April 27, 1965 G. J. HALES ETAL 3,180,963

HIGH PRESSURE CONTACT FOR DISCONNECT SWITCH

Filed Aug. 20, 1962 4 Sheets-Sheet 1

Fig. 1.

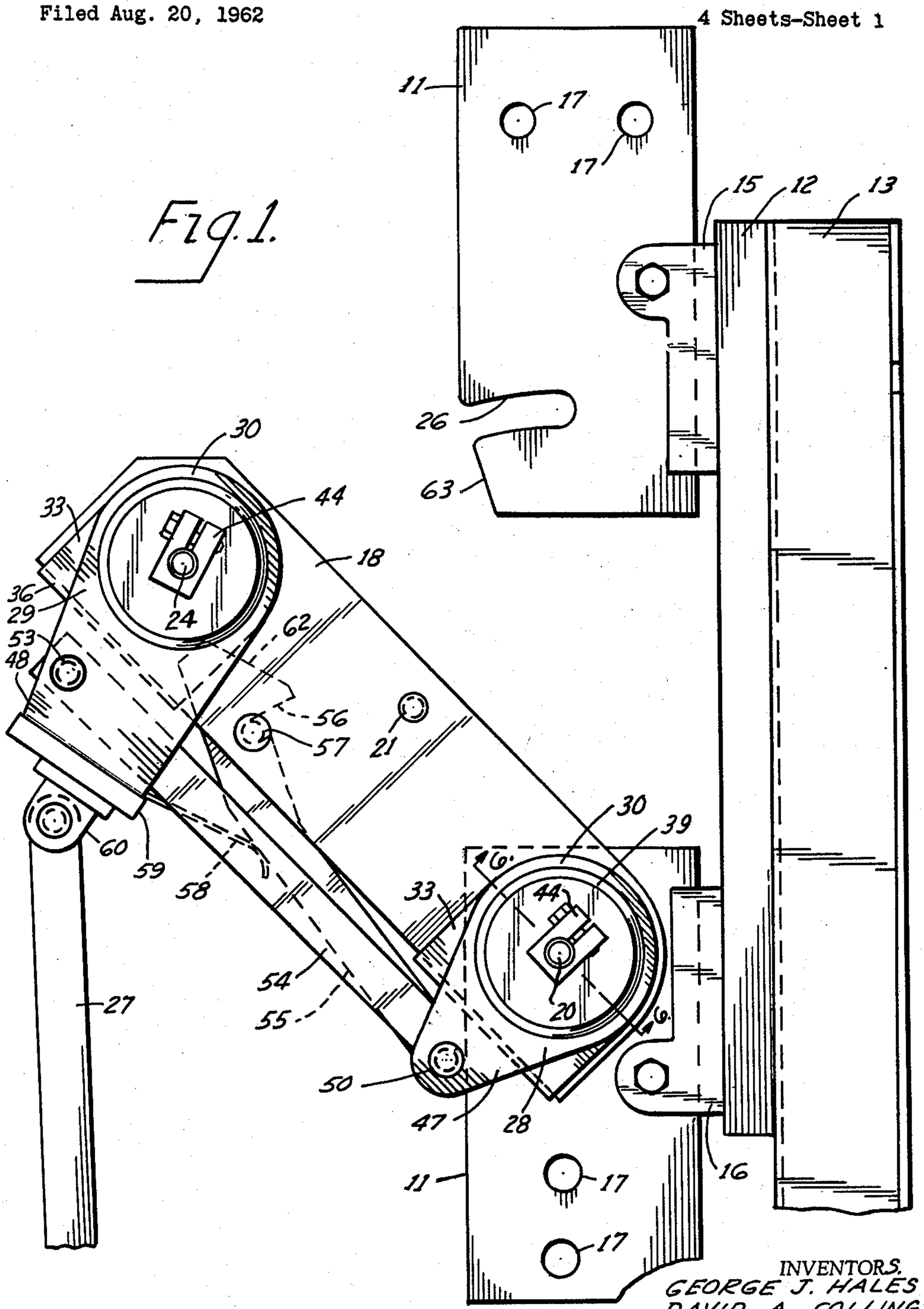

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Fig. 2.

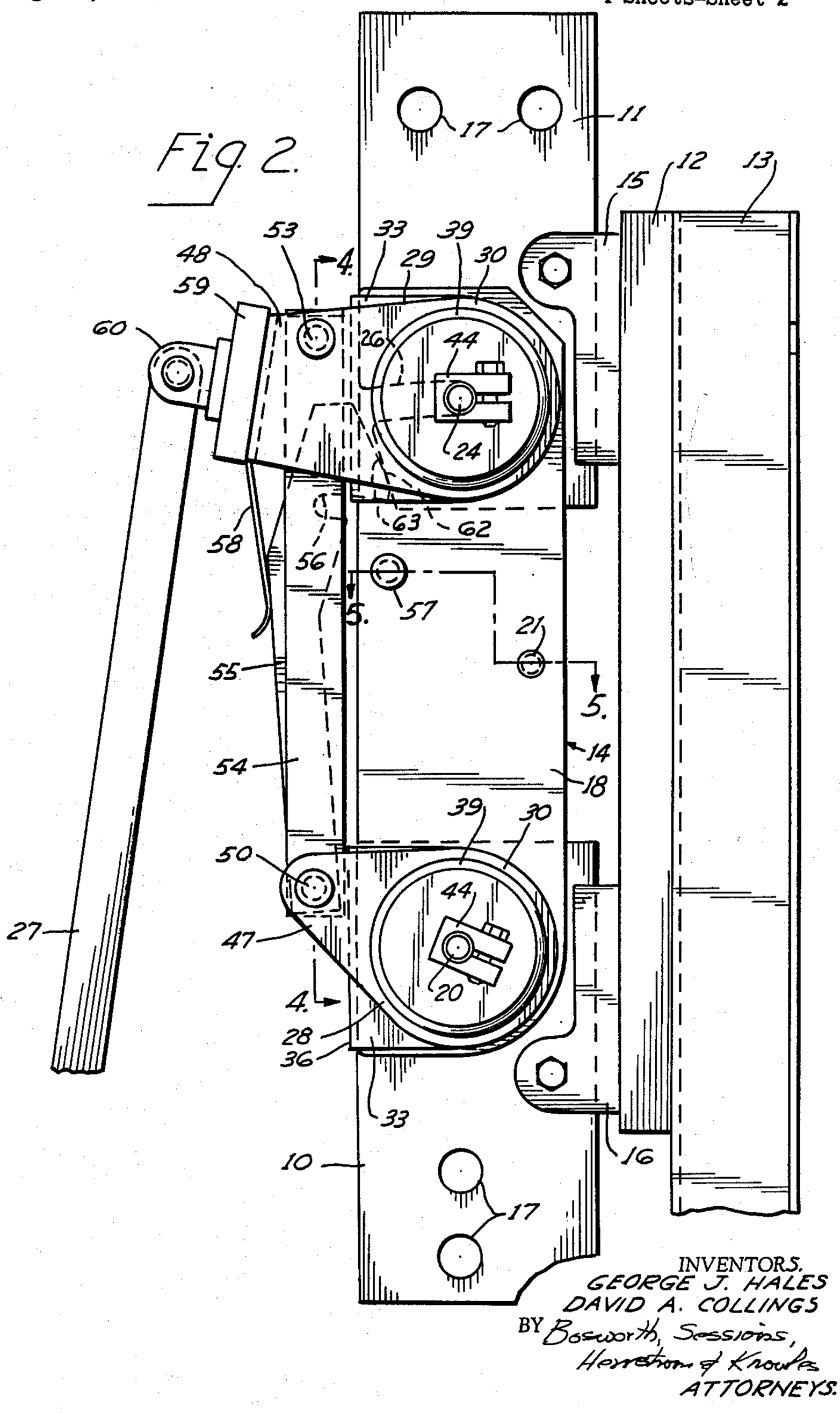

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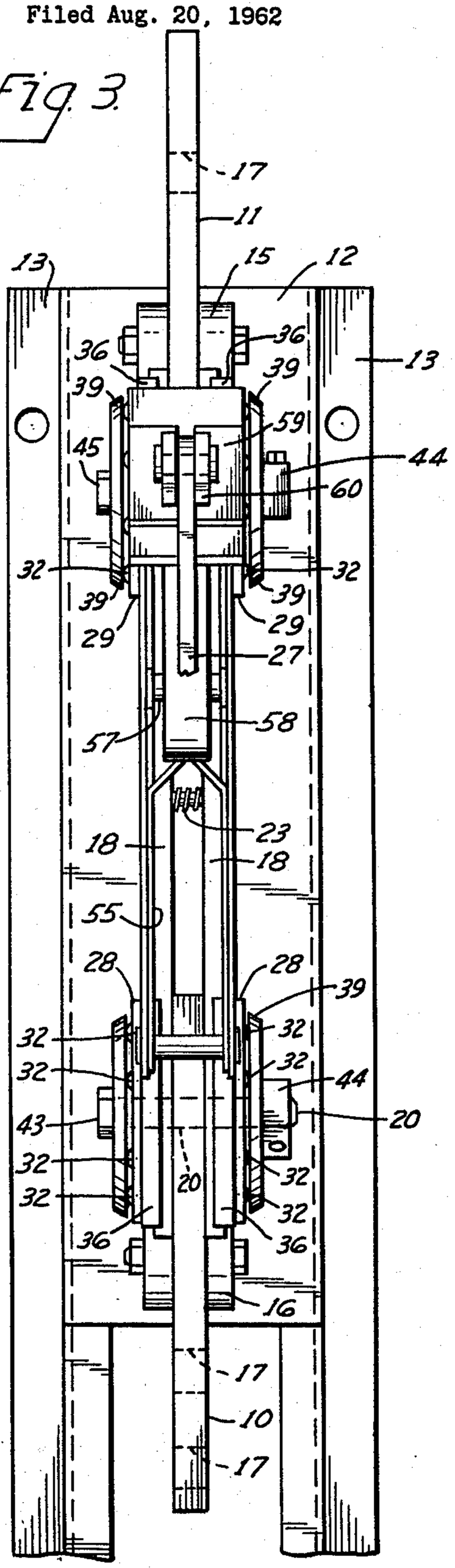
Fig. 3.



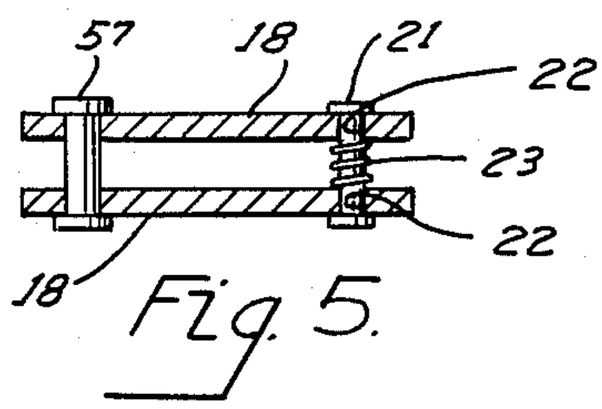


Fig. 5.

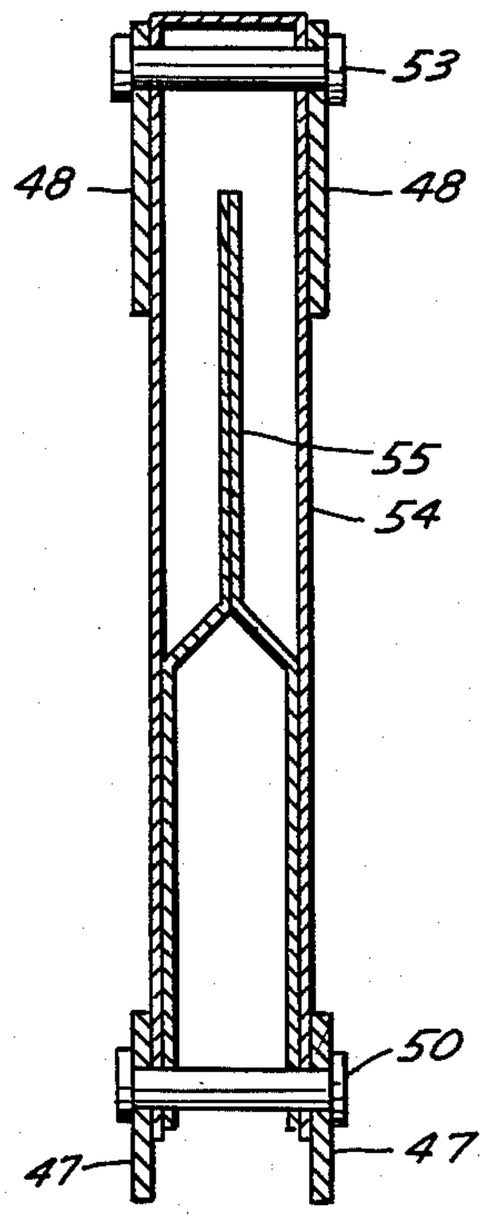


Fig. 4.

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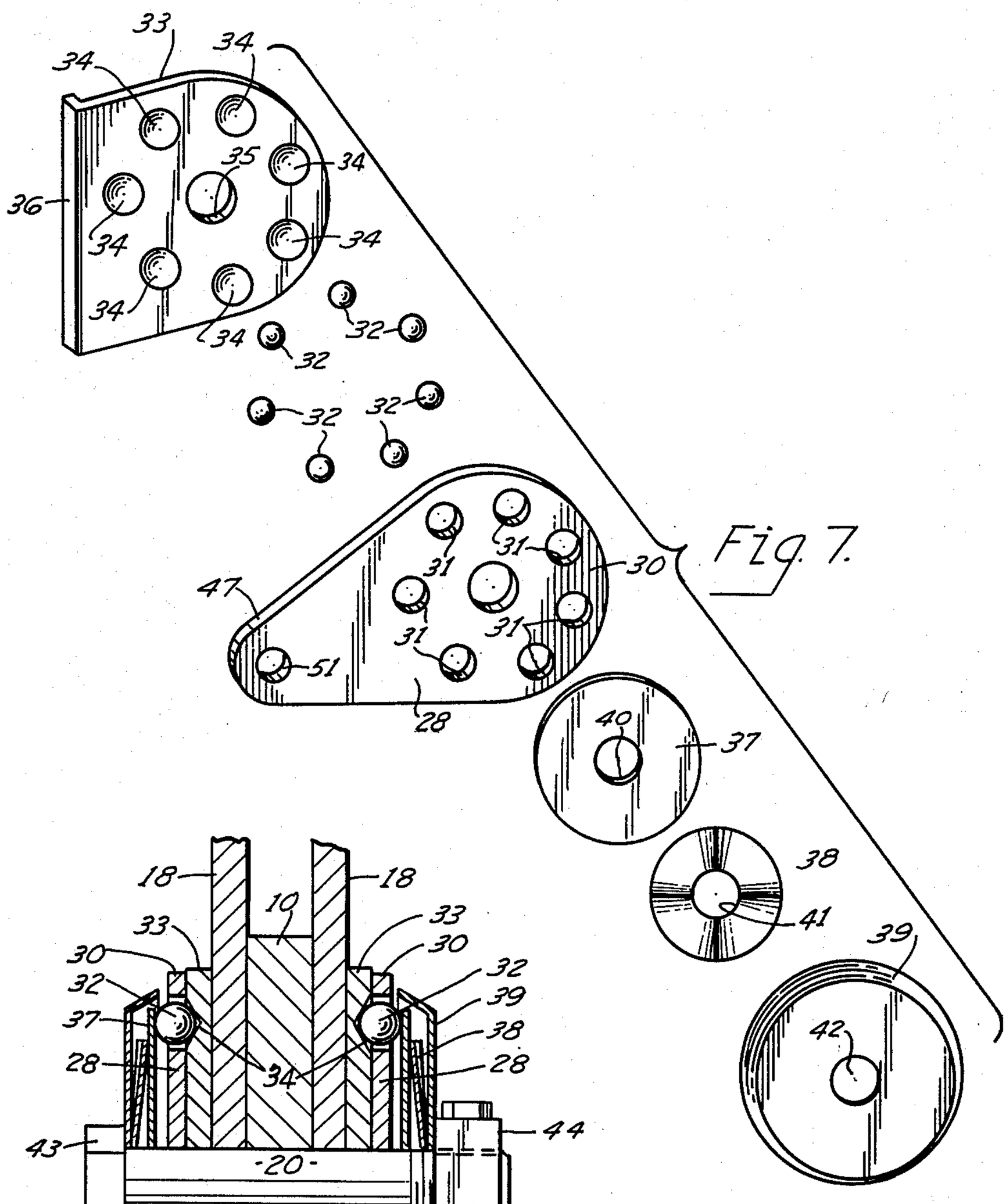

Fig. 7.

Fig. 6.

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HIGH PRESSURE CONTACT FOR DISCONNECT SWITCH

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Filed Aug. 20, 1962, Ser. No. 217,955
13 Claims. (Cl. 200—170)

This invention relates to electric switches and particularly to improvements in electric disconnect switches having relatively large current-carrying capacities and of the type generally known as knife blade switches.

Generally, the knife blade type of disconnect switch consists of a pair of stationary contacts mounted in a spaced apart relationship on an insulated base or panel. Each of the stationary contacts is intended to be connected to a current-carrying conductor in an electrical circuit. The stationary contacts are electrically connected or disconnected by means of a movable blade member pivotally supported at one end on one of the fixed contacts or post for swinging movement into and out of engagement with the other of the fixed contacts or pole. Appropriate means may be provided for swinging the movable blade member and securing it in an open and/or closed circuit position.

The amount of current required to be carried by such switches may be as much as 10,000 amperes or more and, therefore, it is imperative that such switches when closed provide as low a resistance to the flow of current through them as possible. To this end, the fixed contacts and movable blade member of such switches are generally formed of heavy bars of copper or other highly conductive material having a relatively large cross-sectional area. Electrical conductors are generally removably fastened to the fixed contacts by one of a variety of bolted clamping means. Both the pivotally supported and free end of the movable blade member of the switch engage or are engageable with the post and pole fixed contacts, respectively, throughout surface areas varying in extent depending upon the design of the switch. The electrical resistance to the flow of current through the switch is introduced primarily at and along the areas of surface engagement between the movable blade member and the pole and post. This resistance can be reduced by applying clamping or squeezing pressure tending to urge the areas of surface contact into tighter engagement with each other.

It is an object of our invention, therefore, to provide a simple, durable and relatively inexpensive connecting switch of the knife blade type having the ability to carry relatively large currents with only minimal losses. Another object is to provide a knife blade type disconnect switch in which the areas of surface engagement between the movable blade member and its fixed contacts are yieldingly urged together when the switch is in the circuit connecting position in order to minimize the resistance to flow of current therethrough. Another object of our invention is to provide a knife blade type switch in which the contact pressure between the fixed contacts and the movable blade member may be quickly and simply varied from relatively low values permitting easy swinging of the movable blade member between its connected and disconnected positions with respect to the fixed contacts and, at the same time, increasing the resistance to the flow of current through the switch to relatively high values tending to reduce the resistance to current flow through the switch but also increasing friction forces in opposition to relative movement of the movable blade member and the fixed contacts. Another object is to provide an electric switch of the knife blade type in which the clamping pressure applied to the areas of surface engagement between the movable blade member and its fixed contacts when in a connected and clamped condition is adjustable to a predetermined contact pressure. It is also an object to provide such an electric switch in which the resistance to swinging movement of the movable blade member into and out of connecting engagement is adjustable to a predetermined value. An object of our invention is to provide an electric switch of the knife blade type having a single operating handle for swinging the movable blade member into and out of connecting engagement with its fixed contacts as well as for operating the means for applying a predetermined contact pressure between the movable blade member and its fixed contacts when the movable blade member is in its connected position with respect to the fixed contacts. Another object is to provide a latching mechanism for such a switch that prevents the application of contact pressure between the pivotally supported end of the movable blade member and its supporting fixed contact or post at all times while the free ends of the movable blade member is out of engagement with its associated pole fixed contact.

The means for and manner of accomplishment of these and other objects as may appear is set forth in the following description and accompanying drawings in which:

FIGURE 1 is a side elevational view of a single-pole, single-throw electric switch embodying a preferred form of our invention and shown in the open or disconnected condition of operation;

FIGURE 2 is a side elevational view of the switch of FIGURE 1 shown in a connected or closed condition of operation;

FIGURE 3 is a front elevational view of the switch as shown in FIGURE 2;

FIGURE 4 is a sectional view of certain of the latching mechanism elements of the switch shown in FIGURES 1, 2 and 3 and taken in the plane of line 4—4 of FIGURE 2;

FIGURE 5 is a sectional view through the movable blade assembly of the switch shown in FIGURES 1, 2 and 3 and taken in the plane of line 5—5 of FIGURE 2;

FIGURE 6 is a sectional view through the pivotal support and connection between the movable blade member and the fixed contact or post of the switch shown in FIGURES 1, 2 and 3 and taken in the plane of line 6—6 in FIGURE 1; and

FIGURE 7 is an exploded view of the contact pressure-applying portion of the switch embodying our invention and shown variously and in lesser detail in FIGURES 1, 2, 3 and 6.

As seen in the first three figures of the drawings, the switch embodying our invention includes the conventional elements common to the knife blade type of switch, such as a post 10 and a pole 11 comprising stationary contacts mounted on an insulated base panel 12 supported by a frame 13, and a movable blade member indicated generally at 14 pivotally supported at one end on post 10 and swingable into and out of engagement with pole 11. Post 10 and pole 11 preferably are formed of relatively large flat-sided bars of copper or other material having high electrical conductivity and are attached to insulated base panel 12 by means of suitable mounting members 15 and 16, respectively, in a longitudinally aligned relationship with their adjacent ends spaced apart. Their opposite ends are preferably provided with suitable holes through them, such as those designated 17, for receiving clamping bolts and/or other conventional hardware to effect connection of current-carrying conductors (not shown) to them.

Movable blade member 14 preferably comprises a pair of similar flat-sided bars or blades 18 of copper or other suitable conductive material pivotally connected at one end by pin or bolt 20 to and lying on opposite sides of post 10. A large flat side of each of blades 18 thus lies

adjacent to the opposite flat sides of post 10 and blades 18 are laterally spaced apart thereby. As seen in FIGURE 5, the outer or free ends of blades 18 are maintained in a relatively parallel spaced apart relationship by means of a laterally extending double-headed pin 21 passing loosely through a laterally opposite pair of holes 22 in blades 18 and carrying thereon a spacer compression spring 23 tending to urge the blades 18 away from each other and against the heads on pin 21 while permitting blades 18 to be squeezed together slightly in the manner and for purposes to be described below. A second pin or bolt 24 also passes loosely through a laterally opposite pair of holes at or near the free ends of blades 18.

The pivotally supported ends of blades 18 at all times overlap and engage the opposite side surfaces of post 10 and extend longitudinally therefrom a sufficient distance with respect to the spacing of the adjacent ends of post 10 and pole 11 so that they overlap and engage the opposite side faces of pole 11 when swung into the closed circuit condition shown in FIGURE 2. In order to permit substantial longitudinal alignment of movable blade member 14 with post 10 and pole 11 when in the closed circuit condition and thereby increase the overlapping areas of surface engagement between blades 18 and pole 11, an arcuate open-ended slot 26 is preferably provided in pole 11 curving about pivotal supporting pin 20 as a center for receiving pin 24 passing through and between the outer ends of blades 18.

An operating lever or handle 27 is operatively connected to movable member 14 for moving it to close and open the switch.

The foregoing elements of the switch embodying our invention are conventionally found in one form or another in knife blade type electric switches having a high currrent-carrying capacity. The elements to be described below in connection with the conventional elements set forth above are related to the advantageous results and improvements provided by the electric switch embodying our invention over prior electric switches.

Disposed on opposite sides of blades 18 at the pivotally supported ends thereof are a pair of levers 28 pivotally mounted on pin 20 as seen in FIGURES 1, 2 and 3 and in detail in FIGURE 6. A similar pair of levers 29 is disposed on opopsite sides of blades 18 at or near the free end thereof pivotally mounted on pin 24. Each of the levers 28 and 29 comprises a disc-like portion 30 having a plurality of apertures 31 circumferentially spaced from each other and radially spaced from pin 20 or 24 as the case may be. A ball 32, preferably of hardened steel, is disposed in each aperture 31 in the levers 28 and 29. The size of apertures 31 with respect to the size of balls 32 is such that balls 32 have freedom to roll therein. Also, balls 32 are of a diameter somewhat greater than the thickness of the disc-like portion 30 of levers 28 and 29 so that balls 32 may protrude beyond both opposite side faces of the lever when captured in an aperture 31.

A pressure plate 33 is disposed between each lever 28 and 29 and the side face of the blade 18 adjacent to it. Each pressure plate 33 is provided with a plurality of circumferentially arranged and isolated crater-like depressions 34 spaced the same as apertures 31 in levers 28 and 29. Pressure plates 33 are provided with central openings 35 through which passes pin 20 or 24 as the case may be. Each plate 33 has means for securing it against rotation relative to blades 18 such as turned edge portion 36 arranged to overlie the longitudinal edge of the blade 18 when positioned and located by pin 20 or 24 passing through central opening 35.

A disc-like circular compression spring 37, a circumferentially wavy compression spring 38 and a cover cup 39 are disposed outwardly of and overlie each of levers 28 and 29 and are positioned with respect thereto by pins 20 or 24 as the case may be passing through central openings 40, 41 and 42, respectively, therein.

Thus, as shown in section in FIGURE 6, on both opposite sides of the pivotally supported end of the pair of blades 18 comprising movable blade member 14 of the switch are provided a pressure plate 33 lying next to and in engagement with the side face of its adjacent blade 18 and secured against relative rotation therewith and having a plurality of depressions 34 in its outwardly facing side, a lever 28 having apertures 31 therein spaced the same as the depressions 34 in pressure plates 33, compression springs 37 and 38 lying outwardly of levers 28 with compression spring 37 extending radially a sufficient distance to engage balls 32 captured in apertures 31 of levers 28 and a cover cup 39. Pin 20 passes through all of these elements from one side to the other as well as through post 10 lying between blades 18 and is provided with head 43 on one end overlying one of the cover cups 39 and at the other end with a clamping nut 44 which may be secured against rotation relative to pin 20. FIGURE 7 shows in an exploded view all of the elements shown in assembled condition in FIGURE 6 and lying between one of the blades 18 and clamping nut 44 and their relative position with respect to each other.

It will be apparent that rotation of levers 28 relative to their associated pressure plates 33 will roll balls 32 into or out of depressions 34. When balls 32 are rolled out depressions 34 by rotation of levers 28, compression springs 37 and 38 are flexed and tensioned so as to exert an increased yielding force on balls 32 tending to squeeze blades 18 forcibly toward each other and upon post 10. When levers 28 are rotated so as to roll balls 32 into depressions 34 in pressure plates 33, compression springs 37 and 38 are relaxed so that they exert a decreased yielding force on balls 32 toward blades 18 tending to restrain levers 28 from relative rotational movement with pressure plates 33 and blades 18 while decreasing the clamping or squeezing of blades 18 toward each other and upon post 10.

The free end of the pair of blades 18 is provided with a similar assemblage of pressure plates 33 having depressions 34, levers 29, balls 32, compression springs 37 and 38 and cover cups 39 disposed on opposite sides of blades 18 and positioned by pin 24 and held together between head 45 and clamping nut 46 on the opposite ends of pin 24. The relative rotational movement of levers 29 with respect to their associated pressure plates 33 and blades 18 produces the same operational effects when the balls 32 roll into and out of depressions 34 in the pressure plates as does rotation of levers 28 as described above.

Levers 28 and 29 are provided with radially extending arm portions 47 and 48, respectively. By means of a pin 50 passing through laterally aligned openings 51 in levers 28, the two levers 28 are constrained to rotate together about pin 20. Levers 29 are similarly provided with laterally aligned openings 52 and a pin 53 extending therethrough to insure that levers 29 rotate together about pin 24. Additionally, a link 54 extends between and interconnects pins 50 and 53 so that rotation of the pair of levers 29 about pin 24 produces a similar rotation of the pair of levers 28 about the pin 20 and vice versa.

Also pivotally mounted on pin 50 is a latching element 55 extending between the blades 18 toward their free ends and having an arcuate open-ended slot 56 near the free end thereof for engaging a latch pin 57 extending laterally through and between the pair of blades 18 when levers 28 and 29 are rotationally positioned so that the apertures 31 in them are laterally opposite the depressions 34 in their associated pressure plates 33. Latching element 55 is shown in FIGURE 1 in the position of engagement with latch pin 57 into which it is yieldingly urged by means of a leaf spring 58 appropriately mounted for movement with and adjacent to the arm portions 48 of levers 29.

The radially outward ends of arm portions 48 of levers 29 have turned edge portions to which is suitably fastened a cross bar 59 of insulating material. Mounted on

the outward side of cross bar 59 is a clevis 60 pivotally connected by pin 61 to the operating lever or handle 27.

In operation, the switch is opened and closed and the contact pressure-supplying means operated through the single operating lever or handle 27. In FIGURE 1, the switch is shown in an opened condition and levers 28 and 29 in that relative rotational position with respect to their associated pressure plates 33 and blades 18 which aligns apertures 31 in levers 28 and 29 and corresponding depressions 34 in their associated pressure plates 33 and thereby positions all of balls 32 in a depression 33. All compression springs 37 and 38 are in a relatively untensioned condition and thus the pivotally supported end of blades 18 held only relatively lightly against the opposite sides of post 10. In addition, when levers 28 and 29 connected together by link 54 are in this position, latching element 55 is yieldingly urged into engagement with latch pin 57 by leaf spring 58. It will be noted that the interengagement of latching element 55 and latch pin 57 effectively restrains levers 28 and 29 from relative rotational movement with respect to blades 18.

Thus, a more or less axially directed force applied to operating handle 27 aligned as shown in FIGURE 1 will act to swing blades 18 about pin 20 and their pivotally supported end toward pole 11. As swinging movement of the blades 18 continues in a clockwise direction as seen in FIGURE 1, pole 11 is received between the free end of blades 18 with its opposite sides lightly slidingly engaging blades 18 held in a spaced apart relationship by spacer compression spring 23. Pin 24 passing between blades 18 is received in arcuate open-ended slot 26 in pole 11. As pin 24 bottoms in arcuate slot 26 and the swinging movement of the blades 18 is completed to a full closed circuit position, latching element 55 is urged against the force of leaf spring 58 by sliding engagement of its upper forward edge 62 and camming surface 63 on pole 11 so that latch pin 57 is disengaged from arcuate slot 56 in the latching element.

Continued application of substantially axially directed force on operating handle 27 produces simultaneous clockwise rotational movement of levers 28 and 29 about pins 20 and 24, respectively, as permitted by the disengagement of latching element 55 and latch pin 57. As explained above, relative rotational movement of levers 28 and 29 with respect to blades 18 from their position as latched by element 55 and pins 57 acts to roll balls 32 captured in the apertures 31 of the levers out of their position in depressions 34 of pressure plates 33 thereby tensioning their respective compression springs 37 and 38 so that they exert a yielding force of predetermined magnitude on balls 32 tending to squeeze the pivotally supported and free ends of blades 18 forcibly toward each other upon post 10 and pole 11, respectively, and thereby clamping together the current-carrying elements of the switch to complete a good current-carrying path through it. FIGURE 2 illustrates the switch in this fully closed and clamped position.

A downwardly directed and substantially aligned force or pull on handle 27 of the switch as seen in FIGURE 2 acts first to rotate levers 28 and 29 about pins 21 and 24, respectively, in a counterclockwise direction. Such rotational movement of the levers rolls balls 32 and the clamping means into depressions 34 of pressure plates 33 untensioning the springs 37 and 38 and unclamping the opposite ends of blades 18 from the opposite sides of pole 11 by post 10. Rotational movement of levers 28 and 29 is stopped upon engagement of latching element 55 with latch pin 57 under the urging of leaf spring 58. Thereafter, additional pull on handle 27 acts to swing blades 18 about their point of pivotal support on post 10 out and away from pole 11 and into the open circuit condition illustrated in FIGURE 1.

It will be noted that except when the switch is in a closed circuit position and levers 28 and 29 are rotated so as to roll balls 32 out of their associated depressions 34,

blades 18 are urged together against the opposite sides of post 10 and against the opposite sides of pole 11 as the switch is closed with only a light force as determined by the extent to which clamping nuts 44 and 46 are turned on pins 20 and 24, respectively. We prefer to adjust the amount of sliding friction involved between the blades 18 and post 10 and pole 11 when the pressure-applying mechanism is in the unclamped position by closing the switch but not rotating levers 28 and 29 to their clamping position and then turning the nuts 44 and 46 on pins 20 and 24, respectively, until the blades only lightly engage the opposite sides of post 10 and pole 11 and may be easily moved to and between the open and closed switch positions. The amount of clamping pressure applied to the blades and tending to urge them toward each other and against opposite sides of the post and pole upon rotation of the operating levers may be predetermined by the appropriate selection of the properties and number of compression springs provided. In a successful form of switch embodying our invention, we have found, for example, that adequate clamping pressures are provided when 5/16 inch diameter hardened steel balls captured in apertures having an easy sliding fit with them in an operating lever 1/8 of an inch thick are rolled out of 120° conical depressions approximately 1/8 inch deep against the spring force of a disc-like circular compression spring of .025 inch stainless spring steel and a wavy or formed compression spring of .010 of an inch stainless spring steel. In this switch, we employ seven balls captured in the same number of apertures in each operating lever arranged in a 1 3/8 inch radius circle. The working range of the springs was approximately 3/32 of an inch.

It will be obvious to those skilled in the art that electric switches embodying our invention as described above and having more than one movable blade member and associated post and pole may be easily provided and mounted together upon an insulated base with a common cross bar extending across and connected to each of the upper levers 29 for operation together by a single operating handle connected to the common cross bar. When more than one movable blade element and associated post and pole contacts are used, it is usually necessary to have only one latching mechanism for all the clamping assemblies involved.

Changes, modifications and improvements may be made to the above-described preferred form of our invention without departing from the precepts and principles of the invention. Therefore, we do not wish our patent to be limited to the particular form of our invention specifically illustrated and described nor in any manner inconsistent with the extent to which our invention has promoted the art.

We claim:

1. In an electrical switch having a terminal post with a pivot pin, a pair of blades pivotally supported on said pin on opposite sides of said post, a pole removably engageable by said blades and having an arcuate slot curved about the said pin as a center, means for pressing said blades against opposite sides of said post and said pole to improve conductivity therebetween when said switch is closed and for reducing the pressure therebetween in aid of opening the switch, a second pin carried by said blades at the end engageable with said pole and disposed to enter said slot in said pole in the closed position of the switch, and an operating handle for moving said blades to close and open the switch, the improvement comprising levers disposed on opposite sides of said blades in pairs at the opposite ends thereof pivotally mounted on said pins and operatively connected with said handle, each of said levers comprising a disc-like portion having a plurality of circumferentially spaced apertures spaced from said pins, a ball disposed in each aperture with freedom to roll therein, means associated with each blade having isolated depressions spaced the same as said apertures and receptive of said balls in one position of said blades relative to said

levers, and means for exerting yielding force on said balls toward said blades tending to restrain said levers from movement relative to said blades while said balls are pressed into said depressions and tending to squeeze said blades forcibly toward each other upon said post and pole respectively when said levers move said balls out of said depressions.

2. The improvement of claim 1 wherein said last named means constrains said levers and blades to be moved together by said handle to close the switch, and said arcuate slot has a bottom engaging said second pin at the end of switch-closing movement of said blades; further motion of said handle after said pin bottoms in said slot forcing said balls out of said depression and stressing said means for exerting yielding force and squeezing said blades on said pole and post.

3. The improvement of claim 2 with yielding means spreading said blades apart when said balls are disposed to lie in said depressions.

4. The improvement of claim 1 with yielding means spreading said blades apart when said balls are disposed to lie in said depressions.

5. The improvement of claim 1 wherein said last named means comprise resilient discs mounted on each of said pins and contacting all of said balls in the apertures in each of said levers, and means coacting with said pins for adjustably stressing the central portions of said discs whereby to adjustably change the said yielding force.

6. The improvement of claim 1 with means carried by said blades constraining said balls from being moved out of said depressions by movement of said handle in the direction of opening the switch.

7. The improvement of claim 1 in which the said means having said depressions comprise plates harder than said blades and rotatably mounted on said pins and secured to each of said blades and interposed between each blade and each said lever, said depressions comprising substantially conical crater-like indentations in said plates.

8. In an electrical switch having a terminal post with a pivot pin, a blade pivotally supported on said pin, a pole removably engageable by said blade and having a stop to limit switch closing movement of said blade relative thereto, means for pressing said blade against said post and said pole to improve conductivity therebetween when said switch is closed and for reducing the pressure therebetween in aid of opening the switch, a second pin carried by said blade at the end engageable with said pole and disposed to engage said stop in the closed position of the switch, and an operating handle for moving said blade to close and open the switch, the improvement comprising levers disposed on said blade at the opposite ends thereof pivotally mounted on said pins and operatively connected with said handle, each of said levers comprising a disc-like portion having a plurality of circumferentially spaced apertures spaced from said pins, a ball disposed in each aperture with freedom to roll therein, means associated with the blade having isolated depressions spaced the same as said apertures and receptive of said balls in one position of said blade relative to said levers, and means for exerting yielding force on said balls toward said blade tending to restrain said levers from movement relative to said blade while said balls are pressed into said depressions and tending to squeeze said blade forcibly toward said post and pole respectively when said levers move said balls out of said depressions.

9. The improvement of claim 8 wherein engagement between said stop and said second pin transfers torque from said handle tending to rotate said levers about said pins.

10. An electrical switch comprising a fixed member, a movable member engageable therewith and disengageable therefrom, a pin traversing both members when the same are engaged, a lever pivotally mounted on said pin, one of said members having circumferentially spaced depressions radially spaced from said pin, said lever having holes spaced the same as said depressions and alignable therewith in one relation of said lever to said one member, balls freely confined in said holes and disposable in said depressions, and means resiliently pressing said balls into said depressions whereby movement of said lever relative to said one member moves said balls from said depressions and resiliently presses said members upon each other.

11. The switch of claim 10 wherein said last named means comprises a disc of resilient material mounted on said pin and having peripheral engagement with said balls.

12. The switch of claim 11 with an actuating handle for opening and closing the switch connected with said lever whereby the torque for moving said movable member is transmitted through said balls and depressions.

13. The switch of claim 12 with means for limiting the movement of said movable member after said switch is closed whereby to transfer the torque from said handle from moving said member to moving said lever.

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