July 13, 1948. J. C. SLATER 2,445,282
TUNING ARRANGEMENT FOR CAVITY RESONATORS
Filed May 19, 1944

FIG. 1

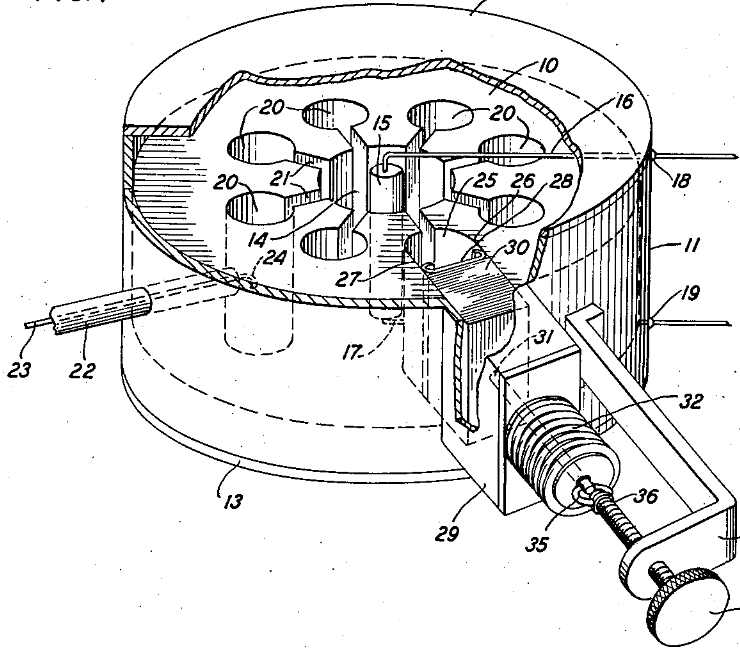
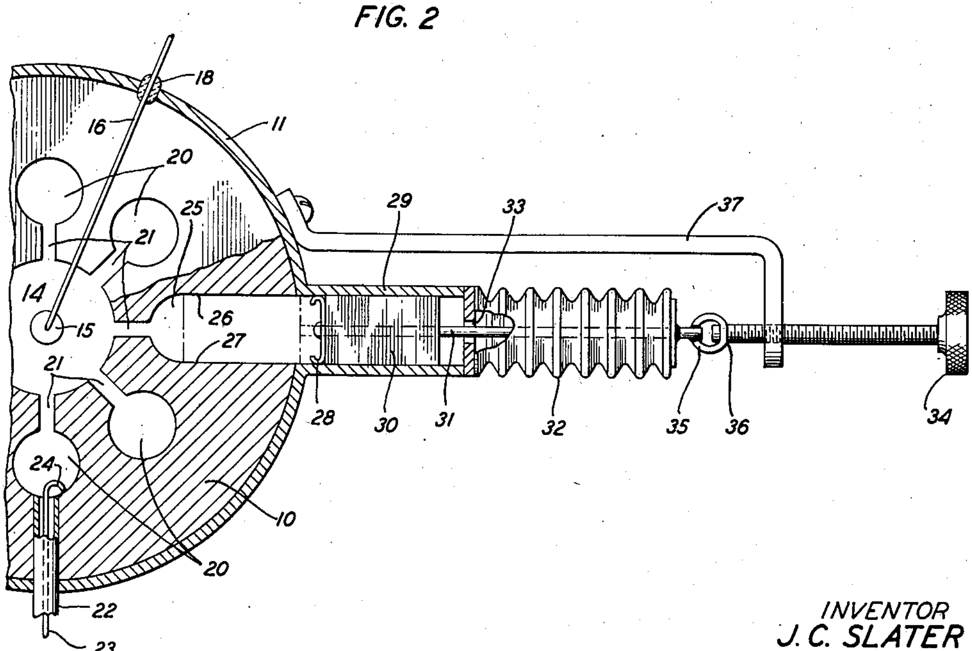


FIG. 2



INVENTOR
J. C. SLATER
BY
Franklin Mohr
ATTORNEY

Patented July 13, 1948

2,445,282

UNITED STATES PATENT OFFICE

2,445,282

TUNING ARRANGEMENT FOR CAVITY RESONATORS

John C. Slater, Cambridge, Mass., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application May 19, 1944, Serial No. 536,298

3 Claims. (Cl. 315—39)

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This invention relates to a tuning arrangement for cavity resonator for an electromagnetic resonator of the type containing a cylindrical resonating cavity. The invention is particularly useful for tuning one or more of the individual cavities in a multicavity resonator such as is commonly employed in a magnetron oscillator.

The need for tuning a cavity resonator may arise in many situations, particularly those involving the handling of microwaves, as in the generation and transmission of such waves. It is customary where power outputs of several kilowatts are required to generate microwaves in a magnetron oscillator which has a resonator containing one or more cylindrical resonating cavities. While the oscillating system of the magnetron may be predesigned to operate approximately at a desired frequency, it is useful to be able to adjust the operating frequency after the oscillator has been connected to a transmission system. One reason for this is that the operating frequency of a system made up of an oscillator and a load, which system may also include an intermediate transmission medium therebetween, depends not alone upon the dimensions of the oscillator but also upon the impedance offered to the oscillator by the load and by any such transmission medium. Oscillators have in certain cases been produced in quantity, inspected and tested in a standardized transmission circuit and those oscillators operating outside a prescribed frequency band have been rejected as unsatisfactory. Of the oscillators passing such a test moreover, some operate in the test circuit at a frequency close to one edge of the band. Such marginal oscillators when placed in the system for which they are ultimately intended, which system may differ somewhat from the test circuit in its impedance characteristics, may operate at a frequency outside the band limits, and thus be unsatisfactory. An oscillator which is off frequency usually can be brought to operate within the band by effecting a small change in the resonating properties of the oscillator. Other reasons for tuning the oscillator are to permit a selection of the final operating frequency and to permit the frequency to be changed from time to time as desired. A further reason is to enable manufacturing tolerances to be relaxed while insuring a commercial product which readily can be made to operate within its prescribed frequency band.

Various mechanical means are known for altering the shape or size of a resonant cavity to change its resonant frequency. In some cases

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the known means may be limited to producing insufficiently large changes in the resonant frequency or may be unsuited electrically or mechanically for the particular application in which it is desired to have a frequency adjustment.

The tuning arrangement of the present invention is particularly adapted to a currently preferred type of multi-anode magnetron having a perforated anode block containing a plurality of circular cylindrical resonating cavities with their axes parallel to the axis of a central cylindrical interaction space. In accordance with the invention, one of the resonating cavities is extended radially outwardly with reference to the interaction space to form a parallel plate transmission line. A tuning bridge is provided which connects the plates of said line and is slidable radially with reference to the central interaction space. The transmission line and the tuning bridge preferably each extend axially substantially the full length of the resonating cavity, or in other words from end to end of the anode block. Mechanical means are shown for adjusting the position of the tuning bridge.

In the drawing,

Fig. 1 is a perspective view, partly broken away, showing a magnetron oscillator embodying the invention; and,

Fig. 2 is a cross-sectional view of a portion of the structure of Fig. 1, showing the tuning element in a different position from that shown in Fig. 1.

Referring to the figures, the anode block 10 of a magnetron is shown with its enclosing case comprising a cylindrical side wall portion 11 and end plates 12 and 13, respectively. The central cylindrical interaction space of the magnetron is shown at 14 and has mounted along its central axis a cathode 15 which may be suitably supported as by means of sufficiently rigid wires or rods 16 and 17 which are brought through the wall portion 11 and supported by sealing means such as glass beads 18 and 19, respectively. A plurality of resonating chambers 20 may be provided as in the form of cylindrical perforations of the anode block 10 the cylinders having their axes parallel to the axis of the interaction space 14. The individual resonating cavities 20 may be connected to the interaction space 14 by means of coupling slots or channels 21 extending from end to end of the anode block 10. One of the resonating cavities 20 may be provided with a coaxial line output fitting comprising an outer sheath 22 and an inner conductor 23, the latter terminating in a coupling loop 24 within the chamber 20 in accordance with well-known practice. The anode block 10 may be composed of conductive material or at least the surfaces of the perforations should be conductive to a sufficient depth to serve as reflectors of electromagnetic waves of the generated frequency.

In accordance with the invention, one of the chambers such as that designated 25 in the drawing, is enlarged by being extended radially to form a parallel plate transmission line having plates or conductive surfaces 26 and 27, respectively, as by a slot extending from end to end of the anode block. A tuning bridge 28 is slidably mounted between the plates or surfaces 26 and 27, the bridge 28 preferably extending in the axial direction the full distance from end to end of the anode plate 10. The slot in which the tuning bridge slides may be described as a tuning slot, and in the embodiment shown, the tuning slot has a width substantially the diameter of the cavity 25.

Any suitable means may be employed for adjusting the radial position of the bridge 28 in the tuning slot, preferably from outside the vacuum chamber of the magnetron. Illustrative of such means is the arrangement shown in the drawing in which a box-like extension 29 is formed upon the wall portion 11 opposite the resonating cavity 25, the vertical walls of the box 29 being preferably formed as extensions of the surfaces 26 and 27. To guide the motion of the tuning bridge 28, there may be provided a block 30 fitted snugly inside the box 29 and attached to the bridge 28 as shown. The block 30 and bridge 28 may be moved together by means of a rod 31. To allow for the motion of the rod 31 while at the same time preventing loss of vacuum in the vacuum chamber of the magnetron, the outer end of the rod 31 may be passed through and sealed to a bellows 32 preferably of metal. The rod 31 may pass through a clearance hole 33 in the outer end of the box 29, the bellows 32 having its inner edge fastened and sealed around the hole 33. Suitable means such as a thumb screw 34 coupled to the rod 31 through a ring 35 and a rotatable joint 36 may be provided for controlling the motion of the rod 31. The thumb screw 34 may be supported as by a bracket 37 secured to the wall 11.

It will be evident that rotation of the thumb screw 34 will cause axial motion of the rod 31 which will in turn cause axial motion of the tuning bridge 28 to vary the position of the bridge 28 along the parallel plate transmission line comprising the surfaces 26 and 27. The limits of motion of the tuning birdge 28 may be chosen as desired, the innermost limit, in the arrangement illustrated, being determined by the striking of the tuning bridge against the circular cylindrical surface of the cavity 25, and the outer limit by the striking of the block 30 against the outer wall of the box 29. It will be evident that the travel

of the tuning bridge 28 may extend over a considerable portion of a wavelength of the operating frequency or even over one or more complete wavelengths, thus providing for a relatively large frequency adjustment.

What is claimed is:

1. A tunable cavity resonator device comprising a perforated cylindrical block of conductive material, the perforations of which include a cylindrical interaction space, and a plurality of cylindrical cavity resonators surrounding said reaction space and spaced therefrom, a central axis of said interaction space and of said cavity resonators being parallel to the central axis of said block, which block also has a plurality of coupling slots each interconnecting one of said cavity resonators with said interaction space, and has a tuning slot which is open at its two ends and is bounded by only two surfaces of said block, said surfaces being parallel with each other and with the central axis of said block, said tuning slot forming a parallel plate transmission line for electromagnetic waves of the operating frequency of said resonator device, said tuning slot extending from end to end of said block and from the interior of one of said cavity resonators outwardly through the outer surface of said block, and a tuning bridge slidably mounted between the two plates of said parallel plate transmission line.

2. A tunable cavity resonator device in accordance with claim 1 and in which the surfaces of said block bounding the said tuning slot are flat, and parallel to a radial plane of the said cylindrical block.

3. A tunable cavity resonator device in accordance with claim 1 in which the surfaces of said block bounding the said tuning slot are flat, parallel to a radial plane of the said cylindrical block and spaced apart a distance substantially equal to the maximum inside diameter of one of said cylindrical cavity resonators.

JOHN C. SLATER.

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