March 2, 1954 G. R. GAMERTSFELDER 2,671,173

SHOCK EXCITED OSCILLATOR CIRCUIT

Filed Aug. 28, 1945

FIG. 1

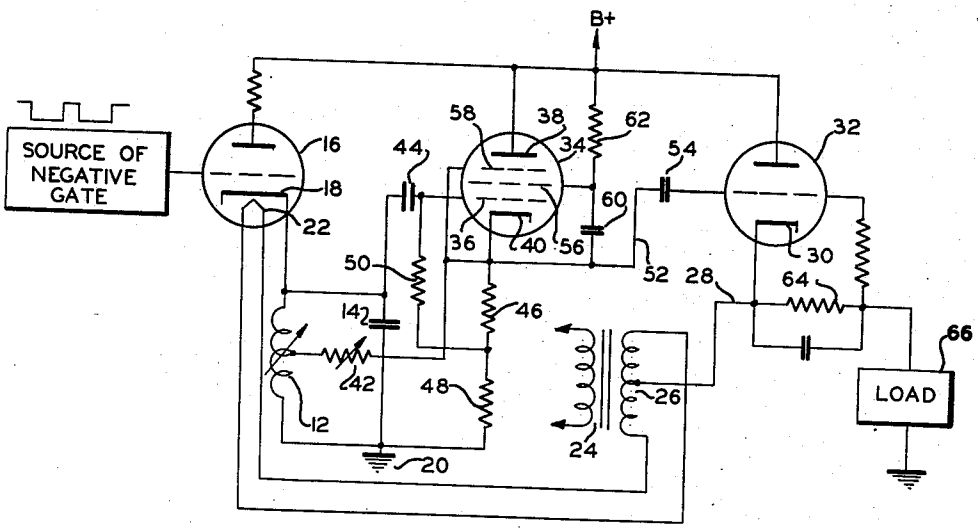
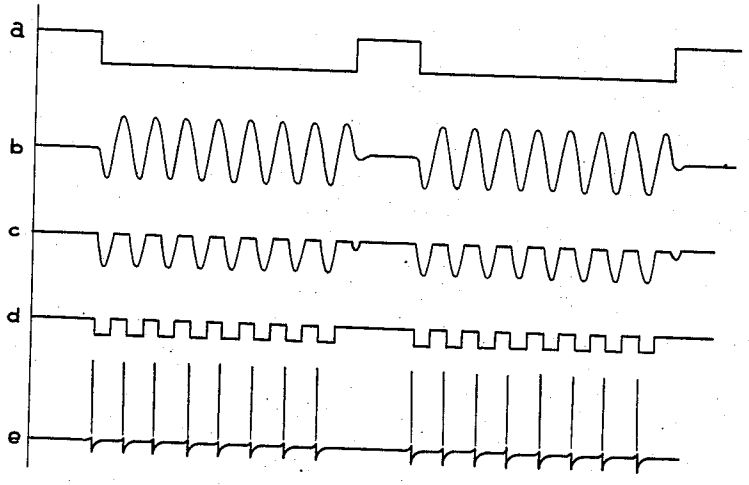


FIG. 2



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Patented Mar. 2, 1954

2,671,173

UNITED STATES PATENT OFFICE

2,671,173

SHOCK EXCITED OSCILLATOR CIRCUIT

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Application August 28, 1945, Serial No. 613,148

8 Claims. (Cl. 250—36)

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This invention relates to electron tube circuits, and more particularly to oscillator circuits of stable frequency.

The primary object of the invention is to generally improve circuits of the character described.

A more particular object of the invention is to improve the circuit disclosed in a co-pending application of Edward F. MacNichol, Jr., Serial No. 617,137 filed September 18, 1945, Patent No. 2,638,548, granted May 12, 1953. In the circuit of the aforesaid application the tank circuit of the oscillator is connected in the cathode lead of a switch tube, so that one side of the tank circuit is connected to the cathode of the switch tube, while the other side of the tank circuit is connected to ground. The cathode heater is grounded in conventional fashion, so that the capacitance between the cathode and the cathode heater shunts the tank circuit. When it becomes necessary to replace the switch tube the new tube will ordinarily have a different heater-cathode capacitance, and this in turn will change the resonant frequency of the tank circuit. Inasmuch as the circuit is being used to generate a train of oscillations for use as a marker for range finding purposes, it is important to avoid any such change in frequency. It is accordingly one object of the present invention to make the frequency of the tank circuit independent of the heater to cathode capacitance.

To accomplish the foregoing objects and others which will hereafter appear, my invention resides in the circuit elements and their relation one to another as are hereafter more particularly described, and sought to be defined in the claims. The specification is accompanied by a drawing in which

Figure 1 is a circuit diagram explanatory of the operation of the invention; and

Figure 2 shows voltage-time plots or wave forms explanatory of the operation of the circuit shown in Figure 1.

Referring to the drawing, and more particularly to Figure 2, a negative gate is shown at *a*, and controls the production of voltage oscillations shown at *b*. One use for such a periodically discontinuous train of oscillations is to produce a marker wave on the oscilloscope of a pulse echo system for indicating range, and for this purpose the oscillations of *b* may be rectified, or clipped as shown at *c*, limited and squared as shown at *d*, and differentiated as shown at *e*, the resulting peaks being suitable for use as a timing wave when applied to the vertically deflecting plates of the oscilloscope.

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Referring now to Figure 1, the tank circuit is made up of an inductor **12** and a capacitor **14**. This tank circuit is connected in the cathode lead of a switch tube **16**, one side of the tank circuit being connected to the cathode **18**, and the other side being grounded at **20**. It will be evident that if the cathode heater **22** were connected to a grounded power supply, the capacitance between the cathode **18** and the cathode heater **22** would be connected in shunt across the tank circuit. Inasmuch as this capacitance is of appreciable magnitude relative to the capacitance **14**, it would affect the frequency of the tank circuit, and replacement of the switch tube **16** with another would shunt the tank circuit by a capacitance of different value, thereby changing the resonant frequency of the tank circuit.

In accordance with the present invention this difficulty is overcome by energizing the heater **22** by means of a separate transformer **24**, the mid point of the secondary **26** of the transformer being connected by means of a lead **28** to a point in the circuit having substantially the same radio frequency potential as the cathode **18**. More specifically the lead **28** is connected to the cathode **30** of a cathode follower tube **32**. Inasmuch as the gain in such a tube is substantially unity, the potential applied to the heater **22** is substantially the same as that existing on the cathode **18**. The capacitance of the heater transformer to ground is large, and may be variable, but because of the low impedance of a cathode follower circuit, there is no appreciable loss in thus shunting the heater circuit across the cathode circuit **64**, including load **66** of the cathode follower tube **30**, whereas a similar impedance load connected across the tank circuit would be undesirable.

In the particular case here illustrated the ringing tank circuit **12**, **14** has a tube acting as a negative resistance device to prevent decay of the oscillations. This idea broadly is not in itself new in the present invention, it being disclosed and claimed in the co-pending application of Edward F. MacNichol, Jr., referred to above. However, in the present case the circuit has been improved with a view to giving the output a better wave form, and with a view to making the frequency of the circuit relatively independent of the tube, should tube replacement be necessary. The circuit may for convenience be called an "oscillator," though it differs from usual oscillators in having a limited amount of feed back, which itself limits the amplitude of oscillation.

The oscillator comprises a pentode **34** having

its control electrode 36 coupled to the upper side of the tank circuit; its anode 38 connected to a B supply and thence to the lower and grounded side of the tank circuit, and its cathode 40 connected to an intermediate point on inductor 12. An adjustable series resistor 42 may be used to control the feed back, and thus to maintain the oscillations at constant amplitude, all as is described in the aforesaid co-pending application.

In the present case the control electrode 36 is connected through a coupling capacitor 44, and the bias on the grid is established by connecting it to an intermediate point between cathode resistors 46 and 48, by means of a series grid resistor 50. This bias arrangement establishes the bias potential at a high enough value to permit of equal potential swing in both directions, so that there will be no deformation of the desired sine wave form in the output. The tube operates class A, and a good sine wave shape is therefor obtained even though the output is not taken from the tank circuit, and instead is taken directly at the cathode 40. If the output were taken from the tank circuit, a change in the impedance of the output circuit would change the frequency of the tank circuit, or/and would change the feed back required. In the present case the output circuit is dissociated from the tank circuit. Class A operation avoids loading the tank circuit, and improves the frequency stability and the wave form of the output. The output is led through lead 52 and coupling capacitor 54 to the grid of the cathode follower tube 32 previously referred to.

The suppressor grid 58 of pentode 34 is connected to the cathode. The screen grid is connected through capacitor 60 to the cathode and therefore is at approximately the radio frequency potential of the control grid. The grid to screen and also the grid to cathode capacitances are thus minimized, and the tube 34 may be changed without appreciably affecting the frequency. Resistor 62 is merely a voltage dropping resistor.

It is believed that the construction and operation of my improved circuit, as well as the advantages thereof, will be apparent from the foregoing detailed description. A negative gate is applied to the control electrode of the switch tube, thus removing the shunt current from the tank circuit, and starting the ringing of the oscillator at full amplitude. On termination of the negative gate the oscillation is instantly damped out. The capacitance between the cathode and the heater of the switch tube is without effect on the resonant frequency of the tank circuit, because both are maintained at the same radio frequency potential. It is therefore possible to replace the switch tube with another having a slightly different cathode to heater capacitance without shifting the frequency of the oscillator, and consequently without changing the accuracy of the marker wave applied to the oscilloscope.

The wave form of the output is a good sine wave. The oscillator tube as well as the switch tube may be changed without appreciable effect on the marker frequency, because the screen grid connection minimizes the grid to screen and also the grid to cathode capacitances. The tank circuit is dissociated from the output load, so that the frequency stability is not affected by changes in the output impedance. The class A operation of the oscillator tube provides a good sine wave output, even though the output is not taken from the tank circuit.

While I have shown and described my invention in a preferred form, changes and modifications may be made without departing from the spirit of the invention, as sought to be defined in the following claims.

I claim:

1. A shock excited oscillator circuit for generating oscillations of stable frequency comprising a resonant loop, a cathode follower circuit, means to couple said resonant loop to said cathode follower, means including an electron tube to excite said loop, said electron tube having a heater, a cathode, a control grid, and an anode, one side of said loop being grounded and the other side of said loop being connected to said cathode, and a transformer having a tapped isolated secondary winding for energizing said heater, said transformer tap being connected to the output of said cathode follower circuit at a point having substantially the same potential at the frequency of said oscillations as said cathode.

2. A shock excited oscillator circuit for generating oscillations of stable frequency and constant amplitude comprising a resonant loop, means for exciting said loop including an electron tube having a heater, a cathode, a control grid, and an anode, said loop being in the cathode circuit of said electron tube, an amplifier having input and output terminals, means to couple said input terminals to said loop, means to feed back to said loop energy from said output terminals to supply the energy loss in said loop, a cathode follower circuit, means to couple said output terminals to said cathode follower, an isolating transformer having a tapped secondary winding for energizing said heater, said transformer tap being connected to said cathode follower circuit at a point having substantially the same potential as said cathode at the frequency of said oscillations.

3. A shock excited oscillator circuit for generating oscillations of stable frequency comprising a resonant loop, a cathode follower circuit, means to couple said cathode follower to said loop, means to excite said loop, said last means including an electron tube having a heater, a cathode, a control grid and an anode, one side of said loop being grounded and the other side of said loop being connected to said cathode, a source of rectangular voltage pulses, means for applying said pulses to said control grid to produce periodically discontinuous trains of oscillations in said resonant loop, and a transformer having a tapped isolated secondary winding for energizing said heater, said transformer tap being connected to said cathode follower circuit at a point having substantially the same potential as said cathode at the frequency of said oscillations.

4. A shock excited oscillator circuit for generating oscillations of stable frequency and constant amplitude comprising a resonant loop, means for exciting said loop, said means including an electron tube having a heater, a cathode, a control grid, an anode, said loop being in the cathode circuit of said electron tube, a source of rectangular voltage pulses, means for applying said pulses to said control grid to produce periodically discontinuous trains of oscillations in said resonant loop, a source of electrical energy, means connecting said heater to said source and means for maintaining said heater at substantially the same potential as said cathode at the frequency of said oscillations, an amplifier having input and output terminals, means to couple said input terminals to said loop, means to feed

back to said loop energy from said output terminals to supply the energy loss in said resonant loop, and an output load coupled to said output terminals.

5. A shock excited oscillator circuit for generating oscillations of stable frequency and constant amplitude comprising a resonant loop, means for exciting said loop, said means including an electron tube having a heater, a cathode, a control grid, and an anode, said loop being in the cathode circuit of said electron tube, a source of rectangular voltage pulses, means for applying said pulses to said control grid to produce periodically discontinuous trains of oscillations in said resonant loop, an amplifier having input and output terminals, means to couple said input terminals to said loop, means to feed back to said loop energy from said output terminals to supply energy loss in said loop, a cathode follower circuit, means to couple said output terminals to said cathode follower, an isolating transformer having a tapped secondary winding for energizing said heater, said transformer tap being connected to said cathode follower circuit at a point having substantially the same potential as said cathode of said electron tube at the frequency of said oscillations.

6. A circuit as defined in claim 5 in which said amplifier includes a pentode electron tube having screen grid and cathode connected through a capacitor in order to minimize the grid to screen and grid to cathode capacitances.

7. A circuit as defined in claim 5 in which said amplifier includes a pentode electron tube having a control grid biased to permit class A operation and having screen grid and cathode connected through a capacitor in order to minimize the grid to screen and grid to cathode capacitances.

8. A shock excited oscillator circuit for producing oscillations of stable frequency, comprising a resonant loop, a source of power for energizing said loop, means for connecting said loop to said source, said means including a normally conducting electron tube having a control grid, an anode, a cathode and a heater, means for periodically biasing said electron tube to non-conduction to initiate oscillations in said loop, a cathode follower circuit, means to couple said resonant loop to said cathode follower, and a transformer having a tapped isolated secondary winding for energizing said heater, said transformer tap being connected to the output of said cathode follower circuit at a point having substantially the same potential at the frequency of said oscillations as said cathode of said electron tube.

GEORGE R. GAMERTSFELDER.

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