SNS COLLEGE OF TECHNOLOGY

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COIMBATORE-35.

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DEPARTMENT OF AUTOMOBILE ENGINEERING

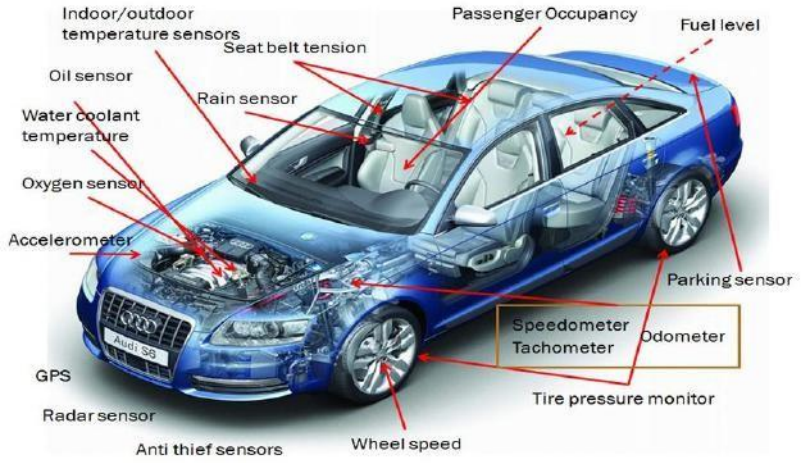
COURSE NAME : 19MCE402 – AUTOTRONICS

IV YEAR / VII SEMESTER

Unit 3 - Working principle and characteristics of Airflow rate, Engine crankshaft angular position

Sensors

Sensors are the components of the system that provide the inputs that enable the computer **(ECM)** to carry out the operations that make the system function correctly.



Types of Sensors

1. Mass air flow (MAF) rate
2. Exhaust gas oxygen concentration (possibly heated)
3. Throttle plate angular position
4. Crankshaft angular position/RPM
5. Coolant temperature
6. Intake air temperature
7. Manifold absolute pressure (MAP)
8. Differential exhaust gas pressure
9. Vehicle speed
10. Transmission gear selector position

Mass air flow (MAF) rate sensor

- Airflow sensors are used on engines with multiport electronic fuel injection. This is because the amount of fuel delivered by an EFI system is controlled by a computer (powertrain control module or PCM) which turns the fuel injectors on and off.
- The airflow sensor keeps the computer informed about how much air is being pulled into the engine past the throttle plates. This input along with information from other engine sensors allows the computer to calculate how much fuel is needed.
- The computer then increases or decreases injector duration (on time) to provide the correct air/fuel ratio.

Types

- Vane type Air Flow Rate Sensor
- Hot Wire type Air Flow Rate Sensor

Vane type air flow (MAF) rate sensor

- An engine requires the correct air–fuel ratio to suit various conditions. With electronic fuel injection the ECM controls the air–fuel ratio and in order to do this it needs a constant flow of information about the amount of air flowing to the engine.
- With this information, and data stored in its memory, the ECM can then send out a signal to the injectors, so that they provide the correct amount of fuel.
- Air flow measurement is commonly performed by a ‘flap’-type air flow sensor. The air flow sensor shown in Figure A. uses the principle of the potential divider (potentiometer).

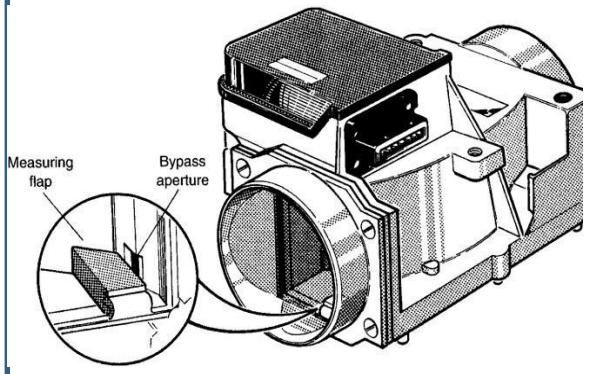


Fig. A

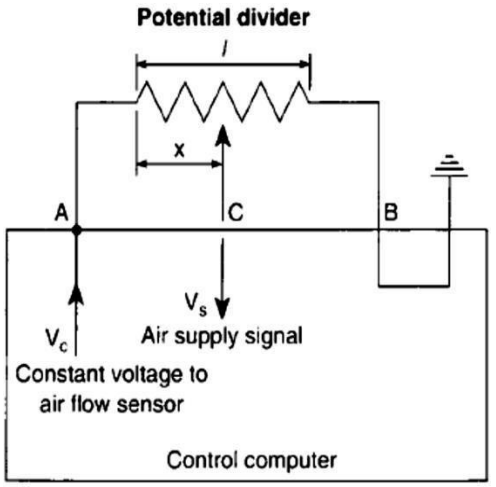


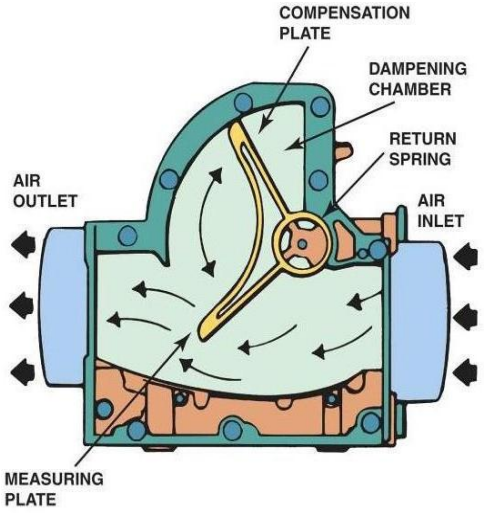
Fig. B

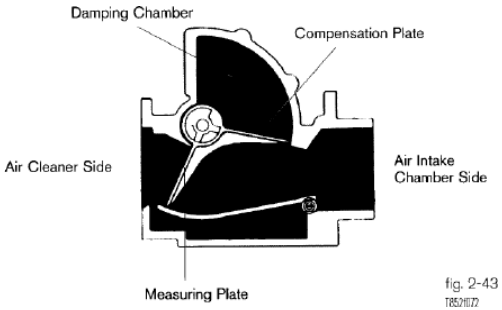
- Figure B. shows the theoretical form of a simple potential divider. A voltage, say 5 V, is applied across terminals *A* and *B*. *C* is a slider which is in contact with the resistor and a voltmeter is connected between *A* and
  - *C*. The voltage V_{AC} is related to the position of the slider
  - *C* in the form $V_{AC} = V_{AB} * x/l$.
- In the air flow sensor, the moving probe (wiper) of the potential divider is linked to the pivot of the measuring flap so that angular displacement of the measuring flap is registered as a known voltage at the potentiometer.

- The flap has a wiper arm that rotates against a sealed potentiometer (variable resistor or rheostat), allowing the sensor's resistance and output voltage to change according to airflow.
- The greater the airflow, the further the flap is forced open. This lowers the potentiometer's resistance and increases the voltage return signal to the computer.
- A compensation plate acts as a shock absorber to prevent rapid movement or vibrations of the measuring plate.
- A sealed idle mixture screw is also located on the airflow sensor. This controls the amount of air that bypasses the flap, and consequently the richness or leanness of the fuel mixture.

VANE AIRFLOW SENSOR

- Figure shows a simplified form of the air flow sensor. The closed position of the measuring flap will give a voltage of approximately zero, and when fully open the voltage will be 5 V.
- Intermediate positions will give voltages between these values. In practice, it is not quite as simple as this, because allowance must be made for other contingencies.
- A vane airflow sensor is located ahead of the throttle and monitors the volume of air entering the engine by means of a spring- loaded mechanical flap. The flap is pushed open by an **amount that is proportional to the volume of air entering the engine.**





VANE AIRFLOW SENSOR PROBLEMS

- Vane airflow sensors as well as all the other types of airflow sensors **can't tolerate air leaks.** Air leaks downstream of the sensor can allow "unmetered" or "false" air to enter the engine. The extra air can lean out the fuel mixture causing a variety of driveability problems, including lean misfire, hesitation and stumbling when accelerating, and a rough idle.
- **Dirt can also cause problems**. Unfiltered air passing through a torn or poor fitting air filter can allow dirt to build up on the flap shaft of a vane airflow sensor causing the flap to bind or stick. The operation of the flap can be tested by gently pushing it open with a finger. It should open and close smoothly with even resistance. If it binds or sticks, a shot of carburetor cleaner may loosen it up otherwise the sensor will have to be replaced.

- **Backfiring in the intake manifold** can force the flap backwards violently, **often bending or breaking the flap.** Some sensors have a "backfire" valve built into the flap to protect the flap in case of a backfire by venting the explosion. But the anti-backfire valve itself can become a source of trouble if it leaks. A leaky backfire valve will cause the sensor to read low and the engine to run rich.

Hot Wire Type MAF

- The hot wire MAF sensor is a variation of a classic air flow sensor that was known as a hot wire anemometer and was used, for example, to measure wind velocity for weather forecasting.
- In this MAF, the hot-wire, or sensing, element is replaced by a hot-film structure mounted on a substrate.
- On the air inlet side is mounted a honeycomb flow straightener that "smooths" the air flow (causing nominally laminar air flow over the film element).

Positions Sensors

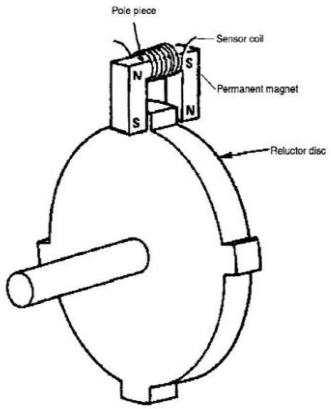
- The positions sensors are generally speed sensors of different working principle used for detecting the position of different parameters.
- Parameters Measured,
  1. Crankshaft Position Sensor
  2. Camshaft Position Sensor
  3. ABS Wheel Sensors
  4. Vehicle Speed Sensor
- Working Principles used,
  1. Magnetic Reluctance (Variable Reluctance) type
  2. Hall Effect type
  3. Optical Type

Crankshaft Position Sensor

- A **crank position sensor** is a component used in an internal combustion engine to monitor the position or rotational speed of the crankshaft. This information is used by engine management systems to control ignition system timing and other engine parameters.

Magnetic Reluctance (or Variable Reluctance) type sensor

- This type of sensor is used in many vehicle applications, such as ignition systems, engine speed sensors for fuelling, and wheel speed sensors for anti-lock braking etc.
- Air has a greater reluctance (resistance to magnetism) than iron and this fact is made use of in many sensors.



The principal elements of the sensor are:

- an iron rotor with lobes on it;
- a permanent magnet;
- a metallic path (the pole piece) for carrying the magnetic
- Flux, a coil, wound around the metallic path, in which a voltage is induced.

- The reluctor disc has a number of tabs on it and these tabs are made to move through the air gap in the magnetic circuit.
- The movement of the reluctor tabs, through the air gap is achieved by rotation of the reluctor shaft. The voltage induced in the sensor coil is related to the rate of change of magnetic flux in the magnetic circuit.
- The faster the rate of change of magnetic flux the larger will be the voltage that is generated in the sensor coil. When the metal tab on the reluctor rotor is outside the air gap, the sensor voltage is zero.

Thank You !