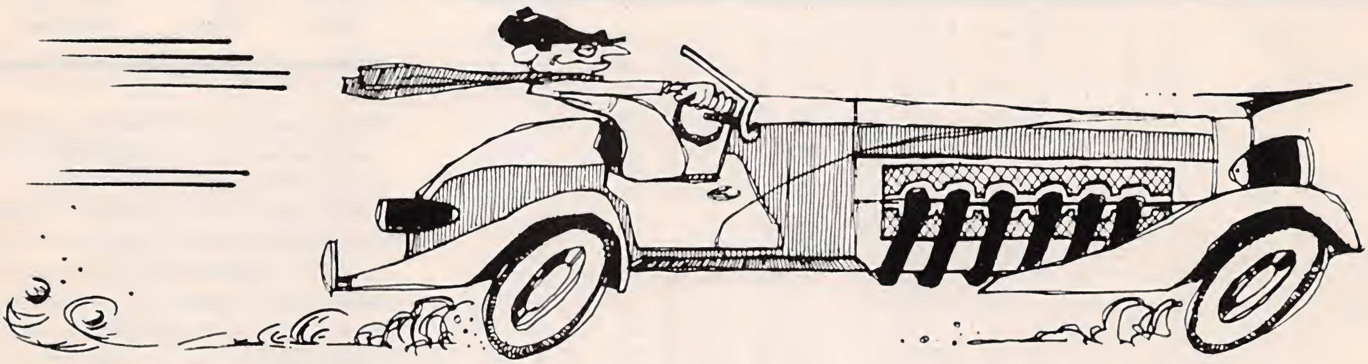
BY ROBERT P. BISEY

BUILD "CRUISEALERT" A 55 MPH SPEED-LIMIT ALARM



Automobile add-on device for highway safety

TO STAY within the 55-mph national highway speed limit, one must keep one eye on the road and the other on the speedometer. This can be a dangerous situation at highway speeds when your whole attention should be fixed on the road. It would be far safer, therefore, if you could keep a constant eye on the road and have some audible means for alerting you when you have exceeded the speed limit. This is exactly what the "Cruisealert" described here was designed to do.

The Cruisealert works on the principal that, with a given vehicle, there is a close relationship between engine rpm and road speed. It constantly monitors engine rpm and is preset to sound an alarm when engine rpm reaches a value that causes your vehicle to travel at 55 mph (or some selected lower speed). When this happens, the Cruisealert sounds a beeper to alert you that you are at the legal speed limit. At no time do you have to take your eyes from the road. And the Cruisealert can be used with 4-, 6-, and 8-cylinder engines.

Circuit Operation. A schematic diagram of the Cruisealert is shown in Fig. 1. Components *R1*, *R2*, *C1*, and *D1* both filter and clip the raw signal coming from the engine's distributor contacts. Resistor *R1* and capacitor *C1* form a single-stage low-pass filter that has a time constant of about 1.5 ms, which is long enough to provide smoothing for the transient, oscillatory-like waveforms present at the points. The frequency range is between 40 and 170 Hz, which approximately corresponds to a four-cylinder engine at a road velocity of about 30 mph and an eight-cylinder engine at approximately 70 mph.

Zener diode *D1* clips the input voltage swing to approximately +7 and −0.7 volts, suitable for use by the following circuitry.

Positive-edge retriggerable monostable multivibrator *IC1A* functions as a frequency discriminator, while *IC1B* forms the annunciator section. The filtered and limited signal from the input filter is applied to *IC1A* via input current limiting resistor *R2*. This portion of the dual multivibrator is arranged to deliver an output pulse at pin 6 when triggered by a positive spike. The pertinent waveforms for *IC1A* are shown in Fig. 2.

Resistors *R5* and *R6*, potentiometers *R12* and *R7*, and capacitor *C3* control the on time (T_{on}) of the multivibrator. For the three relationships shown in Fig. 2, the on time of *IC1A* remains constant, regardless of the input frequency, while the off time (T_{off}) changes with the input frequency. As the input frequency increases and approaches the threshold frequency of the multivibrator, T_{on} remains constant while T_{off} diminishes. At the critical threshold frequency, T_{off} diminishes to zero. The resulting output is a constant logic 1 as shown in Fig. 2C.

Diode *D3*, resistor *R13*, and capacitor *C5* form a negative-going integrating pulse detector. As long as the cathode of *D3* (pin 6 of *IC1*) remains at logic 0, *C5* remains fully charged.

For all input frequencies lower than the threshold frequency of the multivibrator, a negative-going T_{off} signal appears at pin 6 of *IC1A*, which forces *C5*'s

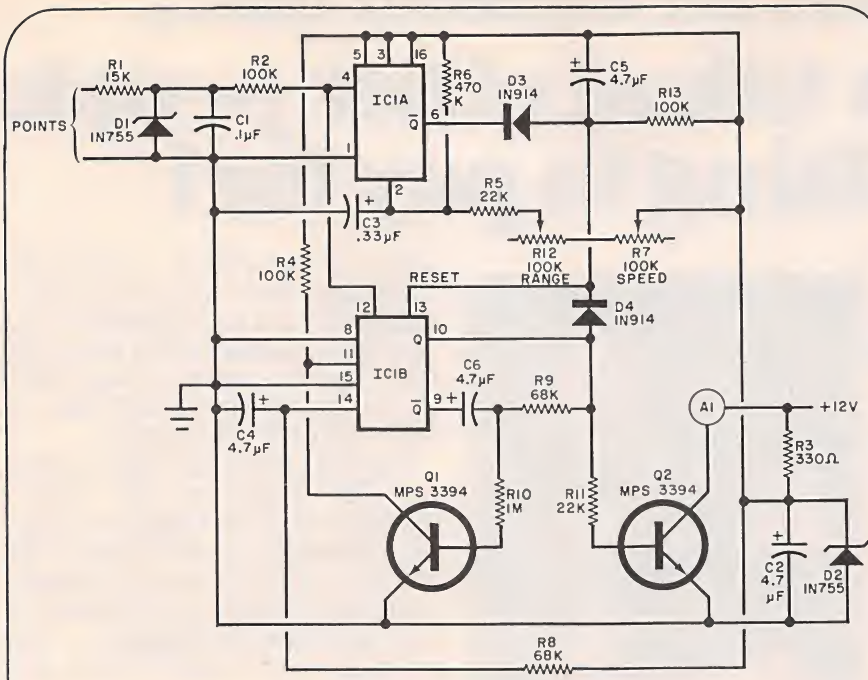


Fig. 1. Frequency discriminator IC1A triggers IC1B to sound alarm when input frequency from distributor points exceeds predetermined limit.

PARTS LIST

A1—SNP Sonalert or similar alarm
C1—0.1-μF, 50-V tantalum
C2, C4, C5, C6—4.7-μF, 50-V tantalum
C3—0.33-μF, 50-V tantalum
D1, D2—1N755 (7.5-V, 400-mW) zener
D3, D4—1N914 switching diode
IC1—MC14528CP dual monostable multivibrator
Q1, Q2—MPS3394 or similar transistor
Following are ½-W, 10% resistors unless otherwise noted:
R1—15,000 ohms
R2, R4, R13—100,000 ohms
R3—330 ohms
R5, R11—22,000 ohms
R6—470,000 ohms
R7—100,000-ohm panel-mount potentiometer
R8, R9—68,000 ohms
R10—1 megohm
R12—100,000-ohm, pc-mount potentiometer
Misc.—4" x 2½" x 2½" (10.2 x 5.7 x 5.7 cm) box; control knob; dry-transfer lettering kit; 16-pin IC socket (optional); hookup wire; solder; machine hardware; etc.
Note—A complete kit of parts is available for $29.95 from EALAB Associates, Box 737, Smithtown, NY 11787.

negative terminal to near ground potential. When the input frequency exceeds the critical threshold frequency, the voltage step T_{off} disappears and becomes a logic 1 (Fig. 2C). At this instant, diode *D3* then becomes reverse biased, causing the negative side of *C5* to rise towards the +V through *R13*.

Retriggerable monostable multivibrator *IC1B* and transistors *Q1* and *Q2* form the annunciator section. The main triggering input at pin 12 responds only to voltage transitions, while master reset at pin 13 responds to dc levels. In this circuit, *IC1B* is arranged so that to initiate astable action, a constant ac trigger signal must be present at pin 12. This is accomplished by connecting this input to the filtered and clipped ac signal source generated by the distributor points.

When the input frequency is below the discriminator's threshold frequency, the negative end of *C5* is near ground. Since this point is connected to pin 13, a logic 0 at this input forces *IC1B* to assume a reset condition in which the Q and not-Q outputs are held at logic 0 and logic 1, respectively. At this time, *C6* (connected between the two outputs via resistor *R9*) is fully charged to the voltage difference between the two outputs. The logic 0 level at Q also holds *Q1* in the off condition via *R9* and *R10*. The collector of *Q1* is held at a logic 1 to allow the input pulses at pin 12 to trigger *IC1B*.

When the input frequency rises above the discriminator's threshold frequency, the voltage at the negative end of *C5* assumes a positive (logic 1) potential. The logic 1 at pin 13 causes *IC1B* to be triggered by the input pulse train present on pin *12*. When triggered, the Q and not-Q outputs change state with a logic 1 and logic 0 appearing at the Q and not-Q outputs, respectively.

The logic 1 at the Q output turns *Q2* on via *R11*, which activates alarm *A1*. At this time, the voltage at the junction of *C6* and *R9* instantly drops below ground and then gradually rises above ground due to the charging current through *R9* whose source is the logic 1 at the Q output. When this voltage eventually rises above 0.7 volt above ground (one diode drop), *Q1* switches on and its collector drops to ground level. By virtue of logic-gate action, a logic 0 at pin 11 inhibits the input pulse stream at pin 12 from further triggering the multivibrator. In the absence of triggering pulses, the multivibrator eventually times out as determined by the *C4/R8* time constant.

The subsequent change of state at the Q and not-Q outputs causes *Q2* to switch off, silencing the alarm. Since *R9* now "sees" a logic 0 source at the Q output, the voltage at the *C6-R9* junction eventually drops to ground potential. When this junction reaches 0.7 volt, *Q1* turns off and its collector assumes a logic 1 state via *R4*. This allows the pulse train at pin 12 to once again trigger the multivibrator. It is in this manner that the astable action of *IC1B* is sustained only when the master reset at pin 13 is maintained at logic 1. The waveforms associated with *IC1B* are shown in Fig. 3.

Hysteresis Dead-Band Circuit. The frequency of the mechanical cam-rotor points breaker system used in the majority of engines is inherently unstable. Even if the engine's rpm were to be held absolutely constant, careful examination of the instantaneous frequency of the points would reveal some frequency modulation. This is due to a variety of factors such as a bent distributor shaft, variations in machining tolerances of the cam lobes, and, most of all, badly burned points.

Since the Cruisealert functions solely as a frequency discriminator, frequency modulation of the breaker points can lead to random and erratic triggering. To make the circuit immune to small incremental frequency variations, diode *D4* was added. It's function is to increase and hold the dc voltage at the negative end of *C5* when *IC1B* is operating (Q output is at logic-1). The result of this addition is illustrated in Fig. 4, which depicts the relationship between the point frequency and the alarm state. Examination of this chart shows that the alarm's turn-on frequency is slightly

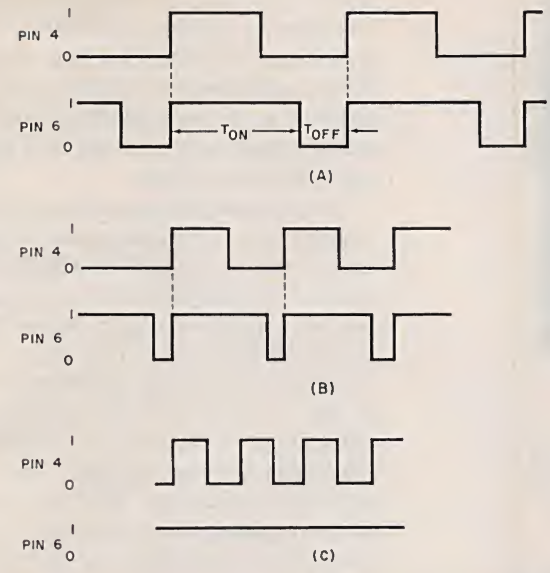


Fig. 2. Waveforms for IC1A show how off time of output (pin 6) varies as frequency of input at pin 4 increases.

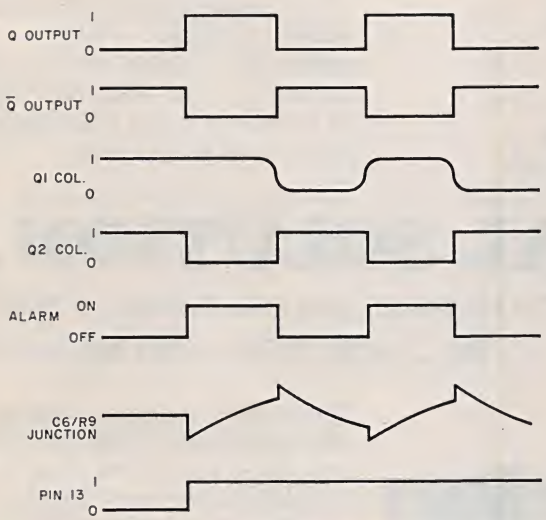


Fig. 3. Timing diagram for IC1B shows waveforms which can be expected at various points in circuit.

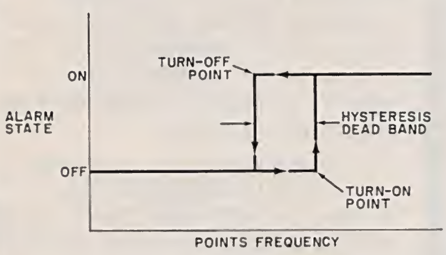


Fig. 4. Hysteresis of input frequency versus alarm state. Difference is less than 2 mph.

greater than its turn-off frequency. The difference between these two frequencies defines the hysteresis deadband, which in terms of vehicle road velocity is less than 2 mph.

Construction. The circuit can be built on a printed circuit board, the etching-and-drilling and components-placement guides for which are shown in Fig. 5. Note that SPEED control potentiometer *R7* and the alarm are both mounted on the box in which the circuit is housed.

After *R7* is mounted, attach a pointer knob to its shaft and provide some kind of marking surface below the knob. Starting at the fully counterclockwise position, mark off 10 equally spaced points to the clockwise limit stop.

Drill a small hole in the Cruisealert's front panel so that trimmer adjust potentiometer *R12* can be reached with a screwdriver after the pc board is in place. Connect the alarm and *R7* to the pc board as shown in Fig. 5. Then connect three long insulated leads to the vehicle's electrical system to provide input.

Select a suitable mounting position in the vehicle. Route the INPUT lead through the firewall and connect it to the screw connector of the ignition coil that goes to the distributor points. Connect the GROUND lead to a convenient metal screw or bolt and the 12-volt lead to a switched +12-volt source, such as the lead that feeds the radio. Insulate all connections.

Photo at right shows the author's prototype with speed control potentiometer R7 at left and loudspeaker at right. The hole in center is to gain access to R12 in making final adjustments with passenger's aid.

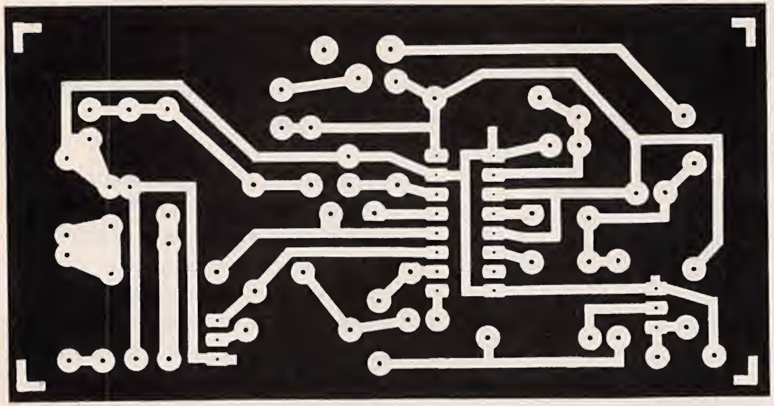
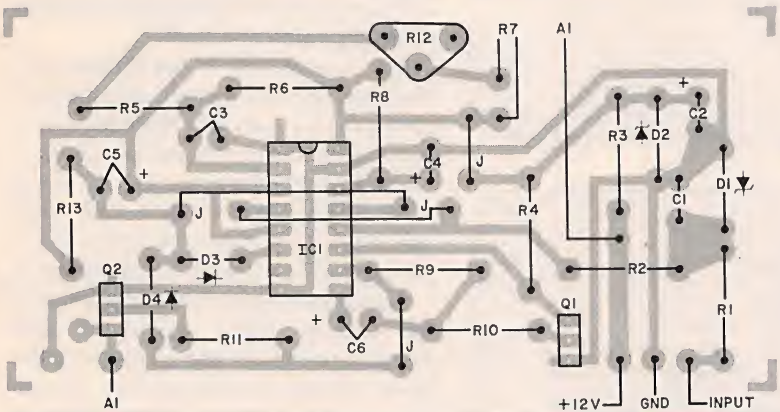


Fig. 5. Actual size etching and drilling guide (above) and components placement (below) for printed circuit board.



Adjustment. The Cruisealert is designed to provide an overspeed alarm indication for selected road speeds between 30 and 70 mph for a four-, six-, or eight-cylinder engine. In the interests of safety, it is recommended that the following adjustments be made by a passenger and not the driver.

Using a small screwdriver, rotate *R12* (RANGE) fully clockwise via the access hole in the front panel and leave the screwdriver engaged in the trimmer slot. Set the front-panel SPEED control (R7) knob to the fifth mark on its scale.

Drive the car until the speedometer indicates 55 mph and try to maintain this speed. Very slowly adjust *R12* until the Cruisealert just starts to beep. Then remove the screwdriver. This completes the range setting, and the SPEED control is set to 55 mph. Note that the SPEED control's scale indications are only relative and do not correspond to vehicle speed.

To preset the Cruisealert to operate at another road speed, rotate the SPEED control fully clockwise, drive the car at the desired speed, and while maintaining this speed, slowly adjust the SPEED knob until the alarm sounds. ◇