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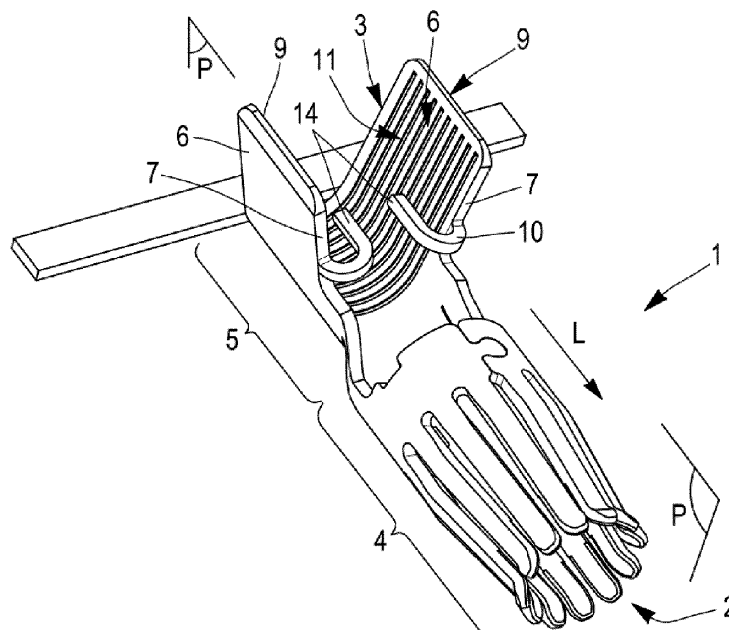
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(54) **POWER TERMINAL WITH IMPROVED CRIMPING PORTION AND CRIMPING METHOD THEREOF**

(57) Power terminal (1) comprising a contact portion (4) and a crimping portion (5) which extends in a longitudinal direction (L). The crimping portion (5) has, before crimping on a multi-strand electrical wire and in cross section, a U-shape defined by crimping tabs (6). Each

crimping tab (6) comprises, towards the front, a front edge (7) which is provided with at least one leg (10) which extends from it parallel with the longitudinal direction (L) and which is intended to be at least partially introduced between the strands of the multi-strand electrical wire.

[Fig. 4]



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Description

Technical field

[0001] The invention relates to the field of automotive connectivity and more particularly the field of power connectivity for motor vehicles.

Prior art

[0002] In the field of motor vehicles and in particular electric vehicles, hybrid vehicles or rechargeable vehicles, powerful currents can be transmitted in wiring networks and/or electric power circuits (these electric circuits being completely integrated in the vehicle itself or comprising at least a portion which is connected to the vehicle). Such circuits, for example, interconnect between them elements such as an electric vehicle supply equipment, a battery, a motor, a voltage converter, etcetera. When it is necessary to integrate connectors in wiring networks which are intended to transmit powerful currents, these connectors must be provided with terminals or contacts having a size and cross section which are large enough to transmit these powerful currents without excessive heating. To this end, the terminals of current power connectors are generally machined, for example, by bar-turning from solid copper bars (or a copper alloy) and/or cut out and formed from relatively thick metal sheets (the document EP2919324 A1 discloses the general form of a cut-out terminal, the terminal further not being necessarily adapted to the power connectivity). Some zones of the terminals are where applicable covered with a metal, such as silver and/or gold, in order to limit the heating actions, particularly at the points of contact between male and female terminals.

[0003] For some applications, for example, for charging plugs which are intended for rapid charging, the industry of power connectivity for motor vehicles needs to connect the terminals to wires whose cross section is large. Thus, in order to prevent excessive heating, it is necessary for the connection between a terminal and a wire also to be as non-resistive as possible, and particularly when this connection is carried out by crimping.

[0004] There is proposed below a contribution to improving the crimping of a power terminal on a wire.

Statement of invention

[0005] It is proposed to act in the region of the crimping portion of male or female terminals.

[0006] More specifically, there is described below a power terminal which is formed by cutting out and forming a blank from a metal sheet of electrically conductive material. This terminal comprises a contact portion and a crimping portion. The crimping portion extends in a longitudinal direction between a front end located towards the contact portion and a rear end. The crimping portion has, before crimping on a multi-strand electrical wire and

in cross section, a U-shape. Each of the legs of this U-shape corresponding to a crimping tab. Each crimping tab comprises a front edge directed towards the front end. This front edge comprises at least one leg or tongue which extends from it, substantially parallel with the longitudinal direction. At least one of these legs is intended to be inserted between the strands of the multi-strand wire, on which the terminal is crimped. In other words, this leg which is inserted between the strands of the multi-strand wire increases the electric contact surface between the terminal and the wire and/or allows better compaction of the clamped and compacted strands by each of the crimping tabs. This is because the contact surface substantially comprises the internal surface of the crimping tabs, to which the external surface of each of the legs inserted between the strands is added, these two surfaces being in contact with the wire.

[0007] Furthermore, since each leg extends from a front edge of a crimping tab, the material which forms this leg is not taken from a portion of the terminal (in particular, it is not taken from the bottom of the channel which forms the U-shape and in which the wire is placed). Thus, the lines of current are distributed over an optimised volume of material; which is particularly advantageous in order to limit occurrences of heating in the case of applications for powerful electric currents. Furthermore, the formation of the legs does not add any complexity to the process for producing the terminal, the legs being able to be cut out from a metal sheet of conductive material (for example, copper, aluminium or an alloy comprising at least one of these metals) at the same time as the crimping tabs.

[0008] This terminal also comprises where applicable one and/or other of the following features which are considered independently of each other or as a combination of one or several other features:

- each of the legs extends over a first portion from a front edge towards the contact portion, this first portion having continuity of material with a second curved portion which continues over a third portion, which extends from the second portion backwards, this third portion corresponding to an internal portion which extends between the crimping tabs;
- the internal portion has a length between 20 and 40% of the length of a crimping tab, parallel with the longitudinal direction;
- each crimping tab comprises two legs which extend from the front edge, each of these two legs being configured to be able to be curved towards the rear end;
- the crimping portion is configured to be able to receive an electrical wire which has a cross section of at least 35 square millimetres and each crimping tab has at least one leg which extends from the front edge;
- the crimping portion is configured to be able to receive an electrical wire which has a cross section of

at least 70 square millimetres and each crimping tab has at least two legs which extend from the front edge; and

- the crimping portion is configured to be able to receive an electrical wire which has a cross section of at least 90 square millimetres and each crimping tab has at least three legs which extend from the front edge.

[0009] There is also proposed an assembly comprising a conductive multi-strand electrical wire, at one end of which a terminal as mentioned above is crimped and in which each crimping tab is folded at least partially around each of the internal portions of the legs.

[0010] This assembly also comprises where applicable one and/or other of the following features which are considered independently of each other or as a combination of one or several other features:

- each tab forms a channel or groove, in which some of the conductive multi-strand electrical wires are placed around at least one leg;
- the non-compacted multi-strand electrical wire has a cross section greater than or equal to 35 square millimetres; this cross section is, for example, 70 or 95 square millimetres; it may be noted that the terminal mentioned above is suitable for receiving before crimping a wire whose cross section is greater than or equal to 35 square millimetres; however, it must also be noted that the value of 35 square millimetres for the cross section of the wire represents a value from which the use of such a terminal is particularly advantageous; however, it is naturally possible to use similar terminals to those mentioned above, in assemblies with wires having a cross section whose value would be less than 35 square millimetres, for example, from 6 square millimetres.

[0011] There is also proposed a crimping method comprising the following operations:

- providing a terminal as mentioned above, wherein each of the legs is formed in such a manner that it extends over a first portion from a front edge towards the contact portion, this first portion having continuity of material with a second curved portion which continues over a third portion which itself extends from the second portion towards the rear end, this third portion corresponding to an internal portion which extends between the crimping tabs,
- providing a multi-strand wire and inserting an exposed end of the multi-strand wire between the crimping tabs, and
- forming the crimping tabs between an anvil and a punch in order to compact the strands of the multi-strand wire around the internal portion of each leg, the anvil and the punch having suitable respective forms for the crimping portion, after forming the

crimping tabs by curving them, to have a cross section in the region of the internal portion with two lobes and at least one internal portion of a leg which is introduced into each lobe.

[0012] This method also comprises where applicable the following feature, considered independently or as a combination of one or several other features:

- during the operation for forming the tabs, they are brought one against the other symmetrically at one side and the other of a plane of symmetry which is parallel with the longitudinal direction, each internal portion being inserted in a region of a lobe which is substantially delimited, on the one hand, by a crimping tab and, on the other hand, by a plane perpendicular to the plane of symmetry, parallel with the longitudinal direction and tangent to a longitudinal edge of each crimping tab.

Brief description of the drawings

[0013] Other features, objects and advantages of the terminal mentioned above will be appreciated from a reading of the following detailed description with reference to the appended drawings which are given by way of non-limiting example and in which:

[Figure 1] is a schematic perspective view of a blank corresponding to a first embodiment of a female terminal;

[Figure 2] is a schematic perspective view of a detail of a contact leg illustrated in Figure 1 after this leg has been formed;

[Figure 3] is a schematic perspective view of the female terminal of Figure 1 after it has been formed but before being crimped;

[Figure 4] is a schematic perspective view of a second embodiment of a female terminal before crimping;

[Figure 5] is a schematic cross section of a crimping portion of a terminal, such as the one illustrated in Figure 4, after a crimping operation; and

[Figure 6] is a schematic perspective view of an example of assembly of the first embodiment of a female terminal after it has been crimped on a multi-strand wire.

Detailed description

[0014] Naturally, since the invention substantially relates to the crimping portion of a power terminal, for the purpose of conciseness only one example of a female terminal is described below among a number of other possible examples of power terminals, whether male terminals or female terminals.

[0015] The terminal 1 described below is, for example, used as a power terminal for a charging plug for an elec-

tric vehicle or for a plug-in hybrid vehicle. In other words, it is intended to be electrically connected to an electrical wire 100 and mounted in a charging plug casing (not illustrated). However, a terminal 1 of this type can be used in applications other than the application corresponding to a charging plug.

[0016] This terminal 1 described below with reference to Figure 1 is formed by cutting out and forming a blank from a metal sheet made from a copper alloy. For example, this metal sheet is 1.4 mm thick. The terminal 1 is thus substantially monobloc.

[0017] As illustrated in Figure 1, the terminal 1 comprises a front end 2 and a rear end 3 ("front" and "rear" refer to the connection direction, the front end 2 corresponding to the end via which the pin of a male terminal is introduced into this female terminal). This terminal 1 thus comprises, in the direction from the front end 2 towards the rear end 3, a contact portion 4 and a crimping portion 5. The contact portion 4 is intended to establish an electrical connection with a male terminal. The crimping portion 5 is intended to receive the free end of an electrical wire 100 and to establish an electrical connection therewith.

[0018] The crimping portion 5 extends in a longitudinal direction L between a front end 2 which is located towards the contact portion 4 and a rear end 3. The crimping portion 5 comprises two crimping tabs 6. Each crimping tab 6 comprises a front edge 7 towards the front end 2, a rear edge 8 towards the rear end 3 and a longitudinal edge 9. Each front edge 7 or rear edge 8 is substantially perpendicular to the longitudinal direction L. Each longitudinal edge 9 is substantially parallel with the longitudinal direction L.

[0019] Each front edge 7 comprises two legs 10. The number of legs 10 may naturally be different from the number illustrated in Figures 1 and 3. The front edge 7 of each crimping tab 6 is provided with two legs 10, for example, in the case of crimping on a wire which has a cross section of 70 square millimetres. As illustrated in Figure 4, each front edge 7 may comprise only one leg 10. The front edge 7 of each crimping tab 6 is provided with a single leg 10, for example, in the case of crimping on a wire which has a cross section of 35 square millimetres. The front edge 7 of each crimping tab 6 is where applicable provided with three legs 10, for example, in the case of crimping on a wire which has a cross section of 95 square millimetres.

[0020] After cutting out the contact portion 4 and crimping portion 5 from the metal sheet made of electrically conductive material, as illustrated in Figure 1, each of the legs 10 extends towards the front end 2 in a manner parallel with the longitudinal direction L, from this front edge 7.

[0021] The legs 10 are subsequently folded back towards the rear end 3, above the internal surface 11 of the crimping tabs 6. This internal surface 11 is intended to move into contact with the wire 100, on which the crimping portion 5 will be crimped. Marks, ribs, indentations,

etc., may be formed on the internal surface 11 of the crimping tabs 6, which surface is intended to come into contact with the wire 100.

[0022] As illustrated in Figure 2, each of the legs 10 thus extends over a first portion from a front edge 7 towards the contact portion 4. This first portion 12 has continuity of material with a second portion 13 which is curved (for example, with a radius of curvature of approximately 3 millimetres). The second portion 13 has continuity of material with a third portion or internal portion 14 which extends from the second portion 13 towards the rear end 3. This internal portion 14 extends between the crimping tabs 6. This internal portion 14 has a length, for example, between 20% and 40% of the length of a crimping tab 6 (that is to say, substantially the length of the longitudinal edge 9) parallel with the longitudinal direction L. For example, the internal portion 14 has a length of approximately 5 millimetres for a length of the crimping tab 6 of approximately 15 millimetres, that is to say, approximately 30% of the length of a crimping tab 6.

[0023] A cambering operation of the crimping tabs 6 is subsequently carried out, at the end of which the crimping portion 5 has a groove-like shape which is symmetrical relative to a plane P of symmetry parallel with the longitudinal direction L.

[0024] Therefore, the crimping portion 5 has, at the end of this crimping operation of the crimping tabs 6, but before being crimped on a wire 100, a U-shape in cross section. Each of the branches of this U-shape then corresponds to a crimping tab 6.

[0025] A wire 100 is placed in the crimping portion 5 while the crimping tabs 6 are not yet folded. For example, the wire 100 is a multi-strand wire which is formed by a plurality of strands 110 which are constituted by a conductive material (for example, made of copper, aluminium or an alloy of one or other of these metals). The wire 100 is covered by a sheath 120 of insulating material. The free end of the wire 100 is exposed before being introduced into the crimping portion 5. Advantageously, the free and exposed end of the wire 100 is inserted into the crimping portion 5, via the rear end 3, substantially parallel with the longitudinal direction L, in such a manner that the legs 10 are inserted more readily between the strands 110 parallel with the longitudinal direction L thereof. In order to facilitate this insertion operation of the wire 100 in the crimping portion 5, the free end of the legs 10 is advantageously chamfered. Where applicable, the free end of the wire 100 is previously formed in a preform, the cavity of which corresponds to the position and form of the legs 10.

[0026] The crimping portion 5, with the exposed end of the wire 100 introduced therein, is subjected to a deformation between an anvil and a punch which are suitable, in order to bring the longitudinal edge 9 of each crimping tab 6 towards the interior and towards the bottom of the groove of the crimping portion 5. As illustrated in Figure 5, during the forming operation of the crimping tabs 6, they are brought one against the other in a sub-

stantially symmetrical manner at one side and the other of a plane of symmetry parallel with the longitudinal direction L. The longitudinal edge 9 is introduced inside the strands 110. This operation is advantageously facilitated by providing chamfered longitudinal edges 9.

[0027] The result of this forming of the crimping tabs 6 is schematically illustrated in Figures 5 and 6. After this forming of the crimping tabs 6, the crimping portion 5 has a cross section in the region of the internal portion with two lobes 15. In Figure 5, the crimping portion 5 is schematically illustrated as a cross-section at a level of the crimping portion 5, in which the internal portion 14 of the legs 10 is located. In this case, a terminal 1 as illustrated in Figure 4 is involved, with the internal portion 14 of a single leg 10 being introduced into each lobe 15. Each internal portion 14 is inserted in a region of a lobe 15 which is substantially delimited, on the one hand, by a crimping tab 6 and, on the other hand, by a plane P' which is perpendicular to the plane P of symmetry parallel with the longitudinal direction L and tangent to a longitudinal edge 9 of each crimping tab 6. Each internal portion 14 is thus surrounded by strands 110 in a flattened zone of the crimping portion 5 in which the strands 110 are compressed by 15% more in relation to the flattened zone of the crimping portion 5 in which the internal portion 14 of the legs 10 does not extend. For example, if, in the zone where there is no internal portion 14, the compression rate of the strands 110 is 20%, in the zone where there is an internal portion, the compression rate of the strands 110 is 35%. In the flattened zone of the crimping portion 5 in which the strands 110 are compressed around the legs 10, the compression is relatively homogeneous. The compression rate is also over the whole of the strands 110 on which the terminal 1 is crimped. This allows the production, in the zone where there is an internal portion 14, of an electrical contact between the strands 110 which is equivalent and better over the whole of the cross section of the wire 100 (without any internal portion 14, the electrical contact between the strands 110 towards the centre of each lobe 15 is worse than at the periphery, near the internal surface 11 of each crimping tab 6. This allows a significant reduction in the internal resistance between the strands 110. If a plurality of groups of strands 110 are defined (for example, one group for each lobe 15 and one group in the median zone under the longitudinal edges 9 of the folded crimping tabs 6), the fact of introducing the internal portion 14 of one or more legs 10 within each group allows the internal resistance of each group to be reduced, not only as a result of the greater compacting of the strands 110 relative to each other, but also as a result of the fact that each leg 10 provides an additional conduction path with little resistance as far as the crimping tab 6 which carries this leg 10.

[0028] With two legs 10 per crimping tab 6 and a wire of 70 square millimetres, the internal contact resistance can thus be reduced by 7 microOhms, changing, for example, from 20 microOhms to 13 microOhms, for example.

[0029] The terminal 1 described above may have a number of variants which differ from the one described above as a result of different dimensions, different materials, different forms and/or a different number of legs 10.

Claims

1. Power terminal (1) which is formed by cutting out and forming a blank from a metal sheet of electrically conductive material, this terminal (1) comprising a contact portion (4) and a crimping portion (5) which extends in a longitudinal direction (L) between a front end (2) located towards the contact portion (4) and a rear end (3), the crimping portion (5) having, before crimping on a multi-strand electrical wire (100) and in cross section, a U-shape with each of the legs of this U-shape corresponding to a crimping tab (6), each crimping tab (6) comprising a front edge (7) directed towards the front end (2), the front edge (7) of each crimping tab (6) comprising at least one leg (10) which extends from it, substantially parallel with the longitudinal direction (L),
characterised in that each of the legs (10) extends over a first portion (12) from a front edge (7) towards the contact portion (4), this first portion (12) having continuity of material with a second curved portion (13) which continues over a third portion, which itself has continuity of material with the second portion (12) and which extends from the second portion (13) towards the rear end (3), this third portion corresponding to an internal portion (14) which extends between the crimping tabs (6).
2. Terminal (1) according to claim 1, wherein the internal portion (14) has a length between 20 and 40% of the length of a crimping tab (6), parallel with the longitudinal direction (L).
3. Terminal (1) according to either claim 1 or 2, wherein each crimping tab (6) comprises two legs (10) which extend from the front edge (7), each of these two legs (10) being configured to be able to be curved towards the rear end (3).
4. Terminal (1) according to either claim 1 or 2, wherein the crimping portion (5) is configured to be able to receive an electrical wire (100) which has a cross section of at least 35 square millimetres and each crimping tab (6) has at least one leg (10) which extends from the front edge (7).
5. Terminal (1) according to either claim 1 or 2, wherein the crimping portion (5) is configured to be able to receive an electrical wire (100) which has a cross section of at least 70 square millimetres and each crimping tab (6) has at least two legs (10) which ex-

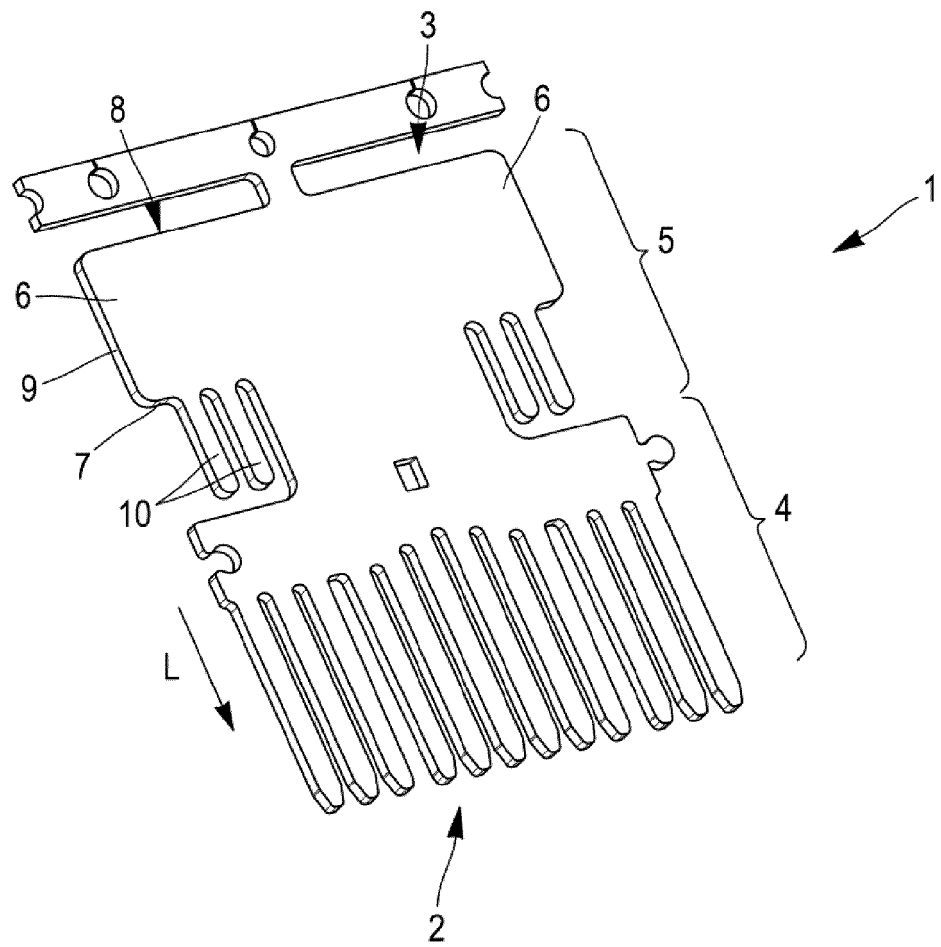
tend from the front edge (7).

6. Terminal (1) according to either claim 1 or 2, wherein the crimping portion (5) is configured to be able to receive an electrical wire (100) which has a cross section of at least 90 square millimetres and each crimping tab (6) has at least three legs (10) which extend from the front edge (7). 5
7. Assembly comprising a conductive multi-strand electrical wire (100), at one end of which a terminal (1) according to any one of the preceding claims is crimped, wherein each crimping tab (6) is folded at least partially around each of the internal portions (14) of the legs (10). 10 15
8. Assembly according to claim 7, wherein each crimping tab (6) forms a channel, in which some of the strands (110) of the conductive multi-strand electrical wire (100) are placed around at least one leg (10). 20
9. Assembly according to claim 7 or 8, wherein the non-compacted multi-strand electrical wire (100) has a cross section greater than or equal to 35 square millimetres. 25
10. Assembly according to any one of claims 7 to 9, wherein the non-compacted multi-strand electrical wire (100) has a cross section greater than or equal to 70 square millimetres. 30
11. Crimping method comprising the following operations:
 - providing a terminal (1) according to claim 1, wherein each of the legs (10) is formed in such a manner that it extends over a first portion (12) from a front edge (7) towards the contact portion (4), this first portion (12) having continuity of material with a second curved portion (13) which continues over a third portion which itself extends from the second portion (13) towards the rear end (3), this third portion corresponding to an internal portion (14) which extends between the crimping tabs (6), 35 40 45
 - providing a multi-strand conductive electrical wire (100) and inserting an exposed end of the multi-strand wire (100) between the crimping tabs (6), and
 - forming the crimping tabs (6) between an anvil and a punch in order to compact the strands (110) of the multi-strand wire (100) around the internal portion (14) of each leg (10), the anvil and the punch having suitable respective forms for the crimping portion (5), after forming the crimping tabs (6) by curving them, to have a cross section in the region of the internal portion (14) with two lobes (15) and at least one internal

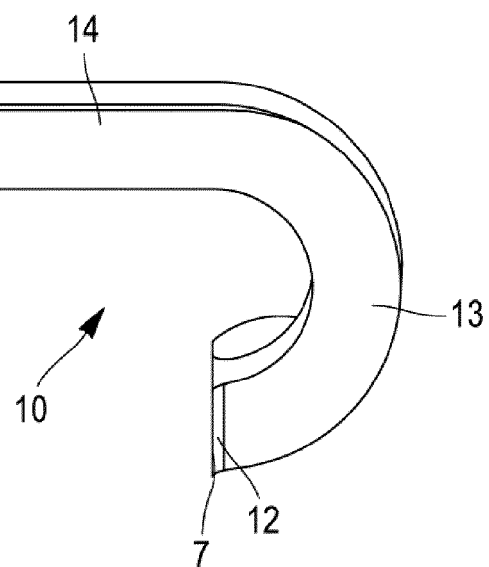
portion (14) which is introduced into each lobe (15).

12. Crimping method according to claim 11, wherein, during the operation for forming the crimping tabs (6), they are brought one against the other symmetrically at one side and the other of a plane (P) of symmetry which is parallel with the longitudinal direction (L), each internal portion (14) being inserted in a region of a lobe (15) which is substantially delimited, on the one hand, by a crimping tab (6) and, on the other hand, by a plane (P') perpendicular to the plane (P) of symmetry, parallel with the longitudinal direction (L) and tangent to a longitudinal edge (9) of each crimping tab (6).

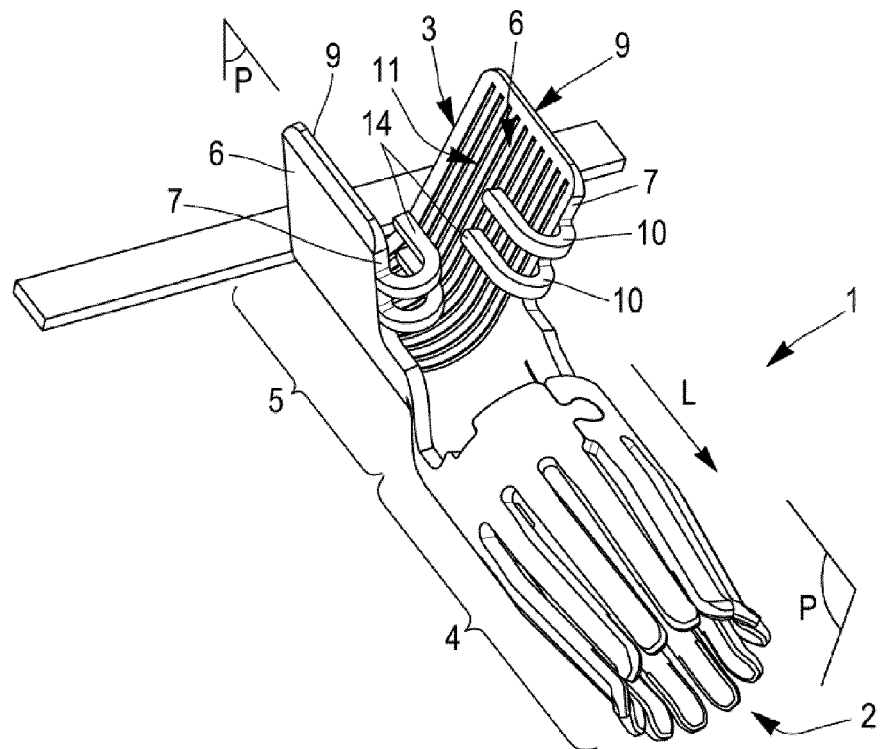
[Fig. 1]



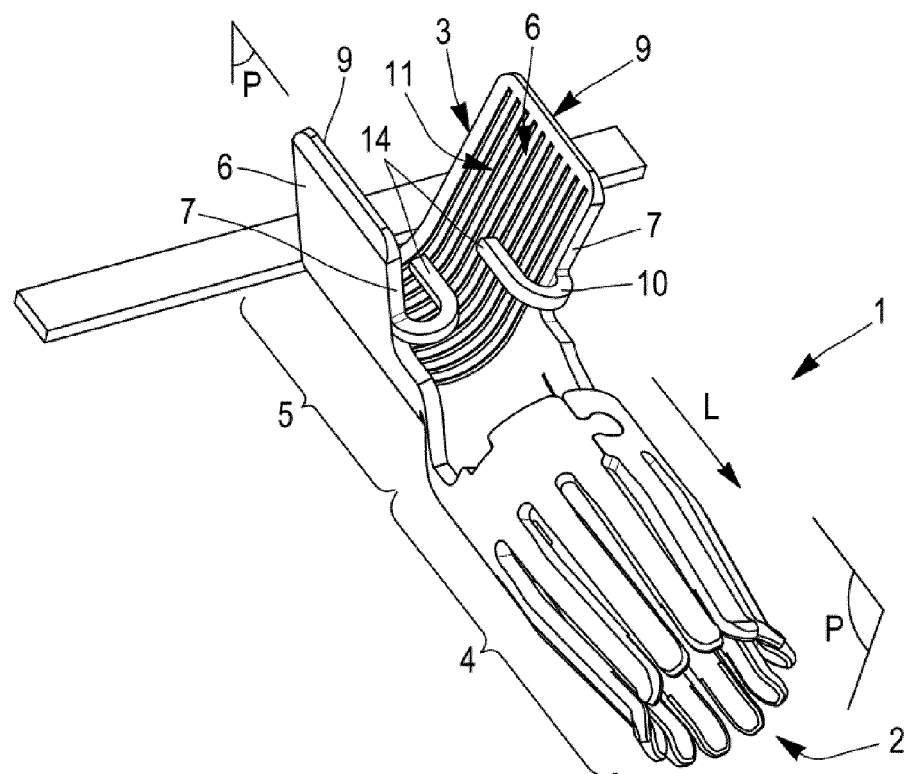
[Fig. 2]



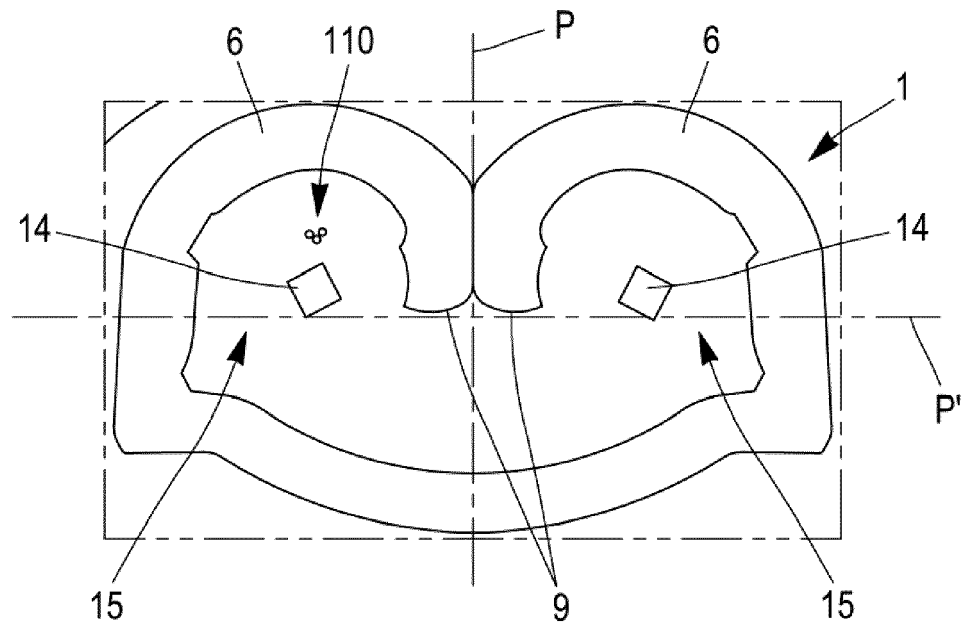
[Fig. 3]



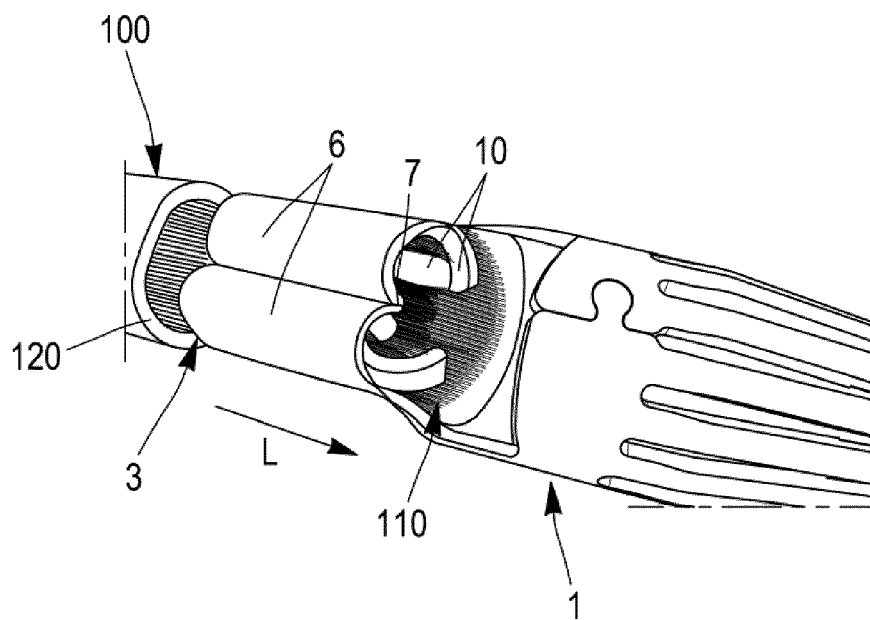
[Fig. 4]



[Fig. 5]



[Fig. 6]





EUROPEAN SEARCH REPORT

Application Number

EP 21 21 0040

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			H01R
The present search report has been drawn up for all claims			

1

EPO FORM 1503 03.82 (P04C01)

Place of search	Date of completion of the search	Examiner
The Hague	18 March 2022	Vautrin, Florent
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