"Speed Sentry" For Safer Driving

There is no doubt that there exists an urgent need for greater safety on our roads and that, in the main, this is the responsibility of the individual driver. We believe that our "Speed Sentry" can contribute to greater safety by assisting responsible drivers to drive within the speed limit at all times.

By George Hughes

The combination of a well made road and a comfortable, quiet vehicle can easily create a condition of slowly increasing road speed; to the point where one is travelling a good deal faster than the prescribed speed limit and, by implication, a good deal faster than is safe on that particular road.

The rude awakening comes when we suddenly find ourselves facing an emergency: another vehicle which appears out of nowhere; a curve and road condition unsuitable for the speed at which we are travelling; or a sudden undulation which can make the vehicle airborne. Alternatively, we may suddenly become aware of a motor cycle alongside us and a curt command to "Pull over please driver".

Another situation with which most drivers will be familiar is that where one suddenly enters a 35 mph zone after travelling at 60 mph or more in a de-restricted zone. Conditioned to the higher speed, 35 mph seems like a crawl and try as one might to observe the restriction, the speed creeps up. And if, in an endeavour to avoid this, one pays more than usual attention to the speedometer, there is the real risk that proper attention is not given to the road.

At best, these situations risk the embarrassment of a fine and loss of points; at the worst a smash, with all the tragedy that this implies.

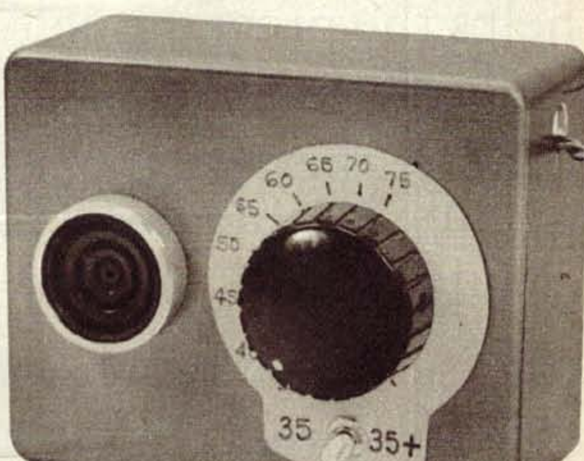
It is to avoid situations like this that we have designed the Speed Sentry. It is a simple alarm system which can be set to any maximum speed the driver cares to select, after which it will sound whenever this speed is exceeded. It may also be fitted with an additional preset position, available via a two position switch, which may be set to any commonly encountered restriction, such as 35 mph.

While such a device could be a complicated mechanical device deriving information from the speedometer, there is a lot more appeal in a simple electronic unit which derives its information from a train of electrical pulses.

A convenient place to obtain such pulses is from the ignition system. These can be applied to a circuit that is capable of triggering an alarm when a nominated pulse rate has been exceeded.

The main drawback when using ignition pulses to measure road speed is the fact that only in top gear is the reading a true one. At other gear ratios the alarm will sound when the engine speed reaches the equivalent of the setting for top gear. It may be possible to overcome this, with a manual transmission, by mounting a microswitch on the gear shift quadrant so that the alarm circuit will be active only when top gear is selected.

Vehicles with automatic transmission also present some problems. Automatic transmission systems fall into two broad categories. Two speed types usually incorporate a wide range torque converter which, because of the coarse range of only two speeds, is used continually to optimise power transfer for best performance. Consequently, its influence on engine speed due to load and throttle setting is continually varying. Unfortunately, in these circumstances the Speed Sentry's behaviour will be dictated by a varying engine speed not necessarily proportional to road speed.



The finished "Speed Sentry" housed in a diecast box. The dial is calibrated in miles per hour, commencing at 35. The switch permits the 35 mph setting to be selected without disturbing the variable setting.

The second type of automatic transmission (usually a three speed type) incorporates a torque converter with a narrower range than the two speed type. In the top speed position it has the advantage of a mechanical locking device which couples the engine drive shaft to the tail shaft. With this type of automatic transmission, engine speed is proportional to road speed, just as in a manual transmission.

In spite of the minor disadvantages which are involved, we felt a device working from the ignition system had the overwhelming advantage of simplicity. On the other hand, for those who feel so inclined, there is no reason why such a device should not be triggered from a pulse generator coupled to the tail shaft or rear axle. There are plenty of sensing devices which could be used, such as magnets and coils, magnets and reed switches, or even lamps and photocells. All one needs is the ingenuity to design it, the skill to find a suitable place to mount it, and the patience and facilities to fit it to your particular vehicle.

In the meantime you might care to build this unit anyway and connect it to the ignition system until such time as your axle driven generator is a practical reality. Our unit connects across the distributor contacts, ie, between the active distributor terminal and chassis. A brief description of how the circuit functions should assist readers to understand it.

The pulses from the ignition circuit are fed to a diode pump through a series limiting resistor. The output of the diode pump produces a DC level proportional to pulse rate. This is applied to a potentiometer circuit, connected in turn, to the input of a Schmitt trigger circuit.

The action of a diode pump circuit may be understood by referring to figure 1.

At the input to the diode pump circuit is an RC network R1, C1. The purpose of the network is to differentiate the incoming train of rectangular pulses from the ignition circuit. "Differentiation" is a process whereby the rectangular pulses fed into the circuit are converted into spikes, and, most importantly, spikes which have a constant "width" (more correctly, area) regardless of the width of the rectangular pulse from which they are derived. It is this vital difference between the original pulse, and the spike derived from it, which makes it possible to "count" the pulses, and produce a direct voltage whose value is indicative of the pulse rate.

In the February 1960 issue of this magazine, an extensive treatment of the process of diffentiation and its application in an automotive tachometer was given. Other texts, such as Television Engineering, Edition 2 by Fink (McGraw-Hill) and Basic Television by Grob (McGraw-Hill) and similar books on the subject, give a more thorough explanation, and are recommended for those who wish to pursue the subject further.

In order to generate the differentiated spikes, C1 and R1 must be of such values that C1 charges very rapidly on the application of a pulse. It is the brief pulse of current which flows during this charging function that constitutes the spike. Since C1, once charged, cannot pass any more current, the length of the rectangular pulse has no effect.

At the end of the rectangular pulse, C1 must be discharged rapidly, before the next pulse appears. This can only take place through the input (or generator) circuit which, ideally, should have zero impedance. Since the generator is, in this case, a pair of breaker points, and they are closed during the "no voltage" period, this ideal is virtually achieved.

Under these conditions, ie, both input voltage and impedance at zero, C1 is discharged through R1, the breaker points, and D2, as indicated by the current loop Ia. When the next square pulse is applied to the input terminals, the capacitor C1 charges again via the current loop Ic.

That portion of the circuit to the right of the series diode D1 – C2 and R2 – is a " summing" or "integrating" circuit.

As each spike is generated, its current path (Ic) is via the diode D1 and C2. As a result of this current, C2 will acquire a certain amount of charge and, thus, a certain voltage will be developed across it. As each following spike or pulse of current flows, C2 will add to its charge and the voltage across it will rise.

Capacitor C2 would, in time, become fully charged, with the voltage across it equal to the spike amplitude, if some method of controlled "bleed" was not present. The load resistor R2 across C2 performs this function (Current loop Ib).

Thus, when we feed a continuous train of pulses into C2 they attempt to charge it while, at the same time, R2 attempts to discharge it. The end result is a degree of charge, and a value of voltage, which is a balance between these two. Since the discharge function is fixed by the value of R2, the actual voltage is determined by the variable factor; the rate at which spikes are fed to C2. Thus the voltage across C2 becomes a direct indication of the rate at which pulses are being generated in the ignition system.

The action of this circuit is analogous to that of a pump – say a water pump – which is delivering small bursts of liquid into a large container. Hence the coined name; "diode pump".

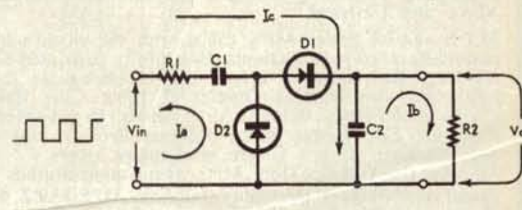
The Schmitt trigger circuit (figure 2) consists of two amplifiers connected so that only one stage can be fully conducting at any one time. It has the desirable characteristic of a rapid change-over from one state to another if the input voltage exceeds a certain level, and will change back to its original state when the input voltage drops below the first level by a certain amount.

The high and low input voltages are called the "upper trip point" and the "lower trip point" respectively; the difference voltage between them, is called the "hysteresis".

The upper trip point is equivalent to the sum of the two voltages Ve and Vin when the transistor TR2 is conducting. The lower trip point is equivalent to the voltage Ve when the transistor TR1 is conducting.

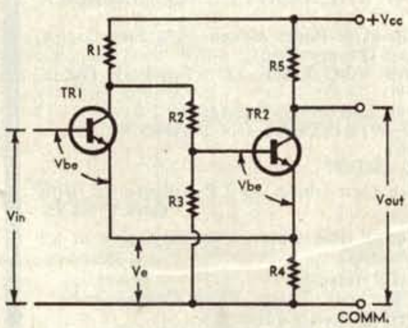
The value of the voltage Ve is that

Figure 1. How the "diode pump" works. It is a differentiating network, such as used in other tachometer circuits, plus an intregrating network producing a DC output proportional to speed.



BASIC CIRCUIT OF A DIODE PUMP

Figure 1



BASIC CIRCUIT OF A SCHMITT TRIGGER

Figure 2

Figure 2. The Schmitt trigger. Normally, TR1 conducts and TR2 is cut off. Input from the diode pump cuts off TR1 and causes TR2 to conduct.

developed across the resistor R4 by the current flowing through the transistor TR2 when it is conducting, or TR1 when it is conducting. If the collector resistors for each transistor (R1 and R5) are identical, the voltage Ve across the resistor R4 will be constant because of identical current flow through either transistor.

If the currents through the transistors are not the same, the voltage Ve developed across R4 will not be constant, and consequently, there will be a wider hysteresis than if the resistors R1 and R5 were equal. In some applications of the Schmitt trigger, this is a very handy characteristic.

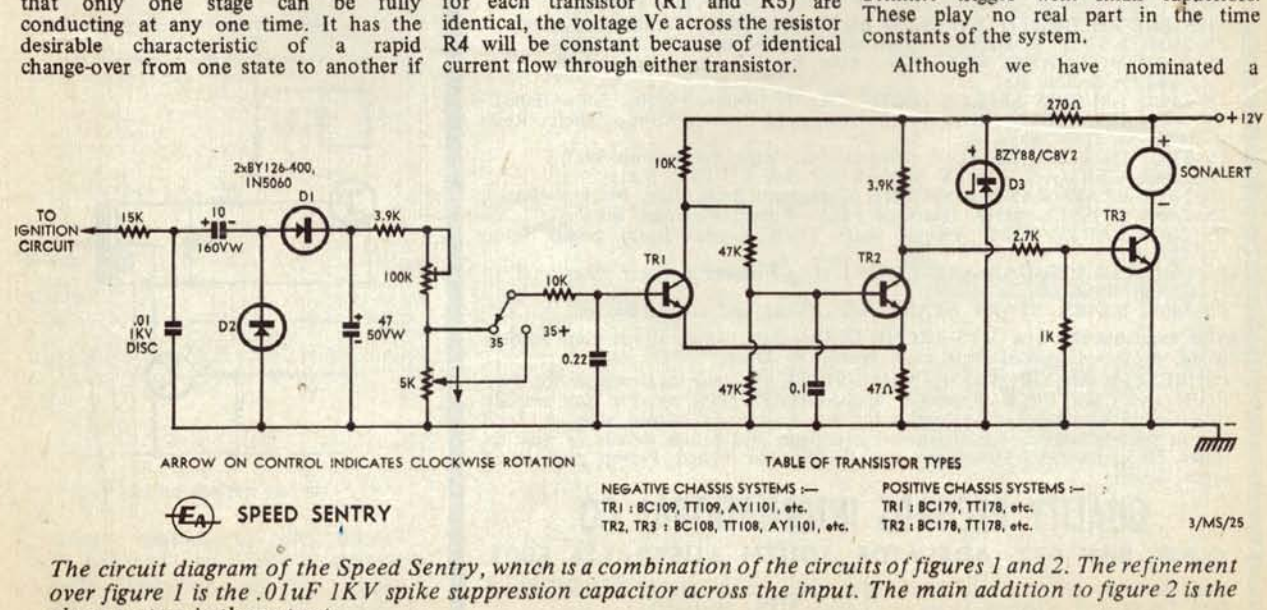
In our case, we have aimed for a width which necessitates a reasonable reduction of pulse rate at the diode pump to change state. This is equivalent to a reduction of vehicle speed to a few miles per hour below that as set up by the motorist.

Reference to the main circuit will show that the first part of it is the combination of the diode pump and the Schmitt trigger. The output from the diode pump is fed to the Schmitt trigger via a potentiometer network, which is really R2 of figure 1. One part of this network is a preset variable resistor and one a variable pot. By suitable selection, two conditions of DC output from the pump circuit can be fed to the Schmitt trigger circuit. The first output is from the top of the preset resistor which is adjusted to correspond to the speed limit of 35 mph. The second output is from the moving contact of the variable potentiometer whose position can be set to any speed above the 35 mph limit.

When the DC input voltage is high enough for the Schmitt trigger to change state (ie TR1 conducting), the cutoff condition of TR2 allows its collector potential to rise. Current then flows in the base circuit of TR3, via a voltage divider, causes it to conduct fully, and sounds a Sonalert alarm connected as TR3's collector load.

Ignition voltage spikes are eliminated at the input to the diode pump and Schmitt trigger with small capacitors. These play no real part in the time constants of the system.

Although we have nominated a



ARROW ON CONTROL INDICATES CLOCKWISE ROTATION

TABLE OF TRANSISTOR TYPES

NEGATIVE CHASSIS SYSTEMS :—
TR1 : BC109, TT109, AY1101, etc.
TR2, TR3 : BC108, TT108, AY1101, etc.

POSITIVE CHASSIS SYSTEMS :—
TR1 : BC179, TT178, etc.
TR2 : BC178, TT178, etc.

EA SPEED SENTRY

3/MS/25

The circuit diagram of the Speed Sentry, which is a combination of the circuits of figures 1 and 2. The refinement over figure 1 is the .01uF 1KV spike suppression capacitor across the input. The main addition to figure 2 is the alarm system in the output.

Sonalert as the alarm proper, other devices could be used. The main advantage would be a saving in cost, particularly where the junk box can supply all or most of the parts required. A typical alternative is the Acoustic Signal Unit described in the November 1968 issue (File No 1/MS/5). We have provided an auxiliary circuit suggesting how this could be coupled to the Speed Sentry in place of the Sonalert.

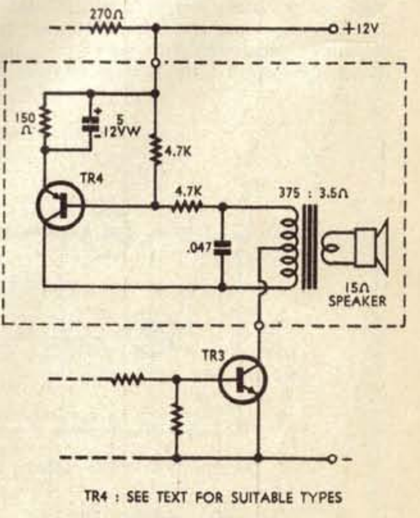
As it is drawn, the circuit of the Speed Sentry assumes a negative chassis electrical system of the vehicle. For positive chassis electrical systems, reverse the pump

PARTS LIST

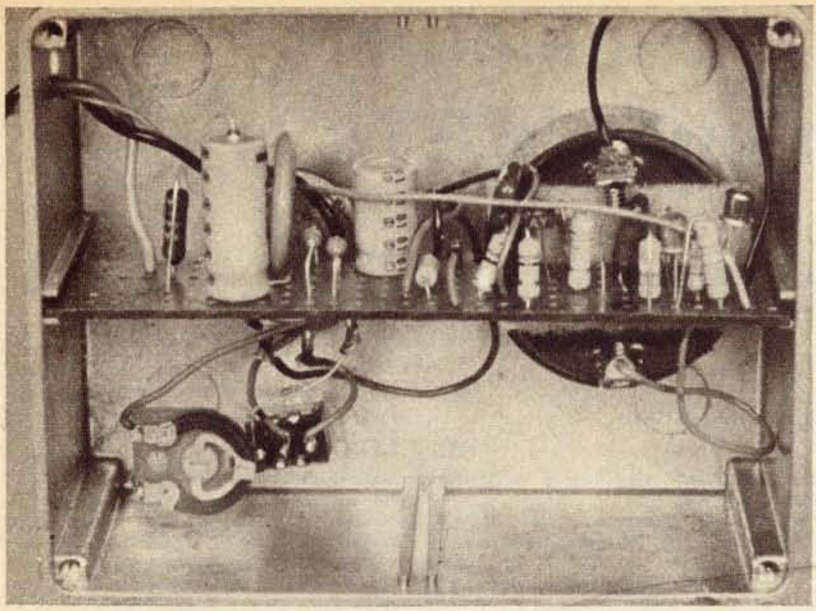
- *1 Metal box approx 5in x 4in x 2in (eg STC type 43BOO).*
- *1 Piece 0.15in Veroboard (see dw'g).*
- *1 Type SC628 Sonalert, or alternative alarm device (see text).*
- *1 5K linear potentiometer.*
- *1 100Kpreset potentiometer.*
- *1 Large knob.*
- *1 Miniature single pole, 2 way toggle switch.*
- *1 10uF 160 volt electrolytic.*
- *1 47uF 50 volt.*
- *1 0.22uF 100 volt polyester.*
- *1 0.1uF 100 volt.*
- *1 0.01uF 1KV disc ceramic.*
- *2 BY126-400 or 1N5060 diodes, or similar.*
- *1 BZY88-C8V2 zener diode.*
- *3 Silicon transistors (see circuit).*
- *1 47 ohm ½ watt resistor.*
- *1 270 ohm.*
- *1 1K.*
- *1 2.7K.*
- *2 3.9K.*
- *2 10K.*
- *1 15K.*
- *2 47K.*
- *Foam plastic, adhesive, bolts, hookup wire, scale, lacquer, etc.*

diodes, the two electrolytic capacitors, the zener regulator diode, the Sonalert connections, and replace all transistor types with their PNP equivalents. Types for both polarities are suggested in the table on the circuit diagram.

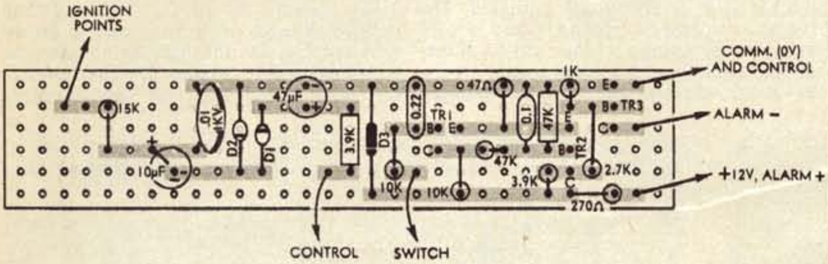
A convenient housing for the Speed Sentry is a die-cast box such as the STC 43B00. This box has slotted ribs centrally placed in each side, which form a simple



Circuit for a simple audio oscillator which can be used in place of the Sonalert. The method of connection into the circuit is also shown.



Internal layout of the Speed Sentry. The 35 mph preset pot (lower left corner) is mounted on the toggle switch. Note how the board is mounted in slots in the diecast case.



The layout of components of the Speed Sentry viewed from the component side of a 0.15in Veroboard. Cut and trimmed to the correct size, it should fit between the guides of the box.

and convenient anchorage for the component board.

However, such an elaborate box is not strictly necessary. Almost any metal box would do provided it has enough room for the few components. Our more ingenious and less affluent readers will doubtless think up numerous alternatives, probably involving discarded containers of one kind or another. And, with a little careful treatment and a coat of paint, there is no reason why these should not be perfectly adequate.

The variable potentiometer, the Sonalert, and the optional selector switch all mount within the box as shown in the photograph. Small strips of foam plastic, glued to the back of the Sonalert and the inside surface of the back cover press against each side of the component board.

The component board is made from Veroboard. The layout of the board with component positions is shown in the accompanying diagram.

By placing a large knob on the shaft of the variable control, an easy-to-read scale can be placed on the Sentry's box so that one can quickly set it to any prevailing limit where speed zoning applies.

It would be virtually impossible to make available a scale for the Speed Sentry, as there are so many factors influencing the calibrations. Apart from component spreads, there are the characteristaics of individual vehicles such as differential ratios, wheel and tyre sizes number of engine cylinders, etc. All have to be taken into account and each scale individually calibrated.

If a small toggle or slider switch is provided, the variable control can be left at a particular setting when operating at tne 35 mph setting. When a higher speed zone is re-entered a flick of the switch places the Sentry at the higher setting of the variable control.

When no switch is used for selection, the 35 mph condition is equivalent to the minimum position of the variable control.

The 35 mph setting should be made first by setting the preset potentiometer with the toggle switch in the "35" position or the variable control at minimum (if no toggle switch is used).

With the assistance of another person, either as driver or passenger, run the vehicle up to a steady 35 mph and adjust the preset pot from its maximum resistance setting towards low resistance until the alarm sounds.

If a calibrated scale is to be used, advance the variable control to the high side of the next desired calibration and run up to this speed. Reduce the setting of the variable control until an alarm is heard, and mark this on the scale card. Repeat the above procedure for each limit.

It is not essential to incorporate a calibrated scale. In fact, it has been suggested that using the scale may call for more diversion of one's attention from the road than is desirable, particularly at the higher speeds.

The easiest way to set the Sentry without diverting one's attention from driving is to turn the knob position above the desired limit, run up to the speed

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limit, and then lower the setting of the control until the alarm sounds. Any speed below this will not trip the alarm.

An alternative to the continuously variable potentiometer and toggle switch arrangement is a multi-position rotary switch with each position equivalent to 5 mph increments above the 35 mph one. Thus, three positions above 35 mph would be the 50 mph setting, and so on.

This arrangement will necessitate a series string of resistors with a total value equal to the variable potentiometer, and each of them of such a value as to allow a 5 mph increment.

Initially, a 5K potentiometer should be installed in the Speed Sentry with a temporary scale. With an assistant, first set the 35 mph preset spot, and then accurately mark off each 5 mph on the scale above this speed.

Disconnect each wire from the variable control and measure the resistance values between the common rail (chassis) end and the highest speed setting marked. Along with each successive setting of the knob towards the 35 mph setting, tabulate each resistance value. The 35 mph position should be the total value of the pot.

The first value measured will be that of the resistor required from the highest speed position of the switch and chassis.

The difference between the first and the second will be the value of the resistor for the next 5 mph increment, and so on to the lowest speed setting.

A single pole rotary switch with the same number of positions as speed settings will be all that is required, but a switch with more contacts than necessary may be pressed into service to avoid the expense of a new rotary switch. Any unused contacts should be joined together and connected to chassis. ■