Jan. 11, 1949. H. C. JONAS ET AL 2,459,030

TUNABLE MAGNETRON

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FIG. 1

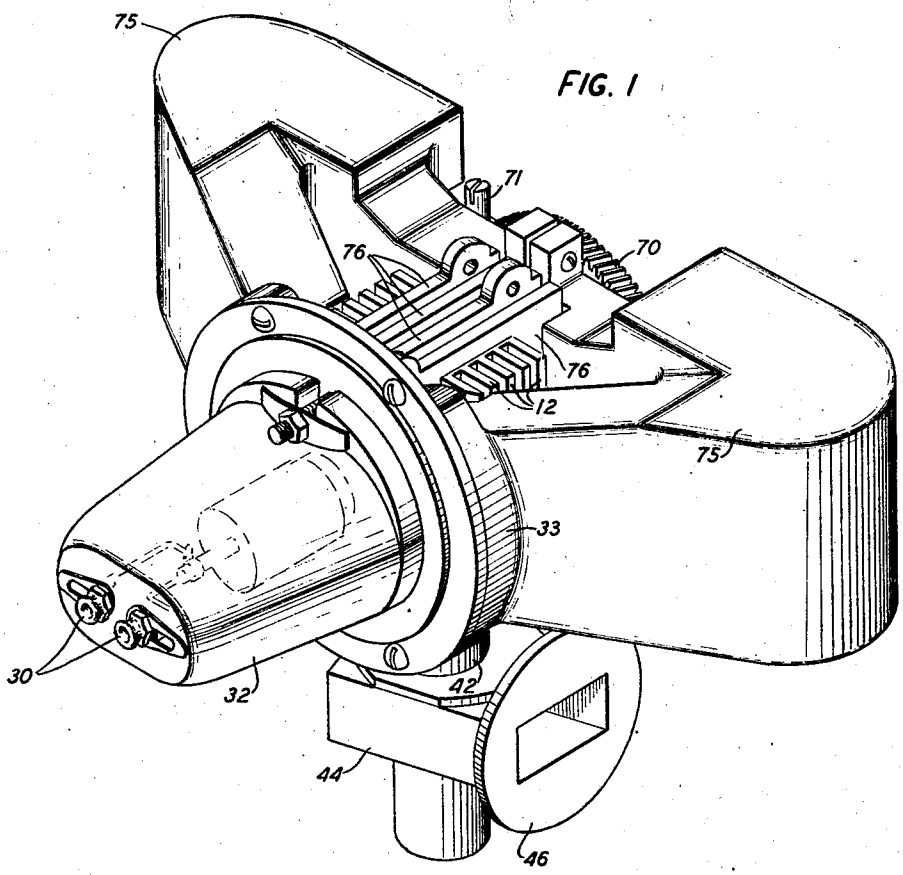

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FIG. 2

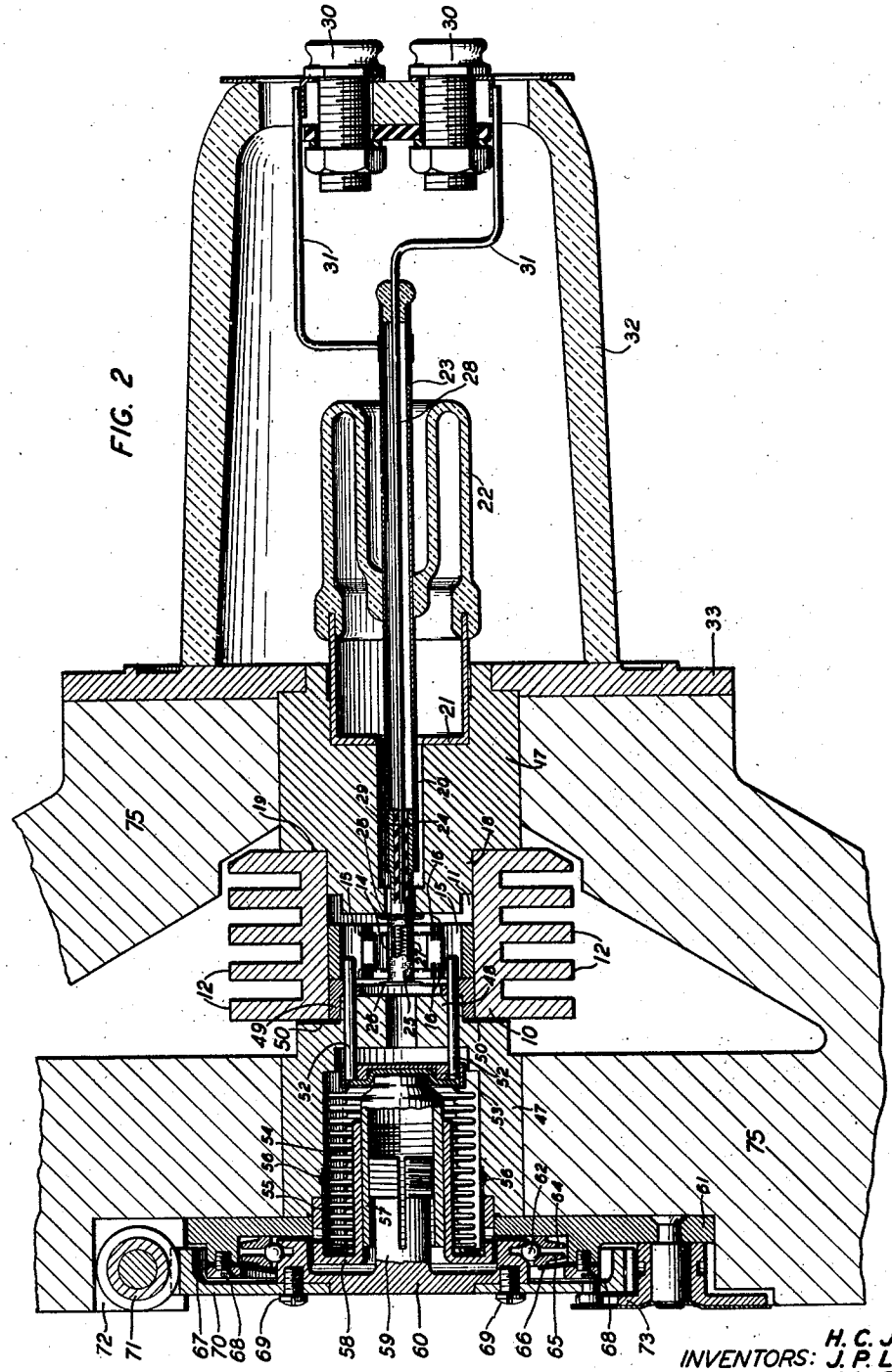

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FIG. 3

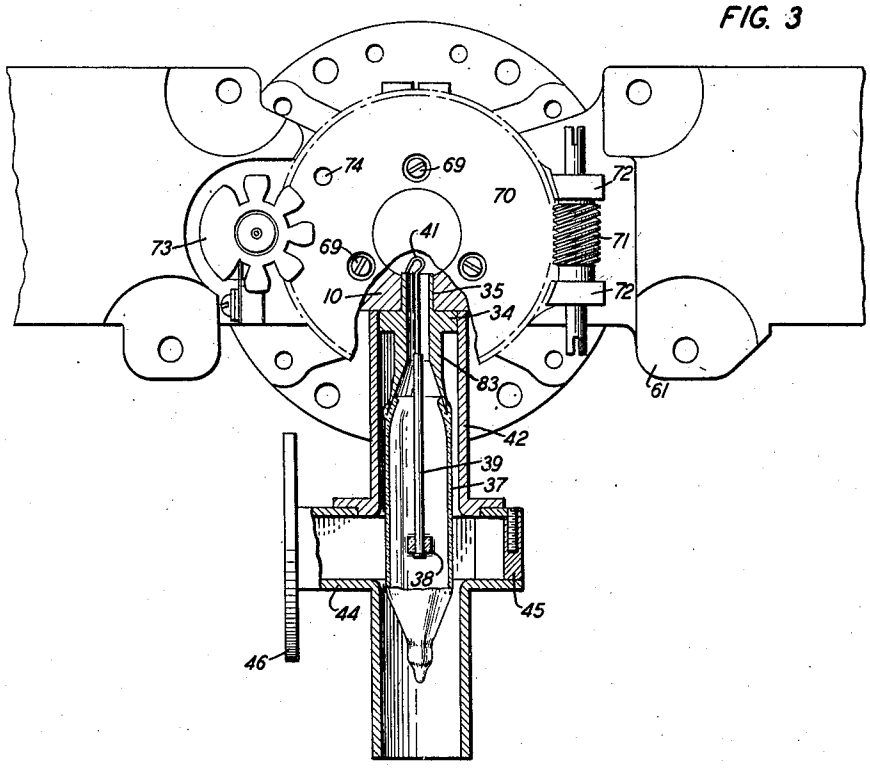
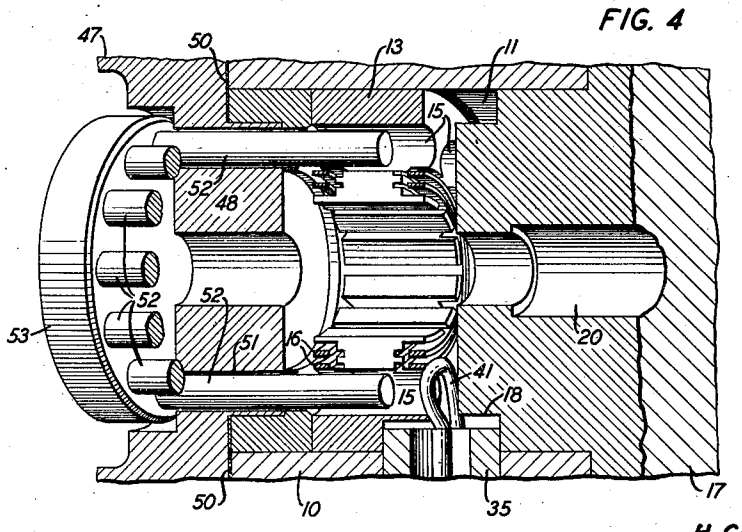


FIG. 4



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2,459,030

TUNABLE MAGNETRON

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Application March 7, 1945, Serial No. 581,410

5 Claims. (Cl. 315—39)

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This invention relates to tunable magnetrons and more particularly to magnetrons of the multicavity type.

Objects of this invention are to improve the construction of multicavity magnetrons, to increase the efficiency of the magnetic system of such devices and to enable accurate tuning of the several cavity resonators thereof.

In one illustrative embodiment of this invention, a magnetron comprises a body assembly including an annular anode having a plurality of parallel, resonant cavity defining bores therein, a cathode in cooperative relation with the anode, a magnetic system for producing a magnetic field parallel to the cathode and in the anode-cathode region, and means for altering the effective volume of the bores thereby to tune the cavity resonators defined thereby.

In accordance with one feature of this invention, the magnetic system comprises a pair of magnetic pole-pieces sealed to the body assembly and defining portions of an enclosing vessel therewith, one of the pole-pieces mounting the cathode and the other pole-piece mounting the tuner for the cavity resonators.

In accordance with another feature of this invention, the tuner comprises a carrier for which the other pole-piece aforenoted serves as a mount and fixture, a plurality of pins, one for each of the bores and insertable longitudinally thereinto, mounted by the carrier, and an actuating mechanism for displacing the carrier to move the pins into or out of the bores, thereby to tune the cavity resonators.

The invention and the above-noted and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is a perspective view of a magnetron illustrative of one embodiment of this invention;

Fig. 2 is a plan view, mainly in section, of the magnetron illustrated in Fig. 1;

Fig. 3 is an end view of the magnetron, portions of the output line and wave guide being broken away; and

Fig. 4 is an enlarged perspective view mainly in section showing details of the anode and portions of the resonator tuner associated therewith.

Referring now to the drawing, the magnetron therein illustrated comprises basically four cooperatively associated assemblies, specifically body and anode, input, output and tuner assemblies. The body and anode structure comprises a rectangular metallic block 10, for example of

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copper, having a central cylindrical bore 11 therethrough and having also a plurality of integral heat radiating fins 12, and a cylindrical anode 13, for example also of copper, fitted coaxially within the bore and brazed thereto. Advantageously the wall portion of the bore engaged by the anode is knurled to provide a tight push fit of the anode therewith, whereby the anode may be positioned accurately and firmly within the body prior to the brazing of the anode to the body.

The anode 13 is provided with an axial cylindrical aperture 14 and also with a plurality of identical, equally spaced bores 15 defining a group of cavity resonators arranged symmetrically about the axial aperture 14. A plurality of arcuate, metallic coupling straps 16 are secured to the ends of the anode 13 and serve to fix the mode of excitation of the several cavity resonators as described in Patent 2,447,537, issued August 24, 1948, to Victor L. Ronci, and application Serial No. 529,619, filed April 5, 1944, of J. B. Fisk.

The input assembly comprises a pole-piece 17, for example of steel, having a cylindrical head portion 18 fitted within the bore 11, an annular seat 19 affixed, as by brazing, to one end of the body 10 and a central aperture 20 coaxial with the head 18 and, thus, with the aperture 14. Sealed in a recess in the outer end of the pole-piece 17 is a cup-shaped metallic member 21 to which a vitreous stem 22 is sealed, the stem having sealed thereto an elongated metallic tube 23 to the inner end of which a tubular member 24 is joined. The member 24 is positioned coaxially with respect to the cylindrical head 18 and, thus, is coaxial with the aperture 14, into which it extends. Fitted upon the member 24 and affixed thereto is a cathode member having a cylindrical sleeve portion 25 coated on its outer surface with electron emissive material, and having also a pair of integral discs 26. Within the cathode member is a helical heater filament 27 one end of which is connected to the tubular member 24 and the other end of which is connected to a leading-in conductor 28 positioned within the tube 23 and tubular member 24 by an insulating sleeve 29. The conductor 28 and tube 23 are connected to terminal jacks 30 by wires 31, the jacks 30 being carried by an insulating shell 32 mounted upon a plate 33 affixed to the pole-piece 17, as by brazing.

The output assembly comprises a metallic coupler 83 having a seating surface 34 affixed, as by brazing, to one side of the body 10 and

having also a cylindrical plug portion 35 secured in an aperture in the body 10. Advantageously, a part of the outer surface of the plug portion 35 is knurled to provide a tight fit between this portion and the aperture wall. The coupler 33 has sealed thereto a vitreous stem 37 having a transverse rectangular bead 38 sealed therein, into which a linear output conductor 39, accurately coaxial with the plug portion 35, is sealed. The inner end of the conductor 39 is bent to form a loop 41 which is opposite and parallel to one end of the anode 13 and aligned with one of the cavity resonator defining bores 15.

The coupler mounts a cylindrical conductor 42, which is coaxial with the conductor 39 and defines therewith and the coupler a coaxial output line. This line is coupled to a wave guide element 44 of rectangular cross-section, the axis of this element being at right angles to the axis of the coaxial line and passing through the center of the bead 38. One end of the guide element 44 is closed by a tuning plug 45 affixed to the guide element, as by soldering, and which, during the fabrication of the device and prior to being fixed in place, is positioned to fix the electrical length of the guide element at a prescribed value. The guide element is provided with a flange 46 for coupling to a suitable wave guide.

The tuner assembly comprises a pole-piece, for example of steel, having a rectangular body portion 47 seated upon one end of the body 10 and a cylindrical portion 48 fitted to an adapter ring 49, the ring 49 fitting within the aperture 11 in the body 10 to locate the cylindrical portion 48 in accurate coaxial alignment with the anode 13. The pole-piece, adapter ring and body are secured to one another as by a gasket of solder indicated at 50. The cylindrical portion 48 is provided with a plurality of apertures 51, one for each of the bores 15 and axially aligned therewith. Extending through each aperture 51 and into the respective bore 15 is a cylindrical tuning pin 52 coaxial with and of somewhat smaller diameter than the bore 15 and aperture 51, the several pins 52 being supported by a carrier 53. The carrier 53 is joined to one end of a metallic bellows 54, the other end of which is sealed hermetically to a cylindrical metallic member 55 hermetically sealed in turn to the pole-piece body portion 47, as by means of a ring of solder indicated at 56.

The carrier 53 is mounted for controlled displacement parallel to the length of the pins 52 to vary the proportion of the pins inserted in the bores 15 and thereby to adjust the resonant frequency of the cavity resonators defined by these bores. Specifically, an internally threaded cylindrical driving member 57 has its inner end affixed, as by soldering, to the bellows 54 and is slidably fitted within a cylindrical bearing or guide 58 which is secured to the pole-piece 47 and locates the member 57 and the carrier 53 coaxially with the anode 13.

The driving member 57 has threaded thereinto a screw 59, the integral head 60 of which is supported for rotation upon a mounting plate 61 by means of ball bearings 62 disposed in a race defined by an annular groove in the peripheral wall of the head 60 and the chamfered faces of a pair of bearing rings 64 and 65. The bearing ring 64 is secured to the mounting plate 61 by screws, not shown; the bearing ring 65 is mounted resiliently by an annular spring 66 affixed to the mounting plate by a clamping ring

67 secured to the plate by screws 68, only two of which are shown. Thus, it will be seen that the bearing ring 65 is floatingly mounted whereby automatic self-centering thereof is realized.

The head 60 has secured thereto, as by screws 69, a helical gear 70 which is cooperatively associated with a worm gear 71 supported from a pair of arms or brackets 72 extending from the mounting plate 61. The worm gear 71 when rotated drives the helical gear 70 to effect rotation of the screw 59 and, hence, axial motion of the driving member 57 and tuning pins 52, whereby the resonant frequency of the cavity resonators defined by the bores 15 is adjusted accordingly. A Geneva stop 73, mounted upon the plate 61 cooperates with a pin 74 carried by the gear 70 to set the limits of rotation of the gear 70 in two directions and, thus, fixes the range of frequencies over which the cavity resonators may be tuned.

It will be appreciated that extremely fine tuning of the cavity resonators may be realized and that all of the resonators are tuned simultaneously so that electrical symmetry of the anode-cathode system is preserved. Because of the mounting of the carrier 53 and, hence, of the tuning pins 52, in the manner described, exact parallel motion of the pins axially of the bores 15 is attained so that but a very small clearance between the pins and the bore walls is required.

A suitable magnetic field in the cathode-anode region and having its lines parallel to the axis of the cathode may be produced by a pair of magnets 75 having their poles abutting the pole-pieces 17 and 47. Inasmuch as the pole-pieces extend into immediate proximity to the ends of the cathode and anode, fringing effects are minimized and, further, a highly efficient magnetic system is attained.

The flux in the anode-cathode region may be adjusted conveniently by one or more magnetic shunt pieces 76 adapted to be inserted into slots in the fins 12 on the body 10.

Although a specific embodiment of the invention has been shown and described, it will be understood that it is but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. An electron discharge device comprising a first structure assembly including a body having a bore extending therethrough and a cylindrical anode within said bore and coaxial therewith, said anode having portions defining a plurality of tubular cavity resonators extending parallel to the axis of said anode, a cathode in cooperative relation with said anode, a second structure assembly including a hollow member joined to said body and having thereon a guide extending parallel to said bore, said second assembly including also a driving member located by said guide for movement in the direction parallel to said axis, a carrier fixedly coupled to said driving member and a plurality of tuning members, one for each of said resonators and extending thereinto, mounted by said carrier, and means coupled thereto for moving said driving member in said direction.

2. An electron discharge device comprising a hollow body defining a portion of an enclosing vessel, an anode and a cathode within said vessel, said anode having portions defining a cavity resonator, a mounting member joined

to said body, a guide supported by said mounting member, a driving member slidably fitted within said guide for motion toward and away from said anode, a carrier mounted by said driving member, a tuning member supported by said carrier and extending into said cavity resonator, means including a flexible bellows forming a hermetic seal between said carrier and said mounting member, and means coupled to said driving member for actuating it to displace said carrier and said tuning member, thereby to tune said cavity resonator.

3. An electron discharge device in accordance with claim 2 wherein said actuating means comprises a screw, threaded into said driving member and supported rotatably by said mounting member, a helical gear coupled to said screw and supported thereby and a worm gear for driving said helical gear supported by said mounting member.

4. An electron discharge device comprising a hollow body defining a portion of an enclosing vessel, an anode within said body and having portions defining a plurality of parallel tubular cavity resonators therein, a cathode in cooperative relation with said anode, a plurality of tuning pins one for each of said resonators and extending thereinto, said pins being parallel to one another and to said resonators, a carrier member mounting said pins, a hollow mounting member joined to said body, means including a bellows within said mounting member hermetically joining said carrier to said mounting member, a cylindrical guide within said mounting member and supported therefrom, said guide having its axis parallel to said pins, a cylindrical driving member fitted slidably within said guide and coupled to said carrier, and means coupled thereto for adjustably displacing said driving member parallel to its axis thereby to adjust the position of said pins within the resonators to tune said resonators.

5. An electron discharge device comprising a first structure assembly including a body having a cylindrical bore extending therethrough and a cylindrical anode fitted in said bore and coaxial therewith, a second structure assembly including a cylindrical pole-piece fitted within said bore and a cathode mounted by and coaxial with said pole-piece and encompassed by said anode, said anode having portions defining a plurality of tubular cavity resonators extending parallel to the axis of said anode and symmetrically about said axis, and a third structure assembly including a hollow second pole-piece joined to said body and in alignment with said first pole-piece, a cylindrical guide within said pole-piece and mounted thereby in coaxial relation with said anode, a plurality of tuning pins, one for each of said resonators and extending coaxially thereinto, means supporting said pins including a carrier to which said pins are affixed and a cylindrical driving member fitted slidably within said guide and coupled to said carrier, a bellows forming a hermetic seal between said second pole-piece and said pin supporting means, and gear means mounted by said second pole-piece for axially displacing said driving member to effect tuning of said cavity resonators.

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