# United States Patent

**Harwood**

[15] **3,643,201**

[45] **Feb. 15, 1972**


## [54] IMPEDANCE MATCHING MICROSTRIP CONNECTOR


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[73] Assignee: **AMP Incorporated,** Harrisburg, Pa.



[22] Filed: **Feb. 9, 1970**

[21] Appl. No.: **9,710**

[52] **U.S. Cl.**.....**339/17 R,** 317/101 DH, 333/84 M, 339/14 R, 339/177 R

[51] **Int. Cl.**.....**H01r 17/18,** H05k 1/02

[58] **Field of Search**.....339/17, 18, 75, 143, 176, 14, 339/177, 191, 192; 174/68.5; 333/84 M



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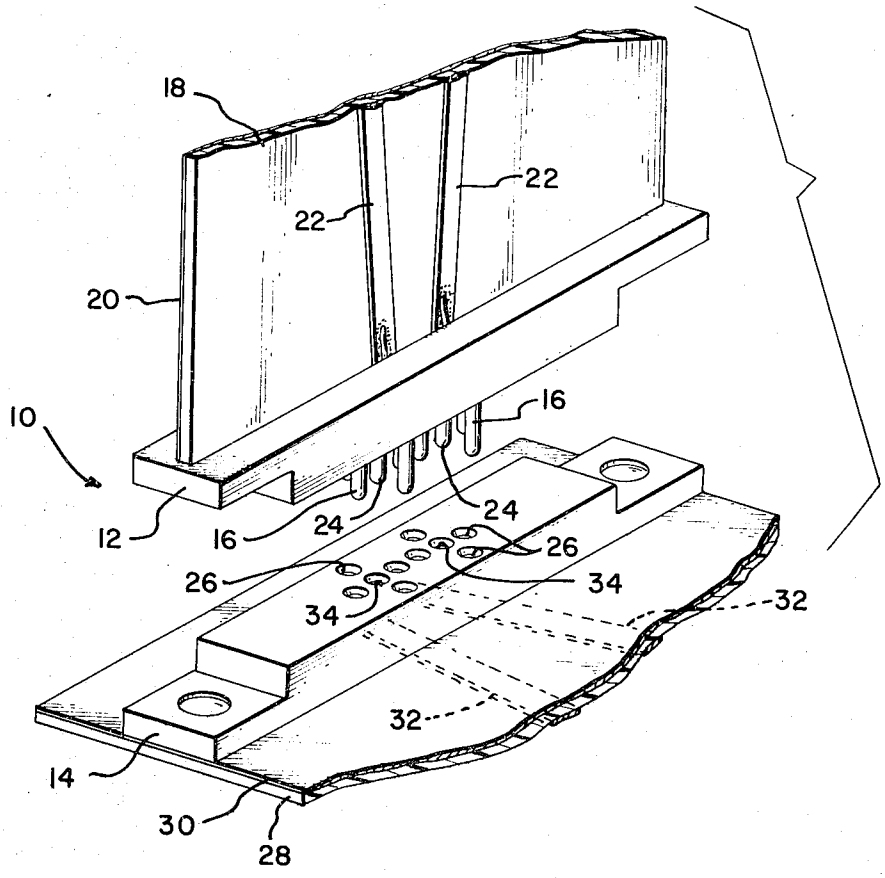
[57] **ABSTRACT**

Disclosed is a connector for making matched impedance connections, for example, as between two microstrip circuit boards. One-half of the connector has pins located therein with one end of each pin electrically connected to respective signal and ground planes in one microstrip, the second half of the connector has receptacles located therein, the ends of each receptacle mating, or making electrical contact respectively with, signal and ground planes on the second microstrip circuit board. The pins and receptacles are arranged in a pattern such that matched impedance, as between the two connectors, and therefore the two microstrip circuit boards, is effected.


**4 Claims, 6 Drawing Figures**



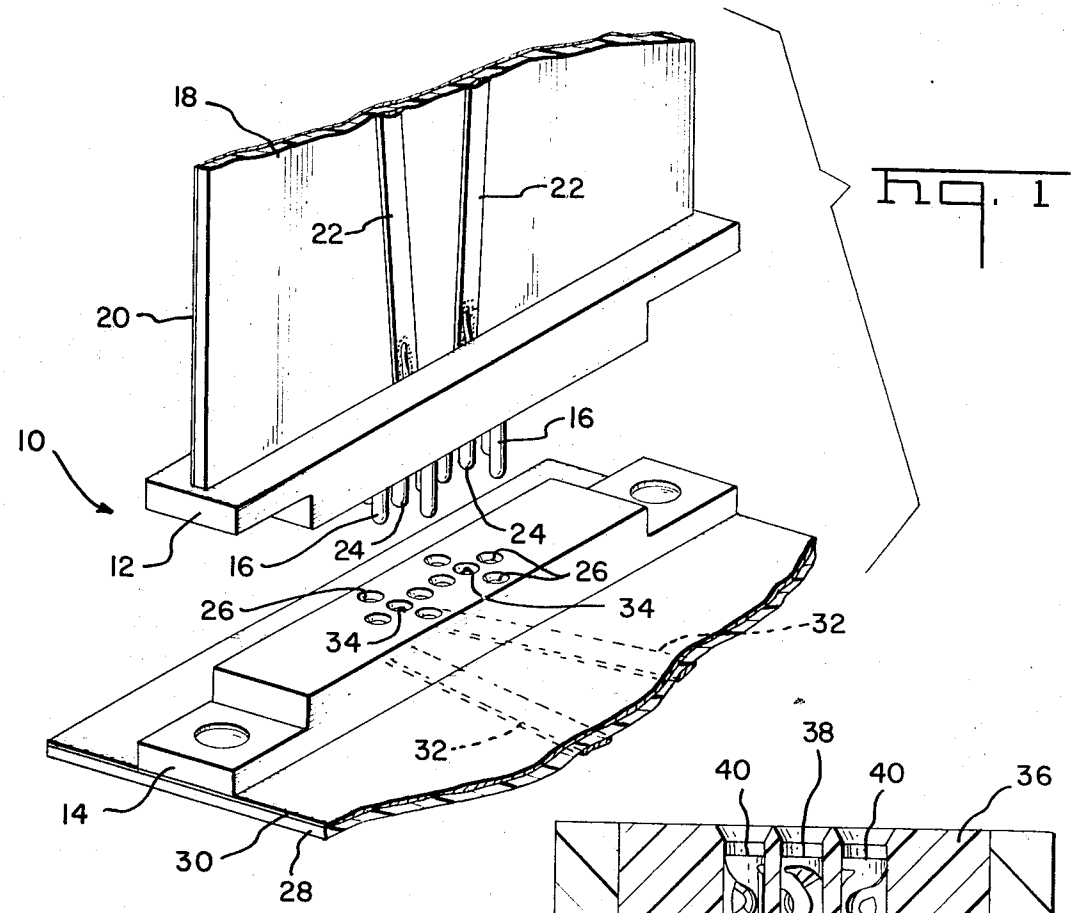



Fig. 1

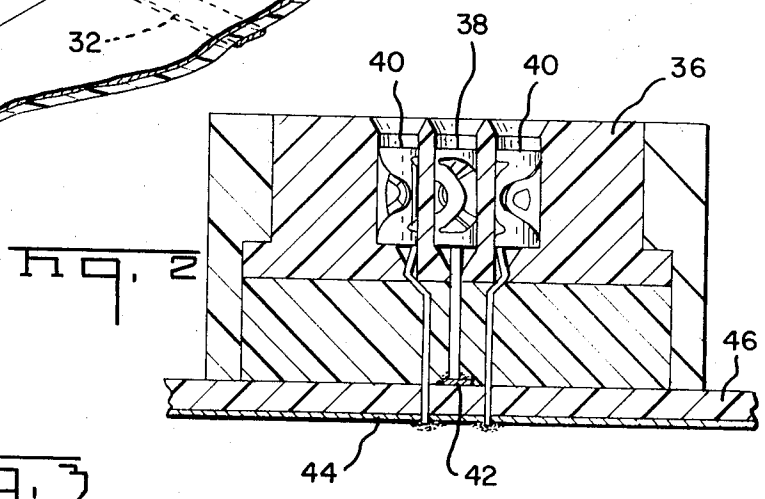



Fig. 2

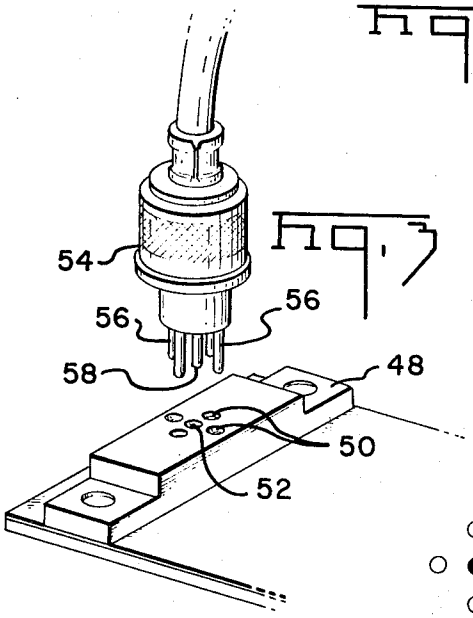



Fig. 3

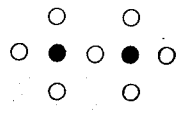


Fig. 4

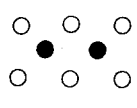


Fig. 5

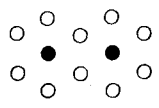


Fig. 6

# IMPEDANCE MATCHING MICROSTRIP CONNECTOR

## BACKGROUND, OBJECTS, AND ATTAINMENTS OF THE PRESENT INVENTION

Until the present invention, the state of microminiaturization had not progressed sufficiently far enough to allow interconnection with matched impedance of microstrip circuit boards. Although connection as between the microstrip circuit boards could be attained, impedance matching was difficult, if not extremely hard, to achieve, and these connections were not acceptable, where low standing wave ratios were desired.

It is therefore an object of the present invention to provide a connector allowing connection of two microstrip circuit boards having matched impedance.

It is a further object of the invention to provide such a connector where the impedance is very accurately matched.

It is still a further object of the invention to provide a matched impedance connector in a sophisticated environment of high-quality electronic applications.

These and other objects of the invention are attained by providing a connector comprising two housing members, one containing receptacles therein, and one containing pins to be received by said receptacles. In each housing member, a matching pin and receptacle is electrically connected to signal circuitry on the respective microstrip circuit board to which the connector housing member is attached. Also carried by each housing member, are respective pins and receptacles, which are attached to ground circuitry on the respective microstrip circuit boards attached to each connector housing member. Each signal pin or receptacle is generally centrally located with respect to a plurality of ground pins or receptacles. Depending upon the impedance desired, which is found by

$$Z=C/\sqrt{\epsilon}\,[\cosh^{-1} 2D/d]$$

wherein $C$ is a constant somewhere between 120 (for one signal pin and one ground pin) and 60 (coaxial signal and ground relationship), $\epsilon$ is the dielectric constant of the circuit board material, $D$ is the spacing as between signal and ground conductors, and $d$ is the diameter of the signal conductor, the number of ground pins and receptacles can be either increased or decreased, spaced farther away from or closer to, its respective signal pin or receptacle. In this manner, matched impedance, as between the two connectors and their relative microstrip circuit boards, is attained.

Other objects and attainments of the present invention will become apparent to those skilled in the art upon a reading of the following detailed description when taken in conjunction with the drawings in which there are shown and described illustrative embodiments of the invention; it is to be understood, however, that these embodiments are not intended to be exhaustive nor limiting of the invention but are given for purposes of illustration and principles thereof and the manner of applying them in practical use so that they may modify them in various forms, each as may be best suited to the conditions of a particular use.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the preferred embodiment of the invention showing the connector just prior to being assembled with each half carrying a microstrip circuit board in mother-daughter board relationship.

FIG. 2 is a section view showing a connector housing member containing the receptacles and their method of attaching to the microstrip circuit board.

FIG. 3 shows a different embodiment wherein the half of the connector containing the receptacles is used in conjunction with an adapter to thereby allow interconnection as between the connector housing half and a coaxial cable.

FIG. 4 shows an embodiment where adjacent signal contacts share one ground contact.



FIG. 5 is yet another embodiment where adjacent signal contacts share two ground contacts.

FIG. 6 is yet a further embodiment showing each signal contact being surrounded by six ground contacts and adjacent signal contacts sharing two ground contacts.

Turning now to FIG. 1, there is seen a separated connector generally indicated at 10. The male housing member is indicated as at 12, and the female housing member is indicated as at 14. Male housing member 12 contains therein a plurality of pins 16, the rear ends of these pins 16 are connected, such as by soldering, to appropriate circuitry on the microstrip circuit board 18. The entire backface of circuit board 18 is coated with electrically conductive material such as copper, the edge of which can be seen at 20. Located on the front face of circuit board 18 are two signal circuits 22, 22, which are electrically connected to signal pins 24, 24. All of the pins other than pins 24, 24 have their ends connected to the copper coating 20, which constitutes a ground circuit plane.

Turning to the female housing member 14, located therein is a plurality of receptacle members 26. These receptacle members are electrically connected to various circuitry located on microswitch circuit board 28. Located on the upper face of microswitch circuit board 28 is a full coating of copper or other electrically conductive material 30. Located on the bottom face of microstrip circuit board 28 are two signal circuits 32, 32. Two of the receptacles 34, 34 are connected electrically at their one end to signal circuits 32, 32. The remainder of the receptacles 26 are electrically connected at their ends to the copper coating 30, which constitutes a ground circuit plane.

As can be seen from FIG. 1, each signal pin and signal receptacle is surrounded by a plurality of ground pins and ground receptacles, the particular pattern allowing for a given matched impedance as between the two microswitch circuit boards.

Turning to FIG. 2 and shown in cross section is a typical female housing member 36 containing a signal receptacle 38 and a plurality of ground receptacles 40. As can be seen, at one end the signal receptacle 38 has means connecting it to the signal plane or circuit 42, and the ground receptacles 40 are electrically connected to the ground plane 44 of the microstrip 46.

It is pointed out at this point, that with the proper connector housing members, any number of microstrip circuit boards could be sandwiched, thereby allowing high density use of the invention. Also as common as microstrip is strip-line wherein two signal circuits are sandwiched between two ground planes. The inventive concept of the instant connector is easily adaptable to strip-line.

In FIG. 3 there is seen a different embodiment of the invention wherein a typical female housing member of the instant invention is used in conjunction with an adapter thereby allowing hookup of a coaxial cable thereto. The female housing member 48 has ground receptacles 50, a signal receptacle 52 located therein, which receptacles are electrically connected to appropriate circuitry on a microstrip circuit board, which is not shown. The adapter 54 has located therein, ground pins 56 and a signal pin 58. This adapter matingly receives a coaxial cable 60, the signal pin of which comes into electrical contact with signal pin 58 of adapter 54, and the ground plane or shield of the coaxial cable comes into contact with the various ground pins 56. Thus it is seen that the connector of the instant invention will allow connection of coaxial cables to a microminiaturized environment.

The contact arrangement shown in FIG. 4 provides for adjacent signal contacts to share or have a mutual ground contact. In this manner, more compact spacing can be achieved and a sacrifice in crosstalk can be acceptable.

In FIGS. 5 and 6 there is seen two more embodiments showing the arrangement of shared ground contacts by adjacent signal contacts. Here again these arrangements provide for greater compactness at the expense of higher levels of crosstalk.

It will, therefore, be appreciated that the aforementioned and other desirable objects have been achieved; however, it should be emphasized that the particular embodiments of the invention, which are shown and described herein are intended as merely illustrative and not as restrictive of the invention.

I claim:

1. An electrical connection for making matched impedance connection between a microstrip circuit board and a coaxial cable conductor, said connector comprising a first housing member connected to said microstrip circuit board and having a plurality of receptacles therein, at least one of said receptacles constituting a signal receptacle and having one end electrically connected to signal circuitry located on one face of said microstrip circuit board, the remaining receptacles being located around said signal receptacle and constituting ground receptacles each having one end electrically connected to ground plane circuitry located on the opposite face of said microstrip circuit board, a second housing member having the end of a coaxial cable connected thereto, said second housing member having a plurality of pins extending outwardly therefrom, only one of said pins constituting a signal pin and having one end thereof electrically connected to the signal conductor in said coaxial cable, the remaining pins being located around said signal pin and constituting ground pins each having one end electrically connected to the ground plane or shield of the coaxial cable, whereby said receptacles will receive said pins allowing for a matched impedance electrical connection.

2. An electrical connection for matching impedance between first and second microstrip circuit boards, each microstrip circuit board having electrically conductive ground plane circuitry located on one side thereof and at least one electrically conductive signal circuit located on the opposite side thereof, said first circuit board having one pin and said second circuit board having one receptacle in electrical engagement with respective signal circuitry thereon, said first circuit board having a plurality of pins in electrical engagement with said ground plane circuitry thereon and in surrounding relationship to said one pin, and said second circuit board having a plurality of receptacles in electrical engagement with said ground plane circuitry thereon and in surrounding relationship to said one receptacle, first and second dielectric housing members in respective engagement with said first and second circuit boards and respectively housing said pins and receptacles, the radial spacing of said pin and receptacle relative to said surrounding plurality of pins and receptacles, and the number of said plurality of pins and receptacles being predetermined so as to achieve a matched impedance connection between said circuit boards.

3. An electrical connection as set forth in claim 2 wherein each circuit board and respective connector includes a plurality of signal circuits including respectively, signal pins and receptacles, each respective signal pin and signal receptacle being surrounded by a plurality, respectively, of ground plane pins and sockets, the number of ground plane pins and sockets being determined by the level of crosstalk desired between adjacent signal circuits.

4. An electrical connection as set forth in claim 3 wherein each signal pin and receptacle of two adjacent circuits share some of the respective surrounding ground plane pins and sockets at the expense of higher crosstalk.

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