

☒ Description : paged ... 1 to paged ... 14
☒ Claim(s) : paged ... 95-212 SG 17
☒ Drawing(s) : paged ... 111 to paged ... 111
☒ Abstract : paged ... 18 to paged ...

SPECIFIC

ZERO INSERTION FORCE ELECTRICAL CONNECTOR FOR FLAT CABLE

Field of the Invention

This invention generally relates to the art of electrical connectors and, particularly, to electrical connectors for terminating flat cables, such as a flat flexible cables, without requiring any insertion force.

Background of the Invention

There are a wide variety of zero insertion force electrical connectors particularly adapted for terminating flat cables, such as flexible flat cables. These electrical connectors conventionally use actuators to push the flexible flat cables, flexible printed circuit boards or the like against resilient contacts or terminals which are mounted in the connector housings.

Heretofore, the actuators have been designed to be pushed in and pulled out of the connector housings. Such designs require the application of insertion forces to the flat cables. In addition, such designs have inevitably resulted in an increase in the overall size of the connectors.

Consequently, some zero insertion force electrical connectors for flat cables have been designed with actuators which are pivotable between first, open positions allowing free insertion of the cables into the connector housings, and second, closed positions for clamping the flat cables against the terminals. In some such connectors, lock means are provided to hold the actuators in locked condition relative to the connector housing.

The present invention is directed to a new and improved zero insertion force electrical connector for flat cables wherein the actuator is rotatably mounted on the connector housing by a floating-pivot means and includes an



improved locking or latching means to hold the actuator in its terminating position, while still allowing the actuator to rotate to an open position generally perpendicular to the flat cable to allow for visual inspection of the engagement of the cable and the terminals.

Summary of the Invention

An object, therefore, of the invention is to provide a new and improved zero insertion force electrical connector for flat electrical cable, of the character described.

In the exemplary embodiment of the invention, the zero insertion force electrical connector includes a dielectric housing mounting a plurality of conductive terminals. The housing has a front end adapted for receiving the flat cable in engagement with the terminals, a rear end and a opposite sides. An actuator is mounted to the housing for rotational and translational movement between a first position allowing free insertion of the flat cable into engagement with the terminals and a second position clamping the cable against the terminals. Complementary interengaging mounting means are provided between the housing and the actuator at opposite sides of the housing intermediate the front and rear ends thereof. Complementary interengaging stop means are provided between the housing and the actuator near the rear end of the housing for limiting rotation of the actuator relative to the housing in a first direction. Complementary interengaging latch means are provided between the housing and the actuator near the front end of the housing for preventing rotation of the actuator relative to the housing in a second direction opposite said first direction.

In at least one embodiment of the invention, the actuator, in its first position, is disposed generally perpendicular to the plane of the flat cable to allow visual inspection of the engagement of the cable and the terminals. The complementary interengaging stop means are



adapted to stop rotation of the actuator relative to the housing beyond its second position. The complementary interengaging latch means are adapted to prevent rotation of the actuator relative to the housing from its second position back to its first position.

As disclosed herein, means are provided between the housing and the actuator for providing generally linear or sliding movement of the actuator relative to the housing from the second position to a third, final position. The stop means and the latch means become operative automatically when the actuator moves to its third, final position.

A pair of mounting arms are provided at opposite sides of the actuator. The arms have the mounting means and the stop means thereon. The arms are generally J-shaped, with the mounting means being on the leg of the J-shape, and the stop means being on the distal end of the J-shape. In one embodiment of the invention, a pair of latch arms also are provided at opposite sides of the actuator. The latch arms are generally L-shaped and have the latch means thereon.

Finally, complementary interengaging support means are provided between the housing and the actuator at a rear end of the actuator intermediate opposite sides thereof to prevent bending of the actuator.

Other objects, features and advantages of the invention will be apparent from the following detailed description taken in connection with the accompanying drawings.



Brief Description of the Drawings

The features of this invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with its objects and the advantages thereof, may be best understood by reference to the following description taken in conjunction with the accompanying drawings, in which like reference numerals identify like elements in the figures and in which:

FIGURE 1(a) is a top plan view of a first embodiment of a zero insertion force electrical connector according to a first embodiment of the invention;

FIGURE 1(b) is a front elevational view of the electrical connector;

FIGURE 2(a) is a front elevational view of the dielectric housing of the connector with the actuator removed;

FIGURE 2(b) is a side elevational view of the connector;

FIGURE 3(a) is a vertical section taken generally along line A-A in Figure 1(b);

FIGURE 3(b) is a vertical section taken generally along line B-B in Figure 1(b);

FIGURE 4 is a side elevational view of the dielectric housing of the connector;

FIGURE 5(a) is a rear elevational view of the actuator;

FIGURE 5(b) is a top plan view of the actuator;

FIGURE 5(c) is a front elevational view of the actuator;

FIGURE 6(a) is a side elevational view of the actuator;

FIGURE 6(b) is a vertical sectional view through the actuator;

FIGURES 7(a) - 7(g) are sequential views of movement of the actuator relative to the housing from the first, open position of the actuator allowing insertion of



the flat cable, to the final locked position of the actuator relative to the housing;

5 FIGURE 8 is a vertical section through a zero insertion force electrical connector according to a modified embodiment of the invention;

FIGURE 9 is a side elevational view of a second embodiment of the invention, similar to the side elevational view of the first embodiment shown in Figure 2(b);

10 FIGURE 10 is a front elevational view of the connector of the second embodiment;

FIGURE 11 is a top plan view of the connector of the second embodiment;

15 FIGURES 12 and 13 are fragmented plan views of the complementary stop means between the actuator and the housing;

FIGURE 14 is a vertical sectional view of the second embodiment similar to the vertical sectional view 3(b) of the first embodiment;

20 FIGURES 15 and 16 are sequential views illustrating the position of the actuator relative to the housing in moving the actuator upwardly to allow insertion of a flat cable;

25 FIGURE 17 is a vertical section through the connector, showing a flat cable having been inserted into the connector, with the actuator elevated; and

FIGURES 18 and 19 are sequential views showing movement of the actuator downwardly after the flat cable has been inserted.



Detailed Description of the Preferred Embodiments

Referring to the drawings in greater detail, and first to Figures 1(a), 1(b) and 2(a), a zero insertion force electrical connector according to a first embodiment of the invention, includes a dielectric housing, generally designated 1, a plurality of terminals, generally designated 2, and an actuator, generally designated 3, rotatably mounted on dielectric housing 1.

As shown in Figures 3(a) and 3(b), each terminal 2 includes a stem 4, a resilient contact 5 integral with an upper end of the stem and a tail 6 integral with a lower end of the stem. The tail has a spike-like projection or barb 7 formed thereon. Each terminal 2 is mounted in dielectric housing 1 with its spike-like projection 7 embedded in the dielectric material of the housing to prevent the terminal from slipping back out of the housing. It can be seen that the terminals are alternately mounted to the front and rear ends of the dielectric housing.

Specifically, terminals 2 on a front longitudinal end 1(a) of the housing are arranged alternately with the terminals 2 on a rear longitudinal end 1(b) of the housing. In this manner, the resilient contacts 5 of the terminals are arranged alternately at regular intervals projecting upwardly of a top surface 1(c) of the dielectric housing.

Referring to Figure 4 in conjunction with Figures 1(a) - 2(b), each lateral side 8a and 8b of dielectric housing 1 has a step-like configuration as viewed from front-to-rear of the longitudinal sides. Specifically, a first or rear lateral side section 9, a second or intermediate lateral side section 10 and a third or front lateral side section 11 are ranged to progressively step outwardly of the housing in the longitudinal direction. Stated differently, the longitudinal distance between front lateral side sections 11 at opposite ends of the housing is greater than the distance between the second or intermediate lateral side sections 10 at opposite ends of the housing which, in turn, is greater than the distance



between the rear side sections 9 at opposite ends of the housing.

Still referring to Figure 4, the first lateral side sections 9 of the dielectric housing is higher than the level at which terminals 2 are arranged as can be seen in comparing Figures 3(a) and 3(b). Each rear lateral side section 9 has an extension 12 extending outwardly from its upper corner so that the outside surface of extension 12 is flush with the surface of front lateral side section 11. In addition, each rear lateral side section 9 has a projection 13 forwardly of extension 12 and projects outwardly beyond intermediate lateral side section 10 but not quite as far as front lateral side section 11.

Intermediate lateral side section 10 at each opposite end of dielectric housing 1 has a rectangular recess 14 opening at the top thereof as shown clearly in Figure 4. In addition, each lateral side section 10 has a step extension 15 formed at the lower part thereof projecting into lateral side section 9, again as clearly shown in Figure 4.

Front lateral side section 11 is as high as rear lateral side section 9, and it has an inner extension 16 (see Fig. 1(b)) formed at its top, and a lower extension 16b extending from the rear of the front lateral side section, through second lateral side section 10 and into rear lateral side section 9.

Lastly, dielectric housing 1 includes a longitudinal bridge 18 (see Fig. 2(a)) extending between the opposite extensions 12 of lateral side sections 9 at opposite ends of the housing. Rectangular through holes 19 are formed beneath bridge 18 and between a plurality of partitions 18a. The through holes are aligned with terminals 2, with the through holes being at rear end 1b of the dielectric housing.

Now, the structure of actuator 3 will be described. Referring to Figure 5(a) - 6(b), actuator 3 is stamped and formed of stainless steel material coated with



an insulating material. The actuator is formed with a U-shaped major part or body 21 which has a lower leg plate 21a and an upper leg plate 21b. The lower leg plate 21a defines an abutment plane, generally designated 22 in
5 Figures 6(a) and 6(b). This abutment plane is adapted to define a lower surface for pushing a flat-type cable, including a flat flexible cable or a flexible printed circuit board against resilient contacts 5 of terminals 2. Lower leg plate 21a also has a plurality of rearwardly
10 extending projections or teeth 23 which are positionable into through holes 19 beneath longitudinal bridge 18 of dielectric housing 1. Lastly, lower leg plate 21a has laterally outwardly extending projections 24 formed at its lateral opposite sides.

15 Upper leg plate 21b of the U-shaped major part or body 21 is somewhat shorter than lower leg plate 21a. The upper leg plate has a notched section 25 at its rearward edge as seen in Figure 5(b), along with laterally outwardly projecting shoulder extensions 26 at its opposite lateral
20 sides. These shoulder extensions 26 have arms 27 extending rearwardly thereof as clearly seen in Figure 5(b).

U-shaped body 21, including upper and lower leg plates 21a and 21b, respectively, is as wide as the longitudinal arrangement of terminals 2 in dielectric
25 housing 1. The longitudinal distance between arm extensions 27 at opposite sides of body 21 is equal to the longitudinal distance between second lateral side sections 10 at opposite ends of the dielectric housing, thus permitting sandwiching of opposite lateral sides 8a and 8b
30 of the dielectric housing therebetween.

Each arm extension 27 is generally J-shaped as shown in Figures 6(a) and 6(b). Each arm extension has an inside projection or round detent 28 formed intermediate the ends of the leg of the J-shape and an inside
35 rectangular projection 29 formed on the free or distal end of the J-shape.



Referring to Figures 7(a) - 7(g), and particularly Figure 7(a), actuator 3 is attached to dielectric housing 1 having terminals 2 mounted thereon, whereby the opposite J-shaped arm extensions 27 of the actuator sandwich second lateral side sections 10 at lateral opposite side 8a and 8b of the dielectric housing. In order to insert a flat cable, including a flat flexible cable or a flexible printed circuit board 30 into the connector, actuator 3 is rotated in the direction of arrow 31 (Fig. 7(c)) to a first position extending upwardly from the dielectric housing generally perpendicular or 90° to surface 1c of the housing. In its first position, actuator 3 exposes contacts 5 of the parallel-arranged terminals 2 which project upwardly of surface 1c of the dielectric housing.

The upper position of actuator 3 is determined by the engagement of projections 13 of rear lateral side sections 9 and arm extensions 27 of the actuator. This permits rotation of the actuator to its upwardly projecting first position which "opens" the connector for insertion of the flat cable.

When actuator 3 is in its first or open position as shown in Figures 7(c) and 7(d), inside projections 29 at the distal ends of arm extensions 27 abut on the step projections 15 (Fig. 4) of second lateral side sections 10 at opposite ends of the housing, thereby stopping further rotation of the actuator. In this position, rearwardly extending projections or teeth 23 (Fig. 5(b)) at the rear longitudinal edge of actuator 3 abut on the top surface of longitudinal bridge 18 of dielectric housing 1.

With actuator 3 in its first or open position, exposing resilient contacts 5 of terminals 2, the flat cable 30 is placed on the parallel arrangement of resilient terminal contacts 5. Due to the full exposure of the terminal contacts, the registration or alignment between the conductors of the flat cable and the resilient terminal contacts can be confirmed by visual inspection, and



inspection of the integrity of the terminal contacts also can be easily made because of the full open position of the actuator.

5 After flat cable 30 is positioned on terminal
contacts 5 with zero insertion force, actuator 3 is rotated
in the direction of arrow 32 (Figs. 7(d) and 7(e)) until
round projections 28 at the inside of arm extensions 27
fall into recesses 14 (Fig. 4) of second lateral side
sections 10 at opposite sides 8(a) and 8(b) of the
10 dielectric housing. The actuator is rotated further until
the actuator is in a second or closed position as shown in
Figure 7(f). This rotational movement of the actuator
pushes the flat cable into engagement with resilient
contacts 5 of terminals 2 and pushes the flat cable into
15 engagement with surface 1c of dielectric housing 1, biasing
the resilient terminal contacts 5 downwardly.

Rotation of actuator 3 in the direction of arrow
32 is permitted by cooperation of the inner edges 27a of J-
shaped arm extensions 27 with projections 13 of front
20 lateral side sections 9 at opposite sides 8a and 8b of
dielectric housing 1. In the second or closed position of
actuator 3, abutment surface 22 of lower leg plate 21a of
the U-shaped major part or body 21 of the actuator pushes
flat cable 30 against resilient terminal contacts 5, thus
25 making electrical connections between the cable and the
contacts.

Finally, as seen in Figure 7(f), actuator 3 is
moved linearly in the direction of arrow 33 to a final or
third, locked position as shown in Figure 7(g). This
30 linear movement is permitted by cooperation of projections
13 and the inner edges 27a of J-shaped arm extensions 27.
This linear movement also is permitted as round projections
28 at the inside of arm extensions 27 fall out of recesses
14 of the dielectric housing. In other words, the
35 interengagement of the round projections in the recesses no
longer exists, and the actuator can be moved linearly to
its final position. In the third or final position of



actuator 3 as shown in Figure 7(g), top flat surfaces 29a of projections 29 on arm extensions 27 of actuator 3 abut bottom flat surfaces 12a of opposite lateral extensions 12 of front lateral side sections 9 at opposite ends of dielectric housing 1. This defines complementary interengaging stop means between the dielectric housing and the actuator near the rear end of the housing for limiting rotation of the actuator relative to the housing in a first direction defined by arrows 32.

At the same time that actuator 3 is moved to its third or final position, top flat surfaces 24a (Fig. 5(b)) of opposite lateral projections 24 of lower leg plate 21 of the actuator abut bottom flat surfaces 16a (Fig. 1(b)) of the opposite, inner lateral extensions 16 of dielectric housing 1. This defines complementary interengaging latch means preventing rotation of actuator 3 in a second direction opposite the first direction of arrows 32, and also keeping the flat cable 30 in electrical contact with resilient terminal contacts 5.

Finally, in the third, final position of actuator 3, projections 23 at the rear longitudinal edge of lower leg plate 21a of actuator 3 enter through holes 19 beneath bridge 18 of dielectric housing 1. This prevents undesirable bending of the lower leg plate of the actuator and, thereby, maintains the flat cable in solid electrical contact with the resilient terminal contacts 5.

When disconnecting flat cable 30 from the electrical connector, actuator 3 is raised by inserting an appropriate tool or an operator's finger into notched section 25 (Fig. 5(b)) of upper leg plate 21b of actuator 3 and pulling on the actuator in a direction opposite the direction of arrow 33 (Fig. 7(f)). This unlocks the actuator relative to the housing by disengaging flat surfaces 12a and 29a as well as flat surfaces 16a and 24a, to allow the actuator to be rotated and raised from its second position shown in Figure 7(f) back to its first



position shown in Figures 7(d) and 7(c), i.e. opposite the direction of arrows 32.

Figure 8 shows an electrical connector according to a modified embodiment of the invention. The modified
5 embodiment is different from the first embodiment only to the extent that its actuator 34 has a sheet metal (stainless steel) core 35 coated with a synthetic resin material 36. The lower leg plate of the resin-coated
10 actuator provides an abutment plane 37 to push flat cable 30 against the underlying terminal contacts 5. The electrical connector is used in the same manner as the electrical connector of the first embodiment described above to make electrical contact between the conductors of the flat cable and the terminal contacts.

15 It should be understood that the number of parallel-arranged terminals 2 can vary considerably in number. The longitudinal lengths of actuator 3 and dielectric housing 1 also may vary accordingly.

Figures 9-19 show a second embodiment of the
20 invention which is very similar to the first embodiment described above and shown in Figures 1(a) - 7(g). Consequently, the identical or similar structures or components of the connector including the dielectric housing 1, the terminals 2 and the actuator 3 will not be
25 described again, and like reference numerals have been applied in Figures 9-19 corresponding to like components described above in relation to Figures 1(a) - 7(g).

One of the differences in the second embodiment of the invention is that, although J-shaped arm extensions
30 27 have round projections 28 on the insides thereof, the round projections do not fall into any recesses, such as recesses 14 (Fig. 4) of the first embodiment. Round projections 28 of the second embodiment simply bear against the opposite sides of the dielectric housing as the
35 actuator is translationally rotated from its open or cable-loading position to its closed or cable-clamping position.



The principal difference between the second embodiment and the first embodiment, generally, resides in the structural arrangement of the complementary interengaging latch means between dielectric housing 2 and actuator 3 near the front end of the housing, the latch means becoming operative when the actuator is linearly moved to its final position. More particularly, as best seen in Figures 9, 15, 16, 18 and 19, an L-shaped latch arm 40 defines a proximal or generally vertically extending leg 40a and a distal or generally horizontally extending leg 40b of the L-shape. One of these L-shaped latch arms 40 are located on each opposite side of the actuator. In addition, each opposite side of dielectric housing 1 includes an L-shaped latch projection 42 having an upper or generally vertically extending leg 42a and a lower or generally horizontally extending leg 42b. The juxtapositions of L-shaped latch arms 40 on the actuator, sort of embracing L-shaped latch projections 42 on the housing, when the actuator is in its completely closed, final position is clearly shown in Figure 9.

In operation of the second embodiment, and referring specifically to Figures 15-19, actuator 3 is pulled forwardly until L-shaped latch arms 40 of the actuator are clear of L-shaped latch projections 42 of the housing as shown in Figure 15. As with the first embodiment, this forward position of the actuator is defined by the abutment of inside projections 29 of J-shaped arm extensions 27 on the actuator with outwardly extending projections 13 on the housing.

The actuator now is free to be rotated upwardly in the direction of arrow 44 as shown in Figure 16. A flat cable 30 then is insertable into the connector as shown in Figure 17 and as described above in relation to the first embodiment of the invention.

With the flat cable fully inserted into the connector, actuator 3 then can be rotated back downwardly in the direction of arrow 46 in Figure 18 as L-shaped latch



arms 40 on the actuator clear L-shaped latch projections 42 on the housing.

Continued rotation of the actuator downwardly and forwardly in the direction of L-shaped arrow 48 in Figure 19 moves the actuator to its full downward cable-clamping position until bottom legs 40b of L-shaped latch arms 40 on the actuator are disposed below bottom legs 42b of latch projections 42 on the housing.

When actuator 3 of the second embodiment is in its final position as shown in Figure 9, bottom horizontal legs 40b of latch arms 40 of the actuator are located beneath bottom horizontal legs 42b of latch projections 42 of the housing, and the latch means created thereby prevent rotation of the actuator in the direction of arrow 44 (Fig. 16). Of course, rotation of the actuator in the opposite direction is prevented by the interengagement of projections 29 on J-shaped arm extensions 27 of actuator 3 and lateral extensions 12 at the front of dielectric housing 1, as in the first embodiment of the invention.

It will be understood that the invention may be embodied in other specific forms without departing from the spirit or central characteristics thereof. The present examples and embodiments, therefore, are to be considered in all respects as illustrative and not restrictive, and the invention is not to be limited to the details given herein.



CLAIMS:

1. A zero insertion force electrical connector for a flat cable (30), comprising:

5 a dielectric housing (1) mounting a plurality of conductive terminals (2), the housing having a front end (1a) adapted for receiving the flat cable in engagement with the terminals, a rear end (1b) and opposite sides (8a,8b);

10 an actuator (3) mounted to the housing (1) for movement between a first position allowing free insertion of the flat cable (30) into engagement with the terminals (2) and a second position biasing the cable against the terminals;

15 complementary interengaging mounting means (13,14,27,28,29) between the housing (1) and the actuator (3) at the opposite sides of the housing intermediate the front and rear ends thereof;

20 complementary interengaging stop means (12a,29a) between the housing (1) and the actuator (3) near the rear end (1b) of the housing for limiting rotation of the actuator relative to the housing in a first direction; and

25 complementary interengaging latch means (16a,24a,40,42) between the housing and the actuator near the front end (1a) of the housing for preventing rotation of the actuator relative to the housing in a second direction opposite said first direction.

30 2. The zero insertion force electrical connector of claim 1 wherein said complementary interengaging stop means (12a,29a) are adapted to stop rotation of the actuator (3) relative to the housing (1) beyond said second position.





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95-212 SG

5 3. The zero insertion force electrical connector of claim 1 wherein said complementary interengaging latch means (16a,24a) are adapted to prevent rotation of the actuator (3) relative to the housing (1) from said second position back to said first position.

10 4. The zero insertion force electrical connector of claim 1, including means (13,27a) between the housing (1) and the actuator (3) for providing generally linear movement of the actuator relative to the housing from said second position to a third, final position.

 5. The zero insertion force electrical connector of claim 1, including mounting arms (27) at opposite sides of said actuator (3), the arms having said mounting means (28) and said stop means (29a) thereon.

15 6. The zero insertion force electrical connector of claim 5 wherein said arms (27) are generally J-shaped and said stop means (29a) being on the distal end of the J-shape.

20 7. The zero insertion force electrical connector of claim 1, including complementary interengaging support means (19,23) between the housing (1) and the actuator (3) at a rear end of the actuator intermediate opposite sides thereof to prevent bending of the actuator.

25 8. The zero insertion force electrical connector of claim 1 wherein said actuator (3), in said first position, is disposed generally perpendicular to the plane of the flat cable (30) to allow visual inspection of the engagement of the cable and the terminals (2).





5 9. The zero insertion force electrical connector of claim 1 wherein said complementary interengaging latch means includes a pair of L-shaped latch arms (40) at opposite sides of the actuator (3) for engaging latch projections (42) at opposite sides of the dielectric housing (1).

10 10. The zero insertion force electrical connector of claim 9 wherein said latch projections (42) on opposite sides of the housing also are generally L-shaped but smaller than the L-shaped latch arms (40) for nesting within the arms.

