April 15, 1958 H. F. MASON 2,831,081

ELECTRIC SWITCH

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FIG. 1.

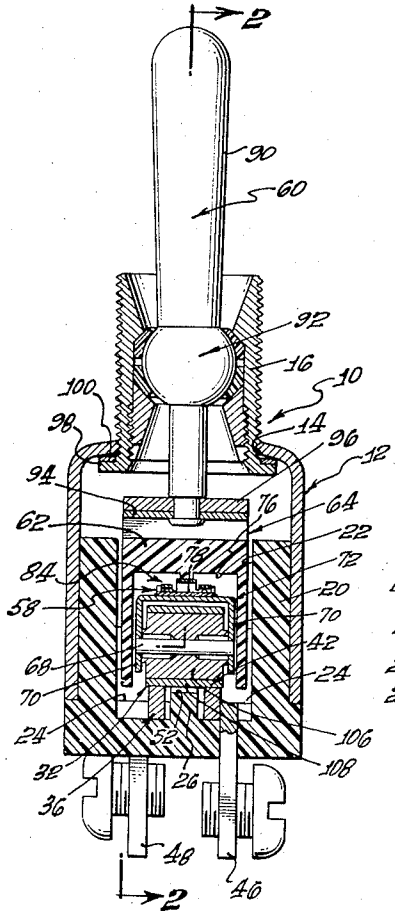
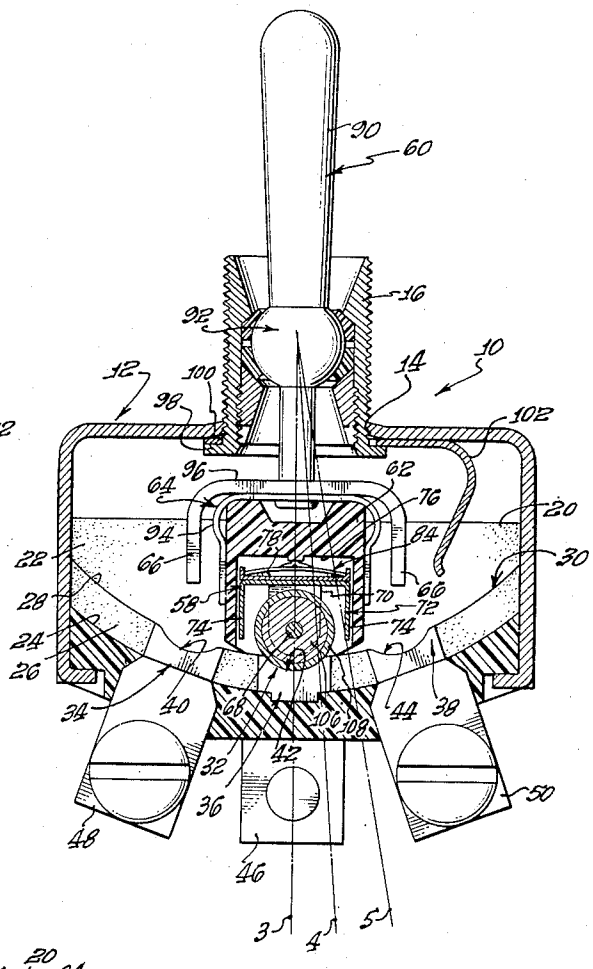


FIG. 2.



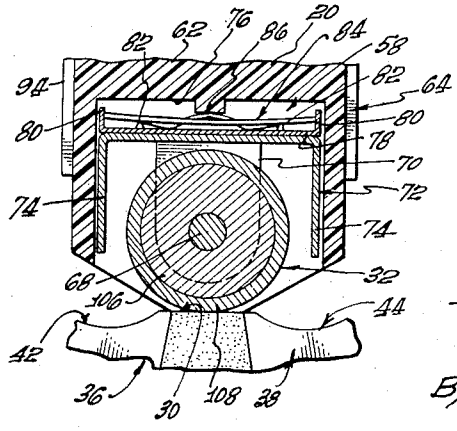


FIG. 6.

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FIG. 7.

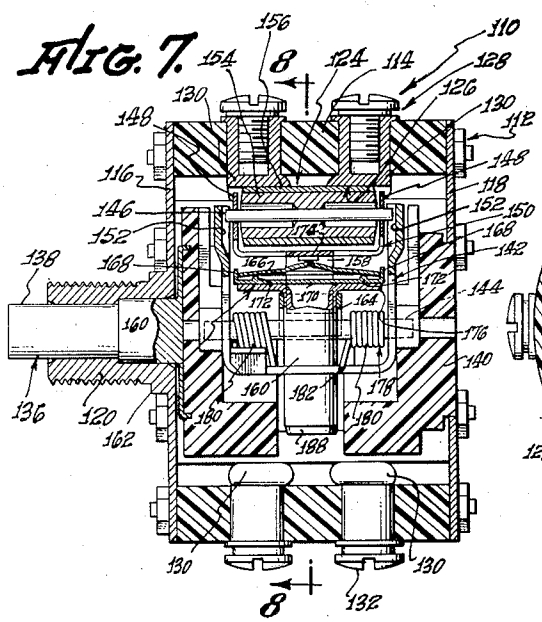


FIG. 8.

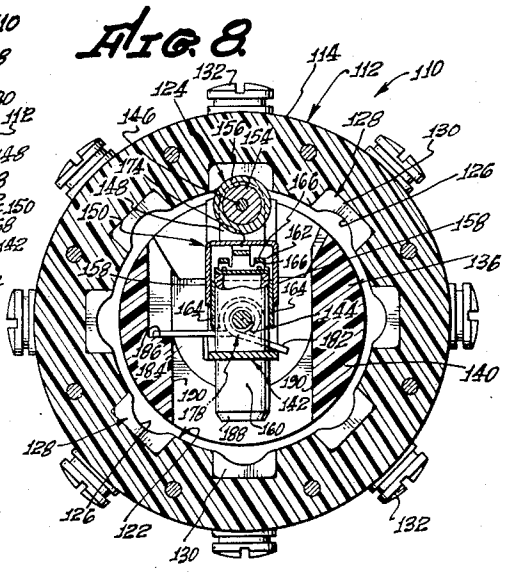


FIG. 3.

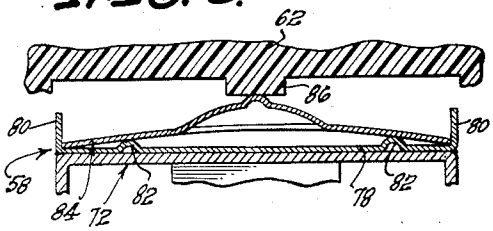


FIG. 4.

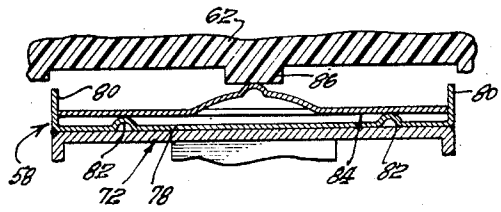
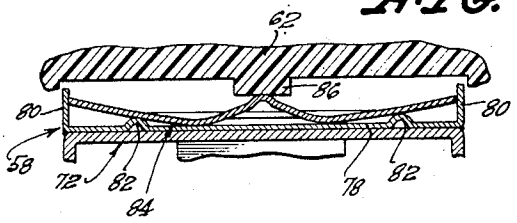


FIG. 5.



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FIG. 9.

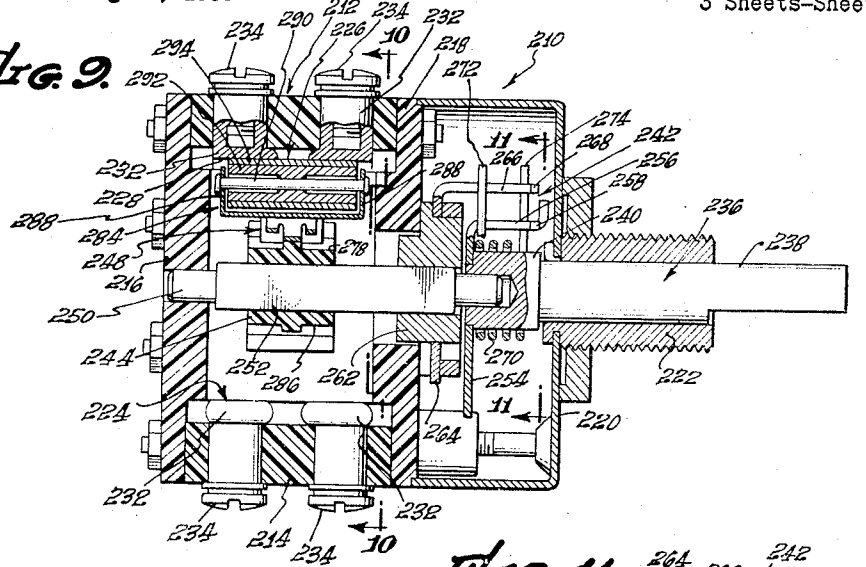


FIG. 10.

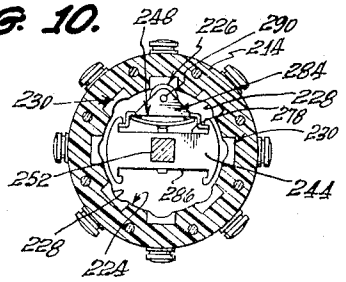


FIG. 11.

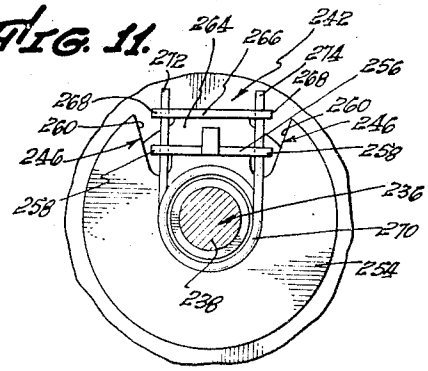


FIG. 12.

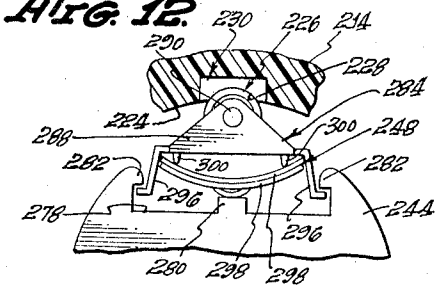


FIG. 13.

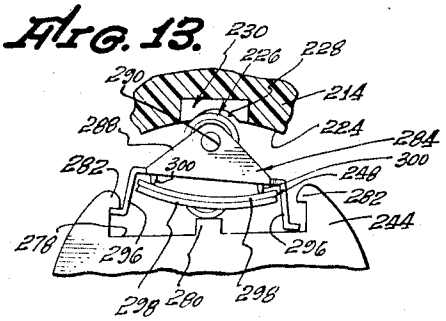
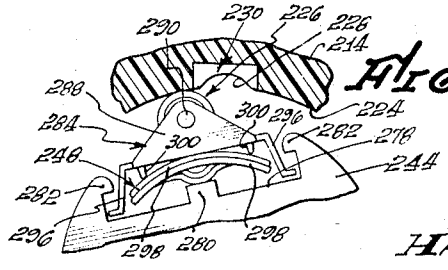


FIG. 14.



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United States Patent Office 2,831,081 Patented Apr. 15, 1958

2,831,081

ELECTRIC SWITCH

Howard F. Mason, Los Angeles, Calif., assignor to Mason Electric Corporation, Los Angeles, Calif., a corporation of California

Application August 8, 1955, Serial No. 526,908

14 Claims. (Cl. 200—67)

The present invention relates in general to electric switches, and a general object of the invention is to provide a switch which operates with a snap action to provide a fast make and break to minimize arcing, which operates in a positive manner in the sense that the movable contact snaps from one operative position to another without any possibility of pausing between the two operative positions, which operates in the foregoing manner irrespective of how the switch is manipulated manually by the operator, which provides a positive "feel" so that the operator can readily tell that the switch has advanced from one operative position to another, and the like.

Another general object of the invention is to provide a switch which in some respects constitutes an improvement on that disclosed and claimed in my copending application Ser. No. 325,401, filed December 11, 1952, of which this application is a continuation in part. However, various features of the switch of the present invention are independent of that disclosed and claimed in my said copending application, and it will be understood that such features are not to be regarded as limited thereto except insofar as may be required by the patent claims forming part hereof.

Considering the switch of the present invention generally, it includes a contact path having two or more recesses therein which define operative positions of a movable contact, the latter preferably being a roller contact adapted to roll along the contact path. More particularly, the invention contemplates a switch wherein the contact path is arcuate, defining either part of a circle, or a complete circle, and wherein stationary contacts are located at at least some of the recesses in the arcuate contact path. Thus, the roller contact engages stationary contacts in one or more of its operative positions wherein it is received in one of the recesses, the contact path being formed of electrically insulating material intermediate the stationary contacts. The switch of the invention also includes an actuating means for moving the roller contact along the contact path and into and out of each of the recesses therein.

With the foregoing general background, a primary object of the invention is to bias the roller contact into engagement with the contact path with a biasing means which applies a maximum bias to the roller contact when it is being moved into or out of each of the recesses, and which applies lesser biases to the roller contact when it is in engagement with the contact path intermediate the recesses and when it is in each of the recesses. In this connection, a related object is to provide means which applies a minimum bias to the roller contact when it is in engagement with the contact path intermediate the recesses therein.

With the foregoing construction, by applying a maximum bias to the roller contact when it is being moved into or out of each of the recesses, resistance to movement out of each recess is a maximum to provide a positive action and "feel," and by applying a minimum bias to the roller contact when it is in engagement with the contact path intermediate the recesses, resistance to movement from one recess to another is minimized to provide ease of action, which are important features of the invention. Preferably, an intermediate bias, intermediate the maximum and minimum biases mentioned, is applied to the roller contact when it is in each of the recesses, which provides a "feel" advising the operator that the roller contact is indeed in one of the recesses.

To accomplish the foregoing, it is an object of the present invention to provide means for applying a minimum bias to the roller contact when it is in engagement with the contact path intermediate the recesses therein, for applying an intermediate bias to the roller contact when it is in each of the recesses, and for applying a maximum bias to the roller contact when it is being moved into or out of each of the recesses.

Still more particularly, an important object of the invention is to provide snap-acting means connecting the roller contact and the actuating means therefor for biasing the roller contact into engagement with the contact path in the manner indicated above. A related object is to provide a snap-acting means for the purpose mentioned which operates with a snap action as the roller contact moves into and out of each of the recesses, whereby the force acting between the roller contact and the contact path is the maximum roller-contact-biasing force applied to the roller contact as it moves into and out of each of the recesses in the manner hereinbefore discussed. Still another object in this connection is to provide a snap-acting means which applies a minimum bias to the roller contact when it is in engagement with the contact path between the recesses, and which applies to the roller contact when it is in each of the recesses an intermediate bias less than the maximum bias but greater than the minimum bias.

Although various snap-acting means capable of applying a variable bias to the roller contact in the foregoing manner may be utilized within the scope of the present invention, I prefer to employ as such snap-acting means the leaf-spring detent means disclosed and claimed in my Patent Number 2,684,843, granted July 27, 1954, to which reference is hereby made for a detailed description of the structure and operation of such leaf-spring detent means. In general, such detent means assumes either of two configurations with a snap action, and is capable of exerting a maximum biasing force in opposition to an applied force causing it to snap from one configuration to the other. When such detent means is in said one configuration, it is capable of exerting the intermediate biasing force hereinbefore mentioned, and when it is snapped into said other configuration, it is capable of exerting the minimum biasing force hereinbefore mentioned, the detent means being in what might be termed a relatively "flaccid" condition under the latter circumstances.

Another important object is to provide a switch wherein the roller contact is mounted on a carrier which is connected to the actuating means and which is connected to the roller contact through the snap-acting means mentioned, the latter preferably being disposed between the carrier and the roller contact. Another object in this connection is to provide a switch wherein there is a resilient lost-motion connection between the actuating means and the carrier, the lost-motion connection providing a range of relative movement between the carrier and the actuating means which is at least equal to the spacing between the recesses in the contact path so as to provide for movement of the roller contact from one recess to another with a snap action in the manner more

fully discussed in my aforesaid copending application. Still another object in this connection is to provide stop means on the actuating means which engages the carrier, after the range of relative movement provided by the resilient lost-motion connection between the actuating means and the carrier has been taken up, for insuring displacement of the roller contact out of the particular recess in which it is disposed so that the roller contact proceeds to the next recess with a snap action, such stop means thus serving as what is frequently termed a "kicker" for kicking the roller out of the particular recess in which it is located. Normally, the kicker comes into operation only if the snap-acting biasing means, or the resilient lost-motion connection between the actuating means and the carrier, becomes inoperative due to changes in characteristics, for example, or if the roller contact becomes welded to one of the stationary contacts, or the like. In general, upon application of a predetermined operating force to the actuating means, the snap-acting biasing means between the carrier and the roller contact will snap into its flaccid condition to permit the roller contact to move out of the particular recess in which it is disposed and to snap into the next recess due to the characteristic action of the resilient means incorporated in the resilient lost-motion connection between the actuating means and the carrier.

Another object of the invention of considerable importance is the provision of a roller contact which includes a magnet, or magnetic hub, having therearound a cylindrical jacket of nonmagnetic, electrically conductive, arc rupturing material, such as a silver alloy, although it may be copper, brass, or a noble metal.

The foregoing construction provides magnetic arc quenching to minimize arcing between the roller contact and the stationary contacts as they are made and broken. By making the arc-quenching magnet movable with the movable contact, only one such magnet is required for a plurality of stationary contacts and, by making the arc-quenching magnet a part of the roller contact, specifically the hub thereof, a very compact magnetic arc-quenching means results, which are important features of the invention.

One advantage of the snap-acting biasing means for urging the roller contact into engagement with the contact path which has not been mentioned heretofore is that it provides a very compact switch, particularly where the leaf-spring detent means of my aforementioned Patent Number 2,684,843 is employed as the snap-acting biasing means. Thus, by using such a snap-acting biasing means and/or the magnetic arc-quenching means incorporated in the roller contact, a very compact switch results, which is particularly desirable in installations wherein the space available for switches is at a premium, this being an important feature of the invention.

The foregoing objects, advantages, features and results of the present invention, together with various other objects, advantages, features and results thereof which will become apparent hereinafter, may be attained with the exemplary embodiments of the invention which are illustrated in the accompanying drawings and which are described in detail hereinafter. Referring to the drawings:

Fig. 1 is a longitudinal sectional view of a three-position toggle switch which embodies the present invention;

Fig. 2 is a transverse sectional view of the toggle switch illustrated in Fig. 1 and is taken along the arrowed line **2—2** of Fig. 1;

Figs. 3, 4 and 5 are enlarged, fragmentary sectional views illustrating the operation of a snap-acting biasing means of the invention for three different positions of a roller contact on a contact path of the switch of the invention, the three positions to which Figs. 3, 4 and 5 correspond being indicated by the broken lines **3, 4 and 5,** respectively, of Fig. 2 of the drawings;

Fig. 6 is an enlarged, fragmentary sectional view corresponding to Fig. 5 of the drawings and corresponding to the roller-contact position indicated by the broken line 5 of Fig. 2 of the drawings;

Fig. 7 is a longitudinal sectional view of a rotary switch which embodies the present invention;

Fig. 8 is a transverse sectional view of the rotary switch of Fig. 7 of the drawings which is taken along the arrowed line **8—8** of Fig. 7;

Fig. 9 is a longitudinal sectional view of a rotary switch which is presently regarded as the preferred embodiment of the invention;

Fig. 10 is a transverse sectional view on a reduced scale taken along the arrowed line **10—10** of Fig. 9;

Fig. 11 is a fragmentary sectional view taken along the arrowed line **11—11** of Fig. 9; and

Figs. 12, 13 and 14 are enlarged, fragmentary sectional views illustrating the operation of a snap-acting biasing means of the embodiment of Fig. 9 for three different positions of a roller contact on a contact path, and correspond to Figs. 3, 4 and 5, respectively.

Referring particularly to Figs. 1 and 2 of the drawings, the embodiment illustrated therein constitutes a toggle switch of the invention and is designated generally by the numeral **10**. The switch **10** includes a case or housing **12** which is open on one side and which is provided in its opposite wall with an aperture **14** through which projects a fitting **16**. The latter is externally threaded to receive a nut, or the like, not shown, for mounting the switch **10** on a panel, not shown, with the panel clamped between such nut and the housing **12** in the conventional manner.

Within the housing **12** is a block **20** of electrically insulating material, such as a suitable plastic. The block **20** is provided with an arcuate cavity **22** therein and extending along the circumferential wall of this cavity are two arcuate grooves **24** separated by an arcuate rib **26**. The radially inner wall **28** of this rib forms part of an arcuate contact path **30** for a roller contact **32** to be described hereinafter.

Spaced apart along the contact path **30** and forming parts thereof are contacts **34, 36** and **38**, the contact path **30** being provided with recesses **40, 42** and **44**, for the roller contact **32**, in the respective contacts **34, 36** and **38**. Preferably, and as more fully disclosed in my aforementioned copending application, each of the contacts **34, 36** and **38** includes two contact elements respectively disposed in the grooves **24**. The three contact elements in one of the grooves **24** are preferably electrically interconnected and are electrically connected to a terminal **46** projecting through the block **20** and the open side of the housing **12**. The other contact element of the contact **36** is not provided with any terminal, while the other contact elements of the contacts **34** and **38** are respectively electrically connected to terminals **48** and **50** which also project from the open side of the housing **12** through the block **20**. The contact elements of each of the contacts **34, 36** and **38** are spaced apart, being separated by the rib **26**, so that they are bridged by the roller contact **32**. Thus, with this construction, which is illustrative only, the switch **10** is provided with an "off" position and two "on" positions, the switch being in the "off" position when the roller contact **32** is in the recess **42** in the contact **36**, and the switch being in its "on" positions when the roller contact is in the recesses **40** and **44** in the contacts **34** and **38**.

As shown in Fig. 1 of the drawings, the arcuate rib **26** is provided with recesses **52** therein which are aligned with and slightly deeper than the recesses **40, 42** and **44** in the contacts **34, 36** and **38**, thereby avoiding engagement between the roller contact **32** and the rib **26** when the roller contact is in one of the recesses **40, 42** and **44**. Only one of the recesses **52** is visible in Fig. 1 of the drawings. Also, it will be noted that the recesses **40, 42** and **44** in the contacts **34, 36** and **38** are not quite as wide as the contacts themselves so that these contacts

form parts of the intermediate sections of the contact path 30 beween the recesses 40, 42 and 44. As pointed out in more detail in the copending application, this prevents arcing between the roller contact 32 and the contacts 34, 36 and 38 within the recesses 40, 42 and 44 in these contacts.

The switch 10 includes snap-acting means 58 for biasing the roller contact 32 into engagement with the contact path 30 with a minimum force when the roller contact is in engagement with the contact path intermediate the recesses 40, 42 and 44, with an intermediate force when the roller contact is in each of these recesses, and with a maximum force when the roller contact is being moved out of these recesses. The snap-acting means 58, which will be described in more detail hereinafter, connects the roller contact 32 to an actuating means 60 through a carrier 62 for the roller contact, the snap-acting means 58 connecting and being positioned between the roller contact and the carrier. A resilient lost-motion connection 64 is provided between the carrier 62 and the actuating means 60, the latter being provided with stop means 66 which limit the range of relative movement between the actuating means 60 and the carrier 62 and which serve as kickers as hereinbefore outlined and as hereinafter described in more detail.

Considering the manner in which the roller contact 32 is mounted on the carrier 62 and connected thereto by the snap-acting means 58, the roller contact, which will be described in more detail hereinafter, is provided with an axle 68 rotatably mounted relative to flanges 70 of a cage 72, the flanges 70 being located at opposite ends of the roller contact and the cage 72 being provided with other flanges 74 on opposite sides of the roller contact. The cage 72 is loosely mounted in a cavity 76 in the carrier 62 so that the cage, and the roller contact 32, may move freely in this cavity in a direction toward and away from the contact path 30.

The cage 72 carries, on the side thereof opposite the roller contact 32, an element 78 having end flanges 80 and projections 82 inwardly of the respective flanges. Confined between the flanges 80 and engaging the projections 82 is a leaf-spring detent means 84 which is constructed as disclosed in my Patent Number 2,684,843 so that a detailed description herein is unnecessary. The projections 82 engage one side of the detent means 84, and the other side thereof is engaged by a projection 86 on the inner wall of the cavity 76, the projection 86 being located between the projections 82.

The actuating means 60 includes a lever 90 which projects through the fitting 16 into the housing 12, there being a ball-and-socket connection, indicated generally by the numeral 92, between the fitting 16 and lever 90 to provide for universal movement therebetween. While the ball-and-socket connection 92 provides for universal movement to provide several degrees of freedom, as more fully discussed in my aforesaid copending application, it will be noted that movement of the carrier 62, to which the lever is connected in a manner to be described, is largely restricted to movement along the contact path 30 because of the fact that the carrier is disposed in the arcuate cavity 22 in the block 20. Thus, movement of the carrier laterally of the arcuate cavity 22 is limited to the clearance between the carrier 62 and the side walls of the arcuate cavity. The lever 90, at its inner end, is connected to a U-shaped spring 94 which embraces the carrier 62. This connection permits relative movement between the lever 90 and the carrier 62 in either direction along the arcuate contact path 30, and constitutes the resilient lost-motion connection 64 hereinbefore mentioned. The kickers 66 mentioned earlier herein are constituted by the ends of a yoke 96 which is also carried by the inner end of the lever 90, the arms of the yoke being spaced outwardly from the respective arms of the U-shaped spring 94 to permit relative movement of the lever 90 and the carrier 62 throughout a limited range as hereinbefore outlined and as hereinafter discussed in more detail.

Clamped between a flange 98 on the fitting 16 and the housing 12 is an eye or annulus 100 which carries a spring 102 engageable by one of the kickers 66 for a purpose to be explained. The spring 102 may be omitted, or two such springs, not shown, one for each kicker 66, may be employed, depending on the mode of operation desired for the switch 10 as hereinafter discussed.

Turning now to a consideration of the over-all operation of the switch 10, the manner in which the roller contact 32 is snapped from one of the recesses 40, 42 and 44 to the next will be considered first for convenience. A detailed description of this snap-action herein is unnecessary, since it is fully described in my aforementioned copending application, and it will therefore be described only briefly. When the lever 90 is moved in a direction to tend to move the roller contact 32 from one of the recesses 40, 42 and 44 to another, the roller contact resists movement out of the recess in which it is disposed until the snap-acting means 58 snaps in a manner to be described hereinafter. Because of this resistance to movement of the roller contact 32 out of the recess in which it is located, the resilient lost-motion connection 64 yields to permit movement of the lever 90 relative to the carrier 62. In other words, the U-shaped spring 94 flexes to permit the carrier 62 to rock relative to the yoke 96. Ultimately, the U-shaped spring 94 is stressed to such an extent that the snap-acting means 58 snaps, whereupon the roller contact 32 leaves the recess 40, 42 or 44 in which it is located and moves to the next recess with a snap action. As hereinbefore mentioned, the total range of relative movement between the carrier 62 and the lever 90 which is provided by the resilient lost-motion connection 64 exceeds the spacing of the recesses 40, 42 and 44 so that the roller contact 32 automatically moves to the next recess once it has been displaced out of the particular recess in which it is located. Consequently, once the operator applies to the lever 90 sufficient force to displace the roller contact 32 out of the recess in which it is located, no manual manipulation of the lever can prevent the roller contact from moving to the next recess. This provides a very positive and reliable action, which is an important feature.

Considering now the operation of the snap-acting means 58 as the roller contact 32 is displaced out of one of the recesses 40, 42 and 44 and moved to the next with the snap-action described, Figs. 3, 4 and 5 of the drawings best illustrate what happens to the snap-acting means 58 as the foregoing occurs. Referring to Fig. 3, the leaf-spring detent means 84 assumes the configuration shown therein when the roller contact 32 is in one of the recesses, e. g., the recess 42, with no force applied to the lever 90. When the detent means 84 has this configuration, which may be termed its normal configuration, it applies an intermediate bias to the roller contact 32, urging it into the recess 42 to center it therein. Now, if an actuating force is applied to the lever 90 sufficient to move the roller contact 32 away from the center of the recess 42, as indicated by the broken line 4 in Fig. 2 of the drawings, the detent means 84 transiently assumes an intermediate, on-center, configuration as shown in Fig. 4 of the drawings. Just before the detent means 84 attains the transient intermediate configuration illustrated in Fig. 4 of the drawings, it is on the verge of snapping over center into the configuration shown in Fig. 5 thereof hereinafter termed its second configuration, and, when the detent means is on the verge of snapping into such configuration, it applies a maximum bias to the roller contact 32 resisting its displacement out of the recess 42. However, when the actuating force applied to the lever 90 reaches

a sufficiently high value, the detent means 84 snaps through the intermediate configuration shown in Fig. 4 of the drawings into the configuration shown in Fig. 5 of the drawings, the detent means, under such conditions, being more or less flaccid and applying a minimum bias to the roller contact 32. Consequently, when the detent means 84 snaps into the configuration of Fig. 5 of the drawings, the roller contact 32 is free to leave the recess 42, whereupon the energy stored in the resilient lost-motion connection 64 snaps the roller contact into the recess 44 in the manner hereinbefore discussed.

Considering the advantages of the action of the detent means 84, since it applies an intermediate bias to the roller contact 32 when the latter is in one of the recesses, e. g., the recess 42, with no force applied to the lever 90, any force applied to the lever encounters increasing resistance as the configuration of the detent means 84 is changed to increase the bias applied to the roller contact 32 from the intermediate value to the maximum value. Thus, the operator is provided with a positive feel advising him that the roller contact is properly positioned within the recess 42, which is an important feature. Once a sufficient actuating force has been applied to the lever 90 to snap the detent means 84 from the configuration illustrated in Fig. 3 through the intermediate configuration illustrated in Fig. 4 into the configuration illustrated in Fig. 5, the detent means, in effect, suddenly goes limp to permit the roller contact to jump out of the recess 42 and to permit it to be snapped into the next recess 44 by the energy stored in the resilient lost-motion connection 64. The bias build-up from the intermediate value to the maximum value required to displace the roller contact 32 out of the recess 42 prevents inadvertent operation of the switch 10, while the minimum bias applied to the roller contact while it is on the contact path 30 between the recesses 42 and 44 minimizes friction and thus assures free rolling of the contact from the recess 42 to the recess 44. Thus, a still more positive action is attained.

As an example, for a switch 10 having a rating of in the neighborhood of from twenty to thirty amperes, the intermediate bias applied to the roller contact 32 by the detent means 84 when the roller contact is in the recess 42 may be of the order of magnitude of two pounds. The maximum bias developed just before the detent means 84 snaps into the configuration illustrated in Fig. 5 of the drawings may be of the order of magnitude of three pounds. The minimum bias occurring when the detent means 84 is between the recesses 42 and 44 and is more or less flaccid, may be of the order of magnitude of one and one-half pounds. The latter is sufficient to cause the detent means 84 to snap back into the configuration illustrated in Fig. 3 of the drawings when the roller contact 32 enters the recess 44. It will be understood that the foregoing bias values are illustrative only and that the invention is not limited thereto.

The kickers 66 normally do not come into operation, and engage the carrier 62 to kick the roller contact 32 out of the recess in which it is disposed only when extraordinary resistance to displacement of the roller contact out of such recess is encountered, the switch thereafter operating as hereinbefore described, Such extraordinary resistance to displacement of the roller contact may be due to the presence of foreign matter, welding of the roller contact 32 to one of the contacts 34, 36 and 38, changes in the operating characteristics of the detent means 84 with the passage of time, and the like.

It will be noted that when the roller contact 32 is displaced into the recess 44 in the manner hereinbefore described, the yoke 96 engages the spring 102 and stresses it. The characteristics and position of the spring 102 relative to the yoke 96 are such that, upon release of an actuating force applied to the lever 90, the spring 102 automatically returns the roller contact 32 from the recess 44 to the recess 42. Thus, the spring 102 might be termed a "momentary return spring" since it permits the roller contact 32 to remain in the recess 44 only so long as a sufficient actuating force is applied to the lever 90, the spring 102 thereby permitting momentary engagement between the roller contact 32 and the contact 38. As hereinbefore pointed out, a similar spring, not shown, may be employed on the opposite side of the yoke 96 to produce the same effect with respect to the contact 34. Alternatively, the spring 102 may be omitted if the momentary return feature is not desired.

Considering the roller contact 32 in more detail, its axle 68 is made of a resilient material, such as spring wire, and the roller contact is provided with a hub 106 which engages the axle 68 throughout only a relatively small portion of its length. Thus, as more fully described in my aforesaid copending application, the axle 68 may flex to permit the roller contact 32 to wobble or rock somewhat, thereby assuring proper engagement with the contact elements of the contacts 34, 36 and 38 even though the recess in one contact element of a particular pair may be deeper than the other, or may be offset circumferentially from the other, due to inaccuracies in manufacture, changes in the recess contours due to arcing, and the like.

An important feature of the invention resides in making the hub 106 of the roller contact 32 a permanent magnet, such as an Alnico magnet, and by surrounding it with a cylindrical open-ended jacket 108 of non-magnetic, electrically conductive material. The jacket 108 is made nonmagnetic to prevent shunting of the magnet field provided by the magnetic hub 106, and is made electrically conductive to carry current between the contact elements of the contacts 34, 36 and 38. As the roller contact 32 engages or disengages one of the contacts 34, 36 and 38, the flux produced by the magnetic hub tends to quench any arc produced between the contacts, magnetic arc quenching being extremely effective as is well known in the art. By making the arc quenching magnet movable with the movable contact, only one such magnet is required for a plurality of stationary contacts, which is an important feature, and by incorporating the magnet as the hub 106 of the roller contact 32, a very compact magnetic arc-quenching means results, which is another important feature.

Turning now to Figs. 7 and 8 of the drawings, illustrated therein is a rotary switch 110 which, except for the fact that it embodies the present invention, is similar to a corresponding embodiment of my aforementioned application, so that only a relatively general description thereof herein will be required. The switch 110 includes a housing 112 comprising an annulus 114 of electrically insulating material clamped between two end plates 116 and 118, the latter being provided with a tubular fitting 120 corresponding to and externally threaded for the same purposes as the fitting 16 of the switch 10. The inner periphery of the annulus 114 provides an arcuate contact path 122 for a roller contact 124, the path 122 being a complete circle in this embodiment. The contact path 122 is provided with a plurality of recesses 126 therein which are formed in stationary, circumferentially spaced contacts 128 each shown as including two contact elements 130 adapted to be bridged by the roller contact 124 and provided with terminals 132 externally of the annulus 114. Thus, with this particular construction, any one of a plurality of circuits may be made by means of the roller contact 124 bridging the contact elements 130 of one of the contacts 128.

Projecting through the fitting 120 into the interior of the housing 112 is an actuating means 136 comprising a shaft 138 connected at its inner end to a rotor 140 of electrically insulating material. The shaft 138 is fixedly connected to the rotor and is journaled in the fitting 120, the opposite end of the rotor being journaled in the end plate 118, whereby the rotor rotates with the shaft. The roller

contact 124 is carried by a carrier 142 which is generally U-shaped and which is mounted on a pin 144 the axis of which coincides with axis of the rotor 140, the carrier 142 being pivotable relative to the rotor about the axis of the pin 144. The roller contact 124 is mounted on a resilient axle 146, which may be formed of spring wire, and this axle extends through flanges 148 of a cage 150 into radial grooves 152 in the respective arms of the U-shaped carrier 142. Thus, the roller contact 124 may move radially toward and away from the contact path 122 to permit it to move into and out of the recesses 126, the roller contact being guided by virtue of the fact that the ends of the axle 146 are disposed in the grooves 152 and being guided by virtue of the fact that the cage 150 is loosely confined between the arms of the U-shaped carrier 142. Further guiding of the cage 150 is accomplished in a manner to be described hereinafter.

The roller contact 124 is in engagement with the axle 146 throughout only a small portion of the length of the axle so that the roller contact may wobble or rock in the manner described in connection with the switch 10 to insure proper engagement with the contact elements 130 of the contacts 128. For arc quenching purposes, the roller contact 124 includes a magnetic hub 154 enclosed by a sleeve or jacket 156 of nonmagnetic, electrically conductive material.

The cage 150 is provided with spaced, radially inwardly extending flanges 158 which embrace a seat member 160 for a snap-acting means 162, the seat member 160 being provided with flat sides 164 cooperating with the flanges 158 to further guide the cage 150, and thus the roller contact 124, for radially inward and outward movement relative to the rotor 140. The seat member 160 is pierced by the pin 144 and extends through a hole in the base of the U-shaped carrier 142 so that the carrier and the seat member pivot as a unit about the axis of the pin 144.

Considering the snap-acting means 162, it includes at least two nested, leaf-spring detent means 166 each corresponding to the detent means 84 of the switch 10, two such detent means being nested in this embodiment to provide greater bias and longer life. The two detent means 166 are confined between flanges 168 at the ends of an element 170 corresponding to the element 78 of the switch 10, one of the detent means 166 being seated on projections 172 spaced inwardly from the flanges 168, respectively. The center of the other detent means 166 is engaged by a projection 174 on the cage 150. The element 170 is carried by a platform 176 on the adjacent end of the seat member 160 for the snap-acting means 162. Thus, it will be apparent that the snap-acting means 162 is similar to the snap-acting means 58 of the switch 10, its operation also being similar so that a detailed description is unnecessary.

There is a resilient lost-motion connection 178 between the rotor 140 of the actuating means 136 and the carrier 142 for the roller contact 124, this resilient lost-motion connection being similar to and serving the same functions as the resilient lost-motion 64 between the carrier 62 and the actuating means 60 of the switch 10. The connection 178 includes two, oppositely acting, torsion springs 180 respectively encircling the pin 144 on opposite sides of the seat member 160 and between it and the arms of the U-shaped carrier 142. Each spring 180 has an end 182 engaging the base of the U-shaped carrier 142, and has an end 184 engaging an internal shoulder 186 on the rotor 140. Thus, regardless of which direction the rotor 140 is rotated, relative motion of the actuating means 136 and the carrier 142 can occur until such time as that one of the torsion springs 180 which is being stressed by such relative movement is stressed to an extent sufficient to produce movement of the roller contact 124 out of the particular recess 126 from which it is disposed. The lost-motion provided by the connection 178 is at least equal to the spacing of the contacts 128 for the reasons hereinbefore indicated to insure that the roller contact 124 will move completely from one recess 126 to the next with a snap action.

The end 188 of the seat member 160 opposite the platform 176 is engageable with stop means or kickers 190 formed by internal shoulders on the rotor 144. Thus, relative rotation of the carrier 142 and the actuating means 136 is limited to the clearance between the end 188 of the seat member 160 and the kickers 190.

It will be quite apparent that the over-all operation of the switch 110 is very similar to that of the switch 10 so that a complete description is unnecessary. Briefly, on application to the actuating means 136 of a force tending to move the roller contact 124 from one recess 126 to the next, the detent means 166 are snapped from one configuration through an intermediate configuration to another configuration in much the same way as the detent means 84. Initially, the detent means 166 apply an intermediate bias to the roller contact 124, this bias increasing to a maximum as the detent means snap, and then decreasing to a minimum as the detent means become flaccid while the roller contact is in engagement with the contact path 122 intermediate the recesses 126. The resilient lost-motion connection 178 produces a snap action which snaps the roller contact 124 from one recess 126 to the next as the stress built up in one of the torsion springs 180 is released. The roller contact 124, due to the provision of the magnetic hub 154, acts as a compact arc-quenching means which is applicable to all of the stationary contacts 128. In various other respects, what has been said hereinbefore in connection with the switch 10 is also applicable to the switch 110 so that it does not need to be repeated.

Considering now the presently preferred embodiment of the invention which is illustrated in Figs. 9 to 14 of the drawings, illustrated therein is a rotary switch 210 which is generally similar to the rotary switch 110 hereinbefore described. The switch 210 includes a housing 212 comprising an annulus 214 of electrically insulating material clamped between two end plates 216 and 218. Suitably secured to the latter is a cup 220 having connected thereto a tubular, externally threaded fitting 222 corresponding to and for the same purpose as the fitting 16 of the switch 10. The inner periphery of the annulus 214 provides an arcuate contact path 224 for a roller contact 226, the contact path being a complete circle. Circumferentially spaced along the contact path 224 are recesses 228 which are formed in stationary contacts 230 each shown as including two contact elements 232 adapted to be bridged by the roller contact 226 and provided with terminals 234 externally of the annulus 214. As will be apparent, any one of a plurality of external circuits may be closed by moving the roller contact 226 into bridging engagement with the contact elements 232 of one of the contacts 230.

Projecting through the fitting 222 into the interior of the cup 220 of the housing 212 is an actuating means 236 comprising a shaft 238 journaled in the fitting 222 and provided with a head 240 at its inner end. A resilient lost-motion connection 242 connects the actuating means 236 to a carrier 244 for the roller contact 226. For the reasons hereinbefore discussed, the resilient lost-motion connection 242 provides a range of relative movement between the actuating means 236 and the carrier 244 at least equal to the spacing of the recesses 228, stop means 246 being provided for limiting this range of relative movement. The stop means 246 also act as kickers as hereinbefore outlined and as hereinafter described in more detail. A snap-acting means 248 interposed between the carrier 244 and the roller contact 226 urges the roller contact into engagement with the contact path 224 with a variable bias as hereinbefore suggested. When this general description of the switch 210 in mind, it will now be considered in detail.

The carrier 244 is disposed within the annulus 214 and

is constituted by a rotor of electrically insulating material fixed on a shaft 250 which is journaled at one end in the end plate 216 and at its other end in the head 240 on the shaft 238. In the particular construction illustrated, the carrier 244 is fixed on the shaft 250 by providing the carrier with a square opening therethrough which receives a square section 252 of the shaft 250.

Considering now the resilient lost-motion connection 242 between the actuating means 236 and the carrier 244, fixed on the head 240 of the shaft 238 is a disc 254 having an integral arm 256 projecting therefrom in a direction parallel to the axis of the switch 210, but spaced therefrom. At the outer end of the arm 256 are transverse lugs 258 for a purpose to be described. The disc 254 is provided with two circumferentially spaced, approximately radial edges 260 respectively located on opposite sides of the arm 256 and respectively constituting the stop means or kickers 246. Fixed on the carrier shaft 250, as by being provided with a square opening receiving the square section 252 of this shaft, is an element 262 having fixed thereon a disc 264 which is provided with an arm 266 parallel to but spaced radially outwardly from the arm 256 on the disc 254. The free end of the arm 266 is provided with lugs 268 corresponding to the lugs 258 and for a purpose to be described.

Carried by the head 240 on the shaft 238 is a torsion spring 270 having arms 272 and 274 which receive the arms 256 and 266 on the discs 254 and 264 therebetween. The lugs 258 and 268 on the arms 256 and 266 prevent axial movement of the torsion spring 270.

Considering the operation of the lost-motion connection 242, it will be apparent that, as the actuator shaft 238 is rotated in the clockwise direction, as viewed in Fig. 11 of the drawings, the arm 256 on the disc 254 rotates the arm 274 of the spring 270, while the arm 266 on the disc 264 prevents rotation of the arm 272 of the spring, thereby stressing the spring. When the spring 270 has been stressed sufficiently, the snap-acting means 248 snaps in a manner to be described, to permit the roller contact 226 to leave the particular recess 228 in which it is disposed, whereupon the energy stored in the spring 270 snaps the roller contact into the next recess in the manner more fully discussed previously herein in connection with the description of the operation of the switch 10. Upon counterclockwise rotation of the actuator shaft 238, similar events occur, but in a reversed sense.

If the spring 270 fails to snap the roller contact 226 from one recess 228 to the next in the foregoing manner for any reason, one or the other of the kickers 246 eventually engages the arm 266 on the disc 264 to force the roller contact out of the particular recess in which it is disposed, whereupon the spring 270 snaps the roller contact into the next recess. The range of the lost motion provided by the lost-motion connection 242 is determined by the circumferential spacing of the kickers 246 and is, as hereinbefore indicated, at least equal to the spacing of the recesses 228. This insures that the roller contact 226 will move to the next recess 228 after it has been displaced out of an adjacent recess, irrespective of any manual manipulations of the actuator shaft 238. Consequently, a positive and reliable action is provided, which is an important feature.

Considering now the manner in which the roller contact 226 is connected to the carrier 244 through the snap-acting means 248, the carrier is provided in one side thereof with a recess 278 having a central projection 280 thereinto and having at its edges inwardly extending lugs 282. As will be described hereinafter, the roller contact 226 is carried by a cage 284 which is confined in the recess 278 by the lugs 282 and which cooperates with the snap-acting means 248, the latter also being disposed in the recess. (In the particular construction illustrated, the carrier 244 is provided with another recess 286 which is identical to the recess 278 and which is adapted to receive another snap-acting means, not shown, and another roller-contact cage, not shown, identical to the snap-acting means 248 and the roller-contact cage 284, respectively. With this construction, the switch 210 may be utilized in installations requiring the making of two external circuits simultaneously. If desired, the carrier 244 may be further modified to carry more than two roller contacts.)

Considering the roller-contact cage 284, it includes two spaced flanges 288 in which is journaled an axle 290 carrying the roller contact 226. The latter is provided with a magnetic hub 292 and a jacket 294 of nonmagnetic, electrically conductive material on the hub. The axle 290 makes contact with the hub 292 throughout only a relatively small portion of the axle so that the roller contact 226 may wobble or rock for the reasons hereinbefore indicated. The cage 284 is provided with arms 296 which fit under the lugs 282 on the carrier 244 to retain the cage in the recess, while still providing several degrees of freedom for the roller contact 226 relative to the carrier 244 for the purposes more fully discussed in my aforementioned copending application.

Considering the snap-acting means 248, it includes at least two nested, leaf-spring detent means 298 each corresponding to the detent means 84 of the switch 10, two such detent means being utilized in this switch to provide greater bias. The two detent means 298 are confined between the arms 296 of the cage 284 and one of them is seated on projections 300 spaced inwardly from the respective arms 296. The center of the other detent means 298 is engaged by the aforementioned projection 280 on the carrier 244.

The operation of the snap-acting means 248 is again similar to that of the snap-acting means 58 of the switch 10 so that only a general description of its operation is necessary. As shown in Fig. 12 of the drawings, when the roller contact 226 is in one of the recesses 228, the detent means 298 assume what might be termed their normal configurations, and apply an intermediate bias to the roller contact.

Referring to Fig. 13, when the actuator shaft 238 is rotated to force the roller contact 226 to one side of the recess 228 in which it is disposed, the force applied to the actuator shaft being transmitted through the torsion spring 270 in the manner hereinbefore discussed, the detent means 298 start to flex from the normal configurations shown in Fig. 12 to the configurations shown in Fig. 14. This flexing occurs with a snap-action, as hereinbefore discussed, the bias applied to the roller contact 226 by the detent means 298 being a maximum as, or just before, the detent means snap from their normal configurations to the configurations shown in Fig. 14. As soon as the detent means 298 snap, they become more or less flaccid and apply a minimum bias to the roller contact 226, whereupon the roller contact leaves the recess 228 in which it is disposed, as shown in Fig. 14 of the drawings, and moves to the next recess with a snap action due to the hereinbefore-discussed action of the torsion spring 270. This over-all action is similar to that of the switch 10 so that what has been said hereinbefore in connection with the switch 10 is equally applicable to the switch 210, as well as to the switch 110. Consequently, repetition is considered unnecessary.

Although I have disclosed exemplary embodiments of my invention herein for purposes of illustration, it will be understood that various changes, modifications and substitutions may be incorporated in such embodiments without departing from the spirit of the invention as hereinafter defined in the claims allowed to me.

I claim as my invention:

1. In a switch, the combination of: a contact path having a recess therein; a contact engaging and movable along said path and receivable in said recess; actuating means for moving said movable contact along said path and into and out of said recess; and snap-acting means connecting said movable contact and said actuating means for biasing said movable contact into engagement

with said bath, said snap-acting means comprising a spring having a normal configuration when said contact is in said recess and arranged to snap over center to a second configuration when said contact moves out of said recess.

2. In a switch, the combination of: stationary contacts spaced apart along a contact path having recesses therein at said stationary contacts, respectively; a contact engaging and movable along said path into engagement with successive ones of said stationary contacts, said movable contact being receivable in each of said recesses; actuating means for moving said movable contact along said path and into and out of each of said recesses; and snap-acting means connecting said movable contact and said actuating means for biasing said movable contact into engagement with said path, said snap-acting means comprising a spring having a normal configuration when said contact is in any one of said recesses and arranged to snap over center to a second configuration when said contact moves out of a recess.

3. In a switch, the combination of: a contact path having spaced recesses therein and having a stationary contact in at least one of said recesses; a roller contact engaging and movable along said path and receivable in each of said recesses; an actuating means for moving said roller contact along said path and into and out of each of said recesses; and snap-acting means connecting said roller contact and said actuating means for biasing said roller contact into engagement with said path, said snap-acting means comprising a spring having a normal configuration when said roller contact is in any one of said recesses and arranged to snap over center to a second configuration when said roller contact moves out of a recess.

4. In a switch, the combination of: stationary contacts spaced apart along an arcuate contact path having recesses therein at said stationary contacts, respectively; a roller contact engaging and movable along said path into engagement with successive ones of said stationary contacts, said roller contact being receivable in each of said recesses; an actuating means for moving said roller contact along said path and into and out of each of said recesses; and snap-acting means connecting said roller contact and said actuating means for biasing said roller contact into engagement with said path, said snap-acting means comprising a spring having a normal configuration when said roller contact is in any one of said recesses and arranged to snap over center to a second configuration when said roller contact moves out of a recess.

5. In a switch, the combination of: stationary contacts spaced apart along an arcuate contact path having recesses therein at said stationary contacts, respectively; a roller contact engaging and movable along said path into engagement with successive ones of said stationary contacts, said roller contact being receivable in each of said recesses; an actuating means for moving said roller contact along said path and into and out of each of said recesses; and snap-acting means connecting said roller contact and said actuating means for biasing said roller contact into engagement with said path, said snap-acting means operating with a snap action as said roller contact moves into and out of each of said recesses, said snap-acting means including means for applying a minimum bias to said roller contact when the latter is in engagement with said path intermediate said recesses, for applying an intermediate bias to said roller contact when it is in each of said recesses, and for applying a maximum bias to said roller contact as it is being moved into or out of each of said recesses.

6. In a switch, the combination of: stationary contacts on an arcuate contact path having recesses therein at said stationary contacts, respectively; a roller contact engaging and movable along said path into engagement with each of said stationary contacts, said roller contact being receivable in each of said recesses; an actuating

means for moving said roller contact along said path and into and out of each of said recesses; and leaf-spring detent means intermediate said roller contact and said actuating means for biasing said roller contact into engagement with said path with a variable force, said detent means comprising a spring having a normal configuration when said roller contact is in any one of said recesses and arranged to snap over center to a second configuration when said roller contact moves out of a recess.

7. In a switch, the combination of: stationary contacts on an arcuate contact path having recesses therein at said stationary contacts, respectively; a roller contact engaging and movable along said path into engagement with each of said stationary contacts, said roller contact being receivable in each of said recesses; an actuating means for moving said roller contact along said path and into and out of each of said recesses; and leaf-spring detent means intermediate said roller contact and said actuating means for biasing said roller contact into engagement with said path with a variable force, said detent means operating with a snap action as said roller contact moves into and out of each of said recesses, said detent means including means for applying a minimum bias to said roller contact when the latter is in engagement with said path intermediate said recesses, for applying an intermediate bias to said roller contact when it is in each of said recesses, and for applying a maximum bias to said roller contact when it is being moved into or out of said recesses.

8. In a switch, the combination of; stationary contacts spaced apart along an arcuate contact path having recesses therein at said stationary contacts, respectively; a roller contact engaging and movable along said path into engagement with successive ones of said stationary contacts, said roller contact being receivable in each of said recesses; a carrier for said roller contact; snap-acting means connecting said roller contact and said carrier for biasing said roller contact into engagement with said path, said snap-acting means comprising a spring having a normal configuration when said roller contact is in any one of said recesses and arranged to snap over center to a second configuration when said roller contact moves out of a recess; and actuating means for moving said carrier so as to move said roller contact along said path and into and out of each of said recesses.

9. In a switch, the combination of: stationary contacts spaced apart along an arcuate contact path having recesses therein at said stationary contacts, respectively; a roller contact engaging and movable along said path into engagement with successive ones of said stationary contacts, said roller contact being receivable in each of said recesses; a carrier for said roller contact; snap-acting means connecting said roller contact and said carrier for biasing said roller contact into engagement with said path, said snap-acting means comprising a spring having a normal configuration when said roller contact is in any one of said recesses and arranged to snap over center to a second configuration when said roller contact moves out of a recess; and actuating means for moving said carrier so as to move said roller contact along said path and into and out of each of said recesses, said actuating means having a resilient, lost-motion connection with said carrier.

10. In a switch, the combination of: stationary contacts spaced apart along an arcuate contact path having recesses therein at said stationary contacts, respectively; a roller contact engaging and movable along said path into engagement with successive ones of said stationary contacts, said roller contact being receivable in each of said recesses; a carrier for said roller contact; snap-acting means connecting said roller contact and said carrier for biasing said roller contact into engagement with said path, said snap-acting means comprising a spring having a normal configuration when said roller contact is

in any one of said recesses and arranged to snap over center to a second configuration when said roller contact moves out of a recess; and actuating means for moving said carrier so as to move said roller contact along said path and into and out of each of said recesses, said actuating means having a resilient, lost-motion connection with said carrier, said lost-motion connection providing a range of movement between said carrier and said actuating means at least equal to the spacing of said stationary contacts.

11. A switch as defined in claim 2 wherein said movable contact includes a magnet, and a jacket of nonmagnetic, electrically conductive material on said magnet.

12. A switch as defined in claim 3 wherein said roller contact includes a magnet and a cylindrical jacket of nonmagnetic, electrically conductive material around said magnet.

13. In a switch, the combination of: an arcuate, concave contact path having circumferentially spaced, radially inwardly facing, recesses therein and having thereon at least one stationary contact in which one of said recesses is formed; a freely rotatable roller contact engaging and movable along said contact path and receivable in each of said recesses; a contact carrier for said roller contact located radially inwardly of and movable adjacent and parallel to said contact path; an axle carrying said roller contact and mounted on said contact carrier and providing free rotation of said roller contact relative to said contact carrier; snap-acting means for biasing said roller contact into engagement with said contact path, said snap-acting means comprising a spring having a normal configuration when said roller contact is in any one of said recesses and arranged to snap over center to a second configuration when said roller contact moves out of a recess; actuating means movable about the center of curvature of said contact path for moving said contact carrier adjacent and parallel to said contact path; means providing a rockable lost-motion connection between said actuating means and said contact carrier; and means for limiting the range of rocking lost motion between said actuating means and said contact carrier.

14. A switch including: a contact carrier; a roller contact carried by said carrier; a contact path engaged by said roller contact and having spaced recesses therein; snap-acting means for biasing said roller contact into engagement with said contact path, said snap-acting means comprising a spring having a normal configuration when said roller contact is in any one of said recesses and arranged to snap over center to a second configuration when said roller contact moves out of a recess; an actuator; and a lost-motion connection between said actuator and said carrier and having means providing relative rocking movement between said actuator and said carrier.

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U. S. DEPARTMENT OF COMMERCE

PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,831,081 Howard F. Mason April 15, 1958

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 70, after "Fig. 5" insert a comma; same line, strike out "thereof"; column 10, line 73, for "When" read -- With --; column 13, line 1, for "bath" read -- path --; column 14, line 31, after "of" change the semi-colon to a colon.

Signed and sealed this 27th day of May 1958.

(SEAL)
Attest:
KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents

U. S. DEPARTMENT OF COMMERCE

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