ELECTRICAL CONNECTOR

TECHNICAL FIELD

[0001]

The present invention relates to an electrical connector, more particularly to an electrical connector that is suitable for installation and use in the hinge portions of folding electronic equipment such as mobile telephones and notebook computers.

BACKGROUND ART

[0002]

Folding electronic equipment such as a mobile telephone or a notebook computer has a first housing in which a circuit board or the like is housed and a manipulation section is provided, and a second housing in which a display panel or the like is installed, with one pair of edges of these first and second housings being rotatably coupled by means of hinge portions. The electronic parts housed in the first and second housings are electrically connected to each other, and rotatable electrical connectors known as hinge connectors are used for such electrical connections. These hinge connectors are so structured as to be incorporated into the hinge portions coupling the first and second housings.

[0003]

A typical hinge connector is disclosed in U.S. Patent No. 6,616,467. This hinge connector is so configured as to be incorporated into a hinge portion of a fold-up mobile telephone.

[0004]

The hinge connector disclosed in U.S. Patent No. 6,616,467 will now be described referring to Figs. 23 and 24, which are accompanying drawings of the aforementioned U.S. Patent. Fig. 23 is an exterior perspective view of such hinge connector, and Fig. 24 is an exploded perspective view thereof.

[0005]

The hinge connector 30 has a pair of first and second members 31, 32, and a pair of second members 33, 34 that are installed so as to be able to turn around a common axis with the first members 31, 32; and is assembled with a middle portion of a flexible printed circuit ("FPC" below) 35 fixed in the interior of the pairs of first and second members 31 to 34. Such assembly is incorporated in a hinge portion of a fold-up mobile telephone, which is omitted from the drawings. The structure of a portion of this hinge connector 30 is described below.

[0006]

The pairs of first and second members 31 to 34 are each divided in two in a planar direction that includes their single axis. The first members 31, 32 have semicircular first turning guide portions 31b, 32b that engage with the second members 33, 34 so as to be able to turn therein, and first housing portions 31c, 32c that house the FPC. The first turning guide portions 31b, 32b form an almost circular outer circumferential surface when combined with each other.

[0007]

The second members 33, 34 have semicircular second turning guide portions 33b, 34b that engage with the first turning guide portions 31b, 32b so as to be able to turn thereon, and second housing portions 33c, 34c that house the FPC 35. The second turning guide portions 33b, 34b also form an almost circular outer circumferential surface when combined with each other.

[0008]

Due to the first turning guide portions 31b, 32b being fitted inside the second turning guide portions 33b, 34b, the pairs of first and second members 31 to 34 are able to turn with respect to each other.

[0009]

The FPC 35 has its lengthwise middle portion bent into a spiral of at least one turn, at the two ends of which there are formed pairs of first and second engaging portions 35a, 36a.

[0010]

The procedure for assembling this hinge connector 30 is as follows. First

of all, the two end portions of the FPC 35 are made to protrude out from the first and second members 31 to 34, while the middle portion is disposed in the first and second housing portions 31c to 34c of the first and second members 31 to 34. Then follows assembling of the first and second members 31 to 34. During such assembling, the first engaging portions 35a of the FPC are gripped by first holding portions 31a, 32a, and the second engaging portions 36a of the FPC are gripped by second holding portions 33a, 34a. The assembled hinge connector 30 is incorporated in a hinge portion of a fold-up mobile telephone omitted from the drawings. Through such incorporation of the hinge connector, the electrical parts housed in the pair of housings composing the fold-up mobile telephone are electrically connected.

[0011]

With the hinge portion connector of such configuration, the bent middle portion of the FPC is housed and held by the pairs of first and second members, and these members are incorporated in a hinge portion of a fold-up mobile telephone. Thus, the hinge connector and the FPC will be held by the first and second holding portions when the FPC is pulled out from the hinge connector, so that even with repeated unfolding manipulations of the fold-up mobile telephone, the stress acting on the FPC will be reduced. Also, displacement of the FPC can be avoided, and further, more compact equipment is enabled. In addition, the FPC can be hidden by the housing.

[0012]

The hinge connector disclosed in U.S. Patent No. 6,616,467 has a pair of first members 31, 32 and a pair of second members 33, 34 that are installed so as to be able to turn around a common axis with the first members 31, 32, and is incorporated, with the middle portion of an FPC 35 fixed inside the pairs of first and second members 31 to 34, into a hinge portion of a fold-up mobile telephone. Thus, the FPC is held by the first and second members, so that the stress acting on the FPC is reduced without the FPC being displaced.

[0013]

Incorporated into the hinge portion of a fold-up mobile telephone, this hinge connector reduces the stress acting on the FPC when the telephone is folded up. Therefore, it is more of a protective member that protects the FPC than a connector that effects electrical connection. More precisely, the pair of housings of the telephone are connected by a single FPC, and the hinge connector is an item that protects the FPC at the hinge portion of the equipment. Note that as well as the hinge connector disclosed in U.S. Patent No. 6,616,467 being an item that protects the FPC, the hinge connectors of other fold-up electronic equipment of a similar kind besides fold-up mobile telephones also are basically protective members that protect an FPC in the same manner as the foregoing hinge connector.

[0014]

Because such hinge connector protects the middle portion of the FPC, once the connector has been fitted to the pair of housings of the electrical equipment, the pair of housings cannot be separated unless the FPC is removed from them. The hinge connector has, of course, no separable electrically connecting portion, and therefore separation via such a portion of the connector is not possible. This means that with fold-up electronic equipment, the freedom of design for the equipment and connector is restricted and consequently it is not possible to meet the specification requirements of a wide range of users.

[0015]

Also, with the hinge connector disclosed in U.S. Patent No. 6,616,467, the work of installing the FPC to the pairs of first and second members is troublesome. Further, this hinge connector is able to lessen to some degree the stress that acts on the FPC, but as the frequency of folding and unfolding manipulations rises, the stress acting on the FPC may exceed the tolerable level or the FPC may become worn by contact with the housings, and due to these and like factors, the risk of electrical failures occurring will increase.

SUMMARY

[0016]

An advantage of some aspects of the present invention is to provide an electrical connector that can be installed to and removed from a hinge portion of fold-up electronic equipment in a simple manner and that moreover has broad utility.

[0017]

An advantage of other aspects of the invention is to provide an electrical connector that, in addition to the above advantage, has the advantage of being easy to maintain.

[0018]

According to an aspect of the invention, an electrical connector includes a pair of first and second connectors rotatable at a particular angle.

The first connector includes: a first connector housing of a particular length and thickness, constituted of electrically insulating resin; and a first contact terminal constituted of material with good electrical conduction and housed in the first contact housing. The first contact terminal is provided with a first contact portion, a first contact installation portion for installation of the first contact portion is provided around the circumferential surface of the first connector housing, and the first contact portion is installed to the first contact installation portion.

The second connector includes: a second contact terminal constituted of material with good electrical conduction and provided with a second contact portion that contacts with the first contact portion of the first contact terminal; and a second connector housing, constituted of electrically insulating resin, which houses the second contact terminal. The second connector housing is provided with a guide face that renders smooth rotation of the first connector housing when the first connector is pushed against the second connector, and the second contact portion is installed to the guide face.

With the first and second contact portions pressed into contact with each other by placing and pushing the first connector against the second connector, rotation of either the first or the second connector causes the first and second

contact portions to slide.

[0019]

With such configuration, the first and second connectors are separate and independent, and can each be fabricated individually, thus facilitating manufacture. Also, the first connector in particular is mechanically robust because the first contact portion of the first contact terminal is installed to and supported by the circumferential surface of the first connector housing. Further, being separate and independent, the first and second connectors can be incorporated into a hinge portion of electronic equipment or the like in a simple manner. Thus, the connector can be installed in a simple manner to various kinds of equipment and will have broad utility. Furthermore, the first and second connectors can be joined merely by placing and pushing either one thereof against the other, and in addition can be rotated smoothly at a particular angle.

[0020]

The first connector housing may be formed as a cylindrical body of a particular length and thickness, the first contact installation portion may be provided on the circumferential surface of the cylindrical body, and a terminal installation hole for installation of the first contact terminal may be provided in the lengthwise direction of the cylindrical body, from the front wall toward the rear wall, with the first contact portion being installed to the first contact installation portion, and a terminal portion provided on the first contact terminal being installed to the terminal installation hole.

[0021]

With such configuration, the first contact terminal can be fixed into the first connector housing just by being installed to (inserted into) the terminal installation hole, and therefore such installation is extremely simple. Also, the first contact terminal will be removable, facilitating maintenance or replacement thereof.

[0022]

In the electrical connector, the first connector housing has the first contact

installation portion divided, from one longitudinal end of the cylindrical body to the other, into multiple portions, is provided with multiple terminal installation holes, and employs multiple first contact terminals; the first contact portions of the multiple first contact terminals being installed to the first contact installation portions so divided; the terminal portions of the multiple first contact terminals being installed to the multiple terminal installation holes; and the second connector housing has, installed to the guide face thereof, multiple second contact terminals provided with second contact portions that contact with the first contact portions of the multiple first contact terminals.

[0023]

With such configuration, numerous contact terminals can be installed, and hence the range of use of the connector is broadened to enable the expansion of the applications thereof.

[0024]

Stepped portions may be provided at boundaries dividing the multiple first contact installation portions in the electrical connector, with the first contact portions being installed to the divided multiple first contact installation portions, and the guide surface of the second connector housing may be formed in a shape such as to complement the contact installation portions of the first connector housing, with the second contact portions being installed to the guide face.

[0025]

With such configuration, because there are stepped portions at the boundaries dividing the multiple first contact installation portions, clearances are secured between the surfaces of the first contact portions, so that short circuit accidents can be prevented. Furthermore, with these stepped portions, positioning is simple during joining with the second connector.

[0026]

In the electrical connector, the first contact installation portions may be formed like a stairway ascending from one longitudinal end of the first connector housing toward the other end, and the guide face be formed in a shape such as to

contact with the wall surfaces of such stairway.

[0027]

With such configuration, because the first contact installation portions are formed like a stairway ascending from one end toward the other end of the first connector housing in the lengthwise direction, the appearance is improved and manufacture of the first contact installation portions is rendered easier.

[0028]

The first contact installation portions in the electrical connector may be formed on a part of the circumferential surface of the first connector housing.

[0029]

The first contact installation portions in the electrical connector may further be formed at least half-way around the circumferential surface of the first connector housing.

[0030]

With such configuration, whereby the first contact installation portions in the electrical connector are formed on a part of the circumferential surface of the first connector housing, such part will constitute the installation part for the first contact portions, enabling rotation coextensive with such part. If such part extends half-way around the circumference, rotation of roughly 180 degrees will be possible.

[0031]

The first connector housing in the electrical connector may have a first guide portion formed on the circumference adjacent to the first contact portions, and the second connector housing be provided with a second guide portion that is guided by the first guide portion.

[0032]

With such configuration, with the first and second guide portions, positioning for joining of the first and second connectors will be accurate, and moreover the rotation of the two connectors will be smooth.

[0033]

The first connector housing in the electrical connector may be provided, on either the front wall or rear wall surface, or both, with an attaching portion that is fixed to an equipment housing.

[0034]

With such configuration, the first connector can be attached to the equipment housing in a simple manner, because the first connector housing is provided, on either the front wall or rear wall surface, or both, with the attaching portion that is fixed to the equipment housing.

[0035]

In the electrical connector, the first contact terminal may be provided with a terminal portion on the opposite end to that where the first contact portion is provided, and the first connector housing may have, formed on the rear wall of the cylindrical body, an insertion hole that communicates with the terminal installation hole, with the first contact terminal being installed to the terminal installation hole and the terminal portion being positioned in the insertion hole.

[0036]

With such configuration, electrical connection with the equipment will be simple, since the first contact housing is provided with insertion holes in which the first contact terminal portions are positioned.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037]

The invention will be described with reference to the accompanying drawings, in which the same numbers refer to the same elements throughout.

Fig. 1 presents exterior perspective views of an electrical connector of an embodiment of the invention.

Fig. 2 is an exploded perspective view of the first connector in Fig. 1A.

Fig. 3 illustrates the exterior appearance of the first connector housing in Fig. 2, Fig. 3A being a rear view, Figs. 3B and 3C being left and right side views, Fig. 3D being a top view, and Fig. 3E being a bottom view.

Fig. 4A is a cross-sectional view along line IVA – IVA in Fig. 3D, and Fig. 4B is a cross-sectional view along line IVB – IVB in Fig. 3A.

Fig. 5A is a front view of the connector in Fig. 1A, Fig. 5B is a cross-sectional view along line VB – VB in Fig. 5A, and Fig. 5C is a cross-sectional view along line VC – VC in Fig. 5A.

Fig. 6 presents perspective views of the first contact terminal and the terminal position assurance in Fig. 2.

Fig. 7 illustrates the exterior appearance of the first connector when assembled, Fig. 7A being a side view thereof, Figs. 7B and 7C being front and rear views respectively, Fig. 7D being a top view, and Fig. 7E being a bottom view.

Fig. 8A is a cross-sectional view along line VIIIA – VIIIA in Fig. 7A, Fig. 8B is a cross-sectional view along line VIIIB – VIIIB in Fig. 7A, Fig. 8C is a cross-sectional view along line VIIIC – VIIIC in Fig. 7C, and Fig. 8D is a cross-sectional view along line VIIID – VIIID in Fig. 7C.

Fig. 9 is an exploded perspective view of the second connector in Fig. 1.

Fig. 10 illustrates the second connector housing of the second connector, Fig. 10A being a front view, Figs. 10B and 10C being left and right side views, Fig. 10D being a top view, and Fig. 10E being a bottom view.

Fig. 11A is a cross-sectional view along line XIA – XIA in Fig. 10A, Fig. 11B is a cross-sectional view along line XIB – XIB in Fig. 10A, and Fig. 11C is a cross-sectional view along line XIC – XIC in Fig. 10A.

Fig. 12A is a rear view of the second connector housing of the second connector, Fig. 12B is a cross-sectional view along line XIIB – XIIB in Fig. 12A, and Fig. 12C is a cross-sectional view along line XIIC – XIIC in Fig. 12A.

Fig. 13A is a perspective view of one of the second contact terminals in Fig. 9, and Fig. 13B is a perspective view of the other second contact terminal in Fig. 9.

Fig. 14A is a perspective view of one of the fixing members in Fig. 9, and Fig. 14B is a perspective view of the other fixing member in Fig. 9.

Fig. 15A is a top view of the second connector, Figs. 15B and 15C are left and right side views thereof, Fig. 15D is a rear view, and Fig. 15E is a front view.

Fig. 16A is a cross-sectional view along line XVIA – XVIA in Fig. 15E, and Fig. 16B is a cross-sectional view along line XVIB – XVIB in Fig. 15E.

Fig. 17 illustrates the electrical connector, Fig. 17A being a side view of the first and second connectors in Fig. 1 when joined, and Fig. 17B being a front view in direction XVIIB in Fig. 17A.

Fig. 18A is a cross-sectional view along line XVIIIA –XVIIIA in Fig. 17A, and Fig. 18B is a cross-sectional view along line XVIIIB –XVIIIB in Fig. 17A.

Fig. 19 illustrates a fold-up mobile telephone with the electrical connector 1 installed therein, Fig. 19A being a perspective view of the fold-up mobile telephone in the closed state, and Fig. 19B being an enlarged view of portion XIXB in Fig. 19A with part of the housing cut away so that the interior of the hinge portion is visible.

Fig. 20A is a perspective view of the fold-up mobile telephone in Fig. 19A when opened roughly 90 degrees, and Fig. 20B is an enlarged view of portion XX in Fig. 20A with part of the housing cut away so that the interior of the hinge portion is visible.

Fig. 21 is a perspective view of the second connector 2 being installed to a circuit board housed inside the fold-up mobile telephone in Fig. 19A.

Fig. 22 presents explanatory views of installation of the electrical connector to the hinge portion of the fold-up mobile telephone in Fig. 19A.

Fig. 23 is an exterior perspective view of a hinge connector of related art.

Fig. 24 is an exploded perspective view of the hinge connector in Fig. 23.

DESCRIPTION OF EXEMPLARY EMBODIMENT

[0038]

An exemplary embodiment of the invention will now be described with reference to the accompanying drawings. It should be understood however that the following embodiment is intended merely by way of example of an electrical connector that realizes the technical concepts of the invention, and not by way of limiting the invention to this particular electrical connector. The invention can

equally well be adapted to yield other embodiments without departing from the scope and spirit of the appended claims.

[0039]

An electrical connector 1 of an embodiment of the invention is composed of a pair of first and second connectors 2 and 15, as Fig. 1 shows. The second connector 15 is fixed to the body of some electrical equipment or the like, and the first connector 2 is fixed to a cover or like part that is installed to and rotates on such electrical equipment body, the first and second connectors 2 and 15 being so configured as to be able to rotate at a particular angle in concert with the rotation of the cover. The structures of the first and second connectors 2 and 15 are each described in turn below.

[0040]

The first connector 2 will be described first, referring to Figs. 1 to 6. Fig. 1 presents exterior perspective views of a connector of an embodiment of the invention. Fig. 2 is an exploded perspective view of the first connector in Fig. 1A. Fig. 3 illustrates the exterior appearance of the first connector housing in Fig. 2, Fig. 3A being a rear view, Figs. 3B and 3C being left and right side views, Fig. 3D being a top view, and Fig. 3E being a bottom view. Fig. 4A is a cross-sectional view along line IVA – IVA in Fig. 3D, and Fig. 4B is a cross-sectional view along line IVB – IVB in Fig. 3A. Fig. 5A is a front view of the first connector in Fig. 1A, Fig. 5B is a cross-sectional view along line VB – VB in Fig. 5A, and Fig. 5C is a cross-sectional view along line VC – VC in Fig. 5A. Fig. 6A is a perspective view of one first contact terminal, Fig. 6B is a perspective view of the other first contact terminal, and Fig. 6C is a perspective view of the terminal position assurance.

[0041]

As Fig. 2 shows, the first connector 2 has a first connector housing 3 constituted of a cylindrical body with a particular thickness and length, and a pair of first contact terminals 12, 13 that are installed to the first connector housing. Reference numeral 14 indicates a terminal position assurance ("TPA" below) that fixes the first contact terminals 12, 13 in the regular positions inside the first

connector housing 3 and prevents them from coming out.

[0042]

As Figs. 1 to 5 show, the cylindrical body constituting the first connector housing 3 has a particular length in the longitudinal direction, and thickness (diameter) varying in the longitudinal front-rear direction; and is formed as a molding of electrically insulating synthetic resin. As Figs. 1A and 4B show, the diameter of the cylindrical body constituting the first connector housing 3 varies from the front toward the rear, in that there is a large-diameter first columnar part 3A extending part-way along the length to a point near the rear, and rearward of the first columnar part 3A is a second columnar part 3B with diameter smaller than that of the first columnar part.

[0043]

The second columnar part 3B constitutes an attaching part that is installed to a circular hollow of a particular depth that is provided in the electrical equipment or the like.

[0044]

The first columnar part 3A is divided, from the front toward the second columnar part 3B, into a first contact installation portion $3A_1$ for installation of the first contact portions 12a, 13a of the pair of first contact terminals 12, 13, and a guide portion $3A_2$ provided with a guide protrusion 10, as Figs. 1A and 3C show. The first contact installation portion $3A_1$ is formed as a cut-out portion of a shape such that part of the outer circumferential surface of the first columnar part 3A, extending over a certain angle □, has been cut out (see Figs. 1A and 5A). This angle □ is roughly 180 degrees. It should be understood, however, that such angle is not limited to being 180 degrees and could be any desired angle, e.g., an angle greater than, or smaller than, 180 degrees.

[0045]

The cut-out portion constituting the first contact installation portion $3A_1$ is formed with a forward first cut-out portion $3A_{11}$ cut relatively deep into the outer circumferential surface and having a particular width, and rearward of such cut-out

portion $3A_{11}$, a second cut-out portion $3A_{12}$ cut shallower than the first cut-out portion $3A_{11}$ and having a particular width. The radius, from the central axis to the outer circumference of the columnar body, of the first cut-out portion $3A_{11}$ is smaller than the radius of the second cut-out portion $3A_{12}$. The widths of the first and second cut-out portions $3A_{11}$, $3A_{12}$ are roughly the same as the widths of the first contact terminals 12, 13. At the boundary between the first and second cut-out portions $3A_{11}$, $3A_{12}$ there is formed a step $3A_0$ of a particular height, as Fig. 1A shows. This step $3A_0$ performs the function of enlarging the clearance between the surfaces of the two first contact portions 12a, 13a of the pair of first contact terminals 12, 13 when those contact portions 12a, 13a are disposed on the first and second cut-out portions $3A_{11}$, $3A_{12}$. Provision of the step portion $3A_0$ of a particular height at the boundary between the first and second cut-out portions $3A_{11}$, $3A_{12}$ results in the first and second cut-out portions $3A_{11}$, $3A_{12}$ having the forms of a stairway rising from the front wall 3C toward the rear wall 3D.

[0046]

By giving the first and second cut-out portions $3A_{11}$, $3A_{12}$ the form of a stairway, the appearance is improved and fabrication is facilitated. Also, as Fig. 5A shows, fixing slots 3a and 3b, into which the end portions of the first contact terminals 12 and 13 are inserted and fixed, are formed at one circumferential-direction end of the first and second cut-out portions $3A_{11}$, $3A_{12}$.

[0047]

Although in this embodiment, the cut-out portion $3A_1$ that constitutes a first contact installation portion is configured with two component portions of the forward first cut-out portion $3A_{11}$, which is cut relatively deep into the outer circumferential surface and has a particular width, and the rearward second cut-out portion $3A_{12}$, which is cut relatively shallow and also has a particular width, the number of these could alternatively be one, or be three or more. If the number is three or more, these cut-out portions will preferably be formed in the form of a stairway. By increasing these cut-out portions, the number of first contact terminals can also be increased, enabling expansion of the use applications of the

connector. Also, the first connector housing is formed as a cylindrical body in this embodiment, but is not limited to such shape, and could alternatively be a circular cylinder or an otherwise shaped columnar body.

[0048]

In the front wall 3C of the first connector housing 3 there are formed, as Figs. 1A and 4A show, two first terminal installation holes 4 and 5 for installation of the first contact terminals 12 and 13, together with an equipment installation hole 7, and an equipment installation slot 8 for fixing the first contact terminals 12 and 13 to the equipment. The first terminal installation hole 4, as Figs. 5A and 5B show, is composed of a slit 4a that is positioned a distance away from the central axis of the cylindrical body and is of a depth such as to reach from the front wall 3C surface to the first cut-out portion $3A_{11}$, and a through-insertion hole 4b that starts at the front wall 3C surface and communicates with the rearward insertion hole 6. The first contact terminal 12 is installed to this first terminal installation hole 4. The other first terminal installation hole 5, as Figs. 5A and 5C show, is located roughly on the central axis of the cylindrical body, and a portion thereof penetrates from the front wall 3C to the rear wall 3D. More precisely, the first terminal installation hole 5 is composed of a slit 5a of a depth such as to reach from the front wall 3C surface as far as the second cut-out portion $3A_{12}$, and a through-insertion hole 5b that starts at the front wall 3C surface and communicates with the rearward insertion hole 6. The other first contact terminal 13 is installed to this first terminal installation hole 5.

[0049]

The equipment installation hole 7, as Figs. 4A and 4B show, is constituted of a circular hollow of a size and depth such as to be pushed onto a columnar protrusion provided on the electronic equipment or the like, and is formed in the empty space left over from provision of the two first terminal installation holes 4 and 5.

[0050]

The equipment installation slot 8, as Figs. 1A and 4A show, is constituted

of a circular hollow of a size and depth such as to be pushed onto a plate-form protrusion provided on the electronic equipment or the like, and is formed in the empty space left over from provision of the two first terminal installation holes 4 and 5.

[0051]

The first columnar portion 3A of the first connector housing 3 has, formed in the outer wall, a TPA installation hole 9, for installation of the TPA 14, as Fig. 2 shows. The TPA installation hole 9 communicates with the first terminal installation holes 4, 5, as Figs. 5B and 5C show.

[0052]

Also, on the guide portion $3A_2$ of the first connector housing 3 there is formed a linear guide protrusion 10 that rises up from and extends a certain distance around the outer wall surface, as Fig. 2 shows. Notice also that a protrusion 11 is formed on the circumference of the second columnar portion 3B.

[0053]

Further, in the rear wall 3D of the first connector housing there is formed an insertion hole 6 for the other connector, as Figs. 4B and 5C show. This insertion hole 6 constitutes a connection point for an electronic part or the like that is housed in the electronic equipment or the like; the connector that is inserted into the insertion hole 6 is connected to, for example, an electronic part, which is omitted from the drawing.

[0054]

The pair of first contact terminals and the TPA will next be described, referring to Figs. 2 and 6.

[0055]

As Fig. 6A shows, the first contact terminal 12 is composed of: a first contact portion 12a constituted of a resilient spring body curved into a shape such as to contact with the wall surface of the first cut-out portion $3A_{11}$; a fixed strip portion 12b bent perpendicularly away from one end of the contact portion; and a terminal portion 12c constituted of a resilient spring body extended from the fixed

strip portion; and is formed by punching and bending processing of a metal sheet material of good electrical conductivity. Latching projections 12_1 are formed between the fixed strip portion 12b and the terminal portion 12c.

[0056]

The other first contact terminal 13, as Fig. 6B shows, is composed of: a first contact portion 13a constituted of a resilient spring body curved into a shape such as to contact with the wall surface of the second cut-out portion $3A_{12}$; a fixed strip portion 13b rising from one end of the contact portion; and an extension portion 13c bent perpendicularly from the apex portion of the fixed strip portion, in the direction away from the contact portion, and of a particular width; and is formed by punching and bending processing of a metal sheet material of good electrical conductivity. Note that the extension portion 13c constitutes a terminal portion curved and bent in the direction orthogonal to the longitudinal.

[0057]

The TPA 14, as Fig. 6C shows, has a relatively long leg portion 14a of a particular width, and a relatively broad fixed portion 14b located at one end of the leg portion, with the boundary between the leg portion 14a and the fixed portion 14b being a step portion 14_1. The TPA 14 is inserted into the TPA installation hole 9 in the first connector housing 3, fixing the first contact terminals 12, 13 in the regular positions and preventing them from coming out. The tip portion 14a' of the leg portion 14a contacts with the first contact terminal 13 (see Figs. 8C and 8D).

[0058]

Assembly of the first connector will now be described, referring to Fig. 1A and Figs. 2 to 8. Fig. 7 illustrates the exterior appearance of the first connector when assembled, Fig. 7A being a side view of the first connector, Figs. 7B and 7C being front and rear views respectively thereof, Fig. 7D being a top view thereof, and Fig. 7E being a bottom view thereof. Fig. 8A is a cross-sectional view along line VIIIA – VIIIA in Fig. 7A, Fig. 8B is a cross-sectional view along line VIIIB – VIIIB in Fig. 7A, Fig. 8C is a cross-sectional view along line VIIIC – VIIIC in Fig.

7C, and Fig. 8D is a cross-sectional view along line VIIID – VIIID in Fig. 7C.

[0059]

First of all, the first contact terminal 13 is installed to the first connector housing 3. To install the first contact terminal 13, the terminal portion 13c thereof is inserted into the through-insertion hole 5b of the first terminal installation hole 5 (see Figs. 1A and 5A). Following such insertion, the first contact portion 13a, with the curved part thereof extended, is placed against and pushed into the second cut-out portion $3A_{12}$ of the first connector housing 3. Simultaneously with such pushing-in, the fixed strip portion 13b is pushed into the slit 5a, and meanwhile, the tip portion 13a' of the first contact portion 13a is inserted into the fixing slot 3b (see Fig. 8B). Thereby, the first contact terminal 13 is fixed with the terminal portion 13c thereof protruding roughly into the center of the interior of the insertion hole 6, and with the first contact portion 13a contacting against the surface of the second cut-out portion $3A_{12}$ (see Figs. 1A and 8D).

[0060]

Next, the other first contact terminal 12 is installed to the first connector housing 3. To install the first contact terminal 12, the terminal portion 12c thereof is inserted into the through-insertion hole 4b of the other first terminal installation hole 4 (see Figs. 1A and 5A). Following such insertion, the first contact portion 12a, with the curved part thereof extended, is placed against and pushed into the first cut-out portion $3A_{11}$ of the first connector housing 3. Simultaneously with such pushing-in, the fixed strip portion 12b is pushed into the slit 4a, and meanwhile, the tip portion 12a' of the first contact portion 12a is inserted into the fixing slot 3a (see Fig. 8A). Thereby, the first contact terminal 12 is fixed with the terminal portion 12c thereof protruding roughly into the center of the interior of the insertion hole 6, and with the first contact portion 12a contacting against the surface of the first cut-out portion $3A_{11}$ (see Figs. 1A and 8C).

[0061]

Finally, the TPA 14 is inserted through the TPA installation hole 9, and the tip portion 14a' of the TPA 14 is made to latch onto the step portion 13_1 of the first contact terminal 13, so that the TPA 14 senses that this first contact terminal is installed in the regular position, and moreover, maintains and assures such position. Because the first contact terminal 13 is inserted into the first terminal installation hole 5 before the other first contact terminal 12 is inserted into the first terminal installation hole 4, the first contact terminal 13 is latched by the TPA 14 and prevented from coming out. Note that the first contact terminal 12 is latched into the terminal installation hole 4 by means of the latching projections 12_1. With the pair of first contact terminals 12, 13 installed in the first terminal installation holes 4, 5, the terminal portions 12c, 13c of the first and second contact terminals 12, 13 are, as Fig. 8D shows, positioned inside the insertion hole 6. Accordingly, by fitting the connector that is connected to the electronic equipment or the like to these terminal portions, electrical connection with such electronic equipment can be effected.

[0062]

With the first connector 2 having such configuration, the pair of first contact terminals 12, 13 can be fixed in the first connector housing 3 just by being inserted thereinto, so that their installation is extremely simple. Also, the pair of first contact terminals 12, 13 can be removed, enabling maintenance or replacement thereof. Further, because the first contact portions 12a, 13a of the pair of first contact terminals 12, 13 are installed to the first and second cut-out portions $3A_{11}$, $3A_{12}$, and there is a step $3A_0$ at the boundary between the first and second cut-out portions $3A_{11}$, $3A_{12}$, the clearance between the surfaces of the first contact portions 12a, 13a can be assured, and short-circuit accidents can be prevented. Further still, with the step $3A_0$, positioning during joining with the second connector 15 will be simple. Yet further, removable installation to the hinge portion of the electronic equipment will be possible by utilizing the second columnar portion 3B, along with the equipment installation hole 7 and equipment installation slot 8. That is, installation to the hinge portion will be simple.

[0063]

Although in this embodiment, the cut-out portion $3A_1$ that constitutes a first contact installation portion is divided into two portions of the first and second cut-out portions $3A_{11}$, $3A_{12}$, the number of these portions could alternatively be one, or be three or more; in the latter case, the number of first contact terminals that can be installed will be increased, enabling expansion of the applications of the connector. Also, although the angle of the cut-out portion $3A_1$ is set at 180 degrees, such angle could be altered as desired, enabling rotation with respect to the second connector at the altered angle.

[0064]

The second connector 15 will now be described, referring to Figs. 9 to 14. Fig. 9 is an exploded perspective view of the second connector in Fig. 1. Fig. 10 illustrates the second connector housing of the second connector, Fig. 10A being a front view thereof, Figs. 10B and 10 C being left and right side views, Fig. 10D being a top view, and Fig. 10E being a bottom view. Fig. 11A is a cross-sectional view along line XIA – XIA in Fig. 10A, Fig. 11B is a cross-sectional view along line XIB – XIB in Fig. 10A, and Fig. 11C is a cross-sectional view along line XIC – XIC in Fig. 10A. Fig. 12A is a rear view of the second connector housing of the second connector, Fig. 12B is a cross-sectional view along line XIIB – XIIB in Fig. 12A, and Fig. 12C is a cross-sectional view along line XIIC – XIIC in Fig. 12A.

[0065]

The second connector 15, as Figs. 1 and 9 show, has a pair of second contact terminals 19, 20 that are electrically connected to the pair of first contact terminals 12, 13 of the first connector 2 by being pushed thereagainst, and a second connector housing 16 that houses these second contact terminals. The second connector housing 16 is so structured as to be fixed to a circuit board or the like using a pair of fixing members 21A, 21B. The second connector housing 16, pair of second contact terminals 19, 20, and pair of fixing members 21A, 21B are described below in the order given.

[0066]

The second connector housing 16, as Figs. 9 and 10 show, is constituted of a roughly square-shaped flattened block having top and bottom walls 16a, 16b, left and right sidewalls 16c, 16d, and front and rear walls 16e, 16f, of particular sizes, and is formed as a molding of electrically insulating synthetic resin. At the corner portion between the front wall 16e and the top wall 16a, there is formed a contacting portion 17 against which the first connector 2 contacts. This contacting portion 17 takes a shape such that the corner portions of the front wall 16e, the top wall 16a, and of parts of the sidewalls 16c, 16d are cut away in a particular form.

[0067]

The contacting portion 17 is divided into three first to third guide faces 17A to 17C that are curved to match the shapes of the first contact installation portion $3A_1$ and guide portion $3A_2$ of the first connector housing 3, so as to contact against those parts. The heights of these first to third guide faces 17A to 17C above the bottom wall 16b match the shapes of the first contact installation portion $3A_1$ and guide portion $3A_2$, with the first guide face 17A being the highest, and the second and third guide faces 17B and 17C each being lower in turn. At each of the boundaries among the first to third guide faces 17A to 17C, there is formed a step 17_0. The height of these steps 17_0 is almost the same as that of the step $3A_0$ in the first connector 2.

[0068]

The first guide face 17A is the face against which the first cut-out portion $3A_{11}$ of the first contact installation portion $3A_1$ of the first connector housing 3 contacts. As Figs. 9 and 11A show, in the first guide face 17A there is formed a slot $17A_1$ at which the contact portion 19a of the third contact terminal 19 protrudes. This slot $17A_1$ constitutes one opening of the second terminal installation hole $17A_0$ to be described hereafter.

[0069]

The second guide face 17B is the face against which the second cut-out portion $3A_{12}$ of the first contact installation portion $3A_1$ of the first connector

housing 3 contacts. As Figs. 9 and 11B show, in the second guide face 17B there is formed an opening $17B_1$ at which the contact portion 20a of the second contact terminal 20 protrudes. This opening $17B_1$ constitutes one opening of the second terminal installation hole $17B_0$ to be described hereafter.

[0070]

The third guide face 17C is the face against which the guide portion $3A_2$ of the first connector housing 3 contacts. As Figs. 9 and 11C show, in the third guide face 17C there is formed a guide slot $17C_1$ into which the guide protrusion 10 of the first connector 2 is fitted.

[0071]

Also, as Figs. 11 and 12 show, two second terminal installation holes $17A_0$, $17B_0$ for installation of the pair of second contact terminals 19, 20 are formed inside the second connector housing 16. These terminal installation holes $17A_0$, $17B_0$ are formed as through-holes running through the second connector housing 16 from the rear wall 16f toward the front wall 16e. At one end of the terminal installation holes $17A_0$, $17B_0$ are, respectively, the slot $17A_1$ and opening $17B_1$ of the first and second guide faces 17A and 17B. The second contact portions 19a, 20a of the pair of second contact terminals 19, 20 protrude from the slot $17A_1$ and opening $17B_1$.

[0072]

The openings at the other end, that is, the openings $17A_2$, $17B_2$ in the rear wall 16f, are insertion openings for the pair of second contact terminals 19, 20. Because the heights of the first and second guide faces 17A and 17B differ, one opening $17A_2$ has a higher height above the bottom wall than the other opening $17B_2$, as Fig. 12A shows. The two second terminal installation holes $17A_0$, $17B_0$ have roughly the same shape. The second terminal installation hole $17B_0$ has a broad portion $17B_{01}$ near the opening $17B_2$, and a narrow inward portion $17B_{02}$, as Fig. 12C shows. This shape is of a size enabling insertion of the second contact terminal 20. Further, as Figs. 12A and 12B show, attachment slots 18 for attachment of the fixing members 21A, 21B are formed at each longitudinal end of

the bottom wall 16b of the second connector housing 16. These attachment slots 18 are formed with a parallel slot 18b that is provided from the rear wall 16f toward the front wall 16e, and with an incised portion 18a that is shaped by cutting away a portion of the sidewall 16d.

[0073]

The pair of second contact terminals and the fixing members will now be described, referring to Figs. 13 and 14. Fig. 13A is a perspective view of one of the second contact terminals in Fig. 9, and Fig. 13B is a perspective view of the other second contact terminal in Fig. 9. Fig. 14A is a perspective view of one of the fixing members in Fig. 9, and Fig. 14B is a perspective view of the other fixing member in Fig. 9.

[0074]

The second contact terminal 19, as Fig. 13A shows, has a connection fixing portion 19d that is fixed by solder to a circuit board or the like, an attachment portion 19c that extends from such connection fixing portion and is slightly broadened, a resilient spring piece 19b extending further on from the attachment portion, and a second contact portion 19a provided at the tip of the spring piece; and is formed by punching and bending processing of metal sheet material of good electrical conductivity. The attachment portion 19c rises from the connection fixing portion 19d at an acute angle. The contact portion 19a has its tip portion curved so as to protrude out above the slot $17A_1$ in the first guide face 17A.

[0075]

The other second contact terminal 20, as Fig. 13B shows, likewise has a connection fixing portion 20d that is fixed by solder to a circuit board or the like, an attachment portion 20c that extends from such connection fixing portion and is slightly broadened, a resilient spring piece 20b extending further on from the attachment portion, and a second contact portion 20a provided at the tip of the spring piece; and is formed by punching and bending processing of metal sheet material of good electrical conductivity. The contact portion 20a has its tip portion curved so as to protrude from the opening $17B_1$ in the second guide face

17B.

[0076]

The second connector housing 16 is fixed to a circuit board or the like using a pair of fixing members 21A, 21B. The structures of the two fixing members 21A, 21B are the same, except that the orientations of their insertion portions that are inserted into the parallel slots 18b in the second connector housing 16 differ. Below, one fixing member 21A will be described, referring also to the other fixing member 21B.

[0077]

The fixing member 21A, as Fig. 14A shows, has a rectangular flat portion 21a of a particular width and length, a rising portion 21b that rises to a particular height from one longitudinal end of the flat portion, and an extension portion 21c that extends from the apical part of the rising portion, roughly in parallel with the longitudinal direction; and is formed from a mechanically strong metallic material. The flat portion 21a is the part that is fixed by solder or the like to a circuit board or the like. The extension portion 21c is the attaching piece that is inserted into the parallel slot 18b in the second connector housing 16. The other fixing member 21B, as Fig. 14B shows, differs only in the location where the extension portion 21c' rises up, and otherwise has the same structure as the fixing member 21A.

[0078]

Assembly of the second connector 15 will now be described, referring to Figs. 1B and 9 to 16. Fig. 15 illustrates the exterior appearance of the second connector when assembled, Fig. 15A being a top view of the second connector, Figs. 15B and 15C being left and right side views, Fig. 15D being a rear view, and Fig. 15E being a front view. Fig. 16A is a cross-sectional view along line XVIA – XVIA in Fig. 15E, and Fig. 16B is a cross-sectional view along line XVIB – XVIB in Fig. 15E.

[0079]

Assembly of the second connector 15 is carried out by inserting and fixing

the pair of second contact terminals 19, 20 into the two second terminal installation holes $17A_0$, $17B_0$ provided in the second connector housing 16. To install the second contact terminal 19, the second contact portion 19a at the tip thereof is inserted through the opening $17A_2$ in the second connector housing 16 and fixed into the second terminal installation hole $17A_0$. As a result of such installation of the contact terminal 19, the second contact portion 19a thereof protrudes out from the slot $17A_1$, as Fig. 16B shows. Likewise, the other second contact terminal 20 is inserted and fixed into the second terminal installation hole $17B_0$ using a similar method. As a result of such installation of the contact terminal 20, the second contact portion 20a thereof protrudes out from the opening $17B_1$, as Fig. 16A shows. The second connector housing 16 is fixed to a circuit board or the like using a pair of fixing members 21A, 21B.

[0080]

The electrical connector 1 will now be described, referring to Figs. 17 and 18. Fig. 17 illustrates the electrical connector, Fig. 17A being a side view of the first and second connectors in Fig. 1 when joined, and Fig. 17B being a front view in the direction XVIIB in Fig. 17A. Fig. 18A is a cross-sectional view along line XVIIIA –XVIIIA in Fig. 17A, and Fig. 18B is a cross-sectional view along line XVIIIB –XVIIIB in Fig. 17A.

[0081]

With the electrical connector 1, the second connector 15 is fixed to a circuit board or the like using the fixing member 21, and the first connector 2 is joined to the second connector 15 so fixed. With such joining, the contact installation portion $3A_1$ and guide portion $3A_2$ of the first connector 2 are placed and pushed against the first to third guide faces 17A to 17C of the second connector 15. Thereby, the first contact portions 12a, 13a of the pair of first contact terminals 12, 13 of the first connector 2 are placed and pushed against the second contact portions 19a, 20a of the second contact terminals 19, 20 of the second connector 15, and electrically connected thereto, as Figs. 18A and 18B show. During such joining, the guide protrusion 10 of the first connector housing 3 enters into the

guide slot $17C_1$ of the second connector housing 16, so that positioning of the first connector 2 is effected accurately. Hence, with this electrical connector 1, the first connector 2 is able to rotate at a particular angle with respect to the second connector 15.

[0082]

An example of installation and use of the electrical connector 1 in a fold-up mobile telephone will now be described, referring to Figs. 19 to 24. Fig. 19 illustrates a fold-up mobile telephone with the electrical connector 1 installed therein, Fig. 19A being a perspective view of the fold-up mobile telephone in the closed state, and Fig. 19B being an enlarged view of portion XIXB in Fig. 19A with part of the housing cut away so that the interior of the hinge portion is visible. Fig. 20A is a perspective view of the fold-up mobile telephone in Fig. 19A when opened roughly 90 degrees, and Fig. 20B is an enlarged view of portion XX in Fig. 20A with part of the housing cut away so that the interior of the hinge portion is visible. Fig. 21 is a perspective view of the second connector 2 being installed to a circuit board housed inside the fold-up mobile telephone in Fig. 19A. Fig. 22 presents explanatory views of incorporation of the electrical connector to the hinge portion of the fold-up mobile telephone in Fig. 19A.

[0083]

The fold-up mobile telephone 22, as Fig. 19A shows, has a first mobile telephone housing ("first phone housing" below) 23 that houses a circuit board or the like and is provided with a manipulation section, and a second mobile telephone housing ("second phone housing" below) 26 in which a display panel or the like is installed. At one end of this pair of first and second phone housings 23, 26, there is formed a hinge portion 27, in which the electrical connector 1 is housed. The second phone housing 26 is rotatable in a range of roughly 180 degrees with respect to the first phone housing 23.

[0084]

The first phone housing 23 has a base housing 23A that houses a circuit board or similar, and a cosmetic cover 23B that is installed on the top surface of the

base housing 23A and is provided with manipulation keys or the like. The second connector 15 is received into the base housing 23A. As Fig. 21 shows, the second connector 15 is fixed to the circuit board 28, which is of a particular size, by means of a pair of fixing members 21A, 21B (21B is located on the opposite side to 21A). More precisely, the attaching pieces 21c, 21c' of the pair of fixing members 21A, 21B are inserted into the parallel slots 18b in the bottom of the second connector housing 16, and the flat portions 21a of the pair of fixing members 21A, 21B are fixed with solder to the locations on the surface of the circuit board 28 that are indicated with shading. Also, the connection fixing portions 19d, 20d of the pair of second connector terminals 19, 20 of the second connector 15 are fixed with solder to the circuit terminals 28a provided on the surface of the circuit board 28. The circuit board 28 with the second connector 15 attached thereto is housed and fixed inside the base housing 23A.

[0085]

The hinge portion 27 is made up of: a rotation axle portion 24 that is provided on a bulged-out part $23B_1$ of one end of the cosmetic cover 23B and rotatably fixes one end of the first connector 2; and a fixing portion 25 that is provided on one end of the second phone housing 26 and fixes the other end of the first connector 2. As Fig. 22A shows, the rotation axle portion 24 is formed with a tubular portion 24a having a central hollow 24b of a size such that the second columnar portion 3B of the first connector 2 can be inserted and rotate therein. This tubular portion can be fitted with a connector which is inserted into the insertion hole 6 in the first connector 2, but which is omitted from the drawings.

[0086]

The fixing portion 25, as Fig. 22B shows, is located at the hinge portion of the second phone housing 26, and is formed with a hinge base portion 25a, a columnar projection 25_1 jutting forward from the hinge base portion, and a plate-form projection 25_2. The columnar projection 25_1 and plate-form projection 25_2 are of sizes such as to be inserted into the equipment installation hole 7 and equipment installation slot 8 in the first connector housing 3.

[0087]

Installation of the first connector 2 to the hinge portion 27 is effected by fixing the second columnar portion 3B of the first connector 2 to the tubular portion 24a of the rotation axle portion 24, and fixing the columnar projection 25_1 and the plate-form projection 25_2 into the equipment installation hole 7 and equipment installation slot 8 respectively.

What is claimed is:

1. An electrical connector comprising:

a pair of first and second connectors rotatable at a particular angle;

the first connector comprising:

a first connector housing having a particular length and thickness, formed of electrically insulating resin; and

a first contact terminal formed of a material having a good electrical conductivity and housed in the first connector housing,

the first contact terminal being provided with a first contact portion,

the first connector housing being provided with a first contact installation portion for installing the first contact portion at around the circumferential surface of the first connector housing, and the first contact portion being installed to the first contact installation portion,

the second connector comprising:

a second contact terminal formed of a material having a good electrical conductivity and being provided with a second contact portion for contacting with the first contact portion of the first contact terminal; and

a second connector housing formed of electrically insulating resin for housing the second contact terminal;

the second connector housing being provided with a guide face for rendering a smooth rotation of the first connector housing when the first connector is pushed against the second connector, and the second contact portion being installed to the guide face, and

with the first and second contact portions pressed into contact with each other by placing and pushing the first connector against the second connector, rotation of either the first or the second connector causes the first and second contact portions to slide.

2. The electrical connector according to claim 1, wherein the first connector housing is formed as a cylindrical body having a particular length and thickness,

the cylindrical body being provided with the first contact installation portion on the circumferential surface thereof and a terminal installation hole for installing the first contact terminal in a lengthwise direction of the cylindrical body, from the front wall toward the rear wall, the first contact portion of the first contact terminal being installed to the first contact installation portion, and a terminal portion provided on the first contact terminal being installed to the terminal installation hole.

3. The electrical connector according to claim 2, wherein:

the first contact installation portion of the first connector housing is divided from one longitudinal end of the cylindrical body to the other end into multiple portions, the first connector housing is provided with multiple terminal installation holes and employing multiple first contact terminals the first contact portions of the multiple first contact terminals are installed to the first contact installation portions, the terminal portions of the multiple first contact terminals are installed to the multiple terminal installation holes, and

the second connector housing has multiple second contact terminals provided at the guide face of the second connector housing with second contact portions for contacting with the first contact portions of the multiple first contact terminals.

4. The electrical connector according to claim 3, wherein:

the multiple first contact installation portions are provided with stepped portions at boundaries dividing thereof, the first contact portions of the first contact terminals are installed to the divided multiple first contact installation portions, and

the guide surface of the second connector housing is formed in a shape such as to complement the contact installation portions of the first connector housing, the second contact portions of the second contact terminals are installed to the guide face.

5. The electrical connector according to claim 4, wherein the first contact installation portions are formed like a stairway ascending from one longitudinal

end of the first connector housing toward the other end, and the guide face is formed in a shape such as to contact with the wall surfaces of such stairway.

6. The electrical connector according to any of claims 1 to 5, wherein the first contact installation portion or portions is or are formed on a part of the circumferential surface of the first connector housing.

7. The electrical connector according to claim 6, wherein the first contact installation portion or portions is or are formed at least half-way around the circumferential surface of the first connector housing.

8. The electrical connector according to any of claims 1 to 7, wherein the first connector housing has a first guide portion formed on the circumference adjacent to the first contact portion(s), and the second connector housing is provided with a second guide portion for being guided by the first guide portion.

9. The electrical connector according to any of claims 1 to 7, wherein the first connector housing is provided, on either the front wall or rear wall surface, or both, with an attaching portion for being fixed to a housing of an equipment.

10. The electrical connector according to any of claim 2 or 3, wherein the first contact terminal is provided with a terminal portion on the opposite end to that where the first contact portion is provided, and the first connector housing has, formed on the rear wall of the cylindrical body, an insertion hole communicating with the terminal installation hole, the first contact terminal being installed to the terminal installation hole and the terminal portion being positioned in the insertion hole.