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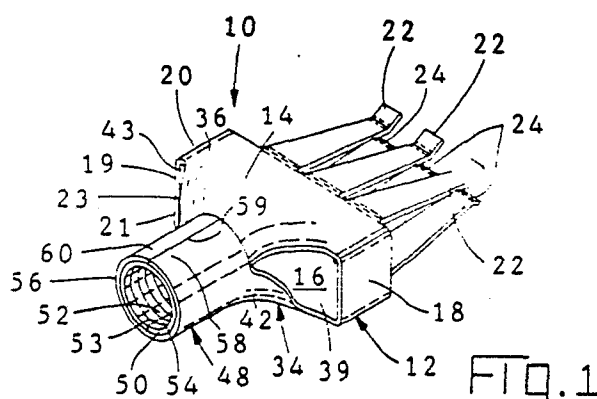
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(54) Electrical contact terminal.

(57) An electrical terminal (10) stamped and formed from a single thickness of metal stock comprises a hollow body portion (12) and a plurality of contact sections (22, 24) extending forwardly therefrom, first and second opposing transition portions (36, 42), and a double layer barrel portion (48). The transition portions (36, 42) coextend rearwardly from respective opposing side sections (14, 16) of hollow body portion (12). The double layer barrel portion (48) including first and second barrel sections (50, 56) which extend rearwardly from respective first and second transition portions (36, 42), the first barrel section (50) being nested within the second barrel section (56) such that a seam (53) of first barrel section (50) is basically diametrically opposed from a seam (59) of second barrel section (56) and a continuous portion of second barrel section (56) overlies the seam (53) of said first barrel section (50). Upon crimping double barrel portion (48) to a wire member (70), barrel portion (48) simulates a continuous annular body and first and second transition portions (36, 42) provide for improved transmis-

sion of current from wire (70) and through terminal (10) without excessive heating. A method for making terminal (10) is also disclosed herein.



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ELECTRICAL CONTACT TERMINAL

This invention is directed to electrical contact terminals and in particular to electrical contact terminals that may be stamped and formed.

In forming power or signal distribution systems, it is necessary to provide interconnections between various members or components of the system. Generally the interconnections are provided by electrical connectors having one or more electrical contact terminals therein.

A major requirement of any connector system is that it be reliable and stable over a life span that may be as long as 10 to 20 years. In many integrated circuit systems there can be no more than a 5 percent voltage drop through the system. Thus each connection can only have a very small percentage of the total drop. It is essential therefore that the connectors be designed to minimize the millivolt drop and to remain stable throughout the life of the system.

With advances in technology, the amount of total termination resistance, which includes a combination of bulk resistance, constriction resistance and crimp resistance, permitted by a system is being reduced and in many systems the total termination resistance is in the magnitude of 10 milliohms or less. It is necessary therefore to design contact members and in particular power contact members that have a very low millivolt drop at each point of termination. In addition, the millivolt drop, which is a function of the resistance of the contact member, should not increase very much over the life of the contact. In order to meet the design requirements, it is necessary to drop the bulk resistance of the contact member as low as possible, lower the "constriction resistance" that is the resistance between the contact points or beams of the contact member and provide a termination to a wire that has a low resistance and is stable.

In designing the mating portion of a power contact member, it is most desirable to use a plurality of spring contact arms which will provide a plurality of parallel paths thus reducing the millivolt dropage of the total contact member. The material selected for the contact, therefore, must be highly conductive yet have sufficient mechanical properties and exhibit sufficient tensile strength that allows beams to be formed having a small cross section and a very low stress relaxation so that the contact beams will continue to exert sufficient normal force over the life of the contact.

U.S. Patent 2,704,358 discloses a contact of the prior art used for power systems having a solid barrel portion, a transition portion and a contact area. The width of the material used in the transition area between contact area and the barrel por-

tion is narrow. The current flowing through this contact area therefore must flow through the narrow transition portion and into the larger body and contact area, thus raising the resistance and thereby the temperature in the transition portion. The very small cross sectional area of the transition portion of the contact terminal in effect may act as a fuse because it can overheat. It is desirable, therefore, to provide a contact terminal or member that will have an essentially constant cross sectional area throughout the length of the terminal.

U.S. Patent 2,535,013 discloses a connector having a crimpable power contact terminal having a solid barrel portion made by brazing the seam of a formed member. Solid barrel terminals may also be made by machining as known in the art. A brazed seam barrel is suitable for terminal members such as those having blade type contact portions or a terminal wherein a wire is bolted to contact portion. The brazed seam barrel, however, is not suitable for the usual contact members having compliant beams. The high temperature required to braze a material having a high conductivity of heat as well as electricity will soften or anneal the metal in the flexible beams contact portion thus removing the resiliency of the beams and reducing the normal force. It is desirable, therefore, to find a means for forming a crimpable barrel connector that will in essence act as a solid member without requiring brazing or joining of the seam or a separate solid sleeve member disposed over the seam.

In accordance with the present invention, an electrical terminal is disclosed that alleviates the disadvantages and deficiencies of the prior art, can be stamped from a sheet of stock metal, and furthermore provides a plurality of contact beams for distributing the current.

It is an object of the invention to provide an electrical connector for use with power systems that will be stable and have a low resistance throughout the life of the system.

It is an additional object of the invention to provide a terminal that has a barrel portion that is stamped and formed but has a construction that is essentially equivalent to that of a solid barrel member.

Another object of the invention is to provide a contact terminal that maintains an essentially constant cross sectional area throughout the length of the contact.

A further object of the invention is to provide an electrical terminal having a plurality of contact paths for carrying the current.

It is an additional object of the invention to provide an electrical terminal member that effec-

tively has no open seam.

It is also an object of the invention to provide a cost effective method for making electrical contact terminals having a crimpable barrel section.

The present invention is directed to an electrical contact terminal stamped and formed from a single thickness of metal stock having a hollow body portion and a contact section extending forwardly therefrom, first and second opposing transition portions and a barrel portion. The first and second transition portions coextend rearwardly from respective opposing side sections of the hollow body portion. The barrel portion includes first and second barrel sections which extend rearwardly from respective ones of the first and second transition portions. The first barrel section is nested within the second barrel section such that a seam of the first barrel section is essentially diametrically opposed from a seam of the second barrel section and a continuous portion of the second barrel section overlies the seam of the first barrel section. Upon crimping the barrel portion to a wire member, the barrel portion simulates a continuous angular body, and the first and second transition portions provide for improved transmission of current from the wire and through the terminal without excessive heating.

In accordance with the preferred embodiment of the terminal the contact section comprises a plurality of cantilevered spring contact beams extending forwardly from the hollow body portion. The hollow body portion has rectangular cross section. It is to be understood the cross section of the body portion may have other geometrical shapes such as circular, elliptical, triangular or other polyhedral configurations.

The invention is further directed to a method for stamping and forming the terminal from a single layer of metal stock.

FIGURE 1 is a perspective view of the electrical contact member of the present invention.

FIGURE 2 is a fragmentary cross sectional view of the barrel portion of the contact of Figure 1 having a conductor member disposed therein.

FIGURE 3 is fragmentary cross sectional view similar to that of Figure 2 illustrating the conductor terminated in the terminal barrel portion.

FIGURES 4 through 7 illustrate the steps in making the electrical terminal member in accordance with the present invention.

FIGURE 8 is an alternative embodiment of the electrical contact terminal member of the present invention.

Referring now to Figures 1 through 7, electrical contact terminal member 10 comprises a first body portion 12, transitional body portion 34 and a barrel portion 48. For purposes of illustrating the invention, body portion 12 of terminal member 10 is

described as having a rectangular cross section. It is to be understood that the terminal members may have a number of different configurations, and that the hollow body portion may be one having, for example, a cylindrical, elliptical, triangular, rectangular, or any other polyhedral configuration.

First portion 12 comprises first and second major side sections 14, 16 and minor side sections 18, 20 as best seen in Figures 1 and 4. A plurality of first and second spaced cantilevered contact arms or beams 22, 24 extend forwardly from respective first and second major sides 14, 16. As best seen in Figures 4 through 6, minor side 20 is formed from two partial side sections 19, 21 respectively which meet at seam 23 along axial edges 26, 28 section 19, 21 respectively. In the preferred embodiment edges 26, 28 include interlocking complementary tab member 30 and slot member 32 respectively for securing edges 26, 28 together. It is to be understood that connector 10 is a representative contact terminal that can be made in accordance with the present invention and that the seam in the first body portion may be secured by other means or need not be secured at all.

Transition portion 34 comprises first and second transition sections 36, 42 respectively which extend rearwardly from first and second major side sections, 14, 16. As best seen in Figure 4 the transition sections 36, 42 have inwardly directed sides 38, 40, and 44, 46 respectively. First and second transition sections 36, 42 are essentially equal in width to the cross sectional area extending along the base of contact beams 22, 24 on corresponding major side sections 14 and 16 respectively and rearwardly along sides 14, 16 to respective transition sections 36, 42. In the formed terminal member first and second transition sections 36, 42 are spaced from each other in areas 39, 43 as shown in Figures 2 and 3.

Barrel portion 48 is comprised of first and second barrel sections 50, 56. In the assembled terminal 10 first barrel section 50 is nested within second barrel section 56 such that seam 53 formed by abutting edges 52, 54 of first barrel section 50 is essentially diametrically opposite seam 59 formed by abutting edges 58, 60 in the second barrel section 56. By positioning the seams 53, 59 in the two barrel portion sections 50, 56 on opposite sides of the assembled barrel portion 48, the double barrel portion 48 functions essentially as a solid barrel when it is crimped. As is shown in Figures 2 and 3, upon insertion of a conductor wire 70 in the barrel 48 and applying crimping force thereto, inner solid barrel portion 50, which is basically aligned with seam 59 of outer or second barrel section 56 and corresponding edges 58, 60 of second barrel 56 are pressed downwardly such that the inner barrel section 50 is subjected to

sufficient plastic deformation that it resists springing back to its original shape. The cold welding and plastic deformation in the inner barrel 50 and cold welding between the wire and barrel 50 resist outward movement and essentially eliminate force directed outwardly against the abutting edges 58, 60 of the outer barrel 56 thereby allowing abutting edges 58, 60 to remain in the crimped position. U.S. Patent 2,535,013 discloses the method for making the crimp shown in Figure 3. Figure 3 is a cross sectional view of the terminal 10 of the present invention terminated to a wire 70 having a plurality of wire strands 72 therein.

The terminal of the present invention may be used with a wide variety of wire sizes. In general, it is preferred that the cross sectional area of the contact terminal be such that the terminal has the same thermal performance as that of the attached wire. As can be seen in Figures 2 and 3, the seam 59 formed by abutting edges 58, 60 of the outer barrel 56 is basically aligned at the center of the crimped section and the center portion of the crimp is plastically deformed preferably below the horizontal axis of the barrel 48 whereby the wire strands 72 are forced into the two sections 64, 66 forming a "B" shape. The crimping force causes cold welding to occur between the internal surface of first or inner wire barrel portion 50 and wire strands 72, which further aid in retaining the wire barrel 48 in its crimped position. In accordance with the present invention, it is preferable that the seam 59 of the outer barrel 56 be aligned essentially at the center of the crimped area to maximize cold welding at the seam, otherwise the abutting edges 58, 60 of the outer barrel 56 will be subjected to undue stress and expand outwardly. The crimp shown in U.S. Patent 2,535,013 is designed to be used with a single annular ring such as a solid screw machined part or a formed member having a brazed seam. When the barrel is crimped it is subjected to sufficient pressure that the outer surface undergoes plastic deformation and is essentially locked into place and does not stress relax enough to affect the function of the crimped barrel. This "locking" was heretofore achieved only with solid rings. In accordance with the present invention, however, the inner seamed ring is subjected to a similar plastic deformation as is a single layer solid ring, thus the inner ring will not stress relax as long as the outer ring is held closed by the cold welding around the seam.

As was previously discussed, a contact terminal having compliant beams of the type shown in Figure 1, cannot be easily soldered, brazed or welded along that outer seam since the high heat carrying capacity of the heavy metal terminal body will carry the heat away from the seam, thus subjecting the flexible cantilevered beams to a suffi-

cient temperature to soften or anneal the metal thereby removing the flexibility of the beams and destroying their function.

In order to assure that parallel paths are provided for the current, it is important that there be an equally low resistance between the inner barrel portion 50 and the outer barrel portion 56 as there is between the wire 72 and the inner barrel portion 50. It is important, therefore, that all surfaces of the inner and outer barrel members 50, 56 remain in physical and electrical engagement so that a equal resistance is presented by inner and outer sections 50, 56 of the barrel portion 48 and through the transition sections 36, 42 to the contact areas 22, 24. Since electricity will always follow the path of least resistance, the alternative paths through the two transition areas 36, 42 would essentially provide equally available paths for the electricity. One such way of assuring good engagement between the respective barrel surfaces is to put a plurality of serrations 57 on at least one of the surfaces of the barrel portions 50, 56 that are in engagement with each other as shown in Figures 4 and 5. Preferably serrations 57 run axially on outer barrel portion 56 to provide a plurality of contact surfaces between barrel portions 50, 56. In addition the inner surface of inner barrel portion 50 may also include serrations 51 for assuring better cold welding of wire strands 72 in barrel portion 50. For ease of manufacturing serrations 57 are preferably put on the inner surface of the outer barrel 56.

A further way of assuring that the outer barrel 56 stays in mechanical and electrical engagement with the inner barrel 50 is to provide a means for securing the edges of the outer barrel to each other without requiring braising, welding or other means that could damage the remainder of the contact. As shown in Figure 8, alternative embodiment 110 of the contact terminal member includes key member 161 and dovetail slot 163 on edges 158, 160 of the outer barrel portion 56, which are securable together to assure that the outer barrel 56 will not "open" during the life of the terminal 110.

Again, since the material for the contact is a good conductor of electricity, and also of heat, solder is not usable as a method for securing a wire to such a terminal since the terminal would carry away the heat from the solder joint. In addition to assuring that the outer barrel remains in contact with the inner barrel by means of the locking arrangement, the locking arrangement also eliminates the need to orient the terminal within the crimping tool since there is no "potentially open" seam that needs to be at the precise center of the crimped area as shown in Figure 2 and 3.

The present invention also provides a means for assuring that parallel contact paths will be pre-

sented for the current to flow from the wire 70 through either the inner barrel portion 50 and first transition portion 36 or the outer barrel portion 56 and second transition portion 42 to the first and second contact arms 22, 24 respectively. The present invention therefore eliminates the "fuse-like" transition portion of the prior art.

FIGURES 4 through 7 illustrate the steps in making the invention as shown in Figure 1. Preferably the connectors 10 are made from a continuous strip of metal in which a plurality of terminal blanks 80 as shown in Figure 4 are stamped from the strip such that blanks extend and are spaced along a carrier strip (not shown). The terminal 10 is formed from blank 80 by first forming inner wire barrel portion 50 into a ring and second or outer barrel portion 56 into a U-shaped member as shown in Figure 5. The partially formed terminal blank 80 is then rolled or formed into hollow body portion 12 such that edges 26, 28 of minor side portions 19, 21 of terminal 10 are brought into alignment to form minor side 20, and concomitantly therewith formed inner barrel portion 50 is received in the open "U" shaped outer barrel portion 56. Outer barrel portion 56 is then closed to form the terminal 10 of the present invention as shown in Figure 1.

In making power contacts of this type, it is necessary to use a material that has a high conductivity, but in addition has a low stress relaxation and adequate yield strength to exert sufficient normal force in the contact areas of the cantilevered beams. While pure copper is a suitable metal for terminal members of the blade type wherein a formed member can be brazed, generally it is not suitable for terminal members having flexible portions in that the copper will stress relax over time thus causing a drop in the amount of current which can be carried by the terminal. The stress relaxation characteristics of pure copper would cause the normal force to be reduced by as much as 50% over the life of the terminal member. It is desirable, therefore, to use a material having a high conductivity and very good mechanical properties. The material should have a sufficiently high tensile strength such that a beam having a small cross section can be formed and the material further should have very low stress relaxation characteristics over a period of time. Suitable material include copper alloys, such as Olin C-151 available from Olin Brass, East Alton, Illinois, C-151 has 85-95% of the conductivity of pure copper yet retains very good mechanical properties such as tensile strength, and low stress relaxation properties so that a crimp will remain closed over the lifetime of the contact. It is to be understood that the strip of material need not be made from a single metal or metal alloy. Terminals can be made from strips

formed of two metals welded together such that for instance the compliant beams may be made of one material and the remaining portions be made of a second material.

The present invention provides an electrical terminal member that may be used for power connections, that has a plurality of contact beams to decrease the resistance of the contact, a barrel portion that is crimpable to wires and one having at least two transition areas such that at least two parallel conductive paths are created to distribute the current through the contact and prevent the "fuse effect" of prior art terminals.

The contact terminal of the present invention is intended to be mated with a complimentary terminal member such as a box-like or blade-like member receivable between the compliant beams, or a box-like member which receives the plurality of cantilevered beams therein.

The electrical contact terminal as disclosed herein and shown in the accompanying Figures, provides a terminal that can be manufactured in a cost effective stamped and formed manner, and permits the use of many grades of materials and combinations of materials as long as the selected material gives the desired amount of conductivity needed for low termination resistance and has the proper mechanical properties to minimize stress relaxation in the beam area. The electrical terminal of the present invention further includes additional cross sectional area in the crimp portion and throughout the transition area which provides for parallel paths for current. In addition the double layer barrel portion thus adds bulk permitting crimping in a manner that is equivalent to crimping a continuous annular barrel member without the need for welding or brazing and gives a stable crimp with a minimum of constriction resistance.

It is thought that the electrical contact terminal of the present invention and many of its attendant advantages will be understood from the foregoing description. Changes may be made in the form, construction and arrangement of parts thereof without departing from the spirit and scope of the invention or sacrificing all of its material advantages.

Claims

1. An electrical terminal stamped and formed from a single thickness of metal stock comprises a body portion having a contact section extending forwardly therefrom and a barrel portion, the terminal (10) being characterized in that:
the body portion (12) is hollow;
first and second opposing transition portions (36, 42) coextend rearwardly from respective opposing

side sections (14, 16) of the hollow body portion (12); and

the barrel portion (48) includes first and second barrel sections (50, 56) extending rearwardly from respective ones of the first and second transition portions (36, 42), the first barrel section (50) being nested within the second barrel section (56) such that a seam (53) of the first barrel section (50) is essentially diametrically opposed from a seam (59) of the second barrel section (56) and a continuous portion of the second barrel section (56) overlies the seam (53) of the first barrel section (50), the barrel portion (48) thereby having two thickness of metal therearound; whereby upon crimping the barrel portion (48) to a conductor member (70), the barrel portion (48) simulates a continuous annular body and the first and second transition portions (36, 42) provide for improved transmission of current from the conductor (70) wire and through the terminal (10) without excessive heating.

2. The electrical terminal (10) of claim 1 further characterized in that:

the hollow body portion (12) has opposed first and second major side sections (14, 16) and opposed first and second minor side sections (18, 20);

at least one contact member (22, 24) extends forwardly from each of the first and second major side sections (14, 16), and

first and second transition portions (36, 42) extend rearwardly from respective the first and second major side sections (14, 16).

3. The electrical terminal of claim 1 or 2 wherein the body portion has a plurality of contact sections extending forwardly therefrom.

4. The electrical terminal (10) of claim 3 wherein the plurality of contact sections (22, 24) comprise cantilevered beams.

5. The electrical terminal (10) of at least one of claims 1 to 4 wherein the hollow body portion (12) has a rectangular cross section.

6. The electrical terminal (10) of at least one of claims 1 to 5 wherein the barrel portion (48) is crimped to a wire member (70).

7. The electrical terminal (10) of claim 6 wherein the center of the crimp is plastically deformed to a position below a horizontal axis of barrel portion (48).

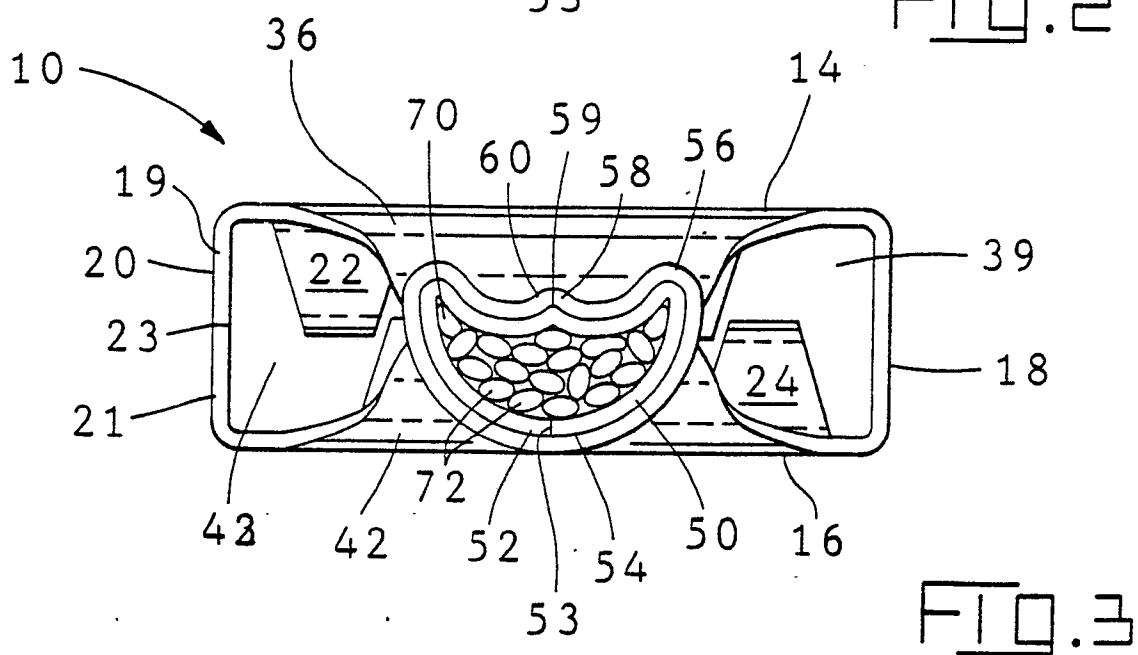
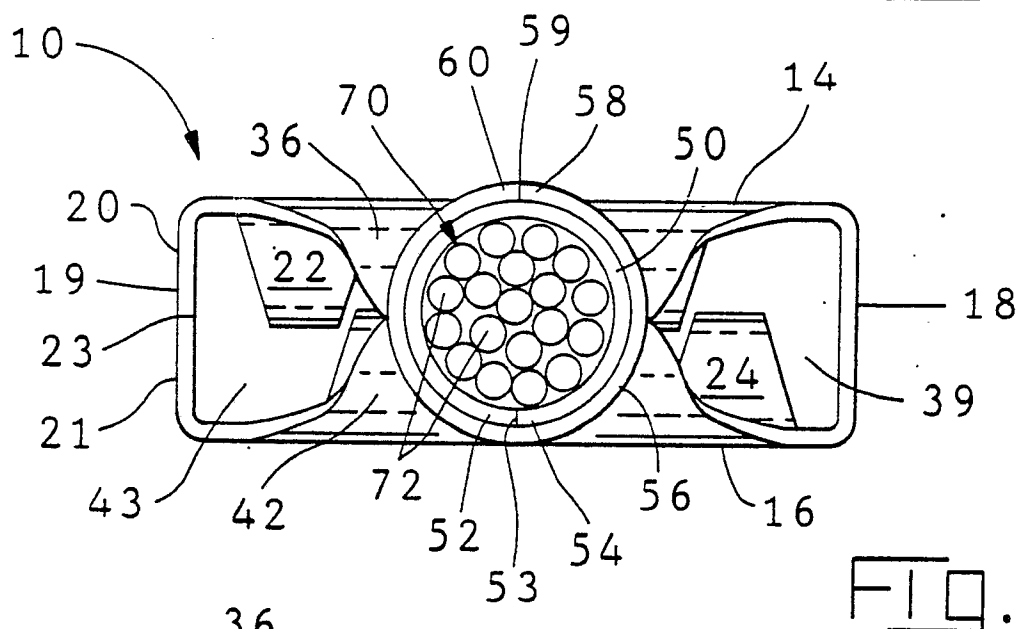
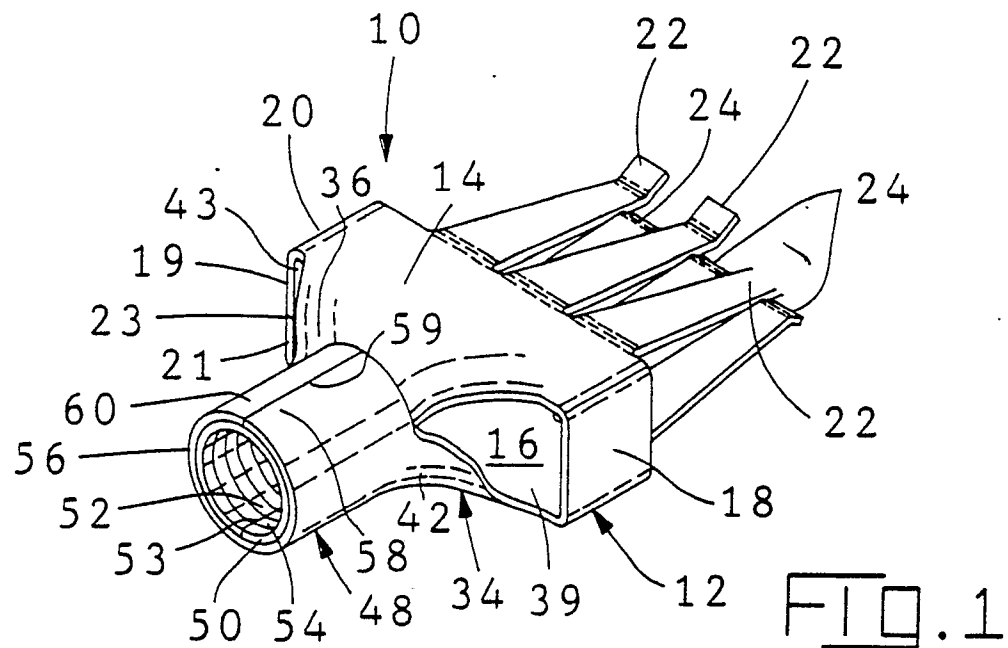
8. The electrical terminal of at least one of claims 1 to 7 further including locking means (161, 163) along the seam (158, 159) of the outer barrel (156) section to secure edges of the seam (158, 159) together.

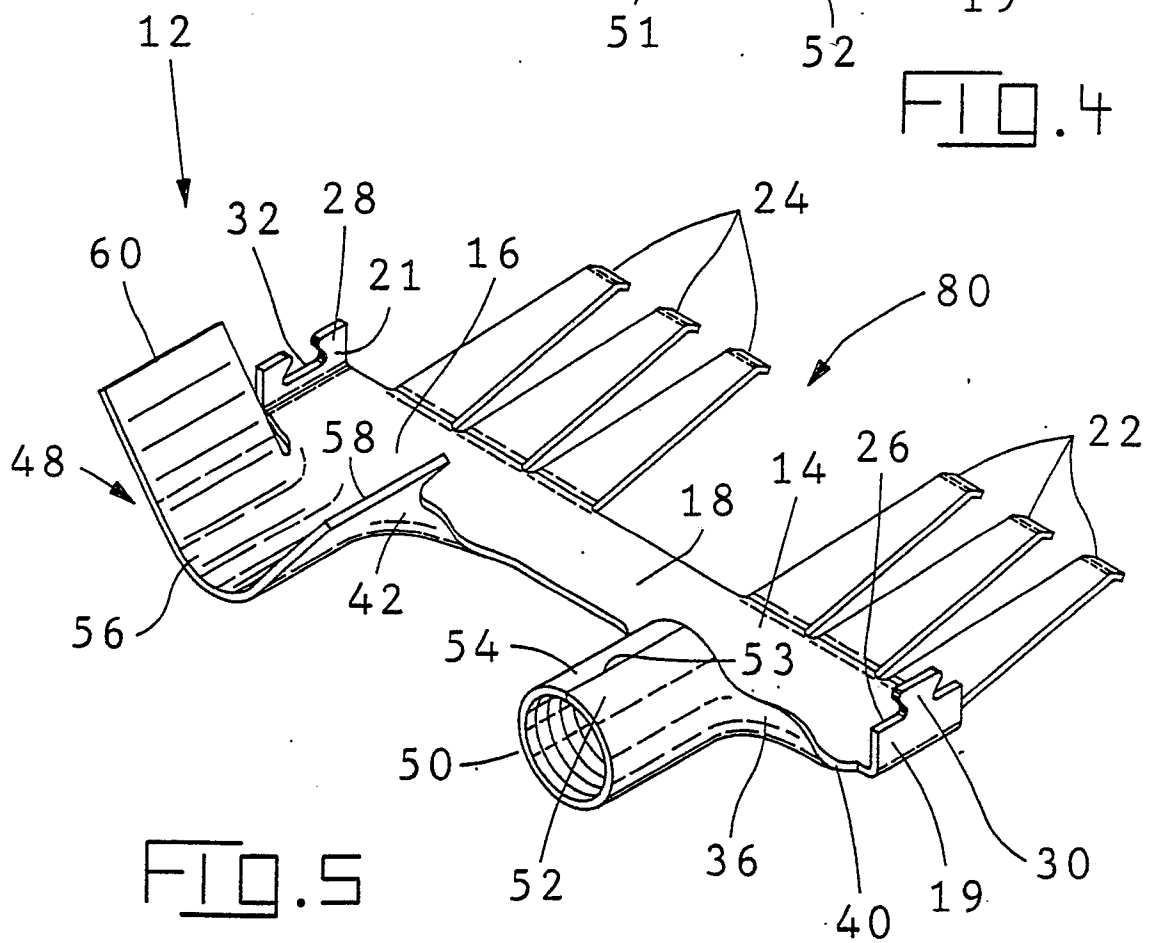
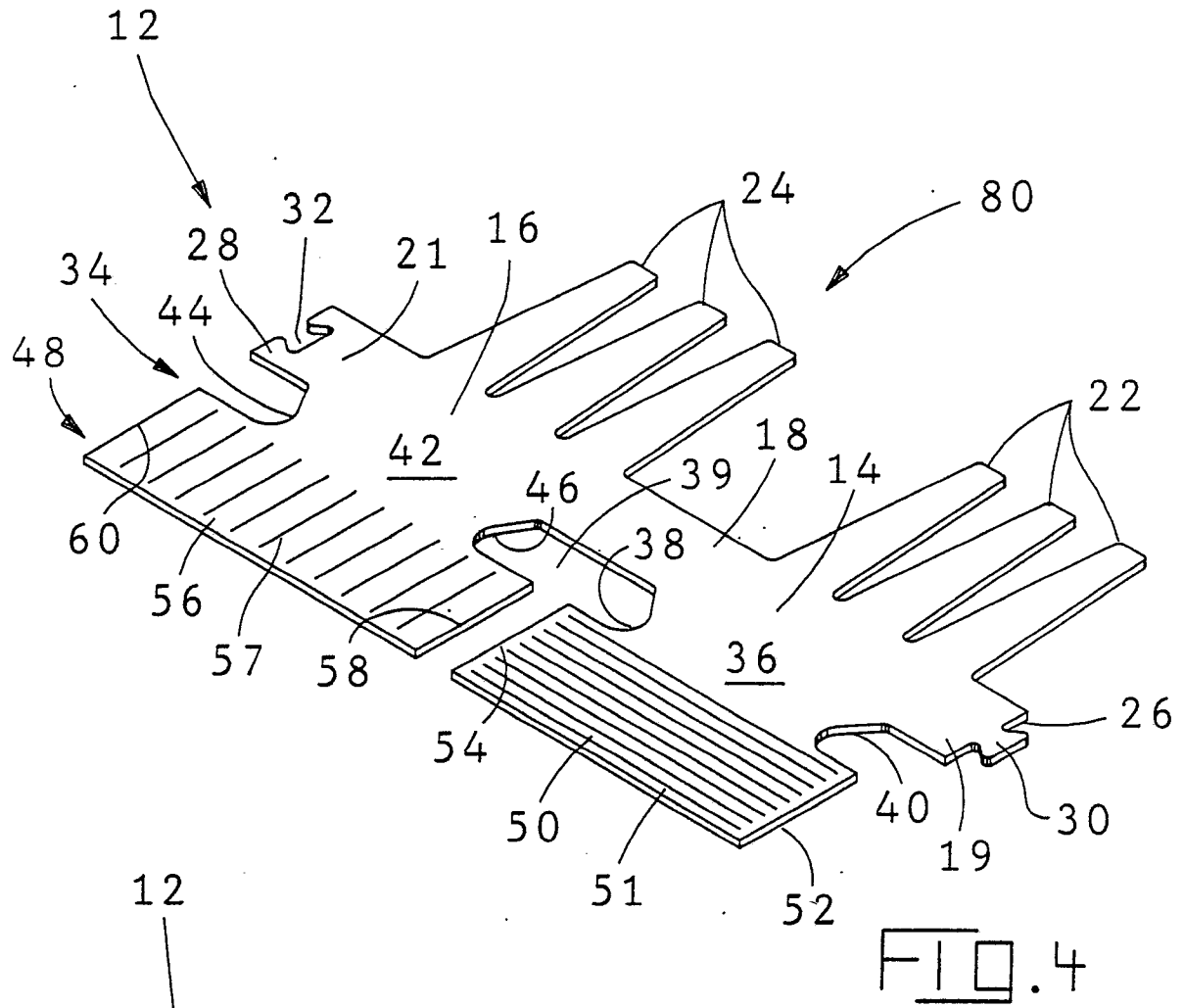
9. The electrical terminal of at least one of claims 1 to 8 further including a plurality of serrations (51, 57) on the inner surface of at least the outer barrel (56) section.

10. A wire-receiving barrel terminal (10) char-

acterized in that:

the wire barrel (48) has an inner hoop (50) and an outer hoop (56), the seams of the inner and outer hoops (53, 59) being essentially transposed to each other and adjacent a continuous wall section of the other hoop whereby upon crimping the terminal (10) to an end of a wire conductor (70), no opening occurs through the circumference of the barrel terminal (10).





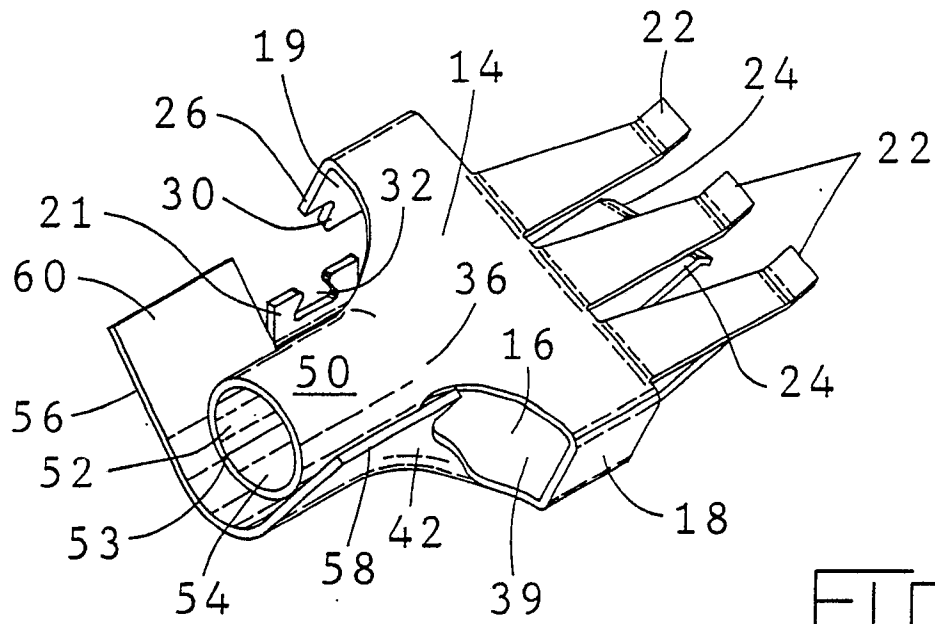


FIG. 6

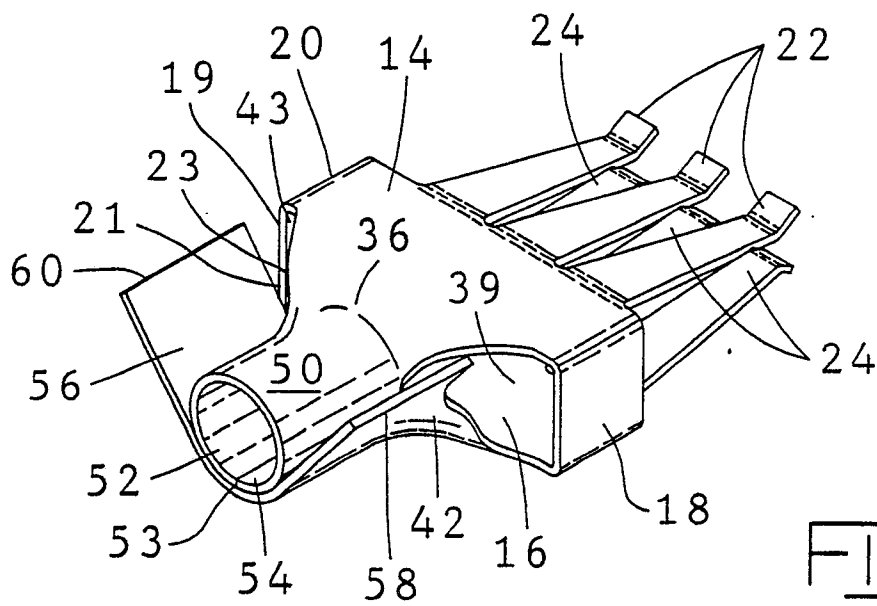


FIG. 7

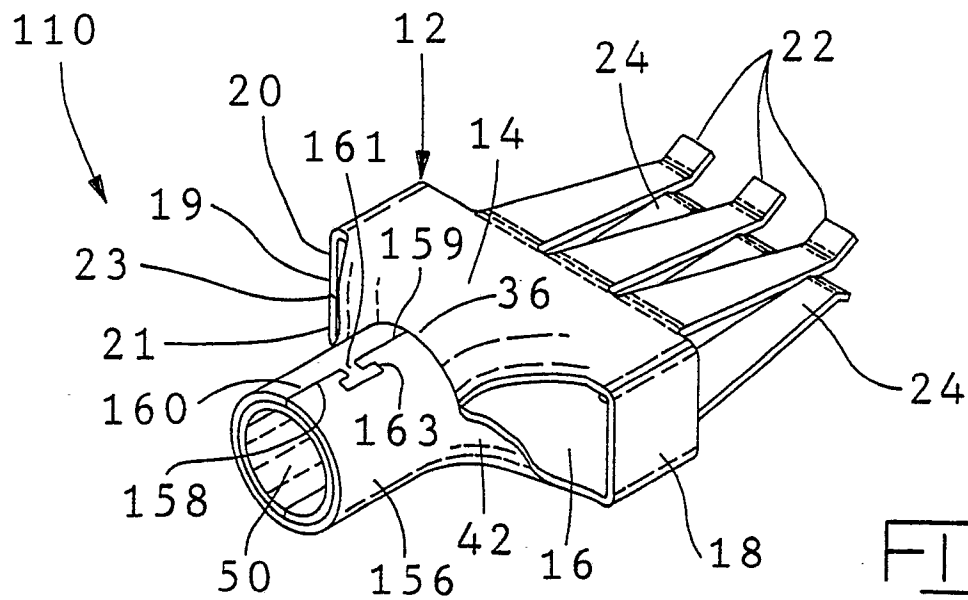


FIG. 8



EP 89 12 3283

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	US-A-3977757 (YURTIN) * column 2, line 49 - column 5, line 9; figures 1-9 *	1, 3, 4, 6, 10	H01R11/11 H01R9/07
A	FR-A-2438359 (BROWN BOYER & CIE AKTIENGESELLSCHAFT) * page 3, last paragraph - page 4, paragraph 1; figure 2 *	1-4, 6	
A,D	US-A-2535013 (T. C. FREEDOM) * column 6, line 17 - column 7, line 25; figures 1-9 *	1, 6, 7, 10	
A	US-A-3141724 (E. B. RAYMOND) * column 2, lines 1 - 18; figures 1-5 *	8, 10	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H01R H02B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 06 MARCH 1990	Examiner TAPPEINER R.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	