Aug. 31, 1954 L. M. PERKINS 2,688,058

SNAP SWITCH APPARATUS

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Fig. 1

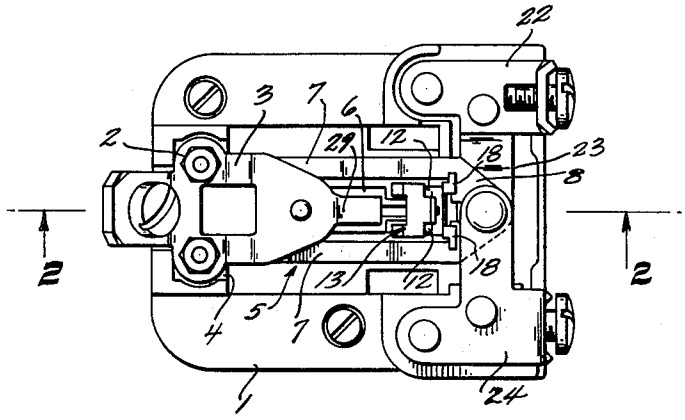
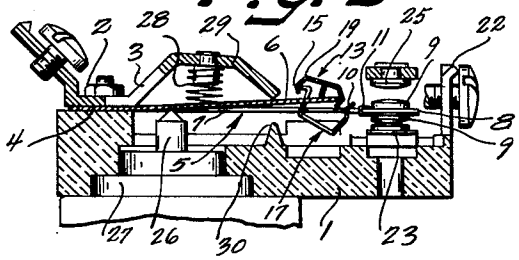


Fig. 2



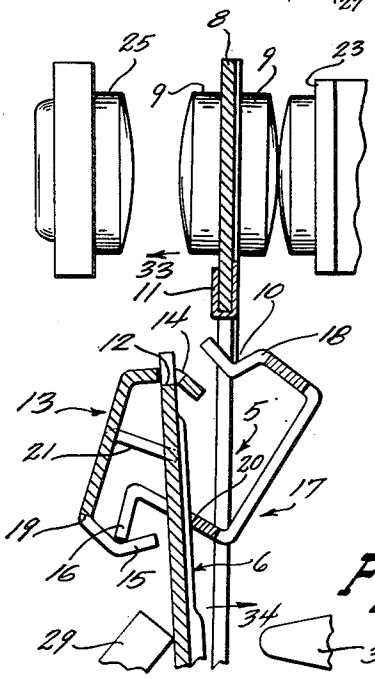
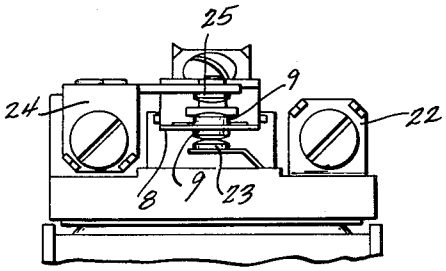


Fig. 4

Fig. 3



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Fig. 5

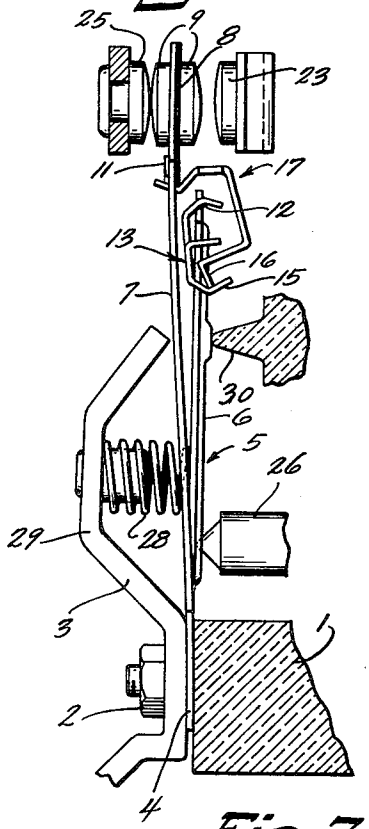


Fig. 6.

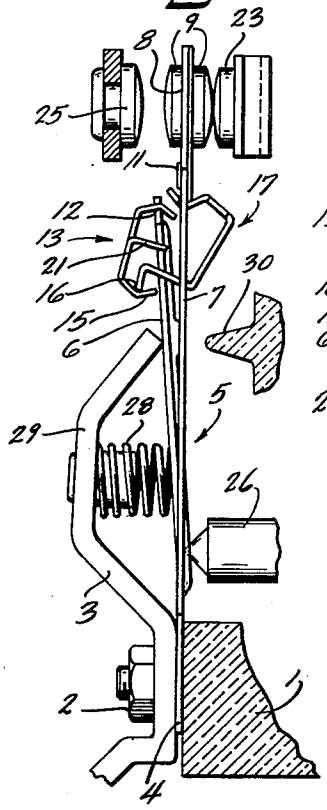


Fig. 10

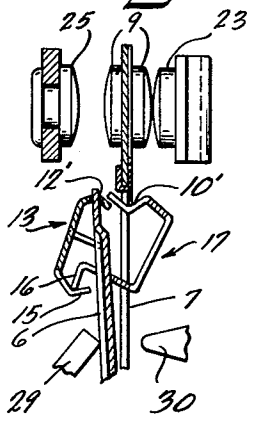


Fig. 7

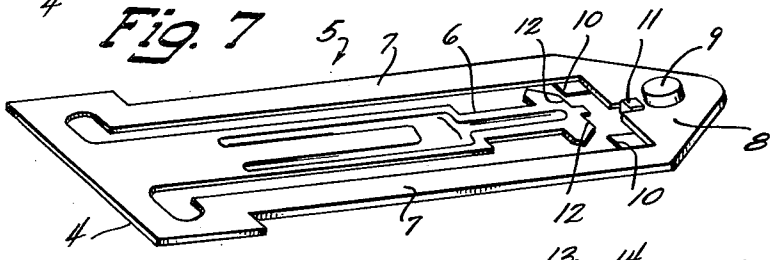


Fig. 8

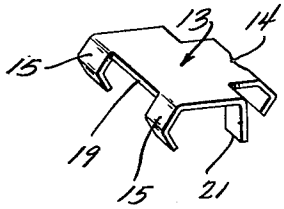
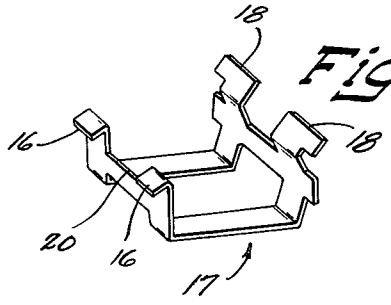


Fig. 9



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2,688,058

SNAP SWITCH APPARATUS

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Application July 28, 1952, Serial No. 301,225

11 Claims. (Cl. 200—67)

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This invention relates to electric snap switches of the type which repeatedly throw at substantially the same precise position in the course of the operating movement thereof, which switches are at times referred to as precision switches, and it resides more particularly in an improved form of such a precision switch wherein a deflectable leaf member carries a movable contact, movable between fixed stops or contacts; which leaf is connected to and serves in tension to sustain the thrust of an expansion toggle spring joined with an intermediate toggle link, the latter being carried by the end of an actuating arm which is movable through the plane of the leaf member, the structure being such as to provide a pair of interdependent toggles which cooperate to become unstable in advance of the pass-over relation between the leaf member and the actuating arm due either to geometry, resilient stress of the parts, or both.

Certain highly sensitive precision snap switches perform dependably and consistently when called upon to respond to fairly rapid actuating motions; these switches being of the type in which the snap over position of instability corresponds with a condition of vanishing contact pressure. If such switches are arranged to be actuated with a motion which pauses for long intervals or which progresses uniformly at a very slow rate, the position of instability, at which contact pressure vanishes, is at times achieved and maintained for long intervals, thus subjecting the contacts to electrical load while engaging with substantially no pressure. Because of the higher electrical resistance which prevails under such conditions heating of the contacts ensues. Such switches are therefor not suitable for certain applications, for example for temperature controls for large refrigerators and other thermostatic controls where the temperature drift is slow and for other regulating units, characterized by actuating motion which progresses slowly.

To meet the special requirements imposed by such applications some precision switches have heretofore been provided which snap from a position in advance of that in which contact pressure vanishes. One instance is the switch described and claimed in the United States patent to Gustav O. Wilms Number 2,260,964, in which spring tensions built up by the actuating force outside of the toggle per se are related to provide a storage of energy which is availed of to cause snap over to occur in advance of extinction of contact pressure. Such a switch presents certain difficulties from the standpoint of adjustment to respond at the position desired

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since the point of snap over is determined not so much by geometry as by coordination of the resilient properties of several cooperating parts. Other switches proposed as suitable to meet the requirements of slow actuation provide for the application of impact at the moment of contact separation to produce an abrupt termination of contact pressure. In such switches wear due to the impact is such as to cause progressive alteration of the position response thereof, thus depriving them to some extent of their precision properties.

One object of this invention is to provide a precision snap switch, which, in the course of actuation cannot at any time occupy a position of stability in which contact pressure vanishes.

Another object of this invention is to provide a precision snap switch, which, in the course of actuation, achieves a position of instability while finite contact pressure is prevailing, and which, upon further actuation enters into and completes a throwing action from a condition of finite contact pressure, without dependence upon kinetically imposed impact and without positional response characteristics dependent primarily upon resilient energy built up by the actuating force and stored outside of the toggle mechanism.

This invention is herein described by reference to the accompanying drawings, forming a part hereof, in which there is set forth by way of illustration, but not of limitation, forms in which switches may be constructed in accordance with the invention.

In the drawings:

Fig. 1 is a top plan view of an instance of a switch embodying this invention,

Fig. 2 is a side view in elevation and in section of the switch shown in Fig. 1, viewed through the plane 2—2 there indicated,

Fig. 3 is an end view of the switch shown in Fig. 1,

Fig. 4 is an enlarged detailed fragmentary side view in elevation and partly in section of the interdependent toggles and contacts of the switch shown in Fig. 1,

Fig. 5 is a fragmentary side view in elevation, partly in section, of the switch shown in Fig. 1, with the parts in the near actuating position,

Fig. 6 is a fragmentary side view in elevation, partly in section, of the switch shown in Fig. 1, with the parts in the far actuating position,

Fig. 7 is a detailed perspective view of the leaf assembly of the switch shown in Fig. 1,

Fig. 8 is a detailed perspective view of the ten-

sion member of the compound toggle of the switch shown in Fig. 1,

Fig. 9 is a detailed perspective view of the compression member of the compound toggle of the switch shown in Fig. 1, and

Fig. 10 is a detailed view of a slightly different form of the switch of this invention.

In the form of the switch of this invention shown in Figs. 1 to 9, a base 1 of insulating material is provided which base serves as a frame for the several parts composing the switch. Secured to the base 1 by means of nuts 2 and terminal member 3 is the anchorage end 4 of a leaf assembly of thin, flat, resilient metal, designated generally by the numeral 5. The leaf assembly 5 includes a central actuating member 6 extending from the anchorage 4. The end of the actuating member 6 adjacent the anchorage 4 is flat, and on this account is free to be resiliently flexed so as to function in the manner of a hinge. The main portion of the actuating member 6, extending substantially to its outer end, is deeply ribbed so as to render the same substantially rigid under the compression and transverse stresses to which it is normally subjected.

Flanking the edges of the actuating member 6 and extending beyond the outer end of the same are legs 7—7 of a forked contact carrier. The legs 7—7 are joined by a bridge portion 8 which provides a mounting for a set of movable contacts 9—9. The contact carrier is integrally formed from the flat material of the leaf assembly 5 and the legs 7—7 thereof are therefore free to be resiliently deflected. Secured to the bridge 8 and extending inwardly therefrom are spaced knife-edge pivots 10—10 formed from an insert crimped in place as indicated at 11.

The outer end of the actuating member 6 terminates in a T shaped head, furnishing outwardly facing, spaced, knife-edge pivots 12—12 which are disposed between and a small distance inwardly from the knife-edge pivots 10—10. Pivotally engaging the knife-edge pivots 12—12 on the actuating member 6 is the hooked outer end of a tension toggle link 13 having an opening 14 therein loosely embracing a retaining lug projecting from the outer end of actuating member 6. The hooked outer end of the tension toggle link 13 is of a width narrower than the spacing between the knife-edge pivots 10—10 so as to permit this part of the link 13 to pass freely therebetween.

The inner end of the tension toggle link 13 is bifurcated to form spaced pivot hooks 15—15 which pivotally engage and resist the outward force exerted by spaced knife-edges 16—16 formed at the ends of spaced legs at the lower end of a resiliently expansible compression toggle link 17. The upper end of the compression toggle link 17 terminates in a pair of spaced hook ends 18—18 which react against and pivotally engage the knife-edges 10—10 secured to the contact carrier. The hook ends 18—18 as well as the knife-edges 10—10 stand apart sufficiently to permit the outer hook end of tension toggle link 13 to pass therebetween.

The lower edge of the tension toggle link 13, between the hook ends 15—15, forms an abutment 19 which in one position engages member 6 to limit counterclockwise rocking motion of the link 13 with respect to the actuating member 6. A bridge portion 20 at the lower end of compression toggle link 17 between the legs 16—16 forms a similar abutment which in another

position engages the actuating member 6 and limits clockwise rotation of compression toggle link 17. A pair of retaining lugs 21—21, extending transversely from the main part of tension toggle link 13, act to facilitate assembly of the toggle mechanism although the same, in normal use, do not engage any part movable in relation thereto.

Secured to the base 1 is a terminal lug 22 from which a lower stationary contact 23 extends laterally into the path of movement of the lower movable contact 9. Symmetrically disposed on the base, on the opposite side but at a higher level, is a stationary contact terminal lug 24 having a lateral extension carrying a stationary contact 25 disposed in the path of movement of upper movable contact 9. The stationary contacts 23 and 25, serve not only their electrical function but they also act to provide mechanical stops which limit the travel of the movable contact carrier.

Disposed near the anchored end of the actuating member 6 in transverse relation thereto to act thereon, is an actuating stem 26 carried in a bushing 27 secured in the base 1. Motion imparted to the actuating member 6, by the stem 26, is multiplied at the outer end of member 6 by reason of the location of the actuating stem 26. In order to impart self returning properties to the actuating member 6, when the stem 26 is allowed to retreat, a coiled spring 28 carried upon an extension 29 of the terminal member 3 bears against the side of the actuating member 6, which is opposite the actuating stem 26. The extreme outer end of the extension 29 acts as a mechanical stop limiting motion of the actuating member 6 when traveling under the influence of the actuating stem 26. A small raised portion 30, formed as a part of the base 1, acts as a mechanical stop limiting travel of the actuating member 6 when traveling under the influence of spring 28.

The tension toggle link 13 and the resilient compression toggle link 17 cooperating with one another, with the actuating member 6, and with the movable contact carrier 7, serve to throw the movable contacts 9—9 from one position to another with a snap action as the actuating stem 26 travels inwardly and outwardly. The sequence of events involved in this action may be explained by first assuming the parts to be in the position shown in Fig. 5, in which position the actuating member 6 is held against the fixed stop 30 by the force of spring 28. In this position, tension toggle link 13 assumes a relation with respect to the actuating member 6 such that the abutment 19 is in bearing contact with the actuating member 6. The knife-edges 16—16 of the inner end of the compression toggle link 17 are therefore maintained to the right of the movable contact carrier 7, as viewed in Fig. 5. The expansive force of the compression link 17 is thus applied to the knife-edges 10—10, secured to the movable contact carrier 7, in a direction having a substantial component toward the left. The transverse component thus applied to the movable contact carrier 5 is sufficient to deflect the carrier 5 and to bring the facing movable contact 9 into engagement with stationary contact 25 with a finite pressure.

As force is applied through the actuating stem 26, and counterclockwise motion of the outer end of actuating member 6 is caused to take place, the knife-edges 12—12 at the outer end of the actuating member 6 and the knife-edges 16 at the

inner end of compression toggle 17 are brought progressively toward a position of near alignment with the knife-edges 10—10. In this position, the inner end of the compression toggle link 17 remains well to the right of the movable contact carrier 5 applying its force obliquely thereto with a substantial transverse component with the result that finite contact pressure between the stationary contact 25 and the facing movable contact 9 continues to be maintained. In spite of maintenance of the contact engagement pressure throughout this motion of the member 6 the relation between tension toggle link 13, compression toggle link 17 and actuating member 6 approaches and attains a state of instability. Once the unstable position is achieved further slight movement of the actuating member 6 upsets the tension toggle link 13 which responds by moving rapidly in a clockwise direction as viewed in Fig. 5. As a result the knife-edges 16 at the inner end of the compression toggle link 17 are suddenly forced to the left of the movable contact carrier 5, which immediately responds by movement to the position shown in Fig. 6. In traveling to the position illustrated in Fig. 6, the abutment 20 of the compression toggle link 17 comes into engagement with the actuating member 6 to limit clockwise motion of the tension toggle link 13, as is more clearly shown in Fig. 4. The facing movable contact 9 is thus forced down and held against stationary contact 23 with a finite pressure.

When force applied to actuating stem 26 is released, permitting stem 26 to retreat, spring 28, acting upon the actuating member 6, causes the knife-edges 12—12 and 10—10 to again approach a position of near alignment. A throwing action, in all respects comparable to that above described, then ensues bringing the parts to the position which is more clearly shown in Fig. 5.

The position of the tension toggle link 13, with respect to the actuating member 6, as shown in Fig. 4, is stable because of the misalignment between the three pivots of the compound toggle defined by the knife-edges 10, the knife-edges 12 and the knife-edges 16. This gives rise to a moment acting to urge the link 13 to turn clockwise which motion is resisted by the stop 20. If the actuating member 6 is caused to travel toward the right, the misalignment upon which the stabilizing moment depends becomes correspondingly reduced. If the contact carrier 7 contributed no resilient force to the system in the direction of arrow 33 and if the knife-edges 12—12 could be moved in the direction of arrow 34 without any resilient deflection of the actuating member 6, a state of critical instability of tension toggle member 13 would not arise since the stabilizing moment would be gradually reduced to zero and would then be reversed and gradually increased.

Such is not the case in the switch shown in Figs. 1 to 9 inasmuch as the actuating member 6 is in some slight measure resilient, even though stiffened to minimize this property, and inasmuch as the movable contact carrier 7 is subject to resilient deflection and reacts accordingly. Because of these factors a condition of critical instability of the tension toggle link 13 is achieved at a point in advance of the position of alignment of the three pivots 12, 10 and 16 of the compound toggle. Snap over is thus caused to occur in both directions of actuation from positions slightly in advance of actual alignment of the three pivots 10, 12 and 16. A switch so constructed has the advantage of a smaller space differential between the two throwover positions and is usually preferred on this account, even though resilient properties of the parts are in part determinative of the positions in which snap action occurs. However, in spite of the essential importance of resilience in producing such snap action, the geometry of the parts remains predominant in determining the throwing positions and the manufacture of switches with predictable properties is thus facilitated.

While the throwing position of the apparatus does not occur until misalignment between members 6 and 7 has been substantially reduced, the line of action of compression member 17 remains oblique with respect to the member 7 until throwing actually is initiated. It will be noted that a straight line passing through pivots 16 and 12 and extending beyond pivot 12 is spaced from and falls on the same side of the pivot 10 as is occupied by the actuating member 6. Reduction of this spacing takes place as the switch is moved toward a throwing position but in the course of this movement pivot 12 approaches member 7 more rapidly than does pivot 16 so that the obliquity of member 17 is actually slightly increased even though the misalignment between pivots 10, 12 and 16 is progressively reduced. Therefore, as previously noted, a transverse component of force acting on member 7 to maintain finite contact pressure is maintained until the snapping rotation of member 13 is well underway.

While the member 13 has been assumed rigid in the above description and the member 17 has been described as a resiliently expansible member, the relationship, so far as resiliency is concerned, may be reversed. That is, member 13 may be a resiliently contractive tension member and the member 17 may be a rigid compression member, or both members may be constructed to act resiliently to a significant degree without major alteration of the structure or mode of operation of the apparatus as above described, and such variants are contemplated as embodiments of this invention.

While the preferred embodiment of the apparatus of this invention is as shown in Figs. 1 to 9, it may be advantageous for certain purposes to construct the apparatus in accordance with Fig. 10, wherein the pivot point 12′ is disposed outwardly beyond the pivot point 10′. In Fig. 10, the parts of the switch other than the pivots 10′ and 12′ which correspond with like parts of the switch shown in Figs. 1 to 9, have been designated with like numerals and will therefore not be described. When the pivot point 12′ is placed beyond the pivot point 10′ as shown, the toggle parts reach and pass through a critical state of instability upon achieving alignment, regardless of whether members 6 and 7 exhibit resilient properties. With a switch so constructed the snap over positions may be made to be entirely dependent upon geometry, but the space differential between the two throwing positions is comparatively large. In special cases, if desired, the pivots 10′ and 12′ may be placed at the same radial distance from the anchorage points of the members 6 and 7.

I claim:

1. In an apparatus for producing motion with a snap action for use in switches and the like where avoidance of vanishing contact pressure is desirable the combination comprising a deflectable responsive member intended to be moved having an anchored inner end and a free outer

end; spaced stops on opposite sides near the free outer end of said responsive member limiting the motion of said free outer end; a deflectable actuating member having an anchored inner end and a free outer end movable to and from opposite positions of rest through a position of alignment with and in the plane of said responsive member; resiliently expansive compound toggle means comprising a rockable tension toggle member pivotally attached at a first pivot point to the free end of said actuating member extending inwardly therefrom to a second pivot point near its inner end, a rockable compression toggle member having an inner end pivotally engaging the second pivot point of said tension toggle member and an outer end pivotally engaging a third pivot point on said responsive member near the outer end thereof, said compound toggle means acting to apply its resiliently expansive force to said actuating member in compression and to said responsive member in tension and when obliquely related to said responsive member to exert a diverging force between said members and to urge said responsive member against one of its stops; and stop means associated with said compound toggle means and said actuating member carried on and movable with the latter limiting rocking motion of said tension toggle member with respect to said actuating member to stop the same in oblique positions in which a straight line and its extensions drawn through the first and second pivot points of said tension toggle member falls on the same side of the third pivot point on said responsive member as that occupied by said actuating member when said actuating member is in either of its positions of rest, whereby the three pivot points of said compound toggle means are movable to a position of alignment with one another when said actuating member is moved toward said responsive member to cause snap over to be initiated while said responsive member is still being urged against one of its stops with finite pressure.

2. An apparatus in accordance with claim 1 wherein the tension toggle member is a rigid member.

3. An apparatus in accordance with claim 1 wherein the compression toggle member is a rigid member.

4. An apparatus in accordance with claim 1 wherein the first and third pivot points are disposed outwardly from the inner anchored end of said responsive member substantially the same distance.

5. An apparatus in accordance with claim 1 wherein the third pivot point is disposed outwardly from the anchored inner end of the responsive member a distance slightly greater than the distance outwardly therefrom of the first pivot point.

6. An apparatus in accordance with claim 1 wherein the actuating member is stiff so as to act as a substantially rigid member except for such deflections as may occur therein close to its anchored inner end.

7. An apparatus in accordance with claim 1 wherein the tension toggle member is resilient.

8. In an apparatus for producing motion with a snap action for use in switches and the like where avoidance of varnishing contact pressure is desirable the combination comprising a deflectable responsive member intended to be moved having an anchored inner end and a free outer end; spaced stops on opposite sides near the free outer end of said responsive member limiting the motion of said free outer end; a deflectable actuating member having an anchored inner end and a free outer end movable to and from opposite positions of rest through a position of alignment with and in the plane of said responsive member; resiliently expansive compound toggle means comprising a rockable tension toggle member pivotally attached at a first pivot point to the free end of said actuating member extending inwardly therefrom to a second pivot point near its inner end, a rockable compression toggle member having an inner end pivotally engaging the second pivot point of said tension toggle member and an outer end pivotally engaging a third pivot point on said responsive member near the outer end thereof, said third pivot point being disposed outwardly from the anchored inner end of the responsive member a distance slightly greater than the distance outwardly therefrom of the first pivot point, said compound toggle means acting to apply its resiliently expansive force to said actuating member in compression and to said responsive member in tension and when obliquely related to said responsive member to exert a diverging force between said members and to urge said responsive member against one of its stops; and stop means associated with said compound toggle means and said actuating member limiting rocking motion of said tension toggle member with respect to said actuating member to stop the same in oblique positions in which a straight line and its extensions drawn through the first and second pivot points of said tension toggle member falls on the same side of the third pivot point on said responsive member as that occupied by said actuating member when said actuating member is in either of its positions of rest, whereby the three pivot points of said compound toggle means are movable to a position of alignment with one another when said actuating member is moved toward said responsive member to cause snap over to be initiated while said responsive member is still being urged against one of its stops with finite pressure.

9. In a switch, a swingably mounted substantially rigid actuating member having an inner anchorage end and an outer swingable pivot end; a tension toggle link pivotally connected to the outer pivot end of said actuating member extending inwardly therefrom and rockable transversely with respect to said actuating member; pivot means on the inner end of said tension toggle link; a resiliently expansible compression toggle link pivotally engaging the pivot means at the inner end of said tension toggle link extending outwardly therefrom; movable contact carrying means including a movable contact adapted for movement transversely of said actuating member and including pivot means mounted thereon disposed outwardly from the pivot means at the inner end of said tension toggle link; pivot engaging means at the outer end of said compression toggle link in pivotal engagement with said pivot means mounted on said movable contact carrying means; an actuator engaging said actuating member adapted to impart transverse movement thereto; stops positioned to be engaged by said actuating member to limit swinging motion thereof; abutment means carried on and movable with the outer end of said actuating member in cooperative engagement with said tension toggle link adapted to limit rocking movement thereof with respect

to said actuating member; and stop means including a stationary contact adapted to limit transverse movement of said movable contact carrying means.

10. In a switch, a swingably mounted substantially rigid actuating member having an inner anchorage end and an outer pivot end, a pair of spaced rests for limiting the excursion of the outer end of said actuating member, a tension toggle link having an outer end pivotally connected to the outer pivot end of said actuating member said tension toggle link extending inwardly and terminating in an inner pivot end which is rockable transversely with respect to said actuating member, a resiliently expansible transversely rockable compression toggle link having an inner end pivotally engaging the pivot means at the inner end of said tension toggle link, said compression toggle link extending outwardly and terminating in an outer pivot end, a transversely movable contact carrier including a movable contact and including inwardly facing pivot means mounted thereon disposed outwardly from the pivot means at the inner end of said tension toggle link and in near proximity to the outer pivot end of said actuating member, the outer pivot end of said compression toggle link being in pivotal engagement with said pivot means mounted on said movable contact carrier, an operating stem engageable with said actuating member for imparting transverse movement thereto, and stop means including a stationary contact disposed to limit transverse movement of said movable contact carrying means.

11. In a switch, a swingably mounted actuating member having an inner anchorage end and an outer pivot end, a tension toggle link having an outer end pivotally connected to the outer pivot end of said actuating member said tension toggle link extending inwardly and terminating in an inner pivot end rockable transversely with respect to said actuating member, a transversely rockable compression toggle link having an inner end pivotally engaging the pivot means at the inner end of said tension toggle link extending outwardly and terminating in an outer pivot end, a transversely movable contact carrier including a movable contact and including pivot means mounted thereon disposed outwardly from the pivot means at the inner end of said tension toggle link and in near proximity to the outer pivot end of said actuating member, the outer end of said compression toggle link being in pivotal engagement with said pivot means mounted on said movable contact carrier; means acting on said tension and compression toggle links loading the same resiliently respectively in tension and in compression, abutment means carried on and movable with the outer end of said actuating member limiting rocking movement of said tension toggle link, and stop means including a stationary contact limiting transverse movement of said movable contact carrying means.

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