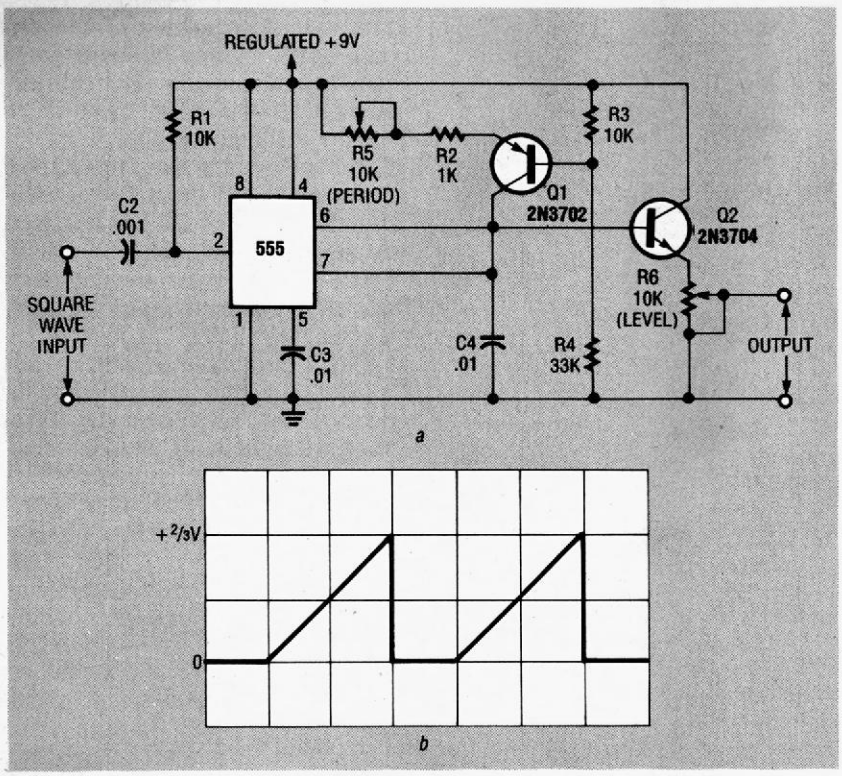

FIG. 3—LINEAR SAWTOOTH OR RAMP waveform generator based on the 555, a, and "ramp" waveform, b.

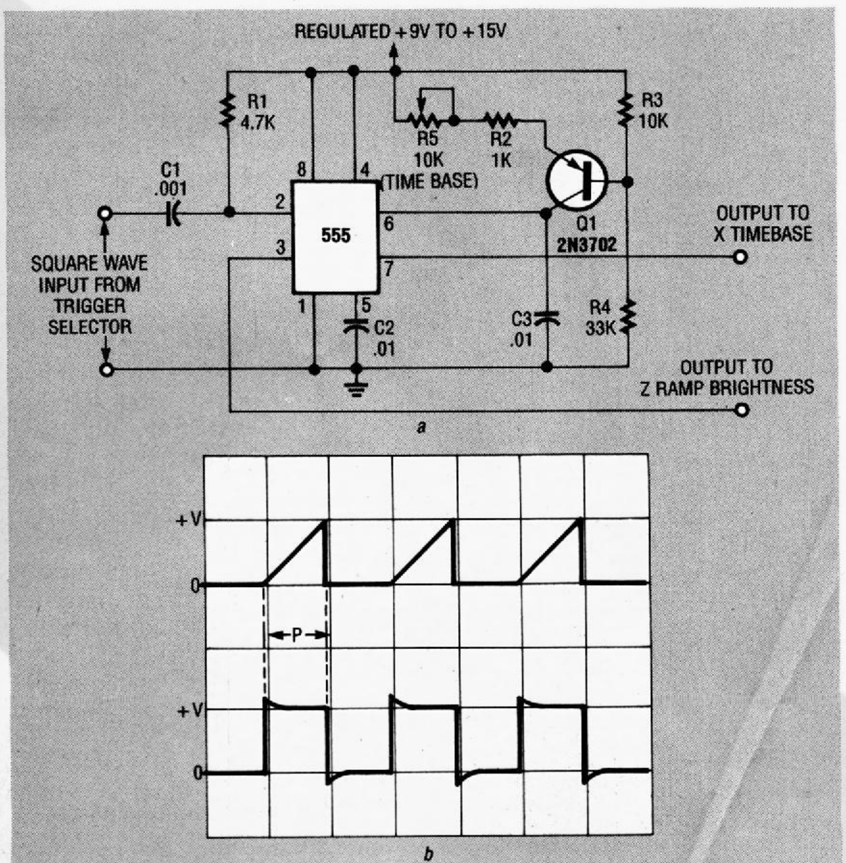

FIG. 4—OSCILLOSCOPE TIME-BASE GENERATOR circuit based on the 555, a, and ramp and ramp brightness pulse waveforms for an oscilloscope's X and Z axes.

monostable multivibrator that is triggered by an external square wave TRIGGER pin 2 obtained through capacitor C2 from the collector of transistor Q1. Note that OUTPUT pin 3 of the 555, used in most of the 555-based circuits presented earlier is unused here.

The voltage across C4 (the timing component) is normally zero, but whenever the circuit is triggered, C4 charges exponentially through resistor R5 and PERIOD potentiometer R6 to two-thirds of the supply voltage. At that time, the monostable period ends and the voltage across C4 drops abruptly to zero. The output sawtooth waveform (Fig. 2-b) is taken across capacitor C4 through buffer transistors Q2 and Q3 and LEVEL potentiometer R7.

The period of the sawtooth or width can be varied from 9 microseconds to 1.2 seconds with the capacitance values for C4 listed in Table 1. The circuit's maximum usable repetition frequency is approximately 100 kHz.

The generator must be triggered by rectangular input waveforms with short rise and fall times. Potentiometer R6 controls the sawtooth period over a decade, and potentiometer R7 controls the amplitude of the output waveform.

Figure 3-a shows a triggered linear sawtooth or *ramp* waveform generator. Capacitor C4 is charged by a constant-current generator that includes Q1. The output waveform (Fig. 3-b) is taken at the wiper of LEVEL potentiometer R6, which is coupled to the voltage across C4 through Q2. Note that the curved ramps of Fig. 2-b have been flattened.

When a capacitor is charged from a constant current source, its voltage rises at a predictable linear rate that can be expressed as:

Volts/second = amperes/farad

By introducing more practical values, alternative expressions for the rate of voltage rise are:

V/μs = A/μF, or

V/ms = mA/μF

Those formulas state that voltage rate-of-rise can be in-

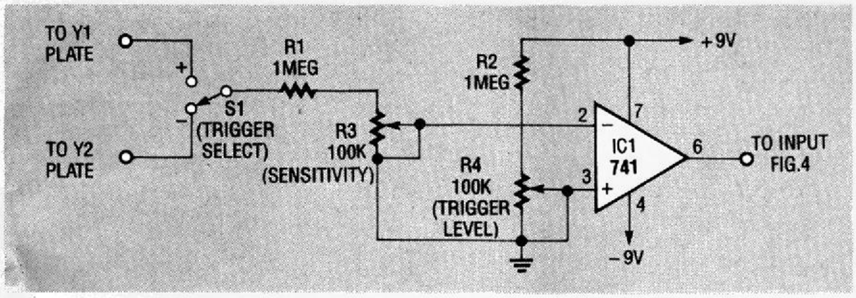

FIG. 5—TRIGGER SELECTION CIRCUIT for the Fig. 4 circuit

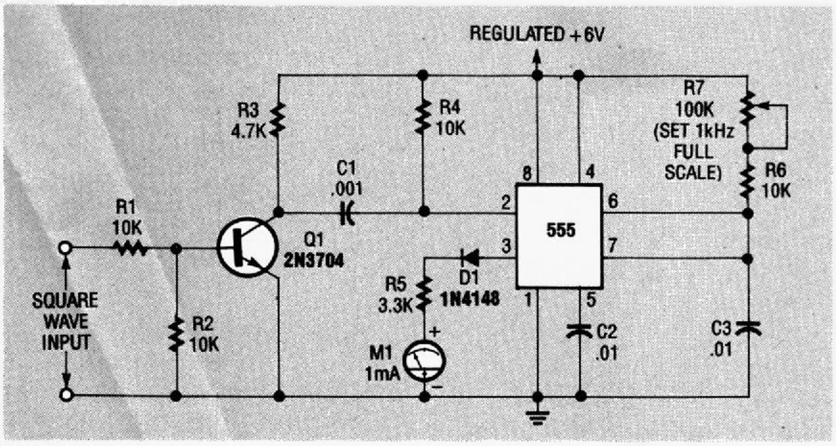

FIG. 6—A 1-kHz LINEAR-SCALE ANALOG FREQUENCY meter circuit based on the 555.

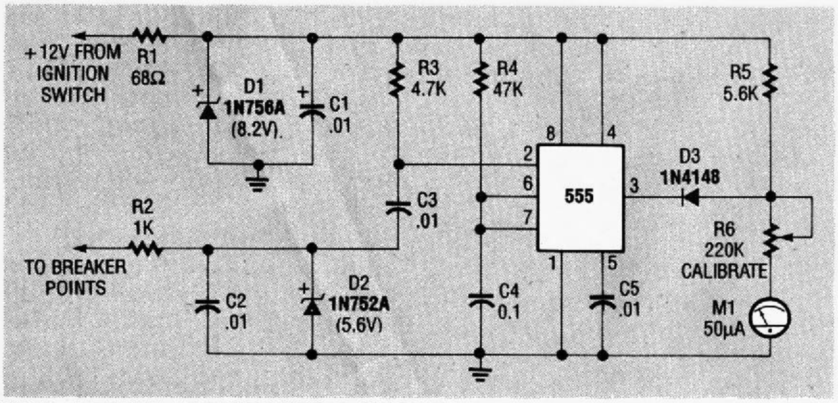

FIG. 7—VEHICULAR TACHOMETER CIRCUIT based on the 555.

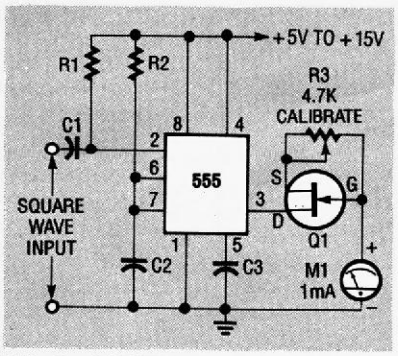

FIG. 8—ALTERNATIVE ANALOG TACHOMETER CIRCUIT to Fig. 6.

creased either by increasing the charging current or by decreasing the capacitance value.

The charging current in the Fig. 3-a circuit can be varied over the range of about 90 microamperes to 1 milliampere with PERIOD potentiometer R5, thus giving the 0.01 microfarad timing capacitor rates-of-rise of 9 volts per millisecond to 100 volts per millisecond.

Each one-shot or monostable cycle of the 555 ends when the voltage across C4 reaches two-thirds of the supply voltage. As shown in Fig. 3-a, the supply is 9 volts, so two-thirds of 9 volts is 6 volts, the amplitude of the ramp waveforms in Fig. 3-b. The sawtooth cycles of the circuit have periods variable from 666 microseconds (2/3 millisecond) to 60 microseconds (6/100 millisecond).

Periods can be increased beyond those values by increasing the value of C4, or reduced by reducing the value of C4. In this circuit, stable timing periods depend on a stable voltage source.

Fig. 4-a shows how the circuit in Fig. 3-a can be modified to become an oscilloscope timebase generator. It can be triggered by external square waves through a suitable trigger selector circuit. The *ramp* output waveform (top of Fig. 4-b is fed to the X plates of an oscilloscope with a suitable amplifier stage. The pulsed OUTPUT from pin 3 of the 555 (shown in the lower half of Fig. 4-b) is fed to the CRT's Z axis to trace the ramps with higher brightness.

The shortest useful ramp period that can be obtained from the circuit in Fig. 4-a (with a 0.001 microfarad capacitor C3) is about 5 microseconds. That value, when expanded to give full deflection on an oscilloscope with a ten-division graticule, yields a maximum timebase rate of 0.5 microsecond per division.

The timebase circuit of Fig. 4-a can synchronize signals at trigger frequencies up to about 150 KHz. At higher frequencies, the input signals must be divided by a single- or multi-decade frequency divider. With that approach, the timebase can be used to view input signals at megahertz frequencies.

Figure 5 illustrates a simple but versatile trigger selector circuit for the timebase generator in Fig. 4-a. Operational amplifier IC1 (a µA741) has a reference voltage fed to its non-inverting input pin 3 by TRIGGER LEVEL potentiometer R4. The signal voltage is then fed to IC1's inverting pin 2 through switch S1, resistor R1 and SENSITIVY potentiometer R3.

Switch S1 selects either in-phase or out-of-phase input signals from the Y-driving amplifier of the oscilloscope, permit-