

ELECTRIC CONNECTOR

BACKGROUND

1. Technical Field

[0001]

The present invention relates to an electric connector composed of a male connector and a female connector, and more particularly to an electric connector that has means for sensing the mating status of the two connectors.

2. Related Art

[0002]

Electric connectors composed of a male and a female connector usually have a locking means that prevents the two connectors from coming apart accidentally in the joined state. However, it sometimes happens that while the two connectors are being mated together and are in, say, a semi-mated state, their contact terminals become electrically connected to each other, in which case the two connectors will be joined without being locked, and therefore may come apart accidentally during use. Accordingly, electric connectors are known which have a mating sensing means that is able to sense the mating status in order to prevent such joining in a semi-mated state.

[0003]

For instance, an electric connector 25 disclosed in US Patent 5720623 has a pair of first and second connectors 26 and 27 that are connected by being mated with each other as shown in Fig. 10. The second connector 27 has a structure such that a cavity 30 of a particular size is formed between a connector body 28 and cover 29 thereof, the cavity 30 runs through the interior in the lengthwise direction, and a locking arm 31 and a connector position assurance ("CPA" below) 32 are installed inside the cavity 30.

[0004]

The locking arm 31 consists of a rectangular resilient arm having a particular width and length. The rear end of such resilient arm is fixed to the rear of the housing, and the front end extends as far as the insertion opening. A particular gap is provided between the connector body 28 and the cover 29, and the arm is elastically deformed in the vertical direction inside such gap. In this resilient locking arm 31 there is formed a slot 31a, having a particular width and length, in the lengthwise direction. The tip projection 33 of the CPA 32 is inserted into this slot 31a. Also, first and second latching holes 29₁ and 29₂ are formed in the two lengthwise sidewalls of the cover 29.

[0005]

Further, the CPA 32 is so configured as to have a pair of side arms 35, 35 having a tip projection 33 as well as locking lugs 34, 34, and an L-shaped manipulation tab 36 that is connected to the side arms, each side arm being connected to an end portion of the manipulation tab 36's L-shape. The CPA 32's pair of locking lugs 34, 34 engage into the first and second latching holes 29₁, 29₂ of the cover 29.

[0006]

For sensing of the mating status using the CPA 32, the CPA 32 is installed in advance into the cavity 30 of the second connector 27. When the CPA 32 is installed inside the cavity 30, the tip projection 33 of the CPA 32 strikes into and is latched by the end portion of the slot 31a in the locking arm, while the locking lugs 34 engage into the first latching hole 29₁. When, with the second connector 27 in such state, the first connector 26 is inserted therein, the first connector's latching projection 26a initially contacts against the bottom of the front end of the locking arm 31, then, as the first connector is inserted further, reaches the slot 31a in the locking arm 31 and enters into such slot, thereby raising up the tip projection 33 of the CPA 32, so that the tip projection 33 becomes unlatched from the end portion of the slot 31a in the locking arm 31. When the tip projection 33 becomes unlatched, pushing-in of the CPA 32 is enabled, and the CPA is pushed in. As a result of such pushing-in, the locking lugs 34 of the CPA 32 engage into the cover's

second latching holes 29₂, and it can be sensed thereby that the first and second connectors have been joined in the normal state. Furthermore, EU Patent Application EP0840398A1 discloses an electric connector wherein the joining status of a pair of connectors can be sensed by a CPA that is slidably installed onto a latching member that is provided with a stop wing possessing resilience and is integrated onto the top surface of the connector housing.

[0007]

In the electric connectors disclosed in both U.S. Patent No. 5,720,623 and EU Patent Application EP0840398A1, the CPA is installed in advance to the housing of either the first or second connector, and during mating of the two connectors is tentatively pushed in. The connectors are sensed as being in the normal mated state if the CPA, when so pushed in, is inserted as far as a prescribed position, but if it is arrested part-way, they are sensed as not being in the normal mated positions and hence as being in an incompletely joined state. However, with these electric connectors, it is not possible to sense the mating status of the first and second connectors during the mating process thereof, which means that if it is determined via pushing-in of the CPA that the two connectors are in a semi-mated state, then it will be necessary to perform over again both the mating manipulation of the connectors and the installation of the CPA. Such manipulations may cause apprehensive feelings in the worker.

[0008]

Depending on the electric connector's mode of utilization, it may in some cases be possible to establish the mating status more accurately by employing coordination between the degree of mating of the first and second connectors and the degree of pushing-in of the CPA when mating the two connectors together. For instance, dividing the mating manipulation of the first and second connectors and the manipulation of the CPA into several steps and joining the connectors via such steps may relieve the worker of apprehensive feelings.

[0009]

Also, in the electric connectors disclosed in both U.S. Patent No. 5,720,623

and EU Patent Application EP0840398A1, the connector housing in which the CPA is installed will be rendered higher, since the CPA will be elastically deformed in directions orthogonal to the lengthwise direction. Further, with the electric connector disclosed in EU Patent Application EP0840398A1, the CPA is exposed when installed to the connector housing, which means that objects could strike against and break or otherwise damage the CPA.

SUMMARY

[0010]

An advantage of some aspects of the present invention is to provide an electric connector that has a mating sensing member able to sense the mating status of a pair of connectors during mating thereof.

[0011]

Another advantage of some aspects of the present invention is to provide an electric connector wherein the mating sensing member is formed as a single part, thereby reducing the cost, and moreover can be installed to the housing with ease.

[0012]

Further another advantage of some aspects of the present invention is to provide an electric connector that is rendered compact.

[0013]

According to an aspect of the invention, an electric connector includes: a first connector in which first contact terminals are installed, a second connector in which second contact terminals are installed that are electrically connected to the first contact terminals, and a mating sensing member that senses the mating status of the first and second connectors when mated together. The first connector has a first latching protrusion on the outer surface of a housing in which the first contact terminals are installed. The second connector has an inner housing in which the second contact terminals are installed and an outer housing that covers the outer peripheries of the inner housing except a portion defining an insertion opening for the first connector. A gap for insertion of the first connector is left between the

inner housing and outer housing, and a receiving cavity is provided that is for insertion of the mating sensing member and that communicates with such gap. Inside the receiving cavity there are provided a pair of first stopper projections, a second stopper projection, and an elastically deformable locking arm that has one end fixed to the inner housing and the other, front end as a free extremity. In the locking arm there is provided an engagement slot with which the first connector's first latching protrusion engages, and moreover the front end is equipped with a pushing portion and a first stopper on each of the two sides thereof. The mating sensing member has a pair of elastically deformable first and second fingers positioned opposing each other in parallel. The first and second fingers are each provided, on the opposed faces thereof, with an actuation portion against which the locking arm's pushing portion pushes, and with a stopper engaging portion into which the first stopper engages. The first and second connectors are mated and connected by carrying out the following manipulations in the order given: a connector primary insertion manipulation consisting of installing the mating sensing member into the gap between the locking arm inside the second connector's receiving cavity and the outer housing, so as to be slidable therein, and inserting either the first or the second connector into/onto the other connector so that the locking arm is raised up by the first latching protrusion, a sensing member primary push-in manipulation consisting of pushing the mating sensing member into the receiving cavity, a connector secondary insertion manipulation consisting of further inserting the connector so that the locking arm ceases to be raised up, and a sensing member secondary push-in manipulation consisting of further pushing in the mating sensing member.

[0014]

According to such aspect of the invention, the first and second connectors are joined together by carrying out in sequence: a connector primary insertion manipulation whereby one connector is inserted into/onto the other connector, followed by a sensing member primary push-in manipulation whereby the mating sensing member is pushed into the receiving cavity in the second connector, then a

connector secondary insertion manipulation whereby the connector is further inserted, followed by a sensing member secondary push-in manipulation whereby the mating sensing member is further pushed in. More precisely, since the mating and joining together of the first and second connectors is carried out via a connector primary insertion manipulation, a sensing member primary push-in manipulation, a connector secondary insertion manipulation, and a sensing member secondary push-in manipulation, it is possible, during joining of the two connectors, to push in the mating sensing member in accordance with the degree of insertion of each connector, and through such linked manipulation of the connectors and the mating sensing member, to effect accurately the joining together of the first and second connectors. In other words, joining together the two connectors consists of a sequence of alternating connector insertion manipulations and mating sensing member push-in manipulations, and by means of such series of manipulations, the mating can be effected while verifying the linkage of the two connectors and the mating sensing member. As a result, the first and second connectors will be reliably joined.

[0015]

According to another aspect of the invention, the first and second stopper projections may be formed as columnar projections of a particular height that are spaced a particular distance apart and project outward from the inner wall of the outer housing inside the receiving cavity, and a gap for preventing a front end portion of the locking arm from colliding with the columnar projections as the locking arm is raised up by the first connector's first latching protrusion may be provided between the columnar projections and the front end portion of the locking arm.

[0016]

With the above aspect, because the first and second stoppers are formed with a certain spacing as columnar projections of a particular height that project outward from the inner wall of the outer housing inside the receiving cavity, the projections are simple to form. Also, thanks to the provision of a gap between the

columnar projections and the front end portion of the locking arm in order that the front end portion of the locking arm will not collide with such columnar projections when the locking arm is raised up by the first connector's first latching protrusion, the elevation of the receiving cavity can be rendered low, and the second connector can be rendered compact.

[0017]

According to a further aspect, one pair of ends of the mating sensing member's first and second fingers may be connected by a connecting part, the other ends be formed in a U-shape as free extremities, and the connecting part serve as a push-in manipulation part.

[0018]

With such aspect, the second connector housing can be rendered compact because forming the mating sensing member in a U-shape permits housing thereof in the lowered-elevation receiving cavity. Also, having the connecting part serve as a push-in manipulation part facilitates the insertion into the receiving cavity.

[0019]

According to a still further aspect, the stopper engaging portions of the first and second fingers may be formed as concavities of a size that enables the second connector's stopper projections to enter therein, and the first stopper strikes against the interior sidewalls of the concavities.

[0020]

With such aspect, the fact that the first and second fingers' stopper engaging portions are formed as concavities of a size such that the second connector's stoppers will enter therein means that the stopper engaging portions are simple to form.

[0021]

According to a yet further aspect, the locking arm's pushing portions and the mating sensing member's actuation portions may each be formed with inclined faces of particular angles.

[0022]

With such aspect, thanks to the locking arm's pushing portions and the mating sensing member's actuation portions each being formed with inclined faces of a particular angle, the mating sensing member can be smoothly pushed outward by utilizing such inclined faces.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described with reference to the accompanying drawings, wherein like numbers reference like elements.

[0023]

Fig. 1 is a perspective view of an electric connector of an embodiment of the present invention.

Fig. 2A is a perspective view of the electric connector in Fig. 1 with part of the female connector housing's outer wall cut away, and Fig. 2B is a perspective view of the interior of the housing at the cut-away portion in Fig. 2A.

Fig. 3 is an exploded perspective view of the female connector.

Fig. 4 is an enlarged perspective view of the CPA in Fig. 3.

Fig. 5 is an exploded perspective view of the male connector.

Fig. 6 is a cross-sectional view illustrating the initial joined state where the male connector has been inserted into the female connector.

Fig. 7A is a cross-sectional view illustrating the state where the male connector has been inserted further relative to the state in Fig. 6, and Fig. 7B is an enlarged view of portion X in Fig. 7A.

Fig. 8 is a cross-sectional view illustrating the state where the CPA has been pushed in further relative to the state in Fig. 7.

Fig. 9A is a cross-sectional view illustrating the state where the male connector has been inserted further relative to the state in Fig. 8, and Fig. 9B is a cross-sectional view illustrating the final joined state where the CPA has been pushed in further relative to the state in Fig. 9A.

Fig. 10 is a general perspective view of an electric connector of the related art.

DESCRIPTION OF EXEMPLARY EMBODIMENT

[0024]

An exemplary embodiment of the present invention will now be described with reference to the accompanying drawings. It will be understood however, that the following embodiment is intended merely by way of an illustrative example of an electric connector that realizes the technical concepts of the invention, not by way of limiting the invention to this particular electric connector. The invention can equally well be adapted to yield other embodiments within the scope and spirit of the claims. Fig. 1 is a perspective view of an electric connector of an embodiment of the invention, Fig. 2A is a perspective view of the female connector housing in Fig. 1 with part of the outer wall thereof cut away, Fig. 2B is a perspective view of the interior of the housing cut-away portion in Fig. 2A, and Fig. 3 is an exploded perspective view of the female connector in Fig. 1.

[0025]

As Figs. 1 and 3 show, an electric connector 1 includes a female connector 2 (second connector) having a female connector housing (“female housing” below) 3 that houses multiple female contact terminals 12, and a male connector 14 (first connector) having a male connector housing (“male housing” below) 15 that houses male contact terminals 19 (first contact terminals) that are connected to the female contact terminals 12 (second contact terminals). The female connector 2 is so configured that a mating sensing member (“CPA” below) 8 that senses the status of mating with the male connector 14 is housed inside the female housing 3. Below, the female connector 2, CPA 8 and male connector 14 composing this electric connector 1 will each be described in turn with reference to the accompanying drawings.

[0026]

First, the structure of the female connector will be described with reference to Figs. 2 to 4. As Fig. 3 shows, the female connector 2 has: multiple female contact terminals 12, a female housing 3 that houses the female contact terminals

12, a CPA 8 that is installed inside the female housing 3, a terminal sensing member 10 (“TPA” below) that senses whether or not the female contact terminals 12 have been correctly installed inside the female housing 3, a cover member 11 that is installed to the rear end of the female housing 3, a seal member 9 through which the female contact terminals 12 are inserted and which seals the outer peripheries thereof so as to prevent penetration of water, etc., thereinto, and a seal member 13 that prevents entry of water, etc., when the female connector 2 is joined to the male connector 14.

[0027]

As Fig. 2 shows, the female housing 3 has an inner housing 4 in which the female contact terminals 12 are installed, and an outer housing 5 that covers the outside surfaces of the inner housing 4 except at the front and rear. The inner housing 4 and outer housing 5 have a particular gap therebetween and are joined at the rear portions thereof. The female housing 3 is formed as a molding of electrically insulative synthetic resin material.

[0028]

The inner housing 4 is of a rectangular shape having a particular width, height and depth, and at the rear thereof there is formed a projecting portion 4_A onto which the cover member 11 is installed. Multiple installation holes 4₂ into which the multiple female contact terminals 12 are installed are formed as through-holes in the inner housing 4, extending longitudinally from the front to the projecting portion 4_A at the rear.

The multiple female contact terminals 12 are inserted through the installation holes 4₂ at the projecting portion 4_A end. Latching protrusions 4_{A1} onto which the cover 11 latches are formed on the sidewalls of the projecting portion 4_A. Installation holes 6 for insertion of the TPA 10 are formed in the sidewalls of the inner housing 4 (see Fig. 2).

[0029]

As Figs. 2 and 3 show, the outer housing 5 covers, with its periphery walls 5_A to 5_D, the outer surfaces of the inner housing 4. The front of the outer housing

5 is formed as an insertion opening for insertion of the male connector 14's male housing 15, and the rear is joined to the rear wall 4₁ of the inner housing 4. The periphery walls 5_A to 5_D consist of a top wall 5_A, a bottom wall 5_B, and two sidewalls 5_C and 5_D. Between the inner and outer housings 4, 5 there are formed an insertion gap S₁ for insertion of the male housing 15 and a receiving cavity S₂ for insertion of the CPA 8. Part of the rear portion 5_{A'} of the outer housing 5's top wall 5_A is cut away to allow insertion of the gripper portion of the CPA 8, and the interior of the receiving cavity S₂ is thereby exposed (see Fig. 1).

[0030]

The receiving cavity S₂ between the top wall of the inner housing 4 and the top wall 5_A of the outer housing 5 is of a size permitting installation of the CPA 8 and also of the locking arm 7 described hereafter. The receiving cavity S₂ has a particular height H₁ and width W₁. The height H₁ is made up of the gap H₃ between the locking arm 7's bottom surface and the inner housing 4's top wall 4_B, and the gap H₂ between the locking arm 7's top surface and the inner surface of the outer housing 5's top wall 5_A, plus the plate thickness D. Also, the width W₁ of the receiving cavity S₂ is formed to be slightly larger than the width of the CPA8, so as to permit insertion of the CPA 8. The inner surface of the top wall 5_A is inside the receiving cavity S₂ and constitutes a ceiling surface 5_{A0} thereof that is located superiorly relative to the top wall 4_B of the inner housing 4.

[0031]

The locking arm 7 is formed as a resilient plate-form body of tongue-like shape having a particular thickness D, width and length. As Fig. 2B shows, the locking arm 7's base portion 7_D is formed at the rear wall of the inner housing 4, and the locking arm 7 extends forward from the base portion 7_D. The thickness D allows for elastic deformation and is determined so that in the horizontally extended state the arm will not contact with the first ceiling protrusions 5₁, 5₁ (first stopper projections). The width is smaller than the width W₁ of the receiving cavity S₂.

[0032]

At roughly the central portion of the locking arm 7 there is formed an engagement slot 7₁ into which the latching protrusion 16 of the male housing 15 latches. The engagement slot 7₁ is surrounded by the two side edges 7_A, 7_B and the front end portion 7_C. On the two sidewalls of the front end portion 7_C there are formed inclined faces 7₂ that perform the function of contacting with the inclined faces of the fingers of the CPA 8 to be described hereafter, and pushing the fingers outward (see Fig. 2B). Fig. 2B shows only the inclined face 7₂ on one sidewall, but such an inclined face is also formed on the other side of the front end portion. These inclined faces 7₂ serve as pushing portions that push outward the first and second fingers 8_A, 8_B of the CPA 8 described hereafter. Also, jutting parts 7₄ are formed on the rear surfaces of the front end portion 7_C (see Fig. 7B). These jutting parts 7₄ serve as what may be called stoppers that temporarily arrest the pushing-in of the CPA 8.

[0033]

The locking arm 7 has its base portion 7_D formed in the rear wall of the inner housing 4, the front end portion 7_C being a free extremity, and is elastically deformable in the vertical direction relative to the base portion 7_D as reference point. Thanks to such structure, when the male housing 15 is inserted during joining with the male connector 14, the latching protrusion 16 thereof will contact against the front end portion 7_C, and as a result of such contacting, the locking arm 7 will be pushed upward relative to the base portion 7_D as reference point. The front end portion 7_C's inclined faces 7₂, 7₂, projected by such upward pushing, will contact against the inclined faces 8₀, 8₀ of the CPA 8, pushing wider the gap between the first and second fingers 8_A, 8_B of the CPA 8. When the male housing 15 is pushed in further, the latching protrusion 16 will slide over and past the lower surface 7₃ of the front end portion 7_C and enter the engagement slot 7₁. When the latching protrusion 16 enters the engagement slot 7₁, the locking arm 7 will descend by its own resilience and engage with the latching protrusion 16, thus latching the male housing 15 to the female housing 3.

[0034]

Inside the receiving cavity S_2 , as Fig. 2B shows, three ceiling projections 5_1 , 5_1 , 5_2 are formed on the ceiling surface 5_{A0} , projecting downward therefrom. The pair of first ceiling projections 5_1 , 5_1 are columnar, are located in the forward part of the receiving cavity S_2 , and perform the function of regulating the pushing-in of the CPA 8 to be described hereafter. The second ceiling projection 5_2 (second stopper projection) is located in the rearward part of the receiving cavity S_2 , that is, at the end where the female contact terminals 12 are connected, and faces a slot in the CPA 8. These first and second ceiling projections 5_1 , 5_2 are provided in places where they will not impede the motion of the locking arm 7, and are of a height such as not to contact with the locking arm 7.

[0035]

The structure of the CPA 8 will next be described with reference to Fig. 4. Fig. 4 is an enlarged perspective view of the CPA in Fig. 3.

[0036]

The CPA 8 has a pair of elastically deformable first and second fingers 8_A , 8_B that oppose each other in parallel, with a particular gap 8_G therebetween, and a connecting part 8_C that connects one pair of ends of such fingers. The other ends of the fingers 8_A , 8_B are left free, and the whole makes a U-shape that is formed as a molding of electrically insulative synthetic resin. This CPA 8 has a longitudinal direction length L_1 and width W_3 , and is formed as a plate-form body of a particular thickness. The connecting part 8_C serves as a gripper of a size that is readily grippable with one's fingertips. The provision of such gripper facilitates the pushing of the female housing 3 into the receiving cavity S_2 . The gap 8_G includes a wide gap portion 8_{G1} at the opening entrance of the U-shape, and a narrow slot portion 8_{G2} in the inmost part thereof. The entrance gap portion 8_{G1} extends inward to a distance L_2 from the entrance. This distance L_2 is roughly half the distance L_1 .

[0037]

The spacing W_4 is a little smaller than the spacing W_2 between the pair of ceiling projections 5_1 , 5_1 (see Fig. 2). More precisely, the design is such that

although the spacing W_4 is formed to be smaller than the spacing W_2 between the pair of ceiling projections $5_1, 5_1$ ($W_4 < W_2$), when the fingers $8_A, 8_B$ are stretched outward the spacing W_4 will become larger than the spacing W_2 ($W_4 > W_2$). With the spacings W_4, W_2 determined in the foregoing manner, when the CPA 8 is inserted into the receiving cavity S_2 , the CPA 8's top portions $8_T, 8_T$ will strike the ceiling projections $5_1, 5_1$, and thereby further insertion will be arrested. Subsequently, such arrested state will be terminated by the outward stretching of the fingers $8_A, 8_B$. Also, provision of the gap 8_{G2} facilitates elastic deformation of the fingers $8_A, 8_B$. Further, the ceiling projection 5_2 enters into the gap 8_{G2} , which performs the role of positioning, when the CPA 8 is inserted into the receiving cavity S_2 .

[0038]

The finger 8_A will now be described. Since the other finger 8_B of the pair has the same shape, description thereof is omitted.

[0039]

The finger 8_A extends forward from the connecting part 8_C , and from part-way along, the inner surface thereof is processed into particular shapes. More particularly, the finger 8_A has a tip portion 8_T with a particular shape, and a recess 8_D provided in the inner surface at a place a little inward from the tip portion. The tip portion 8_T has a flat inner face 8_1 , and an inclined face 8_0 that is inclined downward at a sharp angle from the inner face. When the inclined face 7_2 of the female housing 3's locking arm 7 contacts against it during joining with the male connector 14, this inclined face 8_0 performs the role of making the finger 8_A elastically deform outward, and hence constitutes what may be termed an actuation portion. The recess 8_D is of a size that allows the ceiling projection 5_1 to enter therein, and serves as what may be termed a stopper, since the ceiling projection 5_1 fits thereinto and engages therewith. One sidewall of the recess 8_D , specifically the sidewall 8_2 on the side nearer to the connecting part 8_C , serves as a stopper, in that when the locking arm 7's jutting part 7_4 (see Fig. 6) strikes thereagainst, insertion of the CPA 8 is inhibited. The recess 8_D is a stopper

engaging portion that by engaging with the ceiling projection and striking against the locking arm 7's jutting part 7₄ performs the function of the stopper inhibiting temporary insertion.

[0040]

The female contact terminals, TPA, cover member and seal members will now be described with reference to Figs. 1 and 3.

The female contact terminals are composed of a female contact 12_A and a lead wire 12_B that is connected to the female contact 12_A. The cover member 11 has a box-like shape of a size such as to fit over the projecting portion 4_A of the inner housing 4, and is formed as a molding of electrically insulative resin. In the base wall 11_A of the cover member 11 there are formed insertion holes 11₁ that communicate with the installation holes 4₂. Extending outward from the base wall 11_A there are formed multiple slots in the periphery walls, as well as engagement slots 11₂ in the opposed sidewalls. Formation of multiple slots in the periphery walls facilitates elastic deformation and simplifies installation to the projecting portion. The seal member 9 has, in the middle thereof, insertion holes 9_A through which the female contact terminals are inserted, and is formed from a resilient material, say rubber material, of a particular thickness. The seal member 13 is press-fitted onto the periphery of the inner housing 4 so as to seal the space between such and the male connector 14, has in the middle a hollow space 13A through which the inner housing 4 is inserted, and is formed from a resilient material, say rubber material, of a particular thickness.

[0041]

Assembly of the female connector 2 will next be described with reference to Figs. 1 to 4.

First, the female contact terminals 12 are inserted through the insertion holes 9A in the cover member 11 and the seal member 9, the seal member 9 is brought into contact against the projecting portion 4_A of the inner housing 4, the cover member 11 is latched onto the projecting portion 4_A, and the female contact terminals 12 are inserted into the interior of the female housing 3. Next, the TPA

10 is inserted through the cut-away portion 5_{D1} in the outer housing 5, and the contact terminals 12 are positioned and fixed inside the female housing 3. After that, the first and second fingers 8_A, 8_B of the CPA 8 are inserted through the rear of the female housing 3 into the receiving cavity S₂. As a result of such insertion, the tip portions 8_T, 8_T of the CPA 8 strike against the ceiling projections 5₁, 5₁ and are blocked. Thereupon, assembly of the female connector 2 is complete.

[0042]

The male connector will now be described with reference to Fig. 5. Fig. 5 is an exploded perspective view of the male connector.

[0043]

As Fig. 5 shows, the male connector 14 has multiple male contact terminals 19, a male housing 15 that houses the male contact terminals 19, a terminal sensing member ("TPA" below) that senses whether or not the contact terminals 19 have been correctly installed inside the male housing 15, a cover member 18 that is installed to the rear end of the male housing 15, that is, the end where the male contact terminals 19 are installed, and a seal member 17 through which the male contact terminals 19 are inserted and which seals the outer peripheries thereof so as to prevent penetration of water, etc., thereinto.

[0044]

The male housing 15 has periphery walls 15_A to 15_D, is a cylindrical body of a size permitting insertion into the gap between inner housing 4 and outer housing 5 of the female housing 3, and is formed from electrically insulative synthetic resin. A single latching protrusion 16 is formed on the top periphery wall 15_A of the male housing 15.

[0045]

To assemble the male connector 14, first the male contact terminals 19 are inserted through the insertion holes in the cover member 18 and the seal member 17, the seal member 9 is inserted into the interior of the male housing 15, the cover member 18 is latched, and the female contact terminals 12 are inserted into the interior of the male housing 15. Then a shorting terminal 20 is fitted, together

with a mounting member 21, through the front of the male housing 15, whereupon assembly of the male connector 14 is complete.

[0046]

Next will be described, with reference mainly to Figs. 6 to 9, the connection of the female and male connectors and the action of the CPA 8. Figs. 6 to 9 are explanatory views illustrating the process of connecting the female and male connectors, Fig. 6 being a cross-sectional view illustrating the initial joined state where the male connector has been inserted into the female connector, Fig. 7A a cross-sectional view illustrating the joined state where the male connector has been further inserted relative to the state in Fig. 6, Fig. 7B an enlarged view of portion X in Fig. 7A, Fig. 8 a cross-sectional view illustrating the joined state where the CPA has been further inserted relative to the state in Fig. 7, Fig. 9A a cross-sectional view illustrating the joined state where the male connector has been further inserted relative to the state in Fig. 8, and Fig. 9B a cross-sectional view illustrating the final joined state.

[0047]

The CPA 8 is installed in advance into the receiving cavity S_2 in the female housing 3 of the female connector 2, as shown in Figs. 1 and 2. Such installation of the CPA 8 is carried out via insertion into the receiving cavity S_2 . When the CPA 8 is inserted into the receiving cavity S_2 in the female housing 3, the tip portions 8_T , 8_T of the CPA 8 strike against the ceiling projections 5_1 , 5_1 inside the receiving cavity S_2 as shown in Figs. 2 and 6, and such is the state in which the CPA 8 is installed inside the receiving cavity S_2 . The male housing 15 of the male connector 14 is then inserted into the female housing 3 with the CPA 8 installed therein. In such initial insertion, the latching protrusion 16 of the male housing 15 contacts against the lower surface 7_3 of the front end portion 7_C of the locking arm 7 provided in the female housing 3, as shown in Fig. 6. Also, at this stage there is a gap GA between the sidewall 8_2 of the CPA 8's recess 8_D and the jutting part 7_4 of the locking arm 7 inside the receiving cavity S_2 . In fact, a recess 8_D and a jutting part 7_4 are formed in both the CPA 8 and the locking arm 7, thus

constituting pairs of these respective items, but since Figs. 6 to 9 are cross-sectional views cut along a longitudinal section of the connector, only one member of each such pair, pairs of recesses 8_D and of jutting parts 7_4 , etc., is shown in these drawings, and accordingly only one of each is described below.

[0048]

First is performed the connector primary insertion manipulation of pushing the male housing 15 into the female housing 3. As a result of such insertion manipulation, the latching protrusion 16 of the male housing 15 pushes up the lower surface 7_3 of the front end portion 7_C of the locking arm 7 provided in the female housing 3, as shown in Fig. 7. As a result of such pushing-up, the locking arm 7 is elastically deformed upward relative to the base portion 7_D as reference point. As a result of such upward elastic deformation of the locking arm 7, the inclined faces 7_2 on the two sidewalls of the front end portion 7_C contact against the inclined faces 8_0 of the CPA 8, pushing outward the fingers 8_A of the CPA 8. Hitherto the tip portions 8_T of the fingers 8_A have been contacting against the ceiling projections 5_1 so that push-in motion of the CPA 8 was arrested, but with the pushing outward of the fingers 8_A , the tip portions 8_T are released from being latched by the ceiling projections 5_1 and pushing-in of the CPA 8 is enabled. Accordingly, the CPA primary push-in manipulation of pushing the CPA 8 into the receiving cavity S_2 , is then performed.

[0049]

As a result of such push-in manipulation, the sidewall 8_2 of the recess 8_D contacts against the jutting part 7_4 of the locking arm 7, temporarily arresting the pushing-in, as shown in Fig. 8. The amount by which the CPA 8 is pushed in is equal to the gap GA , and the tip portions 8_T of the CPA 8 are brought into contact with the ceiling projections 5_1 so as to close the gap GA' therebetween, which is the same size as the gap GA . Following such CPA primary push-in manipulation, the connector secondary insertion manipulation of pushing in the male housing 15 is performed.

[0050]

As a result of such secondary insertion manipulation, the tip portion of the male housing 15's latching protrusion 16 slides over and past the lower surface 7₃ of the locking arm 7_c and enters the engagement slot 7₁, as shown in Fig. 9A. When the latching protrusion 16 enters the engagement slot 16, the locking arm 7 descends by its own resilience and engages with the latching protrusion 16. At the same time, the sidewall 8₂ of the recess 8_D is released from pressing against the jutting part 7₄ of the locking arm 7, thus enabling pushing-in of the CPA 8. Accordingly, the CPA secondary push-in manipulation of pushing the CPA 8 further into the interior of the receiving cavity S₂, is then performed.

[0051]

As a result of such push-in manipulation, the ceiling projection 5₁ enters into the recess 8_D in the CPA 8, and the CPA 8 is latched. Thereby, the male housing 15 is correctly joined to the interior of the female housing 3, so that connection of the male connector 14 with the female connector 2 is completed and locked. To uncouple the male connector 14, a tool is inserted inside the receiving cavity S₂ in the female housing 3, the locking of the CPA is released, and the male connector 14 is pulled out and removed.

[0052]

Thus, as described above, the female connector 2 and the male connector 14 are mated and connected together by carrying out, in sequence, a connector primary insertion manipulation whereby one connector is inserted into the other and the locking arm is pushed up by the first latching protrusion, a sensing member primary push-in manipulation whereby the mating sensing member is pushed into the receiving cavity in the second connector, a connector secondary insertion manipulation whereby the connector in question is inserted further and the locking arm ceases to be pushed up, and a sensing member secondary push-in manipulation whereby the mating sensing member is pushed in further.

[0053]

Hence, since the female connector 2 and the male connector 14 are fitted together via a connector primary insertion manipulation, a mating sensing member

primary push-in manipulation, a connector secondary insertion manipulation, and a mating sensing member secondary push-in manipulation, the mating sensing member can be pushed in according to the degree of insertion of the two connectors, and thanks to such linked manipulations of the two connectors and the mating sensing member, the first and second connectors can be joined reliably. In other words, joining the female connector 2 and male connector 14 together involves a sequence of connector insertion manipulations alternating with mating sensing member push-in manipulations, and through such series of manipulations the mating can be effected while verifying the linkage of the two connectors and the mating sensing member, thanks to which the two connectors can be joined reliably without any apprehensive feelings being caused in the worker.

What is claimed is:

1. An electric connector comprising:
 - a first connector in which first contact terminals are installed,
 - a second connector in which second contact terminals are installed that are electrically connected to the first contact terminals, and
 - a mating sensing member that senses the mating status of the first and second connectors when mated together;
 - the first connector having:
 - a first latching protrusion on the outer surface of a housing in which the first contact terminals are installed;
 - the second connector having:
 - an inner housing in which the second contact terminals are installed; and
 - an outer housing that covers the outer peripheries of the inner housing except a portion defining an insertion opening for the first connector;
 - a gap for insertion of the first connector being left between the inner housing and outer housing; a receiving cavity being provided that is for insertion of the mating sensing member and that communicates with such gap; inside the receiving cavity there being provided a pair of first stopper projections, a second stopper projection, and an elastically deformable locking arm that has one end fixed to the inner housing and the other, front end as a free extremity; in the locking arm there being provided an engagement slot with which the first connector's first latching protrusion engages, and at the front end, a pushing portion and a first stopper on each of the two sides;
 - the mating sensing member having:
 - a pair of elastically deformable first and second fingers positioned opposing each other in parallel; the first and second fingers being each provided, on the opposed faces thereof, with an actuation portion against which the locking arm's pushing portion pushes and with a stopper engaging portion into which the first stopper engages.
2. The electric connector according to claim 1, wherein the first and second

stopper projections are formed as columnar projections of a particular height that are spaced a particular distance apart and project outward from the inner wall of the outer housing inside the receiving cavity, and a gap for preventing a front end portion of the locking arm from colliding with the columnar projections as the locking arm is raised up by the first connector's first latching protrusion is provided between the columnar projections and the front end portion of the locking arm.

3. The electric connector according to claim 1, wherein one pair of ends of the mating sensing member's first and second fingers is connected by a connecting part, the other ends are formed in a U-shape as free extremities, and the connecting part serves as a push-in manipulation part.

4. The electric connector according to claim 3, wherein the stopper engaging portions of the first and second fingers are formed as concavities of a size that enables the second connector's stopper projections to enter therein, and the first stopper strikes against the interior sidewalls of the concavities.

5. The electric connector according to claim 1, wherein the locking arm's pushing portions and the mating sensing member's actuation portions are each formed with inclined faces of particular angles.