MECHANCIAL MEASUREMENTS AND METROLOGY(BTME-3503)

Course Name: MMM

Semester: 5th

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Standard

A standard is something that is setup and established by authority as a rule for measurement of quality and value etc.

Throughout the world generally 2 standards are followed for linear measurement is (i) British/English (yard) (ii) Metric (metres) followed by most of the countries due to convenience Either yard meter are standardized by the following standards: (i) line standard (ii) end standard (iii) wave length standard.

Line standard When a length (meter/yard) is measured as the distance between the centers of 2 engraved lined it is called line standard. It is of 2 types. (a) standard yard (followed by Britishers) The empirical standard yard is a bronze bar of 1 square inch cross section and 38 long. A round recess 1 away from each end is cut up to central plane of the bar. A gold plug diameter having 3 lines engraved transversely and 2 lines longitudinally is inserted into these holes such that the lines are in the neutral plane.

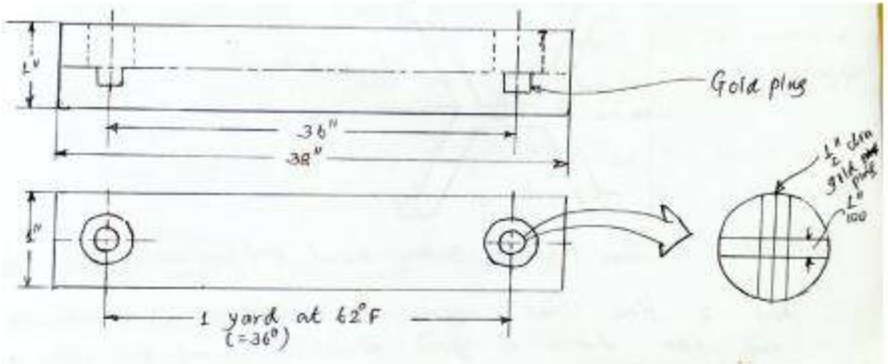

Fig 1.12 : Standard yard

Standard

One yard is then defined as the distance between 2 central transverse lines of the gold plug at 62 f. the purpose of keeping the gold plug lines at neutral axis is that due to bending of beam the neutral plane remains unaffected, secondly the plug being in the well is protected from accidental damage. The supports of the yard bar should be at such distance the 2 end faces of the bar are at zero slopes.

Standard meter (followed by most of the countries) This standard was established originally by international bureau of weights & measures in 1875. The prototype meter is made of platinum iridium alloy(90% platinum & 10% iridium) having a cross section as shown in fig 1.13. the upper surface of the web is highly polished and has 2 fine lines engraved over it. It is in oxidisable and can have a good finish required for ruling good quality lines. The bar is kept at 0 c and under normal atmospheric pressure. The total length = 102 cm at 0 c & normal atmospheric pressure. This type of shape has 2 advantages. i.The graduations being on the neutral plane does not change due to bending effect. ii. The shape (cross section) gives greater rigidity economy for this costly material. The bar is supported by 2 rollers of at least 1cm diameter which are kept 59 mm apart (0.577X1020mm) the distance between the center portions of two lines engaged on the polished surface of this bar of platinum iridium alloy is taken as one meter.

DEFINITION STANDARD METER: According to this standard the length of the meter is defined as the straight line distance at 0 c between the center portion of pure platinum iridium alloy (90% platinum & 10% iridium) of 102 cm total length and having a web cross section as shown in fig 1.13

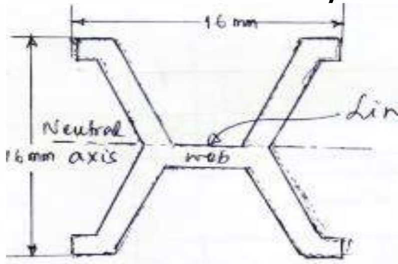

Fig 1.13 : International prototype meter cross section

Wavelength Standards

Disadvantages of material standard

1.The material standard is influenced by effect of variation of environmental conditions like temperature pressure humidity and ageing etc. and it thus changes in length.

2.These standards are required to be preserved or stored under security to prevent their damage or destruction.

3.The replica of these standards are not available somewhere else.

4.These are not easily reproducible.

5.Considerable difficultly is experienced while comparing and verifying the size of gangues.

Wavelength standard

In order to overcome the above draw backs (with the metallic standards meter yard) it became necessary to have a standard of length which will be accurate and invariable.

Jacques cabinet a French philosopher suggested that wave length of monochromatic light can be used as natural and invariable unit of length. in 1907 the international angstrom (A)unit was defined in terms of wave length of red cadmium in dry air at 15 c (6438.4696 A= 1 wave length of red cadmium) seventh general conference of weights and measures approved in 1927 the definition of standard of length (f meter) in terms of wave length of red cadmium as an alternative to international prototype meter.

Orange radiation of krypton isotope was chosen for new definition of length in 1960 by 11th general conference of weights and measures. The committee decided to recommend that krypton 86 was the most suitable element and it should be used in a hot cathode discharge lamp maintained at a temperature of 68 K. According to this standard a meter was defined as equal to 1650763-73 wavelength of the red orange radiation of kr isotope 86gas. The accuracy is about 1 part in 10 now the meter and yard can be refined in terms of wavelength of kr-86 radiation as 1 meter= 1650763.73 wave-lengths

1 yard= 0.9144m= 0.9144X1650763.73 wave length=1509458.3 wave length

Standard and its types

- A standard is a physical representation of a unit of measurement. The term ‘standard’ is applied to a piece of equipment having a known measure of physical quantity.
- Types of standards

  International Standards (defined based on international agreement)

  Primary Standards (maintained by national standards laboratories)

  Secondary Standards (used by industrial measurement laboratories)

  Working Standards (used in general laboratory)

Metrology

CLASSIFICATION OF MEASUREMENT STANDARDS

Standards of measurement are classified into the following four types namely.

1. International standards
2. Primary standards
3. Secondary standards
4. Working standards

1. International standards

- These standards are maintained by the 'International Bureau of Weights and Measurements' at France.
- These standards represent the units of measurement of various physical quantities.
- It is to be noted that the highest possible accuracy is maintained.

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2. Primary standards

- The 'National laboratories or Standard organizations' at various parts of the world maintain these standards.
- The 'National physical laboratory' at Delhi maintains these standards in India.
- Primary standards are maintained for three reasons
  1. To check the secondary reference standard,
  2. To calibrate the secondary reference standard, and
  3. To certify the secondary reference standards
- Hence it is clear that primary standards are the basis of reference. The following factors are to be considered while setting primary standards.
  1. Material used should highly resist change in dimension due to low/high temperatures.
  2. Material characteristics should not get affected due to environmental changes.
  3. Machining operations done on the material should yield accuracy.

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3. Secondary standards

- The 'Regional laboratories and Industrial measurement laboratories' maintain these standards.
- These standards are derived from the primary standards.
- These standards are frequently checked against the primary standards to facilitate calibrations of instruments for maintaining the required precision and accuracy

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4. Working standards

- An accurate and reliable standard that is available with the manufacturer for use by the workers who carry out the operation in the industry is called as working standards. These standards are used by the worker to check / test the manufactured products.
- Working standards are to be checked and certified against the primary or the secondary standards.
- Examples: Precision gauge blocks, Standard resistance.

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GAUGE CONTROL SURFACE

Metrology

Introduction

Measuring tool and instruments (a) Direct group

(b) Indirect Measuring group

Direct Measuring Tools are applied directly to the W/P as in the case of micrometer or a caliper

Indirect Measuring Tools are optical electronics and pneumatic methods to arrive at the final dimensions of a piece

The Direct measuring instruments are either graduated manual or non-graduated manual type. The manual means that hand operated instrument. The graduated type has their linear or angular graduations. The non graduated types consist of fixed gauges or adjustable tools which compare measurement.

GRADUATED MANUAL MEASURING TOOLS

- Rules
- Calipers
- Height gauge
- Micrometer
- Depth gauges
- Dial indicators

C. RULES

It is also steel rules/scales . The Basic graduated measuring instruments is the rule. It is a graduated measuring instruments in the rule. It is a graduated length of steel, used for approximately determining linear dimension. Fig 2.1 shows a steel rule where all the fine graduations are not shown.

Metrology

Control On Environmental Conditions

Control and monitoring of following factors should be controlled and monitored as recommended:

- Temperature (e.g. 25 +/-4.0 deg.C)
- Relative Humidity (e.g. </=70% RH)
- Illumination level (e.g. minimum 450 Lx.)
- Acoustic Level (e.g. max. 60 dB)
- Shock and Vibration should be adequately controlled
- Power supply Regulation (e.g. +/- 1%)
- Temperature gradient (e.g. 1.5 deg.C / hour)
- Proper earthling etc.

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Linear Measurement

- Linear measurement means that measurement of perpendicular **distance between two points or surface.**
- Its applies to measurement of **length, heights, diameters, thickness, radius etc**.

Classification of linear measuring instruments

A) Classification based on methods of measurement

- Direct measuring instruments
- Indirect measuring instruments

B) Classification based on the accuracy that can be obtained

- **Non precision instruments :** It includes Steel Tape, Scale, Calliper, Divider; Depth Gauge, Telescopic Gauge etc
- **Precision instruments:** It includes Vernier Caliper, Vernier Height Gauge, Vernier Depth Gauge, Micrometer, Slip Gauges, etc

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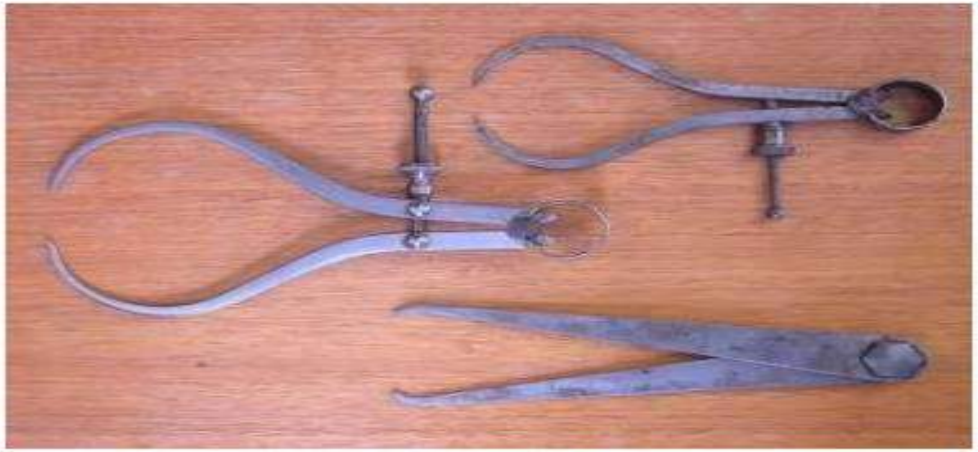
Non Precision Instruments



Outside Caliper

Inside Calipers

Divider

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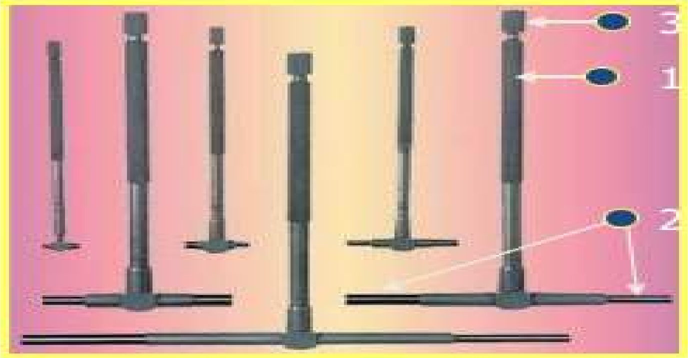
Telescopic Gauge

Use :- Indirect measurement of Bore, Slot, Recesses, etc. Used in accordance with micrometer / Vernier.

Parts :-

1. Handle
2. Pair of Plunger
3. Lock



Construction:-

- It consists of handle, two telescopic rods & locking screw
- For taking measurement, telescopic rods are compressed against spring inserted into the hole whose diameter to be measured.
- Then extended up to the walls of hole.
- Then they locked by locking screw & rods can be measured by micrometer or vernier calliper.

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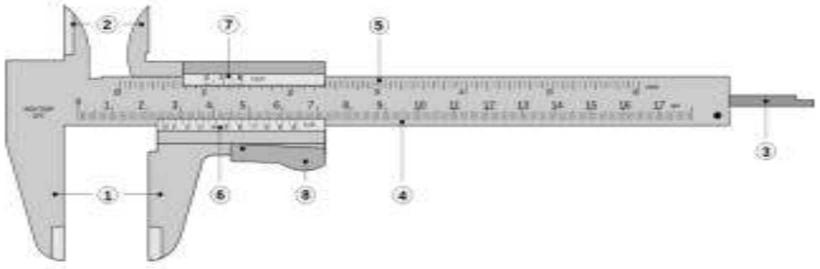
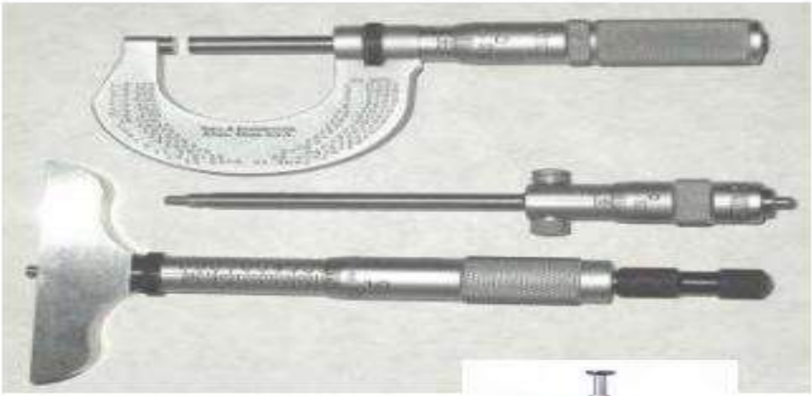
Precision Instruments

List of Precision Instruments

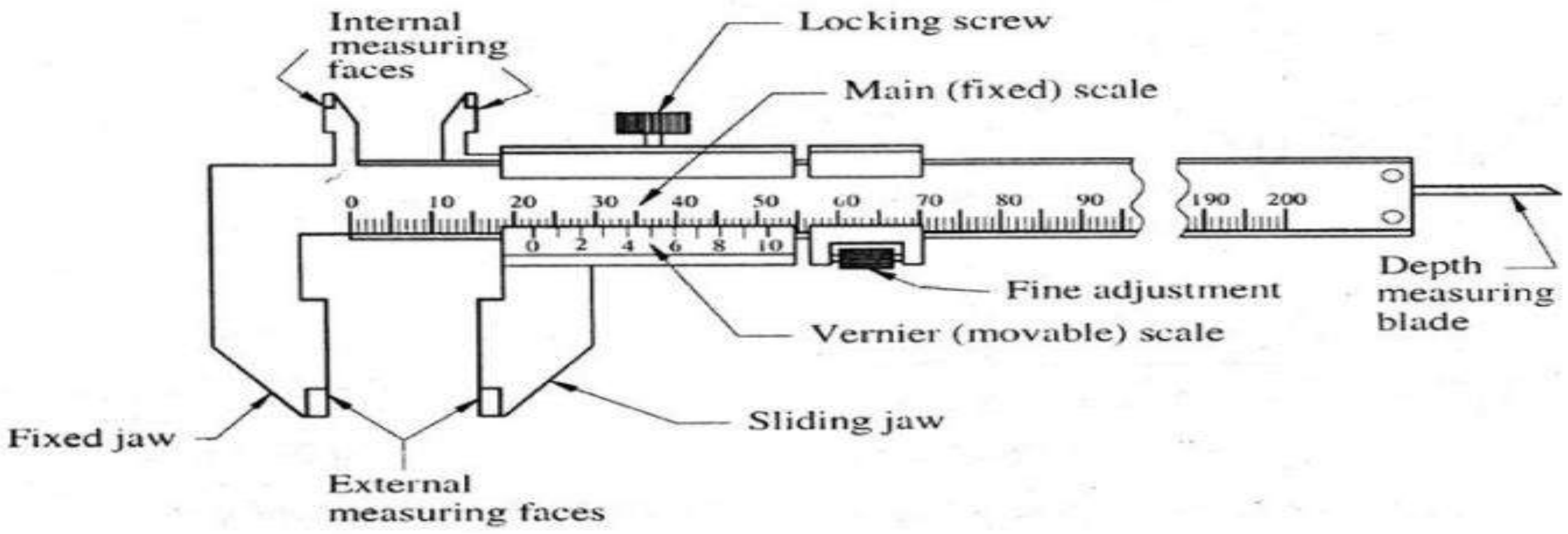
- Vernier Calliper
- Micrometer
- Vernier Height Gauge
- Dial Indicator
- Comparators
- Bore Dial Gauge
- Slip Gauges/Gauge Blocks
- Limit Gauges





Vernier Calliper

- **Vernier Principle :** When two scales (Main and Vernier scales) or divisions slightly different in size are used, the difference between them can be utilized to enhance the accuracy of measurement.



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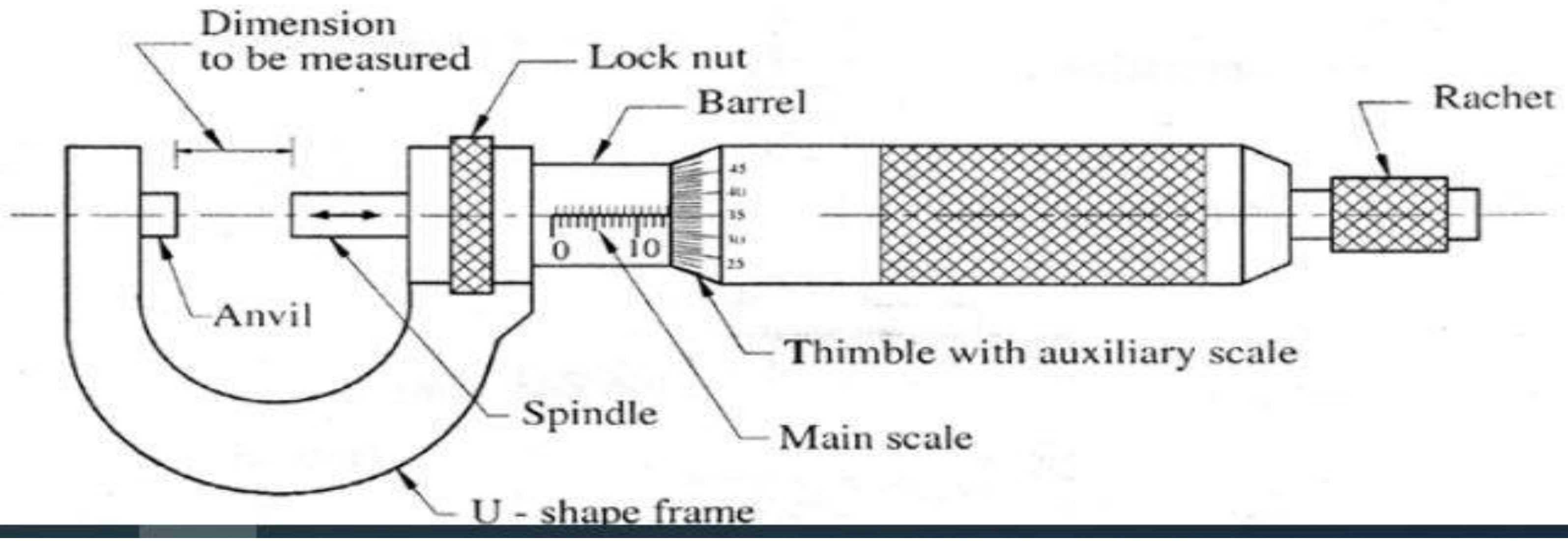
MICROMETERS

- Useful device for magnifying small measurement.
- Micrometers works on the principle of screw and nut. The screw is attached to thimble.
- A screw is turned through nut by one revolution, its axial movement is equal to pitch of the thread of screw.

Construction



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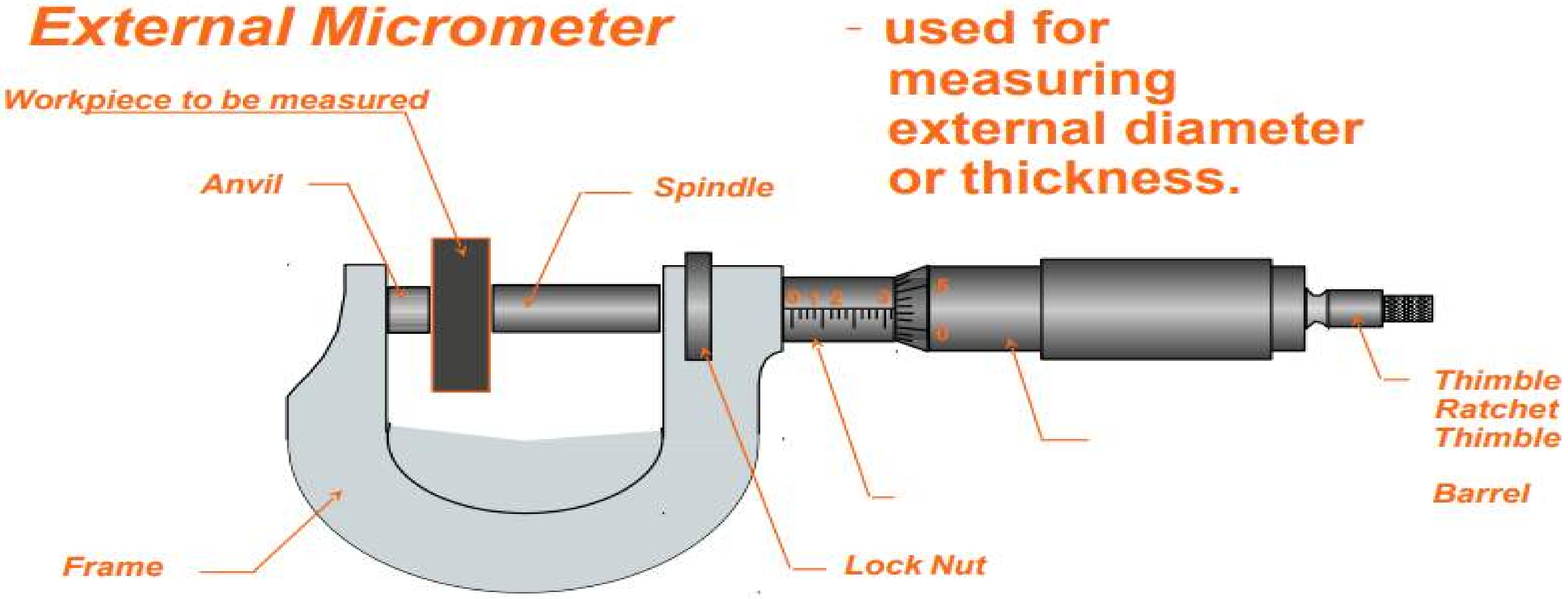

- used for measuring external diameter or thickness.

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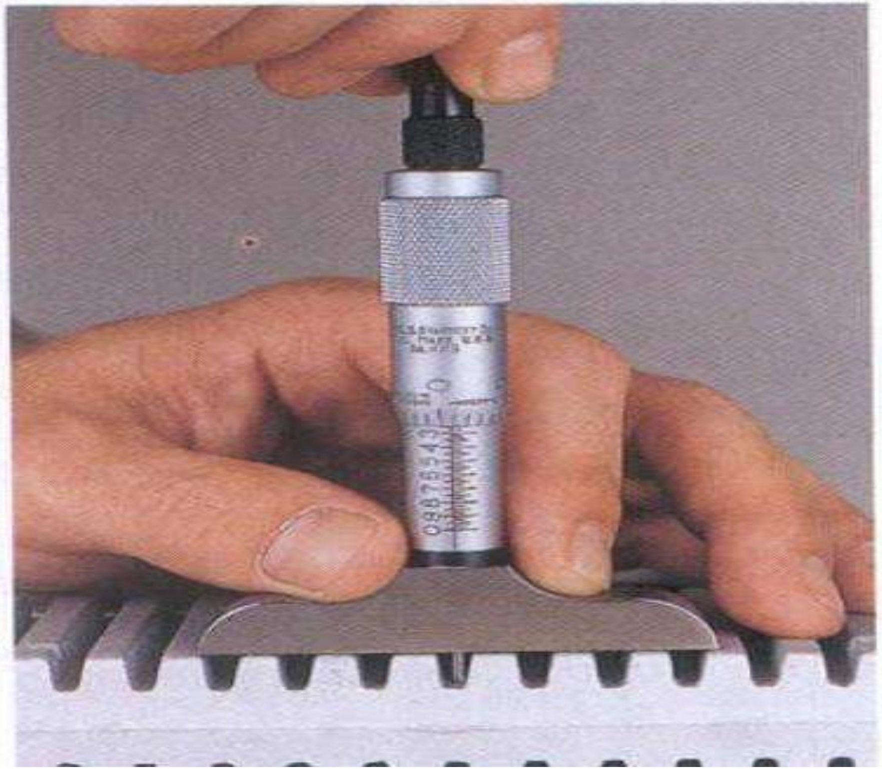
Depth Micrometers



Micrometer with Dial Gauge

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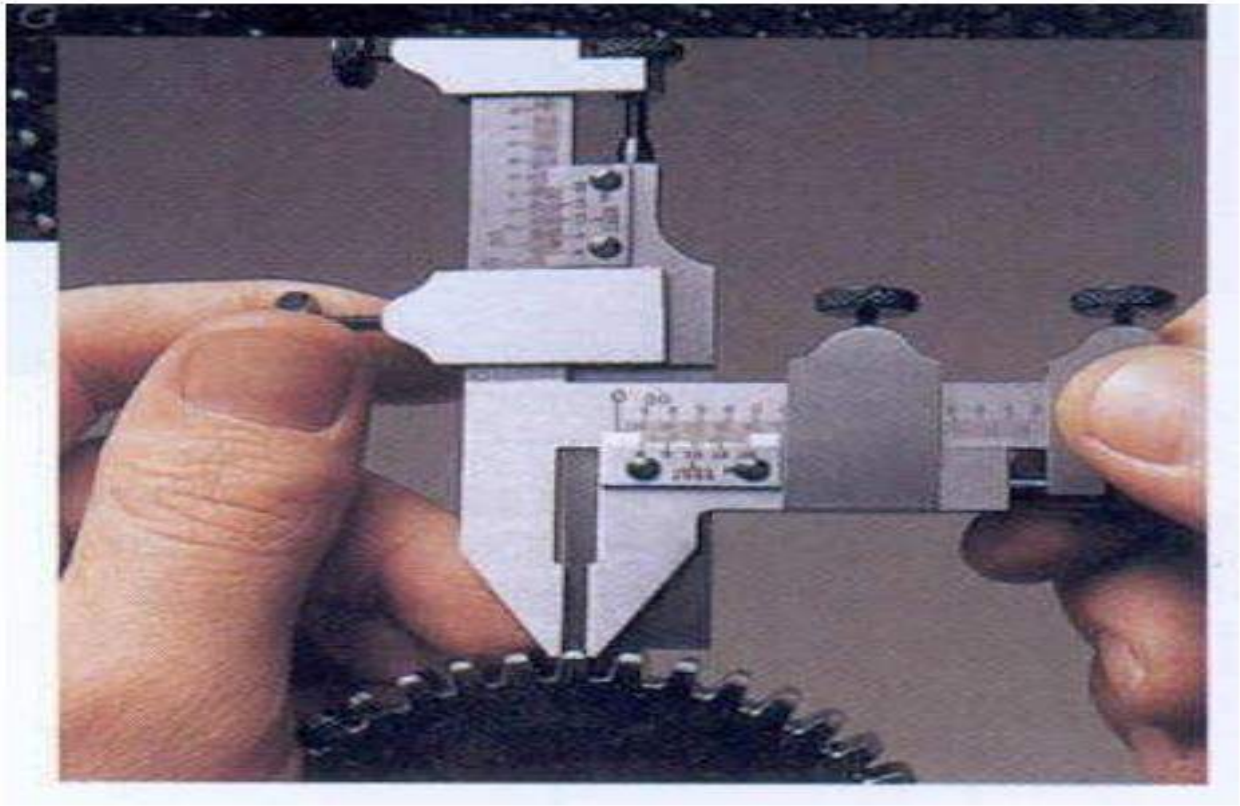
Linear Measurements – Gear Tooth Vernier



Gear Tooth Vernier Similar to two Verniers used at 90°. Used for measuring chordal tooth thickness of gear teeth

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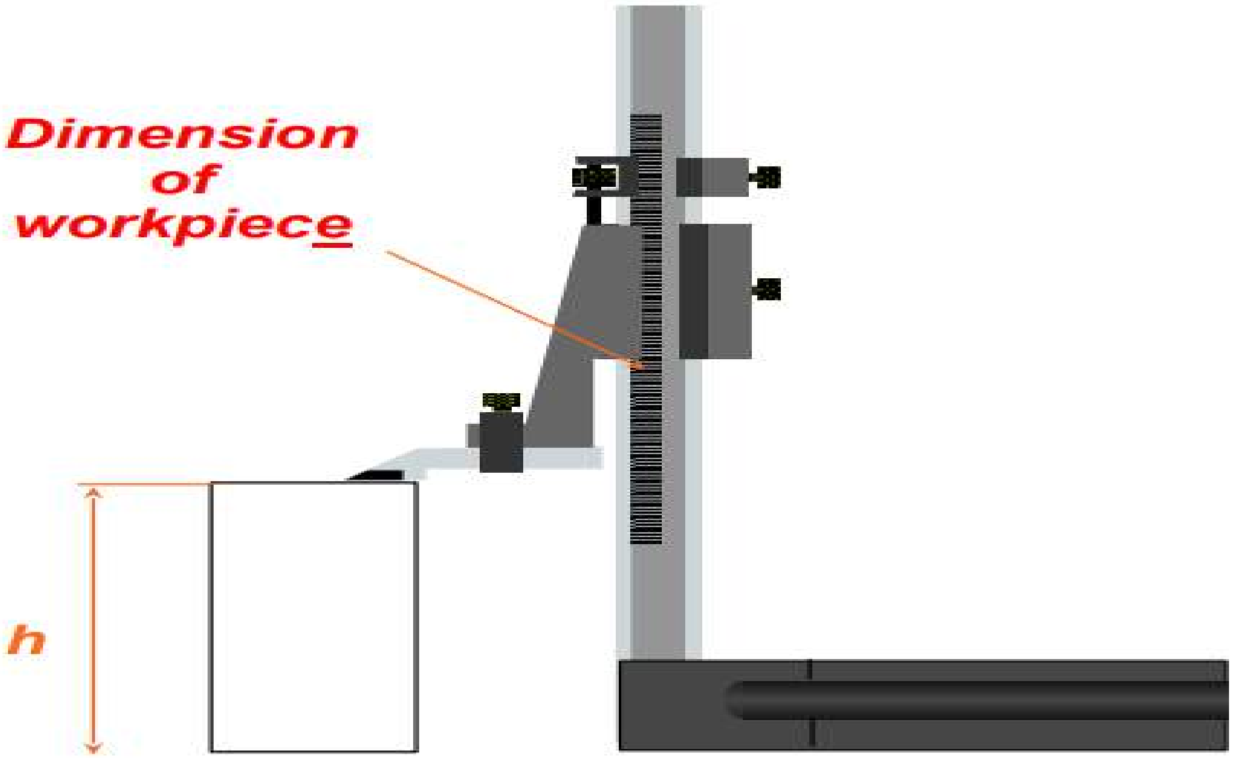
VERNIER HEIGHT GAUGE

Finding out the height of workpiece



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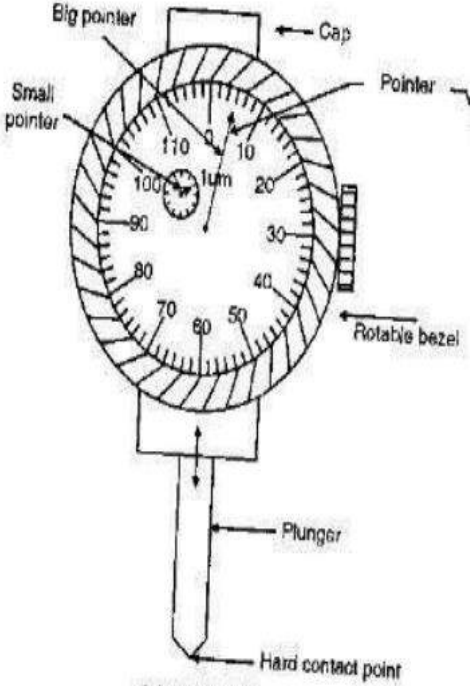
DIAL INDICATOR



(a) Dial indicator

Dial Indicator with Stand

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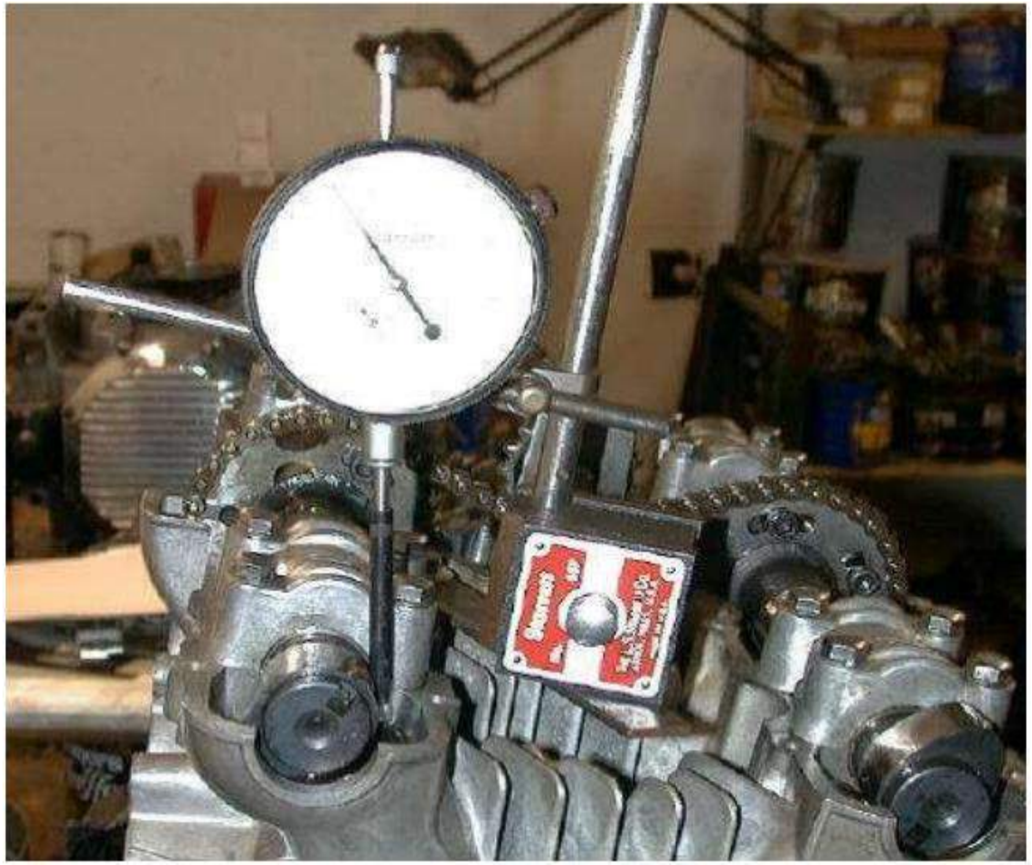

Dial Bore Gauge

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SLIP GAUGE/GAUGE BLOCKS – Slip Gauges are known as Gauge Blocks. They are Precise Measuring Instruments. These Slip Gauges are universally accepted end Standard of length.

Metrology

Classification
(International Standard)

- AA Slip Gauges
- A Slip Gauges
- B Slip Gauges

- **AA SLIP GAUGES**
  - Master slip gauges
  - Accurate to plus or minus two microns per meter
- **A SLIP GAUGES**
  - Reference purpose
  - Type A is guaranteed accurate up to plus or minus four microns per meter
- **B SLIP GAUGES**
  - Working slip gauges
  - Type 'B' for plus or minus eight microns per meter

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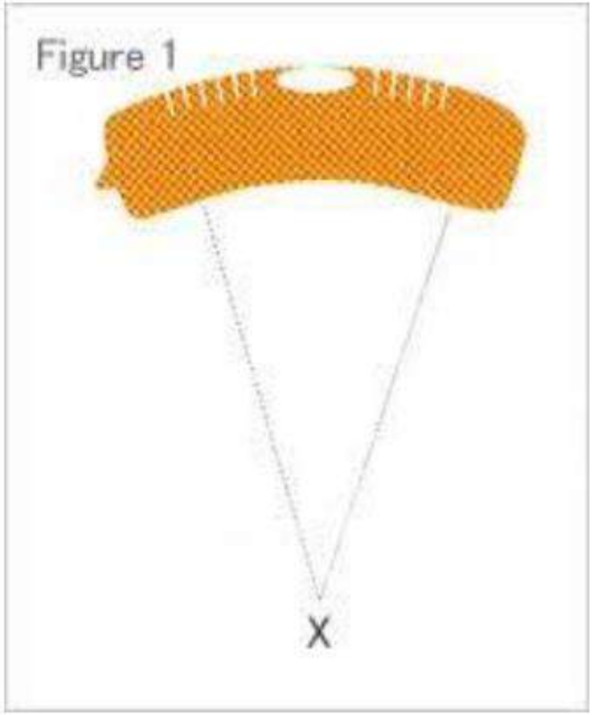
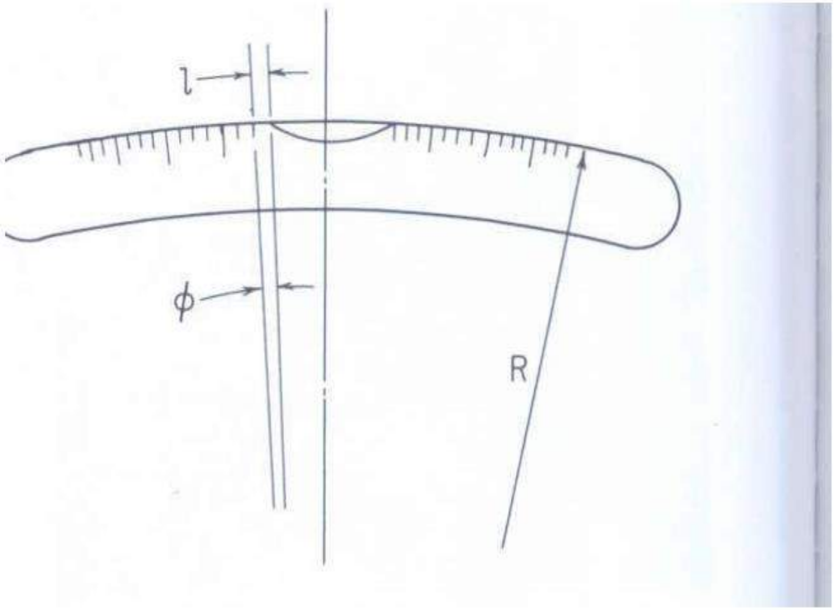
SPRIT LEVEL – ANGLE MEASUREMENT

Angular Measurements –Spirit Level





$$l = R\phi$$

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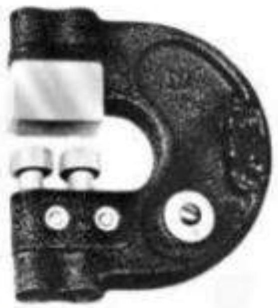
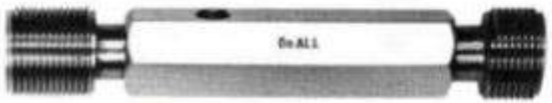
Limit Gauges

- Master Setting Plugs/ Rings
- Limit Plug & Ring Gauges
- Snap gauges
- Taper Plug & Ring Gauges
- Radius Gauges
- Screw Pitch Gauges
- Feeler Gauges


Cylindrical Pin Gauge


Adjustable Snap Gauge


Plain Ring Gauge


Thread Plug Gauge


Cylindrical Plug Gauge


Progressive Cylindrical Plug Gauge


Adjustable Thread Ring Gauge

Comparators

COMPARATORS

- Comparator is an instrument used to measure diameters and lengths on components by suing slip gauges as standard.
- Comparator is the device which compares the unknown dimension of a part with some standard or master setting which represents the basic size.

The basic types of comparator are listed

1. Mechanical comparator
2. Electrical comparator
3. Electronic comparator
4. Optical comparator
5. Pneumatic comparator

Comparators

CHARACTERISTICS OF COMPARATORS

(i) The instrument must be of robust design and construction so as to withstand the effect of ordinary usage without impairing its measuring accuracy.

(ii) The readings should be obtained in least possible time.

(iii) Provision must be made for maximum compensation for temperature effects.

(iv) The scale must be linear and must have straight line characteristic.

(v) Indicator should be constant in it return to zero.

(vi) Instrument must have the maximum versatility.

(vii) Measuring pressure should be low and constant.

Metrology

REED TYPE MECHANICAL COMPARATOR.

Fixed block A	Rigidly fastened to the gauge head
Floating block B	Carries the gauging spindle and is connected horizontally to the fixed block by reeds

- It is available in amplifications ranging from x 500 to x 1000.

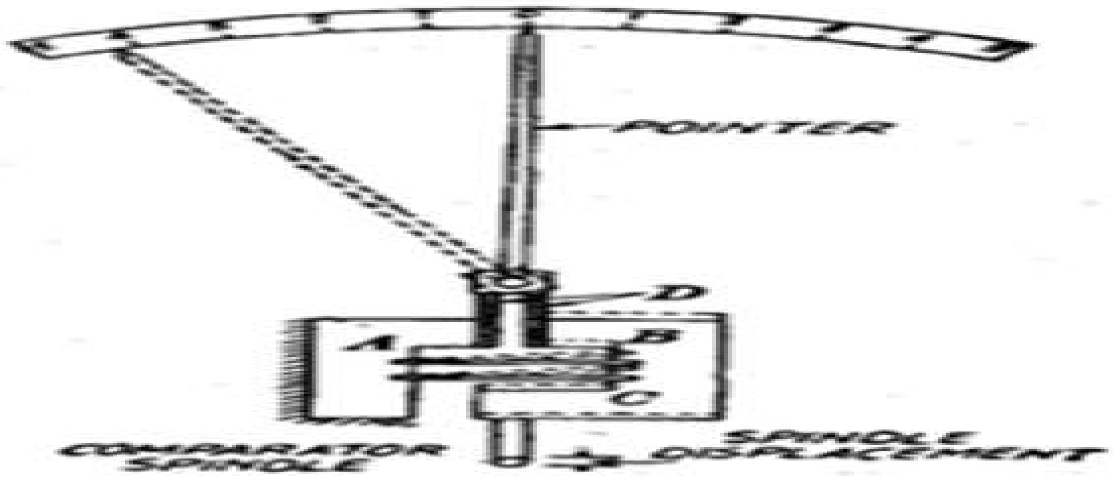


Fig 1.0 Reed type mechanical comparator.

Metrology

Advantages of Mechanical Comparators

1. These are usually cheaper in comparison to other devices of amplifying.
2. These do not require any external supply such as electricity or air and as such the variations in outside supplies do not affect the accuracy.
3. Usually the mechanical comparators have linear scale which is easily understood.
4. These are usually robust and compact and easy to handle.
5. For ordinary workshop conditions, these are suitable and being portable can be issued from a store.

Disadvantages of Mechanical Comparators

1. More number of moving parts
2. Any slackness in moving parts reduces accuracy
3. Sensitive to vibration
4. Ranges is limited
5. Parallax error may occur

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OPTICAL COMPARATOR

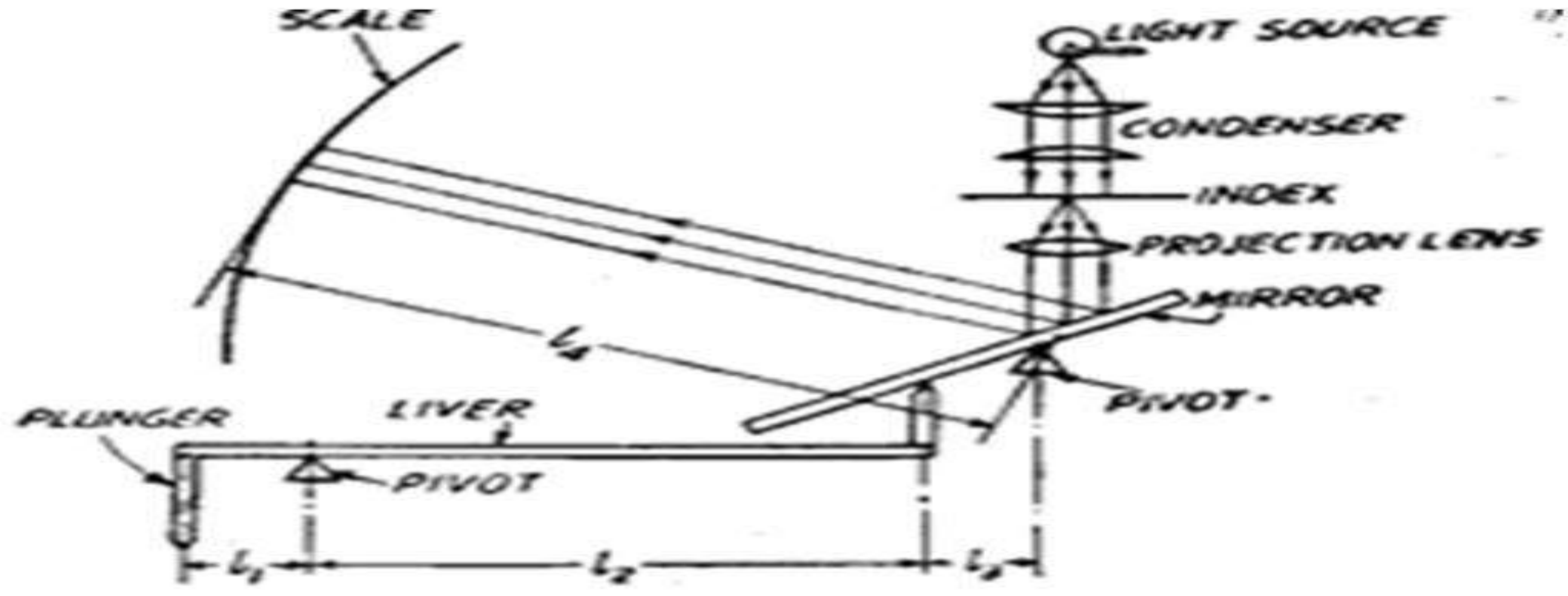

Fig. Principle of Optical Comparator.

Metrology

ELECTRICAL COMPARATOR

- It is also called as electromechanical measuring system.
- This is because they use an electro- mechanical device that converts a mechanical displacement into an electrical signal.
- The block diagram of an electro-mechanical measuring system is shown in the fig

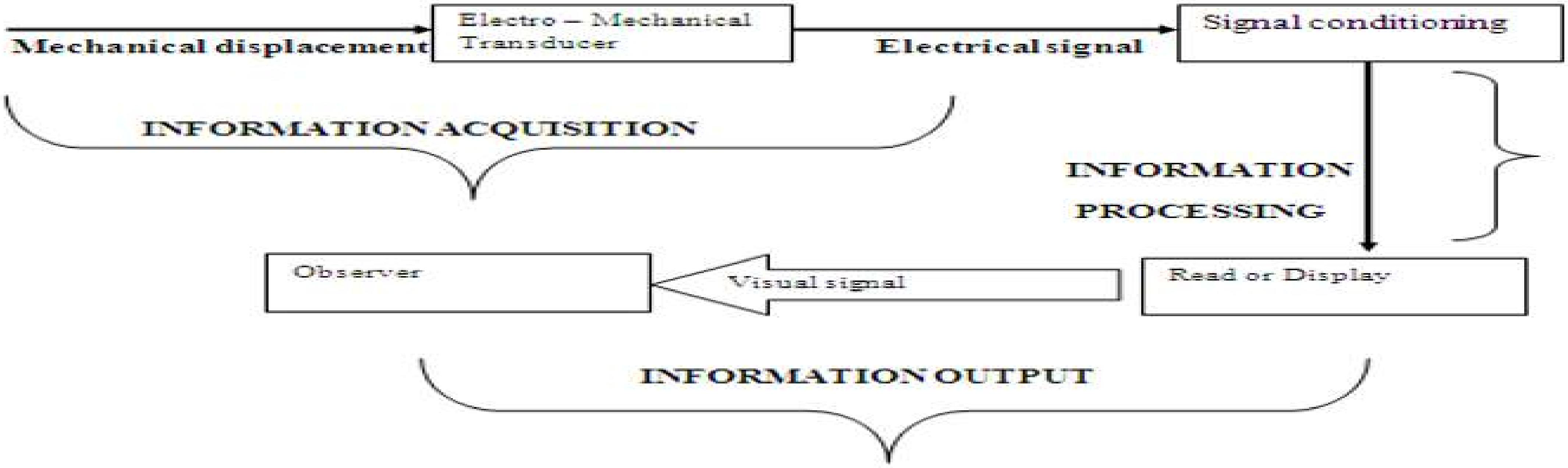

Fig. Block diagram of an electro- mechanical system

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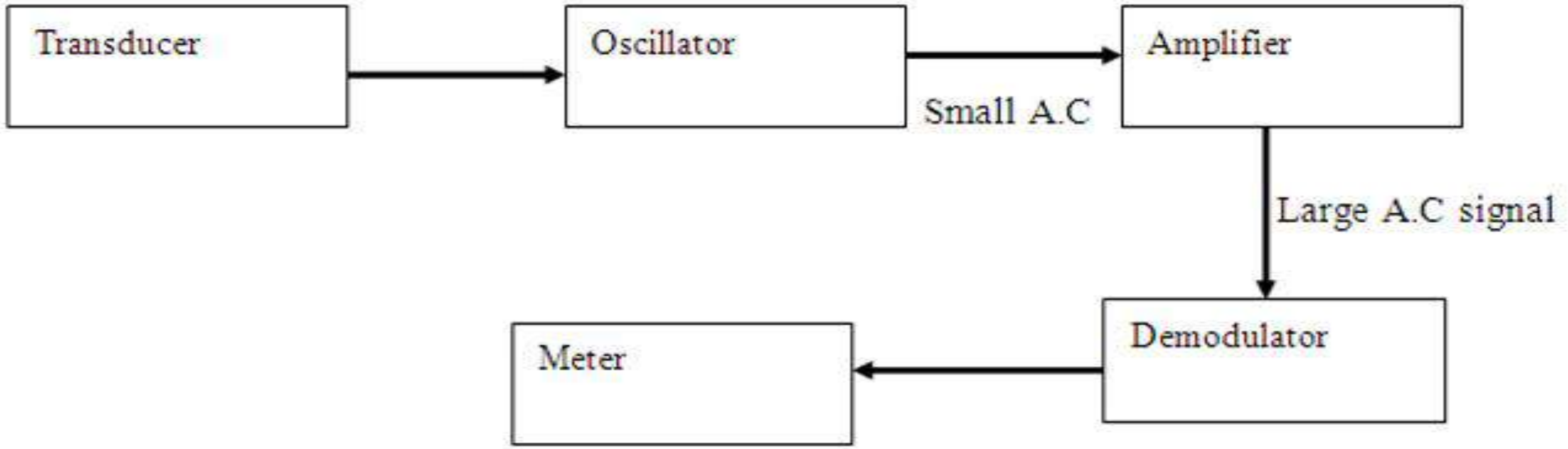
ELECTRONIC COMPARATOR

- In electronic comparator, transducer induction or the principle of application of frequency modulation or radio oscillation is followed.



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Advantages of Electrical and Electronic comparator

1. Small number of moving parts
2. Possible to have very high magnification
3. Used for variety of ranges
4. As it is operated by A.C supply, the cycle vibration substantly reduces errors due to sliding friction.
5. Remote operation can also be done.

Disadvantages of Electrical and Electronic comparator

1. Requires an external agency to operate – A.C power supply
2. Heating of coil may cause zero drift
3. More expensive than mechanical instrument
4. Advantages of electrical comparator

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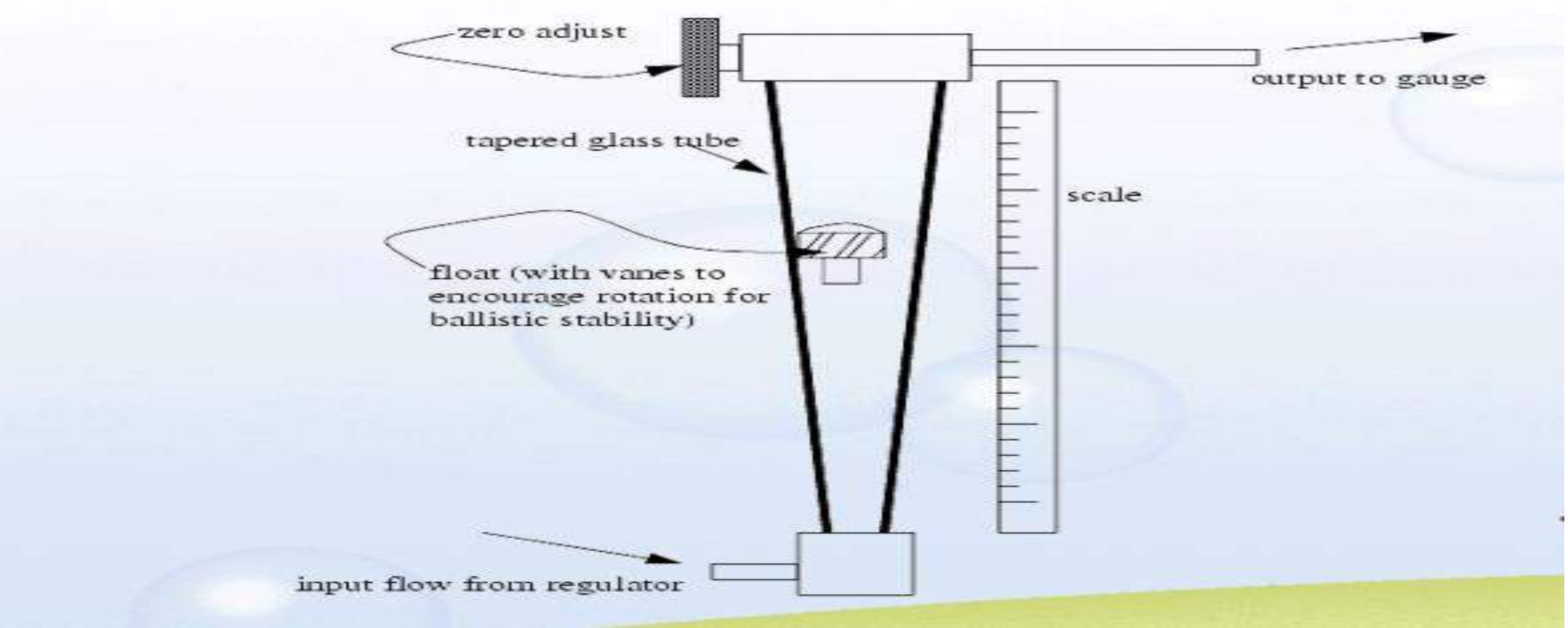
PNEUMATIC COMPARATOR



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Advantages of Pneumatic comparator

1. The wear of measuring heads is avoided due to absence of direct contact.
2. Friction is less due to less number of moving parts
3. High magnification is possible.
4. Workpiece is cleaned by supplying of air during the measurement.
5. It is suitable method to check ovalty and taperness of circular bore.

Disadvantages of Pneumatic comparator

1. Accurate pressure regulators are needed
2. The scale is not uniform
3. Apparatus is not easily portable
4. Different gauging heads are required for different dimensions

Summary

In this topic, main attention was given on the standards and their types in the field of measurements. Overall from the topic, it can concluded that how important is the metrology in the field measurements.

Topics to be Discussed in Next Lecture

- Functional Elements
- Pressure and flow measurements