IMPROVED GAS AND FUME DETECTOR

This high-sensitivity noxious-fume detector is for both home and mobile use.

BY C. R. LEWART

THE Taguchi Gas Sensor has made possible a number of gas and fire detectors (such as the "Poisoned Air Detector," POPULAR ELECTRONICS, February 1974). Now, there is an improved version of this very useful sensor that retains the high sensitivity, compact size, and low cost of its predecessor. The new sensor, however, has greater stability and an electrically isolated low-current 5-volt heater.

The new sensor is an ideal building block for inexpensive but very sensitive ac or dc gas alarms for the home, car, trailer, boat, etc. It also makes it possible to actually measure the gas concentration for mobile antipollution tuneups and for the detection of small gas leaks. Presented here are three ways in which you can put the new sensor to use.

Sensor Characteristics. The sensor consists of a piece of semiconductor material molded around a small filament heater. It is housed in a stainless-steel, wire-mesh-topped enclosure. The semiconductor material — mainly tin oxide (SnO_2) — is put through a sintering process during manufacture to increase the active area to be exposed to the air entering the sensor through the wire mesh cover.

When the semiconductor material is heated in the presence of combustible or oxygen-reducing gases or vapors, the material's resistance decreases. The sensor can respond to carbon monoxide, hydrogen, propane, gasoline, alcohol vapors, etc. A useful indication of the change in sensor conductivity can be obtained with gas concentrations as small as 50 to 100 ppm (parts/million) of carbon monoxide, propane, or methane.

The reactions that occur in the semiconductor material are reversible so that the sensor can be used to make thousands of measurements before having to be replaced. After an initial warmup of 2 to 5 minutes, the sensor responds within a few seconds to the presence or change in concentration of a combustible gas. Recovery time after being exposed to fresh air is 2 to 3 minutes.

About 1 volt greater than the nominal 5-volt operating potential is recommended for the initial warmup and to clean the sensor after exposure to a noxious gas. At the 5-volt operating potential, the sensor's heater draws 130 mA of current. Its resistance in fresh air is between 20,000 and 100,000 ohms.

Home Gas Alarm. The circuit illustrated in Fig. 1 is a line-powered gas detector for home use. Switch *S1* applies a potential of about 6 volts to the filament of gas detector *TGS* when in the CLEAN position and about 5 volts in the RUN position. Sensitivity is preset by placing *S1* in the RUN position and adjusting *R2* until the alarm sounds and then backing off on the adjustment until the alarm just cuts out. Repeat this procedure after a 5-minute warmup period.

You can now test the sensor by rubbing a drop of alcohol between your fingertips in the vicinity of the mesh-topped sensor. The alarm should sound. After the alarm has sounded, set *S1* to CLEAN for 2 minutes or so. Then adjust the sensitivity with *R2*.

To compensate for variations between gas sensors and SCR's, use a value between 1000 and 5000 ohms for *R5* so that potentiometer *R2*'s rotation is approximately three-quarters clockwise when the alarm triggers in fresh air. Of course, when performing tests and making sensitivity adjustments, do not wear after-shave lotion

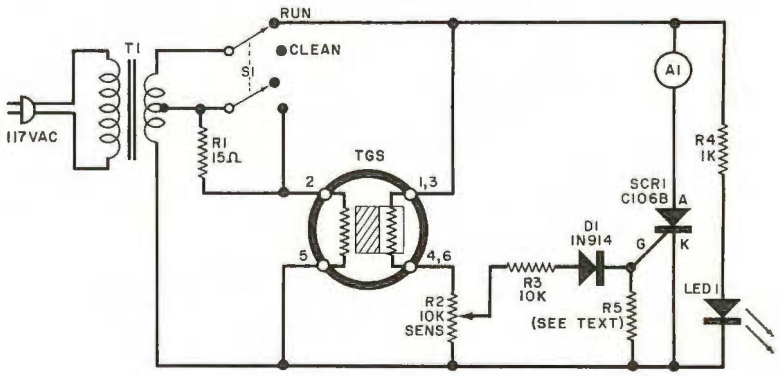

Fig. 1. Basic line-powered gas alarm causes SCR to fire passing current through a 12-volt bell, buzzer, or Sonalert.

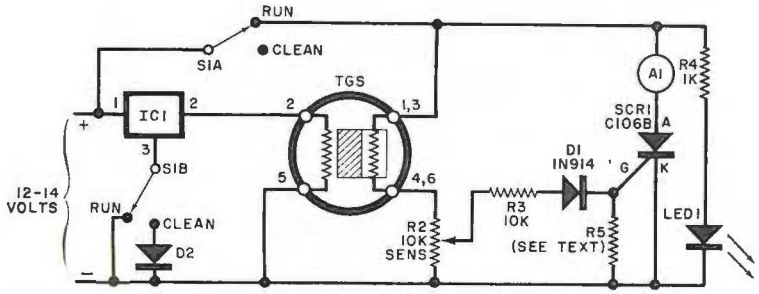

Fig. 2. Powered from a 12-volt dc source, this alarm is useful in trailers, campers, or boats. Operation is similar to home alarm.

(or perfume), or drink alcoholic beverages. If you do, the alarm will trigger falsely.

The entire circuit is simple enough to assemble with point-to-point wiring. Use a standard 7-pin vacuum-tube socket for the *TGS* gas sensor. The audible alarm device you use for *A1* should be rated as 12 volts and not exceed the rating of the SCR in its current demand. If you plan to use this circuit in a potentially explosive atmosphere, use a noncontact type alarm, such as the Mallory Sonalert®. Also, *R4* and *LED1* serve as a power-on indicator system, which can be eliminated from the circuit if you wish to economize.

Mobile Alarm. The circuit for a gas alarm system for car, boat, trailer, etc., is shown in Fig. 2. This circuit is similar to that shown in Fig. 1 except that it does not get its power from the 117-volt ac line. Regulator *IC1* compensates for variations in the vehicle's battery voltage that occur when the generator/alternator cuts in and out. If such variations reach the sensor's filament, changes can occur in the sensor's resistance. Diode *D2* increases the heater potential from the nominal 5-volt operating point to about 5.7 volts when *S1* is set to CLEAN.

PARTS LIST

A1—12-volt signalling device (buzzer, Mallory Sonalert®, etc.)
D1—1N914 diode
D2—50-volt, 1-ampere silicon diode
D3,D4—1N34 germanium diode
IC1—5-volt regulator IC (Radio Shack No. 276-2770 or similar)
LED1—Any red light-emitting diode
M1—50-μA meter movement (Lafayette Radio No. 99R51146 or similar)
The following resistors are ½-watt, 10%:
R1—15 ohms
R3,R6,R7—10,000 ohms
R4,R8—1000 ohms
R5—See text
R9—2700 ohms
R2,R10—10,000-ohm linear-taper potentiometer
S1—Dpdt switch
S2—Spdt switch
SCR1—C106B silicon controlled rectifier (Radio Shack No. 276-1079 or similar)
T1—12.6-volt, 1-ampere center-tapped transformer
TGS—Model 812 Taguchi Gas Sensor (Available from Southwest Technical Products Corp., Dept. PE-1, 219 W. Rhapsody, San Antonio, TX 78216 at $6.95 each)
Misc.—Suitable enclosure; 7-pin tube socket for sensor; perforated board; machine hardware; hookup wire; solder; etc.

The value of *R5* should be selected in the same manner as for the home alarm. Unlike the home alarm system, the mobile system's alarm cannot be turned off via *R2* because of the dc flowing through the SCR unless *A1* is a mechanical buzzer that interrupts the current flow.

To operate the system, first place *S1* in the CLEAN position for 2 to 3 minutes. Then set the switch to RUN.

Turning *R2* down and flipping *S1* to CLEAN, and back to RUN, will turn the buzzer off.

Gas Measuring System. The circuit shown in Fig. 3 is particularly interesting because it provides a quantitative measurement of gas concentration, rather than the simple go/no-go indication of the previous circuits. This circuit can be used for any gas measurement from vehicular engine tuneups to gas-leak detection. In use, the meter's pointer swings up-scale by an amount proportional to the nearness to the source of the gas or concentration of gas.

The power supply for the gas measuring system is similar to that used in the mobile alarm circuit. The sensing element of *TGS* becomes one side of a bridge in this circuit, with the other sides consisting of *R7* or *R8* and both sides of potentiometer *R10*. The meter movement is connected across the bridge and *R10* adjusted for bridge balance (0 indication on the meter). When gas is introduced to the sensor, the resistance of *TGS* decreases, unbalancing the bridge. When this occurs, the meter pointer starts moving upscale by an amount directly proportional to the amount of unbalance in the bridge. Resistor *R6* limits the total current through the Taguchi Gas Sensor.

To operate the system, first set *S1* to CLEAN for 2 minutes, switch to RUN, set *S2* to the desired sensitivity range, and null the meter with *R10*. Accurate

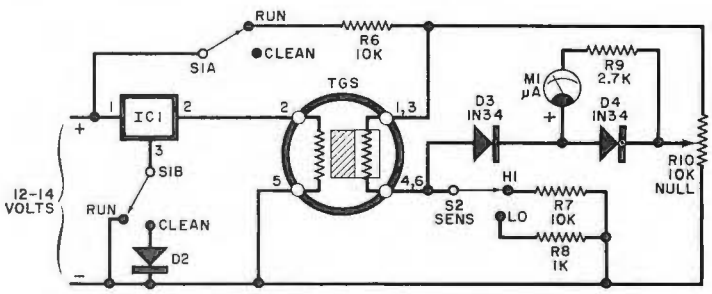

Fig. 3. This 12-volt dc detector uses a meter readout instead of alarm for quantitative leakage measurements and locations.

meter calibration requires specialized equipment, which your local service station might use to perform antipollution emissions checks.

The major problem with the sensor is that it does not differentiate between carbon monoxide and carbohydrates. However, comparing the exhaust readings of your vehicle's exhaust with those obtained with a commercial gas analyzer will give you reasonably good calibration.

In the gas measuring configuration, the gas sensor should be physically separated from the electronics package. Use a flexible four-conductor cable between sensor and electronic package.

When making measurements, you can set the detector to high sensitivity first and, if necessary, switch to the lower sensitivity range. Operated this way, the detector should be able to locate almost any gas leak along a complex arrangement of pipes. ◈