Similarly, other device known as an accelerometer is an instrument to measure the accelerometer with high natural frequency. So vibrometer is known as low frequency transducer and accelerometer as high frequency transducer.

Vibrometer:-

Consider equation

$$\frac{Z}{B} = \frac{(\omega/\omega_n)^2}{\sqrt{\left[1-\left(\frac{\omega}{\omega_n}\right)^2\right]^2 + \left(2\varepsilon\frac{\omega}{\omega_n}\right)^2}}$$

assume $\frac{\omega}{\omega_n} = r$

$$\frac{Z}{B} = \frac{r^2}{\sqrt{\left[1-r^2\right]^2 + \left[2\varepsilon r\right]^2}}$$

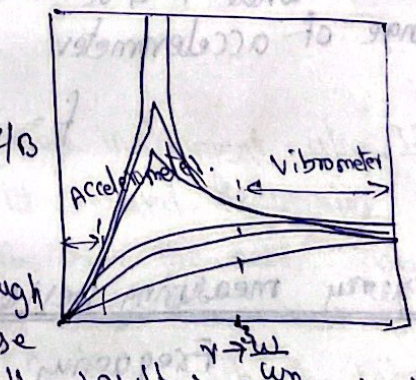
we have plotted the characteristic of this equ

$2\varepsilon r$ very small term.

when the value of r is very high (more than 3), the above equation.

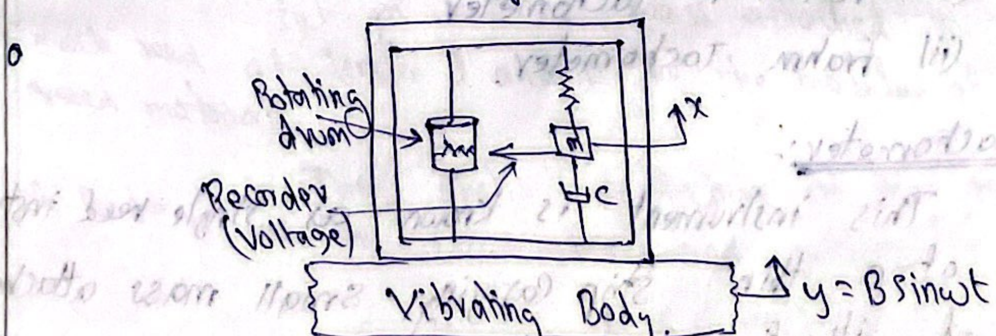
$$\frac{Z}{B} = \frac{r^2}{\sqrt{(1-r^2)^2}} \simeq 1$$

$$Z = B..$$



So the relative amplitude Z is shown equal to the amplitude of vibrating body B on the screen. Through Z and B are not in the same phase but B being in single harmonic, will result in the output signal as true reproduction of input quantity.

For large values of ω/ω_n r the ratio $\frac{Z}{B}$ approaches unity for every value of damping.



- Vibrometer for very large value of r.
- Vibrometer known as low frequency transducer is used to measure the high frequency ω of a vibrating body. Since the ratio r is very high so the natural frequency of the instrument is low.
- Low natural frequency means heavy mass of the body of the instrument which makes its rare application in practice specially in systems.
- It may have natural frequency 1 Hz to 5 Hz.

Accelerometer :-

An accelerometer is used to measure the acceleration of a vibrating body. If the natural frequency ω_n of the instrument is very high compared to the frequency ω which is to be measured, the ratio ω/ω_n (r) is very small.

$$\frac{Z}{B} = \left(\frac{\omega}{\omega_n}\right)^2 f$$

$$Z = \frac{\omega^2 B}{\omega_n^2} f.$$

where f is a factor which remains constant for the useful range of accelerometer

$$f = \frac{1}{\sqrt{(1-r^2)^2 + (2\xi r)^2}}$$

Frequency measuring Device

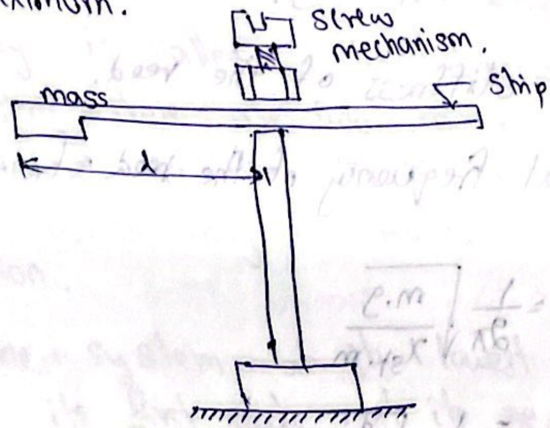
Frequency measuring instruments is based on the principle of resonance. At resonance, the amplitude of vibration is found to be maximum and then the excitation frequency is equal to the natural frequency of the instrument.

(i) Fullarton Tachometer.

(ii) Frahm Tachometer.

Fullarton Tachometer :-

This instrument is known as single reed instrument. It consists of a thin strip carrying small mass attached at one of its free ends. The strip is treated as a cantilever the length of which is changed by means of a screw mechanism. The strip of the instrument is pressed over the vibrating body to find its natural frequency. We go on changing the length of the strip till amplitude of vibration is maximum.



Frequency measuring device.

At the instant, the excitation frequency equals the natural frequency of cantilever strip, which can be directly seen from the strip itself. The strip has directly seen from the strip itself. The strip has different frequencies for its different lengths.

The natural frequency can be determined with the help of this formula

$$f_n = \frac{1}{2\pi}\sqrt{\frac{3EI}{l^3 m}}\ Hz.$$

Frahm Tachometer:-

This is known as multi reed instrument also. It consists of several reeds of known different natural frequencies. There may be a known series of frequencies for the reeds. Small difference in the frequencies of successive reeds will show more accurate results. The instrument is brought in contact with the vibrating body whose frequency is to be measured and one of the reeds will be having maximum amplitude and hence that reed will be showing the frequency of the vibrating body.

Let m be the mass attached to the end of each reed of length l and E be the modulus of elasticity of the reed material.

The static deflection of the reed considering it to be a cantilever fixed at one end

$$x_{st} = \frac{mgl^3}{3EI}$$

where, $I = \frac{bd^3}{12}$

= moment of inertia of the reed about the base

$$K.x_{st} = mg.$$

K = stiffness of the reed.

So natural frequency of the reed = $f_n = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

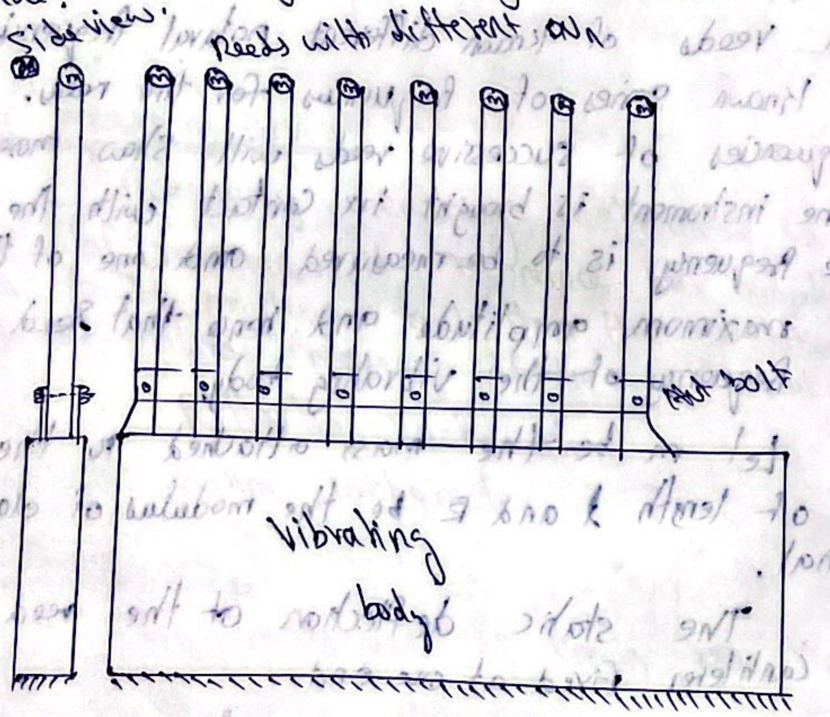
$$f_n = \frac{1}{2\pi}\sqrt{\frac{m.g}{x_{st}.m}}$$

$$= \frac{1}{2\pi}\sqrt{\frac{g}{x_{st}}}$$

$$= \frac{1}{2\pi}\sqrt{\frac{g.3EI}{mgl^3}} = \frac{1}{2\pi}\sqrt{\frac{3EI}{ml^3}}\ Hz.$$

Thus by having different values of mass 'm' or length 'l' of the reed we can have a series of reeds with definite known frequencies.

The one which has a frequency equal to the natural frequency of the vibrating body, vibrates with a large amplitude. Thus the frequency of the vibrating body can be determined easily by knowing the reed with maximum amplitude.



The accuracy of the instrument depends upon the difference between the value of the ω_n of successive reed.