

Sept. 24, 1935.

F. A. GROTHE

2,015,399

ELECTRIC SWITCH

Filed Oct. 26, 1934

3 Sheets-Sheet 1

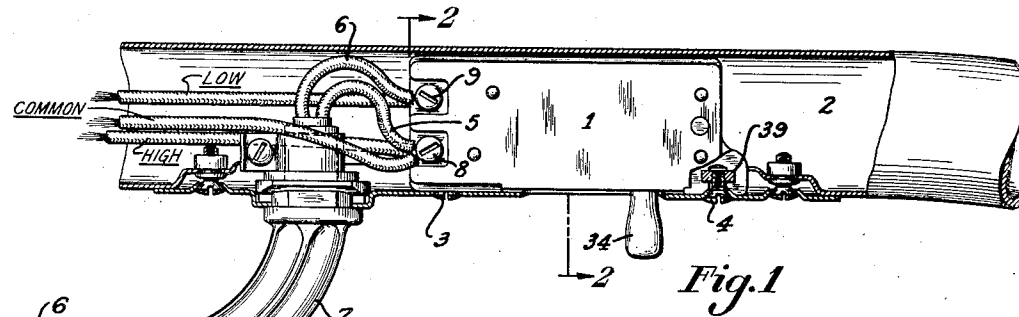


Fig. 1

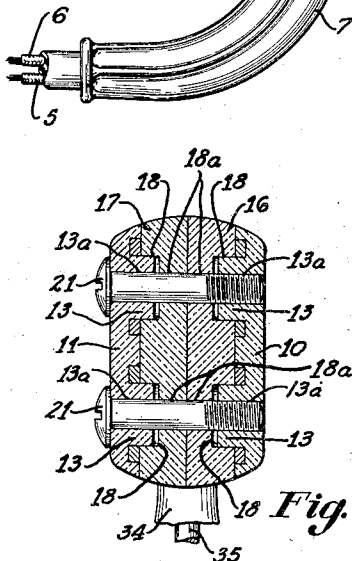


Fig. 5

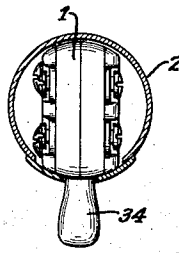


Fig. 2

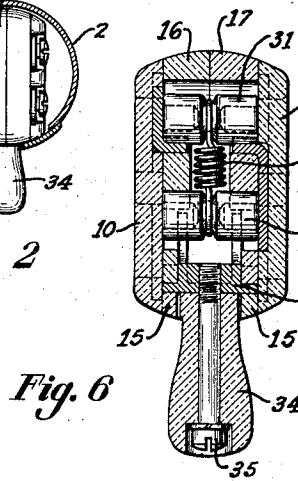


Fig. 6

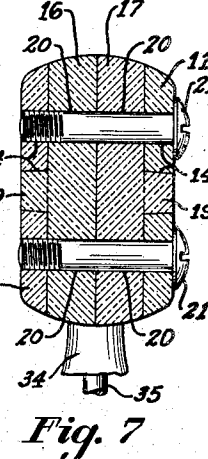


Fig. 7

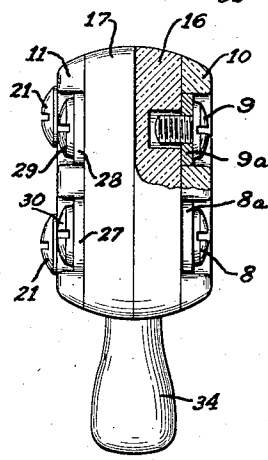


Fig. 4

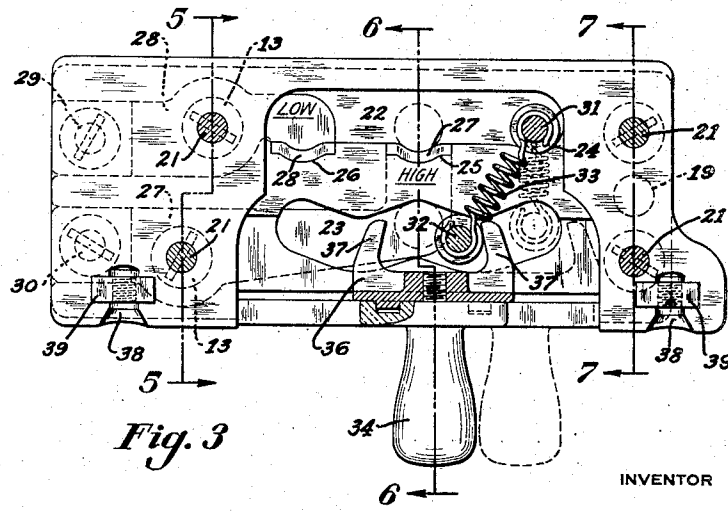


Fig. 3

INVENTOR

Frank A. Grothe

BY

Harry S. Alvarado

ATTORNEY

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F. A. GROTHE

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3 Sheets-Sheet 2

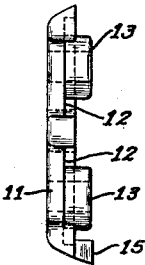


Fig. 9

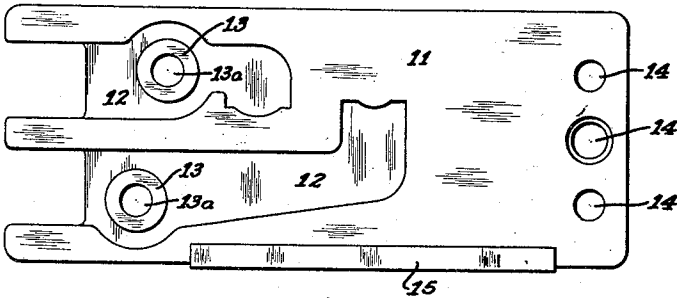


Fig. 8

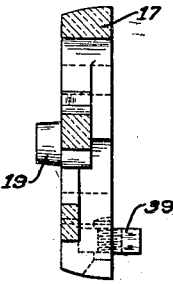


Fig. 11

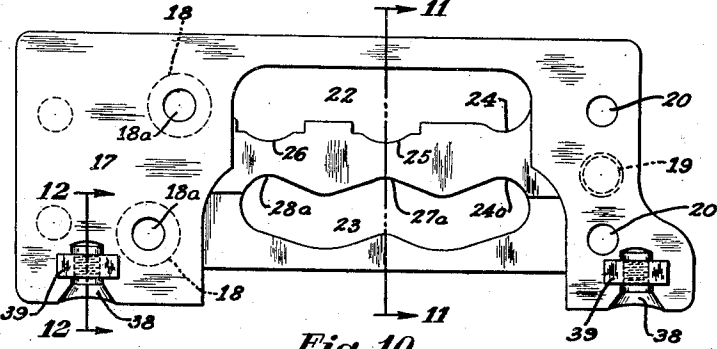


Fig. 10

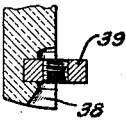


Fig. 12

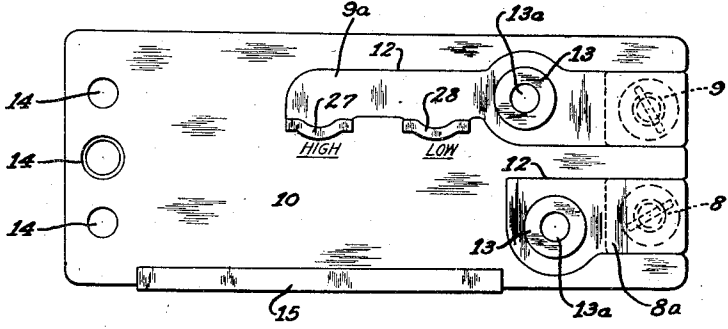


Fig. 13

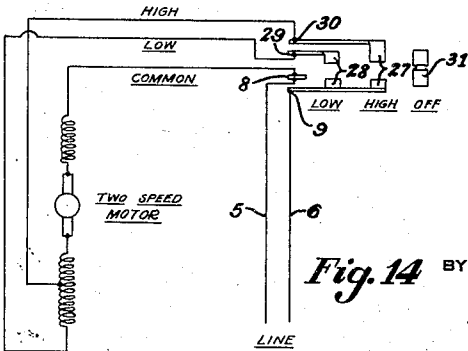


Fig. 14

INVENTOR

Frank A. Grothe

Harry S. [Signature]
ATTORNEY

UNITED STATES PATENT OFFICE

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ELECTRIC SWITCH

Frank A. Grothe, North Canton, Ohio, assignor
to The Hoover Company, North Canton, Ohio,
a corporation of Ohio

Application October 26, 1934, Serial No. 750,043

13 Claims. (Cl. 200—68)

The present invention relates to electric switches in general and particularly to new and novel improvements in manually operable small capacity multi-position switches. More specifically the invention comprises a new and novel switch structure in which the movable contact which moves between a plurality of positions is actuated by a new and novel mechanism in a new and novel manner.

It is an object of the present invention to provide a new and novel manually operable small capacity electric switch. It is another object of the invention to provide an improved small capacity multi-position switch formed of an insulating body and including a flying contact. A further object is to provide an electric switch in which the contact moves with a snap action from one position to another, the actuating means including a cam track and a cam follower. A still further object is the provision of a new and novel switch body. Still another object is the provision of a small capacity electric switch of the manually operable type in which the moving contact is provided with a track in which it is moved by means including a cam track and a cam follower, the relationship being such that the moving contact moves with a snap action from one position to another. These and other more specific objects will appear upon reading the following specification and claims, and upon considering in connection therewith the attached drawings to which they relate.

Referring now to the drawings in which preferred embodiments of the present invention are disclosed and in which the same reference characters refer to the same parts in the various views:

Figure 1 is a longitudinal section through the handle of a small tool in which a switch constructed in accordance with the present invention is positioned;

Figure 2 is a section upon the line 2—2 of Figure 1;

Figure 3 is a longitudinal section through the switch with the flying contact positioned in one position and about to snap to a second position;

Figure 4 is an end view of the switch with certain parts of the body broken away and shown in section to show more clearly a terminal;

Figure 5 is a section upon the line 5—5 of Figure 3;

Figure 6 is a section upon the line 6—6 of Figure 3 with the contacts moved to the dotted line position of that figure;

Figure 7 is a section upon the line 7—7 of Figure 3;

Figure 8 is an elevation of a closure plate of the switch body;

Figure 9 is an end view of the element shown in Figure 8;

Figure 10 is an elevation of one of the central elements or laminations forming the switch body and showing the tracks for the moving contact and for the cam follower;

Figure 11 is a section through the element shown in Figure 10 upon the line 11—11;

Figure 12 is a fragmentary section upon the line 12—12 of Figure 10 showing one of the nuts which is adapted to cooperate with a screw to secure the switch to an enclosing body such as the handle indicated in Figure 1;

Figure 13 is an elevation of the closure plate or element upon the opposite side from the element shown in Figure 8, but with the stationary contacts in place;

Figure 14 is a schematic diagram illustrating the electric switch constructed in accordance with the present invention connected to a two speed electric motor;

Figure 15 is a longitudinal section through a second preferred embodiment of the invention in which a pivoted actuating lever is used in place of the sliding trigger of the first embodiment;

Figure 16 is a transverse section upon the line 16—16 of Figure 15;

Figure 17 is transverse section upon the line 17—17 of Figure 15;

Figure 18 is an elevation of the outside closure member which faces the part of the switch shown in Figure 15;

Figure 19 is a section upon the line 19—19 of Figure 15 and shows the interfitting relationship of the parts of the switch body;

Figure 20 is a longitudinal section upon the line 20—20 of Figure 21 and shows a third embodiment of the present invention in which the pivoted lever is completely rotary and the switch comprises a multiplicity of stationary contacts;

Figure 21 is a transverse cross-section upon the line 21—21 of Figure 20;

Figure 22 is a plan view of the third embodiment of the switch illustrated in Figures 20 and 21.

The switch of the present invention relates to that field of switches which are useful for the operation of small mechanical electrical devices of the household type, such as suction cleaners, floor polishers, etc. the first preferred embodiment is illustrated in Figures 1 to 14, inclusive. The switch is particularly adapted to be positioned

within the handle of a small tool and is so illustrated in Figure 1. In that figure the switch body 1 is shown within a hollow handle 2 in which it is retained by screws 3 and 4. The electric conductors 5 and 6 pass into the handle through a cord protector 7 and are directly connected to switch terminal posts 8 and 9. A lead marked "Common", in Figures 1 and 14, carries current to the motor at all speeds and extends from the terminal post 8 to one end of the motor. Two leads marked "high" and "low" in Figures 1 and 14 extend from the motor to terminal posts 30 and 29 and are adapted to be connected selectively in series with the "common" lead by the switch in a manner which will hereinafter be fully disclosed.

The switch body 1 is made of insulating material. The outer side walls or closure plates 10 and 11, shown in elevation in Figures 13 and 8 respectively, extend the length of the body and are each provided with recesses 12, 12 adapted to receive and position the stationary contact plates. On each closure plate are inwardly extending shoulders 13, 13 of circular cross-section through which bores 13a, 13a extend. These shoulders are apposed in the two closure plates and are adapted to cooperate with suitable recesses in the central laminations of the switch body to align and definitely position the complete body. At the opposite end of each closure plate from the projecting shoulders 13, 13 are vertically spaced bores or seats 14, 14, 14. The middle bore is slightly tapered or conical. Along the bottom edge of each closure plate is found an inwardly extending shoulder 15 which extends only a part of the length of the plate.

Between the two side or closure plates 10 and 11 are positioned two central laminations 16 and 17, also of insulating material. These laminations are substantially identical except that they are inverted in the sense that one is adapted to lie against the inside of closure plate 10 while the other is adapted to contact the inner face of opposite closure plate 11. Lamination 16 cooperates and lies against side plate 10 while lamination 17 contacts closure plate 11. In Figures 10 and 11 lamination 17 is shown.

To cooperate with the inwardly projecting shoulders 13, 13 on each of the closure plates each lamination is provided with seats 18, 18 counter-bored at 18a, 18a, as indicated in Figures 5 and 10. Opposite the centrally located conical seat 14 of the side members each lamination is provided with an outwardly extending conical shoulder 19 which closely fits within its corresponding seat. The cooperation of the shoulders and seats provides proper alignment of the parts of the body. Transverse openings or bores 20, 20 in the laminations are aligned with the adjacent openings 14, 14 of the closure plates to provide continuous screw seats through the entire switch body. Transversely extending screws 21 extend through the aligned openings 20 and 14 and through the aligned bores in the shoulders 13, 13 and their seats 18, 18, and through being threaded at their inner ends, function to clamp the parts of the body into a unitary construction.

Central laminations 16 and 17 are centrally recessed to form an internal body cavity having an extent at its bottom substantially equal to the length of the underlying shoulders 15, 15 upon the side closures 10 and 11. The opposite side walls of the cavity are cut out to form an upper and a lower track, or a guide and a track, which bear the reference characters 22 and 23.

One side of each track is formed in each of the laminations. Each side of the upper track 22 is formed at one end, its right end as viewed in Figure 10 in lamination 17, with a recessed arcuate seat 24, while in the middle of the track and at the opposite end thereof are provided two cut-out stationary-contact-receiving recesses 25 and 26.

The stationary contact seating in recess 25 is indicated by the reference character 27, while that seating in recess 26 bears the reference character 28. The top surface of each of contacts 27 and 28 is curved to form an arcuate seat in the flat surface of the track 22, the recesses in each metallic contact corresponding in shape to the integral insulating seat 24 which is formed in the body of the lamination proper.

The contacts 27 and 28 which seat on lamination 17 are made integrally on separate metallic conducting strips which lie in the recesses 12, 20 12 of closure plate 11. These strips extend to the end of their respective recesses, passing on both sides of the projecting shoulders 13, 13, where they are provided with terminal screws or posts. Post 29 serves as the connector for contact 28 while post 30 performs the same function for contact 27.

The stationary contacts 27 and 28 which seat in the recesses 25 and 26 of lamination 16, are formed on a single conductor strip or plate member 9a which extends through a recess 12 of closure plate 10 and carries the terminal screw 9 at its end. In the second recess in closure plate 10 a dead-end plate 8a is positioned which is connected to no contact and carries a terminal screw 8.

The flying contact which is adapted to seat selectively in either the "off" position, formed by insulated seat 24, the "high" speed position, formed by contacts 27, 27, or the "low" speed position, formed by the contacts 28, 28, is indicated by the reference character 31. The contact comprises a metallic cylindrical member which extends through laminations 16 and 17 in the track 22, and is of such diameter that it conforms to the curvatures of the arcuate seats positioned in that track. With contact 31 between either pairs of contacts 27, 27 or 28, 28, current can pass therebetween. With contact 31 in the insulating seat 24 the switch is in the "off" position and no current can flow.

Immediately below the track 22 is positioned a cam track 23 the upper surface of which, in each of laminations 16 and 17, is provided with three seats 24a, 27a, and 28a. These seats are positioned directly below corresponding contacts 24, 27 and 28, and are separated by sloping surfaces which vary the greatest distance from a straight line at points substantially midway between adjacent seats. Within cam track 23 and extending through the laminations 16 and 17, is the cam follower 32 which is of insulating material, is cylindrical, and of substantially the same size as metallic flying contact 31. Follower 32 is centrally grooved in the manner of contact 31. Between contact 31 and actuator 32 with its ends looped around the central grooves therein is a helical coil spring 33 under tension which draws the two elements together.

The switch trigger is positioned at the base of the body cavity in the laminations 16 and 17, being slidably supported upon the inwardly extending shoulders 15, 15 of the closure plates 10 and 11. Trigger 34 comprises a lower handle portion which is secured by means of a screw 35

to an actuator 36 which is also of insulating material and is formed at its ends with arms 37, 37 which extend upwardly into the cam track 23. A pair of arms are positioned upon each side of the cam follower 32 in all of its positions, the pairs being sufficiently separated longitudinally to permit free movement of the follower within certain limits without attendant handle movement.

To provide means to secure the switch body to a supporting structure, such as the enclosing handle 2 of Figure 1, screw seats 38, 38 are formed at each end of the body, half of each seat being formed in each of laminations 16 and 17. Within these seats nuts 39, 39 are embedded and, through being interiorly threaded, are adapted to cooperate with screws, in the manner of screws 3 and 4 in Figure 1.

The operation of this switch is very simple. From each of its three positions the flying contact 31 is movable to an adjacent position by a force exerted upon the manually operated trigger. A movement of the trigger forces the cam follower 32 along the cam track 23, and as the track slopes away from the contact track 22 between each of its seats the spring 33 is placed under greater tension. At substantially the mid-point of the travel of the cam follower 32 on its way to its next seat the direction of the line of force exerted by spring 33 upon flying contact 31 is such that, as is clearly illustrated in full lines in Figure 3, the flying contact is pulled or rolled from its seat. The tension in the spring tends to draw the two moving members as closely together as possible and as a result the cam follower moves down the slope of the cam track to the next seat and the roller contact moves rapidly to its new seat. In this relationship the parts are in equilibrium for the contact 31 and the follower 32 can approach no closer under the urging of the tension spring 33. Forming the actuator 36 with the pairs of arms 37, 37 spaced as described permits of the flying action of the contact 31 once it has been displaced from its seat under the action of the spring 33 without accompanying movement of the handle. It is believed to be clear that with the terminal posts 8, 9, 29, and 30 of the switch connected to a two-speed motor, as shown in Figure 14, the switch is capable of controlling the flow of electric current therethrough to obtain selective speed operation. With the flying contact 31 extended between the sides of the seat 24, the switch is in the off position and the incoming power leads 5 and 6 are not connected to pass current through the motor. With the contact moved to extend between contacts 27, 27 the leads 5 and 6 are connected as clearly indicated in Figure 14, a part of the motor field being excluded and resulting in high speed motor operation. With the contact moved to seat between the sections of the contact 28 current passes through the entire motor and its field and the machine operates at low speed.

Referring now to Figures 15 to 19, inclusive, in particular a second preferred embodiment of this invention is disclosed in which the sliding trigger of the first embodiment has been replaced by a pivoted lever. The switch body again comprises the outer side or closure plates 10 and 11 and the intermediate laminations 16 and 17. In the present instance, however, insulating sheets 40, 40 are provided between the closure plates and the adjacent laminations which overlie the contact strips or plates. The body is again secured

as a unit by means of shoulders 13, 13 of which there are two additional on each closure member which replace the bores 14, 14, 14. Each shoulder 13 is adapted to seat within a similarly shaped recess 18 in the adjacent lamination, the shoulders and the seats being provided with bores through which the transversely extending securing screws 21 extend.

The laminations 16 and 17 are again recessed to form a central body cavity with the flying contact track 22 with its stationary contacts 24, 27, and 28 and the cam track 23 with its corresponding follower seats 24a, 27a, and 28a. Because of the difference in the actuating mechanism of this embodiment of the invention the tracks 22 and 23, instead of being extended in a straight line as in the first embodiment, are curved and lie on circles having coincidental centers which can be identified as the trigger pivot pin 41. The underlying shoulders 15, 15 20 of the first embodiment are omitted in this embodiment and in their place the closure plates are provided with spaced bearings or pin seats 42 which support the pin 41 which in turn pivotally mounts the manually operable pivotal trigger or lever 43. The inner end of lever 43 is bifurcated and frictionally encloses the pin 41, the ends of the bifurcations extending upon opposite sides of the cam follower 32 in the form of spaced pairs of arms 44, 44. These arms 44 30 perform the function of the arms 37 in the first embodiment and are adapted to move the cam follower from one seat in the direction of a spaced seat and to permit free snap-action movement thereof and of the flying contact which 35 is connected to the follower by the tension spring 33 once the contact has been displaced from its seat and the follower has passed the mid-point of its track. Because of the differences in the shape of the body cavities of this 40 embodiment and of the tracks 22 and 23 the metallic strips upon which the current-carrying contacts 27 and 28 are formed are of slightly different shape than in the first embodiment. Their functional relationship is identical, however.

In the operation of this embodiment of the invention the movement of the flying contact 31 from either of its three seats is accomplished by the pivotal movement of the actuating lever 43, the extended arms 44 of which contact the follower 32 to move it in the manner of the actuator 36 in the first embodiment. The functional relationship and the operation is otherwise identical to that described in connection 55 with that embodiment.

Referring now to Figures 20 to 22, inclusive, the third preferred embodiment of the invention is disclosed. According to this embodiment the actuating trigger is neither sliding nor pivoted, but is instead completely rotary in either direction of rotation. Instead of three positions for the flying contact as in the previous embodiments there are six positions, one of which is an "off" position. The modifications in construction necessary to make possible this different operation distinguish this modification.

The switch body again comprises outer insulating plates which bear the reference characters 50, 50. These closure plates are again 70 spaced by intermediate members which in the present instance, however, comprise rings 51, 51, which are of substantially the same diameter as the closure plates and which are provided with corresponding side lugs so that securing screws 75

52 may secure both plates and rings as a unitary construction. The interior of the body formed by the plates and the rings is substantially a closed cavity, the sides of which are defined by insulating sheets 53, 53 which lie flat against the inside faces of the closure plates.

The sides of cam track 54 and of flying contact track 55 are formed by spaced rings 56, 56 which are secured to the adjacent closure wall by screws 57. Each side of the flying contact track 55, formed by the outer circumference of each ring 56, is again provided with contact-receiving recesses. Apposed pairs of stationary contacts 58, 58 having arcuate seats are positioned in these recesses and are carried by and formed integrally on the contact plates 59 which are located in recesses in the closure plates and extend therebetween and between the rings 51 to the exterior of the body where they are formed with terminal screws 60. One seat for the flying contact 61 is formed directly in the insulating ring so that no current passes through the switch with the moving contact positioned thereon. That seat is indicated by the reference character 62 and is illustrated in Figure 20. The cam follower 63 is again connected to the flying contact by a spring, which here bears the reference character 64, and is adapted to be moved from one seat to another over a sloping surface to provide the flying movement for the contact 61 as in the previous embodiments.

The actuating lever for the present embodiment comprises a rotary actuator 65 formed with spaced pairs of follower-contacting arms 66, 66. Actuator 65 encloses and is connected by a pin to transversely extending shaft 67 which passes through one closure plate 50 to be provided at its outer end with a knurled head 68 and a pointer 69 which is adapted to point to numbers 1, 2, 3, 4, 5 upon the outside of the closure plate to indicate the position of the flying contact within the body relative to the stationary contacts.

In the operation of this embodiment of the switch the current-carrying leads are connected to the various terminal screws 60, 60. Any circuit which is desired to be opened or closed is connected to apposing terminals 60, 60 and with the flying contact bridging the contacts 58, 58 connected thereto current will flow therethrough. Movement of the flying contact is functionally the same as in the previous embodiment and is accomplished by the rotary movement of the knurled knob 68 which functions to move the spaced arms 66, 66 into contact with the cam follower, to move that member over the inclined surface towards the next seat thereby creating a tension in the spring and move, as previously described, the flying contact to the next seat in the direction of actuator movement.

I claim:

1. A manually operable electric switch including a plurality of stationary contacts, a contact track connecting said stationary contacts, a movable contact adapted to seat selectively on said stationary contacts and to move on said track therebetween, a cam track, the distances between said contact track and said cam track being a minimum at said stationary contacts, a cam follower adapted to move on said cam track, means resiliently drawing said movable contact and said cam follower together, and manually operable means to move said cam follower to cause said movable contact to move on said contact track.

2. A manually operable electric switch including a plurality of stationary contacts, a contact track connecting said stationary contacts, a movable contact adapted to seat selectively on said stationary contacts and to move on said track therebetween, a cam track, the distances between said contact track and said cam track being a minimum at said stationary contacts and gradually increasing to a maximum between adjacent stationary contacts, a cam follower adapted to move on said cam track, means resiliently drawing said movable contact and said cam follower together, said means being under minimum stress with said movable contact seating on a stationary contact and with said cam follower at a minimum distance therefrom and under maximum stress with said cam follower moved therefrom to a point at which said tracks are separated by a maximum distance, and manually operable means to move said cam follower to place a maximum stress in said resilient means to move said movable contact.

3. A manually operable electric switch including a plurality of pairs of stationary contacts, a contact track connecting said pairs of stationary contacts, a movable contact adapted to seat selectively on said pairs of stationary contacts and to move on said track therebetween, a cam track, the distances between said contact track and said cam track being a minimum at said pairs of stationary contacts, a cam follower adapted to move on said cam track, a tension spring drawing said movable contact and said cam follower together, and manually operable means to move said cam follower to cause said movable contact to move on said contact track.

4. A manually operable electric switch including a plurality of stationary contacts, a contact track connecting said stationary contacts, the surface of said contacts being slightly below the normal surface of said track, a movable contact adapted to seat selectively on said stationary contacts and displaceable therefrom to move on said track therebetween, a cam track extended adjacent said contact track approaching most closely thereto adjacent said contacts and sloping to a maximum distance therefrom at points midway between said stationary contacts, a cam follower adapted to move on said cam track, means resiliently drawing said movable contact and said cam follower together, and manually operable means adapted to move said cam follower along said cam track to tension said resilient means to snap said movable contact from one seat along its track to an adjacent seat.

5. A manually operable electric switch including a contact track, spaced recessed contact seats in said track certain of which are adapted to be connected to a source of electricity, a movable roller contact adapted to move on said track and seat in said seats, a cam track extended adjacent said contact track provided with seats opposite said contact seats and with raised portions therebetween, a roller cam follower adapted to move on said cam track and seat in its seats, a tension spring connecting said movable contact and said cam follower, said spring being under a minimum tension with said contact and said follower positioned in apposing seats and under maximum tension with said contact seated and said follower on a raised portion, the relationship of said movable contact to its seats being such that the force exerted by said spring is sufficient to displace said contact therefrom immediately

said cam follower passes the top of a raised portion of its track between its seats, and means to move said cam follower.

6. An electric switch including a plurality of stationary contacts, a movable contact, guide means for said movable contact between said stationary contacts, and means to move said movable contact between said stationary contacts including a stationary cam track, a cam follower movable on said track, resilient means connecting said follower to said movable contact, the cam track being so contoured that said resilient means are placed under tension to displace said movable contact with said follower in certain positions thereon, and means to move said follower.

7. An electric switch including a plurality of spaced stationary contacts, a movable contact, guide means for said movable contact between said stationary contacts, and means to move said movable contact between said stationary contacts including a stationary cam track, a cam follower movable on said track, resilient means connecting said follower to said movable contact, and means to move said follower on said track to tension said resilient means to displace said movable contact from a stationary contact, said cam track sloping toward the adjacent contact from the point at which the follower is located at the instant of contact displacement so that the tension of said resilient means will snap said movable contact to the said adjacent contact.

8. An electric switch including a plurality of longitudinally spaced stationary contacts, a movable contact, guide means for said movable contact between said stationary contacts, and means to move said movable contact between said stationary contacts including a cam track extended parallel to said guide means between said stationary contacts, a roller cam follower movable on said track, a coil spring connecting said follower to said movable contact, a trigger mounted for sliding movement adjacent said cam track adapted to contact and move said follower and to allow free movement thereof in the direction of trigger movement, said cam track sloping toward said stationary contacts from points midway therebetween so that upon displacement of said movable contact from one stationary contact by the force exerted by the tension in said coil spring said movable contact and said follower will move with a snap action in the direction of the adjacent stationary contact.

9. An electric switch including a plurality of arcuately spaced stationary contacts, a movable contact, guide means for said movable contact between said stationary contacts, and means to move said movable contact between said stationary contacts including an arcuate cam track positioned adjacent said guide means, a roller cam follower movable on said track, a coil spring connecting said follower to said movable contact, a pivotally mounted trigger adapted to contact and move said follower on said track, and to allow free movement thereof in the direction of trigger rotation, said cam track sloping toward said stationary contacts from points midway therebetween so that upon displacement of

said movable contact by the force exerted by the tension in said coil spring said movable contact and said follower will move with a snap action to the adjacent contact in the direction of trigger rotation.

10. An electric switch including a plurality of circumferentially spaced stationary contacts, a movable contact, guide means for said movable contact between said stationary contacts forming a complete circle, and means to move said movable contact between said stationary contacts and in either direction around said circular guide means including a circular cam track the center of which is coincidental with the center of said guide means, a cam follower movable around said track, a coil spring connecting said follower to said movable contact, a trigger mounted for rotation in either direction upon an axis within said guide means and said track and adapted to move said follower on said track and to allow free movement thereof in the direction of trigger movement, said cam track sloping toward said stationary contacts from points midway therebetween so that upon displacement of said movable contact by the force exerted by the tension in said coil spring said movable contact and said follower will move with a snap action in the direction of the adjacent stationary contact.

11. In a manually operable small capacity switch, spaced outer closure plates, intermediate laminations between said plates recessed to form an interior body cavity with spaced parallel tracks, current-carrying contacts positioned in one of said tracks and connected by means extending between adjacent closure plates and laminations to terminals, a movable contact mounted in said one track adapted to seat selectively on said contacts, the second track being contoured as a cam track, a cam follower adapted to move on said second track, spring means drawing said contact to said follower and holding each on its track, and means to move said cam follower to cause said movable contact to move on its track.

12. In a manually operable small capacity switch, spaced outer closure plates formed with inwardly extending shoulders, intermediate laminations between said plates recessed to form an interior body cavity, and additionally recessed to seat said shoulders, transversely extending screws extending through said plates and laminations to secure same as a unitary construction, circuit opening and closing means in said body cavity, and manually operable means to control said last mentioned means extended from said body cavity.

13. A manually operable switch comprising a hollow insulating body shaped to form two tracks, stationary contacts on one of said tracks, a contact movable on said one track, the second track being shaped to form a plurality of cam surfaces, a follower for movement on said second track, tension means connecting said movable contact and said follower which function to move the former upon the latter being sufficiently displaced therefrom, and means to move said follower.

FRANK A. GROTHE.