

Nov. 14, 1950

E. C. OKRESS
MAGNETRON OUTPUT TERMINAL

2,530,171

Filed June 6, 1944

Fig. 1.

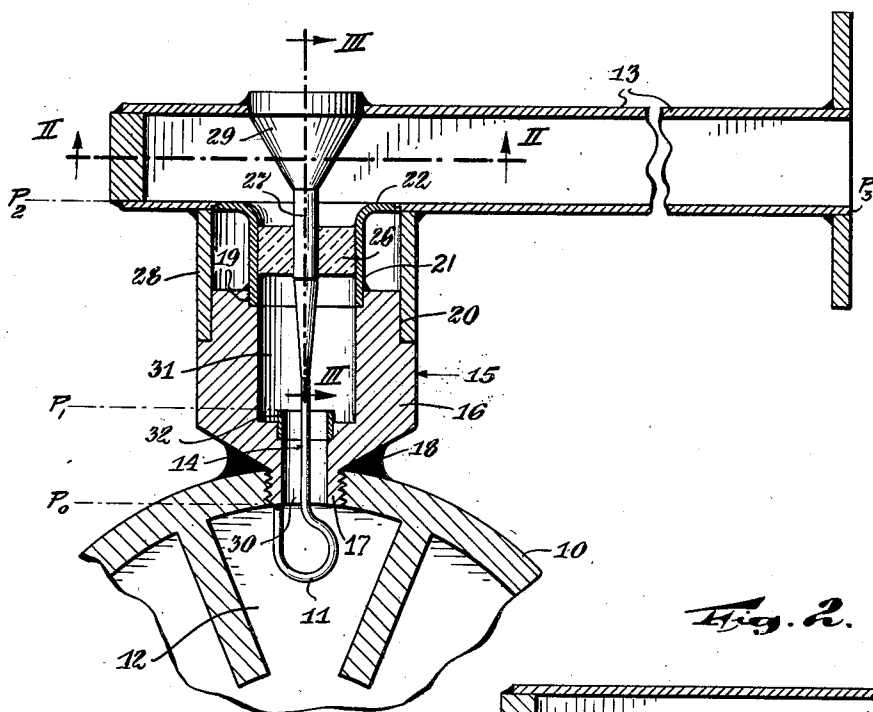


Fig. 2.

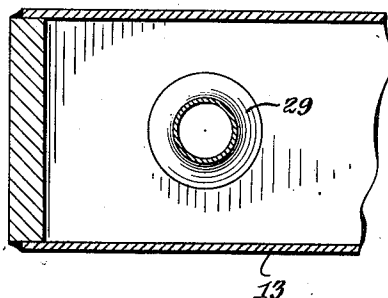
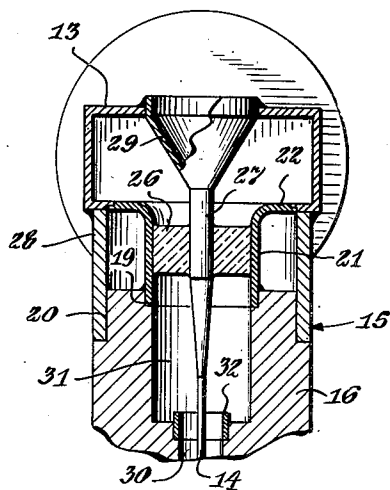


Fig. 3.



INVENTOR
E. C. OKRESS.
BY *J. M. Newlow*
ATTORNEY

UNITED STATES PATENT OFFICE

2,530,171

MAGNETRON OUTPUT TERMINAL

Ernest C. Okress, Montclair, N. J., assignor to
Westinghouse Electric Corporation, East Pitts-
burgh, Pa., a corporation of Pennsylvania

Application June 6, 1944, Serial No. 538,971

5 Claims. (Cl. 178-44)

1

This invention relates to output terminals and more particularly to magnetron output terminals which feed into a hollow wave guide.

In my prior application, Serial No. 461,135, filed October 7, 1942, an output terminal is shown wherein energy transition from the coaxial conductor to the wave guide is accomplished as an open line exposed to atmospheric pressure. That structure is accordingly subject to high voltage gradient in air between the exposed end of the coaxial conductor and surrounding metallic parts. When the device is used at high altitudes, for instance in an airplane, the high voltage gradient and rarified atmosphere combine to cause break-down or sparking between said exposed end of the coaxial conductor and the surrounding metallic parts.

The present invention contemplates use of a proper matching of impedances, energy transition, and enclosure in vacuum of parts subject to high voltage gradients, so as to avoid detrimental effects when the device is used under varying conditions of external atmospheric pressure.

More specifically, an object of the invention is to provide a construction presenting proper input admittance to the magnetron in vacuum while maintaining a sufficiently low standing wave ratio in the remaining portions of the terminal exposed to prevailing atmospheric pressure.

A further object of the invention is to provide a terminal which, in its entirety, inclusive of the wave guide in whole or in part, need not be maintained at vacuum or other fixed pressure in order to prevent breakdown in use at high altitudes.

Yet another object of the invention is to minimize the extent of the region having to be evacuated and maintained under vacuum, and to otherwise provide a simplified sturdy construction.

Still further objects will appear to those skilled in the art as the description progresses both by direct recitation thereof and by inference from the context.

In the accompanying drawing wherein like numerals of reference indicate similar parts throughout the several views:

Figure 1 is a sectional view of a portion of a magnetron and of a wave guide with my invention associated therewith;

Figure 2 is a sectional view on line II—II of Fig. 1; and

Figure 3 is a sectional view on line III—III of Fig. 1.

In the specific embodiment of the invention illustrated in said drawing, the reference numeral 10 designates a part of a known ultra-high fre-

2

quency generator, here shown as a magnetron, from which wave energy is derivable through a coaxial line means which includes a current probe or loop 11 of suitable shape situated within a cavity 12 of the generator. The interior of said generator is evacuated.

The desideratum is to transfer energy picked up by the loop 11 to a hollow wave guide 13 situated exterior to the generator and the hollow interior or passage of which is not evacuated and accordingly subject to the prevailing atmospheric pressure and condition where the device is in actual use whether that be next to the earth or at a high altitude where the air is more rarefied. Wave guides in general are known to the art and constitute a mean by which electromagnetic energy is propagated from one place to another before its ultimate transmission in free space or utilization in some other instrumentality. Usually wave guides are rectangular in cross-section with one dimension greater than the other for purposes of obtaining the desired mode of oscillation and polarization of the wave that may be transmitted.

The energy transmission means from generator to wave guide is identified by the general appellation thereto of terminal, and it is a feature of the present invention to construct this terminal with the part thereof next the wave guide sealed in order that the part next the generator may be evacuated with and subject to the same vacuum as the interior of the generator, and to utilize the evacuated region in obtaining the desired electrical characteristics for the terminal.

The coaxial line means constituted by said terminal comprises, in addition to loop 11 above-mentioned, a rod-like portion or inner coaxial member 14, which extends into the wave guide, and tubular portion or outer hollow member 15 coaxial with the rod portion and extending from the generator to the wave guide, and attached to both.

Said tubular portion 15 is constituted by a conductive base or thimble 16 which is hollow and preferably formed as a body of revolution. One end of said thimble 16 has a threaded neck or basal portion 17 which screws into a side opening for the purpose in the magnetron and sealed, as by solder 18 therein. One end of the loop 11 is secured to the inner end of this neck or basal portion 17 so the loop is within the cavity 12 and so that the rod portion 14 passes outward from the cavity coaxially through the central hole or bore of said neck into the interior of the thimble 16. At the outer end of the thimble the interior

cylindrical wall is provided with an internal annular rabbet 19 and the exterior wall is provided with an external peripheral rabbet 20. An end margin of an internal collar 21 is seated in the internal rabbet 19 and sealed, as by solder, to the thimble thereat. The outer end of this collar is flanged outwardly, as at 22, so the flange is perpendicular to the axis of the collar and in a plane coincident with the near wall of the wave guide wall as a continuation of the inner surface thereof.

Within collar 21 the passage through hollow member 15 is sealed vacuum tight by a glass bead 26 of predetermined thickness. Preferably a borosilicate glass is employed in conjunction with which the said collar 21 and portion 27 of the rod 14 passing through the glass, are made of material having a corresponding coefficient of expansion, such a material being described in Patent 2,062,335 of December 1, 1936, to Howard Scott and sold in the trade under the trade-mark "Kovar." Outside of and coaxial with collar 21 is a sleeve 28 of adequate strength for support purposes, such as brass, which has one end soldered in rabbet 20 and its other end soldered against the near wall of wave guide 13.

Within the wave guide, rod 14 is provided with an antenna head 29 preferably of flaring shape which has a transitional increase in diameter from the portion 27 of the rod toward the outer end of the head, and being shown as frustoconical and hollow. The controlling factor for configuration of this antenna head is to obtain a smooth impedance transition from the coaxial line to the wave guide, thereby obtaining gradual change without setting up the usual localized high electrical gradients thereat. This antenna head at its larger end is sealed to the far wall of the wave guide 13 for obtaining a good electrical connection therewith. For ease of manufacture, said head is shown projecting through the said far wall of the wave guide, thereby enabling the soldering thereof to that wall to be accomplished at the outer side of the wall. This direct attachment of the antenna head of rod 14 to the wave guide wall completes the coaxial terminal as a closed line. Since the wave guide is operated in the fundamental mode, the axial length of the tapered antenna is less than half a wave guide wavelength. The thickness of glass bead 26 lengthwise of the rod is preferably a half wavelength in dimension in the dielectric medium composing the bead referred to free space wavelength.

The interior of the evacuated hollow portion of member 15 is provided with a transformer section of predetermined dimensions. The preferred construction utilizes a passage 30 in the neck portion of said member of smaller diameter than the diameter of passage or chamber 31 in the body of the said member. Furthermore, the passage 30 is of predetermined length and formed within a wall which protrudes as a ring 32 at its upper end into the lower part of the chamber 31. This combination of different sizes of passage and chamber and length of smaller passage with the rabbeted section, and abrupt change of surface direction constitutes a transformer.

For convenience of reference, the end of the neck portion 17 of the member 15 terminating at the inner wall of the magnetron cavity has been designated as in a plane P_0 , and the upper end of the smaller passage terminated by ring 32 has been designated as in a plane P_1 , whereas plane

of the inner surface of the near wall of the waveguide has been designated as plane P_2 . The open end of the waveguide, which is shown flanged for attachment to any desired instrumentality is designated as at a plane P_3 . Configuration and distance between planes P_0 and P_1 have definite relationship for establishing the proper input admittance at the base of the loop at plane P_0 . When once determined and the device constructed, these dimensions and configurations remain constant. Determination of these dimensions and configurations has been realized by following a practical procedure outlined below, namely:

(a) A constant voltage or current Rieke diagram is run with reference to plane P_3 by means of a conventional waveguide coaxial terminal provided with means whereby variable reactance and radiation resistance may be obtained. The variable section is preadjusted, first for maximum output into a matched load in the waveguide and the Rieke taken, another Rieke is taken with the matching section set at 80% of maximum power under the same conditions. By way of definition it may be stated a Rieke diagram is a radio frequency output diagram of frequency, power and voltage contours, for constant current (or voltage, in which case the current contours are plotted), as a function of load impedance with respect to some plane of reference between the load and the base of the coupling loop of the magnetron. The load impedance may be represented on a polar diagram whose radial coordinate denotes the real reflection coefficients and the angular coordinate denotes the phase angle with respect to the reference plane. One convolution of the angular coordinate corresponds to one-half wavelength. The load impedance may also be represented on a circle diagram, or other suitable transformation, in which case resistance and reactance comprise the coordinates.

(b) A suitable operating point is selected from the above data and the corresponding impedance at the plane P_3 obtained from the position of the minimum of standing wave pattern from the reference plane P_3 of the magnetron, and standing wave ratio (voltage). Said operating point is an optimum point of operation as defined by the load impedance (or reflection coefficient and position of minimum) on a Rieke diagram referred to the reference plane of the magnetron, where a definite power output and pulling figure, consistent with a given anode voltage, anode current and magnetic field is obtained characteristic of the load and magnetron.

(c) The conventional terminal is then reset to either maximum power output or 80% output into a matched line depending upon which setting produces the better Rieke contour from a functional point of view.

(d) The conventional output terminal (waveguide and coaxial feed) to plane P_0 is removed from the magnetron intact and to each end are attached lengths of line such that a four terminal network may be obtained which is an ideal transformer defined in terms of three constants, the transformer constant and two lengths of line.

(e) The operating point defined by the admittance at the plane P_3 of the conventional terminal can then be transformed through this network to the base of the loop of the conventional terminal (plane P_0) with the aid of four terminal network theory.

(f) Now, with a matched line beyond plane P_1 in the proposed terminal, a transformer between P_0 and P_1 can be provided to give the desired admittance at plane P_0 .

(g) Next an adjustment of the terminal section looking toward plane P_2 is required to obtain a standing wave ratio which is substantially unity for the wavelength or wavelength band under consideration. This is done by providing a dummy terminal between plane P_1 and P_2 with extended sections of equivalent dimensions, each with probes, and then feeding the desired energy into the coaxial probed line to the matched load in the waveguide.

The terminal constructed in accordance with my invention presents the proper input admittance to the magnetron, in vacuum, while maintaining a low standing wave ratio in the remaining portions of the terminal, exposed to the prevailing atmospheric pressure. Since the high electrical gradient of the transformer is within the evacuated region, it is not affected by change of external atmospheric conditions and the device, inclusive of the waveguide section, functions as well at one elevation as another notwithstanding the atmospheric conditions may vary in the waveguide.

I claim:

1. An output coupling from an ultra high frequency generator to a waveguide, comprising a hollow member having a basal end next to and projecting from said generator and said basal end having a longitudinal passage therein, said passage having an enlargement thereof at the end of the passage remote from the generator, said hollow member providing a chamber of greater diameter than said enlargement, a coaxial inner member extending from said generator to said waveguide coaxially of and through said passage, enlargement and chamber, a ring seated in said enlargement and projecting into said chamber and constituting with the wall of said chamber a transformer, and a vacuum seal for said chamber at the end thereof toward the waveguide whereby the passage, chamber and transformer are at the same vacuum as the generator, and the location and seating of said ring in the enlargement enabling the coupling to be assembled with a desired length of ring protruding into the chamber and obtaining desired transformer characteristics.

2. An output coupling from an ultra high frequency generator to a waveguide, comprising a hollow member having a basal end next to and projecting from said generator and said basal end having a longitudinal passage therein, said passage having a stepped enlargement at the end of the passage remote from the generator, said hollow member providing a chamber of greater diameter than said enlargement thereby constituting a second stepped enlargement of the hollow of said member, a coaxial inner member extending from said generator to said waveguide coaxially of the stepped hollow of said hollow member, a ring seated in the first mentioned enlargement and projecting into said chamber and constituting with the wall of said chamber a transformer, means vacuum sealing the end of said chamber remote from the generator and with the vacuum of the generator effective in said chamber and maintained by said means, and the location and seating of said ring in the first said enlargement and protruding into the second said enlargement enabling the coupling to be assembled with a desired length of ring pro-

truding into the chamber and obtaining desired transformer characteristics.

3. An output coupling from an ultra high frequency generator to a waveguide, comprising a hollow member having a basal end next to and projecting from said generator and said basal end having a longitudinal passage therein, said passage having a stepped enlargement at the end of the passage remote from the generator, said hollow member providing a chamber of greater diameter than said enlargement thereby constituting a second stepped enlargement of the hollow of said member and said second stepped enlargement of said member being again enlarged by a rabbet at the end of said member toward the waveguide, a collar seated in said rabbet and having a flange at its end toward the waveguide, said flange being connected to said waveguide, a coaxial inner member extending from said generator to said waveguide coaxially of and through said hollow member and the passage, enlargement, chamber and rabbet thereof, a ring seated in the first mentioned enlargement and projecting into said chamber and constituting with the wall of said chamber a transformer, a glass bead sealed peripherally to said collar and sealed on and to said coaxial inner member and comprising a closure for said chamber at the end thereof toward the waveguide, the successive stepped enlargements of the hollow of the hollow member enabling the coupling to be assembled and a ring of desired length seated in the first enlargement and protruded into the second enlargement for obtaining desired transformer characteristics.

4. An output coupling from an ultra high frequency generator to a waveguide, comprising a hollow member having a basal end next to and projecting from said generator and said basal end having a longitudinal passage therein, said passage having an enlargement thereof at the end of the passage remote from the generator, said hollow member, providing a chamber of greater diameter than said enlargement, a coaxial inner member extending from said generator to said waveguide coaxially of and through said passage, enlargement and chamber, a ring seated in said enlargement and projecting into said chamber and constituting with the wall of said chamber a transformer, said ring having an internal diameter equal to the diameter of the passage and an outer diameter equal to that of the first said enlargement, and a vacuum seal for said chamber at the end thereof toward the waveguide whereby the passage, chamber and transformer are at the same vacuum as the generator, and the location and seating of said ring in the enlargement enabling the coupling to be assembled with a desired length of ring protruding into the chamber and obtaining desired transformer characteristics.

5. An output coupling from an ultra high frequency generator to a waveguide, comprising a hollow member having a basal end next to and projecting from said generator and said basal end having a longitudinal passage therein, said passage having a stepped enlargement at the end of the passage remote from the generator, said hollow member providing a chamber of greater diameter than said enlargement thereby constituting a second stepped enlargement of the hollow of said member and said second stepped enlargement of said member being again enlarged by a rabbet at the end of said member toward the waveguide, a collar seated in said rabbet and having a flange at its end toward the waveguide, said flange being connected to said waveguide,

a coaxial inner member extending from said generator to said waveguide coaxially of and through said hollow member and the passage, enlargement, chamber and rabbet thereof, a ring seated in the first mentioned enlargement and projecting into said chamber and constituting with the wall of said chamber a transformer, a glass bead sealed peripherally to said collar and sealed on and to said coaxial inner member and comprising a closure for said chamber at the end thereof toward the waveguide, a sleeve coaxial with and at the outside of said collar, said sleeve being rigidly connected at its ends to the said hollow member and waveguide respectively and protecting said collar from strains and distortions, the successive stepped enlargements of the hollow of the hollow member enabling the coupling to be assembled and a ring of desired length seated in the first enlargement and protruded into the second enlargement for obtaining desired transformer characteristics.

ERNEST C. OKRESS.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,927,393	Darbord	Sept. 19, 1933
2,147,717	Schelkunoff	Feb. 21, 1939
2,193,859	Buschbeck	Mar. 19, 1940
2,216,170	George	Oct. 1, 1940
2,312,919	Litton	Mar. 2, 1943
2,394,398	Mouromtseff	Feb. 5, 1946
2,407,911	Tonks	Sept. 17, 1946
2,408,032	Beck	Sept. 24, 1946
2,417,789	Spencer	Mar. 18, 1947
2,429,243	Snow	Oct. 21, 1947
2,432,093	Fox	Dec. 9, 1947
2,433,074	Tuller	Dec. 23, 1947
2,434,925	Haxby	Jan. 27, 1948
2,476,732	Hollingsworth	July 19, 1949