April 12, 1938. W. VAN B. ROBERTS 2,114,113

OSCILLATION GENERATION
Filed Nov. 8, 1934

Fig. 1

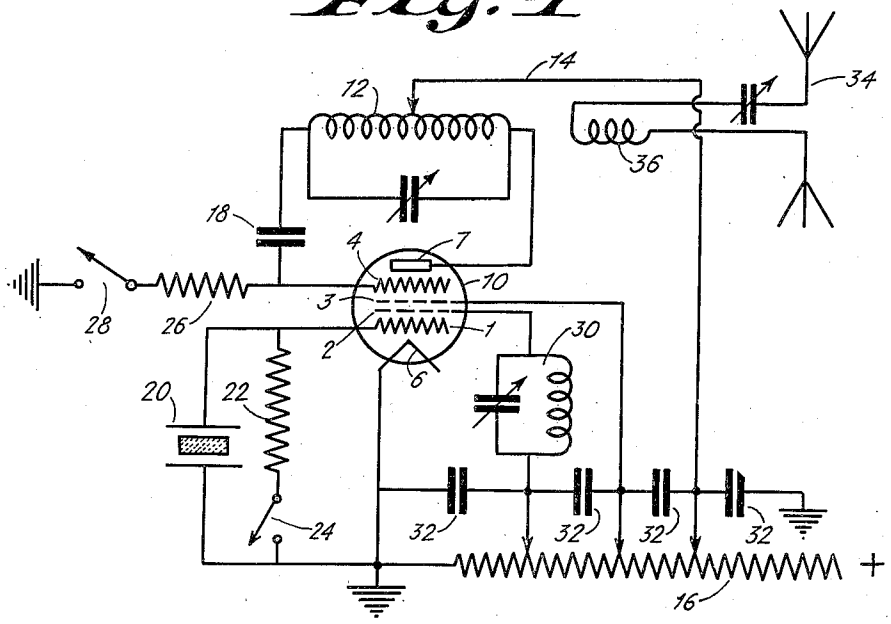
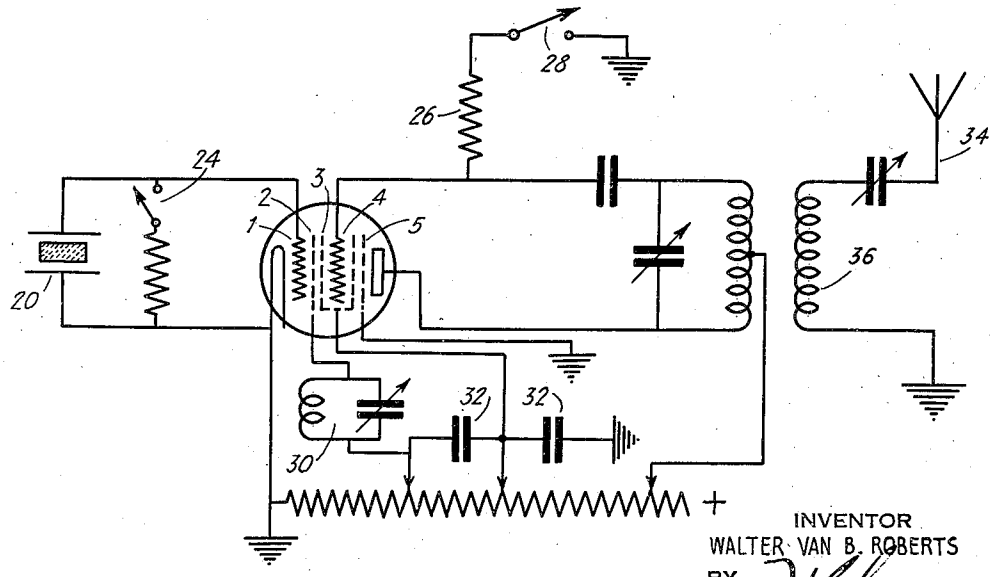


Fig. 2



INVENTOR
WALTER VAN B. ROBERTS
BY
ATTORNEY

Patented Apr. 12, 1938 2,114,113

UNITED STATES PATENT OFFICE

2,114,113

OSCILLATION GENERATION

Walter van B. Roberts, Princeton, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application November 8, 1934, Serial No. 752,020

5 Claims. (Cl. 250—36)

The principal object of my present invention is to provide for the general improvement of oscillation generators and particularly oscillation generators of the crystal controlled type.

In mobile transmitters, for example, it is highly desirable that relatively large power outputs of constant frequency be obtained with a minimum number of tube stages. This requirement may be satisfied by utilizing a tube having a multiplicity of grids. A regenerative oscillation generator crystal controlled can be set up between the cathode, control grid and screen grid of the tube. Another regenerative system utilizing the plate, cathode and another grid may be connected up to deliver high power at the same frequency or at some harmonic frequency. The latter system, if the first is crystal controlled or otherwise stabilized in frequency, will be locked into step in frequency with the stabilized system. However, since the plate oscillatory system develops a high power output, reaction upon the crystal may be such as to dangerously excite it, resulting in its rupture. To overcome this disadvantage is a further object of my present invention and in effecting it, I make use of a shield between the two oscillating systems which will prevent reaction of one upon the other and yet permit of the desired frequency locking effect.

My present invention is defined with greater particularity in connection with the accompanying drawing which, it is to be clearly understood, is only illustrative and is not in any way to be considered limitative of my invention, and wherein Figure 1 illustrates a crystal controlled oscillating system utilizing electrodes within a tube which are electrostatically shielded from another regenerative oscillating system utilizing other electrodes within the same tube, the shield being maintained at a positive potential with respect to the cathode and serving to prevent deleterious plate reaction upon the crystal controlled system; and Figure 2 illustrates a modification of Figure 1 wherein a grounded shield is utilized.

Turning to Figure 1, I have illustrated an electron discharge device or vacuum tube 10 having a first grid 1, a second grid or control electrode 2, a third grid 3 and a fourth grid 4 concentrically spaced about at increasing distances from a common cathode 6. The plate 7 is also concentrically arranged about the cathode and about all of the grids. The plate and grid 4 are connected to opposite ends of the tuned circuit 12, an intermediate point of which is connected by lead 14 to a high positive potential on potentiometer 16. Plate voltage is kept from the grid 4 by means of blocking condenser 18.

Between the grid 1 and cathode 6 there is connected a two electrode piezo-electric crystal 20. Also, between the grid 1 and cathode 6 is connected a leak resistor 22 and keying switch 24. Between the grid 4 and ground is also connected a leak resistor 26 and switch 28 which may be operated simultaneously or unicontrolled with switch 24. Between the grid 2 and the cathode 6 is connected the parallel tuned circuit 30. Grid 3, as illustrated, is maintained at a positive potential with respect to the cathode and is grounded for radial frequency currents by means of bypassing condensers 32. Output energy is fed inductively to the antenna 34 through the coil 36 coupled to the tuned circuit 12.

Oscillations set up in the tuned circuit 12 by regenerative action will be of relatively high power and will be locked into step by the regenerative oscillatory systems formed by the crystal 20, grid 1, grid 2 acting as a plate in a regenerative system, and parallel tuned circuit 30, it being noted that feedback occurs between the grid 2 and grid 1 for the crystal controlled system. This locking effect will take place when circuit 12 is tuned to the crystal frequency or to some harmonic of the crystal frequency. To prevent reaction of the output circuit 12 upon the crystal controlled oscillator, the screening electrode 3 is provided, biased and grounded, as heretofore described. Keying output energy may be accomplished by manipulating key 28 or key 24 or, preferably, by operating both in unison.

Frequently the grid 3 is made so as to completely surround grid 4 on both sides, as shown in Figure 2. In this event, care should be taken that the grid 3 should be maintained at a considerably lower positive potential than the plate, for otherwise secondary emission from the plate will occur. To avoid this possibility an additional grid 5 is provided directly grounded, as shown in Figure 2. Grid 5, if desired, may be maintained at a small positive or small negative potential with respect to ground. If grid 5 is negatively biased, modulation signal voltages may be applied thereto, for example, by connecting the secondary of a modulation transformer in series with the lead to grid 5.

While it has been stated that the circuit 12 is tuned to the same frequency as that of the crystal controlled oscillator system involving crystal 20 and tuned circuit 30, it may also be tuned to some higher harmonic or to some sub-harmonic

of the operating frequency of the piezo-electric crystal.

Having thus described my invention, what I claim is:

1. A system for producing constant frequency oscillations comprising a tube having a cathode, a plate and a multiplicity of grids, means connecting the cathode and a pair of said grids together to form a frequency controlling oscillatory system, a piezo-electric crystal in said frequency controlling system, means connecting the plate, another grid and the cathode together to form another oscillating system of higher power, harmonically related tuning devices in each of said oscillatory systems, means for applying between the tube electrodes suitable direct current potentials for producing an electronic stream from the first to the second of said oscillatory systems such that they may be locked in step, one with the other, and means for preventing capacitive reaction between the two said oscillatory systems, the last said means comprising at least one grid interposed between the electrodes of the respective oscillatory systems and having an alternating current path to ground.

2. Apparatus as claimed in claim 1 characterized by the fact that to assist in preventing reaction between said systems another grid adjacent said plate is connected directly to ground for radio frequency currents and is kept at a potential low compared to that of the plate.

3. A system for generating high frequency currents comprising a tube having a plate, a cathode, and five grids, of which the first grid is nearest the cathode while the third grid is disposed both internally and externally of the fourth grid, a crystal connected between the first grid and cathode, a tuned circuit connected between the second grid and cathode, means for subjecting said second grid to a positive potential with respect to said cathode, keying and biasing means for at times subjecting said first grid to a negative potential with respect to said cathode whereby oscillations under control of said crystal are regeneratively set up in the circuit between the second grid and said cathode, means comprising a regenerative feed back connection between the plate and the fourth grid for generating oscillations in the plate circuit of a frequency harmonically related to the first said oscillations, means for maintaining said third grid at a positive potential with respect to said cathode and at ground radio frequency potential with respect to said cathode, and means for directly grounding said fifth grid lying between said plate and third grid.

4. In an oscillation generator, an electron discharge tube having a cathode, an anode and at least four grids, the cathode, the two grids disposed nearest thereto and external circuits connecting said cathode with said grids constituting a frequency controlling oscillator system, the cathode, anode and another of said grids being included in a network constituting a power oscillator system whose frequency is different from but harmonically related to that of said frequency controlling system, means for so applying direct current potentials to the electrodes that electronic emission from the cathode may pass through all of the grids to the anode, thereby locking in step the oscillations of the controlling oscillator and of the power oscillator, and means including at least one grid disassociated from and disposed between the two oscillator systems and having an alternating current path to ground, whereby capacitive reaction of the power oscillator upon the controlling oscillator may be effectually prevented.

5. An oscillation generator and frequency multiplier comprising an electron discharge device having a cathode, an anode and a multiplicity of grids, means for causing oscillations to be generated in one section of said device which section includes the cathode and two grids adjacent thereto, means for causing oscillations of a multiple frequency to be generated in a second section of said device which section includes the cathode, the anode and a grid intermediate between the anode and the grids of the section first mentioned, a tuned regenerative feed-back circuit connected to said second section, and means including at least one of said multiplicity of grids and a connection thence to ground, for preventing capacitive reactions between the two said sections, the last said means serving also to permit electronic control of the frequency generated in the second section by locking the same in step with the harmonically related frequency generated in the first section.

WALTER VAN B. ROBERTS.