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PULSE GENERATOR

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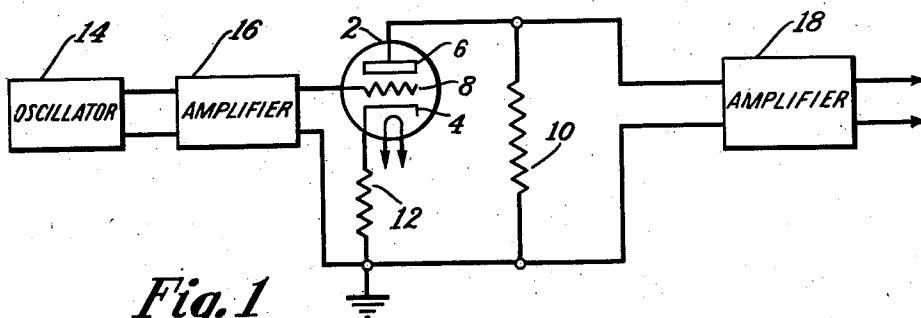


Fig. 1

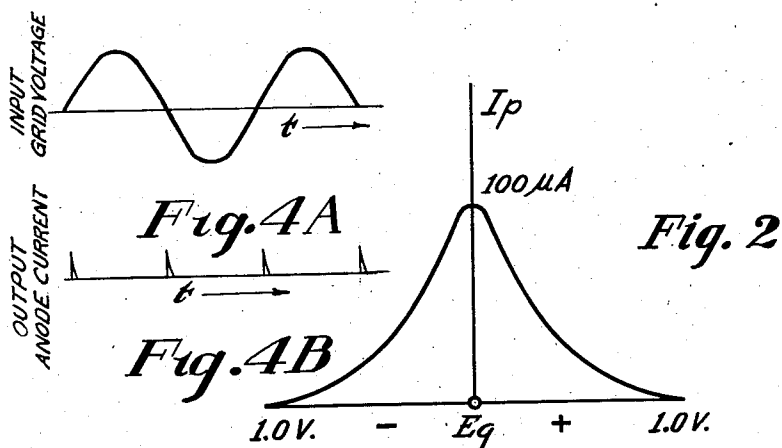


Fig. 4A

Fig. 4B

Fig. 2

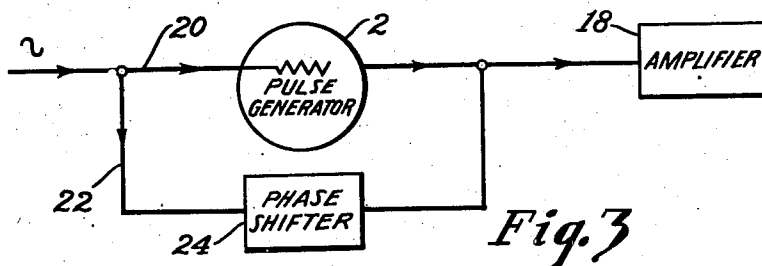


Fig. 3

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PULSE GENERATOR

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This invention relates to pulse generators.

Pulses of electrical energy of short duration are used for keying transmitters of radio frequency energy, for blanking indications, for the synchronization of signals in television apparatus, in the sweep circuits of oscilloscopes, and have many other applications. In many applications it is desirable that such pulses should have a fixed phasic relation to the wave from which they are derived.

Prior art pulse generators having these features have used gas tubes, multivibrators, relaxation oscillators and the like; such devices are comparatively expensive and need complicated circuits and substantial power supplies for their proper operation.

It is, therefore, the primary object of this invention to provide an improved method of, and apparatus for, generating pulses of electrical energy of short duration and having a fixed phasic relation to the wave from which they are derived.

A further object of the invention is the provision of improved apparatus for generating pulses of the character described, in which a comparatively simple circuit and comparatively inexpensive and compact apparatus are used.

For the attainment of these objects, the invention makes use of the abrupt reversal in direction of the transfer characteristic existing between two electrodes of an electron tube when the potentials of the electrodes are properly chosen. A periodic wave is applied to one of the electrodes and as the potential of that electrode, under control of the applied wave, passes through the region in which such a reversal occurs, a pulse of electrical energy appears across an impedance in the circuit which includes the other electrode.

The invention will now be described with reference to the accompanying drawing, in which:

Figure 1 is a circuit diagram of apparatus suitable for carrying out the invention,

Figure 2 is a graph representing the transfer characteristic existing between two of the electrodes of the tube shown in Figure 1,

Figure 3 is a circuit diagram of an alternative connection of the apparatus shown in Figure 1, and

Figs. 4A and 4B illustrate the relation of the input and output signals of the device of Fig. 1.

Referring to Fig. 1, a tube 2, which may be of RCA type 6SL7GT or 6SN7GT, and having a cathode 4, an anode 6 and a control electrode or grid 8, is connected as follows: An impedance 10, which may be a resistor of the value of 20,000 ohms, is connected between anode and ground.

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A resistor 12 (which may have a value of 1,000 ohms) in the cathode circuit serves to limit the current which flows in the grid circuit, as hereinafter explained. The anode is not connected to any source of potential and is maintained at the same potential as the cathode. Since, however, the cathode is made of an electron-emissive substance and the anode is not, the difference of potential between cathode and anode (sometimes called "contact potential") may establish a weak anode current. This potential difference may amount to half a volt. The grid is normally maintained at substantially the same potential as the cathode. In the apparatus thus far described, it may be said that electrons are emitted by the cathode, and since the grid has neither a retarding nor an accelerating effect upon such electrons, some of them reach the anode and, thus, current flows through the impedance 10 in the anode circuit.

A periodic wave is now applied between the grid and the grounded end of the resistor 12. The wave or signal may be obtained from any source thereof, as from the oscillator 14, and may if desired be amplified as by the amplifier 16. The signal may be sinusoidal in form; sine wave input signals at frequencies varying from 200 cycles per second up to 20 kilocycles per second, and of magnitudes varying between 20 to 60 volts R. M. S., have been used with the apparatus described for the generation of pulses.

During the negative half cycle of the signal wave, the applied signal puts a negative potential on the grid, which prevents electrons emitted by the cathode from reaching the anode; and, therefore, during this half cycle no current flows in the anode circuit at all. This effect, however, diminishes as the signal approaches its zero axis, and when the grid is at zero signal potential with respect to the cathode, a weak current may flow in the anode circuit because of "contact potential."

During the positive half of the signal cycle, the grid may be regarded as possessing a sufficiently positive charge to attract all or nearly all of the electrons which are emitted by the cathode. This causes current to flow in the grid circuit and, again, prevents any current at all from flowing in the anode circuit, thereby producing the transfer characteristic shown in Fig. 2; so that it is only in the region in which the input signal crosses its zero axis and the potential of the grid is substantially the same as that of the cathode that current flows at all in the anode circuit, and a pulse of energy appears across the

impedance 13 in the anode circuit, as in Fig. 4B. The greater the frequency of the input signal, the shorter is the duration of the pulse.

Signals in the form of square waves may be used for the production of short pulses. Since the sides of square waves cross the zero axis in a very short space of time, a particularly short pulse is produced.

Whatever periodic waves are used for the input signals, the pulse in the output circuit of the tube will occur twice for each input signal cycle, as the signal crosses its zero axis. It is at this point that the rate of change of a sine wave is greatest. It is to be observed, therefore, that the pulse is not only of extremely short duration but is also in constant phase with respect to the input signal cycle.

The pulses appear across the impedance 10 in the anode circuit and may, if desired, be amplified (as by the amplifier 18) and used for keying a transmitter, or for such other purpose as may be required. Pulses 15 micro-seconds long and having a peak value of 15 volts before amplification have been produced by this method from input signals at a frequency of 200 cycles per second.

Each input cycle results in two pulses in the output circuit. It is often desired, however, to have but one pulse for each input cycle, and in that event the connection shown in Fig. 3 may be used. Two channels 20 and 22 are provided for the input signal. One goes directly to the control electrode of the pulse generator and the other passes through a phase shift device 24, which may consist of a combination of capacitance and resistance. The phase shifter 24 alters the phase of the periodic input signal and applies a negative voltage to the control electrode of the amplifier 18 simultaneously with the application thereto of alternate pulses from the generator 2. The negative voltage blocks the amplifier during the occurrence of alternate pulses so that the output of the amplifier consists of only one amplified pulse for each cycle of the original input signal.

While the apparatus which has been described for carrying out the invention has consisted of a triode in which both the anode and control electrode are held at the same potential as the cathode, the invention is not intended to be limited to that specific form of apparatus. Within the scope of the appended claims, the invention includes any electronic device for the production of pulses of electrical energy of short duration, in which a transfer characteristic, which reverses in direction as shown by Figure 2, may be produced.

I claim as my invention:

1. In combination an electron tube having a cathode and an anode and at least one other electrode located between said cathode and said anode, a circuit including a resistor connecting said cathode and anode externally of said tube said anode and electrode being maintained at such respective potentials with respect to said cathode and to each other that current deriving from the electron stream flows in said circuit, but that on variation in either direction of the potential of said electrode with respect to the cathode said current is completely diverted from said circuit, means for applying a signal of abruptly varying amplitude to said electrode, and means for deriving from said circuit sharply defined pulses of electrical energy.

2. In combination an electron tube having a cathode and an anode and at least one other elec-

trode located between said cathode and said anode, a circuit including a resistor connecting said cathode and anode externally of said tube said anode and electrode being maintained at such respective potentials with respect to said cathode and to each other that current deriving from the electron stream flows in said circuit, but that on variation in either direction of the potential of said electrode with respect to the cathode said current is completely diverted from said circuit, a source of periodic electrical energy, and connections between said source and said electrode for impressing the energy from said source on said electrode whereby to generate in said circuit pulses of electrical energy having a fixed phasic relation to the repetition period of said energy.

3. In combination, an electron tube having a cathode and an anode and at least one other electrode located between said cathode and said anode, a circuit including impedance connecting said anode and cathode externally of said tube said electrode and anode having such respective potentials with respect to said cathode and to each other that on increase of the potential of said electrode with respect to said cathode above cut-off, current, deriving from the electron stream flows in said circuit, and on further increase of said potential in the same direction, said current is completely diverted to the circuit which includes said electrode, means for producing a periodic signal of rapidly varying amplitude, and means for impressing said signal upon said electrode.

4. A pulse generator comprising an electron tube having a cathode and at least two other electrodes so connected to said cathode externally of said tube as to be substantially at contact potential with respect thereto, one of said other electrodes being located between said cathode and a second of said other electrodes, connections for impressing a periodically varying signal between one of said electrodes and said cathode, and a utilization circuit connecting the other of said electrodes to said cathode externally of said tube.

5. A pulse generator comprising the combination of a source of periodic electric energy, an electron tube having a cathode and a control electrode and an anode so connected to said cathode externally of said tube as to be substantially at contact potential with respect thereto, connections from said source to said control electrode and said cathode respectively, and a utilization circuit connecting said anode to said cathode externally of said tube.

6. A pulse generator comprising an electron tube having a cathode and input and output electrodes so connected to said cathode externally of said tube as to be substantially at contact potential with respect thereto, said input electrode being located between said cathode and said output electrode, connections for impressing a periodically varying signal between said input electrode and said cathode, and a utilization circuit connecting said output electrode to said cathode externally of said tube.

7. A pulse generator comprising an electron tube having a cathode, an anode, and a control electrode located between said cathode and said anode, said anode and said control electrode being so connected to said cathode externally of said tube as to be substantially at contact potential with respect thereto, connections for impressing a periodically varying signal between said control electrode and said cathode, and a utiliza-

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tion circuit connecting said anode and said cathode externally of said tube.

8. In combination, a pulse generator comprising an electron tube having a cathode and an anode and at least one other electrode located between said cathode and said anode, a circuit including impedance connecting said cathode and anode externally of said tube, said anode and electrode being maintained at such respective potentials with respect to said cathode and to each other that current deriving from the electron stream flows in said circuit but that on variation

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in either direction of the potential of said electrode with respect to said cathode, said current is completely diverted from said circuit, and connections for applying an abruptly varying signal between said electrode and said cathode, means connected in parallel with said pulse generator for altering the phase of said signal, an amplifier, and connections for applying the output of said pulse generator and of said phase-altering means to said amplifier.

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