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H. KIHN

2,431,941

MICROWAVE COUPLING DEVICE

Filed Nov. 29, 1943

2 Sheets-Sheet 1

Fig. 1.

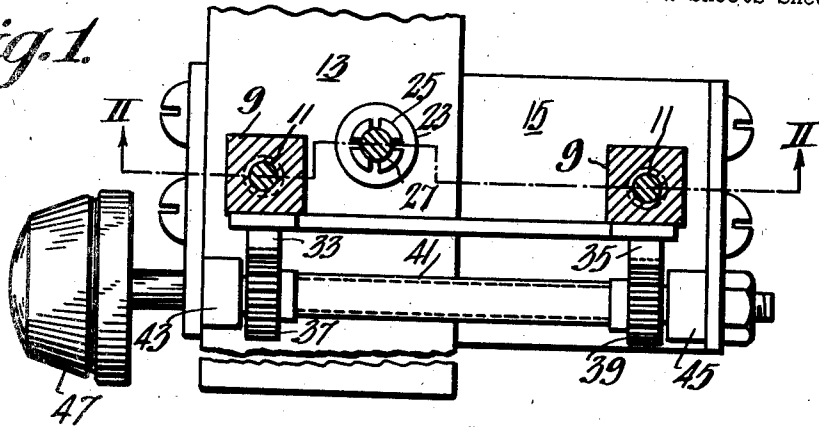
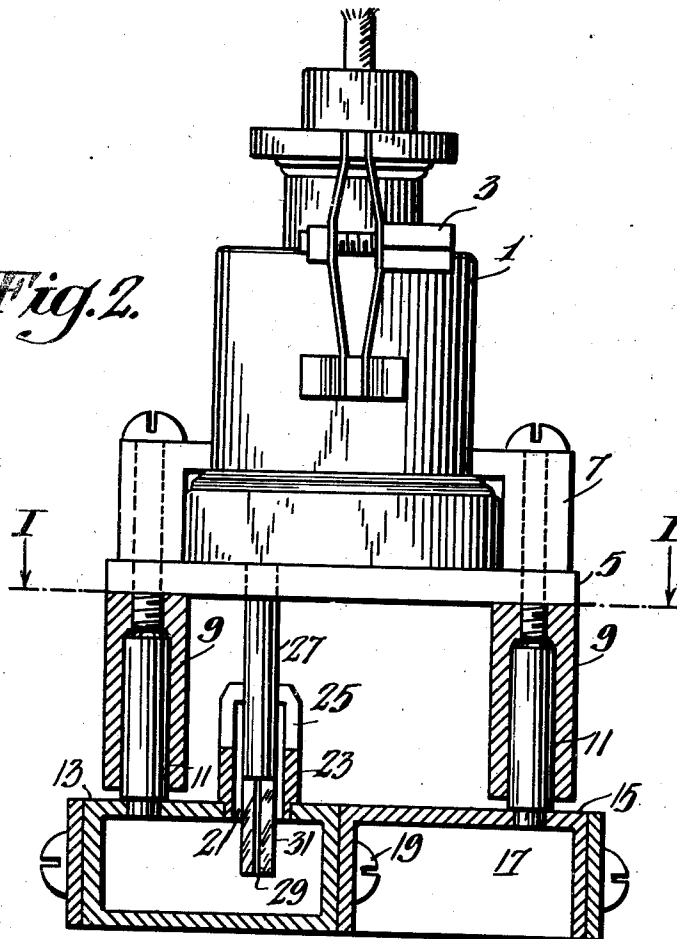


Fig. 2.



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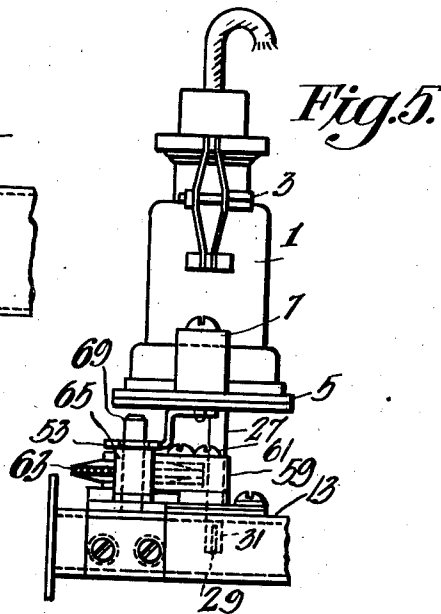
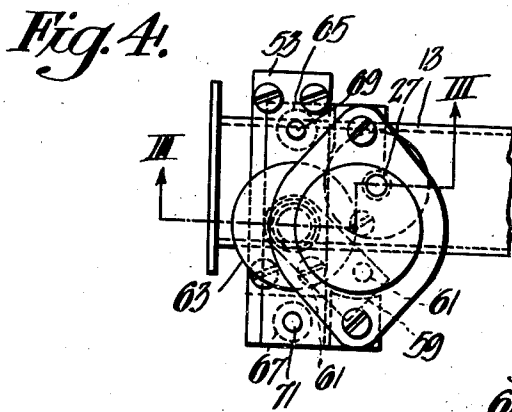
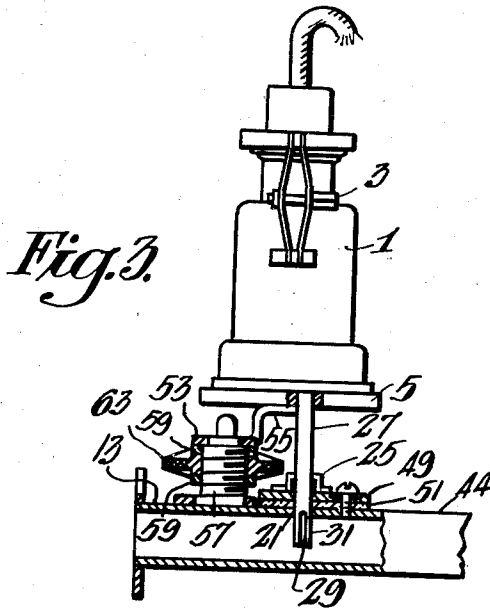
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MICROWAVE COUPLING DEVICE

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6 Claims. (Cl. 178-44)

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This invention relates generally to microwave apparatus and more particularly to adjustable coupling devices for varying the transfer of microwave energy from a microwave source to a waveguide transmission system.

Various types of microwave coupling devices have been employed heretofore in waveguide transmission systems. One of the essential requirements for such devices is that the adjustment of the transferred energy be gradual and readily obtainable by means of simple operating mechanisms. Another requirement of such devices is that electrical contact between movable conductive elements be accomplished at points of minimum microwave current distribution in order to minimize imperfect contact effects. A further requirement of such devices is that they be extremely compact, since the physical sizes of the circuit components are extremely critical at the super-high frequencies employed.

A first embodiment of the instant invention comprises a simple mechanical structure for varying the microwave coupling between a microwave generator such as, for example, a Shepard tube cavity resonator device, and a waveguide transmission system which may be employed for transmitting microwave energy to any selected type of load device. Shepard tubes include a short coaxial transmission line, one end of which terminates in an output coupling loop within the cavity resonator and the other end of which has a quarter wavelength of the inner conductor exposed for coupling to the load system. If desired the inner conductor may be exposed for one-half wavelength and terminated in a coupling loop connected to the cable outer conductor. The Shepard tube is inserted in a standard wafer-type octal socket which is secured to a platform which may be adjusted vertically by means of a simple rack and pinion adjusting mechanism.

A constricted short length of round waveguide, having a cut-off frequency below the operating microwave frequency, surrounds an aperture in one of the faces of the rectangular waveguide transmission system, and includes cylindrical flexible contacts which grasp the outer conductor of the short coaxial cable at any desired point above the aperture in the rectangular waveguide face. This arrangement effectively minimizes leakage from the rectangular waveguide, and provides electrical contact to the outer conductor of the coaxial cable. The depth to which the exposed quarter wavelength of the inner conductor of the coaxial cable penetrates the constricted small round waveguide and the rectangular wave-

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guide transmission system may be adjusted by the rack and pinion mechanism to provide desired microwave coupling between the Shepard tube generator and the rectangular waveguide transmission system.

Another arrangement which provides similar adjustment of microwave coupling, employs a thumb screw mechanism which permits adjustment of the elevation of the Shepard tube with respect to the rectangular transmission system and hence adjustment of the penetration of the Shepard tube output coaxial line into the constricted circular waveguide and the rectangular waveguide transmission system. If desired, the short constricted circular waveguide may be omitted, providing the aperture in the rectangular waveguide faces is sufficiently small to prevent serious leakage of microwave energy. The thumb screw mechanism, to be disclosed in detail hereinafter, includes a yoke which is secured to the waveguide face, and a threaded sleeve which is secured to the platform supporting the Shepard tube and the octal socket. Rotation of the thumb screw within the yoke provides adjustment of the vertical position of the complementarily threaded sleeve, and hence adjustment of the vertical position of the Shepard tube and its output coaxial cable with respect to the waveguide transmission system.

Among the objects of the invention are to provide an improved method of and means for coupling microwave energy into a waveguide transmission system. Another object of the invention is to provide an improved actuating mechanism for adjusting the elevation of a microwave generator with respect to a waveguide transmission system whereby the penetration of a microwave radiator into a waveguide transmission system is varied to control the microwave coupling thereto. A further object of the invention is to provide an improved microwave coupling device wherein a rack and pinion mechanism controls the penetration of a coaxial cable type of microwave radiator within a waveguide transmission system. An additional object of the invention is to provide an improved microwave coupling device wherein a thumb screw mechanism varies the penetration of a microwave radiator within a waveguide transmission system.

The invention will be further described by reference to the accompanying drawings of which Figure 1 is a cross-sectional view taken along the section line I—I of a first embodiment of the invention; Figure 2 is a cross-sectional elevational view taken along the section line II—II of said

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first embodiment of the invention; Figure 3 is a cross-sectional elevational view taken along the section line III—III of a second embodiment of the invention; Figure 4 is a plan view of said second embodiment, and Figure 5 is an elevational exterior view of said second embodiment of said invention. Similar reference characters are applied to similar elements throughout the drawing.

Referring to Figures 1 and 2, a microwave generator 1 such as, for example, a Shepard tube cavity resonator having a frequency adjusting device 3, is inserted in a conventional octal type wafer socket, not shown, which is secured to a platform support 5 and held in position thereon by means of clamping devices 7. The platform 5 includes vertical guide sleeves 9 slidably fitted to vertical cylindrical shafts 11. The cylindrical shafts 11 are secured to the top face 13 of a rectangular waveguide transmission system and the top face 15 of an extension bracket 17 which is secured to one of the side faces of the rectangular waveguide transmission system by means of screws 19.

The top face 13 of the waveguide transmission system includes a circular aperture 21 which is surrounded by the lower end of a short circular waveguide element 23. The upper end of the circular waveguide element 23 includes cylindrical flexible contact elements 25. The contacts engage the outer conductor 27 of a coaxial output transmission line forming the output coupling means for the microwave generator at a region substantially an odd number of quarter wavelengths from said apertured waveguide face 13, as disclosed in the copending U. S. application of Vernon D. Landon, Serial No. 508,229, filed October 29, 1943, which describes tuning and coupling screws for waveguides. A portion of the inner conductor 29 of the coaxial transmission line from the microwave generator is exposed for a length of the order of $\frac{1}{4}$ wavelength at the operating frequency. This portion of the coaxial line is given rigidity by enclosing the inner conductor in a cylindrical sleeve 31 of polystyrene or other low loss microwave insulation.

Vertically disposed racks 33, 35, secured to the vertically disposed sleeves 9, engage pinions 37, 39 respectively, which are secured to a control shaft 41. The control shaft 41 is journaled in bearings 43, 45 secured to the rectangular waveguide and the supporting bracket 17 in any convenient manner. A control knob 47, secured to the external end of the control shaft 41, provides rotational adjustment of the pinions 37, 39 and hence vertical adjustment through the racks 33, 35, respectively, of the platform 5 and microwave generator 1, and hence controls the penetration of the exposed quarter wave portion of the coaxial cable within the short circular waveguide 23 and the rectangular waveguide transmission system. As the platform 5 and microwave generator 1 are moved away from the waveguide transmission system, the penetration of the exposed inner conductor 29 of the coaxial cable within the circular and rectangular waveguides is decreased, thereby decreasing the microwave coupling between the generator and the waveguide transmission system.

Extremely loose coupling is provided when the inner conductor 29 is retracted entirely from the rectangular waveguide transmission system, since the constricted circular waveguide is operated well below cut-off.

Referring to Figures 3, 4, and 5, a thumb screw adjusting mechanism is substituted for the rack

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and pinion adjusting mechanism described in the device illustrated by Figures 1 and 2. A modification of the means for coupling the coaxial output transmission line from the Shepard tube microwave generator 1 through the aperture 21 in the rectangular waveguide faces 44 includes the flexible contacts 25 which engage the outer conductor 27 of a coaxial line. The short section of circular waveguide 23 is omitted and a capacitive element, comprising a capacitor plate 49 and a mica dielectric element 51, bypasses microwave energy to the rectangular waveguide faces 13 in the region of the aperture 21 in the rectangular waveguide face. This allows the cavity to be operated above ground potential. It should be understood however, that the construction employing the short section of round waveguide operated below cut-off, and described in the device of Figures 1 and 2, may be employed to equal advantage in the modifications of the invention illustrated in Figures 3, 4 and 5.

The platform 5 is secured to an elevator platform 53 by means of a double bracket 55. One end of an externally threaded cylindrical sleeve 57 is press-fitted into an aperture in the center of the elevator bracket 53 to support the threaded cylindrical sleeve 57 perpendicular with respect to the top face 13 of the rectangular waveguide transmission system.

A forked yoke 59 is secured to the top face 13 of the waveguide transmission system by means of mounting screws 61. The ends of the forked yoke 59, remote from the mounting screws 61, are apertured to clear the threads of the threaded cylindrical sleeve 57 and are separated to provide clearance for an internally threaded thumb screw 63. Rotation of the thumb screw 63 thereby provides elevational adjustment of the threaded sleeve 57 and hence the elevator support 53, the support 5 and microwave generator 1, and thereby varies the penetration of the exposed inner conductor 29 of the coaxial transmission line within the waveguide transmission system for varying the microwave coupling. A pair of guide sleeves 65, 67, which are press-fitted within apertures adjacent the ends of the elevator support 53, are slidably fitted to vertical pins 69, 71 respectively, for guiding the elevational adjustment of the elevator support 53.

Thus the invention described comprises improved methods of and means for controlling the coupling of microwave energy from a microwave source to a waveguide transmission system wherein the microwave generator and the output coaxial coupling line projecting therefrom is movable with respect to a waveguide transmission system to permit variation of the penetration of the transmission line within the waveguide.

I claim as my invention:

1. Microwave coupling apparatus including a source of microwave energy, a concentric microwave transmission line connected to said source and including a microwave energy radiating element at its end remote from said source, a first waveguide for said radiated microwave energy, said waveguide having a wall apertured to receive said radiating element, a second waveguide having a critical cut-off frequency higher than said microwave source frequency, said second waveguide opening into said first waveguide through said aperture and extending coaxially with said concentric line, flexible contact means connecting the end of said second waveguide remote from said aperture to the outer conductor of said concentric line, and means for simultane-

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ously adjusting the relative positions of said source and said waveguides and the relative penetration of said radiating element within said waveguides for controlling the microwave coupling between said source and said first waveguide.

2. Microwave coupling apparatus including a source of microwave energy, a concentric microwave transmission line connected to said source and including a microwave energy quarter wave radiating element at its end remote from said source, a first waveguide for said radiated microwave energy, said waveguide having a wall apertured to receive said radiating element, a second waveguide having a critical cut-off frequency higher than said microwave source frequency, said second waveguide opening into said first waveguide through said aperture and extending coaxially with said concentric line, flexible contact means connecting the end of said second waveguide remote from said aperture to the outer conductor of said concentric line, and means for simultaneously adjusting the relative positions of said source and said waveguides and the relative penetration of said radiating element within said waveguides for controlling the microwave coupling between said source and said first waveguide.

3. Microwave coupling apparatus including a source of microwave energy, a concentric microwave transmission line connected to said source and including a microwave energy quarter wave radiating element at its end remote from said source, a first waveguide for said radiated microwave energy, said waveguide having a wall apertured to receive said radiating element, a second waveguide having a critical cut-off frequency higher than said microwave source frequency, said second waveguide opening into said first waveguide through said aperture and extending coaxially with said concentric line, flexible contact means connecting the end of said second waveguide remote from said aperture to the outer conductor of said concentric line at a point substantially a predetermined odd multiple of one quarter wavelength from said aperture, and means for simultaneously adjusting the relative positions of said source and said waveguides and the relative penetration of said radiating element within said waveguides for controlling the microwave coupling between said source and said first waveguide.

4. Microwave coupling apparatus including a source of microwave energy, a concentric microwave transmission line connected to said source and including a microwave energy radiating element at its end remote from said source, a first waveguide for said radiated microwave energy, said waveguide having a wall apertured to receive said radiating element, a second waveguide having a critical cut-off frequency higher than said microwave source frequency, said second waveguide opening into said first waveguide through said aperture and extending coaxially with said concentric line, flexible contact means connecting the end of said second waveguide remote from

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said aperture to the outer conductor of said concentric line, and rack and pinion means for simultaneously adjusting the relative positions of said source and said waveguides and the relative penetration of said radiating element within said waveguides for controlling the microwave coupling between said source and said first waveguide.

5. Microwave coupling apparatus including a source of microwave energy, a concentric microwave transmission line connected to said source and including a microwave energy radiating element at its end remote from said source, a first waveguide for said radiated microwave energy, said waveguide having a wall apertured to receive said radiating element, a second waveguide having a critical cut-off frequency higher than said microwave source frequency, said second waveguide opening into said first waveguide through said aperture and extending coaxially with said concentric line, flexible contact means connecting the end of said second waveguide remote from said aperture to the outer conductor of said concentric line, and rack and pinion means including cylindrical aligning means interposed between said source and said first waveguide for simultaneously adjusting the relative positions of said source and said waveguides and the relative penetration of said radiating element within said waveguides for controlling the microwave coupling between said source and said first waveguide.

6. Microwave coupling apparatus including a source of microwave energy comprising a thermionic tube oscillator, a concentric microwave transmission line connected to said source and including a microwave energy radiating element at its end remote from said source, a first waveguide for said radiated microwave energy, said waveguide having a wall apertured to receive said radiating element, a second waveguide having a critical cut-off frequency higher than said microwave source frequency, said second waveguide opening into said first waveguide through said aperture and extending coaxially with said concentric line, flexible contact means connecting the end of said second waveguide remote from said aperture to the outer conductor of said concentric line, and rack and pinion means including cylindrical aligning means interposed between said source and said first waveguide for simultaneously adjusting the relative positions of said source and said waveguides and the relative penetration of said radiating element within said waveguides for controlling the microwave coupling between said source and said first waveguide.

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REFERENCES CITED

The following references are of record in the file of this patent:

FOREIGN PATENTS

Number	Country	Date
116,110	Australia	Nov. 4, 1942