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Brush

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[54] **RACK AND PANEL CONNECTOR ASSEMBLY**

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[51] **Int. Cl.** **H01r 13/62**

[58] **Field of Search** ..... 339/64–66, 184, 186, 17, 18, 34; 317/101 DH

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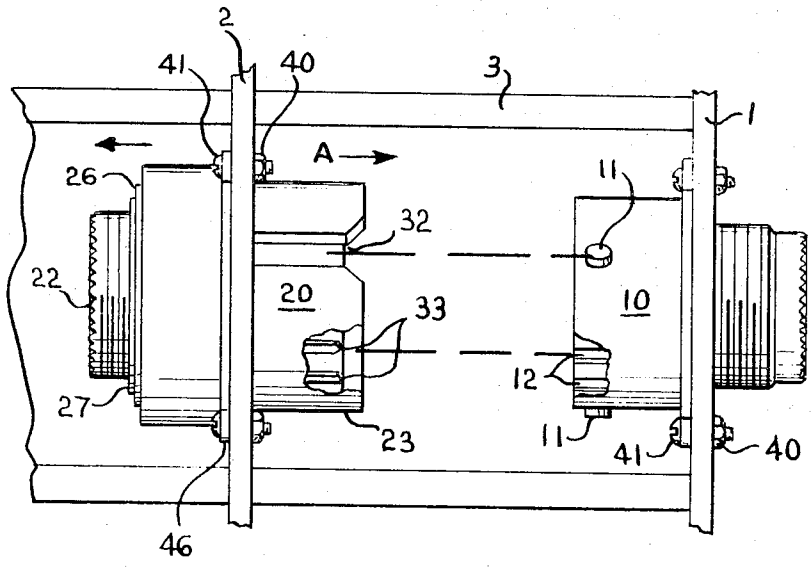
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[57] **ABSTRACT**

A blind mating rack and panel connector assembly in which nonaligned contacts of an unmated plug and receptacle are aligned upon mating by successive engaging cams of the connector assembly. The plug portion of the connector assembly includes a first and second shell that is mounted within the plug housing for radial and axial movement with respect to the plug housing. Upon mating of the plug and receptacle the first shell of the plug has a guide means that interacts with the receptacle to align previously nonaligned contacts. When the plug and receptacle are unmated the shells return to their original position.

32 Claims, 2 Drawing Figures



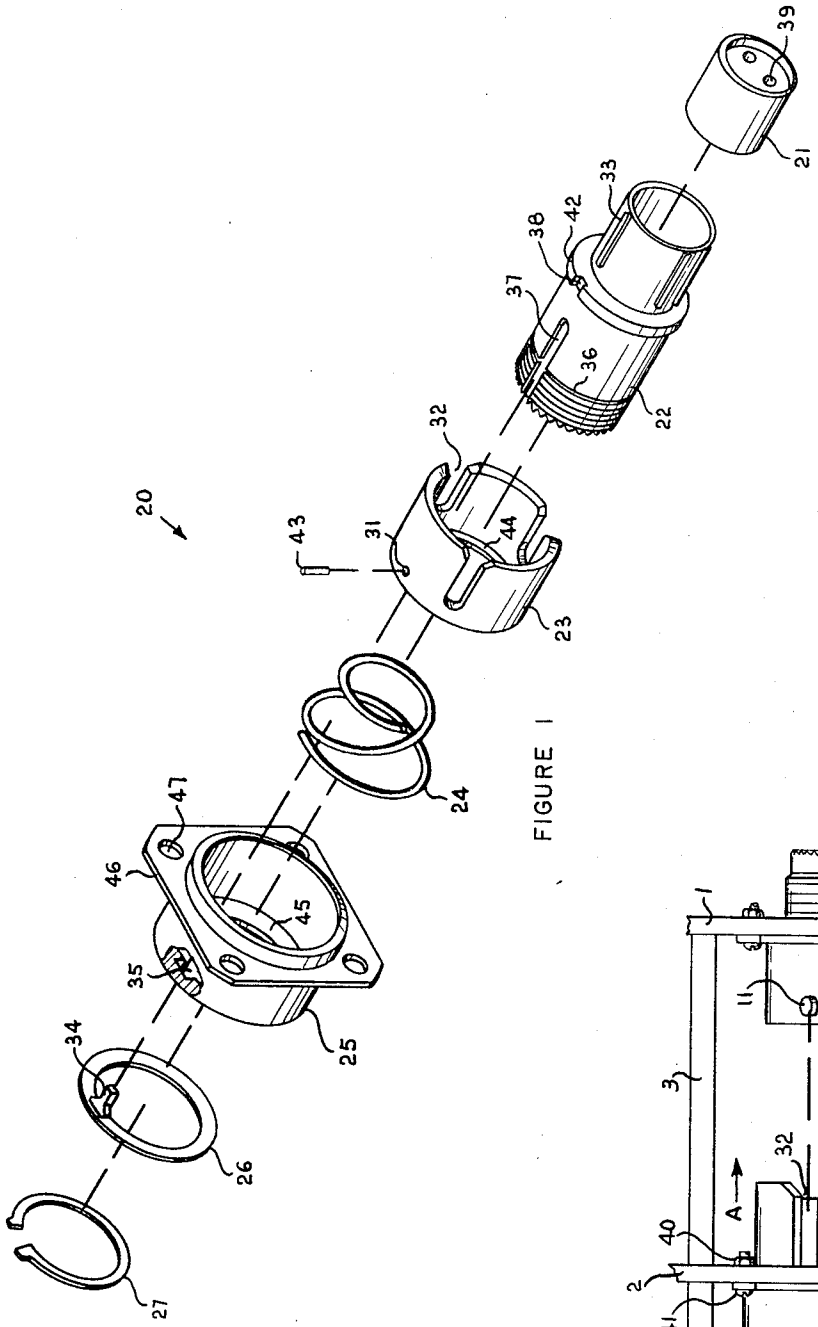


FIGURE 1

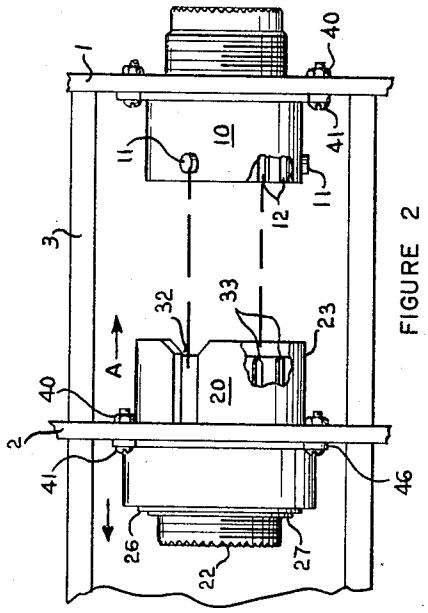


FIGURE 2

RACK AND PANEL CONNECTOR ASSEMBLY

BACKGROUND OF THE INVENTION

This invention relates to a rack and panel connector assembly of the type having a receptacle fixedly mounted on a panel and a plug fixedly mounted on a rack which is slidably mounted for movement to and from the panel to mate and unmate the plug and receptacle. The invention is more particularly related to an improved rack and panel connector assembly that permits blind mating of the plug and receptacle contacts even though the contacts are radially displaced from each other by more than 7°. For purposes of this description radially displaced by 7° means that with respect to a plug and receptacle that have their electrical contacts aligned for mating, if prior to mating the plug or receptacle is rotated on its axis 7°, the contacts are radially displaced from each other by 7° and are not aligned for mating.

Large control systems are generally divided into subsystems that are housed in drawers or racks that are removable for maintenance and/or repair work. Generally, the racks, when in place, form an instrument panel which are interconnected to each other to form the control system. In such a system each rack is connected to the remainder of the control system by a rack and panel connector assembly.

Generally, a rack and panel connector assembly includes a plug which is mounted on the rear portion of a drawer or rack which is slidably mounted upon a track within a cabinet, and a receptacle mounted on the rear panel of the cabinet to engage and mate with the plug when the rack is in place in the cabinet. When the drawer or rack is opened the plug disengages from the receptacle, thereby removing power from the components in the rack so that maintenance and/or repair work may be performed upon the components in the rack without a shock hazard. The separable rack and panel connector assembly also allows the rack to be removed from the cabinet or track without the necessity of disconnecting permanent wire connections and also removes any limitations on how far away from the cabinet the rack may be moved.

At this point it should be noted that what has been described is a blind mating connector assembly which is not connected by hand but is connected together by the mechanical operation of sliding a drawer into place in a cabinet. Obviously, the initial alignment of the plug and receptacle is critical; otherwise, the respective contacts of the plug and receptacle would not mate. Unfortunately, frequent sliding in and out of the drawer or rack tends to radially displace the plug and receptacle contacts from their original position. To compensate for this radial displacement, present rack and panel connector assemblies include alignment means which are capable of aligning the plug and receptacle contacts if they are radially displaced less than 7°. When the plug and receptacle contacts are radially displaced by more than 7°, the plug and receptacle cannot be placed in mating relationship.

SUMMARY OF THE INVENTION

This invention provides a rack and panel connector assembly that is capable of blind mating even though the plug and receptacle contacts are radially displaced from each other by more than 7°.

The invention is a rack and panel blind mating connector assembly characterized by a plug which has two successively operable alignment means associated with a first and second shell mounted for radial movement within the plug housing. The alignment means of the first shell is a plurality of slots therein that cooperate with pins mounted on a standard receptacle to produce a first aligned position and the alignment means of the second shell is a plurality of keys thereon that cooperate with grooves in the standard receptacle to produce a second aligned position which allows the plug contacts to mate with the receptacle contacts upon mating of the plug and receptacle.

In one embodiment of the invention the rack and panel separable connector assembly comprises: a receptacle fixedly mounted on a panel, the receptacle having a plurality of electrical contacts, a plurality of alignment pins and a plurality of alignment grooves; and a plug axially aligned with the receptacle and fixedly mounted on a rack which is slidably mounted for movement to and from the panel to blindly mate and unmate the plug and receptacle, the plug having a housing, a plurality of electrical contacts arranged to mate with the receptacle contacts when the plug and receptacle are mated, an inner shell within the housing having a plurality of longitudinal keys which mate with the alignment grooves of the receptacle to permit mating of the plug and receptacle contacts, and an outer shell connected to the inner shell and mounted for radial movement within the plug housing, the outer shell having alignment means operable to engage the receptacle alignment pins during mating of the plug and receptacle, when the keys and grooves are misaligned, and rotate the plug keys into alignment with the receptacle grooves whereby the plug and receptacle contacts may be mated without rotating the plug housing or receptacle when the plug keys and the receptacle grooves are initially misaligned. The specific embodiment shown herein is capable of blindly mating a rack and panel connector assembly when the plug contacts and receptacle contacts are displaced up to 15° radially from each other.

Accordingly, it is an object of this invention to provide a rack and panel connector assembly which is matable even though the plug contacts and receptacle contacts are radially displaced from each other by as much as 15 degrees.

It is another object of this invention to modify the plug assembly of a standard electrical connector so that the connector may be blind mated when the receptacle contacts are not aligned with said plug contacts.

It is still another object of this invention to provide a rack and panel connector assembly that includes two successively operable guide means for aligning the plug contacts and receptacle contacts upon mating of the plug and receptacle.

It is a further object of this invention to improve the operational capability of a blind mating rack and panel connector assembly.

It is still a further object of this invention to provide recentering of the plug when the connector halves are unmated.

The above and other objects and features of the invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings and claims which form a part of this specification.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded view of a plug for a rack and panel connector assembly that incorporates the principles of this invention.

FIG. 2 illustrates the plug and receptacle of a rack and panel connector assembly that operates according to the principles of this invention.

DETAIL DESCRIPTION OF THE DRAWINGS

Referring now to the drawings, FIG. 1 illustrates an exploded view of a plug 20 which mates with a standard receptacle of a rack and panel connector assembly.

The plug includes an insert 21, a standard plug shell 22, a second plug shell 23, a spring 24, a standard plug housing 25, a keyed ring 26 and a snap ring 27.

The insert 21 includes a plurality of male or female electrical contacts (not shown) mounted in the bores 39. The insert 21 is mounted in a fixed position within the bore of shell 22.

The standard plug shell 22 includes a plurality of alignment keys 33 which mate with grooves in a receptacle (not shown) during mating of the plug and receptacle to align the contacts of the plug with the contacts of the receptacle. The shell 22 includes a shoulder 42 that prevents the first shell 22 from passing completely through the second shell 23. The shoulder 42 includes a keyway 38 for receiving pin 43 which locks together the first shell 22 and second shell 23 so that both shells rotate together, i.e., radial movement of the first shell 22 or the second shell 23 causes a corresponding radial movement of the other shell. First shell 22 includes a groove 36 that receives the lock ring 27 and a keyway 37 that guides the key 34 of keyed ring 26.

The second shell 23 includes a plurality of slots 32 which engage the pins on a receptacle (not shown) to align the keys 33 of the first shell 22 with the grooves in the receptacle (not shown) which in turn align the plug contacts with the receptacle contacts during mating of the plug and receptacle. Second shell 23 includes a hole 31 for receiving the lock pin 43 that locks the second shell 23 with respect to the first shell 22 for rotational movement of the shells. The annular shoulder 44 within the second shell 23 abuts against the shoulder 42 of the first shell 22 to stop forward movement of the second shell 23 when the plug is assembled.

Spring 24 has a diameter of revolution at one end such that the spring contacts the shoulder 44 of the second shell 23 and does not pass through, and a diameter of revolution at the other end such that the spring engages the shoulder 45 of the housing 25. Preferably, the spring is held captive within the housing 25 by action of the lock ring 27 and shells 22 and 23. However, the spring 24 could have one end attached to shoulder 45 within the housing 25 and the other end attached to shoulder 44 of shell 23 so that shell 23 would be biased against radial movement whereby upon removal of a force that radially displaced the second shell 23 with respect to the housing 25, the second shell 23 would return to its original position.

The housing 25 includes a flange 46 and a plurality of mounting holes 47 so that the plug 20 may be mounted in a fixed position. Plug housing 25 includes a shoulder 45 that retains spring 24 in the axial direction and a keyway 35 that receives the key 34 of ring 26.

Ring 26 has an inner diameter slightly larger than the outer diameter of first shell 22 and a key 34 which extends radially past the inner diameter so that when the ring 26 is mounted on the first shell 27, the key 34 travels in the keyway 37.

Snap ring 27 mates with the groove 36 in the first shell 22 to hole the ring 26, housing 25, spring 24, second shell 23 and the first shell 22 in assembled relationship.

When the plug 20 is assembled the spring 24 is held captive between the housing shoulder 45 and the second shell shoulder 44, permitting biased axial movement of the first and second shell with respect to the housing 25 whereby when a force is applied to the front end of the first or second shell 22, 23, said first and second shells travel into the front end of the housing 25, compressing spring 24, and when the force is removed therefrom, the action of the spring 24 returns the first and second shells 22, 23 to their original axial position with respect to the housing 25. In this embodiment radial movement of the first and second shells 22, 23 is prevented by action of key 34 with keyway 35 of the housing 25 until the shells travel a predetermined axial distance into the housing which is equal to the length of the key 34. Once key 34, or a portion thereof, leaves the keyway 35 of the housing 25, shells 22, 23 may be displaced radially with respect to the housing 25. In the event there has been radial displacement of shells 22, 23 with respect to their original position in housing 25, and the compressive force is removed from spring 24 allowing it to force shells 22, 23 to their original axial position, the key 34 cooperates with keyway 35 to return shells 22, 23 to their original radial position with respect to housing 25. In other words, since key 34 is locked in keyway 37 of the first shell 22, when key 34 enters the keyway 35 and returns the ring 26 to its original key position, it also returns shell 22 to its original position.

FIG. 2 illustrates the plug 20 and receptacle 10 of a rack 2 and panel 1 connector assembly that are axially aligned and mounted for sliding movement of the plug 20 to the receptacle 10 along track 3.

The receptacle 10 includes one or more alignment pins 11 and one or more alignement grooves 12, both of which cooperate with the plug 20 grooves 32 and keys 33 to align the plug and receptacle contacts (not shown) upon mating of the receptacle 10 and plug 20. The receptacle 10 is mounted to a panel 1 by nuts and bolts 40 and 41. The panel 1 is the stationary rear portion of a cabinet that contains one or more drawers of instrumentation.

The plug 20 is mounted to a rack 2 by nuts and bolts 40, 41 which fasten the plug housing 25 to the rack 2. The rack 2 is generally the rear portion of a sliding drawer that contains instrumentation (not shown). The rack 2 or drawer is mounted on track 3 so that the drawer containing the instrumentation may be withdrawn from the cabinet (not shown). When the rack 2 is replaced within the cabinet and the drawer 2 is closed, the plug 20 mates with receptacle 10 to interconnect the instrumentation within the drawer to the remaining instrumentation of a control system and/or source of power. When the plug 20 is initially mounted to the rack 2, it is mounted in axial and radial alignment with the receptacle 10. This assures that the electrical contacts of the plug are aligned with the receptacle

contacts so that mating of the plug and receptacle may be accomplished.

The advantages of the invention are not apparent when the receptacle **10** and plug **20** are initially and properly mounted to the rack and panel. However, frequent maintenance and/or repair work on the instrumentation within the drawer requires repeated sliding back and forth of the rack **2** which eventually tends to radially displace the plug contacts (not shown) from their original position with respect to the plug housing **25.** This radial displacement of the plug contacts also serves to misalign the plug contacts with the receptacle contacts (not shown) to the extent that the plug **20** and receptacle **10** are not properly aligned when the connector is unmated. As the plug contacts are displaced radially, so are the grooves **32** and keys **33.** However, although the receptacle and plug contacts are misaligned, this connector assembly will realign them so that the plug and receptacle can be mated.

In the instance where the plug and receptacle contacts are misaligned, moving the rack **2** in the direction of the arrow A will eventually engage pins **11** of the receptacle **10** with grooves **32** of the plug **20.** By action of the pins **11** and grooves **32** the shells **23** and **22** will be radially displaced to a sufficient degree to align keys **33** of the plug **20** with the grooves **12** in the receptacle **10** which will further radially displace the shell **22** to align the plug contacts with the receptacle contacts.

The slots **32** in the second shell **23** cooperate with pins **11** to accomplish a first rough alignment so that the keys **33** may align themselves with the grooves **12** in the receptacle **10,** thereby aligning the plug and receptacle contacts. By utilizing this second shell **23** a standard plug and receptacle can be mated when the contacts of the plug and receptacle are displaced radially more than 7° from each other. Without the second shell **23** and alignment slots **32,** keys **33** would not mate with grooves **12** in the receptacle if the keys **33** were radially displaced therefrom by more than 7°.

While a preferred embodiment of the invention has been disclosed, it will be apparent to those skilled in the art that changes may be made to the invention as set forth in the appended claims, and in some cases, certain features of the invention may be used to advantage without corresponding use of other features. For example, the slots **32** in the shell **23** instead of having a chamfered opening may have angled end portions that extend almost the entire length of the slot **32** to provide a raceway for pin **11.** Further, the key **34** shown in FIG. **1** may be eliminated and replaced with a cam and cam follower and the spring **24** can be fixedly mounted at one end to the shoulder **45** of the housing **25** and at the other end to the shoulder **44** of shell **23** so that the shell **23** will return to its original position after having been radially displaced. Accordingly, it is intended that the illustrative and descriptive materials herein be used to illustrate the principles of the invention and not to limit the scope thereof.

Having described the invention, what is claimed is:

1. In combination with a rack and panel connector assembly of the type having: a receptacle fixedly mounted on a panel, said receptacle having a plurality of electrical contacts, alignment pins and alignment grooves; and a plug axially aligned with said receptacle and fixedly mounted on a rack which is slidably mounted for movement to and from said panel to mate and unmate said plug and receptacle, said plug having a housing, a plurality of electrical contacts arranged to mate with said receptacle contacts when said plug and receptacle are mated, and an inner shell within said housing having a plurality of longitudinal keys which mate with said alignment grooves of said receptacle, when aligned therewith, to permit mating of said plug and receptacle contacts, the improvement comprising:

an outer shell connected to said inner shell and mounted for radial movement within said plug housing, said outer shell having alignment means operable to engage said receptacle alignment pins during mating of said plug and receptacle when said keys and grooves are misaligned, and rotate said plug keys into alignment with said receptacle grooves whereby said plug and receptacle contacts may be mated without rotating said plug housing or receptacle when said plug keys and said receptacle grooves are initially misaligned.

2. The rack and panel connector assembly recited in claim **1** wherein the alignment means of said plug outer shell comprises a plurality of slots arranged in a complementary manner to said receptacle alignment pins.

3. The rack and panel connector assembly as recited in claim **2** wherein said plug includes means for returning said outer shell to its original position with respect to said plug housing when said plug and receptacle are unmated.

4. The rack and panel connector assembly as recited in claim **2** wherein said means for returning said outer shell to its original position includes: a spring mounted around a portion of said inner shell and held captive between said housing and said outer shell whereby depressing said outer shell axially into said housing causes said spring to compress; and cam means to confine radial and axial movement of said outer shell to a predetermined path whereby when said spring returns said outer shell to its original axial position, said cam means returns said outer shell to its original radial position.

5. The rack and panel connector assembly as recited in claim **1** wherein said plug includes means for returning said outer shell to its orignal position with respect to said plug housing when said plug and receptacle are unmated.

6. The rack and panel connector assembly as recited in claim **5** wherein said means for returning said outer shell to its original position includes: a spring mounted around a portion of said inner shell and held captive between said housing and said outer shell whereby depressing said outer shell axially into said housing causes said spring to compress; and cam means to confine radial and axial movement of said outer shell to a predetermined path whereby when said spring returns said outer shell to its original axial position, said cam means returns said outer shell to its original radial position.

7. A plug having a plurality of contacts adapted to mate with a receptacle having a plurality of contacts and thereby connect said plug contacts in predetermined electrical relationship with said receptacle contacts, said plug comprising:

a housing;

an outer shell having means for receiving said receptacle;

means for mounting said outer shell to said plug housing, said mounting means operable to permit axial and radial movement of said outer shell with respect to said housing;

an inner shell connected to said outer shell for radial and axial movement therewith, said inner shell having means for receiving said receptacle;

an insert mounted in said inner shell, said insert having said plug contacts mounted thereto;

said outer shell having first means for guiding said receptacle into a predetermined relationship with said inner shell upon mating of said plug and receptacle; and

said inner shell having second means for guiding said receptacle contacts into alignment with said plug contacts upon mating of said plug and receptacle, whereby the action of said first and second guide means aligns said plug contacts for contact with said receptacle contacts when said plug and receptacle are being mated.

8. The plug as recited in claim **7** including:

biasing means between said housing and said outer shell operable to return said outer shell to its original position when said plug and receptacle are unmated.

9. The plug as recited in claim **8** wherein said biasing means includes a spring mounted around a portion of said inner shell and held captive between said housing and said outer shell whereby depressing said outer shell longitudinally into said housing causes said spring to compress.

10. A plug as recited in claim **7**, including means for preventing the rotation of said outer shell unit said outer shell is depressed into said housing a predetermined distance, said means operable to return said outer shell to its original position when said plug and receptacle are unmated.

11. The plug as recited in claim **10** wherein the means for preventing rotation of said outer shell comprises a key slidably mounted to said inner shell, said key engaged with a keyway in said housing when said outer shell is in its normal position and disengaged from said keyway when said outer shell is depressed a predetermined distance into said housing.

12. The rack and panel connector assembly as recited in claim **8** wherein said plug includes means for returning said outer shell to its original position with respect to said plug housing when said plug and receptacle are unmated.

13. A plug as recited in claim **12**, including means for preventing the rotation of said outer shell until said outer shell is depressed into said housing a predetermined distance, said means operable to return said outer shell to its original position when said plug and receptacle are unmated.

14. The rack and panel connector assembly as recited in claim **9** wherein said plug includes means for returning said outer shell to its original position with respect to said plug housing when said plug and receptacle are unmated.

15. The plug as recited in claim **4** wherein said means for preventing rotation of said outer shell includes a key attached to said inner shell, said key engaged with a keyway in said housing when said spring is not compressed and wherein said key is disengaged from said keyway when said spring is compressed a predetermined distance.

16. A plug and receptacle connector assembly comprising:

a receptacle having a plug receiving portion that includes first and second guide means and an insert mounted within said receptacle, said insert having a plurality of electrical contacts mounted therein, said first guide means comprising a plurality of pins, and said second guide means comprising a plurality of grooves; and

a plug having a housing which is nonrotatably mounted in fixed axial alignment to said receptacle an inner shell slideably mounted in said housing, an outer shell mounted around a portion of said inner shell and slideably mounted in said housing, and an insert mounted within said inner shell of said plug, said insert having a plurality of electrical contacts therein arranged complementary to the contacts located in said receptacle for contact therewith when said plug and receptacle are in mated relationship; said plug including third and fourth guide means, said third guide means comprising a plurality of slots that cooperate with said pins, said fourth guide means comprising a plurality of longitudinal keys that cooperate with said grooves, and said first and third guide means operable upon mating to align in cooperative relationship said second and fourth guide means; said second and fourth guide means thereby operable to align said plug contacts with said receptacle contacts whereby when said plug and receptacle are in mated relationship, said plug and receptacle contacts are in electrical circuit relationship.

17. The connector assembly recited in claim **16** wherein said pins are located on the outside of said plug receiving portion of said receptacle; said grooves are located on the inside of said plug receiving portion of said receptacle; said slots are located in an outer shell of said plug; said keys are located on the outside of an inner shell of said plug; and said pins and slots are arranged to come into cooperative relationship before said keys and grooves when said plug and receptacle are brought into mated relationship.

8. The connector assembly as recited in claim **17** wherein said outer and inner shells are mounted for radial movement relative to said plug housing.

19. The connector assembly as recited in claim **18** including means for returning said shells to their original axial and radial position with respect to said plug housing when said plug and receptacle are unmated.

20. The connector assembly as recited in claim **16** wherein said outer and inner shells are mounted for radial movement relative to said plug housing.

21. The connector assembly as recited in claim **20** including means for returning said shells to their original axial and radial position with respect to said plug housing when said plug and receptacle are unmated.

22. The connector assembly as recited in claim **16** wherein said outer and inner shells are mounted for radial movement relative to said plug housing.

23. The connector assembly as recited in claim **22** including means for preventing radial movement of said shells until said outer shell slides a predetermined distance into said housing.

24. The connector assembly as recited in claim **23** including means for returning said shells to their original axial and radial position with respect to said plug housing when said plug and receptacle are unmated.

25. The connector assembly as recited in claim **22** including means for returning said shells to their original axial and radial position with respect to said plug housing when said plug and receptacle are unmated.

26. The connector assembly as recited in claim 25 including means for retaining said plug and receptacle in mated relationship.

27. The connector assembly as recited in claim 16 including means for returning said shells to their original axial and radial position with respect to said plug housing when said plug and receptacle are unmated.

28. The connector assembly as recited in claim 28 including means for retaining said plug and receptacle in mated relationship.

29. In combination with a rack and panel connector assembly of the type having: a receptacle fixedly mounted on a panel, said receptacle having a plurality of electrical contacts, alignment pins and alignment grooves; a plug having a housing and a plurality of electrical contacts arranged to mate with said receptacle contacts when said plug and receptacle are mated; and means for mounting said plug housing in fixed relationship to said receptacle so that said plug and receptacle are axially aligned for mating and unmating, the improvement comprising:

means for providing for greater than 7° of radial movement of said plug contacts with respect to said plug housing upon mating of said plug and receptacle when said plug contacts and said receptacle contacts are misaligned by greater than 7°.

30. The combination as recited in claim 29 wherein said means for providing for radial movement of said plug contacts comprises:

a first and second shell mounted in said plug housing for radial movement therewith, said first shell having means for radially aligning said first shell with said receptacle alignment grooves upon mating of said plug and receptacle so that said plug and receptacle contacts are aligned for mating and said second shell having means for radially aligning said second shell with said receptacle alignment pins upon mating of said plug and receptacle so that said first shell alignment means is operable with said receptacle grooves to align and mate said plug and receptacle contacts when said plug and receptacle are mated.

31. The rack and panel connector assembly recited in claim 30 including means for returning said first and second shells to their original position when said plug and receptacle are unmated.

32. The rack and panel connector assembly recited in claim 31 wherein said first and second shell are capable of rotating up to 15 degrees in either direction by action of said alignment means of said first and second shell upon mating said plug and receptacle.

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