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(54) **Improvements in and relating to high frequency electrical connectors**

Verbesserungen an und im Zusammenhang mit elektrischen Hochfrequenzsteckverbindern

Améliorations dans et concernant des connecteurs électriques haute fréquence

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Description

[0001] The present invention relates to high frequency electrical connectors, and particularly to electrical contacts provided in electrical sockets for such connectors.

[0002] Multiple pole connectors are used in applications such as data communications networks and telecommunications networks. To enable such networks to transmit increased volume of data, it is necessary to increase the operating frequency, and hence the data transfer rate. To ensure compatibility with existing lower operating frequency networks, it is desirable to provide data communications connectors that can operate at high data rates while still remaining backward compatible with older, lower data rate systems.

[0003] Data transfer rates are limited by a degradation of the signal and / or signal to noise ratio that occurs during transmission. A factor that may cause such degradation is crosstalk between adjacent pairs of conductors, where a data signal on one pair of conductors induces an electrical signal noise on an adjacent conductor.

[0004] By way of example, such a known data communications connector is the RJ45 connector which is provided with eight spring socket contacts, arranged so that all of the spring socket contacts run parallel and in line for a substantial proportion of their lengths. This configuration has been sufficient for systems characterised up to 100MHz (Cat 5/5e), provided contact lengths are minimised. However it becomes more difficult, as data rates increase beyond 100MHz systems (i.e. Cat 6 / 250MHz and higher to Augmented Cat 6 at 500MHz), to deal with crosstalk using the traditional style contact arrangement. This is because crosstalk compensation circuitry is applied relatively late and becomes ineffective at high frequencies.

[0005] Our UK patent application number GB 2,393,858 describes a High frequency socket connector which provides a significant improvement in performance over earlier arrangements. In the arrangement of the '858 application an improvement in the Near End Crosstalk (NEXT) is obtained by providing the socket with electrical socket contacts having different shapes.

[0006] US patent application number US 2002/0132532 (Roy L. Henneberger) describes a snap fit arrangement for facilitating assembling a socket connector where the electrical contacts are of several different shapes.

[0007] According to the present invention, there is provided a high frequency electrical connector comprising a socket and a plug, the plug insertable into the socket in a first direction, the socket and plug each having multiple electrical contacts which are arranged to electrically interconnect the plug and socket, the socket having a base for fixedly mounting a fixed end of the socket contacts, the base being mounted in a housing arranged to receive

the plug,

the socket contacts having contact areas arranged for electrically interconnecting to corresponding plug contacts,

5 the contact areas being aligned so as to be parallel in a first dimension with the first direction,

and having a resiling portion in-between the contact areas and the fixed ends,

10 the socket contacts are formed in several different shapes,

characterised in that each shape has an at least partly arcuate contact area and a free end of each socket contact is enclosed by the base.

[0008] A benefit of the invention is that a high frequency data communications connector for use with a standard RJ45 plug may be arranged to have short socket contacts where the contact ends are protected from physical damage during both the manufacturing process and during use when a plug is inserted and removed from the socket.

20 **[0009]** Preferably the base comprises at least an upper part and a lower part, each socket contact being arranged to mount between the upper part and lower part.

[0010] A benefit of each socket contact being arranged to mount between the upper part and lower part is that the small contacts may be assembled into a sub-assembly.

25 **[0011]** Preferably the upper and lower part clip together to retain the socket contacts.

[0012] A benefit of the upper and lower part clip together to retain the socket contacts is that the sub-assembly may be safely handled, and passed, for example, through a flow soldering process without risk that the contacts will be dislodged.

30 **[0013]** Preferably the free ends are enclosed under a portion of the upper part, and more preferably the fixed ends pass through the lower part.

[0014] A benefit of the free ends being enclosed under the upper part, and the fixed ends passing through the lower part is that the base may be moulded from a plastics material using simple tooling. A further benefit is that the free end of each of the socket contacts are protected during subsequent assembly operations and during the use of the socket when in service. A further benefit of the socket contacts at the fixed ends passing through the lower part is that the fixed ends are accurately and repeatedly positioned ready for insertion into a circuit board for subsequently soldering.

35 **[0015]** Preferably at least one socket contact has a free end facing substantially in the first direction, and at least a second socket contact has a free end facing substantially in a direction opposite to the first direction.

[0016] A benefit of at least one socket contact has a free end facing substantially in the first direction, and at least a second contact has a free end facing substantially in a direction opposite to the first direction is that the negative effect on crosstalk introduced by the contacts of pin-pairs 3,6 & 4,5 is reduced by effectively spacing the socket contacts apart, while maintaining small overall

dimensions.

[0017] Preferably all the arcuate contact areas are tangential to a contact plane passing through a point of contact between the socket contacts and the plug contacts when a plug is fully inserted into the socket.

[0018] Preferably a length of a shortest socket contact, measured in the first direction, is equal to or less than two thirds of an overall length measured across all the socket contacts, the overall length measured in the same first direction.

[0019] Preferably a minimum bend radius of the resiling portion is greater than 0.5mm.

[0020] A benefit of a minimum bend radius of the resiling portion is greater than 0.5mm is that the use of a larger radius avoids creating a noise radiating "hot-spot".

[0021] Preferably a plurality of the socket contacts have a substantially straight portion adjacent the fixed end, the substantially straight portion having a longitudinal axis parallel to the first direction.

[0022] Preferably the substantially straight portion has a wider portion, the wider portion being arranged to wedge in slots in the base.

[0023] A benefit of the substantially straight portion has a wider portion, the wider portion being arranged to wedge in slots in the base is that the socket contacts are held in place during the sub-assembly of the base.

[0024] Preferably the wider portion has a chamfered side facing in a direction of insertion of the socket contact into the lower part of the base, and a substantially flat side facing the opposite direction.

[0025] A benefit of the wider portion has a chamfered side facing in a direction of insertion of the socket contact into the lower part of the base, and a substantially flat side facing the opposite direction is that the contacts may be more easily inserted into the base, and then held more firmly in position.

[0026] Preferably the substantially straight portions of at least two socket contacts are arranged on a plane parallel to the contact plane, and wherein at least the straight portion of a further socket contact being arranged on a different plane parallel to the contact plane.

[0027] A benefit of the substantially straight portions of at least two socket contacts are arranged on a plane parallel to the contact plane, and wherein at least the straight portion of a further contact being arranged on a different plane parallel to the contact plane is that adjacent contacts may be spaced further apart than would be possible in one plane.

[0028] Preferably each socket contact further comprises a perpendicular straight portion in a plane substantially perpendicular to the first direction.

[0029] A benefit of each socket contact further comprises a perpendicular straight portion in a plane substantially perpendicular to the first direction is that the end of the socket contacts are all aligned in the same direction.

[0030] Preferably the perpendicular straight portions each have chamfered ends at an end of the fixed end for

easy insertion into the base and through the holes in the circuit board.

[0031] A benefit of the perpendicular straight portions each have chamfered ends at an end of the fixed end for easy insertion into the base and through the holes in the circuit board is that the aligned pins may be inserted into closely sized holes in a printed circuit board.

[0032] Preferably the perpendicular straight portions are arranged to pass through the base to the circuit board in four different perpendicular planes, each plane being perpendicular to the first direction.

[0033] A benefit of the perpendicular straight portions are arranged to pass through the base to the circuit board in four different perpendicular planes, each plane being perpendicular to the first direction is that adjacent socket contacts may be spaced further apart than would be possible in one plane and further that the track layout on the printed circuit board may be improved.

[0034] Preferably the contacts are arranged so that the perpendicular straight portions of at least three socket contacts lie on each of two of the perpendicular planes.

[0035] A benefit of the socket contacts are arranged so that the perpendicular straight portions of at least three contacts lie on each of two of the perpendicular planes is that the socket contacts that are most susceptible to crosstalk may be kept furthest away from each other.

[0036] Preferably each free end comprises a substantially straight portion, arranged at an angle to a tangent extending from an end of the arcuate contact areas.

[0037] A benefit of each free end comprises a substantially straight portion, arranged at an angle to a tangent extending from an end of the arcuate contact areas is that the free end may be more securely maintained enclosed in the base, and will resist being disengaged from being enclosed on a roughly inserted plug.

[0038] Preferably said angle is greater than 15 degrees and less than 25 degrees.

[0039] A benefit of said angle is greater than 15 degrees and less than 25 degrees is that the end may be positioned furthest away from adjacent resiling portions of adjacent contacts.

[0040] Preferably the free ends of at least one of the socket contacts is at least one fifth of the said overall length measured in the same first direction from an end across which the overall length is measured.

[0041] More preferably the free ends of each of the socket contacts is at least one fifth of the said overall length measured in the same first direction from an end across which the overall length is measured.

[0042] A benefit of the free ends of each of the socket contacts being at least one fifth of the said overall length measured in the same first direction from an end across which the overall length is measured, is that the ends may be positioned further away from adjacent resiling portions of adjacent socket contacts.

[0043] Preferably the base and the circuit board are arranged so that there is a gap between the circuit board and the base. Preferably the gap is at least 0.1mm, and

more preferably it is 0.3mm.

[0044] A benefit of a gap between the circuit board and the base is that any pressure applied to the base in normal use does not result in a change in the performance of the connector, due to effects such as capacitance.

[0045] Specific embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:-

Figure 1 is a partially sectioned side view of a high frequency electrical connector according to the invention;

Figure 1A is a partially sectioned side view of a second base and socket contacts as shown in Figure 1, but with a second plug shown in a minimum permitted engagement with the socket contacts;

Figure 2 is a perspective view of a base and socket contacts as shown in Figure 1;

Figure 3 is a perspective view of the socket contacts in the positions as shown in Figure 2, but without the base shown;

Figure 4 is a side view of the socket contacts shown in Figure 3;

Figure 4A is a side view of a first socket contact shown in Figure 4;

Figure 4B is a side view of a second socket contact shown in Figure 4;

Figure 4C is a side view of a third socket contact shown in Figure 4;

Figure 4D is a side view of a fourth socket contact shown in Figure 4;

Figure 5 is a perspective view of the base shown in Figures 1 and 2 but without the socket contacts present;

Figure 5A is a sectional view across the base as shown in Figure 5, the view taken through the clip fit feature;

Figure 5B is a perspective view of an upper part of the base shown in Figure 5;

Figure 5C is a perspective view of a lower part of the base shown in Figure 5;

Figure 6 is a partly exploded perspective view of a second embodiment of a high frequency electrical connector according to the invention; and

Figure 7 is a graph showing experimental results obtained when testing an embodiment of the invention.

[0046] From Figure 1 there is shown a high frequency electrical connector 1 comprising a socket 2 and a plug 3. The plug 3 is insertable into the socket 2 in a first direction 1D. The socket 2 and plug 3 each have multiple electrical contacts 21 to 28 and 31 to 38 (only one plug contact being visible in Figure 1) respectively, which are arranged to electrically interconnect the plug and socket. The socket 2 has a base 4 for fixedly mounting a fixed end 41 to 48 of each of the socket contacts 21 to 28 respectively. The base is mounted inside a housing 29, that provides location and support for the circuit board 30 and the base 4. The housing 29 is arranged to receive the plug, so as to guide and support it in such a position so that electrical contact is made between the socket contacts and the corresponding plug contacts.

[0047] The socket contacts 21 to 28 have contact areas 51 to 58 arranged for electrically interconnecting to corresponding plug contacts 31 to 38 respectively. The contact areas being aligned so as to be parallel in a first dimension 1M with the first direction 1D. Each socket contact has a resiling portion 61 to 68 in-between the contact areas 51 to 58 respectively and the fixed ends 41 to 48 respectively.

[0048] From Figures 2 and 3 it can be seen that the socket contacts 21 to 28 are formed in a plurality of shapes, and from Figure 4 it can be seen that in this embodiment there are four different shapes 1S, 2S, 3S, 4S, each shape having an at least partly arcuate contact areas 81 to 88. The at least partly arcuate contact areas 81 to 88 are between the resiling portion and a free end 71 to 78 of each socket contact. The free end of each socket contact is enclosed by the base 4. Hence the socket may be arranged to have short socket contacts where the contact ends are protected from physical damage during both the manufacturing process and during use when a plug is inserted and removed from the socket. Shape 1S has a length 4J, shape 2S has a length 4K, shape 3S has a length 4L, and shape 4S has a length 4M, all measured along the direction 1D. Shapes 1S and 3S being longer than shapes 2S and 4S.

[0049] The IEC standards state that the jack must survive 750 insertions, and if the free ends were not trapped by the base, then they are potentially so short they could catch on a plug and be damaged on removal of the plug.

[0050] The plug 3 is preferably a standard RJ45 plug, which in Figure 1 is shown to be at a maximum size permitted by the relevant standard. Hence the socket contacts in Figure 1 are shown resiliently deflected to their maximum amount 1V.

[0051] From Figure 1A, a second socket 2' with a base 4' similar to that shown in Figure 1 and associated socket contacts 22', 25' and 26' are visible and shown interacting with a second standard RJ45 plug, however the second standard RJ45 plug 3U, is dimensioned such that it is at a minimum size allowed by the relevant standards.

Hence Figure 1A, shows the socket contacts resiliently deflected a minimum acceptable amount 1U to achieve satisfactory performance of the high frequency electrical connector 1'. For clarity some detail has been omitted from Figure 1A, such as a housing, but the connector 1' is similar or identical to that of Figure 1.

[0052] From Figure 2 the base 4 can be seen to comprise an upper part 401 and a lower part 402, each socket contact being arranged to mount between the upper part and lower part. The upper part is provided with guides 403 and 404 to provide an accurate means of locating the base in the socket housing 29.

[0053] When the socket contacts are mounted between the upper part and lower part they form an easily handled sub-assembly. From Figures 5, 5A, 5B and 5C it may be seen that the upper and lower parts clip together with resilient clips 421 and 422, which have latching faces 423 and 424, which in use abut against abutments 425 and 426 in the lower part of the base to retain the socket contacts. Once clipped together the sub-assembly may be safely handled, and passed, for example, through a flow soldering process without risk that the socket contacts will be dislodged.

[0054] With the socket contacts absent in Figure 5, vertical locations 431 to 438 may be clearly seen. The vertical locations are for supporting the socket contacts adjacent to the resiling portion.

[0055] From Figure 5C, lower part 402 of the base 4 can be seen to comprise location pins 427 and 428 for ensuring accurate orientation with the upper part 401 when they are clipped together. The lower part 402 also has horizontal locations 461 to 468 for providing support to straight portion 91 to 98 of the socket contacts 21 to 28. At an end of each horizontal location is a rectangular hole 471 to 478 through the lower part to accept the perpendicular straight portions 121 to 128. Horizontal locations 462 and 467 are on a raised plane above the other locations, so that the socket contacts 22 and 27 respectively are spaced apart from the socket contacts that are adjacent to them.

[0056] The combination of the horizontal locations, the vertical locations and the rectangular holes, together with the enclosing of the free ends ensures that this arrangement is robust and easy to handle.

[0057] To ensure the base is supported away from the circuit board 30, the lower part 402 is provided with four spacers 411 to 414, one at each corner. On two diagonal corners, location pillars 415 and 416 are provided to locate in corresponding holes in the circuit boards. The spacers and pillars standing off the base from the circuit board are important to avoid change in performance due to plug tolerances or movement of the twisted pair cable applying a force to the plug, and hence to the socket. Having the pillars standing off the base from the circuit board enables the use of a double sided circuit board with most of the tracks for the socket contacts being mounted on the side of the board adjacent to the base. Hence a distance between the socket contacts and the

tracks on the circuit board is minimised. The air gap between the circuit board and the base provided by the spacers also prevents wicking of the solder up the fixed ends into the base during the soldering process. A suitable size for the air gap between the circuit board and the base has been found to be a minimum of 0.1mm. Preferably the gap is 0.5mm.

[0058] From Figures 1 and 2 the free ends can be seen to be enclosed under the upper part, and the fixed ends seen to pass through the lower part. Since the base is constructed as two parts, each part of the base may be moulded from a plastics material with a simple mould tool with no moving cores. Hence, since the free end of each socket contact is enclosed under a portion 449 of the upper part, the free end of each of the socket contacts are protected during subsequent assembly operations and during the use of the socket when in service a plug is inserted in to the socket or removed from the socket. For example, if a plug were to snag or catch on an unenclosed end of a socket contact, it would damage such a contact so that it would become unusable.

[0059] From Figures 2, 3 and 4 it can be seen that the socket contacts 21, 22, 23 and 25 have a free end facing substantially in the first direction 1D, and that the socket contacts 24, 26, 27 and 28 have a free end facing substantially in a direction 1R opposite to the first direction.

[0060] By arranging at least one socket contact, such as socket contact 23 or 25 to have a free end facing substantially in the first direction 1D, and at least a second contact, such as socket contact 24 to have a free end facing substantially in the direction 1R opposite to the first direction is that the negative effect on crosstalk introduced by the socket contacts of pin-pairs 3,6 & 4,5 is reduced by effectively spacing the socket contacts apart by a distance 4P, while maintaining small overall dimensions 4H measured along a direction of arrow 1D across all the socket contacts.

[0061] From Figure 4, it can be seen that the arcuate contact areas 81 to 88 are tangential to a contact plane 1P passing through a point of contact between the socket contacts and the plug contacts when a plug is fully inserted into the socket.

[0062] Having arcuate contact areas that are tangential to a contact plane passing through a point of contact between the socket contacts and the plug contacts when a plug is fully inserted into the socket, reduces a variability in the positions taken-up by the socket contacts when in use with different plugs. Hence, an effect of compensation for crosstalk applied by the tracks on the circuit board 30 on the performance of the connector is more predictable and a closer tolerance on performance can be achieved than would otherwise be possible.

[0063] From Figures 4B and 4D a length 4K and 4M of a short socket contact, measured in the first direction, is equal to or less than two thirds of an overall length 4H measured across all the socket contacts, the overall length measured in the same first direction 1D.

[0064] Contact shape 2S has a minimum bend radius

4R of the resiling portion 62 which is greater than 0.5mm. An effect of a small radius is to provide a hot spot for radiation of electrical noise, which would be detrimental to the performance of the connector.

[0065] The socket contacts each have a substantially straight portion 91 to 98 adjacent the fixed end 41 to 48, the substantially straight portion having a longitudinal axis parallel to the first direction 1D. The straight portions provide good location within the base for the socket contacts. To further improve the location, the substantially straight portions 91 to 98 each has a wider portion 101 to 108. A width of the wider portion being arranged to wedge in slots 451 to 458 in the base. Hence the contacts are held in place during the sub-assembly of the base.

[0066] The substantially straight portions of at least two socket contacts 22 and 27 are arranged on a high plane 4T parallel to the contact plane 1P, and the straight portion of socket contacts 21, 23, 24, 25, 26, and 28 being arranged on a low plane 4U parallel to the contact plane.

[0067] By arranging socket contacts on different substantially parallel planes 4U and 4T adjacent contacts may be spaced further apart than would be possible in one plane, and hence crosstalk can be reduced.

[0068] The fixed end 41 to 48 of each socket contact is perpendicular to the adjacent straight portion 91 to 98 and in a plane substantially perpendicular to the first direction. The perpendicular straight portions 121 to 128 each have chamfered ends 111 to 118 at an end of the fixed end for easy insertion into the base and through the holes in the base and the circuit board 30, which may be of a closely fitting size, and hence this assists in ensuring close control on the position of the assembled socket contacts.

[0069] From Figure 4, it can be seen that the perpendicular straight portions 121 to 128 are arranged to pass through base to circuit board in four different perpendicular planes, each plane being perpendicular to the first direction 1D. Hence, the perpendicular straight portions are arranged to pass through base to circuit board in four different perpendicular planes, so that adjacent socket contacts may be spaced further apart than would be possible in one plane and further that the track layout on the printed circuit board may be improved, giving further improvement to the performance of the socket. That is, the socket contacts that are most susceptible to crosstalk may be kept furthest away from each other.

[0070] Each free end 71 to 78 has a substantially straight portion, arranged at an angle 4N to a tangent extending from an end of the arcuate contact areas 81 to 88. The straight free end may be more securely maintained enclosed in the base in enclosures 441 to 448, and will resist being disengaged from the base if a roughly inserted plug exerts an unusual force on the socket contacts.

[0071] In the preferred embodiment the angle 4N is preferably greater than 15 degrees and less than 25 degrees. Such an angle assists in keeping the overall length of the socket contacts short, and hence the free ends

may be positioned further away from adjacent resiling portions of adjacent socket contacts where these face in the opposite direction.

[0072] Hence each of the socket contacts, both the contacts having a free end facing substantially in the first direction, and the contacts having a free end facing substantially in the direction opposite to the first direction have a point of inflection (or point of inflexion) between the arcuate contact areas 81 to 88 and the straight free ends 71 to 78 respectively. Hence for each socket contact, the point of inflection is between the contact area and the free end of the contact.

[0073] From Figure 4, it can be seen that the free ends are a distance of 4P and 4Q from adjacent contacts resiling bend areas. In the preferred embodiment the distances 4P and 4Q are preferably at least one fifth of the overall length 4H.

[0074] Hence in the preferred embodiment the free ends of each of the socket contacts is spaced at least one fifth of the said overall length measured in the same first direction from an end across which the overall length is measured.

[0075] For improved electrical performance of the connector 1, socket contacts have been orientated in the following position to achieve the required performance. Coupling between socket contacts 23 & 25, and 23 & 21 is strongly desired so these socket contacts have the same profile to provide maximum coupling. Coupling between socket contacts 26 & 24 and 26 & 28 is also strongly desired so again these contacts have the same profile. No coupling between socket contacts 22 and 23 is desired so contacts 22 is shortened to be out of line and equally contact 26 and 27 are desired not to couple so contact 27 is shortened to be out of line. Coupling between contacts 24 and 25 is not desired so contact 24 has been placed in a reverse direction to reduce the coupling.

[0076] Hence the negative effect on crosstalk introduced by the contacts of socket contact-pairs 23,26 & 24,25 has been addressed by minimising these contact lengths beyond the plug contact points. This has the effect of improving NEXT at higher frequencies required by 10GbaseT applications since plug NEXT cancellation begins earlier.

[0077] Particularly important in the embodiments of this invention is the improved operating characteristic above 250Mhz, since although 250MHz is the existing Category 6 specification limit, the new augmented Cat 6 (10GE) application and new cabling performance standard will require good 500MHz performance.

[0078] Figure 7, which is a graph showing experimental results obtained when testing an embodiment of the invention, where the straight line 7S represents the standards requirements, and the line 7C6- demonstrates the Cat 6 performance achievable using quality components. The results of testing a high speed connector according to present invention are shown on line 7W. The improvement achieved is significant.

[0079] Figure 6 is an exploded perspective view of a second embodiment of the invention of a high frequency electrical connector 200, comprising a socket 202 and a plug 203 to which are connected twisted pair cables 212 and 213 respectively. The plug is an industry standard RJ45 plug, and may be shielded, or unshielded. The plug is insertable into the socket in a first direction of arrow 6D. The socket 202 has a contact array 220 comprising multiple electrical socket contacts 221 to 228 mounted to a base 230. All free ends of the contacts 243 and 244 (only two labelled) are enclosed by the base 230. The base is provided with four spacers 231 and 232 (others not visible in Figure 6), and the array is mounted to a circuit board 240. The spacers space the base away from the circuit board so as to provide an air gap. Conductive tracks are provided on a top side 241 of the circuit board 240 to interconnect each of the electrical socket contacts 221 to 228 with holes 242 (only one labelled) to which insulation displacement connectors 250 and 251 are mounted and electrically connected. Wires 214 (only one labelled) of the cable 212 are untwisted sufficiently to attach them to the insulation displacement connectors to effect the electrical connection to the socket. Socket 202 has a housing 260 with an aperture 262 defining an entrance to a space to receive the plug 203. When the array and the insulation displacement connectors are mounted to the circuit board, it is assembled to the socket housing by sliding it in the direction of arrow 6A, when slides 229 either side of the base 230 engage with channels 263 in the housing to ensure accurate positioning of the socket contacts with respect to the aperture 262 to ensure correct mating of the plug and socket contacts. A closure plate 263 is provided to close the rear of the housing when the circuit board is in position. Fastener 264 is provided to retain the circuit board to the housing 260 by insertion of the fastener 264 through hole 265.

Claims

1. A high frequency electrical connector (1, 200) comprising a socket (2, 202) and a plug (3, 203), the plug insertable into the socket in a first direction (1D, 6D), the socket and plug each having multiple electrical contacts (21 to 28, 221 to 228 and 31 to 38 respectively) which are arranged to electrically interconnect the plug and socket, the socket having a base (4, 230) for fixedly mounting a fixed end (41 to 48) of the socket contacts, the base being mounted in a housing (29, 260) arranged to receive the plug, the socket contacts having contact areas (51 to 58) arranged for electrically interconnecting to corresponding plug contacts, the contact areas being aligned so as to be parallel in a first dimension with the first direction (1D, 6D), and having a resiling portion (61-68) in-between the

contact areas and the fixed ends, the socket contacts are formed in several different shapes,

characterised in that each shape has an at least partly arcuate contact area and a free end (71 to 78, 243 and 244) of each socket contact is enclosed by the base.

2. A high frequency electrical connector as claimed in claim 1, wherein the base comprises at least an upper part (401) and a lower part (402), each socket contact (21 to 28, 221 to 228) being arranged to mount between the upper part and lower part.
3. A high frequency electrical connector as claimed in claim 2, wherein the upper and lower part clip together to retain the socket contacts (21 to 28, 221 to 228).
4. A high frequency electrical connector as claimed in claim 2 or 3, wherein the free ends are enclosed under the upper part, and wherein the fixed ends pass through the lower part.
5. A high frequency electrical connector as claimed in any of the preceding claims, wherein at least one socket contact (21, 22, 23 or 25) has a free end facing substantially in the first direction (1D, 6D), and at least a second socket contact (24, 26, 27 or 28) has a free end facing substantially in a direction (1R) opposite to the first direction.
6. A high frequency electrical connector as claimed any one of claims 2 to 5 when dependent on claim 2, wherein the free end of each contact is enclosed under a portion (449) of an upper part of the base.
7. A high frequency electrical connector as claimed any one of claims 2 to 6 when dependent on claim 2, wherein the socket contacts at the fixed ends pass through a lower part of the base.
8. A high frequency electrical connector as claimed in any one of the preceding claims, wherein all the arcuate contact areas (81 to 88) are tangential to a contact plane (1P) passing through a point of contact between the socket contacts and the plug contacts when a plug is fully inserted into the socket.
9. A high frequency electrical connector as claimed in any one of the preceding claims, wherein a length (4K, 4M) of a shortest socket contact (22, 27 and 222, 227), measured in the first direction (1D, 6D), is equal to or less than two thirds of an overall length (4H) measured across all the socket contacts (21 to 28, 221 to 228), the overall length measured in the same first direction.
10. A high frequency electrical connector as claimed in any one of the preceding claims, wherein a minimum

bend radius (4R) of the resiling portion (62) is greater than 0.5mm.

11. A high frequency electrical connector as claimed in any one of the preceding claims, wherein a plurality of the socket contacts have a substantially straight portion (91 to 98) adjacent the fixed end (41 to 48), the substantially straight portion having a longitudinal axis parallel to the first direction.
12. A high frequency electrical connector as claimed in claim 11, wherein the substantially straight portion has a wider portion (101 to 108), the wider portion being arranged to wedge in slots (451 to 458) in the base.
13. A high frequency electrical connector as claimed in claim 12, wherein the wider portion (101 to 108) has a chamfered side facing in a direction of insertion of the socket contact into the lower part of the base, and a substantially flat side facing the opposite direction.
14. A high frequency electrical connector as claimed in any one of claims 11 to 13, wherein the substantially straight portions of at least two socket contacts are arranged on a plane parallel to the contact plane, and wherein at least the straight portion of a further socket contact being arranged on a different plane parallel to the contact plane.
15. A high frequency electrical connector as claimed in any one of the preceding claims, wherein each socket contact further comprises a perpendicular straight portion (121 to 128) in a plane substantially perpendicular to the first direction (1D, 6D).
16. A high frequency electrical connector as claimed in claim 15, wherein the perpendicular straight portions (121 to 128) each have chamfered ends (111 to 118) at an end of the fixed end.
17. A high frequency electrical connector as claimed in claim 15 or 16, wherein the perpendicular straight portions (121 to 128) are arranged to pass through the base to a circuit board (30) in four different perpendicular planes, each plane being perpendicular to the first direction (1D, 6D).
18. A high frequency electrical connector as claimed in claim 17, wherein the socket contacts are arranged so that the perpendicular straight portions (121 to 128) of at least three socket contacts lie on each of two of the perpendicular planes.
19. A high frequency electrical connector as claimed in any one of the preceding claims, wherein each free end (71 to 78) comprises a substantially straight por-

tion, arranged at an angle (4N) to a tangent extending from an end of the arcuate contact areas (81 to 88).

20. A high frequency electrical connector as claimed in claim 19, wherein said angle (4N) is greater than 15 degrees and less than 25 degrees.
21. A high frequency electrical connector as claimed any one of the preceding claims, wherein the free end of at least one of the socket contacts is at least one fifth (4P, 4Q) of the said overall length (4H) measured in the same first direction from an end across which the overall length is measured.
22. A high frequency electrical connector as claimed in any of claims 1 to 21, wherein the free end of each of the socket contacts is at least one fifth (4P, 4Q) of the said overall length (4H) measured in the same first direction from an end across which the overall length is measured.
23. A high frequency electrical connector as claimed in any of the preceding claims, wherein the base (4, 230) and a or the circuit board (30) are arranged so that there is a gap between the circuit board and the base.

Patentansprüche

1. Ein elektrischer Hochfrequenzsteckverbinder (1, 200), der eine Buchse (2, 202) und einen Stecker (3, 203) beinhaltet, wobei der Stecker in einer ersten Richtung (1D, 6D) in die Buchse einführbar ist, wobei die Buchse und der Stecker jeweils mehrere elektrische Kontakte (21 bis 28 bzw. 221 bis 228 bzw. 31 bis 38) aufweisen, die eingerichtet sind, um den Stecker und die Buchse elektrisch zu koppeln, wobei die Buchse eine Basis (4, 230) zum fixierten Montieren eines fixierten Endes (41 bis 48) der Buchsenkontakte aufweist, wobei die Basis in einem Gehäuse (29, 260) montiert ist, das eingerichtet ist, um den Stecker aufzunehmen, wobei die Buchsenkontakte Kontaktflächen (51 bis 58) aufweisen, die zum elektrischen Koppeln mit den entsprechenden Steckerkontakten eingerichtet sind, wobei die Kontaktflächen so ausgerichtet sind, dass sie in einer ersten Dimension zu der ersten Richtung (1D, 6D) parallel sind, und einen federnden Abschnitt (61-68) zwischen den Kontaktflächen und den fixierten Enden aufweisen, wobei die Buchsenkontakte in mehreren unterschiedlichen Formen gebildet sind, **dadurch gekennzeichnet, dass** jede Form eine mindestens teilweise gebogene Kontaktfläche auf-

- weist und ein freies Ende (71 bis 78, 243 und 244) jedes Buchsenkontakts von der Basis eingeschlossen ist.
2. Elektrischer Hochfrequenzsteckverbinder gemäß Anspruch 1, wobei die Basis mindestens einen oberen Teil (401) und einen unteren Teil (402) beinhaltet, wobei jeder Buchsenkontakt (21 bis 28, 221 bis 228) eingerichtet ist, um zwischen dem oberen Teil und dem unteren Teil montiert zu werden. 5 10
 3. Elektrischer Hochfrequenzsteckverbinder gemäß Anspruch 2, wobei der obere und der untere Teil ineinander einrasten, um die Buchsenkontakte (21 bis 28, 221 bis 228) zu halten. 15
 4. Elektrischer Hochfrequenzsteckverbinder gemäß Anspruch 2 oder 3, wobei die freien Enden unter dem oberen Teil eingeschlossen sind und wobei die fixierten Enden durch den unteren Teil verlaufen. 20
 5. Elektrischer Hochfrequenzsteckverbinder gemäß einem der vorhergehenden Ansprüche, wobei mindestens ein Buchsenkontakt (21, 22, 23 oder 25) ein freies Ende aufweist, das im Wesentlichen in die erste Richtung (1D, 6D) gerichtet ist, und mindestens ein zweiter Buchsenkontakt (24, 26, 27 oder 28) ein freies Ende aufweist, das im Wesentlichen in eine Richtung (1 R) entgegengesetzt zu der ersten Richtung gerichtet ist. 25 30
 6. Elektrischer Hochfrequenzsteckverbinder gemäß einem der Ansprüche 2 bis 5, wenn von Anspruch 2 abhängig, wobei das freie Ende jedes Kontakts unter einem Abschnitt (449) eines oberen Teils der Basis eingeschlossen ist. 35
 7. Elektrischer Hochfrequenzsteckverbinder gemäß einem der Ansprüche 2 bis 6, wenn von Anspruch 2 abhängig, wobei die Buchsenkontakte an den fixierten Enden durch einen unteren Teil der Basis verlaufen. 40
 8. Elektrischer Hochfrequenzsteckverbinder gemäß einem der vorhergehenden Ansprüche, wobei alle gebogenen Kontaktflächen (81 bis 88) zu einer Kontaktebene (1 P), die durch einen Kontaktpunkt zwischen den Buchsenkontakten und den Steckerkontakten verläuft, wenn ein Stecker vollständig in die Buchse eingeführt ist, tangential sind. 45 50
 9. Elektrischer Hochfrequenzsteckverbinder gemäß einem der vorhergehenden Ansprüche, wobei eine Länge (4K, 4M) eines kürzesten Buchsenkontakts (22, 27 und 222, 227), gemessen in der ersten Richtung (1D, 6D), gleich oder weniger als zwei Drittel einer Gesamtlänge (4H) ist, gemessen über alle Buchsenkontakte hinweg (21 bis 28, 221 bis 228), wobei die Gesamtlänge in derselben ersten Richtung gemessen wird. 55
 10. Elektrischer Hochfrequenzsteckverbinder gemäß einem der vorhergehenden Ansprüche, wobei ein Mindestbiegungsradius (4R) des federnden Abschnitts (62) größer als 0,5 mm ist.
 11. Elektrischer Hochfrequenzsteckverbinder gemäß einem der vorhergehenden Ansprüche, wobei eine Vielzahl der Buchsenkontakte einen im Wesentlichen geraden Abschnitt (91 bis 98) angrenzend an das fixierte Ende (41 bis 48) aufweisen, wobei der im Wesentlichen gerade Abschnitt eine zu der ersten Richtung parallele Längsachse aufweist.
 12. Elektrischer Hochfrequenzsteckverbinder gemäß Anspruch 11, wobei der im Wesentlichen gerade Abschnitt einen breiteren Abschnitt (101 bis 108) aufweist, wobei der breitere Abschnitt eingerichtet ist, um in Schlitze (451 bis 458) in der Basis einzukeilen.
 13. Elektrischer Hochfrequenzsteckverbinder gemäß Anspruch 12, wobei der breitere Abschnitt (101 bis 108) eine abgeschrägte Seite, die in eine Richtung der Einführung des Buchsenkontakts in den unteren Teil der Basis gerichtet ist, und eine im Wesentlichen flache Seite, die in die entgegengesetzte Richtung gerichtet ist, aufweist.
 14. Elektrischer Hochfrequenzsteckverbinder gemäß einem der Ansprüche 11 bis 13, wobei die im Wesentlichen geraden Abschnitte von mindestens zwei Buchsenkontakten auf einer zu der Kontaktebene parallelen Ebene eingerichtet sind und wobei mindestens der gerade Abschnitt eines weiteren Buchsenkontakts auf einer unterschiedlichen, zu der Kontaktebene parallelen, Ebene eingerichtet ist.
 15. Elektrischer Hochfrequenzsteckverbinder gemäß einem der vorhergehenden Ansprüche, wobei jeder Buchsenkontakt ferner einen senkrechten geraden Abschnitt (121 bis 128) in einer zu der ersten Richtung (1D, 6D) im Wesentlichen parallelen Ebene beinhaltet.
 16. Elektrischer Hochfrequenzsteckverbinder gemäß Anspruch 15, wobei die senkrechten geraden Abschnitte (121 bis 128) an einem Ende des fixierten Endes jeweils abgeschrägte Enden (111 bis 118) aufweisen.
 17. Elektrischer Hochfrequenzsteckverbinder gemäß Anspruch 15 oder 16, wobei die senkrechten geraden Abschnitte (121 bis 128) eingerichtet sind, um in vier unterschiedlichen senkrechten Ebenen durch die Basis zu einer Leiterplatte (30) zu verlaufen, wobei jede Ebene zu der ersten Richtung (1D, 6D) senk-

recht ist.

18. Elektrischer Hochfrequenzsteckverbinder gemäß Anspruch 17, wobei die Buchsenkontakte so eingerichtet sind, dass die senkrechten geraden Abschnitte (121 bis 128) von mindestens drei Buchsenkontakten auf jeder von zwei der senkrechten Ebenen liegen. 5
19. Elektrischer Hochfrequenzsteckverbinder gemäß einem der vorhergehenden Ansprüche, wobei jedes freie Ende (71 bis 78) einen im Wesentlichen geraden Abschnitt beinhaltet, der in einem Winkel (4N) zu einer Tangente eingerichtet ist, die sich von einem Ende der gebogenen Kontaktflächen (81 bis 88) erstreckt. 10 15
20. Elektrischer Hochfrequenzsteckverbinder gemäß Anspruch 19, wobei der Winkel (4N) größer als 15 Grad und kleiner als 25 Grad ist. 20
21. Elektrischer Hochfrequenzsteckverbinder gemäß einem der vorhergehenden Ansprüche, wobei das freie Ende von mindestens einem der Buchsenkontakte bei mindestens einem Fünftel (4P, 4Q) der Gesamtlänge (4H) ist, gemessen in derselben ersten Richtung, von einem Ende, über das die Gesamtlänge gemessen wird. 25
22. Elektrischer Hochfrequenzsteckverbinder gemäß einem der Ansprüche 1 bis 21, wobei das freie Ende jedes der Buchsenkontakte bei mindestens einem Fünftel (4P, 4Q) der Gesamtlänge (4H) ist, gemessen in derselben ersten Richtung, von einem Ende, über das die Gesamtlänge gemessen wird. 30 35
23. Elektrischer Hochfrequenzsteckverbinder gemäß einem der vorhergehenden Ansprüche, wobei die Basis (4, 230) und eine oder die Leiterplatte (30) so eingerichtet sind, dass eine Lücke zwischen der Leiterplatte und der Basis vorhanden ist. 40

Revendications

1. Un connecteur électrique hautes fréquences (1, 200) comprenant une prise femelle (2, 202) et une prise mâle (3, 203), la prise mâle étant insérable dans la prise femelle dans une première direction (1 D, 6D), la prise femelle et la prise mâle ayant chacune de multiples contacts électriques (21 à 28, 221 à 228 et 31 à 38 respectivement) qui sont arrangés pour interconnecter électriquement la prise mâle et la prise femelle, la prise femelle ayant une base (4, 230) pour monter de façon fixe une extrémité fixe (41 à 48) des contacts de prise femelle, la base étant montée dans un boîtier (29, 260) ar- 45 50

rangé pour recevoir la prise mâle, les contacts de prise femelle ayant des zones de contact (51 à 58) arrangées pour s'interconnecter électriquement à des contacts de prise mâle correspondants, les zones de contact étant alignées de manière à être parallèles dans une première dimension avec la première direction (1 D, 6D), et ayant une portion élastique (61 à 68) entre les zones de contact et les extrémités fixes, les contacts de prise femelle étant façonnés en plusieurs formes différentes, **caractérisé en ce que** chaque forme a une zone de contact au moins partiellement arquée et une extrémité libre (71 à 78, 243 et 244) de chaque contact de prise femelle est enclose par la base.

2. Un connecteur électrique hautes fréquences tel que revendiqué dans la revendication 1, dans lequel la base comprend au moins une partie supérieure (401) et une partie inférieure (402), chaque contact de prise femelle (21 à 28, 221 à 228) étant arrangé pour se monter entre la partie supérieure et la partie inférieure.
3. Un connecteur électrique hautes fréquences tel que revendiqué dans la revendication 2, dans lequel la partie supérieure et la partie inférieure se clipsent ensemble afin de retenir les contacts de prise femelle (21 à 28, 221 à 228).
4. Un connecteur électrique hautes fréquences tel que revendiqué dans la revendication 2 ou la revendication 3, dans lequel les extrémités libres sont encloses sous la partie supérieure, et dans lequel les extrémités fixes traversent la partie inférieure.
5. Un connecteur électrique hautes fréquences tel que revendiqué dans n'importe lesquelles des revendications précédentes, dans lequel au moins un contact de prise femelle (21, 22, 23 ou 25) a une extrémité libre tournée substantiellement dans la première direction (1 D, 6D), et au moins un deuxième contact de prise femelle (24, 26, 27, ou 28) a une extrémité libre tournée substantiellement dans une direction (1 R) opposée à la première direction.
6. Un connecteur électrique hautes fréquences tel que revendiqué dans l'une quelconque des revendications 2 à 5 lorsque dépendantes de la revendication 2, dans lequel l'extrémité libre de chaque contact est enclose sous une portion (449) d'une partie supérieure de la base.
7. Un connecteur électrique hautes fréquences tel que revendiqué dans l'une quelconque des revendications 2 à 6 lorsque dépendantes de la revendication 2, dans lequel les contacts de prise femelle au niveau des extrémités fixes traversent une partie inférieure

de la base.

8. Un connecteur électrique hautes fréquences tel que revendiqué dans l'une quelconque des revendications précédentes, dans lequel toutes les zones de contact arquées (81 à 88) sont tangentielles à un plan de contact (1 P) passant par un point de contact entre les contacts de prise femelle et les contacts de prise mâle lorsqu'une prise mâle est entièrement insérée dans la prise femelle. 5
9. Un connecteur électrique hautes fréquences tel que revendiqué dans l'une quelconque des revendications précédentes, dans lequel une longueur (4K, 4M) d'un contact de prise femelle le plus court (22, 27 et 222, 227), mesurée dans la première direction (1 D, 6D), est égale ou inférieure aux deux tiers d'une longueur hors-tout (4H) mesurée sur tous les contacts de prise femelle (21 à 28, 221 à 228), la longueur hors-tout étant mesurée dans la même première direction. 10
10. Un connecteur électrique hautes fréquences tel que revendiqué dans l'une quelconque des revendications précédentes, dans lequel un rayon de courbure minimal (4R) de la portion élastique (62) est supérieur à 0,5 mm. 15
11. Un connecteur électrique hautes fréquences tel que revendiqué dans l'une quelconque des revendications précédentes, dans lequel une pluralité des contacts de prise femelle ont une portion substantiellement droite (91 à 98) adjacente à l'extrémité fixe (41 à 48), la portion substantiellement droite ayant un axe longitudinal parallèle à la première direction. 20
12. Un connecteur électrique hautes fréquences tel que revendiqué dans la revendication 11, dans lequel la portion substantiellement droite a une portion plus large (101 à 108), la portion plus large étant arrangée pour se caler dans des fentes (451 à 458) dans la base. 25
13. Un connecteur électrique hautes fréquences tel que revendiqué dans la revendication 12, dans lequel la portion plus large (101 à 108) a un côté chanfreiné tourné dans une direction d'insertion du contact de prise femelle dans la partie inférieure de la base, et un côté substantiellement plat tourné dans la direction opposée. 30
14. Un connecteur électrique hautes fréquences tel que revendiqué dans l'une quelconque des revendications 11 à 13, dans lequel les portions substantiellement droites d'au moins deux contacts de prise femelle sont arrangées sur un plan parallèle au plan de contact, et dans lequel au moins la portion droite d'un contact de prise femelle supplémentaire est ar- 35

rangée sur un plan différent parallèle au plan de contact.

15. Un connecteur électrique hautes fréquences tel que revendiqué dans l'une quelconque des revendications précédentes, dans lequel chaque contact de prise femelle comprend en outre une portion droite perpendiculaire (121 à 128) dans un plan substantiellement perpendiculaire à la première direction (1 D, 6D). 40
16. Un connecteur électrique hautes fréquences tel que revendiqué dans la revendication 15, dans lequel les portions droites perpendiculaires (121 à 128) ont chacune des extrémités chanfreinées (111 à 118) à une extrémité de l'extrémité fixe. 45
17. Un connecteur électrique hautes fréquences tel que revendiqué dans la revendication 15 ou la revendication 16, dans lequel les portions droites perpendiculaires (121 à 128) sont arrangées pour traverser la base jusqu'à une carte de circuit (30) dans quatre plans perpendiculaires différents, chaque plan étant perpendiculaire à la première direction (1D, 6D). 50
18. Un connecteur électrique hautes fréquences tel que revendiqué dans la revendication 17, dans lequel les contacts de prise femelle sont arrangés de sorte que les portions droites perpendiculaires (121 à 128) d'au moins trois contacts de prise femelle se trouvent sur chacun de deux des plans perpendiculaires. 55
19. Un connecteur électrique hautes fréquences tel que revendiqué dans l'une quelconque des revendications précédentes, dans lequel chaque extrémité libre (71 à 78) comprend une portion substantiellement droite, arrangée à un angle (4N) par rapport à une tangente s'étendant à partir d'une extrémité des zones de contact arquées (81 à 88). 60
20. Un connecteur électrique hautes fréquences tel que revendiqué dans la revendication 19, dans lequel ledit angle (4N) fait plus de 15 degrés et moins de 25 degrés. 65
21. Un connecteur électrique hautes fréquences tel que revendiqué dans l'une quelconque des revendications précédentes, dans lequel l'extrémité libre d'au moins un des contacts de prise femelle est à au moins un cinquième (4P, 4Q) de ladite longueur hors-tout (4H) mesuré dans la même première direction d'une extrémité sur laquelle la longueur hors-tout est mesurée. 70
22. Un connecteur électrique hautes fréquences tel que revendiqué dans n'importe lesquelles des revendications 1 à 21, dans lequel l'extrémité libre de chacun des contacts de prise femelle est à au moins un cin- 75

quième (4P, 4Q) de ladite longueur hors-tout (4H) mesuré dans la même première direction d'une extrémité sur laquelle la longueur hors-tout est mesurée.

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- 23.** Un connecteur électrique hautes fréquences tel que revendiqué dans n'importe lesquelles des revendications précédentes, dans lequel la base (4, 230) et une ou la carte de circuit (30) sont arrangées de sorte qu'il y ait un intervalle entre la carte de circuit et la base.

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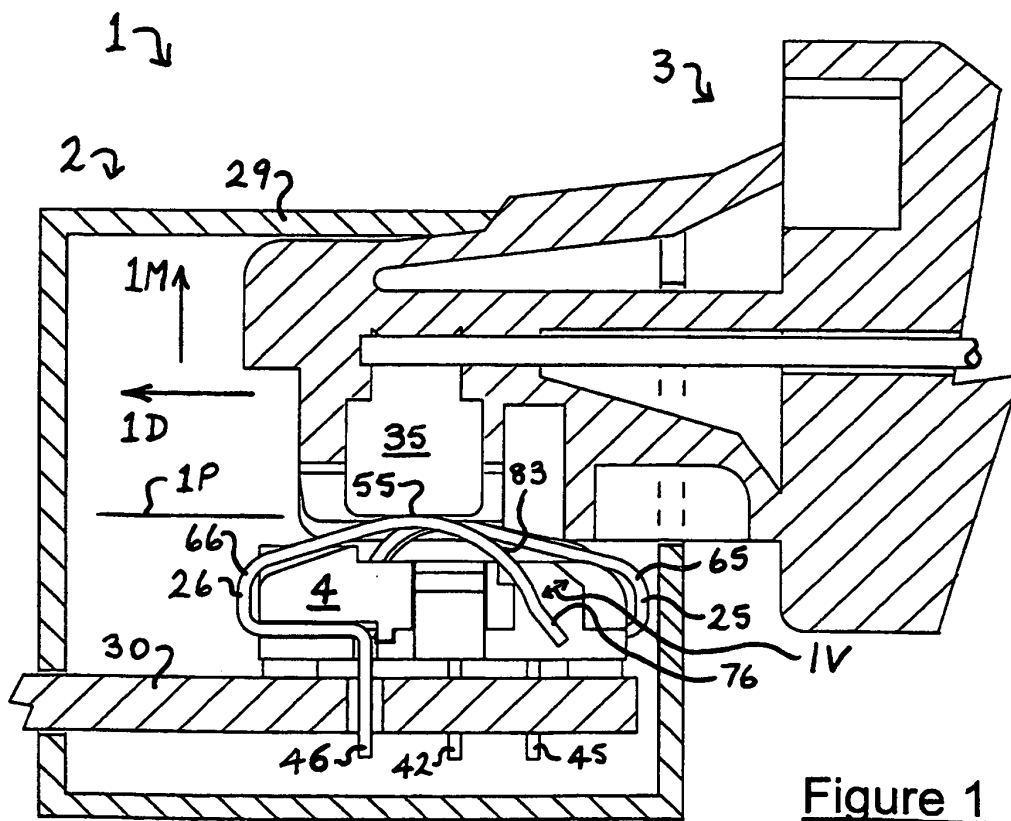
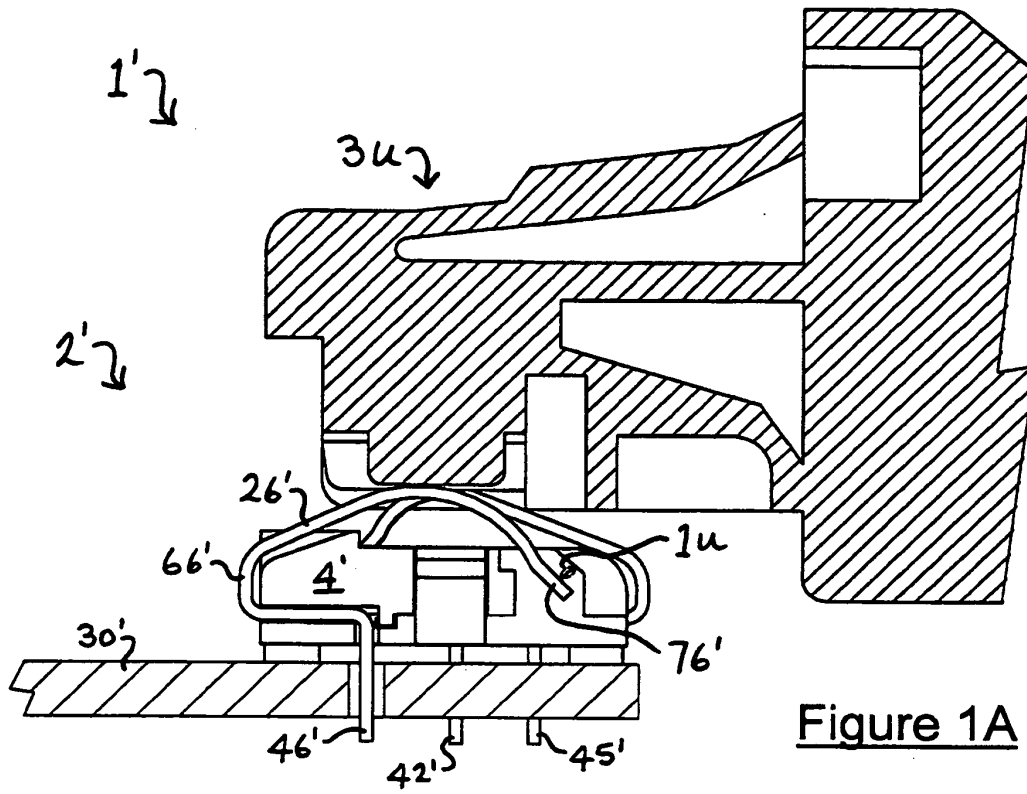
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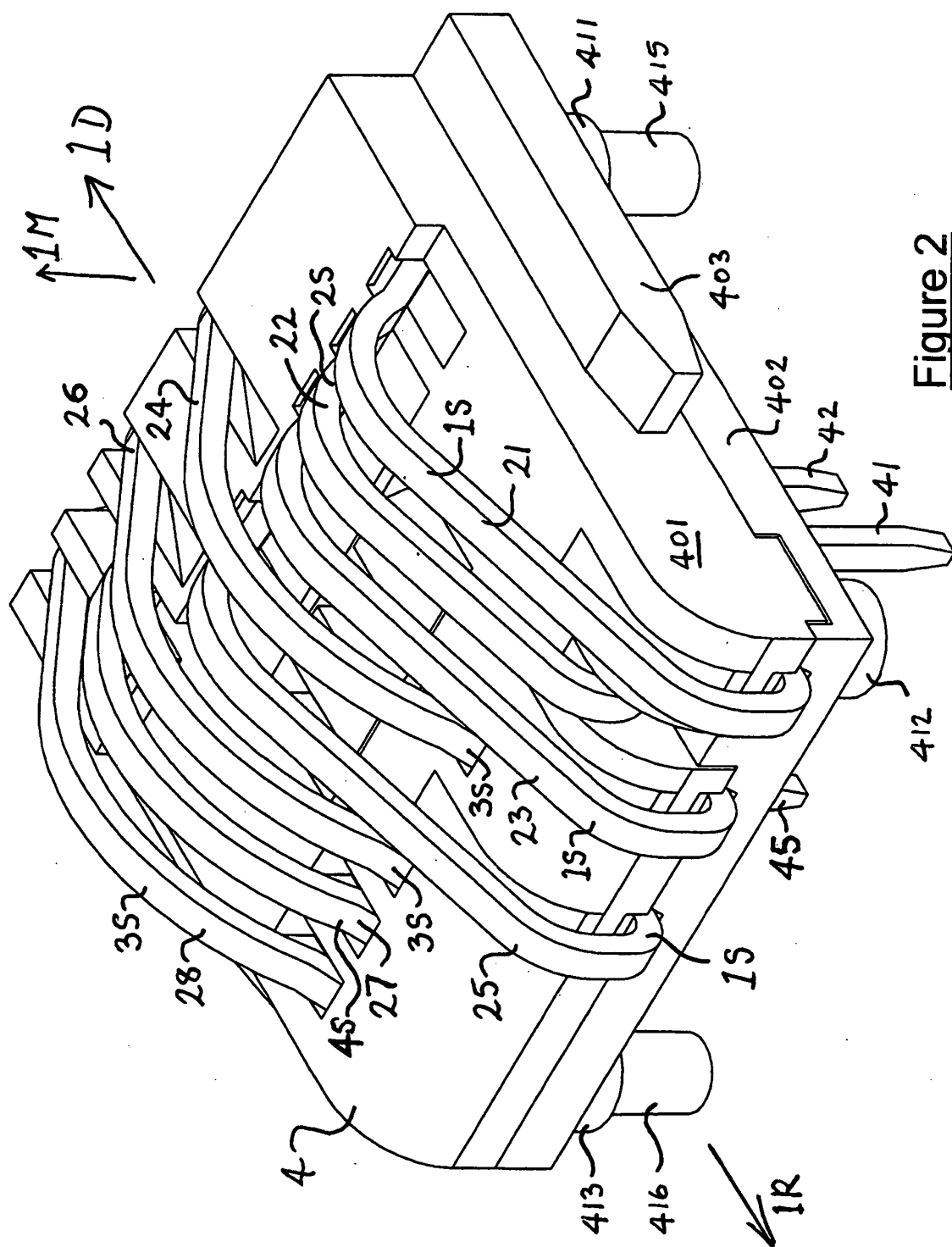


Figure 2

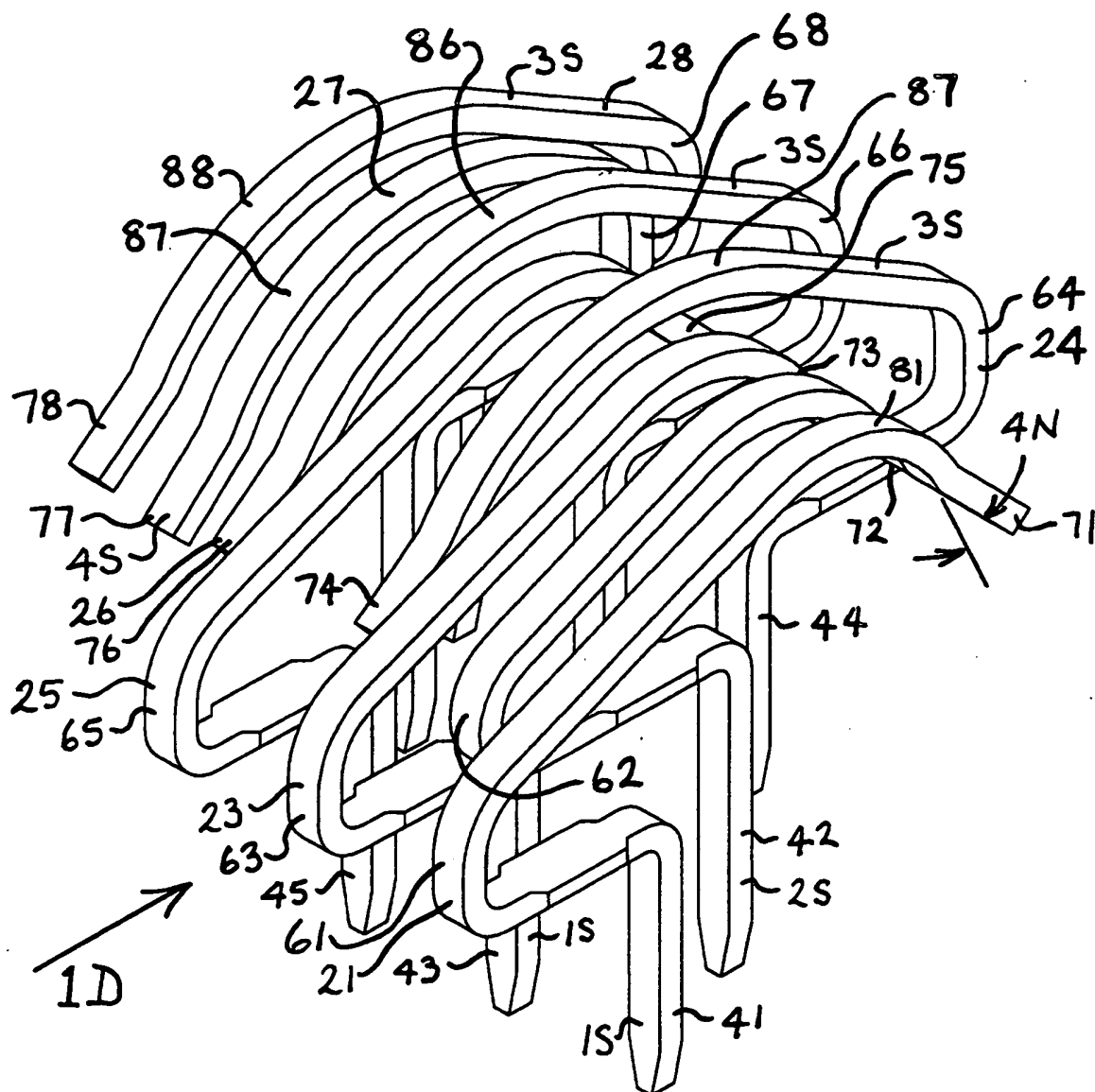


Figure 3

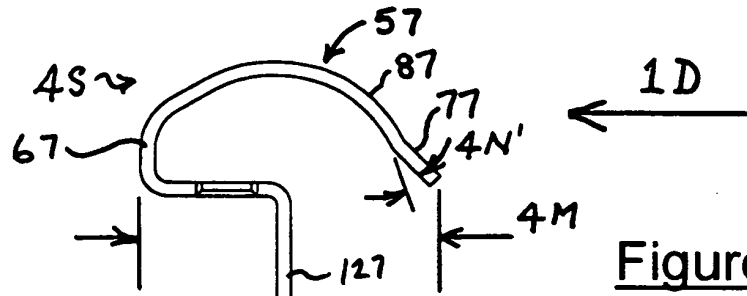


Figure 4D

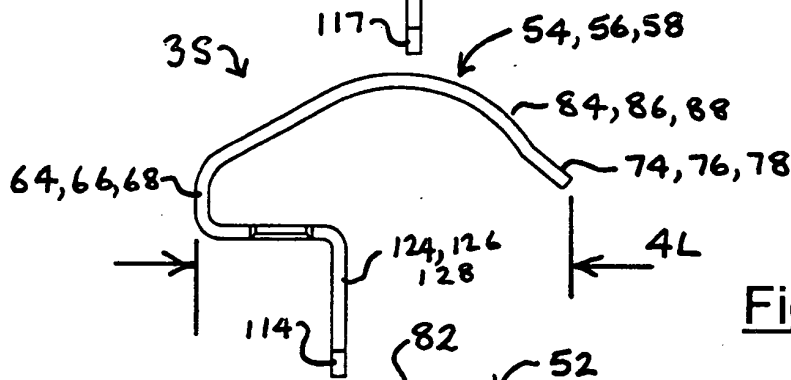


Figure 4C

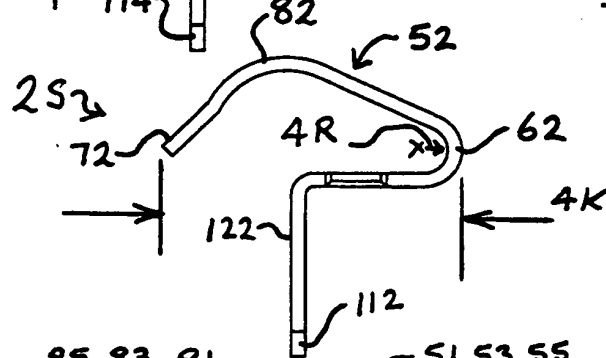


Figure 4B

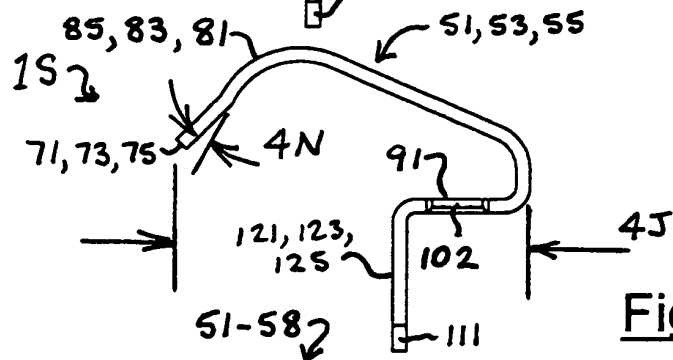


Figure 4A

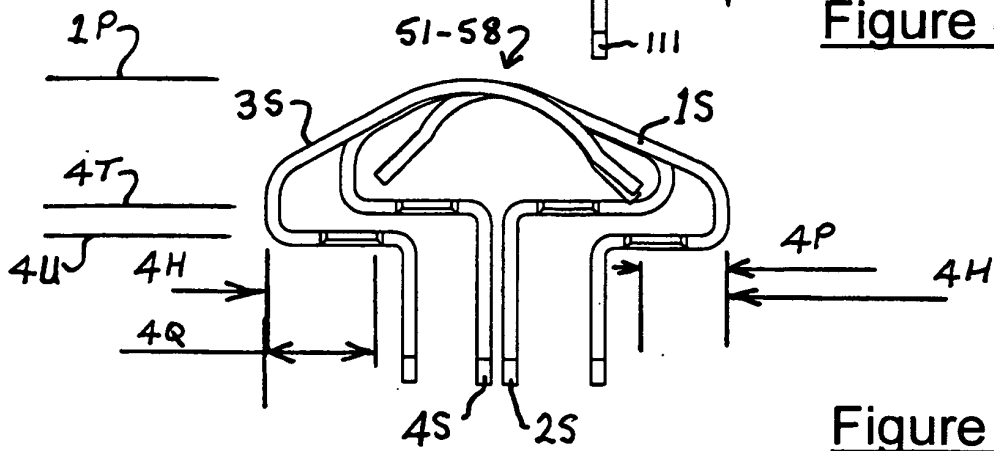


Figure 4

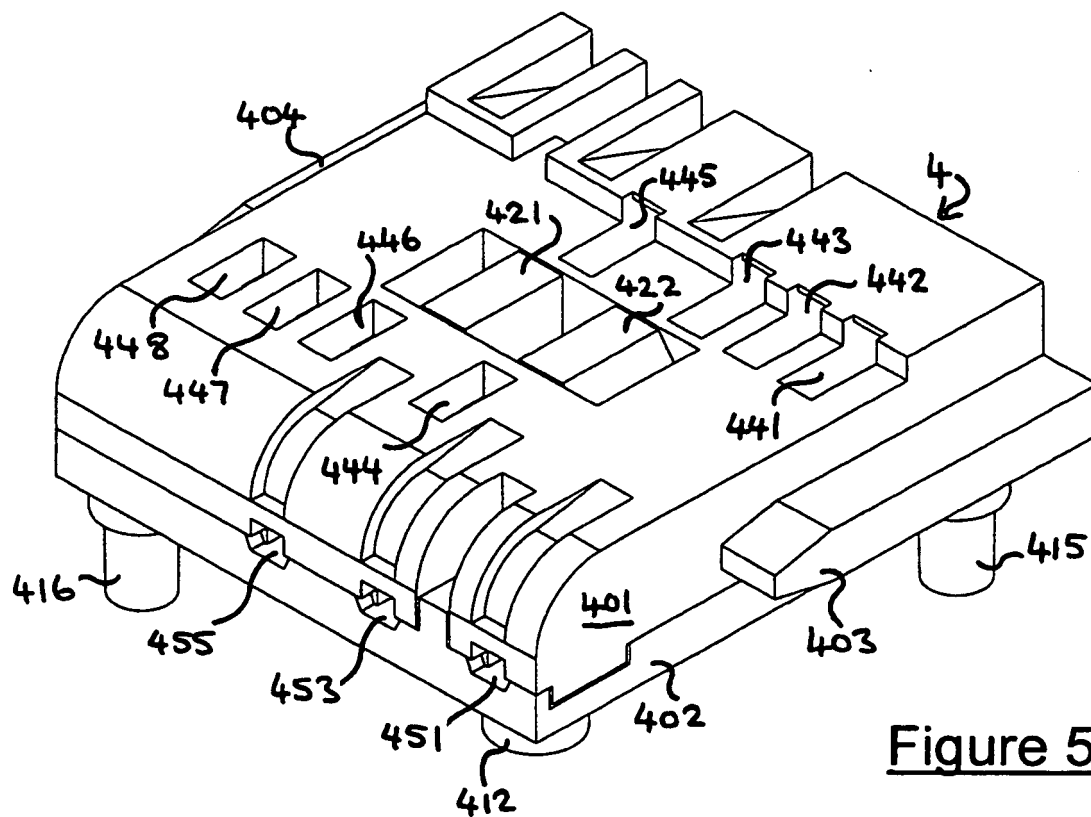


Figure 5

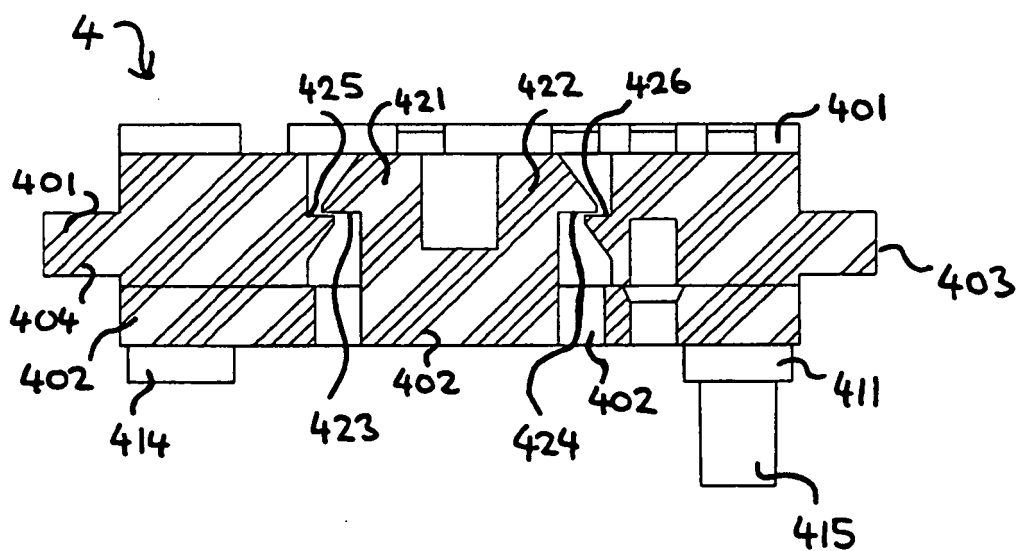


Figure 5A

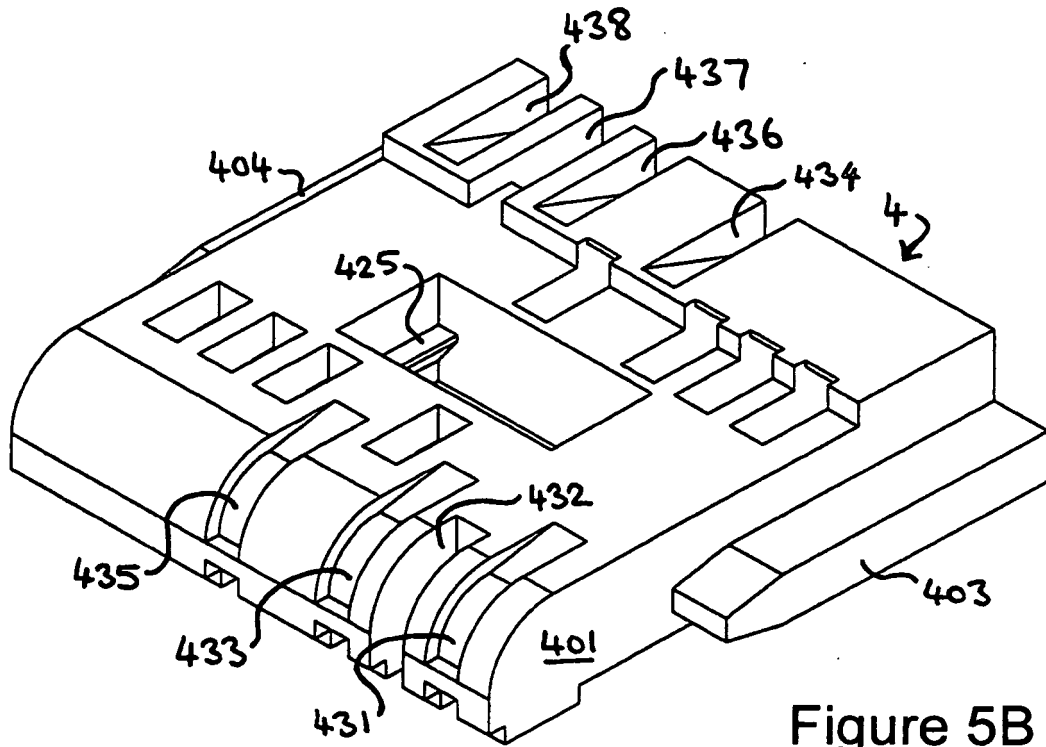


Figure 5B

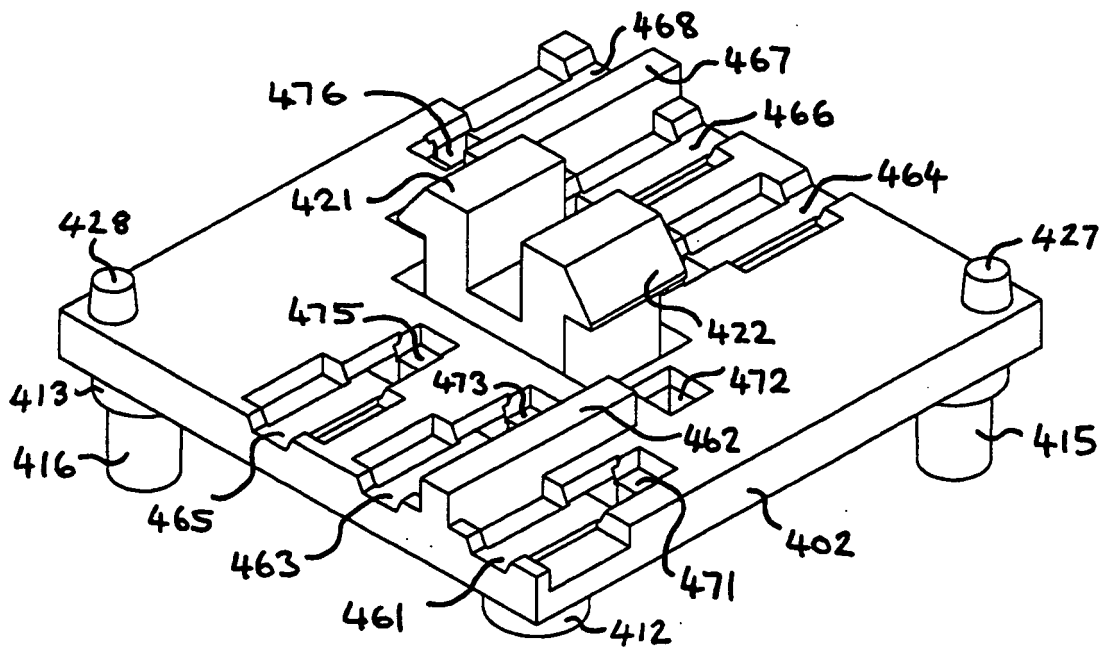


Figure 5C

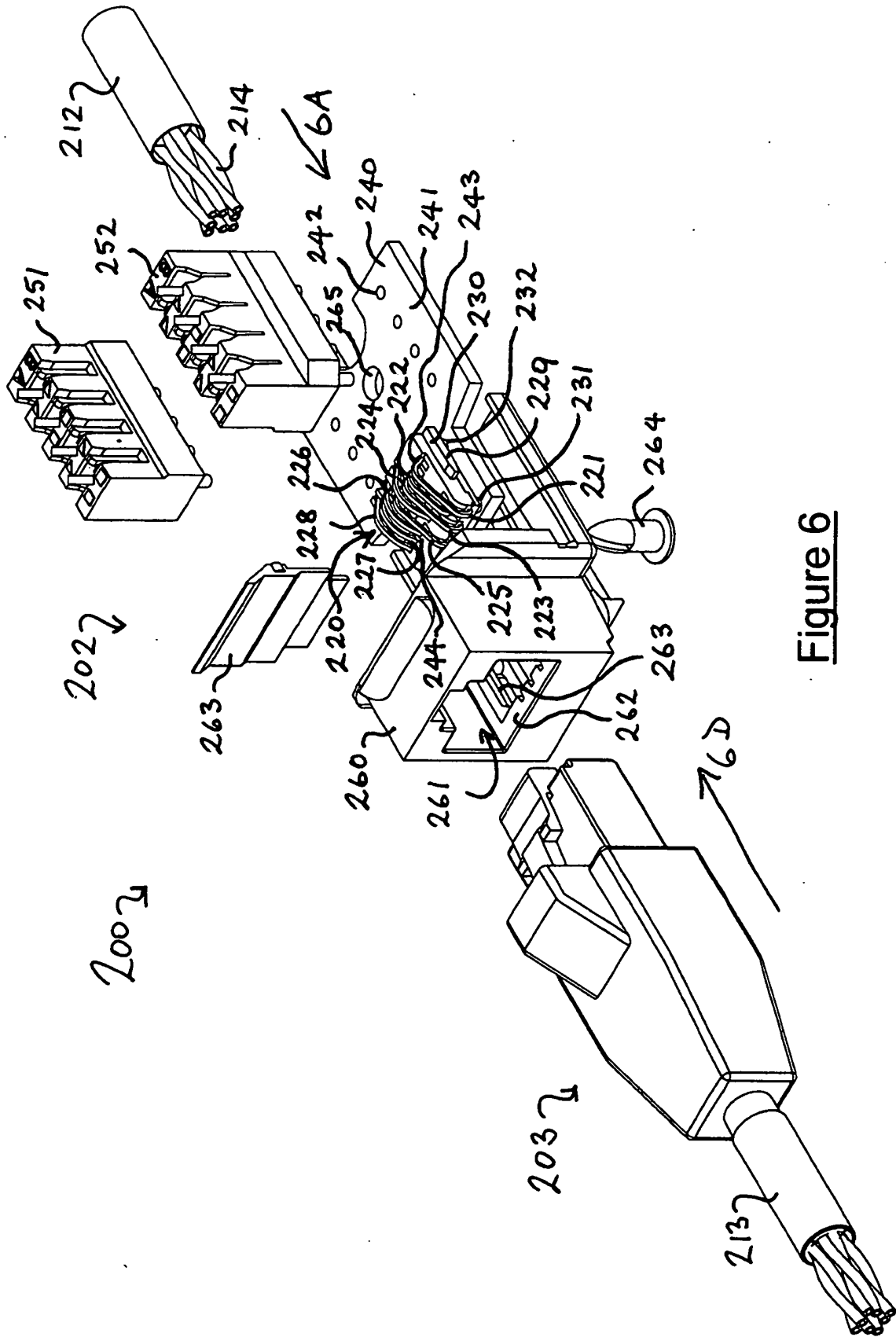
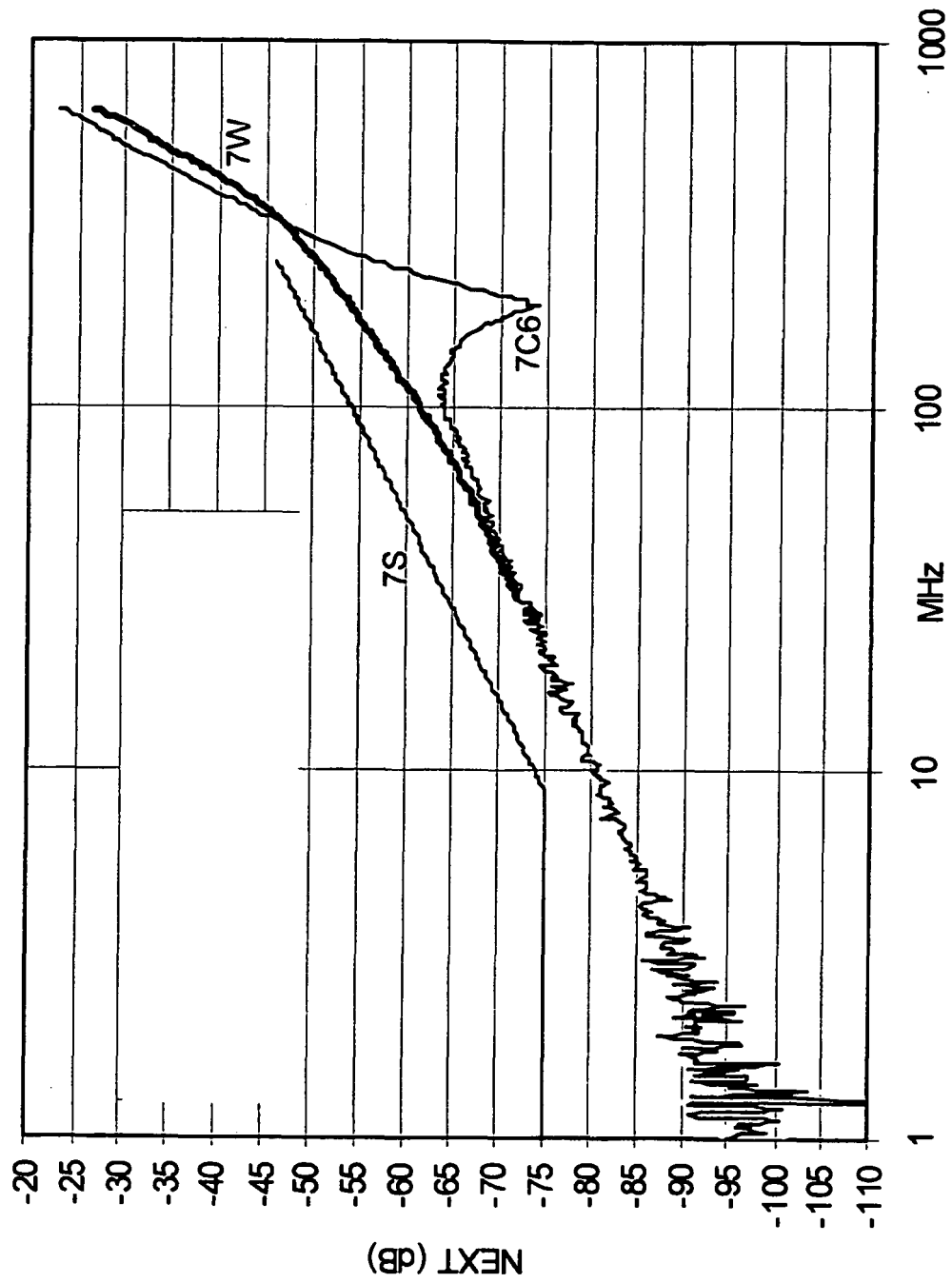


Figure 6

Figure 7

REFERENCES CITED IN THE DESCRIPTION

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