Feb. 20, 1968 Q. BERG 3,370,265

ELECTRICAL CONNECTOR

Filed May 9, 1966

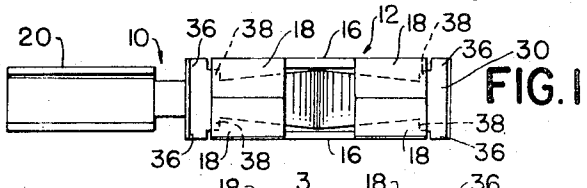

FIG. 1

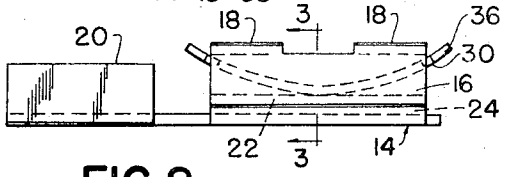

FIG. 2

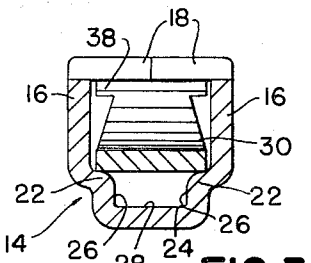

FIG. 3

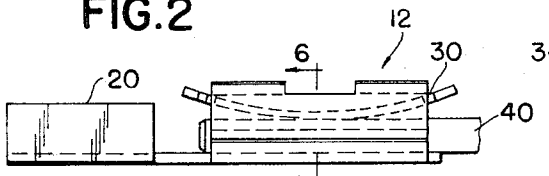

FIG. 5

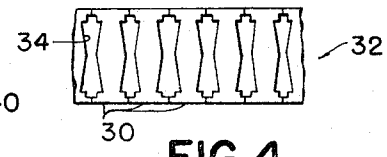

FIG. 4

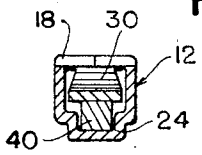

FIG. 6

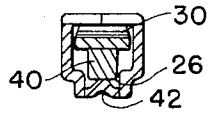

FIG. 7

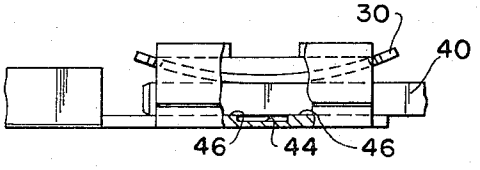

FIG. 8

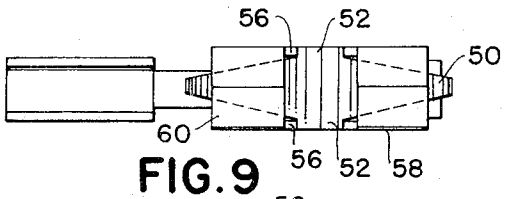

FIG. 9

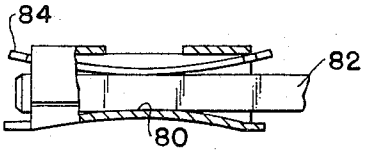

FIG. 16

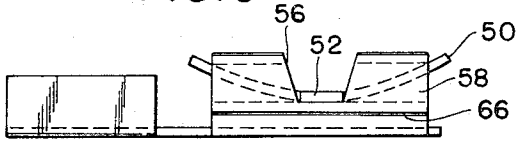

FIG. 10

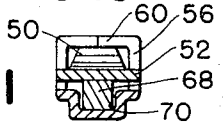

FIG. 11

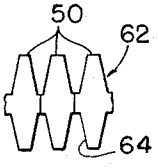

FIG. 12

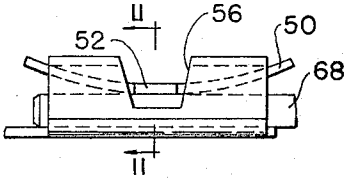

FIG. 13

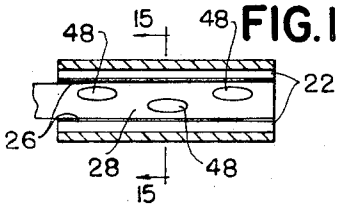

FIG. 14

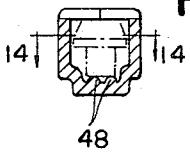

FIG. 15

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ELECTRICAL CONNECTOR

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31 Claims. (Cl. 339—256)

This invention relates to an electrical connector and particularly to an improved electrical contact member for receiving and making contact with a square or rectangular pin connector. The contact member includes a contact socket formed from relatively malleable sheet metal stock and a bowed metal spring which is held within the socket. The spring and socket cooperate to assure that a positive electrical connection is made between the socket and the pin despite repeated insertions of the pin into the socket. The socket is provided also with novel means for orienting the pin as it is inserted so as to assure proper mating of the pin in the socket.

Accordingly, an object of the invention is to provide an improved electrical connector.

Another object is to provide an electrical contact element with a novel spring and socket construction having a long useful life.

A further object is to provide an electrical connector having improved means for orienting the contact pin within the connector.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawings, illustrating preferred embodiments of the invention, wherein:

FIGURE 1 is a top plan view of a contact member according to the invention;

FIGURE 2 is a side view of FIGURE 1;

FIGURE 3 is an enlarged sectional view taken along line 3—3 of FIGURE 2;

FIGURE 4 shows a ladder of spring elements formed from a sheet metal strip;

FIGURE 5 is a view similar to FIGURE 2 except that a disconnect pin has been inserted into the contact member;

FIGURE 6 is a sectional view taken along line 6—6 of FIGURE 5;

FIGURE 7 is a sectional view similar to that of FIGURE 6, showing a modification of the invention;

FIGURE 8 is a partially broken away view similar to that of FIGURE 5, showing a modification of the invention;

FIGURES 9, 10, 11, 12 and 13 illustrate a modified form of the invention;

FIGURE 14 is a sectional view of another modification of the invention taken along line 14—14 of FIGURE 15;

FIGURE 15 is a sectional view taken along line 15—15 of FIGURE 14; and

FIGURE 16 illustrates a further modification of the invention.

As shown in the drawings, the invention comprises a contact member **10** having an elongated socket **12** with base **14**, side walls **16**, and a top formed from bent over tabs **18** located at each end of the side walls **16**. A suitable wire contact ferrule **20** is located at one end of socket **12**. The socket **12** and ferrule **20** are formed from relatively malleable metal of high conductivity. The socket

base **14** includes stepped portions **22** at the lower ends of each side wall **16** and a disconnect groove **24** between the stepped portions **22**. The disconnect groove **24** runs the length of the socket **12** and is defined by side walls **26** and a bottom wall **28**.

A contact spring **30** is formed from a strip **32** of relatively resilient spring metal as illustrated in FIGURE 4. Portions **34** are punched from the strip **32** leaving a ladder-like strip formed of a number of contact springs **30** joined together at their ends so that the length of the contacts **30** forms the ladder rungs. The cut-out strip **32** is then fed between curved rollers so that the springs in the strip are bowed downwardly at the center thereof. The individual spring elements are then severed from the strip **32** and inserted in a socket **12**, following which the upstanding tabs **18** are bent over as illustrated in FIGURE 1 to form the top of the socket and hold the spring **30** within the socket.

The spring is confined between the socket side walls **16** with the center of the spring having a width almost equal to the interior width of the socket. To either side of the center of the spring the width thereof decreases so that the width of the spring adjacent the ends of the socket is substantially less than the width of the spring at the center of the socket. The ends of the spring **30** are provided with lateral ears **36** which project to either side of the socket outside of the side walls **16** and limit axial shifting of the spring in the socket. Shoulders **38** located adjacent the ears **36** have a sliding fit within the socket between the side walls **16** and serve to position the spring **30** between the side walls.

As illustrated in FIGURE 2, the downwardly bowed spring **30** is normally confined in the socket **12** with the ends thereof slidably abutting the outer edges of the bent over tabs **18** and with the center portions thereof resting on the stepped portions **22** of the socket. The spring **30** is not physically attached to the socket **12** but is movably confined in position within the socket by the ears **36** and by the spring tension due to its curved shape. This is important since the spring is free to move relative to the socket **12** so that the elastic limits of the spring **30** are not exceeded as the pin is inserted in the socket.

A square disconnect pin **40** may be inserted into the socket **12** of the contact member **10** by pushing the beveled end thereof into the exposed end of the disconnect groove **24**. The groove **24** has a width slightly greater than the width of the pin **40** and guides the pin as it is pushed into the socket. At the ends of the socket the distance between the bottom **28** and the spring **30** is greater than the pin height. This distance decreases toward the center of the socket so that the pin is easily placed in the end of the socket and inserted by pushing it along groove **24**.

With insertion of the pin in the socket the center portion of the spring **30** comes into contact with the pin and is lifted upwardly so that it no longer abuts the stepped portions **22**. Since the spring is not rigidly connected to the socket **12**, the ends thereof slide outwardly of the socket so as to compensate for the flattening of the spring caused by pin **40**. The decreasing width of the spring **30** to either side of the center thereof assures that the stressing of the spring caused by the pin **40** is more uniform along the length of the spring and that the elastic limit of the spring is not exceeded. By tapering the spring to

either side of the center thereof and by freely confining it within the socket the spring life is extended since the spring is never stressed past its elastic limit.

As the pin is inserted into the socket the spring **30** and groove **24** assure that the pin is properly oriented relative to the socket so that the desired connection therebetween is achieved. Since it is contemplated that the pin **40** may be very small with a side dimension of approximately 0.025 inch, this automatic alignment of the pin relative to the socket is very important because of the near impossibility of checking the orientation of the pin relative to the socket.

The spring **30** holds the contact pin **40** against the bottom **28** of the disconnect groove **24** as the pin is inserted into the socket and guarantees a positive wiping action between the contact surface of the pin **40** and the base of the groove. This wiping of the contact surfaces assures that oxides or impurities on either of the surfaces are broken up and that a desirable metal-to-metal contact is made between the surfaces. The spring force exerted at the contact surface is greater than in conventional connectors of the type disclosed herein because the spring width is greater than the width of the square contact pin. This spring force guarantees that a proper electrical contact is maintained between the pin and the socket.

FIGURE 7 shows a modification of the invention wherein an upwardly extending contact ridge **42** is formed along the length of the bottom of the disconnect groove. The height of the contact ridge **42** above the bottom of the groove is less than the height of the groove side walls **26** so that the contact pin **40** is accurately held within the socket between the walls **26** and the contact ridge **42**. The ridge may extend the length of the socket or a number of ridges may be formed on the bottom of the disconnect groove. The spring **30** holds the pin **40** against the top of the contact ridge **42**. As illustrated in FIGURE 7, the stressed area of the spring is greater than the contact area of the socket so that a greater contact pressure between the pin and socket is achieved. This greater contact pressure results in improved wiping and electrical contact between the pin and the socket. In the case where there are a number of contact ridges formed in the base of a disconnect groove, the top of each ridge makes contact with the pin **40** so that a number of electrical connections are formed between the pin and the socket. The redundancy of contact guarantees a positive connection between the pin and the socket. If for some reason one of the contacts fails or has a high contact resistance, the other contacts will establish the desired connection between the pin and socket.

Another modification of the invention is illustrated in FIGURE 8 which is similar to FIGURE 5 with the exception that the bottom of the disconnect groove is provided with a recessed portion **44**. The recessed portion extends between the groove side walls and isolates the two bottom contact areas **46** with the result that a redundant contact is formed between the pin and the bottom contact areas.

The modification of the invention illustrated in FIGURES 14 and 15 utilizes a socket similar to that shown in FIGURES 1 and 2 with the exception that the bottom of the disconnect groove is provided with three upwardly projecting contact points **48**. The spring holds the pin in intimate contact with the three contact points **48** so as to provide the desired electrical connection therebetween. The contact points **48** may be staggered within the disconnect groove so that the contact portions of the points define a plane which in cooperation with the disconnect groove side walls properly orients the pin within the socket and provides the maximum redundancy of contact points. In very low voltage circuits where high reliability is essential (such as in electronic computers or missile control circuits) this configuration best assures multiple contact with warped or bent pins **40**. While the drawings illustrate a contact member with three contact points formed in the disconnect groove, it is clear that a different number of such contact points may be formed in the groove.

FIGURES 9–13 illustrate a modification of the invention in which the spring member **50** is of cruciform shape with lateral ears **52** at the center thereof. The ears **52** are positioned within grooves **56** in the side walls **58** of the socket. The ends of the spring **50** extend outwardly past the bent over top tabs **60** and slidingly abut the outward ends thereof. Springs **50** are formed from a strip **62** of relatively resilient spring metal by removing the areas indicated at **64** so as to form a chain of springs **50** connected by the lateral ears. The formed chain is then rolled so as to bend the spring **50** as desired.

The lateral ears **52** of the spring **50** limit axial shifting of the spring within the socket. As illustrated in FIGURE 10, the spring **50** is normally positioned in the socket with the center portion thereof resting on the stepped portions **66** of the socket and with the ends thereof biased against the top tabs **60** by the resiliency of the spring. When the contact pin **68** is inserted in the disconnect groove **70**, the spring **50** is forced upwardly by the pin and holds the pin in the groove so as to assure a desirable electrical connection between the contact surface of the pin and the bottom of the disconnect groove. The cruciform shaped spring may be used with any of the socket constructions previously described.

The spring **50** is widest at its center where the ears project outwardly of the socket. The width of the spring tapers inwardly to either side of the center thereof so that the spring is uniformly and elastically deformed when the pin is fully inserted in the socket. As mentioned with regard to the embodiment disclosed in FIGURES 1 and 2, this feature results in extended spring life so as to assure that proper connection is made between the socket and the pin despite repeated insertions of the pin in the socket. Spring **50** is also wider than pin **68** and accordingly exerts the desired high spring force at the contact interface.

FIGURE 16 illustrates a further modification of the invention wherein the bottom of the disconnect groove is curved upwardly to provide a raised contact surface **80** for engagement with pin **82**. The spring **84** holds pin **82** against surface **80** to assure a positive electrical connection despite relative movement of the pin and socket.

The contacts disclosed herein utilize a bi-metal construction wherein the socket and ferrule are formed of relatively malleable metal of high electrical conductivity, such as brass, copper, or bronze, and may be plated or solder-dipped to improve the contact properties of the socket. The spring is formed from high yield strength spring metal, such as a beryllium copper alloy, stainless steel, or other metals or alloys. The spring holds the pin in the socket and assures that a proper electrical connection is made between the pin and socket. The high electrical conductivity of the socket and ferrule metal aids in eliminating electrical resistance across the connector. The high yield strength of the spring and its elastic spring deformation result in long spring life and the ability to withstand repeated pin insertions without reduction of spring force. The high yield strength of the spring is such that complete flattening of the spring against the top of the socket, such as may occur during insertion of a misaligned pin into the socket, does not stress the spring past its elastic limit and does not result in weakening the spring. Conventional connector of the type disclosed are formed from a single piece of metal stock and are unsatisfactory since it is impossible in a one-metal connector construction to achieve the desired electrical properties and spring properties of the bi-metal construction taught by the invention.

While I have illustrated and described preferred embodiments of my invention, it is understood that these are capable of modification, and I therefore do not wish to be limited to the precise details set forth but desire to avail myself of such changes and alterations as fall within the purview of the following claims.

What I claim as my invention is:

1. A contact member for an electrical connector comprising an elongated socket formed from relatively malleable sheet metal stock; said socket having a base, two side walls extending upwardly therefrom, a top wall extending between the tops of the side walls at the ends thereof, and means extending from one end of the socket for forming an electrical connection with a circuit element; said socket base including stepped portions located adjacent said socket side walls and a disconnect groove located between said stepped portions, said disconnect groove including groove side walls and a bottom wall located at a level below that of said stepped portions, the width of said disconnect groove being less than the interior width of said socket; an elongated spring member formed from resilient sheet metal stock located within said socket, said spring member being bowed longitudinally along the length thereof and the central portion thereof engaging said socket so as to be normally confined by spring tension against said top wall, and locating means for limiting axial shifting of said spring member in said socket whereby upon insertion of a pin contact element in said socket said spring member is elastically stressed by the contact element and holds the contact element in intimate contact with said bottom wall so as to form an electrical connection therebetween.

2. A contact member as in claim 1 wherein said spring member has a decreasing width to each side of its center.

3. A contact member as in claim 1 wherein said locating means includes slots in said socket side walls and lateral ears located at the center of said spring member, said ears being positioned in said slots.

4. A contact member as in claim 1 wherein said locating means includes lateral ears located at the ends of said spring member outside of said socket so that the ends of said spring member have a width greater than the width of said socket.

5. A contact member as in claim 1 wherein said spring member has a greater stressed area than the contact area of said groove bottom wall.

6. A contact member as in claim 1 wherein said bottom wall includes a number of contact points extending upwardly therefrom a distance less than the height of said groove side walls so as to form a redundant electrical connection with said contact element.

7. A contact member as in claim 1 wherein said bottom wall includes a longitudinal contact ridge running along the length of said socket, said ridge extending upwardly from said bottom wall a distance less than the height of said side walls.

8. A contact member as in claim 1 wherein said bottom wall includes a recessed portion to define a plurality of contact areas on said bottom wall.

9. A contact member as in claim 1 wherein the distance between said bottom wall and said spring member at one end of the socket is greater than the width of said groove.

10. A contact member as in claim 1 wherein the width of said spring member is greater than the width of said groove.

11. A contact member as in claim 1 wherein said bottom wall has a raised contact area for engagement with said contact element.

12. A contact member as in claim 1 wherein the central portion of said spring member engages said stepped portions.

13. A contact member for an electrical connector comprising an elongated socket formed from relatively malleable sheet metal of high electrical conductivity and having a base, side walls, and a top, a longitudinally bowed elongated spring member formed from high yield strength metal, said spring member being confined within said socket with end portions thereof slidably abutting said top, locating means for limiting axial movement of said spring member in said socket, the central portion of said spring member engaging a portion of said socket so that said spring member is confined under spring tension between said top and said portion of said socket, said spring member having a decreasing width to each side of its center so that the spring member is uniformly and elastically deformed when a pin contact element is fully inserted in the socket, and means for connecting said contact member to a circuit element whereby upon insertion of the pin contact element in said socket said spring member holds the contact element in intimate contact with said base so as to form an electrical connection therebetween.

14. A contact member as in claim 13 wherein the central portion of said spring member engages said base.

15. A contact member as in claim 13 wherein said locating means comprises lateral ears carried by said spring member, said ears having a width greater than the width of said socket.

16. A contact member as in claim 13 wherein said locating means comprises slots formed in said socket side walls, and lateral ears at the center of said spring member, said ears being positioned within said slots.

17. A contact member as in claim 13 wherein said base includes guide means for orienting the pin contact element in said socket.

18. A contact member as in claim 17 wherein said guide means comprises a disconnect groove running the length of said socket.

19. A contact member as in claim 13 wherein said base has a raised contact area for engagement with said contact element.

20. A contact member for an electrical connector comprising an elongated socket formed from relatively malleable sheet metal of high electrical conductivity and having a base, side walls, and a top, a longitudinally bowed elongated cruciform shaped spring member formed from high yield strength metal and having lateral ears at the center thereof, said spring member being confined within said socket with end portions thereof slidably abutting said top, the central portion thereof bowed downwardly toward said base and the underside thereof engageable with a portion of said socket, said ears limiting axial movement of said spring member in said socket, and means for connecting said contact member to a circuit element whereby upon insertion of a pin contact element in said socket said spring member is elastically stressed by the contact element and holds the contact element in intimate contact with said base so as to form an electrical connection therebetween.

21. A contact member as in claim 20 wherein the central portion of said spring member normally engages said base to put the spring member under spring tension.

22. A contact member as in claim 20 including slots formed in said socket side walls, said ears being positioned within said slots.

23. A contact member as in claim 20 wherein said spring member has a greater stressed area than the contact area of said base.

24. A contact member as in claim 20 wherein said base includes guide means for orienting the contact element in said socket.

25. A contact member as in claim 24 wherein said guide means comprises a disconnect groove running the length of said socket.

26. A contact member as in claim 25 wherein said spring member has a width greater than that of said groove.

27. A contact member as in claim 25 wherein said groove includes a number of contact points extending upwardly from the bottom thereof a distance less than the depth of said groove so as to form a redundant electrical contact with said pin.

28. A contact member as in claim 21 wherein the bottom of said groove includes a longitudinal contact ridge

running along the length of said socket, said ridge extending upwardly from said bottom a distance less than the depth of said groove.

29. A contact member as in claim **21** wherein the bottom of said groove includes a recessed portion so as to define a plurality of contact areas in such groove.

30. A contact member as in claim **20** wherein said spring member decreases in width from said ears toward its opposite ends.

31. A contact member as in claim **20** wherein said base has a raised contact area for engagement with said contact element.

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