June 7, 1966 R. E. HARTSOCK 3,255,299

RIGHT-ANGLE PRINTED CIRCUIT BOARD

Filed March 16, 1964

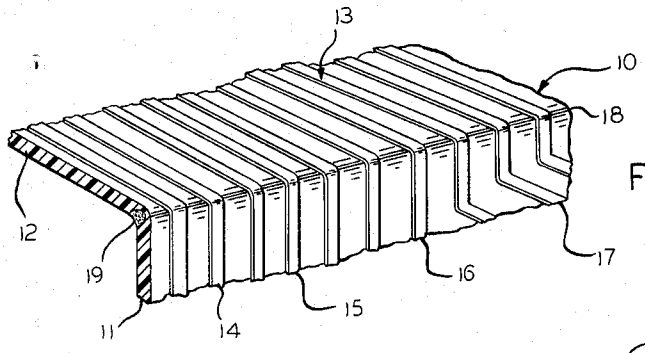

FIG.1

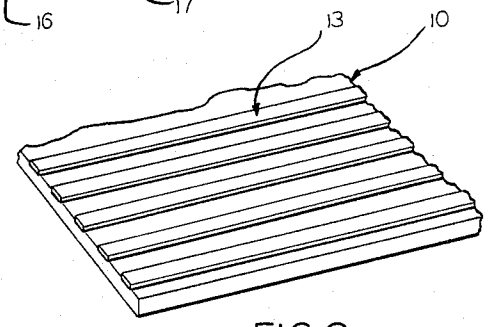

FIG.2

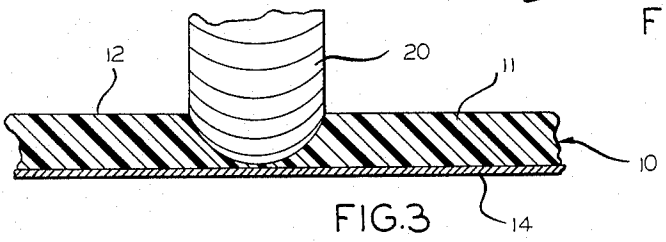

FIG.3

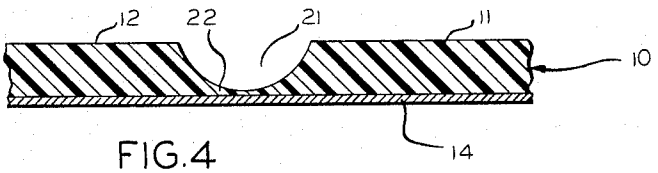

FIG.4

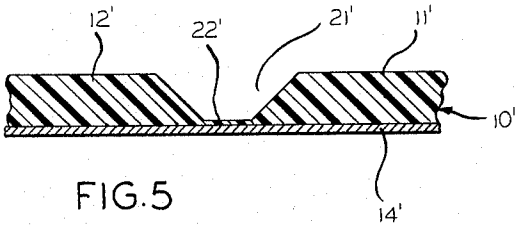

FIG.5

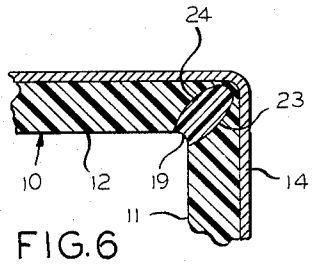

FIG.6

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RIGHT-ANGLE PRINTED CIRCUIT BOARD

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3 Claims. (Cl. 174—68.5)

This is a continuation-in-part of my abandoned patent application, Serial Number 60,334, filed October 4, 1960.

This invention relates to a conductor-equipped panel, and more particularly to a conductor-equipped panel having sections thereof angularly disposed with respect to each other.

Conductor-equipped panels are most frequently referred to generically as printed wire boards or panels although the conductors may be provided along the panel by techniques other than printing as, for example, etching processes, stencil and spraying techniques, etc.; and consequently wherever this term is used herein, it is intended to apply to conductor-equipped panels generally. Irrespective of the particular process or technique employed for equipping the panel with conductors, it is generally advantageous to work with a panel that is planar in contrast to one having angular sections or other non-planar configurations. However, in many installations, it is not feasible to have an entire circuit formed along one planar panel, and as a result it is customary to employ a number of separate panels angularly oriented with respect to each other, and the conductors of the various panels are respectively inter-connected by means of separate connector structures each of which has a plurality of contacts that respectively engage the conductors of the associated panels to establish an electric connection therebetween.

An object of the present invention is to provide a pair of conductor-equipped integral panels or panel sections which are angularly disposed with respect to each other, and in which the conductors common to each panel section are integral or uninterrupted along the juncture of the panels.

Another object of the invention is in the provision of a printed wire circuit defined along a pair of integral panels or panel sections that are rigidified with respect to each other in an angular orientation, and in which at least certain of the conductors in the circuit extend integrally from panel to panel.

Still another object of the invention is that of providing a conductor-equipped panel having integral sections thereof rigidified in an angular orientation relative to each other with at least certain conductors extending integrally between the sections along the exterior or outside surface thereof, and in which such integral sections are fabricated from a single planar panel after the circuit has been provided thereon.

Other and additional objects and advantages of the invention will become apparent as the specification develops.

Embodiments of the invention are illustrated in the accompanying drawing, in which—

FIGURE 1 is a perspective view of a conductor-equipped panel arrangement embodying the invention;

FIGURE 2 is a broken perspective view illustrating a portion of a planar panel after conductors have been provided therealong but prior to formation of the panel into the angularly disposed sections shown in FIGURE 1;

FIGURE 3 is a broken longitudinal sectional view illustrating the step of slitting or notching the conductor-equipped panel;

FIGURE 4 is a broken longitudinal sectional view similar to that of FIGURE 3, but showing the panel after the notch has been formed therein;

FIGURE 5 is a broken longitudinal sectional view similar to that of FIGURE 4, but illustrating a notch of modified configuration; and

FIGURE 6 is an enlarged, broken longitudinal sectional view of the panel structure shown in FIGURE 1.

The panel or board illustrated in FIGURE 1 is designated in its entirety with the numeral **10**, and comprises integral panel sections **11** and **12** which are angularly related with respect to each other and in the specific illustrative embodiment define a right-angle therebetween. The panel **10** is equipped with a circuit pattern denoted generally as **13**, and the circuit comprises a plurality of conductors such as those designated with the numerals **14**, **15**, **16** and **17** which extend integrally between the sections **11** and **12** and are common to each, forming a continuous circuit pattern on the outer surface of the panel sections. The panel sections **11** and **12** meet along a line of mergence **18** which extends transversely thereacross and also traverses the conductors **14–17**. Along the line **18** is a corner block or filler **19** which is secured to the adjacent edges of the sections **11** and **12** and rigidifies the same in the angular disposition thereof.

As will be noted from the drawings, and particularly in FIGURE 1, panel sections **11** and **12** extend in substantially right angle relationship to one another and are integrally secured to one another by a thin bowed section **22**. The bowed section **22** has a depth less than the thickness of the panel sections **11** and **12**, and joins the panel sections with its outer surface tangent to the outer surface of the panel sections, thereby forming an integral bridging section therebetween. A continuous circuit pattern **13** is provided on the outer surface of the panel **10** with the conductors **14**, **15**, **16** and **17** extending from the outer surface of the panel section **12** to the outer surface of the panel section **11** along the bridging surface formed by the outer side of the bowed section **22**. It will be noted that with this construction the greater portion of the thickness of the bowed section **22** underlying the conductors **14**, **15**, **16** and **17** is under slight compression, and that the metal conductors supported thereby are under slight tension but that because of the thinness of the bowed section the compressive and tensile stresses are kept so small that no fracture in the bowed or bridging area occurs. In other words, the relative width and the thickness of the bowed sections are such that the radius of curvature in the bridging area is attained without exceeding the tensile strength of the conductors **14–17** and of the immediately underlying surface portion of the bowed section **22**. The walls of the panel **10** adjacent the bowed section lie in spaced relation to one another forming a notch **21** underlying the bowed section **22**. The width of the notch **21** at the sides of the panel remote from the conductors must be great enough so that the lips thereof stand in spaced relation to each other when the panel sections **11** and **12** are bent at the bridging section, whereby the walls of the panel **10** adjacent the bowed section **22** are in spaced relation to one another to form a notch underlying the bowed section **22**. The filling or reinforcing material **19** is disposed in the mouth of the formed notch **21**, thus rigidifying the panel sections **11** and **12** in angular relationship to one another.

The panel **10** may be formed from any of the conventional materials customarily used in making printed wire circuits boards, such as Bakelite or an epoxy glass composition. As stated hereinbefore, the circuit pattern **13** may be formed along the generally planar panel **10**, as shown in FIGURE 2, by any of the well known techniques, and the various conductors defining the circuit are comprised of a conductive material such as copper.

After the circuit pattern **13** has been provided along the generally planar panel **10**, the panel is sectioned by notching the same along the surface thereof opposite the surface receiving the circuit pattern **13** by means of a cutting tool **20** such as an abrasive wheel which is capable of forming a relatively wide notch **21**.

As hereinbefore indicated, the end walls of the panel sections **11** and **12** and the bowed portion **22** forming the notch **21** are of a sufficient lateral width such that the bowed section will not bend sharply nor will the end walls abut. By having a wide groove or notch **21**, an area is provided having a fairly uniform cross-section which permits the distribution of the bending of the panel **10** over a length sufficient to keep the stress in both the conductors **14, 15, 16** and **17** and the panel **10** in the plastic range.

The notch **21** extends transversely or at right angles across the panel and correspondingly across the path of the conductors **14–17**, and the depth of the slot is controlled so that it terminates a spaced distance from the conductor-equipped surface of the panel and therefore a spaced distance from the conductors. This uncut incremental panel portion or bowed portion **22** may have any desired thickness which will permit the desired bending under the conditions herein enumerated and will not fracture or break. A preferred thickness is, for example, 0.010 inches.

After the panel **10** has been notched, the sections **11** and **12** thereof are rotated relative to each other in a direction tending to bring the end walls **23** and **24** of each in close proximity to form the notch **21** and locate the conductors along the outer surface of the sections **11** and **12**. It will be appreciated that substantially any angular orientation may be enforced upon the sections **11** and **12**, such as the 90° angle illustrated in FIGURES 1 and 6.

The sections **11** and **12** are rigidified in their angular disposition by means of the corner block or filler **19** which has a configuration such that it fits into the notch **21** defined between the adjacent edges **23** and **24** and the bowed section **22** after such edges are moved toward each other in establishing the desired angle between the sections. Therefore, the block **19** in the specific form shown, wherein the end walls or edges **23** and **24** are generally arcuate and the angle defined between the sections **11** and **12** is substantially 90°, has a generally ovate configuration in transverse section. The edges **23** and **24** of the panel sections are adhesively secured to the block **19**, such as by means of one of the commercially available epoxy resins; and since the formulation of such commercial epoxy resins affords substantial latitude in the curing procedure to be followed, the time required to effect a bond between the block and panel sections can be selected and controlled through temperature and pressure selection. The incremental panel portion **22** serves as a filler or backing element to confine the bonding material about the block **19** along the line **18**, and augments the rigidification afforded by the block **19** in that the bonding agent effectively reunites the cracked or broken edges of the increment **22**.

The modified construction shown in FIGURE 5 is essentially the same as the embodiment heretofore described except that the notch has a slightly different configuration, and serves to emphasize the point that the precise configuration of the notch is not critical so long as the width thereof is sufficient to permit the sections **11** and **12** to be pivoted toward each other to the desired angular orientation. For purposes of differentiating the structure shown in FIGURE 5 from the prior embodiment, the panel in its entirety is denoted with the numeral **10'**, the two sections with the numerals **11'** and **12'**, the conductors **14'**, the notch **21'**, and the incremental panel portion **22'**.

In the structure shown, a conductor-equipped panel is provided having angularly disposed sections wherein at least one conductor extends integrally and without interruption between the sections along the outer surface thereof. Therefore, in many instances a complete printed circuit pattern can be produced on a single planar panel thereby simplifying fabrication procedures and obviating the need for connecting angularly-disposed panel sections one with another through separate connector structures.

While in the foregoing specification embodiments of the invention have been set forth in considerable detail for purposes of making a complete disclosure thereof, it will be apparent to those skilled in the art that numerous changes may be made in such details without departing from the spirit and principles of the invention.

I claim:

1. A printed wire circuit structure comprising an integral panel having first and second panel sections extending in angular relation to one another, and a thin bowed section of a depth less than the thickness of said panel sections and joining said panel section with its outer surface tangent to the outer surfaces of said panel sections to form a bridging section therebetween, said panel having a continuous circuit pattern on the outer surface thereof having at least one conductor thereof extending from the outer surface of one of said panel sections to the outer surface of the other panel section along the bridging surface formed by the outer side of said bowed section, said panel section underlying said conductor being under compression, the walls of said panel adjacent said bowed section lying in spaced relation to each other thereby forming a notch underlying said bowed section, and reinforcing material disposed at said notch and rigidifying said sections in said angular relation to one another.

2. A printed circuit construction in accordance with claim **1**, wherein the first and second panels are at substantially right angles to one another.

3. A printed circuit construction in accordance with claim **1**, wherein the walls of the panel adjacent the bowed section converge inwardly to the bowed section.

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