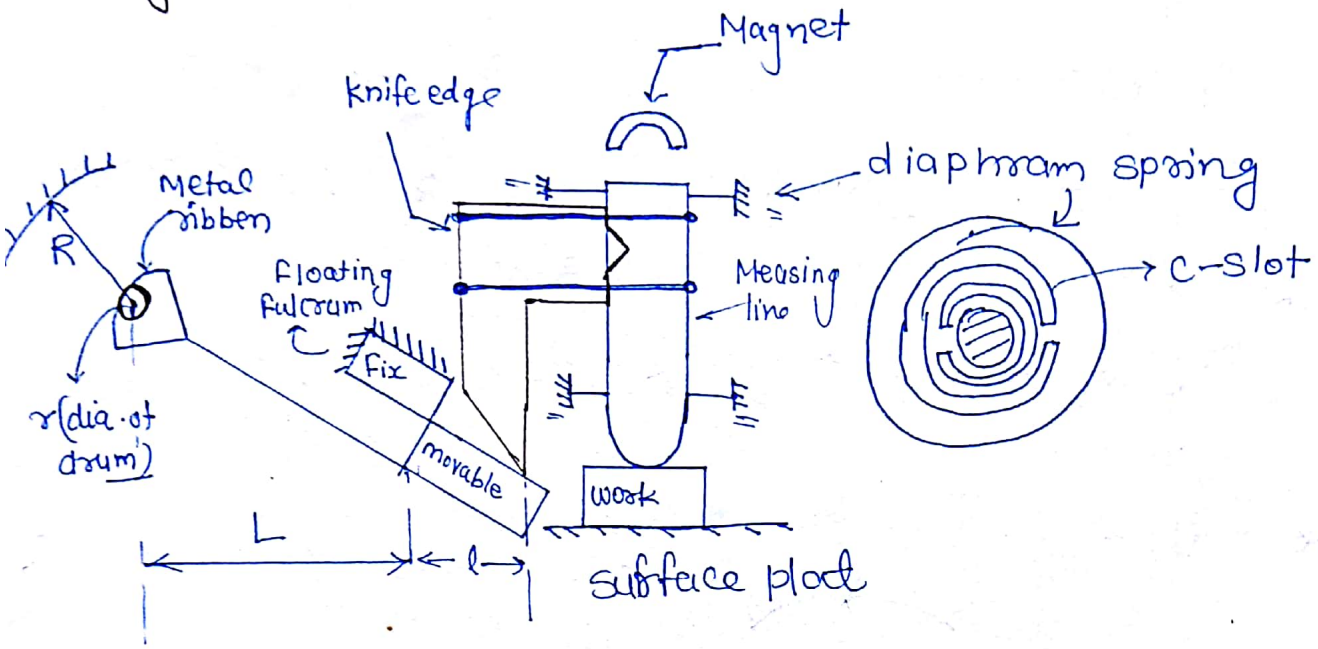
Comparator :- ① Mechanical (Magnification ~1000)

② Pneumatic

Mechanical → off line inspection only

① Sigma :-



Mag. factor :- $\frac{L}{r} \times \frac{R}{l} \simeq 1000$.

Mechanical comparator are not only cheap but also doen't require any power for inspection But there magnification factor is limited to 1000 and also due to inertia of link makes the comparator insensitive for smaller change in diameter.

→ Comparator Gives measurment from a detum value and this detum is establish using Slip Gauge.

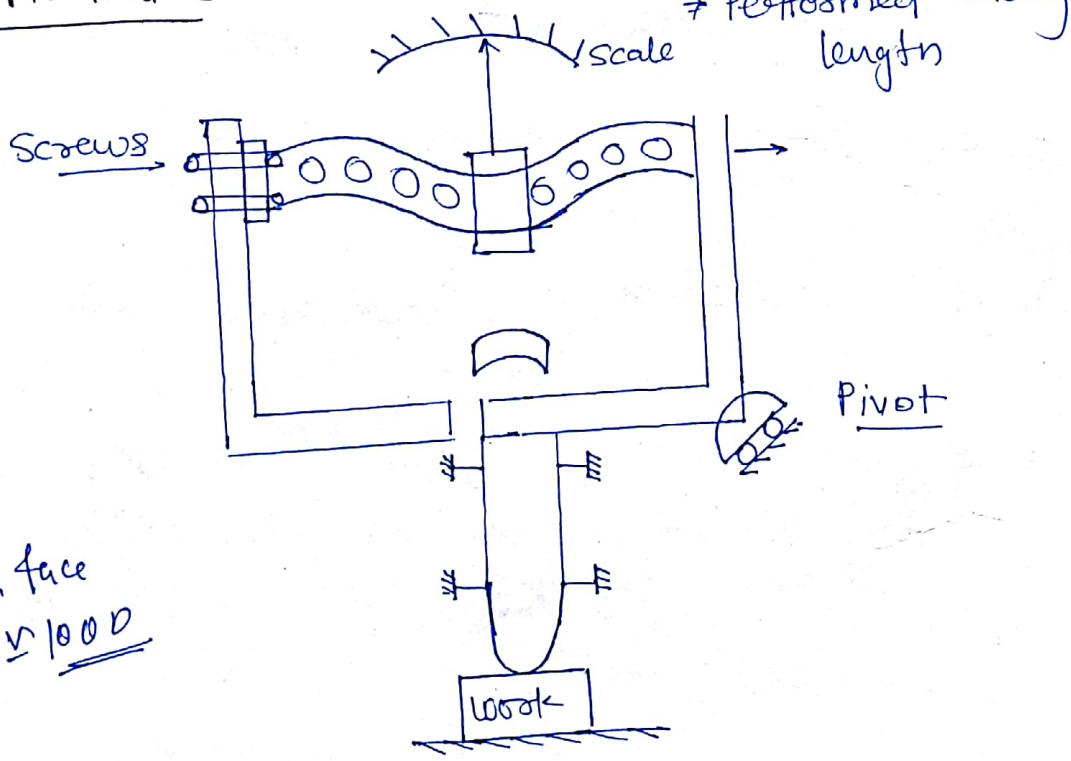
→ Helical spring are not used as restoring device in any of the metrological equipment because due to development of residual Stress it

takes time for the system to come back to its neutral position.

→ Diaphram spring with C-slots are used as restoring device. C-slots are provided to relieve any residual stress.

→ A magnet is provided over the measuring link to have the uniform pressure on the link so that jerk can be avoided

② Mikrokator

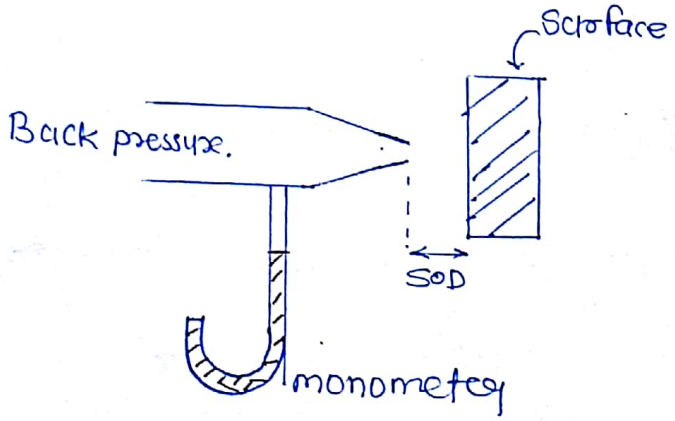


Mag. face
V 1000

A thin sheet is given Right hand twist on Right side and left hand twist on left side centre is Neutral. If the sheet is too thin there will be plastic deformation during twist and if the sheet is too thick there will be development of Residual stress

This sheet is perforated all along it's length to relieve any residual stress if develope. As it can be seen in the diagram that any change in size of work will ~~cost~~ cause right hand side of spring to either twist more or untwist little bit. Any imbalance in twist causes the central portion to rotate.

Pneumatic

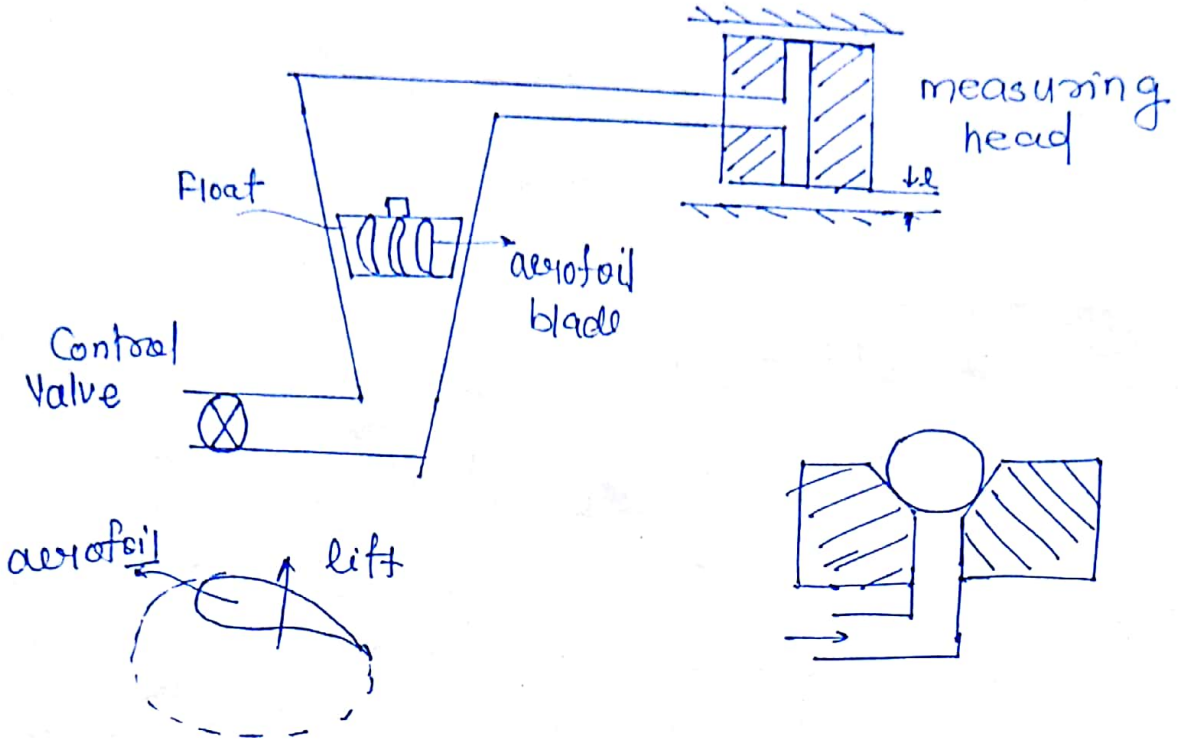


Mag. factor
50,000 : 1

Pneumation comparator work on the principle of an air jet i.e. when we try to block the orifice, due to loss of momentum pressure will develope on the back ground of jet.

These comparator are very popular in industries b'coz
① Since it is not contact type active inspection are possible.
② Compressed air is anyway used in industries for varies purposes like tightning bolts, Making ribben etc. Same air is used for measurement.
③ high Mag. factor

① Rotameter :-

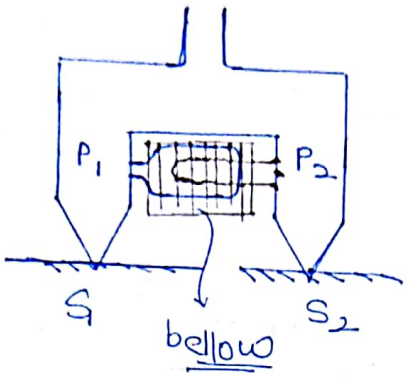


Measuring heads are designed according to the Geometry of work.

Rotameter tube is slightly taper to have linearity in measurement

Float of there are aerofoil blades so that it rotate all the time Otherwise it will come in contact with the rotameter tube and due to static friction makes the ~~rotater~~ rotameter insensitive for smaller change in diameter

② Differential type :-



Used when one surface is above and one is below

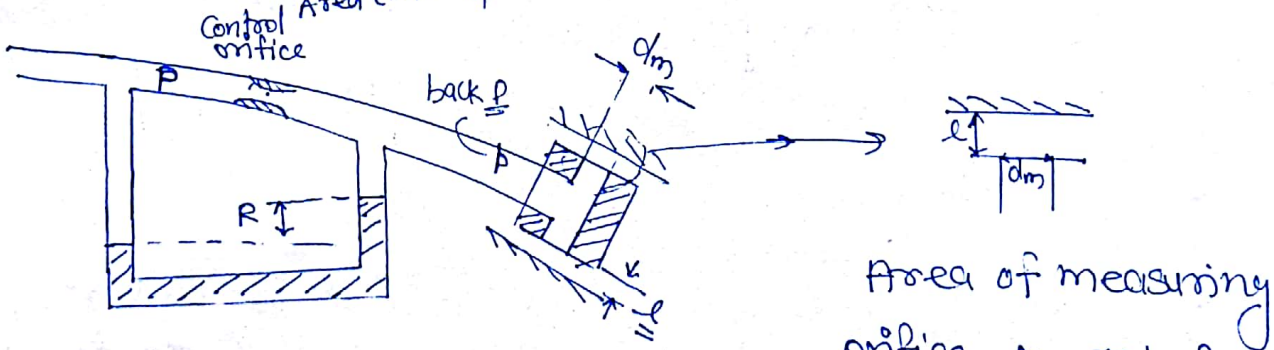
P_1 & P_2 → back pressure

→ This type of comparator is used to compare two surface i.e. which surface is higher and which is lower.

→ Two back pressure steams goes inside bellow but doesn't mix with each other. By looking at the position of bellow from neutral it can be known that which surface is higher & which is surface is lower.

③ Back pressure type :—

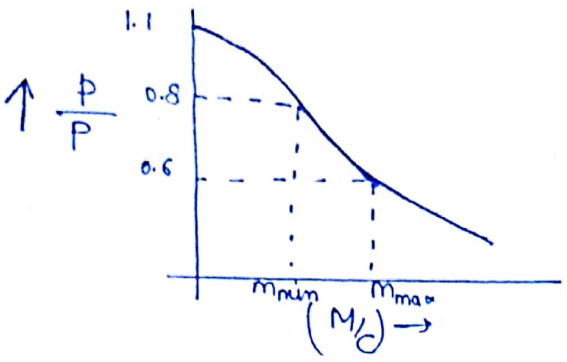
C.O.A. $= \frac{\pi}{4} d_c^2 = C$



Area of measuring orifice $M = \pi d_m l$

$C = \frac{\pi}{4} d_c^2$, $M = \pi d_m l$

So back P ← $\boxed{\frac{P}{P} = A - b\left(\frac{M}{C}\right)}$ Characteristic eqn



$$\frac{p}{P} = A - b\left(\frac{M}{C}\right)$$

$A = 0$ ~~$A = 0$~~ $\quad A = 1.1$

$$0.6 = 1.1 - \frac{b}{C} M_{max}$$

$$0.8 = 1.1 - \frac{b}{C} M_{min}$$

$$\Rightarrow \frac{b}{C} M_{max} = 0.5 \quad , \quad \frac{b}{C} M_{min} = 0.3$$

Devide both $\quad \frac{M_{max}}{M_{min}} = \frac{5}{3}$

Now

$$\frac{M_{max}}{M_{min}} - 1 = \frac{5}{3} - 1$$

and

$$\frac{M_{max}}{M_{min}} + 1 = \frac{5}{3} + 1$$

$$\text{Range} = M_{max} - M_{min} = \frac{2}{3} M_{min}$$

$$M_{max} + M_{min} = \frac{8}{3} M_{min}$$

$$R = \frac{2}{3} M_{min}$$

$$M_{avg} = \frac{4}{3} M_{min} = 2(\text{Range})$$

$$M_{av} = 2R$$

$$\Rightarrow \frac{p}{P} = A - \frac{b}{C} M$$

only p (back Pre) change so differentiate it

$$\frac{dp}{dM} = -\frac{b}{C} P$$

$$0.6 = 1.1 - \frac{b}{C} M_{max}$$

$$0.8 = 1.1 - \frac{b}{C} M_{min}$$

take avg both side.

$$\Rightarrow \quad 0.7 = 1.1 - \frac{b}{c} M_{avg.}$$

$$\frac{b}{c} = \frac{0.4}{M_{av.}}$$

$$\boxed{\frac{dP}{dM} = -\frac{0.4P}{M_{avg}}}$$

Pneumatic Sensitivity

Sensitivity of pneumatic comparator is better when total pressure is high but higher pressure require large size manometer which may not be suitable for ergonomics point of view.

Smaller total pressure generates a weak signal and before signal reaches manometer it will be lost due to compressibility of air

$$\text{mag. factor} = \frac{\text{output}}{\text{input}}$$

$$= \frac{dR}{dl}$$

$$\text{magnification factor} = \underbrace{\frac{dR}{dP}}_{\text{indicator sensitivity}} \times \frac{dP}{dM} \times \underbrace{\frac{dM}{dl}}_{\text{measuring head sensitivity}}$$

$$M = \pi d m \ell$$

$$\frac{dM}{dl} = \pi d m$$

Question The characteristic eqn of ~~pen~~ pneumatic comp comparator is given $\frac{p}{P} = 1.1 - 0.5\left(\frac{M}{C}\right)$

diameter of control & measuring orifice are $d_c = 0.5$ mm $d_m = 1$ mm if indicator sesitivity $\frac{dR}{dP} = 30 \frac{mm}{KN/m^2}$ and the total pressure $P = 3$ bar. Calculate

(i) linear range of equipment = 0.025 mm

(ii) overall magnification factor = 72,000

Soln $\frac{p}{P} = 1.1 - 0.5\left(\frac{M}{C}\right)$

$\frac{dp}{dM} = -0.5\frac{P}{C}$

$\frac{dP}{dM} = -0.5 \times \frac{3\times10^5 \times 4}{\pi(0.5)^2 \times}$

Range $R = \frac{2}{3} M_{min}$

$\frac{b}{C} M_{min} = 0.3$

$\frac{0.5 M_{min}}{\frac{\pi}{4}(0.5)^2} = 0.3$

$M_{min} = 0.117$

$\frac{dR}{dl} = \frac{dR}{dP} \times \frac{dP}{dM} \times \frac{dM}{dl}$

$M = \pi d_m l$

$\frac{dM}{dl} = \pi d_m$

$= \frac{30}{1000} \times \frac{0.5\times3\times10^5\times4}{\pi(0.5)^2} \times \pi \times (1)$

$\frac{dR}{dl} = 72,000$ Ans