

PATENT SPECIFICATION

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(54) ELECTRICAL CONTACT SOCKETS

(71) We, ILLINOIS TOOL WORKS INC., a corporation organized under the laws of the State of Delaware, United States of America, of 8501 West Higgins Road, Chicago, Illinois 60631, 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:—

The subject matter of the present invention relates generally to electrical contact sockets for use with associated pin members. In particular, the present invention is concerned with female contact members having internal flexing contact arms integrally associated with a surrounding sleeve member. The contact arms are particularly adapted to provide an efficient electrical contact in micro-miniature environments.

Existing female contact members for establishing a separable electrical contact in an electric circuit have utilized resilient finger members suitably biased or deformed to engage a male pin member under spring pressure. One of the principal advantages of such a system is that one socket can accommodate pin members which, due to production tolerances, are slightly smaller or larger than design size. However, most of these prior art efforts to provide a socket member are of a multi-piece design. For example, a contact cylinder having radially biased arms may be situated within a preformed sleeve. Electrical contact between the cylinder and the sleeve is necessary to complete a circuit between connecting wires and the spring arms.

The contact arms of the prior art are generally cantilevered from a fixed cylinder and tend to provide only point contact between a pin and the socket. Unsupported cantilevered contact arms tend to lose spring pressure and consequently cause intermittent electrical contact between the pin and

socket. The space requirements in the micro-miniature environments naturally require that the deflection of the female contact member by insertion of an associated pin member should involve storage of substantial spring energy in the female contact member, so as to provide a sound electrical contact. At the same time, in relation to the size of the female contact member, the size of the associated pin member should be substantial, so as to provide a firm and efficient mechanical joint.

It is a broad object of the invention to provide a socket having internal flexing contact elements which are capable of being efficiently made as a stamping from a single piece of metal.

It is an object of the invention to provide a novel, one-piece female contact member which can store substantial spring energy in miniature environments.

It is a further object of the invention to provide a contact member which will establish firm line contact with an associated pin member.

It is yet another object of the invention to provide improved wiping contact over an appreciable surface area of a pin member in a socket member.

According to this invention, an electrical contact socket consists of a sleeve defining a mouth and an inner wall, and at least one contact arm integrally attached to the sleeve, solely at the mouth, each arm extending longitudinally within the sleeve and including a first portion extending longitudinally from the mouth and abutting against the inner wall, and a preformed second portion which is biased radially inwardly of the sleeve and is able to be deflected by a pin of appropriate size inserted into the socket, so as to lie against the inner wall while maintaining pressing contact against the pin.

The accompanying drawings show examples of sockets embodying the invention. In these drawings:—

[Price 33p]

Price 75p

Figure 1 is a perspective, partially cut away, view of a first socket;

Figure 2 is an end view of this first socket;

Figure 3 is a section on the line 3—3 in Figure 2;

Figures 4 and 5 are plan and end views, respectively of the first socket in an initial stage of construction;

Figure 6 is an end view of a second socket;

Figure 7 is a section on the line 7—7 in Figure 6;

Figure 8 is an end view of a third socket, similar to that shown in Figure 6 but showing a generally square sleeve member;

Figure 9 is a section on the line 9—9 in Figure 8; and

Figure 10 is a perspective view, partly cut away, of this third socket.

Turning now to the drawings, Figure 1 shows a preferred socket 10. The contact is an integral unit including a square-sectioned sleeve 12 having a plurality of contact arms 14 folded back within the bore of the sleeve and extending longitudinally within the sleeve. Each arm 14 includes a first portion 18 lying flat against the inner wall 20 of the sleeve, and a second portion 16 which extends into the bore, being preformed and biased radially inwardly of the sleeve 12.

The arms are able to be completely flattened against the inner wall of the sleeve 12. This characteristic is especially important in providing a connector system for micro-miniature environments. The integral, folded-back contact arms 14 will permit entry into the socket of an associated square-section pin, which is of substantial size in relation to the size of the sleeve 12, in order to provide, as far as possible, a structurally sound connection.

Having observed the general details of the socket body 10, attention may now be given to the particular manner of providing for storage of substantial spring energy on deflection of a contact arm 14. Attention is drawn to the fact that the second portion 16 is in a position, relatively to the first portion 18, twisted about an axis generally longitudinal of the arm 14, or about an axis which is more longitudinal than lateral to the arm 14. The arms 14 shown in Figures 1 to 3 are, therefore, bent about a line of intersection 36. This line of intersection 36 serves as a flexible hinge, where deformation occurs and energy becomes stored, when the second portion 16 is flattened against the inner wall of the sleeve 12 by insertion of a pin into the socket. The line is shown to extend from one longitudinal side of the arm to the other at a small acute angle A (Figure 3) which is shown to be substantially less than 45°. As a consequence, the associated square-sectioned pin, having a cross section very slightly less than that of

the entrance 22 to the socket, makes initial contact with the second portion 16 at a point 34 near the entrance 22. As the pin continues to be inserted into the socket 10, a firm engagement with an edge 38 and a surface 40 of the second portion 16 will result. As a consequence, a smooth, controlled insertion force exerted by the associated pin wall cause deflection of the portion 16 and storage of spring energy, and so will provide the necessary and required electrical contact and connection between two members. It is to be particularly noted that the contact between the second portion 16 and an associated pin member will be a line or surface contact extending over a substantial axial extent of the pin member.

While a socket, in accordance with the invention, may be constructed with any number of arms, including one arm only, and the sleeve may take a variety of cross-sectional configurations, the preferred embodiment shown in Figures 1 to 3 involves four such integral arms in a square sleeve. It is to be particularly noted that the angle 8 shown in Figure 2, being the angle which the second portion 16 of each inwardly extending arm makes with the flat first portion 18, is a factor in the extent to which the portion 16 extends into the socket when unstressed, and hence is a factor in determining the spring energy residing in the contact arms when deflected. The twisted configuration of the portions 16 enables a plurality of arms, such as the four arms 14 shown in Figure 2, to be utilized without much problem of interference of the portions 16 with one another. If these portions were to be biased like a normal cantilevered spring arm, the amount of biasing would be limited by the width of the individual arms. In the present invention, the placement of all of the portions 16 at angles consistent with one another enables the initial flexure to be dependent only to a minor extent on the width of the arms.

In Figures 6 to 10 alternative embodiments of the invention are shown, wherein the contact structure is generally similar to that described above, as indicated by the application of identical reference numerals with suffixes *a* and *b* added to the corresponding identical elements. The structural features of these modifications of the invention also provide for a one-piece socket connector having spring contact arms adapted to completely flatten against the internal wall of the sleeve thereby allowing substantial spring energy to be stored, and allowing for substantial size of the corresponding pin member in relation to the size of the socket.

The socket 10_a shown in Figures 6 and 7 comprises a generally cylindrical sleeve 12_a having integrally attached spring-like contact arms 14_a bent over and extending within the

sleeve. While two contact arms 14a are shown, it should be apparent that any number of contact arms can be provided and still come within the scope of the invention. These bent-over integral arms 14a include support portions 18a, 18aa situated respectively near the opening 22a and at the extremity of the arm. The pressing contact is provided by the portions 16a which are biased inwardly towards each other and acquire the necessary stored spring energy when an associated cylindrical pin (not shown) is inserted with a smooth, controlled force.

15 The portions 18a, 18aa of the arm advantageously provide intimate contact at all times between the arm and the inner surface of the sleeve. Also, the support at either end of the spring portion 16a gives a greater reaction force than would be obtained from a cantilever spring of similar size with a free end.

20 While the complete flattening of the integral contact arm 14a against the inner surface will involve storage of substantial spring energy and will permit the diameter of the associated pin to be substantial, as discussed above, a further feature is the provision of grooves 30. These grooves receive, and are radially aligned with, associated contact arm members 14a. As a pin is inserted in the socket, the bowed portion 16a will be deflected against the bottom surface of the groove 30. Upon full deflection, the diametral distance between arms 14a will be substantially the same as the diametral distance between the inner surfaces 20a. The arms will be substantially flush with the inner wall. In accordance with the discussions above, this will allow for further spring energy to be stored, and will allow a larger contact pin to be associated with the socket.

25 Figures 8 to 10 show a socket 10b having a square cross-sectional configuration. As in the embodiment shown in Figures 6 and 7, the socket 10b is provided with integral folded-back arms 14b having bowed portions 16b with which electrical contact is achieved and ensured. Substantially flat portions 18b, 18bb are situated at either end of the bowed portions to provide support. Grooves 32 may also be provided to increase the effective inner diameter of the socket.

30 A further advantage of the grooves 30 or 32 is the added stability and structural integrity which they impart to the one-piece spring socket member. In Figures 8 to 10, for example, the axial force exerted on the bowed portion 16b will force the arm to move in only two directions. The arm will be deflected radially against the inner wall 20b, and the flat portion 18bb will be slightly displaced in a direction longitudinally of the socket. The groove 32 will not allow lateral

movement of the arm 14b. Insertion of an associated pin may be accompanied by slight rotation forces which tend to impart lateral movement to the arms. If such movement were permitted, the additional stress, on a spring member of the size utilized in small environments, could be extremely deleterious to the life of the spring member. It is apparent, therefore, that the provision of grooves increases the efficiency of a socket.

In Figures 1 to 3 grooves are not provided, as there is in any event considerable resistance to any rotation of the square-sectioned pin relatively to the socket.

For purposes of affording a more complete understanding of the invention, it is advantageous to now provide a description of a mode of manufacturing the socket shown in Figures 1 to 3. As best shown in Figures 4 and 5, a blank 42 is provided having portions 12 and 14 which will eventually be formed into the sleeve and contact arms respectively. The longitudinal edges of this blank will form a seam, as shown at 26 in Figure 2. A tab 28 may serve as a means for locating the blank 42 for further deformation, and may aid in connection of a wire in a portion 24 of the socket. This connection may be of any type known in the art, such as crimping or soldering.

Portions 16 are shown initially deformed at angles substantially identical to each other. This will provide the advantageous configurations shown in Figure 2. Following this stage in the manufacture, the arms 14 will be folded over on top of portion 12 with portions 18 firmly and intimately contacting the surface of the portion 12. At the same time, portions 16 will assume positions biased away from the portion 12, ready for reaction with an associated pin member. After these arms are placed in the folded-over position, the body 12 may then be deformed to provide the sleeve with either a square, circular or polygonal cross section. It may be desirable to harden the arms before folding them over onto the portion 12.

In order to make the sockets shown in Figures 6 to 10, one starts with a blank in which different portions of the sheet are of different thickness.

WHAT WE CLAIM IS:—

1. An electrical contact socket consisting of a sleeve defining a mouth and an inner wall, and at least one contact arm integrally attached to the sleeve, solely at the mouth, each arm extending longitudinally within the sleeve and including a first portion extending longitudinally from the mouth and abutting against the inner wall, and a preformed second portion which is biased radially inwardly of the sleeve and is able to be de-



sleeve. While two contact arms 14a are shown, it should be apparent that any number of contact arms can be provided and still come within the scope of the invention.

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flected by a pin of appropriate size inserted into the socket, so as to lie against the inner wall while maintaining pressing contact against the pin.

5 2. A socket in accordance with claim 1, wherein the sleeve and arms are of sheet metal, and each arm is joined to the sleeve at the mouth by a fold in the sheet metal.

10 3. A socket in accordance with claim 1 or claim 2, wherein the first portion of each arm is planar, and the second portion of each arm extends generally longitudinally of the sleeve, and lies at an angle to the plane of the first portion.

15 4. A socket in accordance with claim 3, wherein the arm is able to lie flat against the inner wall along the entire axial extent of the arm when the arm is in a fully deflected state.

20 5. A socket in accordance with any of claims 1 to 4, wherein the side walls of the sleeve include grooves extending longitudinally of the sleeve and adapted to receive the arms to stabilise the arms and guide their movement relative to the sleeve upon deflection.

25 6. A socket in accordance with claim 5, wherein the grooves are placed to allow the arms to become substantially flush with an

associated side wall of the sleeve when fully deflected. 30

7. A socket in accordance with any of claims 1 to 3, wherein the second portion of the arm is in a position, relatively to the first portion, twisted about an axis generally longitudinal of the arm. 35

8. A socket in accordance with claim 3, wherein the second portion intersects the plane of the first portion of the arm at a line which extends from one longitudinal edge of the arm to the other, at a small acute angle to the longitudinal axis of the arm. 40

9. A socket in accordance with any of claims 1 to 8, which includes a plurality of the arms, circumferentially spaced. 45

10. A socket in accordance with claim 9, wherein the sleeve is polygonal, each side having an associated one of the arms.

11. A socket in accordance with claim 9, wherein the sleeve is generally cylindrical. 50

12. A socket in accordance with claim 1, substantially as described with reference to Figures 1 to 5, Figures 6 and 7, or Figures 8 to 10 of the accompanying drawings.

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