United States Patent

Nagano

[15] **3,671,924**

[45] **June 20, 1972**

[54] ELECTRIC CONNECTOR

[72] Inventor: **Hideo Nagano**, 13-5, 5-chome Shimo-Meguro, Tokyo, Japan

[22] Filed: **Sept. 23, 1970**

[21] Appl. No.: **74,742**

[30] **Foreign Application Priority Data**

Sept. 24, 1969 Japan.....44/90955

[52] **U.S. Cl.** .....**339/95 D**, 339/274

[51] **Int. Cl.**.....**H01r 9/06**

[58] **Field of Search**.....339/95, 204, 205, 198 G, 198 GL, 339/273, 274; 24/81, 126, 134

[56] **References Cited**

UNITED STATES PATENTS

3,324,447	6/1967	Pistey	339/95 D
3,474,389	10/1969	Nagano	339/95

FOREIGN PATENTS OR APPLICATIONS

904,304	2/1954	Germany	339/274
544,149	1/1956	Belgium	339/95 D
1,254,214	11/1967	Germany	339/95 D
85,256	5/1965	France	339/274

Primary Examiner—Marvin A. Champion
Assistant Examiner—Robert A. Hafer
Attorney—Waters, Roditi, Schwartz & Nissen

[57] **ABSTRACT**

An electric connector for electrically connecting various electric wires and plugs in a very simple manner comprises a housing made of electrically insulating material, an electrically conductive place, a spring means disposed above said electrically conductive plate and consisted of a retaining plate spring having an end turned back inwardly at an angle larger than 90° and a clamping plate spring disposed underneath said retaining plate spring, and an operating member movably disposed above said spring means so as to assume a first position and a second position. In said first position of said operating member a conductor to be connected is allowed to be inserted into said electric connector and in said second position of said operating member, said spring means is depressed to urge said conductor against said electrically conductive plate. The electric connector further comprises a means for supporting said spring means in such a manner that when said operating member is in said first position, there can be formed a spacing between said spring means and said electrically conductive plate sufficient for inserting said conductor therebetween without striking against said spring means so as to connect said conductor electrically and mechanically in a very stable manner.

8 Claims, 20 Drawing Figures

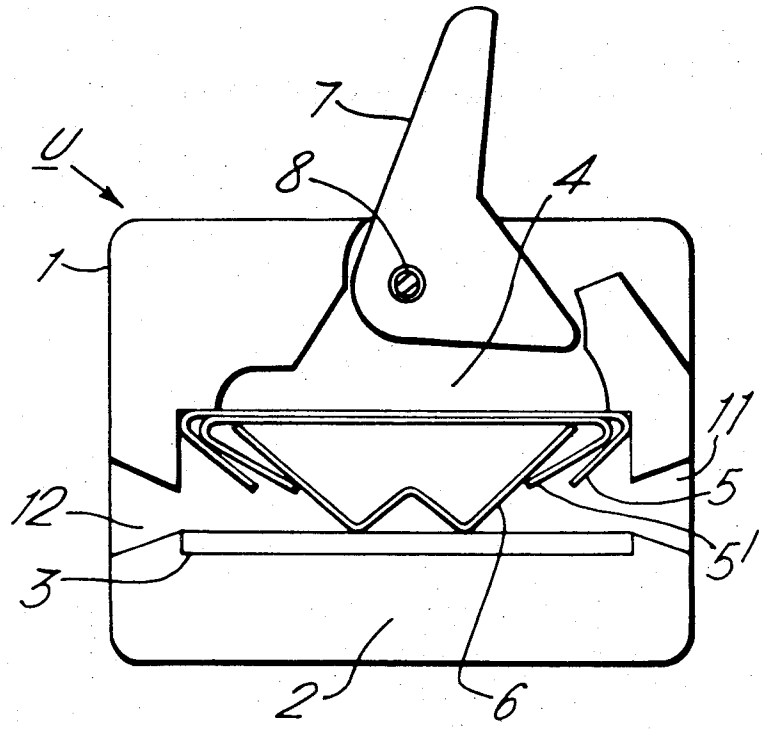
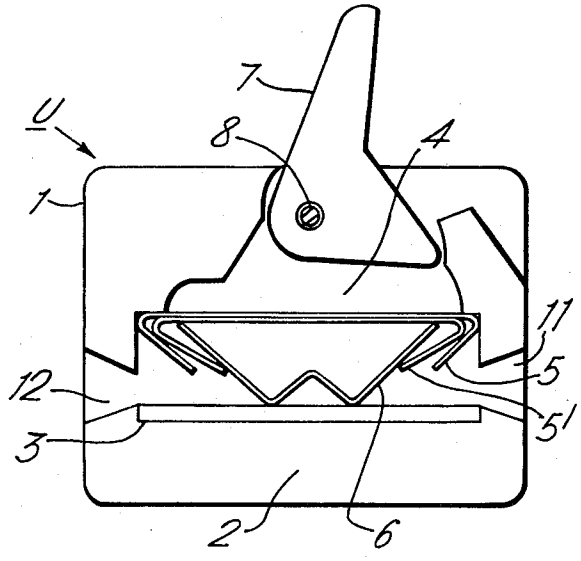


Fig. 1.



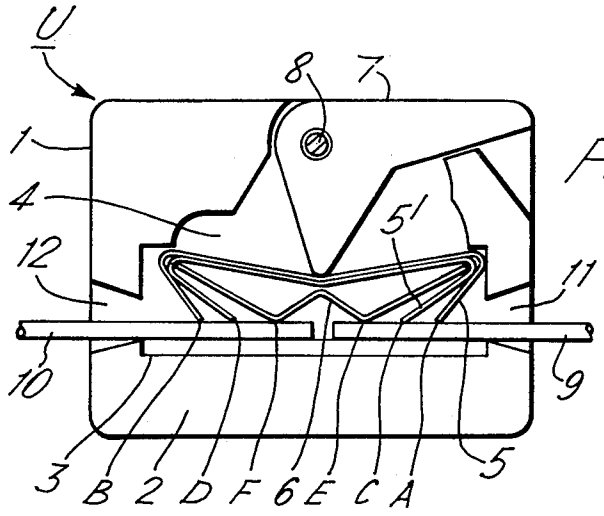
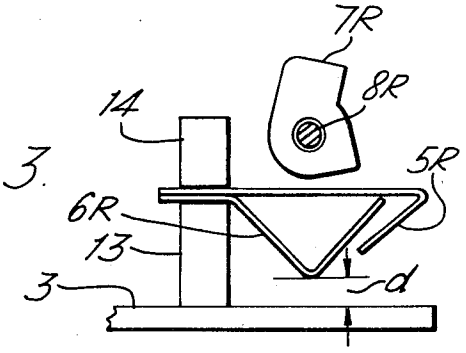


Fig. 2.

Fig. 3.



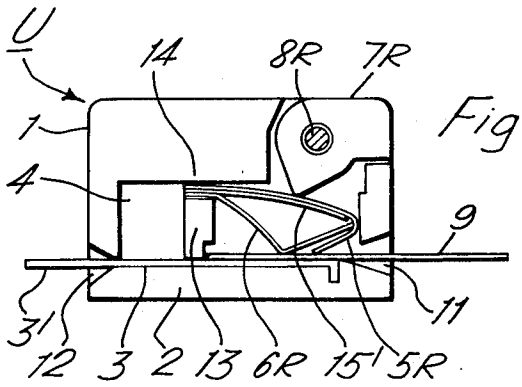


Fig. 4.

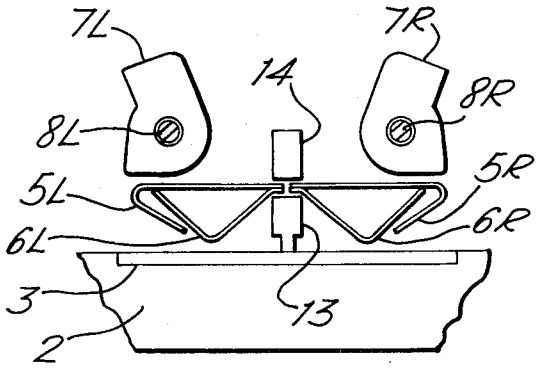


Fig. 5.

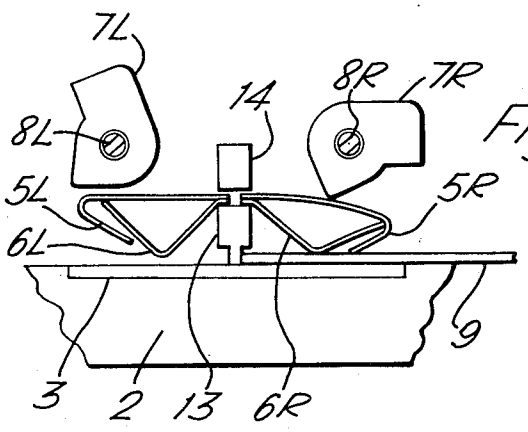


Fig. 6.

Fig. 7.

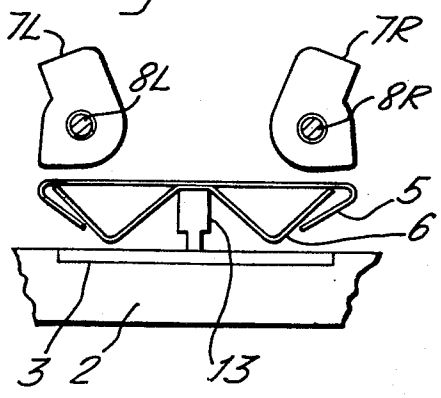
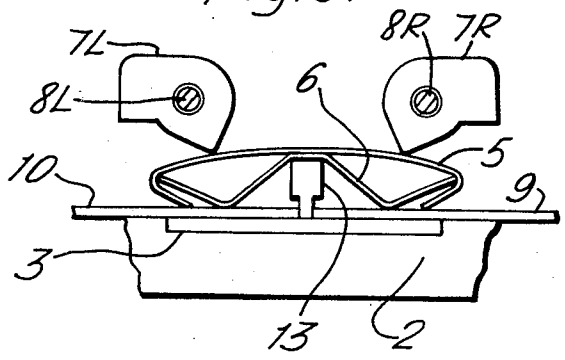


Fig. 8.



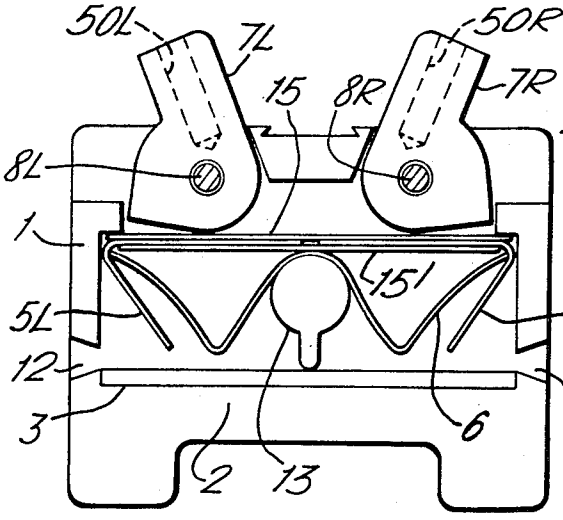


Fig. 9.

Fig. 10.

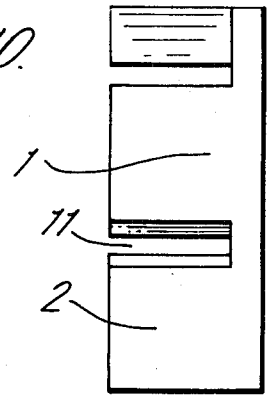


Fig. 11.

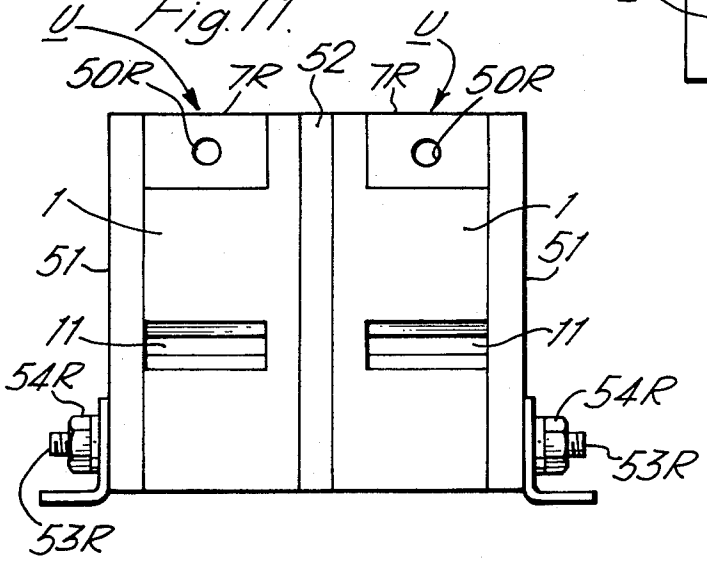


Fig. 12.

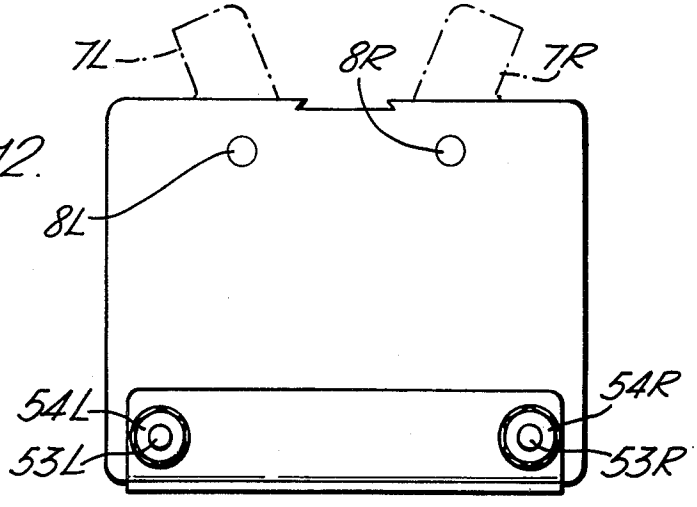


Fig. 13.

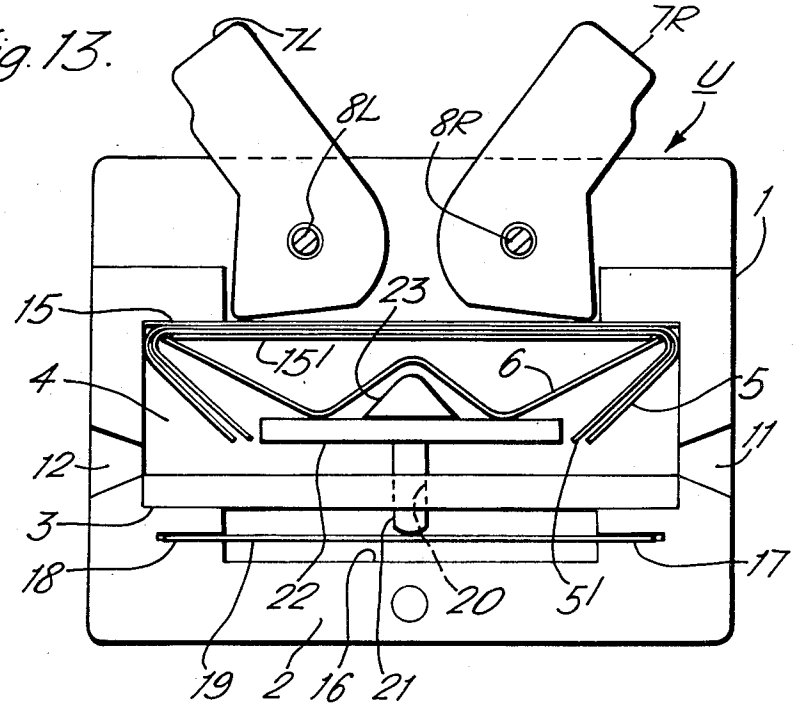

7L
7R
U
8L
8R
1
15
23
151
6
5
4
11
12
3
18
17
22
20
51
19
2
16
21

Fig. 14.

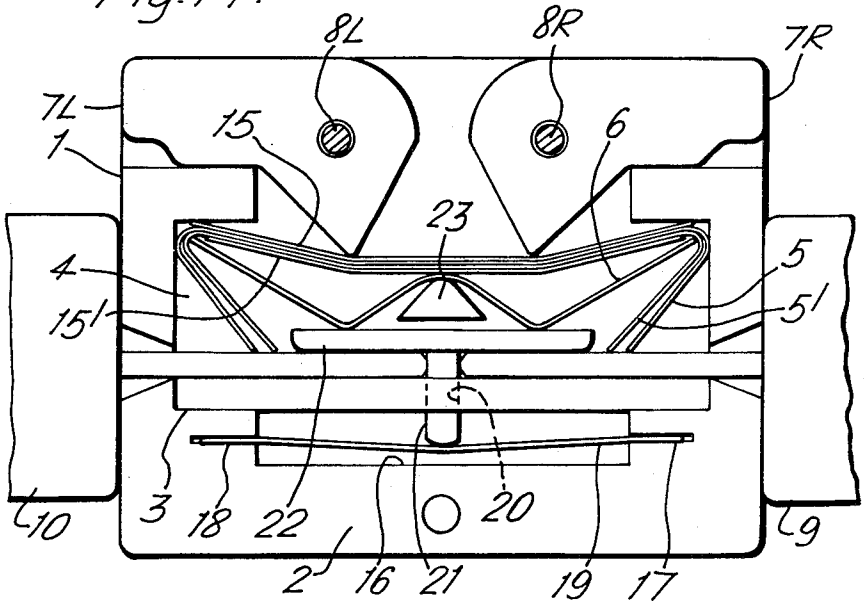

8L
8R
7R
7L
1
15
6
23
4
5
151
51
3
18
22
20
10
9
2
16
21
19
17

Fig. 15.

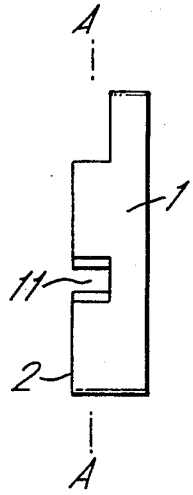


Fig. 16.

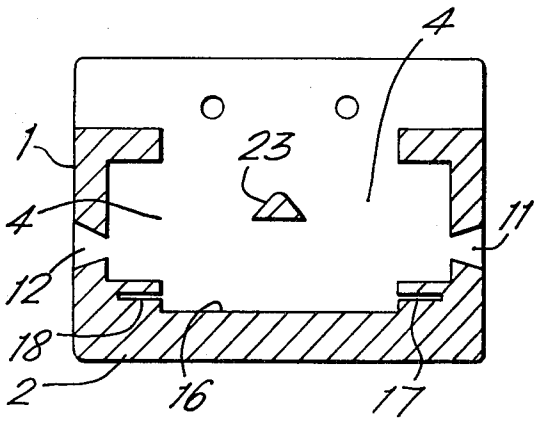


Fig. 17.

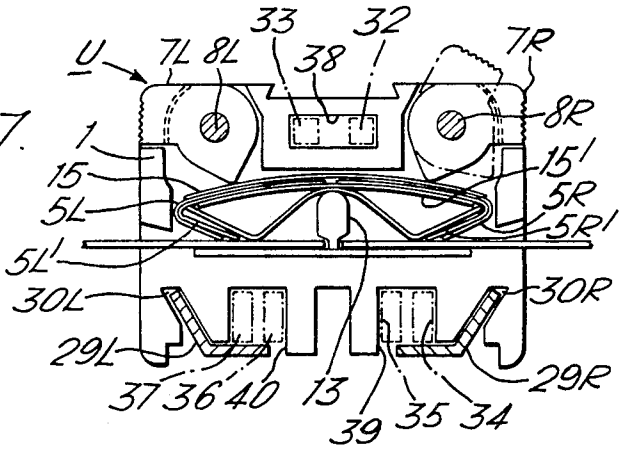


Fig. 18.

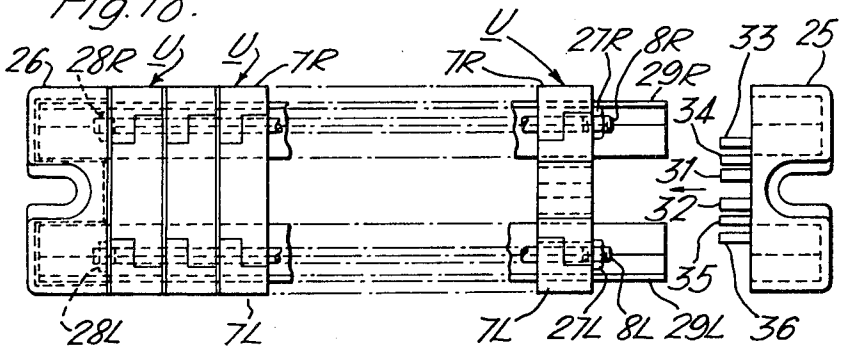


Fig. 19.

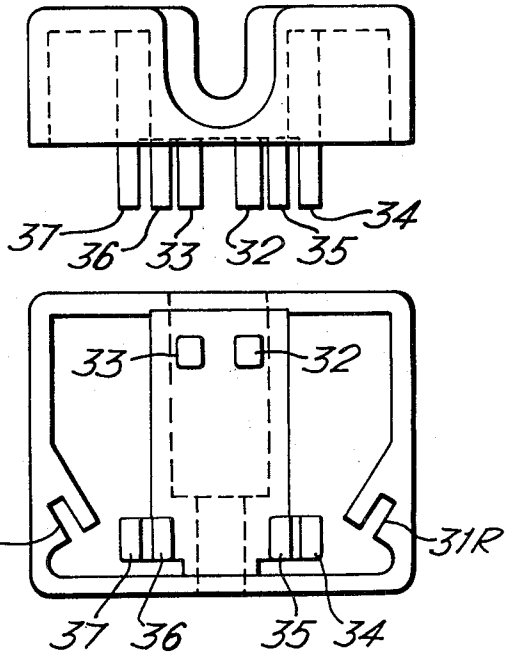
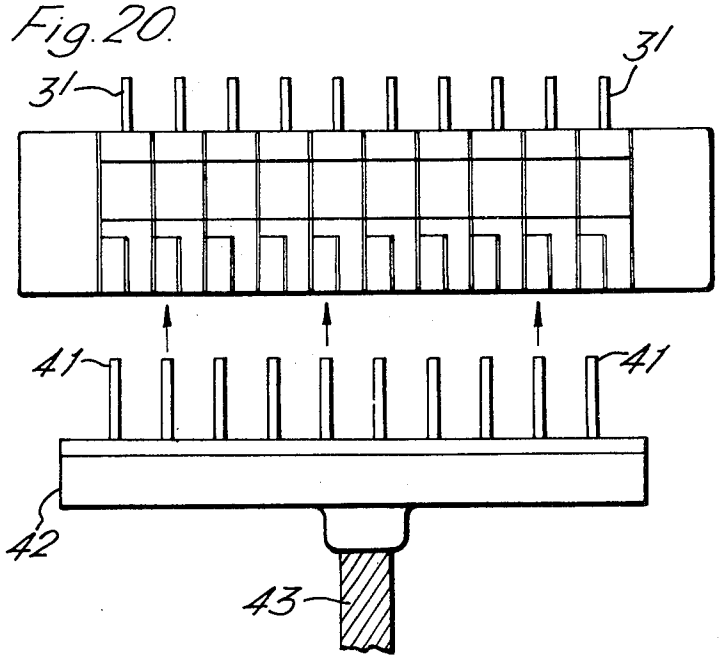


Fig. 20.



ELECTRIC CONNECTOR

This invention relates to an electric connector, and more particularly to a connector of electric wires and connecting plugs.

Terminal boards are widely used in various electric and electronic industries to interconnect electric conductors such as single or bundled electric wires, single or multi-core cables, single or stranded bare conductors, etc. A known terminal board comprises one or more electrically conductive plates, each having a pair of fastening screws located at opposite ends thereof, and an electrically insulating supporting means such as a board made of electrically insulating material, to hold the electrically conductive plates thereon, with proper spacings therebetween. Each end of the wires to be connected is secured to the electrically conductive plate by means of the fastening screws. Such electric connectors are simple in construction and provide electric connection with a low contact resistance. However, they have the following disadvantages:

1. To fasten each wire conductor to the terminal board, the end portion of each conductor has to bend or wind around the fastening screw, so as to insure reliable engagement of the wire conductor with the fastening screw. Such bending or winding of the end portions of the wire conductor amounts to considerable labor.
2. When terminal pieces are used at each end of the wire conductor, the mounting of such terminal pieces securely on the wire conductor also amounts to appreciable labor.
3. The fastening screws of such terminal board tend to be loosened when they are used under vibratory conditions, resulting in an increase in the contact resistance between the wire conductors connected thereby.
4. When stranded conductors are used, the contact resistance tends to be unstable.
5. Incomplete tightening of the fastening screws results in a high contact resistance.
6. Due to the existence of exposed metallic portions, there is a danger of contamination and electric shock to man. Concealing the metallic portions with electrically insulating members results in an increased cost and an increase in labor for connecting and disconnecting of the wire conductors.
7. Laborious checking is necessary to keep low contact resistance between the wire conductors.

In order to obviate such disadvantages, there is now provided an electric connector which comprises a housing made of electrically insulating material; a spring means disposed inside of said housing and consisting of a retaining plate spring having both ends turned back at an angle larger than 90°, and a clamping plate spring disposed underneath said retaining plate spring; an electrically conductive plate disposed on the upper surface of a bottom wall of the housing; and an operating member rotatably supported at the top of the housing so as to selectively assume a first position to allow an insertion of conductors to be connected between said spring means and said electrically conductive plate, and a second position to depress said spring means so as to retain and clamp said conductors against said electrically conductive plate by both said retaining and clamping plate springs.

With such an electric connector, the conductors are urged against the electrically conductive plate by both of the retaining and clamping plate springs. In this case, both ends of the retaining plate spring are turned back at an angle larger than 90°, so that upon depression of the retaining plate spring, there is produced an elastic force having a component in the longitudinal direction of the conductors being connected, in a sense toward the inside of the connector. With such component force, the retaining plate spring engages the conductor in a wedge-like fashion. As a result, the retaining plate spring exerts a large resistance against pulling of the conductor out of the connector. Thus, with such an electric connector, the conductors are urged against the electrically conductive plate by both the retaining and clamping plate springs and, hence, the conductors can be connected electrically and mechanically in a very stable manner.

After many tests and experiments, it has been found that when the operating member is in its first position to allow the insertion of the conductors between the electrically conductive plate and the spring means, the clamping plate spring which is arranged between the retaining plate spring and the electrically conductive plate is still in contact with the electrically conductive plate with a certain elastic force, so that when a weak wire of a small diameter or a stranded wire consisting of fine wires is inserted between the spring means and the electrically conductive plate, it cannot push the clamping plate spring upwards against its elastic force and is liable to bend. Moreover, it has been found that according to the above previously proposed connector, the conductors to be connected or being connected cannot be treated separately. Thus, when an operator wishes to replace one of the conductors by another conductor, he must take care not to loose the other conductor which should not be replaced during the replacing operation. Moreover, in some applications it is enough to connect or disconnect only one of the conductors, and the other conductor is permanently secured to the electrically conductive plate by, for example, soldering or wrapping. In such applications, it is not necessary to provide a connector which can connect or disconnect more than two conductors.

There has also been proposed an electric connector assembly consisting of a plurality of connectors which are fastened to each other by means of a pair of bolts and nuts. When a large number of connectors are assembled, however, fastening means such as bolts and nuts are not sufficient to firmly assemble them against various mechanical stresses such as upwards and/or downwards bending stresses, rightwards and/or leftwards bending stresses and twisting stresses.

It is a primary object of the present invention to provide an improved electric connector of the kind mentioned above, wherein a thin and weak conductor can be inserted into the electric connector without being inhibited by the spring means so as to obtain a good electrical and mechanical connection.

It is a further object of the present invention to provide an improved electric connector, wherein conductors being connected or to be connected can be separately treated without affecting the connection of other conductor.

A further object of the present invention is to provide an improved electric connector which is particularly suitable for power application.

It is still further object of the present invention to provide an improved electric connector assembly which is mechanically strong against mechanical stresses such as upward and/or downward bending stresses, rightward and/or leftward bending stresses, and twisting stresses.

An electric connector according to the present invention comprises a housing made of electrically insulating material and having at least a bottom wall and a hollow space; an electrically conductive plate disposed on the upper surface of said bottom wall of said housing; a spring means disposed within said hollow space of said housing and above said electrically conductive plate and consisting of at least a retaining plate spring having one end turned back inwardly at an angle larger than 90° and a clamping plate spring disposed underneath said retaining plate spring; an operating member movably supported above said spring means so as to assume a first position to allow an insertion of a conductor between said spring means and said electrically conductive plate and a second position to depress said spring means so as to retain and clamp said conductor against said electrically conductive plate; and a means for supporting said spring means at a raised position while said operating member is in said first position so as to form a spacing between the lower portion of said spring means and the electrically conductive plate sufficient for inserting said conductor without striking against said lower portion of said spring means.

With such an electric connector according to the invention, when the operating member is in its first position, there is formed a spacing between the lower end of the spring means and the electrically conductive plate sufficient for inserting an electrical conductor into the connector without striking

against the spring means so that even when a thin and weak conductor is used, it can be connected to the electric connector mechanically and electrically in a very stable manner.

According to a further aspect of the present invention, the electric connector comprises a housing made of electrically insulating material and having at least a bottom wall and a hollow space; an electrically conductive plate disposed on the upper surface of said bottom wall of said housing; a spring means disposed within said hollow space of said housing and above said electrically conductive plate and consisting of a retaining plate spring both ends of which are turned back inwardly at an angle larger than 90° and a clamping plate spring disposed underneath said retaining plate spring; a pair of operating members each of which is movably supported above said spring means so as to assume a first position to allow an insertion of a conductor between said spring means and said electrically conductive plate and a second position to depress said spring means so as to retain and clamp said conductor against said electrically conductive plate; and a means disposed at a middle of said pair of the operating members and for supporting said spring means at its middle point so that two half portions of the spring means can be operated separately, the height of said supporting means being so determined that when said operating member is in its first position, there may be formed a spacing between the lower portion of said spring means and said electrically conductive plate sufficient for inserting said conductor into said electric connector without striking against said lower portion of said spring means, whereby said pair of operating members are made operative separately so as to operate each half portion of said spring means independently from each other.

According to such an electric connector, each half portion of the spring means can be separately operated by each of the operating members such as cam levers, so that either one of conductors can be inserted into or pulled out of the electric connector independently from each other.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

FIGS. **1** and **2** are plan views showing a basic construction of a previously proposed electric connector;

FIG. **3** is a plan view showing a basic construction of an electric connector according to the present invention;

FIG. **4** is a plan view of an electrical connector illustrating a first embodiment of the invention;

FIGS. **5** and **6** are plan views showing a second embodiment of the invention;

FIGS. **7** and **8** are plan views illustrating a third embodiment of the invention;

FIG. **9** shows a plan view of a fourth embodiment of the invention, which is particularly suitable for a power application;

FIG. **10** is a side view of a housing of the electric connector shown in FIG. **9**;

FIG. **11** is a side view showing a connector assembly composed of two electric connectors shown in FIG. **9**;

FIG. **12** is a front view of the connector assembly shown in FIG. **11**;

FIGS. **13** and **14** are plan views showing a fifth embodiment of the invention, which is particularly suitable for a large power application;

FIG. **15** is a side view of a housing of the electric connector illustrated in FIGS. **13** and **14**;

FIG. **16** is a cross sectional view showing the housing taken along a line A—A in FIG. **15**;

FIG. **17** is a plan view showing a sixth embodiment of the invention;

FIG. **18** shows a connector assembly composed of a plurality of the connectors shown in FIG. **17**;

FIG. **19** shows a detailed construction of an end block shown in FIG. **18**; and

FIG. **20** shows an electric connector assembly composed of a plurality of the electric connectors shown in FIG. **4** and a connecting means which can be connected simultaneously to the connector assembly.

FIGS. **1** and **2** show a basic construction of an electric connector which had been previously proposed. This electric connector designated generally by a reference figure U consists of a housing **1** made of electrically insulating material, such as synthetic resin. On an upper surface of a bottom wall of the housing **1**, an electrically conductive plate **3** is arranged. A hollow space **4** within the housing **1** receives a spring means consisting of upper and lower retaining plate springs **5** and **5'** and a clamping plate spring **6** of W-shape. Both ends of the retaining plate springs **5** and **5'** are turned back inwardly at an angle larger than 90°. The clamping plate spring **6** is disposed between the lower retaining plate spring **5'** and the electrically conductive plate **3**. A cam lever **7** is pivotally supported by the housing **1** through a shaft **8** journalled by the housing **1**. When the cam lever **7** is in a first position, it does not engage with the upper retaining plate spring **5**, so that it does not exert any influence on the spring means. In this first position of the cam lever **7**, wire conductors **9** and **10** (see FIG. **2**) to be connected can be inserted into the connector U through holes **11** and **12** formed on side walls of the housing **1**, respectively.

After the conductors **9** and **10** are inserted into the connector to a given extent, the cam lever **7** is turned clockwise so as to assume a second position shown in FIG. **2**. Then, the lower end of the cam portion of the cam lever **7** depresses the upper retaining plate spring **5** as well as the lower retaining plate spring **5'** at their central portions, so as to cause engagement of the end portions of the retaining plate springs **5**, **5'** and the conductors **9** and **10** at points A, B, C and D. Due to the fact that both ends of the retaining plate springs **5** and **5'** are turned back at an angle larger than 90°, upon depression of the retaining plate springs **5** and **5'** vertically downwards, there are produced horizontal components of force in the sense to keep the conductors **9** and **10** towards the center of the connector U. Besides, the tips of the retaining plate springs **5** and **5'** slightly bite the conductors **9** and **10** to retain and stop them securely against the pulling out of the connector U.

At the same time, the clamping plate spring **6** are also depressed downwards by the cam lever **7** through the retaining plate springs **5** and **5'**. Thus, the clamping plate spring **6** urges the conductors **9** and **10** against the common electrically conductive plate **3** at points E and F, respectively

Thus, with the previously proposed electric connector U shown in FIGS. **1** and **2**, the wire conductors **9** and **10** are electrically connected effectively by depressing the conductors against the electrically conductive plate **3** by both of the retaining plate springs **5**, **5'** and the clamping plate spring **6**, while insuring firm mechanical connection thereof against pulling-out by the plate spring means **5**, **5'** and **6**, particularly by the inwardly oriented engagement between the retaining plate springs **5**, **5'** and the conductors **9** and **10**.

In the above explained electric connector U, when the cam lever **7** is in the first position shown in FIG. **1**, usually there is formed little or no spacing between the lower end of the spring means and the electrically conductive plate **3**, so that when the wire conductor is inserted into the connector U, it engages the clamping plate spring **6** and pushes it upwards together with the retaining plate springs **5** and **5'** against the elastic force of the clamping spring **6**. However, when a thin and weak wire conductor or a weak stranded conductor consisting of fine wires is inserted into the connector, it strikes against the clamping plate spring **6** but it cannot push the spring means upwards against the spring force of the clamping plate spring **6**, so that it cannot be inserted into the connector U beyond a point at which the clamping plate spring **6** contacts the electrically conductive plate **3**. Thus, the wire conductor is liable to bend and the satisfactory connection between the conductors cannot be obtained.

The present invention provides an improved electric connector which can obviate the abovementioned disadvantage and can also offer further advantages as will be explained hereinafter.

Next, a few embodiments of the according to the invention will be explained in detail with reference to the accompanying drawings. However, it is clear that the present invention is now limited to only these embodiments and many modifications are possible within the scope of the invention.

FIG. 3 shows the principal construction of the spring means according to the invention. The spring means consists of a retaining plate spring 5R the outer end of which is turned back inwardly at an angle greater than 90° and of a clamping plate spring 6R of V-shape, which is disposed between the retaining plate spring 5R and an electrically conductive plate 3. As shown in FIG. 3, each inner end of the retaining and clamping plate springs 5R and 6R opposite to the end which is turned back is clamped between a pair of clamping members 13 and 14. The height of the lower clamping member 13 is so selected that in the first position of the cam lever 7R shown in FIG. 3, distance d between the lower end of the clamping plate spring 6R and the electrically conductive plate 3 is larger than a diameter of a thin conductor to be inserted into the connector. Thus, with the spring means according to the invention, when a thin conductor is inserted between the clamping plate spring 6R and the electrically conductive plate 3, it does not strike against the clamping plate spring 6R, so that there is no risk of bending of the thin conductor and a mechanically and electrically stable and firm connection is possible.

FIG. 4 shows an electric connector according to the invention which utilizes the spring means shown in FIG. 3. In this embodiment, a bottom wall 2, lower and upper clamping members 13 and 14 are formed integrally with a housing 1. In this embodiment, a spring means consists of a retaining plate spring 5R, a clamping plate spring and a reinforcing plate spring 15' disposed underneath the retaining plate spring 5R. Inner ends of these plate springs 5R, 6R and 15' are clamped between a pair of clamping members 13 and 14. In this case, it is not always necessary to clamp tightly the spring means by the clamping members 13 and 14 so far as the spring means is held in a position within the hollow space 4 of the housing 1. The outer end of the retaining plate spring 5R is turned back at an angle greater than 90°. On the upper surface of the housing 1, there is provided an electrically conductive plate 3. An end of the electrically conductive plate 3 opposite to the end from which a conductor 9 is to be inserted into the connector U through a hole 11 formed on a side wall of the housing 1, is extended out of the housing 1 through a hole 12 formed on the opposite side wall of the housing 1 to form a projection 3'. To this projection 3', a conductor may be permanently secured by, for example, soldering or wrapping which is commonly employed in telephone communication apparatus. A cam lever 7R is arranged above the spring means 5R, 6R and 15'. The cam lever 7R is pivotally supported by a shaft 8R. When the cam lever 7R is rotated around the shaft 8R counterclockwise, the spring means assumes a raised position by means of its own elastic force. At this time, since the inner end of the spring means is held at the raised position by the clamping members 13 and 14, there is formed a spacing between the lower end(s) of the spring means and the electrically conductive plate 3 enough for inserting a conductor 9 of small diameter without being inhibited by the spring means. Thus, the conductor 9 can be inserted into the connector U through the hole 11 to a given extent and the conductor 9 is connected to the electrically conductive plate 3 in a mechanically and electrically stable and firm manner.

It has been also found that when a conductor of relatively large diameter is used, it is sometimes difficult to pull the conductor out of the previously proposed connector as shown in FIGS. 1 and 2, because in such a case, the turned back end of the retaining plate spring 5 still contacts the conductor and retains the conductor within the connector. While, with the electric connector according to the invention, since the spring means is held at a raised position by the clamping members 13 and 14, a relatively thick conductor can be pulled smoothly out of the housing 1 through the hole 11.

With the previously proposed electric connector, when the cam lever 7 is in the second position shown in FIG. 2, it is impossible to pull only one of the conductors out of the connector U with the other connector being still firmly retained in the connector U, unless the cam lever 7 is rotated counterclockwise to the first position shown in FIG. 1. In many applications, it is often desirable to replace only one of the conductors with the other conductor being still retained in the connector U.

FIG. 5 shows a second embodiment of the electric connector according to the invention, which can satisfy the above-mentioned requirements. In this second embodiment there are provided two spring means each of which is shown in FIG. 3. That is, the right hand half of the spring means consists of a retaining plate spring 5R an outer end of which is turned back inwardly at an angle greater than 90° and of a clamping plate spring 6R of V-shape, and the left hand half portion of the spring means consists of a retaining plate spring 5L, an outer end of which is likewise turned back inwardly at an angle larger than 90° and of a clamping plate spring 6L of V-shape. Inner ends of both half portions 5R, 6R and 5L, 6L of the spring means are clamped between a lower clamping member 13 and an upper clamping member 14 which may be formed integrally with the housing 1 at a middle thereof. A pair of cam levers 7R and 7L are pivotally supported by a pair of shafts 8R and 8L above the spring means. Thus, when the right and left hand cam levers 7R and 7L are in their first positions shown in FIG. 5, the spring means are held at a raised position by the lower clamping member 13. In this position of the spring means there is formed a sufficient spacing between the lower end portions of the V-shaped clamping plate springs 6R and 6L and the electrically conductive plate 3 for inserting the wire conductors of small diameter without striking against the lower end portions of the clamping plate springs 6R, 6L. Moreover, it is apparent from FIG. 6 that the right and left hand half portions of the spring means can operate independently from each other, so that it is possible to connect or disconnect either one of the wire conductors by operating either one of the cam levers 7R and 7L. In FIG. 6 only a conductor 9 is inserted into the connector.

FIGS. 7 and 8 show a third embodiment of the electric connector according to the invention. In this embodiment, the composition and shape of the spring means are essentially the same as those of the previously proposed electric connector shown in FIGS. 1 and 2. That is, the spring means consists of a retaining plate spring 5 and a clamping plate spring 6 and both ends of the retaining plate spring 5 are turned back inwardly at an angle larger than 90° and the clamping plate spring 6 of W-shape is disposed between the retaining plate spring 5 and an electrically conductive plate 3 provided on an upper surface of a bottom portion 2 of a housing. According to the invention a center pillar 13 is provided at the central portion of the spring means between the clamping plate spring 6 and the electrically conductive plate 3. The center pillar 13 may be made integral with the housing. The height of the center pillar 13 is so determined that when the spring means is not depressed as illustrated in FIG. 7, the bottom corners of the clamping plate spring 6 do not contact the electrically conductive plate 3 and there is formed an enough spacing therebetween for inserting a wire conductor without being inhibited by the bottom corner of the clamping plate spring 6. Therefore, the wire conductors can be inserted smoothly into the electric connector and during this insertion, a wire conductor of small diameter never strikes against the clamping plate spring 6, so that the conductor can be inserted into the connector to a desired extent. It is clear that when a wire conductor having a diameter larger than the spacing between the clamping plate spring 5 and the electrically conductive plate 3 is inserted into the connector, the tip of this wire conductor actually hits against the clamping plate spring 6. However, in this case since the mechanical strength of the wire conductor of such a large diameter is large, it can push the spring means upwards against the spring force of the clamping plate spring

6, so that there is not caused any trouble. In fact, the clamping force of the retaining and clamping plate springs 5 and 6 exerted on the wire conductors is somewhat reduced due to the provision of the center pillar 13. However, when the wire conductor of small diameter is inserted into the connector, in general it is not necessary to produce such a large clamping force as in the case of the wire conductor of larger diameter. Therefore, even if the clamping force of the clamping plate spring 6 is a little reduced when the wire conductor of small diameter is used, the retaining and clamping actions caused by the retaining and clamping plate springs 5 and 6 are still effective to retain firmly the wire conductor of small diameter within the electric connector.

It has been further found that by providing the center pillar 13 at the central portion of the spring means right and left half portions of the spring means can operate substantially independent to each other by means of a pair of cam levers 7R and 7L. Thus, from the state shown in FIG. 8, when one of the cam levers 7R and 7L, for example, the right hand cam lever 7R is rotated anticlockwise, only the right hand half portion of the spring means is made loose, so that the wire conductor 9 can be pulled out of the connector freely. In this case the left hand half portion of the spring means is still depressed by the left hand cam lever 7L, so that the other wire conductor 10 is still urged against the electrically conductive plate 3 by means of the left hand half portion of the spring means depressed by the left hand cam lever 7L.

FIG. 9 shows a fourth embodiment of the electric connector according to the invention. The connector of this embodiment is particularly suitable for power applications in which a large current more than, for example, 50 amperes flows, so that wire conductors of quite large diameter or connecting plugs of large size have to be used. The basic construction of the spring means of this embodiment is substantially the same as the preceding embodiments. That is the spring means consists of two retaining plate springs 5R and 5L, a substantially W-shaped clamping plate spring 6 and two reinforcing plate springs 15 and 15'. In this embodiment a central pillar 13 having a circular portion is formed integral with the housing 1 and the spring means is disposed on the central pillar 13. According to the invention the height of the central pillar 13 is so chosen that with the first position of the cam levers 7R, 7L shown in FIG. 9, there may be formed an enough spacing between the lower ends of the spring means and the electrically conductive plate 3 for inserting wire conductors of large diameter or connecting plugs of a large size into the electric connector U without striking against the spring means. In this embodiment the retaining plate spring consists of two separate half portions 5R and 5L. Thus, the right and left hand half portions of the spring means can operate separately by actuating the cam levers 7R and 7L independently to each other. Since the spring means of this embodiment for power application is made of thick plate springs, having a large width and a large mechanical strength, it is difficult to operate the cam levers 7R and 7L by, for example, a finger. Therefore, there are formed holes 50R and 50L in the lever portion of cam levers 7R and 7L, respectively. The cam levers 7R and 7L can be actuated by a suitable tool such as a screw driver which can be inserted into the holes 50R and 50L.

FIG. 10 is a side view showing the housing 1 of the electric connector illustrated in FIG. 9. FIG. 11 is a side view of the electric connector assembly consisting of two units U shown in FIG. 9. In this connector assembly, two connector units U are arranged side by side with the interposing of a partition plate 52. The width of the partition plate 52 is so determined that there may be made enough spacing between the holes 11, in order to prevent a short-circuiting. On outer sides of connector units U, there are placed cover plates 51, 51. These components are assembled by means of bolts 53R and 53L and nuts 54R, 54R' and 54L, 54L' as shown in FIG. 12. According to the invention the number of connector units U is not limited to two, but any number of connector units U may be assembled into a connector assembly.

In the abovementioned embodiment of power applications, a large current up to for instance 100 amperes can be passed through the connector U. If it is desired to pass an electric current larger than 100 amperes, one can use the next embodiment of the invention.

FIGS. 13, 14, 15, 16 show a fifth embodiment of the electric connector according to the invention. The electric connector of this embodiment is particularly suitable for power applications in which wire conductors of quite large diameter or plugs of quite larger size as compared with the wire conductor connected thereto must be inserted into the connector. In such a case an electrically conductive plate 3 is often insufficient to conduct an extremely large current with low resistance. Thus, in order to obviate such a disadvantage, according to the present embodiment use is made of an auxiliary electrically conductive plate 22. As shown in FIG. 13, the spring means consisting of two retaining plate springs 5, 5', a clamping plate spring 6 and two reinforcing plate springs 15, 15', is disposed within a hollow space 4 of a housing 1. Right and left hand cam levers 7R and 7L are pivotally supported by shafts 8R and 8L, respectively. A bottom wall 2 of the housing 1 receives an electrically conductive plate 3. In this embodiment, the bottom wall 2 is further provided with a depressed portion 16, on the opposite side walls of the depressed portion 16 there are formed recesses 17 and 18, in which recesses are inserted both ends of a plate spring 19. At a middle of the electrically conductive plate 3, there is formed a hole 20, through which hole 20 a stem 21 is loosely inserted. On the top end of the stem 21, an auxiliary electrically conductive plate 22 is secured. The auxiliary electrically conductive plate 22 may be a metal plate having more or less elasticity, such as a plate of phosphor bronze. On the top surface of the auxiliary plate 22, the spring means is disposed, that is the lower end portions of the clamping plate spring 6 of W-shape lie on the top surface of the auxiliary plate 22. Thus, when the cam levers 7R and 7L are in the non-actuated positions as shown in FIG. 13, the stem 21 and the auxiliary plate 22 and therefore the spring means are at raised positions by the elastic force of the plate spring 19. In this position there is formed a large spacing between the electrically conductive plate 3 and the auxiliary plate 22 sufficient for inserting the wire conductors of quite large diameter or the large plugs without striking against the spring means. Then, the right and left hand cam levers 7R and 7L are rotated clockwise and anti-clockwise, respectively to reach the second positions shown in FIG. 14. In this position the cam portions of the cam levers 7R and 7L depress the spring means against the elastic force of the plate spring 19 and the wire conductors 9 and 10 are strongly arged against the interconnecting conductor plate 3 by means of the retaining plate springs 5, 5', the clamping plate spring 6 through the auxiliary plate 22. Since the wire conductors 9 and 10 are clamped between the electrically conductive plate 3 and the auxiliary electrically conductive plate 22 of comparatively large area, the electrical contact resistance of connection can materially be reduced, so that a large current can be conducted with an extremely small loss.

When the cam levers 7R and 7L are again rotated to their initial positions shown in FIG. 13, the stem 21, the auxiliary plate 22 and therefore the spring means disposed thereon are raised upwards by the elastic force of the plate spring 19. Thus, the wire conductors of large diameter can be smoothly pulled out of the connector U without being retained within the connector U by the spring means, particularly by the retaining plate springs 5R and 5L.

In order to operate the right and left hand portions of the spring means separately, the central pillar 23 of triangular shape is formed integral with the housing 1. As shown in FIG. 14, the spring means are arged against the central pillar 23 at its central point, so that the right and left hand half portions of the spring means can be operated independently from each other by operating the right and left hand cam levers 7R and 7L separately.

FIG. 15 shows a side view of the housing 1 of the electric connector U shown in FIGS. 13 and 14. FIG. 15 is a cross-sectional view of the housing 1 taken along a line A—A in FIG. 15. The housing 1 may be made of electrically insulating material, such as synthetic resin with a use of a suitable mold. The electric connector U according to the invention can be manufactured in a very simple manner by arranging the spring means including the retaining plate spring 5 and the clamping plate spring 6; the plate spring 19; the electrically conductive plate 3; and the cam levers 7R and 7L within the hollow space 4 of the housing 1.

FIG. 17 shows a sixth embodiment of the electric connector U according to the invention. In this embodiment, the spring means consists of two retaining plate springs 5R, 5R' and 5L, 5L' which are separated at central points thereof and turned back at outer ends inwardly by an angle larger than 90°, a clamping plate spring 6 of W-shape and two reinforcing plate springs 15 and 15' disposed above and below the retaining plate springs 5R and 5L, respectively. A central pillar 13 is arranged between the clamping plate spring 6 and the electrically conductive plate 3. In the present example, the central pillar 13 is formed integral with the housing 1. The height of the central pillar 13 is so selected that when the spring means is in its raised position as shown in FIG. 14, there may be formed a sufficient space for smoothly inserting the wire conductors into the connector U. In the present embodiment, since the retaining plate springs 5R and 5L are cut at their central points, it is further ensured that either one of the wire conductors can be inserted into or pulled out of the electric connector U by operating either one of the cam levers 7R or 7L without operating the other cam lever 7L or 7R.

A salient feature of the present invention is in that any number of electric connectors hereinbefore described can be assembled together to form a connector assembly. As shown in FIG. 18, a suitable number of electric connectors U illustrated in FIG. 17 can easily be assembled and the thus assembled connectors are fastened together by end blocks 25 and 26 provided at both ends thereof. The right and left hand cam levers 7R and 7L are commonly journaled by a pair of shafts 8R and 8L, respectively, extending through all of the connectors assembled. Both ends of the shafts 8R and 8L are screwed by nuts 27R, 28R and 27L, 28L, respectively to fasten tightly a plurality of the connectors U together. According to the invention it has been found that if a number of electric connectors U are assembled only by the shafts 8R, 8L and the nuts 27, 28, there is a risk of displacement of connector units U in the assembly due to upwards and/or downwards bending stress, right and/or left-wards bending stress and twisting stress exerted on the connector assembly. In order to avoid such disadvantage, according to the invention a pair of reinforcing plates 29R and 29L are tightly passed through recesses 30R and 30L (see FIG. 17) formed in the electric connectors. As shown in FIG. 18, at both ends of the connector assembly the reinforcing plates 29R and 29L are projected to a certain extent. These projections are tightly inserted into recesses 31R and 31L (see FIG. 19) formed in the end blocks 25, 26. In the embodiment shown in the drawing, the reinforcing plate 29 has a cross-section similar to L. It is apparent that the shape of the reinforcing plate 29 may be any suitable shape such as a trough. In such a case, the shape of the recesses 30 and 31 formed in the housing 1 and the end blocks 25, 26 must correspond to the shape of the reinforcing plate 29.

As best shown in FIG. 19, on that side of the end block 25, 26 which faces the electric connector U, there are provided with a plurality of projections 32, 33; 34, 35; 36, 37. At the same time, there are formed corresponding recesses 38, 39 and 40 in the housing 1 of the electric connector U as shown in FIG. 17. Upon securing the end block 25, 26 to the electric connector U, the projections 32 - 37 are tightly inserted into the recesses 38–40 so as to ensure a mechanically firm connection therebetween.

In some applications, it is often desirable to connect simultaneously many electrical conductors to a common point such as an electrical supply source, ground (earth), etc. FIG. 20 shows such an application. In his case, the electric connector assembly is composed of a plurality of the electric connectors U illustrated in FIG. 4. A plurality of electrically conductive pins 41 are mounted on an electrically insulating member 42 with a given interval which corresponds to an interval between two subsequent holes 11 formed on side walls of the housing 1 (see FIG. 4). In the member 42, all of the pins 41 are electrically coupled to a common electrical wire 43. Various conductors may be permanently secured to the projections 3'. When all of the pins 41 are simultaneously inserted into the electric connectors U through the holes 11 and then the common wire 43 is connected to, for example, the ground. Thus, many conductors may be connected to the ground in a very simple manner.

What is claimed is:

1. An electric connector, comprising a housing of electrically insulating material and including at least a bottom wall and being provided with a hollow space;

an electrically conductive plate disposed on the upper surface of said bottom wall of said housing;

a spring means disposed within said hollow space of said housing and above said electrically conductive plate and consisting of at least a retaining plate spring having one end turned back inwardly at an angle larger than 90° and a clamping plate spring of substantially V-shape disposed underneath said retaining plate spring;

a cam lever pivotally supported above said spring means so as to assume a first position to allow an insertion or an extraction of a conductor between said spring means and said electrically conductive plate and a second position to depress said spring means in a direction at substantially 90° with respect to said conductor so as to retain and clamp said conductor against said electrically conductive plate; and

a means for supporting said spring means in a raised position while said cam lever is in said first position so as to form a spacing between the lower portion of said spring means and the electrically conductive plate sufficient for inserting or pulling out said conductor without striking against said lower portion of said spring means, said means for supporting said spring means consisting of a pair of clamping members formed integrally with said housing, between which that end of the spring means which is opposite to said turned back end is loosely or tightly clamped.

2. An electric connector comprising

a housing of electrically insulating material and including at least a bottom wall and provided with a hollow space;

an electrically conductive plate disposed on the upper surface of said bottom wall of said housing;

a spring means disposed within said hollow space of said housing and above said electrically conductive plate and consisting of a retaining plate spring including ends both of which are turned back inwardly at an angle larger than 90° and a clamping plate spring of substantially W-shape disposed underneath said retaining plate spring;

a pair of cam levers each of which is pivotally supported above said spring means so as to assume a first position to allow an insertion or an extraction of a conductor between said spring means and said electrically conductive plate and a second position to depress said spring means in the direction at substantially right angles with respect to said conductor so as to retain and clamp said conductor against said electrically conductive plate; and

a means disposed at a middle of said pair of the cam levers and for supporting said spring means at its middle point so that two half portions of the spring means can be operated separately, the height of said supporting means being so determined that when said operating member is in said first position, there may be formed a spacing between the lower portion of said spring means and said electrically conductive plate sufficient for inserting or

pulling out said conductor into or out of said electric connector without striking against said lower portion of said spring means, said means for supporting said spring means being composed of a central pillar on which said spring means disposed at its central position, whereby said pair of cam levers are separately operative so as to operate each half portion of said spring means independently from each other.

3. An electric connector as claimed in claim 2, wherein said spring means is composed of a pair of half portions of a retaining plate spring and a pair of half portions of a clamping plate spring completely cut at their middle point at which said supporting means is provided.

4. An electric connector particularly suitable for power application, comprising

a housing of electrically insulating material and including at least a bottom wall and provided with a hollow space;

an electrically conductive plate disposed on an upper surface of said bottom wall of said housing;

a spring means disposed within said hollow space of said housing and above said electrically conductive plate and consisting of at least a pair of half portions of a retaining plate spring cut at the central point outer ends of these half portions being turned back inwardly at an angle larger than 90°, a clamping plate spring of substantially W-shape disposed underneath said retaining plate spring and two reinforcing plate springs disposed on and below said retaining plate spring, respectively;

a pair of cam levers disposed above said spring means and pivotally supported by a pair of shafts so as to assume a first position to allow an insertion or an extraction of a conductor into or out of said electric connector and a second position to depress said spring means so as to retain and clamp said conductor against said electrically conductive plate; and

a means formed integral with said housing and having a substantially circular contour for supporting said spring means at a raised position while said cam lever is in said first position so as to form a spacing between the lower portion of said spring means and the electrically conductive plate sufficient for inserting or pulling out said conductor without striking against said lower portion of said spring means, whereby said pair of cam levers are separately operable so that each half portion of said spring means can be operated independently from each other.

5. An electric connector as claimed in claim 4, wherein said cam lever consists of a cam portion and a lever portion and said lever portion is provided with a recess, whereby said cam lever can be operated by means of a tool having a portion which can be inserted into said recess.

6. An electric connector particularly suitable for power applications, comprising

a housing of electrically insulating material and including at least a bottom wall and provided with a hollow space;

an electrically conductive plate disposed on the upper surface of said bottom wall of said housing;

a spring means disposed within said hollow space of said housing and above said spring means and consisting of two retaining plate springs including ends both of which are turned back inwardly at an angle larger than 90°, a clamping plate spring of substantially W-shape disposed underneath said retaining plate springs and two reinforcing plate springs arranged on and below said retaining plate springs, respectively;

a pair of cam levers disposed above said spring means and pivotally supported by a pair of shafts so as to assume a first position to allow an insertion or an extraction of a conductor into or out of said electric connector and a second position to depress said spring means so as to retain and clamp said conductor against said electrically conductive plate;

a depressed portion being provided in said bottom wall of said housing;

a plate spring disposed in said depressed portion;

a means for supporting said spring means and consisting of a stem and an auxiliary electrically conductive plate secured to said stem and extending in a direction parallel to said electrically conductive plate, said spring means being disposed on said auxiliary electrically conductive plate; and

a central pillar formed integral with said housing between said clamping plate spring and said auxiliary electrically conductive plate, the height of said central pillar being so determined that when one of said cam levers is actuated, one of half portions of said spring means can only be operated; whereby said means for supporting said spring means is movably arranged on said plate spring disposed in said depressed portion through a hole provided in said electrically conductive plate and the length of said stem of said supporting means is so determined that when said cam lever is in said first position, there may be formed a spacing between said electrically conductive plate and said auxiliary electrically conductive plate sufficient for inserting or pulling out said conductor therebetween without striking against said auxiliary electrically conductive plate.

7. An electric connector comprising

a housing of electrically insulating material and including at least a bottom wall and provided with a hollow space;

an electrically conductive plate disposed on the upper surface of said bottom wall of said housing;

a spring means disposed within said hollow space of said housing and above said electrically conductive plate and consisting of two pairs of half portions of a retaining plate spring having outer ends each of which is turned back inwardly at an angle larger than 90°, a clamping plate spring of substantially W-shape disposed underneath said retaining plate springs and two reinforcing plate springs disposed on and below said retaining plate springs, respectively;

a pair of cam levers disposed above said spring means, and pivotally supported by a pair of shafts so as to assume a first position to allow an insertion or extraction of a conductor into or out of said electric connector and to a second position to depress said spring means to retain and clamp said conductor against said electrically conductive plate; and

a central pillar formed integral with said housing for supporting said spring means at its central position, the height of said central pillar being so determined that, when said cam lever is in said first position, the spring means is supported at a raised position to form a spacing between said electrically conductive plate and the lower portion of said spring means sufficient for inserting or pulling out said conductor therebetween without striking against the lower portion of said spring means.

8. An electric connector assembly, comprising

a plurality of electric connectors as claimed in claim 7 disposed in a row;

at least one reinforcing plate having a non-straight cross-section and being tightly passed through recesses formed in the housings of said electric connectors, the shape of said recesses corresponding to said cross-section of said reinforcing plate; and

a pair of end blocks having recesses corresponding to said cross-section of said reinforcing plate into which recesses both ends of said reinforcing plate are tightly inserted.

* * * * *