March 24, 1953 K. GAROFF ET AL 2,632,867

TRANSMIT-RECEIVE TUBE AND RESONANT CIRCUIT ASSOCIATED THEREWITH

Filed May 3, 1951 2 SHEETS—SHEET 1

FIG. 1

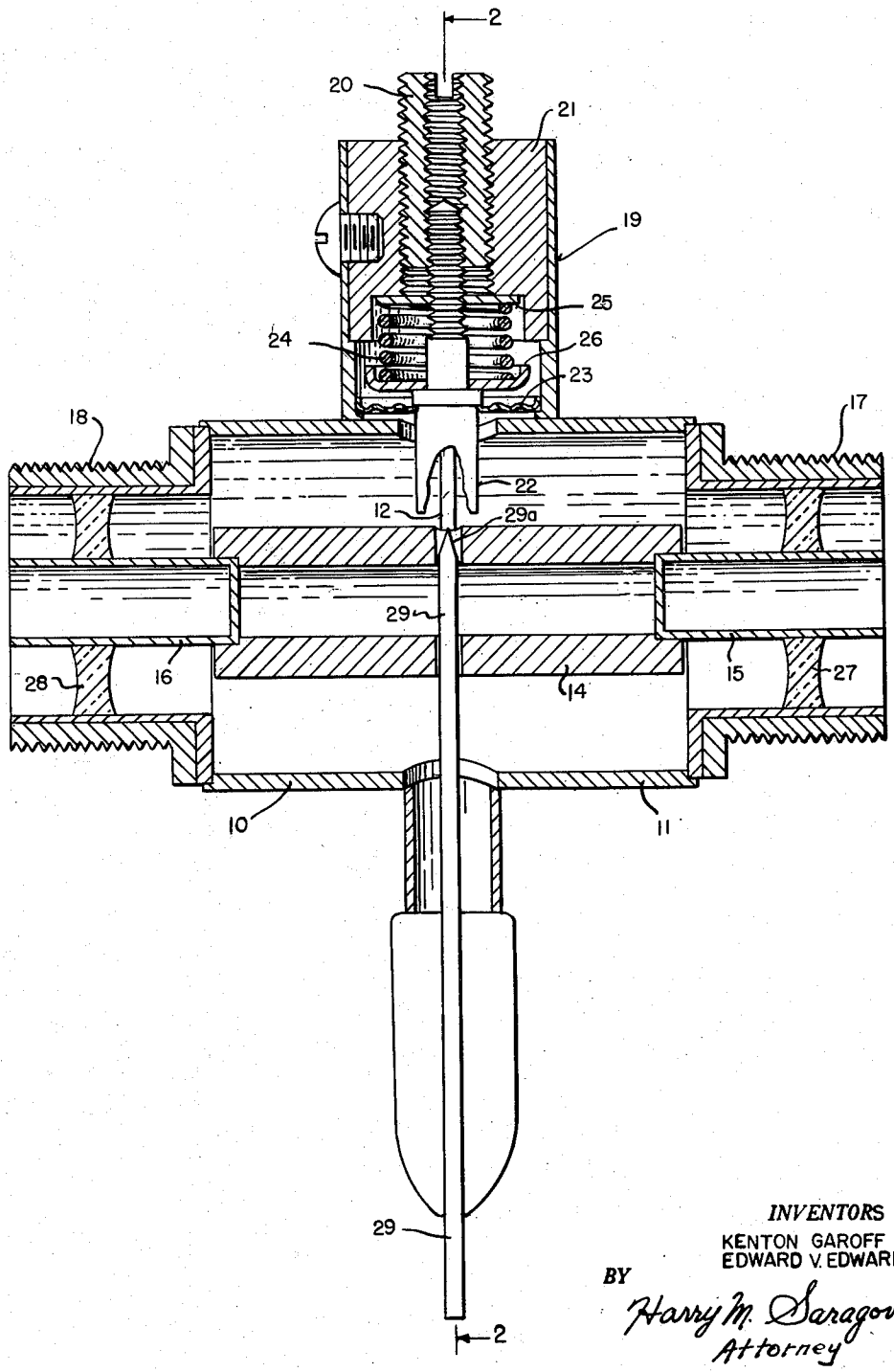

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FIG. 2

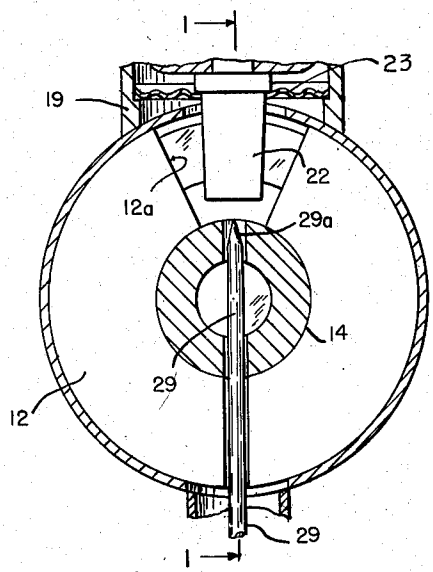


FIG. 4

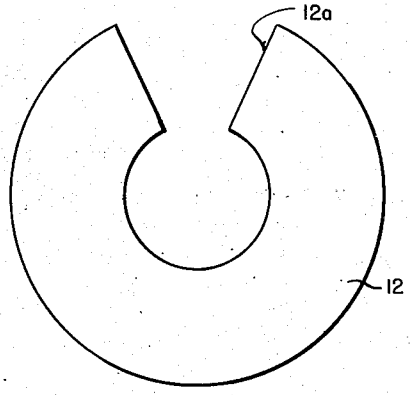


FIG. 5

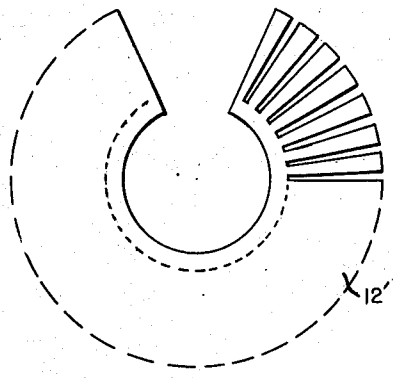
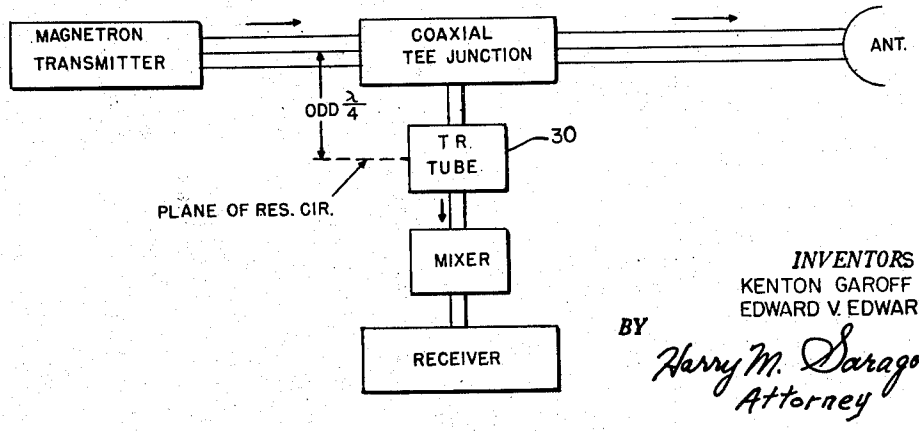


FIG. 3



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UNITED STATES PATENT OFFICE

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TRANSMIT-RECEIVE TUBE AND RESONANT CIRCUIT ASSOCIATED THEREWITH

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Application May 3, 1951, Serial No. 224,438

7 Claims. (Cl. 315—39)

(Granted under Title 35, U. S. Code (1952), sec. 266)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment of any royalty thereon.

This invention relates to improvements in transmit-receive tubes and resonant circuit associated therewith.

Present day gas switching transmit-receive tubes of either the cavity or wave-guide type, for the 3000 megacycle region also known as the S-band frequency, have an operating limitation which resides in the fact that in none of these tubes will the gas be ionized by peak line power levels as low as 50 to 100 watts. In microwave, radar and beacon systems where a common antenna-and-transmission line receives and transmits signals, this unfavorable characteristic, of prior transmit-receive tube designs and associated resonant circuits, detracts appreciably from the function of the same which is to protect the sensitive receiver input during transmission and to pass the returning echo signal with minimum attenuation during reception.

With the foregoing in mind, it is one of the objects of the present invention to provide an improved gas switching transmit-receive tube and a resonant circuit therefor which have the operating characteristic, particularly for S-band frequency, of gas-ionization or activation at power levels as low as 50 to 100 watts.

Another object is to provide a very small transmit-receive tube, to operate at S-band frequency, in applications where weight and space are important considerations.

Another object is to provide a tube and associated resonant circuit for the purpose aforesaid and with which employment of a resonant cavity, as heretofore required, is avoided.

Other objects and advantages will hereinafter appear.

In accordance with the present invention, a resonant circuit is incorporated in a coaxial line, for application as a gas switching transmit-receive tube.

For the purpose of illustrating the invention, an embodiment thereof is shown in the drawings, wherein:

Fig. 1 is an enlarged sectional view, partly broken away and illustrative of the improved resonant circuit incorporated in a coaxial line for application as a gas switching transmit-receive tube, a partial section being taken on the line 1—1 in Fig. 2;

Fig. 2 is a view partly in section and partly in elevation, the section being taken on the line 2—2 in Fig. 1;

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Fig. 3 is a simplified diagrammatic view explanatory of the manner in which the improved resonant circuit is incorporated in a coaxial line, for application as a gas switching transmit-receive tube in a conventional radar system;

Fig. 4 is a front, elevational, detail view of one of the unassembled parts in Figs. 1 and 2; and

Fig. 5 is a view similar to Fig. 4, showing a modification thereof.

Referring to Figs. 1 and 2, the tube casing is comprised of two similar, tubular, steel parts 10 and 11 fitted and sealed or otherwise fixed together, vacuumtight. Between the parts 10 and 11 of the casing and disposed in a plane perpendicular to the longitudinal axis of the latter, is a solid steel disc 12 cut away at 12a and having a press fit on a center-conductor part 14 whose opposite ends fit and connect with the inner conductors 15 and 16 of the coaxial connections 17 and 18, respectively.

Mounted on casing 10, 11 and sealed thereto, vacuumtight, is a housing 19 containing differential, complementary screws 20 and 21 which support for adjustment a tapered tuner probe 22 disposed in the break or gap 12a in disc 12. Probe 22 is held against a copper diaphragm 23 by a music-wire spring 24 compressed between washers 25 and 26. The diaphragm 23 is sealed, vacuumtight, to housing 19 and probe 22.

Seals 27 and 28, which may be of crushed glass, are disposed respectively at opposite ends of the casing to confine the gas at the desired pressure, in the tube.

A keep-alive electrode 29 of a conventional construction is sealed to the casing. Electrode 29 may be a .030'' diameter Kovar rod with a glass coating, and extends upwardly through disc 12 and suitable holes or passages drilled in conductor 14. The casing is drilled to accommodate the glass-coated electrode 29, the outside diameter of which is greater than the thickness of disc 12. This drilling operation, therefore, cuts entirely through disc 12, previously sealed and fixed between the casing parts 10 and 11.

The exposed tip 29a of electrode 29 is ground to about .010'' diameter.

For application in a conventional radar system, the tube, designated in Fig. 3 by the reference numeral 30, is connected as shown. It may be mounted and used in a conventional type of coaxial duplexer.

The resonant elements in the tube are disc 12 and probe 22.

For the purpose of tuning the tube to resonance at the desired frequency, the tuner probe

is adjusted by screw 20. When tuned to resonance, the overall insertion loss of the tube is approximately .4 db.

In operation of the tube, the concentrated E field built up between the tuner probe 22 and center conductor 14, by the resonating elements 12 and 22, ionizes the gas in the tube when peak line power levels of 50 to 100 watts are applied. Such discharge detunes the resonant circuit permitting only a small amount of power to leak through to the crystal detector of the receiver.

The keep-alive electrode 29, brought in diametrically opposite the tuner probe 22, has the conventional function of helping to initiate the radio frequency gas-discharge in as short a time as possible.

A resonant section including disc 12 and probe 22 can be used as a filter, in addition to the aforesaid application as a gas switching device. Furthermore, two or more of these resonant filters, spaced approximately one-quarter wavelength apart, would constitute a band-pass type of filter or transmit-receive tube.

The same resonant circuit, but with a different Q, is provided by radially slotting disc 12, as shown in Fig. 5. The construction, disposition and function of disc 12', otherwise, are identical to those of disc 12. In Fig. 5, disc 12' is shown provided with 33 slots uniformly spaced and each about .011'' wide. The number, length and width of the slots are made to result in the desired Q for the resonant circuit.

In one workable embodiment of the invention, the respective dimensions thereof were as aforesaid and, also, the outside diameter and length of each of the casing parts 10 and 11 were about .875'' and .6'', respectively.

Although disc 12 has a snug or press fit on center-conductor part 14, it does not constitute a radio frequency short-circuit across or between the latter and the casing because the disc is made of steel and the operating action of the tube is in the S-band, that is, at a 3000 megacycle frequency range.

For details of electronic or other operating action, and those of features or characteristics of structure herein which correspond generally to or are the electrical or mechanical equivalent of those in resonant circuits and transmit-receive tubes of the prior art; reference is made to book dated April 28, 1944, and identified as War Department Technical Manual TM11–467 on Radar System Fundamentals. For the same purpose, reference is also made to Patent Number 2,404,116, issued July 16, 1946, to Wolowicz et al., and to Patent No. 2,454,741, issued November 23, 1948, to Henry J. McCarthy.

While but one embodiment of the invention has been shown and described, it will be apparent to those skilled in the art that various modifications, such as in the size, shape and arrangement of the parts, are possible without departing from the spirit of the invention or the scope of the claims.

What is claimed is:

1. Wave-transmission apparatus comprising a coaxial section having an outer and an inner conductor, said outer conductor providing a casing for said apparatus, first and second tuning electrodes, said first electrode comprising a disc radially connected to said inner conductor and having a sector cut out therefrom, a portion of said second electrode being juxtaposed to said first electrode and partially inclosed within the cut-out sector thereof, and means coupled to one of said electrodes for moving it relative to the other of said electrodes to vary the degree by which said first electrode incloses said second electrode.

2. An apparatus according to claim 1, wherein said disc has a plurality of radial slots therein.

3. An apparatus according to claim 1, wherein the inclosed portion of said second electrode is shaped in the form of a frustum of a cone.

4. An apparatus according to claim 3, wherein said outer and said inner conductors form an air tight cavity therebetween, said cavity being filled with gas.

5. An apparatus according to claim 4, further including means coupled to said coaxial section for applying electromagnetic energy thereto, ionization of said gas between said second electrode and said inner conductor occurring when said energy exceeds a given power level.

6. An apparatus according to claim 5, wherein said outer conductor is provided with an opening through which said second electrode moves, said means for moving said one electrode relative to said other electrode comprising a differential screw mechanism connected to said second electrode and coupled to a diaphragm which hermetically seals the opening in said outer conductor.

7. An apparatus according to claim 6, additionally including a keep alive electrode which pierces said outer and inner conductors as well as said first electrode and is juxtaposed to said second electrode.

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