

Aug. 5, 1969

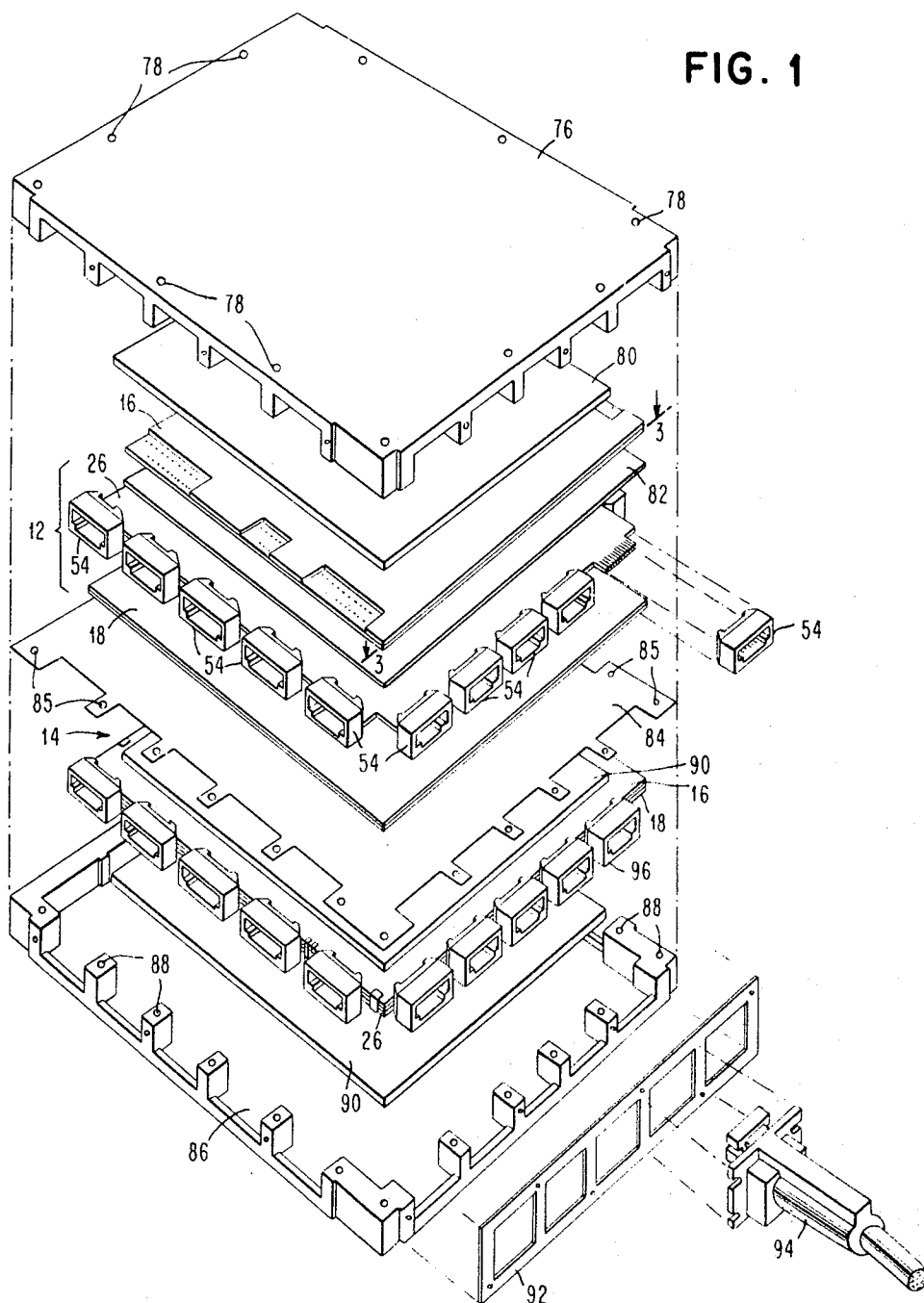
E. C. UBERBACHER ETAL
DIRECTIONAL COUPLER UNIT HAVING A PLURALITY
OF STRIPLINE COUPLERS

3,460,069

Filed Jan. 12, 1968

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FIG. 1



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Aug. 5, 1969

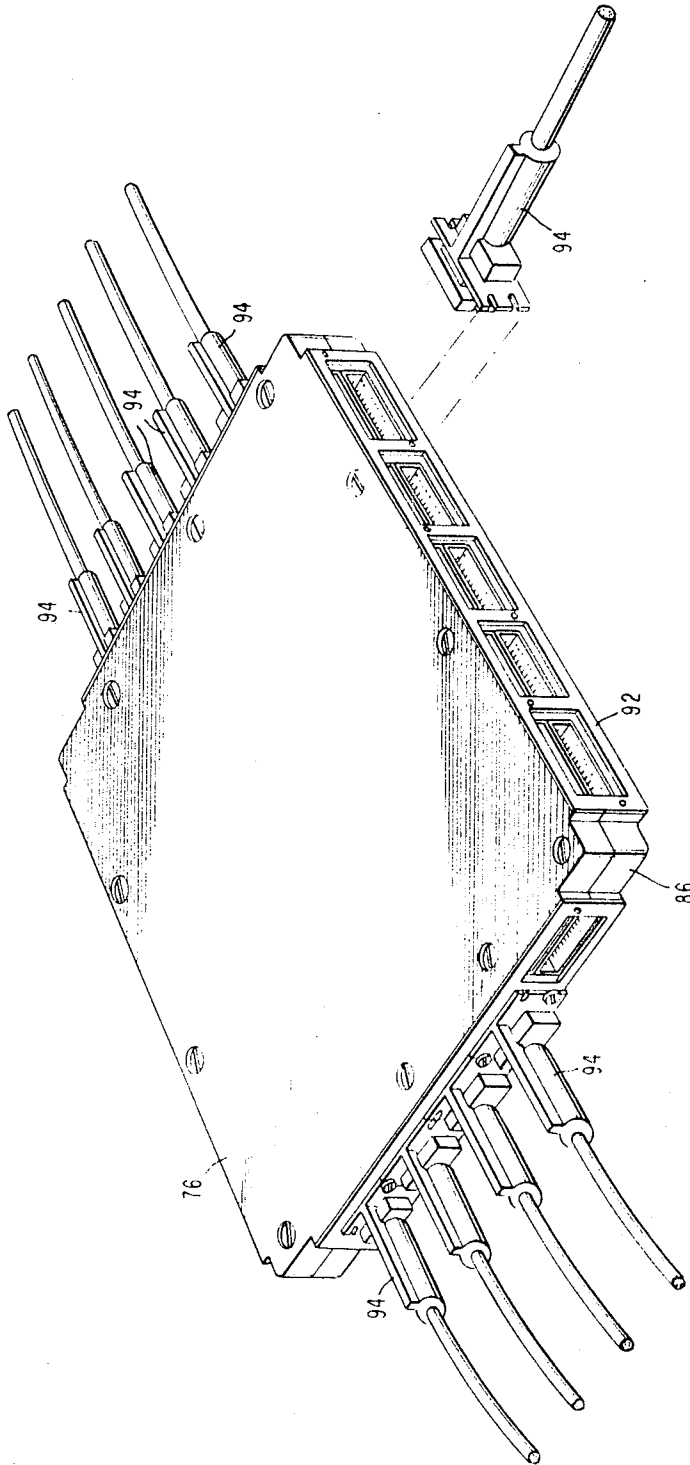
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FIG. 2



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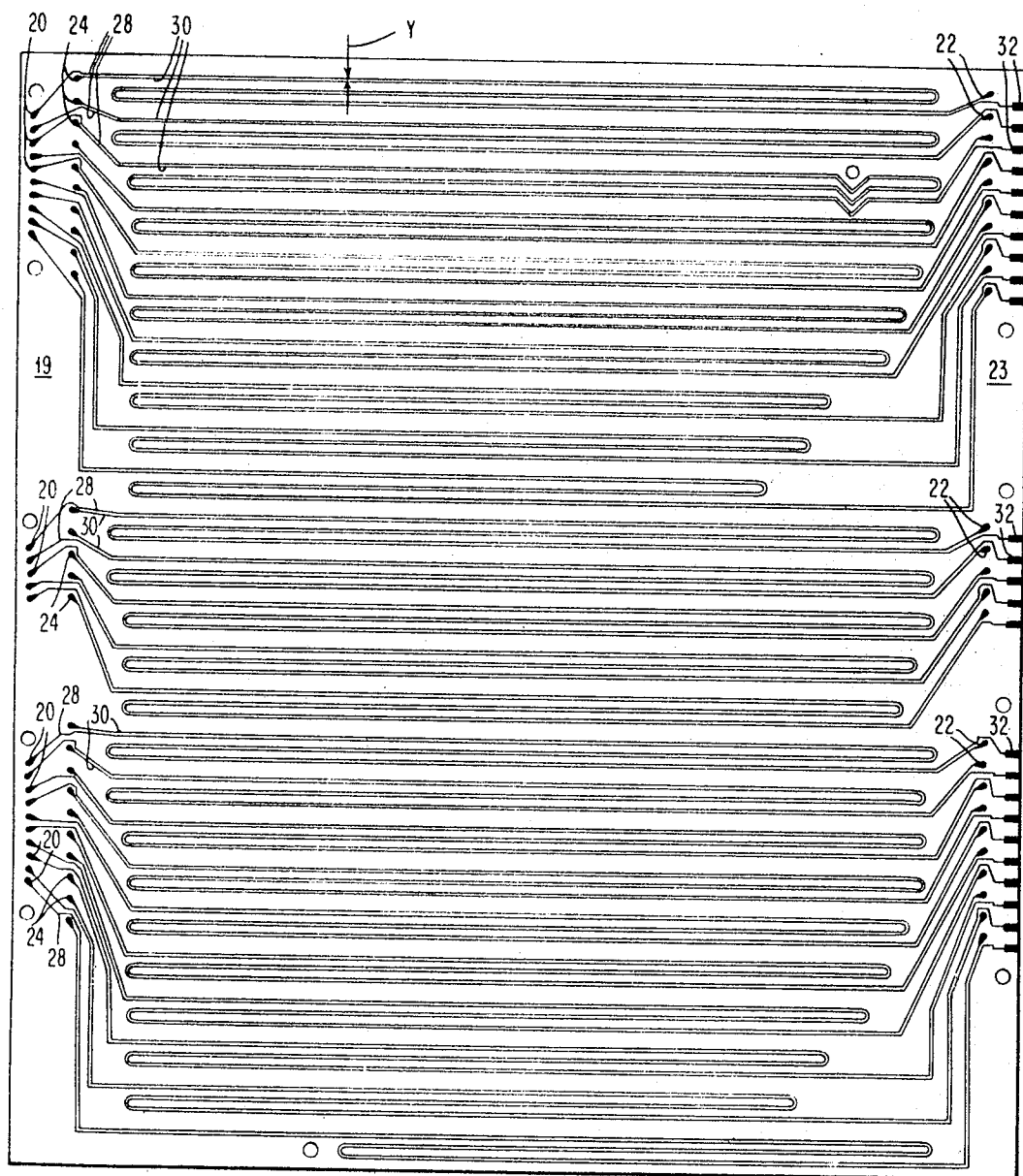
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FIG. 3



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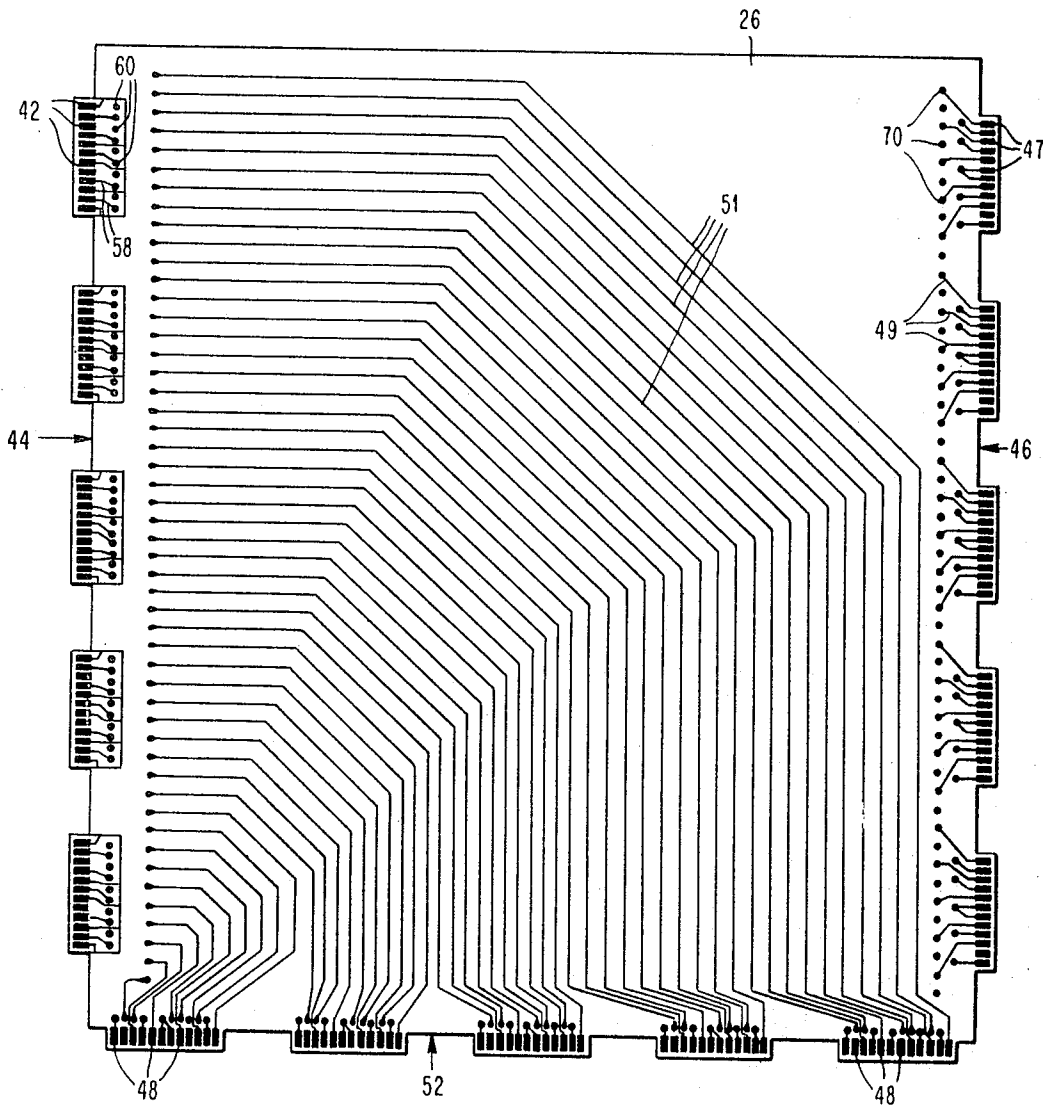
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FIG. 4



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FIG. 5

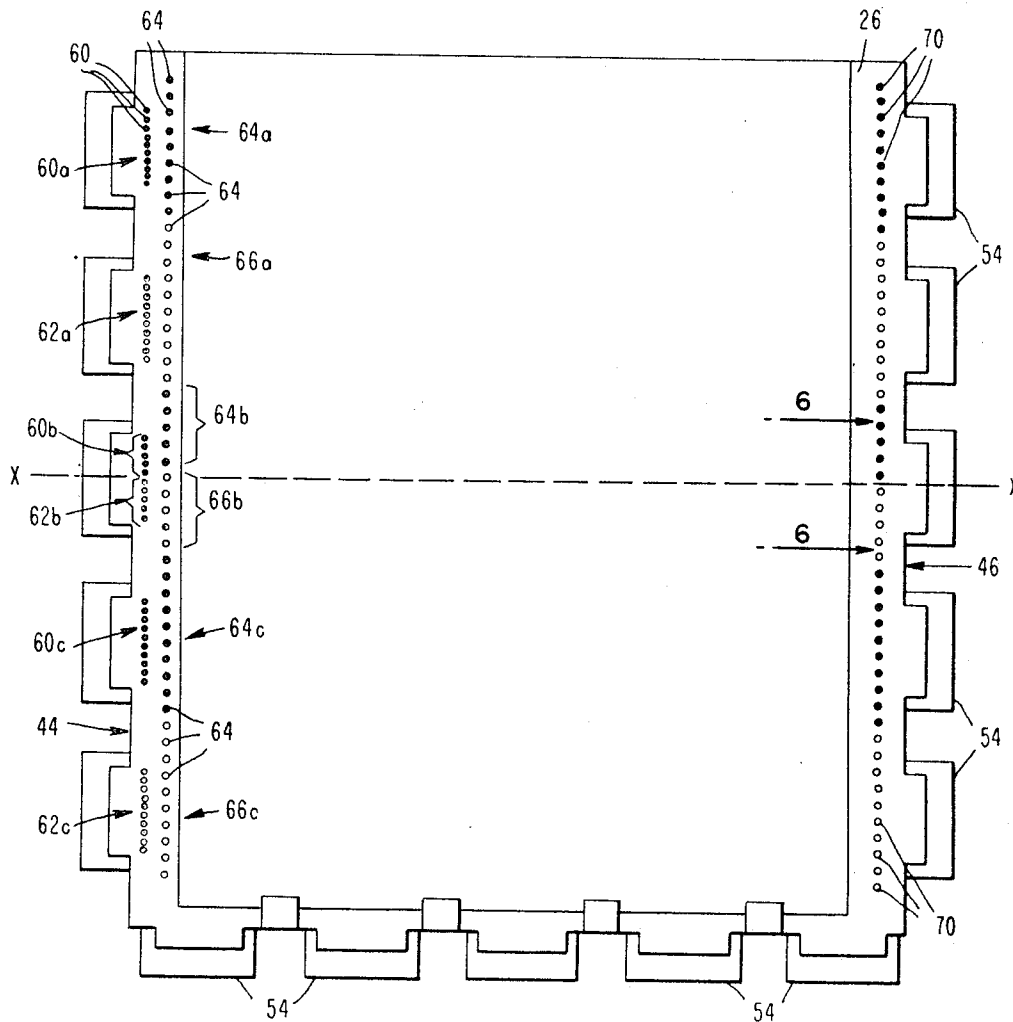
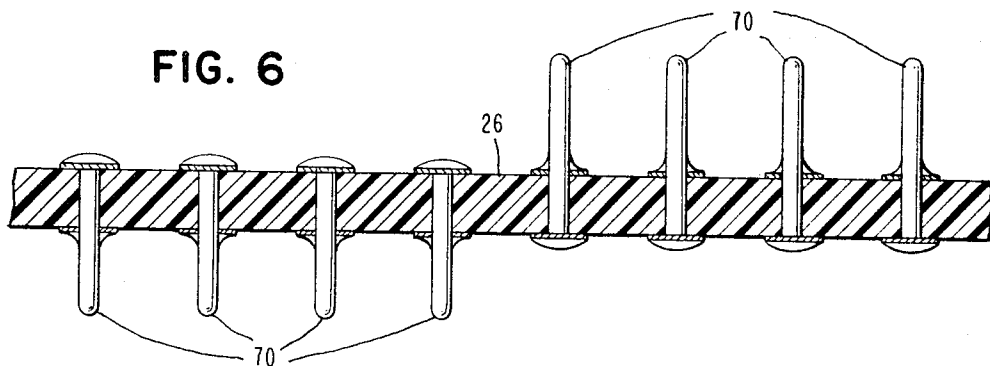


FIG. 6



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DIRECTIONAL COUPLER UNIT HAVING A PLURALITY OF STRIPLINE COUPLERS

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Filed Jan. 12, 1968, Ser. No. 697,380

Int. Cl. H01p 5/14

U.S. Cl. 333—10

10 Claims

ABSTRACT OF THE DISCLOSURE

A multiplex directional coupler unit is provided having three circuit boards which are parallel and in register with one another. The two outside boards contain a plurality of strip-line directional couplers, the circuits of which have a path which winds back and forth between the input and output of the board a predetermined number of times to obtain the circuit coupling length and to also provide a substantially square, relatively small strip-line circuit board in relation to the number of directional couplers provided. The input and output connections for the directional couplers are made to the middle board and the outer boards are connected to the inner board by means of pins which extend from the middle board to the circuits on each outer coupler board.

This invention relates to a directional coupler unit and more particularly, to a multiplex strip-line directional coupler package containing a large number of directional couplers in a small space. The unit is especially adapted for use in computer bussing.

The strip-line directional coupler is a device wherein two parallel adjacent printed circuit strip-lines sandwiched between two ground planes are inductively and capacitively coupled so that the edges of a first pulse, of fast rise and fall time characteristics, propagating along one line, produce a positive pulse and a negative pulse in the other line. The lines are back coupled or directional in that the thus produced pulses propagate along the second line in a direction opposite to the direction in which the first pulse propagates along the first line. Strip-line directional coupler operation and theory has been adequately covered in the literature.

A system for transmitting digital data between a plurality of data processing devices by means of strip-line directional couplers is disclosed in co-pending U.S. application Serial No. 609,083, filed January 13, 1967. The strip-line directional coupler package of the present invention is adapted for use in such a system.

Directional couplers have not been used as a multiplexing tool in the past. The only suggestion in the prior art with respect to packaging of directional couplers is that the package can be made shorter by the serpentine winding of a coupler. However, there is no suggestion as to how a plurality of directional couplers can be economically and compactly packaged.

Accordingly, it is an object of the present invention to provide a multiplex directional coupler package of small dimensions in relation to the number of directional couplers provided therein.

A further object of the present invention is to provide a directional coupler package suitable for use in a digital data transmission system.

Another object of the present invention is to provide a multiplex directional coupler for use in a digital transmission system which is compact and economical to manufacture.

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A multiplex coupling unit is provided for use in a digital data transmission system having three parallel conductor boards in register with one another. The outer boards each contain a plurality of strip-line directional couplers consisting of a main transmission line and a branch transmission line located co-planar and parallel to one another within a predetermined coupling distance. The middle board has input and output connection means located along the edges thereof. A plurality of conductive interconnecting means extend from the middle board to each of the outer boards where they are connected to the ends of the main transmission line and to the non-terminated end of the coupling line, respectively. Further electrical conductive means are connected between each of the conductive interconnecting means and the appropriate input or output connecting means.

A further feature of the invention is the arrangement of the strip-line directional couplers on the coupling boards. The main transmission line and the branch or coupling transmission line run parallel to one another along a continuous path between the input side and the output side of the board a predetermined number of times providing a back and forth winding path. This arrangement of the directional coupler circuitry provides a high density packaging with a minimum of intercoupling between directional couplers for the side of the package.

The foregoing and other objects, features and advantages of the invention will be apparent from the following and more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawings.

FIG. 1 is a schematic exploded view of a multiplex coupler package containing two identical coupler board assemblies.

FIG. 2 is a schematic diagram of the multiplex coupler package of FIG. 1 assembled.

FIG. 3 is a sectional plan view of a coupler board taken along the plane 3—3 on FIG. 1 showing the strip-line circuitry.

FIG. 4 is a plan view of the transition board showing the etched circuitry and the input/output contacts.

FIG. 5 is a schematic plan view of the transition board showing the conductive interconnecting pin layout.

FIG. 6 is a schematic cross sectional view looking along the line 6 of FIG. 5 showing the pin directions.

Referring to FIG. 1, there is shown a multiplex directional coupler package containing two identical coupler board assemblies designated generally as 12 and 14. Each of the coupler board assemblies consists of a three-board arrangement consisting of coupler boards 16 and 18 and a transition board 26 located between the coupler boards 16 and 18. Coupler boards 16 and 18 are strip-line conductor boards which consist generally of two outer ground plane conductors having the strip circuit conductors sandwiched therebetween. The inner conductors are usually applied by a well-known etching technique while the ground planes consist of a very thin sheet or coating of copper applied on each side thereof. The resulting coupler board is very thin. The process for making strip-line coupler boards is well known in the prior art.

The strip-line circuit arrangement forming the directional couplers on coupler boards 16 and 18 is shown in detail on FIG. 3. Along the input side 19 of the coupler board, there are shown a plurality of lands 20 arranged in spaced groups. Likewise, the lands 22 located along the output side 23 of the coupler board are similarly arranged in spaced groups. The spacing of the groups of lands 20, 22 is such that if two coupler boards 16 and 18 are manufactured exactly the same and one of the boards is rotated 180° about the central horizontal axis so that the lands on each board face each other, the groups of lands

along the input and output sides 19, 23 of either board will fit into the spacing between the groups of lands on the other facing board. This allows both boards 16 and 18 to be duplicates for the purpose of manufacture and yet have the lands arranged along the edges so as not to be opposite one another thereby minimizing the possibility of interference. Thus, any connection between a coupler board and the intermediate transition board 26 can be made without interfering with a connection from the other coupler board since each land on any one board is opposite a space on the opposing board. This is true also of the inner groups of lands 24 as shown on the coupler board as well as the terminating resistors 32 along the output side 23 of the coupler board.

The groups of lands 20 along the input side 19 of either coupler board 16, 18 have electrical conductive connections made thereto from the intermediate transition board 26. These lands 20 have connected thereto strip transmission lines 28, respectively which are the main transmission lines of the directional coupler. These lines 28, if followed from the lands 20 on the input side 19 of the coupler boards 16, 18 run along a path which generally traverses or winds on the coupler board from the input side 19 to the output side 23 three times in a continuous line. The number of traverses of the main transmission line depend on the directional coupler length as well as the length of the package. A respective coupler or branch transmission line 30 is connected to each of the lands 24 of the coupler boards 16, 18. This branch transmission line 30 is a strip-line conductor which runs parallel to and at a predetermined small coupling distance Y from the main transmission line 28 of the respective directional coupler. Accordingly, the branch transmission line 30 runs back and forth on the coupler board 16, 18 between the input side 19 and the output side 23 in a similar winding path as the main transmission line 28 thus forming the directional coupler. The windings of the directional coupler are limited in length by the length of the coupler boards 16, 18. Also, the windings are placed as close to one another as possible without introducing unwanted coupling. The winding and the close spacing makes it possible for a large number of directional couplers to be placed within the predetermined dimensions of the coupler package. The branch transmission line 30 is terminated at the output side 23 of the coupler boards 16, 18 in a resistor 32 which has a resistance which provides the branch transmission line 30 with an impedance which matches the characteristic impedance of the main transmission line 28 of the coupler 16, 18. The length of the presently embodied directional coupler path is thirty inches. The length of the directional coupler is determinative of the length of the pulse which is obtained as a result of the coupling. The theory of the coupling which takes place in such a directional coupler is well known and will not be considered further here other than to note that the pulse which is induced in the branch transmission line 30 or in the main transmission line 28 is in the opposite direction of the inducing pulse. Thus, considering a pulse entering the directional coupler at the main transmission line 28 at the input land 20, the pulse induced in the branch transmission line 30 will be traveling in the opposite direction and thus will be flowing out of the land 24 at the input side 19 of the coupler boards 16, 18. The main transmission line 28 has an electrically conductive output 70 shown in FIGS. 5 and 6, connected thereto at the land 22 adjacent to the output side 23 of the coupler boards 16, 18. Thus, the input transmission line comes into the coupler board at land 20 at the input side 19 of the coupler boards 16, 18 and leaves at land 22 at the output side 23 of the coupler board after passing through the respective directional coupler. It will be noted that the back and forth winding paths of the directional couplers have loops thereof which are of different lengths. This is due to the fact that the overall coupling length of each directional coupler is required to be the same to prevent skew of

pulses from different couplers. As can be seen on FIG. 3, the paths of the couplers from lands 24 to the place where they begin their winding path differs in length, which differences in length are compensated for by the differences of length of the winding loops of the respective directional couplers.

The transition board 26 located between the coupler boards 16, 18 provides the input and output connections and wiring for both coupler boards 16, 18. Contacts are arranged along three edges of the transition board. In the embodiment depicted and described herein there are 50 contacts along each of the three edges making a total of 150. Referring to FIG. 4, there are 50 contacts 42 along the input side 44 of the transition board 26 for connecting to each of the main input transmission lines. Across the transition board, at the output side 46 thereof, there are likewise 50 contacts 47 for making connections to further transmission lines leading to subsequent computer units. Fifty more contacts 48 are located along a third side 52 of the transition board 26. These contacts 48 serve as input/output connection means for the branch transmission lines 30 of the directional couplers. In FIG. 1, there is shown an exploded view of one of the socket connectors 54 which are utilized for making connections to the contacts along the edges of the transition boards 16, 18.

The contacts 42 along the input side 44 of the transition board 26 are connected by means of etched circuits 58 to conductive pins 60. As can be seen from FIG. 5, the pins 60 are arranged in groups. Groups 60a, 60b and 60c designate pins extending from the transition board 26 to the upper coupler board 16 while the groups of pins designated 62a, 62b and 62c represent pins extending downwardly from the transition board 26 to the underlying coupler board 18. It will be noted that the group of pins 60b have five pins extending up to the coupler board 16 and the group of pins 62b likewise have five pins extending down to the underlying coupler board 18. Thus, the transition board pin arrangement is non-symmetrical about an axis xx crossing the board between the groups of five pins 60b and 62b. The pin arrangement corresponds to the previously described land arrangement on both the upper and lower coupler board. Each of the pins 60 serve as the conductive connecting means between the main transmission line connected at the input side 44 of the transition board 26 to the main transmission line circuit 28 of the directional couplers on the coupler boards 16 and 18. Similarly, the pins 64 can be considered to be arranged in groups along the input side 44 of transition board 26. The groups of pins 64a, 64b and 64c designate the pins 64 connecting the transition board 26 to the upper coupler board 16 with the groups of pins 66a, 66b and 66c designate the downwardly extending pins 64 from the transition board 26 to the underlying coupler board 18. These pins 64 connect the branch transmission lines 30 of the directional couplers on the coupler boards 16 and 18 to the transition board 26. Along the output side 46 of the transition board 26 there are located 50 output pins 70 which have the identical grouping as the pins 60 and 64. These pins 70 serve as the conductive connecting means between the output land 22 of the main transmission lines 28 of the directional couplers on the coupler boards 16 and 18 to the output side 46 of the transition board 26. As can be seen on FIG. 4, these pins 70 and connected by etched circuits 49 to the output contacts 47 at the output side 46 of the transition board 26. FIG. 6 which is a view of the pins looking in at the section 6 on FIG. 5, shows the pins 70 in detail. The dark circle represents a downward extending pin 70 and the light circle represents an upward extending pin 70.

The input signals from the main transmission lines enter the directional coupler package at the input contacts 42 and are conducted along the etched circuits 58 to the appropriate conducting pins 60 extending either up or down to the appropriate coupler boards 16 and 18,

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respectively. These same signals are transmitted along the main transmission lines 28 of the directional couplers on the respective boards 16 and 18 and are connected back to the transition board 26 by the pins 70 at the output side 46 of the transition board 26. The signals are conducted from the pins 70 to the output contacts by means of the etched circuits 49. The signal which is induced in each branch transmission line 30 by the signal passing through the corresponding directional coupler main transmission line 28 is, as was mentioned previously, induced in the opposite direction. Thus, the signal induced in each branch transmission line 30 is conducted from the coupler boards 16, 18 through the conductive pins 64 which extend therefrom to the input side of the transition board 26. These pins 64 are each connected to an output contact 48 along a third side 52 of the transition board 26 by means of etched circuits 51 shown on FIG. 4. All the input and output connections for the entire coupler package are located on the transition board 26. The coupler boards 16 and 18 contain an equal number of directional couplers, 25 each, which are connected to the transition board by the previously mentioned pins. It will be appreciated, that a unitary three-board structure containing 50 directional couplers, each having a 30-inch length, is provided which contains simplification for economical manufacture and which is of a small compact size.

Referring to FIG. 1, the coupler board assembly 12 is shown having a cover 76 with appropriate screw holes 78 located therein. Below the cover is shown a resilient pad 80 which is located between the cover 76 and the upper most coupler board 16 of the coupler assembly 12. The pad 80 can be made of a resilient material such as foam rubber to provide a shock absorber for the coupler assembly 12. A spacer 82 is shown located between the uppermost coupler board 16 and the transition board 26. This spacer 82 is a non-conductor and provides the insulation between the outer copper conductor of the upper coupler board 16 and the etched circuits on transition board 26. It also provides space for making the ground connections (not shown) to the ground planes of the boards 16 and 18. Below the coupler assembly 12, there is located a gasket 84 having holes 85 therein which correspond with the holes 78 of the upper cover 76. Although not shown, a plate of metal could be located below the gasket 84 and screwed to the cover 76 thereby completing the packaging for the individual coupler assembly 12 which has a watertight feature provided by the gasket 84 and which, by virtue of the metallic cover 76 and metallic plate, is electrically shielded.

In the embodiment depicted in FIG. 1, an identical coupler assembly 14 is shown adapted to be included in a single package with the coupler assembly 12. A metallic cover 86 is shown having screw holes 88 therein which will, when the cover 76 is assembled therewith, be indexed with screw holes 78. A pad 90 of resilient material such as foam rubber is shown located on each side of this coupler assembly. It will be appreciated that the gasket 84 between the upper and lower cover means 76, 86 provides a waterproof seal when the unit is assembled. Likewise, a gasket 92 is provided along the sides of the assembled unit to which connections are to be made. A plug 94 is shown schematically which connects simultaneously to the connectors 54 and 96 of the upper and lower coupler assembly. In the event, that an input or output connector is not to have a connection made thereto during the use of the coupler package, a blank may be attached thereto which covers the opening and presses firmly against the gasket 92 to maintain the waterproof feature of the unit. The exploded view of the multiplex coupler package containing two coupler assemblies depicted in FIG. 1 is shown in assembled form in FIG. 2. This package contains 100 directional couplers, 50 in the upper directional coupler assembly and 50 in the lower. The overall package is approximately one foot long, one foot wide and one and one half inches in height.

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While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and detail may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A multiplex coupling unit comprising a first, second and third conductor board located parallel to and in register with one another;

said first and third boards each containing a plurality of strip-line directional couplers each of which comprise a main transmission line and a branch transmission line located co-planar and parallel to one another within a predetermined coupling distance;

said second board located between said first and third boards and having contact means located along the edges thereof serving as input and output means for said directional couplers on said first and third boards;

a first and second plurality of conductive interconnecting means extending from said second board to lands at the ends of said main transmission lines and one end of said branch transmission lines on said first and third boards, respectively and;

circuit means on said second board connecting each of said conductive interconnecting means to said respective contact means.

2. A multiplex coupling unit according to claim 1, wherein said first and third boards each have an input side and an opposite output side, said plurality of directional couplers having a winding path extending across said boards the same number of times between said input side and output side to obtain the same predetermined length of coupling between the main and branch transmission lines of each directional coupler, the length and number of traverses being determinative of the length and width of the first and third circuit boards.

3. A multiplex coupling unit according to claim 2, wherein said lands are arranged in groups in a straight line parallel to said input and output sides of said first and third boards, the groups being non-symmetrical about an axis perpendicular to and running between said input and output sides at the middle of the board so that said first and third boards are identical for manufacture and when one of said first and third boards is reversed about said axis so that the groups of lands on each of said first and third boards face one another the groups of lands of one board fit into the spaces between groups of lands on the opposing board.

4. A multiplex coupling unit according to claim 1, wherein said first and second plurality of conductive interconnecting means extending from said second board to lands on said first and third boards, respectively, are rigid pins, thereby forming a unified three-board structure.

5. A multiplex coupling unit according to claim 4, wherein said rigid pins are arranged in groups which alternate in direction of extension from the upper and lower surface of the transition board to make perpendicular contact with the spaced groups of lands on the first and third coupler boards, respectively.

6. A multiplex coupling unit according to claim 1, wherein a first cover means is provided comprising a half shell like member defining a shallow U-shaped cavity therein for containing said first, second and third coupler boards, and a flat plate member for attachment at the open end of said half shell member thereby enclosing said first, second and third strip-line conductor boards.

7. A multiplex coupling unit according to claim 6, wherein said cover means is provided with gasket means between said half shell member and said plate member, thereby forming a watertight joint when said members are attached.

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8. A multiplex coupling unit according to claim 7, wherein said cover means has gasketed openings therein opposite the contact means along the edges of said second board, and connecting means located in said gasketed openings adapted to receive connectors therein forming a watertight seal.

9. Apparatus according to claim 6, wherein a second multiplex coupling unit is located parallel to and in register with said multiplex coupling unit, a second cover means comprising a half shell like member defining a shallow U cavity therein for containing said first, second and third boards of said second coupling unit, said first and second cover means adapted for connection at the openings of said U-shaped members.

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10. Apparatus according to claim 9, wherein gaasket means are provided between the openings of said first and second cover members thereby providing a watertight seal when the first and second cover members are attached.

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