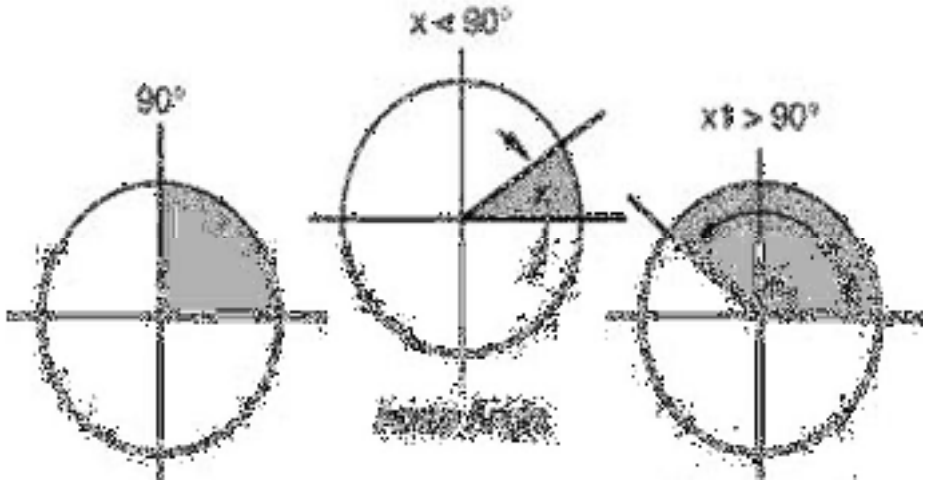
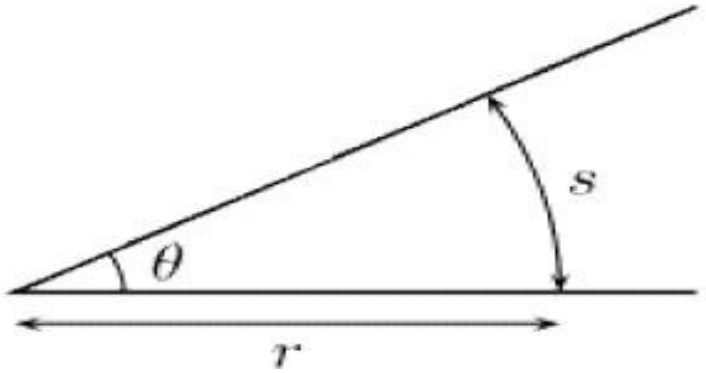
ANGULAR MEASUREMENTS

TOPIC OF THE DAY



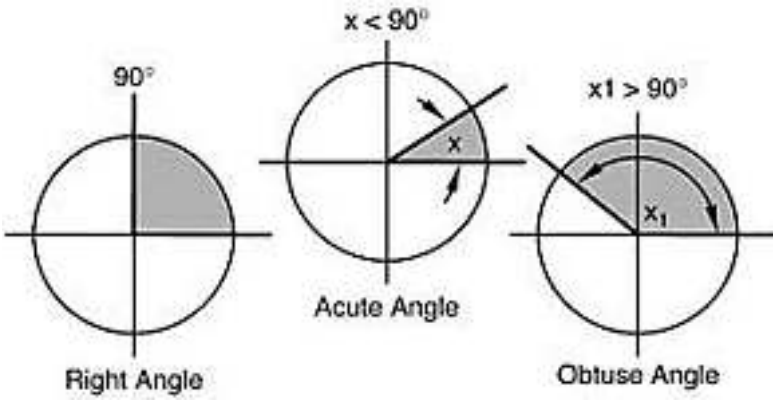
Angle:

- In Geometry an angle is the figure formed by two rays sharing a common end point, called the vertex of the angle.
- The magnitude of the angle is the "amount of rotation" that separates the two rays, and can be measured by considering the length of circular arc swept out when one ray is rotated about the vertex to coincide with the other.



Right angle – one-fourth of circle or one quadrant

Acute angle - an angle measures less than 90° *Obtuse angle* - an angel measure more than 90°



ANGULAR MEASUREMENT

Angle: Units of Measurement

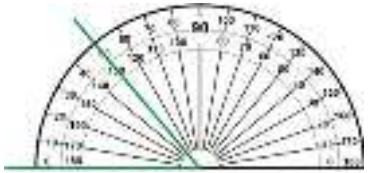
1. **Degree:** denoted by a small superscript circle (°), is 1/360 of a full circle
2. **Minute:** is 1/60 of a degree. It is denoted by a single prime (′).
3. **Second:** is 1/60 of a minute of arc or 1/3600 of a degree. It is denoted by a double prime (″).
4. **Radian:** is the angle subtended by an arc of a circle that has the same length as the circle's radius.

   1Rad = 57.2958 degrees.

INSTRUMENTS FOR ANGULAR MEASUREMENT

1. Protractors:
    a. Vernier Bevel Protractor
    b. Dial Bevel Protractor
    c. Optical Bevel Protractor
2. Sine Bars
3. Sine tables
4. Sine Centre
5. Angle Gauges
6. Spirit Level
7. Clinometers
8. Plain Index Centers
9. Optical Instruments for angular measurement such as autoclinometer

Angular Measurement



Introduction

- The angle is defined as the opening between two lines which meet at a point.
- Circle is divided into 360 parts, each part is called a degree (º).
- Each degree is divided in 60 minutes (') and each minute into 60 Seconds (“)
- Unit of angle derived from theoretical considerations is the radian, defined as the angle subtended at the centre of a circle by an are length equal to radius of circle.

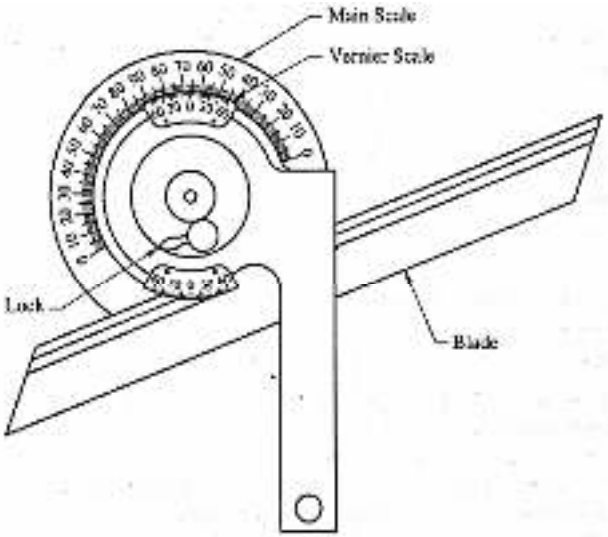
The general formula for converting from degrees to radians is to simply multiply the number of degree by Π /180°. The general formula for converting from radians to degrees to simply multiply the number of degree by 180°/(Π)

Angle Measurement Instrument

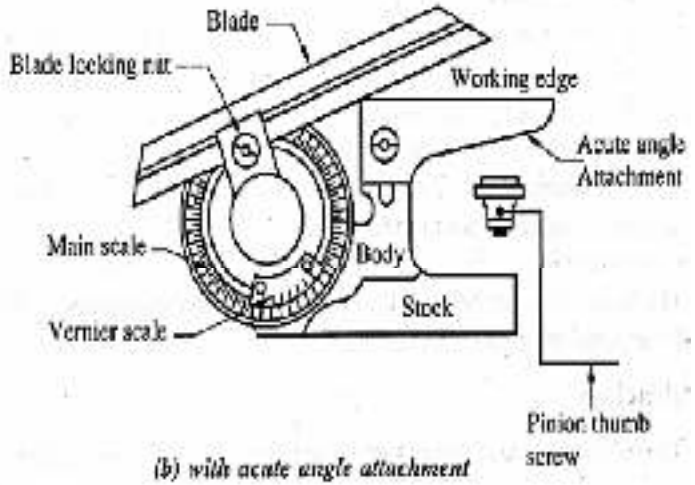
- ❑ Line Standard Angular Measuring Devices
- Protractors
- Universal Bevel Protractors
- ❑ Face Standard Angular Measuring Devices
- Sine bar
- Sine Center
- ❑ Measurement of Inclines
  - Spirit Level
  - Clinometer
- ❑ Angle Comparators
- Autocollimators

Vernier Bevel protractor

- The simplest instrument for measuring the angle between two faces of component.
- Main scale on the protractor is divided into degrees from 0 to 90 each way.

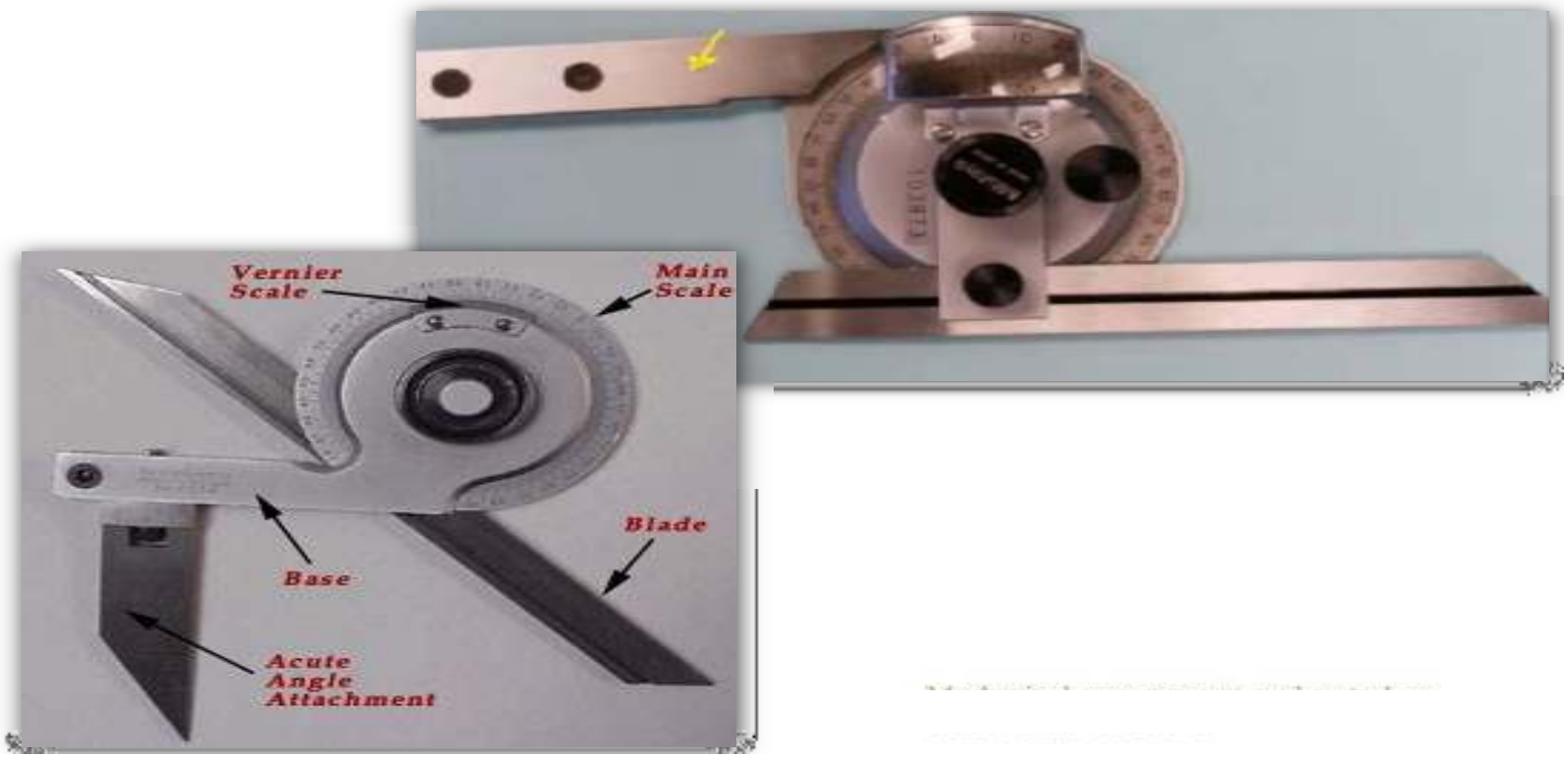


(a) Without acute angle attachment

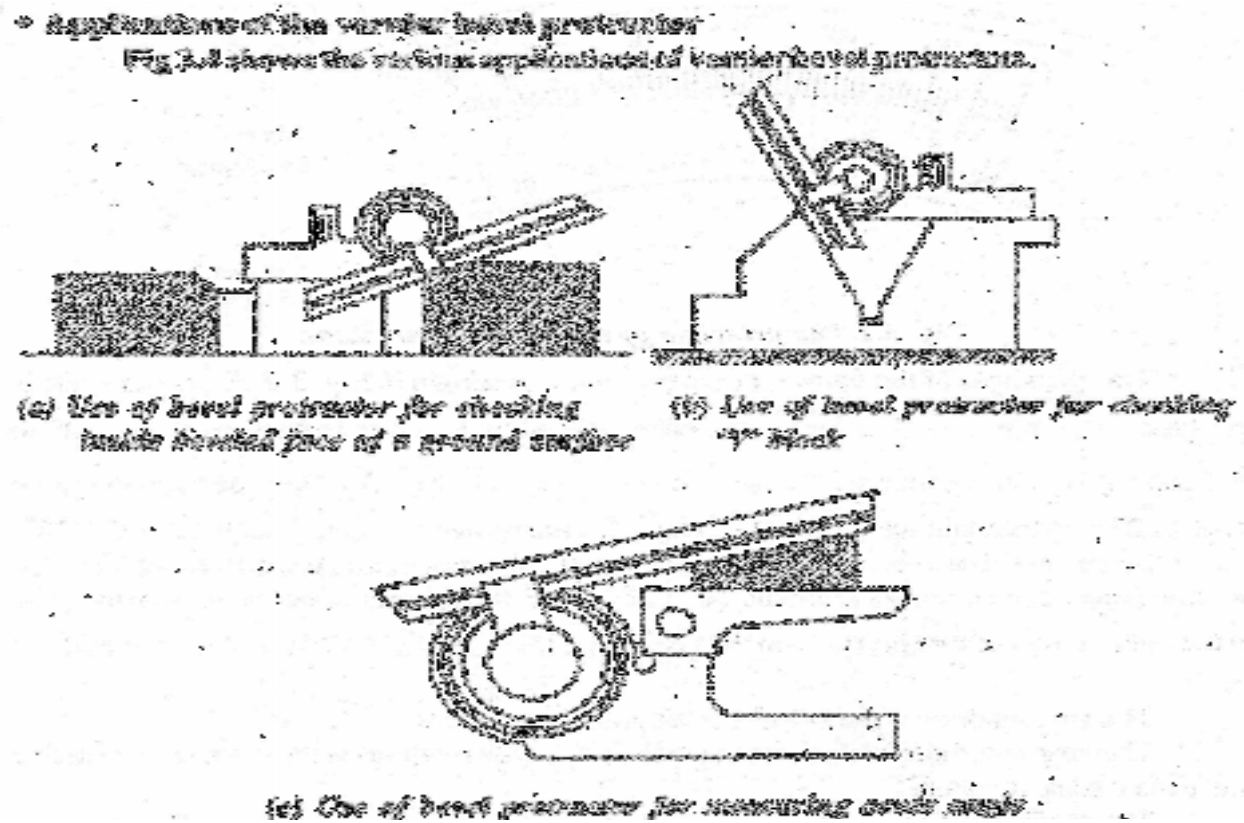


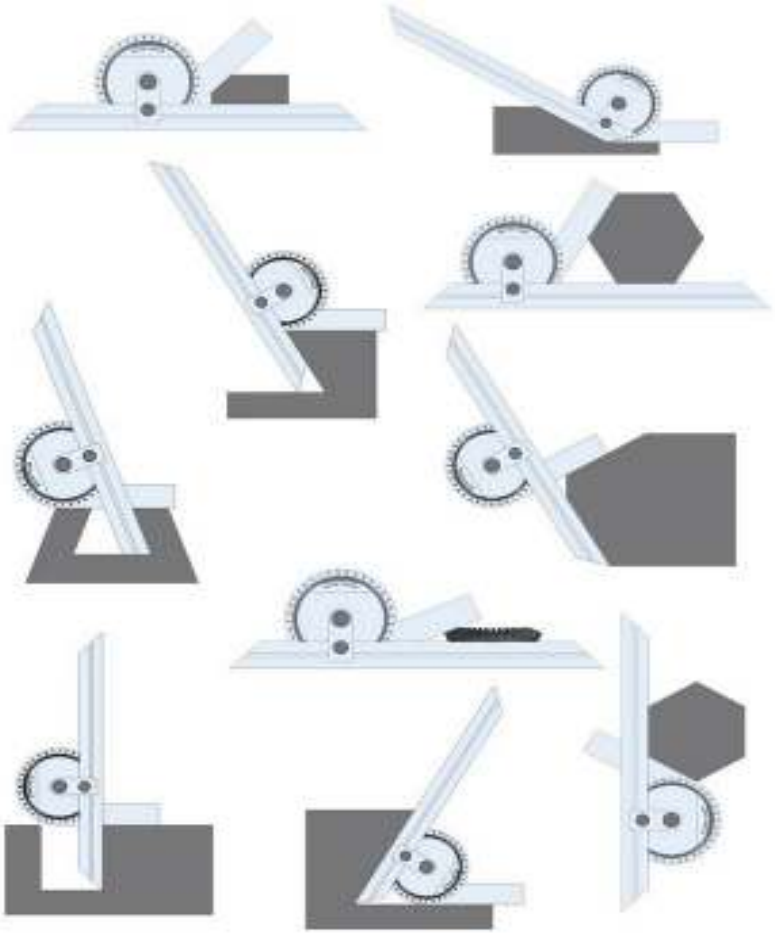
(b) with acute angle attachment

Vernier Bevel protractor

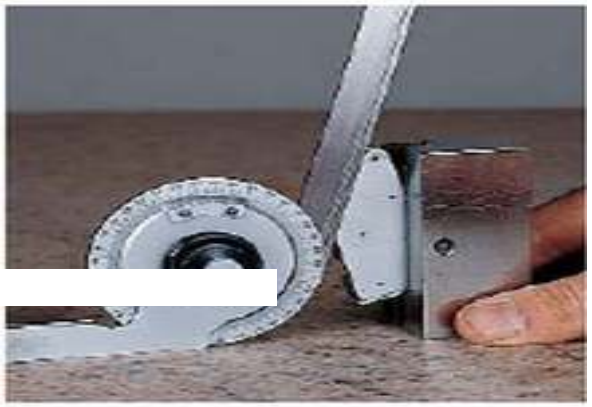


Vernier Bevel protractor



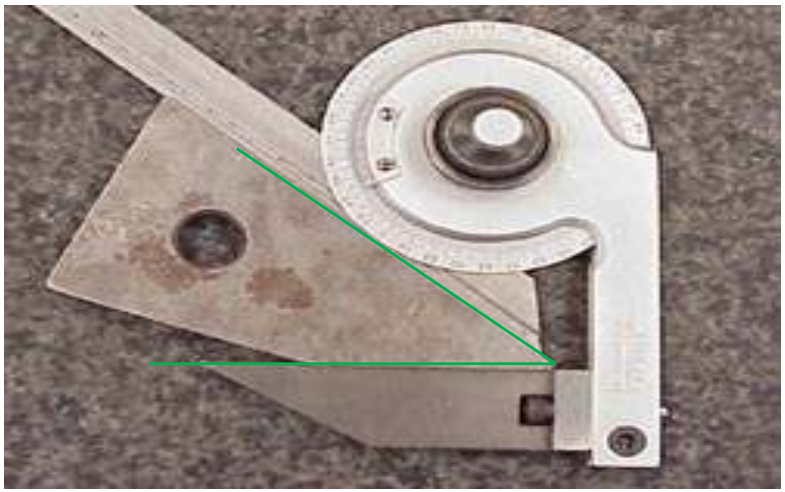


Measuring acute angle.

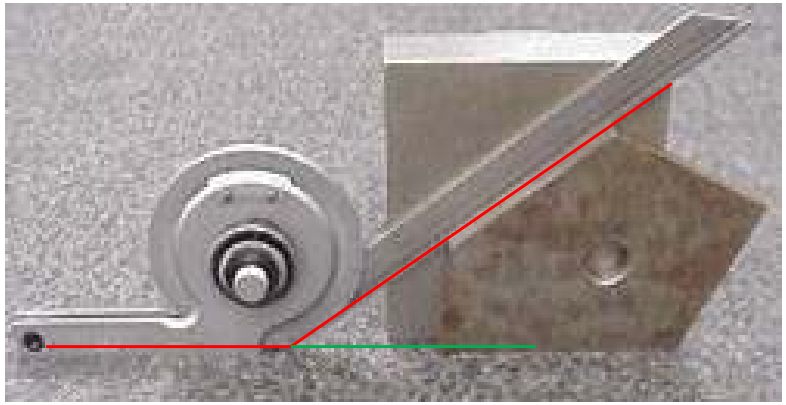


Measuring obtuse angle.

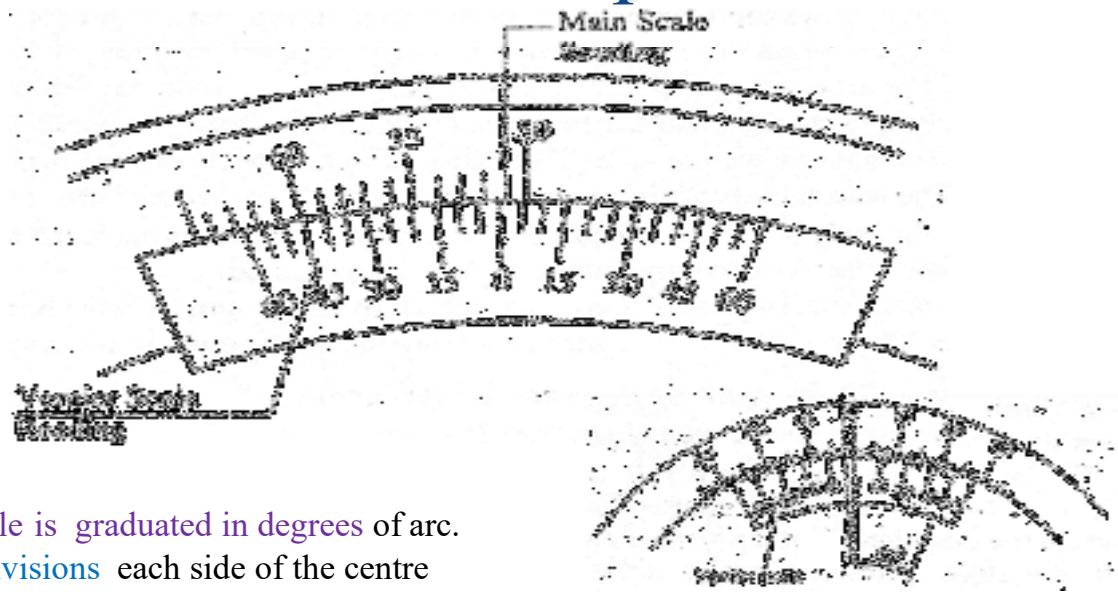
Measuring Acute Angles



Measuring Obtuse Angles

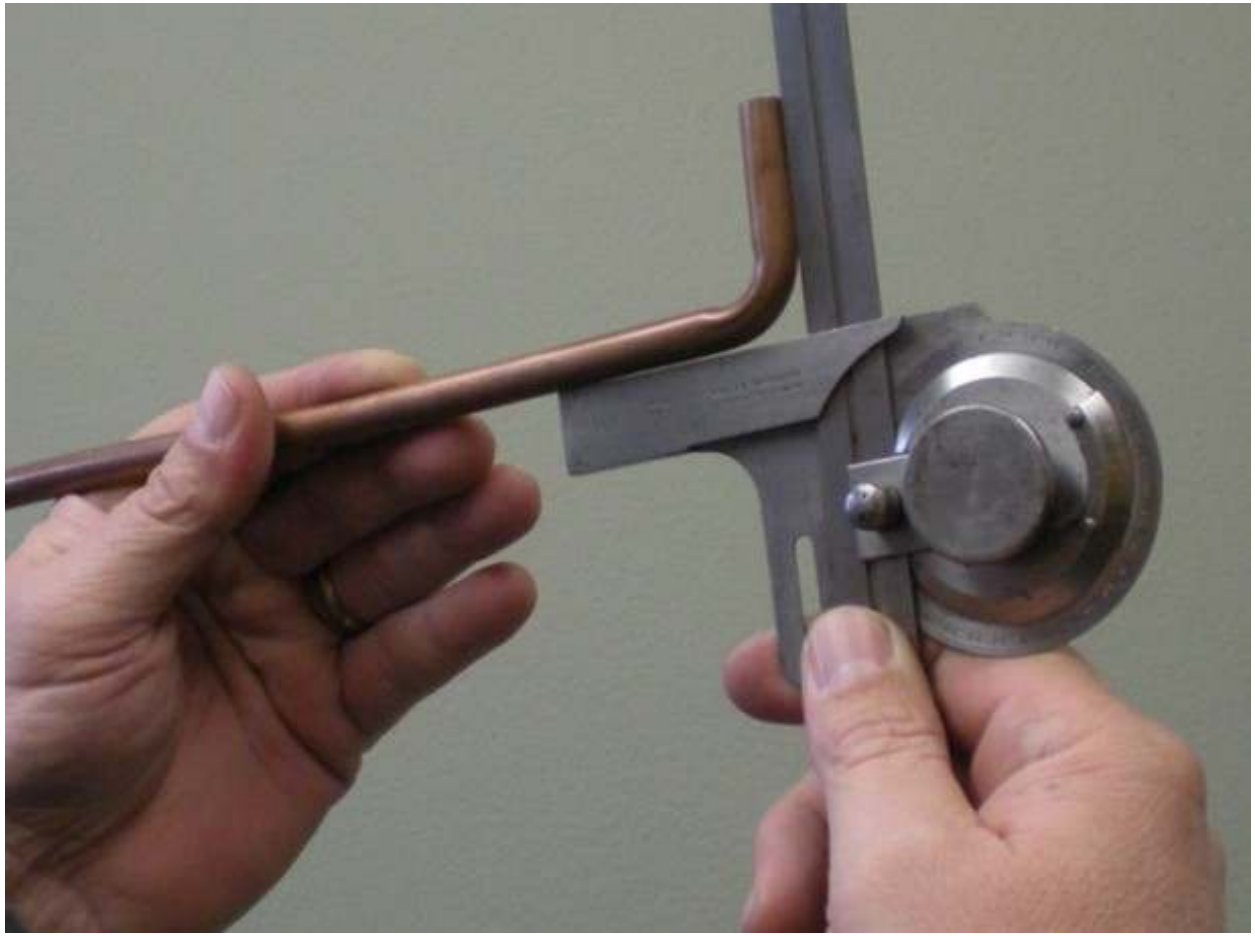


Vernier Bevel protractor



- As shown in the main scale is graduated in degrees of arc.
- The Vernier scale has 12 Divisions each side of the centre zero.
- These are marked 0-60 minutes of arc, so that each division equals 1/12 of 60, that is 5 minutes of arc.
- These 12 divisions occupy the same space as 23 degrees on the main scale. Therefore, each division of the Vernier is equal to $\frac{1}{12}$ of 23° or $1\frac{11}{12}°$

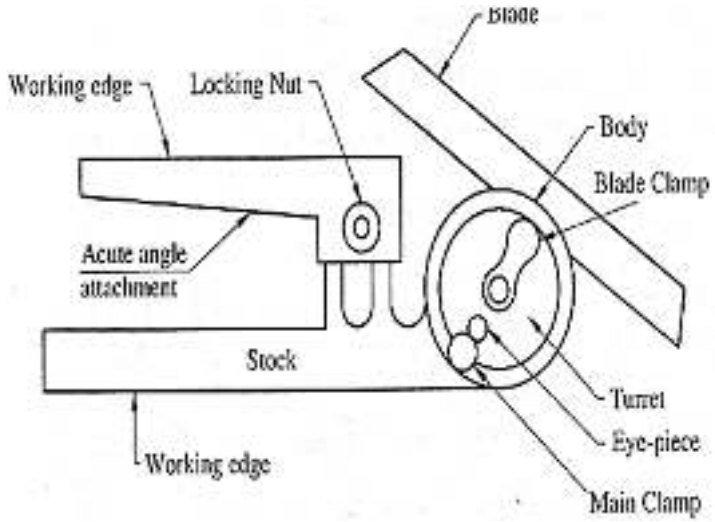
Vernier Bevel protractor



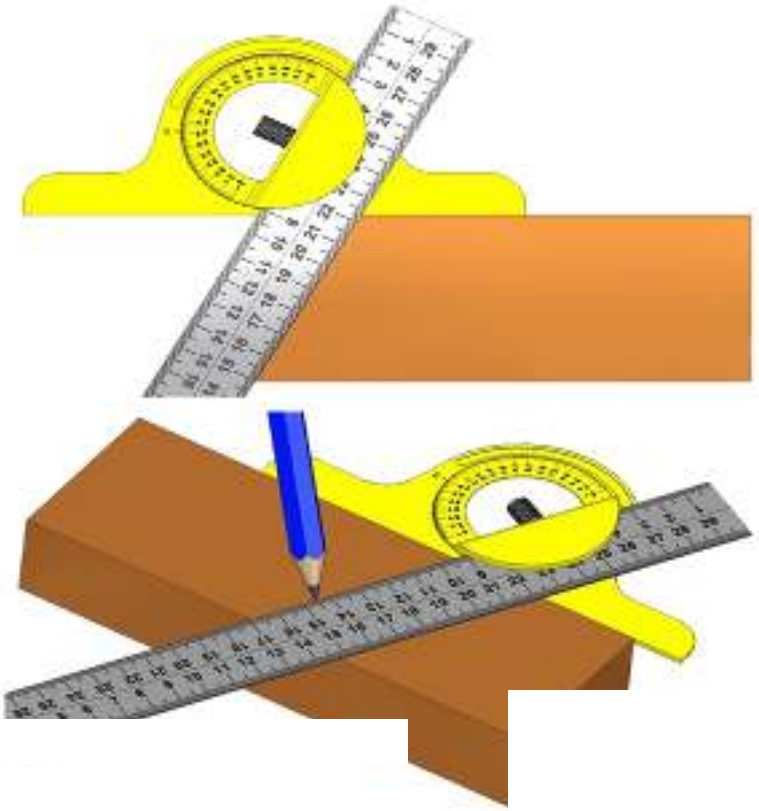
Working of Bevel Protractor (3D Animation) - YouTube

Optical bevel protractor

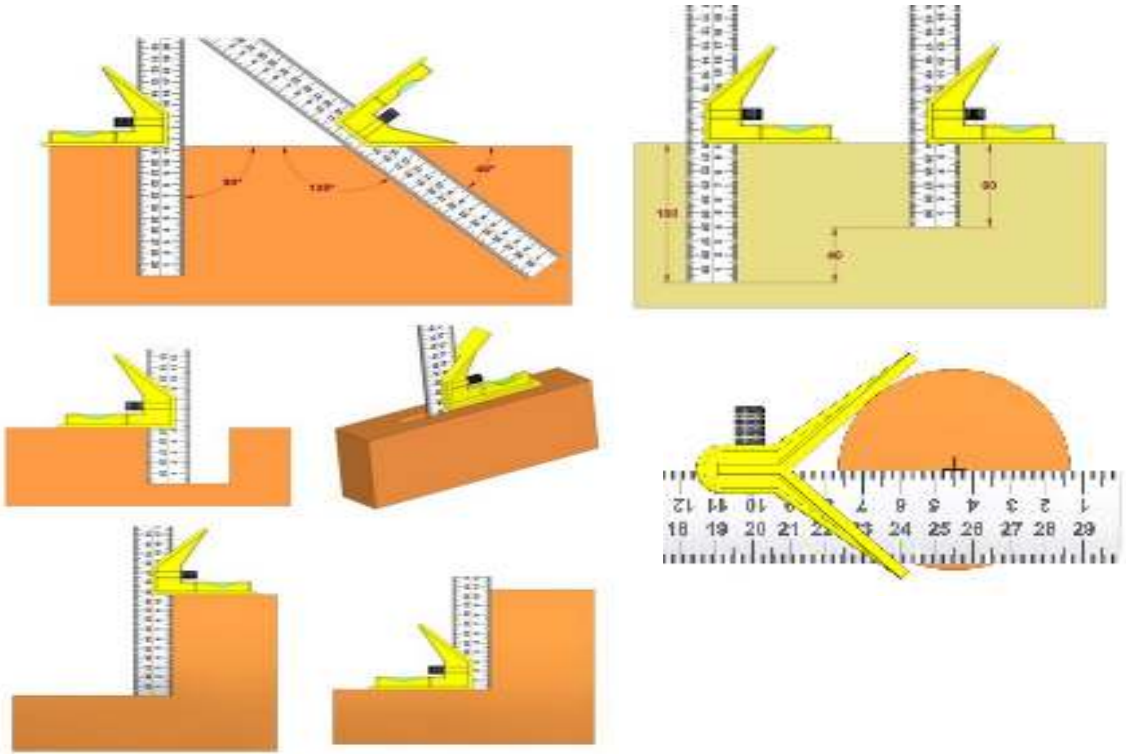
- A circle divided at 1.0 minutes intervals throughout the circle is fitted inside the body.
- Small microscope is fitted through which the circle graduations can be viewed.
- Adjustable blade is clamped to a rotating member which carries its microscope.



Combination Set

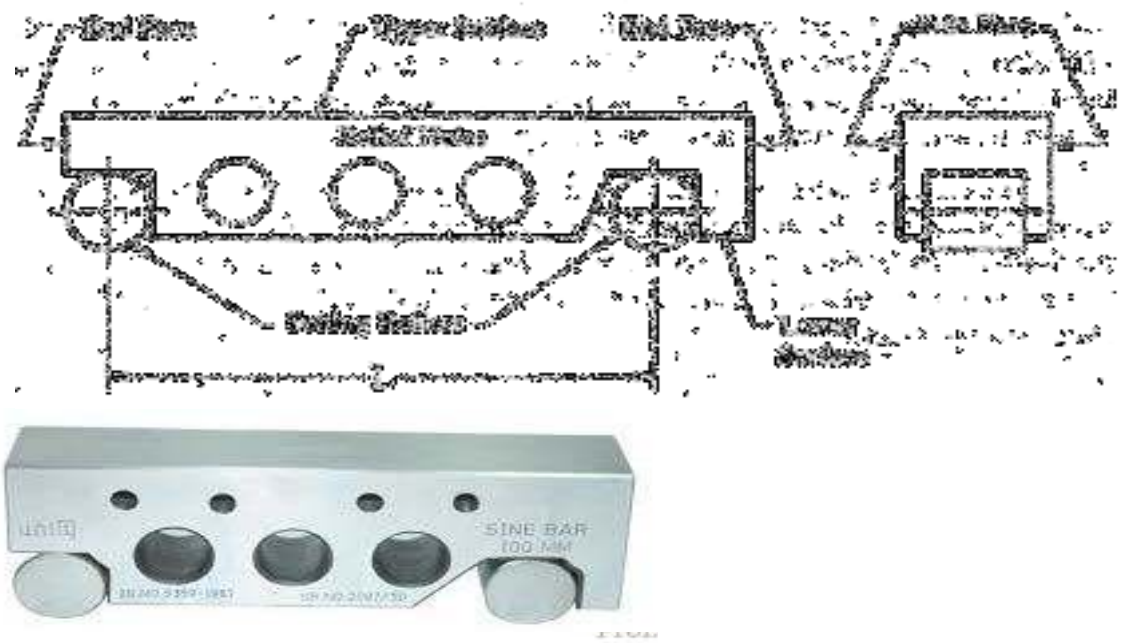


Combination Set

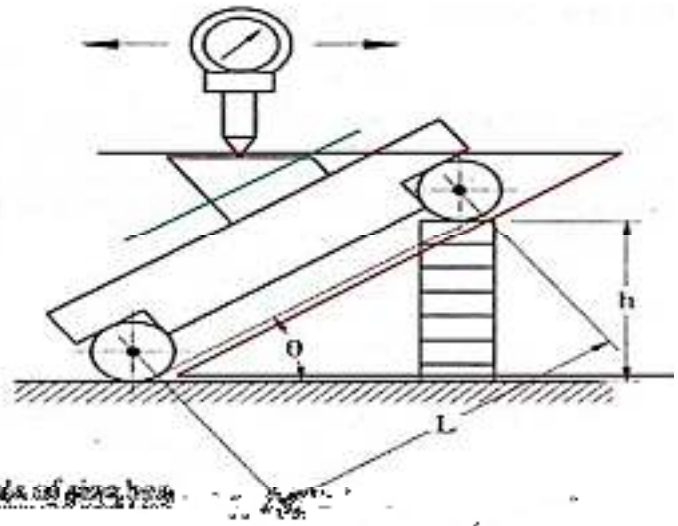


Sine bars

- A precision angle measuring instrument used along with slip gauges



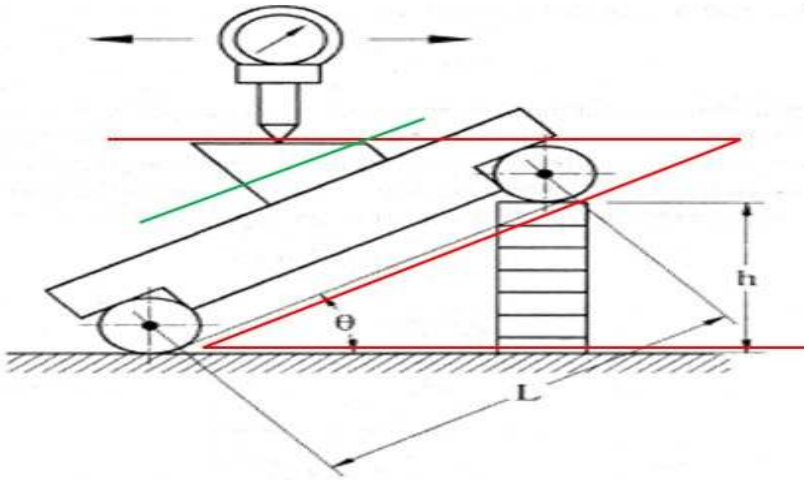
Sine bars



Use of sine bar :

1. locating any work to a given angle :

Sine bars



Measuring angle of small size component

The sine bars inherently become increasingly impractical and inaccurate as the angle exceeds 45° because of following reasons :

—The sine bar is physically clumsy to hold in position.

—The body of the sine bar obstructs the gauge block stack, even if relieved.

—Slight errors of the sine bar cause large angular errors.

—Long gauge stacks are not nearly as accurate as shorter gauge blocks.

—A difference in deformation occurs at the point of roller contact to the support surface and to the gauge blocks, because at higher angles, the weight load is shifted more toward the fulcrum roller.

—The size of gauges, instruments or parts that a sine bar can inspect is limited, since it is not designed to support large or heavy objects.

Sine bars

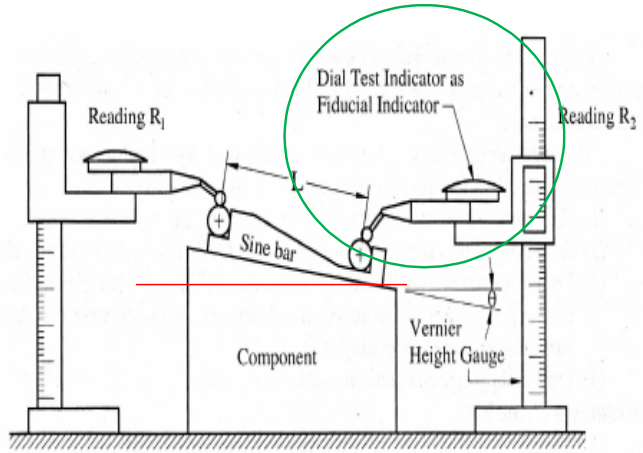


Fig. 3.10 Measuring angle of large size component.

- Height over the rollers can be measured by a vernier height gauge; using a dial test gauge mounted on the anvil of height gauge to ensure constant measuring pressure.
- This is achieved by adjusting the height gauge until the dial gauge shows the same zero reading each time

$$\sin\theta = \frac{R_1 - R_2}{L}.$$

Sine bars

- Advantages of sine bar

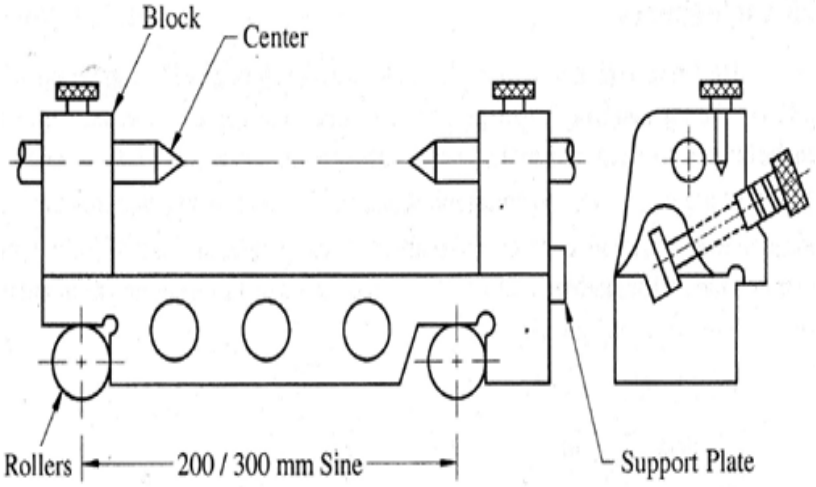
1. It is precise and accurate angle measuring device.
2. It is simple in design and construction.
3. It is easily available

- Disadvantages

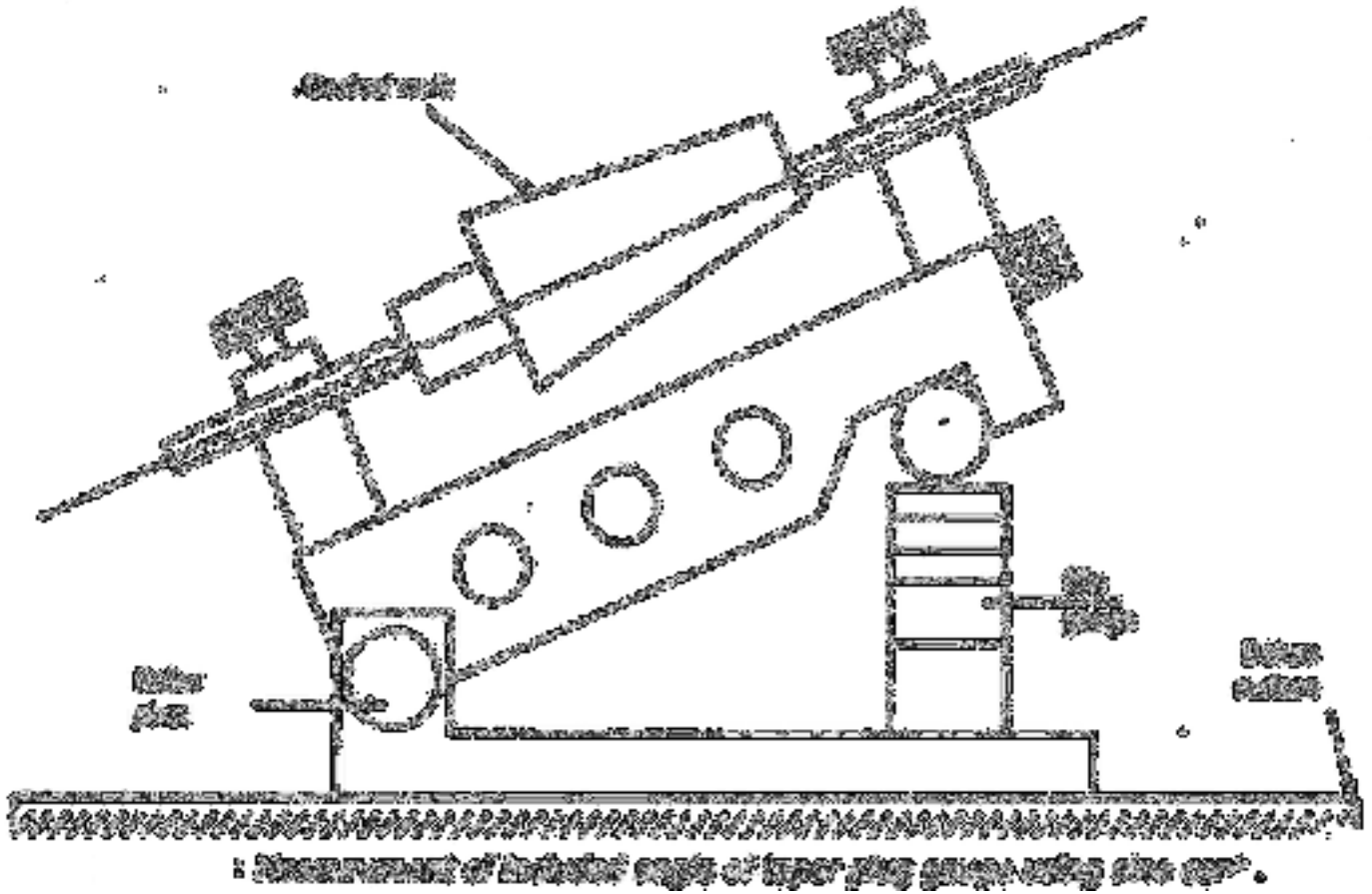
1. It is fairly reliable at angles less than 15 but become increasingly inaccurate as the angle increases. It is impractical to use sine bar for angle above 45 .
2. It is difficult to handle and position the slip gauges.
3. The sine bar is physically clumsy to hold in position.
4. The application is limited for a fixed center distance between two rollers.
5. Slight errors of the sine bar cause larger angular errors.

Sine Centre

- Sine center is basically a sine bar with block holding centers which can be adjusted and rigidly clamped in any position. used for the testing of conical work, centered at each end as shown.
- Extremely useful since the alignment accuracy of the centers ensures that the correct line of measurement is made along the workpiece.
- The centers can also be adjusted depending on the length of the conical work piece, to be hold between centers.



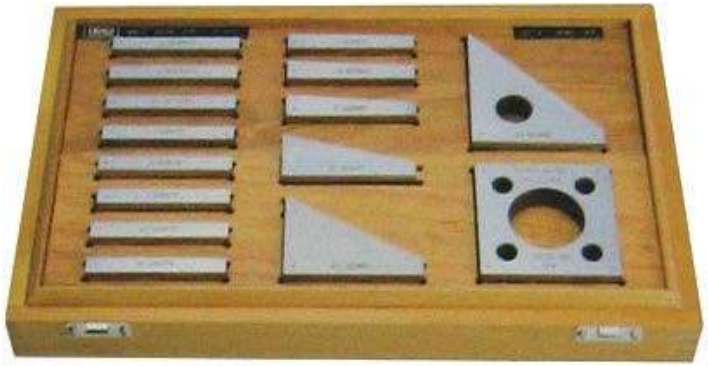
Sine Centre



[How to use a Sine Bar -#5minFriday - #3 - YouTube]

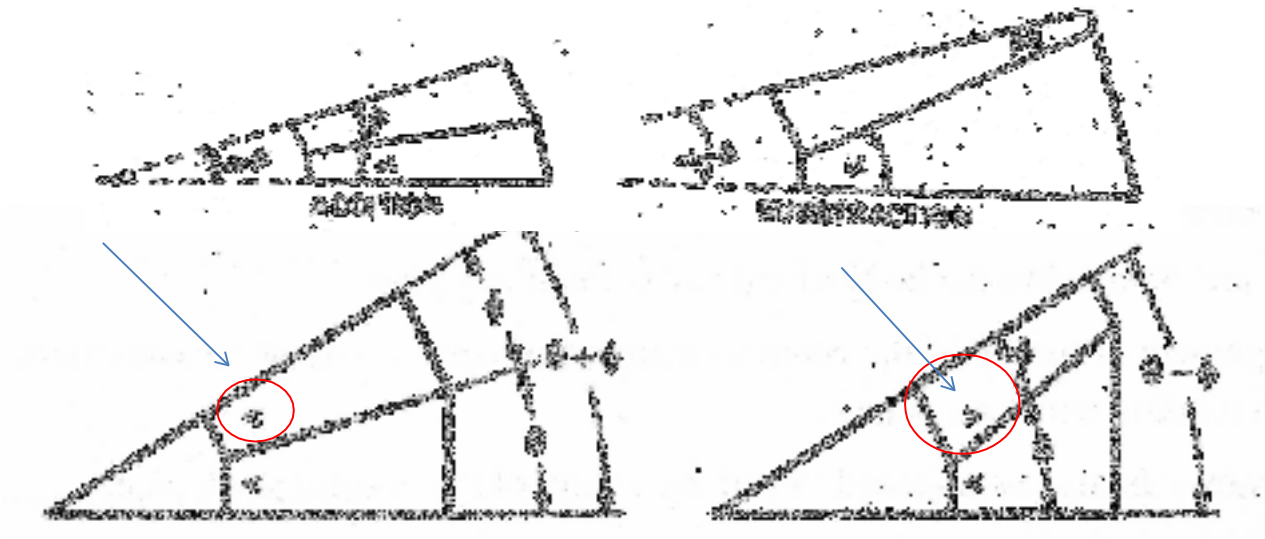
Angle Gauge

- Angle gauges are made of hardened steel and seasoned carefully to ensure permanence of angular accuracy, and the measuring faces are lapped and polished to a high degree of accuracy and flatness like slip gauges.



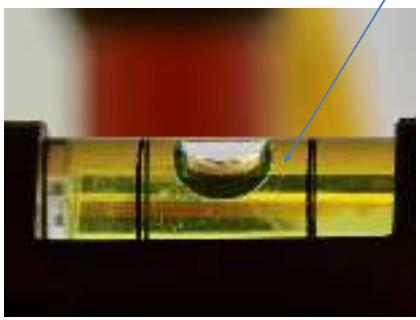
Angle Gauge

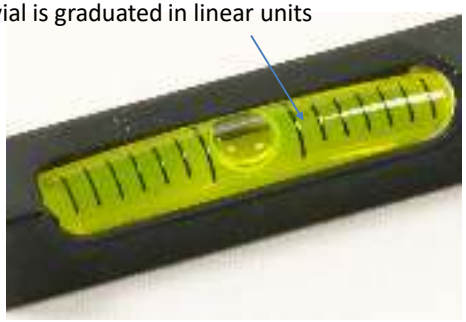
- Like linear gauge blocks, angle gauge blocks can also be wrung together to build up a desired angle.
- In addition, they can also be subtracted to form a smaller angle as a difference of two larger angles as shown in Figure.
- The plus and minus ends of each block are marked.



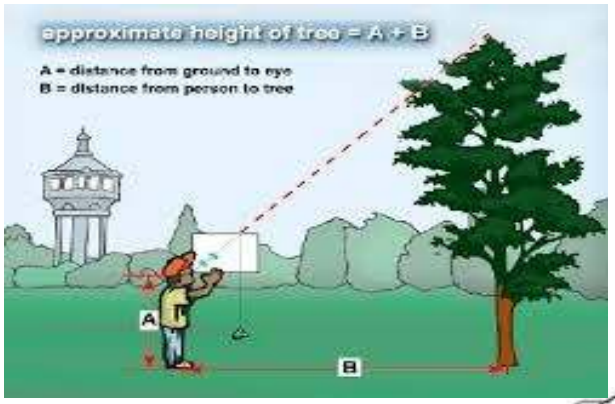
Spirit Level

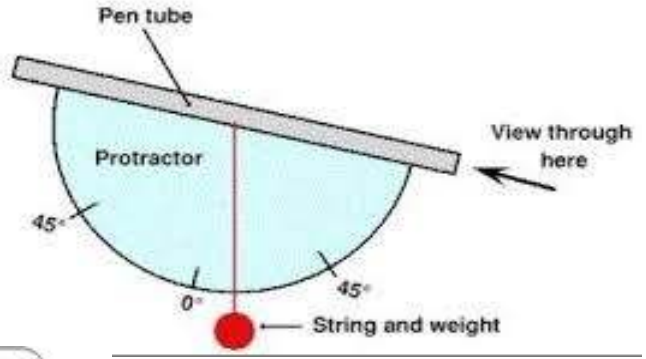
low viscosity fluids
the vial is graduated in linear units

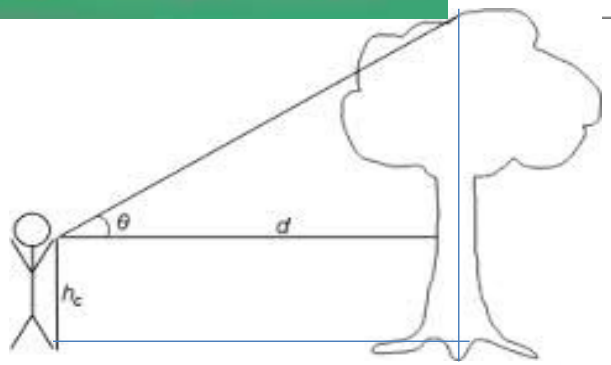




Clinometers







Clinometers

Clinometers.

The clinometer is especially used for the adjustment of the spirit level by the instrument and for measuring angle subtended by a distant object. The various types of clinometers are

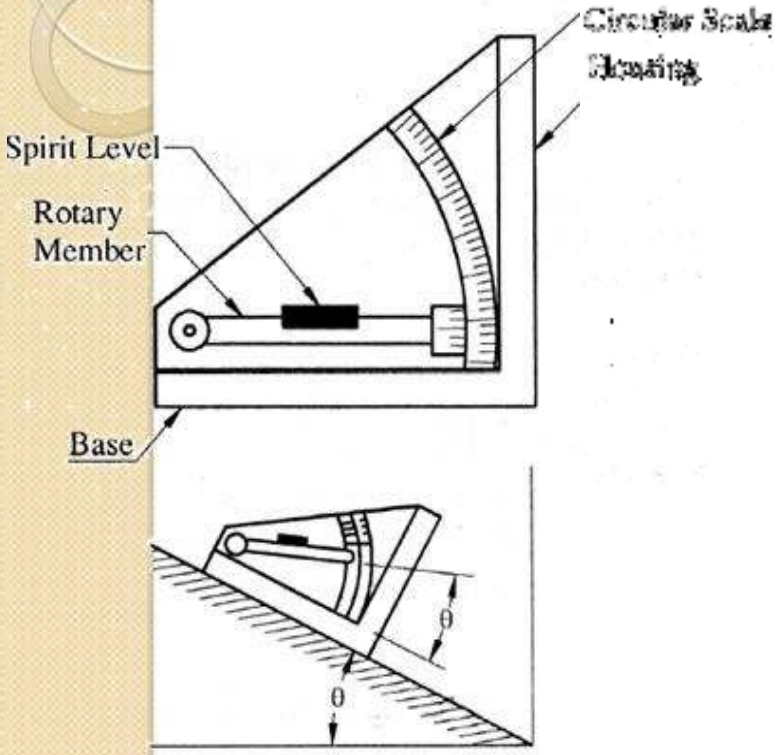
(1) Hunter clinometer.

(2) Abney clinometer.

(3) Indian clinometer.

(4) Optical clinometer.

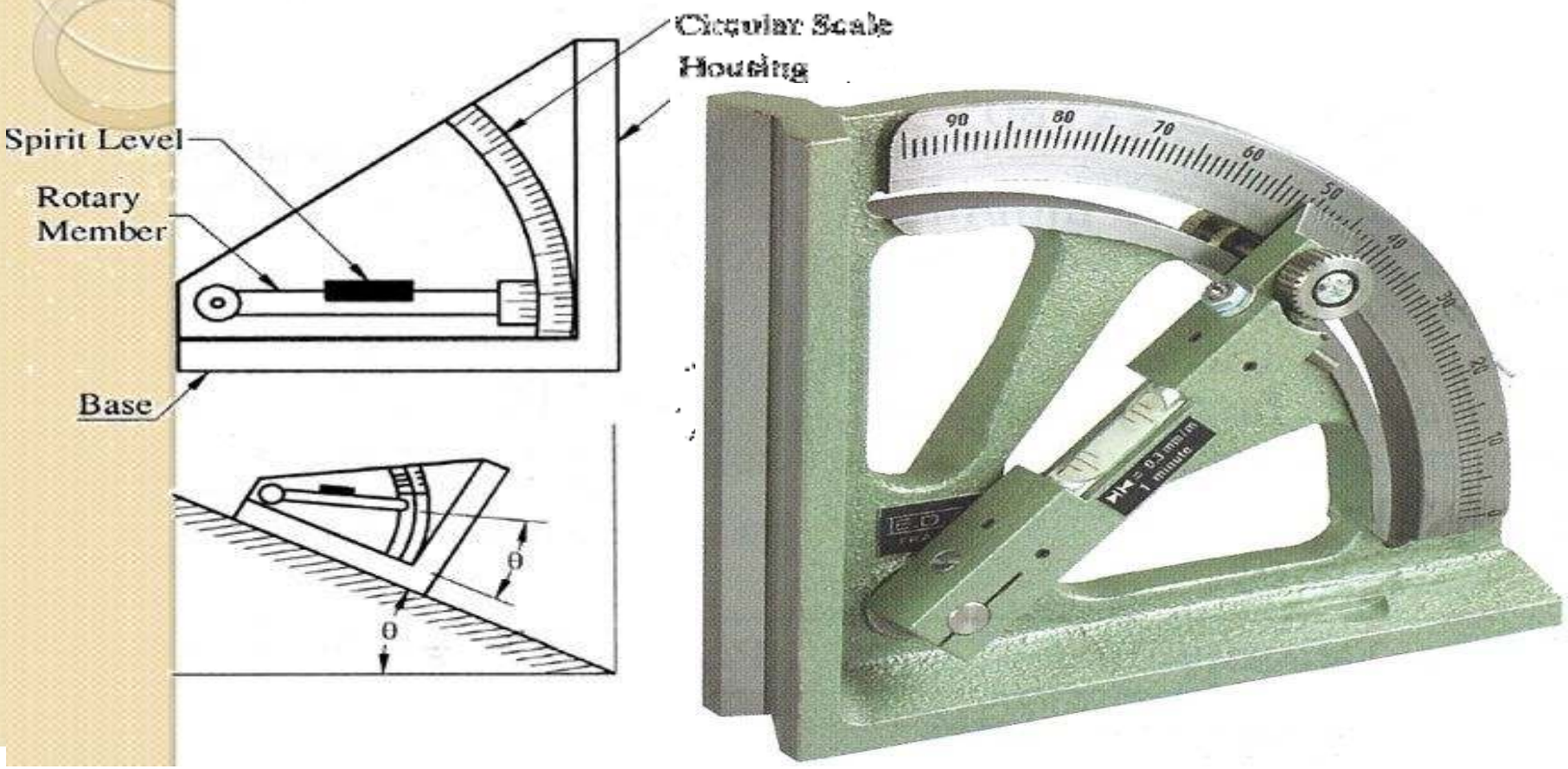
Clinometers



The clinometers is a special case of the application of the spirit level. It is an instrument used for measuring angle relative to the horizontal plane.

- It consists of a spirit level mounted on a rotary member carried in a housing.
- One face of the housing forms the base of the instrument.
- A circular scale is provided on the housing. A circular scale is used to measure the angle of inclination of the rotary member relative to the base.
- The scale may cover the whole circle or only part of it.
- The base of the instrument is placed on the surface and rotary member is adjusted till zero reading of the bubble is obtained as shown in Fig.
- The angle of rotation is then noted on the circular scale against an index.

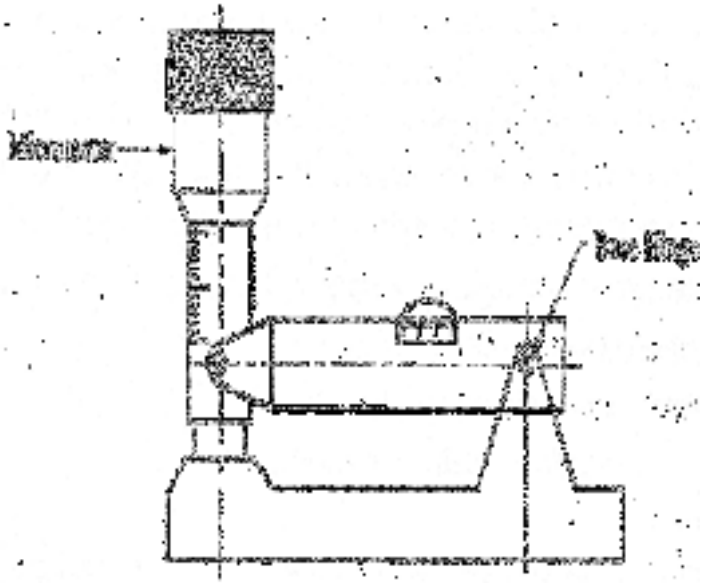
Clinometers



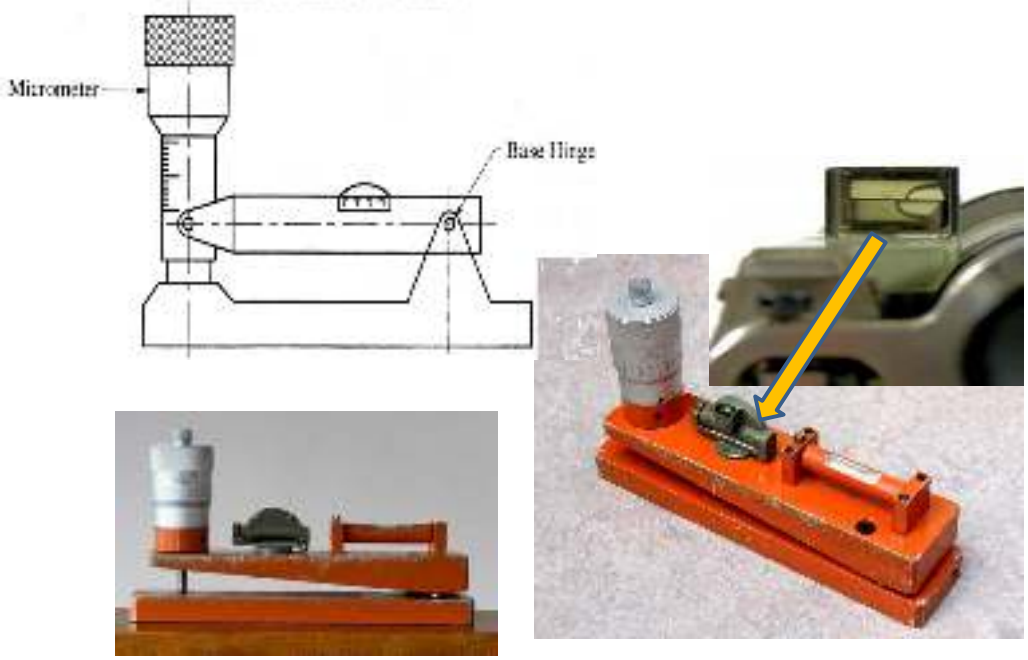
Clinometers

Clinometers

- Micrometer clinometers is shown in Fig. In this type, one end of spirit level is attached at end of the barrel of a micrometer
  - The other end of the spirit level is hinged on the base. The base is placed on the surface whose inclination is to be measured.
  - The micrometer is adjusted till the level is horizontal. This type of clinometers is suitable for measuring small angles.
- The most commonly used clinometers is of the Hilger and Walts type in which circular, scale is totally enclosed and is divided from 0 to 360 at l0' interval. For observation of 10‘-subdivision optical micrometer is provided..



Clinometers



Clinometers