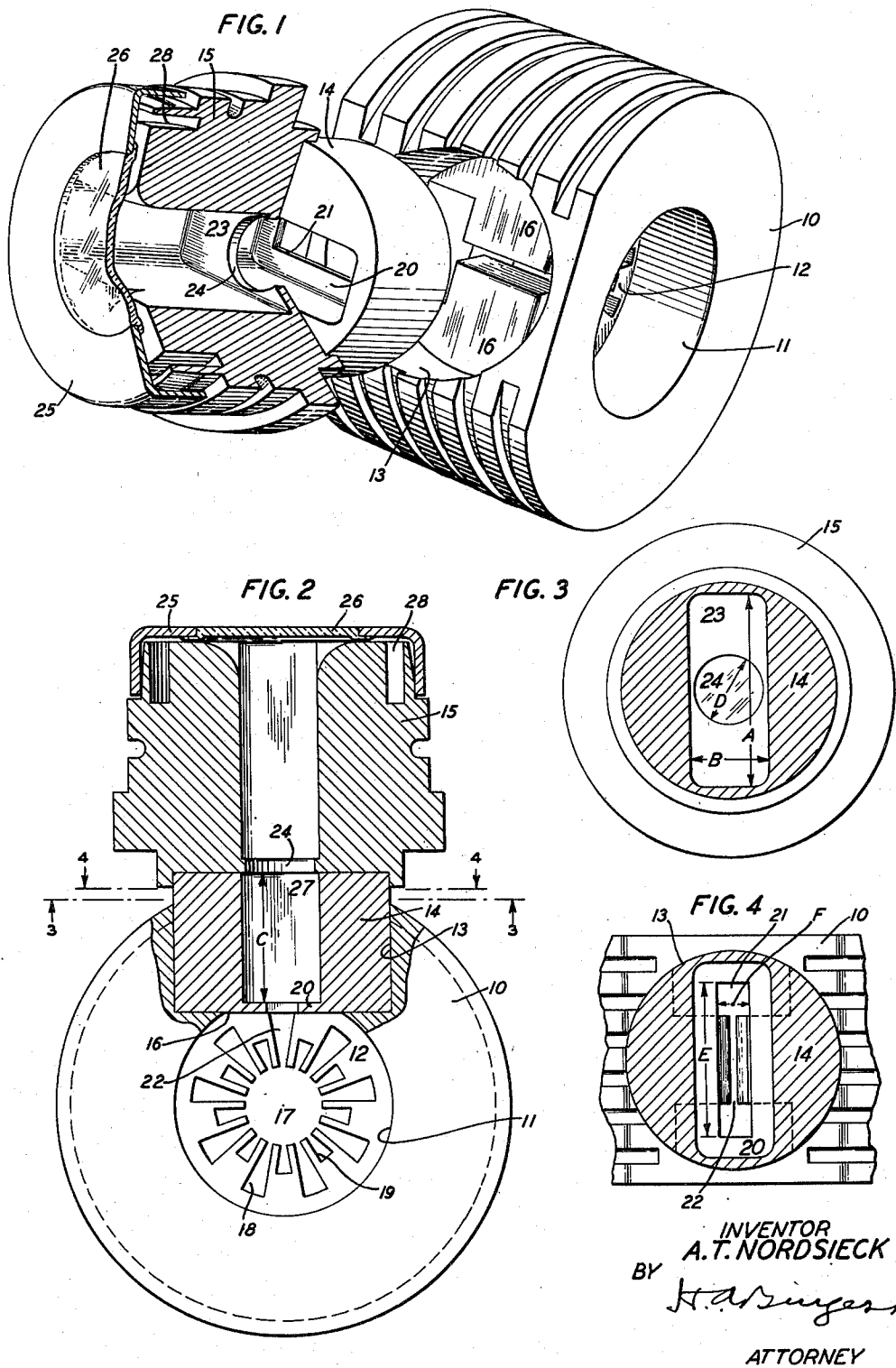


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WAVE GUIDE COUPLER

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WAVE GUIDE COUPLER

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This invention relates to electromagnetic coupling devices and more particularly to wave guide couplings for microwave apparatus.

An object of the invention is to increase the frequency stability of an oscillator coupled to a load circuit which latter may have a variable impedance.

A related object is to reduce the frequency pulling figure of an oscillator-load combination by means of an improved coupling device.

A feature of the invention is a half wave stabilizing cavity resonator suitable for coupling between an oscillator and a load.

A further feature is a resonant aperture or iris at one end of the half wave cavity resonator for connection to the resonant cavity of an oscillator.

A still further feature of the invention is a decoupling aperture at the opposite end of the stabilizing cavity for connection to a load circuit.

In general, in the case of two wave transmission elements, such as cavity resonators, coupled by way of an opening, the coupling between the two elements is dependent upon the character of the opening. Generally, the opening provides a shunt reactance impairing the coupling. In accordance with a feature of this invention, the opening is so constructed and arranged that the shunt reactance is in effect eliminated. Specifically, the opening is constructed and arranged to constitute an iris resonant at a preassigned frequency whereby the shunt reactance is in effect balanced out and maximum coupling between the two elements, e. g. cavity resonators or cavity resonator and wave guide is realized.

For frequencies other than the preassigned one, the effect of the iris upon the coupling depends upon the Q of the iris. Advantageously, therefore, where broad band transmission is desired, the iris is constructed to have as low a Q as is practicable as well as to be resonant at a preassigned frequency.

In the drawings

Fig. 1 is a perspective view, partly in section, showing the preferred embodiment of my invention partially disassembled;

Fig. 2 is a plan view of the embodiment of Fig. 1 after assembly, partly in longitudinal section; and

Figs. 3 and 4 are cross-sectional views of the same embodiment.

Referring to the drawing, a magnetron anode block 10 is shown having a cylindrical bore 11 at each end and an inner portion constituting a resonator 12. At right angles to the longitudinal axes of the bore 11 and resonator 12 is shown

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another cylindrical bore 13. The wave guide output coupling according to the invention comprises preferably two sections 14 and 15 respectively although these may be combined in one piece if desired. The section 14 is preferably in the outward form of a short circular right cylinder which is fitted snugly into the bore 13. The bore 13 extends a short distance into the resonator 12 to form a flat seat 16 against which the section 14 may rest. The section 15 is fitted over the outer end of the section 14 as shown.

The resonator 12 contains a hollow central interaction space 17 and a plurality of radial slots such as 18 and 19 which may be of different lengths and which extend from end to end of the resonator. The wave guide sections 14 and 15 are each preferably fabricated from a solid cylindrical metallic blank by hobbing a rectangular cavity therein of desired dimensions for a wave guide. The section 14 is terminated at the end next to the magnetron by a thin wall 20 containing a rectangular aperture 21 which registers with a slot 22 in the anode block 12, one of several slots like slot 18, for example. The section 14 is terminated at the outer end by a thin wall 23 of the section 15 having a round aperture 24. The section 15 is covered at the outer end by a cap 25 having a circular glass window 26.

The length of the wave guide section 14 is made such as to operate as a half wave resonator. The actual length of the guide differs slightly from a half wavelength due to the disturbing effect of the rectangular aperture 21 and the circular aperture 24 at the respective ends and may be found by trial and error. The interior of the half wave resonator section appears at 27 in Fig. 2. The wave guide section 15 may be of convenient length and may have a groove 28 at the end to serve as a coupling choke.

The section 14 is preferably fitted in vacuum-tight manner in the bore 13 and the section 15 attached in vacuum-tight manner to the section 14. In the completed magnetron the anode block 10 is provided with vacuum-tight end closures (not shown) and the vacuum chamber is sealed off in any suitable manner with the cap 25 and window 26 forming a vacuum-tight closure at the outer end of the wave guide output fitting 14—15.

In a particular embodiment which was built for a generated free space wave length of 1.25 cm., the transverse dimensions of the wave guide were A, 0.418 inch, and B, 0.168 inch. The length C of the half wave section was 0.281 inch. The diameter of the circular aperture D was 0.151

inch and the dimensions of the rectangular aperture were E, 0.330 inch and F, 0.070 inch. The wall 20 had a thickness of 0.020 inch and the wall 23 was 0.030 inch thick. The rectangular aperture so dimensioned was substantially in resonance with the half wave resonant cavity. The rectangular resonant cavity aperture was found to be advantageous over the use of a completely open junction between the magnetron slot 22 and the half wave resonator 27, the advantage taking the form of an increased coupling between the resonator of the magnetron and the half wavelength resonator in the wave guide and in the elimination of stray shunt reactances at the junction. The dimensions of the rectangular aperture were found not to be exceedingly critical so that a given aperture will accommodate a considerable range of frequencies with the advantage of broad band tuning when desired.

The circular aperture 24 may be viewed as a decoupling device whereby the sections 14 and 15 are very loosely coupled thereby improving the energy storing property and hence the Q factor of the half wavelength cavity. The latter cavity serves as a stabilizing cavity to improve the frequency stability of the device. Improvement of performance with the output coupling shown is due to advantageous use of energy storage in the half wave section between the magnetron and the outgoing wave guide, the storage being enhanced by the use of the decoupling aperture 24. Increased storage of energy is related in a well-known way to increased frequency stability or reduced pulling figure in an oscillator. The pulling figure is commonly employed as a measure of the change in operating frequency of an oscillator accompanying a given standard change in the output impedance of the circuit to which the oscillator is connected. For a constant radio frequency voltage impressed upon the anode segments of the resonator 12 and hence for constant electronic efficiency in the magnetron, the use of the output wave guide fitting shown results in a reduction of the pulling factor by a factor of about 2 compared with the best earlier designs. Very little reduction in the over-all circuit efficiency was observed with the use of the improved coupling circuit because the unloaded Q value of the stabilizing cavity is very high.

Inasmuch as the invention resides in the wave guide output coupling arrangement, the disclosure of the magnetron oscillator has been made only sufficiently complete to show clearly how the output coupling is connected. Magnetrons per se are well known in the art.

While the coupling device of the invention has been shown in the drawing as connected to a magnetron, it will be evident that the resonator of the magnetron is illustrative of microwave resonators in general and it is immaterial by

what means oscillations are set up in the resonator. The coupling device of the invention may be used to join any suitable resonator with any suitable utilization device for electromagnetic waves.

What is claimed is:

1. An oscillator and wave guide output coupling and frequency stabilizer therefor, said oscillator being of a type including a first cavity resonator, said coupling comprising a frequency stabilizing second cavity resonator resonant to the operating frequency of the oscillator and separated from the cavity resonator of the oscillator by a relatively thin metallic wall with a resonant aperture therein resonant at the operating frequency of the oscillator, whereby a relatively high degree of coupling is provided between the said first and second cavity resonators at the operating frequency to enhance frequency stability of the oscillator, and a wave guide separated from said frequency stabilizing cavity resonator by a relatively thin metallic wall with a non-resonant aperture therein, whereby a relatively weak coupling is provided between said frequency stabilizing cavity resonator and said wave guide to reduce reaction of said wave guide upon said frequency stabilizing cavity resonator and upon said oscillator.

2. A magnetron oscillator and coupling therefor comprising an anode block having a central bore and a plurality of cavity resonators opening out of said central bore, said anode block having a side bore opening into one of said cavity resonators, a stabilizing cavity resonator resonant to the operating frequency of said magnetron oscillator and having a relatively thin metallic wall portion with a resonant aperture therein resonant at the operating frequency of said magnetron oscillator, said stabilizing cavity resonator being mounted within said side bore with the said resonant aperture registered with the opening into one of the cavity resonators of said anode block, said stabilizing cavity resonator having a second aperture opposite said resonant aperture in a second relatively thin metallic wall portion, said second aperture being non-resonant and a wave guide opening into said stabilizing cavity through said non-resonant aperture.

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