June 6, 1967 H. P. SHERLOCK 3,324,230

ELECTRICAL CONNECTOR WITH PREPLACED SOLDER

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FIG. 1.

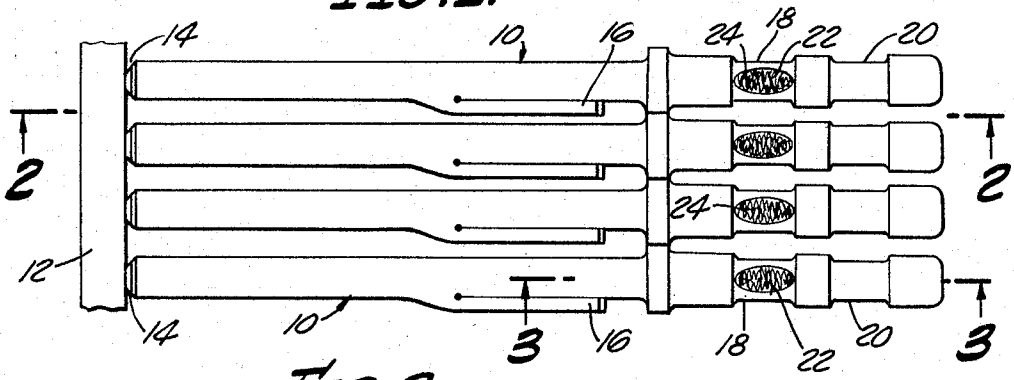


FIG. 2.

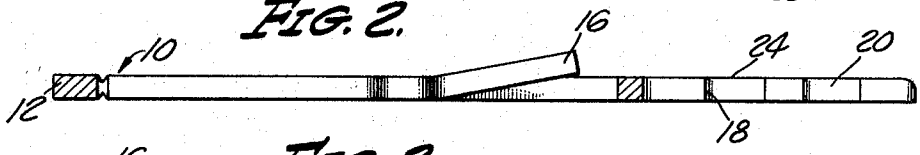


FIG. 3.

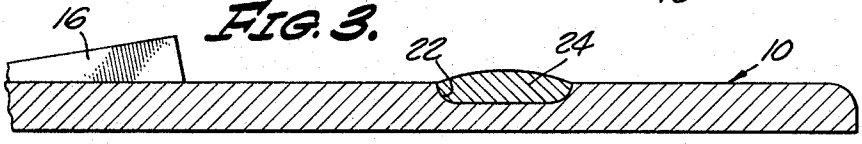


FIG. 4.

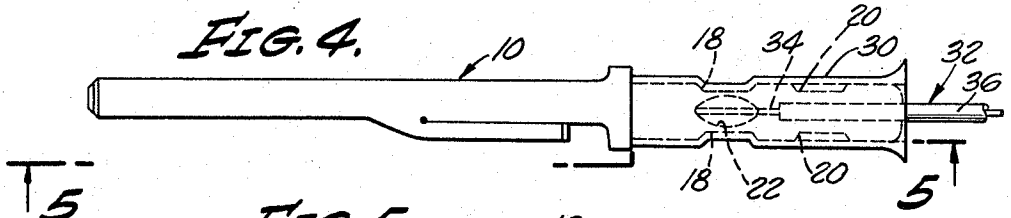


FIG. 5.

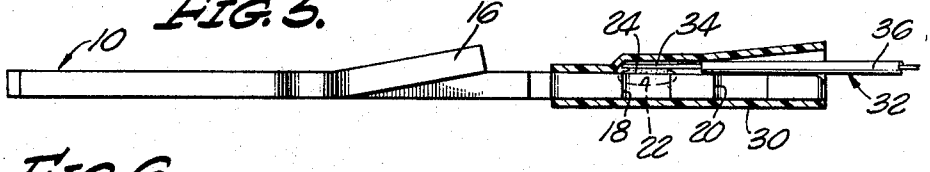
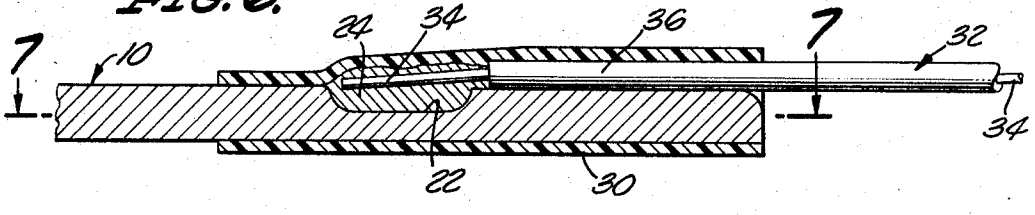


FIG. 6.



INVENTOR.
HUGH PAUL SHERLOCK
BY Lyon & Lyon
ATTORNEYS

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ELECTRICAL CONNECTOR WITH PREPLACED SOLDER

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FIG. 7.

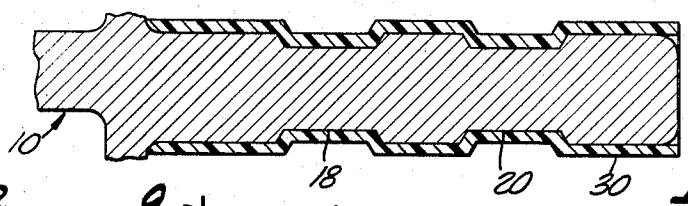


FIG. 8.

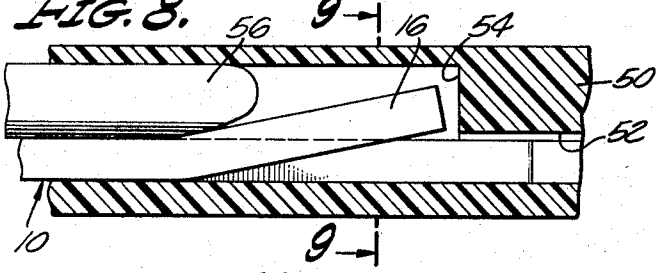


FIG. 9.

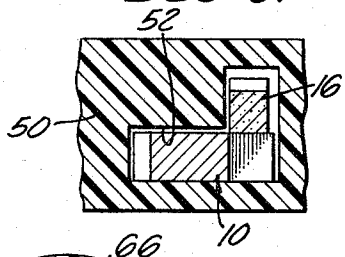


FIG. 10.

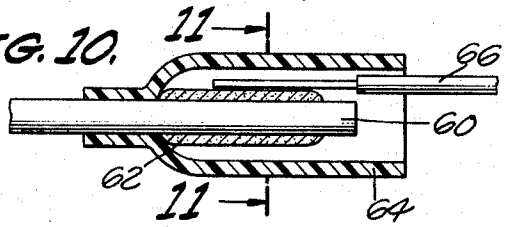


FIG. 11.

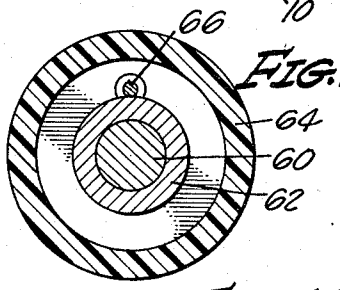


FIG. 12.

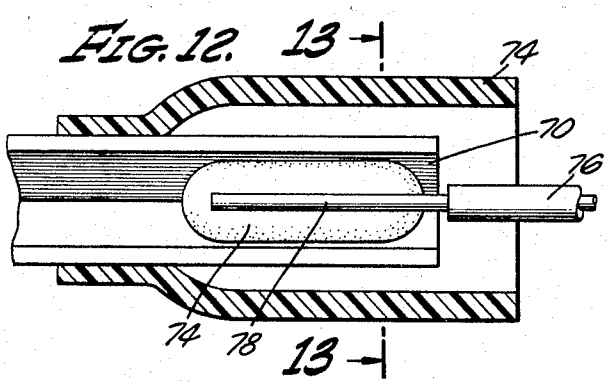
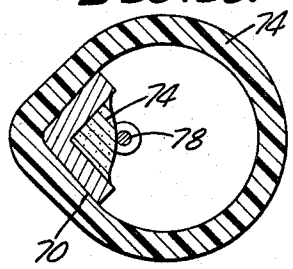


FIG. 13.



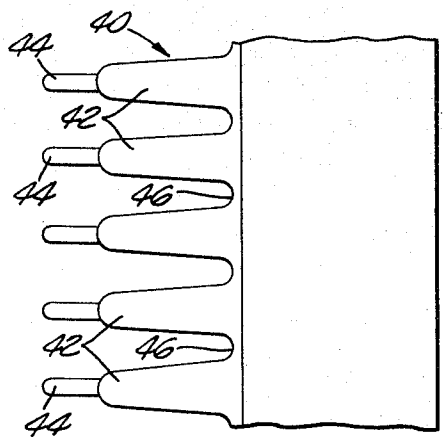
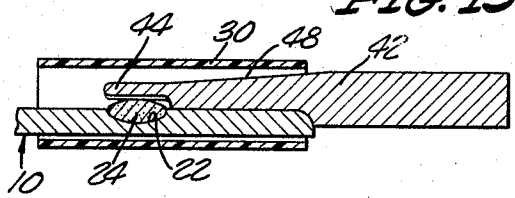


FIG. 14.

FIG. 15.



INVENTOR.
HUGH PAUL SHERLOCK
BY Lyon & Lyon
ATTORNEYS

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3,324,230 ELECTRICAL CONNECTOR WITH PREPLACED SOLDER

Hugh Paul Sherlock, Menlo Park, Calif., assignor to Raychem Corporation, Redwood City, Calif., a corporation of California

Filed Aug. 23, 1965, Ser. No. 481,534
22 Claims. (Cl. 174—84)

This invention relates to an electrical connector and more particularly relates to an electrical terminal having a pre-installed wire connector thereon.

In Wetmore application Ser. No. 211,747 filed July 23, 1962, now Patent Number 3,243,211, several types of novel electrical connectors are disclosed. The electrical connectors of the Wetmore application, the disclosure of which is incorporated by reference herein, include a dimensionally heat unstable member such as a sleeve in which is placed a solder insert. In a typical connector of this type, both ends of the member or sleeve are open to receive the electrical conductors that are to be connected. The connector is then heated causing the member or sleeve to shrink and firmly grip the electrical conductors. The heat also causes the solder to flow and form a soldered connection between the two electrical conductors. The sleeve acts to contain the movement of the solder so that a good soldered joint is assured.

In general, such members or sleeves are made of a material having the property of plastic or elastic memory and are expanded under heat and pressure to a diameter greater than their normal diameter and cooled while kept under pressure. A sleeve treated in this manner will retain its expanded position until it is again heated to above its heat recovery temperature at which time it will recover to its original shape. Examples of materials useful in forming such dimensionally heat unstable recoverable members may be found in Currie Patent 2,027,962 and Cook et al. Patent 3,086,242, the disclosures of which are incorporated herein by reference. Polymeric materials which have been cross-linked by chemical means or by radiation, for example, with high energy electrons or nuclear radiation, such as those disclosed in the Cook et al. patent are preferred for use in the present invention. Non-crystalline polymeric materials exhibiting the property of plastic or elastic memory, such as polyurethane, ionomers, etc., could also be used in practicing the present invention.

In Hess application Ser. No. 446,246 filed Apr. 7, 1965, there are shown various types of electrical connectors made in accordance with the Wetmore invention and apparatus for simultaneously making a plurality of electrical connections, for example, between a plurality of wires and a plurality of terminals. While the electrical connectors of the type disclosed in the aforementioned Wetmore and Hess applications are quite useful, there are some occasions where it would be desirable to have a connector pre-installed on a conductor such as a terminal pin so that only one conductor, rather than two, need be inserted into and held in place in the sleeve before it is heat recovered. In many instances this would greatly simplify the making of an electrical connection and permit terminal pins or the like to be provided that could be spaced very close to one another.

It is also desirable that the skill required of the operator making the connections be made as low as possible. By providing a predetermined amount of solder in the sleeve, the devices disclosed in the previously mentioned applications greatly reduce the skill required to make a good connection. However, problems can still arise, and faulty connections result, because of the need to properly locate the two conductors to be soldered and then preventing their relative movement during cooling of the solder. It would therefore be of great benefit if the probability of mislocation could be reduced or eliminated. The pre-installation of a connector such as a heat recoverable sleeve on one of the conductors would serve to cause such a reduction as only one of the conductors would now need to be properly positioned.

It is accordingly an object of the present invention to provide an electrical conductor, such as a terminal pin, having a pre-installed wire connector mounted thereon.

It is another object of the present invention to provide such a conductor in which the pre-installed wire connector serves to properly locate a wire with respect to the conductor for a soldering operation.

It is also an object of the present invention to provide such a connector wherein the amount and characteristic of the solder be predetermined and controlled at the time of the manufacture of the conductor.

These and other objects and advantages of the present invention will become more apparent upon reference to the accompanying description and drawings in which:

FIGURE 1 is a top plan view of a plurality of terminal pins constructed in accordance with a first embodiment of the present invention;

FIGURE 2 is a cross-sectional view taken along lines 2—2 of FIGURE 1;

FIGURE 3 is an enlarged sectional view taken along lines 3—3 of FIGURE 1;

FIGURE 4 is a top plan view of one of the terminal pins of FIGURE 1 after a heat recoverable sleeve has been installed thereon;

FIGURE 5 is a sectional view taken along lines 5—5 of FIGURE 4;

FIGURE 6 is an enlarged sectional view of the terminal pin of FIGURE 4 after a soldered connection has been made and the heat recoverable sleeve recovered;

FIGURE 7 is a cross-sectional view taken along lines 7—7 of FIGURE 6;

FIGURE 8 is the cross-sectional view illustrating how the terminal pins of FIGURE 1 are positioned in a terminal block;

FIGURE 9 is a cross-sectional view taken along lines 9—9 of FIGURE 8;

FIGURE 10 is a cross-sectional view of a second embodiment of a terminal pin having a pre-installed wire connection thereon;

FIGURE 11 is a cross-sectional view taken along lines 11—11 of FIGURE 10;

FIGURE 12 is a cross-sectional view of the third embodiment of a terminal pin having a pre-installed wire connector installed thereon;

FIGURE 13 is a cross-sectional view taken along lines 13—13 of FIGURE 12;

FIGURE 14 is a plan view of a mandrel used in pre-installing heat recoverable sleeves on the terminal pins of the first embodiment of the present invention; and

FIGURE 15 is a cross-sectional view showing the mandrel of FIGURE 14 in use.

Briefly, the present invention is directed to a terminal pin or similar electrical conductor on which is firmly installed a heat recoverable sleeve which has one end open to receive another electrical conductor. The terminal pin is provided with a body of solder and flux which may be coated on the pin in any suitable manner or deposited in a recess formed in the pin. The amount, type and shape of the solder is predetermined at the time of the manufacture of the pin. The sleeve is preferably pre-formed so that the conductor is automatically positioned on the terminal when it is inserted into the sleeve. When heat is applied, the sleeve shrinks and presses the conductor

against and through the solder as the solder melts and holds it there as the solder cools.

In the preferred embodiment, the terminal pin is provided with a series of recesses into which the sleeve recovers so that a strong and reliable connection is assured. The terminal pins can be produced in strips and the solder and sleeves then installed while the pins are still in strip form. Individual pins can then be separated and used as needed. If desired, the pins may be installed directly on the ends of cables or other conductors and then snapped into a suitable terminal block instead of first snapping the pin into the block and then installing the cable or conductor.

Turning now to the drawings, FIGURE 1 shows a strip of terminal pins constructed in accordance with a first embodiment of the present invention. Each of the pins **10** is connected to a carrier strip **12** and to each other by scored joints **14**. Each pin **10** is provided with an offset, spring-like terminal tang **16**, the end of which extends above the surface of pin **10** and which serves to position and hold the terminal in a terminal block as will be seen in connection with FIGURES 8 and 9. The terminal pins **10** are also provided with first and second pairs of lateral indentations or recesses **18** and **20** on the side surfaces and a recess **22** on the top surface. The recess **22** receives a body of solder **24**, the body of solder extending along an appreciable length of the pin **10** so that a fairly large surface area is provided as can be seen in FIGURE 3. The body of solder **24**, of course, includes a suitable flux, the amount of solder and flux being predetermined for optimum results.

In FIGURES 4 and 5, each of the terminal pins **10** has been provided with a dimensionally heat unstable tubular member or sleeve **30** having a configuration optimally suited for receiving an electrical conductor. Although only a single pin is shown in FIGURES 4 and 5, it should be understood that in practice a sleeve is installed on each of the pins **10** attached to the carrier strip **12** shown in FIGURE 1. An electrical conductor **32** having a conductive portion **34** and an insulating portion **36** is inserted into the sleeve **30**. As can be seen from the various Figures, the ends of the pins are rounded to prevent any damage to the conductor when it is flexed.

The configuration of the sleeves shown in FIGURES 4 and 5 may be obtained in the following manner. A tubular sleeve is positioned over each terminal pin **10**, and a mandrel, such as that indicated generally at **40** in FIGURE 14 is then positioned over the terminal pin strip. For this purpose, the mandrel **40** is comb-like in structure and is provided with a plurality of teeth **42** each having a tip **44** of reduced size. The teeth **42** are joined by rounded regions **46**. As can be seen in FIGURE 15, each of the teeth **42** of the mandrel **40** is inserted into a sleeve **30** surrounding each of the terminal pins **10** in such a manner that the end of the reduced tip **44** of the tooth **42** extends to the end of the solder body **24**. If, as illustrated, the amount of solder positioned in the recess **22** is such that it protrudes above the recess, the reduced tip **44** of the tooth **42** is undercut so that the tip **44** will slide smoothly over the body of solder **24**. Preferably, the upper surface **48** of the tooth **42** is inclined and the incline continues beyond the end of the sleeve **30** so that the mandrel can relatively easily be withdrawn from the sleeve **30** and the terminal pin **10** after the sleeve has been shrunk. Of course, the teeth **42** are spaced apart by a distance equal to the spacing between pins **10** and the width of the main portion of the teeth are made substantially equal to the width of the terminal pins.

After the mandrel has been placed in position, heat is very briefly applied to the sleeves **30** causing them to shrink down around the pins **10** and the teeth of the mandrel. Since the crystalline melting temperature of the material from which the sleeves are made is below that of the melting temperature of the solder, a brief application of heat will cause the sleeves to shrink without causing the solder or flux to melt or flow. This effect can also be enhanced by constructing the mandrel of a material having relatively poor heat conduction characteristics so that heat is not transferred to the solder before the sleeve has been shrunk. The mandrel is now removed from the formed sleeves. The shape of the sleeves after this first heating operation can be seen in FIGURES 4 and 5.

The sleeve has shrunk into the first pair of indentations **18** formed in the terminal pin because the reduced tip **44** of the tooth **42** of the mandrel did not extend laterally outward far enough to prevent this. However, the main portion of the tooth did extend out to the edge of the pin **10** in the region of the indentations **20** and hence the sleeve has not shrunk into these indentations. The tip **44** has also prevented the sleeve **30** from engaging the solder body **24** and hence has left a space sufficient to receive the conductive portion or wire **34** of the electrical conductor **32**. The inclined portion **48** of the tooth **42** has left the sleeve **30** at a similar incline so that easy access is provided for the conductor **32**. Since the sleeve has shrunk down into engagement with all the other surfaces of the terminal pin **10**, there can be no mistake made in placing the wire into the sleeve. The terminals are now complete and ready for use.

FIGURES 6 and 7 illustrate the position of the various elements of the assembly after a wire has been inserted and the final heating operation completed. As can be seen, when the assembly is heated to above the crystalline melting temperature of the material of the sleeve **30** and the melting point of the solder **24**, the sleeve **30** shrinks around the insulation **36** of the conductor **32** and causes conductive portion **34** to be pressed against the solder. As the heating continues, the flux flows to prepare the surfaces and then the solder melts to form the joint. The sleeve **30** continues to shrink, pressing the wire into the molten solder while at the same time controlling the flow of the solder. Upon cooling, the solder hardens and the sleeve cools to provide an insulated mechanically supported solder connection.

Since it is good practice in soldering to bring the temperature of the metals to be soldered up to the temperature necessary to melt the solder before the solder is actually melted, heat is preferably first applied to the sleeve on the side of the wires so that the wire must be heated first because it is closest to the heat source. This consequently insures that the wire is up to proper soldering temperature. The shrinking action of the sleeve assures close proximity of the metals to be joined and lack of movement during cooling, two requirements which must be met for good solder joints. As the sleeve **30** shrinks, it follows the contour of the pin and thus enters the indentations **20** creating a positive mechanical look between the sleeve and the terminal pin **10**.

FIGURE 8 illustrates a convenient manner in which the individual terminal pins **10** may be used after they are removed from the connecting strip **12**. A terminal block **50** of a suitable insulating material is provided with a passageway **52** having an offset shoulder **54** for each terminal pin **10**. The terminal pin **10** is slid into the passageway **52** from the right hand side until the tang **16** clears the shoulder **54** at which time it flexes upwardly to lock the pin **10** against outward movement. The terminal pin can be simply removed by inserting a pin **56** into the other end of the passageway **52**. The pin **56** will serve to depress the tang **16** so that the pin **10** can be pulled clear.

Turning now to FIGURES 10 and 11, there is shown a second embodiment of a terminal pin according to the present invention. In this embodiment, the terminal pin **60** is shown as circular in cross-section although it could, of course, have any desired cross-section. A body of solder **62** is positioned around the entire periphery of the

terminal pin 60 and extends along an appreciable length of the pin 60. A heat recoverable sleeve 64 is positioned over the terminal 60 and solder 62 and the portion of the sleeve between the body of solder 62 and the inner end of the pin 60 is shrunk down into engagement with the terminal pin 60. This shrinking can be accomplished by local heating or by the use of a suitable mandrel as will be obvious to those skilled in the art.

A conductor 66 may now be inserted into the annular space between the body of solder 62 and the sleeve 64 such that the conductive portion 68 of the conductor 66 overlies the solder body 62. The remainder of the sleeve 64 now can be heat recovered so that it will tightly engage the insulation of the conductor 66 and control the flow of the solder 62 which will be caused to melt by the same application of heat. If desired, of course, the solder could be positioned on only a limited portion of the circumference of the pin 62 and the sleeve 64 shrunk down to engage the pin except in the area of the solder so that a more restricted opening for receiving the conductor 66 is provided.

FIGURES 12 and 13 show a third embodiment of the present invention. In this embodiment, the terminal pin 70 is either V-shaped along its entire length or is provided with a trough at its outer end. A body of solder 72 is provided in this trough and a heat recoverable sleeve 74 positioned around the terminal pin and shrunk into engagement with the terminal pin in a region lying between the body of solder 72 and the inner end of the pin 70. The sleeve 74 is preferably also shrunk into engagement with the pin 70 on the side of the pin opposite to the body of solder 72. A conductor 76 having a conductive portion 78 may now be inserted into the sleeve 74 and the sleeve shrunk in the same manner as was done in FIGURES 10 and 11 to make a good solder contact which is mechanically strengthened by the engagement of the sleeve 74 with the insulation of the conductor 76.

From the foregoing description, it can be seen that the present invention provides an electrical connector which is simple and sturdy and which allows close spacing between terminal pins. The solder, flux and insulating sleeve are already packaged on the terminal pin, eliminating the need of any bulky applicators. Heat may be applied to many pins simultaneously from distant hot air or infrared sources, thus eliminating the need for room around the pins for installation tools. The sleeves may be constructed of a transparent material so that the soundness of the solder connection can be visually inspected.

The invention may be embodied in other specific forms not departing from the spirit or central characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

I claim:

1. An electrical connector comprising an elongated electrically conductive member; a body of solder positioned on said conductive member adjacent one end thereof and extending along an appreciable length of said conductive member; and a dimensionally heat unstable tubular member positioned over said one end of said conductive member and the body of solder positioned thereon, the longitudinal axis of said tubular member being substantially parallel to the longitudinal axis of said conductive member, a portion of said tubular member being in intimate engagement with said conductive member in a region of said conductive member between said body of solder and the other end thereof.

2. An electrical conductor comprising an elongated electrically conductive member; a body of solder positioned on said conductive member adjacent one end thereof and extending along an appreciable length of said conductive member; and a dimensionally heat unstable tubular member positioned over said one end of said conductive member and the body of solder positioned thereon, the longitudinal axis of said tubular member being substantially parallel to the longitudinal axis of said conductive member, a portion of said tubular member being in intimate engagement with said conductive member in a region of said conductive member between said body of solder and the other end of said conductive member, the remainder of said tubular member having at least a portion thereof spaced from said conductive member for receiving an electrical conductor between said tubular member and said conductive member.

3. An electrical conductor comprising an elongated electrically conductive member; a body of solder positioned on said conductive member adjacent one end thereof and extending along an appreciable length of said conductive member; and a dimensionally heat unstable tubular member positioned over said one end of said conductive member and the body of solder positioned thereon, the longitudinal axis of said tubular member being substantially parallel to the longitudinal axis of said conductive member, a portion of said tubular member being in intimate engagement with a region of said conductive member of substantial longitudinal dimension located between said body of solder and the other end of said conductive member, the remainder of said tubular member having at least a portion thereof spaced from said conductive member for receiving an electrical conductor between said tubular member and said body of solder such that the longitudinal axis of said conductor is substantially parallel to that of said conductive member.

4. The connector of claim 1 wherein the melting temperature of said body of solder is above the heat recovery temperature of said tubular member.

5. The connector of claim 1 wherein said tubular member comprises a cross-linked polymer.

6. The connector of claim 5 wherein said tubular member comprises an irradiated polymer.

7. The connector of claim 1 wherein said conductive member is provided with a recess in one surface thereof, said body of solder being positioned in said recess.

8. The connector of claim 1 wherein said body of solder is disposed around the outer periphery of said conductive member.

9. The connector of claim 1 wherein said conductive member is provided with a longitudinal trough, said body of solder being disposed in said trough.

10. The connector of claim 3 wherein said conductive member is provided with a recess in one surface thereof, said body of solder being positioned in said recess.

11. The connector of claim 3 wherein said body of solder is disposed around the outer periphery of said conductive member.

12. The connector of claim 3 wherein said conductive member is provided with a longitudinal trough, said body of solder being disposed in said trough.

13. The connector of claim 10 wherein said remainder of said tubular member engages said conductor member except on said one surface.

14. The connector of claim 11 wherein the entire remainder of said tubular member is spaced from said conductive member.

15. The connector of claim 12 wherein said remainder of said tubular member engages said conductive member except in the region of said trough.

16. An electrical connecter comprising an elongated electrically conductive member having side surfaces and top and bottom surfaces, a recess formed in said top surface adjacent the forward end of said conductive member, a first indentation formed in each of said side surfaces approximately at the location of said recess, and a second indentation formed in each of said side surfaces

between said first indentation and said forward end; a body of solder positioned in said recess; and a dimensionally heat unstable tubular member position over said forward end of said conductive member and said body of solder, said tubular members being in intimate engagement with the bottom surface of said conductive member, the side surfaces thereof to the rear of said second indentations, and the top surface thereof to the rear of said body of solder.

17. The connector of claim **16** wherein said tubular member comprises a cross-linked polymer.

18. The connector of claim **17** wherein said tubular member comprises an irradiated polymer.

19. An electrical connector comprising an elongated electrically conductive member having side surfaces and top and bottom surfaces, a recess formed in said top surface adjacent the forward end of said conductive member, a first indentation formed in each of said side surfaces approximately coextensive with said recess, a second indentation formed in each of said side surfaces between said first indentation and said forward end, and a spring-like tang attached to one of said side surfaces and being normally flexed so that its end extends above said top surface; a body of solder positioned in said recess; and a dimensionally heat unstable tubular member positioned over said forward end of said conductive member and said body of solder, said tubular member being heat recovered into intimate engagement with the bottom surface of said conductive member, the side surfaces thereof between said second indentations and the end of said tang, and the top surface between said body of solder and the end of said tang.

20. An electrical connector comprising an elongated electrically conductive member having side surfaces and top and bottom surfaces, a recess formed in said top surface adjacent the forward end of said conductive member and extending along an appreciable length thereof, a first indentation formed in each of said side surfaces approximately at the location of said recess, a second indentation formed in each of said side surfaces between said first indentation and said forward end; a body of solder positioned in said recess; and a dimensionally heat unstable tubular member positioned over said forward end of said conductive member and said body of solder, the longitudinal axis of said tubular member being substantially parallel to the longitudinal axis of said conductive member, said tubular member being heat recovered into intimate engagement with the bottom surface of said conductive member, the side surfaces thereof to the rear of said second indentations, and the top surface thereof to the rear of said body of solder whereby a space for receiving an electrical conductor is formed between said tubular member and said body of solder, said space being narrower in the vicinity of said body of solder than at the forward end of said conductive member.

21. An electrical connector comprising an elongated electrically conductive member having side surfaces and top and bottom surfaces, a recess formed in said top surface adjacent the forward end of said conductive member and extending along an appreciable length thereof, a first indentation formed in each of said side surfaces approximately at the location of said recess, a second indentation formed in each of said side surfaces between said first indentation and said forward end; a body of solder positioned in said recess; and a dimensionally heat unstable tubular member positioned over said forward end of said conductive member and said body of solder, the longitudinal axis of said tubular member being substantially parallel to the longitudinal axis of said conductive member, said tubular member being heat recovered into intimate engagement with the bottom surface of said conductive member, the side surfaces thereof to the rear of said second indentations, and the top surface thereof to the rear of and on either side of said body of solder, and being heat recovered toward the remainder of said top surface, said heat recovery being more pronounced in the vicinity of said body of solder than in the vicinity of the forward end of said conductive member whereby a space for receiving an electrical conductor is formed between said tubular member and the top surface of said conductive member, said space being more restricted at said body of solder than at said forward end of said conductive member whereby an electrical conductor inserted therein will be guided to said body of solder.

22. An electrical connection comprising an elongated electrically conductive member having side surfaces and top and bottom surfaces, a recess formed in said top surface adjacent the forward end of said conductive member, a first indentation formed in each of said side surfaces approximately coextensive with said recess, a second indentation formed in each of said side surfaces between said first indentation and said forward end, and a spring-like tang attached to one of said side surfaces and being normally flexed so that its end extends above said top surface; a body of solder positioned in said recess; and a dimensionally heat unstable tubular member positioned over said forward end of said conductive member and said body of solder, said tubular member being heat recovered into intimate engagement with the bottom surface of said conductive member, the side surfaces thereof, and the top surface thereof to the rear of said body of solder; and an electrical conductor having a conductive portion and an insulated portion positioned in the space between said tubular member and said conductive member with the conductive portion thereof immersed in said body of solder and the insulating portion thereof being intimately engaged by said tubular member.

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LEWIS H. MYERS, *Primary Examiner.*

D. L. CLAY, *Examiner.*