

PATENT SPECIFICATION

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(54) ELECTRICAL CONNECTOR

(71) We, AMP INCORPORATED, a corporation organised and existing under the laws of the State of New Jersey, United States of America, of Eisenhower Boulevard, Harrisburg, Pennsylvania, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to electrical connectors comprising male and female contacts and is particularly concerned with the avoidance of high insertion and withdrawal forces which, especially in a multiple contact connector, may give inconveniently high forces and which may lead to excessive wear of or damage to the contacts.

An electrical connector according to the invention comprises male and female contacts engageable by elastic deformation of the male contact, the female contact having a pair of spaced contact surfaces for receiving the male contact between them; the male contact comprising an elongate body formed with an enlargement at its free end projecting from opposite sides of the body, distal parts of the enlargement on opposite sides of the body defining male contact surfaces spaced apart by a distance greater than the spacing between the female contact surfaces, surfaces of the enlargement proximal to the contact surfaces falling within a circular envelope of diameter equal to the spacing between and passing through the male contact surfaces, a slot extending into the enlargement longitudinally between the male contact surfaces from an end of the enlargement remote from the body, the arrangement being such that the body can be oriented at a first inclination relative to the female contact for insertion of the enlargement into the female contact with minimum interference between the enlargement and the female contact surfaces, and thereafter can be reoriented by rotation relative to the female contact to

present maximum interference and elastically to deform the enlargement and move the male contact surfaces towards each other to engage the male contact surfaces with respective female contact surfaces.

Suitably the female contact surfaces in relaxed condition are spaced apart by a distance greater than the parts of the enlargement proximal to the male contact faces and diametrically opposite in relation to the circular envelope so that the male contact can be so oriented in relation to the female contact to present zero or negative interference between the male and female contact surfaces and zero insertion or withdrawal forces.

In order more easily to accommodate manufacturing variations and to facilitate mating assembly, the male contact surfaces can be arcuate to correspond with the circular envelope, and the enlargement can be formed with straight side portions extending from the contact surfaces towards the body. The enlargement can be of generally square form defined by a pair of generally triangular arms spaced by the slot. The relaxed distance between the female contact surfaces may be intermediate the distance between opposite sides of the rectangular pattern and the diameter of the circular envelope.

Both the male and female contacts may be formed as springs to facilitate resilient deformation on interference between the male and female contact faces.

The male contact or an associated housing and the female contact or an associated housing are suitably formed with interfitting latch means arranged releasably to secure the male and female contacts in a relative condition of maximum interference.

The male contact is suitably supported in an associated housing at a portion distal from the enlargement, and the male contact body is suitably reduced in thickness adjacent the support to provide increased flexibility at the reduced portion for accommodation of slight displacements

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between the supported portion and the female contact. This is useful in a multi-contact connector where there may be slight variations from the desired positioning of the contacts due to manufacturing tolerances. These variations are accommodated by the flexure of the male contact bodies.

The invention will now be described by way of example with reference to the accompanying partly diagrammatic drawings, in which:—

Figure 1 is a side elevation of male and female contacts before engagement;

Figure 2 is a view similar to Figure 1 but of the contacts in an initial position of engagement;

Figure 3 is a view similar to Figure 2 but of the contacts fully engaged;

Figure 4 is a fragmentary view of the assembly of Figure 1 to an enlarged scale;

Figure 5 is a side elevation of an alternative connection; and

Figure 6 is an end view of the connection of Figure 5.

In the embodiment of Figures 1 to 3 a male contact 1 is releasably matable with a female contact 2. The contacts are suitably mounted in respective insulating housing or support members, not shown. The female contact 2 is formed as a rigid fork having a pair of arms presenting a pair of opposed generally parallel contact surfaces 3 spaced by a distance A.

The male contact 1 comprises an elongate body 7 formed at one end with an enlargement 4 and at the other end with a reduced thickness section 8 extending from a support portion 6. The enlargement 4 is formed with a slot 9 open at the forward end and extending rearwardly of the enlargement 4. The enlargement is of generally square form, having one diagonal extending axially of the body 7 and the other diagonal extending perpendicular to the body 7 to define generally triangular arm portions presenting contact areas 5 at the distal apices spaced by a distance B greater than A. The contact areas 5 are suitable curved in convex arcuate manner to coincide with the circular envelope of radius $R = \frac{1}{2}B$ as seen in Figure 4 which permits a constant contact force to be maintained under slight angular misalignment of the male and female contacts. Opposite sides of the square form are spaced by a distance D which is less than A.

It is evident from Figures 1, 2 and 3 that if the longitudinal axis of the body 1 is inclined to the axis of the female contact 2 at a suitable angle α , the distance B when projected parallel to the contact faces 3 of the female contact may be equal to or slightly less than A. When so inclined the

enlargement 4 of the male contact 1 may be inserted into the female contact 2 without or substantially without frictional engagement with the contact surfaces 3. If then a turning force F is applied to the supported end 6 of the male contact to rotate the enlargement 4 within the female contact 2, an interference fit is developed between the dimensions A and B such that the arms of the enlargement 4 are urged resiliently together partially to close the slot 9 as shown in Figure 3, when B becomes greater than A.

In order to remove the male contact 1, the body 7 is rotated in a reverse direction into the position of Figure 2, and then withdrawn.

In use, the contacts 1 and 2 may form parts of a multiple contact connector having a row of female contacts 2 in one housing part, and a row of male contacts 1 in another housing part. Due to manufacturing tolerances it is probable that there will be slight displacements of the contacts from the optimum positions. The reduced section 8 allows for increased flexibility of the male contact bodies 7 to accommodate slight lateral displacements between the longitudinal axis at the support end 6 and at the female contact, without adversely affecting the torque applied by force F at the support end 6 to rotate the enlargement 4 within the female contact 2.

As the contacts are symmetrical about a longitudinal axis mating is possible by insertion and rotation of the male contact from either side of the axis of the female contact.

In the embodiment of Figures 5 and 6, in which like reference numerals refer to similar parts to those of Figures 1 to 3, the female contact 2 is formed as a resilient receptacle of generally C-shape section and having a longitudinal slot 10 along one side which side projects forwardly of the receptacle portion at projection 11. The body 1 of the male contact is formed with a lateral pin 12.

In operation, which is generally similar to that described in connection with the embodiment of Figures 1 and 2, the enlargement is inserted into the C-shaped receptacle and on turning the male contact 1, there is flexure of both the receptacle and the male contact enlargement. The pin 12 engages with the slot 10 in the projection 11 to latch the male contact 1 in fully engaged condition in a snap fit.

WHAT WE CLAIM IS:—

1. An electrical connector comprising male and female contacts engageable by elastic deformation of the male contact, the female contact having a pair of spaced contact surfaces for receiving the male



between the supported portion and the female contact. This is useful in a multi-contact connector where there may be slight variations from the desired positioning of the contacts due to manufacturing tolerances. These variations are accommodated by the flexure of the male contact bodies.

The invention will now be described by way of example with reference to the accompanying partly diagrammatic drawings, in which:—

Figure 1 is a side elevation of male and female contacts before engagement;

Figure 2 is a view similar to Figure 1 but of the contacts in an initial position of engagement;

Figure 3 is a view similar to Figure 2 but of the contacts fully engaged;

Figure 4 is a fragmentary view of the assembly of Figure 1 to an enlarged scale;

Figure 5 is a side elevation of an alternative connection; and

Figure 6 is an end view of the connection of Figure 5.

In the embodiment of Figures 1 to 3 a male contact 1 is releasably matable with a female contact 2. The contacts are suitably mounted in respective insulating housing or support members, not shown. The female contact 2 is formed as a rigid fork having a pair of arms presenting a pair of opposed generally parallel contact surfaces 3 spaced by a distance A.

The male contact 1 comprises an elongate body 7 formed at one end with an enlargement 4 and at the other end with a reduced thickness section 8 extending from a support portion 6. The enlargement 4 is formed with a slot 9 open at the forward end and extending rearwardly of the enlargement 4. The enlargement is of generally square form, having one diagonal extending axially of the body 7 and the other diagonal extending perpendicular to the body 7 to define generally triangular arm portions presenting contact areas 5 at the distal apices spaced by a distance B greater than A. The contact areas 5 are suitably curved in convex arcuate manner to coincide with the circular envelope of radius $R = \frac{1}{2}B$ as seen in Figure 4 which permits a constant contact force to be maintained under slight angular misalignment of the male and female contacts. Opposite sides of the square form are spaced by a distance D which is less than A.

It is evident from Figures 1, 2 and 3 that if the longitudinal axis of the body 1 is inclined to the axis of the female contact 2 at a suitable angle α , the distance B when projected parallel to the contact faces 3 of the female contact may be equal to or slightly less than A. When so inclined the

enlargement 4 of the male contact 1 may be inserted into the female contact 2 without or substantially without frictional engagement with the contact surfaces 3. If then a turning force F is applied to the supported end 6 of the male contact to rotate the enlargement 4 within the female contact 2, an interference fit is developed between the dimensions A and B such that the arms of the enlargement 4 are urged resiliently together partially to close the slot 9 as shown in Figure 3, when B becomes greater than A.

In order to remove the male contact 1, the body 7 is rotated in a reverse direction into the position of Figure 2, and then withdrawn.

In use, the contacts 1 and 2 may form parts of a multiple contact connector having a row of female contacts 2 in one housing part, and a row of male contacts 1 in another housing part. Due to manufacturing tolerances it is probable that there will be slight displacements of the contacts from the optimum positions. The reduced section 8 allows for increased flexibility of the male contact bodies 7 to accommodate slight lateral displacements between the longitudinal axis at the support end 6 and at the female contact, without adversely affecting the torque applied by force F at the support end 6 to rotate the enlargement 4 within the female contact 2.

As the contacts are symmetrical about a longitudinal axis mating is possible by insertion and rotation of the male contact from either side of the axis of the female contact.

In the embodiment of Figures 5 and 6, in which like reference numerals refer to similar parts to those of Figures 1 to 3, the female contact 2 is formed as a resilient receptacle of generally C-shape section and having a longitudinal slot 10 along one side which side projects forwardly of the receptacle portion at projection 11. The body 1 of the male contact is formed with a lateral pin 12.

In operation, which is generally similar to that described in connection with the embodiment of Figures 1 and 2, the enlargement is inserted into the C-shaped receptacle and on turning the male contact 1, there is flexure of both the receptacle and the male contact enlargement. The pin 12 engages with the slot 10 in the projection 11 to latch the male contact 1 in fully engaged condition in a snap fit.

WHAT WE CLAIM IS:—

1. An electrical connector comprising male and female contacts engageable by elastic deformation of the male contact, the female contact having a pair of spaced contact surfaces for receiving the male



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5 contact between them; the male contact comprising an elongate body formed with an enlargement at its free end projecting from opposite sides of the body, distal parts of the enlargement on opposite sides of the body defining male contact surfaces spaced apart by a distance greater than the spacing between the female contact surfaces, surfaces of the enlargement proximal to the contact surfaces falling within a circular envelope of diameter equal to the spacing between and passing through the male contact surfaces, a slot extending into the enlargement longitudinally between the male contact surfaces from an end of the enlargement remote from the body, the arrangement being such that the body can be oriented at a first inclination relative to the female contact for insertion of the enlargement into the female contact with minimum interference between the enlargement and the female contact surfaces, and thereafter can be reoriented by rotation relative to the female contact to present maximum interference and elastically to deform the enlargement and move the male contact surfaces towards each other to engage the male contact surfaces with respective female contact surfaces.

35 2. An electrical connector as claimed in claim 1 in which, with the female contact in relaxed condition, the female contact surfaces are spaced apart by a distance greater than the parts of the enlargement proximal to the male contact surfaces and diametrically opposite in relation to the circular envelope.

40 3. An electrical connector as claimed in claim 1 or claim 2, in which the enlargement is of generally square form, defined by a pair of generally triangular arms spaced by the slot, one diagonal of the square extending perpendicular to and the other longitudinally of the body.

45 4. An electrical connector as claimed in any one of claims 1 to 3, in which interfitting latch means associated with the contacts are arranged releasably to hold the contacts in a relative position of maximum interference in a snap fit.

5. An electrical connector substantially as described with reference to and as shown in Figures 1 to 4 of the accompanying drawings.

55 6. An electrical connector substantially as described with reference to and as shown in Figures 5 and 6 of the accompanying drawings.

60 7. A male contact for a connector as claimed in claim 1 comprising an elongate body formed with an enlargement at its free end projecting from opposite sides of the body, distal parts of the enlargement on opposite sides of the body defining male contact surfaces spaced apart by a distance greater than the spacing between opposed contact surfaces of a female contact between which the enlargement is to be received to engage the male and female contact surfaces, surfaces of the enlargement proximal to the contact surfaces falling within a circular envelope of diameter equal to the spacing between and passing through the male contact surfaces, a slot extending into the enlargement longitudinally between the male contact surfaces from an end of the enlargement remote from the body, the arrangement being such that the body can be oriented at a first inclination relative to the female contact for insertion of the enlargement into the female contact with minimum interference between the enlargement and the female contact surfaces, and thereafter can be reoriented by rotation relative to the female contact to present maximum interference and elastically to deform the enlargement and move the male contact surfaces towards each other to engage the male contact surfaces with respective female contact surfaces.

8. A male contact as claimed in claim 7 and substantially as hereinbefore described with reference to and as shown in Figures 1 to 4 of the accompanying drawings.

For the Applicants:
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