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[54] **PERMANENT WAVEGUIDE CONNECTION FOR OCCASIONAL USE**
3 Claims, 2 Drawing Figs.

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333/21 R, 333/83 R, 333/98 R
[51] **Int. Cl.** **H01p 1/16,**
H01p 5/08, H01p 7/06
[50] **Field of Search** 333/34–35,
9, 27, 6, 21, 21 A, 98, 83; 324/58, 95, 72.5

[56] **References Cited**
UNITED STATES PATENTS

2,782,383	2/1957	Olive	333/83
2,838,670	6/1958	Marcuvitz	324/58 X
3,023,381	2/1962	Rowland	333/98 X
3,305,799	2/1967	Levin	333/24

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ABSTRACT: A coaxial coupling for connecting a test or other incidental signal with a waveguide by means of a probe within the guide is provided with a cavity forming cap so that when the connection is not in use and the cap is in place, the cap together with the probe forms a quarter wavelength shorted stub which renders the probe electrically invisible within the waveguide.

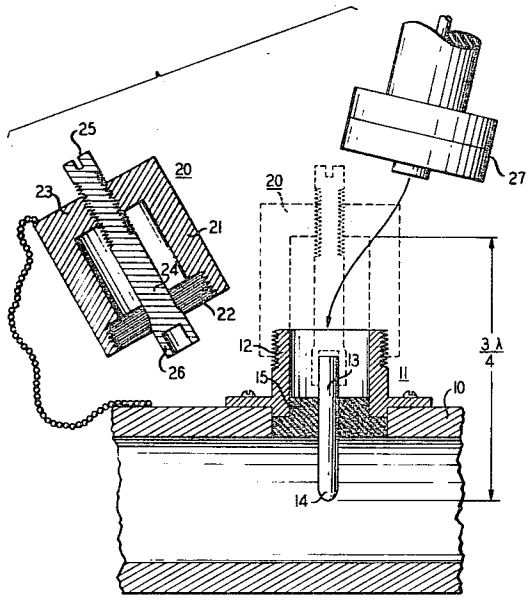


FIG. 2

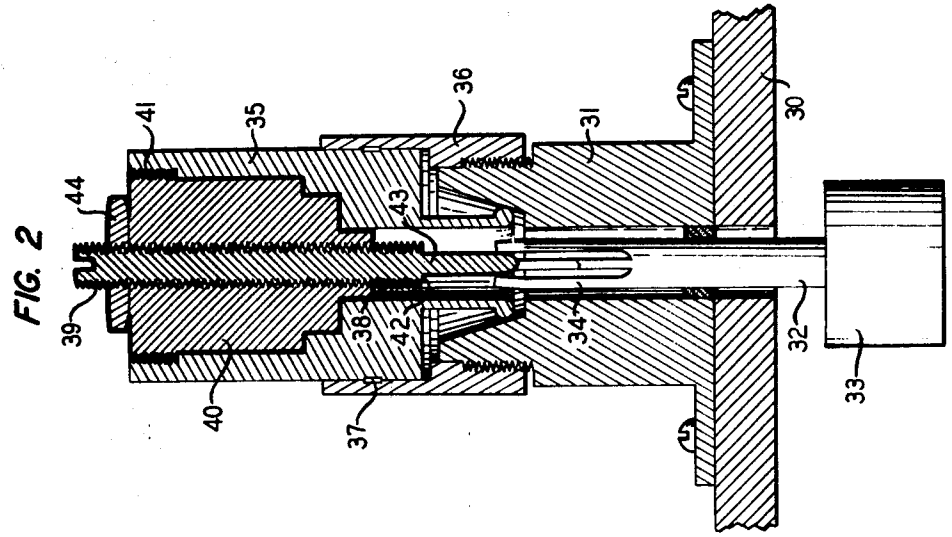
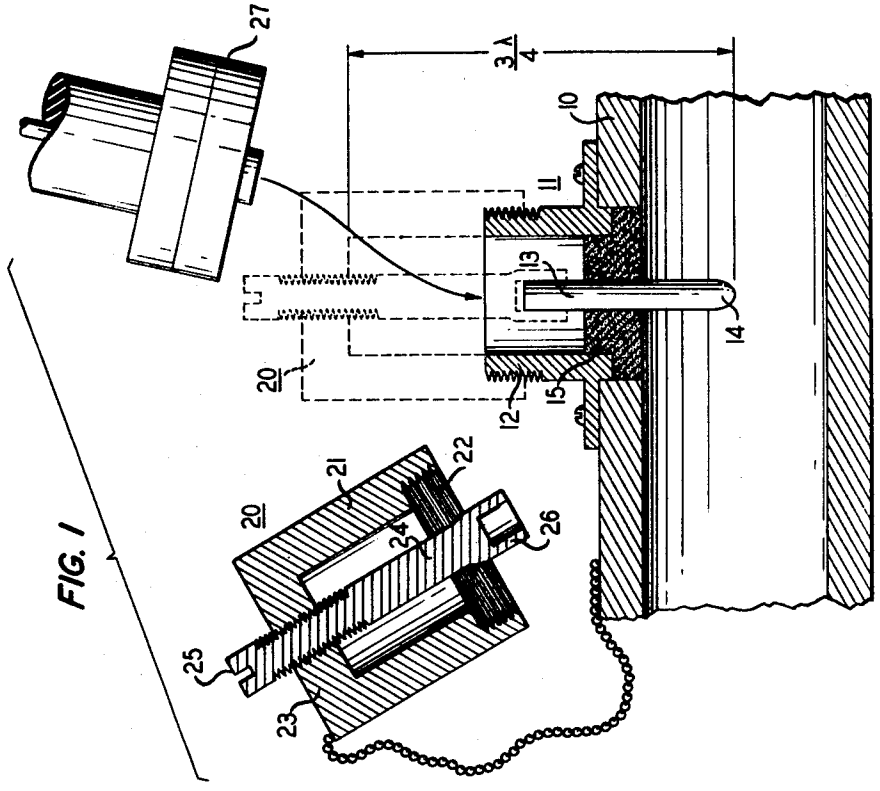


FIG. 1



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PERMANENT WAVEGUIDE CONNECTION FOR OCCASIONAL USE

BACKGROUND OF THE INVENTION

This invention relates to electromagnetic waveguide-coupling devices and, more particularly, to a coaxial connection which can be used on occasion but remains permanently affixed and electrically inactive when not in use.

It is often necessary in operation and testing of a microwave communication system to occasionally connect a given microwave device with a signal-carrying waveguide within the system. For example, in routine testing it is necessary to inject signals into the system at some point and either at the same time or at other times to remove a signal sample at the same or at another point from the system. Typical procedures presently involve removing a section of the waveguide and inserting a suitable coaxial to waveguide test transducer, performing the test, and then replacing the original waveguide section. Obviously this is a time-consuming procedure and also one which is likely to damage the waveguide flanges and cause signal leakage. Permanent connections to the system have not been satisfactory because of the interference that they may introduce during normal operation between the tests.

SUMMARY OF THE INVENTION

In accordance with the present invention a permanent coaxial probe-type connection is made to a signal-carrying guide. The connection is, however, provided with a particularly designed cap which forms a shorted coaxial cavity with the probe when the connection is not in use and the cap is in place. When the cap-probe-cavity is tuned by particular means provided so that the cavity is an odd multiple of ¼ wavelengths long at the frequency of interest, the probe within the guide becomes electrically invisible and therefore electrically inactive in the guide.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of the coupling in accordance with the invention shown in both its used and unused conditions; and

FIG. 2 is a cross-sectional view of an embodiment of the invention made by the adaptation of commercially available coaxial jacks and plugs.

DETAILED DESCRIPTION

Referring more particularly to FIG. 1, the combination of probe connection and cap therefor is shown in both the associated (in phantom) and disassociated conditions with a section of conductively bounded waveguide **10**. While guide **10** may have a circular or square cross section the most usual application involves a guide of rectangular cross section. Thus the illustrated view may be assumed to be taken through the narrow dimension of a rectangular cross section. The broad wall of guide **10** is provided with a coaxial connector **11** of a commercially available type generally adapted for coupling a coaxial cable to a probe within the waveguide. Particularly, connector **11** includes an outer conductive body **12** suitable fastened to the wall of guide **10** and a center conductor **13** having a probe portion **14** which extends through dielectric plug **15** into guide **10**. Body **12** is illustrated as having male threads upon its outer periphery suitable for mating with female threads upon a conventional coaxial cable end fitting Obviously, other forms of mechanical fastenings familiar to the art may be used instead of threads. The proportions and location of probe **14** within guide **10** are those conventionally employed to produce a desired degree of matching and coupling between a coaxial cable connected to coupling **11** and fields within guide **10**.

When the coupling is not actually in use, the present invention provides a cap **20** which is placed over connector **11** and held in place by the threads on outer body **12**. More particularly, cap **20** comprises a coaxial cavity having an outer conductive boundary **21** including the required female threads **22**, an end conductive boundary **23** remote from threads **22**, and a center conductor **24** suitably provided with means for adjusting its longitudinal penetration coaxially within boundary **21**. For example, as illustrated, conductor **24** is threaded through an aperture in end boundary **23** and is provided with a screwdriver slot **25** for adjusting penetration. The end of conductor **24** remote from slot **25** is provided with a plurality of resilient fingers **26** such that when cap **20** is tightened into position on conductor **11**, fingers **26** slide over and make electrical connection with center conductor **13** at a point determined by the penetration of conductor **24**. The axial dimensions of cavity **20** is such that when combined with the elements of connector **11** and probe **14** the total has an approximate effective electrical length of some odd multiple of one-quarter wavelengths at the frequency of interest. In the usual application, one-quarter wavelength is too short to physically accommodate the required components so that three-quarter wavelength seems to be the preferred dimension. The total cavity thus comprises a shorted ¼ wave stub and presents an open circuit at probe **14** which renders the probe substantially invisible to electromagnetic fields in guide **10**. In accordance with one feature of the invention, the enlargement caused by fingers **26** produces a capacitive impedance discontinuity the position of which is adjustable to tune the exact electrical length of the cavity thereby allowing the invention to be used over a wide range of frequencies.

The structure of FIG. 1 will couple wave energy travelling in either direction in guide **10** into a coaxial line **27** connected to coupling **11** or will launch the signal fed to the coupling in both directions in guide **10**. If it is desirable to couple to or from a wave travelling in one direction only in the waveguide, the coupling probe may be associated with a waveguide short located an odd multiple of quarter wavelengths within guide **10** away from the probe. Such a short may, for example, be formed by a shutter which is inserted or withdrawn through slots in the waveguide wall.

FIG. 2 illustrates an embodiment of the invention constructed by a simple adaptation of commercially available coaxial plugs and jacks. The lighter faced lines of the drawing represent parts of the commercially available components and the darker faced lines those of the adaptation. In particular, the connector illustrated comprises a plug and a jack or receptacle of the type designated "N"-type marketed, for example, by American Phenolic Corporation and generally similar to those described in their patent 2,870,420 Jan. 20, 1959. The body **31** of the jack portion, used without substantial modification, is mounted on guide **30** in the usual way so that center conductor **32** extends within guide **30** to end in an enlarged cylindrical-shaped probe **33** of the proper impedance. The upper part of center conductor **32** is provided by the manufacturer with resilient fingers **34**.

In accordance with the invention a cavity-producing cap is formed from body **35** of the N-type plug, retaining the coupling ring **36** and its split washer **37**, but discarding the remainder of its internal components. An adapter bushing **40** is then cast or machined to fit the internal contours of body **35** and to be received by threads **41** which have been provided by the manufacturer for the discarded clamping nut. Bushing **40** extends down into body **35** to the position required for short circuit **38** in accordance with the present invention as described above taking into account the length within guide **30** of probe **33** and the thickness of the wall of guide **30** in a particular application. Short **38** is illustrated as occurring in the smallest diameter cross section of body **35** since this cross section will have a characteristic impedance that most nearly matches the rest of the structure. Except for this consideration, short **38** can be placed at other cross sections of body **35** if necessary to obtain the required longitudinal dimension of the cavity. Bushing **40** is then center bored and threaded to receive threaded core **39**. The lower end of core **39** is reduced

at shoulder 42 to a point 43 corresponding in diameter to the discarded center conductor pin so that point 43 may be received within fingers 34 when ring 36 is locked in place. Tuning is accomplished by inserting or withdrawing point 43 within fingers 34 to vary the spacing therefrom to shoulder 42. The reduced diameter of point 43 has in inductive reactance proportional to its length so that varying this length varies the total electrical length from probe 33 to short 38. Proper adjustment is obtained when this total electrical length as modified by the inductive reactance of point 43 is substantially three-quarters wavelength. Lock nut 44 is provided to set this position when determined. In order to inject a test or other signal into guide 30, ring 36 is unlocked, body 35 removed and a signal-carrying coaxial cable suitably terminated in an N-type plug is connected to jack 31.

It should be understood that while the principles of the invention have been illustrated with one particular type of coaxial coupling, others, such as the familiar bayonet type, may be similarly adapted.

What I claim is:

1. A signal connection comprising a conductively bounded waveguide for electromagnetic wave energy, a coaxial cable connector having center and outer conductors affixed to the boundary of said guide and adapted to receive a mating connection of a coaxial cable, a conductive probe extending to an end within said guide from said center conductor, means for disabling and rendering electrically inactive said coaxial cable connector comprising a shorted coaxial structure adapted to be interchangeable with said mating connection on said connector and for forming with said connector a shorted coaxial cavity, said shorted coaxial cavity having an outer boundary and a center conductive member and a shorting boundary therebetween, said outer boundary being adapted to be removably affixed to the outer conductor of said connector so that the center member of said cavity contacts the center conductor of said connector, said cavity having such dimensions that the electrical distance from said shorting boundary to said end is an odd multiple of one-quarter wavelengths.

2. The connection according to claim 1 wherein said center member of said cavity slidably engages said center conductor of said connector for relative axial movement therebetween.

3. The connection according to claim 2 including an impedance discontinuity means associated with said slidable engagement for varying said electrical distance with said relative axial movement.