Measuring Instruments
&
Domestic Wiring

Lecture-61
Measuring Instruments

Lecture delivered by:

Topics

- Measurement Instruments and its examples
- Classification of measuring Instruments
- Torques required for the Indicating Instruments

Objectives

At the end of this lecture, student will be able to:

- Define and classify measuring Instruments along with examples
- Demonstrate different types of measuring instruments and their usage
- Describe the torques required for the Indicating Instruments

Introduction

Necessity Of Measuring Instruments

- In day-to-day life the electrical and non-electrical quantities measurement is very essential.
- We need to know the electrical quantities in sub-stations, laboratories etc.
- We also need to know the speed, temperature of the machines in work-shops or laboratories etc. for better performance

Measurements

- Instrument used to measure any quantity like electrical or non-electrical is known as measuring instrument.

  For example;

  - Speedometer,
  - Ammeter etc.

- Instrument used to measure the electrical quantity is known as electrical measuring instrument.

Examples of Electrical Measuring Instruments

AMMETER : measure the current

VOLTMETER : measure the voltage

OHMETER : measure the resistance

WATTMETER : measure the power

Classification of Instruments

Measuring instruments are classified as follows:

- **Absolute instruments**
- **Secondary instruments**
  - **Indicating instruments**
  - **Integrating instruments**
  - **Recording instruments**

Absolute Instruments

- Absolute instruments gives the value of the quantity to be measured, in terms of instrument constant and deflection.
- Absolute instruments do not require any previous calibration or comparison.

Example:

1) Tangent galvanometer
2) Rayleigh's current balance instruments

Uses :

As standardizing instruments in standard laboratories like R&D.

Secondary Instruments

- The value of the electrical quantity to be measured can be determined from the deflection of instruments directly.

- The instrument doesn't have any meter constant.

Indicating Instruments

- This instrument indicates (shows) the physical quantity to be measured directly from the graduated scale.

For example:

- Ammeter
- Speedometer
- Voltmeter
- Thermometer

Indicating Instruments

Ammeter

Voltmeter

Recording Instrument

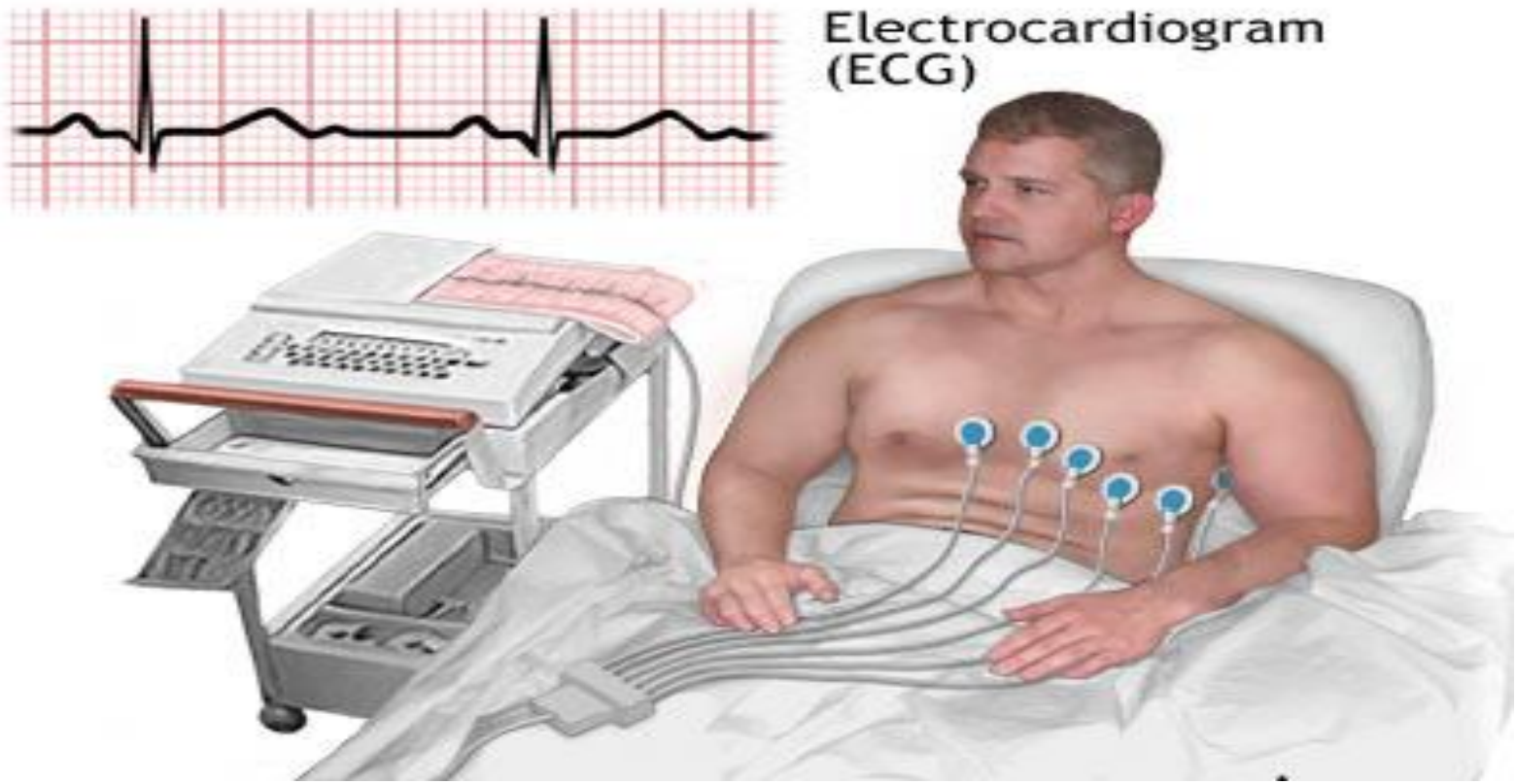
- Recording instrument records the physical quantity to be recorded on a graph paper with the help of a ink-pen attached to it.

For Example:

- ECG
  (Electronic Cardiogram: measures the heart beatings on a graph paper)

- Strip chart recorder

ECG



Integrating Instrument

- Integrating instruments are those which measures the total quantity of electricity delivered in a particular time.

For example:

- Energy meter
- Ampere-hour mete
- Watt-hour meter

Integrating Instruments

Energy meter

Secondary Instruments

Uses :

Indicating Instruments: in all sub-stations, laboratories, work-shops etc.

Recording Instruments: In power-houses, hospitals etc.

Integrating Instruments: in end-users (domestic consumers), laboratories etc.

Difference between Absolute and Secondary Instruments

S.No	Absolute Instrument	Secondary Instrument
1	The reading obtained in terms of meter constant	The reading is directly obtained from the meter reading
2	It is costly instrument	It is cheap compared to absolute instrument
3	It is used in R&D laboratories	All the instruments we see in the market are secondary type

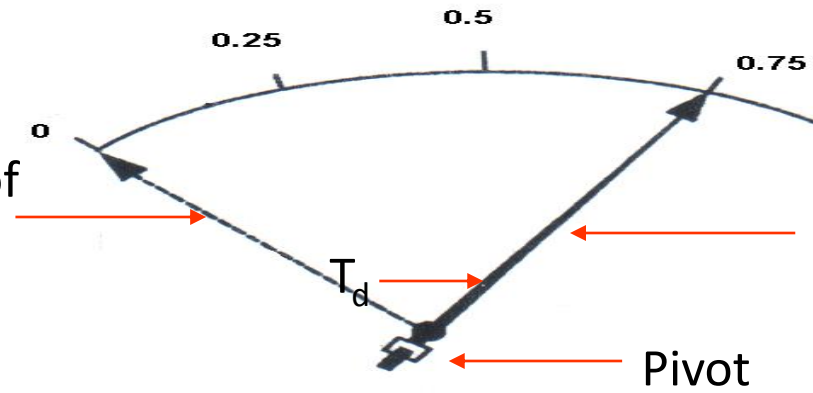
Torques Required for The Indicating Instruments

- Deflecting torque
- Controlling torque
- Damping torque

Deflecting Torque

- To move the pointer from its zero position to the magnitude of the quantity to be measured.
- Deflecting torque produced depends on type of principle of working
- Magnitude of deflecting torque depends on the quantity to be measured

Deflecting Torque



A pointer moves on the calibrated scale.

Controlling Torque

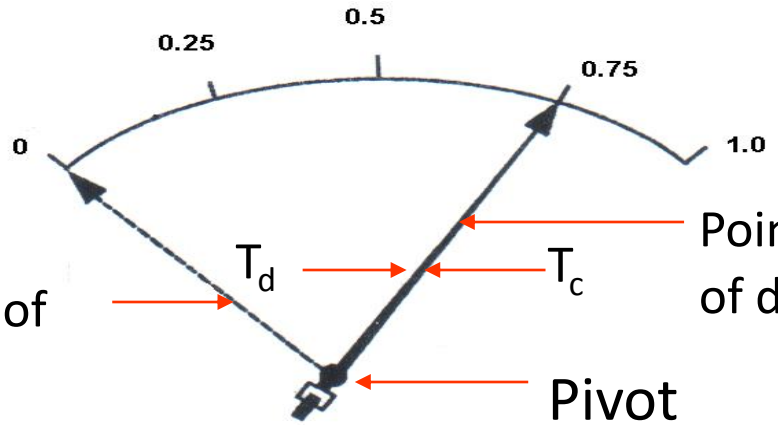
- At every instant the controlling torque is equal and opposite to the deflecting torque.
- When deflection torque is zero, the pointer comes to zero position.

Classification of controlling torque

Spring control

Gravity control

Controlling Torque



Spring Control

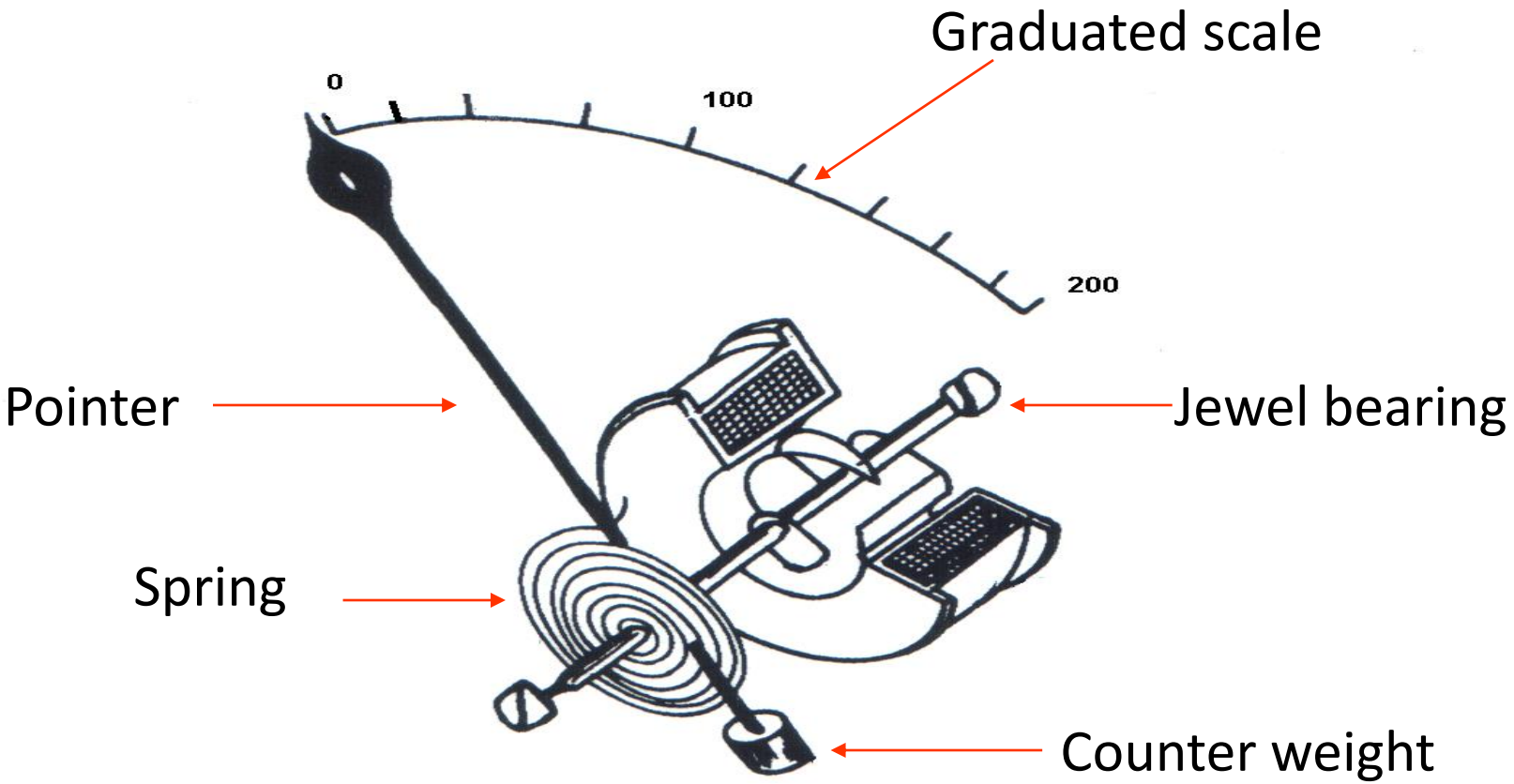


Fig.

Spring Control

Control torque is proportion to the angle of deflection.

- At zero position ,
  - The controlling torque is zero, as deflection torque is zero.
- As the deflection increases ,
  - Stress increases in the spiral spring.
  - So that controlling torque increases.

Spring Control

- At Final deflection position

Control torque $T_c = T_d$ Deflecting torque

- Absence of controlling torque

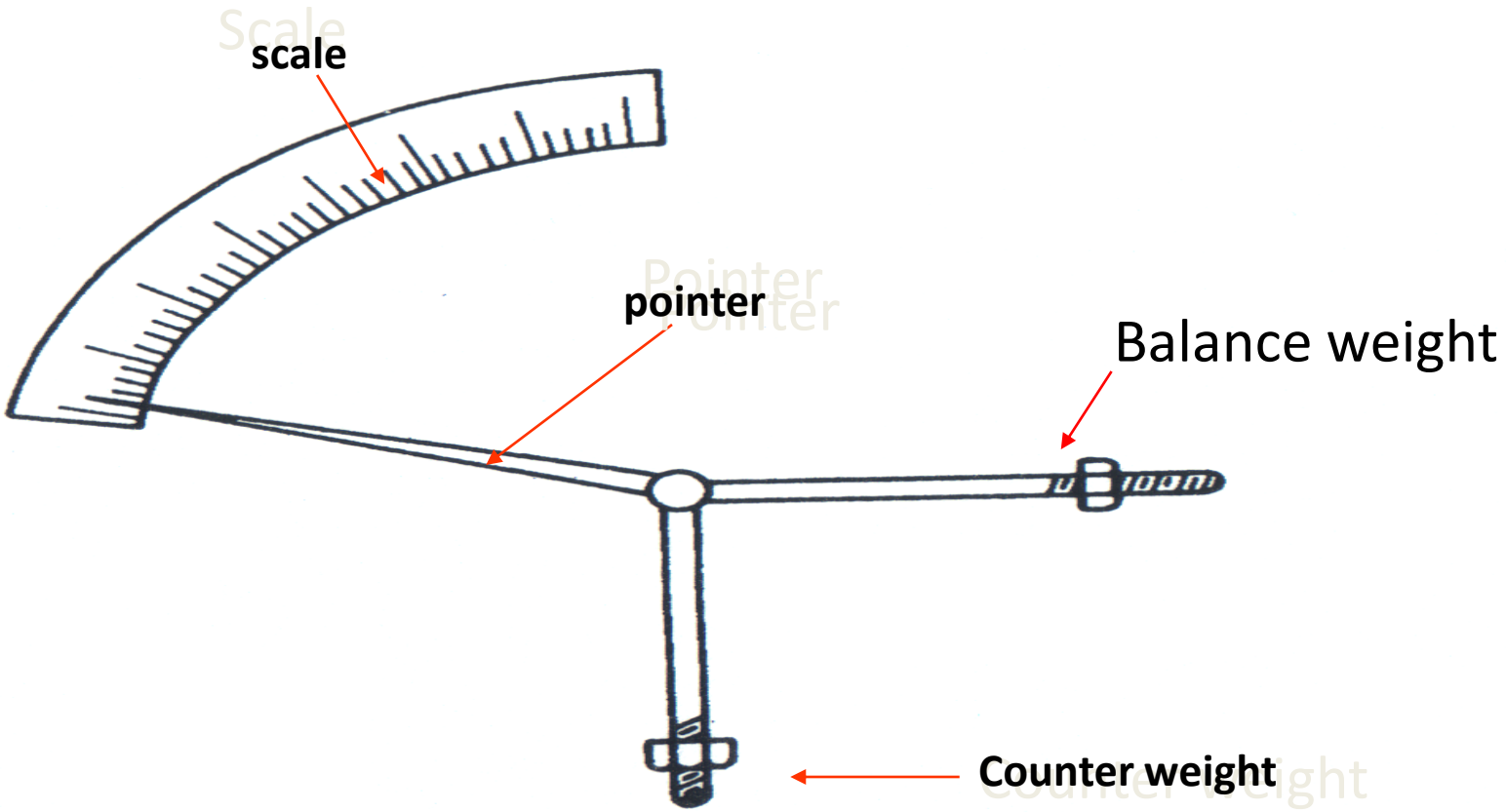
  - The pointer strikes the maximum end of the scale (full scale).
  - The reading obtained is irrelevant to the measurable quantity.

Gravity Control

Controlling torque is produced due to the gravitational force of the weight

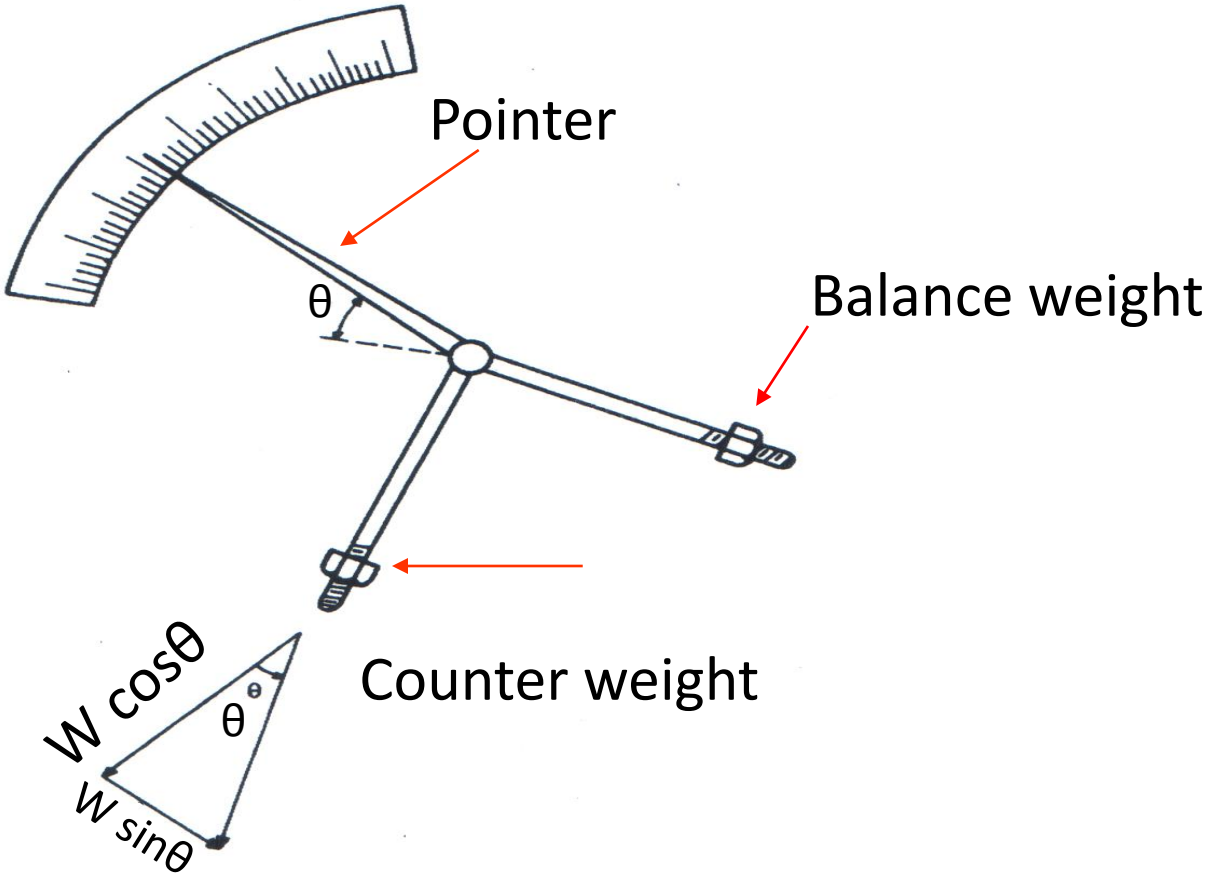
- A small adjustable weight ‘W’ is attached to the moving system.
- It activated at the time of operation.
- Produce a control torque proportional to the deflection torque.
- The magnitude of the controlling torque can be varied by adjusting the position counter weight.

Zero Deflection



- The Instrument should be kept in vertical position only.

Final Deflection



- The control arm shift from vertical position to the deflection angle.

Damping Torque

- Due to the inertia and the two opposite torques, the pointer will oscillate.

Need of damping torque:

- To bring the pointer to the final deflected position quickly to read the value clearly (otherwise the pointer will be oscillating at that position)

Summary

We have discussed about Classification of Secondary Instruments and Different torques required for the Indicating Instruments

Indicating Instruments - indicates the value on a dial.

Recording Instruments - records the value on paper

Integrating Instruments - integrates and shows the summated value