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2,681,441

ELECTRICAL CONNECTOR SOCKET

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Fig. 1.

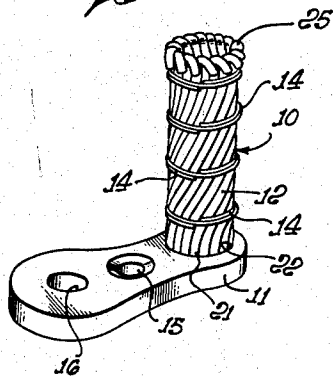


Fig. 2.

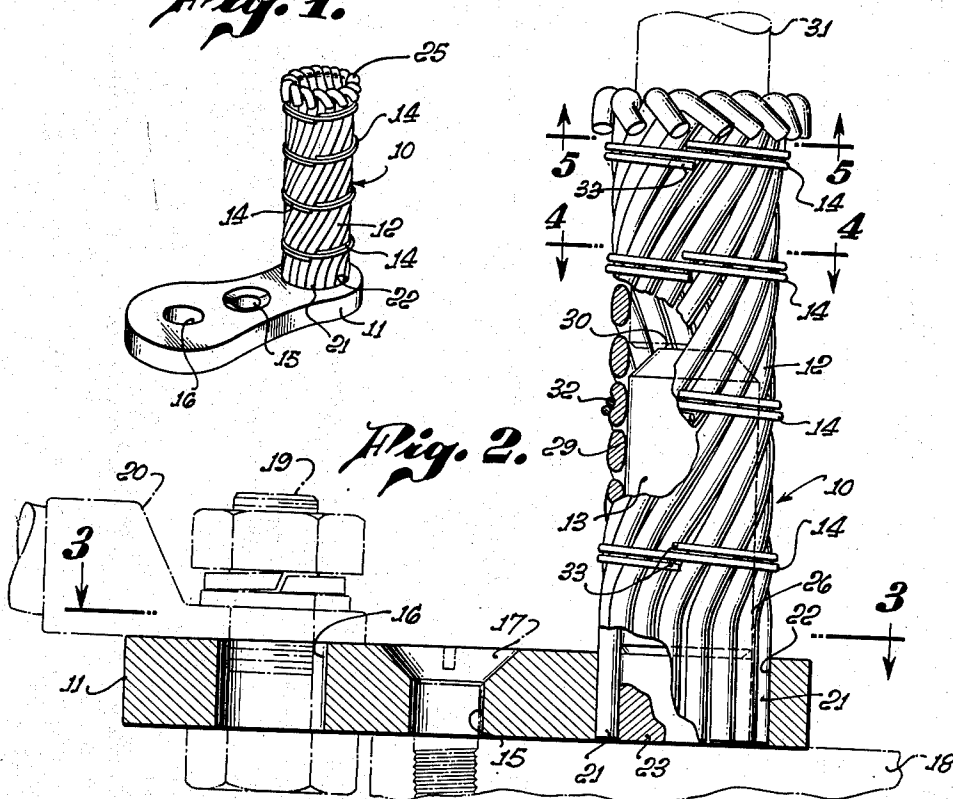


Fig. 4.

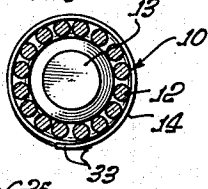


Fig. 3.

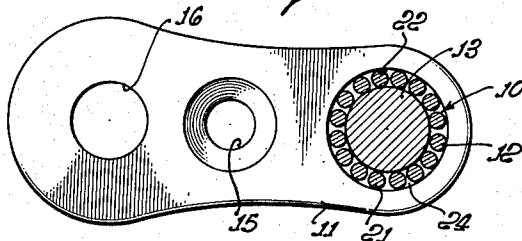


Fig. 5.

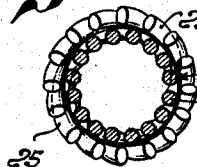
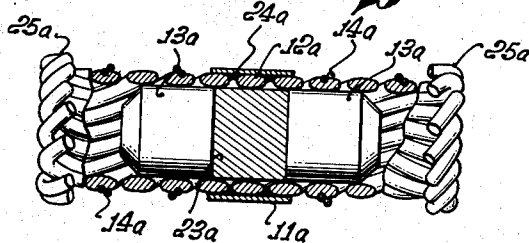


Fig. 6.



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ELECTRICAL CONNECTOR SOCKET

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This invention relates to improved electrical connectors of a type comprising a tubular open ended electrically conductive socket into which a mating conductive pin is to be inserted.

The general object of the present invention is to provide a socket connector which is so constructed as to assure, upon each insertion of a mating pin, a more positive and effective electrical connection with the pin than has been achieved by prior pin and socket connectors. Particularly contemplated is a socket structure so designed as to assure direct electrical contact with the pin at a large number of different points, so that the overall resistance of the connector assembly is very low, and the heat loss in the connection is therefore at a minimum. At the same time, it is an object of the invention to so form the socket as to facilitate the dissipation of whatever small amount of heat may be formed in the connection at very high loads.

Further features of the invention have to do with the formation of the present sockets in a manner making possible considerably lower mating pin insertion and pull out forces than are normally required for sockets of the same size, as well as allowing a greater tolerance of mating pin diameters than is normally achieved. Additionally contemplated is a socket construction which permits adequate flexibility to compensate for substantial axial and/or angular misalignment between socket and mating pin, with no loss of contact effectiveness.

Structurally, a connector embodying the invention includes a plurality of elongated electrically conductive elements which are arranged circularly about an axis to form together an essentially tubular open ended pin receiving socket. To maximize the number of points of contact between these elongated elements and a received pin, it has been found highly desirable that the individual elements be of essentially helical formation. Also, to maintain effective contact between the elements and pin regardless of slight twisting or deformation of the individual elements, I preferably form the elements of circular cross-section wire. The wire elements may be mounted at first ends thereof to a suitable base or carrier body, and have second ends at the open end of the socket which are free for relative radially expanding movement upon insertion of a pin into the socket. The base may include an electrically conductive portion by which the socket is electrically connected to an associated lead.

For maintaining the various socket forming

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wires or elements in tight electrical contact with a received pin, the socket preferably includes one or more annular spring units extending about the wires or elements and yieldingly urging them radially inwardly against the pin. These spring units may be positioned axially of the socket by partial reception within an annular series of notches formed in the outer surfaces of the elongated elements.

For assuring a most uniform inward force against the elements in a structurally very simple arrangement, the spring units may comprise coil springs, the individual turns of which extend entirely about all of the elements. In order that such a coil spring may be radially expandable to the degree desired upon insertion of a mating pin, each spring should be so formed as to normally tend to return to a condition in which its adjacent turns are spaced axially apart. The spring may then be radially expanded upon insertion of a pin, without having to overcome the frictional resistance to expansion which would be present if adjacent turns of the spring were normally urged tightly together. Also, some radial expansion of the socket is permitted by virtue merely of the axial contraction of the spring, that is, as its successive turns move more closely together. With further regard to the spring structure, it has been found highly desirable that the ends of the coil spring be distorted slightly radially outwardly into a spaced relation with the socket forming wires or elements, to prevent the spring ends from digging into or catching on the elements.

Radially inward deflection of the wires or elongated elements may be resisted or limited by a member which is inserted into the socket and engaged by the elements at a location inwardly beyond the pin-receiving portion of the socket. This member may be of an electrically conductive material, and electrically engage the elements or wires to assist in the transmission of current through the inner portion of the socket and thus reduce the resistance to current flow. Best results are achieved when this member is solid and externally cylindrical, with its upper end immediately below the contact area.

Additional features of the invention have to do with a special formation of the outer free ends of the socket forming wires or elements to present a smooth entrance end to a pin and to provide an interlock between the outer ends of the elements, which interlock assures sufficient mechanical resistance to deformation of both the individual elements and socket. For achiev-

ing the first of these purposes, the element ends may be turned outwardly and then doubled back upon themselves, so that the elements together form a somewhat converging throat at the entrance to the socket. For achieving the second purpose, that is, to form an interlock between the outer ends of the elements, the end of each element may be turned in a manner to overlap and be received radially outwardly of an adjacent element, to thus limit the relative radially outward movement of that element. In order that some relative movement of the element ends may be permitted, to enable conformance of the socket to slightly irregular pins, the overlapping end portion of each element is spaced a short distance radially outwardly from the overlapped portion of the adjacent element.

The above and other features and objects of the present invention will be better understood from the following detailed description of the typical embodiments illustrated in the accompanying drawing, in which:

Fig. 1 is a perspective view of a first form of electrical socket embodying the invention;

Fig. 2 is an enlarged side view of the Fig. 1 socket, shown partly in section;

Figs. 3, 4 and 5 are sectional views taken on lines 3—3, 4—4, and 5—5, respectively, of Fig. 2; and

Fig. 6 is a side view, partly broken away, of a second form of the invention.

The socket 10 shown in Figs. 1-5 comprises a base member 11, a plurality of elongated circular cross-section socket forming wires 12 carried in circular arrangement by the base member, an inner backing plug 13 at the inside of the socket, and a plurality of springs 14 constricting the wires toward both the plug 13 and a contact pin 31 with which the socket mates. The base members 11, wires 12, and plug 13 are all formed of a suitable electrically conductive material, preferably copper, and the entire socket may be covered with a thin plate of silver to assure the maintenance of a good electrically conductive surface. Base member 11 may be shaped as formed, and contain a pair of openings 15 and 16, for receiving respectively a mounting screw 17 by which the socket is attachable to a support 18, and a terminal 19 to be electrically connected to a lead 20.

Wires 12 are mounted in a circular arrangement to the base member 11, typically by reception of their base ends 21 within a circular opening 22 in the base. A circular plug 23 may be received within base opening 22 and at the inside of wires 12, to form with the base an annular space within which the ends 21 of the wires are received and retained. An electrically conductive solder 24 may be injected into the space between plug 23 and the base member and about the wires to integrate the base portions of the wires and the parts engaged thereby into an electrically conductive unit.

The base portions 21 of wires 12, that is, the portions of the wires secured within the opening of base member 11, preferably extend parallel and in the direction of the axis of the socket. The portions 26 of the wires outwardly beyond the base member are given a helical twist, which continues to the outer free relatively movable ends 25 of the wires. The wires are formed of a material which is sufficiently flexible to assure radial deflection of the wires in conformance with the mating contact pin 31.

The outer ends 25 of the wires are interlocked

in a manner limiting the relative radial deflection of adjacent wires. For this purpose, the end 25 of each wire is turned radially outwardly and then doubled back angularly as shown to a location overlapping and received radially outwardly of an adjacent wire. Radially outward deflection of each wire relative to the adjacent wire is thus limited by engagement with the turned end of that adjacent wire.

In certain instances, it is desirable, for most effective control of the relative movement of the wires, that each wire end 25 overlap two adjacent wires as shown. It is also noted that, in order to permit some relative movement of the wires, the turned end portion 25 of each wire is normally (i. e. when the wires are in an exactly circular arrangement) spaced radially outwardly from the wire which it overlaps, so that the overlapped wire may move outwardly a predetermined distance before its relative movement is limited. To attain such a spaced relation of the wires and wire ends, the wires are turned back in such a manner that the inner wire-engaging surface of the end 25 of a particular wire is located farther from the socket axis than is the portion of the outer surface of that same wire which is to be engaged by the turned end of an adjacent wire. It is also pointed out that the manner in which the wire ends 25 are curved outwardly and then back is such as to form a smoothly converging pin-receiving throat at the open end of the socket.

The inner backing plug 13 preferably is elongated as shown, and has an outer essentially cylindrical surface engaging wires 12 along substantially the entire extent of the plug. The plug is solid to positively limit inward deflection of the engaged wire portions and to afford a wide cross-section electrical path at the base of the socket. Plug 13 engages the wire mounting plug 23 at its inner end, and terminates outwardly at an end 30, which is axially spaced from the outer ends 25 of the wires a distance permitting reception of the pin 31 within the socket. Plug 13 is not directly attached to any other part of the socket, to thus permit movement of the plug in a manner allowing some change of the socket axis relative to base 11.

Each of the springs 14 comprises a coil spring, the individual turns of which extend entirely about the socket formed by wires 12. Each spring is positioned relative to the wires by partial reception within a circular series of notches 32 formed in the outer surfaces of the wires. A number of such springs may be employed at locations spaced axially along the socket, to urge the wires inwardly against and into tight electrical contact with both plug 23 and pin 31. Preferably, four springs are employed, two being received about the pin receiving portion of the socket, and two about the plug 13.

The springs are so formed that their individual turns normally tend to return to the condition of Fig. 2, in which they are slightly axially spaced to thus prevent excessive resistance to expansion resulting from tight frictional contact between the turns. Such spacing also facilitates radial expansion of the spring, since some expansion is then allowed by mere axial contraction of the spring. It is further noted that the ends 33 of the individual springs (see Fig. 4) are distorted slightly outwardly in radially spaced relation to the wires 12, to prevent the spring ends from digging into or catching on the wires. Preferably, each spring comprises more than $1\frac{1}{2}$ and less

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than $2\frac{1}{2}$ turns about the socket. It is found desirable for best operation that only one turn of each spring 14 be received within the corresponding positioning notches or recesses 32, and that the notches be so dimensioned as to allow freedom of movement of the received turns. These purposes are preferably achieved by giving the notches a width axially of the socket equal to about $1\frac{1}{2}$ times the diameter of the spring wire.

In placing the socket of Figs. 1 to 5 in use, the socket is first of all mounted to support 18, and terminal 19 is then electrically connected to lead 20. A mating contact pin 31 may then be inserted into the end of the socket to the position of Fig. 2, to form an effective but releasable electrical connection between the pin and socket. The wires, by virtue of their helical formation and the manner in which they are urged tightly inwardly against the pin, form a large number of positive electrical connections between the pin and socket to in the aggregate produce a connection of very low resistance with the pin. Plug 32 gives rigidity to the socket and decreases its electrical resistance, and at the same time does not interfere with conformance of the wires to the pin, since the plug is not in any way directly attached to the wires. The turned ends 25 of the wires form an effective interlock between the elements, but still permit their relative movement in conforming to a pin.

To assure proper movability of the wires, the helical twist of the wires should extend through at least about 180 circular degrees from the base of the socket to the outer free ends of the wires. Also, in order that the wires will not unduly resist radial expansion, it is desirable that the helical twist of the wires be not greater than about 360 circular degrees from the pin engaging portion of the socket, i. e. from the end 30 of plug 13, to the free ends 25 of the wires.

Fig. 6 shows a variational form of the invention which takes the form of a line connector having at its opposite ends two socket recesses for receiving a pair of pins which are to be electrically connected together. This connector is constructed in basically the same manner as the Figs. 1 to 5 form of the invention, including a number of circularly arranged helical wires 12a. These wires are secured in the illustrated circular arrangement by reception of their central portions within a tubular sleeve 11a, against which the wires are retained by an inner copper plug 23a. As in the first form of the invention, the wires may be integrated with the members 11a and 23a between which they are received by electrically conductive soldering material 24a. At opposite ends of sleeve 11a and plug 23a, the wires receive a pair of backing plugs 13a. The wires are yieldingly urged radially inwardly against mating pins 31 and plugs 13a by a number of springs 14a received within positioning notches in the wires. The outer ends 25a of the wires are turned back into interlocking relation in the same manner as ends 25 of the Figs. 1 to 5 form of socket.

I claim:

1. An electrical connector comprising a plurality of elongated electrically conductive elements mounted in an essentially circular arrangement and extending essentially helically in a common general direction to form together an essentially tubular open ended pin-receiving socket, said elements being deflectible radially of said socket, and a coil spring having an individual turn thereof completely encircling said helical

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elements and urging them radially inwardly against a received pin, said spring having ends normally distorted radially outwardly into radially spaced relation to said elements.

2. An electrical connector comprising a base body having an electrically conductive portion, a plurality of elongated substantially circular cross section electrically conductive wires mounted to said body and projecting therefrom helically in a common general direction to form together an essentially tubular open ended pin receiving socket, said wires being deflectible radially of said socket in conformance to a received pin, said wires having notches formed in the outer surfaces thereof along a plurality of axially spaced areas each extending circularly about the socket, a solid electrically conductive axially elongated essentially cylindrical member inserted in said socket in electrical contact with the wires at a location near said base and acting to limit radially inward movement of the wires at said location, said member terminating at a location spaced from said open end of the socket to permit reception of a pin within the socket beyond the member, and a plurality of coil springs extending about said wires at axially spaced locations and partially received within said notches, the individual turns of said springs encircling said wires and urging them radially inwardly against said member and a received pin, each of said individual wires being doubled back angularly at said open end of the socket to a position of extension across the path of radially outward deflection of an adjacent wire.

3. An electrical connector comprising a plurality of elongated electrically conductive elements in an essentially circular arrangement forming together an essentially tubular socket having an open end for receiving a mating electrically conductive pin, said elements being deflectible radially of said socket, and individual ones of said elements having portions extending to positions in the paths of radially outward movement of adjacent elements to thereby restrict relative movement of the elements.

4. An electrical connector as recited in claim 3, in which said portions of the elements are located at said open end of the socket, said connector including spring means extending about said helical elements for urging them radially inwardly against a pin received in the socket.

5. An electrical connector comprising a plurality of elongated electrically conductive elements in an essentially circular arrangement extending essentially helically in a common general direction and forming together an essentially tubular socket having an open end for receiving a mating electrically conductive pin, said elements being deflectible radially of said socket, and individual ones of said elements having portions extending to positions in the paths of radially outward movement of adjacent elements to restrict relative movement of the elements.

6. An electrical connector as recited in claim 5 in which said portions of the elements comprise ends thereof at said open end of the socket turned radially outwardly and to said positions in the paths of radially outward movement of adjacent elements.

7. An electrical connector as recited in claim 5 in which said portions of the elements comprise ends thereof received in side-by-side relation about said open end of the socket and each turned radially outwardly and then doubled back

in an axial direction away from said socket end and at an angle such as to have extent circularly about the socket axis and to extend across the path of radially outward movement of an adjacent element.

8. An electrical connector as recited in claim 7 in which said elements comprise wires of substantially circular cross section, said end of each of said wires extending across the path of radially outward movement of two adjacent wires and being radially spaced from one of said wires.

9. An electrical connector comprising a body having an electrically conductive portion, a plurality of elongated electrically conductive elements fixed at first ends to said body and projecting therefrom in a circular arrangement and essentially helically to form together an essentially tubular socket having an open end for receiving a mating electrically conductive pin, said elements being deflectible radially of said socket, spring means disposed about said helical elements and urging them radially inwardly against a pin when received in the socket, the individual elements having second end portions at said open end of the socket extending to positions in the paths of radially outward movement of adjacent elements.

10. An electrical connector comprising a plurality of elongated electrically conductive elements mounted in an essentially circular arrangement and extending essentially helically in a common general direction to form together an essentially tubular socket having an open end for receiving a mating electrically conductive pin, said elements being deflectible radially of said socket, spring means extending about said helical elements and urging them radially inwardly and against a pin when received in said socket, and an electrically conductive circular plug received within said socket at a location spaced from said open end of the socket and limiting radially inward movement of the elements at said location, said plug having an axial extent as great as its transverse extent, said elements having portions extending alongside and electrically engaging essentially helical areas of an outer surface of said member and movable relative thereto.

11. An electrical connector as recited in claim 10, including an electrically conductive body carrying said electrically conductive elements, and means attaching said elements to said body in an essentially circular arrangement and in fixed relation thereto at a point beyond said plug in

a direction away from said open end of the socket, said elements comprising a plurality of wires of essentially circular cross section, said outer surface of said plug being substantially cylindrical, and said spring means including a first spring disposed about the wires at a location radially opposite said plug, and a second spring disposed about the wires beyond said plug in a direction toward said open end of the socket.

12. An electrical connector comprising a plurality of elongated electrically conductive elements mounted in an essentially circular arrangement and extending essentially helically in a common general direction and forming together at their opposite ends a pair of essentially tubular oppositely facing sockets for receiving mating electrically conductive pins, said elements having portions adjacent their opposite ends respectively forming said sockets and deflectible radially of said sockets, and spring means extending about said elements and urging said opposite end portions radially inwardly and against mating pins when received in the sockets, the individual helical elements having at both of their ends portions turned to positions in the paths of radially outward movement of adjacent elements to thereby restrict relative movement of the elements.

13. An electrical connector as recited in claim 12, in which each end of each element is doubled back toward the opposite end of that element and at an angle such as to have extent circularly about the socket axis.

14. An electrical connector as recited in claim 12, including means securing said elements together in said circular arrangement at a location intermediate their opposite ends.

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