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Cuzzone

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[54] **EXPULSION FUSE AND SUPPORT MEANS**

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[52] **U.S. Cl.** **337/204,** 337/187, 337/202, 337/251

[51] **Int. Cl.** **H01h 85/02**

[58] **Field of Search** ..... 337/187, 277, 251, 337/202, 204, 189–199, 251–254; 174/14 BH, 15 BH, 145; 317/15

[56] **References Cited**

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Attorney—Vale P. Myles et al.

[57] **ABSTRACT**

An expulsion fuse that is adapted to be immersed in operating position in a fluid coolant of a transformer is provided with a support means to facilitate installation of the fuse in vibration-resistant relationship within the transformer. The support means includes a rigid angle support member having a coupling stud positioned on it for clamping a lead from the transformer primary winding in operating relationship to one terminal of the fuse. The fuse is also characterized by having a baffle means that restricts the flow of transformer coolant around the fusible link of the fuse when it is immersed in the coolant.

10 Claims, 3 Drawing Figures

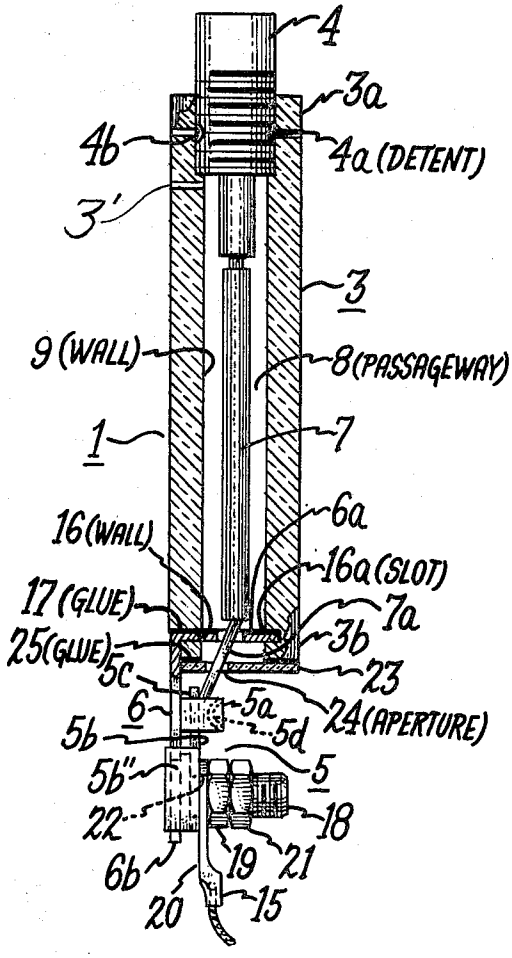


Fig. 1.

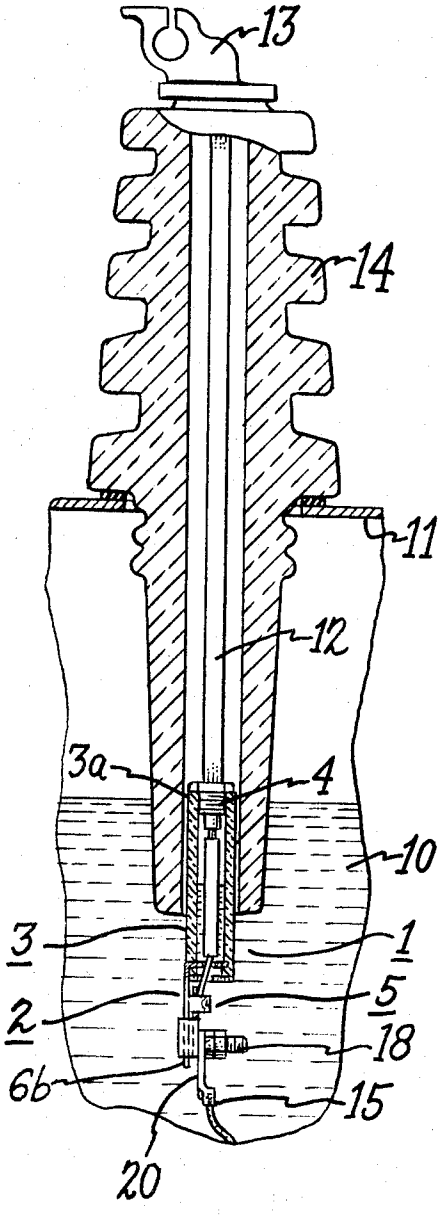


Fig. 2.

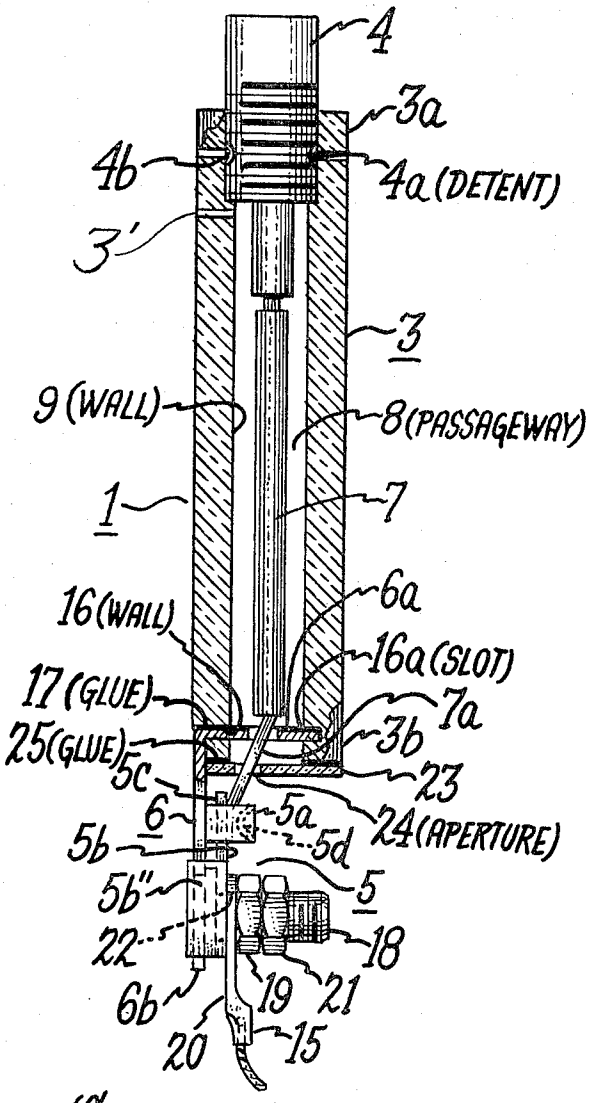
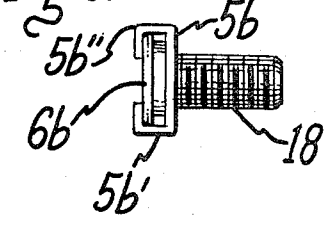


Fig. 3.



EXPULSION FUSE AND SUPPORT MEANS

BACKGROUND OF THE INVENTION

It is well known in the distribution transformer field to utilize a primary fuse mounted inside the tank of a transformer to protect the transformer from damage due to overcurrents. The term "primary fuse" as used herein is meant to designate a fuse that is connected in series between a high voltage supply line to the transformer, and the primary winding of the transformer. An example of such a primary fuse is disclosed in U.S. Pat. No. 2,937,253—Smith, which issued May 17, 1960 and is assigned to the assignee of the present invention.

Heretofore, in the manufacture of such primary fuses, it has been fairly common practice to form the fuse link of a lead-silver alloy. An electrical connection between the fuse link and the primary winding of a transformer is conventionally made by manually assembling a threaded coupling between these two elements. An example of such a prior art manual coupling arrangement is shown in U.S. Pat. No. 3,187,146—Schraeder, which issued on June 1, 1965 and is assigned to the assignee of the present invention. These prior art structures and assembling techniques have some inherent disadvantages. A fundamental cause of some of the problems occurring with the use of such prior art devices is the presence of increasing amounts of structural vibration in distribution transformers due to the increasingly high overloads that these transformers are subjected to in present day distribution systems. In addition to the mechanical strains that are placed on both the fuse link and its connecting arrangement to the primary winding, severe stresses are imparted to these elements by the thermal cycling that inevitably attends the periodic overloading of distribution transformers.

Besides presenting a substantial maintenance expense, the failure of an expulsion fuse within a transformer due to either a rupture of the fuse link by vibration, or due to a disconnection or loosening of the electrical connector forming a circuit between the fuse link and the transformer primary winding, such outages are very undesirable due to the resultant loss of power on a segment of the distribution system served by the affected transformer. Therefore, to the extent possible, it is apparent that primary fuses for use in the protection of distribution transformers should be designed to be vibration resistant both in their fuse link structure and in the means used to support the fuse in operating position and to connect it to a transformer winding. At the same time, it is important to provide a fuse structure and fuse mounting means that is economical to manufacture and assemble in operating position.

Therefore, a primary object of the present invention is to provide a fuse and fuse support means that are economical to manufacture and assemble in operating position while at the same time being adapted to afford a vibration resistant assembly.

Another object of the invention is to provide a fuse and support therefore that is readily adaptable to rapid, high-torque connection with an air-driven connector fastener.

Still another object of the invention is to provide an expulsion fuse, that is adapted for immersion in the coolant of a transformer, with coolant-restricting baffle means that are operable to prevent distortion of the fuse interruption characteristics due to circulation of coolant through the fuse body.

A further object of the invention is to provide a primary expulsion fuse with a rigid support member that affords a readily accessible and easily employed means for making a vibration-resistant connection between the fuse link and a primary winding of a transformer.

Additional objects and advantages of the invention will become apparent from the description of it that follows taken in connection with the accompanying drawings.

SUMMARY OF THE INVENTION

In one preferred embodiment of the invention, an expulsion fuse having a rigid, insulating tubular housing, is provided with a rigid angle support member mounted adjacent to, and extending beyond, one end of the housing. A fuse link is connected between a terminal mounted at the other end of the fuse housing and a second terminal rigidly fixed on the angle supporting member. The support member also has a threaded stud mounted in fixed position on it adjacent the second terminal. The stud is adapted to have a threaded nut, or other suitable clamping means, driven onto it by an air-actuated wrench, thereby to readily effect a vibration-resistant electrical connection between the fuse link and an end of a transformer primary winding that is clamped in position around the stud by the clamping means. The fuse housing is provided with a baffle means that restricts the flow of coolant around the fuse link, thereby to prevent distortion of the interruption characteristics of the fuse, due to the flow of such coolant in response to cyclical heating of the fuse link.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side elevation view, partly in cross section, of a fuse and support therefor, constructed pursuant to the teaching of the invention, and shown with respect to a transformer bushing and associated portion of a transformer tank and some coolant with which the fuse and support means are adapted to be utilized.

FIG. 2 is an enlarged side elevation view, partly in cross section and partly in phantom, of the fuse and fuse support means illustrated in FIG. 1.

FIG. 3 is an end view of the fuse support means depicted in FIG. 2, omitting the related fuse structure and winding connector shown in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. 1 and 2 of the drawing, it will be seen that there is shown a fuse 1 having an integral fuse support 2 that is constructed according to the teaching of the present invention. More specifically, the fuse 1 comprises an elongated, tubular housing 3 that is formed of a suitable dielectric material, such as bone fiber or other conventional expulsion fuse housing materials that are designed to evolve arc extinguishing gases when exposed to an arc by the interruption of a fuse link therein. Threaded into fixed position on one end (3*a*) of housing 3 is a first fuse terminal 4. The fuse terminal 4 is formed of any rigid electrically conductive material, such as copper. A second electrically conductive fuse terminal 5 is mounted in fixed position adjacent the other end (3*b*) of housing 3. Pursuant to the invention, this second terminal 5 is mounted in fixed position on a rigid angle support member 6.

The support member 6 in the preferred embodiment of the invention is formed of flat steel plate stock into

a generally L-shaped configuration. The first leg portion 6*a* and second leg portion 6*b* of the L-shaped support member 6 are disposed at approximately a 90° angle to one another. Now, before explaining the preferred arrangement for mounting the angle support member 6, the remaining structure of the fuse 1 and its connection to support 2 will be described.

At this point, it need only be understood that the support member 6 is mounted in fixed position on the housing 3 adjacent the second end 3*b* thereof, and the second electrically conductive terminal 5 is mounted in fixed position on the angle support member 6. As best illustrated in FIG. 2, in the preferred embodiment of the invention, the second terminal 5 comprises a tubular connector 5*a* and a flat contact 5*b* that has a tongue 5*c* extending from it. Of course, it should be understood that in alternative embodiments of the invention the connector 5 could be formed so that the flat contact portion 5*b* is integral with the terminal-receiving tubular portion 5*a*.

A fuse link 7 that may be formed of copper wire or other conventional vibration-resistant fuse link material is disposed at least partially within a passageway 8 that is defined by wall means 9 through the fuse body 3 from one end (3*a*) to the other end (3*b*) thereof. As best seen in FIG. 3, the fuse link 7 is electrically and mechanically connected to both the first terminal 4 and the second terminal 5 to form a fusible conductive circuit between them.

Referring again to FIG. 1, it will be noted that the fuse 1 is mounted in a conventional operating position where it is partly immersed in a body of transformer oil or other well known liquid coolant 10 within the steel housing 11 of an electric-power distribution transformer. Moreover, the first terminal 4 of the fuse 1 is staked onto one end of an elongated rod 12 that is made of copper, or other suitable material and forms an electrical circuit from the terminal 4 to a line terminal 13 mounted on the top of a transformer bushing 14. The other terminal 5 of fuse 1 is electrically connected by conductor 15 to a primary winding (not shown) of the transformer housed in the tank 11. Before describing the structure used to effect this connection to the primary winding of the transformer, it should be understood that the fuse housing 3 is provided with a vent hole 3′ through which some of the liquid coolant 10 can enter the housing 3 and surround the fuse link 7.

Now, reference is again made to FIG. 2 of the drawing to describe the novel features of the invention in greater detail. First, it should be appreciated that the first leg 6*a* of support member 6 must be fixed rigidly in position with respect to the housing 3 of fuse 1 so that vibration is not allowed to occur between the support means 2 and the housing 3 when current is passing through the transformer in transformer housing 11. Pursuant to the invention, such a rigid mounting arrangement for the support member 6 is provided by a second wall means 16 that defines an elongated slot 16*a* that is adapted to receive one leg (6*a*) of the support member 6 therein. The slot 16*a*, in this form of the invention, is formed to extend from the outside of one side of the housing 3 around at least the center portion of the passageway 8. In addition, a suitable holding means 17 is provided for retaining the leg 6*a* in a fixed position within the slot 16*a*. In this embodiment of the invention, the holding means 17 comprises an epoxy adhesive that may be of any suitable, well known type. The adhesive 17 used in the preferred embodiment of the invention is thermally cured at 125° C for approximately 1 hour, when it is positioned between a substantial portion of the leg 6*a*, as shown in FIG. 2, and the second wall means 16, so that it forms a rigid bond between these members and prevents movement between the support member 6 and the housing 3 of fuse 1.

As illustrated in FIG. 2, in the preferred form of the invention being described, a threaded stud 18 is mounted in fixed position on the angle support member 6 adjacent its outermost end. The stud 18 is formed of copper-coated steel or other suitable electrically conductive material, and it is mounted in fixed position on the support member 6 by being welded thereto. At least one threaded nut 19 is mounted on the stud 18 to clamp a conductor terminal 20 between it and the contact portion 5*b* of the second terminal 5 that is disposed adjacent the stud 18. Actually, in order to prevent the nut 19 from being vibrated loose on the stud 18, a second nut 21 is secured against it, as shown.

One feature of the invention is the provision of a terminal 5 tbat affords a convenient and economical means for forming a secure, vibration resistant connection between a transformer winding lead 15 and the fuse link 7 without damaging the relatively weak fuse link 7. Such a connection is made possible with the preferred embodiment by crimping the tubular connector 5*a*, as shown by the detent 5*d* therein, so that it secures one end 7*a* of fuse link 7 and the tongue 5*c* of contact 5*b* in electrically conductive relationship within the tubular connector 5*a*. This arrangement makes it possible to utilize an air-driven wrench to drive the nut 19 against the connector 20 on primary lead 15, and contact 5*b*, thereby to secure them in operating position. It has been found that a torque of up to 25 inch-pounds should be used in securing the nut 19 against the connector 20, in order to prevent the nut from being loosened by normal vibration encountered during the operation of the transformer housed in transformer housing 11. With the present invention, this torque can be applied without risk of damage to the fuse link 7.

Another important feature of this embodiment of the invention is the provision of a first tab 5*b*′ and a second tab 5*b*″ (See FIG. 3) on contact 5*b*. The tabs 5*b*′ and 5*b*″ are bent at least partially around the leg portion 6*b* of support 6, as shown in FIGS. 2 and 3. This arrangement of the tabs is effective to prevent the contact 5*b* from being twisted sufficiently to tear the tongue 56 when the nut 19 is driven into its clamping position. Of course, in some modifications of the invention, only one tab, e.g. the first tab 5*b*′, would be necessary to prevent the contact 5*b* from being rotated and torn during installation. However, in order to fully protect contact 5*b* during both an installation operation and a removal of nut 19, both tabs 5*b*′ and 5*b*″ are used in the preferred embodiment of the invention. In this form of the invention, the tabs are formed integrally with contact 5*b*, but it should be apparent that they may be articulated components, if desired.

As mentioned above, it should be understood that although the second terminal 5 is shown as an articulated contact 5*b* and tubular connector 5*a* in the embodiment of the invention disclosed herein, the second terminal 5 could be formed with a flat contact portion 5 and an integral, crimpable portion 5*a* that could be secured to one end 7*a* of the fuse link 7. Also, the flat

contact portion 5*b* of second terminal 5 may be formed to define an aperture 22 in it that is adapted to receive the stud 18 therethrough. This aperture could either be a U-shaped channel or a circular hole in the contact portion 5*b* of terminal 5.

Since the support member 6 must withstand both; a torque of up to 25 inch-pounds, applied to it when a nut 19 is threaded onto the stud 18 with an air-driven wrench, and the vibration forces encountered during normal installation within a transformer, it is constructed of flat steel that is approximately one-sixteenth of an inch thick by one-half of an inch wide. It should also be understood that the slot 16*a* in housing 3 is formed by milling a generally rectangular-shaped groove in the walls of housing 3 such that the slot 16*a* snugly engages the edges of leg portion 6*a* of support member 6. The tubular connector 5*a* of second terminal 5 is brazed to the support member 6; to facilitate the brazing, a copper coating is flashed on, or otherwise affixed to, the surface of it. Finally, in order to further protect the structure of fuse 1 from damage due to vibration, the first terminal 4 is prevented from rotating with respect to the housing 3 by upsetting the threads on terminal 4 as shown by detents 4*a* and 4*b*, in FIG. 2.

Another important feature of the present invention is the provision of a baffle member 23 mounted on the housing 3 around the fuse link 7 so that it substantially encloses one end of the passageway 8 through the housing. In the preferred form of the invention, the baffle member 23 comprises a substantially flat piece of insulating material, such as pressed fiberboard, and it has an aperture 24 formed in it for receiving the fuse link 7. Moreover, a suitable mounting means 25, which in the preferred form of the invention comprises a thermally-cured epoxy adhesive, is provided for holding the baffle member 23 in its fixed position. The aperture 24 is preferably a circular aperture slightly larger than the diameter of the fuse link 7, so that the walls of the aperture 24 serve to restrict the movement of the fuse link when the housing 3 is subjected to vibration. However, a narrow slot cut into the baffle member 23 from one side thereof has been found to be suitable. The primary purpose of baffle member 23 is not as a vibration damping means, but rather to restrict the flow of the liquid coolant 10 around the fuse link 7. It has been found that during relatively low overcurrent conditions, when the fuse link might take 20 to 25 seconds to interrupt, the resultant convection currents within the coolant 10 in fuse housing 3 can cause an appreciable circulation of the coolant 10, which results in an unpredictable variation in the interrupting characteristics of the fuse link 7. Therefore, the novel function of the baffle member 23 is to prevent or limit such circulation and thus avoid such a variation in the interrupting characteristics of the fuse link 7.

Those skilled in the art will understand that various modifications and extensions of the invention can be made from the teaching of it that is presented herein; therefore, it will be understood that the true spirit and scope of my invention is intended to be defined by the appended claims.

What I claim and desire to secure by Letters Patent of the United States is:

1. A fuse and support therefor, comprising, in combination;
   - a fuse housing formed of an elongated rigid body of insulating material,
   - wall means defining a passageway through said body from one end to the other end thereof,
   - a first electrically conductive terminal mounted in fixed position on said housing adjacent a first end thereof,
   - a rigid angle support member mounted in fixed position on said housing adjacent a second end thereof,
   - a second electrically conductive terminal mounted in fixed position on said angle support member and comprising a tubular connector and a flat contact having a tongue extending therefrom, and
   - a fuse link disposed at least partially within said passageway and electrically and mechanically connected to said first and second terminals to form a fusible, conductive circuit between them,
   - said tubular connector being crimped around said tongue and one end of said fuse link thereby to secure them in fixed, electrically conductive relationship with said tubular connector.

2. An invention as defined in claim 1 wherein both said tubular connector and said flat contact are formed of electrically conductive copper, and wherein said angle support member is formed of steel, said tubular connector being mounted in fixed position on said angle support member by being brazed thereto.

3. A fuse and support therefor, comprising, in combination;
   - a fuse housing formed of an elongated rigid body of insulating material,
   - wall means defining a passageway through said body from one end to the other end thereof,
   - a first electrically conductive terminal mounted in fixed position on said housing adjacent a first end thereof,
   - a rigid angle support member mounted in fixed position on said housing adjacent a second end thereof,
   - a second electrically conductive terminal mounted in fixed position on said angle support member and comprising a tubular connector and a flat, apertured, contact portion having a tongue extending from one side thereof, and
   - a fuse link disposed at least partially within said passageway and electrically and mechanically connected to said first and second terminals to form a fusible, conductive circuit between them,
   - said tubular connector being crimped around said tongue and one end of said fuse link thereby to secure them in fixed, electrically conductive relationship within said tubular connector and said stud being positioned through the aperture.

4. An invention as defined in claim 3 including a baffle member mounted on said housing around the fuse link thereby to substantially close one end of the passageway through said housing.

5. A fuse and support therefor, comprising, in combination;
   - a fuse housing formed of an elongated rigid body on insulating material,
   - wall means defining a passageway through said body from one end to the other end thereof,
   - a first electrically conductive terminal mounted in fixed position on said housing adjacent a first end thereof,
   - a rigid angle support member mounted in fixed position on said housing adjacent a second end thereof,

a threaded stud mounted in fixed position on said angle,

a second electrically conductive terminal mounted in fixed position on said angle support member, said second electrically conductive terminal being formed with a first tubular portion and a second flat contact portion including wall means defining an aperture through it, said aperture being adapted to receive said stud therethrough,

a fuse link disposed at least partially within said passageway and electrically and mechanically connected to said first and second terminals to form a fusible, conductive circuit between them,

said stud being positioned through the aperture in said second portion, said first tubular portion being electrically connected to said fuse link.

6. A fuse and support therefor, comprising; a tubular, dielectric housing having wall means defining a passageway through it, a first terminal mounted in fixed position on one end of said housing, second wall means defining a slot in said housing adjacent the other end thereof, said slot being formed to extend from the outside of one side of the housing around at least the center portion of said passageway, a rigid angle support member having a first and a second leg portion, a second terminal, the first leg portion of said angle support member being positioned in said slot and the second leg portion of said support member being arranged to support the second terminal in fixed position with respect to said housing, a stud mounted on said second leg portion, said stud being adapted to have a conductor clamped in fixed position with respect thereto, thereby to hold said conductor in electrically conducting relationship with said second terminal, and a fuse link electrically connected between said first and second terminals.

7. An invention as defined in claim **6** including a baffle member of dielectric material mounted over said other end of said housing, around said fuse link, thereby to substantially seal said other end of the housing.

8. An invention as defined in claim **7** wherein said first terminal member is threaded into said one end of the housing thereby to seal said one end.

9. An invention as defined in claim **6** wherein said second terminal (**5**) comprises a contact (*5b*) having a first tab (*5b'*) thereon, said tab (*5b'*) being disposed at an angle to said contact and in engagement with one side of said support member (**6**) thereby to prevent the contact from being rotated relative to said support member.

10. An invention as defined in claim **9** wherein said contact (*5b*) is generally flat and includes a second tab (*5b''*) thereon that is disposed at an angle of approximately 90° to the plane in which said contact (*5b*) is disposed, said first tab (*5b'*) and said second tab (*5b''*) being positioned adjacent opposite sides of said support member (**6**), respectively, thereby to prevent said contact (*5b*) from being rotated with respect to said support member (**6**).

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