United States Patent [19]

Izraeli

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[54] **ELECTRICAL CONNECTOR WITH RESILIENT PRESSURE PAD**

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[73] Assignee: **Thomas & Betts Corporation,** Elizabeth, N.J.

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[21] Appl. No.: **376,601**

[52] **U.S. Cl.** ..... **339/95 R,** 339/272 R

[51] **Int. Cl.** **H01r 11/20**

[58] **Field of Search** 339/95, 97, 272

[56] **References Cited**

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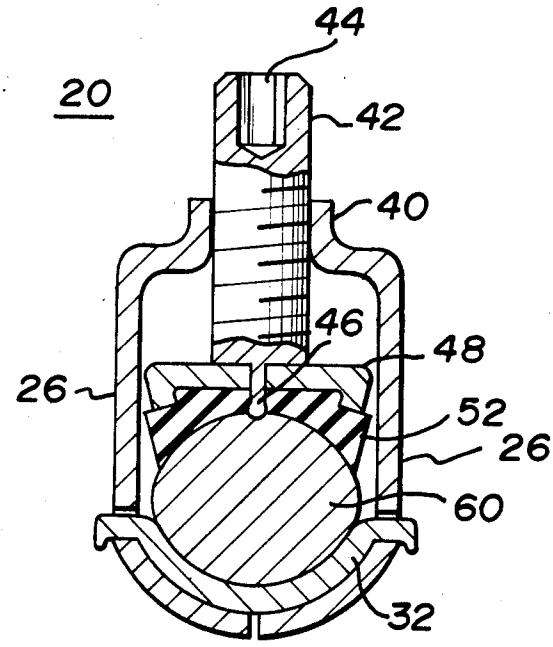
Attorney, Agent, or Firm—David Teschner; Jesse Woldman

[57] **ABSTRACT**

The connector of the present invention is arranged to couple an electrical conductor to a terminal point and to compensate for the different coefficients of expansion between the connector and the conductor. A resilient pressure pad is added to the normal metallic pressure plate of a mechanically operated connector to force a conductor, placed within the connector, against a contact portion of the connector regardless of changes in the dimensions of the conductor and connector resulting from thermal expansion and contraction of the dissimilar metals. The connector consists of a tubular body for the receipt therein of an electrical conductor and a pressure plate, operated by a mechanical screw, to exert connecting pressure between the conductor and the connector body. A resilient pad member, added to the pressure plate, permits the connector to accommodate dimensional changes, while the coupling between the pressure plate and resilient pad member limits tightening of the connector to prevent destruction of the resilient pad member.

10 Claims, 11 Drawing Figures



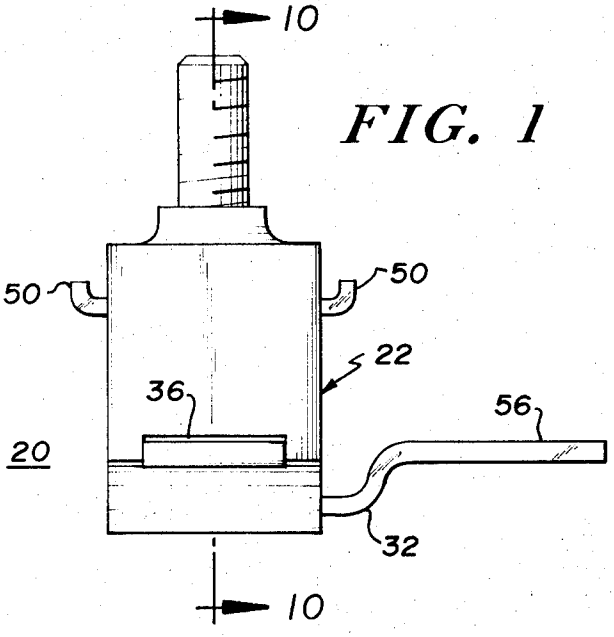


FIG. 1

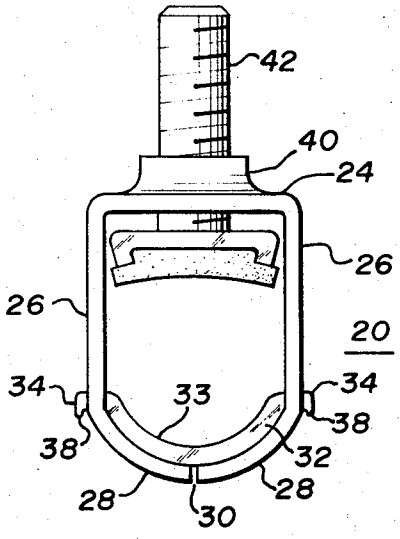


FIG. 2

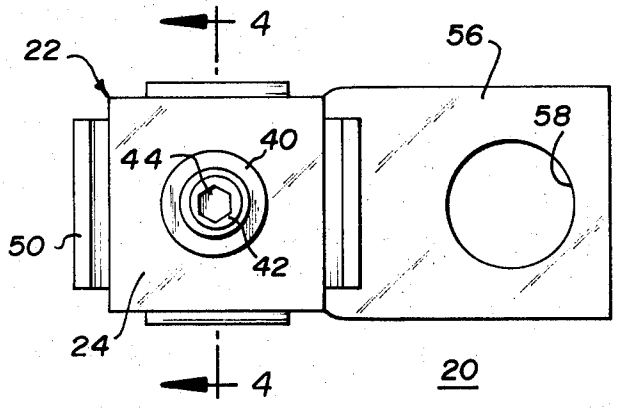


FIG. 3

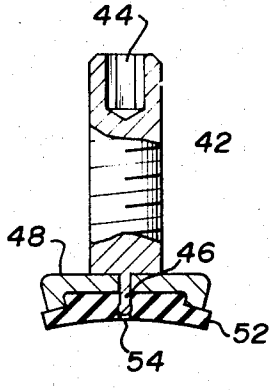


FIG. 4

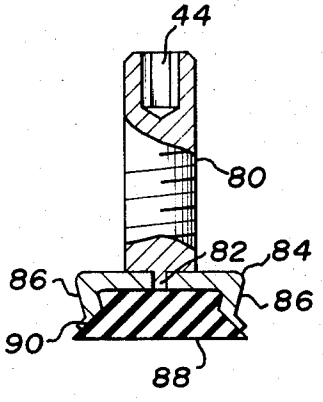


FIG. 5

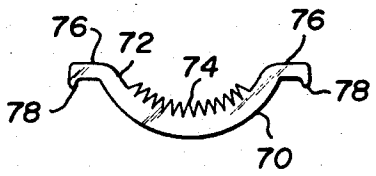


FIG. 6

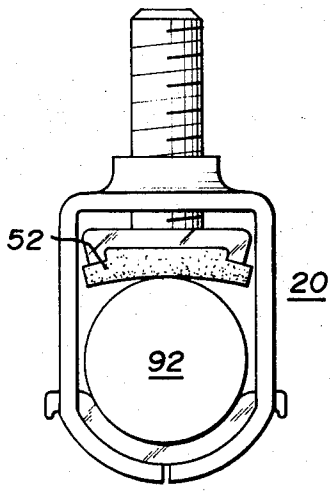


FIG. 7

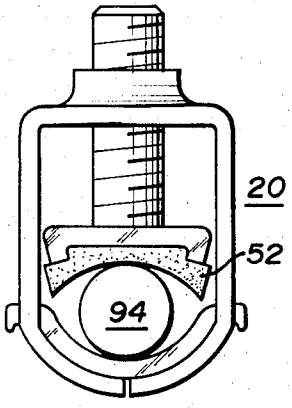


FIG. 8

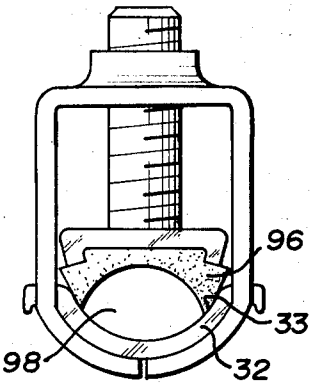


FIG. 9

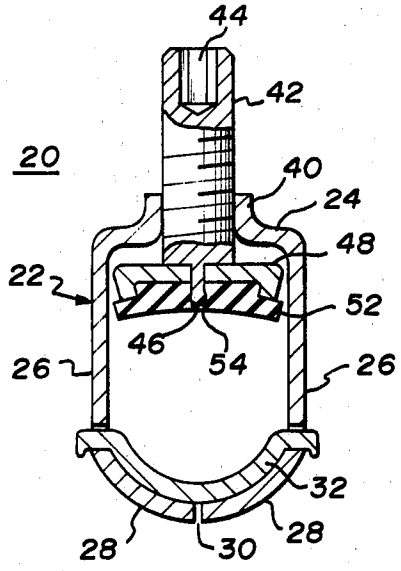


FIG. 10

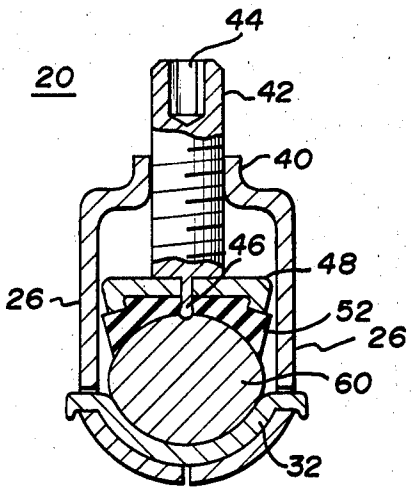


FIG. 11

ELECTRICAL CONNECTOR WITH RESILIENT PRESSURE PAD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention is directed to the field of connecting conductors to one another or connecting conductors to a connection point or terminal points such as a bus bar, transformer or the like.

2. Description of the Prior Art

Mechanically operated connectors of the type generally described herein have been employed for large sized conductors for many years. These connectors were fabricated from copper or copper alloys, in order to be employed with copper conductors. The relative rates of thermal expansion and contraction of the connector and conductor were the same due to the similarity of material used. Vibration of the joint did at times cause loosening of the mechanical clamping screw removing some of the pressure between the connector and conductor and thus degrading the joint. Pressure problems could usually be corrected by the use of a Belleville washer or the like to accommodate any loosening which might take place within the connector. However, with the introduction of aluminum conductors, attempts to use connectors fabricated of copper and copper alloys with such conductors were generally unsuccessful due to radically different rates of thermal expansion and contraction in the copper or copper alloys of the connector and the aluminum of the conductor. The normal heating and cooling of the conductor and connector, as a result of the cycling found in the electrical equipment, caused sufficient loosening of the connector to provide a very high resistance contact, commonly known as a "hot joint," which might ultimately lead to the destruction of the joint. In addition to the use of specially formed pressure plates, or the addition of Bellevile washers, it is also well known in the prior art to use specially formed connector bodies having deflectable sections to make up for expansion of the conductor. However, in each of these cases the introduction of the aluminum conductor produced such strain upon the existing connectors that they could no longer perform as needed, unless the connectors were very often inspected and retightened to desired torque levels.

SUMMARY OF THE INVENTION

The present invention overcomes the difficulties noted above with respect to prior art devices by providing a mechanically actuated connector which introduces a resilient pressure pad to the pressure plate of the connector to compensate for wide variations in the thermal expansion and contraction characteristics of the material of the connector and the material of the conductor. This is achieved by providing a resilient, elastomeric pressure pad on the pressure plate operated by the mechanical clamping screw of the connector and forcing the conductor into intimate contact with a portion of the connector body throughout the operation of the connector to permit changes in the pressure applied by the resilient pressure pad to accommodate differences in thermal expansion of the conductor with respect to the connector. To prevent overtightening of the mechanical clamping screw the pressure plate itself is fabricated with a protrusion which

engages the pressure pad and when fully tightened upon a conductor inserted within the connector, engages the surface of the conductor in such a manner as to prevent further tightening of the connector to the point where the pressure pad might be destroyed. Also, the protrusion engaging the conductor increases the mechanical strength of the joint and increases the pull-out forces required to remove the conductor from the connector. Further, by the inclusion of insulation and oxide piercing teeth to the lower, inner portion of the connector body, as the connection is made the oxide of the aluminum conductor is successfully broken through and contact is made between the connector and newly exposed material of the conductor to assure the best possible contact therebetween. It is therefore an object of this invention to provide an improved mechanically operated connector.

It is yet another object of this invention to provide an improved mechanically operated connector for aluminum conductors.

It is still another object of this invention to provide an improved mechanically operated connector fabricated of copper or copper alloy, for use with aluminum conductors.

It is still another object of this invention to provide an improved mechanically operated connector employing a pressure pad to compensate for difference in thermal expansion between the material of the connector and the material of the conductor to insure a good electrical and mechanical joint therebetween throughout the operation of the connector and the conductor.

It is yet another object of this invention to provide an improved mechanically operated connector having a resilient pressure pad having means for limiting torque applied to such pressure pad to a point below that which would destroy it.

It is yet another object of this invention to provide an improved mechanically operated connector for use with aluminum conductors having an insulation and oxide piercing portion thereon to insure a good mechanical and electrical joint between said conductor and said connector.

Other objects and features of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of invention, the principles of the invention and the best modes contemplated for carrying it out.

BRIEF DESCRIPTION OF THE DRAWING

In the Drawings:

FIG. 1 is a side elevation of a connector constructed in accordance with the concepts of the invention.

FIG. 2 is a front elevational view of the device of FIG. 1.

FIG. 3 is a top plan view of the device of FIG. 1.

FIG. 4 is an elevational view in section of the pressure plate and pressure pad of the device of FIG. 1.

FIG. 5 is a front elevational view of an alternative construction of a pressure pad and pressure plate.

FIG. 6 is a front elevational view of an alternative form of lug for use with the device of FIG. 1.

FIG. 7 is a front elevational view of the device of FIG. 1 applied to a conductor of large diameter.

FIG. 8 is a front elevational view of the connector of FIG. 1 applied to a conductor of small diameter.

FIG. 9 is a front elevational view of yet another connector constructed in accordance with the concepts of the invention applied to a small conductor.

FIG. 10 is a front elevational view, in section, of the device of FIG. 1 taken along the lines 10—10.

FIG. 11 is a front elevational view, in section, similar to that shown in FIG. 10 but shown applied to a conductor.

Similar elements are given similar reference characters in each of the respective figures.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning now to FIGS. 1, 2 and 3, there is shown a connector 20 constructed in accordance with the concepts of the invention. Connector 20 has a tubular body portion 22 consisting of a base portion 24 and two generally parallel extending legs 26 which terminate at inwardly turned ends 28. Inwardly turned ends 28 of the legs 26 are brought closely together to form an open seam 30 therebetween. Bridging the open seam 30 and extending across the inwardly turned ends 28 of the legs 26 is a lug 32 (see FIG. 2) whose ends 34 pass through slots 36 (see FIG. 1) within the parallel extending legs 26 of the body portion 22. Ends 34 are turned downwardly as at 38 to permit the retention of th lug 32 within the body portion 22. By using the body portion 22 formed in the manner just described and by bridging the open ends of seam 30 with a lug member such as 32 anchored to the side walls 26 of the body portion 22 it is possible to employ flat stock for the formation of the body portion 22 to avoid expensive castings, or drilling, or machining operations to form such a tubular body from solid stock. Base portion 24 has a raised boss 40 thereon internally threaded to receive a clamping screw 42 therethrough. Clamping screw 42 has a hexagonal recess 44 therein (see FIG. 3) for receipt of an appropriate tool, such as an Allen wrench, in order that the clamping screw 42 may be advanced or retracted with respect to the cavity within the tubular body portion 22. Although a hexagonal slot 44 is shown it should be understood that any other convenient shape, including a slot, may be employed to accept a tool to cause the advancing or retracting of the clamping screw 42.

At the lower end of the clamping screw 42, which is best seen in FIG. 4, is fabricated a protrusion 46 to which the pressure plate 48 is rotatably fastened. Forming the protrusion 46 with a bulbaceous end it is possible to slip the pressure plate 48 over the protrusion 46 and to cause it to be loosely retained thereby. Pressure plate 48 has upturned ends 50, as is best seen in FIG. 1, to help center pressure plate 48 with respect to the connector body portion 22. The protrusion 46 of the clamping screw 42 also extends into the central aperture 54 of the pad 52 and due to the resiliency of the pressure pad 52 it is maintained on the protrusion 46 although the protrusion 46 is free to move within central aperture 54 of the pressure pad 52. Also, this loose fitting arrangement of the protrusion 46 with the pressure pad 52 permits the pressure pad 52 to be replaced to provide pressure pads of other contours, if desired. In addition to retaining pressure pad 52 and the pressure plate 48 on the clamping screw 42, protrusion 46 will, as described below, serve the additional function of limiting the tightening of the clamping screw 42 in such a manner that the pressure pad 52 will not be distorted beyond its resilient limits and thereby render it incapable of functioning in the manner to be described below. As will be set forth below, the protrusion 46 is partly embedded into the conductor and as such aids in gripping the conductor, thus increasing the pullout strength of the conductor from the connector. Lug 32 is extended to a terminal tab 56 which has an aperture 58 therein for receipt therethrough of a terminal screw or similar fastening device. With the availability of such a terminal tab 56, connector 20 may be employed to connect a conductor to a terminal point on a bus bar or terminal block or similar device. However, if it is desired, terminal tab 56 may be omitted and connector 20 used to connect two or more conductors as a splice.

Turning now to FIGS. 10 and 11, the operation of the connector 20 will be better appreciated. In FIG. 10 there is shown a front elevational view, in section, of the connector in the fully open position so that the relative positions of the component portions of the connector 20 may be viewed. As can be seen, the clamping screw 42 is in a fully retracted position, that is, with the major portion of its threaded shank extending out of the threaded boss 40 of the body portion 22. As such, the pressure plate 48 is held close to the inner surface of the base portion 24 of the body 22 and the pressure pad 52 is also held close to the under surface of the base portion 24. The protrusion 46 of the clamping screw 42 is fully within the central aperture 54 of the pressure pad 52. Now a conductor 60, as is shown in FIG. 11, is inserted and rested on the upper surface of the lug 32 and the connection between the connector 20 and the conductor 60 is made by means of tightening the clamping screw 42.

It should be noted that the inner surface 33 of the lug 32, shown in FIG. 2, is smooth, and in such case it will be necessary, if the conductor 60 is aluminum, that the conductor 60 be scraped clean and protected with proper oxide inhibiting agents prior to the insertion within the connector 20. Alternatively, as shown in FIG. 6, the lug 32 may be replaced with a lug 70 having along its inner surface 72 a plurality of insulation and oxide piercing teeth 74 so formed that they will pierce through the aluminum oxide formed on the outside of the aluminum conductor 60 and contact fresh aluminum in the conductor 60 itself. In such case it is not necessary to prepare the conductor 60 prior to insertion within the connector 20. Lug 70 is affixed by means of tabs 76 at its ends through slots such as 36 in the side walls 26 of the connector 20 of FIG. 1 and the ends 78 downturned as was true of the ends 38 of the lug 32 of FIG. 2.

With the conductor 60 properly placed upon the upper surface of the lug 32 of FIG. 2, clamping screw 42 is tightened by inserting an appropriate Allen wrench, or the like, in the hexagonal recess 44 and driven downwardly so as to cause first the outer surface of pressure pad 52 to contact the outer surface of the conductor 60. The tightening operation will continue until the leading edge of the protrusion 46 extends completely through the central aperture 54 of the pressure pad 52 and contacts the outer surface of the conductor 60 and slightly thereafter partially compressing the conductor 60. (See FIG. 11). With the protrusion 46 so contacting the conductor 60, the operator is assured that proper tightening has taken place and is warned against such further tightening that could cause the crushing of the resilient pressure pad 52 and its de-

struction. The urging of the clamping screw **42**, the pressure plate **48** and the pressure pad **52** press the conductor **60** against the upper surface **33** of the lug **32** and thereby assure an intimate contact between such conductor **60** and the connector **20**. The limitation of the compression of the resilient pressure pad **52** will permit the pressure pad **52** to continue to be compressed as the conductor **60** expands to a degree greater than the connector **20**, and will also allow the pressure pad **52** to recover and expand as the connector **20** and conductor **60** are caused to contract during cooling. The resilience of the pad **52** will permit it to match the disparity between the contraction of the conductor **60** and the smaller contraction of the connector **20**.

When the conductor being employed with a connector such as **20** is more irregular or flatter than the generally round shape of the conductor **60**, shown in FIG. **11**, the pressure plate and pressure pad may be modified, as shown in FIG. **5**, to accommodate such change in the profile of the conductor. As is shown in FIG. **5**, clamping screw **80** has affixed at its lower end by means of a pin **82**, a pressure plate **84**. Pin **82** makes it possible for the clamping screw **80** to turn freely without causing the pressure plate **84** to rotate. Plate **84** has two downturned legs **86** contoured so as to be able to fit within grooves **90** of a pressure pad **88** placed partially within the pressure plate **84**. Downturned legs **86** will thereby act as a limitation on the tightness of the clamping screw **80** and will also serve to retain the pressure pad **88** to the clamping screw **80**.

Turning now to FIGS. **7** and **8**, the position of the relative elements of the connectors **20** are shown with conductors of different sizes. For example, in FIG. **7**, connector **20** is applied to a conductor **92** of rather large diameter. Very little distortion of the pressure pad **52** is necessary because of the rather large size of the conductor **92**. However, as shown in FIG. **8**, the pressure pad **52** is greatly distorted when a very small sized conductor **94** is placed within the body portion **22** of the connector **20**. Great distortion of the pressure pad **52** may be used to advantage to provide a seal for the conductor within the connector, as is shown in FIG. **9**, by providing a pressure pad **96** which when installed about a small conductor such as **98** distorts to form a complete enclosure about the conductor **98** as the conductor **98** is fitted upon the inner surface **33** of the lug **32** of the connector of FIG. **1**. Pressure pad **96** because of the loose fit on protrusion **46** is easily interchangeable with pressure pad **52** of FIG. **10**.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to the preferred embodiments, it will be understood that various omissions and substitutions and changes of the form and details of the devices illustrated and in their operation may be made by those skilled in the art, without departing from the spirit of the invention. The embodiments of the invention in which an exclusive property and privilege is claimed are defined as follows:

I claim:

1. In a connector for coupling an electrical conductor to a terminal position of the type having a tubular body having first and second spaced apart portions for receipt of an electrical conductor therebetween; a terminal portion for engagement with a terminal position at a first end and having its second end positioned adjacent said second portion of said tubular body for receipt thereon of an electrical conductor; a clamping screw threadably engaging a threaded hole in said first portion of said tubular body; said clamping screw having a slot for receiving a tool at a first end thereof for advancing and retracting the second end thereof into and out of said tubular body and a pressure plate coupled to said second end of said clamping screw, the improvement comprising: resilient pad means coupled to said pressure plate for engaging an electrical conductor placed in said tubular housing when said clamping screw is completely advanced into said tubular body and holding said electrical conductor in intimate contact with said second end of said terminal portion.

2. A connector as defined in claim **1**, wherein said resilient pad means is so proportioned and contoured that when said resilient pad means is brought into contact with said electrical conductor said resilient pad means forms a seal about said electrical conductor within said connector.

3. A connector as defined in claim **1**, wherein said second end of said terminal portion has a plurality of insulation and oxide piercing teeth formed on the portion of its surface arranged to engage an electrical conductor.

4. A connector as defined in claim **1**, wherein said pressure plate has first and second extensions extending from first and second transverse ends, said extensions centering said pressure plate within said tubular body.

5. A connector as defined in claim **1**, wherein said tubular body is formed of a length of elongated material formed to provide said first and second portions with an open seam adjacent said second portion; apertures in the portions of said body extending between said first and second portions; and tabs on said terminal portion adjacent said second end to engage said apertures in the portions of said body extending between said first and second portions to assemble said terminal portion to said body and to retain the ends of said body member adjacent said seam.

6. A connector as defined in claim **5**, wherein said second end of said terminal portion has a plurality of insulation and oxide piercing teeth formed on the portion of its surface arranged to engage an electrical conductor.

7. In a connector for coupling an electrical conductor to a terminal position of the type having a tubular body having first and second spaced apart portions for receipt of an electrical conductor therebetween; a terminal portion for engagement with a terminal position at a first end and having its second end positioned adjacent said second portion of said tubular body for receipt thereon of an electrical conductor; a clamping screw threadably engaging a threaded hole in said first portion of said tubular body; said clamping screw having a slot for receiving a tool at a first end thereof for advancing and retracting the second end thereof into and out of said tubular body and a pressure plate coupled to said second end of said clamping screw, the improvement comprising: resilient pad means coupled to said pressure plate for engaging an electrical conductor placed in said tubular housing when said clamping screw is completely advanced into said tubular body and holding said electrical conductor in intimate contact with said second end of said terminal portion;

said resilient pad means having first and second generally parallel sides, each of said sides having a groove therein and said coupling between said pressure plate and said resilient pad means is provided by turning lateral edges of said pressure plate adjacent said first and second sides of said resilient pad means inwardly into the grooves of said first and second sides of said resilient pad means.

8. In a connector for coupling an electrical conductor to a terminal position of the type having a tubular body having first and second spaced apart portions for receipt of an electrical conductor therebetween; a terminal portion for engagement with a terminal position at a first end and having its second end positioned adjacent said second portion of said tubular body for receipt thereon of an electrical conductor; a clamping screw threadably engaging a threaded hole in said first portion of said tubular body; said clamping screw having a slot for receiving a tool at a first end thereof for advancing and retracting the second end thereof into and out of said tubular body and a pressure plate coupled to said second end of said clamping screw, the improvement comprising: resilient pad means coupled to said pressure plate for engaging an electrical conductor placed in said tubular housing when said clamping screw is completely advanced into said tubular body and holding said electrical conductor in intimate contact with said second end of said terminal portion; said resilient pad means having an aperture extending generally from a first face to a second face thereof and said pressure plate having a protrusion thereon; said protrusion arranged to extend into and through said aperture of said resilient pad means to retain said resilient pad to said pressure plate and to limit the advancement of said clamping screw into said tubular body.

9. In a connector for coupling an electrical conductor to a terminal position of the type having a tubular body having first and second spaced apart portions for receipt of an electrical conductor therebetween; a terminal portion for engagement with a terminal position at a first end and having its second end positioned adjacent said second portion of said tubular body for receipt thereon of an electrical conductor; a clamping screw threadably engaging a threaded hole in said first portion of said tubular body; said clamping screw having a slot for receiving a tool at a first end thereof for advancing and retracting the second end thereof into and out of said tubular body and a pressure plate coupled to said second end of said clamping screw, the improvement comprising: resilient pad means coupled to said pressure plate for engaging an electrical conductor placed in said tubular housing when said clamping screw is completely advanced into said tubular body and holding said electrical conductor in intimate contact with said second end of said terminal portion; said resilient pad means having an aperture extending generally from a first face to a second face thereof; said pressure plate means having an aperture extending therethrough and said clamping screw having a protrusion thereon at said second face thereof; said clamping screw protrusion extending through said aperture in said pressure plate to releasably mount said pressure plate to said screw and into and through said aperture of said resilient pad means to retain said resilient pad to said pressure plate and to limit the advancement of said clamping screw into said tubular body.

10. A connector as defined in claim **9,** wherein said resilient pad means has first and second generally parallel sides, each of said sides having a groove therein and the lateral edges of said pressure plate adjacent said first and second sides of said resilient pad means being turned inwardly into the grooves of said first and second sides of said resilient pad means to assist in coupling said resilient pad means to said pressure plate.

* * * * *