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McDonald

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[54] COMPACT WAVEGUIDE-COAX TRANSITION

[75] Inventor: **Oakley McDonald Woodward,** Princeton, N.J.

[73] Assignee: **The United States of America as represented by the Secretary of the Navy**

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[52] **U.S. Cl.**.....**333/21 R,** 333/34, 333/35, 333/97 R

[51] **Int. Cl.**.....**H01p 5/10,** H03h 7/38

[58] **Field of Search** .....333/21 R, 21 A, 32–35, 333/98 R, 98 TN, 97 R

[56] **References Cited**

UNITED STATES PATENTS

2,633,493 3/1953 Cohn.....333/34

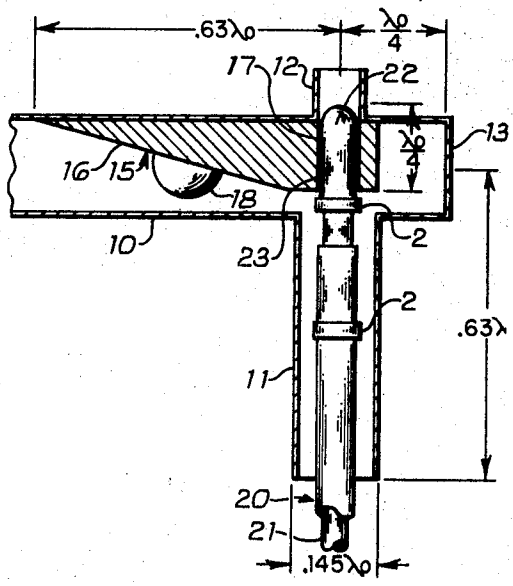
3,087,127 4/1963 Borghetti.....333/98 X

Primary Examiner—Rudolph U. Rolinec
Assistant Examiner—Marvin Nussbaum
Attorney—R. S. Sciascia et al.

[57] **ABSTRACT**

A compact waveguide-to-coaxial transition coupling having a half-height waveguide with a shorted termination and with a tapered ridge waveguide section having a port therein one-quarter wavelength from the termination into which port is "floatingly" fitted a coaxial line termination with impedance matching steps thereon, and inductive buttons on the side walls of the half-height waveguide laterally of the tapered ridge waveguide section to provide transition of microwave at a voltage standing wave ratio of 1.1 or less over at least a 13 percent band.

8 Claims, 4 Drawing Figures



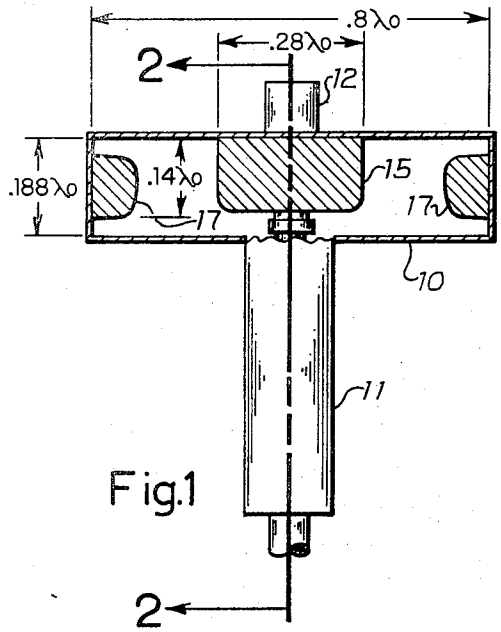


Fig.1

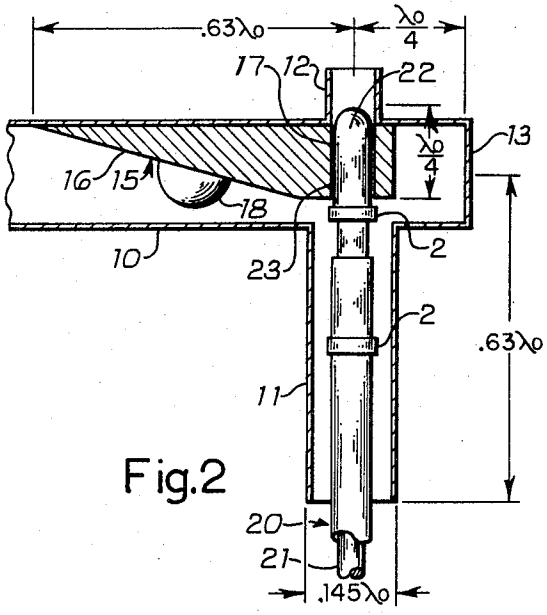


Fig.2

SMITH CHART

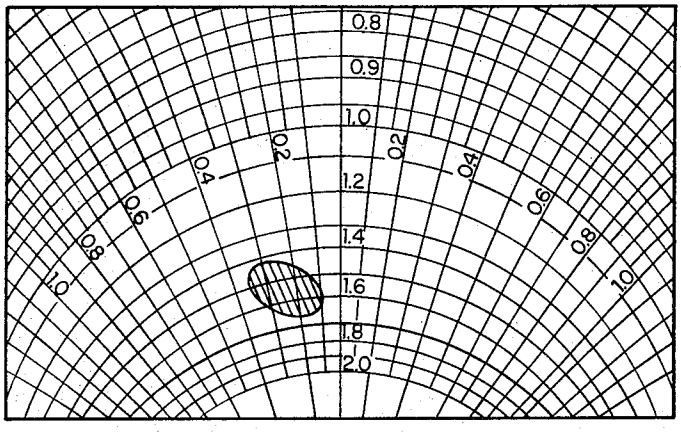


Fig.3

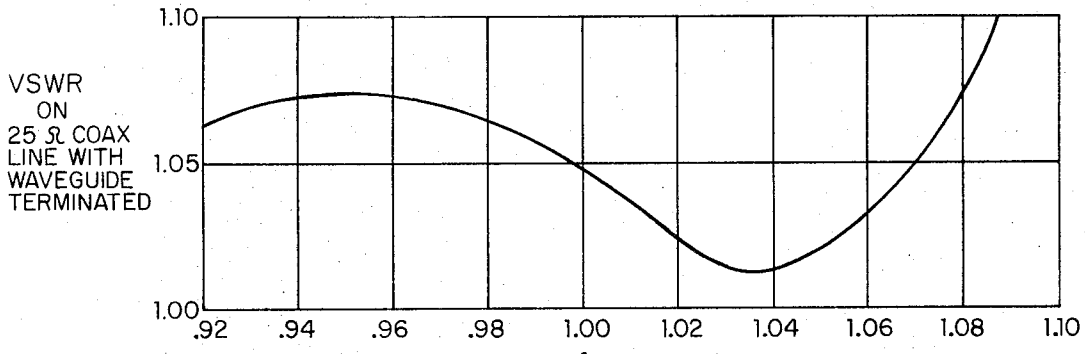


Fig.4

COMPACT WAVEGUIDE-COAX TRANSITION

BACKGROUND OF THE INVENTION

This invention relates to a coupling from a waveguide to a coaxial cable and more particularly to the coupling of a half-height waveguide section at right angles to a 25 ohm coaxial line having power handling capacity, moderate impedance bandwidth, and non-contacting coaxial inner conductor with the waveguide section.

It is a general practice to couple a coaxial line into a full size waveguide. The coaxial line is mechanically supported in the waveguide wall to project the radiation or probe junction within the waveguide cavity or section to provide microwave transition. It is also a general practice to provide impedance matching steps in a waveguide section when there is a transition from a smaller waveguide section to a larger one. As an alternative, adjustable studs may be used near the transition area to provide the transformer action desired with the proper impedance match. While these known transition devices have been successful in operation, there were complications in impedance matching requiring implementation with materials of substantial bulk and weight.

SUMMARY OF THE INVENTION

In the present invention a half-height waveguide section can be used to provide small size. A tapered ridge member is positioned within the waveguide backed by a short section of shorted waveguide. An opening in the long sidewalls of the waveguide through the thick end of the tapered ridge member accommodates the inner conductor of the coaxial line which "floats" in the tapered ridge member opening. This condition of a non-contacting inner conductor is satisfied by the use of a quarter-wave, open circuited stub in series at the junction of the waveguide and coaxial line. A metal button on opposite side walls of the waveguide in the area of the tapered ridge member improves the impedance over the desired bandwidth. The inner conductor of the coaxial line at the junction has impedance matching steps as is typical for such couplings. It is accordingly a general object of this invention to provide a compact waveguide-to-coaxial line transition coupling that has a floating junction to simplify assembly and is capable of producing a voltage standing wave ratio (VSWR) of 1.1 or less over at least a 13 percent band.

BRIEF DESCRIPTION OF THE DRAWING

These and other objects and the attendant advantages, features, and uses will become more apparent to those skilled in the art as a more detailed description proceeds when taken in consideration with the accompanying drawing in which:

FIG. **1** is a partly elevational and partly cross-sectional view of the preferred embodiment of the invention;

FIG. **2** is a cross-sectional view of the preferred embodiment of the invention taken along the line A—A of FIG. **1**;

FIG. **3** is a view of a Smith chart showing the measured impedance in the shaded area for the transition coupling of this invention; and

FIG. **4** presents a plot of the measured VSWR characteristic of the transition over at least 13 percent band above and below the center frequency.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring particularly to FIGS. **1** and **2** a half-height waveguide section **10** has a coaxial leg input **11** and an open-circuited stub **12**. Dimensions of the waveguide section are given in wavelength of the microwaves used therein at mid band frequency. The waveguide section is 0.188 of a wavelength (λo) high, 0.8 λo wide, and the coaxial leg **11** at least 0.5 λo long but preferably 0.63 λo. The section **10** ends in a shorted termination **13** that is one-quarter wave distant from the center of the leg **11**.

Within the waveguide section **10** is a tapered ridge waveguide member **15** of metal suitably attached to the underneath side of one long sidewall having a tapered surface **16** facing the open waveguide. The large end near the shorted termination **13** has a hole **17** concentrically aligned with the leg **11** and the series stub **12**. The length of the taper **16** is at least a half wave but preferably 0.63 λo similar or equal in length to the coaxial leg **11**. Also within the waveguide section **10** are two metal buttons **18**, each suitably affixed to the inner side walls in the area adjacent to the center of the tapered portion **16** of the tapered ridge member **15** to improve the impedance bandwidth.

A coaxial cable **20** having an inner conductor **21** enters through the coaxial leg **11** with a terminating stub portion **22** concentrically supported in the hole **17** in the tapered ridge member **15**. The coaxial cable may be supported in any suitable way but can be secured by a thin "Teflon" sleeve **23** to facilitate assembly and disassembly of the coupling. The coaxial line has stepped changes in diameter over the length of the inner conductor to provide the best impedance match for a 25-ohm coaxial line over the wavelength band. The exact dimensions of these stepped sections are determined experimentally after the ridged waveguide section is constructed, the typical change being 0.145 λo.

The impedance of the matched waveguide is in the order of 180 ohms. The characteristic impedance of the coaxial line is 25 ohms, or a relatively high impedance change of 7.2:1 over the 13 percent frequency band. However, both the waveguide leg and the coaxial line leg are at least one-half wavelength long. Thus, there is room for four cascaded quarter-wave transformers (or equivalent circuitry) between the transition input and output ports. With the proper choice of characteristic impedances for the four transformer sections, the maximum VSWR on any one transformer is only about 1.64:1, and broad impedance bandwidth is assured.

The tapered ridge member **15** functions as the first two transformer sections. The width of the tapered ridge member **15** is chosen to provide the maximum waveguide loading. The ridge extends over the maximum length available to minimize the ridge taper angle **16** and reduce the impedance discontinuities. The maximum height of the tapered ridge member **15** at the junction **17,22** is chosen as a reasonable compromise between the needs of impedance transformation and voltage breakdown considerations at the junction region.

Referring more particularly to FIG. 3, the impedance was measured over the required band on the 25 ohm coaxial line **20** relative to the junction **17,22**. All impedance points fell within the small shaded region shown on the Smith chart.

The inner conductor length of the open-circuited series stub **12** is adjusted to present a short circuit at its input. The characteristic impedance of this stub **12** is chosen to be small in the order of 4.3 ohms so that the voltage at the open circuited end is low, and also to minimize the reactance change over the band. The voltage at the open end of **12** at mid-frequency is equal to the product of the line characteristic impedance and the line current at the base of the stub. For the assumed peak power under the worst condition, this voltage is only a few hundred volts. The base reactance change over the 13 percent band is less than 1 ohm.

Referring more particularly to FIG. 4 there is plotted in graphic form the VSWR for a 25 ohm coaxial line with the waveguide section terminated. The plot provides the VSWR along the abscissa and the frequency right and left of the center frequency of 1.00 along the ordinate axis. Thus it may be seen that the VSWR is less than 1.1 over at least 13 percent band of frequency.

While modification and changes may readily occur to those skilled in the art to accomplish the same or similar results, it is to be understood that I desire to be limited in the spirit of my invention only by the scope of the appended claims.

I claim:

1. A compact waveguide-to-coaxial line transition coupling comprising:

a section of ½ height waveguide for a predetermined microwave frequency ending in a shorted termination with an open circuited series stub and a coaxial line coupling stub in alignment in opposite walls thereof;

a tapered ridge member having an opening therethrough on the thick end thereof mounted in said waveguide with said opening in alignment with said series and coupling stubs with said taper rising from said waveguide wall in a direction toward said shorting termination;

a metal button on opposite side walls of said waveguide along the taper of said tapered ridge member; and

a coaxial line entering through said coupling stub with a junction end concentrically supported floatingly within said tapered ridge member opening, said coaxial line within said coupling stud having impedance matching steps therein whereby a transition of microwave energy in said waveguide to said coaxial line and vice versa are accomplished with high power capability, with a voltage standing wave ratio of not over 1.1 over at least a 13 percent band, and with a half-height waveguide to a predetermined low impedance matching coaxial line providing a compact transition coupling.

2. A compact waveguide-to-coaxial line transition coupling as set forth in claim **1** wherein

said series and coaxial coupling stubs are centered one quarter wavelength from said shorted termination and said junction end of said coaxial line is one-quarter wavelength.

3. A compact waveguide-to-coaxial line transition coupling as set forth in claim **2** wherein

said tapered ridge member is from 0.5 to 0.63 of a wavelength from the point of taper to the centerline of said opening and its width is 0.28 of a wavelength.

4. A compact waveguide-to-coaxial line transition coupling as set forth in claim **3** wherein

said waveguide coupling section is about 0.188 of a wavelength high and about 0.8 of a wavelength wide.

5. A compact waveguide-to-coaxial line transition coupling as set forth in claim **4** wherein

said metal buttons are each about 0.14 of a wavelength in diameter.

6. A compact waveguide-to-coaxial line transition coupling as set forth in claim **5** wherein

said impedance matching steps are each about 0.145 of a wavelength.

7. A compact waveguide-to-coaxial line transition coupling as set forth in claim **6** wherein

said concentric supporting of said coaxial line junction end is by a thin wall "Teflon" sleeve.

8. A compact waveguide-to-coaxial line transition coupling as set forth in claim **7** wherein

said open-circuited series stub is a quarter-wave in series with said junction.

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