

March 26, 1963

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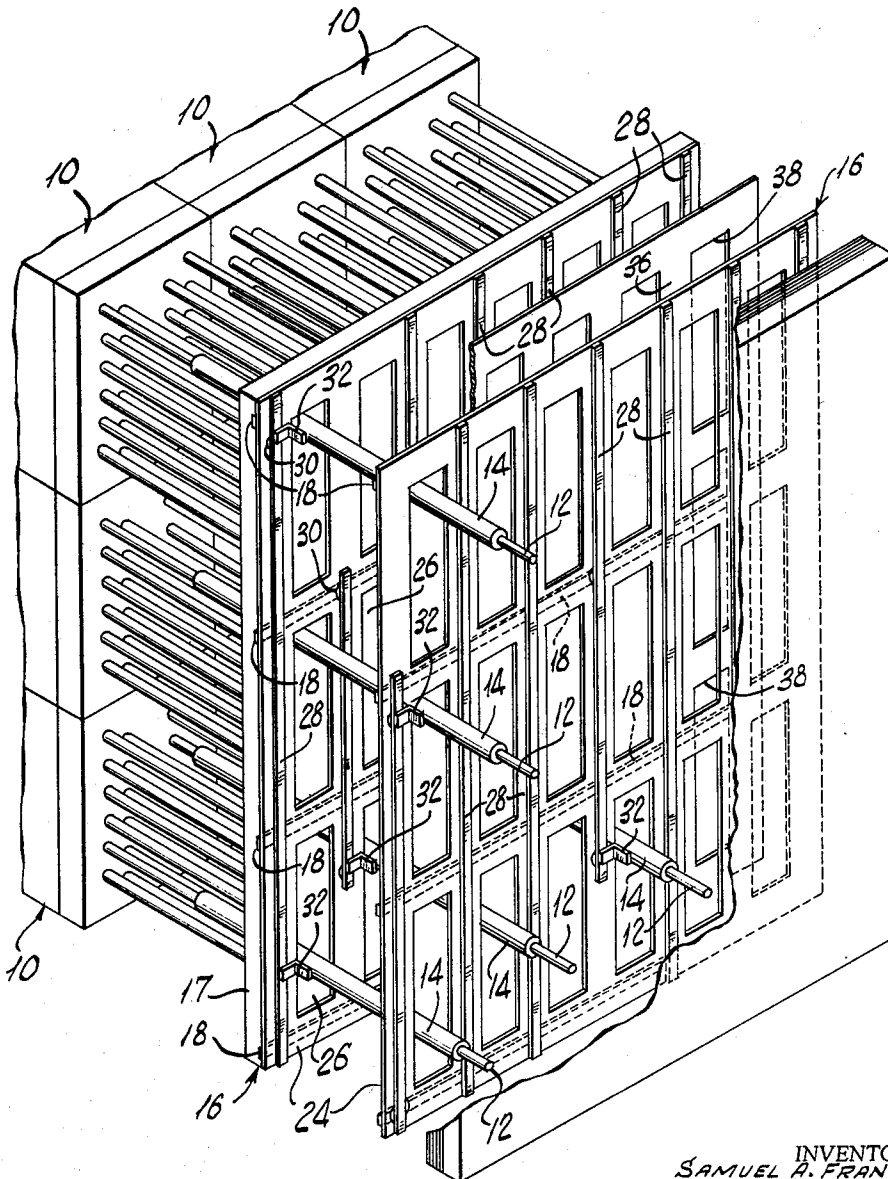
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ELECTRICAL CONNECTOR FOR CLOSELY SPACED TERMINALS

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7 Sheets-Sheet 1

Fig. 1.



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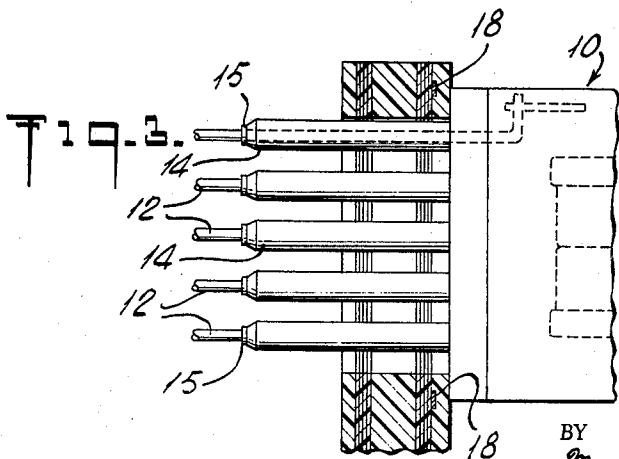
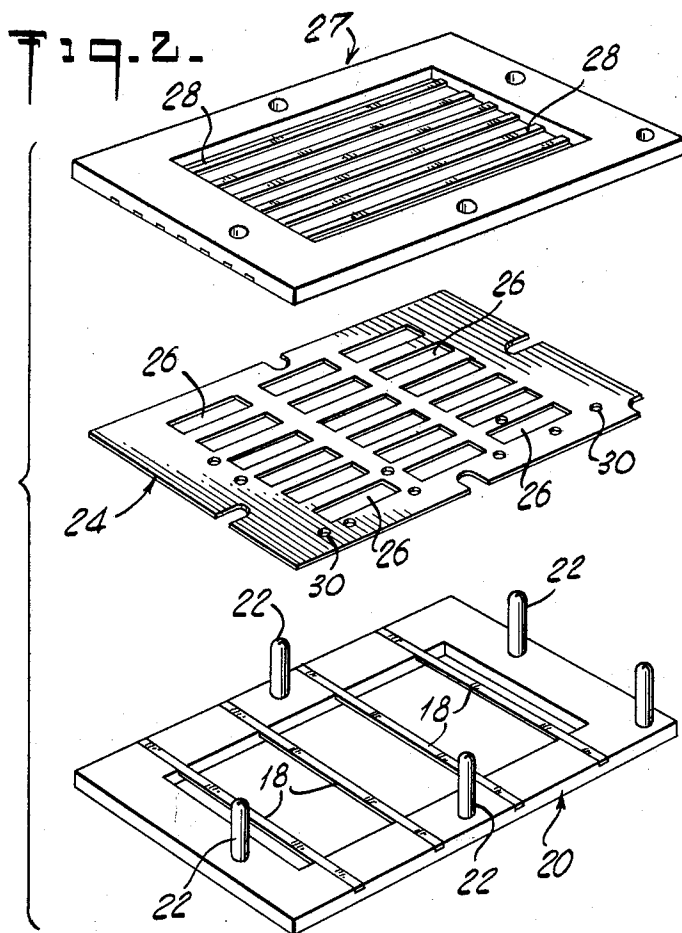
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7 Sheets-Sheet 2



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Fig. 4.

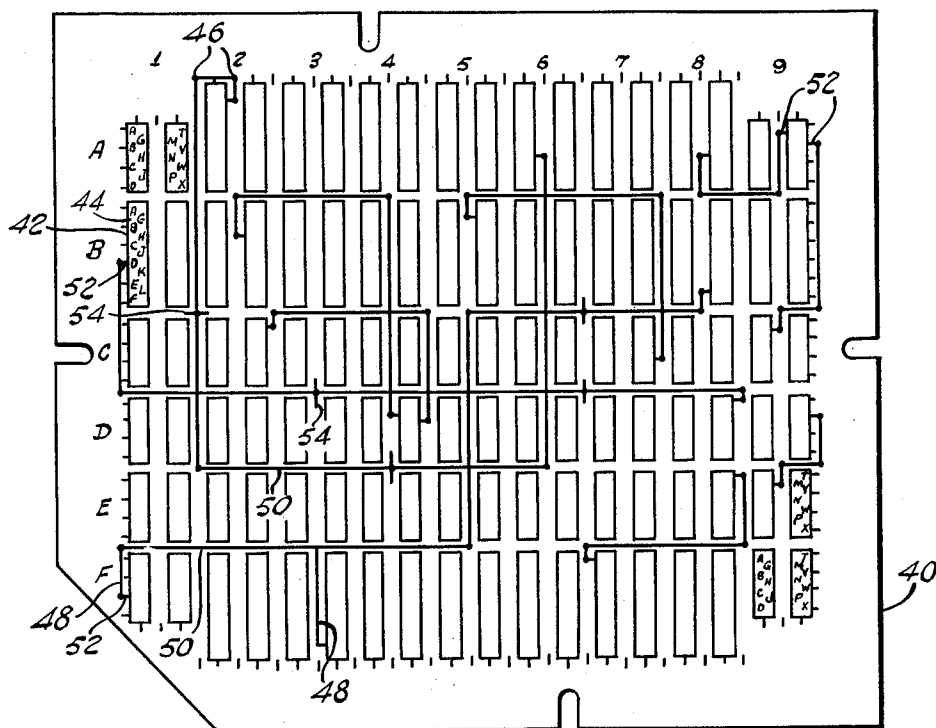
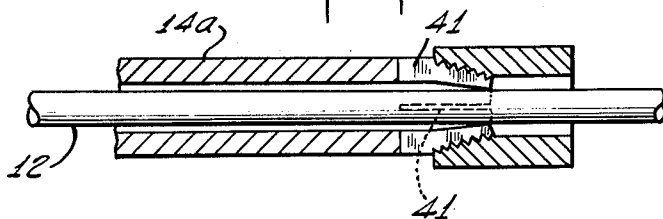


Fig. 5.



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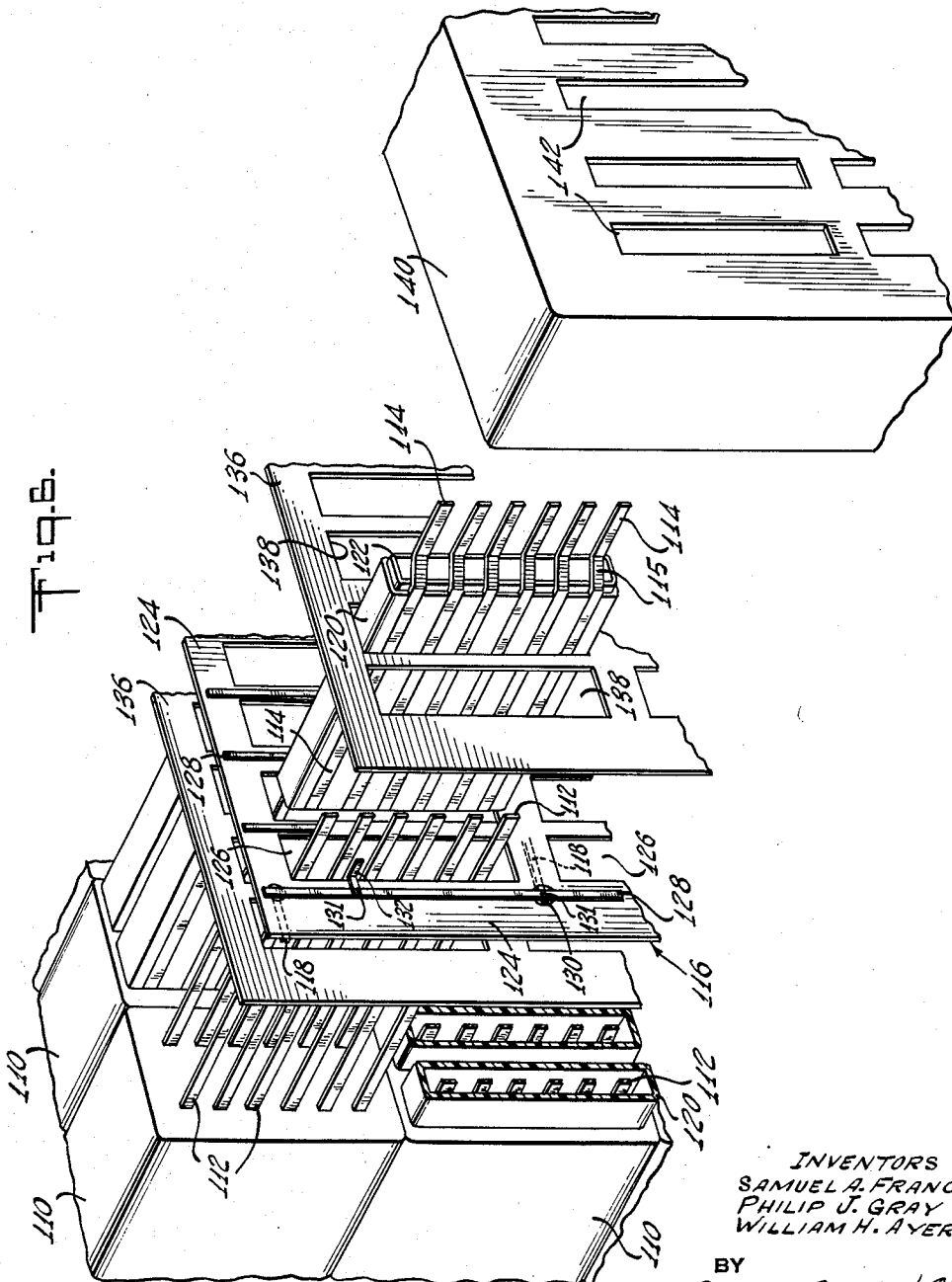
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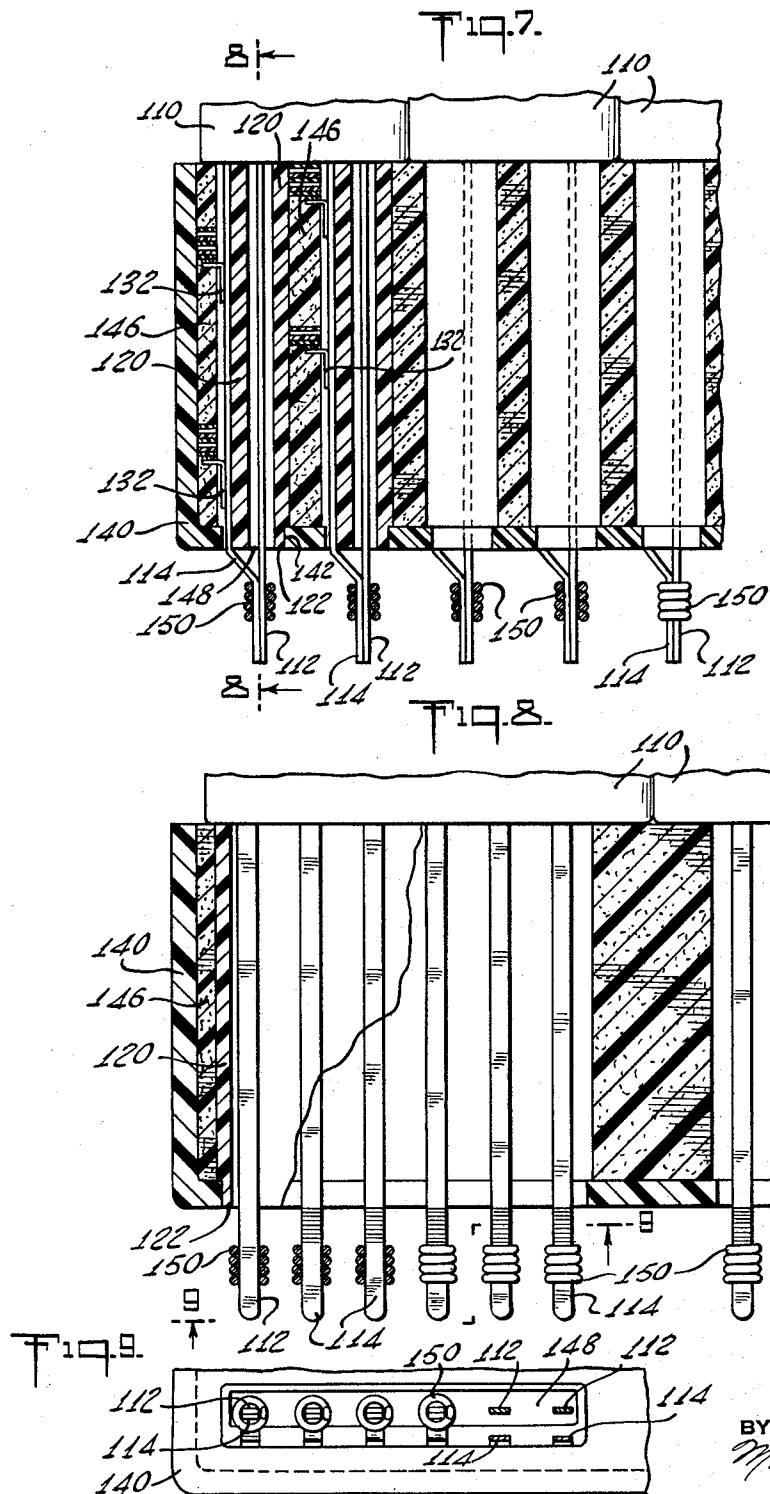
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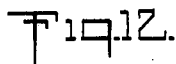
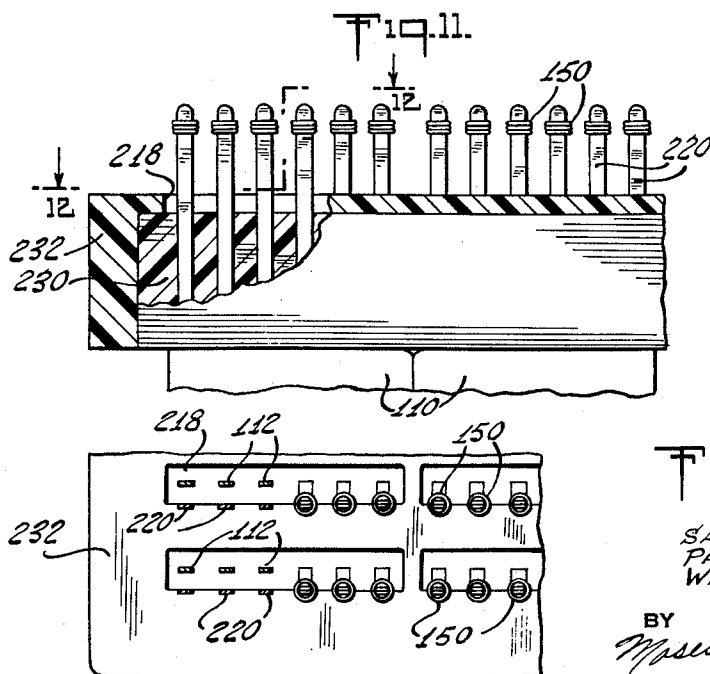
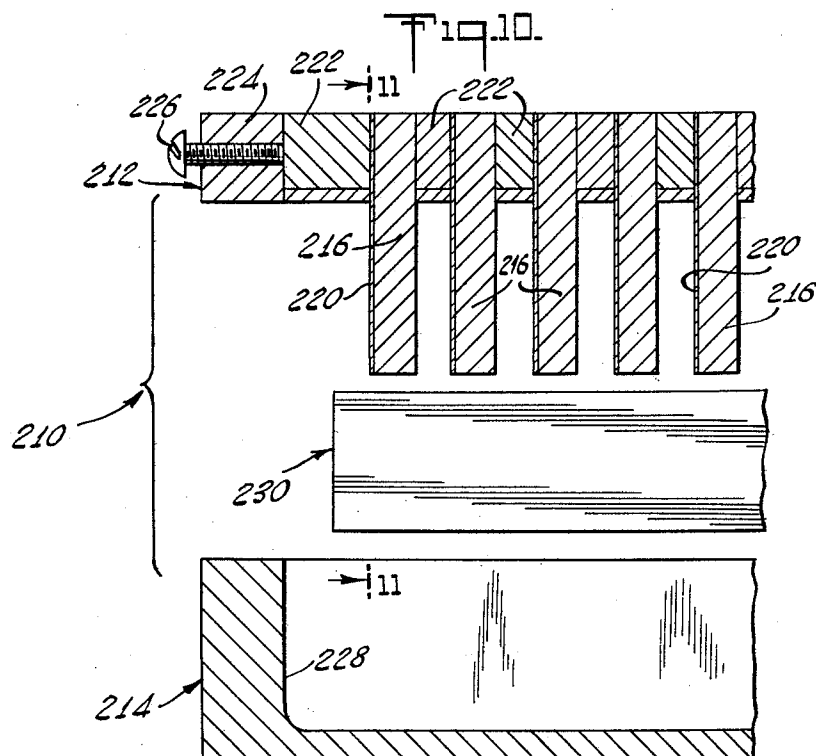
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ELECTRICAL CONNECTOR FOR CLOSELY SPACED TERMINALS

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Fig. 13.

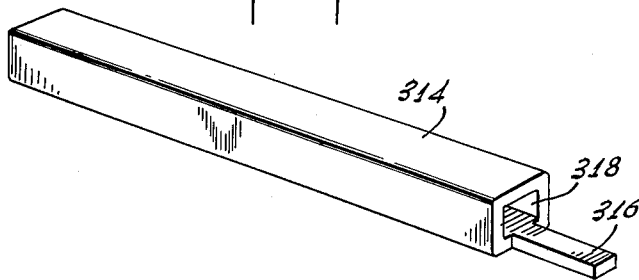


Fig. 14.

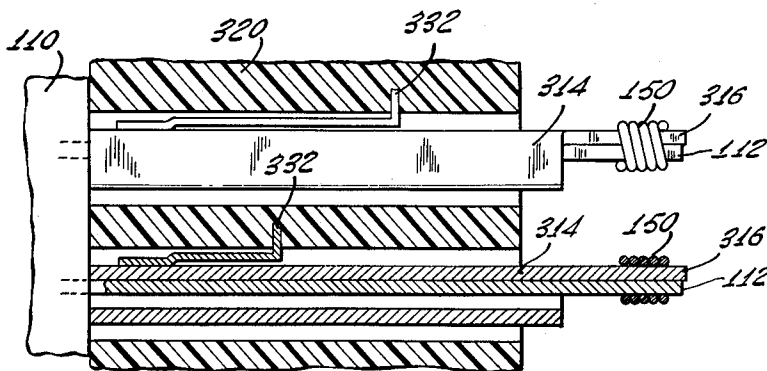
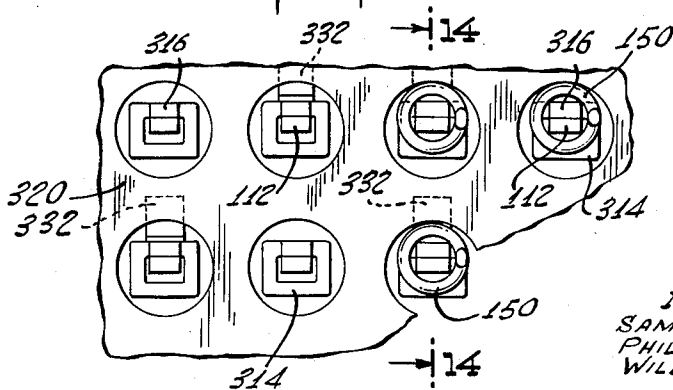


Fig. 15.



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ELECTRICAL CONNECTOR FOR CLOSELY SPACED TERMINALS

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8 Claims. (Cl. 174-88)

This invention relates in general to electrical circuits and in particular to a new and useful circuit construction in the form of a connector for effecting the interconnection of a multiplicity of small size conductors and to a method of forming such circuit construction.

This application is a continuation-in-part of our prior copending application Serial No. 857,009, filed December 3, 1959, for a Device, now abandoned, which application was in turn a continuation-in-part application of our prior copending application Serial No. 775,332, filed December 1, 1958, now abandoned, on the same subject matter.

The invention finds particular application in electrical devices, such as may be found in missiles and similar equipment, where the systems must be incorporated into a limited space. In such high density component packing applications the electrical circuits are of very small size and they must be assembled with accuracy and precision to obtain the necessary reliability. It is essential that such circuits be interconnected in a minimum amount of time and by an accurately controlled system which insures that the proper circuits are made while others are insulated and maintained in their proper orientation.

In accordance with one form of the present invention there is provided a method of interconnecting various terminals within a multi-pin connector by providing composite, sandwich-like layers of criss-cross electrical conductors. Each layer in the sandwich provides electrical interconnection between a preselected number of conductive sleeves or terminals and as additional interconnections are required additional layers are added. The present invention includes a lamination of crossed conductor elements on each side of an insulating film, welded together at desired locations through apertures in the film to form an electrical matrix. The film also includes suitable rectangular cutout portions to accommodate spaced groups of conductive sleeve elements. The spaced sleeves are later fitted over terminal wires protruding from the electrical modules thereby accomplishing circuit connection and interconnection.

To fabricate the connector of the invention employing tubular sleeves, the outside periphery of each tubular element is welded to a selected conductive tab portion formed from the matrix conductors. A multiplicity of such matrix layers are constructed and connected sequentially in accordance with chosen circuit patterns to preselected sleeves to achieve a sandwich-like series of circuits. Thereafter, the assembly is potted or sealed with insulation material to expose only the ends of the tubular elements. The connector is then ready for connection to the terminal wires extending from an associated electrical unit in various novel ways.

The inside dimension of each tubular element or sleeve is purposely made larger than the outside diameter of its associated terminal conductor, so that no binding between the parts will occur during connection. The clearance between the sleeve and conductor thereby allows for large dimensional variations in sleeve and conductor spacing without worry of mechanical interference or high connector insertion force. This feature of the invention is particularly advantageous in modern connectors employing many hundred of terminal pins where tolerance ac-

cumulations can become excessively large and cause difficulty in joining the connector halves.

Upon insertion of the connectors over their respective wires electrical connection between a wire and its sleeve may be made in various ways. If the duty cycle of the connector will require frequent removal, a wire-wrap or a chuck-type connection at one end of the tube may be used. If a limited number of connector removals are contemplated the wire and sleeve may be crimped and welded to provide maximum reliability.

In another form of the invention, a plurality of rectangular terminal strips are employed in place of the connector sleeves to allow a wire-wrapped electrical interconnection between the connector and the electrical units. In this form of the invention, the connector terminals are arranged adjacent an elongated aperture extending through the connector in registry with each group of electrical unit terminals projecting therethrough.

Accordingly, it is an object of this invention to provide a connector assembly formed of a multiplicity of joined conductive sleeves.

Another object of the invention is to provide an improved method for interconnecting a multiplicity of electrical terminal wires.

A still further object of the invention is to provide an improved connector comprising a plurality of spaced tubular sleeves electrically interconnected by cross conductor elements secured to an insulating film.

Still another object of the invention is to provide an improved method of making a connector.

Another object of the invention is to provide a terminal connector assembly incorporating inter-terminal wiring which may readily be connected by a wire-wrapped technique to the terminals of an associated electrical component.

Still another object of the invention is to provide a connector assembly employing a plurality of terminal strips arranged about the periphery of an aperture therethrough.

A still further object of the invention is to provide a conductive sleeve of rectangular cross-section having a recessed end portion to provide a convenient wire-wrap terminal tab.

Still another object of the invention is to provide a circuit connector including a multiplicity of sandwich-like matrices each matrix interconnecting various tubular sleeves extending transversely through the connector, said tubular sleeve being capable of slidable engagement with associated conductors extending from an electronic module.

Yet another object of the invention is to provide a circuit construction in the form of a connector which is simple in design, high in density, durable in construction and economical to manufacture.

For a better understanding of the nature of the invention, reference should be had to the accompanying drawings in which:

FIG. 1 is an exploded perspective view of the invention in association with a modular electronic assembly having wires extending outwardly therefrom and containing two matrix layers with interconnecting cross conductive elements;

FIG. 2 is an exploded perspective view of a jig used in positioning and assembling the criss-cross conductors on either side of an insulating film;

FIG. 3 is a fragmentary section of the invention in a connected relation with an electronic module;

FIG. 4 is a layout diagram used in the routing of conductors employed in a single matrix;

FIG. 5 is an enlarged view in cross section of an alternate sleeve embodiment employing a chuck terminal wire securing arrangement;

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FIG. 6 is an exploded perspective view, similar to FIG. 1, of another form of the invention;

FIG. 7 is a broken transverse section of the form of invention shown in FIG. 6;

FIG. 8 is a fragmentary sectional view taken along line 8—8 of FIG. 7;

FIG. 9 is a fragmentary sectional view taken along line 9—9 of FIG. 8;

FIG. 10 is an exploded fragmentary sectional view of the jig and method employed for fabricating yet another embodiment of the invention;

FIG. 11 is a partial cross-sectional view of the invention as produced by the method and jig of FIG. 10 as connected to typical electrical units;

FIG. 12 is a fragmentary sectional view taken along lines 12—12 of FIG. 11;

FIG. 13 is a perspective view showing a modified form of a conductive sleeve having a rectangular end tab portion;

FIG. 14 is a cross-sectional view taken along lines 14—14 of FIG. 15; and

FIG. 15 is a fragmentary end view of the connector of FIG. 14.

Referring to the drawings, the novel connector of the invention is shown in exploded fashion in FIG. 1. The connector is designed to properly electrically interconnect a multiplicity of grouped terminal wires 12 extending from a plurality of electrical units or modules 10. The electrical modules contain a large number of electrical circuits employing transistors, resistors, etc. (not shown), which terminate in the protruding wires 12. These terminal wires require interconnection with similar wires on other adjacent electrical units to effect a completely operational device. To this end the invention is provided with a spaced array of tubular conductive sleeves suitably positioned in proximate registry with the terminal wires 12 so that slidable engagement may be made therewith. The elongated sleeve 14 is made of conductive material and has an inside diameter sufficiently large to permit free telescoping passage over the terminal wires 12.

In accordance with the invention, the connector is fabricated from a multiplicity of prewired matrices 16. Each matrix includes an insulating sheet 24 supporting front and rear spaced conductors respectively numbered 28 and 18. Each matrix may be readily constructed in a jig assembly as shown in FIG. 2. The jig base 20 contains upstanding locating pins 22 and is formed to receive and locate the rear conductor strips 18. The matrix insulating sheet 24 is applied thereover and in turn a jig cover 27 locating the front matrix conductors 28 is applied. The insulating sheet 24 contains a plurality of spaced cutout window-like portions shown generally as 26 which are provided to allow passage therethrough of groups of sleeves 14. Also, on the insulating sheet are spaced apertures 30, some of which are punched in registry with selected conductor crossover points. These apertures permit weldable connection of a rear matrix conductor 18 to a front matrix conductor 28. Those apertures 30 not lying at intersection points of the criss-cross primary front and rear matrix conductors 18 and 28 are provided for weldable connection of a conductive tab 32. The tab portion 32 is formed to project from the plane of the matrix in a parallel adjacent relationship to a selected sleeve 14.

For a better understanding of the matrix construction, reference should be made to FIG. 4, wherein a typical matrix wiring layout pattern 40 has thereon a multiplicity of spaced rectangular areas 42. These areas 42 correspond substantially in size and location to the cutout portions 26 of the insulating sheet 24. Each area 42 is lettered with the terminal wire positioning code 44 (A, B, C, D . . . K, L, etc.). The dots 46 indicate the locations for the apertures 30 which are punched in the matrix insulating sheet 24. The vertical lines 48 repre-

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sent the routing paths for the conductors 28 while the horizontal lines 50 represent the routing paths for conductors 18. Weldable interconnection between front and rear matrix conductors is accomplished at each dot 46 locations. Also included on the matrix wiring layout pattern 40 are short lines 52 which represent the location for the conductive tabs 32. These tabs may be welded to either conductors 28 or 18 as required. A short cross conductor line 54 indicates the location for securing tack welds. These tack welds 54 are located along long unsupported lengths of conductor ribbons 18 or 28, as needed to provide mechanical securing and are non-functional electrically.

Referring now to FIG. 1, the novel connector shows how two matrix wiring patterns are connected to various sleeves 14 through the welded tabs 32. For clarity, it should be understood that sleeves are provided for all the terminal wires 12 although only a representative number of sleeves 14 are shown. An insulating sheet 36 is provided between each adjacent matrix so that shorting does not occur between the rear conductors 18 of one matrix and the front conductors 28 of the adjacent matrix. Suitable cutout portions 38 are provided in the separating sheet 36 to allow passage of groups of conductive sleeves 14.

In the construction of the invention, a sleeve positioning jig is used (not shown) which includes a plurality of vertical pins spaced in a fashion corresponding to the lettered portions 44 of FIG. 4. The diameter of the holding pins is such that the sleeves 14 can be slidably placed thereover. After the sleeves 14 have been properly located on the jig pins each matrix is successively stacked and the connections are made between the matrix tab portions 32 and selected sleeves 14. Following the connection of the first matrix the insulating sheet 36 is placed over the upstanding sleeve and a second matrix 16 is located thereover and again the desired connections are made between the tab portion 32 and the selected sleeves 14. In this manner it can be seen that alternate layers of wiring matrices and insulating sheets may be applied in sandwich-like fashion to construct a highly compact connector comprised of a multiplicity of sleeves which are interconnected by the matrix wiring. After application of all the wiring layers, the assembly is potted with insulating material to form a rigid assembly having the sleeve portion extending therefrom on one side. In FIG. 3, the sleeve 14 end portions have been crimped and welded to their respective terminal wires 12 extending therethrough. The location of the crimp weld 15, away from the body portion of the connector allows subsequent removal of the connector by the mere severance of the sleeves and wire below the crimped weld location. The excess length of the sleeve 14 is sufficient to allow for repeated welding and removal of the connector from the electrical unit 10.

Referring to FIG. 5, an alternate embodiment is shown for securing the terminal wires 12 to the sleeve-like members 14a of the connector. In this embodiment a sleeve having a threaded and split end 41 is employed in combination with a tapered threaded nut member 15a. On threaded engagement of 15a upon the sleeve 14a a decreasing sleeve internal diameter causes rigid gripping of the terminal wire 12. In this form of sleeve to wire securing, repeated assembly and removal of the connector may be made without the foreshortening of the sleeve portion as in the previous method of connection.

Referring to FIGS. 6-9 inclusive, an alternate form of connector assembly is shown for electrically interconnecting a plurality of module assemblies 110 having elongated rectangular terminal pins 112 extending therefrom. The connector includes a shallow shell or casing portion 140 which may be made from any suitable dielectric material. The casing contains a plurality of openings 142 spaced to be in substantial registry with the outline of the groups of electrical terminals 112. Fitted

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into each of the casing openings 142 is a rectangular core member 120 also made of dielectric material having a flange or lip portion 122 which snugly engages the aperture 142. Secured, as by cementing, to one outside wall of the rectangular core 120 are a plurality of rectangular terminals 114 having an inclined portion 115 so that the end portion of the terminal will overhang the rectangular aperture 148 within the core. Each of the cores 120 is fitted into its respective casing aperture 142 so that the ends of the terminals 114 protrude sufficiently for subsequent electrical connection.

Each of the terminals 114 of the connector assembly is electrically interconnected in the desired circuit manner by a plurality of prefabricated wiring matrix layers shown generally at 116. Each layer includes a pattern of criss-crossed conductors 118 and 128 arranged respectively in a horizontal and a vertical plane on opposite sides of a separating insulating sheet 124 (similar to the layout shown in FIG. 4). The insulating sheet 124 contains a plurality of openings or cutout portions 126 which are sufficiently large to pass over the outside of the core member 120. The conductor strips 118 and 128, on opposite sides of the insulating layer 124, are interconnected in the desired fashion by welds 131 spaced over apertures 130 at the conductor crossover points. In this manner, the electrical interconnection between the criss-crossed wires additionally provides mechanical securing of the conductors to the insulating sheet. Each matrix assembly 116 is fitted over the core portions 120 within the cavity of the casing 140 and the desired electrical connections made between the matrix and the terminals 114 by a short conductive tab portion 132 which is welded to the side of the conductor 114 to make connection to the conductor 128. Thereafter, subsequent conductor layers 116 may be added as required and they need only be insulated one from the other by an insulating sheet 136 having apertures 138 which conform with the apertures 126. Finally, the voids between the matrix layers 116 within the casing 140 are potted with a plastic resin potting compound 146 or other similar material to form a unitary end connector which may be readily placed over the grouped terminal pins 112 of an array of electrical units 110. The necessary electrical joining of the associated terminals 112 and 114 may now readily be accomplished by a conventional wire-wrapped connection 150 which maintains intimate surface contact between the respective terminals and also electrically interconnects the terminals through the wrapped connection wire per se. Such wire-wrapped electrical connections may be similar to that employed in the U.S. Letters Patent 2,759,166, issued August 14, 1956.

As in the previous embodiment, this embodiment provides for the electrical interconnection of various pins on a multipin connector. The multipin connector is provided with a plurality of conductor matrix layers having criss-cross conductors welded at selected points through apertures with sheets of insulating film therebetween. The entire connector assembly is readily attached to an electrical unit having a multiplicity of terminal pins without undue insertion force due to large tolerance buildups in conventional multipin connectors.

Referring to the embodiment of the invention shown in FIGS. 10, 11 and 12, an exploded jig assembly 210 is shown having an upper male mold half 212 and a lower female mold half 214 having a cavity 228 therein. The male mold half 212 carries a plurality of depending rectangular cores 216 which form the rectangular through passageways 218 in the finished connector (see FIG. 12). The male mold half includes a plurality of terminal strips 220 which abut against the core piece 216 and are held in fixed orientation by a plurality of spacers 222 held within the frame 224 by a clamping screw 226. In the specific connector constructed with this jig assembly six parallel terminal strips 220 are arranged adjacent each of the cores 216 and secured in spaced relation

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within the jig half. Thereafter, the previously described type wiring matrices 116 of FIG. 6 may be sequentially inserted over the upstanding cores 216 and the desired electrical welds made between terminal strips 220 and selected connection tabs 132. In FIG. 10 the aforesaid assembly of laminated conductor layers is schematically shown at 230, but it should be understood that this interconnecting wiring is applied layer by layer about the cores and terminal strips of the male jig half 212. Following assembly and connection of the electrical layers 230 to the male jig half 212, the upper assembly is lowered into the cavity 228 of the female mold portion 214. Thereafter, the voids are filled with a suitable encapsulating compound such as an epoxy resin or the like to form an outer shell or casing portion 232 (see FIG. 11). Finally the screw 226 may be loosened and the cores 216 withdrawn and the finished connector may be removed from the cavity 228 and connected in the previously described manner to a plurality of electrical units 110 by a wire-wrapped terminal 150.

In the embodiment of the invention shown in FIGS. 13, 14 and 15, a rectangular sleeve 314 of conductive material is embedded within the body portion 320 of a connector containing layers of wiring matrices (not shown). The sleeve 314 has a protruding wall extension 316 which forms a terminal portion which may be readily connected by a coil of conductive wire 150 to an associated terminal strip 112 of an electrical unit 110. The terminal 112 extends likewise through the rectangular aperture 318 in the sleeve 314 and assumes an approximate parallel orientation to the extension 316 prior to connection. Secured to the outside of the sleeve portions 314 by a weld 331 is an L-shaped conductive tab portion 332 which may be secured to any desired conductor of a matrix layer (not shown) embedded within the body portion 320.

Thus, the invention provides a simple means for electrically interconnecting a multiplicity of terminal wires extending from electrical units. The electrical interconnection of many electrical units may be easily accomplished with a single connector without adverse tolerance build-up effects because of the novel sleeve to wire configuration. The large sleeve inside diameter, in relation to the outside diameter of the associated terminal wire, allows wide variation in mating part location without creating binding engagement of the connector to the electrical unit. The high insertion force usually required in multi-pin connectors is eliminated by the clearance between the terminal wire and the sleeve inside diameter thereby giving an extremely low insertion force to the improved connector assembly.

While a specific embodiment of the invention has been shown and described in detail to illustrate the application of the invention principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. An electrical connector for equipment having a multiplicity of substantially parallel terminal elements comprising a matrix composed of a lamina of an insulating web containing apertures and substantially parallel conductors on each side thereof, said conductors on one side crossing the conductors on the other side at preselected positions, said conductors being electrically interconnected through selected apertures in said web to at least one crossing conductor on the opposite side of said web, terminal means extending substantially perpendicularly through the plane of said matrix in substantial parallel alignment with the terminal elements to be connected, means for selectively connecting a surface of said terminal means to said conductors, and insulation means encapsulating said conductors leaving end portions of said terminal means exposed for electrical connection to the terminal elements of the equipment to which the connector is to be connected.

2. An electrical connector according to claim 1, wherein there are provided a plurality of matrices each electrically interconnecting preselected terminal means, and sheets of insulating material interposed between said matrices for insulating the conductors on one matrix from the conductors on the adjacent matrix.

3. In an electrical connector for connection to a multiplicity of closely spaced conductive terminal elements, the improvement comprising means for electrically interconnecting predetermined ones of said terminal elements in an electric circuit, said means including a sheet of insulating material, spaced substantially parallel conductors on each side thereof and arranged in crossing relationship with respect to the conductors on the opposite side, electrical connections between conductors on opposite sides of the insulation sheet through apertures in the insulation sheet securing said conductors to said sheet, conductive sleeves extending through said insulation sheet in alignment with the terminal elements to be connected and adapted to be positionable thereover, and electrical connections from the outer surface of said sleeves to predetermined crossing conductors at predetermined locations.

4. An electrical connector according to claim 3, wherein said sleeves are of rectangular cross-section and carry an extending wall portion for connection purposes to said terminal elements.

5. A combination according to claim 3, including a plurality of insulation sheets each having crossing conductors thereon and means intermediate the conductors on the adjacent sheets for insulating the conductors on one sheet from the conductors on the adjacent sheet.

6. The combination according to claim 5, wherein one end of said sleeves is provided with chucking means for

mechanical and electrical connection to its associated terminal element.

7. A combination according to claim 5, wherein the ends of said sleeves include means adapted to mechanically and electrically engage the terminal elements adapted to pass therethrough.

8. An electrical connector for a plurality of electrical terminations comprising at least one sheet of insulating material having openings, spaced connection terminals passing through said openings in a direction substantially perpendicular to the plane of said insulating sheet, a plurality of conductive members positioned on opposite faces of said insulating sheet, said conductive members on one side of said insulating sheet crossing the conductive members on the opposite side of the insulating sheet and being interconnected at selected crossing locations in registry with a plurality of apertures in said insulation sheet, said connection terminals being electrically interconnected in predetermined fashion by connection to preselected conductive members and being arranged to be adjacent said electrical terminations for subsequent connection thereto to electrically connect said terminations in accordance with the connections made to said conductive members, and insulation means encapsulating said conductive members and portions of said connection terminals.

References Cited in the file of this patent

UNITED STATES PATENTS

1,649,923	Post	Nov. 22, 1927
2,872,565	Brooks	Feb. 3, 1959
2,981,787	Brautigam et al.	Apr. 25, 1961
3,002,045	Ayer	Sept. 26, 1961