April 23, 1963 F. P. SPINELLI ET AL 3,087,031

SOLENOID-OPERATED SWITCH

Filed June 20, 1960 2 Sheets-Sheet 1

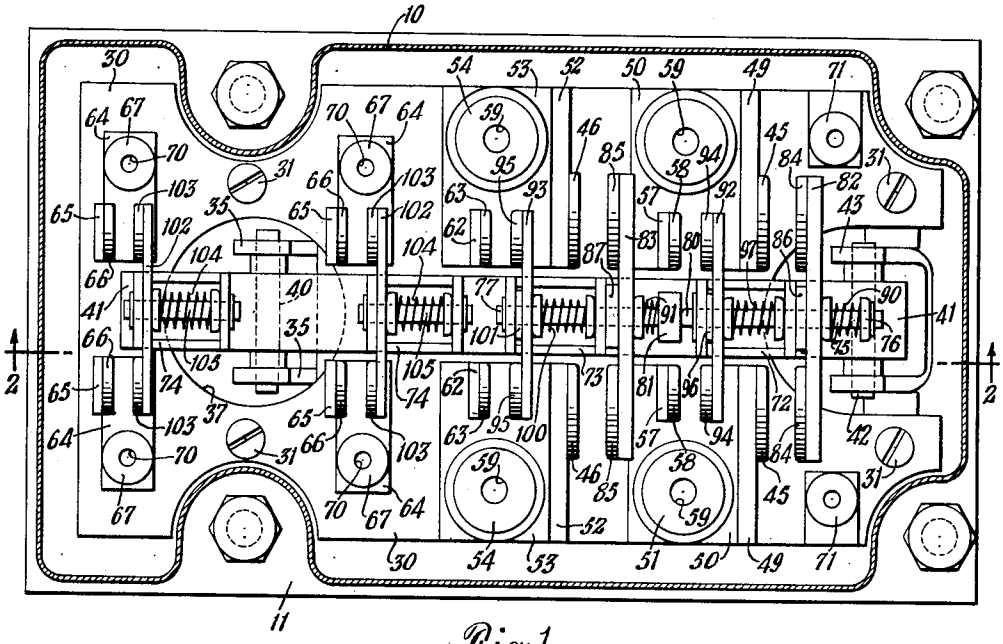


Fig:1.

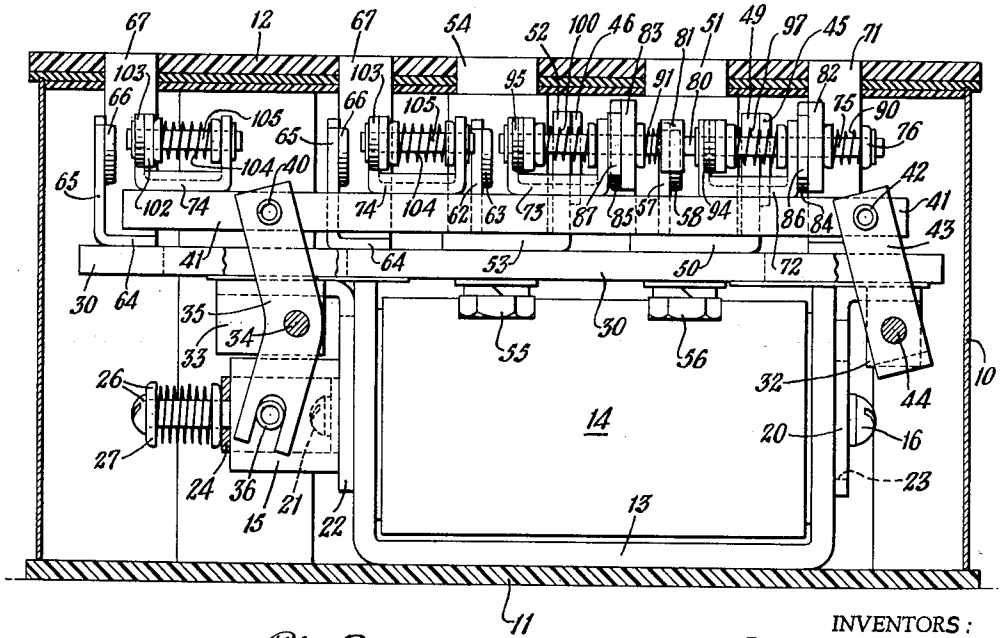


Fig:2.

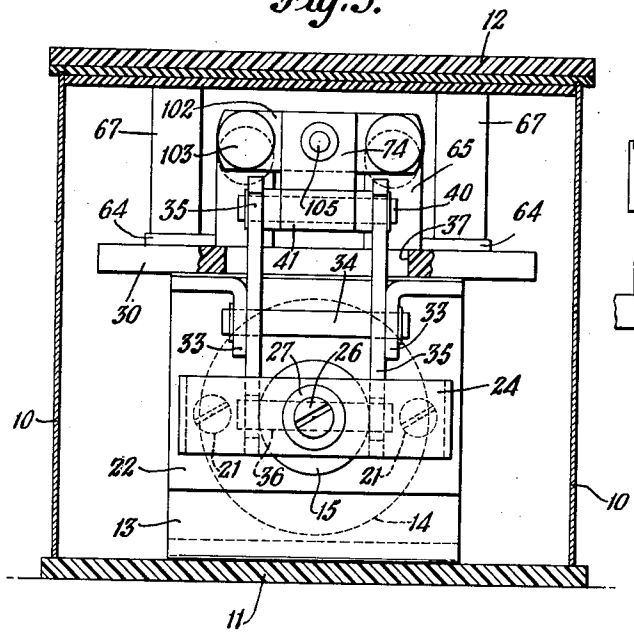
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Fig:3.



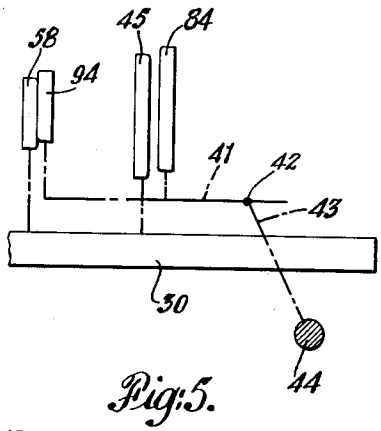
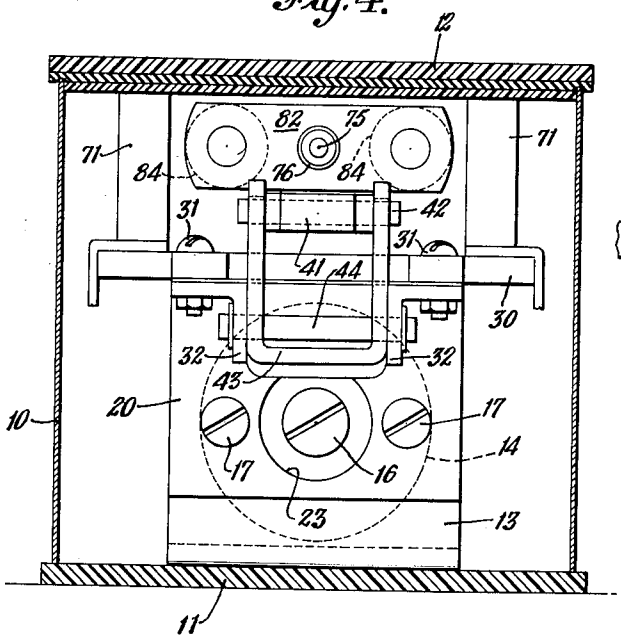


Fig:5.

Fig:4.



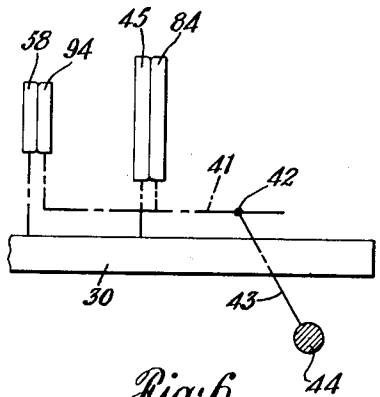


Fig:6.

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SOLENOID-OPERATED SWITCH

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4 Claims. (Cl. 200—104)

This invention relates generally to switches or relays and in particular to electromagnetically operated relays in which electrical switch contacts are caused to make and break in response to the actuation of a solenoid.

A serious problem often found in relays of this type is caused by the presence of an undesirably high electrical resistance between the relay contacts when they are engaged. Such resistance, of course, is accompanied by a power loss which results in decreased efficiency of the electrical system. Although this resistance may be low when the relay is new, it often builds up as the relay is used. This build-up of resistance may be caused by erosion of the contacts if there is arcing across the contacts as they make and break, or it may be due to deposits of dirt or other foreign matter on the contacts, or various other circumstances which prevent proper contact over the entire area of the relay contacts.

It is a general object of this invention to alleviate the above and other difficulties by means of a novel relay construction in which arcing across the main contacts is almost entirely eliminated and in which the contacts are caused to wipe across one another each time they make and break, thus insuring that the contacts remain free of dirt and other foreign matter.

The improved relay includes not only main relay contacts but additional arcing contacts which make before and break after the main contacts do, thus eliminating arcing at the main contacts as the latter make and break.

More specifically, the invention provides novel means for transmitting the movement of the solenoid to the movable contact members in order to produce a wiping action of one contact on another. The relay comprises a frame which may carry any number of stationary main contacts and stationary arcing contacts; a solenoid, which may be a round core linear stroke solenoid thus permitting effecient relay design; and an elongated carrier bar preferably arranged parallel to the axis of the solenoid, which carries suitably arranged moveable main and arcing contacts corresponding to the stationary contacts. The movable contacts are spring backed and movable with respect to the carrier bar against the force of their springs. The carrier bar is pivotally connected to the armature of the solenoid by levers which are pivoted to the relay frame in such a way that when the solenoid is energized and the armature moves through its linear stroke, the carrier bar is translated parallel to itself through an arc with respect to the relay frame, thus moving the movable contacts obliquely with respect to the stationary contacts. As a result, after the contacts engage, continued movement of the carrier bar causes the movable contacts to wipe across the stationary contacts as the springs behind the movable contacts are compressed.

It is another object of the invention to provide a relay of the type described wherein the carrier bar and solenoid armature move in opposite directions in order that shock and vibration accelerations on these members will cancel one another. As a result, the tendency of the contacts to close and open under shock is minimized. Furthermore, the weights of the carrier bar and armature, which move in opposite directions, are balanced and a spring is used to effect the return stroke of the armature upon deenergization of the solenoid. Consequently, smooth,

reliable and vibrationless operation of the relay is assured, independent of its mounted orientation.

It is a further object of the invention to provide a relay of the type described in which the arcing contacts are of lesser mass than the main contacts in order to reduce the bounce of the main contacts when they are engaged, thus further reducing any arcing between these contacts.

It is an additional object of the invention to provide a relay of such physical form that it may be conveniently enclosed within a dust-tight housing of economical design.

Other objects and advantages of the invention will be apparent from the following description in which reference is made to the accompanying drawings.

In the drawings:

FIG. 1 is a plan view, partially in section, of an illustrative embodiment of the present relay;

FIG. 2 is a vertical cross-sectional view taken on line 2—2 of FIG. 1;

FIG. 3 is a left-hand end elevational view, partly in section, of the relay shown in FIG. 2;

FIG. 4 is a right-hand end elevational view similar to FIG. 3; and

FIGS. 5 and 6 are schematic views showing the relationship between the main and arcing contacts of the relay.

Referring to FIGS. 1–4, we have chosen to illustrate the invention in a switch having a housing **10**, a bottom wall **11**, and a removable cover **12**. Fastened to the bottom wall **11** is a U-shaped frame **13** positioned with its opposed arms extending upwardly. Between the arms of the U-shaped frame **13** is a linear stroke solenoid **14** having an axially movable armature **15**. A screw **16** helps to properly locate the core of the solenoid and hold it in place with respect to the frame. Mounted on the right-hand arm of the U-frame **13**, by means of the screws **17**, is an angle bracket **20**, and mounted on the left-hand arm of the frame by means of the screws **21**, is an angle bracket **22**. The vertical leg of the bracket **20** is provided with an aperture **23** so that it does not interfere with the screw **16**, and the left-hand arm of the U-frame **13** and the vertical leg of the bracket **22** are provided with a pair of aligned holes to accommodate the solenoid armature **15**. The screws **21** also serve to secure a C-shaped bracket **24** to the vertical leg of the angle bracket **22**.

The body portion of the bracket **24** serves as an abutment for the end of the armature **15** when the solenoid **14** is in deenergized condition (as shown in the drawings). The bracket **24** also serves as a bearing surface for one end of a compression spring **25** which surrounds a stud **26** threaded into the end of the armature **15**. The bracket **24**, of course, is provided with an aperture through which the stud **26** is permitted to pass. The spring **25**, which may be provided with a cup washer **27** at each end, serves to return the armature **15** into abutting relationship with the bracket **24** when the solenoid **14** is deenergized. Supported on the horizontal legs of the angle brackets **20** and **22** is a preferably non-metallic platform **30**, the platform being secured to the angle brackets by the screws **31**. The platform **30** may be fabricated of plastics, or any other suitable type of nonconducting material.

The horizontal arm of the angle bracket **20** is deformed in order to present a pair of opposed downwardly-projecting ears **32**. Similarly, the horizontal leg of the angle bracket **22** is deformed to present a pair of downwardly-projecting ears **33**. A pin **34** is supported between the ears **33**, and a pair of bell crank levers **35** is pivotally mounted on the pin **34**, one of the levers being arranged adjacent to each of the ears **33**. The lower end

of each of the bell cranks 35 is bifurcated for engagement with a pin 36 arranged in a transverse bore in the solenoid armature 15. The upper end of each of the bell cranks 35 projects through an aperture 37 in the platform 30, and is pivotally secured adjacent to the end of a pin 40. The pin 40 extends transversely through a carrier bar 41 arranged above and spaced from the platform 30.

The carrier bar 41 is essentially an elongated strip of preferably non-metallic material, and may be fabricated of plastic or fibrous material. The carrier bar serves as a moving platform for supporting the movable contacts of the relay, as will be described below, and for moving the latter into and out of contact with the stationary contacts. Preferably, the carrier bar is arranged parallel to the axis of the solenoid 14; however, this is not essential.

The pin 40 is arranged near one end of the carrier bar 41, and near the other end of the carrier bar is a similarly arranged pin 42. The ends of the pin 42 are engaged by the arms of a U-shaped idler link 43 which is pivotally mounted on a pin 44 extending between the ears 32 of the bracket 20. It will readily be seen from what has thus far been described that when the solenoid 14 is energized and the armature 15 moves rightwardly in FIG. 2, the bell cranks 35 will be pivoted counterclockwise thus translating the carrier bar 41 in a fixed arc with respect to the frame of the relay. In this way, the linear travel of the armature 15 is converted into the arcurate travel of the carrier bar 41. Note, however, that throughout its travel the carrier bar will remain parallel to the axis of the solenoid.

Mounted on the upper face of the platform 30 are two pairs of fixtures 50 and 53 which carry the stationary main contacts 45 and 46 of the relay. Although only two such pairs of fixtures are shown, it is obvious that any number may be used, depending upon the design of the particular relay. Each of the contacts 45 is mounted on the metallic fixture 50 which comprises besides a base which rests on the platform 30, an upright arm 49, and an upright post 51. The fixture is fastened to the platform 30 by means of the bolt 52. Similarly, the contacts 46 are mounted on the fixture 53 comprising a base, the arm 52, and the post 54. A bolt 55 secures each of the latter fixtures to the platform 30. Each of the posts 51 and 54 is provided with a threaded aperture for accommodating a screw (not shown) to bind an electrical conductor to the post. Fastened to the base of each of the fixtures 50, and in electrical contact therewith, is an upright arm 57 which carries a stationary arcing contact 58. Similar upright arms 62 are fastened to the bases of the fixtures 53, each of these arms carrying a stationary arcing contact 63.

Also mounted on the upper surface of the platform 30 are pairs of auxiliary fixtures 64, each having an upright arm 65 carrying a stationary auxiliary contact 66. A post 67 provided with an axial threaded aperture 70 forms a part of each of the fixtures 64 and permits a conductor to be electrically connected to each of the fixtures. The platform 30 also has mounted on it a pair of posts 71 by means of which the solenoid 14 is connected to a source of power.

Mounted on the carrier bar 41, as by means of rivets (not shown), are four U-shaped brackets 72, 73 and 74. Each of the U-shaped brackets has a pair of upright arms, and each of the arms is provided with a hole which is aligned with the holes in each of the other arms. Extending through the holes in the arms of the brackets 72 and 73 is a shaft 75. The shaft 75 is provided with a pair of collars 76 and 77 fixed at its ends, and a third collar 80 fixed intermediate the ends of the shaft. Adjacent to the collar 80 is an insulator 81, of non-conducting material. Slidably mounted on the shaft 75 is a pair of main contact members 82 and 83, each of which carries two movable main contacts 84 and 85 in opposed relation to the stationary main contacts 45 and 46 respectively. The contact member 82 is arranged between the bracket 72 and the collar 76, and the contact member 83 is mounted between the bracket 73 and the insulator 81. Contact member 82 is spaced from the rightward arm (FIGS. 1 and 2) of the bracket 72 by a washer 86, and contact member 83 is spaced from the rightward arm of the bracket 73 by a washer 87. Between the contact member 82 and the collar 76 is a compression spring 90 provided at each end with a cup washer. The spring 90 urges the contact member 82, or more correctly, the washer 86, against the rightward arm of the bracket 72. Similarly, a compression spring 91 is arranged between the contact member 83 and the insulator 81, and urges the contact member 83 and washer 87 against the rightward arm of the bracket 73.

In addition to the contact members 82 and 83, a pair of arcing contact members 92 and 93 are slidably arranged on the shaft 75. The arcing contact member 92 carries a pair of movable arcing contacts 95, the movable arcing contacts being arranged in opposed relation to stationary arcing contacts 58 and 63 respectively. The arcing contact member 92 is arranged between the arms of the bracket 72, and is spaced from the leftward arm of the bracket by a washer 96. A compression spring 97 arranged between the member 92 and the rightward arm of the bracket 72 urges the member 92 toward the leftward arm of the bracket 72. The arcing contact member 93 is disposed between the arms of the bracket 73 and is spring pressed by a compression spring 100 toward the leftward arm of the bracket 73, from which it is spaced by a washer 101.

Between the arms of each of the brackets 74 is an auxiliary contact member 102 carrying a pair of auxiliary contacts 103 in opposed relation to the stationary auxiliary contacts 66. Each of the contact members 102 is slidably mounted on a short shaft 105 arranged in the aligned holes in the arms of the bracket 74. A compression spring 104, surrounding each of the shafts 105, presses each of the contact members 102 against the leftward arm of its associated bracket 74.

It is highly desirable to position the contact members 82 and 92 in such relation to the fixture 50 carrying the contacts 45 and 58, that the spacing between the movable main contacts 84 and stationary main contacts 45 is slightly greater than the spacing between the movable arcing contacts 94 and the stationary arcing contacts 58. This may easily be done by proper design of the washers 86 and 96. Thus, if the washer 86 is made wider, the contacts 84 will be positioned further from the contacts 45. It will be noticed that once the relative positions of the contact members 82 and 92 are determined, they will always automatically return to their initial relationship when the relay is in deenergized condition, due to the fact that it is the fixed bracket 72 which determines the positioning of these members, together with the compression springs 90 and 91.

The purpose of spacing the arcing contacts 94 and 58 closer together than the main contacts 84 and 45, when the relay is deenergized, may be seen by referring to FIGS. 5 and 6. When the relay is energized, the arcing contacts 94 and 58 engage before the main contacts 84 and 45 engage, and when the relay is deenergized the arcing contacts disengage before the main contacts disengage. As a result, arcing at the main contacts during engagement and disengagement is entirely eliminated, thus doing away with corrosion of the main contacts and the attendant high contact resistance between the main contacts.

It is also desirable to make the movable arcing contacts 94, and the entire arcing contact member 92, of lesser mass than the main contact member 82 and main contacts 84. This is due to the fact that when contacts are engaged, there is always a tendency for the movable contacts to bounce on the stationary contacts, and naturally, the greater the mass of the movable contacts with the same contact pressure, the greater the tendency to bounce. Since the

arcing contacts engage first, their lower mass will minimize the bounce and in addition they will absorb some of the shock and reduce the tendency of the heavier main contacts to bounce when they engage. Reducing contact bounce, of course, reduces arcing across the contacts.

What has been said above concerning the relationship of the contact members **82** and **92** to each other and to the fixture **50** applies as well to the contact members **83** and **93** and the fixture **53**.

It is apparent from an inspection of FIG. 2 of the drawings that the solenoid armature **15** and the carrier bar **41** move in opposite directions. Consequently, any accelerations of these members caused by shock or vibration will cancel one another, thus minimizing the tendency of the contacts to open or close under shock. Furthermore, the weight of the carrier bar **41** and the movable contacts and fittings mounted thereon is so chosen that it balances the weight of the armature **15**. As a result of this, and the fact that a spring **25** is employed to return the armature to deenergized position, the operation of the relay is substantially unaffected by the orientation of the relay.

Notice also that the present relay affords a most compact construction, and hence the entire relay may conveniently and economically be enclosed in a dust-tight container.

In operation, when the solenoid **14** is deenergized the parts of the relay are arranged as shown in the drawings. When the solenoid is energized, the armature **15** moves rightwardly in FIG. 2, thus pivoting the bell crank levers **35** counterclockwise about the pin **34**. As a result, the carrier bar **41** which may be initially arranged parallel to the axis of the solenoid **14**, is swung through a fixed arc while remaining parallel to the axis of the solenoid. It may be seen that the movable contacts carried by the carrier bar are thus moved obliquely with respect to the stationary contacts. The movable arcing contacts **94** and **95** first engage the stationary arcing contacts **58** and **63** respectively, thus closing the main lines. At the same time, the movable auxiliary contacts **103** engage the stationary auxiliary contacts **66**. Such auxiliary contacts are optional and may be employed to perform some auxiliary functions, such as for example, energizing of a signal circuit. Upon further movement of the armature **15** and hence the carrier bar **41**, the main contacts **84** and **85** engage the stationary main contacts **45** and **46**. During this time the springs **97** and **100** are compressed slightly. Upon further movement of the armature **15** and the carrier bar **41**, the springs **90** and **91** are compressed and the springs **97** and **100** are compressed further, thus moving the main contact members **82** and **83** and the arcing contact members **92** and **93** with respect to the carrier bar **41** and the shaft **75**. Since, however, during this further movement of the carrier bar **41**, the latter is moved downwardly toward the platform **30**, all the movable contacts are also moved downwardly in a vertical plane with respect to their associated stationary contacts. The result is an automatic wiping action of the movable contacts on the stationary contacts. This wiping action insures that the contacts always remain clean and make perfect contact.

The invention has been shown and described in preferred form only and by way of example, but many variations and modifications may be made in the invention and in its mode of application which will still be comprised within its spirit. It is understood, therefore, that the invention is not limited to any specific form or embodiment, except insofar as such limitations are specified in the appended claims.

What is claimed is:

1. A relay having a frame, stationary main and arcing contacts fixed with respect to said frame, a carrier bar translatable parallel to itself in an arcuate path, a pair of upstanding abutments fixed on said carrier bar in spaced relation, a shaft fixed to and extending longitudinally along said carrier bar, a movable main contact member slidable on said shaft, a main spring normally maintaining said movable main contact member against one of said abutments wherein it is spaced from said stationary main contact, a movable arcing contact member slidable on said shaft, an auxiliary spring normally maintaining said movable arcing contact member against the other of said abutments wherein it is spaced from said stationary arcing contact, said movable main and arcing contacts being thereby normally maintained in a fixed spaced relationship, and a solenoid for translating said carrier bar to bring said movable contacts into engagement with said stationary contacts and to slide said movable contacts across said stationary contacts as said springs are compressed.

2. A relay according to claim 1 wherein the spacing between said arcing contacts is smaller than the spacing between said main contacts.

3. A relay according to claim 2 wherein the mass of said movable arcing contact is less than the mass of said movable main contact.

4. A relay having a frame, a stationary contact member fixed with respect to said frame, a carrier bar translatable parallel to itself in an arcuate path, an upstanding abutment fixed on said carrier bar, a shaft fixed to and extending longitudinally along said carrier bar, a movable contact member slidable on said shaft, a spring normally maintaining said movable contact member against said abutment wherein it is spaced from said stationary contact member, and a solenoid for translating said carrier bar to bring said movable contact member into engagement with said stationary contact member and to slide said movable contact member across said stationary contact member as said spring is compressed.

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