MECHANICAL ENGINEERING MEASUREMENTS
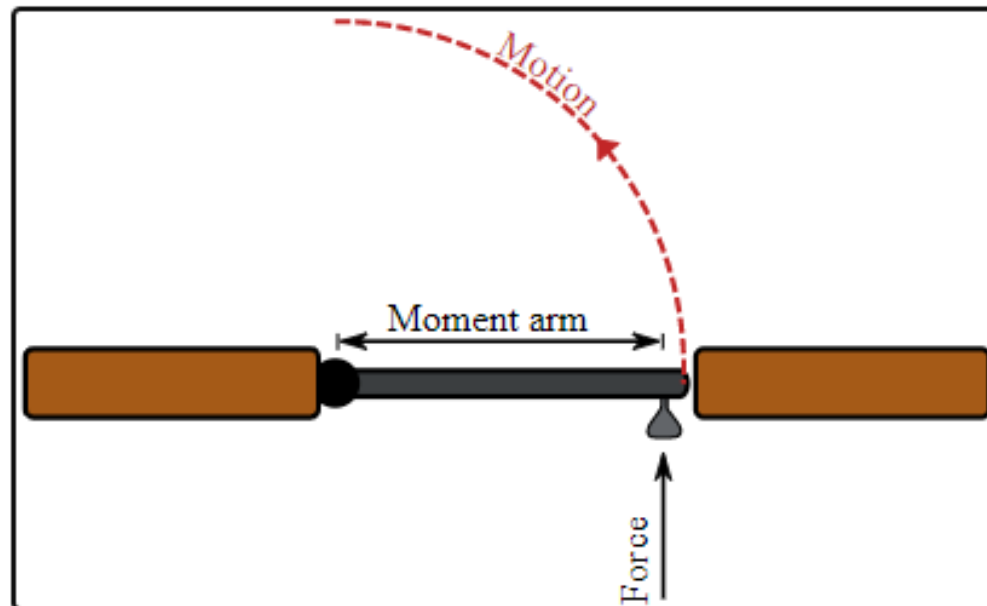
UNIT 2: TORQUE MEASUREMENT

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INTRODUCTION

❑ **TORQUE MEASUREMENT:**

✓ Torque is a measure of the force that can cause an object to rotate about an axis.

✓ Torque is a vector quantity. The direction of the torque vector depends on the direction of the force on the axis.

INTRODUCTION

❑ **TORQUE MEASUREMENT:**

✓ A torque sensor, torque transducer or torque meter is a device for measuring and recording the torque on a rotating system, such as an engine, crankshaft, gearbox, bicycle crank, etc.

✓ Static torque is relatively easy to measure. Dynamic torque, on the other hand, is not easy to measure, since it generally requires transfer of some effect (electric, hydraulic or magnetic) from the shaft being measured to a static system.

INTRODUCTION

❑ **TORQUE MEASUREMENT:**

✓ One way to achieve this is to condition the shaft or a member attached to the shaft with a series of permanent magnetic domains.

✓ The magnetic characteristics of these domains will vary according to the applied torque, and thus can be measured using non-contact sensors.

✓ Such magneto elastic torque sensors are generally used for in-vehicle applications on racecars, automobiles, aircraft, and hovercraft.

Torque Measurement:

- ***Torque:*** Force that causes twisting or turning moment.

  E.g. the force generated by an internal-combustion engine to turn a vehicle's drive or shaft.

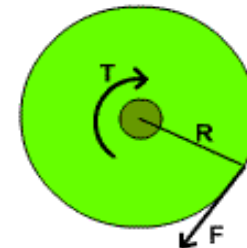- Torque measuring devices are called as *dynamometers*.
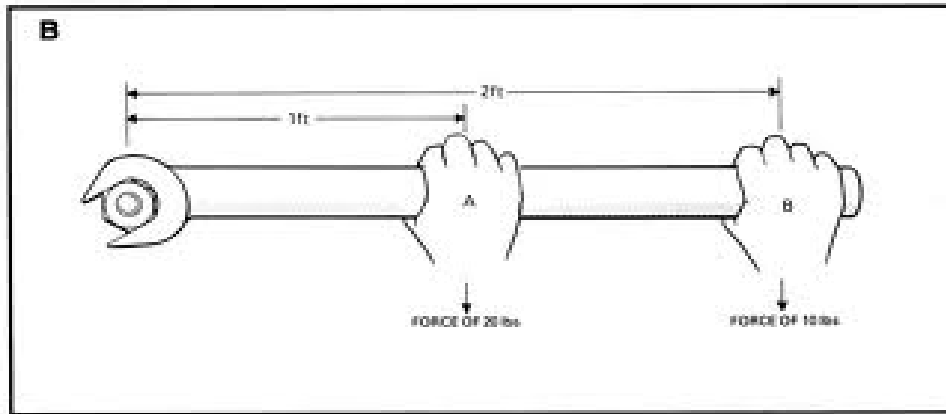
- The torque may be computed by measuring the force 'F' at a known radius 'r', given by the formula

$$T = FR \quad \text{in N - m}$$
or
$$F = T/R$$

Torque applied to wheel results in force on edge

Torque Measurement:

- Torque measurement is usually associated with determination of mechanical power, either power required to operate a machine or to find out the power developed by the machine.

$$power = \frac{2\pi NT}{60*1000} kw$$

Where,

N = Speed in rpm.

T =Torque developed due to load "W", (N-m)

R = Radius from the center to the point of application of force (m)

Types of Dynamometers:

- **Absorption dynamometers:**
  - They are useful for measuring power or torque developed by power source such as engines or electric motors.

- **Driving dynamometers:**
  - These dynamometers measure power or torque and as well provide energy to operate the device to be tested.
  - These are useful in determining performance characteristics of devices such as pumps and compression.

- **Transmission dynamometers:**
  - These are the passive devices placed at an appropriate location within a machine or in between the machine to sense the torque at that location.

Eddy Current Dynamometer
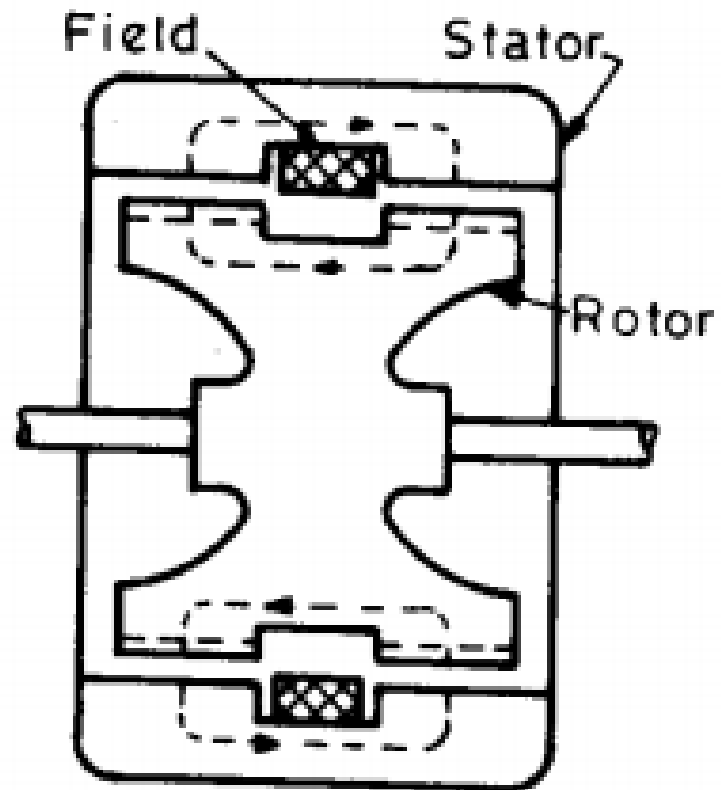
Eddy current dynamometer.

Mechanical Dynamometer (Prony Brake):
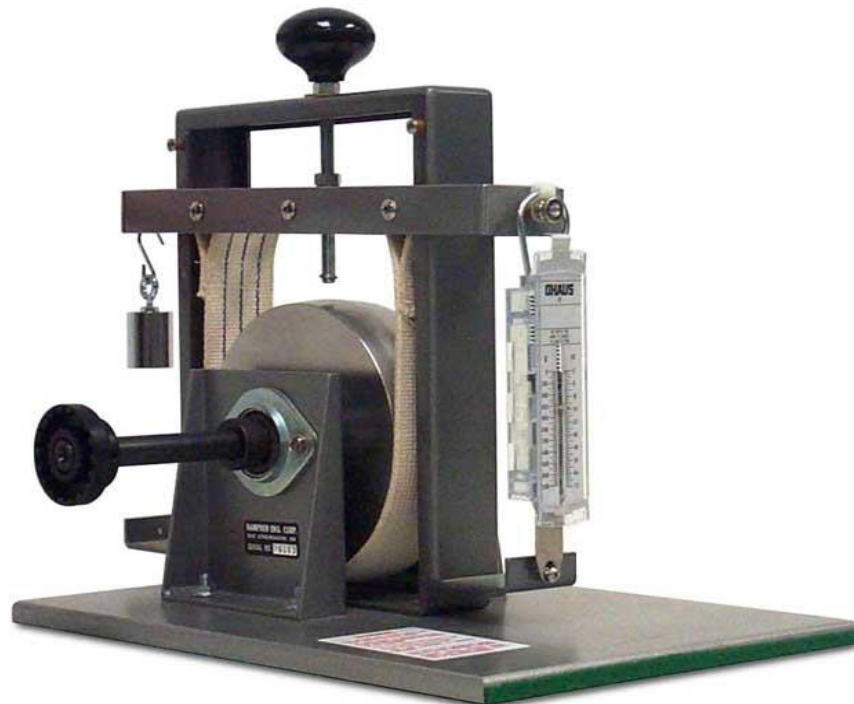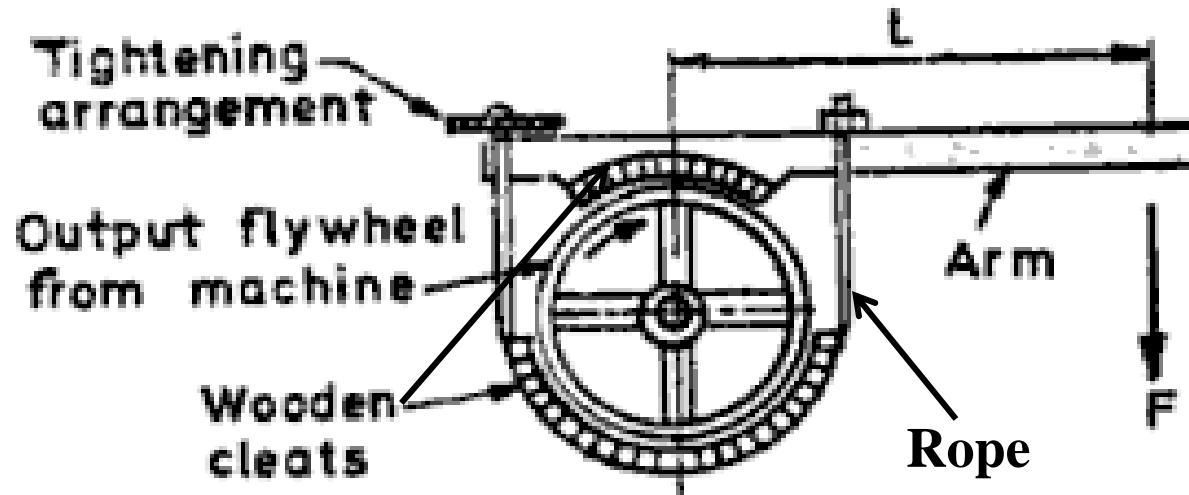
- Consists of wooden cleats or blocks mounted diametrically opposite on a flywheel attached to the rotating shaft whose power is to be determined.

- One wooden block carries a lever arm and an arrangement is made to tighten the rope to increase the frictional resistance between the blocks.

- The torque exerted by the Prony brake is T = F . L

W

Spring scale

Ω

$F = W - w$

$\leftarrow r \rightarrow$

Several turns of rope (lubricate)

W
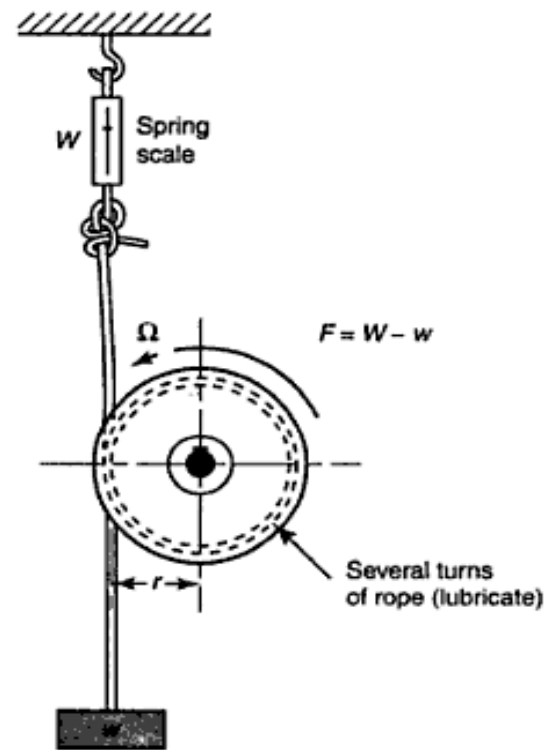
Hydraulic Dynamometer:

- This is a power sink which uses fluid friction for dissipation of the input energy and there by measures the input torque or power.

- The capacity of hydraulic dynamometer is a function of two parameters speed and the water level.

- The torque is measured with the help of reaction arm or shaft.

- The power absorption at a given speed may be controlled by adjustment of water level in the housing.

- This dynamometer may be used in larger capacities than the simple Prony brake dynamometer because heat generated can be can be easily removed by circulating the water in and out of the housing.

- The force acting on the shaft is then measured by using the force measuring device or strain gauges.

- Then by using the relation, T = F . r, we can find the torque acting on it.

Hydraulic Dynamometer:
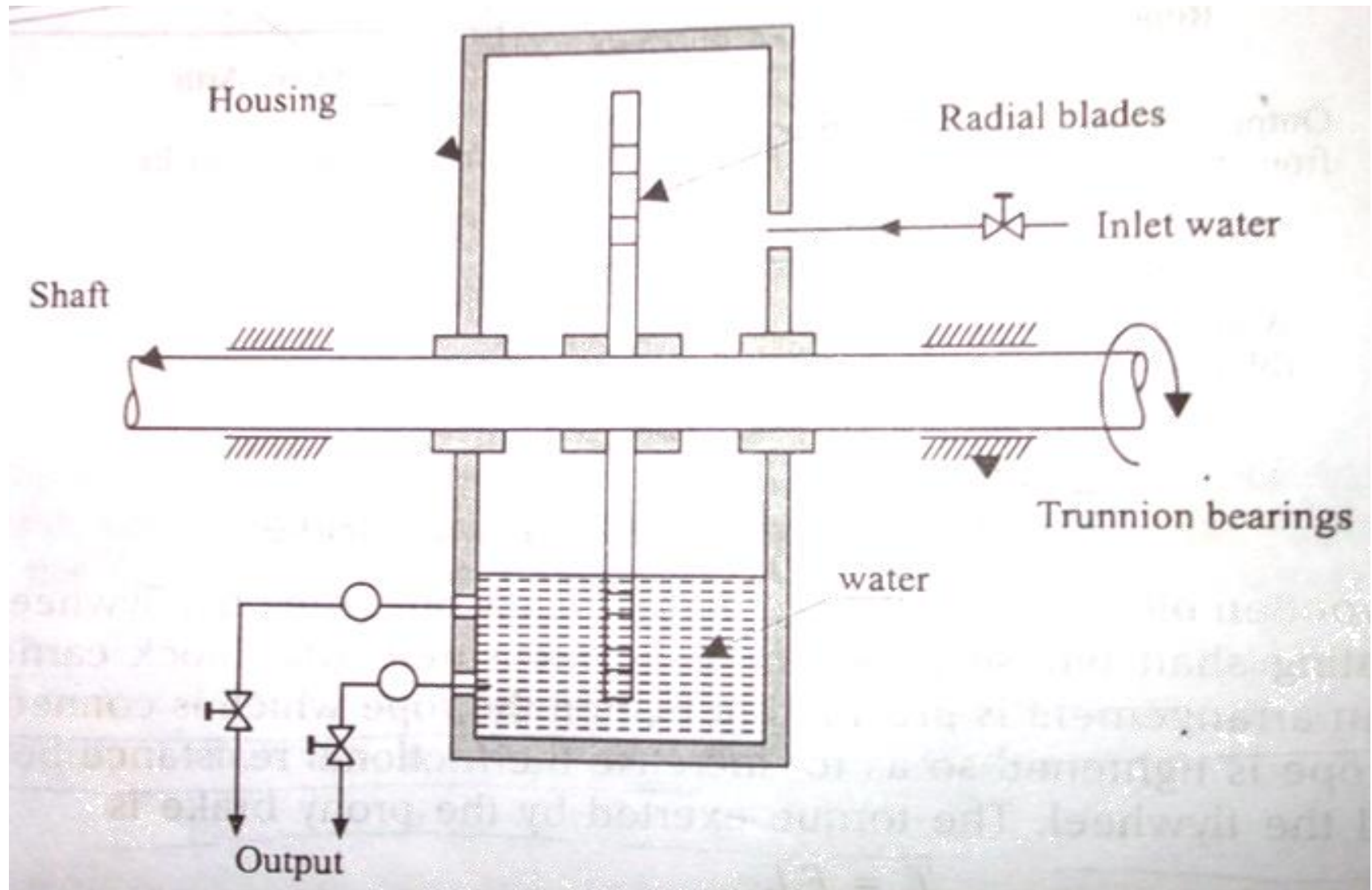
Hydraulic Dynamometer Characters

- Small in size. Easy installation
- Simple dynamometer structure and easy for maintenance
- High brake torque
- High measurement accuracy
- Reliable and stable working condition
- High real-time speed measurement accuracy with EM sensors
- Fast loading control by electronic-control butterfly valve
- High reaction speed which is suitable on dynamic testing Tuning of in-use engines, typically at service centers or for racing applications