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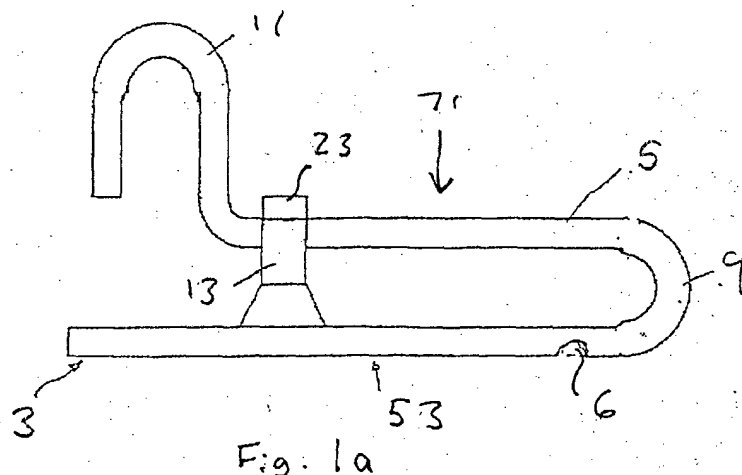
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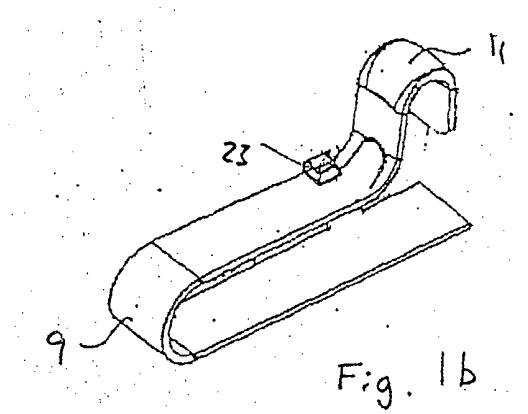
(54) **Sprung electrical terminal**

(57) A sprung terminal for mounting on a printed circuit board to provide a electrically conductive path between the printed circuit board and separate components is described. The sprung terminal 1 has a base

strip 3 and a contact strip 5 extending from a fold region and defining a gap 43 between the strips 3,5. Side flaps 13,15 integrally formed from the same sheet as the sprung terminal impede access to the gap 43. A solder well 7 and a gap 77 minimise solder wicking.



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Description

[0001] This invention relates to electrical terminals, and in particular to sprung electrical terminals for mounting on printed circuit boards.

[0002] Electronic devices commonly have terminals for making electrically conductive paths between two components. Often, one of the two components is a printed circuit board, to which the terminal is soldered, and the other component has contact pads which are urged against the terminal.

[0003] For example, the casing of a wireless communication device such as a two-way radio or mobile telephone may comprise first and second lateral halves, with a printed circuit board assembled into the first half and components including a microphone, antennae or battery assembled into the second half. When the halves are mated, contact pads on the components in the second half are urged against terminals on the printed circuit board in the first half to make electrically conductive paths. Terminals are also used on the printed circuit boards of mobile telephones to make electrical contact with removable SIM (subscriber identity module) cards.

[0004] A known form of terminal is the sprung terminal. Conventional sprung terminals may be made from a strip of resilient metallic material formed into a generally C-shaped configuration to provide two strips extending from a fold region. The first strip of the sprung terminal is a base strip, which is soldered to a printed circuit board. The second strip of the sprung terminal is a contact strip, against which the contact pads of mating components are urged. As a consequence of the resilience of the material, the contact strip acts as a spring when loaded in a direction normal to the plane of the printed circuit board.

[0005] A sprung terminal can provide a robust and reliable electrical connection between a printed circuit board and a mating contact pad because, if the contact strip of the terminal is displaced, it reacts on the mating contact pad with a corresponding normal force. A sprung terminal can also maintain the electrical connection between the printed circuit board and mating contact pad of assemblies that have dimensional tolerances or are moving. This is because, if the contact strip is displaced, the tolerances or movement can either increase or reduce the displacement of the contact strip without breaking the electrical connection with the contact pad.

[0006] A particular difficulty with sprung terminals lies when it is needed to manufacture components incorporating such sprung terminals using automatic manufacturing equipment.

[0007] Another problem associated with sprung terminals is that they tend to become tangled when loosely packaged together. The manual untangling of loosely packaged sprung terminals is a time consuming task and their tendency to tangle effectively precludes the

use of automated part loading on the assembly lines of devices that use them. A second problem associated with sprung terminals is that interference between loosely packaged terminals during transit can cause their fragile contact strips to become damaged, especially those that are preloaded in the manner described above. There is thus a need for an improved sprung terminal that is less susceptible to tangling and damage.

[0008] Sprung terminals may have a preloaded contact strip. The base strip of terminals with preloaded contact strips may be extended at its end to form a generally perpendicular ring that surrounds and engages an extension to the contact strip, acting on it to limit its travel in one direction. In its engaged condition, the contact strip is preloaded, i.e. the contact strip is resiliently biased against the ring. The primary advantage of a preloaded contact strip is that its displacement can give rise to large reactive forces over relatively small displacements.

[0009] However, the extension of the contact strip is especially prone to tangling with other components in storage which may result in bending or damage to the extension.

[0010] Another problem in prior art sprung terminals is solder wicking. When the sprung terminal is soldered to a circuit board, solder can wick along the length of the terminal. This can remove solder from the solder area reducing the strength of the solder bond. Further, if solder is deposited on the fold region, this can affect the resilient properties of the sprung terminal which are in general precisely defined and this can reduce the performance of the sprung terminal in use.

[0011] There is thus a need for an improved sprung clip that addresses one or more of these issues.

[0012] According to the invention there is provided a sprung terminal formed from a single sheet of resilient material comprising: a base strip having a planar contact area for soldering to a substrate; a contact strip spaced transversely of the base strip defining a gap therebetween, the contact strip having a contact protrusion for making contact with mating electrical components; a resilient fold region joining one end of the base strip to one end of the contact strip to permit motion of the contact protrusion towards the base strip and to resiliently bias against such motion, the base strip and the contact strip extending longitudinally from the fold region; at least one flap depending from the base strip transversely across the gap; and at least one preload member extending from the flap arranged so that the contact strip is resiliently biased against the preload member; wherein the contact strip has a grip region that is substantially parallel to the base strip when the contact strip is against the preload member.

[0013] The sprung terminal according to the invention is particularly suitable for automatic manufacture using pick and place operation. Automatic pick and place equipment can pick the sprung terminal using the contact strip parallel to the base strip.

[0014] The preload member allows the contact strip to be preloaded, i.e. to be resiliently biased in the initial position. This reduces the deformation of the contact strip required, in use, to provide a particular force on the contact strip, which in turn allows a better contact for small deformation.

[0015] In a preferred embodiment, said at least one flap is a pair of laterally opposed side flaps depending from laterally opposite sides of the base strip transversely across the gap to impede access to the gap; and said at least one preload member comprises a pair of preload members extending laterally inwardly from respective side flaps.

[0016] By providing flaps that impede access to the gap defined between the base and contact strips, the sprung terminals are much less susceptible to becoming knitted and tangled when loosely packaged.

[0017] By preloading the contact strip from each of its sides, it is less prone to becoming damaged or twisted.

[0018] The side flaps may also protect the delicate contact strip of the sprung terminal from damage, as well as guide the motion of the contact strip.

[0019] The planar contact area for soldering to the base strip may be separated from the fold region by a solder barrier. The solder barrier may comprise a groove extending between opposite sides of the base strip; or a surface area of the contact strip coated with a material that is more resistant to soldering than the material of the contact strip; and/or a bent region between the contact area and the fold region, the bent region extending transversely inwardly with respect to the plane of the contact area.

[0020] The sprung terminal may include as the solder barrier a bent region of the base strip is a bent region of the base strip shaped so that when the planar contact area is mounted on a planar substrate the fold region is spaced from the substrate.

[0021] The solder well between the contact area and the fold region acts as a barrier to solder wicking from the contact area to the fold region. The solder well also has a blocking function.

[0022] The sprung terminal may be formed from a single blank of sheet material in order to minimize manufacturing costs.

[0023] The contact strip may include a flat grip region between the contact protrusion and the fold region. The sprung terminal may be picked up by the grip region during manufacture to allow pick and place operation.

[0024] The fold region may extend transversely outwardly beyond the solder well but not as far as the plane of the planar contact area. This means that when the planar contact area is mounted on a planar substrate the fold region is spaced from the substrate. This prevents the fold region from being impeded by the substrate and also reduces the risk of the accidental contact being made between the fold region and electrical tracks on the substrate.

[0025] Thus, fingers depending from the side flaps are

used to preload the contact strip instead of a shaped end member. This avoids the possibility of the part of the contact strip that extends through the shaped end member becoming tangled with other components.

[0026] The preload members may be shaped as fingers. Alternatively, the preload members may be formed by bending a part of the top of each side flap inwards to engage the contact strip.

[0027] The contact strip may be movable against the resilient bias between an extended position abutting the preload members with the contact protrusion extending to its maximum extent and a retracted position in which the contact protrusion is retracted between the side flaps. In this way, the contact protrusion is protected and damage is avoided.

[0028] A pair of end flaps may be provided to close the gap at the opposite end of the sprung terminal to the fold region. The end flaps also assist in preventing other components from hooking up the contact strip and lifting the strip to cause damage.

[0029] In embodiments, the sprung terminal may be of nickel plated beryllium copper alloy.

[0030] The contact strip may include a contact protrusion for making contact with mating electrical components, the protrusion projecting away from the base strip. The contact protrusion optimizes the electrically conductive path to mating contact pads and allows the contact strip to stand proud of the side and end members. The external surface of the contact protrusion may be gold plated.

[0031] The base strip may define at least one external contact region and the external surface of the contact protrusion and of the at least one external contact region may be gold plated.

[0032] The invention also relates to a wireless communication device comprising at least one sprung terminal as set out above.

[0033] In another aspect, the invention relates to a method of forming a sprung terminal, including: forming a flat blank from a sheet of resilient material to have a base strip and a contact strip longitudinally separated by a fold region, side flaps depending from the base strip and fingers depending from the side flaps; plating part of the base strip and part of the contact strip to define plated contact areas; folding the side flaps to be perpendicular to the base strip; folding the fingers inwardly from the side flaps; and folding back the contact region to be resiliently biased against the fingers such that the plated contact areas are on the external surface of the base and contact strips.

[0034] In another aspect, there is provided a sprung terminal formed from a single sheet of resilient material comprising: a base strip having a planar contact area for soldering to a substrate; a contact strip spaced transversely of the base strip defining a gap therebetween, the contact strip having a contact protrusion for making contact with mating electrical components; a resilient fold region joining one end of the base strip to one end of

the contact strip to permit motion of the contact protrusion towards the base strip and to resiliently bias against such motion, the base strip and the contact strip extending longitudinally from the fold region; a pair of laterally opposed side flaps depending from laterally opposite sides of the base strip across the gap to impede access to the gap; wherein the base strip forms an inwardly bent region between the contact area and the fold region extending inwardly with respect to the planar contact area.

[0035] The invention will now be described further with reference to the following drawings in which:

Figure 1 shows perspective and side views of a first embodiment of a sprung terminal according to the invention;

Figure 2 shows perspective and side views of a second embodiment of a sprung terminal according to the invention;

Figure 3 shows side, perspective and top views of a third embodiment of a sprung terminal according to the invention;

Figure 4 shows a view of the sprung terminal of Figure 3 with the contact depressed;

Figure 5 shows the shape of a single blank from which the embodiment of Figure 3 may be formed;

Figure 6 shows a tape with a plurality of sprung terminals mounted upon the tape.

Figure 7 shows an exploded view of a mobile phone according to the invention; and

Figure 8 shows a detail side view of part of the mobile phone of Figure 7.

[0036] Figure 1 shows a first embodiment of a sprung terminal. The sprung terminal 1 comprises a base strip 3, for soldering to a printed circuit board, and a resiliently biased contact strip 5, against which a mating contact pad of another component is urged. The base strip 3 and contact strip 5 are formed from a resilient strip of nickel plated berillium copper alloy sheet and extend longitudinally from a fold region 9.

[0037] The base strip 3 includes a substantially flat, planar contact region 53 that may be used to solder the sprung terminal to a flat surface. An indentation 6 acts as to prevent solder on the planar contact region 53 wicking to the fold region 9 and affecting the resilient properties of the fold region.

[0038] The contact strip 5 defines a protruding contact protrusion 11. The contact strip is substantially parallel to the plane of the flat, planar contact region 53 and accordingly defines a substantially flat grip region 71 between the contact protrusion 11 and the fold region 9,

parallel to the planar contact region 53. The substantially flat grip region 71 is used in pick and place operation for gripping the sprung terminal to pick the sprung terminal.

[0039] A side flap 13 supports a finger 23 that preloads the contact strip 5 such that the contact strip is resiliently biased against the finger 23. This preloading increases the force that the contact is able to exert for small displacements of the contact strip 5.

[0040] Figure 2 shows a second embodiment that differs from that shown in Figure 1 only in that an end flap 17 is used in place of side flap 13 to support the finger 23 that preloads the contact strip.

[0041] Figures 3a to 3c show a third embodiment of the sprung terminal 1. Again, the sprung terminal is formed from a single resilient metal sheet defining a base strip 3 and a contact strip 9 separated by a fold region 9.

[0042] Moving along the base strip 3 from its end towards the fold region 9, the base strip 3 then bends inwards to form the bent region 7, and then outwards again in the fold region 9 but not as far as the plane as the planar contact region. This means that when the sprung terminal is mounted on a substrate, fold region 9 does not come into contact with the substrate. This reduces the risk of making contact between the sprung terminal and any metallisation tracks that may be on the substrate surface on which the sprung terminal is mounted. The contact region 53 is gold plated.

[0043] The base strip 3 and contact strip 5 define a transverse gap 41 therebetween. The notional planes 43,45 extending between the lateral edges of the strips 3,5 transversely across the gap 41 at the sides of the gap are referred to in this specification as side faces 43,45.

[0044] The bent region 7 projects transversely inwardly towards the contact strip 5 and is located near the fold region 9. The bent region 7 prevents solder wicking - when the contact region 53 is soldered on a substrate, the bent region 7 acts as a well to prevent solder wicking onto the fold region 9. Thus, the bent region 7 will also be referred to as a solder well. The bent region 7 also acts as a blocking region to impede objects such as other sprung terminals from entering the gap 41 through the side faces 43,45 near the fold region 9 and becoming tangled.

[0045] The sprung terminal may be picked up by region 71 which is parallel to the plane of the contact region 53 on the base strip. The pick and place tool 73 is shown schematically in Figure 3a by hatched lines.

[0046] The contact strip 5 has a gold plated contact protrusion 11 at its distal end projecting away from the base strip 3. The gold plating forms a contact area 55 on the contact strip. The contact protrusion 11 provides a point contact against which a mating contact pad is urged, and ensures that the point contact stands proud of the rest of the sprung terminal 1.

[0047] Two laterally opposed side flaps 13, 15 depend

from the laterally opposite sides of the base strip 3 and extend transversely across the gap 41 along part of the side faces 43, 45 to block other components entering the gap 41 through the side faces 43,45. The side flaps 13, 15 are formed from the same piece of material that forms the base strip 3 and contact strip 5. Two longitudinally spaced legs 75 support each side flap on the base strip 3 - a side gap 77 is formed between the legs 75 on each side, defined by the base strip 3, the legs 75 and the respective side flap 13,15. The side gap aims to prevent solder wicking from the solder contact 53 onto the side flaps 13,15.

[0048] An end member 17 is formed from end flaps in the form of wing extensions 19, 21 to the side flaps 13,15 depending from the distal ends of the side flaps. The wings 19,21 laterally span the gap 41 at the distal end of the gap. The side flaps 13, 15 and end member 17 impede the passage of objects into the gap 41 between the base strip 3 and contact strip 5, thus reducing tangling between a plurality of the sprung terminals 1 while loosely packaged. Furthermore, the side flaps 13, 15 and end member 17 provide some protection to the contact strip 5 and help to prevent it from becoming damaged, particularly damage caused by other components hooking under the contact strip and bending or twisting it.

[0049] The side flaps 13, 15 of the sprung terminal 1 have fingers 23, 25 that protrude laterally towards each other. The fingers 23, 25 engage the contact strip 5 to limit its movement and to preload it. The use of two fingers 23, 25, one on either side flap 13, 15 improves the balance of the preloaded contact strip 5 and reduces its susceptibility to twisting.

[0050] The form of the sprung terminal 1 is intended to avoid damage caused by overcompression of the sprung terminal. Thus, as shown in Figure 4. The contact strip 5 may be bent towards the base strip against the natural resilience of the fold region 9 sufficiently far that the contact protrusion 11 lies between and protected by the side walls. In this position, end member 17 acts as an end stop to limit further travel of the contact strip 5 and so to prevent further damage. Even if some bending occurs and further motion should become possible, the contact strip 5 contacts the base strip 3 which again prevents further motion. This all improves reliability.

[0051] Figure 5 shows schematically the shape of a single blank 39 from which the third embodiment of the sprung terminal 1 may be formed. The area 27 enclosed by dashed lines forms the base strip of the sprung terminal 1. Area 33 extends longitudinally from area 27, for forming the contact strip 5. Side flap 13 and side flap 15 are formed from the areas 29 and 31 which are joined to and arranged on either side of area 27. End regions 49, 51 and finger regions 35, 37 depend from areas 29,31.

[0052] Nickel is plated onto the whole of the strip to a thickness of 1 to 2 μm . To form the sprung terminal, gold

is plated over the nickel onto contact areas 53,55. For manufacturing convenience, the gold is plated in a single stripe 81 of thickness 0.05 to 0.1 μm along the entire length of blank 39. It will be noted that it is only necessary to plate on one side of the blank 39. A further thicker gold plating 83 is carried out on the contact area 55 that will form contact projection 9. The thicker gold plating is carried out to a thickness of 0.2 to 1 μm , preferably 0.5 to 0.6 μm . This increases the reliability of the contact.

[0053] The blank 39 is folded to form the contact strip, with both contact areas 53, 55 facing outwards, and held in a preloaded condition. The areas 35,37 are folded to form fingers 23, 25, end regions 49, 51 are folded to form end flaps 19, 21 and the areas 29 folded down to form the side flaps 13,15. The fingers 23,25, end flaps 19, 21 and side flaps 13,15 may be folded in a single operation or in any order.

[0054] In the same operation that folds the blank 39 the contact area 55 is coined to form the contact protrusion 11 to have a domed profile, i.e. one that is rounded laterally as well as longitudinally.

[0055] A plurality of the formed sprung terminals are then mounted in wells 87 on a tape 83 for automatic pick and place operation, as illustrated in Figure 6. The sprung terminals may be removed from the tape by gripping the grip region 71 in an automatic pick and place machine. Alternatively, the sprung terminals can be delivered loose, not on a tape.

[0056] In use, the sprung terminals are picked up from the tape and soldered to a printed circuit board. The lack of gold on the legs 75, the gap 77 between the legs, the shape of the bent region 7, and the spacing of the fold region 9 from the printed circuit board all assist in preventing solder wicking up the sides of the sprung terminal.

[0057] Figure 7 shows a mobile phone 47 in an exploded view, and Figure 8 shows a part of the mobile phone 47 in a side view.

[0058] A PCB 63 has a number of sprung terminals 1 mounted on it to provide connections to a plurality of components 61. These include a battery 90, an input output connector 91, a key pad 92, an LCD 93, a speaker/microphone 94, a vibrator 95, an antenna 96, and side switches 97. As well as these permanent parts of the mobile phone 47 Figure 7 also shows a SIM card 98 which as will be appreciated is intended to be added and removed by the user.

[0059] As shown in Figure 8, the components are electrically connected to the PCB by aligning them in a mating housing, in many cases the outer housing of the mobile phone, which aligns them against the sprung terminals of the PCB to connect components to the PCB. This allows the components 61 to be connected to the PCB without requiring the components 61 or the housing to be provided with its own integral sprung contacts.

[0060] This approach to manufacture is efficient. The PCB 63 needs in any case to be populated with components, so adding one or more sprung terminals 1 to the

PCB causes little increase in manufacturing difficulty.

[0061] The invention is not limited to mobile telephone applications. Indeed, the sprung terminal can be applied to interconnect a variety of devices. Sprung terminals according to the invention offer a flexible modular approach to PCB layout and component infrastructure.

[0062] The embodiments of the invention described using the drawings are purely preferred, and described by way of example only. It will be apparent to one skilled in the art that there are many other embodiments of the invention not described.

[0063] For example, the fingers that protrude from the side flaps of the sprung terminal may take the form of any type of protrusion capable of acting on, and preloading the contact strip. Further, the form of fingers 23, 25 can be varied significantly.

[0064] In the embodiments described, the solder barrier is formed by a groove 6 or a fold region 7. Alternatively, the solder barrier can be formed by plating or otherwise covering a region of the base strip with a material which acts as a barrier to solder, for example by being resistant to wetting by solder.

[0065] The sprung terminal may be manufactured from any resilient conductive material, including copper beryllium alloy substitutes.

Claims

1. A sprung terminal formed from a single sheet of resilient material comprising:

a base strip (3) having a planar contact area (53) for soldering to a substrate;

a contact strip (5) spaced transversely of the base strip defining a gap therebetween, the contact strip having a contact protrusion (11) for making contact with mating electrical components;

a resilient fold region (9) joining one end of the base strip (3) to one end of the contact strip (5) to permit motion of the contact protrusion (11) towards the base strip and to resiliently bias against such motion, the base strip and the contact strip extending longitudinally from the fold region;

at least one flap (12,13,17) depending from a side edge of the base strip transversely across the gap (41); and

at least one preload member (23,25) extending laterally from the flap towards the contact strip, the contact strip (5) being resiliently biased away from the base strip against said preload member (23,25) and the contact strip (5) being substantially parallel to the base strip.

2. A sprung terminal (1) according to claim 1 wherein said at least one flap is a pair of laterally opposed

side flaps depending from laterally opposite sides of the base strip transversely across the gap to impede access to the gap; and

said at least one preload member comprises a pair of preload members (23,25) extending laterally inwardly from respective side flaps (13,15).

3. A sprung terminal according to claim 1 or 2 wherein the planar contact area (53) for soldering to the base strip is separated from the fold region (9) by a solder barrier (6,7).

4. A sprung terminal according to claim 3 wherein the solder barrier (6,7) comprises a groove (6) extending between opposite sides of the base strip; and/or a surface area of the contact strip coated with a material that is more resistant to soldering than the material of the contact strip; and/or a bent region (7) between the contact area (53) and the fold region (9), the bent region extending transversely inwardly with respect to the plane of the contact area.

5. A sprung terminal (1) according to claim 3 or 4, wherein said barrier (6,7) includes a bent region of the base strip, the bent region of the base strip being shaped so that when the planar contact area (53) is mounted on a planar substrate the fold region (9) is spaced from the substrate.

6. A sprung terminal according to any preceding claim wherein the contact strip (5) is movable against the resilient bias between an extended position abutting the preload members with the contact protrusion extending to its maximum extent and a retracted position in which the contact protrusion is retracted between the side flaps.

7. A sprung terminal according to any preceding claim, further comprising a pair of end flaps (19, 21) depending from the opposed side flaps (13, 15) blocking the gap at the other end of the base and contact strips to the fold region.

8. A sprung terminal according to any preceding claim, wherein the sprung terminal (1) is of nickel plated beryllium copper alloy.

9. A sprung terminal according to claim 6, wherein the external surface of the contact protrusion and of the planar contact area are gold plated.

10. An apparatus comprising at least one sprung terminal according to any of the preceding claims connecting a pair of components.

11. A method of forming a sprung terminal, including:

forming a flat blank from a sheet of resilient material to have a base strip and a contact strip longitudinally separated by a fold region, side flaps depending from the base strip and fingers depending from the side flaps;

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plating part of the base strip and part of the contact strip to define plated contact areas;

folding the side flaps to be perpendicular to the base strip;

folding the contact region such that the plated contact areas are on the external surface of the base and contact strips; and

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folding the fingers inwardly from the side flaps.

12. A method according to claim 11 further including coining the contact strip to form a domed contact protrusion.

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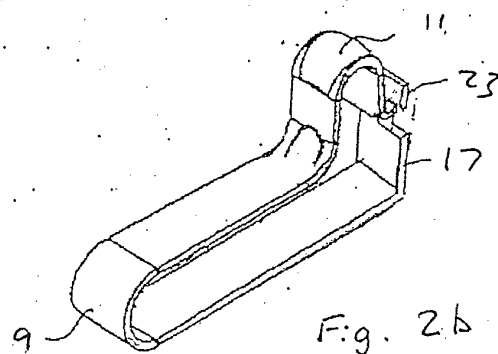
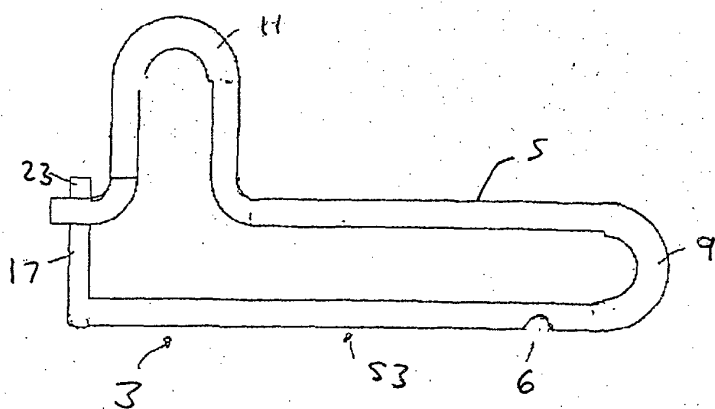
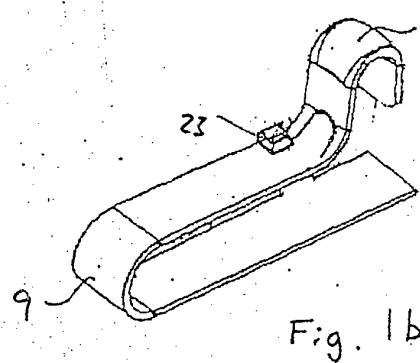
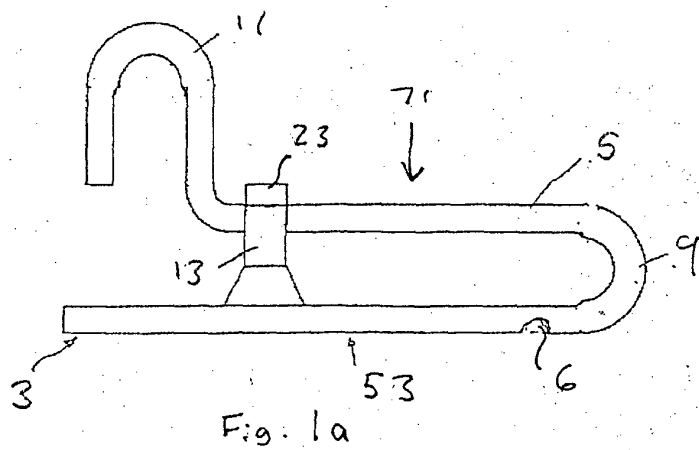
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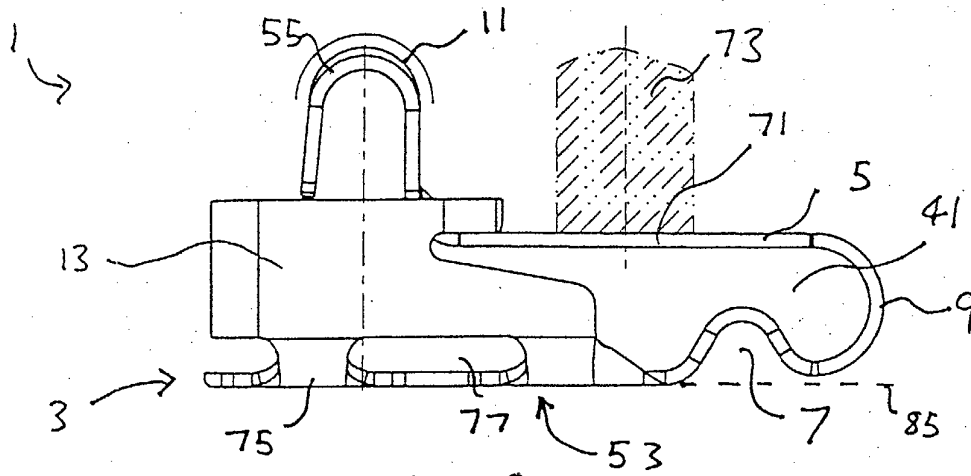


Fig. 3a

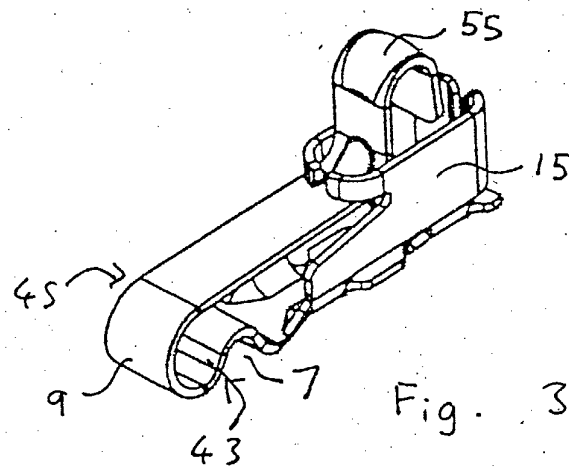


Fig. 3b

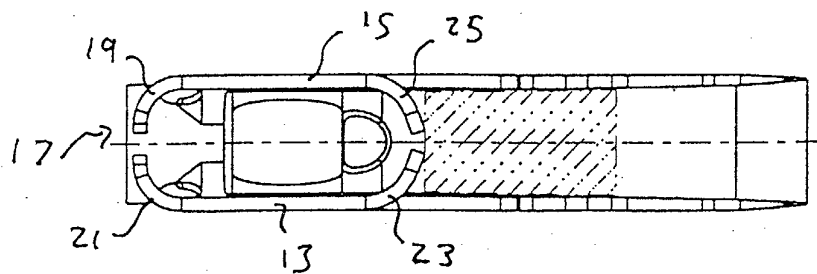


Fig. 3c

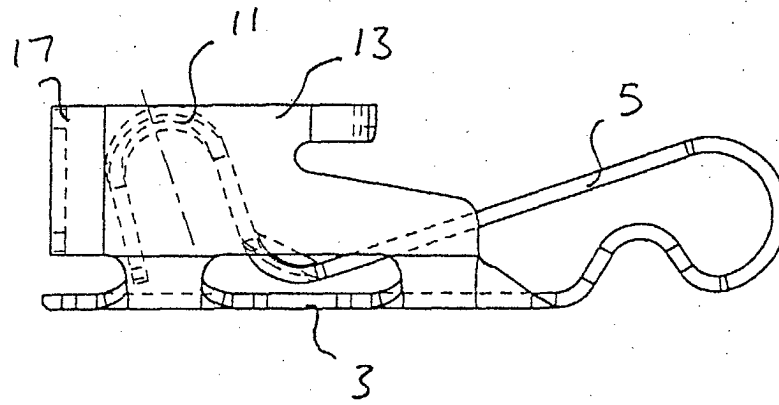


Fig. 4

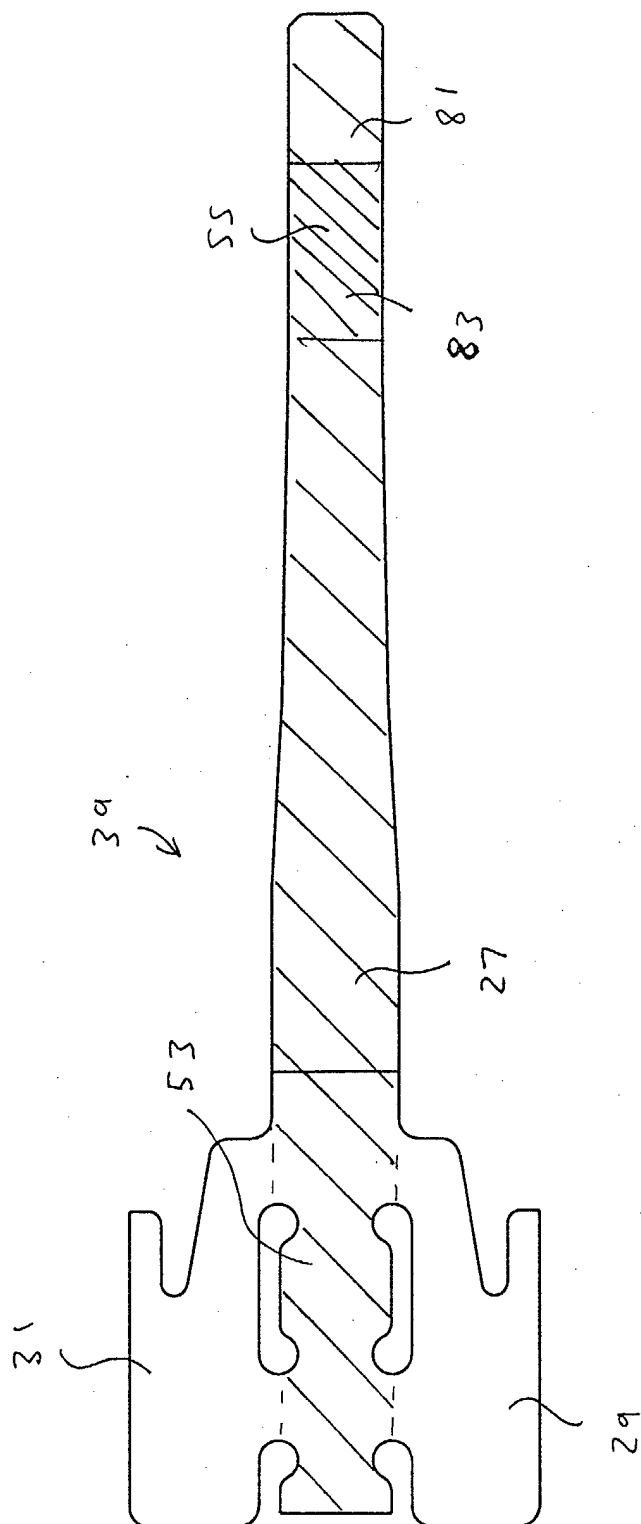


Fig. 5

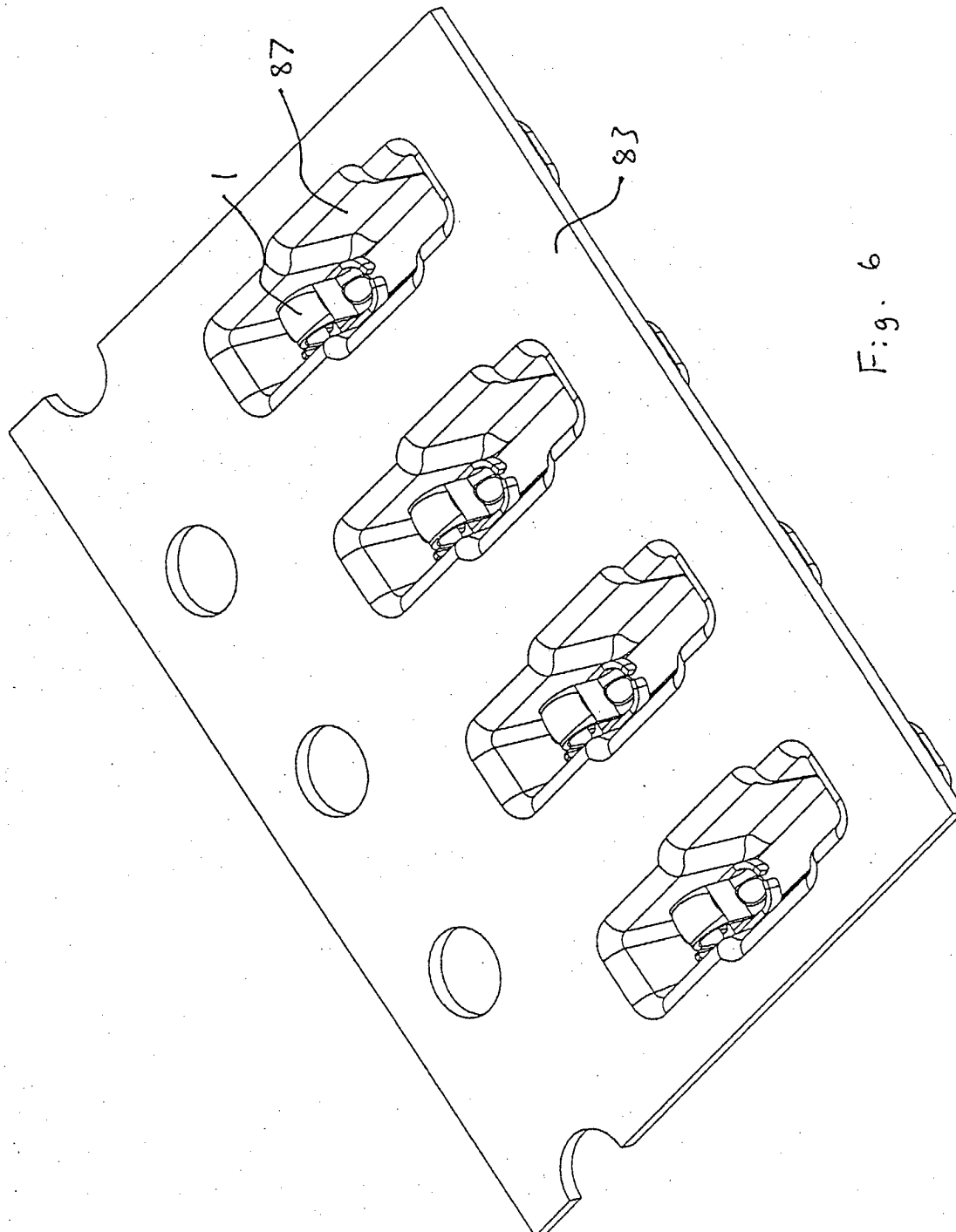


Fig. 6

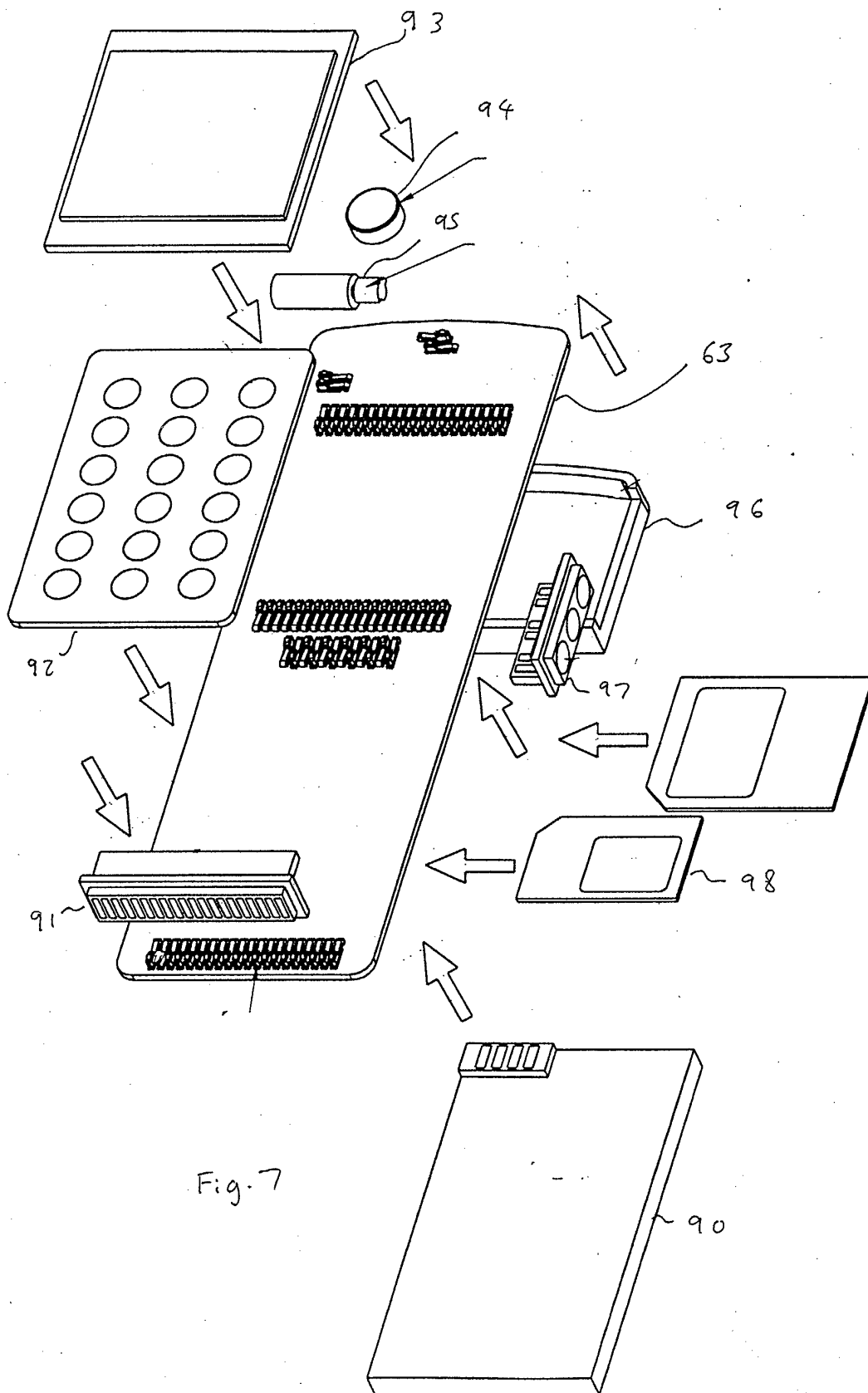
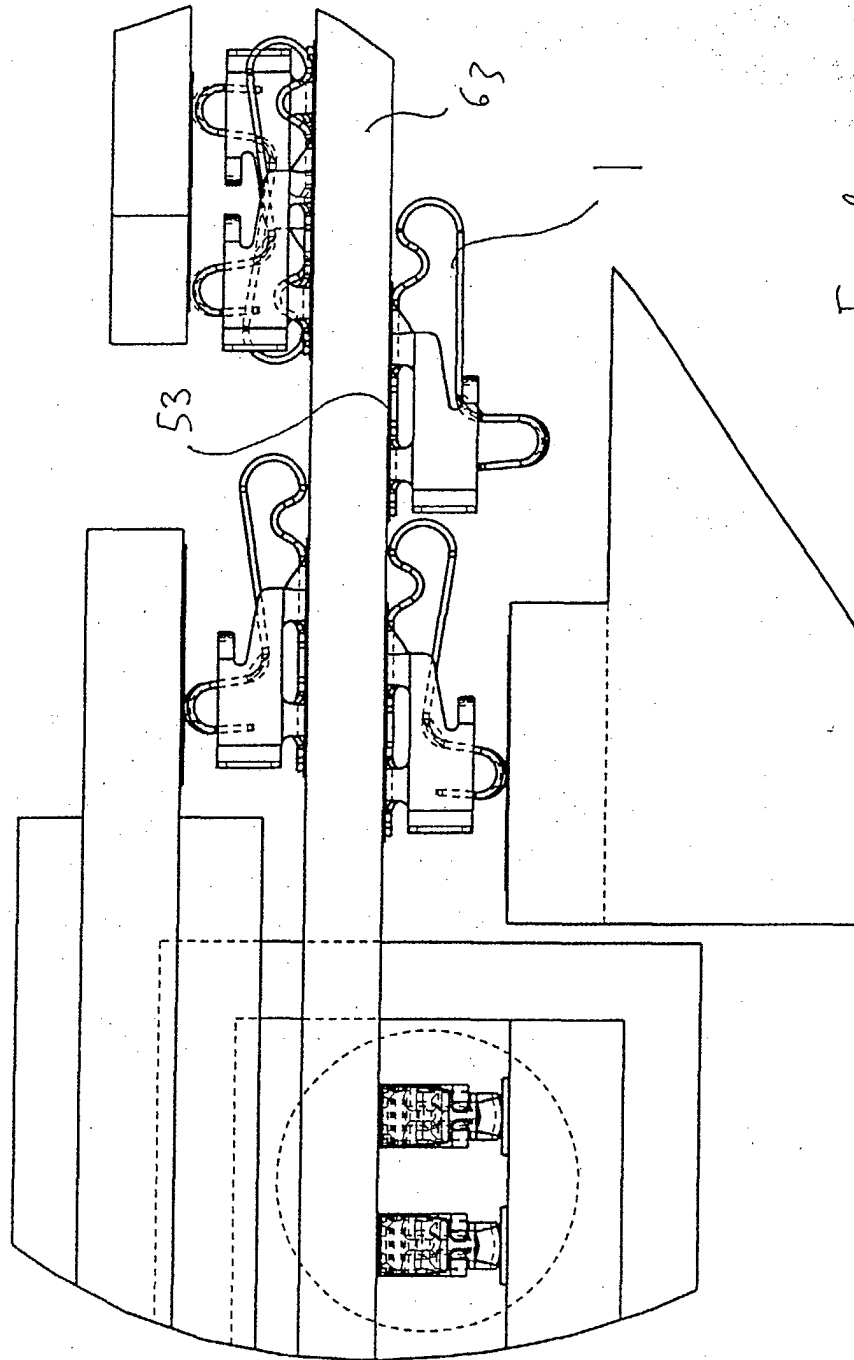


Fig. 7





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 25 8950

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.7)
A	US 5 655 913 A (J.C.CASTANEDA ET AL) 12 August 1997 (1997-08-12) * column 4, line 38 - column 5, line 8; figures 4-6 *	1,2,6, 9-11	H01R13/24
A	US 5 660 569 A (S.YAMADA ET AL) 26 August 1997 (1997-08-26) * column 1, line 15 - line 46; figures 7-10 *	1,11	
A	WO 97 45900 A (WHITAKER) 4 December 1997 (1997-12-04) * page 4, line 18 - page 5, line 34; figures 1-6 *	1,2,10	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			H01R
Place of search		Date of completion of the search	Examiner
BERLIN		26 September 2003	Alexatos, G
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			

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

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