Oct. 11, 1966 W. H. FRANK ETAL 3,277,560

METHOD OF MAKING A PLUG-IN CONNECTOR

Original Filed Dec. 28, 1956

FIG. 1.

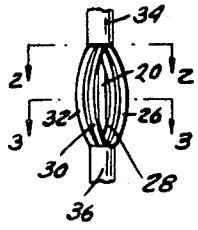


FIG. 4.

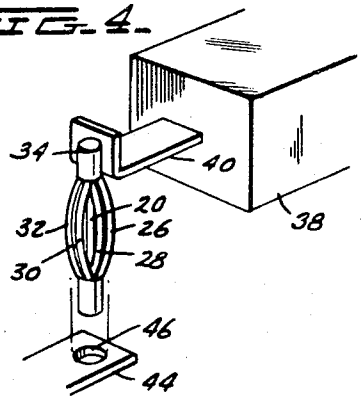


FIG. 6.

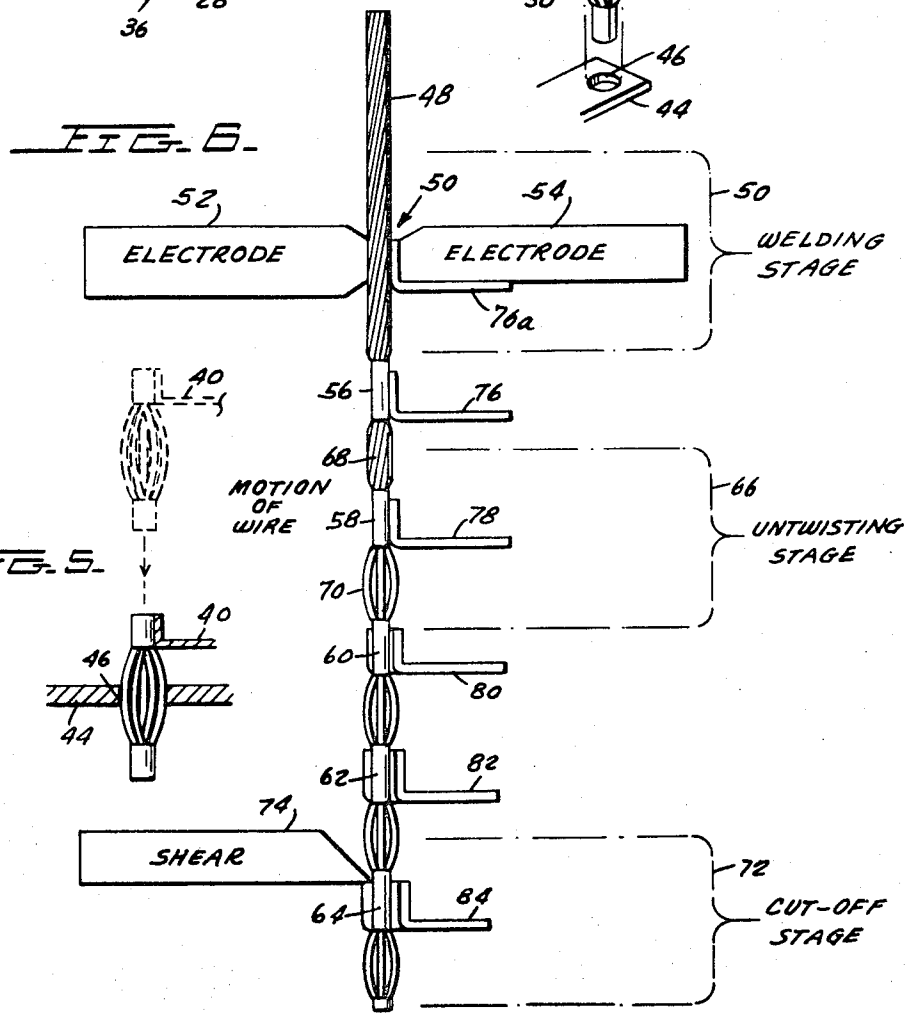


FIG. 5.

FIG. 2.

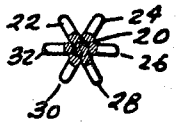
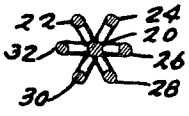


FIG. 3.



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United States Patent Office

3,277,560
Patented Oct. 11, 1966

3,277,560

METHOD OF MAKING A PLUG-IN CONNECTOR

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Original application Dec. 28, 1956, Ser. No. 631,090, now Patent No. 3,017,605. Divided and this application May 2, 1961, Ser. No. 107,162

13 Claims. (Cl. 29—155.55)

This invention is a division of our copending application Serial No. 631,090 filed December 28, 1956, now Patent No. 3,017,605 and relates to a novel method of manufacture of a male plug-in connector.

In the past, male plug-in connectors of small size utilized spring type devices for obtaining contact pressure and were difficult to manufacture. Thus, connectors of this type have usually relied on the temper of the material employed to obtain the self-biasing effect for achieving the required contact pressure. Even this, however, has been difficult since it is usually necessary to utilize a non-ferrous type of material to achieve the desired electrical conductivity, these materials usually being relatively low in mechanical strength.

The primary object of our invention is to provide a compact, rugged and low cost connector than can be made of inexpensive non-ferrous metal of good conductivity which lends itself to simple manufacturing techniques and has adequate mechanical strength for providing necessary flexibility to achieve the required mechanical contact pressure.

In essence our novel plug-in connector is comprised of a plurality of strands of conducting wire which could be of a copper alloy material wherein a center strand is surrounded by a plurality of external strands. Each of these strands are fastened together or joined by welding or any other desired means at specific points, the center strand being shorter than the strands surrounding the center strand. Accordingly, the central strand is placed in tension and the external strands in compression and the external strands will bow out at their center so that the length between their their two ends will be the same as that of the shorter center strands. Hence the outer strands of our novel plug-in connector which are inexpensive and of a high conductivity material, may serve as self-biased spring members when inserted into a cooperating female type connector. That is to say, since the strands are bowed outwardly, they are forced towards the center strand when being plugged into a female connector having a diameter which is less than the diameter formed by the bowed strands and there will be mechanical stresses set up in the bowed strands causing a strong contact engagement with respect to the internal surfaces of the female connector.

One novel method by which our novel plug-in connector can be manufactured is to take a length of spirally twisted strands which surround a central strand and to weld the strands together at predetermined lengths along the length of the bundle of strands to form a plurality of connectors having a length determined by the distance between the welded points. After welding, the bundle of strands may then be unravelled so that each of the strands are substantially parallel to the central strand whereby the length of the external strands will exceed the length of the center strand and therefore bow outwardly to form our novel plug-in connector. The connectors may then be cut at their welded points so as to form male connectors which can be subsequently fastened to electrical apparatus in any desired manner.

It is noted that strands of copper wire are usually cold worked to their desired cross-sectional area. This cold working imparts a degree of hardness and also increases resiliency. On the other hand prior art plug-in connectors have, for the most part, been constructed of stampings from sheet material. In order to perform a clean stamping operation it is necessary to use material which is more ductile than strands of wire. Hence, plug-in connectors of the prior art did not have the desirable resilient properties of a device constructed by applicant's novel method.

Accordingly, the primary object of our invention is to provide a novel method of manufacture for a male plug-in connector.

Another object of our invention is to provide a novel method of manufacture of a male plug-in connector wherein a plurality of strands are first wound around a center strand and are welded thereto at a first and second point and the strands are thereafter unwound whereby the strands surrounding the center strand will be forced to bow outwardly.

Still another object of our invention is to provide a novel method of manufacture, for a male plug-in conductor, which is inexpensive and simple to carry out.

A further object of our invention is to provide a novel method of manufacture for a male connector which affords multiple contact surfaces around its circumference.

These and other objects of our invention will become apparent when taken in connection with the drawings and the following description in which:

FIGURE 1 is a side view of our novel invention.

FIGURE 2 is a cross-sectional view of FIGURE 1 when taken across the lines 2—2.

FIGURE 3 is a cross-sectional view of FIGURE 1 when taken along the lines 3—3.

FIGURE 4 shows one application of our novel invention in a perspective view with the plug-in connector of one electrical component about to be plugged into a cooperating female connector.

FIGURE 5 shows a side cross-sectional view of a portion of FIGURE 4 where our novel plug-in connector is shown in dotted lines in a disengaged position and in solid lines in the engaged position.

FIGURE 6 is a diagram illustrating the manufacture of our novel plug-in connector.

Referring now to the FIGURES 1, 2, and 3 it is seen that our novel plug-in connector is comprised of a central conducting strand **20** which is encompassed by a plurality of encompassing strands **22**, **24**, **26**, **28**, **30**, **32** wherein the strands **22** through **32** run in a direction which is substantially parallel to the central conducting strand **20**. Each of the strands is then connected at a first and second axially displaced point **34** and **36**, respectively, by welding or by any other desired fastening means. Strand **20**, however, is constructed, as will be seen hereinafter with reference to FIGURE 6, to have a shorter length between points **34** and **36** than at least one of and preferably all of the encompassing strands **22** through **32**. Hence, the strands **22** through **32**, in view of their longer length, will be forced to bow outwardly as seen in FIGURE 1.

It is to be clearly noted that while the embodiment of FIGURES 1, 2 and 3 show our novel invention when utilizing six encompassing strands that any number of encompassing strands could be utilized.

One application of our novel plug-in connector is set forth in FIGURE 4 where a piece of electrical apparatus schematically illustrated as block **38** has an electrical terminal **40** extending out therefrom. The electrical apparatus **38** could be any type of apparatus utilizing plug-in connectors and their terminals. A plug-in connector of the type of FIGURE 1 is fastened to the output terminal **40** at the point **34** by means of welding or any desired clamping so that the plug-in connector is rigidly

fastened in electrical and mechanical contact to the terminal **40**. The electrical apparatus **38** may then be connected to an associated piece of electrical apparatus or a line conductor or load conductor **44** which has an aperture **46** therein which forms a cooperating female plugging connector.

In the disengaged position as shown in FIGURE 5 which is a side view of FIGURE 4, the encompassing strands **26, 28, 30, 32** as well as the strands not shown in this figure are bowed out to an outer diameter which is determined by the difference between these encompassing strands and the length of the central conductor. When, however, they are moved to the engaged position and inserted in aperture **46** as shown in the solid view of FIGURE 5 the strands are forced inwardly so as to set up internal stresses which operate as biasing forces to bias each individual strands into rigid contact engagement with at least a portion of the inner periphery of aperture **46** to thereby form a good electrical connection between terminal **40** and terminal **44**.

It is to be noted that while the plug-in connector set forth herein is a preferred embodiment, it shows the encompassing strands as being substantially parallel to the center strand. The encompassing strands could still be helical in configuration with respect to the center strand, the only limitation being that the length of the helical strand, when measured to the axis of the helix, is longer than the length of the central restraining strand which keeps the encompassing strands in their bowed position.

In manufacturing our novel plug-in connector an elongated stranded conductor **48** (FIGURE 6) which comprises a plurality of encompassing strands surrounding a central strand is positioned to be fed, as is shown in FIGURE 6, in a downwardly position so that it will first pass the welding stage indicated generally at **50** wherein a first and second electrode **52** and **54**, respectively, engage either side of stranded conductor **48** to pass a high current therethrough in any of many well known manners whereby each of the plurality of encompassing strands and the central strand will be welded together. Thus, in FIGURE 6 points **56, 58, 60, 62** and **64** have been previously welded. The wire then moves into an untwisting stage **66** where for the case of stranded conductor **48** the conductor is unraveled in a clockwise direction so that the encompassing strands at portion **68**, between welding portions **56** and **58**, will be unraveled and, because of the central strand, will be forced to bow out as is seen for portion **70** which has already been unraveled. The unraveled strands then move further in a downwardly direction and into a cut-off stage **72** wherein a shear **74** is brought into engagement with welded portion **64** to cause a shearing thereof and production of a single plug-in connector of our novel invention.

It is to be noted that the mechanism utilized in either the welded stage **50**, the untwisted stage **66** or the cut-off stage **72** could be of any of many well known structures and will not be set forth herein.

While FIGURE 6 sets forth a method of construction wherein the encompassing wires are untwisted at untwisting stage **66** so that the encompassing wires will lie in a direction which is substantially parallel to the direction of the center strand. The wires could be untwisted to an extent where they will still form a helix having a portion of the helix biased into contact engagement with a mating connector, without departing from our novel invention.

If desired, the terminal conductor can be welded to its respective connector at the same time the strands are welded together. Thus, in FIGURE 6 it is seen that terminal **76***a* is positioned between electrode **54** and stranded conductor **48** and is welded to the conductor at the same time the strands are welded together.

As a result of this process, point **58** has terminal **78** welded thereto and similarly terminals **80, 82** and **84** have been welded at points **60, 62** and **64**, respectively.

Their terminals **76, 78, 80, 82** and **84** can be advantageously used in the untwisting stage **66** if desired since they will act as levers with one maintained stationary and the other rotated. By way of example, conductor **70** which is in the untwisting stage in FIGURE 6 could pass through any desired mechanism whereby terminal **78** is maintained stationary while terminal **80** is rotated into the plane of the drawing to the position shown to thereby untwist the outer strands of the conductor.

In the foregoing we have described our invention solely in connection with specific illustrative embodiments thereof. Since many variations and modifications of my invention will now be obvious to those skilled in the art, I prefer to be bound not by the specific disclosures herein contained, but only by the appended claims.

We claim:

1. The method of making male plug in connectors comprising the steps of welding encompassing conductor strands would about a central strand to said central strand at predetermined axial points, unwrapping said encompassing conductor strands to cause said strands to bow out and run in a direction substantially parallel to said central strand and thereafter separating individual male plug in connectors by cutting through said welded points.

2. The method of making male plug in connectors comprising the steps of welding encompassing conductor strands wound about a central strand to said central strand at predetermined axial points, unwrapping said encompassing conductor strands to cause said strands to bow out and thereafter separating individual male plug in connectors by cutting through said welded points.

3. The method of making a male plug in conductor comprising the steps of wrapping a plurality of strands of conducting material about a central strand, fixedly fastening said wrapped plurality of strands to said central strand at a first and second axially displaced point, and thereafter unwrapping said plurality of wrapped strands to cause them to bow outwardly.

4. The method of making a male plug in conductor comprising the steps of wrapping a plurality of strands of conducting material about a central strand, fastening said wrapped plurality of strands to said central strand at a first and second axially displaced point, and thereafter unwrapping said plurality of wrapped strands to cause them to bow outwardly and run in a direction substantially parallel to said central strand.

5. The method of making male plug in connectors comprising the steps of welding encompassing conductor strands wound about a central strand to said central strand at predetermined axial points and simultaneously welding a terminal member at said points, unwrapping said encompassing conductor strands to cause said strands to bow out and run in a direction substantially parallel to said central strand and thereafter separating individual male plug in connectors by cutting through said welded points.

6. A method of fabricating a pin connector for use with a cooperating socket connector of a given inside diameter, characterized by the steps of: winding a plurality of resilient metal wires helically around at least one elongated member to form a pin element of less diameter than said given diameter; fixedly connecting the opposite ends of the helical wires to the corresponding ends of the member; and expanding the diameter of the pin element by twisting the pin element in the direction to reduce the number of helical turns of the plurality of wires without eliminating the helical turns to make the pin resiliently radially contractible.

7. A method of fabricating a pin connector for use with a cooperating socket connector, characterized by the steps of: winding a plurality of metal wires helically around at least one elongated member to form a pin element comprising an axial core surrounded by a cluster of

helically formed wires; fixedly connecting one end of the core to the corresponding ends of the helical wires at one end of the pin element; fusing together the other end of the core and the other ends of the helical wires whereby said fused-together core and said ends of the wires ultimately form a solid nose on the other end of the pin element; and forcing said helical wires radially outward from the core to bowed configuration to make the pin element resiliently radially contractible.

8. A method of fabricating a pin connector for use with a cooperating socket connector, characterized by the steps of: winding a plurality of metal wires helically around at least one elongated member to form a pin element comprising an axial core surrounded by a cluster of helically formed wires; fixedly connecting the opposite ends of the helical wires to the corresponding ends of the core; and forcing said helical wires outward from the core to permanently bowed configuration to increase the diameter of the pin element and make the pin element resiliently radially contractible.

9. A method of fabricating a pin connector for use with a cooperating socket connector characterizezd by the steps of: helically winding a plurality of wires around a core consisting of at least one wire to form a composite wire strand comprising multiple end-to-end units of pin material; permanently interconnecting the helical wires and the core at one end of each unit; applying heat to the other end of each unit to fuse the core of the unit to the surrounding helical wires to form a solid body on the end of the unit to ultimately serve as a nose for a pin connector; forcing the helical wires of each unit radially outward from the core to permanently bowed configuration to increase the diameter of the unit and to make the unit yieldingly radially contractible; and severing said units from the strand to provide pin connectors.

10. A method of fabricating a pin connector for use with a cooperating socket connector, characterized by the steps of: helically winding a plurality of wires around a core consisting of at least one wire to form a composite wire strand comprising multiple end-to-end units of pin material; fusing together the plurality of wires and the

core at one end of each of the units to form a solid body to ultimately serve as one end of a pin connector; fusing together the core and the plurality of wires at the other end of each unit to form a solid body to serve as a second end of a pin connector; forcing the plurality of wires radially outward from the core of each unit to bowed configuration to increase the over-all diameter of the unit and make the unit yieldingly radially contractible; and severing said units from said strand.

11. A method of fabricating pin connectors, including the steps of: bringing together a plurality of wires to form a composite strand of multiple times the length of a single pin connector, thereby providing an end-to-end series of integrally interconnected units of material for connector pins; connecting together all the wires at one end of each unit; fusing together all of the wires at the other end of each unit to form a solid nose for the leading end of a pin connector; radially expanding each of the units of material by forcing wires of the unit outward to bowed configuration; and severing the units from the composite strand.

12. A method as set forth in claim **11** in which the wires are bowed outward to helical configuration.

13. A method as set forth in claim **11** in which the step of connecting together all of the wires at said one end of each unit is carried out by fusing all of the wires together.

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