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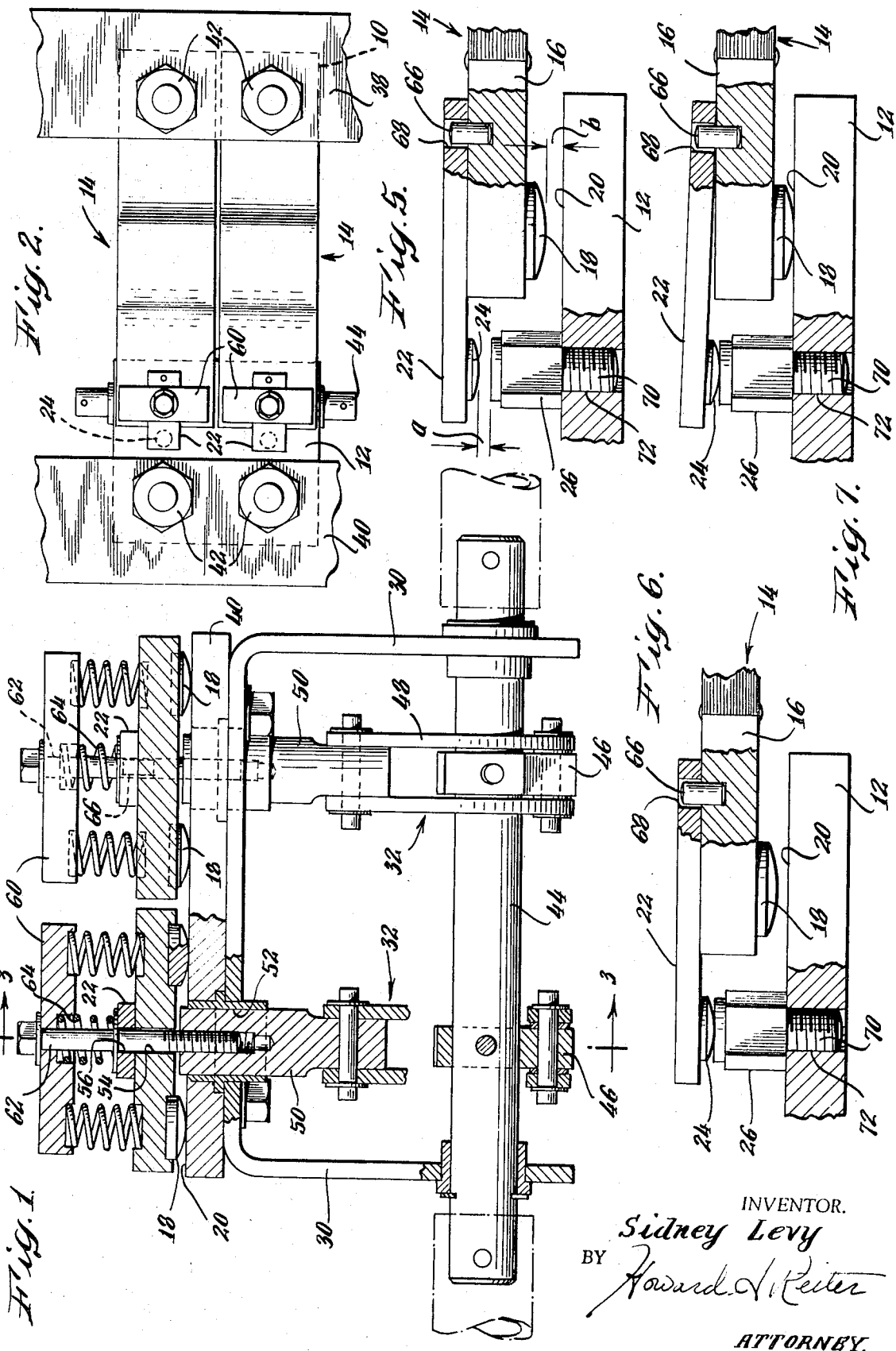
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HIGH-CURRENT SWITCH WITH SECONDARY CONTACT PIN COUPLED
IN OFFSET RELATIONSHIP TO PRINCIPAL CONTACT

Filed March 18, 1968

2 Sheets-Sheet 1



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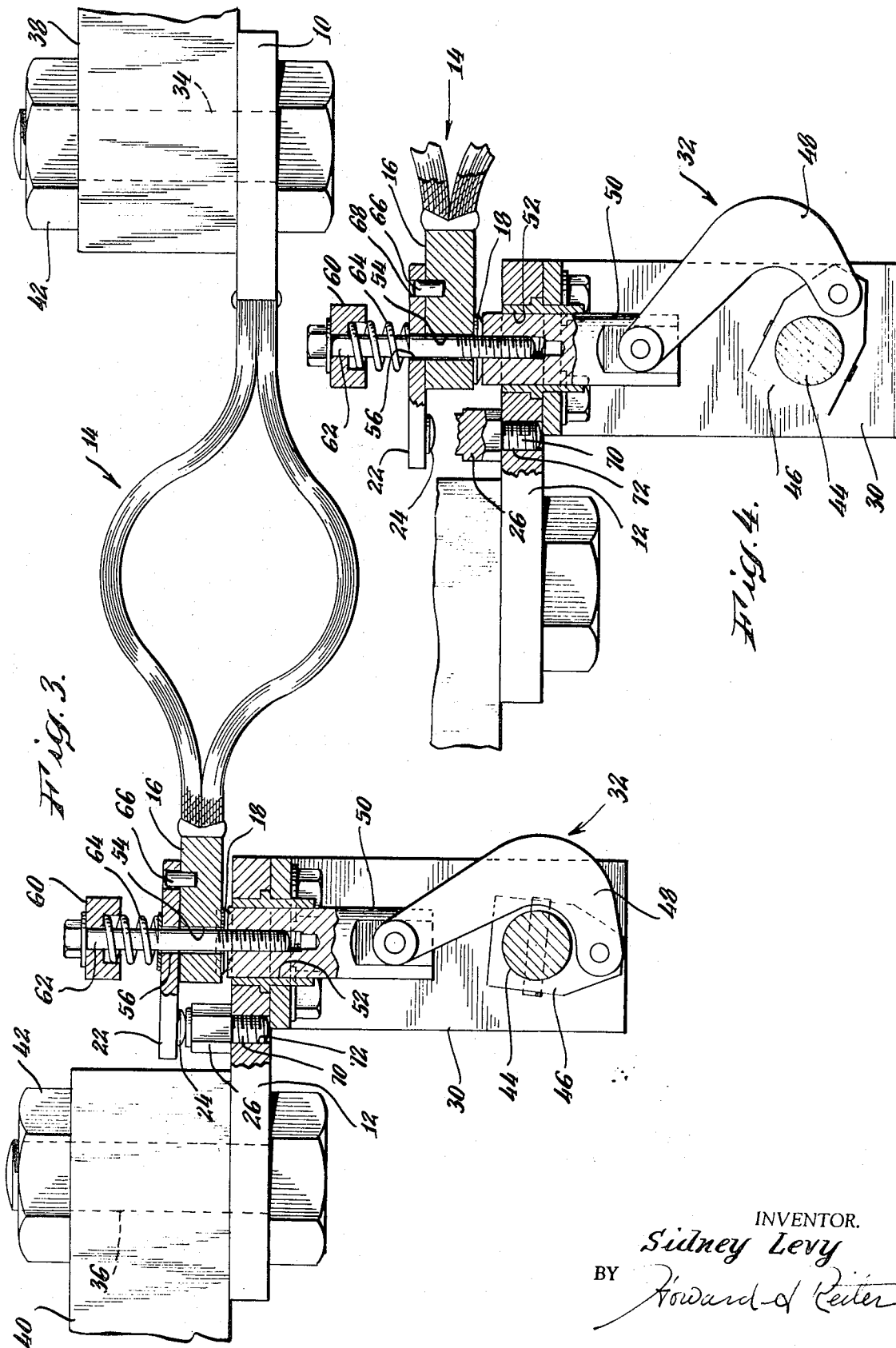
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4 Claims

ABSTRACT OF THE DISCLOSURE

A shunting switch for high-current applications in which a pair of readily replaceable secondary contact surfaces are provided to protect the main contact surfaces from electrical arcing damage. The secondary contacts are resiliently mounted in position to direct and absorb electrical arc formation as the switch is opened and closed, so as to eliminate arcing damage to the main contact surfaces. Pin couplings attach the secondary contacts to the principal contacts, and combined with the particular position at which the operating lever is connected to the secondary contacts, result in a wiping action between the principal contacts. A flexible link between the input and output terminals of the switch accommodated expansion and contraction of external conductors.

This invention relates generally to electrical switches, and more particularly, to high-current shunting switches which include means for eliminating arcing damage to contact surfaces.

The manufacture of chlorine gas involves in one known process, the use of a plurality of electrolytic "cells" connected in electrical series circuits. Extremely high electrical currents, up to 300,000 or even 500,000 amperes, may be encountered in the operation of such cells. Since it is necessary for these series circuits to operate continuously (i.e., 24 hours a day, for several weeks at a time), means are required for separating an individual cell from its series circuit, for cleaning and maintenance purposes, without interrupting current flow through the remainder of the cells in the circuit.

This objective has been achieved, in practice, through the use of normally-open shunting switches which can be closed so as to "shunt" or "by-pass" current around a cell which is to be serviced. Because of the extremely high currents encountered in these operations, and further because of the corrosive atmospheres involved, erosion of the switch contact surfaces due to electrical arcing during opening and closing, is a serious problem. Arcing at the contact surfaces has been considered to be an essentially unavoidable aspect of high-current switching operations.

This problem has been met in the prior art through the use of special erosion-resistant alloy materials for the contact surface elements. However, this solution is subject to the disadvantage of reliance upon a compromise contact material, which has neither optimum conductivity for the desired current-carrying capacity, nor optimum erosion-resistance for desirable long in-service periods.

Replacement of eroded contact surfaces in the prior art

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devices, generally has been a difficult and tedious procedure. This is due to the fact that the contacts must be mounted to the switching apparatus as securely as possible, in order to achieve the desired current-carrying capacity. Good design practice thus has called for elimination of bolted or clamped mechanical interfaces wherever possible in the current-carrying paths of these switches. For this reason, the electrical contact members of a switch are often brazed or similarly bonded to the switch structure. This method of construction presents numerous difficulties in attempting to repair or replace contact surface elements.

Another problem involved in the use of switches of this type is the thermal expansion of structural conductor members. Installation of these switches frequently requires fastening the switch terminals directly on to the ends of relatively long and inflexible conductors such as flat or tubular bus bars. Because these parts are fastened directly to one another, expansion or contraction of the bus bars causes relative movement of the switch elements which can render a switch inoperative due to jamming or separation of the contacts.

Accordingly, it is an object of this invention to provide a high-current shunting switch in which a pair of current-carrying contact surfaces are not subjected to electrical arcing and resultant damage.

A further object of this invention is the provision of a shunting switch in which contact elements subject to arcing erosion are mounted for convenient removal and replacement, without affecting the current-carrying capacity of the switch.

Still another object of this invention is to provide a high-current shunting switch in which contact materials may be selected separately for optimum conductivity and for optimum erosion-resistance parameters.

And still one more object of this invention is the provision of a shunting switch having internal means for accommodating expansion and contraction of conductors coupled to the switch terminals.

A feature of this invention is the use of a pair of resiliently mounted secondary contacts which are adapted to engage prior to engagement of the main contacts when the switch is being closed, and to part subsequent to parting of the main contacts when the switch is being opened. This feature provides significant arcing protection for the main contacts by forcing electrical arcing within the switch to occur only at the secondary contacts.

Another feature of this invention is the use of a flexible bow of conductive material, interposed between the switch frame and one switch terminal, which serves as a conductive and mechanical link for accommodating relative motion between the frame and terminal.

These and other and further objects, features and advantages of this invention are more particularly pointed out and distinctly claimed in the following specification and claims, and are clearly illustrated in the accompanying drawings in which:

FIG. 1 is a partially sectioned front elevation view of a pair of switch units constructed in accordance with this invention;

FIG. 2 is a partial top plan view of the switch units shown in FIG. 1;

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FIG. 3 is a transverse section view taken in plane 3—3 of FIG. 1, showing the switch in "closed" position, as in FIG. 1;

FIG. 4 is a partial view taken in the same plane as FIG. 3, showing "opening" of the switch;

FIG. 5 is a detailed and partially sectioned view of the contact members of the illustrated switch, shown in fully-open position;

FIG. 6 is a view identical to FIG. 5, but showing the contact members in partly-open or partly-closed position; and

FIG. 7 is a view identical to FIG. 5, but showing all of the contact members in fully-closed position.

Now, referring to the drawings more particularly, it may be seen most clearly in FIG. 3 that the switch of this invention comprises a first conductor terminal plate 10 and a second conductor terminal plate 12 disposed in spaced apart relationship, with a flexible cantilever arm means 14 extending from the first plate 10 and having a free end portion 16 positioned in overlapping, spaced-apart relationship with the second plate 12. A principal contact subportion 18 is formed on the free end 16 of cantilever arm 14 and a principal mating contact surface 20 is defined on second conductor plate 12 to engage the opposed principal contact subportion 18 upon deflection of the cantilever arm. The free end 16 of cantilever arm 14, carries, additionally, a secondary support arm 22 which overlaps and extends beyond the free end 16. A secondary contact subportion 24 is electrically and mechanically carried on this extending support arm. A secondary mating contact means 26 is electrically and mechanically carried by second conductor plate 12 in position to engage the opposed secondary contact 24 on support arm 22. And, a frame or bracket 30 mounted to second conductor plate 12 is provided to support a lever assembly 32, which is operable to deflect free end 16 of cantilever 14 so as to bring the principal contacts 18, 20 and secondary contacts 24, 26 into mating engagement. The first and second terminal plates 10 and 12, are provided with means such as apertures 34, 36 to facilitate electrical and mechanical coupling of the conductor plates to external conductors such as bus-bars 38 and 40. In the illustrated embodiment, this coupling is achieved by bolts 42 which extend through aperture 34, 36.

Cantilever arm 14 may be seen to comprise two oppositely bowed straps of laminated construction. This structure combines optimum flexibility with the necessary conductivity, to provide an electrical and mechanical coupling between the first terminal plate 10 and the principal contact 18. Free end portion 16, which carries contact 18, is fixed against longitudinal motion relative to second plate 12 by the construction of lever assembly 32, as described below. The provision of bowed cantilever arm 14 assures that a conductor coupled to terminal 10 will be able to move longitudinally relative to a conductor coupled to terminal 12, without disturbing alignment of the internal switch contacts, 18, 20 and 24, 26.

Lever assembly 32 comprises, a rotary shaft 44 which is supported on bracket 30, an eccentric arm 46 mounted to the rotary shaft, a J-bar link member 48 coupled to the eccentric arm, and a sliding drive rod 50 coupled to the J-bar link. This assembly converts limited rotary motion of shaft 44 into limited rectilinear sliding motion of rod 50.

FIG. 4 illustrates the relative position of lever assembly 32 when the switch of this invention is in "open" condition. The figure shows that rotary shaft 44 has been rotated in a counter clockwise direction so as to move the coupling between J-bar 48 and eccentric arm 46 from a position just slightly to the left of a vertical line through the central axis of 44, to a position which is well to the right of such a vertical line. When this coupling point is positioned to the left of the vertical line, as shown in FIG. 3, the coupling forces on shaft

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50 will tend to urge shaft 44 into clockwise rotation, but such rotation will be prevented by engagement of J-bar 48 with the surface of shaft 44. The assembly thus will be effectively "locked" in the position shown. Upon application of manual force sufficient to overcome the "locking" forces shaft 44 may be rotated in a counter clockwise direction into the position shown in FIG. 4 to "open" the switch. Limited rotary motion of shaft 44 thus will have been translated into upward sliding motion of shaft 50. Movement of free end portion 16 away from second conductor plate 20 under these circumstances as a result of the stored resilient forces in cantilever arm 14 aided by the upward force exerted by engagement of end portion 52 of shaft 50 with the opposed surface of free end portion 16.

The sliding drive rod is arranged to extend through the apertures 52, 54 and 56 in second plate 12, free end 16 and support arm 56, respectively, so as to extend a short distance from both sides of these three elements. At the lower end, rod 50 is coupled to J-bar 48. At the upper end, this rod or shaft is coupled to a header member 60 by means of a coupling bolt 62, which is threaded into the shaft. A helical compression spring 64 is captured between header 60 and extension arm 22 for transmission of compression forces generated by movement of rod 50. Compression spring 64 transmits force from rod 50 directly to the extension arm 22 which carries secondary contact 24. Rod 62 is coupled to the extension arm 22, through compression spring 64 at a location which is between a "coupling location" (66, 68) and the secondary contact means 24. In addition, another set of compression springs are captured between header 60 and the surface of free end portion 16 to transmit forces from the lever assembly 32 directly to the free end portion 16.

It may be seen most clearly in FIG. 3, that extension arm 22 has a certain amount of freedom of motion, permitting it to slide along coupling bolt 60 independently of free end portion 16. The principal restraint on the motion of extension arm 22 is represented by alignment pin 66 which is captured to free end portion 16 and fits loosely within an aperture 68 in the extension arm. This prevents parallel relative motion between the engaging surfaces of the extension arm 22 and free end portion 16, and limits arm 22 to pivotal relative motion only. The limited pivotal motion of arm 22 which occurs as the switch is "closed" produces a certain amount of relative "wipe" between secondary contacts 24, 26, thereby helping to eliminate insulating films or other obstacles which may have formed between the contacts in their "open" position.

The structure which has been described was conceived for the purpose of protecting principal contacts 18 and 20 from pitting or erosion caused by electrical arcs formed during opening and closing of the switch. This purpose is accomplished through the use of secondary contacts 24, 26 and their particular mounting means. Specifically, as shown most clearly in FIG. 6, the principal and secondary contacts and related elements which are assembled to free end 16 and second plate 12 are adapted to cause engagement of secondary contacts 24, 26 prior to engagement of principal contacts 18, 20, as free end 16 is moved toward second plate 12. The secondary contacts 24, 26, accordingly, necessarily form any electrical arc caused by differences in electrical energy levels between free end 16 and second plate 12. The full force and erosive effect of electrical arcing thus are absorbed by the secondary contacts 24, 26 before the opportunity occurs for arc formation at principal contacts 18, 20. Also, upon engagement of secondary contact parts 24, 26, extension arm 22 is deflected relative to the free end 16 of cantilever arm 14, so that the deflection forces produced by the lever means 48, 62 (and transmitted to free end 16 through extension arm 22) become generally concentrated at the extension arm

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end near "coupling location" 66, 68. Because the forces applied at this location are offset with respect to principal contact 18, there is a perceptible shifting (or wiping) of principal contact 18 relative to mating contact 20 upon engagement.

Ease of replacement of secondary contacts 24, 26 is a particular advantage of the illustrated structure. Secondary mating contact 26 may be provided simply with a threaded slide portion 70 which engages a threaded aperture 72 in second conductor plate 12, for convenient removal and replacement. Similarly, secondary contact 24 may be replaced with equal convenience, together with extension arm 22, by simple disassembly of coupling bolt 60 from sliding shaft 50. A concomitant advantage is the provision of conveniently replaceable secondary contacts, is that the principal contacts require less frequent replacement and therefore may be securely mounted or integrally formed with free end portion 16 and second conductor plate 12.

FIG. 2 of the drawings illustrate the relative positions of free end portion 16 and extension arm 22 when the switch of this invention is in fully-closed position (i.e., principal contacts 18, 20 and secondary contacts 24, 26 are both in mating engagement). It may be seen that extension arm 22 has been tilted upward relative to free end portion 16 under the force exerted on secondary contact 24 by secondary mating contact 26. This position of the contacts is achieved as a result of free end portion 16 being urged downward toward second plate 12 beyond the position at which the secondary contacts 24, 26 first engage (as shown in FIG. 6). The force for carrying free end portion 16 to this position is transmitted to the free end through compression springs. In order to achieve this mode of operation it is necessary to select the spring constants so that the "tilt" force exerted by springs 66, 68 will exceed the force exerted by compression spring 64 on extension arm 22. It should be noted that the tilting of extension arm 22, as shown, following engagement of secondary contacts 24, 26, produces the "wiping" motion between the secondary contact surfaces which has been described above.

FIG. 1 shows two switch units, mounted in side-by-side relationship, and sharing a common rotary shaft 44. It is considered clear that a plurality of such units may be mounted similarly for operation by a common rotary shaft. It is clear also, that the ends of shafts 44 may be provided with coupling units 70 for joining to other, axially aligned shafts, or to operating levers (not shown) and the like.

For the purpose of complete illustration of the relative motion of the principal and secondary contacts during operation of the switch, FIG. 5 illustrates the position of the respective contacts when the switch is in fully-open position. It may be seen that in this position the separation between secondary contacts 24, 26 is at a distance "a" which is a finite amount less than the distance "b" between principal contacts 18, 20.

The invention has thus been described but it is desired to be understood that it is not confined to the particular forms or usages shown and described, the same being merely illustrative, and that the invention may be carried out in other ways without departing from the spirit of the invention; therefore, the right is broadly claimed to employ all equivalent instrumentalities coming within the scope of the appendent claims, and by means of which objects of this invention are attained and new results accomplished, as it is obvious that the particular embodiments herein shown and described are only some of the many that can be employed to obtain these objects and accomplish these results.

I claim:

1. An electrical switch for high-current electrical circuit applications, comprising:
a first terminal plate;

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a second terminal plate disposed in spaced-apart relationship to said first terminal plate;

flexible and conductive cantilever arm means electrically coupled to said first conductor plate and having a free end disposed in overlapping, spaced-apart relationship relative to said second conductor plate, said free end being movable from an undeflected to a deflected position upon deflection of said cantilever arm;

principal contact means mounted to the said free end of said cantilever arms;

principal mating contact means mounted to said second conductor plate in opposed, spaced-apart relationship relative to the said principal contact means on said free end;

extension arm means, having one end engaging said free end in overlapping relationship including a coupling location at said one end, and having another end extending beyond said free end into overlapping, spaced-apart relationship with said second conductor plate;

said coupling location being offset with respect to said principal contact means on said free end;

secondary contact means electrically coupled to the said other end of said extension arm means;

secondary mating contact means electrically coupled to said second conductor plate in opposed, spaced-apart relationship relative to said secondary contact means on said extension arm;

a support member coupled to said second terminal plate;

a lever means pivotally coupled to said support member and coupled to said extension arm means at a location between said secondary contact means and said coupling location for deflecting said cantilever arm means together with said extension arm means towards the respective principal and secondary mating contact means on said second terminal plate;

completion spring means interposed and forming a coupling between said extension arm means for transmitting deflection forces;

wherein, the distance between said secondary contact means and said secondary mating contact means is less than the distance between said principal contact means and said principal mating contact means, such that upon engagement of the secondary contact and mating contact the said extension arm means is flexed relative to the said free end of said cantilever arm means to apply added deflection force at said coupling location.

2. An electrical switch in accordance with claim 1, wherein;

said lever means includes an eccentric arm pivotally coupled to said support member and a sliding drive rod having a first end portion operatively coupled to said eccentric arm and having an extending second end portion;

said second terminal plate, said free end of said cantilever arm, and said extension arm each include at least one through aperture, the said apertures being arranged in alignment with one another; and said sliding drive rod extends through each of the said apertures with the said second end of said drive rod being coupled to the said free end of said cantilever arm through said principal compression spring means and being coupled to the said extension arm through said secondary compression spring means.

3. An electrical switch in accordance with claim 2 wherein said cantilever arm means comprises a bow of flexible conductive material adapted to permit longitudinal relative motion between said free end and said first conductor plate.

4. An electrical switch in accordance with claim 1 wherein said secondary mating contact means is mounted to said second conductor plate by means of a thread-

ed fastener to provide for convenient separation of said contact means from said second conductor plate.

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