ting the selection of either the plus or minus trigger modes. The output of the circuit in Fig. 5 is coupled directly to the C1 input of Fig. 4.

Analog frequency meters

Figure 6 shows the 555 IC organized as a linear-scale analog frequency meter with a full-scale sensitivity of 1 kHz. The circuit's power is obtained from a regulated 6-volt supply, and its input signals can be pulses or square-wave signals with peak-to-peak amplitudes of 2 volts or greater. Transistor Q1 amplifies this input signal enough to trigger the 555. The output from pin 3 is fed to the 1-milliampere full-scale deflection moving-coil meter M1 through offset-canceling diode D1 and multiplier resistor R5.

Each time the monostable multivibrator is triggered, it generates a pulse with a fixed duration and amplitude. If each generated pulse has a peak amplitude of 6 volts and a period of 1 millisecond, and the multivibrator is triggered at an input frequency of 500 Hz, the pulse will be high (at 6 volts) for 500 milliseconds in each 1000 milliseconds. Moreover, the *mean* value of output voltage measured over this period is 500 milliseconds/1000 milliseconds × 6 volts = 3 volts or half of 6 volts.

Similarly, if the input frequency is 250 Hz, the pulse is high for 250 milliseconds in each 1000-millisecond period. Therefore, the mean output voltage equals 250 milliseconds/ 1000 milliseconds × 6 volts = 1.5 volts or one quarter of 6 volts. Thus, the circuit's mean value of output voltage, measured over a reasonable total number of pulses, is directly proportional to the repetition frequency of the monostable multivibrator.

Moving-coil meters give *mean* readings. In the circuit of Fig. 6 a 1-milliampere meter is connected in series with multiplier resistor R5, which sets meter's sensitivity at about 3.4 volts full-scale deflection. The meter is connected to give the mean output value of the multi-

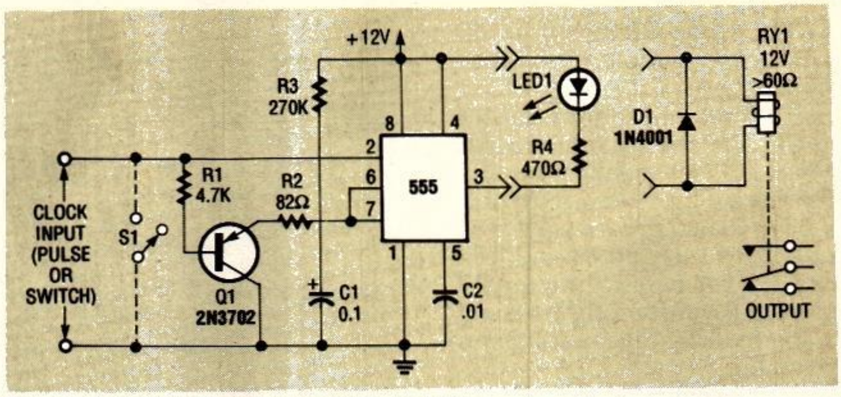

FIG. 9—MISSING-PULSE DETECTOR with LED or relay output.

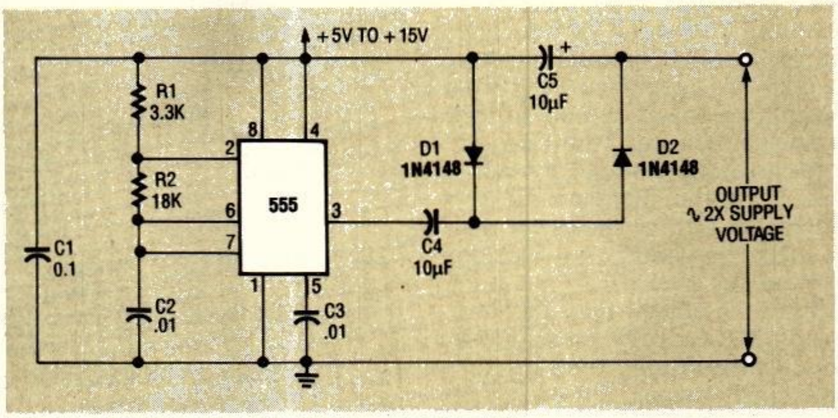

FIG. 10—DC VOLTAGE-DOUBLER based on the 555.

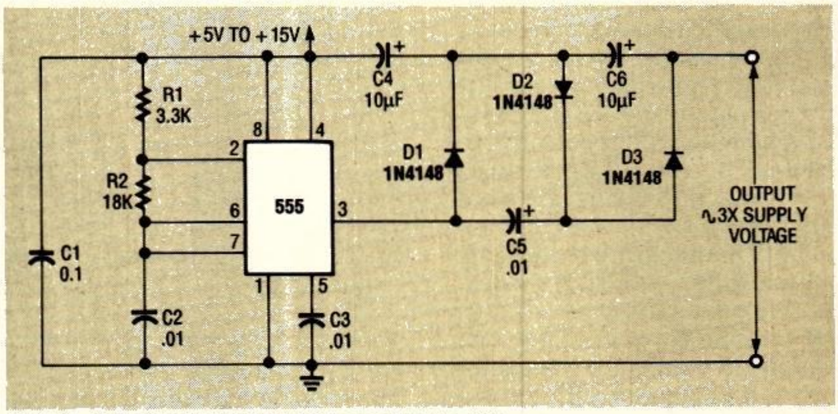

FIG. 11—DC VOLTAGE-TRIPLER based on the 555.

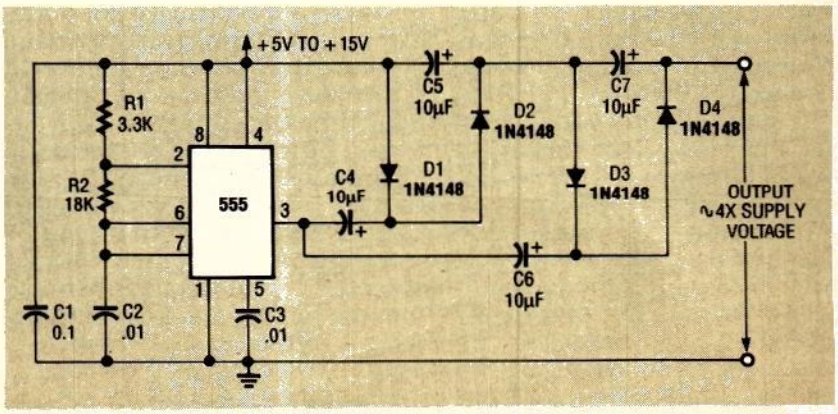

FIG. 12—DC VOLTAGE-QUADRUPLER based on the 555.

vibrator, and its reading is directly proportional to the input frequency.

With the component values shown, the circuit is organized to read full-scale deflection at 1 kHz. To set up the circuit initially, a 1-kHz square-wave signal is fed to its input, and full-scale-adjust potentiometer R7 (it controls pulse length) is set to give a full-scale reading on the meter.

The full-scale frequency of the circuit in Fig. 6 can be varied from about 100 Hz to 100 kHz by selecting the value of C3. The circuit can read frequencies up to tens of megahertz by introducing the input signals to the monostable multivibrator through either a single or multidecade digital divider. The dividers can reduce the input frequencies to values that can be read on the meter.

Figure 7 shows how the circuit in Fig. 6 can be modified to become an analog tachometer or revolutions per minute (rpm) meter for motor vehicles. The circuit is powered by a regulated 8.2 volts derived from the vehicle's 12-volt battery with resistor R1, Zener diode D1, capacitor C1, and the ignition switch. The 555 is triggered by a signal from the vehicle's breaker points conditioned by the network of resistor R2, capacitor C2, and Zener diode D2.

The 50-microampere moving-coil meter M1, the rpm indicator, is activated from OUTPUT pin 3 of the 555 through diode D3. Current is applied to the meter through series-connected resistor R5 and CALIBRATE potentiometer R6 from the power supply when the 555's output is high. But current is dropped nearly to zero by diode D1 when the 555's output is low.

Both the circuits of Figures 6 and 7 are powered from regulated sources to ensure a constant pulse amplitude and provide accurate, repeatable readings from the meter. The meter is actually a current-indicating device, but it is connected as a voltage-reading meter with suitable *multiplying* resistors. They are R6 and R7 in Fig. 6 and R5 and R6 in Fig. 7.

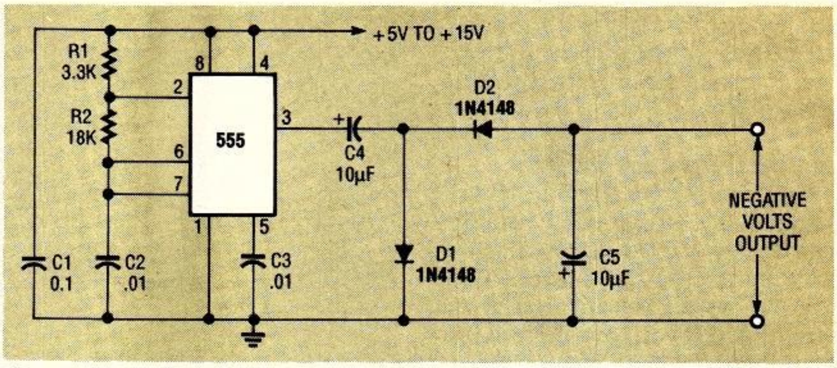

FIG. 13—DC NEGATIVE-VOLTAGE GENERATOR based on the 555.

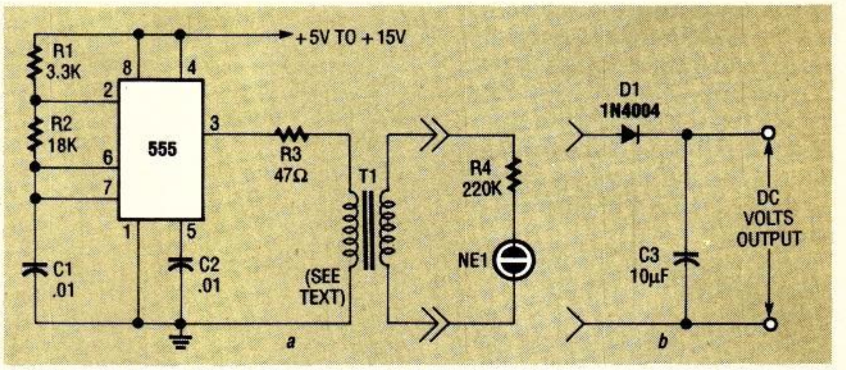

FIG. 14—NEON-LAMP DRIVER based on the 555, a, and DC-to-DC converter with rectifier and filter replacing lamp, b.

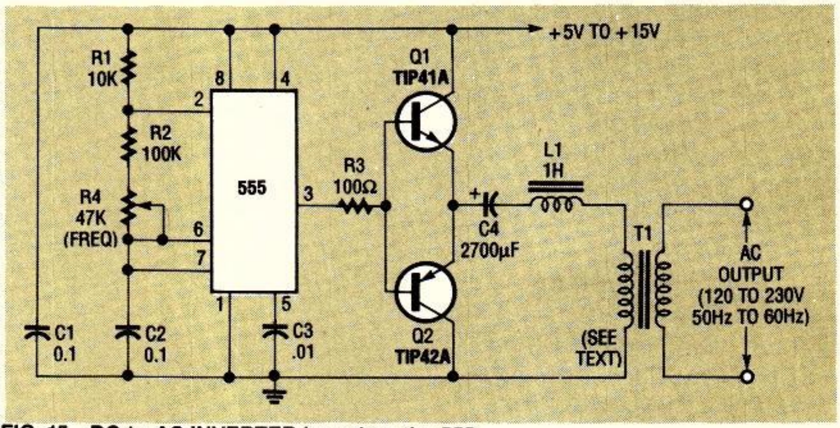

FIG. 15—DC-to-AC INVERTER based on the 555.

The diagram of Fig. 8 shows the outline schematic for an alternative analog frequency meter that requires neither a multiplier resistor nor a regulated power supply. In this circuit, OUTPUT pin 3 of the 555 is connected to the meter through JFET transistor Q1. Configued as a constant-current generator through potentiometer R3, it sends a fixed-amplitude pulse to the meter regardless of variations in the supply voltage.

Missing-pulse detector

Figure 9 illustrates how the 555 can become the key component in a *missing-pulse detector* that closes a relay or illuminates a LED if a normally expected event fails to occur. The 555 is connected as a monostable multivibrator except that Q1 is placed across timing capacitor C1, and its base is connected to TRIGGER pin 2 of the IC through R1.

A series of short pulse- or switch-derived clock input signals from the monitored event is sent to pin 2. The values of R3 and C1 were selected so that the natural monostable period of