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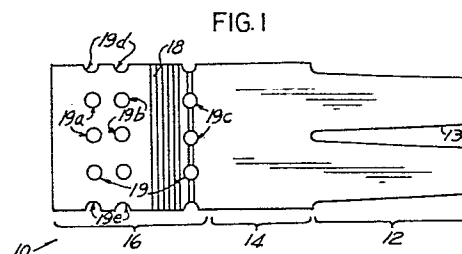
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54 **Electrical contact with inner sleeve member and method of making the same.**

57 An electrical contact (100) for terminating an electrical conductor including an inner sleeve member (10) stamped from a flat sheet of conducting material and formed in a cylindrical shape, with its rear portion (16) including a plurality of round holes (19) extending through the sleeve member and internal circumferential grooves. The round holes are arranged in radially spaced portions, each including a closely-adjacent pair of axially spaced holes (19a, 19b) and a third hole (19c) spaced axially from the pair of holes. The internal grooves or grooved indentations (18) extend circumferentially around the inside periphery of the formed cylindrical contact sleeve. The grooved indentations are located in the rear conductor-receiving portion (16) of the sleeve, preferably forwardly of the rear-most holes (19c).



ELECTRICAL CONTACT AND METHOD OF MAKING

TITLE MODIFIED

see front page

This invention relates to electrical connectors of the type having an outer shell or housing ; a plurality of electrical contacts, each of which are electrically a dielectric insert or insert assembly mounted to the housing for either fixedly or removably mounting the electrical
5 contacts in the shell electrically isolated from other conductors. This invention is more particularly related to an improved electrical contact assembly and a superior method of making the contact.

The present invention is related to and an improvement upon the invention disclosed in US Patent 4 120 556, issued October 17, 1978 and
10 entitled "Electrical Contact Assembly". This patent is hereby specifically incorporated herein by reference and is herein sometimes referred to as the "Three-Piece Contact Patent".

The present invention is also related to US Patent 4 072 394 to C.R. Waldron et al, for "Electrical Contact Assembly". This patent is also
15 incorporated herein by reference, sometimes referred to as the "Alternate Three-Piece Contact Patent".

The present invention is also similar to US SN 158 654 filed June 11, 1980 in the names of D.L. Pfendler and E.J. Bright, also hereby specifically incorporated herein by reference and sometimes referred to as
20 the "Pfendler/Bright Patent Application".

A variety of electrical contacts have been suggested in the prior art. A variety of methods of making such contact also have been suggested in the prior art. Advantageously the contact will be inexpensive and simple to manufacture and assemble, having superior electrical properties,
25 and have good mechanical characteristics (resistance to conductor "pull out" or undesirable contact disassembly).

The Three-Piece Contact Patent describes an electrical contact (and method of making it) somewhat similar to the present invention. The electrical contact described therein, however, presents possible manufacturing and assembly difficulties which could lead to quality and reliability
30 problems in electrical or mechanical properties. The contacts in that

patent are shown to have four elongated slots. Typically, the four slot sleeve (shown therein) is crimped in place by a crimping mechanism having four radially spaced crimp members. The elongated slots could coact with the equal number of crimpers to provide an unreliable mechanical and electrical connection.

The Pfendler/Bright patent addresses this problem by providing an arrangement of slots unequal to the number of crimpers and provides internal grooves in the sleeve. While such a design works well, the removal of so much material (to form slots) may be undesirable in some instances by reducing mechanical and electrical characteristics of the contact.

In other embodiments, electrical contacts are machined from cylindrical metal stock. In these machined contacts, very close manufacturing tolerances (0,05 mm or less) are frequently desired to avoid oversized contact parts. An oversized contact may not be insertable into connector apertures designed to receive the contacts. Further, an insufficient clearance, caused by either an undersized or oversized part, could prevent proper electric or mechanical operation of the contact.

Machined contacts are also generally relatively expensive to manufacture when machine and operator costs are considered. Further, the weight of a machined contact is typically greater than the weight of a stamped and formed contact as described in present invention. While individual contact weight is generally small, an aircraft requires a very large number of contacts and every extra gram of aircraft equipment (e.g., in the contacts) displaces a gram of potential load, since the maximum weight for equipment and load is specified for the aircraft.

Machined contacts are also disadvantageous in that the machines producing them are time-consuming and difficult to set up and inherently produce a parts output which have a relative wide dimensional range. This dimensional range requires a costly post-manufacture inspection, at which a significantly number of machined parts may be rejected or discarded as not meeting specifications. The reject problem significantly raises the costs of good parts.

Some prior art electrical contacts which are stamped and formed into a shape having a seam which is welded or brazed together. The added step of welding or brazing the seam adds an extra step to the manufacturing process and the step is difficult to accomplish accurately in view of the small dimensions which are involved in contact manufacture.

Examples of such prior art contacts are shown in US Patents 2 689 337, 2 804 602, 3 125 396, 3 137 925, 3 314 044, 3 316 528, 3 317 887, 3 648 224, 3 660 805, 3 721 943, 3 920 310 ; French patent 1 447 759 and German patent 60 347.

5 Accordingly, the prior art contacts present various and sundry limitation and disadvantages (depending on the type of contact selected).

It is an object of the present invention to replace the expensive machine contacts with a less expensive, yet high quality, stamped and formed contact of the present invention.

10 It is also an object of the invention to provide an electrical contact which, when stamped from sheet metal, formed into a cylindrical shape and crimped to a conductor, makes a good mechanical attachment and good electrical connection of the conductor.

15 It is still another object of this invention to provide an electrical contact which can be fabricated rather easily in large quantities at low cost with relatively low number of unacceptable parts.

It is still a further object of the present invention to provide an inexpensive electrical contact which is of lower weight than machined electrical contacts.

20 To this end, the invention proposes an electrical contact characterized in that it comprises a tubular sleeve member having a front contact section, a rear wire receiving section and a medial section, said rear wire receiving section including a plurality of axially spaced grooves extending around the internal periphery thereof and having a plurality of
25 holes extending therethrough, said holes being arranged in an axial and radial pattern in the rear wire receiving section and a second sleeve member telescopically mounted over at least one portion of the sleeve member and secured thereon.

The invention also proposes a method of making an electrical
30 contact assembly, characterized in that it comprises the steps of :

- stamping from a sheet of metal in an elongated shape including a plurality of holes in a rear wire receiving section ;

- forming grooves indentations in the rear section extending perpendicular to the elongated length thereof ;

35 - forming said sheet of metal into a sleeve member having a longitudinal axis parallel to the longitudinal axis of the piece with the wire receiving section at one end and a contact section at the other end with the grooved indentations on the inside and extending around the sleeve

member ;

- sliding a sleeve over the sleeve member and securing it there-to.

This invention is an electrical contact assembly and method of making it which overcomes the limitations of disadvantages of prior art electrical contacts. The present contact assembly includes a sleeve stamped to have an arrangement of holes in a conductor-receiving rear portion and advantageously includes a plurality of internal grooved indentations extending circumferentially around the conductor-receiving portion forwardly of some, but preferably not all of the holes. The holes are arranged in sets of a pair of axially-spaced closely adjacent holes, with a third hole spaced axially at a significantly greater distance. Sets of holes are repeated at several (e.g. four) radial locations. In the preferred embodiment, the holes are small and round and of uniform size, allowing the sleeve to be easily crimped while retaining substantial sleeve portions for mechanical (conductor retention) and electrical (current and signal transmission) purposes.

The electrical contact of the present invention has the advantage that it is lower weight and higher quality than that of prior art machined contacts.

The present invention also has the advantage that it has better electrical and mechanical characteristics than the contact described in the Three-Piece Contact Patent or the Alternate Three-Piece Contact patents referred above.

The preferred embodiment of the present invention is a three-piece electrical contact assembly including a sleeve that is stamped and formed from a piece of sheet metal and is characterized by a tubular inner sleeve which has an unwelded seam and twelve holes arranged in a pattern of four holes symmetrically radially at each of three axial location in the rear of the sleeve when formed into a tubular shape. A conductor is secured within the sleeve by being crimped in place with crimps engaging each of the sets of holes.

The foregoing and other objects, advantages and features of the present invention will become apparent to those skilled in the art, in view of the following description and claims, taken in conjunction with the accompanying drawings wherein :

- Figure 1 is a top view of a contact sleeve stamped as a flat piece, prior to forming into a three-dimensional cylindrical shape ;

- Figure 2 is a partial cross-sectional view of the contact sleeve of Figure 1, after it has been formed to its tubular or three-dimensional shape ;

5 - Figure 3 is a partial cross-sectional view of a second piece of the contact assembly of the present invention ;

- Figure 4 is a partial cross-sectional view of a third piece of the electrical contact assembly of the present invention ;

- Figure 5 shows a subassembly of the first and second pieces of the electrical contact assembly of the present invention ;

10 - Figure 6 is a partial cross-sectional view of the assembly of Figure 5, looking along the line VI-VI, looking in the direction of the arrows ;

- Figure 7 is a top view of the assembly portion of Figure 6, looking along the line VII-VII, looking in the direction of the arrows ;

15 - Figure 8 is a partial cross section of the three-piece assembly ;

- Figure 9 is an alternate embodiment of the sleeve of Figure 1 ;

- Figure 10 is another alternate embodiment of the sleeves of Figures 1 and 9.

20 Figure 1 is a top view of a one-piece contact sleeve member 10 showing elements of the present invention. The sleeve member 10 is shown as it is initially formed, a flat piece of sheet metal or other electrically conducting material, stamped in substantially the shape shown.

25 The sleeve member 10 includes a forward contact section 12, a medial section 14, and a rear conductor-receiving section 16. The forward contact section 12 includes two (or, alternatively a plurality of) projections 13 which taper to narrower forward ends. The projections become spring fingers for receiving a male or pin-type electrical contact in both mechanical contact and an electrical circuit relationship after the sleeve member is formed into its three-dimensional cylindrical shape.

30 The medial section 14 spatially connects and electrically joins the forward contact section 12 and the rear conductor-receiving section 16. The rear conductor-receiving section 16 includes a plurality of grooved depressions or indentations 18 extending transverse to the length of the sleeve member 10 and transverse to the axis of the cylindrically-shaped sleeve member 10 (when formed). These grooves 18 are formed on the inside side of the sleeve member 10 when it is formed into its three-dimensional cylindrical shape.

The rear section 16 also includes a plurality of holes generally circular and of small diameter with respect to the width of the sleeve member 10. At each of four radial locations (when the sleeve is formed into its cylindrical shape) there are three axially spaced holes 19a, 19b, 19c, with two holes (19a, 19b) being spaced closely, for example by approximately 1-2 times the hole diameter, and the third hole being spaced by a greater distance, for example by three or more hole diameters. When the sleeve member 10 is formed along the seam, as first hole halves 19d cooperates with second hole halves 19e to form a single set of holes. These radially spaced holes and hole portions are separated by a uniform lateral spacing to provide a uniform angular (radial) separation of the hole sets when the contact sleeve portion is formed into its cylindrical shape.

Figure 2 shows the contact sleeve member 10 formed into a cylindrical shape by forming the sleeve 10. The sleeve member 10 is symmetrical about an axis which is parallel to the length of the sleeve portion and the slots. The forward contact section 12 has the spring fingers 13 converging to its forward end for receiving the pin-type contact therein. The grooved indentations 18 are shown in the cut-away portion extending circumferentially around the inside portion of the sleeve member 10 of Figure 2. The grooves 18 are preferably located forwardly of at least the rear holes (19a, 19b) but within the rear contact receiving section 16.

A rear end portion 21 of the contact body is flared radially outwardly for more ease in inserting an electrical conductor therein. The hole halves 19d, 19e meet at a seam 22 to form a single set of holes, generally similar in shape to the other hole sets 19.

The contact sleeve portion 10 is crimped after a conductor is inserted into the rear end thereof to retain the conductor therein. Existing crimping apparatus are well known and generally have a plurality of radially spaced crimping elements, including four bi-lobed elements spaced 90 degrees apart in the preferred embodiment. Applicants preferred structure is specifically disclosed to have holes axially arranged to fall under or near each of the lobes, as, for example, holes 19c falling near one lobe with the other lobe falling near holes 19a and/or holes 19b. The present invention, therefore, provides arrangement in which the crimps of the sleeve made by the crimping apparatus will deform the sleeve into contact with in the region of the holes 19c and either holes 19a or 19b (or both) as well as the grooves 18 are deformed into the conductor slots. In this way, applicants insure that a significant solid portion of the

sleeve in the region of the holes will be crimped into the conductor to, thereby retain the conductor within the contact sleeve. The contact sleeve is positioned within the crimping members to insure that a portion of the crimping members extends into the region occupied by the grooved portions 18 to further retain the conductor within the sleeve member. By crimping the sleeve member 10 within the region of the groove portions 18, the conductor and groove portions 18 cooperate to additionally prevent external forces from pulling the conductor out of the sleeve member 10.

Figures 3 and 4 illustrate the second (liner) and third (hood) members 30, 40, respectively, of the three-piece contact of the present invention. These members 30, 40 are generally similar in structure and function to the members disclosed in the Three-Piece Contact and Alternate Three-Piece contact patents. The structure of the members 30, 40 are not particularly relevant to the present invention, except that the present invention has preferred and alternate embodiments as described in the Three-Piece Contact and Alternate Three-Piece Contact patents, respectively. Reference should be made thereto for a fuller understanding of the present invention and its environment. The liner 30 includes a radial enlargement 32.

Figure 5 shows an initial (partial) assembly of the contact pieces 10, 30 in the present invention. Wall portions 11, 31 of the members 10, 30, respectively, are punched and bent inwardly to form an inspection aperture 50.

Figure 6 shows a cross-sectional view of the assembly of Figure 5. The sleeve 10 and the member 30 are shown, and have the inspection aperture 50 and indentations 52 shown. The aperture 50 allows a visual inspection of an inserted conductor to insure its proper preparation and positioning.

Figure 7 shows a top view of the member 30 in the vicinity of the inspection aperture 50 and better show the preferred shape of the aperture.

Figure 8 shows a partial cross-sectional view of the entire assembly of a contact 10 showing the inner sleeve 10, the liner 30 and the hood 40. The hood 40 extends rearwardly to (and over) the radial enlargement 32.

Figure 9 shows an alternate structure for a sleeve 10'. The alternate sleeve 10' has the same general configuration, to include the grooved portions 18. The holes 19a', 19b', 19c", however, are uniformly spaced but do not include a set of holes which is formed (split) along the seam, by including half on one side, half on the other. The five set of holes are fully defined in the material even in its flat state.

Figure 10 shows a second alternate structure for a sleeve 10",

including 18 holes arranged in three axial rows 19a", 19b", 19c" of six holes spaced radially around the sleeve.

While a preferred embodiment of the present invention has been disclosed with some particularity, it will be apparent to those skilled in the art that changes may be made to the present preferred embodiment without departing from the spirit of the present invention. In some instances, certain features of the present invention may be used to advantage without the corresponding use of other features. For example, the number and shape of holes is not important. Instead of a pair of closely spaced holes in the rear with a spaced hole forwardly (in each radial set), the pair of holes could be forwardly, with the single hole rearwardly (in each radial set). The grooves can be between the sets of holes, or overlap one of both sets. Additionally, the grooved portions need neither be continuous nor extend completely circumferentially around the body. Accordingly, it is intended that the illustrative and descriptive materials herein be used merely to illustrate the principles of the present invention and not to limit the scope thereof which is described solely by the appended claims.

CLAIMS

1. An electrical contact, characterized in that it comprises a tubular sleeve member (10) having a front contact section (12), a rear wire receiving section (16) and a medial section (14), said rear wire receiving section (16) including a plurality of axially spaced grooves (18) extending around the internal periphery thereof and having a plurality of holes (19) extending therethrough, said holes being arranged in an axial and radial pattern in the rear wire receiving section, and a second sleeve member (30) telescopically mounted over at least one portion of the sleeve member and secured thereon.

2. An electrical contact according to claim 1, characterized in that the pattern of holes (19) includes a plurality of radially spaced sets of holes, each set including a pair of closely spaced holes (19a, 19b) axially separated and a third hole (19c) axially spaced by a relatively greater separation than between the pair of holes (19a, 19b).

3. An electrical contact according to claim 2, characterized in that the grooves (18) are located between the pair of holes (19a, 19b) and the third hole (19c).

4. A method of making an electrical contact assembly, characterized in that it comprises the steps of :

- stamping from a sheet of metal in an elongated shape including a plurality of holes (19) in a rear wire receiving section ;

- forming grooves indentations (18) in the rear section extending perpendicular to the elongated length thereof ;

- forming said sheet of metal into a sleeve member having a longitudinal axis parallel to the longitudinal axis of the piece with the wire receiving section at one end and a contact section at the other end with the grooved indentations on the inside and extending around the sleeve member ;

- sliding a sleeve over the sleeve member and securing it thereto.

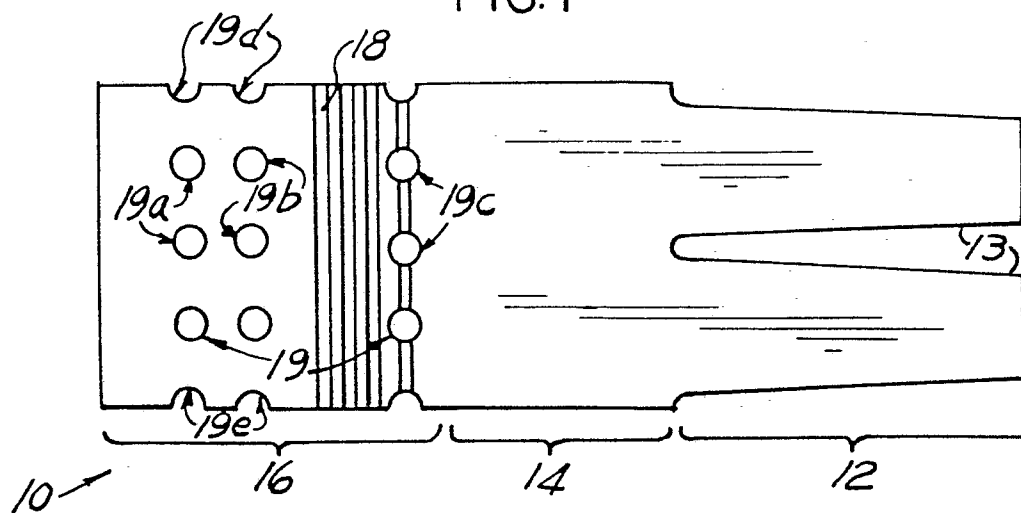
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FIG. 1

FIG. 2

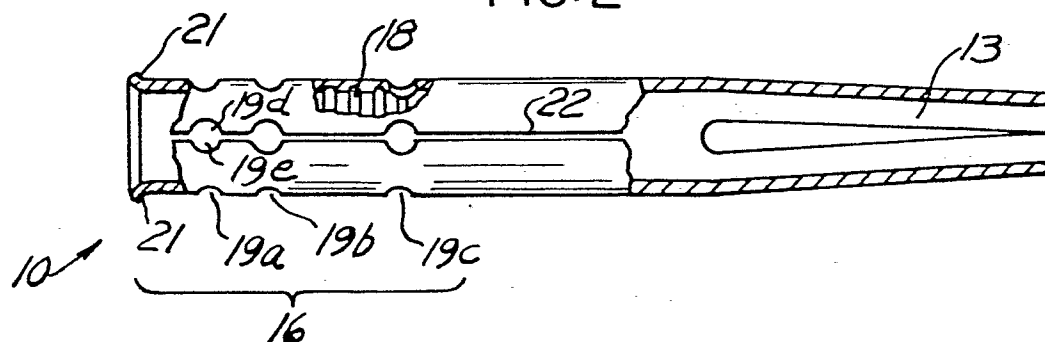


FIG. 3

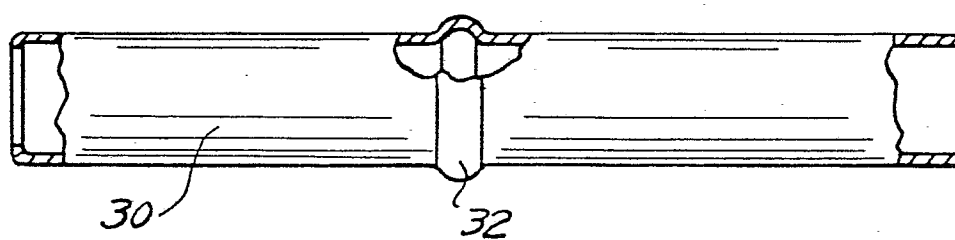


FIG. 4

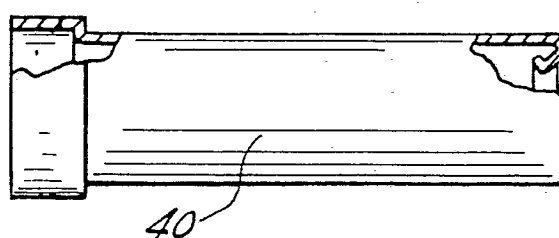


FIG.5 2 / 2

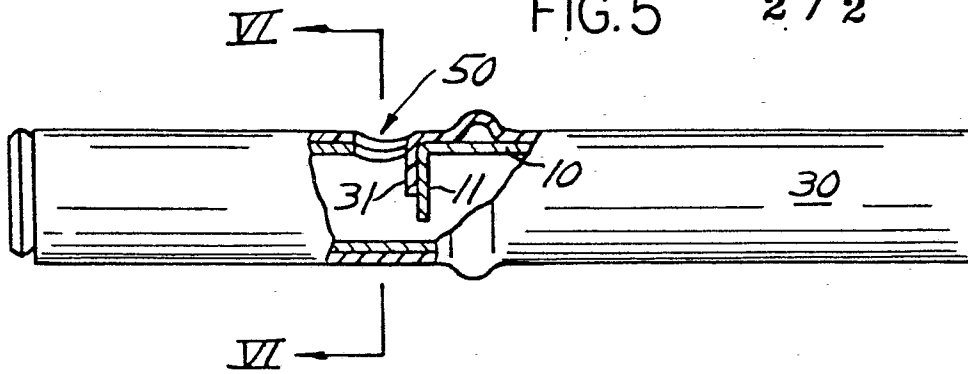


FIG.6

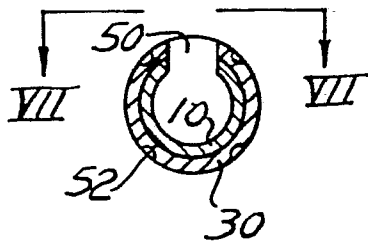


FIG.7

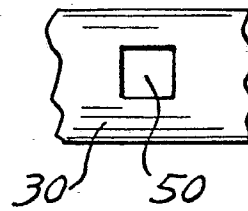


FIG.8

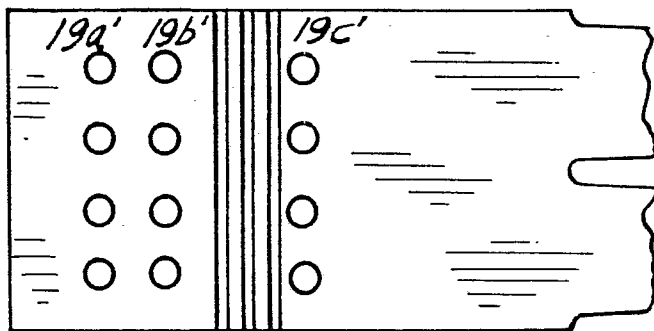
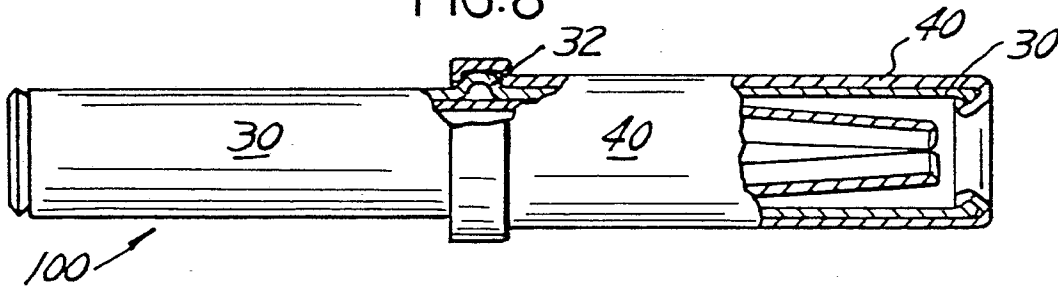
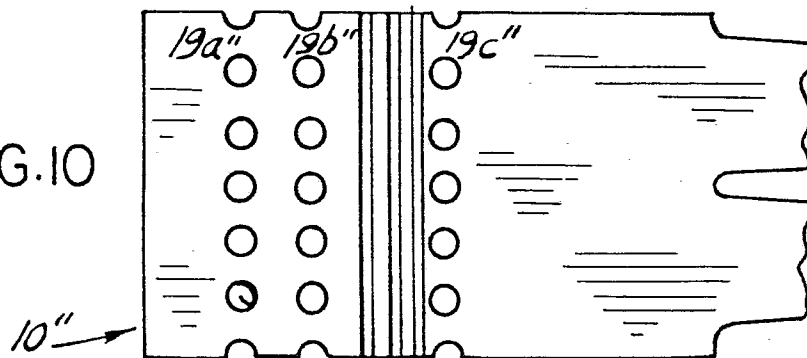


FIG.9

FIG.10





DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.)	
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim		
D E/P	<u>US - A - 2 685 076 (AMP)</u> * Column 2, line 40 to column 3, line 14; figures 1-5 * ---	1,4	H 01 R 13/115	
	<u>US - A - 2 452 932 (AMP)</u> * Column 2, lines 13-55; figures 1-3 * ---	1,4		
	ELECTRICAL WORLD, vol. 168, no. 24, December 11, 1967, NEW YORK (US) "Terminals/Splices...", pages 120 and 122 * Page 120, right-hand column, figures and last paragraph; page 122, right-hand column, paragraph 1 * ---	1,2,4		
	<u>GB - A - 1 164 100 (AMP)</u> * Page 1, line 87 to page 2, line 83; figures 1-6 * ---	1,2,4	TECHNICAL FIELDS SEARCHED (Int. Cl.)	
	<u>FR - A - 2 343 344 (BENDIX)</u> * Page 4, line 33 to page 9, line 27; figures 3-12 and 15-21 * ---	1,4	H 01 R 13/115 13/11 13/187 4/18 4/20	
	<u>& US - A - 4 120 556 (BENDIX)</u> ---		CATEGORY OF CITED DOCUMENTS	
	<u>EP - A - 0 025 366 (BENDIX)</u> * Page 4, line 10 to page 7, line 17; figures 1-7 * -----	1,4	X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons	
			&. member of the same patent family, corresponding document	
	The present search report has been drawn up for all claims			
	Place of search	Date of completion of the search	Examiner	
The Hague	28.09.1981	LOMMEL		