United States Patent

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[31] 6806783

[54] **RESONANT CAVITY MAGNETRONS USING CATHODE HEATER CURRENTS TO INTENSIFY MAGNETIC FIELDS**
4 Claims, 2 Drawing Figs.

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[56] **References Cited**

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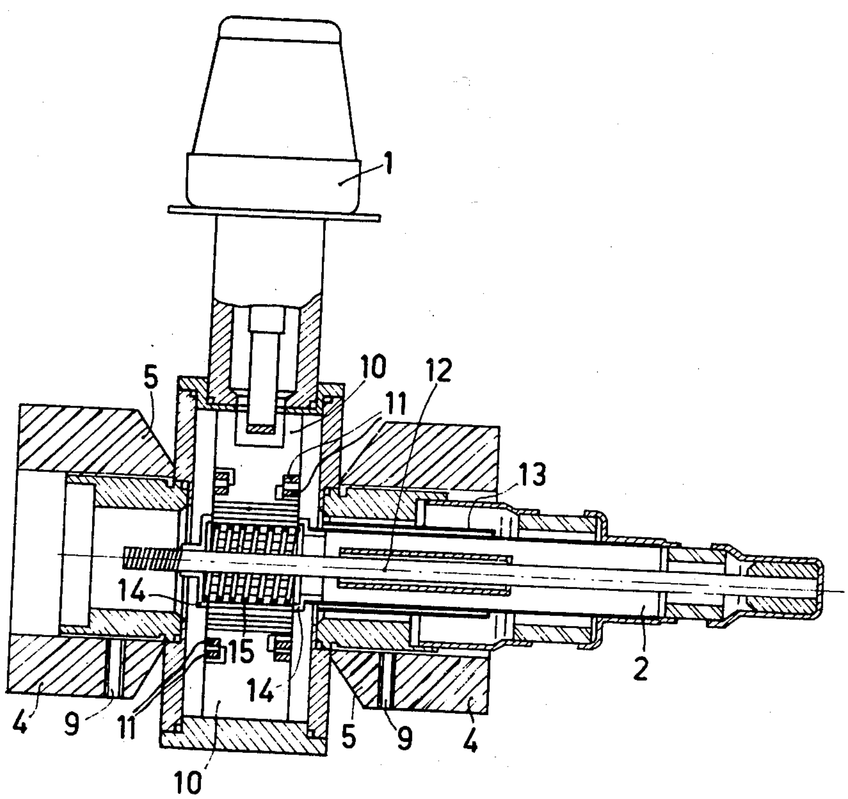
ABSTRACT: A resonant cavity magnetron having a directly heated helical cathode using its heater currents to set up magnetic fields for intensifying the externally supplied magnetic fields in the cathode-anode reaction spaces. A more efficient operation of the magnetron due to resulting homogeneous magnetic fields is realized even when the anode voltages contain strong ripples in its power supply.



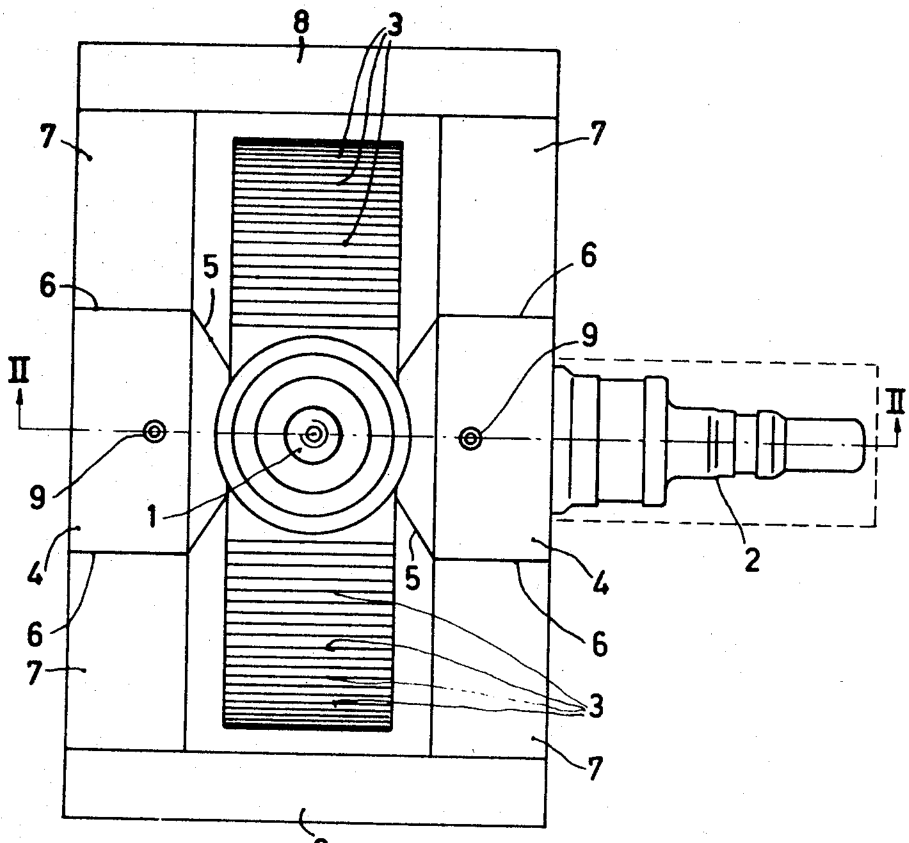


fig.1

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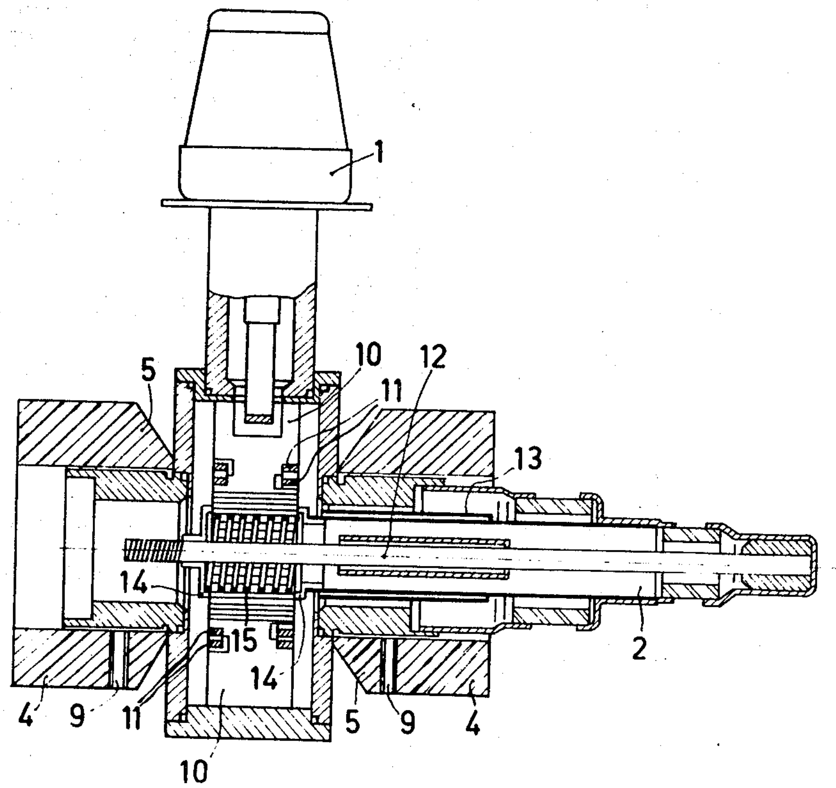

fig. 2

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RESONANT CAVITY MAGNETRONS USING CATHODE HEATER CURRENTS TO INTENSIFY MAGNETIC FIELDS

The invention relates to a device for producing an unmodulated electric wave by means of a resonant cavity magnetron provided with a single helical directly-heated cathode.

Magnetrons of the foregoing type usually operate at a frequency which is low compared with that at which magnetrons for radar installations operate. When such magnetrons are used, for example, for ovens for preparing food, the frequency usually is 2,450 mc. The magnetic field in the reaction space between the anode and the cathode has a strength of from approximately 1,000 to 1,500 gauss.

The magnetic field is usually produced by means of perforated pole shoes in which the parts of the magnetron housing which surround the ends of the cathode are incorporated.

As a result of the shape of the pole shoes, the magnetic field in the anode-cathode reaction space is strongly inhomogeneous. As a result of this, the voltage-current characteristic of the magnetron has a less sharp bend than would be the case in a homogeneous magnetic field. The inhomogeneous magnetic field as such is already unfavorable for the efficiency of the magnetron with a readily smoothed supply voltage. With a supply voltage having a strong ripple, which often occurs in devices of the type described, the efficiency is even further reduced.

It is the object of the invention to provide an improvement.

According to the invention, in a device for producing an unmodulated electric wave by means of a resonant cavity magnetron which is provided with a single, helical directly-heated cathode, the filament current of the cathode is a direct current of such a direction that the magnetic field produced by the cathode intensifies the magnetic field in the anode-cathode reaction space.

The intensification of the magnetic field in the anode-cathode space according to the invention results in said field becoming homogeneous which considerably improves the efficiency particularly when a non- or poorly smoothed supply voltage is used. As a result of the use of cathode-direct current instead of cathode-alternating current, the magnetron operates in a constant magnetic field and not in an alternately intensified and weakened field. This also influences the efficiency favorably. Upon calculating the magnet system to be used for the magnetron, the field produced by the cathode can be taken into account.

It is to be noted that it is known in magnetrons (British Pat. No. 739,092)for radar with millimeter wavelength to heat the filament of the indirectly heated cathode with direct current to center same in the cathode body by means of the strong magnetic field. The small influence of the magnetic field of the weak filament current on the strong magnetic field of approximately 10 kilogauss, which operates in the same direction as according to the invention, is, however, negligible. The centering force of the magnetic field on the cathode in the device according to the invention is rather small as compared with the strength of the cathode but certainly no disadvantage.

In order that the invention may be readily carried into effect, one embodiment thereof will now be described in greater detail, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 shows an elevation of a magnetron for a device according to the invention incorporated in the magnetic system, and

FIG. 2 is a cross-sectional view of the magnetron with the pole shoes connected thereto.

In FIG. 1 the elevation is shown in the direction of the output coupling **1**. The cathode line **2** is shown on the right-hand side. The cooling fins are denoted by **3**, the two concave cylindrical pole shoes by **4**, the conical edge thereof by **5**, the flattened sides by **6**.

Blocks of permanent magnetic material **7** connected by soft magnetic terminating members **8** adjoin the flattened sides. The material of **7** and **8** may also be interchanged.

The pole shoes **4** are secured to the ends of the magnetron by means of bolts **9**.

In FIG. **2** the flattened sides **6** of the pole shoes **4** extend parallel to the plane of the drawing. In this figure, the cooling fins are not shown. In the housing of the magnetron a number of anode vanes **10** are situated, which are alternately connected by straps **11**.

From the cathode line **2**, a central conductor **12** and a sleeve **13** situated coaxially around it, lead to the cathode consisting of the helix **15**. The helix **15** consists of 5½turns of 1 mm. thick tungsten thorium wire having an outside diameter of approximately 13.5 mm.

For starting the magnetron a direct current of 30 a. is conducted through the cathode at a voltage of 5.5 v., which after starting the oscillations of the magnetron, is reduced to 18 to 19 a. The field produced by the pole shoes has a strength of approximately 1,100gauss. The anode voltage is approximately 5 kv. and the anode current 0.4 a. The produced power at 2,450 mc. is 1 kw. When a supply of alternating current is used of the cathode, the power produced is well over 100 w. lower.

I claim:

1. A resonant cavity magnetron comprising a space resonant housing, magnetic means for producing a magnetic field within said housing, a plurality of anode vanes coaxially mounted within said housing for electric field interaction with said magnetic field, a single directly-heated cathode axially positioned within said anode vanes and having a helical configuration to produce a second magnetic field along the axis thereof, and means to supply direct current to said helix to produce therein said second magnetic field in the direction of the magnetic field of said magnetic means.

2. A resonant cavity magnetron as claimed in claim **1** wherein said means to supply direct current to said helix comprises a single-ended current-carrying conductor.

3. A resonant cavity magnetron as claimed in claim **1** wherein said magnetic means produce magnetic field strengths of 1,000to 1,500 gauss for operation at a frequency of the order of 2,450 H_z.

4. A resonant cavity magnetron as claimed in claim **2** wherein said single-ended conductor operates at approximately 5.5 v. and currents of approximately 30 a. initially and approximately 18a. for continuous operation at a frequency of the order of 2,450H_z.

It is the object of the invention is provide an improvement.

For starting the magnetron a direct current of 30 a. is conducted through the cathode at a voltage of 5.5 v., which after starting the oscillations of the magnetron, is reduced to 18 to 19 a. The field produced by the pole shoes has a strength of approximately 1,100 gauss. The anode voltage is approximately 5 kv. and the anode current 0.4 a. The produced power at 2,450 mc. is 1 kw. When a supply of alternating current is used of the cathode, the power produced is well over 100 w. lower.