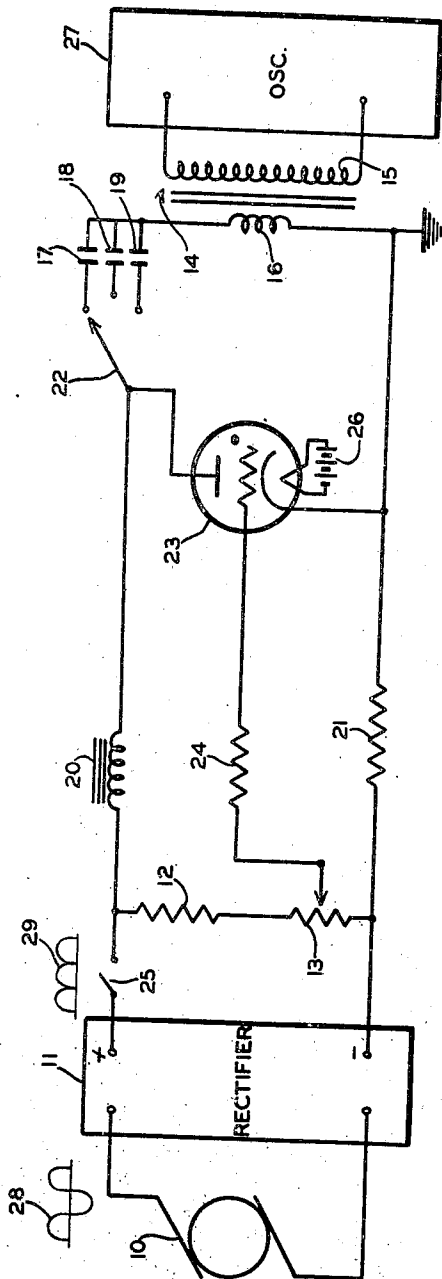


Jan. 1, 1946.

J. E. GORHAM ET AL
MODULATOR

Filed Dec. 8, 1943

2,391,894



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2,391,894

MODULATOR

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Application December 8, 1943, Serial No. 513,376

4 Claims. (Cl. 250—36)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to use of any royalty thereon.

This invention relates to radio impulse systems and more particularly to impulse generators for use in pulse modulation systems and other electrical systems where high power impulses are desirable.

Modern ultra-high frequency technique necessitates in many applications the operation of ultra-high frequency oscillators such as the magnetron at relatively high power levels. Since the maximum power level at which continuous operation of these oscillators may be safely maintained is limited by design, it is common practice to operate the apparatus with high power inputs for brief periods only, thereby keeping the average operating conditions well within the limits of safety.

For the purpose of operating oscillators in this manner, modulators are provided which deliver surges or pulses of a high power level, the duration of which constitute the "on time" of transmission. The interim between pulses which is long compared with their duration then determines the time the oscillator is turned off before signals are again transmitted.

Modulators for furnishing these high power pulses have assumed two forms, namely, the vacuum tube type and that of the spark gap generator. Because accurate timing of the spark is difficult to maintain, the spark gap generator is not adaptable to systems in which the oscillator is triggered from a synchronizing source. Modulators of the vacuum tube type are not subject to this difficulty but have heretofore been unwieldy because of the high power requirements.

Accordingly, it is an object of this invention to provide a vacuum tube modulator which is compact in structure, simple in design, and adaptable to mobile and portable equipment where minimum weight is essential.

Another object of this invention is to provide a modulator pulse network which performs the dual function of shaping the power pulse and of increasing the magnitude of the power pulse.

A further object of this invention is to provide apparatus for accurately timing a high power pulse.

These and other objects will become apparent in the ensuing description.

In carrying out this invention in a preferred embodiment thereof, we employ a voltage step-

up transformer the secondary of which is connected to the transmitter plate input. The primary of the transformer is connected in series resonance with a capacitance and this combination serves as a pulse forming network. Shunted across the network is a Thyatron control tube. In operation, a pulsating direct current having a frequency equal to the desired pulse frequency is impressed across the network thereby charging the condenser. The resultant charging current, by means of a voltage drop developed across a resistor connected in the control grid circuit of the Thyatron, is made to fire the tube at the instant of maximum condenser charge, thus in effect shorting the Thyatron and allowing the condenser to discharge through the transformer primary. A surge of power of increased potential is induced in the secondary winding of the transformer which is impressed upon the load circuit. Since the series combination of condenser and transformer primary acts as an oscillatory circuit the collapsing transformer field tends to recharge the condenser with a polarity opposite to its initial polarity which was positive in respect to the plate. The reversal in potential checks the ionization of the tube. The condenser proceeds to recharge with the next cycle of pulsation D. C. and the above described process is repeated.

A more comprehensive understanding of this invention may be obtained from the following detailed description, when taken together with the accompanying drawing in which:

The figure is a schematic circuit diagram of an embodiment of this invention.

Referring now to the figure, the output of an alternating current generator 10 is applied to a full wave rectifier 11 of conventional design. The generator 10 has an operating frequency which is equal to one-half of the desired pulse repetition rate. The output of the rectifier 11 is a pulsating direct current having a frequency twice that of the generator and equal to the desired repetition rate. Wave form 28 illustrates the generator output while form 29 shows the rectifier output.

Shunted across the output of the rectifier is a bleeder composed of two resistors in series, resistor 12 being fixed and resistor 13 having an adjustable tap.

A high ratio voltage step-up transformer 14 is provided having its secondary windings 15 connected to the plate supply line of transmitter 27. The primary winding 16 of transformer 14 has one end connected through condenser 17 in series

with choke 20 to the positive terminal of the rectifier 11. The other end of primary 16 is wired through resistor 21 to the negative terminal of rectifier 11. A selector switch 22 permits the insertion of either condenser 17, 18, or 19 in the circuit.

A grid controlled gas rectifier tube 23 of the type commonly known as Thyatron has its cathode connected to one side of the primary 16 and its plate connected to the selector arm of switch 22. Power for the Thyatron heater is obtained from battery 26. The firing grid of the tube 23 is connected to the sliding arm of resistor 13 through a current limiting resistor 24.

When switch 25 is closed, the pulsating D. C. output of rectifier 11 is applied to the circuit and condenser 17 begins to charge. The resultant charging current creates a voltage drop across resistor 21 the polarity of which is opposed to that of resistor 13 in respect to the grid, the polarity of resistor 13 being positive and that of 21 being negative. Thus, it may be seen that as the current through resistor 21 increases, the greater becomes the negative potential on the control grid. Since as condenser 17 attains its maximum charge the current diminishes, the voltage drop across resistor 21 is correspondingly decreased. Resistor 13 is adjusted so that at the instant the condenser reaches its maximum charge the negative voltage impressed on the grid is sufficiently low to fire the Thyatron.

The ionization of the tube provides a conductive path permitting the discharge of the condenser through the primary 16 of the transformer thus inducing a voltage pulse in the secondary 15 which powers the transmitter 27 for the duration of the pulse. Choke 20 serves to impede the discharge of the condenser through the rectifier circuit 11.

The combination of condenser 17 and primary 16 performs as a series resonance circuit so that when the condenser has discharged in one direction through primary winding 16, the collapsing primary field tends to recharge the condenser in the reversed direction. Hence, a negative potential is momentarily applied to the plate of the Thyatron thereby opening the Thyatron cathode-plate circuit as well as the oscillatory circuit so that but a single pulse is formed in the primary winding 15.

In order to secure pulses of any desired width the resonant characteristics of the pulse LC network may be altered by substituting condensers of different values by means of selector switch 22. Transformer 14 is preferably of the type described in copending patent application "Vacuum insulated transformer" of H. A. Zahl (Serial No. 486,498, filed May 11, 1943) having a very high step-up ratio and a high grade insulation between the primary and secondary to prevent breakdown. This transformer is not per se a part of this invention and any suitable transformer having similar characteristics may be used.

Although the pulsating D. C. power input aids in synchronizing the modulator, a direct current power source may be effectively used in its stead. In this case, the D. C. is applied directly to the bleeder and the repetition rate may be controlled by varying the LC circuit of the transformer primary winding and its associated condenser.

While we have shown and described a specific embodiment of this invention, we do not limit ourselves to the exact details of construction and arrangements shown, but may employ such

changes and modifications as come within the meaning of the appended claims.

We claim:

1. In a pulse generator whose pulse repetition rate is synchronized with an alternating-current power source, the combination comprising a capacitor, an inductor in series connection with said capacitor to form a resonant circuit, an unfiltered rectifier associated with the alternating-current power source and having its pulsating direct-current output chargeably applied to said resonant circuit, a gaseous discharge device having a control electrode, and means responsive to the charging current of said resonant circuit for applying a voltage to the control electrode of said device whose value at the instant said capacitor attains its maximum charge is such as to render said device conductive, thereby discharging said resonant circuit, the time constant of said resonant circuit being such that said capacitor attains its maximum charge once each charging cycle.

2. In a pulse generator whose pulse repetition rate is synchronized with an alternating current power source, the combination comprising a capacitor, a step-up transformer having its primary winding in series connection with said capacitor to form a resonant circuit and its secondary winding connected to a load, an unfiltered rectifier associated with the alternating-current power source and having its pulsating direct-current output chargeably applied to said resonant circuit, a gaseous discharge device including an anode, a cathode and a control electrode, and having said anode connected to one side of said resonant circuit and said cathode to the other side thereof, a resistor connected in series with said resonant circuit and said rectifier, and means for applying to the control electrode of said device the voltage drop developed across said resistor during the charging of said resonant circuit whereby at the instant said condenser attains its maximum charge, the value of voltage applied to said control electrode is such as to render said device conductive, thereby discharging said resonant circuit, the time constant of said resonant circuit being such that said capacitor attains its maximum charge once each charging cycle.

3. In a pulse generator whose pulse repetition rate is synchronized with alternating-current power source, the combination comprising a capacitor, a step-up transformer having its primary winding in series connection with said capacitor to form a resonant circuit and its secondary winding connected to a load, an unfiltered rectifier associated with the alternating-current power source and having its pulsating direct-current output chargeably applied to said resonant circuit, a gaseous discharge device including an anode, a cathode and a control electrode and having said anode connected to one side of said resonant circuit and said cathode to the other side thereof, a resistor connected in series with said resonant circuit and said rectifier, and a voltage divider shunted across the output of said rectifier, said divider having a tap thereon connected to said control electrode, the position of said tap being such whereby the voltage applied to the control electrode is, at the point of maximum charge of said capacitor, of a value rendering said device conductive, thereby discharging said resonant circuit, the time constant of said resonant circuit being such that said capaci-

tor attains its maximum charge once each charging cycle.

4. In a pulse generator whose pulse repetition rate is equal to twice the frequency of an alternating-current power source, the combination comprising a capacitor, a step-up transformer having its primary winding in series connection with said capacitor to form a resonant circuit and its secondary winding connected to a load, an unfiltered full-wave rectifier associated with the alternating-current power source and having its pulsating direct-current output chargeably applied to said resonant circuit, a gaseous discharge device including an anode, a cathode and a control electrode and having said anode connected 15 to one side of said resonant circuit and said

cathode to the other side thereof, a resistor connected in series with said resonant circuit and said rectifier, and a voltage divider shunted across the output of said rectifier, said divider having 5 a tap thereon connected to said control electrode, the position of said tap being such whereby the voltage applied to the control electrode is, at the point of maximum charge of said capacitor, of a value rendering said device conductive, thereby 10 discharging said resonant circuit, the time constant of said resonant circuit being such that said capacitor attains its maximum charge once each charging cycle.

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