Aug. 16, 1960 C. C. RAYBURN 2,948,953

METHOD FOR FORMING A WIRE CONNECTOR

Filed Feb. 2, 1956 2 Sheets-Sheet 1

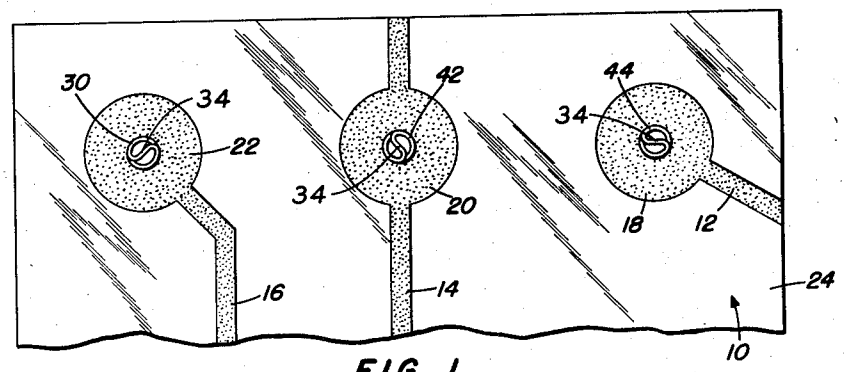


FIG. 1

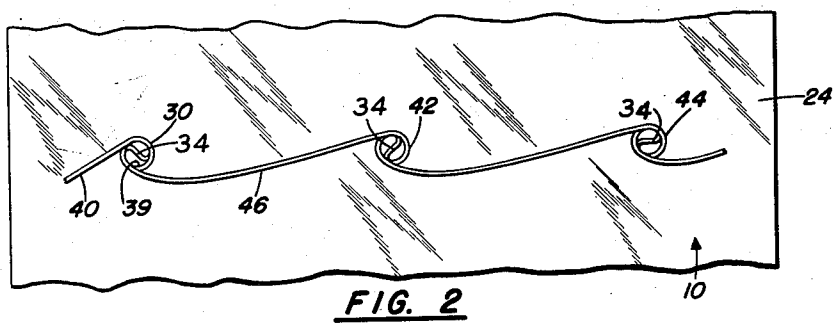


FIG. 2

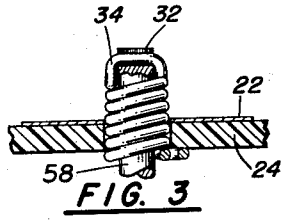


FIG. 3

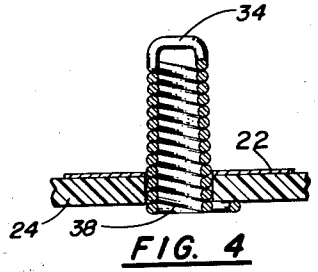


FIG. 4

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METHOD FOR FORMING A WIRE CONNECTOR

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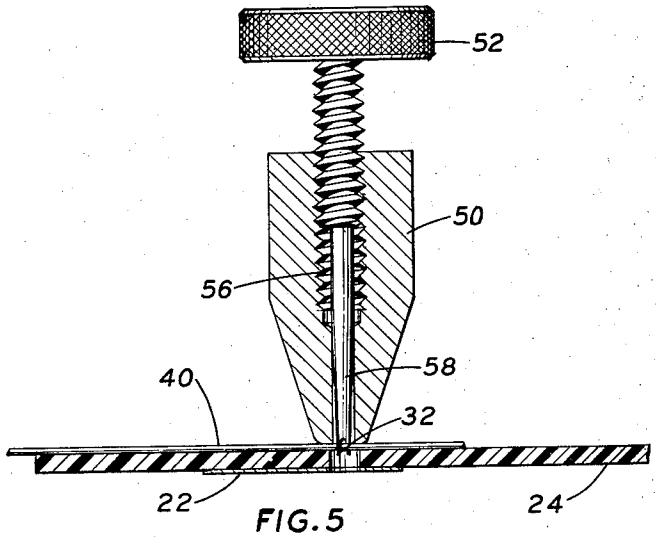


FIG. 5

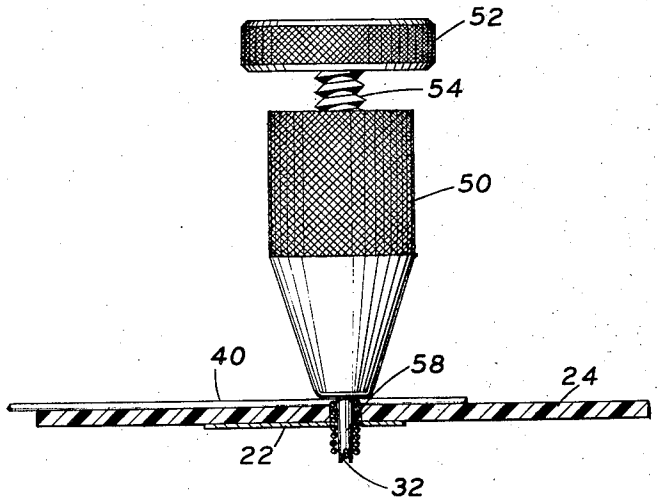


FIG. 6

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METHOD FOR FORMING A WIRE CONNECTOR

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5 Claims. (Cl. 29—155.55)

This invention relates generally to circuit boards or panels of the printed laminar type, and more particularly to a method of making a connection between conductive paths on the panel or between opposing surfaces of the panel.

Modern electronic fabrication techniques make extensive use of circuit panels of the type known as printed circuits. The present invention provides an improvement in the method of making connections to or interconnecting between the conductive paths of such circuit panels. In the printed circuit art an array of conductors is formed on one side of an insulating sheet and when interconnections between selected conductors are to be made it is usual practice to utilize the opposite surface of the panel for the crossover conductor. The ordinary method is to form passages piercing the insulating sheet and conductive paths and deposit a coating of metal on the inside of the passages so formed, or sometimes a rivet or the like is used to form a conductive area through the body of the panel and a wire is extended between the ends of the terminals. These methods are complicated and reasonably expensive as will be readily appreciated, but the method of interconnection hereinafter disclosed adroitly solves the problem of panel surface path connection in a manner particularly suited to automatic machinery.

Summarily stated, the invention consists of a novel method of forming a terminal on an insulating panel carrying an array of conductive paths and having passages therethrough piercing selected paths, which comprises the steps of applying a flexible wire parallel to the plane of the panel and bridging a passage, grasping the wire at the bridging portion, and simultaneously applying torque and thrust to the bridging portion to thereby twist the wire into a series of convolutions forming a helix thus threading such helix through the passage in edge-engaging relationship to extend beyond the path. As will be apparent, such method is useful in interconnecting between conductive paths carried on an insulating panel and is well adapted to interconnect such path if only one side of the panel is available as a working surface, all operations being carried out from the usable side. This situation frequently exists in fabrication of small parts for the aircraft industry where limited volumes must hold mounted components and the spacing does not allow access to a panel from both sides.

It is therefore an object of this invention to improve on the printed circuit panels now in use.

It is another object of this invention to provide a panel supporting printed circuitry on one side thereof and a conductive strand on the other side, to provide a novel method whereby such strand electrically intercommunicates between the conductive paths of the circuitry.

It is a further object of the invention to provide a method of applying a flexible wire to a metal clad insulting panel having a passage therethrough piercing the metal which consists of twisting the strands into a helix

and simultaneously advancing the end of the helix through the panel to extend beyond the metal.

It is a further and more distinct object of this invention to provide a novel method of applying a conductive strand to an insulating panel carrying an array of printed paths and having a series of passages therethrough piercing selected paths which consists of simultaneously twisting the strand into a helix and advancing the end of the helix through successive passages to extend from the panel.

Other features and advantages of the invention will appear from the detailed description when taken with the drawings in which:

Figure 1 is a fragmentary top plan view of a printed circuit panel embodying the present invention.

Figure 2 is a bottom view of the panel of Figure 1 and showing the opposite surface thereof.

Figure 3 is an elevation partly in section showing the position of the conductive strand of the present invention during the assembly process.

Figure 4 is an elevation partly in section showing a completed assembly of the novel disclosed terminal.

Figures 5 and 6 taken together, are elevations partly in section showing a novel hand tool used to perform the method of the instant invention.

Referring now to the drawings wherein like reference characters designate like or corresponding parts throughout, the assembly is shown generally by reference character **10** of Figures 1 and 2. A panel **24** which may consist of a sheet of electrically insulating material such as a phenolic plastic or other synthetic resinous material carries on one or both surfaces an array of conductive paths such as **12**, **14** and **16**. There are a number of well-known and accepted methods to produce these paths, among which may be mentioned providing a surface area completely covered by the conducting metal and etching chemically the unwanted portion; or removing the same by an abrading method. Another well-known and useful method comprises plating onto the insulating panel the desired metal configuration so to provide an array of conductive paths in a desired pattern. As will be readily appreciated cross-connections between co-planar conductive paths lying spaced one from another on the panel with a third path extending between them cannot be made on the carrying surface but must be made on the opposing surface. For example in Figure 1 the illustrated conductive paths have respective enlarged portions **18**, **20** and **22** for interconnection with other components or circuits. If it is desired to connect between paths **12** and **16** path **14** must be bridged, and the other side of the panel must necessarily be used for the connection.

An example of the method of interconnection between the three paths in accordance with this invention is now offered.

Passages **30**, **42**, and **44** are formed through the insulating panel and piercing the conductive area substantially as shown; a length of wire **40** is placed on the insulating panel on the side opposite to the surface carrying the conductive paths in successive bridging relation to the several passages and a tool, which will presently be described, is used to grasp to wire at the bridging portion and twist the same into a helix substantially as seen in Figure 3 and thread it in edge-engaging relationship (Figure 4) with the passage whereby a part at least of the helix engages against the edge of the conductive path to extend beyond the panel. The wire extends between the successive terminals so formed as at **46** and interconnects the conductors.

The resulting helical structure illustrated in Figure 4 is a flexible terminal or binding post with a hollow bore whose entrance, **38** is opened from the bottom sur-

face of the panel. The terminal extends away from the conductive path and the longitudinal axis thereof forms a right angle with the plane of the panel. An electrical component may be readily connected to the terminal by soldering its lugs to the portion, 34 which bridged the passage in the first method step, or merely by wrapping its lug or end wire around the terminal body and soldering the same.

It should be noted that the conductive wire strand when placed between passages and prior to twisting should be provided with a considerable slack so that when the helix is formed by the combined torque and thrust applied thereto the wire is not unduly tensioned. An amount of longitudinal slack commensurate with the desired convolutions of the helix must be provided.

The tool for winding the helix is shown in Figures 5 and 6 and consists of a body member and a driving spindle. The body **50** has a passage formed therethrough, which passage is threaded substantially as shown by reference character **56**. The driving spindle consists of a driving element, **52** shown here as a handle but which may represent any source of energy, an enlarged spindle portion **54** having threads formed thereon to cooperate with threads **56**; and an end portion **58** of reduced diameter and tapering to terminate in a bifurcated end **32**. When it is desired to form the helical terminal the tool is brought to the surface of the panel as shown in Figure 5 with the end of body **50** engaging same and bifurcated end **32** straddling the conductive wire strand **40**. The body **50** and the free ends of the strand **40** are fixed to prevent their turning while driving element **52** is turned, thereby imparting torque and thrust to the grasped portion of the strand forcing it through the passage as shown in Figure 6 as the threaded members cooperated to advance the spindle throught the body. It should be noted that the pitch of the threads **54** and **56** must be twice the diameter of the conductive wire strand **40** so that the end of the spindle **58** gathers and advances a double fold of the strand for each revolution. The tapering of spindle end **58** permits it to be readily withdrawn at the end of the forming cycle; this tapering configuration having the further advantage of increasing the edge contact force as the spindle advances down through the panel. An alternative method of withdrawing the spindle end from the completed helix consists of holding element **52** stationary and turning body **50** in the same direction as element **52** was turned in the winding step so that the threads therein cause spindle **58** to remove from the helix.

The tool is preferably operated by a motor and it is within the purview of the invention to provide an impact and limit switch circuit to turn the motor on and off automatically.

One of the chief advantages flowing from the techniques described above is that the interconnections are easily and cheaply made entirely from one side of the panel. If for example the other side of the panel is not available for work access then the accompanying method will interconnect paths without the necessity of their being engaged in any way except through the passages as described. It will also be apparent that the disclosed method will provide a circuit which does not, in any wise depend on the printed technique. The conductive paths may be eliminated entirely and a circuit formed on an insulating panel as would be shown in Figure 2; then the interconnecting wires as at **46** perform functions of the conductive paths of the printed circuit boards.

I claim:

1. The method of forming a terminal on an insulating panel having an electrically conductive coating on one surface thereof, said method comprising the steps of forming a passageway through said panel and a portion of said conductive coating and extending from said one panel surface to an opposite surface of said panel, positioning a flexible wire on said opposite panel surface and bridging said passageway, anchoring said panel and the free ends of said flexible wire to prevent rotation thereof, simultaneously applying twisting and thrusting motions to the portion of said wire bridging said passageway whereby a coil helix is formed and threaded into said passageway, continuing said twisting and thrusting motions to said wire until said helix contacts said conductive coating on said one panel surface.

2. The method of forming a terminal on an insulating panel having an electrically conductive coating on one surface thereof, said method comprising the steps of forming a passageway through said panel from said one surface to an opposite surface with said conductive coating extending to said passageway, positioning a flexible wire on said opposite panel surface and bridging across said passageway, anchoring said panel and the free ends of said flexible wire to prevent rotation thereof, simultaneously applying twisting and thrusting motions to the portion of said wire bridging said passageway whereby a coil helix is formed and threaded into said passageway, continuing said twisting and thrusting motion to said wire until said helix extends through said passageway beyond said one panel surface with a portion of said helix in contact with said conductive coating.

3. The method of forming a terminal on an insulating panel having an electricaly conductive coating on one surface thereof, said method comprising the steps of forming a passageway through said panel and a portion of said conductive coating and extending from said one panel surface to an opposite surface of said panel, positioning a flexible wire on said opposite panel surface and bridging across said passageway, anchoring said panel and the free ends of said flexible wire to prevent rotation thereof, simultaneously applying twisting and thrusting motions to the portion of said wire bridging said passageway to form a coil helix threaded within said passageway, continuing said twisting motion to said wire to thread said helix through said passageway beyond said one panel surface and into contact with said conductive coating.

4. The method of forming terminals on an insulating panel having a plurality of electrically conductive coatings on one surface thereof, said method comprising the steps of forming a plurality of passageways through said panel from said one panel surface to an opposite surface of said panel with a different one of said conductive coatings extending to each one of said passageways, positioning a different flexible wire portion having a surfeit of said flexible wire bridging across each of said passageways on said opposite panel surface, anchoring said panel and the free ends of said flexible wires to prevent rotation thereof, applying simultaneous twisting and thrusting motions to each of said wire portions bridging said passageways to form a coil helix within each passageway and to thread said helixes into said respective passageways, continuing said twisting and thrusting motions to said wire portions until each one of said helixes consumes said surfeit of said wire and contacts said different one of said conductive coatings on said one panel surface.

5. The method of conductively joining together a plurality of spaced electrically conductive coatings on one surface of an insulating panel, said method comprising the steps of forming a plurality of passageways through said panel from said one panel surface to an opposite surface of said panel with a different one of said conductive coatings extending to each one of said passageways, positioning a flexible wire having a surfeit of said flexible wire with different portions thereof bridging across each one of said passageways on said opposite panel surface, anchoring said panel and the free ends of said flexible wire to prevent rotation thereof, applying simultaneous twisting and thrusting motions to each of said different wire portions to form a coil helix within each passageway and to thread said helixes into said respective passageways, continuing said twisting and thrusting motions to said wire portions until each of said helixes consumes

said surfeit of said wire and contacts said different one of said conductive coatings on said one panel surface.

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