring the contacts thereon into engagement and the circuit is again closed.

Preferably the pitch of the threads on the upper enlarged end 52, of screw 53, is different from the pitch of the threads on the lower end 54, where the latter is threaded into the switch. For example the number of threads per inch at one end of the screw may be 32 while the number of threads per inch at the other end of the screw may be 30, the threads at both ends being right handed. Rotation of the screw through 360° will cause movement of the adjacent spring and $\frac{1}{480}$ part of an inch and the tension in the springs of the switch may thus be varied and controlled within narrow limits, to bring about the opening of the switch at various temperatures of the liquid in which the heater is immersed.

In order to prevent undue strain on the switch 48, and to prevent rotation thereof on the rod 49, during the adjustment of screw 53, the disc 61, at the upper end of the switch, is slotted at 62, to receive a vertical rib 63, formed in casing 45, the rib entering the slot 62 and holding the disc 61, and thus the switch against movement except in a direction lengthwise of the casing. If desired the opening 64, in cap 50, above the screw 53, may be closed by a plug 65, threaded in the upper end of opening 64 and seating against a washer 66. The opening 58 may likewise be closed or sealed in any usual manner.

In the modification shown in Fig. 7, the springs of the switch are made out of a single strip of material 67, bent intermediate its ends to form two substantially parallel legs or springs 68 and 69, which are bowed between their ends with the convex sides thereof opposing one another. The free ends of the springs are bent inwardly towards one another to form flanges similar to those shown in the form of the invention illustrated in Figs. 1 to 6 inclusive and, as in the latter form, serving to connect the adjacent spring ends together and to give added tension to the bowed portions. Reinforcing means may be likewise applied to the ends of this form of the invention.

The modification shown in Figs. 8 and 9 differs principally from the preceding forms with respect to the reinforcing means applied to the ends of the springs. In this case the bottoms 70 and 71, of the slots 72 and 73, of reinforcing inner disc 74, are inclined to fit against the bowed springs 75 and 76, a saddle 77 having a disc-like central part 78 and radial arms 79 and 80 being applied to the outer end of the spring assembly, the arms being bent downwardly into the slots 72 and 73, to prevent separation of the springs 75 and 76 and to lock the several parts of the switch at the end thereof together against movement. With this form the welding of these parts together may be dispensed with.

In each of the several embodiments of the invention described above, an increased tension is given to the spring elements beyond that possible in the mere flexing of the bowed parts of the springs and I am thus able to dampen vibratory movements of the springs and to obtain greater uniformity of action in the making and breaking of the contacts at predetermined settings. As a result excessive sparking between the contacts

is prevented which not only conserves the contacts but, when the unit is used in connection with a household appliance, reduces radio interference to a minimum.

5 While I have shown and described several preferred embodiments of my invention, it is to be understood that the same is not to be limited to the details shown but is capable of modification and variation within the spirit of the invention and the scope of the appended claims.

10 What I claim is:

1. A switch unit for a thermostat or the like comprising, a pair of bowed metallic leaf springs arranged with their convex sides opposing, electrical contacts associated one with each of said springs on the opposing convex sides thereof, and means at each end of the unit for connecting the adjacent opposing spring ends together, said means at at least one end of the unit comprising 15 inturned flanges on the springs, the flanges being secured together in overlapping relation.

2. A switch unit for a thermostat or the like comprising, a pair of bowed metallic leaf springs arranged with their convex sides opposing one another, electrical contacts associated one with each of said springs on the opposing convex sides thereof, said contacts being normally engaged, the springs at their ends being flexed towards one another to be placed under tension, and means 20 at the ends of said springs for producing an additional tension in said springs.

3. A switch unit for a thermostat or the like comprising, a pair of bowed metallic leaf springs arranged with their convex sides opposing one another, electrical contacts associated one with each of said springs on the opposing convex sides thereof, said contacts being normally in engagement, said springs being flexed towards one another in a direction transversely of the unit to resiliently urge said contacts into engagement, 40 and means associated with said springs and flexed in a direction longitudinally of the unit to increase the relative pressure of the springs on said contacts.

4. In a switch unit for a thermostat or the like, a pair of metallic leaf springs bowed towards each other intermediate their ends, inwardly turned flanges at the ends of said springs, the flanges on the opposing ends of the springs being 50 in overlapped relation, electrical contacts associated with the convex sides of said springs and normally in engagement, and reinforcing means applied to the flanges at the ends of the unit, said reinforcing means and flanges being secured together against relative movement, whereby said parts after assembly may be handled as a unit.

5. In a switch unit for a thermostat or the like, a pair of metallic leaf springs bowed towards each other intermediate their ends, inwardly turned flanges at the ends of said springs, the flanges on the opposing ends of the springs being 60 in overlapped relation, electrical contacts associated with the convex sides of said springs and normally in engagement, and reinforcing means applied to the flanges at the ends of the unit, said reinforcing means comprising pairs of plates between which the overlapped flanges are clamped.

6. In a switch unit for a thermostat or the like, 70 a pair of metallic leaf springs bowed towards each other intermediate their ends, inwardly turned flanges at the ends of said springs, the flanges on the opposing ends of the springs being in overlapped relation, electrical contacts asso-

ciated with the convex sides of said springs and normally in engagement, and reinforcing means applied to the flanges, said reinforcing means comprising pairs of plates between which the overlapped flanges are clamped, the outer one of 5 said plates at each end of the unit having end portions turned downwardly against the springs forming a saddle over the end of the unit.

7. A bowed spring thermostatic switch having in combination, a pair of opposed bowed springs 10 the convex sides of which are opposing, each of said springs having a portion at each end thereof bent towards the convex side of its respective spring forming overlapping end flanges, the springs being flexed in directions to increase the radii of curvature thereof, the free ends of the flanges being flexed outwardly, and means for clamping the springs and flanges in such dual 15 flexed relation.

8. A thermostatic switch constructed for assembly as a unit in a thermally controlled instrument comprising two opposed bowed leaf springs each having a contact point generally central at its bowed face, said contacts being engaged, and said springs being tensioned about said engaged 20 contacts and retaining said tension by an integral inturned flange member connecting said springs at each end of the unit.

9. A thermostatic switch constructed for assembly as a unit in a thermally controlled instrument according to claim 8 in which said flange member at at least one end of the unit consists of 25 two overlapping portions one inturned from each spring.

10. A thermostatic switch constructed for assembly as a unit in a thermally controlled instrument according to claim 8 having a device at each end of said unit adapted for attachment to the switch actuating means forming a part of the instrument which the switch is to control. 30

11. A thermostatic switch constructed for assembly as a unit in a thermally controlled instrument according to claim 8 having a pair of reinforcing plates one within and one without the spring connecting member at each end of the unit each pair of plates being secured to and clamping the associated connecting member between them. 35

12. A switch for assembly as a unit in a thermally controlled instrument comprising two leaf springs bowed toward each other intermediate their ends, each spring having an electrical contact at its bowed face and said contacts being closed, and each spring having had its normal radius of curvature increased for holding said 40 contacts closed under spring tension, and means at at least one end of the unit providing a contact closing tension in said springs in addition to that imparted by their increased radius of curvature.

13. A metallic leaf spring for thermostatic switches, bowed throughout its working length and having a short portion at each end bent to lie at an angle to the adjacent portion of the spring. 45

14. A bowed, metallic leaf spring for thermostatic switches having a portion at each end bent toward the convex face of the spring and forming integral end flanges. 50

15. A bowed, metallic leaf spring for thermostatic switches having a flange at each end projecting from the convex face of the spring, the angle within each flange and the adjacent end portion of the spring being less than a right angle. 55

WILFRED J. TURENNE.