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

(57) A high frequency electrical connector (1) comprises a socket (2) and a plug (3). The plug is insertable into the socket in a first direction (1D), the socket and plug each having multiple electrical contacts (25, 26, 35) which are arranged to electrically interconnect the plug and socket. The socket has a base (4) for fixedly mounting a fixed end (42, 45, 46) of the contacts. The contacts have contact areas (55) arranged for electrically inter-

connecting to corresponding plug contacts, the contact areas being aligned so as to be parallel in a first dimension (1M) with the first direction (1D), and having a resiling portion (66) in-between the contact areas and the fixed ends (46), the socket contacts are formed in several different shapes (1S, 2S, 3S, 4S), wherein each shape has an at least partly arcuate contact area (81 to 88) and wherein a free end (76) of each contact is enclosed by the base (4).

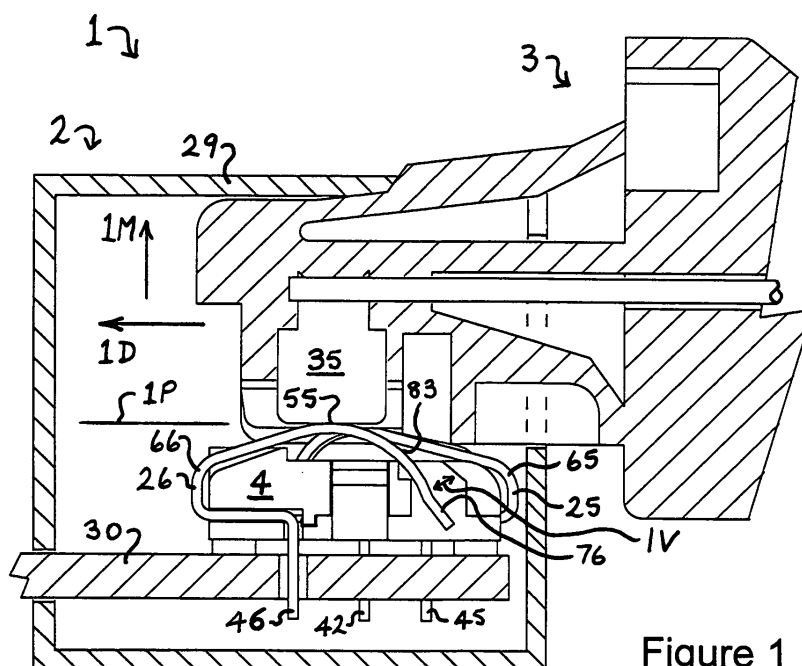


Figure 1

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 contacts, arranged so that all of the spring 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 contacts having different shapes.

[0006] 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 socket contacts having contact areas 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,

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

the socket contacts are formed in several different shapes,

wherein each shape has an at least partly arcuate contact area

5 and wherein a free end of each contact is enclosed by the base.

[0007] 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 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.

[0008] Preferably the base comprises at least an upper part and a lower part, each contact being arranged to mount between the upper part and lower part.

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

[0009] Preferably the upper and lower part clip together to retain the contacts.

A benefit of the upper and lower part clip together to retain the 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.

[0010] Preferably the free ends are enclosed under a portion of the upper part, and more preferably the fixed ends pass through the lower part.

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 contacts are protected during subsequent assembly operations and during the use of the socket when in service. A further benefit of the contacts at the fixed ends passing through the lower part is that the fixed ends are accurately and repeatably positioned ready for insertion into a circuit board for subsequently soldering.

[0011] Preferably at least one 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.

A benefit of at least one 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 contacts apart, while maintaining small overall dimensions.

[0012] Preferably all the arcuate contact areas are tangential to a contact plane passing through a point of contact between the contacts and the plug contacts when a plug is fully inserted into the socket.

A benefit of all the arcuate contact areas are tangential to a contact plane passing through a point of contact between the contacts and the plug contacts when a plug is fully inserted into the socket

[0013] Preferably a length of a shortest contact, measured in the first direction, is equal to or less than two thirds

of an overall length measured across all the contacts, the overall length measured in the same first direction. A benefit of a length of a shortest contact, measured in the first direction, is equal to or less than two thirds of an overall length measured across all the contacts

[0014] Preferably a minimum bend radius of the resiling portion is greater than 0.5mm.

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".

[0015] Preferably a plurality of the contacts have a substantially straight portion adjacent the fixed end, the substantially straight portion having a longitudinal axis parallel to the first direction.

A benefit of a plurality of the contacts have a substantially straight portion adjacent the fixed end, the substantially straight portion having a longitudinal axis parallel to the first direction.

[0016] Preferably the substantially straight portion has a wider portion, the wider portion being arranged to wedge in slots in the base.

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 contacts are held in place during the sub-assembly of the base.

[0017] Preferably the wider portion has a chamfered side facing in a direction of insertion of the contact into the lower part of the base, and a substantially flat side facing the opposite direction.

A benefit of the wider portion has a chamfered side facing in a direction of insertion of the 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.

[0018] Preferably the substantially straight portions of at least two 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.

A benefit of the substantially straight portions of at least two 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.

[0019] Preferably each contact further comprises a perpendicular straight portion in a plane substantially perpendicular to the first direction.

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

[0020] 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. 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.

[0021] 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.

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 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.

[0022] Preferably the contacts are arranged so that the perpendicular straight portions of at least three contacts lie on each of two of the perpendicular planes.

A benefit of the 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 contacts that are most susceptible to crosstalk may be kept furthest away from each other.

[0023] 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.

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.

[0024] Preferably said angle is greater than 15 degrees and less than 25 degrees.

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.

[0025] Preferably the free ends of at least one of the 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.

More preferably the free ends of each of the 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.

A benefit of the free ends of each of the 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 contacts.

[0026] 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.

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.

[0027] 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 contacts as shown in Figure 1, but with a second plug shown in a minimum permitted engagement with the contacts;

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

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

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

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

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

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

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

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

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

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.

[0028] 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.

[0029] 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 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.

[0030] 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 contact. The free end of each contact is enclosed by the base 4. Hence the socket may be arranged to have short 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.

[0031] 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.

[0032] 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 contacts in Figure 1 are shown resiliently deflected to their maximum amount 1V.

[0033] 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 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.

[0034] From Figure 2 the base 4 can be seen to comprise an upper part 401 and a lower part 402, each 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.

When the 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 contacts. Once clipped together the sub-assembly may be safely handled, and passed, for example, through a flow soldering process without risk that the contacts will be dislodged.

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

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 contacts 22 and 27 respectively are spaced apart from the contacts that are adjacent to them.

[0035] 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.

[0036] 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 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.

[0037] 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 contact is enclosed under a portion 449 of the upper part, the free end of each of the 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 contact, it would damage such a contact so that it would become unusable.

[0038] From Figures 2, 3 and 4 it can be seen that the contacts 21, 22, 23 and 25 have a free end facing substantially in the first direction 1D, and that the contacts 24, 26, 27 and 28 have a free end facing substantially in a direction 1R opposite to the first direction.

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

[0039] 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 contacts and the plug contacts when a plug is fully inserted into the socket.

Having arcuate contact areas that are tangential to a contact plane passing through a point of contact between the contacts and the plug contacts when a plug is fully inserted into the socket, reduces a variability in the positions taken-up by the 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.

[0040] From Figures 4B and 4D a length 4K and 4M of a short contact, measured in the first direction, is equal to or less than two thirds of an overall length 4H measured across all the contacts, the overall length measured in the same first direction 1D.

[0041] 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.

[0042] The 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 par-

allel to the first direction 1D. The straight portions provide good location within the base for the 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.

[0043] The substantially straight portions of at least two contacts 22 and 27 are arranged on a high plane 4T parallel to the contact plane 1P, and the straight portion of contacts 21, 23, 24, 25, 26, and 28 being arranged on a low plane 4U parallel to the contact plane.

By arranging 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.

[0044] 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.

[0045] 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 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 contacts that are most susceptible to crosstalk may be kept furthest away from each other.

[0046] 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.

[0047] 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 contacts short, and hence the free ends may be positioned further away from adjacent resiling portions of adjacent contacts where these face in the opposite direction.

[0048] 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 contact, the point of inflection is between the contact area and the free end of the contact.

[0049] 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.

[0050] Hence in the preferred embodiment the free ends of each of the 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.

[0051] For improved electrical performance of the connector 1, socket contacts have been orientated in the following position to achieve the required performance. Coupling between contacts 23 & 25, and 23 & 21 is strongly desired so these contacts have the same profile to provide maximum coupling. Coupling between contacts 26 & 24 and 26 & 28 is also strongly desired so again these contacts have the same profile. No coupling between 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.

[0052] Hence the negative effect on crosstalk introduced by the contacts of 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 10GbseT applications since plug NEXT cancellation begins earlier.

[0053] 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.

[0054] 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.

[0055] 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 contacts 221 to 228 mounted to a base 230. All free ends of the contacts 223 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 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 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.

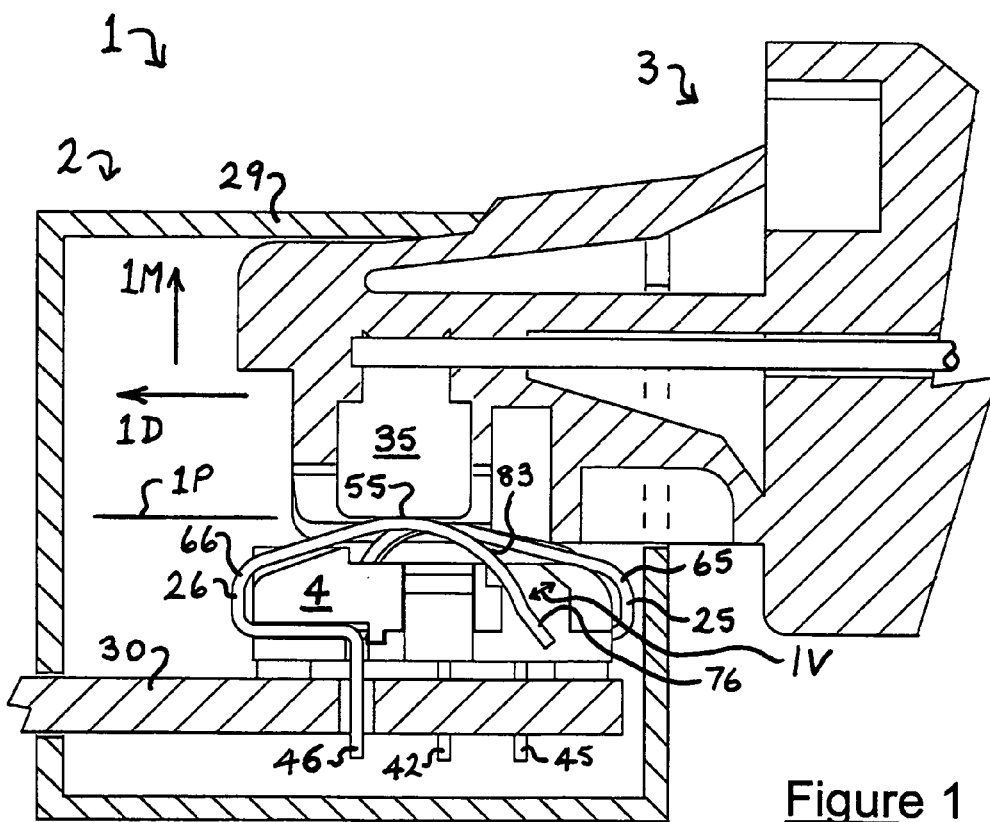
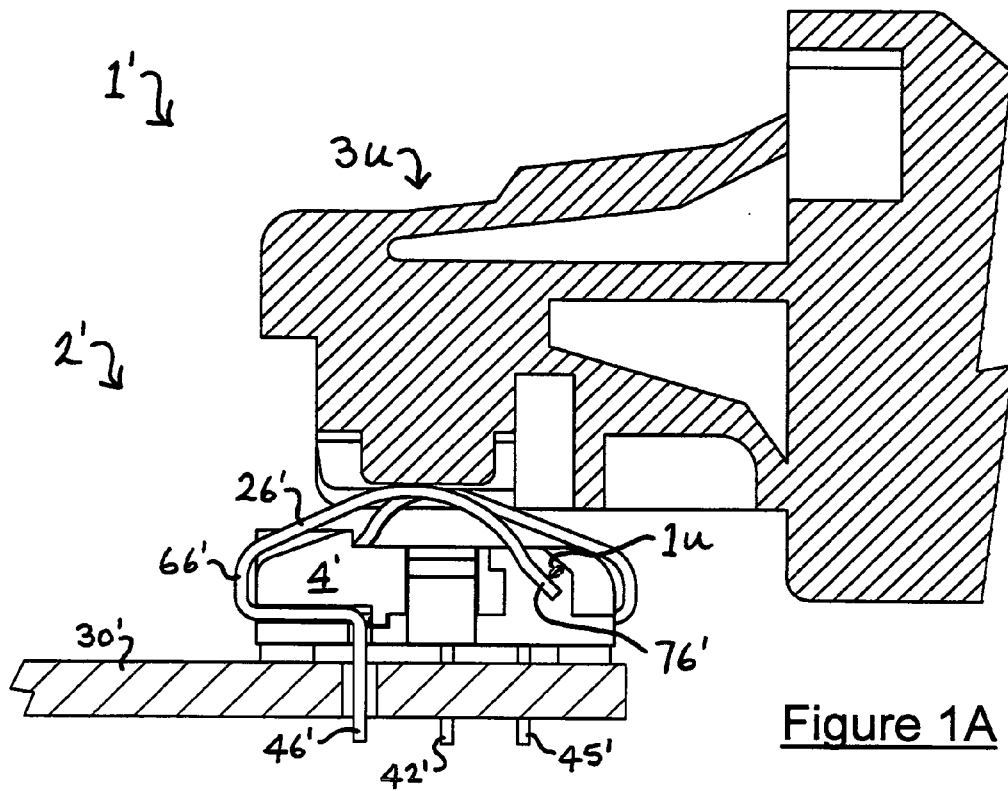
Claims

1. A high frequency electrical connector 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 socket contacts having contact areas 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,
and having a resiling portion in-between the contact areas and the fixed ends,
the socket contacts are formed in several different shapes,
wherein each shape has an at least partly arcuate contact area
and wherein a free end of each 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 and a lower part, each contact 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 contacts.
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 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.
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 of the upper part.
7. A high frequency electrical connector as claimed any one of claims 2 to 6 when dependent on claim 2, wherein the contacts at the fixed ends pass through the lower part.
8. A high frequency electrical connector as claimed in any one of the preceding claims, wherein all the arcuate contact areas are tangential to a contact plane passing through a point of contact between the 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 of a shortest contact, measured in the first direction, is equal to or less than two thirds of an overall length measured across all the contacts, 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 of the resiling portion 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 contacts have a substantially straight portion adjacent the fixed end, 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, the wider portion being arranged to wedge in slots in the base.

- 13.** A high frequency electrical connector as claimed in claim 12, wherein the wider portion has a chamfered side facing in a direction of insertion of the contact into the lower part of the base, and a substantially flat side facing the opposite direction. 5
- 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 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. 10
- 15.** A high frequency electrical connector as claimed in any one of the preceding claims, wherein each contact further comprises a perpendicular straight portion in a plane substantially perpendicular to the first direction. 15
- 16.** A high frequency electrical connector as claimed in claim 15, wherein the perpendicular straight portions each have chamfered ends at an end of the fixed end. 20
- 17.** A high frequency electrical connector as claimed in claim 15 or 16, wherein the perpendicular straight portions are arranged to pass through the base to a circuit board in four different perpendicular planes, each plane being perpendicular to the first direction. 25
- 18.** A high frequency electrical connector as claimed in claim 17, wherein the contacts are arranged so that the perpendicular straight portions of at least three contacts lie on each of two of the perpendicular planes. 30
- 19.** A high frequency electrical connector as claimed in any one of the preceding claims, wherein each free end comprises a substantially straight portion, arranged at an angle to a tangent extending from an end of the arcuate contact areas. 35
- 20.** A high frequency electrical connector as claimed in claim 19, wherein said angle is greater than 15 degrees and less than 25 degrees. 40
- 21.** A high frequency electrical connector as claimed any one of the preceding claims, wherein the free end of at least one of the 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. 45
- 22.** A high frequency electrical connector as claimed in any of claims 1 to 20, wherein the free ends of each of the 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. 50
- 23.** A high frequency electrical connector as claimed in any of the preceding claims, wherein the base and the circuit board are arranged so that there is a gap between a or the circuit board and the base. 55
- 24.** A high frequency electrical connector, substantially as hereinbefore described and with reference to the accompanying drawings.
- 25.** A socket for the high frequency electrical connector of any one of claims 1 to 24.



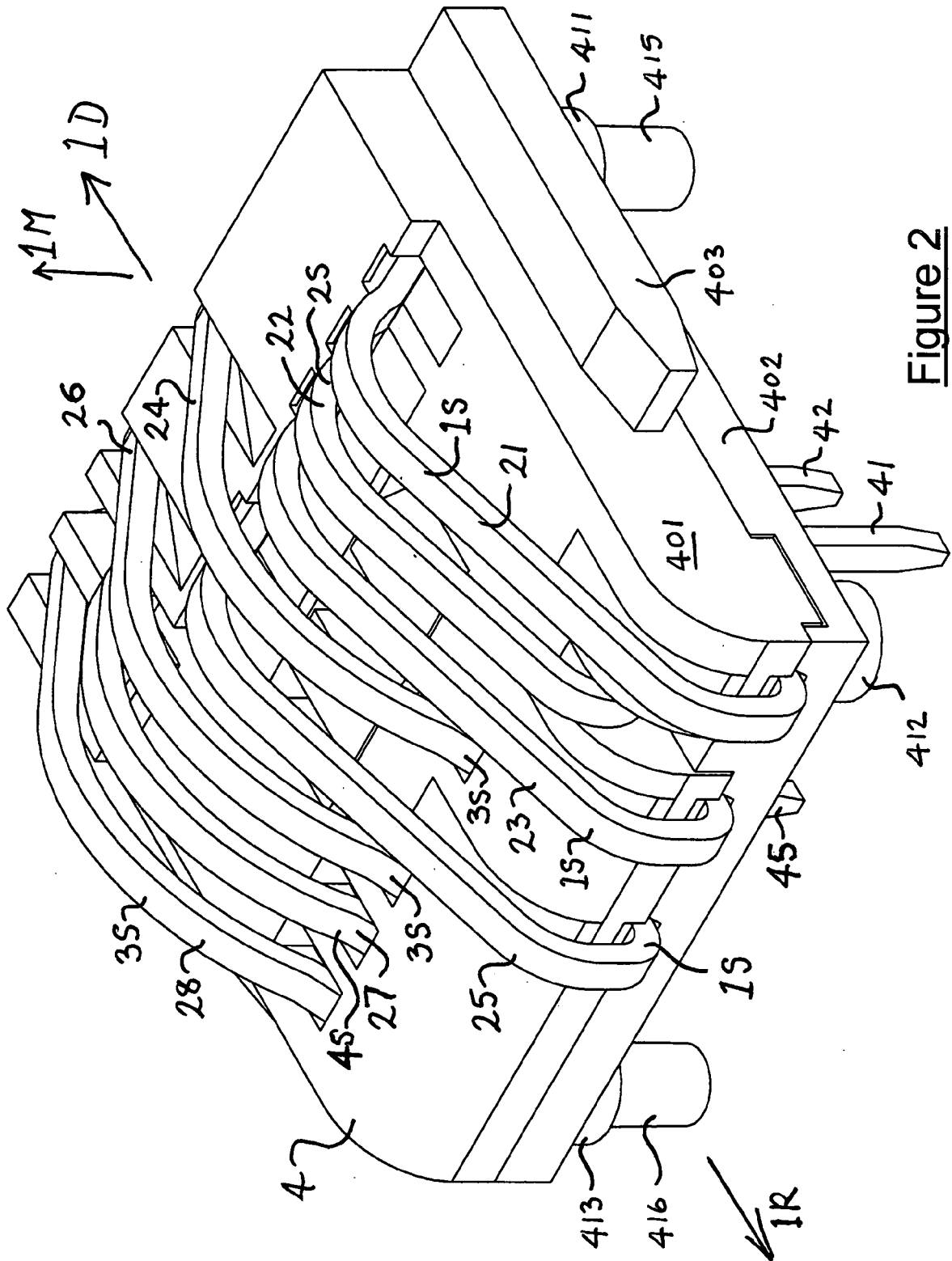


Figure 2

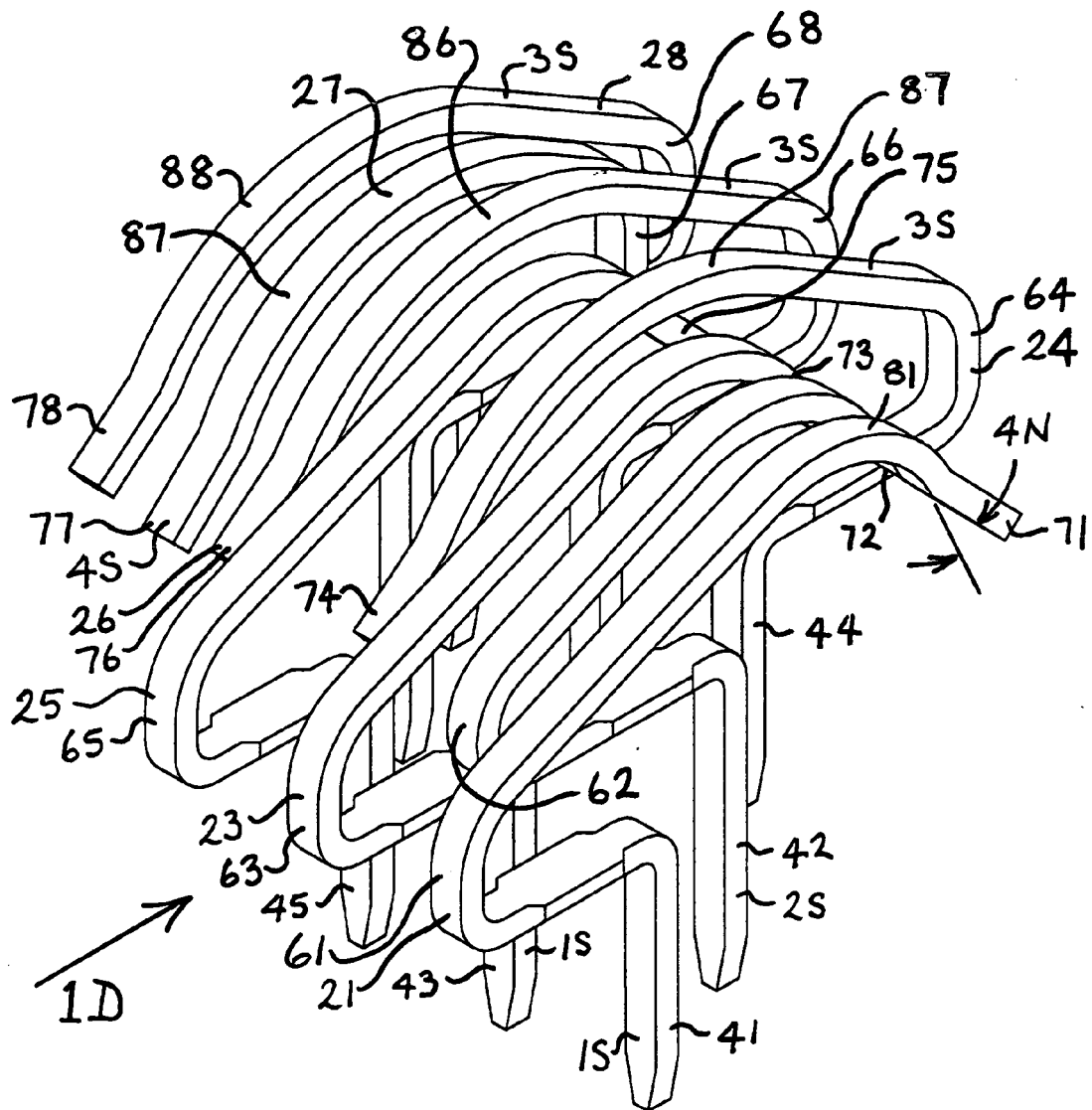


Figure 3

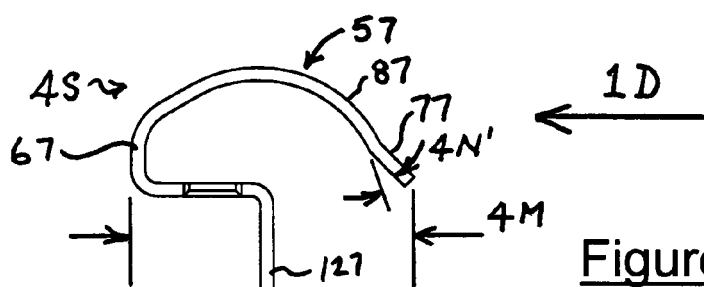


Figure 4D

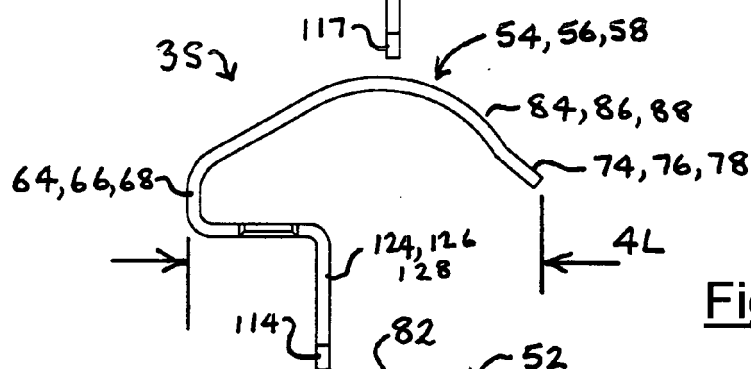


Figure 4C

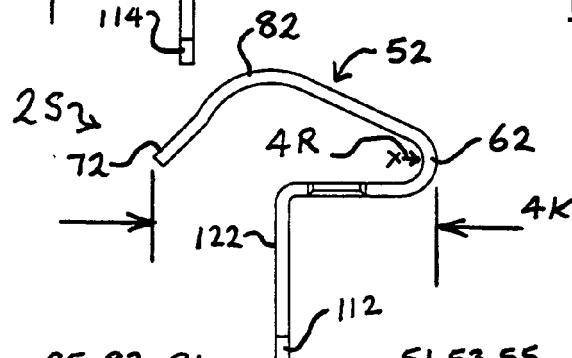


Figure 4B

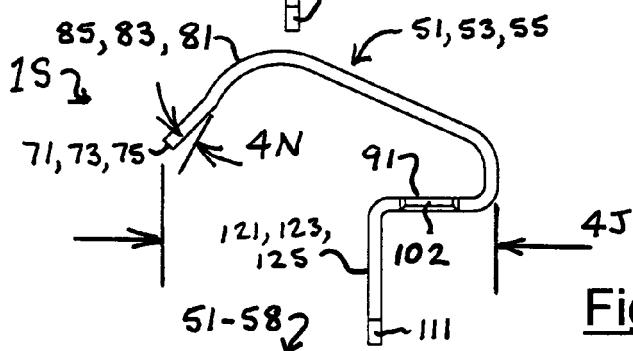


Figure 4A

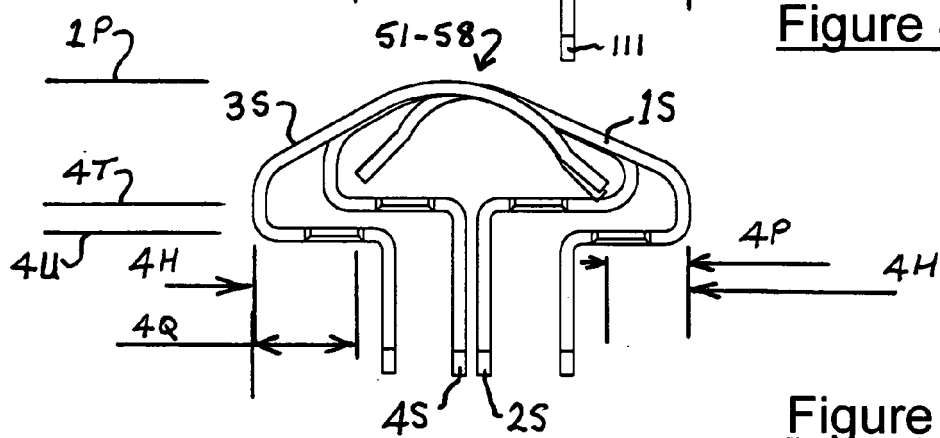
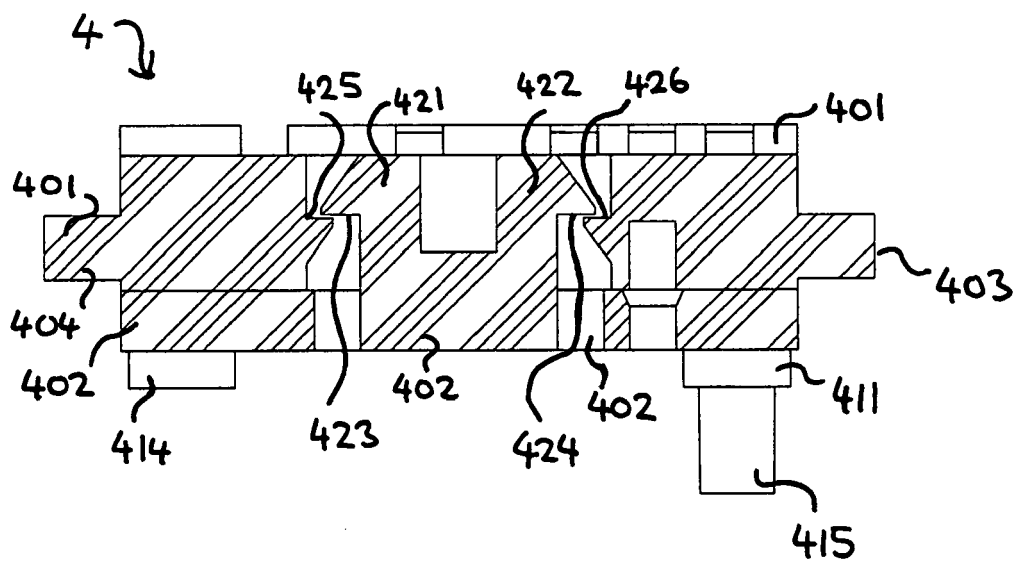
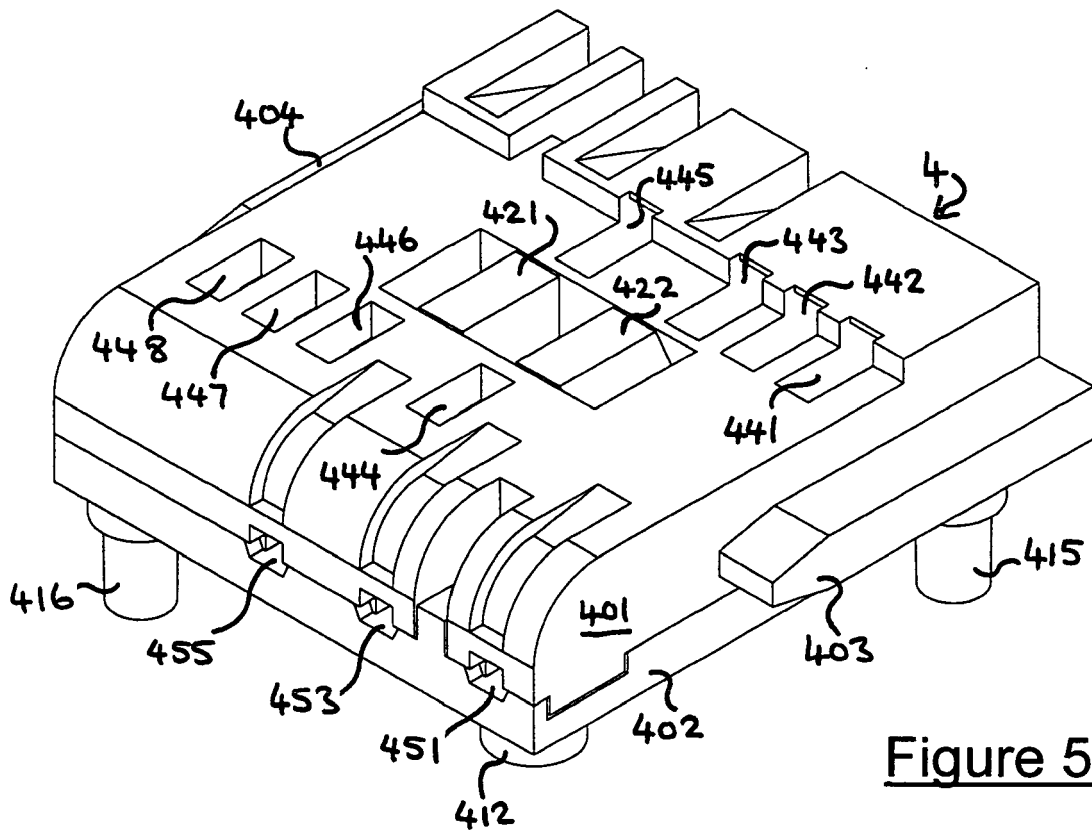


Figure 4



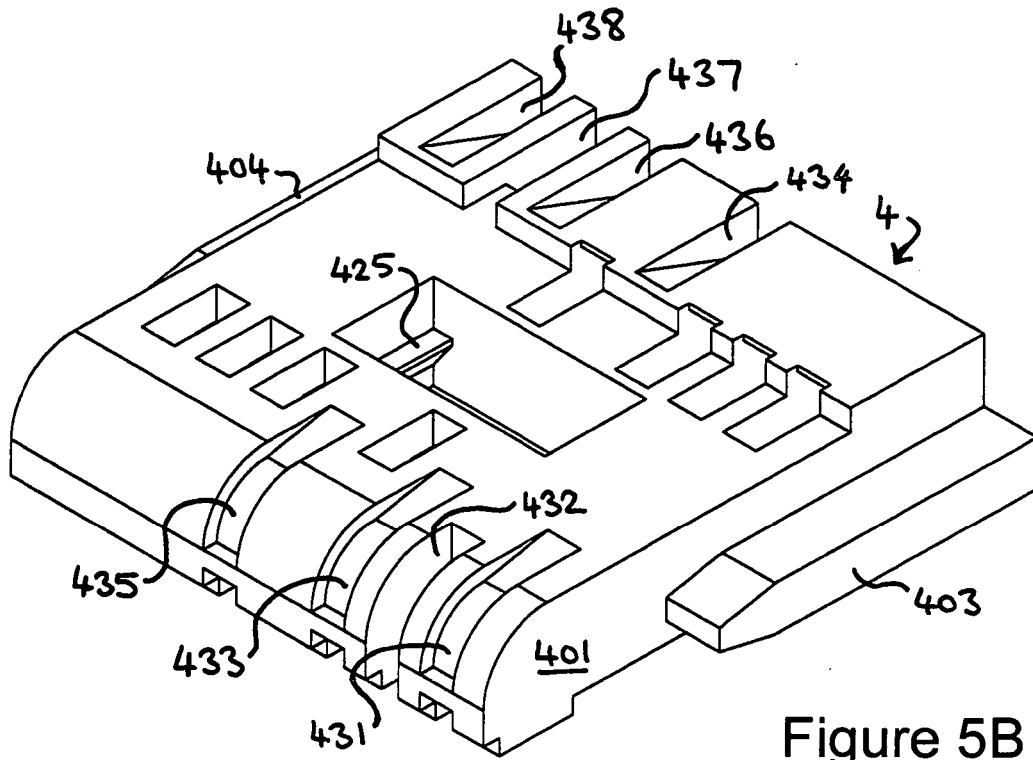


Figure 5B

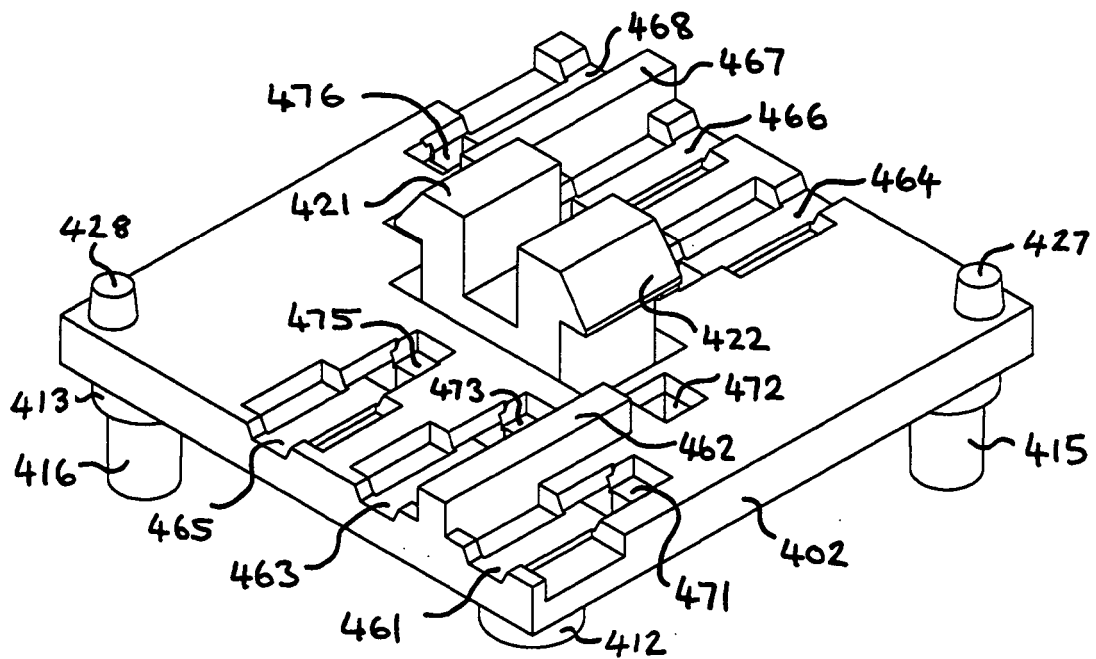


Figure 5C

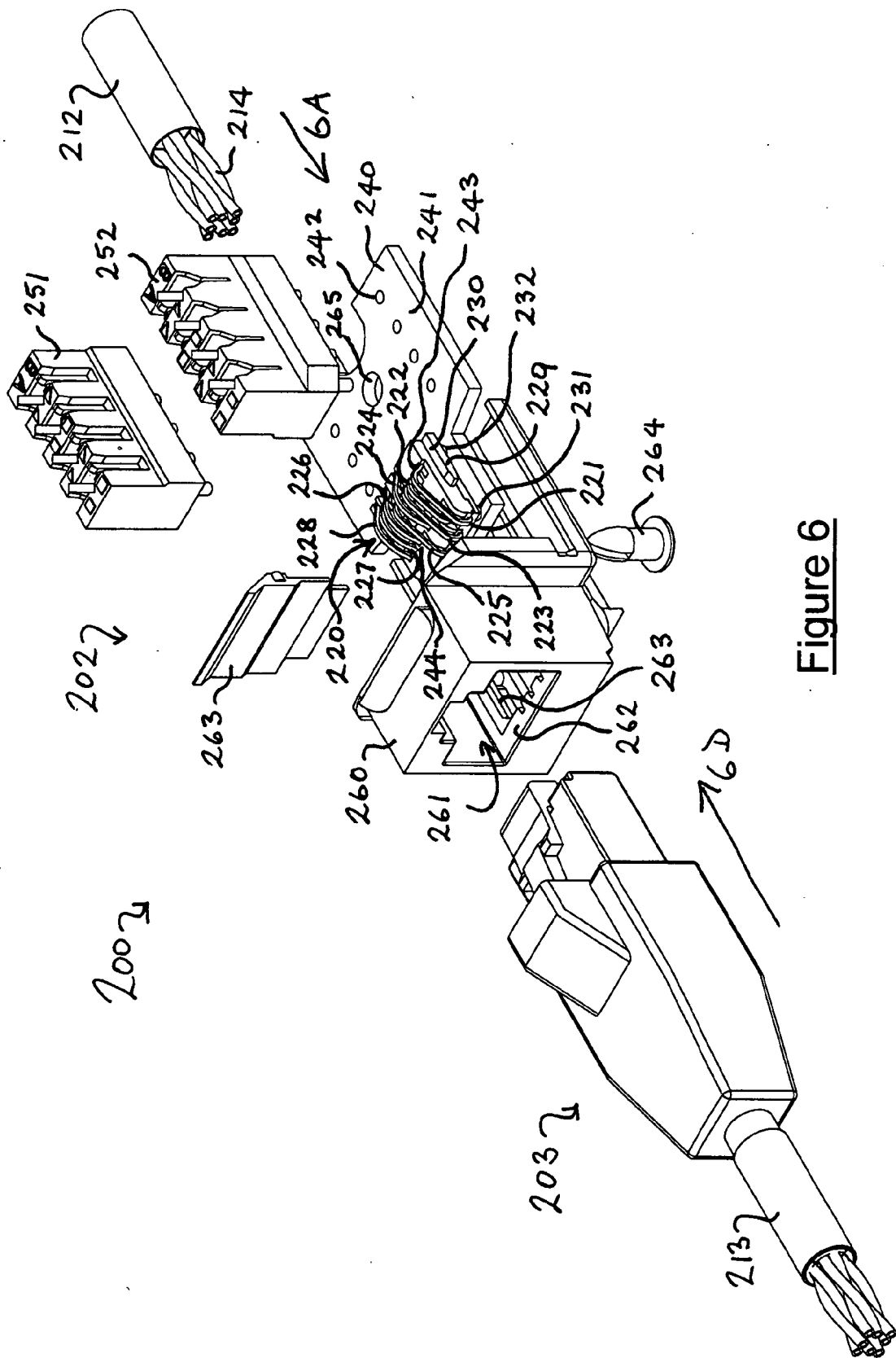


Figure 6

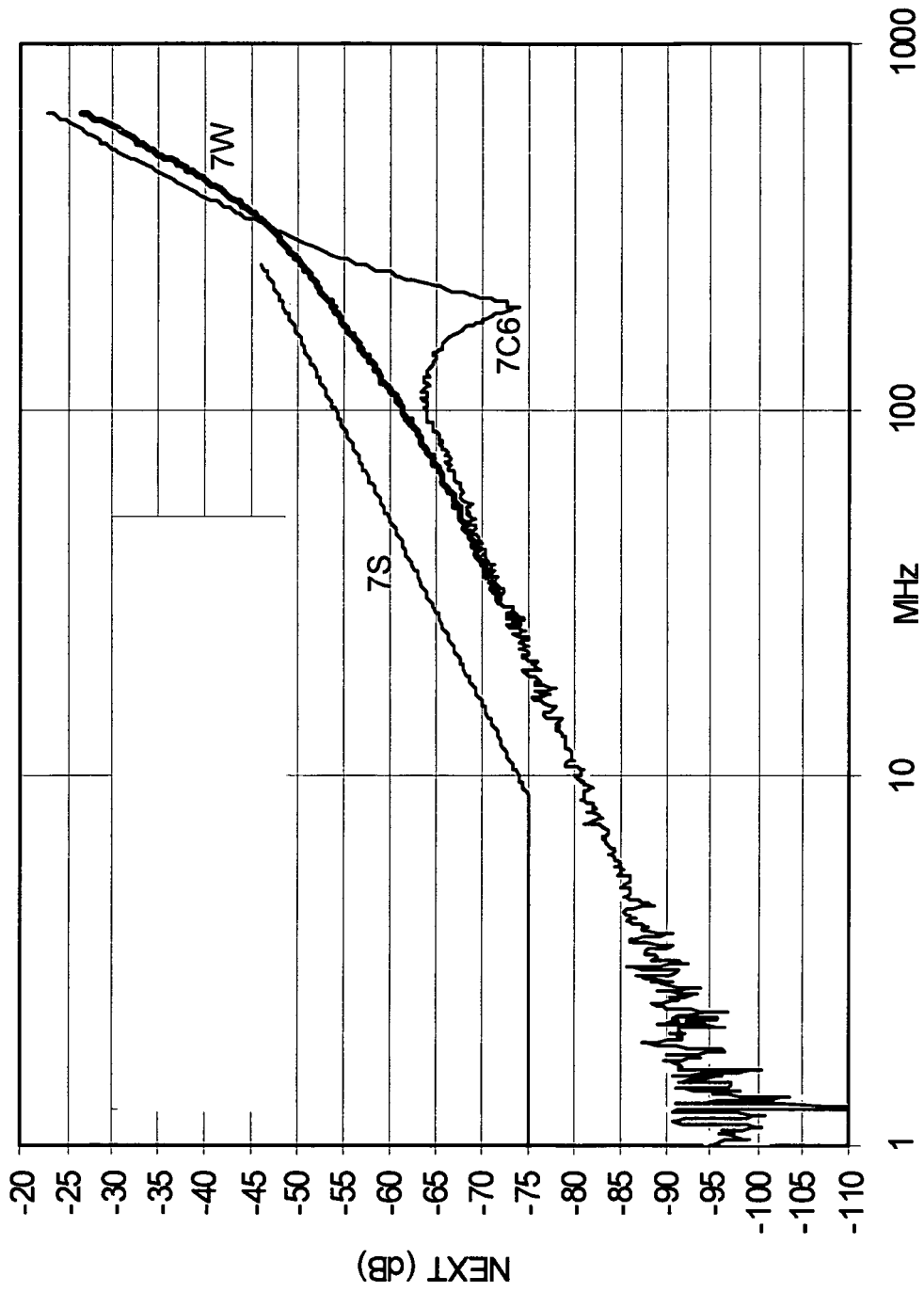


Figure 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- GB 2393858 A [0005]