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LIGHTWEIGHT PRINTED CIRCUIT PANEL

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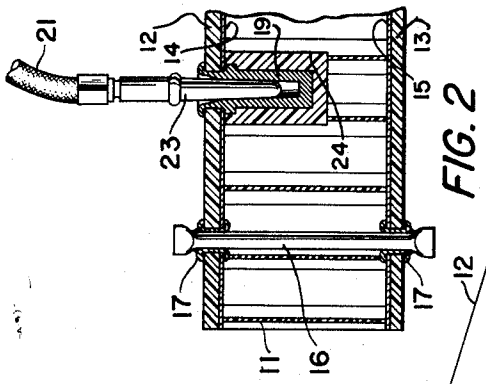


FIG. 2

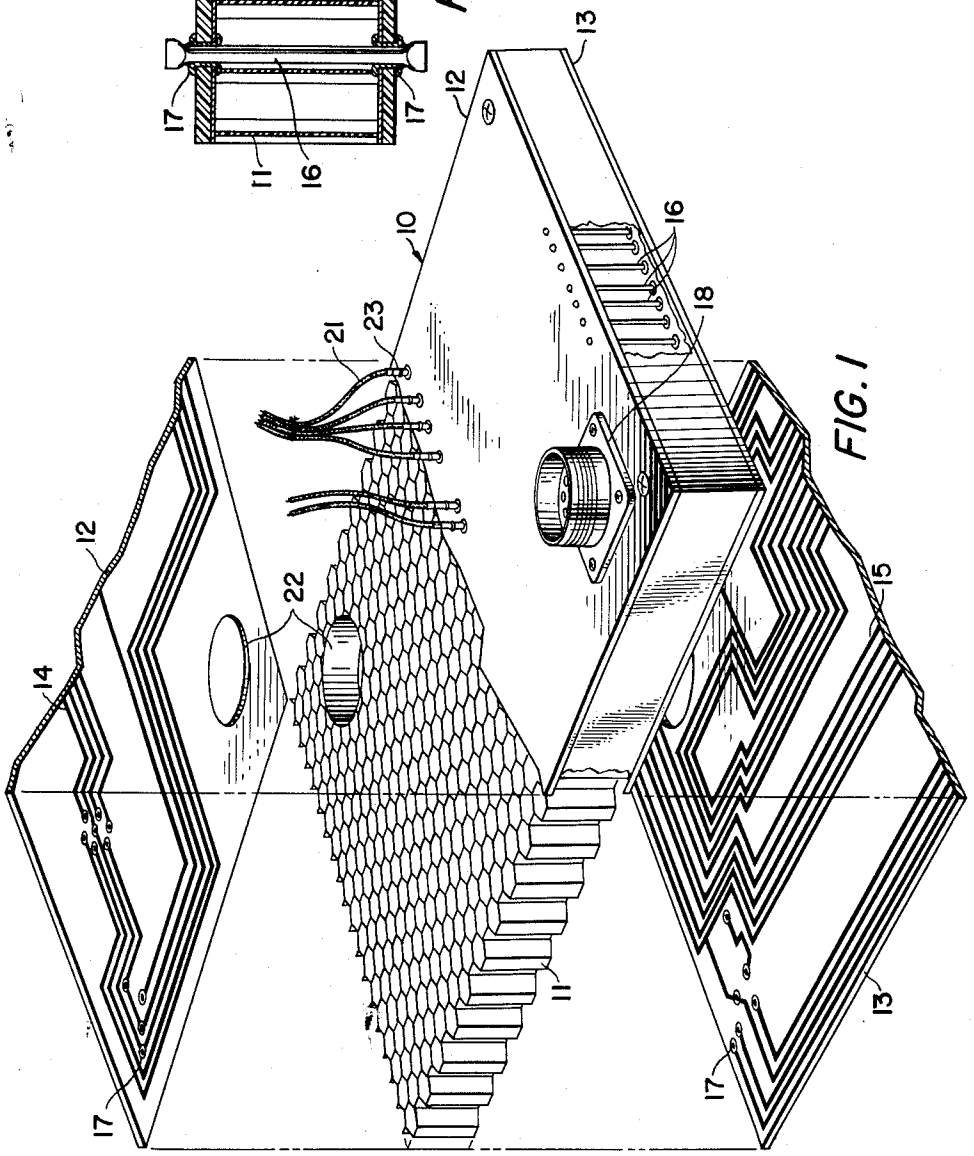


FIG. 1

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LIGHTWEIGHT PRINTED CIRCUIT PANEL

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This invention relates to lightweight panel construction for use with electrical apparatus, and more particularly to a panel comprising lightweight core material having skins secured on opposite sides thereof, with at least one of the skins having a current carrying laminae disposed in insulated relationship thereon.

In the aircraft and missile field, frequent use is made of structural materials having high strength to weight ratio, such as aluminum. Due to the high material strength which can always be used effectively in tension, it was often found that the material thicknesses necessary to support the design loads in tension were completely inadquate in compression, as a result of the material's natural tendency to buckle. This required either the use of heavier to withstand compression, or complex stiffeners and reinforcements to prevent distortion. In the design of secondary structural elements such as supports for electrical apparatus and other auxiliary equipment, it frequently became necessary to use heavier gages in order to avoid the complexity and fragileness of stiffened panels. However, in recent years, various types of conventional sandwich panels have been developed for use in such instances, with great savings in weight and cost.

In the mounting of electrical apparatus according to conventional techniques, many separate electrical connections are required and this results in the use of heavy, bulky and complex harnesses. Approximately 40 to 60 hours of a skilled technician's time is involved in preparing a typical electrical harness, and even then, human errors are prone to occur, necessitating many additional hours of trouble-shooting and rewiring. In addition to production problems, maintenance problems are also present, due to the fragile nature of individual wires, which are likely to break at points of attachment, such as at soldered joints.

According to the present invention, we provide a lightweight panel of sturdy construction, particularly adapted for use with electrical apparatus. A lightweight core is used, with skins secured to opposite sides thereof, and at least one of the skins having a current carrying lamina disposed in insulated relationship thereon. Means accessible from the exterior are provided, connected to the current carrying lamina so that electrical connections can be easily established with the panel. The current carrying laminae can be disposed on the inner surface of the skins of the panel, thereby removing the danger of external breakage. By the placement of the circuitry on the skins of the panel, external wiring for the electrical components associated with the panel can be largely eliminated.

A lightweight panel according to a preferred arrangement involves the use of honeycomb core, with skins secured to opposite sides of the core, that is, the sides having open cell ends. As is well known, such construction techniques result in high strength panels particularly adapted for the mounting of heavy components. By utilizing current conducting laminae in the panel, virtually all external wiring for the electrical component carried by the panel can be eliminated, with a resultant saving in cost and weight. Any problems normally accompanying the insulating of the current conducting laminae from ordinary core construction can be eliminated by utilizing non-conducting skins and honeycomb core, with the skin being of resin-impregnated fibreglass for example. Printed circuitry techniques can advantageously be employed, with

any of several well known techniques for placing the circuitry on the skins being satisfactory. Construction of panels according to this invention enables rapid visual and electrical checks of the circuitry before the skins are secured to the core, thereby making it possible for the circuitry associated with a component to be created much more rapidly than by the utilization of prior art harnesses. The resulting panel provides a high strength mounting platform containing the circuitry for the device to be carried by the panel, this being furnished at a minimum of expense and weight.

In the drawings:

FIGURE 1 is a perspective view of a honeycomb panel according to this invention, with a portion of each skin of the panel in exploded relation to reveal essential features of the construction; and

FIGURE 2 reveals a detail of the construction of the panel wherein various electrical connections can be made between a panel and electrical components.

Referring first to FIGURE 1, the panel **10** principally comprises a section **11** of lightweight core, to the upper and lower sides of which are secured skins **12** and **13**, respectively. The core can be of honeycomb, as illustrated, but it is of course to be understood that any of several lightweight core constructions could be utilized within the spirit of this invention, such as core made from foamed plastic material. Current carrying laminae **14** and **15** are disposed on the skins **12** and **13** so as to create circuits integral with panel **10**. By placing the circuits on the inner surfaces of skins as shown, totally enclosed circuits will be created when the skins are secured to the core.

Although current carrying laminae could be established between skin and core in any of a number of ways, such as by electric wires, it is preferable for printed circuitry techniques to be employed, due to their light weight, inexpensiveness and dependability. Plating or etching techniques may be utilized for the creation of the printed circuits, and the skins upon which the printed circuits are disposed can be made of non-conducting materials such as epoxy, Teflon or the like. Copper clad laminates are commercially available, and these may be employed for the skins of the panel, with a portion of the copper surface etched away in a pre-established manner so as to create the electrical circuit desired. When ordinary honeycomb circuitry techniques are employed for creating the circuitry on the underside of the skins, it is preferable that the honeycomb core **11** be of non-conducting material, for otherwise, an insulating medium will have to be applied between circuit and core to prevent undesired grounding of the circuit. Honeycomb core of cotton phenolic laminate, resin impregnated glass or paper phenolic laminate may be employed for example, depending upon the structural requirements to be met.

Ordinarily the circuits on each skin are independent of the other circuit, so that when interconnection between various points on the upper and lower skins are necessary, jumper wires **16** may be utilized, as illustrated in the figures of the drawing. Rather than the jumper wires being fastened between two points on the printed circuits themselves, appropriate eyelets **17** may be secured to the upper and lower skins for receiving the jumper wires, the eyelets being electrically secured to the circuits by soldering or the like.

Appropriate electrical connectors **18** are employed, which are electrically interconnected in the desired manner to the circuits of the panel. When connectors of the type illustrated in FIGURE 1 are employed, the connection of power to the panel may be broken within moments if such is necessary. The illustrated panel is particularly adapted for the mounting of gyroscopes thereon, and to that end, a hole **22** is provided entirely

through the panel, extending through the core as well as the skins, and at this location the vertical gyro (not shown) is secured to the panel by appropriate bolts or the like. A number of leads or wires 21 extend from the gyro, and it is necessary to electrically connect these wires to the electrical circuits of the panel. Appropriate taper pin receptacles 19 are provided at the surface of the skins as shown in the figures of drawing, and into these receptacles, taper pins can be inserted in a tight-fitting manner. The electrical leads 21 are provided with pins 23 at their ends so that these components may be rapidly connected or disconnected from the panel. As should be obvious, this type of construction is extremely versatile, and may be utilized for the mounting of transformers, accelerometers, rate switches and other such components thereon.

A lightweight panel according to this invention is constructed as follows:

Upper and lower skins are cut or shaped to size and the appropriate electrical circuitry created thereon by desired technique. Numerous holes are then drilled in the skins in order to receive the eyelets 17, the taper pin receptacles 19 and the connector or connectors 18. The eyelets and taper pin receptacles are then installed in the prepared holes, and are secured therein by appropriate mechanical means, such as crimping. The connectors are next installed and then each skin preferably dip soldered in order to provide good electrical connections with the circuitry located on the skins.

The core is then prepared by undercutting it at the locations in which taper pin receptacles are to be installed. This is because the receptacles are to be installed in the pre-established relation dictated by the placement of the holes in the skins, and the cells in the core cannot be relied upon to occur in such a pattern as to permit this to be easily accomplished. Therefore, this preparation of the core by the undercutting step enables the panel components to be assembled without misalignment, or crushing of portions of the core by the receptacles.

Filler material is preferably placed in areas of the core that have been undercut, which hardens during the bonding of the panel to form a firm connecting portion 24 between each receptacle 19 and the surrounding core. The material also may be used in each area where mounting holes are to be located, in order to prevent crushing of the core, although filler blocks could be employed for latter purpose if desired. The filler material may be Core Fill 615, manufactured by the Bloomingdale Rubber Company, Aberdeen, Maryland.

Although other core manufacturing techniques can be employed, lightweight panels made according to this invention are preferably manufactured utilizing bonding techniques. This is brought about by cleaning the skins thoroughly and then spraying the surfaces to be bonded with a suitable structural adhesive, such as FM–47, manufactured by Bloomingdale Rubber Company, a licensee of the Martin Company, Baltimore 3, Maryland. As should be obvious, other structural adhesives may be utilized according to the design and structural requirements.

After the surfaces of the skins and core to be placed in mating relation have been allowed to dry, a layer of adhesive film is then preferably placed between skins and core. This adhesive film is in the nature of open weave cloth, such as of glass, upon which many layers of structural adhesives have been sprayed and allowed to dry, and the use of this adhesive film insures that a proper amount of structural adhesive is located between the parts to be secured together. The adhesive film may be of the type described and claimed in the copending application of Merriman, Serial No. 522,116, filed July 14, 1955, now Patent No. 2,952,579, and assigned to the assignee of the present invention. The skins and core are placed in tight fitting relation, and then bonded to complete a cure using the proper time, temperature and pressure cycling in accordance with the adhesive structural materials being used and the structural design requirements, if any. After bonding, the edges of the panel are trimmed to exact size, if such be necessary, and any open core cells are filled with appropriate edging compound to protect any edges of the core that would otherwise remain exposed. Then holes are drilled in appropriate places in the panel in order to receive the mounting bolts for the gyros or other electrical components to be installed upon the panel. Also, holes are drilled through the panel in order to receive the mounting bolts for the panel and if necessary, a drill may be employed to insure that solder is removed from eyelets so that the jumper wires may be installed easily. The jumper wires are then installed, such as by crimping, and the panel is ready to receive the components to be mounted thereon. Good electrical contact between jumper wires and the eyelets is provided by soldering. The components are then installed upon the panel and connection therewith is accomplished by the use of the wires 21 and their taper pins 23, latter items being pushed into the appropriate taper pin receptacles 19 to complete electrical contact. The completed assembly may then be installed in the craft.

Although the above described panel has been found to be suitable in most instances, a number of variations can be utilized within the spirit of this invention. For example, in the event numerous electrical connections are to be employed, it may be desirable to employ two or more layers of honeycomb core with a current carrying layer interspersed therebetween, as well as current carrying layer above and below in order to provide a sufficient number of current paths. Furthermore, the panel can be of tapered, curved or of other construction.

This invention is in no manner to be limited to aircraft use, for panels constructed according to this invention may be employed for modular fluorescent ceiling construction, switchboards, automotive firewalls, computer chassis fabrication, and the like.

Various techniques associated with the creation of honeycomb panels have previously been patented and assigned to the assignee of the present invention, such as the Engel et al. Patents Nos. 2,609,314 and 2,609,315, the Pajak Patents Nos. 2,609,068, 2,704,587, and 2,720,949 and the Merriman Patent No. 2,608,502. It is to be understood that the teachings of these and other patents may be employed wherever appropriate in the creation of lightweight electro-structural panels according to this invention.

We claim:

1. Lightweight panel construction for supporting electrical apparatus and for furnishing the electrical circuitry therefor, comprising a section of honycomb core constructed of insulating material, and a pair of skins secured in substantially parallel relation on opposite sides of said core so as to form therewith a panel possessing considerable strength, each of said skins having electrical circuitry disposed on the side of the skin nearest the core, at least some of the circuitry of the pair of skins being inter-related and having connection portions disposed in predetermined, substantially aligned relationship with each other, connection means for interconnecting said connection portions from the exterior of said panel, means on at least one of said skins for supporting electrical apparatus upon said panel, and additional connection means for interconnecting the electrical apparatus with said circuitry, said additional connection means including sections extending through one of said skins, whereby the apparatus supported from said panel can be interconnected with the circuitry of the panel without the need for an external wiring harness.

2. The lightweight panel construction as defined in claim 1 in which said connection means for interconnecting said circuits is in the form of jumper wires extending through said core, and through said skins, said jumper wires being secured in position by means on the external sides of said skins.

3. The lightweight panel construction as defined in claim 1 in which said sections of said additional connection means comprise receptacles disposed on the surface of the panel, and tapered pins, each of a configuration to fit into a receptacle so as to be in electrical contact therewith, said pins being associated with said electrical apparatus and insertable into said receptacles when said apparatus is to be interconencted with said circuitry.

4. Lightweight panel construction for use with electrical apparatus comprising a section of honeycomb core constructed of insulating material, skins secured substantially continuously to said core on opposite sides of said core to create a panel having considerable strength, at least one of said skins having a current carrying lamina on the side nearest said core, thereby placing said lamina on the interior of said panel, and means accessible from the exterior of said panel through one of said skins and connected to said current carrying lamina for the establishment of insulated electrical connections with said panel.

5. Lightweight panel construction for use of electrical apparatus comprising a section of honeycomb core constructed of insulating material, skins secured substantially continuously to said core on opposite sides of said core, to create a panel having considerable strength, each of said skins having an electrical circuit thereon in the form of a current carrying lamina, the circuit of each skin being disposed in insulated relationship with respect to the surface of the skin and being normally independent of the circuit on the other skin, and means accessible from the exterior of said panel through one of said skins and connected to said circuits so that properly insulated electrical connections can be established with said panel.

6. The panel construction as defined in claim 5 in which electrical interconnections are provided between portions of circuits of each of said skins.

7. Lightweight panel construction for supporting electrical apparatus comprising a section of honeycomb core made of insulating material, and a pair of skins secured in substantially parallel relation on opposite sides of said core and substantially continuously to said core so as to form therewith a panel possessing considerable strength, said skins having electrical circuitry located on the sides nearest said core so as to be disposed on the interior of said panel, means for securing electrical apparatus on said panel, and means for connecting said apparatus with preselected portions of said circuitry.

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