United States Patent

Kinkaid et al.

[15] **3,705,376**

[45] **Dec. 5, 1972**

[54] **CONNECTOR WITH RELEASABLE SPRING CONTACT AND RELEASING TOOL**

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[73] Assignee: **AMP Incorporated,** Harrisburg, Pa.

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[21] Appl. No.: **92,742**

[52] **U.S. Cl.**.....**339/30,** 287/53 H, 339/75 R, 339/95 D, 339/255 R, 339/259 R, 339/262 R

[51] **Int. Cl.**.....**H01r 11/20,** H01r 13/20

[58] **Field of Search**.....339/19, 21, 22, 31, 32, 33, 339/74 R, 75 R, 256 R, 258 R, 258 S, 259, 262 R, 262 P, 255 R, 95 R, 95 D, 242, 223; 292/349; 287/53 H; 279/15 G, 29, 76; 248/221, 230

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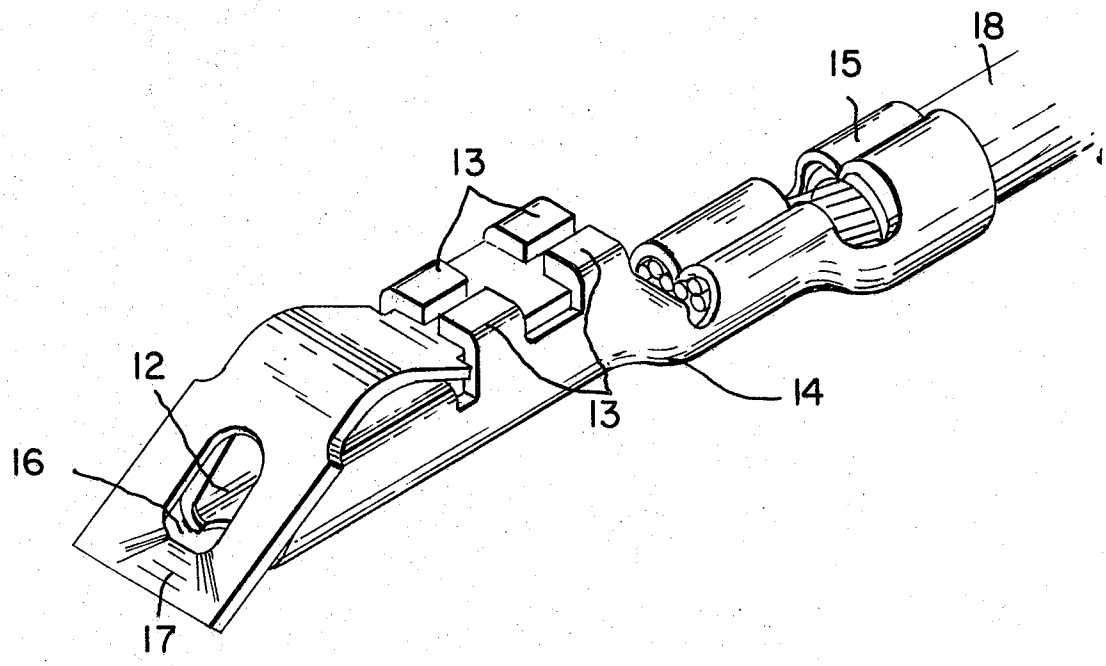
[57] **ABSTRACT**

A connector assembly including a contact body having a crimped wire barrel portion and a channel portion with a finger-like spring mounted on the channel portion. An opening near a free end of the spring is located opposite one end of the channel permitting insertion of a conductive post through the opening and into the channel. The spring is appropriately biased to bite the post along one edge of the opening while releasing the post by use of a tool which applies a force at the end of the spring in the direction of the channel.

11 Claims, 10 Drawing Figures



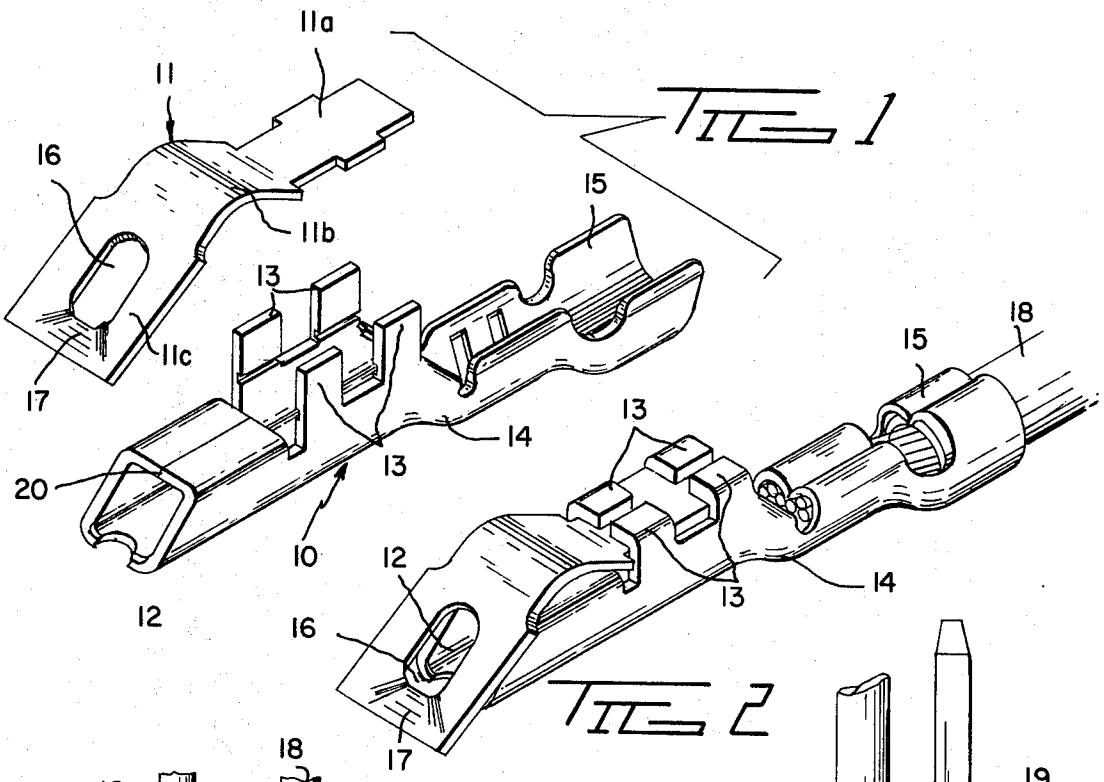


FIG 1

FIG 2

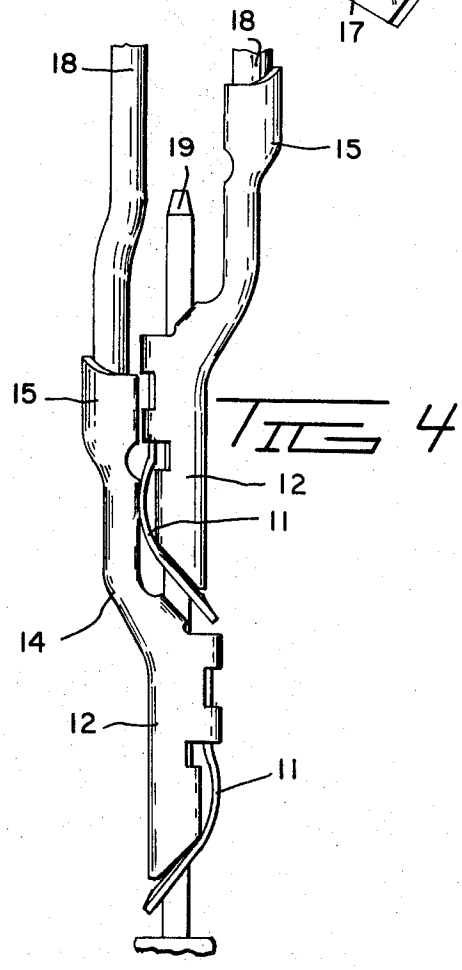


FIG 4

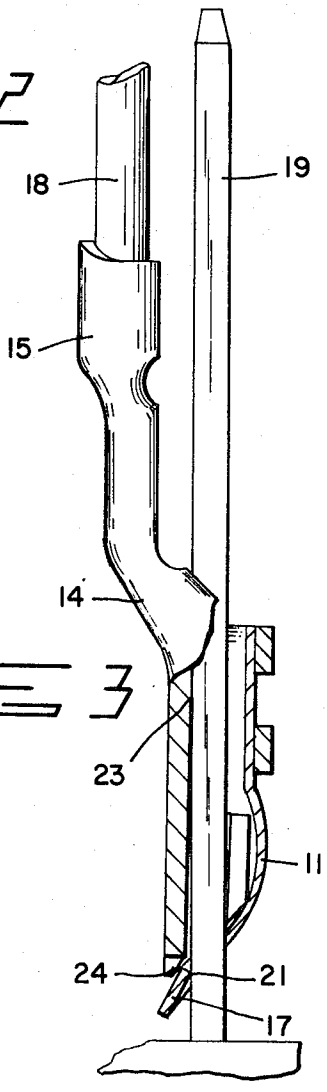


FIG 3

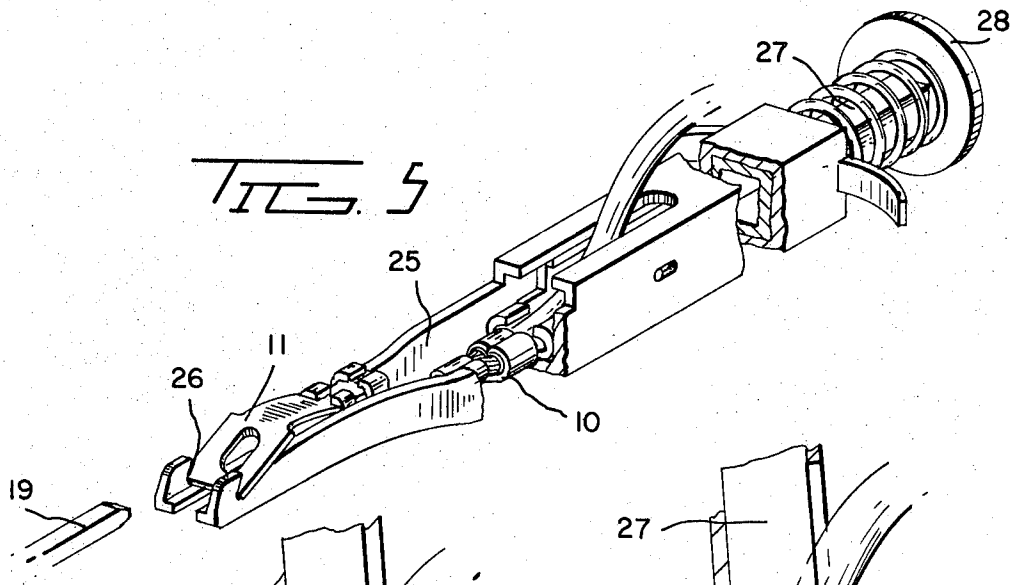


FIG. 5

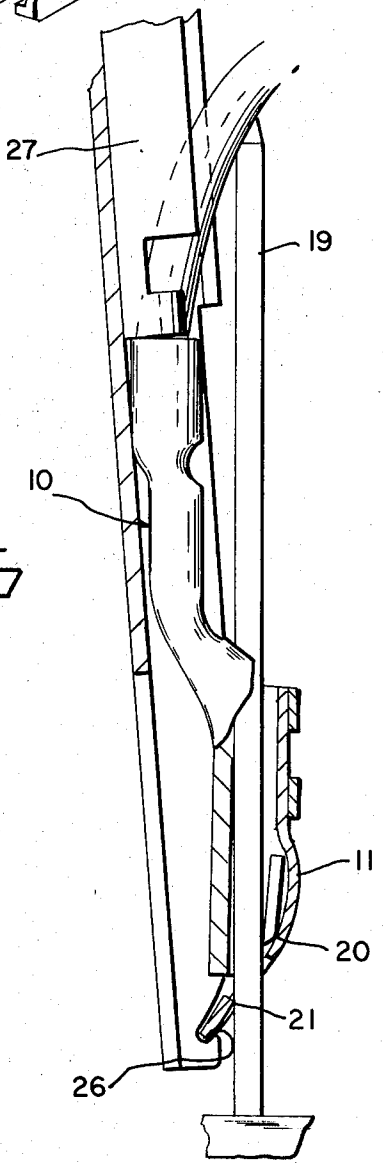


FIG. 6

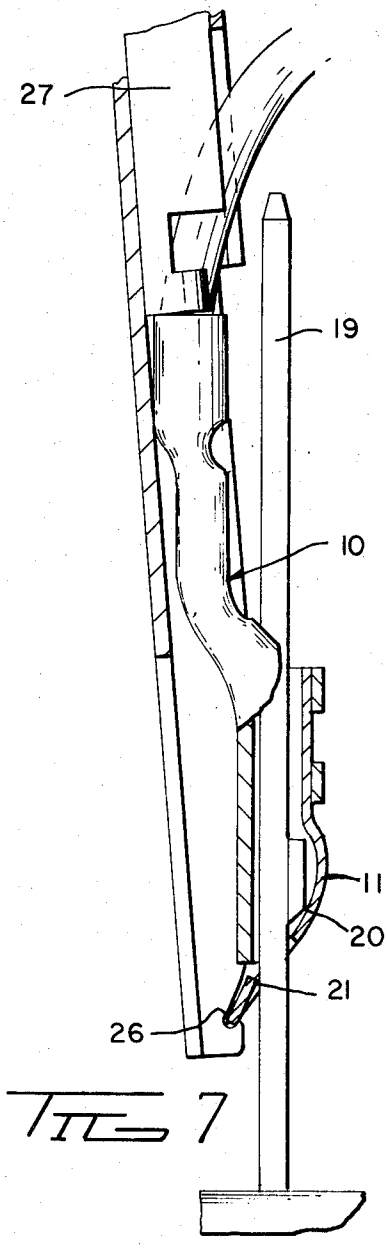


FIG. 7

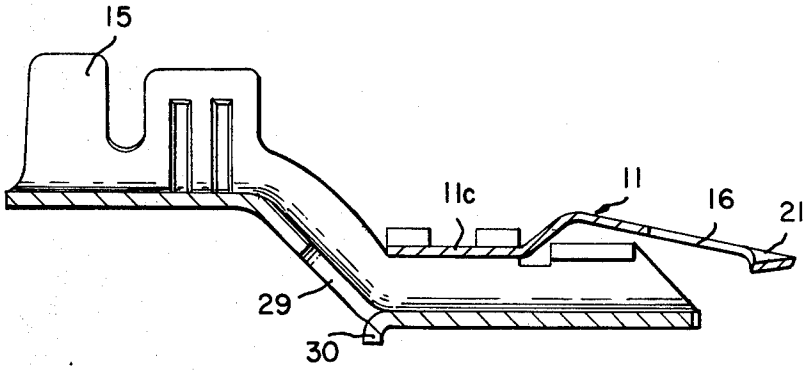


FIG 9

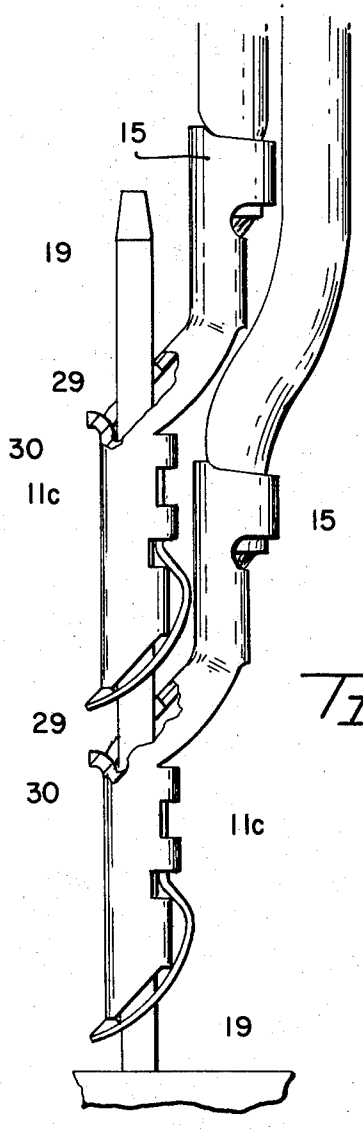


FIG 8

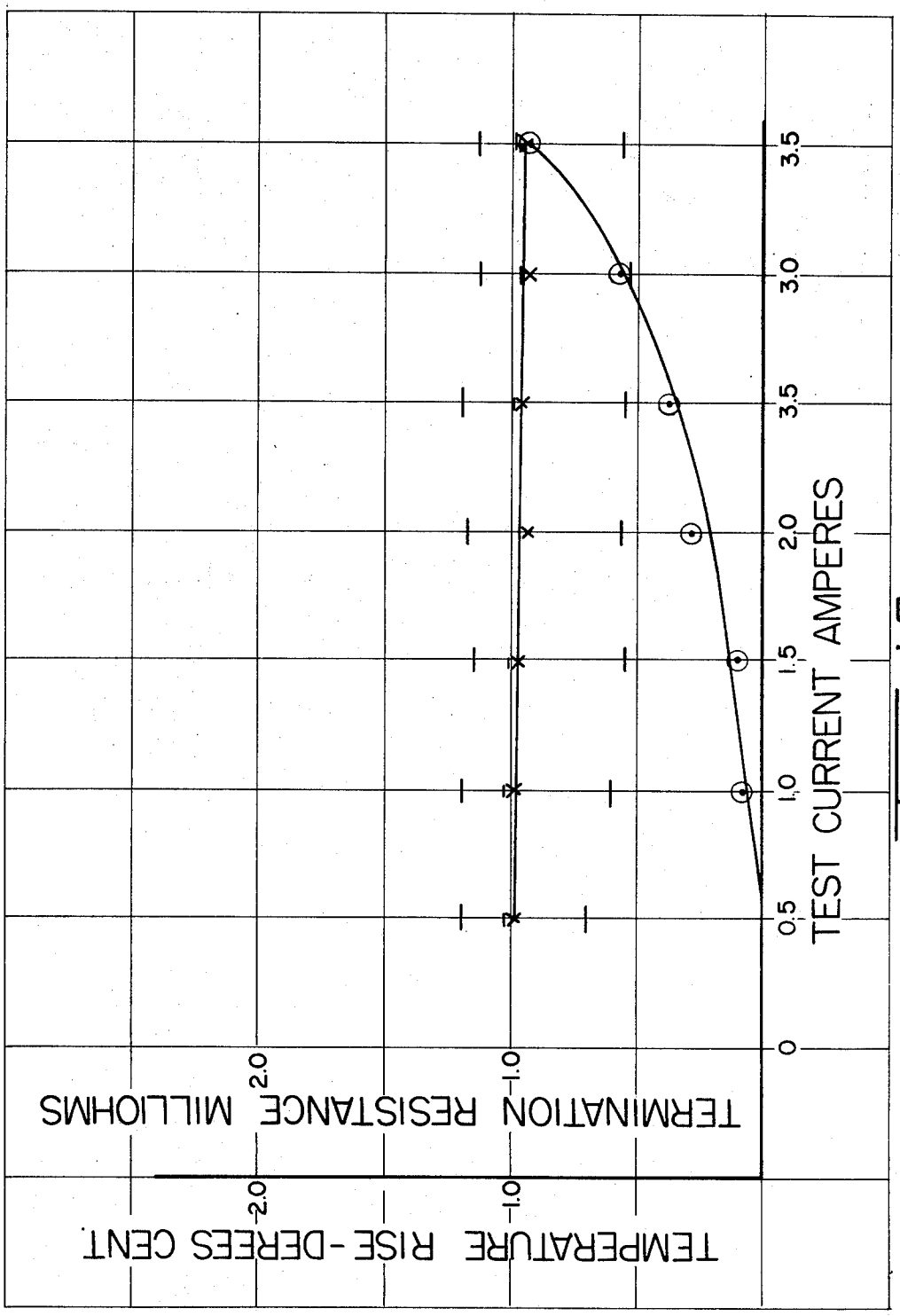

TEMPERATURE RISE - DEGREES CENT
TERMINATION RESISTANCE MILLIOHMS
2.0
1.0
2.0
1.0
0
0.5
1.0
1.5
2.0
3.5
3.0
3.5
TEST CURRENT AMPERES

FIG 10

CONNECTOR WITH RELEASABLE SPRING CONTACT AND RELEASING TOOL

BACKGROUND OF THE INVENTION

This invention relates to connectors and, more particularly, to connectors of the spring contact type for releasably receiving conductive posts.

Various connectors of the spring contact type have been proposed, but many spring contacts will not readily release a mating conductive post. In many instances, the connector must be destroyed to break the electrical connection. In other instances, rather complicated tools must be employed to break the connection.

The nature of the electrical contact between the connector and the conductive post is also a source of some difficulty in the spring contact prior art. For example, the spring contact disclosed in U.S. Pat. No. 1,240,186 — Fahnestock does not provide an elongated conductive channel to assure substantial contact with a conductive post. Furthermore, the spring contact of Fahnestock is examplary of prior art which is characterized by an undesirable increase in resistance with temperature.

In certain cases, the prior art spring contacts have precluded the stacking of contacts on a single conductive post. The spring contact disclosed in U.S. Pat. No. 2,617,844 — Sanda is illustrative.

SUMMARY OF THE INVENTION

In accordance with one important aspect of the invention, a connector of the spring contact type is provided which will readily release a conductive post. Accordingly, the spring contact comprises a conductive channel adapted to receive a conductive post and further comprises a spring having an opening located at the end of the channel. The spring is appropriately biased to a position characterized by misalignment between an edge of the opening and one side of the channel so as to bite one side of the conductive post at the edge of the opening upon insertion of the post into the channel through the opening. By applying a force at the end of the spring adjacent the opening, the conductive post is released by the spring.

In accordance with another important aspect of the invention, proper contact is made between the channel and the conductive post. In this connection, the spring of the connector comprises a fixed portion extending along the channel and a flexible portion including the opening near the spring end which is free to move about a fulcrum at the end of the channel. Upon insertion of the conductive post into the channel through the opening in the spring, contact is made between the post and the channel at the side of the channel opposite the edge of the opening and adjacent the fulcrum of the spring. Another area of contact between the channel and the post is located at the other end of the channel and on the side of the post which the edge of the opening bites.

In accordance with still another important aspect of the invention, a connector is provided displaying a negative resistance characteristic. This is accomplished by utilizing a spring separate from and mounted on the channel of the spring contact. The spring comprises a material having a thermal coefficient of expansion less than the thermal coefficient of expansion for the channel so as to increase the pressure between the conductive post and the channel adjacent the fulcrum with increasing temperature.

In accordance with yet another aspect of the invention, connectors are provided which may be conveniently stacked on a conductive post. Accordingly, the connectors include a wire barrel portion which is axially offset from the channel portion and connected thereto by a transition portion. This permits two or more connectors to be mounted on a single conductive post with the spring of one connector biting one side of the conductive post and the spring of the adjacent connector biting the other side of the conductive post. By axially off-setting the wire barrel portion of the connector on the same side as the fixed portion of the spring and providing a somewhat longer transition portion, a pair of connectors may be stacked on a conductive post with the respective springs biting the same side of the conductive post. With such a connector, it is desirable to provide ears at the end of the channel remote from the opening of the spring for purposes of engagement by a tool utilized in releasing the conductive post from the channel.

In accordance with a further important aspect, a tool is provided for the release of a conductive post from the connector. Such a tool may comprise hook means for engaging the free end of the spring and an actuated member for applying an axially compressive force on the connector. As an axially compressive force is applied to the connector, the free end of the spring pivots about the fulcrum forcing the end of the spring away from the conductive post to release the bite.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded view of a connector embodying the invention;

FIG. 2 is a perspective view of the connector shown in FIG. 1;

FIG. 3 is a side view of the connector shown in FIG. 2 in combination with a conductive post, the contact being shown in partial cross-section;

FIG. 4 is a side view of a pair of the connectors shown in FIG. 2 stacked on the conductive posts;

FIG. 5 is a perspective view of a tool releasing a conductive post from the spring contact of FIG. 2;

FIGS. 6 and 7 depict sequential steps in the operation of the tool shown in FIG. 5;

FIG. 8 is a side view of a pair of modified connectors embodying the invention which are stacked on a conductive post;

FIG. 9 is a sectional view of one of the connectors shown in FIG. 8; and

FIG. 10 is a graph depicting connector characteristics as a function of current.

BRIEF DESCRIPTION OF PREFERRED EMBODIMENTS

FIG. 1 is an exploded view of a connector of the spring contact type comprising a body 10 and spring 11. As shown, the body includes a channel portion 12 for receiving a conductive post, a transition portion 14, and a wire barrel portion 15 axially offset from the channel portion 12 for receiving a wire. The body 10 also includes ears 13 which are adapted to bend over a fixed portion 11a of the spring 11.

The spring also includes an arched portion 11b and a locking portion 11c. An opening 16 is provided in the locking portion 11c which is partially aligned with the channel when the connector is assembled as shown in FIG. 2. The locking portion 11 of the spring also includes a dish 17 which strengthens the spring 11 and, as will be subsequently explained, optimizes the bite of the locking portion 11c on the post.

Note that each of the ears 13 is precreased. Therefore, when the ears are bent over the fixed portion 11c of the spring, the resulting bend across the fixed portion 11c will be uniform, right-angled and not radiused. This type of bend will not buckle the spring. The wire barrel 15 is bent or crimped over the connecting wire 18 in a substantially conventional manner.

FIG. 3 shows the connector in place on a post 19. The arched portion 11b of the spring extends around the corner, or fulcrum point 20 external to the channel. An edge 21 of the opening 16 is biased to a position of slight misalignment with one side of the channel before the post 19 is inserted. When the post 19 is inserted into the channel through the opening 16 as shown in FIG. 3, the spring 11 bites, that is, bears against, the post 19 at the edges 21 in the dish 17.

Note that the angle of bite for the spring at the edge 21 is reduced and thereby optimized by the dish 17. Furthermore, the dish 17 forms radiased corners which fit into frictional engagement with the corners of the post 19 and improve the holding ability of the connector.

The electrical contact between the post 19 and the channel occurs in three different areas. One area is adjacent the fulcrum 20. The other area 23, is on the opposite side of the channel adjacent the transition portion 14. The pressure exerted by the spring holding the post 19 against the two areas of the channel provides ample electrical contact between the post 19 and the channel. There is also electrical contact through the spring member.

Referring again to FIG. 3, it will be noted that, when the connector is in place on the post 19, there is a gap 24 between the spring 11 and the portion of the body 10 which forms the channel 12. This gap is important because the spring can be depressed through this gap to release the bite or pressure on the post. Note further that, if the tip of the spring is pushed upwardly or in the direction of the channel portion 12, that is, fulcrumed about the corner 20, the spring pressure is released. In this embodiment of the invention, it is particularly convenient to apply pressure to the wire barrel 15 and to the tip of the spring 11 to increase the arch in the arched portion 11c and release the pressure on the post 19. In this manner there is provided a connector which is truly a zero force connector when it is applied. However, after it is applied to the post 19 and the spring bites, the connector cannot be pulled off. It has been found that the wire 18 will pull out the wire barrel 15 before the connector will pull off the post.

FIG. 4 shows two connectors on the post 19. In use, it is commonly necessary to stack two or more connectors on a post in this manner and the connector of this invention is a particularly convenient way of doing so.

FIG. 5 shows a tool for releasing the spring. The tool includes a channel portion 25 which receives the connector and post and hooks 26 which hold the end of the spring 11. A spring-loaded plunger 27 is moved toward the hook by hand operation of the handle 28 thereby applying an axially compressive component of force on the connector as a force is applied to the free end of the spring 11 directed toward the channel 12. FIG. 6 shows the plunger 27 in the position before pressure is applied by the operator. FIG. 7 shows that the hooks 26 which extend perpendicular to the axis of the channel 12 and plunger 27 have been moved closer to each other to further arch the edge 21 of spring 11 away from the post 19 thereby further pivoting the spring around the fulcrum 20 to release the pressure between the post 19 and the body 10. The actual movement of the plunger 27 is very slight as is apparent from an inspection of FIGS. 6 and 7 but is sufficient for releasing the spring from the post.

One particularly useful modification of the tool has an overcenter lever which pushes the plunger 27 forward. With this modification the operator need not maintain the pressure on the plunger 27 while pulling the connector from the post 19.

FIGS. 8 and 9 show a modified connector embodying the invention. In this modification the wire barrel 15 is on the same side as the fixed spring portion 11c. A hole 29 has also been provided in the transition portion. The post extends through this hole. This modification is particularly useful where the connectors are applied by an automated machine. Note that it is not necessary to reverse or rotate two adjacent, stacked connectors by 180° with respect to one another. In this modification of the invention, an ear 30 is provided for exerting pressure to release the spring 11. If pressure were applied between the tip of the spring 11 and the wire barrel 15, as in the embodiment of FIG. 2, the spring would kink. This is avoided by applying pressure between the ear 30 and the tip of the spring 11 to release the bite on the post 19.

FIG. 9 shows the spring 11 in its relaxed position before the post is inserted for the first time. Note the misalignment between the edge 21 and the side of the channel 12. After the post 19 is inserted into the channel 12 through the opening 16, the spring 11 will be bent to a position shown in FIG. 8 while the memory of the spring holds the edge 21 against the post 19.

In one actual embodiment of the invention, the spring 11 comprised stainless steel having a modulus of elasticity of 28×10^6 lbs. The body comprised phosphor bronze although other materials are suitable for use. Other suitable materials include soft copper, grade C copper or any other good conductive material. In one embodiment, the connector of FIGS. 1–4 comprises a body in which the channel portion 12 has a square cross-section $.028 \pm .001$ inches on a side. The square cross-section of the post 19 is $.025 \pm .001$ inches on a side. In the modification of FIGS. 8 and 9, one actual embodiment has a channel 12 with a rectangular cross-section, $.034 \pm .002$ by $.067 \pm .002$. The post in this embodiment is $.031 \pm .001$ by $.062 \pm .001$ inches.

The connector of the present invention exhibits a resistance versus current characteristic. Normally, as the current through a connector increases, the resistance increases. This causes the temperature to increase and the voltage drop across the connector to increase.

However, the connector of the present invention exhibits a negative resistance characteristic. As heat is

generated in the connector by increased current, the body **10** expands faster than the spring **11** due to the different coefficient of expansion between spring and body. In the embodiment previously described, the coefficient of expansion of stainless steel is less than that of a phosphor bronze body. As the body **10** expands, the fulcrum point or corner **20** engages the spring **11** with increased pressure to increase the bias on the spring **11**. The increased bias on the spring improves the contact between the post **19** and the body **10**.

This characteristic is demonstrated by the graph of FIG. **10** which contains two plots. The first is a plot of termination resistance in milliohms as a function of current. The X's are average values of tests on five samples. The bars above and below the X's represent the maximum and minimum resistance exhibited for each of the five samples. Note that as the current increased from 0.5 amps to 3.5 amps, there was a decrease in average termination resistance from 1.00 to 0.95 milliohms. This is about a 6 percent decrease in resistance.

The other plot in FIG. **10** is a plot of temperature as a function of current. The temperature indicated on the ordinate is the difference between ambient temperature and the temperature of the transition portion **14** of the connector. This is usually considered a hot spot in connectors. Note that there is approximately a 10° increase in temperature. This represents approximately a 50 percent rise in temperature while the contact actually exhibited a 6 percent decrease in resistance. The foregoing test demonstrates that within the parameters of the connector design there is a decreasing resistance instead of the normal increasing resistance with increased current.

Various modifications of the disclosed embodiments of the invention may be made without departing from the scope of the appended claims.

What is claimed:

1. An electrical connector comprising a conductive wire receiving portion, a conductive channel portion connected to said wire receiving portion and having two ends including at least one open end adapted to receive a conductive post, and a spring attached to said channel portion between said two ends, said spring having an opening located at said open end of said channel portion, said spring being normally biased to a position of nonalignment between an edge of said opening and one side of the channel in said channel portion so as to bite one side of the conductive post at said edge upon insertion of said post into said channel through said opening, said bite being of sufficient force to establish and maintain a stable electrical connection between said post and said conductive channel portion.

2. The connector of claim **1** wherein said spring comprises a fixed portion extending along said channel and a flexible portion having a free end with the fulcrum for said free end being located at said open end of said channel, said opening being located in said flexible portion with said edge biting said post being adjacent said free end and remote from said fixed portion, the bias on said spring permitting release of said post by applying a force in the direction of said channel at said free end of said spring.

3. The connector of claim **2** wherein the bias on said spring creates contact between said channel and the post adjacent said fulcrum.

4. The connector of claim **3** wherein said flexible portion of said spring includes an arched portion extending away from said channel and a locking portion extending across said end of said channel and terminating in said free end of said spring, said locking portion including said opening.

5. The connector of claim **4** wherein said locking portion of said spring is dished at said edge in a direction which reduces the angle between said post and said spring at said edge.

6. The connector of claim **4** wherein said spring is separate from said channel and mounted to said channel at said fixed portion.

7. The connector of claim **6** wherein the thermal coefficient of expansion for said spring is less than the thermal coefficient of expansion for said channel so as to increase the pressure of the contact between said post and said channel adjacent said fulcrum with increasing current and temperature.

8. The connector of claim **4** wherein said wire receiving portion comprises a wire barrel portion axially offset from said channel portion and opposite said fixed portion of said spring and a transition portion connecting said wire barrel with said channel portion.

9. A connector assembly comprising a plurality of the connectors as recited in claim **8** and a conductive post, said post being inserted through the respective openings and channels of said connectors with the respective springs of said respective connectors biting said post on opposite sides thereof.

10. The connector of claim **4** wherein said wire receiving portion comprises a wire barrel portion axially offset from said channel portion on the same side as said fixed portion and a transition portion connecting said wire barrel with said channel portion, said channel portion including an ear on the end of said channel portion adjacent said transition portion adapted to be engaged by a tool when releasing said post from said connector by applying a force between said ear and said free end of said spring.

11. A connector assembly comprising a plurality of the connectors as recited in claim **10** and a conductive post, said post being inserted through the respective openings and channels of said connectors with respective springs of said connectors biting said post on the same side thereof.

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