

Dec. 21, 1943.

H. TUNICK

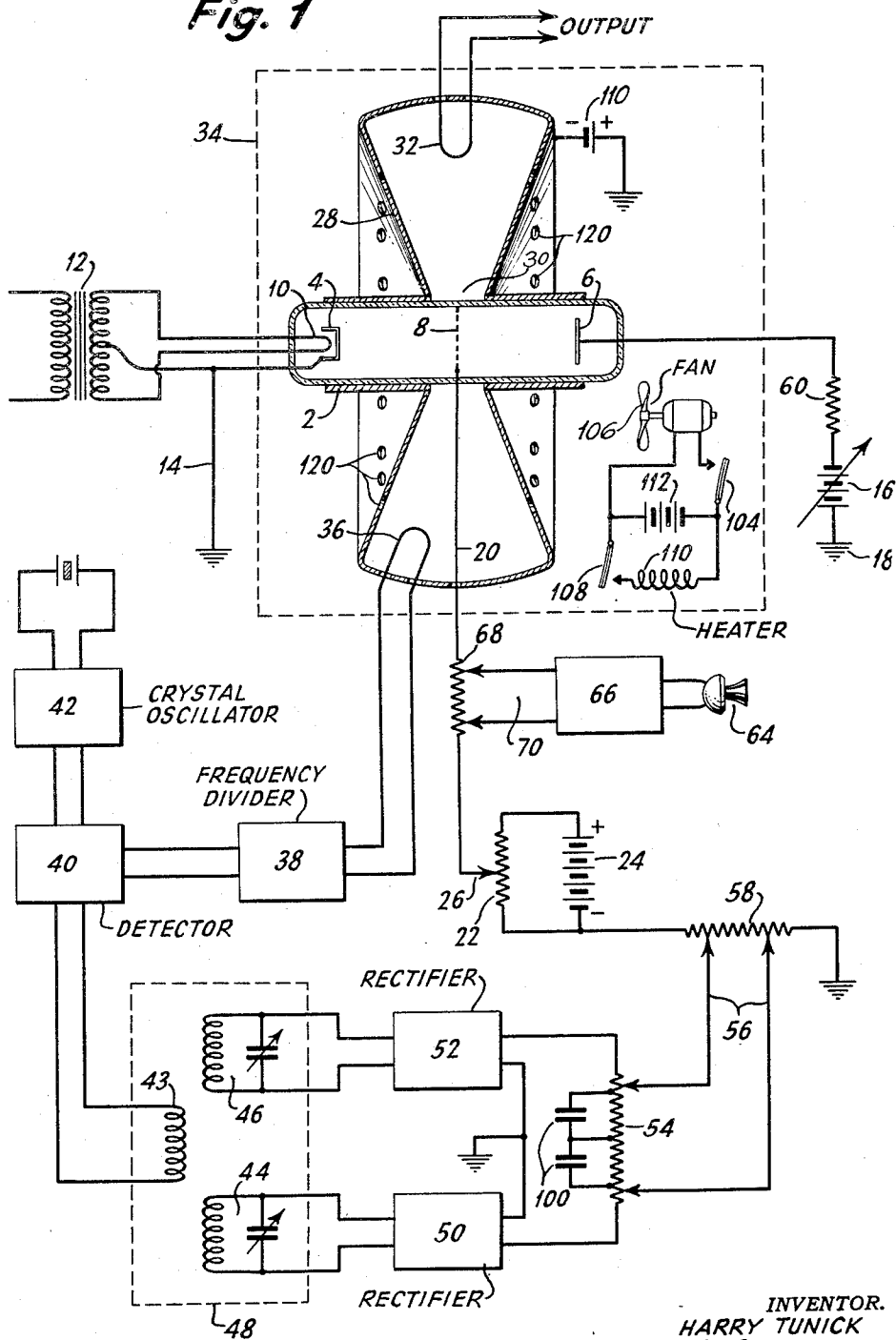
2,337,214

ULTRA SHORT WAVE APPARATUS

Filed April 17, 1941

2 Sheets-Sheet 1

Fig. 1



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2 Sheets-Sheet 2

Fig. 2

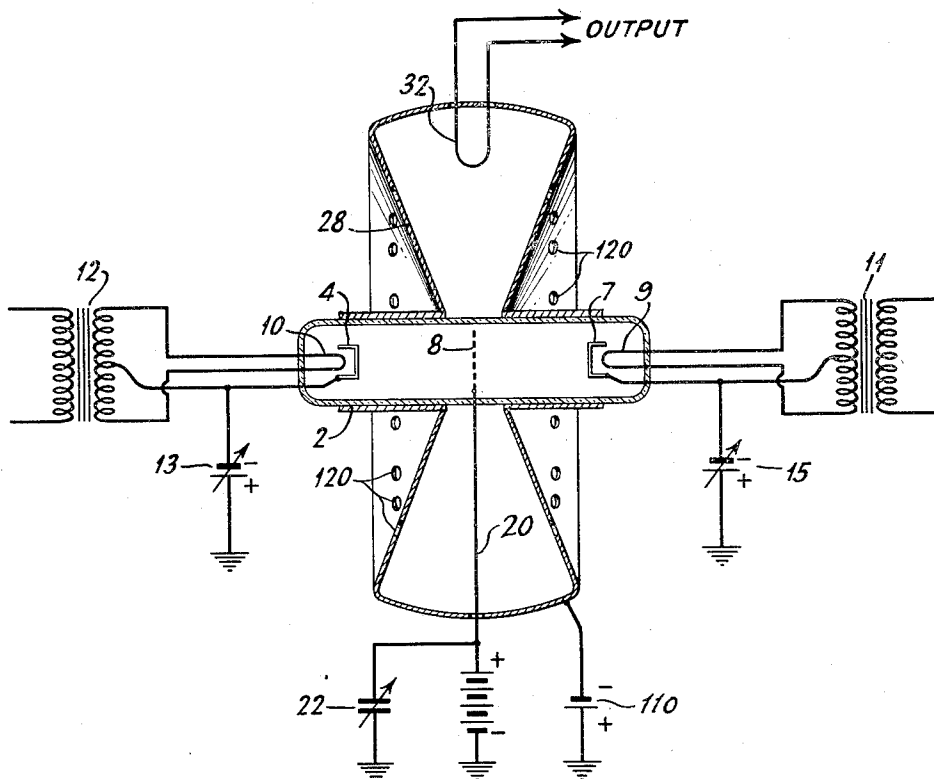
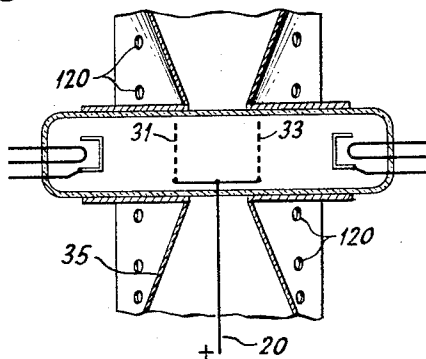


Fig. 3



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UNITED STATES PATENT OFFICE

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ULTRA SHORT WAVE APPARATUS

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6 Claims. (Cl. 179—171.5)

My present invention relates to apparatus particularly useful for the generation of ultra short waves.

It has been proposed to generate ultra short waves by unidirectionally passing groups or pulses of electrons past a gap forming part of a space or cavity resonator. My present invention has as its main object to provide a somewhat similar, but improved system in which the clouds, pulses or groups of electrons are caused to vibrate back and forth over the gap.

Other objects, advantages and features of my invention will be apparent as the more detailed description thereof proceeds.

In the drawings:

Figure 1 illustrates one form of my invention for causing groups or clouds of electrons to vibrate back and forth across the gap of a cavity resonator in order to inductively excite the same;

Figure 2 is a modification in which an electron emitting surface has been used to replace the negatively charged anode of Figure 1; and

Figure 3 illustrates diagrammatically still another modification of my invention.

Turning to Figure 1, I have provided a vacuum tube having an hermetically sealed, evacuated, cylindrical glass container 2. Within the tube 2 there is provided a cathode 4 at one base of the tube, a disc-like plate 6 at the other base of the tube 2, and intermediate these two electrodes there is provided a perforated disc-like grid or control electrode 8. Grid 8 extends across the entire cross-section of tube 2. Cathode 4 is provided with a heater element 10 which may be energized by a suitable filament transformer 12 whose primary is connected to any suitable source, not shown. The cathode 4, as shown, is connected directly to ground or may be maintained at a small negative potential with respect to ground by inserting a suitable biasing source in series with the grounding lead 14. Similarly, the disc-like anode 6 may be connected to ground through a variable source of potential 16 which, preferably, is adjusted so as to subject the anode 6 to a negative potential with respect to ground 18. The grid 8 is connected by way of conductor 20 to potentiometer 22 in shunt to potential source 24. Tap 26 is so adjusted on potentiometer 22 as to cause the grid 8 to be subjected to a high positive potential.

As a consequence of the foregoing construction and connections, electrons are attracted from cathode 4 by the positively charged grid 8 and are given such velocity that they pass through grid 8 only to approach the negatively

charged anode 6 which now serves to slow up the electrons and repel them. In addition, after the electrons pass through the grid 8, the grid is now behind the electrons and tends to pull them back towards the cathode 4. It therefore follows that clouds of electrons are caused to oscillate through and about the grid 8.

By appropriately mounting a cavity resonator 28 about the tube 2, as shown, the pulses, clouds or groups of electrons oscillating between cathode 4 and anode 6 and through grid 8 inductively excite the resonator 28. By appropriate choice of voltages impressed upon the anode 6 and the grid 8 and by appropriately choosing the size of the gap 30 for the cavity resonator 28, as well as the dimension of the cavity resonator 28, the electron cloud oscillations may be brought into synchronism with the resonant waves set up within the cavity oscillator, thereby producing oscillations of extremely high frequency and high power. Output energy may be taken inductively from the cavity resonator by means of the metal loop or conductor 32 insulatingly passed through the walls of the capacity resonator 28. The latter is preferably made of a high conducting metal, such as copper, although it may also be made of invar and coated on its interior surface with silver or copper. The cavity resonator 28, together with the tube 2, may be placed within a temperature controlled container 34 provided with thermostatically operated heaters and fans so as to maintain the temperature of the system constant and thereby enhance frequency stability. As a further method of frequency control, a loop 36 may be provided for picking up some of the energy within the cavity resonator and this high frequency energy may be frequency divided by a frequency divider 38 and fed to a detector 40. The detector 40 is also fed with constant frequency oscillations from a crystal controlled oscillator 42 which, preferably, is temperature controlled. If desired, of course, the output of the crystal oscillator may be frequency multiplied by a suitable frequency multiplier before being fed into the detector 40.

The beat frequency resulting from action of detector 40 is fed to a coil 43 and thence to a pair of off-tuned circuits 44, 46 having overlapping resonance curves. The frequency discriminator system consisting of off-tuned circuits 44, 46 may also be mounted within a temperature controlled chamber 48. The outputs of discriminator circuits 44, 46 are fed to detectors 50, 52 connected in opposition across resistor 54. When the system is operating at its proper frequency,

there will be no voltage drop across resistor 54. However, with departure in frequency of the oscillator from that for which the beat frequency 40 lies at the cross-over point of the characteristics of circuits 44, 46, a voltage drop will be established across resistance 54 and this is fed through conductors 56 to a resistor 58 in series with the grid supply source 24. The voltage then injected into resistor 58 is of such sense and magnitude as to change the frequency of the oscillator in the direction tending to reduce the voltage drop across resistor 54.

The frequency controlling voltage may be fed, if desired, into the anode circuit by tapping conductors 56 to resistor 60.

The output of the oscillator may be modulated by means of a voice microphone or other suitable pick-up device 64 whose output is amplified by amplifier 66. The output of 66 may be inserted in series with the resistor 68 in the grid lead 20 or the output of amplifier 66 may be fed to the plate 6 by connection of conductors 70 to resistance 60. By appropriately controlling the injected modulation voltages, the output of the oscillator will be frequency modulated and substantially free of amplitude modulation.

The oscillator of Figure 2 is similar in construction and operation to that shown in Figure 1 with the exception that the anode 6 has been replaced by a cathode 7 heated by heater 9 and energized by transformer 11. Variable negative voltages from sources 13 and 15 may be provided for subjecting the cathodes 4, 7 to initial negative potentials with respect to ground. Also in Figure 2 the inductance of the grid conductor 20 may be tuned out by the series tuning condenser 22 at the operating frequency.

As shown diagrammatically in Figure 3 the grid may be made in the form of two perforated or woven metal discs 31, 33. The resonator may then occupy the position shown diagrammatically at 35.

In all of the modifications shown, the cavity resonator may be moved along the tube for optimum operation. For example, it is not essential that the grid be symmetrically disposed with respect to the gap in the cavity resonator, but rather the entire resonator, if desired, may be arranged so that the gap is unsymmetrical to the grid or entirely to either side thereof.

Also, the cathodes may be in the form of electron guns producing a concentrated, thin cylindrical stream of electrons or, if desired, the cathodes may be of the type to provide the emission of a hollow cylinder of electrons, which cylinder is concentric with the tube 2 and the cavity resonator 28. Also, if desired, a variable unidirectional electro-magnet may be mounted outside of the cavity resonator and around the tube 2 to further control the cloud of electrons oscillating back and forth across the gap. Such an electro-magnetic system will, of course, serve to prevent diffusion of the pulses or groups or clouds of electrons swinging back and forth through the grid 8.

Incidentally, as illustrated in Figure 1, time constant condensers 100 may be provided so that the automatic frequency control operates only for slow drifts in frequency and does not wipe out the modulation frequency changes produced by the modulating system 64, 66.

The cavity resonators 28, shown in Figures 1 and 2, are preferably maintained at a small negative potential with respect to ground by means

of source 110. This will serve to assist in the prevention of electron diffusion. However, the outer surface of the resonators may be connected directly to ground or, if desired, may be subjected to a positive D. C. potential with respect to ground.

In connection with Figure 1, bi-metallic strip 104 closes when the temperature within the heat insulated chamber 34 becomes too high, thereby causing fan 106 to operate, in turn causing circulation of air around the oscillator and through openings in the chamber 34. When the temperature is too low, strip 108 closes, energizing heater 110 from source 112. A similar fan and heater system may be placed within chamber 48.

In order to expedite temperature control, metal fins may be added to the outer surfaces of the cavity resonators and/or small holes 120 may be provided in the walls of the cavity resonators so that air may circulate there-through.

Having thus described my invention, what I claim is:

1. The combination with a cavity resonator comprising a hollow metallized enclosure having a narrow central portion forming a gap and an aperture in each wall of said central portion, of means for causing electrons to oscillate through said apertures and across and past said gap, said means including an electron emitting cathode on one side of said gap, a permeable electrode substantially centrally located within the confines of said gap and a circuit for maintaining said permeable electrode at a positive potential relative to said cathode, whereby each movement of electrons across said gap induces an electromagnetic field in said resonator.

2. The combination with a cavity resonator comprising a hollow metallized enclosure having a narrow central portion forming a gap and apertures in the confronting walls of said central portion, of means for causing electrons to oscillate across and past said gap, said means including an electron emitting cathode on one side of said gap, a grid substantially centrally located within the confines of said gap and a circuit for maintaining said grid at a positive potential relative to said cathode, said circuit including a battery and a lead connecting said battery to said grid, said grid being in a plane at right angles to the direction of movement of said electrons, and an electrode maintained at a negative potential relative to said grid located on the other side of said gap, whereby each movement of electrons across said gap induces an electromagnetic field in said resonator.

3. In combination, a cavity resonator comprising a hollow metallized enclosure having a narrow central portion forming a gap and an aperture in each wall of said central portion, means for causing electrons to oscillate a plurality of times over the same path across and past said gap comprising an evacuated electron discharge device inserted in said resonator and bridging said gap, an electron emitting cathode on one side of said gap, an electron permeable electrode in said device and located substantially symmetrically between the edges of said gap, a circuit for maintaining said electron permeable electrode at a positive potential relative to said cathode, whereby each movement of said electrons across said gap induces an electromagnetic field in said resonator, and a signal modulating circuit coupled to said last circuit.

4. The combination with a cavity resonator comprising a hollow metallized enclosure having an aperture passing therethrough, of means for causing electrons to oscillate across and past said aperture, said means including an electron 5 emitting cathode on one side of said aperture, an electron permeable electrode within the confines of said aperture and a circuit for maintaining said permeable electrode at a positive potential relative to said cathode, whereby each 10 movement of electrons across said aperture induces an electromagnetic field in said resonator, and signal modulating means coupled to said electron permeable electrode.

5. The combination with a cavity resonator 15 comprising a hollow metallized enclosure having a narrow central portion forming a gap and an aperture in each wall of said central portion, of an electron discharge device comprising an evacuated envelope inserted in said resonator and 20 bridging said gap, means for causing electrons to oscillate across and past said gap including electron emitting cathodes within said envelope on opposite sides of said gap, an electron permeable electrode also within said envelope but located 25 within the confines of said gap, and a circuit for

maintaining said grid at a positive potential relative to both said cathodes, whereby each movement of electrons across said gap induces an electromagnetic field in said resonator.

6. The combination with a cavity resonator comprising a hollow metallized enclosure having a central aperture passing therethrough, of means for causing electrons to oscillate across and past said aperture, said means including an electron emitting cathode on one side of said aperture, a grid substantially centrally located within the confines of said aperture and a circuit for maintaining said grid at a positive potential relative to said cathode, said circuit including a battery and a lead connecting said battery to said grid, said grid being in a plane at right angles to the direction of movement of said electrons, and a condenser connected to said lead for tuning out the inductance of said lead at the operating frequency, and an electrode maintained at a negative potential relative to said grid located on the other side of said aperture, whereby each movement of electrons across said aperture induces an electromagnetic field in said resonator.

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