# Experiment No: 10

***AIM:*** Linear and Angular measurement using, Micrometer, Slip Gauges, Dial Gauge and Sine-bar.

***APPARATUS USED:*** Micrometer, Slip Gauges, Dial Gauge and Sine-bar

**INTRODUCTION:** In Metrology, Linear measurement applies to the measurement of lengths, diameters, heights and thickness including external and internal measurements.

Linear measurement instruments can be classified into Direct and indirect measuring instruments.

1. Direct measuring instruments.
    - Graduated Measuring instruments
    - Non Graduated measuring instruments
2. Indirect measuring instruments.

Angle is a measurement that we can measure between the two line which meets at one point.

The Micrometer is known for screw gauge because a calibrated screw is used for precise measurements. The accuracy of the micrometre screw gauge is 0.01. This is very high accuracy compared to the vernier calliper accuracy 0.02.

WORKING: The working principle of the Micrometer is based on screw and nut.(Rotational moment to linear moment) As we know as the screw rotates one revolution on the screw, then the screw moves linearly by one pitch distance.

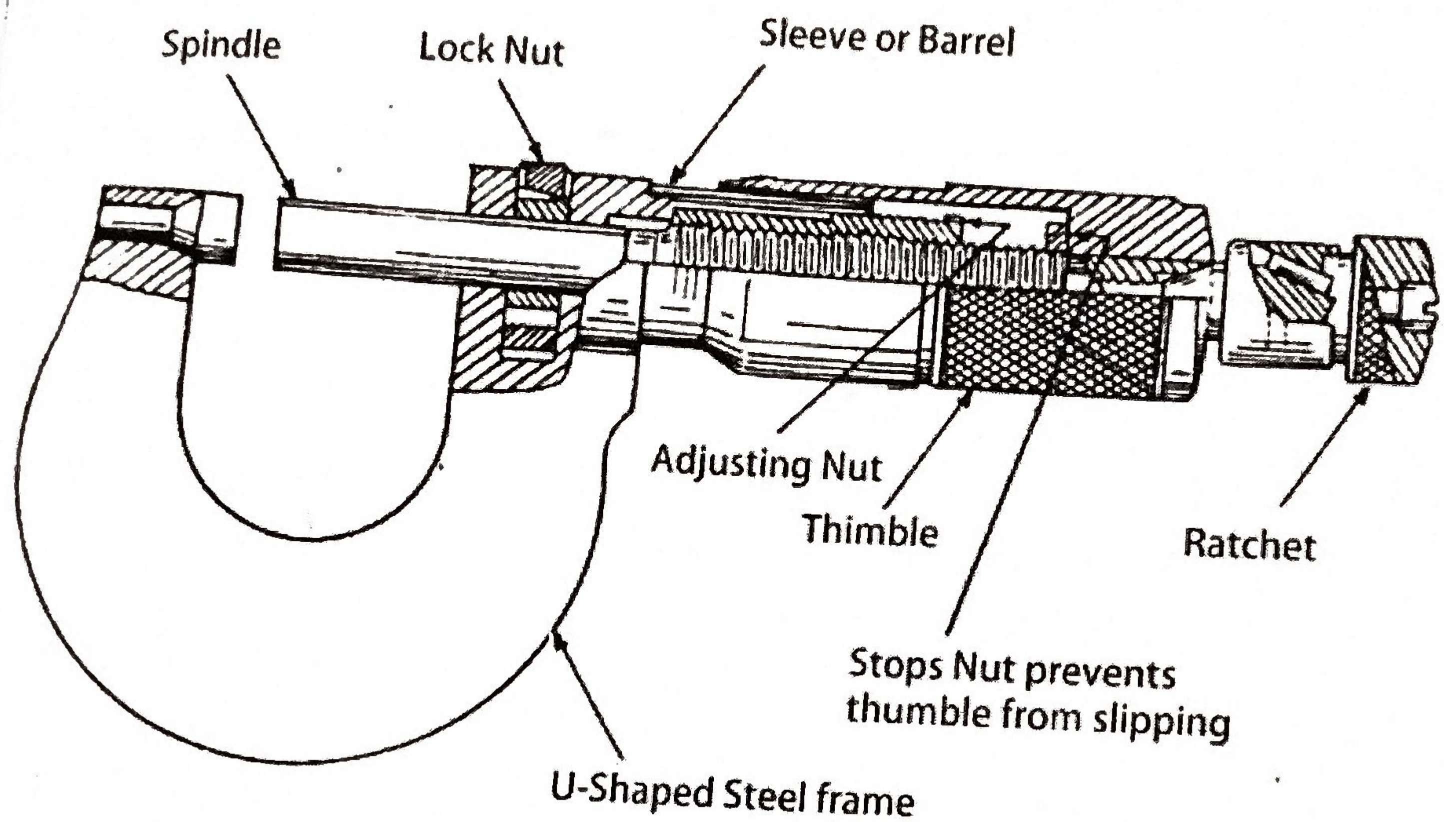
Divide the circumference of the screw into a number of fine parts. let's say 100 parts on the circumference. and the pitch of the screw is 1mm then

The minimum length can be measured the screw gauge = **Screw pitch/ Number of parts the circumference**

= 1mm/100 = 0.01

We can minimise the pitch distance of the screw to minimise the length that can be measured with that screw gauge.

**Construction of Micrometer Screw Gauge**




*Main parts of Screw gauge*

**U-shaped Steel Frame**

U shaped or C shaped frame will hold all the other parts together. The gap between the two frames in the U or C shaped frame determines the maximum diameter of the workpiece that can be measured with that screw gauge.

**Anvil and spindle**

Anvils are at the measuring faces. They were attached to the spindle face and fixed face on the frame. The spindle will have the threads acts as a screw and it should be run freely and smoothly through the length of its travel and there should be no backlash between the screw and nut.

**Lock Nut**

The lock nut is to lock the spindle without altering the distance between the measuring faces when the Micrometer is at its correct reading.

**Sleeve or Barrel**

This is having a 0.5 mm division length along the length of the sleeve. This is the main scale for the Micrometer screw gauge.

**Thimble**

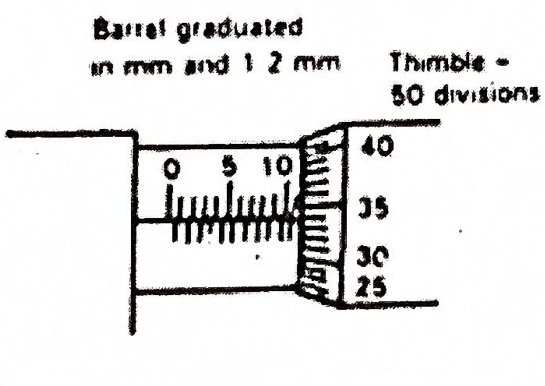
This is the main part of the screw gauge. Which is having 50 divisions on its circumference. It will be moved over the barrel.

**Ratchet**

The ratchet will be provided at the end of the thimble to assure the accurate measurement by preventing the too much pressure being applied on the micrometer. This slips the thimble over the barrel when the spindle reaches the surface of the workpiece.

**Reading the Micrometer**

1. Select the suitable micrometre size depending on the size of the workpiece. ( Usually, the measuring ranges are from 0 to 25 mm, 25 to 50mm, 125 to 150 mm, up to 575 to 600 mm are available.)
2. Check the zero error
3. Place the Object in between the two measuring faces and rotate the thimble to make the spindle touches the workpiece. Rotate until when ratchet starts slipping over the thimble.
4. Now take the reading on the main scale(scale on the sleeve) let's say it is 11.00mm
5. Take the thimble reading which by where the thimble coincides with the reference line on the sleeve or main scale. for example, it coincides with the main scale at the 34th division.




**Dial Indicators**

The Dial indicator is a mechanical mean, having gears and pinions or levers for magnification system. They can responses to linear measurements even when they are too small.

- The Dial Indicators can be used as comparators.
- Basically, comparators are the precession measuring instruments used to compare the workpiece measurements with the standard measurements.

- When this Dial Indicator is used in any measuring equipment for comparison purpose then these equipment are called **Dial Gauges.**
- A Dial Indicator must be mounted on any other base/Equipment, otherwise, it will be useless.
- The accuracy of the dial indicator is up to 0.001 mm are available

## Construction of Dial Indicators

There is a classification of dial indicators based on their dial shape. They are sector shape Dial Indicator and Circular shape Dial Indicator.

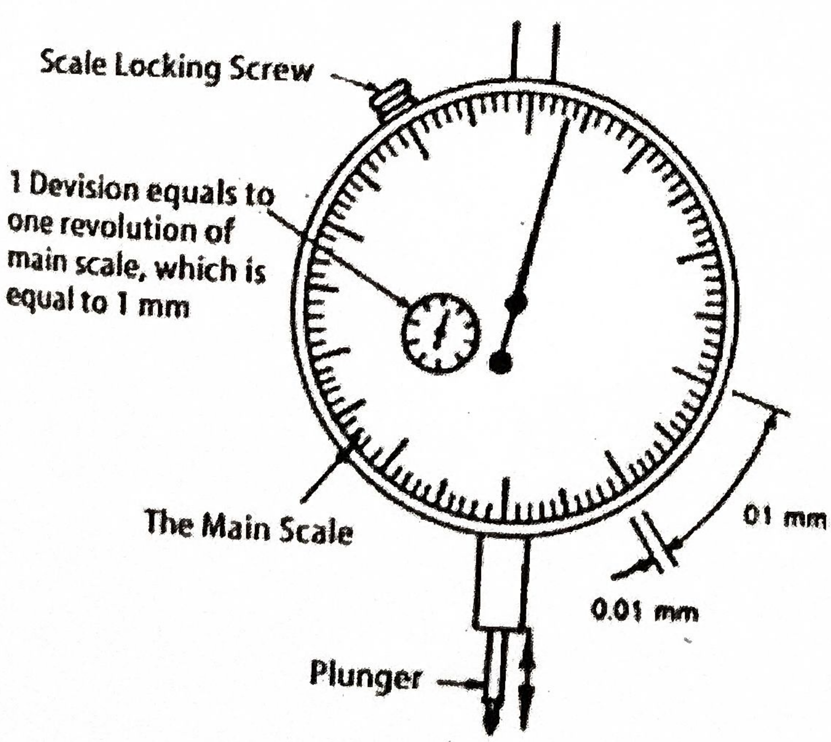
But sector type is a quite limited range, so this sector type Dial Indicator is used for extremely accurate measurements.

The circular type of Dial Indicators can be classified into two types based on their Mechanisms

1. Gear and Pinion type Dial Indicator
2. Lever Type Dial Indicator

## The Main Parts of Dial Indicator

- Dial with the main scale
- Indicator(Needle)
- The plunger (spindle)
- Mini dial (to represent the number of revolutions of the indicator.)
- Locking screw
- Magnification Mechanism(Lever/Gear and Pinion)



WORKING:

The Principle of this gear and pinion is that the movement of the Plunger(spindle) will be multiplied thru the series of gears and pinions and indicated on the main scale on the dial by the indicator(Needle).

See the picture of the mechanism of the gear and pinion type of Dial Indicator.

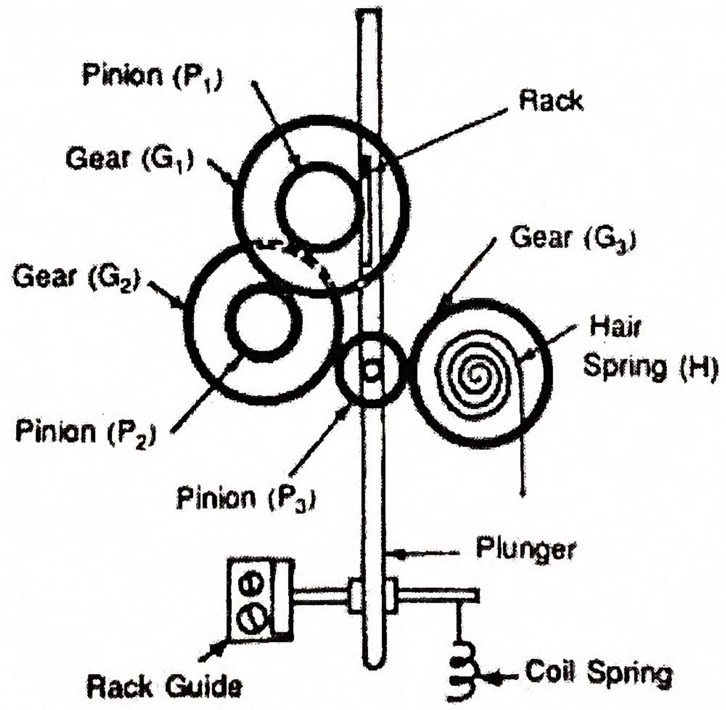
The plunger will be the one which is moving linearly with respect to the change in on the workpiece while taking measurements.

So the plunger will consist of a rack and it meshes with a pinion(P1) on the gear(G1)

This Gear (G1) will mesh with the series pinions and gears to multiply the movement to increase the accuracy of measurement.

The final Pinion (P3) is connected to the Indicator(Needle) this indicator will show the deflection on the main scale.

This is how the gear and pinion type dial indicator works.

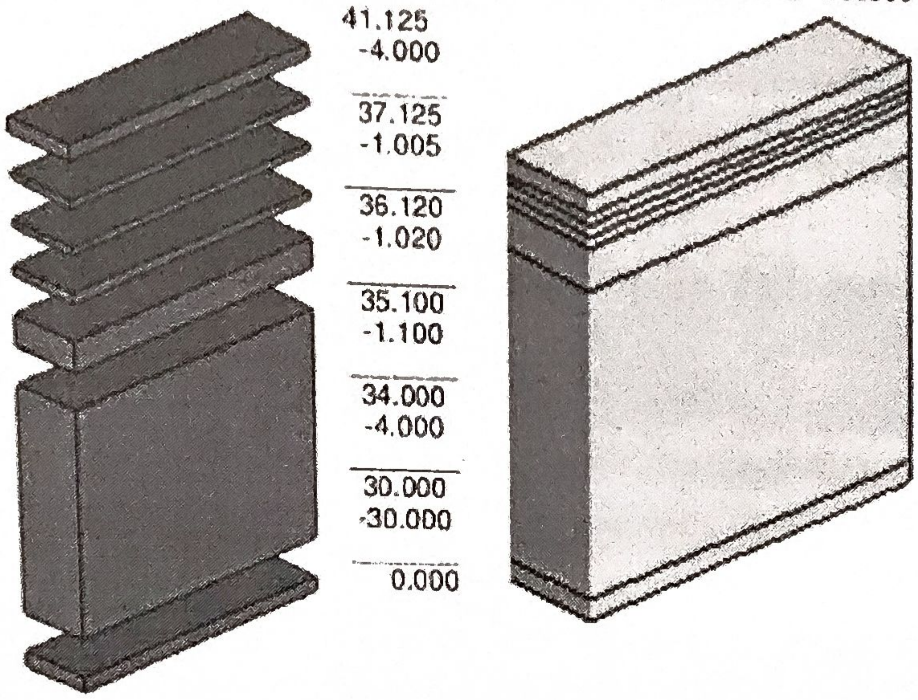



SLIP GAUGE:

Also known for Gauge Blocks, Johansson Gauges.

These have come with a set of a box. The individual block is precision ground and lapped specific thickness. These blocks are stacked together to make up the desired length. See the below Example

**make up a Slip Gauge pile to 41.125 mm**




A sine bar is used in conjunction with slip gauge blocks for precise angular measurement. A sine bar is used either to measure an angle very accurately or face locate any work to a given angle. Sine bars are made from a high chromium corrosion resistant steel, and is hardened, precision ground, and stabilized.

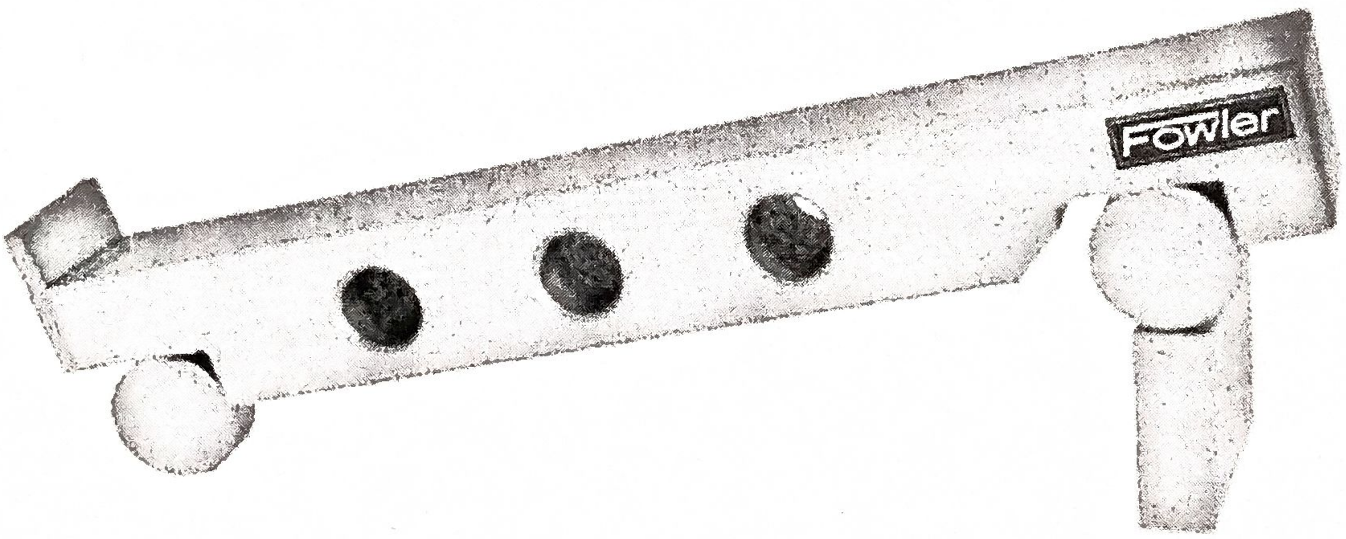
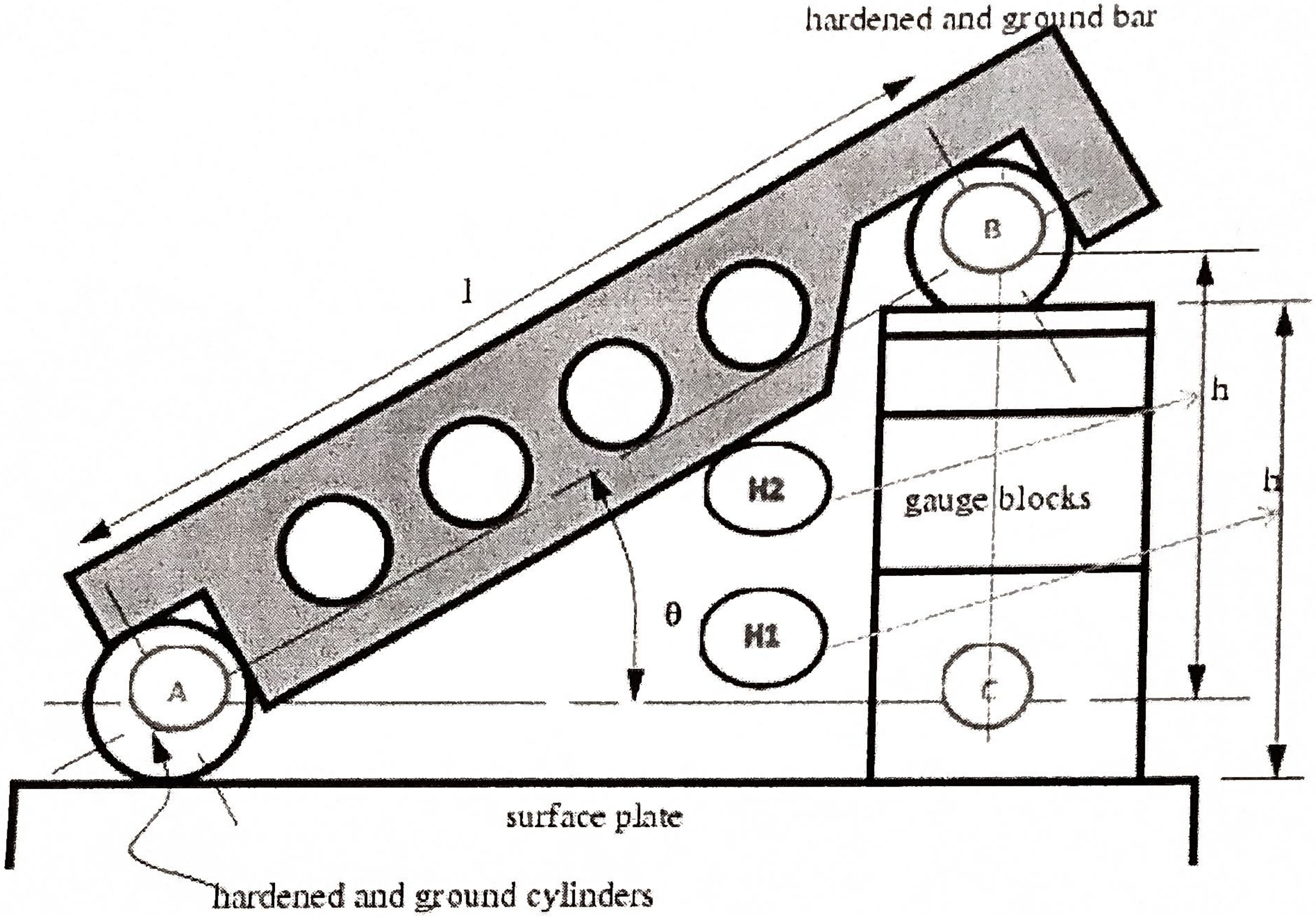



**Figure 1. The Sine Bar**

Two cylinders of equal diameter are placed at the ends of the bar. The axes of these two cylinders are mutually parallel to each other, and are also parallel to, and at equal distance from, the upper surface of the sine bar. Accuracy up to 0.01mm/m of length of the sine bar can be obtained.

A sine bar is generally used with slip gauge blocks. The sine bar forms the hypotenuse of a right triangle, while the slip gauge blocks form the opposite side. The height of the slip gauge block is found by multiplying the sine of the desired angle by the length of the sine bar: $\mathbf{H = L * \sin(\theta)}$.




l = distance between centres of ground cylinders (typically 5" or 10")
h = height of the gauge blocks
θ = the angle of the plate

$\boxed{\cancel{\theta = \text{asin}\left(\frac{h}{l}\right)}}$ $\boxed{\theta = \sin^{-1}\left(\frac{h}{l}\right)}$

**Figure: Forming an Angle with a Sine Bar and Gauge Blocks**