A unitary connector particularly suitable for high amperage applications is disclosed. It provides high density of smaller conductor connections per length of connector. A preferred embodiment facilitates visual inspection of all connections for confirmation of the completeness and security of such connections. The connector can be made from a single metal extrudate and current passes through the integral connector without passing across butting interfaces between elements within the connector assembly.

8 Claims, 4 Drawing Figures
3,725,851

1

CONNECTOR FOR HIGH AMPERAGE APPLICATIONS

This invention relates to distribution of electrical power to a plurality of branch circuits and particularly pertains to a unitary connector for electrically connecting a plurality of conductors to a common potential. The connectors of the present invention are suitable for use as feeder bars, neutral junction connections, and the like, in power distribution systems involving relatively high amperage, such as for example, 100 amps and higher.

It is an object of the present invention to provide a unitary electrical connector which is relatively inexpensive to manufacture, which is suitable for use in high amperage applications, and which does not involve the use of butting interfaces within the connector assembly across which the current would pass. It is another object of the present invention to provide such a unitary connector which can not only accommodate relatively large supply or ground conductors, but moreover can accommodate a relatively high density of smaller conductors per length of connector face for feeding a plurality of individual loads.

It is another object of a preferred embodiment of the present invention to provide a connector which facilitates visual inspection of the unit after all electrical connections are made for confirmation that each of the electrical connections is completed and secure.

These and other objects are all achieved in accordance with the present invention which is described herein and with the aid of the accompanying drawings in which:

FIG. 1 is a perspective view of a preferred embodiment of the present invention;
FIG. 2 is an end elevational view taken from the left of FIG. 1;
FIG. 3 is a cross sectional view taken approximately along the lines 3—3 of FIG. 2; and
FIG. 4 is a top view of an alternative embodiment of the present invention.

In FIG. 1 a unitary metal connector in accordance with the present invention is generally indicated by the numeral 10. Connector 10 comprises a unitary integral segment 11 of metal, such as a segment of metal extrudate, securing means for electrically connecting a plurality of conductors thereto, and other important structural features. Connector 10 is secured by securing means, such as threaded fasteners 12, to an insulating support 14, and conventionally, is installed within a suitable box or cabinet (not shown because conventional).

In the illustrated embodiment a large conductor 16 is secured within a substantially circular opening 18 which passes through first enlarged portion 20 of connector 10. Conductor 16 is secured by compression in opening 18 by means of a set screw 22 (indicated by broken lines 24 in FIG. 1) which can be threaded within opening 26 which, in turn, communicates with opening 18.

First enlarged portion 20 of connector block 11 is connected to second enlarged portion 27 through relatively narrow central bridging portion 28. However, the gap between enlarged portions 20 and 27 is preferably sufficiently great to provide a line of sight over the top of portion 20 to the junction between bridge 28 and portion 27. This line of sight forms an angle of at least 10°, more preferably at least 20° with the adjacent part of portion 27. (See angle a, FIG. 3).

A number of smaller conductors 30, 31 such as for example feeder wires, are receivable in respective openings 32, 33 in second enlarged portion 27. As used herein, the numeral 30 is intended to indicate any of the conductors which are secured within one of the lower line of openings 32 (as viewed in FIG. 1) and 31 is intended to include any of the conductors affixed to any of the upper openings 33.

The conductors 30 of the lower tier are secured by compression in the respective openings 32 by respective set screws 34. Conductors 31 are secured by compression in their respective openings 33 by respective set screws 35. All conductors are pressed directly against the integral metal body of the connector 10. Set screws 34, 35 are threaded through respective tapped openings 36, 37 which are positioned to direct the respective set screws across the respective wire-receiving openings 32, 33.

It is noted that openings 32, 33 pass entirely through section 27. Although it is not essential that pass-through openings be employed, and "blind" openings of sufficient depth can be employed, it is preferred that all conductor-receiving openings pass through section 27. In such a most preferred embodiment, the completed system can be visually inspected for confirmation that the conductors in each of the respective openings has been inserted a sufficient distance to provide a complete and secure electrical connection. When pass-through conductor-receiving openings are employed, and when conductors are inserted sufficiently to cause the ends thereof to extend at least to the inner side 38 of enlarged portion 27, the completed assembled unit can be visually inspected by glancing down along side 38 to visually confirm the proper insertion of each of the conductors.

When "blind" conductor-receiving holes are employed, it is not uncommon for inadequate and incomplete insertion of the conductor to be encountered. In the high amperage applications to which the present invention primarily directs itself, the use of multiple strand cable is conventional. When such cable is inserted in the conductor-receiving openings, there is a tendency for some of the strands to jam against burrs, threads, etc., and give the impression that the conductor is completely inserted past the set screw. Tightening of the set screw under such circumstances may provide a very secure electrical connection. On the other hand, in accordance with the preferred embodiment of the invention, in which pass-through openings are utilized, and sufficient spacing is provided between the enlarged lateral portions to facilitate visual inspection, it will be immediately apparent whether the individual cables are completely and properly inserted for secure electrical connection.

Second enlarged portion 27 has a cross section (as seen in FIG. 3) resembling stairs, and comprises steps 40, 42. It is noted that, as shown in FIG. 3, the steps 40, 42 are so positioned that successive steps ascend as the first enlarged portion 20 is approached along a line drawn through the steps 40, 42 towards enlarged portion 20, such as for example, along a line proceeding in a direction from the left of FIG. 3 through second enlarged portion 27 towards first enlarged portion 20.
First step 40 includes a side face 44 through which openings 32 pass, and a top surface 46 through which openings 36 pass. The second step 42 includes a side face 48 through which openings 33 pass, and a top surface 50 through which openings 37 pass. Additional steps can be provided if desired.

Thus, in the embodiment illustrated in FIGS. 1, 2 and 3, a single large conductor 16 approaches connector 10 along a line from a first direction, and smaller conductors 30, 31 enter conductor 10 along parallel lines from the opposite direction, and current can pass directly through the connector block 11 without passing through butting interfaces such as those which would be encountered in a non-utility connector comprising a number of assembled elements.

As a consequence of the positioning of the enlarged portions 20, 27 on opposite sides of narrow central bridging portion 28, and providing openings along the sides of the connector 10 to accommodate and secure the conductors, and by arranging the connector 10 in such a manner for the smaller conductors along the steps 40, 42, relatively high density smaller conductor input is achieved along the length of enlarged portion 27. Moreover, as a result of this configuration, all the set screws 22, 34, 35 and threaded fasteners 12 are accessible from the same direction (i.e., from the top as viewed in FIG. 3) and this provides considerable convenience and facilitates safety during the course of installing or servicing the connector or the distribution system.

In the preferred illustrated embodiments, all conductors enter the connector through parallel lines into two opposite sides of the connector 10. However, the connecting means for the conductors could be arranged to accept conductors approaching from different directions, e.g., from the bottom, but this would involve changing the direction of approach of tools for adjustment of conductor-securing means.

In the embodiment illustrated in FIG. 1, eleven smaller conductors 30, 31 are accommodated along a length of the extrude which is not much greater than twice the diameter of the large conductor 16. As indicated above, more steps (not shown) which are substantially identical to steps 40, 42 can be provided adjacent step 42, in which case still smaller conductors could be accommodated by a connector having the same length.

In the embodiment illustrated in FIG. 4, a greater length of metal extrude is employed to provide a connector 55 which is suitable for higher amperage application even though it has a cross section which is substantially identical to that shown in FIG. 3. Connector 55 comprises a first enlarged portion 57, a central bridging portion 59, and a second enlarged portion 61. These and other elements are similar to the corresponding elements in the first described embodiment. For example, openings 63 are provided in the central bridging portion 59 to accommodate fasteners, for example threaded fasteners 12, to secure connector 55 to an insulating support. Large conductors 64 are admitted through openings 65 which are equivalent to openings 18 in the first described embodiment, and are secured therein by compression set screws 67. Smaller conductors 69 are received in pass-through or blind openings 70 corresponding to openings 32, 33 and are secured therein by set screws 71.

The embodiment illustrated in FIG. 4 is particularly useful for very high amperage applications. For example, for very high amperage applications, instead of utilizing extremely large diameter conductors, which are difficult to pull, bend, and install, it is more convenient to use a number of relatively small large cables which are easier to pull, bend and install, and yet provide the same current carrying capacity. One of these individual cables is indicated in FIG. 4 by the numeral 64.

In the embodiment shown in FIG. 4 the connector 55 can accommodate four such large conductors 64, and 27 smaller conductors 69.

The unitary metal piece 11 from which connector 10 is manufactured is a length of metal extrudate having a cross section shown in FIG. 3. The depth of the bridge portion 28 is chosen to amply accommodate anticipated current even though one or more passages 52 are provided in bridge portion 28 to accommodate threaded fasteners 12. In the preferred embodiment a metal extrudate is utilized, and the structural elements corresponding to first enlarged portion 20, bridging portion 28, and second enlarged portion 27 comprising steps 40, 42 are automatically produced during the extrusion. The extrudate metal after appropriate hardening treatment, if desired, is cut into appropriate lengths, and holes are drilled and tapped as desired. Alternatively, the holes can be drilled and tapped before the larger segments of extrudate are cut into operating segments 11.

Although any conducting solid metal can be used to make the conductor of the present invention, preferred metals are those metals having tensile strength greater than about 35,000 psi and a yield strength greater than about 25,000 psi. It is unnecessary to use an expensive material such as highly conductive silver in accordance with the present invention. Copper or aluminum can be employed, and other solid conducting metals can be used. A most preferred metal, however, is an aluminum alloy identified as AA 6061. This is a heat hardenable, extrudable aluminum alloy having approximately the following constituents in addition to aluminum:

- Silicon 0.4–0.8% (nominal 0.6%)
- Iron
- Copper
- Manganese 0.15–0.4% (nominal 0.25%)
- Magnesium 0.08–1.2% (nominal 1.0%)
- Chromium 0.15–0.35% (nominal 0.25%)
- Nickel
- Zinc
- Titanium
- Others

Physical characteristics of these and other alloys are described in Metals Handbook, Eighth Edition, Volume I, Properties and Selection, published by the American Society for Metals (See page 917 for description of Aluminum 6061). The preferred Aluminum 6061 is that metal which has been heat treated to provide a hardness identified as T-6. This metal has a yield strength of 37,000 psi and a tensile strength of 42,000 psi. Consequently, even though the electrical volume conductivity of this metal is only 40 percent IACS, the physical characteristics of this alloy, particularly the high strength and low cold flow, are believed to be factors contributing to its outstanding success when used in the connector of the present invention.
In illustrated embodiments of the present invention the enlarged side portions 20, 27 and 57, 61 are connected by relatively thin bridging portions 28 and 59 respectively, near the base thereof. These bridging portions 28, 59 can be eliminated, and the connector 10 secured to an insulating support by means of threaded fasteners, or other suitable means, extending through the insulating support into the bottom of connector 10. However, it is much more preferable to provide the narrow bridging portion since several additional advantages accrue as a result. For example, the presence of the gap above the bridging portion 28 or 59 between enlarged portions 20, and 27, or between enlarged portions 57 and 61, respectively, combined with the use of pass-through openings 18, 32, 33, 64, 70, assists the installer in visually confirming complete insertion of the conductors 16, 30, 31 within their respective securing openings 18, 32, 33. Thus, upon insertion of conductors 16, 30, 31 into their respective securing openings, until the respective conductor is visible at walls 38, or 78 above bridge portion 28 or 59, respectively, provides confirmation of the positioning of the respective smaller conductor that the necessary secure and complete electrical connection is made. Visual inspection of the completeness and security of the connection of the larger wires is also facilitated in the same way. Also, if a rivet is used as a securing means, the narrower section permits the use of a relatively short rivet.

In general, the structural relationships and spacings of the preferred connector of this invention is such that the line of sight over the top inner edge of the first enlarged portion receiving the large conductor forms an angle of at least 10° and preferably more than 20° with the bottom of the wall of the second enlarged portion (angle a, FIG. 3).

It will be appreciated that all of the laterally extending planes formed by the body 11, 56 such as for example, inner sides 38, 78, and sides 44, 48, which form vertical planes, and also horizontally extending surfaces such as for example, top surfaces 46, 50, and all the other laterally extending surfaces of the body, extend the entire width of the body, encountering no other transverse structural elements of body 11, 56. Thus, the topography or external surfaces of the general cross section of the body 11, 56, is substantially constant from end to end, except of course, for the conductor-receiving and set screw-receiving openings.

I claim:

1. A unitary connector comprising: an integral body portion consisting of a single piece of solid metal having two ends, and being shaped such that the topography of the general cross-section of the body is the same from end to end and providing a plurality of steps in said body, said general cross-section comprising first and second laterally positioned enlarged portions, said first and second enlarged portions being joined by an integral relatively narrow bridging portion; first recess means for axially receiving a large conductor through one side of said body, and first securing means for compressing said large conductor transversely against said body within said first recess means; and a plurality of second recess means for axially receiving respective smaller conductors through another side of said body, and second securing means for compressing said respective smaller conductors transversely to said body, said second recess means comprising sets of recess passing through respective parallel faces of said steps, and said second securing means passing transversely to said conductors through respective tops of said steps, said first enlarged portion including said first recess means, and said first securing means, said second enlarged portion including said second recess means and said second securing means.

2. A unitary connector of claim 1 in which adjacent opposing sides of said first and second enlarged portions are spaced apart from each other a sufficient distance that a line of sight over the top edge of said first enlarged portion to the juncture of the narrow bridging portion and the adjacent opposing side of the second enlarged portion forms an angle of at least 10° with said opposing side; and wherein said first and second recess means comprises passageways passing through respective first and second enlarged portions and opening at said opposing sides of said enlarged portions.

3. The connector of claim 2 in which a line of sight passing over the top of the first enlarged portion forms an angle greater than 20° with said opposing side of said second enlarged portion.

4. The connector of claim 2 wherein said steps are so positioned as to ascend towards said first enlarged portion.

5. The connector of claim 2 in which said first enlarged portion includes a plurality of first recess means and first securing means for receiving and securing a plurality of respective large conductors.

6. A unitary connector particularly suitable for high amperage applications comprising: an integral body consisting of a single piece of solid metal, having two ends and a cross section with uniform external shape from said end to said end, said body comprising first and second enlarged lateral portions connected by a relatively narrow integral bridging portion disposed between the bases of the lateral portions whereby the opposing sides of said first and second lateral portions are spaced apart; first recess means for receiving a large conductor, and first securing means and compressing said large conductor in said first enlarged portion of said body; said second enlarged portion being shaped to include at least a portion thereof which has a cross section in the form of steps wherein a first surface of the steps is parallel with said opposing side of said first enlarged portion, and a second surface of the steps is in a plane which is transverse to the first step surface; said second recess means comprising a plurality of recesses passing completely through said second enlarged portion, said recesses being sized for receiving smaller conductors, said pass-through recesses opening in said opposing surface of said second enlarged portion.

7. The connector of claim 6 in which said opposing sides of said second enlarged portion is spaced apart from an opposing side of said first enlarged portion by a distance sufficient to provide a line of sight over the top of said first enlarged portion to the juncture between the opposing side of said second enlarged portion and said bridging portion, which line forms an angle of at least 10° with said opposing side.

8. The connector of claim 6 wherein said first enlarged portion includes a plurality of recess and securing means for receiving large conductors.

* * * *