An improved electrical conductor of the type having spaced, oblique louvers resiliently mounted on a pair of spaced strips and adapted for making bridging electrical contact between a pair of electrically conducting terminals, such as a pair of current-carrying buss bars, having means for drawing the same together. Means coupled with the conductor is provided for determining the minimum distance between the terminals. In a preferred embodiment, the conductor is circular in configuration and the louvers are radially disposed. One form of the determining means includes a pair of continuous inner and outer peripheral flanges integral with the body of the conductor, the flange width being less than the latterly projected width of the louvers. In another form of such means, a pair of spacers are provided for the inner and outer peripheries of the conductor, the spacers being either separate from or attached to the conductor body.

9 Claims, 6 Drawing Figures
ELECTRICAL CONDUCTOR WITH STANDOFF MEANS

This invention relates to improvements in the making of electrical connections between a pair of current-carrying devices and, more particularly, to an electrical conductor for placement between a pair of separable electrical terminals to enhance the electrical contact therebetween.

BACKGROUND OF THE INVENTION

In U.S. Pat. No. 3,453,587, a tubular electrical connector is disclosed wherein a plurality of generally parallel vanes or louvers are integral with and are resiliently connected in angled relationship to a pair of spaced, circular strips. The connector is constructed so that it can be inserted into the sleeve of a connector of the type utilizing a jack receivable within the sleeve. Generally, the plug will be dimensioned such that, when it is inserted in the sleeve, it will engage the louvers and compress the same, yet the louvers will also make electrical contact with the sleeve. Thus, the louvers assure that intimate electrical contact is made between the sleeve and the plug. When the plug is removed, the louvers return to their initial positions due to the resilient contact thereof with the two strips.

Other modifications of the type of connector described include a generally flat conductor having a plurality of such vanes of louvers resiliently secured to a pair of parallel side strips. Such a flat conductor is suitable for use between a pair of terminals having flat working surfaces in which case, the louvers bridge the working surfaces and enhance the electrical contact therebetween.

Oftentimes, the two terminals are constructed so that they are relatively shiftable toward and away from each other and are interconnected by a fastener, such as a screw freely movable through one of the terminals and threadably connected to the other terminal. By rotating the screw in one direction, the terminals can be moved toward each other and into electrical contact with each other. Such contact may be less than that which is desired because of surface defects of the terminals. Thus, better electrical contact between the terminals should be established to minimize or eliminate energy losses at the terminals themselves.

SUMMARY OF THE INVENTION

The present invention is directed to a conductor for use with a pair of relatively shiftable electrical terminals of the type having fastener means for drawing the same together. To this end, the conductor of this invention is provided with a plurality of spaced, angled, resilient vanes for making electrical contact with the working surfaces of the terminals and further includes means thereon for limiting the distance between the terminals as the latter are drawn toward each other when the connector is disposed therebetween. Thus, the limiting means assures that the terminals can be brought together to provide for the necessary electrical contact therebetween, yet the louvers of the connector will make the desired electrical contact with the working surfaces of the terminals without being deflected so much as to cause a permanent set in the louvers.

In one embodiment, the invention comprises a circular connector having radial louvers and generally continuous inner and outer peripheral flanges for engaging the working surfaces of the two terminals as the terminals are drawn together by the fastener means. The flanges, therefore, provide stops which determine the minimum distance between the terminals. Accordingly, the louvers of the connector will be in proper bridging electrical contact with both terminals yet the louvers will be protected against structural damage.

In another embodiment of the invention, the connector is circular and has radial louvers and further includes generally flat inner and outer peripheral surfaces. An inner spacer engages the inner surface of the connector and an outer spacer engages the outer peripheral surface of the connector. The two spacers have the same thickness and serve to provide stops to determine the minimum distance between a pair of terminals when the connector is positioned therebetween. The spacers can be attached to or separate from the connector.

The connector of this invention can have other configurations, such as rectangular, or the like. The flanges and spacers can be continuous or comprised of a number of spaced segments. Also, the flanges can be integral with the connector itself so that the conductor and the flanges can be formed simultaneously in a suitable manufacturing operation, such as a stamping process.

Terminals with which the invention is usable can be of any construction, such as flat bars wherein one is stationary and the other movable or both can be stationary or both movable. If movable, a terminal can be rotatable or can be capable of straight-line movement. The connector of this invention can electrically bridge the gap between any two electrical conducting devices wherein transfer of electricity is required.

The primary object of this invention is to provide an improved electrical connector for use with a pair of electrical terminals of the type having fastener means for drawing the same toward each other, wherein the connector has spaced, angled, resilient louvers and a lateral projection adjacent to the louvers so that, when the connector is disposed between the terminals and the terminals are drawn together by the fastener means, the louvers will move into electrical contact with the working surfaces of the terminals and the projection means will limit the travel of the terminals toward each other so as to assure that the louvers will not be excessively deflected and thereby damaged.

Another object of this invention is to provide a connector of the type described wherein the connector is circular in configuration and the projection means comprises inner and outer peripheral flanges on opposed sides of the louvers so that the flanges engage the working surfaces of the terminals yet allow the louvers to be deflected sufficiently to assure proper electrical contact between the terminals without compressing the terminals to the extent of causing a permanent set therein.

A further object of this invention is to provide a connector of the aforesaid character wherein the connector is circular in configuration and the projection means comprises inner and outer peripheral spacers for limiting the distance by which a pair of terminals used with the connector can be brought together yet allow sufficient electrical contact between the louvers and the terminals.

Other objects of this invention will become apparent as the following specification progresses, reference
being had to the accompanying drawings for an illustration of the invention.

In the drawings:
FIG. 1 is a side elevational view of a preferred embodiment of the connector of this invention, only a limited number of louvers being shown to simplify the figure.
FIG. 2 is an enlarged, cross-sectional view taken along line 2—2 of FIG. 1.
FIG. 3 is an end elevational view of a pair of terminals having fastening means for drawing the same together, illustrating the use of a pair the connectors of the present invention between the working faces of the terminals;
FIG. 4 is a fragmentary, perspective view of the connector showing the inner and outer peripheral standoff flanges thereof;
FIG. 5 is a view similar to FIG. 1 but showing another form of the connector; and
FIG. 6 is an enlarged, cross-sectional view taken along line 6—6 of FIG. 5.

A preferred embodiment of the connector of this invention is broadly denoted by the numeral 10 and comprises a body 12 of metal, such as beryllium copper or the like. Body 12 is circular in configuration and has a central hole 14 therethrough formed by a continuous inner peripheral flange 16 integral with a first circular strip 18 (FIG. 2), the latter being integral with a second circular strip 20 but in a different plane therefrom.

Body 12 further includes a third circular strip 22 spaced outwardly and surrounding strip 20 and a fourth circular strip 24 integral with strip 22 and having a diameter greater than the diameter of strip 22. Strips 18 and 20 form a first pair of interconnected, circular, concentric strips, and strips 22 and 24 form a second pair of interconnected, circular, concentric strips surrounding the first strips 18 and 20. As shown in FIG. 2, strips 20 and 22 are in a first plane and strips 18 and 24 are in a second plane substantially parallel with the first plane. A continuous outer peripheral flange 26 is integral with strip 24 and is concentric with and of the same width as flange 16.

Body 12 has a plurality of electrically conducting, angled louvers 28 which span the distance between and are integral with strips 20 and 22. Each louver 28 has a pair of opposed terminal-engaging side margins 30 and 32 (FIG. 2) and is resiliently mounted on strips 20 and 22 so that the louver can be deflected or rotated about its central axis 34 when side margins 30 and 32 engage working surfaces of a pair of terminals 36 and 38 in a manner to be described. Louvers 28 are, therefore, substantially radial with respect to the central axis 40 (FIG. 1) of body 12 and the louvers surround axis 40 although FIG. 1 merely shows a limited number of louvers, the concentric dashed lines 42 and 44 representing the end boundaries of omitted louvers to simplify FIG. 1.

Flanges 16 and 26 are substantially symmetrical with respect to center line 34 of each louver 28. Moreover, side margins 30 and 32 of each louver 28 projects outwardly a distance from center line 34 greater than the distance by which flanges 16 and 26 project outwardly from such center line. This is illustrated in FIG. 2, the flanges being shown with flat side faces 46 and 48 at one side of body 12.

Terminals 36 and 38 can be of any construction, such as a pair of plates or bus bars. The terminals are interconnected by a pair of spaced fasteners 50 and 52, with each fastener comprising a machine screw having a head 54 and a threaded shank to which a nut 56 is coupled. The terminals are adapted to be moved toward each other when the nuts are rotated in one direction on the shanks.

For purposes of illustration, a pair of connectors 10 are shown between the flat working faces 58 and 60 (FIG. 3) of terminals 36 and 38, respectively. The shanks of fasteners 50 and 52 extend through the central holes 14 of the two connectors. FIG. 3 illustrates the operative positions of terminals 36 and 38 with connectors 10 therebetween. In such operating condition, the curved side margins 30 and 32 of louvers 28 of each connector 10, make electrical contact with working surfaces 58 and 60. Moreover, side faces 46 and 48 of flanges 16 and 26 engage working surface 58 of terminal 36; whereas, the outer flat faces of side strips 18 and 24 engage working surface 60 of terminal 38. Thus, flanges 16 and 26 of each connector 10 define standoff means limiting the travel of terminals 36 and 38 toward each other as nuts 56 are tightened onto the shanks of fasteners 50 and 52. Thus, the flanges determine the minimum distance by which terminals 36 and 38 are separated from each other so that louvers 28 are not excessively deflected through a distance which would otherwise cause structural damage thereto and provide a permanent set in the louvers. Since the louvers project laterally from body 12 a greater distance than flanges 16 and 26, proper electrical contact between the louvers and terminals 36 and 38 is assured even though flanges 16 and 26 provide stops for preventing further movement of terminals 36 and 38 toward each other after a predetermined minimum distance has been reached between the terminals. This minimum distance, determined by the width of flanges 16 and 26, is selected to assure the proper contact between the louvers and the terminals, yet permits the louvers to return to their original, unsprung positions when the terminals are separated from each other.

While body 12 has been shown as being circular in configuration, it can have other configurations as well. For instance, it can be rectangular. Also, it can be formed in a suitable stamping process to minimize production costs. In such a stamping process, flanges 16 and 26 are formed simultaneously with the formation of the other parts of body 12. Also, flanges 16 and 26 need not necessarily be continuous. They can be formed of spaced flange segments if desired, only criterion being that they serve to limit the movement of terminals 36 and 38 toward each other as they are drawn together by fasteners 50 and 52.

While only a single annular group of louvers has been shown, two or more such annular groups in concentric relationship could be provided for body 12. In each group, the louvers would be resiliently mounted to adjacent annular bands surrounding the central axis of body 12 and the louvers would essentially be radial with respect to the central axis.

A feature of the present invention is that the resiliency of the louvers of body 12 compensates for expansion and contraction of the terminals with which the invention is used even though the terminals are of different metals. For instance, one of the terminals could be of copper and the other of aluminum. Thus, even if one terminal expands or contracts differently from the other terminal, the louvers will be maintained in good
electrical contact at all times, thus assuring maximum energy transfer between the terminals notwithstanding their dissimilarities. The resiliency of the louvers also assures good electrical contact without the need for large torques. Furthermore, the louvers can be of different configurations, such as straight or curved to form an “S” configuration. Also, the louvers can have sharp edges so as to scrape adjacent terminals surfaces, thus maintaining the proper electrical contact at all times.

Another form of the invention is illustrated in FIGS. 5 and 6 and comprise a connector assembly 70 having a body 72 of metal, the body being substantially of the same construction as that of body 12 (FIGS. 1–4) except that body 72 does not have flanges 16 and 26 thereon. To this end, body 72 includes a plurality of spaced, radially disposed louvers 74 which are angled with respect to the plane of the body as shown in FIG. 6. Body 72 includes an inner peripheral strip 76 and an outer peripheral strip 78, louvers 74 spanning the distance between and being resiliently mounted on and integral with strips 76 and 78. The inner periphery of strip 76 defines an opening 80 into which a first spacer 82 is received. The spacer has a stepped cross section in the manner shown in FIG. 6 so that it can support strip 76 when spacer 82 extends into opening 80. For purposes of illustration, spacer 82 has a central opening 84.

An outer, annular spacer 86 is provided for supporting strip 78. To this end, spacer 86 has a stepped cross section as shown in FIG. 6, it being clear that strips 76 and 78 are flat as are the strip-engaging surfaces of the stepped portions of spacers 82 and 86.

Spacers 82 and 86 have flat, outer surfaces and are of the same thickness, namely, a thickness greater than the thickness of strips 76 and 78 but less than the normal lateral projected width of louvers 74 as shown in FIG. 6. Thus, when a pair of terminals 88 and 90 are brought together, louvers 74 engage the inner surfaces of the terminals and are deflected until the flat, outer surfaces of spacers 82 and 86 engage the terminals. At this point, the louvers are not compressed to the extent that they are permanently deformed. Thus, when the terminals are separated from each other, the louvers will return to their normal, equilibrium positions as shown in FIG. 6.

The outer surfaces of spacers 82 and 86 can have other configurations if such are desirable. It is only necessary that they be operable to provide the necessary stops for preventing further movement of terminals 88 and 90 toward each other after the separation of the terminals has reached a minimum value.

I claim:

1. An electrical conductor comprising a circular body of electrically conducting material, said body having a central hole therethrough, a first pair of circular strips surrounding the hole, a second pair of circular strips surrounding and being spaced from the first pair of strips, each pair of strips including an inner strip and an outer strip, and a plurality of louvers spanning the distance between the first and second pairs of strips, the louvers being at acute angles relative to said strip pairs and being substantially radial to the central axis of the hole; a continuous lateral flange integral with the inner strip of the first pair, whereby the flange surrounds the hole; and a second flange integral with the outer strip of the second pair, the inner strip of the first pair and the outer strip of the second pair being in a first plane, the outer strip of the first pair and the inner strip of the second pair being in a second plane parallel to the first plane, each louver projecting outwardly in opposed directions from the second plane through a predetermined distance, the width of each flange being less than two times the distance, whereby the louvers will engage the working surfaces of a pair of terminals when the connector is disposed therebetween before the flanges engage said working faces.

2. An electrical conductor comprising: a circular body of electrically conducting material, said body having a central hole therethrough, a first annular strip surrounding the hole and a second annular strip spaced from and surrounding the first strip, and a plurality of louvers spanning the distance between the first and second strips, the strips being flat and substantially coplanar, the louvers being at acute angles relative to said strips and being substantially radial to the central axis of the hole; and a pair of spacers, one of the spacers being provided for the inner periphery of the body and the other spacer being provided for the outer periphery thereof, each spacer having an annular stepped portion engageable with a respective strip, said one spacer extending through said central hole, each spacer having a pair of opposed, generally flat, outer, terminal- engaging surfaces with the distance between said outer surfaces of each spacer being less than the normal projected distance of the louvers laterally of the plane of the strips.

3. An electrical conductor comprising: a body having a circular configuration, a central hole therethrough, and being formed of electrically conducting material, said body having a pair of spaced strips and a number of spaced, electrically conducting louvers resiliently mounted on the strips and extending at an acute angle with respect thereto, said body adapted to be disposed between a pair of electrically conducting terminals moveable toward and away from each other with the louvers being engageable with the terminals; and an inner peripheral flange and an outer peripheral flange, said flanges being coupled with the body and projecting laterally therefrom with the inner flange surrounding said hole and the outer flange surrounding said inner flange, the flanges being operable for limiting the movement of the terminals toward each other when the connector is disposed therebetween.

4. A connector as set forth in claim 3, wherein said flanges are continuous and are provided with respective flat, outer terminals-engaging faces at one side of the body.

5. A connector as set forth in claim 3, wherein the body includes a pair of spaced, concentric strips, the louvers being integral with and spanning the distance between the strips, said flanges being integral with the strips in spaced relationship to respective ends of the louvers.

6. An electrical conductor comprising: a body of electrically conducting material, said body having a first pair of interconnected, circular strips and a second pair of interconnected, circular strips surrounding the first strips, one of the strips of each pair having a diameter greater than that of the other, adjacent strip; a number of spaced, electrically conducting louvers being resiliently mounted on, integral with and spanning the distance between the outer strip of the first pair and the inner strip of the second pair, the louvers
extending at an acute angle with respect to the strips, the outer strip of the second pair being coplanar with the inner strip of the first pair and the inner strip of the second pair being coplanar with the outer strip of the first pair, said body adapted to be disposed between a pair of electrically conducting terminals movable toward and away from each other with the louvers being engageable with the terminals; and means coupled with the body and projecting laterally therefrom for limiting the movement of the terminals toward each other when the connector is disposed therebetween.

7. An electrical conductor comprising: a body of electrically conducting material, said body having a pair of spaced strips and a number of spaced, electrically conducting louvers resiliently mounted on the strips and extending at an acute angle with respect thereto, said body adapted to be disposed between a pair of electrically conducting terminals movable toward and away from each other with the louvers being engageable with the terminals; and a pair of spacers coupled with the body and projecting laterally therefrom for limiting the movement of the terminals toward each other when the connector is disposed therebetween, one of the spacers being at the inner periphery of said body and the other spacer being at the outer periphery of the body, each having a thickness greater than that of said strips but less than the normal projected distance of the louvers laterally of the strips, each spacer having a stepped portion engageable with a respective strip.

8. A connector as set forth in claim 7, wherein said spacers are connected to respective strips.

9. A connector as set forth in claim 7, wherein the spacers are separable from respective strips.