



Measurements and Measurements systems

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Electrical and Electronic Measurements



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Measurements and Measurements systems

Measurements: The measurements of a given quantity is a result of comparison between The quantity (whose magnitude is unknown) and a predefined standard

The result of the measurements are meaningful if:

- ✓ The standard used for comparison must be accurately defined.
- ✓ The apparatus used and method adopted is provable.

Significance of Measurements

Modern Science and technology are associated with sophisticated methods of measurements.

Methods of Measurements

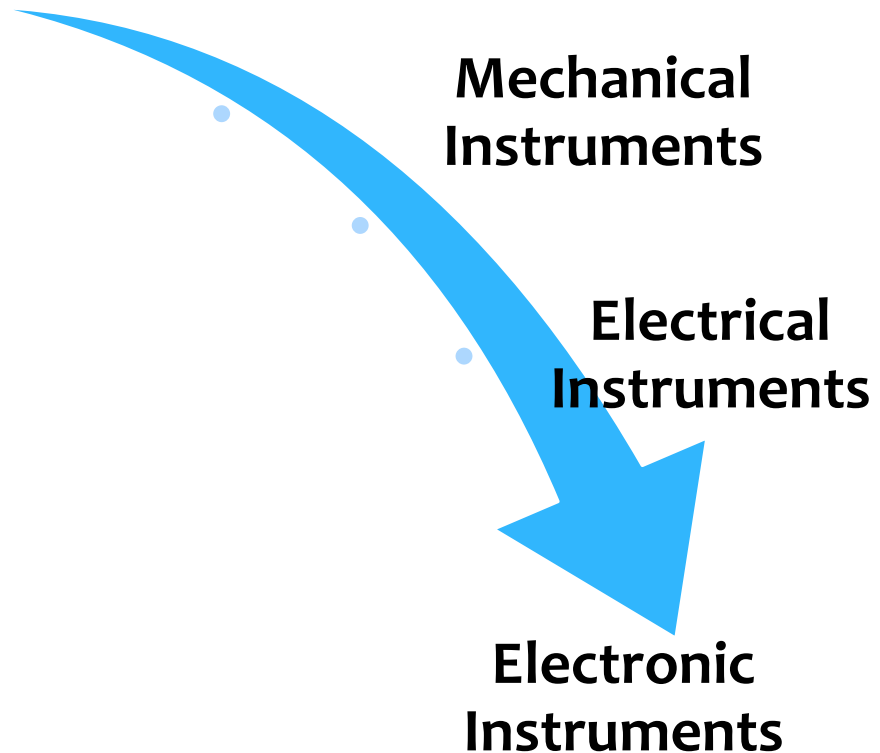
```
graph TD; A[Methods of Measurements] --> B[Direct Methods]; A --> C[Indirect Methods];
```

Direct Methods

Indirect
Methods

Measurements system: consists of a transducing element which converts the quantity to be measured in an analogous form , the analogues signal is then processed by some intermediate means and is then fed to the end devices which present the result .

History of development of instruments



Classification of Instruments

```
graph TD; A[Classification of Instruments] --> B[Secondary Instruments]; A --> C[Absolute Instruments]; B --> D[Analog mode]; B --> E[Digital mode];
```

Secondary Instruments

Absolute Instruments

Analog mode

Digital mode

Elements of a generalized Measurement system

Primary Sensing
Element

Variable conversion
Element

Data presentation
Element

Characteristics of instruments and measurements systems

Accuracy

- It is the closeness with which an instrument reading approaches the true value of the measured quantity.

True Value

- The average of an infinite number of measured values when the average deviation tends to zero.

Reproducibility

- It is the degree of closeness with which a given value may be repeatedly measured.

Static Error

- The difference between the measured value and the true value of the quantity.

Scale Range

- The difference between the largest and the smallest reading of the instrument.

Precision

- The degree of agreement within a group of measurements.

Due to
shunt
connected
Instrument



Due to
series
connected
Instrument



Loading
effect

Errors in Measurements and Their Statistical Analysis

Limiting Error

- The limits of deviation from the specified value.

Relative Error

- The ratio of the error to the specified magnitude of a quantity.

Types of Errors

Gross Error

Systemic Error

Random Error

Instrumental Error

Environmental Error

Observational Error

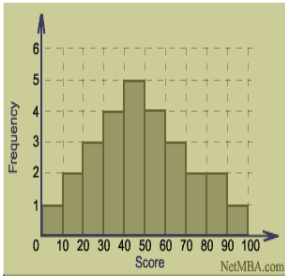
Due to

Inherent Shortcoming of Instruments

Misuse of Instruments

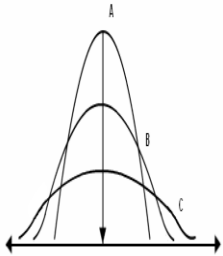
Loading effects

Statistical Treatment of Data



Histogram

- Presenting the measured data which scattering about some central value.



Dispersion

- The property denotes the extent of data to which the values are dispersed about the central value.

Deviation

- Departure of the observed reading from the arithmetic mean of the group of readings.

Average Deviation

- An indication of the precision of instruments used in making the measurements.

Standard Deviation

- The square root of the sum of the individual deviation squared divided by the number of reading.

Variance

- The mean square deviation.

Standard and their Classification

International standards

- They represent the units of measurements which are closest to the possible accuracy attainable with present day technological and scientific methods

Primary standard

- They are absolute standard of such high accuracy that can be used as the ultimate reference standards

Secondary standards

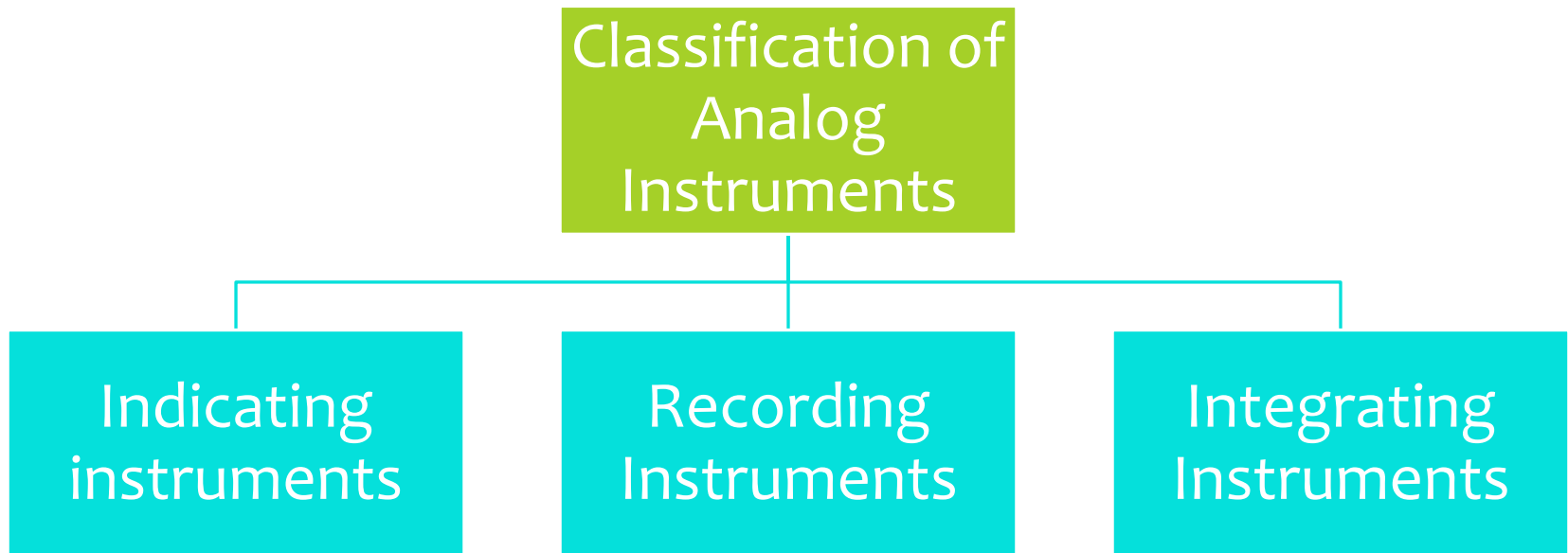
- They are the basic reference standard used in industrial measurements laboratories.

Working standards

- They are the major tools of a measurements laboratory. They used to calibrate and check general laboratory instruments for their accuracy and performance.

Analog Instruments

- ❑ It is a device in which the output or display is a continuous function of time



Classification on the basis of method of measurements

```
graph TD; A[Classification on the basis of method of measurements] --> B[Direct Measuring Instruments]; A --> C[Comparison Instruments]; B --- D[It convert the energy of measured quantity into energy that actuates the instrument]; C --- E[It measure the unknown quantity by comparison with a standard];
```

Direct Measuring Instruments

It convert the energy of measured quantity into energy that actuates the instrument

Comparison Instruments

It measure the unknown quantity by comparison with a standard

Principle of operation

Magnetic Effect

Ammeter
Voltmeters
Wattmeter
Integrating meters

Heating Effect

Ammeter
Voltmeter

Electrostatic Effect

Voltmeter

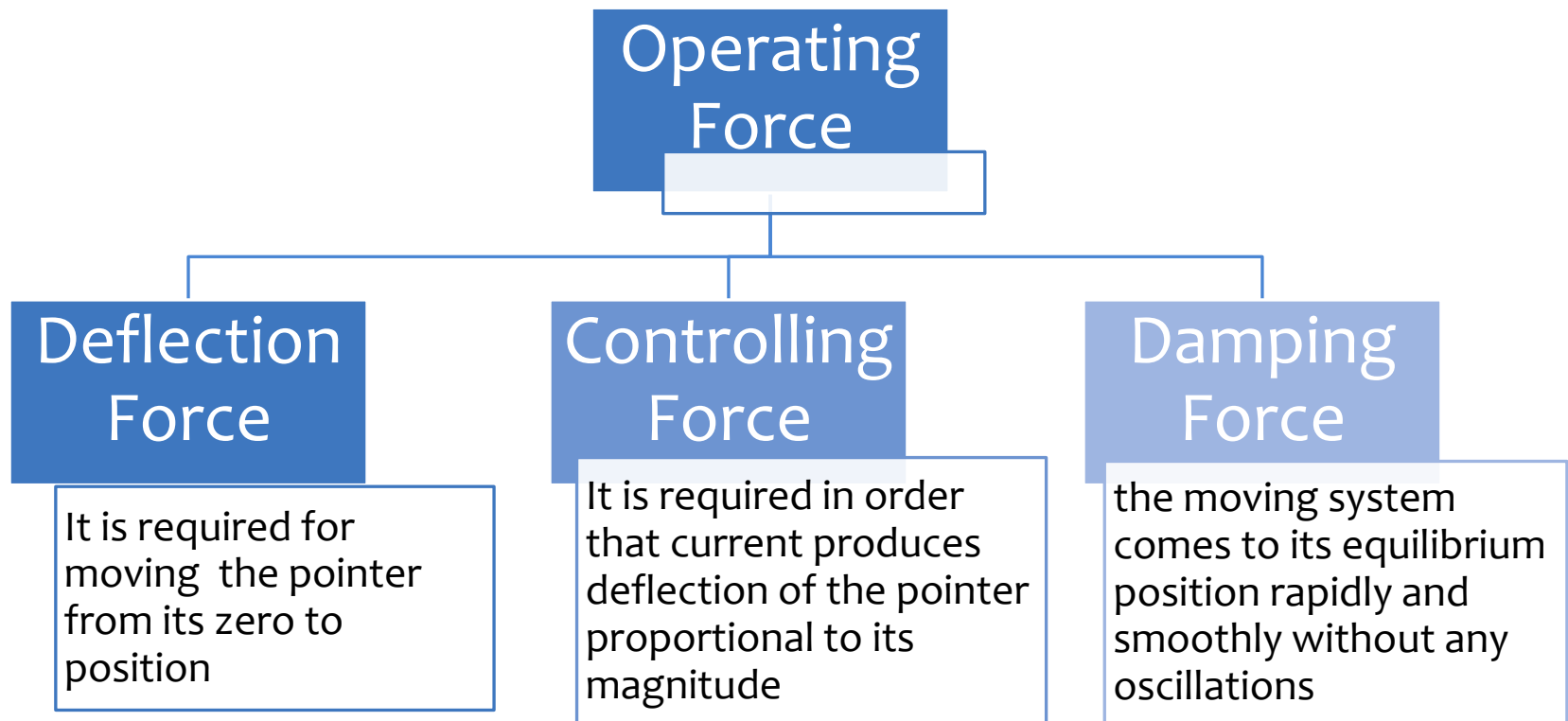
Electromagnetic Effect

A.C
Ammeter,
Voltmeter

Hall Effect

Flux meter
ammeters

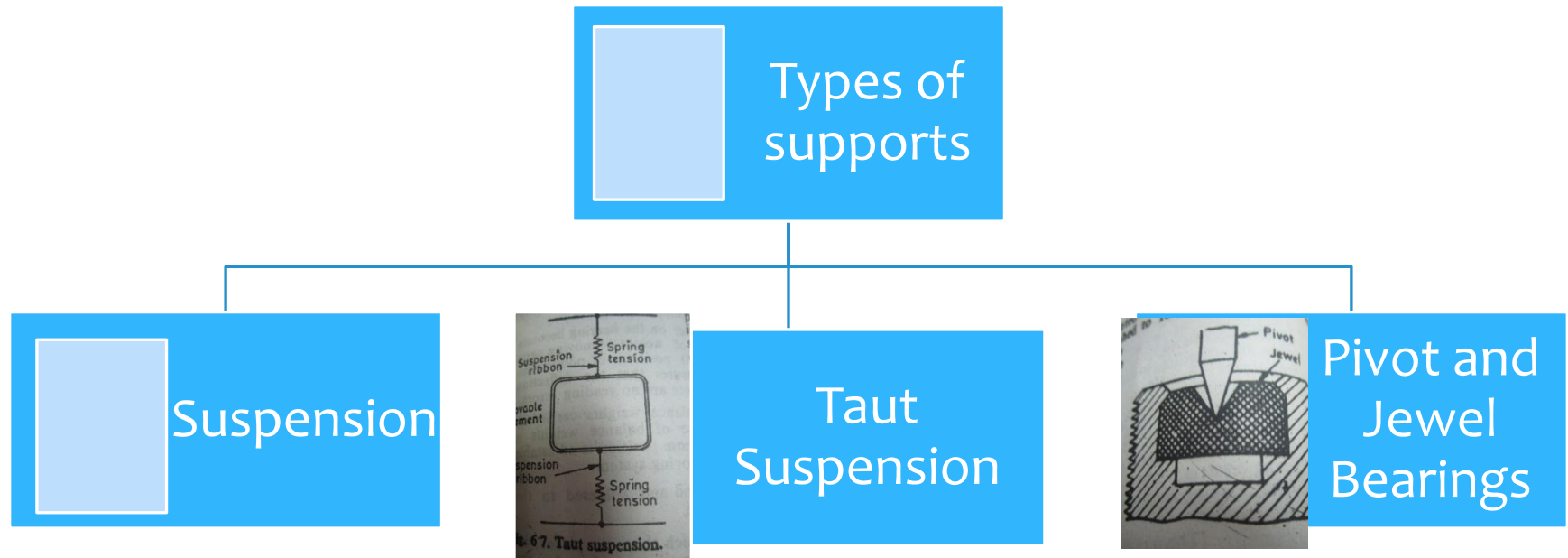
Electro-mechanical Indicating Instruments



Construction details

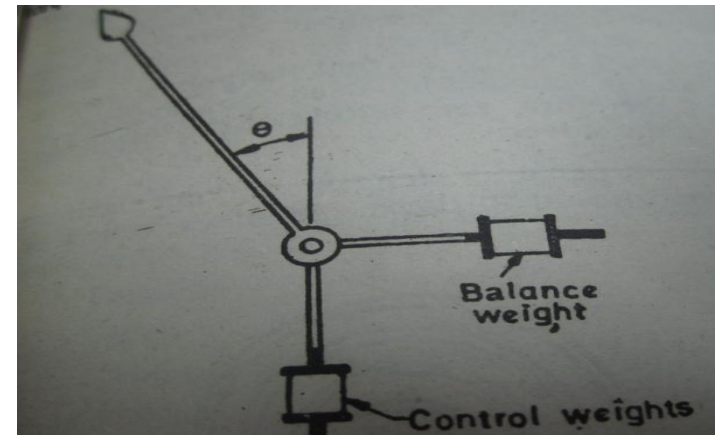
➤ Moving system

1. The moving parts should be light
2. The frictional force should be minimum



Control Systems

1. Gravity control: a small weight is placed on an arm attached to the moving system

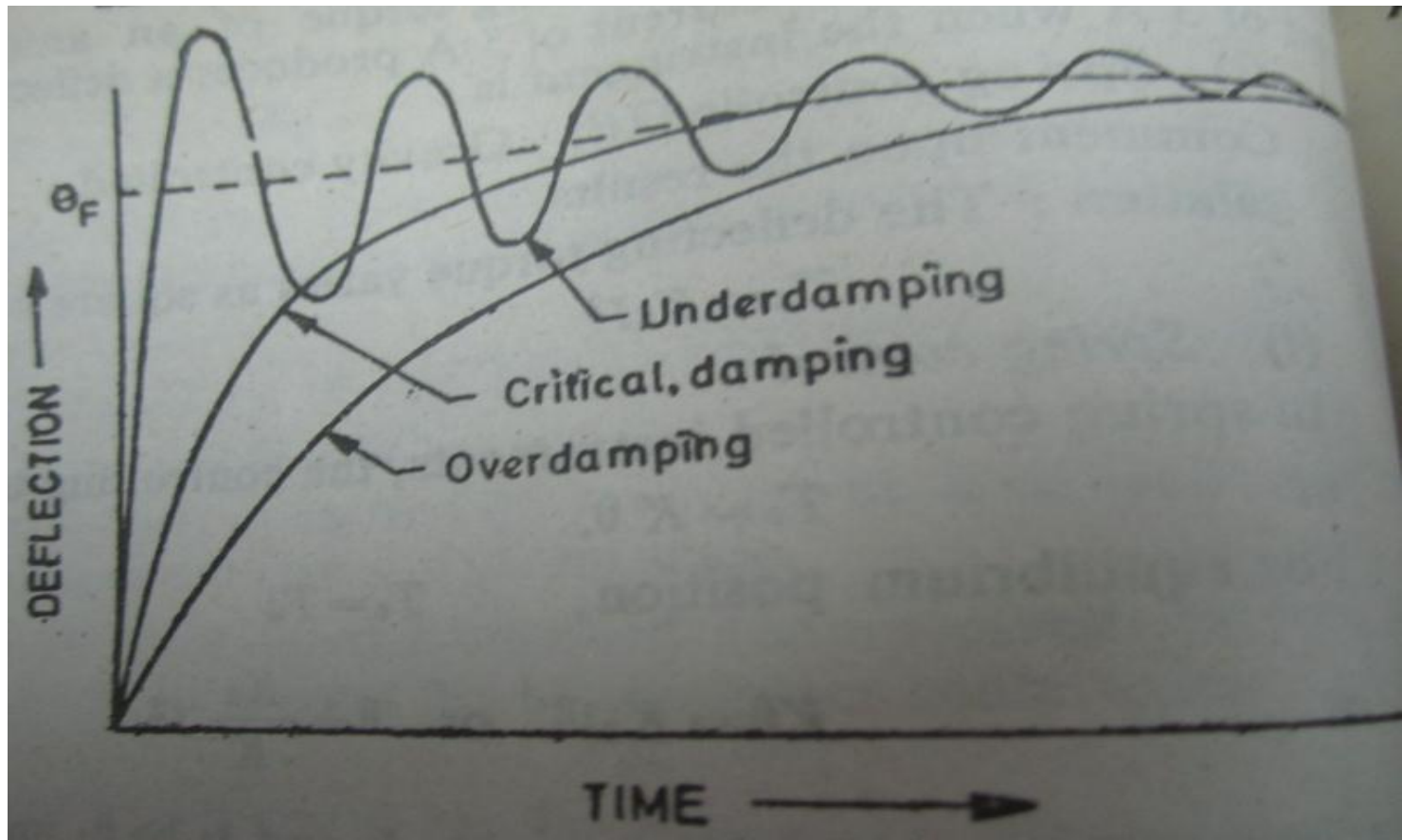


2. Spring control: a hair spring attached to the moving system exerts a controlling torque.



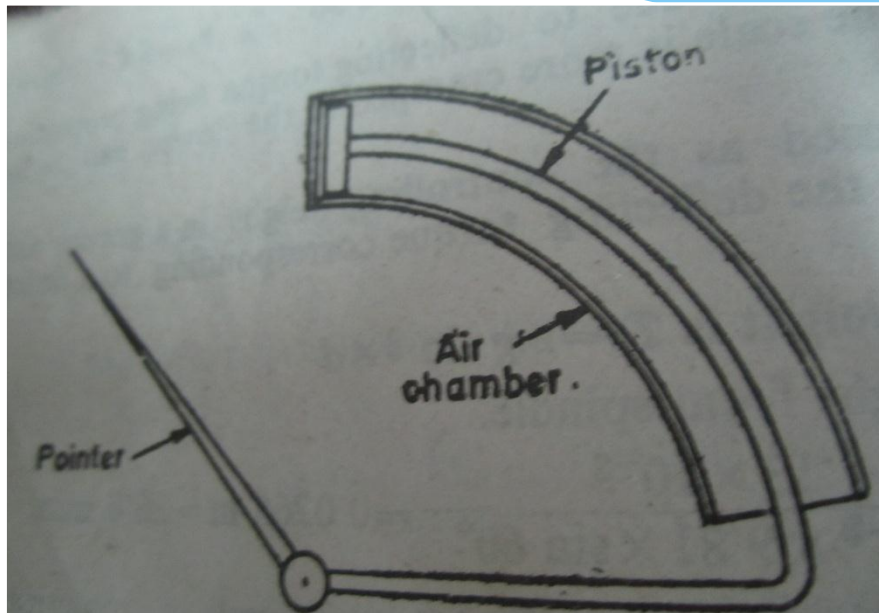
Damping Systems

The damping torque should be of such a magnitude that the pointer quickly comes to its final steady position, without overshooting.

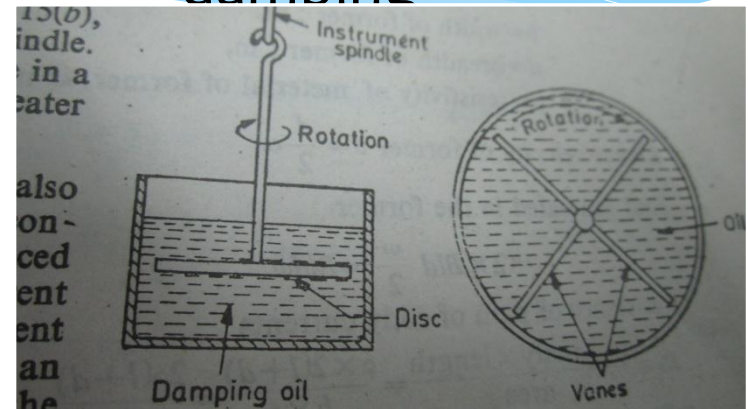


Methods for producing damping

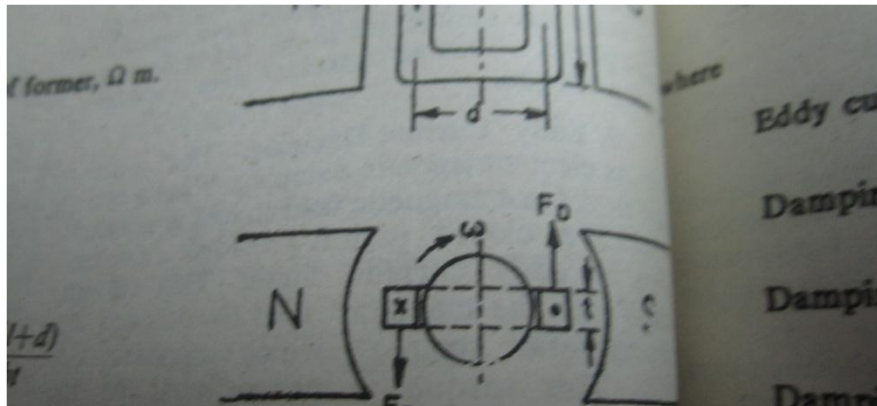
Air friction



Fluid friction damping



Eddy current damping



Electromagnetic damping

The movement of a coil in a magnetic field produces a current in the coil which interacts with the magnetic field to produce a torque.

END

