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PATENT SPECIFICATION

DRAWINGS ATTACHED

26 JAN 1962

878,342

Date of Application and filing Complete Specification Nov. 21, 1957.

No. 36376/57.

Application made in United States of America on Dec. 13, 1956.

Complete Specification Published Sept. 27, 1961.

Index at acceptance: —Class 38(5), B1(D1X:D4:D5:F1A3:F1E:F8), B2(A5AX:A7:C6D:C6F:C17).

International Classification: —H02c.

COMPLETE SPECIFICATION

Electric Switch Mechanism

We, TEXAS INSTRUMENTS INCORPORATED, a company organized and existing according to the laws of the State of Delaware, United States of America, of 13500, Central Expressway, Dallas, 21, Texas, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to electrical switches embodying a spring member which is readily flexible in a first path or direction and is substantially non-flexible or stiff in a path or direction perpendicular to said first path or direction.

To render the spring member readily flexible and substantially non-flexible in these respective paths or directions, the spring member is preferably formed with a high width-to-thickness ratio. Thereby, the spring member is readily flexible in a path or direction perpendicular to its width and is substantially non-flexible in a path or direction perpendicular to the path or direction in which it is readily flexible. The spring member is operatively associated with at least one electrical contact so that flexure of the spring member in or along said substantially flexible plane is effective to move that contact into and out of engagement with at least one other electrical contact.

With an electrical switch including a spring member operatively associated with an electrical contact as set forth above, the problem of separating the contacts if they should become welded or otherwise stuck together often becomes critical. It will be clear that since the spring member is flexible in the direction of its movement to make and break the contacts, any force applied to this spring member to effect such movement of the contacts, in most cases, is not efficiently transmitted through the spring member. For example, if a first contact which was carried at one end of a spring member became stuck to another contact, it might be exceedingly difficult, if not impossible, to pull or break the first contact away from the other by means of a force applied to a remote region of the spring member and in a direction in which the spring member is flexible.

The invention has particular adaptability to electrical switches embodying a snap-acting mechanism which includes such a spring member. The invention includes those snap-acting mechanisms in which the spring member may itself be a snap-acting member or a portion of such a snap-acting member; it may be carried by said snap-acting member as an integral part thereof or extension secured thereto; or it may be a member separate from the snap-acting member but operatively connected thereto, mechanically or otherwise, to be actuated thereby.

It is a normal characteristic of an electrical switch embodying a snap-acting mechanism that when the snap-acting mech- is manipulated to snap the movable contact out of engagement with another member, the snap-acting mechanism approaches and passes through an unstable neutral condition. The closer the snap-acting mechanism approaches this neutral condition, the less the force is that it exerts tending to maintain the movable contact against the member; to the end that when it reaches this neutral condition it ordinarily exerts no force tending to maintain the movable contact against the member or tending to move the movable contact away from the member. That is, at the instant the snap-acting mechanism starts to snap, no appreciable force is ordinarily transmitted by it to the contact which is moved thereby. The result is that whenever the contact which is moved in response to snapping of the snap-acting mechanism is disposed in engagement with another contact, and the

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snap-acting mechanism approaches and reaches this unstable neutral condition, there may be substantially no pressure urging the contacts together. With little or no force urging the contacts together, among other deleterious effects, the electrical resistance between the contacts increases and an incipient arc may form between the contacts which could produce sufficient heat to weld the contacts together.

It will be seen then that in those instances where a contact which is movable for make and break is associated with a spring member or a snap-acting mechanism as described above, and particularly in those instances where the snap-acting mechanism includes a spring member associated with such a contact, the problems involved are of pronounced concern. As noted above, the snap-acting mechanism includes the spring member in those cases where the spring member and the snap-acting member are one and the same; where the spring member is a portion of the snap-acting member, or is carried thereby as an integral part thereof or an extension thereto; and where the spring member is separate from the snap-acting member but is operatively associated therewith.

An object of this invention is to provide an improved electrical switch which is automatically effective, when actuated, to break apart or separate two or more of its contacts if they should become welded or otherwise stuck together.

A further object of this invention is to provide an improved electrical switch which is automatically effective to counteract the tendency of its contacts to become welded together.

A further object of this invention is to provide an electrical switch wherein at least one of its contacts is movable laterally relative to a contact with which it co-operates for make and break of an electrically conductive path. A further object of this invention is to provide a snap-acting switch wherein at least a portion of the force, under which said lateral relative movement is effected, is independent of the force exerted by snapping of the snap-acting mechanism of the switch.

A further object of this invention is to provide a snap-acting switch which is effective, during actuation thereof, to take up or reduce a tendency for one of its contacts to creep away from a co-operating contact in one direction without decreasing the extent of snap movement of said one contact in the opposite direction.

A further object of this invention is to provide a snap-acting switch which is effective to counteract or to reverse a tendency toward loss of pressure between these contacts.

Among further objects of this invention may be noted the provision of an electrical switch which, when actuated, is automatically and inherently effective to wipe its contacts one against another to maintain at least a portion of their surfaces in a constantly clean state free from the presence of sulfides, oxides and other foreign matter or material.

A further object of this invention is to provide an electrical switch which has a minimum number of parts, which is compact, durable, efficient, easy to calibrate and adjust, economical to manufacture and dependable in operation.

In the accompanying drawing, in which several of various possible embodiments of the invention are illustrated;

Fig. 1 is a plan view of an electrical switch forming one embodiment of this invention, the parts being shown in full lines at the fully released position and in broken lines at the position of full throw of the actuating means;

Fig. 2 is a front view of the electrical switch shown in Fig. 1;

Fig. 3 is a sectional view taken along line 3—3 in Fig. 2;

Fig. 4 is a fragmentary front view of the electrical switch shown in Fig. 1, several of the electrical leads shown in Fig. 1 being removed as is the case in certain other figures throughout the drawings for purposes of clarity of illustration;

Fig. 5 is a view similar to Fig. 3 but showing the parts in their respective positions at full throw of the actuating means;

Fig. 6 is a view similar to Fig. 4 but showing the parts in their respective positions at full throw of the actuating means;

Fig. 7 is an isometric view on a scale slightly reduced from that of Figs. 1—6 and showing the actuating member along with the electrical contacts carried thereby;

Fig. 8 is a fragmentary plan view of the switch shown in Fig. 1 with a portion of the snap-acting element being broken away for purposes of clarity of illustration, the parts being shown in full lines at full throw of the actuating means and a portion of the actuating means being shown in broken lines at fully released position;

Figs. 9—11 are fragmentary plan views of the electrical contacts of the switch shown in Fig. 1, these views being on a scale slightly enlarged over that of Fig. 1 and showing the relationship of the respective contacts at several positions of movement;

Figs. 12—15 are more or less diagrammatic views based on Figs. 3 and 5 and on an enlarged scale, these views showing the relationship of the respective contacts at several positions of movement;

Fig. 16 is a plan view showing the modified parts of the embodiment of Figs. 1—15 according to a first modification which can be applied to each of the embodiments shown in the drawings, these parts being shown in full

lines at one extreme position of relative movement and in broken lines at the opposite extreme position of relative movement;

Fig. 17 is a front elevation of the switch shown in Fig. 16;

Fig. 18 is a fragmentary sectional view taken along line 49—49 in Fig. 16;

Fig. 19 is a sectional view taken along line 50—50 in Fig. 18;

Fig. 20 is a view similar to Fig. 18 but showing the contacts which are snapped in response to snapping of the snap-acting mechanism in the opposite extreme position from that shown in Fig. 18;

Fig. 21 is a sectional view taken along line 52—52 in Fig. 20;

Fig. 22 is a plan view showing the modified parts of the embodiment of Figs. 1—15 according to a second modification which can be applied to each of the embodiments shown in the drawings, these parts being shown in full lines in one extreme position of relative movement and in broken lines in the opposite extreme position of relative movement;

Fig. 23 is a front elevation of the switch shown in Fig. 22;

Fig. 24 is a sectional view taken along line 55—55 in Fig. 23;

Fig. 25 is a view similar to Fig. 23 but fragmentary and showing the contacts which are snapped in response to snapping of the snap-acting mechanism in the opposite extreme position from that shown in Fig. 23;

Fig. 26 is a sectional view taken along line 57—57 in Fig. 25;

Fig. 27 is a more or less diagrammatic sectional view taken substantially along the line 58—58 in Fig. 22 but being on an enlarged scale;

Fig. 28 is a view similar to Fig. 27 but showing the parts in broken lines at the initial position of relative movement shown in Fig. 27 and showing the parts in full lines at their position of relative movement (in the respective directions indicated by the arrows) immediately after snapping of the inner contacts in response to snapping of the snap-acting mechanism, the inner contacts also being shown in broken lines immediately prior to snapping thereof in response to snapping of the snap-acting mechanism;

Fig. 29 is a view similar to Fig. 27 but showing the parts in broken lines at the position of relative movement shown in full lines in Fig. 28 and showing the parts in full lines at the position of relative movement of the parts after full throw of the actuating means which effects movement of the parts in the respective directions indicated by the arrows in this figure and in Fig. 28;

Fig. 30 is a view similar to Fig. 27 but showing the parts in broken lines at the position of relative movement shown in full lines in Fig. 29 and showing the parts in full lines at their position of relative movement (in the respective directions indicated by the arrows) immediately after snapping of the inner contacts in response to snapping of the snap-acting mechanism, the inner contacts also being shown in broken lines immediately prior to snapping thereof in response to snapping of the snap-acting mechanism; and

Fig. 31 is a view similar to Fig. 27 but showing the parts in broken lines at the position of relative movement shown in full lines in Fig. 30 and showing the parts in full lines at the extreme position of relative movement in the directions indicated by the arrows in this figure and in Fig. 30.

The term "contact" as used throughout this specification is intended to encompass any means which is engageable and disengageable with another means for the purpose of providing an electrically conductive path when these two means are mutually engaged and for disrupting that path when these two means are mutually disengaged. By way of example it is pointed out that, whereas the electrical contacts disclosed herein which are moved for make and break purposes by a spring member comprise, in some instances, structure in addition to the spring member, an equivalent arrangement would be to eliminate this additional structure whereby the portion of the spring member which would then engage and disengage a co-operating contact would provide the contact-forming structure.

Referring to Figures 1 to 15 of the drawings, the snap-acting mechanism shown includes a double-looped, snap-acting member generally indicated by the reference numeral 30. Snap-acting member 30 is formed by a strip of springy material such as phosphor-bronze, beryllium-copper, or spring-steel and has a high width-to-thickness ratio. Member 30 may be, for example, twenty to twenty-five times wider than it is thick. Snap-acting member 30 is secured adjacent each of its ends to base 31 by means of studs 32, 33. Base 31 of this embodiment, as well as the base of each of the other embodiments disclosed herein, is formed of a suitable electrically insulating material such as one of the customary molded plastics, ceramics, etc. Stud 32 passes through washer 34, an aperture in snap-acting member 30, washer 36, an aperture 37 (see Fig. 7) in member 38, washer 39, and is fixedly secured to and supported by member 40. Stud 33 passes through an aperture in washer 44, through an aperture in snap-acting member 30, in threaded engagement with a nut 47, and is fixedly secured to and supported by member 40. Supporting member 40 is fixedly supported on base 31 by means such as rivets 41 and 42. The spacing of studs 32 and 33 with respect to each other is such that the opposite ends of snap-acting member 30 are forcibly urged away from each other to put member 30 in tension. The end of snap-

acting member 30 adjacent stud 33 is permanently secured upwardly (as viewed in Fig. 2) and out of the normal plane of the snap-acting member thereby to warp it to a first condition in the manner clearly described in the specification of Patent No. 700,213 (see particularly Figs. 17 and 20 of the drawings attached to the specification referred to). Reference may be made to that specification for the details of construction and function of this snap-acting member.

The snap-acting mechanism of this embodiment further includes a member 50 integral with snap-acting member 30 as shown in Fig. 1 or otherwise fixedly secured thereto. In this instance, member 50 is formed of springy material, which may be the same material of which snap-acting member 30 is formed, and has a high width-to-thickness ratio. Accordingly, member 50 is readily flexible in opposite directions along a plane perpendicular to its width and is substantially non-flexible in a plurality of opposite directions along the plane in which member 50 lies. This last-mentioned plane is disposed at a substantial angle with respect to said plane along which member 50 is readily flexible, namely: 90°. Thus, where, as in this instance, both member 50 and member 30 are flexible in one plane, and non-flexible in a plane substantially at 90° thereto, the composite structure of these two members can be considered as a spring member. However, if desired, member 50 may be non-flexible, in which case member 30 may be considered as the spring member. In any event, it will be apparent as this description proceeds that snapping of the snap-acting mechanism of this embodiment, as well as that of each of the embodiments described herein, results in flexure of the spring member for making and breaking movement of at least one electrical contact.

The free end of member 50 carries an electrical contact 53 for co-operation with an electrical contact 54. Contact 54 is fixedly secured to member 38 by means of a rivet 55 or any other equivalent means. The free end of member 50 also carries an electrical contact 56 for co-operation with another electrical contact 57. Contact 57 is fixedly secured to member 38 by means such as a rivet 58. Electrical leads 59 and 60 are connected to contacts 57 and 54, respectively, as shown in Fig. 1 in any suitable manner such as by welding. Stud 33 supports the end of snap-acting member 30 adjacent thereto a slight distance above the normal plane of member 30 whereby member 30, in the position of the parts shown in Figs. 2—4, is biased to the above-mentioned first condition. With the parts in this condition, snap-acting member 30 urges the free end of member 50 upwardly resiliently to urge contact 53 into engagement with and against co-operating contact 54 and resiliently to urge contact 56 out of engagement with and away from co-operating contact 57. Snap-acting member 30 is snappable, by means later to be described, from this first condition to a second condition whereby the free end of member 50 is quickly moved downwardly to snap contact 53 out of engagement with contact 54 and to snap contact 56 into engagement with contact 57. Also, the snap-acting mechanism of this embodiment is snappable from said second condition back to said first condition whereby contact 56 is snapped out of engagement with contact 57 and contact 53 is snapped into engagement with contact 54. As shown in Figs. 1, 2 and 4, an electrical lead 61 is secured against member 40 by rivet 42 whereby snap-acting element and contacts 53 and 56 are electrically connected to lead 61.

It will be clear that either set of the above-described co-operating contacts could be eliminated if the function of these contacts were not desired or required. For example, an insulating piece could be substituted for either of contacts 53 or 54 in which event the switch would be merely a single-throw switch rather than a double-throw switch as shown in Figs. 1—15. Alternatively, of course, an insulating piece could be substituted for either of contacts 56 or 57 in the same manner as described above with respect to contacts 53 and 54.

A pin 68 is fixed to member 40 and rides in a slot 69 which is provided in member 38. Member 38, along with washers 34 and 36, is pivotable about stud 32 between limits fixed by the engagement of pin 68 with the opposite ends of slot 69.

The switch of this embodiment may be provided with a spring 65 secured to base 31 by studs 66 and 67 and having a portion abutting member 38 pivotally to bias member 38 to the position shown in full lines in Fig. 1. With this arrangement, member 38 can be pivoted downwardly from the full-line position shown in Fig. 1, in response to a downwardly applied force against member 38 and can then be pivoted upwardly by merely releasing this applied force to permit spring 65 to return member 38 back to the full-line position shown in Fig. 1. Alternatively, spring 65 and studs 66 and 67 could be eliminated from the switch whereby member 38 could be returned back to the full-line position shown in Fig. 1 manually or by a different force-applying means. In any event, member 38 is pivotable in each of two opposite directions in response to an applied force corresponding to that direction.

In this embodiment, the means for effecting snapping of the snap-acting mechanism from said first condition to said second condition and from said second condition to said first condition includes a cam 64 carried by member 38. When member 38, in response

to or under an applied force, is moved downwardly as viewed in full lines in Fig. 1, cam 64 is moved against the relatively adjacent portion of snap-acting member 30 whereby a portion of this applied force is utilized to elevate that adjacent portion and thereby effect snapping of the snap-acting member from said first condition to said second condition. Also, when member 38, in response to or under a force applied by spring member 65 or other means, is moved upwardly as viewed in Fig. 1, cam 64 is moved away from said relatively adjacent portion of snap-acting member 30 to permit that relatively adjacent portion to move downwardly and thereby effect snapping of the snap-acting member from said second condition to said first condition.

Since contacts 54 and 57 are fixed with respect to member 38, they are laterally moved in an arcuate path relative to contacts 53 and 56, respectively, in response to or under the corresponding applied force which effects pivotal movement of member 38 in each of the two opposite directions. The parts of this embodiment, and each of the other exemplary embodiments disclosed herein, are so constructed and arranged that the snap-acting mechanism is snapped from one of said conditions to the other during the corresponding laterally relative movement of the respective co-operating contacts. It is noted that the path of the laterally relative movement of the contacts lies at a substantial angle to the direction of movement of the contacts between their make and break positions.

A preferred setup of the parts of this embodiment provides substantially the operational sequence depicted in Figs. 3—6 and 8—15. It will be noted that the respective dotted-line positions of the contacts as shown in each of Figs. 13—15 are the same as the corresponding full-line positions of these contacts in the respective, immediately preceding figure. During downward pivotal movement of member 38 from the full-line position shown in Fig. 1, the snap-acting mechanism will be snapped from said first condition to said second condition at substantially the relative position of member 50 and contacts 54 and 57 indicated in full lines in Figs. 9 and 13. Slot 69 and pin 68 permit further relative movement of contacts 54 and 57 relative to member 50 to substantially the position shown in full lines in Figs. 10 and 14. During this further relative movement the snap-acting mechanism, of course, remains in said second condition. During return movement or movement in the opposite direction of contacts 54 and 57, cam 64 will be released from the relatively adjacent portion of snap-acting member 30 to permit the latter to snap from said second condition to said first condition at substantially the relative position of the parts shown in Figs. 11 and 15. Continued relative movement of contacts 54 and 57 in this direction with respect to member 50, will bring the parts back to the relative position shown in full lines in Figs. 1, 12 and 15. During this continued relative movement snap-acting member 30, of course, will remain in said first condition.

Accordingly, it is apparent that contacts 54 and 57 are movable laterally in an arcuate path relative to contacts 53 and 56 before, at and after snapping of the snap-acting mechanism in both of the opposite directions of pivotal movement of member 38. Also, it is apparent that the path of the laterally relative movement between the co-operating contacts of each of the respective pairs is disposed at a substantial angle to the direction of relative movement of these contacts between their mutually engaged and mutually disengaged position.

When either of contacts 53 or 56 is engaged with but not stuck to its co-operating contact 54 or 57, respectively, the above-described laterally relative movement between these mutually engaged contacts results in a frictional force between these contacts. In this embodiment, as well as in each of the embodiments disclosed herein, at least a portion of this frictional force acts on and is resisted by the spring member in a plane or direction in which it is substantially non-flexible. In the same manner, when either of contacts 53 or 56 is welded or otherwise stuck to its co-operating contact 54 or 57, respectively, any attempt to move one of these contacts laterally relative to the other results in a force between these contacts which likewise acts on and is resisted by the spring member in a plane or direction in which the spring member is substantially non-flexible. Since at least a portion of the resulting force between the mutually engaged contacts is resisted by the spring member in a plane or direction in which the spring member is substantially non-flexible, at least a portion of the force applied to actuate the switch will be effective acting through the spring member to overcome the force between the contacts. It follows that since the spring member resists this portion of resulting force rather than yielding thereunder by flexing, any weld which might have formed between the contacts will be broken or sheared apart and the switch will remain in operative condition. Of course, any other sticking effect between the contacts will be alleviated in the same manner.

It will be apparent, as this description proceeds, that the same holds true for each of the other embodiments set forth herein.

Furthermore, any tendency for a weld to form between two co-operating contacts is counteracted inherently by this improved switch due to the laterally relative movement between the contacts. This result obtains for the reasons that the contacts tend to wipe

themselves clean of any molten metal therebetween, the contacts continually present relatively cool surfaces to each other during the intervals in which arcing may occur, and, as is obvious, a weld will not form between parts so long as they are moving relative to each other.

Another important advantage which flows from this invention is that the laterally relative movement of the co-operating contacts, which takes place each time the switch is actuated, results in the contacts wiping and abrading themselves against each other whereby a constantly clean surface, free of sulfides, oxides and other foreign material, is presented by each contact to the contact with which it co-operates for make and break.

Still another important advantage of this improved switch is that the force under which the contacts are moved laterally relative to each other is independent of the force exerted by snapping of the snap-acting member. Obviously, the force exerted on the contacts by snapping of the snap-acting member. limited, whereas with the switch of this invention, the force available for the laterally relative movement of the contacts is not so limited.

As the description proceeds, it will become apparent that each of the advantages pointed out above is provided by each of the respective embodiments set forth herein.

It will be apparent that the present invention is not limited to the particular form of snap-acting member, snap-acting mechanism or spring member described and that, whereas the contacts carried by the spring member are moved laterally of the co-operating contacts, the co-operating contacts could as well be moved laterally of the contacts carried by the spring member.

Figs. 16 to 21 illustrate a modification which can be applied to and incorporated into a switch structure embodying this invention. In the light of the following description it will become apparent that regardless of the particular form of snap-acting member and regardless of the relationship between the spring member or members and the snap-acting member, the modification now to be described can be incorporated in a device of this invention. However, to avoid unnecessarily complicating this description, only the embodiment shown in Figs. 1—15 has been so modified by way of example.

The parts of this modified switch are or may be substantially identical with those of the embodiment as shown in Figs. 1—15 except as pointed out hereinafter. In this regard, those parts of the modified switch structure shown in Figs. 16 to 21 which have primed reference numerals are or may be identical with their respective counterparts in Figs. 1—15, these respective counterparts having the same but unprimed reference numerals.

The modified switch structure shown in Figs. 16 to 21 includes a member 50' which may or may not be a spring member as explained above with respect to member 50 of the embodiment shown in Figs. 1—15. Member 50' carries electrical contacts 53' and 56' and forms part of the snap-acting mechanism 30' whereby member 50' snaps in or along its flexible plane upon snapping of the snap-acting mechanism in the manner set forth with respect to the counterparts of the embodiment of Figs. 1—15. However, according to this modification, two additional spring members 220, 221 are provided, each of which has the same flexibility characteristics as those ascribed to the spring member of the previously described embodiment. Spring members 220 and 221 are mounted for movement with member 222 by means of a rivet 224 or its equivalent which clamps an end portion of spring member 220 between blocks 225 and 226 and clamps an end portion of spring member 221 between blocks 226 and 227. It will be noted that member 222 is or may be identical with member 38 of the embodiment as shown in Figs. 1—15 except that it is cut away as indicated at 223 to avoid interference between it and adjacent structure. Each of blocks 225, 226 and 227 is formed of suitable electrically insulating material whereby spring members 220 and 221 are electrically insulated from each other.

Each of spring members 220 and 221 may be resiliently biased into engagement with that one of electrical contacts 229 and 230 to which it is adjacent as shown in the drawing. In this manner, spring members 220 and 221 remain in electrical connection with contacts 229 and 230, respectively, throughout operation of this switch. Contact 229 is supported by base 31' by means of a screw 231 which also clamps a lead 232 in electrical engagement with this contact. Likewise, contact 230 is mounted on base 31' by means of a screw 233 which also clamps a lead 234 in electrical engagement with this contact. It will be clear, then, that contacts 53', 56', 229 and 230 are fixedly mounted directly or indirectly through intermediate means on base 31' whereas spring members are mounted for movement with member 222 and relative to each of these contacts.

In operation, movement of member 222 from the full-line to the dotted-line position shown in Fig. 16 is effective to move contacts 53' and 56' relative to base 31' in the same manner that corresponding movement (in the embodiment of Figs. 1—15) of member 38 effects movement of contacts 53 and 56 relative to base 31. In the full-line position of the parts in Figs. 16 to 19, however, contact 53' electrically connects with and presses against the adjacent portion of spring member 220 whereby this latter portion is biased against contact 229. Accordingly, when

in this position, contact 53' is electrically connected through spring member 220 with contact 229, and of course, contact 56' is electrically disconnected from contact 230. When member 222 is moved to the dotted-line position shown in Fig. 16, thereby effecting snapping of contacts 53' and 56' to the position shown in Figs. 20 and 21, contact 56' electrically connects with and presses against the adjacent portion of spring member 221 whereby this latter portion is biased against contact 230. Accordingly, when in this position, contact 56' is electrically connected through spring member 221 with contact 230, and of course, contact 53' is electrically disconnected from contact 229.

It will be clear that, with this modification, movement of member 222 from the full-line to the dotted-line position shown in Fig. 16 is also effective to move or swing spring members 220 and 221 about stud 32' and laterally relative to each of contacts 53', 56', 229 and 230. Since spring members 220 and 221 are laterally movable relative to contacts 53', 56', 229 and 230 in opposite directions along a path lying at a substantial angle with respect to the direction of relative movement of these contacts during make and break thereof, it is clear that the advantages and novel characteristics ascribed above with respect to the previously described embodiments are also provided by this modification. In addition, with this modification the problem of electrically connecting contacts 229 and 230 in the desired circuitry is simplified since these latter contacts (in contradistinction to contacts 54 and 57 of the embodiment as shown in Figs. 1—15) are fixed relative to base 31'. For example, the use of pigtails leading to contacts 229 and 230 is avoided. Furthermore, due to the resiliency and/or "take-up" of each of spring members 220 and 221 in its respective plane of flexibility, the tendency for contacts 53' and 56' to bounce when snapped into electrical connection with contacts 229 and 230, respectively, is materially reduced. It will be obvious that in an installation where none of the pressure by which the contacts are held closed can be sacrificed, intermediate spring members 220 and 221 can be arranged to be biased against contacts 229 and 230, respectively, immediately adjacent the place where the intermediate contacts are respectively engaged by contacts 53' and 36'. It will be equally clear that by this latter arrangement, the reduction of contact bounce will be correspondingly relinquished.

It is well known in the art of snap-acting switches of the general type described herein that, unless accommodation is provided therefor, a contact which is snapped out of engagement with a co-operating contact will ordinarily creep or tend to creep away from the co-operating contact a substantial distance before snap movement ensues. Among the disadvantages and deleterious effects of this creep are arcing between the contacting surfaces of the contacts and consequent deterioration of these surfaces. With a snap-acting switch which incorporates a spring member as described earlier in this description, this creep during movement of the snappable contact in one direction can be eliminated by decreasing the gap between the open and closed positions of these contacts an amount equal to the range throughout which the snappable contact would otherwise creep in that direction. However, this has the accompanying effect of decreasing, by the same amount, the extent of snap motion of the snappable contact in the opposite direction. If the creep in the said opposite direction were to be eliminated in the same manner, snap motion in said one direction would likewise be decreased the same amount. The modification now to be described, along with the provision of the advantages ascribed above with respect to the previously described embodiments, provides the added feature of avoiding this creep effect while permitting the snappable contact to snap throughout its full range of snap motion in both of its opposite directions of movement, and this applies when the switch is of the double-throw type as well as the single-throw type.

According to the modification now to be described at least two electrical contacts are provided, and the spring member and one of these contacts are mounted for urging the contacting surfaces of the two contacts together in a direction at an oblique angle with respect to at least one of the contacting surfaces. The result is that laterally relative movement between the two contacts is effected and, at the same time, the snap-acting mechanism is stressed in a direction to cause snapping of the snap-acting mechanism. By way of example, Figs. 22 to 31 depict the manner in which the embodiment illustrated in Figs. 1—15 may be altered to incorporate this modification. The present modification can be incorporated in a device of this invention regardless of the particular form of snap-acting member and regardless of the particular relationship between the spring member or members and the snap-acting member.

The modification shown in Figs. 22 to 31 will be or may be identical to the embodiment shown in Figs. 1—15 except as pointed out hereinafter. In this regard, the parts shown in Figs. 22 to 31 which are provided with double-primed reference numerals are or may be identical to their respective counterparts in the embodiment shown in Figs. 1—15. Although a cam 64'' equivalent to cam 64 of Figs. 1—15 will be referred to, it is in fact not shown in Figs. 22—26.

According to this modification, contacts 240 and 242, which correspond to contacts 54 and

57 of the embodiment of Figs. 1—15, provide inclined contacting surfaces 241 and 243, respectively. As noted in Figs. 23 to 31, surfaces 241 and 243 lie at an oblique angle to the planes or directions in which spring member 50^{11} is flexible and non-flexible, and these surfaces are substantially parallel with each other. Member 244 is or may be identical with member 38 of the embodiment shown in Figs. 1—15 except that member 244 may be provided with a recess or cut-away portion 245 to accommodate contact 242 (see particularly Figs. 23 and 24).

When member 244 is swung downwardly in the direction of the arrow as viewed in Fig. 22, contacts 240 and 242 will move from the broken-line toward the dotted-line position as shown in Fig. 28 and contact 240 will be urged against contact 53^{11} in a direction parallel with that of the arrow in the upper left-hand portion of Fig. 28. As is apparent from Fig. 28, the direction in which contact 240 and contact 53^{11} are urged together is at an oblique angle with respect to surface 241 of contact 240. This urging of contacts 240 and 53^{11} against each other results from the continuous decrease in the effective height of contact 240 relative, for example, to a point on base 31^{11} directly below contacts 53^{11} and 56^{11} during the movement of contact 240 from the full-line to the broken-line position of Fig. 28. During the movement of contact 240 from the broken-line to the full-line position shown in Fig. 28, contact 53^{11} will move from the uppermost, broken-line position to the intermediate, broken-line position shown in Fig. 28. It will be clear that during the above-described movement of contact 240, contacts 240 and 53^{11} will have moved laterally relative to each other. Also, as contact 53^{11} moves from the uppermost, broken-line position to the intermediate, broken-line position shown in Fig. 28, the adjacent portion of spring member 50^{11} will have moved the same amount and in the same direction to stress the snap-acting mechanism in a direction to cause snapping of the snap-acting mechanism. With contact 240 continuing to move in the direction of the arrow in the upper left-hand portion of this figure, the snap-acting mechanism will be snapped quickly to flex or snap contact 53^{11} out of engagement with contact 240 and quickly to flex or snap contact 56^{11} into engagement with contacting surface 243 of contact 242. Fig. 28 shows the parts in full lines immediately after this snapping of the snap-acting mechanism.

It will be apparent then that snapping of the snap-acting mechanism resulting in snapping of contact 53^{11} to the full-line position shown in Fig. 28 is accomplished under the combined influence of cam 64^{11} and the urging of the contacting surfaces of contacts 240 and 53^{11} against each other. Since the effective height of contact 240 continuously decreases during movement from the broken-line to the full-line position shown in Fig. 28, creep of contact 53^{11} away from contact 240 is at least partially taken up. In fact, so long as contact 240 continues to be urged against contact 53^{11} to just beyond the point at which the latter snaps away from contact 240, it is obvious that creep of contact 53^{11} away from contact 240 is impossible. As will be obvious, the effectiveness of cam 64^{11} in snapping of the snap-acting mechanism as compared to that due to urging of contacts 240 and 53^{11} against each other may be varied as desired.

Immediately after snapping of the snap-acting mechanism, movement of contacts 240, 242, 53^{11} and 56^{11} takes place from the broken-line to the full-line positions shown in Fig. 29.

Since contacts 240 and 242 are fixed with respect to each other and when the spacing between contacting surfaces 241 and 243 as measured in the direction of movement of contacts 53^{11} and 56^{11} is sufficient to permit snapping of the snappable contacts through the full range which they are capable of snapping (in both directions), it will be clear that contact 53^{11} will snap through this full range. That is, since contacting surfaces 241 and 243 remain spaced apart a distance sufficient to permit snapping of contact 53^{11} through its full range of snap movement, at the instant when snapping of contact 53^{11} occurs contacting surfaces 241 and 243 are necessarily so spaced apart.

It will be clear that movement of contacts 240 and 242 in the opposite direction as depicted in Figs. 30 and 31 will effect the same results as ascribed above with respect to Figs. 28 and 29 since the coaction between the parts is then the same but in respectively reverse directions.

It will be apparent that the laterally relative movement between contacts 240 and 53^{11} and between contacts 242 and 56^{11} provides the wiping effect between the respectively engaged contacts along with the ensuing advantages and the other advantages as ascribed above with respect to the previously described embodiments.

Depending upon the obliqueness of the angle presented by contacting surfaces 241 and 243 with respect to the direction in which the respective contacts are urged together, the cam 64^{11} and/or any other actuating means which might otherwise be provided for effecting snapping of the snap-acting mechanism, can be eliminated whereby the snap-acting mechanism would be snapped solely due to the action of the respective contacts being moved against each other. Accordingly, it will be clear that this arrangement, whereby at least one of the contacts presents a contacting surface lying at an oblique angle to the direction in which the contacts are urged together, may be incorporated into any of the previously

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described embodiments or it may be substituted for the actuating means for the snap-acting mechanism of any of the previously described embodiments. It will be equally clear that in those cases where snapping of the snap-acting mechanism is effected solely by the urging of two contacts together in a direction at an oblique angle with respect to the contacting surface of at least one of the contacts, creep of the contacts away from each other is impossible. Obviously, the angle presented by at least one of the contacting surfaces to the direction in which the contacts are urged together need not remain constant along its respective length, but may vary as desired. Also, depending upon factors such as the operating characteristics to be provided by a particular switch of the double-throw type, corresponding portions of contacting surfaces such as surfaces 241 and 243 need not be, but in many instances preferably are, parallel with each other.

It will be noted that incorporation of this modification in the switch embodiment of Figs. 1—15 entails simply twisting the two outermost contacts in the manner described.

Another advantage of this modification is that loss or decrease in the pressure exerted by the snappable contact against the contact with which it is associated is counteracted, at least at the initial portion of the actuation which is effective to snap the snap-acting mechanism. Also, incorporation of this modification lessens the criticality of setting or arranging the parts to eliminate creep of one of the contacts away from another.

Numerous variations other than that particularly described with respect to Figs. 22 to 31 will suggest themselves in the light of this disclosure. By way of example, the surfaces of contacts 53 and 56 of the embodiment shown in Figs. 1—15 could be correspondingly inclined rather than or in addition to modifying the inclination of the surfaces of contacts 54 and 57 in the manner depicted by contacts 240 and 242 in Figs. 22 to 31.

It will be clear that during operation of each of the exemplary embodiments and modifications disclosed herein, wiping movement between at least one pair of contacts is continuously effected so long as these contacts are mutually engaged.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

Dimensions of certain of the parts and movements of certain of the parts have been exaggerated in the drawings for the purpose of clarity of illustration.

WHAT WE CLAIM IS:—

1. An electrical switch comprising one or more interengaging first and second contacts, the second contacts being carried by a snap-acting resilient member having a high width-to-thickness ratio so that it is flexible longitudinally of its length and relatively rigid transversely of its length, which resilient member upon flexure serves to snap the second contacts into and out of engagement with the first contacts associated therewith, the switch further comprising a member operable to impart lateral movement to the first contacts, with respect to the second contacts, and which is formed with means for flexure and operation of the snap-acting resilient member.

2. A switch according to Claim 1 in which the snap-acting resilient member is a flat metal spring.

3. A switch according to Claim 1 or 2 in which the means formed on said member comprises a cam.

4. A switch according to any one of the preceding claims in which the surfaces of the first contacts are inclined with respect to the surfaces of the second contacts.

5. A switch according to any one of Claims 1—3 in which the surfaces of the second contacts are inclined with respect to the surfaces of the first contacts.

6. A switch according to any one of the preceding claims in which a spring member is interposed between the first and second contacts.

7. A switch according to any one of the preceding claims in which the lateral movement of the first contacts with respect to the second contacts is along a path lying at an angle to the longitudinal axis of the snap-acting resilient member.

8. A switch according to any one of the preceding claims in which the force due to the lateral movement of the first contacts with respect to the second contacts when the contacts are in interengagement, is partly resisted by the snap-acting resilient member in a direction substantially transversely of its length.

9. A switch according to any one of the preceding claims in which the member arranged to impart movement to the first contacts has means operable to limit the extent of said movement.

10. An electrical switch constructed and arranged to operate substantially as hereinbefore described with reference to Figs. 1—15, or as modified by Figs. 16—21 or by Figs. 22—31 of the accompanying drawings.

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Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1961.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

described embodiments or it may be substituted for the actuating means for the snap-acting mechanism of any of the previously described embodiments. It will be equally clear that in those cases where snapping of the snap-acting mechanism is effected solely by the urging of two contacts together in a direction at an oblique angle with respect to the contacting surface of at least one of the contacts, creep of the contacts away from each other is impossible. Obviously, the angle presented by at least one of the contacting surfaces to the direction in which the contacts are urged together need not remain constant along its respective length, but may vary as desired. Also, depending upon factors such as the operating characteristics to be provided by a particular switch of the double-throw type, corresponding portions of contacting surfaces such as surfaces 241 and 243 need not be, but in many instances preferably are, parallel with each other.

It will be noted that incorporation of this modification in the switch embodiment of Figs. 1—15 entails simply twisting the two outermost contacts in the manner described.

Another advantage of this modification is that loss or decrease in the pressure exerted by the snappable contact against the contact with which it is associated is counteracted, at least at the initial portion of the actuation which is effective to snap the snap-acting mechanism. Also, incorporation of this modification lessens the criticality of setting or arranging the parts to eliminate creep of one of the contacts away from another.

Numerous variations other than that particularly described with respect to Figs. 22 to 31 will suggest themselves in the light of this disclosure. By way of example, the surfaces of contacts 53 and 56 of the embodiment shown in Figs. 1—15 could be correspondingly inclined rather than or in addition to modifying the inclination of the surfaces of contacts 54 and 57 in the manner depicted by contacts 240 and 242 in Figs. 22 to 31.

It will be clear that during operation of each of the exemplary embodiments and modifications disclosed herein, wiping movement between at least one pair of contacts is continuously effected so long as these contacts are mutually engaged.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

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1. An electrical switch comprising one or more interengaging first and second contacts, the second contacts being carried by a snap-acting resilient member having a high width-to-thickness ratio so that it is flexible longitudinally of its length and relatively rigid transversely of its length, which resilient member upon flexure serves to snap the second contacts into and out of engagement with the first contacts associated therewith, the switch further comprising a member operable to impart lateral movement to the first contacts, with respect to the second contacts, and which is formed with means for flexure and operation of the snap-acting resilient member.

2. A switch according to Claim 1 in which the snap-acting resilient member is a flat metal spring.

3. A switch according to Claim 1 or 2 in which the means formed on said member comprises a cam.

4. A switch according to any one of the preceding claims in which the surfaces of the first contacts are inclined with respect to the surfaces of the second contacts.

5. A switch according to any one of Claims 1—3 in which the surfaces of the second contacts are inclined with respect to the surfaces of the first contacts.

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9. A switch according to any one of the preceding claims in which the member arranged to impart movement to the first contacts has means operable to limit the extent of said movement.

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