Measurenment & Metrology

UNIT-1

Metrology: The word metrology consist of two wards one is metro which indicates metric which means measurement and other one is logy which indicates Technology means science behind the measurement.

Measurement: Measurement is a process of comparision between a predefined standered and unknown physical quantities with some unit.

Essential character of standerd;

(i) It should be easily readable and understandable.
(ii) It should be properly defined and universaly acceptable.
(iii) It should not change its character.
(iv) It should be accordance to the size of quantity to be measure.

Need of measurement;

To exactly define the physical quantity we need measurment.

Without measurment we can't find/Define the physical quantity with exact and accurate value.

The purpose of measurement is to determine the dimension of any object or product, for measurment we required three basic things.

1. For which measurment is to be taken.
2. By which measurement is to be taken.
3. How measurement is to be taken.

Significance of measurement in metrology;

1. Metrology is basically a science of measurement. In manufacturing industry must have the knowledge of metrology. Through this the engineer get to know which is to be measured, by which it is to be measured and how it is to be measured.
2. Through this we can achieve a highly dimensionaly accurate product and thus makes the product easily acceptable and minimize the wasteage.
3. To study measurement related problem at work place and find out neccesary solution and thus develope a new mordenh technique of measurement.
4. After several time of uses the instrument losses its accuracy. Thus caliberation of measuring instrument is done so that accuracy is maintained through metrology we get known after which time period Instrument required caliberation.
5. After several uses the machine losses its alignment and thus start producing product which is not dimensionaly correct. However it can be detected through measurement of product produced and through this if the product produced is not dimensionally correct then we can estimate that our machine needs alignment.
6. To evaluate the designing parameter of gauges.

Standerd in measurement;

Standerd are basically the refrences used in measurement from which we derive the value of unknown physical quantity by comparing with it.

Standered are of three type;

1. Line standered
2. End standered
3. Wavelength standered.

Line standard

Dimension of unknown physical quantity are expressed as a distance between two lines.

- Accuracy is upto ± 0.2 mm.
- Measurement is quick and easy.
- Scale and Marking are subjected to wear.
- They are simple in operation and less costly.
- Example, Plane Scale.

End standard

Dimension of unknown physical quantity are expressed as a distance between end surface.

- Accuracy is upto ± 0.1 mm.
- Measurement is time consuming.
- Wear take place on measureing surface.
- They are complex in operation and costly.
- Example, Slip gauges.

Method of Measurement;

1. Direct Measurement
2. Indirect Measurement.

Direct Measurement,

- Direct measurement refer to measuring exactly the things you are looking to measure.
- In direct measurement the value of unknown physical quantity and determined by directly comparing it with predefined standerds.

- It is also known as absolute measurement.
- Example ; Measurement Through scale, vernier calliper, micrometer etc.

Indirect Measurement.

- Indirect measurement means the measuring something by using measured something.
- In indirect measurement value of unknown quantity are determined by comparing it with predefined standerd through the help of some other devices.
- It is also known as comparitive measurement.
- Example ; Measurement through caliper and guages.

Accuracy :

- Closeness of measured value with true value.
- Accuracy is concerned with true value.
- It is defined for single measurement.
- Difficult to achieve high accuracy for any measuring instrument.

Precision :

- Repeatability of measuring instrument about a particular value.
- It is concerned with mean value.
- It is defined for set of measurement.
- Easy to achieve high precision for any instrument.

Terms Related to measuring Intrument :

Accracy : The dimension of product produced after manufacting is called standerd or true value, while the dimension of product measured by ~~meas~~ instrument is called measured value of accrate value.

- The closeness of actual value with true value is called accuracy of instrument.
- More will be the closeness, more accurate will be instrument.

Error : The different between accurate value and true value is called error of instrument.

$$E = |M.V - T.V|$$

Generally "Error is inversaly perpostional to accuracy".

$$\text{Accuracy} \propto \frac{1}{\text{Error}}$$

Precision : Precision is defined as repeatability of measuring instrument to obtain a perpendicular value while taking set of measurement. For a particular value of reading measurement is taken, for several time and the measurement value thus obtain is varied by very small amount. Then mean value of set of value is called precise value and the istrument is called precise instrument.

Sensitivity : It is defined as the ratio of changes in the output of measuring intrument to the changes in value of quantity to be measured.

- It denotes the ability of measuring instrument to detect small variation in quantity is being measured.
- $$S = \frac{\text{Change in output}}{\text{Change in input}}$$

Repeatability: It is the ability of measured instrument to give almost some value of reading everytime when the measurement is repeated by same operator & same condition.

Reproducibility: It is the ability of measuring instrument is to continously produce a particular value of reading everytime when measurement is repeated by different operator & different condition.

Range: The minimum to maximum value on scale of measuring for which the instrument is design to measure any quantity.

Hysteresis: Hysteresis basically means the time lag between input given to the measuring instrument and output obtained from measuring instrument.

Thresold: The minimum value of input after which the instrument gives the output reading is called thresold.

Caliberation: Due to several uses the parts of measuring instrument gets aligned from its exact position due to which the instrument starts giving incorrect reading.

- The measuring instrument regularly checked by comparing it with predefined standered. If instrument gives incorrect reading this indicates parts of instrument give misaligned.
- Properly aligned of Parts/component of Instrument. The process of rechecking and realignment of measuring instrument is called caliberation.

Error Calculation

Absolute Error: It is basically difference between actual value of reading (Measured value) & standerd value of reading (true value). It is represented by ΔA.

Relative Error: It is the ratio of absolute error with standerd value of reading. It is expressed in percentange and also known by percentage error.

Types of Error;

1. Systematic Error:

The error which ~~is not~~ has definite magnitude and direction. They repeat the error value consistantly when the measurement is done reapeatedly.

They are also known as controllable error.

2. Random Error:

The error which is not fixed in magnitude and direction and they doesn't repeat the error value consistantly when measurement is done repeatedly.

They are also known as uncontrollable error.

Angle Measuring Instrument

SINE BAR

The Instrument which is used for measurement of slop of any object surface is called angle measuring instrument.

There are three main type of angle measuring instrument :-

1) Sine Bar
2) Clinometer
3) Bevel protecter

Sine Bar

Sinebar is an angle measuring instrument which measures slope of any object with the help of slip gauge & dial indicator.

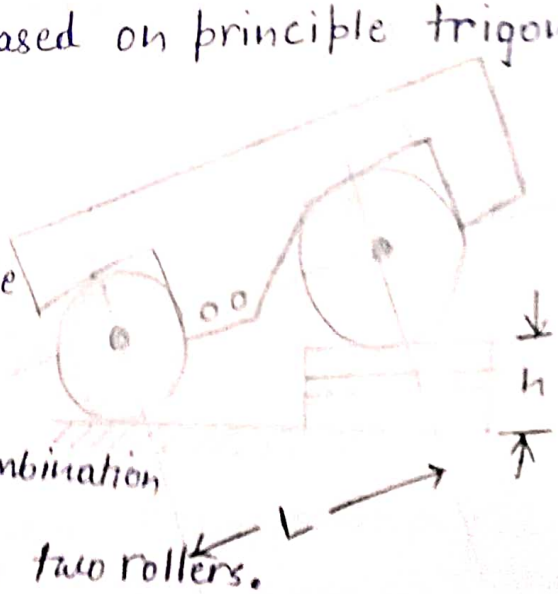
It is a steel piece mounted over hardended steel cylinderical roller having equal diameter.

To make it lighter in weight small holes are drilled along steel piece

Principle;

The working of sinebar is based on principle trigonometry

In this one roller is placed over combination of slip gauges and another is placed over table surface.



If H is hight of slip gauque combination and L is centre distance betueen two rollers.

then,

$$\sin\theta = H/L$$

$$\therefore \theta = \sin^{-1}(H/L)$$

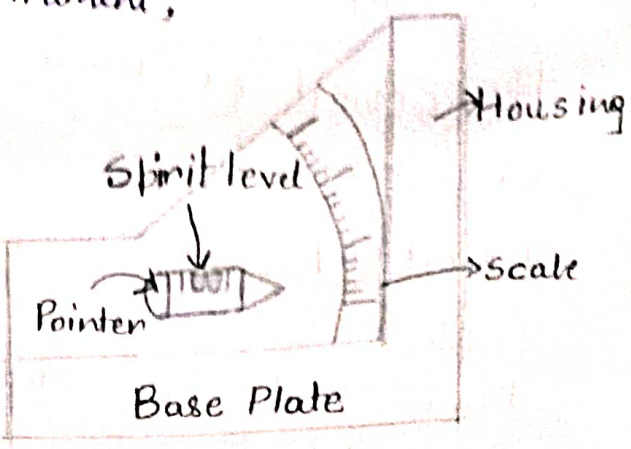
Where, 'θ' be the slope of object surface.

Working:

- First place the object whose surface inclination is to be measured over the flat surface of Sinebar.
- Make combination of slip gauges such that inclined surface of workpiece or object become parallel to the ground.
- Place on cylindrical roller over slipgauges & one over table surface.
- Move the dial indicator over workpiece surface to ensure the workpiece inclined surface become parallel to ground.
- If there is deviation in dial indicator then re arrange the slip gauge till deviation eliminates.
- Then calculate $\theta = \sin^{-1}(H/L)$

CLINOMETER

It is an angle measuring instrument,



Construction

1. It consist of one plate known as base plate.
2. It has a pointer which is so arranged that it is always parallel to ground.
3. Pointer contains a spirit level having ethanol in it inform of bubble.
4. It has a scale of degree and whole unit is enclosed in a casing known as housing.

Working:

- The base plate is placed over workpiece surface whose inclination is to be measured.
- Now the pointer deflect as it always tends to become parallel to ground.
- During movement of pointer bubble in spirit level vibrates but when pointer becomes parallel to ground bubble stops vibrating and comes at its center.

UNIVERSAL BEVEL PROTECTOR

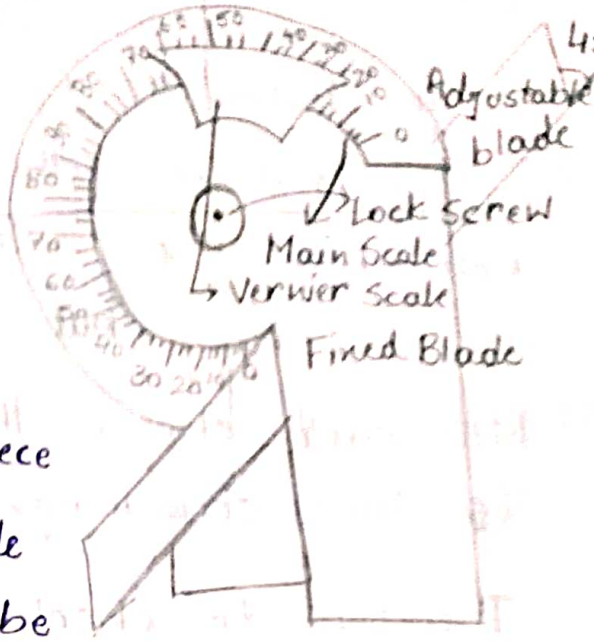
Bevel protector is the simplest instrument for measurement of angle.

It consit of main circular plate arranged on adjustable blade.

Fixed blade carries a circular plate with vernier scale.

Main plate can swivel inside fixed circular plate.

Main plate has reading from 0-90.



- Main plate has reading from 0-90-0.
- Vernier scale has 24 division and each division = 5 min.

Working:

The base plate consides with workpiece one surface so that adjustable blade concides with whose angle is to be measured.

Due to this main plate swivelled and thus reading is obtained.

- Reading will be sum of M.S.R. and V.S.R.
  ie Total Reading = M.S.R. + V.S.R.
- For MSR '0' of vernier concide with main scale marking.
- For VSR marking of VSR coneide with marking of main scale.

LIMIT GUAGES

Limit gauges are non recording type inspection device which is used to check the dimension of product produced lies within the permissible limit or not.

- If on inspection the dimension of product produced lies within the permissible limit then the product is accepted. But if on inspection the dimension of product produced doesn't lies within the permissible limit then the product is rejected.

In manufacturing the product produced is either of two nature either it will be shaft or it will be hole. We have to take the measurement to check its accuracy, but when the production rate is high we can't choose the method of measurement which is time consuming.

Therefore to check the manufactured accuracy within less time we use. Type of inspection devices called "limit gauge".

Limit gauges are non recording inspection device ie they doesn't give the reading of dimension of product produced but they only check whether the product produced lies within the permissible limit or not

"Gauges"	'Instrument'
1. They are inspection devices.	1. They are measuring tool.
2. It is without scale arrangement.	2. It has scale arrangement.
3. It doesn't give actual reading	3. It gives actual reading.
4. Process is less time consuming	4. Process is more time consuming
5. Suitable for mass production	5. Not suitable for mass production
6. Skilled operator is not required.	6. Skilled operator is required.

Double Ended Plug Gauges

According to taylor principle Go or No Go Gauge should be design to check minimum and maximum material condition.

Taylor's Principle;

"Taylor's First Statement":

There are two sides of gauge;

1. Go side of gauge:-

According to Taylor's principle go side of gauge are designed to maximum material condition. ie upper limit for shaft and lower limit for Hole.

2. No Go side of gauge:-

Taylor's principle No Go side of gauge are designed to minimum material condition. ie upper limit for Hole and lower limit for shaft.

"Taylor's Second Statement":

1. Go side should be designed in such a way possible dimension and features like flatness, roundness in single pass.

2. No Go Side should be designed in such a way that seprate gauge is required to measure seperate dimension.

Type Of Limit Gauge :

Plug Gauge :

A plug gauge is a type of limit gauge which is used to check the accuracy of a hole.

- Plug gauge check the whether the whole diameter is within the specified limit or not.
- Go plug gauge corresponds to lower limit hole while No-Go plug gauge corresponds to upper limit of hole.
- It is of following type ;

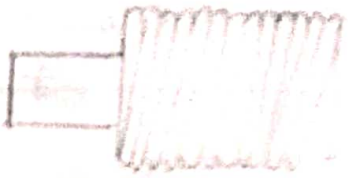
Single Ended Plug Gauge – In these plug gauge Go side and NoGo side are made seperatly at end of gauge.

Double Ended Plug Gauge – In these plug gauge both Go side & No Go side are made on two opposite end of pluge gauge.

Progressive Plug Gauge –
It is a type of limit plug gauge in which both Go and No Go Side of gauges are made on a single gauge and also made consecutive to each other both Go & No Go side are seperated by groove spacing.

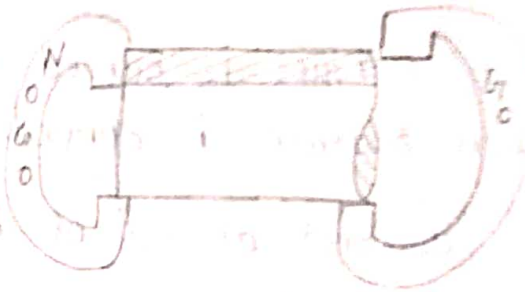
Threaded Ended Plug Gauge –

In these type of limit plug gauge at the Go side and No Go side threds are made to check the accuracy of Nut.

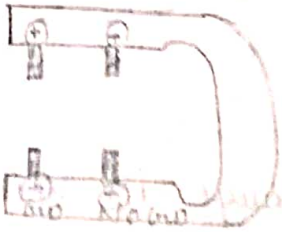


Snap Gauge

It is U-shaped frame used check the accuracy of shaft.



- In this Go side which corresponds UL of shaft and No Go side which corresponds LL of shaft are made saparately. [Fixed single Ended Snap Gauge]
- In this Go or NoGo Side are on single gauge & limit of Go side can be adjusted by adjustable screw. [Adjustable snap Gauge]
- In this the Go side and No Go side are made on two opposite end of a sigle gauge. [Double Ended Fixed Snap Gauge]

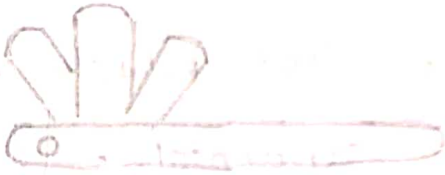


Ring Gauge

It is used to check the accuracy of shaft. ie shaft lies within limit or not.

Radius & Fillet Gauge

- When surface is curved externally it is called radius and When surface is curved internally it is called fillet.
- It consist of set of blades at two opposite ends. At one end blade corresponds to measure external radius & At other end blade corresponds to measure internal radius. ie Fillet.



Feeler Gauge

Thickness of filler gauge is used frequently to measure clearance between two components or very narrow slot thickness.

Calliper Gauge

A calliper gauge is similar to snap gauge but it is used to check both inside and outside dimension.

COMPARATOR : Comparator is a device which picks up small variation in dimension, magnifies it and display it by using indicating device by comparing the object dimension with any standard.

Comparator only indicates dimension difference when compared with any standered.

Elements of comparator :

Sensing Device - It sense the caused due to variaton in dimension usually a plunger is used as sensing device.

Magnifying Device - It is used to increase or amplify the input signal, so that small variation in input signal (Dimension) magnifies and output reading can be obtained.

Display Device - It is used to display the dected detected variation as output reading. Grenerally a scale with pointer is used as display devices.

The various desirable characteristics of comparator are as follow :-

1. Robust in construction and design :

The comparater should be robust in design and construction so that it can be used in ordinary way without affecting the accuracy of device.

2. Compactness :

All the components should be arranged tightly in less spacing so that the size of comparator become small due to this the comparator become portable and can be easily transfered to another place.

3. Quick In Responce :

The comparator should quick in responce. ie comparator gives reading within least posible time.

4. Verstality :

The comparator should be vestatile in nature.

ie,

i) It can be used wide range of prodcast.

ii) The plunger should not wear easily.

iii) Pointer should be free from oscillation.

5. Higher Magnification :

To detect small dimension in variable it should be higher in magnification.

Type of Comparator

Comparator are basically of four types:

1. Mechanical Comparator: Those comparator which for magnifying input signal mechanical linkages such as gears, belt and pulleys etc are used and known as mechanical comparator.

ie Dial indicator and Sigma comparator.

Optical Comparator:

Those comparator which works on principle of laws of refraction and for magnifying input signal magnifying lens are used and known as optical comparator.

ie Zeiss optimeter, Zeiss optotect.

Electrical Comparator:

Those comparator which converts the input signal into electrical signal which is ferther magnified with help of transformer which is shown on the display unit of galvanometer is called electrical comparator.

ie LVDT.

Pneumatic Comparator:

Those comparator which uses compressed air to detect variation in dimension are called pneumatic comparator.

ie. Solex comparator.

Dial - Indicator

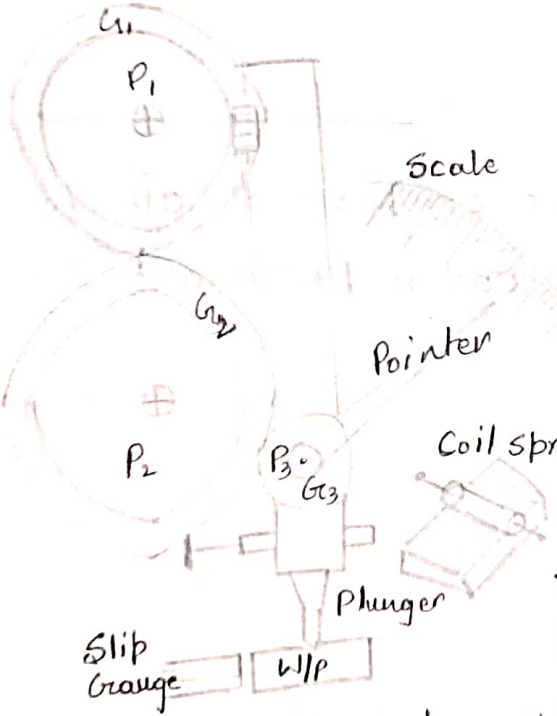
Construction:

It consist of a plunger spindle which travels in vertical direction with help of guide ways.

The plunger spindle carres a rack which is attached with pinion gear 'P_1'.

Grear G_1P_1, G_2P_2 are compound gear train G_1P_1, G_2P_2, G_3P_3 are mounted on same shaft.

Pointer is attacted with pinion gear 'P_3' and a coil spring is attached to gear 'G_3' as shown in fig.



Working:

When Plunger is placed and slides over the surface of object if there is any variation in dimension the plunger moves in vertical direction through guide ways. The up and down movement of plunger is followed by rack and moves accordingly

Since rake is attached with gear P_1

$\therefore$ P_1 is rotate with RPM N_1.

$\because$ P_1 and G_1 are mounted on same shaft.

$\therefore$ G_1 rotates with same rpm N_1.

Grear G_1 is in mesh with P_2. Therefore P_2 also rotates but the no. of teeth in pinion P_2 is less than G_1.

$\therefore$ It rotates with increased RPM N_2. Grear G_1 and P_2 are mounted on same shaft $\therefore$ G_2 Rotates with RPM N_2.

Gear G_2 Now in Mesh with G_{13} ∴ G_{13} also rotate with increased RPM N_3. Since P_3 and G_{13} are mounted on same shaft.

∴ It also rotate, This makes the pointer to deflect Which is indicated on scale.

SOLEX - COMPARATOR

- Solex Comparator is a pneumatic comparator as it uses compressed air.

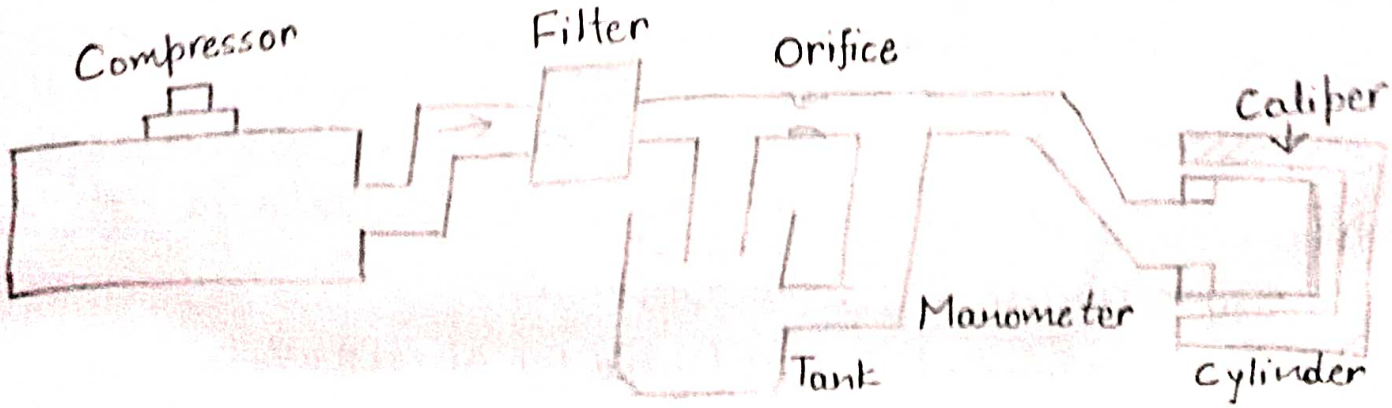
Construction :-

A ~~comparator~~ compressor is connected to air filter through a tube. The air filter removes the dust and moisture present in compressed air.

The tube contains an orifice to regulate the discharge of compressed air.

Further the tube is connected to caliper through which the air exits to detect the variation in dimention of object.

A long tube is dipped in water filled tank in orderd to measine manometric variation when variation in dimension at object takes place.



Working :-

1. When the compressed flowr through orifice control amount of air gets discharged from tube. The large amount of air return to tank which forms bubble.
2. Now the discharged air exist from caliper strikes the surface of standerd offers resistance to air and a back pressure is developed which is indicated on manometer.
3. Now the caliper is fitted inside the object whose dimension then the back pressure varies and fluctuation in manometer heeght take place which indicated variation in dimention.

Optical Comparator

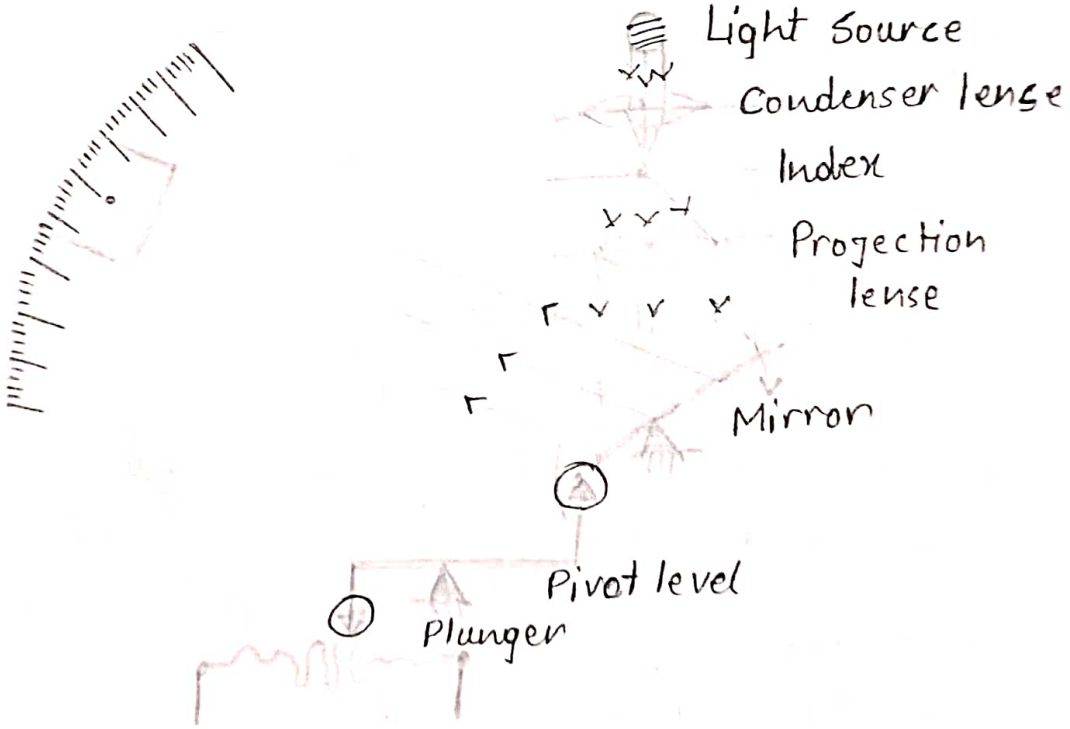
Those comparator which uses laws of optics to detect the variation in dimensions of object are called optical comparator.

Almost all optical comparator consist of mechanical linkages hence they are also known as mechanical optical comparator.

Working :-

- Initially the plunger is placed over standerd and light ray is allowed to strike the reflecting mirror through the condenser & projection lens.
- Now the scale is so adjusted that the reflected light ray is captured at its zero marking.
- Now the standerd is replaced by object whose variation in dimension is to be checked.

- If there is variation in dimention of the plunger moves up and down. This the lever to swing about its pivoted point.
- This causes the mirror to swing. This makes the reflected light ray to capture at scale at marking other than zero.
- Ie. If the reflected light ray captured at screen other than zero marking indicates variation in dimension.
- But if the reflected light ray captured at screen at zero marking indicates no vibration in dimension.



Linear Variable Differential Tranduced (L.V.D.T.)

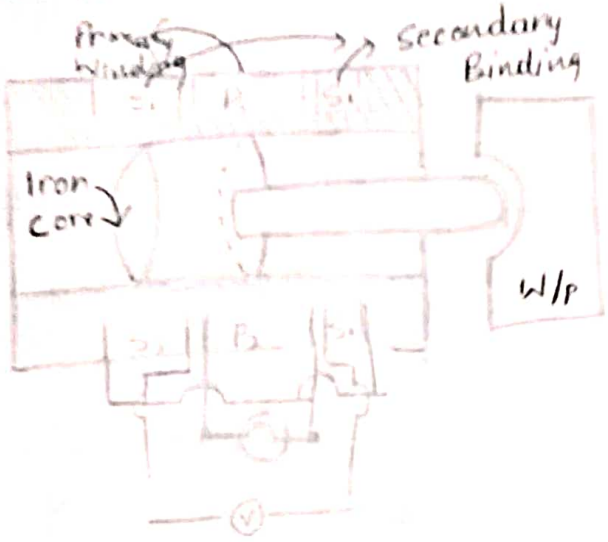
Transducer is a device which converts mechanical signal into electrical signal.

It is a type of electrical comparator which is used to detect the variation in dimension of object.

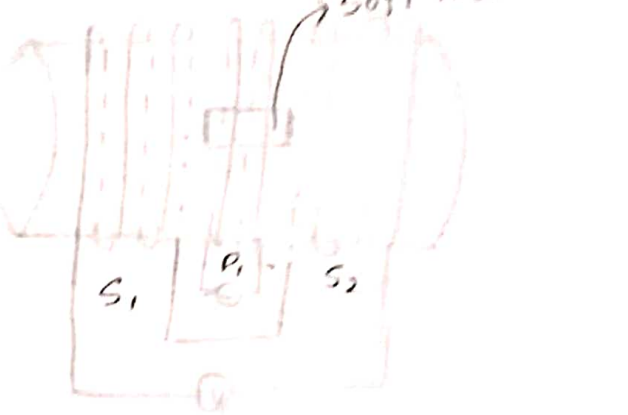
It consist of three equally spaced coil winding the two are secondary winding and one is primary winding.

The primary winding is intermediate of two secondary Winding.

- For secondary winding coils are connected in series, but nature of winding are opposite to each other.
- The primary winding is connected to each other according to source and secondary winding connected to voltmeter.



"Construction"



Working :-

When the plunger is placed over a object which has no variation in dimension. Then the core remains in control position and EMF developed in both the Secondary winding is same in magnitude but opposite in direction.

Hence Net EMF read by voltmeter is zero.

This is called "Null Position". $V = E_1 + E_2 = E_1 + (-E_1) = 0$.

When there is variation in dimension of object the plunger moves due to which core also moves. This makes the core to move toward one SW and away from another SW.

Due to this magnitude of EMF on SW near to core is more than SW away from core. Now the voltmeter shows reading which indicates variation in dimension.

If core near to S_1
$E_1 > E_2$
$V = E_1 + (E_2) \geq 0$

If core near to S_2
$E_2 > E_1$
$V = E_1 + (E_2) < 0$

Measurement Of surface finish

Basically we measure or calculate the surface roughness inorder to estimate the surface finish.

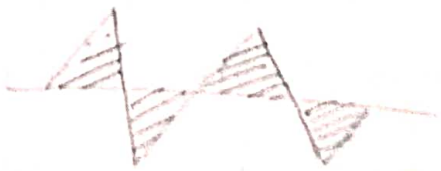
If the roughness is very high it estimate the poor surface finish, but if the surface roughness is low it indicates good surface finish.

As we know that it is impossible to produe perfectly smooth surface, some imperfactions and irregulation are present at the surface.

These irregularities are present inform of hills and valleys which are varying in hight and spacing. These irregularities present at surface are called surface roughness and the pattern of hills and valleys are called surface texture.

The surface texture are basically of two type :-

Primary Texture : If the surface irregularities are of very shorter wavelength ie the two consecutive hills or two consecutive valleys are very closely spaced are called primary texture. It is created due to improper feed, depth of cut and cutting speed.



Secondary Texture : If the surface irregularities are of very longer wavelength ie two consecutive hills or two consecutive valleys are far apart it created due to blunt tool, improper alignment of tool or workpiece.

Terminology Of Surface Finish

Due to various manufacturing process the material at the surface of workpiece acts deviates from its normal surface. This Deviation of material from its normal surface is called irregularities. These irregularities are in form of hills and valleys.

Some Basic Terms :

Roughness : If the irregularities are of very shorter wavelength then these irregularities are called roughness. They are also known as primary texture. It is considerd as irregularities of third or fourth order.

Distance between hills and valleys of a roughness are called "roughness height" and distance between two consecutive Hills and two consecutive valleys are called "roughness width".

Waviness :- If the irregularities are of larger wavelength then these irregularities are called as "waviness". They are also known as secondary texture. It considered as irregularities of first and second order.

Distance between Hills and valleys of a waviness are called "waviness height" and distance between two end valleys and two end hills of waviness are called "waviness width".

Flaws : They are basically cracks stratches or blows holes present at workpiece surface.

Lay : It is basically a directional parameter. It is direction of markings produced at W/P surface after machining process through viewing lay we can easily identify which machining process is performed on W/P.

Tomilson's Surface Meter

Construction –

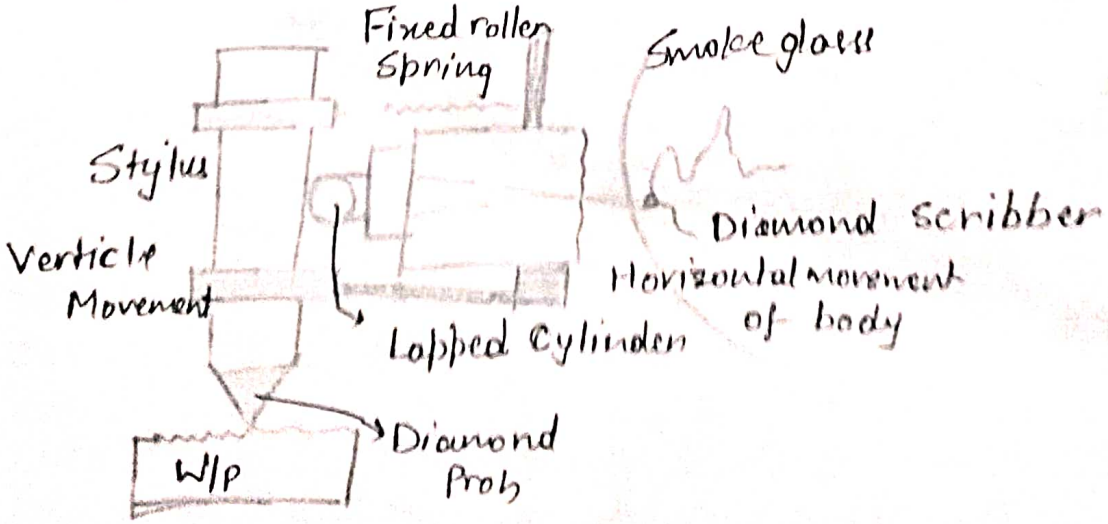
The instrument consist of a style having very hard tip and bottom known as diamond probe.

- The styles is held against the surface of lapped cylinder with pressure achieved by spring.
- Lapped cylinder is support on one side by stylus and on other side by fixed roller.
- Light steel spring arm is attached to the lapped cylinder The arm carries a dimond scribber at its tip which rest against smoke glass.

Working –

While measuring the surface finish the instrument is moved across the workpiece surface through motor.

- Any vertical movement of stylus caused due to irregularities cause the lapped cylinder to roll.
- By its rolling arm deflect and diamond scribber at tip of arm will produce pattern of irregularities on smoke glass.
- The pattern on smoke glass can be magnified by optical projector.



Stylus Probe Instrument

Principle :—

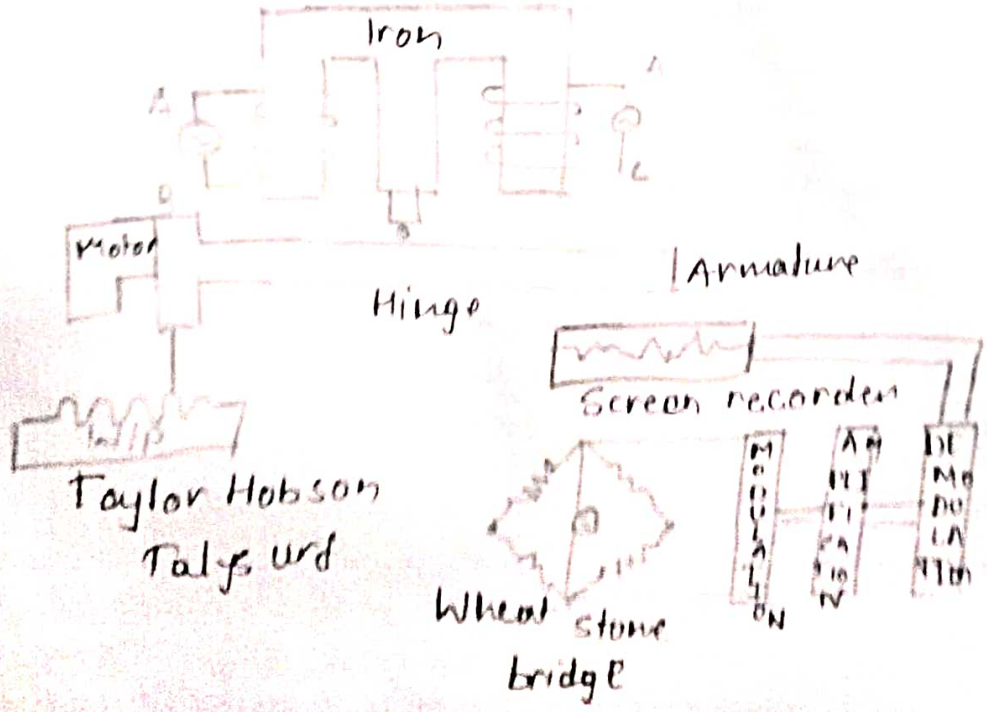
If a finely pointed probe or stylus is moved over the surface of workpiece, the vertical movement of stylus caused due to irregularities in surface is the measure of surface roughness.

"Taylor - Hobson - Talysurf" is a stylus probe type instrum

Construction :

It consist of an iron specimen with three leg two extreme leg are coiled with an A.C source and a variable resistance and these two legs connected with each other to form a wheat stone bridge circuit. The intermediate leg is hinged with an armature.

- The armature contain a stylus which is a thin diamond needle of diameter 0.002 mm. A motor is attached with armature which helps in moving the armature in linear direction.



UNIT -2

Transducer ;

The tranducer are those device which converts one form of energy to other form of energy.

The transduced which converts non-electrical quantity to electrical quantity / signal is called electrical tranducer.

Input → [Sensing element] → [Transducer element] → output

Primary Transducer ;

Those tranducer which converts the physical quantity into mechanical displacement are called primary transducer.

Example ; Burdon Tube.

- It is a mechanical device.

Secondary Transducer ;

Those transducer which conved mechanical ~~transducer~~ displacement to electrical output are called secondary transducer.

Example ; LVDT.

- It is also known as electrical transducer.
- It is further classified in ; Active tranducer & Passive Transducer.

Active transducer ;

Those transducer which converts the physical quantity to be measured. ie Input into electrical output signal without help of any external power source are called active tranducer

Passive Transducer ;

Those transducer which converts the physical quantity to be measured ie input to electrical output signal with the help of any external power source are called passive transducer.

Inductive Transducer;

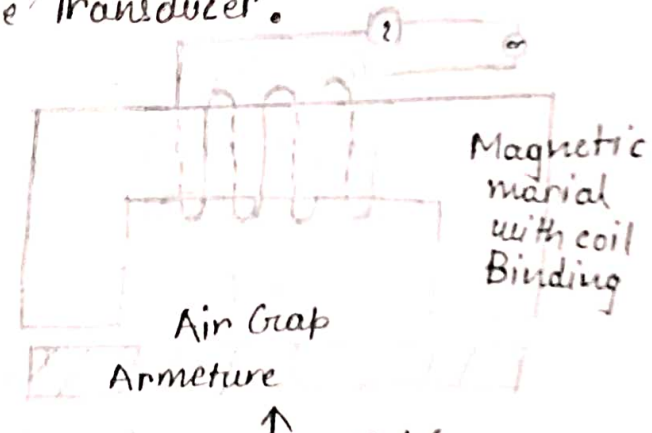
Inductive transducer work on the principle of Faraday law of electro-magnetic induction, which states that "Whenever any magnetic material experiences change in its magnetic flux, it induced an EMF to oppose this change in flux."

This induced EMF is the output of transducer and changes with amount of change in flux and by measuring the value of EMF, the value of physical quantity like force, displacement are determined.

It is of two types;

1. Self Inductance Tranducer
2. Two coil mutual inductance Transducer.

Self Inductance Transducer



Working;

When current starts following through coil winding it starts producing magnetic field which produces magnetic flux on magnetic material. Due to Alternating nature current magnetic flux changes and to apposse this change in flux emf is induced across current carrying material. This is called self induced.

Construction;

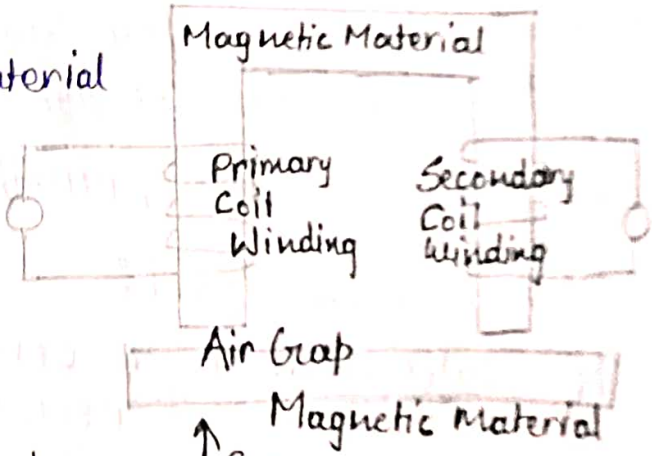
- It consist of a magnetic material having coil winding which is connected with an AC source and voltmeter.
- There is also another magnetic material called armature which sense the physical quantity to be measured.

- Now when the armature makes movement due to input (force) air gap varies and this makes variation in EMF whose reading is obtained in voltmeter through which the value of input parameter is determined

Two coil mutual inductance transducer;

Construction;

- It consist of a magnetic material having two coil winding one is primary coil winding connected with AC current source another is secondary coil winding connected with voltmete.
- There is another magnetic material seperated from coil winding magnetic material by air gap between them.



Working;

When the current is supplied to primary coil winding. The coil winding produces magnetic field lines. These magnetic field lines crosses over secondary coil winding and thus produces magnetic flux on it and due to alternating nature of current magnetic flux on secondary coil changes and induce emf over it. This is called mutual inductance.

- Now when the another magnetic material makes movement air gap changes and amount of change in flux varies due to which emf varies.
- This variation in EMF is read by voltmeter and through which the input is determined.

Strain Gauge ;

It is an instrument which is used for measurement of strain produced in an object due to applied external load.

As we know that when any material is subjected to load it experieces change in its dimension with respect to its original dimension and ratio of change in dimension with respect to original dimension is called strain.

By the help of strain gauge we measure the value of strain produced in object due to applied load.

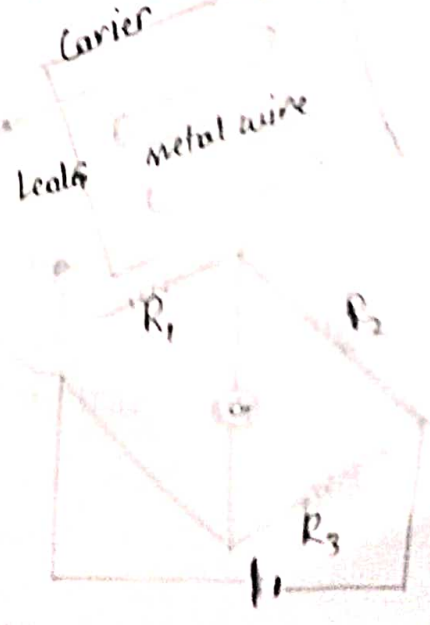
- It works on the principle of piezo-electric effect.

Piezo-electric effect;

It states that in a conductor there is always in resistance per unit resistance, when there is change in length per unit original length.

Bonded Type Strain Gauge;

- The material wire is bonded with carrier through epoxy.
- And the whose structure is attached to specimen whose strain is to be measured.
- The wire has a uniform diameter of 0.025 mm.
- The whole arrangement is connected to bridge circuit, through leads in such a way it forms a balanced wheat stone bridge.



Working;

- When the current starts flowing through circuit and load is applied to specimen, strain is produced.
- Due to this resistance of strain gauge changes and now wheat stone bridge un balanced by galvanometer shows some reading by caliberation, we determine the value of strain.

Strain Gauge Rosette

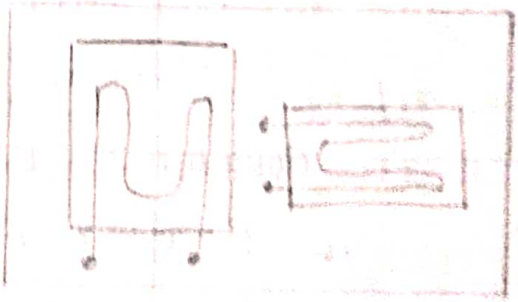
Strain gauge rosette is basically an arrangement of two or more strain gauges that are positioned closely to measure strain along different direction in an object under load.

It is basically of two types

- Two Elements :

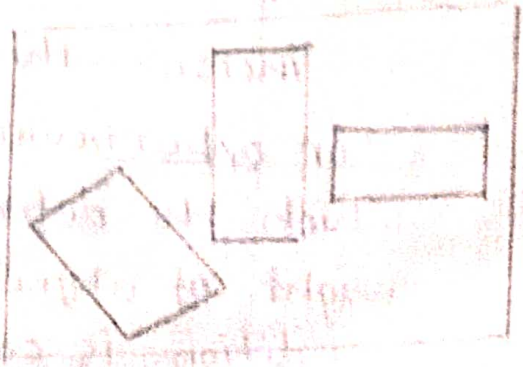
It is mainly used for measuring Bi-axial strain. ie strain in two perpendicular direction.

In two strain gauge are placed in such a way that axis of strain gauge are bisecting each other.



- Three Elements :

It is mainly used for measuring the tri-axial strain. ie Strain in three direction. In this three strain gauge are placed to specimen at 0°, 45°, 90°.



SPRING BALANCE

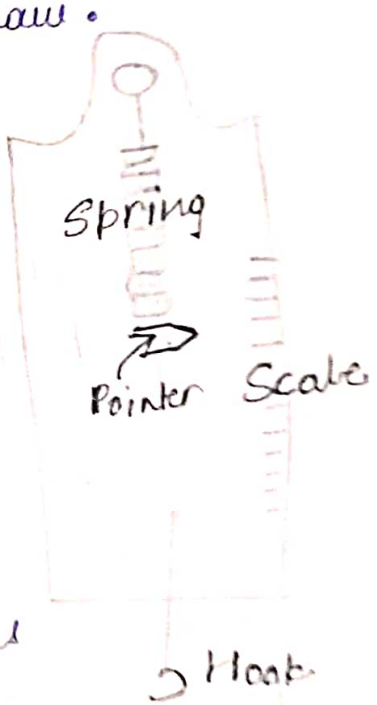
It is used to measure the weight of any body or object.

Construction;

It is very simple in construtions. It consist of a helical coil spring & pointer. The coil spring is fixed at the top and its bottom consist of a pointer with a hook at which the body is attached whose weight is to be measured.

There is a scale at the body of spring balance which gives the reading of weight of body which is to be measured.

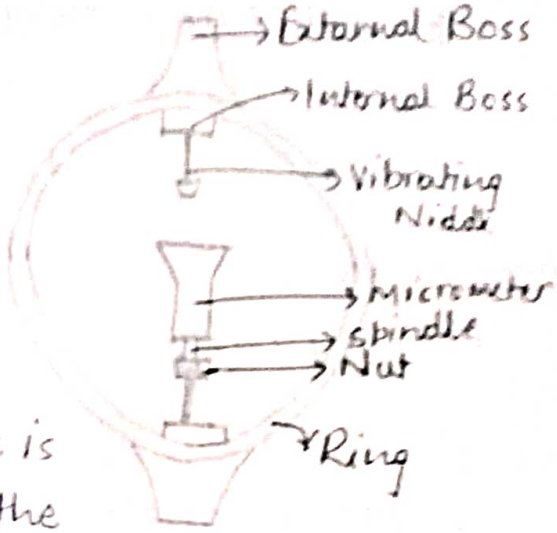
It work on the principle of "Hookes Law".



Working;

- When the object is attached with the hook whose weight is to be measured due to the gravitational force spring deform & starts moving with pointer in downward direction.
- Due to deformation in spriengs a force $F = -kx$ is developed in the spring as x - increases this force increases.
- For a particular value of 'x' there is a condition at which the deforming force in magnitude is equal to weight of object which is to be measured. This condition is called equilibrium condition.
- As this condition reading shown by pointer on scale represent the weight of object which is to be measured.

Proving Ring Load Cell



It is force measuring instrument.

Construction;

- It consist of a steel ring due to its modulus of elasticity.
- At the outer periphery of Ring there is external Boss are present at which the load is applied which is to be measured
- At the inner periphery of ring there is internal Boss is present which is used for griping purpose.
- As upper internal Boss a vibrating needle is attached and at lower internal boss a micrometer is attached. This is Depth micrometer.

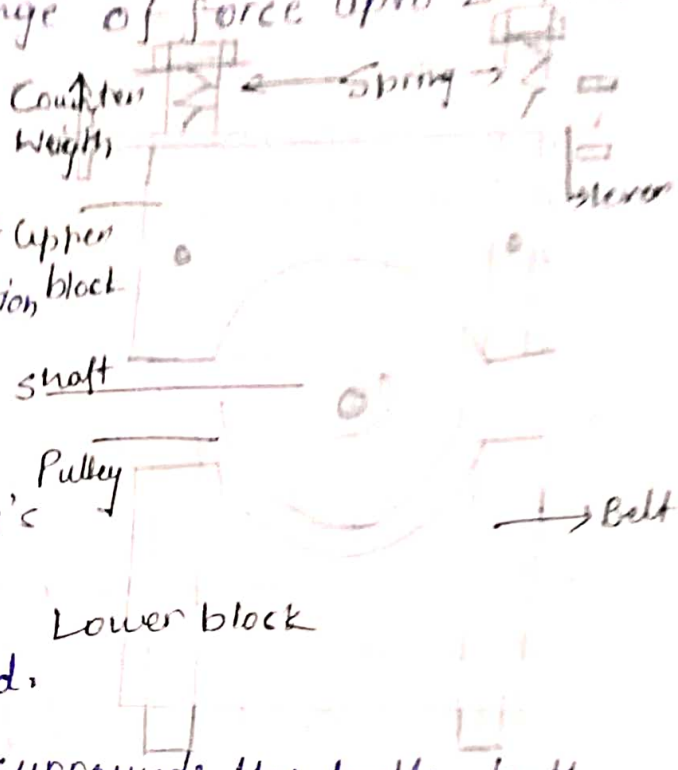
Working;

Initial the external boss is in unloaded condition. ie Force of zero Newton, F=0N, is present at external boss the vibrating needle is given some vibration. Now the nut of micrometer is rotated due to which its spindle moves in upward direction and Base of micrometer touches with cup of needle. This causes the damping in vibration of needle.

- As needle start dampling in vibration this indicates micrometer is in contact with needle at this instant micrometer reading is noted as 'R1'.
- Now load which is to be measured is applied at external Boss. Due to which ring deform and transform into oval shape and again micrometer nut is rotated and needle is vibrated when micrometer touches cup of needle its vibration starts damping at this instant reading is noted as 'R2'.

- Now diffusion in micrometer reading will give the reading of load through a load calibrated chart/table.
- It is a instrument with upto good accuracy and used for measurement of wide range of force upto 2 MN.

Prony Brake Dynamometer.



It is used to measure the brake power of shaf. It is an absorption type brake dynamometer.

Construction;

- It consist of a pulley which is situated on the shaft whose brake power is to be measured.
- There are two blocks which surrounds the pulley both the blocks are connected to each other with nut and bolt.
- There is a lever placed at upper block and is connected with bolt through helical coil spring.
- lever is balanced by a counter weight which eliminates vibration.

Working;

- When the pulley is connected with the shaft whose brake power is to be measured as the shaft rotates the pulley.
- Now we attach load at one end and when the load gradually increase this makes lever to move downward.

- This makes the upper block to also move downward and touches the pulley.
- Due to frictional contact between block and pulley start to stop.
- At this time load value is calculated and brake power is measured by

$$BP = \frac{2\pi N}{60} \times W.L$$

MCLEOD Gwage

A mcleod gauge is a device which is used to measure a very low pressure. ie Vaccume pressure of 10^{-6} Torr.

Components;

Mercyry Resevior; It is a movable reservoir which is used to store mercyry in it. The mercury is use to measure the pressure.

Reference coulmn with reference capality;

The gas in air whose pressure to be measured applied to guase through this coulmn. The reference column is connected with reference capillary which has scale and zero redding of refrence capillary is called zero reference point.

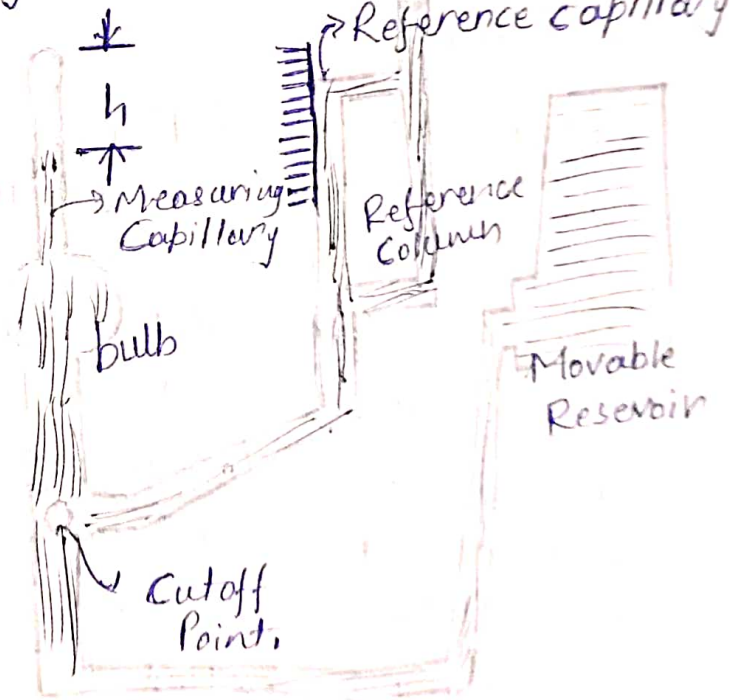
Bulb & Measuring Capillary;

The reference capbidary is connected with a measuring capillary which having a bulb at cutof point.

Working

- It works on the priciple of Boyle's law, ie $P_1 V_1 = P_2 V_2$.
- Initially when movable reservior is at bottom, the mercury is at cut of point. Both capillary and column are empty.
- Now the air/gas whose pressure is to be measured is admitted to column and this air/gas flows to bulb.
- Now movable reservoir is moved upward mercury gets filled up in both capillary and column.
- This movement of mercury compresses the air/gases of column and 'h' ie difference in level of mercury is recorded.

This 'h' gives the reading of pressure calculation,



$$P_1 V_1 = P_2 V_2$$

$$\Rightarrow h = P_2 - P_1$$

$$\Rightarrow P_1 V_1 = P_2 (ah)$$

$$\Rightarrow P_1 V_1 = (h + P_1)(ah)$$

$$\Rightarrow P_1 V_1 = ah^2 + P_1 ah$$

$$\Rightarrow P_1 V_1 - P_1 ah = ah^2$$

$$\Rightarrow P_1 (V_1 - ah) = ah^2$$

$$= P_1 = \frac{ah^2}{V_1 - ah}$$

$$V_1 >>> ah$$

$$\therefore \boxed{P_1 = \frac{ah^2}{V_1}}$$

UNIT-3

Tachometer; It is a measuring instrument which is used for measurement of rotational speed which is known as rpm, revolution per minute of any rotating element.

Classification of Techometer;

Techometer are basically of two types;

1. Mechanical Tachometer
2. Electrical Tachometer

Mechanical Tachometer;

Mechanical Tachometer uses mechanical linkage or mechanical parts for measurement of rotational speed of rotating elements. It has following type;

1. Revolution Counter
2. Hand speed indicator
3. Tachoscope
4. Centrifugal Tachometer
5. Resonance Tachometer.

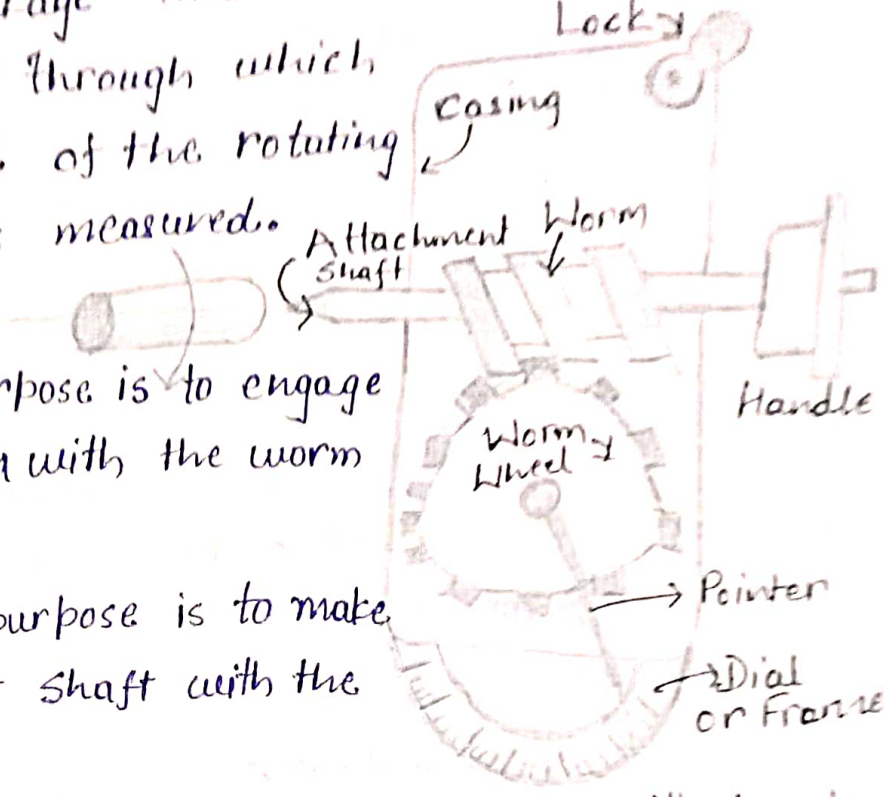
Electrical Tachometer;

Electrical Tachometer consist of transducer which converts the rotational speed of rotating element into electrical signal and Through electrical signal rotational speed is further calculated. It is of following type;

1. Eddy current (Drag-up) Tachometer
2. Tachogenerator
3. Magnetic pick-up Tachometer
4. Photo electric Tachometer
5. Stroboscope Tachometer

Revolution Counter Tachometer

It is a type of mechanical tachometer as it consis of mechanical linkage like worm, worm-wheel, shaft through which the rotational speed of the rotating elements ie RPM is measured.



Components;

1. Lock; Its main purpose is to engage & disengage the worm with the worm wheel.
2. Handle; Its main purpose is to make contact of attachment shaft with the rotating element.
3. Shaft Attachment; It is basically a shaft with handle which attaches with rotating element inorder to measure its rotational speed. It has thread cut on its periphery hence it is called as worm.
4. Worm Wheel; It is basically spur gear which is mesh with the worm.
5. Pointer; A pointer is attached with shaft of worm wheel to indicate reading of RPM on scale.
6. Dial on Fram; It is a scale on which readings are graduated it shows the measured RPM.
7. Casing: It is a housing which encloses the component of Tachometer.

Working:

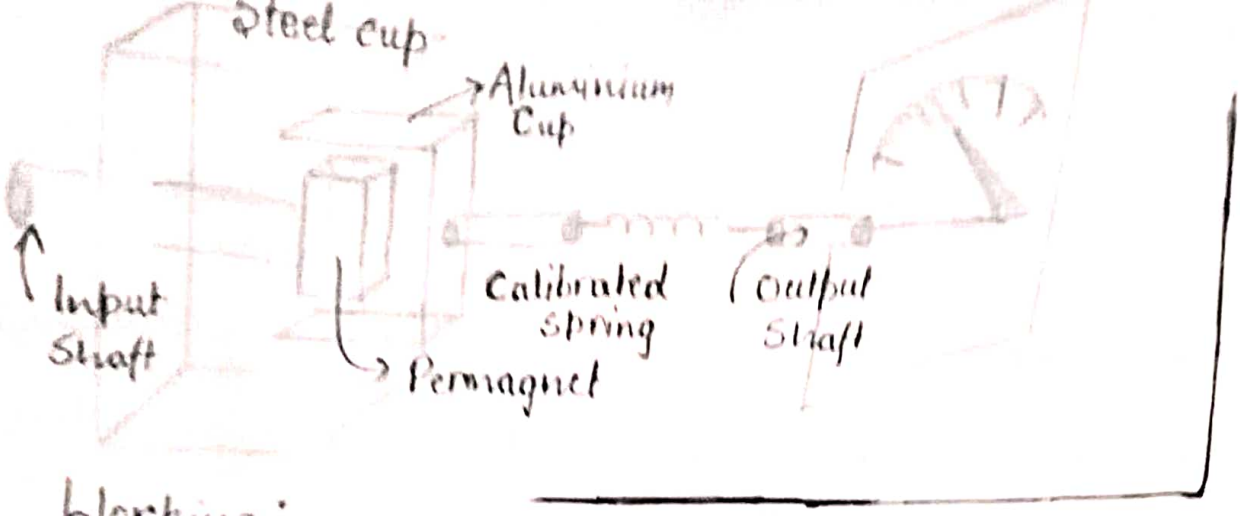
- Initially the unlocking the lock and by pushing the handle we make contact of our attachment shaft with rotating element whose RPM is to be measured.
- Now by pushing the lock forward the worm and worm wheel gets meshed.
- Now when rotating element rotates the armature shaft in contact with rotating element rotates and since worm wheel in mesh with worm. And its also rotates.
- For one revolution of worm, worm wheel rotates one teeth circumferential distance.
- Now due to movement of wormwheel, pointer deflects as shows the reading of RPM on scale.

Eddy-Current Drag-cup Tachometer

It is an electrical tachometer used for measurement of rotational speed ie RPM of rotating elements.

Construction:

- It consist of an input shaft which is coupled with the rotating element whose RPM is two be measured. The input shaft carries a permanent magnet with it self.
- The permanent is enclosed by an aluminium cup known as drug cup. The shaft of Drag cup is coupled with out put shaft through a calibrated helical spring.
- The output shaft has pointer which gives reading of RPM measured on scale.
- The drag cup is enclosed in a housing of steel cup.



Working:

- As the rotating element whose ram is to be measured is coupled with the input shaft when rotating elements rotates input shaft also rotates.
- Due to rotation of input shaft the polarity of permanent magnet towards drag cup changes due to this magnetic flux on drag cup changes.
- Now by faraday law, the drag cup induced current at its suface to oppose this change in flux and this current is called Eddy current.
- The Eddy current produces Torque on drag cup due to which it start rotating and when the torque on the shaft of dragcup equals to torque of spring this condition is called equilibrium.
- When equilibrium is reached movement of drug cup is perpotional to rotational speed of rotating element.
- After equilibrium when drag cup rotates output shaft rotates and pointer deflects to give reading on scale.

Turbine-Meter

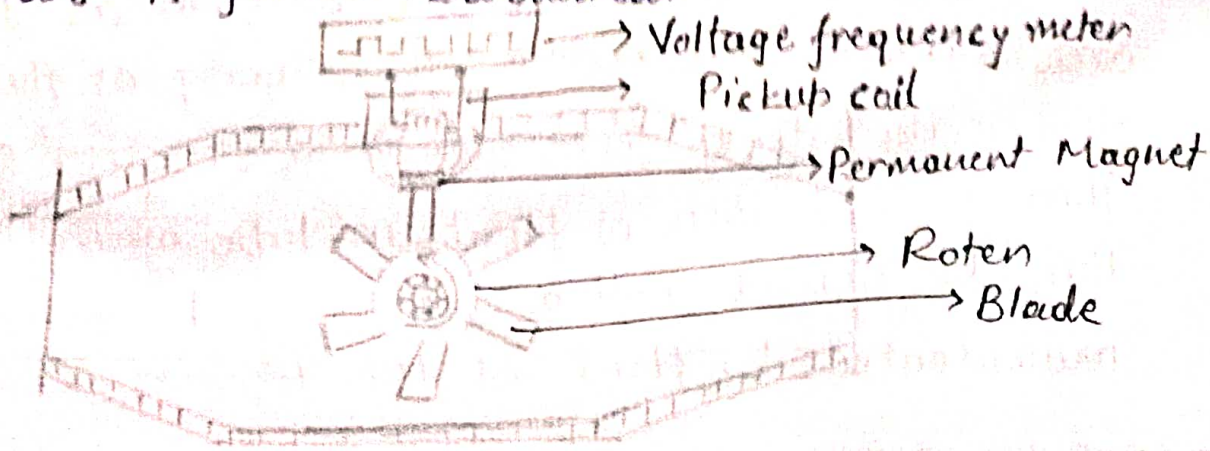
Turbine meter is a flow rate measuring device which is used to measure the rate of fluid flow.

Construction;

- It consist of multi blade rotor which is placed at circumference of rotor uniformly.
- The rotor is supported by ball bearing on shaft due to this rotor is free to rotate about its own axis
- A permanent magnet is placed over one of the blade.
- There is a magnetic pick-up coil with a voltage frequency meter which measure the rate of flow.

Working;

- When the flued enters in the turbine flow meter it strikes the blade of rotor. Due to which an impulsive force is exerted on blade of rotor which cause the rotor to rotates.
- The rotation of rotor causes the magnetic flux on pick-up coil to change. The pickup opposes this change in magnetic flux & generator an EMF across it.
- The generated emf is pulsating in nature. The frequency meter measures the magnitude and frequency of voltage generated and by using some mathematical relation flow rate is further calculated.



RotaMeter

- Rotameter is a variable area flow meter used to measure the rate of fluild flow.
- It measures the rate of fluid flow by allowing the cross-section of the device to vary in response to fluid flow.

Construction;

- It consist of a graduated tapered tube arranged in vertical position.
- The tube has reading engraved on it whose scale is in LPM (Létre per minute)
- The tube contains a float within itself which indicates flow rate of fluid flow through it directly on the scale of the tube.
- The bottom of the tube is connected to inlet pipe through which the fluid enters and the top of tube is connected to outlet of pipe through which fluid discharge.

Working;

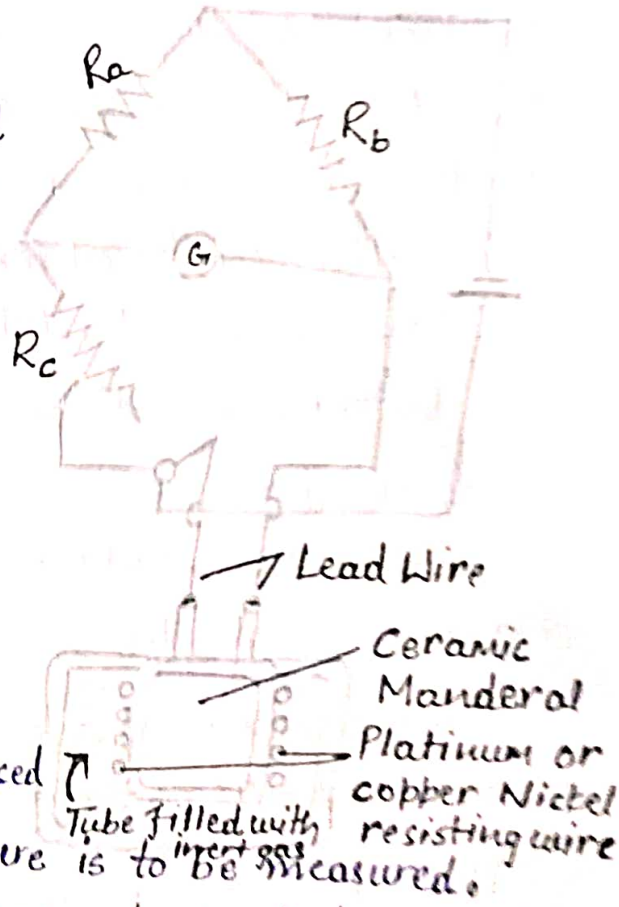
- When the fluid whose flow rate is to be measured enters to the tube of rotameter it exerts two forces on the float in upward direction one is drag face and other is upthrust. This causes the float to move in upward direction.
- There is always a force due to gravity acts on float in downward direction.
- When float moves in upward direction as the annular area increases this reduces the velocity of fluid flow and since drag force which a function of $F_d = \frac{1}{2} C_d \cdot A_f \cdot \rho_f \cdot V_f^2$
- There is a position of float in tube where $\boxed{F_D + F_{ur} = F_G}$ This position is called equilibrium position and reading indicateated by float at this position is called flow rate.

Resistance Thermometer

- Resistance thermometer is a temperature measuring instrument.
- As we know that when the temperature of conductor changes its resistance also ~~changes~~ its ~~resistance~~ by resistance also changes and by calculating the changed resistance value we can measure the change in temperature.

Construction;

- It consist of a metal or glass tube field with inert gas.
- The tube encloses a ceramic mandrel around which resistance wire is wounded.
- The resistance wire are inter-connected to each other with two lead wire.
- The two lead wire are connected with a wheat-stone bridge ckt.



Working;

- The resistance thermometer is introduced with the medium whose temperature is to be measured.
- Due to heat of medium inert gas gets heated up and transfer this heat to resistance wire attains temperature of medium.
- Due to this resistance of thermometer changes and wheat stone bridge become unbalance but by varying the resistance of variable resistance the bridge is balance.
- Now in this condition R_T - resistance of wire of thermometer is calculated.

Optical - Pyrometer

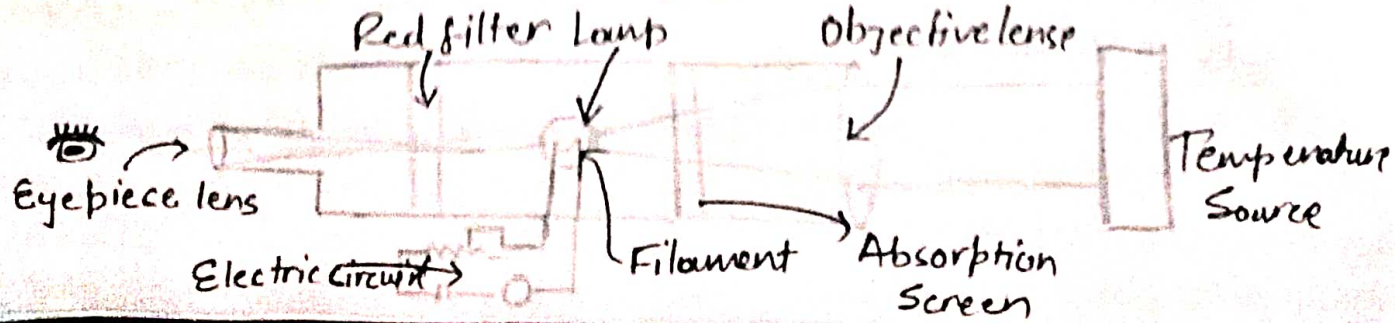
- It is a non-contact type temperature measuring device which is used for measurement of high temperature of heated body like temperature of molten metal, temperature of furnace etc.

Construction;

- It consist of a cylindrical tube whose both ends are fitted with lens. The lens nearer to temperature source whose temperature is to be measured is called objective lens & the lens nearer to eye of observer is called eyepiece lens.
- A power source ie a lamp with tungsten filament, Red filter and absorption screen is fitted at required position inside the tube.
- A battery, multimeter and rheostat are connected to the lamp.
- An absorber screen is arranged in the middle of lamp and objective lens.
- Main function of absorption screen is to maintain high temperature range around the lamp.
- The red filter is placed between lamp and eyepiece lens. The main function of red filter is to allow only monochromatic light ray to fall on eye piece.

Principle;

"The temperature of source is equal to temperature of filament at a condition when brightness of lamp & brightness of filament are equal."



Working

- When optical pyronder is placed near the heated body whose temperature is to be measured.
- The relation is focused by convex lens and lamp. Due to which lamb become bright which is obserbed through eyepiece lens.
- Now current is supplied through battery via variable resistance this lighten-up the filament.
- Now there is three cases;

CASE I; When resistance is high & current is low. Then we obserbed from eyepiece lens filament looks dark. That means temperature of source is more than temperature of filament.

CASE II; When the resistance is low and the magnitude of current is high we observe from eyepiece lens filament looks more bright than lamp. That means temperature of filament is more than temperature of source.

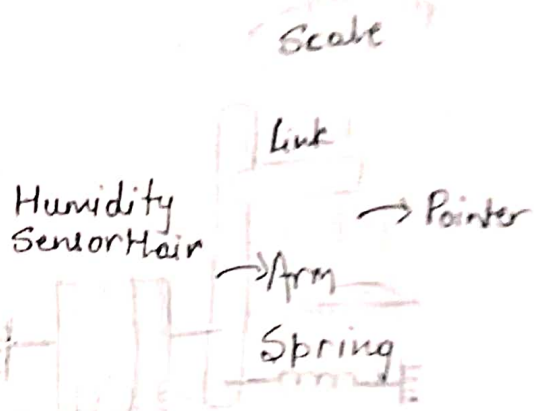
CASE III; When the value of current is so adjusted that the brightness of lamp and filament is same. This is indicated as on viewing from eyepiece lens filament vanishes. At this condition temperature of filament is equal to temperature of source and is calculated from calibrated current-temperature table.

Hygrometer;

Hygrometer is a measuring instrument which is used to measure the relative humidity of atmospheric air.

Construction;

- In this intrument human hair is used as humidity sensor. The group of hair are arranged parallel to each other and are supported by two columns. The number of hair are arranged such that they are exposed to surrounding atmosphere.
- The hair is arrangement is placed under small tension spring which increases the mechanical strength of hair and for proper function.



Principle;

"Certain material such as human hair undergoes changes in linear dimension under the influence of moisture content in air increases length of ~~increa~~ hair also increases and if moisture content in air decreases length of hair also decreases Through this change in liniar dimention relative humidity of air is measured."

Working;

As the air sample whose humidity is to be measured passes over the hair. If the moisture content in air is high then air absorbs moisture and expands. This makes arm to move, which move the link due to which pointer deflect on calibrated scale and give the reading of humidity and if moisture content in air is less, hair become dry and contract. This arm to move, which move the link due to which pointer deflect in calibrated scale to give reading.

Hydrometer

Hydrometer is a measuring instrument which is used for measuremen of specific gravity of any liquid.

Construction;

It is simple in construction as this device is typically made up with a glass tube which consist of a very thin narrow stem of neglesible at top & a bulb at bottom. The bulb is fitted with mercury or lead shot which enables the hydrometer to be upright position when inserted in liquid

Principle;

For floatation,

upthrust = Weight of test specimen

∵ Weight of test specimen = Weight of liquid displaced

Volume of liquid displaced = $a \times l_1$

∵ Weight of liquid displaced = $\rho_1 \times g \times a \times l_1$

Weight of specimen = $\rho_1 \times g \times a \times l_1$

Volume of liquid displaced = $a \times l_2$

∵ Weight of specimen = $\rho_2 \times g \times a \times l_2$

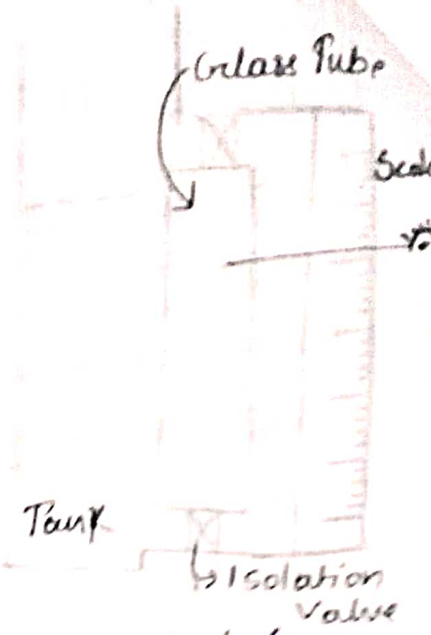
$\Rightarrow$ $\rho_1 \times g \times a \times l_1 = \rho_2 \times g \times a \times l_2$

$$\Rightarrow \boxed{\frac{\rho_1}{\rho_2} = \frac{l_2}{l_1}}$$

Working;

- The test tube is placed in a tall ~~tube~~ container and the hydrometer is gradually inserted in it untill it float freely.
- The sp. gravity of liquid is determined directly on scale of hydrometer which is calibrated on basis of hydrometer submersed in liquid.

Sight - Glass



It is a liquid level measuring instrument.

Construction;

- It is basically a cylinderical tube of narrow diameter having reading engraved at its surface.
- It connects with the tank from outside with the two isolation valve.
- Through isolation valve the tube can be seperated from tank in case of maintainance work.

Working;

- When the liquid is pourd in the tank it also gets bypass into or flow into the glass tube.
- As we know that since the liquid in tank and glass tube is same ie of some specific gravity hence level of liquid in tank and in glass tube is same.
- Therefore by direct sighting the glass tube reading of level of liquid is determined.

Float - Guage.

Float guage is a liquid level measuring instrument, which is used to measure the level of liquid.

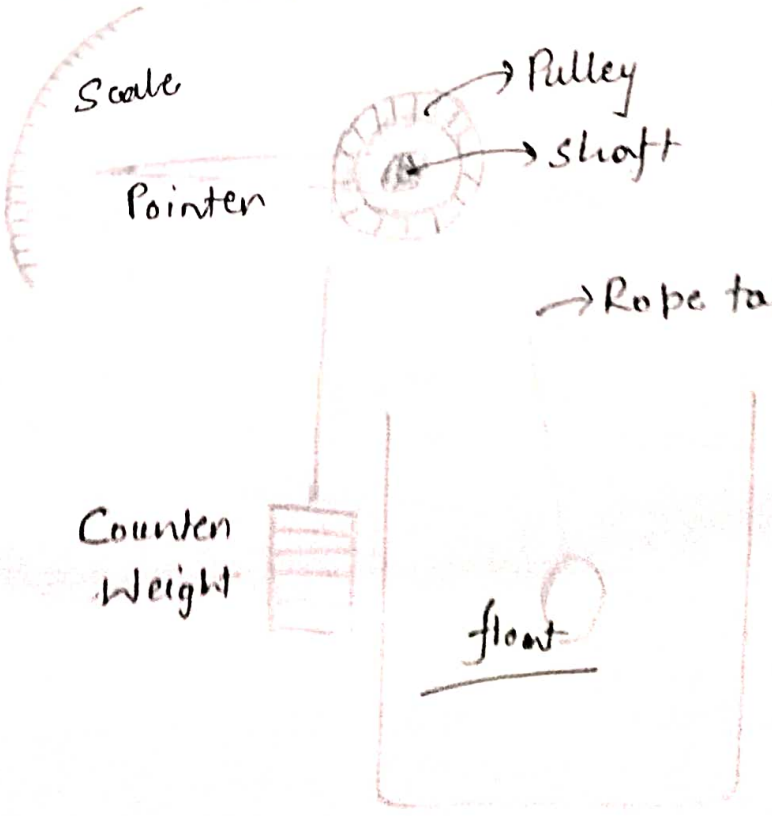
Construction;

- It consist of a float which is mounted over a pulley throug rope/tape counter weight.
- The float is counter balance over the pulley by a counter weight of some weight as that of float, to eliminate the effect of gravity on float.

- The density of float should be less than the density of liquid whose level is to be measured so that float doesn't immersed in liquid.
- The pulley carrying counter weight and float is mounted over the shaft. The shaft carries a pointer which deflects on the scale to give the reading of liquid level on scale.

Working;

- When the float is placed over the liquid surface whose level is to be measured. Due to counter weight it begins to float.
- As the liquid level up or down float also move up & down due to this pulley rotates. This makes the shaft to rotate.
- As shaft rotates the pointer deflects to give reading of level of liquid on scale.



UNIT-4 Limit, Fit & Tolerance

Introduction :

It is very difficult to manufacture the component with a very high level of accuracy when the component is to be produced in large numbers or quantities.

- As if the component is to be produced at very high level of accuracy, then it will require more time and cost which is not desirable.
- Therefore in manufacturing some variation in dimension of product is allowed so that it can be produced in large quantity within less time.
- For this in manufacturing two permissible limit is given to any component one is max. limit and another is minimum limit.

Some Basic Terms

1. Hole : In assembly hole is considered to be that component into which another component is fitted.
2. Shaft : In assembly shaft is considered to be that component which gets fit into hole.

Limit : The two extreme permissible valve allowed in manufalcturing is called limit. There are two limit.

a) Maximum Limit : The greater value out of two limit is called maximum. At maximum limit product wire be at its maximum size. It is also called upper limit.

b) Minimum Limit : The smaller value out of two limit is called minimum limit. At minimum limit product will be at its minimum size. It is also called lower limit.

Daviation : It is defined as the algebric diffecence between the actual size of shaft or hole with its basic size.

Daviation are also of two types;

1.) Upper Daviation : The algebric difference between the maximum size at upper limit of either shaft or hole with its basic size is called upper deviation of shaft or upper deviation of hole respectively.

2.) Lower Daviation : The algebric difference between the minimum size at Lower limit of either hole or shaft with its basic size is called deviation of hole or lower deviation of shaft respectively.

Basic Shaft

It is a system of shaft in which the upper limit given to the shaft considers with zero line. ie. Upper daviation becomes zero.

Basic Hole

It is a system of hole in which the lower limit given to the hole concides with zero line. ie lower daviation becomes zero.

Limit Gauge

- Limit gauges are non-recording type inspection device which is used to check the dimension of product produced lies within the permissible limit or not.
- If on inspection the dimension of product produced lies within the permissible limit then the product is accepted.
- But if on inspection the dimension of product doesn't lies within the permissible limit then the product is rejected.
- In manufacturing the product produced is either of two nature either it will be shaft or it will be hole. We have to take the measurement to check its accuracy. But when the production rate is high we can't choose the method of measurement which is time consuming.
- Therefore check the manufactured, accuracy with in less time, we use this type of inspection devices called "limit Gauge".
- Limit gauges are non recording measurement devices. ie. they doesn't give the reading of dimension of product produced but they only check whether the product produced lies between the permisible limit or not.

Double Ended Plug Gauge

According to taylor's principle Go & No Go gauge should be design to check Min & Max material condition.

There are two sides of gauge

i) Go Side of Gauge :

According to taylor's principle Go sides of gauge are designed to maximum material condition ie upper limit for the shaft and lower limit for the hole.

ii) No Go Side of Gauge :

Taylor's principle No Go side of gauge are designed to minimum material condition. ie upper limit for hole and lower limit for shaft.

Types of limit Gauge

Plug Gauge : A plug gauge is a type of limit gauge which is used to check the accuracy of a hole.

- Plug gauge check whether the hole diameter is within the specified limit or not.
- Go plug gauge corresponds to lower limit hole while No-Go plug gauge corresponds to upper limit of hole.
- It is of following types;

① Single Ended Plug Gauge : In these plug gauge Go side and No Go side are made separately at end of gauge.

② Double Ended Plug Gauge : In these plug gauge both Go side and No Go side are made on two opposite end of same gauge.

FIT

- In assembly of shaft and hole these two are considered as mating parts.
- The degree of tightness and looseness between the two matching parts during the assembly is called FIT.
- There are three basic type of FIT.
  - (i) Clearance FIT
  - (ii) Interference FIT
  - (iii) Transition FIT.

When the largest permissible shaft diameter is always smaller than minimum size of hole so that there will be clearance gap between shaft and hole and the shaft can easily and the shaft can easily slide and rotate inside the hole such FIT are cased clearance FIT.

Tolerance

- It is not possible to make component exactly to a given dimension because of various properties of material change in operator, change in shift, change in methode.
- Therefore it is essential to allow definite variation on specified dimension.
- This permisibble variation in dimension is called "Tolerance"
- The difference between maximum limit and minimum limit either for shaft or hole is called tolerance.

- Because of tolerance product acceptability increases, There are two system specified for tolerance.

UNILATERAL

In unilateral system of tolerance, the total tolerance lies in one direction from zero line.

BILATRAL

In bilateral system of Tolerance lies on both side of zero line.

Hole Basis System

- In this system holes are manufactured and for manufactured Hole shaft are produced.
- Holes are produced are of constant size of fixation of limits and shaft sizes are varied by varying the limit to obtain different FIT.
- Lower Limit of Hole must concides with zero line ie lower daviation of hole must be zero and for this the hole having minimum size of basic size and is known as basic hole.
- Clearance Transition Interfen,
  Since it must easier to vary the size of the shaft. Then to vary the size of hole basis system are adopted.

Hole Basis System

- In this First hole is produced and on basis of size of hole shaft are provided with required dimension according to type of FIT required.
- In this size of hole is kept constant and size of shaft is varied to obtain different FIT.
- Lower daviation of hole is zero.
- Lower limit of hole conside with zero line.
- Minimum size of hole produced is basic size called Basic hole.
- Mostly Adopted in industry.
- It is represented by 'H'.

Shaft Basis System

- In this first shaft is produced and on the basis of size of shaft holes are produced with required dimension according to FIT required.
- In this size of shaft is kept constant and size of hole is varied to obtain FIT.
- Upper daviation of shaft is zero.
- Upper limit of shaft concides with zero line.
- Maximum size of shaft produced is of basic size called basic shaft.
- Mostly Not adopted in industries.
- H is represented by 'h'.

Multi Gauging Inspection

- Multi-Gauging machine are useful for measurement of number of dimensions at a time.
- In this part to be checked are compound with a standerd and then daviation are recorded.
- First the setting standard is hold between two centre than the dial indicator are adjusted to zero position for different dimension.
- Then setting standered is removed and component to be tested is fixed between two centre and then reading of dial indicator are recorded by moving plunger over workpiece surface.

"Multi-gauge inspection is basically a checking process in which more than one dimensional feature are inspected at a time through a machine called Multi-Gauge Machine."

Measurement of screw thread

Major Diameter :

It is the diameter of an imaginary cylinder co-axial with screw which just touches the crest of an external thread or root of an internal thread.

Minor Diameter :

It is the diameter of an imaginary cylinder co-axial with screw which just touches the root of an external thread or crest of an internal thread.

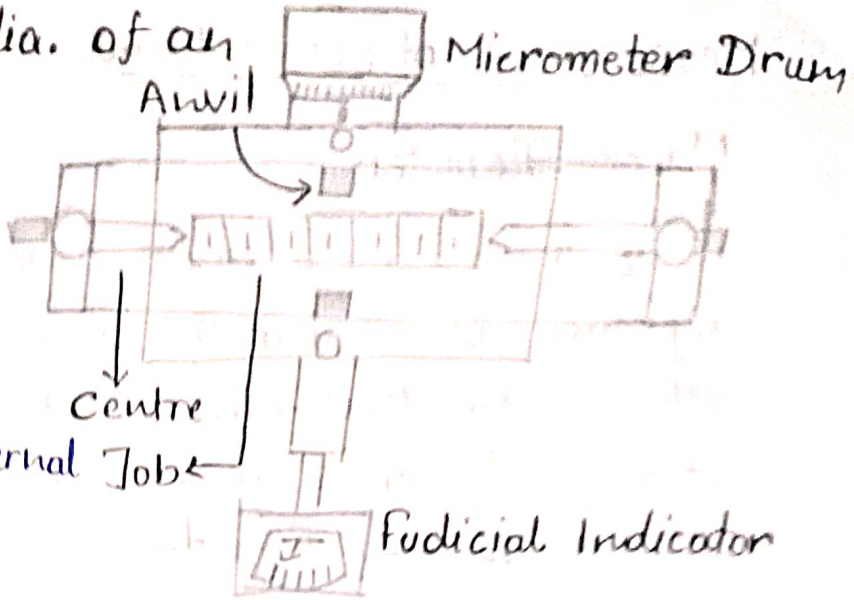
Righthand Screw

When the screw is hold such that its axis is vertical if thread slope upward from left to right.

Lefthand Screw

When the screw is hold such that its axis is vertical and if thread slope downward from left to right.

Measurement of ~~external~~ Major dia. of an external screw thread;



Floating Carraige Micrometer

(I) Floating carraiage micrometer used for measurement of major & minor diameter of external screw thread.

(II) This set-up is used for measurement of external screw thread major diamete.

(III) In this set up these are two anvil one is attached with micrometer and other is attached with fudicial indicator.

(IV) Fudicial indicator indicates pressure beeing applied on thread while taking measurement.

(V) We have to take all the reading at constant pressure.

During the measurement initially a setting cylinder called a master piece approximately the same diameter as that of major diameter is held between as that of major diameter is held between anvil of micrometer and fudicial indicator and a reading R_1 is obtained at a certain pressure

Now the master cylinder is replaced by threaded workpiece and with same pressure its reading is taken as R_2 on Micrometer.

Now the major diameter is given by an emphirical relation, $d_o = D \pm (R_2 - R_1)$

(+) $R_2 > R_1$

(−) $R_1 > R_2$

Measurement of Minor diameter

- Minor diameter of external screw thread is also calculated by the floating carraige bench micrometer
- For minor diameter the anvil of floating carraige micrometer is made up with V-shaped.
- Initially anvil is kept is kept in contact with a standard cycle specimen having approx diamer as that of minor diameter. The reading R_1 is obtained on micrometer at a particular pressure which is applied by fudial indicator.
- Now the specimen is replaceaed by screw thread ~~Both~~, and anvil is made to touch root of screw thread. Both anvils are sepere by $P/2$ distance. A reading R_2 is obtained on micrometer at same pressure.

Minor Diameter is given as $d_c = D \pm (R_1 - R_2)$

+ R
− R

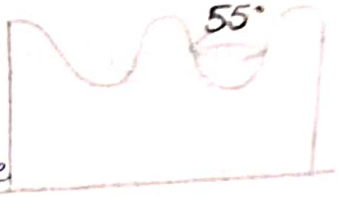
.. ...spread otherwise rejected.

Qn. While measuring the minor diameter of screw thread, a 30.5 mm diameter standard. The micrometer reading over standard and thread are 15.36 mm and 13.521 mm respectively calculate minor diameter.

Dia.- 28.645 mm

ISO GRADING FOR SCREW THREAD

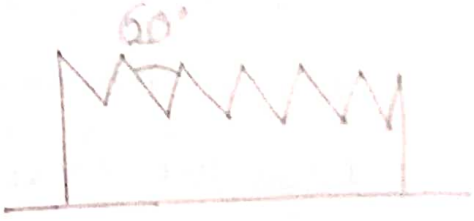
Whitworth Thread : They have included angle of 55°. The are better as they doesn't have sharp-corners at top and bottom.



Square Thread : Square Threads are used for power transmission as they have maximum efficiency.

V - Thread :

It has included angle of 60° V-thread screaw are used in fasteners of automotive and aeronotical parts as they have very less chances of loosening due to vibration.



ACME Thread :

It is not as efficient than screw thread, but are easier to cut and stronger than square thread.

UNIT-5

Function And Analytical Inspections of gears;

As we know that gear is a metal piece which is manufactured from a metal blank by generating teeth on the circumference of metal blank through machining process.

The teeth generated on the blank has various geometrical parameter like tooth thickness, width of tooth, addendum, pitch kod etc.

Therefore whenever any gear is manufactured we have to check whether all the geometrical parameter of teeth are upto their standard value or not.

For this we perform inspection of gears. There are two methodes by which inspection of gears are performed

a) functinal inspection

b) Analytical inspection.

Analytical Inspection;

In this methode of inspection all the geometrical parameter of each teeth are checked and the mean ie average of all elements are calculated if the average value of the elements has within the permissible range product is accepted otherwise rejected.

- However this methode is tedious hence not considered as primary methode.

Frictional Inspection;

Frictional type of inspection are carried out the running test of gear with another gear which is accurate and true known as master gear.

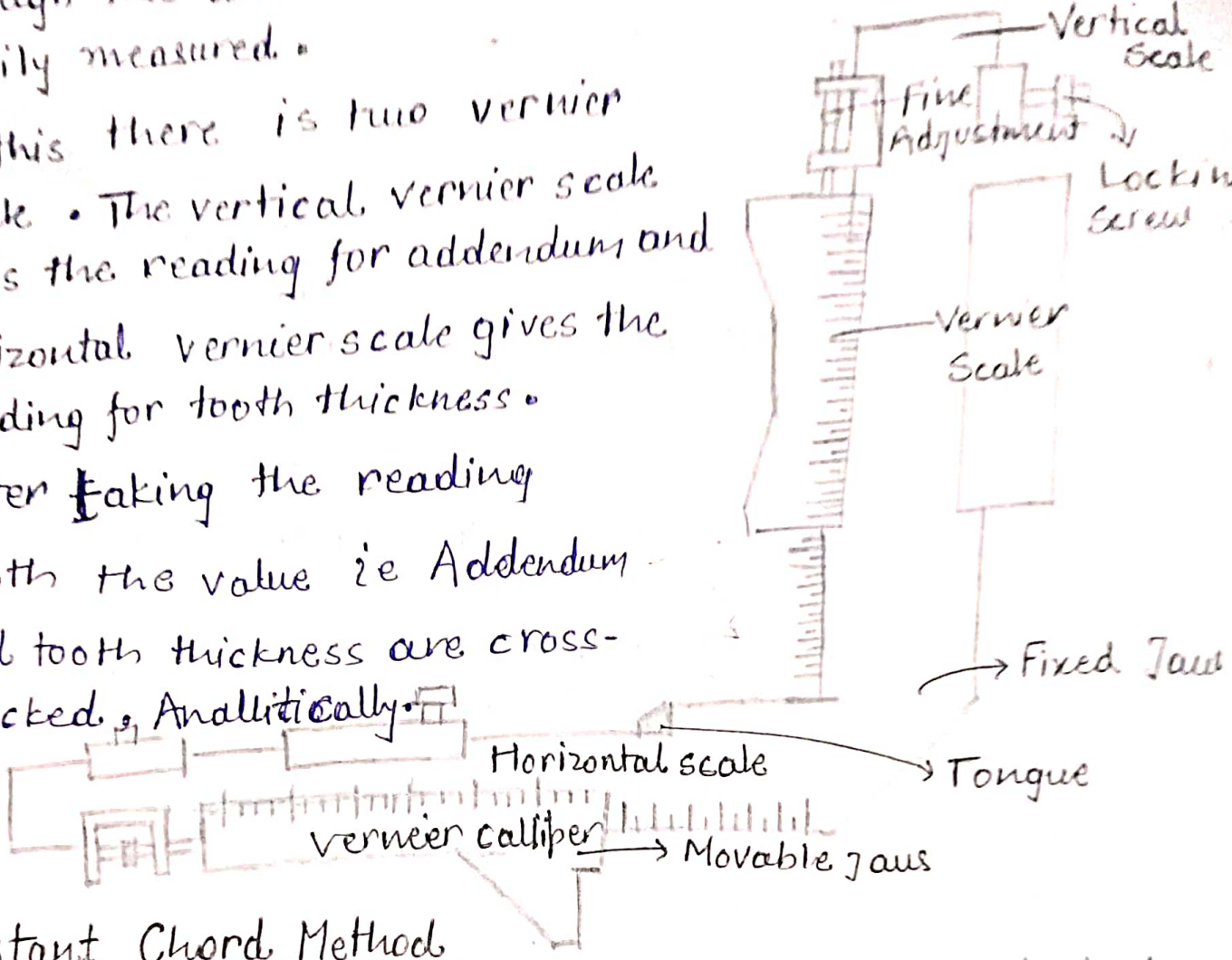
- When they are rotated together at certain speed the noise level and vibration and checked.
- If when the pair of gear re rotated with little noice and vibration the product is accepted otherwise rejected.

Gear tool Vernier Calliper;

Through this addendum as well as tooth thickness can be easily measured.

In this there is two vernier scale. The vertical vernier scale gives the reading for addendum and horizontal vernier scale gives the reading for tooth thickness.

After taking the reading both the value ie Addendum and tooth thickness are cross-checked Analitically.

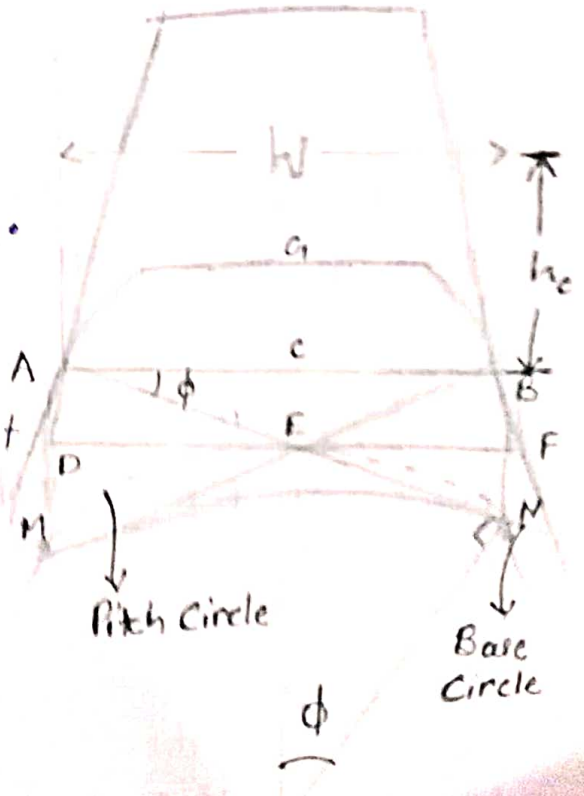


Constant Chord Method

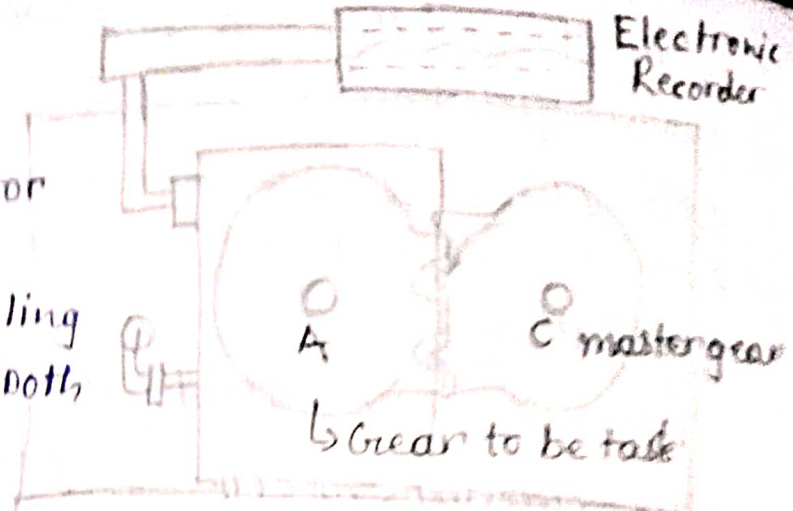
This methode measures the tooth width at pt of contact of a symmetrical closed mesh rack.

The length of chord is same for all gears having some module & pressure angle irrespective to no of teeth.

- If the tangent is drawn from the base circle at a pt from where tooth profile is initiated, the tangent intersect at the gear flank at A & B.
- The line of joining these intersected point A and B on gear flank is called constant chord or chordal thickness.

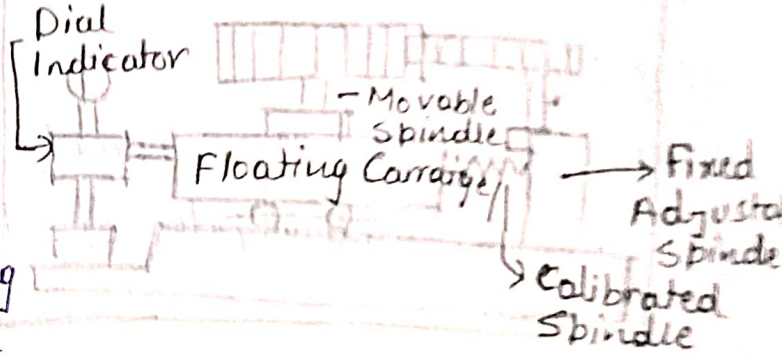


Parkinson's Rowing Test



Parkinson's Rolling test is used for measuring the variation in central distance of two rolling gears caused by error in tooth profile.

Machine Tool Testing



Machine tool testing is a morden technique for checking the geomentrical specification of any machine component by various scientific tool & instruments.

The common geometrical specification that are needed to be checked are;

1. Straightness 2. Flatness 3. Squareness 4. Parallesim &
5. Circularity and Roundness.

Straightness;

- It is generally used to check the correctness of any edge of the component.
- Edge is basically a line which is said to be correct for a given length if the variation of distance of points on it from to perpendicular plane lies with tolerance limit.
- straightness testing is generally done by three methods
  1. Straight edge methode
  2. Spirit level Methode
  3. Wedge Methode

• In this methode a straigth edge tool made of ste. having flat base ranging from 500 mm to 2000 mm is use.

• For check the tool flat ~~base ranging~~ surface is kept over the edge to be checked and light ray is then incident against it.

• If the edge is perfectly straight no light will be seen by the observer on other side through edge of specimen.

Wedge Method:

• In this methode the straight edge to be tested is supported between two unequal piles of slip gauges so that a wedge is formed.

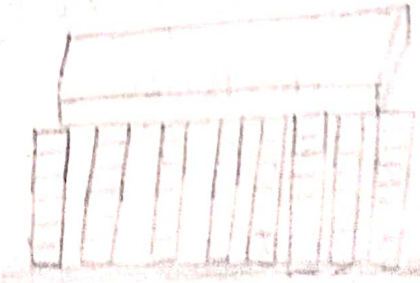
• While testing, the slip gauges of height H_1 and H_2 are taken such that $H_2 - H_1 = 0.1$ mm.

• The distance between slip guages ~~of height~~ are equal to 0.5 L.

• Now we devide the distance between two guages into some equal no of parts, since the difference between slip guage height is 0.1 mm.

• And if we made five equal parts the we choose five guage of height 8, 8.02, 8.04, 8.06, 8.08, 8.1.

• Now the slip gauge of above calculated height are inserted between the straight edge and surface plate at required, egii- distance. If the slip gauge is exactly fit in gap. it means edge of component is correct & straight.



Spirt level test ;

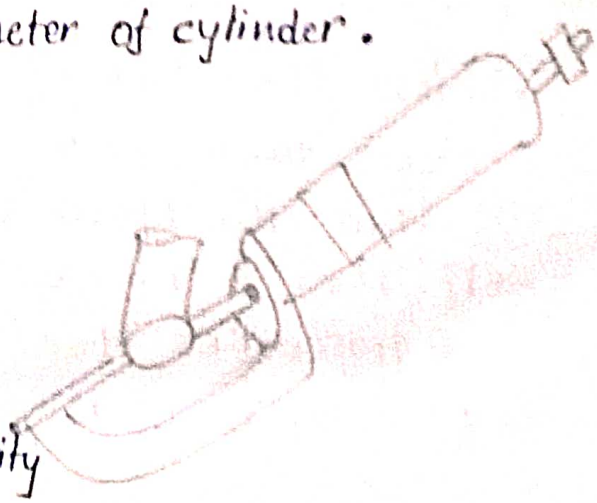
- In this method a cubical block of flat base containing ethanol is used to check the straightnes of any edge & component.
- The block is placed over the edge whose straighness is to be checked.
- And then the block is slide along the edges, if there is no oscillation in ethanol spirit then it will indicate the edge is correct and straight.
- While if there is oscillation in the ethanol sprit it indicate the edge is not correct and straight.

Circularity & Roundness testing ;

- Circularity is defiend as the ability of component in which the distance of point lying on the circumferential curve of cross-sectional surface from a point where axis meets cross-sectional surface is within specified tolerence limit.
- When component is manufactured in lobbed condition. ie without centering then the points lying on the circumference will not be equidistant and this phenomena is called "lobbing".

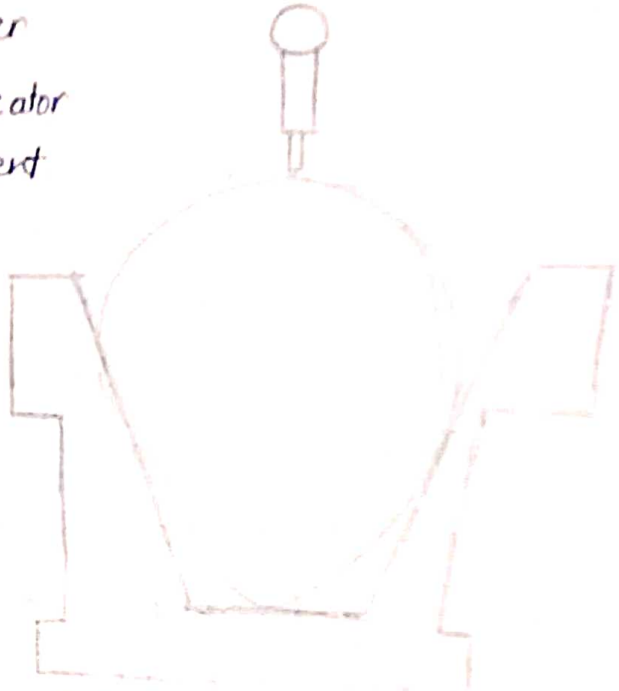
Micrometer test method ;

- In this the cylinder whose roundness is to be checked is placed between the anwits of micrometer. Then the micrometer shows reading which represent diameter of cylinder.
- Now the cylinder is rotated & randomly at difference point reading is taken by micrometer. If there is no vibration in reading of micrometer for the diameter of cylinden then cylinder is said to be correct in its circularity and roundness.



Dial Indicator Method

- In this methode a V-block and a dial indicator arrangement is used to determine the amount of cylindrical component.
- In this keep the component over the V-block & mount dial indicator over it now the cylinder component is rotated slowly.
- If the dial indicator shows variation in reading then it will indicate cylinder is not correct in its circularity and roundness.



Squareness Testing

Squareness is the property of componet to form right angle at the point of intersection of two edges.

Squareness is tested by two methodes;
a) Try-square methods. b) Indicator method.

Try Square Methode

- Small size component can be tested by this method.
- In this method the component whose squareness is to be tested is placed on the table whose surface is perfectly smooth.
- Now the stock of trysquare is also placed on the same table and is firmly pushed towards the component so that the blade of try-square touches face of component.
- If there is no gap between face of component and blade of trysquare then it will indicate that the squareness of component is correct.

Indicating / Indicator Methode;

- In this methed arrangement consist of flat base having a fix knife edge at the bottom and dial gauge at its top it is generally used for large size component.
- The component to be tasted and flat base is properly on a surface plate.
- The block is slightly pressed so that if makes contact with knife edge.
- The plunger of dial gauge is if at some lever of knife edge then there is no fluctuation is reading of dial gauge is observed. This indicate the component is correctly in its squareness.
- But if pointer shows some fluctuation in reading. This indicate the component is not correct in squareness.

Parallelism between a plane and axis;

- In this testing methode we are going to check the correctness of parallelism between axis of a component with the plane of any other component.
- To check the parallelism we use dual gauge with a surface plate. Surface plate is placed over the plane the surface while the dial guage is attacted with the surface plate through a support.
- To check the parallelism the whole arragment is moved in the axial direction of cylinder. If there is variation in the reading of dial guage is observed this indicate the parallelism between axis of component with surface of component is not correct.
- But if there is no fluctuation in pointer of dial guage this means that parallelism between them is correct.

Parallelism between two planes ;

- Two planes are said to be parallel if perpendicular distance between them at anywhere remain constant..
- To check the parallelism between two surface we use a dial guage with a surface plate. The surface plate is placed over one surface while the plunger of dial guage is in contact with other surface.
- The dial guage is attached with the surface plate through a support.
- To check the parallelism the whole arrangement of dial guage and surface plate with support is moved along the surface in two perpendicular direction.
- If there is variation in the reading of dial indicator is observed then it will indicate there is error in parallelism between two surface but if there is no variation in the reading of dial indicator is observed then it will indicate the parallelism between surface is correct.