July 30, 1968 A. LOGAN 3,394,454

METHODS OF MAKING INSULATION-PENETRATING CLIP-TYPE ELECTRICAL CONNECTORS

Original Filed June 4, 1963 2 Sheets-Sheet 1

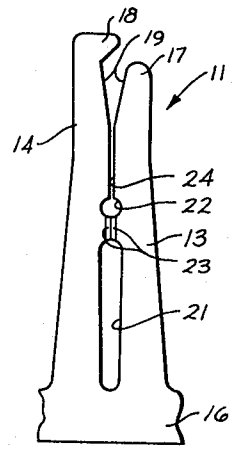


FIG. 1

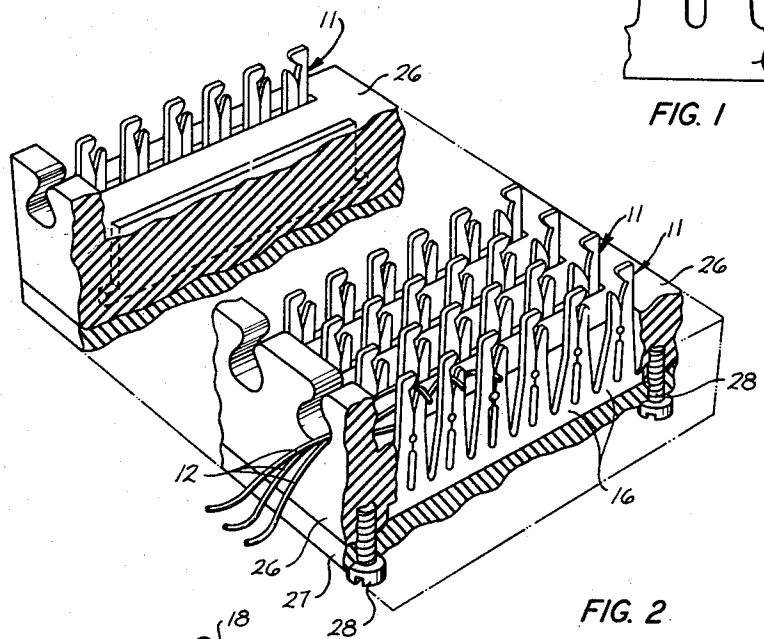


FIG. 2

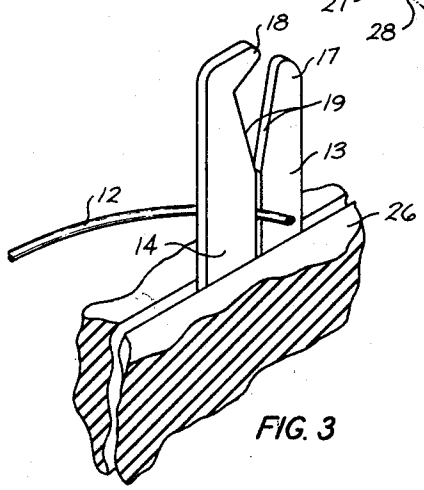


FIG. 3

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METHODS OF MAKING INSULATION-PENETRATING CLIP-TYPE ELECTRICAL CONNECTORS

Original Filed June 4, 1963 2 Sheets-Sheet 2

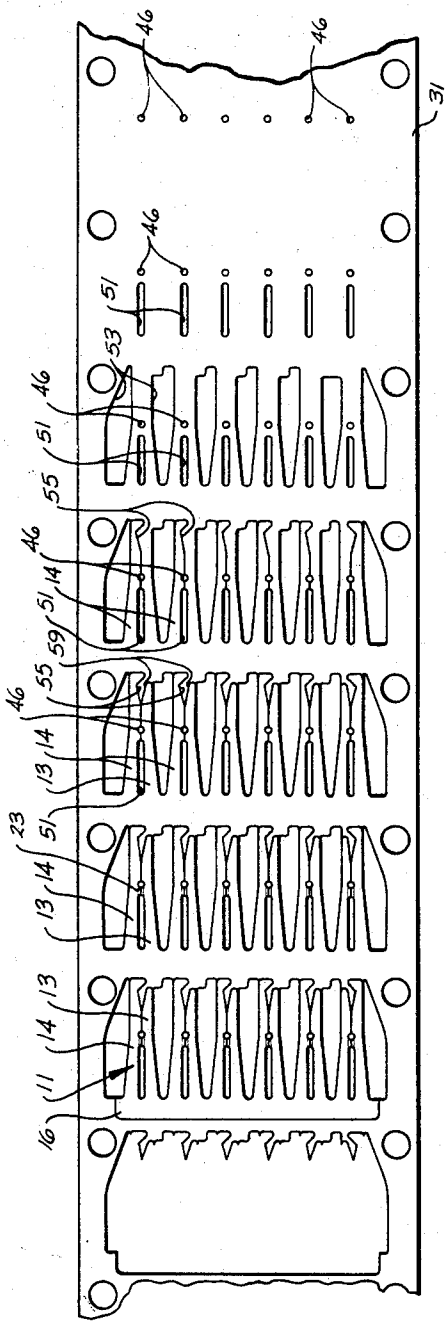


FIG. 5

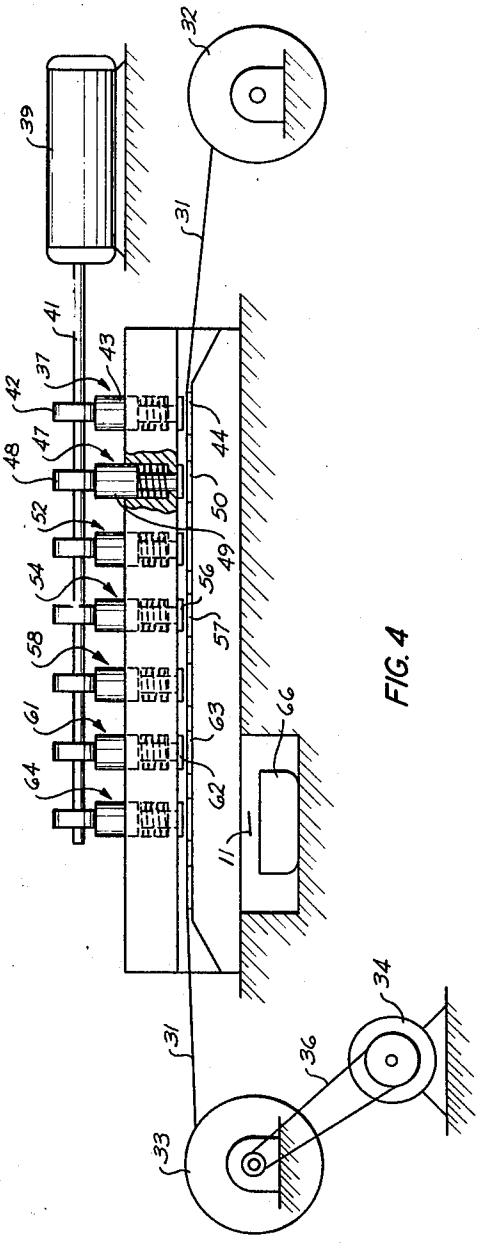


FIG. 4

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3,394,454

METHODS OF MAKING INSULATION-PENETRATING CLIP-TYPE ELECTRICAL CONNECTORS

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Original application June 4, 1963, Ser. No. 285,339, now Patent No. 3,234,498, dated Feb. 8, 1966. Divided and this application July 6, 1965, Ser. No. 478,513
3 Claims. (Cl. 29—629)

ABSTRACT OF THE DISCLOSURE

A method of making an electrical connector having a pair of juxtaposed jaws for receiving an insulated conductor therebetween which ruptures and penetrates the insulation to make electrical contact between the connector and the conductor including the step of forming the jaws in abutting engagement along adjacent edges thereof with the jaws joined at one end and free at the other end. Adjacent portions of the abutting edge of each jaw are deformed plastically toward the adjacent jaw to spread apart the free ends of the jaws. Additionally, a corrosion-resistant material may be deposited onto at least the opposed, adjacent edges of the free ends of the jaws.

This is a division of application Ser. No. 285,339, filed June 4, 1963 and now Patent No. 3,234,498.

This invention relates to methods of making devices for mechanically retaining and electrically contacting conductors. More particularly, this invention relates to methods of making corrosion resistant clip-type electrical connectors for penetrating the insulation of electrical conductors to connect such conductors without first removing the insulation therefrom.

Clip-type electrical connectors of the prior art have been used to mechanically retain and electrically contact insulated conductors without first removing the insulation from the conductor. (See copending application Ser. No. 182,560 now Patent No. 3,112,147 field on Mar. 26, 1962 by W. Pferd, K. H. Pohland and D. W. Tyler.) Such connectors include a pair of elongated, contiguous, contacting jaws formed from a resilient, electrically conductive material, such as Phosphor bronze or the like. The insulated conductor to be joined to the connector is forced between the contiguous jaws to space them apart a slight distance. Due to the resiliency of the jaws, they tend to close or re-obtain their contiguous state, thereby penetrating or tearing apart the insulation and tightly clamping the conductor. Thus, the connector mechanically retains and electrically contacts the conductor.

In using these connectors in moist or corrosive environments, the contacting faces of the resilient jaws have developed nonconducting coatings which interfere with both the electrical connection and mechanical retention of the conductor. However, if the contacting faces of the jaws could be plated with a corrosion resistant conductive metal, such as tin or the like, and if this plating would in no way interfere with the resiliency of the jaws of the connector, the connectors could be used in moist or corrosive environments. Moreover, such plating could increase the wear resistance of the jaws. Accordingly, it is necessary to space apart the contiguous contacting jaws prior to the joining of a conductor thereto a sufficient distance to permit the plating of the faces of such jaws and at the same time without sacrificing the resiliency of the contacting jaws. Moreover, the spacing of the jaws must be equal to a distance of less than the diameter of the conductor to be joined to the connector to thereby

enable the jaws to exert a sufficient force on the conductor to securely hold it and provide a good electrical connection.

It is, therefore, an object of this invention to provide methods of making new and improved devices for mechanically retaining and electrically contacting conductors.

Another object of this invention is the provision of methods of making clip-type connectors for interconnecting a plurality of electrical conductors without first removing the insulation therefrom.

With these and other objects in view, the present invention contemplates a method of making a device for mechanically retaining and electrically contacting a conductor. Such method includes forming a pair of elongated contacting elements or jaws, joined at one end and free at the other, from a strip of electrically conductive resilient material. After these elements are formed, the inner edges of the free ends of the elements are deformed to space apart such free ends a distance less than the diameter of the conductor to be mechanically retained and electrically contacted.

Other objects and advantages of the invention may be more clearly understood by reference to the following description in the accompanying drawings, wherein:

FIG. 1 is an enlarged, fragmentary, front-elevational view of an electrical connector, clearly showing the spaced relationship of the jaws of the connector and the deformation of the inner edges of such jaws for maintaining this spaced relationship;

FIG. 2 is a perspective view of a terminal block incorporating a vast number of the connectors of FIG. 1 and illustrates the manner in which a plurality of insulated conductors are either joined to, or temporarily held by, the connectors;

FIG. 3 is an enlarged, fragmentary perspective view, showing how an insulated conductor is securely joined to the jaws of the connector and how the terminal block for supporting the connector prevents the conductor from sliding downwardly beyond a predetermined portion of the jaws into an aperture formed between such jaws;

FIG. 4 is a schematic, front-elevational view of an apparatus for making the electrical connectors in accordance with the present invention; and

FIG. 5 is a plan view of a strip of electrically conductive resilient material from which the connectors are formed.

Referring now to the drawings, and more particularly to FIG. 1, there is shown a device or a clip-type connector **11** for mechanically retaining and electrically contacting an insulated conductor **12**, FIGS. 2 and 3. The connector **11** is formed from a sheet of resilient, electrically conductive material such as Phosphor bronze or the like.

The connector **11** includes first and second elongated elements or jaws **13** and **14** joined at one end by a base portion **16** and free at the other end. The free end of the first jaw **13** has a rounded portion **17** while the free end of the second jaw **14** has a sidewise rounded protruding portion or hook **18** extending partially over the rounded portion **17**. The rounded portion **17** coacts with the hook **18** to form a V-shaped conductor-receiving passageway **19** in which an insulated electrical conductor **12** may be conveniently placed and held, as shown in FIG. 2, before such conductor **12** is forced down between the jaws **13** and **14**, as shown in FIG. 3. Moreover, the roundness of the portion **17** and hook **18** prevents the jaws **13** and **14** from piercing, tearing or injuring in any way the insulation of the conductor **12** as it is being positioned in, or as it is being temporarily held by, the passageway **19**. In addition, the hook **18** of the jaw **14**, which is

longer than the jaw **13**, in conjunction with the V-shaped conductor-receiving passageway **19**, greatly facilitates the positioning of the conductor **12** within such passageway **19**. Also, the V-shaped passageway **19** provides an inclined plane against the conductor **12** as it is forced downwardly between the jaws **13** and **14** to slowly open such jaws **13** and **14** and slideably receive the conductor **12**.

Formed between the jaws **13** and **14** is a slot **21**, the dimensions of which determine the forces exerted by these jaws **13** and **14** against the conductor **12** when it is forced therebetween, as shown in FIG. 3, and as disclosed in the aforementioned application Ser. No. 182,560 filed Mar. 26, 1962. Moreover, an aperture **22** located above the slot **21** is formed between the jaws **13** and **14**. The aperture **22**, in cooperation with the slot **21**, defines the length of portions **23** produced by plastically deforming the inner edges of the jaws **13** and **14**. The function of the deformed portions **23** is to resiliently hold apart the jaws **13** and **14** to establish a space **24** between such jaws **13** and **14**. The lateral dimension of this space **24** is critical. Such dimension must be less than the diameter of the conductive part of the insulated conductor **12**, but must be sufficiently large to permit plating of the inner edges of the jaws **13** and **14** which contact the conductor **12**. For a 24 gauge insulated conductor, this lateral dimension is equal to 0.005 inch.

As shown in FIG. 2, a plurality of the connectors **11** are joined together by the base portions **16** thereof, and a group of such joined connectors **11**, are mounted in a terminal block **26** to form a unit. Securely holding the connectors **11** within the block **26** is a base **27** secured to the block **26** by threaded members **28**. As is apparent from FIG. 3, the terminal block **26**, in addition to holding a group of joined connectors **11**, prevents the conductor **12** from sliding too far down the jaws **13** and **14** and into the apertures **22** of the connectors **11**.

Also, as is illustrated in FIG. 2, a plurality of electrical conductors **12** may be temporarily held by the V-shaped passageways **19** of the connectors **11**.

On the other hand, with the aid of the inclined edges of the passageway **19**, one of the conductors **12** may be slideably forced down beyond such passageway **19**, between the jaws **13** and **14**, and into the space **24**. As the conductor **12** is forced into the space **24**, the jaws **13** and **14** are resiliently opened by the conductor **12**. Since the jaws **13** and **14** are resiliently biased toward each other, the inner edges of such jaws **13** and **14** pierce or tear apart the insulation of the conductor **12** and bite into the conductor **12** to mechanically retain such conductor **12** with great force and make a good electrical connection between the conductor **12** and connector **11**.

Shown in FIG. 4 is a schematic of an apparatus for making the clip-type electrical connectors **11** joined together by base portions **16** in accordance with the present invention. In making such connectors **11**, a strip of electrically conductive resilient material **31**, such as Phosphor bronze or the like, is advanced from a supply reel **32** to a take-up reel **33**. The take-up reel **33** is driven by a conventional indexing motor **34** through a standard V-belt drive **36**.

The material **31** is initially advanced to a punching station **37**; whereupon the material **31** is stopped by the indexing motor **34**. Then, a motor **39** rotates a shaft **41** to rotate a cam **42**. Rotation of the cam **42** pushes a punch **43** through the material **31** into a die **44** to form a plurality of aligned apertures **46**, perpendicular to the longitudinal edges of the material **31**, as shown in FIG. 5.

After the apertures **46** are formed in the material **31**, the indexing motor **34** advances the material **31** to move the apertures **46** to a position just in front of a second punching station **47**. Next, the motor **34** stops the material **31**. Then, the motor **39** rotates the shaft **41** to rotate a cam **48**. The roation of the cam **48** then pushes a punch **49** through the material **31** into a die **50** to produce a plurality of slots **51** (FIG. 5) in front of each aperture **46**. At the same time that the slots **51** are formed in the material **31**, a second series of apertures **46** are also produced at the first punching station **37**.

Upon the formation of the slots **51** in the material **31**, the indexing motor **34** advances the material **31** to a third punching station **52** where a plurality of openings **53** are formed in the material **31** in the same manner that the slots **51** are formed in the material **31**. The openings **53** are clearly shown in FIG. 5.

Again, the indexing motor **34** advances the material **31**, but this time to a shearing station **54** where a first portion of the material **31** is sheared, as shown at **55** in FIG. 5, by a movable shear **56** which coacts with a stationary shear **57**. This shearing of the material **31** joins the slots **51** with the apertures **46** and, further, defines the second jaw **14**, as illustrated in FIG. 5. Such shearing action is controlled by the motor **39**, in the same manner that the punching action at stations **37** and **38** is controlled by the motor **39**.

Next, the material **31** is advanced by the indexing motor **34** to another shearing station **58**; whereupon, the material **31** is again sheared, as clearly shown at **59** (FIG. 5), to form the first jaw **13**. This shearing is accomplished in the same way that the shearing at the station **54** is accomplished.

The material **31** is then advanced to a deforming station **61** where the inner edges of the jaws **13** and **14** are stamped, coined or plastically deformed by a movable stamping die **62** which coacts with a stationary platen **63** to form the portions **23** to thereby space such jaws **13** and **14**. This stamping operation is controlled by the motor **39** in the same manner that such motor controls the punching and shearing operations at the other stations **37**, **47**, **52**, **54** and **58**.

After the stamping operation, the indexing motor **34** advances the material **31** to a blanking station **64**. At this station **64**, the jaws **13** and **14** are blanked from the strip **31** in such a manner that such jaws **13** and **14** are joined together by the base portion **16** to form the connector **11**, and a group of such connectors **11** are also joined together by a group of such base portions **16**. The blanking dies, which are of the conventional type, are controlled by the motor **39** in the same manner that the punching and shearing operations are controlled by such motor **39** at the other stations **37**, **47**, **52**, **54**, **58** and **61**. After the connectors **11** are blanked from the strip **31**, they fall into and are collected by a bin **66**.

Next, the connectors **11** are plated with a wear and corrosion resistant, electrically conductive material which does not interfere with the resiliency of the jaws **13** and **14**. Since the jaws **13** and **14** are spaced by the deformed portions **23**, such plating may be effectuated at the inner edges of the jaws **13** and **14**, which bite into the conductor **12** when it is forced into the space **24** between such jaws **13** and **14**.

As to the thickness of the plated material, it must be sufficiently thin so as not to interfere with or block up the space **24** between the jaws **13** and **14**.

An example of a satisfactory plating material is tin which may be very easily electroplated in accordance with conventional techniques and typically is plated to a thickness of about 0.0001 inch.

Inasmuch as the connectors **11**, which may be more efficaciously utilized by being positioned within the terminal block **26**, are plated with a corrosion resistant material, they may be utilized in a moist, corrosive environment and such connectors **11** would not develop nonconducting coatings on the inner faces of the jaws **13** and **14** which would interfere with the electrical connection and the mechanical retention of the electrical conductors **12**.

Since the connector **11** is formed first by shearing the jaws **13** and **14** from the material **31** with no space **24** between such jaws **13** and **14**, and then the jaws **13** and

14 are subsequently plastically deformed to produce the portions 23 to space apart such jaws 13 and 14 to establish the space 24 therebetween, the force tending to close the space 24 between the jaws 13 and 14 is the same as if the connector 11 were formed with no space 24. Thus, the jaws 13 and 14 of the connector 11 have the same abliity to penetrate and tear apart the insulation to tightly clamp and bite into the conductive part of the insulated conductor 12 as the jaws 13 and 14 would have if there were no space 24 between them. In other words, the provision of the space 24 between the jaws 13 and 14 does not sacrifice the resiliency of the jaws 13 and 14 nor the force which the jaws 13 and 14 exert on an insulated conductor forced between such jaws 13 and 14 and into the space 24. Moreover, with the space 24 between the jaws 13 and 14, such jaws 13 and 14 may be easily plated, as mentioned above, with a wear and corrosion resistant material such as tin or the like and the connector 11 may be readily utilized in an unfavorable environment.

It is to be understood that the above-described method forms only one embodiment of the present invention, and numerous methods may be derived from the above-described embodiment wtihout departing from the spirit and scope of the invention.

What is claimed is:

1. The method of making a clip-type insulation-penetrating electrical connector for insulated conductors from a strip of electrically conductive resilient metal, comprising the steps of:

punching in the strip a plurality of laterally aligned apertures perpendicular to the longitudinal edges of the strip,

punching in the strip a slot spaced from and longitudnially aligned with each aperture,

punching in the strip an opening between said aligned slots and apertures to define a portion of a first jaw of the connector,

shearing a first portion of the strip to join each slot to each adjacent aperture and to further join each aperture with said opening to thereby define said first jaw having a contacting edge and a free end,

shearing a second portion of the strip to define a second jaw having a free end and having a contacting edge contiguous with the contacting edge of said first jaw so that the contacting edges are abutting in a plane of shear between the first jaw and the second jaw,

deforming the contacting edges of said first and second jaws situated between said slot and said aperture to expand plastically the deformed edges of the jaws in a direction perpendicular to the plane of shear and toward the opposite jaw so that the free ends of the jaws are spread apart a distance equal to less than the diameter of the conductor to be joined to the connector,

blanking said strip a predetermined distance from the free ends of said jaws to form a base portion for said jaws at the end of said jaws opposite the free ends and to remove said jaws and base portion from the strip, and

plating said connector with a wear and corrosion resistant conductive metal.

2. A method of making a device for mechanically retaining and electrically contacting a conductor, comprising the steps of:

forming a pair of elongated elements joined at one end and free at the other end and in contacting engagement along adjacent abutting edges between the ends from a strip of electrically conductive material, and

deforming adjacent portions of each of the abutting edges in contacting engagement to expand plastically the material of the deformed portions toward the adjacent deformed portion of the other elongated element so that portions of the abutting edges of the elements at the free ends thereof are moved and spaced apart a distance less than the diameter of the conductor to be mechanically retained and contacted.

3. The method as set forth in claim 2 including the step of depositing a corrosion-resistant material on at least the adjacent edges of the elements which are spaced apart by the deformed portions of the elements.

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