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(54) **CABLE CONNECTOR ASSEMBLY HAVING CABLE OF A FLAT STRUCTURE**

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H01B 11/18	(2006.01)
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H01R 13/502	(2006.01)
H01R 107/00	(2006.01)

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CPC ***H01R 24/64*** (2013.01); ***H01B 9/003*** (2013.01); ***H01B 11/1813*** (2013.01); ***H01P 3/06*** (2013.01); ***H01R 9/0515*** (2013.01); ***H01R 13/502*** (2013.01); ***H01R 13/6592*** (2013.01); *H01R 2107/00* (2013.01)

(58) **Field of Classification Search**

CPC H01R 24/60; H01B 9/003; H01B 11/1813

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,630,624	B2 *	10/2003	Tsao	H01B 7/0861 174/113 R
9,350,126	B2 *	5/2016	Little	H01R 24/60
9,490,549	B2 *	11/2016	Little	H01R 4/023
9,520,673	B2 *	12/2016	Xing	H01R 13/5845
9,525,223	B2 *	12/2016	Little	H01R 13/6658
9,525,227	B2 *	12/2016	Little	H01R 13/6273

(Continued)

FOREIGN PATENT DOCUMENTS

CN	204884664	12/2015
CN	105702334	6/2016

(Continued)

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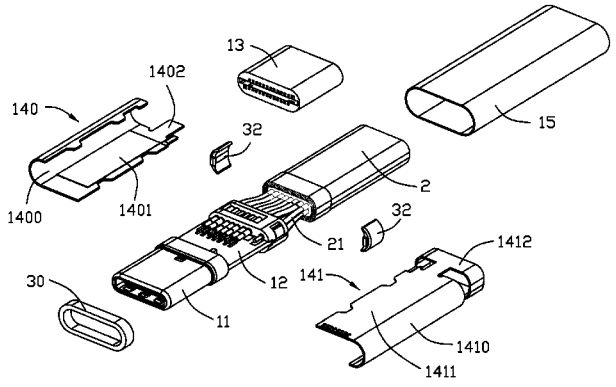
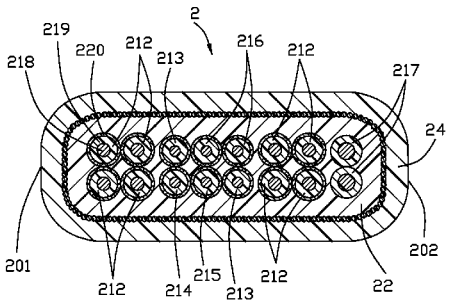
(57) **ABSTRACT**

A cable connector assembly includes a connector and a cable, the cable including plural core wires arranged in an upper and a lower rows, wherein several pairs of high-speed signal lines, a pair of low-speed signal lines, a power signal line, and a spare signal line are located in the upper row, and other pairs of high-speed signal lines, a detection signal line, a power supply line, another spare signal line, and another power signal line are located in the lower row.

20 Claims, 8 Drawing Sheets





(56) **References Cited**

U.S. PATENT DOCUMENTS

9,583,889	B2 *	2/2017	Wu	H01R 13/6593
9,590,363	B2 *	3/2017	Wu	H01R 13/6585
9,607,738	B1 *	3/2017	Wu	H01B 11/20
9,620,910	B2 *	4/2017	Chen	H01R 13/6581
9,697,926	B2 *	7/2017	Huang	H01B 7/0823
9,698,540	B2 *	7/2017	Xing	H01R 13/6593
9,698,544	B2 *	7/2017	Wu	H01R 13/7175
9,762,009	B2 *	9/2017	Little	H01R 24/60
9,768,568	B1 *	9/2017	Jin	H01R 24/60
9,774,111	B2 *	9/2017	Liang	H01R 12/57
9,780,495	B2 *	10/2017	Wu	H01R 4/023
9,825,407	B2 *	11/2017	Wu	H01R 13/6581
9,843,143	B2 *	12/2017	Wu	H01R 13/665
9,881,717	B2 *	1/2018	Chen	H01R 13/6581
9,979,145	B2 *	5/2018	Wu	H01R 24/60
10,014,638	B1 *	7/2018	McCracken	H01R 24/60
10,063,018	B2 *	8/2018	Xing	H01R 13/516
10,084,245	B2 *	9/2018	Chang	H01R 13/6586
10,096,936	B2 *	10/2018	Ju	H01R 13/6275
10,103,505	B1 *	10/2018	Izaki	H01R 31/06
10,134,507	B2 *	11/2018	Wu	H01B 11/08
10,135,105	B2 *	11/2018	Ishikawa	H01B 1/02
2010/0084157	A1 *	4/2010	Wang	H01B 11/12 174/107
2011/0278043	A1 *	11/2011	Ueda	H01B 7/1895 174/115
2014/0305675	A1 *	10/2014	Liang	H01B 11/00 174/107
2015/0044886	A1 *	2/2015	Little	H01R 12/75 439/55
2015/0288107	A1 *	10/2015	Wu	H01R 13/6593 439/357
2016/0020002	A1 *	1/2016	Feng	H01B 11/20 174/103
2016/0079689	A1 *	3/2016	Wu	B23K 1/0016 439/581
2016/0141817	A1 *	5/2016	Wu	H01R 24/60 439/676
2016/0225488	A1 *	8/2016	Pon	H01B 9/003
2017/0025203	A1 *	1/2017	Chen	H01B 11/20
2017/0093076	A1 *	3/2017	Yokoyama	H01R 4/02
2017/0110223	A1 *	4/2017	Wu	H01B 11/20
2017/0140851	A1 *	5/2017	Chen	H01R 13/6581
2017/0149153	A1 *	5/2017	Gou	H01R 12/53
2017/0149183	A1 *	5/2017	Gou	H01R 12/716
2017/0256837	A1 *	9/2017	Ishikawa	H01B 1/02
2017/0330651	A1 *	11/2017	Kunz	H01B 11/1821
2018/0001407	A1 *	1/2018	Wu	B23K 1/0016
2018/0040969	A1 *	2/2018	Wu	H01R 13/6593
2018/0115122	A1 *	4/2018	Xing	H01R 13/516
2018/0166797	A1 *	6/2018	Ju	H01R 13/6597
2018/0166825	A1 *	6/2018	Ju	H01R 13/6275
2018/0212337	A1 *	7/2018	Chang	H01R 13/6586
2018/0375232	A1 *	12/2018	Wu	H01R 4/182
2019/0020157	A1 *	1/2019	Wu	H01R 24/64

FOREIGN PATENT DOCUMENTS

CN	205583296	9/2016
CN	106450827	2/2017

* cited by examiner

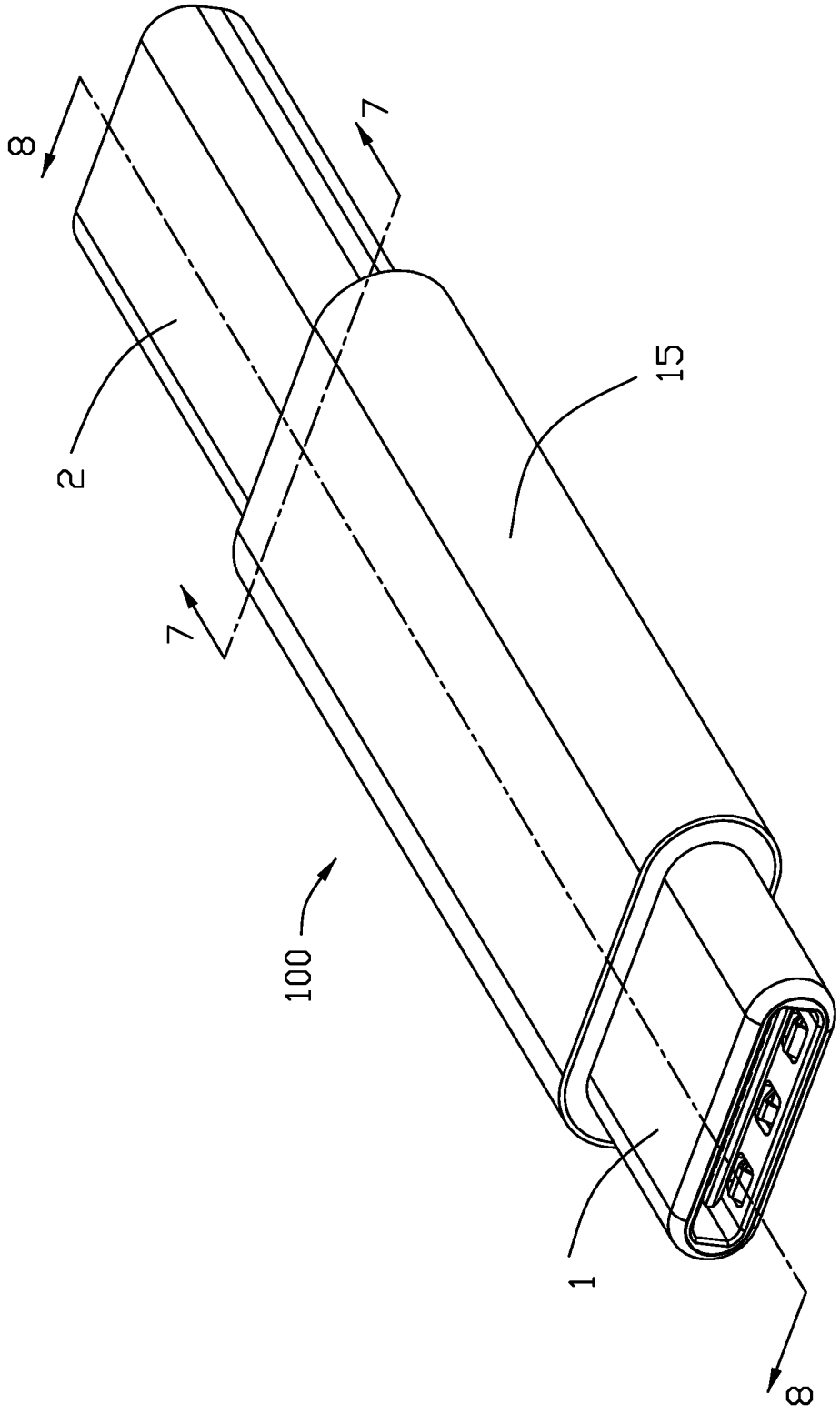


FIG. 1

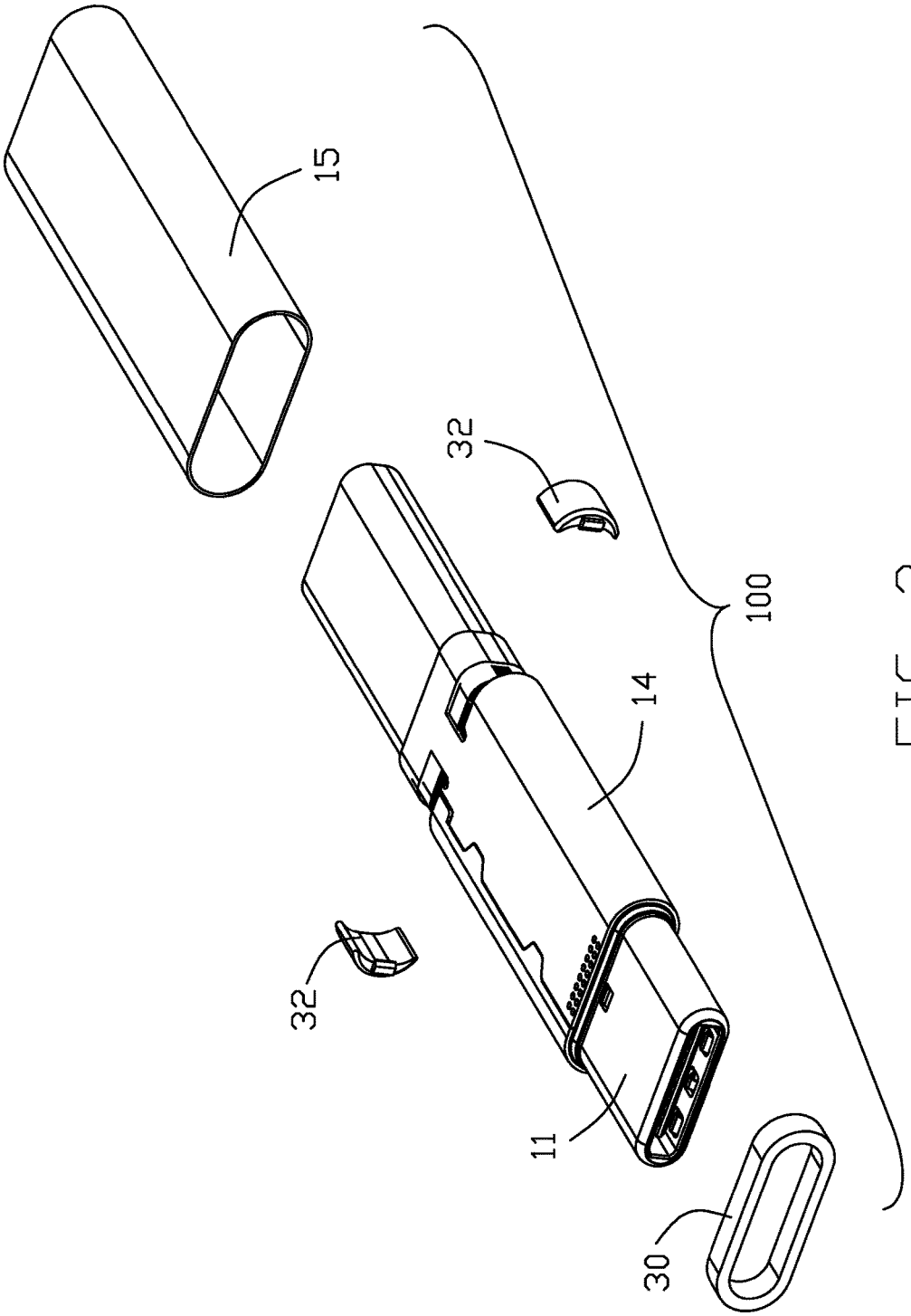


FIG. 2

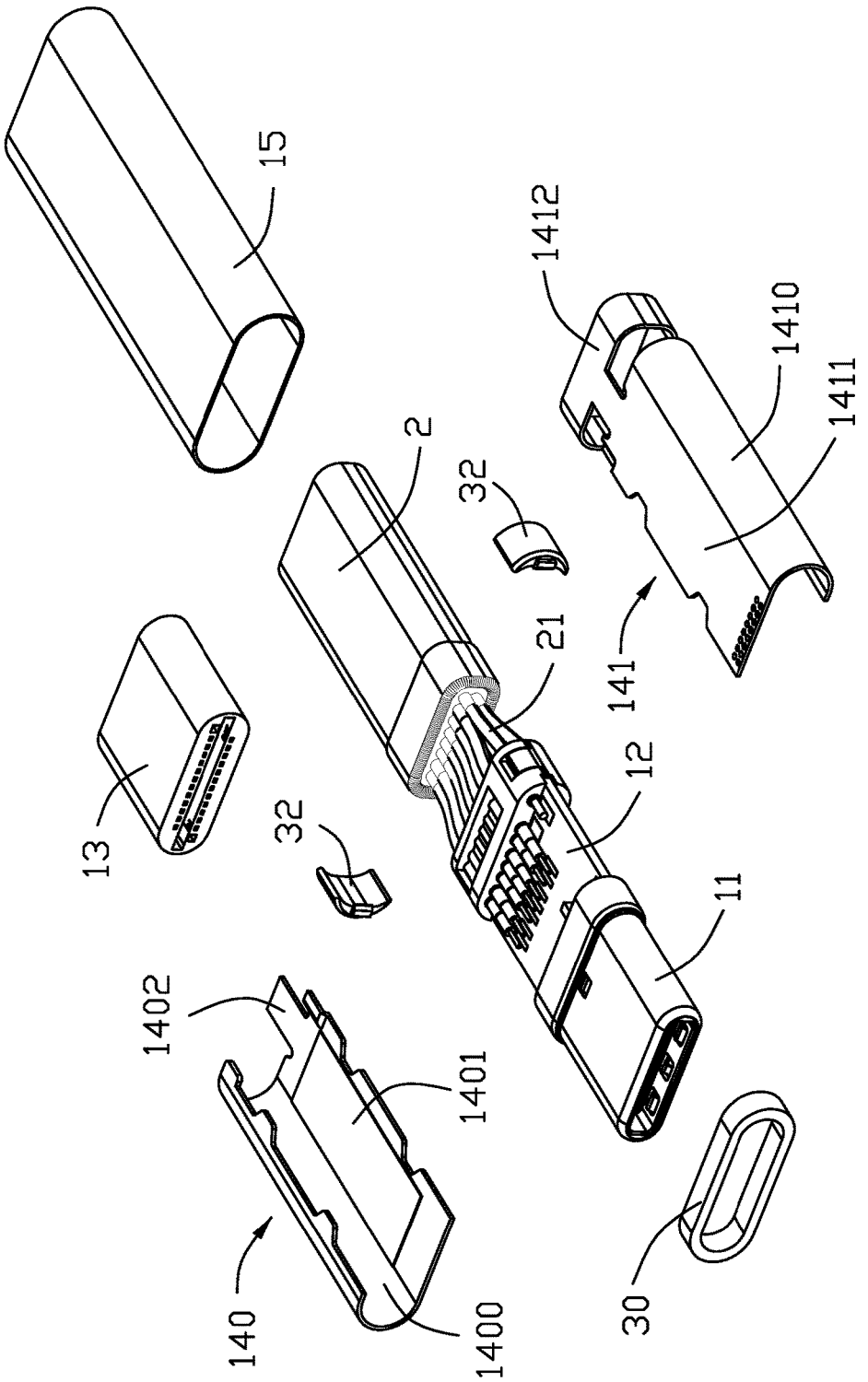


FIG. 3

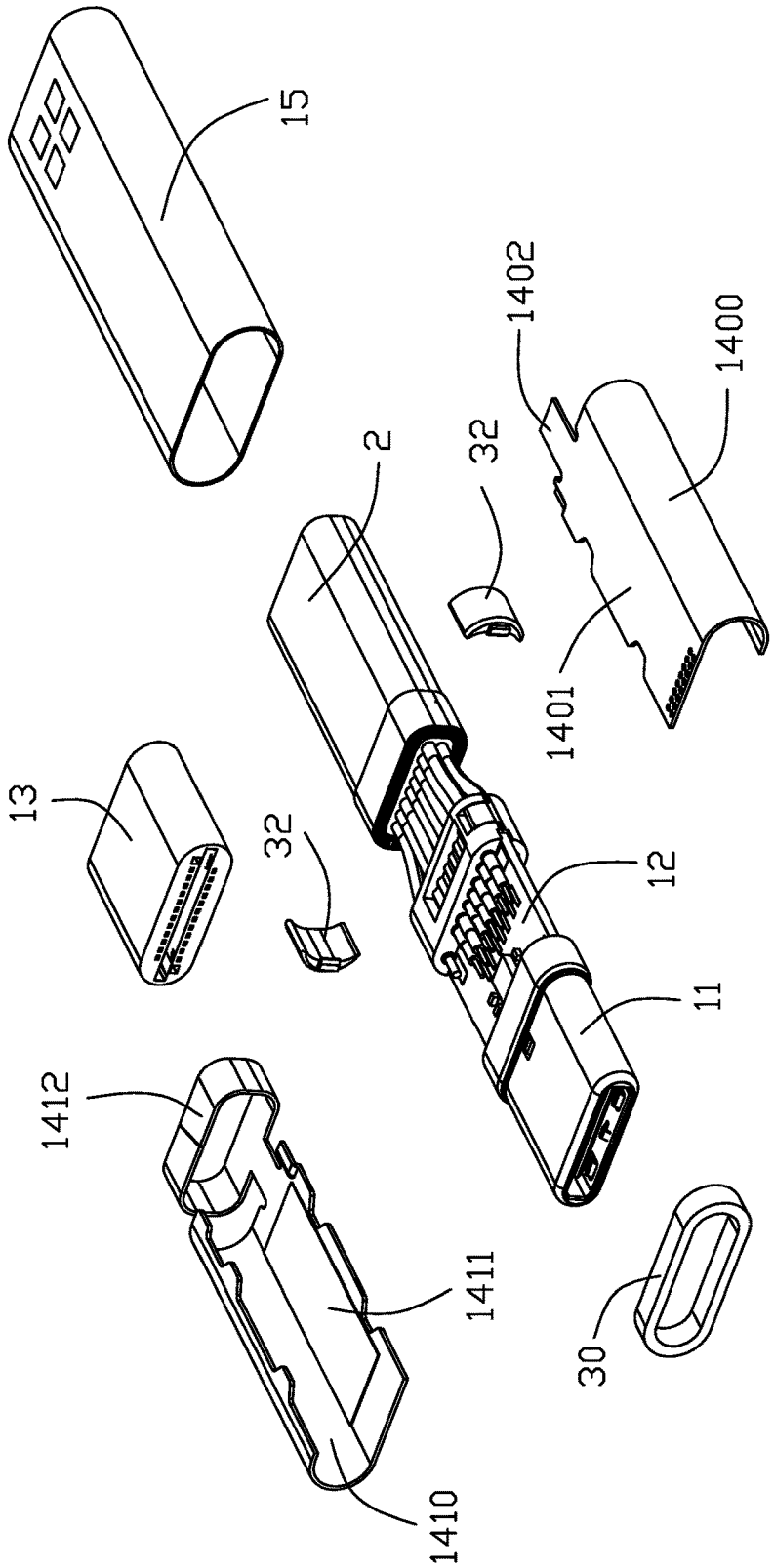


FIG. 4

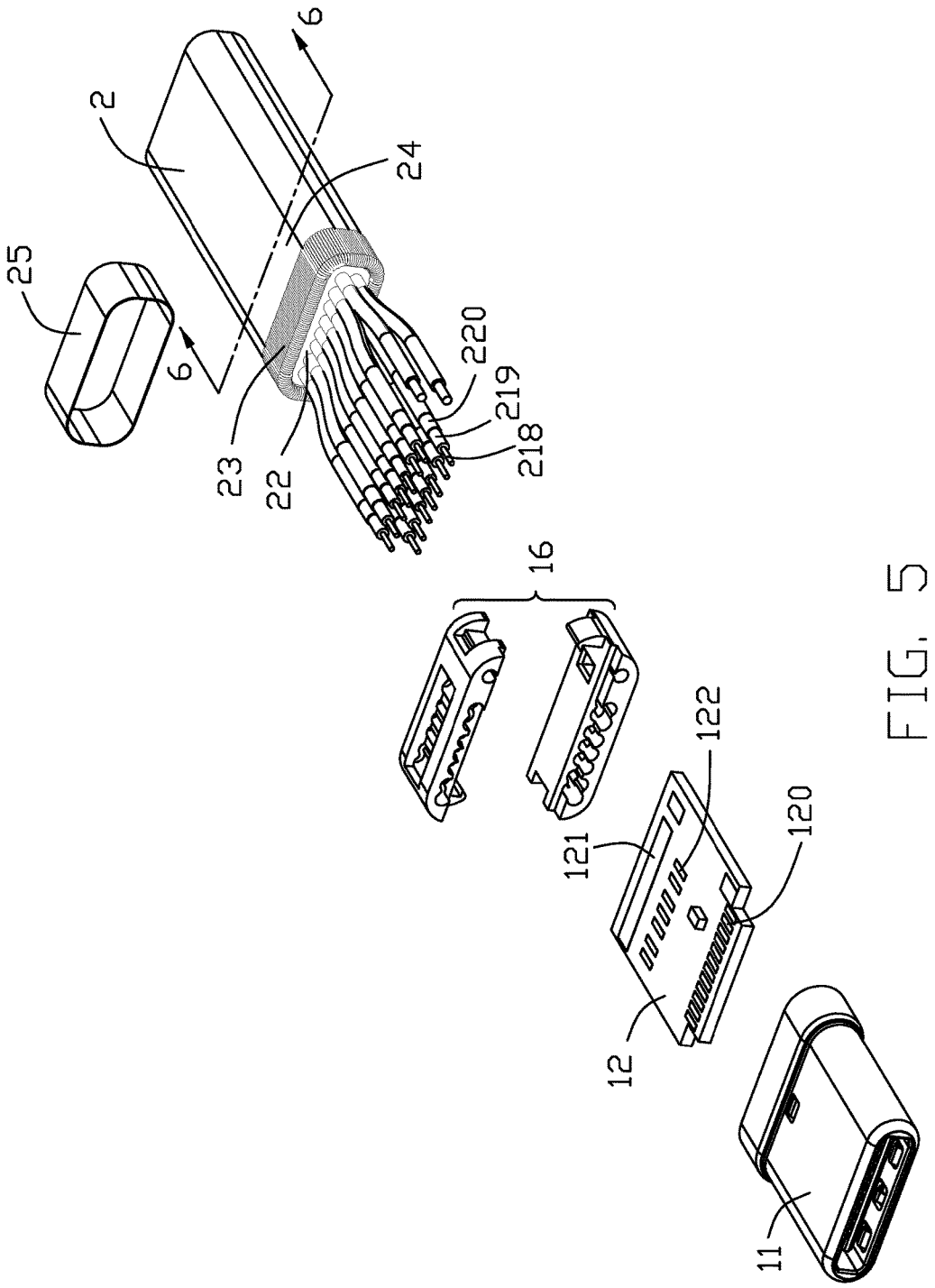
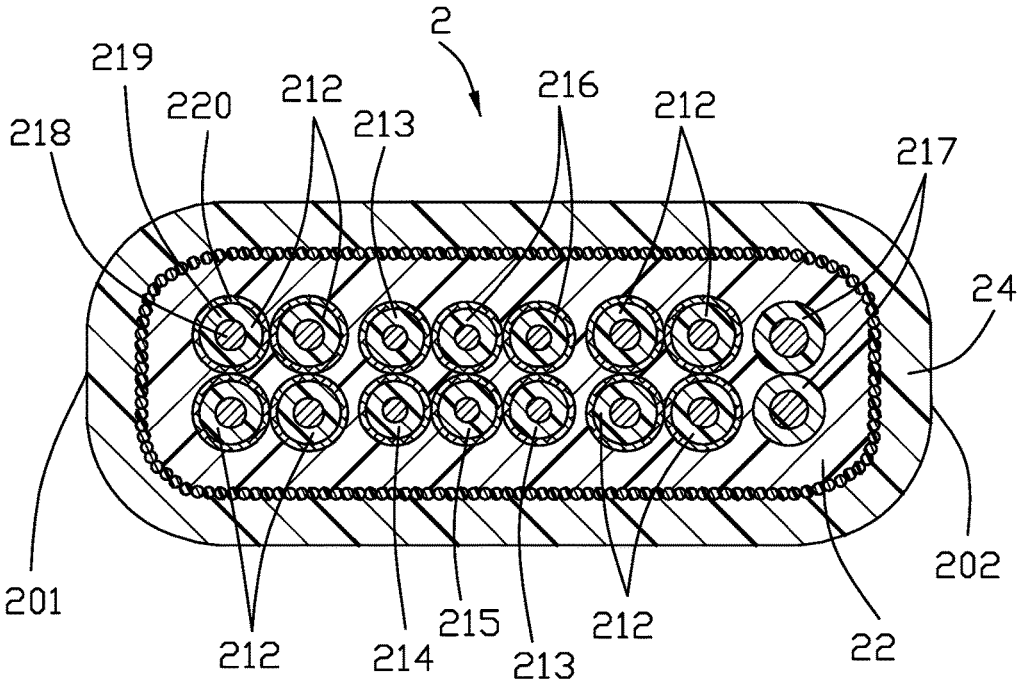


FIG. 5


2
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220
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216
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24
201
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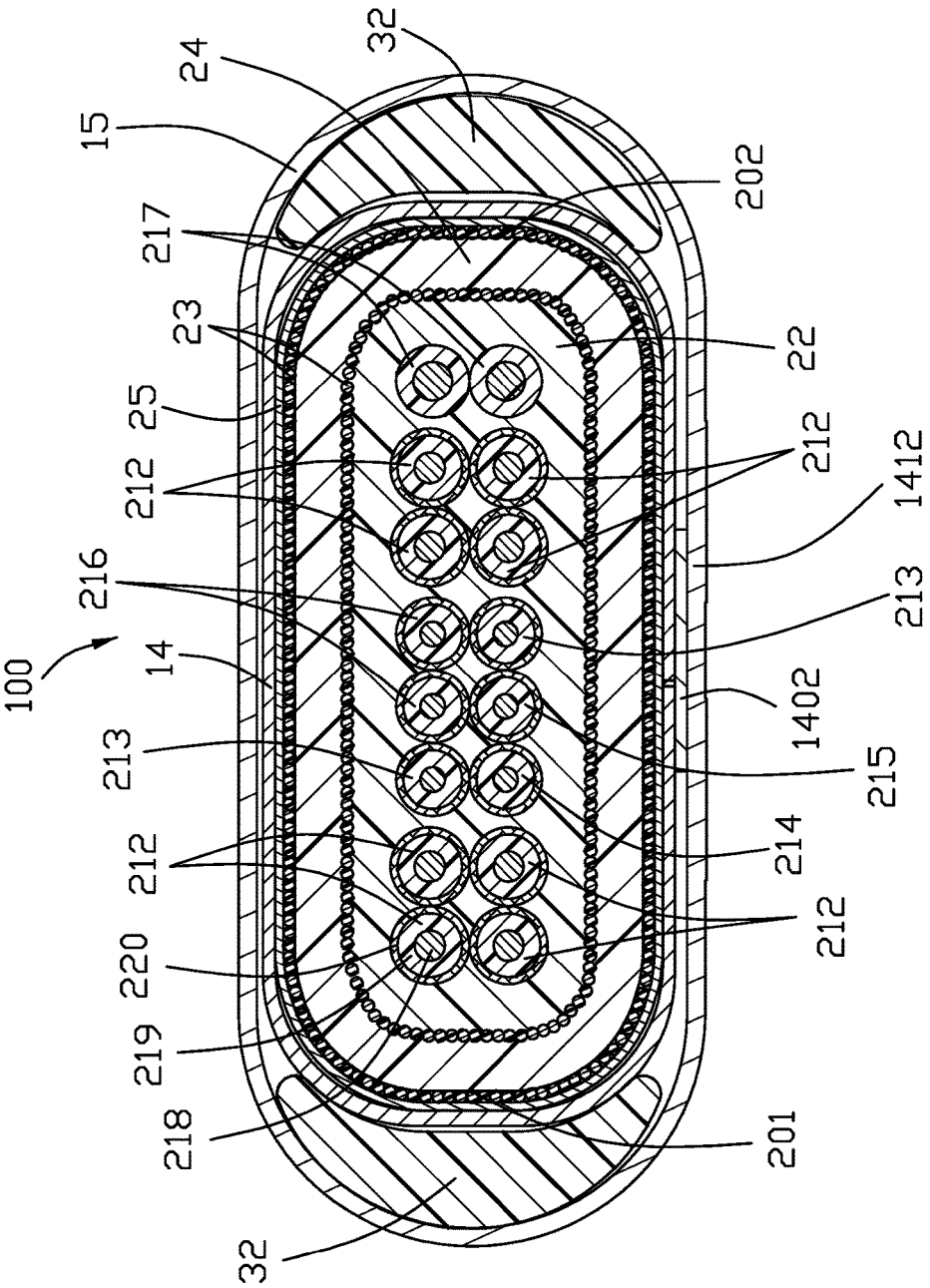
212
22
202

FIG. 6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220
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201
32

FIG. 7

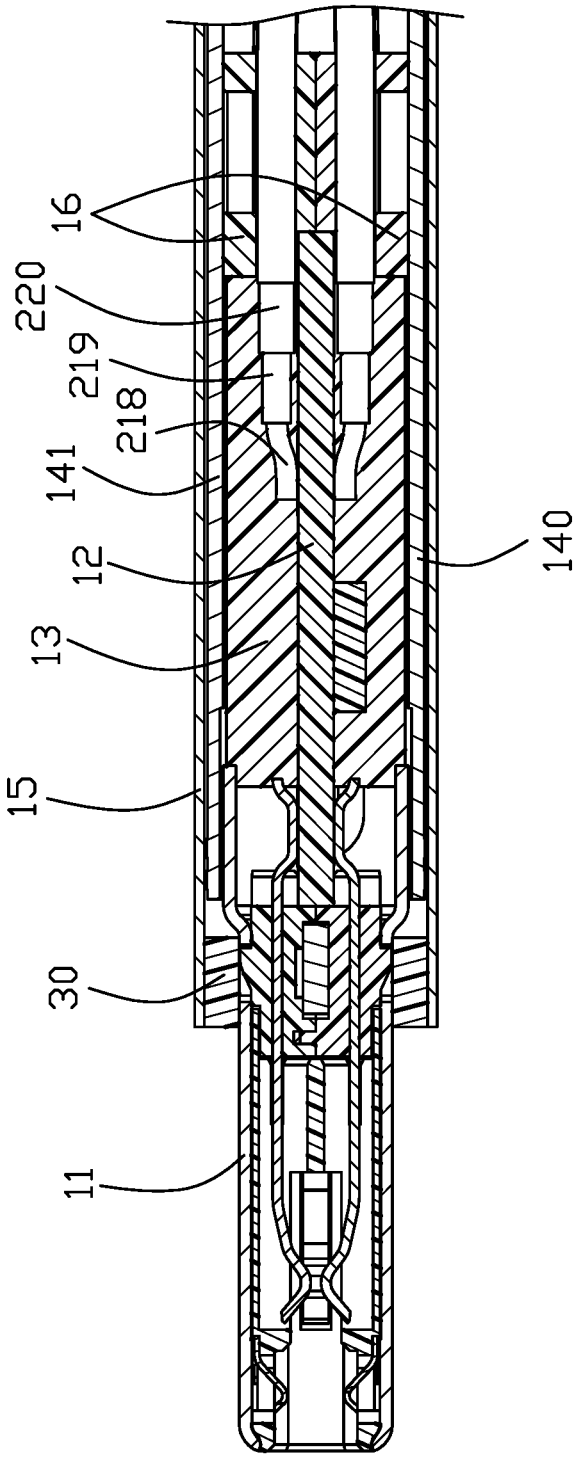

FIG. 8

CABLE CONNECTOR ASSEMBLY HAVING CABLE OF A FLAT STRUCTURE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a cable connector assembly having a cable of a flat structure.

2. Description of Related Arts

U.S. Patent Application Publication No. 2016/0079689, published on Mar. 17, 2016, shows a cable connector assembly including a connector and a cable electrically connected to the connector. The cable includes a plurality of core wires and associated outer insulative layers. The cross-section of the cable is circular such that the cable has a large dimension in the thickness direction.

An improved cable connector assembly is desired.

SUMMARY OF THE INVENTION

An object of the present invention is to provide an improved cable connector assembly with a cable having a small dimension in the thickness direction.

To achieve the above-mentioned object, a cable connector assembly comprises: a connector; and a cable electrically connected to the connector and extending along a longitudinal direction, the cable including a plurality of core wires, the core wires comprising plural pairs of high-speed signal lines for transmitting high-speed signals, a pair of low-speed signal lines for transmitting low-speed signals, a pair of power signal lines for transmitting power signals, a pair of spare signal lines, a detection signal line for transmitting detection signals, and a power supply line, wherein the core wires are arranged in an upper row and a lower row along a width direction perpendicular to the longitudinal direction, and a part of the high-speed signal lines, the pair of low-speed signal lines, one power signal line, and one spare signal line are located in the upper row, and the remaining high-speed signal lines, the detection signal line, the power supply line, another spare signal line, and another power signal line are located in the lower row.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a perspective view of a cable connector assembly in accordance with the present invention;

FIG. **2** is a partially exploded view of the cable connector assembly shown in FIG. **1**;

FIG. **3** is a further partially exploded view of the cable connector assembly shown in FIG. **2**;

FIG. **4** is an exploded view similar to FIG. **3**, but from a different perspective;

FIG. **5** is an exploded view of the cable connector assembly shown in FIG. **3**;

FIG. **6** is an cross-section view of the cable of the cable connector assembly shown in FIG. **1**;

FIG. **7** is another cross-section view of the cable of the cable connector assembly shown in FIG. **1**; and

FIG. **8** is another cross-section view of the cable of the cable connector assembly of FIG. **1**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. **1** to **8**, a cable connector assembly in accordance with the present invention for mating with a mating connector (not shown), comprises an electrical connector **1** and a cable **2** electrically connected with the electrical connector **1**. The electrical connector **1** includes s mating member **11** for mating with the mating connector, a printed circuit board (PCB) **12** connected between the mating member **11** and the cable **2**, an inner mold **13** enclosing the conjunction portion of the cable **2** and the PCB **12**, a shielding case **14** enclosing the mating member **11** and the PCB **12**, an insulative outer case **15** enclosing the shielding case **14** and the cable **2**, and a management block **16** for locating the cable **2**.

Referring to FIGS. **3** to **6**, The cable **2** includes a plurality of core wires **21**, an inner insulative layer **22** enclosing the corresponding core wires **21**, a first braided layer **23** enclosing the inner insulative layer **22** and a outer insulative layer **24** formed on outside of the first braided layer **23**. The cable **2** is used to transmit USB Type C signal. The core wires **21** includes four (differential) pairs of high-speed signal lines **212** for transmitting high-speed signals, a pair of spare signal lines **213**, a detection signal line **214** for transmitting detection signals, a power supply line **215** for supplying power to the connector, a pair of low-speed signal lines **216** and a pair of power signal lines **217** that transmit power signals. The low-speed signal lines **216** are used to transmit USB 2.0 signals with lower speed. The pair of power signal lines **217** is used respectively to transmit positive and negative signals of the power source. The pair of spare signal lines **213** can set transmission of signals such as audio as required.

All the core wires **21** except the pair of power signal wires **217** are coaxial wires. The coaxial lines include a center conductor **218**, an insulating layer **219** covering the center conductor **218** and a second braided layer **220** wrapped around the insulating layer **219**. The first and second braided layers **23**, **220** can effectively weaken the external radiation of the center conductor **218** and strengthen its own anti-interference ability.

The core wires **21** are arranged up and down in two rows. An upper row includes two pairs of high-speed signal lines **212**, the pair of low-speed signal lines **216**, a spare signal line **213** and a power signal line **217**. The lower row includes two pairs of high-speed signal lines **212**, a detection signal line **214**, a power supply line **215**, a spare signal line **213** and a power signal line **217**. The cable **2** is flat and is divided into a first side **201** and a second side **202** in a width direction. The two pairs of high-speed signal lines **212** are located on the first side **201** and are oppositely disposed one above the other. The power signal lines **217** are located on the second side **202** and are oppositely disposed one above the other. The other two pairs of high-speed signal lines **212** are located inside the power signal lines **217** in the width direction. The pair of low-speed signal lines **216** and a spare signal line **213** are disposed between the two pairs of high-speed signal lines **212** in the upper row, and the spare signal lines **213** are located between the low-speed signal lines **216** and the high-speed signal lines **212** located on the first side **201**. The detection signal line **214** in the lower row is adjacent to the high speed signal lines **212** on the first side **201**. The lower spare signal line **213** in the low row is adjacent to the high speed signal lines **212** near the second side **202**. The power supply line **215** for powering the connector **1** internally is located between the detection signal line **214** and the spare signal line **213** in the lower row. This arrangement allows the spare signal lines **213** to be arranged separately, effectively preventing them from coupling with each other.

The cable **2** is not provided with a ground wire, instead, the second braided layer **220** of each coaxial line serves as a ground wire, and can satisfy a voltage drop of 250 mV when there is a current of 3 A or 5 A. The specifications of the two power signal lines **217** can be flexibly designed with 26 or 24 AWG (American wire gauge), and can meet 500 mV voltage drop when there is 3 A or 5 A current.

The PCB **12** includes an upper surface and a lower surface, and the front and back conductive sheets are symmetrical, because it can be inserted along both of the forward and backward direction. The PCB **12** defines a plurality of first conductive pads **120** on a front end thereof, a grounding region **121** on a rear end and a plurality of second conductive pads **122** between the first conductive pads **120** and the grounding region **121**. Both of the upper surface and the lower surface define the first conductive pads **120**, the grounding region **121** and the second conductive pads **122**. The first conductive pads **120** are electrically connected to the contacts of the mating member **11**. The grounding regions **121** are soldered to the second braided layers **220**. Each of the center conductors **218** is electrically connected to the second conductive pads **122** corresponding on the front and rear ends of the PCB **12** respectively.

The shielding case **14** includes a first case **140** and a second case **141**. The first case **140** includes a first edge **1400**, an upper surface **1401**, and a tail portion **1402** extending from the upper surface **1401** toward the extending direction of the cable **2**. The second case **141** includes a second edge **1410**, a lower surface **1411** and a retaining portion **1412** extending from the lower surface **1411** towards the extending direction of the cable **2**. The end of the first braided layer **23** of the cable **2** is overturned on the surface of the cable **2**, and is wrapped with a copper foil **25**. The tail portion **1402** extends to the copper foil **25**. The retaining portion **1412** is held on the tail portion **1402** and the copper foil **25** to be caulked on the cable **2**. The first case **140** and the second case **141** are assembled together by laser welding. The shielding case **14** and the mating member **11** are also assembled by laser welding. In this embodiment, an insulative or rubbery front cap **30** surrounds the mating member **11** and is enclosed in the shielding case **14** for better sealing performance, and a pair of insulative or rubbery rear caps **32** sandwiched between the copper foil **25** and the outer case **15** for compensating the contour difference between the outer profile of the cable **2** with the associated copper foil **25** thereon and that of the outer case **15** which is essentially of a capsular cross-sectional configuration.

What is claimed is:

1. A cable connector assembly comprising:

a connector; and

a cable electrically connected to the connector and extending along a longitudinal direction, the cable including a plurality of core wires, the core wires comprising plural pairs of high-speed signal lines for transmitting high-speed signals, a pair of low-speed signal lines for transmitting low-speed signals, a pair of power signal lines for transmitting power signals, a pair of spare signal lines, a detection signal line for transmitting detection signals, and a power supply line; wherein

the core wires are arranged in an upper row and a lower row along a width direction perpendicular to the longitudinal direction, and a part of the high-speed signal lines, the pair of low-speed signal lines, one power signal line, and one spare signal line are located in the upper row, and the remaining high-speed signal lines, the detection signal line, the power supply line, another spare signal line, and another power signal line are located in the lower row.

2. The cable connector assembly as claimed in claim **1**, wherein the high-speed signal lines located in the upper and lower rows are oppositely disposed along a thickness direction perpendicular to the longitudinal direction and the width direction, and the high-speed signal lines in same row are disposed at intervals.

3. The cable connector assembly as claimed in claim **1**, wherein the cable is provided with a first side and an opposite second side along the width direction, and the part of the high-speed signal lines is located on the first side, the power signal lines are located on the second side, and the remaining high speed signal lines are located inside the power signal lines along the width direction.

4. The cable connector assembly as claimed in claim **3**, wherein the low-speed signal lines are located between the spare signal line and the high-speed signal lines near the second side.

5. The cable connector assembly as claimed in claim **3**, wherein the detection signal line is adjacent to the high-speed signal line on the first side, and the spare signal line in the lower row is adjacent to the high-speed signal line near the second side, and the power supply line is located between the detection signal line and the spare signal line in the lower row.

6. The cable connector assembly as claimed in claim **1**, wherein the core wires other than the power signal lines are all coaxial wires, and the coaxial wires include a braided layer.

7. The cable connector assembly as claimed in claim **6**, wherein the connector includes a printed circuit board electrically connected with the cable, the printed circuit board includes an upper surface and a lower surface, the printed circuit board defines grounding region on both of the upper surface and the lower surface, and the braided layers of the upper and lower rows are respectively electrically connected to the corresponding grounding regions.

8. The cable connector assembly as claimed in claim **1**, wherein the connector includes a shielding case riveted to the cable, and the shielding case includes:

a first case including a first side and an upper surface;

a second case including a second side and a lower surface; and

the first case and the second case are welded together.

9. The cable connector assembly as claimed in claim **8**, wherein the connector includes a mating member, and the shielding case is welded to the mating member.

10. A cable comprising:

a plurality of core wires, the core wires comprising plural pairs of high-speed signal lines for transmitting high-speed signals, a pair of low-speed signal lines for transmitting low-speed signals, a pair of power signal lines for transmitting power signals, a pair of spare signal lines, a detection signal line for transmitting detection signals, and a power supply line; wherein

the core wires are arranged in an upper row and a lower row along a width direction perpendicular to the longitudinal direction, and a part of the high-speed signal lines, the pair of low-speed signal lines, one power signal line, and one spare signal line are located in the upper row, and the remaining high-speed signal lines, the detection signal line, the power supply line, another spare signal line, and another power signal line are located in the lower row.

11. The cable as claimed in claim 10, wherein the spare signal lines are respectively placed in the upper and lower rows, and the positions of the spare signal lines in the width direction are staggered with each other.

12. The cable as claimed in claim 10, wherein the high-speed signal lines located in the upper and lower rows are oppositely disposed along a thickness direction perpendicular to the longitudinal direction and the width direction, and the high-speed signal lines in same row are disposed at intervals.

13. The cable as claimed in claim 10, wherein the core wires other than the power signal lines are all coaxial wires, and the coaxial wires include a first braided layer.

14. The cable as claimed in claim 13, wherein the cable further includes an inner insulative layer enclosing the core wires and a second braided layer covering the inner insulative layer.

15. The cable as claimed in claim 10, wherein the pair of power signal lines are oppositely disposed on an outermost side of the core wires.

16. A cable connector assembly comprising:

a printed circuit board;

a mating member connected to a front edge region of the printed circuit board;

a cable connected to a rear edge region of the printed circuit board and including a plurality of coaxial core wires, an inner insulator, a metallic braiding layer and an outer insulator sequentially arranged with one another outwardly; and

each of the coaxial core wires including a center conductor, an insulating layer and another braiding layer sequentially arranged with one another outwardly in coaxial manner, all said coaxial core wires having an amount of fourteen and being arranged in two rows along a transverse direction wherein each row is equipped with seven coaxial core wires thereof, and including two differential pairs of high-speed signal lines at one end and another two differential pairs of high-speed signal lines at the other end with six coaxial core wires therebetween in the transverse direction; wherein

said six coaxial core wires include a pair of low speed signal lines for transmitting USB 2.0 signals, a pair of spare signal lines, a detection signal line and a power supply line.

17. The cable connector assembly as claimed in claim 16, further including a pair of power lines enclosed within said inner insulator and commonly located by one side of said coaxial core wires in said transverse direction and respectively aligned with the corresponding rows in said transverse direction.

18. The cable connector assembly as claimed in claim 17, further including a metallic shielding case enclosing a rear portion of the mating member, the printed circuit board and a front portion of the cable, wherein a front end region of the braiding layer is folded backward to be pressed and electrically connected to the shielding case.

19. The cable connector assembly as claimed in claim 18, further including an insulative outer case which is preformed and attached unto to cover the shielding case.

20. The cable connector assembly as claimed in claim 19, further including a metallic foil sandwiched between the shielding case and the folded front end region of the braiding layer wherein said folded front end region of the braiding layer is initially retained by the metallic foil before the shielding case is assembled thereto.

* * * * *