# United States Patent

[11] 3,602,676


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[21] Appl. No. 815,595
[22] Filed Apr. 14, 1969
[45] Patented Aug. 31, 1971
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[54] **KNIFE BLADE SWITCH WITH TOGGLE OPERATING MEANS AND MEANS FOR FASTENING THE KNIFE BLADE TO A TIE BAR**
**10 Claims, 7 Drawing Figs.**


[52] U.S. Cl. ..... 200/162, 200/153 G
[51] Int. Cl. ..... H01h 21/56, H01h 3/46, H01h 1/42
[50] Field of Search ..... 200/162, 166 E, 153 G, 144; 335/191



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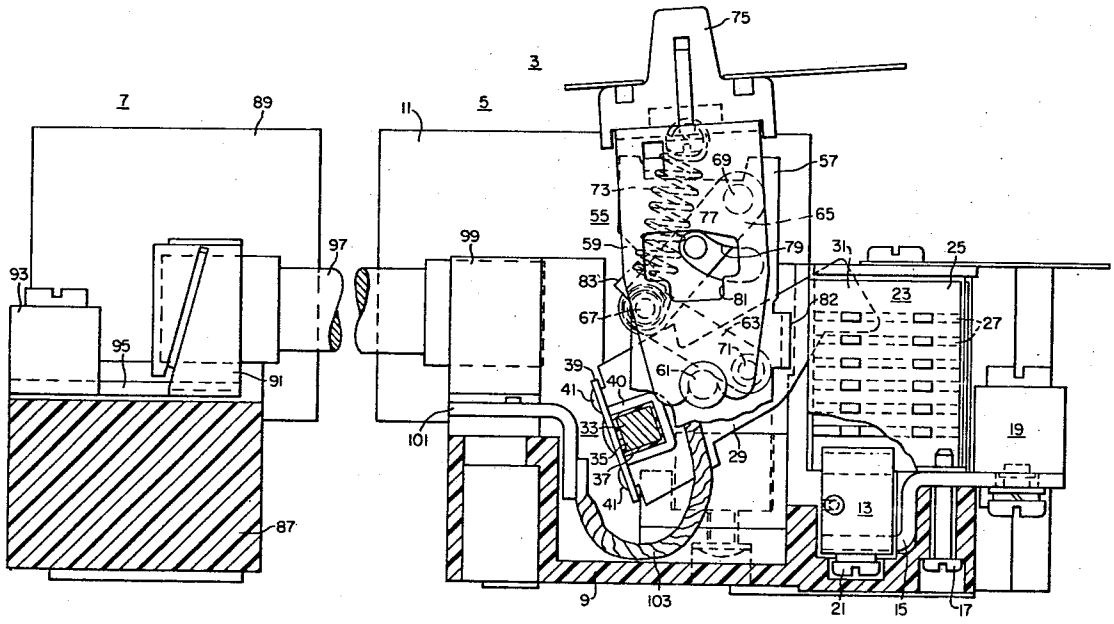
**ABSTRACT:** An efficient low-cost compact knife-blade switch with improved operating characteristics, good current carrying ability and improved short-circuit withstandability.

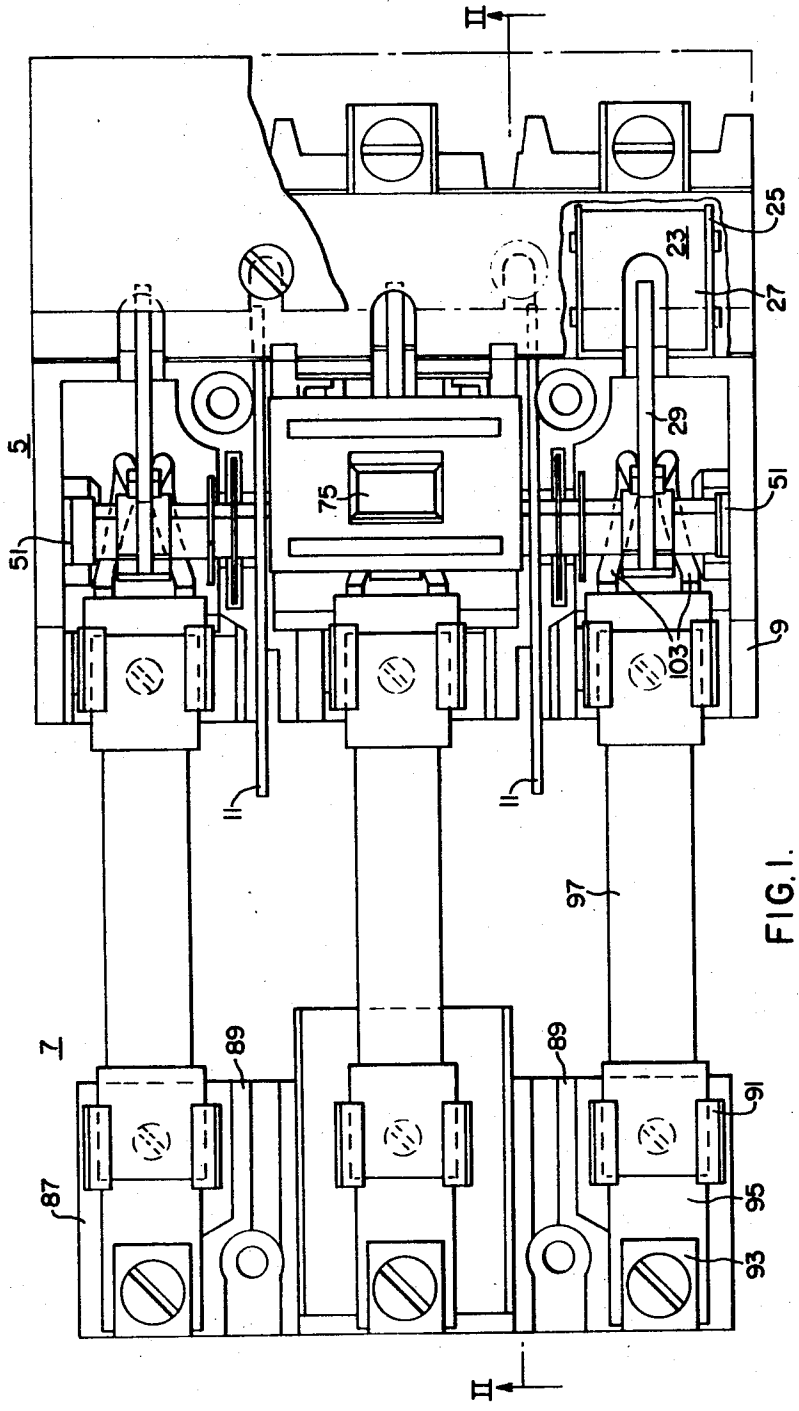
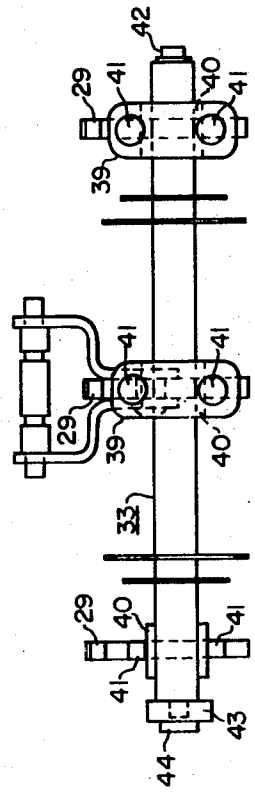



FIG. 1.

FIG. 7.

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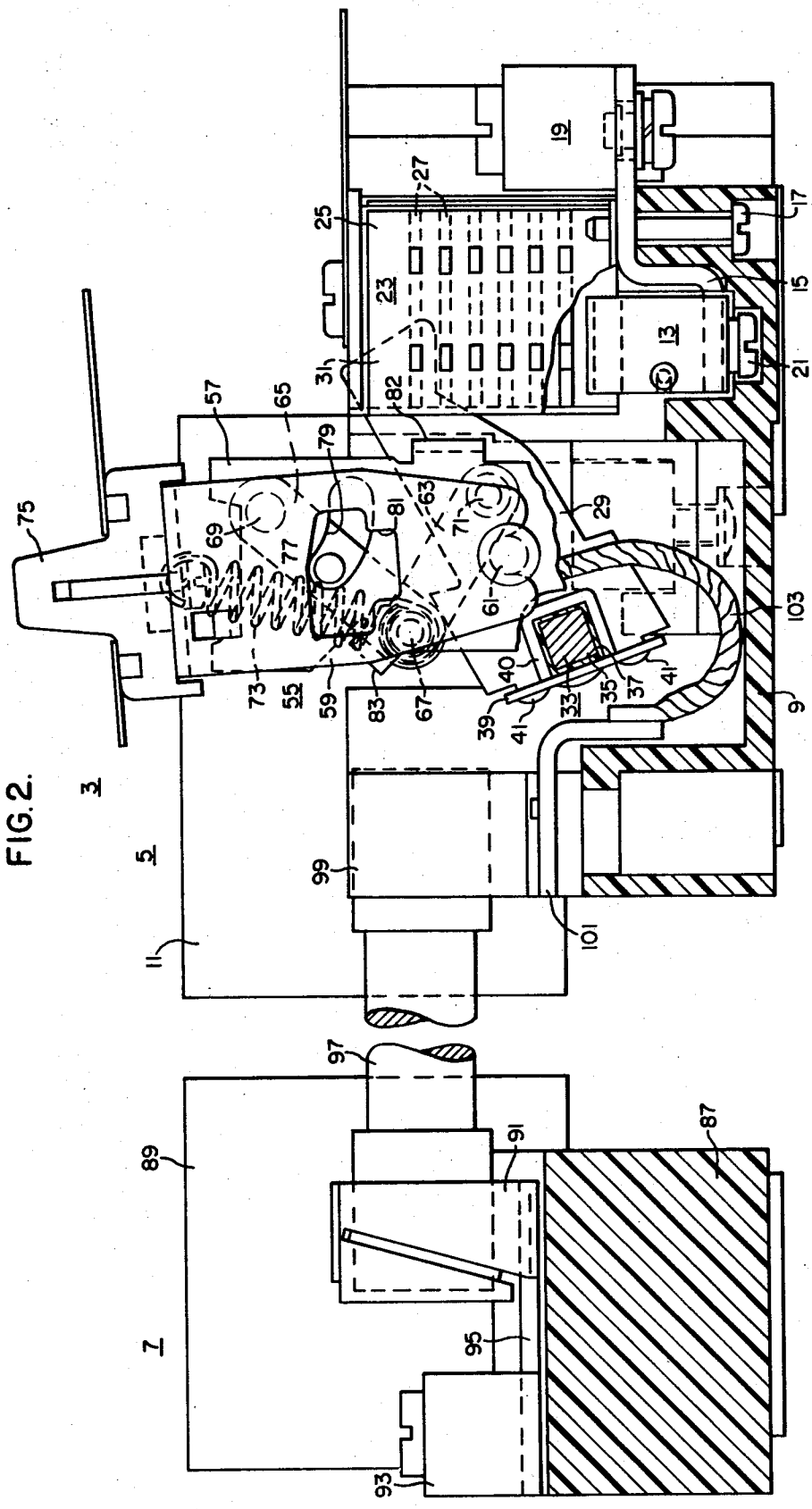
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FIG. 2.

FIG. 5.

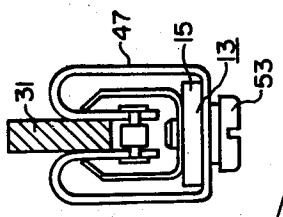


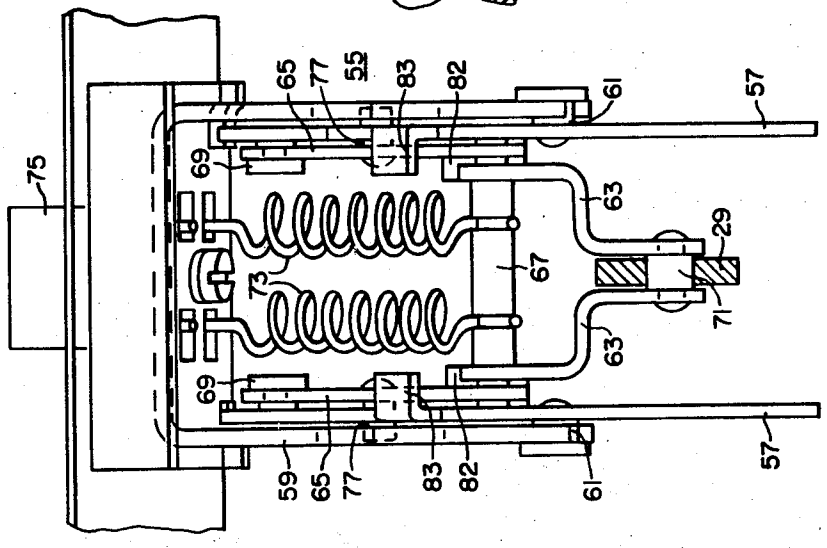

FIG. 3.




FIG. 6.




FIG. 4.



# KNIFE BLADE SWITCH WITH TOGGLE OPERATING MEANS AND MEANS FOR FASTENING THE KNIFE BLADE TO A TIE BAR

## BACKGROUND OF THE INVENTION

1. Field of the Invention

Knife blade switches of the type operated by an overcenter spring operating mechanism.

2. Description of the Prior Art

In the patent to C. Aalborg No. 1,539,819 there is disclosed a snap switch (FIGS. 1 and 2) of the type comprising a pair of knife blade contact arms operated by an overcenter spring operating mechanism that is connected to the contact arms by means of a tie bar that extends across the free ends of the contact arms, with each of the contact arms being mounted by means of a separate pivotal mounting. In this type of switch, it is common to provide frictional contact engagement at each pivotal mounting in order to conduct current from the contact arm to the terminal support means. The subject invention is an improvement over this type of prior art in that the knife blade contact arms of this invention are fixedly connected to a rigid elongated insulating tie bar that is pivotally mounted to simultaneously move the contact arms, and a flexible connection is provided between each contact arm and the associated terminal means. Moreover, the operating mechanism of this invention is pivotally connected to one of the contact arms between the knife blade contact and the mounting end of the one contact arm, for simultaneously driving the plurality of contact arms. In addition to providing an efficient and compact arrangement of parts, this construction facilitates the use of a separate arc-extinguishing structure for each of the contact structures with each of the knife-blade contacts moving within slotted plates in the associated arc-extinguishing unit.

In the patent to S. A. Mrenna et al. 3,278,710, there is disclosed a knife-blade switch comprising a plurality of knife-blade contact arms each of which is mounted on a separate pivotal support that also serves as a terminal between the stationary support and the contact arm that is pivotally mounted thereon. In this type of switch, it is common to provide an overcenter spring operating mechanism supported at the side of the switch unit for operating a yoke bar between open and closed positions with motion being transmitted from the yoke bar to the plurality of knife-blade contact arms by means of a lost motion connection. In the subject invention, the overcenter spring-operating mechanism is connected directly to the one knife-blade contact arm to drive the one contact arm and thereby simultaneously drive the three contact arms which are fixedly connected to the tie bar that is pivotally mounted on the switch support structure, and flexible conductors connect the knife-blade contact arms to their associated terminals.

In the patent to L. W. Dyer et al. 3,163,042, two different types of prior art switches are disclosed. Each of these switches comprises an overcenter spring operating means that is mounted on an insulating support block for driving a plurality of butt-type contacts into and out of butt-type engagement by driving the center-pole switch arm to thereby simultaneously drive all of the switch arms which are fixedly connected to an elongated tie bar that is mounted for pivotal movement about the elongated axis thereof. In the one embodiment, (FIGS. 3 and 4) contact pressure between the butt-type contacts is achieved by mounting flexible contact arms to the rigid switch arms. In the other embodiment, (FIG. 9) contact pressure is achieved by pivotally mounting a rigid contact arm on a rigid switch arm and providing a biasing spring for biasing the contact arm about the switch arm in the closed position of the contacts. In both of the embodiments electromagnetic hold-down means is provided to offset blow-off forces under short circuit conditions to thereby increase the current withstandability of the switches. This invention is an improvement over prior art of the type disclosed in the Dyer at al. patent in that current withstandability is achieved by providing a knife-blade switch construction as herein disclosed, and the mechanism is simplified in that each of the flat contact arms provides a knife-blade contact at one thereof and is fixedly spun-over or riveted at the other end thereof to the common tie bar with the operating mechanism being pivotally connected directly to the one contact arm which in the preferred embodiment is the contact arm of the center-pole unit of a three-pole switch. Each of the stationary contact structures comprises a precharged looped conductor structure providing good contact pressure and high current withstandability in the closed position of the contacts.



## SUMMARY OF THE INVENTION

A compact overcenter spring operated knife-blade switch comprises an insulating support block and a switch mechanism supported on the support block. The switch mechanism comprises a plurality of spaced stationary contact structures and a separate movable knife-blade contact arm for each of the stationary contact structures. Each of the movable contact arms is fixedly supported on an elongated common insulated tie bar that is supported for pivotal movement about the elongated axis thereon. The operating mechanism comprises overcenter spring means for operating lever means which is pivotally connected directly to one of the contact arms, (the contact arm for the center pole unit of a three-pole switch in the preferred embodiment), between the support end and the contact end of the one contact arm. Upon operation of an operating handle structure, the overcenter spring means is operated to operate through the lever means to move the one contact arm between open and closed positions with a snap action which movement, because all of the contact arms are fixed to the common tie bar, simultaneously drives all of the plurality of movable contact arms into and out of knife-blade engagement with the stationary contact structures. A separate magnetic plate arc-extinguishing unit is mounted in proximity to each of the stationary contacts with the associated knife-blade contact moving within aligned slots in the magnetic plates during opening and closing operations of the switch. Each of the contact arms is a flat rigid conductor with one end thereof serving as the knife-blade contact and the other end thereof being spun-over or riveted to the tie bar. The lever means of the operating mechanism is connected directly to the one contact arm for operating the contacts. Each of the contact arms is electrically connected to an associated terminal conductor by flexible conducting means. The stationary contact structure comprises oppositely disposed precharged looped conductors providing good contact pressure and high current withstandability in the closed position of the contacts. The novel construction provides a compact knife-blade switch with improved operating characteristics, good current carrying ability and increased short circuit or high current withstandability.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top plan view, with parts broken away, of a switch constructed in accordance with principles of this invention;

FIG. 2 is a sectional view, with parts broken away, taken generally along the line II—II of FIG. 1;

FIG. 3 is a partial view similar to FIG. 2 with the switch shown in the closed position;

FIG. 4 is a sectional view, with parts broken away, taken generally along the line IV—IV of FIG. 3;

FIG. 5 is a sectional view, with parts broken away, taken generally along the line V—V of FIG. 3;

FIG. 6 is a view similar to FIG. 5, with the movable contact shown disengaged from the stationary contact; and

FIG. 7 is an end view, with parts broken away, illustrating the tie bar and the means securing the contact arms to the tie bar.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, there is shown, in FIGS. 1 and 2, a fused switch 3 comprising a switch 5 and fuse means 7.

The switch 5 comprises an insulating support block 9 having insulating barrier means 11 thereon for insulating adjacent pole units of the three-pole switch. At each pole unit, a clip-type stationary contact structure 13 is supported on a conducting strap 15 that is secured to the mounting block 9 by means of a screw 17 and that extends out to the end of the support block where a solderless terminal connector 19 is suitably secured to the outer end thereof. Each stationary contact structure 13 is secured to the associated conductor 15 by means of a screw 21. A separate arc-extinguishing structure 23 is supported on the support block for each of the stationary contact structures 13. Each of the arc-extinguishing structures 23 comprises an insulating arc wrapper 25 and a plurality of stacked slotted magnetic plates 27 supported on the wrapper 25 in a vertically spaced relationship with the slots thereof aligned vertically.

In each pole unit, a movable contact arm 29 is provided for cooperating with the associated stationary contact structure 13. Each of the contact arms 29 is a flat rigid conducting plate member with one end thereof, at 31, serving as a flat knife-blade contact. Each of the contact arms 29 is fixedly secured, at the other end thereof, to a common tie bar 33 that extends across the three pole units of the breaker. The tie bar 33 comprises a rigid metallic bar 35, that is rectangular in cross section, and an insulating cover 37 on the metallic bar 35. The mounting of the contact arms 29 on the tie bar 33 will be best understood with reference to FIGS. 2, 3 and 7. In FIG. 7, the contact arm 29 on the left is shown in position prior to the time when a plate member 39 is connected thereto and prior to the time that the contact arm is spun-over to the secured position of the two contact arms on the right in this Figure. A U-shaped metallic plate 40 is positioned on the tie bar 33 in each pole unit to provide a larger surface area of applied force to the tie bar 33 in order to protect the insulating cover on the tie bar. As can be understood with reference to FIG. 7, the U-shaped plate 40 is positioned on the tie bar 33 and the contact arm 29, which has a slot at the one end thereof for fitting over the U-shaped plate member 40, is mounted over the plate 40 with a pair of projections or leg portions 41 protruding back past the free ends of the legs of the U-shaped plate member 40. Thereafter, a rigid metallic plate member 39, having a pair of openings therein for receiving the projections 41, is mounted against one side of the tie bar at the free ends of the legs of the member 40 with the projections 41 protruding through the openings in the plate 39. Thereafter, the projections 41 are spun-over (hammered with a tool that is rotated during the hammering operation) to deform the material of the projections 41 thereby riveting the contact arm 29 to the plate 39 during which riveting operation the contact arm 29 and plate 39, along with the associated plate 40, are fixedly secured to the tie bar 33. As can be seen in FIG. 7, the metallic bar 35 of the tie bar 33 is formed to provide a bearing 42 on the right of the tie bar 33, and an insulating member 43 is secured to the left end of the tie bar, which insulating member 43 is provided with a bearing portion 44. The bearings 42, 49 are suitably mounted on spaced supporting plates 51 (FIG. 1), that are supported on the insulating support block 9, to support the tie bar 33 for pivotal movement about the elongated axis of the tie bar 33.

As can be seen in FIGS 5 and 6, each stationary contact structure 13 comprises a resilient conducting sheet metal contact member 47 that is generally U-shaped with the opposite legs thereof being again looped over to extend downward generally toward the bight portion of the U-shaped part of the member 47. A spacing member 49 is positioned between the contact portions of the member 47 to precharge the spaced contact portions of the resilient member 47, and an additional U-shaped spring clip 51 is provided to bias the contact portions of the member 47 toward each other which movement is limited by the large diameter portion of the spacer 49. As can be understood with reference to FIGS. 2, 3, 5 and 6, the smaller diameter end portions of the spacer 49 fit in slots in the contact portions of the member 47 and the spring 51, along with the resiliency of the member 47, bias the leg portions of the member 47 toward each other which movement is limited by the larger diameter internal portion of the spacer 49. As can be seen in FIGS. 5 and 6, the spacer 49 has enlarged stop parts at the opposite ends thereof to limit outward movement of the contact portions of the stationary contact structure.

The member 47 and spring 51 are secured to the conductor 15 by means of a screw 53. In the closed position of the contacts, the loop effect magnetic forces of the stationary contact structure serve to increase contact pressure between the stationary contact structure 13 and movable contact 29 under high current and short circuit conditions.

The contacts are manually operated between the open and closed positions by operation of an operating mechanism 55 (FIGS. 2–4) which is supported on a pair of spaced supporting plates 57 that are fixedly secured to the support block 9. The operating mechanism 55 comprises an inverted U-shaped operating lever 59 that is pivotally supported at the lower free ends of the legs thereof on a pair of pins 61 that are supported on the side plates 57. The mechanism comprises a toggle comprising lower toggle links 63 and upper toggle links 65. As can be seen in FIG. 4, each of the toggle links 63 and 65 comprises a pair of twin toggle members. The toggle link members 63, 65 are pivotally connected by means of a knee pivot pin 67. The upper toggle links 65 are pivotally supported on the frame 57 by pivot pins 69, and the lower toggle links 63 are pivotally connected to the contact arm 29 of the center pole unit by means of a pivot pin 71. A pair of overcenter springs 73 are connected, under tension, between the knee pivot 67 and the bight portion of the operating lever 59. An insulating operating handle 75 is fixedly connected to the operating lever 59 to permit manual operation of the switch.

The switch is shown in FIG. 2 in the open position. In order to operate the switch to the closed position the operating handle 75 is moved to move the operating lever 59 clockwise about the pivot 61. During this movement, the operating lever 59, at the periphery of the opening 81 thereof, engages the projections 77 to start the toggle 65, 63 toward the closed position and during this movement the springs 73 are moved over center to a position where the springs 73 operate to erect the toggle 63, 65 to the closed position seen in FIG. 3 with a snap action. This movement of the lever means or toggle 63, 65 operates, through the pivotal connection between the links 63 and the movable contact arm 29 of the center pole unit, to move the movable contact arm 29 of the center pole unit to the closed position and, because all three of the movable contact arms 29 are fixedly connected to the tie bar 33, this movement simultaneously drives all three of the movable contact arms 29 into the closed position seen in FIG. 3 wherein each knife-blade contact 31 is between the contact portions of the precharged associated stationary contact structure 13. Movement of the operating mechanism to the closed position is stopped by the engagement of the toggle links 63 with bent over stop projections 82 (FIG. 4) on the support plates 57. The switch is opened by opposite movement of the operating lever 59 in a counterclockwise direction (FIG. 3) about the pivot 61. During this movement, the operating lever 59, at the periphery of the opening 81 therein engages the projections 77 to start the toggle in opening direction, and the overcenter springs 73 are moved to an overcenter position whereupon the springs 73 operate to collapse the toggle 63, 65 to the open position (FIG. 2) with a snap action. This movement, because of the pivotal engagement of the toggle links 63 with the contact arm 29 of the center pole unit, drives the contact arm 29 of the center pole unit to the open position and, because all three of the contact arms are fixedly connected to the tie bar 33, this movement simultaneously drives all three of the contact arms 29 to the open position seen in FIG. 2. Movement of

the operating mechanism to the open position seen in FIG. 2 is limited by the engagement of the toggle links 65 with a pair of bent over stop projections 83 (FIG. 4) on the supporting plates 57.

The fuse means 7 comprises an insulating support block 87 comprising insulating barrier means 89 positioned between adjacent pole units. A separate clip-type fuse terminal 91 is supported in each pole unit and connected to a separate solderless terminal connector 93 by means of a conductor 95. The circuit through each pole unit extends from the terminal connector 93 (FIG. 2) through the conductor 95, fuse terminal 91, a fuse 97 that is clipped into the terminal 91 at one end thereof and a terminal 99 at the other end thereof, a conductor 101 that is supported on the block 9 and suitably connected to the terminal 99, a pair of flexible conductors 103 that are welded or brazed at one end thereof to the terminal 101 and at the other end thereof to the associated contact arm 29, the contact arm 29 which includes the contact part 31, the stationary contact structure 13, a terminal 15, to the other solderless terminal 19. The fuse unit serves to interrupt the overload currents in the fused switch structure in a manner well known in the art.

We claim:

1. A switch comprising support means, a plurality of clip-type stationary contacts supported on said support means, a separate movable contact arm for each of said stationary contacts, an elongated rigid tie bar supported on said support means for pivotal movement about the elongated axis thereof, each of said movable contact arms being generally flat rigid unitary conductor fixedly supported at one end thereof on said tie bar and comprising a knife-blade contact at the other end thereof, a spring operating mechanism, said spring operating mechanism comprising a toggle, said toggle comprising a first toggle link and a second toggle link, means pivotally connecting said first toggle link to a fixed pivot, means pivotally connecting said second toggle link to one of said contact arms, means pivotally connecting said first toggle link to said second toggle link at a knee pivot, an operating handle structure movable between a closed position and an open position, spring means connected between said operating handle structure and said knee pivot, said operating handle structure being movable to a closed position to operate said spring means to erect said toggle to thereby operate through said pivotal connection of said second toggle link and one movable contact arm to rotate said rigid tie bar to the closed position to simultaneously drive said plurality of knife-blade contacts into knife-blade engagement with said plurality of clip-type stationary contacts, and said operating handle structure being movable from said closed position to the open position to operate said spring means to collapse said toggle to thereby operate through said pivotal connection of said second toggle link and one movable contact arm to rotate said rigid tie bar to the open position to simultaneously drive said plurality of knife-blade contacts to an open position disengaged from said plurality of clip-type stationary contacts.

2. A switch according to claim 1, a separate terminal conductor for each of said contact arms, and a separate flexible conductor means for each of said movable contact arms electrically connecting the movable contact arm with the associated terminal conductor.

3. A switch according to claim 2, and said second toggle link being pivotally connected directly to said one movable contact arm intermediate the ends of said one movable contact arm.

4. A switch according to claim 1, said plurality of stationary contacts being three stationary contacts supported in a spaced aligned relationship, a separate of said movable contact arms for each of said three stationary contacts, each of said movable contact arms being a flat rigid unitary conducting member with one end thereof being a knife-blade contact and with the other end thereof being fixedly secured to said tie bar, said second toggle link being pivotally connected directly to the center contact arm of said three contact arms intermediate the ends of said center contact arm, a separate arc-extinguishing unit for each of said stationary contacts, each of said arc-extinguishing units comprising insulating support means and a plurality of slotted magnetic plates supported on said insulating support means in a spaced relationship with the slots thereof being aligned, and each of said knife-blade contacts moving with the slots of the magnetic plates of the associated arc-extinguishing unit during opening and closing operations of said switch.

5. A switch according to claim 4, said spring means being overcenter tension spring means connected between said knee pivot and said operating handle structure, upon operation of said operating handle structure to the closed position said overcenter tension spring means being operated to erect said toggle to move said contact arms into the closed position, and upon operation of said operating handle structure to the open position said overcenter tension spring means being operated to collapse said toggle to operate said contact arms to the open position.

6. A switch according to claim 1, each of said stationary contact structures comprising a generally U-shaped resilient sheet metal conducting member bent over at the free ends of the opposite legs thereof to provide a pair of spaced contact portions that extend in a spaced relationship toward the bight portion of said U-shaped member generally parallel to the opposite legs of said U-shaped member, said spaced contact portions being resiliently biased toward each other, spacing means limiting the movement of said spaced contact portions toward each other thereby providing that said resiliently biased spaced contact portions are precharged, and each of said knife-blade contacts in moving to the closed position thereof forcing the associated precharged spaced contact portions of the associated stationary contact structure away from each other to provide contact pressure between the knife-blade contact and the associated spaced contact portions.

7. A switch according to claim 6, said plurality of stationary contacts being three stationary contacts supported in a spaced aligned relationship, a separate of said movable contact arms for each of said three stationary contacts, each of said movable contact arms being a flat rigid unitary conducting member with one end thereof being knife-blade contact and with the other end thereof being fixedly secured to said tie bar, said second toggle link being pivotally connected directly to the center contact arm of said three contact arms intermediate the ends of said center contact arm, a separate arc-extinguishing unit for each of said stationary contacts, each of said arc-extinguishing units comprising insulating support means and a plurality of slotted magnetic plates supported on said insulating support means in a spaced relationship with the slots thereof being aligned, and each of said knife-blade contacts moving within the slots of the magnetic plates of the associated arc-extinguishing unit during opening and closing operations of said switch.

8. A switch comprising support means, a plurality of clip-type stationary contacts supported on said support means, a separate movable contact arm for each of said stationary contacts, an elongated rigid tie bar supported on said support means for pivotal movement about the elongated axis thereof, each of said movable contact arms being a rigid unitary conductor fixedly supported at one end thereof on said tie bar and comprising a knife-blade contact at the other end thereof, an overcenter spring operating mechanism comprising an operating handle structure and lever means, said operating mechanism comprising overcenter spring means connected to operate said lever means upon operation of said operating handle structure, means pivotally connecting said lever means to one of said contact arms, said operating handle structure being movable to a closed position to operate said overcenter spring means and lever means to an overcenter closed position to operate through said pivotal connection of said lever means and one movable contact arm to rotate said rigid tie bar to the closed position to simultaneously drive said plurality of knife-blade contacts into knife-blade engagement with said plurality

of clip-type stationary contacts, and said operating handle structure being movable from said closed position to the open position to operate said overcenter spring means and lever means to an overcenter open position to operate through said pivotal connection of said lever means and one movable contact arm to rotate said rigid tie bar to the open position to simultaneously drive said plurality of knife-blade contacts to an open position disengaged from said plurality of clip-type stationary contacts, each of said movable contact arms being a flat rigid unitary conducting member with one end thereof being a knife-blade contact and with a slot at the opposite end thereof forming a pair of spaced projections at said opposite end, said tie bar being generally rectangular in cross section comprising a first pair of opposite sides and a second pair of opposite sides, each of said contact arms extending from a first side of said first pair of opposite sides of said tie bar with the pair of projections thereof extending along the second pair of opposite sides of said tie bar, a separate supporting plate for each of said movable contact arms, each of said separate supporting plates having opening means therein and being disposed at the second side of said first pair of opposite sides of said tie bar with the spaced projections of the associated movable contact arm extending through said opening means and being riveted over to fixedly secure the associated flat rigid unitary conducting movable contact arm to said generally rectangular tie bar.

**9**. A switch according to claim **8**, a separate U-shaped flat plate member for each of said contact arms, each of said U-shaped flat plates being nested in the slot of the associated movable contact arm between said tie bar and said movable contact arm to provide an increased surface area of pressure on said tie bar at the connection of the associated movable contact arm to said tie bar.

**10**. A switch according to claim **9**, said plurality of stationary contacts being three stationary contacts supported in a spaced aligned relationship, a separate of said movable contact arms for each of said three stationary contacts, said lever means being pivotally connected directly to the center contact arm of the three movable contact arms intermediate the ends of said center contact arm, a separate arc-extinguishing unit for each of said stationary contacts, each of said arc-extinguishing units comprising insulating support means and a plurality of slotted magnetic plates supported on said insulating support means in a spaced relationship with the slots thereof being aligned, and each of said knife-blade contacts moving within the slots of the magnetic plates of the associated arc-extinguishing unit during opening and closing operations of said switch.