ZERO INSERTION FORCE CONNECTOR ASSEMBLY

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ABSTRACT

A zero insertion force connector assembly including a plug housing that is movable in a socket housing, each housing having an array of terminals. As the housings are initially moved together, the terminals are not in engagement and zero insertion force is provided. When the housings are subsequently moved toward each other, the terminals are engaged with each other. Movement of the housings is effected by an improved means which include a pair of actuator elements mounted on either side of one housing by an integral hinge and movable into a latched position so that it forces the other housing member to a position whereby the individual pairs of contacts are in a touching relation.

11 Claims, 20 Drawing Figures
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ZERO INSERTION FORCE CONNECTOR ASSEMBLY

BACKGROUND OF THE INVENTION

1. Field of the Invention
The present invention relates to electrical connectors, and more particularly to connector assemblies known as zero insertion force assemblies.

2. Brief Description of the Prior Art
In the use of the conventional electrical terminals, such as widely used pin and socket terminals, a frictional force, known as an insertion force, is encountered when terminals are interconnected. The forces involved are not objectionable when only one or a few pairs of such terminals are interconnected. However, when a large number of interconnections are made in a single operation, for example in the connecting of wiring harnesses or the like, the total insertion force becomes undesirably large.

In order to overcome the problem of excessive insertion forces, so-called zero insertion force connectors have been developed. In the usual arrangement of such connectors, two connector housings are moved with respect to one another. Each housing carries a terminal which is adapted to be adjacent a corresponding terminal carried in the other housing. Initially, the pairs of terminals of the two housings are not in contact with one another so that little or no frictional forces resulting from such engagement need be overcome. When the housings are moved from the initial position to a final position, the terminals of each pair are moved into engagement with one another.

In order to move the housings from the initial position to the final position, there is ordinarily provided some sort of actuating means. One example of a suitable actuating means is disclosed in U.S. application Ser. No. 463,267 which has been assigned to the assignee of the present application. The actuating means of the earlier filed application is in the form of a single hinge strap having a portion which pushes against one of the housings when in a locked position. While this configuration is satisfactory when dealing with relatively small forces, it has been found that this configuration does not offer the positive locking forces necessary over a long period of time when dealing with larger forces generated when a large number of terminals are interconnected. This is due to deformation caused by forces exerted against the actuating member by the two housings and their respective terminals.

SUMMARY OF THE INVENTION

It is therefore the principal object of the present invention to provide a zero insertion force connector assembly having an improved actuating means that will consistently exert a positive locking force over long periods of time.

This object is accomplished by one form of the improved actuating means which provides for a cam surface formed on the first housing facing the second housing, and cam means movable between the cam surface and the second housing from a released position to a latched position whereby the housings are moved from an initial position to a final position, and interengaging means formed on the cam surface and cam means for holding the cam means in the latched position.

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BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a zero insertion force connector assembly constructed in accordance with the present invention;

FIG. 2 is a top view of the assembly of FIG. 1 with the connector housings in an initial position;

FIG. 3 is a top view of the assembly of FIG. 1 with the connector housings in a final position;

FIG. 4 is a side view, partially broken away, of the assembly of FIG. 1 with the housings in an initial position;

FIG. 5 is a fragmentary side view similar to part of FIG. 4 in illustrating the housings in their final position;

FIG. 6 is a front view of the plug connector housing of the assembly of FIG. 1;

FIG. 7 is an enlarged detail view of one portion of FIG. 6 showing one terminal receiving cavity and contact chamber;

FIG. 8 is a sectional view taken generally along the line 8—8 of FIG. 7;

FIG. 9 is a sectional view taken generally along the line 9—9 of FIG. 7;

FIG. 10 is a back view of the socket connector housing of the assembly of FIG. 1;

FIG. 11 is an enlarged detail view showing one terminal receiving cavity of the housing of FIG. 10, viewed from the front;

FIG. 12 is a sectional view taken generally along the line 12—12 of FIG. 11;

FIG. 13 is an elevational view of one terminal of the assembly of FIG. 1, illustrating the terminal before it is engaged with a conductor;

FIG. 14 is a sectional view taken generally along the line 14—14 of FIG. 13;

FIG. 15 is an end view of the terminal of FIG. 13;

FIG. 16 is a view similar to FIG. 12 illustrating a terminal mounted in a terminal receiving cavity of the socket connector housing;

FIG. 17 is a view similar to FIG. 8 illustrating a terminal mounted in a terminal receiving cavity of the plug connector housing;

FIG. 18 is a fragmentary sectional view taken generally along the line 18—18 of FIG. 17 and showing two contacts of a terminal pair when the housings are in the initial position;

FIG. 19 is a view similar to FIG. 18 showing the contacts when the housings are transversely moved partly to the final position; and

FIG. 20 is a view similar to FIG. 18 and 19 showing the contacts when the housings are in the final position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. 1-5 in greater detail, the zero insertion force connector assembly of the present invention, generally designated 20, is seen to generally include a pair of connector housings 22 and 24. In the illustrated embodiment of the invention, the housings 22 and 24 comprise respectively a plug housing and a socket housing. It should be understood that other housing configurations could be provided, and in addition one or both of the housings may be provided with conventional panel mounting structure.

Each of the housings 22 and 24 is provided with a plurality of terminals 26. Although each of the terminals used in the assembly 20 is identical with the others, to facilitate an understanding of the invention the des-
ignation 26P is used to designate a terminal when mounted in the plug housing 22, and the designation 26S is used to designate a terminal when mounted in a socket housing 24. The assembly 20 serves to provide a releasable electrical connection between the group of electrical conductors 28 connected to the terminals 26P of housing 22 and a second group of electrical conductors 30 connected to the terminals 26S of the housing 24.

Referring now to FIGS. 13-15, each terminal 26 is formed, as for example by a sequence of press operations, from conductive sheet metal material such as a brass or the like. Each terminal 26 includes an intermediate base portion 32 extending between a conductor engaging portion 34 and a flat blade contact portion 36. In the illustrated arrangement, the conductors 28 and 30 comprise insulation clad wire conductors. Consequently, the conductor engaging portion 34 of each terminal 26 includes wire crimp structure in the form of a pair of alternate crimping flanges 38 adapted to be cramped against a conductor wire and a pair of insulation crimping flanges 40 adapted to be cramped against the insulation of a wire. It should be understood that the present invention may be applied to connectors used with conductors other than insulation clad wires, and the conductor engaging portions 34 may take other forms, such as, by way of example, solder tails, wire wrap posts, etc.

In order to assist in guiding and retaining each terminal 26 in position in the housings 22 or 24 after connection to a wire, the base portion 32 of the terminal is provided with a pair of wing members 42 on its opposite sides and with a locking tank 44 struck from an intermediate region of the base 32, preferably the sides and end of the blade contact portion 36 are coined in order to provide for smooth insertion of the terminal 26 into its housing and to provide for smooth engagement of the blade contacts 36 with one another.

Proceeding now to a more detailed description of the plug and socket housings 22 and 24, the housings may be formed as by molding from a suitable plastic material having electrical insulating properties. In the preferred embodiment, the plug housing 22 and the socket housing 24 are each adapted to receive 36 terminals 26 arranged in 4 rows of 9 each. It should be understood that more or fewer terminals could be provided in any type of array. The housings 22 and 24 are each provided with an array of cavities 48, one for receiving each terminal 26. Although the cavities of the plug 22 and socket 24 are similar, the reference 48P is used to designate a cavity socket 24.

A cavity 48S of the socket housing 24 is shown in FIGS. 11 and 12, and a cavity 48P of the plug housing 22 is shown in FIGS. 7-9. Each cavity includes an enlarged entrance area 50 facing the rear of the respective housing through which a terminal 26 with a conductor attached is inserted. The individual entrance areas 50 of the various cavities 48 are separated in both housings 22 and 24 by a honeycomb wall structure 52 serving to prevent inadvertent short circuiting between the conductor engaging portions 34 of adjacent terminals 26.

In order to capture a terminal 26 within the cavity 48, the cavities are provided with a neck portion of relatively small cross sectional area defined between sloping guide surfaces 54 facing toward the entrance area 50 and a pair of opposed shoulders 56. Commencing adjacent the sloped surface 54, a pair of opposed guide slots 58 are provided and a stop surface 60 is disposed within each of the slots 58. When a terminal 26 is inserted into the cavity 48 as shown in FIGS. 16 and 17, the blade contact portion is guided into the slots by the sloped surfaces 54. As the terminal is further inserted, the wing members 42 also enter the slots 58. The locking tang 44 is resiliently compressed toward the base 32 and moves through the reduced area neck portion of the cavity. When the tang clears the shoulders 56, the tang moves outwardly to engage one shoulder 56 and prevent inadvertent withdrawal of the terminal. Over insertion is prevented by engagement of the leading edges of wing members 42 with the shoulders 60. The terminal may be inserted in either of two positions offset one hundred eighty degrees from each other. This serves to facilitate the assembly of the connector.

Upon insertion of a terminal 26 into a cavity 48, the base 32 of the terminal is captured and held in position between the shoulders 56 and 60. The blade contact portion 36 extends outwardly from the cavity 48 and is supported by the cavity structure in the nature of a projecting cantilever beam or spring.

The socket housing 24 includes a front surface 62 onto which the cavities 48S directly open (FIGS. 11 and 17). Thus, in the case of the socket housing 24, the blade contacts 36 of the terminals 26S extend forwardly from the surface 62.

With reference to the plug housing 22, this situation is somewhat different. As can best be seen in FIGS. 8, 9 and 17, there is provided a contact chamber 64 at the forward end of each cavity 48P. The individual contact chambers 64 are separated from one another by means of a honeycomb-like cord wall structure 66. As appears in FIG. 17, in profile each of the contact chambers 64 is somewhat in the shape of a modified parallelogram. The front surface of the plug housing 22 is defined by a forward wall 68 (FIGS. 6-9 and 17) onto which each of the contact chambers 64 opens.

In accordance with the invention, there is provided structure for guiding the housings 22 and 24 relative to one another as they are joined together in face-to-face relationship. More specifically, the plug housing 24 is provided with a series of projections 70 extending to the sides of the housing from adjacent the front surface 62. The socket 24 is provided with two side walls 72 and two end walls 73 surrounding the periphery of the forward wall 62 of the socket. The walls 72 and 73 serve to protect the blade contents 36 extending from the wall 62 prior to joining of the housings 22 and 24 and also to receive the plug housing 22. In order to guide the housing relative to one another, the side walls 72 are provided with a group of inwardly opening slots or grooves 74 located to receive the guide projections 70 of the plug housing 22.

Initially, as the housings 22 and 24 are moved toward one another, one of the projections 70 is received into each of the grooves 74. Preferably, the projection 70 and groove 74 are located at irregular positions at the edges of the housings in order to provide an indexing function by insuring that the housings can be joined only when in the proper orientation.

The path of relative movement between the housings 22 and 24 is fixed by the shape of the groove 74. As can be seen in FIGS. 4 and 5, each groove 74 is generally L-shaped. Thus, as the housings are first moved together, they can only move in a first vertical direction.
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toward one another as the projections move along the upright leg of the L. The two housings come fully into engagement with each other in an initial position wherein the forward wall 68 of the plug housing 22 is substantially in engagement with the front surface 62 of the socket housing 24. In this position, each guide projection 70 reaches the base portion of the corresponding L-shaped groove 74. It is now possible for the two housings 22 and 24 to be moved transversely relative to one another with the projections 70 moving along the base of the L.

As the housings 22 and 24 are moved transversely at one another, the blade contact portions 36 of each set of terminals 26P and 26S are moved into electrical engagement. Referring now to FIG. 18, it can be seen that when the housings are initially joined, and prior to being moved transversely, the blade contacts 36 of each set of terminals are spaced from one another within the corresponding contact chamber 64. The blade contact portions of each pair include overlapping end segments which overlay one another. The blade contact portions 36 are parallel with one another, and are inclined at an angle relative to the direction of transverse movement of the housings 22 and 24.

As noted above, the chamber 64 is somewhat in the shape of a parallelogram in cross section and, for the most part, the blade contact portions 36 are unsupported as they move into engagement with one another. However, there is provided a support shoulder 78 located behind the back surface of the blade contact 36 associated with the terminal 26P. This support shoulder 78 supports the blade contact 36 only adjacent one edge of the blade, the majority of the width of the blade being unsupported. The supported edge is that which is furthest from the other blade contact 36 of the socket housing terminal 26S.

As the two housings are moved transversely from their initial position of FIG. 18 toward the final position of FIG. 20, the two blade contact portions 36 move into engagement with one another as shown in FIG. 19. Relative to the contact chamber 64, the blade contact 36 of the terminal 26S moves toward the support shoulder 78 and toward the other blade contact 36. After engagement of the two contacts 36, some additional transverse housing movement takes place. During this additional movement, both terminals, in engagement with one another, twist or pivot about the support shoulder 78. Thus, the support shoulder 78 acts in the nature of a fulcrum or pivot. Due to this twisting or torsional movement and to the resiliency of the metal blade contacts 36, a highly desirable reliable electrical contact action takes place. Moreover, the need for exacting tolerances is avoided since this arrangement provides for a degree of overtravel.

Each of the several blade contacts 36 is disposed at a 45° angle relative to the direction of transverse housing movement. In light of the fact that the assembly includes a large number of interconnections, it is desirable to normalize or cancel out those forces resulting from engagement of the contacts which are not in line with the direction of transverse housing movement in order to avoid a tendency of the housings to bind against one another during transverse movement. For this reason, two of the four rows of contacts are located offset 90° from the other two rows. (FIGS. 6 and 10).

In accordance with the present invention, there is provided a novel actuating means for bringing about transverse movement of the housings 22 and 24 relative to one another. More specifically, and referring now to FIGS. 1-5 and 10, the improved actuating means is seen to generally include two actuator elements, generally designated 80, formed on the outside of each side wall 72 of the socket housing 24. Each actuator element 80 is mounted for pivotal movement by means of an integral hinge portion 82 of reduced cross sectional area. Each actuator element 80 is movable from a released or unlocked position illustrated in FIGS. 2, 4 and 10 to a latched or locked position illustrated in FIGS. 1 and 5.

Each actuator element 80 is provided with an arm portion 84 extending from the hinge portion 82. A wedge shaped cam portion 86 extends generally perpendicular and inwardly from the end of the arm portion 84. The cam portion 86 of each actuator element 80 is adapted to be received in through a respective aperture 90 formed in each of the side walls 72 of the socket housing 24.

Two cam surfaces 92 are formed on the interior of one of the end walls 73 of socket housing 24. Cam surfaces 92 face and are spaced from an end wall 96 of the plug housing 22. Each cam surface 92 is provided with a protrusion 98 which is adapted to be snap-fitted into a recess 100 formed in each of the respective cam portions 86 of each actuator element 80.

Looking at FIGS. 2 and 3, the operation of the actuating means is demonstrated as the plug housing 22 is moved from its initial position (FIG. 2) to its final position (FIG. 3). As each actuator element 80 is moved toward its latched or locked position, each cam portion 86 enters its respective aperture 90 and simultaneously engages its respective cam surface 92 and the end wall 96 of the plug housing 22. Further insertion of the cam portion 86 of each actuator element 80 causes the plug housing 22 to move in the direction indicated by arrow A in FIG. 2 relative to the socket housing 24. This occurs because of the contour of the cam surfaces 92. When the actuator elements 80 reach their fully latched or locked position, protrusion 98 is received in a recess 100 in a snap-fit fashion to lock the respective actuator or element 80 in the latched position.

The L-shaped configuration of the grooves 74 provide a bayonet-like locking action. As long as the actuator elements 80 are latched, the two housing 22 and 24 cannot be separated by pulling them apart. Should the plug housing 22 not be fully seated within the socket housing 24, then each actuator element cannot be closed, and an indication is provided that the housings have not been properly assembled. Due to the integral hinging of each actuator element 80 on the side wall 72, the arm portion 84 acts as a lever and provides a mechanical advantage in effecting transverse movement of the housings 22 and 24 relative to one another.

As the housings 22 and 24 are moved to their initial position, the blade portion 46 of each socket housing terminal 26S is received within one of the contact chambers 64 adjacent to but spaced from one of the blade portions 36 of one plug housing terminal 26P. Since the terminals 26P and 26S do not contact one another at this time, zero insertion force is provided. Each contact set is then closed as housings 22 and 24 are moved transversely of one another. The wall structure 66 surrounding each contact chamber serves to isolate each contact pair from its neighbors.
The configuration of the actuating means as described above is such that deformation of the actuator element 80 or unlocking thereof will not occur even after relatively long periods of time. This is due in large part to the fact that the force exerted by the plug housing 22 is against a relatively thick cam portion 86. Because of the interengagement of the protrusion 98 with the recess 100, this force will not cause the actuator element 80 to pop out into an unlocked or released position. On the other hand, it is still possible to manually release or unlock each actuator element 80 when desired.

The actuating means of the present invention can be used in any socket and plug assembly of the type described regardless of the specific terminal or contact arrangement involved. The same positive locking feature will be effective in any configuration.

We claim:

1. A zero insertion force connector assembly including a first connector housing, a second connector housing mounted for movement relative to said first housing between an initial position and a final position, a plurality of pairs of terminals each pair including one terminal supported by the first housing and the other terminal supported by the second housing, the terminals of each pair being spaced apart when said housings are in the initial position and moving into engagement with each other when said housings are moved to the final position, and actuating means associated between said housings for moving said second housing from the initial position to the final position, the improvement in said actuating means comprising:
   a cam surface formed on the first housing facing the second housing;
   cam means movable between said cam surface and second housing from a released position to a latched position, whereby said second housing is moved from the initial position to the final position; and
   interengaging means formed on said cam surface and cam means for holding said cam means in the latched position.

2. The assembly of claim 1 wherein said cam means is mounted at the end of an arm movably mounted on the first housing, movement of the arm causing said cam means to move from its released position to its latched position.

3. The assembly of claim 1 wherein said cam means is generally wedge shaped and said cam surface complements said cam means.

4. The assembly of claim 1 wherein said interengaging means includes a protrusion formed on said cam surface and a recess formed on said cam means adapted to receive said protrusion when said cam means is in its latched position.

5. A zero insertion force connector assembly including a first connector housing, a second connector housing mounted for movement relative to said first housing between an initial position and a final position, a plurality of pairs of terminals each pair including one terminal supported by the first housing and the other terminal supported by the second housing, the terminals of each pair being spaced apart when said housings are in the initial position and moving into engagement with each other when said housings are moved to the final position, and actuating means associated between said housings for moving said second housing from the initial position to the final position, the improvement in said actuating means comprising:
   a pair of cam surfaces formed on the first housing facing the second housing;
   a pair of cam means, each associated with one of the cam surfaces and movable in opposite directions between the respective cam surfaces and the second housing from a released position to a latched position, whereby said second housing is moved from the initial position to the final position; and
   interengaging means formed on each cam surface and cam means for holding each cam means in the latched position.

6. The assembly of claim 5 wherein each cam means is mounted at the end of an arm movably mounted on the first housing, movement of the arm causing said cam means to move from its released position to its latched position.

7. The assembly of claim 5 wherein each cam means is generally wedge shaped and said cam surface complements said cam means.

8. The assembly of claim 5 wherein each interengaging means includes a protrusion formed on each cam surface and a recess formed on each cam means adapted to receive said protrusions when said cam means is in its latched position.

9. A zero insertion force connector assembly including a first connector housing, a second connector housing mounted for movement relative to said first housing between an initial position and a final position, a plurality of pairs of terminals each pair including one terminal supported by the first housing and the other terminal supported by the second housing, the terminals of each pair being spaced apart when said housings are in the initial position and moving into engagement with each other when said housings are moved to the final position, and actuating means associated between said housings for moving said second housing from the initial position to the final position, the improvement in said actuating means comprising:
   said second housing being received and reciprocally movable within said first housing between said initial and final positions;
   said first housing including an interior defined by side walls and end walls, a pair of cam surfaces formed at one end of the interior of the first housing extending from an end wall and facing and spaced from said second housing, a pair of apertures formed in opposing side walls at opposite ends of the space between the cam surfaces and the second housing, two actuating elements mounted on the outside of the first housing side walls, one near each aperture, each actuating member including an arm pivotally mounted on the side wall having a cam portion on the free end thereof adapted to be received through the aperture into the space between the cam surface and the second housing and is movable in said space from a released position to a latched position when said arm is pivoted whereby said second housing is moved away from said cam surfaces from the initial position to the final position, said first housing further including interengaging means formed on each cam surface and cam portion for holding each actuator element in the latched position.
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10. The assembly of claim 9 wherein each cam portion is generally wedge shaped and said cam surface compliments said cam portion.

11. The assembly of claim 9 wherein each interengaging means includes a protrusion formed on each cam and a recess formed on each cam portion adapted to receive said protrusion when said cam portion is in its latched position.

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