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WAVE GENERATOR

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Fig.1.

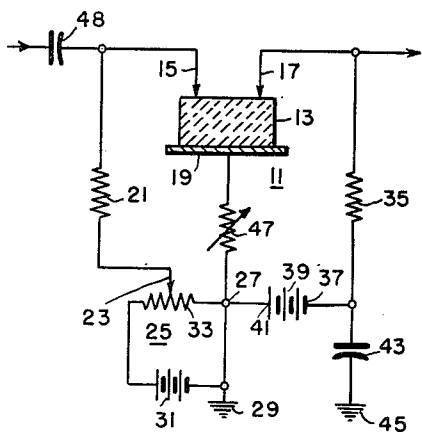


Fig.2.

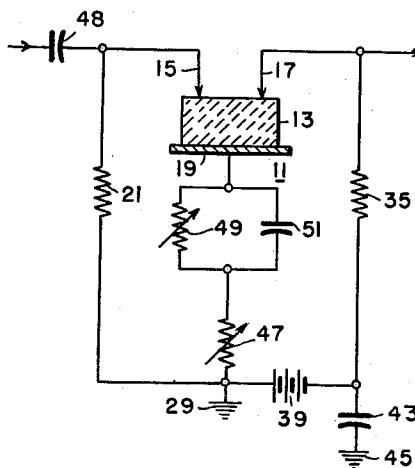


Fig.3.

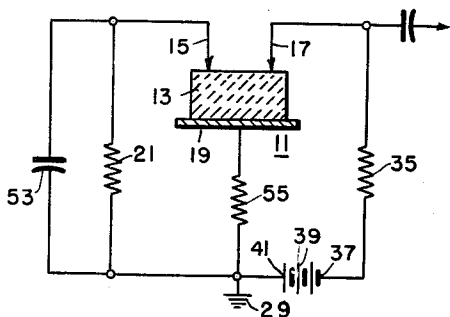
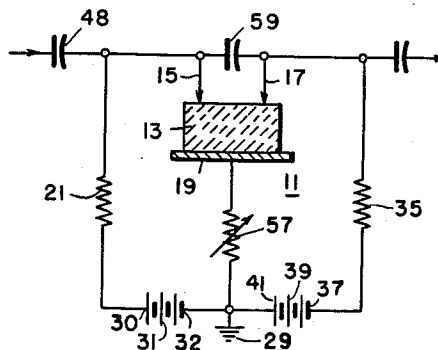


Fig.4.



WITNESSES:

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WAVE GENERATOR

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3 Claims. (Cl. 250—36)

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My invention relates to electronic circuits, and more particularly to electronic circuits of the type designed to generate various wave forms.

Wave-form generators in accordance with the prior art of which I am aware include electric discharge devices and their associated components such as cathode transformers. These generators are relatively complicated and bulky and their components are costly.

It is accordingly an object of my invention to provide a wave generator which is simpler and less costly than prior art apparatus for performing a similar function.

It is another object of my invention to provide a wave generator which shall require a minimum of circuit components.

It is an object of my invention to provide a pulse generator which is versatile in its operation.

Recent developments in the art of solid conduction have produced a device which can perform some of the functions of a vacuum tube. This device termed a "transistor" comprises a block of semi-conductive material, such as silicone or germanium, with which are associated three electrodes. Two of these electrodes, called the emitter and the collector, are conductive probes having relatively small contact areas, and are located near each other on one face of the semi-conductive block. The third electrode, called a base electrode, which is a conductor having a relatively large contact area, is placed contiguous to the opposite face of the semi-conductive block.

In accordance with my invention, I provide a wave generator circuit utilizing a transistor. A wave generator constructed in accordance with my invention is versatile in operation and is simple and compact in structure.

My invention together with additional objects and advantages thereof, will be best understood from the following description taken in connection with the accompanying drawing, in which:

Figure 1 is a schematic diagram showing a preferred embodiment of my invention,

Fig. 2 is a schematic diagram showing a modification of the embodiment of Fig. 1,

Fig. 3 is a schematic diagram of another embodiment of my invention, and

Fig. 4 is a schematic diagram showing a further embodiment of my invention.

In Fig. 1 there is shown a semi-conductive device which may be a transistor, indicated generally at 11. The transistor 11 comprises a block of semi-conductive material 13 which may be silicone or germanium and with which are associated

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emitter, collector and base electrodes 15, 17 and 19, respectively. The emitter and collector electrodes 15, 17 are pin-pointed conductive probes which are located in proximity to each other on one face of the semi-conductive block 13. The base electrode 19 is a plate of conductive material which is placed contiguous to the opposite face of the semi-conductive block. Positive bias is supplied to the emitter electrode 15 from a direct-current bias potential source indicated generally at 25. This bias potential source 25 may take any convenient form, but is preferably variable, and is shown as a battery 31 connected in shunt with a potentiometer 33. The emitter electrode 15 is connected through a first resistance 21 to the adjustable tap 23 of the potentiometer 33. The junction of the potentiometer 33 and the negative terminal 27 of the battery 31 is connected to ground at 29. The collector electrode 17 is connected through a second resistance 35 to the negative terminal 37 of a direct-current bias potential source which is shown as a battery 39, the positive terminal 41 of which is connected to ground at 29. The negative terminal 37 of said last mentioned bias potential source is connected through a by-pass capacitance 43 to ground at 45. The base electrode 19 is connected through a variable resistance 47 to ground at 29.

The circuit just described may be used to produce either continuous or keyed pulses of any desired width or repetition frequency within the fundamental transit time limitations of the transistor 11. The variable resistor 47 provides a positive feedback loop which causes oscillation when the feedback assumes a magnitude of sufficient value to be sustained. An increase of the magnitude of the variable resistance 47 beyond this critical magnitude will result in an increase in the repetition frequency. The pulse rise time is thought to be primarily an innate property of the semi-conductive material of the transistor. The decay time is thought to be primarily a function of the collector resistance and capacitance as well as the emitter collector capacitance. If it is desired to key the generator, the emitter bias is adjusted to a magnitude which blocks oscillation. Application of a keying pulse through a suitable coupling means, shown in Fig. 1 as a capacitor 43, to the emitter then allows oscillation for the time duration of the keying pulse. It is thus possible to produce groups of pulses at a selected repetition rate. Pulse repetition rates as high as 500 kilocycles are readily obtainable and higher rates are possible with reduced distributed capacitance. Pulses with a

rise time of 5 microseconds are readily produced, and by differentiation of the output pulses from the collector, one microsecond pulse can be obtained.

The circuit shown in Fig. 1 was found to operate satisfactorily using the following circuit constants: Emitter bias resistance, 470 ohms; collector bias resistance, 30,000 ohms; base electrode resistance, 450 ohms; emitter bias source potential, 0.7 volt; collector bias potential, 88 volts.

Fig. 2 shows a modification of Fig. 1 in which emitter self-bias is employed. In this modification, a second variable resistance 49 in shunt with a capacitance 51 is inserted between the first variable resistance 47 and the transistor base electrode 13. The battery potential source 25 is eliminated and the emitter electrode 15 is connected through the first resistance 21 to ground at 29. In practice, the magnitudes of 2000 ohms and 0.1 microfarad respectively has been used for the last mentioned resistance and capacitance.

Fig. 3 shows an embodiment of my invention in which the repetition frequency of the generated pulse is determined primarily by a resistance capacitance combination in the emitter circuit. In Fig. 3, the emitter electrode 15 of the transistor is connected through a first resistance 21 in shunt with a capacitance 53 to ground at 29. The collector electrode 17 is connected through a second resistance 35 to the negative terminal 37 of a direct-current bias potential source shown as a battery 39, the positive terminal 41 of which is connected to ground at 29. The base electrode 19 is connected through a third resistance 65 to ground at 29. The circuit shown in Fig. 3 produces pulses having very sharp leading edges, the rise times of which are dependent upon the magnitude of the emitter capacitance. At a repetition frequency of 500 kilocycles using a 50 micro-microfarad emitter capacitance, the rise time is of the order of .5 micro-second. The repetition may be varied by changing the magnitude of either the emitter bias resistance 21 or the emitter capacitance 53. In operation of the circuit of Fig. 3, the following circuit constants have been used and parameters noted: Emitter capacitance, 1 microfarad; emitter resistance, 10 megohms; collector resistance, 30,000 ohms; base electrode resistance, 40,000 ohms; collector bias battery potential, 56 volts; collector current, 3 milliamperes; repetition frequency about 1 cycle per second; pulse width approximately 10 micro-seconds.

The circuit shown in Fig. 4 is a further embodiment of my invention, in which I provide a novel and improved means of generating a saw tooth wave form. In this embodiment, a single transistor 11 is utilized to produce a saw tooth wave form, whereas two or more vacuum tubes are commonly used in such generators of the prior art. In Fig. 4, the emitter electrode 15 is connected through a first resistance 21 to the positive terminal 30 of a direct-current bias potential source shown as a battery 31, the negative terminal 32 of which is connected to ground at 29. The collector electrode 17 is connected through a second resistance 35 to the negative terminal 37 of a direct-current bias potential source shown as a battery 39, the positive terminal 41 of which is connected to ground at 29. The base electrode 19 is connected to a variable resistance 57 to ground at 29. A capacitance 59 is

connected between the emitter and collector electrodes 15, 17.

In practice, the variable resistance 57 is adjusted to a magnitude which will provide sufficient feedback for oscillation with an appropriate emitter bias voltage. The frequency of oscillation may be varied by changing the magnitude of the capacitor 59 which is connected between the emitter and collector electrodes 15, 17. The magnitude of said last mentioned capacitor 59 may be chosen so as to get a pulse rise time as small as $\frac{1}{10}$ microsecond. If a triggered or synchronized wave is desired, it may be obtained by adjusting the emitter bias so that the circuit is no longer free running and applying synchronizing pulses through a suitable coupling means shown in Fig. 4 as a capacitance 48 to the emitter electrode 15. By means of a differentiating circuit, very sharp pulses may be obtained due to the inherent small raise time of the wave form. Proper adjustment of the variable resistance 57 and the emitter-collector capacitance 59 in combination will provide improved linearity.

The circuit of Fig. 4 has been found to operate well using the following circuit constants: Emitter bias resistance, 470 ohms; collector bias resistance, 30,000 ohms; base electrode variable resistance, 1,400 ohms; emitter collector capacitance, 0.007 microfarad. With these constants the repetition frequency was 3 kilocycles, the collector current 2.4 milliamperes and the emitter current 1.5 milliamperes.

While I have shown certain specific embodiments of my invention, I am aware that certain modifications could be made without departing from the scope of my invention. I desire, therefore, to be limited only insofar as is necessitated by the prior art and the spirit of the appended claims.

I claim as my invention:

1. A circuit for generating a saw tooth wave form including a device of the semi-conductive type having emitter, collector, and base electrodes, a first resistance connected from said emitter electrode to the positive terminal of a first direct-current potential source, the negative terminal of which is connected to ground, a second resistor connected from said collector electrode to the negative terminal of a second direct-current potential source, the positive electrode of which is connected to ground, a feedback resistance connected between said base electrode and ground, and a capacitance connected between said emitter and collector electrodes.

2. A circuit for generating a saw tooth wave form including a device of the semi-conductive type having emitter, collector, and base electrodes, a first resistance connected from said emitter electrode to the positive terminal of a first direct-current potential source, the negative terminal of which is connected to ground, a second resistor connected from said collector electrode to the negative terminal of a second direct-current potential source, the positive electrode of which is connected to ground, a variable feedback resistance connected between said base electrode and ground, a capacitance connected between said emitter and collector electrodes, and means for coupling a source of synchronizing signals to said emitter electrode.

3. A pulse generator comprising a transistor having emitter, collector, and base electrodes, an external network interconnecting said electrodes, said network including a first path extending from the collector electrode to the emit-

ter electrode by way of which collector output power is fed back to the emitter, and a second path common to the emitter and collector electrode circuits by way of which collector output power is fed back to the emitter, said first path comprising a capacitor connected between said collector and emitter electrodes, and said second path comprising a feedback resistor connected between said base electrode and a terminal which is common to the emitter and collector electrode circuits.

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