



TUNNEL-DIODE DELAY-LINE OSCILLATOR

by

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A FEW YEARS AGO a wide-range oscillator using a vacuum triode and a variable delay line was described in *The General Radio Experimenter*¹. That oscillator is shown in Fig. 1 while a similar one, using a tunnel diode as the active element, appears in Fig. 2. This circuit is a variation of the "series-parallel" oscillator described by Gottlieb,² with the tank circuit replaced by a shorted delay line.

The supply voltage and resistors serve to bias the tunnel diode into the negative-resistance region of its current-voltage characteristic as shown in Fig. 3. Here's how the circuit works:

A voltage step occurs when the tunnel diode switches from its low-voltage state to its high-voltage state. The voltage step propagates down the delay line and

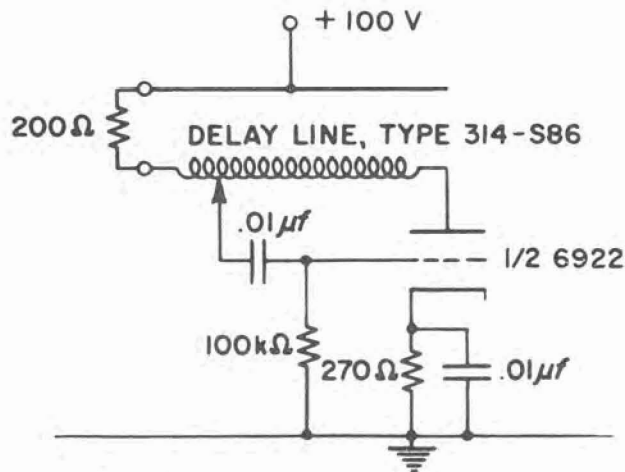


Fig. 1. This triode oscillator uses a delay line as the feedback element.

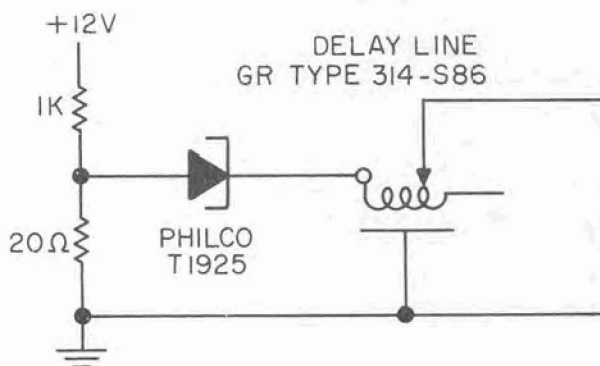


Fig. 2. The tunnel-diode delay-line oscillator.

is reflected back in opposite polarity by the short circuit. When the reflected step reaches the tunnel diode, it makes the diode reverse state, generating a new voltage step which travels again down the delay line and the process repeats.

Fig. 4 show voltage and current waveforms at the input of the delay line for oscillation frequencies of 1 mc and 5 mc. The waveforms suggest the operating path shown in Fig. 3. Due to the on-off nature of the oscillations, the voltage amplitude is fairly constant over the entire frequency range and the frequency is quite stable, since it depends primarily on the delay line and is relatively independent of the diode characteristics.

Since an opposite voltage transition occurs for each round trip of the delay line, the oscillation period is equal to four times the delay setting. The circuit shown, using a General Radio Type 314-S86 Variable Delay Line³ (0 to 0.5μsec), oscillates readily from

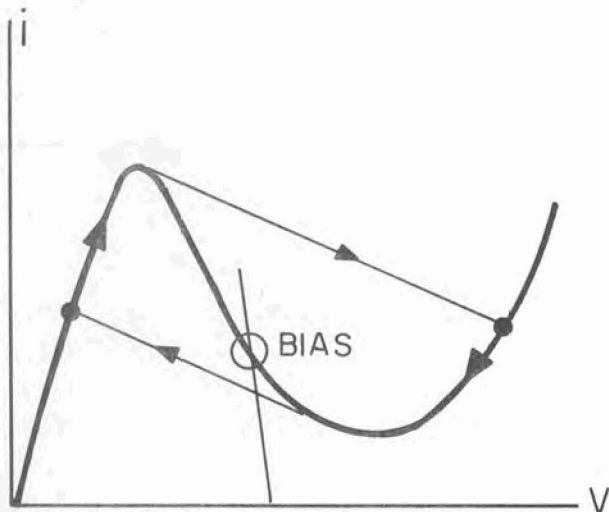


Fig. 3. The current-voltage characteristics of the tunnel diode with the operating path for the oscillator of Fig. 2.

0.5 mc up to about 20 mc. The upper end of the frequency range is quite crowded because of the hyperbolic relationship between frequency and the shaft rotation of the linear delay line ($f = 1/4T$). Up to about 10 mc, operation is smooth and uniform. Other delay lines and tunnel diodes can, of course, be used. Oscillations in the 100 mc region have been obtained by using sections of shorted transmission line in place of the delay line.

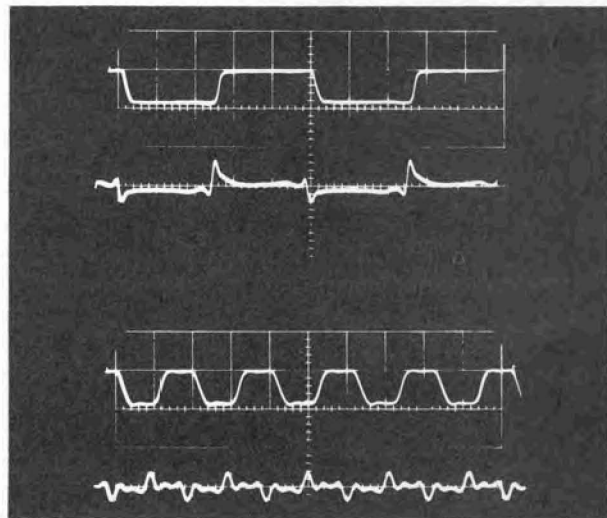


Fig. 4. Voltage and current waveforms at the delay-line input of the tunnel-diode oscillator. The upper oscillogram is for 1 mc oscillation while the lower is for 5 mc. Voltages are shown in the upper halves of each oscillogram on a scale of 0.5 v/cm. Currents are shown at 1 ma/cm. The time scale for the upper oscillogram is 0.2 μ sec/cm, while it is 0.1 μ sec/cm for the lower oscillogram.

References

1. Harold T. McAleer, "Delay-Line Oscillator," *General Radio Experimenter*, Vol. 33, no. 11, p 11, November, 1959.
2. Erich Gottlieb, "Tunnel-Diode Sinewave Oscillators," *Application Note 90.33*, General Electric Company, Syracuse, New York, 1961.
3. F. D. Lewis and R. M. Frazier, "A New Type of Variable Delay Line," *General Radio Experimenter*, Vol. 31, no. 5, October, 1956.

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