Nov. 7, 1961 R. C. SWENGEL 3,008,119

CRIMPED CONNECTION FOR ELECTRICAL WIRE

Filed Dec. 28, 1955

Fig. 1

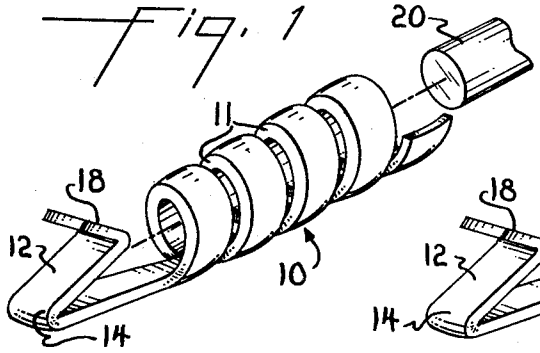


Fig. 2

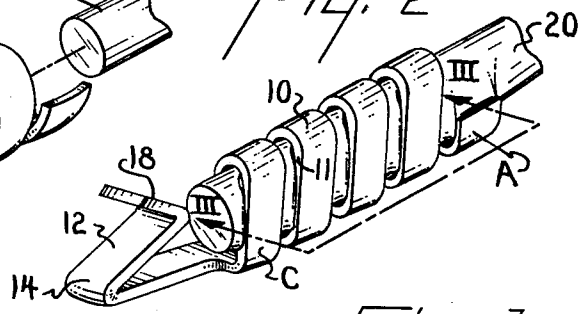


Fig. 3

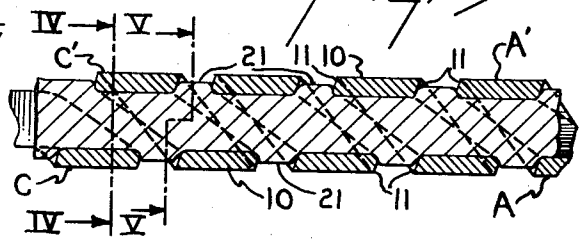


Fig. 4

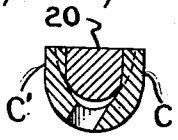


Fig. 5

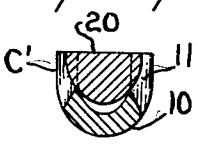


Fig. 6

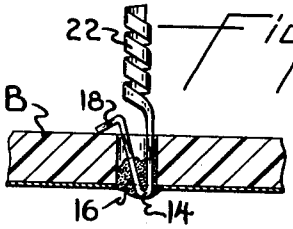


Fig. 7

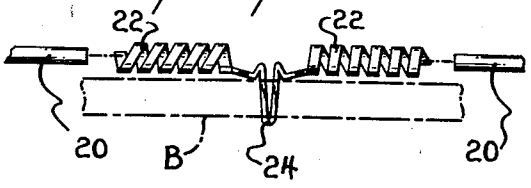


Fig. 9

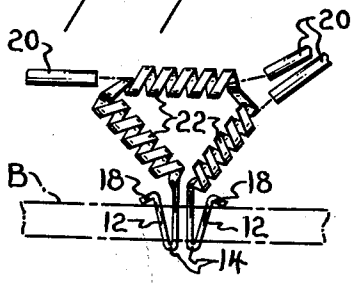


Fig. 8

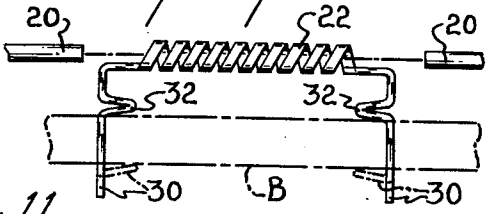


Fig. 10

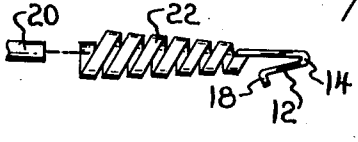
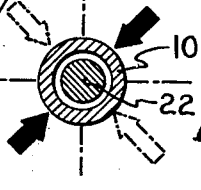


Fig. 11



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CRIMPED CONNECTION FOR ELECTRICAL WIRE

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7 Claims. (Cl. 339—276)

The requirements demanded of a connector used in securing a conductor to a printed circuit board are indeed stringent. Some of the factors involved include (1) expense, (2) strength, (3) ease and speed of application with standard tools, (4) low resistance, and (5) vibration resistance, among many others. Thus, it is an object of this invention to provide a connection that will excel in these qualities.

It is also an object of this invention to provide such a connection that will lend itself to automatic assembly.

Other important features and objects of the invention to which reference has not been made hereinabove will appear hereinafter when the following description and claims are considered with the accompanying drawings, in which:

FIGURE 1 shows a connector and conductor prior to assembly;

FIGURE 2 shows a connector and conductor secured together;

FIGURE 3 is a cross-sectional view taken through plane III—III of FIGURE 2;

FIGURES 4 and 5 are views taken through planes IV—IV and V—V respectively of FIGURE 3;

FIGURE 6 shows a connector soldered to a board;

FIGURES 7 and 8 show modifications for joining two wires together;

FIGURE 9 shows a modification for connecting three wires to each other and to a board;

FIGURE 10 shows another embodiment involving the principles set forth herein; and

FIGURE 11 is a diagrammatic view showing the relationship of the conductor to the connector and the pressure points involved.

A connector embodying the principles of this invention, as shown in FIGURE 1, includes a conductive helical element **10**. One end of this helical element is substantially Z-shaped as at **12**. The element **10** may be of constant diameter as shown in FIGURES 1 to 3, or may be tapered as shown in FIGURE 10, for easier insertion of the conductore **20** within the connector **10**.

As shown in FIGURE 1, one form of the connector, generally designated **10**, is a helically wound strip having an inner circumference slightly larger than the conductor **20** which it is designated to accommodate. The number of turns will depend upon the wire size, application, etc. However, for the smaller size wires generally used in conjunction with printed circuit boards, four or five turns is usually sufficient. The end **12** of the connector **10** engaging the printed circuit board is substantially Z-shaped, as shown in FIGURE 1, for reasons to be discussed.

The conductor **20** is secured to the connector **10** by disposing the conductor centrally of the connector and crimping or flattening opposite sides of the connector. As shown in FIGURE 11, pressure is brought to bear on opposed faces of the connector **10**. This operation may be performed by a pair of dies designed for the purpose or simply by the use of ordinary pliers.

Flattening the connector **10** in this manner serves to set up the following forces which cooperate to secure the conductor **20** to the connector **10**: (1) Compression of the turns of the connector **10**, which are at an angle to the longitudinal axis of the conductor **20**, causes longitudinal extension of the connector and a consequent reduction of the internal diameter of the connector. This lightly binds the conductor **20** within the connector **10**.

(2) Embedding the connector **10** effects a secure connection and prevents longitudinal retraction of the connector, whereby the forces for retaining contact are stored within the connector **10**. These factors cooperate to perfect a good strong connection between the connector **10** and the conductor **20**.

The Z-shaped end **12** of the connector is inserted into the printed circuit board designated "B." As shown in FIGURE 6, the doubled-over portion **14** of the connector is immersed in the solder **16** while the bend **18** holds the connector in position on the board. The fold at **18** permits a certain amount of flexibility to compensate for solidification of the solder. Hardening of the solder causes it to contract. If the connector **18** were rigidly secured to the board, cooling of the solder would place a strain on the connector, tending to crack it. This flexibility also prevents cracking due to difference in the coefficients of expansion of the solder and the connector. This permits the brass and solder to expand at different rates when temperature changes occur due to cycling, ambient changes, etc.

Additional flexibility is provided by crimping the connector **10** to the conductor **20** so that several uncrimped turns of the helix are provided between the crimped portions of the connector and the board. This in effect permits a spring action between the conductor and the board. Any vibration will be taken up by the spring. For example, in FIGURE 2 the conductor **20** is shown crimped over all four turns of the connector **10**. If the crimp had been made on the three upper turns of the connector **10**, the fourth turn of the connector **10** would provide a spring-like connection between the conductor **20** and the board. Vibration of the board would be dissipated by the spring, rather than tending to destroy or weaken the connection.

FIGURES 4 and 5 depict cross-sections taken through planes IV—IV and V—V respectively of FIGURE 3. It is noted from these figures that the connector embeds itself into the surface of the conductor along the areas deformed by the dies. A comparison of FIGURES 4 and 5 shows that a type of keyed connection is created between the connector **10** and the conductor **20** that tends to prevent them from being separated. As previously mentioned, the force resulting from longitudinal extension of the connector **10** which lessens the internal diameter of the connector when the crimp is made serves as the means for holding the connector and conductor **20** in a secure relationship. More particularly, the action which achieves the advantageous forceful engagement between the helical connector **10** and conductor **20** is as follows: crimping the helical connector **10** initially causes the helix to wind up and elongate axially whereby energy is imparted to the helix which tends to cause the helix to contract longitudinally when the crimping pressure is removed. The helix may be wound up in this initial action without substantial interference from conductor **20** because of the lesser diameter of the conductor wire. While the helix is thus wound up, the opposed portions A—A', C—C' of the turns are flattened and imbedded in conductor **20**, as shown in FIGURE 3, causing portions **21** of conductor **20** relatively to be interposed between the turns of the helix and in engagement with the turns at their side faces **11**, the side faces of a turn being the surfaces defining the stock thickness of the helical strip. Interposition of conductor portions **21** along side faces **11** serves to block the helix from contracting on release of the crimping pressure since the turns no longer can move relative to each other longitudinally. As a consequence, part of the energy imparted to the helix during crimping beneficially remains stored in the helix in the form of residual contact pressure between side faces **11** and conductor portions **21**.

An additional effect is achieved due to the crimping action. The strands of the connector **10** being embedded into the surface of the conductor **20** at an angle to the longitudinal axis thereof causes a sliding or "wiping" action that strips the oxide from the contact surface. This provides better conductivity between the conductor **20** and the connector **10**.

FIGURES 7 to 10 present embodiments adapting the principles of the invention to various uses. FIGURE 7 illustrates how a pair of conductors may be joined to each other and to the printed circuit board utilizing this invention. Each of the conductors **20** is fed into a helical strip **22** and the strips are crimped to the conductors. A V-shaped element **24** joins the helical strips and provides a means for securing these strips to the board. The V-shaped element has a pair of gull wings to provide resiliency between the connector and the board, similar to member **18** in FIGURE 1. It is observed that the connector may be formed from one integral strip. This connector may be used to secure two conductors together on a board without electrically joining the connector to the board. As shown in FIGURE 8, the V-shaped member **24** is omitted and the opposite ends **30** of the connector are secured to the board similar to a staple-type arrangement, i.e.: the ends **30** are fed through the board and then bent upwardly to clinch the connector to the board. The holding action is effected by cooperation of the clinched ends **30** and a folded portion of the conductor, as shown at **32**, which engages the upper surface of the board.

A plurality of conductors may be secured to each other and to the printed circuit board in a conductive relationship by means of a delta-shaped connector, as shown in FIGURE 9. Each conductor is fed into a portion of the helical strip and the connector crimped to the conductors. The free ends of the connector are then secured to the board in conductive relationship, as shown in FIGURE 1, or a staple-like arrangement, as shown in FIGURE 8. Of course, the connector may be two-sided, four-sided, five-sided, six-sided, etc., theoretically without limitation, rather than the three-sided configuration set forth in FIGURE 9. The greater the number of sides, the more conductors it will accommodate.

A connector embodying the principles of this invention will find wide employment in the field of printed circuits. It is especially adaptable to a lead wire joining an outside lead to a printed circuit board. The connector is inserted in place on the board and solder applied. When the connector is soldered to the board, the board is installed in the television set, or radio, or wherever its use is desired. When it is desired to join conductively the printed circuit board with the other elements of the device, a conductor is inserted into the strands of the connector and the connector deformed with a pair of pliers, or any suitable pressure means. Some of the advantages acquired by this connection include: (1) The crimp may be made at any angle. This is particularly important when the connection is to be made in close quarters. (2) Crimp may be made with ordinary tools (i.e. pliers). (3) A mechanically secure connection. (4) High electrical conductivity. (5) Inexpensive. (6) High vibration resistance due to its flexibility.

The size and composition of the connector will vary according to its end use. Ordinarily a connector of brass or bronze can be made on a standard spring winding machine.

I claim:

1. In an electrical connection with an electrical wire, coupling means comprising a helix formed of a strip of conductive metal rectangular in cross-section, the turns of the helix having an appreciable spacing therebetween and surrounding the end of said wire, portions of said wire extending between said turns, the helix being elongated beyond its relaxed length and thus flexed with the side faces of said turns being in spring pressure engagement with portions of said wire extending between said turns, said portions blocking longitudinal relaxation of the helix toward its relaxed length, and an integral contact element extending from an end turn of the helix.

2. The electrical connection of claim 1 wherein the portions of said wire extending between the turns present substantially flat transverse surfaces in face-to-face engagement with said side faces of the turns of the helix.

3. The device of claim 1 wherein the helical element when relaxed in internally tapered.

4. In an electrical connection with an electrical wire, coupling means comprising an oblate helix formed of a strip of conductive metal rectangular in cross-section, the turns of the helix having an appreciable spacing therebetween and surrounding the end of said wire with the more nearly flat portions thereof being embedded in the wire so that portions of said wire extend transversely therebetween, the helix being elongated beyond its relaxed length and thus in flexure urging the side faces of said turns into pressure engagement with the portions of said wire which extend between the turns, and an integral contact element extending from an end turn of the helix.

5. The method of making an electrical connection between an electrical wire and a helical strip of resilient conductive metal, the helix having an appreciable spacing between the turns thereof, including the steps of inserting coaxially into the helix an electrical conductor wire of lesser diameter than the helix, applying an external stress to the helix to alter its length, displacing portions of the wire at a plurality of spaced points along the length and between the turns of the helix and in engagement with the side faces of the strip, and removing the externally applied stress whereby relaxation of the helix toward its original length subjects the points of engagement on the wire to spring pressure.

6. The method of making an electrical connection between an electrical wire and a helical strip of resilient conductive metal, the helix having an appreciable spacing between the turns thereof and a larger initial diameter than the wire, including the steps of disposing the wire coaxially within the helix, stressing the helix to alter its length, and while the helix is thus altered embedding a plurality of turns of the helix at opposed points into the wire to displace portions of the wire to between the turns of the helix and in engagement with the side faces of the strip whereby the tendency of the helix to relax toward its original length on release of the applied stress subjects the points of engagement on the wire to spring pressure.

7. The method of making an electrical connection between an electrical wire and a helical strip of resilient conductive metal, the helix having an appreciable spacing between the turns thereof, including the steps of: disposing the wire within the helix; stressing a plurality of turns of the helix by closing thereon a pair of opposed substantially planar die surfaces first to elongate the helix and reduce the turn diameter, and secondly to flatten the helix transversely and to deform portions of the wire to between the turns and in engagement with the turn side faces at least in the flattened portions of the helix, whereby the tendency of the helix to relax toward its original configuration on release of the applied stress will be resisted by interposed portions of the wire.

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