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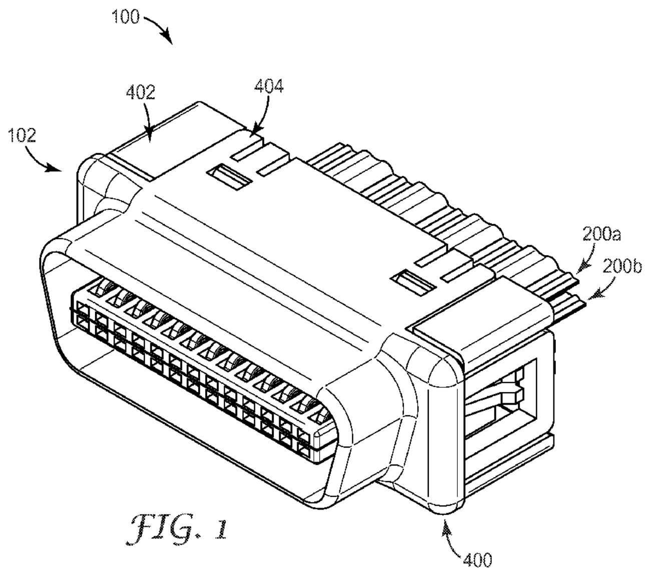

FIG. 1

(57) Abstract: An electrical cable connector assembly includes a shielded connector housing and first and second connector wafer assemblies having a mating portion. The shielded connector housing includes an insulative connector body and a shield member. Each connector wafer assembly includes a planar insulative connector wafer body including a plurality of channels, a set of electrical contacts disposed in the channels, and an electrical cable terminated to the electrical contacts. The first and second connector wafer assemblies are inserted in the shielded connector housing such that a bottom surface of the connector wafer body of the first connector wafer assembly abuts a bottom surface of the connector wafer body of the second connector wafer assembly, and the mating portion of the first and second connector wafer assemblies extends through an opening in a front wall of the connector body into a mating cavity of the shield member.

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ELECTRICAL CABLE CONNECTOR AND ASSEMBLY

TECHNICAL FIELD

The present disclosure relates generally to electrical cable connectors for the transmission of electrical signals. In particular, the present invention relates to electrical cable connectors to which electrical cables can be mass-terminated and that provide high speed electrical characteristics.

BACKGROUND

Electrical cable connectors for transmission of electrical signals are well known and widely used in the global market. Such connectors typically have not been difficult to form, especially when the signal line densities have been relatively low, and when the circuit switching speeds (also referred to as edge rates or signal rise times) have been slow when compared to the length of time required for a signal to propagate through a conductor in the connector. As user requirements grow more demanding with respect to both connector sizes and circuit switching speeds, the design and manufacture of electrical cable connectors that can perform satisfactorily in terms of both physical size and electrical performance has grown more difficult. In addition, common types of electrical cable connectors are often not suitable for the use of mass-termination techniques, i.e., the simultaneous connection of a plurality of electrical cable conductors to individual connector contact elements.

Electrical cable connectors have been developed to provide the necessary impedance control for high speed circuits, i.e., circuits with a transmission frequency of at least 3 GHz. Although many of these electrical cable connectors are useful, there is still a need in the art for connector designs that are capable of transmitting high speed signals and facilitate mass-termination techniques.

SUMMARY

In one aspect, the present invention provides a connector wafer including a planar insulative connector wafer body including a plurality of channels, and a set of electrical contacts disposed in the channels. Each electrical contact includes a body portion, and a terminal portion formed at an end of the body portion and including a width that is larger than a thickness thereof. The terminal portion is disposed in a corresponding one of the channels of the connector wafer body so that a width direction of the terminal portion is substantially along a depth direction of the channels.

In another aspect, the present invention provides a connector wafer assembly including a connector wafer and an electrical cable terminated to the electrical contacts.

In another aspect, the present invention provides a connector wafer arrangement including a first connector wafer and a second connector wafer. The first and second connector wafers are arranged such that a bottom surface of the connector wafer body of the first connector wafer abuts a bottom surface of the connector wafer body of the second connector wafer.

In another aspect, the present invention provides a connector wafer assembly arrangement comprising a first connector wafer assembly and a second connector wafer assembly. The first and second connector wafer assemblies are arranged such that a bottom surface of the connector wafer body of the first connector wafer assembly abuts a bottom surface of the connector wafer body of the second connector wafer assembly.

In another aspect, the present invention provides an electrical cable connector including a shielded connector housing and first and second connector wafers having a mating portion. The shielded connector housing includes an insulative connector body and a shield member. The insulative connector body includes a front wall having an opening therein, and a top wall, a bottom wall, and opposing side walls extending from the front wall and defining a cavity. The shield member includes a base portion disposed on the front wall of the connector body, a mating portion extending from the base portion and defining a mating cavity, a top flange extending from the base portion and disposed adjacent the top wall of the connector body, and a bottom flange extending from the base portion and disposed adjacent the bottom wall of the connector body. Each connector wafer includes a planar insulative connector wafer body including a plurality of channels, and a set of electrical contacts disposed in the channels. The first and second connector wafers are inserted in the shielded connector housing such that a bottom surface of the connector wafer body of the first connector wafer abuts a bottom surface of the connector wafer body of the second connector wafer, and the mating portion of the first and second connector wafers extends through the opening in the front wall of the connector body into the mating cavity of the shield member.

In another aspect, the present invention provides an electrical cable connector assembly including a shielded connector housing and first and second connector wafer assemblies having a mating portion. The shielded connector housing includes an insulative connector body and a shield member. The insulative connector body includes a front wall having an opening therein, and a top wall, a bottom wall, and opposing side walls extending from the front wall and defining a cavity. The shield member includes a base portion disposed on the front wall of the connector body, a mating portion extending from the base portion and defining a mating cavity, a top flange extending from the base portion and disposed adjacent the top wall of the connector body, and a bottom flange extending from the base portion and disposed adjacent the bottom wall of the connector body. Each connector wafer assembly includes a planar insulative connector wafer body including a plurality of channels, a set of electrical contacts disposed in the channels, and an electrical cable terminated to the electrical contacts. The first and second connector wafer assemblies are inserted in the shielded connector housing such that a bottom surface of the connector wafer body of the first connector wafer assembly abuts a bottom surface of the connector wafer body of the second connector wafer assembly, and the mating portion of the first and second connector wafer assemblies extends through the opening in the front wall of the connector body into the mating cavity of the shield member.

The above summary of the present invention is not intended to describe each disclosed embodiment or every implementation of the present invention. The Figures and detailed description that follow below more particularly exemplify illustrative embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a top-front perspective view of an exemplary embodiment of an electrical cable connector assembly according to an aspect of the present invention.

Fig. 2 is an exploded top-front perspective view of a shielded connector housing of the electrical cable connector assembly of Fig. 1.

Fig. 3 is an exploded top-rear perspective view of a connector wafer assembly of the electrical cable connector assembly of Fig. 1.

Fig. 4 is a top-rear perspective view of the connector wafer assembly of Fig. 2.

Fig. 5 is a top-rear perspective view of the connector wafer assembly of Fig. 3 including a cover.

Fig. 6 is a top-rear perspective view of the connector wafer assembly of Fig. 4 including a shielding tape.

Fig. 7 is a bottom-rear perspective view of the connector wafer assembly of Fig. 5.

Fig. 8 is a rear perspective view of two connector wafer assemblies of Fig. 5 positioned for assembly.

Fig. 9 is a side view of two connector wafer assemblies of Fig. 5 positioned for assembly.

Fig. 10 is a partially exploded top-rear perspective view of the electrical cable connector assembly of Fig. 1.

Fig. 11 is a top-rear perspective view of the electrical cable connector assembly of Fig. 1.

DETAILED DESCRIPTION

In the following detailed description of the preferred embodiments, reference is made to the accompanying drawings that form a part hereof. The accompanying drawings show, by way of illustration, specific embodiments in which the invention may be practiced. It is to be understood that other embodiments may be utilized, and structural or logical changes may be made without departing from the scope of the present invention. The following detailed description, therefore, is not to be taken in a limiting sense, and the scope of the invention is defined by the appended claims.

Referring now to the Figures, Fig. 1 illustrates an exemplary embodiment of an electrical cable connector assembly according to an aspect of the present invention. Electrical cable connector assembly 100 includes a shielded connector housing 400 and first and second connector wafer assemblies 200a, 200b (also referred to herein as connector wafer assemblies 200) inserted in shielded connector housing 400.

Referring to Fig. 2, shielded connector housing 400 includes an insulative connector body 402 and a shield member 404. Connector body 402 includes a front wall 406. A top wall 408, a bottom wall 410, and opposing side walls 412 extend from front wall 406 and define a cavity 414. Front wall 406 of connector body 402 includes an opening 426 configured to receive a mating portion A (Fig. 10) of connector wafer assemblies 200. Connector body 402 is configured to retain connector wafer assemblies 200 and provide electrical insulation between connector wafer assemblies 200 and shield member 404. Shield member 404 includes a base portion 416 disposed on front wall 406 of connector body 402, a mating portion 418 extending from base portion 416 and defining a mating cavity 420, a top flange 422, and a bottom flange 424. Top flange 422 extends from base portion 416 and is disposed adjacent top wall 408 of connector body 402 when connector body 402 and shield member 404 are in an assembled configuration. Bottom flange 424 extends from base portion 416 and is disposed adjacent bottom wall 410 of connector body 402 when connector body 402 and shield member 404 are in an assembled configuration. Shield member 404 is configured to shield connector wafer assemblies 200 from electromagnetic interference (EMI) from external devices, for example.

As best seen in Fig. 10, connector wafer assemblies 200 include a mating portion A that extends through opening 426 in front wall 406 of connector body 402 into mating cavity 420 of shield member 404 when connector wafer assemblies 200 are inserted in shielded connector housing 400.

Referring to Figs. 3-4, each connector wafer assembly 200 includes a connector wafer 202 and an electrical cable 208. Connector wafer 202 includes a planar insulative connector wafer body 204 and a set of electrical contacts 206. Electrical cable 208 is terminated to electrical contacts 206. Connector wafer body 204 includes a plurality of channels 214 in which electrical contacts 206 are disposed. Channels 214 are disposed side by side in a top surface 222 of connector wafer body 204. Channels 214 are spaced apart at substantially equal intervals and penetrate through top surface 222 of connector wafer body 204. The longitudinal direction of channels 214 is substantially identical with the width direction of connector wafer body 204. Adjacent channels 214 are separated by separating ribs 224. In the embodiment illustrated in Figs. 3-4, channels 214 have substantially the same width and depth. Electrical contacts 206 each include a body portion 216 and a terminal portion 218 formed at an end 220 of body portion 216. Terminal portion 218 has a width that is larger than a thickness thereof. Terminal portion 218 is disposed in a corresponding one of channels 214 of connector wafer body 204 so that a width direction of terminal portion 218 is substantially along a depth direction of channels 214, as shown in Fig 4, for example. In the embodiment illustrated in Figs. 3-4, terminal portion 218 is disposed in channel 214 so as to abut a side wall of channel 214. Therefore, when a conductor, such as, e.g., insulated conductor 226 or ground conductor 250, of electrical cable 208 is connected to terminal portion 218 of electrical contact 206, an end portion of the conductor, such as, e.g., end portion 228 of insulated conductor 226 or end portion 252 of ground conductor 250, will be positioned in channel 214 adjacent a major surface of terminal portion 218. Advantageously, this configuration allows mass-termination of the conductors to electrical contacts 206, it allows electrical contacts 206 to be placed at a closer distance (smaller pitch), and it provides an effective connection area of terminal portion 218. In addition, separating ribs 224 between adjacent channels 214 can efficiently prevent electrical shorts from occurring between adjacent terminations.

In the embodiment illustrated in Figs. 3-4, a plurality of channels 214 are disposed side by side in a top surface 222 of connector wafer body 204, are spaced apart at substantially equal intervals, and have substantially the same width and depth. However, the present invention is not limited to this. In other embodiments, based on the gauge of the conductors to be terminated, channels 214 may have different widths and depths. According to the number of conductors to be terminated, channels 214 may be of any suitable number. For example, in the case of one conductor, only one channel 214 needs to be present. Channels 214 may be spaced apart at unequal intervals. Channels 214 may be disposed in a bottom surface 230 of connector wafer body 204 or in both top surface 222 and bottom surface 230. In case channels 214 are disposed in both top surface 222 and bottom surface 230, channels 214 disposed in top surface 222 may be symmetrical with those disposed in bottom surface 230.

In the embodiment illustrated in Figs. 3-4, channels 214 include a substantially rectangular cross-section, but, in other embodiments, the cross-section of channels 214 may have any suitable shape, such as, for example, a U-shape. The bottom surface of channels 214 may be a flat surface or a bevel inclined downward. Channels 214 may include a chamfer, so that the shape of the bottom surface of channels 214 is adapted to the shape of electrical contact 206.

In one embodiment, each electrical contact 206 includes a flat one-piece sheet member (for example a metal sheet), in which terminal portion 218 is formed at an end 220 of body portion 216. Body portion 216 has a width that is larger than a thickness thereof. Terminal portion 218 has a width that is larger than a thickness thereof. At the initial state, terminal portion 218 and body portion 216 are positioned in the same plane. That is, the width direction of terminal portion 218 is consistent with that of body portion 216. Referring to Fig. 3, body portion 216 has a longitudinal central axis L1 extending along the longitudinal direction thereof, and terminal portion 218 has a longitudinal central axis L2 extending along the longitudinal direction thereof. Longitudinal central axis L1 and longitudinal central axis L2 are substantially parallel with each other and spaced apart from each other by a predetermined distance in a width direction of electrical contact 206. During the formation of terminal portion 218, terminal portion 218 is twisted or bent by about 90 degrees about a predetermined axis parallel with the longitudinal axis thereof so that terminal portion 218 is positioned in a vertical state with respect to body portion 216. As a result, the width direction of terminal portion 218 is substantially orthogonal to the width direction of body portion 216. During the twisting or bending process, a transition portion 232 is formed, connecting body portion 216 and terminal portion 218 such that the width direction of terminal portion 218 is substantially orthogonal to the width direction of body portion 216. In one embodiment, transition portion 232 is tangential to the plane of terminal portion 218 and that of body portion 216.

It should be noted that, at the initial state, longitudinal central axis L2 of terminal portion 218 may also be consistent with longitudinal central axis L1 of body portion 216. In other words, terminal portion 218 and body portion 216 may have substantially the same longitudinal central axis.

Body portion 216 further includes a contact portion 234 configured to make separable electrical contact with a mating electrical contact (not shown). Contact portion 234 is formed by a horizontal portion of electrical contact 206 and includes an elastic support part 236, a lapping contact part 238, and a projection contact part 240. Elastic support part 236 is formed by a horizontal portion of contact portion 234 joined to transition portion 232. Lapping contact part 238 is formed at a free end of contact portion 234 away from transition portion 232, that is, lapping contact part 238 is formed by a short portion at a free end of contact portion 234. Lapping contact part 238 cooperates with connector wafer body 204 to control the deflection of and insertion force associated with contact portion 234 of electrical contact 206. Projection contact part 240 is located between elastic support part 236 and lapping contact part 238 and protrudes upward. Projection contact part is to be connected to an electrical contact of a mating connector (not shown), thus achieving electrical connection.

Terminal portion 218 further includes a hold portion 242 formed by a vertical portion located substantially at the center of electrical contact 206, and is to be mounted to connector wafer body 204 so as to retain electrical contact 206 in connector wafer body 204.

In some embodiments, elastic support part 236 and transition portion 232 may extend into the terminal area of electrical contact 206, defining a substantially L-shaped terminal portion 218. In other embodiments, terminal portion 218 may have any shape suitable to facilitate mass-termination of conductors to electrical contacts 206, such as, e.g., a U-shape.

It is apparent from the above embodiments that a connector wafer assembly according to aspects of the present invention is simple in structure and low in manufacturing cost, and the problems occurring conventionally during termination of an electrical cable to a fine pitch connector can be solved to some extent. In addition, a connector wafer assembly according to aspects of the present invention is advantageous in improving the processing properties of termination and increasing the stability of the manufacturing process and termination reliability. In case of a relatively large gauge wire, the above advantages and features will be more apparent.

Still referring to Figs. 3-4, the type of electrical cable 208 used in an aspect of the present invention can be a single wire cable (e.g., single coaxial or single twinaxial), a plurality of single wire cables, or a multiple wire cable (e.g., multiple coaxial, multiple twinaxial, or twisted pair).

The embodiment of electrical cable 208 illustrated in Figs. 3-4 includes a plurality of spaced apart conductor sets 244 arranged generally in a single plane. Each conductor set includes two substantially parallel longitudinal insulated conductors 226. Insulated conductors 226 may include insulated signal wires, insulated power wires, or insulated ground wires. Two generally parallel shielding films 246 are disposed around conductor sets 244. A conformable adhesive layer 248 is disposed between shielding films 246 and bonds shielding films 246 to each other on both sides of each conductor set 244. In one embodiment, conductor sets 244 have a substantially curvilinear cross-sectional shape, and shielding films 246 are disposed around conductor sets 244 such as to substantially conform to and maintain the cross-sectional shape. Maintaining the cross-sectional shape maintains the electrical characteristics of conductor sets 244 as intended in the design of conductor sets 244. This is an advantage over some conventional shielded electrical cables where disposing a conductive shield around a conductor set changes the cross-sectional shape of the conductor set.

Although in the embodiment illustrated in Figs. 3-4, each conductor set 244 includes two insulated conductors 226, in other embodiments, each conductor set 244 may include one or more insulated conductors 226. For example, instead of electrical cable 208 including four conductor sets 244 each including two insulated conductors 226 as shown in Figs. 3-4, electrical cable 208 may include one conductor set 244 including eight insulated conductors 226, or eight conductor sets 244 each including one insulated conductor 226. This flexibility in arrangements of conductor sets 244 and insulated conductors 226 allows electrical cable 208 to be configured suitable for the intended application. For example, conductor sets 244 and insulated conductors 226 may be configured to form a multiple twinaxial cable, i.e., multiple conductor sets 244 each including two insulated conductors 226, a multiple coaxial cable, i.e., multiple conductor sets 244 each including one insulated conductor 226, or a combination thereof. In other embodiments, a conductor set 244 may further include a conductive shield (not shown) disposed around the one or more insulated conductors 226, and an insulative jacket (not shown) disposed around the conductive shield.

In the embodiment illustrated in Figs. 3-4, electrical cable 208 further includes optional longitudinal ground conductors 250. Ground conductors 250 may include ground wires or drain wires. Ground conductors 250 are spaced apart from and extend in substantially the same direction as insulated conductors 226. Conductor sets 244 and ground conductors 250 are arranged generally in a single plane. Shielding films 246 are disposed around ground conductors 250 and conformable adhesive layer 248 bonds shielding films 246 to each other on both sides of ground conductors 250. Ground conductors 250 may electrically contact at least one of shielding films 246.

Examples of electrical cables that can be used in connector wafer assemblies according to aspects of the present invention are shown and described in U.S. Provisional Patent Application Nos. 61/218739, 61/260881, 61/348800, 61/352473, 61/378856, 61/378868, 61/378872, 61/378877, 61/378902, and 61/385670, each of which is incorporated by reference herein in its entirety.

In one embodiment, electrical cable 208 includes a conductor set, two generally parallel shielding films disposed around the conductor set, and a conformable adhesive layer disposed between the shielding films and bonding the shielding films to each other on both sides of the conductor set. The conductor set includes one or more substantially parallel longitudinal insulated conductors.

In one embodiment, electrical cable 208 includes a plurality of spaced apart conductor sets arranged generally in a single plane, two generally parallel shielding films disposed around the conductor sets, and a conformable adhesive layer disposed between the shielding films and bonding the shielding films to each other on both sides of each conductor set. Each conductor set includes one or more substantially parallel longitudinal insulated conductors.

In one embodiment, electrical cable 208 includes a conductor set including one or more substantially parallel longitudinal insulated conductors, at least one longitudinal ground conductor spaced apart from and extending in substantially the same direction as the one or more insulated conductors, two generally parallel shielding films disposed around the conductor set and the ground conductor, and a conformable adhesive layer disposed between the shielding films and bonding the shielding films to each other on both sides of the conductor set and the ground conductor. The conductor set and the ground conductor are arranged generally in a single plane.

In one embodiment, electrical cable 208 includes a conductor set, two generally parallel shielding films disposed around the conductor set, and a transition portion defined by the shielding films and the conductor set. The conductor set includes one or more substantially parallel longitudinal insulated conductors. The shielding films include a concentric portion substantially concentric with at least one of the conductors and a parallel portion wherein the shielding films are substantially parallel. The transition portion provides a gradual transition between the concentric portion and the parallel portion of the shielding films.

In one embodiment, electrical cable 208 includes a plurality of spaced apart conductor sets arranged generally in a single plane, two generally parallel shielding films disposed around the conductor sets, and a plurality of transition portions defined by the shielding films and the conductor sets. Each conductor set includes one or more substantially parallel longitudinal insulated conductors. The shielding films include a plurality of concentric portions substantially concentric with at least one of the conductors and a plurality of parallel portions wherein the shielding films are substantially parallel.

The transition portions provide a gradual transition between the concentric portions and the parallel portions of the shielding films.

In one embodiment, electrical cable 208 includes a conductor set and two generally parallel shielding films disposed around the conductor set. The conductor set includes one or more substantially parallel longitudinal insulated conductors. The shielding films include a parallel portion wherein the shielding films are substantially parallel. The parallel portion is configured to electrically isolate the conductor set.

In one embodiment, electrical cable 208 includes at least two spaced apart conductor sets arranged generally in a single plane and two generally parallel shielding films disposed around the conductor sets. Each conductor set includes one or more substantially parallel longitudinal insulated conductors. The shielding films include a parallel portion wherein the shielding films are substantially parallel. The parallel portion is configured to electrically isolate adjacent conductor sets from each other.

In one embodiment, electrical cable 208 includes at least one longitudinal ground conductor, an electrical article extending in substantially the same direction as the ground conductor, and two generally parallel shielding films disposed around the ground conductor and the electrical article.

In one embodiment, electrical cable 208 includes two spaced apart substantially parallel longitudinal ground conductors, an electrical article positioned between and extending in substantially the same direction as the ground conductors, and two generally parallel shielding films disposed around the ground conductors and the electrical article.

In one embodiment, electrical cable 208 includes a conductor set and a shielding film. The conductor set includes one or more substantially parallel longitudinal insulated conductors. The shielding film includes a cover portion partially covering the conductor set, and parallel portions extending from both sides of the conductor set.

In one embodiment, electrical cable 208 includes a plurality of spaced apart conductor sets arranged generally in a single plane and a shielding film. Each conductor set includes one or more substantially parallel longitudinal insulated conductors. The shielding film includes a plurality of cover portions partially covering the conductor sets, and a parallel portion disposed between adjacent conductor sets and configured to electrically isolate the adjacent conductor sets from each other.

Electrical cable 208 may be suitable for high speed data transmission and may have unique and beneficial properties and characteristics. Electrical cable 208 may be in a generally planar or ribbon format, with multiple channels or conductor sets extending along a length dimension of the cable and spaced apart from each other along a width dimension of the cable.

Electrical cable 208 may provide high packing density in a limited cable width, preferably while maintaining adequate high frequency electrical isolation and/or low crosstalk between different channels or conductor sets of the cable. Electrical cable 208 may provide an on-demand or localized drain wire feature. Electrical cable 208 may provide multiple drain wires, and the drain wires may be attached differently to different termination components on opposite ends of the cable. Electrical cable 208 may provide mixed conductor sets, e.g., one or more conductor sets adapted for high speed data transmission, and one or more conductor sets adapted for lower speed data transmission or power transmission. Electrical cable 208 may provide only one of these beneficial design features, or may provide combinations of some or all of these features.

Electrical cable 208 may include conductor sets each including one or more insulated conductors, and a first and second shielding film on opposite sides of the cable. In transverse cross section, cover portions of the shielding films may substantially surround each conductor set, and pinched portions of the films may form pinched portions of the cable on each side of each conductor set. Dense packing can be achieved while maintaining high frequency electrical isolation between conductor sets. When the cable is laid flat, a quantity S/Dmin may be in a range from 1.7 to 2, where S is a center-to-center spacing between nearest insulated conductors of two adjacent conductor sets, and Dmin is the lesser of the outer dimensions of such nearest insulated conductors. Alternatively, a first and second conductor set each having only one pair of insulated conductors can satisfy a condition that Σ/σ is in a range from 2.5 to 3, where Σ is a center-to-center spacing of the conductor sets, and σ is a center-to-center spacing of the pair of insulated conductors of one of the conductor sets.

In some cases, each pair of adjacent conductor sets in the plurality of conductor sets may have a quantity corresponding to S/Dmin in the range from 1.7 to 2. In some cases, each of the conductor sets may have only one pair of insulated conductors, and a quantity $\Sigma avg/\sigma avg$ may be in a range from 2.5 to 3, where σavg is an average center-to-center spacing of the pair of insulated conductors for the various conductor sets, and Σavg is an average center-to-center spacing between adjacent conductor sets. In some cases, cover portions of the first and second shielding films in combination substantially surround each conductor set by encompassing at least 75% of a periphery of each conductor set. In some cases, the first conductor set may have a high frequency isolation between adjacent insulated conductors characterized by a crosstalk C1 at a specified frequency in a range from 3-15 GHz and for a 1 meter cable length, and a high frequency isolation between the first and second conductor sets may be characterized by a crosstalk C2 at the specified frequency, and C2 may be at least 10 dB lower than C1. In some cases, one or both shielding films may include a conductive layer disposed on a dielectric substrate. In some cases, the cable may include a first drain wire in electrical contact with at least one of the first and second shielding films. Second cover portions of the first and second shielding films may substantially surround the first drain wire in transverse cross section. The first drain wire may be characterized by a drain wire distance σ1 to a nearest insulated wire of a nearest conductor set, and the nearest conductor set may be characterized by a center-to-center spacing of insulated conductors of σ2, and σ1/σ2 may be greater than 0.7.

In one embodiment, electrical cable 208 includes a plurality of conductor sets, a first shielding film, and a first drain wire. The plurality of conductor sets extend along a length of the cable and are spaced apart from each other along a width of the cable, each conductor set including one or more insulated conductors. The first shielding film may include cover portions and pinched portions arranged such that the cover portions cover the conductor sets and the pinched portions are disposed at pinched portions of the cable on each side of each conductor set. The first drain wire may be in electrical contact with the first shielding film and may also extend along the length of the cable. Electrical contact of the first drain wire to the first shielding film may be localized at at least a first treated area.

The electrical contact of the first drain wire to the first shielding film at the first treated area may be characterized by a DC resistance of less than 2 ohms. The first shielding film may cover the first drain wire at the first treated area and at a second area, the second area being at least as long as the first treated area, and a DC resistance between the first drain wire and the first shielding film may be greater than 100 ohms at the second area. In some cases, a dielectric material may separate the first drain wire from the first shielding film at the second area, and at the first treated area there may be little or no separation of the first drain wire from the first shielding film by the dielectric material.

In one embodiment, electrical cable 208 includes a plurality of conductor sets, a first shielding film, and first and second drain wires. The plurality of conductor sets may extend along a length of the cable and be spaced apart from each other along a width of the cable, each conductor set including one or more insulated conductors. The first shielding film may include cover portions and pinched portions arranged such that the cover portions cover the conductor sets and the pinched portions are disposed at pinched portions of the cable on each side of each conductor set. The first and second drain wires may extend along the length of the cable, and may be electrically connected to each other at least as a result of both of them being in electrical contact with the first shielding film. For example, a DC resistance between the first shielding film and the first drain wire may be less than 10 ohms, or less than 2 ohms. This cable may be combined with one or more first termination components at a first end of the cable and one or more second termination components at a second end of the cable.

In such combination, the first and second drain wires may be members of a plurality of drain wires extending along the length of the cable, and a number $n1$ of the drain wires may connect to the one or more first termination components, and a number $n2$ of the drain wires may connect to the one or more second termination components. The number $n1$ may not be equal to $n2$. Furthermore, the one or more first termination components may collectively have a number $m1$ of first termination components, and the one or more second termination components may collectively have a number $m2$ of second termination components. In some cases, $n2 > n1$, and $m2 > m1$. In some cases, $m1 = 1$. In some cases, $m1 = m2$. In some cases, $m1 < m2$. In some cases, $m1 > 1$ and $m2 > 1$.

In some cases, the first drain wire may electrically connect to the one or more first termination components but may not electrically connect to the one or more second termination components. In some cases, the second drain wire may electrically connect to the one or more second termination components but may not electrically connect to the one or more first termination components.

In one embodiment, electrical cable 208 includes a plurality of conductor sets and a first shielding film. The plurality of conductor sets may extend along a length of the cable and be spaced apart from each other along a width of the cable, each conductor set including one or more insulated conductors. The first shielding film may include cover portions and pinched portions arranged such that the cover portions cover the conductor sets and the pinched portions are disposed at pinched portions of the cable on each side of each conductor set. Advantageously, the plurality of conductor sets may include one or more first conductor sets adapted for high speed data transmission and one or more second conductor sets adapted for power transmission or low speed data transmission.

The electrical cable may also include a second shielding film disposed on an opposite side of the cable from the first shielding film. In some cases, the cable may include a first drain wire in electrical contact with the first shielding film and also extending along the length of the cable. A DC resistance between the first shielding film and the first drain wire may be less than 10 ohms, or less than 2 ohms, for example. The one or more first conductor sets may include a first conductor set including a plurality of first insulated conductors having a center-to-center spacing of $\sigma 1$, and the one or more second conductor sets may include a second conductor set including a plurality of second insulated conductors having a center-to-center spacing of $\sigma 2$, and $\sigma 1$ may be greater than $\sigma 2$. The insulated conductors of the one or more first conductor sets may all be arranged in a single plane when the cable is laid flat. Furthermore, the one or more second conductor sets may include a second conductor set having a plurality of the insulated conductors in a stacked arrangement when the cable is laid flat. The one or more first conductor sets may be adapted for maximum data transmission rates of at least 1 Gbps (i.e., 1 gigabit per second, or about 0.5 GHz), up to e.g. 25 Gbps (about 12.5 GHz) or more, or for a maximum signal frequency of at least 1 GHz, for example, and the one or more second conductor sets may be adapted for maximum data transmission rates that are less than 1 Gbps (about 0.5 GHz) or less than 0.5 Gbps (about 250 MHz), for example, or for a maximum signal frequency of less than 1 GHz or 0.5 GHz, for example. The one or more first conductor sets may be adapted for maximum data transmission rates of at least 3 Gbps (about 1.5 GHz).

In one embodiment, electrical cable 208 includes at least one conductor set including at least two elongated conductors extending from end-to-end of the cable, wherein each of the conductors are encompassed along a length of the cable by respective first dielectrics. Electrical cable 208 further includes a first and second film extending from end-to-end of the cable and disposed on opposite sides of the cable, wherein the conductors are fixably coupled to the first and second films such that a consistent spacing is maintained between the first dielectrics of the conductors of each conductor set along the length of the cable. Electrical cable 208 further includes a second dielectric disposed within the spacing between the first dielectrics of the wires of each conductor set.

In more particular embodiments, the second dielectric may include an air gap that extends continuously along the length of the cable between closest points of proximity between the first dielectrics of the conductors of each conductor set. In any of these embodiments, the first and second films may include first and second shielding films. In such a case, the first and second shielding films may be arranged so that, in a transverse cross section of the cable, at least one conductor is only partially surrounded by a combination of the first and second shielding films.

In any of these configurations, the cable may further include a drain wire disposed along the length of the cable and in electrical communication with at least one of the first and second shielding films.

In any of these embodiments, at least one of the first and second films may be conformably shaped to, in transverse cross section of the cable, partially surround each conductor set. For example, both the first and second films may be in combination conformably shaped to, in transverse cross section of the cable, substantially surround each conductor set. In such case, flattened portions of the first and second films may be coupled together to form a flattened cable portion on each side of at least one conductor set.

In any of these embodiments, the first dielectrics of the conductors may be bonded to the first and second films. In such a case, at least one of the first and second films may include: a rigid dielectric layer; a shielding film fixably coupled to the rigid dielectric layer; and a deformable dielectric adhesive layer that bonds the first dielectrics of the conductors to the rigid dielectric layer.

In any of these embodiments, the cable may further include one or more insulating supports fixably coupled between the first and second films along the length of the cable. In such case, at least one of the insulating supports may be disposed between two adjacent conductor sets, and or at least one of the insulating supports may be disposed between the conductor set and a longitudinal edge of the cable.

In any of these embodiments, a dielectric constant of the first dielectrics may be higher than a dielectric constant of the second dielectric. Also in any of these embodiments, the at least one conductor set may be adapted for maximum data transmission rates of at least 1 Gb/s.

In one embodiment, electrical cable 208 includes a plurality of conductor sets each including a differential pair of wires extending from end-to-end of the cable, wherein each of the wires are encompassed by respective dielectrics. The cable further includes first and second shielding films extending from end-to-end of the cable and disposed on opposite sides of the cable. The wires are bonded to the first and second films such that a consistently spaced air gap extends continuously along a length of the cable between closest points of proximity between the dielectrics of the wires of each differential pair. The first and second shielding films are conformably shaped to, in combination, substantially surround each conductor set in transverse cross section. Further, flattened portions of the first and second shielding films are coupled together to form a flattened cable portion on each side of each of the conductor sets.

In this embodiment, at least one of the first and second shielding films may include: a deformable dielectric adhesive layer bonded to the wires; a rigid dielectric layer coupled to the deformable dielectric layer; and a shielding film coupled to the rigid dielectric layer. Further, any of these embodiments may include at least one of the conductor sets that is adapted for maximum data transmission rates of at least 1 Gb/s.

In one embodiment, electrical cable 208 includes a plurality of conductor sets extending along a length of the cable and being spaced apart from each other along a width of the cable. Each conductor set includes one or more insulated conductors. The cable also includes first and second shielding films disposed on opposite sides of the cable. The first and second films include cover portions and pinched portions arranged such that, in transverse cross section, the cover portions of the first and second films in combination substantially surround each conductor set. The pinched portions of the first and second films in combination form pinched portions of the cable on each side of each conductor set. Electrical cable 208 further includes a first adhesive layer bonding the first shielding film to the second shielding film in the pinched portions of the cable. The plurality of conductor sets includes a first conductor set that includes neighboring first and second insulated conductors and has corresponding first cover portions of the first and second shielding films and corresponding first pinched portions of the first and second shielding films forming a first pinched cable portion on one side of the first conductor set. A selected one of the insulated conductors has a wire diameter no greater than 24 American wire gauge (AWG), and a transverse bending of the cable at a cable location of no more than 180 degrees over an inner radius of at most 2 mm causes a cable impedance of the selected insulated conductor proximate the cable location to vary by no more than 2 percent from an initial cable impedance measured at the cable location in an unbent configuration.

In one configuration, the wire diameter of the selected insulated conductor may be no greater than 26 AWG, and wherein a transverse bending of a cable location of no more than 180 degrees over an inner radius of at most 1 mm causes the cable impedance of the selected insulated conductor proximate the cable location to vary by no more than 1 percent from the initial cable impedance. In another configuration, the selected insulated conductor may be part of a selected one of the conductor sets that includes at least two insulated conductors each having a wire diameter no greater than 24 AWG and a nominal differential impedance of 100 ohms. In such a case, the transverse bending of the cable causes a differential cable impedance of the selected conductor set proximate the cable location to vary by no more than 2 ohms from an initial differential cable impedance measured at the cable location in the unbent configuration. Also in such a case, the wire diameter of the at least two insulated conductors may be no greater than 26 AWG, and therefore the transverse bending of a cable location of no more than 180 degrees over a second inner radius of at most 1 mm causes the differential cable impedance of the selected conductor set proximate the cable location to vary by no more than 1 ohm from the initial differential impedance.

In any of the embodiments above, the selected insulated conductor may have a nominal cable impedance of 50 ohms, and in such a case the cable impedance of the selected insulated conductor proximate the cable location varies by no more than 1 ohm from the initial cable impedance. In any of these embodiments, the cable may further include a bend of at least 45 degrees around a fold line that extends across a width of the cable, wherein the bend has an inner radius of at most 5 mm. In such a case, the bend may be at least 90 degrees and conforms to geometry of a structure that encloses the cable, and/or the bend may be at least 180 degrees and the fold line is at a fold angle relative to a longitudinal edge of the cable such that the cable turns at a turn angle in response to flattening of proximate regions before and after the bend to a plane. In the latter case, the fold angle may be 45 degrees, and the turn angle 90 degrees.

In one embodiment, electrical cable 208 includes a plurality of conductor sets extending along a length of the cable and being spaced apart from each other along a width of the cable. Each conductor set includes one or more insulated conductors. The cable also includes first and second shielding films disposed on opposite sides of the cable. The first and second films including cover portions and pinched portions arranged such that, in transverse cross section, the cover portions of the first and second films in combination substantially surround each conductor set. The pinched portions of the first and second films in combination form pinched portions of the cable on each side of each conductor set. Electrical cable 208 further includes a first adhesive layer bonding the first shielding film to the second shielding film in the pinched portions of the cable. The plurality of conductor sets includes a first conductor set that includes neighboring first and second insulated conductors and has corresponding first cover portions of the first and second shielding films and corresponding first pinched portions of the first and second shielding films forming a first pinched cable portion on one side of the first conductor set. A selected one of the insulated conductors has a wire diameter no greater than 24 American wire gauge (AWG), and a transverse bending of the cable at a cable location of no more than 180 degrees over an inner radius of at most 5 mm causes an insertion loss of the selected insulated conductor proximate the cable location to vary by no more than 0.5 dB from an initial insertion loss measured at the cable location in an unbent configuration.

In this embodiment, electrical cable 208 may further include a bend of at least 45 degrees around a fold line that extends across a width of the cable, wherein the bend has an inner radius of at most 5 mm. In such a case, the bend may be at least 90 degrees and conforms to geometry of a structure that encloses the cable, and/or the bend may be at least 180 degrees and the fold line is at a fold angle relative to a longitudinal edge of the cable such that the cable turns at a turn angle in response to flattening of proximate regions before and after the bend to a plane. In the latter case, the fold angle may be 45 degrees, and the turn angle 90 degrees.

In one embodiment, electrical cable 208 includes a plurality of conductor sets extending along a length of the cable and being spaced apart from each other along a width of the cable. Each conductor set includes one or more insulated conductors. The cable also includes first and second shielding films disposed on opposite sides of the cable. The first and second films include cover portions and pinched portions arranged such that, in transverse cross section, the cover portions of the first and second films in combination substantially surround each conductor set. The pinched portions of the first and second films in combination form pinched portions of the cable on each side of each conductor set. Electrical cable 208 further includes a first adhesive layer bonding the first shielding film to the second shielding film in the pinched portions of the cable. The plurality of conductor sets includes a first conductor set that includes neighboring first and second insulated conductors and has corresponding first cover portions of the first and second shielding films and corresponding first pinched portions of the first and second shielding films forming a first pinched cable portion on one side of the first conductor set. An application of a force on the cable, the cable being simply supported between two supporting points that are 3.0 inches apart and the force being applied midpoint between the supporting points, results in a deflection in the direction of the force of at least one inch. The force, measured in pounds-force, does not exceed the sum of individual forces for each of the insulated conductors, the individual forces being equal to 11000 times a wire diameter cubed of the respective insulated conductor, the wire diameter being expressed in inches.

In one arrangement, the wire diameter may be no greater than 24 American wire gauge (AWG). In any of these arrangements, the maximum force may occur when the deflection is between 1 inch and 1.5 inches. Similarly, the cable in any of these arrangement may further include a bend of at least 45 degrees around a fold line that extends across a width of the cable, wherein the bend has an inner radius of at most 5 mm. In such a case, the bend may be at least 90 degrees and conform to geometry of a structure that encloses the cable. Or, in such a case, the bend may be at least 180 degrees and the fold line is at a fold angle relative to a longitudinal edge of the cable such that the cable turns at a turn angle in response to flattening of proximate regions before and after the bend to a plane. For example, the fold angle may 45 degrees, and the turn angle 90 degrees.

In one embodiment, electrical cable 208 includes a plurality of conductor sets extending along a length of the cable and being spaced apart from each other along a width of the cable, each conductor set including one or more insulated conductors. First and second shielding films are disposed on opposite sides of the cable, the first and second films including cover portions and pinched portions arranged such that, in transverse cross section, the cover portions of the first and second films in combination substantially surround each conductor set, and the pinched portions of the first and second films in combination form pinched portions of the cable on each side of each conductor set. A first adhesive layer bonds the first shielding film to the second shielding film in the pinched portions of the cable. The plurality of conductor sets includes a first conductor set that includes neighboring first and second insulated conductors and has corresponding first cover portions of the first and second shielding films and corresponding first pinched portions of the first and second shielding films forming a first pinched region of the cable on one side of the first conductor set. A maximum separation between the first cover portions of the first and second shielding films is D. A minimum separation between the first pinched portions of the first and second shielding films is d_1, and d_1/D is less than 0.25 or less than 0.1. A minimum separation between the first cover portions of the first and second shielding films in a region between the first and second insulated conductors is d_2, and d_2/D is greater than 0.33.

In one embodiment, electrical cable 208 includes a plurality of conductor sets extending along a length of the cable and being spaced apart from each other along a width of the cable, each conductor set including one or more insulated conductors. First and second shielding films are disposed on opposite sides of the cable, the first and second films including cover portions and pinched portions arranged such that, in transverse cross section, the cover portions of the first and second films in combination substantially surround each conductor set, and the pinched portions of the first and second films in combination form pinched portions of the cable on each side of each conductor set. A first adhesive layer bonds the first shielding film to the second shielding film in the pinched portions of the cable. The plurality of conductor sets includes a first conductor set that includes neighboring first and second insulated conductors and has corresponding first cover portions of the first and second shielding films and corresponding first pinched portions of the first and second shielding films forming a first pinched cable portion on one side of the first conductor set. A maximum separation between the first cover portions of the first and second shielding films is D. A minimum separation between the first pinched portions of the first and second shielding films is d_1, and d_1/D is less than 0.25 or is less than 0.1. A high frequency electrical isolation of the first insulated conductor relative to the second insulated conductor is substantially less than a high frequency electrical isolation of the first conductor set relative to an adjacent conductor set.

The high frequency isolation of the first insulated conductor relative to the second conductor is a first far end crosstalk C1 at a specified frequency range of 3-15 GHz and a length of 1 meter, and the high frequency isolation of the first conductor set relative to the adjacent conductor set is a second far end crosstalk C2 at the specified frequency, and wherein C2 is at least 10 dB lower than C1.

The cover portions of the first and second shielding films in combination substantially surround each conductor set by encompassing at least 70% of a periphery of each conductor set.

In one embodiment, electrical cable 208 includes a plurality of conductor sets extending along a length of the cable and being spaced apart from each other along a width of the cable, each conductor set including one or more insulated conductors. First and second shielding films including concentric portions, pinched portions, and transition portions arranged such that, in transverse cross section, the concentric portions are substantially concentric with one or more end conductors of each conductor set, the pinched portions of the first and second shielding films in combination form pinched portions of the cable on two sides of the conductor set, and the transition portions provide gradual transitions between the concentric portions and the pinched portions. Each shielding film includes a conductive layer and a first one of the transition portions is proximate a first one of the one or more end conductors and has a cross-sectional area A_1 defined as an area between the conductive layers of the first and second shielding films, the concentric portions, and a first one of the pinched portions proximate the first end conductor, wherein A_1 is less than a cross-sectional area of the first end conductor. Each shielding film is characterizable in transverse cross section by a radius of curvature that changes across the width of the cable, the radius of curvature for each of the shielding films being at least 100 micrometers across the width of the cable.

The cross-sectional area A_1 may have as one boundary a boundary of the first pinched portion, the boundary defined by the position along the first pinched portion at which a separation d between the first and second shielding films may be about 1.2 to about 1.5 times a minimum separation d_1 between the first and second shielding films at the first pinched portion.

The cross-sectional area A_1 may have as one boundary a line segment having a first endpoint at an inflection point of the first shielding film. The line segment may have a second endpoint at an inflection point of the second shielding film.

In one embodiment, electrical cable 208 includes a plurality of conductor sets extending along a length of the cable and being spaced apart from each other along a width of the cable, each conductor set including one or more insulated conductors. First and second shielding films include concentric portions, pinched portions, and transition portions arranged such that, in transverse cross section, the concentric portions are substantially concentric with one or more end conductors of each conductor set, the pinched portions of the first and second shielding films in combination form pinched regions of the cable on two sides of the conductor set, and the transition portions provide gradual transitions between the concentric portions and the pinched portions. One of the two shielding films includes a first one of the concentric portions, a first one of the pinched portions, and a first one of the transition portions, the first transition portion connecting the first concentric portion to the first pinched portion. The first concentric portion has a radius of curvature R_1 and the transition portion has a radius of curvature r_1, andR_1/r_1 is in a range from 2 to 15.

A characteristic impedance of the cable may remain within 5-10 % of a target characteristic impedance over a cable length of 1 meter.

In one embodiment, electrical cable 208 includes at least one conductor set including at least two elongated conductors extending from end-to-end of the cable, wherein each of the conductors are encompassed along a length of the cable by respective first dielectrics. A first and second film extend from end-to-end of the cable and disposed on opposite sides of the cable and, wherein the conductors are fixably coupled to the first and second films such that a consistent spacing is maintained between the first dielectrics of the conductors of each conductor set along the length of the cable. A second dielectric disposed within the spacing between the first dielectrics of the wires of each conductor set.

In one embodiment, electrical cable 208 includes a plurality of conductor sets extending lengthwise along the cable and being spaced apart from each other along a width of the cable, and each conductor set including one or more insulated conductors, the conductor sets including a first conductor set adjacent a second conductor set. First and second shielding films disposed on opposite sides of the cable, the first and second films including cover portions and pinched portions arranged such that, in transverse cross section, the cover portions of the first and second films in combination substantially surround each conductor set, and the pinched portions of the first and second films in combination form pinched portions of the cable on each side of each conductor set. When the cable is laid flat, a first insulated conductor of the first conductor set is nearest the second conductor set, and a second insulated conductor of the second conductor set is nearest the first conductor set, and the first and second insulated conductors have a center-to-center spacing S. The first insulated conductor has an outer dimension D1 and the second insulated conductor has an outer dimension D2, and S/Dmin is in a range from 1.7 to 2, where Dmin is the lesser of D1 and D2.

In one embodiment, electrical cable 208 includes one or more conductor sets extending along a length of the cable and being spaced apart from each other along a width of the cable. Each conductor set has one or more conductors having a size no greater than 24 AWG and each conductor set has an insertion loss of less than -20 dB/meter over a frequency range of 0 to 20GHz. First and second shielding films are disposed on opposite sides of the cable, the first and second films including cover portions and pinched portions arranged such that, in transverse cross section, the cover portions of the first and second films in combination substantially surround each conductor set, and the pinched portions of the first and second films in combination form pinched portions of the cable on each side of each conductor. A maximum separation between the first cover portions of the first and second shielding films is D, a minimum separation between the first pinched portions of the first and second shielding films is d_1, and d_1/D is less than about 0.25.

The conductor set may include two conductors in a twinaxial arrangement and the insertion loss due to resonance of the conductor set may be about zero.

The conductor set may include two conductors in a twinaxial arrangement, and a nominal insertion loss without insertion loss due to resonance may be about 0.5 times the insertion loss due to resonance of the conductor set.

The cable may include an adhesive layer disposed between the pinched portions of the shielding films.

The insertion loss of each conductor set may be less than about -5 dB per meter or about -4dB per meter, or about -3 dB per meter.

The cable may have a skew of less than about 20 psec/meter or less than about 10 psec/meter at data transfer speeds of up to about 10 Gbps.

The cable may have a characteristic impedance that remains within 5-10 % of a target characteristic impedance over a cable length of about 1 meter.

One or more conductor sets of the cable may include a first conductor set and a second conductor set, each conductor set having a first insulated conductor and a second insulated conductor and a high frequency electrical isolation of the first insulated conductor relative to the second insulated conductor in each conductor set may be substantially less than a high frequency electrical isolation of the first conductor set relative to an adjacent conductor set.

The high frequency isolation of the first insulated conductor relative to the second conductor is a first far end crosstalk C1 at a specified frequency range of 5-15 GHz and a length of 1 meter, and the high frequency isolation of the first conductor set relative to the adjacent conductor set is a second far end crosstalk C2 at the specified frequency. C2 can be at least 10 dB lower than C1.

The cable may have d_1/D less than 0.1.

In one embodiment, electrical cable 208 includes a plurality of conductor sets extending along a length of the cable and being spaced apart from each other along a width of the cable, each conductor set having two conductors having a size no greater than 24 AWG and each conductor set having a signal attenuation of less than -20 dB/meter over a frequency range of 0 to 20GHz. The cable also includes a drain wire and first and second shielding films disposed on opposite sides of the cable, the first and second shielding films including cover portions and pinched portions arranged such that, in transverse cross section, the cover portions of the first and second films, in combination, substantially surround each conductor set, and the pinched portions of the first and second films, in combination, form pinched portions of the cable on each side of each conductor set. For at least one conductor set, a separation between the drain wire and a closest conductor of the conductor set may be greater than 0.5 times a center to center spacing between the two conductors of the conductor set.

Electrical cable 208 may include a plurality of conductor sets extending along a length of the cable and being spaced apart from each other along a width of the cable, each conductor sets having two conductors arranged in a twinaxial configuration, each of the conductors having a size no greater than 24 AWG. First and second shielding films are disposed on opposite sides of the cable, neither shielding film includes a longitudinal fold that orients the shielding film to cover the conductor sets on both sides of the cable. Each conductor set has an insertion loss of less than -20 dB/meter over a frequency range of 0 to 20GHz and an insertion loss due to resonance of the conductor set is about zero.

The cable may also include at least one drain wire, wherein the first and second shielding films include cover portions and pinched portions arranged such that, in transverse cross section, the cover portions of the first and second films, in combination, substantially surround each conductor set, and the pinched portions of the first and second films, in combination, form pinched portions of the cable on each side of each conductor set, wherein, for at least one conductor set, a separation between the center of the drain wire and the center of closest conductor of the conductor set can be greater than 0.5 times a center to center spacing between the two conductors of the conductor set.

In one embodiment, electrical cable 208 includes a plurality of conductor sets extending along a length of the cable and being spaced apart from each other along a width of the cable, each of the conductors sets including two conductors arranged in a twinaxial configuration, neither conductor having a size greater than 24 AWG. First and second shielding films are disposed on opposite sides of the cable, neither shielding film including a seam that bonds the shielding film to itself, wherein each conductor set has an insertion loss of less than -20 dB/meter over a frequency range of 0 to 20GHz and an insertion loss due to resonance loss of the conductor set is about zero.

Each shielding film, individually, may surround less than all of a periphery of each conductor set.

In one embodiment, electrical cable 208 includes a plurality of conductor sets that extend along a length of the cable and are spaced apart from each other along a width of the cable. Each conductor set includes one or more insulated conductors; and first and second shielding films that are disposed on opposite first and second sides of the cable. The first and second films include cover portions and pinched portions arranged such that, in transverse cross section, the cover portions of the first and second films in combination substantially surround each conductor set, and the pinched portions of the first and second films in combination form pinched portions of the cable on each side of each conductor set. Each conductor set further includes a first EMI absorbing layer that is disposed on the first side of the cable; and a first adhesive layer that bonds the first shielding film to the second shielding film in the pinched portions of the cable. The plurality of the conductor sets includes a first conductor set that includes neighboring first and second insulated conductors and has corresponding first cover portions of the first and second shielding films and corresponding first pinched portions of the first and second shielding films that form a first pinched region of the cable on one side of the first conductor set. The maximum separation between the first cover portions of the first and second shielding films is D. The minimum separation between the first pinched portions of the first and second shielding films is d_1. d_1/D is less than 0.25. The minimum separation between the first cover portions of the first and second shielding films in a region between the first and second insulated conductors is d_2. d_2/D is greater than 0.33. In some cases, d_1/D is less than 0.1. In some cases, the first EMI absorbing layer is disposed between the first shielding film and the plurality of conductor sets. In some cases, the first shielding film is disposed between the first EMI absorbing layer and the plurality of conductor sets. In some cases, the cable further includes a second EMI absorbing layer that is disposed on the second side of the cable.

In one embodiment, electrical cable 208 includes a plurality of conductor sets that extend along a length of the cable and are spaced apart from each other along a width of the cable. Each conductor set includes one or more insulated conductors; and first and second shielding films that are disposed on opposite first and second sides of the cable. The first and second films include cover portions and pinched portions that are arranged such that, in transverse cross section, the cover portions of the first and second films in combination substantially surround each conductor set, and the pinched portions of the first and second films in combination form pinched portions of the cable on each side of each conductor set. Each conductor set further includes a first EMI absorbing layer that is disposed on the first side of the cable; and a first adhesive layer that bonds the first shielding film to the second shielding film in the pinched portions of the cable. The plurality of conductor sets includes a first conductor set that includes neighboring first and second insulated conductors and has corresponding first cover portions of the first and second shielding films and corresponding first pinched portions of the first and second shielding films that form a first pinched cable portion on one side of the first conductor set. The maximum separation between the first cover portions of the first and second shielding films is D. The minimum separation between the first pinched portions of the first and second shielding films is d_1. d_1/D is less than 0.25. The high frequency electrical isolation of the first insulated conductor relative to the second insulated conductor is substantially less than the high frequency electrical isolation of the first conductor set relative to an adjacent conductor set. In some cases, d_1/D is less than 0.1. In some cases, the high frequency isolation of the first insulated conductor relative to the second conductor is a first far end crosstalk C1 at a specified frequency range of 3-15 GHz and a length of 1 meter, and the high frequency isolation of the first conductor set relative to the adjacent conductor set is a second far end crosstalk C2 at the specified frequency, and C2 is at least 10 dB lower than C1. In some cases, the cover portions of the first and second shielding films in combination substantially surround each conductor set by encompassing at least 70% of a periphery of each conductor set.

In one embodiment, electrical cable 208 includes a plurality of conductor sets that extend along a length of the cable and are spaced apart from each other along a width of the cable. Each conductor set includes one or more insulated conductors; and first and second shielding films that include concentric portions, pinched portions, and transition portions arranged such that, in transverse cross section, the concentric portions are substantially concentric with one or more end conductors of each conductor set, the pinched portions of the first and second shielding films in combination form pinched portions of the cable on two sides of the conductor set, and the transition portions provide gradual transitions between the concentric portions and the pinched portions. Each conductor set also includes a first EMI absorbing layer that is disposed on the plurality of conductor sets. Each shielding film includes a conductive layer. A first one of the transition portions is proximate a first one of the one or more end conductors and has a cross-sectional area A_1 defined as an area between the conductive layers of the first and second shielding films, the concentric portions, and a first one of the pinched portions proximate the first end conductor. A_1 is less than the cross-sectional area of the first end conductor. Each shielding film is characterizable in transverse cross section by a radius of curvature that changes across the width of the cable. The radius of curvature for each of the shielding films is at least 100 micrometers across the width of the cable. In some cases, the cross-sectional area A_1 includes as one boundary a boundary of the first pinched portion. The boundary is defined by the position along the first pinched portion at which a separation d between the first and second shielding films is about 1.2 to about 1.5 times a minimum separation d_1 between the first and second shielding films at the first pinched portion. In some cases, the cross-sectional area A_1 includes as one boundary a line segment having a first endpoint at an inflection point of the first shielding film. In some cases, the line segment has a second endpoint at an inflection point of the second shielding film.

In one embodiment, electrical cable 208 includes a plurality of conductor sets that extend along a length of the cable and are spaced apart from each other along a width of the cable. Each conductor set includes one or more insulated conductors; and first and second shielding films that include concentric portions, pinched portions, and transition portions arranged such that, in transverse cross section, the concentric portions are substantially concentric with one or more end conductors of each conductor set, the pinched portions of the first and second shielding films in combination form pinched regions of the cable on two sides of the conductor set, and the transition portions provide gradual transitions between the concentric portions and the pinched portions. Each conductor set also includes a first EMI absorbing layer that is disposed on the plurality of conductor sets. One of the two shielding films includes a first one of the concentric portions, a first one of the pinched portions, and a first one of the transition portions. The first transition portion connects the first concentric portion to the first pinched portion. The first concentric portion has a radius of curvature R_1 and the transition portion has a radius of curvature r_1. R_1/r_1 is in a range from 2 to 15.

Referring now to Fig. 5, in one embodiment, connector wafer 202 further includes an insulative cover 210 disposed on top surface 222 of connector wafer body 204. Cover 210 functions to provide protection and electrical isolation of at least a portion of electrical contacts 206 and electrical cable 208. In one embodiment, cover 210 provides protection and electrical insulation of at least terminal portions 218 of electrical contacts 206, and end portions of conductors of electrical cable 208, such as, e.g., end portions 228 of insulated conductors 226 or end portions 252 of ground conductors 250. In one embodiment, cover 210 may have a shape corresponding to top surface 222 of connector wafer body 204. Cover 210 may be assembled to connector wafer body 204 using any suitable method/structure, including but not limited to snap fit, friction fit, press fit, mechanical clamping, and adhesive. In the illustrated embodiment, cover 210 has a generally U shape and includes a cover base portion 254 and pair of opposing cover side portions 256 extending from cover base portion 254. Cover side portions 256 may be used for the attachment of cover 210 to connector wafer body 204.

In each of the embodiments and implementations described herein, connector wafer body 204, electrical contacts 206, and cover 210 may be cooperatively configured in an impedance controlling relationship. An impedance controlling relationship here means that connector wafer body 204, electrical contacts 206, and cover 210 may be cooperatively configured to control the characteristic impedance of connector wafer 202. In one aspect, the design of connector wafer body 204, electrical contacts 206, and/or cover 210 may be adjusted, e.g., by changes in geometry, material, and/or relative location, to bring the characteristic impedance of connector wafer 202 closer to a desired target value, such as, for example, 50 ohms. In another aspect, the design of connector wafer body 204, electrical contacts 206, and/or cover 210 may be such that a desired consistency in geometry is accomplished along the length of connector wafer 202 such as to provide an acceptable impedance variation as suitable for the intended application. In one embodiment, this impedance variation is less than 5 ohms and preferably less than 3 ohms.

Referring now to Figs. 6-7, in one embodiment, connector wafer assembly 200 further includes a shielding tape 212 disposed on an end portion of electrical cable 208 and at least one of cover 210 and bottom surface 230 of connector wafer body 204. Shielding tape 212 provides electrical shielding to connector wafer assembly 200. In one embodiment, shielding tape 212 makes electrical contact with shielding films 246 of electrical cable 208. To establish a ground connection, shielding tape 212 may contact shielding films 246 directly, via one or more ground conductors 250, or via one or more electrical contacts 206 designated as ground contacts. Shielding tape 212 may be applied to an end portion of electrical cable 208 and cover 210 (as best seen in Fig. 6), an end portion of electrical cable 208 and bottom surface 230 of connector wafer body 204 (as best seen in Fig. 7), or both, and may include a single piece of tape or multiple pieces of tape. A single piece of tape may be wrapped around an end portion of electrical cable 208 and the assembly of connector wafer body 204 and cover 210. Multiple pieces of tape may be folded or pinched together to provide full shielding of the terminations.

Examples of shielding tapes that can be used in connector wafer assemblies according to aspects of the present invention include shielding tapes designed for applications requiring reliable point-to-point electrical contact, particularly EMI shielding, grounding and static charge draining. An exemplary shielding film includes a metal coated with an adhesive, such as, e.g., a copper foil coated with an acrylic pressure sensitive adhesive, and may be of any suitable thickness, such as, e.g., a thickness in the range of about 2.6 mils (0.066 mm) to about 5 mils (0.127 mm). In one embodiment, shielding tape 212 is smooth copper foil, having a thickness of about 2.6 mils (0.066 mm), with conductive acrylic adhesive, available under the trade designation 3M EMI Copper Foil Shielding Tape 1181, 2.6 Mil Copper Foil, from 3M Company, St. Paul, MN, U.S.A.

In each of the embodiments and implementations described herein, connector wafer body 204, electrical contacts 206, cover 210, and shielding tape 212 may be cooperatively configured in an impedance controlling relationship. An impedance controlling relationship here means that connector wafer body 204, electrical contacts 206, cover 210, and shielding tape 212 may be cooperatively configured to control the characteristic impedance of connector wafer 202. In one aspect, the design of connector wafer body 204, electrical contacts 206, cover 210, and/or shielding tape 212 may be adjusted, e.g., by changes in geometry, material, and/or relative location, to bring the characteristic impedance of connector wafer 202 closer to a desired target value, such as, for example, 50 ohms. In another aspect, the design of connector wafer body 204, electrical contacts 206, cover 210, and/or shielding tape 212 may be such that a desired consistency in geometry is accomplished along the length of connector wafer 202 such as to provide an acceptable impedance variation as suitable for the intended application. In one embodiment, this impedance variation is less than 5 ohms and preferably less than 3 ohms.

Figs. 8-9 illustrate an exemplary embodiment of a connector wafer assembly arrangement according to an aspect of the present invention. This arrangement includes a first connector wafer assembly 200a and a second connector wafer assembly 200b. First connector wafer assembly 200a includes a first connector wafer 202a and a first electrical cable 208a terminated to the electrical contacts of first connector wafer 202a. Second connector wafer assembly 200b includes a second connector wafer 202b and a second electrical cable 208b terminated to the electrical contacts of second connector wafer 202b. First and second connector wafer assemblies 200a, 200b (also referred to herein as connector wafer assemblies 200) are arranged such that bottom surface 230 of connector wafer body 204 of first connector wafer assembly 200a abuts bottom surface 230 of connector wafer body 204 of second connector wafer assembly 200b.

An exemplary embodiment of a connector wafer arrangement according to an aspect of the present invention includes a first connector wafer 202a and a second connector wafer 202b. First and second connector wafers 202a, 202b (also referred to herein as connector wafers 202) are arranged such that bottom surface 230 of connector wafer body 204 of first connector wafer 202a abuts bottom surface 230 of connector wafer body 204 of second connector wafer 202b.

Figs. 10-11 illustrate the assembly of electrical cable connector assembly 100, whereby first and second connector wafer assemblies 200a, 200b are inserted in shielded connector housing 400 such that bottom surface 230 of connector wafer body 204 of first connector wafer assembly 200a abuts bottom surface 230 of connector wafer body 204 of second connector wafer assembly 200b, and mating portion A extends through opening 426 in front wall 406 of connector body 402 into mating cavity 420 of shield member 404. To cooperatively retain first and second connector wafers 202a, 202b in shielded connector housing 400, first and second connector wafers 202a, 202b and shielded connector housing 400 include cooperative latch members 258. Latch members 258 may have any suitable configuration. In the embodiment illustrated in Figs. 10-11, opposing side walls 412 of connector body 402 each include a latch opening 258a (as part of latch member 258) and connector wafer body includes opposing side surfaces 260 and a latch 258b (as part of latch member 258) extending from each of opposing side surfaces 260 (Fig. 3). Latch opening 258a and latch 258b are configured to cooperatively retain first and second connector wafers 202a, 202b in shielded connector housing 400. First and second connector wafers 202a, 202b may be retained in shielded connector housing 400 using any suitable method/structure, including but not limited to snap fit, friction fit, press fit, mechanical clamping, and adhesive.

In some applications, it may be advantageous to arrange first electrical cable 208a of first connector wafer assembly 200a and second electrical cable 208b of second connector wafer assembly 200b in a nested configuration. Examples of electrical cables arranged in a nested configuration that can be used in electrical cable connector assemblies according to aspects of the present invention are shown and described in U.S. Provisional Patent Application No. 61/378640, incorporated by reference herein in its entirety. A nested configuration of first and second electrical cables 208a, 208b (also referred to herein as electrical cables 208) enables a higher linear cable density than a conventional electrical cable arrangement, wherein a first electrical cable and a second electrical cable are, for example, in a stacked configuration, wherein the cable arrangement has a thickness that is equal to the combined thickness of the first electrical cable and the second electrical cable. A higher linear cable density beneficially enables applications wherein the conductor sets can be packed more densely. For example, if insulated conductors 226 are relatively large and the contact elements to which insulated conductors 226 are to be terminated are relatively small, then a higher linear density could be beneficial. Another example is where two or more electrical cables must route through a relatively thin channel. Compared to conventional cable arrangements, other benefits of a cable arrangement wherein electrical cables are arranged in a nested configuration may include a higher degree of electrical shielding between adjacent conductor sets of adjacent electrical cables, mechanical flexibility as a result of sliding between adjacent electrical cables, and the ability to terminate insulated conductors in a longitudinal and/or lateral staggered formation, thereby reducing crosstalk at the termination location.

In one embodiment, an electrical cable arrangement includes first electrical cable 208a and second electrical cable 208b. First electrical cable 208a includes first and second conductor sets including two or more substantially parallel longitudinal insulated conductors and a first carrier film. The first carrier film includes cover portions at least partially covering each of the first and second conductor sets, and parallel portions extending from both sides of each of the first and second conductor sets. The parallel portions form pinched portions of first electrical cable 208a. The cable includes a first pinched portion between the first and second conductor sets. Second electrical cable 208b includes a third conductor set including two or more substantially parallel longitudinal insulated conductors and a second carrier film. The second carrier film includes a cover portion at least partially covering the third conductor set, and parallel portions extending from both sides of the third conductor set. The parallel portions form pinched portions of second electrical cable 208b. First electrical cable 208a and second electrical cable 208b extend in substantially the same direction and are arranged in a nested configuration such that the insulated conductors of the third conductor set are disposed within the first pinched portion of first electrical cable 208a.

In one embodiment, an electrical cable arrangement includes first electrical cable 208a and second electrical cable 208b. First electrical cable 208a includes a plurality of spaced apart first conductor sets arranged generally in a single plane and two generally parallel first carrier films disposed around the first conductor sets. Each first conductor set includes one or more substantially parallel longitudinal insulated conductors, a minimum spacing between neighboring first conductor sets being a first distance. Second electrical cable 208b includes a plurality of spaced apart second conductor sets arranged generally in a single plane and two generally parallel second carrier films disposed around the second conductor sets. Each second conductor set includes one or more substantially parallel longitudinal insulated conductors, a maximum width of the second conductor sets being a second distance less than the first distance. First electrical cable 208a and second electrical cable 208b extend in substantially the same direction and are arranged in a nested configuration such that the first conductor sets and second conductor sets overlap along a thickness direction of the electrical cable arrangement.

In one embodiment, an electrical cable arrangement includes first electrical cable 208a and second electrical cable 208b. Each cable includes a plurality of conductor sets and first and second shielding films disposed on opposite sides of the cable. The plurality of conductor sets extend along a length of the cable and are spaced apart from each other along a width of the cable. Each conductor set includes one or more insulated conductors. The first and second shielding films include cover portions and pinched portions arranged such that, in transverse cross section, the cover portions of the first and second shielding films in combination substantially surround each conductor set, and the pinched portions of the first and second shielding films in combination form pinched portions of the cable on each side of each conductor set. Second electrical cable 208b is disposed on first electrical cable 208a such that the conductor sets of each cable are at least partially disposed within the pinched portions of the other cable.

In one embodiment, an electrical cable arrangement includes first electrical cable 208a and second electrical cable 208b. Each cable includes a plurality of conductor sets and first and second shielding films disposed on opposite sides of the cable. The plurality of conductor sets extend along a length of the cable and are spaced apart from each other along a width of the cable. Each conductor set includes one or more insulated conductors. The first and second shielding films include cover portions and pinched portions arranged such that, in transverse cross section, the cover portions of the first and second shielding films in combination substantially surround each conductor set, and the pinched portions of the first and second shielding films in combination form pinched portions of the cable on each side of each conductor set. Second electrical cable 208b is disposed on first electrical cable 208a such that when the electrical cable arrangement is in a planar configuration, the shielding films of the first and second electrical cables 208a, 208b overlap along a thickness direction of the cable arrangement.

In each of the embodiments and implementations described herein, the various exemplary embodiments of an electrical connector according to an aspect of the present invention and elements thereof are formed of any suitable material. The materials are selected depending upon the intended application and may include both metals and non-metals (e.g., any one or combination of non-conductive materials including but not limited to polymers, glass, and ceramics). In one embodiment, connector body 402, connector wafer body 204, and cover 210 are formed of a polymeric material by methods such as injection molding, extrusion, casting, machining, and the like, while shield member 404 and electrical contacts 206 are formed of metal by methods such as molding, casting, stamping, machining, and the like. Material selection will depend upon factors including, but not limited to, chemical exposure conditions, environmental exposure conditions including temperature and humidity conditions, flame-retardancy requirements, material strength, and rigidity, to name a few.

Following are exemplary embodiments of a connector wafer, a connector wafer assembly, a connector wafer arrangement, a connector wafer assembly arrangement, an electrical cable connector, and an electrical cable connector assembly according to aspects of the present invention.

Embodiment 1 is a connector wafer comprising: a planar insulative connector wafer body including a plurality of channels; and a set of electrical contacts disposed in the channels, each electrical contact including a body portion, and a terminal portion formed at an end of the body portion and including a width that is larger than a thickness thereof, and wherein the terminal portion is disposed in a corresponding one of the channels of the connector wafer body so that a width direction of the terminal portion is substantially along a depth direction of the channels.

Embodiment 2 is the connector wafer of embodiment 1 further comprising an insulative cover disposed on a top surface of the connector wafer body.

Embodiment 3 is the connector wafer of embodiment 2, wherein the connector wafer body, the electrical contacts, and the cover are cooperatively configured in an impedance controlling relationship.

Embodiment 4 is the connector wafer of embodiment 1, wherein the body portion includes a width that is larger than a thickness thereof so that the width direction of the terminal portion is substantially orthogonal to a width direction of the body portion.

Embodiment 5 is the connector wafer of embodiment 4, wherein the longitudinal axis of the terminal portion is spaced apart from the longitudinal axis of the body portion.

Embodiment 6 is the connector wafer of embodiment 4, wherein each electrical contact further includes a transition portion connecting the body portion and the terminal portion, and wherein the body portion further includes a contact portion including an elastic support part joined to the transition portion, a lapping contact part formed at a free end of the contact portion away from the transition portion, and a projection contact part located between the elastic support part and the lapping contact part and protruding upward.

Embodiment 7 is the connector wafer of embodiment 1, wherein the terminal portion includes a hold portion located substantially at the center of the electrical contact.

Embodiment 8 is a connector wafer assembly comprising the connector wafer of embodiment 1 and an electrical cable terminated to the electrical contacts.

Embodiment 9 is the connector wafer assembly of embodiment 8 further comprising an insulative cover disposed on a top surface of the connector wafer body.

Embodiment 10 is the connector wafer assembly of embodiment 9 further comprising a shielding tape disposed on an end portion of the electrical cable and at least one of the cover and a bottom surface of the connector wafer body.

Embodiment 11 is the connector wafer assembly of embodiment 10, wherein the connector wafer body, the electrical contacts, the cover, and the shielding tape are cooperatively configured in an impedance controlling relationship.

Embodiment 12 is the connector wafer assembly of embodiment 8, wherein the electrical cable includes one of a plurality of single wire cables and a multiple wire cable.

Embodiment 13 is the connector wafer assembly of embodiment 8, wherein the electrical cable includes: a plurality of spaced apart conductor sets arranged generally in a single plane, each conductor set including one or more substantially parallel longitudinal insulated conductors; two generally parallel shielding films disposed around the conductor sets; and a conformable adhesive layer disposed between the shielding films and bonding the shielding films to each other on both sides of each conductor set.

Embodiment 14 is the connector wafer assembly of embodiment 13, wherein the electrical cable further includes at least one longitudinal ground conductor extending in substantially the same direction as the one or more insulated conductors.

Embodiment 15 is the connector wafer assembly of embodiment 13, wherein the electrical cable further includes a plurality of longitudinal ground conductors extending in substantially the same direction as the one or more insulated conductors and disposed between the conductor sets.

Embodiment 16 is the connector wafer assembly of embodiment 8, wherein the electrical cable includes a plurality of conductors, each conductor including an end portion positioned in a corresponding one of the channels of the connector wafer body adjacent a major surface of the terminal portion.

Embodiment 17 is a connector wafer arrangement comprising a first connector wafer of embodiment 1 and a second connector wafer of embodiment 1, wherein the first and second connector wafers are arranged such that a bottom surface of the connector wafer body of the first connector wafer abuts a bottom surface of the connector wafer body of the second connector wafer.

Embodiment 18 is a connector wafer assembly arrangement comprising a first connector wafer assembly of embodiment 8 and a second connector wafer assembly of embodiment 8, wherein the first and second connector wafer assemblies are arranged such that a bottom surface of the connector wafer body of the first connector wafer assembly abuts a bottom surface of the connector wafer body of the second connector wafer assembly.

Embodiment 19 is an electrical cable connector comprising: a shielded connector housing comprising: an insulative connector body including a front wall having an opening therein, and a top wall, a bottom wall, and opposing side walls extending from the front wall and defining a cavity; and a shield member including a base portion disposed on the front wall of the connector body, a mating portion extending from the base portion and defining a mating cavity, a top flange extending from the base portion and disposed adjacent the top wall of the connector body, and a bottom flange extending from the base portion and disposed adjacent the bottom wall of the connector body; first and second connector wafers having a mating portion, each connector wafer comprising: a planar insulative connector wafer body including a plurality of channels; and a set of electrical contacts disposed in the channels, wherein the first and second connector wafers are inserted in the shielded connector housing such that a bottom surface of the connector wafer body of the first connector wafer abuts a bottom surface of the connector wafer body of the second connector wafer, and the mating portion of the first and second connector wafers extends through the opening in the front wall of the connector body into the mating cavity of the shield member.

Embodiment 20 is the electrical cable connector of embodiment 19, wherein each connector wafer further comprises an insulative cover disposed on a top surface of the connector wafer body.

Embodiment 21 is the electrical cable connector of embodiment 20, wherein the connector wafer body, the electrical contacts, and the cover are cooperatively configured in an impedance controlling relationship.

Embodiment 22 is the electrical cable connector of embodiment 19, wherein the first and second connector wafers and the shielded connector housing include cooperative latch members configured to cooperatively retain the first and second connector wafers in the shielded connector housing.

Embodiment 23 is the electrical cable connector of embodiment 19, wherein the opposing side walls of the connector body each include a latch opening and the connector wafer body further includes opposing side surfaces and a latch extending from each of the opposing side surfaces, and wherein the latch opening and the latch are configured to cooperatively retain the first and second connector wafers in the shielded connector housing.

Embodiment 24 is the electrical cable connector of embodiment 19, wherein the electrical contacts each include a body portion, and a terminal portion formed at an end of the body portion and including a width that is larger than a thickness thereof, and wherein the terminal portion is disposed in a corresponding one of the channels of the connector wafer body so that a width direction of the terminal portion is substantially along a depth direction of the channels.

Embodiment 25 is an electrical cable connector assembly comprising: a shielded connector housing comprising: an insulative connector body including a front wall having an opening therein, and a top wall, a bottom wall, and opposing side walls extending from the front wall and defining a cavity; and a shield member including a base portion disposed on the front wall of the connector body, a mating portion extending from the base portion and defining a mating cavity, a top flange extending from the base portion and disposed adjacent the top wall of the connector body, and a bottom flange extending from the base portion and disposed adjacent the bottom wall of the connector body; and first and second connector wafer assemblies having a mating portion, each connector wafer assembly comprising: a planar insulative connector wafer body including a plurality of channels; a set of electrical contacts disposed in the channels; and an electrical cable terminated to the electrical contacts, wherein the first and second connector wafer assemblies are inserted in the shielded connector housing such that a bottom surface of the connector wafer body of the first connector wafer assembly abuts a bottom surface of the connector wafer body of the second connector wafer assembly, and the mating portion of the first and second connector wafer assemblies extends through the opening in the front wall of the connector body into the mating cavity of the shield member.

Embodiment 26 is the electrical cable connector assembly of embodiment 25, wherein each connector wafer assembly further comprises an insulative cover disposed on a top surface of the connector wafer body.

Embodiment 27 is the electrical cable connector assembly of embodiment 26, wherein each connector wafer assembly further comprises a shielding tape disposed on an end portion of the electrical cable and at least one of the cover and a bottom surface of the connector wafer body.

Embodiment 28 is the electrical cable connector assembly of embodiment 27, wherein the connector wafer body, the electrical contacts, the cover, and the shielding tape are cooperatively configured in an impedance controlling relationship.

Embodiment 29 is the electrical cable connector assembly of embodiment 25, wherein the electrical contacts each include a body portion, and a terminal portion formed at an end of the body portion and including a width that is larger than a thickness thereof, and wherein the terminal portion is disposed in a corresponding one of the channels of the connector wafer body so that a width direction of the terminal portion is substantially along a depth direction of the channels.

Embodiment 30 is the electrical cable connector assembly of embodiment 25, wherein the first and second connector wafer assemblies and the shielded connector housing include cooperative latch members configured to cooperatively retain the first and second connector wafer assemblies in the shielded connector housing.

Embodiment 31 is the electrical cable connector assembly of embodiment 25, wherein the electrical cable includes one of a plurality of single wire cables and a multiple wire cable.

Embodiment 32 is the electrical cable connector assembly of embodiment 25, wherein the electrical cable includes: a plurality of spaced apart conductor sets arranged generally in a single plane, each conductor set including one or more substantially parallel longitudinal insulated conductors; two generally parallel shielding films disposed around the conductor sets; and a conformable adhesive layer disposed between the shielding films and bonding the shielding films to each other on both sides of each conductor set.

Embodiment 33 is the electrical cable connector assembly of embodiment 32, wherein the electrical cable further includes at least one longitudinal ground conductor extending in substantially the same direction as the one or more insulated conductors.

Embodiment 34 is the electrical cable connector assembly of embodiment 32, wherein the electrical cable further includes a plurality of longitudinal ground conductors extending in substantially the same direction as the one or more insulated conductors and disposed between the conductor sets.

Although specific embodiments have been illustrated and described herein for purposes of description of the preferred embodiment, it will be appreciated by those of ordinary skill in the art that a wide variety of alternate and/or equivalent implementations calculated to achieve the same purposes may be substituted for the specific embodiments shown and described without departing from the scope of the present invention. Those with skill in the mechanical, electro-mechanical, and electrical arts will readily appreciate that the present invention may be implemented in a very wide variety of embodiments. This application is intended to cover any adaptations or variations of the preferred embodiments discussed herein. Therefore, it is manifestly intended that this invention be limited only by the claims and the equivalents thereof.

What is claimed is:

1. A connector wafer comprising:

a planar insulative connector wafer body including a plurality of channels; and

a set of electrical contacts disposed in the channels, each electrical contact including a body portion, and a terminal portion formed at an end of the body portion and including a width that is larger than a thickness thereof, and wherein the terminal portion is disposed in a corresponding one of the channels of the connector wafer body so that a width direction of the terminal portion is substantially along a depth direction of the channels.

2. The connector wafer of claim 1 further comprising an insulative cover disposed on a top surface of the connector wafer body.

3. The connector wafer of claim 1, wherein the body portion includes a width that is larger than a thickness thereof so that the width direction of the terminal portion is substantially orthogonal to a width direction of the body portion.

4. The connector wafer of claim 3, wherein the longitudinal axis of the terminal portion is spaced apart from the longitudinal axis of the body portion.

5. The connector wafer of claim 3, wherein each electrical contact further includes a transition portion connecting the body portion and the terminal portion, and wherein the body portion further includes a contact portion including an elastic support part joined to the transition portion, a lapping contact part formed at a free end of the contact portion away from the transition portion, and a projection contact part located between the elastic support part and the lapping contact part and protruding upward.

6. The connector wafer of claim 1, wherein the terminal portion includes a hold portion located substantially at the center of the electrical contact.

7. A connector wafer assembly comprising the connector wafer of claim 1 and an electrical cable terminated to the electrical contacts.

8. The connector wafer assembly of claim 7 further comprising an insulative cover disposed on a top surface of the connector wafer body.

9. The connector wafer assembly of claim 8 further comprising a shielding tape disposed on an end portion of the electrical cable and at least one of the cover and a bottom surface of the connector wafer body.

10. The connector wafer assembly of claim 7, wherein the electrical cable includes:

a plurality of spaced apart conductor sets arranged generally in a single plane, each conductor set including one or more substantially parallel longitudinal insulated conductors;

two generally parallel shielding films disposed around the conductor sets; and

a conformable adhesive layer disposed between the shielding films and bonding the shielding films to each other on both sides of each conductor set.

11. The connector wafer assembly of claim 7, wherein the electrical cable includes a plurality of conductors, each conductor including an end portion positioned in a corresponding one of the channels of the connector wafer body adjacent a major surface of the terminal portion.

12. A connector wafer arrangement comprising a first connector wafer of claim 1 and a second connector wafer of claim 1, wherein the first and second connector wafers are arranged such that a bottom surface of the connector wafer body of the first connector wafer abuts a bottom surface of the connector wafer body of the second connector wafer.

13. A connector wafer assembly arrangement comprising a first connector wafer assembly of claim 7 and a second connector wafer assembly of claim 7, wherein the first and second connector wafer assemblies are arranged such that a bottom surface of the connector wafer body of the first connector wafer assembly abuts a bottom surface of the connector wafer body of the second connector wafer assembly.

14. An electrical cable connector comprising:

a shielded connector housing comprising:

an insulative connector body including a front wall having an opening therein, and a top wall, a bottom wall, and opposing side walls extending from the front wall and defining a cavity; and a shield member including a base portion disposed on the front wall of the connector body, a mating portion extending from the base portion and defining a mating cavity, a top flange extending from the base portion and disposed adjacent the top wall of the connector body, and a bottom flange extending from the base portion and disposed adjacent the bottom wall of the connector body;

first and second connector wafers having a mating portion, each connector wafer comprising:

a planar insulative connector wafer body including a plurality of channels; and

a set of electrical contacts disposed in the channels,

wherein the first and second connector wafers are inserted in the shielded connector housing such that a bottom surface of the connector wafer body of the first connector wafer abuts a bottom surface of the connector wafer body of the second connector wafer, and the mating portion of the first and second connector wafers extends through the opening in the front wall of the connector body into the mating cavity of the shield member.

15. An electrical cable connector assembly comprising:

a shielded connector housing comprising:

an insulative connector body including a front wall having an opening therein, and a top wall, a bottom wall, and opposing side walls extending from the front wall and defining a cavity; and

a shield member including a base portion disposed on the front wall of the connector body, a mating portion extending from the base portion and defining a mating cavity, a top flange extending from the base portion and disposed adjacent the top wall of the connector body, and a bottom flange extending from the base portion and disposed adjacent the bottom wall of the connector body; and

first and second connector wafer assemblies having a mating portion, each connector wafer assembly comprising:

a planar insulative connector wafer body including a plurality of channels;

a set of electrical contacts disposed in the channels; and

an electrical cable terminated to the electrical contacts, wherein the first and second connector wafer assemblies are inserted in the shielded connector housing such that a bottom surface of the connector wafer body of the first connector wafer assembly abuts a bottom surface of the connector wafer body of the second connector wafer assembly, and the mating portion of the first and second connector wafer assemblies extends through the opening in the front wall of the connector body into the mating cavity of the shield member.

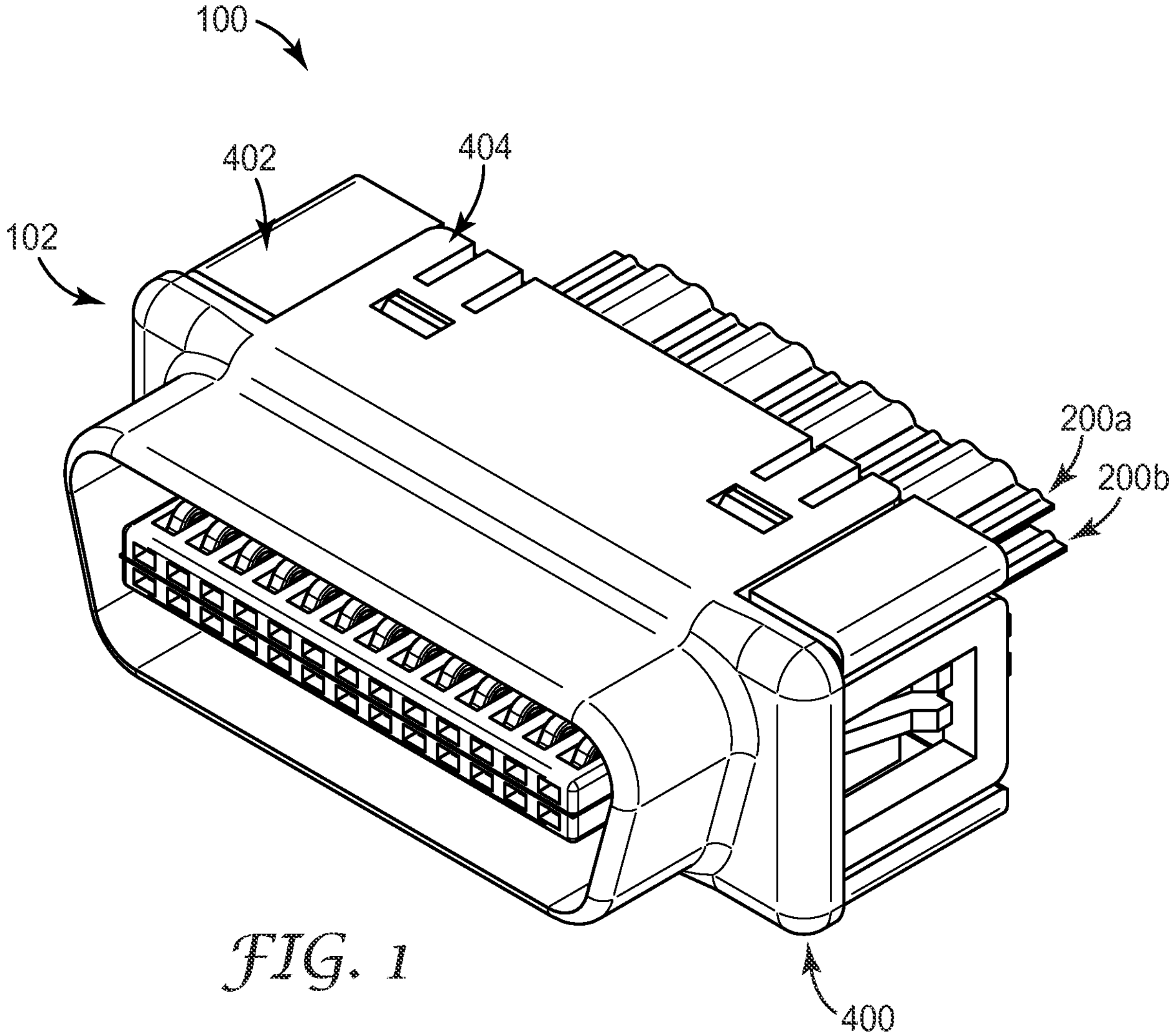


FIG. 1

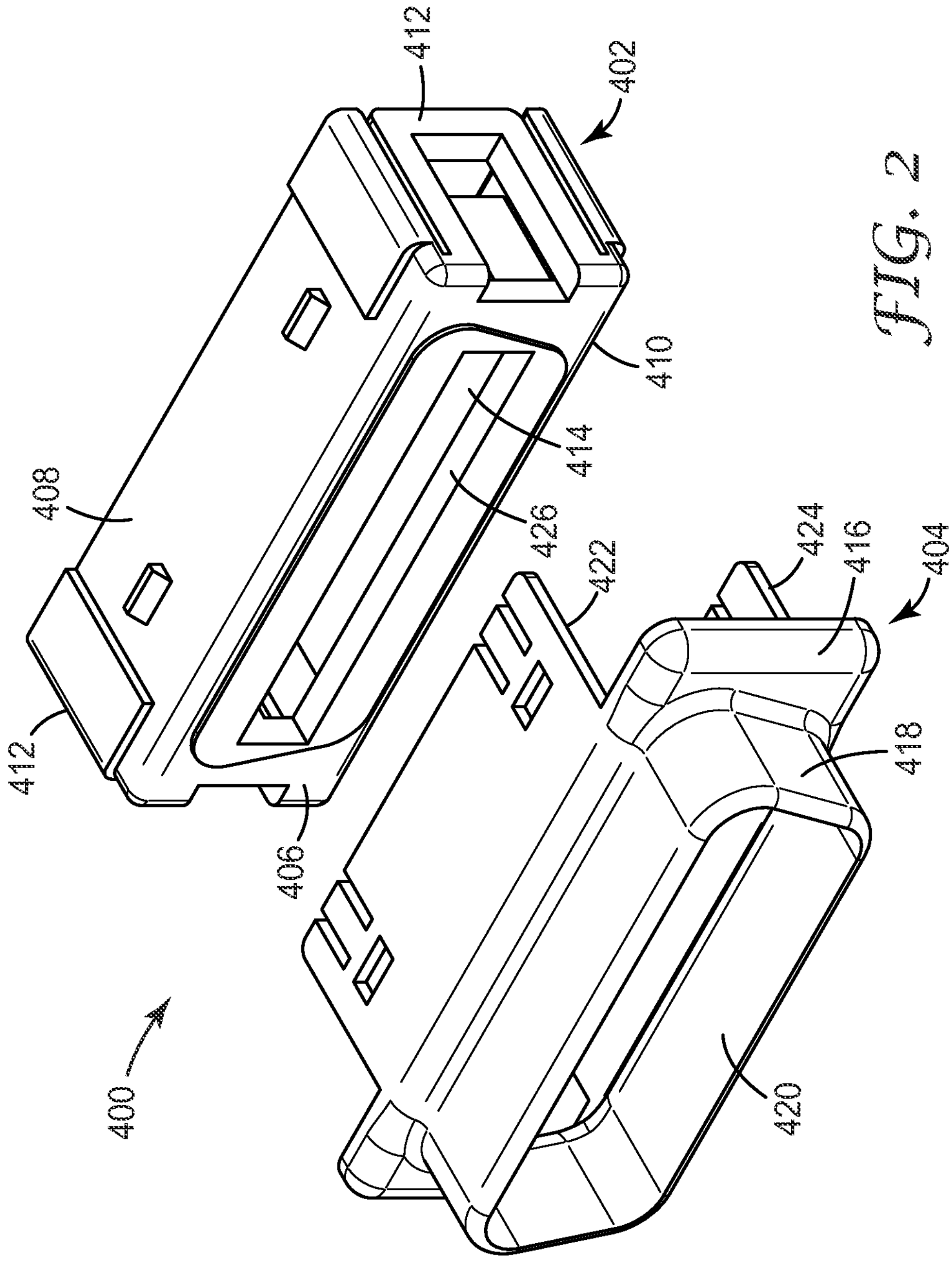
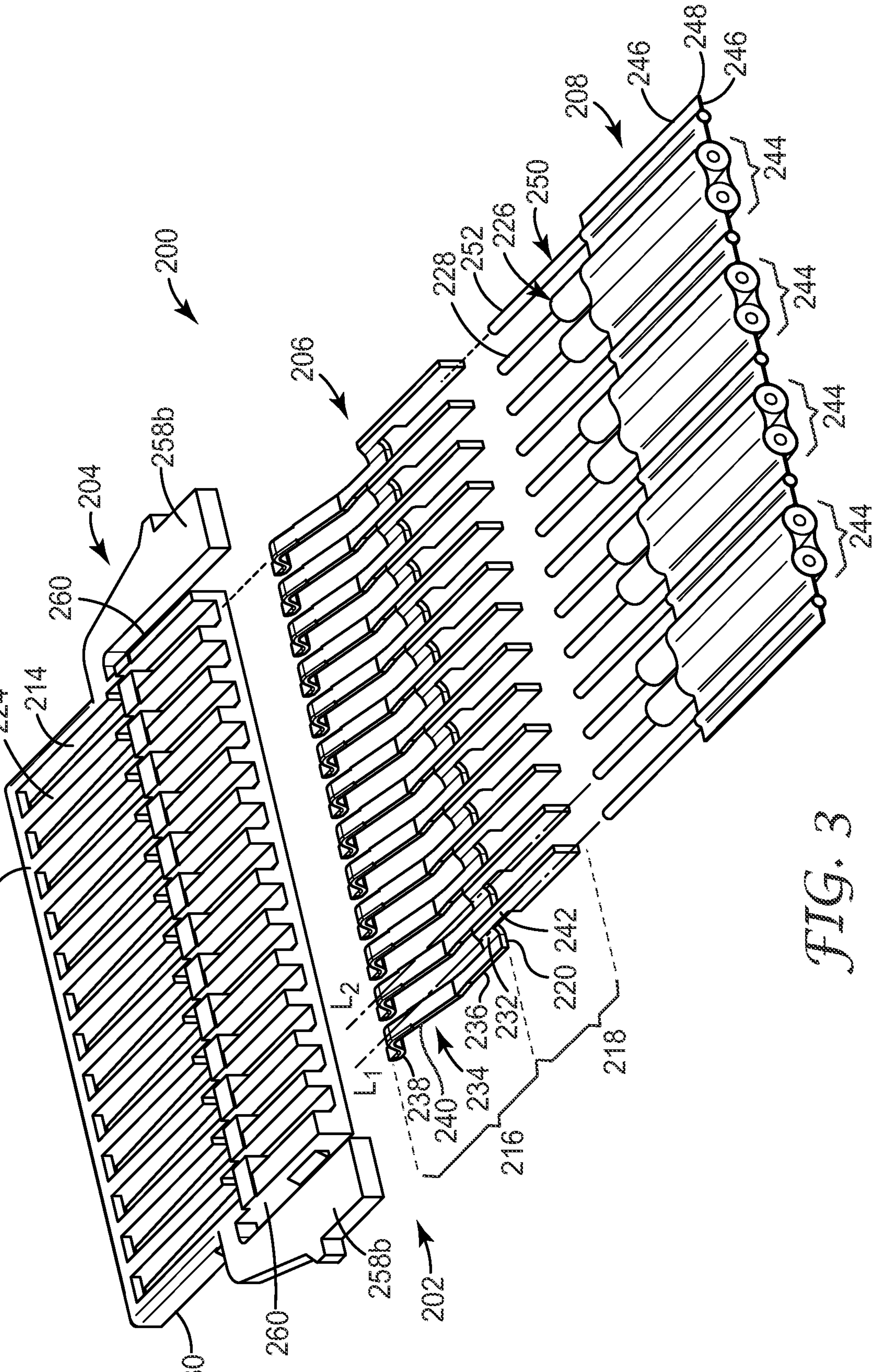


FIG. 2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242
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246
248
250
252
258b
260
L1
L2

FIG. 3

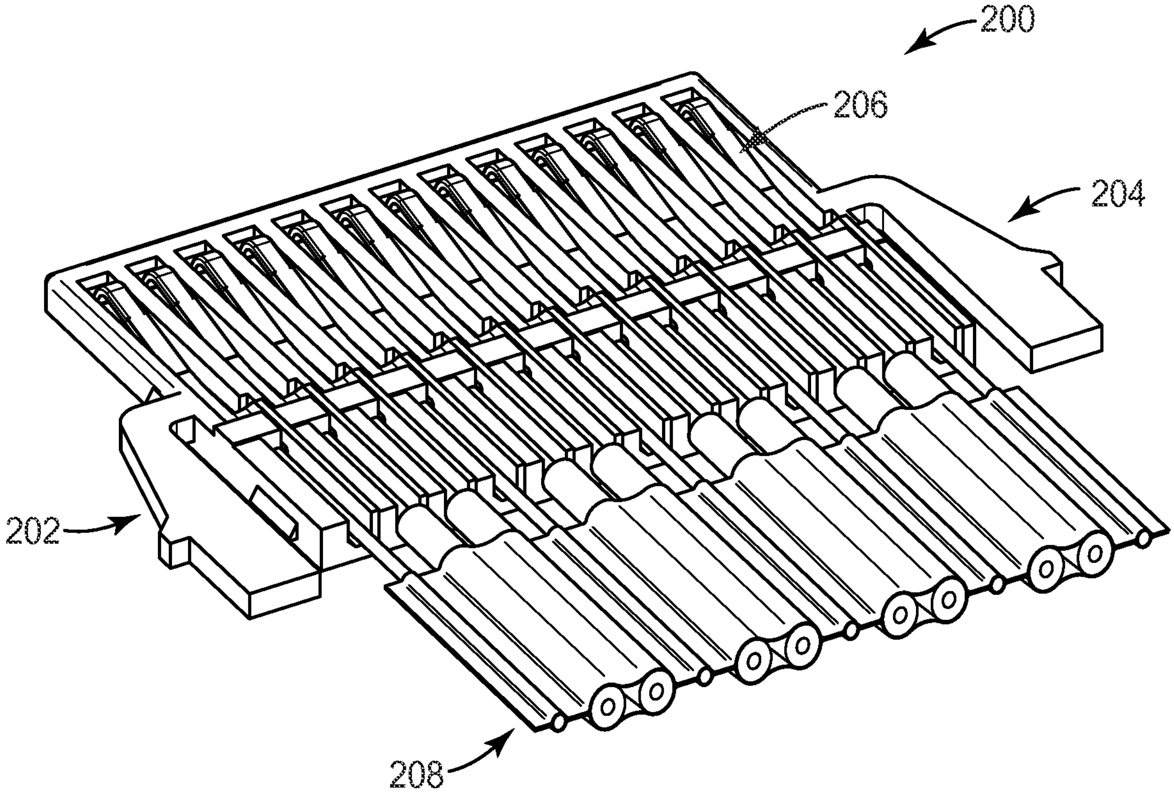

FIG. 4

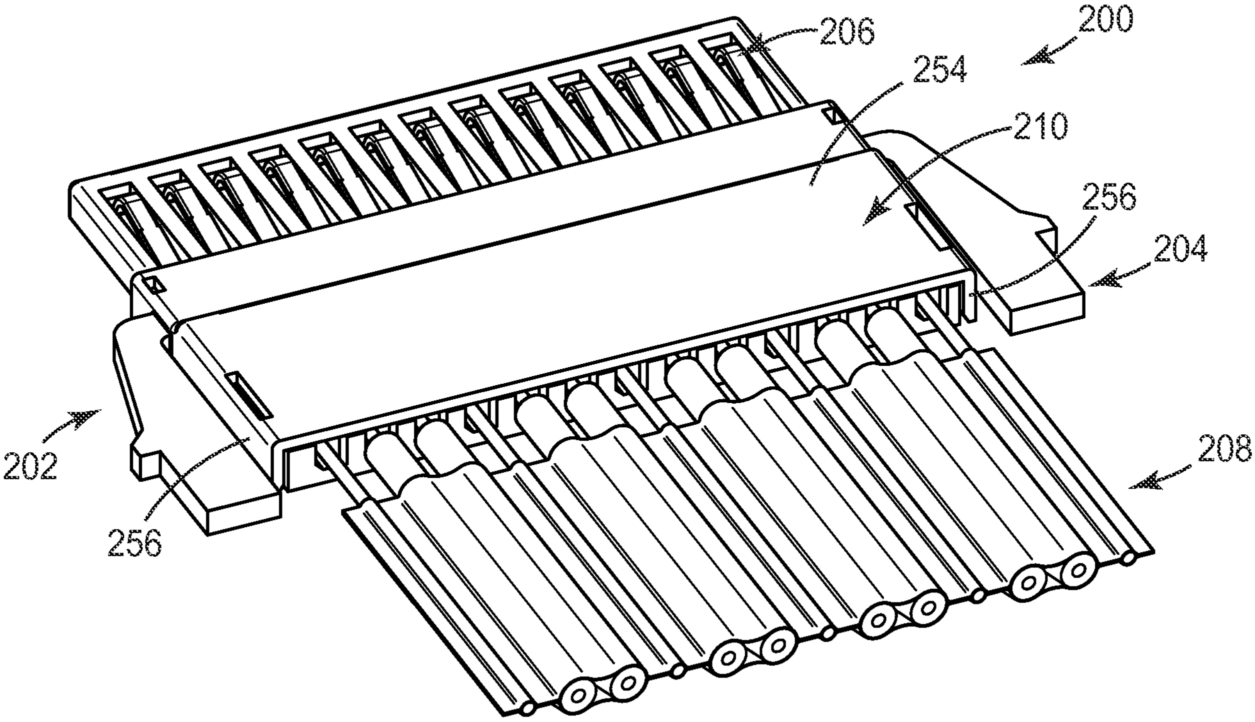

FIG. 5

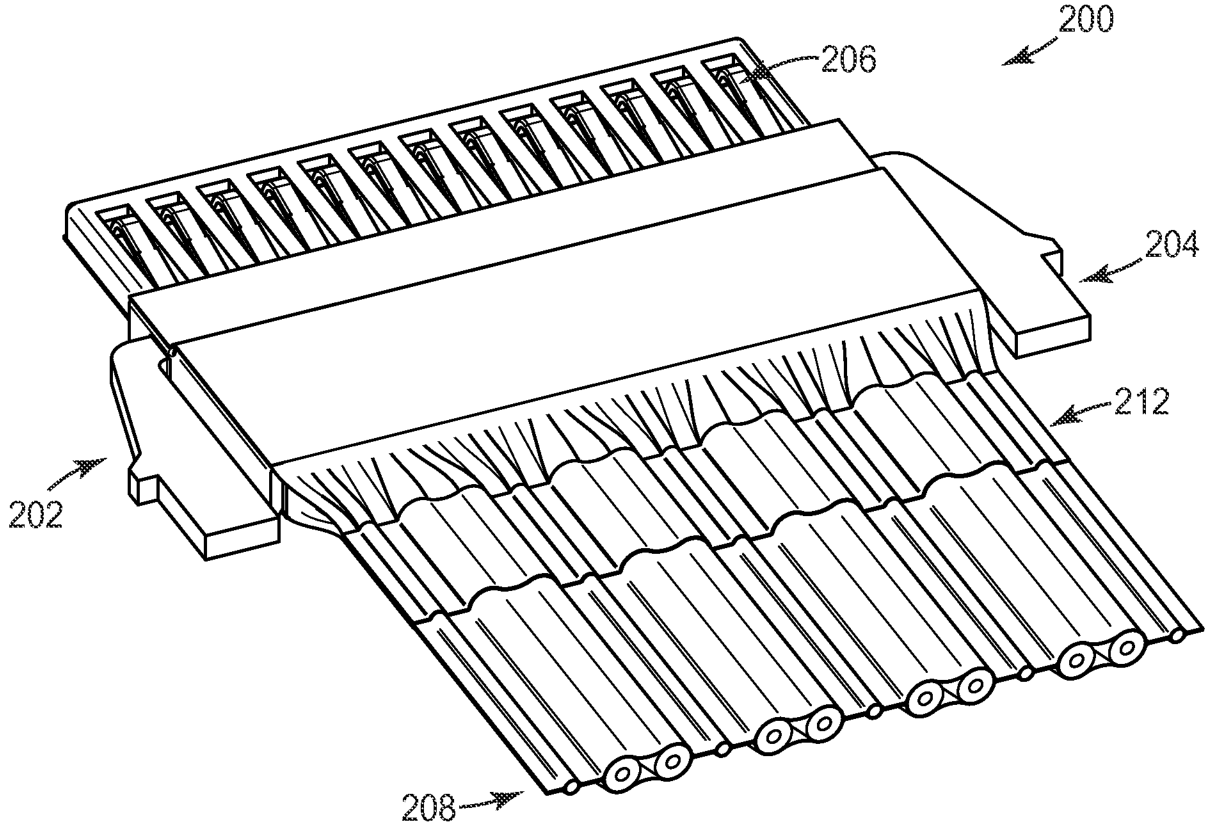

FIG. 6

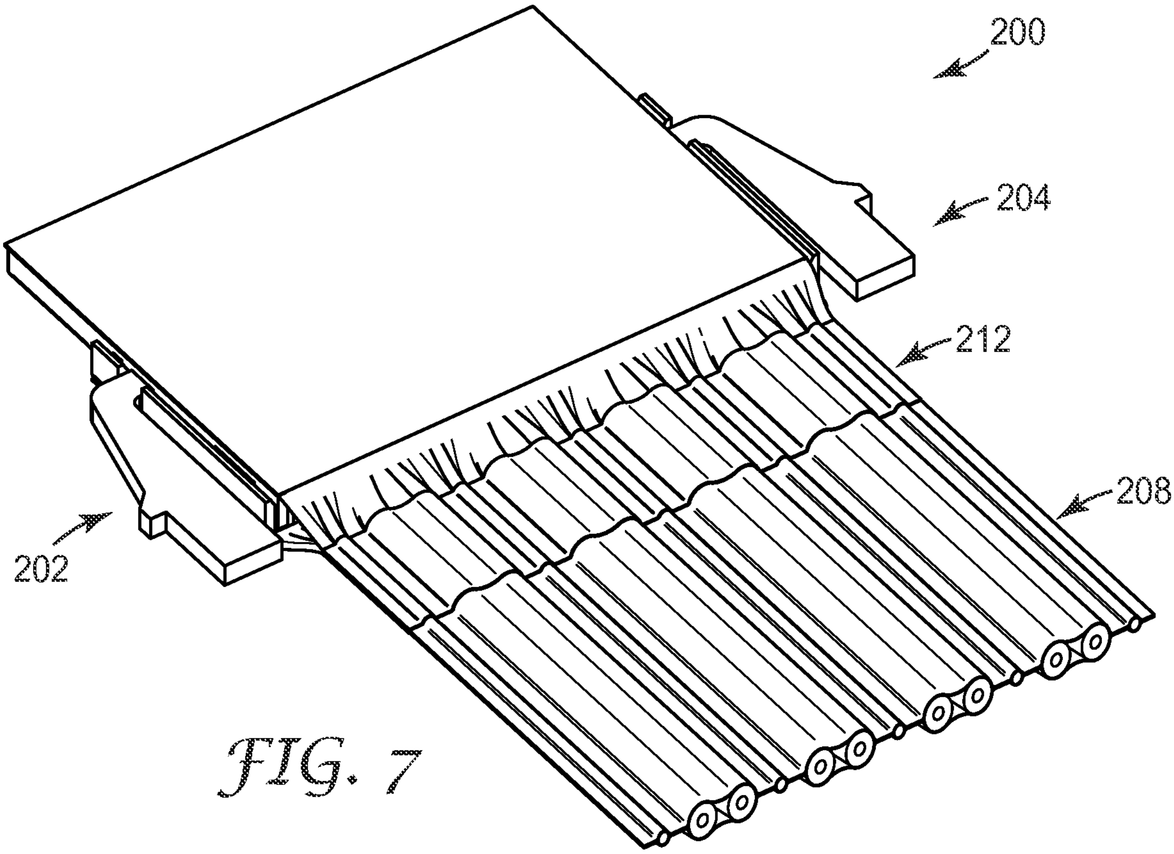

FIG. 7

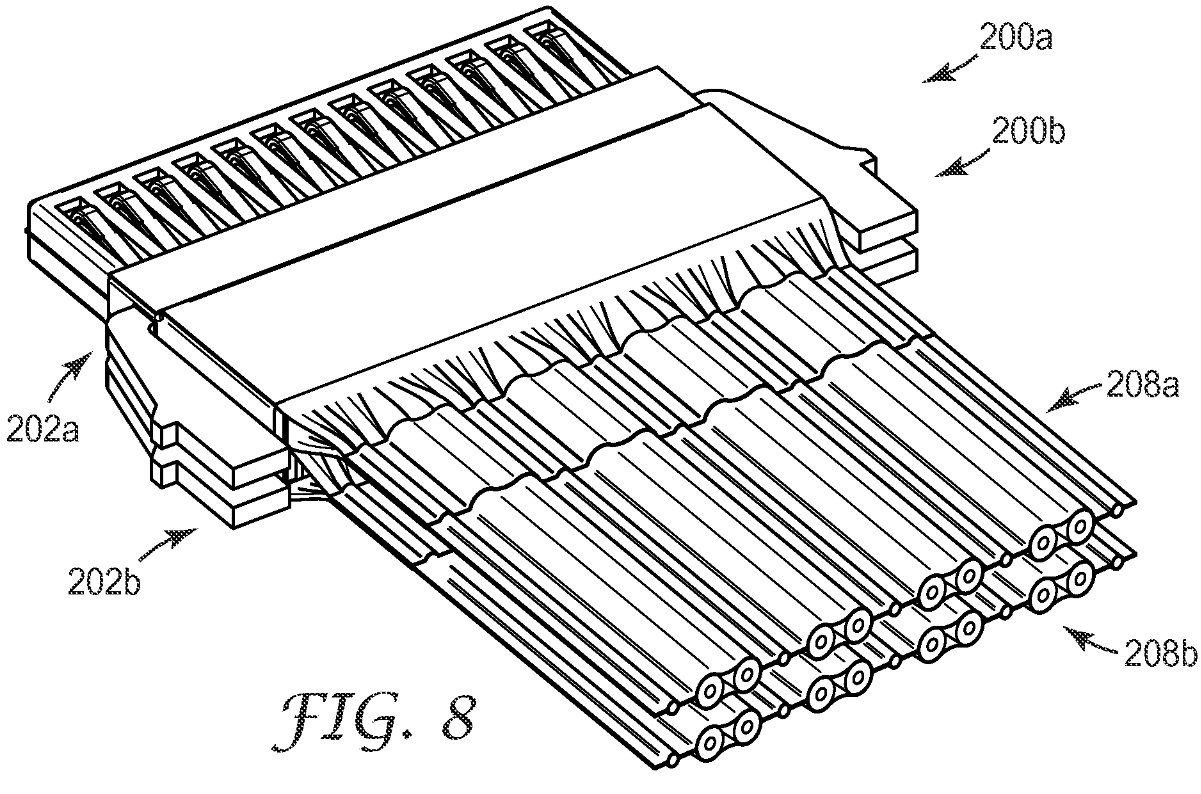

FIG. 8

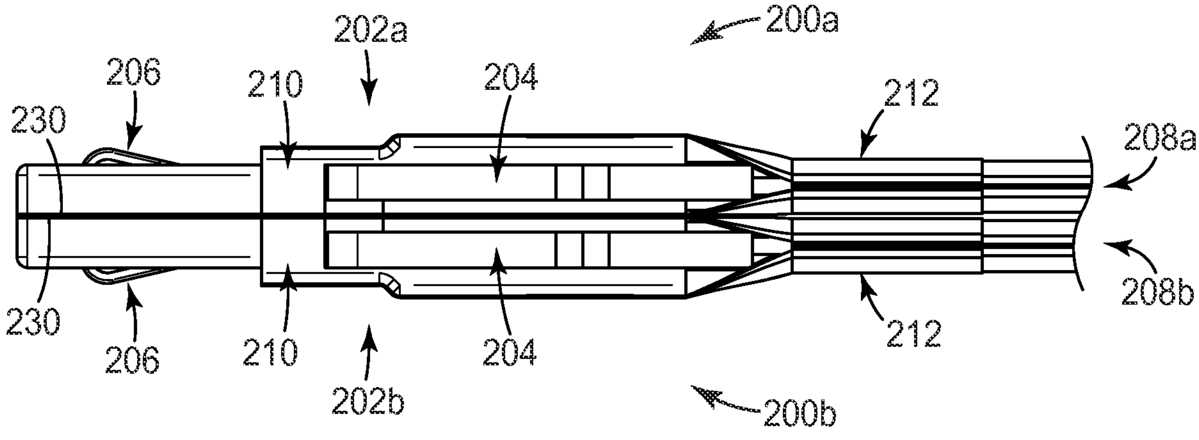
206
230
210
202a
204
200a
212
208a
230
206
210
202b
204
200b
212
208b

FIG. 9

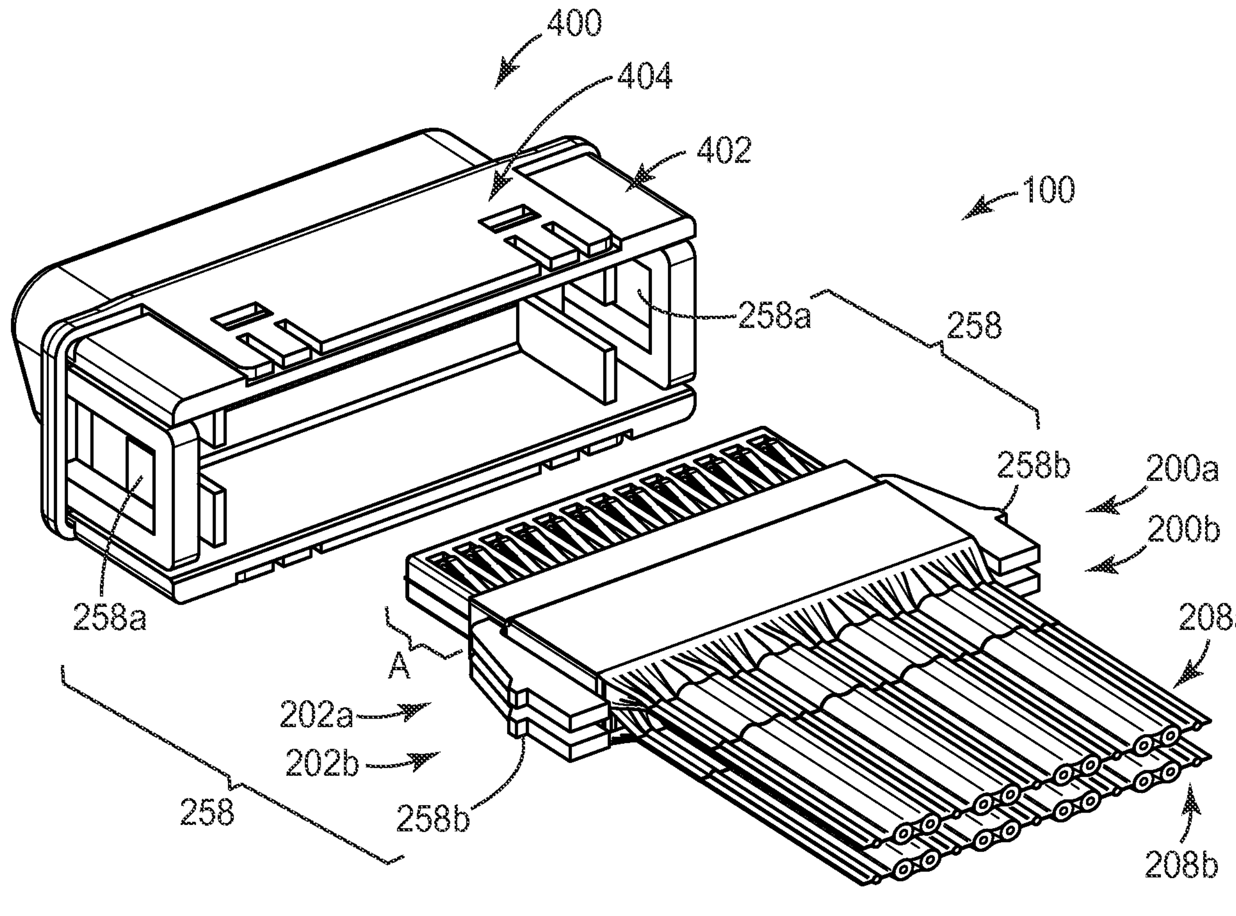
400
404
402
100
258a
258
258b
200a
200b
208a
258a
A
202a
202b
258
258b
208b

FIG. 10

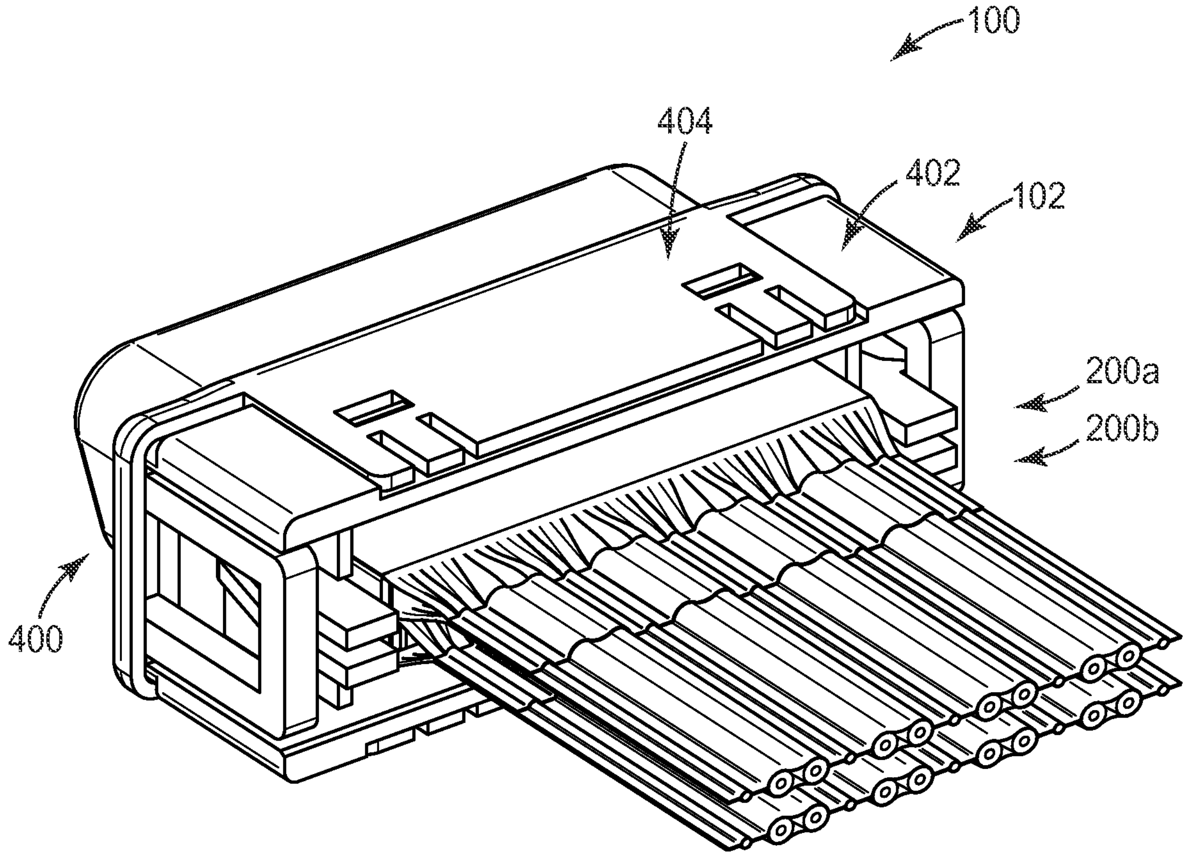

FIG. 11