

March 8, 1966

H. S. SILVER

3,239,798

ELECTRICAL CONNECTOR FOR INTERCONNECTING PRINTED CIRCUIT PANELS

Filed March 14, 1963

5 Sheets-Sheet 1

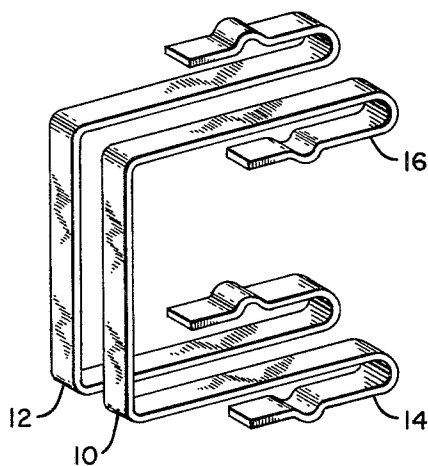


Fig. 1

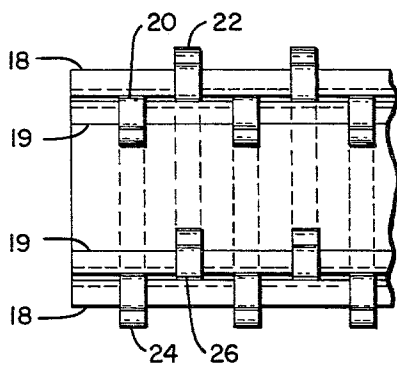


Fig. 2

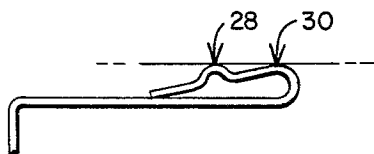


Fig. 3

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5 Sheets-Sheet 2

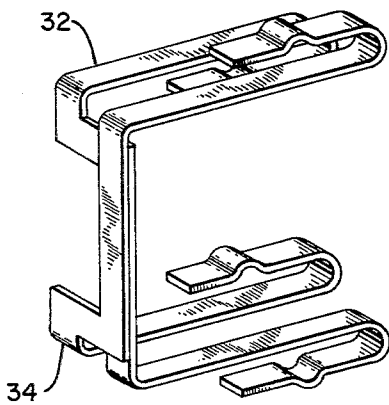


Fig. 4

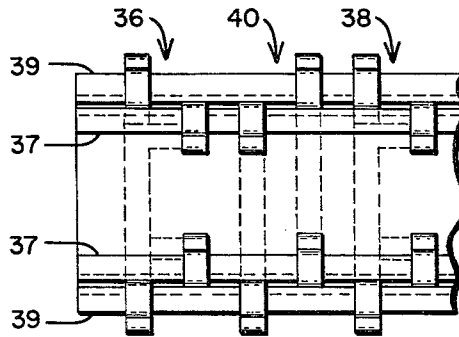


Fig. 5

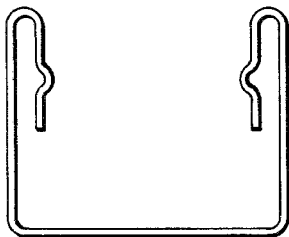


Fig. 6



Fig. 7

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5 Sheets-Sheet 3

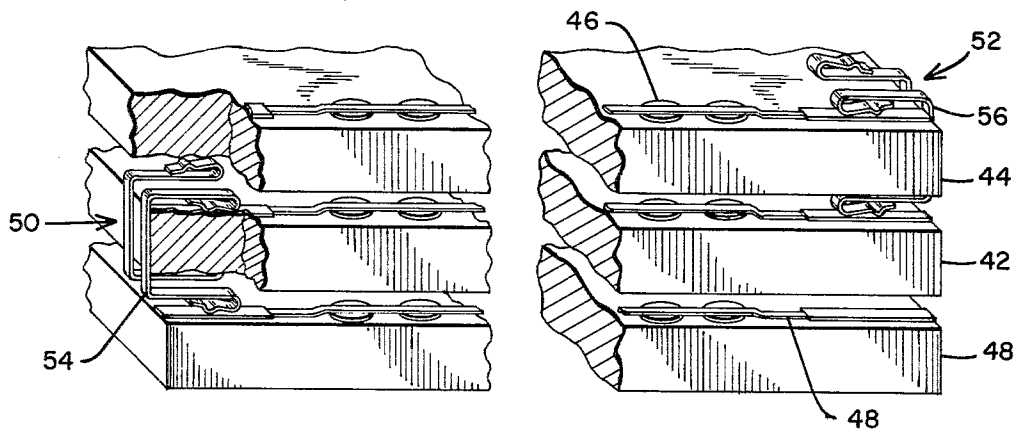
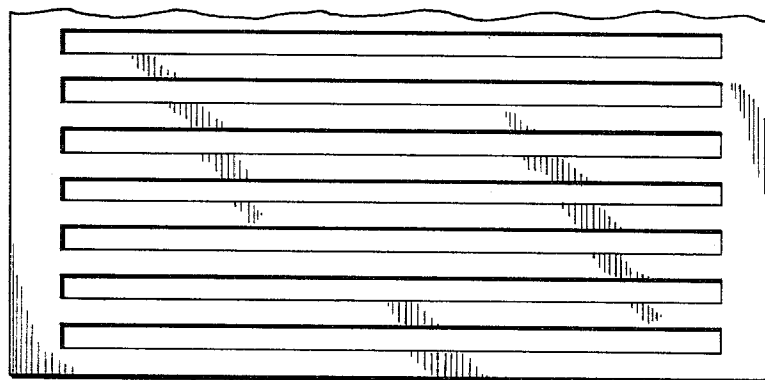


Fig. 8



CONTACT
STRIPS

JOINING
STRIPS

Fig. 9

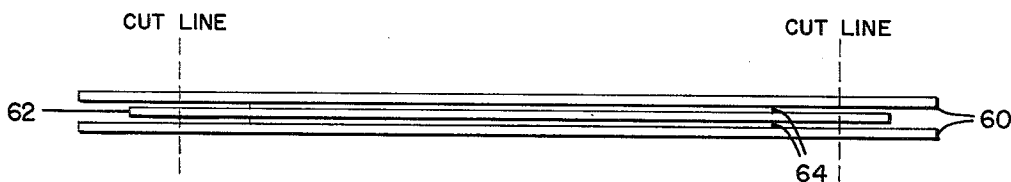


Fig. 10

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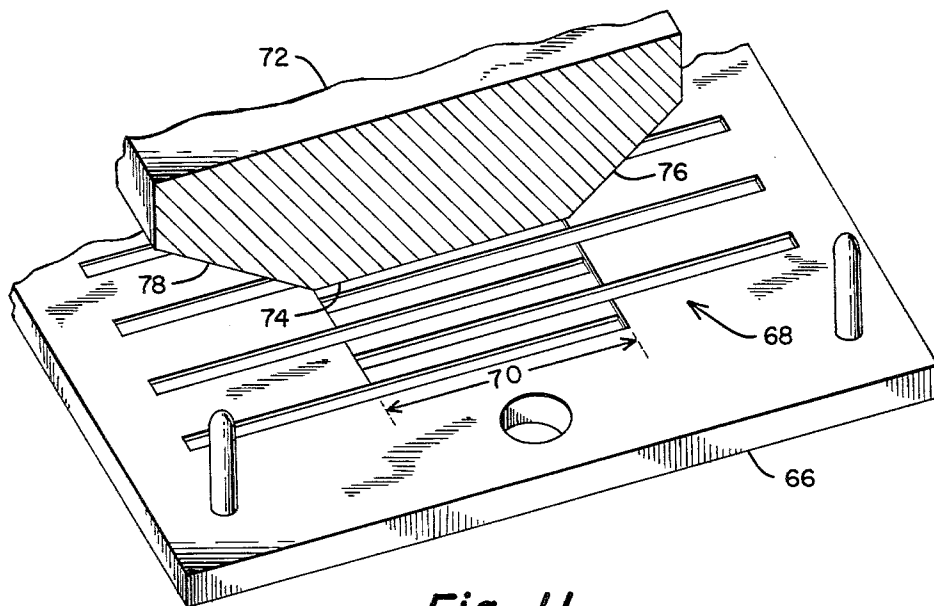


Fig. 11

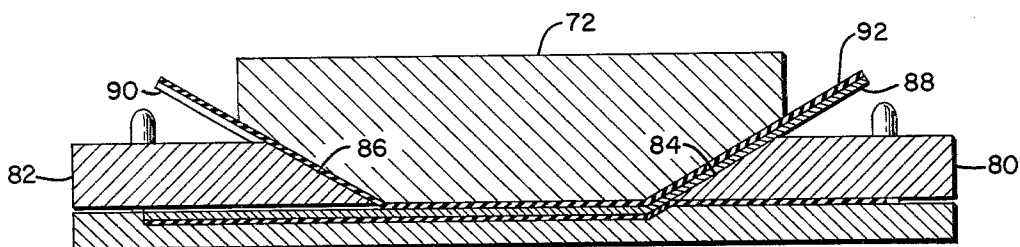


Fig. 12

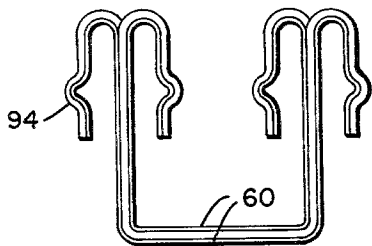


Fig. 13

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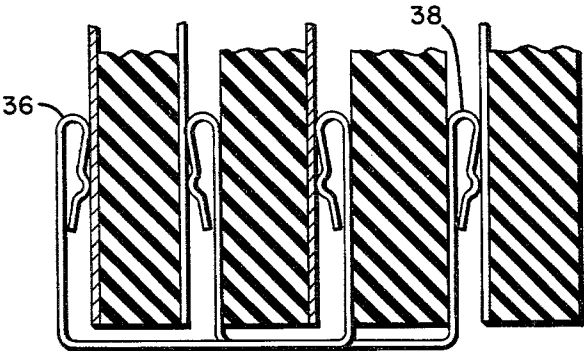


Fig. 14

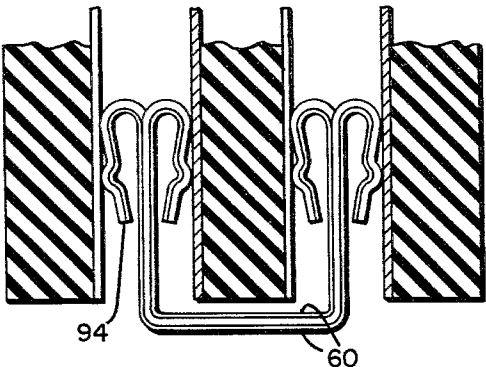


Fig. 15

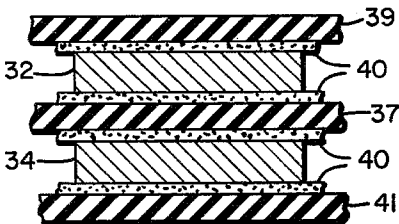


Fig. 17

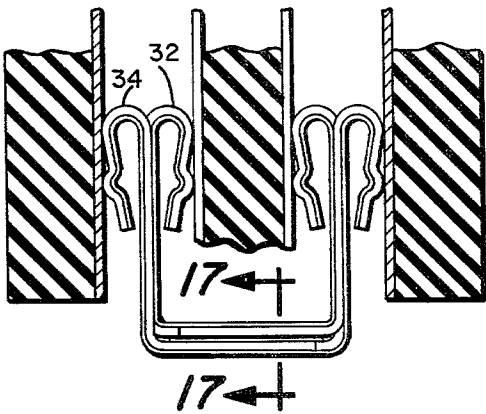


Fig. 16

1

2

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ELECTRICAL CONNECTOR FOR INTERCONNECTING PRINTED CIRCUIT PANELS

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11 Claims. (Cl. 339—176)

This invention relates generally to electrical connectors and more particularly to electrical connectors for making electrical interconnections between printed circuit panels.

There has been recently a definite trend in the electronics industry toward miniaturization and micro-miniaturization of electronic devices. This has been spearheaded by technology which has lead to the development of what is referred to as microelectronic circuits. These circuits are sometimes further referred to as thin-film or integrated circuits which titles reflect the process of fabrication. The micro-electronic circuits, in the form in which they are finally assembled together in electronic devices, comprise very thin films of passive and active components as well as electrical conductors on the surface of a suitable substrate layer. They may be fabricated, for example, by printed circuit techniques, etching processes, deposition processes or the like. Hereafter as used in the specification and the claims the term "printed circuits" will be the generic term including micro-electronic circuits as well as the more generally well-known printed circuits with no intent to limit as to the manner in which the circuit is initially formed. The phrase "printed circuit panel" will be hereafter utilized in the specification and the claims as generically including the printed circuit and the substrate upon which it is laid.

Electronic devices assembled with printed circuits include, to a large degree, a plurality of these circuits arranged in stacked relationship with electrical connections between the panels. A good example of this is in the memory section of electronic digital computers wherein a plurality of magnetic elements, such as toroidal cores or magnetic thin films, are arranged in a planary array of rows and columns with electrical conductors for carrying electrical signals passing in inductive relationship to the magnetic elements. These conductors may be either of the printed circuit form or their terminations at the edges of the panels for making electrical connection to other panels are usually of the printed circuit type. A plurality of these planar arrays are usually combined in a stacked relationship to form a complete memory apparatus. As a typical example, 32 planar arrays each having 64 rows and 64 columns of magnetic elements form a memory stack. Since anywhere from three to five electrical conductors must be inductively coupled to each of the magnetic elements and since most of these conductors are common to all of the planar arrays, the required large number of electrical interconnections required between the planar arrays in a stack can be visualized. Although electrical connectors for making interconnections between the planar arrays have been satisfactory in the past, they generally are of too great of a bulk and so off-set some of the advantage gained by the reduced space requirements of the printed circuitry. Therefore, it is an object of this invention to provide an electrical connector for printed circuit panels which is compact and of reduced space requirements.

While attempts have been made in the past to fabricate compact connectors, these attempts have generally resulted in fabrication methods which are costly and time consuming. Therefore, it is a further object of this invention to provide a process for fabricating compact, electrical connectors for printed circuit panels which proc-

ess is readily adaptable to mass production techniques with the accompanying reduction in time and cost.

In general, once a group of printed circuit panels have been assembled with the electrical interconnections therebetween they operate in a very reliable manner requiring little in the way of maintenance. However, during initial assembly and tests some malfunctions may be discovered which require replacement of at least portions of some of the printed circuit panels or the connectors. Further it is sometimes necessary, after assembly and use, to modify some of the printed circuits to incorporate circuit changes and also some field repair and maintenance may be necessary. In the past the electrical connectors were such that disassembly of stacks of printed circuit panels was difficult and time-consuming. It is an object of this invention to provide an electrical connector for printed circuit panels which allows relatively simple assembly and disassembly of printed circuit panels in stacked relationships.

It has been found advantageous to form printed circuit panels with printed circuitry on both major surfaces thereof to achieve an increased amount of circuitry with substantially no increase in space requirements. Additionally, by having printed circuitry on the two surfaces, a larger number of contacts for external connections either to other printed circuit panels or other types of circuits can be obtained. It is therefore a further object of this invention to provide a compact electrical connector for making electrical connections between printed circuits on corresponding surfaces of printed circuit panels which are arranged in stacked relationship.

It is a further object of this invention to provide a compact, electrical connector for making interconnections between printed circuits in a varied pattern. An example of this is where it is desired to electrically interconnect alternate ones of stacked printed circuit panels.

The electrical contact strips of this invention have a first predetermined length formed into a general U shape and further lengths formed into arcuate extensions from each arm of the U to provide resilient contacts. In the preferred embodiment, one of the arcuate extensions extends downward and inwardly to the U-shaped portion and the other arcuate extension extends downwardly and outwardly from the U-shaped portion. A multiple contact connector comprises a plurality of the previously described contact strips which are affixed to one another by a suitable adhesive in spaced-apart relationship with the U-shaped portions aligned to form a channel running transversely to the lengths of the contact strips. The contact strips are arranged such that along each sidewall of the channel some of the resilient contacts extend inwardly and others of the resilient contacts extend outwardly from the channel. The channel is for receiving at least the edge portion of a printed circuit panel and the inwardly extending resilient contacts of the connector make pressure contact to printed circuit strips on the respective surfaces of the printed circuit panel. The outward extending resilient contacts are adapted for pressure contact to printed circuits on adjacent printed circuit panels to effect the electrical connection between circuitry on corresponding surfaces of adjacent printed circuit panels. The connector may further include sheets of suitable insulating material covering the outer and inner surfaces of the contact strips except for the resilient contact portions. The additional sheets of insulating material not only serve to protect the contact strips against environmental conditions but further serve to add rigidity to the connector body. Since these sheets of insulating material are contoured to follow the channel and are of relatively thin dimension they are resilient so that in assembling a plurality of stacked interconnected printed circuit panels the panels can be squeezed together to reduce the overall

space requirement. In disassembly of a stack, because of the resiliency of the connector, the printed circuit panels and connectors are readily separable and are easily removable. As a further feature of this invention the arcuately extending resilient contacts are formed such that when making pressure contact to printed circuit panels, contact is made to at least two points along the printed circuit conductor.

It is still a further object of this invention to provide a relatively low cost, multiple contact, compact, electrical connector having some degree of resiliency while maintaining dimensional stability. In the preferred process of fabricating the multiple contact connector, a plurality of spaced-apart, elongated, parallel contact strips are formed from a sheet of suitable electrically conductive material. Preferably any well-known printed circuit etching technique is utilized for formation of the contact strips. The contact strip layer is then placed between two sheets of suitable insulating material each having a film of a suitable adhesive on the facing surfaces and the layers are pressed together to form a laminate. The adhesive is applied to extend only over a certain predetermined length of the contact strips so that the ends of the strips are not bonded. The ends of the strips are formed into arcuately extending resilient contacts with all of the extensions extending in the same direction being formed concurrently. The laminar portion is formed into a channel running transverse to the length of the strips having a substantial U-shaped cross section. It can be seen then that a feature of this invention is that the process is one in which the electrical contact members are formed concurrently with the formation of the insulating body member. This is distinguished from the more common practice in the connector art of forming the contacts and the insulating body separately and subsequently assembling the two together. The process of this invention lends itself to time and cost saving techniques.

These and other more detailed specific features and objects will be disclosed in the course of the following specification, reference being had to the accompanying drawings, in which:

FIGURE 1 shows a pair of electrical connector contact strips in a form according to one embodiment of the invention;

FIGURE 2 shows the top view of a portion of a multiple contact electrical connector embodiment of this invention incorporating contact strips shown in FIG. 1;

FIGURE 3 is a view of the resilient electrical contact as it appears when in pressure contact with a printed circuit;

FIGURE 4 shows a pair of electrical contact strips for an electrical connector as another embodiment of this invention;

FIGURE 5 is a top view of a multiple contact electrical connector comprising a plurality of the contacts shown in FIG. 4 in combination with contacts of the embodiment shown in FIG. 1;

FIGURES 6 and 7 are further embodiments of the contacts for an electrical connector of this invention;

FIGURE 8 is a partial view of an assembly of stacked printed circuit panels incorporating in part an electrical connector embodiment of this invention;

FIG. 9 is a top view of a contact strip group;

FIG. 10 is a side view of a laminate of a contact strip insulation, and adhesive;

FIG. 11 is a perspective view illustrating structure for forming end lengths of contact strips;

FIG. 12 is an end view of the invention illustrated in FIG. 11 showing a bending technique for the laminate;

FIG. 13 is an end view of the contact strip of FIG. 1 additionally showing insulation;

FIG. 14 is an end view of the contact strip embodiment illustrated in FIGURES 6 and 7 showing inter-plane connections;

FIG. 15 is an end view of the contact strip embodiment with insulation illustrated in FIG. 13 showing inter-plane connections;

FIG. 16 is an end view of the contact strip embodiment illustrated in FIG. 4 additionally showing insulation, adhesive, and inter-plane connections;

FIG. 17 is an end view in section taken along line 17—17 in FIG. 16.

Before describing in detail the various embodiments of this invention as shown in the figures it is important to note that in general all of the figures are enlarged views. Although not limited thereto, this invention is most advantageously used, as previously stated, in combination with miniaturized and micro-miniaturized circuitry. To set the proper perspective in viewing the various figures it should be pointed out that as a typical example in connectors fabricated according to the teachings of this invention the electrical contact strips are made of beryllium-copper alloy ranging in the order of .004 to .008 inch thickness, the insulating sheets are of polyethylene terephthalate in the order of .001 inch thick and the adhesive film is of substantially less than one-half the thickness of the insulating sheets. In a typical example connectors of approximately $1\frac{1}{2}$ inch length containing 48 contact strips having 96 contacts and an overall height and width in the range of $\frac{3}{16}$ inch have been fabricated.

Referring now to FIG. 1 there are shown two electrical contact strips, 10 and 12 respectively, each having a general U shape over a predetermined length and having arcuate extensions from the arms of the U-shaped portion forming resilient electrical contacts such as 14 and 16. The two contact strips 10 and 12 are identical except that one is turned 180° with respect to the other so that the arcuately extending resilient contact 16 from one arm of the U portion of contact strip 10 extends inwardly into the U portion while the arcuately extending resilient contact 14 from the other arm of the U portion of strip 10 extends outwardly from the U portion. Contact strip 12 has resilient contacts 15 and 17 wherein contact 15 extends inwardly and contact 17 extends outwardly of the U portion. Although no in accordance with the orientation shown in FIG. 1, hereafter in the specification and the claims the base of the U-shaped portion will be considered and referred to as the bottom or downward direction and the arms of the U-shaped portion will be referred to as the arms or sides. The two contact strips are laterally displaced from one another with their U-shaped portions aligned to form a channel the length of which extends transversely to the length of the contact strips. As shown in FIGS. 13 and 15 the contact strips may be affixed to a sheet of insulating material which covers the outside surface of the U-shaped length and which further may be extended to cover the inside surface, the non-contacting surface, of the resilient contact. Additionally, in FIGS. 13 and 15, it is within the contemplation of the instant invention that a further insulation sheet covering the inside surface of the channel and the non-contacting surface of the resilient contacts may be included. As will subsequently be described in greater detail during the description of the process for fabricating the connectors, the strip contacts 10 and 12 may be on separate layers and affixed to one another with a film of adhesive. It should be noted that the adhesive film would be so thin that for all practical purposes the bottoms and side arms of the U-shaped lengths would lie in the same respective planes.

In FIG. 2 there is shown a plurality of the contact strips of FIG. 1 arranged to form a multiple contact connector. FIG. 2 is a top view of the connector, that is a view looking down into the channel formed by the U-shaped portions of the contact strips. The drawing of FIG. 2 is primarily intended to show the arrangement of the contact strips in one embodiment of this invention. Two layers of sheets of insulating material, 18 and 19, are indicated along the sidewalls of the channel. The insulating layers serve to provide elastic rigidity to the connector as well as protective and insulative features. In the embodiment shown in FIG. 2, along one sidewall of the channel starting at the upper left-hand of the fig-

ure it can be seen that the first resilient contact, 16, extends into the channel and the next adjacent contact 17 extends outwardly from the channel and the remaining successive contacts alternately extend in these respective directions. Along the opposite side wall of the channel, toward the bottom of the figure, each of the contact strips has a resilient contact on the end thereof which is an arcuate extension of the contact strip extending oppositely to that of the resilient contact along the first mentioned side wall. In other words, the contact strip having the resilient contact 16 on its one end along the one side wall has a corresponding resilient contact 14 extending outwardly from the channel along the opposite side wall of the channel and the contact strip having the outwardly extending resilient contact 17 on the one side wall has an inwardly extending resilient contact 15 along the opposite side wall. It can be seen then that along each of the side walls the arcuate extensions from the respective contact strips alternately extend inwardly and outwardly from the channel. With the edge portion of a printed circuit panel inserted into the channel, it can be seen that the inward directed resilient contacts alternately would be in pressure contact with printed circuitry on opposite sides of the printed circuit panel.

FIG. 3 shows the advantageous effect of the crimped contour along the contacting surface of the resilient contact. The dashed line indicates the relative placement of the contacting surface of the printed circuit panel which positions the resilient contact in the compressed condition as shown. From the figure it can be seen that pressure contact is made with the printed circuit panel circuitry at at least two points, as indicated at 28 and 30, to insure a reliable electrical connection.

FIG. 4 shows a pair of contact strips as another embodiment of this invention and FIG. 5 shows the strips of the FIG. 4 type embodied into a multiple contact connector arranged in combination with the type shown in FIG. 1. The two contact strips, respectively 32 and 34, are formed and arranged in a cross-over relationship. The U-shaped length of each of the contact strips has a jog in it so that the arms thereof are laterally displaced from one another. Further, each contact strip is shown to have two resilient contacts as in FIG. 1 with one being an inward extending arcuate extension and the other an outward extending arcuate extension. It should be recognized, however, that no limitation thereto is intended since both of the arcuate extensions on a given contact strip in the arrangement shown in FIG. 4 can be inward or outward extensions. The inner and outer sheets of insulating material which are preferably incorporated into the connector, as previously described with reference to FIGS. 1 and 2, are shown in FIGURE 16. Since the contact strips of the embodiment shown in FIG. 4 cross over one another, obviously they cannot be initially etched from one sheet of conductive material and they must be insulated from one another by insulation as shown in FIG. 16. As shown in FIG. 17, the insulation 37, 39, 41, may be provided by a thin layer of adhesive 40 which has insulation properties and which serves the dual purpose of affixing the contact strips in aligned relationship. A sheet of insulating material 37 similar to that previously described could also be used to insulate the contact strips from one another. The latter would further serve to provide elastic rigidity to the connector.

FIG. 5 is a view of the connector looking down into the channel similar to the view of FIG. 2 and shows pairs of connectors at 32 and 34 which are arranged according to the embodiment shown in FIG. 4 and a further pair of connector strips 10 and 12 arranged in the manner as shown in FIG. 1. Similar to FIG. 4, FIG. 5 does not show an insulating layer between the crossed-over contact strips but it should be understood that this would be included as illustrated in FIG. 17. The connector embodiment shown in FIG. 5 does include the inner and outer sheets of insulating material, 41 and 39 respectively.

Obviously, from the foregoing it can be seen that a wide variety of patterns of arrangement of connector strips can be incorporated into a single connector in accordance with any desired pattern of interconnections. For example, connector strips having both resilient contacts 36 extending inwardly as in FIG. 6 or both contacts 38 extending outwardly as in FIG. 7 can be incorporated into a connector in combination with any or all of the previously described connector strip arrangements.

FIG. 8 illustrates a typical embodiment of a further aspect of the instant invention. The figure shows three printed circuit panels 40, 42, and 44 stacked one on top of the other and can be considered as representing planar arrays of magnetic thin films, such as 46, with only one row of thin films shown for each of the arrays for purposes of clarity. There is further shown a printed circuit electrical conductor, such as 48, on each of the printed circuit panels passing over all of the thin film elements on the respective panels. It should be recognized that in general there would be a greater number of printed circuit panels each of which contain a large number of circuits and printed circuit conductors on both sides of the panel in a great variety of arrangements. It is felt that the simplified FIG. 8 is sufficient to illustrate all of the possibilities considered within the scope of the teachings of the instant invention. Also, for clarity, only two connector pairs 10 and 12, each pair incorporating only a pair of strip contacts of the type shown in FIG. 1 are shown. All of the possible extensions should be obvious. Each of the connectors are coupled to opposite edges of adjacent printed circuit panels with one edge of panel 42 inserted in the channel of connectors 10 and 12 and the opposite edge of printed circuit panel 44 inserted into the channel of connectors 10 and 12. Following the electrical circuit path of conductor 48 on the top surface of the lower-most printed circuit panel 40, this is serially connected through contact strip 10 to the corresponding conductor on the top surface of the next adjacent printed circuit panel 42 and is further serially connected to the corresponding conductor on the top surface of panel 44 through contact strip 10. In a similar manner the other contact strip of each of the connectors completes the electrical interconnection between conductors on the bottom surfaces of adjacent printed circuit panels. From the foregoing it can be seen that other contact strip arrangements, for example those shown in FIGS. 4-7 but not limited thereto, can be incorporated into a connector under the teachings of this invention and substituted for those arrangements shown in FIG. 8 to result in a variety of different patterns of interconnections of the printed circuit panels.

FIGS. 9-13 illustrate some of the steps in the process of fabricating connectors previously described. FIG. 9 shows a group of contact strips 62 after they have been formed from a sheet of suitable conducting material such as beryllium-copper alloy ranging, for example, in the order of .004 to .008 inch thick. The two joining strips 63 along the ends of the contact strips serve to maintain the alignment of the contact strips until they have been affixed in desired alignment to one another. The contact strips as shown in FIG. 9 can be formed in any manner, for example by etching processes which are well known in the printed circuit art. The particular process for forming the contacts initially in the shape as shown in FIG. 9 is a matter of choice and does not constitute a part of this invention. All of the contact strips are of equal length, parallel to one another and laterally displaced from one another. In the process of fabricating a connector incorporating a combination of different configurations of contact strips, as for example those shown in FIG. 5, it is necessary to initially etch out different sets of contact strips corresponding to the various types of configuration to be incorporated into the connector. It is further within contemplation of this invention that two layers of contact strips can be initially formed and aligned relative to

one another to achieve the layout shown in FIG. 9. The latter would afford the possibility of a larger number of contacts over a given length of connector since the two layers of contact strips would, during the course of the fabrication process, be insulated from one another and therefore overlap of the contact strips would be possible. It is apparent, of course, that for fabricating a connector incorporating crossed-over strips, such as those shown in FIG. 4, two layers of strips must be aligned to one another with insulation therebetween.

A further step in the fabrication process is illustrated in FIG. 10 which shows the contact strips 62 previously formed in the step illustrated in FIG. 9, sandwiched between two sheets of insulating material, 60, such as polyethylene terephthalate in the order of .001 inch thick which is more commonly known by the trademarked name Mylar. Adhesive, indicated at 64, is applied to the facing surfaces of the insulating sheets prior to sandwiching the contact strips therebetween. It should be recognized that since the adhesive material is applied in such a very thin layer, for example substantially less than one-half the thickness of the insulating sheets, that for all practical purposes the sandwich arrangement of FIG. 10 is only a three layer arrangement. The adhesive film is shown as a layer to indicate its presence and to indicate that it is preferably applied to extend only over a centrally located predetermined length of the contact strips. By any well-known means, such as a press, pressure is applied to the layers of insulating sheets for a period of time to allow the adhesive to set properly to form a laminate of the three layers with the laminate extending over the said predetermined length of the contact strips. This leaves the ends of the contact strips free so as to facilitate formation of these ends into resilient contact members as will be subsequently described as a further step of the process. Obviously if the adhesive were to extend beyond the preferred length no major difficulty would be encountered in the subsequent step of formation of the ends of the contact strips. With the contact strips positionally fixed between the two sheets of insulating material the joining strips can now be removed which is done by a cutting operation along the dashed lines.

It should be pointed out at this juncture that in fabricating a connector comprising a combination of configurations of contact strips, two layers of contact strips properly aligned according to the desired pattern would be required. This would appear in an end view, similar to that of FIG. 10, as showing five layers instead of the three shown with the additional two layers being a second set of contact strips laying between the sheets of insulating material and a third layer of insulating material between the two sets of contact strips. This third layer of insulating material can, of course, be a film of adhesive having insulating properties. A further variation of the step in the process illustrated by FIG. 10 is the possibility of using only a single sheet of insulating material to which is affixed the contact strips of the pattern shown in FIG. 9. Still another possible variation within contemplation of the invention is the use of two layers of contact strips with a single sheet of insulating material therebetween to which the layers of contact strips are affixed. The foregoing listed possible variations are only intended to be illustrative and not limitative since it is within the contemplation that other variations are possible under the teachings of this invention.

FIGS. 11 and 12 illustrate steps in the process of forming the end lengths of the contact strips into resilient electrical contacts which are arcuate extensions of the lengths which had been previously bonded together. This step and others in the process are generally illustrated in the figures by sketches of some of the fixtures and tools which may be utilized in the process. The fixture used as illustrated in FIGS. 11 and 12 comprises a base plate, 66 preferably of hardened steel having a series of grooves or slots, 68, machined on a surface in the same pattern layout as

the contact strips are in the laminar, as shown in FIG. 8. Since this illustrative step in the process is being described for the fabrication of a connector the form of FIG. 2, the machined pattern on the surface of the base plate is intended to be illustrative and not limitative. The pattern will, of course, vary according to the desired pattern of the final connector. Extending for a length between the dashed lines indicated at 70 which corresponds to the predetermined length of the contact strips previously bonded as described above, there is a slot provided for each of the contact strips. However, it should be noted that none of the slots extend for the full length of the contact strips. The hole and the studs in the base 66 are merely for indexing the parts of the fixture.

The fixture further includes an elongated forming bar, 72, shown in cross-section, which has a generally horizontal bottom surface indicated at 74 of width corresponding to that indicated at 70. Two further surfaces, indicated at 76 and 78, are inclined with respect to the horizontal. A pair of elongated wedge-shaped holding blocks, 80 and 82 in the cross-sectioned end view FIG. 12, are further included in the fixture. The latter each have an inclined surface, indicated at 84 and 86, respectively corresponding to 76 and 78 of the forming bar 72.

The laminar, illustrated in FIG. 10, is laid on the machined surface of the base plate member 66 with the contact strips oriented to lie in their corresponding slots in said base plate. It should be noted that extending out from the contact lengths indicated at 70, only alternate end-lengths of the contact strips are aligned with a corresponding slot on the surface of the base plate. The forming bar 72 is brought down with its horizontal surface 74 bearing on the laminar to apply pressure thereto over the dimension indicated at 70. It can be seen that as a result of this the end-lengths of the contact strips which are not aligned with slots in the base plate will be subjected to pressure that will cause them to bend upward toward the inclined surfaces 76 and 78 of the forming bar while those end-lengths which are aligned with slots will remain substantially horizontal. This is indicated in FIG. 12 which shows an end-length, 88, of one contact strip extending upwardly to the right and another end-length, 90, of another contact strip extending upwardly to the left. The opposite end-lengths of those shown remain straight. Obviously, as indicated in FIG. 12, the insulating sheets, such as 92, will bend in a similar fashion.

Although at this juncture of the process, the end-lengths can be subject to further bending to form them into the resilient contacts, it has been found preferable to bond the end-lengths of the contact strips to the insulating sheets to provide further dimensional stability. This is done by raising the forming bar 72 sufficiently to allow insertion of the wedge-shaped blocks, 80 and 82, into position as indicated in FIG. 12. The contact strip end-lengths which had been previously raised and a portion of one sheet of insulation lie on the inclined surfaces, 84 and 86, of the wedge-shaped blocks while the unraised end-lengths and a portion of another sheet of insulation lie underneath the blocks in the substantially horizontal position as indicated in FIG. 12. The forming bar 72 is again lowered and clamped in a pressure bearing position and the entire assembly is then subjected to temperature for a period of time for curing purposes and to bond the end-lengths of the contact strips to the sheets of insulating material. Any excess contact strip lengths can now be removed.

Upon termination of the foregoing step the partially formed connector is then removed from the fixture and is placed in a further forming fixture, not shown, and the end-lengths are bent back on the respectively corresponding contact strips in the desired pattern. In the instant illustration, the raised end-lengths are bent back upwardly from the horizontal plane of the figures and the end-lengths which had remained in a horizontal posi-

tion are bent back downwardly from the horizontal, thereby providing the arcuately extending resilient contacts in the pattern as illustrated in FIG. 2.

FIG. 13 is an end view of a connector, fabricated according to the teachings of this invention, in its final form. The U-shaped portion defining a channel for receiving at least the edge portion of a printed circuit panel can be formed by any well-known operation such as by pressing the laminar into a forming jig. The particular connector illustrated in FIG. 13 is one in which along each side wall of the channel formed by the U-shaped portions, successive arcuately extending resilient contact members alternately extend inwardly to and outwardly from the channel in a downward direction. Each of the contact strips has one end-length extending outwardly from the channel and the other end-length extending inwardly to the channel in the manner as taught by the instant invention. The arrangement shown in FIG. 13 includes the two layers of insulating material 60 but, as previously stated, no limitation thereto is intended. Because of their relative thinness, the sheets of insulating material are formed concurrently with the formation of the contact strips into the desired pattern and further serve to provide resilient rigidity to the connector which maintains dimensional stability. The bump 94 on the resilient contact which provides the reliable contacting feature described with relation to FIG. 3, can be achieved by any crimping operation which preferably is done concurrently with the bending back step previously described.

Although the steps in the process have been described in the preferable sequential order, it should be understood that no limitation thereto is intended since the sequence is a matter of choice. For example, it is possible that the step illustrated by the final form illustration of FIG. 13 of forming the channel of a general U-shaped cross section can be effected prior to forming of the resilient contact members as illustrated in FIGS. 11 and 12. Further, it is contemplated that the individual contacts can be formed prior to affixing them to an insulating sheet or they can be partially formed, that is, the resilient contact portions can be formed and then affixed to the insulating sheet and then formed into the channel. Again it is understood that these suggested variations in the sequence of steps are only intended to be illustrative and not limitative and it is within contemplation of the instant invention that the process can be done in any desired sequence under the teachings of this invention according to optimum manufacturing techniques and know-how.

It is understood that suitable modifications may be made in the structure as disclosed provided such modifications come within the spirit and scope of the appended claims. Having now, therefore, fully illustrated and described my invention, what I claim to be new and desire to protect by Letters Patent is:

1. An electrical connector, comprising: insulating means forming a longitudinally extending groove; a plurality of strip contact members each having a generally U-shaped portion, the U-shaped portions insulatively mounted transversely within the groove with the upwardly extending arms of the U portion of each of the strip contact members laterally displaced from one another along the side walls of the groove said plurality of members forming a plurality of rows along both sides of the U; each of said strip contact members further including arcuate extensions from the ends of the arms of the U-shaped portions forming resilient electrical contacts; some of said extensions extending downwardly and inwardly into the groove and other of said extensions extending downwardly and outwardly from the groove, said arcuate extensions containing a raised portion.

2. An electrical connector as in claim 1 wherein the respective arms of the U-shaped portion of each of the strip contact members face each other across the groove.

3. An electrical connector as in claim 1 wherein the respective arms of the U-shaped portion of some of the

strip contact members are laterally displaced from one another on opposite walls of the groove.

4. An electrical connector for making electrical connection between at least two printed circuit panels, comprising: insulating material formed in a general U shape to provide a channel for receiving a first printed circuit panel; a plurality of electrically conductive strip contact members laterally displaced along the channel, each of said contact members having a general U-shaped portion integrally formed with said insulating material and arcuate extensions from each end of the U-shaped portion forming resilient electrical contacts, one of said extensions extending downwardly and inwardly in the channel for making electrical contact with a circuit strip on said first printed circuit panel and the other extension extending downwardly and outwardly from the channel for making electrical contact with a circuit strip on a further printed circuit panel; said plurality of members forming a plurality of rows along both sides of the U.

5. An electrical connector as in claim 4 wherein said contact members are disposed in the channel such that there are inward and outward extensions on both side walls of the channel.

6. An electrical connector as in claim 5 wherein the strip contact members having inward extensions along one side wall of the channel have corresponding outward extensions along the other side wall of the channel.

7. An electrical connector as in claim 5 wherein along each side wall of the channel successive extensions are alternately inwardly and outwardly extending.

8. An electrical connector for making electrical interconnections for a group of at least three printed circuit panels, comprising: a plurality of strip contact members each having a general U-shaped portion insulatively mounted in spaced apart relationship with the U-shaped portions substantially aligned to form a channel for receiving an edge of the center one of three printed circuit panels, said plurality of members forming a plurality of rows along both sides of the U, each of said strip contact members having arcuate extensions from each end of the U-shaped portion forming resilient electrical contacts, one of the extensions of each strip contact member extending downwardly and inwardly into the channel and the other extension of each strip contact member extending downwardly and outwardly from the channel; said strip contact members further disposed with respect to the channel to effect electrical connection of circuit strips on one surface of the center printed circuit panel with circuit strips on the corresponding surface of a second printed circuit panel and to effect electrical connection of circuit strips on the other surface of the center panel with circuit strips on the corresponding surface of a third printed circuit panel.

9. For an electrical connector: a strip contact of electrically conductive material, a portion of said contact formed into a U-shaped configuration; an arcuate extension portion extending from each of the ends of the arms of the U, one of said extensions extending inwardly and the other extending outwardly with respect to the U, each of said arcuate extensions containing a raised portion along the length thereof, said extensions forming resilient electrical contacts.

10. A connector comprising:

(A) a plurality of mutually insulated electrically conductive contact strips, each strip forming a U-shaped base and arm configuration, each of said arms including an arcuate extension terminal portion, one of said extensions on each arm extending inwardly and the other extending outwardly with respect to the U, and each of said arcuate extensions containing a raised portion along the length thereof, said extensions forming electrical contacts.

11. A connector comprising:

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(A) a plurality of mutually insulated electrically conductive contact strips, each strip forming a U-shaped base and arm configuration, each of said arms including an arcuate extension terminal portion forming an electrical contact, one of said extensions on each arm extending inwardly and the other extending outwardly with respect to the U, and said connector including contact strips wherein the arms of each individual strip are laterally displaced from each other along the connector and including contact strips wherein the arms face each other across the U.

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