Tachometer, What's That?

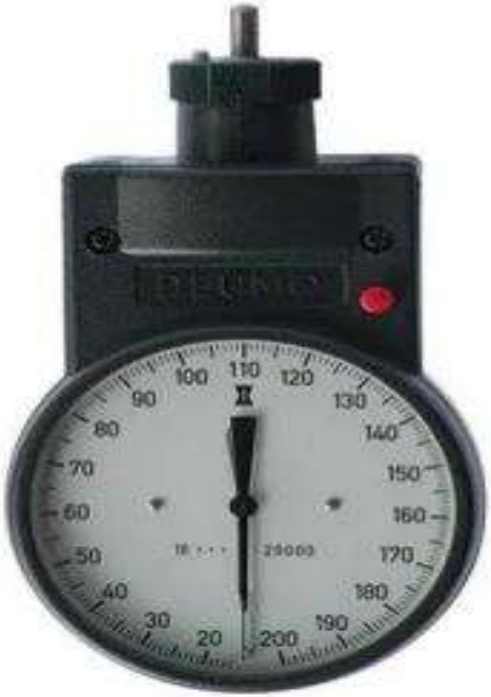
- Tachometer is used for measuring rotational speed
- Can be used to measure speed of a rotating shaft
- Can also be used to measure flow of liquid by attaching a wheel with inclined vanes
- Tachometers can be classified
  1. On the basis of data acquisition
     - Contact
     - Non contact types
  2. Classified as data type
     - Analog
     - Digital
  3. On the basis of power .
     - Mechanical
     - Electrical

What Are the Different Types of Tachometers?

- Classification of tachometers:
  - Mechanical Tachometers
    - Revolution counter
    - Hand speed indicator
    - Tachoscope
    - Centrifugal tachometer
    - Resonance (vibrating read) tachometer
  - Electrical Tachometers
    - Eddy current or drag cup tachometer
    - Tachogenerator (DC and AC)
  - Contactless electrical Tachometers
    - Magnetic pickup tachometer
    - Photo-electric tachometer
    - Stroboscope

Mechanical Tachometers

Hand speed indicator



Tachoscope

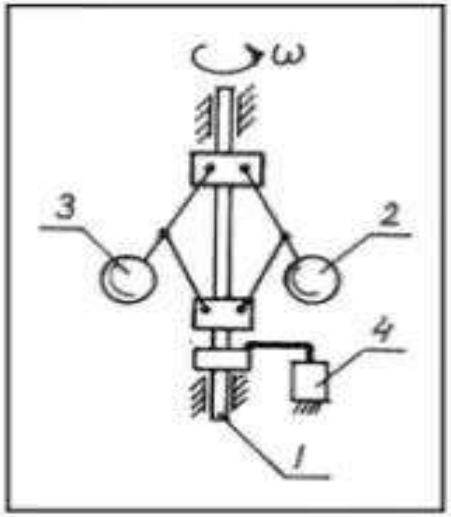
- Tachoscope consists of revolution counter for timing device.
- The two components are integrally mounted and start simultaneously when contact point is pressed against rotating shaft.
- The rotational speed is computed from reading of counter and timer.
- Tachometer can be used to measure speeds up to 5000r.p.m.

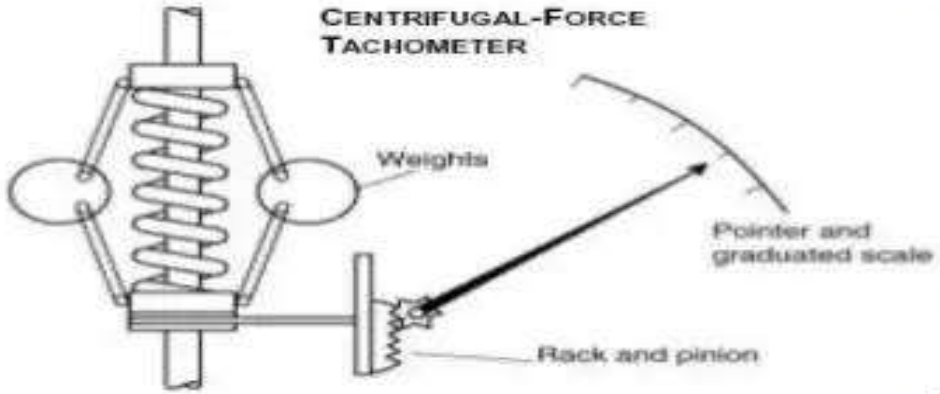
Tachoscope

Centrifugal tachometer

- Centrifugal Tachometer operates on principle that centrifugal force is proportional to speed of rotation.
- It consists two balls arranged about spindle. Centrifugal force developed by these balls compress spring as function of speed positions pointer.
- They are suitable for 4000r.p.m.

Centrifugal tachometer



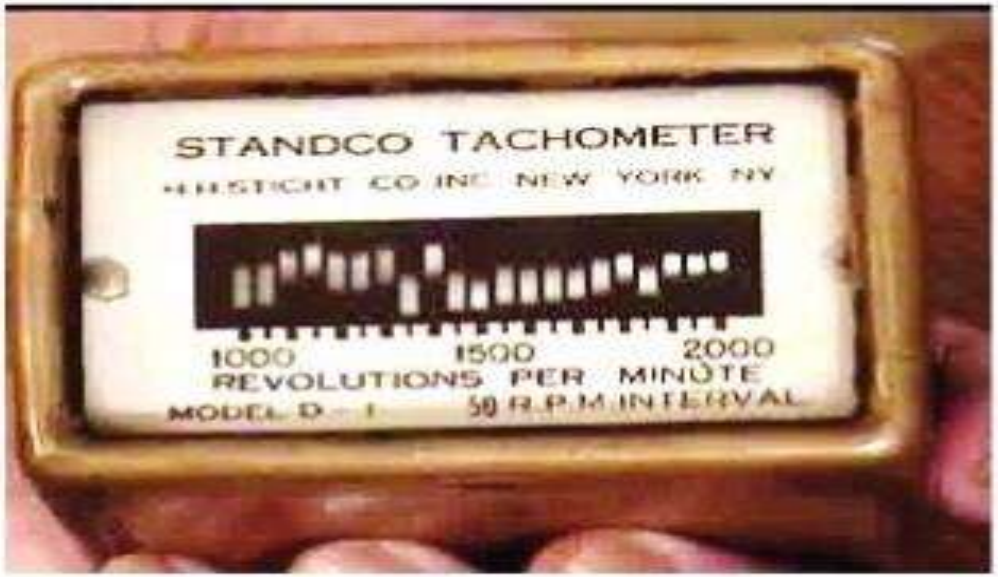


w = angular speed, 1 = shaft,
2 and 3 = masses, 4 = displacement-sensitive element.

Resonance (vibrating read) tachometer

- In Vibrating Read Tachometers a series of consecutively timed steel rods are used to determine speed on basis of vibrations created by machine.
- One end of rod is fixed to a base which is kept in contact with any non-moving part of machine and other is attached to calibrated scale.
- These can be used in speed range of 600-10000 rpm .

Resonance (vibrating read) tachometer

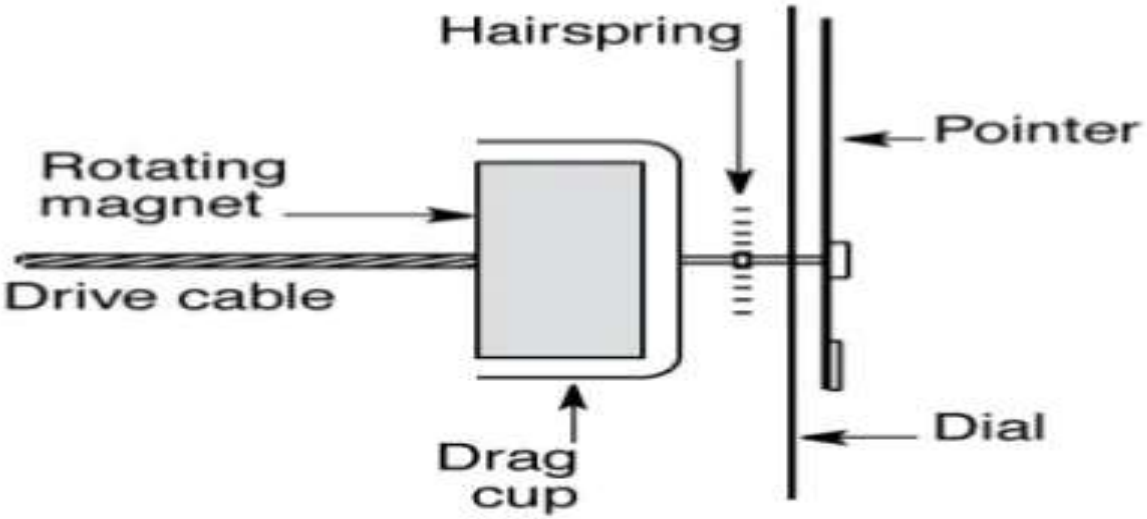


Electrical Tachometers

Eddy current or drag cup tachometer

- An eddy-current tachometer uses the interaction of the magnetic fields generated by a permanent magnet and a rotor, whose speed of rotation is proportional to the eddy currents generated.
- The currents tend to deflect a disk, which is mounted on the shaft and restrained by a spring, through a certain angle.
- The deflection of the disk, which is rigidly connected to a pointer, is indicated on a dial.

Eddy current or drag cup tachometer



magnetic-drag tachometer

D.C. Tachogenerator

- In a D.C. generator the e.m.f generated depends upon the following two factors:
  - (i) Field excitation
  - (ii) Speed
- If for the field system permanent magnet pole pieces are used, then the generated voltage depends only on the speed. Hence the **speed can be computed by measuring the generated e.m.f.**
- The shaft whose speed is to be measured is coupled to the armature.
- A moving coil voltmeter is connected across the brushes to measure the generated voltage. The variable resistance R is incorporated to limit the current through the voltmeter.
- Since voltage is proportional to speed, the voltmeter may be calibrated in terms of speed (r.p.m.).

D.C. Tachogenerator

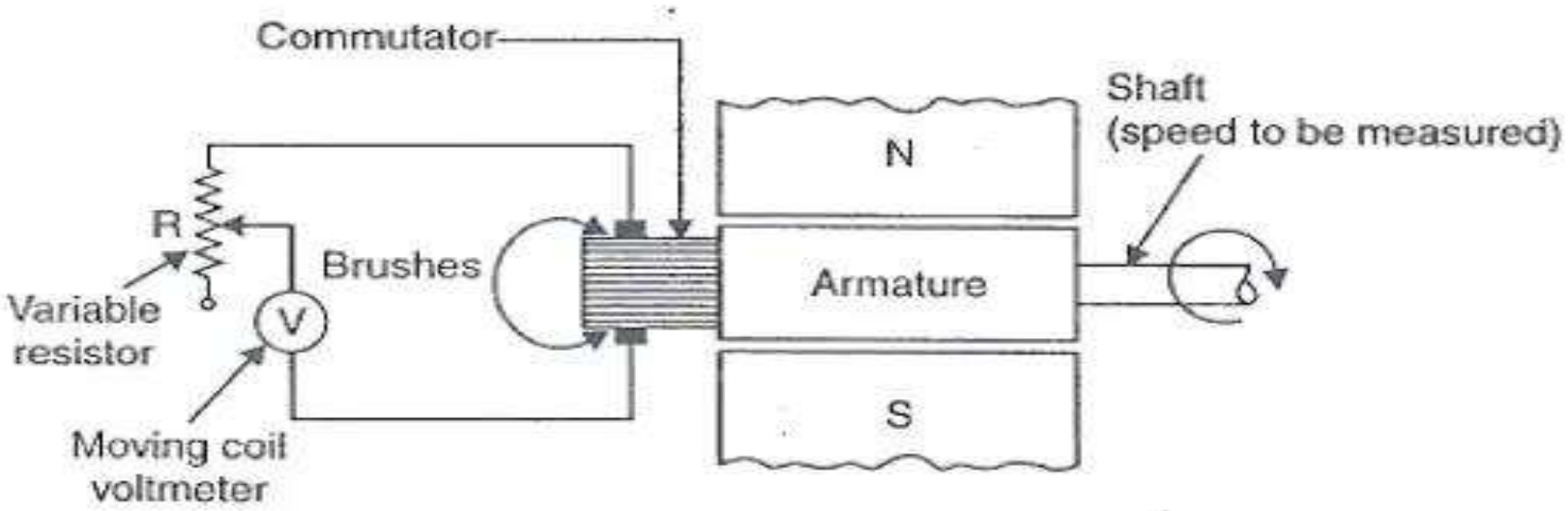


Fig. 32. D.C. tachometer generator.

A.C. Tachogenerator

- The inherent demerits associated with D.C. tachometer generator, due to the provision of commuter and brushes, are eliminated in A.C. tachometer generator.
- It consists of, like an alternator, a stationary armature (stator) and a rotating field system (rotor). Owing to the generation of e.m.f in a stationary coil on a stator, commutation problems no longer exist.
- The alternating e.m.f. induced in the stationary coil is rectified, and the output D.C. voltage is measured with the help of a moving coil voltmeter (V).
- The ripple content of the rectified voltage is smoothened by the capacitor filter (C).

A.C. Tachogenerator

- As the speed depends on both the amplitude of the voltage and frequency, anyone of them can be used as a measure of the speed. In an A.C. tachometer, it is the induced voltage that is considered as the required parameter.

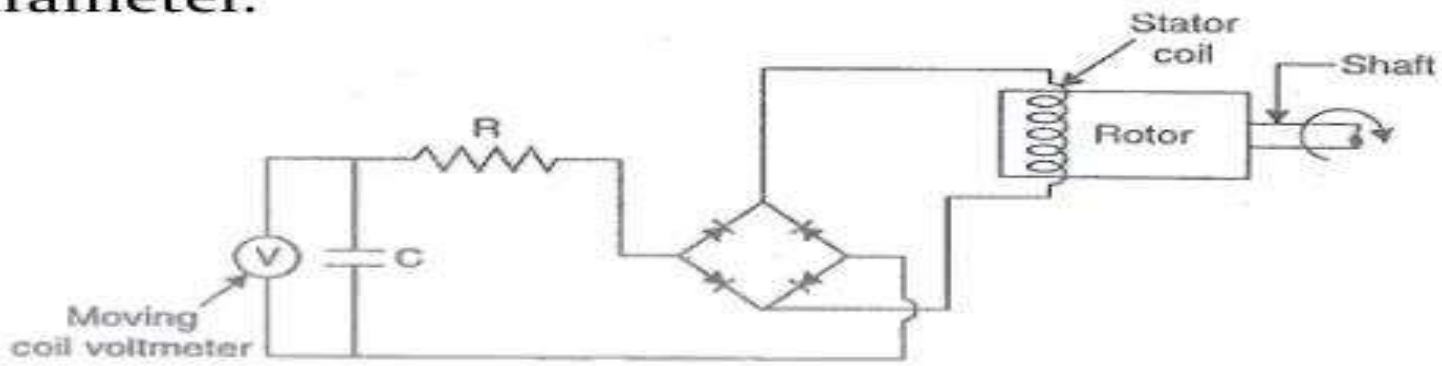


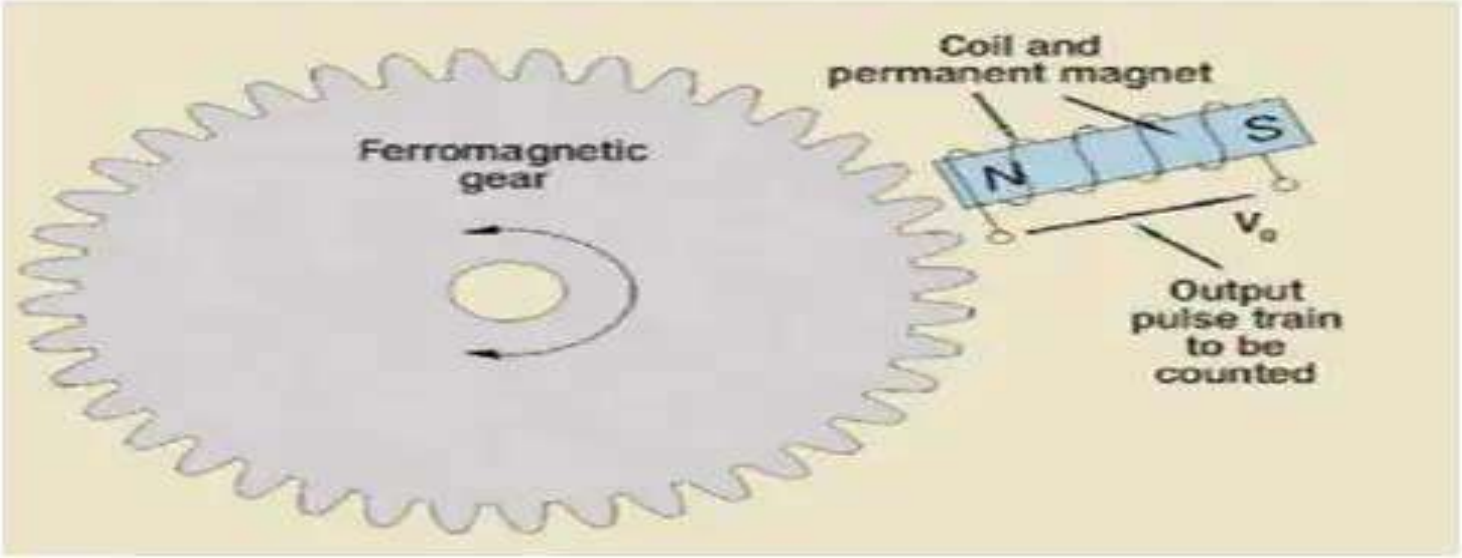
Fig. 33. A.C. tachometer generator.

Contactless electrical Tachometers

Magnetic pickup tachometer

- A coil wounded on permanent magnet not on iron core, this configuration enable us to measure rotational speed of the systems.
- In the construction of variable reluctance sensor, we use ferromagnetic gearwheel. As the gearwheel rotates, change in magnetic flux take place in the pickup coil which further induces voltage. This change in magnitude is proportional to the voltage induced in the sensor.

Magnetic pickup tachometer



Pickup tachometer

- Various pick-up devices can be used in conjunction with a digital counter to give a direct reading of speed.
- An inductive pick-up tachometer is shown in Figure (a).
- As the individual teeth pass the coil they induce an e.m.f. pulse which is appropriately modified and then fed to a digital counter.
- A capacitive pick-up tachometer is shown in Figure (b). As the rotating vane passes between the plates a capacitance change occurs in the form of a pulse.
- This is modified and then fed to the digital counter.

Pickup tachometer

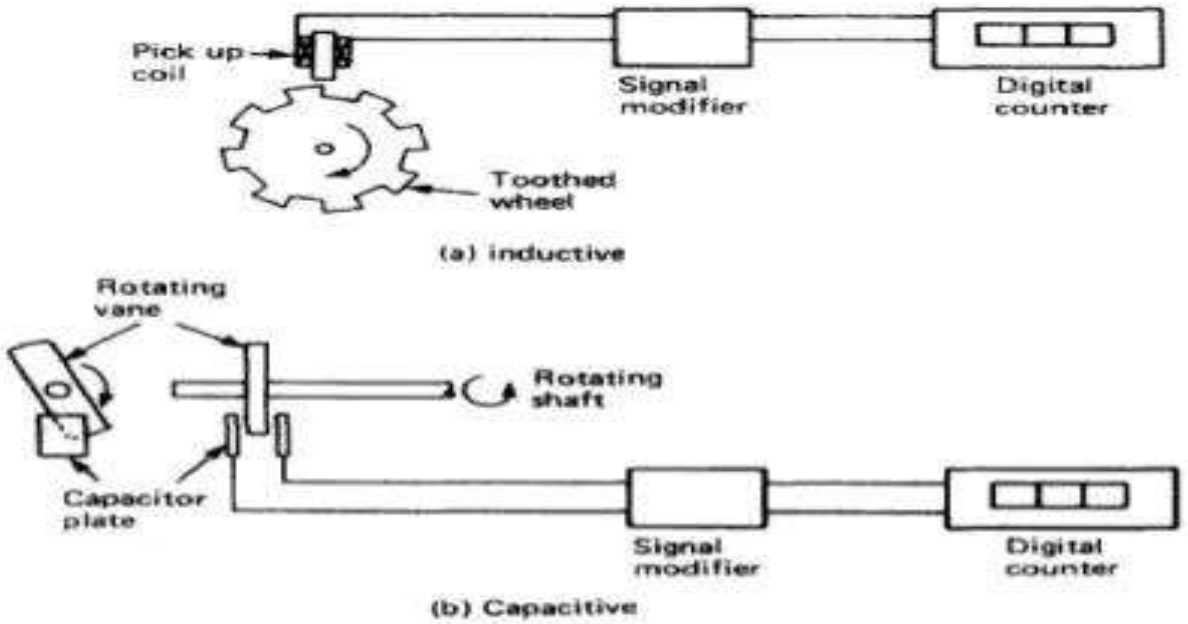


Figure Pick-up tachometers, (a) inductive; (b) capacitive

Photo-electric tachometer

- It consists of a opaque disc mounted on the shaft whose speed is to be measured. The disc has a number of equivalent holes around the periphery. On one side of the disc there is a source of light (L) while on the other side there is a light sensor (may be a photosensitive device or photo-tube) in line with it (light-source).
- On the rotation of the disc, holes and opaque portions of the disc come alternatory in between the light source and the light sensor. When a hole comes in between the two, light passes through the holes and falls on the light sensor, with the result that an output pulse is generated. But when the opaque portion of the disc comes in between, the light from the source is blocked and hence there is no pulse output.
- Thus whenever a hole comes in line with the light source and sensor, a pulse is generated. These pulses are counted/measured through an electronic counter.

Photo-electric tachometer

- The number of pulses generated depends upon the foliowing factors:
  - i. The number of holes in the disc;
  - ii. The shaft speed.
- Since the number of holes are fixed, therefore, the number of pulses generated depends on thespeed of the shaft only. The electronic counter may therefore be calibrated in terms of speed (r.p.m.)

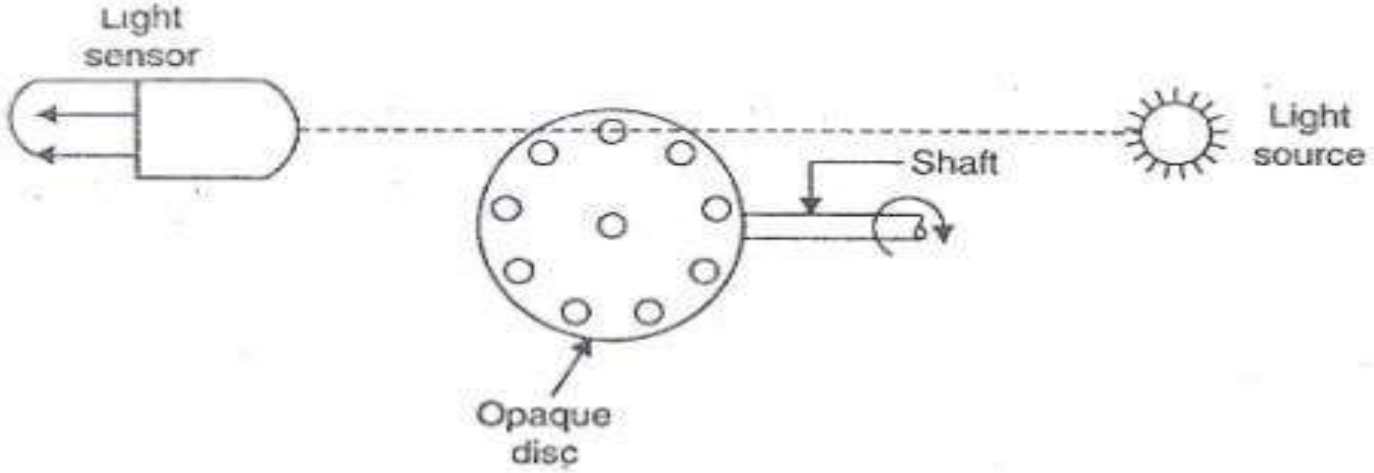
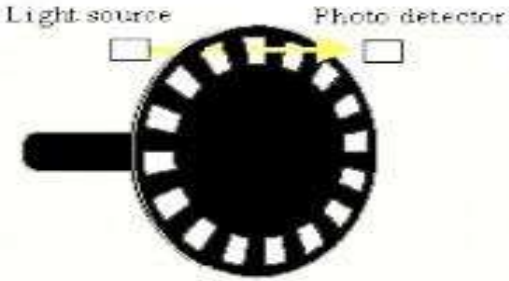
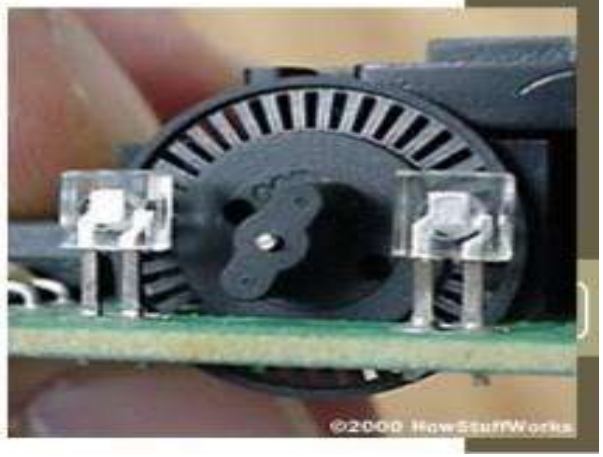


Photo-electric tachometer

- Computer mouse with a ball



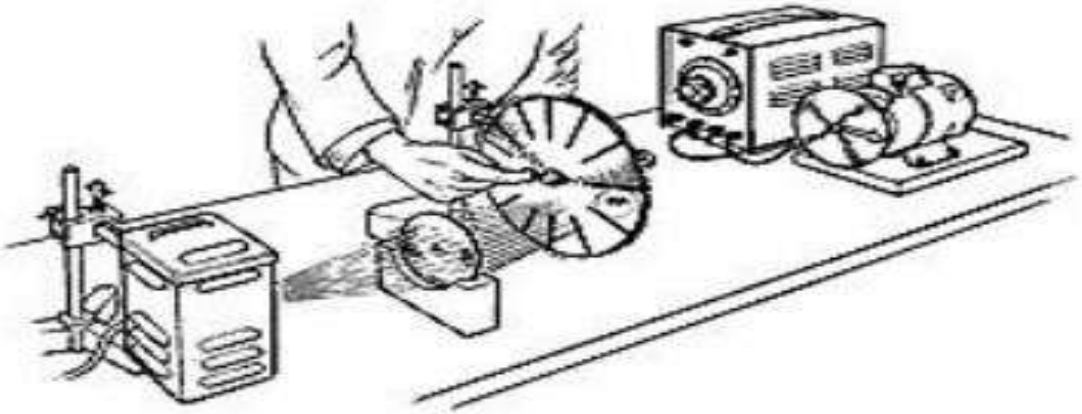


Stroboscope

- The instrument operates on the principle that if a repeating event is only viewed when at one particular point in it's cycle it appears to be stationary. A mark is made on rotating shaft, and a flashing light is subjected on the shaft. The frequency of the flashing is one very short flash per revolution.
- To determine the shaft speed we increases the frequency of flashing gradually from small value until the rotating shaft appears to be stationary, then note the frequency. The frequency then doubled, if there is still one apparent stationary image, the frequency is again doubled. This continued until two images appear 180 degrees apart. When first appear for these two images the flash frequency is twice the speed of rotation.

Stroboscope

- Stroboscopes are used to measure angular speed between 600 to 20000 rpm .
- It's advantage is that it doesn't need to make contact with the rotating shaft.



Comparison Between Analog and Digital Tachometers

Analog Tachometer

- Has a needle and dial type of interface
- No provision for storage of readings
- Cannot compute average, deviation, etc

Digital Tachometer

- Has a LCD or LED readout
- Memory is provided for storage
- Can perform statistical functions like averaging, etc