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Toedtman et al.

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[54] **ELECTRICAL CONNECTOR WITH INSULATION-PIERCING CONTACT PINS**

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[52] **U.S. Cl.** .....**339/95 A,** 339/97 P

[51] **Int. Cl.** **H01r 9/08**

[58] **Field of Search**.....339/95, 97–99, 339/263, 265, 272

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[57] **ABSTRACT**

An electrical connector having a contact pin carried by a body and selectively movable into contact with a conductor received in a body socket. The pin is provided with a blunt end having a peripheral cutting edge, and with an end-open recess inside the cutting edge, the recess receiving the conductor material displaced by the cutting edge as the pin penetrates the conductor. The pin is threadedly mounted to achieve a tight, intimate contact with the conductor upon pin rotation. A pair of such contact pins engage diametrically opposite sides of the conductor, each pin providing a back-up for the other. The body includes adjacent sections interconnected by clamping means located between a pair of conductor-receiving sockets, the body sections acting as leaf springs urging contact pins against the conductors. When the contact pin pierces the insulation of an insulated conductor, the severed insulation pad is received in the end-open recess to avoid wedging of insulation between the contact areas.

9 Claims, 4 Drawing Figures

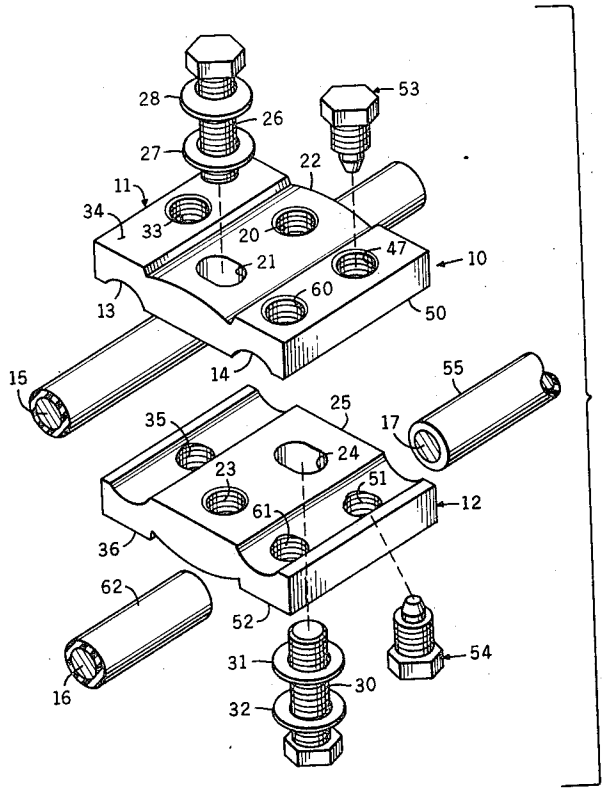


FIG. 3

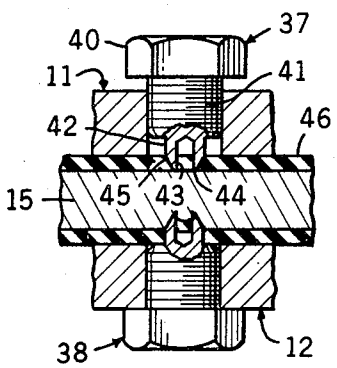
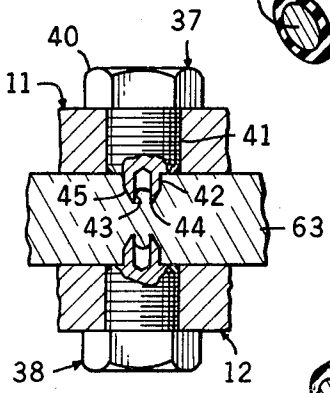


FIG. 4



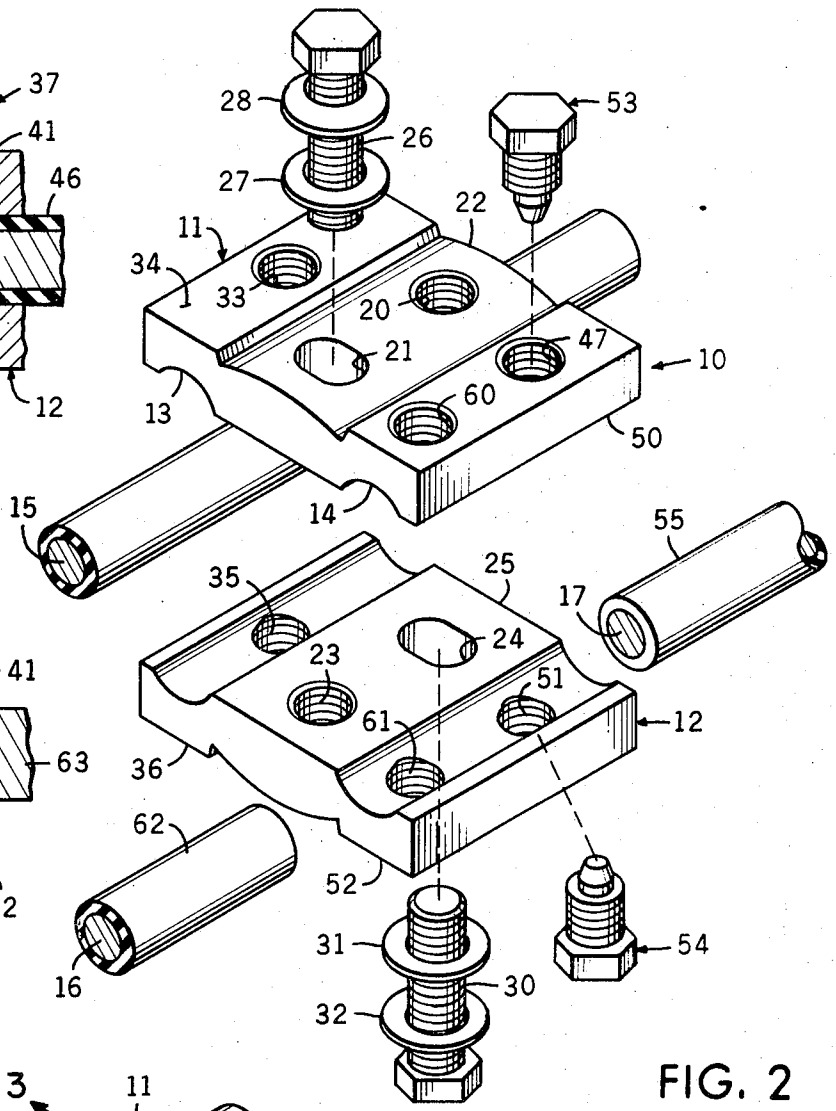


FIG. 2

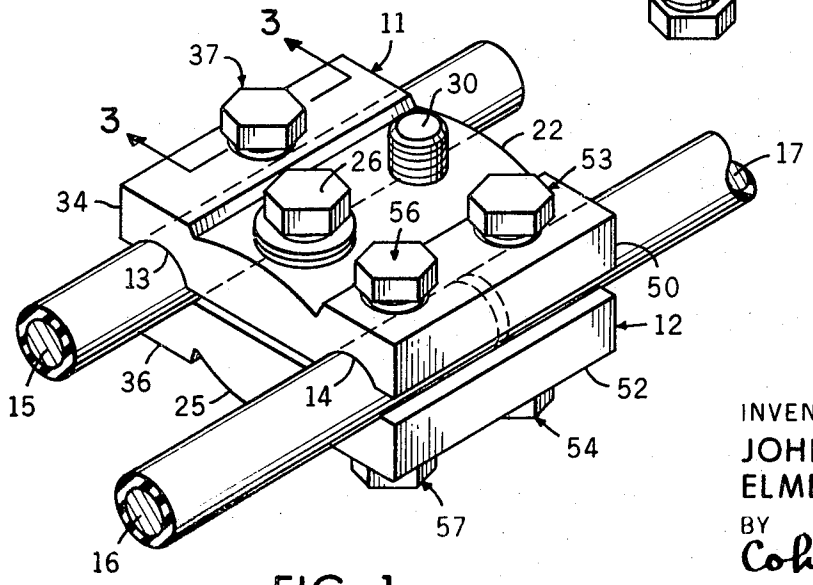


FIG. 1

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ELECTRICAL CONNECTOR WITH INSULATION-PIERCING CONTACT PINS

BACKGROUND OF THE INVENTION

This invention relates generally to improvements in an electrical connector, and more particularly to an improved electrical connector having contact pins adapted to pierce an insulated conductor.

Many of the prior electrical connectors did not incorporate insulation-piercing contact pins. Consequently, when such connectors were used, the insulation had to be stripped before connection was made. This type of connector is prevalently used to connect tap wires to secondary conductors of power lines which are frequently buried or located high overhead. Because the connection was made usually under adverse conditions, such as muddy ground or up on a pole, it was a time-consuming, and hence costly, procedure.

The heretofore conventional connectors did not provide optimum electrical contact with relatively soft, solid conductors, such as aluminum of soft tempers. Those connectors that utilized a contact pin were not satisfactory because the pin was usually driven or forced straight into the conductor, and as a result, the electrical contact was deficient because of the low residual stress in the conductor at the contact area. The contact was further deficient because such pins did not usually remove the oxide film from the conductor surface.

In addition, certain prior types of contact pins have pointed ends which penetrate the conductor, but do not provide an acceptable contact in view of the creep of the soft-tempered solid metal.

When utilizing these prior connectors with an insulated connector, the contact pin presented a large conical surface on which the insulation could smear during penetration of the pin. There was a distinct possibility that displaced insulation could be wedged between the slanted pin surface and the remaining insulation or be wedged between the pin and the conductor metal at the contact area.

SUMMARY OF THE INVENTION

The present insulation-piercing connector can be quickly and easily applied to an insulated conductor without requiring the conductor to be stripped, thereby resulting in considerable economy.

This connector is especially designed for solid conductors of soft tempers. The contact pin penetrates the metal in a manner so as to obtain optimum lateral contact with minimum lateral metal displacement, and so as to remove the oxide film from the metal. The pins are constructed to provide localized work-hardening only at the contact area which enhances the physical properties, primarily increasing the yield point with a resultant reduction in creep.

When utilized with a conductor, an end-open recess in the contact pin end accommodates and receives a portion of displaced metal as the pin penetrates the conductor. This action achieves a most effective electrical contact.

The connector body includes a contact pin mounted for selective extension into electrical contact with a conductor received in a body socket, the pin having a peripheral cutting edge adapted to penetrate the conductor. An end-open recess inside the peripheral cutting edge receives the conductor material displaced by the pin upon penetration.

A blunt end on the pin achieves a work-hardened area on the conductor, larger than that attained by a pointed, conical tip, to enhance the physical properties and reduce creep, the work-hardened area being localized at the blunt pin end without adversely affecting the temper of the remaining conductor length.

The contact pin is mounted to the connector body by a threaded connection that enables the pin to penetrate the conductor upon pin rotation with a minimum of effort, with a minimum of metal and insulation displacement, and with an abrading action that cleans the contact surfaces.

A pair of contact pins are carried by and disposed on opposite sides of the connector body, the pins being in direct transverse alignment diametrically of the conductor in order that each blunt pin end provides a reinforcing back-up for the other and thereby attains an effective, localized work-hardening action on the conductor.

Because adjacent body sections are clamped together between a pair of conductor-receiving sockets, the body sections act as leaf springs tending to urge the contact pins against the conductors in such sockets.

Of course, when the connector is used with an insulated conductor, the contact pin pierces the insulation and penetrates the metal of the conductor. The insulation pad, displaced or severed by the peripheral cutting edge, is moved into the end-open recess of the blunt pin end, where such pad is retained. The displaced insulation cannot adversely wedge between or otherwise adversely affect the contact surfaces.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an isometric view of the connector applied to an insulated secondary conductor and a pair of insulated tap conductors;

FIG. 2 is an exploded view of the connector and conductors;

FIG. 3 is a cross section taken on line 3—3 of FIG. 1, and

FIG. 4 is a cross section similar to FIG. 3, but showing a non-insulated conductor.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now by characters of reference to the drawing, and first to FIGS. 1 and 2, it is seen that the electrical connector includes a connector body generally indicated by **10**, having adjacent, compatible body sections **11** and **12**. Formed in and between the body sections **11** and **12** are a pair of laterally spaced, parallel elongate sockets **13** and **14**. The walls defining the sockets **13** and **14** are partially formed in both of the body sections **11** and **12**.

An insulated electrical conductor **15** is located in the socket **13** between the body sections **11** and **12**. As stated previously, this insulated conductor **15** is usually a secondary conductor of a power line. Coacting tap conductors **16** and **17** are located in the socket **14**. These conductors **15–17** are relatively soft, solid conductors, such as aluminum of soft tempers.

The clamping means for effectively securing the body sections 11 and 12 together include a threadedly tapped hole 20 and a laterally elongate, untapped hole 21 formed in the central portion 22 of body section 11, and include a threadedly tapped hole 23 and a laterally elongate untapped hole 24 formed in the central portion 25 of body section 12. The tapped hole 20 of body section 11 is axially aligned with the untapped hole 24 of the other body section 12. Similarly, the tapped hole 23 of body section 12 is axially aligned with the untapped hole 21 of the body section 11.

A bolt 26, carrying a washer 27 and a Belleville washer 28, is inserted through the untapped hole 21 and threadedly connected to the body section 12 in the tapped hole 23. A similar bolt 30 carrying a washer 31 and a Belleville washer 32, is inserted through the untapped hole 24 of body section 12 and is threadedly connected to the body section 11 in the tapped hole 20. Upon tightening the bolts 26 and 30, the body sections 11 and 12 are urged together to clamp the conductor 15 in socket 13 and to clamp the conductors 16 and 17 in socket 14.

A tapped hole 33 is formed in a side portion 34 of body section 11 immediately overlying and communicating with socket 13. A similar tapped hole 35 is formed in a side portion 36 of the body section 12. The tapped holes 33 and 35 are axially aligned in diametrically opposed relation to the conductor 15 disposed in socket 13. As is best seen in FIG. 3, identical contact pins 37 and 38 are threadedly connected in the tapped holes 33 and 35 respectively for selectively penetrating the conductor 15 to provide an electrical connection.

The contact pins 37 and 38 are of identical construction so that a detailed description of one will suffice for the other. For example, the contact pin 37 includes a head 40 and an integral, threaded shank 41 operatively interfitting the tapped hole 31. The contact pin 37 is provided with a reduced end 42 having an end-open recess 43. A peripheral cutting edge 44 defines the opening of recess 43 and provides an essentially blunt terminal. The pin end 42 includes a conical surface 45 tapered and leading to the peripheral cutting edge 44.

The contact pin 37 in FIG. 3 is tightened to an extent such that the peripheral cutting edge 44 has severed the insulation 46 of conductor 15 without penetrating the conductor 15. It will be apparent that the severed insulation pad is received in and retained by the recess 43 of the pin end 42. The contact pin 38 is tightened completely to show the piercing of the insulation 46 and penetration of the conductor 15. Again, it will be apparent that the severed insulation pad has moved into the recess 43 and that a small portion of the displaced metal of conductor 15 also projects to a slight extent into the end-open recess 43.

Because the contact pins 37 and 38 are in direct transverse alignment diametrically of the conductor 15, the blunt ends 42 of such pins 37 and 38 act as a reinforcing back-ups for each other and thereby attain an effective, localized work-hardening action on the conductor 15 without adversely affecting the temper of the remaining conductor length. In addition, because of the threaded mounting and connection of the contact pins 37 and 38, the blunt pin ends 42 abrade the conductor 15 to remove any film oxide and penetrate the conductor for a tight, intimate contact with the conductor with a minimum of effort, and with a minimum of metal and insulation displacement.

Similar contact pins are utilized to interconnect the connector body 10 with the tap conductors 16 and 17. For example, a tapped hole 47 is formed in the side portion 50 of the body section 11 immediately overlying and communicating with the socket 14. A similar tapped hole 51 is formed in the side portion 52 of body section 12, the tapped hole 51 communicating with socket 14 also. The tapped holes 47 and 51 are in direct transverse alignment diametrically of the tapped conductor 17 located in the socket 14.

A pair of contact pins 53 and 54 are attached to and carried by the body sections 11 and 12 respectively in the cooperating tapped holes 47 and 51. As explained previously with respect to contact pin 37, these contact pins 53 and 54 have substantially the same construction and act to pierce the insulation 55 of the conductor 17 and penetrate the conductor 17 for an effective electrical contact. These pins 53 and 54 operate in the same manner and attain all of the functional advantages previously described.

Another pair of contact pins 56 and 57 (FIG. 1) are operatively carried by the body sections 11 and 12 respectively in tapped holes 60 and 61 (FIG. 2). Again, it will be understood that these contact pins 56 and 57 cooperate to pierce the insulation 62 of the conductor 16, penetrate the conductor 16 to provide an effective electrical contact, and attain all of the functional advantages previously described with respect to the similar contact pins 37 and 38.

It is thought that the usage of the electrical connector 10 has become fully apparent from the foregoing detailed description of parts, but for completeness of disclosure, the installation of the connector 10 will be described.

First, the secondary conductor 15 is located in the socket 13 between the body sections 11 and 12, and the tap conductors 16 and 17 are located in endwise relation in the socket 14 between the body sections 11 and 12. Then, the bolts 26 and 30, together with their respective washers 27–28 and 31–32, are inserted through the respective untapped holes 21 and 31 and threadedly connected to the tapped holes 23 and 20 respectively, whereby to clamp the body sections 11 and 12 together and fix the conductors therebetween.

To electrically connect the body 10 to the conductor 15, the contact pins 37 and 38 are located in the respective tapped holes 33 and 35 and are tightened. Upon threadedly tightening the pins 37 and 38, the peripheral cutting edges 44 of the blunt pin ends 42 will first pierce the insulation 46 and sever insulation pads that are received and retained in the end-open recesses 43. Upon continued tightening, the blunt pin ends 42 will penetrate the conductor 15. A small portion of the displaced metal will project slightly into the end-open recesses 43 of blunt pin ends 42. As the pins 37 and 38 are rotatively tightened, the blunt pin ends 42 will abrade the conductor 15 to remove any film oxide. Because of the particular structure of the blunt pin ends 42, an effective electrical contact will be realized with only minor displacement of insulation and metal and with localized work-hardening of the conductor 13. Insulation 46 cannot be wedged or trapped between the contact areas.

The other contact pins 53 and 54 can be tightened to provide an effective electrical contact with the tap conductors 17 in the same manner. An electrical contact with the tap conductors 16 can be provided by tightening of the contact pins 56 and 57. In each instance, the same functional results will be attained.

Because the bolts 26 and 30, together with their mounting connections, are located in the center portion 22 and 25 of the body sections 11 and 12 respectively, and between the spaced parallel sockets 13 and 14, these bolts 26 and 30 secure the body sections 11 and 12 together and cause such body sections 11 and 12 to act as leaf springs. It is seen that the side portions 34 and 36 are spaced laterally outward from the clamping means provided by the bolts 26 and 30, and acting as spring-loaded cantilevers urge the contact pins 37 and 38 against the conductor 15. Of course, the side portions 50 and 52 of the body sections 11 and 12 are located laterally outward from the clamping means also. Acting as spring-loaded cantilevers, these side portions 50 and 52 urge the contact pins 53 and 54 against the tap conductor 17 and urge the contact pins 56 and 57 against the tap conductor 60.

It will be understood that this electrical connector can be utilized with non-insulated conductors also. FIG. 4 illustrates the contact pins 37 and 38 forming an effective electrical contact with a non-insulated conductor 63. Such conductor 63 is located in the body socket 13 in the usual manner and the contact pins 37 and 38 are tightened as described previously with respect to the insulated conductor 15. Upon tightening the contact pins 37 and 38, the blunt ends 42 penetrate the conductor 63 to provide the electrical contact. A small portion of the displaced metal projects into the end-open recesses 43 of the blunt pin ends 42.

Essentially, the only difference between the embodiments of FIGS. 3 and 4 is that in FIG. 3, the cutting edge 44 of the blunt pin end 42 severs an insulation pad that is received and retained in the recess 43 before the pin end 42 penetrates the conductor 15. In FIG. 4, the pin end 42 immediately penetrates the metal of solid conductor 63 in the absence of any insulation. While the usage of a non-insulated conductor 63 is illustrated in FIG. 4 with respect to contact pins 37 and 38, it will be readily understood that similar noninsulated conductors can be utilized in a like manner with the other contact pins 53–54 and 56–57. In each instance, there is a minimal displacement of metal, an abrading action that removes the film oxide, and localized work-hardening action that increases the physical properties of the metal without adversely affecting the soft temper of the remaining conductor lengths, all as previously described with respect to the insulated conductors.

We claim as our invention:

1. An electrical connector, comprising:
   a. a connector body provided with an elongate socket adapted to receive a conductor,
   b. a pair of contact pins carried by the body,
   c. means mounting the pins on the body for selectively extending the pins into the socket and into electrical contact with the conductor,
   d. the pins including a peripheral cutting edge adapted to penetrate the conductor,
   e. the contact pins being carried by and disposed on opposite sides of the body, the pins being in direct transverse alignment diametrically of the conductor,
   f. each of the opposed pins being provided with a blunt end,
   g. the cutting edge being provided at each blunt pin end, and
   h. each blunt pin end being provided with an end-open recess inside the peripheral cutting edge.

2. An electrical connector as defined in claim 1, in which:
   i. the mounting means for each contact pin includes a threaded connection that enables the pin to be rotated and urged into engagement with and to penetrate the conductor for a tight, intimate contact.

3. An electrical connector comprising:
   a. a connector body provided with an elongate socket adapted to receive a conductor,
   b. a contact pin carried by the body,
   c. means mounting the pin on the body for selectively extending the pin into the socket and into electrical contact with the conductor,
   d. the pin including a peripheral cutting edge adapted to penetrate the conductor,
   e. the connector body including adjacent body sections,
   f. the socket being located between the body sections,
   g. clamping means securing the body sections together and securing the conductor in the socket, and
   h. a second contact pin carried by the body, one of the contact pins being carried by each body section, the pins being in direct transverse alignment diametrically of the conductor.

4. An electrical connector as defined in claim 3, in which:
   i. each of the opposed pins is provided with a blunt end,
   j. the cutting edge is provided on each blunt pin end, and
   k. each blunt pin end is provided with an end-open recess inside the peripheral cutting edge.

5. An electrical connector as defined in claim 4, in which:
   l. the mounting means for each contact pin includes a threaded connection that enables the pin to be rotated and urged into engagement with and to penetrate the conductor for a tight, intimate contact.

6. An electrical connector comprising:
   a. a connector body provided with a pair of elongate sockets adapted to receive a conductor, the connector body including adjacent body sections,
   b. the pair of sockets being located between the body sections, the sockets being substantially parallel for receiving a pair of conductors,
   c. a pair of contact pin carried by each body section, one pin of each pair extending into one of the sockets for engagement with the associated conductor,
   d. clamping means, located between the sockets and securing the body sections together,

e. the body sections acting as leaf springs urge the contact pins against the conductors,
f. each of the pins being provided with a blunt end,
g. a peripheral cutting edge adapted to penetrate the conductor being provided on each blunt pin end,
h. each blunt pin end being provided with an end-open recess inside the peripheral cutting edge, and
i. the pins extending into the same socket being in direct transverse alignment diametrically of the conductor in the socket.

7. An electrical connector, comprising:
a. a connector body provided with an elongate socket adapted to receive a conductor,
b. a pair of contact pins carried by the body,
c. means mounting the pins on the body for selectively extending the pins into the socket and into electrical contact with the conductor,
d. the pins including a peripheral cutting edge adapted to penetrate the conductor,
e. the socket is adapted to receive an insulated conductor,
f. the contact pins being provided with a blunt end,
g. the peripheral cutting edge being provided on the blunt pin end, and
h. the blunt pin end being provided with an end-open recess inside the peripheral cutting edge adapted to receive a severed insulation pad upon piercing the insulation of the conductor, and
i. the pair of contact pins being carried by and disposed on opposite sides of the body, the pins being in direct transverse alignment diametrically of the conductor.

8. An electrical connector, comprising:
a. a connector body provided with an elongate socket adapted to receive a conductor,
b. a pair of contact pins carried by the body,
c. means mounting the pins on the body for selectively extending the pins into the socket and into electrical contact with the conductor,
d. the pins including a peripheral cutting edge adapted to penetrate the conductor,
e. the socket is adapted to receive an insulated conductor,
f. the contact pins being provided with a blunt end,
g. the peripheral cutting edge being provided on the blunt pin end, and
h. the blunt pin end being provided with an end-open recess inside the peripheral cutting edge adapted to receive a severed insulation pad upon piercing the insulation of the conductor, and
i. the connector body including adjacent body sections, the socket being located between the body sections,
j. clamping means securing the body section together and securing the conductor in the socket, and
k. one of said contact pins being carried by each body section, the pins being in direct transverse alignment diametrically of the conductor.

9. An electrical connector comprising:
a. a connector body provided with a pair of elongate sockets adapted to receive an insulated conductor, the connector body including adjacent body sections,
b. the pair of said sockets being located between the body sections, the sockets being substantially parallel for receiving a pair of conductors,
c. a pair of contact pins carried by each body section, one pin of each pair extending into one of the sockets for engagement with the associated conductor, and
d. clamping means located between the sockets, and securing the body sections together, the body sections acting as leaf springs hold the contact pins against the conductors,
e. each of the pins being provided with a blunt end,
f. a peripheral cutting edge being provided on each blunt pin end,
g. each blunt pin end being provided with an end-open recess inside the peripheral cutting edge adapted to receive a severed insulation pad upon piercing the insulation of the conductor, and
h. the pins extending into the same socket are in direct transverse alignment diametrically of the conductor in the socket.

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