ABSTRACT

Connector apparatus for connecting a coaxial cable to a strip transmission line on an etched circuit board is described including a resilient socket member mounted on the circuit board and a plug member attached to the end of the cable. The plug includes a tubular inner eyelet crimped onto the jacket of the cable and surrounded by an outer eyelet which clamps a portion of the outer conductor of the cable between such two eyelets by an interference fit. One end of the inner conductor of the coaxial cable extends out of the eyelets and is inserted into a hole in the circuit board which may contain a separate tubular inner socket member for connection to the signal conductor of the strip line. An outer socket member in the form of a split sleeve having a plurality of legs attached to the circuit board is connected to the ground conductor of the strip line and resiliently holds the plug member inserted therein.

1 Claim, 8 Drawing Figures
COAXIAL CABLE CONNECTOR FOR CIRCUIT BOARD

This is a division of application Ser. No. 95,627, filed Dec. 7, 1970.

BACKGROUND OF THE INVENTION

The subject matter of the present invention relates generally to electrical connectors for cables and, in particular, to connectors for connection of a coaxial cable to a strip line type transmission line on an etched circuit board.

The coaxial cable connector of the present invention includes a resilient outer socket member in the form of a split sleeve having legs which are soldered to the circuit board, and a plug member including two tubular eyelets attached to the end of the outer conductor of such cable. The plug member is inserted into such outer socket member which acts as a guide so that the end of the inner conductor of the cable extending out of the plug member is also inserted through a hole in the circuit board which may contain a separate inner socket member. The circuit board may have a strip line type transmission line formed thereon with a uniform characteristic impedance equal to that of the coaxial cable, and includes a signal conductor and a ground conductor, respectively connected to the inner socket member and the outer socket member. As a result of its simplified construction, the coaxial connector apparatus of the present invention is inexpensive to manufacture and is provided with an extremely high frequency response as well as a low standing wave ratio due to the fact that the characteristic impedance of the cable is maintained throughout the entire length of the connector which minimizes signal reflections.

The connector apparatus of the present invention is especially useful for connecting the signal input of a wide band cathode ray oscilloscope to its vertical amplifier.

Previous coaxial cable connectors for connecting to etched circuit boards have employed a plug member including a pin connected to the inner conductor of the cable and a resilient outer shield connected to the outer conductor of such cable which mate with corresponding inner and outer socket members joined together by solid dielectric material, as shown in U.S. patent 2,869,090 of Johanson, granted January 13, 1959, in addition to being simpler and less expensive in construction due in part to the use of a split sleeve socket member and the use of a bare end portion of the inner conductor of such cable as the inner plug member, the connector apparatus of the present invention also has a higher frequency response and a lower standing wave ratio than such prior apparatus.

It is therefore one object of the present invention to provide an improved cable connector apparatus of simple and inexpensive construction.

Another object of the invention is to provide such a connector apparatus for connecting a coaxial cable to a strip transmission line on a circuit board in which the characteristic impedance of the cable is maintained through the entire length of the connector apparatus to provide a higher frequency response and a lower standing wave ratio.

An additional object of the invention is to provide such a connector apparatus with a plug means which may be attached to the cable and a socket means which may be mounted on the circuit board by automatic assembly.

A further object of the present invention is to provide such a connector apparatus with a socket member in the form of a split sleeve which resiliently engages a rigid plug member attached to the cable and guides the insertion of a bare end portion of the cable into a hole in the circuit board for easy reliable connection operation.

Still another object of the present invention is to provide such connector apparatus in which the socket means includes an inner socket member mounted in the hole in a circuit board and separate from the split sleeve socket member for releasable connection of the cable to the circuit board while enabling a permanent connection merely by replacing the inner socket member with a soldered connection.

A still further object of the present invention is to provide such a connector apparatus in which the plug means is formed by a pair of tubular eyelet members clamping the shield wires at one end of the outer conductor of such cable theretwixt to form a connector of short length so that the cable can extend parallel to the circuit board a short distance therefrom for less mounting space.

An additional object of the invention is to provide an improved electrical connector socket in the form of a split sleeve member having a polygonal cross section with flat sides and mounting legs extending from such sides to provide good mechanical contact with a plug member of circuit cross section inserted into such socket.

A further object of the invention is to provide such a connector socket with a lower inductance to ground by providing one of the leg portions with a shorter length extending substantially perpendicular to the main body of the socket and by providing a slot in such main body extending longitudinally along its full length.

Other objects and advantages of the present invention will be apparent from the following detailed description of the preferred embodiment thereof and from the attached drawings of which:

FIG. 1 is a side elevation view of the connector apparatus of the present invention with a portion of the circuit board broken away for clarity;

FIG. 2 is a front elevation view of the connector apparatus of FIG. 1 with the plug shown removed from the socket;

FIG. 3 is an exploded view of the connector apparatus of FIGS. 1 and 2;

FIG. 4 is an enlarged horizontal sectional view taken along the line 4—4 in FIG. 1;

FIG. 5 is an enlarged plan view of the inner socket member taken along the line 5—5 of FIG. 2;

FIG. 6 is a horizontal sectional view taken along the line 6—6 of FIG. 5;

FIG. 7 is a plan view of the circuit board taken along the line 7—7 of FIG. 1; and

FIG. 8 is an enlarged vertical section view taken along the line 8—8 of FIG. 1.

DESCRIPTION OF PREFERRED EMBODIMENT

The electrical connector apparatus of the present invention is shown in FIGS. 1 and 2 and includes a socket 10 mounted on an etched circuit board 12 and a plug 14 attached to one end of an electrical cable 16. The cable 16 may be a coaxial cable including an inner sig-
nal conductor 18 and an outer shield conductor 20 separated by solid dielectric material 22 of a suitable plastic material, and a protective jacket 24 of plastic material provided over the outer conductor 20.

The outer conductor 20 may be in the form of braided wire strands woven together along its entire length except for shield wires 26 at one end thereof which, as shown in FIGS. 3 and 8, are separated and bent back along the cable over an inner plug member 28. The inner plug member is in the form of a tubular metal eyelet having an outer flange portion 30 extending outwardly from the side of the eyelet one end thereof, such eyelet being crimped onto the jacket 24 of the cable. An outer plug member 32 in the form of a second tubular metal eyelet is forced over the inner eyelet 28 to clamp the shield wires 26 between such eyelets. Thus, the inner diameter of eyelet 32 is just slightly larger than the outer diameter of eyelet 28, in order to provide the proper spacing for a good friction fit when the shield wires 26 are between such two eyelets. The outer eyelet 32 is also provided with a flange 34 extending radially outward at one end thereof. Flange 34 engages the flange 30 on the inner eyelet and during assembly such flanges shear off any excess length of shield wires 26 which may extend between them.

The plug means 14 also includes a bare end portion of the inner conductor 18 which extends out of the eyelets 28 and 32 after some of the dielectric 22 is trimmed off in the region where the shield wires have been removed. This bare end of the inner conductor is inserted through an opening in the circuit board as hereafter discussed.

The socket means includes an outer socket member 10 in the form of split sleeve of spring metal having a slot 36 extending longitudinally through one side of the sleeve to provide a resilient socket member. Three mounting legs 38, 40 and 42 extend from one end of the sleeve into holes through the circuit board and are soldered to a ground conductor strip 44 on the bottom of such circuit board. An inner socket member 46 may also be provided to form a releasable connection with the bare end of the inner conductor 18. The inner socket member 46 is a tubular member separate from the outer socket member 10, and is mounted in an opening extending through the circuit board by soldering to metal plating 47 on the walls of such opening as shown in FIG. 6. A signal conductor strip 48 is provided on the bottom of the circuit board uniformly spaced from the ground conductor 44 to form a strip line type transmission line having a uniform characteristic impedance equal to that of the coaxial cable 16, as shown in FIG. 7. The inner socket member 46 is connected to one end of the signal conductor 48 by its soldered connection. Thus, the inner conductor 18 of the coaxial cable is connected to the signal conductor 48 of the strip line through the inner socket member 46, while the outer conductor 20 of the cable is connected to the ground conductor 44 of such strip line through the outer socket member 10 and plug eyelet 28. It should be noted that the inner socket member 46 can be eliminated and the bare end of the inner conductor 18 soldered in the plated hole 47 to form a permanent connection to the signal conductor strip 48.

Also, a ground plane 49 and an annular soldering tab 51 spaced therefrom may be provided on the top of the circuit board for shielding the strip line and to facilitate soldering of the socket members.

As shown in FIG. 4, the outer socket member 10 is of a polygonal cross sectional shape which may be an octagon including four flat side portions 50 which engage the outer eyelet 32 of the plug at point contact areas since such eyelet has a circular cross section whose outer diameter is slightly larger than the distance between two opposed flat side portions 50. The three mounting legs 38, 40, and 42 extend from three of the four flat sides 50 while the fourth flat side is divided by the slot 36. As a result, it is easier to form the leg portions merely by bending flat sheets of metal extending from the main body portion of the socket.

The two opposed legs 38 and 42 each extend at an acute angle of approximately 45° to the side of the main body portion of the socket member 10 at a point midway down such sides as shown in FIG. 2. Legs 38 and 42 are formed by providing notches 52 in the main body portion on opposite sides of such legs extending approximately half the length of such body portion as shown in FIG. 1. The third leg 40 extends substantially perpendicularly from the side of the main body portion of the socket member 10 at a point on its bottom end so that such leg is of a shorter length than the other legs 38 and 40 in order to reduce its inductance and provide good electrical ground for the socket member to the ground plane 49 on the circuit board. The other two legs, 38 and 40 primarily serve as the resilient mounting legs which resiliently urge the flat side portions 50 of the socket 10 into engagement with the outer eyelet member 32 of the plug 14. The longitudinal slot 36 in the socket member 10 not only enables it to resiliently engage the plug with a springlike action but also reduces the inductance of such socket member.

As shown in FIGS. 3, each of the legs 38, 40 and 42 are each provided with a pair of shoulders 54 which act as stops for engagement with the surface of the etched circuit board. The legs also each include a tab portion 56 projecting from such shoulders through the mounting hole in the printed circuit board to enable soldering to the conductive surface of such printed circuit board. In addition, while not shown, such tabs 56 can be made sufficiently long to enable the end of the tab portion on the opposite side of the circuit board from the shoulder 54 to be bent over for preliminary attachment of the socket to the etched circuit board before soldering. In any event, the socket members 10 and 46 are automatically machine assembled on the circuit board and dip soldered.

As shown in FIGS. 3 and 4, the inner eyelet 28 of the plug is crimped onto the jacket 24 of the coaxial cable 16 at three crimp areas 58 on the eyelet about mid-way along its length, such crimp portions projecting inwardly into frictional engagement with such jacket.

As shown in FIGS. 5 and 6, the inner socket member 46 includes a conventional spring insert member 60. The spring insert 60 may be in the form of a strip of spring metal having a plurality of slits therein to provide separate strips, alternate ones of which are bent inwardly toward the axis of the socket member 46 and act as leaf springs.

The inner socket member 46 and the outer socket member 10 are both flared outwardly at the top end of such socket members to enable easier insertion of the inner conductor 18 and the outer eyelet 32 of the plug. Also, during insertion, the outer eyelet 32 of the plug
engages the outer socket member 10 first and guides the inner conductor 18 into the inner socket member 46 upon further insertion.

It will be obvious to those having ordinary skill in the art that many changes may be made in the details of the preferred embodiment of the present invention without departing from the spirit of the invention. For example, two wire cables may be employed rather than coaxial cables merely by attaching the ground wire between the two eyelets and using the signal wire as inner conductor 18. Therefore, the scope of the present invention should only be determined by the following claims.

I claim:

1. A coaxial cable connector for terminating an end of a coaxial cable having an inner conductor surrounded by a sheath of insulation with an exposed section extending outwardly from the insulation and an outer conductor surrounded by a sheath of insulation with an exposed section of the outer conductor extending outwardly from the sheath of insulation, comprising:

   a first ferrule means positioned on the sheath of insulation surrounding the outer conductor and a second ferrule means telescopically positioned on said first ferrule means, both of said ferrule means electrically connected by capturing the exposed section of the outer conductor therebetween, whereby both of said ferrule means and the inner conductor so assembled define a plug means;

   a first connector means resiliently connected only to the exposed section of the inner conductor thereby terminating the inner conductor and a second connector means resiliently connected to the second ferrule means thereby terminating only the outer conductor, whereby both of said connector means are independently connected to the coaxial cable and so assembled define a socket means mated to said plug means to terminate the end of the coaxial cable.

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