Aug. 4, 1970 R. G. COOK ET AL 3,523,216

ELECTRONIC PACKAGING MODULE FOR DEEP OCEAN ENVIRONMENTS

Filed July 29, 1968 2 Sheets-Sheet 1

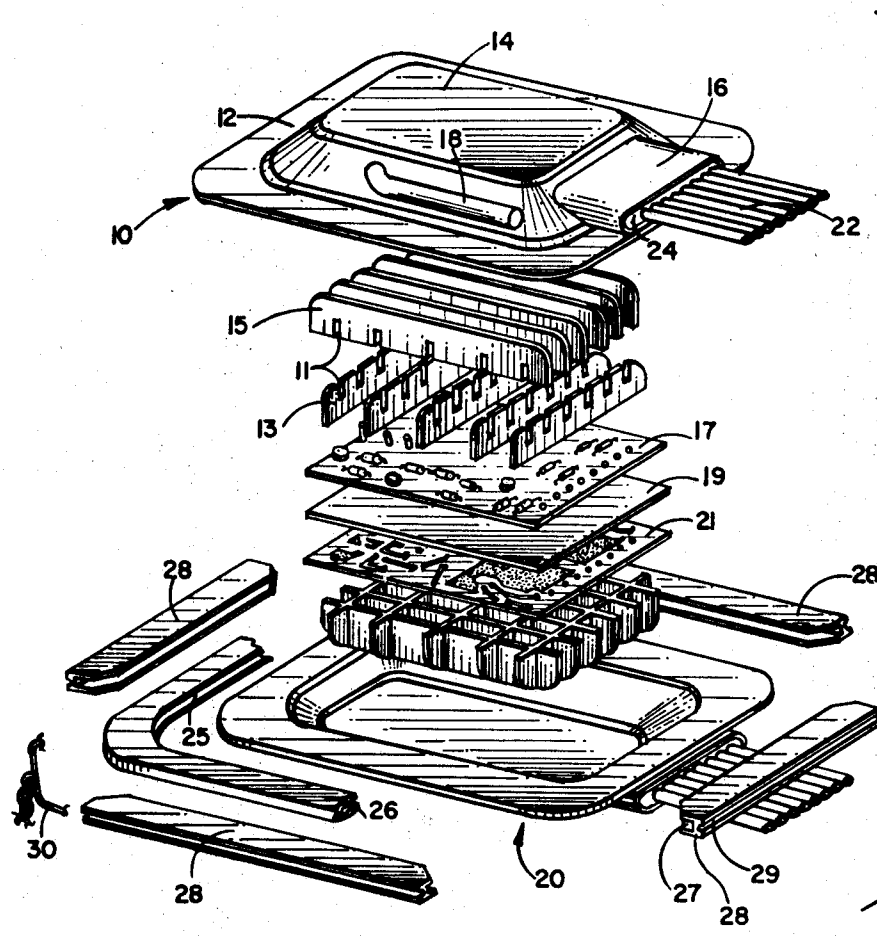


FIG. 1

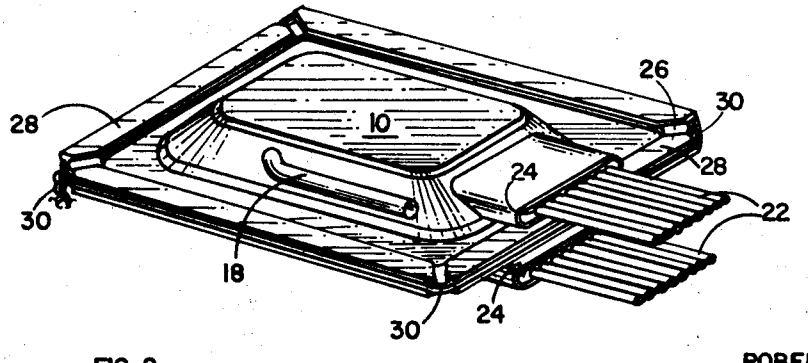


FIG. 2

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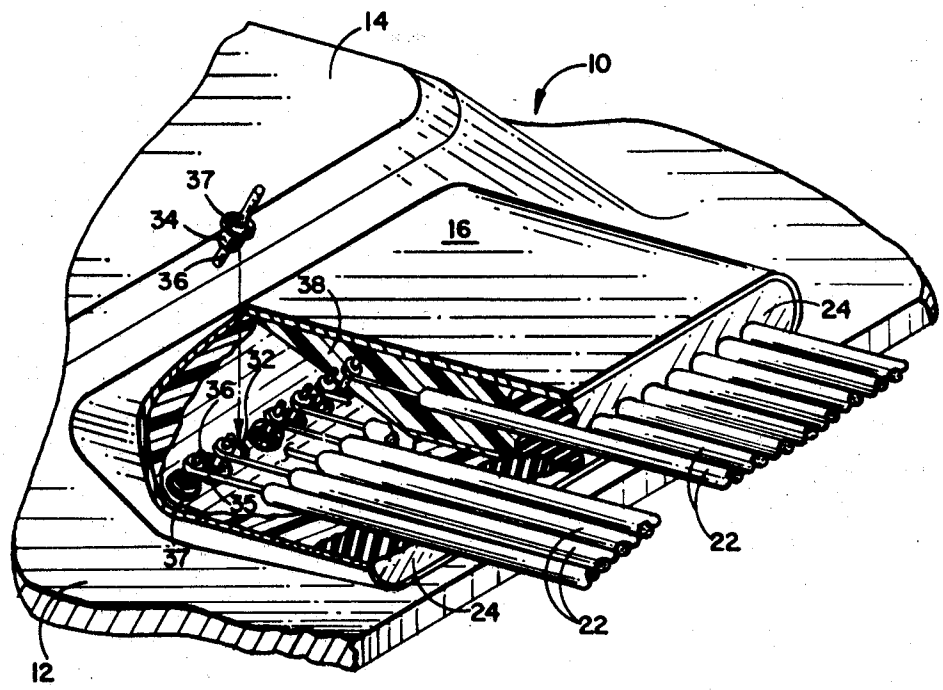


FIG. 3

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ELECTRONIC PACKAGING MODULE FOR DEEP OCEAN ENVIRONMENTS

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Int. Cl. H02b 1/04
U.S. Cl. 317—101 8 Claims

ABSTRACT OF THE DISCLOSURE

The module is comprised of two can assemblies each having relatively wide, flat, lip portions which in the assembled position butt against each other forming a partial seal. A set of egg-crate grid structures fit inside the two cans to provide the cans with structural strength against outside pressures. The electronic package mounted on circuit boards is sandwiched between the grid structures inside the can assemblies. An elastomeric molded channel seal fits over the butted lip portions and is held in place by a number of rigid retainer channels which, in turn, are secured in place by a safety wire which passes around the assembled panels. Electrical connections to the electronic package is made through the can assemblies by means of potted fittings which are welded in place on the cans.

BACKGROUND OF THE INVENTION

This invention pertains to the field of electronic packaging and more particularly to a device for packaging electronic devices for use in environments having a pressure of up to 5,000 lbs. per square inch. Considerable effort and money have been expended to date by the ocean sciences related industries in the development of electronic packaging techniques suitable for acquiring basic engineering and scientific data on the world's oceans related to temperature, salinity, and ocean currents, etc. System engineering research efforts have been directed toward development for economic methods for putting electronic systems such as information and automatic process control systems in a deep water environment with reliable operation and good maintainability over long time period while the equipment remains submerged on station.

Electronic equipment used under water is exposed to high pressures, moisture, electrolytic corrosion, and marine growth in addition to the usual environmental factors encountered in ground or airborne environments. Specific solutions to the problem of packaging electronics under water revolve around packaging the electronic module and providing reliable underwater connectors which can be engaged under water. Semi-conductor components are particularly subject to variations due to pressure as a function of the device's geometrics and material impurity concentrations. Individual components have been immersed in oil pressurized chambers which protect the components from moisture but which expose them to high ambient pressures. Semi-conductor surfaces in these oil chambers are also exposed to any possible contaminants within the oil. The principal disadvantages to packing circuits in oil are possible contamination by impurities within the oil or by moisture within the oil and unpredictable pressure effects due to variations in the component manufacturer processes which can alter pressure sensitivity.

In U.S. Pat. No. 3,381,372 entitled Method of Electrically Connecting and Hermetically Sealing Packages for Microelectronic Circuits by V. J. Capano, there is disclosed a prior art device of interest as background to the present invention. A small and somewhat fragile circuit chip is mounted between two cover plates of ceramic material, the halves of which are hermetically sealed together to form a tight package. For extremely small circuit boards, or chips, this technique could prove adequate. But when entire electronic modules are packaged in a similar way, the ceramic covering would increase in surface area and, of course, would be subjected to a greater pressure loading for the same thickness of material and could not be expected to withstand the pressures encountered in a deep-ocean environment. A more rigid structure is disclosed in U.S. Pat. No. 2,898,522 entitled Circuit Package by C. Handen. In the package of that invention, there is provided for each of the basic circuits a circuit module in the form of a "hollowed-out" square which contains the necessary circuit elements on a thin printed circuit type wafer within the hollowed-out cavity. Once the module is assembled, the entire module may be dipped in a potting compound to provide hermetic sealing. This particular module would suffer the same fate as the preceding one in that the covers for each end of the square hollowed-out cavity would buckle or collapse under the pressures normally encountered in the deep-ocean environment.

The module of the present invention specifically solves the aforementioned problems of housing an electronic package safely for use in high pressure environments.

SUMMARY OF THE INVENTION

In the preferred embodiment of the invention, two can assemblies, each having a relatively wide, flat-lipped portion extending around the outer periphery of the can, is assembled with the lipped portions butting against each other to form a sealing surface. A set of egg-crate grid structures is formed to fit snugly inside the two can assemblies. Circuit boards containing the electronic packages are sandwiched between the set of grid structures. An elastomeric molded channel seal fits over the butted lip portions and is held in place by a number of rigid retainer channels which, in turn, are secured in place by a safety wire which passes around the assembled channels. Electrical connection to the electronic modules is made through the can assemblies by means of fittings which are welded in place on the cans. The egg-crate grid structure provides the can assemblies with structural support to withstand the deep-ocean pressures. The use of the rigid retainer channels, in combination with an elastomeric molded channel, allows the module to be opened and serviced without destroying it.

Accordingly, it is an object of the present invention to provide an improved electronic packaging module.

It is another object of the present invention to provide a module for use in a high-pressure environment, which module may be re-opened without damage for purposes of servicing the electronic package.

It is a further object of the present invention to provide an improved electronic packaging module which is relatively inexpensive to manufacture.

The aforementioned and other objects of the present invention will become more apparent when taken in conjunction with the following description and drawings, throughout which like characters indicate like parts and which drawings form a part of this application.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded view of the preferred embodiment of the invention;

FIG. 2 is an assembled view of the embodiment illustrated in FIG. 1; and

FIG. 3 is an enlarged partially sectioned view of a portion of the embodiment illustrated in FIGS. 1 and 2.

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1 and 2, the outer casing or housing of the module is comprised of two can assemblies **10** and **20** which are identical in construction and which have a dished portion **14** which forms a hollow chamber when the can assemblies are butted together. The cans may be formed from 17–7 PH sheet steel which can be shaped on a hydropress. The edges or flanges **12** are relatively wide and flat and extend around the periphery of each of the can assemblies. These edges may be made relatively flat to form a sealing surface; and depending upon the material used for the cans and the accuracy of the dies, it may be necessary to add a sealant such as epoxy between the two lip surfaces or to lap the surfaces to obtain a flat sealing surface. An elongated oval-shaped housing **16** is welded, or affixed by other means, to the can assemblies. The purpose of this housing will be more clearly understood with the description of FIG. 3. An evacuation tube **18** is affixed to the can assemblies to provide a simple means for evacuating the module when the final seals have been made and for sealing the evacuated modules. Electrical lead-in wires are recevied into the oval-shaped housing **16** and are held in place by a potting compound **24**. The electronic circuit boards to be packaged (**17** and **21**, respectively) have all of the discrete components mounted on one side of the board which faces towards its respective can assembly. The electronic components are positioned on the face of the board in a grid-type arrangement to allow for a grid spacing, such that egg-crate grid structure which is formed by the assembly of reinforcement members **13** and **15** can fit flush against the circuit board proper without intefering of resting upon any of the delicate electronic components. Each of the structural members **13** and **15** is notched with notches **11** to provide the grid structure which has a high structure which has a high degree of rigidity against compression forces. A blank insulating circuit board **19**, which may be a sheet of ceramic material, is positioned between or sandwiched between the circuit boards **17** and **21**. This blank circuit board **19** provides the necessary isolation between electrical connections on the two active boards **17** and **21** while also providing a flat pressure surface between the two boards. A flexible elastomeric seal **26** having a channel groove **25** therein fits over the lip portions **12** of the can assemblies when the cans are butting against each other. This elastomeric material provides a seal against moisture. Rigid channel members **28** clamp the elastomeric seal into position and provide a rigid connection for the two can assemblies. The channel members **28** have two channels therein, one **27** which meets with the elastomeric seal **26** and another, shallower channel **29**, on the outer surface thereof which provides a locking path for a safety wire **30** which is used to bind the module assembly together.

Referring now to FIG. 3, the elongated oval member **16** is firmly affixed by means of welding to the upper cap portion **14** of the can assembly **10**. The oval assembly **16** covers a plurality of holes **32** which pass through the can assembly **10**. Through-type electrical connectors having a metallic outside body **34**, which is insulated from the electrical conductor **36** by means of insulating material **37**, are welded or brazed into these holes **32**. Insulated wires **22** are attached to the feed-through conductors **36**. The electronic components on the circuit boards **17** and **21** are then connected in standard fashion to the feed-through conductors **36** inside the can assemblies **10**. A semi-rigid potting compound **38** is then poured into the area of the connectors **34** to provide a moisture seal and add structural strength to provide protection against physical abuse of the wires. As an additional precaution, a second sealant of a more resilient potting material **24**, such as mastic or elastomer, may be applied at a point where the electrical conductors **22** leave the elongated housing **16** to provide a back-up moisture barrier.

In final assembly, the circuit boards are connected to the electrical penetrator outlets on both halves of the can assemblies. The halves are then assembled together with the elastomeric seal and the seal channel retainers. The wiring harness is then connected and tested and if it tests OK, the wire harness is potted. The module is then purged through the evacuation tubes **18** and evacuated. When the proper seal has been established, the evacuation tubes are pinched and welded. Safety wire may then be applied to secure the entire assembly. This forms on electronic packaging module which is a sandwiched-type structure which can resist hydrostatic pressure without pressurizing the electronic components. The electronic circuit boards themselves have become part of the structural members isolating the electronic components from external loads. In addition, low impedance thermal paths are provided from components to ceramic board, through the grid structure to the extrenal shell, and from the external shell or can to the ambient water about the module. By creating a partial vacuum in the module, the water pressure seals are never forced through a load reversal and are more likely to maintain their integrity. A resistive type sensor which has an affinity for water vapor may be mounted to the circuit board to provide a built-in self-test feature. These particular types of sensors are well known to those persons skilled in the art and do not form a part of this invention. In the preferred embodiment, for the purposes of achieving increased strength and superior heat transfer characteristics, the circuit boards should be made from alumina or beryllia. The structural grid assemblies can also be made from this material as it has a very high compressive strength.

While there has been shown what is considered to be the preferred embodiment of the present invention, it will be manifest that many changes and modifications may be made therein, without departing from the essential spirit of the invention. It is intended, therefore, in the annexed claims, to cover all such changes and modifications that may fall within the true scope of the invention.

What is claimed is:

1. An electronic component packaging module comprising in combination:

(a) a pair of mating can assemblies each having a relatively wide, flat-lip portion extending outwardly from each can assembly and disposed substantially in a plane which portions are adapted to butt against each other;

(b) an electronic package including a circuit board having electronic components on one side thereof;

(c) an egg-crate grid structure disposed on the side of said board having said components and disposed between said board and one of said can assemblies to support said can assemblies against outside pressures; and

(d) sealing means, sealing said can assemblies together.

2. The invention according to claim **1** and further comprising:

(a) a plurality of electrical connectors passing through said can assemblies and electrically connected to said electronic package.

3. The invention according to claim **1** and further comprising:

(a) means for evacuating said module when said can assemblies are sealed together.

4. The invention according to claim **1** wherein said electronic components are mounted on said boards in the spaces between said grid structures.

5. An electronic component packaging module comprising in combination:

(a) a pair of mating can assemblies each having a relatively wide, flat-lip portion which are adapted to butt against each other;

(b) at least one pair of electronic circuit boards;

(c) an insulating board separating said electronic circuit boards;

(d) a pair of egg-crate grid structures disposed on opposite sides of said pair of boards, each of said grid structures being disposed between a respective board and respective can assemblies to support said assemblies against outside pressures; and

(e) means for sealing said lip portions together.

6. The invention according to claim **5** and further comprising:

(a) means for evacuating said module after said module is sealed.

7. The invention according to claim **5** and further comprising:

(a) a plurality of electrical connectors passing through said can assemblies and electrically connected to said electronic package.

8. The invention according to claim **5** wherein said sealing means is comprised of:

(a) an elastomeric molded channel seal which fits over said butted lip portions;

(b) a plurality of rigid retainer channels which fit over said molded channel to hold it in place; and

(c) wire means passing around said rigid retainer channels to secure said channels in place.

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U.S. Cl. X.R.

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