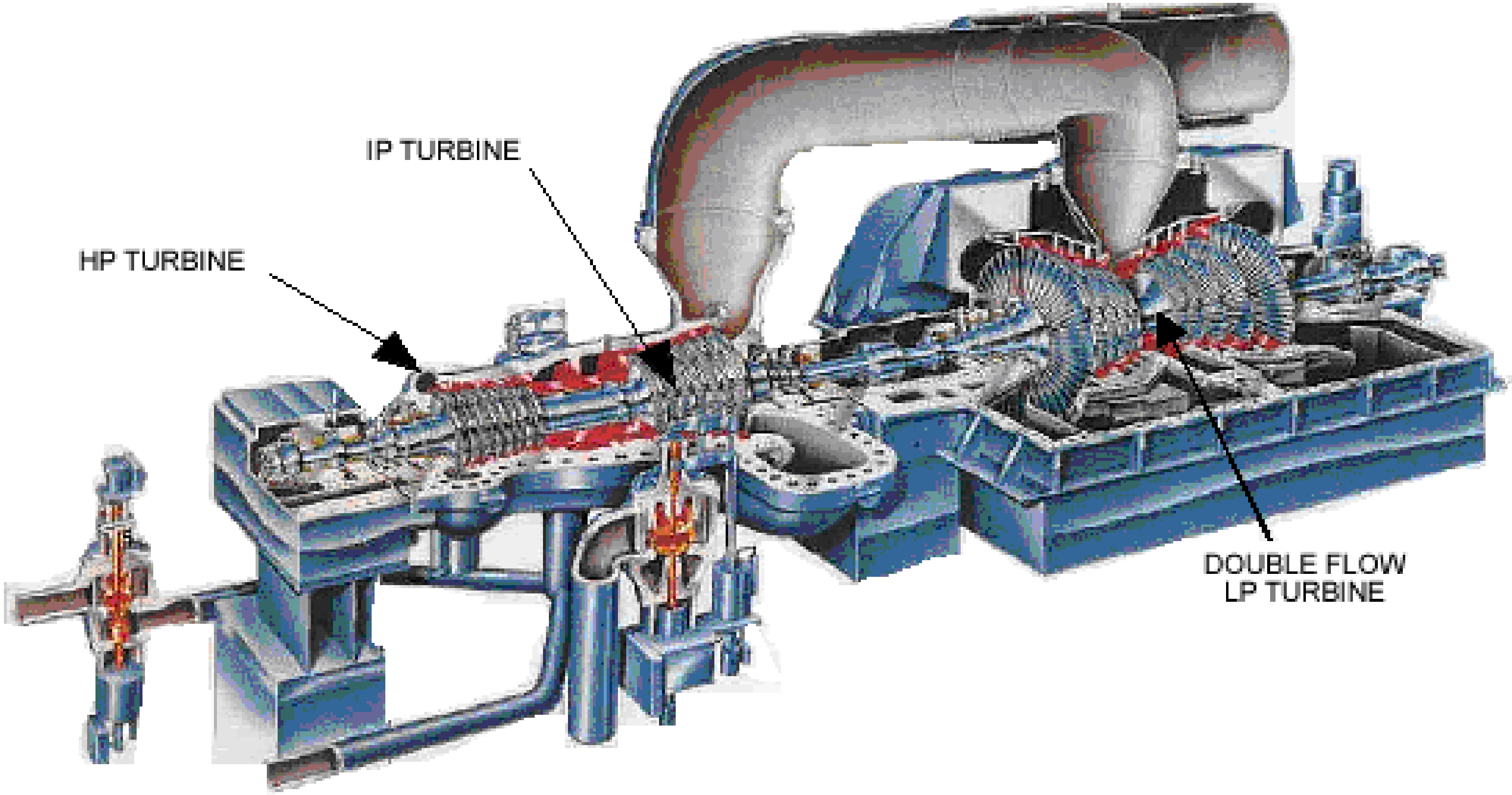
TRAINING MANUAL ON
BASIC ASPECTS OF
STEAM TURBINE MAINTENANCE



TURBINE FLEET IN NTPC

Steam Turbines of Following OEM,s are running in NTPC

- LMZ (Russia)
- KWU, Siemens (Germany)
- ABB-Alstom (Germany)
- GEC- Alstom (U.K)
- SKODA, (Chezkoslovakia)
- MHI (Japan)
- GE (USA)
- ANSALDO (Italy)

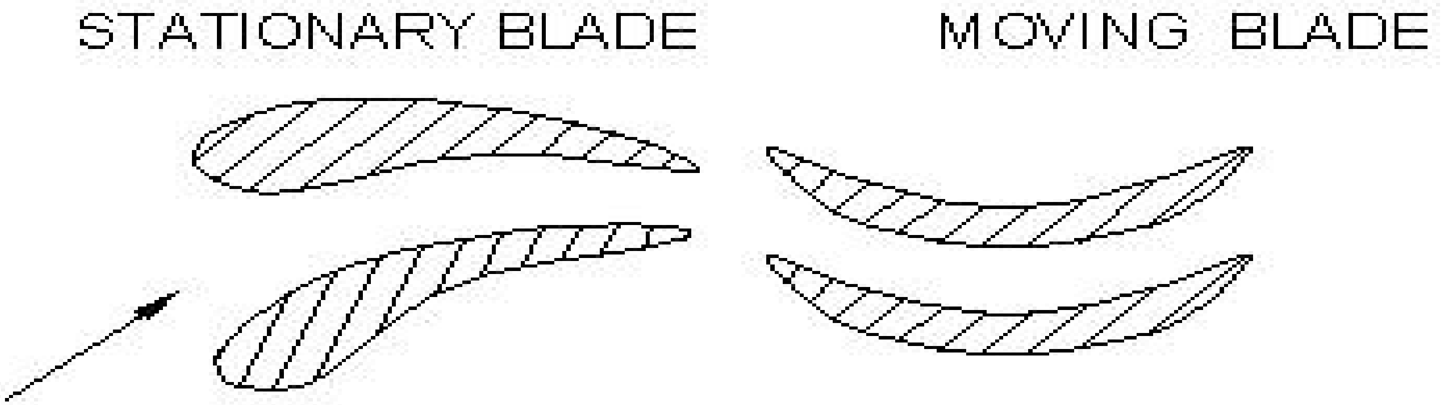
WORKING OF STEAMTURBINE

- A steam turbine works on the principle of conversion of High pressure & temperature steam into high Kinetic energy , thereby giving torque to a moving rotor.
- For above energy conversion there is requirement of converging /Converging-Diverging Sections
- Such above requirement is built up in the *space between two consecutive blades* of fixed and moving blades rows.

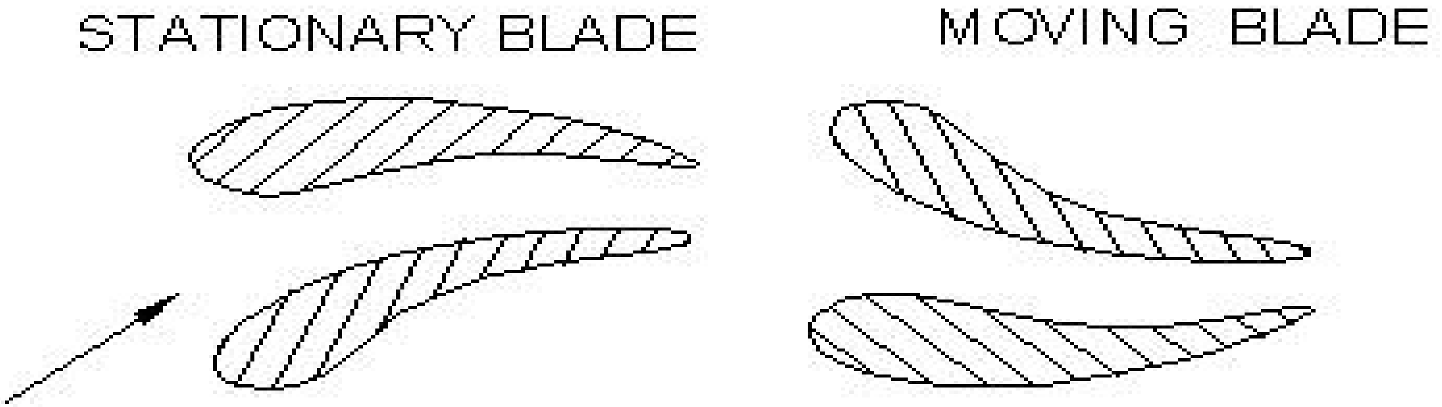
TYPE OF TURBINE

- IMPULSE TURBINE = In a stage of Impulse turbine the pressure/Enthalpy drop takes place only in Fixed blades and not in the moving blades

- REACTION TURBINE = In a stage of Reaction Turbine the Pressure/enthalpy drop takes place in both the fixed and moving blades.



IMPULSE STAGE



REACTION STAGE

- DEGREE OF REACTION=

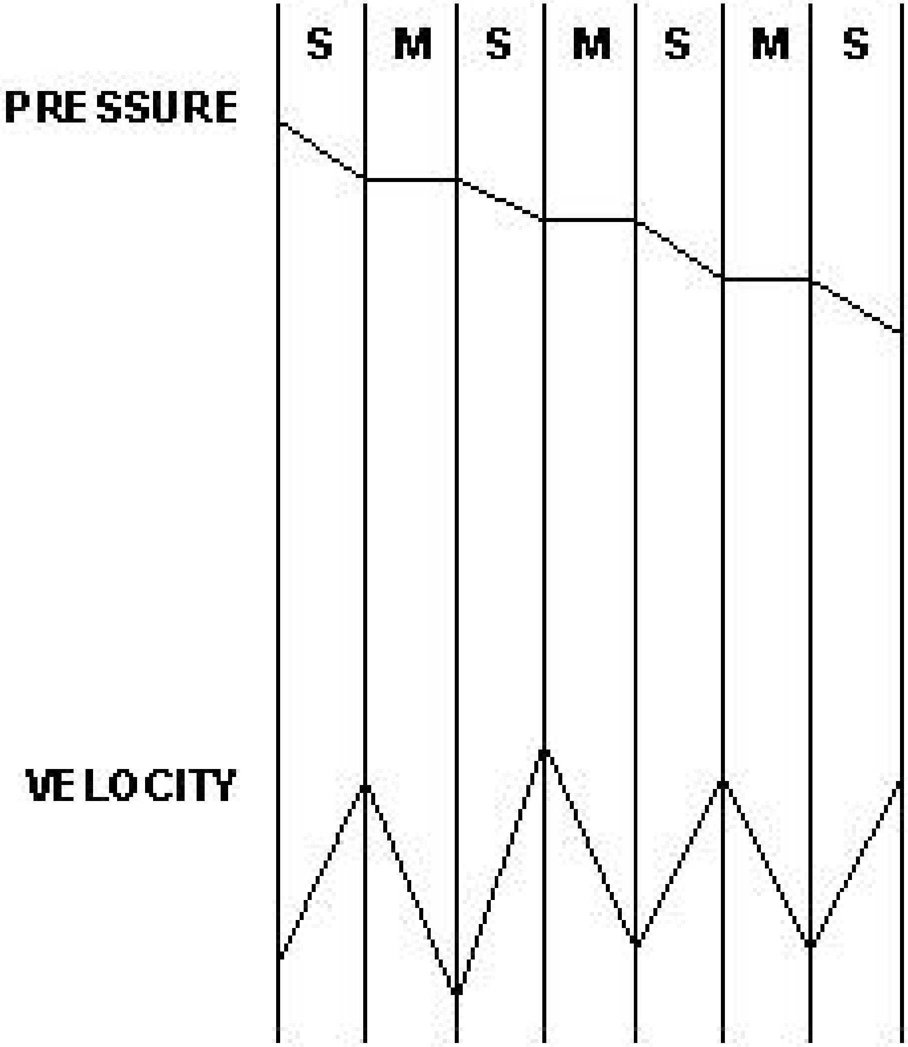
(Heat drop in Moving stage)
____

- (Heat drop in moving blade + Heat drop in fixed blade)
- In impulse stage ,degree of reaction is O
- Single stage impulse turbine is called as *De-laval* Turbine.
- Series of impulse stages is called as *Rateau* Turbine
- Double Stage Velocity Compounded impulse turbine is called as *Curtis* Stages
- 50% Reaction turbine is called as *Parson* Turbine
- Practically the degree of reaction of a stage can be *0 - 60%* over the different stages of a turbine

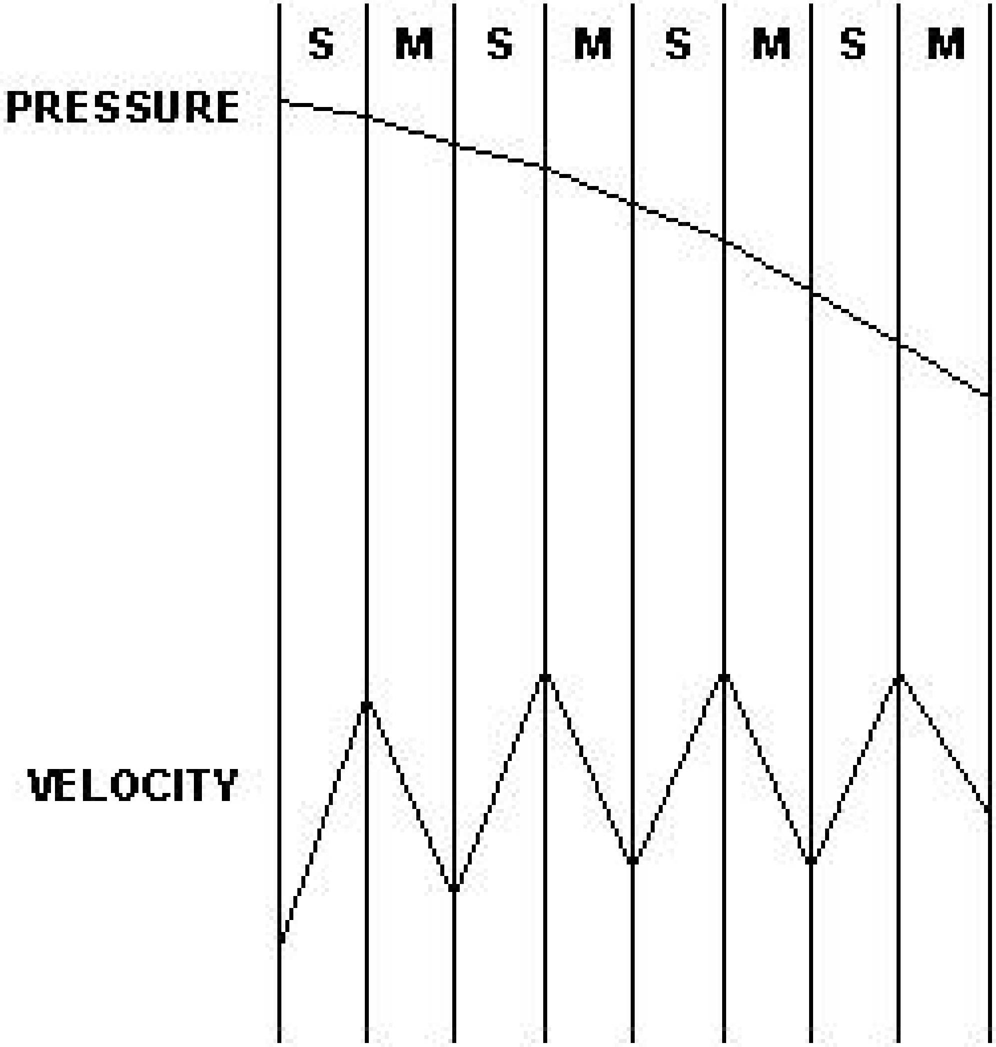
Velocity Compounded Turbines Here the High temperature, Pressure Steam is expanded in a single row of fixed blades into very high velocity which is then fed to 2 or 3 rows of moving blades with one each guide/turning row placed in between the two moving stages.

Pressure compounding Turbines Here the pressure is dropped in stages and employs low velocity of Steam in each stage. Each stage consists of Fixed blade(nozzles) and moving blades .

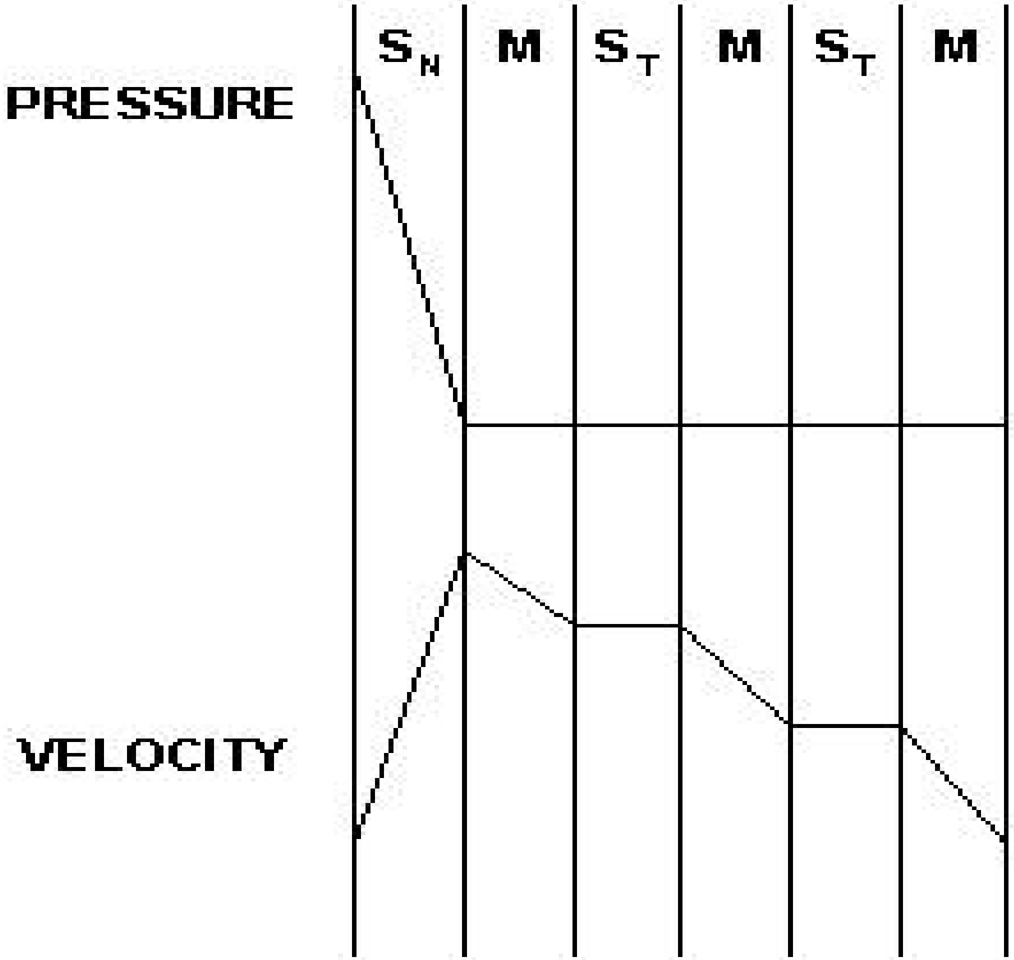
PRESSURE COMPOUNDING IMPULSE



PRESSURE COMPOUNDING REACTION



VELOCITY COMPOUNDING



S_N = STATIONARY NOZZLE

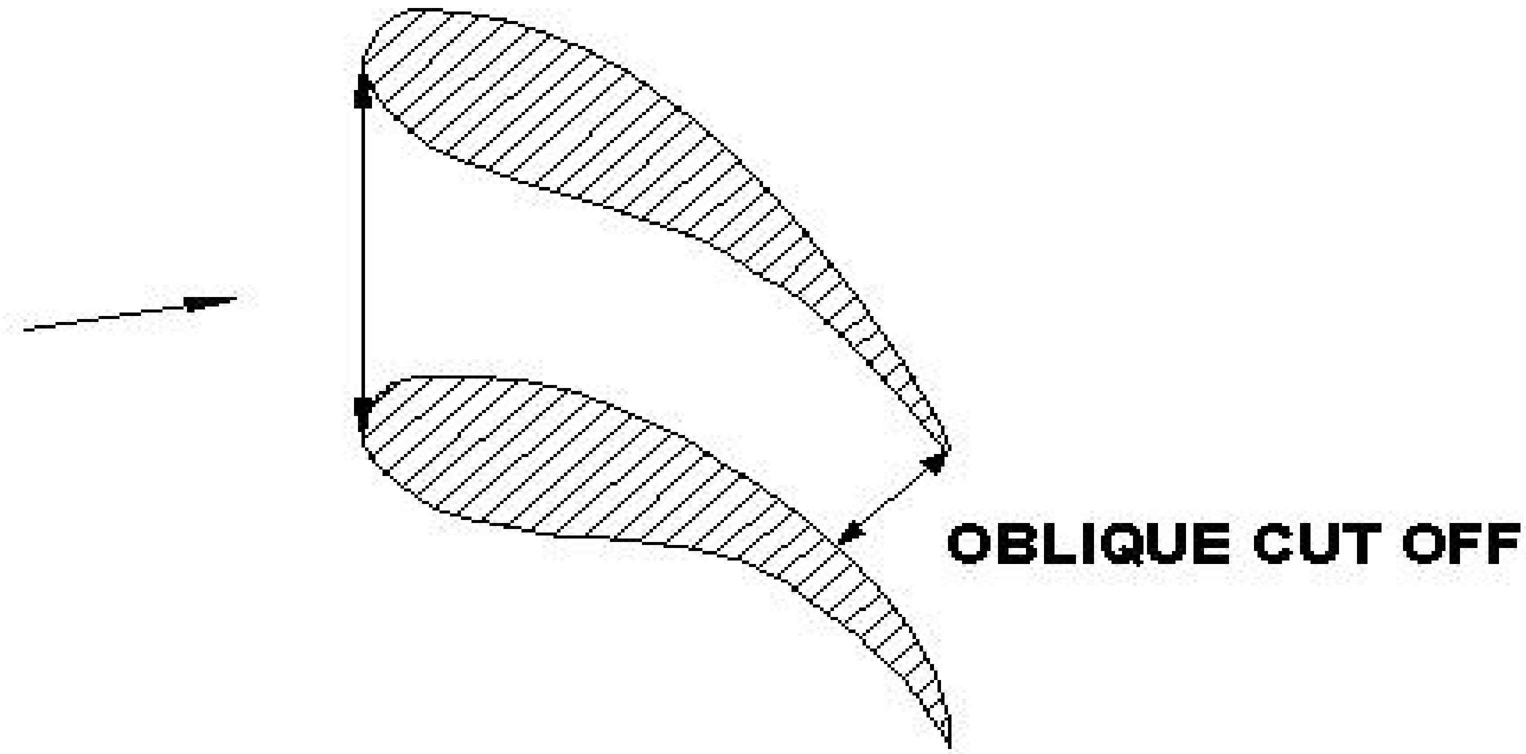
M = MOVING

S_T = STATIONARY TURNING

- All the Steam turbines in NTPC are PRESSURE COMPOUNDED ,Except the 110 MW Skoda make steam Turbine at Tanda ,Muzaffarpur and Talcher ,where two stage Velocity compounding impulse rows are there at the inlet of HP Turbine.

- The LMZ Turbines of 210 MW has one pure impulse in the first stage which is also the controlling stage.

SUPERSONIC CONDITION IN CONVERGENT NOZZLE



LOSSES IN STEAM TURBINE

- Friction losses
- Leakage losses
- Windage loss(More in Rotors having Discs)
- Exit Velocity loss
- Incidence and Exit loss
- Secondary loss
- Loss due to wetness
- Loss at theBearings(appx 0.3% of total output)
- Off design losses

MAIN LOSSES IN TURBINE

FRICTION LOSS It is more in Impulse turbines than Reaction Turbines,because impulse turbines uses high velocity of steam and further the flow in the moving blades of the Reaction turbines is accelerating which leads to better and smooth flow(Turbulent flow gets converted to Laminar flow)

LEAKAGE,S LOSS It is more in Reaction turbines than Impulse turbines because there is Pressure difference across the moving stage of reaction turbines which leads to the Leakages. In Impulse turbine such condition is not there.

- Leakage loss predominates over friction losses in the High Pressure end of the Turbine
- Friction Losses predominates over the Leakage's Loss in the Low Pressure end of the Turbine.
- It is observed that the Efficiency of The IP Turbine is the maximum followed by The HP and LP Turbine .

- LMZ Turbines are more impulse in nature
- KWU Turbines are more reactive in nature
- Sparing Rateau and Curtis stages, all other stages of turbine is a mixture of Impulse and Reaction with varying degree of reaction.
- Pressure/Enthalpy drop is more in Impulse stage than in reaction.
- Comparatively Reaction Blade is more efficient than the Impulse blade.
- Impulse turbine requires fewer no. of stages than reaction turbine for same condition of steam and power requirement.

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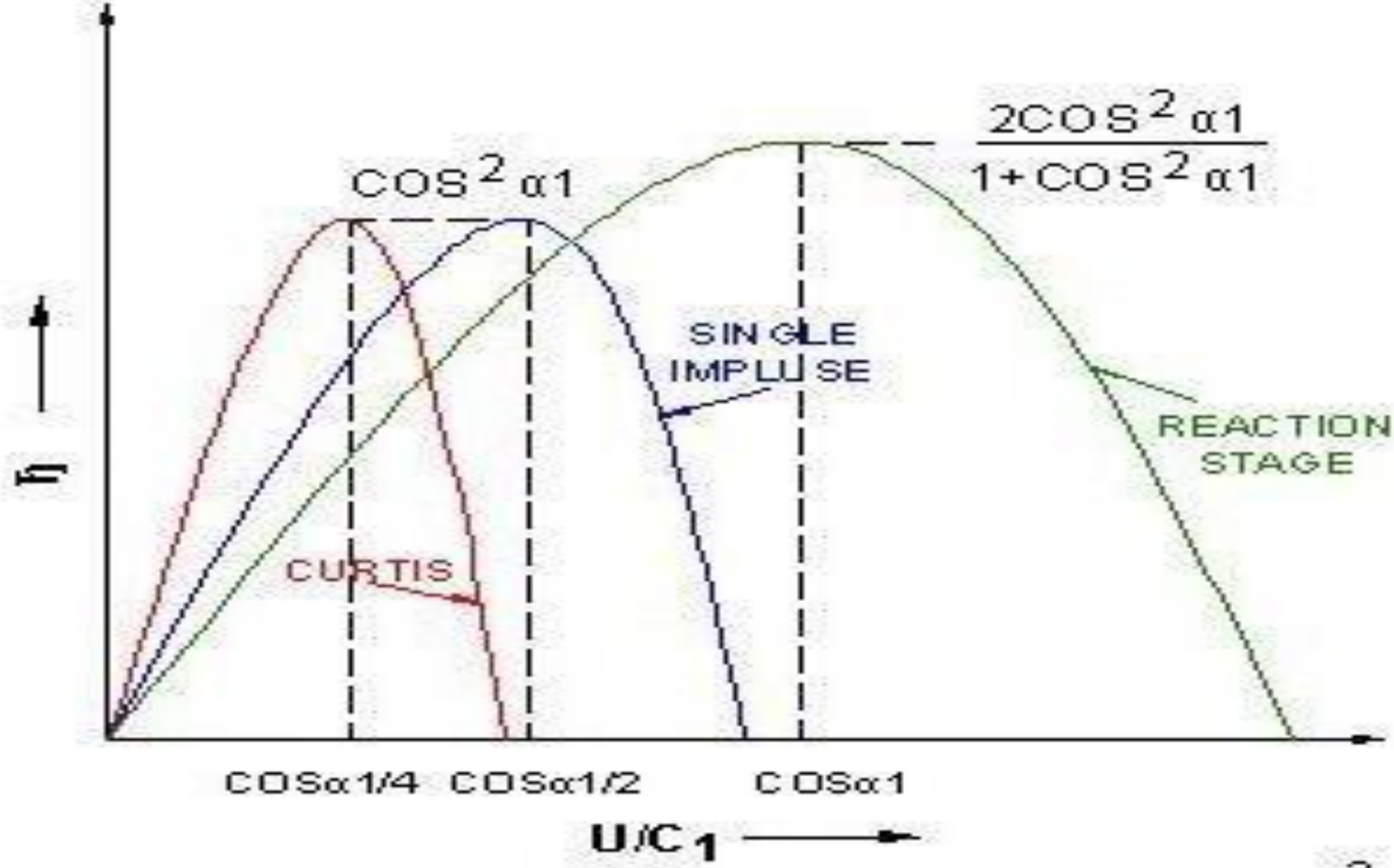
RELATION BETWEEN ῃ, U & C1



OPTIMUM WORKDONE IN SINGLE INPULSE STAGE = $2U^2$

CURTIS STAGE = $8U^2$

REACTION STAGE = U^2

ῃ = EFFICIENCY

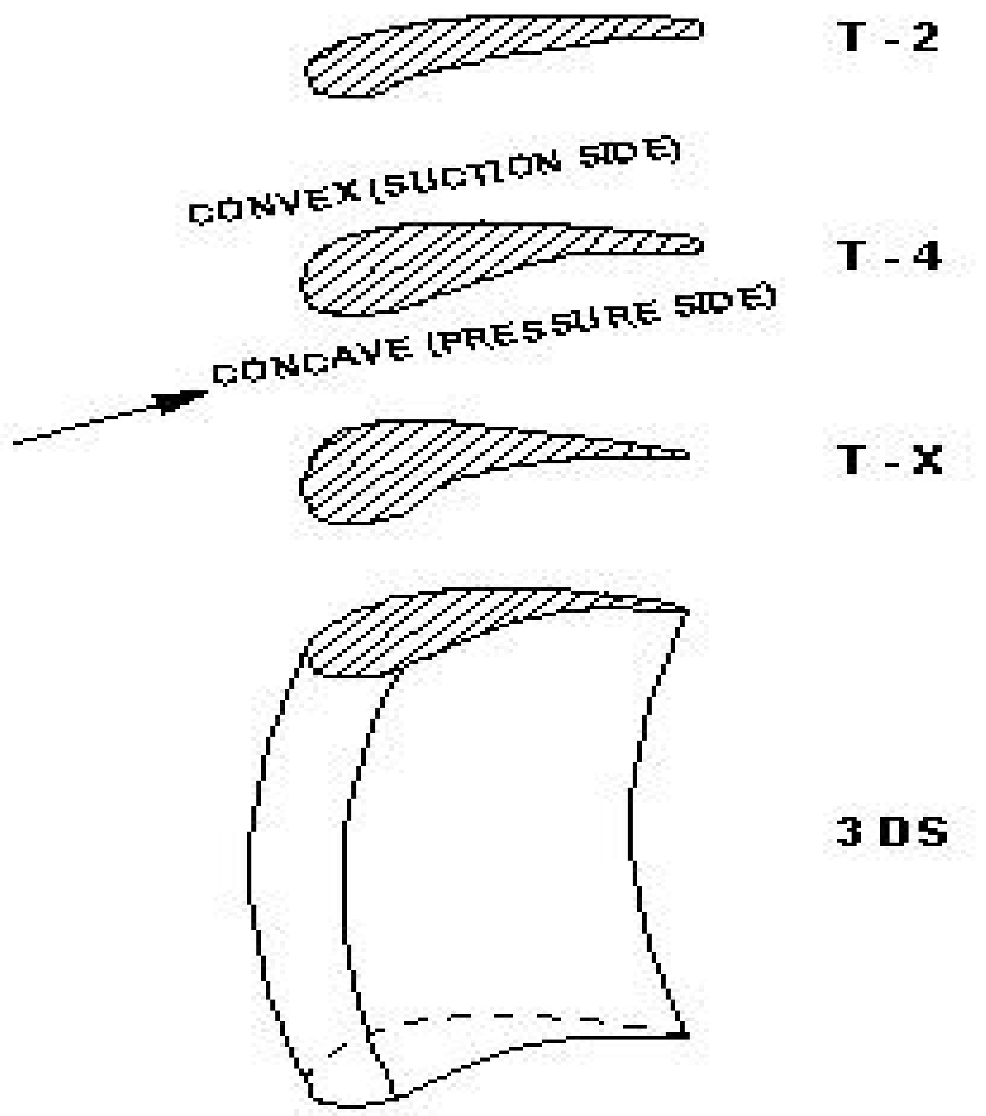
U = TANGENTIAL SPEED OF ROTOR

C_1 = ABSOLUTE VELOCITY OF STEAM

MODIFICATIONS IN THE BLADES IN TERMS OF EFFICIENCY

- T2 It is comparatively flat blade with thinner inlet
- T4 It is More Curved and thicker inlet
- Tx More Curved, thicker inlet but thinner outlet
- 3DS Three Dimensional with reduction in secondary losses

EVOLUTION OF BLADING



LUBRICATION

Turbine bearings are hydro dynamically Lubricated. For this to happen following things are important

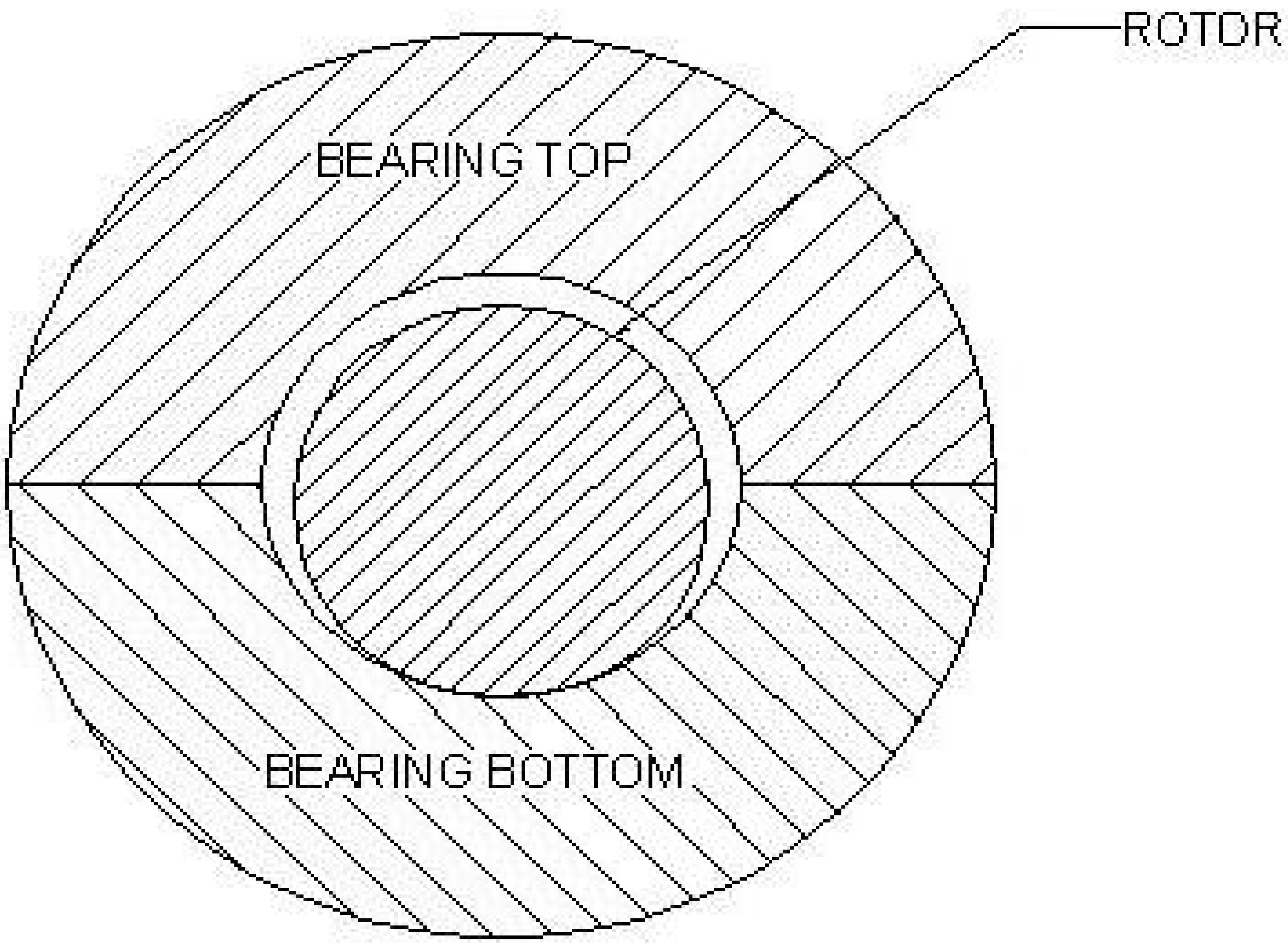
1. Viscosity of oil which is directly related to the oil Temperature.
2. Rotation/speed of the Rotor.
3. Desired Clearances/Converging Wedge in the Bearings. (convergence should be in the direction of rotation)

In fact the Pressure of the Lube oil is mainly just to ensure that oil reaches the Bearing. However it is also very important and requires to be maintained as per design.

LUBRICATION

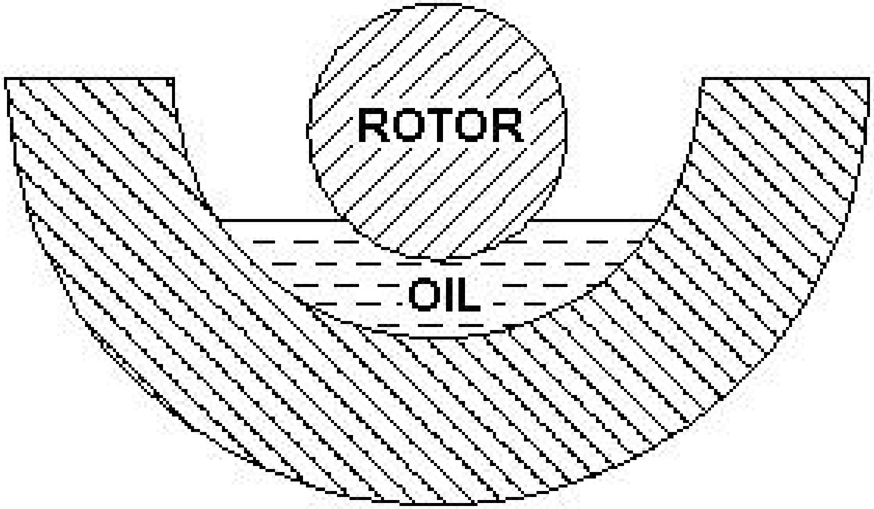
- As rotor rotates at low speed ,initially there is no film lubrication but as its speed increases there is conversion of boundary layer lubrication into Film lubrication.
- From zero speed to appx. 540 RPM there is no continuos film between rotor and bearings and there is chance of rubbing between rotor and Bearing. Therefore JOP is used to prevent the contact between rotor and bearings.
- At Above 540 RPM the JOP can be Switched off, as film lubrication comes into picture.

LUBRICATION

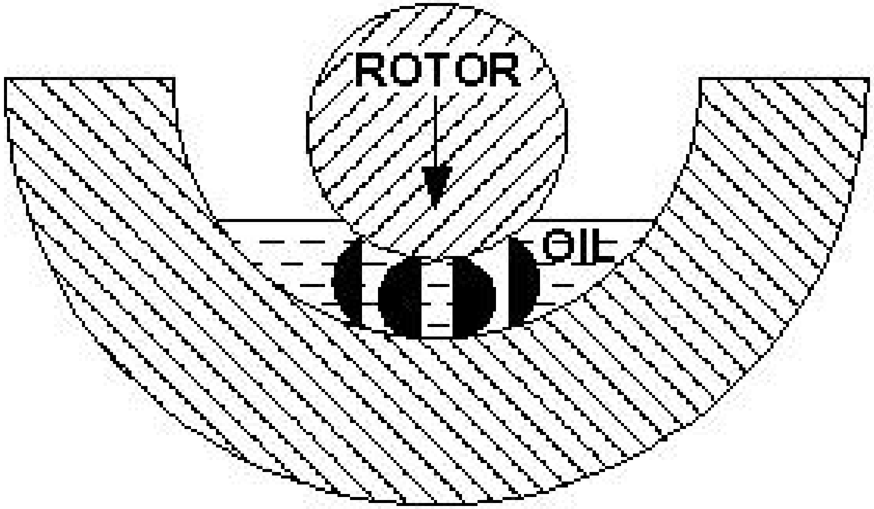


STAND STILL CONDITION

LUBRICATION

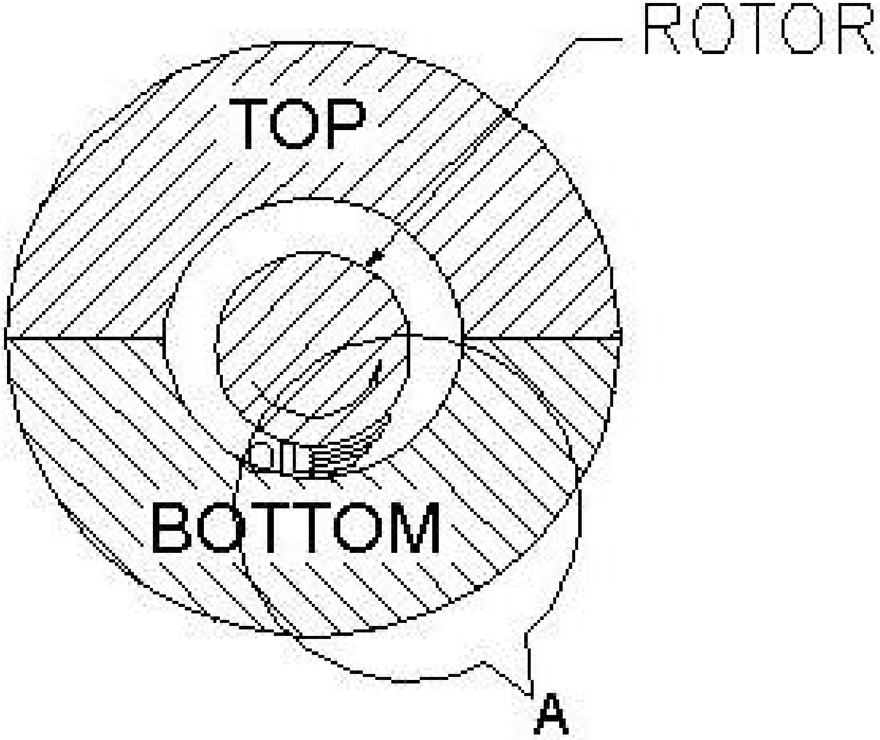


BEARING BOTTOM

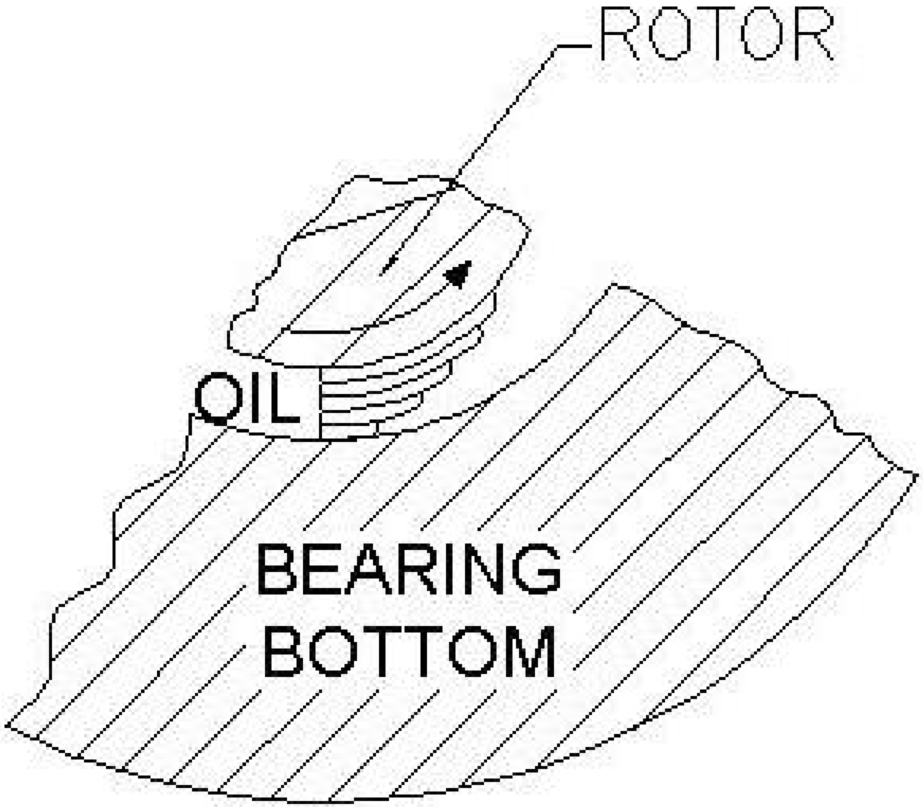


BEARING BOTTOM

LUBRICATION

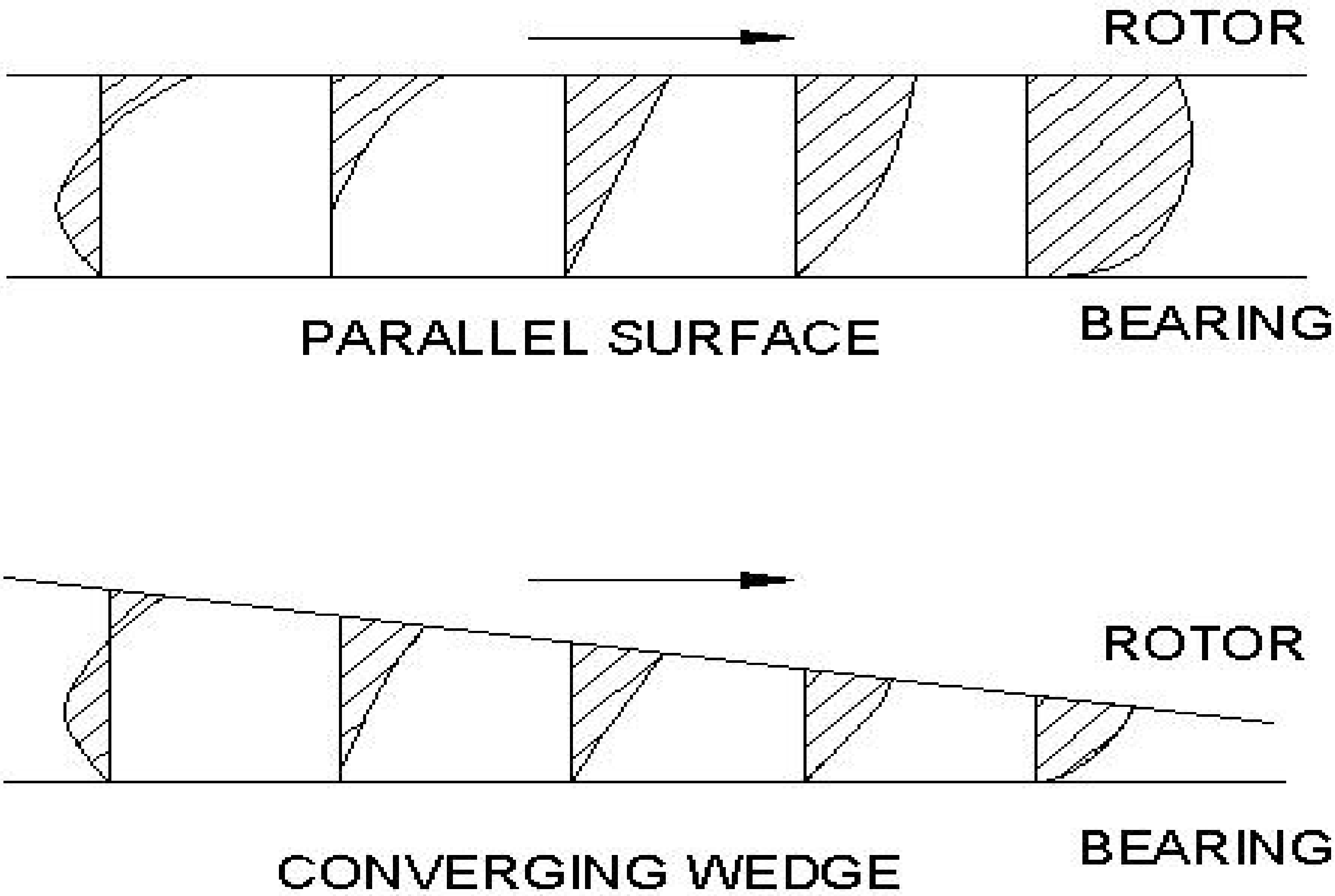


ROTOR IN MOTION



VIEW 'A'

BEARING LUBRICATION



- It is to be noted that when the surfaces are parallel the volume flow rate at inlet is less than the outlet flow rate and film can,t sustain.
- Therefore for a stable film, area needs to be convergent to ensure equal volume flow throughout the length.
- The minimum clearance depends upon following

- Viscosity of oil

- Speed of Rotor

- Load on the rotor

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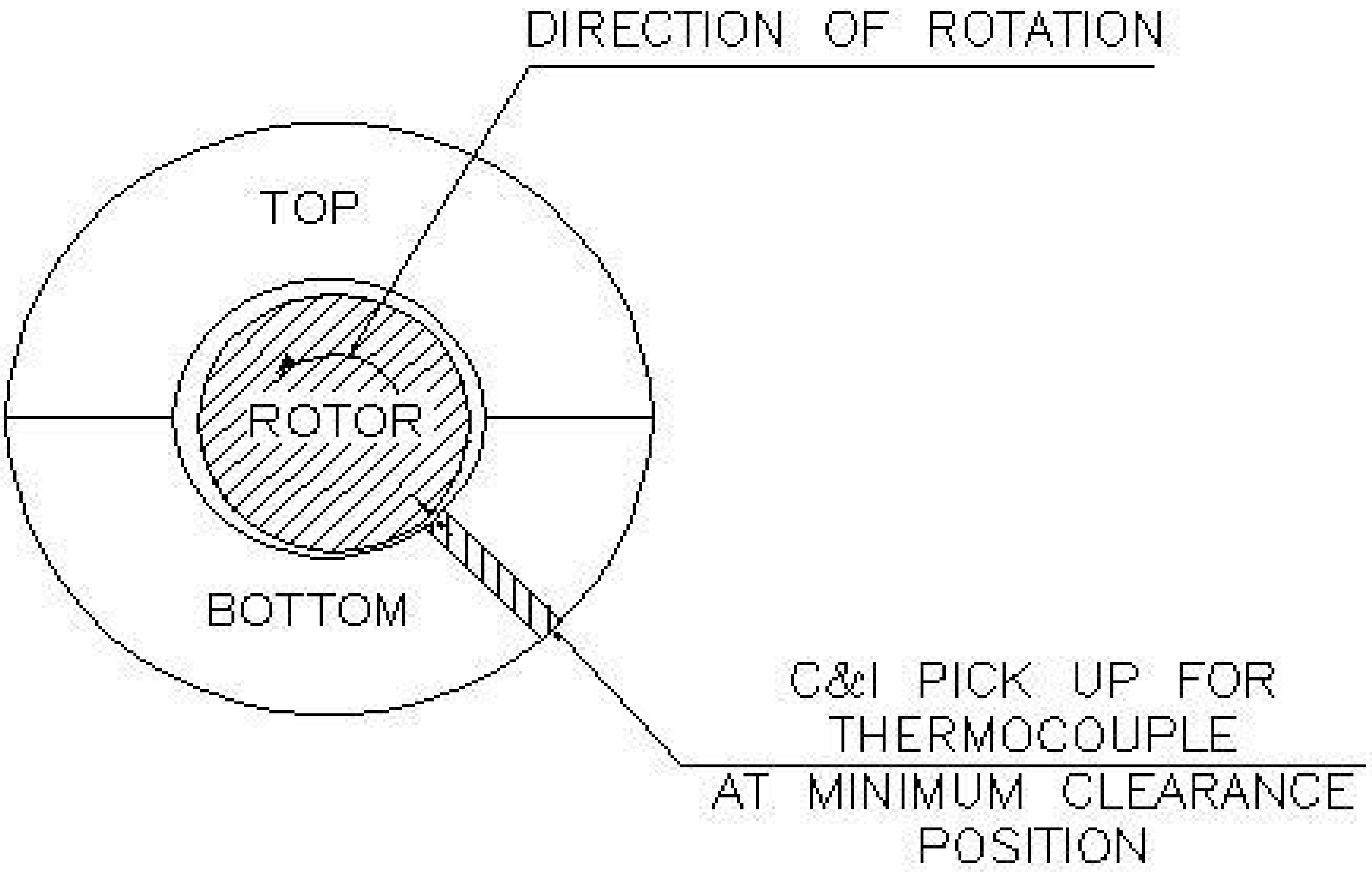
FINAL POSITION OF ROTOR IN THE BEARING



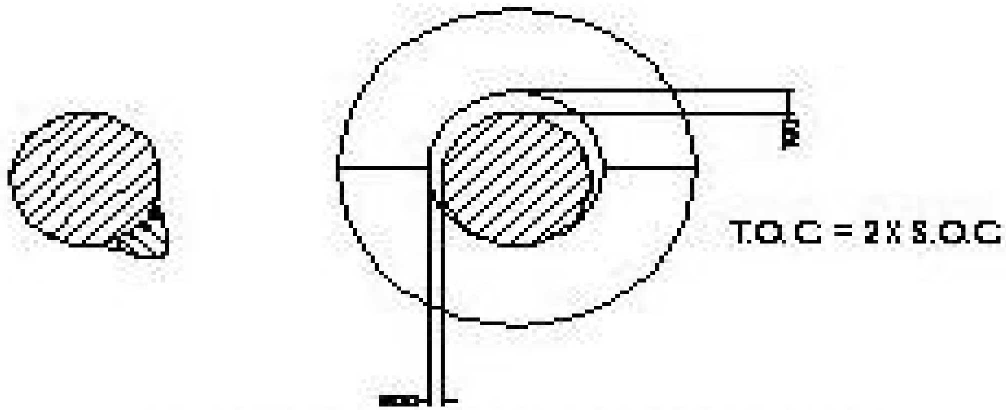
TYPE OF BEARINGS

- Cylindrical Bearing(Single wedge ring)
  This has single oil inlet

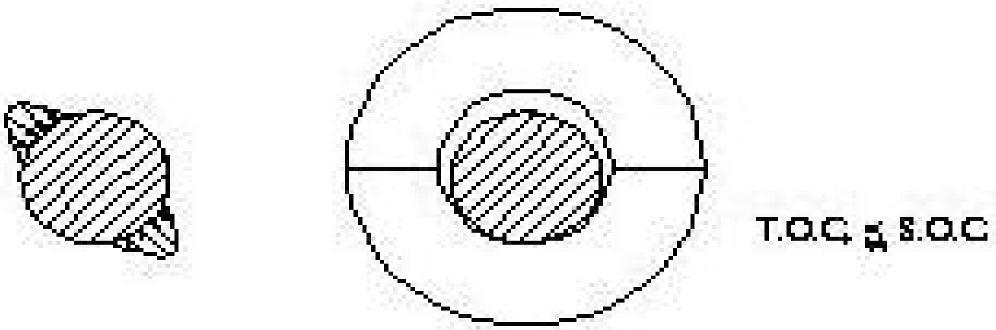
- Elliptical Bearing(Double wedge bearing)
  This has double oil inlet

- Segment Bearing(Multi wedge Bearing)

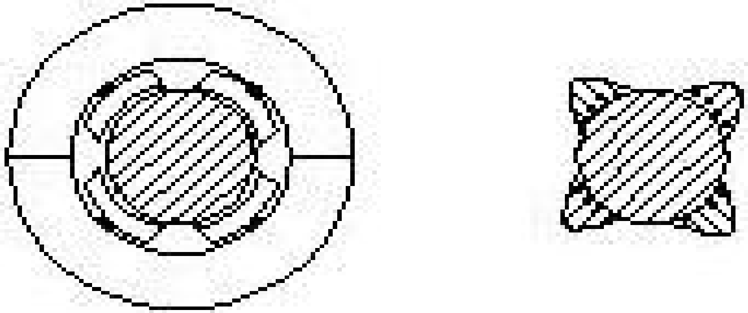
TYPES OF BEARING



CYLINDERICAL BEARING (SINGLE WEDGE)



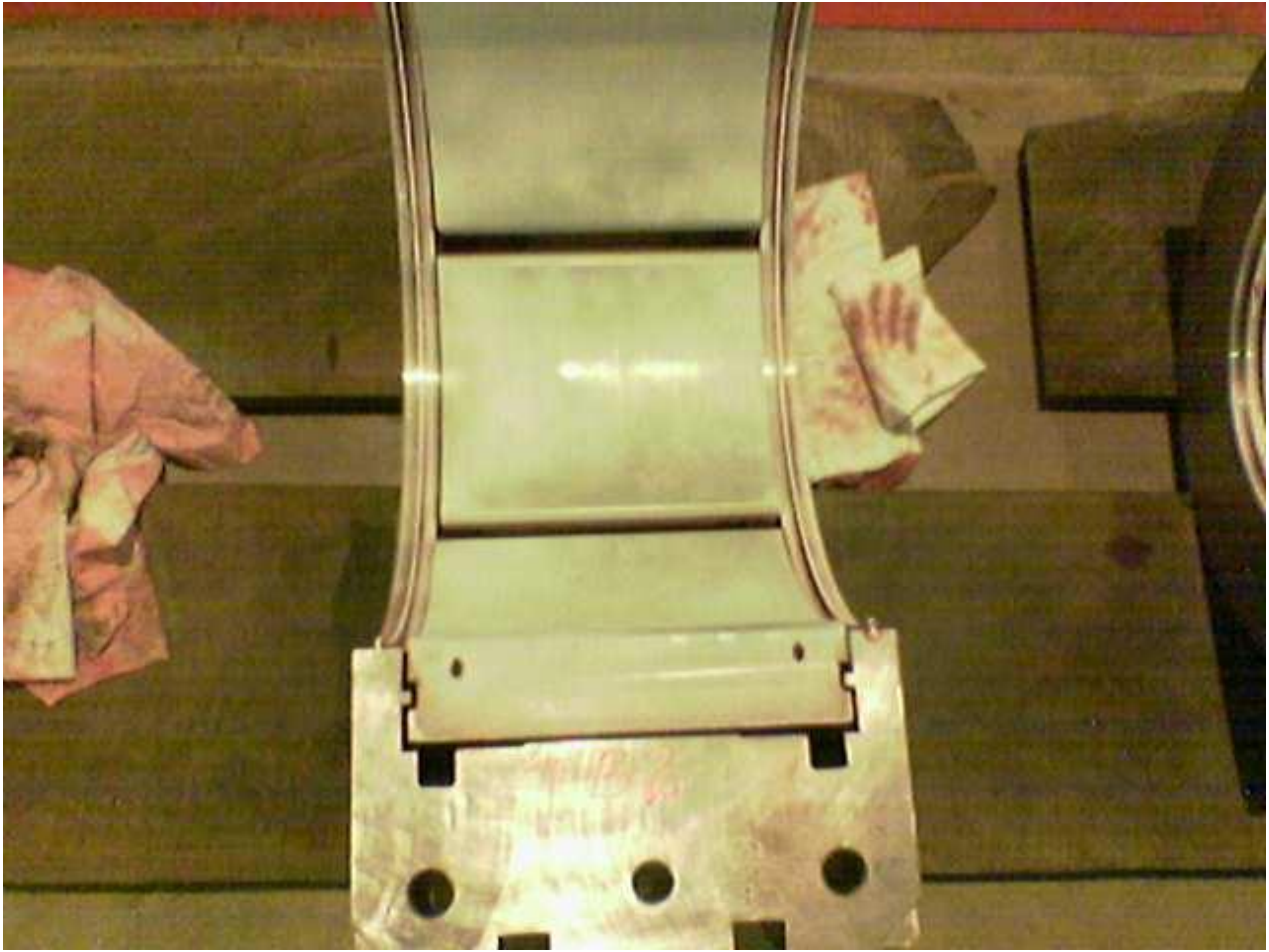
ELLIPTICAL BEARING (DOUBLE WEDGE)



MULTI SEGMENT BEARING (MULTI WEDGE BEARING

BEARINGS

- Cylindrical bearings are normally used for system where no transients are envisaged particularly in turbines without controlling stage, whereby one side radial impulse due to steam forces is not there.
- Multi wedge bearings are used by installing bearings in segments . Each Segment will have its own wedge.
- Multi wedge bearings can take more load ,can dampen the sudden disturbance on shaft and there is no formation of Oil Whirl and low frequency vibration components.



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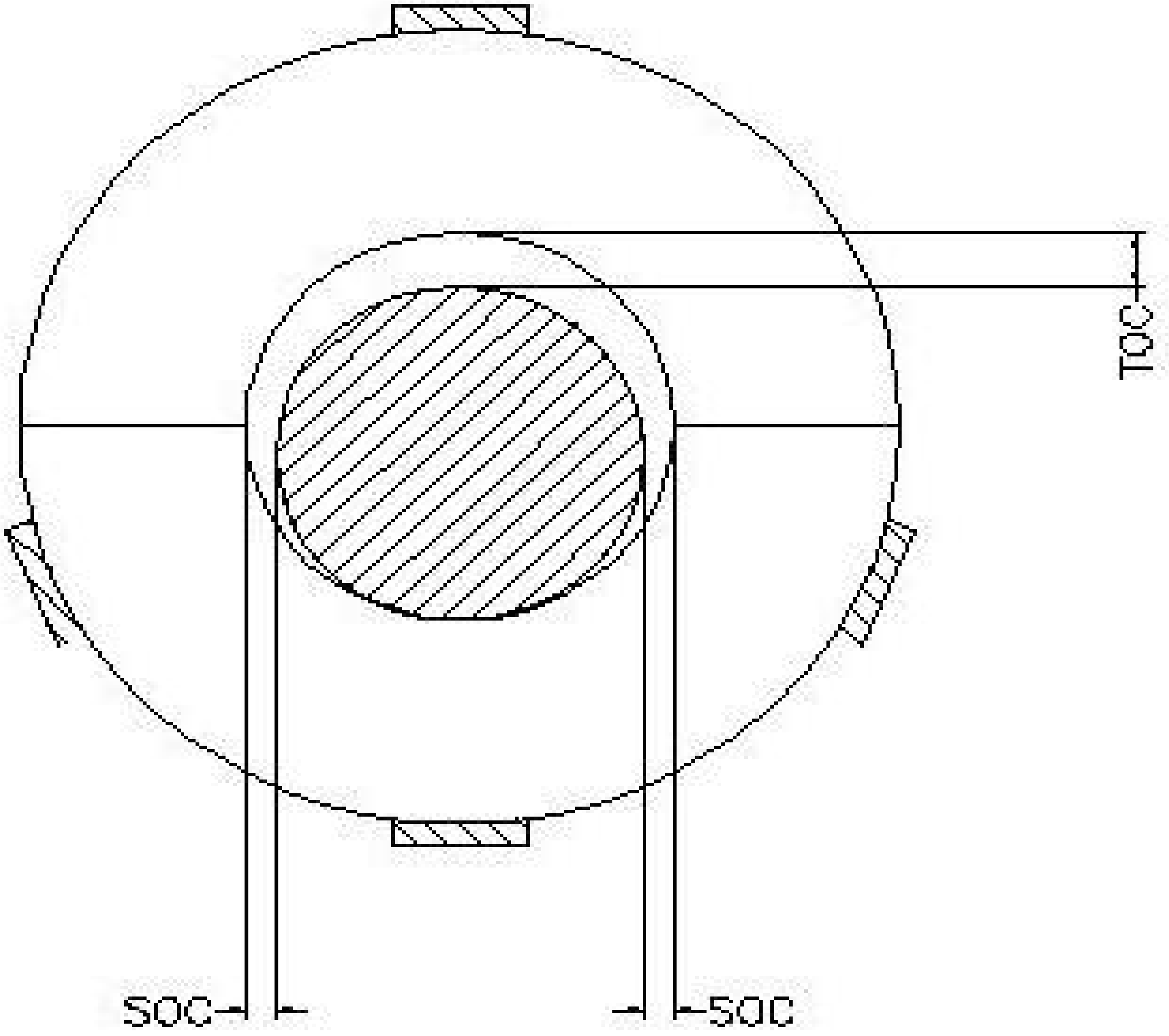
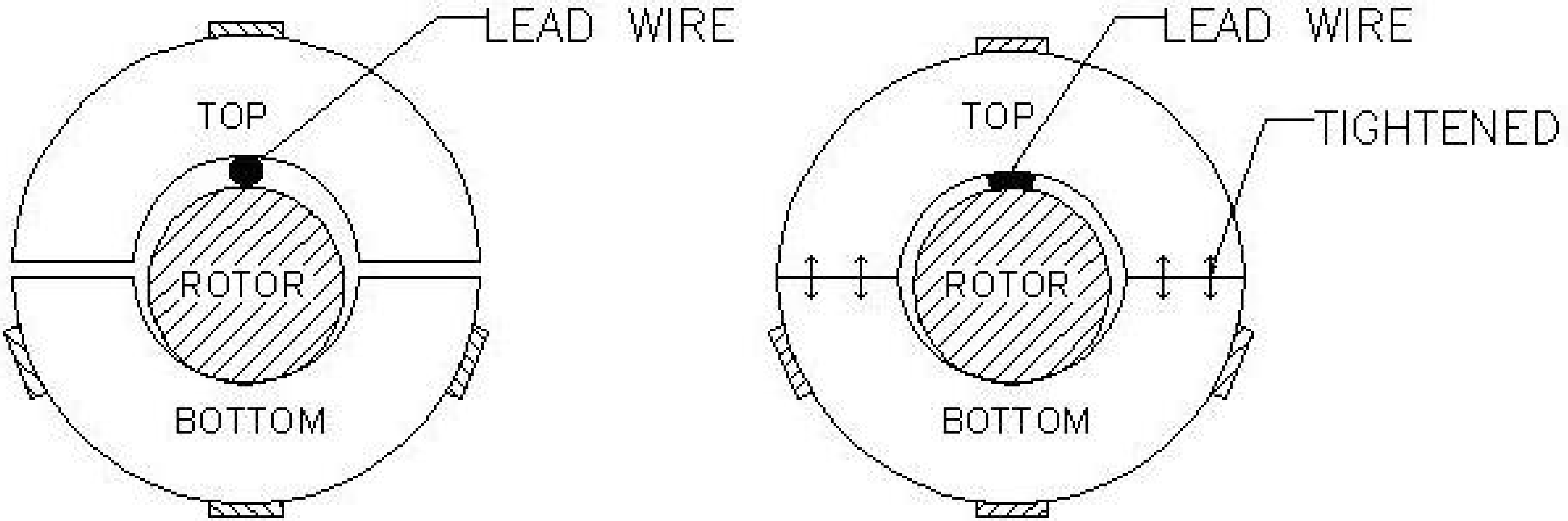
TOP OIL CLEARANCE (T.O.C.)
& SIDE OIL CLEARANCE (S.O.C.)



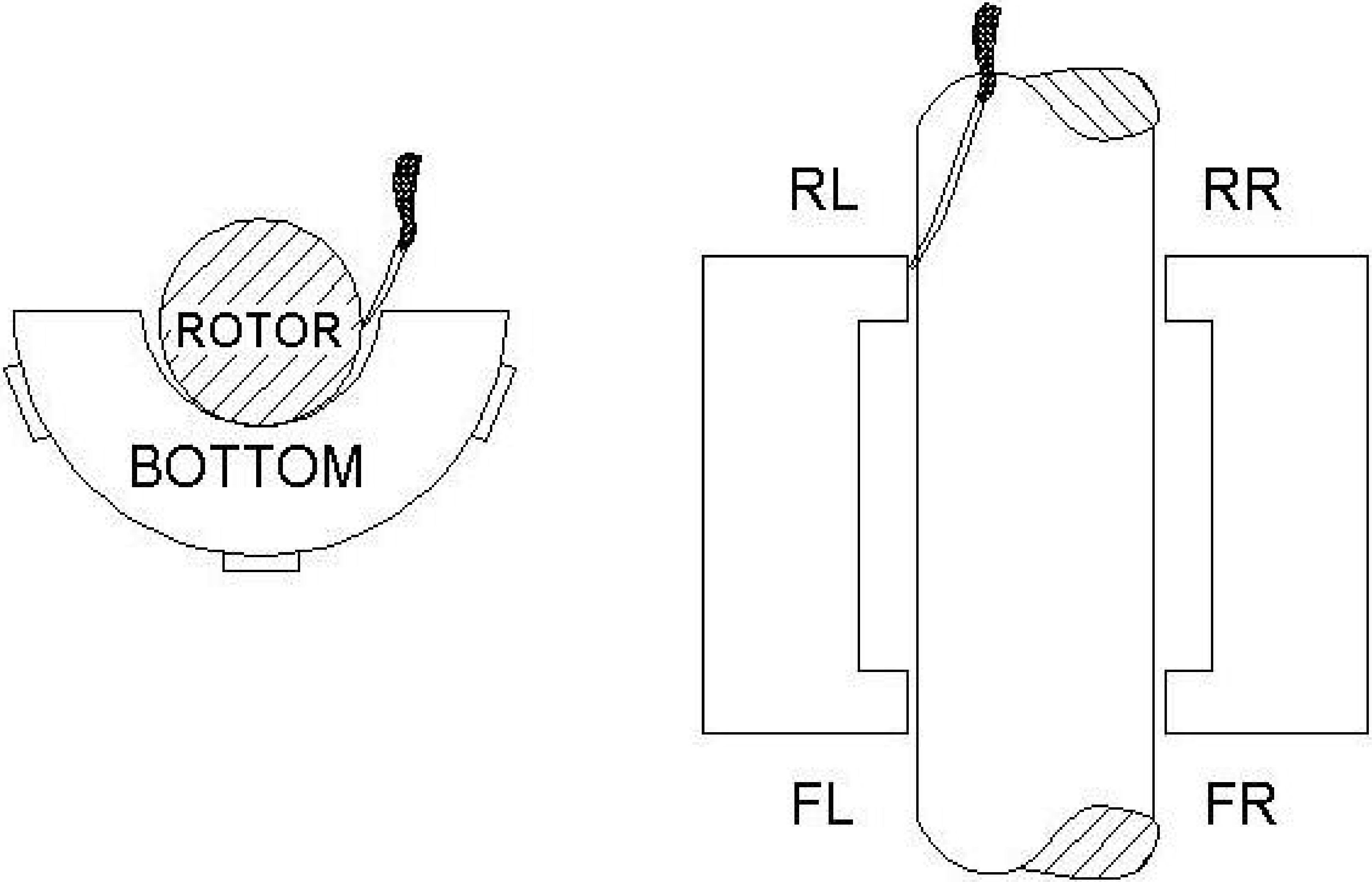
MEASURING TOP OIL CLEARANCE (T.O.C.)

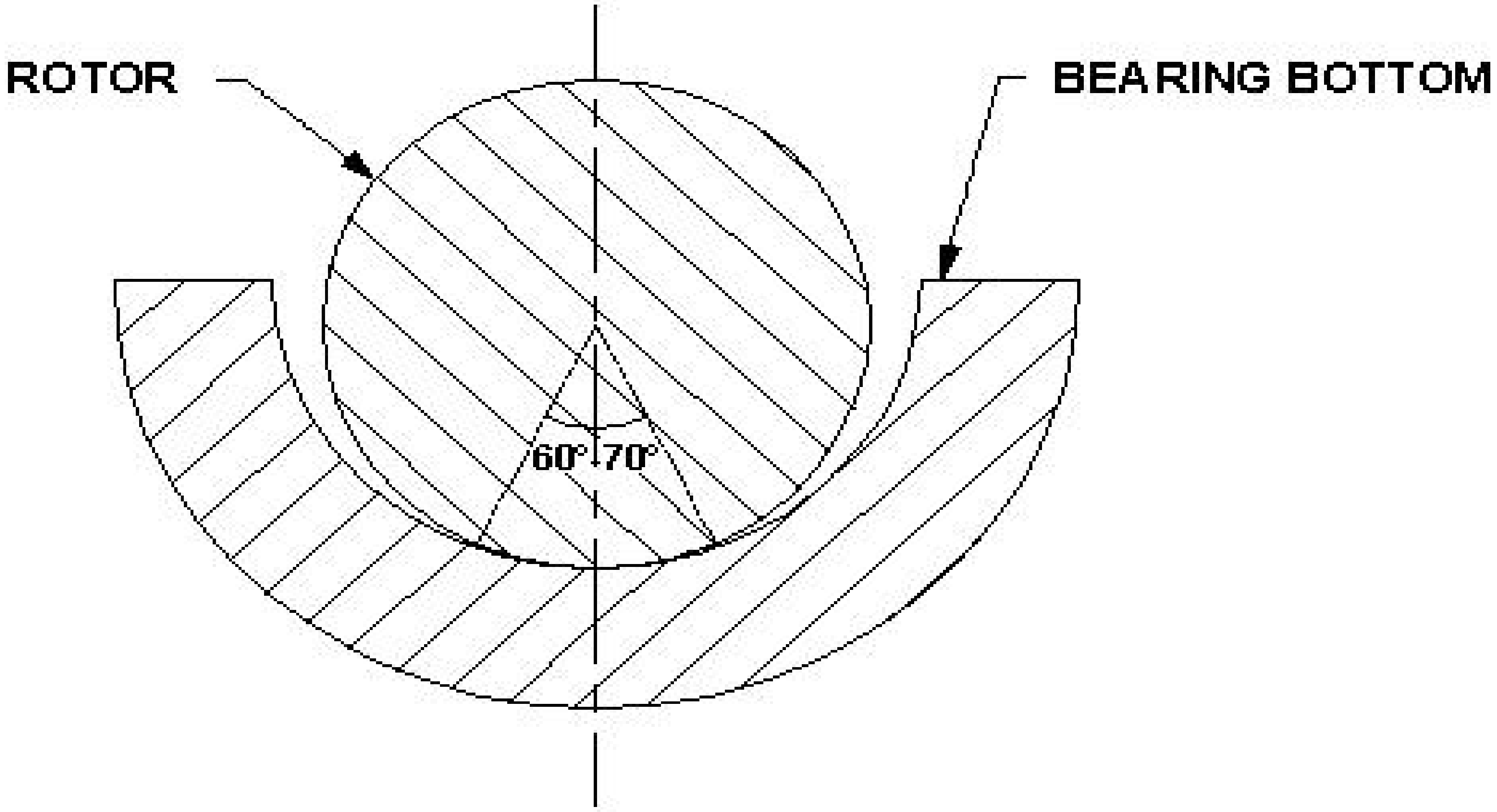


LEAD WIRE IN FREE CONDITION

LEAD WIRE IN COMPRESSED CONDITION

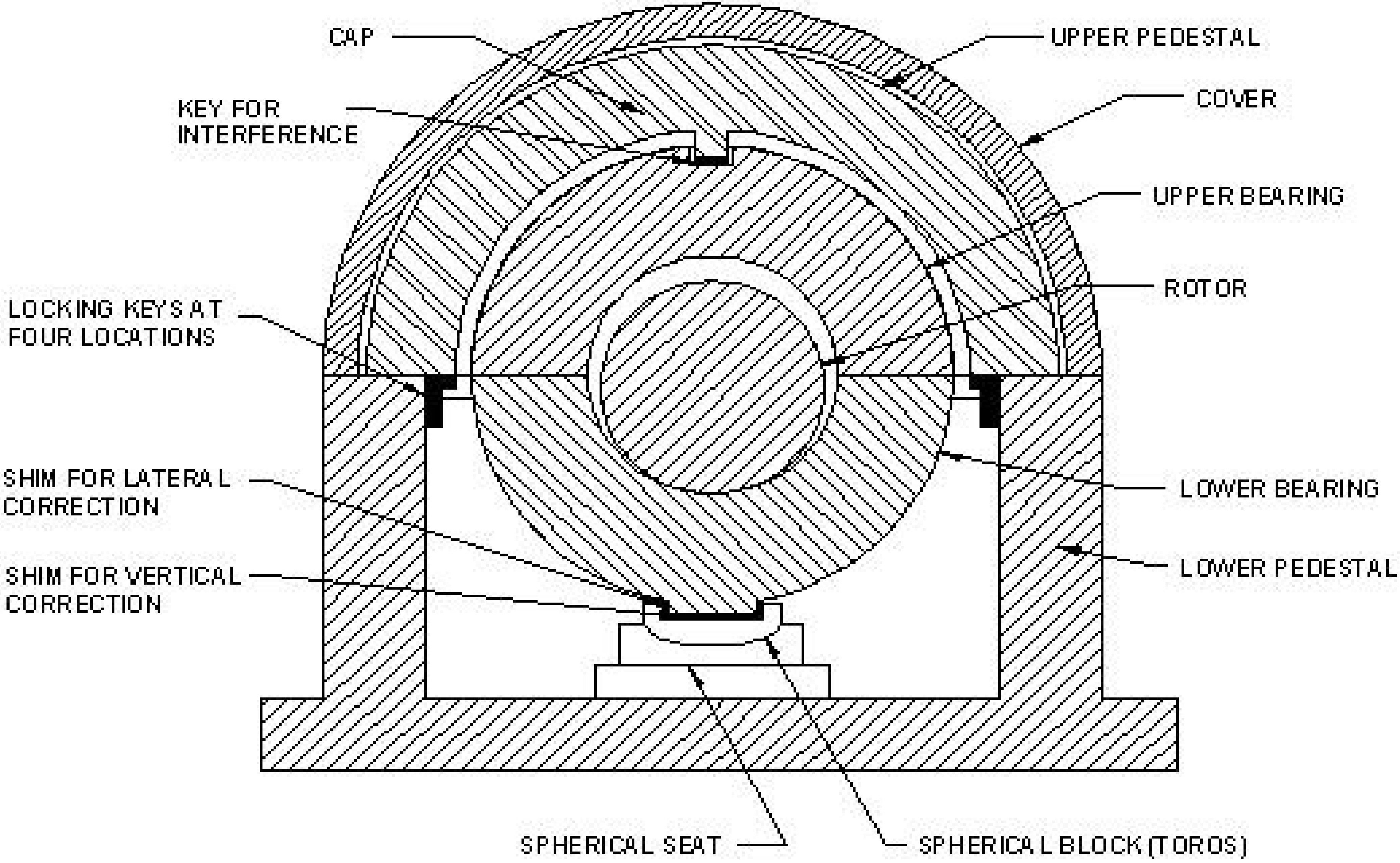
MEASURING SIDE OIL CLEARANCE (S.O.C.)





BEDDING ACTIVITY

TYPICAL BEARING IN KWU M/C



BEARINGS

- Acceptance of Dye Penetrant testing ,DPT & Ultrasonic testing, UT results should be strictly as per BHEL (Hyderabad) AA 0850126 standard which is available on COS website.
- Always carry out DPT test before UT Test
- If any old bearing fails then replace with New/ Rebbabited bearings (both the halves needs to be replaced)
- If New / Rebbabited bearing is used then ensure blue matching of pads with respect to their female seats.
- Blue matching of pads of old good or New/ rebaabbited bearing with pedestal should be more than > 90 % with all the sides touching all around .
- *Bearing should not be touched with hand* S.O.C and T.O.C of bearing should be made on machine only. In no case babbit to be removed manually more than 0.1 mm (across dia)

•Bedding should be 30-35 degrees all around on both sides.

-Less bedding will lead to more oil leakages from the side of the bearing

- Extra bedding will lead to more friction loss.

•No of shims in each pad should not be more than 4 nos. If it is more , substitute with suitable equivalent sheet of stainless steel only.

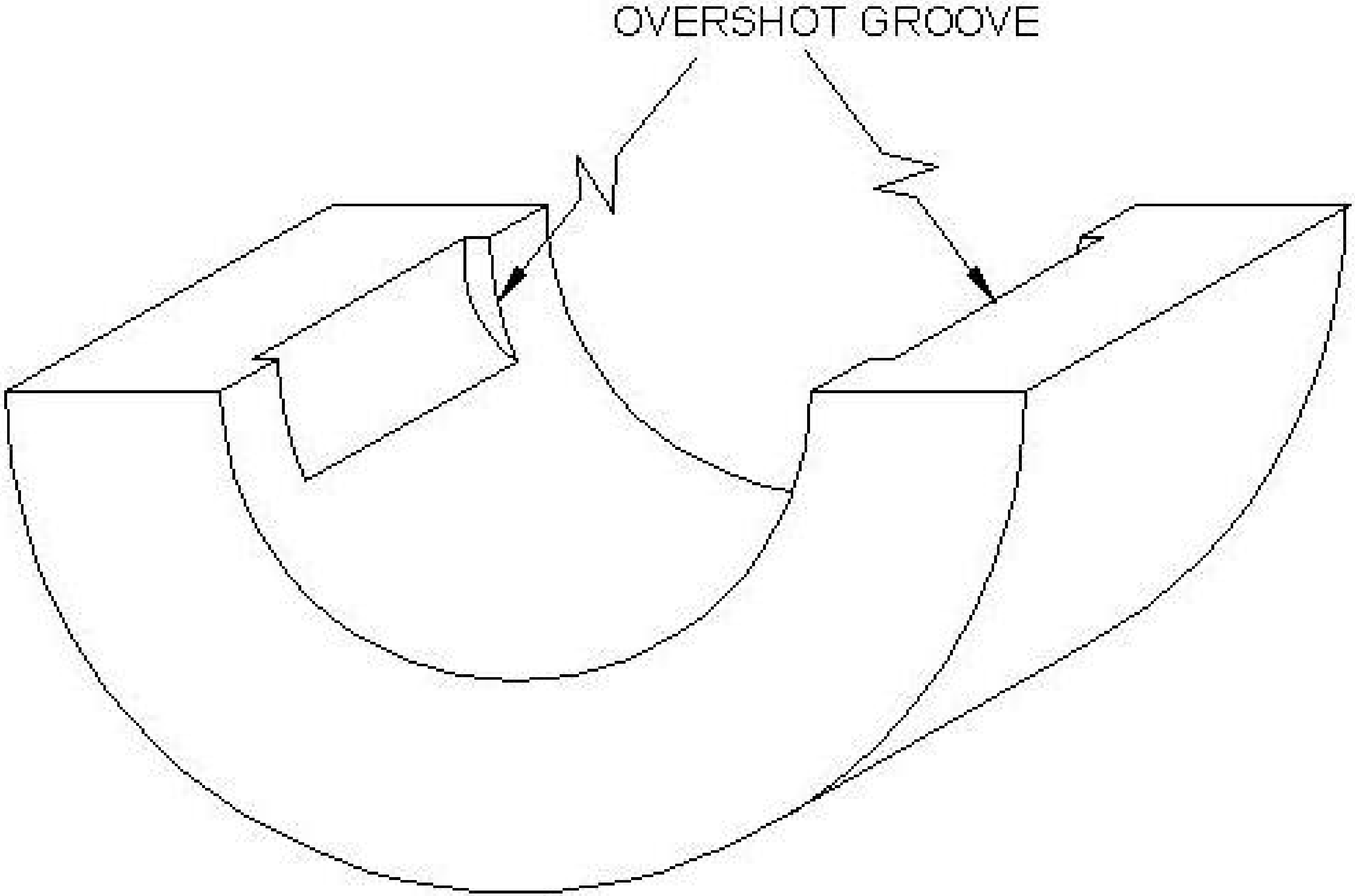
•The difference in the values of SOC and TOC when measured from two sides (front and rear) of bearing should not be more than 0.05 mm.

•**Thumb Rule :** In any bearing the side oil clearance on one side will be appx. equal to D/500 mm, where D is the rotor Dia in mm.

- **OVERSHOT OIL GROOVE IS VERY-2 IMPORTANT. ALWAYS CHECK FOR IT**

- While measuring S.O.C ensure that the feeler should go into the gap neither less and nor more than appx. 25 mm.

- Never Exchange the bearing shell of thrust bearing with the yoke of other bearing and viceversa. Always use their Original set in pair.



OVERSHOT GROOVE IN BEARING

BEARINGS AND TOROUS/PEDESTAL CONTACT

Three types of contacts are there

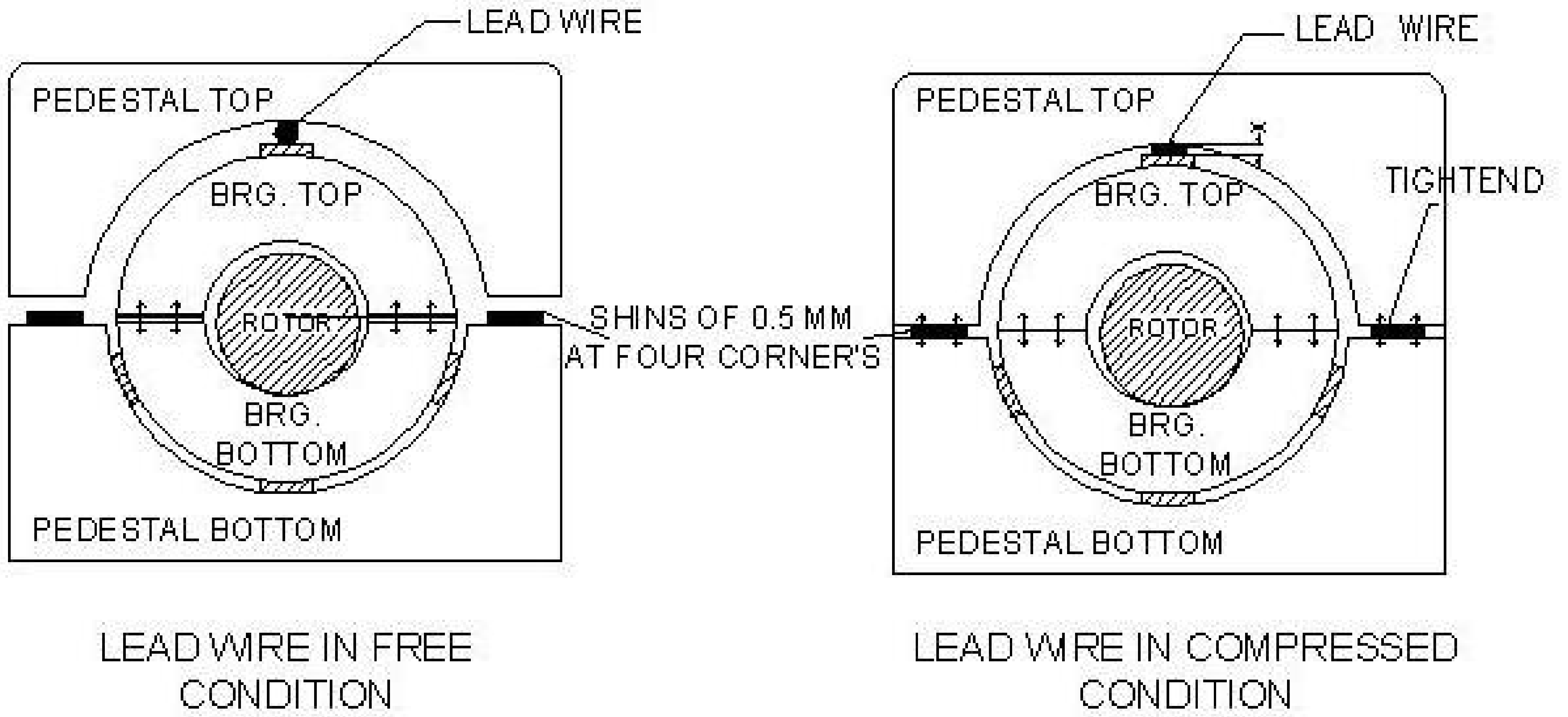
1. Cylindrical-cylindrical
2. Spherical- spherical
3. Spherical -Cylindrical

Cylindrical-cylindrical contact can be obtained by the manual scrapping, but *Spherical-spherical and Cylindrical- Spherical* should be brought with the machining only. In Urgency spherical-spherical can be rectified at site provided correction is very small.

INTERFERENCE OF THE BEARINGS WITH THE PEDESTAL

- Interference is kept to ensure proper loading on the Bearing Top to ensure its proper clamping which helps in the damping of the bearing Vibration
- It is in the limit 0f 0.15 to 0.35 mm
- This check is carried out after the completion of the TOC checking of the bearing.

INTERFERENCE OF BEARING WITH PEDESTALS

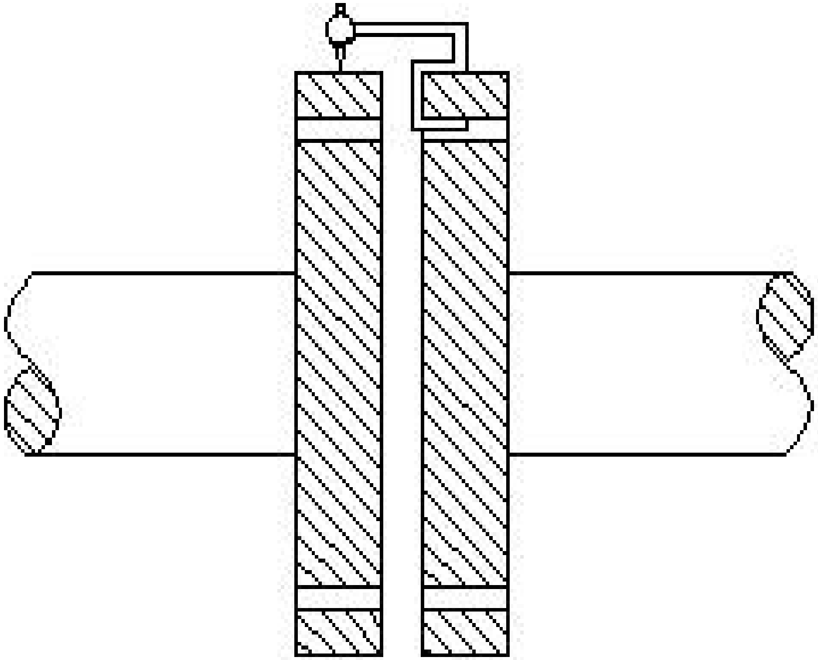


INTERFERENCE IS = 0.5 - X

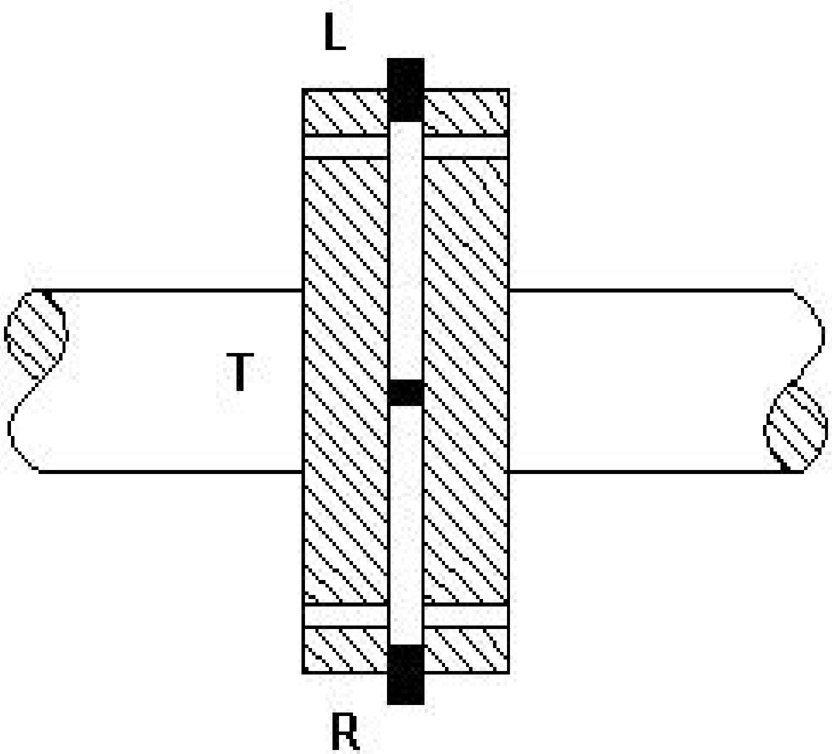
ALIGNMENT

- Alignment readings are taken at four positions at 12,3,6,9,12 O clock position by rotating the couplings together
- Readings for Radial Alignment is taken by Dial Gauges at four locations.
- Readings for axial alignment ie the gap between the couplings is taken by the means of the slip Gauges at four location of couplings ie L,R,T,B each at four position of clock. Axial reading is averaged for four position of the Coupling locations

ALIGNMENT MEASUREMENT



RADIAL MISALIGNMENT MEASURED BY DIAL GAUGE



AXIAL MISALIGNMENT MEASURED BY SLIP GAUGE

ALIGNMENT

1. Always Ensure Bedding of the rotor with the bearing.
2. During alignment process for IP-LP and LP-GEN coupling , condenser is to be kept on springs and water filled upto the tubenest level. During the final correction/ checking place LPT top half in position and tighten intermittently
3. Always take readings for two sets.
4. Best compromise between alignment and slope is to be achieved with priority for alignment.
5. Always refer to the Dismantling readings of Alignment , Seal Bore and Slope during the process of alignment.

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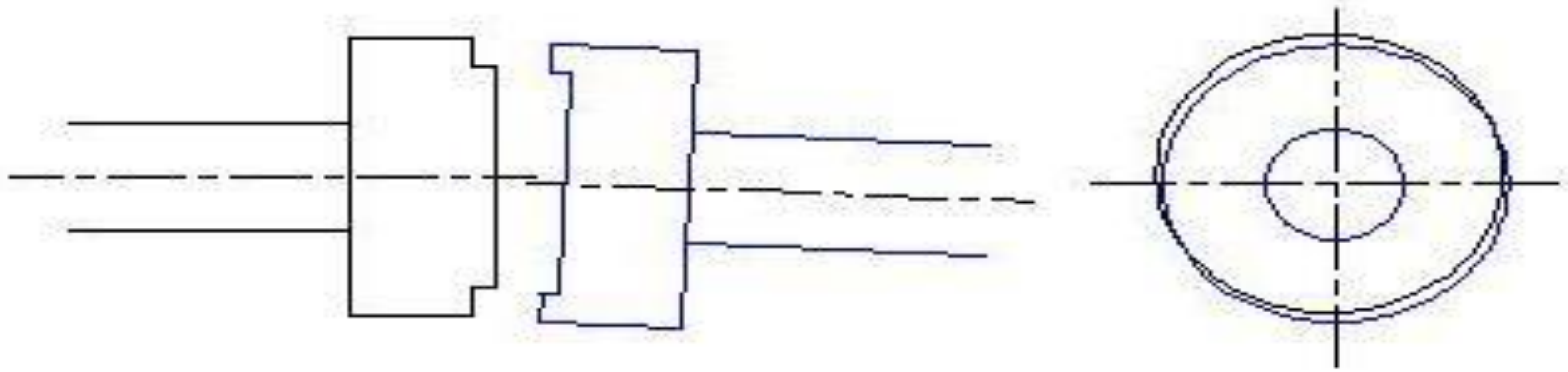
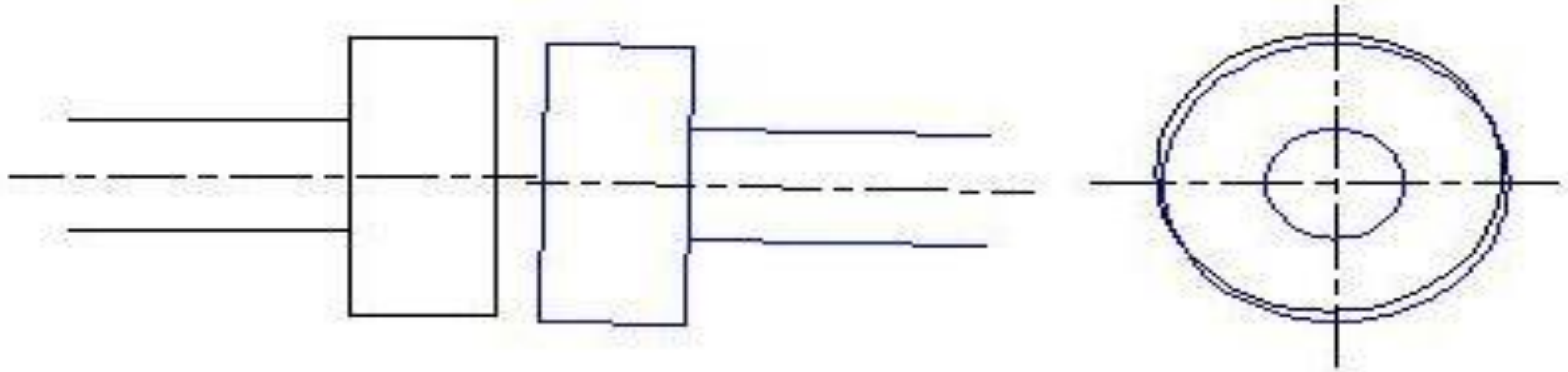
ALIGNMENT



ONLY AXIAL ALIGNMENT IS DONE



BOTH RADIAL & AXIAL ALIGNMENT IS DONE

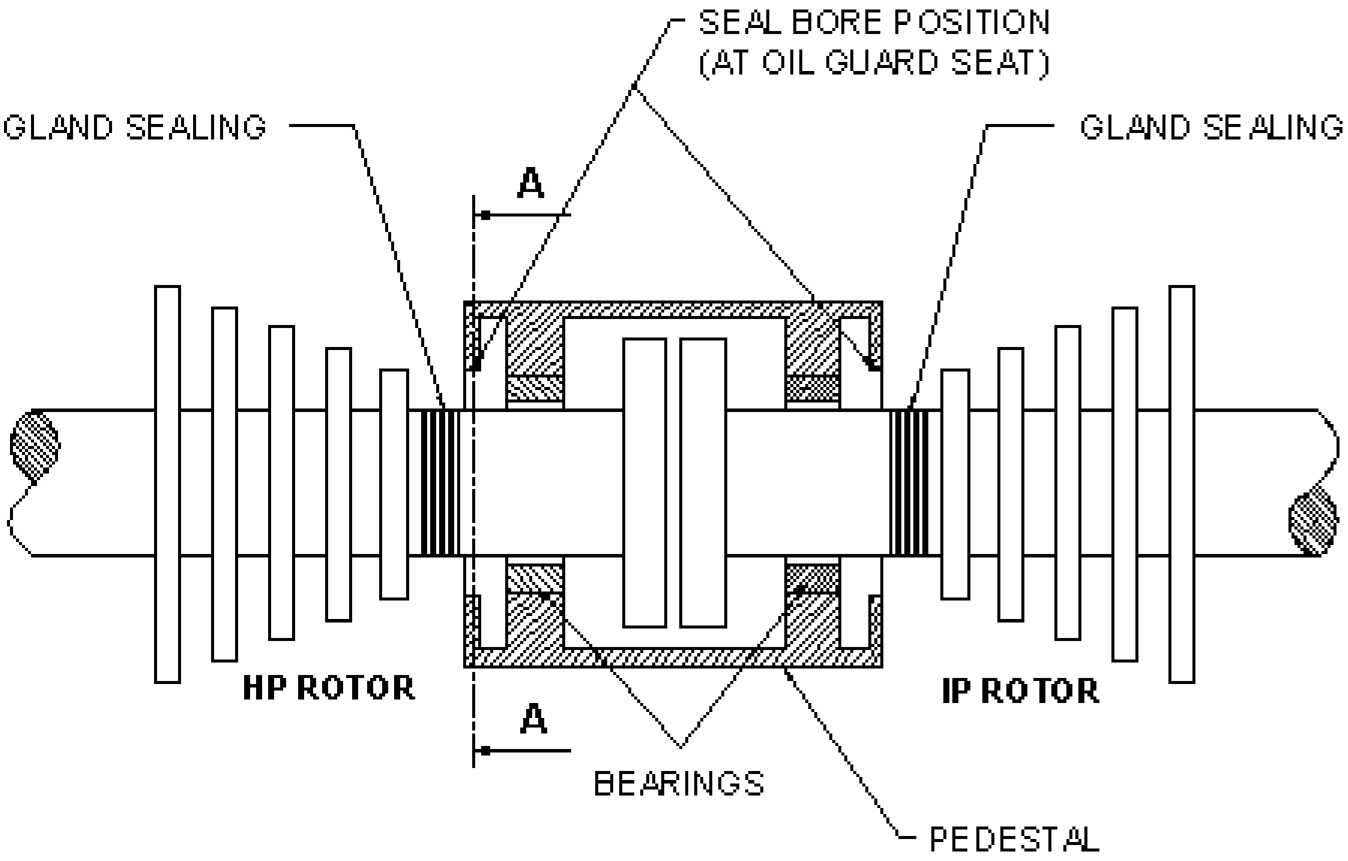
ALIGNMENT

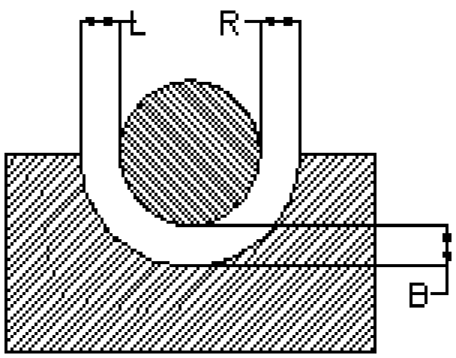
<u>Alignment Deemed to be over</u>

- If the readings obtained are as per design values
- Readings obtained in two consecutive sets are appx. Identical
- Check whether readings of L+R = T+B . If difference is there then readings are not proper.
- Ensure the final radial position of couplings is same as of set datum initially. If it is more than 0.01 mm then retake the reading.

SEAL BORE

- Seal Bore readings are the Rotor Centering readings with respect to the Bearing Pedestals.
- It is measured by means of inside micrometers from the oil guard Seat surface to the surface of the rotor Journal. At each location it is measured at the three points, *Left, Right, bottom*
- Seal bore readings are the reference readings for any correction and normally should not change.
- But over a period of time due to change in foundation characteristics it can lead to change in seal bore readings.



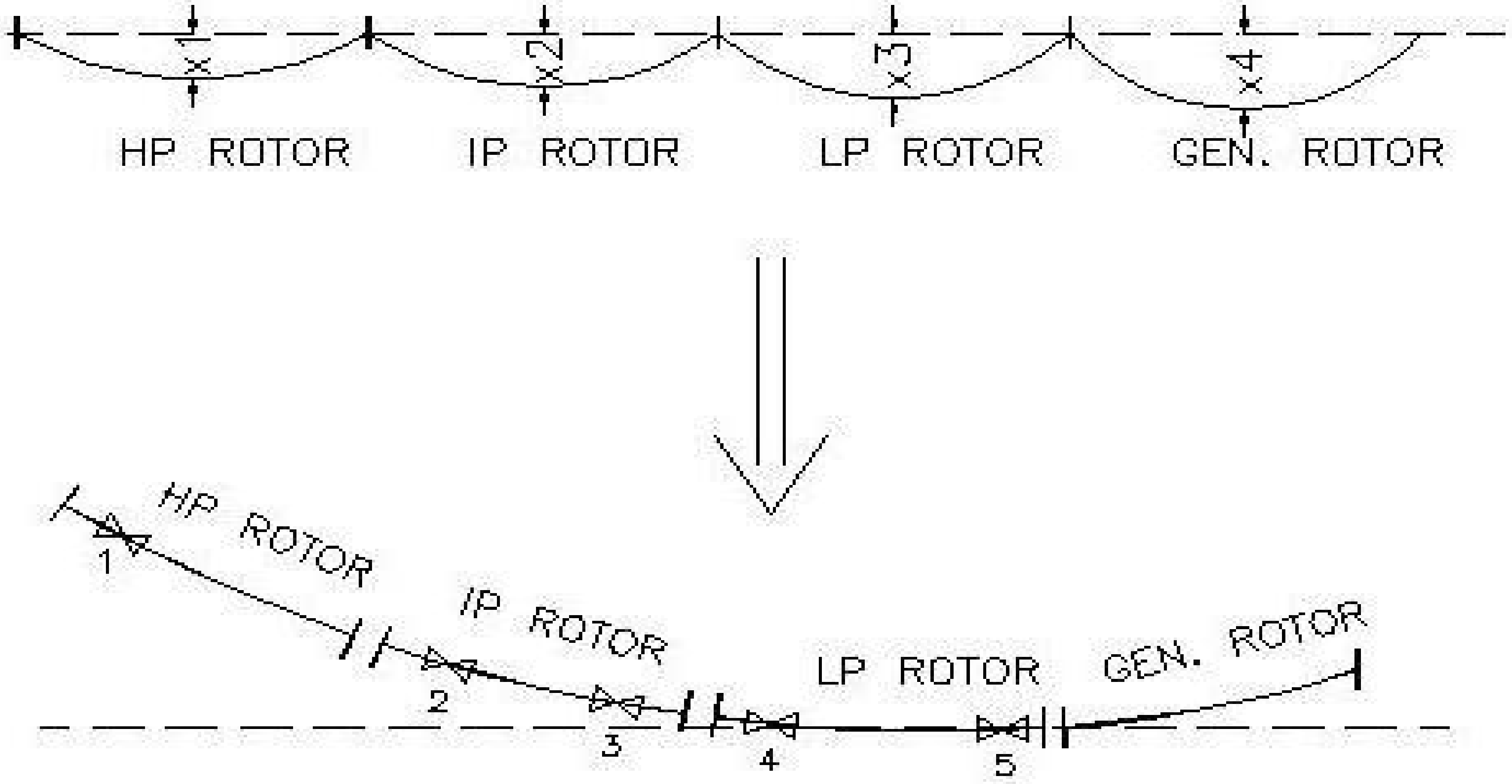


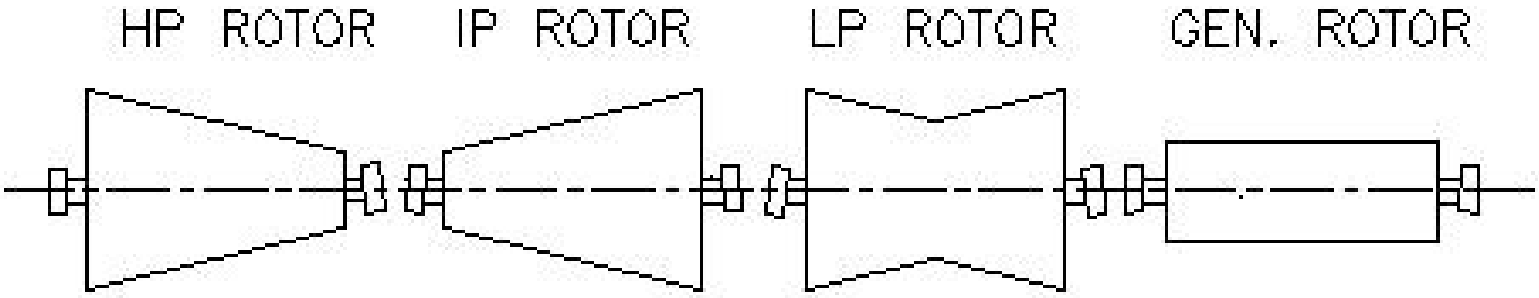
SECTION AT A-A

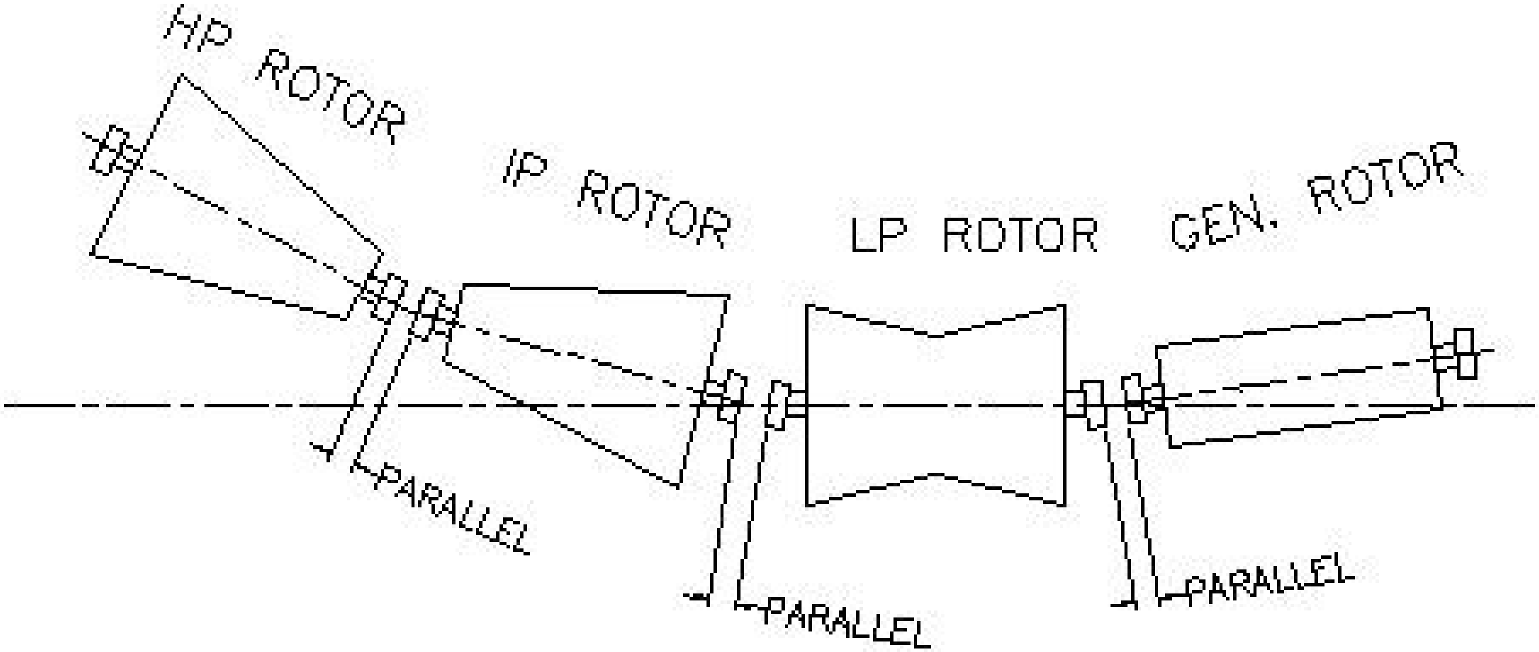
MEASUREMENT TAKEN BY INSIDE MICROMETER

SEAL BORE MEASUREMENT

TURBINE CATENARY







ROTOR WITH VERTICAL HEIGHT ADJUSTMENT

CATENARY

- When rotors are resting in free condition on their bearings, there will be individual sags in them due to its dead weight and dimensions.
- Due to above the mating coupling faces of the rotors shall be at an angle. In this condition it is very difficult to couple the rotors.
- To align the coupling faces the rotors are given vertical adjustment through bearing or pedestal adjustment so that they become parallel and coupling becomes easier. One rotor normally *LP rotor is kept as MASTER.*
- From above adjustment the deflected lines of rotors also approaches the Center line which reduces the Centrifugal forces on the rotor.

CATENARY /SLOPE ADJUSTMENT

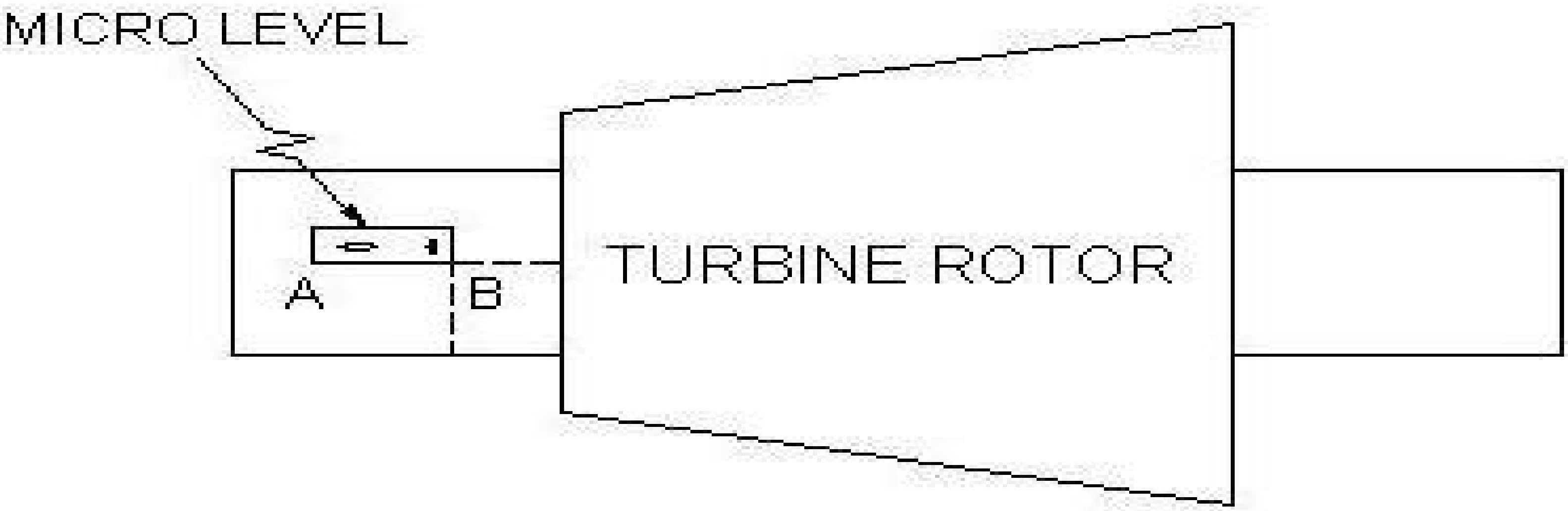
- Correction / Adjustment in the Slope is carried out by making changes in the Pads / Keys of the bottom half of the bearing .
- In New design it is carried out by Spring Deck Correction whereby the whole pedestal lift is affected by means of adding/ removing plates/Sheets in the spring deck foundation.

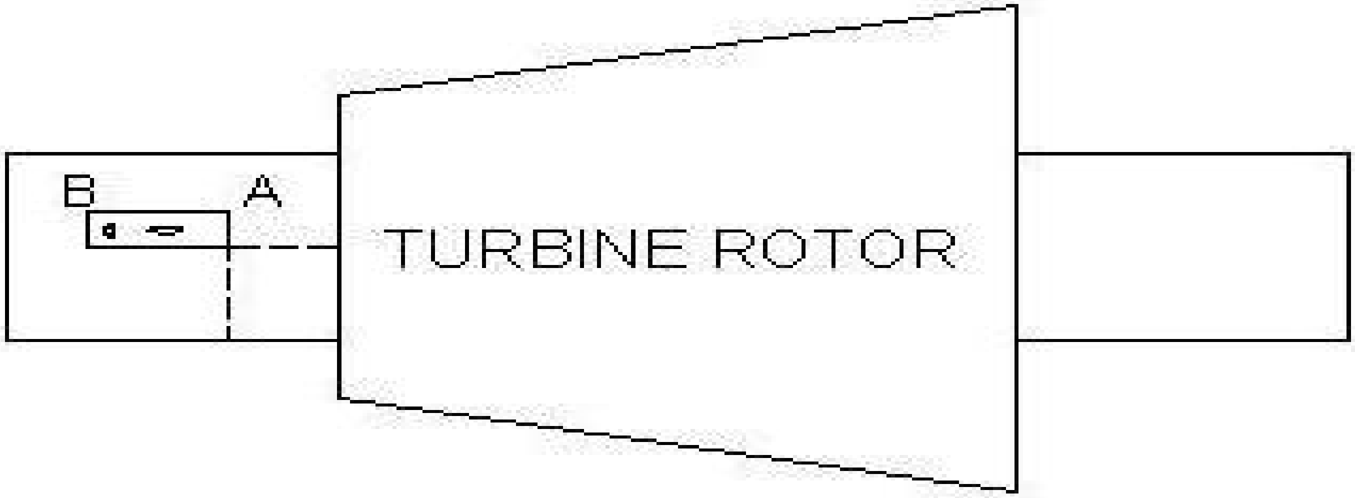
CATENARY /SLOPE

- Slope is measured by Microlevel. Before taking slope readings , MICROLEVEL should be calibrated. It should be calibrated on a Known surface like Lathe machine Bed and then sealed with lacquer to avoid any disturbance.

- After above slopes should be taken in the two direction(to minimize the any error of the level). Second one in 180 degree opposite to first position but at the same location . For this ensure the vertical level is in the center
- Final slope reading is the average of the two readings
- Slopes are measured by a micro level one division of which corresponds to slope of 0.1 mm per mtr length
- Slope to be taken in uncoupled position of rotors

SLOPE MEASUREMENT

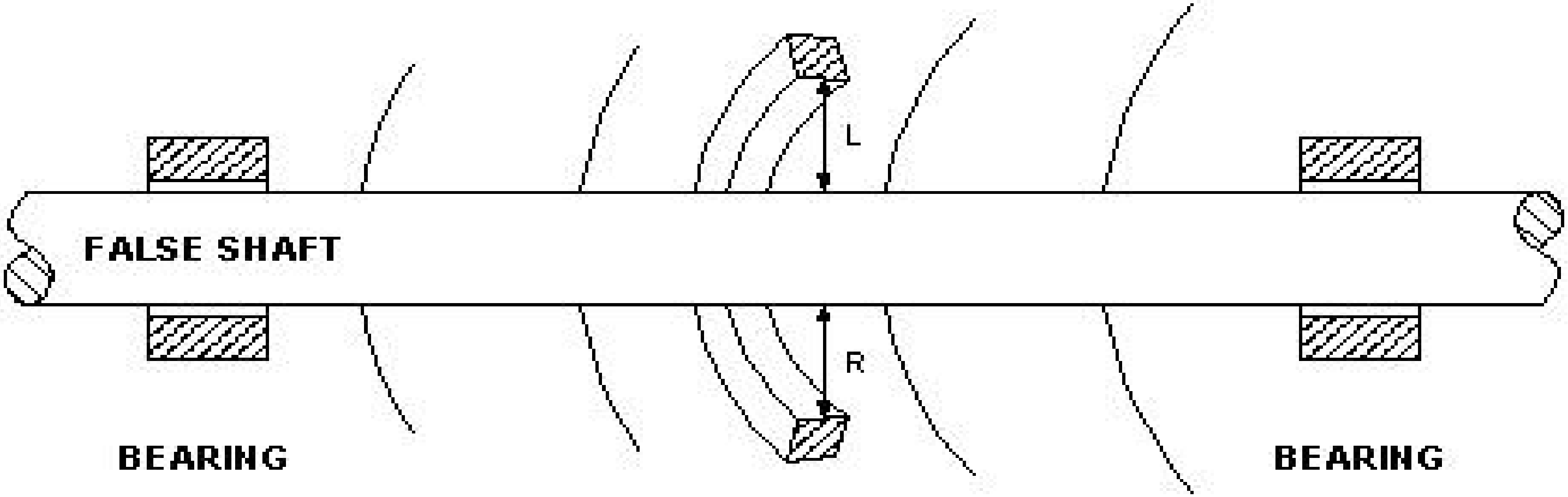


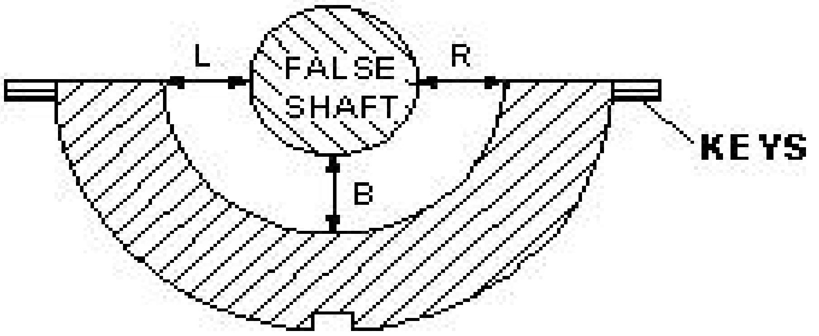


CENTERING

- Centering is the Radial clearances between the Diaphragms/Casing blades with the Rotor
- In LMZ,SKODA,GE Turbines it is measured by means of False Rotor shaft, where by reading are measured at three position L,R,B at each stage of Diaphragms and Glands. Readings are measured by *Inside micrometer.*
- Correction is affected by means of Keys in the Diaphragms/casing

CENTERING





READINGS ARE TAKEN BY INSIDE MICROMETER

CENTERING

1. Before taking centering readings ensure radial play of diaphragm in Liner and gland boxes in no case should be more than 0.08 mm
2. During centering reading push the components towards Left side
3. No of shims packers below each key should not be more than 4. If it is more than it then replace it with suitable sheet of equivalent size of SS

CENTERING

- In KWU turbines it is measured by actually lifting ,downing and moving left and right the inner casing w.r.t rotor which is rotated in the bearings.It is also called as *ROLL CHECK* .At the moment where touching/Resistance is observed gives value of the clearance between casing and rotor. Inner casing movement is affected by means of Hydraulic Jacks and Screws. *It is a faster means of Centering check*
- Correction is affected by means of changing Dimensions of keys of the Casing.

IMPORTANCE OF SEALS

- Sealing fins reduces the leakage's of steam through inter stage and turbine ends there by leading to high efficiency and better Heat Rate
- They also result in balancing of the Thrust.
- <u>Sealing fins deemed to be reject/damaged</u>

1. When the desired clearances have increased
2. When their Knife edge is lost or found bend
3. When they are broken at the intermittent places

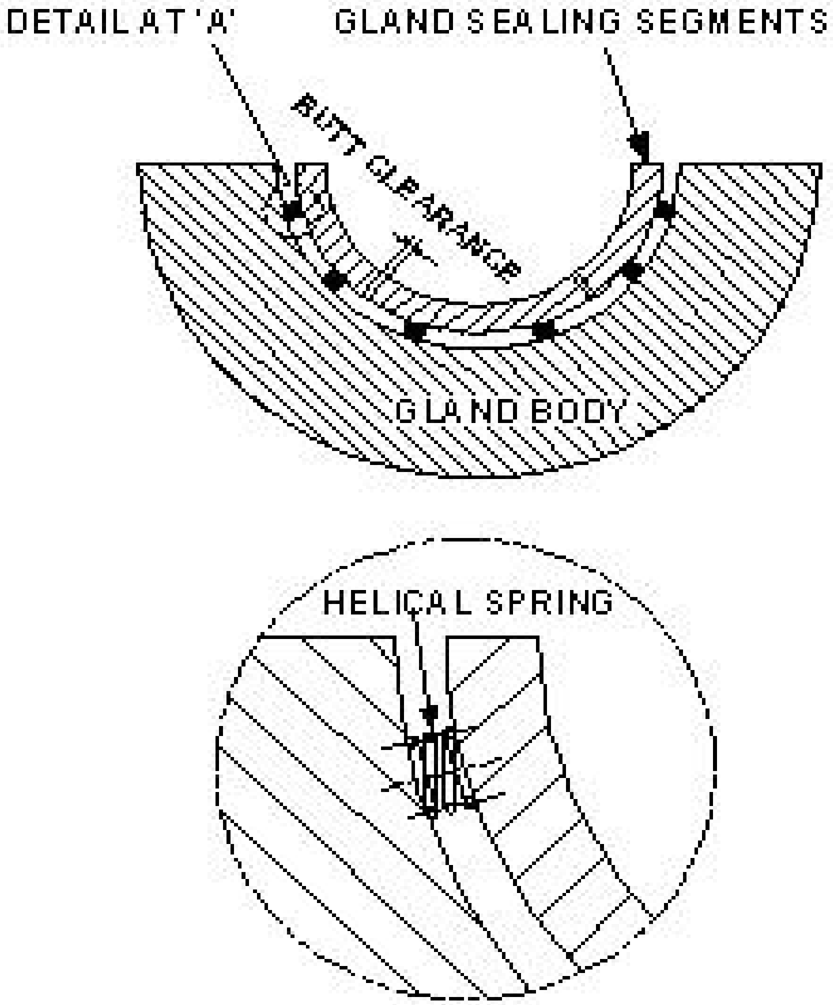
SEALINGS RINGS

- During Overhauling ,Even if the Old Seals

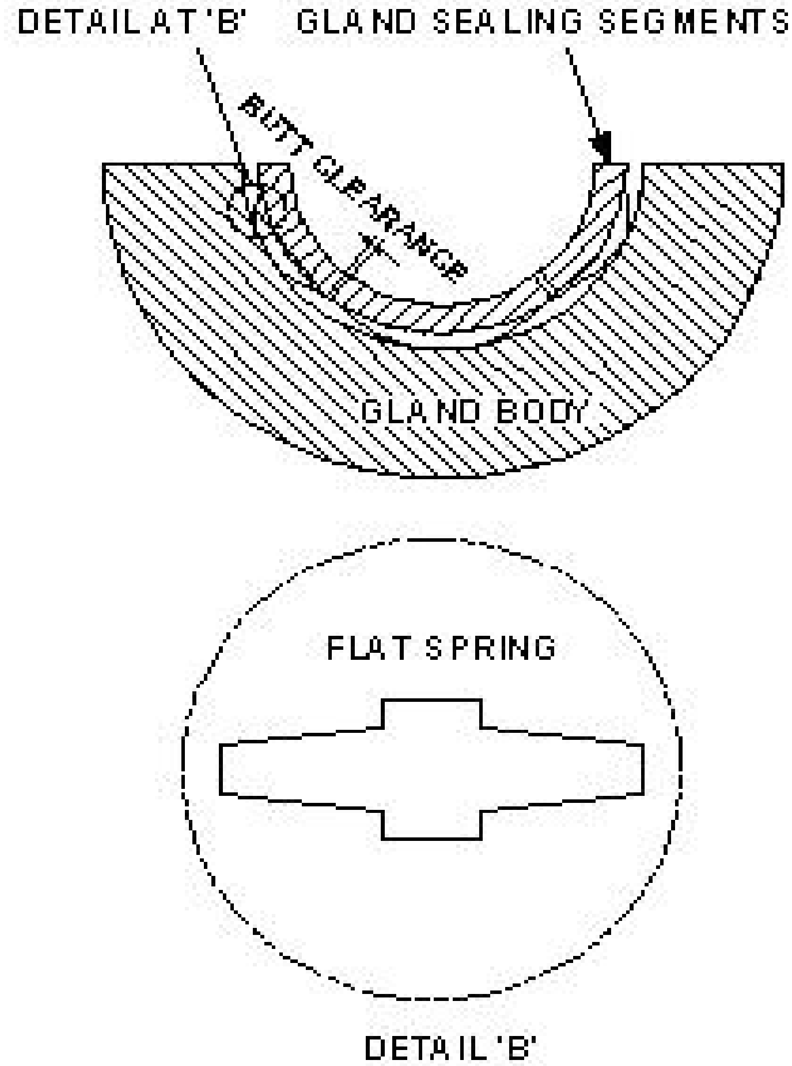
  are used, never use the old Helical/ Flat Springs

- Butt Clearances between sealing segments should be strictly as per Design values.

GLAND SEALS



GLAND BODY WITH HELICAL SPRING



GLAND BODY WITH FLAT SPRING

SEAL FIN CUTTING

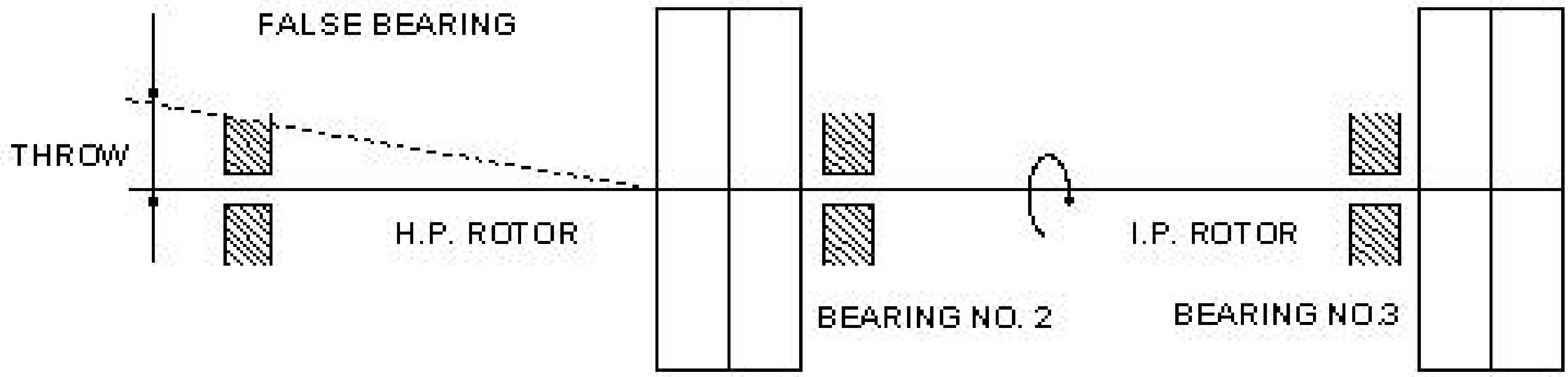
It is checked by Tape Test

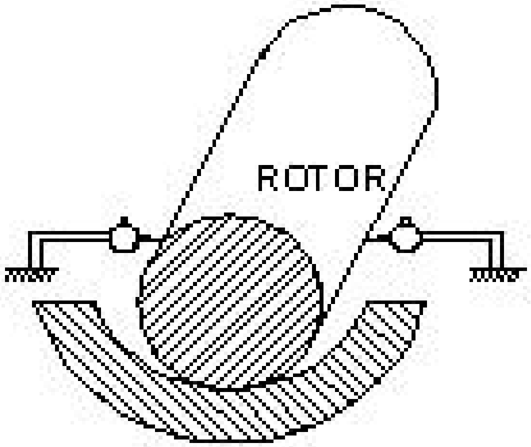
- Gland Sealing segment Radial clearance are checked by a putting Suitable Medical Adhesive tape sealed on rotor and colored by blue color and then rotating the rotor by 360°. If the fins are not touching with tape then the clearance achieved is equal to the Thickness of the tape.
- Wherever rubbing in the tape is observed the corresponding row of segments are taken out , further grinded and rechecked sane as above to get the designed clearances.

SWING CHECK

- Swing check is a measurement which shows the mating accuracy of the coupling faces of the two rotors coupled together.
- It is the measurement of the radial throw at the free end due to coupling face geometric form of the two rotors coupled together.
- It is carried out by removing the Real bearing and putting a false bearing/Lifting tackle on which the rotor is supported. This false bearing has larger side oil clearances. Dial is put at the horizontal level and then rotors are rotated . Readings are taken at many positions, The max throw is the Swing of the rotor.

SWING CHECK OF HP ROTOR





FALSE BEARING

SWING CHECK

- Readings are to be recorded after elongation of all coupling bolts of HP-IP and IP-LP coupling.
- Allowable Swing value depends upon the diameter of coupling and length of rotor.
- The final dial gauge reading at start position should be same as the Initial set Dial gauge reading at start position
- If the swing check is on very high side then same is to be corrected by following method
  - -- By interchanging the coupling position
  - – Improving facial run out
  - – Honing and reaming & fixing with new coupling bolts.

ELEVATION TRANSFER

- It is the measurement taken between the two mating parts which are themselves assembled in two halves.
- This is taken to ensure proper fitting of the components so that there is no fouling among themselves.
- This measurement is taken by Height Gauge at the parting plane on both the sides.

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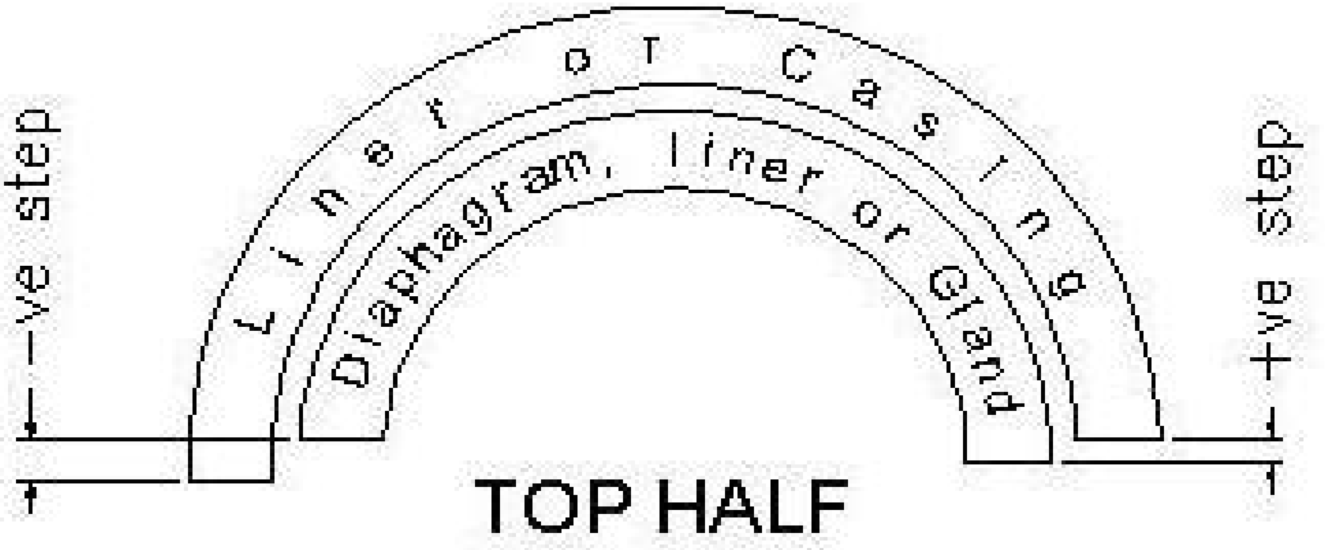
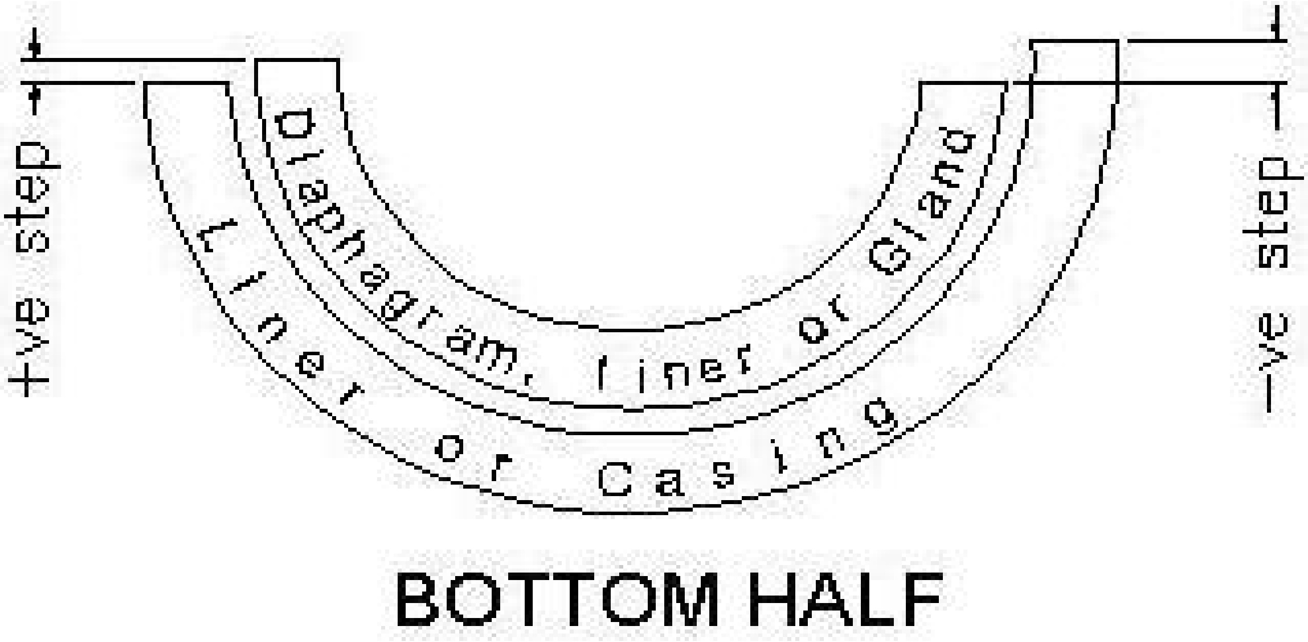




ELEVATION TRANSFER READING

BUMP CHECK

- It is Maximum total axial gap of the steam path of the turbine Cylinders . Normally carried out for HP& IP Cylinders
- It is measured by moving the entire rotors from the zero position on either side.(Zero position is Rotor collar on the working thrust pads in LMZ turbines and Rotor collar in the 50% float Position of the thrust Bearing in KWU Machines)
- The Reading is taken by Dial Gauges
- Total sum of the Left and right movement is the BUMP Value

TOTAL BUMP CHECK OF TURBINE

	Dial Gauge Reading
1. Working pads removed and rotor shifted towards generator	X
2. Non Working Pads removed and rotor shifted towards Front Pedestal	Y

TOTAL BUMP CHECK = X+Y mm

BEARING FLOAT

- It is the total axial movement of the Rotors between the working and the Non working Pads of the Thrust Bearing.
- It is measured by moving the rotors from the extreme end of the working pads to the extreme end of the Non working pads or vice versa Reading is measured by Dial Gauges .
- Its value varies from 0.3 mm to 0.55 mm depending upon the turbine design
- Value less than the design value leads to Lubrication problem

BEARING FLOAT

- Value more than the design value can lead to accelerated wearing of the Babbit pads

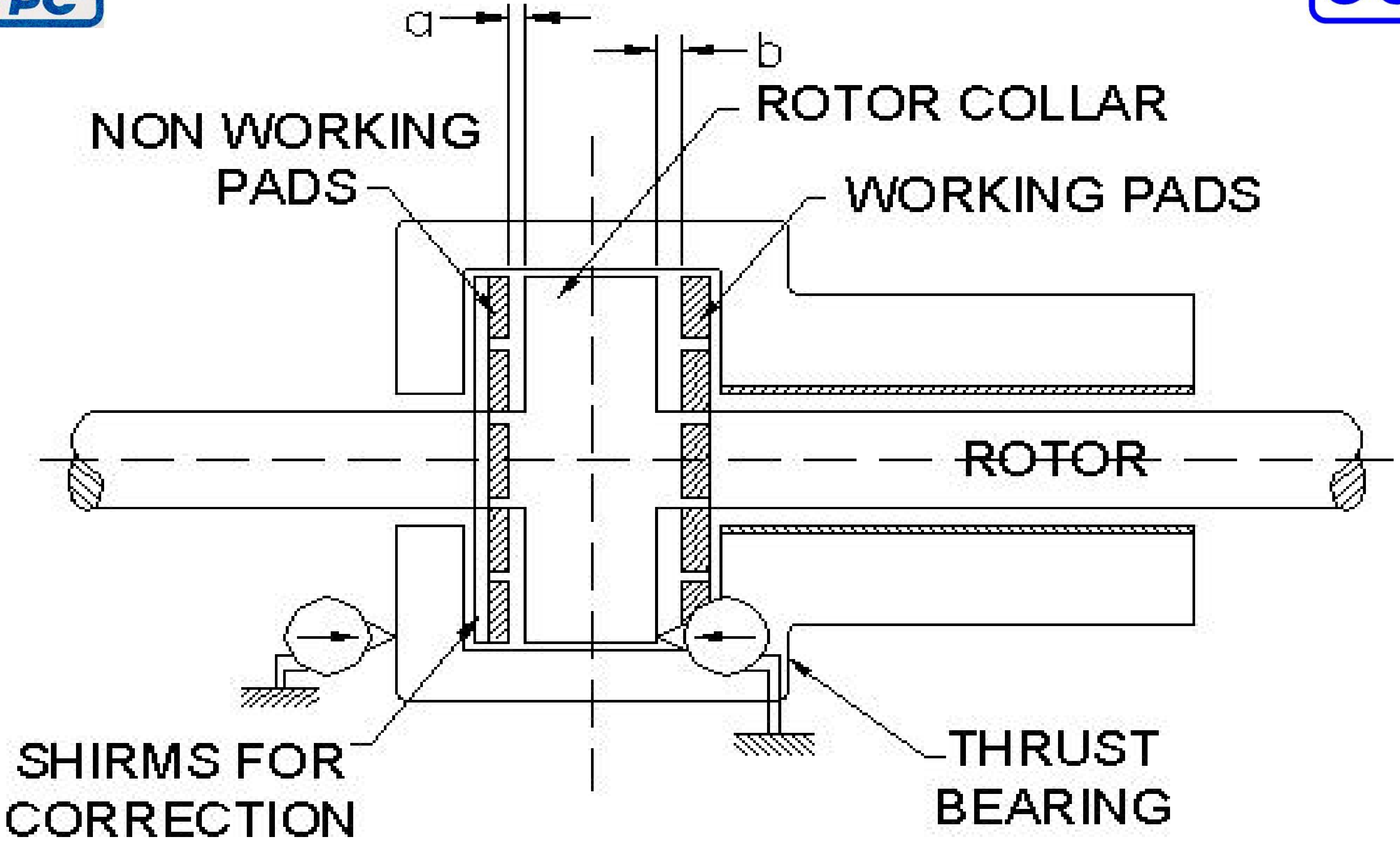
BEARING FLOAT MEASUREMENT: Rotor collar is touched with one set of thrust pads and Dial Gauge is set to ZERO. After this the rotor is shifted to other thrust pads on opposite side . During this rotor is also rotated to ease the shifting . Record the Final Readings.

Movement Between Pads = X

Thrust Bearing Movement = Y

FLOAT = X-Y

Bearing Movement should not be more than 0.03 mm



FLOAT = a+b

BEARING FLOAT MEASUREMENT

HORN DROP TEST

- By horn drop test the loading of the casing on each corner is determined. It is taken on HP and IP Outer Casing.
- In a horn drop test a drop is measured on an individual corner of the casing with the help of dial indicator by removing the support of the individual corner and then it is compared with the opposite corner.
- Procedure . During the horn drop test the individual packer of the casing is removed and the load of that corner is supported over the jacking screws of the casing . Now gradually the jacking screw is

HORN DROP TEST

relieved with the help of Hydraulic jacks on that corner and drop is recorded. This is repeated for each corner of the casing.

- In case of variation in the left and right side reading the drop is adjusted by adjustment of the shims from left to right or vice versa . No addition/subtraction of shims is allowed from the outside.Correction is carried out till the equal loading is observed.
- Above Complete test at four corners is again repeated after joining all the Pipe lines with

the Casing

- The variation in horn drop reading of left and right side of the casing may be permitted up to difference of 50%.
- If the variation is much , then no correction is made by adjustment of casing packers. The variation at this stage is caused due to piping pull /push only and hence if any correction is required then the same is to be carried out in the piping joints and its Hangers support only. Sometimes it is necessary to cut the piping joint for the necessary correction.

ANCHOR POINT

- Anything when heated will expand. Same is true for Turbine rotors and Casings.
- Problem with rotors is more complex as it is also subjected to the axial thrust also.
- To allow their controlled motion during operation and to prevent any eventuality between rotor and casing they are required to be anchored
- Rotors are anchored at Bearing no 2(between HP &IP) by means of thrust bearing. In some Turbines they are also anchored at free end
- ***Thrust bearing(Anchor point) is always located near High temperature end to minimize the differential expansion.***

ANCHOR POINTS

- Casings which are connected together by means of pedestals and keys have LPT front as the anchor point.
- It is to be noted that rotor rests on the bearings and bearings further rests on the pedestals
- The pedestals can be moving / sliding or can be fixed. When it is sliding it carries bearing along with it which further carries rotor along with it.

  When pedestals are fixed the necessary casing expansion is taken by the bellows at the ends.
- Total Expansion of Turbine can be calculated which is appx. Equal to $L\alpha\Delta T$ where

  L = Length of Turbine

  α = coefficient of thermal expansion

  ΔT= Difference of temperature.

DIFFERENTIAL EXPANSION

- It is the difference between the rotor expansion and the Casing Expansion
- It is +ve if rotor expands more than casing
- It is -ve if casing expands more than rotor
- During initial startup diff Exp. is +ve as rotor mass is less and expands at more faster stage than casing. After full load this gap reduces.
- Diff. Expansion pick up is mounted at the *farthest point* from the anchor point to record the max difference.

AXIAL SHIFT

- Axial shift on the Rotors comes due to two components
- Direct Pressure Thrust: It is the axial thrust due the diff of the *pressure X Area* component across the moving stage blading and Discs
- Velocity Component: It is due to diff. of the *velocity X Mass* component across the moving stage blading.
- Total summation of all the above components leads to the Axial Thrust.

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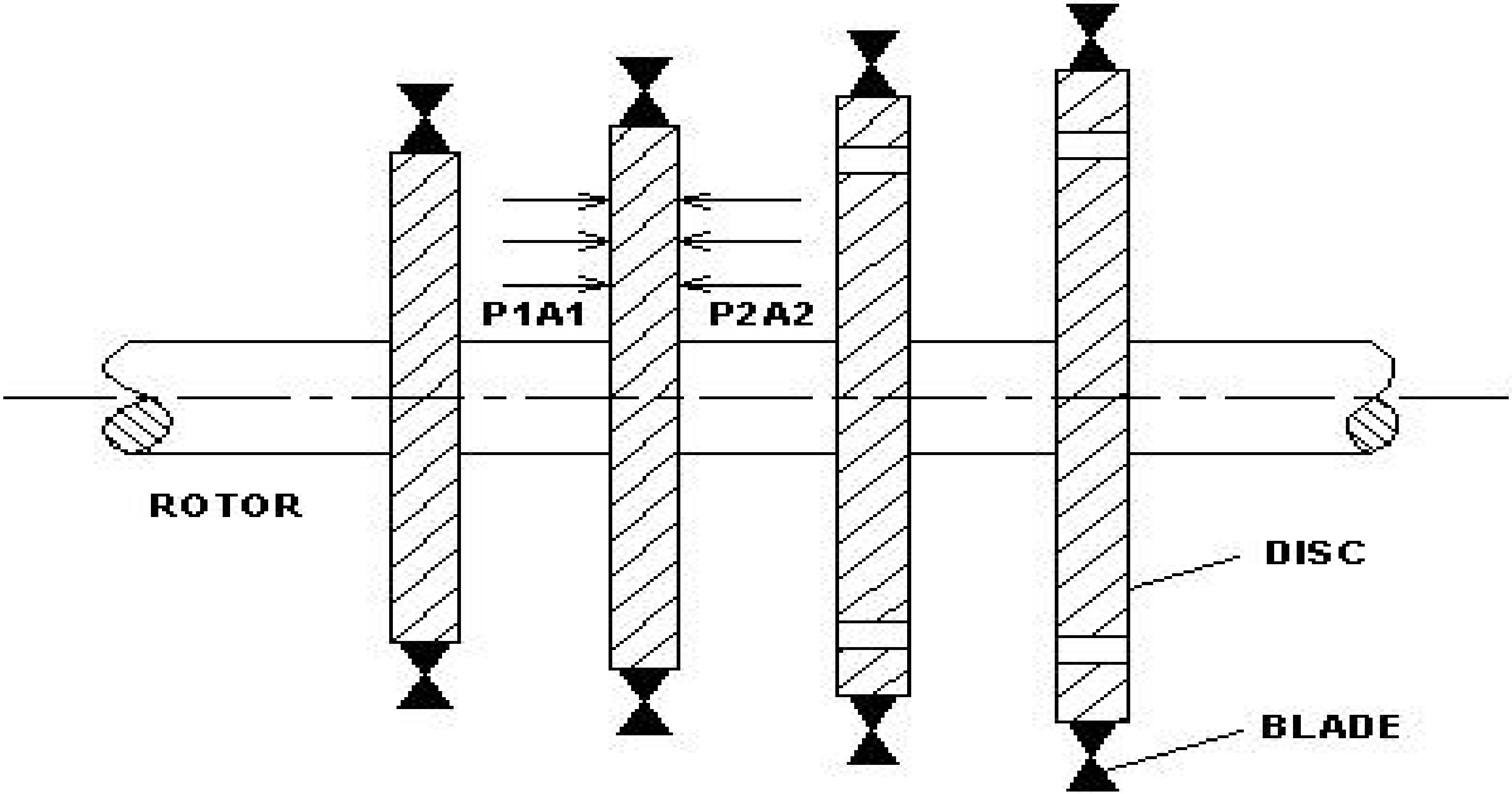
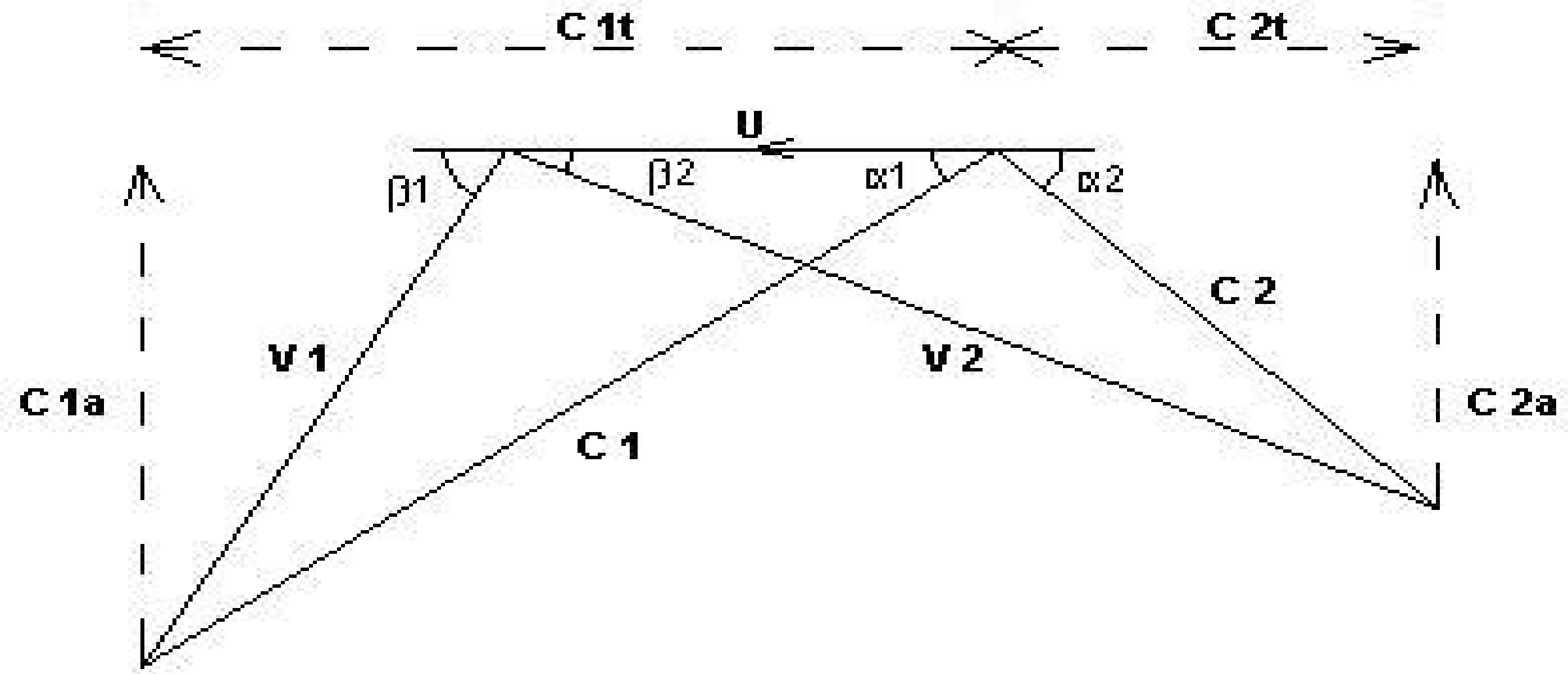
PRESSURE THRUST



PRESSURE THRUST = P1 A1 - P2 A2

VELOCITY DIAGRAM ACROSS BLADE



USEFUL FORCE = (C 1t + C2t) x mass x U [IT SHOULD BE MAXIMUM]

VELOCITY THRUST OR AXIAL FORCE = (C 1a - C2a) x mass [IT SHOULD BE MINIMUM]

AXIAL SHIFT

- Axial Thrust is +ve if it is towards generator
- Axial Thrust is -ve if it is towards HPT front
- There are many ways of balancing axial thrust

1. Double flow self balanced cylinder
2. Mutually balanced individual cylinders
3. By putting balancing drum in the HP Module
4. Having holes in the Discs of the blading
5. Reverse flow in individual cylinder after partial Expansion.
6. Optimizing Steam Extraction Locations

AXIAL SHIFT

7. Sealing fins are also important component of balancing axial thrust

The Residual thrust is taken care by the Thrust pads.

Tripping Limits of Axial shift

- The Max. + ve axial shift tripping value is just less than the minimum axial gap in the HP Casing which is in its first stage.
- The Max. - ve axial shift tripping value is just less than the minimum axial gap in the IP Casing which is in its first stage.

GOVERNING SYSTEM

- To regulate the speed of the Turbine at various loads in a isolating set
- To regulate the load as per the frequency demand when working in a grid network.
- To prevent and protect the turbine from over speeding.
- To allow on line testing of various safety protections .
- To enable the tripping of TG set in the event of actuation of protections.
- Safe and healthy loading of the TG Set

TYPES OF GOVERNING-I

- Nozzle Governing
- Throttle governing
- Bypass Governing

Governing is effected by varying the amount of steam which is further done by changing the positions of control valves.

Any Throttling of Steam will lead to losses . In governing system along with the change of quantity of steam the quality of the steam also changes. Therefore Throttling should be minimum.

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THROTTLE GOVERNING	NOZZLE GOVERNIMG
All the valves in a set opens or closes simultaneously / together	The Valves in a set opens or closes consequentially or in a sequence
It is a Full arc Admission Turbine	It is a Partial Arc admission turbine except at full Load.
It is most suitable for full load or based Load plants	It is good for Low load or variable load turbines.
No operational Problems	May have operational Problem at partial Loads

BYPASS GOVERNING

- It is employed in small capacity turbines running on high pressure conditions and with small blading dimensions.
- Here the loading up to appx 80% (Economic loading) is met by normal control valves feeding the First stage. For higher loading , to supply more steam which is not possible due to small blading dimensions (can lead to operational problems) the extra quantity of the steam is fed to the intermediate section of turbine bypassing the initial high pressure stages.

TYPES OF GOVERNING-II

- Constant Pressure Mode: Here pressure upstream of control valves is kept constant and change is made by changing the position of control valves.
- Variable Pressure mode:Here control valves are in full open position and pressure upstream of control valves varies proportionately with the load requirement.
- Response of Constant pressure Mode is much faster than Variable pressure mode, but Constant pressure leads to more losses.

TYPE OF GOVERNING -III

- Mechanical: Transducer is mechanical centrifugal speed governor which actuates controls valves through mechanical linkages.
- Hydro mechanical: Here transducer is a centrifugal speed governor .It is connected to a Hydraulic system where the signal is amplified so that Control valves servomotor can be actuated.
- Hydraulic: Here speed transducer is a centrifugal pump whose discharge pressure is proportional to square of speed. This signal is sent to hydraulic converter which generates

a signal which is proportional to valve opening/Closure is required. Before applying it to control valves servomotor this signal is suitably modified.

- Electro Hydraulic:Here transducer can be electrical or Electronic. The generated signal after processed electronically and electrically is fed to a Electro- hydraulic converter which converts electrical signal into Hydraulic signal.Hydraulic signal before applying to control valve servomotor is suitably amplified.

REGULATION

- Regulation % of Turbine is defined as

$$\frac{(\text{No load Speed - Full Load speed})}{(\text{Nominal Speed})} \times 100\ \%$$

- It varies from 2.5% to 8%
- Normally it is 4 to 5 %
- Turbine having less regulation will be more sensitive in the grid and hence will share more load and vice versa
- Normally base load plant has high regulation and Peak load plant has small regulation.

VIBRATION

- Its manifestation in the form of amplitude of Oscillation, indicate some problem with the equipment e.g. Fever in a body
- The impact of high vibration usually are loss of integrity of components and associated generation loss because of forced outage either as a preventive measure or consequence of any failure due to high vibration/vice versa.

CAUSES, TYPE OF PROBLEMS

AND CORRECTIVE ACTIONS

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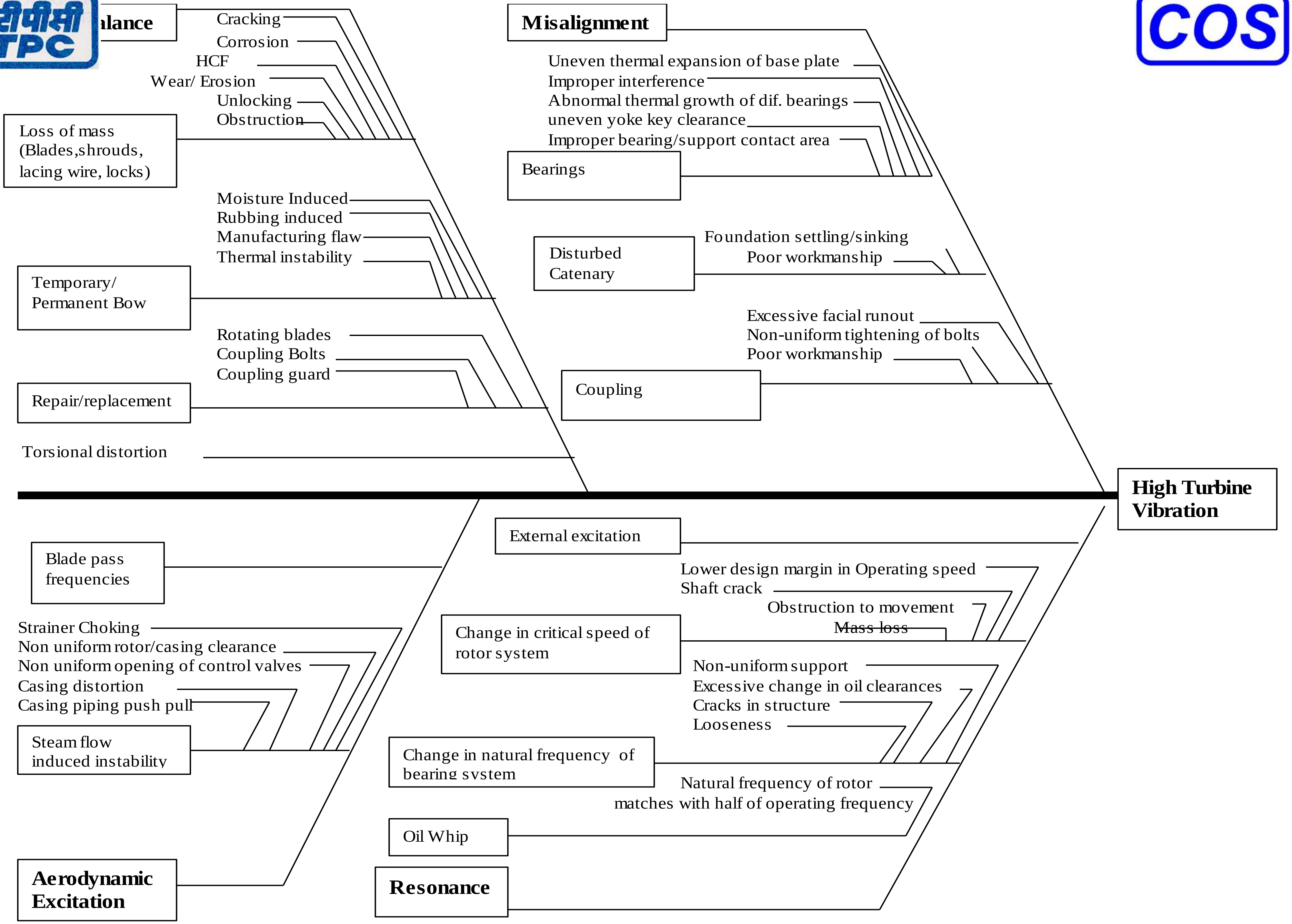
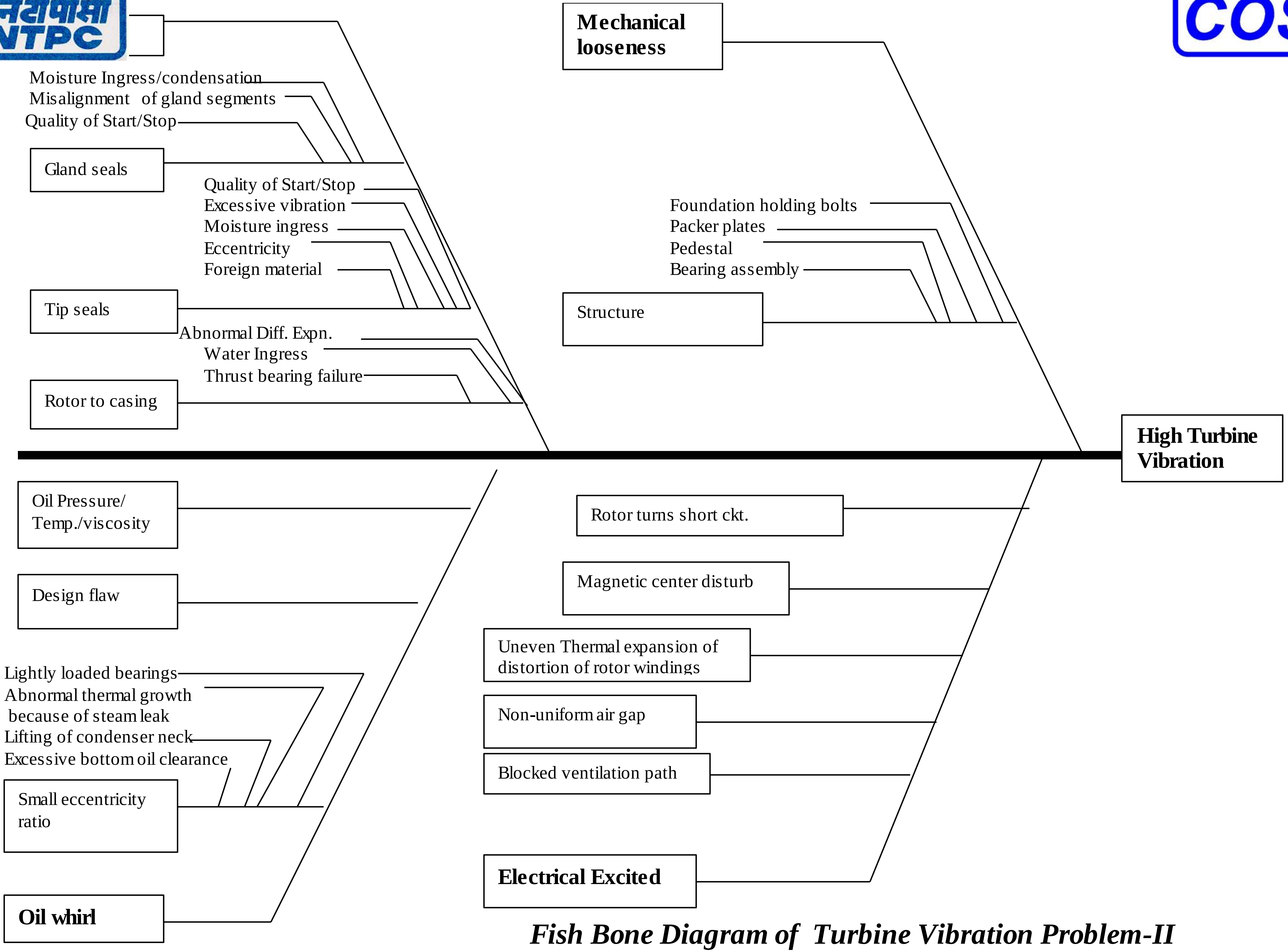
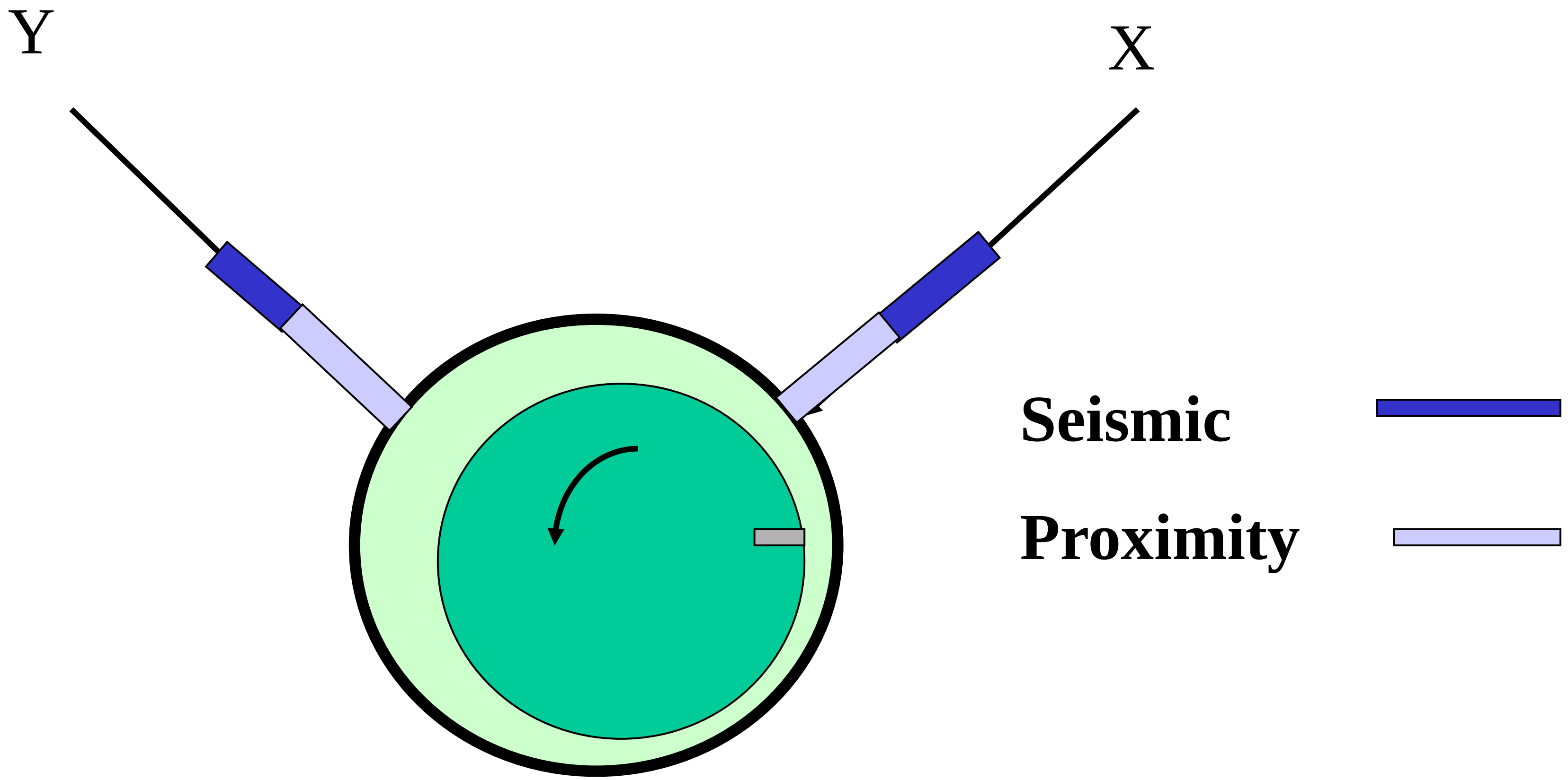


Fish Bone Diagram of Turbine Vibration Problems-I



Fish Bone Diagram of Turbine Vibration Problem-II

MEASUREMENTS, PORTABLE/ON-LINE



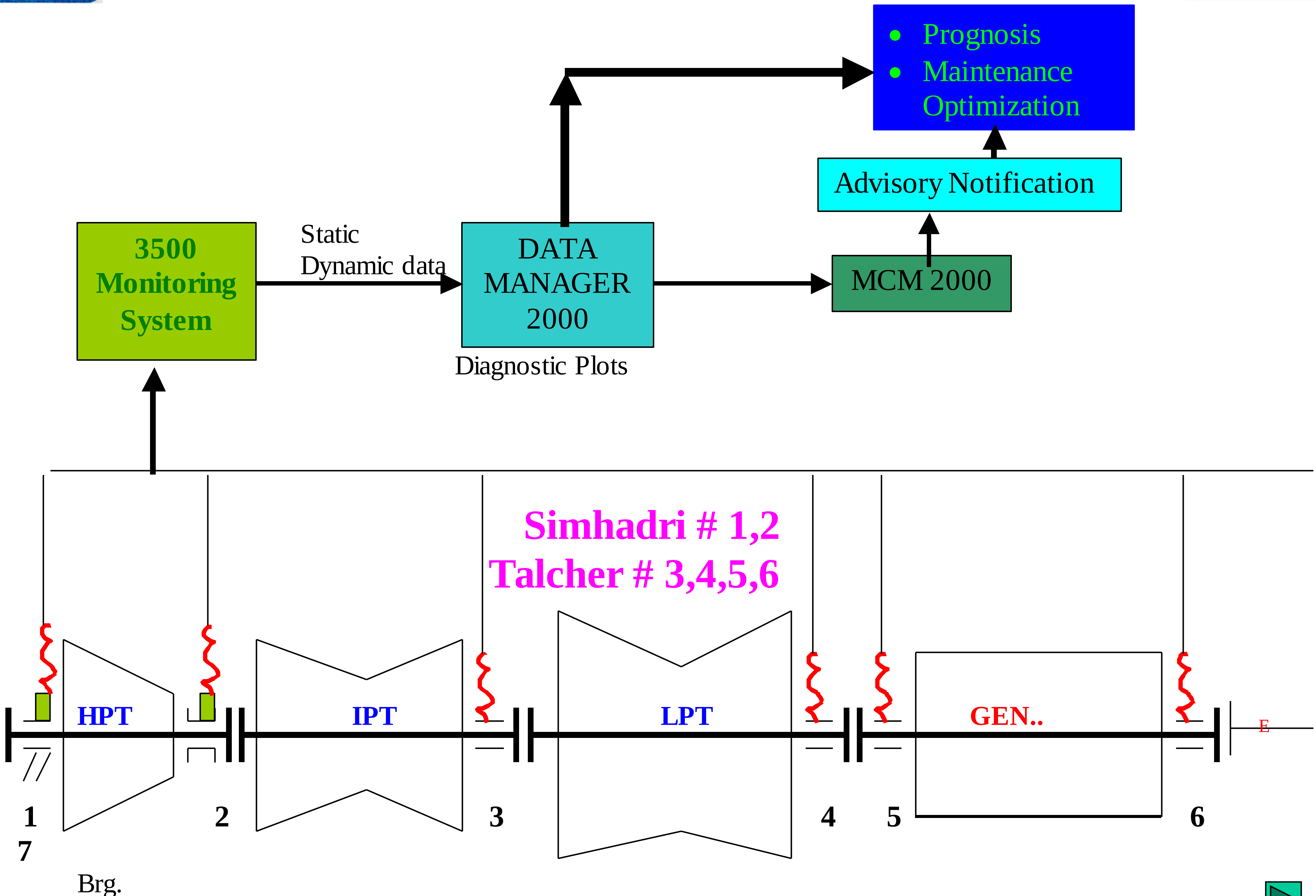
Shaft / Bearing assembly

with Orthogonal Transducers for capturing overall vibration and waveform

INFORMATION REQUIRED TO DIAGNOSE THE PROBLEM

- Frequency components causing change in amplitude of vibration (low frequency,1x, higher frequency etc.)
- Vector position (Phase and Amplitude) of 1x across different bearings in H,V and A directions, at different speeds.
- Bode plots,Cascade,Waterfall,Orbit plots,time waveform
- Process parameters correlation with load,speed,vacuum, etc.

LATEST DEVELOPMENTS- ONLINE DIAGNOSTIC SYSTEMS



Flow Diagram

FEATURES

- **Bar Graph**
- **Time waveform,Orbit**
- **Trend, Multi variable trend, XY plots**
- **Frequency spectrum,**
- **Acceptance region**
- **Bode,Water fall, Cascade**
- **Shaft average Centreline plot**

MCM/EXPERT SYSTEM WORKING