April 21, 1964 C. K. BROWN 3,129,995

ELECTRICAL CONNECTOR

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FIG. 1

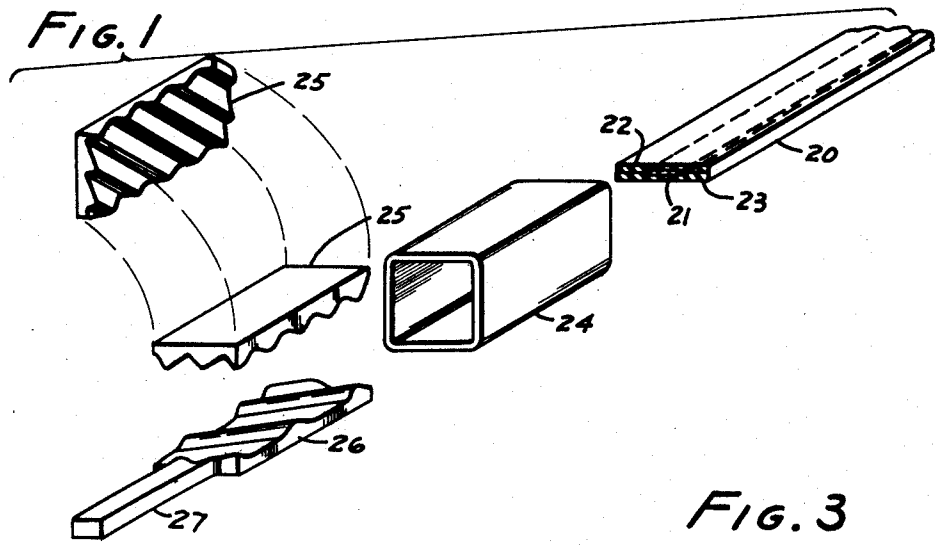


FIG. 3

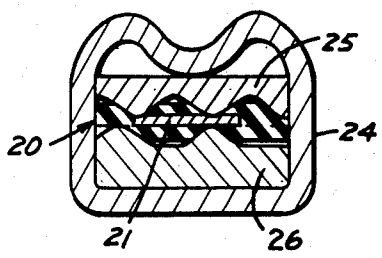


FIG. 2

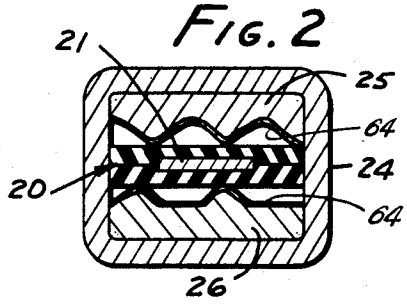
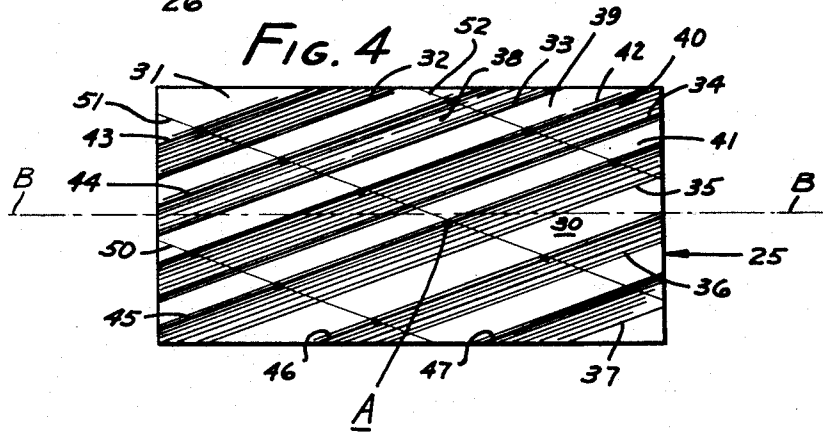


FIG. 4



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FIG. 5

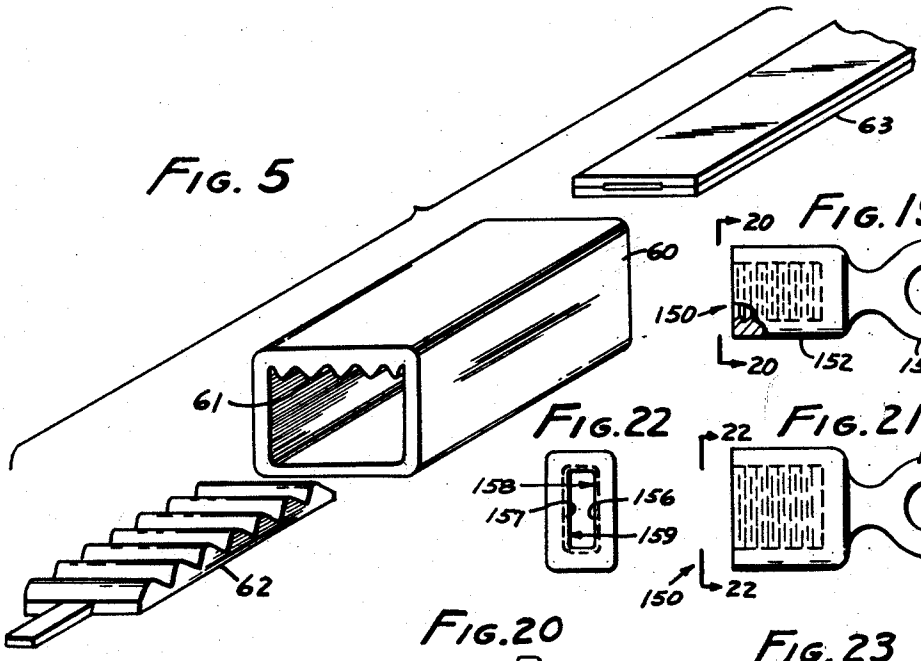


FIG. 19

FIG. 22

FIG. 21

FIG. 20

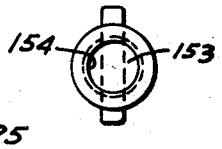


FIG. 23

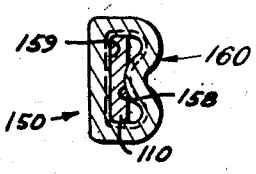


FIG. 6

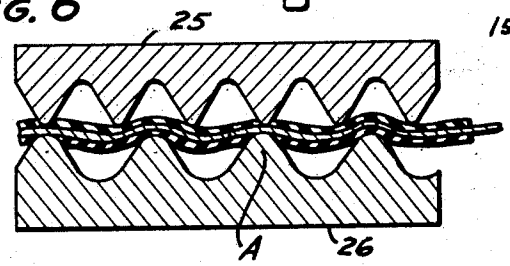
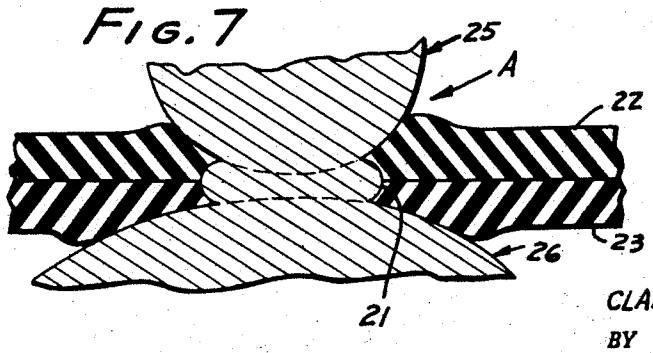


FIG. 7



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FIG. 8

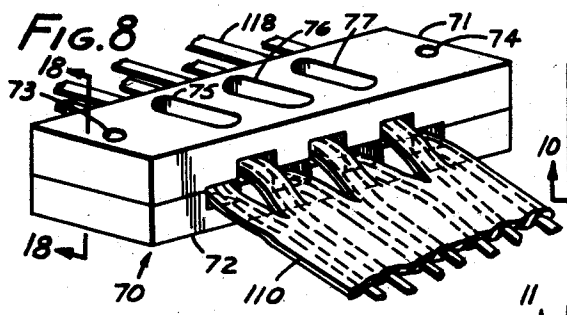


FIG. 9

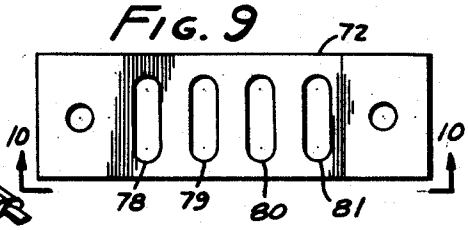


FIG. 10

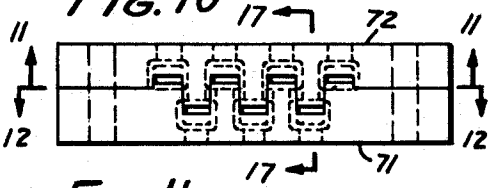


FIG. 12

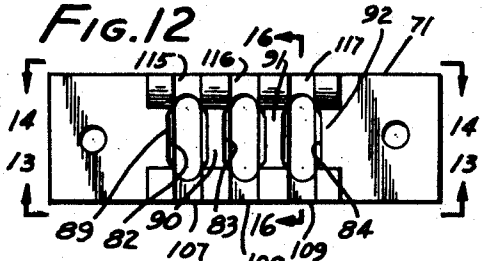


FIG. 11

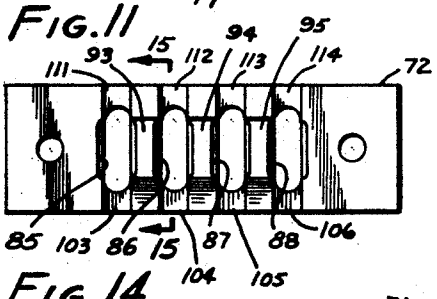


FIG. 13

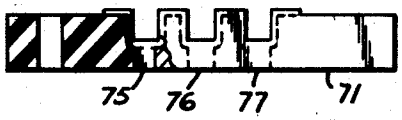


FIG. 14

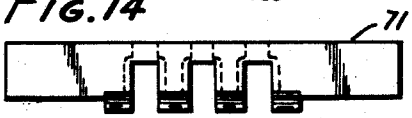


FIG. 15

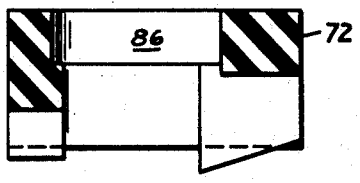


FIG. 17

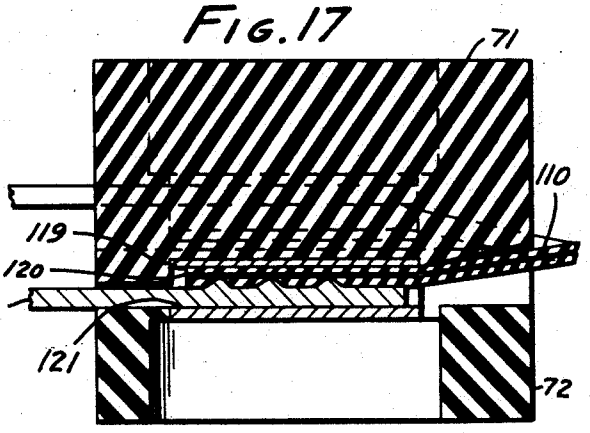
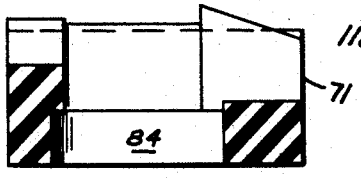


FIG. 16



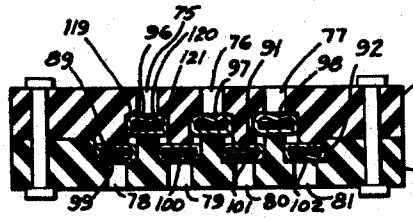


FIG. 18

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United States Patent Office 3,129,995 Patented Apr. 21, 1964

3,129,995

ELECTRICAL CONNECTOR

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Filed Nov. 14, 1960, Ser. No. 68,903
18 Claims. (Cl. 339—97)

This invention relates to a connector for making connective engagement with insulated electrical conductors.

A well-known type of electrical conduit comprises a flat conductive metal strip, usually copper, enclosed by an insulating cover. The most familiar member of this class includes a plurality of parallel copper strips sandwiched between two sheets of plastic. This assembly looks like, and is called a "tape." It is an object of this invention to provide means for making circuit and terminal connections to individual ones of the metallic strips.

A connector according to this invention includes a pair of metallic grid plates, each of which has a plurality of parallel striations in one of its faces. These striations are formed as troughs having bounding shoulders, adjacent shoulders of adjacent troughs being interconnected by a crest. The striated faces of the grids face each other with their crests criss-crossed, and sandwich between them that portion of the tape which incloses the conductive connection.

The plates are forced together so that the crests displace the insulating cover at the points where the criss-crossed crests intersect. Pressure of the grid plates on the metal strip causes cold-welding between the crests and the metallic strip, thereby forming a good conductive contact at the said points.

According to a preferred but optional feature of the invention, a deformable sleeve surrounds the grid plates and that portion of the tape to which the grid plates are to be attached, whereby pressure applied to the sleeve deforms the same and presses the crests into contact with the metallic strip. The sleeve thereafter serves to hold the plates in contact with the metallic strip.

According to still another preferred but optional feature of the invention, the crests are formed convexly curved.

According to still another preferred but optional feature of the invention, the connector includes a terminal block which has a cavity for receiving the aforesaid sleeve and grids, a passage to the cavity for the tape to pass through, and an opening into said cavity to receive a tool for deforming the sleeve. Force exerted on the sleeve through the opening deforms the sleeve as above described, and the terminal block thereby holds the electrically connected conductor in place.

The above and other features of this invention will be fully understood from the following detailed description and the accompanying drawings, in which:

FIG. 1 is an exploded isometric view showing the presently-preferred embodiment of the invention;

FIG. 2 is a cross-section of the assembled embodiment of FIG. 1 before making the conductive contact;

FIG. 3 is a showing of the device of FIG. 2 in its assembled condition;

FIG. 4 is a plan view of one part of the connector with portions of another part projected thereon;

FIG. 5 is an exploded isometric view of another embodiment of the invention;

FIG. 6 is an enlarged detail cross-section showing the connecting action of the presently-preferred embodiment of the invention;

FIG. 7 is an enlarged portion of FIG. 6;

FIG. 8 is an isometric view of a terminal block for use with the connector;

FIG. 9 is a bottom view of FIG. 8;

FIG. 10 is a side view taken at line **10—10** of FIG. 9;

FIGS. 11 and 12 are cross-sections taken at lines **11—11** and **12—12** of FIG. 10, respectively;

FIGS. 13 and 14 are side views taken at lines **13—13** and **14—14** of FIG. 12, respectively;

FIG. 15 is an inverted cross-section taken at line **15—15** of FIG. 11;

FIG. 16 is a cross-section taken at line **16—16** of FIG. 12;

FIG. 17 is a cross-section taken at line **17—17** of FIG. 10;

FIG. 18 is a cross-section taken at line **18—18** of FIG. 8;

FIG. 19 is a plan view of an intermediate step in the manufacture of a modification of the invention;

FIG. 20 is an end view taken at line **20—20** of FIG. 19;

FIG. 21 is a plan view of another embodiment of the invention made from the item shown in FIG. 19;

FIG. 22 is an end view taken at line **22—22** of FIG. 21; and

FIG. 23 is a cross-section view of the embodiment of FIG. 21 in its set configuration.

The presently-preferred embodiment of the invention is shown in FIG. 1. The object of the invention is to make a conductive connection with tape **20**. It will be understood that tape **20** may either be a single-conductor tape, or that it may be part of a multiple tape conductor, as preferred. Furthermore, although this invention is principally intended for use with this type of tape, this is not a limitation on the generality of the invention. Its use extends to insulated conductors in general. Tape **20** includes a flat metallic strip **21**, usually copper, sandwiched between layers **22**, **23** of insulating material, such as polyethylene. The strips are connected to circuit boards and the like, as desired. Such connections have hitherto been very difficult to make. It is an object of this invention to provide means for forming terminal connections to said metallic strip in an efficacious and convenient manner.

The connector includes a sleeve **24** which may conveniently have a square or rectangular cross-section. The sleeve is deformable, preferably being made of copper or copper alloy. Two grid plates **25**, **26** are adapted to be fitted within the outer sleeve, leaving a spacing between them for accommodating the end of tape **20** (see FIG. 2). A tail **27** is formed on grid **26** to act as a terminal, to which other circuits can be connected. The shape of the tail is a matter of choice.

The details of grid plate **25** are shown in FIG. 4. One face **30** of this plate is striated, and as shown in FIG. 4, there are striations **31**, **32**, **33**, **34**, **35**, **36**, and **37**. These striations are all parallel and are formed as troughs in face **30**. The striations are all bounded by shoulders; for example, striations **33** and **34** are bounded by shoulders **38**, **39**, and **40**, **41**, respectively. Striations **33** and **34** have their adjacent shoulders connected by a crest **42**. This construction is common to all of the adjacent striations so that there are formed on the face of the plate crests **42**, **43**, **44**, **45**, **46**, and **47**. As best shown in FIGS. 2 and 3, these crests are preferably convexly curved.

Grid plate **26** also has a plurality of striations. The pattern of the striations may be identical, in which case the adjacent faces of the two grid plates would look exactly alike, or the striations could be farther apart and fewer on grid plate **26** than on grid plate **25**.

Lines **50**, **51**, **52** represent the path of the crests of grid plate **26** relative to the path of crests **42–47** when the striated faces are brought toward each other. The crests are criss-crossed. There are fewer striations on grid plate **26** than on plate **25** in this example. There are

formed twelve points of intersection exemplified by point A where criss-crossed crests 45 and 51 intersect each other. All of the crests of each plate lie in a common plane.

It is at these intersecting points that the grid plates will press in and cold-weld with the metallic strip. The pitch, that is, the distance between crests of the two plates, will be selected having in mind the number of points of cold-welding desired. In FIG. 4, there are more crests per inch on plate 25 than there are on plate 26, that is, the spacing between crests on plate 26 is greater than the spacing between crests on plate 25. The crests on both plates shown in FIG. 4 make an angle of about 20° with a reference line B in FIG. 4, and thus intersect with each other at an angle of 40°. This angle is also a matter of choice. As can be seen from FIG. 6, the troughs are desirable in order to give the portions of the tape which are not located at the points of intersection some place to move to when the points are brought closer together than the thickness of the tape. As can be seen in FIG. 6, these other portions simply move into the troughs. Thus, the spacing apart of the points of intersection, as determined by the relative spacings of the crests, and the angle selected, will be such that there will be sufficient undisturbed portions of tape between the grids that the tape will not be cut in two by the crests. Also, it is preferable that neither of the crests lie normal to the axis of the tape, but instead lie at an angle to it. Then the points of intersection are staggered and there is less risk of breaking or cutting the tape.

FIG. 5 illustrates another embodiment of the invention wherein an outer sleeve 60 made of deformable material has a grid plate 61 identical to grid plate 25 integral therewith. A loose grid plate 62, identical to grid plate 26, can be fitted within the outer sleeve. The end of tape 63 is placed between the two grid plates.

Terminal block 70, which is particularly suitable for use with the connector according to the invention, is shown in FIGS. 8–18. This block includes a pair of plates 71, 72 adapted to be joined by fasteners passed through aligned holes 73, 74 through the two plates.

Plate 71 has three openings 75, 76, 77 through which a clinching tool can be applied to connectors disposed between the two plates. Plate 72 has four similar openings 78, 79, 80, 81.

As can best be seen in FIGS. 11 and 12, plate 71 has three recesses 82, 83, 84 in its inside face, while plate 72 has four similar recesses 85, 86, 87, 88. Recesses 82–84 are spaced apart, and are bounded by abutments 89, 90, 91, 92 on the inner face of plate 71. Similar abutments 93, 94, 95 in plate 72 are placed between recesses 85–88. The recesses are staggered, so that an abutment partially closes each recess. Connectors 96–102 are respectively fitted in recesses 82–88.

As can best be seen in FIGS. 11 and 12, the recesses have passages 103–109 through one side of the block for passing end portions of tape 110, and passages 111–117 through the block and at the other side for passing conductive terminal tails 118. The passages are smaller in cross-section than the recesses so that the connectors are held within the recesses.

Connector 96 is like all of the other connectors and will be described in detail as a single example. It includes a deformable sleeve 119, and a pair of grid plates 120, 121. The sleeve and grid plates are like those described in either FIG. 1 or FIG. 5.

The terminal tails may be attached to grid plates 121 as best shown in FIG. 17, or if preferred may be made integral with the various sleeves.

FIGS. 19–23 illustrate another embodiment of the invention wherein a connector 150 made of the same material as the sleeve of FIG. 5, includes an eyelet portion 151 for use as a terminal, and a sleeve portion 152 which in its intermediate configuration includes a round, thread-tapped hole 153 with internal threads 154.

The connector is formed by squaring up the tubular portion as shown in FIGS. 21 and 22, by placing it in a forming tool. This, of course, straightens out the threads 156, 157 in faces 158, 159 (which are sensibly planar). These faces are equivalent to the grid plates in the previous embodiments, and threads 156, 157 are equivalent to the striations.

The technique of utilizing the terminal block should be evident from the drawings. The device is assembled with the sleeves undeformed, and the ends of the tape are passed through passages 103–109 and placed between the grids. Then a clinching tool is applied to the side portion of one of the plates and, through respective openings connected with the recesses, to a sleeve to apply crimping force on the sleeve to deform it and press the grid plates into contact with the tape, as in the embodiments of FIGS. 1 and 5. The clinching tool is then removed and the terminal block is ready for use by connecting a circuit to the various terminal tails, as desired. It will be noted that it is also possible to attach terminal connections to the deformable sleeve through the respective openings.

With respect to the material of the grid plates, it is desirable to have the crests of the grid plates where contact is made with the metallic strip of a soft, highly conductive material, which will readily cold-weld with the metallic strip. The entire grid plate could be made of such a material, although ordinarily such soft material will not give the best structural characteristics. This is because it is desired to build up high pressure at the localized areas, such as point A, where cold-welding is to occur, and often these soft materials will not withstand high pressures without excessive deformation. Therefore, the preferred construction is shown in FIG. 2 wherein substantially the entire base plate is made of a fairly hard conductive material, such as beryllium-copper alloy, or even steel, and is faced with a plated layer 64 of a relatively soft, highly conductive material, such as pure copper, silver, aluminum, or gold, which will tend to cold-flow with those materials commonly used for electrical conductors. Copper plating is preferred for use with a copper metallic strip. The plated layer is shown only in FIG. 2 where its thickness is greatly exaggerated relative to the size of the grid plates, it being understood that the plating is optional and could be provided in any of the other embodiments.

The sleeve itself may be of any desired material. Ordinarily it is made of a fairly hard material, such as beryllium-copper alloy, because it is needed for support.

The use of the embodiment of FIG. 1 should be evident from the drawings. The grids are placed within the sleeve, and the tape is placed between the grids to assume the initial condition shown in FIG. 2. Then the sleeve is deformed by applying a compression tool, such as a pair of pliers adapted for the purpose, to deform the top surface of the sleeve, thereby transmitting force to the grids to force them together. The resulting interaction is best illustrated in FIGS. 6 and 7. Those portions of the tapes elsewhere than between points of intersection of the crests move within the troughs, as shown in FIG. 6, so that the insulation is not cut except at these intersections. It will usually be found advantageous to make the spacing between crests greater in one plate than in the other, as shown in FIG. 6, in order to better provide for a place for the uncut portions of the tape to move into without having to substantially stretch the tape.

The reaction at the points of intersection is best shown at FIG. 7, where it will be seen that the insulating cover has been squeezed to one side by the intersecting crests, and then high pressure has been concentrated at the points of intersection to cause a cold-welding fusion between the crests at their intersections and the metallic conductor. The pressure exerted at the individual points is quite high, because the setting force is transmitted to

a comparatively small number of regions of small area. The high pressures form an effective cold-welded joint. In fact, the joint between the grid plates and the metallic strip is strong enough that the use of a surrounding sleeve is optional in this invention. However, the grid plates are ordinarily quite small, and the sleeve will usually be used to assure that the connection does not come apart.

The embodiment of FIG. 5 operates in the same manner as that of FIGS. 1–3, grid plate **61** being substituted for grid plate **25**.

The device of FIGS. 21–22 is set as shown in FIG. 23 by deforming one of the sides of the rectangular portion, such as side **160** in FIG. 23, thereby forcing the threads of face **158** toward the threads of face **159** to carry out the same connecting action as in the other embodiments. Alternately, both faces could be so deformed.

In the terminal block of FIGS. 8–18, the various connectors are physically spaced apart from each other so that there will be no short-circuiting between them. However, in some installations, it may be found desirable to place a strip of insulation between the two plates when the terminal block is assembled. Such installation may, for example, be a strip of polyethylene material, coextensive with the adjacent faces of the plates. This strip will not substantially change the spatial relationship between the various parts, but will serve to insert between the connectors an insulating layer, should additional assurance of non-short-circuiting be desired.

This invention thereby provides simple means for quickly and efficaciously making a good electrical connection with the metallic strips in electrical conductors, and further provides means for ganging a plurality of them into a convenient terminal block.

This invention is not to be limited by the embodiments shown in the drawings and described in the description which are given by way of example and not of limitation, but only in accordance with the scope of the appended claims.

What is claimed is:

1. A conductive connection comprising: an electrical conductor of the class wherein a conductive metallic strip is enclosed by an insulating cover; and a pair of metallic grid plates, each plate having a plurality of parallel striations in one face thereof, said striations being formed as troughs having bounding shoulders, a plurality of crests formed by adjacent shoulders, said crests being of substantial length, and the crests of each plate lying in the same respective plane, whereby the conductor may be sandwiched between the grid plates with said faces against it and with the striations of the two plates disposed so as to criss-cross each other, whereby when the plates are forced toward each other, the crests simultaneously displace portions of the insulating cover and simultaneously contact the metallic strip by pressure between the grid plates and strip, causing cold-welding between them to form a conductive contact at the points where the striations cross.

2. A conductive connection according to claim 1 in which said crests are convexly curved.

3. A conductive connection according to claim 2 in which each of the striations extends between two edges of the respective plates.

4. A conductive connection according to claim 2 in which the spacing between crests is the same on both plates.

5. A conductive connection according to claim 2 in which the spacing between crests is greater on one plate than on the other.

6. A conductive connection according to claim 1 which includes means for holding the grid plates in contact with the metallic strip.

7. A conductive connection according to claim 1 in which a deformable sleeve surrounds the grid plates and that portion of the conductor to which the grid plates are to be attached, whereby force applied to the sleeve deforms the same to press the grid plates into contact with the metallic strip and the sleeve serves thereafter to hold the plates in contact with the conductor.

8. A conductive connection according to claim 6 in which said crests are convexly curved.

9. A conductive connection according to claim 7 in which said crests are convexly curved.

10. A conductive connection according to claim 9 in which each of the striations extends between two edges of the respective plates.

11. A conductive connection according to claim 9 in which the spacing between crests is greater on one plate than on the other.

12. A connector for making conductive engagement with an electrical conductor of the class wherein a conductive metallic strip is enclosed by an insulating cover, comprising: a deformable sleeve; a pair of metallic grid plates within said sleeve, each having a face facing the other grid plate, each of said faces having a plurality of parallel striations extending continuously across the plate, all of said striations being formed in their respective faces as troughs having bounding shoulders, a plurality of crests formed by adjacent shoulders, said crests being of substantial length, and the crests of each plate lying in the same respective plane, the plates being so disposed and arranged that the striations of the plates criss-cross to form a plurality of points of intersection, whereby, with the tape between said surfaces, the sleeve may be deformed to force the plates toward each other, so that the crests simultaneously displace portions of the insulating cover at said points of intersection and simultaneously contact the metal strip to cold-weld therewith and there form conductive contacts, the sleeve thereafter serving to hold the grid plates in place.

13. A connector according to claim 12 in which said crests are convexly curved.

14. A connector according to claim 13 in which each of the striations extends between two edges of the respective plates.

15. A connector according to claim 13 in which the spacing between crests is the same on both plates.

16. A terminal block for making conductive engagement with an electrical tape of the class wherein a conductive metallic strip is enclosed by an insulating cover, comprising: a first and a second plate joined together, each having a face adjacent the other, said faces having recesses therein which are staggered relative to each other; an abutment on said faces opposite each recess of the opposite face; said plates having a passage connecting the outside of the plate and each recess for passing the conductor to the recess; a deformable sleeve in each of said recesses; a pair of metallic grid plates in said sleeve, each grid plate having a face facing the other grid plate, each of said faces having a plurality of parallel striations extending continuously between two edges of the plate, all of said striations being formed in their respective faces as troughs having bounding shoulders, shoulders of adjacent striations being interconnected by crests, the highest portion of each crest of each plate lying in a common plane, the plates being so disposed and arranged that the striations of the plates intersect to form a plurality of points of intersection, whereby, with the tape between said surfaces, the sleeve may be deformed to force the plates toward each other, so that the crests displace the insulating cover and contact the metal strip to cold-weld therewith and form conductive contacts when the crests cross, the sleeve serving to hold the grid plates in place, and the plates serving to hold the sleeves in place.

17. A terminal block according to claim 16 in which each plate has an opening therethrough to each recess to provide access to the sleeve for a tool to deform the sleeve.

18. A terminal block according to claim 17 in which a terminal tail is connected to one of the grids in each

sleeve, which passes through the terminal block to provide a terminal connection.

References Cited in the file of this patent

UNITED STATES PATENTS

1,625,485	Maurer	Apr. 19, 1927
2,749,383	Pigman et al.	June 5, 1956
2,788,508	Buchanan	Apr. 9, 1957
2,939,905	Canfield	June 7, 1960
2,962,919	Grundmann et al.	Dec. 6, 1960

FOREIGN PATENTS

765,751	Great Britain	Jan. 9, 1957
1,070,302	Germany	Dec. 3, 1959