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[54] BROADBAND END COUPLING

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[51] **Int. Cl.** **H01p 1/16,** H03n 7/38

[58] **Field of Search** ..... 333/21, 21 A, 27, 35, 98, 34

[56] **References Cited**

UNITED STATES PATENTS

2,845,601 7/1958 Jaffe ..... 333/73 W X

2,976,498 3/1961 Locus ..... 333/73 S X

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[57] **ABSTRACT**

A broadband end coupling arrangement for coupling a coaxial transmission line into a waveguide. The coupling is achieved by providing the center conductor of the coaxial line, which extends axially into the waveguide, with a transverse coupling pin the face of which forms an adjustable capacitor with the oppositely disposed waveguide wall, and by providing at least one bar which is parallel to the center conductor and connected at one of its ends to the free end of the center conductor via a crossbar and at its other end to the outer conductor of the coaxial line so that the length of the coupling loop from the coupling loop to the outer conductor via the crossbar and the additional bar is approximately ¾λ.

8 Claims, 3 Drawing Figures

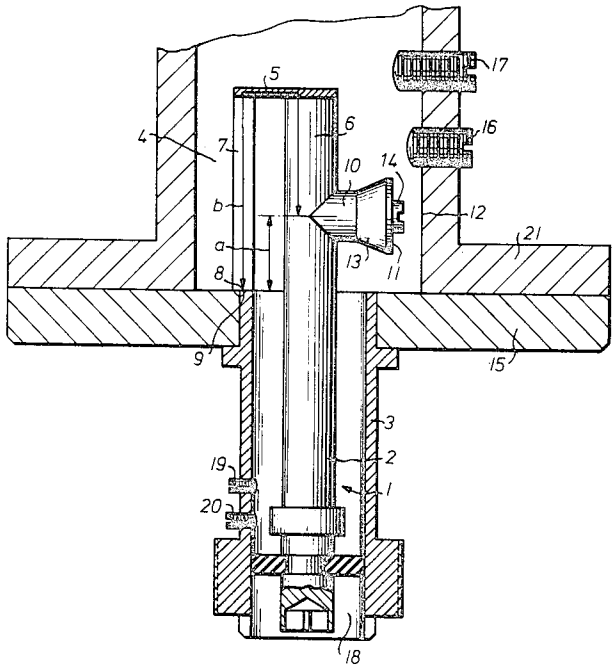


Fig. 1

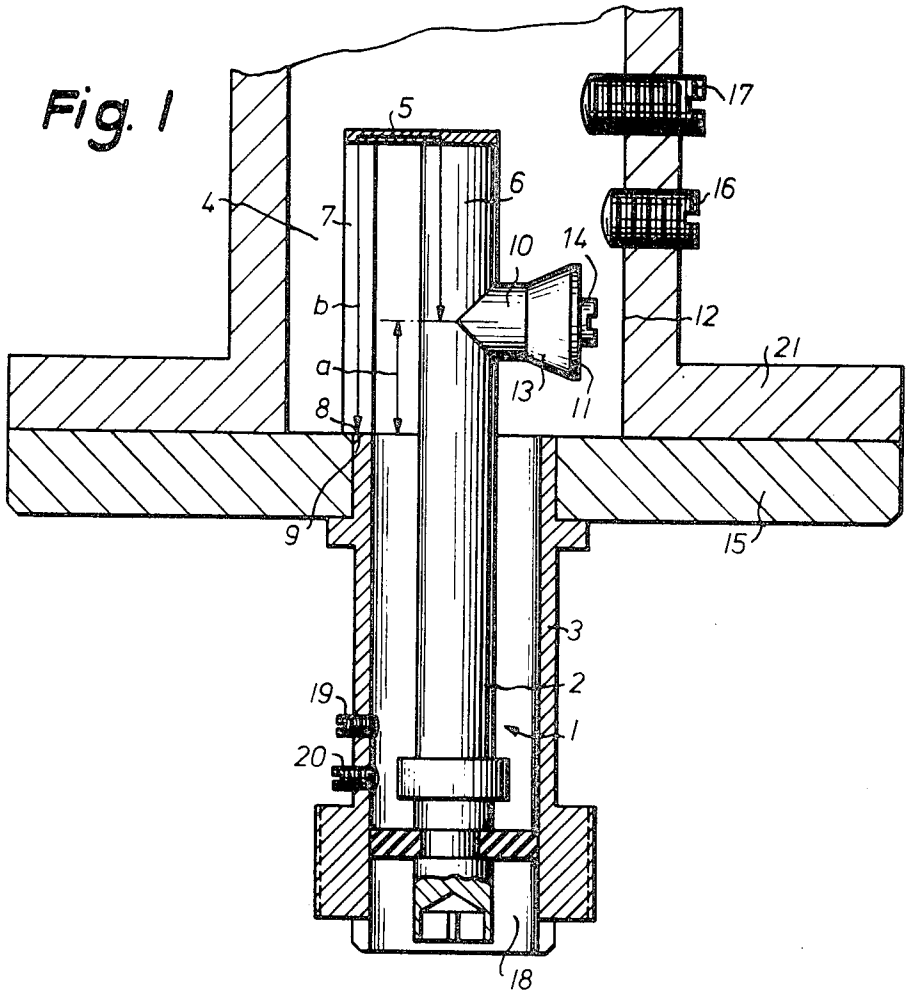
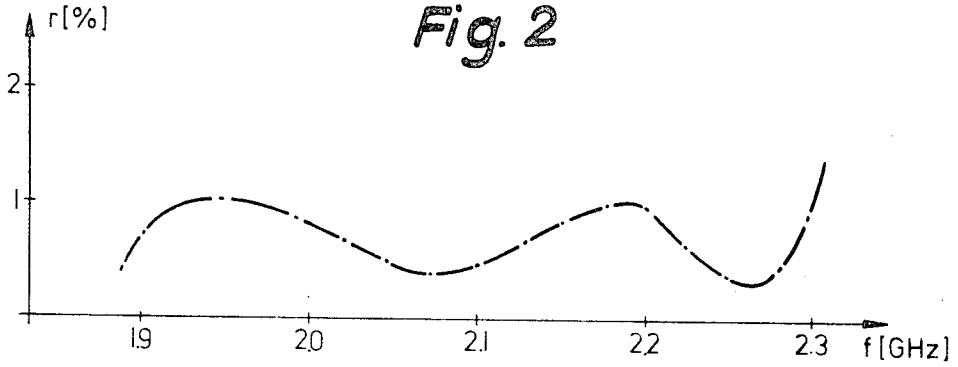


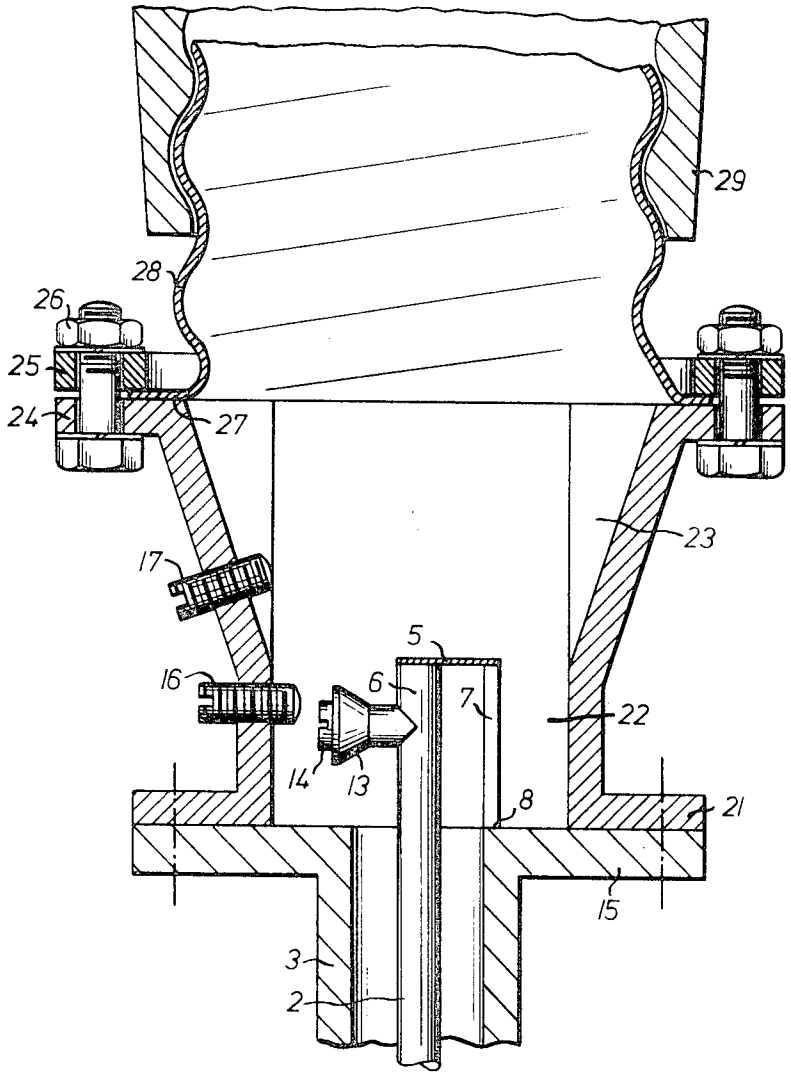
Fig. 2



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Fig. 3



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BROADBAND END COUPLING

BACKGROUND OF THE INVENTION

The present invention relates to a very broadband end coupling for coupling a coaxial line into a waveguide, particularly into an elliptical corrugated waveguide.

End couplings for such purposes are known per se and are so designed, for example, that a coupling element which effects the excitation of the desired waveform is inserted into the waveguide coming from the coaxial line through the frontal face of the waveguide. The coupling itself was usually a so-called crossbar. The realizable bandwidth with such couplings was approximately 10 percent. The drawback of these arrangements is the low bandwidth and the relatively complicated mechanical structure.

SUMMARY OF THE INVENTION

The drawbacks of the prior art couplings are eliminated according to the present invention in that the inner conductor of the section of a coaxial line extends axially beyond the outer conductor and is mounted so that is extends axially into the waveguide section. The free end of the inner conductor is provided with a crossbar, and at least one conductive bar, which extends parallel to the extended portion of the inner conductor, is provided whose ends are respectively connected with the end of the outer conductor of the coaxial line and the crossbar. A coupling pin is attached to the to the extended portion of the inner conductor which extends perpendicular thereto so that its frontal face will form an adjustable capacitance with the oppositely disposed wall of the waveguide. The coupling pin is attached to the inner conductor at an axial spacing from the outer conductor so that the length of the coupling loop extending into the waveguide section from the coupling pin to the end of the outer conductor via the crossbar and conductive bar is approximately $\frac{3}{4}\lambda$.

According to other features of the invention, the section of waveguide and the section of coaxial line are fastened together to form a single structural unit.

According to still a further feature of the invention the section of waveguide is an adapter of the type utilized for connecting an elliptical waveguide to a standardized rectangular cross section waveguide.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of a broadband coaxial line to waveguide end coupling according to the invention.

FIG. 2 is a curve of reflection factor verses frequency for an end coupling according to the invention.

FIG. 3 is a cross-sectional view of an arrangement of the invention with an elliptical corrugated waveguide.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows a sectional view of the end coupling constructed according to the present invention. The section of a coaxial line **1**, with its inner conductor **2** and its outer conductor **3**, is provided at one end with a plug-in coupling **18** for connecting it to further sections of coaxial line, not shown. At its other end, the section of coaxial line **1** is connected with the section of a waveguide **4**. The end **6** of the inner conductor **2** extends axially beyond the outer conductor **3** and axially into the end of waveguide section **4**. A crossbar **5** is attached at the frontal face or free end of the extended portion **6** of the inner conductor **2** and produces a conductive connection with a conductive bar **7** which extends parallel with the extended portion **6** of the inner conductor **2**. The other end **8** of bar **7** i.e., the end which faces away from crossbar **5**, is conductively connected with the end **9** of the outer conductor **3**. At a predetermined axial spacing a from the foot end **8** of bar **7**, i.e., the end **9** of outer conductor **3**, a coupling pin **10** is attached to the extended portion **6** of the inner conductor **2** which pin **10** extends perpendicular to the inner conductor **2**. This coupling pin **10** forms an adjustable capacitance between its frontal face or end **11** and the oppositely disposed waveguide wall **12**. In the illustrated embodiment the adjustment is made by a screw **14** which is disposed on the frontal face **11**. The coupling pin **10** is preferably conically widened in the direction toward the waveguide wall **12** in order to produce a sufficiently large frontal area **11**. The coupling pin **10** is attached to the inner conductor **2** so that the length b of the coupling loop from coupling pin **10** to the end of the outer conductor **9**, or the foot **8** of the bar **7**, via the crossbar **5** and bar **7** is approximately $\frac{3}{4}\lambda$. The already mentioned axial distance a of the coupling pin **10** from the foot of bar **7** lies between $\lambda/8$ and $\lambda/4$.

The waveguide section **4** is provided with a flange **21** at its end in a known manner while the section of coaxial line is provided with a corresponding mating flange **15** which closes off the end surface of the waveguide section **4** so that the two sections may be connected together. Preferably, as illustrated, the section **1** of the coaxial line, together with the coupling loop, and the waveguide section **4** are constructed as a structural unit so that the entire arrangement can be connected with a further waveguide section in a simple manner. The screws **16** and **17** shown in FIG. **1** as being in the wall **12** of the waveguide serve in a known manner for fine tuning, as do the tuning screws **19** and **20** shown in coaxial line section **1**.

Preferably only one conductive bar **7** is provided which, with square or round waveguide sections, passes on the side of the extended portion **6** of the inner conductor **2** which faces away from the coupling pin **10**. The coupling of the present invention is of particular advantage with flexible waveguides, e.g., elliptical corrugated waveguides, since as a result of the coupling device extending substantially axially, the torsional forces which are always present in flexible waveguides in their mounted state do not exert any adverse influence.

Additionally, since when utilizing elliptical corrugated waveguides there must inevitably be provided, at the coupling points, an adapter piece to the standardized waveguide cross sections, preferably rectangular cross sections, the above-described end coupling can be inserted directly into the adapter required for this purpose. When utilized in this manner, the coaxial line section **1** with the coupling loop is flanged by means of flange **15** to that portion of the waveguide adapter which has the standard cross section, with the coupling pin **10** being so aligned that it extends in the direction of the E vector of the wave which is excited in the waveguide section.

FIG. **3** shows a cross-sectional view of a prefered embodiment of the invention. Here the end coupling arrangement similar to FIG. **1** is connected with a transition from the normal rectangular waveguide to the elliptical corrugated waveguide. This transition adapter serves both for the mechanical attachment and for the reflectionless matching. The construction of the transition may choosen in any way, for example, as described in U.S. Pat. No. 3,293,573. Usually the transition consists of a piece of a rectangular waveguide **22** and a part **23** the cross-section of which is tapered in a known manner. On both ends of the transition there are flanges **21** and **24**. Flange **21** is connected with the corresponding flange **15** of the coaxial line **2, 3** and the flange **24** is connected with a special formed plate or disk **25** by screws **26**. Part **25** presses the flanged end **27** of the corrugated elliptical waveguide **28** towards the foresaid flange **24** for mechanical and electrical contacting. In the region of the plate **25** the dielectric protective sheathing **29** is removed. The portion **22** of the transition may be very short and then the end coupling **5, 6, 7, 13, 14** penetrates the portion **23** of the transition.

In one embodiment of the preset invention which has been reduced to practice, the reflection factor r resulted, in dependence on the frequency, as plotted in FIG. **2**. In addition to the advantage of a very simple mechanical structure, the configuration of the present invention for the end coupling also results in an increase in the bandwidth by the factor **2** as compared to the previously used arrangements.

It will be understood that the above description of the present invention is susceptible to various modifications, changes and adaptations, and that the same are intended to be comprehended within the meaning and range of equivalents of the appended claims.

We claim:

1. A broadband end coupling for coupling a coaxial line into a waveguide comprising:

a section of coaxial line having an inner and an outer conductor with the inner conductor extending axially beyond the outer conductor;

means for mounting said section of coaxial line on the end of a section of waveguide so that said extended portion of said inner conductor extends axially into the waveguide;

a crossbar connection at the free end of said inner conductor;

at least one conductive bar disposed parallel to said extended portion of said inner conductor and connected at its respective ends to said crossbar and to said outer conductor of said coaxial line; and,

a coupling pin attached to said extended portion of said inner conductor and extending perpendicular thereto so that the frontal face of said coupling pin will form an adjustable capacitor with the oppositely disposed wall of the waveguide, said coupling pin being attached to said inner conductor at an axial distance from said outer conductor so that the length of the coupling loop from said coupling pin to said outer conductor via said crossbar and conductive bar, and which extends into the waveguide, is approximately $\frac{3}{4}\lambda$.

2. The end coupling as defined in claim 1 wherein said coupling pin is attached to said extended portion of said inner conductor at an axial distance from said outer conductor of between $\lambda/8$ and $\lambda/4$.

3. The end coupling as defined in claim 1 wherein the said coupling pin is conically widened toward its frontal face.

4. The end coupling as defined in claim 3 wherein a screw is disposed in the frontal face of said coupling pin.

5. The end coupling as defined in claim 1 wherein only one conductive bar is provided.

6. The end coupling as defined in claim 5 including a waveguide section of square or circular cross-section to which said coupling is connected and into which said inner conductor axially extends, and wherein said bar is located on the side of said extended portion of said inner conductor which faces away from said coupling pin.

7. The end coupling as defined in claim 1 including a section of waveguide having a flange terminating the end thereof; wherein said means for mounting said coaxial line section comprises a corresponding end flange; and wherein said flanges are connected together so that said section of coaxial line and said section of waveguide form a single structural unit.

8. The end coupling as defined in claim 1 including a waveguide section constructed as an adapter between an elliptical corrugated waveguide and a standardized rectangular waveguide; and wherein said coupling pin extends in the direction of the E vector of the wave to be excited in the rectangular portion of said waveguide section.

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