United States Patent [19]

Chow

[11] **3,747,209**

[45] **July 24, 1973**

[54] **AUTOMATED WIRING SYSTEM AND METHOD**

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[73] Assignee: **The Bunker-Ramo Corporation**, Oak Brooks, Ill.

[22] Filed: **Nov. 12, 1969**

[21] Appl. No.: **875,906**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 854,413, Sept. 2, 1969, abandoned.

[52] U.S. Cl. .... **29/629**, 29/624, 29/625, 29/628, 29/630 R, 29/630 B, 29/630 G

[51] Int. Cl. **H02g 15/00**

[58] Field of Search 29/624–630, 605, 602, 597

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Assistant Examiner—James R. Duzan
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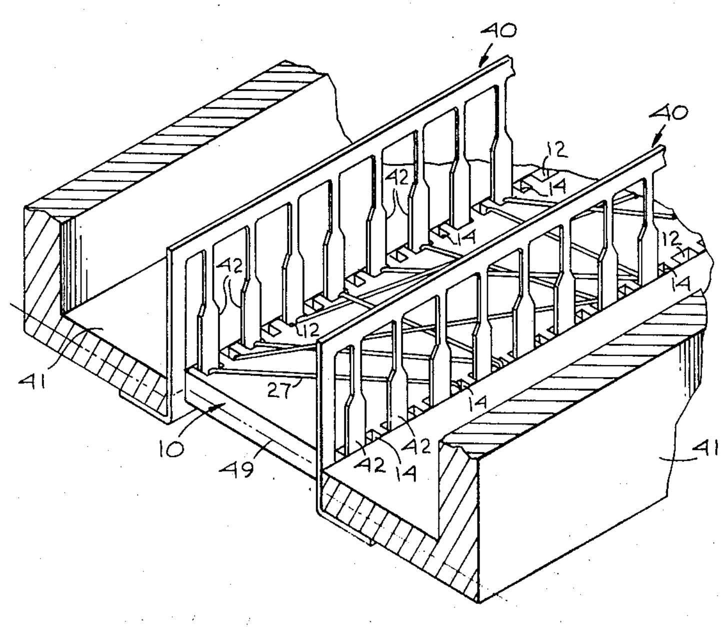
[57] **ABSTRACT**

A plug-in interconnection module having a desired interconnection pattern is provided by winding loops in predetermined slots of a slotted core in a predetermined sequence using a winding means whose position is automatically controlled by a computer in accordance with the interconnections desired. The loop wires in the slots are electrically connected to each other and/or to respective terminals, such as by the use of dip-soldering, infrared bonding or conductive epoxy. The loop portions on one side of the core are removed so that interconnections between terminals are provided by the remaining loops on the other side. The resulting structure is then encapsulated to form the completed interconnection module which may be plugged into printed circuit boards, mother boards and the like for providing desired interconnections between other components, such as discrete components, terminal sockets and integrated circuit modules. Electric shielding means may also be incorporated into the structure at appropriate stages during the fabrication thereof.

19 Claims, 19 Drawing Figures



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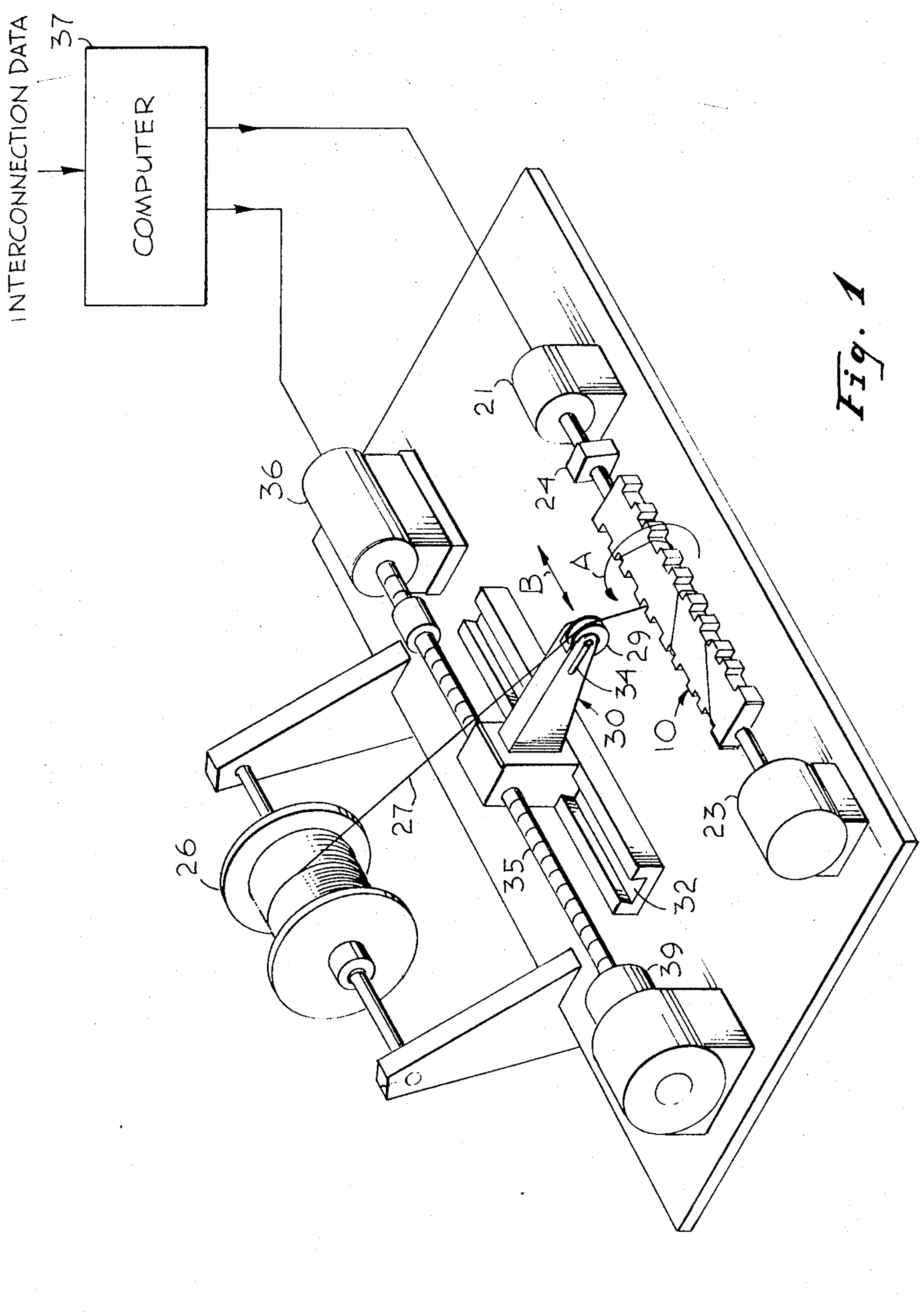

Fig. 1

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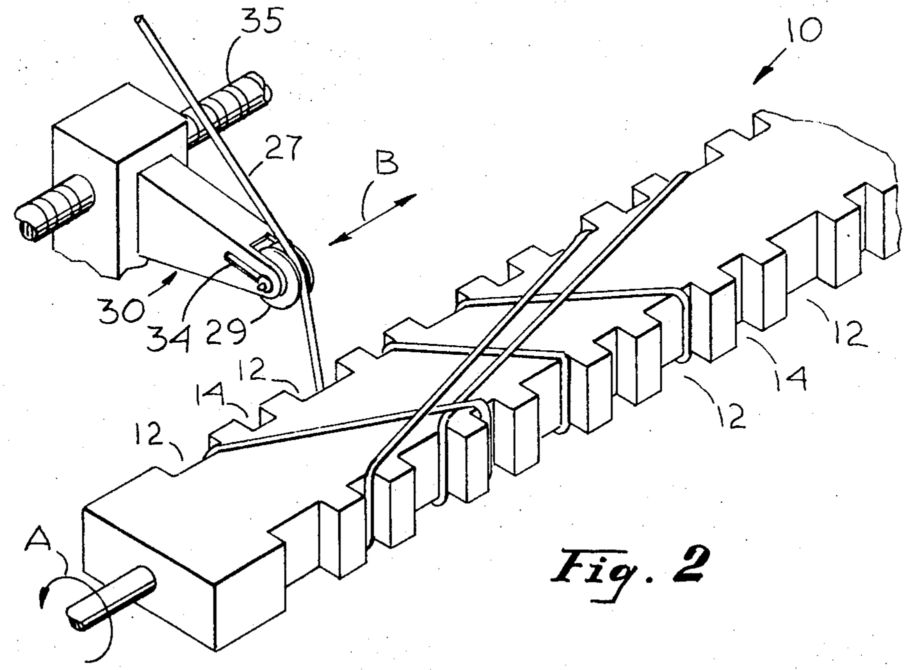

Fig. 2

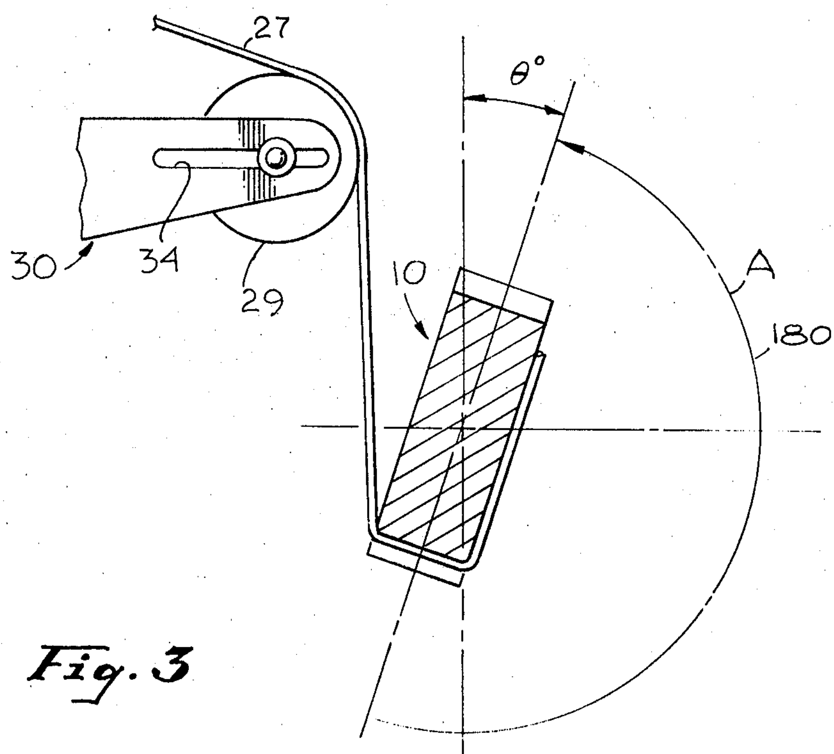

Fig. 3

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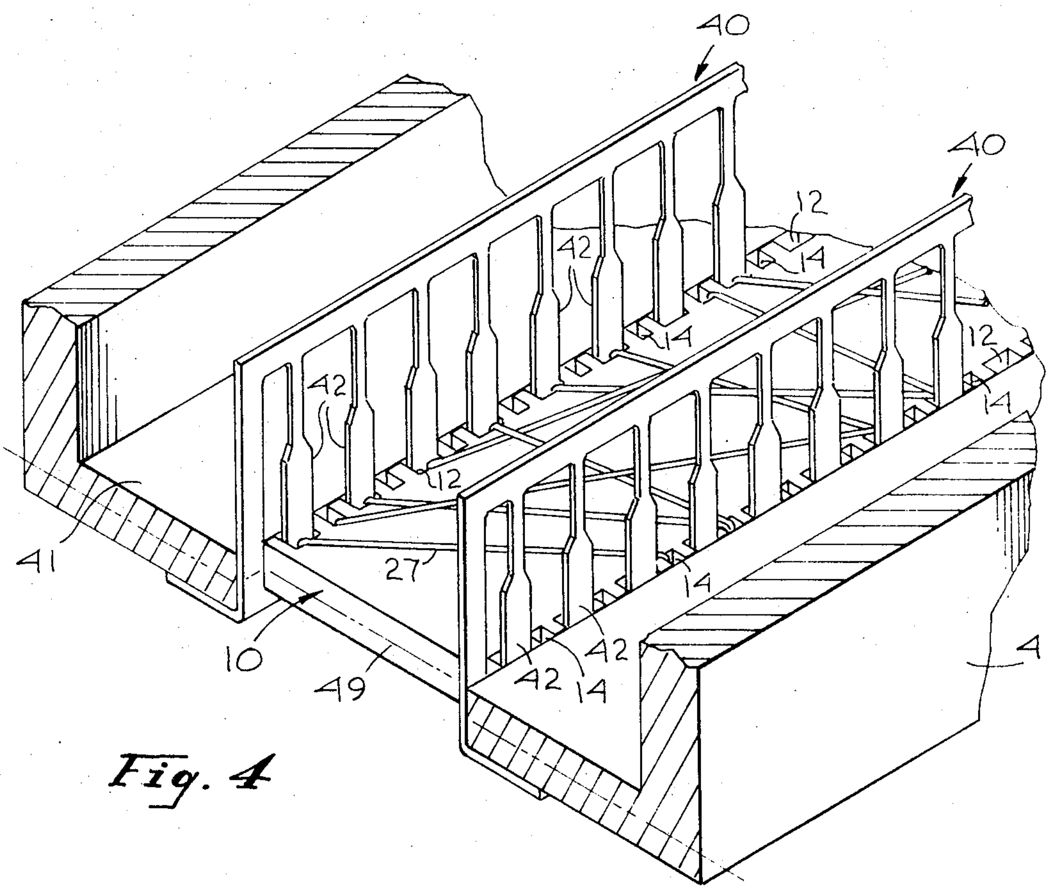

Fig. 4

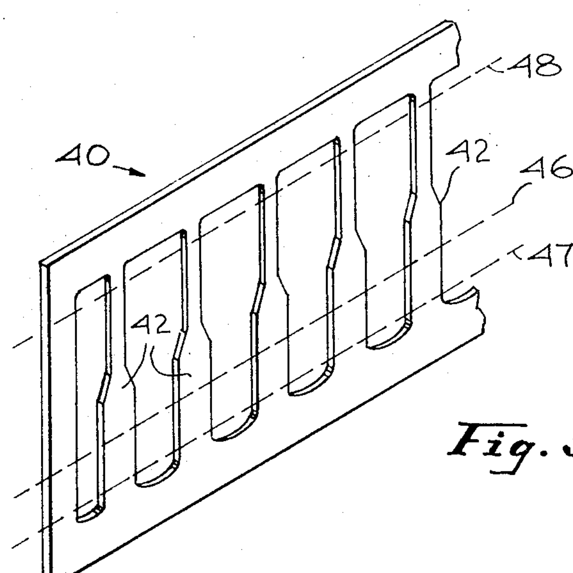

Fig. 5

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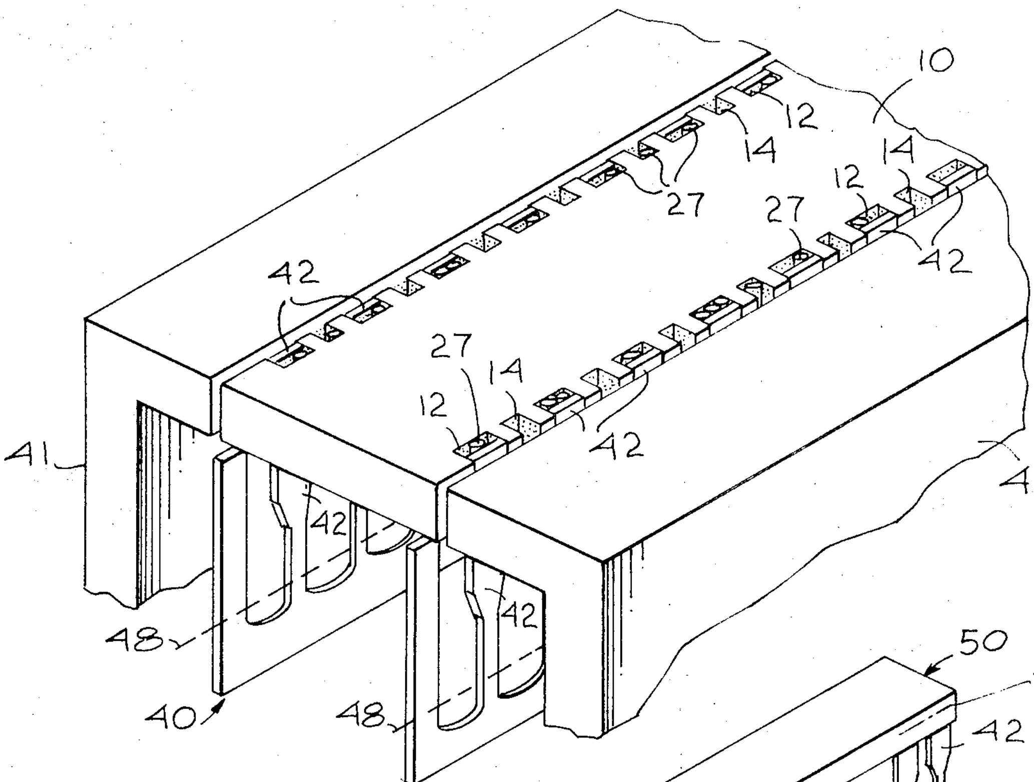


Fig. 6

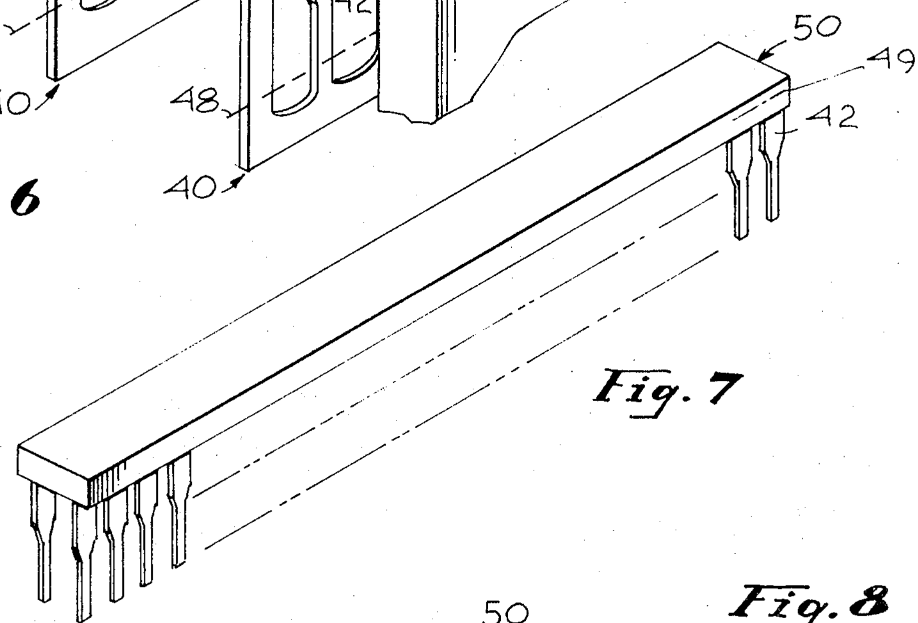
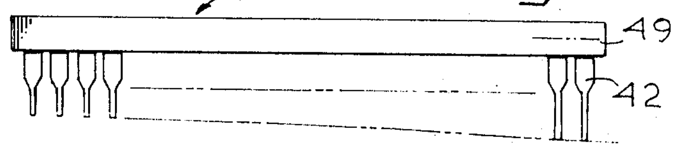


Fig. 7

Fig. 8



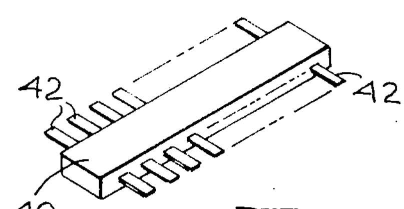


Fig. 9

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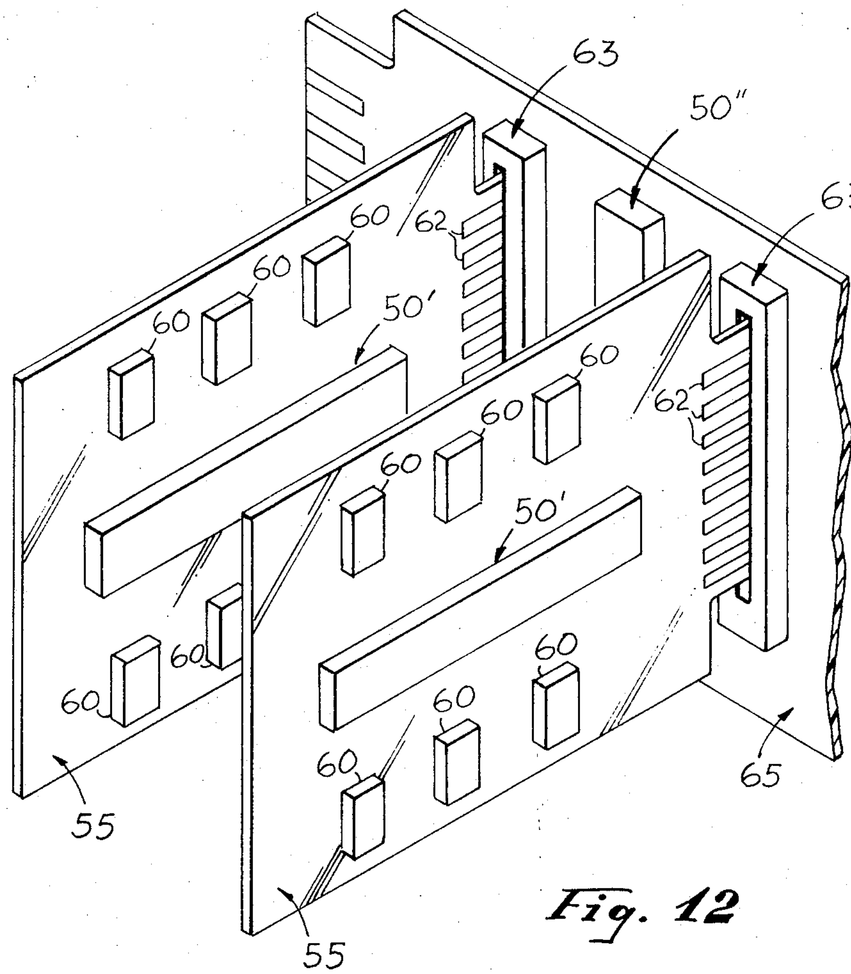

Fig. 12

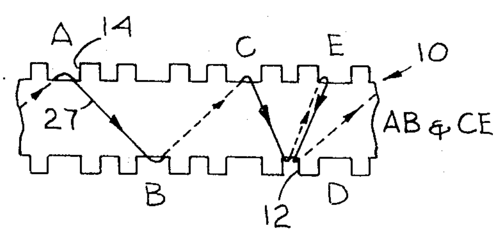

Fig. 10

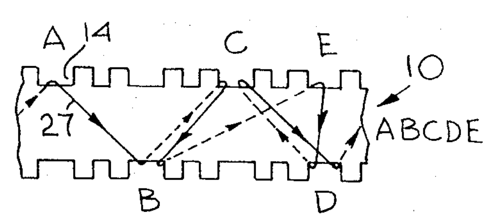

Fig. 11

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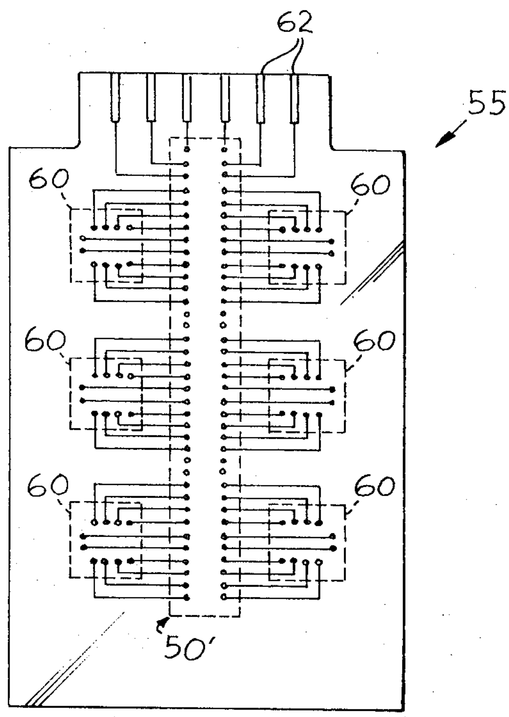

Fig. 13

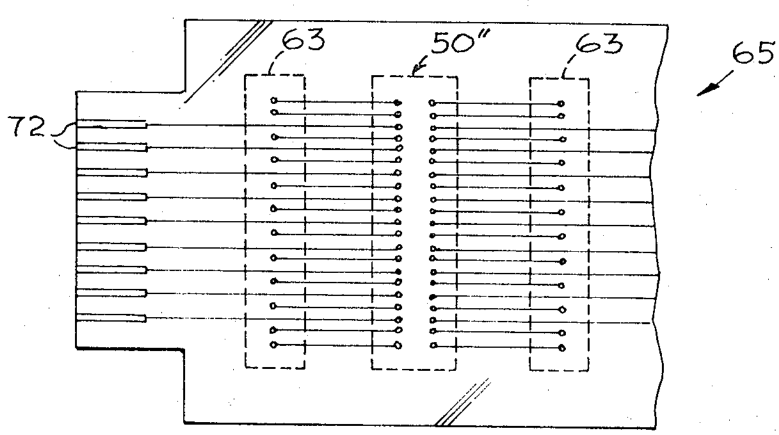

Fig. 14

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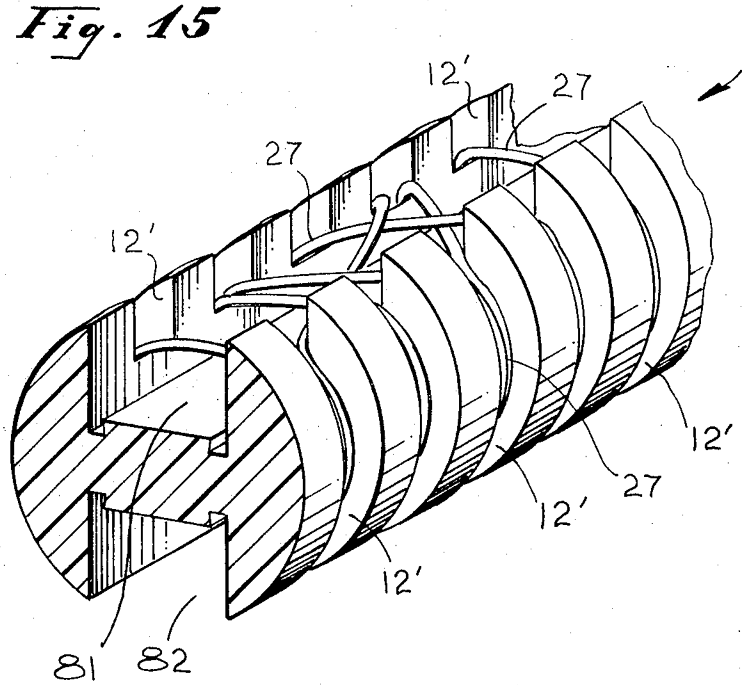
Fig. 15



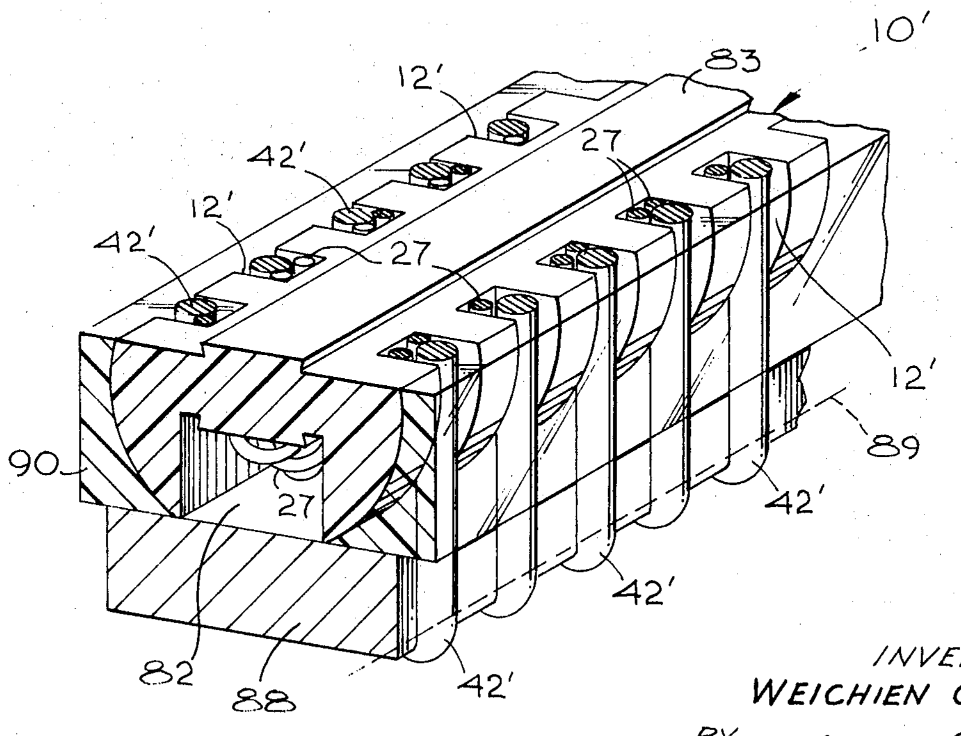


Fig. 16

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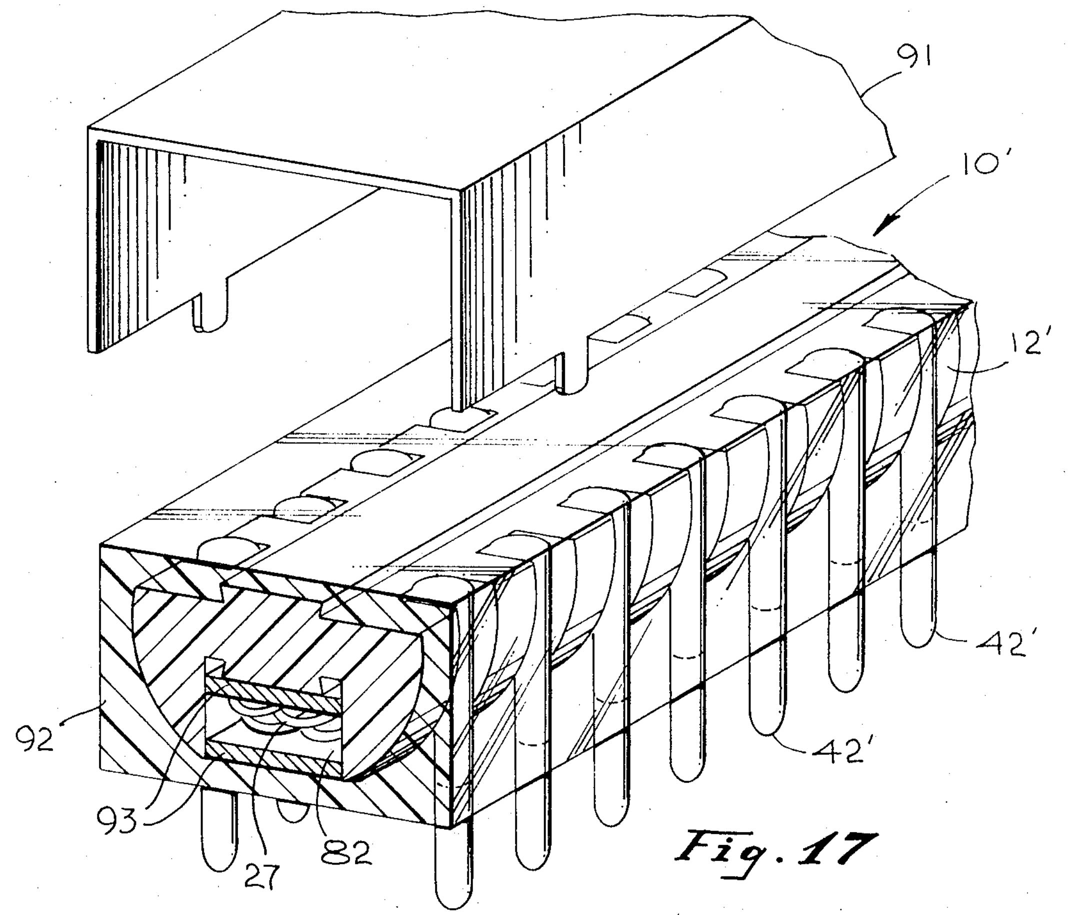

Fig. 17

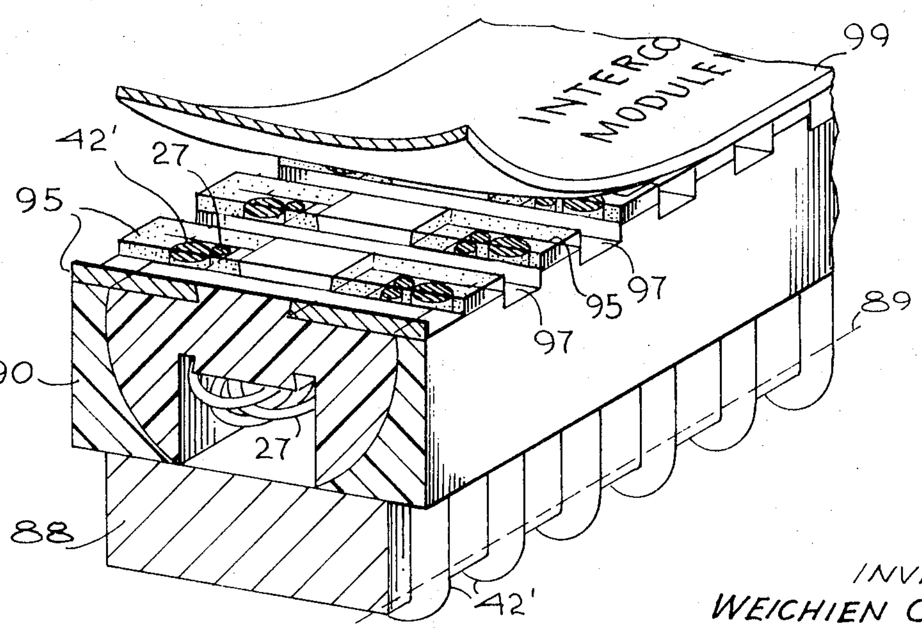

Fig. 18

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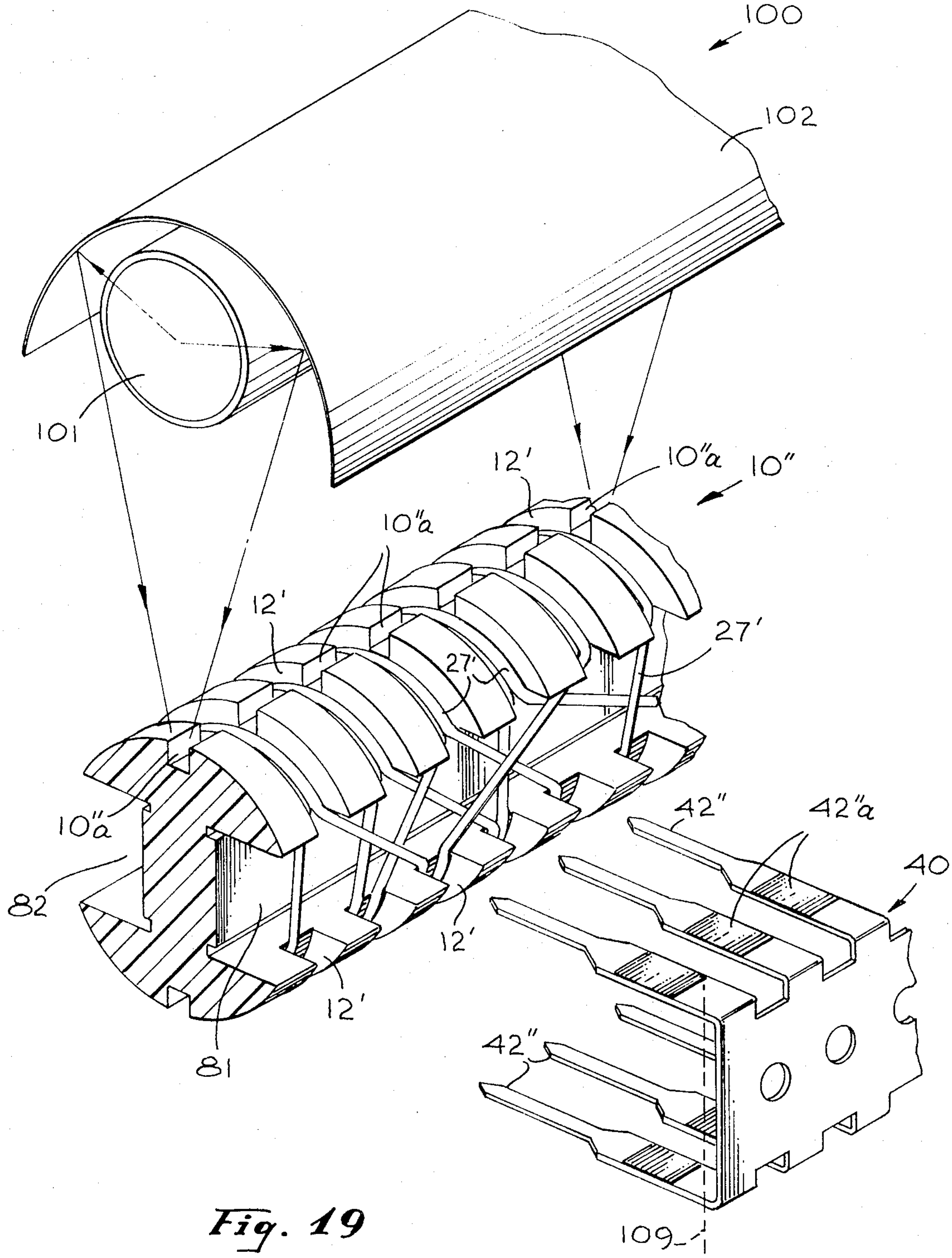

Fig. 19

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AUTOMATED WIRING SYSTEM AND METHOD

CROSS-REFERENCE TO RELATED PATENT APPLICATION

This patent application is a continuation-in-part of the commonly assigned copending patent application Ser. No. 854413 filed Sept. 2, 1969 now abandoned.

BACKGROUND OF THE INVENTION

It will be recognized that the provision of appropriate electrical interconnections for printed and integrated circuit boards and modules has presented a very considerable problem in the past, particularly with regard to the provision of point-to-point wiring interconnections. A variety of conventional approaches to the point-to-point interconnection problem are known, but have the disadvantage of requiring high cost methods and constructions, particularly where both high reliability and high density are required.

OBJECTS AND SUMMARY OF THE PRESENT INVENTION

It is accordingly the broad object of the present invention to provide a low cost electrical interconnection system and method for printed and integrated circuit boards, modules, and the like, which is capable of providing high reliability as well as high density.

Another object of the present invention is to provide a system and method in accordance with the foregoing object which is capable of being automated to a high degree.

A further object of the present invention is to provide a novel, low cost plug-in interconnection module for use with printed and integrated circuit boards, modules, and the like.

A still further object of the invention in accordance with the foregoing objects is to provide a novel system and method for making an interconnection module.

Briefly, the above objects are accomplished in a typical embodiment of the invention in which one or more encapsulated plug-in type interconnection modules are employed to provide desired interconnections between printed circuit board components. The fabrication and construction of each interconnection module are such that the interconnection pattern provided thereby is advantageously caused to be a function of the automatic sequential positioning of a winding means which performs loop winding operations on the core of the interconnection module. A desired interconnection pattern for an interconnection module is thus readily and automatically obtainable using a computer to control the sequential positioning of the winding means in accordance with the interconnection pattern desired.

The specific nature of the invention as well as other objects, uses, and advantages thereof will become clearly evident from the following detailed description of a typical embodiment taken in conjunction with the accompanying drawings in which:

FIG. 1 is a pictorial, partially schematic representation illustrating the manner in which an automatically positionable winding means is employed to provide loops in predetermined slots of a slotted core of an interconnection module in order to provide a predetermined interconnection pattern therefor;

FIGS. 2 and 3 illustrate details of the winding means and interconnection module of FIG. 1;

FIGS. 4 to 8 illustrate various stages and associated components involved in the fabrication of an interconnection module after the winding operation illustrated in FIGS. 1 to 3 has been performed;

FIG. 9 illustrates an alternate embodiment of an interconnection module;

FIGS. 10 and 11 schematically illustrate how typical desired interconnections may be provided between terminals of the resultant interconnection module;

FIG. 12 is a pictorial view illustrating how interconnection modules in accordance with the invention may typically be used in printed and/or integrated circuit constructions;

FIG. 13 illustrates the manner in which an interconnection module in accordance with the invention may typically be employed for interconnecting integrated circuits on a printed circuit board;

FIG. 14 illustrates the manner in which an interconnection module in accordance with the invention may typically be employed for interconnecting printed circuit boards plugged into a mother board;

FIG. 15 illustrates details of a modified form of interconnection module core in accordance with the invention;

FIG. 16 illustrates a stage in the fabrication of an interconnection module using the modified form of interconnection module core shown in FIG. 15;

FIG. 17 illustrates how ground shields and a ground cover may be provided in an interconnection module in accordance with the invention; and

FIGS. 18 and 19 illustrate other modifications in the fabrication of an interconnection module in accordance with the invention.

Like numerals designate like elements throughout the figures of the drawings.

Referring to FIGS. 1 to 3, and most particularly to FIG. 1, illustrated therein is a slotted interconnection module core 10 disposed between a motor 21 and a bearing 23 for rotation in the direction indicated by the arrow A. For purposes which will shortly become evident, the interconnection core 10 is caused to rotate 180° or half-rotation steps by the use of a conventional coupling means 24 provided for this purpose and interposed between the motor 21 and the core 10. The dwell position of the core 10 is shown in FIG. 3, the angle θ being preferably as small as possible. The core 10 is of non-conductive material, such as a plastic.

As shown in FIG. 1, a bobbin 26 having insulated wire 27 wound thereon is mounted for rotation in a conventional manner so that tension on the wire 27 unwinds the wire from the roller 26 to permit automatic wire feed therefrom as required during the winding operation on the interconnection module core 10. The wire 27 is applied to the interconnection module core 10 via a rotatable roller 29. The roller 29 is carried by a wire positioning means 30 which is constructed and arranged to cooperate with a track 32 and a lead screw 35 so that the position of the wire 27 along the core 10 is controllable (as indicated by arrows B) in response to rotation of the lead screw 35. A stepping motor 36 receives one end of the lead screw 35 and a bearing 39 receives the other end of the lead screw 35, whereby desired controlled step-by-step rotation of the lead screw 35 in either direction may be provided. An alternate arrangement is to let the lead screw 35 move the module core 10, while the mean 30 remains stationary. The tension on the wire 27 may be adjusted by means of an adjusting slot 34 which controls the position of the roller 29 on the winding means 30.

Still with reference to FIG. 1, a computer 37, or other suitable data processing means, operates in response to suitably applied interconnection data to provide operating signals for the motors 21 and 36 so as to cooperatively control the step-by-step positioning of the winding means 30 and the 180° or half-rotations of the interconnection module core 10 so as to form loops of wire thereon (FIG. 2) passing through predetermined ones of the edge slots 12 and 14 (FIG. 2) in a predetermined order, as determined by the interconnection data applied to the computer 37.

It will be understood that typical operation of the apparatus of FIG. 1 may be in cycles. During each cycle the positioning of the winding means 30 and the 180° rotation of the core 10 occur alternately. More specifically, operation during each cycle is such that, with the core 10 held stationary in its dwell position (FIG. 3), the computer 37 first causes the winding means 30 (and thus the wire 27) to be stepped to a position adjacent the particular slot 12 or 14 which is next to receive the wire 27 as determined by the interconnection data applied to the computer 37. When the winding means 30 has been thus positioned, the computer 37 then causes the core 10 to be given a half or 180° rotation, resulting in the wire entering the desired slot. It will be understood that any number of such cycles may be consecutively performed as required by the interconnection data until the final desired loop arrangement on the core 10 is obtained. FIG. 2 illustrates an intermediate stage in the formation of a typical plurality of loops. Obviously, the starting and ending portions of the wire wound on the core 10 may be secured thereto in any suitable manner such as, for example, by using an adhesive, or by wrapping or tying to an appropriately provided means on the core. After having provided the interconnection module core 10 with loops passing through predetermineed edge slots (12 and 14) thereof in a predetermined order in accordance with the interconnection data, the next step, as illustrated in FIG. 4, involves the use of clamping fixtures 41 for securing a terminal blank 40 to each of the edges of the core 10 in a manner so that each terminal portion 42 of a terminal blank 40 engages a respective slot 12 to reside therein along with any loop wire or wires which may have been disposed therein during the previously described winding operation. Accordingly, the slots 12 will henceforth be referred to as terminal slots in order to conveniently distinguish them from the slots 14, which do not receive terminal portions and which will henceforth be referred to as non-terminal slots. Although the non-terminal slots 14 are not essential, they are additionally provided in order to permit achieving a considerably greater interconnection capability among the output terminals 42 of the resulting interconnection module, as will become evident as the description progresses. Although the non-terminal slots 14 are preferably of smaller width than the terminal slots 12 (for greater compactness) and are conveniently arranged to alternate therewith, it is to be understood that equal or different widths and arrangements may also be employed within the scope of the invention.

FIG. 5 illustrates a typical terminal blank 40, such as used in FIG. 4. The dashed lines 46 and 47 in FIG. 5 illustrate the relative position of the edge of the core 10 when clamped as shown in FIG. 4. The dashed line 47 in FIG. 5 also illustrates where the terminal blanks 40 are bent in FIG. 4 after clamping by the clamping fixtures 41. The dashed line 47 in FIG. 5 further indicates, along with the dashed line 48, where the terminal blank portions are removed during later steps in the fabrication of the interconnection module.

The bottom of the clamped assembly shown in FIG. 4 is next prepared for dip-soldering, which preparation includes stripping the insulation from loop wire portions traversing the bottom of the core 10 (as viewed in FIG. 4) and also from adjacent loop wire portions extending into the slots 12 and 14. The bottom of the assembly of FIG. 4 is then dip-soldered, such as, for example, to the indicated dip-solder line 49. As a result, the bottoms of slots 12 and 14 are filled with solder, thereby causing electrical connections to be made between the respective terminal portion 42 and any loop wire or wires disposed in the terminal slot 12, and between any loop wires disposed in a non-terminal slot 14.

The next step in the fabrication of the interconnection module is to cut and/or grind the dip-soldered side of the FIG. 4 assembly to remove the bottom loop wire portions and the bent-over portions of the terminal blanks 40. The resulting assembly is shown in FIG. 6 with the dip-soldered side up. The clamping fixtures 41 are then removed, and the interconnection module core 10 with wires 27 and the remaining portions of the terminal blanks 40 are then encapsulated in a suitable epoxy, following which the terminal blanks 40 are cut along the dashed line 48 in FIGS. 5 and 6. The completed encapsulated interconnection module 50 is illustrated in FIG. 7. The numeral 49 indicates the epoxy, and the terminal portions 42 have become the terminals 42 of the interconnection module 50. To aid in the insertion of the interconnection module 50 in a printed circuit board, it is preferred to provide the terminals 42 of increasing length, as illustrated in FIG. 8.

An alternate form for the interconnection module suitable for flat packaging is illustrated in FIG. 9. It will be understood that this alternate form may conveniently be obtained from the structure of FIG. 6 by bending the terminal blanks 40 at right angles prior to encapsulation.

Referring now to FIGS. 10 and 11, schematically illustrated therein are two examples showing how the interconnection module may achieve typical desired interconnections between particular terminals by appropriate control of the formation of the loop windings on the interconnection module core 10 using the winding and associated apparatus of FIGS. 1 to 3. The solid line wires 27 in FIGS. 10 and 11 run along the top surface of the core 10 (as viewed in FIG. 2), while the dashed line wires 27 run along the bottom surface of the core 10. It will be remembered that the bottom wires 27 are removed in the fabrication of the interconnection module so that only the solid line wires remain in the finished interconnection module to provide electrical interconnections between terminals.

As will be evident, the loop pattern of FIG. 10 will result in providing the completed interconnection module with an electrical connection between the respective terminals subsequently provided in the terminal slots A and B and an independent electrical connection between the respective terminals subsequently provided in the terminal slots C and E. As will also be evident, the loop pattern of FIG. 11 will result in providing an electrical connection among all of the respective terminals subsequently provided in the terminal slots A, B, C, D, and E of the completed interconnection module. From these examples it should be evident how to achieve any desired interconnection pattern for the terminals of the completed interconnection module by appropriate choice of the order and arrangement of loop formation on the core **10.** It will accordingly be understood that the computer 37 in FIG. 1 need merely operate in response to the interconnection data applied thereto to control the positioning of the winding means **30** so as to cause a loop pattern to be wound on the core **10** which will provide resultant interconnections for the completed interconnection module as called for by the interconnection data. Such operation of a computer or data processing means can readily be provided by those skilled in the art based upon the disclosure provided herein.

Having described how the interconnection module **50** may be fabricated in accordance with the invention, typical uses thereof will now be considered with reference to FIGS. **12** to **14.** FIG. **12** illustrates two printed circuit boards **55** having terminal tabs **62** by means of which the boards **55** are plugged into respective connectors **63** of a mother board **65** having terminal tabs **72.**

Each printed circuit board **55** has, for example, six plugin integrated circuit modules **60** therein. In accordance with the present invention, an interconnection module **50'** is plugged into each board **55** for providing the desired interconnections between the integrated circuit modules **60,** and another interconnection module **50''** is plugged into the mother board **65** for providing the desired interconnections between the connectors **63.**

FIGS. **13** and **14** respectively illustrate the opposite sides of each printed circuit board **55** and the mother board **65.** FIG. **13** illustrates typical interconnections which may be provided between the plug-in sockets of the integrated circuit modules **60** and the interconnection modules **50'** on each printed circuit board **55,** and FIG. **14** illustrates typical interconnections which may be provided between the plug-in sockets for the terminal tabs **62** and the interconnection module **50''.**

Referring now to FIG. **15,** illustrated therein is a modified form of slotted interconnection module core **10'** which may be employed in accordance with the invention and permit achieving a higher density for the interconnections. It will be seen that the interconnection core **10'** is formed from a non-conductive member of generally circular cross-section having slots **12'** spaced along the length thereof and in predetermined ones of which insulated wire **27** is provided as previously described in connection with FIGS. **1** to **3.** The module core **10'** also has oppositely disposed, generally rectangular cavities **81** and **82** extending along the length of the core **10'** in order to provide greater protection for the loops of wire **27** disposed in the slots **12'.**

Using the modified module core **10'** of FIG. **15,** the fabrication of the interconnection module is such as to produce the intermediate stage illustrated in FIG. **16,** which is upside down with respect to FIG. **15.** This stage is obtained by disposing round terminal wires **42'** in respective slots **12'** by bending the wires **42'** around a temporarily provided spacer block **88,** followed by encapsulation of the structure in a suitable epoxy **90** to secure the interconnection wires **27** and the terminal wires **42'** in their respective slots **12'** and then cutting the encapsulated structure, including the core **10',** to bare the interconnection and terminal wires **27** and **42'** for electrical connection. The raised longitudinal central portion **83** may also be provided to aid in the next following dip-soldering operation which serves to electrically connect the interconnection and terminal wires **27** and **42'** in each of the respective slots **12'.**

To aid in the performance of the above operations, the core **10'** in FIG. **15** could originally be formed from two separable, secured members which remain together during winding, but one of which members is removed when the wires **27** and **42'** are bared, instead of having to cut the core **10'** as described in connection with FIG. **16.** Such an approach also offers the advantage that the removable member could be provided of a material for achieving particular characteristics, such as by using a removable member of metal in order to provide greater rigidity during winding of the core.

It is to be understood with respect to FIG. **16** that, in order to permit the resulting structure to be more clearly shown, the epoxy **90** is illustrated in FIG. **16** as being transparent except at its cross-section where appropriate cross-hatching is provided. A similar showing is provided for the epoxy in FIGS. **17** and **18** which will be considered later on herein. It is also to be understood with respect to FIG. **16** that, because of the use of round wire for the terminals **42',** the slots **12'** may all be of the same size, and a terminal may be provided in each slot **12'** as shown in FIG. **16** so as to permit achieving a high interconnection density. However, the terminals **42'** could be disposed in every other slot **12',** or in any other manner which may be desired.

In the modified fabrication now being described, the terminal wires **42'** are next cut at the plane indicated by the line **89** in FIG. **16,** followed by removal of the spacer block **88** and encapsulation of the structure in a suitable epoxy **92** to form the resulting interconnection module shown in FIG. **17** having the output terminals **42'.** As shown in FIG. **17,** if electrical shielding is desired for low-noise high-speed applications, metal ground planes **93** can be incorporated within the cavity **82** prior to and subsequent to the winding of the interconnection wire loops **27** in their respective slots **12',** and a metal grounding cover **91** can additionally be provided over the dip-soldered side of the interconnection module. It also has been found desirable to use these metal ground planes **93** and cover **91** as one side of the input power in order to reduce undesirable capcitative effects.

Referring now to FIG. **18,** a further modification of the invention is illustrated which provides for electrical connection of the interconnection and terminal wires **27** and **42'** in the slots **12'** by the use of a conductive epoxy instead of dip-soldering as previously described. This is accomplished, for example, using the structure of FIG. **16,** by providing a layer of conductive epoxy **95** in each of the recesses adjacent the raised central portion **83** so as to electrically connect the interconnection and terminal wires **27** and **42'** in each slot **12'** to one another. Then, in order to insulate the interconnection and terminal wires **27** and **42'** in each slot **12'** from those of other slots, perpendicular grooves **97** of sufficient depth are provided between adjacent slots **12'** as shown in FIG. **18.** As also shown in FIG. **18,** a label **99** may be bonded over the resulting surface for identification purposes, as well as for providing electrical insulation and environmental protection.

A still further modification of the invention is disclosed in FIG. 19, which illustrates how interconnection wires 27′ in the slots 12′ of the core 10″ may be electrically connected to appropriate terminals 42′ using infrared bonding. In such an approach, the interconnection wires 27′ are chosen to be of a type having infrared-meltable insulation, such as polyurethane insulation. A solder cream is applied to selected portions of the wires 27′ along the length of the core 10″ using a groove 10″a which may be provided in the core 10″ for this purpose. An infrared lamp unit 100 including an infrared source 101 and a reflector 102 serves to direct a high-intensity narrow infrared beam along the groove 10″a for a time sufficient to melt both the polyurethane insulation of the wire 27′ and the solder cream so as to thereby effectively strip and tin the wire portions in the groove 10″a.

As will be apparent from FIG. 19, a terminal blank 40′ is next coupled to the core 10″ so that the terminals 42″ thereof are disposed in respective slots 12″ with their tinned portions 42″a adjacent and in contact with respective tinned wire portions in the groove 10″a. The high intensity infrared beam is then again applied to the groove 10″a so as to cause the tinned wire portions therein to be soldered to the respective tinned portions 42″a of the terminals 42″ by solder reflow.

Having thus provided the desired electrical connection between the interconnection wires 27′ and the terminals 42″ using infrared heating as desired above in connection with FIG. 19, fabrication of the interconnection module may then proceed as previously described herein. Such fabrication will include cutting of the terminal blank 40′ along the line 109 indicated in FIG. 19 in order to form the final terminals 42″, and will, of course, also include the removal of appropriate portions of the interconnection wires 27′ so as to provide the desired interconnection pattern for the resulting interconnection module.

Although the present invention has been primarily described with regard to particular exemplary embodiments thereof, it is to be understood that the invention is subject to a wide variety of modifications in construction, arrangement, method, and use without departing from the scope of the invention as defined by the appended claims.

The embodiments of the invention in which an exclusive property or provilege is claimed are defined as follows:

1. In a method of making an interconnection module, the steps of:

automatically moving a winding member in opposite axial directions with respect to an elongated core and by amounts so as to automatically wind wire loops using a continuous wire on the core in engagement with predetermined spaced receiving locations along the length thereof in a predetermined order determined in accordance with the terminal interconnection pattern desired for said module and independently of their positioning on the core, the winding of said wire loops being performed in cycles, each cycle including automatically positioning the wire from which the loops are formed adjacent the next receiving location along the core which is to receive the wire while the core remains stationary and then rotating the core by a partial revolution so as to cause the wire to engage the core at the wire receiving location adjacent which the wire was positioned during said positioning.

providing terminals at predetermined ones of said receiving locations,

electrically connecting each terminal at a receiving location to any loop wire also provided thereat during said winding, and

removing a predetermined portion of said core along with the loop wire portions traversing the removed core position.

2. The invention in accordance with claim 1, wherein said partial revolution is approximately one-half a revolution.

3. In a method of making an electrical interconnection module having a desired predetermined electrical interconnection pattern, the steps of:

providing an elongated core having at least two axially extending rows of receiving means at spaced predetermined locations thereof,

automatically coupling wires between selected ones of said receiving means in a predetermined order as determined by said predetermined electrical interconnection pattern and so as to traverse selected paths along said structure in a manner so that receiving means between which electrical connections are desired in the completed module in accordance with said desired predetermined electrical interconnection pattern are coupled via first predetermined paths while receiving means between which electrical connections are not desired are coupled via second predetermined paths, said first predetermined paths being contained on one side of said core between said rows and said second predetermined paths being contained on the other side of said core, and

removing a continuous predetermined portion of said core between said rows and on the side containing said second predetermined paths so that the wire portions traversing said second predetermined portion are electrically disconnected to thereby provide said module with said desired predetermined electrical interconnection pattern.

4. The invention in accordance with claim 3, wherein said method includes providing module output terminals at predetermined ones of said receiving means and electrically connecting said terminals to the respective wires coupled thereto.

5. The invention in accordance with claim 4, wherein the step of automatically coupling is accomplished using a continuous wire.

6. The invention in accordance with claim 4, wherein said core is formed of two separable members, and wherein the step of removing includes separating said members.

7. The invention in accordance with claim 4, wherein said method includes the step of encapsulating the core following said removing so as to provide a unitary structure having terminals extending therefrom.

8. The invention in accordance with claim 4, wherein slots are provided in said core at said predetermined locations.

9. The invention in accordance with claim 4,

wherein the step of electrically connecting is performed by dip-soldering.

10. The invention in accordance with claim **4,**
wherein the step of electrically connecting is performed by using conductive epoxy.

11. The invention in accordance with claim **4,**
wherein the step of electrically connecting is performed by using infrared heat-bonding.

12. The invention in accordance with claim **4,**
wherein said terminals are provided in the form of terminal blanks having terminal portions disposed in predetermined ones of said slots, and
wherein the step of removing includes removing portions of said terminal blanks so that said terminal portions are electrically separated from one another.

13. The invention in accordance with claim **8,**
wherein certain ones of said slots are terminal slots for receiving respective ones of said terminals and other ones of said slots are nonterminal slots, and
wherein the step of automatic coupling is such that each nonterminal slot receives at least a plurality of wires or no wires.

14. The invention in accordance with claim **13,**
wherein the step of electrically connecting causes each wire disposed in a terminal slot during the step of automatic coupling to be electrically connected to the respective terminal also disposed therein and causes the plurality of wires disposed in each nonterminal slot during the step of automatic coupling to be electrically connected to each other.

15. In a method of making an electrical interconnection module having a desired predetermined electrical interconnection pattern, the steps of:
providing an elongated core having at least two axially extending rows of receiving means at spaced predetermined locations thereof,
automatically coupling wires between selected ones of said receiving means in a predetermined order as determined by said predetermined electrical interconnection pattern and so as to traverse selected paths along said structure in a manner so that receiving means between which electrical connections are desired in the completed module in accordance with said desired predetermined electrical interconnection pattern are coupled via first predetermined paths while receiving means between which electrical connections are not desired are coupled via second predetermined paths, said first predetermined paths being contained on one side of said core between said rows and said second predetermined paths being contained on the other side of said core, and
cutting the wires traversing said second predetermined paths by cutting the wires along a continuous uninterrupted path between said rows on the side of said core containing said second predetermined paths.

16. The invention in accordance with claim **15,**
wherein said method includes providing module output terminals at predetermined ones of said receiving means and electrically connecting said terminals to the respective wires coupled thereto.

17. The invention in accordance with claim **16,**
wherein said cutting occurs for all wires traversing said portion between said rows.

18. The invention in accordance with claim **15,**
wherein the step of automatically coupling is accomplished using a continuous wire.

19. In a method of making an interconnection module, the steps of:
providing an elongated core having at least one longitudinal recess and a plurality of traversely extending slots;
forming wire loops traversing said slots and said recess by winding a continuous wire upon said core, said wire loops traversing said slots in a predetermined order determined in accordance with the interconnection pattern desired for said module;
providing two parallel rows of upstanding terminals attached to a temporary central backing portion with said terminals spaced along said backing portion to coincide with the longitudinal spacing of said slots;
assembling said plurality of terminals upon said core with the terminals overlaying the loops in the slots and the backing portion overlaying the said recess, bonding each loop to an overlaying terminal; and
disconnecting unwanted electrical interconnections among the various terminal and loop assemblies by removing portions of the loops overlaying the recess and said backing portion.

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