March 24, 1970 H. W. KENNEDY, JR 3,503,033

COIL SPRING CONNECTOR

Filed Dec. 12, 1967 2 Sheets-Sheet 1

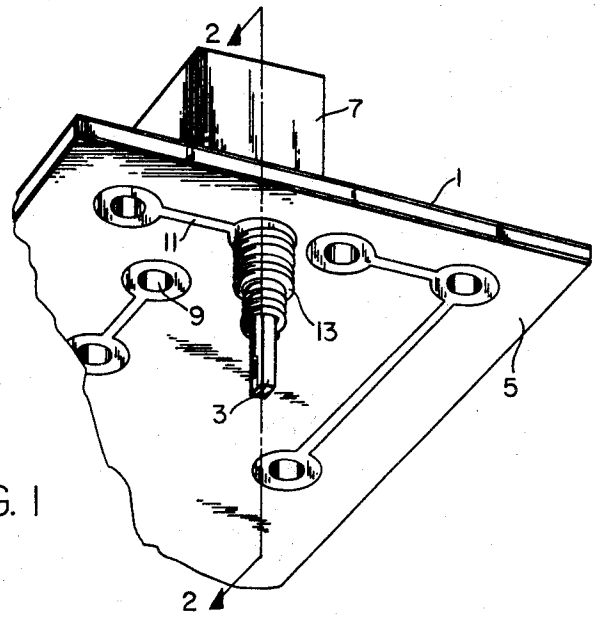


FIG. 1

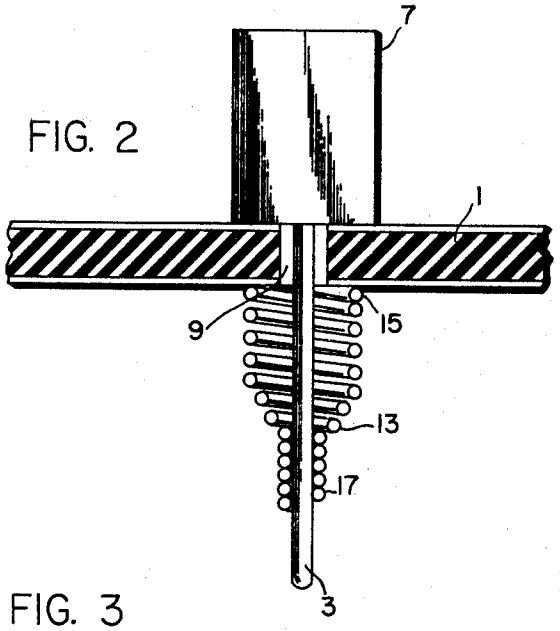


FIG. 2

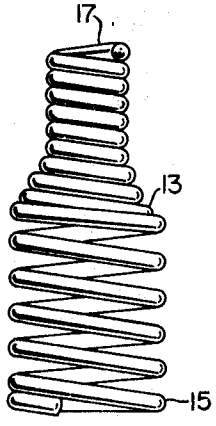


FIG. 3

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COIL SPRING CONNECTOR

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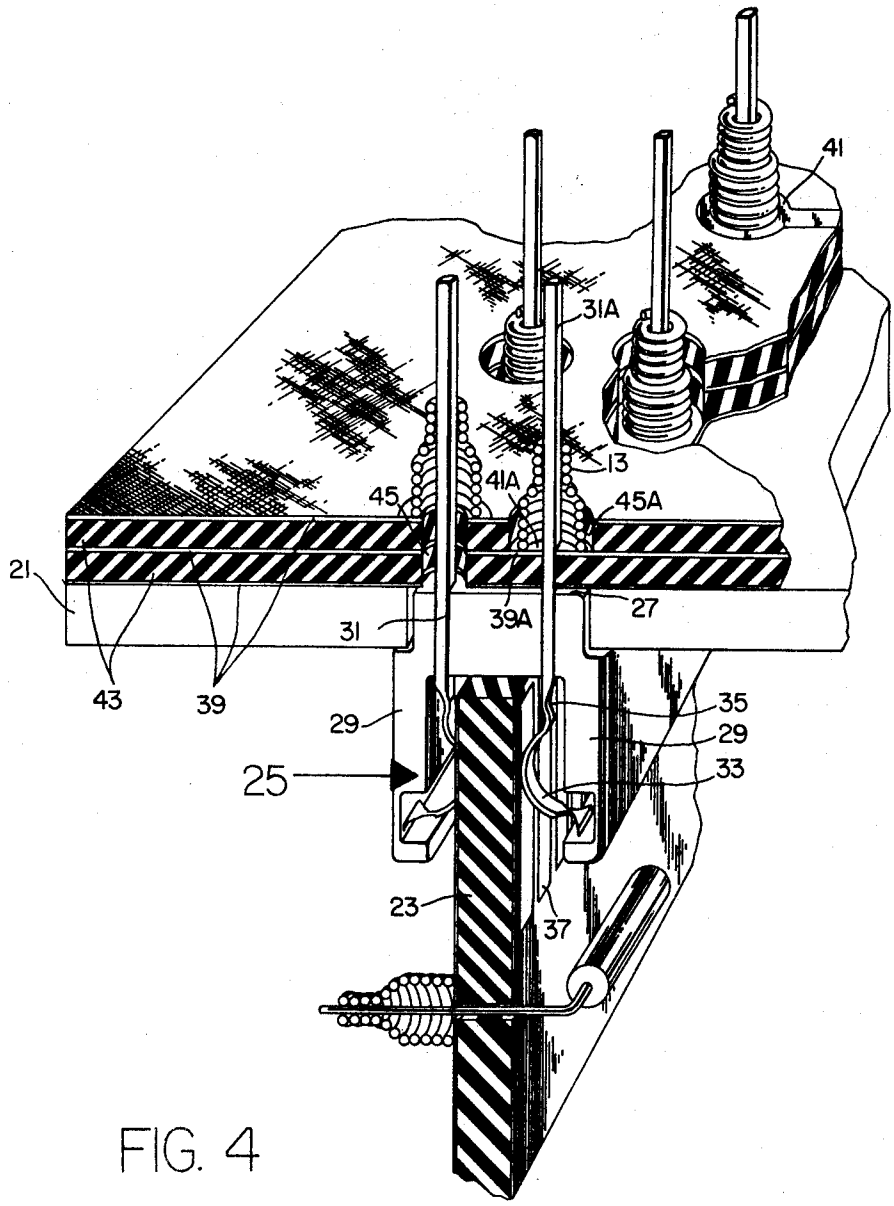


FIG. 4

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COIL SPRING CONNECTOR

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U.S. Cl. 339—17 11 Claims

ABSTRACT OF THE DISCLOSURE

An electrical connector is provided to effect both electrical contact and mechanical stability between a terminal post or component lead and a conductive portion of an electrical circuit board. The electrical connector comprises a helically-wound coil spring which is conically shaped along at least a portion of its length. The spring connector engages the terminal post which extends through an aperture in the board. The end of the spring with the larger opening is inserted over the terminal post and is pushed down until the smaller end encompasses and grippingly engages the post, and until the spring is partially compressed so that the larger end thereof firmly abuts the conductive portion of the board.

BACKGROUND OF THE INVENTION

This invention relates to electrical connectors and, more particularly, to means for making an electrical connection between a terminal post and a conductive surface.

It is known in the electrical connector art to provide a conductive coil spring for making electrical contact between a terminal post, or a component lead, and a conductor surface on a supporting plane such as a printed circuit board. Often, the connection between the terminal post and the spring is made by offsetting the coil convolutions or by providing for a small spring portion of diminished diameter which encompasses and grippingly engages the terminal post. In such prior art devices, however, an additional conductive member is often required for connecting the spring with the conductive surface of the circuit board. And, while in a known arrangment, a second portion of the spring is caused directly to engage the conductive surface of the circuit board to effect a solderless connection, the electronic component must be specially designed to accommodate the spring.

Another deficiency of the prior art devices is that they have generally required additional means for mechanically stabilizing the critical elements, that is, the terminal post, the circuit board and the coil spring, with respect to each other. Furthermore, when an electrical component with integral leads is used, additional means is required to retain the component in position. Such mechanical stability is most important since a jarring of any of these elements could possibly break the electrical connection and cause failure of the system. In some instances, the elements must be soldered together; in other instances additional springs or retainers must be provided to obtain this result. Furthermore, special designing of the circuit board or the components themselves is also necessary to secure the elements properly.

SUMMARY OF THE INVENTION

It is, therefore, an object of this invention to provide an improved solderless electrical connection between a terminal post and a conductor surface on a supporting plane.

It is a further object of this invention to provide an electrical connection between a terminal post and a conductor surface which enhances the mechanical stability among the elements.

Another object of the invention is to provide a coil spring connector which maintains a compression bond between an electrical conductor and the conductive portion of an electrical circuit board to obtain electrical connection and mechanical stability.

In accordance with my invention, I provide a helical coil spring connector which is generally conical in shape along at least a portion of its length. The end of the spring connector with the larger opening is inserted over a terminal post or component lead which passes through an aperture in an electrical circuit board and pushed down until the smaller end encompasses the post or lead and the larger opening abuts a conductive portion of said board. Thus the spring connector is in tension with the post or lead and in compression with the conductive portion of the board, thereby establishing a solderless electrical connection and enhancing the mechanical stability thereof.

DETAILED DESCRIPTION OF THE INVENTION

Other objects and advantages of my invention may better be understood by reference to the following detailed description taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a perspective view of a printed circuit board wherein the spring connector of the present invention electrically connects an electrical component lead and a conductor surface thereon;

FIGURE 2 is a cross-sectional view taken along lines 2—2 of FIGURE 1;

FIGURE 3 is a plan view of the coil spring connector; and

FIGURE 4 is a perspective view of another embodiment of the present invention.

Referring now to FIGURE 1, there is shown a printed circuit board **1** and an electrical terminal post or component lead **3** extending from the underside **5** thereof. An electrical component **7** is positioned upon the other side of the printed circuit board **1** of insulating material, the terminal post **3** extending through one of the apertures **9** in the board. On the underside **5** of the printed circuit board **1** there are provided a plurality of conductor surfaces **11** laid out for the purpose of completing an electrical circuit among the particular components **7** mounted thereon.

To effect a solderless electrical connection between the electrical conductors **3** (a term chosen to include terminal posts and component leads) of the various components **7** mounted on the printed circuit board and the conductor surfaces **11**, there is provided a novel spring connector **13** of the present invention. The spring connector **13** comprises a helical coil spring of conductive material which is generally conical in shape along at least a portion of its length. The connector **13** includes an end **15** having a relatively large opening and an opposite end **17** having a smaller opening which is of smaller diameter than the diameter of the terminal posts **3**. When it is desired to effect electrical connection between a terminal post **3** and a conductor surface **11**, the end **15** of the spring connector **13** with the larger opening is inserted over the terminal post **3** and is pushed down until the smaller end **17** encompasses and grippingly engages the post **3**. The spring connector **13** is then pushed further until the end **15** firmly abuts the conductor surface **11** of the printed circuit board **1**. Thus, the spring connector **13** is in compression between the electrical conductor **3** and the conductor surface **11**, establishing electrical contact therebetween.

The fact that the spring connector **13** is in compression means that it exerts an opposing force against the underside **5** of the board **1** and against the post **3** at the point of contact to spring enhance the mechanical stability be-

tween these elements. When the electrical component **7** to be mounted includes its own lead member in place of the terminal post, it can be seen that there is really no necessity to include other means for securing the component **7** to the circuit board **1**. The spring action upon the component lead serves to maintain the component in its desired position.

The spring shown in FIGURE 3 of the drawings has many unique features. It is noted that a portion of the coils are close wound and a portion are open wound. The open wound coils are necessary to provide the compressive forces against the surface of the electrical circuit board and the point of contact to the post. The close wound coils provide the advantage of small overall size, Since, in the preferred embodiment of the invention, the spring is used with printed circuit boards where size is of the essence, a major portion of the coils are close wound.

The ratio of the number of small diameter coils to large diameter coils of the spring connectors is uniquely determined for each application. It is dependent upon the shape of the terminal post, e.g. a substantially round electrical conductor requires a greater number of small coils to establish sufficient frictional force to overcome the longitudinal forces exerted by the compression of the spring. It is also dependent upon the size of the small coils relative to the size of the large coils for a given spring. The greater the ratio of the diameters of the coils is the smaller the ratio need be between the number of small coils to large coils. In addition, the ratio of numbers of coils is dependent upon the compression force needed to maintain good electrical contact with the surface of the board.

To better understand the relationship between number of coils and coil diameters, force vectors should be considered. Since the spring is in compression there is a force exerted along the terminal post tending to push the spring away from the board. The spring is also under tension at the small end where the coils grip the post. The gripping of the small coils creates a frictional force along the post to oppose the compressive force and enables the spring to remain in compression. The greater the number of small coils, the greater is the friction force. The greater the number of large coils, the greater is the compression force. In addition, if the large coils are very close in diameter to the small coils the force of the compression is more in line with the friction force and more readily overcomes it. With bigger diameter large coils the component of compression force that is realized along the post is only a fraction of the force exerted by the board against the spring. This is because there is an ever increasing radial force with the increase in size of the large coils.

Referring now to FIGURE 4, there is shown another embodiment of the present invention wherein a panel or chassis **21** is used to mount a series of printed circuit boards **23**. In a preferred form, the printed circuit boards **23** are retained individually on the chassis **21** by means of socket connectors **25** which fit in longitudinal slots **27** in the chassis **21**. Each socket connector **25** includes a pair of opposed upstanding walls **29**, in each of which are retained end portions **33** of terminal posts **31**. The terminal posts **31** extend into the space between the upstanding walls **29** and are disposed generally parallel to each other. Each terminal post **31** includes a generally nonlinear segment **35** and is sufficiently resilient so that opposed sets of terminal posts **31** may frictionally receive and retain a supporting plane or printed circuit board **23**. Each printed circuit board **23** is so designed that conductor surfaces **37** thereon will abut the nonlinear portions **35** of each terminal post **31** to effect electrical contact. The components on the printed circuit board may be electrically connected to the conductor surfaces thereon by means of the electrical connection arrangement shown in FIGURE 1.

Disposed on the other side of the chassis **21** are one or more voltage and ground planes **39** oriented in generally parallel relation to each other. The planes **39** have conductor surfaces **41** thereon for selective electrical connection with the terminal posts **31**. The planes **39** are separated from each other by suitable insulation **43**. The planes **39** and insulators **43** constitute a multilayer electrical circuit board which includes aligned apertures **45** at predetermined locations therein for receiving extended portions of the terminal posts **31**. As can be seen, a particular terminal post, such as **31*a***, may be selectively electrically connected to a particular voltage or ground plane, such as **39*a***, by means of a spring connector **13** of the kind described and shown in FIGURE 3. This is accomplished by enlarging the apertures **45** in the ground and voltage planes **39** and in the insulators **43** sufficiently to expose the conductor surface **41*a*** on the plane **39*a***. The larger end of the spring connector **13** is larger than the aligned aperture **45*a*** but smaller than the enlarged portion thereof. The spring connector **13** is then fitted around the exposed end portion of the terminal post **39*a*** and pressed down until the smaller end engages the terminal post and the larger end of the spring connector **13** is in compression with the conductor surface **41*a*** to ensure effective electrical contact therewith.

Thus, there is provided a solderless electrical connection between a terminal post and a conductor surface which effects both electrical contact and enhances mechanical stability among the elements. This result is accomplished by the provision of a relatively simple coil spring which may be easily applied or removed from its operative position. Furthermore, because the electrical elements do not have to be designed elaborately to accommodate the spring, the spring connector may be utilized in a wide variety of applications.

It is to be understood that while the coil spring connector has been referred to as being constructed of electrically conductive material such as beryllium copper, it may be plated to achieve this conductivity and consist of any spring-like material. Also, while the embodiment of the spring which has been described shows small windings at the opposite end of the spring from the large windings, the smaller coils could appear anywhere along the spring such as at the midpoint. In this case the spring would take on an hourglass type shape. In addition, the spring need not be generally conically shaped, as shown, but may abruptly change from small coils to large coils. It is also to be understood that while printed circuit boards are shown in the drawings, the coil spring connector of the present invention is equally applicable to solid conductor plates. For example, the multilayer board shown in FIGURE 4 could consist of interspersed sheets of solid conductor material and insulator material.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In an electrical circuit board assembly having electrical conductors which pass through apertures in the boards for the purpose of making electrical connection between the conductors and conductive portions of the boards, coil spring connectors making said electrical connections, each connector comprising:

a coil spring capable of conducting electricity,

a portion of the coils of said spring being slightly smaller in diameter than the diameter of said electrical conductors,

the diameter of the coils at one end of said spring being larger than the diameter of said apertures,

each coil spring encircling one of said conductors with the end having large coils abutting said board at a conductive portion thereof and the smaller coils of said spring gripping said conductors at a point which is a lesser distance from the contacted surface of said board than the initial relaxed length of said spring placing said spring in compression,

said spring thus asserting pressure on the surface of said board securing said conductor to said board providing electrical connection therebetween.

2. The assembly recited in claim 1 wherein said smaller diameter coils are at the other end of said spring.

3. The assembly recited in claim 2 wherein at least a portion of said coil spring connector is conically shaped.

4. The assembly recited in claim 3 wherein at least a portion of said coil spring connector is open wound.

5. The assembly recited in claim 4 wherein a portion of said coil spring connector is close wound.

6. The assembly recited in claim 5 wherein the ratio of small coils to large coils in said coil spring connector is sufficient to maintain said spring in adequate compression to thereby provide good electrical contact with the conductive portion of said board.

7. The assembly recited in claim 1 wherein said electrical circuit board is a multilayer board and portions of selected ones of said apertures are enlarged to expose conductive portions of the board at a layer to which connection is desired, wherein the diameter of the larger coils in said spring is less than the enlarged portion of said apertures, and wherein those springs which make contact with exposed inner layers of said board are at least partially contained by the enlarged portion of said apertures.

8. The assembly recited in claim 7 wherein said smaller diameter coils are at the other end of said spring.

9. The assembly recited in claim 8 wherein at least a portion of said coil spring connector is conically shaped.

10. The assembly recited in claim 9 wherein the ratio of small coils to large coils in said coil spring connector is sufficient to maintain said spring in adequate compression to thereby provide good electrical contact with the conductive portion of said board.

11. Connecting means mechanically and electrically connecting component parts to printed circuits comprising a mounting board having a printed circuit thereon, and openings therein where component parts are to be connected to the circuit, a component connecting terminal aligned in a mounted position and projecting through said opening, an electrically conductive helical spring surrounding the connecting terminal with the terminal being inside the spiral formed by the spring, one end of the spring being of larger inside diameter than the outside diameter of the terminal and pressing against and being in electrical contact with a portion of the printed circuit, the other end of the spring being of smaller diameter than the outside diameter of the terminal, said spring being axially compressed with the other end of the spring frictionally engaging a portion of the terminal which is at a lesser distance from the printed circuit than the distance would be if the spring were not axially compressed, the tension forces associated with said other end being greater than the compression forces associated with said one end of said spring such that said spring exerts pressure against said printed circuit and said board to hold terminal in said aligned position and to provide electrical connection between said printed circuit and said terminal.

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DARRELL L. CLAY, Primary Examiner

U.S. Cl. X.R.

174—68.5; 317—101; 339—256