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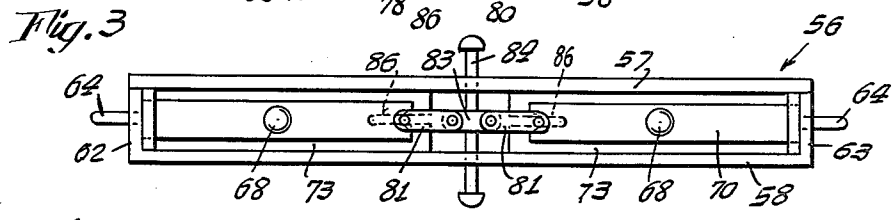
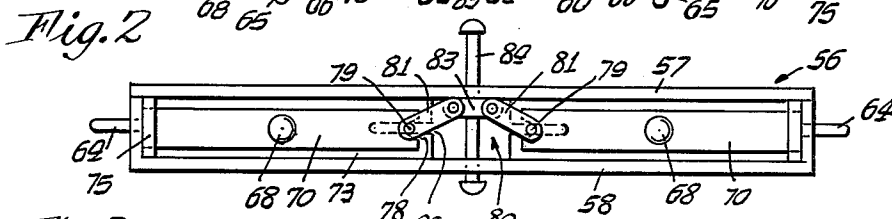
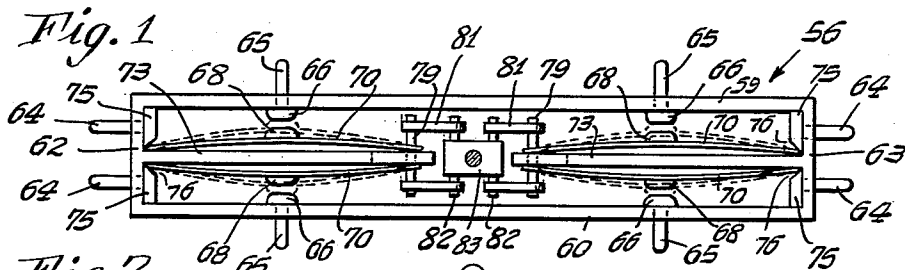
I. STRAUSS

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SNAP ACTING ELECTRICAL SWITCH

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SNAP ACTING ELECTRICAL SWITCH

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4 Claims. (Cl. 200-67)

This invention relates to electrical switches, and more particularly to switches of the general class wherein the contact making member or means has a rate and extent of movement which is different from that of the operator member to which the operating force is directly applied.

An object of the present invention is to provide an improved electrical switch device wherein there is a large ratio between the movements of the contact-carrying member and the switch operating member while at the same time the switch structure is extremely simple, uncomplicated and economical to fabricate and manufacture.

Another object of the invention is to provide an improved and simplified quick-acting type electrical switch, wherein only a relatively small and slow operating movement is required to effect a quick-acting, large-magnitude movement of the contact means.

A further object of the invention is to provide an improved electrical switch in accordance with the foregoing, wherein one or several circuits may be controlled to either open or close the same with but extremely little force being required on the switch operator.

An additional object of the invention is to provide an improved switch mechanism as above characterized, having a large ratio of movement together with extreme simplicity, wherein there is obtained a desirable wiping action of the contacts, thereby to normally maintain the same in relatively clean and operative condition throughout an extended period of use.

Yet another object of the invention is to provide an improved single-circuit or multi-circuit electrical switch wherein the switch-operating system is characterized by balanced or opposed forces which provide for a high degree of efficiency, smooth operation, a reduction of working stresses, and reliable response to small operating forces at specified positions of the switch operator.

A still further object of the invention is to provide an improved electrical switch device as set forth above, which may employ either a direct or indirect actuating or operating system and which is characterized by an elongate actuator device placed in operation by the application of a longitudinally directed force to either one or both ends of said device, to translate said force into a lateral movement of a portion of the device for causing circuit-controlling movement of one or several electrical contacts carried thereby.

Still another object of the invention is to provide an improved momentary-contact switch construction employing an elongate actuating device as outlined, wherein an inherent spring action is had, thereby to obviate the necessity for additional components for the purpose of returning the switch to an initial or starting position.

An additional object of the invention is to provide an improved simplified elongate switch actuator device as characterized, wherein a large ratio of movement exists between the longitudinally directed end force which is applied to the device and the resultant lateral movement of the contact or contacts carried by the device.

A further object of the invention is to provide a novel and improved switch construction involving opposed or balanced operating forces, wherein a self-locking action is had for one position of the switch operator, and wherein the switch may be tripped either to open or close the circuit with but the application of a very small operating force.

Yet another object of the invention is to provide an improved switch construction having opposed or balanced

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forces as above stated, wherein the switch may be sustained in one operative position by the application of only very small or minute forces.

A feature of the invention resides in the provision of an improved switch construction which is extremely sensitive in its response and may be operated by the application of relatively small forces while at the same time there are produced high contact pressures between the cooperating contact elements.

Another feature of the invention resides in the provision of a novel and improved switch adapted for momentary contact service, wherein either single or multiple circuits may be controlled and switched either on or off by an actuator mechanism involving either balanced or unbalanced operating forces, such switch mechanism having a "dead center" position and being operable either to one side or both sides of the said center position.

A further feature of the invention resides in the provision of a novel and improved switch arranged for sustained-contact service, which may handle either single or multiple electrical circuits to switch the latter on or off utilizing a switch actuator mechanism having either balanced or unbalanced operating forces.

Other features and advantages will hereinafter appear.

In the drawings accompanying this specification similar characters of reference are used to designate like components wherever possible throughout the several views, in which:

FIG. 1 is a top plan view, with the cover removed, of an improved multiple circuit balanced-type electrical switch as provided by the invention, the switch being shown in its normal, open-circuit position.

FIG. 2 is a side elevational view of the switch shown in FIG. 1, with a side plate of the casing removed to reveal the interior construction.

FIG. 3 is a view like FIG. 2, but showing the switch in closed circuit position with the operator at "dead center."

FIG. 4 is a view like FIGS. 2 and 3 but showing the switch again in open circuit position, with the switch operator having passed the "dead center" position.

FIG. 5 is a fragmentary side elevational view showing the center portion of the switch mechanism illustrated in FIG. 3, and showing further a stop for the switch operator, to establish as one of the limits of movements thereof the "dead center" position.

FIG. 6 is a diagrammatic representation of a simple, single pole single throw switch mechanism made in accordance with the invention, the switch being shown in open-circuit position.

FIG. 7 is a view like FIG. 6, but showing the switch as having been actuated to closed-circuit position by a longitudinal force on one of the switch blade mounting means, shifting said means toward the other blade mounting means.

FIG. 8 is a view like FIGS. 6 and 7, but showing the switch in closed-circuit position in response to the application of a longitudinal actuating force to the other one of the blade mounting means.

FIG. 9 is a view like FIGS. 6, 7 and 8 but showing the switch as having been closed in response to longitudinal actuating forces applied to both of a blade mounting means.

FIG. 10 is a diagrammatic representation of a double blade switch as provided by the invention, the switch being shown in open-circuit position and the left end mounting means for the blades being indicated as movable by the showing of arrows which are representatives of longitudinal operating forces applied to the said mounting means.

FIG. 11 is a diagrammatic representation of a four-circuit switch mechanism as provided by the invention.

FIG. 12 is a diagrammatic representation of a two-cir-

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cuit switch mechanism as provided by the invention, having a rotary type operator.

FIG. 13 is a diagrammatic representation of a four-circuit switch mechanism in accordance with the invention, said mechanism having a lever type switch operator.

FIG. 14 is a diagrammatic representation of a four-circuit switch mechanism along lines similar to the two-circuit switch shown in FIG. 12.

FIG. 15 is a representation of a two-circuit balanced-force type switch mechanism, utilizing a slide or plunger type operating member.

FIG. 16 is a diagrammatic representation of a single-circuit switch device as provided by the invention using rigid members or arms in place of resilient or bowed members as disclosed in the previous figures.

FIG. 17 is a diagrammatic representation of a single-circuit switch mechanism, illustrating yet another embodiment of the invention characterized by a very large ratio of movement between the switch contact and the switch operator.

FIG. 18 is a view like FIG. 17 but showing the switch in its closed-circuit position.

FIG. 19 is a diagrammatic representation of still another switch mechanism as provided by the invention, having a very high ratio of movement utilizing non-resilient or rigid pin-connected actuator arms.

FIG. 20 is a view similar to that of FIG. 19, but showing the switch in its closed-circuit position.

FIG. 21 is a representation of a single-circuit switch mechanism in accordance with the invention, this embodiment employing a plunger-type operator and showing the switch in its open circuit position when the plunger and toggle mechanism are at dead-center, the mechanism being of the opposed-force type.

FIG. 22 is a diagrammatic representation of a modified form of throw-switch mechanism made in accordance with the present invention, the switch being shown in open circuit position.

An understanding of the basic action underlying the switch mechanism of the present invention may be readily had by first referring to the structures shown in FIGS. 6-9. As illustrated in these figures, the switch comprises an elongate resilient blade member indicated generally by the numeral 25, said member being also hereinafter referred to as an "elongate actuator device." While in FIGS. 6-9 and in other illustrated embodiments of the invention the elongate actuator device is constituted of a single resilient strip, the invention is not limited to such construction since the actuator device may be formed of a number of separate parts, as for example rigid arms pivotally connected together as described in detail below.

The elongate actuator device 25 may thus be considered as constituted of a pair of substantially aligned actuator arms 27 and 28, having juxtaposed ends or end portions 29 and 30 respectively, the said end portions being operatively connected together. In the illustrated embodiments of FIGS. 6-9 the end portions 29, 30 of the arms 27, 28 are integral with each other, and accordingly the operable connection between said end portions is characterized by a certain degree of flexibility but with no looseness, free pivotal movement or play of any kind. As will be hereinafter brought out, in other forms of the invention the two arms making up the elongate actuator device may be pivotally secured together as by means of suitable pin connections.

As shown, the remote ends 32 and 33 of the arms 27, 28 are received in sockets 34 and 35 respectively provided in end mounting means or members 37, 38. The end mounting means 37 and 38 may be connected by suitable leads 40 and 41 with electrical terminals 42, 43, as shown.

The juxtaposed end portions 29, 30 of the arms 27, 28 have secured to them an electrical switch contact 45 which is cooperable and engageable with a stationary electrical contact 46 connected by means of a lead 47 with an elec-

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trical terminal 48. It is to be noted that while for illustrative purposes the contact 45 is described as a separate part secured to the arms, the present invention nevertheless contemplates the provision of a contact surface which is a part of and integral with the arms themselves.

The elongate actuator device comprising the bowed flexible strip 25 may be formed of any suitable material, such as spring steel, spring brass or bronze, beryllium copper, stainless steel, etc. As illustrated in the figures, the actuator or strip 25 is always bowed, either to a greater or lesser extent, regardless of whether the switch contacts 45, 46 are engaged or separated. In FIG. 6 the switch contacts are shown in their separated positions, and in accordance with the present invention closure of the switch and engagement of the contacts 45, 46 is effected in response to the application of a longitudinally directed operating force on either one or else both of the mounting means 37, 38.

In FIG. 7, such operating force is represented by the arrow 50, applied to the left mounting member 37. In FIG. 8 the arrow 51 represents the longitudinal operating force applied to the right mounting means 38. In FIG. 9 the arrows 52 and 53 represent operating forces applied to both of the end mounting means 37, 38. Referring to FIG. 7 the application of the force 50 will cause an increased flexing of the actuator device 25, whereby the center portion thereof, constituted of the arm ends 29, 30 and the switch contact 45, will be shifted laterally of the actuator device and in an upward direction until the contact 45 engages the cooperable stationary contact 46.

It will be noted that the movable contact 45 has shifted edgewise a slight extent to the right from a centralized position, and part of such shifting will occur after engagement of the contacts 45, 46 has occurred, thereby resulting in a wiping action of the contacts which is desirable in maintaining the same in a clean and bright condition, and in removing foreign particles and matter which might collect at the contacts.

In FIG. 8 the movable contact 45 has been shifted from its centralized position to the left, effecting a left wiping action when the switch is closed. In FIG. 9, the operating forces 52, 53 may be substantially balanced whereby the movable contact 45 will shift neither to the right nor to the left, and with this construction there is no appreciable wiping action present. In circumstances where extremely small currents and voltages are being handled, the absence of a wiping action if not a disadvantage, and accordingly the embodiment illustrated in FIG. 9 would find an application for such uses.

It will be seen that with the novel and improved switch construction illustrated in FIGS. 6-9 a relatively small movement of either or both of the end mounting means 37, 38 will result in a correspondingly greater lateral movement of the movable contact 45 whereby a desirable movement multiplying action is had. Thus, in response to a relatively short travel of one or both of the end mounting means, the movable contact may be caused to travel a correspondingly greater extent, and also to more rapidly move into engagement with the stationary contact 46. Conversely, upon the removal of the operating force from the mounting means, the spring action of the actuator device 25 will restore it to the initial flexed condition shown in FIG. 6, and opening of the switch will be characterized by a relatively rapid movement of the contact 45 together with a great extent of movement, as compared with the movements of the end mounting means 37, 38. As is well-known in certain applications, the rapid separation of contact points or surfaces is beneficial in minimizing arcing, sparking and the like, and the present switch construction by virtue of the quick-break action, also has an advantage in this respect. In conjunction with the large ratio of movements, the quick-acting make and break and the wiping action of the contacts, the switch construction shown in FIGS. 6-9 has the added advantage of an inherent return force without requiring the utilization

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of separate springs or other biasing means, since the bowed member 25 may be formed with the desired bias to effect separation of the contacts 45, 46 upon removal of the operating force from the end mounting means.

A novel and advantageous construction employing balanced forces, and utilizing the principles of the basic structures illustrated in FIGS. 6-9 is set forth in FIGS. 1-4. In these figures there is illustrated a switch capable of controlling as many as four separate or individual electrical circuits. The switch as shown comprises an elongate box-like casing 56 having top and bottom walls 57, 58, side walls 59, 60 and end walls 62, 63. The end walls 62, 63 mount electrical terminal elements 64, and the side walls 59, 60 mount terminal elements 65. At their inner ends, the terminals 65 carry stationary electrical contacts 66 which are cooperable with movable contacts 68 carried by elongate actuator devices in the form of bowed elements or strips 70. The strips 70 may be similar in construction and functioning to the actuator device or element 25 described above.

The bowed elements 70 are arranged in pairs, as shown, and the elements of each pair are separated by an elongate separator and guide member 73 disposed centrally in the casing 56 and preferably secured to the bottom wall 58 and/or end walls 62, 63 of the casing. The separator elements 73 may be advantageously constituted of an insulating material such as plastic, or they may be formed of metal where no insulation is required between the bowed elements 70 of any one pair. End mounting means 75 are provided, having sockets 76 receiving the ends of the bowed elements 70. The remaining ends of the bowed elements, located adjacent the central portion of the casing 56, are provided with V-notches 78 to receive actuator pins 79 of a step-down transmission or toggle operator mechanism 80, said mechanism including links 81, pins 82 and a common connector and operator member 83 carried by a plunger 84 which has a bearing in the upper and lower walls 57, 58 of the casing. The operating pins 79 also extend through guide slots 86 in the separator members 73, as seen in FIGS. 2, 3 and 4. FIGS. 1 and 2 depict the open-circuit position of the switch mechanism. When, referring to FIG. 2, the plunger 84 is depressed so that it assumes the position of FIG. 3, the toggle mechanism will be arranged with its legs in alignment or in dead-center position, and the resultant operating forces applied by the pins 79 to the ends of the bowed members 70 will cause increased bowing of the latter, causing the members to assume the dotted line positions shown in FIG. 1 whereby the cooperable contacts 66, 68 will be brought into engagement with each other, closing the circuit through the switch. Upon further downward movement of the plunger 84 from the position of FIG. 3 to the position of FIG. 4, the toggle mechanism will again be "broken" and the operating pressure will be removed from the ends of the bowed members 70, whereupon said members will become less bowed, thereby separating the movable contacts 68 from the stationary contacts 66 so as to open-circuit the switch.

When the plunger 84 is in the dead-center position shown in FIG. 3, no sustaining force will be required to maintain it in such position, since normally the small friction existing in the relatively movable parts will effect this. Thus, the switch will be maintained in its closed-circuit position with virtually no operating force being required on the plunger 84. Also, by the same token, as the plunger 84 attains the dead-center position the operating force which must be applied to it becomes less and less, while at the same time the contact pressures between the cooperable contacts will not only be maintained, but will be increased an appreciable extent. Thus, a very appreciable contact pressure may be had with relatively little force being required on the switch operator at the time that the toggle attains its dead-center position. The balanced forces experienced by the toggle for such dead-center position will thus be acting to maintain the contact

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pressures independent of force applied to the plunger. Also, at the time that the switch is to be opened-circuited, the force which is required on the plunger 84 to shift it from the dead-center position of FIG. 3 to the open-circuit position of FIG. 4 will be relatively small, and in fact upon the plunger being started toward the open-circuit position the resilience of the bowed members 70 will effect a completion of the movement of the plunger, without requiring further external force thereon.

Instead of the plunger 84 being shifted downward from the FIG. 3 position to the FIG. 4 position to effect open-circuiting of the switch, the movement of the plunger may be reversed, and a stop may be provided to halt the plunger in its dead-center position, this being illustrated in FIG. 5. In this figure, the stop member is indicated by the numeral 88.

With the above balanced-force switch construction it is seen that the opposed forces enable a self-locking of the switch to be had in one position, and enable the switch to be tripped from its self-locked position with the application of but very small forces. The sustaining of the switch in its locking position further requires only very small forces, if indeed any whatsoever. The switch construction is moreover extremely sensitive in its response, involving high contact pressures and relatively small operating forces as the toggle approaches its dead-center position. Therefore relatively large currents may be handled by the switch with safety. The switching action is also characterized by little movement being required of the operator, and by a relatively fast make and break, thereby reducing arcing as compared with slow-acting switch mechanisms.

Another embodiment of the invention is illustrated in FIG. 10, wherein a pair of elongate actuator devices 90 and 91 is shown, said devices being similar to the actuator device 25 described above. The actuator devices or members 90, 91 are disposed broadside to each other, and have cooperable movable contacts 92 and 93 which may be brought into engagement by application of an operating force 94 and 95 applied to either of the end mounting means of the devices. The rapidity of the relative movement of the contacts is increased where, as illustrated, two operating forces 94 and 95 are concurrently applied. By such construction, in addition to the advantages already enumerated above there is had the further advantage that a much wider separation of the cooperable contacts is effected, together with the aforesaid more rapid relative movement of the contacts as compared with switch constructions employing but a single actuator device.

In FIG. 11 a four-circuit switch mechanism as provided by the invention is illustrated. This switch mechanism comprises four elongate actuator devices 97, 98, 99 and 100, having movable contacts 101, 102, 103 and 104 which are respectively cooperable with stationary contacts 105, 106, 107 and 108. The stationary contacts 105-108 are carried on spring leaf members 109, 110, 111 and 112, the said members being insulated by suitable separator strips 114, 115. The leaf elements 109-112 may yield a slight extent upon engagement between the cooperable contacts, and accordingly a wiping action is had between the contacts while at the same time the dimensions and adjustment of the switch mechanism is not so critical, since the yielding of the leaf elements 109-112 will permit complete closing of all four of the switch circuits even though some of the contacts become engaged prior to others. The operating forces for actuating the switch members may be applied to the end mounting means, as indicated by the arrows shown in conjunction with each such mounting means. Such operating forces may accordingly be of the opposed or balanced type, similar to the organization shown in FIGS. 1-4. It will be understood that the arrangement of FIG. 11 provides for a wiping action of the switch contacts even though operating forces are applied to both ends of any

or all of the four elongate actuator devices, inasmuch as the yielding of the leaf-members 109-112 will cause a slight displacement of the stationary contacts 105-108 in an edgewise direction, that is, longitudinally of the actuator devices.

Another embodiment of the invention is illustrated in FIG. 12, wherein a rotary shaft 115 is provided, carrying an operator disc 116 having notches 117 and 118, in conjunction with elongate actuator devices 119, 120. It will be readily understood that counterclockwise turning of the disc 116 will effect a greater flexure of the devices 119, 120 and closing of the switch circuits, and upon removal of the operating force from the disc 116 the resilience of the devices 119, 120 will cause them to flex to a lesser degree, returning the operating disc 116 to its open circuit position. An arm 121 is carried by the operating disc 116 and is adapted to engage a fixed stop member 121a whereby the return movement of the operating disc may be stopped at a predetermined point.

In FIG. 13 an operating lever 122 has notches 123 accommodating the ends of elongate actuator devices 125, in an organization where four separate circuits may be controlled. Counterclockwise turning movement of the lever 122 will effect a closing of the upper left and lower right switch devices, and clockwise movement of the lever 122 will effect an opening of such devices and a closing of the upper right and lower left switch devices. If, for example, only the upper left and lower right switch devices are employed and the other switch devices are omitted, stop 127 may be utilized for engagement with the lever 122 to provide the opposing or reactive force which was removed by removal of the upper right and lower left switch devices.

FIG. 14 illustrates an organization quite similar to that of FIG. 13 except that the operating lever 122 is replaced by an operating disc or wheel 129, having notches 130 which function in the manner of the notches 123 in the lever 122. The operation of the switches in FIGS. 13 and 14 is otherwise similar.

Still another embodiment of the invention is illustrated in FIG. 15. In this figure two elongate actuator devices 132 and 133 are provided, said devices being associated with opposed-action operating levers 135 and 136. Between the levers 135, 136 there is disposed a plunger 138 having a carrier member 139 provided with rollers 140, 141 which are engageable respectively with the levers 135, 136. It will be understood that when the plunger 138 is depressed or shifted downward as seen in the figure, the levers 135, 136 will be swung in opposite directions or away from each other, thereby increasing the flexing of the actuator devices 132, 133 and closing the switch circuits. A stop 142 is provided to prevent further downward movement of the plunger. The resilience of the actuator devices 132, 133 may be employed to return the plunger 138 to its raised position, or if the operating mechanism is designed to be self-locking by virtue of the levers 135, 136 becoming parallel when the switches are in closed positions, the return of the plunger 138 must be effected by the application of an external returning force, regardless of the resilience of the devices 132, 133. Thus, the opposed or balanced force characteristic of the switch illustrated in FIGS. 1-4 may also be had with the construction shown in FIG. 15.

Another embodiment of the invention is illustrated in FIG. 16, wherein the elongate actuator device 143 comprises a pair of rigid arms 144, 145, the remote ends of said arms being received in sockets 146, 147 respectively of and mounting means 148, 149. The juxtaposed end portions 150, 151 of the rigid arms 144, 145 may be operatively connected together by a pivotal connection employing a pivot pin 153. One actuator arm, as for example, the arm 145 shown in FIG. 16 may have an extension 155 provided with a movable contact 156 which is cooperable with a stationary contact 158. Upon the application of an operating force to one or both of the

end mounting means, as indicated by the arrows 160 in FIG. 16, the movable contact 156 will be shifted laterally with respect to the actuator device, and will be brought into engagement with the stationary contact 158, thereby to close the switch circuit. With this construction, a slightly greater mechanical advantage or multiplication of movement is had, whereby a larger and faster movement of the contact 156 is experienced with respect to the movement of the end mounting means 148, 149 as effected by the operating force 160. A return spring 162 may be provided, to effect opening of the switch circuit and straightening of the actuator arms 144, 145 upon removal of the operating force 160.

Another embodiment of the invention is illustrated in FIGS. 17 and 18. In this form, an elongate actuator device 165 is provided, in the form of a bowed strip, and such strip may be considered as being constituted of two actuator arms, each arm comprising a half of the strip. Thus, the center portion 167 of the strip 165 may be thought of as the junction or connection between the two actuator arms, which latter have been labeled 168 and 169 in the figures. Therefore, the juxtaposed end portions of the actuator arms 168, 169 may be thought of as being operatively connected together at the mid-point 167 of the actuator device 165, insofar as the action and functioning of the said device is concerned. For, the center portion 167 of the actuator device will be shifted laterally at a greater speed and with a greater travel than one of the end mounting means for the switch mechanism, upon the application of an operating force (as shown by the arrow 170 in FIG. 18) thereto. Thus, the action of the elongate actuator device 165 is similar in many respects to the other forms of the invention described above. In FIGS. 17 and 18 a separate contact carrying arm 172 is provided, having a movable contact 173 cooperable and engageable with a fixed contact 174, the arm 172 being secured to an end portion of the actuator device 165. In the figures, the contact carrying arm 172 is shown as secured to the left end portion of the actuator device. With this organization there is retained the resilient or spring action characteristic of a bowed actuator device while at the same time an even greater ratio of movement exists between the movable contact and the end mounting means to which the operating force is applied. Also, there is present a wiping action of the contacts upon their being engaged, and dimensions need not be critical inasmuch as the contact carrying arm 172 may also be made resilient, whereby it can yield after effecting engagement between the contacts 173 and 174. A single operating force is indicated at 170, resulting in an unbalanced arrangement. It will be understood, however, that with regard to the structures shown in FIGS. 16, 17 and 18, a balanced organization may be provided by duplicating these structures and arranging them in alignment with each other along the lines suggested by the embodiment of FIGS. 1-4. A toggle-type operator may then be employed, or else a cam-type operator, the latter being illustrated in FIG. 15, for example. Thus, a balanced force or opposed force system may be had with the attendant advantages already mentioned above.

Still another embodiment of the invention is illustrated in FIGS. 19 and 20, wherein an elongate actuator device 175 is provided, having rigid arms 176, 177 which are pin connected together with a pin 178. The arms 176, 177 may be pivotally mounted at their remote ends, and an operating force 180 may be applied to one of the pivotal mounting pins, to effect lateral movement of the center portion of the actuator device, where the pivot pin 178 is located. A contact carrying arm 182 may be provided, secured to one of the actuator arms 176, 177, said carrier being provided with a movable contact 182 which is cooperable with a stationary contact 183, as shown. In FIGS. 19 and 20 the contact carrying arm or extension 184 is illustrated as carried by the left actuator arm 176 of the switch mechanism, and the contact carrier may be

either rigid or else resilient, as will be understood. With this organization as with the embodiment of FIGS. 17 and 18 an added mechanical advantage is had in that an even greater ratio of movement exists between the operating force 180 and the movable contact 182. As shown, a return spring is provided to open the switch circuit and straighten the actuator arms 176, 177 upon removal of the operating force 180.

In the foregoing examples of switch construction as provided by the invention the application of the operating force has been utilized to effect the closing of the circuit by a driving action. However, by a simple reversal of the contact arrangement, the application of operating force to the switch may be utilized to open the switch circuit by an indirect action. Such arrangement is illustrated in FIG. 21 wherein an elongate actuating device 185 is shown which is normally biased to a straight position, said device having a movable contact 186 which is co-operable with a stationary contact 187. A plunger 188 and toggle arrangement 189 is illustrated, for actuating an end mounting means 190 for the elongate actuator device 185. When the plunger 188 is shifted from the raised full line position of FIG. 21 to the lowered or dotted line position, the actuator device 185 will be flexed to a lesser degree, thereby engaging the movable contact 186 with the stationary contact 187. It will be understood that the open-circuit position of the switch is illustrated by the full-line showing, and that the toggle mechanism is in dead-center position for such open circuit condition. With the organization shown in FIG. 21 there is also the advantage of an opposed-force or balanced-force organization in conjunction with a toggle mechanism, while at the same time but a single elongate actuator device is utilized for controlling but a single electrical circuit. Thus, the advantages of the balanced-force or opposed-force construction set forth in connection with FIGS. 1-4 is had with the switch shown in FIG. 21, while at the same time the switch need not utilize multiple switching elements but instead may be of the single-circuit type.

In the modified form of the present invention shown in FIG. 22 the actuator arm 201 is made of non-conductive material, such as plastic or the like. Upon the flexing of the arm by application of force 202 the actuator 201 will flex and shift in an upward direction to engage and move the movable contact 45, thereupon causing the movable contact 203 to engage the cooperable stationary contact 204, providing a circuit of which the actuating arm is not a part. It will be understood that while the actuating arm 201 has been described as being of non-conductive material, the same results may be obtained by providing an insulating cover over the metal arms hereinbefore described.

While in the description the contacts have been usually set forth as comprising separate parts, it is to be understood that the contacts may be an integral part of the switch arms, which themselves will then provide contact surfaces to equal advantage.

From the foregoing it will now be understood that I have provided by the present invention an extremely simple, sensitive and efficient electrical switch mechanism wherein relatively small operating forces are required while at the same time effecting high contact pressures. The switch mechanisms are characterized by rapid make and break, and a high ratio of movement between the cooperable contacts and the operating force applied to operate the switch. In conjunction with these advantages there is also had a wiping action of the contacts, together with a simple, inherent spring action for effecting return of the members to their initial positions. Switch mechanisms employing opposed or balanced operating forces and also unbalanced forces are illustrated, and the balanced or opposed-force type of mechanism may be self-locking in one position and may be tripped with the application of

a very small operating force, and also maintained in one position by a small operating force.

Variations and modifications may be made within the scope of the claims, and portions of the improvement may be used without others.

I claim:

1. An electrical switch for controlling an electrical circuit and comprising a normally bowed flexible strip, opposed mounting means for end mounting said flexible strip in its normally bowed position, at least one of said mounting means being movable relative to the other mounting means, operable means for increasing the flex of said strip, a contact connected intermediate the ends of said strip and adapted to engage a cooperable contact upon further flexing of said strip in response to the relative movement of said mounting means toward one another upon the actuation of said operable means, said operable means including a toggle mechanism being shiftable between out of dead center and dead center positions, said toggle mechanism including a plunger and a link pivoted at one end to said plunger and having its other end pivoted to said strip, movement of said toggle mechanism to dead center further flexes said strip and moves said contact carried thereby into resilient engagement with said cooperable contact, said strip resiliently disengaging said contacts upon movement of said toggle mechanism to an out of dead center position, and said further flexing of said strip causing an edgewise movement of the contact connected thereto relative to the cooperable contact after engagement therebetween to produce a wiping action between said contacts; and said contacts being maintained closed with a minimum of sustaining force on said plunger.

2. An electrical switch comprising a housing, a normally bowed flexible strip disposed in said housing, a pair of opposed mounting means for end mounting said flexible strip in a normally bowed position, means mounting at least a first of said mounting means for movement relative to the other mounting means, operable means for moving said first mounting means for further flexing said strip, a movable contact connected to the high point of said normally bowed strip and adapted to engage a cooperable stationary contact upon said further flexing of said strip in response to the relative movement between mounting means toward one another upon the actuation of said operable means, said operable means including a plunger shiftable between operative and inoperative positions, a link pivoted at one end to said plunger and pivoted at its other end to the end of said strip, whereby movement of said plunger moves said connected link into a dead center position and effects said further flexing of said strip to move said movable contact into engagement with said cooperable stationary contact, said contacts being maintained closed with minimum of sustaining force on said plunger, and movement of said link out of dead center causing resilient disengagement of said contacts.

3. An electrical switch capable of controlling a plurality of electrical circuits comprising a housing, normally bowed flexible strips arranged in pairs disposed in said housing, each strip of each pair of strips being oppositely bowed, said pairs of strips being disposed in spaced end to end relationship, end mounting means for receiving the remote ends of the strips in each pairs of strips, a movable contact connected to the high point of each of said normally bowed strips, a fixed cooperable contact opposite each of said movable contacts, operable means disposed between the adjacent spaced ends of said pairs of strips for simultaneously shifting the adjacent ends of said pairs of strips laterally toward the remote ends thereof for increasing the flex of said strips to effect contact between the respective movable contacts connected thereto and the adjacent cooperable fixed contacts to control the respective circuits, said operable means comprising a toggle operator having a plunger shiftable between opposed walls of said housing, toggle links each having one end pivotally connected to the plunger and having its

other end pivotally connected to the adjacent ends of one of said pairs of flexible strips whereby movement of said toggle links to their dead center positions effects flexing of said strips to close the respective contacts so that the closing pressure between contacts increases as the operating force diminishes, whereby said contacts are maintained closed with a minimum of sustaining force on said plunger, and movement of said toggle operator out of said dead center position being operative to permit return of said strips to their original flexed position and the separation of said movable and cooperable contacts.

4. An electrical switch capable of controlling a plurality of electrical circuits comprising a housing having connected top, bottom, side and end walls, normally bowed flexible strips arranged in pairs disposed in said housing, each of said pairs of strips being disposed in spaced end to end relationship, end mounting means for receiving the remote ends of said pairs of strips, a separator connected to one of said walls, said separator being of insulating material and being disposed between said strips of each pair, a movable contact connected to the high point of each of said normally bowed strips, a fixed contact connected to the walls of said housing opposite to each of said movable contacts, operable means disposed between the adjacent ends of said pairs of strips for simultaneously shifting the adjacent ends of said pairs of strips laterally toward the respective remote ends thereof for increasing the flex of said strips to effect contact between the respective movable contact connected thereto

and the adjacent cooperable fixed contact to control the respective circuits, said operable means comprising a toggle operatively connected to said adjacent ends of said pairs of strips, said toggle means being movable into and out of dead center position, said strips being flexed to effect said contact of said movable and fixed contacts when toggle is in said dead center position, and said strips being in said original flexed position with said movable and fixed contacts spaced apart when said toggle is out of said dead center position.

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