Avoid speeding fines. Build this . . .

Speed Sentry for cars

by COLIN DAWSON

Paying speeding fines can be a painful business. Build this speed sentry and avoid further pains in the wallet due to this cause.

It's a situation familiar to every driver: a long stretch of good road leads you to imperceptibly increase speed. After a while you can be exceeding the speed limit by a wide margin which means that you're a goner if you stumble upon a roadside radar trap. It could well be a case of the book, the bag and a large extraction from the wallet.

Similarly, driving into a built-up area after a long stretch of highway can make the 60km/h restriction seem like an agonising crawl. Constant vigilance is required to keep the speed under the limit, but clearly, the driver's attention should be directed outside the car – not at the dashboard. In such cases, the warning buzzer of the Speed Sentry will greatly assist in re-orientating the driver to the lower speed limit.

The Speed Sentry actually has two alarm speeds. One of these is set at installation and would normally be calibrated to trigger at about 60km/h. The other can be adjusted on the move by means of a remote potentiometer mounted in any position convenient to the driver. Selection between the two alarm speeds can be made by a switch mounted near the potentiometer.

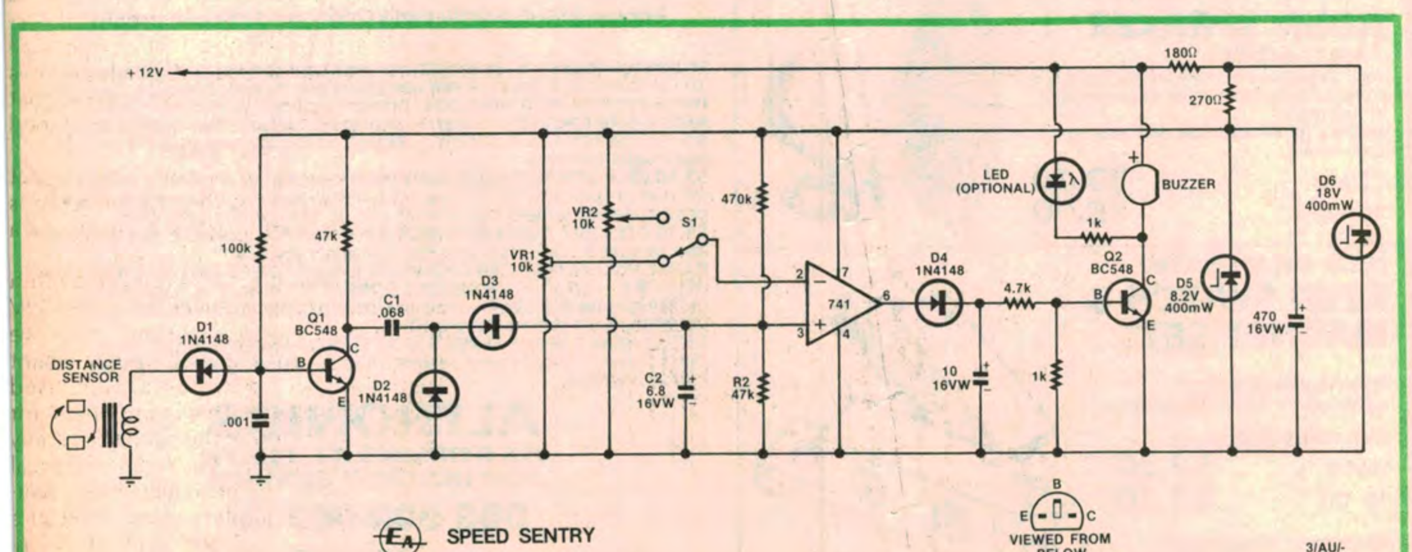
When the driver does not need the Sentry, it is simply switched to the adjustable mode and the trigger speed set to maximum.

The original version of the Speed Sentry, presented in May 1981, interfaced to the car's ignition system. In fact it was monitoring engine speed rather than road speed, but provided the car is in top gear this is a valid technique. By calibrating the circuit to trigger at a given engine RPM, it is also being calibrated to trigger at a given speed. Unfortunately, this type of monitor will also trigger at this same RPM in the lower gears even though the speed is well below the preset value. And it was not really valid for cars with automatic transmission.

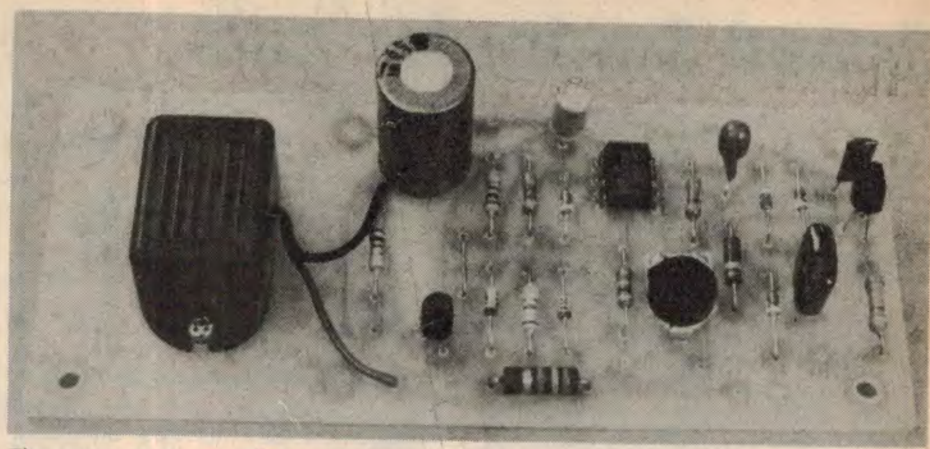
> We estimate that the current cost of components for this project is approximately
>
> **$11**
>
> This includes sales tax but not the cost of the sensor.

Now we are able to present a revised version of the Speed Sentry which responds directly to road speed – irrespective of the engine RPM. Following the introduction of our car computer project last year, several retailers are supplying the distance transducers specified for that project. As it happens, these transducers are equally suitable for use with the Speed Sentry.

Although these transducers have an output which gives a direct indication of distance, this can easily be processed so that it represents speed. For vehicles already fitted with the car computer, no



SPEED SENTRY



The components are all mounted on a small printed circuit board.

modification to the sensor circuit will be necessary. The Speed Sentry will simply require a "tap" from the output line of the sensor. This could be taken from any convenient point between the sensor and the computer.

There are two different types of distance sensors available, both of which can be used with this project: (1) a magnetic pick-up using a coil and rotating magnets, or (2) a speedometer cable sensor. Generally, the magnetic pick up system will suit most rear-wheel drive cars with a front mounted engine as the tailshaft is an ideal position for the magnets. It may also be possible to find a suitable position on some front-wheel drive cars.

The cost of the speedometer cable sensor is about $20, but the driveshaft sensor is cheaper at about $12. Actually, it is quite practical to manufacture your own driveshaft sensor. All you need is a coil and two reasonably strong magnets. We are aware of one reader who used an old washing machine solenoid for the coil. Large relay coils could prove equally suitable for the purpose and the magnets are available commercially.

With either type of sensor the output is a series of pulses, for which the frequency is dependent on the speed of the vehicle. From this, it is apparent that the Speed Sentry is actually a frequency sensing circuit. In fact it utilises a diode charge pump to produce a DC level which is proportional to the frequency of input pulses. When this DC level exceeds a preset reference (as determined by an op amp comparator) an alarm condition exists and the warning buzzer sounds. An optional LED can also be used to signal the warning.

The output of the magnetic sensor cannot be used to drive the charge pump directly, since the amplitude of the pulses tends to vary with RPM. Instead, the sensor is coupled to Q1 via a diode, D1. By virtue of the diode, the base of Q1 is held at 0.6V.

With no signal supplied from the coil, Q1 is on the verge of being forward biased, hence only a very small signal from the coil is needed to bias it into conduction. As soon as Q1 is forward biased, its collector goes low. Since the coil is rotating rapidly we can expect that Q1 will be on only briefly with its collector then being pulled high by the 47kΩ resistor. Each one of these positive transitions counts as an input pulse.

The speedometer cable sensor has an integral buffer transistor which serves the same purpose as Q1. This means "squared up" pulses can be taken directly from the sensor, eliminating Q1 and its associated circuitry from the Sentry. The disadvantage with this sensor – besides more difficult mechanical installation – is that it must have a power supply connection to the Sentry circuit.

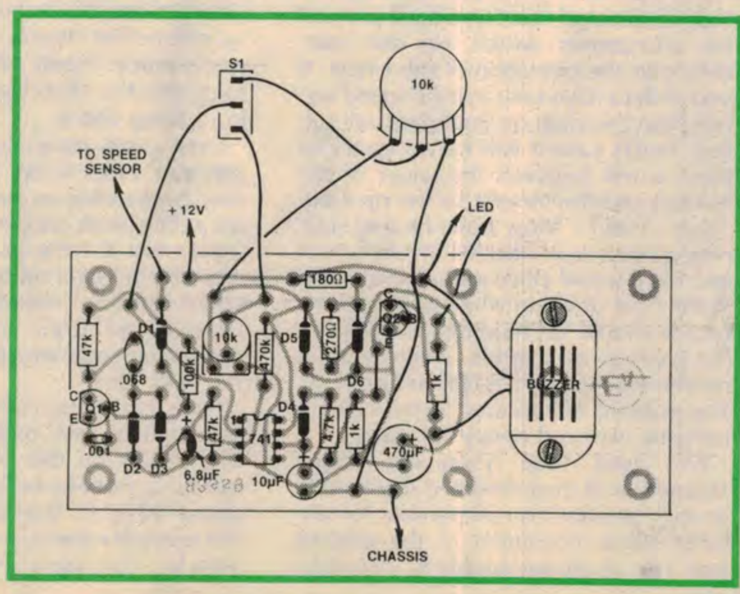
Although Q1 provides pulses of constant amplitude, the pulse width is still determined by vehicle speed. With faster driving the pulses become shorter and shorter. To provide a pulse of constant duration for the charge pump, the signal from Q1 is differentiated by C1. This converts each pulse into a short spike, the duration of which is independent of vehicle speed.

The signal spikes are transmitted via diode D1 to C2, which consequently acquires a certain amount of charge. The 47kΩ resistor across C2 allows this charge to bleed off at a fixed rate so that the voltage across C2 can be determined by the rate of input pulses.

Reference to the complete circuit diagram shows that the charge pump is followed by a comparator consisting of a 741 op amp and two trimpots.

The op amp (IC1, a 741) is fed from a regulated supply, derived from the 12V of the car's electrical system. Here we have used an 8.2 volt zener shunt regulator to provide a stabilised operating voltage. This is important for reliable operation of the circuit since any voltage changes in the main electrical system (due to the headlights being switched on for example) would result in a change in the reference levels at the inverting input of the op amp.

Right: parts layout and wiring diagram for the speed sentry. Take care with polarised components



The circuit (left) consists of a diode charge pump, an op amp comparator and a transistor output stage.

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The voltage developed across C2 is applied to the non-inverting input (pin 3) of IC1, while an adjustable reference voltage is applied to the inverting input (pin 2). If the voltage on pin 3 is lower than the voltage on pin 2, the output (pin 6) will be close to 0 volts. As soon as the voltage on pin 3 rises above that of pin 2, the output will rise to almost 8.2V (the zener regulated voltage).

The output of the op amp is fed to a second diode/capacitor combination which is used to smooth any pulses appearing there. Where the voltage across the capacitor in the charge pump circuit is just at the threshold level of the comparator, pulses will appear at the output, due to the ripple at the input. This ripple is due to the charging and discharging of the capacitor with the input pulses.

This smoothed voltage at the output of the op amp is used to drive transistor Q2 which is a saturating switch for an oscillator-driven buzzer or a piezo alarm device.

The purpose of the 18V zener diode across the power supply of the Sentry is to clip any high voltage spikes that may occur on the car's electrical system. This protects the IC from the spikes which are quite common.

Power for the circuit should be taken from a part of the car's wiring which is active when the ignition is switched on.

Fig. 1. Magnetic pick-up sensor system for rear-wheel drive cars. Note the twin magnet arrangement.

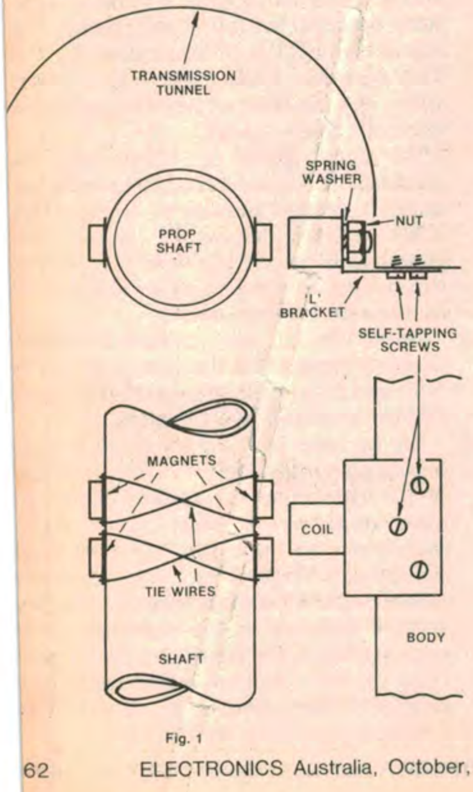


Fig. 1

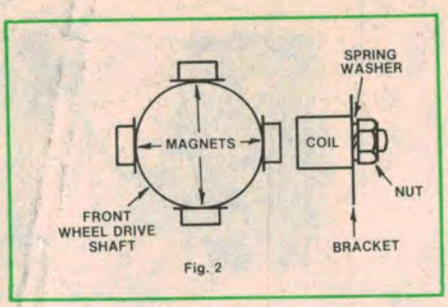


Fig. 2

Fig. 2. Suggested coil and magnet arrangement for front-wheel drive cars.

We have designed a printed circuit board which accommodates all the components except the sensor, the second potentiometer and the changeover switch. The board measures 117 × 52mm and is coded 83ss9. Construction is simple and should not take more than half an hour or so. The components should be mounted in the usual order; starting with resistors and diodes, then capacitors, transistors and lastly the IC. The wire link on the board should be soldered in at the same time as the resistors.

We have made provision on the board for an additional 1kΩ resistor which allows a series LED to be connected in place of the buzzer, or if desired, in parallel.

If using the speedometer cable sensor, omit D1, Q1 the associated 100kΩ and 47kΩ resistors and the 0.001μF greencap. What was the collector of Q1 now becomes the input.

The external connections to the board are the input, power supply, the switch and the external potentiometer. This is shown in the wiring diagram.

The remote pot and the changeover switch can be mounted on the dash, or, if your car has it, in the centre console. It should be noted that the second pot and the changeover switch are not mandatory to the operation of the circuit. If you wish to have only a single speed setting then the input on the board will suffice. In this case it will be necessary to place a link between the wiper of the trimpot and the trimpot to the op amp.

Figs. 1 and 2 show how the magnetic pick-up sensor is installed in rear-wheel and front-wheel drive cars respectively. In the case of a rear-wheel drive car the sensor should be mounted as close to the gearbox as possible, where vertical movements of the tailshaft are minimal. The magnets are secured to the tailshaft using tie wire and epoxy adhesive.

We used four 15mm-dia round magnets in all, two mounted side-by-side at each position to compensate for any longitudinal movement of the tailshaft (see Fig. 1). Some suppliers, however, will provide 25mm-long bar magnets, in which case only one magnet will be required at each position.

The coil was mounted on an L-shaped bracket made from aluminium and secured to the underside of the car using self tapping screws. This bracket should be positioned so that there is a 10mm gap between the end of the coil and the magnets when they are directly opposite each other.

Wiring to the coil can be run along the underside of the car, with the leads secured at various points as convenient. Connect one of the leads from the pick up coil to the chassis at the coil mounting position. Plastic tubing can be used to protect the other lead against damage from flying debris.

Front-wheel drive cars are a somewhat different proposition. In some cars, it may be possible to mount the magnets on a drive-shaft coupling flange where it bolts onto the transaxle (provided it is not covered by a rubber boot). The coil could then be mounted on a suitable bracket secured to the nearest convenient mounting point. Fig. 2 shows the basic idea.

Note that in this case the magnets are mounted at four positions, 90° apart. The reason for this is that, for a given speed, a front-wheel driveshaft rotates about three to four times slower than the propeller shaft on a rear-wheel drive vehicle. The extra magnets are thus

Parts List

1 printed circuit board 117 x 52mm, code 83ss9
1 switch, single pole double throw (SPDT)
1 buzzer
1 knob to suit potentiometer

SEMICONDUCTORS
1 741 op amps
2 BC548 NPN transistors
4 1N4148 diodes
1 18V/400mW zener diode
1 8.2V/400mW zener diode
1 LED (See text)

CAPACITORS
1 470μF/16V electrolytic
1 10μF/16V electrolytic
1 6.8μF/16V electrolytic
1 .068μF metallized polyester (greencap
1 .001μF greencap

RESISTORS (¼W, 10%)
1 x 470kΩ, 1 x 100kΩ, 2 x 47kΩ, 1 x 4.7kΩ,, 2 x 1kΩ,, 1 x 270Ω,, 1 x 180Ω,½W, 1 x 10kΩ linear potentiometer, 1 x 10kΩ, trimpot small horizontal.

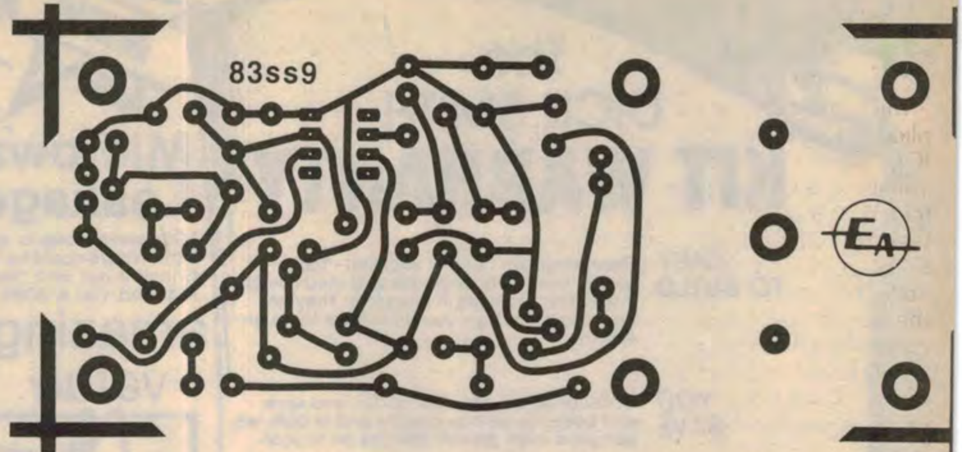
necessary in order to get a similar number of pulses for a given distance.

Do not mount the magnets directly onto one or other of the driveshafts. They move about too much when the vehicle is in motion to allow for reliable coupling between coil and magnets.

The alternative speedometer cable sensor can be used with both front and rear-wheel drive cars, but is mainly applicable to front-wheel drive cars where the driveshaft flanges are not accessible. In order to fit it, the outer sheath must be removed from the speedometer cable and cut at a suitable point. The inner cable is then pushed through the sensor and the speedometer cable reassembled.

Generally speaking, the best position for the speedometer sensor is close to the firewall in the engine compartment. The installation procedure is as follows:

- Mark the appropriate position with white chalk, then remove the speedometer cable from the vehicle;
- Remove the retaining circlip and withdraw the inner cable;
- Using a hacksaw, cut out and discard a 15mm section of the outer sheath at the marked position;
- Push the inner cable through the sensor and refit the two sheath sections by clamping the ends in the slotted end tubes. Note that the inner cable should be a force fit into the sensor, otherwise the slotted disc inside the sensor will not rotate;
- Check that the inner cable is free to rotate, then re-install the speedometer cable in the vehicle.



When wiring the speedometer cable sensor, the colour coding for the wires is: Brown +8.2V; Green/Yellow signal; Blue ground.

The PCB itself is best installed under the dashboard of the car. Alternatively, the PCB may be mounted in a plastic case and installed towards the top of one of the front kick panels.

Once construction has been completed and the unit has been fitted to the car, you should enlist the help of a friend, either as driver or passenger, to set the trimpot.

Get the car moving at a constant speed of say 60km/hr (or any other that may be required) and then set the trimpot so that the buzzer just begins to sound. Now drop the speed back a little and make sure that the buzzer stops. Accelerating up to or just over the preset speed should cause the alarm to sound.

The same procedure is used to set the second pot, although here the driver can do it while driving along.