Feb. 9, 1932. E. HATT 1,844,319

MEANS FOR PRODUCING RADIO WAVES

Filed Sept. 25, 1929 3 Sheets-Sheet 1

Fig. 1.

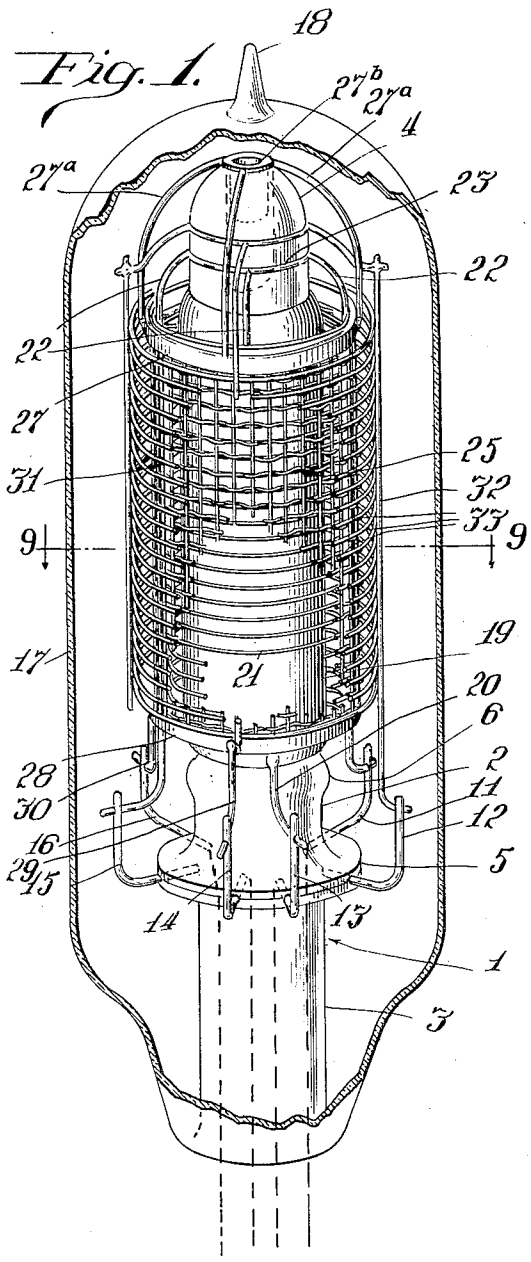


Fig. 2.

Fig. 3.

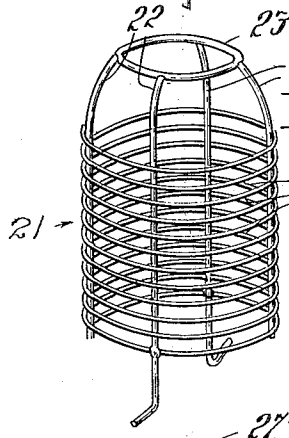
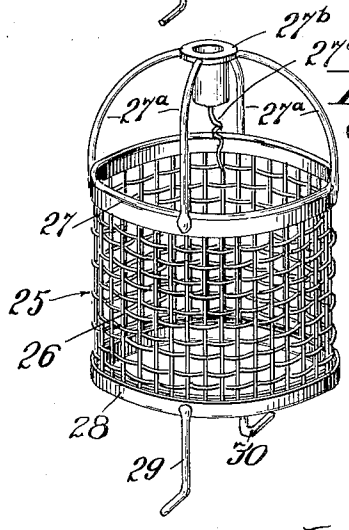


Fig 4



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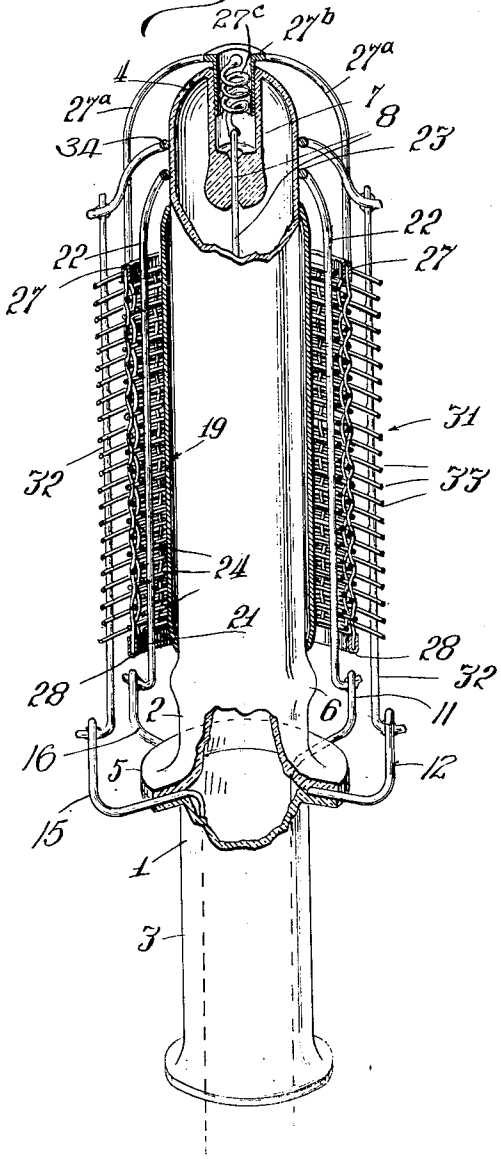
Filed Sept. 25, 1929 3 Sheets-Sheet 2

Fig. 5.



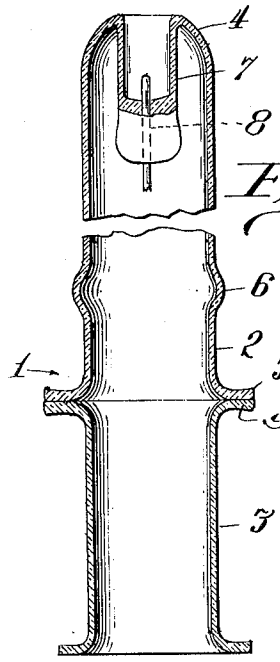
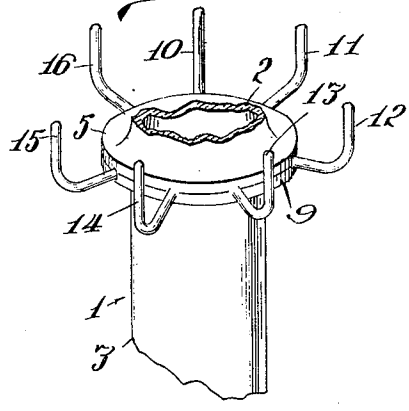


Fig. 6.

Fig. 7.



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Feb. 9, 1932. E. HATT 1,844,319

MEANS FOR PRODUCING RADIO WAVES

Filed Sept. 25, 1929 3 Sheets-Sheet 3

Fig. 8.

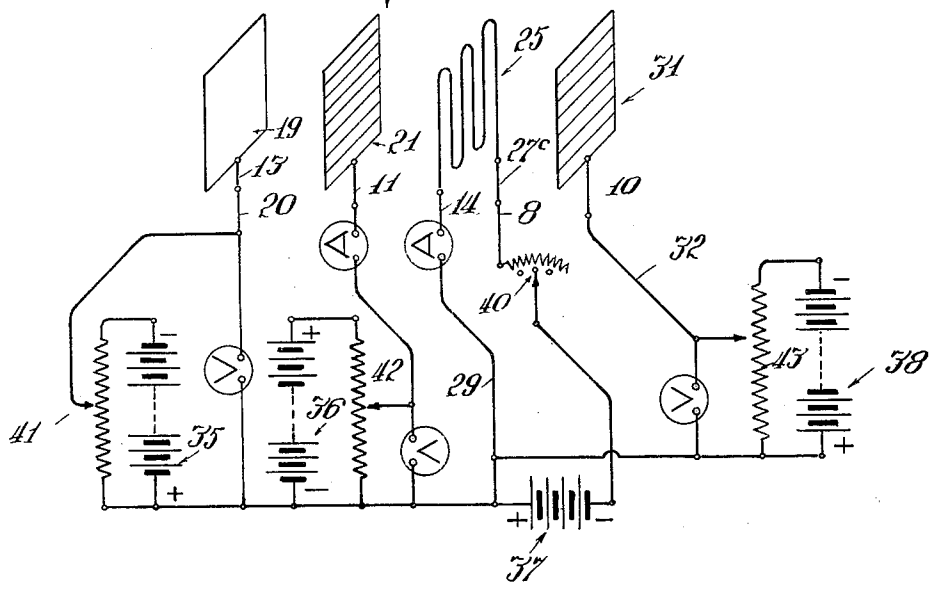


Fig. 9.

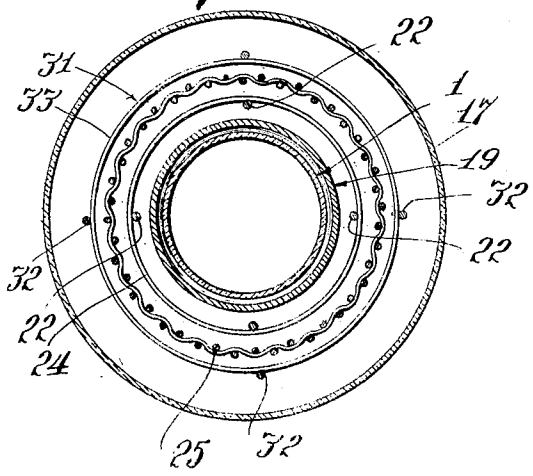
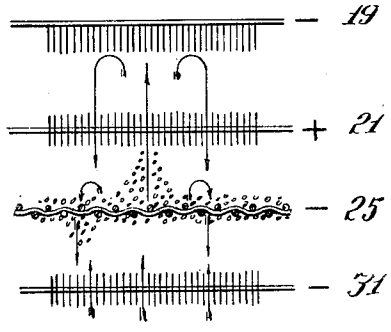


Fig. 10.



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Patented Feb. 9, 1932 1,844,319

UNITED STATES PATENT OFFICE

EMIL HATT, OF MAYWOOD, ILLINOIS

MEANS FOR PRODUCING RADIO WAVES

Application filed September 25, 1929. Serial No. 394,952.

This invention relates to improvements in methods of and means for producing radio waves and the like and it consists of the matters hereinafter described and more particularly pointed out in the appended claims.

Under certain methods of producing radio waves, audions are employed in a circuit to generate an oscillating current. Where such an audion is employed to produce electromagnetic waves of a given wave length or frequency, the same is controlled by devices in the circuit. However, the loss in such a circuit is very high and the efficiency is impaired in proportion.

The primary object of the present invention is to provide an improved means for producing oscillation or electromagnetic waves without the aid or necessity of an extraneous oscillating circuit whereby circuit loss is reduced and efficiency is increased.

Another object of the present invention is to provide an improved apparatus for producing electromagnetic waves of ultra short length as for example those ranging from one half a meter down to a millimeter and less and, with a corresponding higher frequency and increased energy.

Still a further object of the invention is to provide a novel means in the form of a valve or tube for producing oscillations in the nature of radio waves or the like of short length without the necessity of employing an exterior oscillating circuit.

In the drawings:—

Fig. 1 is a perspective view of a valve or tube embodying the preferred form of my invention for producing radio waves and the like.

Figs. 2—3 and 4 respectively are perspective views of elements employed in the tube of Fig. 1 and which will be more fully referred to later.

Fig. 5 is a sectional perspective view illustrating the manner of mounting the several elements of my improved tube upon the associated supporting stem.

Fig. 6 is a longitudinal vertical sectional view through the supporting stem of the tube.

Fig. 7 is a detail perspective view of the base portion of the supporting stem and illustrates the manner of securing or anchoring certain conductor terminals and associated supporting members therein.

Fig. 8 is a view illustrating the circuit associated with the several parts of the tube.

Fig. 9 is a horizontal sectional view through the improved tube as taken on the line 9—9 of Fig. 1.

Fig. 10 is a diagrammatic detail view on an enlarged scale and which will be more fully referred to later.

Referring now in detail to the construction of the valve or tube illustrated in Figs. 1 to 7 and Fig. 9 of the accompanying drawings, which represent the preferred form of valve or tube, the same includes an upright, tubular stem 1 of glass made up of a top or supporting section 2 and a bottom or base section 3. The stem section 2 has a rounded closed top end 4 and a flanged bottom end 5 and near said bottom end is formed an annular enlargement or shoulder 6. In the rounded top end of the top section is fused a depending tubular member 7 in which is sealed a conductor 8.

The base section 3 includes a radial top flange 9 which is fused to the flanged bottom end of the section 2 and sealed between said flanges in the fusing thereof is a plurality of radially extending arms 10—11—12—13—14—15 and 16 respectively, each having an upturned end. Some of said arms constitute conductor terminals and others merely constitute associated supports for elements mounted on the top extension of the stem as will later appear. Those arms constituting conductor terminals extend down through the base section of the stem which has fused to it the bottom end of the glass body 17 of the tube as a whole, which body is exhausted and sealed at the top by the tip 18.

Supported upon the top section of the stem is an electrode 19, which constitutes the "plate" element of the tube. This plate element which functions as a negative anode is tubular in form and is of a diameter greater than that of the stem. Its ends are reduced in diameter so that its bottom end rests upon the shoulder 6 and its top end engages about

the stem, a suitable distance below its top end as best shown in Fig. 5 in a manner affording a suitable support for the plate upon the stem. A conductor 20 connects said plate with the terminal 13 in the stem.

Surrounding the plate but radially spaced therefrom is a second electrode which constitutes the positive inner or primary "grid" 21 of the tube. Said grid comprises four upright supporting rods or members 22 which are bent inwardly at their top ends to be secured to a ring 23 to snugly engage about the top section of the stem a short distance above the top end of the plate 19. Upon said supporting rods is helically wound a wire 24 of any suitable material. The bottom ends of two of the supporting members are secured to two substantially oppositely disposed terminals 11 and 15 respectively. The terminal 15 in this instance is a "dead" one and the terminal 11 is a live one whereby current is conducted to the grid.

25 indicates a third electrode which constitutes the "heating" element or cathode of the tube and said element surrounds but is radially spaced from the inner or primary grid 21. This heating element which is best shown in Fig. 4 is in the form of a cylinder of substantially fine mesh wire screen 26. The wire of the screen may be of any suitable filament material but I find that thoriated tungsten is usable for the purpose. The top and bottom ends of said mesh material are bound by and secured in suitable rigidifying rings 27 and 28 respectively. Fixed to the bottom ring is a pair of relatively stiff conductors 29 and 30 respectively which are secured to the arms 14 and 16 respectively in the stem, the former of which is a live terminal and the latter of which is a supporting member. Fixed to the top ring 27 is a plurality of inwardly converging members 27^a that support a metallic sleeve 27^b adapted to engage in the depending tubular part 7 at the top end of the stem and said sleeve is electrically connected to the conductor 8 in said depending tubular part 7 by a flexible pig tail like conductor 27^c. Such a conductor accommodates the relative movement between the heating element and conductor 8 due to expansion and contraction of said element in the heating and cooling thereof.

Such a heating element with a mesh like filament is advantageous because it provides a greater filament surface area which is foraminous for the passage of electrons therethrough. Again such a mesh insures a universal emission of electrons in every conceivable direction because said electrons when emitted begin their flight in directions radial to each and every filament wire in the mesh. Instead of employing thoriated tungsten in the wire of the mesh or screen alone, I may employ platinum iridium wire as a base core and coat the same with a suitable oxide compound of barium or calcium, etc. Another advantage gained in making the cathode in the form of a wire mesh is that the several wires reinforce each other to provide a strong rigid light weight cathode wherein said wires are secured against mechanical vibration which induces field disturbances. Again such a cathode is free to expand equally and will not warp but will maintain its true and original state.

Surrounding the heating element but radially spaced therefrom is another electrode which constitutes a negative outer or secondary grid 31. Said grid which is substantially of the same structure as the grid 21 comprises a plurality of upright supporting members 32 upon which is helically wound a wire 33 of any suitable material. The top ends of the supporting members converge inwardly to be fixed to a ring 34 which engages the stem above the like ring of the first mentioned grid. The bottom ends of two of said supporting members 32 are secured to the terminals 10 and 12 respectively, the former being a "live" terminal and the latter being a "dead" one with a purpose of assisting in supporting said grid.

The live terminals 10—11—13 and 14 as well as the conductor 8 pass down through the bottom section of the stem for attachment to suitable contacts in the insulated base of the tube which is not illustrated here.

When the four elements are mounted on the stem as described, the stem is inserted in a tube blank which is fused at its bottom end to the base and is then exhausted through the tip 18 which is thereafter sealed.

In Fig. 8 I have illustrated diagrammatically the various elements of the tube in circuit and for convenience in illustration there is shown a source of energy or current supply for each element. Thus there are shown batteries 35—36—37 and 38 respectively associated with the plate 19, grid 21, heater 25 and grid 31 in the order mentioned.

The positive and negative conductors 14 and 8 respectively for the heating element 25 are connected to the ends of the battery 37. In the conductor 8 is provided a rheostat 40 for controlling the current supply for said heating element. The conductor 20 of the plate 19 is connected to the negative side of its associated battery 35 by means of a potentiometer 41 interposed between the opposite sides of said battery, the positive side of which is connected to the like side of the heating element battery 37. The conductor 11 of the inner or primary grid is connected to the positive side of its associated battery 36 by means of a potentiometer 42. The negative side of the battery is connected up to the positive side of the heating element battery 37.

The conductor 32 of the outer or secondary grid is connected to the negative side of its

associated battery 38 by means of a potentiometer 43 and the positive side of said battery is connected to the positive side of the heating element battery. The various conductors include the usual current indicating instruments as shown.

When the heating element is energized it functions as an electronic radiator or emitter. With a positive potential on the grid 21 an effect is produced which draws the electrons emitted by the heating element when energized, through said grid to the plate 19 and thus said electrons are impelled toward said plate because of the electrostatic field set up by said grid. In this impelled movement or flight of electrons they acquire kinetic energy. As the eltctrons pass through the grid they approach or enter a negative electrostatic field adjacent the plate and are repelled.

If the plate be at a sufficiently high positive potential with respect to the heating filament, the kinetic energy of the swiftly moving electrons would be converted into heat by collision with said plate, and this would result merely in heating up the plate with a possible destruction of the same. In my improved tube wherein a negative potential is impressed upon the plate, the imparted energy of the moving electrons is converted into electromagnetic waves or radiations by reason of their motion being retarded by said negative electrostatic field formed by the plate which is opposing or repelling the moving charge of electrons before they can reach and impinge against the plate and this action is best illustrated in Fig. 10.

When the electrons are retarded in their motion or flight, they give up part of their kinetic energy in the form of radiation. Howover, as the electrons are repelled by the electrostatic field adjacent the plate, the retarded motion of electrons is transferred to the space charge set up about the heater and in the space between the two grids.

These electrons in said space are thus effected and become disturbed in their motion, acting through the meshes of the heater where a second opposing electrostatic field as set up by the outer grid acting against them and the disturbed electrons are thus again retarded and upon repetition sustained radiations or oscillations are produced as the heater gives off a continuous flow or source of electrons.

To further explain the electronic action, it is evident that in order to accelerate an electron, work must be done upon it and if the electron is retarded in its motion, it must give up a part of its kinetic energy. If the inertia of an electron is wholly electromagnetic the work in accelerating it is work done on lines of force. Supposing then a charge of electrons with its lines of force, moves through space with uniform veloicity. If said charge is suddenly retarded the ends of the lines of force thereoef will be jerked backwards so to speak. In accordance with the characteristics of lines of force the kinks or reversals created at the end of each line will not be transmitted along the entire line instantaneously but will be propagated along the line with a finite velocity substantially that of light. These kinks or reversals in said lines of force are those parts thereof wherein the electrons are retarded and the electro and magnetic forces associated with such lines are more intense than those associated with the straight parts of said lines.

When an electrostatic disturbance passes over an electron moving with uniform velocity the electro and magnetic fields associated with it will be modified by the intense fields in the disturbance and this modification is propagated to the center of the moving electron along lines of forces constituting it. The result is a change or reversal in the motion of the electron. It is therefore apparent that the energy of a moving electron is transformed into radiation energy and this transformation take place when the electron is retarded or accelerated.

From the above it is apparent that the heating element functions as an electronic radiator and the electrons given off thereby pass into the vicinity of an electrical field, negative in character and this results in arresting the movement of the flying electrons causing them to give up a part of their stored or kinetic energy and this energy constitutes the short wave desired.

It is also apparent that the length of the waves produced may be changed or varied without departing from the spirit of the invention by changing the spacing between the various elements and by providing an applied voltage which is in proportion to the charge of electrons liberated or emitted by the heating element.

While in describing the invention, I have referred in detail to the form, arrangement and construction of the several parts of the tube, the same is to be considered merely as illustrative so that I do not wish to be limited thereto except as may be specifically set forth in the appended claims.

I claim as my invention:—

1. A radio wave producing tube embodying therein a hollow stem, a tubular plate member surrounding said stem and engaged at its ends only upon said stem, an electron emittor spaced from the plate member and grid members one on each side of the emittor with one of said grid members disposed between said electron emittor and said plate.

2. A radio wave producing tube comprising a tubular supporting stem, a cylindrical plate surrounding the stem and engaged only at its ends thereon, a cylindrical electron emittor and cylindrical devices for forming negative and positive electrostatic

fields, all mounted concentrically upon said stem with one of said last mentioned devices disposed between the plate and emittor and the other one disposed outside and surrounding the emittor.

3. A radio wave producing tube embodying therein, a supporting stem, a plate surrounding said stem and engaged at its ends therewith but spaced therefrom between said ends, a grid, an electron emittor and a second grid, all cylindrical in form and disposed the one within the other in radially spaced relation, in the order mentioned and means included in both grids and the emittor engaging the stem in manner spacing said elements from the top of said stem and supporting them from the bottom of said stem.

4. A radio wave producing tube embodying therein, a supporting stem, a plate surrounding said stem, and engaged at its ends therewith but spaced therefrom between said ends, a grid, an electron emittor and a second grid, all cylindrical in form and disposed the one within the other in radially spaced relation in the order mentioned, supporting members including conductors fixed in said stem, means connecting one end of each grid and the emittor to said supporting member and means formed at the top end of each grid and the radiator and engaging the stem to hold said grids and emittor in spaced relation with respect to the stem.

5. A radio wave producing tube embodying therein, a tubular supporting stem having an annular shoulder thereon and a radial flange below said shoulder, supporting members fixed in and extending outwardly beyond said flange, a tubular plate member on said stem and seating upon said shoulder, a heating element and grid elements of tubular form disposed concentrically about and spaced from said plate member, means on the bottom ends of said heating and grid elements secured to said supporting members fixed in said flange and means on the other ends of said heater and grid elements engaging the stem for holding them in relatively spaced relation.

In testimony whereof, I have hereunto set my hand, this 20th day of September, 1929.

EMIL HATT.