# United States Patent [19]

**Kinkaid et al.**

[11] **3,818,569**

[45] **June 25, 1974**


[54] **RELEASING TOOL FOR MULTIPLE CONTACT**


[75] Inventors: **Robert John Kinkaid,** New Cumberland; **John Carl Asick,** Harrisburg, both of Pa.

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



[22] Filed: **Sept. 5, 1972**

[21] Appl. No.: **285,983**

**Related U.S. Application Data**

[62] Division of Ser. No. 92,742, Nov. 25, 1970, Pat. No. 3,705,376.

[52] **U.S. Cl.** ..... **29/203 H**

[51] **Int. Cl.** ..... **B25b 27/02**

[58] **Field of Search** ..... 29/203 H, 206 R, 203 HC, 29/203 R



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 3,166,114 | 1/1965 | Stoltz | 29/203 H |
| 3,377,689 | 4/1968 | Kimmett | 29/203 H |
| 3,600,784 | 8/1971 | Propst | 29/203 H |



*Primary Examiner*—Thomas H. Eager

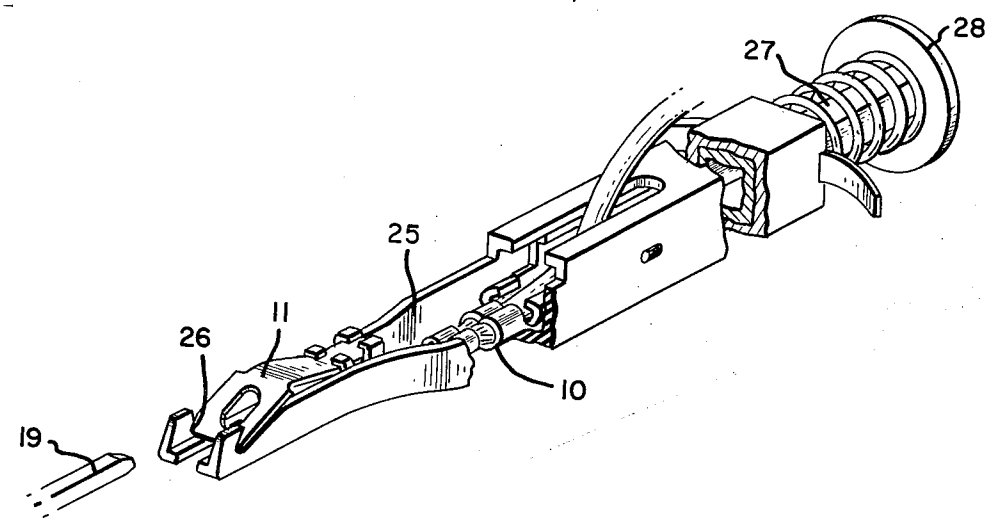
*Attorney, Agent, or Firm*—Gerald K. Kita



[57] **ABSTRACT**

A tool for releasing an electrical contact of 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.


**3 Claims, 10 Drawing Figures**



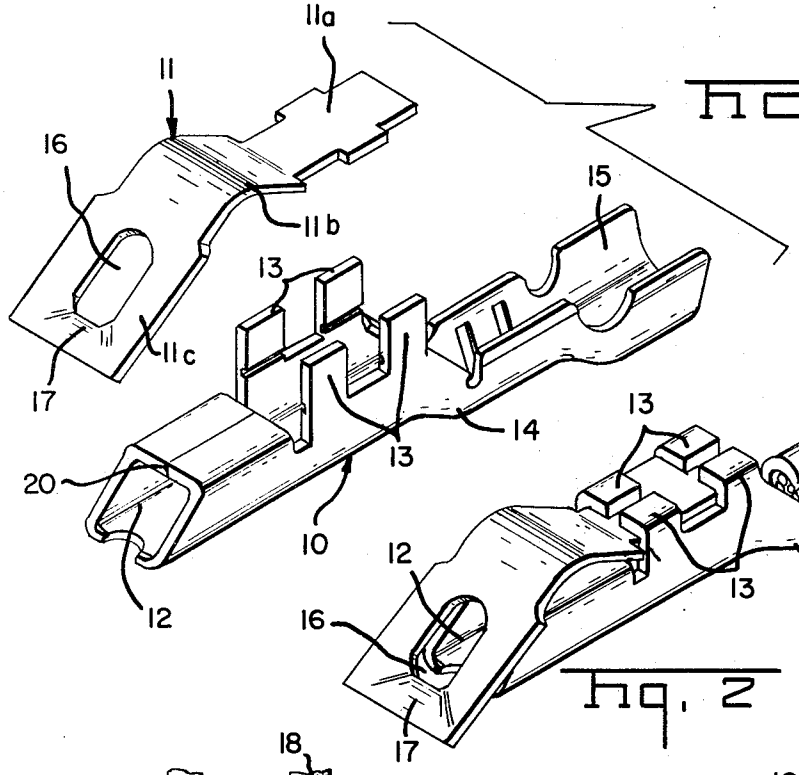



Fig. 1




Fig. 2

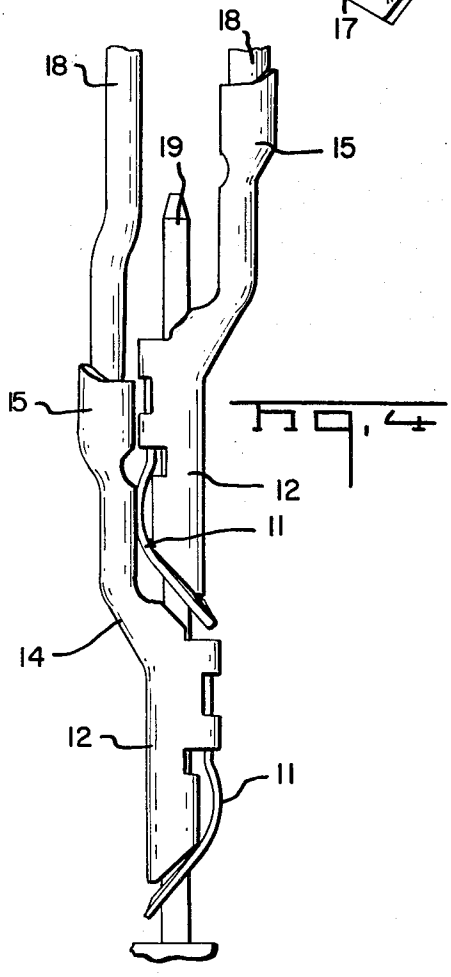



Fig. 4

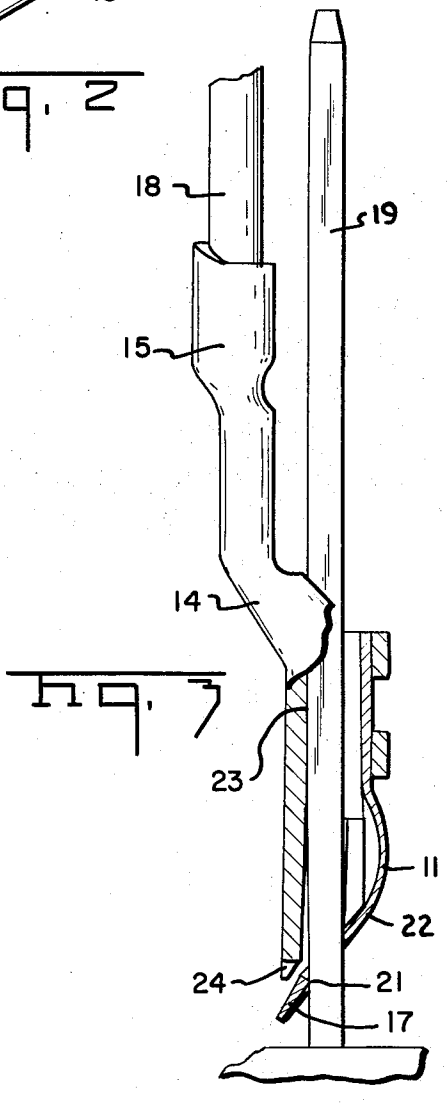



Fig. 3

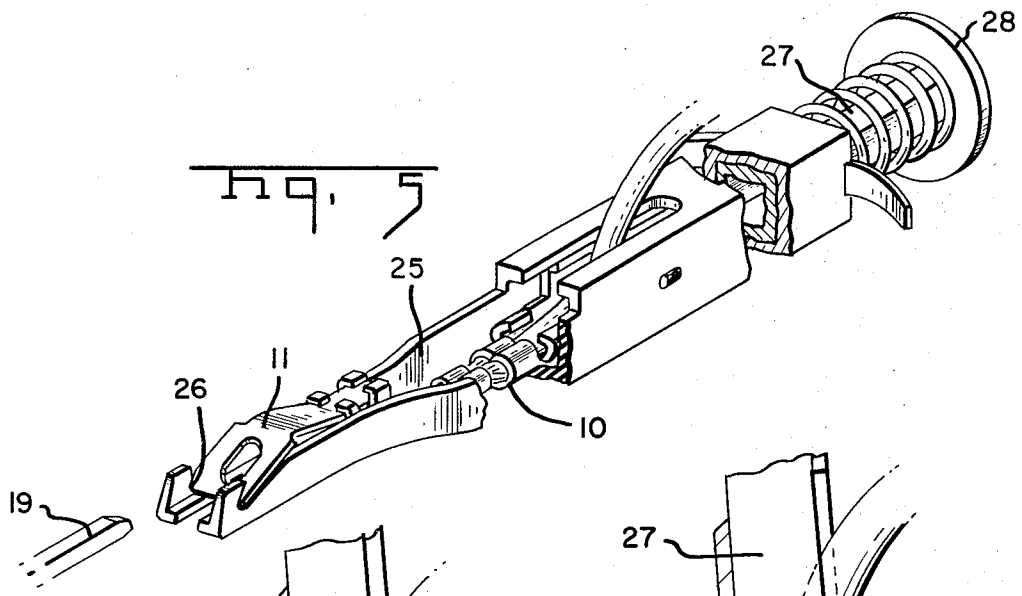



Fig. 5

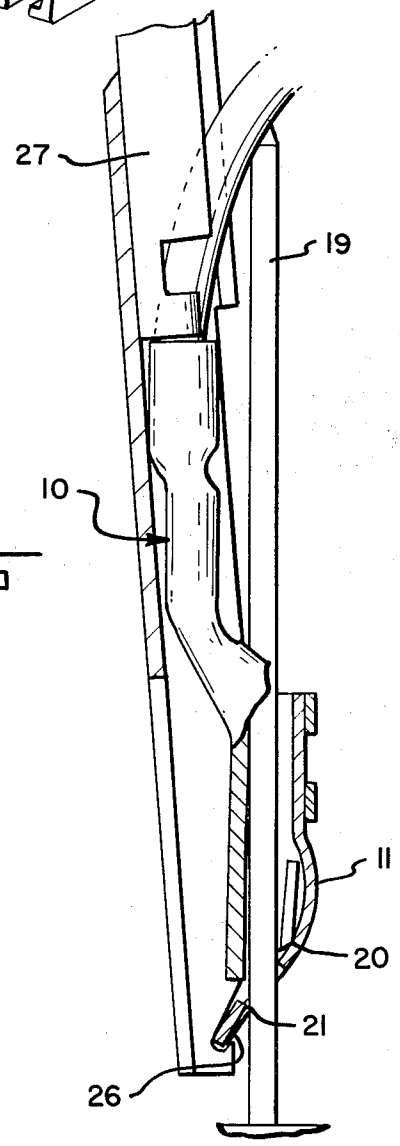



Fig. 6

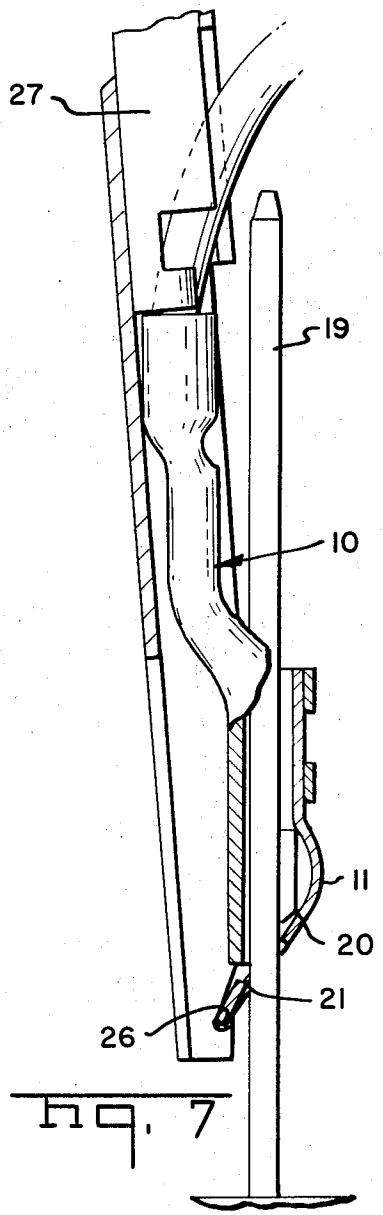



Fig. 7

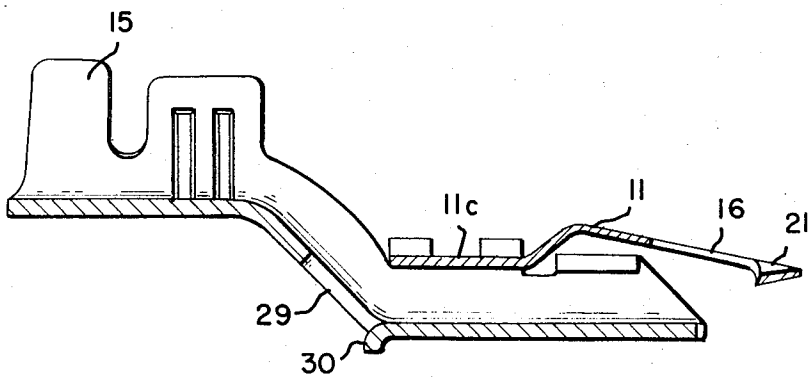



Fig. 9

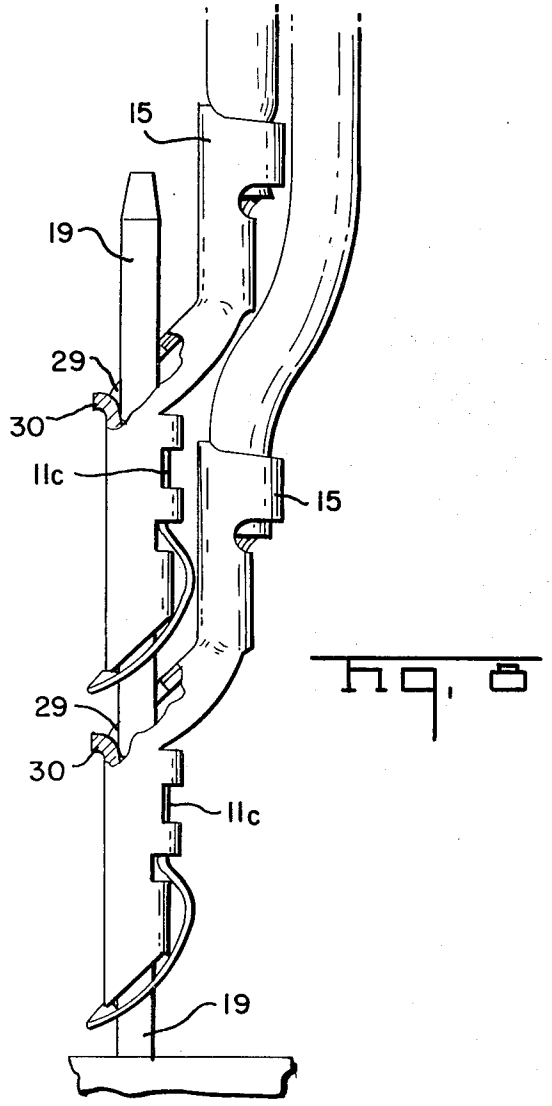



Fig. 8

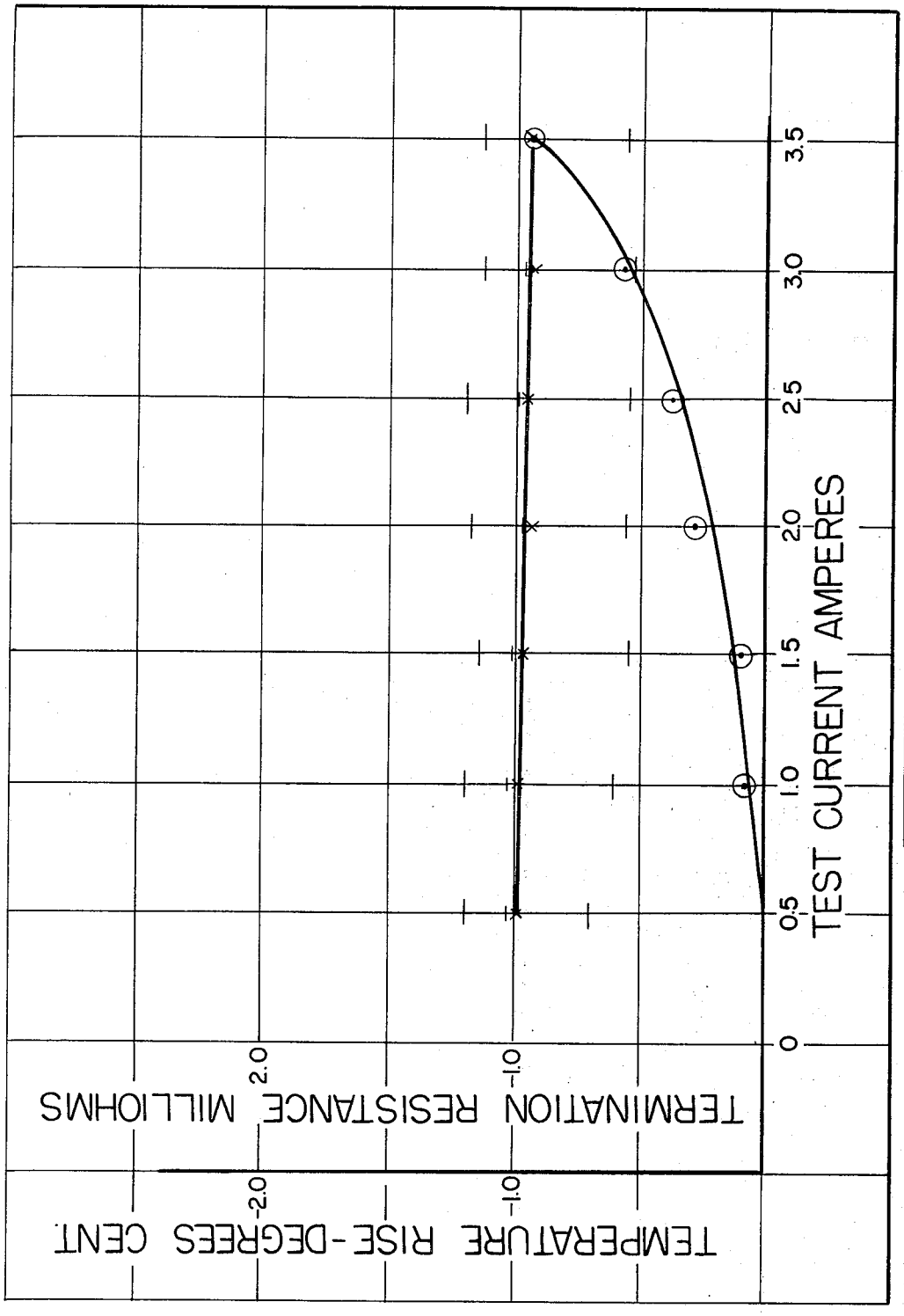

TEMPERATURE RISE-DEGREES CENT
TERMINATION RESISTANCE MILLIOHMS
-2.0
-1.0
2.0
-1.0
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
TEST CURRENT AMPERES

Fig. 10

# RELEASING TOOL FOR MULTIPLE CONTACT

This is a division of application Ser. No. 92,742, filed Nov. 25, 1970 and now U.S. Pat. No. 3,705,376.

## 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 tool for releasing a contact connector of the spring contact type is provided which will readily release the contact from 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 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 **11***a* of the spring **11**.

The spring also includes an arched portion **11***b* and a locking portion **11***c*. An opening **16** is provided in the locking portion **11***c* 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 **11***c* on the post.

Note that each of the ears **13** is precreased. Therefore, when the ears are bent over the fixed portion **11***c* of the spring, the resulting bend across the fixed portion **11***c* 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 **11***b* 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 edge **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 **22** 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 **11***c* 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 **11***c*. 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 $28 \times 10^6$ 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 $0.028 \pm 0.001$ inches on a side. The square cross-section of the post **19** is $0.025 \pm 0.001$ inches on a side. In the modification of FIGS. **8** and **9,** one actual embodiment has a channel **12** with a rectangular cross-section, $0.034 \pm 0.002$ by $0.067 \pm 0.002$. The post in this embodiment is $0.031 \pm 0.001$ by $0.062 \pm 0.001$ 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 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 is:

1. A tool for use in releasing a conductive post from a connector of the type comprising a conductive channel portion adapted to receive the post and a spring having an end fixed with respect to said channel and a free end having an opening located at one end of the channel, the free end of the spring being biased about a fulcrum so as to bite the post with an edge of the opening and lock the post in place, said tool comprising:

a connector receiving section including means for engaging said connector at the extremity of said free end;

a depressible plunger cooperating with said connector receiving section for engaging said connector nearer said fixed end of said spring than said free end, said plunger applying a substantially axially compressive component of force along said channel so as to pivot said free end of said spring about said fulcrum thereby releasing the bite on said post.

2. The tool of claim 1 wherein said connector receiving section forms a channel for receiving said connector.

3. The tool of claim 2 wherein said means for engaging said spring comprises at least one hook projecting substantially perpendicular to the axis of a connector located in said channel of said tool.

* * * * *