

March 21, 1950

R. R. LAW

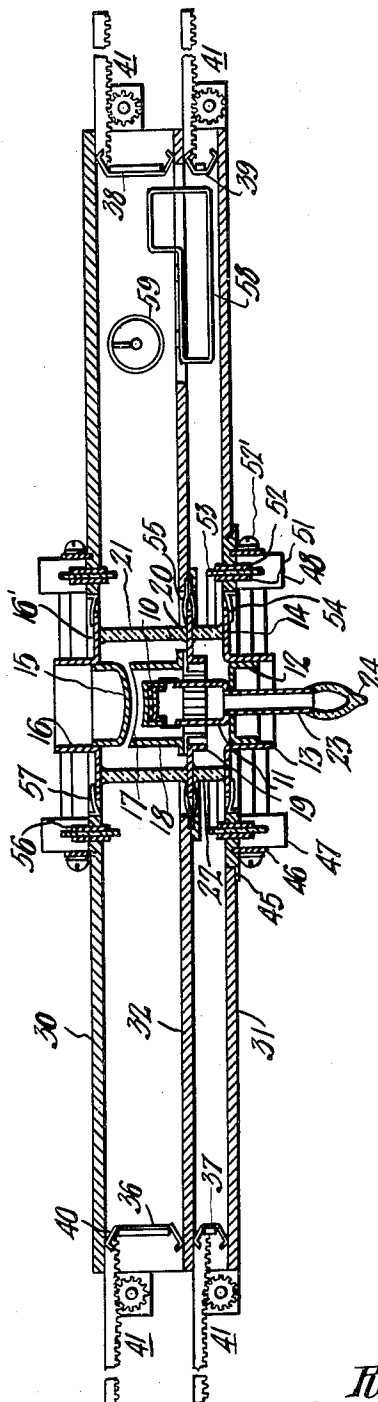
2,501,181

HIGH-FREQUENCY CAVITY RESONATOR APPARATUS

Filed Aug. 15, 1944

3 Sheets-Sheet 1

Fig. 1.



INVENTOR
Russell R. Law
BY
Charles McClair
ATTORNEY

March 21, 1950

R. R. LAW

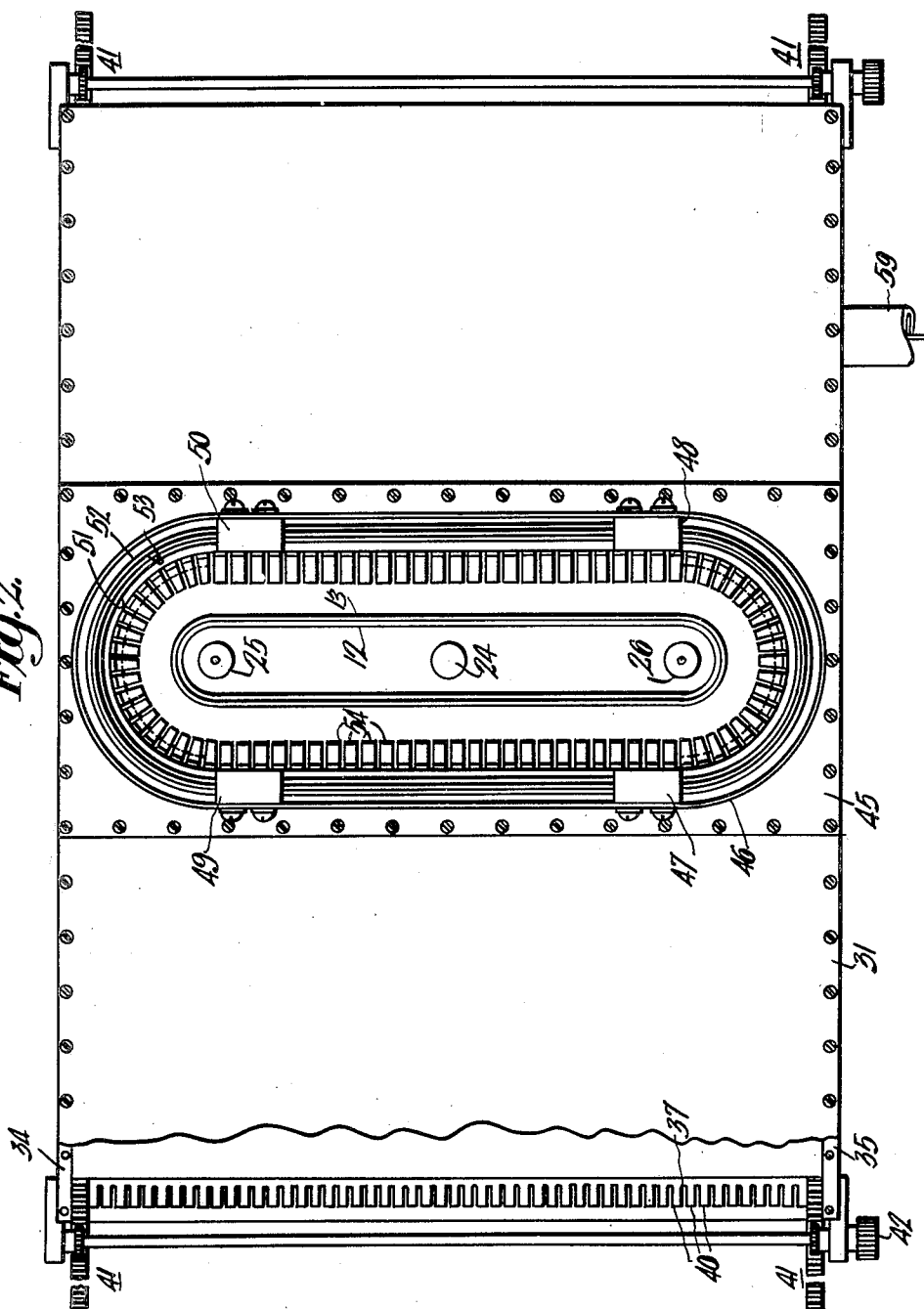
2,501,181

HIGH-FREQUENCY CAVITY RESONATOR APPARATUS

Filed Aug. 15, 1944

3 Sheets-Sheet 2

Fig. 2.



INVENTOR

Russell R. Law

BY

Charles M. Clair

ATTORNEY

March 21, 1950

R. R. LAW

2,501,181

HIGH-FREQUENCY CAVITY RESONATOR APPARATUS

Filed Aug. 15, 1944

3 Sheets-Sheet 3

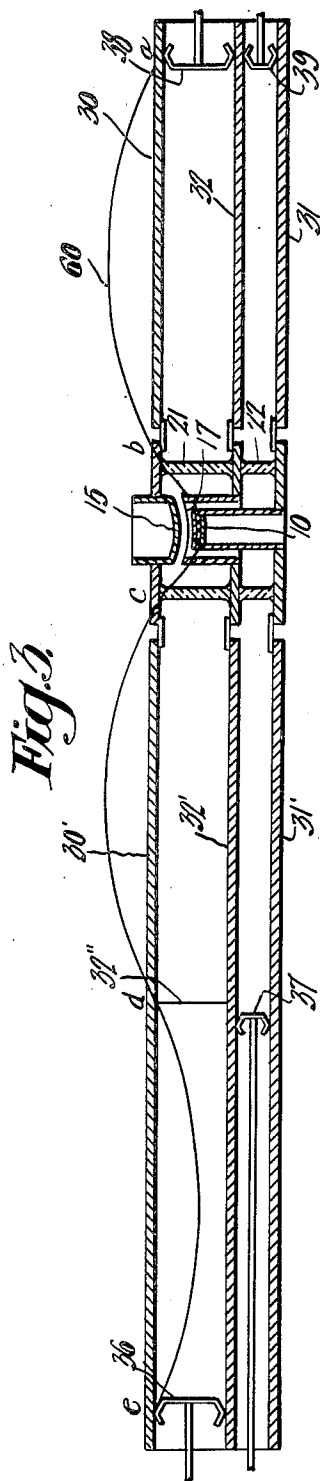
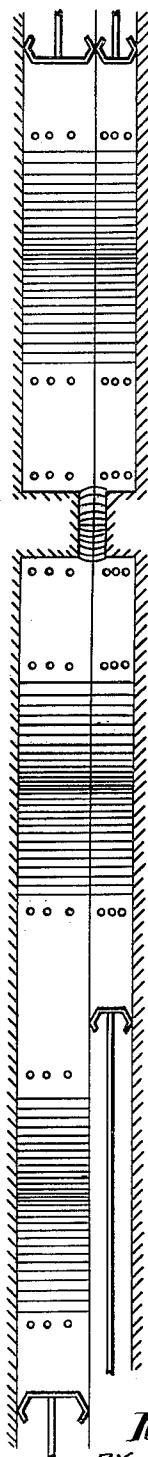


Fig. 4



INVENTOR
Russell R. Law
BY *Charles McClair*
ATTORNEY

UNITED STATES PATENT OFFICE

2,501,181

HIGH-FREQUENCY CAVITY RESONATOR APPARATUS

Russell R. Law, Princeton, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application August 15, 1944, Serial No. 549,514

9 Claims. (Cl. 315—39)

1

My invention relates to electron discharge devices and associated circuits useful at ultra high frequencies and more particularly to cavity resonator circuits suitable for use with electron discharge devices having elongated electrodes and flange-like leads and supports extending through the walls of the envelope of the electron discharge device.

As operation of electron discharge devices and associated circuits of the cavity resonator types is raised to higher frequencies, the circuit cross-sections must be made smaller and smaller resulting in a number of difficulties. I propose to overcome these difficulties by providing a circuit of the cavity resonator type which may be operated in a harmonic mode.

It is, therefore, an object of my invention to provide a high frequency apparatus employing a circuit of improved design and operable at ultra high frequencies.

A further object of my invention is to provide a high frequency apparatus employing a tube of the type described and a cavity resonator circuit in which circuit cross-sections of small dimensions are avoided.

A still further object of my invention is to provide high frequency apparatus employing a tube and circuits of the cavity resonator type which may be operated in a harmonic mode.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawing in which Figure 1 is a transverse section of an electron discharge device and associated circuit made according to my invention, Figure 2 is a bottom view of Figure 1, and Figures 3 and 4 are diagrams showing potential distributions and electric and magnetic fields in electron discharge devices and associated circuits made according to my invention.

Referring to the drawings, there is shown in Figure 1 an electron discharge device of the type described and claimed in the copending application of Russell R. Law and Louis Pensak, Serial No. 549,513, filed August 15, 1944, now U. S. Patent No. 2,481,026, granted September 6, 1949, and assigned to the same assignee as the present application, and a circuit made according to my invention utilizing such a tube.

The electron discharge device comprises an elongated indirectly heated cathode 10 supported on an elongated U-shaped member 11 fixed to

2

the elongated cup-shaped member 12 sealed to the member 13 provided with a flange 14. Oppositely disposed to the cathode 10 is an elongated anode electrode 15 supported within the elongated collar-like member 16 having a transverse flange 16'. Mounted intermediate the cathode and anode is a grid 17 supported on a collar 18 fixed to the member 19 having the flange 20. To provide an evacuated envelope an elongated collar-like insulating element 21, preferably of glass, is sealed between the flange 16' and the flange 20, and a second elongated insulating collar-like member 22 is sealed between the flange 20 and the flange 14. The envelope may be exhausted through the tubular member 23 sealed off at 24 as shown in Figures 1 and 2. Other tubular members 25 and 26 of like construction may have sealed therethrough the cathode and cathode heater leads.

In accordance with my invention I provide a cavity resonator circuit between the cathode and grid and between the grid and anode. The cavity resonators are formed by means of a box-like structure having upper plate member 30 and a lower plate 31 with a partition 32 parallel to the top and bottom surfaces for separating the box into two mutually shielded spaces which with the tuning members 36, 37, 38 and 39 form cavity resonators, the ends being closed by side walls 34 and 35. Each of the tuning elements or shorting members is provided with spring fingers 40 which slidably contact the conducting walls of the box-like structure forming the resonators. These members may be operated by means of a rack mechanism designated generally at 41 and operated by means of the knob 42.

Each of the outside walls 30 and 31 and the partition 32 are provided with suitable apertures and contacting fingers for receiving the electron discharge device and contacting various flanges. The plate 31 carries a second plate 45 in which is mounted a collar 46 normal to the surface of the plate 35. This collar member supports a plurality of insulating blocks 47, 48, 49 and 50, which in turn support an isolating condenser arrangement whereby the cathode of the electron discharge device is insulated for direct currents and voltages from the plate 31 while permitting radio frequency currents to flow to and from the cathode. This comprises a novel form of condenser arrangement comprising a pair of elongated collar-like conducting elements 51 and 52 separated by means of an insulating collar-like element 53 which may be of mica. The member 51 carries a plurality of spring fingers 54

3

which engage the flange 14 of the cathode. The screws 52' fix the isolating condenser and spring fingers to the plate 45.

The partition 32 carries a plurality of spring contact fingers 55 which engage the grid flange 20. The grid is thus directly connected to the partition and the whole device may be operated as a grounded grid device if the resonator structure is grounded.

A construction for contacting the anode in insulating relationship with the plate member 30 is mounted in the plate 30, and is similar to that used for the cathode. The inner conducting collar 56 of the condenser carries a plurality of resilient contact fingers 57 which engage the anode flange 16'.

When used as an oscillator, the coupling loop 58 is used for coupling the input resonator or cathode-grid cavity with the output resonator or anode-grid cavity. Energy may be taken from the output resonator by means of the coaxial line 59.

Figure 3 shows the voltage distribution within the resonator and it will be observed that the apparatus functions in the three-quarter wave mode with voltage minimums at the seal between the glass collars 21 and 22 and the flanges supporting the various electrodes. The arrangement shown in Figure 3 is a modification of that shown in Figure 1. One side of the resonator has been extended as shown at 30', 32' and 31' in order to obtain a partial short at the three-quarter wave point of the five-quarter wave side of the anode cavity resonator. This may comprise one or a plurality of conductors 32'' electrically connecting opposite sides of the cavity. The purpose of this arrangement is to further encourage the desired mode.

When operated in the three-quarter wave mode, the voltage distribution is that shown from points *a* to *d* and when operated in the mode shown in Figure 3 the voltage distribution is that shown from *a* to *e*. The distribution of the magnetic and electric fields is that indicated in Figure 4 by the circles and the straight lines respectively, the magnetic field lines being designated by the full and closed circles and the electric field by the straight lines, the electric field being most intense where the lines are closest together.

While I have indicated the preferred embodiments of my invention of which I am now aware and have also indicated only one specific application for which my invention may be employed, it will be apparent that my invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the purpose for which it is employed without departing from the scope of my invention as set forth in the appended claims.

What I claim as new is:

1. An ultra high frequency apparatus comprising an electron discharge device having elongated cathode, grid and anode electrodes, the active surfaces of said electrodes being longer along one axis than the axis perpendicular thereto and including adjacent cavity resonators of elongated rectangularly shaped box-like structure and having elongated registering apertures transversely of said resonators and along one axis containing said electron discharge device, the edges of said apertures being coupled to said cathode, grid and anode electrodes providing an input resonator between the cathode and grid electrodes and an output resonator between the anode and grid elec-

4

trodes, the portions of each of said resonators on opposite sides of said electron discharge device during operation of said electron discharge device operating in like phase, whereby maximum voltage differential occurs between said apertures and the ends of the resonators parallel to said apertures.

2. An ultra high frequency apparatus comprising an electron discharge device having elongated cathode, grid and anode electrodes, the active surfaces of said electrodes being longer along one axis than the axis perpendicular thereto and provided with flange-like conductors and including adjacent cavity resonators of rectangularly shaped elongated box-like structure and having elongated registering apertures transversely of said resonators and along one axis containing said electron discharge device, the edges of said apertures being coupled to said flange-like conductors providing an input resonator between the cathode and grid electrodes and an output resonator between the anode and grid electrodes whereby the portions of each resonator on opposite sides of said electron discharge device will operate in like phase.

3. A high frequency apparatus including a flat hollow conducting box-like structure of rectangular shape, a partition intermediate the sides of the box-like structure dividing the interior thereof into two chambers providing a pair of adjacent cavity resonators, said partition and the outside surfaces of the box-like structure having elongated registering apertures therein containing an electron discharge device having elongated electrodes, the active surfaces of which are longer along one axis than the axis perpendicular thereto and provided with flange-like conducting members contacting the edges of said apertures, said apertures being positioned along an axis of said box-like structure.

4. A high frequency apparatus including a flat hollow conducting box-like structure of rectangular shape, a partition intermediate the sides of the box-like structure dividing the interior thereof into two chambers providing a pair of adjacent cavity resonators, said partition and the outside surfaces of the box-like structure having elongated registering apertures therein containing an electron discharge device having elongated electrodes, the active surfaces of which are longer along one axis than the axis perpendicular thereto and provided with flange-like conducting members contacting the edges of said apertures, said apertures being positioned along an axis of said box-like structure, and means for tuning said resonators comprising slidable conducting end members extending between the walls of said box-like structure and said partition.

5. A high frequency apparatus including a flat conducting box-like structure of rectangular shape, a partition intermediate the sides of said box-like structure dividing the interior thereof into two chambers providing a pair of adjacent cavity resonators, the ends of said box-like structure being closed by movable conducting members extending between the walls of said hollow box-like structure and said partition, said partition and the outside walls of said box-like structure having elongated registering apertures therein receiving an electron discharge device having elongated electrodes, the active surfaces of which are longer along one axis than the axis perpendicular thereto and provided with flange-like conducting members contacting the edges of

5

said apertures, said apertures being positioned along a short axis of said box-like structure.

6. A high frequency apparatus including a flat conducting box-like structure of rectangular shape, a partition intermediate the sides of said box-like structure dividing the interior thereof into two chambers providing a pair of adjacent cavity resonators, the ends of said box-like structure being closed by movable conducting members extending between the walls of said hollow box-like structure and said partition, said partition and the outside walls of said box-like structure having registering apertures therein containing an electron discharge device having electrodes provided with flange-like conducting members contacting the edges of said apertures, said apertures being positioned along a short axis of said box-like structure, and means between one of said apertures and said movable end members electrically connecting one of the walls of said box-like structure and said partition for providing a radio frequency short.

7. A high frequency apparatus including a hollow conducting box-like structure, a partition intermediate the sides of said box-like structure dividing the interior thereof into two chambers providing adjacent cavity resonators, said partition and the walls of said box-like structure being provided with registering apertures containing an electron discharge device having cathode, grid and anode electrodes provided with flange-like conducting members, the apertures in the outside walls being provided with isolating condensers each comprising a pair of conducting collars separated by an insulating collar and supported within the aperture, the inside conducting collar of each isolating condenser having contacting spring fingers, the fingers on one inside collar contacting the flange of the anode electrode and the fingers of the other inside collar contacting the flange of the cathode electrode.

8. A high frequency apparatus including a hollow conducting rectangularly shaped box-like structure, a partition intermediate the sides of said box-like structure dividing the interior thereof into two chambers providing adjacent cavity resonators, said partition and the walls of said box-like structure being provided with elongated registering apertures containing an electron discharge device having elongated cathode, grid and anode electrodes, the active surfaces of said electrodes being longer along one axis than the axis perpendicular thereto and provided with

6

flange-like conducting members, the apertures in the outside walls being provided with isolating condensers each comprising a pair of concentric conducting collars separated by an insulating collar and supported within the apertures, the inside conducting collars having contacting spring fingers contacting the flanges of the anode electrode and the cathode electrode, said partition having a plurality of spring fingers contacting the grid electrode flange-like conducting member.

9. A high frequency apparatus including a rectangularly shaped hollow conducting box-like structure, a partition intermediate the sides of said box-like structure dividing the interior thereof into two chambers providing adjacent cavity resonators, said partition and the walls of said box-like structure being provided with elongated registering apertures containing an electron discharge device having elongated cathode, grid and anode electrodes, the active surfaces of said electrodes being longer than one axis than the axis perpendicular thereto and provided with flange-like conducting members, the apertures in the outside walls being provided with isolating condensers each comprising a pair of conducting collars separated by an insulating collar and supported within the aperture, the inside conducting collars having contacting spring fingers contacting the flanges of the anode electrode and the cathode electrode, said partition having a plurality of spring fingers contacting the grid electrode flange-like conducting member, and conducting means slidable within said chambers and extending between the outside walls and the partition for varying the enclosed space within said resonators.

RUSSELL R. LAW.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,030,178	Potter	Feb. 11, 1936
2,199,083	Schelkunoff	Apr. 30, 1940
2,241,119	Dallenbach	May 6, 1941
2,281,717	Samuel	May 5, 1942
2,353,742	McArthur	July 18, 1944
2,400,753	Haefl	May 21, 1946
2,404,261	Whinnery	July 16, 1946
2,416,565	Beggs	Feb. 25, 1947