UNIT-1

STUDY MATERIAL

1. Tachometers
   - **Contact tachometers**
   - **Non-Contact tachometers**
2. Stroboscopes

Speed is a rate variable defined as the time rate of the motion. Common forms and Units of speed measurement include linier speed (m/s) and angular speed (radian/s or rpm). Angular speed measurement is made with tachometer which may be broadly classified as:

1. Mechanical tachometer
2. Electrical tachometer

In selecting proper type of tachometer, following terms should be considered.

-Cost.
-Need of portability.
-Accuracy desired.
-Magnitude of speed to be measured.
-Size of rotating element.

- **Mechanical Tachometer**

  1- Revolution counter and timer.

  2- Tachoscope

  3- Hand speed indicator

  4- Slipping clutch tachometer

  5- Centrifugal force tachometer

  6-Vibrating reed tachometer

- **Electrical Tachometer**

  1- Drag cup tachometer

  2- Commutated capacitor tachometer

  3- Tachogenerators

  (A) AC type

  (B) DC type

4- Contactless electrical tachometer

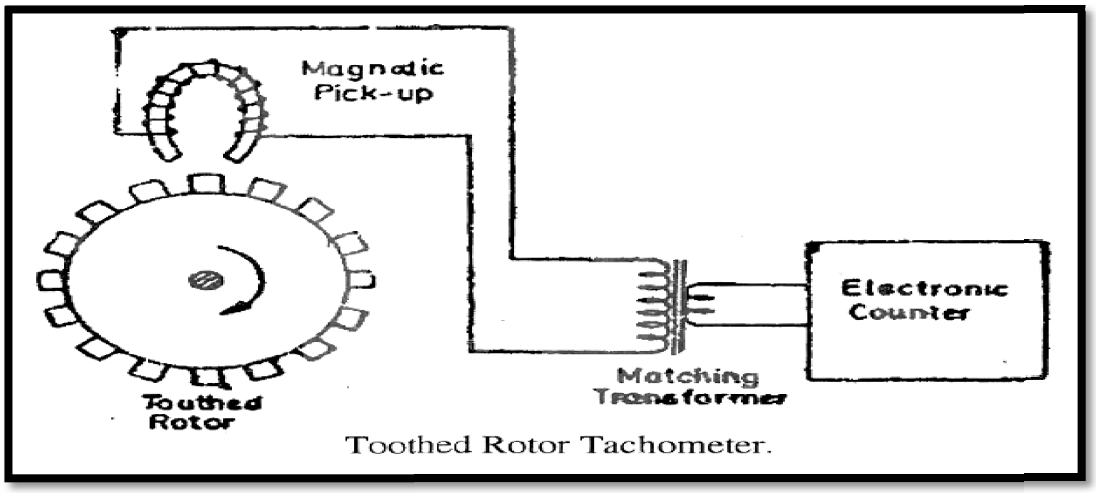
(A) Inductive pickup tachometer

(B) Capacitive type pickup tachometer

(C) Photo electric tachometer

(D) Stroboscope tachometer

Inductive Pickup Tachometer



Toothed Rotor Tachometer.

This type of tachometer produces pulse from a rotating shaft without any physical contact between tachometer and rotating shaft. This tachometer consists of metallic tooth rotor mounted on the shaft, whose speed to be measured. The magnetic pickup is placed near to tooth gear. The magnetic pickup consists of housing containing a small permanent magnet with a coil turn around it. When the shaft rotates the teeth pass in front of the pickup and produce a change in the reluctions of magnetic circuits. The magnetic flux becomes high when the tooth of gear comes in front of magnetic pick up a flux drop off as the tooth gear past. Hence a voltage is generated in coil, which is proportional to the rate of change in magnetic flux. The frequencies of pulse depend on the number of teeth on rotor and speed of rotation.

The rotational speed of shaft is given by,

N = Pulses per second/Number of teeth on rotor

N= f/t in rpm

Advantages

- It provides accurate indication of speed.
- It may be work under conditions when oil, water or non-corrosive liquids are present.
- It can be measure speed of rotating reciprocating or vibrating components.
- It is available with ranges from 0-25 rpm to 0-72000rpm.

Capacitive Type Pickup Tachometer

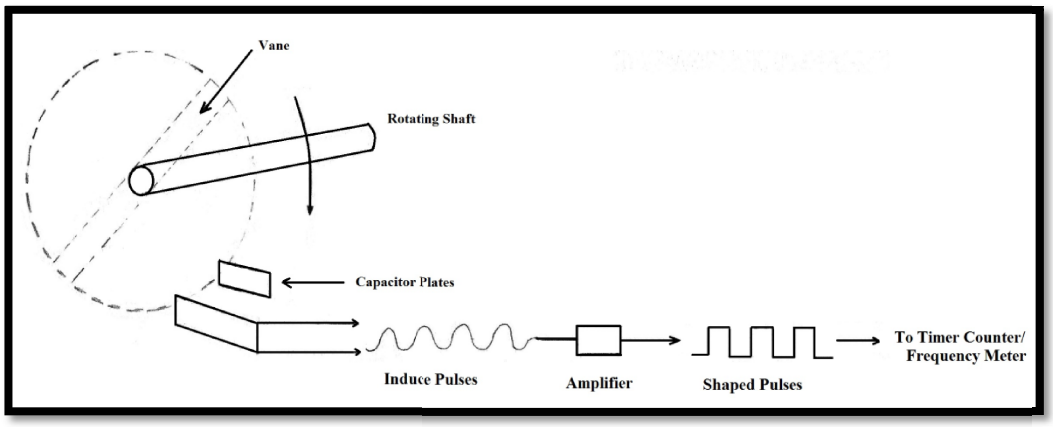
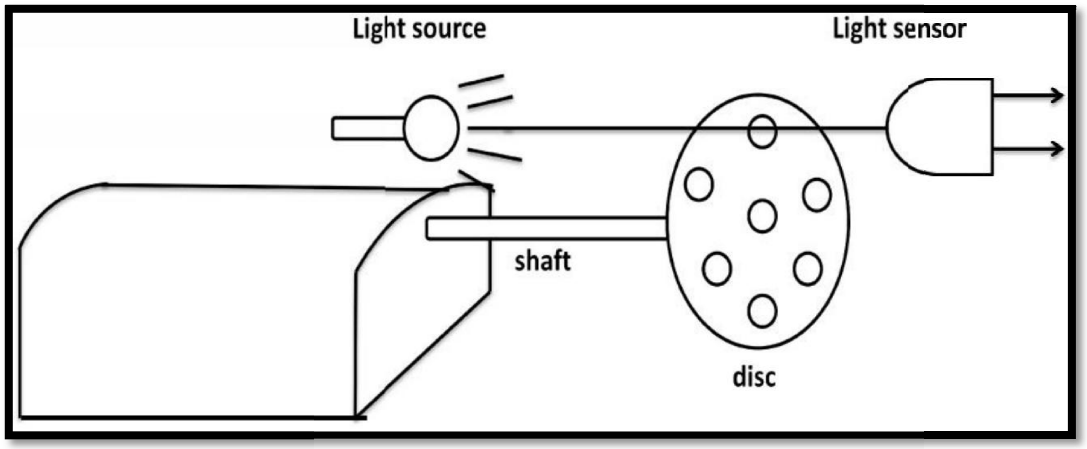


Fig.1 Capacitive Type Pickup Tachometer

The device consist of a vane attach to one end of rotating machine shaft. When the shaft rotates between the fixed capacitive plates a change in capacitance result.The capacitor form a part of an oscillator tank so that number of frequency changes per unit time is a measure of shaft speed. The pulses thus produce and are amplified and conditioned

then sent to the frequency measuring unit or digital counter. From counter reading or frequency measurement shaft rotation can be obtained.

Stroboscope



Stroboscope

If a rotating shaft or wheel is having a radial mark as shown in figure, and the flash or pulse light thrown on rotating disc each time the mark arrives at the same position, the mark will appear stationary. If we know the rate of flashing (no. of light pulse thrown on disc per minute) we know the speed of the shaft or wheel in rpm, as they are numerically equal.

The stroboscope is non-contact type speed measuring instrument and commercially are generally available the speed range of 600 to 20000 RPM. Therefore, Shaft speed in RPM = No. of flash of light per minute.

Equipment which produces pulses of light at a controllable frequency is called stroboscope or stroboflash in which the pulse of light is produce by a neon or xenon lamp. The frequency of flashing is set by a pointer knob which also indicates the frequency on a circular scale.

Therefore, the measure a rotational speed of rotating, reciprocating or an oscillating member, the rate of flashing is so adjusted then the member (mark on number) appears stationary. This occurs when the frequency of illumination (flash light throw) equal the frequency of rotating member, i.e. A cycle motion occurring 1000 times a minute will appear stationary if it viewed against uniformly spaced light flashes occurring 1000 time per minute.

Procedure for speed measurement by Stroboscope:

1) Makes mark on the shaft whose speed to b e measured. Generally one mark is made on the shaft.
2) Throw flash light on the rotating shaft on which mark is made. Starting with highest flashing rate, slowly and steadily reduces the flashing rate. Each time a number of stationary images appear, the corresponding flash speed is noted.

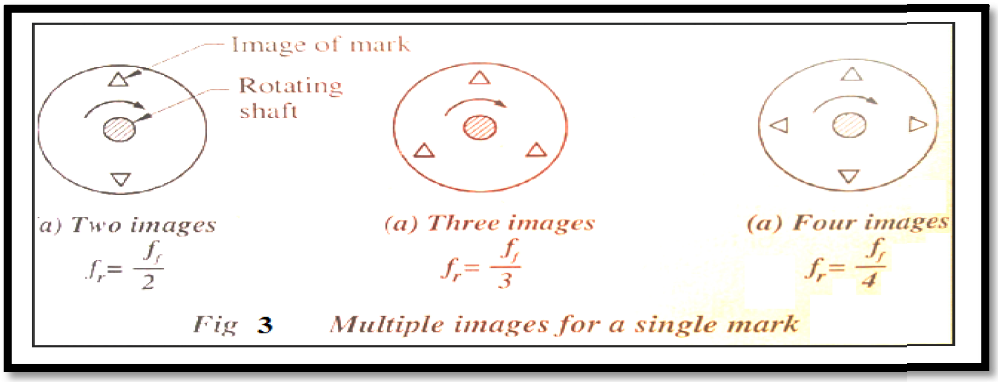


Fig 3 Multiple images for a single mark

<u>Advantages of stroboscope</u>:

1) They are non-contacting type speed measuring instrument, hence it imposes no load on the shaft.
2) Light weight and simple in construction.
3) No special attachment is required for measurement of speed.

4) They are particularly useful where it is inconvenient or impossible to make contact with shaft or moving part.

Disadvantages of stroboscope:

1) Less accurate because variable frequency oscillator cannot stabilize to give fixed frequency.
2) It cannot be used in surroundings where the ambient light is above a certain level.

Sensors

Definition: The generic name for a device that senses either the absolute value or a change in a physical quantity such as temperature, pressure, flow rate, or pH, or the intensity of light, sound, or radio waves and converts that change into a useful input signal for an information-gathering system; a camera is therefore a sensor, and a transducer is a special type of sensor.
There are many sensors used in automobiles are listed below:

1. Engine coolant temperature
2. Air temperature
3. Barometric pressure/manifold absolute pressure
4. Mass air flow
5. Idle air controller
6. Crankshaft
7. Camshaft
8. Throttle position

9. Oxygen sensor
10. Knock sensor

Name	Principle	Position	Description
Manifold Absolute Pressure (MAP) sensor	Mechanical Piezoelectric, Capacitive.	In intake manifold	A manifold absolute pressure sensor (MAP) is one of the sensors used in an internal combustion engine's electronic control system. Engines that use a MAP sensor are typically fuel injected. The manifold absolute pressure sensor provides instantaneous manifold pressure information to the engine's electronic control unit (ECU). This is necessary to calculate air density and determine the engine's air mass flow rate, which in turn is used to calculate the appropriate fuel flow.
Knock sensor	Piezoelectric	Near combustion chamber	Sound consist of pressure covers which for example dissipates through the air through solid materials such as metal. Acoustic sensors are used for measuring pressure waves one such example are knock Sensors which registers combustion noise in the engine. Knock sensor is bolted to the crank case. The actual sensor element is a ring shape piezzo ceramic. The sound osscilation are transferred by the crank case initially to the seismic mass. This seismic mass transfers to oscilation to the piezzo element in the form of pressure forces. These forces trigger electrical alterations voltage signaling in the piezzo element. They picked of by contact plates and processed further in the control module.
Hot wire thin film air flow sensor	thermister	Intake manifold	It is usually located between the air cleaner and the throttle valve. The sensor element consists of the ceramic chip on which different resistors are located. One of these is an electrically heated platinum resistor. The proportion of the intake is lead passed these resistors and cools it. Immediately next to is a temperature dependent sensor resistor which registers the temperature of the heating resistor. Sensors electronic regulate the temperature at the heating resistor by varying the voltage. If the air mass flow changes the amount of heat transferred by heating resistor to the air flowing pass it also changes. The electronics detect the change in temperature and reduce the voltage of the heating resistor until the set temperature is reached. his controlled voltage used by engine control module is a measure for the intake air mass.
Crankshaft position sensor	Optical, inductive,	Near flywheel	The Crank shaft position sensors consist of a permanent magnet. The soft iron core and a stationery coil. The sensor is located on the engine housing and is separated from the fly wheel by an air gap. The fly wheel may have teeth or grooves.

Actuators

'Actuators' is a general term used here to describe a control mechanism. When controlled electrically actuators will work either by the thermal or magnetic effect. The term actuator will be used to mean a device that converts electrical signals into mechanical movement.

Definition: An actuator is a type of motor for moving or controlling a mechanism or system. It is operated by a source of energy, typically electric current, hydraulic fluid pressure, or pneumatic pressure, and converts that energy into motion.

Here we are about to study different sensors and actuators used in **MARUTI 800CC**

MPFI car engine. Different sensors and actuators used are as follows:

(i) CMP sensor.

(ii) TP sensor.

(iii) MAP sensor.

(iv) Idle speed actuators.

DESCRIPTION:

CMP sensor

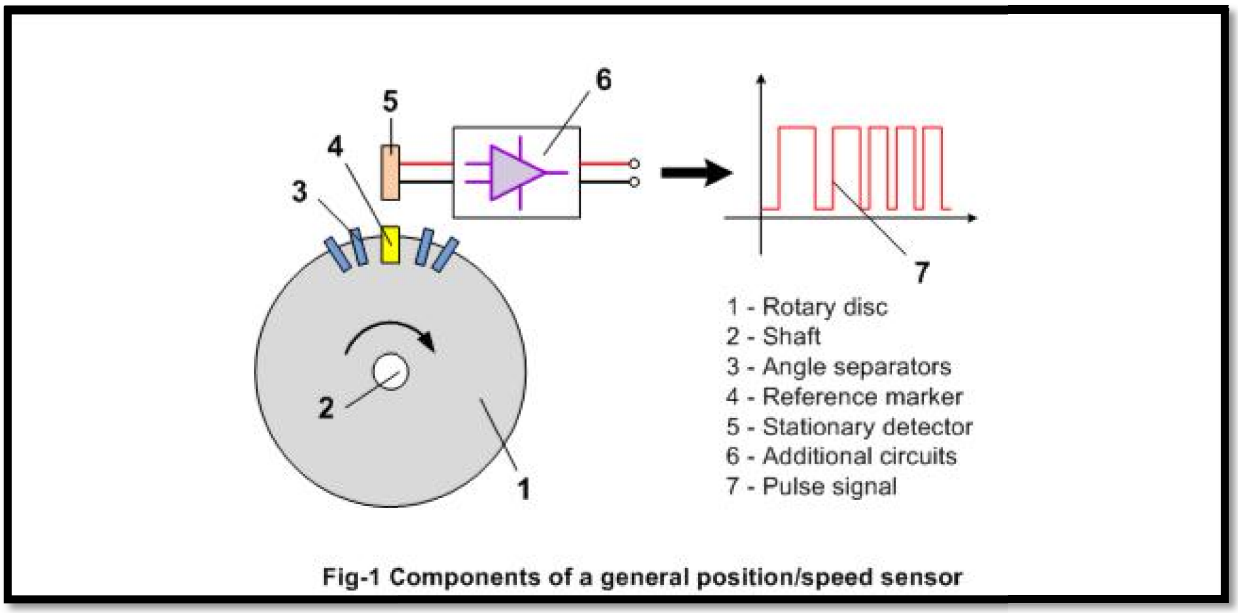


Fig-1 Components of a general position/speed sensor

Camshaft position sensors are similar devices that operate based on pulse detection and counting. The fundamental components of these sensors include a toothed disc mounted on the shaft, a stationary detector and electronic circuitry (Fig-1).

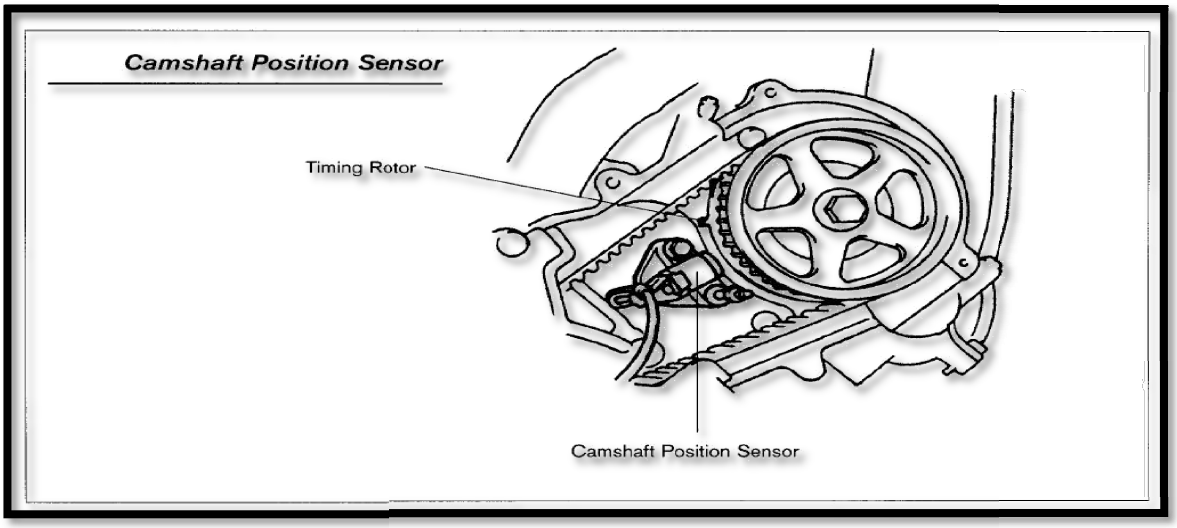
The disc has teeth or marks distributed evenly around the circumference. When the shaft spins, teeth or marks pass by the stationary detector and generate a series of electrical pulses.

The frequency of these pulses is detected and converted to the corresponding shaft rotation speed. The relative angular position can be obtained by counting the number of pulses.Additional reference markers are required to sense the absolute position of the crank or camshaft. The Crank position sensor is usually mounted in the crankcase over the toothed wheel on the crankshaft.

The Camshaft position sensor is usually mounted in line with the toothed wheel on the end of the camshaft. It is usually hidden under the timing chain cover on the front of the engine. Some sensors have two sets of discs with a constant phase shift in order to determine the direction of the rotary motion.

Generally, there are four types of camshaft position sensors: magnetic pick- up coils, Hall-effect sensors, magneto-resistive element (MRE) sensors, and optical sensors. The first three utilize the metal teeth of a wheel to generate a series of electric pulses, based on changes in the magnetic field, as the teeth come into the proximity of the sensor.

Optical position sensors use a light-emitting diode (LED) light source and a photodiode to detect optical marks on the shaft or slots in a disk as they move fast the detector. Optical sensors have a good degree of accuracy and are suitable for both high-speed and low-speed applications, but the optical components and disc must be kept clean to ensure an accurate reading.



TP sensor

A throttle position sensor (TPS) is a potentiometer, connected to the throttle shaft on the throttle body, which reports the position of the throttle as a value ranging from 0 to 5V.

Engines using cams with large amounts of overlap tend to generate less manifold vacuum and have a very unsteady MAP signal especially at idle. As a result, the normal MAP are unable to be used to achieve an acceptable state of tune. Instead, the engine load signal can be based on the signal from a throttle position sensor (TPS). In this mode Link ECUs don't show units of kPa, but instead uses 0% to 100% to represent fully closed to fully open throttle.

In Link ECUs, a TPS sensor can be used in conjunction with a MAP or MGP sensor, and is particularly useful for features such as:

- Overrun Fuel Cut
- Idle Speed Control
- Acceleration Fuelling

Two modes are available when TPS is being used as the load axis - TPS with BAP correction, or TPS with MAP correction.

With BAP correction, Barometric Absolute Pressure (BAP) is used under vacuum as part of the fuel calculation to allow for atmospheric pressure changes. Under boost, Manifold Absolute Pressure (MAP) is used in place of BAP. This mode is most useful in engines where manifold pressure at low load is unstable (possibly due to aggressive camshaft profiles).

As manifold pressure is not automatically allowed for in the fuel equation, compensation must be made in the numbers used in the fuel table. This will result in small numbers in the low load areas and large numbers in the high load areas. The only drawback of this is decreased tuning resolution in low load areas.

With MAP correction, only Manifold Absolute Pressure (MAP) is used during the fuel calculation. This is suitable for applications that have more stable manifold pressure but require a throttle position based load scheduling (such as multi- throttle engines with gentle camshaft profiles). As this mode allows for manifold pressure in the fuel calculation a more even spread of numbers across the fuel table is achieved.

MAP sensor

MAP sensors are usually located on or near the inlet manifold on the engines.A manifold absolute pressure sensor is one of the sensors used in internal combustion engine with electronic control system. These engines are generally fuel injected. The MAP sensors provide instantaneous pressure information to engine electronic control unit. This calculates necessary air mass flow rate on the basis of air density.All engines are not fitted with these sensors. Some engines are also fitted with MAF mass air flow sensor for the same purpose.

Idle speed actuators

It regulates the position of the throttle valve plates to compensate for additional loads on the engine, like the air conditioner. It measures engine RPM readings, compares them to the reference RPM in the engine-control computer memory and adjusts the idle air by-pass. Figure 2 below shows the position of IAC valve. It is in fact a solenoid type of actuator.