United States Patent [19]

Treczka

[11] **3,849,743**

[45] **Nov. 19, 1974**

[54] **DIRECTIONAL QUARTERWAVE COAXIAL COUPLER HAVING MEANS TO AXIALLY MOVE THE COUPLING CONDUCTORS**

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[22] Filed: **Sept. 25, 1973**

[21] Appl. No.: **400,658**

[30] **Foreign Application Priority Data**

Sept. 28, 1972 Germany 2247687

[52] **U.S. Cl.** **333/10,** 333/33

[51] **Int. Cl.** **H01p 5/02**

[58] **Field of Search** 333/10

[56] **References Cited**

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[57] **ABSTRACT**

The specification describes a directional coaxial coupler with a coupling range of two mutually parallel lines in a common external line, whose coupling length amounts to Lambda/4. An external line is coordinated with the internal lines extending from the bend.

10 Claims, 3 Drawing Figures

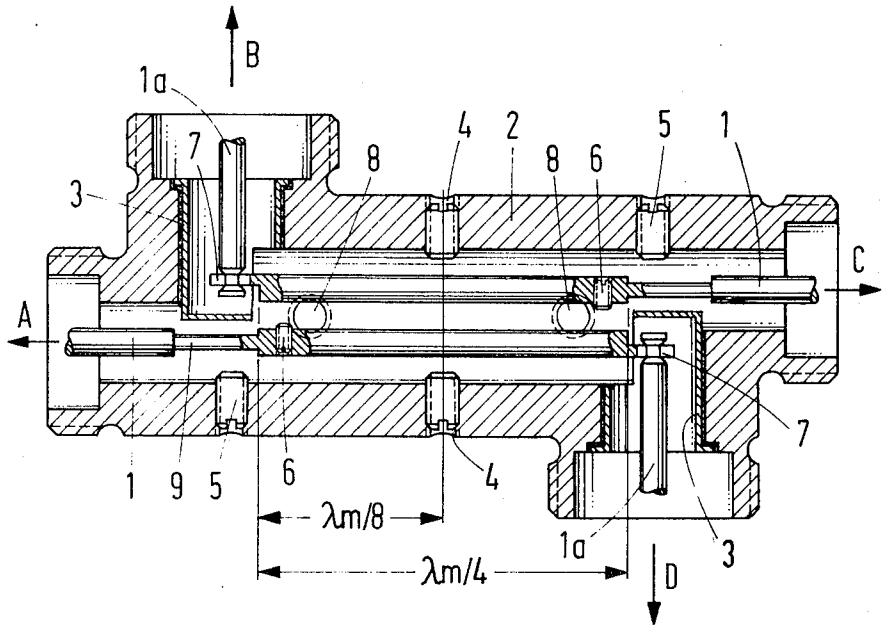


Fig. 1

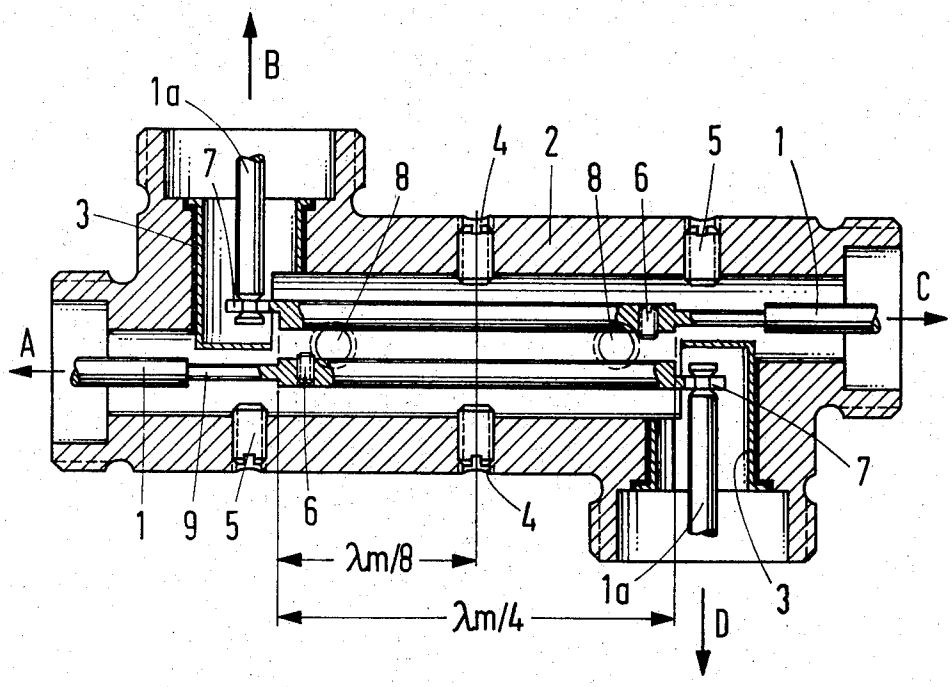


Fig. 2

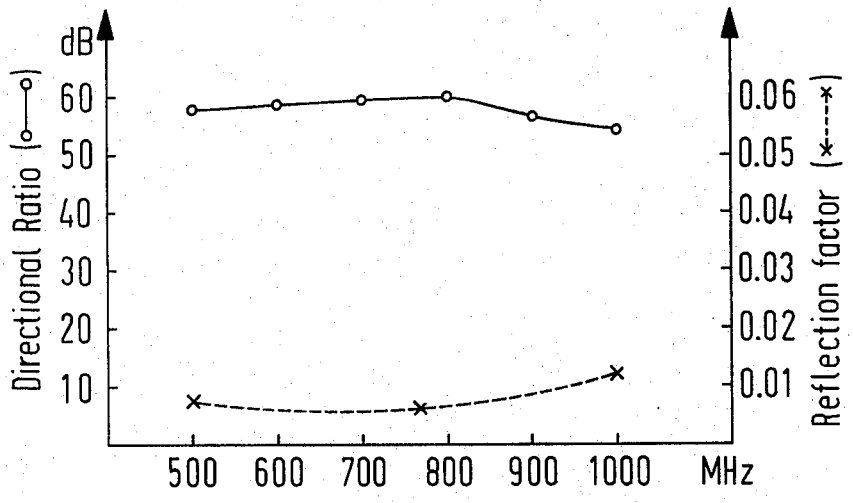
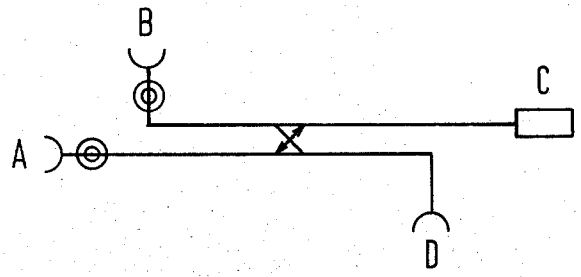

dB
60
50
40
30
20
10
Directional Ratio (o—o)
0.06
0.05
0.04
0.03
0.02
0.01
Reflection factor (×---×)
500
600
700
800
900
1000
MHz

Fig. 3


B
C
A
D

DIRECTIONAL QUARTERWAVE COAXIAL COUPLER HAVING MEANS TO AXIALLY MOVE THE COUPLING CONDUCTORS

BACKGROUND OF INVENTION

1. Field to Which Invention Relates

The invention relates to a coaxial directional coupling with a coupling zone of two mutually parallel lines in a common outer line, whose coupling length amounts to Lambda/4.

2. The Prior Art

Prior art directional couplings have been manufactured with a directional ratio of 40 and 45 dB respectively for a frequency range of f_1 to f_2 of 1:2. This directional ratio is, however, not sufficient for many measurements.

Directional couplings for measuring purposes are preferably manufactured with a coupling damping of 10 dB. The length of the coupling zone for the mean operational frequency is equal to Lambda/mean/4.

It is generally known that the coupling length can be adjusted by the arrangement at an angle of one respective line. At the ends of the coupling zone dispersion or loss coupling effects occur owing to the bending of the angle internal line. These dispersion coupling effects of the electric and magnetic field have a disadvantageous effect as regards a satisfactory directional ratio. Without adopting special measures at this edge zone it is only possible to achieve a directional ratio of approximately 40 dB.

SUMMARY OF INVENTION

One aim of the invention is to provide a coaxial Lambda/4 directional coupler with an improved directional ratio while at the same time achieving a good reflection factor in the frequency range between 450 and 5,000 MHz.

In accordance with one aspect this aim is achieved in accordance with the invention in that the internal lines extending away from a right angle bend are provided with an external line or duct as well. This external line, which can be separately inserted makes possible the field separation of the two coupled lines at the position adjacent to the angled or bent internal line segments.

For the frequency range of f_1 to f_2 of 1:2 f_1 being less than 2.5 GHz and when f_1 is greater than 2.5 GHz with f_1 to f_2 being equal to 1:1.6 the invention makes it possible to produce directional couplings with a directional ratio of more than 50 dB and to keep the passage reflection factor less than 1.5 percent.

The disturbance or impedance discontinuity owing to the external line inserted for the straight lines is corrected by reducing the internal line dimension. By bringing the external line insert very close to the two internal lines adjacent to the separation plane and the beginning of the coupling zone electric field lines are caused to pass to the external line insert. This part of the electric field is lost to the coupling zone. In accordance with the invention this difficulty is overcome by arranging a pin screw in this coupling zone extending crosswise through the straight internal line. The screw can be so set on matching the directional coupling that over a large frequency range the directional ratio of 50 dB can be obtained.

In the case of a directional coupling with a directional ratio of more than 50 dB it is necessary to fix the

absorber for the leading energy in the coupled line. In accordance with the invention for the connection of the absorber and of the measuring connection the same input of the directional coupling is employed. These inlets are arranged in straight lines, which can be produced very accurately, since the reflection factors in respect of these sections of the line enter into the value of the directional ratio. In the case of a directional ratio of 40 dB a reliable value of the reflection factor of 0.15 percent can be achieved for both straight inlets. The reflection factor is the ratio of the power reflected on the line in relation to the forward propagating power.

In the case of tolerances which can be obtained at reasonable costs for the manufacture of the individual parts it is necessary to provide for fine matching by matching screws in the external line.

In order to be able to mount the straight internal lines in a simple manner and to connect them in a stress-free manner mechanically with the angled or bent line segment, the straight inner line is constructed as a fork contact, which makes electrical contact in a projection, produced by machining, of the angled or bent line segment.

Owing to the overall effect of the various tolerances of the individual parts it is necessary to measure the parallelism and mutual spacing in the case of the two coupled lines in the assembled condition. For this purpose holes are provided in the external line.

LIST OF SEVERAL VIEWS OF DRAWINGS

In what follows an embodiment of the invention will be described with reference to the drawing.

FIG. **1** shows a sectional view of a coaxial Lambda/4 directional coupler constructed in accordance with the invention.

FIG. **2** shows measurement curves of the directional ratio and of the reflection factor in a frequency range between 500 and 1,000 MHz.

FIG. **3** shows a block circuit diagram of the directional coupler.

DESCRIPTION OF PREFERRED EMBODIMENTS

The directional coupling possesses straight connections A and C for the measurement connection and absorber, respectively. It is also provided with connections extending from the bend, these connections being denoted by B and D. In the common external line housing the straight inner lines **1** are mounted so that they can be moved axially. In the coupling range of Lambda/4 they are precisely parallel and have a predetermined spacing between them. At the inner ends these straight inner lines **1** are connected with the inner lines or line segments **1a**, branching off at the angle at 90°, via a fork contact **7** arranged on the straight inner line. This fork contact **7** makes electrical contact in a projection, produced by machining, on the angled inner line segment **1a** and allows axial displacement.

The angled internal lines **1*a*** are respectively surrounded by a separately insertable external line **3**, which makes possible the field separation of the two coupled lines at a position adjacent to the angled internal lines and is preferably connected with the external line basic body **2** by means of a conducting adhesive.

In the external line **2** for each internal line two matching screws **4** and **5**, respectively, are provided, of

which the grub screw **4** is located in the center of the coupling zone and the grub screw **5** is arranged opposite the line segment extending at an angle from the bend.

In the zone of the coupling length Lambda/4 the two internal lines **1** have a threaded hole extending transversely through them with an adjustable grub screw **6** and these two screws are capable of being adjusted externally by means of a respective hole, which can be closed, in the external line **2.** In the external line **2,** furthermore, in the end zone of the coupling zone two checking holes **8,** which can be closed, are provided, through which it is possible to measure the two coupled lines as regards parallelism and mutual spacing in the assembled condition.

The Z-disturbance or impedance discontinuity owing to the inserted external line **3** for the straight lines at the connections A and C is corrected by a section **9,** reduced in diameter at this position, of the internal line. Owing to the very close positioning of the inserted external line **3** to the two inner lines adjacent to the separation plane and the beginning of the coupling zone electric field lines are conducted in the external line **3;** this part of the electrical field is lost in the coupling zone and the disturbance is compensated for by the corresponding setting of the pin screws **6,** which on matching the directional coupling are so set that over a large frequency range the directional ratio of 50 dB is obtained.

The absorber connected at the connection C for the leading energy of the coupled line is constructed as a metal layer resistor in accordance with a preferred embodiment of the invention. The connection of the absorber at C and the block diagram representation of the directional coupler are illustrated in FIG. **3,** with the magnetic coupling between the parallel straight coupling portions indicated by arrows.

The measurement curves in FIG. **2** show that in the case of a directional coupling in accordance with the invention in the frequency range between 500 and 1,000 MHz a directional ratio of 50 dB is fulfilled with a low reflection factor. This graph only indicates the measured data in the case of one embodiment of the invention. In accordance with the invention directional couplings with such a directional ratio can be constructed in a frequency range generally between 450 and 5,000 MHz.

I claim:

1. A coaxial directional coupling for coupling electromagnetic energy at microwave frequencies, comprising an elongated coupler body of electrically conductive material having opposite ends each provided with an end connector opening and having an elongated main bore therethrough communicating with said end connector openings, said body having a lateral branch connector opening adjacent each end thereof opening in opposite directions and first and second branch bore sections communicating the main bore with the branch connector openings along branch bore axes perpendicular with the longitudinal axis of the main bore, first and second straight internal main conductors disposed in adjacent parallel lapping relation over their major length paralleling the main bore axis each having an outer end extending through a'diferent one of the end connector openings and an inner end portion crossing and terminating near the branch bore axis farthest from its outer end, said main conductors being axially movable in said main bore to provide quarter wavelength parallel lapping portions of variable length for different frequencies, a branch internal conductor extending axially through each branch bore perpendicular to said main conductors in respective opposite directions having an outer end projecting through respective ones of said branch connector openings and inner ends joined to the inner end portions of said main conductors, movable connection means at the inner ends of said main conductor and branch internal conductors permitting axial movement of the main conductors relative to the branch conductors while maintaining electrically conductive contact therebetween.

2. A coaxial directional coupler as defined in claim **1,** wherein each of said main conductors has an adjustable screw threaded therein adjustable along an axis perpendicular to the main conductor axis inwardly adjacent the inner end of the other main conductor for varying the effective distance from each main conductor to the other main conductor.

3. A coaxial directional coupler as defined in claim **1,** wherein each of said main conductors has a longitudinal section of reduced cross section adjacent to the inner end of the opposite main conductor for wave resistance matching.

4. A coaxial directional coupler as defined in claim **1,** including a pair of matching screws for each internal main conductor threaded into said body and extendable into the main bore adjacent their associated main conductor, one of the screws of each pair being located at the middle of the lapping portion of the main conductors and the other screw of each pair being axially alined with the opposite branch internal conductor.

5. A coaxial directional coupler as defined in claim **1,** wherein said movable connection means comprises a circumferential groove in the end portion of each branch connector and a bifurcated end formation on the end portion of the main conductors defining a slot slidably receiving the groove portion of the associated branch conductor in sliding contact therein.

6. A coaxial directional coupler as defined in claim **1,** including a cup-like cylindrical insert sleeve of electrically conductive material located in each of said branch bores to effect field separation of the main conductors adjacent the branch internal conductors, said sleeve including a cylindrical wall interrupted for passage of an associated main conductor thereinto concentrically surrounding its associated branch internal conductor in electrically conductive contact with the walls of the associated branch bore and including an end wall located between the end of its associated branch conductor and the opposite main conductor.

7. A coaxial directional coupler as defined in claim **6,** wherein each of said sleeves is secured in contact with the portions of said body forming the walls of their respective associated branch bores with electrically conductive adhesive.

8. A coaxial directional coupler as defined in claim **6,** wherein each of said main conductors has an adjustable screw threaded therein adjustable along an axis perpendicular to the main conductor axis inwardly adjacent the inner end of the other main conductor for varying the effective distance from each main conductor to the other main conductor.

9. A coaxial directional coupler as defined in claim **8,** wherein each of said main conductors has a longitudinal section of reduced cross section adjacent to the

inner end of the opposite main conductor for wave resistance matching.

10. A coaxial directional coupler as defined in claim **9,** including a pair of matching screws for each internal main conductor threaded into said body and extendable into the main bore adjacent their associated main conductor, one of the screws of each pair being located at the middle of the lapping portions of the main conductors and the other screw of each pair being axially alined with the opposite branch internal conductor.

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