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(54) **PLUG CONNECTOR**

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H01R 13/64 (2006.01)

(52) **U.S. Cl.** **439/677**; 439/680; 439/607.36

(58) **Field of Classification Search** 439/607.35, 439/607.36, 607.4, 108, 677, 680, 681
See application file for complete search history.

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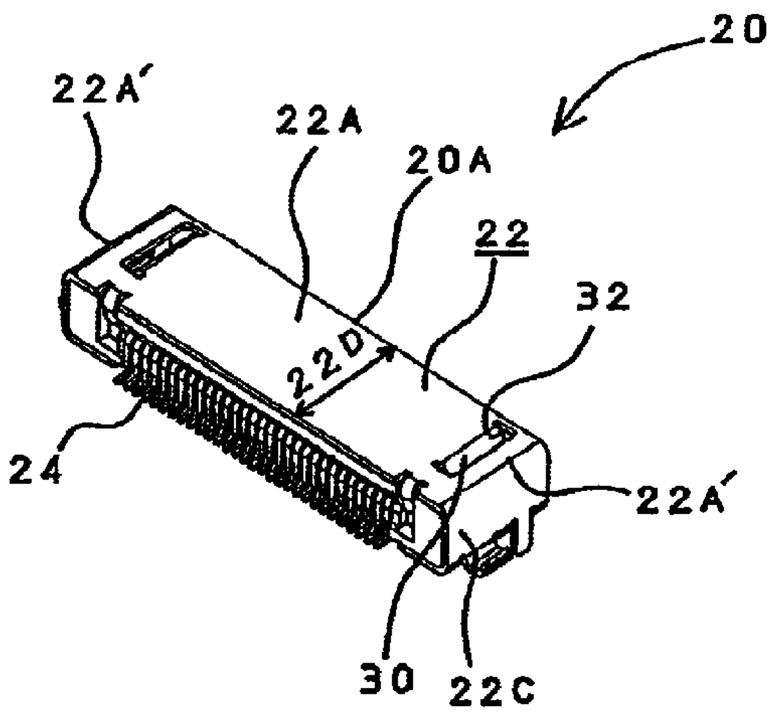
(57) **ABSTRACT**

A connector including a first connector element and a second connector element that are coupled into a single unit, in which the first connector element has an engagement projection that projects interior of the first connector element and extends in the direction of the depth of the first connector element so that the front end of the engagement projection is spacedly apart from the front edge of the first connector element, and the second connector element is formed with an engagement slit that extends in the direction of depth of the second connector element and engages with the engagement projection of the first connector element.

25 Claims, 6 Drawing Sheets



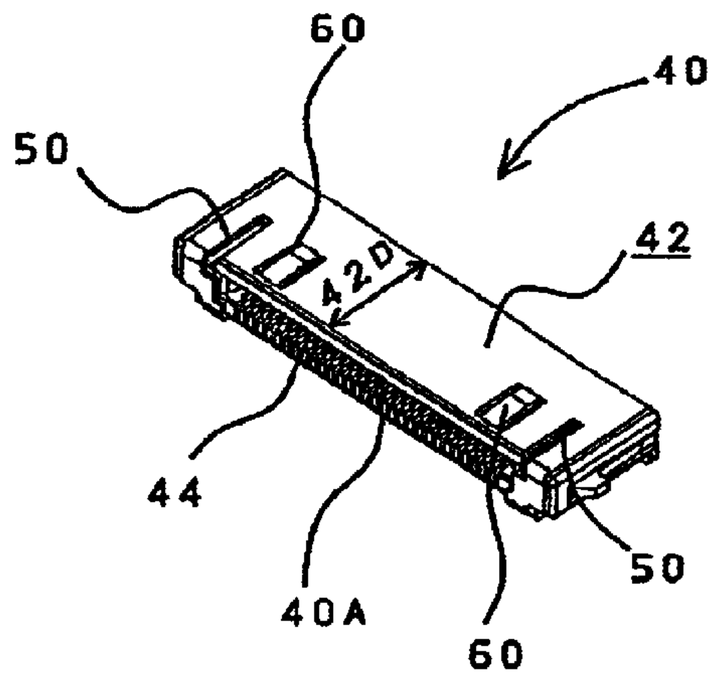


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FIG. 1

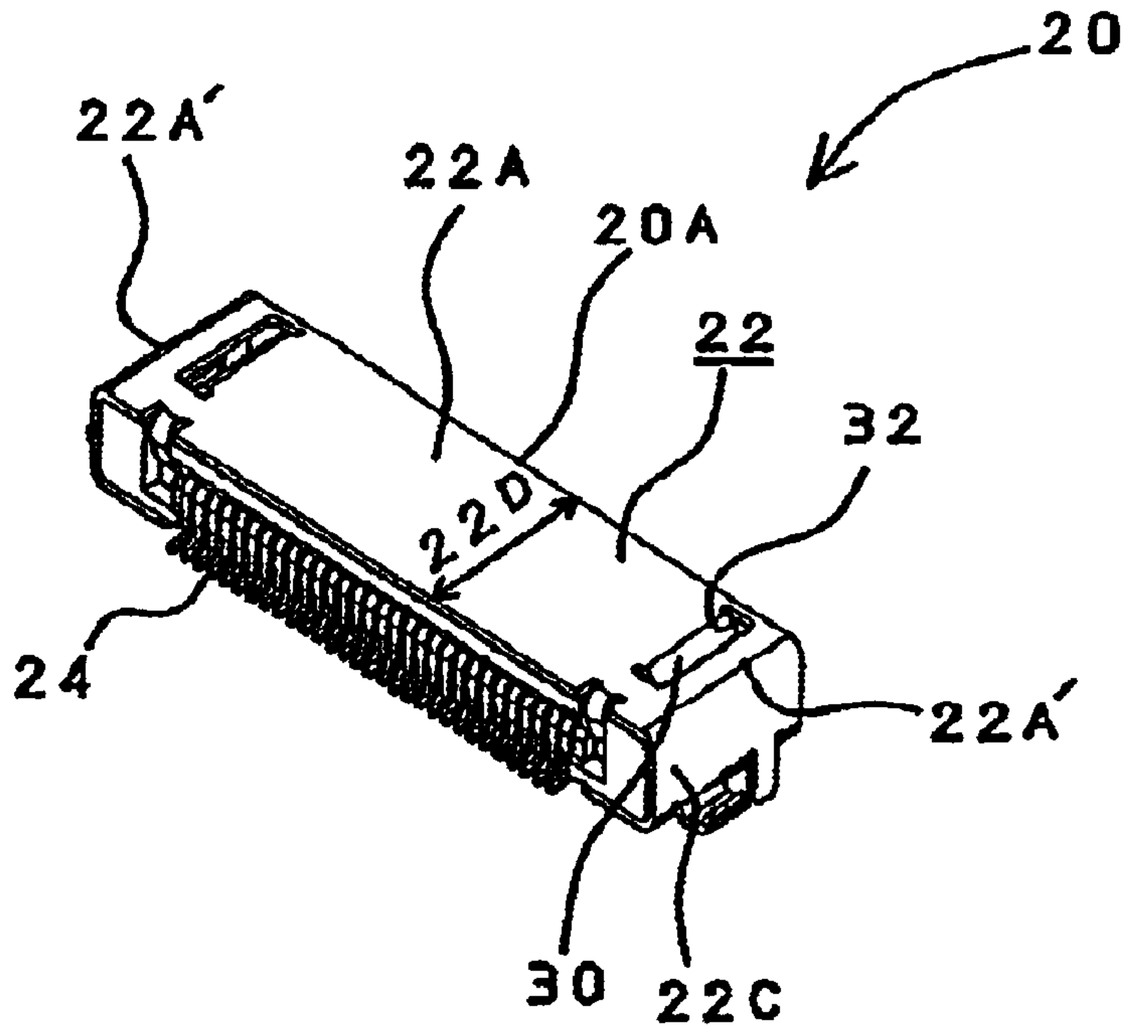


FIG. 2

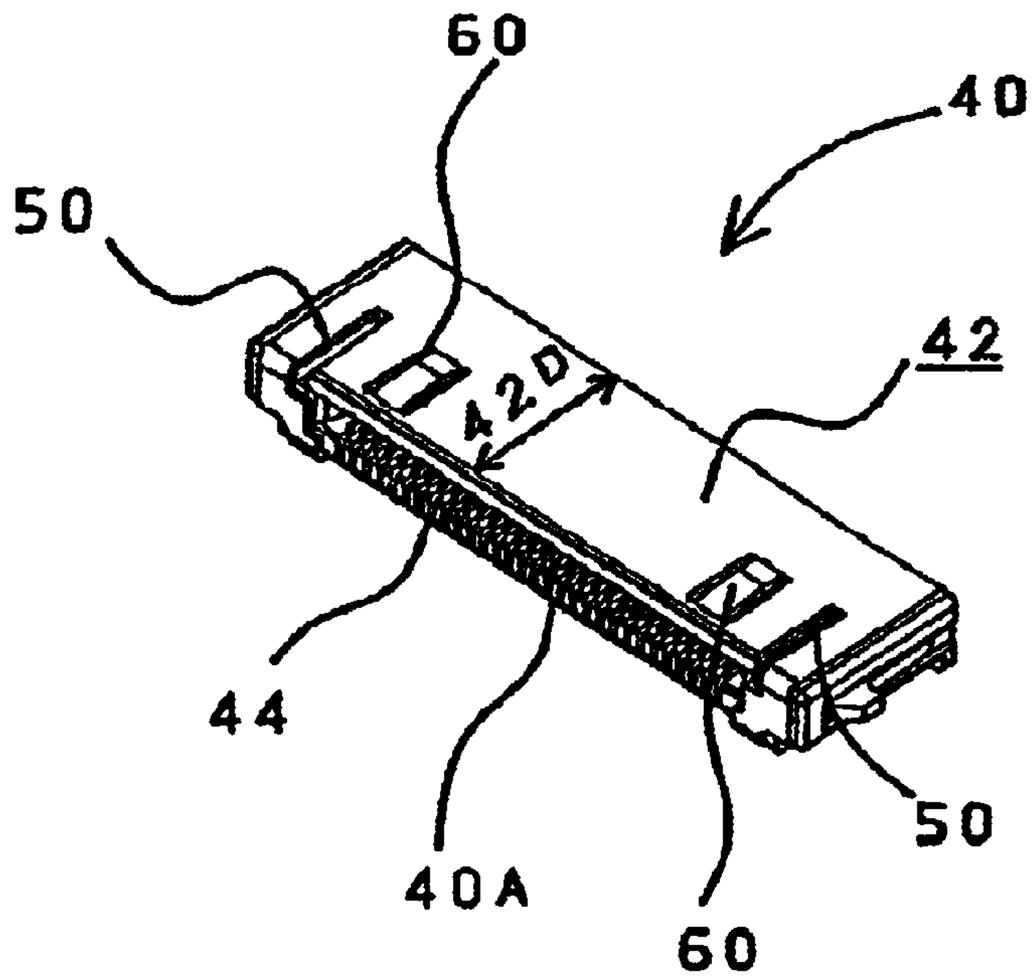


FIG. 3

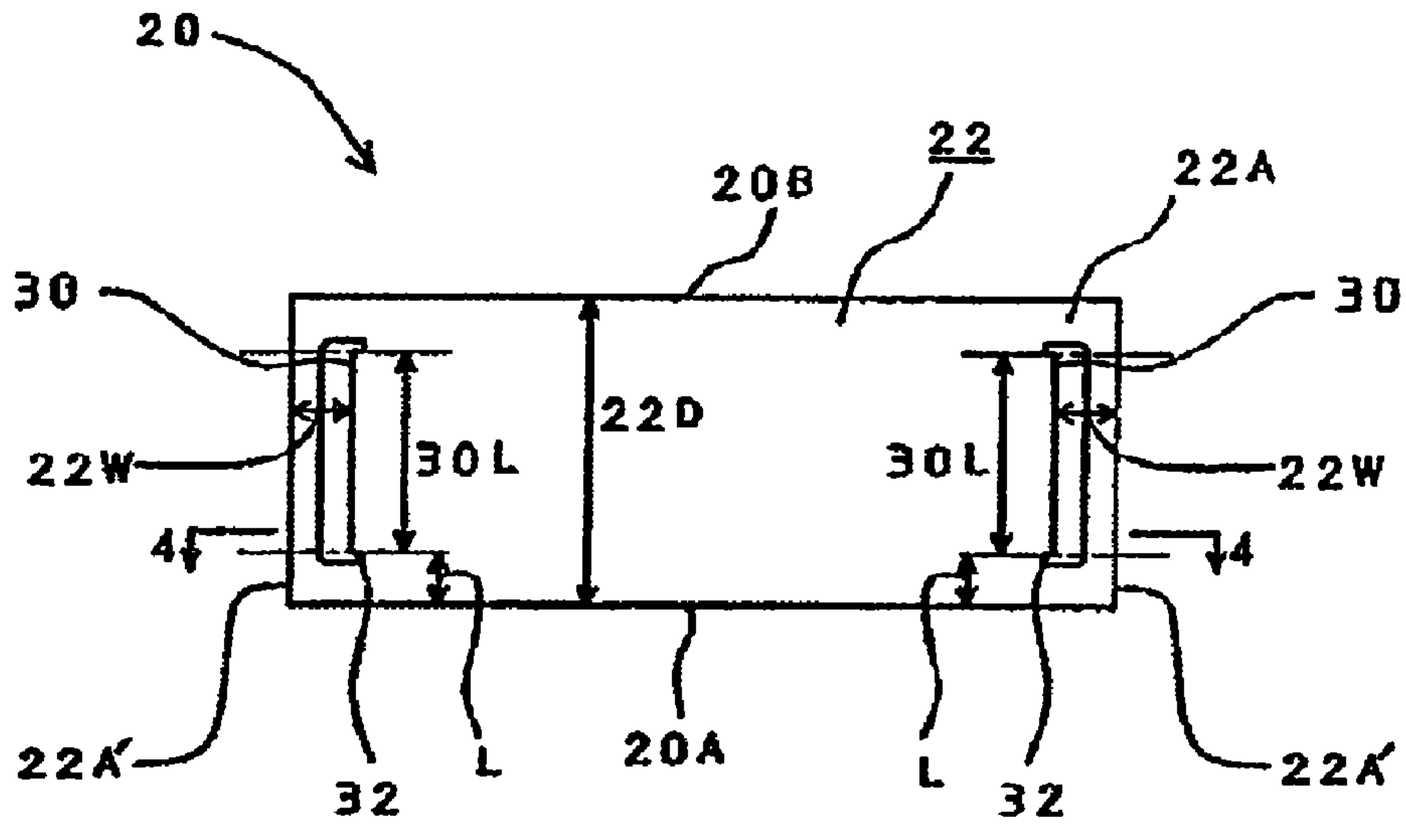


FIG. 4 (Amended)

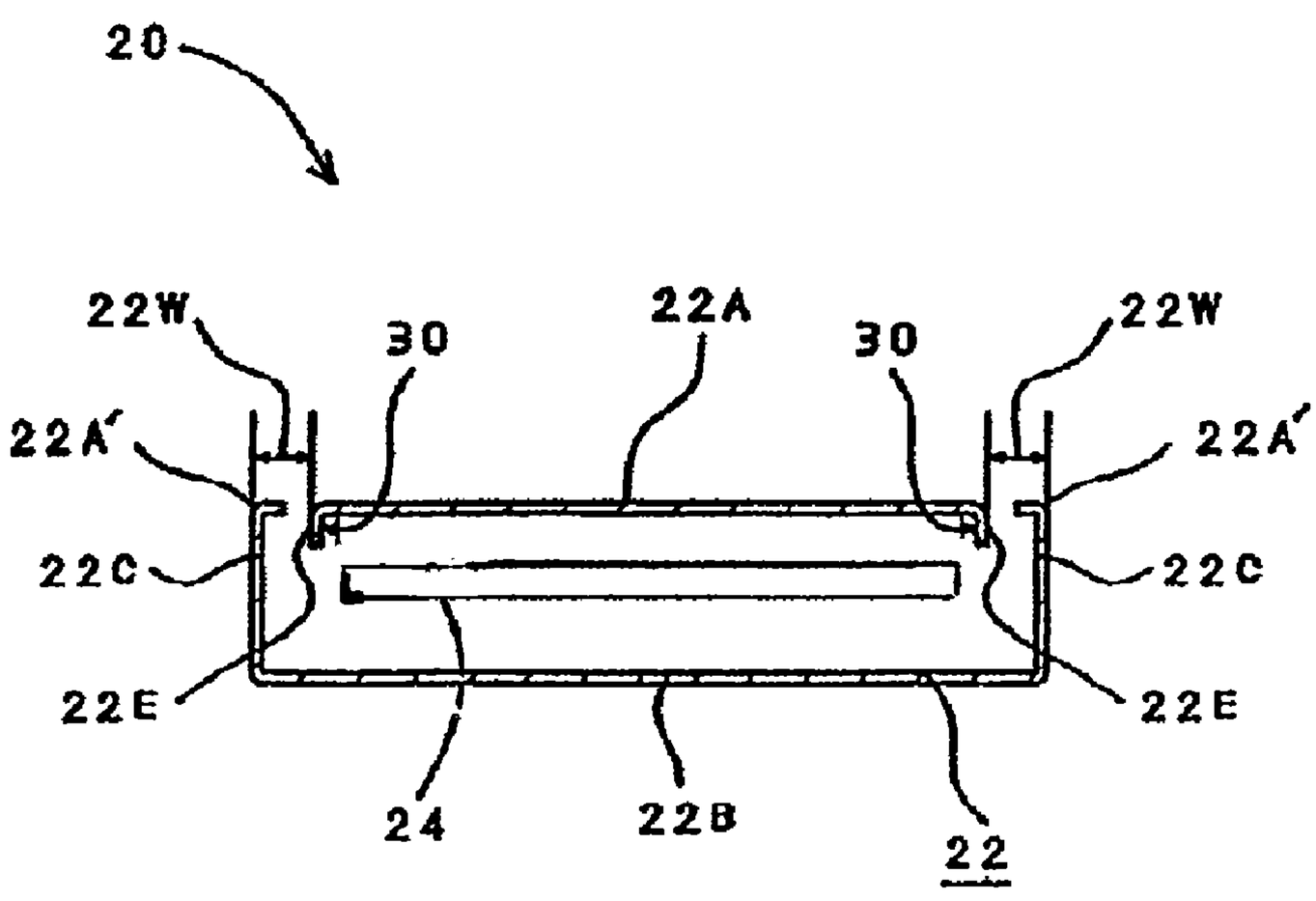


FIG. 5

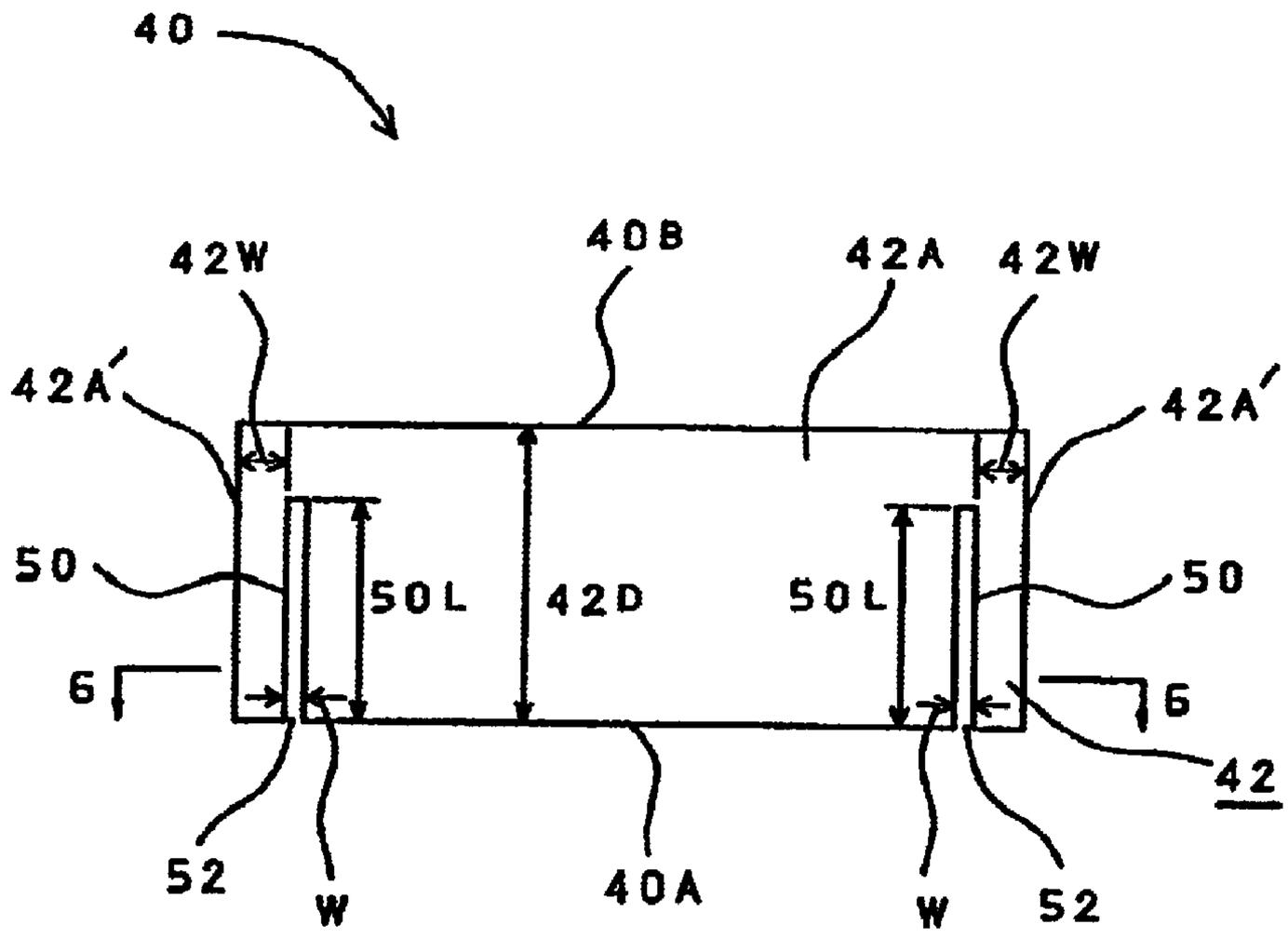

40
42W
40B
42A
42W
42A'
42A'
50
50L
42D
50L
50
6
6
42
52
W
40A
W
52

FIG. 6

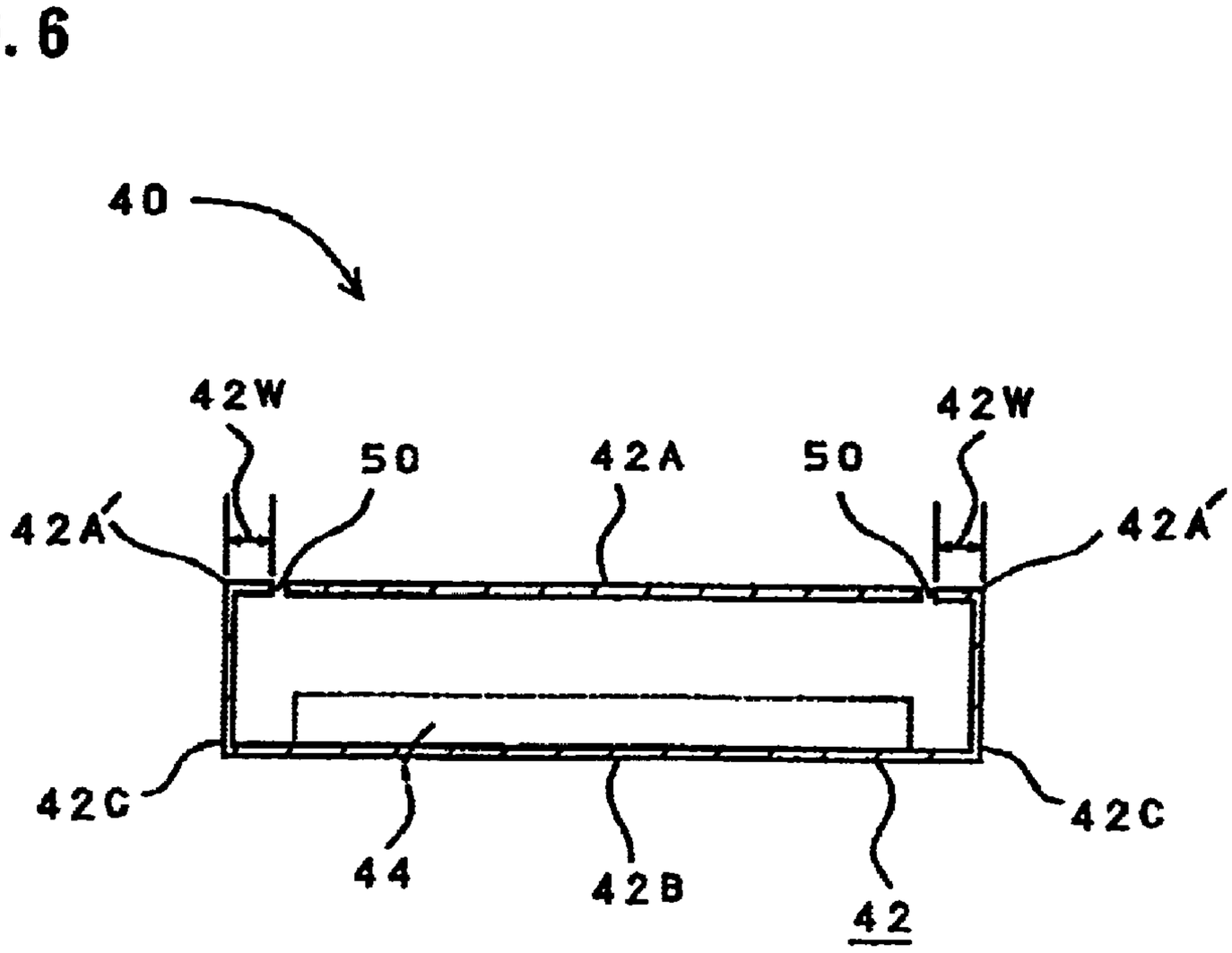

40
42W
50
42A
50
42W
42A'
42A'
42C
42C
44
42B
42

FIG. 7 (Amended)

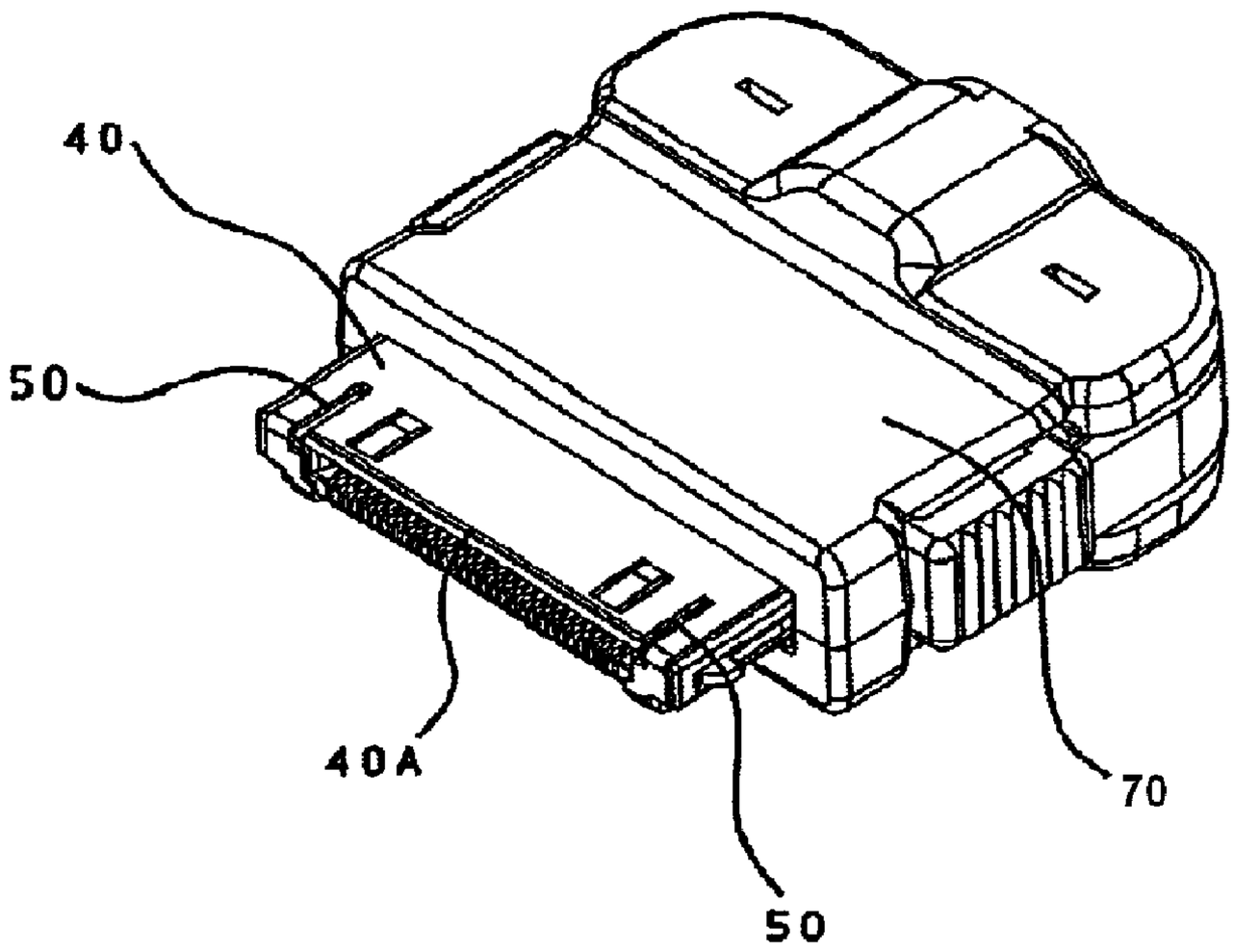


FIG. 9 (Amended)

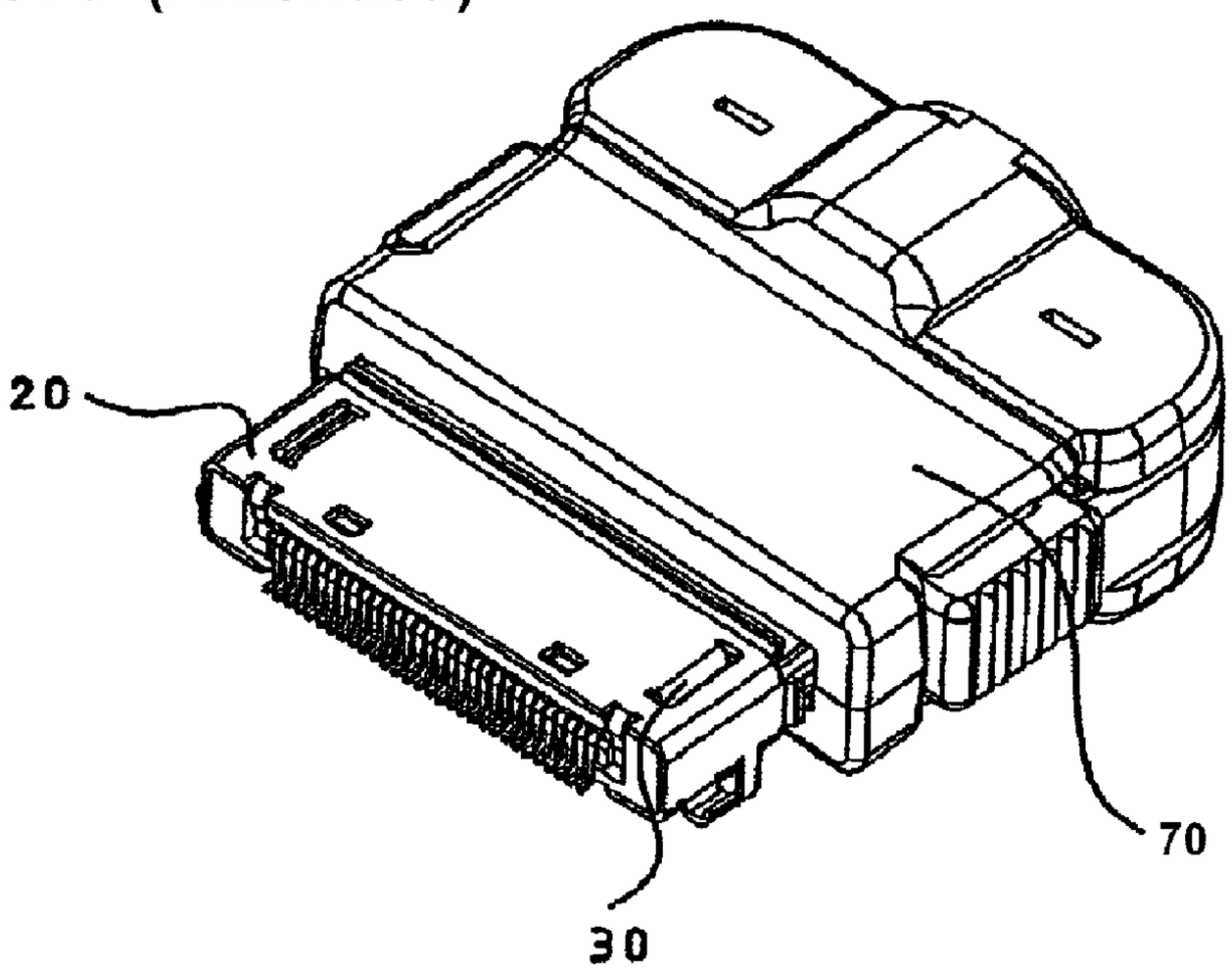


FIG. 8

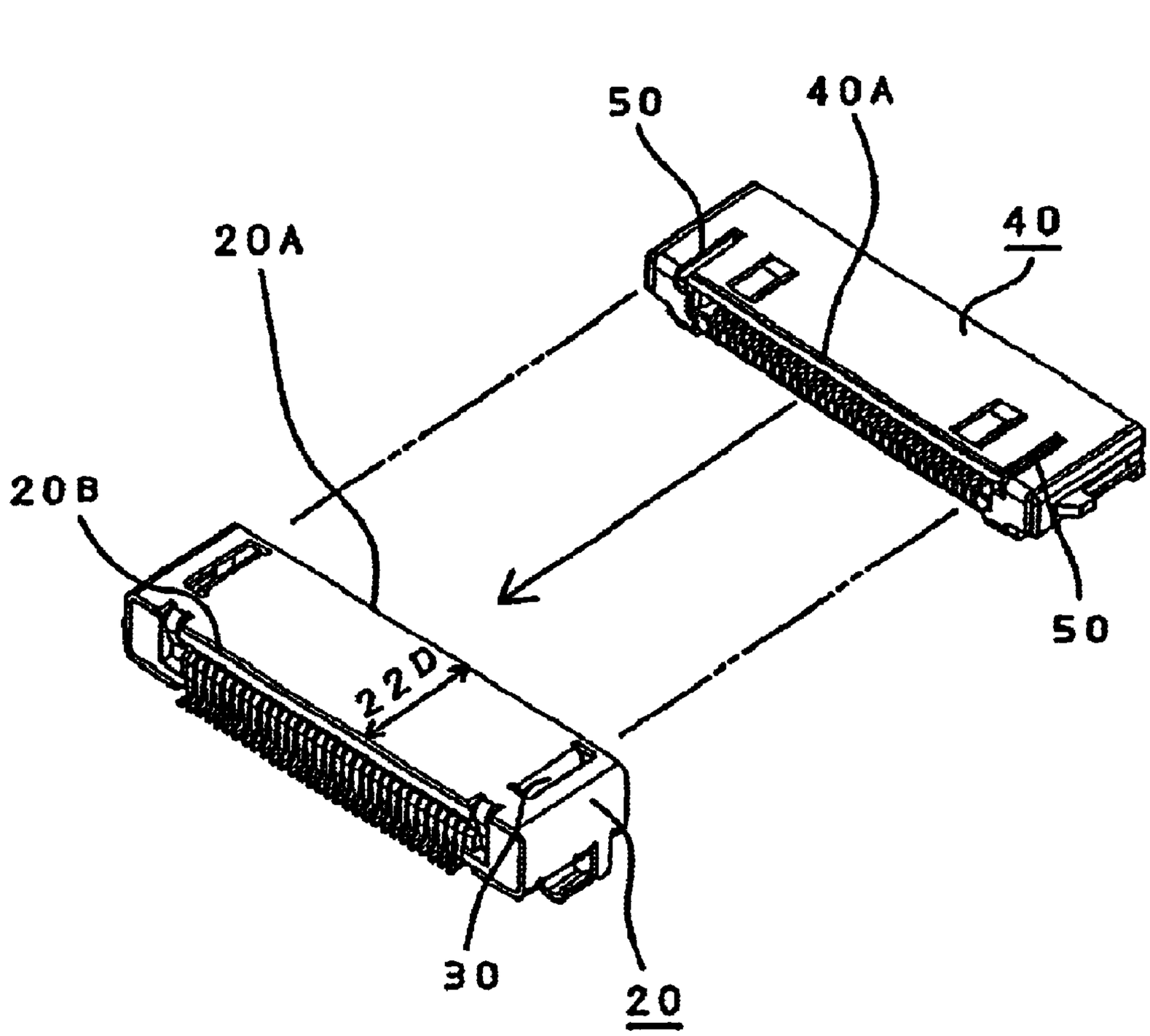
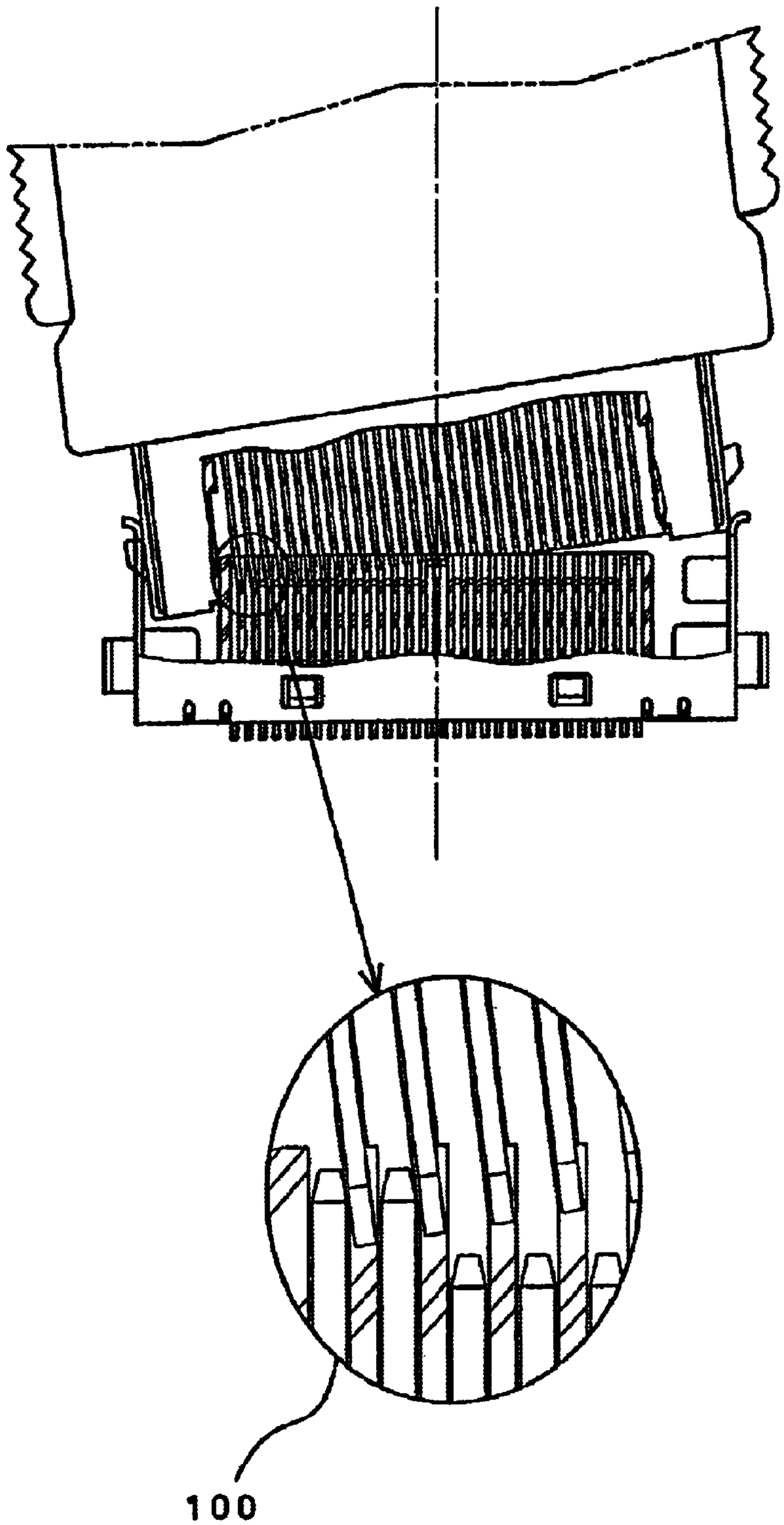


FIG. 10
PRIOR ART



PLUG CONNECTOR

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

Notice: More than one reissue application has been filed for the reissue of U.S. Pat. No. 6,776,660. The reissue applications are application Ser. Nos. 11/334,820 and 29/318,045, all of which are continuation reissues of Ser. No. 11/334,820.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a connector and more particularly to an electrical connector used in, for instance, small size electrical appliances.

2. Prior Art

In for instance, computer related electronic appliances, the electrical connections including connections to an AC adapter, to interfaces, etc. are made in many different ways. Such electrical connections are typically made by connectors that substantially comprise a receptacle (female) side connector element and a plug (male) side connector element that is brought into the receptacle side connector and coupled thereto for making electrical connection in between so that pin-shaped electrodes installed in the connector elements are connected.

More specifically, connectors typically include in their metal shells a plurality of pins (or terminals) that are arranged in parallel in their longitudinal directions and positionally secured by insulator material such as polyamide, LCP (liquid crystalline polymer), etc. The pins in the receptacle and plug side connector elements are spacedly arranged side by side in the direction in which the connector elements are mated together.

Upon making connection of the plug side connector element into the receptacle side connector element, it is necessary that respective pins in two connector elements be aligned to be on a straight line. In other words, it is necessary to avoid the connector elements from being oblique to each other when they are brought together at their front edges for connection. If the plug side connector element in an oblique posture with reference to the receptacle side connector element, as shown in FIG. **10**, is pushed into the receptacle side connector element, an irregular pin connection is made (as at **100**) as seen from the enlarged view shown in the circle in FIG. **10**, and this would cause several problems including short-circuiting.

In addition, when the plug side connector element is connected to the receptacle connector element in a slanted posture (which can easily occur when there is size differences between the receptacle and plug side connector elements), removing of the plug side connector element from the receptacle side connector element is not easily done and occasionally requires forcible and repeated twists on the shell of the plug side connector element This would cause damage to the pins and the shells of both connector elements.

Thus, though pin alignment is essential when connection is made between the two connector elements, such a pin alignment is not obtained easily and this difficulty can occur often when the connector is small in size and used in small size

electrical devices such as a personal digital assistance (PDA), digital cameras, camcorders, etc.

SUMMARY OF THE INVENTION

Accordingly, the object of the present invention is to provide an electrical connector that allows accurate and secure connections or coupling between connector elements to be made easily without causing pin or electrode misalignment.

The above object is accomplished by a unique structure of the present invention for a connector that comprises a first connector element and a second connector element that are coupled together when the second connector element is fitted in the first connector element, and in the present invention:

the first connector element is formed with an engagement projection that extends in the direction of the depth of the first connector element, the front end of the engagement projection being spacedly apart from the front edge of the first connector element; and

the second connector element is formed with an engagement slit or slot that extends in the direction of the depth of the second connector element so that the engagement slit receives therein the engagement projection of first connector element when the first and second connector elements are connected.

With the structure above, upon connecting the second connector element to the first connector element, the front end of the engagement slit of the second connector element engages with the engagement projection of the fist connecting element after the front end of the engagement slit has advanced the distance between the front edge of the first connector element and the front end of the engagement projection, and then the second connector element is pushed all the way to back of the first connector element in the depth of the first connector element while being guided by the engagement slit engaging with the engagement projection. Accordingly, even when the second connector element is obliquely pushed into the first connector element at the initial stage of coupling process, such oblique posture is corrected by the engagement projection of the first connector element as the second connector element is pushed and advanced to the back of the first connector element, and a connection between the first and second connector elements with the pins (electrodes) inside both of them being aligned straight can be made assuredly.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of the first connector body (first connector element) of the connector according to the present invention;

FIG. **2** is a perspective view of the second connector body (second connector element) of the connector according to the present invention;

FIG. **3** is a schematic top view of the first connector body,

FIG. **4** schematically shows the cross section of the first connector body taken along the line **44** in FIG. **3**;

FIG. **5** is a schematic top view of the second connector body,

FIG. **6** schematically shows the cross section of the second connector body taken along the line **6-6** in FIG. **5**;

FIG. **7** illustrates the second connector body which is combined with a plug assembly,

FIG. **8** illustrates the manner of connecting the second connector body to the first connector body,

FIG. **9** illustrates the first connector body to which the second connector body (not seen) is connected; and

FIG. **10** illustrates the manner of oblique connection of the first and second connector elements in prior art connector.

DETAILED DESCRIPTION OF THE INVENTION

The connector of the present invention is comprised of a first connector body **20** (a receptacle side connector element) and a second connector body **40** (a plug side connector element).

As seen from FIGS. **1** and **2**, the first and second connector bodies **20** and **40** comprise respectively a relatively flat box shape shell **22** and **42** made of a metal and include therein a plurality of pins or elongated electrodes, which are collectively referred to by the reference numerals **24** and **44** respectively, and an insulating material (not shown) is filled therein so as to positionally secure the pins **24** and **44**.

The shell **22** of the first connector body **20** comprises, as best seen from FIG. **4**, a top shell plate **22**A and a bottom shell plate **22**B as well as side shell plates **22**C, thus forming a box shape that has a predetermined depth **22**D (see FIG. **3**) that extends from the front edge **20**A to the rear edge **20**B of the first connector body **20**. The pins **24** of the first connector body **20** are arranged parallel to the direction of the depth **22**D.

The shell **22** of the first connector **20** is formed in its top shell plate **22**A with engagement projections **30**. Each of the projections **30** is formed by cutting the top shell plate **22**A in an angled C shape, and the resulting tongue pieces **22**E are bent inward toward the interior of the shell **22**. The tongue pieces **22**E are in the shape of elongated parts of the shell **22** that extend in the direction of the depth **22**D of the first connector body **20**, and they are parallel to the side shell plates **22**C of the first connector body **20** or to the side edges **22**A' of the top shell plate **22**A.

The tongue pieces **22**E are bent at locations of distance **22**W from the side shell plates **22**C or from the side edges **22**A' of the first connector body **20** to make the engagement projections **30**. The engagement projections **30** are provided with a space of a distance L apart from the front edge **20**A of the first connector body **20**. In other words, the front ends **32** of the engagement projections **30** are spaced apart from the front edge **20**A of the first connector body **20**. The engagement projections **30** have a length **30**L which is, in the shown embodiment, about two third the depth **22**D of the first connector body **20**.

On the other hand, the shell **42** of the second connector body **40** comprises, as best seen from FIG. **6**, a top shell plate **42**A and a bottom **[**shall**]** *shell* plate **42**B as well as side shell plates **42**C, thus forming a box shape with a predetermined depth **42**D (see FIG. **6**) that extends from the front edge **40**A to the rear edge **40**B of the second connector body **40**. The overall size of the shell **42** of the second connector **42** is slightly smaller than the shell **22** of the first connector body **20** so that the second connector body **40** is fitted in the first connector body **20** from the front side of the first connector body **20**. The pins **44** of the second connector body **40** are arranged so be parallel to the direction of the depth **42**D.

The shell **42** of the second connector body **40** is formed in its top shell plate **42**A with engagement slits **50**. Each of the engagement slits **50** is formed by cutting away parts of the top shell plate **42**A linearly so that the engagement slits **50** are parallel to and adjacent to the side plates **42**C or to side edges **42**A' of the top shell plate **42**A. An alternate construction would be to mold the slits **50** into the shell **42** when the shell **42** is made. The engagement slits **50** are provided so as to extend in the direction of depth **42**D of the shell **42** of the second connector body **40**. In other words, the front end ends

52 of the engagement slits **50** are on the front edge **40**A of the second connector body **40**. The engagement slits **50** have a length **50**L which is, in the shown embodiment, about two thirds of the depth **42**D of the second connector body **40** and is slightly larger in length than the engagement projections **30** of the first connector body **20**.

The engagement slits **50** are opened at locations of distance **42**W from the side shell plates **42**C or from the side edges **42**A' of the top shell plate **42**A of the second connector body **40**, the distance **42**W being substantially the same as the distance **22**W of the engagement projections **30** of the first connector body **20**. Thus, the engagement slits **50** positionally correspond to the engagement projections **30** of the first connector body **20**. The width W of the engagement slits **50** is substantially the same as (or slightly larger than) the thickness of the tongue pieces **22**E (engagement projections **30**) which is the thickness of the metal material of the shell **22** of the first connector body **20**.

The reference numerals **60** shown in FIG. **2** are raised springy holders formed by notching the top shell plate **42**A of the second connector body **40** and raised outwardly.

The first and second connector bodies **20** and **40** structured as described above are connected by way of mating together at the front ends of the shells **22** and **42**.

More specifically, as shown in FIG. **7**, the second connector body **40**, which is attached at its rear edge **40**B to, typically, a plug assembly **[60]** *70* that is connected to, for instance, an electrical cable (not shown), is held by hand, and then it is brought to the vicinity of the first connector body **20** which is installed in a casing body of, for instance, a PDA (not shown).

The front edge **40**A of the second connector body **40**, which is a plug side connector element, is set so as to face the front edge **20**A of the first connector body **20**, which is a receptacle side connector element, so that the first and second connector bodies **20** and **40** are aligned in the direction of the depth thereof (which brings an alignment of the pins **24** and **44** installed in such connector bodies **20** and **40**). In this positioning, since the distances **22**W and **42**W of the first and second connector bodies **20** and **40** are substantially equal, the engagement projections **30** of the first connector body **20** and the engagement slits **50** of the second connector body **40** are also aligned on imaginary straight lines.

Then, the second connector body **40** is pushed into the first connector body **20** as shown by arrow in FIG. **8**. During the initial pushing movement, the outer surfaces of the shell **42** of the second connector body **40** are guided by the inner surfaces of the shells **22** of the first connector body **20**. After advancing the distance L which is the distance from the front edge **20**A to the front ends **32** of the engagement projections **30** in the first connector body **20**, the engagement slits **50** of the second connector body **40** come into engagement with the engagement projections **30** of the first connector body **20**. As a result, the sliding movement of the second connector body **40** in the depth **22**D of and toward the rear edge **20**B of the first connector body **20** is guided by the engagement projections **30**. The second connector body **40** is thus pushed into the first connector body **20** straight with the pins inside both connector bodies aligned straight as well and connected to the first connector body **20** (see FIG. **9**, in which the second connector body **40** is unseen since it is inside the first connector body **20**). The second connector body **40** is held inside the first connector body **20** by the raised springy holders **60** that press against the inside surface of the top shell plate **22**A of the first connector body **20**.

The width W of each engagement slit **50** is substantially the same as (or slightly larger than) the thickness of the engage-

ment projection **30**, and thus the engagement projections **30** have substantially no space for play in the direction perpendicular to the direction of the length of the engagement slits **50** or to the direction of the connecting direction of the first and second connector bodies **20** and **40**. Accordingly, the engagement slits **50** of the second connector body **40** make no lateral movements during the sliding movement, keeping the straight alignment obtained by the engaged engagement projections **30** and engagement slits **50**.

As a result, even when the second connector body **40** is slanted with reference to the first connector body **20** during the initial connecting stage, such a slanted positional relationship is automatically corrected to a straight relationship as the second connector body **40** is pushed into deep in the first connector body **20**, and a snug and secure engagement of the first and second connector bodies **20** and **40** is accomplished, and pins **24** and **44** of the first and second connector bodies **20** and **40** are connected properly. The engagement projections **30** and the engagement slits **50** are formed near the side edges **22**A' and **42**A' of the first and second connector bodies **20** and **40**, respectively; accordingly, the connection of the connector bodies **20** and **40** can be made in a stable fashion, and a separation of the connected connecting bodies can be made easily.

What is claimed is:

[1. A connector comprising a first connector element and a second connector element that are coupled together, wherein

said first and second connector elements are each formed with a metallic shell;

said first connector element is formed with an engagement projection that projects toward an interior of said first connector element and extends in a direction of depth of said first connector element, a front end of said engagement projection being spaced apart from a front edge of said connector element by a predetermined distance;

said engagement projection is formed by cutting a C-shape slit in a top surface of said metallic shell of said first connector element and bending a tongue formed downwardly; and

said second connector element is formed with an engagement slit in said metallic shell that extends in a direction of depth of said metallic shell of said second connector for engaging with said engagement projection formed in said metallic shell of said first connector element.**]**

[2. The connector according to claim **1**, wherein said engagement projection is provided at two locations of said first connector element so as to be parallel to side edges of said first connector element, and said engagement slit is provided at two location of said second connector element so as to be parallel to side edges of said second connector element and to correspond to said two locations of said engagement projections of said first connector element.**]**

[3. The connector according to claim **1**, wherein said engagement projection has a predetermined length in said depth direction and said engagement slit has a predetermined length in said depth direction which is at said predetermined length of said engagement projection.**]**

4. An electrical connector comprising:

a plug connector element having a first metallic shell and adapted to be coupled to a receptacle connector element having a second metallic shell, the first shell comprising a top plate, a bottom plate, a first side and a second side and having a width W and a depth D, the first and second sides being small relative to the top and bottom plates making the first shell substantially flat;

first and second engagement slits formed in the top plate of the first shell, the first and second engagement slits starting from a front edge of the top plate and extending in a direction of the depth D;

an array of electrodes positioned within the first shell extending in a direction of the depth D between the first and second engagement slits such that there are no electrodes between an engagement slit and its respective side, the array of electrodes being positionally secured by insulating material to an interior surface of the bottom plate of the first shell, leaving an insertion cavity in the interior of the shell between the array of electrodes and the top plate;

wherein the first and second engagement slits in the first shell are adapted to engage with first and second engagement projections of the receptacle connector element that project toward an interior of the receptacle connector element and extend in a direction of a depth of the receptacle connector element, a front end of the first and second engagement projections being spaced apart from a front edge of the receptacle connector element by a predetermined distance, the engagement projections being formed by cutting a C-shape slit in a top surface of the second shell and bending a tongue formed downwardly.

5. The electrical connector of claim 4 further comprising first and second raised springy holders that are raised upwardly from the top plate of the first shell, the raised springy holders providing for compressive action when the plug connector element is coupled to the receptacle connector element.

6. The electrical connector of claim 4 further comprising a plug assembly attached to a rear edge of the plug connector element; and

a cable coupled to the plug assembly and electrically coupled to the array of electrodes via the plug assembly.

7. An electrical connector comprising:

a plug connector element having a first shell and adapted to be coupled to a receptacle connector element having a second shell, the first shell comprising a top plate, a bottom plate, a first side and a second side and having a width W and a depth D, the first and second sides being smaller relative to the top and bottom plates;

first and second engagement slits formed in the top plate of the first shell, the first and second engagement slits starting from a front edge of the top plate and extending in a direction of the depth D;

an array of electrodes positioned within the first shell extending in a direction of the depth D between the first and second engagement slits such that there are no electrodes between an engagement slit and its respective side, the array of electrodes being positionally secured by insulating material to an interior surface of the first shell, leaving an insertion cavity in the interior of the shell between the array of electrodes and the top plate;

wherein the first and second engagement slits in the first shell are adapted to engage with first and second engagement projections of the receptacle connector that project towards an interior of the receptacle connector element and extend in a direction of depth of the receptacle connector element.

8. The electrical connector of claim 7 wherein the plug connector element is formed with a metallic shell.

9. The electrical connector of claim 8 further comprising first and second raised springy holders that are raised upwardly from the top plate of the shell, the raised springy

holders providing for compressive action when the plug connector element is coupled to the receptacle connector element.

10. The electrical connector of claim 7 further comprising first and second springy retention pins protruding from the first and second sides, respectively, the retention pins providing releasable locking mechanism when the plug connector mates with a receptacle connector.

11. The electrical connector of claim 10 wherein a length of the first and second engagement slits is about two thirds the depth D of the first shell.

12. The electrical connector of claim 11 further comprising a plug assembly attached to a rear edge of the plug connector element.

13. The electrical connector of claim 12 further comprising a cable coupled to the plug assembly and electrically coupled to the array of electrodes via the plug assembly.

14. The electrical connector of claim 13 wherein the plug assembly comprises a mechanism for retracting the springy retention pins into the body of the plug connector to release the locking mechanism.

15. An electrical plug connector comprising:

a body having a top plate, a bottom plate, a first side and a second side, the body having a width W and a depth D, wherein the first and second sides are smaller relative to the top and bottom plates providing a generally flat body;

first and second engagement slits formed on the top plate of the body and extending from a front edge of the top plate in a direction of depth D for engaging with engagement projections formed in a body of a corresponding receptacle side connector element;

an array of electrodes positioned within and extending in the direction of the depth D of the body between the first and second engagement slits such that there are no electrodes between an engagement slit and its respective side, the array of electrodes being positionally secured by insulating material to an interior surface of the bottom plate of the body, leaving an insertion cavity in the interior of the body between the array of electrodes and the top plate;

wherein the first and second engagement slits facilitate insertion alignment when the plug connector mates with a corresponding receptacle connector by mating with engagement projections that project toward an interior of the receptacle connector and extend in a direction of depth of the receptacle connector.

16. The electrical plug connector of claim 15 wherein the body comprises a metallic shell.

17. The electrical plug connector of claim 16 wherein the first engagement slit is formed at a distance W from the first side and the second engagement slit is formed at a distance W from the second side.

18. The electrical plug connector of claim 16 further comprising a retention mechanism formed on the body and operable to provide secure engagement between the plug connector and a corresponding receptacle connector when the plug connector mates with the corresponding receptacle connector, wherein the retention mechanism comprises at least one raised springy holder raised outwardly from one of either the top plate or the bottom plate of the body, the raised springy holder providing compressive action when the plug connector mates with a corresponding receptacle connector.

19. The electrical plug connector of claim 15 further comprising a plug assembly attached to the body for coupling an electrical cable to the connector.

20. An electrical plug connector comprising:

a body having a top plate, a bottom plate, a first side and a second side, the body having a width W and a depth D, wherein the first and second sides are smaller relative to the top and bottom plates providing a substantially flat body;

an array of electrodes extending in the direction of the depth D, the array of electrodes being positionally secured by insulating material to an interior surface of the body;

a retention mechanism formed on the body and operable to provide secure engagement between the plug connector and a corresponding receptacle connector when the plug connector mates with the corresponding receptacle connector, wherein the retention mechanism comprises at least one raised springy holder raised outwardly from a plate of the body, the raised springy holder providing compressive action when the plug connector mates with a corresponding receptacle connector; and

first and second slits formed on the top plate of the body extending in the direction of the depth D, the first slit being formed at a distance S1 from the first side and the second slit being formed at a distance S2 from the second side,

wherein the array of electrodes is disposed between the first and second slits such that there are no electrodes between a slit and its respective side, and

wherein the first and second slits facilitate insertion alignment when the plug connector mates with a corresponding receptacle connector.

21. The electrical plug connector of claim 20 wherein each of the outermost electrodes of the array of electrodes is spaced away from its respective side by a distance that is no less than S1 or S2.

22. The electrical plug connector of claim 21 wherein each of the first and second slits has a length that is about two thirds of the depth D of the body.

23. The electrical plug connector of claim 20 further comprising first and second springy retention pins protruding from the first and second sides, respectively, the retention pins providing releasable locking mechanism when the electrical connector mates with another connector.

24. The electrical plug connector of claim 20 further comprising a plug assembly attached to a rear edge of the body for coupling an electrical cable to the body.

25. The electrical plug connector of claim 24 wherein the plug assembly comprises a mechanism for retracting the springy retention pins into the body of the electrical connector to release the locking mechanism.

26. The electrical plug connector of claim 20 wherein the slits are formed by one of either cutting through the top plate or molding them into the top plate.

27. The electrical plug connector of claim 20 wherein the top plate and the bottom plates are made of metal.

28. The electrical plug connector of claim 20 wherein each of the first and second slits begins at a front edge of the top plate.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : RE43,780 E
APPLICATION NO. : 12/613474
DATED : October 30, 2012
INVENTOR(S) : Yoshifumi Kubota et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page:

At Item (73) Assignee,

"Apple Inc., Cupertino, CA (US)"

should read,

-- Japan Aviation Electronics Industry, Limited, Tokyo (JP) --

Signed and Sealed this
Twenty-fifth Day of June, 2013

Teresa Stanek Rea
Acting Director of the United States Patent and Trademark Office