Sept. 8, 1970 — A. R. BRISHKA — 3,528,052

RIGHT ANGLE CONNECTORS

Filed May 13, 1968 — 2 Sheets-Sheet 1

FIG. 1

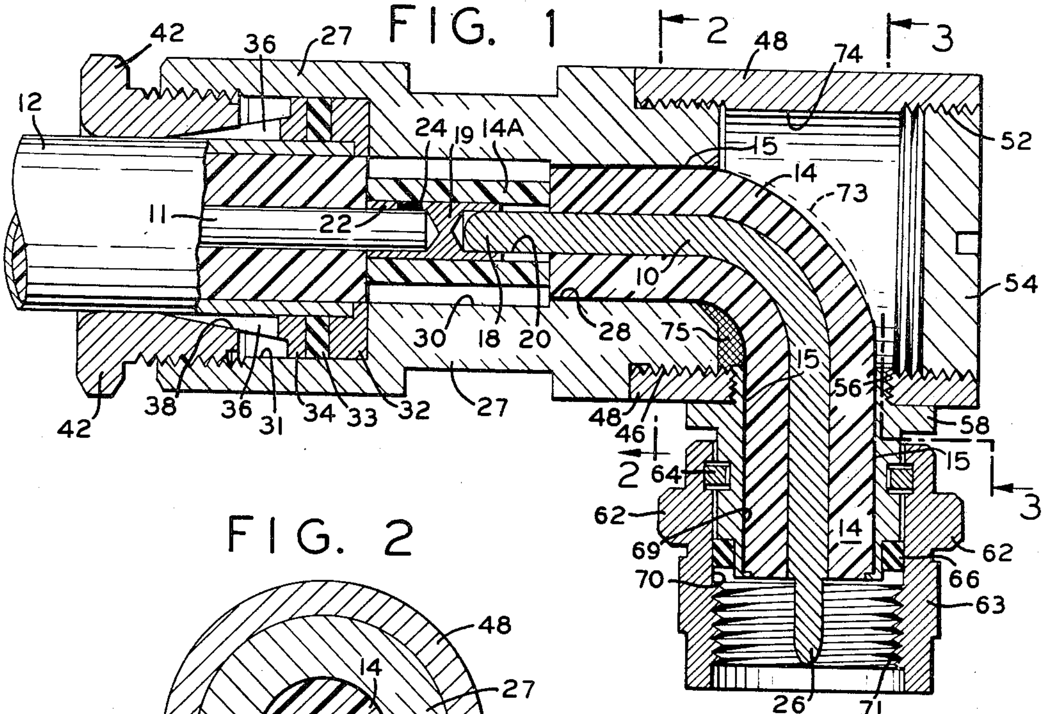

FIG. 2

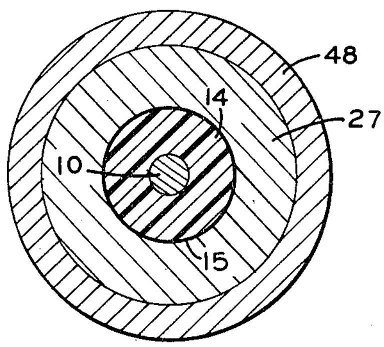

FIG. 3

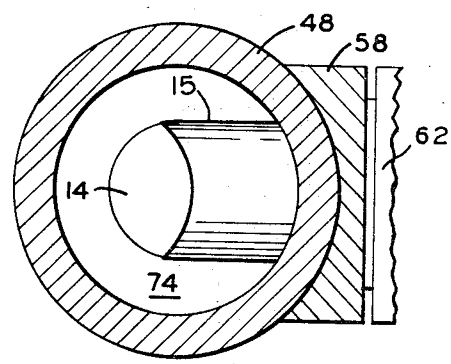

FIG. 4

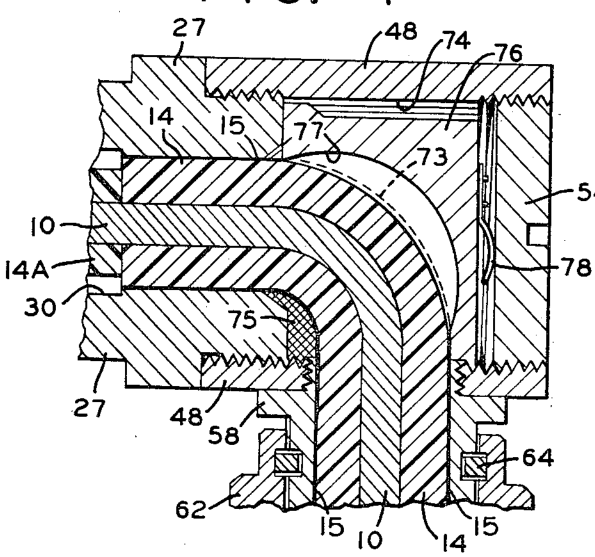

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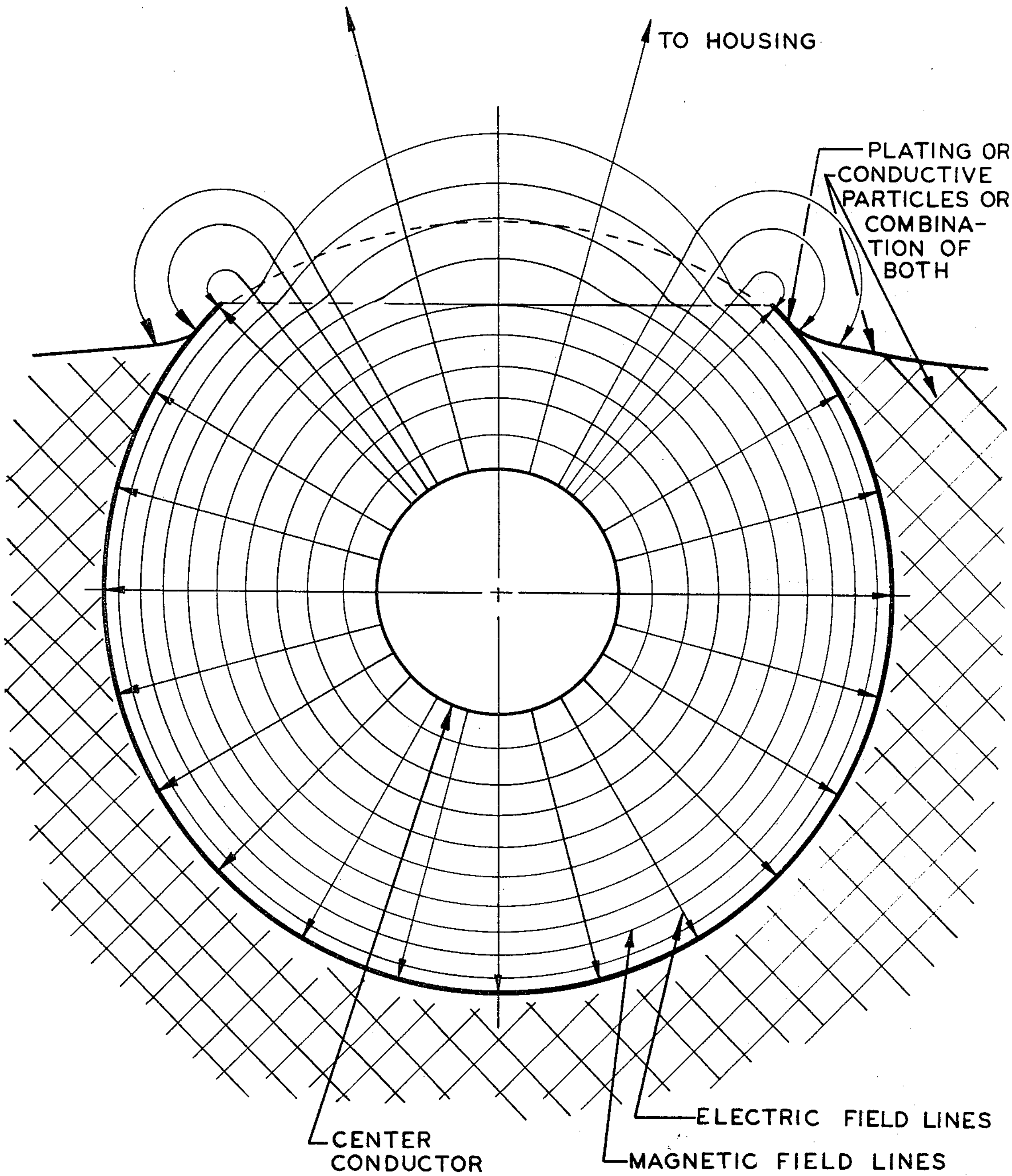
FIG. 5



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RIGHT ANGLE CONNECTORS

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Continuation-in-part of application Ser. No. 659,729, Aug. 10, 1967. This application May 13, 1968, Ser. No. 728,648

Int. Cl. H01r *17/18*

U.S. Cl. 339—177 4 Claims

ABSTRACT OF THE DISCLOSURE

A right angle coupling for high frequency concentric lines includes a conductive housing having coupling means at either end. An air cavity adjoining a bend in the insulation on the central conductor corrects for a bad impedance match and reduces wave reflection.

This application is a continuation-in-part of my copending application Ser. No. 659,729, filed Aug. 10, 1967, and now Pat. No. 3,432,798.

This invention relates to angular electrical connectors and more particularly to right angle coupling units used for high frequency signals.

An object of the present invention is to provide an angular connector for concentric lines having improved electrical characteristics. Another object is to provide an improved right angle connector which eliminates, as far as possible, impedance discontinunities and thereby excludes wave reflections at the connector.

The usual practice in forming angular or elbow connectors has been to use a two piece contact and insulator design to form the right angle and then solder the two straight contacts together. The cavity surrounding the joint is then filled with insulating material, or the cavity may be left unfilled with air acting as the dielectric. This device gives poor electrical performance due primarily to the varying relationships between the outer diameter of the inner conductor and the inner diameter of the outer conductor.

The present invention provides a right angle connector with the usual cylindrical insulation provided for the concentric line. At the portion of the line where both the inner conductor and its cylindrical insulation covering are bent at an angle, the outer covering is always stretched to a considerable degree and for this reason its thickness is reduced, thereby changing the impedance of the line, and introducing wave reflections. An attempt has been made to solve this difficulty by packing finely divided conductive material around the bend and thereby simulate a continuous outer conductive coating. This means, while eliminating part of the trouble, does not completely solve the problem because the conductive material is then closer to the inner conductor due to the fact that the insulation has been diminished at this point. One method of eliminating this discontinuity is to omit the finely divided material but provide an enclosing conductive structure filled with air as the dielectric insulating covering. This type of structure generally overcompensates for the change in impedance and, to produce a nonreflective coupling, a portion of the conductive plating and some of the insulation at the bend is removed by means of a file or other cutting tool. Still another compensating means is to provide a similar enclosing structure and insert a conductive filler next to the reduced insulation. The portion of this conductive filter and/or plating which is adjacent to the bend must be hollowed out and/or removed at the apex of the bend so that a variable air space is supplied to that portion of the line.

In the drawings:

FIG. 1 is a central longitudinal cross section taken through a right angle connector embodying one form of the invention;

FIG. 2 is a cross sectional view of the connector shown in FIG. 1 and is taken along line 2—2 of that figure;

FIG. 3 is a cross sectional view of the connector shown in FIG. 1 and is taken along line 3—3 of that figure;

FIG. 4 is a cross sectional view of a portion of the connector shown in FIG. 1. This view shows a conductive insert having a cut-out portion which produces a variable air gap;

FIG. 5 is a graph showing the approximate directions of the lines of force in the electric field when a portion of the plating has been removed from the insulator and there is no adjoining conductor.

The right angle connector shown in FIG. 1 employs a single contact conductor **10** of substantially the same diameter as the central conductor **11** of a coaxial cable **12**, the contact being enclosed in an insulating sleeve **14**. The insulating sleeve **14**, enclosed in conductive portions **27** and **69** of the coupling components, forms an adequate outer conductor for a wide range of high frequencies without serious power loss. However, when the transmitted power frequency is above 10^9 Hz., the losses are excessive and it has been found necessary to surround the insulating sleeve in the region of the bend with conductive particles or plating or a combination of both in order to provide a continuous conductive path between portions **27** and **69**. The plating may be either silver or gold or some other metal.

One end of the contact **10** may have a reduced or rounded terminal section **18** which is received in force fit relationship in a female contact having a solid central section **19**, a slotted bore **20** to receive the contact and a bore **22** at its other end to receive the central conductor **11**. Section **19** is surrounded by a cylindrical insulator **14A**. The wall of bore **22** may have an opening for outgasing purposes as well as to receive a drop of solder shown at **24**. The other end section of the contact is rounded and is of reduced diameter near its end **26** in order to be received in a female contact (not shown) for connection with another coaxial cable.

A tubular body **27** receives one end of the insulated right angular contact and, at one end, it has a bore **28** for receiving one end of the insulated covering **14**. The inner end of bore **28** is chamfered at the end of the bore to facilitate the entry of the insulated contact. The section of the tubular body **27** adjacent to the end of the central contact **10** is enlarged slightly as indicated at **30** and an additional enlarged bore indicated at **31** is provided for an insulating washer **33** positioned adjoining to a metal bushing **32**. A similar metal bushing **34** is positioned on the other side of washer **33** and these three units are clamped into place by a short length of pipe having threads which mesh with internal threads on body **27** and a wrench receiving extension **42** for screwing into place. The washer **34** is formed with slotted wedge-like projections **36** which fit against a tapered section **38** of the internal surface of the pipe **42** and thereby facilitates a close fitting between the body **27** and the external surface of conduit **12**. The opposite end of this body member **27** has a reduced threaded section **46** which receives a sleeve **48** internally threaded to receive section **46**. Sleeve **48** is also internally threaded at its other end **52** to receive a closure plug **54**. The lower portion of sleeve **48**, when viewed as in the drawing, has a threaded hole **56** to receive a reduced threaded terminal **58** of a tubular body whose axis is at right angles to the major axis of body member **27** and has an upper flange which is screwed tight against its adjoining portion of member **27**.

A coupling nut **63** is formed with a wrench receiving surface **62** and is connected to body **58** by a split locking ring **64** positioned in aligned annular slots formed in members **58** and **62**. Body **58** has a bore **69** of such size as to receive the insulation **14** of the contact in snug fit. A sealing gasket **66** is positioned in a recess **70** near the outer end of body **58**, thus providing a seal between the body **58** and its coupling nut **63**. An internal thread **71** is provided on the inside portion of the nut **63** for connection to another coupling unit.

When bending the conductive portion **10** at right angles the outer insulation, which may be Teflon, is elongated and for this reason its thickness is reduced. In FIG. 1, the normal extent of the insulation is shown by dotted line **73**. Since there is always a reduction in thickness, a compensation means must be provided to maintain substantially constant impedance along all portions of the line. The conductive plating **15** is removed from this part of the insulation and the hollow portion **74** within the sleeve **48** is used to provide this compensation because the distance between the center conductor and the surfaces of cavity **74** is greater than the distance between the center conductor and the plating adjacent to the exposed Teflon insulating material. The sleeve **48** and the plug **54** are both conductive and the air portion inside cavity **74** acts as additional insulation which is added to that portion of the Teflon insulating **14** adjoining it. The electrical field lines existing in the region of the removed plating will terminate on the outer conducting surface of the plating in the immediate vicinity of the unplated portion of the insulating material as shown in FIG. 5. The increase in the length of the electric field lines results in an increased impedance section, thus providing a means of compensation for the impedance discontinuity and reduction of wave reflection.

Referring now to FIG. 4, the structure is similar to that shown in FIG. 1 except that a conductive insert **76** has been added to the cavity **74** formed by the inside surface of sleeve **48**. The insert **76** is formed with a concave surface **77** which is generally in the form of a portion of a sphere and this portion, as shown in FIG. 4 fits over the insulation covering **14** where it has been reduced in thicknes. As before, the air space between the Teflon covering **14** and the conductive boundary **77** of the air space compensates for the change in impedance caused by stretching the insulation. A flat spring **78** may be added to the insert **75** in order that the closure plug **54** may retain the insert in conductive contact with the cylindrical body **27** at all times. In this embodiment, as illustrated in FIG. 4, compensation is achieved in a different manner, viz., the electric field lines in the region of the bend terminate on the concave surface of the insert.

While there have been described herein what are at present considered preferred embodiments of the invention, it will be obvious to those skilled in the art that many modifications and changes may be made therein without departing from the essence of the invention. It is therefore to be understood that the exemplary embodiments are illustrative and not restrictive of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An angular connector for joining two sections of a concentric conductor comprising a single central conductor with end contact portions and formed with an angular bend covered with solid insulation between its contact portions, a main tubular body having a bore to receive one end of the insulation and having a first terminal portion to receive another conductor, an inner conductive extension of said main body, axially aligned therewith, and enclosing the bend portion of the central conductor and its insulation covering, conductive closure means at the outer end of said extension, said extension and said closure means defining an air space adjoining the insulation covering on the convex bend portion, a conductive insert positioned in said space and formed with a concave surface adjacent to the convex surface of the insulation at its bent portion for providing a restricted air space which compensates for the change in impedance due to the reduced thickness of solid insulation at the bend, said extension having a side wall opening and a conductive tubular extension secured in the opening at an angle to the main tubular body for supporting the other end of the central conductor and its insulation and for forming a second terminal portion.

2. A connector as claimed in claim **1** wherein said concave surface in the insert is formed with the shape of an ellipse.

3. A connector as claimed in claim **1** wherein said insert includes edge portions bordering the concave space which are substantially adjoining the insulation on the central conductor.

4. A connector as claimed in claim **1** wherein said insert is provided with a resilient means for holding at least one edge portion in conductive contact with the main tubular body.

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