



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
13.05.2026 Bulletin 2026/20

(21) Application number: **24211201.9**

(22) Date of filing: **06.11.2024**

(51) International Patent Classification (IPC):
H01R 12/71 ^(2011.01) **H01R 12/79** ^(2011.01)
H01R 13/405 ^(2006.01) **H01R 13/6587** ^(2011.01)
H01R 13/6591 ^(2011.01) **H01R 13/6594** ^(2011.01)
H01R 43/24 ^(2006.01)

(52) Cooperative Patent Classification (CPC):
H01R 12/79; H01R 12/716; H01R 13/405;
H01R 13/6587; H01R 13/65914; H01R 13/6594;
H01R 43/24

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

(71) Applicant: **TE Connectivity Nederland B.V.**
5222 AR 's-Hertogenbosch (NL)

(72) Inventors:
• **TUIN, Jacobus Nicolaas**
5222 AR 's-Hertogenbosch (NL)
• **SMINK, Rutger Wilhelmus**
5222 AR 's-Hertogenbosch (NL)

(74) Representative: **Grünecker Patent- und**
Rechtsanwälte
PartG mbB
Leopoldstraße 4
80802 München (DE)

(54) **ELECTRICAL CONNECTOR AND SUBASSEMBLY FOR DIFFERENTIAL SIGNALS**

(57) An electrical connector (100) is disclosed, for connecting one or more differential pair cables (690) to a circuit board (670). The electrical connector (100) includes one or more terminal pairs; and overmolds for each terminal pair, the overmolds covering a portion of the respective terminal pair between distal ends and proximal ends of the respective terminal pair. The prox-

imal ends of the terminals project out of the overmolds in a mating direction (199) toward the circuit board (670). A pair of conductive leads are at opposite sides of each overmold. The electrical connector (100) includes a shield 150 for shielding the terminal pairs and a holder (610) for handling. A subassembly for forming the connector (111) is also disclosed.

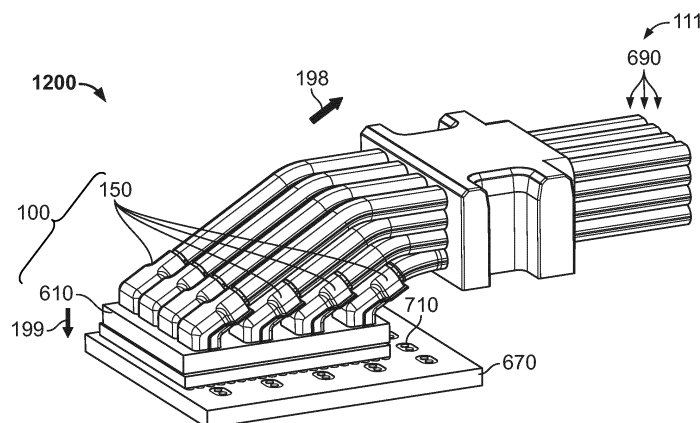


Fig. 1

Description

[0001] Electrical connectors are used for enabling data communication between devices at various interfaces. Electrical connectors can be used to connect cables to circuit boards.

[0002] It is desirable to reduce electrical devices' sensitivity to vibration or shock. It is also desirable to make electrical devices small. It is desirable to shield electrical connectors and/or devices from noise, such as noise that could be picked up at a connection. It is also desirable to keep manufacturing costs low; simplify assembly and/or disassembly procedures; and ensure robust electrical contact between contacting elements. The ability to routinely make robust low-noise electrical connections with reduced sensitivity to noise can be important for fast data transfer.

[0003] The use of differential signaling can reduce susceptibility to noise. Connections to differential pair cabling, particularly multiple differential pair cables, can benefit from inventive ways of reducing noise and/or providing robust connections, e.g. between differential pair cables and a circuit board.

[0004] Herein is disclosed an electrical connector which can be used for connecting one or more differential pair cables to a circuit board, and method of manufacture thereof. The electrical connector may include one or more connector subassemblies, as described herein. A header, as described herein, can be used to connect the electrical connector to a circuit board.

[0005] A connector subassembly for an electrical connector is disclosed, including a terminal pair; an overmold, through which the terminal pair extends; and a pair of conductive leads at opposite sides of the overmold. The conductive leads can provide a connection surface for a shield and/or shielding of a cable. The proximal end of the terminal pair projects out of the overmold in a mating direction. The overmold can aid in physically supporting the terminal pairs and/or conductive leads. The proximal direction can have a component along the mating direction, and can include a component pointing below the overmold from above. There can be a pair of channels in the overmolds for the terminal pairs. The overmold can go between terminal pairs. The terminal pairs can abut walls of the channels. The subassembly can include a lead frame that includes the conductive leads and a bridge that connects the distal ends of the conductive leads. The distal direction can be toward the cable side. The proximal direction can be the header/circuit board side.

[0006] Connector subassemblies, electrical connectors, and methods of manufacture can include the following further developments and/or embodiments, which can be combined singly or multiply, independently of each other unless indicated otherwise, for further embodiments. The invention is defined by the claims.

[0007] The terminal pair can include a curve such that a distal end of the terminal pair extends along a second mating direction which is oblique to the mating direction, e.g. the mating direction at the proximal end. The proximal end and distal end of the terminal pair can extend along different directions, e.g. due to the curve of the terminal pair which can be between the ends. A distal direction can be opposite to the proximal direction, and/or include a vector component that points in the same direction as above the overmold from below. The curve can allow the cables to extend at an oblique angle to the connector/subassembly, and may save space.

[0008] The curve of the terminal pair can be at least partially within the overmold. The terminal pair can include a curve distal to the bottom of the overmolds. Optionally, the curve of the terminal pair is at least partially covered by the overmolds. The overmold can physically support the curved region of the terminal pair.

[0009] The conductive leads can include a curve which is parallel to the curve of the terminal pair. The parallel curves can aid in alignment of the cable to be attached to the subassembly. Alternatively/additionally, the parallel curves can simplify the formation of the subassembly. The conductive leads can be parallel to the terminal pair. The curves of the conductive leads can be at opposite lateral sides of the overmolds. The terminal pair and conductive leads can be at least partially parallel; for example, be parallel in a region covered by the overmold, the curved region. The distal ends of the terminal pair and conductive leads, e.g. projecting from the overmold along the second mating direction, can be parallel.

[0010] The proximal end of the terminal pair can project along the mating direction farther than the conductive leads. This can aid in allowing electrical contact at the proximal side of the subassembly. For example, the conductive leads extend to the bottom of the lateral sides of the overmold. The interaction of the conductive leads and lateral sides of the overmold can aid in physically stabilizing the subassembly, e.g. during manufacture. The conductive leads can extend farther distally than the distal ends of the terminal pair. The distal ends of the conductive leads can be used to attach to a shield and/or shielding of a cable.

[0011] The conductive leads can include inner surfaces that face the terminal pair and abut the respective opposite sides of the overmold. The opposite sides of the overmold can include recesses that abut the inner surfaces of the conductive leads. The interaction of the conductive leads and lateral sides of the overmold can aid in physically stabilizing the subassembly, e.g. during manufacture.

[0012] The proximal ends of the terminal pair can be curved to present an inclining surface at the proximal tip of the terminal pair. The proximal ends can present a contact surface for lateral contact with a mating pin pair, e.g. a pin pair. This can aid in making robust electrical contact on the proximal side of the subassembly and/or simplify manufacturing of a connector assembly.

[0013] The connector subassembly can include a shield forming a cavity in which the overmold is disposed. The shield

can reduce noise being picked up by the terminal pairs. Overmolds in cavities can aid in physical separation between neighboring terminal pairs. The shield can include an upper shield and a lower shield; and the upper shield can attach to an upper surface of the conductive leads and/or the lower shield can attach to a lower surface of the conductive leads. The lower shield can extend farther proximally along the mating direction than the upper shield. A multipart shield can simplify assembly, and/or allow for robust multidirectional shielding from environmental noise.

[0014] Herein is disclosed a connector. The connector can include a plurality of connector subassemblies as disclosed herein, and at least one shield forming at least one respective cavity. Each of the respective connector subassemblies can be disposed in each respective cavity. Overmolds and terminal pairs being disposed in respective cavities can aid in physical separation between neighboring terminal pairs. Cross-talk can be reduced.

[0015] Herein is disclosed a connector that includes a plurality of connector subassemblies as disclosed herein, and a shield which includes a row of cavities. Each terminal of the terminal pairs can be along the row. The conductive leads can include immediately neighboring conductive leads between adjacent overmolds of the subassemblies. The overmolds can be separate from each other. The immediately neighboring conductive leads can be connected, e.g. monolithic and/or monolithically formed. Organizing the connector to have rows of subassemblies can allow multiple cable connections to take up less space, and/or allow for multichannel connections.

[0016] The conductive leads between adjacent subassemblies of the row can be monolithically formed. Upper shields can be monolithically connected and lower shields can be monolithically connected. Monolithic leads can be mechanically robust and/or can ease manufacture.

[0017] The overmolds of the plurality of subassemblies can be discrete overmolds, separate from each other. Having discrete overmolds can aid in reducing cross-talk between neighboring terminal pairs and/or reduce sensitivity to environmental noise. Organizing the connector to have rows of subassemblies can allow multiple cable connections to take up less space, and/or allow for multichannel connections.

[0018] The connector can include a holder, which can be planar, which holds the shield or the at least one shield such that the shield or at least one shield projects upward from the holder. The terminal pairs can be accessible from the bottom of the holder. The holder can provide mechanical stability.

[0019] The holder can include through-holes providing access to the proximal ends of the terminal pair from the bottom of the holder. Through-holes are convenient for allowing the shields to be effective.

[0020] A plurality of cables can attach, respectively, to the subassemblies. The respective electrical connections can include: connections between the conductive leads and respective cable shielding, and/or connections between the terminal pair and respective wires of the cables. At the respective electrical connections, the cables can extend along the second mating direction.

[0021] Herein, a header is disclosed, including a housing extending in a plane, and a plurality of sets of fingers extending out of the plane. The distal ends of the fingers can be elastically deformable in directions parallel to the plane. The header can include a plurality of spacers, each spacer being surrounded by a respective set of the sets of fingers. The spacers can be configured to pass along a direction perpendicular to the plane, at least one of a terminal pair or a pin pair. The distal ends of the fingers of the sets of fingers can mate with a shield of a connector. The header can facilitate connection to a circuit board of one or more cables, e.g. cables of a connector.

[0022] Herein is disclosed a connection assembly, including a header as described herein, a connector as described herein, a circuit board, and a plurality of pin pairs in electrical contact with the circuit board and respective terminal pairs. The pin pairs can extend along the mating direction and/or through the circuit board.

[0023] Herein is disclosed a method of forming an electrical connector, including: stamping and bending a metal sheet to form a lead frame including a plurality of terminal pairs and plurality of leads; forming a plurality of overmolds, the overmolds covering a respective terminal pair of the terminal pairs between a distal end and a proximal end of the respective terminal pair such that the proximal ends of the terminal pairs extend below the overmolds; stamping and bending at least one additional metal sheet; and welding the at least one additional metal sheet to the lead frame to form a shield, such that the shield extends along respective outside surfaces of the overmolds.

[0024] The method can include electrically connecting a differential pair cable to the terminal pairs and at least one of the lead frame or the shield.

[0025] Herein is disclosed a method of forming an electrical connector, including: stamping and bending a metal sheet to form a lead frame including at least one terminal pair and at least one pair of conductive leads; forming at least one overmold, wherein each overmold of the at least one overmold covers exactly one respective terminal pair of the at least one terminal pair between a distal end and a proximal end of the respective terminal pair such that the proximal end of the at least one terminal pairs extends below the at least one overmold along a mating direction and the pair of conductive leads are at opposites sides of the overmold. The method can include stamping and bending at least one additional metal sheet; welding the at least one additional metal sheet to the lead frame to form a shield that includes at least one cavity. Each overmold of the at least one overmold can be disposed within one respective cavity of the at least one cavity.

[0026] Herein "and/or" means at least one of the listed elements. For example, "A and/or B" means: only A; only B, at least A; at least B; or at least A and B. For example, "X, Y, and/or Z" means: only X; only Y; only Z; at least X; at least Y; at

least Z; only X and Y; only X and Z; only Y and Z; only X, Y, and Z; at least X and Y; at least X and Z; at least Y and Z; or at least X, Y, and Z. Herein, a slash can be used for " and/ or ". For example, a "device/component" can be a device and/or component. Herein an "(s)" at the end of a word means one or more; for example a shield(s) is one or more shields.

[0027] In the following, embodiments are described with the aid of figures to aid in understanding. In the figures, elements which correspond to one another in terms of structure and/or function are provided with the same reference signs.

[0028] The combinations of features shown and/or described in the individual embodiments are for explanatory purposes only. According to the above explanations, a feature of an embodiment can be omitted if its technical effect is not important for a particular application. Conversely, according to the above explanations, a further feature can be added to an embodiment if its technical effect should be advantageous or necessary for a particular application.

[0029] In the following, several examples are described.

[0030] In the figures:

Fig. 1 shows a connector assembly, according to embodiments described herein;

Fig. 2 shows a portion of an exploded view of an electrical connector, according to embodiments described herein;

Figs. 3A, 3B, and 3C show a connector subassembly, according to embodiments described herein;

Fig. 4 shows a connector subassembly, according to embodiments described herein;

Fig. 5 shows, according to embodiments described herein, a cross sectional view of a connector;

Fig. 6 shows, according to embodiments described herein, a cross sectional view of a connector;

Fig. 7 shows, according to embodiments described herein, a cross sectional view of a connector;

Fig. 8 shows, according to embodiments described herein, a header;

Fig. 9 shows, according to embodiments described herein, a header;

Fig. 10A shows, according to embodiments described herein, receptacle modules;

Fig. 10B shows, according to embodiments described herein, a unit for a header;

Fig. 10C shows, according to embodiments described herein, a unit for a header, in cross-section;

Fig. 11 shows, according to embodiments described herein, a part of a header; and

Fig. 12 illustrates, according to an embodiment, a method of forming an electrical connector.

[0031] The examples described herein are for illustrative purposes. Embodiments can be combined with each other.

[0032] Fig. 1 illustrates, according to an embodiment, a connector assembly. The assembly 111 can include an electrical connector 100, a header 710, and optionally, a circuit board 670 which attaches to the header 710. The connector 100, according to any embodiment described herein, can be a plug 1200. The header 710 can receive the plug 1200, such that cable(s) 690 are attached to a circuit board 670. The plug 1200 and/or connector 100 can mate with the header 710 along a mating direction 199. Herein, the mating direction can be referred to as the downward direction, or along z.

[0033] The connector 100 can mate with one or more cables 690 along a second mating direction 198. The second mating direction 198 can be oblique to the mating direction 199. The oblique mating direction 198, nonparallel and nonperpendicular to z, can aid in reducing the size of the connector assembly 111.

[0034] Herein, the terms distal and proximal are used, and can be understood as being opposites. Proximal can be a downward direction, having a downward component along z and/or along the mating direction 199. Proximal can mean at positions nearer the bottom of the device/component than the top. For example, nearer the bottom of the circuit board 670 is a more proximal position, as seen in Fig. 1. Distal can imply having a positive component along the second mating direction 198 and/or opposite to the mating direction 199. Distal can be an upward direction. For example, a distal direction can be such that a dot product of a vector in the distal direction and a vector in the opposite mating direction 198 is more than zero. Alternatively/additionally, a distal direction can be such that a dot product of a vector in the distal direction and a

vector in the mating direction 199 is less than zero.

[0035] The distal direction can refer to the cable side of the assembly 111. The proximal direction can refer to the circuit board side of the assembly 111.

[0036] The plug 1200 and/or connector 100 can include a shield(s) 150. The shield(s) 150 can point distally and/or upward from the holder 610. The cable(s) 690, which are distal to the shield (150), holder 610, header 710, and/or circuit board 670, can be regarded as part of the plug 1200 and/or connector 100. The holder 610 can hold one or more shield(s) 150 and can aid in handling the electrical connector 100, such as by facilitating alignment of the electrical connector 100 to the header 710 and/or circuit board 670.

[0037] Fig. 2 illustrates a partially exploded view of an electrical connector, according to an embodiment. The connector can 100 include terminal pairs 200, overmolds 140, and one or more shields 150. The distal and proximal ends 230, 210 of the terminal pairs 200 can be above and below, respectively, the overmolds 140. The connector 100 can also include a lead frame 180, which, like the terminal pairs 200, can be conductive, e.g. made of metal. The terminal pairs 200 and/or lead frame 180 can be plated and/or suitable for laser welding and/or soldering to other components, such as complementary connectors or the shield 150.

[0038] Overmolds 140 can mechanically support the terminal pairs 200, e.g. individually. The overmolds 140 can aid in mechanically supporting each of the terminal pairs 200. The overmolds 140 may also support the shield 150. The overmolds 140 can be discrete overmolds 140 which are separate from each other. Portions of the shield 150 can be between adjacent overmolds 140.

[0039] The shield 150, such as a multipart shield can include an upper shield 170 and lower shield 160, such as shown in Fig. 2. A shield 150, such as that formed by the upper and lower shields 170, 160 can cover a respective terminal pair 200 of the terminal pairs 200.

[0040] The shield 150 can shield differential signals transmitted through the terminal pairs 200. The overmolds 140 can be in cavities 450 formed by the shield 150.

[0041] Figs. 3A and 3B illustrate a connector subassembly, according to an embodiment. One or more connector subassemblies 300 can be used to make an electrical connector 100. For example, an electrical connector 100 includes any number of identical subassemblies 300.

[0042] A connector subassembly 300 and/or connector 100 can include a terminal pair 200, an overmold 140, and a pair of conductive leads 190a, 190b. The distal and proximal ends 230, 210 of the terminal pairs 200 can be above and below, respectively, the overmolds 140. The distal end 230 can be for mating to a circuit board 670 and/or header 710, e.g. below the overmold 140. The proximal end 210 can be for mating to a cable(s) 670, e.g. above the overmold 140.

[0043] The connector 100 and/or subassembly 300 can also include conductor leads 190a, 190b. The conductive leads 190a, 190b can be part of a lead frame 180. The optional lead frame 180 can include a bridge 182 that connects the distal ends of the conductive leads 190a, 190b.

[0044] Herein, metal components can be plated, suitable for laser welding, and/or suitable for soldering, such as the terminal pairs 200, conductive leads 190a, 190b, shield 150, and/or lead frame 180.

[0045] Figs. 3A, 3B, and 3C illustrate, according to embodiments, views of a subassembly. A subassembly 300 can include a terminal pair 200 and an overmold 140. The view of Fig. 3C is perpendicular to the mating direction 199 which points down in Fig. 3C. The view of Fig. 3C is perpendicular to the transverse axis 197, which extends left and right in Fig. 3C. As illustrated in Fig. 3C, the terminal pairs 200 can be separate from each other along the transverse axis 197. There can be material of the overmold 140 between the terminals of the terminal pair 200.

[0046] The overmold 140 can have, as illustrated in Figs. 3A, 3B, and 3C, outside surfaces 350, such as a top 355, bottom 357, front 351, and back 352. The outside surfaces 350 of the overmold 140 can include an opposite lateral sides 359a, 359b. The back 352 can include upper and lower back surfaces 352b, 352a. Any one or more of the outside surfaces 350 can be planar. The lateral sides 359a, 359b can be planar, excepting optional respective recesses 360, e.g. for engaging/holding conductive leads 190a, 190b.

[0047] The overmold 140 can mechanically support the terminal pairs 200, e.g. individually and/or as a pair. The overmold 140 can aid in mechanically supporting each of the terminal pairs 200. The overmold 140 and/or conductive leads 190a, 190b may support a shield 150. The terminal pair 200 can extend through the overmold 140, as shown in Fig. 3A and 3B. As illustrated in Figs. 3A and 3B, a proximal end 210 of the terminal pair 200 can project out of the overmold 150 in the mating direction (199), e.g. below the overmold 140.

[0048] The conductive leads 190a, 190b can be at opposite sides 359a, 359b of the overmold 140. Figs. 3A and 3B show a transverse axis 197 which is perpendicular to the mating direction 199 and second mating direction 198. The terminals of the terminal pair 200 can be disposed, e.g. separately disposed, along the transverse axis 197. The terminals of the terminal pair 200 can be separated along the transverse axis 197; for example the terminals of a pair 200 are identical, but transposed with a distance between them being along (e.g. parallel to) the transverse axis 197. The distal end 230 of each terminal can be parallel to the second mating direction 198; the proximal end 210 parallel to the mating direction; and the two terminals of the terminal pair 200 can intersect the transverse axis 197 at different locations.

[0049] A transverse plane 196 can intersect the transverse axis 197 and be perpendicular to the mating direction 199.

The second mating direction 196 can make an angle less than 90° with the transverse plane 196. The transverse plane 196 and/or transverse axis 197 can be imaginary and useful for describing the geometry of the components described herein, such as the connector assembly 111, subassembly 300, and/or connector 100.

[0050] The opposite sides 359a, 359b of the overmold can be offset from each other along the transverse axis 197. The opposite sides 359a, 359b can be planar, or planar except for recesses 360. Recesses 360 of the opposite lateral sides 359a, 359b can be for holding the respective conductive leads 190a, 190b. The opposite sides 359a, 359b can be parallel to the mating direction 199 and/or the second mating direction 198. The opposite sides 359a, 359b can be referred to as opposite lateral sides.

[0051] The conductive leads 190a, 190b can intersect the transverse plane 196 and/or axis 197.

[0052] The terminal pair 200 and the conductive leads 190a, 190b can be at least partially parallel. For example, they are parallel in at least one of: a region covered by the overmold, the curved regions, and the distal end projecting from the overmold along the second mating direction 198.

[0053] As shown in Figs. 3A and 3B, the conductive leads 190a, 190b can include curves 195. The curves 195 of the conductive leads 190a, 190b may be such that a lead portion 19d that is immediately distal to the curve 195 extends along the second mating direction 198. Alternatively/additionally, the curves 195 of the conductive leads 190a, 190b may be such that a lead portion 19p that is immediately proximal to the curve 195 extends along the mating direction 199.

[0054] Alternatively/additionally, the curves 195 of the conductive leads 190a, 190b may be such that the entirety of the conductive leads 195a, 195b which is distal to the curve 195 is along the second mating direction 198. Alternatively/additionally, the curves 195 of the conductive leads 190a, 190b may be such that the entirety of the conductive leads 195a, 195b which is proximal to the curve 195 is along the mating direction 199.

[0055] The proximal end of the terminal pairs 210 can extend farther along the mating direction 199 than the conductive leads 190a, 190b, which may extend to the bottom 357 of the overmold 140.

[0056] The terminal pairs 200 can include a curve 614. The curve 614 can be such that the distal end 230 of the terminal pair 200 extends along the second mating direction 198. The distal end 230 may be the entirety of the terminal pair 200 distal to the curve 614.

[0057] The curve 614 can be at or near the top surface 355 of the overmold 140, such as within the overmold 140, or partially within the overmold 140. The curve 614 can be distal to the bottom 357 of the overmold 140. The curve 614 of the terminal pair 200 can be at least partially covered by the overmold 140.

[0058] The terminal pair 200 and the conductive leads 190a, 190b can include parallel curves 195, 614. The curves 614, 195 of the terminal pair 200 and the conductive leads 190a, 190b can be parallel to each other. The parallel curves 614, 195 can be offset along the transverse axis 197. The offset can also have a component along the mating direction 199 and/or second mating direction 198.

[0059] The curves 195 of the conductive leads 190a, 190b can be at opposite lateral sides 359a, 359b of the overmold 140.

[0060] As shown in Fig. 3C, the overmold 140 can include channels 140c. The terminal pair 200 can extend through the channels 140c, e.g. a pair of channels 140c. The material of the overmold 140, e.g. a liquid crystal polymer, can extend between the channels 140c and/or the terminal pairs 200. The terminal pairs 200 can abut the walls of the channels 140c.

[0061] As illustrated in Figs. 3A, 3B, and 3C, the proximal end 210 of the terminal pair 200 can project along the mating direction 199 farther than the conductive leads 190a, 190b. The conductive leads 190a, 190b can extend to the bottom of the lateral sides 359a, 359b of the overmold. The conductive leads 190a, 190b can extend farther distally than the distal ends 230 of the terminal pair 200. The proximal ends of the conductive leads 190a, 190b can extend to the bottom 357 of the overmold 140.

[0062] The conductive leads 190a, 190b can include inner surfaces 191i, 192i that face the terminal pair 200 and abut, respectively, the opposite lateral sides 359a, 359b of the overmold 140. The conductive leads 190a, 190b can aid in mechanically stabilizing the overmold 140 and vice versa. Abutment may also save space and allow for a smaller device. Recesses 360 of the opposite lateral sides 359a, 359b of the overmold 140, for holding the conductive leads 190a, 190b can also add to stability, and/or reduce the device footprint and/or size. The widths of the conductive leads 190a, 190b along the transverse axis 197 can be greater than the width, along the transverse axis 197, of the recesses 360. An exposed surface of the conductive leads 190a, 190b, e.g. the surface not within the recess 360 can be attached to the shield 150, e.g. by welding.

[0063] As illustrated in Fig. 3B, the proximal end 210 of the terminal pair 200 can be curved to present an inclining surface 231 at the proximal tip 232 of the terminal pair 200. An inclining surface 231 can act as a spring connector, e.g. when the terminal pair 200 is mated with a complementary terminal, such as a pin pair. The curve at the proximal end 210 can alternatively/additionally present a contact surface for lateral contact with a complementary terminal, e.g. a mating pin pair.

[0064] The proximal end 210 of the terminal pair 200 can elastically flex, in a plane parallel to the transverse plane 196, below the overmold 140.

[0065] Fig. 4 illustrates a subassembly, according to an embodiment, in a partially exploded view. A subassembly 300 can include a shield 150, such as a multipart shield, e.g. a two-part shield. A shield 150 can include an upper shield 160 and

lower shield 170, as shown in Fig. 4. A shield 150 can aid in reducing noise pickup by the terminal pair 200.

[0066] The shield 150 can extend along one or more outside surfaces 350 of the overmold(s) 140. For example, the shield 150 can extend along the front 351 and back 352 surfaces. The shield 150 can abut the overmold(s) 140 at one or more outside surfaces 350 of the overmold 140. For example the front and back surfaces 351, 352 of the overmold 140 can abut inside walls of the shield 150.

[0067] Alternatively/additionally, the lateral sides 359a, 359b of the overmolds 140 can abut walls of the shield 140. Additional mechanical support between the shield 150 and overmolds 140, e.g. through multiple abutting surfaces, can reduce susceptibility to mechanical damage.

[0068] It is to be appreciated that multiple terminal pairs 200 can be shielded by one shield 150, e.g. an assembled multipart shield, e.g. a shield 150 assembled from an upper and a lower shield 160, 170 as illustrated in Fig. 2. The shield 150 can have multiple cavities 450, each cavity 450 having exactly one overmold 140 and exactly one terminal pair 200 within. In another embodiment, as illustrated in Fig. 4, each shield 150, as part of each subassembly 300, may shield exactly one terminal pair 200; and the connector 100 can have multiple subassemblies 300; such a connector 100 can have an equal number of shields 150 and terminal pairs 200.

[0069] Embodiments of the electrical connector 100 that are disclosed herein can be formed from subassemblies 300 as described herein. The subassembly 300 may optionally include shields 150. The electrical connectors 100 described herein can include one or more shields 150.

[0070] Fig. 4 shows the shield 150, overmolds 140, distal ends 230 of the terminal pairs 200, conductor leads 190a, 190b, and lead frames 180.

[0071] The shield 150 can include a cavity 450. The inner walls 460 of the shield 150 can form the cavity 450. The overmold 140 can be disposed in the cavity 450 of the shield 150. A multipart shield 150, e.g. as shown in Fig. 2 or Fig. 4, can form one or more cavities 450 when assembled.

[0072] As illustrated in Figs. 2, 3, and 4, the connector 100 can include a lead frame 180 and/or conductive leads 190a, 190b, which may be regarded as being part of the lead frame 180. The lead frame 180 and/or conductive leads 190a, 190b can be formed from a sheet of metal, e.g. by stamping, bending, and/or cutting. The manipulation of the sheet, e.g. by stamping, bending, and/or cutting, can alternatively/additionally form the terminal pairs 200.

[0073] The conductive leads 190a, 190b can be electrically connected to the shield 150, e.g. by welding. Alternatively/additionally, the conductive leads 190a 190b can be inserted into respective slots 470 in lateral sides 475 of the shield 150.

[0074] The shield 150 can be welded, e.g. laser welded, to the conductive leads 190a, 190b and/or lead frame 180.

[0075] The shield 150, terminal pairs 200, and/or conductive leads 190a, 190b can include a curve 195. Fig. 2 illustrates a curve 195 of the conductive lead 190a; the curve 195 of the other conductive lead 190b is not labeled. The terminal pairs 200 can include curves 614 at or near the top surface 355 of the overmold 140, such as within the overmold 140.

[0076] Fig. 5 illustrates a cross sectional view of a connector. A connector 100 can include at least one cable 690 and/or be in electrical connection with a cable(s) 690, e.g. a differential pair cable, according to embodiments described herein. See also Fig. 1. Fig. 5 shows wire pairs 510 of cables 690 in contact with the distal ends 230 of terminal pairs 200. Electrical contact can be made using welding and/or soldering. The wire pairs 510 can be attached to the upper surface 230u of the terminal pairs 200.

[0077] A connector 100, e.g. that of Fig. 5, can be formed from a plurality of subassemblies 300. The distal ends 230 of the terminal pairs 230 can be configured to electrically contact the wire pairs 510 of a respective cable 690, such as a differential pair cable. Multiple wire pairs 510 of cables 690 can be electrically attached to the respective distal ends 230 of terminal pairs 200. Respective conductive leads 190a, 190b, e.g. of the optional lead frames 180, can attach to cable shielding.

[0078] The curve(s) 195 of the conductive leads 190a, 190b can be distal to (e.g. above) the bottom 357 of the overmold 140. The curve(s) 195, 614 can aid in the physical arrangement of an attached cable 690, which electrically connects to the terminal pairs 200, lead frame 180, and/or conductive leads 190a, 190b. A cable 690 can attach to the electrical connector 100 at an angle which can be facilitated by the curve(s) 195, 614. It can be advantageous to have cables 690 approach the connector 100 at an angle, so that the cables 690 can lie flatter with respect to an underlying planar circuit board 670 to which the connector 100 may attach. This may allow device configurations that save space. For example, in applications in which the electrical connector 100 attaches to a circuit board 670, or a header 710 on a circuit board 670, spatial constraints may be relaxed if the cables 690 can be at a flatter orientation rather than at a right angle to the circuit board.

[0079] Partially or completely covering the curves 614 of the terminal pairs 200 by respective overmolds 140 can be advantageous, e.g. for mechanical support of the terminal pairs 200. The distal ends 230 of the terminal pairs 200 that are exposed above the top surface 355 of the overmolds 140 can be straight, e.g. the portion of the terminal pairs 200 that is distal to the curve 614. Strong mechanical connections can be made between the distal ends 230 of each terminal pair 200 and the connecting ends of the wire pairs 510 of the cable 690. Mechanical strain at the connection interface between the connector and the cable 690 can be reduced.

[0080] For example, the conductive leads 190a, 190b include a curve 195 and a portion 490, distal to the curve 195, that

is parallel to the distal ends 230 of the terminal pairs 200. The portion 490 of the conductive leads 190a, 190b can attach to at least one of the shield 150 of the connector 100 or the cable shielding. Alternatively/additionally, the curves 195 of the conductive leads 190a, 190b are at opposite lateral sides 359a, 359b of the overmolds 140. The portion 490 and distal end 230 can be straight, e.g. to facilitate attachment to shielding and wires 510 of the cables 690. The upper side of the of the conductive leads 190a, 190b

[0081] As illustrated in Fig. 5, the terminal pairs 200, overmolds 140, and/or cavities 450 of the shield(s) 150 can be arranged in a row 420. This can allow facile connection of multiple cables 690 to the terminal pairs 200; conductive leads 190a, 190b; and/or lead frames 180. The shield(s) 150 can extend along the row 420. A shield 150 with cavities 450 in a row can be relatively easy to handle for manufacturing and meeting tolerances.

[0082] The shield(s) 150 can include opposite walls 465 on either side of the overmolds 140, such as the walls 465 extending along the front 351 and back 352a, 352b of the overmolds 140.

[0083] For example, the upper shield 170 can attach to an upper surface 190u of the conductive leads 190a, 190b. Alternatively/additionally, the lower shield 160 can attach to a lower surface 190L of the conductive leads 190a, 190b. The lower shield 160 can extend farther proximally along the mating direction 199 than the upper shield 170.

[0084] The overmolds 140 can be discrete structures and/or spaced apart. The conductive leads 190a, 190b can be between adjacent overmolds 140.

[0085] A connector 100 can be formed with one or more connector subassemblies 300. For example, one or more connector assemblies 300 that each do not include a shield 150 are used, and at least one shield 150 that forms one or more cavities 450 is provided such that each of the respective connector subassemblies 300 are disposed in each respective cavity 450. For example, as illustrated in Fig. 5, a row 420 of subassemblies 300 includes overmolds 140 that are disposed in cavities 450 of a shield 150 made by an upper and lower shield 170, 160 that may be attached to the conductive leads 190a, 190b of the subassemblies 300. Each terminal of the terminal pairs 200 of the subassemblies 300 can be along the row 420, as seen in Fig. 5.

[0086] A connector that includes connector subassemblies 300 in a row 420 can include immediately neighboring conductive leads 190a, 190b between adjacent overmolds 140 of the subassemblies 300. The overmolds 140 can be separate from each other. The immediately neighboring conductive leads 190a, 190b can be connected. The immediately neighboring conductive leads 190a, 190b can be monolithic, e.g. monolithically formed. The upper shield 170 can be monolithically formed, e.g. formed from a metal plate. The lower shield 160 can be monolithically formed, e.g. formed from a metal plate.

[0087] Fig. 6 illustrates, according to embodiments described herein, a cross section of a connector, header, and circuit board. The cross section is taken through two shields 150 which are arranged perpendicular to the cross section. The terminal pairs 200 are arranged perpendicular to the cross section, the cross section passing through one terminal of respective terminal pairs 200 in respective overmolds 140.

[0088] A connector 100 can be made that includes a plurality of subassemblies 300, e.g. a plurality of subassemblies 300 and one or more shields 150.

[0089] Fig. 7 illustrates, according to embodiments described herein, a cross section of a connector, header, and circuit board.

[0090] The connector 100 can include a holder 610 that holds one or more shields 150. Each shield 150 can shield a row of terminal pairs 200. The respective bottom(s) 650 of the shield(s) 150 can be inserted into the holder 610 and held such that the terminal pairs 200 can be reached through the bottom(s) 650 of the shield(s) 150. The shield(s) 150 can extend/project upward from the holder 610.

[0091] The terminal pairs 200 can be accessible from the bottom of the holder 610. The holder 610 can include through-holes providing access to the proximal ends 210 of the terminal pairs 200 from the bottom of the holder 610.

[0092] The top(s) 555 of the shield(s) 150 can extend above the distal ends 230 of the terminal pairs 200. This can enhance rejection of environmental noise and/or cross talk.

[0093] The proximal ends 210 of the terminal pairs 200 can mate complementary pin pairs 660 at a surface of a circuit board 670. In Fig. 6, the cross section is taken through one of the respective pins of the pin pairs 660. The gap can allow deformation of the terminal pairs 200 and/or shield 150. Alternatively/additionally, the gap can allow insertion of a spacer 840 of a header 710.

[0094] The proximal ends 210 of the terminal pairs 200 can be elastically deformable. A gap 777 can exist between the proximal ends 210 of the terminal pairs 200 and the inner walls 460 of the cavities 450 of the shield 150.

[0095] Optionally, the proximal ends 210 of the terminal pairs 200 can be deformed in at least one direction, e.g. laterally, parallel to the transverse plane 196, e.g. in a plane perpendicular to the long axis of the terminal pairs 200.

[0096] As seen in Fig. 6, the proximal ends 210 of terminal pairs 200 can make electrical contact with pin pairs 660 which are in electrical contact with a circuit board 670. Using deformable terminal pairs 200, e.g. deformable at the proximal ends 210, can allow contact to be made with complementary pin pairs 660, and save space, such as in comparison to using complementary male/female connectors. The proximal ends 210 can be in a plane 605. Planarity can facilitate an easy assembling process with a circuit board 670.

[0097] In mating the proximal ends 210 to the pin pairs 660, it is advantageous to have the proximal ends 210 deform in a direction parallel to the transverse plane 197 and/or the plane 605 at the proximal ends 210 of the terminal pairs. Such elastic deformation can reduce stress transfer to the circuit board 670 and/or the contacts between the pin pairs 660 and the circuit board 670.

[0098] The shield 150 can include a mating end which is elastically deformable. Alternatively/additionally, the mating end can mate with a finger 680 of a complementary connector, such as a header 710. Alternatively/additionally, the finger(s) 680 can be elastically deformable, e.g. parallel to the transverse plane 196.

[0099] The proximal end 520 of the shield(s) 150 can be below the proximal ends 210 of the terminal pairs 200, e.g. in a plane that is parallel to the bottom 357 of the overmold 140, holder 610, and/or circuit board 670. The shield 150, e.g. the proximal end 520 thereof, can be configured to make shielding contact and/or mechanical contact to a finger 680 and/or surface mounted shield extending above the circuit board 670. The finger 680 can be a complementary surface mounted finger 680. Elastic deformation of the proximal end 520 of the shield 150, and/or finger 680, in a laterally extending plane, parallel to the transverse plane 196, in forming the mechanical/electrical contact, can reduce stress transfer vertically to the circuit board 670 and/or to the contacts between the fingers 680 and the circuit board 670.

[0100] The fingers 680 can make electrical contact to the top surface of the circuit board 670. The fingers 680 can be part of a header 710.

[0101] The shield 150 can be configured such that contact forces between the shield 150 and the surface mounted fingers 680 are parallel to the transverse plane 196, plane 605, the plane of the circuit board, and/or the bottom 357 of overmold 140. This can aid in preventing damage to the circuit board 670, e.g. by restricting contact forces to be along the transverse plane 196.

[0102] The proximal end 520 of the shield 150 can extend down and include a front wall 665b and a back wall 665a that are parallel to the respective walls at the front 351 and back 352a of the overmolds 140, e.g. at the proximal end of the overmold(s) 140 (e.g. at or near the bottoms 357; e.g. nearer the bottom 357 than the top 355 of the overmold 140).

[0103] As shown in Fig. 6, the connection between the shield 150 and the surface mounted fingers 680 can be with the shield 150 surrounding the fingers 680. Alternatively, such as illustrated in Fig. 7, the shield 150 can fit inside a region defined by the fingers 680. In either case the elastic deformation of the proximal end 520 of the shield 150 and/or fingers 680 can be in the laterally extending plane, e.g. parallel to the transverse plane 196 and/or plane 605.

[0104] There can be a gap 777 is between the proximal ends 210 of the terminal pairs 200 and the walls 465 of the proximal end 520 of the shield 150. This can allow for some movement laterally of the terminal pairs 200, e.g. when in contact with the pin pairs.

[0105] Fig. 6 also shows cables 690 in cross section. Cables 690 can be connected to the distal ends 230 of the terminal pairs 200 and/or the lead frame 180 such as at the conductive leads 190a, 190b.

[0106] The distal ends 230 of the terminal pairs 200 can be below the top(s) 555 of the shields 150. This can allow the shield(s) 150 to effectively reduce cross-talk and/or environmental noise being picked up by the connectors and deteriorating the electrical signals. The wire pairs 510 can connect physically and/or electrically to a top side 630 of the distal end 230 of the respective terminal pairs 200.

[0107] The cross section of Fig. 7 is taken through three shields 150 which are arranged perpendicular to the cross section. The terminal pairs 200 are arranged perpendicular to the cross section, the cross section passing through one terminal of respective terminal pairs 200 in respective overmolds 140. The bottom 650 of a shield can be inserted into a set of fingers 680, e.g. fingers 680 of the header 710, as shown in Fig. 7.

[0108] The connector 100, according to any embodiment described herein, can attach to a complementary header 710, in accordance with any complementary embodiment of a header 710 described herein. Fig. 6 shows a complementary header 710 which attaches to a connector 100 by insertion of sets 820 (see Fig. 8) of fingers 680 of the header 710 into respective shields 150 of the connector 100. Fig. 7 shows a header 710 which attaches to a complementary connector 100 by insertion of the shields 150 into respective sets 820 of fingers 680.

[0109] The connector 100 can include cable(s) 690 that are attached, respectively to subassemblies 300. The electrical connections of the connector 100 can include connections between the conductive leads 190a, 190b, and respective cable shielding, and connections between the terminal pair(s) 200 and respective wires 510 of the cables 690. At the respective electrical connections, the cables 690 can extend along the second mating direction 198.

[0110] Fig. 8 illustrates, according to an embodiment, a header. A header 710 can include a planar housing 810; and sets 820 of fingers 680 extending upward and/or distally, out of the planar housing 810. The distal ends 830 of the fingers 680 can be elastically deformable in a plane parallel to the plane of the housing 810 and/or the transverse plane 196. The header 710 can include a plurality of spacers 840, each spacer being surrounded by a respective set 820 of fingers 680. The spacers 840 are configured to pass at least one of terminal pairs 200 or pin pairs 660 vertically within to form electrical connections. The distal ends 830 of the fingers 680 of the sets 820 of fingers 680 can be configured to mate with the bottom 650 of a shield 150. As illustrated in Figs. 6 and 7, the fingers 680 and/or spacers 840 can extend through the planar housing 810, e.g. from the bottom to the top of the housing 810.

[0111] The fingers 680 can be metal. The housing 810 and/or spacers 840 can be nonconductors, such as plastic, such

as liquid crystal polymer. Fingers 680 can be flared at their distal ends, which can aid in mating to the shield 150.

[0112] The spacers 840 can be in a row 860, and there can be multiple rows 860. The rows 860 can be each configured to mate with a shield 150, e.g. at least one shield 150 of one or more rows of shield(s) 150 of a connector 100. As described herein, one shield 150 can shield an entire row of terminal pairs 200, and the connector 100 can include one or more such shields 150. Alternatively/additionally, a row of shields 150 can be formed by a row of shields, each shield by one cavity 450.

[0113] A connector 100 can include multiple rows of terminal pairs 200 and/or overmolds 140, and include one shield 150 per row. The spacers 840 of the header 710, in a row 860, can be configured to mate with the bottom 650 of a shield 150 along the row 860.

[0114] Fig. 9 illustrates, according to an embodiment, a header. A header 710 can include a housing 810 that extends in a plane, e.g. parallel to the transverse plane 196; and sets 820 of fingers 680 extending upward out of the planar housing 810. The distal ends 830 of the fingers 680 can be elastically deformable in a plane parallel to the plane of the housing, e.g. the transverse plane 196. Alternatively/additionally, the deformation can be parallel to the plane 605 of proximal ends 210 of terminal pairs 200 and/or the circuit board 670. The distal ends 830 of the fingers 680 of the sets 820 of fingers 680 can be configured to mate with the bottom 650 of a shield 150.

[0115] As illustrated in Fig. 9, the header 710 can be adapted to have the bottom 650 of the shield(s) 150 inside fingers 680.

[0116] Spacers 840 can extend through the planar housing 810, e.g. from the bottom to the top of the housing 810. Alternatively/additionally the cavities 450 of the one or more shields 150 of the connector 100 can fit inside each set 820 of fingers 680.

[0117] For example, when the header 710 and connector 100 are connected, the lateral sides 475 of shields 150 can abut respective fingers 680. Alternatively/additionally, the cavities 450 of the shield(s) 150 can be above the spacers 840, when the connector 100 is connected to the header 710. More sets 820 are possible. There can be lateral alignment of cavities 450 and spacers 840.

[0118] A header 710 can include multiple rows of spacers 840 and sets 820 of fingers 680. As illustrated in Figs. 8 and 9, a header 710 can include a second set of fingers and a second set of spacers in a second row that is parallel to the first row. The fingers of the second set are configured to mate with the bottom of a second shield. The connector 100 can include multiple shields 150, each forming a row of cavities 450.

[0119] There can be at least one row of sets 820 of fingers 680 and a corresponding at least one row of spacers 840 in the respective sets 820 of fingers 680 of each row. Each row of fingers and spacers can be configured to mate with a shield 150 of a connector 100 that includes the same number of shields 150 as number of rows of the header 710.

[0120] As illustrated in Fig. 8, the header 710 can include a plurality of standoffs 890 projecting downward from the bottom surface of the planar housing 810, the standoffs 890 being between neighboring sets 820 of fingers 680. The bottoms of the standoffs 890 can be coplanar with the bottoms of the fingers 680. This can aid in connecting the header 710 to the circuit board 670 and/or maintaining good connections when the header 710 is exposed to shock and/or vibrations.

[0121] The fingers 680 of the header 710 can perform at least partially a shielding function, such as in synergy with the shield(s) 150. The pin pairs 660 may be regarded as part of the header 710 and/or circuit board 670. Each pin pair 660 may extend up into a respective spacer 680. Alternatively/additionally, each pin pair 660 may extend above the tops of the respective spacers 680 of the header 710.

[0122] Fig. 10A illustrates, according to an embodiment, multiple receptacle modules. The receptacle modules 1000 can include units 1001, e.g. units 1001 that include a spacer 840 and a set 820 of fingers 680. The receptacle modules 1000 can include a row of units 1001. The receptacle modules 1000 and/or units 1001 can be configured to be inserted into a planar housing 810 to form the header 710. The receptacle modules 1000 can include spacers 840 that may be within respective sets 820 of fingers 680.

[0123] Fig. 10B illustrates, according to an embodiment, a unit for a header. The unit 1001, such as shown in Fig. 10B, can include a set 820 of fingers 680 and a spacer 840, and can be regarded as a unit 1001 or variation of a receptacle module 1000. In embodiments of receptacle modules 1000, 1001, and/or headers 710 described herein, the spacer(s) 840 can include a slot 845, e.g. one slot through each spacer 80. The slot 845 can be for receiving a terminal pair 200 from above and/or receiving a pin pair 660 from below. The slot 845 can pass through the spacer 840 and allow connection between the terminal pair 200 and the pin pair 660.

[0124] Fig. 10C illustrates, according to an embodiment, a unit for a header in cross-section. Pin pairs 660 are seen in a slot 845 of a spacer 840. The spacer 840 can be surrounded by a set 820 of fingers 680. The fingers 680 can extend upward and be configured to engage with the bottom of a shield 150 of a connector 100.

[0125] Fig. 11 illustrates, according to an embodiment, a part of a header. Fig. 11 shows a planar housing 810 which can receive one or more units and/or receptacle modules 1000, 1001, such as the receptacle module 1000 illustrated in Fig. 10A. The bottom of a partially assembled header 710 is shown in Fig. 11.

[0126] The receptacle modules 1000 and/or units 1001 can include at least one spacer 840 and a respective set 820 of fingers 860 that each surround one spacer 840 in a plane. The respective spacer(s) 840 and sets 820 of fingers 680 can be a receptacle module 1000 and/or unit 1001 which can connect, e.g. by insertion, into the planar housing 810 of the header

710. Alternatively, a receptacle module 1000 can include a row 1100 of spacers 840 and respective sets 820 of fingers 680, each set 820 surrounding one spacer 840 of the row 1100. Fig. 10A illustrates four such receptacle modules 1000.

[0127] A connection assembly 111, such as that shown in Fig. 1, can include a header as described according to any embodiment herein; a connector 100 according to any embodiment described herein; a circuit board 670; and a plurality of pin pairs 660 in electrical contact with the circuit board 670 and respective terminal pairs 200. The pin pairs 660 can extend along the mating direction 199 and/or through the circuit board 670.

[0128] Fig. 12 illustrates, according to an embodiment, a method of forming an electrical connector. An electrical connector 100 according to any embodiment described herein can be formed.

[0129] The method 1300 of forming an electrical connector 100 can include stamping and bending 1310 a metal sheet to form a lead frame 180 including a plurality of terminal pairs 200 and plurality of leads 190a, 190b; forming 1320 a plurality of overmolds 140, the overmolds covering a respective terminal pair 200 of the terminal pairs 200 between a distal end 230 and a proximal end 210 of the respective terminal pair 200 such that the proximal ends 210 of the terminal pairs 200 extend below the overmolds 140; stamping and bending 1400 at least one additional metal sheet; and welding 1340, 1360 the at least one additional metal sheet to the lead frame to form a shield 150, such that the shield 150 extends along respective outside surfaces 350 of the overmolds 140. Stamping can allow tolerances can be met.

[0130] As illustrated in Fig. 12, the method 1300 can include electrically connecting 1350 cable(s) 690, such as differential pair cable(s). A cable(s) 690, to the terminal pairs 200 and at least one of the lead frame 180 or the shield 150. For example, the conductive leads 190a, 190b can be electrically connected to the ground shield(s) of the cable(s) 690. The shield 150 may be attached, e.g. by being welded 1340, 1360, e.g. in multiple steps. For example, a lower shield 160 is welded 1340 before an upper shield 170 is welded 1360.

[0131] The upper shield can be attached to the upper surface of the conductive leads 190a, 190b, and the lower shield attached to the lower surface of the conductive leads 190a, 190b. The lower shield 160 can extend farther proximally along the mating direction 199 than the upper shield 170.

[0132] One or more cables 690 can be attached 1350, for example, after part of the shield 150 is attached, the remainder of the shield 150 being attached subsequent to the attachment of the cable 690.

[0133] As illustrated in Fig. 12, the method can include separating 1330 the terminal pairs 200 from the lead frame 180, such as after forming 1320 the overmolds 140. The intermediate structure that is formed after forming 1320 the overmolds 140 can be easily handled, e.g. when the terminal pairs 200 extend through the overmolds 200, and the terminal leads 190a, 190b are in contact with the overmolds 140. The overmolds 140 can allow the terminal pairs 200 to be separated from the lead frame 180, such. A bridge 182 of the lead frame 180 can also stabilize the intermediate structure.

[0134] The lead frame 180 can be trimmed 1370, such as after connecting 1350 the cable(s) 690. The bridge 182 may be removed in the trimming 1370, which may allow the connector 100 to take up less space and/or allow the cable(s) 690 to flex. Alternatively, the bridge 182 may be retained, which may provide more mechanical support to the connection between the cable(s) 690 and terminal pairs 200. The shield(s) 150 can be inserted 1380 at least partially into a holder 610. The connector 100 can conveniently be used as a plug.

[0135] At least one metal sheet can be used to form the shield 150. The metal sheet(s) can be stamped and bent. For example, a first metal sheet is stamped and bent to form the upper shield 170; and a second metal sheet is stamped and bent to form the lower shield 160. The stamped and bent metal sheet(s) can be attached to form a shield 150, for example a shield 150 with at least one cavity 450. The stamped and bent metal sheet(s) can be attached to each other, and/or to conductive leads 190a, 190b to form the shield 150.

[0136] Herein, soldering and/or welding, such as of the shield, can be by laser welding. Metal components can be attached by soldering and/or welding. Laser welding, which can provide precise welds and/or reduce the risk of damage to other nearby components, may be especially advantageous. Herein, at least the shields of the connectors, terminals, pins, leads, lead frames, and/or the fingers of the header can be conductive, such as made of metal.

[0137] Herein, the housing, and spacers of the header, can be nonconductive, such as made of a plastic, such as a liquid crystal polymer. The overmolds and/or holder of the connectors described herein can be nonconductive, such as made of a plastic, such as a liquid crystal polymer. The header can be at least partially metallized. For example, the housing 810 of the header 710 can be at least partially metallized, such as at least the distal surface thereof. Metallization may contribute to additional shielding function.

[0138] Herein, the following planes can be parallel to one or more of each other in any combination: a plane at the proximal ends of the terminal pairs, the plane of the circuit board, a plane parallel at the bottoms of the overmolds, and a plane of the housing in which the shields are held. These planes can be perpendicular to a long axis of the terminal pairs and/or the mating direction 199.

[0139] Herein, "surrounding" may be such that the surrounding feature has discontinuities, such as seams or gaps along a circumferential direction of the surrounding material. For example, fingers described herein can surround a spacer such that there are gaps between adjacent fingers in the circumferential direction. Herein, overmolds may surround terminal pairs continuously, without gaps or seams in the circumferential direction. Herein, shields that surround overmolds may have gaps or seams in the circumferential direction around the overmolds.

[0140] The following enumerated examples are disclosed.

[0141] Example 1 is an electrical connector 100, including a plurality of terminal pairs 200; a plurality of overmolds 140, each overmold 140 covering a respective terminal pair 200 of the terminal pairs 200 between a distal end 230 and a proximal end 210 of the respective terminal pair 200 such that the proximal ends 210 of the terminal pairs 200 extend below the overmolds 140; and a shield 150 extending along respective outside surfaces 350 of the overmolds 140. The terminals pairs can include at least one row, optionally forming a two dimensional grid of terminal pairs. There can be at least one shield 150, each shield for one row of overmolds. The shield(s) can each be a multi part shield.

[0142] Example 2 is that of example 1, and the top of the shield 150 is above the distal ends 230 of the terminal pairs 200. The bottom of the shield 150 can be below the proximal ends 210 of the terminal pairs.

[0143] Example 3 is that of example 1 or 2, such that the shield 150 includes a mating end which is configured to make shielding contact and/or mechanical contact to a complementary surface mounted finger 680 extending above a circuit board. The shield 150 can be configured such that a contact force between the shield 150 and the surface mounted finger is parallel to the plane.

[0144] Example 4 is that of the above examples 1, 2, or 3, and having the proximal end of the shield 150 extend downward and possibly including a front wall 665b and a back wall 665a that are parallel to a respective front wall 351 and a back wall 352a, 352b of the overmolds 140. There can be a gap 777 between the proximal ends 210 of the terminal pairs 200 and the walls 460, 465, 475, 665a, 665b of the proximal end of the shield 150.

[0145] Example 5 is that of any of the above examples 1-4, and including a lead frame 180 which optionally includes conductive leads 190a, 190b between the overmolds 140. Optionally the shield 150 is welded to the lead frame 180. The proximal ends 210 of the terminal pairs 200 can extend farther below the proximal ends of the conductive leads 190a, 190b.

[0146] Example 6 is that of any of examples 1-5, and such that each overmold 140 includes a pair of channels 140c. The respective terminal pairs 200 pass through the respective pairs of channels 140c; and the respective terminal pairs 200 abut the walls of the channels 140c. The overmolds 140 can include a row 420 of overmolds 140, and the shield 150 can extend along the row 420. Opposite walls of the shield 150 can extend along opposite sides of the overmolds 150. For example, the overmolds 140 include a second row of overmolds and a second shield along the second row of overmolds.

[0147] Example 7 is that of any of examples 1-6, and such that the proximal ends 210 of the terminal pairs 200 are configured to mate pin pairs 660 at a surface of a circuit board 670. The proximal ends 210 are elastically flexible in at least one direction, e.g. along the transverse plane 196.

[0148] Example 8 is that of any of examples 1-7, and such that the terminal pairs 200 include a curve 614 distal to the bottom 357 of the overmolds 140; optionally the curves 614 of the terminal pairs 200 are at least partially covered by the overmolds 140; optionally, the conductive leads 190a, 190b include a curve 195 which is parallel to the curve 614 of the terminal pairs 200; and optionally the curves of the conductive leads 190a, 190b are between adjacent terminal pairs 200. The curves of the conductive leads 190a, 190b can be at opposite lateral sides 359a, 359b of the overmolds 140. For example, at least two of the shield 150, terminal pairs 200, or conductive leads 190a, 190b include parallel curves.

[0149] Example 9 is the electrical connector 100 of any of examples 1-8, that also includes a holder 610, which may be planar, in which the bottom of the shield 150 is inserted for holding the shield 150 such that the terminal pairs 200 are accessible from the bottom of the holder 610. The shield 150 can extend upward from the holder 610. The holder 610 can include through-holes providing access to the proximal ends 210 of the terminal pairs 200 from the bottom of the holder 610.

[0150] An example of a header 710 for a circuit board 670 can include a planar housing 810; and a plurality of sets 820 of fingers 680 extending upward out of the planar housing 810. The distal ends 830 of the fingers 680 can be elastically deformable in a plane parallel to the plane of the housing, e.g. parallel to the transverse plane 196. The header 710 can include a plurality of spacers 840, each spacer being surrounded by a respective set 820 of the sets of fingers 680. The spacers 840 can be configured to pass at least one of terminal pairs 200 or pin pairs 660 vertically within to form electrical connections. The distal ends of the fingers 680 of the sets of fingers can mate with the bottom of a shield 150. The fingers 680 can extend through the planar housing from the bottom to the top. The spacers 840 can extend through the planar housing 810.

[0151] The header 710 can have the spacers 840 in a row 420. The spacers can be configured to mate with the bottom of the shield along the row.

[0152] The header 710 can include a second set of fingers and a second set of spacers in a second row that is parallel to the first row. The fingers of the second set can be configured to mate with the bottom of a second shield. The header can include a plurality of standoffs 890 projecting downward from the bottom surface of the planar housing, the spacers 890 being between neighboring sets of fingers.

[0153] It is to be understood that the above description is intended to be illustrative, and not restrictive. For example, the above-described embodiments (and/or aspects thereof) may be used in combination with each other. A list of reference numerals used herein is provided for convenience and is not intended to be limiting.

REFERENCE NUMERALS

[0154]

5	connector	100
	connector assembly	111
	overmold	140
10	channels	140c
	multipart shield	150
	lower shield	160
	upper shield	170
15	lead frame	180
	bridge of lead frame	182
	conductive leads	190a, 190b
20	lower surface of conductive lead	190L
	upper surface of conductive lead	190u
	inner surfaces of conductive leads	191i, 192i
	proximal lead portion	19L
25	distal lead portion	19d
	curve of leads	195
	transverse plane	196
	transverse axis	197
30	second mating direction	198
	mating direction	199
	terminal pair	200
35	proximal end	210
	distal end	230
	upper surface of terminal pair	230u
	inclining surface of proximal tips	231
40	proximal tip of proximal end of terminal pair	232
	connector subassembly	300
	outside surface	350
45	front	351
	back	352a, 352b
	top	355
	bottom	357
50	lateral sides	359a, 359b
	recesses on surfaces of overmolds	360
	row	420
55	cavities of shield	450
	inner walls of cavities	460
	opposite walls of shield (front and back)	465

EP 4 742 459 A1

(continued)

	slots of shields	470
	lateral sides or walls of shields	475
5	conductive lead portion distal to the curve	490
	wire pairs of cable	510
	proximal end of shields	520
10	top of shield	555
	plane of proximal ends	605
	holder	610
	curves of terminal pairs	614
15	top side of distal end of terminals	630
	bottom of shield	650
	pin pair	660
20	back wall of shield	665a
	front wall of shield	665b
	circuit board	670
	fingers	680
25	cable	690
	header	710
	gap between terminal pair and shield	777
30	planar housing of header	810
	sets of fingers	820
	sets of fingers	820
	distal ends of fingers	830
35	spacers of header	840
	slot of spacer of header	845
	rows of spacers	860
40	standoffs on bottom of header	890
	receptacle module	1000
	unit	1001
	plug	1200
45	method of forming connector	1300
	stamping and bending	1310
	forming overmolds	1320
	separating	1330
50	welding	1340
	connecting electrically	1350
	welding	1360
55	trimming	1370

Claims

1. A connector subassembly (300) for an electrical connector (100), comprising:

a terminal pair (200);
an overmold (140), through which the terminal pair (200) extends;
a pair of conductive leads 190a, 190b at opposite sides (359a, 359b) of the overmold (140); wherein
a proximal end (210) of the terminal pair (200) projects out of the overmold (140) in a mating direction (199).

2. The connector subassembly (300) of claim 1, wherein

the terminal pair (200) includes a curve (614) such that
a distal end (230) of the terminal pair (200) extends along
a second mating direction (198) which is oblique to the mating direction (199).

3. The connector subassembly (300) of claim 2, wherein

the curve (614) of the terminal pair (200) is at least partially within the overmold (140).

4. The connector subassembly (300) of claim 2 or 3 wherein

the conductive leads (190a, 190b) include a curve which is parallel to the curve of the terminal pair.

5. The connector subassembly (300) of any one of claims 1-4, wherein

the proximal end (210) of the terminal pair (200) projects along the mating direction farther than the conductive leads (190a, 190b).

6. The connector subassembly (300) of any one of claims 1-5, wherein

the conductive leads (190a, 190b) include inner surfaces (191i, 192i) that face the terminal pair (200) and abut the opposite sides (359a, 359b) of the overmold (140).

7. The connector subassembly (300) of claim 6, wherein

the opposite sides (359a, 359b) of the overmold include recesses (360) that abut the inner surfaces (191i, 192i) of the conductive leads (190a, 190b).

8. The connector subassembly (300) of any one of claims 1-7, wherein

the proximal ends (230) of the terminal pair (200) are curved to present an inclining surface (231) at the proximal tip (232) of the terminal pair (200).

9. The connector subassembly (300) of any one of claims 1-8, further comprising:

a shield (150) forming a cavity (450) in which the overmold (140) is disposed; wherein
optionally

the shield includes an upper shield (170) and a lower shield (160); wherein optionally
the upper shield (160) is attached to an upper surface of the conductive leads (190a, 190b)
the lower shield (170) is attached to a lower surface of the conductive leads (190a, 190b);
wherein optionally
the lower shield (160) extends farther proximally along the mating direction (199) than the upper shield (170).

10. A connector (100), comprising:

a plurality of connector subassemblies (300) according to any one of claims 1-8;
at least one shield (150) forming at least one respective cavity (450); wherein
each of the respective connector subassemblies (300) are disposed in each respective cavity.

11. A connector (100), comprising:

a plurality of connector subassemblies (300) of any one of claims 1-8;
a shield (150) which includes a row (420) of cavities (450); wherein

the conductive leads (190a, 190b) include immediately neighboring conductive leads (190a, 190b) between adjacent overmolds (140) of the subassemblies (300); wherein the overmolds (140) are separate from each other; wherein the immediately neighboring conductive leads (190a, 190b) are connected, and optionally are monolithic.

12. The connector (100) of claim 10 or 11, further comprising:

a holder (610) which holds the shield or the at least one shield (150) such that the shield or at least one shield (150) projects upward from the holder (610), wherein the terminal pairs (200) are accessible from the bottom of the holder.

13. A header (710), comprising:

a housing (810) extending in a plane;
a plurality of sets (820) of fingers (680) extending out of the plane; wherein the distal ends (830) of the fingers (680) are elastically deformable in directions parallel to the plane; a plurality of spacers (840), each spacer (840) being surrounded by a respective set (820) of the sets (820) of fingers (680); wherein the spacers (840) are configured to pass, along a direction perpendicular to the plane, at least one of a terminal pair (200) or a pin pair (660); wherein the distal ends (830) of the fingers (680) of the sets (820) of fingers (680) are configured to mate with a shield (150) of a connector (100).

14. A connection assembly (111), comprising:

the header (710) of claim 13;
the connector (100) according to any one of claims 10-12;
circuit board (670); and
a plurality of pin pairs (660) in electrical contact with the circuit board (670) and respective terminal pairs (200), wherein the pin pairs (660) extend along the mating direction (199).

15. A method (1300) of forming an electrical connector (100), comprising:

stamping and bending (1310) a metal sheet to form a lead frame (180) including at least one terminal pair (200) and at least one pair of conductive leads (190a, 190b);
forming (1320) at least one overmold (140), wherein each overmold of the at least one overmold (140) covers exactly one respective terminal pair (200) of the at least one terminal pair (200) between a distal end (230) and a proximal end (210) of the respective terminal pair (200) such that the proximal end (210) of the at least one terminal pairs (200) extends below the at least one overmold (140) along a mating direction (199) and the pair of conductive leads 190a, 190b are at opposites sides (359a, 359b) of the overmold (140); optionally further comprising:

stamping and bending (1400) at least one additional metal sheet;
welding (1340, 1360) the at least one additional metal sheet to the lead frame (180) to form a shield (150) that includes at least one cavity (450); wherein each overmold (140) of the at least one overmold (140) is disposed within one respective cavity (450) of the at least one cavity (450).

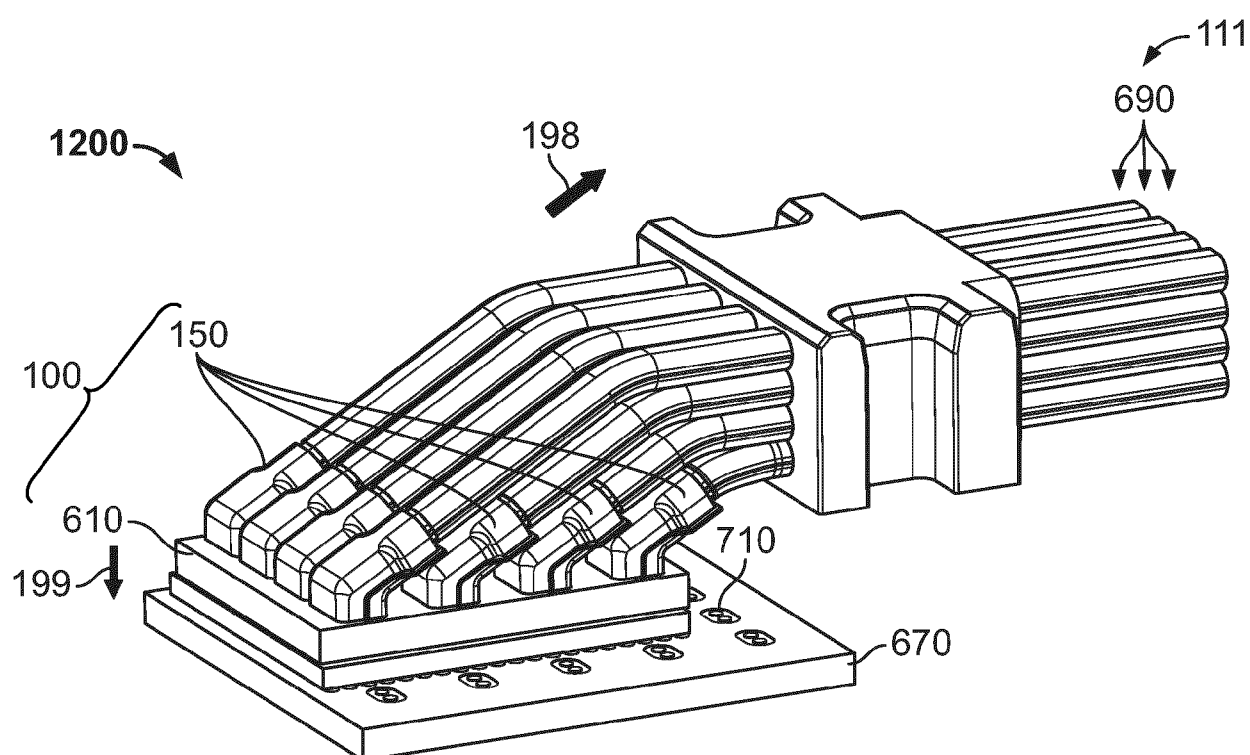


Fig. 1

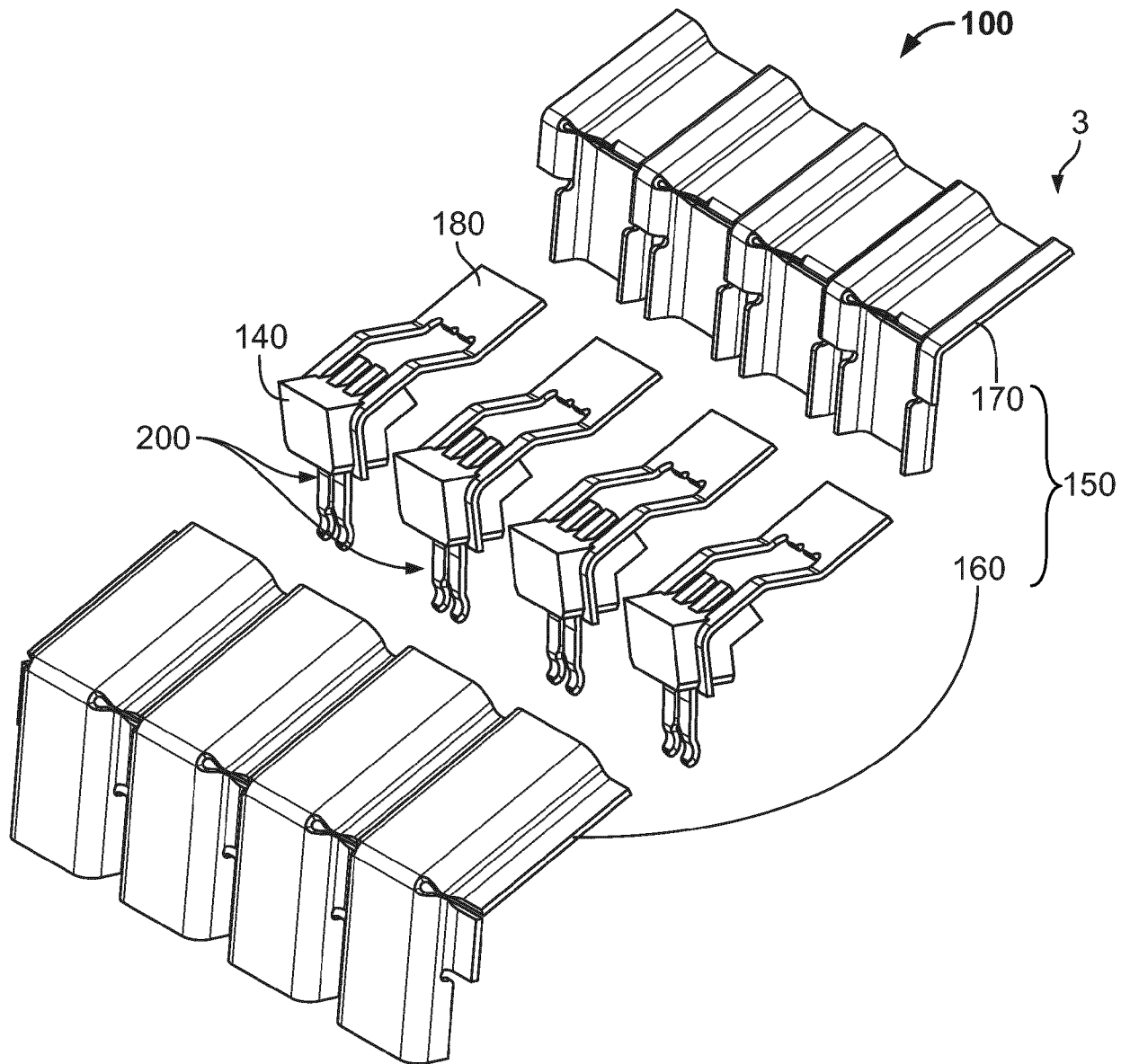


Fig. 2

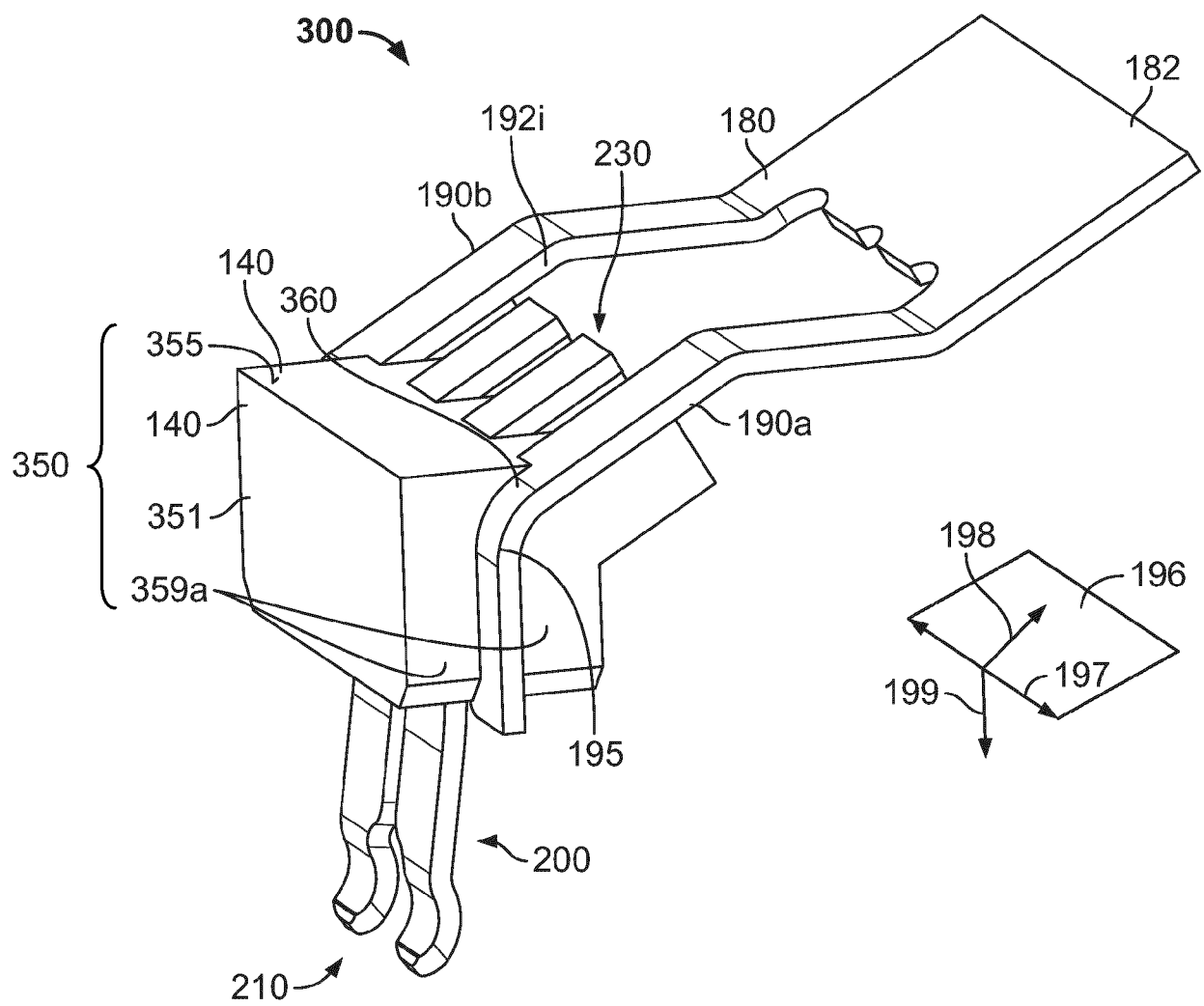


Fig. 3A

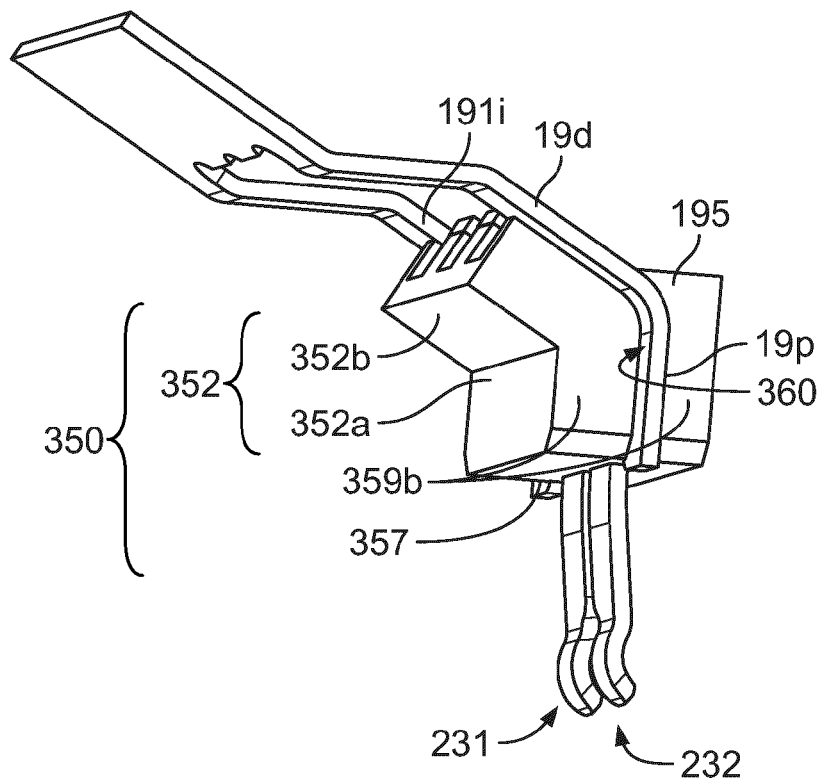


Fig. 3B

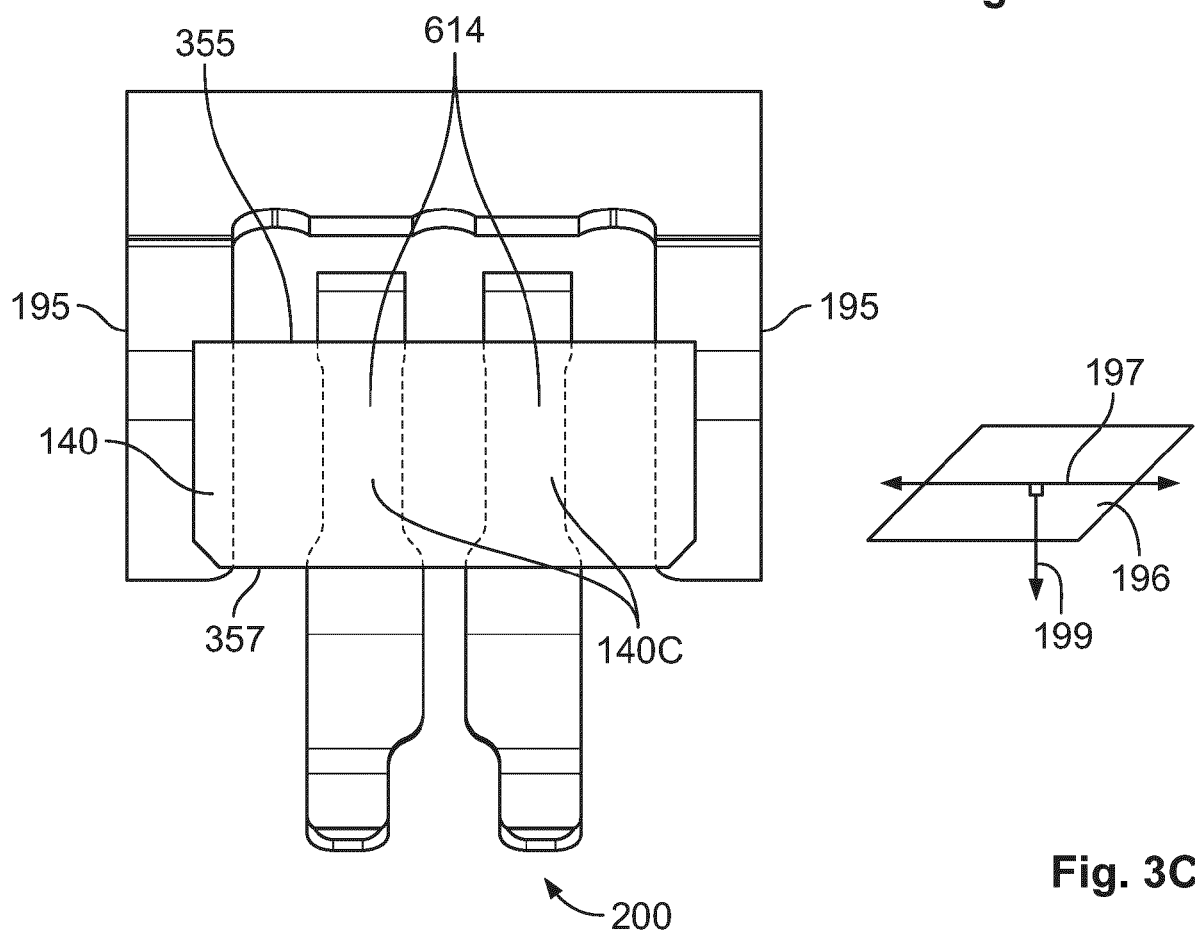


Fig. 3C

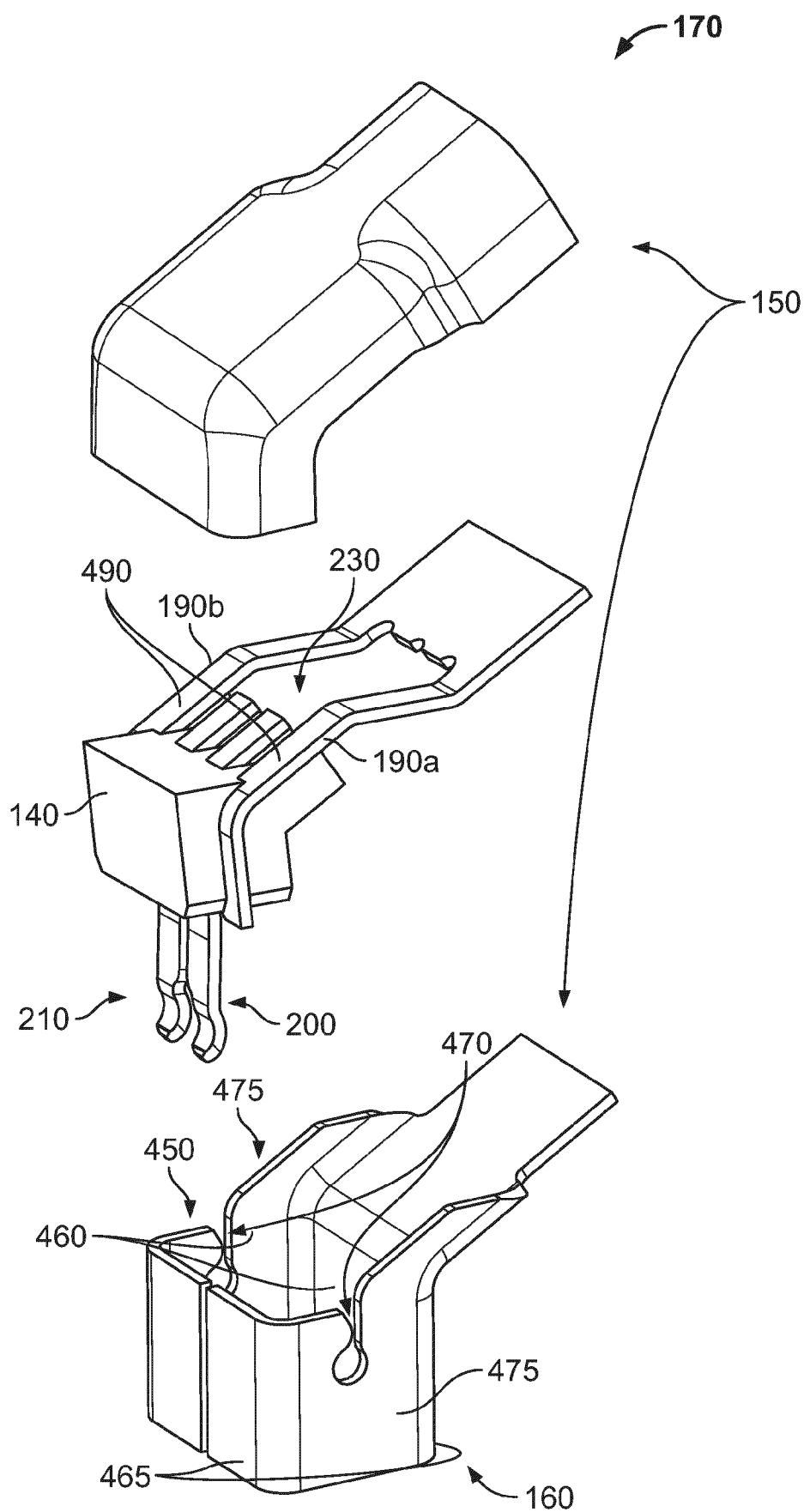


Fig. 4

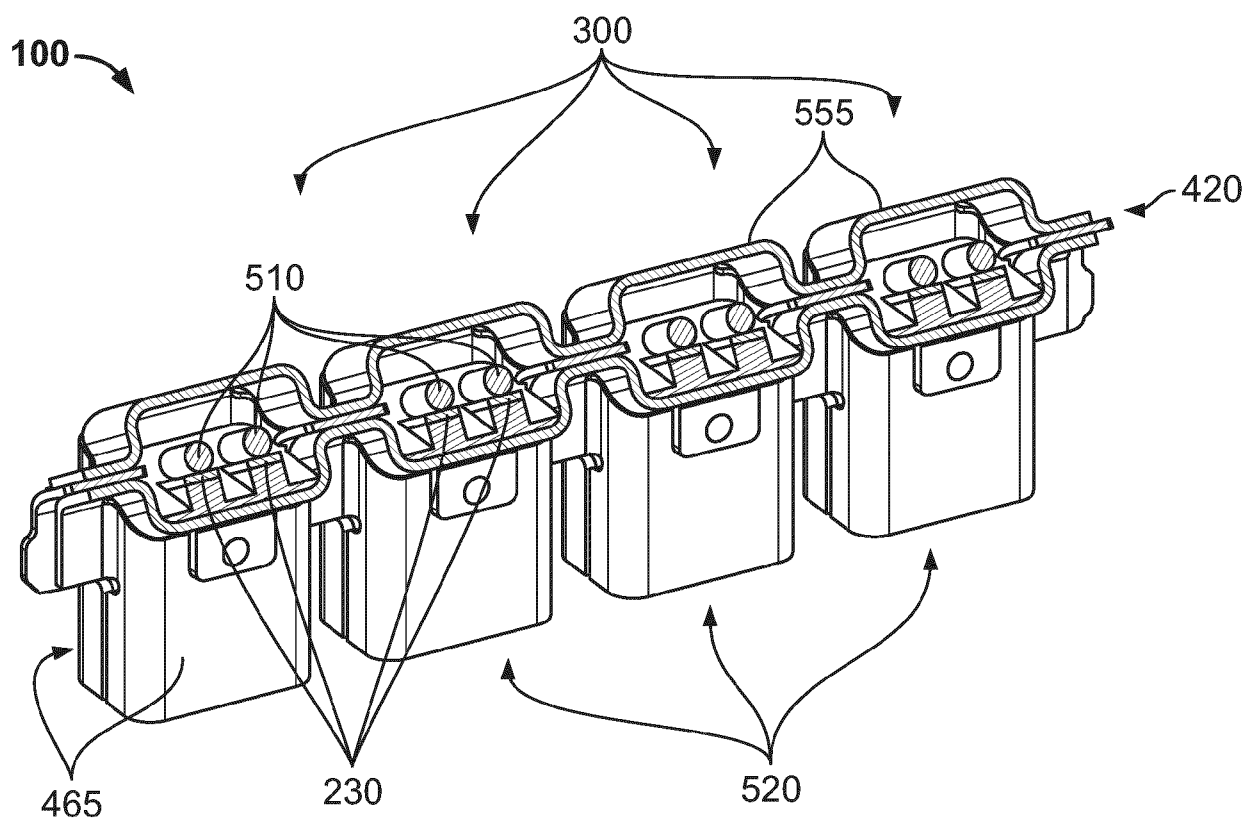


Fig. 5

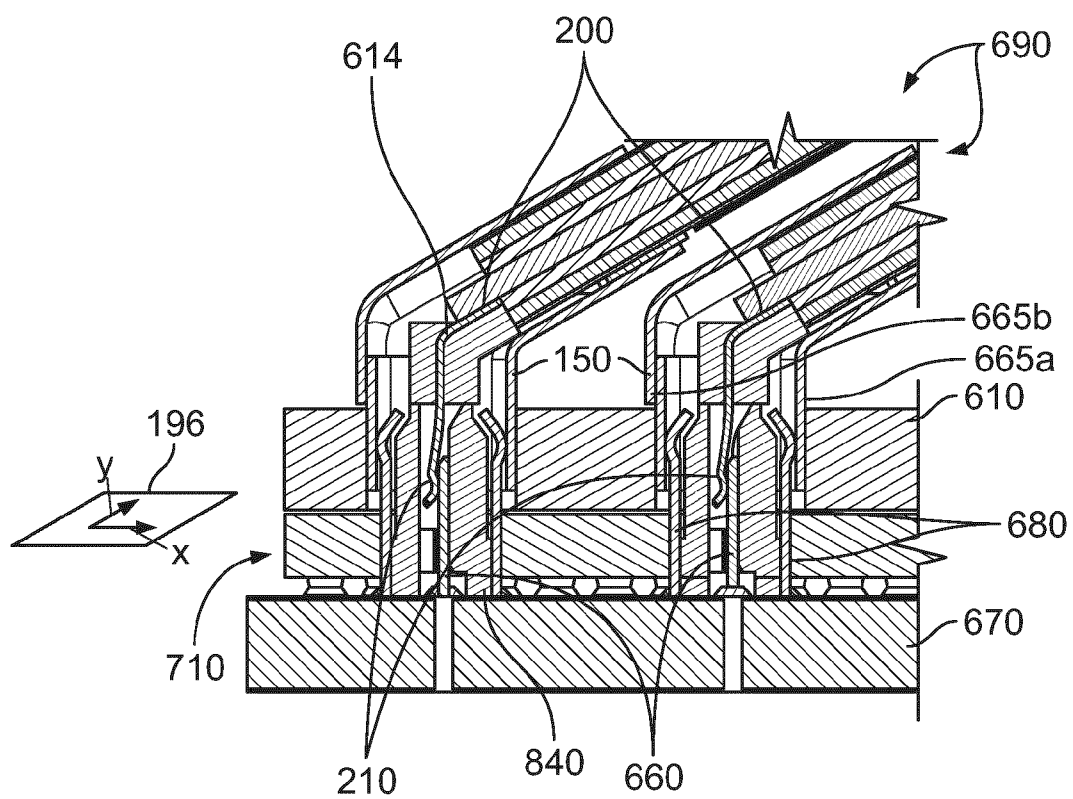


Fig. 6

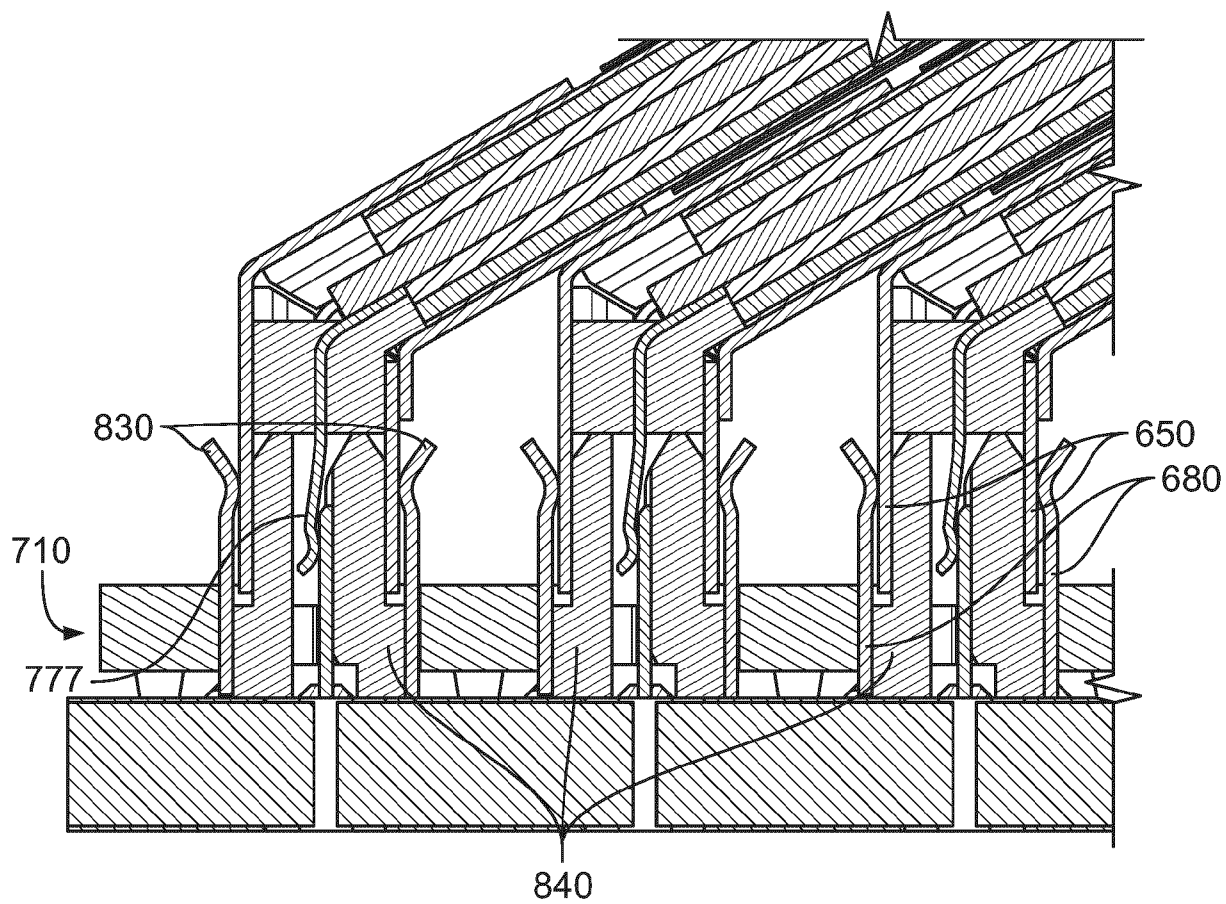


Fig. 7

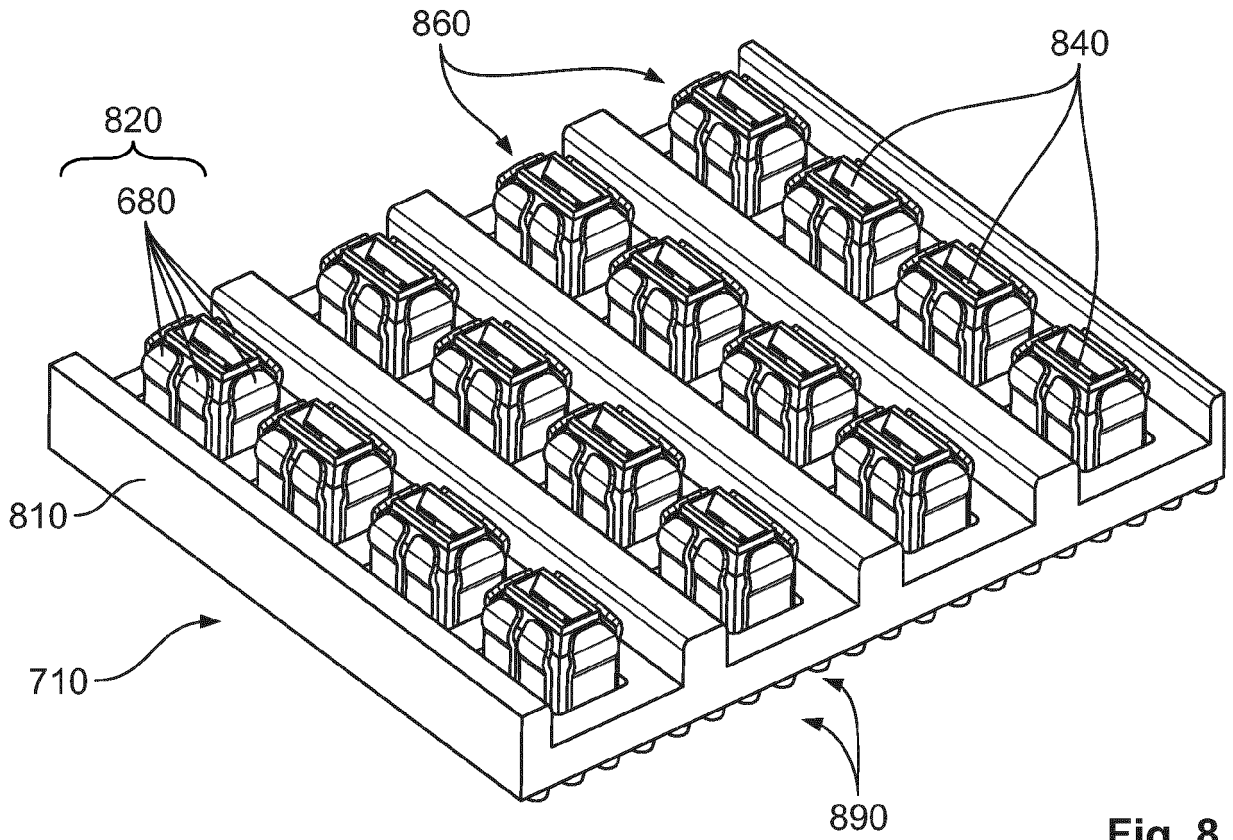


Fig. 8

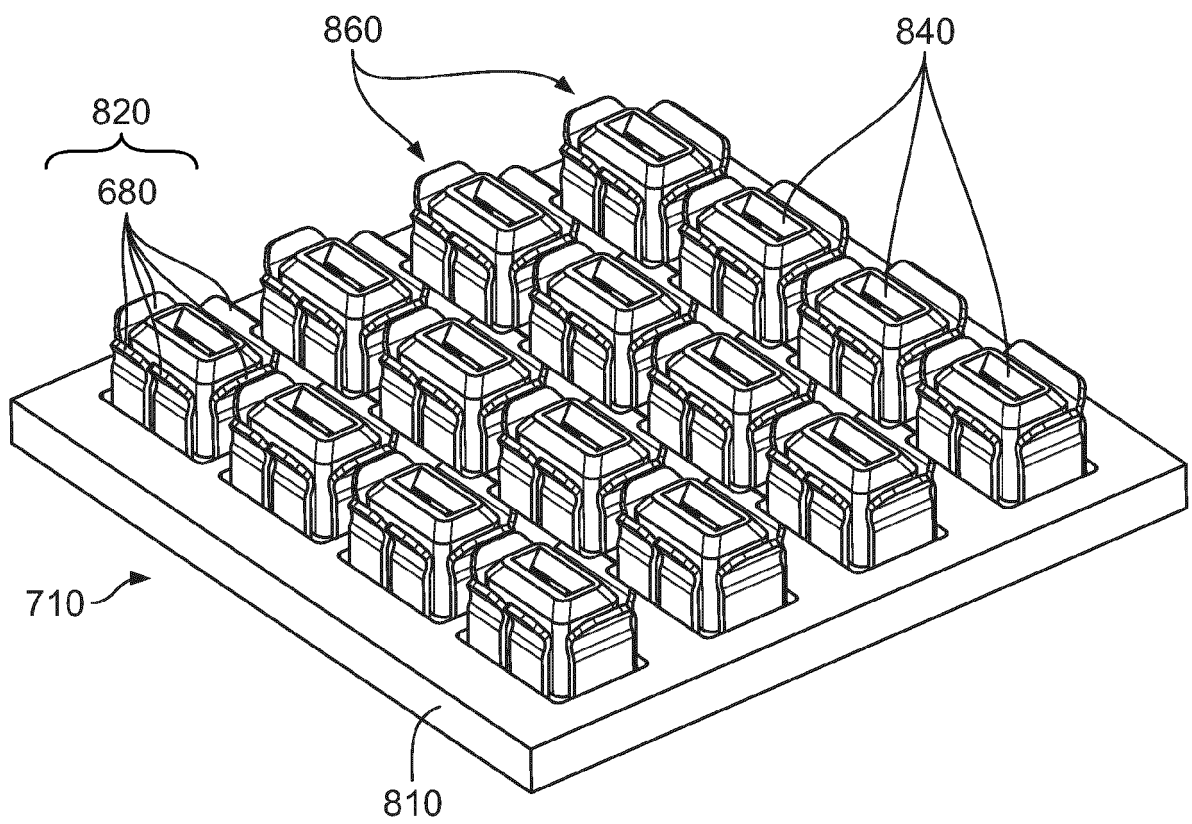


Fig. 9

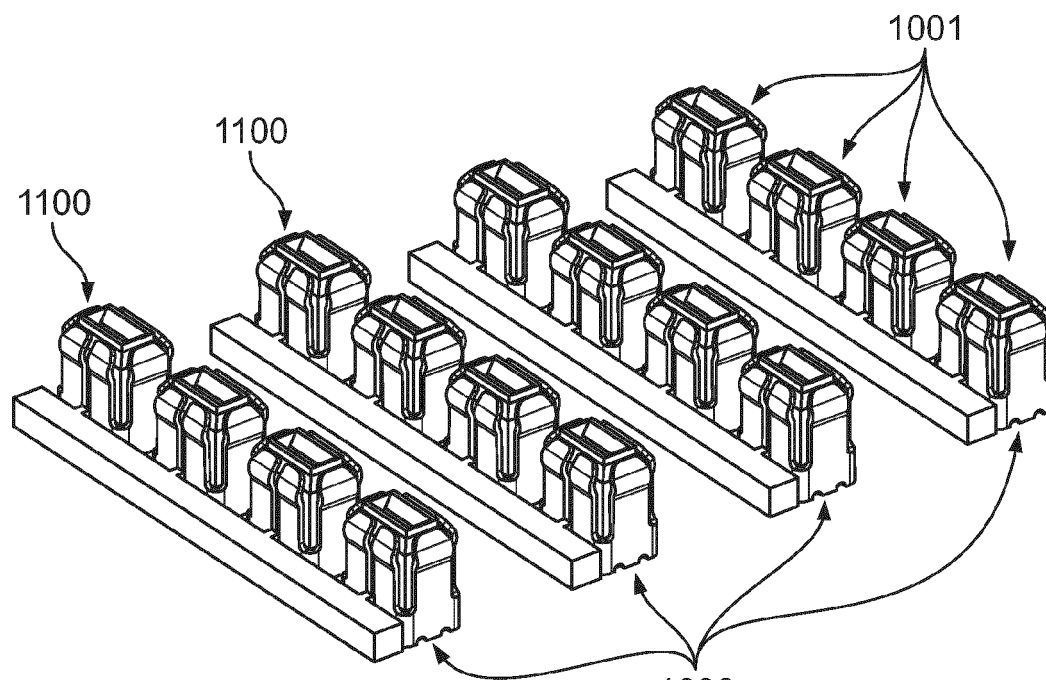


Fig. 10A

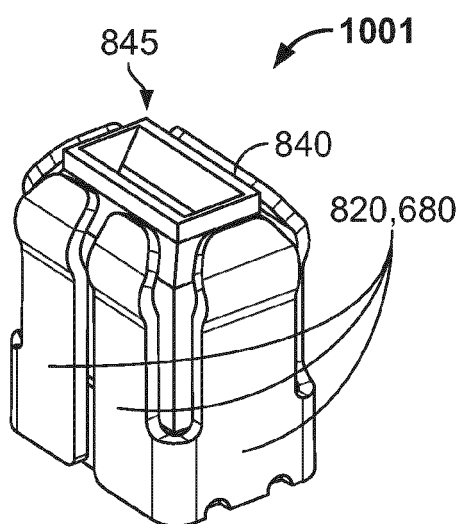


Fig. 10B

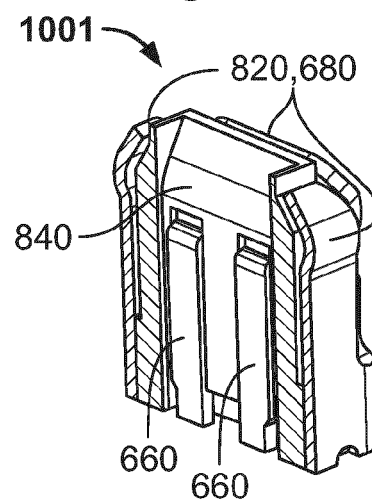


Fig. 10C

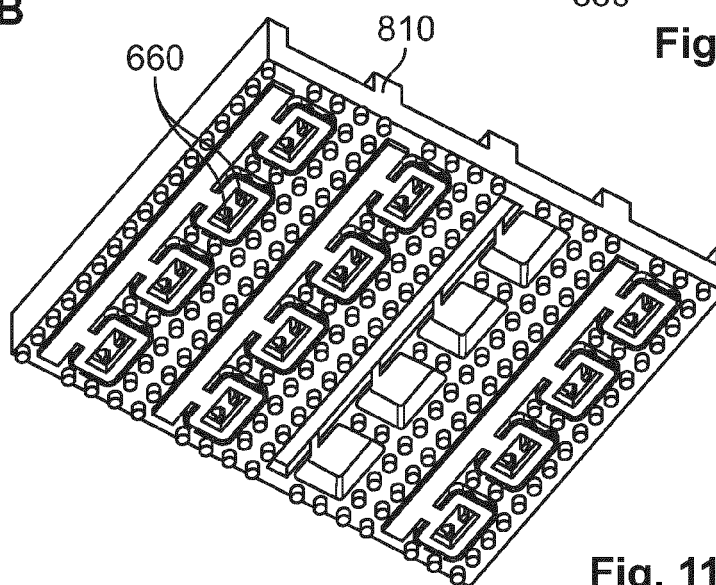


Fig. 11

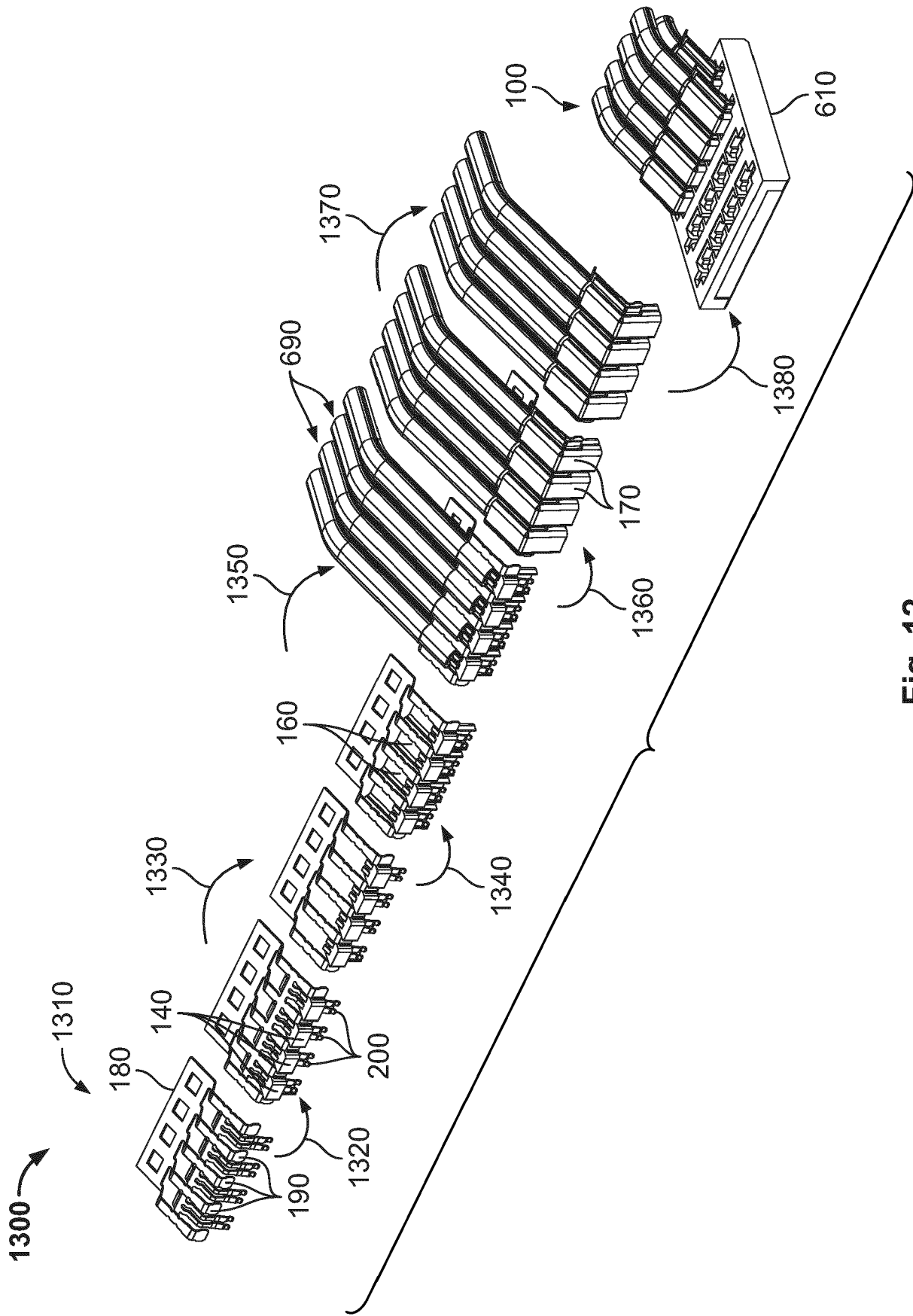


Fig. 12



EUROPEAN SEARCH REPORT

Application Number

EP 24 21 1201

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP H06 64385 U (UNKNOWN) 9 September 1994 (1994-09-09) * abstract * * figures 1-4 *	1-8,15	INV. H01R12/71 H01R12/79 H01R13/405 H01R13/6587
X	DE 10 2023 001377 A1 (TELEGAERTNER KARL GAERTNER GMBH [DE]) 10 October 2024 (2024-10-10) * abstract * * figures 1-16 *	1-3, 8-10,15	H01R13/6591 H01R13/6594
Y	US 2024/088587 A1 (HARMON III DEAN MARLIN [US] ET AL) 14 March 2024 (2024-03-14) * abstract * * figures 1-9 *	11,12,14	ADD. H01R43/24
A	US 2021/399496 A1 (SONG TAO [CN] ET AL) 23 December 2021 (2021-12-23) * abstract * * paragraph [0051] - paragraph [0051] * * figures 14-24 *	6	
X		13,14	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01R
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		13 May 2025	Pugliese, Sandro
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

EPO FORM 1503 03.82 (P34C01)



Application Number

EP 24 21 1201

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

**LACK OF UNITY OF INVENTION
SHEET B**

Application Number

EP 24 21 1201

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-12, 15(completely); 14(partially)

Connector subassembly for an electrical connector,
corresponding electrical connector and method of forming an
electrical connector

2. claims: 13(completely); 14(partially)

Header

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

EP 24 21 1201

13-05-2025

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP H0664385 U	09-09-1994	JP 2605822 Y2 JP H0664385 U	21-08-2000 09-09-1994
DE 102023001377 A1	10-10-2024	NONE	
US 2024088587 A1	14-03-2024	CN 117691413 A US 2024088587 A1	12-03-2024 14-03-2024
US 2021399496 A1	23-12-2021	CN 111682366 A CN 111682367 A CN 111682368 A CN 111682369 A CN 111864475 A CN 111864476 A CN 111864477 A CN 111864478 A CN 111900577 A CN 112510442 A CN 112864724 A CN 113823958 A CN 212412338 U CN 212412339 U CN 212412340 U CN 212849123 U CN 212849124 U CN 212849125 U CN 212849126 U CN 212849127 U CN 212849128 U CN 213151157 U CN 213151158 U CN 213151159 U CN 213151160 U CN 213460337 U CN 213878626 U CN 213878627 U CN 213878628 U CN 214798035 U TW M603629 U TW M604507 U TW M607438 U TW M608316 U TW M609292 U TW M611640 U TW M613652 U TW M614360 U	18-09-2020 18-09-2020 18-09-2020 18-09-2020 30-10-2020 30-10-2020 30-10-2020 30-10-2020 06-11-2020 16-03-2021 28-05-2021 21-12-2021 26-01-2021 26-01-2021 26-01-2021 30-03-2021 30-03-2021 30-03-2021 30-03-2021 30-03-2021 30-03-2021 07-05-2021 07-05-2021 07-05-2021 15-06-2021 03-08-2021 03-08-2021 03-08-2021 19-11-2021 01-11-2020 21-11-2020 11-02-2021 01-03-2021 21-03-2021 11-05-2021 21-06-2021 11-07-2021

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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

EP 24 21 1201

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

13-05-2025

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		TW M616729 U	11-09-2021
		TW M618159 U	11-10-2021
		TW M618935 U	01-11-2021
		TW M619773 U	21-11-2021
		TW M619876 U	21-11-2021
		TW 202046583 A	16-12-2020
		TW 202046584 A	16-12-2020
		TW 202101833 A	01-01-2021
		TW 202103394 A	16-01-2021
		TW 202123549 A	16-06-2021
		TW 202123552 A	16-06-2021
		TW 202123560 A	16-06-2021
		TW 202123562 A	16-06-2021
		TW 202127752 A	16-07-2021
		TW 202135390 A	16-09-2021
		TW 202139542 A	16-10-2021
		US 2021399448 A1	23-12-2021
		US 2021399462 A1	23-12-2021
		US 2021399471 A1	23-12-2021
		US 2021399472 A1	23-12-2021
		US 2021399473 A1	23-12-2021
		US 2021399474 A1	23-12-2021
		US 2021399475 A1	23-12-2021
		US 2021399476 A1	23-12-2021
		US 2021399477 A1	23-12-2021
		US 2021399478 A1	23-12-2021
		US 2021399479 A1	23-12-2021
		US 2021399483 A1	23-12-2021
		US 2021399485 A1	23-12-2021
		US 2021399486 A1	23-12-2021
		US 2021399487 A1	23-12-2021
		US 2021399489 A1	23-12-2021
		US 2021399490 A1	23-12-2021
		US 2021399491 A1	23-12-2021
		US 2021399492 A1	23-12-2021
		US 2021399494 A1	23-12-2021
		US 2021399495 A1	23-12-2021
		US 2021399496 A1	23-12-2021
		US 2021399497 A1	23-12-2021
		US 2021399498 A1	23-12-2021

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82