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PULSED OSCILLATOR

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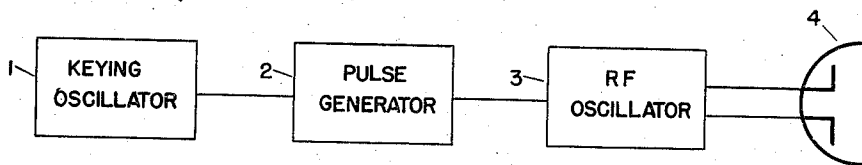


FIG 1

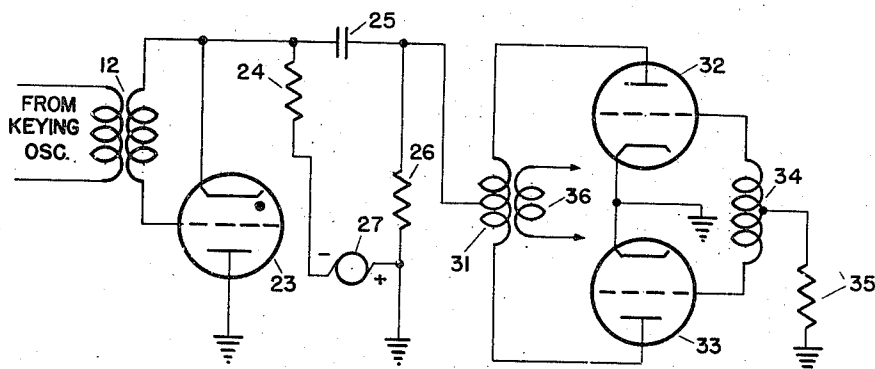


FIG 2

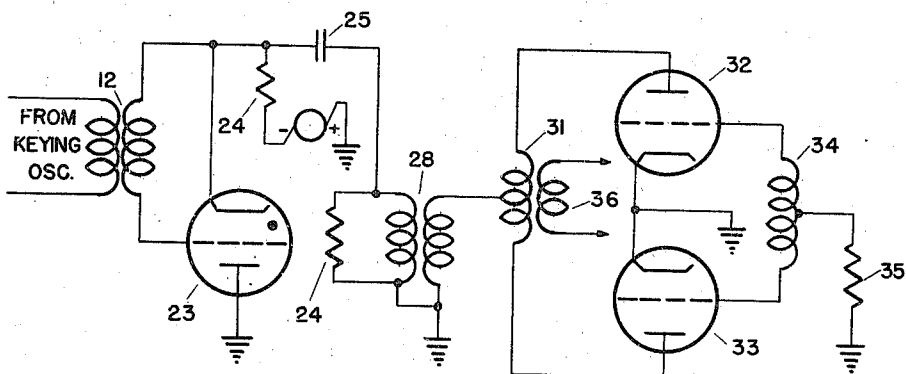


FIG. 3.

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PULSED OSCILLATOR

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United States of America as represented by the
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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to radio transmitters, especially such as are used in pulse-echo systems of object detection.

It is frequently necessary in such systems to make the pulses as sharp as possible in order to avoid confusion between the transmitted pulses and the pulses reflected from objects a relatively short distance away. Sharp pulses also permit use of large peak powers and at the same time keep the average power at a relatively low level.

It is therefore an object of this invention to devise a radio frequency transmitting system which can be used for emitting very sharp pulses of radio frequency energy.

It is a further object of this invention to devise an improved method of pulse modulating a transmitter of radio frequency waves.

Further objects will be apparent from the following specification and drawings, wherein like reference numerals indicate like parts and wherein:

Figure 1 is a block diagram of a pulse transmitter system;

Figure 2 is a schematic diagram of the circuits used in Fig. 1; and

Figure 3 is a schematic diagram of a modification of the invention.

Referring to Fig. 1, a keying oscillator 1, of relatively low frequency, is connected to a pulse generator of such construction that it generates a sharp pulse of potential at every cycle of current from the keying oscillator. The sharp pulse of potential is used to energize the tubes of a radio frequency oscillator 3, which in turn generates radio frequency power for the duration of said pulse. The output of the oscillator is radiated from a directional antenna 4 connected thereto.

Figure 2 illustrates the abovementioned circuits in greater detail. The output of oscillator 1 is connected to the primary of a transformer 12, the secondary of which is connected to the grid and cathode of a gas tube 23. This tube is of the grid controlled arc-discharge type, one brand of which is generally known by the trade mark "Thyratron." The plate of tube 23 is connected to the grounded positive pole of the plate potential source 27. The cathode of said tube is connected to the negative pole of source 27 through a high resistance 24, which for example, may be of the order of 100,000 ohms. The cathode is also connected to the ground through

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a condenser 25 and resistor 26, which may be, for example, of the order of 1,000 ohms.

The high potential side of resistor 26 is connected to the center-tap of a coil 31. One end of this coil is connected to the plate of tube 32 and the other end of the coil is connected to the plate of tube 33. The cathodes of both tubes are grounded. The grids of said tubes are connected to opposite ends of a coil 34, the center tap of which is connected to ground through a high resistance 35, of the order of 20,000 ohms.

Coils 31 and 34, together with the distributed capacity and interelectrode capacities thereacross, form the resonating tank circuits for the plates and grids, respectively, of radio frequency oscillating tubes 32 and 33 connected for push-pull operation. Feedback between the plate and grid circuits to maintain oscillation is produced by electromagnetic coupling between plate and grid coils 31 and 34 or by means of the interelectrode capacitances, or by both expedients. The radio frequency output of the oscillator is fed to an antenna, either directly or through a series of power amplifiers, by means of a coil 36 coupled to the coil 31.

The above described system operates as follows:

When the voltage applied through transformer 12, from the keying oscillator 1 to the grid of tube 23, is negative, the other circuit parameters are such that the gas tube is non-conducting. Under such conditions, the condenser 25 will be charged to substantially the full voltage of plate source 27 through resistors 24 and 26. When the condenser becomes charged, the current through resistor 26 drops to zero and therefore the voltage applied to anodes of the oscillator tubes 32 and 33 is zero.

When the grid of gas tube 23 becomes sufficiently positive, the tube discharges and in turn, due to the low resistance of the anode-cathode path of said tube, condenser 25 discharges suddenly through said tube and resistor 26, resulting in a very rapid surge of potential across resistor 26. Said surge is applied to the anodes of tubes 32 and 33 of the radio frequency oscillator, resulting in oscillations being generated for the duration of the pulse.

The duration of the pulse is determined by the time constant of the R. C. network constituted by resistor 26 and condenser 25, the anode-cathode resistance of tube 23 being negligible. When condenser 25 is completely discharged, the anode-cathode path of tube 23 becomes deionized, because resistor 24 depresses the plate potential below the operating level, and the grid again

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regains control until the next positive alternation from the keying oscillator 1. Thus a sharp pulse is generated at each cycle of the keying oscillator frequency.

Figure 3 is similar to Fig. 2 with the exception that condenser 25 discharges through the primary of a transformer 28, the secondary output of which is applied to the anodes of oscillator tubes 32 and 33. The transformer sharpens the pulse and permits more effective isolation of the pulse generating oscillator and the radio frequency oscillator.

The above described circuits have several features which permit safety and economy of operation. Only one high voltage lead is necessary to couple the keying circuit to the oscillator. There is no high voltage on the transmitter during intervals between pulses permitting less severe insulation requirements. A particular feature is the absence of direct current potentials in the oscillator circuits thus reducing hazard to personnel during "tune-up" periods.

Only those elements of a complete transmitting system have been shown which are necessary to explain the operation of the system. Other elements of such a system have not been shown or described, since they are conventional. It is to be understood that many variations are possible which will readily suggest themselves to one skilled in the art.

I claim:

1. A pulse generator comprising a tube having a cathode, an anode, and a grid, said grid being connected to a source of control potential, said anode being connected to one pole of a source of plate potential and to ground, said cathode being connected to one end of a resistor the other end of which is connected to the other pole of said source, a condenser connected directly to said cathode, the other side of said condenser being connected to one end of a second resistor, the other side of which is connected to ground.

2. A pulse generator comprising a tube having a cathode, an anode, and a grid, said grid being connected to a source of control potential, said anode being connected to one pole of a source of plate potential and to ground, said cathode being connected to one end of a resistor the other end of which is connected to the other pole of said source, a condenser connected directly to said cathode, the other side of said condenser being connected to one end of a second resistor the other side of which is connected to ground, and an output circuit coupled to one of said resistors.

3. A pulse generator comprising a gas tube of the arc discharge type having a cathode, an anode, and a grid, said grid being connected to a source of control potential, said anode being connected to one pole of a source of plate potential and to ground, said cathode being connected to one end of a resistor the other end of which is connected to the other pole of said source, a condenser connected directly to said cathode, the other side of said condenser being connected to one end of a second resistor the other side of which is connected to ground, said second resistor being a small fraction of the value of said first mentioned resistor, and an output circuit coupled to said second resistor.

4. A pulse generator comprising a gas tube of the arc discharge type having a cathode, an anode, and a grid, said grid being connected to a source of control potential, said anode being

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connected to one pole of a source of plate potential and to ground, said cathode being connected to one end of a resistor the other end of which is connected to the other pole of said source, a condenser connected directly to said cathode, the other side of said condenser being connected to one end of a second resistor the other side of which is connected to ground, one of said resistors being a small fraction of the value of the other, and a transformer, the primary of which is connected across said second mentioned resistor and the secondary of which constitutes the output circuit of the pulse generator.

5. A pulse generator comprising a tube having a cathode, an anode, and a grid said grid being connected to a source of control potential, said anode being connected to one pole of a source of plate potential and to ground, said cathode being connected to one end of a resistor the other end of which is connected to the other pole of said source, a condenser connected directly to said cathode, the other side of said condenser being connected to one end of a second resistor the other side of which is connected to ground, and a transformer, the primary of which is connected across said second mentioned resistor and the secondary of which constitutes the output circuit of the pulse generator.

6. A pulse generator comprising a gas tube of the arc discharge type having a cathode, an anode, and a grid said grid being connected to a source of control potential, said anode being connected to one pole of a source of plate potential and to ground, said cathode being connected to one end of a resistor the other end of which is connected to the other pole of said source, a condenser connected directly to said cathode, the other side of said condenser being connected to one end of a second resistor, the other end of which is connected to ground, and a transformer, the primary of which is connected across said second mentioned resistor and the secondary of which constitutes the output circuit of the pulse generator.

7. A radio pulse transmitter including at least a pair of electron tubes, one tube having its anode grounded, the other tube having its cathode grounded, a pulse transformer, a circuit including one of said tubes and the primary of said transformer to charge and discharge said condenser at spaced intervals, and a radio frequency oscillator circuit including the space current path of the other of said tubes in series with the secondary of said transformer, the direction of said discharge being such, that a positive potential is impressed upon the anode of said other tube during said discharge.

8. A system for transmitting spaced wave trains, each train comprising a plurality of cycles having a period which is a minor fraction of the duration of each train, said system comprising at least a pair of electron tubes having their space-current paths oppositely connected, respectively, relative to ground, a wave transmitter including one tube, said transmitter being tuned to the period of said cycles, said one tube having insufficient potential normally applied to the terminals thereof to enable said transmitter to operate, an energy storage network, a first circuit controlled by the other tube to intermittently charge said storage network, a second circuit controlled by said other tube to alternately discharge said storage network, and means in said second circuit responsive to each discharge to intermittently in-

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crease said potential and render said transmitter operative during each discharge circuit.

9. A system as set forth in claim 8, wherein said last-named means comprises a transformer having its primary coupled to said second circuit and its secondary coupled to the space-current path of said one tube.

10. A system for transmitting spaced wave trains, each train comprising a plurality of cycles of a frequency which is considerably higher than the repetition rate of said wave trains, said system comprising at least a pair of electron tubes having their space current paths oppositely connected, respectively, relative to ground, an oscillator including one tube, said oscillator being tuned to said frequency, said one tube having zero potential applied to the terminals thereof, whereby said oscillator is normally inoperative, an energy storage network, means including the other tube to periodically charge said storage network externally of said one tube and to alternately discharge said storage circuit, and means excited by each discharge to intermittently apply sufficient potential to said one tube to render said oscillator operative during each discharge.

11. A system as set forth in claim 10, wherein said last-named means comprises a transformer having its primary coupled to said storage network and its secondary in series with the space-current path of said one tube.

12. A system for transmitting spaced wave trains, each train comprising a plurality of cycles having a period which is a minor fraction of the duration of each train, said system comprising at least a pair of electron tubes having their space-current paths oppositely connected, respectively, relative to ground, a radio-wave transmitter including one tube, said transmitter being tuned to the period of said cycles, said one tube having zero potential normally applied to the electrodes thereof, whereby said transmitter is normally inoperative, a storage condenser, a first circuit controlled by the other tube to periodically charge

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said storage condenser externally of said one tube, a second circuit controlled by said other tube to alternately discharge said storage condenser circuit through said one tube in such direction as to intermittently render said transmitter operative during each discharge.

13. A system as set forth in claim 12, wherein said other tube is of the arc-discharge type, and a source of keying oscillations to alternately render it conducting and nonconducting.

14. A system for transmitting intermittent wave trains, each train comprising a plurality of cycles of a frequency which is considerably higher than the repetition rate of said wave trains, said system comprising at least a pair of electron tubes having their space-current paths oppositely connected, respectively, relative to ground, a transmitting oscillator including one tube, said oscillator being tuned to said frequency, said one tube having zero potential normally applied to the anode thereof, whereby said oscillator is normally inoperative, an energy storage network, means controlled by the other tube to periodically charge said storage circuit externally of said one tube and to alternately discharge said storage condenser circuit through both tubes, whereby said oscillator oscillates during each discharge of said storage network.

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