

PATENT SPECIFICATION

DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

Transistor Blocking Oscillator.

We, RADIO CORPORATION OF AMERICA, a Corporation organized under the laws of the State of Delaware, United States of America, of 30, Rockefeller Plaza, City and State of New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a transistor blocking oscillator.

In a transistor blocking oscillator, a transistor is switched successively between conductive and nonconductive states, the duration of the nonconductive state being controlled principally as a function of the time constant of a resistance-capacitance circuit. Typically, the capacitance is coupled between the input (e.g. base and emitter) terminals of the transistor while the resistance is returned to a suitable voltage source. The transistor is switched on when the voltage across the capacitance (i.e., base to emitter voltage) reaches the base-emitter diode conduction voltage for the particular transistor. This conduction voltage varies inversely with temperature, a lesser voltage being required to switch the transistor to an "on" or forwardly conductive state as ambient temperature increases. Consequently, the transistor "off" time and cycle duration decrease as temperature increases. The frequency of operation of the blocking oscillator therefore tends to vary directly with temperature.

The present invention is useful in a variety of applications. It is particularly suitable for use in connection with the horizontal deflection circuit of a transistor television receiver, an application wherein the frequency of

oscillation of the blocking oscillator should be maintained relatively constant.

An object of the present invention is to provide a transistor blocking oscillator wherein means are provided for decreasing substantially the effects of ambient temperature variations upon the oscillation frequency.

It is another object of the present invention to provide a transistor blocking oscillator wherein means are provided for decreasing substantially the effect upon the oscillator frequency of variations in transistor turn-on voltage caused by variations in ambient temperature.

In accordance with the present invention there is provided a transistor blocking oscillator for producing regularly recurring output pulses comprising a transistor having a base-emitter circuit including the series connection, of a secondary winding of a feedback transformer of which the primary winding is connected in the collector circuit of the transistor, a charging capacitor and an inductor serving together with said charging capacitor to determine the duration of said pulses, wherein the base is connected through a first resistor to the junction of a temperature-dependent resistor and a substantially fixed value second resistor connected in series across a voltage supply source, whereby the inter-pulse period of said output pulses is maintained substantially constant at a value depending upon said first resistor and charging capacitor throughout the operating range of ambient temperatures.

Referring to the accompanying drawing:

Figure 1 is a horizontal deflection waveform generating circuit of a television receiver including an embodiment of transistor

[Price 4s. 6d.]

blocking oscillator constructed in accordance with the present invention; and

Figure 2 is a simplified waveform diagram (not drawn to scale) illustrating the operation of the oscillator compensation.

Referring to Figure 1, the oscillator comprises a transistor 10 having its emitter electrode 10e grounded, while the collector electrode 10c is coupled to a suitable positive voltage supply (e.g. +30V) by means of the series combination of a primary winding 11a of a three winding transformer 11 and dropping resistors 12 and 13. Capacitors 14 and 15 bypass resistors 12 and 13, respectively, to ground. The emitter-collector circuit is regeneratively coupled to the base-emitter circuit of the transistor by means of feedback winding 11b inductively associated with primary winding 11a and having one end coupled to base electrode 10b. The other end of feedback winding 11b is coupled to the series combination of: (1) a series resonant circuit 16 essentially comprising a capacitor 17 and an inductor 18; and (2) a parallel resonant circuit 19 comprising a capacitor 20 and an inductor 21. The parallel resonant circuit 19 is returned to ground by means of a capacitor 22, the junction of resonant circuit 19 and capacitor 22 being coupled to a source of automatic frequency control (AFC) voltage (not shown). An AFC voltage developed across capacitor 22 is direct coupled by means of a resistor 38, resistor 28 and winding 11b to base electrode 10b of transistor 10. A switching capacitor 23 and a damping resistor 24 each are coupled in parallel with inductor 18, the capacitor to provide a low-impedance shunt for the inductor and thus assisting a rapid rise of the output pulse, and the resistor for damping any oscillation set up in the parallel combination of inductor and capacitor.

A temperature responsive voltage divider circuit 25 comprising the series combination of a resistor 26 and a temperature dependent resistor or thermistor 27 having a negative temperature coefficient of resistance is coupled from the junction of resistor 13 and primary winding 11a to ground.

Capacitor 17 is coupled by means of the series combination of a resistor 28 and a frequency controlling variable potentiometer, or "hold" control 29 to a variable positive potential developed at the point 9 which is at the junction of resistor 26 and thermistor 27.

A damping circuit comprising the series combination of a resistor 30 and a diode 31 is coupled across primary winding 11a.

The output signal produced across primary winding 11a is coupled by means of a third winding 11c of transformer 11 and a resistance-capacitance coupling circuit 32 to a transistor amplifier 33. The coupling

circuit 32 and the transistor amplifier 33 comprise a portion of a horizontal driver circuit 34 of the television receiver. An amplified output produced by driver circuit 34 is coupled to a horizontal output stage 35, the output stage 35 being coupled in turn to a horizontal deflection winding 36 associated with an image-reproducing kinescope 37.

In operation, the transistor 10 periodically is rendered highly conductive and substantially non-conductive according to predetermined variations in the energy stored in the components comprising series resonant circuit 16 and parallel resonant circuit 19. Operation commences when a positive voltage exceeding the base-emitter conduction, or turn-on, voltage of transistor 10 is applied to base electrode 10b. The positive voltage may be developed, for example, as a result of the charging of the capacitors 17, 20 and 22 from the voltage supply (+30V). The positive base-emitter voltage so developed and applied to transistor 10, in conjunction with the positive voltage applied to collector 10c by means of the voltage supply (+30V), initiates conduction in both the base-emitter (input) and collector-emitter (output) circuits of transistor 10. The base-emitter current increases rapidly, causing the collector-emitter current to increase in a similar manner. The increasing collector-emitter current causes the collector voltage to drop rapidly, the change in collector voltage being inverted and regeneratively coupled via windings 11a and 11b of transformer 11 to base electrode 10b such that transistor 10 is driven rapidly into a saturation conduction state. After the initial surge of base current drives transistor 10 into saturation, the base current varies in a substantially half-sinusoidal manner, the frequency of the current variation being determined principally by the resonant frequency of series resonant circuit 16. When the base current decreases sufficiently after having passed through approximately one-half cycle of oscillation, transistor 10 is driven out of saturation, causing the collector current to decrease and the collector voltage to increase. The change in collector voltage is coupled regeneratively to base electrode 10b via transformer 11, rapidly cutting off conduction in transistor 10. A voltage pulse having a duration determined substantially by the oscillation frequency of series resonant circuit 16 has therefore been produced at collector electrode 10c. The voltage at collector electrode 10c then remains substantially constant at a positive level slightly less than the voltage supply (+30V) throughout the non-conductive or "off" portion of the blocking oscillator cycle.

During the "off" portion of the cycle, the voltage at base electrode 10b, which was

driven sharply negative as the collector voltage increased, increases from the attained negative level in a substantially exponential manner, the exponential voltage being modified by a sinusoidal voltage variation appearing across parallel resonant circuit 19. The exponential voltage variation is produced by the discharge of capacitor 17 through the series combination of resistor 28 and hold control 29 towards the positive potential existing at the point 9, namely at the junction of resistor 26 and thermistor 27.

Transistor 10 is switched "on" or returned to a conductive state to start a new oscillation cycle when the voltage at base 10b (supplied by capacitor 17) passes through the base-emitter diode conduction or turn-on voltage required for transistor 10. The sinusoidal voltage component attributable to parallel resonant circuit 19 serves to cause the voltage at base electrode 10b to rise sharply through the turn-on voltage for transistor 10. The cycle described above is repeated at an appropriate rate (e.g. 15,750 cycles per second) to provide voltage pulses at the television horizontal scanning frequency.

The output pulse waveform produced at collector electrode 10c is applied via winding 11c and coupling circuit 32 to transistor amplifier 33. An amplified pulse output produced by amplifier 33 is coupled to horizontal output stage 35. Output stage 35, in response to the applied pulse waveform, supplies to horizontal deflection winding 36 a substantially sawtooth current waveform to deflect an electron beam across the face or screen of kinescope 37 in a recurring pattern.

A direct voltage supplied by an AFC circuit (not shown) is developed across capacitor 22 and coupled via resistors 38 and 28 to base electrode 10b to maintain the operation of the blocking oscillator substantially in synchronism with the synchronizing signal component of the composite television signal being processed by the remainder (not shown) of the television receiver.

The waveform contribution of the parallel tuned circuit 19 substantially decreases the effect upon the blocking oscillator operating frequency of variations in component parameters and supply voltage. However, variations in ambient temperature produce additional uncompensated variations in the blocking oscillator frequency.

Specifically, as noted above, the base-emitter turn-on voltage of transistor 10 varies inversely with temperature. Referring to Figure 2, the effect of ambient temperature variations upon the transistor turn-on voltage and upon oscillator frequency may be illustrated in the following manner. Since

such variation with temperature may be applied either to the embodiment illustrated in Figure 1 or to blocking oscillators which do not include the parallel resonant circuit 19, the description which follows and the waveforms shown in Figure 2 will not include any reference to the effect of resonant circuit 19.

In Figure 2, voltage is represented along the ordinate and time along the abscissa. The waveform labelled T_1 illustrates the exponential base-emitter voltage (approximating a linear waveform) applied to transistor 10 at a given ambient temperature T_1 . The base-emitter turn-on voltage for transistor 10 at the ambient temperature T_1 is indicated by the voltage V_{B1} . The corresponding non-conductive portion (the interpulse period) of the blocking oscillator cycle is indicated by the designation T_{off} . A decrease in ambient temperature produces an increase in the turn-on voltage for transistor 10, for example, to the voltage V_{B0} . In the absence of the temperature-responsive voltage divider circuit 25, the non-conductive portion of the blocking oscillator cycle then would increase by an amount $+\Delta t_{off}$, as shown. Consequently, the oscillation frequency would decrease. Similarly, an increase in ambient temperature would produce a decrease in transistor turn-on voltage, a decrease in blocking oscillator "off" time and an increase in oscillator frequency.

The hold control potentiometer 29 is coupled to temperature-responsive voltage divider circuit 25 in a manner such that the voltage towards which capacitor 17 discharges varies with temperature in the same sense or direction as the base-emitter turn-on voltage for transistor 10 varies.

Thermistor 27 exhibits a negative temperature coefficient of resistance. That is, as the ambient temperature increases (e.g. from T_1 to T_2), the resistance of thermistor 27 decreases, producing a decrease in the positive voltage appearing at the point 9. As is shown in Figure 2, the slope of the base-emitter waveform applied to transistor 10 (i.e. the discharge waveform of capacitor 17) then decreases such that the transistor turn-on voltage V_{B2} required at an ambient temperature T_2 is reached in the time interval T_{off} .

Similarly, as the ambient temperature decreases (from T_1 to T_0) the resistance of thermistor 27 increases, producing an increase in the positive voltage at point 9 towards which capacitor 17 discharges. The turn-on voltage V_{B0} is therefore reached in the same time interval T_{off} .

The thermistor 27 and fixed resistor 26 are selected and proportioned such that the effect of the change in transistor turn-on voltage is substantially nullified by the change in the voltage across thermistor 27.

Furthermore, resistor 26 is selected to have a substantially lower resistance value than thermistor 27 so that, as temperature changes, substantially no change takes place in the effective discharging resistance in series with capacitor 17. The time constant associated with the discharge of capacitor 17 therefore remains substantially constant.

In a preferred example of the circuit of Figure 1, which is applicable to television receivers, the circuit components may have the following values:—

	transistor 10	...	RCA Type 2N3568
	resistor 12	...	3,900 ohms
15	resistor 13	...	220 ohms
	capacitor 14	...	100 microfarads
	capacitor 15	...	250 microfarads
	capacitor 17	...	.0068 microfarads
20	inductor 18	...	1—3 millihenries (adjustable)
	capacitor 20	...	.047 microfarads
	inductor 21	...	1—3 millihenries (adjustable)
	capacitor 22	...	.022 microfarads
25	capacitor 23	...	820 picofarads
	resistor 24	...	1,800 ohms
	resistor 26	...	820 ohms
	thermistor 27	...	50,000 ohms at 25°C
30	resistor 28	...	3,900 ohms
	potentiometer 29	...	12,000 ohms (adjustable)
	resistor 30	...	560 ohms
	diode 31	...	Type 1N60
35	resistor 38	...	10,000 ohms

WHAT WE CLAIM IS:—

1. A transistor blocking oscillator for producing regularly recurring output pulses

comprising a transistor having a base-emitter circuit including the series connection, of a secondary winding of a feedback transformer of which the primary winding is connected in the collector circuit of the transistor, a charging capacitor and an inductor serving together with said charging capacitor to determine the duration of said pulses, wherein the base is connected through a first resistor to the junction of a temperature-dependent resistor and a substantially fixed value second resistor connected in series across a voltage supply source, whereby the interpulse period of said output pulses is maintained substantially constant at a value depending upon said first resistor and charging capacitor throughout the operating range of ambient temperatures.

2. A transistor blocking oscillator according to claim 1 wherein a further capacitor is connected in parallel with said inductor for providing a rapid rise in said output pulses.

3. A transistor blocking oscillator according to claim 1 wherein a parallel connected inductor-capacitor combinations is also connected in series with said base-emitter circuit for causing the voltage at the base electrode of said transistor to rise sharply through the turn-on voltage for said transistor.

4. A blocking oscillator substantially as herein described with reference to Figure 1 of the drawings.

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