Feb. 2, 1971 J. A. ZIMMERMAN, JR., ET AL 3,560,911

DISENGAGEABLE ELECTRICAL CONNECTIONS HAVING IMPROVED CONTACT SPRING MEANS

Filed Sept. 24, 1968

3 Sheets-Sheet 1

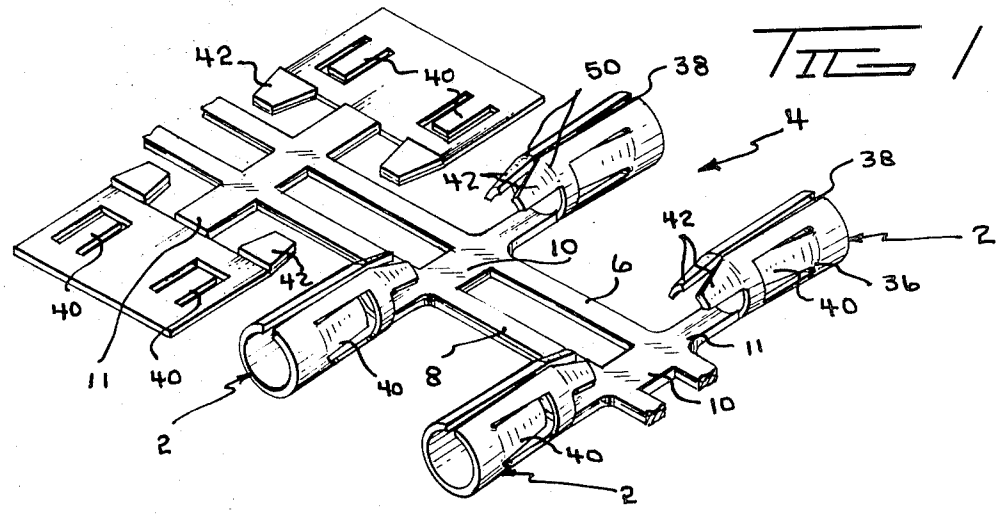

FIG 1

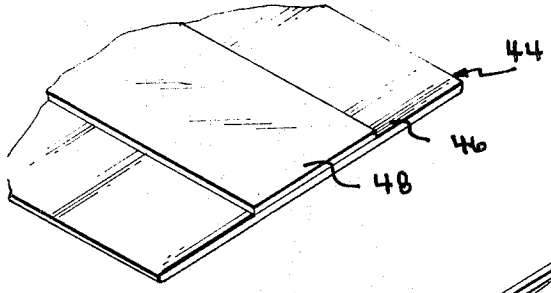

FIG 2

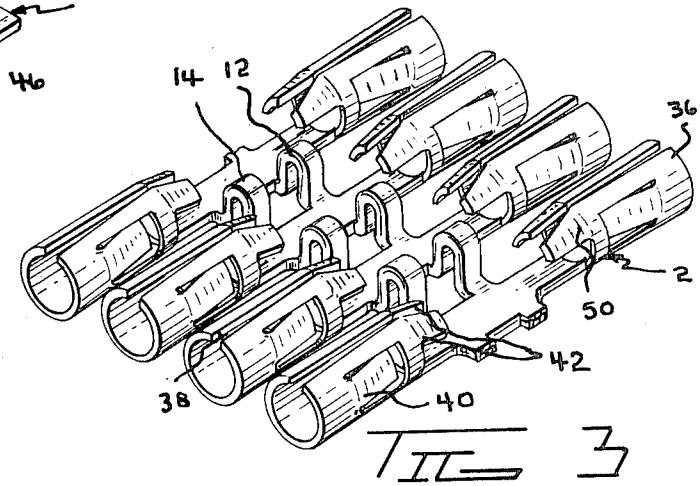

FIG 3

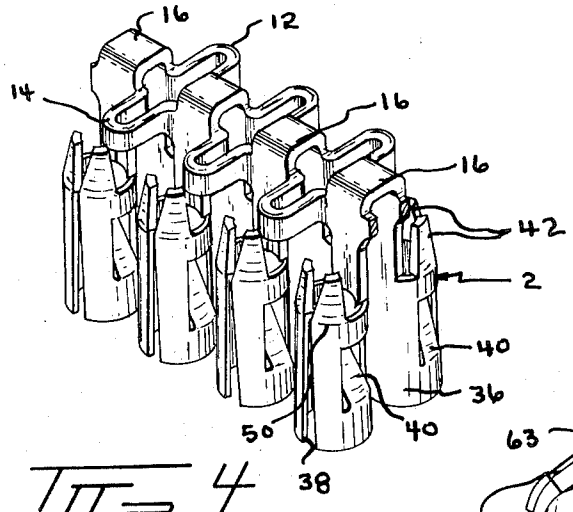

FIG 4

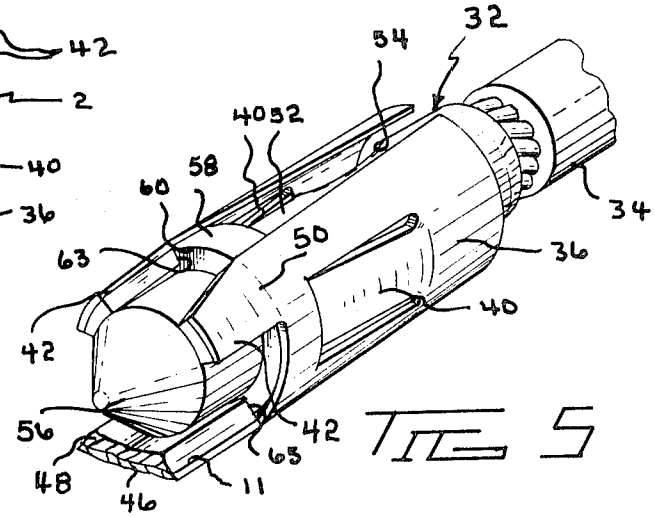

FIG 5

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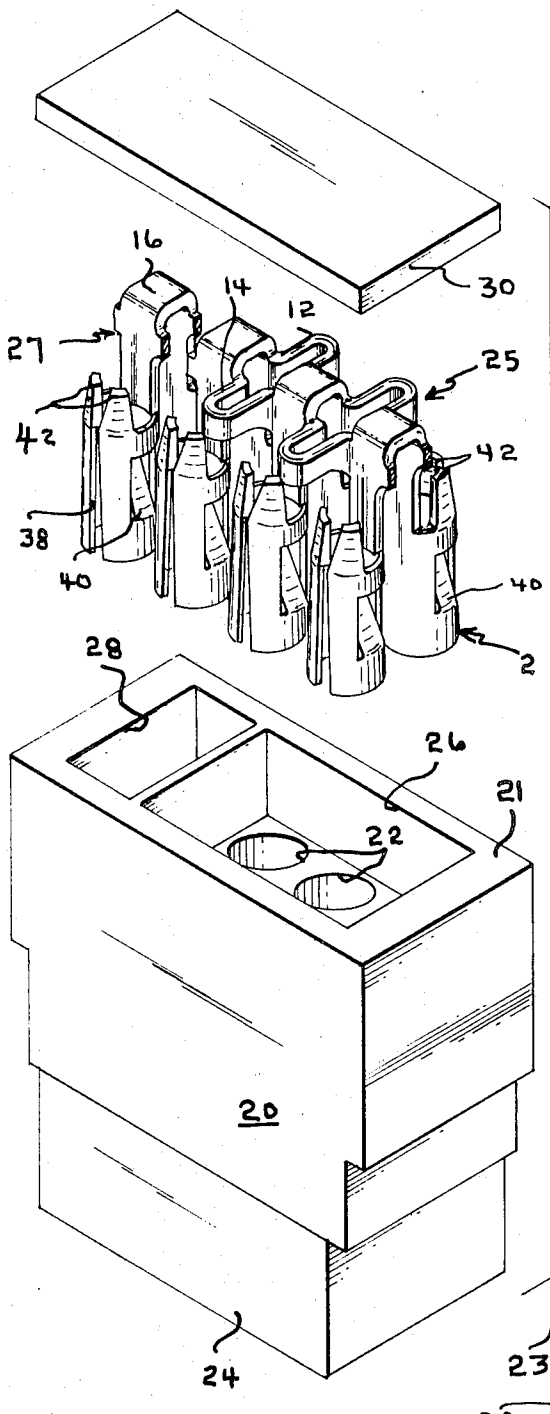

FIG 6

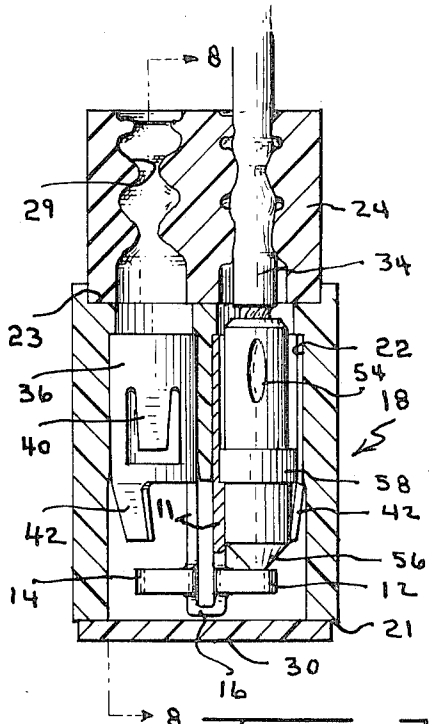

FIG 7

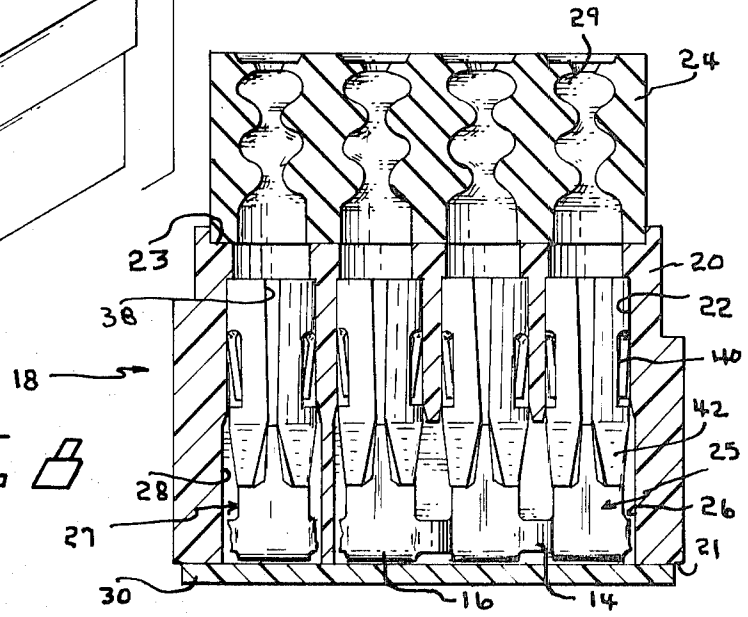

FIG 8

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DISENGAGEABLE ELECTRICAL CONNECTIONS HAVING IMPROVED CONTACT SPRING MEANS

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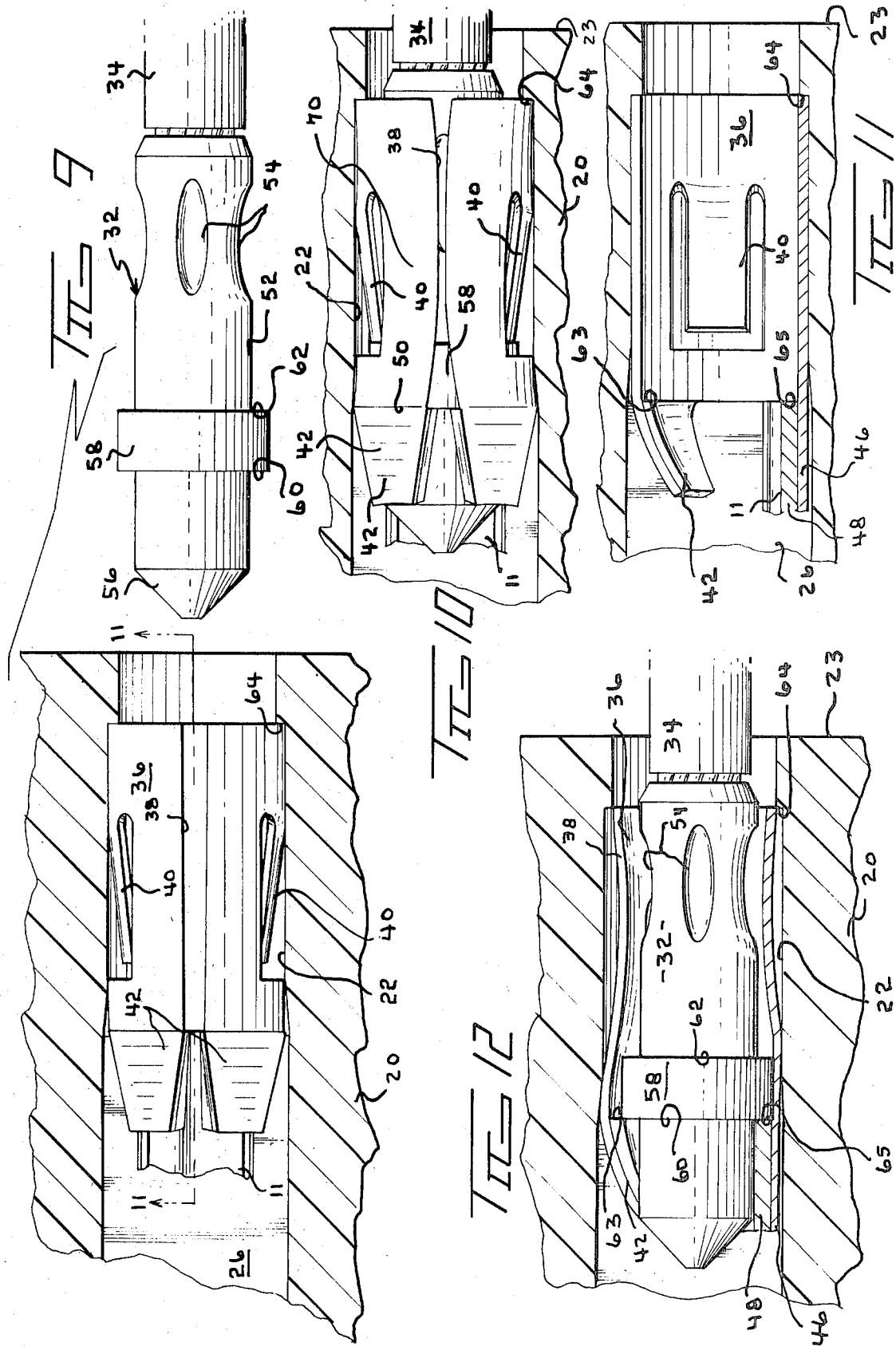

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3,560,911

DISENGAGEABLE ELECTRICAL CONNECTIONS HAVING IMPROVED CONTACT SPRING MEANS

John Aaron Zimmerman, Jr., Hershey, and Clarence Leonard Paullus, Camp Hill, Pa., assignors to AMP Incorporated, Harrisburg, Pa.

Continuation-in-part of application Ser. No. 640,649, May 23, 1967. This application Sept. 24, 1968, Ser. No. 762,088

Int. Cl. H01r *13/12*

U.S. Cl. 339—258 8 Claims

ABSTRACT OF THE DISCLOSURE

Pin and socket connecting means in which the socket comprises a stamped and formed cylindrical body portion which is adapted to receive the pin at one end thereof and which has ears extending from its other end obliquely inwardly with respect to the axis of the body portion. The body portion of the socket has an axially extending open seam and is contained relatively snugly within a cylindrical cavity in an insulating housing. The ears are relatively rigid and are rigidly connected to the body portion so that when the pin is inserted into the socket, the ears are moved relatively outwardly, however, because of the fact that the ears are rigid and nonflexible, the body portion of the socket is forced to elastically deform to accommodate the movement of the ears. Because of the fact that the body portion of the socket is circumferentially confined in the cavity, the body portion deforms along its length and functions as a spring means maintaining electrical contact between the socket and the leading end of the inserted pin.

BACKGROUND OF THE INVENTION

This application is a continuation-in-part of our pending application Ser. No. 640,649 filed May 23, 1967 for Interconnection Wiring System now U.S. Pat. 3,456,231.

This invention relates to pin and socket type electrical connections and particularly to pin and socket connecting devices intended for use in terminal junction systems. The herein disclosed embodiment of the invention is particularly intended for use in a terminal junction system of a general type disclosed in the above identified U.S. Pat. 3,456,321, however, it will be apparent that the principles of the invention can be employed in alternative terminal junction systems or in alternative types of electrical connecting devices.

The terminal junction system disclosed in U.S. Pat. 3,456,321 comprises a plurality of individual modules contained in a suitable mounting frame. Each module has mounted therein a plurality of contact sockets, each of which is adapted to receive a contact pin having a radially extending integral collar intermediate its ends. Two or more sockets are electrically connected to each other in each module so that upon insertion of the contact pins, the wires to which the pins are connected are electrically connected to each other.

The individual contact sockets for a terminal junction system are advantageously provided with a means for engaging an inserted pin and retaining it in the socket against accidental removal and additionally should have a means for establishing a contact pressure at the interface between the socket and the pin thereby to insure the achievement of a stable, low resistance electrical contact between the parts. Because of the fact that terminal junction systems are frequently used in aircraft or under other circumstances where weight and space limitations are present, the length of the contact sockets is advantageously held to a minimum dimension. These requirements of terminal junction systems render the application of previously known principles in the design of contact sockets inappropriate and difficulty has been encountered in achieving adequate, and sufficiently stable, electrical contact between the socket and an inserted pin in such systems. The present invention is therefore directed to the achievement of a contact socket which can be manufactured in a relatively short length without sacrifice of electrical or mechanical performance.

It is accordingly an object of the invention to provide an improved disengageable electrical connection of the pin and socket type. It is a further object to provide a contact socket which can be manufactured in relatively short lengths without sacrifice of electrical or mechanical advantages. A still further object is to provide an improved contact socket for use in a terminal junction system. A still further object is to provide a contact socket having improved means for maintaining the contact force exerted at the electrical interface between the socket and an inserted pin.

These and other objects of the invention are achieved in a preferred embodiment thereof in which a contact socket of the pin and socket connection comprises a stamped informed cylindrical body portion which is adapted to receive a contact pin at one end thereof and which has contact ears extending obliquely inwardly, with respect to the axis of the body portion, from its other end. The contact ears are relatively rigid and are rigidly connected to the body portion so that they are resistant to flexure when the pin is inserted. The cylindrical body portion is contained in a cylindrical cavity in an insulating housing, the diameter of this cavity being substantially equal to the outside diameter of the body portion of the socket so that circumferential expansion of the body portion of the socket is prevented when the pin is inserted. The socket must, nonetheless, be deformed when the pin is inserted and such deformation takes place along the length of the body portion of the socket. In a preferred embodiment, sections of the body portion are bowed inwardly as a result of the stresses imposed on the ears and the resulting movement of the ears away from the axis of the socket. In effect then, the entire cylindrical body portion of the socket functions as a contact spring maintaining the ears in intimate contact with the leading end of the pin thereby insuring a stable low resistance electrical connection.

In the drawing:

FIG. 1 is a perspective view of a progression showing the manner in which contact sockets in accordance with the invention are formed from strip metal;

FIG. 2 is a perspective view of a short section of stock metal of the type used in the manufacture of the strip of FIG. 1;

FIG. 3 is a perspective view of a section of strip of contact sockets illustrating the manner in which the pitch of the strip is reduced by folding the carrier strips extending between adjacent contacts.

FIG. 4 is a perspective view of a short strip of contact sockets illustrating the manner in which the sockets may be bent, with respect to the original plane of the strip, to locate the sockets in parallel, side-by-side relationship.

FIG. 5 is a perspective view of a contact socket and a contact pin in accordance with the invention illustrating the manner in which the two parts are engaged with each other.

FIG. 6 is an exploded view of a module suitable for use in a terminal junction system and illustrating the manner in which the strip of contacts of FIG. 4 is assembled to the module.

FIG. 7 is a sectional end view of the module of FIG. 6

showing the parts in their assembled relationship and showing a contact pin engaged with one of the contact sockets.

FIG. 8 is a sectional side view of the module of FIG. 7 taken along the lines 8—8 of FIG. 7.

FIG. 9 is a sectional plan view, on an enlarged scale, showing an individual contact socket mounted in a cavity in the module housing of FIG. 6 and illustrating the appearance of the socket prior to insertion of a contact pin.

FIG. 10 is a view similar to FIG. 9 but showing the appearance of the socket after insertion of the pin and particularly illustrating the resilient deformation of the socket.

FIG. 11 is a sectional side view taken along the lines 11—11 of FIG. 9 of an individual socket mounted in a cavity in a housing.

FIG. 12 is a view similar to FIG. 11 but illustrating the appearance of the socket after insertion of the pin.

Referring first to FIG. 1, contact sockets 2 in accordance with the invention are advantageously manufactured in the form of continuous strip 4 comprising a pair of parallel spaced apart carrier strips 6, 8. The carrier strips are connected to each other by integral rungs 10 and the individual sockets are connected to the carrier strip on each side of each run by means of laterally extending connecting strips 11. The individual sockets are stamped and formed from the stock material on each side of the carrier strips 6, 8 and the spacing between the individual sockets is therefore determined by the diameters of the sockets. This spacing is somewhat greater than the spacing ordinarily required in the terminal junction system and the pitch of the strip, that is the spacing between adjacent sockets on the strip, must be shortened prior to mounting the sockets in the module housings. Such shortening of the strip is achieved by folding the sections of the carrier strips 6 and 8 which extend between adjacent sockets as shown at 12 and 14, FIG. 3.

A strip of contact sockets in the condition shown in FIG. 3, that is after the carrier strips 6, 8 have been folded as shown at 12 and 14, can be used in a feed-through terminal junction module. As explained more fully in the above identified U.S. Pat. 3,456,321, terminal junction modules of this type are used where it is desired to connect wires extending axially towards each other. As an alternative, the connecting strips 11 can be bent as indicated at 16 (FIG. 4) to locate the individual contact sockets 2 in side-by-side parallel relationship and facing in a common direction. Strips of contact sockets of the type shown in FIG. 4 are used in the so-called feed-to modules as shown in FIGS. 6–8 to form disengageable electrical connections among wires extending parallel to each other towards a common location.

The instant invention is directed to the structural features of the individual contact sockets 2 and it should be understood that sockets of this type can be used in a variety of connecting devices other than terminal junction systems. The structure of the feed-to terminal junction module of FIGS. 6–8 is briefly described below for the purpose of illustrating a specific use of a socket contact and an electrical connection in accordance with the instant invention. It will be understood that the advantages of the invention in terminal junction systems discussed below are achieved in feed-through terminal junction modules as well as feed-to modules of the type illustrated.

Each feed-to terminal junction module 18 comprises a generally rectangular insulating housing 20 of a suitable firm plastic material such as diallylphthalate having a plurality of cavities 22 extending from its upper side 23 to its lower side 21. FIG. 6 shows a typical module in an inverted position in order to illustrate the structure of the lower side of the module and the manner in which the terminal strip is placed in the module. Recesses 26, 28 are provided on the lower side 21 of the housing section 20 and clusters of connected sockets are inserted through these recesses to locate the individual contact sockets in the cavities 22. In FIG. 6, the recess 26 contains 6 cavities 22 and a section of strip 25 to which six sockets are attached is mounted in this portion of the housing. The recess 28 contains two individual cavities 22 and two individual sockets connected to each other as shown at 27 are inserted into the cavities which open into the recess 28. After insertion of the sections of terminal strip 25, 27 into the cavities as illustrated in FIG. 6, a suitable lower cover plate 30 is cemented to the lower side 21 of the housing to retain the sections of terminal in the housing section 20.

A sealing block 24 of relatively soft material is mounted against the upper side 23 of the housing section 20 and has passageways extending therethrough which communicate with the individual cavities 22 in the housing. The individual contact pins 32 can then be moved downwardly, as viewed in FIGS. 7 and 8, through openings 29, the sealing block 24 and into the individual contact sockets contained in the housing section 20. The particular module illustrated in FIGS. 6–8 provides a common connection for six individual conductors on its right hand side as viewed in FIGS. 6–8 and provides additionally a common connection for two individual conductors on its left hand side. As fully explained in U.S. Pat. 3,456,321, modules of this type are made in a variety of configurations capable of forming common connections among varying numbers of conductors. Similarly, the so-called feed-through modules, in which strip having aligned sockets of the type shown in FIG. 3 is mounted, can be provided to interconnect varying numbers of conductors.

The individual contact sockets 2 each comprise a cylindrical body portion 36 having an open seam 38. Retaining lances 40 are struck from the wall of the body portion on each side of the seam and extend obliquely inwardly toward the axis of the body portion, these retaining lances being adapted to bear against an inserted pin and retain the pin in the socket in a manner described below. Ears 42 are integral with the body portion 36 on each side of the open seam and extend obliquely inwardly with respect to the axis of the body portion, these ears being connected to the body portion along arcuate lines 50 which render the ears resistant to flexure when the pin is inserted.

Contact sockets in accordance with the invention are advantageously manufactured from strip material 44 which comprises a relatively wide layer 46 of thin sheet stock having good spring properties such as beryllium copper. A layer of high conductivity metal 48, such as pure copper, is bonded to the surface of the layer 46 and located midway between the edges of the layer of beryllium copper stock. When the terminals are stamped from the stock as illustrated in FIG. 1, the body portions are thus formed from the high strength material 46 while the inner surfaces of the ears 42, (FIG. 1), the inner surfaces of the connecting strips 11, and the carrier strips 6 are provided with a layer of the high conductivity metal 48. During manufacture, the connecting strips 11 are formed arcuately so that they match the curvature of the body portion so that these strips provide a contact surface for engagement with the pin.

The individual contact pins 32 have cylindrical bodies 52 with wire receiving openings at their rearward ends to receive the stripped ends of wires 34, the pins being crimped to the wires by any suitable electrical crimp as shown at 54. Intermediate the ends of its body portion 52, each pin is provided with a circumferential collar 58 which defines a rearwardly facing shoulder 62 and a forwardly facing shoulder 60. At the front end of the pin, a conical surface 56 is provided which is adapted to engage the inner surfaces of the ears 42 and to move the ears outwardly during insertion. The diameter of the collar 54 is substantially equal to, and slightly less than, the inside

diameter of the body portion **36** of the socket so that the pin can be inserted into the socket as illustrated in FIGS. 9 and 10 until the forward shoulder **60** abuts the rearwardly facing shoulders **63, 65** defined by the edges of the high conductivity layers an the inner surfaces of the ears **42** and the upper surface of the connecting strip portion **11**. These shoulders in the socket thus function as stops which prevent movement of the pin through the socket beyond the position shown in FIGS. 10 and 12.

The previously identified inwardly directed lances **40** are sprung outwardly while the pin is being inserted and, after completion of the inserting operation are lodged behind the collar **58** and against the rearwardly facing shoulder **62** of this collar. These lances thus prevent accidental removal of the pin from the socket although an individual pin can be removed from a socket by the use of a suitable extraction tool which is adapted to surround the conductor **34** and the body portion **52** of the pin. Such extraction tools can be moved along the axis of the pin until they bias the retaining lances **40** outwardly thereby permitting the pin and the extraction tool to be removed from the socket.

Referring now to FIGS. 9–12, it can be seen that the cavities **22** in which the sockets are contained have a shoulder **64**, adjacent to the side **23** of the housing, which prevents movement of the individual sockets leftwardly in FIG. 9 with respect to the module housing. The cavities also have a diameter which is substantially equal to, and slightly greater than, the outside diameter of the sockets so that the sockets are prevented from expanding circumferentially when the pins are inserted. Contact pressure between the inner surfaces of the connecting strip **11** and the leading end of the pin **32** is achieved when the pin is inserted by virtue of the fact that the leading end of the pin forces the ears to move relatively outwardly and away from the axis of the socket as illustrated in FIGS. 10 and 12. The ears however, are rigid along their lengths by virtue of the fact that they are formed from a double layer of material and additionally by virtue of the fact that they are connected to the body portion of the socket along an arcuate, rather than a straight line, transition zone **50**. These transitions between the ears and the body portion of the socket are thus highly resistant to flexure and should not be confused with a simple straight line transition which would permit the ears to act like simple cantilevers, that is, to be flexed outwardly.

Because of the rigidity of the ears and additionally because of the fact that they are forced to move outwardly when the pin is inserted, the stresses imposed by the inserted pin are transmitted from the ears to the body portion **36** of the socket which deforms in response to these stresses along its length as illustrated in FIGS. 10 and 12. As shown in FIGS. 10 and 12, the body portion has a tendency to flex inwardly, particularly in the zones indicated at **70** between the open seam **38** and the lances **40**. These sections, at least, of the body portion appear to function as elliptic or semi-elliptic springs resiliently biasing the inner surfaces of the ears against the surface of the leading end of the pin. The ears, in turn, bias the lower side of the pin (as viewed in FIG. 12) against the upper surface of the connecting strip **11**. In the particular embodiment of the invention disclosed, the nature of the deformation also causes the seam **38** in the body portion to be opened somewhat immediately adjacent to the ears **42** and to be closed intermediate the ends of the body portion. The right hand or rearward end of the seam may open slightly as a result of the stresses imposed by the insertion of the pin or may have the same width after insertion as it has before insertion. Finally, it should be mentioned that in the particular embodiment of the invention herein disclosed, the body portion assumes a slighly oval configuration after insertion of the pin with the major axis of the oval extending transversely of the open seam **38** on the upper side of the body portion. This effect is illustrated best in FIG. 12 where it can be seen that the upper edge of the right hand side of the body portion has been drawn away from the shoulder **64** in the housing while the edge on each side of the seam is firmly against this shoulder, see FIG. 10.

An essential feature of the invention is that the body portion **36** of the socket deforms along its length when the pin is inserted and performs the function of a contact spring maintaining the inner surfaces of the ears **42** against the surface of the inserted pin. As noted previously, the ears bias the leading end of the contact pin against the surface of the connecting strip **11**. The surface of this connecting strip comprises the high conductivity metal **48** of the strip and extends continuously to the other contact sockets of the cluster. By virtue of this arrangement, a low resistance conducting path is provided between contact sockets in the module. The ears themselves function as contact means to some extent in that they are resiliently biased against the pin, however, the conducting path from the ears of one socket to the other socket or sockets of the cluster must extend through the body portion of the socket and in the disclosed embodiment, this body portion is of a material having a relatively lower conductivity (because it is of beryllium copper) than the conductivity of the connecting section **11**. If the socket were to be made from homogeneous stock metal, rather than the laminated stock of FIG. 2, the electrical function of the ears would be of greater significance than in the disclosed embodiment.

The precise mechanism by means of which the contact spring effect is achieved may vary somewhat from the mechanism discussed above which pertains to the particular embodiment of the invention herein disclosed. The variations in the mechanism may depend upon, for example, the thickness of the stock metal **46**, the length of the body portion, and the amount of movement of the ears brought about by the leading end of the inserted pin. It is quite possible that a combination of effects will result when the pin is inserted and there may be some outward deflection of the ears relative to the body portion of the socket after the body portion itself has been resiliently deformed as shown in FIGS. 10 and 12. In other words, when the leading end of the pin first engages the ears as the pin moves toward its fully inserted position, the ears will be moved outwardly and the body portion of the terminal will be resiliently deformed as illustrated in FIG. 12. As the body portion is deformed, however, it becomes resistant to further elastic deformation and relative movement of the ears with respect to the body portion, that is bending of the ears with respect to the body portion, can take place.

It will be apparent that the salient feature of the invention, that is, the use of the body portion of the socket as a contact spring, can be achieved in a variety of specific socket designs so long as the ears, or their equivalents, remain resistant to flexure when the pin is inserted and function to transmit stresses to the body portion which in turn should be capable of resiliently deforming so that it can perform its function as a spring means.

Changes in construction will occur to those skilled in the art and various apparently different modifications and embodiments may be made without departing from the scope of the invention. The matter set forth in the foregoing description and accompanying drawings is offered by way of illustration only.

What is claimed is:

1. An electrical contact socket adapted to receive a contact pin at one end thereof, said socket comprising a hollow cylindrical body portion having pin engaging means extending inwardly from its other end and having conductor means extending from said other end, said socket being contained, and relatively closely confined against circumferential expansion, in a cavity in an insulating housing, said pin engaging means being rigidly attached to said body portion and said body portion being resiliently deforamable inwardly towards the axis of said

body portion along its length upon relative movement of said pin engaging means away from the axis of said body portion whereby, upon insertion of said contact pin, said pin engaging means is moved relatively away from the axis of said body portion and said body portion is resiliently deformed along its length, said body portion functioning as a contact spring urging said pin engaging means against said pin and said pin engaging means urging said pin against said conductor means.

2. A contact socket as set forth in claim 1 wherein said socket is formed of relatively thin sheet metal stock having good spring properties, said socket having a layer of a metal having good electrical properties on said conductor means, said layer forming a shoulder for engagement by said pin to prevent movement of said pin through said socket.

3. A contact socket as set forth in claim 1 including integral retaining lance means struck from the wall of said body portion and extending towards said other end, said lance means being adapted to engage said contact pin to prevent removal thereof from said socket.

4. A contact socket as set forth in claim 1 wherein said body portion has an axially extending seam.

5. A contact socket as set forth in claim 1 wherein said pin engaging means comprises ear means integral with, and extending from, said other end of said body portion.

6. A contact socket as set forth in claim 5 wherein said socket is formed of relatively thin sheet metal stock having good spring properties, said socket having a layer of metal having good electrical properties on said conductor means and on said ear means, said layer forming shoulder means for engagement by said pin to prevent movement of said pin through said socket.

7. Disengageable electrical connecting means comprising a contact socket and a contact pin disposed in said socket, said socket being contained in a cavity in an insulating housing and comprising a cylindrical body portion having an axially extending open seam, said cavity confining said body portion against substantial circumferential expansion,

ear means rigidly attached to the end of said body portion which is adjacent to the end of said pin, said ear means extending obliquely inwardly with respect to the axis of said body portion and being held in an outwardly displaced position by said contact pin,

said body portion being resiliently inwardly bowed along its length by stresses transmitted from said ear means whereby said body portion functions as a contact spring and maintains said ear means against said pin.

8. Connecting means as set forth in claim 7 wherein said contact pin has a circumferential collar intermediate its ends, lance means struck from said body portion, said lance means being in engagement with one side of said collar and preventing movement of said contact pin in one direction, shoulder means in said socket, said shoulder means being in engagement with the other side of said collar and preventing movement of said pin in the opposite direction.

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MARVIN A. CHAMPION, Primary Examiner

J. H. McGLYNN, Assistant Examiner

U.S. Cl. X.R.

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