United States Patent [19]

Fischer

[11] **3,778,745**

[45] **Dec. 11, 1973**

[54] **CIRCUIT BOARD AND METHOD OF MAKING THE SAME**

[76] Inventor: **Arthur Fischer**, Altheimer Strasse 219, D-7241, Tumlingen, Germany

[22] Filed: **Aug. 18, 1971**

[21] Appl. No.: **172,725**

[30] **Foreign Application Priority Data**

Aug. 27, 1970 Germany ..... P 20 42 423.1

[52] **U.S. Cl.** ..... **339/18 C**, 317/101 CC, 339/95 D

[51] **Int. Cl.** .. **H01r 11/20**, H01r 29/00, H01r 31/08

[58] **Field of Search** ..... 317/101 C, 101 CC; 339/17, 18 R, 18 C, 95 D, 198, 65, 66, 258, 256, 192

[56] **References Cited**

UNITED STATES PATENTS

3,060,400	10/1962	Pistey	339/95 D
3,107,963	10/1963	Hansen	339/65 X
3,189,866	6/1965	Lazar et al.	339/65 X
3,214,722	10/1965	Weimer, Jr.	339/95 D
2,575,161	11/1951	Deakin	339/258 F
2,944,240	7/1960	Barber	339/186 M X
3,027,534	3/1962	Deakin	339/18 C
3,152,849	10/1964	Deakin	339/18 C

FOREIGN PATENTS OR APPLICATIONS

293,949	4/1968	Australia	339/95 D
66,587	9/1913	Switzerland	339/198 G
1,095,619	12/1967	Great Britain	339/192 R

Primary Examiner—Marvin A. Champion
Assistant Examiner—Terrell P. Lewis
Attorney—Michael S. Striker

[57] **ABSTRACT**

A member of electrically insulating material is provided with a plurality of recesses each of which is bounded by an interior surface. Electrically conductive contact assemblies are anchored in the material of the member and each have several resiliently deflectable clamping portions which bear against or towards the interior surface of one of the recesses, being connected by a base portion both mechanically and electrically with the base portion being embedded in the material of the member.

9 Claims, 3 Drawing Figures

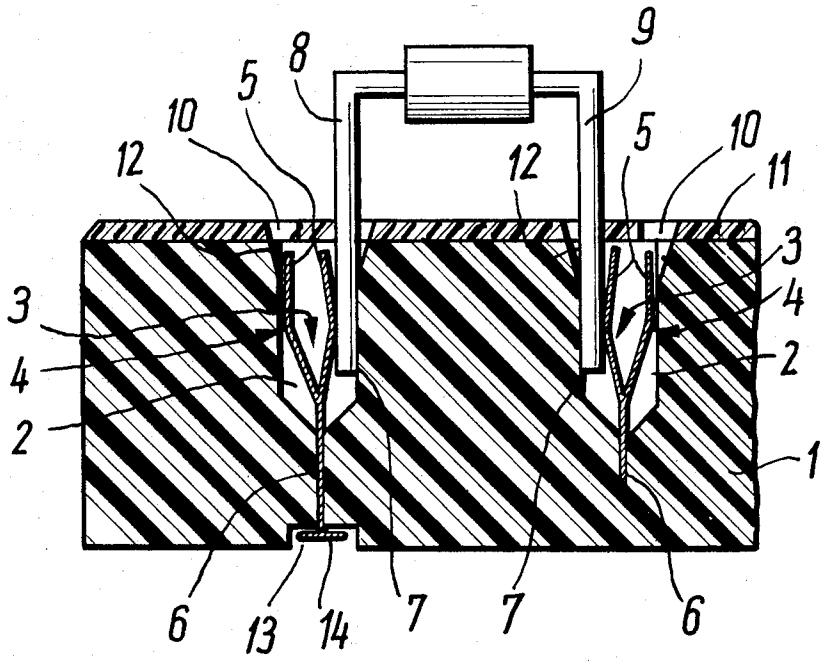


Fig. 1

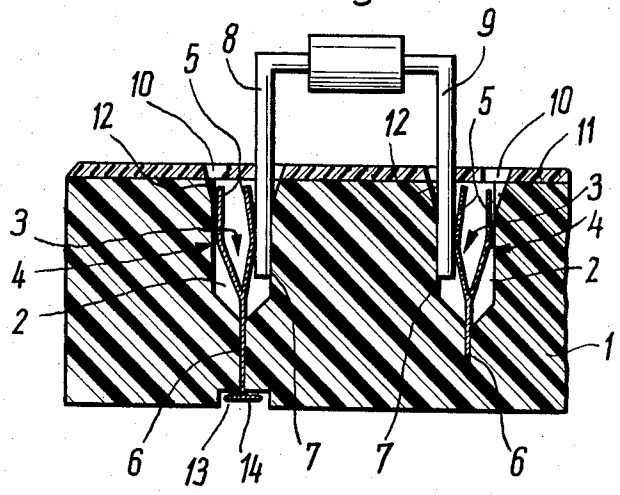


Fig. 2

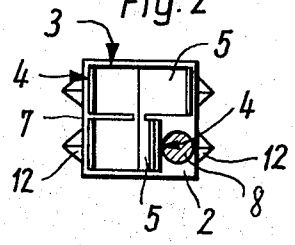
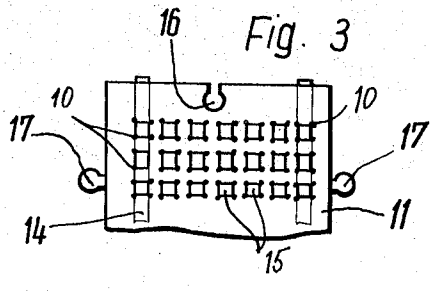


Fig. 3



Inventor:
ARTUR FISCHER
By: Richard S. Stecker
Attorney

CIRCUIT BOARD AND METHOD OF MAKING THE SAME

BACKGROUND OF THE INVENTION

The present invention relates generally to an electrical connector, and more particularly to an electrical circuit board. Still more particularly the invention relates to an electrical circuit board for establishing electrical or electronic circuit connections, particularly for use in toy or experimentation kits.

In many instances, of which toy kits and experimentation kits are representative but not exhaustive examples, electrical or electronic circuit connections must be made in such a manner that they can be readily made as well as discontinued. For example, in an experimentation or hobby kit, it is usually the practice to provide sufficient components so that the user can establish several devices and the electrical or electronic circuits therefor, with a single kit. Of course, this possibility presupposes that the user be capable of assembling a circuit for one device and, when he has completed this device, that he be able to disassemble the circuit and assemble a new one for another different device, always using the same circuit components. It would evidently be economically impractical to provide circuit components for each of the several circuit connections which can be established with such a kit. The same is of course true also of other applications, for instance in the case of experimenters who make so-called "breadboard" lay-outs.

It is known from the art to provide a circuit board permitting the establishment and disconnection of electrical or electronic circuits. This known circuit board provides a plurality of connecting locations each having several contacts which are arranged in line one behind the other and at relatively significant spacing from one another. Of course, to be able to have a circuit board which has considerable versatility of use, such a circuit board requires a large number of such contact locations. Because they are relatively widely spaced from one another, this requires further that such circuit board be very large which is often not feasible. This is particularly true of the aforementioned prior-art circuit board. Furthermore, with this prior-art construction the clarity of a circuit connection established on the board—which must be very large as pointed out in order to be versatile—suffers from the necessarily significant distances of the contacts of one contact location from the electrical components which are associated with this contact location. This means that as the establishment of a circuit using such a circuit board progresses, the circuit becomes more and more confusing even if the associated contacts of a contact location are marked on the board, and it becomes more and more difficult to find and trace the extent of a contact location and thereby to find the contact possibilities which still exist for further contacts of components which are to be connected into the circuit.

Consideration has already been given to utilizing a single much larger contact, with the contact wires of the various components all to be connected to this single contact. However, this has been found to be impractical because the cross-sectional dimensions of different contact wires are frequently different and thus make it difficult if not impossible to connect them to a single contact. Moreover, the contact wires may be bent by previous use and the known contacts, which

usually consist of two resiliently deflectable tongues which engage one another and between which the contact wires must be pushed to accomplish an electrical connection, do not guarantee a proper electrical engagement with the wires if for instance two wires are inserted between them the cross-sectional dimension of one of which deviates even slightly from that of the other. This is particularly important and unacceptable in the case of electronic circuits where it is essential that a contact be established which assures proper current flow in order to avoid the possibility of interference or malfunction.

A further disadvantage of the prior art in which the contacts associated with a given contact location are arranged in line, and in which the spatially separated contacts of a contact location necessitate a large-area configuration of circuit board, is the fact that this makes it impossible to use such circuit boards in combination with one of the popular kits in which electronic components are provided in form of modules each of which in itself contains electronic circuits and wherein the modules are to be electrically connected with one another by the use of a circuit board. The electronic circuits used in such modules are industrially produced and are so small as to permit the dimensions of each module to be similarly very small. Such modules can frequently be connected with one another by means of cooperating undercut male and female coupling portions which are frequently so constructed that a mechanical connection in this manner results automatically in an electrical connection between the circuits of the thus-connected modules, for instance by means of appropriate contact space. Such modules cannot be used in conjunction with the known circuit board because despite the large area of such circuit boards a much smaller number of electrical or electronic modules can be connected with them than the number with which the very much smaller modules are provided. On the other hand, circuit boards whose surface area corresponds to the modules would have so few connecting locations—because of the necessary dimensions of such locations resulting from the considerations behind the prior-art construction—that it would not be possible to construct or appropriately completely a usable electronic circuit.

All of this indicates the desirability of further improvements in this field, improvements which however have not heretofore been forthcoming.

SUMMARY OF THE INVENTION

It is, accordingly, a general object of the present invention to overcome the aforementioned disadvantages of the prior art.

More particularly it is an object of the present invention to provide an improved circuit board of the type under dicussion.

It is a further object of the invention to provide such an improved circuit board which is so constructed that a maximum number of contacts can be accommodated in each switching or contact location in a minimum amount of space.

Another object of the invention is to provide such a circuit board in which the space required for the various contacts of a contact location be so small as to be barely in excess of the sum of the cross-sections of the connecting wires of components which are to be electrically connected with one another via the switching or

connecting location. In particular it is desirable that the spatial separation of 2.5 mm which has been established as the norm in some countries for electronic circuits be capable of being met. With this it is intended to assure that the novel circuit board can be utilized also in conjunction with a system of modules which contain electrical or electronic circuits and which are connected via undercut mating mechanical and electrical connections, so that the circuit board according to the present invention permits a useful and practical completion of the circuits which are incorporated in the individual modules.

In pursuance of the above objects, and of others which will become apparent hereafter, one feature of the invention resides in a circuit board which, briefly stated, comprises a member of electrically insulating material having an outer surface which is provided with a plurality of recesses each bounded by an interior surface. A plurality of electrically conductive contact means are also provided, each accommodated at least in part in one of the recesses and each comprising a plurality of resiliently deflectable clamping portions bearing towards the interior surface of the respective recess, and a base portion electrically and mechanically connecting these clamping portions.

The prior-art concept of providing each contact in form of two springy or resiliently deflectable contact portions which bear against one another, and between which the wire or wires to be connected are inserted, has thus been abandoned in the present invention. Instead a wire or wires to be inserted are introduced between one of the clamping portions and the interior surface bounding the recess, so that such wire is pressed by the clamping portion against this interior surface. This means that two of the clamping portions thus provide two contacts which take up almost exactly the same amount of space as a single contact in the prior art which is composed of two cooperating springy contact portions. This means that, given the same amount of space in the construction according to the present invention as in the prior-art construction, two connecting wires can be connected in the present circuit board where in the prior-art construction only a single contact wire could be connected. Moreover, with the construction according to the present invention each of the wires thus connected to the novel circuit board will be in proper contact with its associated clamping portion or spring contact, irrespective of the cross-sectional configuration or dimension of the wire.

It is particularly advantageous, but not mandatory, that each contact location of the novel circuit accommodate at least four contacts, in which case four of the resiliently deflectable clamping portions are required which may be arranged in laterally adjacent pairs, with a wire to be connected to each or any one of these four contacts. In other words, the reference to a "pair" here is not to be understood as meaning that two of the contacts or clamping portions cooperate with one another; on the contrary, each individual clamping portion cooperates only with the interior surface bounding the recess in which it is located. Thus, four contact or connecting wires of identical or differential thickness or cross-sectional configuration can be connected with each contact location so constructed by each being connected to one of the clamping portions. This arrangement permits in a simple manner the maintenance of the aforementioned normative respective spacing of contact points of small resistors, transistors, tubes and the like.

According to the present invention the clamping portions of a contact location may be in form of a substantially rectangular plate-like member of electrically conductive material, of which the clamping portions themselves are punched out and deflected out of the general plane of the member, with the remaining part of this member constituting the base which mechanically (in this case by being of one piece with them) and electrically connects the clamping portions.

Such a contact assembly may be made by punching in known manner and with known tools the contact portions out of the rectangular blank or member, leaving them connected at one end, and then bending them to desired position with respect to the remainder of the blank. The thus formed contact assembly is inserted into a recess of the circuit board member, with the recess constituting a contact location, and at the base of the recess they are connected via their base portion—that is the remainder of the blank—with the circuit board member in suitable manner, for instance by clamping, by adhesion, by formation of requisite connecting projections, by embedding or in other ways. In fact, according to the present method it is also possible to form the circuit board member of synthetic plastic material around the appropriately positioned and retained contact assemblies.

According to the present invention it is also possible and in certain instances advantageous to provide a cover plate which overlies the outer surface of the circuit board member in which the recesses are formed. The cover plate will then be provided with a plurality of apertures which are arranged in sets, with each set being coordinated with one of the recesses and with the apertures of each set affording access to one of the clamping portions in this recess. Such an arrangement has the advantage that the clamping portions are not visible at the exterior of the board, and that at the same time they are largely protected against contamination by dust, moisture and the like, as well as being protected against mechanical damage. The contact wires are then inserted through these apertures and into clamping engagement between a respective clamping portion and the interior surface of the recess against which it bears or towards which it bears. It will be understood that the clamping portions need not necessarily be in direct engagement with the interior surface, but that it may be sufficient if they simply approach the interior surface. The exposed side of the cover plate may be provided with markings to indicate the associated contacts of a contact location, if this is still desirable despite the very small spacing between the contacts and the contact locations. For instance if the apertures are located on the corners of an imaginary square, the outer or exposed side of the cover plate may be provided for each set of apertures with an appropriate marking, for instance a square which is printed, painted, incised or otherwise provided and on whose corners the apertures are located. However, it should be pointed out that the recesses could also be provided at the underside of the circuit board and be enclosed towards the upper side with only openings being provided at the upper side which register with the respective clamping portions. This would eliminate the need for a cover plate at the top, but in such a case a cover plate could then be provided or might be neces-

sary to close the recesses at the underside of the board member.

The insertion of the connecting wires may be facilitated by providing the rim portions bounding the respective recesses with guide grooves or notches in the region of the respective clamping portions, and these notches may have approximately triangular cross-sections and extend to the respective clamping portions. This then makes it possible to have the clamping portions terminate in a straight-line configuration rather than having to bend or otherwise deform their free ends in order to provide a guide surface for the incoming contact or connecting wires. By having the contact portions terminate in a straight-line configuration the additional advantage is obtained that they may be provided at their free ends with a sharp edge or the like which slides over the surface of the wire as it is being inserted and thus scrapes off oxide layers which might otherwise disadvantageously influence the quality of electrical connection; such a sharp edge is produced when the contact portions are stamped or punched from their respective blank, without having to carry out a separate step to produce the edge.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional advantages and objects thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an enlarged vertical section through two contact locations of a circuit board according to the present invention;

FIG. 2 is a top-plan view of a contact location such as shown in FIG. 1; and

FIG. 3 is a fragmentary top-plan view of the embodiment in FIG. 1, with the electrical component shown connected in FIG. 1 having been omitted for the sake of clarity.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Discussing now the drawing in detail, and firstly FIGS. 1 and 2 thereof, it will be seen that reference numeral 1 identifies a circuit board member which is of electrically non-conductive or insulating material, and which in the illustrated embodiment is shown as consisting of synthetic plastic material. However, other materials are of course suitable. The outer surface—in this case the upper surface—of the member 1 is provided with recesses 2 each of which accommodates a contact location 3. Located in each of the contact locations 3 is a contact assembly 4 composed of a plurality of resiliently deflectable clamping or retaining portions 5 which are electrically conductively connected —here also mechanically by being of one piece therewith—with the base portion 6. The clamping portions 5 are clampingly directed towards and along the inner surface 7 bounding the respective recess 2, but they need not contact the surface 7 and can instead merely approach it closely enough to provide a sufficient clamping action between the surface 7 and the respective clamping portion 5. In FIG. 1 there is illustrated an electrical or electronic component the contact wires or terminals 8 and 9 of which are inserted through apertures 10 provided in a cover plate 11 which overlies the surface of the member 1 which is provided with the recesses 2. The boundary rims bounding the upper open ends of the respective recesses 2 are in the illustrated embodiment provided with notches or kerfs 12 of here approximately triangular cross-section which extend to the respective clamping portions 5 as illustrated. This facilitates the insertion of the contact wires 8 and 9 after the latter have been introduced through respective ones of the apertures 10.

The apertures 10 in the cover plate 11 may, incidentally constitute extensions of the respective kerfs 12, that is they may be located on a line passing longitudinally of the kerfs 12.

Several of the contact locations 3 of the novel circuit board must be connected with a conductor which supplies electrical energy. In the illustrated embodiment this is achieved by having the base portions 6 of the contact assemblies 4 located in some of the contact locations 3 extend through the circuit board member 1 to a recess 13 in which a current-conducting member 14 is accommodated which is electrically conductively connected with the respective base portions 6, for instance by soldering or the like. The remaining contact assemblies in the other contact locations 3 are electrically insulated from one another and not connected with the conductor 14.

The configuration of the contact assembly, and its position in a recess 2, can be clearly seen from FIG. 2 and it is recalled that such contact assembly may be produced by punching the clamping portions 5 out of a blank and deflecting them in requisite manner, leaving them connected with the remainder of the blank at one end with the remainder then serving as the base portion 6 which may of course be appropriately shaped if desired.

In FIG. 3 there is illustrated diagrammatically the distribution of the contact locations 3, or more particularly the manner in which this distribution is marked on the cover plate 11. The squares 15 shown in FIG. 3 are the markings which indicate which of the apertures 10 belong together, thus showing which of the several apertures 10 connected by them (and located at the corners of the respective squares) are all associated with one and the same recess 2 and the contact assembly 4 accommodated therein. Thus, if one of the contact wires is inserted through one of the apertures 10 located at the corners of the respective squares 15, then the inserted contact wire will become clamped between the clamping portion 5 located between the respective aperture and the inner surface 7 with which the clamping portion 5 cooperates. Of course, the arrangement may be other than quadratic or square, as shown in FIG. 3, but this particular arrangement makes it especially easy to determine which particular apertures 10 belong to a given contact location 3, so that the establishment of a circuit is made very simple. In this illustrated embodiment the contact locations 3 associated with the squares 15 of the two outer rows on the cover plate 11 are connected with the current conductor 14, whereas all of the other contact locations 3 are electrically insulated from one another.

It is advantageous to make the novel circuit board connectable mechanically and/or electrically with other components, for instance with modules in which circuits are accommodated and which are provided

with cooperating coupling portions. This makes it possible to utilize the novel circuit board as part of a system of electronic modules and, if necessary or desired, to complement the circuits accommodated in the modules. This is for instance the case when an additional partial circuit is required in order to obtain the function which is to be achieved by connecting the individual circuits incorporated in the different modules with one another. Of course, conceivably the function could be obtained by adding an additional module which provides this partial circuit, but in some circumstances it may for instance be the case that the circuit incorporated in this particular module is more complex than the partial circuit which is required for this completion purpose, and in such case it may be desired to utilize the circuit board according to the present invention to establish this partial circuit rather than utilize the additional module. It is then a simple matter to add the necessary electrical or electronic components on the circuit board which will establish the additional partial circuit which is to cooperate with the circuits of the modules themselves.

Such connection may be established, in accordance with the present invention, by providing the circuit board member **1** with suitable coupling means, here illustrated as an undercut groove **16** located in the region of one side of the member **1**, and undercut coupling heads **17**—which may be of circular or polygonal cross-section or may be elongated in form of ribs—of which one or more may be located at different parts of the board member **1**. A connection between the novel circuit board and other components can then be established by inserting a coupling head corresponding to the one identified with reference numeral **17** but provided on another component, into the groove **16** and/or by inserting one or more of the coupling heads **17** on the circuit board into grooves corresponding to the groove **16** but provided on respective other components.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of constructions differing from the types described above.

While the invention has been illustrated and described as embodied in a circuit board, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

1. A circuit board, comprising an insulating member having an outer surface, at least one recess extending inwardly from said outer surface and having an open end at the latter, and an inner surface surrounding said recess; electrically conductive contact means installed at least in part in said recess, said contact means including a base portion secured to said insulating member and a plurality of independently deflectable resilient retaining portions electrically and mechanically connected to each other by way of said base portion, said retaining portions extending from said base portion at circumferentially spaced locations of said recess towards said open end and each being deflectable from a normal position in which it is located adjacent to but defines a gap with said inner surface to thereby store energy; and at least one current-conducting terminal extending through said open end into one of said gaps, deflecting the respective retaining portion out of said normal position so that such retaining portion frictionally engages said terminal and biases the same into frictional engagement with said inner surface, so that said terminal can be withdrawn by overcoming the force of said frictional engagement.

2. A circuit board as defined in claim **1**, wherein said contact means comprises a first pair of oppositely located ones of said retaining portions, and a second pair of oppositely located ones of said retaining portions laterally adjacent said first pair.

3. A circuit board as defined in claim **2**; and further comprising cover means overlying said outer surface and having four apertures each of which overlies said open end in registry with one of said gaps so as to permit insertion and removal of said terminal through a respective aperture in substantial parallellism with the elongation of said recess.

4. A circuit board as defined in claim **3**, wherein said apertures form a polygonal pattern.

5. A circuit board as defined in claim **1**, wherein said retaining portions are integral with said base portion.

6. A circuit board as defined in claim **1**, wherein said insulating member consists of synthetic plastic material.

7. A circuit board as defined in claim **1**, wherein said contact means is a rectangular plate, said retaining portions being punched and deflected out of the general plane of said plate and the remainder of said plate constituting said base portion.

8. A circuit board as defined in claim **1**, wherein said insulating member is provided in said outer surface thereof with a peripheral rim portion surrounding said recess and having in the region of each retaining portion a bevelled notch extending toward the respective gap to facilitate the introduction of terminals into said gap.

9. A circuit board as defined in claim **8**, wherein each of said notches has a triangular outline.

* * * * *