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(54) **ELECTRIC CONNECTION ARRANGEMENT**

(57) Electric connection arrangement comprising:
a female terminal (1) having a receiving space (3) extending in direction of a longitudinal axis (L) of the connection arrangement and being delimited by upper lamellae (4) and lower lamellae (5), wherein the upper lamellae (4) each have an inner surface (6) facing the receiving space (3), and wherein the lower lamellae (5) each have an inner surface (7) facing the receiving space (3),
a male terminal (2) having a blade (8) that is received within the receiving space (3) in a mated condition of the

connection arrangement,
wherein the upper lamellae (4) and the lower lamellae (5) extend traverse to the longitudinal axis (L),
wherein the inner surfaces (6) of the upper lamellae (4) are concave in a direction traverse to the longitudinal axis (L), and
wherein the blade (8) has an upper surface (9) being formed convex in a direction traverse to the longitudinal axis (L) and which is, in the mated condition of the connection arrangement, in contact with the concave inner surfaces (6) of the upper lamellae (4).

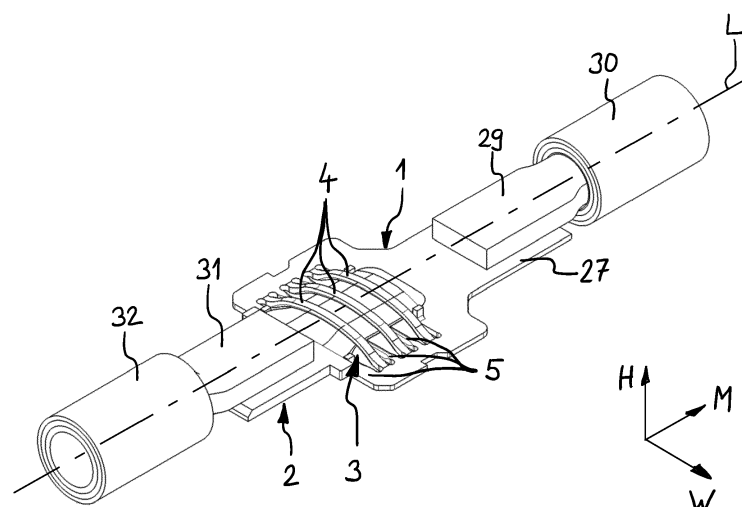


FIG. 1

Description

[0001] The present invention refers to an electric connection arrangement comprising a female terminal having a receiving space extending in direction of a longitudinal axis of the connection arrangement and being delimited by upper lamellae and lower lamellae, wherein the upper lamellae each have an inner surface facing the receiving space, and wherein the lower lamellae each have an inner surface facing the receiving space. The connection arrangement further comprises a male terminal having a blade which blade is received within the receiving space in a mated condition of the connection arrangement.

[0002] Such a connection arrangement is disclosed in US 2005/0118891 A1. In connection arrangements, and particularly in those for high electrical power applications, it is essential that the electrical contact resistance due to the contact between the terminals is as low as possible. US 2005/0118891 A1 addresses this issue by providing a plurality of points of contact between the female and the male terminal. When the blade is inserted into the receiving space, a first elastic piece of the female terminal will contact one end face in a height direction of the blade and another first elastic piece of the female terminal facing the receiving space will contact the other end face in the height direction of the blade. On the other hand, a second elastic piece of the female terminal will contact one end face in a width direction of the blade and another second elastic piece of the female terminal facing the receiving space will contact the other end face in the width direction of the blade. In that case, the female terminal will contact the blade at a plurality of points.

[0003] US 3 107 966 A discloses a socket for a plug-in member, wherein the socket wall is constituted by a plurality of wires stretched between two coaxial annular anchorages spaced from one another along a common axis and disposed in planes which are perpendicular to said common axis. The wires are fixed at the ends thereof to said anchorages at spaced points there around. The positions at which the wires at one end thereof are affixed to the anchorage at that end of the wires are angularly displaced around the common axis with respect to the positions at which the same wires at the other end thereof are affixed to the other anchorage. As a result, the wires are located on straight lines, which are generatrices of the same family of a hyperboloid of revolution about said axis, containing the two circles on which said spaced points lie and having its throat located between said circles. When a plug is inserted into the socket, it deforms the wires, which are thus made to engage the plug each along a helical line.

[0004] The object of the present invention is to provide a connection arrangement comprising a female terminal and a male terminal, which has a low electric contact resistance and is easy to manufacture.

[0005] The object is achieved by an electric connection arrangement comprising a female terminal having a re-

ceiving space extending in direction of a longitudinal axis of the connection arrangement and being delimited by upper lamellae and lower lamellae, wherein the upper lamellae each have an inner surface facing the receiving space, and wherein the lower lamellae each have an inner surface facing the receiving space. The connection arrangement further comprises a male terminal having a blade that is received within the receiving space in a mated condition of the connection arrangement. The upper lamellae and the lower lamellae of the female terminal extend traverse to the longitudinal axis. The inner surfaces of the upper lamellae are formed concave in a direction traverse to the longitudinal axis, wherein the blade has an upper surface being formed convex in a direction traverse to the longitudinal axis and which is, in the mated condition of the connection arrangement, in contact with the concave inner surfaces of the upper lamellae.

[0006] It should be noted that the terms "upper", "lower", "height" and "width" refer to a Cartesian coordinate system with a mating direction, a height direction and a width direction being perpendicular to each other. The mating direction is parallel to the longitudinal axis and the height direction is the direction from the lower lamellae to the upper lamellae. The cross-section of the receiving space perpendicular to the longitudinal axis L extends in the height direction and the width direction.

[0007] The receiving space extends along the longitudinal axis so that the male terminal can be inserted in the mating direction, which is parallel to the longitudinal axis, into the receiving space. Hence, the upper lamellae and the lower lamellae are orientated traverse to the mating direction and the longitudinal axis.

[0008] Due to the fact that the upper surface of the blade of the male terminal is convex traverse to the longitudinal axis, a line contact is established between the upper surface of the blade and the inner surfaces of the upper lamellae. This makes the connection arrangement particularly suitable for high power and high voltage applications.

[0009] "Concave travers to the longitudinal axis" means that the inner surfaces of the upper lamellae are concave viewed in a plane of the height direction and the width direction.

[0010] In one embodiment, the inner surfaces of the lower lamellae are straight and arranged in one common plane. Alternatively, the inner surfaces of the lower lamellae can be formed concave in a direction traverse to the longitudinal axis.

[0011] The complete upper lamellae can be curved, concave in a direction traverse to the longitudinal axis towards the receiving space and convex on the opposite side, thereof.

[0012] The blade of the male terminal has a curved cross-section in a plane perpendicular to the longitudinal axis. The blade can be made from a sheet metal material and be forged to achieve the curved cross-section.

[0013] The male terminal may have a front end facing the female terminal wherein at the front end the male

terminal has a lead-in zone with a slanted upper surface portion. The slanted upper surface portion is inclined relative to the longitudinal axis so that it facilitates the insertion of the blade of the male terminal into the receiving space of the female terminal.

[0014] In particular, the blade of the male terminal can be spoon-shaped so that it is convex towards the upper lamellae and concave towards the lower lamellae. "Spoon-shaped" means that the blade is convex towards the upper lamellae and concave to the lower lamellae viewed in a plane defined by the mating direction and the height direction as well as in a plane defined by the width direction and the height direction. One advantage of this is that the convex upper surface of the blade and the lead-in zone can be manufactured in one simple forming manufacturing step.

[0015] In one embodiment of the electric connection arrangement, the maximum height in a height direction between the upper lamellae and the lower lamellae of the female terminal is smaller than the height of the blade of the male terminal. Thus, when inserting the blade of the male terminal into the receiving space of the female terminal, the upper lamellae and the lower lamellae are elastically deformed such that their shape, and hence the cross-section of the receiving space, adjusts to the shape of the blade of the male terminal thus compensating the overlap in height. In particular, the upper lamellae may be stretched in direction of their extension traverse the longitudinal axis and slightly bent. Hence, the upper lamellae are being wrapped around the upper surface of the blade of the male terminal and thereby constituting a line contact between the upper lamellae and the blade.

[0016] The upper lamellae and the lower lamellae of the female terminal may be integrally cut out of a flat sheet metal material. At opposite ends in width direction, the upper lamellae and the lower lamellae are integrally connected to lateral portions of the female terminal. The lateral portions and the lower lamellae may be arranged in one common plane.

[0017] The upper lamellae and lower lamellae may be arranged alternately in direction of the longitudinal axis, i.e. in the mating direction.

[0018] Where it is desirable to increase the contact pressure between the upper lamellae and the blade the inner surfaces of the upper lamellae can be formed convex in direction of the longitudinal axis. In order to achieve this, the upper lamellae can have a curved longitudinal cross-section being convex towards the receiving space. This provides for a line contact between the upper lamellae and the blade, which has a small extension in a direction of the longitudinal axis, increasing the contact pressure.

[0019] In an embodiment of the electric connection arrangement, the male terminal has a stop face being in contact with a stop face of the female terminal in the mated condition. By this, it is avoided to push the male terminal too far into the receiving space.

[0020] In order to facilitate the insertion of the blade of

the male terminal into the receiving space of the female terminal, the female terminal may have guiding surfaces guiding the blade of the male terminal while being inserted into the receiving space.

[0021] For providing guiding surfaces, the female terminal may have, for example, guiding tabs, which have the guiding surfaces facing each other, and which project into the receiving space.

[0022] In order to connect the female terminal and the male terminal each to a separate cable, the male terminal and the female terminal each have a connection portion for connecting conductors of electric cables to the connection portions. The connection between the contact portions and the conductors may be established by any process well known in the art, such as welding, soldering, crimping, etc.

[0023] Exemplary embodiments of an electric connection arrangement are described with reference to the Figures hereinafter. Herein

- Figure 1 is a perspective view of the connection arrangement;
- Figure 2 is a perspective view of the female terminal according the connection arrangement of Figure 1;
- Figure 3 is a top view of the female terminal of Figure 2;
- Figure 4 is a side view of the female terminal of Figure 2;
- Figure 5 is a front view of the female terminal of Figure 2;
- Figure 6 is a partial longitudinal sectional view of a connection arrangement having an alternative embodiment of the female terminal;
- Figure 7 is a perspective view of the male terminal connected to a cable according to the connection arrangement of Figure 1;
- Figure 8 is a bottom-up perspective view of the male terminal of Figure 7;
- Figure 9 is a front in direction of the longitudinal axis of the blade of the male terminal according to Figure 7; and
- Figure 10 is a cross-sectional view perpendicular to the longitudinal axis of the connection arrangement according to Figure 1.

[0024] Figure 1 shows a perspective view of an electric connection arrangement with a female terminal 1 and a male terminal 2. The female terminal 1 and the male ter-

terminal 2 are shown in a fully mated condition, in which they are in electrical contact to each other. The female terminal 1 has a connection portion 27 that is connected to a conductor 29 of a first cable 30. The male terminal 2 has a connection portion 28 that is connected to a conductor 31 of a second cable 32.

[0025] The female terminal 1 can best be seen in Figures 2 to 5, which are described together hereinafter. The female terminal 1 has a receiving space 3 extending in direction of a longitudinal axis L of the connection arrangement. As shown in Figure 1 the male terminal 2 can be inserted into the receiving space 3 in a mating direction M parallel to the longitudinal axis L and towards the female terminal 1. The receiving space 3 is delimited by upper lamellae 4 and lower lamellae 5. The upper lamellae 4 each have an inner surface 6 facing the receiving space 3. The lower lamellae 5 each have an inner surface 7 facing the receiving space 3.

[0026] The upper lamellae 4 and the lower lamellae 5 extend traverse to the longitudinal axis L. The inner surfaces 6 of the upper lamellae 4 are concave in a direction traverse to the longitudinal axis L. In the disclosed embodiment, the inner surfaces 7 of the lower lamellae 5 are straight and arranged in one common plane E.

[0027] Alternatively, also the inner surfaces 7 of the lower lamellae 5 may be concave in a direction traverse to the longitudinal axis L.

[0028] The upper lamellae 4 and the lower lamellae 5 are cut out of a piece of sheet metal extending in the plane E. According to the disclosed example six parallel slots 17 are cut into the sheet metal forming the upper lamellae 4 and the lower lamellae 5 alternately in mating direction M. The upper lamellae 4 are then bent and formed into a curved shape so that the upper lamellae 4 project from the plane E in a height direction. Accordingly, the entire upper lamellae 4 are formed concave towards the receiving space 3 and convex in the opposite orientation away from the receiving space 3, all in a plane traverse to the longitudinal axis L.

[0029] At opposite ends in width direction W, the upper lamellae 4 and the lower lamellae 5 are integrally connected to lateral portions 35, 36 of the female terminal 1. The lateral portions 35, 36 and the lower lamellae 5 are arranged in the common plane E.

[0030] The mentioned directions refer to a mating direction M, a height direction H and a width direction W of a Cartesian coordinate system.

[0031] The male terminal 2 can best be seen in Figures 7 to 9, which are described together hereinafter. The male terminal 2 has a blade 8 that can be inserted into the receiving space 3 of the female terminal 1 as disclosed in Figure 1. For mating the female terminal 1 and the male terminal 2, the blade 8 is inserted into the receiving space 3 in the mating direction M that is parallel to the longitudinal axis L.

[0032] The blade 8 has an upper surface 9 that is formed convex traverse to the longitudinal axis L, and that is, in the fully mated condition of the connection ar-

rangement as shown in Figure 1, in contact with the inner surfaces 6 of the upper lamellae 4, thereby establishing a line contact between the upper surface 9 of the blade 8 and the inner surfaces 6 of the upper lamellae 4. In practice, the blade 8 will touch the upper lamellae 4 at a large number of contact points with at least a tendency towards a line contact. In order to increase the contact pressure between the upper lamellae 4 and the blade 8, the upper lamellae 4 can be formed as shown in Figures 4 and 6 with inner surfaces 6 being convex in the direction of the longitudinal axis L. Thereby, the width of the line of the line contact in the mating direction M is decreased resulting in a higher contact pressure. In the shown example, even the entire upper lamellae 4 are curved. Alternatively, the surfaces of the upper lamellae 4 opposite the inner surfaces 6 of the upper lamellae 4 may be straight in the mating direction M.

[0033] In the shown example, the blade 8 is made from a sheet metal material and is formed to have a curved cross-section. The blade 8 is convex towards the upper lamellae 4 and concave towards the lower lamellae 5 viewed in a plane defined by the height direction H and the width direction W. Hence, the blade 8 has two lower surfaces 13, 14 spaced from each other, which are in contact to the inner surfaces 7 of the lower lamellae 5. The blade 8 is clamped between the upper lamellae 4 and the lower lamellae 5.

[0034] In the shown exemplary embodiment the blade 8 is spoon shaped so that it has a curved cross-section in a plane perpendicular to the longitudinal axis L as well as a curved cross-section in a plane perpendicular to the width direction W. This facilitates a simple manufacturing of the blade 8 wherein the male terminal 2 is also provided with the lead-in zone having a slanted upper surface portion 16 at a front end 15 of the male terminal 2 in a single manufacturing step, e.g. by forming. The lead-in zone makes it easier to insert the blade 8 into the receiving space 3 at the beginning of the mating procedure.

[0035] In the cross-sectional view according to Figures 9 and 10 showing the cross-section of the blade 8 in a plane defined by the height direction H and the width direction W, it can be seen that in the disclosed embodiment the upper surface 9 has a central surface region 10 that is arranged between two peripheral surface regions 11, 12.

[0036] Figure 10 shows a cross-sectional view perpendicular to the longitudinal axis L of the connection arrangement. The blade 8 of the male terminal 2 and the female terminal 1 are shown in a non-deformed state. The central surface region 10 is that region of the upper surface 9 of the blade 8 which overlaps with the upper lamellae 4. The peripheral surface regions 11, 12 are that regions of the upper surface 9 of the blade which do not overlap with the upper lamellae 4. Alternatively, the entire upper surface 9 can overlap with the upper lamellae 4 without peripheral regions.

[0037] In the disclosed embodiment, when the blade 8 is inserted into the receiving space 3 of the female

terminal 1, the upper lamellae 4 and the lower lamellae 5 are elastically deformed such that their shape, and hence the cross-section of the receiving space 3, adjusts to the shape of the blade 8 of the male terminal 2 thus compensating an overlap in the height direction H. In particular, the upper lamellae 4 may be stretched and bent as described hereinafter. Further, the blade 8 may be compressed in the height direction H. However, in order to explain why the upper lamellae 4 and the blade 8 are elastically deformed these are shown in Figure 10 in a non-deformed state.

[0038] The blade 8 contacts the inner surfaces 7 of the lower lamellae 5. The blade 8 has a first height H1 in height direction H that is greater than a second height H2 of the receiving space 3 in height direction H, thereby creating an overlap O between the blade 8 and the upper lamellae 4.

[0039] The overlap O results in a force against the upper lamellae 4 onto the inner surfaces 6 thereof as well as forces from the blade 8 onto the inner surfaces 7 of the lower lamellae 5, as indicated by arrows shown in Figure 5. Thereby the upper lamellae 4 are elastically deformed, for instance stretched in a direction of their extension and slightly bent in a direction traverses the stretching direction.

[0040] The male terminal 2 is provided with tabs 17, 18 projecting in opposite lateral direction transverse to the longitudinal axis L. Each tab 17, 18 has a stop face 19, 20 orientated in direction towards the front end 15 of the male terminal 2 and towards the female terminal 1.

[0041] At a front end 33, the female terminal 1 has two tabs 21, 22 each of which has a stop face 37, 38 serve as stop limits. In the fully mated condition as disclosed in Figure 1, each stop face 19, 20 of the male terminal 1 abuts one of the stop faces 37, 38 of the female terminal 1 in order to avoid that the male terminal 2 is inserted too far into the receiving space 3 of the female terminal 1.

[0042] The distance between the tabs 21, 22 of the female terminal 1 is greater than the width of the blade 8 of the male terminal 2 over a large part of the longitudinal extension of the blade 8 starting from its front end 15. In the real part of the blade 8, adjacent to the lateral tabs 18, 19, the width of the blade 8 continuously increases towards the tabs 18, 19. In the transition from the blade 8 to the lateral tabs 18, 19, the width of the blade 8 is approximately identical or only slightly smaller than the distance between the two tabs 21, 22 at the front end 33 of the female terminal 1.

[0043] The tabs 21, 22 at the front end 33 of the female terminal 1 facilitate the insertion of the male terminal 2 into the receiving space 3 by laterally guiding the blade 8. Further, at the front end 33 the female terminal 1 has a guiding flap 34, which projects in a direction of the longitudinal axis L opposite the mating direction M. The guiding flap 34 is bent out of the plane E in an opposite direction than the tabs 21, 22. It further facilitates the insertion of the blade 8 of the male terminal 2 into the receiving space 3.

[0044] The female terminal 1 is further provided with two guiding tabs 23, 24 that each have a guiding surface 25, 26 facing each other. The distance between the two guiding tabs 23, 24 is equal or just slightly bigger than the width of the blade 8 over a large part of the longitudinal extension between the front end 15 of the blade 8 and the region of the blade 8, which has an increasing width. Thereby, during at least the final movement of the blade 8 into the receiving space 3, blade 8 is laterally guided by the guiding tabs 23, 24 of the female terminal 1.

[0045] The tabs 21, 22 and the guiding tabs 23, 24 are cut out of the sheet-metal material of the female terminal 1 so that they are parallel to the height direction H and project, viewed in the longitudinal axis L, into the receiving space 3.

Reference Numerals

[0046]

1	female terminal
2	male terminal
3	receiving space
4	upper lamella
5	lower lamella
6	inner surface of upper lamella
7	inner surface of lower lamella
8	blade
9	upper surface of the blade
10	central surface region
11	peripheral surface region
12	peripheral surface region
13	lower surface of the blade
14	lower surface of the blade
15	front end of the male terminal
16	slanted upper surface section
17	tab of the blade
18	tab of the blade
19	stop face
20	stop face
21	tab of the female terminal
22	tab of the female terminal
23	guiding tab
24	guiding tab
25	guiding surface
26	guiding surface
27	connection portion
28	connection portion
29	conductor
30	first cable
31	conductor
32	second cable
33	front end of the female terminal
34	guiding flap
35	lateral portion
36	lateral portion
37	stop face
38	stop face

H height direction
H1 first height
H2 second height
L longitudinal axis
M mating direction
W width direction

Claims

1. Electric connection arrangement comprising:

a female terminal (1) having a receiving space (3) extending in direction of a longitudinal axis (L) of the connection arrangement and being delimited by upper lamellae (4) and lower lamellae (5), wherein the upper lamellae (4) each have an inner surface (6) facing the receiving space (3), and wherein the lower lamellae (5) each have an inner surface (7) facing the receiving space (3),

a male terminal (2) having a blade (8) that is received within the receiving space (3) in a mated condition of the connection arrangement,

characterized in

that the upper lamellae (4) and the lower lamellae (5) extend traverse to the longitudinal axis (L),

that the inner surfaces (6) of the upper lamellae (4) are concave in a direction traverse to the longitudinal axis (L), and

that the blade (8) has an upper surface (9) being formed convex in a direction traverse to the longitudinal axis (L) and which is, in the mated condition of the connection arrangement, in contact with the concave inner surfaces (6) of the upper lamellae (4).

2. Electric connection arrangement according to claim 1,

characterized in

that the inner surfaces (7) of the lower lamellae (5) are straight and arranged in one common plane (E).

3. Electric connection arrangement according to claim 1 or 2,

characterized in

that the blade (8) of the male terminal (2) has a curved cross-section.

4. Electric connection arrangement according to any one of claims 1 to 3,

characterized in

that the male terminal (2) has a front end (15) facing the female terminal (1), and

that at the front end (15) the male terminal (2) has a lead-in zone with a slanted upper surface portion (16).

5. Electric connection arrangement according to any one of claims 1 to 4,

characterized in

that the blade (8) of the male terminal (2) is spoon-shaped.

6. Electric connection arrangement according to any one of claims 1 to 5,

characterized in

that the maximum height (H2) in a height direction (H) between the upper lamellae (4) and the lower lamellae (5) is smaller than the height (H1) of the blade (8) in the height direction (H).

7. Electric connection arrangement according to any one of claims 1 to 6,

characterized in

that the upper lamellae (4) and the lower lamellae (5) are integrally cut out of a flat sheet metal material.

8. Electric connection arrangement according to any one of claims 1 to 7,

characterized in

that upper lamellae (4) and lower lamellae (5) are arranged alternately in direction of the longitudinal axis (L).

9. Electric connection arrangement according to any one of claims 1 to 8,

characterized in

that the inner surfaces (6) of the upper lamellae (4) are formed convex in direction of the longitudinal axis (L).

10. Electric connection arrangement according to any one of claims 1 to 9,

characterized in

that the male terminal (2) has a stop face (19, 20) being in contact with a stop face (37, 38) of the female terminal (1) in the mated condition.

11. Electric connection arrangement according to any one of claims 1 to 10,

characterized in

that the female terminal (1) has guiding surfaces (25, 26) guiding the blade (8) of the male terminal (2) while being inserted into the receiving space (3).

12. Electric connection arrangement according to claim 11,

characterized in

that the female terminal (2) has guiding tabs (23, 24) which have the guiding surfaces (25, 26) and which project into the receiving space (3).

13. Electric connection arrangement according to any one of claims 1 to 12,

characterized in

that the male terminal (2) and the female terminal (1) each have a connection portion (27, 28) for connecting conductors (29, 31) of electric cables (30, 32) to the connection portions (27, 28).

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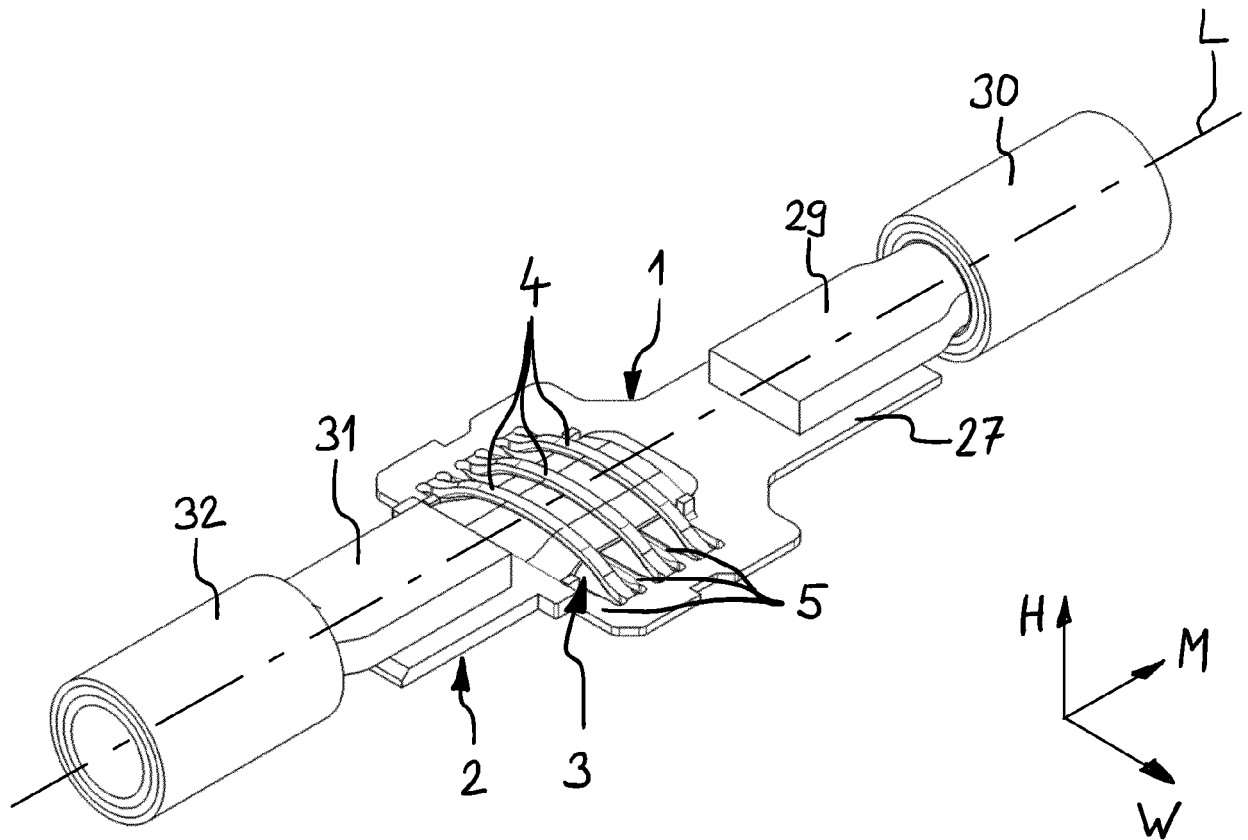
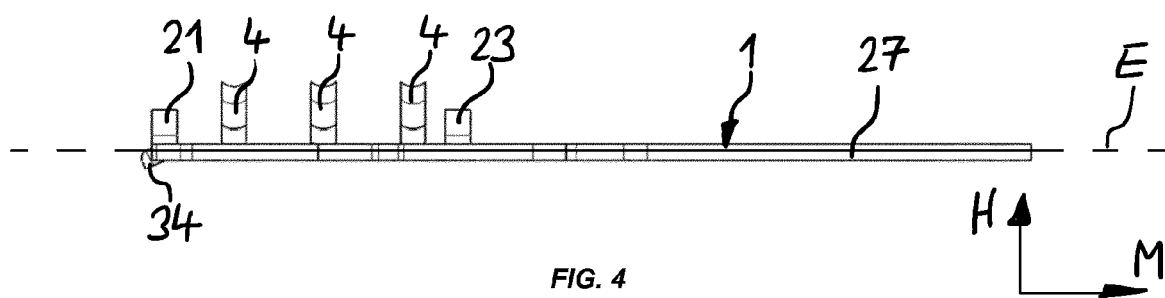
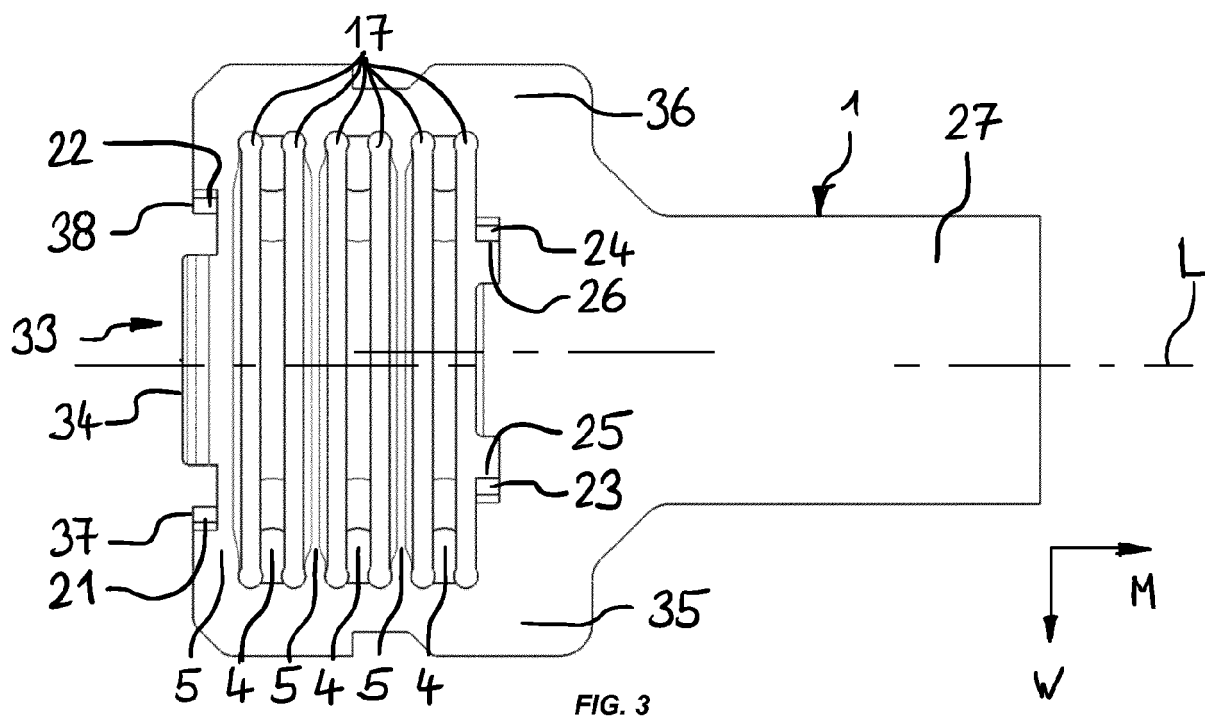
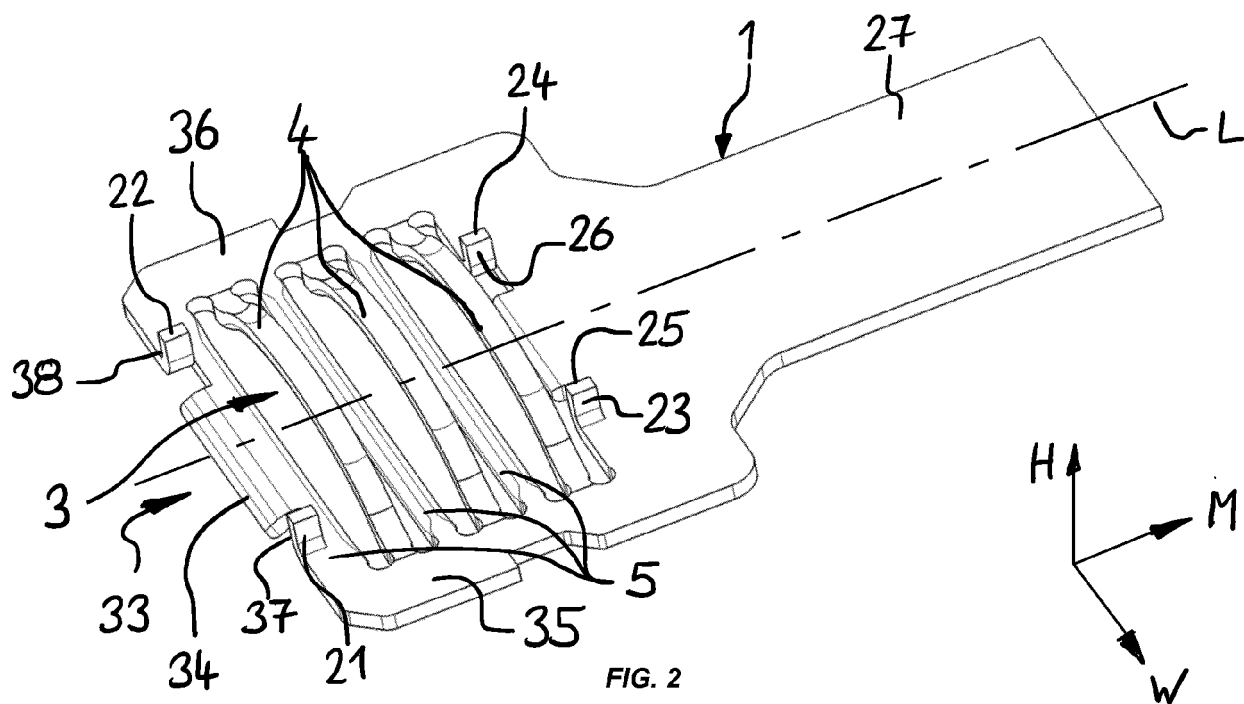


FIG. 1



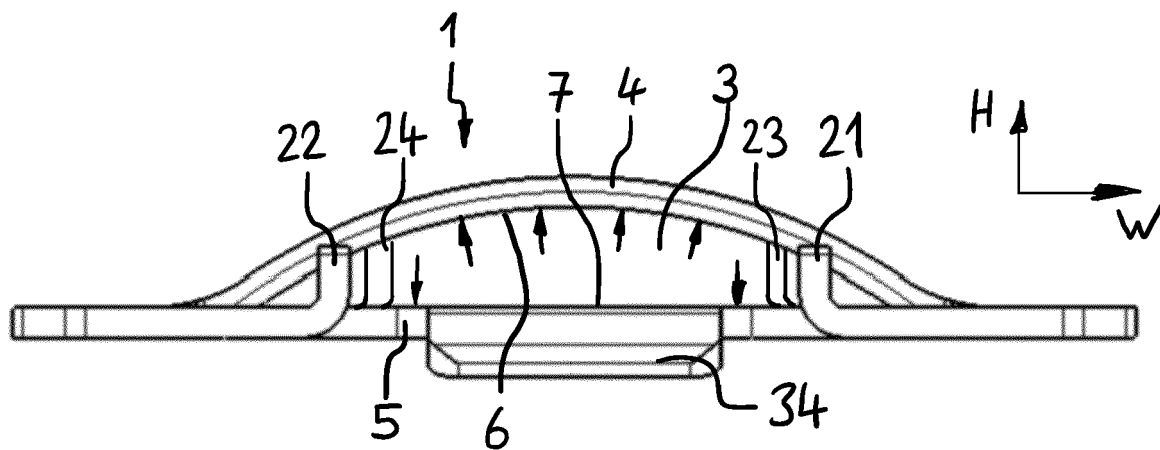


FIG. 5

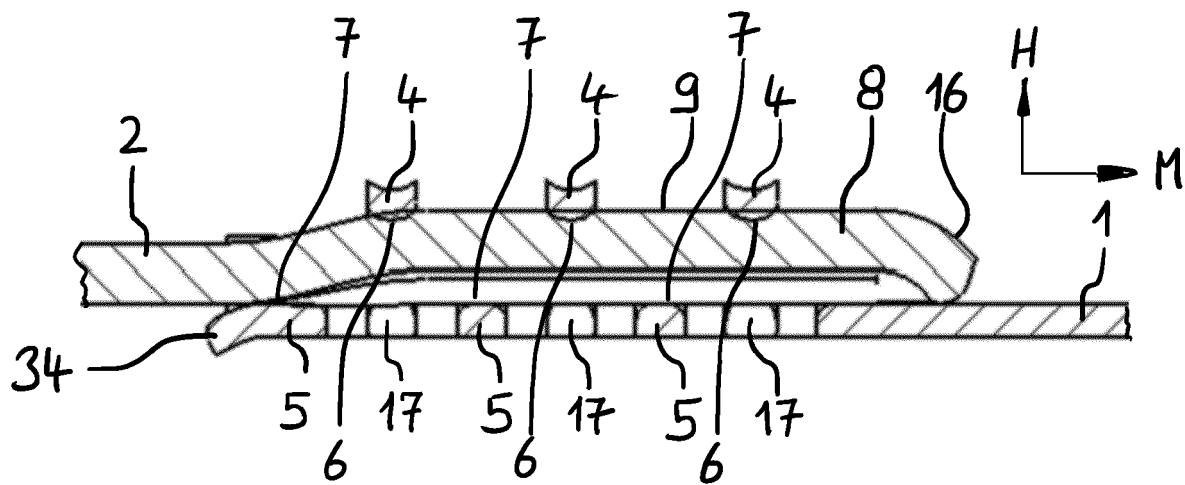
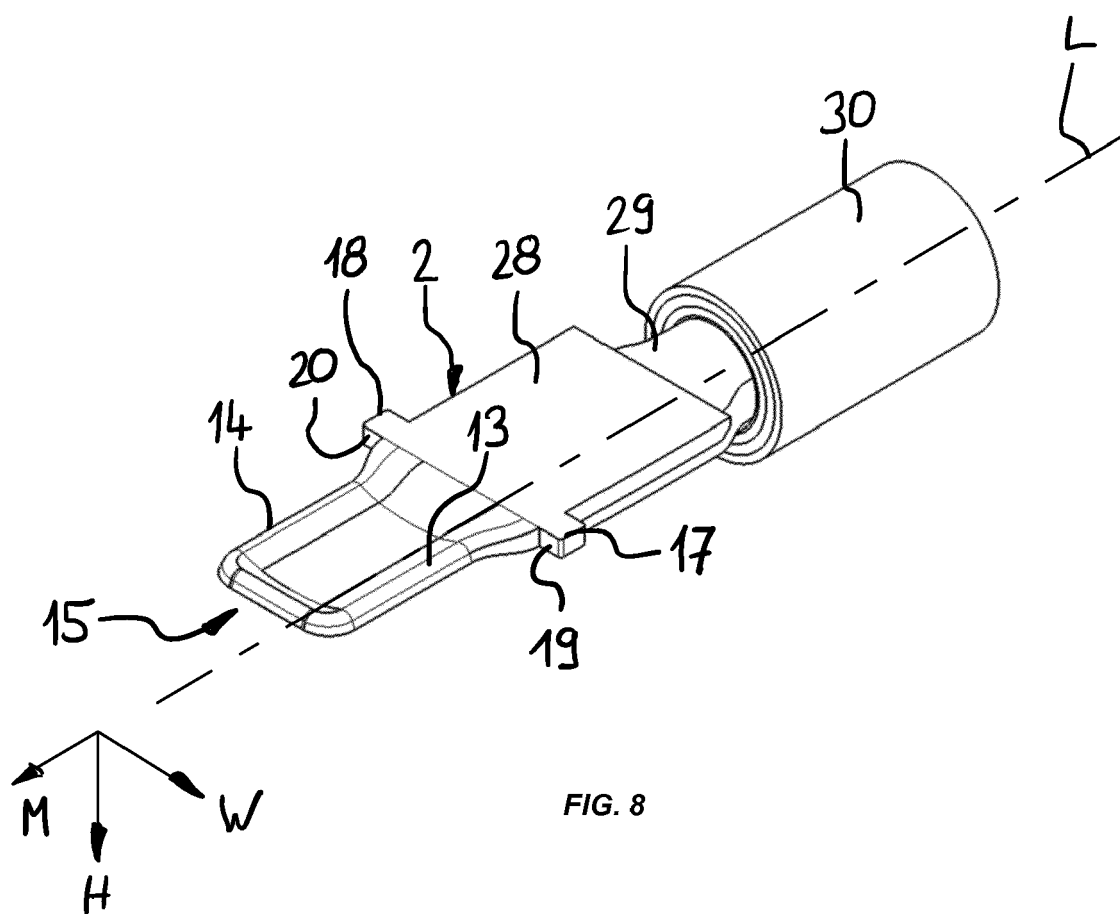
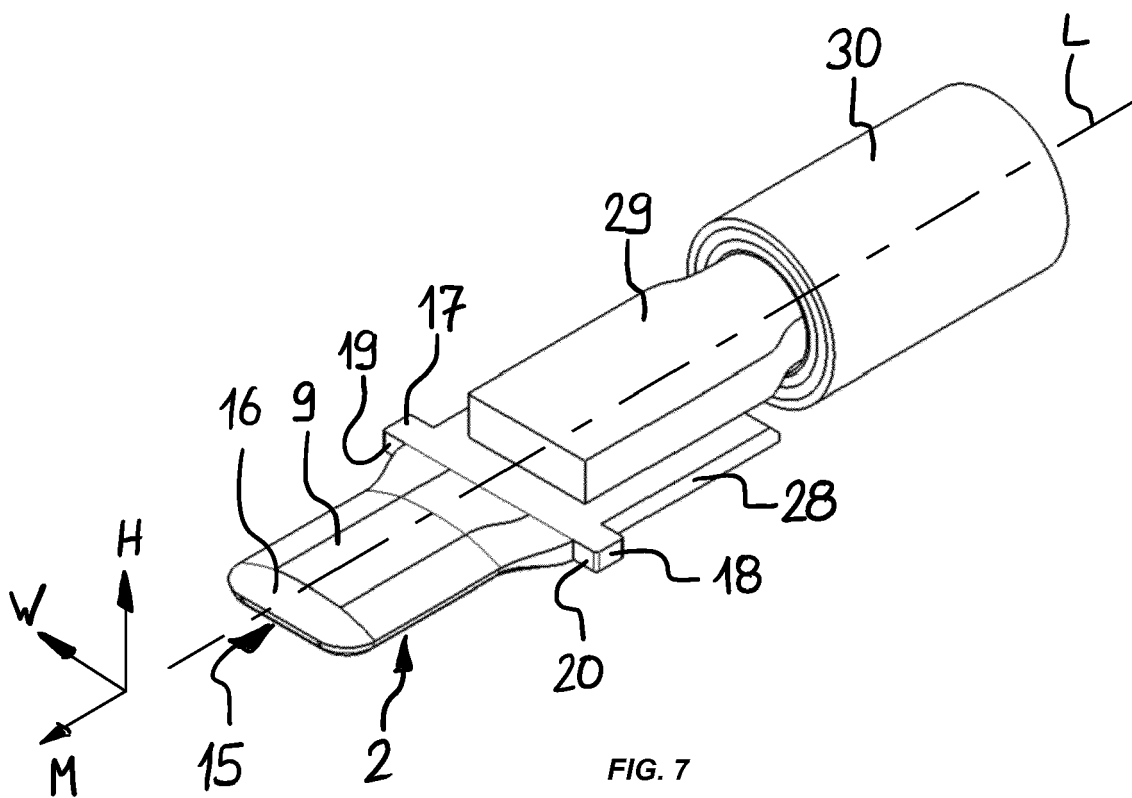


FIG. 6



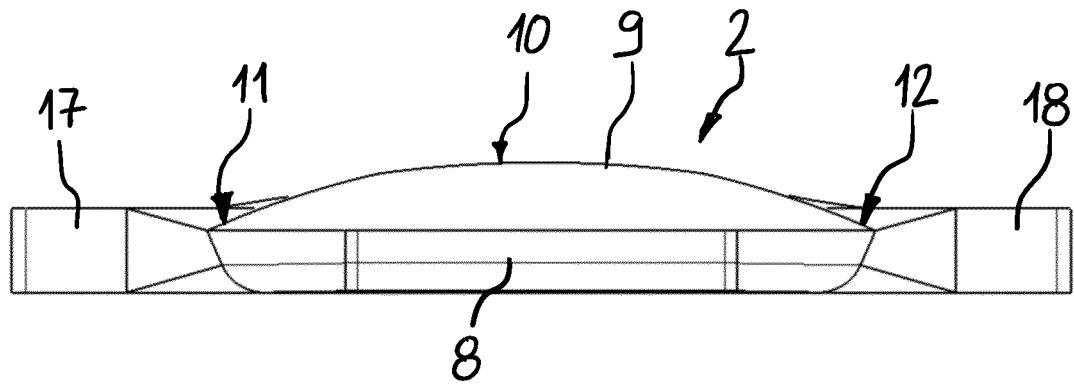


FIG. 9

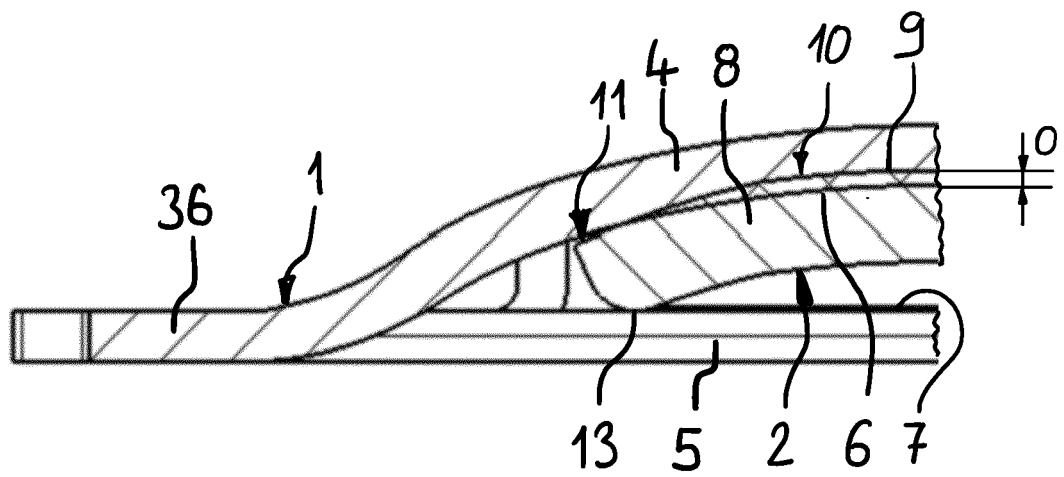


FIG. 10



EUROPEAN SEARCH REPORT

Application Number
EP 19 19 3311

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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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Y	EP 1 401 056 B1 (NEUTRIK AG [LI]) 10 May 2006 (2006-05-10) * paragraph [0003] - paragraph [0020]; figures 6-17 *	1-13	ADD. H01R13/24 H01R24/20 H01R24/28
A	US 9 793 620 B2 (TYCO ELECTRONICS LTD UK [GB]; TE CONNECTIVITY GERMANY GMBH [DE]) 17 October 2017 (2017-10-17) * column 6, line 2 - column 6, line 8 *	12	
A	US 2008/293287 A1 (ZINN BERND [DE]) 27 November 2008 (2008-11-27) * the whole document *	1-13	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01R
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 14 January 2020	Examiner Mateo Segura, C
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	

EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 19 19 3311

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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