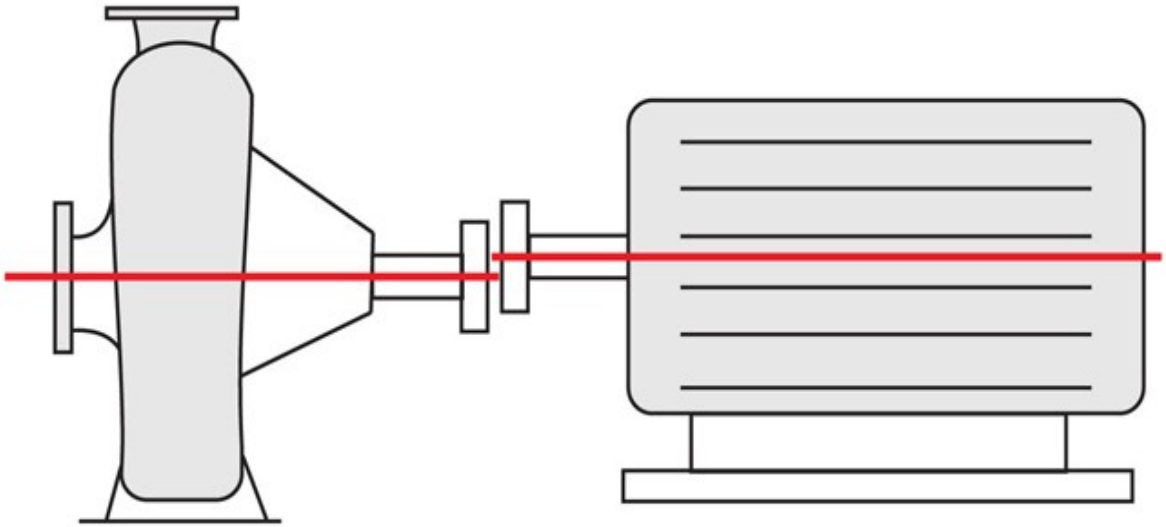
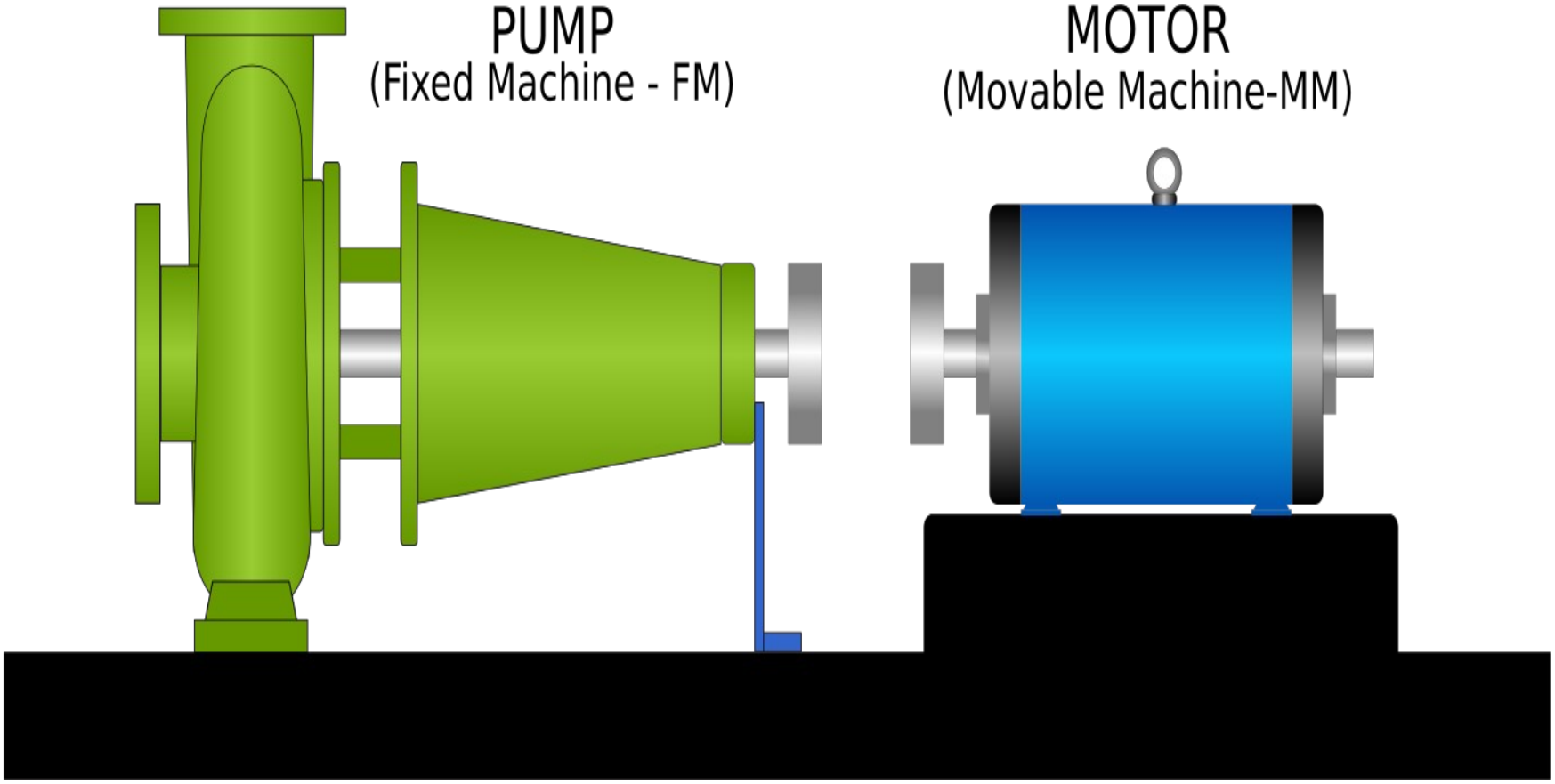
Pump Alignment



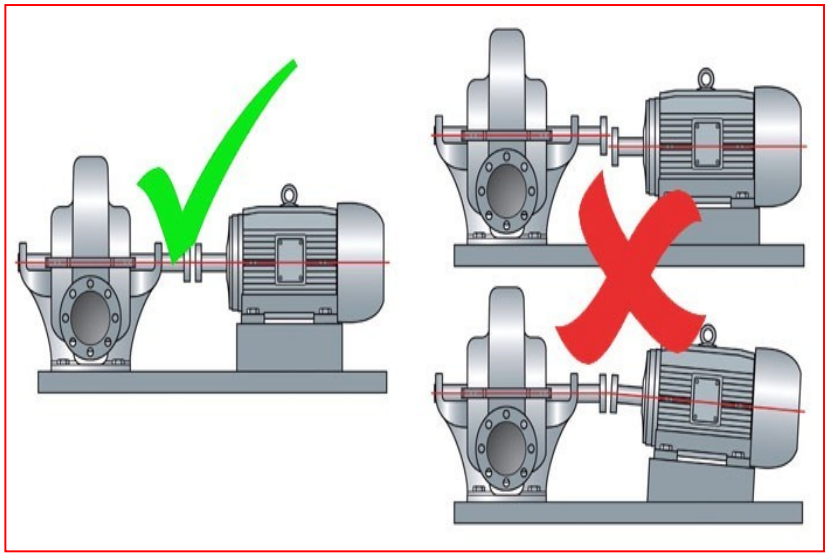

PUMP
(Fixed Machine - FM)
MOTOR
(Movable Machine-MM)

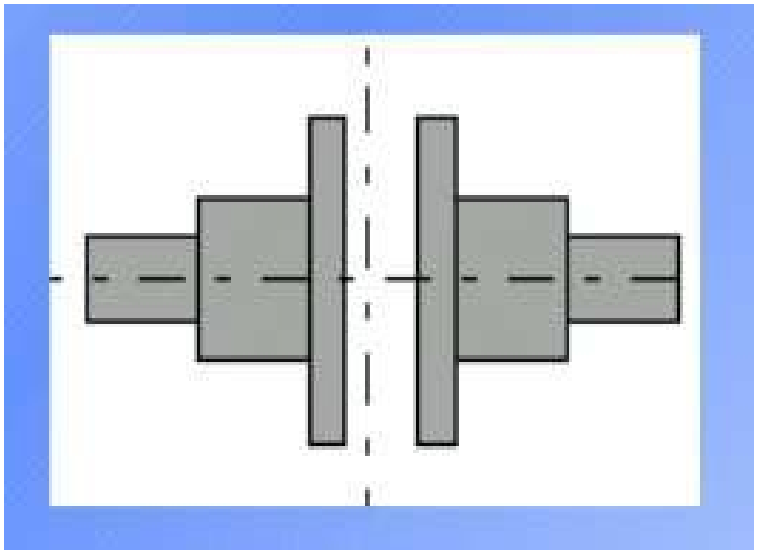
MACHINERY ALIGNMENT

- **Table of Contents**

What is Machinery/Shaft Alignment?

- The center lines of rotating shafts form a single line when the machines are working at normal operating temperature .
- Arrangement in a straight line .





Aligning Your Machinery Mean…

1. **Performance and protection of industrial equipment.**
2. **Increase operating time.**
3. **Increase production**
4. **Cost saving**

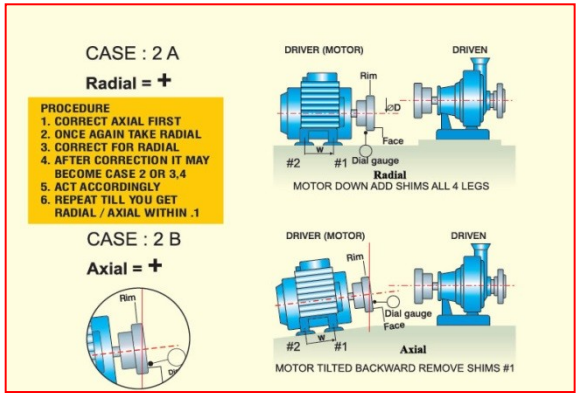
What is Misalignment & Types

- Shaft misalignment occurs when the center lines of coupled shafts do not match up.

There are two Types of misalignment.

1) **Offset/Radial Misalignment**
2) **Angular /Axial Misalignment**

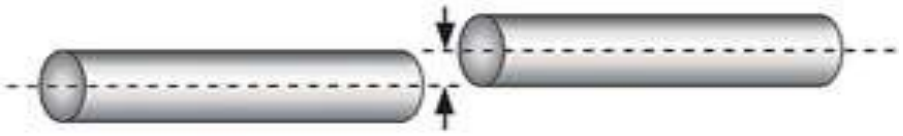
More than 50%problems are due to misalignment .



Radial Misalignment

- Parallel (radial) misalignment occurs when the driving and driven shafts are parallel but with some offset between their axial centers.
- Radial Misalignment can be further classified as

1) **Radial Vertical Misalignment**
2) **Radial Horizontal Misalignment**



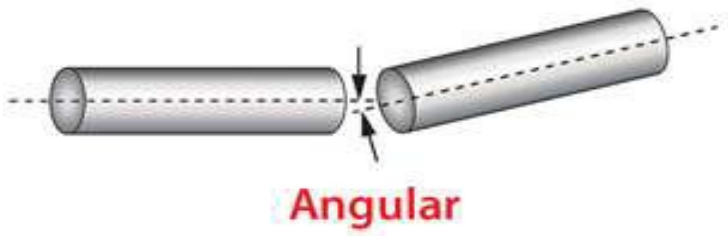
Parallel

Axial Misalignment

- Angular misalignment occurs when the axial centers line of driving and driven shafts intersect.

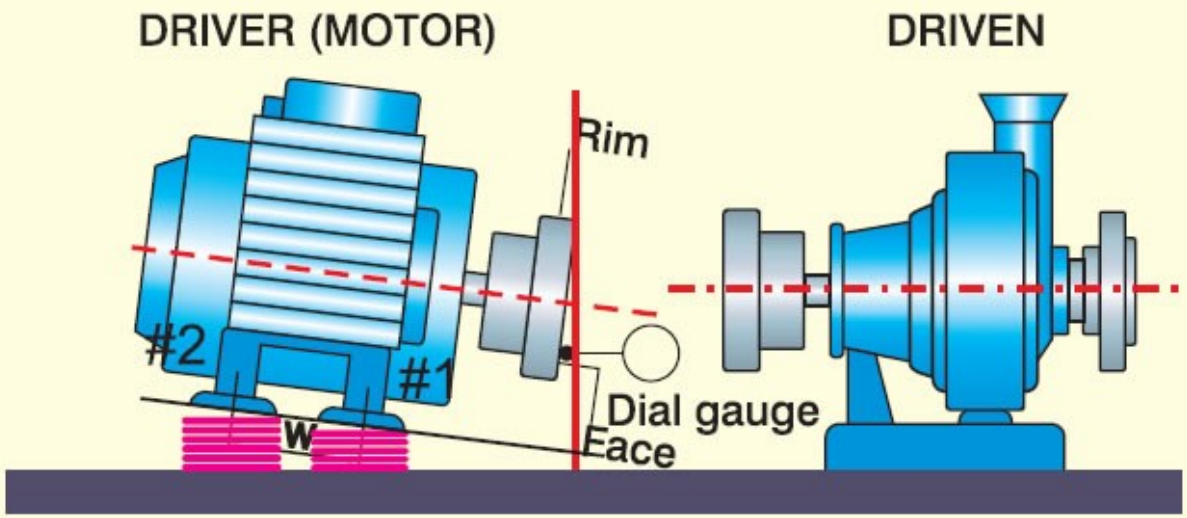
Axial Misalignment can also be classified as

1) **Axial Vertical Misalignment**
2) **Axial Horizontal Misalignment**
3) **Combination**



Axial Misalignment

UNDERSTANDING AXIAL
AXIAL - AT 180

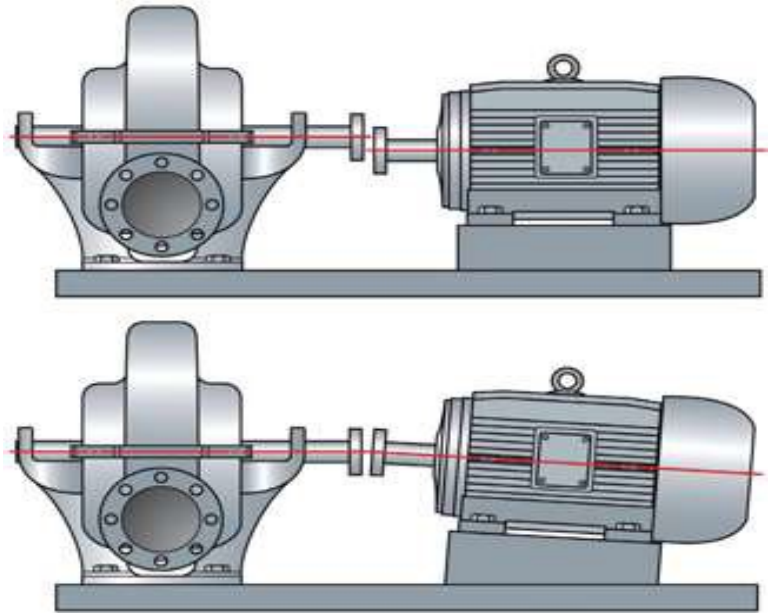


Axial

MEANS THERE ARE MORE SHIMS AT #2 AND LESS #1 *REMOVE SHIMS AT #2

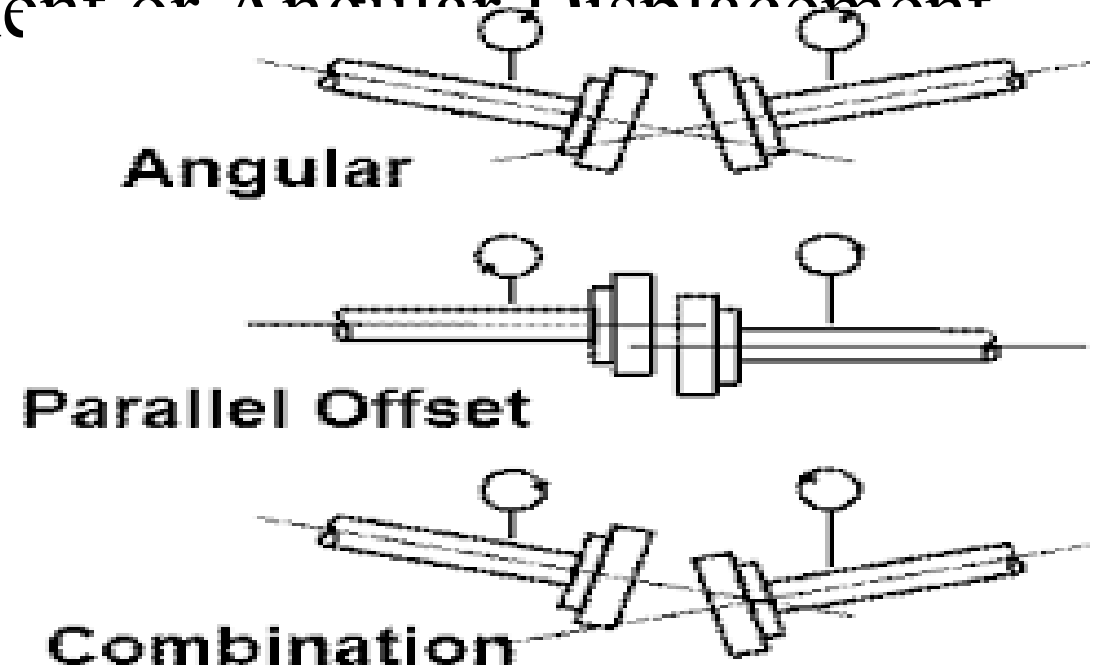
Misaligned Your Machinery Mean..

1. *Is a risk to your business.*
2. *Lead to unplanned*
3. *production stops.*
4. *Consume more power.*
5. *Can affect the quality of*
6. *the product you are*
7. *manufacturing.*
8. *Financial loss.*



Types of Misalignment

1) Parallel Displacement or Radial Displacement
2) Face Displacement or Angular Displacement
3) Combination



Method of Alignment

- Rough Alignment

1=Straight Edge ,steel rule, feeler gauge & Wire Method

Precision Alignment

2 = Rim & Face Method

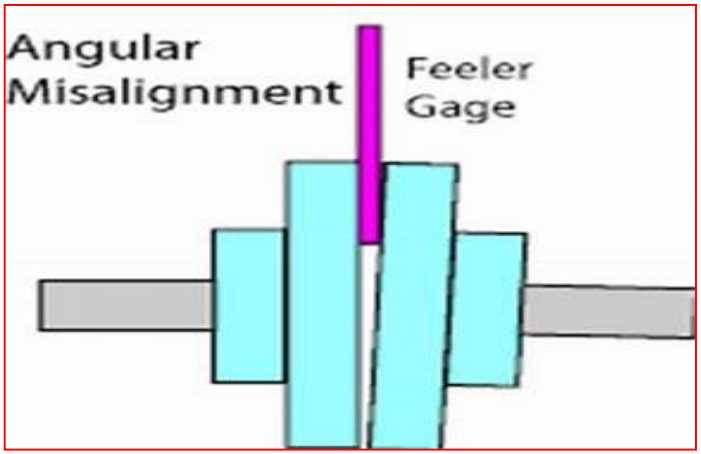
3 = Reverse Method/Graphical Method

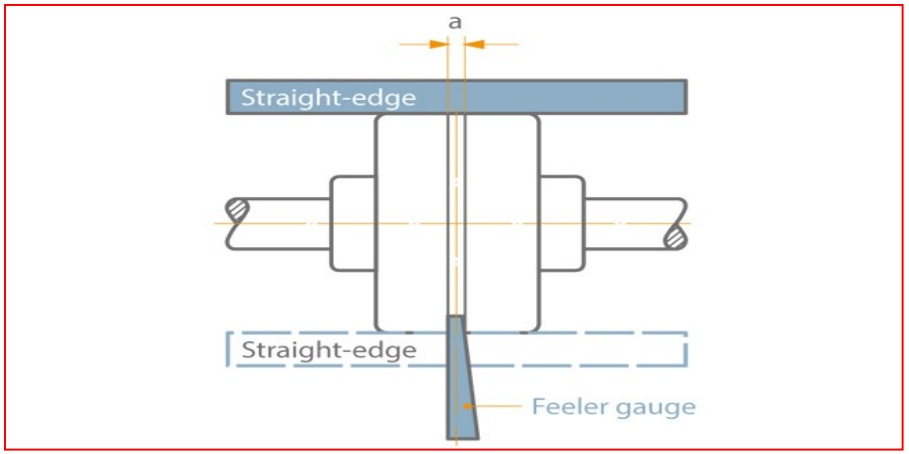
4 = Laser Method

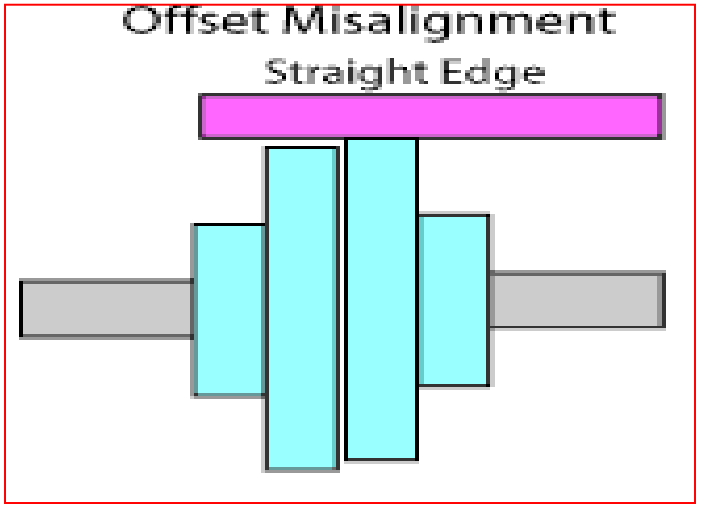
Method of Alignment

- feeler gauge and steel rule: This method is used when the coupling are mostly flexible and there is no spacer in between both hubs.
- Axial alignment check by feeler gauge.
- Radial alignment check by knife edge rule .

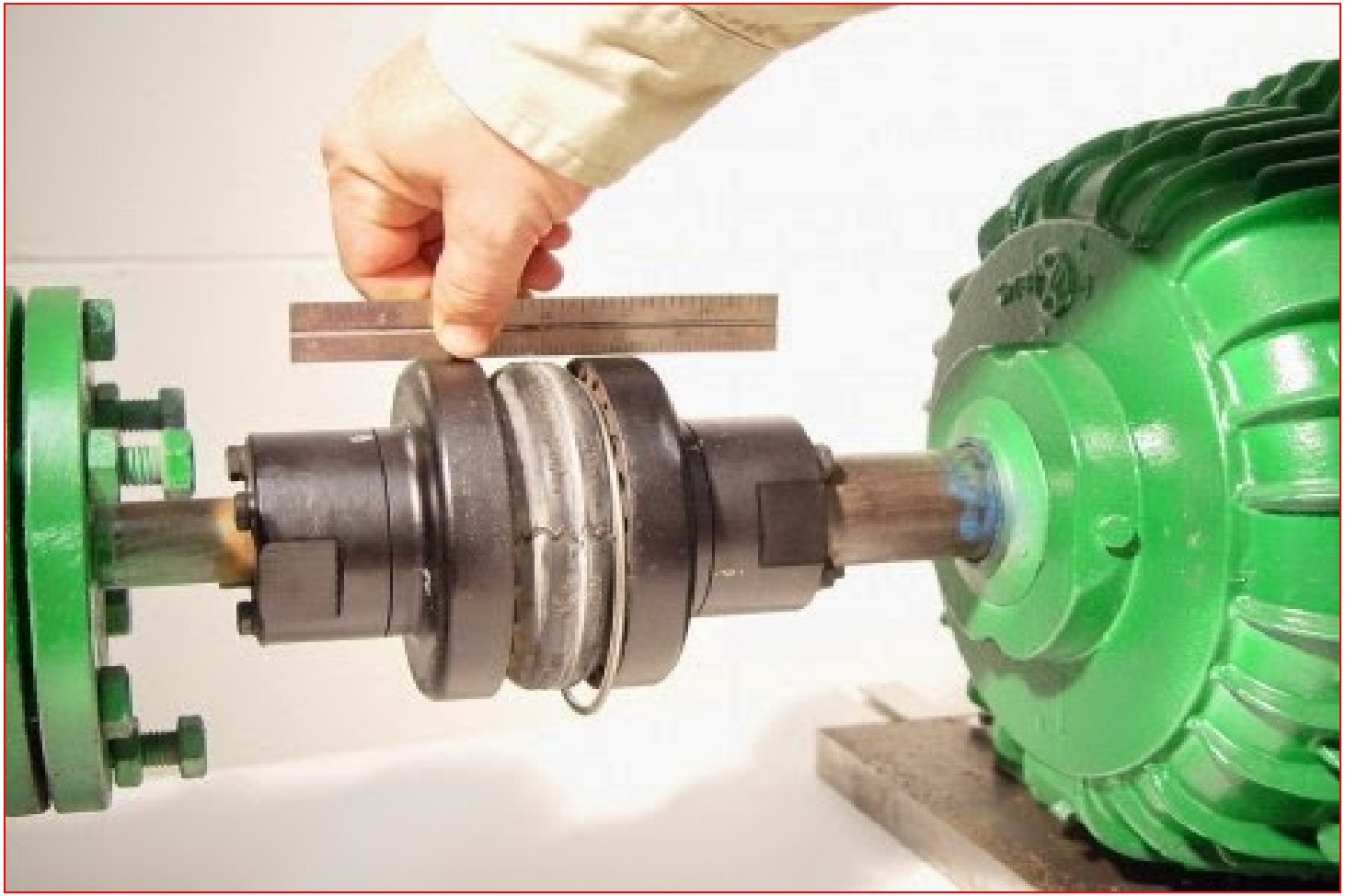
ALIGNMENT


Angular
Misalignment
Feeler
Gage


a
Straight-edge
Straight-edge
Feeler gauge

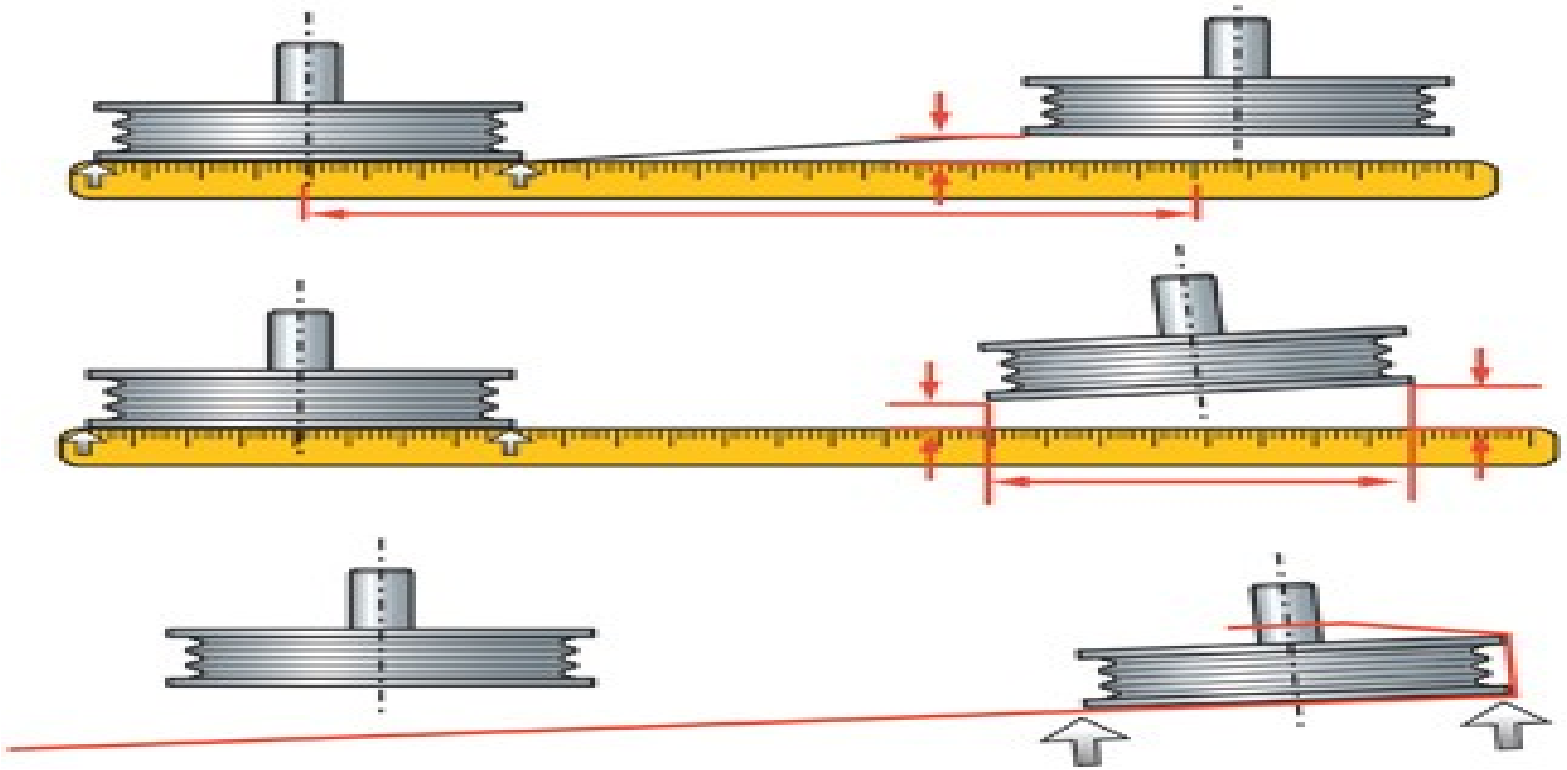

Offset Misalignment
Straight Edge

BY STRAIGHT EDGE



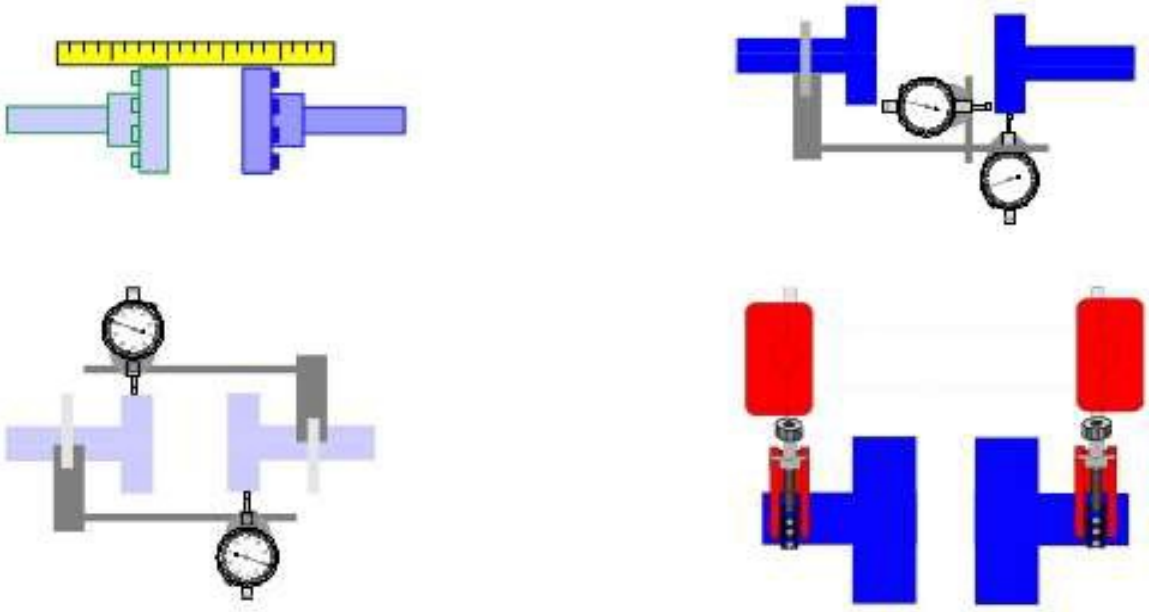
Alignment with straight edge

Alignment of V belt ,pulleys, sprockets and gears.



Method of Alignment

Shaft Alignment



Symptoms of Misalignment

1. Premature bearing, seal, shaft and coupling failure
2. High vibration
3. High Casing / Bearings / Oil Temperatures
4. Excessive oil leakage from bearing seals
5. Coupling is hot
6. Foundation bolts get loosen
7. Coupling bolts/Shims broken or loosen
8. Shafts are breaking (or cracking) at or close to the inboard bearings or coupling hubs Similar machine has less vibration

Effects of Misalignment

Misalignment can cause the following problems on the running machine. Vibration in the machine and associated / linked equipment's.

A.Excessive wear and temperature rise in the bearings.

B.It causes coupling failure.

C.Abnormal noise arises

D.Over loading of prime movers

E.Decreases the efficiency of the machine

Causes of Misalignment

1) Thermal Expansion
2) Stress.
3) Soft foot.
4) Bearing Failure.
5) Vibration.
6) Poor workmanship.

Mechanical Causes of Vibration

1) Unbalanced rotating components. Damaged impellers
2) Misalignment
3) Pipe strain.
4) Either by design or as a result of thermal growth.
5) Thermal growth of various components, especially shafts.
6) Rubbing parts.
7) Worn or loose bearings.
8) Loose hold down bolts.
9) Loose parts.

Why Precise Alignment is needed?

1) These factors increases the need of precise alignment and balancing to minimize vibration and premature wears of couplings, bearings and shaft seals.
2) Stresses from misalignment are directly proportional to the speed of unit.

Alignment States

Cold Alignment

Alignment which is carried out when the machine is at cold state.

Hot Alignment

- Alignment which is carried out when the machine is at hot state.

Pre-Alignment requirements?

Foundation

- Grout
- Base plate
- Piping
- Coupling Installation
- Soft Foot
- Shims
- Sag
- Feeler gauge

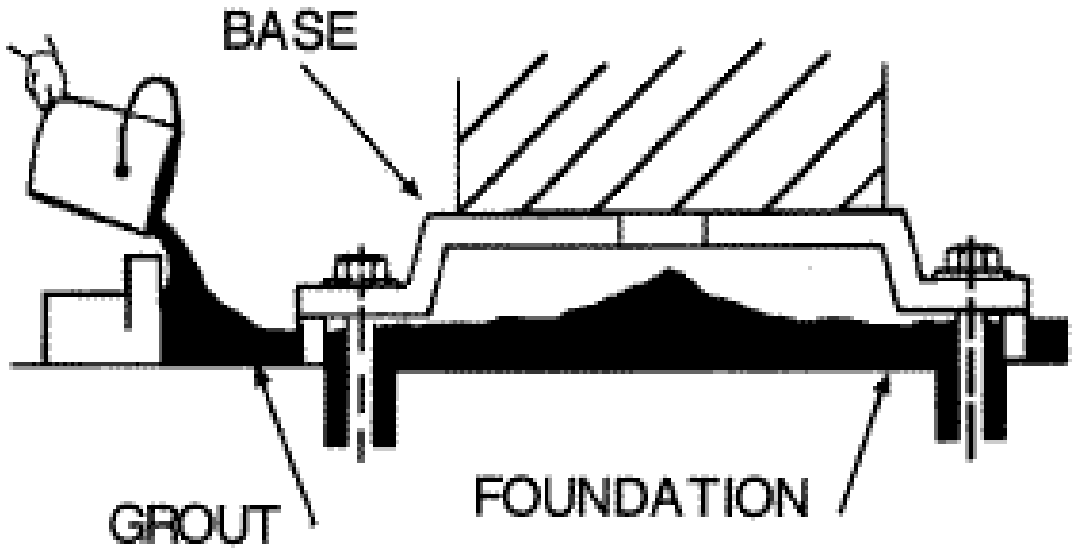
Foundation

- Thumb Role

  - Concrete weight should be equal to three times machine weight for rotating machines
  - Concrete weight should be five times for reciprocating machines

Grout

- Should be in good condition
- Tapping with a small hammer can detect hollow spots



Base Plate

- Should be rigid
- Machine mounting pads should be level flat and clean.

Piping

- Well fitted and supported.
  - Stress Free.
  - Sufficiently flexible, no more than 0.08mm
- vertical and horizontal movement occurs at coupling

Coupling

The coupling should be installed with a light interference fit with shaft.

Vary from .002”to .005”per inch of the shaft diameter.

Soft Foot

- **Machine feet do not rest flatly on the base of machine**.

One or more feet of a machine differ in height from the others .

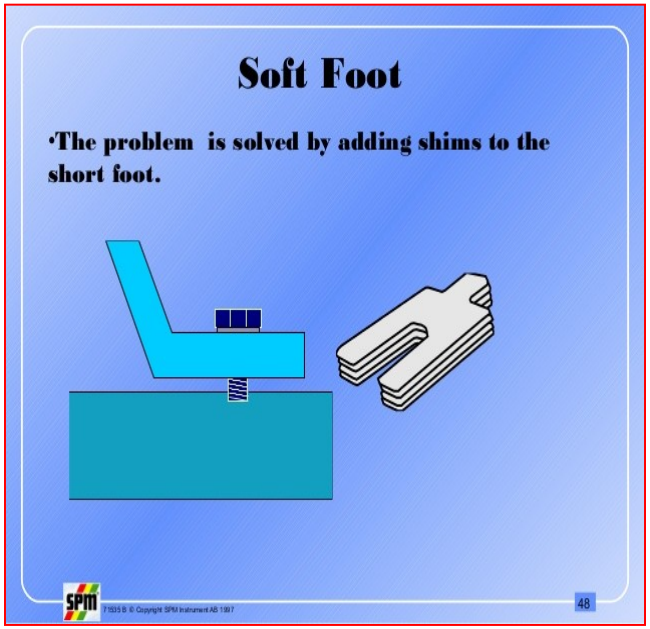
- Soft foot is caused by deformed machine base plates or deformed machine feet.
- This method is commonly used for soft foot check & correction.
- Place the Dial at foot of machine.

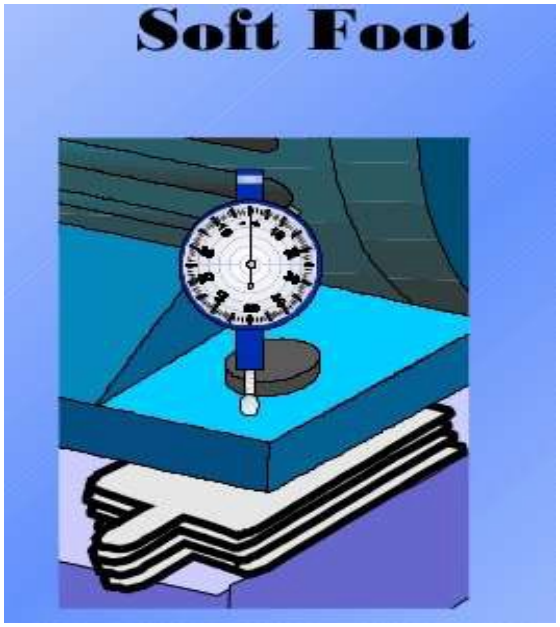
Tighten all hold down bolts then loosen one bolt at a time and note the deflection

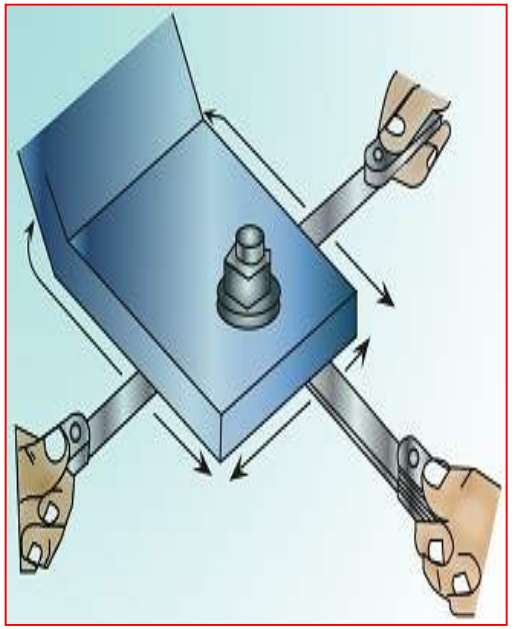
Maximum soft foot allowable limit is 0.05mm

Soft Foot

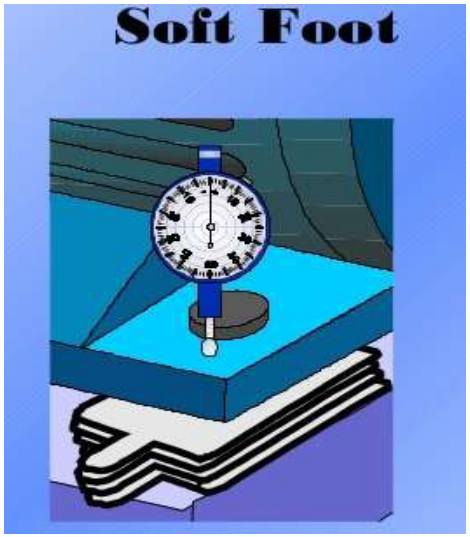
- Soft foot must be detected and eliminated on both the driving and driven machines before performing the alignment. Soft foot should be checked in each stages of the alignment .1=pre-alignment 2=Final alignment. Soft foot check by feeler gauge and dial indicator .

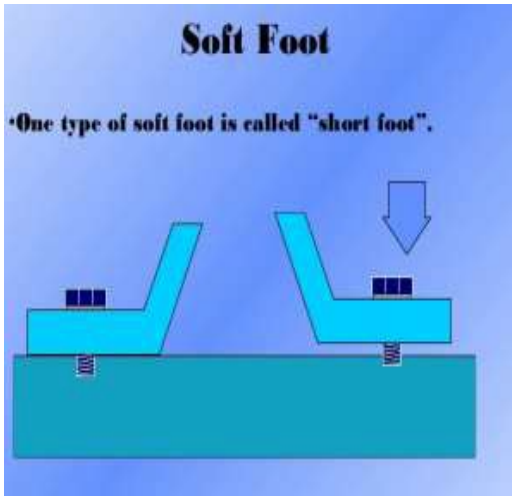


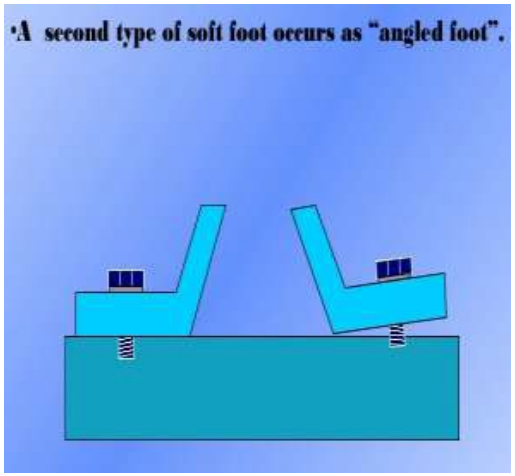


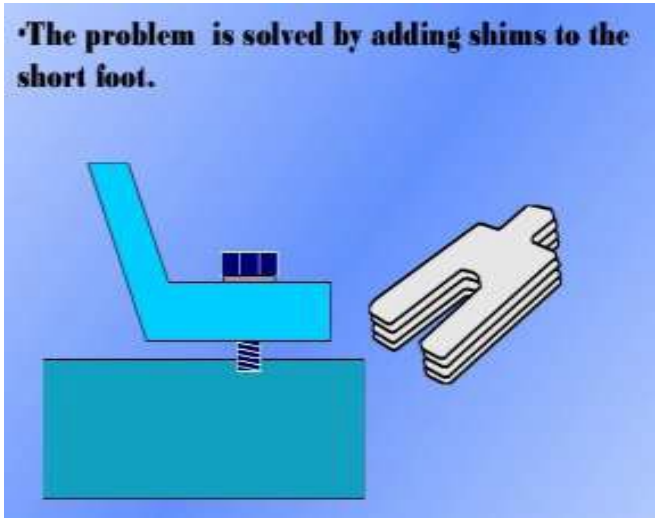


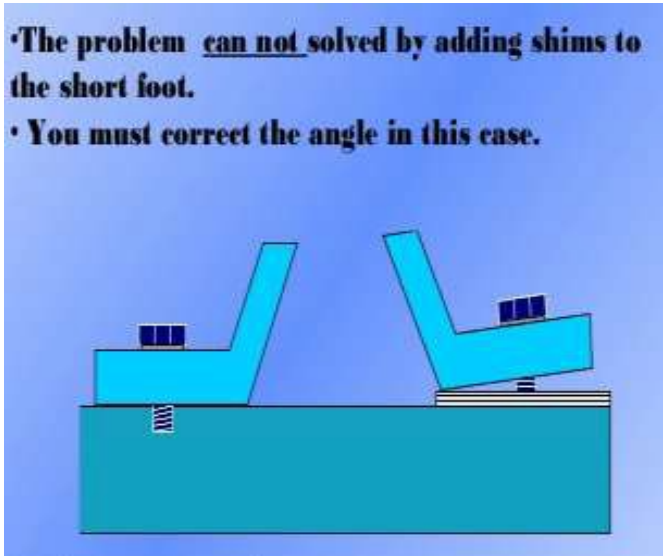
SOFT FOOT


Soft Foot


Soft Foot
•One type of soft foot is called "short foot".


•A second type of soft foot occurs as "angled foot".


•The problem is solved by adding shims to the short foot.


•The problem can not solved by adding shims to the short foot.
• You must correct the angle in this case.

Shims

- The shims used should be large enough to adequately support each foot.
- Don’t use Dirty shims-Clean them
- Many shims replace with fewer thick shims
- Use Pre-cut stainless steel shims
- Don’t reuse painted, or badly bent shims
- Best choice for shim material is stainless steel
- Maximum shim limit is12mm
- Try to use max 5 or less shims under each foot.

Its not always possible but try to minimize

SAG

The Inclination towards downwards in alignment Bracket due to gravitational force is called Bracket Sag .

Sag does not normally effect horizontal alignment.

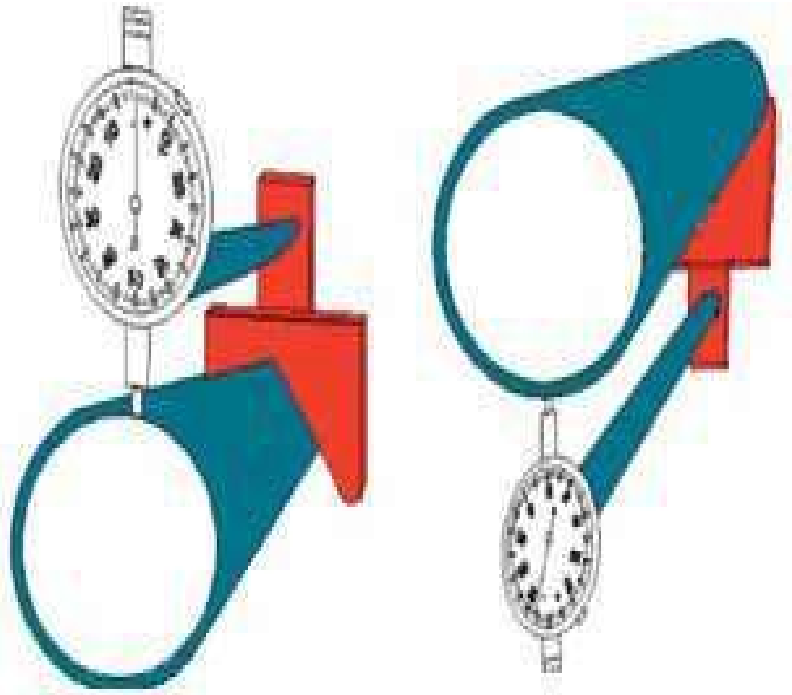
But in vertical measurement it depends on the spacer length

Q For less then 6” length of the spacer sag is negligible.

Q For spans greater then 6” sag should checked & Note down.

SAG CHECK

Dial



Thermal Growth

- For liquids 93 C° and below set motor shaft at same height as pump shaft.
- For liquids above 93 C°, set pump shaft lower or motor shaft higher as per OEM Recommendation.
- For foot mounted pumps or turbines

Tools requird for Machinery alignment

1) Dial Indicator (two dials)
2) Two brackets (for reverse indicator method)
3) Straight Edge/Steel Rule,
4) Meter tape
5) Venire Caliper
6) Micro meter
7) Inspection Mirror
8) Crowbar
9) Tool Box
10) Shims

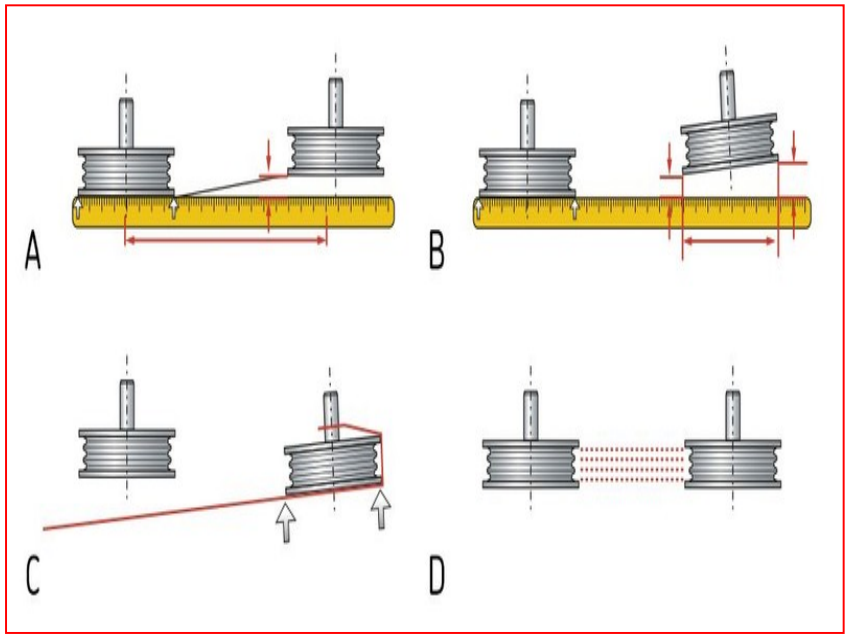
Alignment Methods (Cont.)

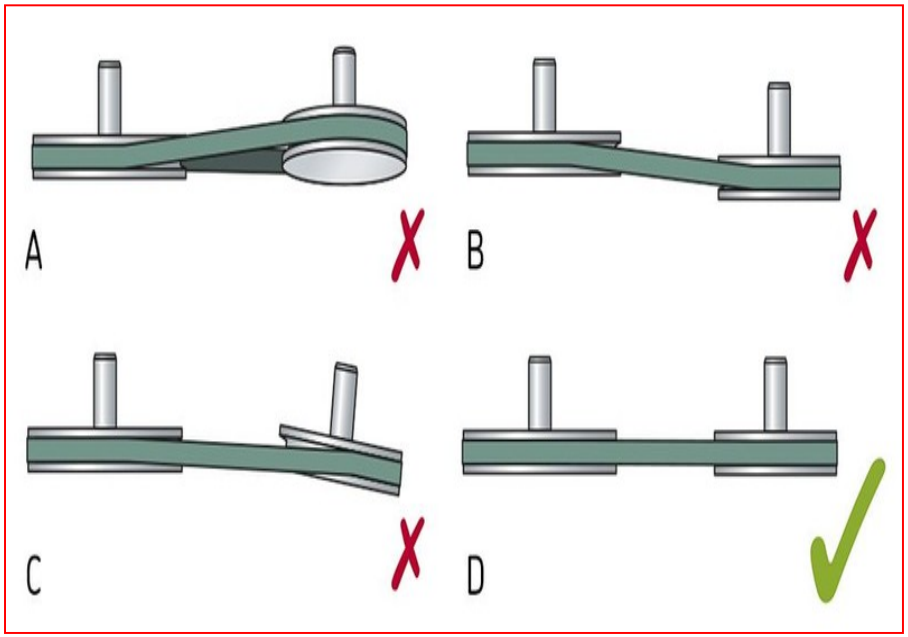
- **Alignment with Straight edge/Feeler Gauge.**

1. Allowed only on flexible coupling, as precise alignment can not be achieved.
2. Radial misalignment is checked / corrected with the help of straight edge or knife edge.
3. Axial misalignment is checked / corrected with the help of feeler gauge & ID Mic.
4. This method is used only for aligning the shafts of non critical machines.

MACHINERY ALIGNMENT

- **Pulleys /Sprockets Alignment With Steel Rule/Straight Edge**
- V Belt pulleys or sprockets can be align with straight edge bars/Steel Rule or strings.





Graphical or Reverse method

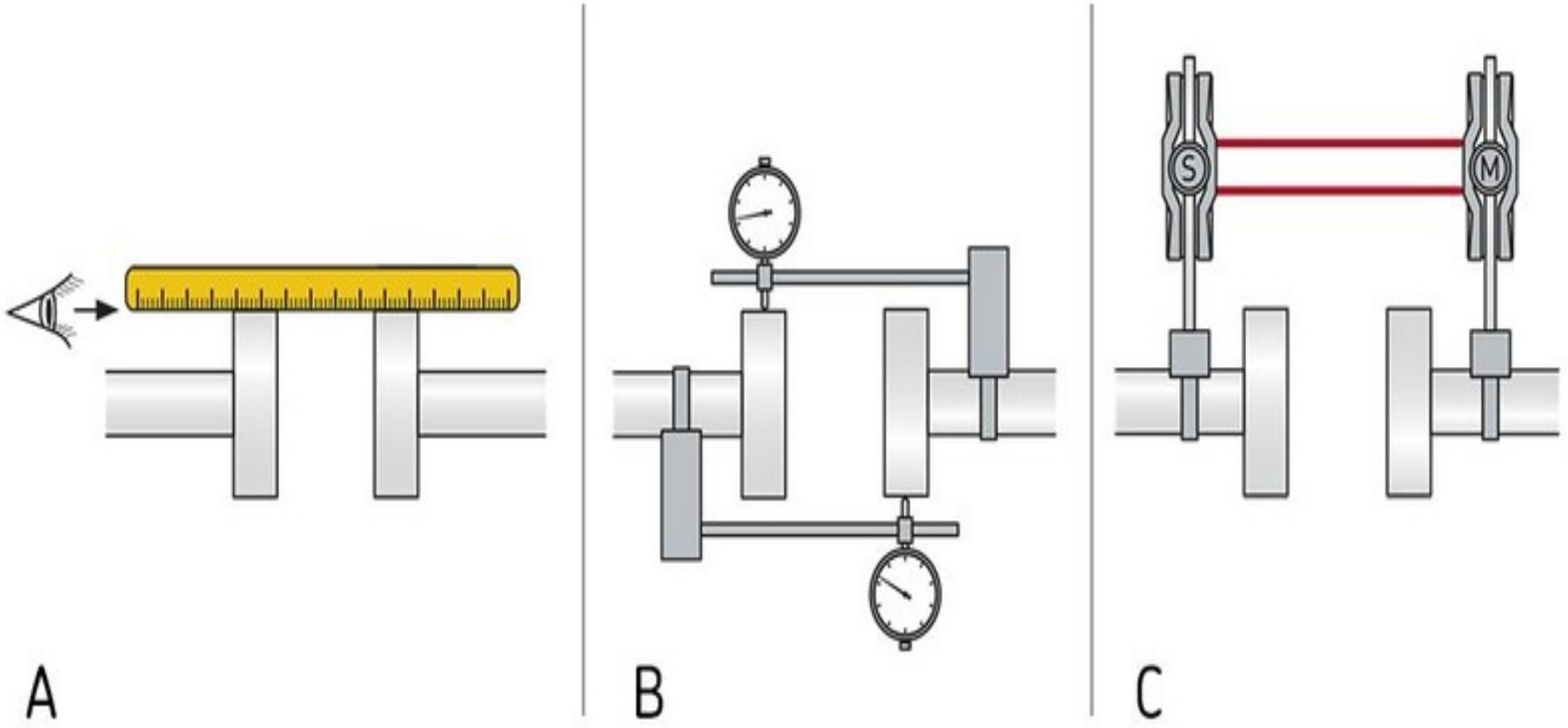
- In this method two dial indicators are fixed on both hub rims(radially).
- The dials are fixed on both sides such driver and driven. Shim calculate on graph paper .

One set of readings is taken from the loose machine to the fixed machine, and the second set of readings is taken from the fixed machine to the loose machine.

- It is therefore sometimes referred as reverse method.
- These readings are then plotted on the graph using suitable scale. How

- .

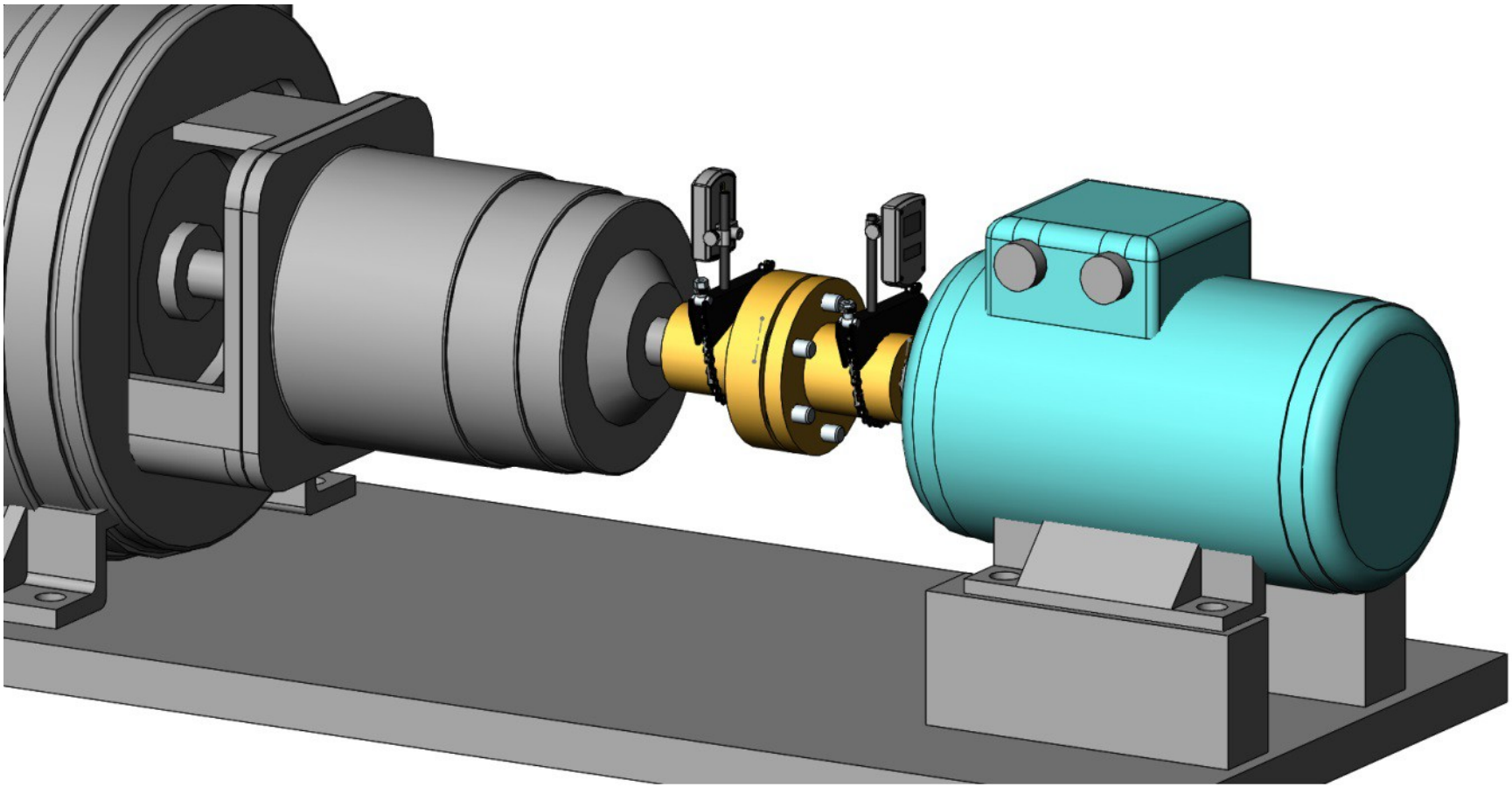
Graphical or Reverse method



Laser Method

1. The most modern & accurate method for aligning the shafts.
2. Laser alignment is the process of determining
3. misalignment by a laser beam.
4. Where laser is mounted on one shafts and a receiver or reflector is mounted on the other.
5. Both shafts are turned at the same time. The
6. deviation in the laser beam is measured as the shaft is turned and readings show on Display Unit.

Laser Method

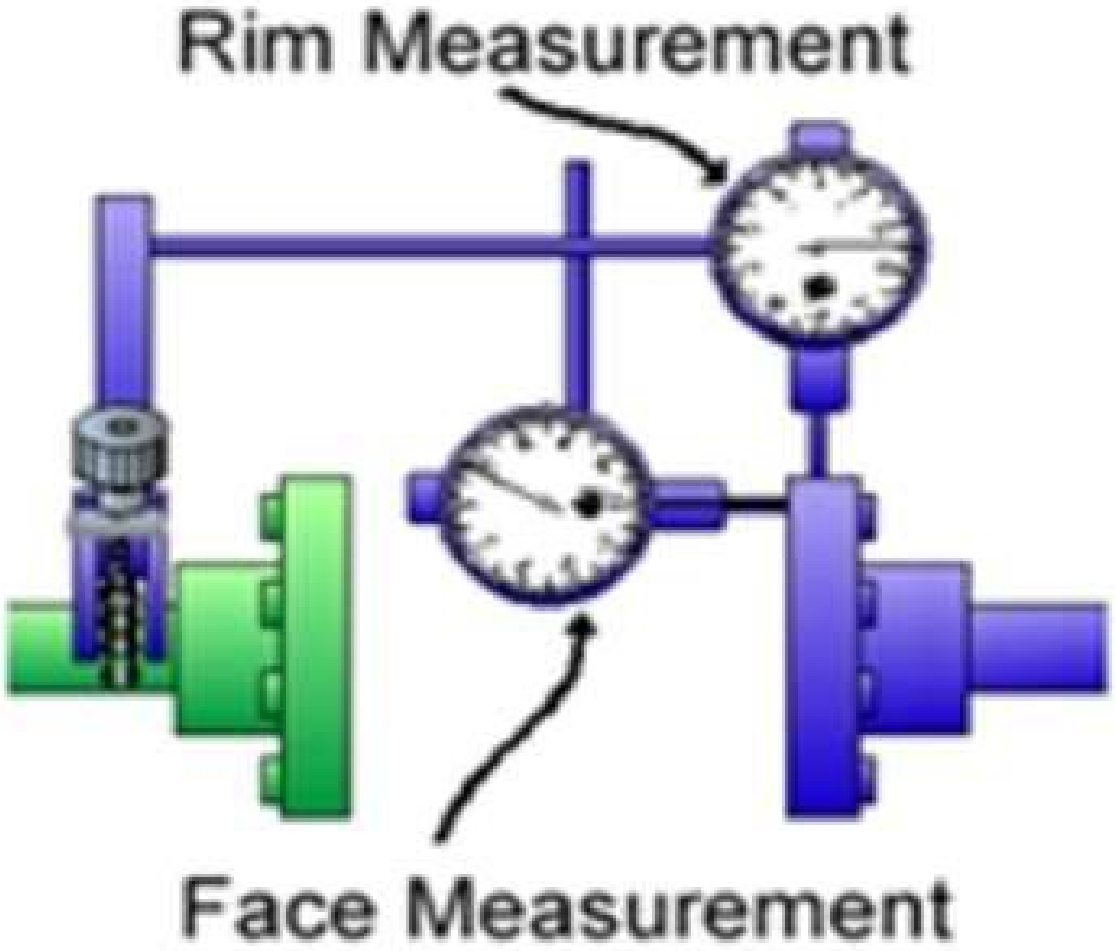


Rim & Face Method

For using dial indicators, it is necessary to prepare a suitable Fixture, which can hold two or three dial indicators

One dial indicators (R), with the axis in the radial direction, will measure the radial misalignment of the shafts. And one dial indicator (A) with the axis in the axial direction, will measure the axial misalignment of the shafts.

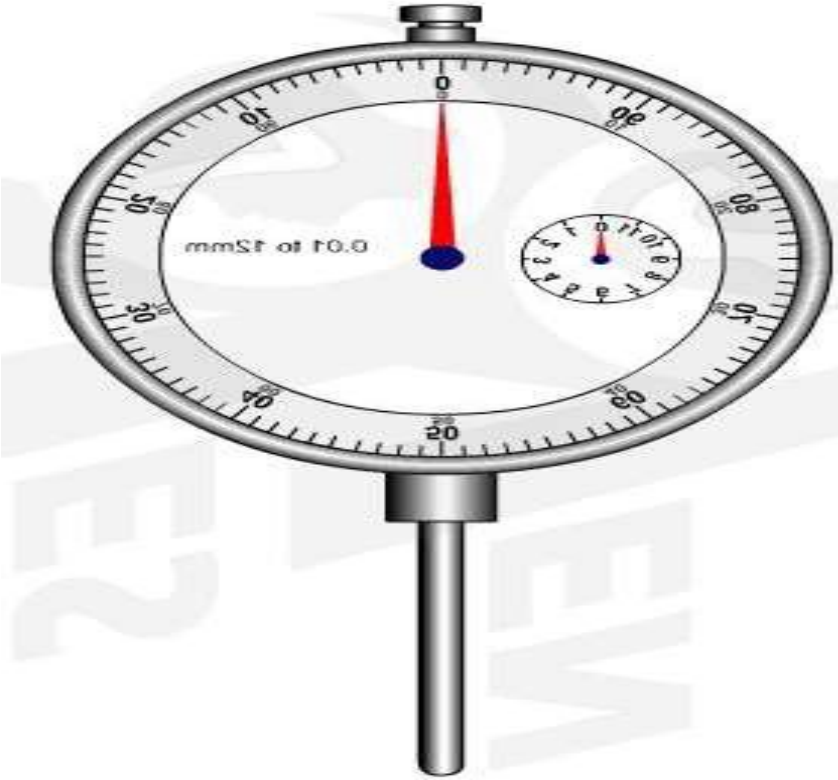
Rim & Face Method



Dial Indicator

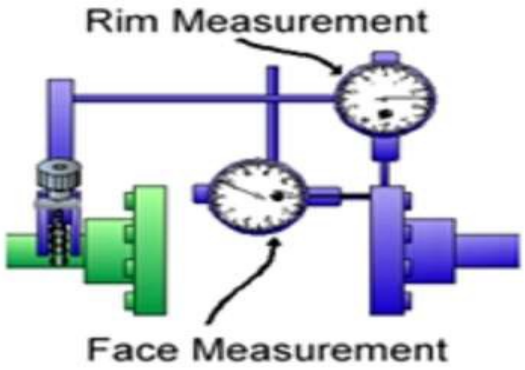
- ✓ Dial indicator can be used when there is a spacer between both hubs .
- ✓ One dial is fixed on the face of the hub ,for axial alignment and other is fixed at the rim of the hub ,for radial alignment
- ✓ Dial on fixed moveable machine .
- ✓ View from fixed machine.
- ✓ Dials must be some pre load for reading .
- ✓ After zero.
- ✓ When the dial indicator main pointer rotates by 360^{o}, the dial indicator small pointer will show 1mm displacement of the rod

Dial Indicator



Rim & Face Method

- Place the dial on the rim & Face of the coupling hub and secure it with the help of suitable Fixture.
- Measure the data during a rotation of 360o The algebraic sum of the values read on the horizontal plane (90o& 270o) will be equal to the values read on the vertical plane (0o and 180o).



Advantages & Disadvantages of Rim & Face Method

Advantages:

Good for large dia coupling hubs where the shafts are close together.

To be used where one of the shafts can not rotate during alignment.

Easy to use.

Disadvantages:

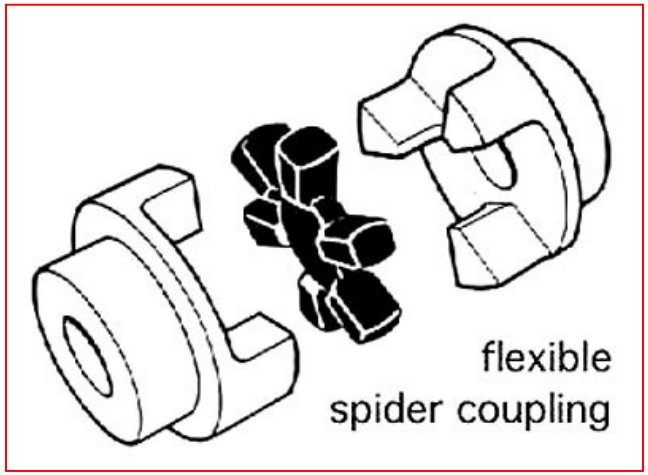
Difficult to take face readings, if there is axial float in the shaft

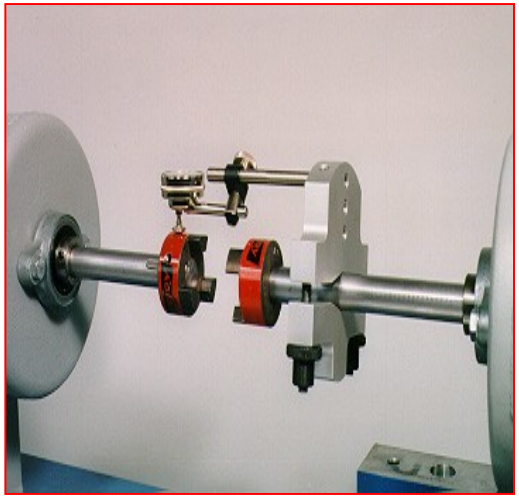
Requires removal of coupling spool.

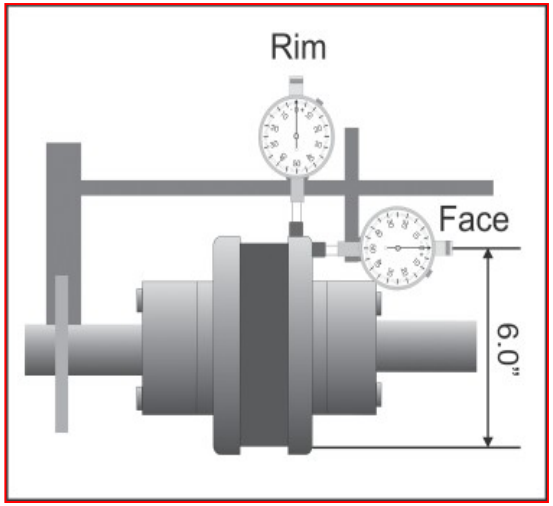
Indicator Sag

SPIDER COUPLING GAPE

- After alignment spider must be free inside of the jaws.
- Maintain the gap between the jaws ,2mm-4mm .

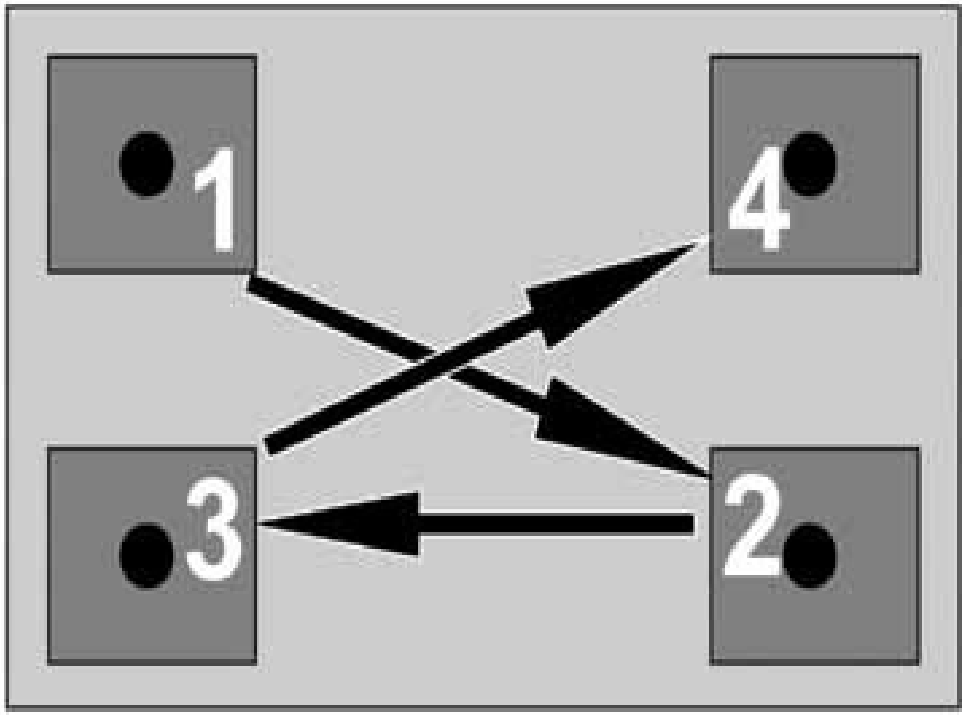






Tightening Hold Down Bolts

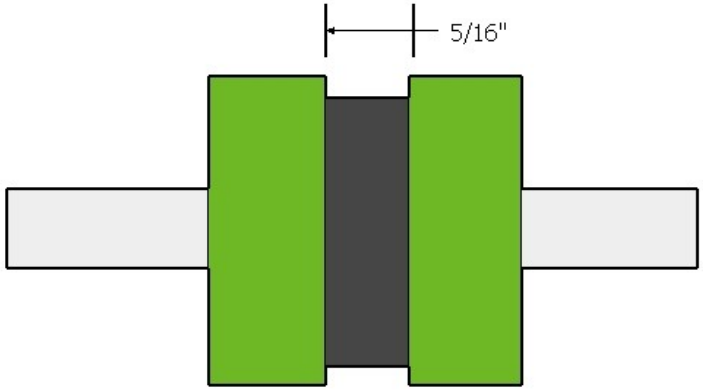
- Bolts should always be tightened in a known sequence so that vertical positions are repeated as you re-tighten the bolts.



Coupling Gap

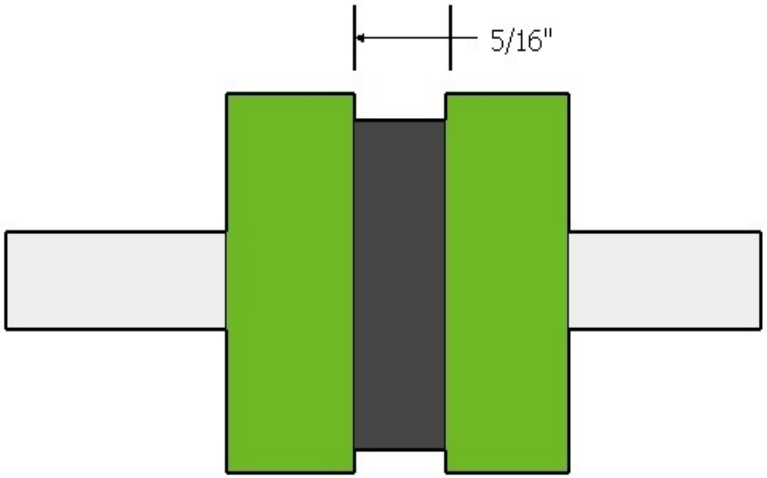
- An improper coupling gap causes excessive axial forces which result in increased bearing load.
- Improper gap can also cause destruction of an electric motor with plain bearings.
- The coupling gap should be set to the manufacturer's specification (to take care of thermal expansion in axial direction). DBSE= Distance between shaft end

  DBFF= Distance between face to face



Setting the Coupling Gap

- ✓ You check the coupling gap with a scale, feeler gauge, taper gauge, or an inside micrometer.
- ✓ Move the motor axially to set the proper gap.
- ✓ Electric motors with plain bearings have endplay.
- ✓ Therefore, you must position the motor shaft at magnetic center before setting the coupling gap.



Important Tips

1. Clean the Machine Base, Removes Rust, burrs etc.
2. Perform pre-alignment checks on machine
3. Use correct bolt tightening procedure.
4. Use jack bolts
5. Try to put the stem of dial gauge perpendicular to the surface of coupling hub
6. Check indicator sag
7. Check Run out of(Bent shaft, Out of round couplings)
8. Check the coupling gap

Important Tips

- After decoupling the machine, take alignment reading, if time permits. It serves as a reference reading, as some time it becomes difficult to get the desired readings.
- Before alignment, always ensure that there is no “soft footing” in the machine. If it exists, remove it prior to align.
- Use Jacking Bolts For move the Motor Never use Hammer
- If the machine has more than four feet, then it is better to carry out the alignment of the machine by reverse /graphical method.
- Always carry out the alignment job in the early day time.