April 16, 1957 E. M. SORENG 2,789,278

ELECTRICAL CONNECTION AND METHOD OF MAKING THE SAME

Filed May 1, 1953

Fig. 1.

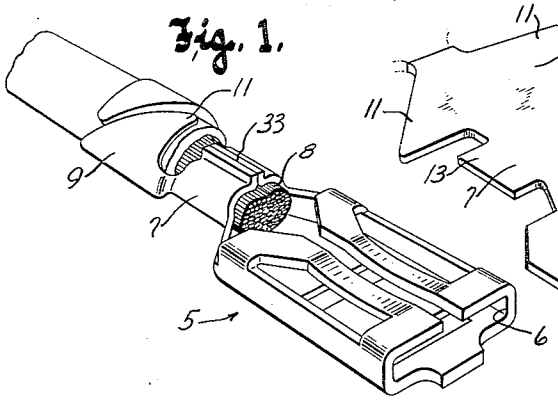


Fig. 2.

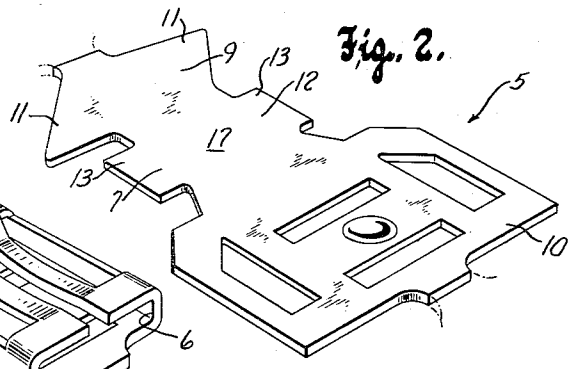


Fig. 3.

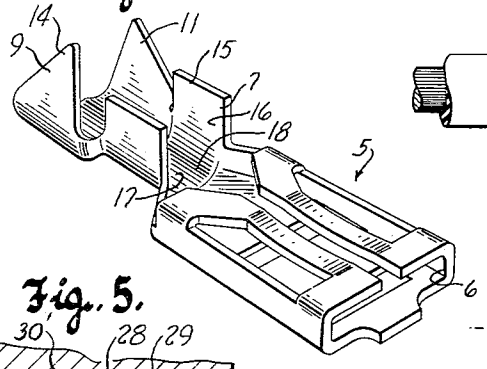


Fig. 4.

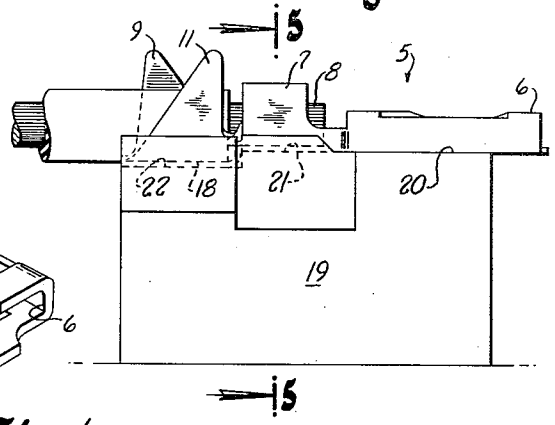


Fig. 5.

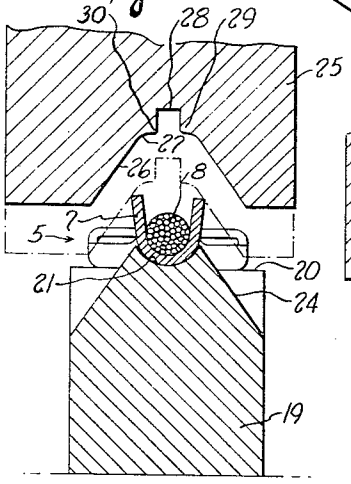


Fig. 6.

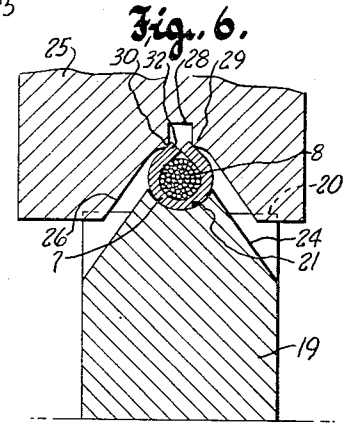
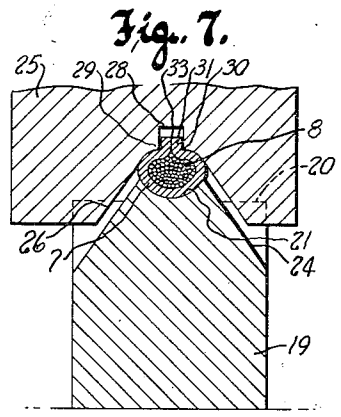


Fig. 7.



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2,789,278

ELECTRICAL CONNECTION AND METHOD OF MAKING THE SAME

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Application May 1, 1953, Serial No. 352,564

3 Claims. (Cl. 339—276)

This invention relates to electrical connectors and refers more particularly to a method and means for securing an electrical terminal connector to a multi-strand conductor.

In general, it is the object of this invention to provide an improved clinched connection between a multistrand conductor and an electrical terminal connector element. This invention is applicable to any of the many types of electrical terminal elements which are formed from relatively light sheet metal stampings and may be either the well-known solderless connectors used to fasten a wire to a binding post or one of a pair of cooperating male and female connectors that can be employed to establish a good mechanical and electrical connection of a conductor with another conductor or with a terminal on an electrical instrumentality. As a rule the male and female elements of the latter type of connectors are readily disconnectable from one another. An example of a separable connector of the type to which this invention has particular applicability is shown in the copending application of Edgar M. Soreng, Serial No. 315,524, filed October 18, 1952, now U. S. Patent 2,701,350, of which this is a continuation in part.

It will be observed that in said copending application the female socket element of the separable electrical connector is shown as having an integral ferrule in which a bare end portion of a multi-strand conductor is permanently secured. The novel solderless connection between the ferrule and conductor in that application forms the subject matter of the present invention.

It is thus a more specific object of this invention to provide a solderless ferrule connection between a terminal connector of the character described and a bare end portion of a multi-strand conductor, which connection will have excellent electrical characteristics and high mechanical strength.

Another object of this invention resides in the provision of a ferrule for an electrical terminal connector of the character described which will very securely grip a bare end portion of a multi-strand conductor extending therethrough and make an excellent mechanical and electrical connection therewith, and in which the ferrule is deformed during its application to the conductor in a manner which will securely and permanently compress the strands of the conductor but nevertheless entail no risk of cutting any of the conductor strands.

Still another object of this invention resides in the provision of a method of clinching to a multi-strand conductor a ferrule of the character described, which method entails the deformation of the ferrule blank by relatively simple and inexpensive apparatus and assures that such deformation of the ferrule, while resulting in a good mechanical and electrical connection between the ferrule and the conductor, will not result in the cutting of any of the conductor strands.

With the above and other objects in view, which will appear as the description proceeds, this invention resides in the novel method and construction, combination and arrangement of parts substantially as hereinafter described

and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the hereindisclosed invention may be made as come within the scope of the claims.

The accompanying drawing illustrates one complete example of the physical embodiment of the invention practiced and constructed according to the best mode so far devised for the practical application of the principles thereof, and in which:

Figure 1 is a perspective view of an electrical terminal connector having a ferrule of this invention providing the connection between the connector and a multi-strand conductor;

Figure 2 is a perspective view of a blank from which the Figure 1 electrical connector may be formed;

Figure 3 is a perspective view of the blank of Figure 2 formed up preparatory to receiving a conductor to be connected therewith;

Figure 4 is a side view of a fixed die block having the Figure 3 connector in place thereon and with a multi-strand conductor located in the ferrule portion of the connector and in position to be secured therein; and

Figures 5, 6 and 7 are cross-sectional views taken on the plane of the line 5—5 of Figure 4 and showing the tool by which the ferrule is clinched to the conductor in accordance with the present invention, the several figures depicting the successive steps or stages in the clinching process.

Referring now more particularly to the accompanying drawing in which like numerals designate like parts throughout the several views, the numeral **5** designates generally one element of a readily separable electrical terminal connector, in this case the female or socket-forming element. The male element (not shown) is endwise insertable into the socket portion **6** of this connector, and for a more detailed description of the male connector element and of its cooperation with the socket-like female element **5**, reference may be made to the aforesaid copending application of Edgar M. Soreng. It should be noted, however, that this specific type of socket is shown in the present case merely for purposes of illustration and that the connection of this invention lends itself to a wide variety of electrical terminal elements of the type which are stamped from sheet metal.

At the rear of the socket portion **6** and integral therewith is a ferrule **7**, through which the bare end portion **8** of a multi-strand conductor extends and in which it is clinched to establish a good mechanical and electrical connection between the conductor and the terminal element. Preferably, but not necessarily, the terminal element has an integral securement portion **9**, behind the ferrule, clinched around the insulated portion of the conductor adjacent to the bare end thereof to further assure a good mechanical connection between the conductor and the terminal element and to prevent the insulation on the conductor from being pulled back along the wire.

The terminal element is formed up from a unitary blank (Figure 2) which comprises a relatively simple sheet metal stamping. The socket forming portion **10** is at the front of the blank; the prongs **11** which are clinched around the insulation of the conductor to form the securement **9** are at the rear thereof; and the ferrule forming portion **12** comprises the intermediate portion of the blank and includes tab-like extensions **13** projecting laterally in opposite directions. Before the terminal element is secured to a conductor it is formed up as shown in Figure 3, with the socket portion completely formed but with the securement portion and the ferrule portion bent to U-shaped cross-sections, as at **14** and **15** respectively.

The ferrule portion of the connector element thus

provides a trough, the sides **16** of which may be said to comprise upright arms projecting upwardly from a longitudinally central zone **17** which forms the bottom of the trough. The bottom **18** of the securement portion is stepped downwardly, as viewed from the side, to accommodate the additional thickness of the insulation on the conductor and thereby dispose the insulated and bared end portions of the conductor coaxially with one another when the terminal element is secured to the conductor.

In securing the terminal element to a conductor, the terminal element is placed on a fixture **19** which securely holds it during the succeeding operation and which comprises an anvil or fixed die block having a substantially flat face **20** upon which the socket portion rests, a concave face **21** immediately behind the flat face and in which the bottom of the ferrule forming trough rests, and a second concave face **22**, stepped down below the face **21** a distance corresponding to the step between the ferrule and securement portions and in which the bottom of the latter is of course received. The sides of the fixed die block taper upwardly toward these concave faces, as at **24**, to accommodate a cooperating movable die block **25** which descends toward the fixed block to effect the clinching operation by which the terminal element is secured to the conductor.

The movable die block is in effect a female die member and has a cavity therein opening to its underside and defined by upwardly converging flat sides **26** which are filleted, as at **27**, into the flat bottom of the cavity. Centrally of the converging sides and slightly inwardly from the fillets a slot **28** opens to the flat bottom of the cavity so as to define opposite, downwardly facing flat shoulders **29** in the bottom of the cavity spaced apart the width of the slot. The corners **30** defined by the junctions of these shoulders with the sides of the slot are slightly chamfered, for reasons which will appear presently. The width of the slot is substantially equal to twice the thickness of the stock from which the terminal element is formed.

With the bared end of a conductor disposed in the trough-like ferrule portion (the terminal element being in place on the fixed die block) the movable die block is moved downwardly into engagement with the terminal element. Upon initial contact of the movable die block with the terminal element (as shown in construction lines in Figure 5) the upper ends of the upstanding arms of the trough are engaged by the flat portions **26** of the converging surfaces in the cavity, and as the movable die block continues to descend these converging surfaces cam the upper end portions of the arms inwardly, toward one another, curling the arms around the conductor until all of the inner surface of each arm with the exception of a small part at the top thereof is in snug contacting engagement with the conductor. At the conclusion of this phase of the operation, shown in Figure 6, the upper ends of the arms are in contacting engagement above the conductor, as at **32**, having been moved the last part of the way into this position by the corners **30** engaging the outer surfaces of the arms and camming them toward one another. It will be seen that because the corners **30** are chamfered they can slide along the arms, rather than biting into them, and the chamfering thus facilitates this phase of the operation.

Attention is directed to the fact that the upper end portions of the arms extend into the slot at the time the upper ends of the arms engage one another. As the upper, movable die block continues to descend, the engagement of the corners with the arms, just below the top edges of the arms, bends the top portion of the arms into flat surface-to-surface engagement with one another, the upper portions of the arms being in effect squeezed up into the slot to form a pair of flanges **31**, and the slot thus holds the arms against separation during this phase of the operation. At the same time that the flanges are

being formed, the shoulders **29** press the portions of the arms just below the corners **30** downwardly into engagement with the strands of the conductor. As the movable die block continues its descent these shoulders **29** flatten the ferrule out of roundness, to thus reduce its internal cross-sectional area while at the same time its periphery remains substantially constant by reason of the fact that the slot in the movable die block holds the free ends of the arms against separation, as just described. This reduction in internal cross-sectional area of the ferrule will of course result in a substantial compression of the strands of the conductor which assures a good mechanical and electrical connection between the ferrule and the wire.

It will be observed that the chamfering of the corners **30** prevents the movable die block from cutting off the flanges **31** on the top of the ferrule and has the further very important effect of bending the flanges outwardly from the ferrule on a radius which, although quite small, nevertheless presents a curved inner surface to the strands of the conductor in the neighborhood of the top of the ferrule, so that there is no possibility of any sharp portion of the ferrule cutting into the conductor strands during the clinching operation or as a result of that operation.

It will be noted, incidentally, that the tapering sides **24** of the fixed die block are disposed at an angle corresponding to the angle of the flat sides **26** in the die cavity, so as to afford clearance for the travel of the movable die, although the die blocks preferably do not engage one another during the clinching operation. It will also be noted that the depth of the slot **28** is not material so long as it is deep enough to enable the upper end portions of the arms to be squeezed up into it during the last phase of the clinching operation to provide the external flanges **31**.

Although the ferrule formed according to this invention has a seam **33** extending longitudinally along the center of its top wall, it is nevertheless effectively a closed tube because of the flat surface-to-surface abutment of the radially outwardly projecting flanges **31** which thus provide, in effect, a pair of lips extending along the length of the seam.

Obviously the prongs **11** may be curled and clinched around the insulated portion of the conductor to form the securement **9** simultaneously with the operation by which the ferrule is clinched around the bare end portion thereof, the configuration of the portion of the movable die block by which this is accomplished being readily discernible to those skilled in the art.

From the foregoing description, taken together with the accompanying drawing, it will be apparent that this invention provides a ferrule by which a solderless connection between a multi-strand conductor and an electrical terminal element may be obtained, which connection will have good mechanical and electrical properties, particularly by reason of the fact that the ferrule will not have any tendency to cut the strands of the conductor. It will also be apparent that the invention provides a method of forming up such a ferrule and clinching it onto a conductor in an expeditious manner involving only simple and inexpensive tools.

What I claim as my invention is:

1. The method of making an electrical connection which comprises: inserting a multistrand conductor into a trough-like ferrule portion of a sheet metal blank having integral arms projecting upwardly at opposite sides thereof to define the sides of the trough with the conductor extending lengthwise of the trough axis; curling said arms toward one another around the conductor to bring their upper ends into contacting engagement with one another and to bring most of the inner surface of said arms into snug contacting engagement with the conductor; and applying radially inward pressure to both of said arms simultaneously at localized areas slightly below their upper edges to bend the upper marginal edge portions of the arms into

flatwise engagement of their inner faces with one another outside the ferrule and to flatten the portions of said arms adjacent to said upper marginal edge portions downwardly into compressing engagement with the strands of the conductor.

2. The method of making an electrical connection which comprises: inserting a multistrand conductor into a trough-like ferrule portion of a sheet metal blank having integral arms projecting upwardly at opposite sides thereof to define the sides of the trough; curling said arms toward one another around the conductor to bring their upper ends into contacting engagement with one another and to bring most of the inner surface of said arms into snug contacting engagement with the conductor; bending the upper end portions of the arms into flat surface to surface engagement with one another; and while holding the upper end portions of the arms flatwise together outside the ferrule, simultaneously flattening the upper portion of the ferrule, to thereby decrease the cross-sectional area of the ferrule while preventing any increase in its periphery, thus compressing the ferrule into firm clinching engagement with the conductor.

3. An electrical connection comprising an electrical conductor having a bare terminal portion and a connector member attached thereto, the connector member having at one end a connector element adapted to receive a complemental connector part, said connector member also including a ferrule element embracing the bare portion of the electrical conductor in electrical contact therewith, the ferrule comprising a pair of arms integral with the connector element and embracing the bare terminal portion of the conductor with the free terminal portions of said arms bent radially outward and disposed with their inner surfaces in face to face contact with each other to form an outwardly projecting, longitudinally extending rib, the ferrule and the conductor embraced thereby, being deformed inwardly at the base of said rib on opposite sides thereof and substantially throughout the longitudinal extent thereof to insure good electrical contact between the ferrule and conductor and between the contacting faces of the terminal portions of said arms throughout the length of the rib.

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