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[54] **ELECTRICAL SWITCH WITH HIGH PRESSURE CONTACTS**

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[52] **U.S. Cl.... 200/48 A,** 200/DIG. 29, 200/166 BB
[51] **Int. Cl.** **H01h 31/00**
[58] **Field of Search**...... 200/48 A, DIG. 29, 166 BB

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[57] **ABSTRACT**

A stationary jaw contact assembly for use in high current disconnect switches including opposed fixed contact members, each fixed contact member associated with a variable diameter cylindrical contact member rotatably mounted between the fixed contacts. Each rotatable contact member has a reduced diameter portion which engages the associated fixed contact member and an enlarged diameter portion. The enlarged diameter portions on each rotatable contact define a space between themselves receivable of a movable blade contact during closing of the switch so that the blade contact simultaneously engages each enlarged diameter portion. The size of the force required to make or break electrical contact is proportional to the ratio of the radius of the small diameter portion to the radius of the enlarged diameter portion.

11 Claims, 4 Drawing Figures

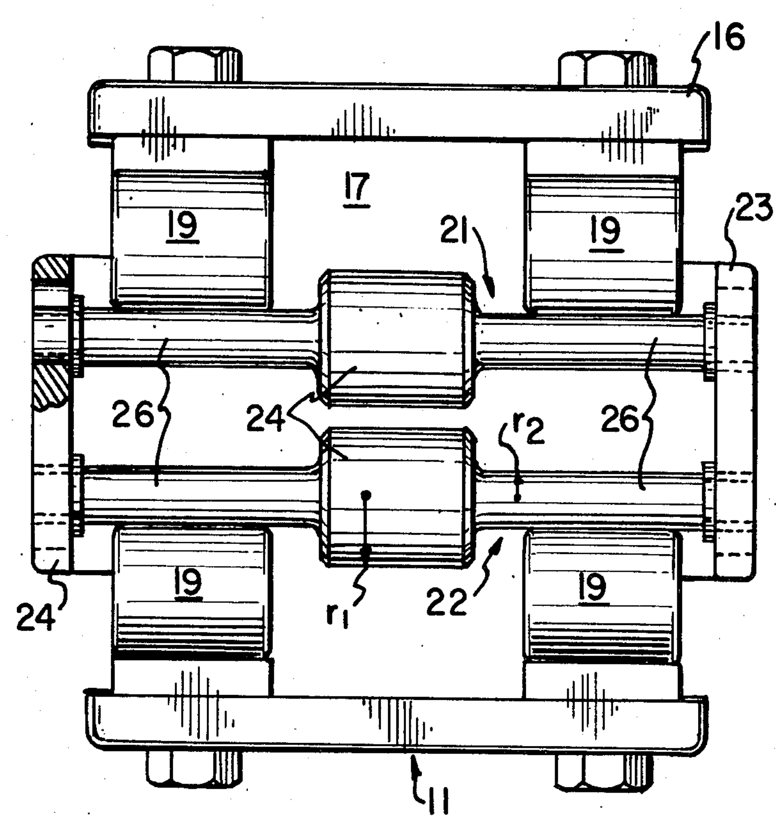


FIG. 1

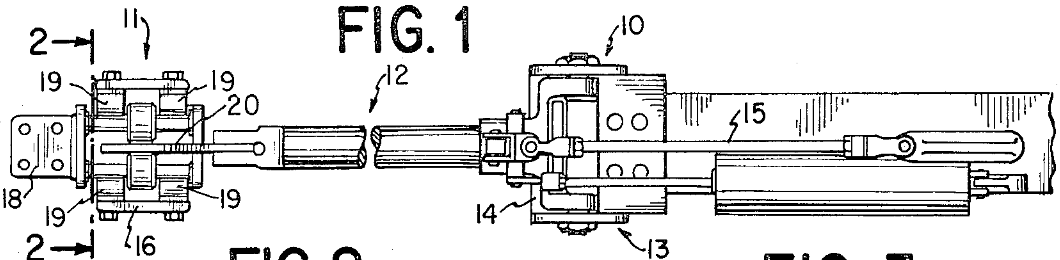


FIG. 2

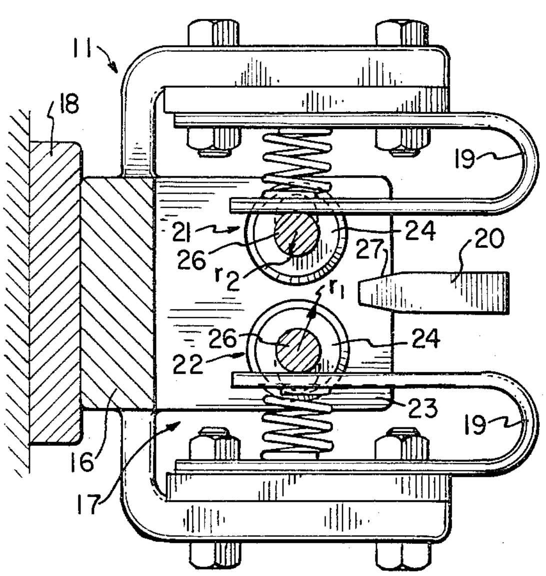


FIG. 3

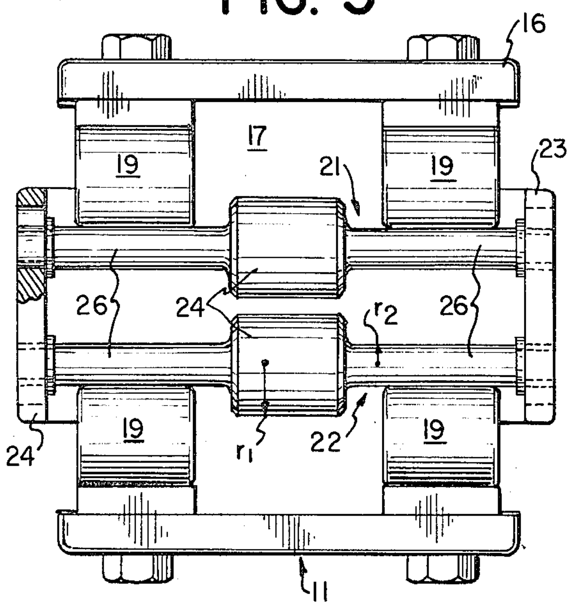
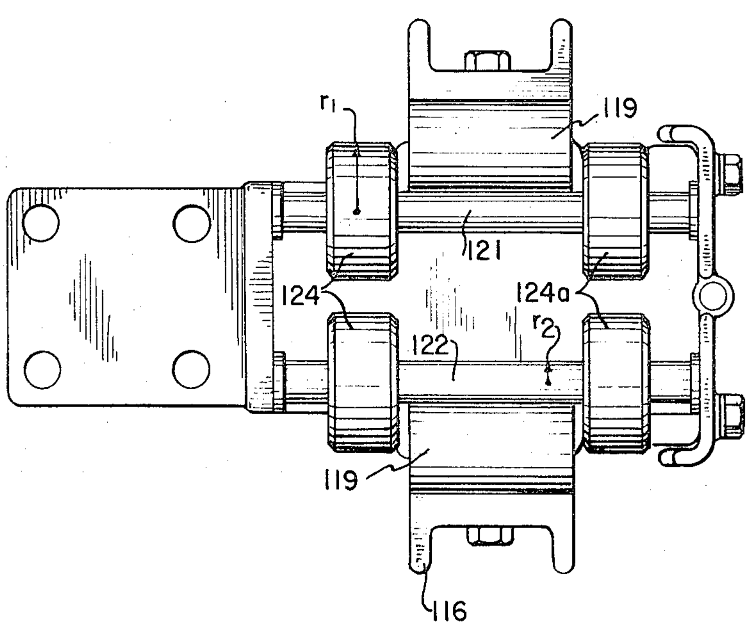


FIG. 4



ELECTRICAL SWITCH WITH HIGH PRESSURE CONTACTS

BACKGROUND OF THE INVENTION

The invention relates to disconnect switches, and in particular to fixed or stationary jaw contact assemblies adapted to receive a movable contact blade of a high current disconnect switch.

Disconnect switches of the type described herein have long utilized a pivotal switch blade element hinged at one end to a base whereby the other end of the blade may be moved into and out of engagement with the stationary contact jaw. One requirement for switches such as that described herein, which are adapted to transmit currents as high as 1,200 amperes and above, is that when the switch is in the closed position, the engagement between the movable contact blade element and the fixed contact elements of the stationary jaw be under high pressure so as to minimize any tendency for arcing or other associated current fault situations.

Heretofore, existing high current disconnect switches utilize various techniques for ensuring that such an appropriate pressure is applied when the switch is closed to minimize the possibility of current fault situations. However, a major disadvantage of these prior disconnect switches has been that the high pressure engagement of the contacts provided when the switch is closed prevents quick and easy disengagement of the contacts when it is desired to disconnect the switch. The reason for this is that the high pressure between the contact surfaces creates high frictional forces which must be overcome before the pivotal switch blade can be manipulated to the open position.

SUMMARY OF THE INVENTION

Of course, it has been attempted to overcome this difficulty by providing complicated and necessarily expensive hinge and operator linkages for manipulating the movable switch blade. Accordingly, it is the main objective of the present invention to provide a high current disconnect switch having a suitable high pressure engagement between the stationary jaw and movable blade contacts with respect to which only minimal frictional forces need be overcome to manipulate the movable switch element to the open position.

To this end, the invention provides for a compound diameter electroconductive roller element interposed between the stationary contact and the movable contact of the switch. The roller element is provided with an enlarged diameter portion for engaging the movable element of the switch, and a reduced diameter portion for engaging the fixed contact element of the switch. In each of the preferred embodiments, the roller element is biased by means of the inherent resiliency of the stationary jaw contacts to an appropriate position in order to provide the requisite high pressure contact engagement to facilitate faultless current transfer.

In accordance with the compound diameter configuration of the roller, the size of the force required to break the electrical contact is proportional to the ratio of the radius of the small diameter portion to the radius of the enlarged diameter portion. This ratio is adjusted to minimize the force required to break the switch subject to limitations of the general design of the contact jaw dictated by such factors as space requirements and the materials utilized in its construction.

As disclosed herein, the invention is utilized in disconnect switches in which the movable contact element is a hinged switch blade having a contact portion at its free end which may be pivoted into position between a pair of opposed stationary contact elements. The stationary jaw assembly of the present invention includes a pair of spaced conductive rollers, each having an enlarged diameter cylindrical contact surface, which surfaces engage the switch blade simultaneously as it passes between them. The reduced diameter portions of each of the rollers simultaneously continuously engage their corresponding fixed contact elements.

DESCRIPTION OF THE DRAWINGS

To facilitate understanding of the present invention, reference will be made to the accompanying drawings, in which:

FIG. **1** is a top plan view of a high voltage disconnect switch which incorporates the present invention;

FIG. **2** is a view of the stationary jaw contacts of the switch taken along the line **2—2** of FIG. **1**;

FIG. **3** is a view taken along the line **3—3** of FIG. **2**; and

FIG. **4** is a top plan view of an alternate embodiment of the fixed contact assembly in accordance with the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, and in particular to FIG. **1**, there is shown in pertinent part a high voltage disconnect switch, indicated generally by reference numeral **10**, having a fixed or stationary jaw contact assembly **11**, a pivoting switchblade assembly **12**, and suitable linkage and operating elements **13** for effecting movement of the switchblade to open and close the switch. As viewed in FIG. **1**, the movement of the switchblade **12** is in a single plane perpendicular to the plane of the drawing. The hinge mechanism for the pivotal switchblade is included within the operating elements **13**. The linkage and hinge eleents, as well as the stationary jaw contact assembly are mounted on suitably anchored support elements **14** and **16**, respectively. Generally, in operation, actuation of the switchblade operating elements, such as operator arm **15**, causes the switchblade to pivot at its hinge so that the free end of the blade is moved into and out of engagement with the stationary contact jaw assembly to open and close the switch as desired.

The present invention resides in the structure of the fixed or stationary jaw contact assembly as illustrated in particular in FIGs. **2** and **3**. In the preferred form, the support structure **16** has a substantially U-shaped cross-section providing a frame on which the contacts of the jaw contact assembly are mounted so as to extend into a suitably shielded internal space **17** defined by the frame. The frame **16** is insulated from ground potential by being suitably anchored to a base member **18** which may be either on the ground or elevated from the ground on a suitable structure, such as a conventional insulator stack, depending upon the locale and the assigned utility of a particular switch.

In general, high current switches of the type described herein utilize a particular form of fixed contact, namely the U-shaped loop contact elements **19** which are illustrated as secured to opposite end walls of the frame **16.** Such loop contacts are normally made of a resilient material having suitable strength and electrical properties for carrying currents of the order of 1,200 amperes and above. The structure of this type of contact loop is such that when an electric current is introduced into one end or one leg of the contact loop, to flow around the loop toward the other end, electric fields of conflicting polarity are generated within the space between the opposed legs to cause the free end of the loop to be repelled or to be urged away from the fixed end. This phenomenon occurs generally when current is moving in opposite directions through two parallel and relatively closely spaced electric conductors. This principle is of great significance for high current disconnect switches, particularly under circumstances of a sudden unpredictable surge of electrical current sometimes known as a current fault. The present invention is described in its preferred form in combination with such reverse loop contacts; however, it should be understood that other types of fixed jaw contacts may be equally suitable.

As shown in FIG. **2,** the contact jaw requires at least two opposed fixed contacts such as the loop contact **19,** although some switches utilize two opposed pairs of fixed jaw contacts such as shown in FIG. **3,** and under some circumstances it may be desirable to utilize more than four contact elements. In any case, the arrangement of the contacts is such that the movable blade of the switch is inserted between opposing contact elements so as to indirectly engage both contacts simultaneously as explained in greater detail below to close an electrical circuit. Such structure is typical of the type of high current switches with respect to which the present invention has a preferred utility.

In this environment, the present invention provides for the blade contact element **20** of the switch blade **12** to be moved into simultaneous engagement with a pair of identical roller elements **21** and **22** which are positioned substantially side by side within the space **17** between the opposed, fixed loop contacts **19.** The dimensions of the structure are such that any space between the rollers in which the blade contact element **20** is intended to pass is smaller than the maximum width of the blade contact element.

The major axis of each of the roller elements **21** and **22** is arranged mutually parallel to each other within the space between the loop contacts in the same horizontal plane which is substantially perpendicular to the plane of movement of the blade contact element **20.**

Suitable support members **23** and **24** (FIG. **3**) are provided on the frame for rotatably securing each of the roller elements in operating position.

In accordance with the invention, each of the identical rollers **21** and **22** is provided with an enlarged diameter portion **24** and a reduced diameter portion **26.** The radius of the enlarged diameter portion, as measured from the center or axis of rotation, is indicated in FIGS. **2** and **3** as being r_1, while the radius of the reduced diameter portion **26,** also measured from the axis of rotation, is indicated in FIGS. **2** and **3** as r_2.

As mentioned above, it is a major objective of the present invention to provide means for overcoming frictional forces which arise during opening and closing disconnect switches between the movable and stationary contact members. Accordingly, the rollers **21** and **22** are provided so that the large diameter portion having radius r_1 always engages the blade contact element **20** during opening and closing of the switch, while the small diameter portions of the rollers having radius r_2 always engage the stationary contacts. This difference between the two radii results in a mechanical advantage in overcoming the frictional forces at the points of engagement between the reduced diameter portions **26** of the rollers and the corresponding fixed contacts. For example, the force which is required to break the engagement of the fixed and movable contacts, i.e., to open the switch (F_a) is generally equal to the ratio of r_2 to r_1 multiplied by a force F_c which is due to static friction between the rollers and the fixed contacts. This equation implies that as the radius r_2 is decreased relative to the radius r_1, the force required to be applied to the contact blade **20** to break it free from the contacts is reduced in proportion to the relative values of r_1 and r_2.

Although not shown in the drawings, the support members **23** and **24** are provided with supporting slots to receive the end portions of each of the rollers **21** and **22.** The arrangement is such that the rollers float in the supporting slots and are free to rotate and to move outwardly (away from each other) in the horizontal plane containing the axes of rotation in response to forces applied by the contact blade **20** as it enters or leaves the contact assembly. When the switch is open, the loop contacts bear against the respective rollers biasing them into position where their end portions are received at the innermost extremities of the slots so that their separation distance is minimal.

In the preferred embodiments described herein, each half of the contact assembly structure, including a pair of side-by-side U-shaped loop contacts and a roller element, is the mirror image of the other half of the jaw structure. While this arrangement is preferred, it should be noted that certain modifications may be made which have an effect upon the symmetry of the design, without departing from the scope of the invention. It is important though that the movable contact blade come into engagement with the enlarged diameter portion of each of the rollers **21** and **22;** however, the invention is not to be limited by the symmetrical arrangement depicted.

Since the distance between the enlarged diameter portions of the rollers is less than the width of the movable blade contact **20,** the blade is preferably provided with a somewhat tapered edge **27** (FIG. **2**) to facilitate spreading of the rollers against the bias of resilient contact **19** as the blade is moved to close the switch. As the rollers move outwardly in response to entry of the blade contact **20** between them, each presses against a corresponding loop contact thereby urging the free leg of the loop toward the other leg. The compression springs **30** provided between the legs of the loop contact members assure that there will be sufficient positive pressure against the blade element **20** to ensure a good electrical connection. One end of the spring is electrically insulated so as to provide a resiliency independent of the current carrying portions of the loop contact. Furthermore, during high fault currents as described above, the free contact leg of each of the loop elememts will be urged, by virtue of the electric fields generated, away from the fixed leg against its corresponding roller element, thereby increasing the pressure against the blade contact **20** and facilitating maintenance of the electrical connection under these conditions.

As indicated above, the present invention is applicable with respect to disconnect switches having stationary jaw contacts with either one or two (or more) pairs of opposed loop contacts. In FIG. **4**, there is illustrated a second preferred embodiment of the invention in which a stationary contact assembly is provided with only one pair of opposed loop contacts **119.** This embodiment has proven especially well suited for operation during current fault situations. Each of the contacts **119** is secured to a suitable supporting member extending from a frame **116.** Each of the rollers **121** and **122,** mounted in a manner similar to that described above in the previous embodiment, is provided with a pair of enlarged diameter portions **124** and **124***a* which are separated by a reduced diameter portion **126** which engages the free leg of the corresponding loop contact element. As with the previous embodiment, the ratio of the radii r_2 to r_1 is adjusted to give the maximum practical mechanical advantage in overcoming the frictional forces arising between the reduced diameter portion **126** and the associated loop contact.

In all other respects, the operation of the embodiment shown in FIG. **4** is essentially the same as that described above in connection with the previous embodiment. With respect to each particular roller, the distance between the enlarged diameter portions is just slightly greater than the width of the leg of the corresponding loop contact element **119.** Thus, forces which are generated during operation of the switch are applied more equally across the major portion of the contact area between the loop contact element **119** and the reduced diameter portion **126** of the roller. This ensures a more efficient electrical connection.

Additionally, the use of rollers having a pair of separated enlarged diameter portions provides for twice as many contact areas between the movable blade contact and the rollers when the switch is in its closed position. This arrangement also serves to enhance the efficiency of the electrical operation of the switch.

It should be noted that while the switch has been described in connection with a preferred usage respecting stationary jaw contacts of high current disconnect switches, the invention need not be limited to such usage and may be applicable in other situations in which one contact member is movable into and out of engagement with a corresponding fixed or stationary contact element.

What is claimed is:

1. In a switch having a pivotally mounted blade, a contact assembly comprising:

a frame assembly;

at least one fixed, resilient contact member mounted on said frame assembly including a substantially stationary contact surface;

at least one rotatable contact member having an axis of rotation comprising a first cylindrical portion integral with a second coaxial cylindrical portion having a larger diameter than said first cylindrical portion, said first and second cylindrical portions being provided with communicating electroconductive contact surfaces;

means for pivotally mounting said rotatable contact member on said frame assembly so that said axis of rotation is substantially stationary in a direction parallel to said stationary contact surface; and

wherein said fixed and rotatable contact members are mounted on the frame assembly with said substantially stationary contact surface being biased against said contact surface of said first cylindrical portion so as to be maintained in continuous electrical communication during rotation of said rotatable contact member, the rotation being induced by said blade engaging said second cylindrical portion of said rotatable contact member during the opening and closing of the switch.

2. In a switch having a pivotally mounted blade, a contact assembly comprising:

a frame assembly;

at least one rotatable contact member pivotally mounted on said frame assembly, said rotatable contact member comprising a first cylindrical portion integral with a second coaxial cylindrical portion having a larger diameter than said first cylindrical portion, said first and second cylindrical portions being provided with communicating electroconductive contact surfaces;

at least one fixed, resilient contact member mounted on said frame assembly including a substantially stationary contact surface, said fixed resilient contact member including a U-shaped contact member having a pair of leg portions extending in substantially parallel direction connected by a bridging portion, one of said leg portions fixed to said frame assembly and the other of said leg portions biased against the first cylindrical portion of the rotatable contact member; and

wherein said fixed and rotatable contact members are mounted on the frame assembly with said substantially stationary contact surface being biased against said contact surface of said first cylindrical portion so as to be maintained in continuous electrical communication during rotation of said rotatable contact member, the rotation being induced by said blade engaging said second cylindrical portion of said rotatable contact member during the opening and closing of the switch.

3. In a switch having a pivotally mounted blade, a contact assembly comprising:

a frame assembly;

at least one fixed, resilient contact member mounted on said frame assembly including a substantially stationary contact surface;

at least one rotatable contact member having opposite end portions pivotally mounted on said frame assembly, said rotatable contact member comprising a first cylindrical portion integral with a second coaxial cylindrical portion having a larger diameter than said first cylindrical portion, said first and second cylindrical portions being provided with communicating electroconductive contact surfaces;

said frame assembly being provided with a pair of opposed spaced slots adapted to receive said end portions, said slots being formed so as to permit movement of said rotatable contact member in a direction transverse to the cylindrical axis thereof; and

wherein said fixed and rotatable contact members are mounted on the frame assembly with said substantially stationary contact surface being biased against said contact surface of said first cylindrical portion so as to be maintained in continuous electrical communication during rotation of said rotatable contact member, the rotation being induced by said blade engaging said second cylindrical portion of said rotatable contact member during the opening and closing of the switch.

4. A contact assembly as defined in claim 3, wherein the biasing of said substantially stationary contact surface against said first cylindrical portion of said rotatable contact member urges said rotatable contact member to an extreme position in said slots.

5. In a switch having a pivotally mounted blade, a contact assembly comprising:

a frame assembly;

at least one fixed, resilient contact member mounted on said frame assembly including a substantially stationary contact surface, said resilient contact member comprising a pair of U-shaped contact members mounted on said frame assembly in opposed relationship, each U-shaped contact member having one leg portion fixed to said frame assembly so that the free leg portion opposes the respective free leg portion of the other U-shaped contact member;

a pair of rotatable contact members, each rotatable contact member being pivotally mounted on said frame assembly and comprising a first cylindrical portion integral with a second coaxial cylindrical portion having a larger diameter than said first cylindrical portion, said first and second cylindrical portions being provided with communicating electroconductive contact surfaces, and each rotatable contact member being mounted on said frame assembly adjacent to a respective U-shaped contact member so that the free leg portion of each U-shaped contact member is biased inwardly against the respective contact surface of said first cylindrical portion of the rotatable contact member; and

wherein said fixed and rotatable contact members are mounted on the frame assembly with said substantially stationary contact surface being biased against said contact surface of said first cylindrical portion so as to be maintained in continuous electrical communication during rotation of said rotatable contact member, the rotation being induced by said blade engaging said second cylindrical portion of said rotatable contact member during the opening and closing of the switch.

6. A contact assembly as recited in claim 5, wherein said second cylindrical portion formed on each rotatable contact member comprises a pair of cylindrical segments of equal diameter separated from each other by said first cylindrical portion, wherein said pair of rotatable contact members are mounted so that said cylindrical segments on one rotatable contact member oppose corresponding cylindrical segments formed on the other rotatable contact member constituting a pair of sets of opposed cylindrical segments.

7. A contact assembly as recited in claim 6, wherein the cylindrical segments of each set of opposed cylindrical segments are separated by a distance which is smaller than the thickness of said blade.

8. In a switch having a pivotally mounted blade, a contact assembly comprising:

a frame assembly;

at least one fixed, resilient contact member mounted on said frame assembly including a substantially stationary contact surface, at least one fixed, resilient contact member comprising two pairs of U-shaped contact members mounted on said frame assembly, each pair in opposed relationship to the other, each U-shaped contact member of each pair having one leg portion fixed to said frame assembly so that the free leg portion opposes the respective free leg portion of the corresponding contact member of the other pair;

a pair of rotatable contact members, each rotatable contact member being pivotally mounted on the frame assembly and comprising a first cylindrical portion integral with a second coaxial cylindrical portion having a larger diameter than said first cylindrical portion, said first and second cylindrical portions being provided with communicating electroconductive contact surfaces, and each rotatable contact member being mounted on said frame assembly adjacent to a respective pair of U-shaped contact members so that the free leg portions of each pair of U-shaped contact members are biased inwardly against the respective contact surface of said first cylindrical portion of each rotatable contact member; and

wherein said fixed and rotatable contact members are mounted on the frame assembly with said substantially stationary contact surface being biased against said contact surface of said first cylindrical portion so as to be maintained in continuous electrical communication during rotation of said rotatable contact, the rotation being induced by said blade engaging said second cylindrical portion of said rotatable contact member during the opening and closing of the switch.

9. A contact assembly as recited in claim 8, wherein said first cylindrical portion formed on each rotatable contact member comprises a pair of cylindrical segments of equal diameter separated from each other by said second cylindrical portion, wherein said pair of rotatable contact members are mounted so that said second cylindrical portion formed on one rotatable contact member directly opposes the second cylindrical portion formed on the other rotatable contact member constituting a set of opposed cylindrical segments.

10. A contact assembly as recited in claim 9, wherein the cylindrical segments of the set of opposed cylindrical segments are separated by a distance which is smaller than the thickness of said blade.

11. A contact assembly for switches comprising:

a first contact member having a contact surface;

a second contact member movable to one position substantially adjacent said first contact member, said second contact member being movable in a direction generally parallel to said contact surface in the vicinity thereof; and

a third contact member adapted for simultaneous engagement with said first and second contact members when said second contact member is proximate to said one position and having first and second coaxial cylindrical surfaces, said first cylindrical surface being tangentially engageable with said contact surface and having a diameter smaller than the diameter of said second cylindrical surface, said second contact member to engage tangentially said second cylindrical surface when said second contact member is in said one position thereby to complete an electrical circuit between said first and second contact members.

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