

TORQUE & POWER MEASUREMENT

$$P = \omega T$$

P= Power transmitted
(W) T= Torque (N-m)
 ω = angular speed (rad/s)

Devices used for power measurement are also known as dynamometers which are classified as

1. Transmission type – device is used on the shaft transmitting power.
2. Driving type – in this drive is obtained from the dynamometer itself.
3. Absorption type – in this mechanical energy is absorbed after it is measured.

Transmission Dynamometers - Types

1. Torsion dynamometer:
 - a. Torque meter – torque is directly measured using resistance strain gauges.
 - b. Torsion meter – angle of twist in the shaft due to torque is measured.
2. Belt dynamometer
3. Gear dynamometer

Torsion dynamometer

In a solid shaft of diameter d , subjected to torque T , following relations exist:

f_s – shear stress in shaft

G – shear modulus

γ – shear strain

ϵ_{45° – longitudinal strain in shaft at 45° to axis

θ – twist in the shaft over a shaft length L

For hollow shaft of outer radius r_o and inner radius r_i

$$T = f_s \left(\frac{\pi}{16} d^3 \right)$$

$$\gamma = \frac{f_s}{G}$$

$$\epsilon_{45^\circ} = \frac{\gamma}{2}$$

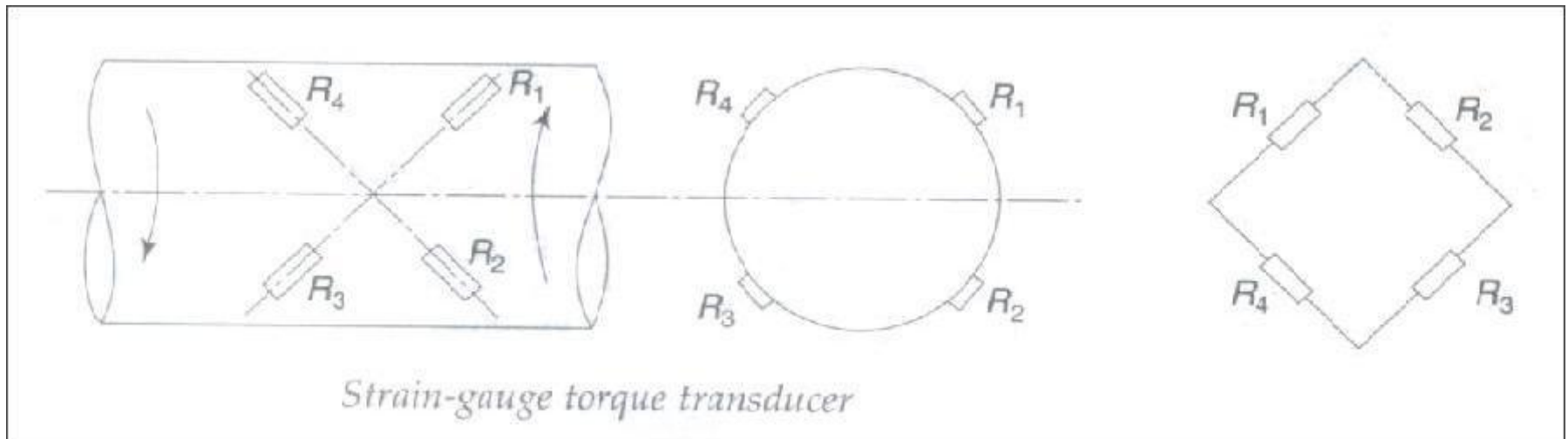
$$T = \frac{G\theta\pi d^4}{32L}$$

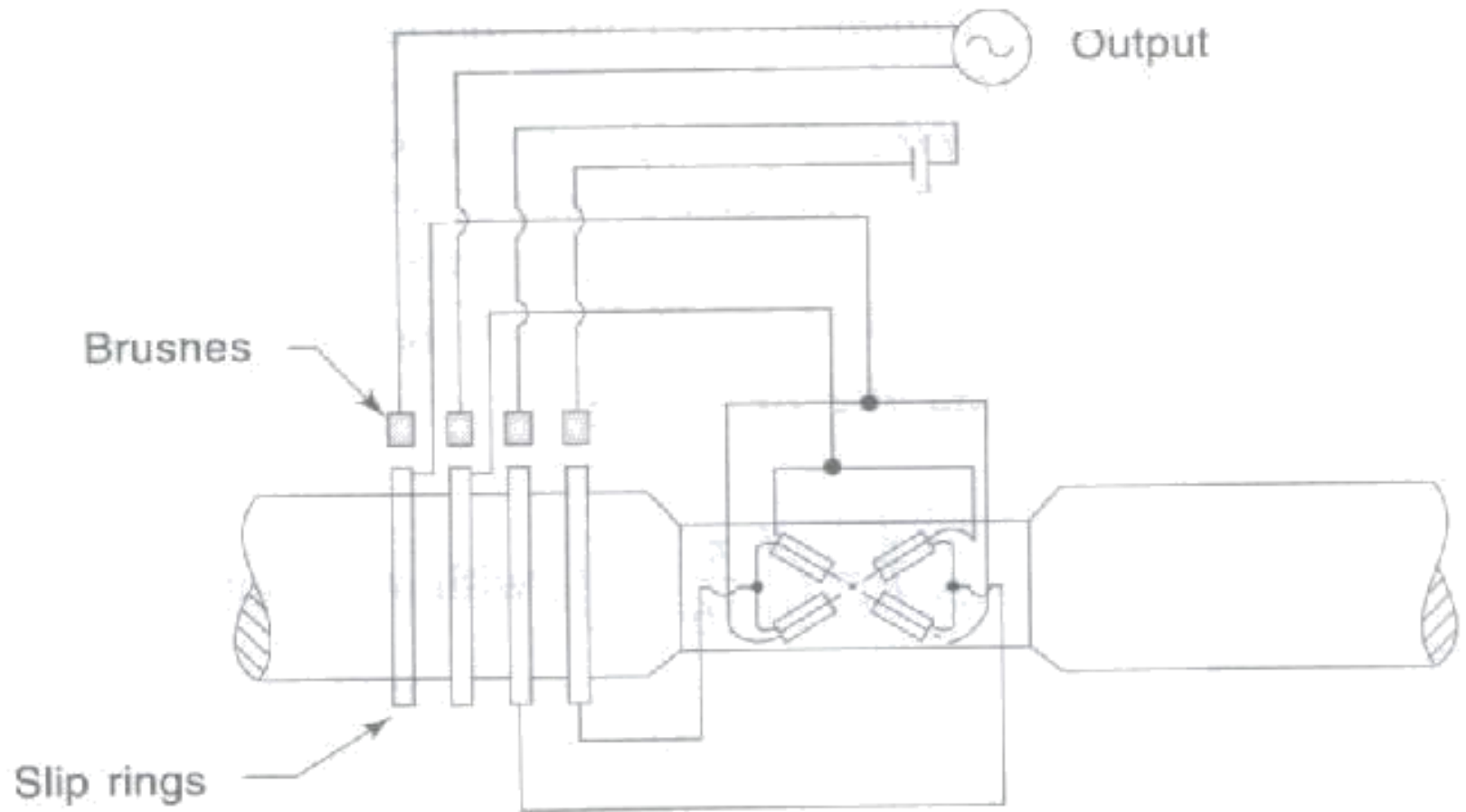
$$\epsilon_{45^\circ} = \frac{Tr_o}{\pi G (r_o^4 - r_i^4)}$$

$$\theta = \frac{2TL}{\pi G (r_o^4 - r_i^4)}$$

Torque Meter

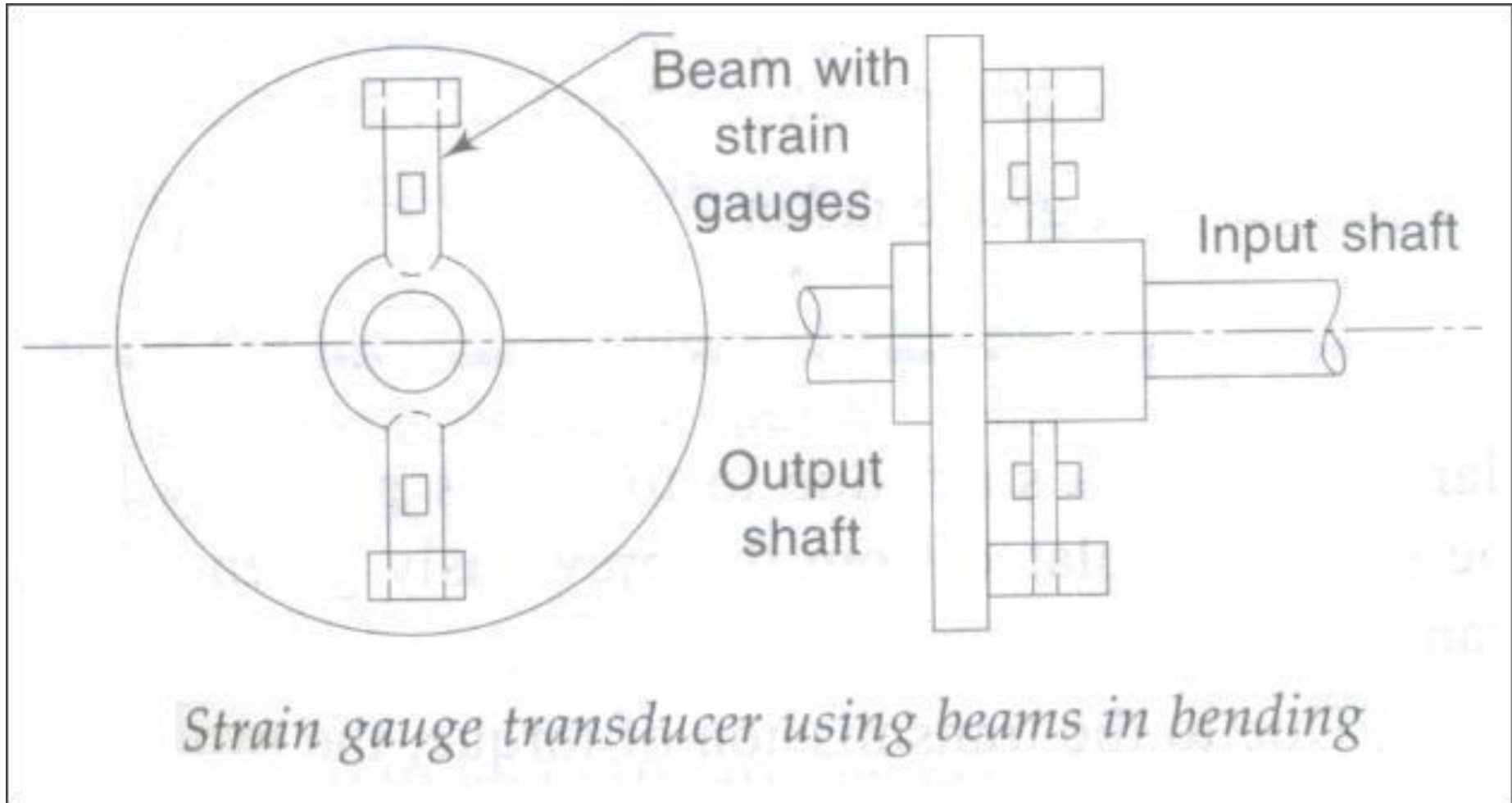
- During torsion of cylinder, principal strains (tensile or compressive) exists at 45° to the axis.
- Output of strain gauges is increased by using four gauges so that adjacent arms have strains of opposite nature.
- For taking signals in & out of the rotating shaft, slip rings & brushes are used.
- Useful for both static & dynamic torque measurement.
- Used for 100 to 100000 N-cm torque



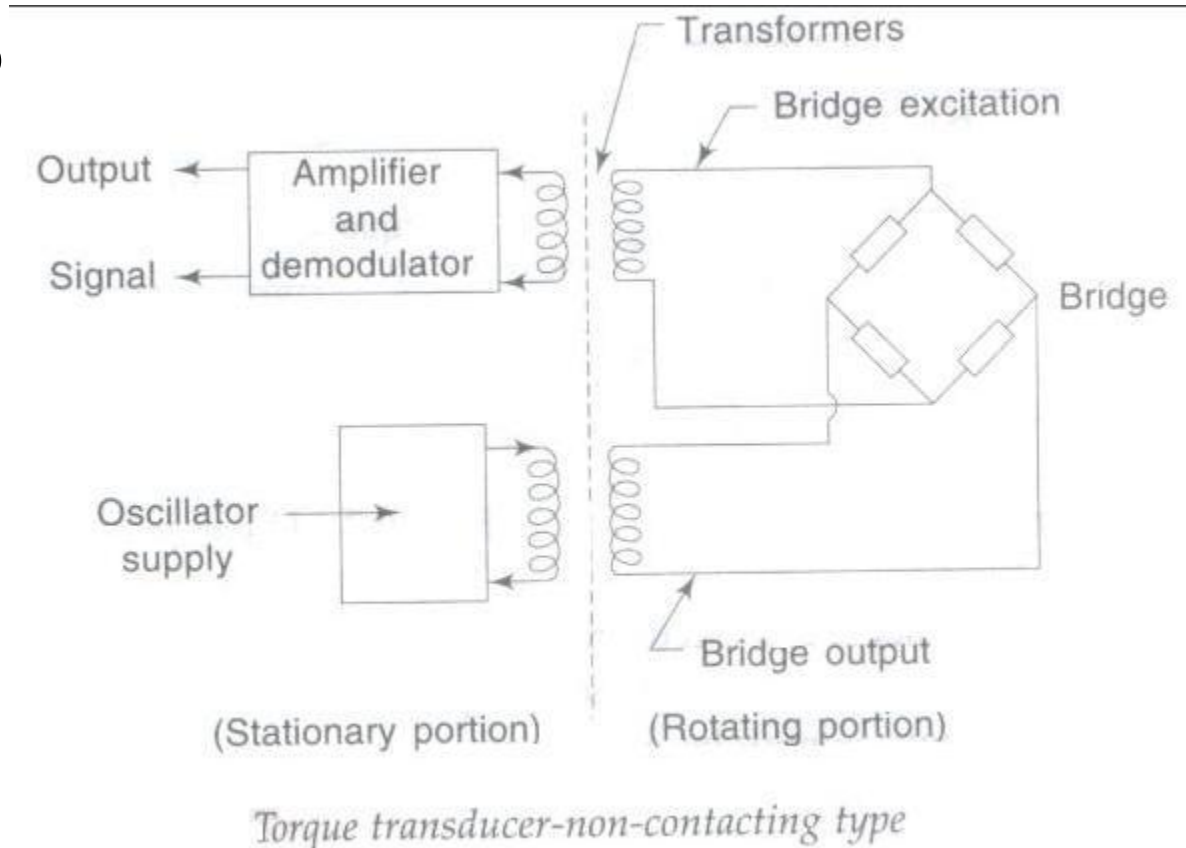


Slip ring arrangement in torque transducer

- To measure torque easily bending strains in beam can be used.

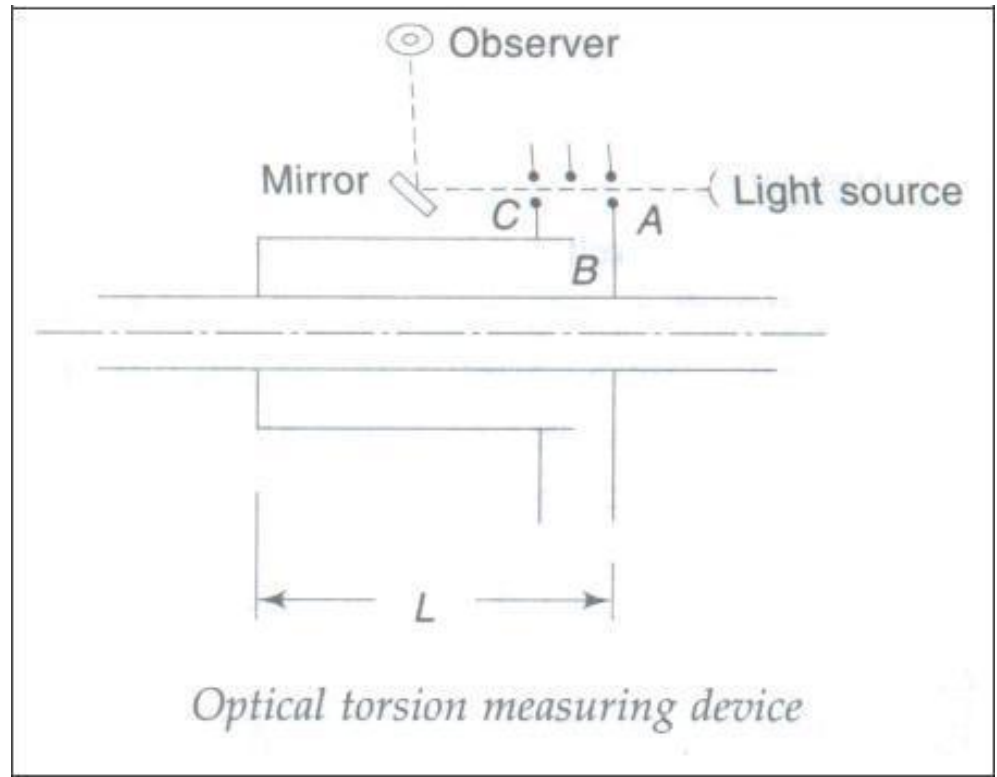


- A slip-ring arrangement, results in noise due to changes in contact resistance.
- The bridge supply and output signals are transmitted between rotating and stationary members through transformers.
- AC bridge arrangement is employed, which gets modulated due to torque.
- A demodulator is employed to eliminate the carrier frequency of the oscillator.

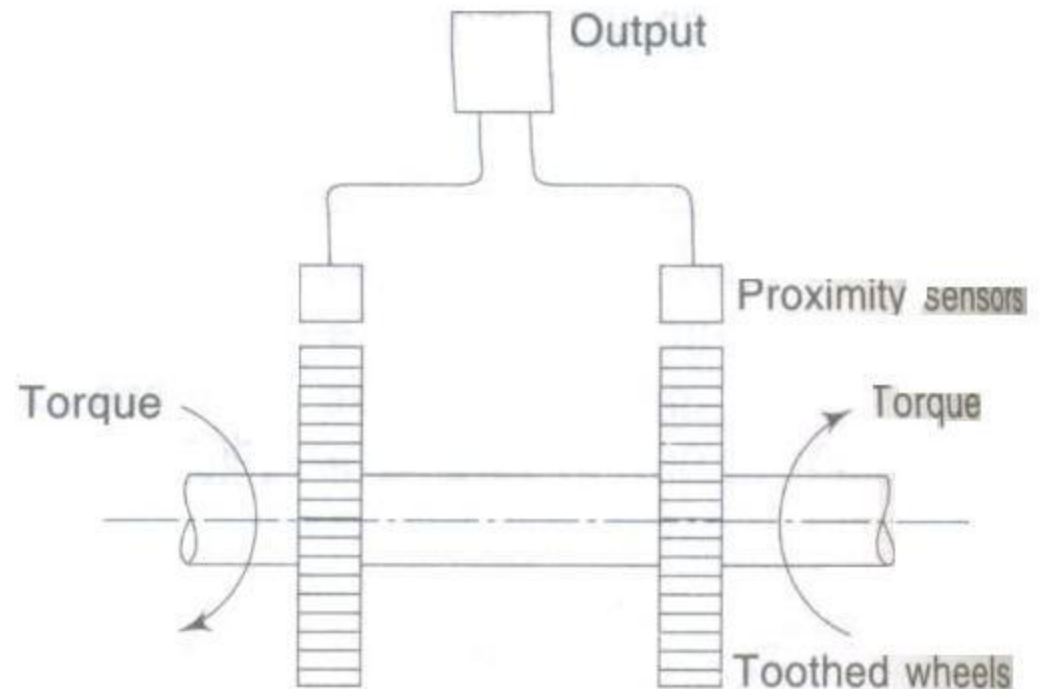


Torsion Meter

- Measures angular twist θ either an optical or electrical arrangement.
- In optical arrangement, due to transmission of torque, the two discs A & B mounted at distance L on the shaft move relative to each other through an angle θ .
- This is recorded by the observer.
- Disc C is only to help in viewing the relative angular displacement of A & B.



- For measurement of θ toothed wheels & proximity sensors of electro-mechanical types also can be used.
- two identical toothed wheels are fixed on the shaft at a certain distance.
- The two proximity sensors produce output voltages with phase difference proportional to torque.
- Also an arrangement using photocells & light source can be used.



Use of proximity sensors