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Tamburro

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[45] **Mar. 12, 1974**

[54] **INTERCONNECTION SYSTEM FOR REUSABLE GANG-TYPE CONNECTIONS BETWEEN FLEXIBLE PRINTED CIRCUITRY AND THE LIKE**

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[21] Appl. No.: **268,725**

[52] **U.S. Cl.** .... **339/92 M,** 339/176 MF, 339/278 C

[51] **Int. Cl.** **H01r 13/54**

[58] **Field of Search** 339/17, 92, 176, 278

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Primary Examiner—Joseph H. McGlynn

Attorney, Agent, or Firm—C. E. Graves

[57] **ABSTRACT**

Connections to flexible printed wiring elements and rigid printed circuit board elements are effected by the disclosed interconnection system consisting essentially of a pressure contact type connector block and backing element. Various shapes of pin connectors are disclosed. Add-on features include feed-through elements, and a variant of backing element in which removable pressure contact wire-wrap terminal elements may be inserted. Non-noble metal, low pressure contact elements are usable.

3 Claims, 15 Drawing Figures

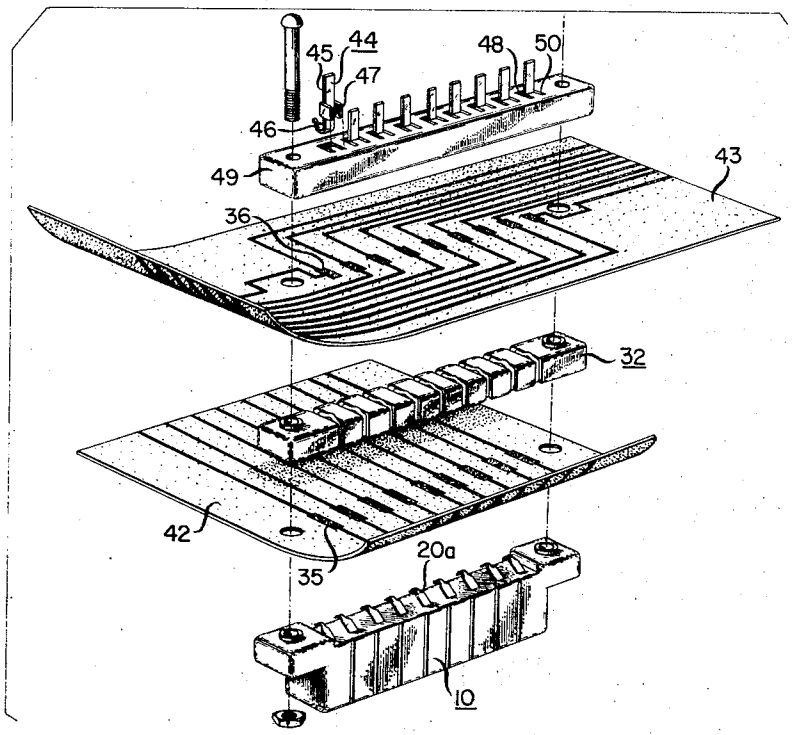


FIG. 1

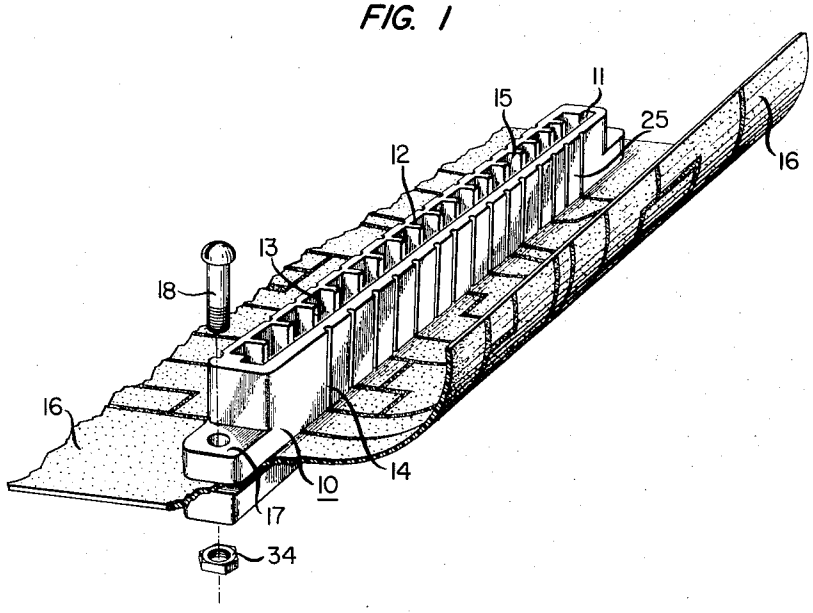


FIG. 2

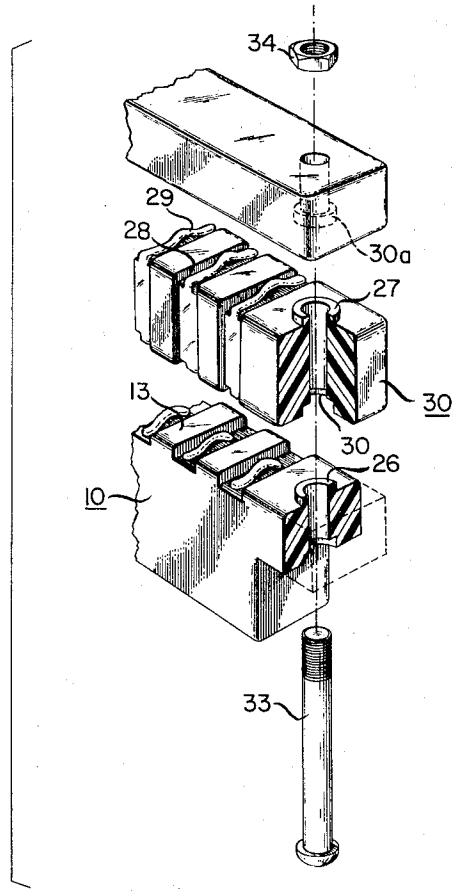


FIG. 3

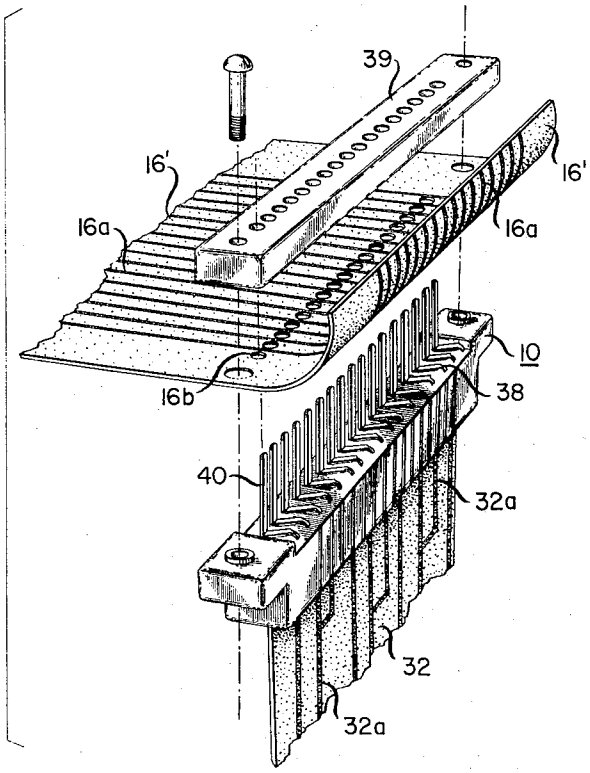

39
16'
16'
16a
16a
10
16b
38
40
32a
32
32a

FIG. 4

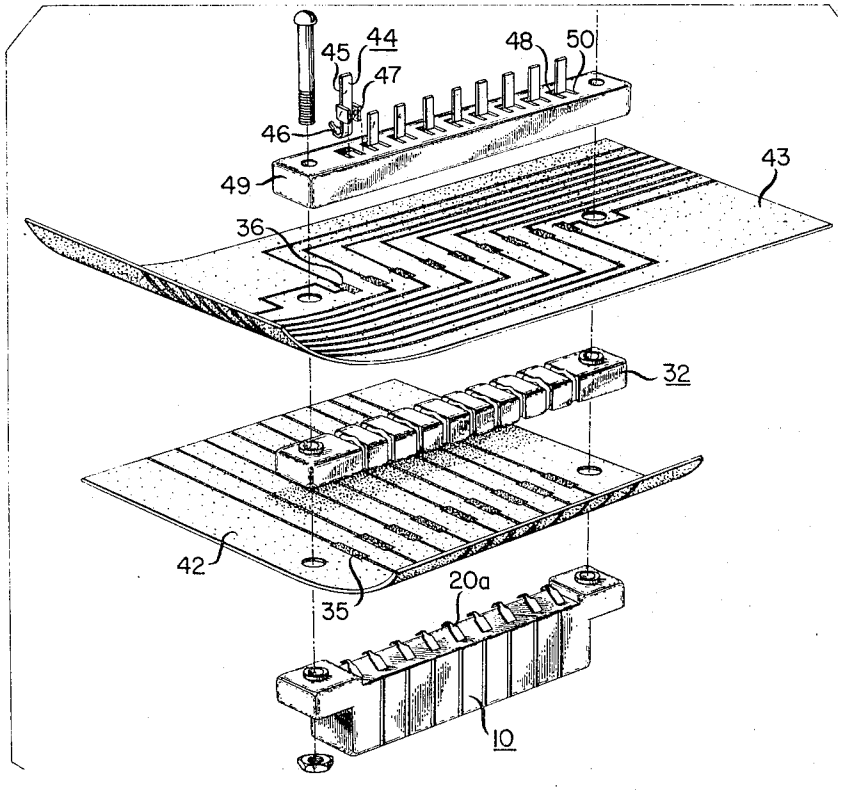

45
44
47
48
50
46
43
49
36
32
42
35
20a
10

FIG. 5

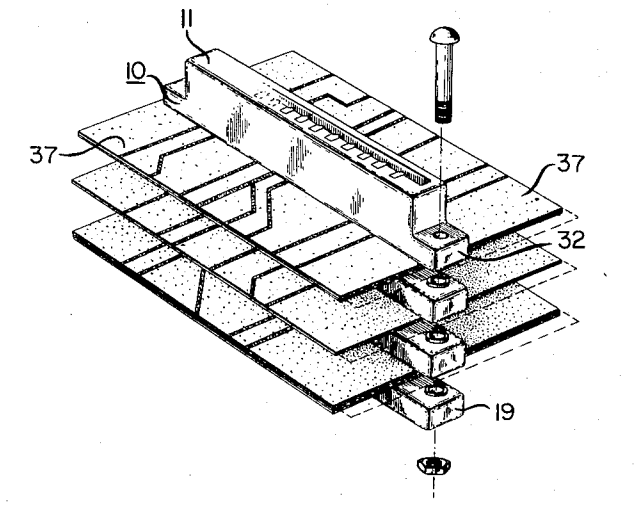


FIG. 6

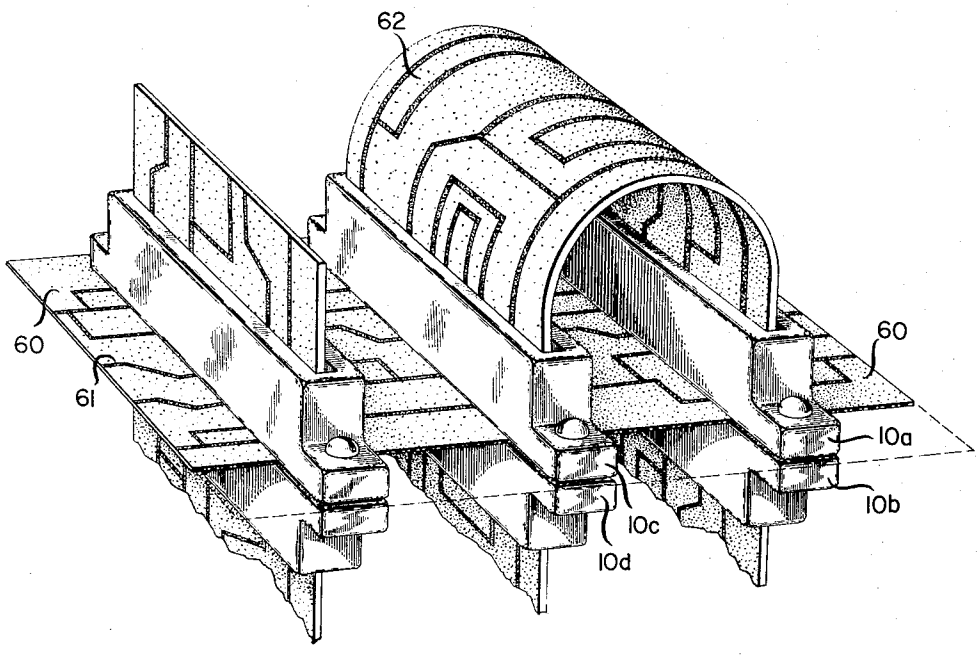


FIG. 7

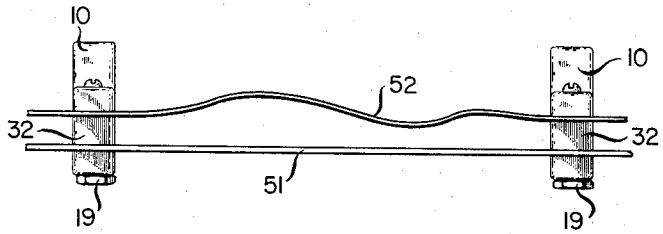


FIG. 8

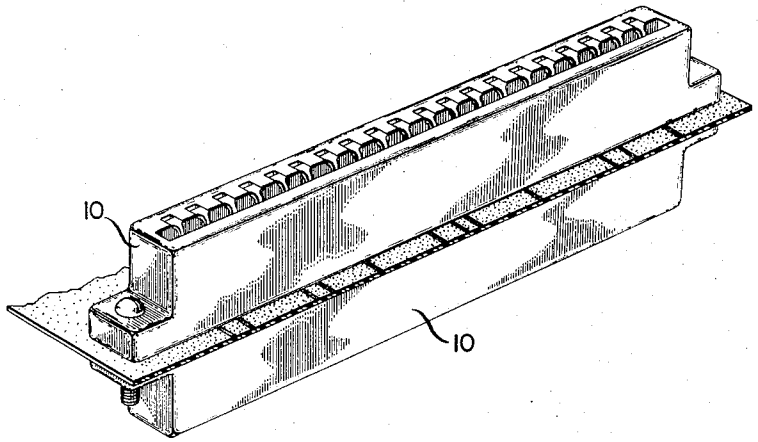


FIG. 1B

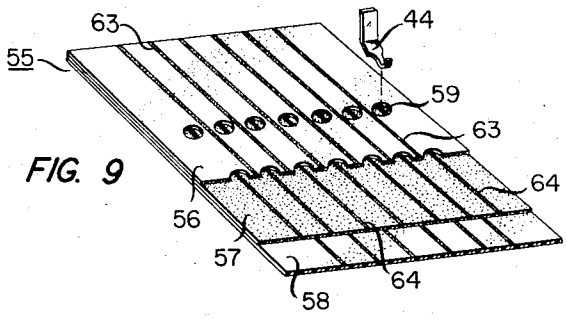


FIG. 9

FIG. 10

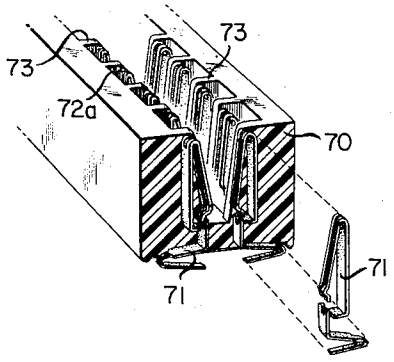


FIG. 11

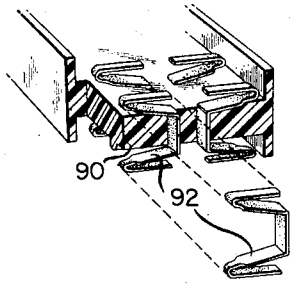
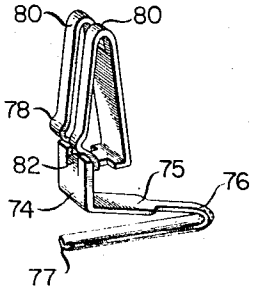


FIG. 12



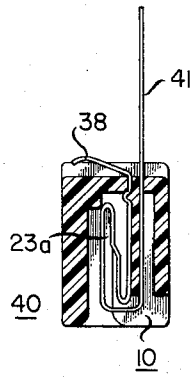


FIG. 3A

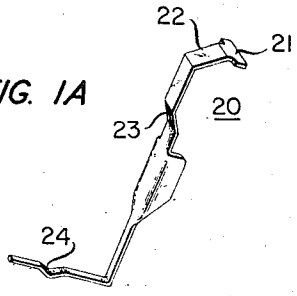


FIG. 1A

INTERCONNECTION SYSTEM FOR REUSABLE GANG-TYPE CONNECTIONS BETWEEN FLEXIBLE PRINTED CIRCUITRY AND THE LIKE

FIELD OF THE INVENTION

This invention relates to electrical multiconnection technology and in particular to connections made with so-called flexible printed wiring or the like.

BACKGROUND OF THE INVENTION

As is well known, the main attractiveness of flexible printed wiring (FPW) is in reduced labor costs. Numerous FPW configurations and associated contact structures presently exist or have been proposed. One type of structure is a double-sided FPW member having solder-fastened through-pins. The double-sided FPW may have other layers of circuitry between the outer layers, thus becoming increasingly inflexible as the number of layers increase. At some point the FPW becomes mechanically equivalent to a hard printed wiring board (PWB).

Many pressure-type connectors are available which rely upon a force contact between a land and a contact element to achieve reliable electrical connection. There are, however, several problems associated with the force-contact pressure connector. For one, it is usually required that both the contact element and the land area be gold-protected because—unlike all other contact metals—gold does not form an oxide coating. Hence, use of gold avoids the condition of contact resistance which other metals in time develop, and which renders the connector unreusable or inferior even if the connection is never distrubed.

Gold-plated contacts are, however, expensive and, if only for this reason, ample incentive exists to devise a satisfactory non-noble metal contacting scheme.

A further problem with present FPW connections is the lack of a standard and versatile system that with relatively few modules, will accommodate rigid boards and FPW elements alike, will permit cross-over interconnections, will provide for wire-wrap terminal connections, and will enable unlimited feed-through from one FPW to another.

This invention is addressed to the general solution of the last-named problem, and takes for its several further inventive objects the following:

- to reduce the cost of back-plane wiring;
- to enhance the reliability of inexpensive electrical gang-type contacts for use with FPW elements;
- to achieve a solder-to-solder contact between FPW apparatus and a solid connector; and
- to provide all of the foregoing in a specific design of connector element featuring reusable as well as removable contacts.

SUMMARY OF THE INVENTION

In its broadest aspect, this invention is a gang-connector system comprising a body for mounting of a linear array of contacting pins. The pins are phosphor-bronze or beryllium-copper solder-plated to a thickness of about 0.0003 to 0.0005 on that portion which contacts the FPW. A chamber for receiving the end contacts of an FPW element is provided in one side of the body. Into this chamber each pin extends. The opposite face of the connector body is flat, and each pin is looped through the body to lie in planar array a predetermined distance above this flat surface. These ends of the pins are to join to a land area of the FPW or flexible flat cable member, and accordingly are normally disposed slightly above a recessed part of the body.

A feature of the invention is pressure-type contacts using non-noble metals to achieve connection between two elements such as a rigid circuit board and a flexible printed cable.

A further feature of the invention in combination with the first-mentioned feature, is the use of single tapes with printed circuitry on one or both sides interconnected vertically and horizontally by the disclosed system, and stacked to form a truly flexible multiple layer circuit.

The invention and its further objects, features, and advantages will be readily understood from a reading of the description to follow of illustrative embodiments.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic perspective view showing the basic connector block;

FIG. 1A is a type of contact for FIG. 1, seen in side perspective view;

FIG. 1B is a sectional side view of the connector block of FIG. 1.

FIG. 2 is an exploded schematic perspective diagram of the connector block of FIG. 1 together with a feed-through block and a backup block;

FIG. 3 is a variation of the FIG. 1 embodiment in which terminals in the connector blocks are supplied with wire-wrap extensions and the flexible tape is perforated to receive the extensions;

FIG. 3A is a type of contact for use in the FIG. 3 embodiment;

FIG. 4 is a variant demonstrating a further system involving the FIG. 1 connector block, useful to interconnect horizontal and vertical FPW members; and further showing use of removable pressure contacts on a backing block;

FIG. 5 is a schematic perspective diagram illustrating multiple use of feed-through blocks to interconnect multilayer boards to an FPW element via the connector block;

FIG. 6 is a two-sided FPW with plural pairs of connector blocks connecting thereto, one member of each pair per side; and further shows various further interconnect capabilities;

FIG. 7 is a side schematic diagram illustrating use of the FIG. 1 connector block and backup plate to interconnect a rigid PCB to an FPW.

FIG. 8 illustrates two connector blocks of FIG. 1 used in back-to-back fashion in the manner of FIG. 6;

FIG. 9 is a side schematic perspective of several multilayer FPW elements interleaved and perforated to enable remote interior contacts through a pressure contacting element of the connector block;

FIG. 10 illustrates in sectional side schematic diagram a double-connector block and the associated pin element;

FIG. 11 illustrates in similar fashion a double-feed-through type block; and

FIG. 12 is a side schematic perspective view of contact element of FIG. 10.

DETAILED DESCRIPTION OF AN ILLUSTRATIVE EMBODIMENT

In the description to follow, emphasis will be periodi-

cally placed on the system's aspects of the interconnection scheme, its flexibilities and add-on features made possible by the overall inventive concept. Where necessary, details of the structural elements involved will be amply set forth; but elsewhere, only so much structural detail as necessary to practice the invention will be supplied.

The basic connector block is shown in FIGS. **1, 2, 8,** in detail. The block designated generally **10** consists of an inner cavity **11,** which includes a bottoming floor **25** and a number of dividing wells **12** rising from floor **25** and terminating in the plane of the top edge of block **10.** The walls are about one-half the width of the cavity **11,** and form a plurality of wells **15,** which receive connector pins such as pin **20** illustrated in FIG. 1A. Numerous shapes of pins may be placed in the wells **15** of connector block **10** as will be shown in illustrations to follow. All pins are, however, pressure-type contact members.

In FIG. **1** the FPW element, or tape **16,** is not supplied with through holes. In consequence, the entirety of both sides of tape **16** may be used for circuit paths. Holes are not needed in this case except for the occasional interconnection between sides. The sectional side view of the connector block is shown in FIG. 1B. In FIG. **3,** however, the tape **16'** is provided with through-holes in between the land regions **16***a*. The connector block **10** is substantially the same as that shown in FIG. **1** except that the pin element designated **40** shown in FIG. 3A includes extension **41** which serves as a wire-wrap terminal when such is desired. The pins **40** shown in place in connector block **10** in FIG. **3** need not, of course, be situated in every position; but may be selectively placed where needed. Those pins **40** which are in place are insertable through the holes **16***b* in tape **16'**. To complete the assembly, a backup block **39** similar to block **19** but with holes therein is supplied to accommodate the terminals **41.** FIG. **3** thus depicts an embodiment of the invention which receives an FPW tape **16'**, contacts where necessary its land regions **16***a* with a cantilevered pad **38** of the pins **40.** Then, the same assembly receives a plug-in board **52** which is inserted into the inner cavity **11,** shown in FIG. **1,** where the board contacting belly **23***a* of the pin **40** makes contact with extensions of the land areas **32***a*.

The embodiment of FIG. **4** illustrates the use of a feed-through block **32** which in combination with the pin **20** and a somewhat modified backing block **49** will permit connection of a horizontal FPW **42** to a "vertical" FPW **43.** Further, the assemblage of FIG. **4** illustrates use of a removable pressure contact element **44,** consisting of an upstanding wire-wrap terminal portion **45,** a spring-contact pad **46,** and a pair of guide arms **47** with locking ears. Corridors **48** in the backing block **49** each with guide slot pairs are provided to receive the locking ears of guide arms **47.**

Thus, the assemblage of FIG. **4** provides capability of receiving a printed wiring board in the connector block **20** in the manner shown in FIG. **3;** of receiving and interconnecting also a pair of flexible printed wiring elements using the feed-through block **32;** and then by use of removable pressure contacts provides further capability for interconnection.

The feed-through member **32** is depicted also in FIG. **2** as consisting of a plurality of three-sided hollow-outs **28** in which are inserted connector pin elements **29** which are also three-sided. The elements **29** are contained wholly within the hollowouts, except for the contact surface bulge **29***a* which occurs twice on each element on opposite sides thereof. Illustrated in FIG. **2** also is a guide flange **26** on the connector block **10** bottom, which engages a locating well **30** in the feed-through block **32.** In turn, a guide flange **27** on block **32** engages a locating well **30***a* in the backup block. A threaded pin **33** and nut **34** are the fastening means for the already axially coordinated assemblage of FIG. **2.** The guide flanges also may be used to polarize, that is, fixedly orient, the connector assembly and system assembly with flexible and hard printed boards.

With reference again to FIG. **4,** the FPW elements **42, 43** are supplied with lands **35, 36** respectively. Lands **35** are contacted by pressure pad ends of modified connector pins **20***a*. The pins **20***a* are the same as those shown in FIG. 1A and designated **20,** except that the ends are cantilevered upward and extend out beyond the connector block body so as to effect spring-loaded connection to a horizontal FPW such as **42**—in contrast to the connector pins depicted in FIG. **8** which feature the stationary ears **21** embedded below and within the connector block body.

The lands **36** of FPW **43** are contacted by the spring-contact elements **46** of the removable pressure contact **44.** An interference fit provided between the arms **47** and the guide-slot pairs **50** supply adequate holding force to maintain position. As in the embodiment of FIG. **3,** the upstanding terminal portion **45** of the contact **44** is for wire-wrap connection where needed.

In a further variation of the inventive interconnection system, as seen in FIG. **5,** a capability for interconnecting a plurality of multilayer rigid boards is provided by use of the backup block **19** or **49,** as many feed-through members **32** as necessary and by connector block **10.** The operation of this configuration is much the same as already described with respect to the interconnection of several FPW members depicted in FIG. **4.** The land areas on the several rigid boards **37** are not shown; but it is seen that connection to lands are effected by the mechanisms already shown in FIG. **4.** Similarly, by using a backup member such as **49,** removable pressure contacts can be added to the configuration; and the inner cavity **11** of connector block **10** supplies the already described capability of receiving yet another rigid board.

With respect again to the FIG. **5** embodiment, flexible printed wiring elements (not shown) could be used in place of any or all of the rigid boards **37.** Using the add-on capabilities of a backup block **49** with a plug-in board (not shown), for connector block **20** in the assemblage of FIG. **4,** it is possible to interconnect any two circuit paths on either of the FPW elements **42, 43;** and also to establish one or more connections from any or all of the lands of FPW elements **42, 43** to the outside world.

FIG. **6** shows a further embodiment of the invention in which a plurality of pairs of connector blocks **10** are placed back-to-back on opposite sides of a two-sided PWB tape designated **16.** A desirable characteristic of the spacing of the pins **20** of block **10** is that the spacing be uniform. In FPW element **60,** the spacing between the lands such as **61,** is, at recurrent intervals along the length of the element **60,** equal to the spacing between the pins **20.** The equal spacing occurs on both sides of

element **60** along the same lateral plane; thus, two back-to-back connector blocks such as blocks **10***a*, **10***b*, can be located and fastened together as already described. Then, a second FPW element **62** can be used to interconnect selected ones of land areas **61** by connection of the opposite ends of element **62** into the connection cavities **11** of the connector blocks **10***a* and **10***c*. Additionally, the connection cavities **11** of the remaining paired connector blocks depicted in FIG. **6** receive plug-in cards or other kinds of already described connection devices. Circuit packs "*a*," "*b*," and "*c*," of FIG. **6** are examples of such plug-in devices.

Although not shown in FIG. **6**, it should be apparent that feed-though blocks such as **32** illustrated in FIG. **4** can also be used with respect to this assemblage, to the same advantage as already described with respect to FIG. **4**. Likewise, a backup block such as **19** or **39** or **49**, all already described, may be used in place of or in addition to any one of the connector blocks depicted in FIG. **6**—again in the manner and to the advantage already described.

In a further inventive embodiment depicted in FIG. **7**, a rigid printed circuit board **51** may be interconnected with an FPW element **52** by use of a pair of connector blocks **10** with associated backup blocks **19** and use of feed-through blocks **32**. FIG. **7** is intended to illustrate that the interconnection system of the present invention supplies circuit connections between rigid and flexible elements quite simply. The embodiment of FIG. **7** further demonstrates that flexible printed wiring will allow for more manufacturing tolerances than a hard board with fixed locating holes.

In a variation of the use of the backup block **39** with its removable pressure contacts **44**, FIG. **9** depicts a multilayer FPW **55** which has top, middle and bottom layers **56**, **57**, **58** respectively. Here, the objective is to make contact to a lower level such as FPW **57**. To this end, windows such as **59** are placed between the circuit paths **63** of layer **56**, so as to reveal the paths **64** of layer **57** in offset relation with respect to the path **63** of element **56**. Then, a pressure contact such as element **44** held in a backup block (not shown) are oriented to protrude through the windows **59** and effect a pressure contact with the paths **64**. The windows **59** can occur in recurrent rows along the top layer **56**, as shown. This may also be accomplished by any of the contacts in blocks **10**, **70** provided there are windows in the printed circuit elements to accept the contacts.

As has already been discussed, a large number of different pin configurations can be envisioned in the general connection system described.

FIG. **10** depicts a double connector block designated **70**, which differs from block **10** by its use of two opposing pins **71** in each well **72***a* and **72***b*. The wells are opposing and are achieved by opposite rows of dividers **73**.

Pin **71** is depicted specifically in FIG. **12** and consists of a heavy central portion **74**, an offset arm **75**, and a bow **76** of reduced width. Bow **76** includes a length whose face **77** is rounded to supply a pressure point for interconnection circuitry. The opposite end of central portion **74** supports a pair of contact points **78** formed by an outwardly extending zone of the central region. A slot **79** separates the contact points **78**. The arms **80** on which the contact points are built are supported by a spring member **81** from its top portion. The bottom portion of spring member **81** is connected to the portion of metal that is directly beneath the slot **79**. Thus, the spring-loaded movement of the arms **80** and their contact points **78** occurs with respect to the relevance of a stationary arm support **82** for the spring member **81**.

FIG. **11** depicts a double-feed-through block designated **90** which performs the same function as feed-through block **32**, but achieves the feed-through with two separate pin elements for each of numerous longitudinal points along the block **90**. The pin elements **91** are generally shaped like a W with a flat **92** separating the central region. It is seen that such a double-feed-through block as depicted in FIG. **11** supplies the added advantage of increased density of contact and cross-connect points.

It is to be understood that the embodiments described herein are merely illustrative of the principles of the invention. Various modifications may be made thereto by persons skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A system for making electrical connection to circuit paths contained on at least one side of a flexible tape, comprising:

a connector block comprising:

an interior cavity defined between two elongate closely spaced walls, said cavity having a bottoming floor, plural ribs rising from said floor, each being attached along one of said elongate walls, each rib terminating at a plane substantially half-way to said other elongate wall, adjacent ones of said ribs defining plural pin containers, said block further comprising a sunken flat exterior surface on the side opposite said interior cavity, said bottoming floor having passages through to a central zone of said flat exterior surface, one said passage occurring between each pair of adjacent ribs; and

a pin element lockably disposed in each said container, each said pin comprising:

a first section extending through said passage and terminating in a spring-loadable cantilevered tape-contacting pad that in the unloaded state extends beyond said sunken surface, said pad being formed by a bow in the cantilevered region formed inwardly of the bitter end of said first section said pin element further comprising a second section housed in each said container and including a spring-loadable midportion that in the unloaded state extends beyond the terminal plane of said ribs,

each said pad being adapted to pressure-contact a selected circuit path of a flexible tape placed on said sunken flat exterior surface of said connector block and each said midportion being adapted to pressure-contact a selected circuit path of an electrical insert element placed in said block interior cavity;

backup block means substantially coextensive in length with said connector block means and comprising a pressure application surface for contacting said tape; and

means for pressably engaging said backup block means and said connector block means to force said tape against said pin element pads thereby to spring-load said pad onto said tape.

2. Apparatus pursuant to claim **1**, wherein:

each said pin element further comprises an elongate terminal extending through the respective said passage and out substantially beyond said sunken surface at an attitude normal thereto and generally at right angles to said pin's said cantilevered pad, said flexible tape including holes for passably receiving said elongate terminals; and

wherein said backup block further comprises a like number and spacing of holes also for passably receiving said elongate terminals, each said elongate terminal adapted to receive a wire connection on the region exposed beyond said backup block means.

3. Apparatus pursuant to claim **2,** further comprising:

feed-through block means substantially coextensive in length with said connector block means and comprising plural three-sided hollowout regions spaced in corresponding relation to said spring-loadable contacting pads, three-sided metallic pin connector means disposed within each said hollowout region and including first and second spring-loadable ends, each said end including a midportion that in the unloaded state extends out and beyond the hollowout regions, and

means for positioning said feed-through block means upon said connector block means with a first flexible tape thereinbetween.

* * * * *