Dec. 22, 1970 G. M. BROOKS 3,550,043

MICROWAVE COUPLING DEVICE AND MOUNTING THEREFOR

Filed Oct. 4, 1968 3 Sheets-Sheet 1

Fig. 1.

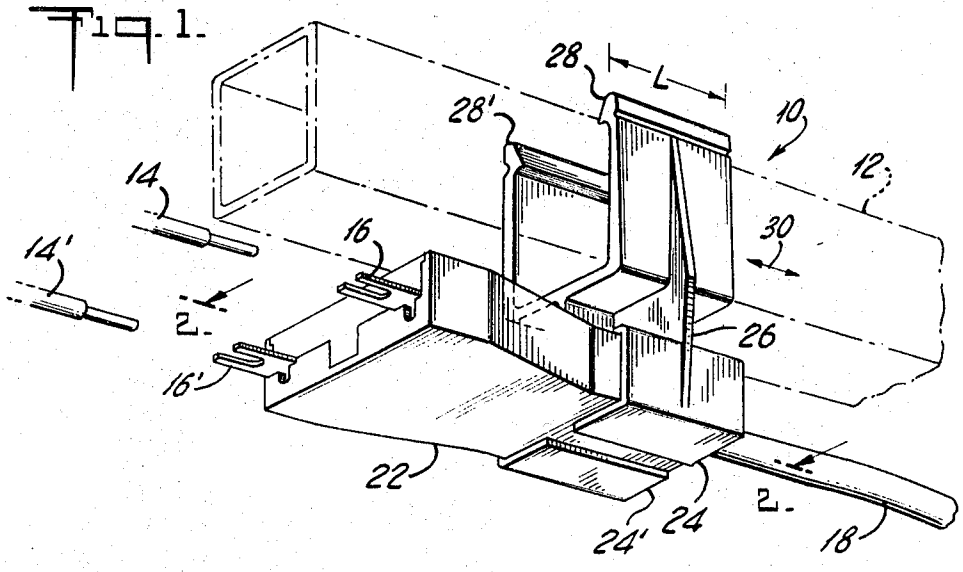


Fig. 7.

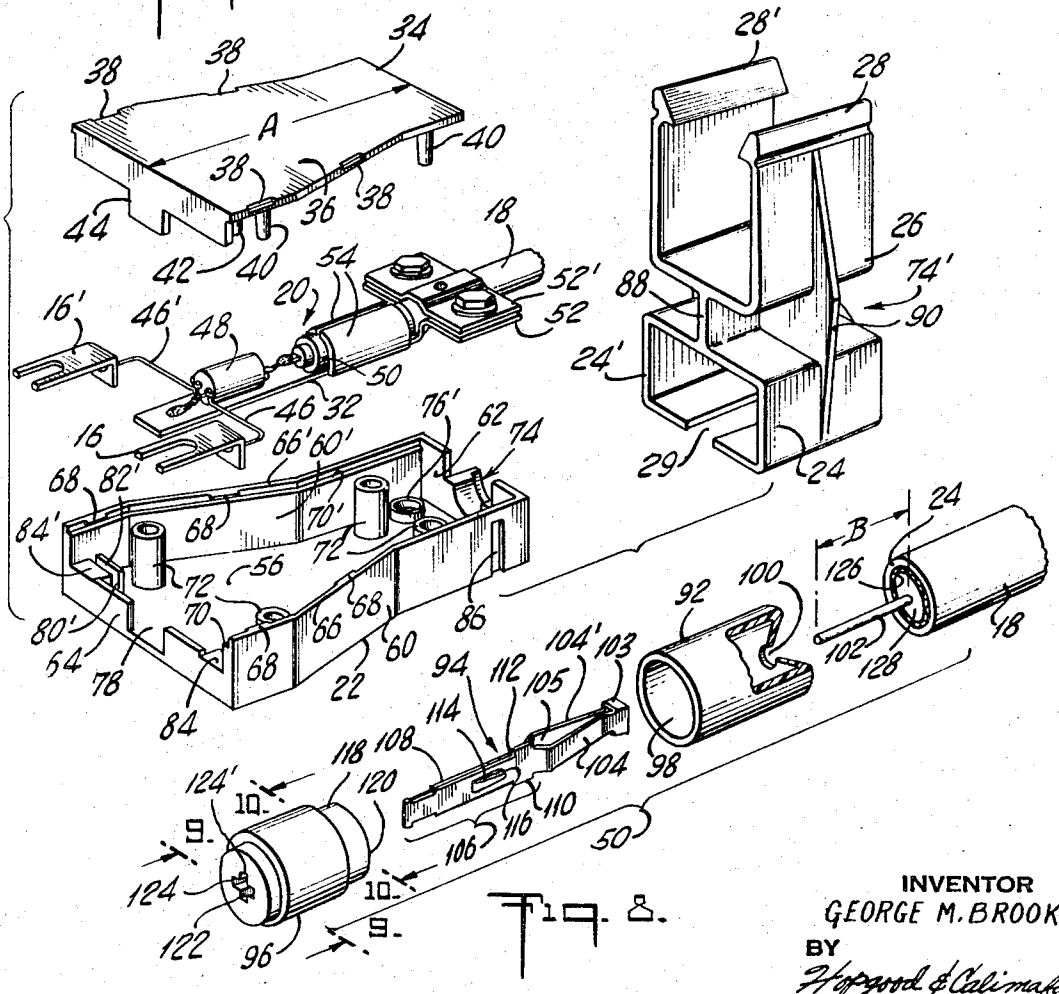


Fig. 8.

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Fig. 2.

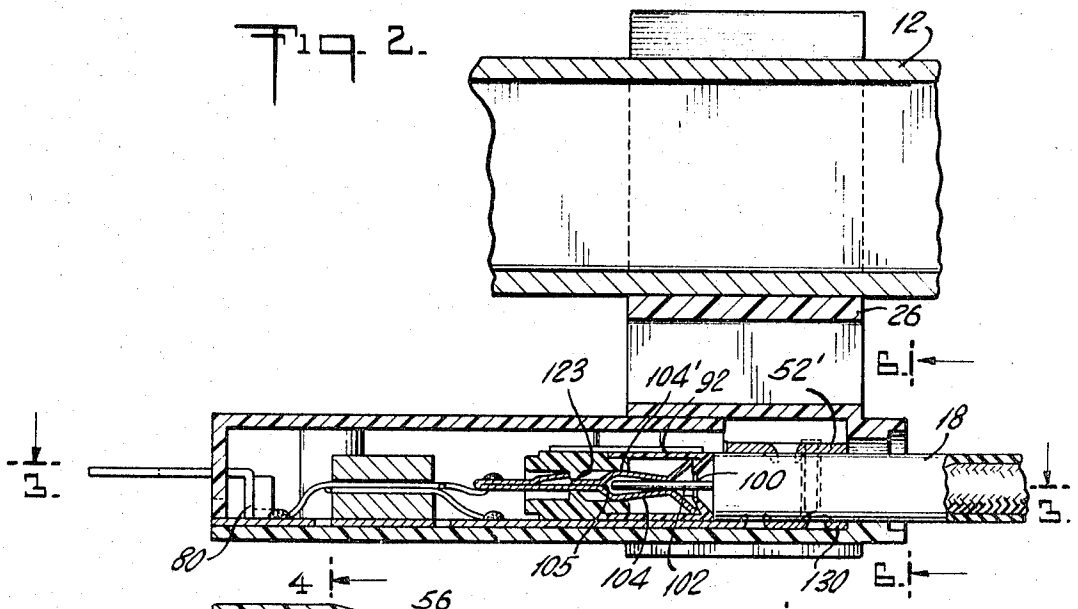


Fig. 3.

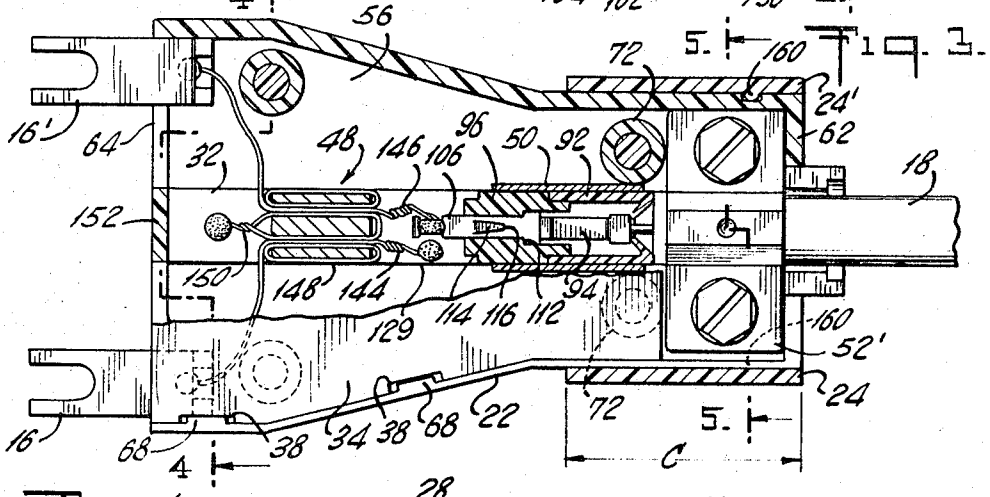


Fig. 4.

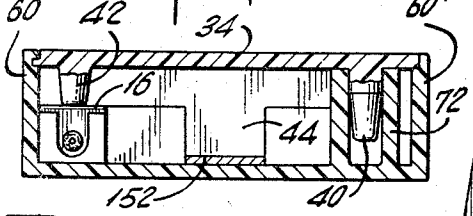


Fig. 5.

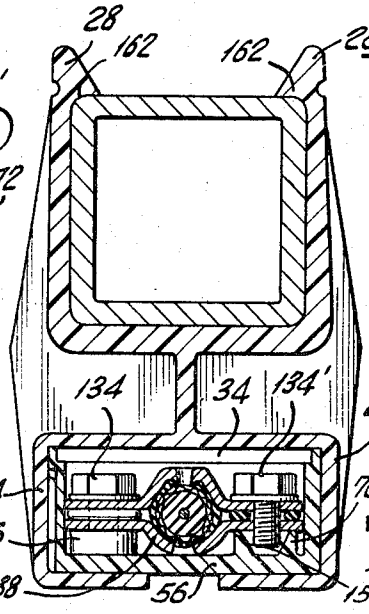
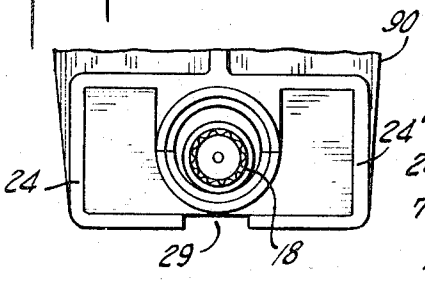


Fig. 6.



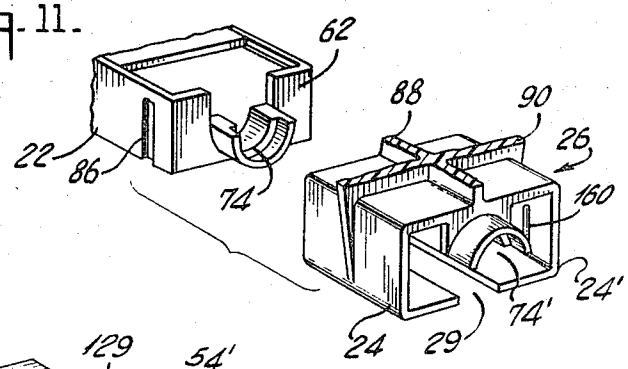
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MICROWAVE COUPLING DEVICE AND MOUNTING THEREFOR

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Fig. 11.



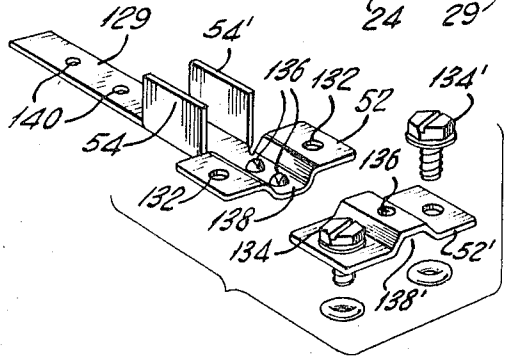


Fig. 12.

Fig. 9.

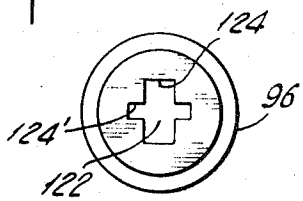


Fig. 13.

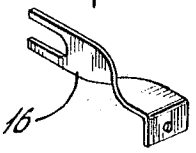
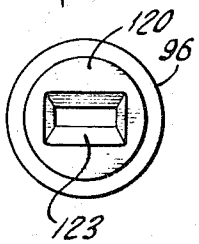


Fig. 10



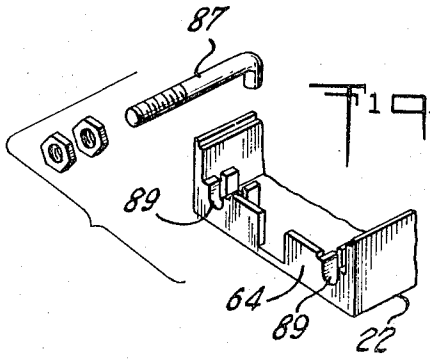


Fig. 14.

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United States Patent Office 3,550,043 Patented Dec. 22, 1970

3,550,043

MICROWAVE COUPLING DEVICE AND MOUNTING THEREFOR

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Int. Cl. H03h 7/42
U.S. Cl. 333—26 37 Claims

ABSTRACT OF THE DISCLOSURE

An easily assembled and installed microwave coupling device is described for interconnecting a pair of balanced leads to a coaxial cable. The device is especially suitable for television frequencies and may be conveniently clipped onto an antenna or placed near a receiver. A clip having two pairs of resilient clutching fingers is provided with one pair of fingers gripping the boom of an antenna and the other pair gripping a case enclosing the microwave network. The case includes a novel lid which retains the case-enclosed network as well as provides protective covering thereof and is in turn lockingly retained by the case-clutching fingers of the clip. A novel coaxial cable connector is employed which further facilitates assembly of the coupling device and interconnection thereof to the coaxial cable. The entire arrangement is simply assembled yet mechanically rugged and rigid to yield excellent electrical performance.

This invention relates to a microwave radio frequency coupling device. More specifically, it relates to an easy-to-assemble microwave network containing housing for the interconnection of a radio frequency balanced twin-lead line to a coaxial cable.

For several technical reasons, such as omnidirectional reception and impedance matching purposes, the majority of home-used TV antennas provide antenna signals on a pair of lines which are balanced with respect to ground. The antenna signals are then led via an unshielded balanced twin-lead cable to a TV receiver which is designed to accept the balanced twin input leads. Such a TV antenna signal transmission system is generally designed to have a characteristic impedance of about 300 ohms.

There are several quite frequently occurring situations where the use of balanced twin leads of the unshielded type is unsatisfactory because of radio frequency interference problems. One could conceivably shield such twin-lead cable to avoid the interference, but such shielded cable would become prohibitively expensive. Instead, it is common practice to convey the TV signals in such interference situations via an unbalanced coaxial cable.

Typical situations involving such interference problems arise when there are strong TV "ghost" signals, i.e. TV signals arriving along a different path from those received by the antenna and which are picked up by the balanced twin-lead line, or where the balanced twin-lead line passes adjacent high-current-carrying cables which may generate noise well into the TV frequency spectrum. Another such situation arises when one utilizes an amplified TV signal distribution system, wherein it is important to contain the amplified TV signals so that they will not interfere with TV receivers which operate independently of the distribution system. In all these situations, it is customary to transmit the TV signals over unbalanced coaxial cables and, as a result, balanced-to-unbalanced TV cable coupling devices are needed to properly feed the TV signals to the receiver. In one situation, the coupling device must be located adjacent the antenna, and in another case, the coupling device must be located adjacent the TV receiver.

The coaxial cable is made of a central inner conductor surrounded by an outer conductor which is spaced from the inner conductor and coacts therewith to convey microwave signals over a wide frequency spectrum which easily encompasses with little loss the entire VHF and UHF TV microwave spectrum from 54 to 890 mHz. Such coaxial cable are well known in the art and further technical description may be obtained from numerous handbooks and the like. Suffice it to say that for several technical and economic reasons, the conventional coaxial cables have a characteristic impedance of about 75 ohms vs. 300 ohms for the commonly used VHF and UHF twin-lead balanced TV leads. As may be appreciated by one skilled in the art, the transfer of TV signals from a balanced 300 ohm line to a 75 ohm coaxial line produces excessive RF signal loss unless a coupling device is used for proper impedance matching between the lines. Since the impedance coupling device may have to be mounted close to an outdoor antenna or adjacent a TV receiver, it may be exposed to a wide variety of environmental conditions and for this reason must be rugged in design, yet must be easily assembled and attached to an antenna or TV receiver with little effort.

The rigidity required for the coupling device may be appreciated when it is realized that mechanical movements in a microwave network such as in a TV impedance-matching device operable over the frequency range from 54 to 890 mHz., can affect the electrical performance. Accordingly, the antenna-mounted impedance transformer must be rigid in structure, yet easy to assemble for such remote, poorly accessible locations, and mechanically strong to withstand the weather elements to which such antenna-mounted device is likely to be exposed.

It is therefore an object of this invention to provide a balanced-line-to-coaxial-cable coupling device which is simple in construction and easily mountable to an antenna or receiver.

It is a further object of this invention to provide a device for enclosing a microwave network for protection against the weather elements and which may be simply attached to an outdoor antenna to provide proper impedance-matching between a balanced and an unbalanced line.

It is still further an object of this invention to provide an insulative clip-on housing which encloses a microwave network in a weather-protective manner and is easily installed with a minimum of preparation.

It is still another object of this invention to provide an insulative housing which encloses an electrical microwave network in a mechanically rigid electrical-characteristic-retaining manner, free from sensitivities caused by weather-induced disturbances or other externally-induced vibrations and which is easily assembled and simple in construction.

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will best be understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, the description of which follows.

FIG. 1 is a perspective view of a transformer coupling device made in accordance with the invention and is shown mounted to an antenna boom;

FIG. 2 is a section view taken along a line 2—2 in FIG. 1 bisecting the transformer and coaxial cable;

FIG. 3 is a partial sectional view and plan view of the transformer taken along the line 3—3 in FIG. 2;

FIG. 4 is a section view of the transformer taken along the line 4—4 in FIG. 3;

FIG. 5 is a section view of the transformer taken along the line 5—5 as shown in FIG. 3;

FIG. 6 is an end view of the transformer from the coaxial cable end thereof, taken along the line 6—6 in FIG. 2;

FIG. 7 is an exploded perspective view of the lid, electrical network, the case and the clip used in the formation of the transformer according to this invention;

FIG. 8 is an exploded perspective view of the coaxial cable connector assembly used in the coupling device of FIG. 1;

FIG. 9 is an end view of a stud mount used in the coaxial cable connector shown in FIG. 8;

FIG. 10 is an end view of the other end from that shown in FIG. 9 of the stud mount used in the coaxial cable connector shown in FIG. 8;

FIG. 11 is a perspective exploded view of the coaxial end of the case and clip used in the coupling device shown in FIG. 1;

FIG. 12 is a perspective view of an electrical conducting frame used for mounting of the microwave network used in the transformer device of FIG. 1;

FIG. 13 is a perspective view of a twisted lug which may be used with the transformer device shown in FIG. 1; and

FIG. 14 is a perspective exploded view of the twin-lead facing end of the case and a cylindrical lug used to connect to a twin-lead cable.

In FIG. 1, a microwave coupling device **10** is mounted to a boom **12** of a microwave antenna (not shown) from which a pair of electrically balanced leads **14–14′** provide antenna-received signals to a coupling device **10** by connection to protruding lugs **16–16′**. A coaxial cable **18** is connected to one end of the coupling device for further transmission of the antenna signals to, for instance, a television receiver (not shown). The coupling device **10** encloses a microwave impedance transformer network **20** (see FIG. 7) for interconnection of the balanced line and coaxial cable. The coupling device **10** comprises an impedance transformer holding case **22** held between lid locking resilient clutching fingers **24–24′** of a clip **26**. The clip **26** being made of insulative material such as plastic in turn is mounted to the boom by another pair of resilient boom-gripping fingers **28–28′** located at a clip end opposite where the case-clutching fingers are located.

The antenna leads **14–14′** may be of the rigid type or may be flexible, as desired, since the case **22** is positively held between fingers **24–24′**, as will be explained, preventing escape of the case. In the event the antenna leads **14–14′** are rigid, the coupling device **10** may be slid along the boom in the directions of the double-headed arrow **30** for proper location of the lugs **16–16′** opposite the ends of the leads **14–14′**. The antenna boom **12** is shown in FIG. 1 to have a rectangular cross-section so that the antenna-boom-gripping fingers **28—28′** are shaped to form a rectangular channel between them for a snug fitting to the boom. The channel formed between the fingers **28–28′** is normally smaller than the boom which fits with interference therebetween. The boom-gripping fingers sufficiently envelop the boom to provide full case mounting support and grip along a sufficiently long distance C of the boom to prevent twisting of the coupling device **10** in a plane parallel to the boom. As a result, firm, rigid attachment to the boom is established with simple assembly thereto. Such attachment and assembly is still retained where the boom is cylindrical and the fingers **28–28′** are correspondingly shaped. Furthermore, instead of a horizontally oriented boom, it may be vertically disposed with the resilient grip of the fingers on the boom being sufficient to retain the coupling device at any desired position and orientation along the vertical boom.

In the situation where the coupling device **10** is to be mounted adjacent a TV receiver, the boom-gripping fingers **28–28′** are replaced by a suitable mounting bracket (not shown) for direct mounting of the clip to the receiver or an adjacent wall from which the coaxial cable **18** emerges. In such case, a conventional 300 ohm balanced twin-lead line interconnects the coupling device **10** to the TV receiver RF input.

The lid-locking case-gripping fingers **24–24′** form a channel between them which is shaped to conform, but normally somewhat smaller, to the cross-section of the case **22** where the fingers hold the case. The fingers are separated by a gap **29** (See FIG. 7) to permit mounting over the coaxial cable **18**.

The component parts of the coupling device **10** may be best illustrated by the perspective exploded view of FIG. 7 wherein the coupling device includes the case **22**, the microwave network **20** assembled on a conductive frame **32**, a lid **34** and the clip **26**.

The lid **34** is formed of a substantially flat plate made of an insulating material such as plastic, having a length A and provided at an upper or exposed surface **36** around the periphery thereof with a plurality of snap-in recessed shoulders **38**. Several alignment pins **40** are shown projecting inwardly from the inner surface of the lid, and a lug clamp **42** is shown projecting inwardly parallel to the alignment pins. The lid **34** is further provided with a front surface from which inwardly projects a frame-retaining tab **44**.

The microwave network **20** includes a pair of lugs **16–16′** connected via leads **46–46′** to a balun coil **48** for transformer interconnection to coaxial cable **18** through a coaxial cable connector assembly **50**. The conductive frame **32** is T-shaped and is used for holding the balun coil **48**, the coaxial cable connector **50** as well as clamping of the coaxial cable **18**. The coaxial cable **18** is retained by the T-shaped frame **32** by means of a pair of complementary cable clamps **52–52′**. The coaxial cable connector **50** is held to the frame **32** by means of bendable connector retainer tabs **54**. The lugs **16–16′** are L-shaped and are grooved to receive a screw and nut for connection to twin-leads **14–14′**. The tabs **54** are bent over the cylindrically shaped coaxial cable connector **50** to form therewith a coaxial cable section which is sized and shaped to impedance-match the coaxial cable **18** to the balun coil **48**. For this reason the coaxial connector **50** has a preselected diameter and the tabs are sufficiently long to provide substantially a full radially enclosing conducting jacket. The axial length of the tabs **54** is selected to extend substantially flush with one axial end of the connector **50**. The tabs **54** thus combine mechanical rigidity of the mounting of the connector **50** with good electrical performance.

The microwave network holding case **22** has a flat bottom **56** rimmed by a peripheral wall composed of a pair of side walls **60–60′**, a coaxial-cable-facing wall **62** and a twin-lead-facing wall **64** which is larger than the wall **62**. The side walls have top edges **66–66′** which are provided with a plurality of tongues **8** located above shoulders **70–70′** for complementary snap-in fit with the recessed shoulders **38** of the lid. The side walls flare outwardly to meet the edges of the twin-lead-facing wall. The peripheral edge of the lid **34** seats on the shoulders **70–70′**. The alignment pins **40** of the lid **34** fit within recessed posts **72** projecting from bottom **56** and serve to properly align the lid onto the case **22**. Four posts **72** are shown, but it is to be realized that fewer can be employed as long as the alignment function is accomplished. The coaxial-cable-facing wall **62** is provided with a coaxial-cable-guiding aperture **74** which is a half-cylindrical section preferably sized so that the cable **18** has a slightly larger diameter for firm guidance and retention of the cable **18** when the case **22** is assembled in the clip **26**. The clip **26** has a complementary cable-guiding aperture **74′** which is more clearly shown in the view of FIG. 11. When the clip **26** is positioned over the case **22**, the cable-guiding apertures match to form a cylinder sized to grip the coaxial cable **18**.

The case **22** is further supplied with a pair of coaxial cable clamp recessed supporting posts **76–76'**, one of which **76'** is visible in the view of FIG. 7, and which seat the coaxial cable clamps **52–52'** properly with respect to the cable-guiding aperture **74**. The twin-lead-facing wall **64** of the case **22** is provided with a T-frame-receiving aperture **78** and a pair of lug-receiving recesses **80–80'**, one of which only, **80'**, is visible in FIG. 7, and which are located generally in the corners formed between the twin-lead-facing wall **64** and the side walls **60–60'**. The lug-receiving recesses **80–80'** are formed between a pair of rectangular flat posts **82–82'**, one of which is visible in the view of FIG. 7, and a pair of shoulders **84–84'** which are an integral part of the twin-lead-facing wall **64** of the case **22**. The upper surfaces of the posts **82–82'** and the shoulders **84–84'** are flat and coplanar to provide smooth supporting surfaces for the angled lugs which also fit with clearance in the recesses **80–80'**.

Adjacent the coaxial-cable-facing wall **62** but located on the side walls **66–66'** are a pair of outwardly facing clip-locking grooves **86–86'**, only **86** being visible in the view of FIG. 7. The grooves **86–86'** are oriented to be transverse to the motion by which the lid-locking clutching fingers **24–24'** of the clip may be mounted to the case **22** so that positive locking may be accomplished with complementary sized inwardly facing tongues attached to the fingers **24–24'** and described in relation to FIG. 2.

Alternatively, one may wish to use a cylindrical lug **87** which is either angled as shown in FIG. 14 or straight, depending upon whether it is to protrude from the twin-lead-facing wall **64** or through apertures (not shown) in the lid **34**. The lug configuration is not critical but the cylindrical lug may be threaded at an end thereof, thus facilitating the connection of a twin-lead thereto by the mere use of one or several nuts. Note that to accommodate the cylindrical lug in the wall **64**, appropriately shaped recesses **89** are provided.

The clip **26** is provided with a pair of oppositely facing antenna-boom-gripping resilient fingers **28–28'** which are connected by means of a strut **88** to the pair of oppositely facing cover locking clutching fingers **24–24'**. A transverse reinforcement strut **90** is provided for rigid interconnection of the boom-gripping fingers to the case-clutching fingers.

The coaxial cable connector assembly **50** shown in FIG. 7 is composed of several parts which, when assembled, provide at one end a convenient interconnection with the center conductor of the coaxial cable **18** and at the other end a lug for electrical connection to the balun coil transformer **48**. With reference to FIG. 8, the coaxial cable connector **50**, which is clamped between the connector retainer tabs **54–54'** of the T-shaped frame **32**, is composed of a cylindrically shaped plastic pin guide **92**, a stud **94** of conductive material and a stud mount **96**, also cylindrically shaped.

The plastic pin guide **92** has at one axial end a bore **98** which terminates short of the other end of the cylindrically shaped pin guide. The pin guide **92** at the end opposite the bore opening is provided with a radially centered aperture **100** slightly larger than the center conductor **102** of the coaxial cable **18**. The surface around the aperture **100** is inwardly conically shaped to provide guidance of the inner conductor **102** into the aperture **100** when the coaxial cable **18** is connected to the case **22**.

The stud **94** is formed on one end with a pair of oppositely disposed inwardly urged abutting electrically conducting spring fingers **104–104'** which are flared outwardly at the tip **103** so that the inner conductor **102** from the coaxial cable, when it enters the aperture **100** of the pin guide **92**, will be guided between the spring fingers **104–104'** to make electrical connection therewith. For this reason the spring fingers **104–104'** initially flare outwardly at **105** from a flat lug section **106** to thereafter bend inwardly until they normally abuttingly contact each other before again flaring outwardly at the tip. The spring fingers **104–104'** project from the flat lug section **106** which has a narrow portion **108** and connecting wider middle portion **110** forming a shoulder **112** between them of a preselected height. A resilient lock finger **114** is located on a side of the narrow portion **108**. The resilient lock finger is raised above the flat surface of the portion **108** to project parallel thereto in cantilever fashion with the finger depressable towards the surface of the flat lug portion **108**. The free end or tip **116** faces the flat spring fingers **104–104'** but terminates short of the shoulder **112** by a preselected distance for a locking function to be described.

The entire stud **94** may be stamped from a longitudinal flat ribbon of suitable metal which afterwards is folded at the tip of lug section **106**, deformed to form the spring fingers **104–104'** and **114**, and subsequently heat-treated to impart resiliency to the fingers. The stud mount **96** and the pin guide **92** are each made of nonconductive material, such as plastic, and may be conveniently made by a plastic injection molding process.

The stud mount **96** is cylindrical with an annular shoulder **118** sized to fit with slight clearance within the bore **98** of the pin guide. The stud mount has at end **120** a bore of a diameter sized to enclose the inner conductor gripping spring fingers **104–104'** with the bore bottoming at an axially located rib **123** (visible in FIG. 2). The stud mount is provided at the other axial end with a centrally located cross-shaped aperture **122** which is an end of crossing channels **124–124'** partially axially extending along the stud mount. Channel **124** is slightly wider than channel **124'** so that channel **124** may accommodate the tip **116** of the stud-locking finger **114** as explained in relation to FIGS. 2 and 3 hereafter. The width of the channel **124'** is slightly greater than the width of the narrow portion **108** of the flat lug section **106** so that upon insertion of the stud into the stud mount **96**, the stud is concentrically supported in alignment with the inner conductor **102** of the coaxial cable **18** with a portion of the lug section **108** protruding from the aperture **122**. With reference to FIGS. 9 and 10, the stud mount end views of the cross-shaped channel and the opening provided by the inner rib **123** are clearly shown.

With further reference to FIG. 8, the coaxial cable **18** is shown prior to mounting to the case **22**. The coaxial cable is formed of an outer insulator jacket **124** enclosing an annular outer conductor braid **126** and an annular layer of insulating low dielectric material **128** between the central conductor **102** and the braid **126**. The coaxial cable is prepared for insertion into the connector mount **50** by removing the jacket **124**, the braid **126** and the inner insulation material **128** along a predetermined distance B to expose the inner conductor **102** as a pin of preselected length B. The braid, the jacket and the inner insulating material are all cut substantially flush in a common plane, with care being taken that no braid material will short-circuit against the exposed inner conductor.

Such preparation of a coaxial cable is greatly superior to that necessary with conventional coaxial cable connectors. For instance, there is no need to prepare the woven braid in a special manner. All that is needed is to sever the jacket **124**, the braid **126** and the dielectric material **128** at an easily determined location (a distance B from an end of the cable) in a plane substantially transverse to the longitudinal axis of the cable **18**.

With reference to FIG. 12, the frame **32** which supports the microwave network **20**, the connector mount **50** and holds the coaxial cable **18** is made of T-shaped conductive material and is composed of a flat stem portion **129** and a cross-bar section **52** which is shaped to clamp the coaxial cable **18** and which is raised above the flat stem portion **129** to permit proper alignment of the coaxial cable inner conductor with the coaxial cable connector. The cross-bar section **52** is provided with a pair

of threaded apertures **132** for receiving screws **134–134'** and a pair of insulator-jacket-piercing tabs **136** located along a longitudinal cable-receiving channel **138** which serves to partially envelop the coaxial cable. Projecting uprightly from the stem are the pair of upright bendable connector-clamping tabs **52–52'** which are to be bent over the connector **50** as shown in FIG. 7. The stem **129** of the T-shaped frame is provided with optional mounting apertures **140** for mounting of the hybrid transformer coil **48** and for making electrical connection to the frame **32** which, being a conductor, is connected to the grounded braid of coaxial cable **18** by means of the piercing tabs **136**. The tabs **136** are sufficiently long to penetrate the insulating jacket and contact the braid outer conductor beneath it. A clamp **52'** which is similar to the cross-bar section **52** of the T frame **32** is provided with a pair of screw-receiving apertures to permit connection to the cross-bar section **52** in the manner shown in FIG. 7. A pair of rubber spacers are provided to resiliently space the clamp **52'** from the cross-bar section **52** when the screws **134–134'** engage the threaded apertures in the cross-bar. Note that a piercing tab **136** is located in a longitudinal cable-receiving channel **138'** for making electrical contact with the outer braid of the cable **18**.

With the foregoing description, the component parts of the coupling device **10** have been indicated. The simple steps involved in assembling the coupler and connecting it to the balanced twin-lead line, the coaxial cable as well as the antenna are set forth as follows with particular reference to the FIGS. 2, 3 and the specific sectional views thereof.

In a first preassembly step, the microwave network **20** is assembled on the frame **32** without connection to the coaxial cable **18**. Thus, with reference to FIG. 3, the lugs **16—16'**, the hybrid coil **48**, and the connector mount **50** are electrically interconnected and assembled to the flat stem portion **129** of the frame **32**. The hybrid coil **48** is of the conventional balun type with a balanced input from the lugs and an unbalanced output composed of ground lead **144** and lead **146** for interconnection to the flat lug section **106**. The hybrid coil includes ferrite core **148** and an intermediate grounded lead **150**. The grounded leads **144** and **150** are soldered to the stem **129**. The component parts of the connected mount **50** are telescoped together in the manner shown in FIGS. 2 and 3. Note the inner rib **123** which effectively captures the stud **94** upon the latter's insertion in the channel **124'** of stud mount **96** because the lock finger **114** as it is located has its tip **116** immediately adjacent the rib **123** preventing movement of the stud to the right in the plane of the paper. Leftward movement of the stud is prevented by the seating of the shoulder **112**; this shoulder **112** seats onto the side of the rib **123** which is opposite to the side facing the lock finger **114** so that the stud, after insertion into the stud mount, is captured thereby.

The advantage of using a cross-shaped channel in the stud mount may now be appreciated. The tip **116** of the lock finger **114** is resiliently depressed towards the flat surface of the lug section as it is forced past the rib **123**. After passage of the tip **116**, the finger **114** is permitted to resume its natural position which brings the tip **116** into protrusion of the channel **124** which is opposite or substantially transverse to the flat lug section surface from which the finger **114** arises. For this reason, the tip **116** and a portion therefrom along the finger **114** has a width slightly smaller than the width of channel **124**. To further assure capture of the stud by the stud mount, the distance between the tip **116** and shoulder **112** must be slightly greater than the width of rib **123** but not so much larger that excessive axial play of the stud arises. To prevent any such axial play, the rib **123** has its surface opposite the tip **116** slightly tapered as shown in FIG. 2 to assure positive contact between them during capture. Such firm mechanically rigid connection of the stud greatly enhances the electrical performance of the interconnection between the coil **48** and the coaxial cable **18**. The transition from coil to coaxial cable transmission may now be designed with a minimum of reflections and optimum impedance matching. Furthermore, the facility with which the stud **94**, the stud mount **96** and the pin guide **92** fit telescopically together simplifies the installation. The use of a cross-shaped bore in stud mount **96** and a flat lug section **106** which fits in a channel provides positive restraint against rotation of the stud, thus enhancing the mechanical rigidity. Once the inner conductor **102** contacts the spring fingers **104–104'**, the interconnection, although frictionally made, is virtually free from sensitivity due to vibrations.

After installation of the microwave network **20** and the firm retention of the coaxial cable connector **50** by the tabs **54–54'**, the preassembly is located on the bottom **56** of the case **22** as shown in FIG. 2. The lugs are positioned with angled portions in the lug-receiving recesses **80–80'**. The cross-bar section **52** has a snug fit between the coaxial-cable-facing wall **62** and a pair of alignment recessed posts **72**, one of which only is visible in the view of FIG. 3; hence the frame **32** cannot be moved axially by tension in the balanced line and is properly trapped within the case **22**. The stem **129** of the frame has a length which places the tip **152** to a plane flush with the outer side of the twin-lead-facing wall **64**. For this reason the width of the stem **129** is slightly smaller than the width of the frame-receiving aperture **78** (FIG. 7). After placement of the frame **32** in the case **22** without retention by screws and the like, the lid **34** is added and snapped into place with the tongues **68** being snapped over the recessed shoulders **38**.

The placement of the lid completes a second preassembly and firmly accomplishes retention of the lugs **16–16'**, and the stem **129** of the frame **32**. This retention is most clearly illustrated in FIG. 4 .The lug clamp **42** comes down to press upon the lug **16** and the frame-retaining tab **44** contacts the stem **129** near the tip **152** thereof. The lugs **16–16'** are now firmly held between the flat posts and the clamps **42** and the lug-receiving recesses **80–80'**. The alignment pin **40** snugly fits within the recessed post **72** and is provided with a slight taper to aid the guidance of the lid onto the case **22**. With reference to FIG. 3, the lid **34** terminates at a location adjacent the clamp **52'** to permit assembly of the coaxial cable **18** to the coupling device **10** after the lid **34** has been attached.

At this point the twin leads **14–14'** (FIG. 1) or the coaxial cable **18** may be attached, depending upon the situation. Assuming the coaxial cable is to be first connected, the cable **18** is prepared by stripping it as shown in FIG. 8 leaving a portion of exposed inner conductor of a length which will permit electrical contact between the spring fingers **104–104'** and yet is sufficiently short to avoid contacting the flat lug section at **105**. The coaxial cable inner conductor **102** is then inserted into the pin guide **92** at its aperture **100** until the coplanar face formed by the outer jacekt **124**, the braid **126** and dielectric material **128** abuts the conically shaped surface around the aperture **100** of the pin guide **92**.

With reference to FIG. 5, the frame clamp **52'** is then mounted and firmly attached to the cross-bar section **52** with the screws **134–134'**. Since the cross-bar section **52** in the vicinity of the screw mountings is elevated above the bottom **56** of the case **22**, the application of the clamp **52'** could conceivably twist the frame about an axis of the coaxial cable. Accordingly, a pair of cylindrical cross-bar or coaxial cable recessed supporting posts **76–76'** are provided flanking the longitudinal cable-receiving channel **138** of the frame **32**. The recesses in the posts **76–76'** are tapering inwardly so that the screws **134–134'** contact the wall **158** of the recesses in posts **76–76'**. In this manner, twisting motion about the coaxial cable axis is practically eliminated, providing further mechanical rigidity.

With the lid **34** in place, the coaxial cable **18** firmly connected to the frame **32** and proper electrical contact made through piercing tabs **136–136'** between the frame **32** and the braid **126** of cable **18**, with the inner conductor **102** electrically coupled to the stud **94**, and the balanced twin-lead line attached to the lugs with suitable connecting means such as nuts and bolts, the case **22** is ready for mounting to the boom **12** as in FIG. 1 with clip **26**.

The lid-locking case-clutching fingers **24–24'** of the clip **26** face one another with a gap **29** normally between them and which is sized to fit over the cable **18**. The clip is thus placed with the cable in the channel formed between the fingers **24–24'** and the fingers spread apart to fit over the coaxial-cable-facing wall **62** of the case and portions of the side walls **60–60'** to come to rest generally as indicated in FIGS. 2 and 3 near the portions of the side walls which commence to flare outwardly to meet the side edges of the balanced-lead-facing wall **64**.

The lid-locking resilient case-clutching fingers **24–24'** are each provided at the channel-facing sides thereof with a pair of opposing tongues **160** which are sized and shaped to fit within the clip-locking grooves **86–86'** of the side walls **60–60'**. The clip **26**, therefore, is positioned until the tongues **160** snap into the grooves **86–86'**, thus firmly seating the clip onto the case **22** with axial motion of the latter relative to the clip being positively prevented.

The channel length C formed between the lid-locking clutching fingers **24–24'** is so selected that the fingers **24–24'** partially cover the lid **34** as well as the normally exposed section of the case opposite the clamp **52'**. In this manner the lid is positively held to the case and cannot escape; at the same time a cover protection is obtained of the inner part of the case, preventing dust or water from entering the case.

The clip **26** is mounted to the rectangular boom **12** by spreading the boom-gripping fingers **28–28'** apart and permitting overlapping portions **162** of the fingers to hold the entire coupling device **10** to the boom **12**.

Having thus described a novel microwave coupling device and holder therefor, the previously mentioned advantages become readily apparent. The coaxial cable connector is easily assembled but firmly held without mechanical play which may affect the electrical performance. The device is easily mounted to an antenna without requiring complicated mounting metal screws which are likely to rust, thus making repairs simple. The simplicity of the mounting may especially be appreciated by those who must install such devices on outdoor antennas during inclement weather. The device further being made of a highly corrosive resistance substance such as plastic is durable and its small size and insulative characteristics reduce interference problems with the antenna elements.

While the principles of the invention have been described in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of the invention as set forth in the objects thereof and in the accompanying claims.

I claim:

1. A microwave coupler device for interconnecting a radio frequency balanced line to a coaxial cable comprising

a microwave transformer holding case having a coaxial cable receiving aperture and a transformer mounting aperture,

a transformer mounted in the case to couple the balanced line to the coaxial cable,

a lid for covering the transformer mounting aperture, and

a mounting clip having a pair of lid locking resilient clutching fingers enclosing the case and the lid.

2. The device as recited in claim **1** wherein the case and a clutching finger of the clip are provided with a complementary tongue and groove for positive retention of the case and the lid by said clip.

3. The device as recited in claim **2** wherein the lid and case are provided with complementary snap fitting tongues and grooves for snap-in fit of the lid onto the case.

4. A microwave coupler device for interconnecting a radio frequency balanced line to a coaxial cable comprising

a transformer holding case having a coaxial cable receiving aperture, and a transformer mounting aperture,

a microwave transformer mounted in the case for coupling the balanced line to the coaxial cable, a lid sized to cover the transformer mounting aperture of the case, with the periphery of the mounting aperture and the periphery of the lid being provided with a plurality of complementary tongues and grooves sized to mount the lid with snap-like action to the case,

and a mounting clip having a pair of lid locking resilient clutching fingers resiliently enveloping the case and lid to hold the lid and case in unitary assembly.

5. A microwave coupler device for interconnecting a radio frequency balanced line to a coaxial cable comprising

a microwave network holding case made of an insulating material and having a coaxial cable receiving aperture and a microwave network mounted to the case for coupling the balanced line to the coaxial cable,

a removable lid of insulating material fitted with snap-like action to the case for permitting mounting of said network within the case,

a pair of conducting lugs coupled to the balanced line input of the microwave network and protruding from the preassembled case and lid,

a mounting clip of insulating material having a pair of lid locking resilient oppositely disposed fingers clutching the case and lid in unitary assembly,

said preassembled case and lid and one of said fingers being provided with a complementary fitting oppositely disposed tongue and groove for positive locking against rotation and sliding of the case and lid relative to the clip.

6. The device as recited in claim **5** wherein the case is provided with a pair of outwardly facing grooves in opposite sides, and wherein the clip fingers are provided with a pair of inwardly facing tongues sized to fit within the grooves.

7. A microwave coupler device for interconnecting a radio frequency balanced line to a coaxial cable comprising

a microwave network holding rectangular cross-section case of insulating material and having a coaxial cable receiving aperture and formed into a rectangular channel shaped end adjacent the coaxial receiving aperture,

a side of the case being formed by a removable lid to permit mounting in the case of a microwave balanced line to coaxial cable coupling network, said lid covering the case, and

a mounting clip of insulating material having a pair of lid locking resilient oppositely disposed fingers shaped to form a rectangular channel shaped aperture therebetween with the channel aperture sized to fit with interference over the channel shaped case end and the lid.

8. The device as recited in claim **7** wherein the fingers are each provided with a longitudinal tongue protruding into the channel aperture and located in the vicinity of one end thereof, said tongues being oriented substantially to present a longitudinal edge facing the channel axis and wherein the case is provided with a pair of complementary grooves sized and oriented with the tongues of

the fingers to provide positive locking of the case in the channel direction when gripped by the fingers.

9. A microwave coupler device for interconnecting a radio frequency balanced line to a coaxial cable comprising

a microwave coupling network holding case of insulating material and having a substantially flat bottom and a peripheral wall extending upright from the case bottom,

a removable substantially flat lid of insulating material and sized to fit with snap-like action to the edge of the peripheral wall away from the case bottom,

said case forming at one end a rectangular shaped enclosure with a coaxial cable receiving aperture formed in the peripheral wall at said rectangular end,

and a mounting clip of insulating material having a pair of lid locking resilient oppositely disposed fingers shaped to form a rectangular shaped channel aperture therebetween with the channel aperture sized to fit with interference over the channel shaped case and the lid,

said peripheral wall being provided at the channel shaped case end with a pair of upright grooves on opposite channel end sides, and

with said clip fingers being provided with a pair of tongues oriented like the grooves and complementary sized therewith to positively lock the case to the clip.

10. A microwave coupler device for interconnecting a radio frequency balanced line to a coaxial cable comprising

a microwave coupling network holding case of insulating material and having a substantially flat bottom and a peripheral wall extending from the case bottom,

a microwave network mounted in the case for coupling of the balanced line to the coaxial cable, a conductive frame for supporting the microwave network, said frame being mounted adjacent the bottom of the case,

a removable substantially flat lid of insulating material, said lid being sized to fit with snap-like action to a peripheral wall edge away from the case bottom, said lid further having a frame retaining tab extending towards the conducting frame to hold the frame against the case bottom.

11. The device as recited in claim 10 wherein the conductive frame has the shape of a T with a cross-bar section of the T formed with a centered longitudinal coaxial cable receiving channel facing upwardly away from the case bottom to retain a coaxial cable, and a pair of oppositely disposed clamping tabs located on sides of the stem of the T-shaped frame adjacent the cross-bar section for clamping of a coaxial cable connector assembly therebetween.

12. The device as recited in claim 11 wherein the frame is further provided with a coaxial cable piercing tab extending from the channel in the cross-bar section to penetrate the insulation jacket of a coaxial cable and electrically contact the outer conductor thereof.

13. The device as recited in claim 12 wherein the lid extends in length commensurate with the length of the stem of the T-shaped frame to leave a coaxial cable clamping aperture accessible for the mounting of a coaxial cable to the cross-bar section and wherein said retaining tab is located to retain the frame stem at an end thereof away from the cross-bar section.

14. The device as recited in claim 13 wherein the lid and case bottom are provided with a recessed post and an alignment pin sized to fit within the post and placed opposite one another to guide the lid onto the case.

15. The device as recited in claim 14 and further comprising

a pair of lugs projecting from the case at an end thereof substantially opposite to that of the coaxial cable aperture and wherein said lid is provided with a pair of lug clamps for holding the lugs against the case bottom.

16. The device as recited in claim 14 wherein the case is provided with a pair of lug posts mounted on the bottom and each forming a lug-receiving recess to retain a lug inserted therein and wherein the lid is further provided with a pair of lug clamps generally oppositely located from the lug posts and having a length commensurate with that necessary to retain a lug mounted in the lug-receiving recesses.

17. The device as recited in claim 16 wherein the lugs are flat strips of angled conductive material shaped to fit with clearance in the lug-receiving recesses.

18. The device as recited in claim 17 wherein a pair of flat posts project from the flat case bottom and are selectively spaced from a wall of the case to form said recesses therewith.

19. The device as recited in claim 18 wherein said wall of the case is provided with a pair of flat shoulders opposite the flat post for lug support.

20. The device as recited in claim 16 wherein the case is provided with a pair of U-shaped lug-supporting posts mounted on the case bottom and each shaped for receiving a lug between the arms of the U-shaped posts, and

wherein said lugs are shape in the form of angled cylindrical metal studs sized to fit between the arms of the U-shaped posts, and

where the lid is provided with a pair of lug clamps generally oppositely located from the lug supporting posts and having a length sufficient to clamp the lugs mounted between the arms of the U-shaped posts.

21. The device recited in claim 16 wherein a pair of U-shaped posts are mounted adjacent the balanced lead facing portion of the peripheral wall and wherein said wall portion is provided with a pair of recesses spaced opposite to and aligned between the arms of the U-shaped posts to retain the lugs.

22. A connector for coupling a coaxial cable to an electrical network comprising

a conductive stud having at one end a pair of oppositely disposed abuttingly urged conducting spring fingers terminating in an outwardly flared coaxial cable inner conductor guiding section said stud further having at another end a lug section for making electrical contact to the electrical network,

an insulative stud mount having a centrally located bore sized to receive and retain the stud,

an insulative pin guide having a bore extending from one end and sized to enclose the spring fingers said bore terminating short of the other end of the guide, and a coaxial cable inner conductor guiding aperture in the other end of the guide, with said stud mount and pin guide being shaped to telescopically fit to one another with concentric support and enclosure of the stud spring fingers to form an axially aligned coaxial cable connector.

23. The device as recited in claim 22 wherein the conductive stud lug section is flat and composed of a narrow end section and a wider middle section with a shoulder formed terminating short of the other end of the guide, said guide being provided at said other end with a centered coaxial cable inner conductor receiving aperture, said other end further being conically shaped to guide the conductor through the aperture into the guide bore,

a longitudinal stud having at one end a pair of oppositely disposed inwardly urged abutting conducting spring fingers terminating in an outwardly flared coaxial cable inner conductor guiding section, said stud being provided at another end with a flat narrow longitudinal portion and a flat wider middle

portion interconnecting the fingers to the narrow portion, said middle portion forming a retaining shoulder with the narrow portion and said narrow portion being provided with a resilient lock finger cantilever mounted substantially parallel to a surface of the narrow section with the free end of the lock finger facing the spring fingers, the tip of the lock finger and the shoulder of the middle portion being spaced a preselected distance from one another,

a stud mount having a first bore formed at one end and partially extending along the mount for receiving the wider middle portion of the stud and a cross-shaped cylinder bore center in the stud mount and extending from the other end of the stud mount, said cross-shaped counter bore having a width commensurate with the width of the narrow portion of the stud,

said stud mount further having a raised inner rib placed between the end and middle sections to inhibit movement of the stud in a first direction and a resilient lock finger extending from the stud to inhibit movement of the stud in a second direction opposite the first direction.

24. The device as recited in claim **23** wherein the stud mount further includes an inner rib located adjacent the end of the bore for seating of the shoulder between the end and middle lug sections and for locking of the lock spring finger to firmly retain the stud.

25. The device as recited in claim **23** wherein the stud mount bore is channel-shaped to receive the flat lug section with snug fit.

26. The device as recited in claim **24** wherein the stud mount bore is shaped in the form of crossing channels to receive the flat lug section in one channel and provide protrusion by the lock finger in the other channel.

27. The device as recited in claim **24** wherein the stud mount and pin guide are cylindrically shaped with the stud mount provided with an annular shoulder sized to fit within the bore of the pin guide.

28. The device as recited in claim **27** wherein the other end of the pin guide is conically shaped to guide a coaxial cable inner conductor through the aperture in the other end between the abutting spring fingers for electrical contact therewith and seat the coaxial cable.

29. A microwave coupler device for interconnecting a radio frequency balanced-twin-lead line to a coaxial cable having an inner and an outer conductor, comprising

a microwave network including a cylindrical coaxial cable connector coupled to the coaxial cable and a balun coil interconnecting the balanced line to the coaxial cable connector and a conductive frame supporting the balun coil and the connector,

said frame being provided with a body portion forming a coaxial cable section with the coaxial cable connector said coaxial cable section having a diameter and length selected to provide good impedance matching between the balun coil and the coaxial cable.

30. The device as recited in claim **29** wherein the frame is T-shaped, with a cross-bar section sized and shaped to receive a portion of the coaxial cable and a cable clamp shaped like the cross-bar section and mounted thereto for affixing the coaxial cable in axial alignment with the coaxial cable connector.

31. The device as recited in claim **29** wherein the coaxial cable connector further includes

an electrically conductive stud having at one end thereof a pair of oppositely disposed abuttingly urged resilient conducting spring fingers terminating in an outwardly flared coaxial cable inner conductor guiding section and

a cylindrical insulative stud mount supporting the stud concentrically and a cylindrical insulative pin guide telescopically fitted to the stud mount to form a body therewith of continuous cylindrical outer shape with said frame body portion holding the telescopically fitting pin guide and stud mount to the frame with the pin guide in alignment with the inner conductor of the coaxial cable to enable the conducting spring fingers to contact the inner conductor.

32. The device as recited in claim **31** wherein the pin guide has a conically shaped surface with a central aperture and with the surface facing the cable to guide the inner conductor between the spring fingers and seat the coaxial cable outer conductor.

33. The device as recited in claim **30** wherein the coaxial cable section formed between the frame body portion and the connector is larger in diameter than the coaxial cable diameter measured across the outer conductor and wherein said cross-bar section of the T-shaped frame is raised to bring the coaxial cable inner conductor in alignment with the connector.

34. A microwave coupler device for interconnecting a radio frequency balanced twin-lead line to a coaxial cable having an inner and an outer conductor comprising

a microwave network including a cylindrical coaxial cable connector coupled to the coaxial cable and a balun coil interconnecting the balanced line to the connector and a T-shaped conductive frame supporting the balun coil and the connector,

said frame having a longitudinal stem portion and a cross-bar section at one end thereof to receive a portion of a coaxial cable with a pair of bendable connector conducting retainer tabs arising from the stem portion and bent over the coaxial cable connector for retention thereof and to form therewith a coaxial cable section of a diameter and length selected to provide good impedance matching between the balun coil and the coaxial cable,

an insulative case for holding the microwave network and having a substantially flat bottom and a peripheral wall extending upright from the bottom with said peripheral wall including a balanced lead facing wall and a coaxial cable facing wall and a pair of side walls,

an insulative lid sized to fit with snap-like action to the peripheral wall upper edge and a pair of aligned complementary fitting alignment pins and recessed posts selectively mounted to the lid and case bottom to properly guide the lid onto the case, said pair of complementary fitting pins and recessed posts being spaced from the coaxial cable facing wall and from one another for snug fitting of the cross-bar section of the frame between the coaxial cable facing wall and the complementary fitting pins and posts for axial retention of the frame.

35. The device as recited in claim **34** wherein said lid is provided with a frame-retaining tab for retaining the frame against the case bottom.

36. The device as recited in claim **34** wherein the balanced lead facing wall has a frame-receiving aperture and wherein the stem portion of the frame extends to within said frame-receiving aperture and wherein said lid is provided with a frame-retaining tab size and shaped to fit within the frame-receiving aperture to retain the frame against the case bottom.

37. The device as recited in claim **34** wherein the lid has a length terminating short of the cross-bar section of the frame for exposure thereof and enabling the attachment of the coaxial cable.

References Cited

UNITED STATES PATENTS

2,694,183	11/1954	Edlen et al.	339—97X
3,357,023	12/1967	Hemmie	333—25X

ELI LIEBERMAN, Primary Examiner

M. NUSSBAUM, Assistant Examiner

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