

[54] **RIBBON CABLE CONNECTOR SYSTEM
HAVING FEED THRU CONNECTOR**

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M

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R, 210 M, 262 R

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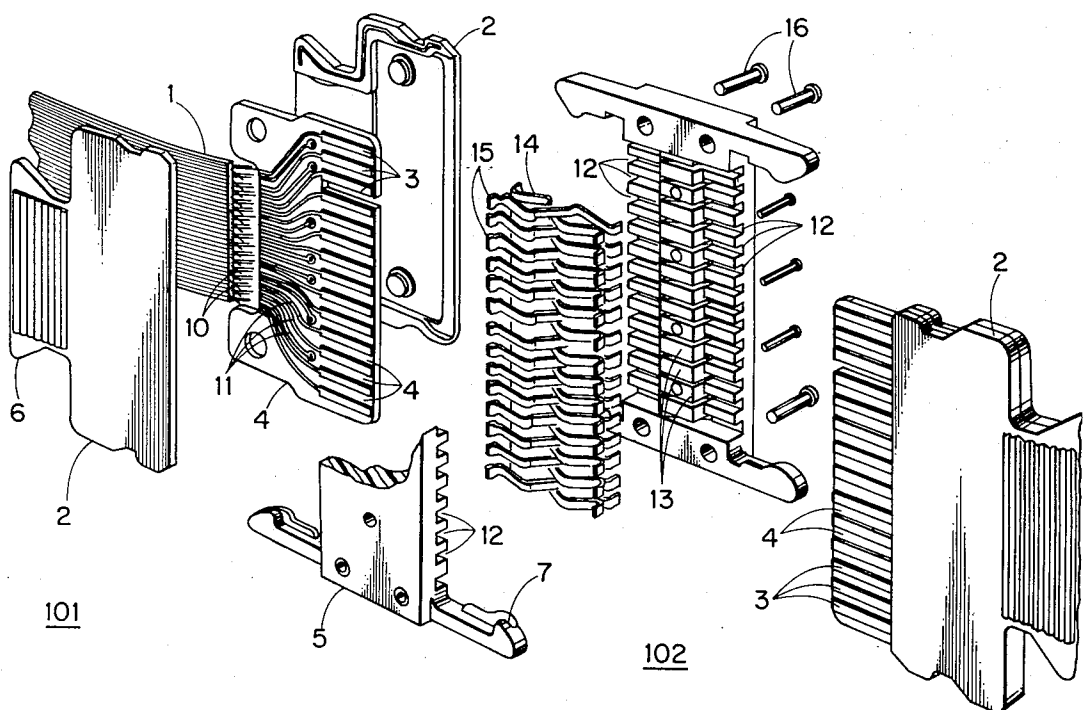
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[57] **ABSTRACT**

An improved ribbon cable connector system for accurate and reliable connection of flat multiconductor electrical ribbon cable to other electrical components or subsystems. A plurality of flat conductive fingers embedded in a non-conductive medium are connected one each to a wire of the flat multi-conductor ribbon cable and encapsulated in a protective case which grips the ribbon cable so as to minimize stresses on the electrical connections. A female edge type connector having a plurality of receptacles along two edges, is adapted to receive a plurality of flat conductive fingers and electrically reverse the position of the wires it connects.

7 Claims, 4 Drawing Figures



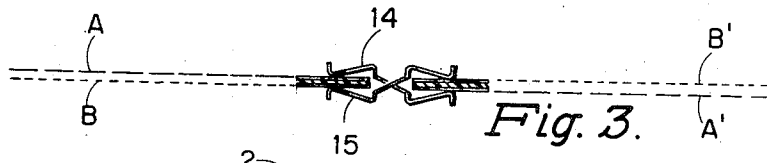


Fig. 3.

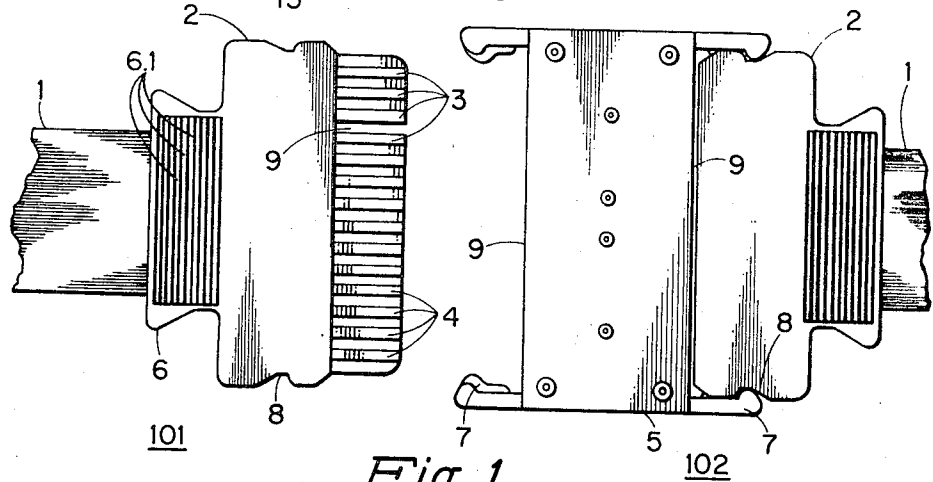


Fig. 1.

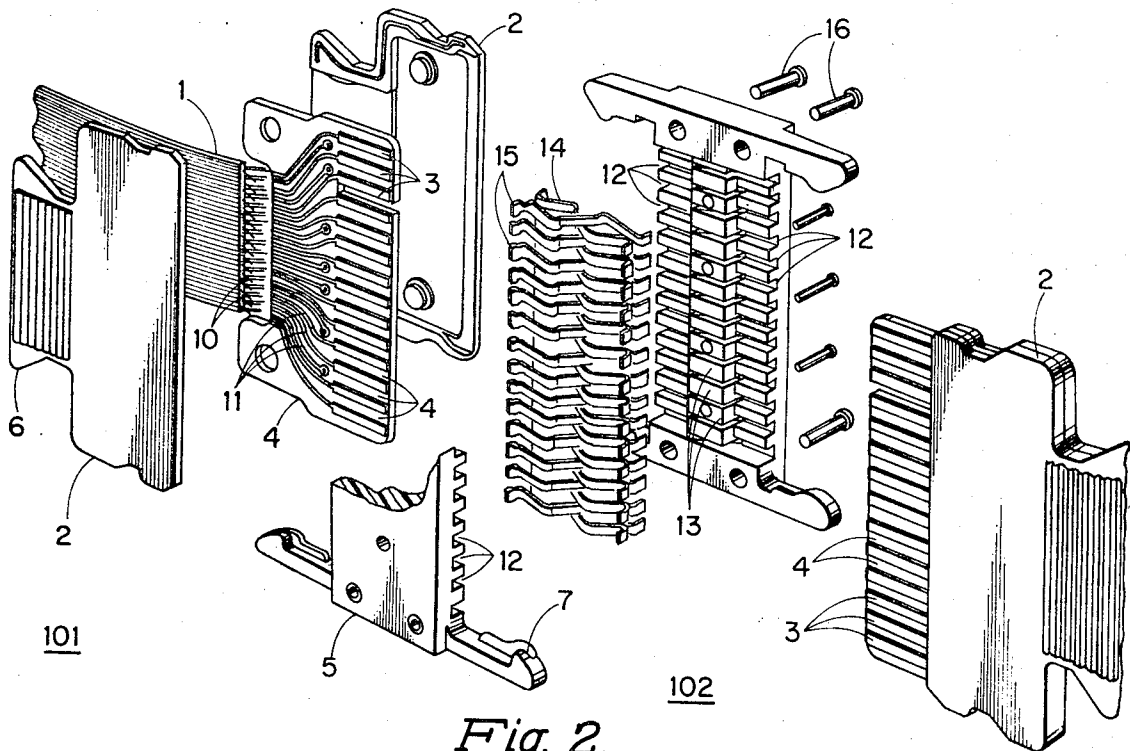


Fig. 2.

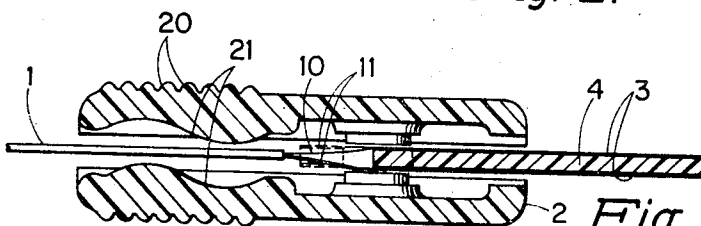


Fig. 4.

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RIBBON CABLE CONNECTOR SYSTEM HAVING FEED THRU CONNECTOR

BACKGROUND OF THE INVENTION

1. Field of the Invention:

This invention relates generally to electrical connectors, and more particularly to connectors designed for use with flexible flat multiconductor cable having embedded therein a plurality of thin electrical conductors.

2. Description of the Prior Art:

Flexible, flat multiconductor cable comprised of a plurality of thin parallel wires longitudinally embedded in a thin flat belt-like insulating medium has been commercially available for a number of years. Such flat cable is particularly adapted for making economical electrical connections to high density closely arrayed circuit elements as are found in circuit boards and other electrical components of modern day computers. To effect such connections rapidly and economically a number of connectors and connecting systems have been devised. Some typical prior art devices are to be found in the Patents having the following numbers: U.S. Pat. Nos. 3,508,187; 3,307,139; 3,034,091; 3,221,286; 3,319,216; 3,084,302; 3,131,017; 3,159,447; 2,932,810; 3,059,211; 3,407,374; 3,114,587.

Some reasons why flat ribbon cable connector systems have not found more extensive application, and particularly harness applications for interconnecting electrical components and circuits in the computer field, is the requirement for accuracy, consistency, and reliability.

In a present day computer system each electrical termination is identified and its position accurately known. Furthermore, rows of electrical terminals may be spatially stacked vertically one above the other, i.e., the electric terminals of spatially stacked printed circuit boards. Each electric terminal is associated with one wire, and a pair of wires is generally associated with one complete electric circuit — a live wire and a ground wire. For the purposes of this invention the termination of a pair of associated electrical wires available for operatively coupling to other components, sub-components, circuits or other similar terminations will be termed a port. When it is desired to interconnect rapidly one electrical terminal with another, and especially to connect each-to-each a plurality of electrical terminals, flat cable connectors may be effectively used. However, since each electric port may comprise at least two wires it is very important that a wire-to-wire correspondence be maintained for each terminal in the port. With prior art connectors such wire-to-wire correspondence is not always possible. For example, when a flat ribbon cable having two wires embedded one each on opposite surfaces of the cable, is used to connect two printed circuit boards disposed in vertical spatial alignment, the ribbon cable is bent in a U-shape and disposed such that the open ends of the U, face the wires they are to connect so that the wire on the upper surface of the cable forming one leg of the U is connected to the upper wire of the top circuit board. The same wire on the upper surface of the cable however becomes the lower wire embedded on the lower surface of the cable forming the other leg of the U — physically the wire still remains embedded in the insulating medium in the same prior position, but its relative position changes. Hence, with such a prior art connection the

top wire of one port of a top circuit board could become connected to the bottom wire of another port of a bottom circuit board. Wherein a top-wire to top-wire connection is desired, a top-wire to a bottom wire can result.

Still another problem with prior art connectors is one of reliability. Since flat ribbon cable generally is comprised of a plurality of very thin wires embedded in an insulating medium, the wires are fragile and not capable of withstanding even ordinary stresses encountered with other types of electrical connecting systems, especially during the process of pulling the connectors apart.

SUMMARY OF THE INVENTION

Briefly, the invention herein disclosed comprises a ribbon cable connector system for accurate and reliable connection of flat multiconductor electrical ribbon cable to electrical circuits, components or subsystems.

A plurality of flat conductive fingers are embedded on either surface of a flat non-conductive medium, each finger having a portion of its area exposed and accessible for making surface-to-surface contact with other electrical conductors. Each of said fingers are also capable of soldered connection each-to-each with a plurality of thin wires embedded in a flexible ribbon-like electrically non-conductive medium. The combination is encapsulated in an electrically non-conductive housing having a predetermined curved portion for gripping the flexible ribbon cable.

Also provided in the connector system is a female edge-type connector having a plurality of receptacles along two of its edges, and adapted to receive the plurality of flat conductive fingers in registered interlocked engagement so as to electrically unite one or more of said conductors of said cable with other conductors.

The female connector has the terminals of each of its receptacles on either edge in alternate electrical continuity, i.e., the right terminal of one edge coupled to the left terminal of the other edge. Thus, when interconnecting ribbon cable, an electrical connection is effected between a wire on the right face of one cable and a wire on the opposite face of a second cable.

OBJECTS

It is an object, therefore, of the instant invention to obviate the hereinabove mentioned disadvantages.

It is a further object of the invention to provide an improved ribbon cable connector and system.

It is still a further object of the invention to provide an improved low cost, high density ribbon cable connector and system.

Still another object is to provide a ribbon cable connector and system having improved reliability.

Other objects and advantages of the invention will become apparent from the following description of a preferred embodiment of the invention when read in conjunction with the drawings contained herewith.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a pictorial representation of a front elevation of the ribbon cable connector system.

FIG. 2 is an exploded diagram of the invention.

FIG. 3 is a schematic diagram of a portion of the invention.

FIG. 4 is a partially exploded cross-section of a portion of the invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to FIG. 1 a plurality of flat conductive fingers 3 are shown embedded on one surface of a flat non-conductive medium or wafer 4 each finger having one of its surfaces exposed. Similar non-conductive fingers 3 are also embedded on the opposite face of the flat non-conductive medium 4. A non-conductive housing 2 encloses a portion of the embedded electrically conductive fingers 3, the actual joint between the conductive fingers 3 and the plurality of wires of ribbon cable 1 further encloses and firmly grips a portion of ribbon cable 1. A serrated handle 6 with serrations 6.1 thereon provides a means for firmly gripping the unit when extracting it or inserting it in female connector 102. The female connector 102 has a plurality of receptacles along two of its edges 9 and is adapted to receive the plurality of flat conductive fingers 3 in registered interlocked engagement as shown in FIG. 1 on the right side of female connector 102. Notch 8 on the housing 2 of male connector 101 engages a resilient protrusion 7 which locks the male and female connectors together. The locking portion of the resilient protrusion 7 is rounded to permit ease of disengagement when an axial force is applied for separating said female and male connector. A space 9 devoid of any material is left between one pair of adjacent fingers and acts as a key in order that male connector 101 be inserted into the receptacles of female connector 102 having the proper relationship therewith.

Referring now to FIG. 2 details of the ribbon cable connector system are shown in an exploded view. A plurality of flat conductive fingers 3 fashioned from material such as aluminum, copper, gold, or silver which has good electrical conducting properties, are embedded on a portion of either or both surfaces of the wafer of predetermined shape and comprised substantially of a flat, substantially rigid, electrically non-conductive medium 4. It will be understood that the plurality of conducting fingers 3 may also be plated on the flat non-conducting medium 4 by techniques well known in the plated circuit board art and utilized to produce printed circuit boards. The conductive fingers 3 are disposed in parallel rows which extend transversely along the front edge of wafer 4. Each finger on either face of wafer 4 extends in parallel configuration rearward from the front edge to a position roughly midway between the front edge and the rear edge of wafer 4. The electrical path of each finger is continued toward the rear edge of wafer 4 by means of conductive connections 11 which may be plated on the surface of wafer 4. The conductive connections 11 provide not only a continuous electrical path for each finger from the front edge of the rear edge of the wafer but it also provided for compressed transverse dimensions of the electrical path of the fingers as they emerge at the rear edge of the wafer so that there is a one-to-one registration between cable wires and connector paths where the small wires 10 of ribbon cable 1 are permanently joined to the male connector. Electrical connection between the wires 10 and conductive paths 11 is effected by removing a portion of the insulation medium at the terminal end of the ribbon cable to expose a portion of each of the embedded wires and joining one each of the

wires by soldering or other bonding means to one each of the conductive paths on the rear edge of the wafer. A non-conductive housing to protect the joints between wires 10 and conductive interconnections 11 is formed by bringing the two halves of the housing 2 together in correspondence one with the other and bonding the two casings together by compatible bonding techniques such as, for example, a thermal compression welding technique.

The female connector is typically assembled from two non-conductive mouldings or bodies made of plastic or other suitable non-conductive material. Each body 5 has a plurality of electrically isolated recesses 12 on one face of each body 5 extending inward from each edge. Spacer elements 13 provide the correct spaced relationship between bodies to form a receptacle at either end for receiving the male portion of the male connector 101. Inserted in each recess 12 of each body 5 are conductive resilient members 14 and 15. Hence, when the two bodies 5 are brought together in registered alignment and joined by means of bolts 16 or other suitable joining techniques, a female connector 102 is formed having at least two receptacles at opposite edges for receiving the male portion of connector 101, and also having a plurality of open ended channels formed by the recesses 12 terminating on either edge of said female connector 102 and with each open ended channel containing therein a pair of resilient members 14 and 15 extending from edge to edge. It will be noted that resilient members 14 and 15, which may be constructed from any suitable electrically conductive spring material such as beryllium copper each having at either end, toe sections in transverse relation to the longitudinal dimension, intermediate sections at either side of the center section in conjugate inverse lateral displacement relative to each other and a center section are assembled in each recess 12 in the form of an X. Each resilient member 14 and 15 of the X structure is electrically isolated from the other by having the cross-over point at the center section of the X structure, smaller in dimensions than the main body of the X structure and by displacing the center section of each finger 14 or 15 laterally from the longitudinal center. Pairs of resilient members are assembled in each recess so that the center section complements one another in position, i.e., one resilient member 15 has its center section raised relative to the other member 14, thus leaving a space at the cross-over point. (For ease of manufacture of members 14 and 15 both are identical; they differ however in assembly in that one is turned over so that its cross-over point complements in position the cross-over point of the other member.)

When the several components are assembled as shown in FIG. 1, each one of fingers 3 of the male connector will slidably insert between resilient members 14 and 15 at either end. When two male connectors 101 are inserted into either edge of the opening of female connector 102 an edge schematic view would appear as shown in FIG. 3. A and B and also A' and B' represent wires on either face of a ribbon cable. It will be noted that wire A is on a top face whereas wire A' is on a bottom face. When the male connectors are inserted into the female connectors an electrical contact is made between the wires on the respective faces of ribbon cable 1, the wires on the A face of one ribbon cable is connected to the wire in A' face of another ribbon cable. Thus it will be observed that electrical connection is

made between wires on opposite faces of separate ribbon cables. As hereinabove discussed, this feature permits accurate connection of desired terminals within a port particularly when connecting components in spaced parallel vertical alignment. It will of course be understood that said wires may also be in one plane and by bending the ends of each wire sequentially in alternate directions — one up and the next one down, and so on - the same effect is achieved as if the wires were on separate planes as herein discussed.

Referring now to FIG. 4 a plurality of conductive fingers 3 on either surface of a non-conducting wafer 4 are connected each to each by wires 11 to exposed wire portions 10 of conductive wires embedded within a flat ribbon cable 1. A non-conductive housing 2 comprised of a left half and a right half envelops and protects the connections and a portion of ribbon cable 1. Each half of the housing has an envelope section for enclosing the connections and a portion of the wafer with the plurality of embedded wires therein, and an S-curve section 21. When the two halves of the housing are aligned and joined together S-curves 21 interior to the housing fit together in coordinated engagement crimping the ribbon cable 1 to the same configuration and firmly holding it thereinbetween. Any force which is applied in any direction on the ribbon cable 1 external to the housing is absorbed within the configuration of the curve 21 and is not transmitted to the joints of wires 10 and 11.

Having shown and described one embodiment of the invention, those skilled in the art will realize that many variations and modifications can be made to produce the described invention and still be within the spirit and scope of the claimed invention.

I claim:

1. A female multi-contact electrical connection device for interconnecting flat thin multiconductor ribbon cable which is provided with a male edge-type connector adapted to mate in edge-to-edge relation with said female connector device, said female device comprising:

a. a plurality of electrically conductive resilient members, said axis being defined as passing through the center of gravity of the member and extending on either side of the center of gravity in a direction toward either end, each of said ends being in the same plane as its respective longitudinal axis, each end of each of said resilient members being spatially offset transverse to its longitudinal axis in conjugate relationship on either side of and in the same plane with its longitudinal axis whereby each of said members has one of its ends in spatial conjugate and transverse offset relation relative to the other of its ends;

b. and a substantially flat thin electrically non-conductive body having at least two edge-type receptacles adapted to receive in mating edge-to-edge union the male portion of the male edge-type connector when present, said flat thin body also having on its internal surface an array of discrete open-ended channels, each channel adapted to receive pairs of said conductive resilient members in an X-configuration, each pair of resilient members having substantially the same longitudinal axis and each pair lying in the same plane as their longitudinal axis and with each member of each pair lying on opposite sides of each pair's respective longitudinal axis, each pair of said resilient members being

electrically isolated from each other pair, and also each resilient member of each pair being electrically isolated one from the other.

2. A female multicontact electrical connection as recited in claim 1 wherein each of said resilient members has a predetermined shape comprising in electrical continuity a substantially flat center section, substantially flat intermediate sections disposed longitudinally one each on either side of said center section and having larger lateral face dimensions than said center section, said intermediate sections also being transversely and spatially displaced one each on alternate sides of a plane containing the flat face of said center section and in conjugate face-to-face relation one intermediate section with the other, and two sections one each on either end of said intermediate sections in transverse relation to the face of said intermediate section.

3. A female multicontact electrical connection device as recited in claim 2 wherein said center section of each of said resilient members is displaced transversely from the longitudinal center, and wherein said open-ended channels are adapted to receive pairs of said resilient members in an X-configuration with their center section in complementary relation, position-wise, thereby leaving a space at the cross-over point to provide electrical isolation between members.

4. A female multi-contact electrical connection device as recited in claim 3 wherein said toe section of said resilient members are disposed in pairs external to said body beyond the open ends of each of said channels, each pair of toe sections adapted for resilient lateral motion external to said body for receiving therebetween the mating portion of the edge-type connector when slidably inserted thereinbetween.

5. A female multicontact electrical connection device as recited in claim 4 wherein said non-conductive body comprises two mating halves each half including on the internal surfaces thereof an array of discrete open-ended channels each of said channels adapted to receive said conductive resilient members and with each of said halves joined in registered mating alignment, and including spacing means disposed on the internal surfaces thereof for spacing said mating halves at a predetermined distance from each other.

6. A female multi-contact electrical connection device as recited in claim 5 including a resilient electrically non-conductive protrusion on said non-conductive body for operatively engaging a notch on the male edge-type connector when present in operative engagement with said female connection device and locking said female connector to the male connector.

7. An electrical ribbon cable connector system comprising:

A. at least two male connectors each male connector further comprising;

a. a wafer of predetermined shape, each wafer having corresponding faces (1) and (2) and comprised substantially of a flat non-conductive medium;

b. a plurality of flat electrically conductive fingers affixed on faces (1) and (2) of said each wafer, each of said plurality of electrically conductive fingers having three of its surfaces substantially embedded in said non-conductive medium and with its fourth surface substantially exposed, each of said fingers further being disposed on

said each wafer in parallel longitudinal relationship with each other for a portion of their longitudinal dimensions, and for the remainder of their longitudinal dimensions converging toward constricted lateral dimensions in isolated independence one from the other, and including key- means for assuring a predetermined registration of said electrical ribbon cable connector system;

c. a flexible ribbon-cable comprised of a plurality of longitudinally oriented substantially parallel flexible conductive wires embedded in a thin flat belt-like insulating medium having a portion of the insulating medium at the terminal end removed to expose a portion of each of the embedded wires, said exposed wires of said flexible ribbon cable disposed, relative to the constricted end of said conductive fingers affixed to said each wafer, in registered contacting alignment each-to-each and bonded on each-to-each at the contacting points;

d. non-conductive housing means comprised of two mating halves, each half further comprising an envelope section and an S-curve section, said halves of said housing means joined in mating alignment, with the envelope sections enveloping a portion of said wafer, the portion of said wafer and conductive fingers therein not enveloped by said envelope section protruding longitudinally forward of said envelope section, and with said S-curve sections in coordinated engagement with said flat ribbon cable;

B. at least one female connector further comprising;

e. a plurality of electronically conductive resilient members, each member having two ends and a longitudinal axis each of said members being in the same plane as its respective longitudinal axis,

each end of each of said resilient members being spatially offset transverse to its longitudinal axis in conjugate inverse relationship on either side of and in the same plane with its longitudinal axis whereby each of said resilient members has one of its ends in spatial conjugate inverse and transverse offset relation relative to the other of its ends;

f. and a substantially flat thin electrically non-conductive body having at least two edge-type receptacles adapted to receive in mating edge-to-edge union that portion of said wafer, when present, with said electrically conductive fingers affixed thereto, that protrudes beyond said non-conductive housing means, said flat thin body also having on its internal surfaces an array of discrete open-ended channels, each channel adapted to receive pairs of said conductive resilient in an X-configuration, each pair of resilient members having substantially the same longitudinal axis and each pair lying in the same plane as their longitudinal axis and with each member of each pair lying on opposite sides of each pairs respective longitudinal axis, each pair of said resilient members being electrically isolated from each other pair, and also each resilient member of each pair being electrically isolated from the other,

whereby said electrical ribbon cable system, when assembled in operative registration, connects the conductive fingers on face 1 of the wafer of one male connector with the conductive fingers on face 2 of the wafer of the other male connector and vice versa.

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