

ITP 329

Pump Service & Maintenance
2017

Shaft Alignment

Aligning Base Mounted Pumps

- 1. After the base plate is leveled and anchor bolts are snugged up.**
 - Ensures that alignment can be attained at the completion of installation.
- 2. After grout (if required) has been poured and cured.**
 - Ensures that no changes have occurred during the grouting process.
- 3. After anchor bolts are properly tightened.**
 - Ensures that no changes have occurred after the base plate was mechanically locked to the grout and foundation.
- 4. After connecting piping.**
 - Ensures that pipe strain is not altering alignment.
- 5. After running at design temperature.**
 - Produces the best results for misalignment tolerances. Referred to as a “hot alignment”.
- 6. Alignment checks are required periodically throughout the life span of the pump.**



Couplings:

- Some couplings handle more misalignment than others
- Some couplings handle more horsepower than others



Pre-Alignment Checks:

- Properly grouted base
- No pipe strain (0.002")
- Good shims on clean flat surfaces
- No soft foot
- Heat adjustments



Types of Misalignment:

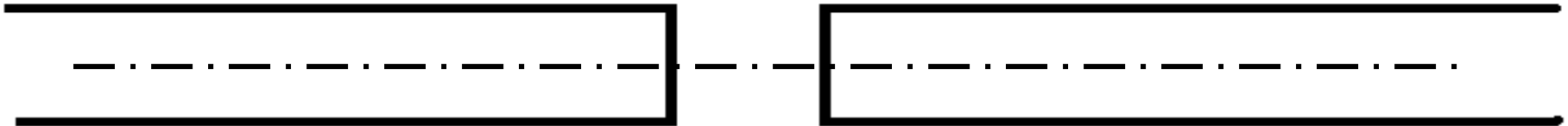
- Angular
- Parallel
- Combination of both



Alignment Methods:

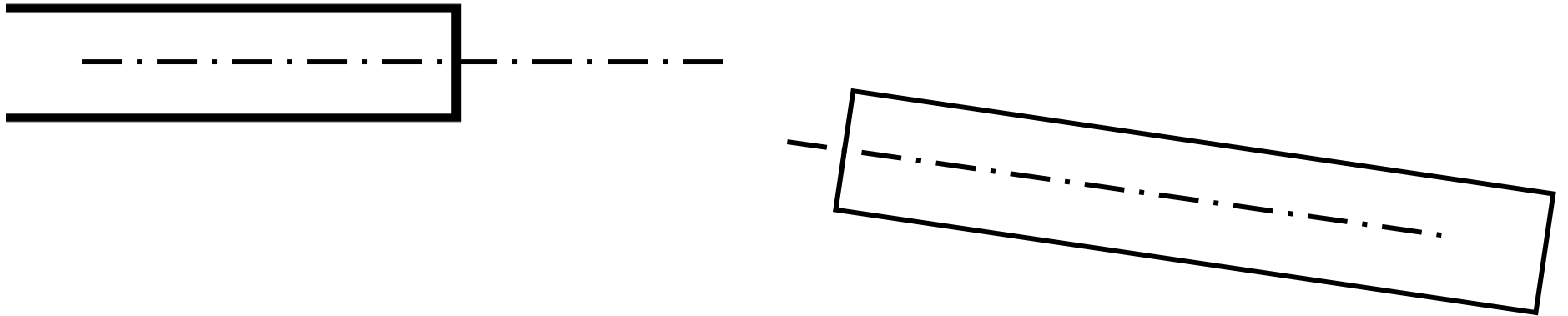
- Straight edge
(rough alignment)
- Dial indicator
(rim & face)
- Laser
(most accurate)

Alignment



- They must be properly aligned:
- a. Parallel
 - b. Coincident (Same axis)

Alignment



Often, they are not.

Alignment is Critical

- Correct alignment of pump and motor shafts is critical to proper operation
- Always align the motor to the pump, and not the pump to the motor

Misalignment leads to:

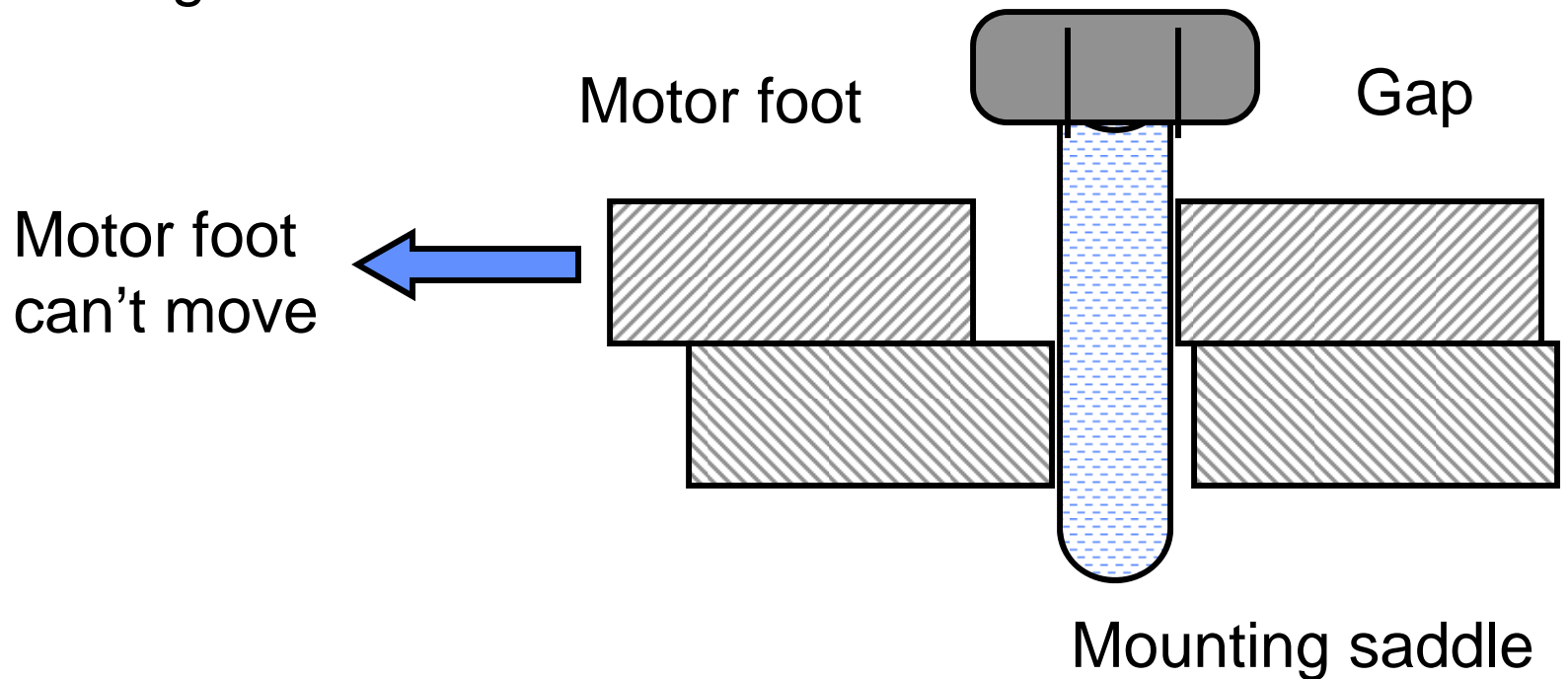
- reduced bearing life
- coupling damage
- high vibration
- reduced seal life
- increased downtime
- need for eventual re-alignment
(do the job right the first time)

Some Symptoms of Misalignment

- Rapid coupling failure
 - “Sawdust” under the coupler
- High level of vibration
 - Seal failure
- Bearings or couplings running hot
 - Bearing failure
- Lubricant leakage from bearing assembly
- High temperature at the coupling

Factory Checks

1. Bolt bound
2. Bottoming out

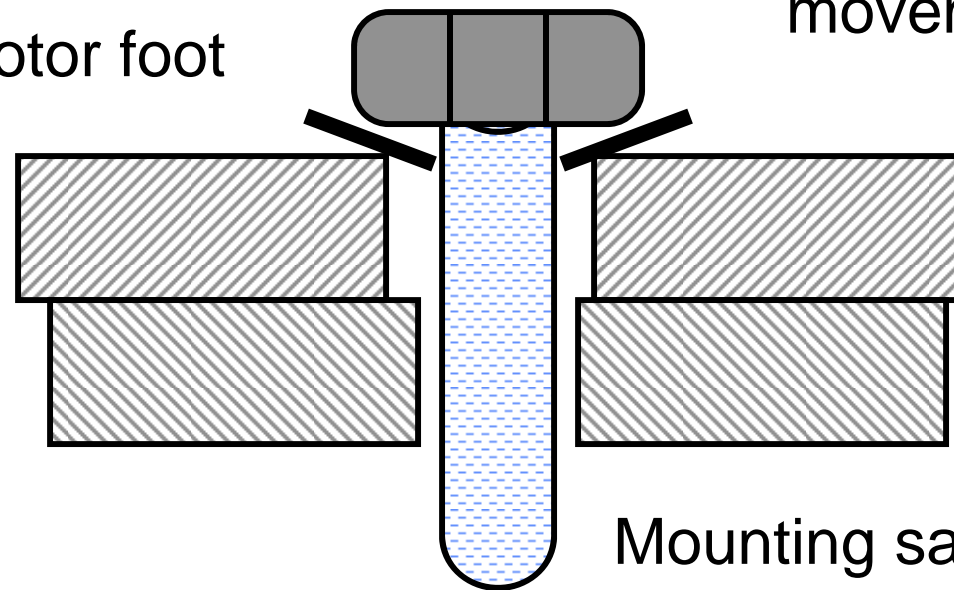


Factory Checks

Dowel effect

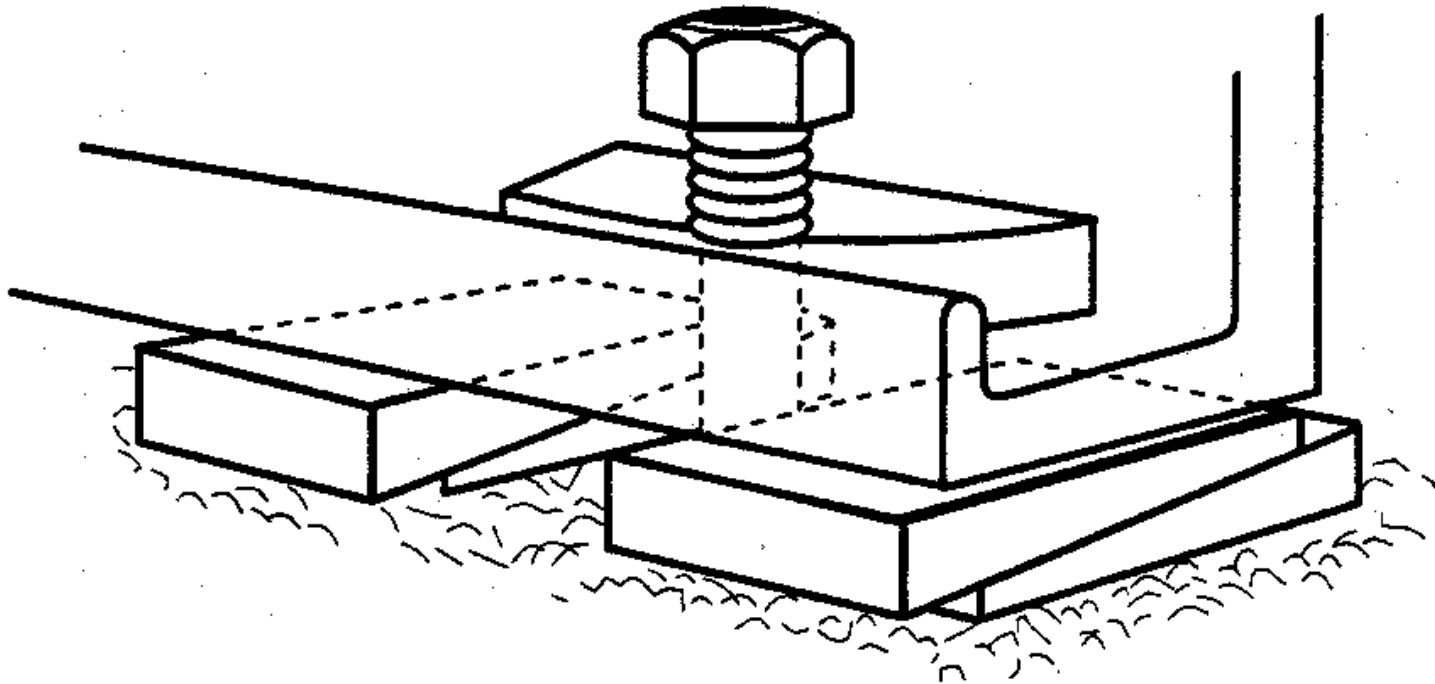
Washer prevents movement

Motor foot



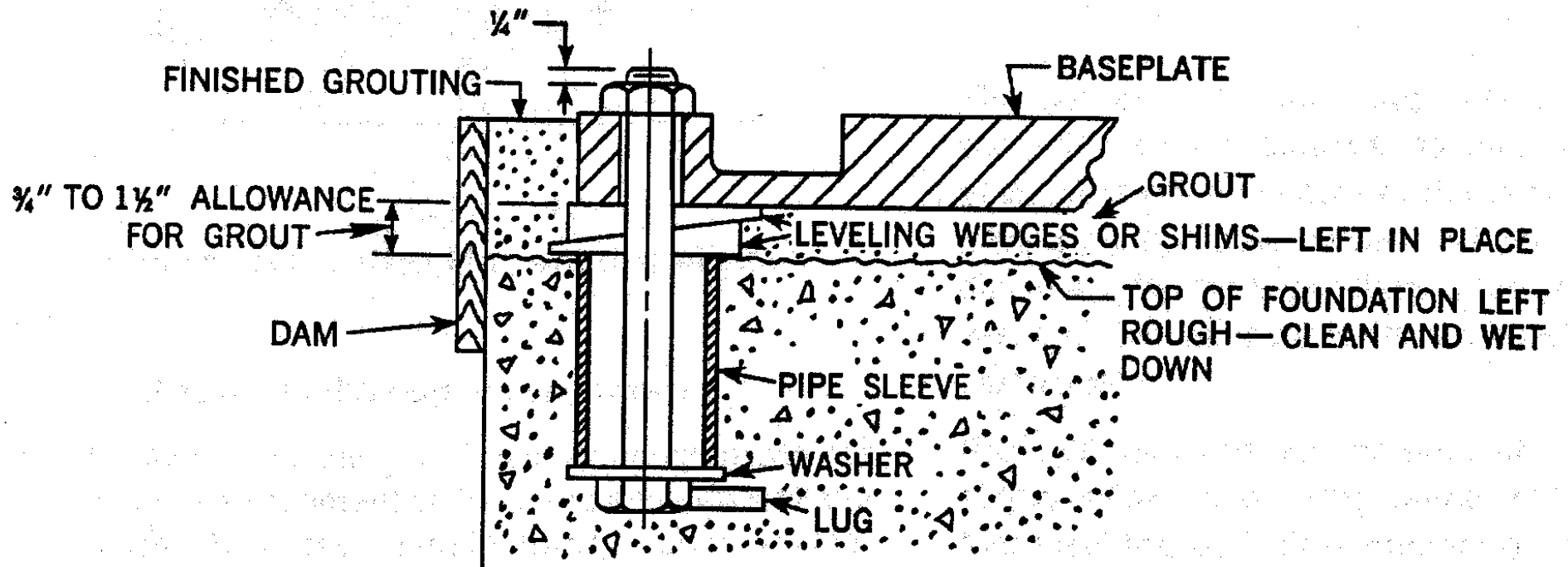
Mounting saddle

Proper Baseplate Installation



Wedge-shaped shims must bear equal weight to prevent distortion of the base

Grout the Baseplate



Given:

The pump comes from the factory rough aligned and has been checked to insure that precise alignment is possible; e.g. not hole bound etc.

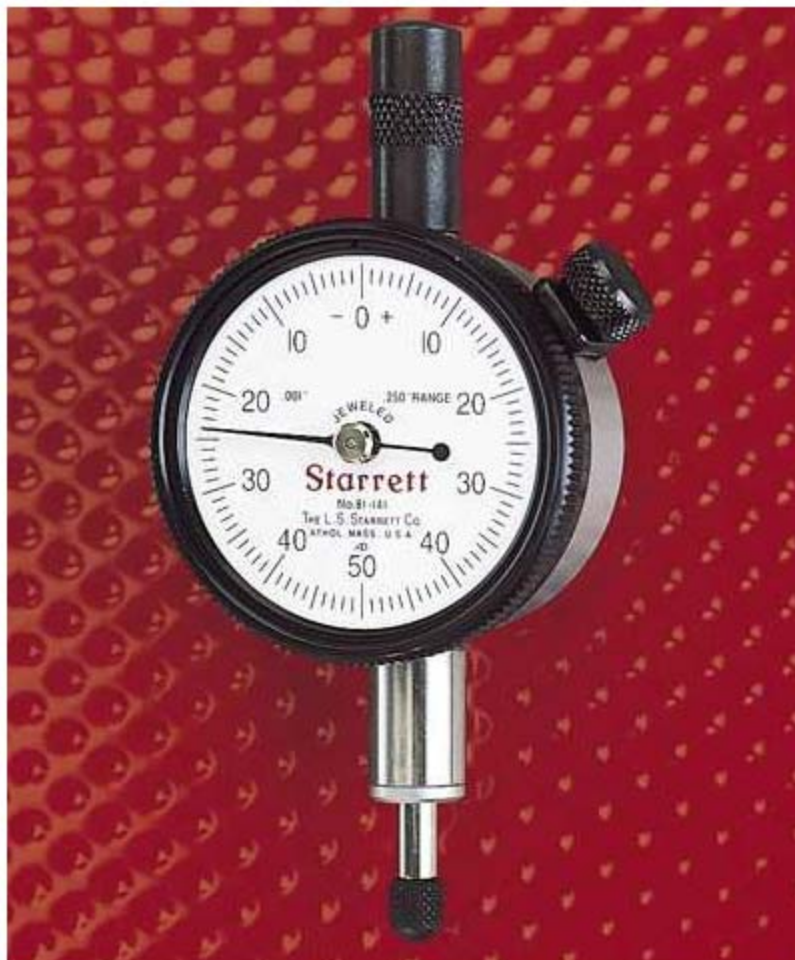
The pump is the stationary machine, “SM”.

The motor is the machine to be shimmed, “MTBS”.

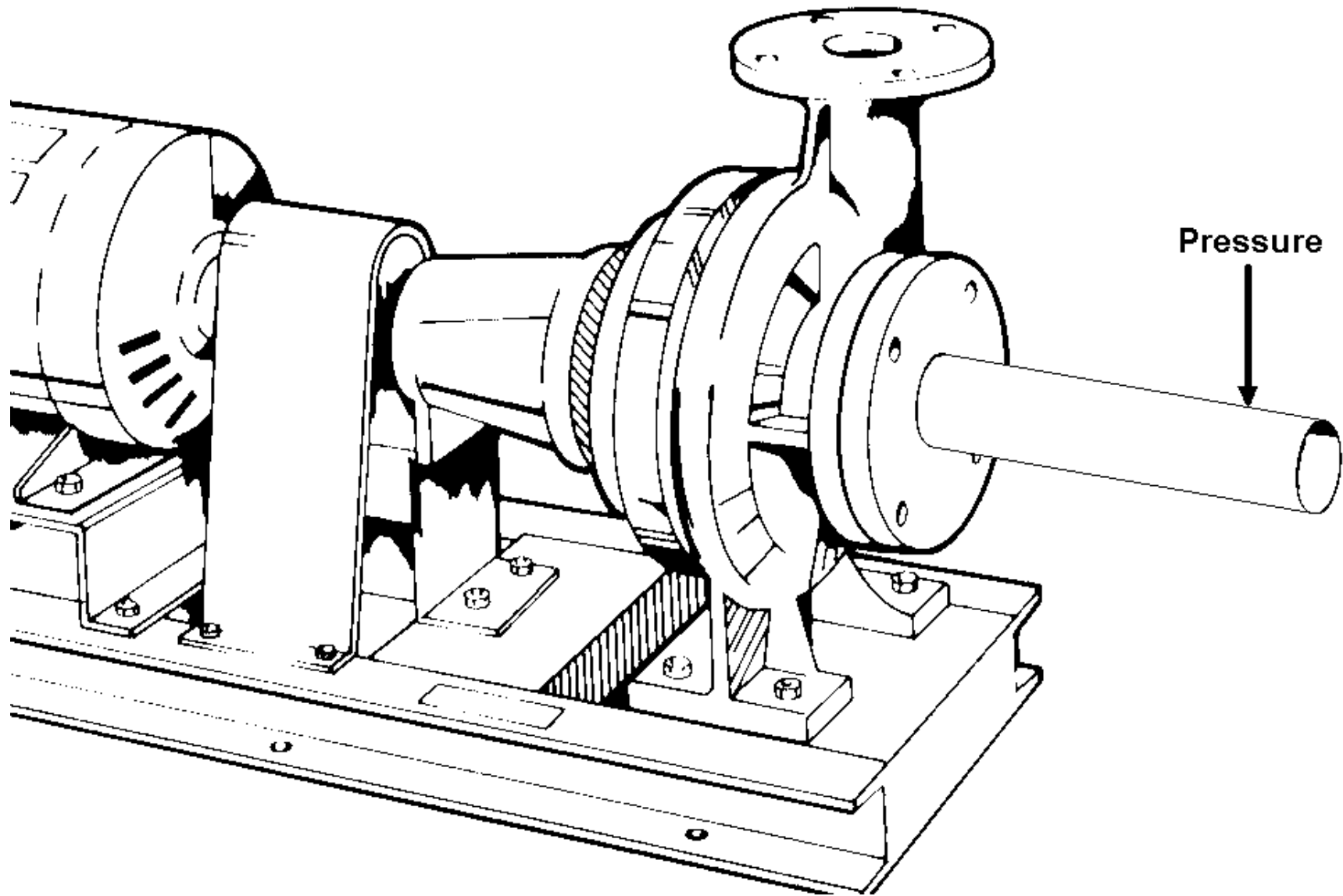
Good Practice

- It is a good idea to do a rough alignment (see Straight Edge method) with the base in place and ready to be grouted
- The pump shaft should not move more than 0.002” when the piping is fastened
- How can we measure the shaft deflection?

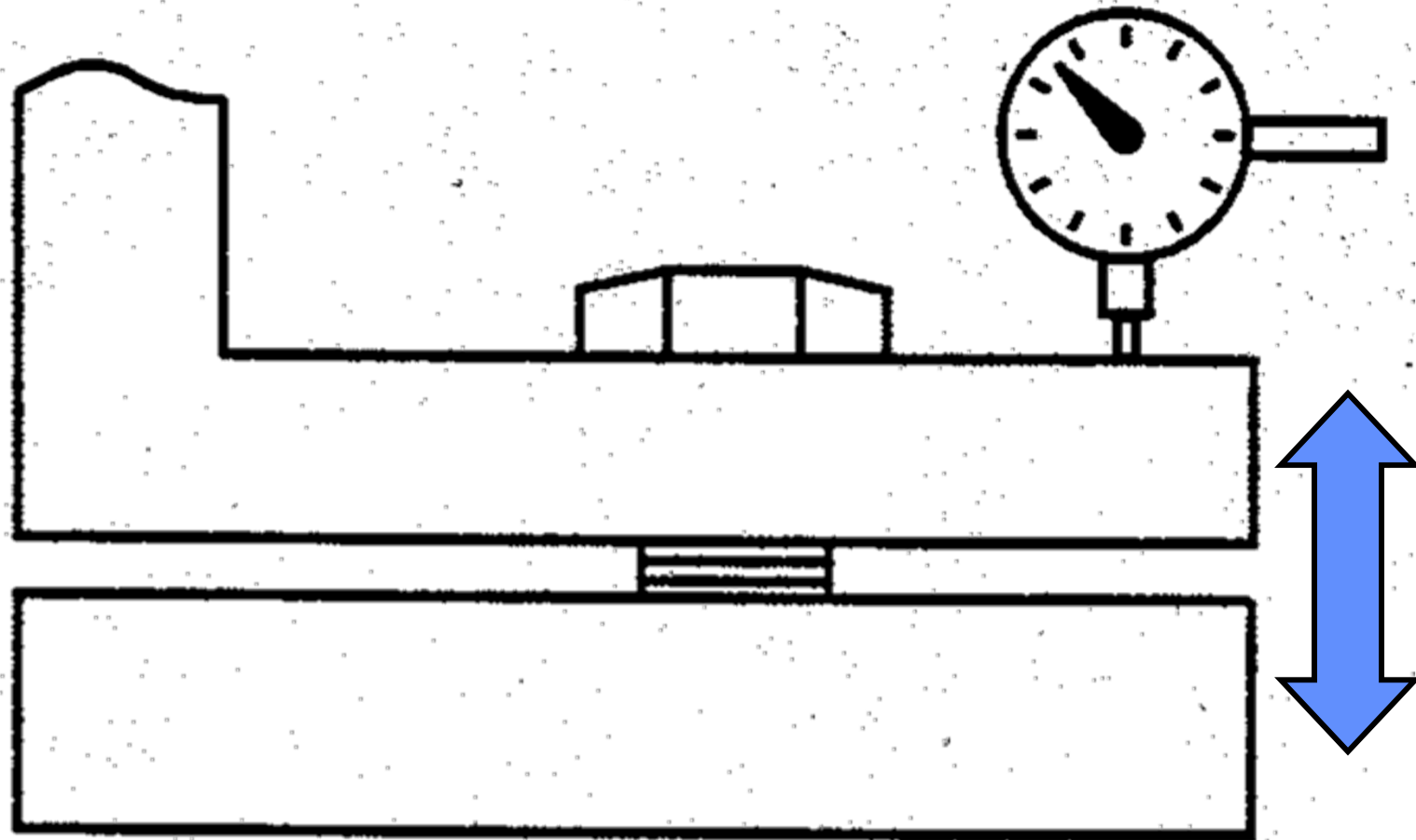
Dial Indicator



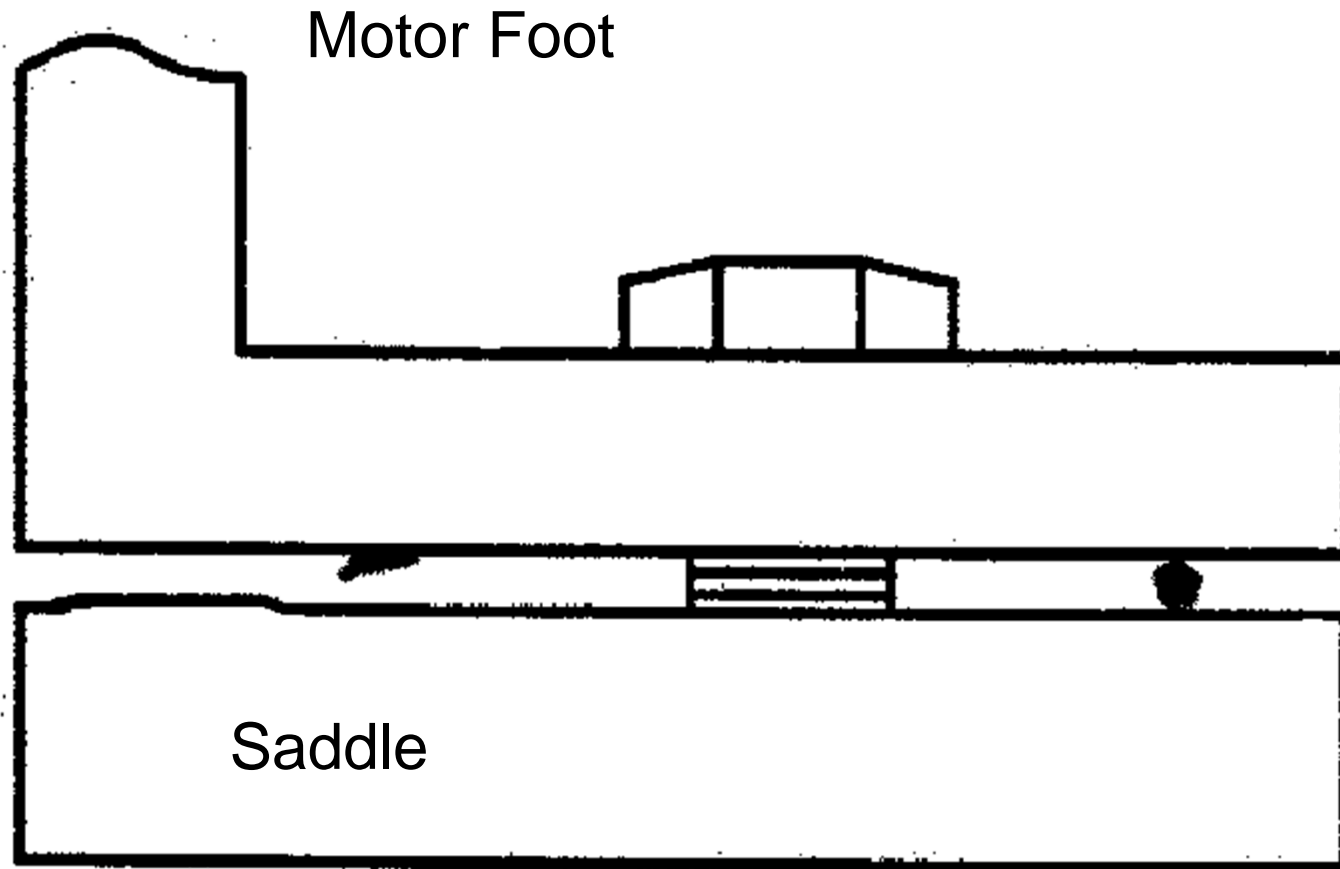
Pipe Strain



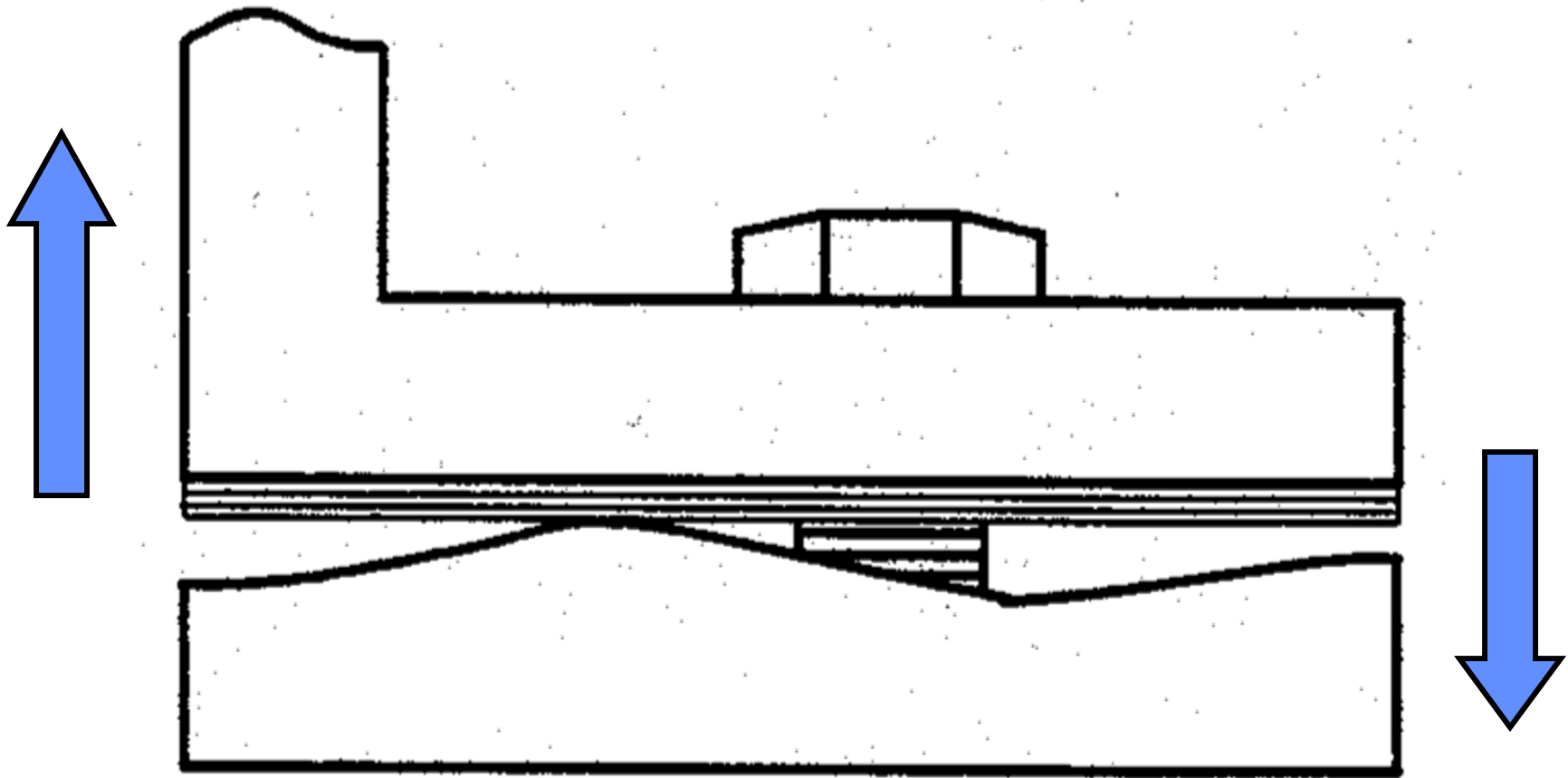
Ordinary Soft Foot



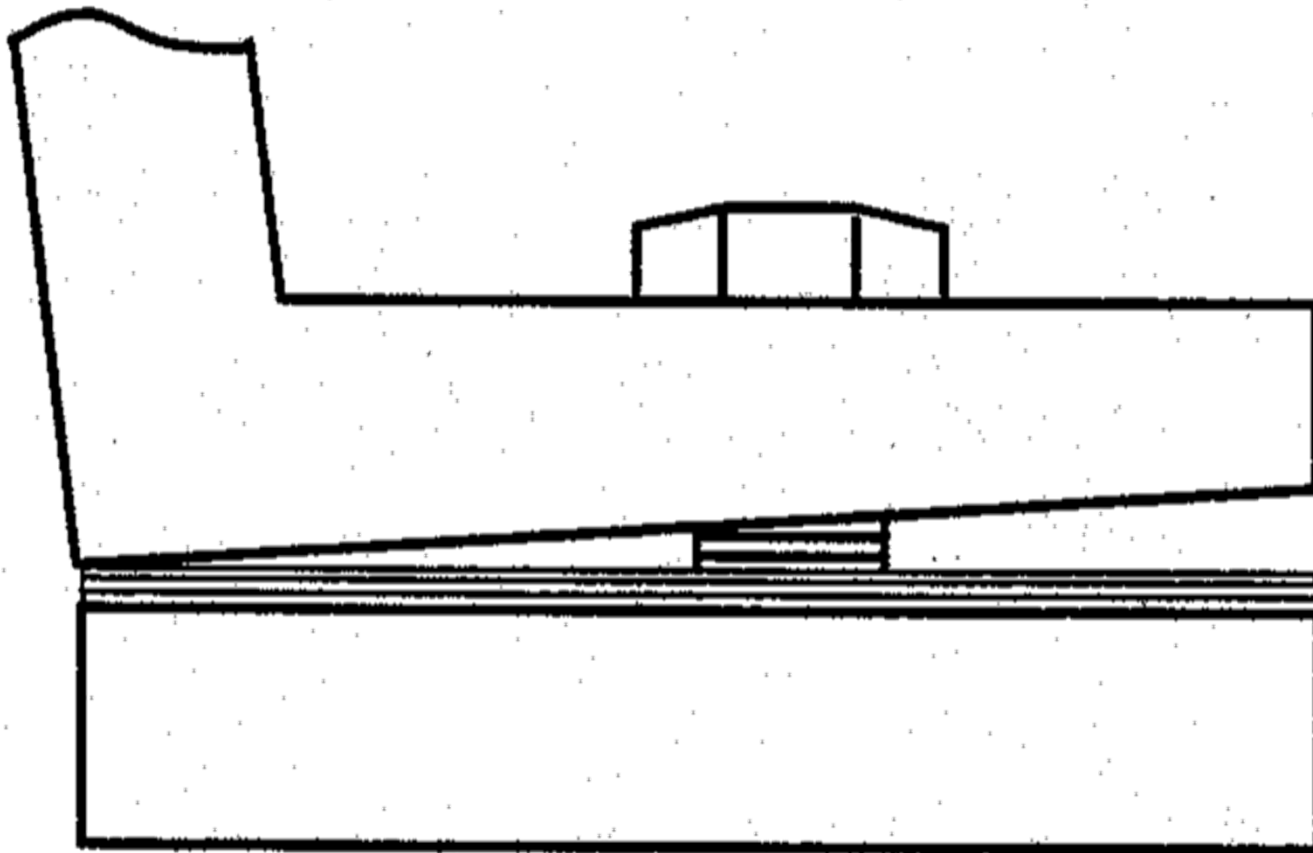
Surfaces - Clean & Flat



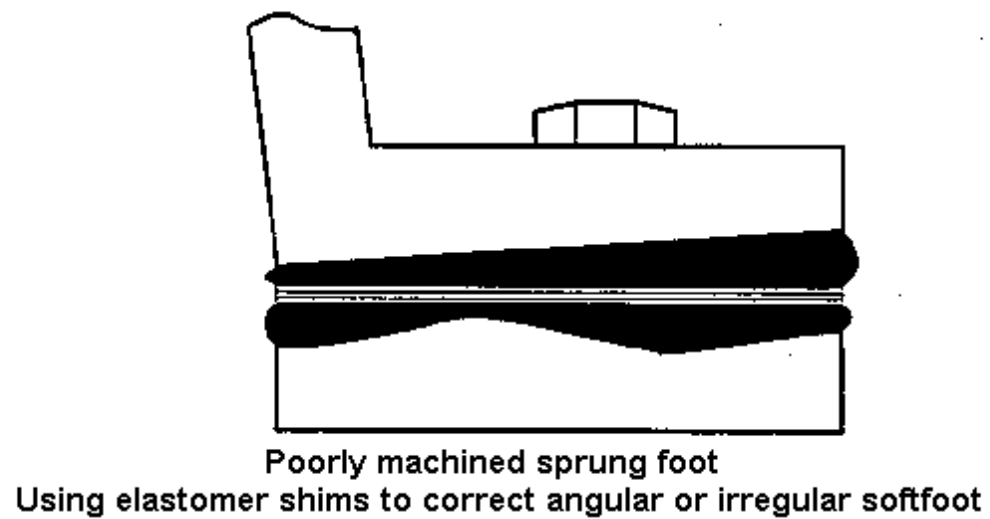
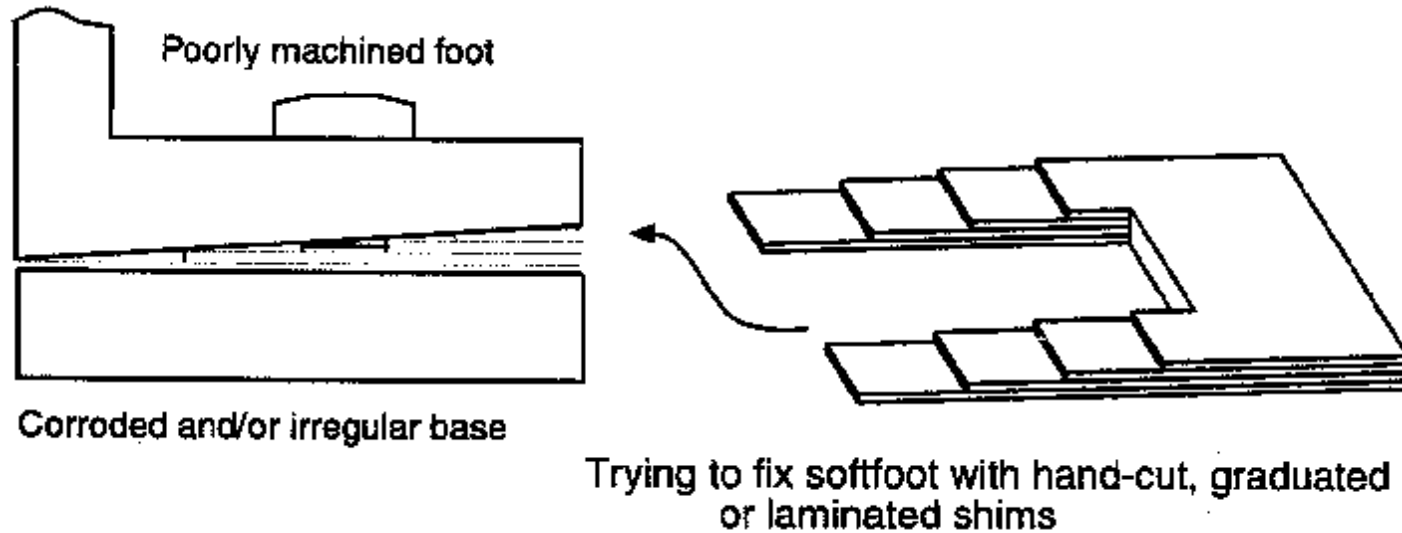
Soft Foot Due to Poorly Machined Base



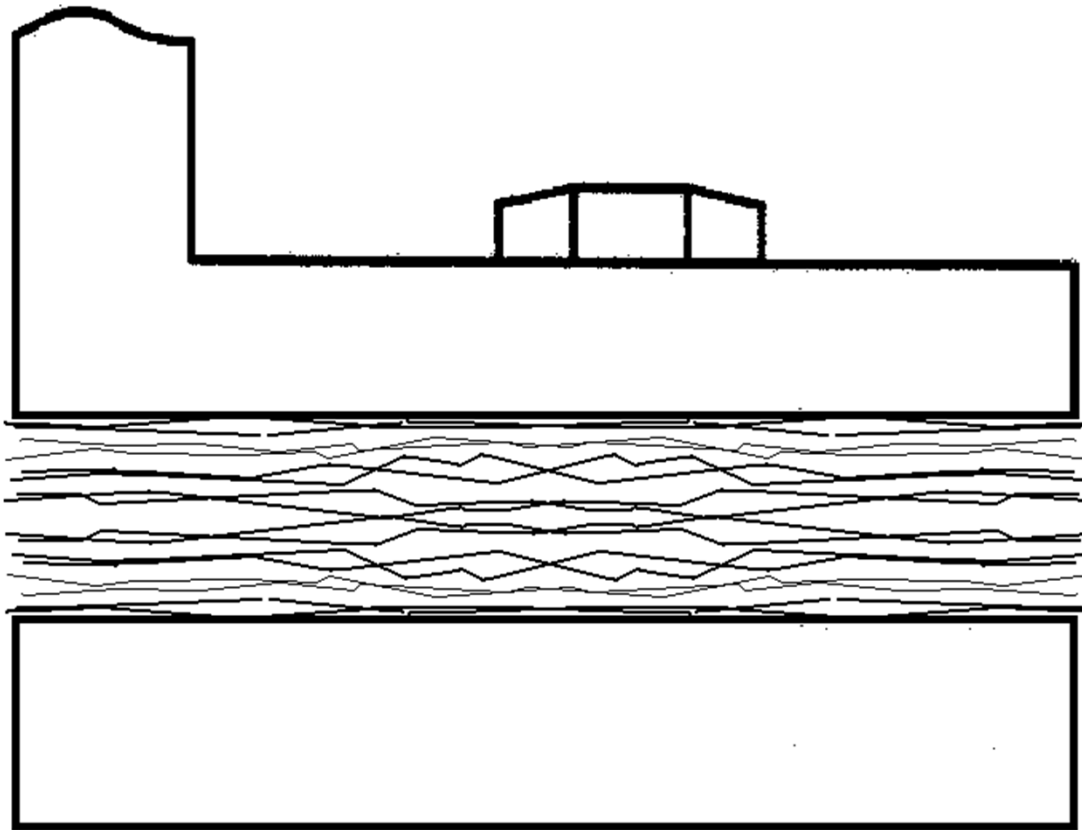
Soft Foot Due to Corroded Base



Correction ?

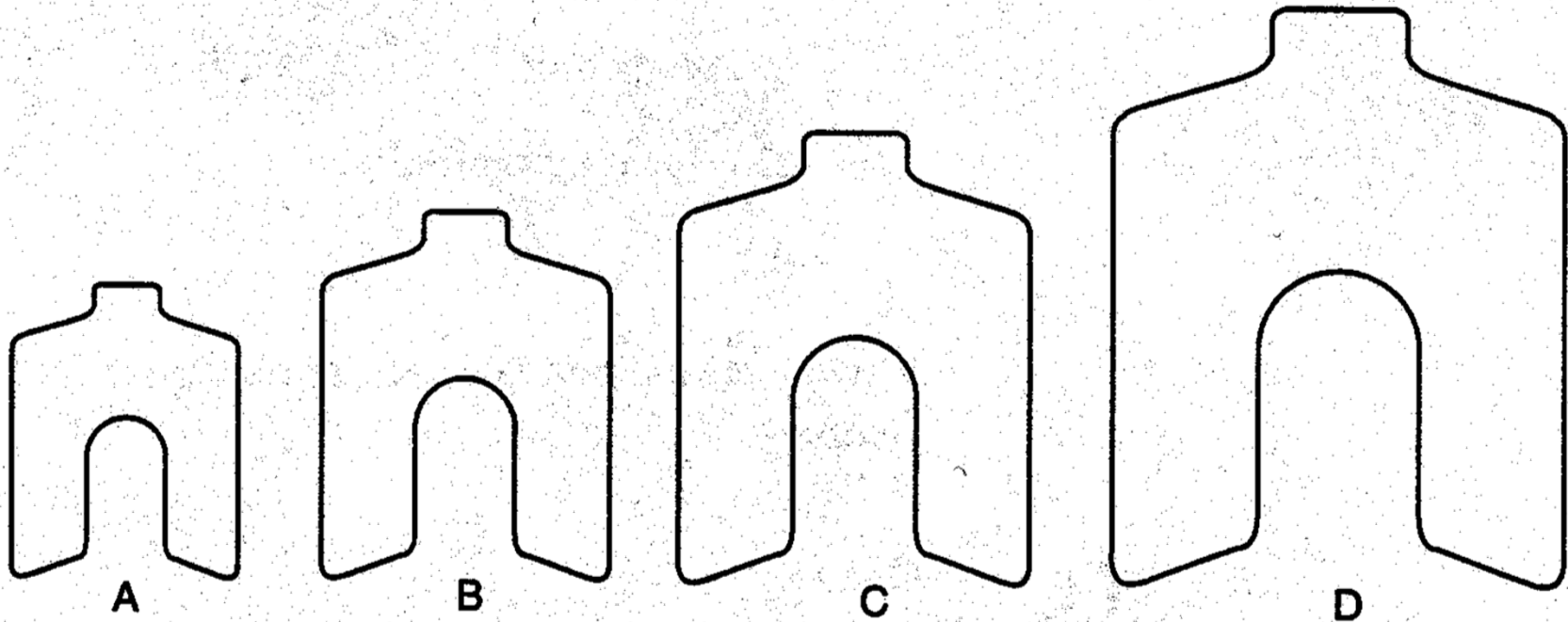


Soft Foot



Use as few
shims as
possible to
avoid
sponginess

Shims, Stainless Steel



A=2"x2",

B=3"x3",

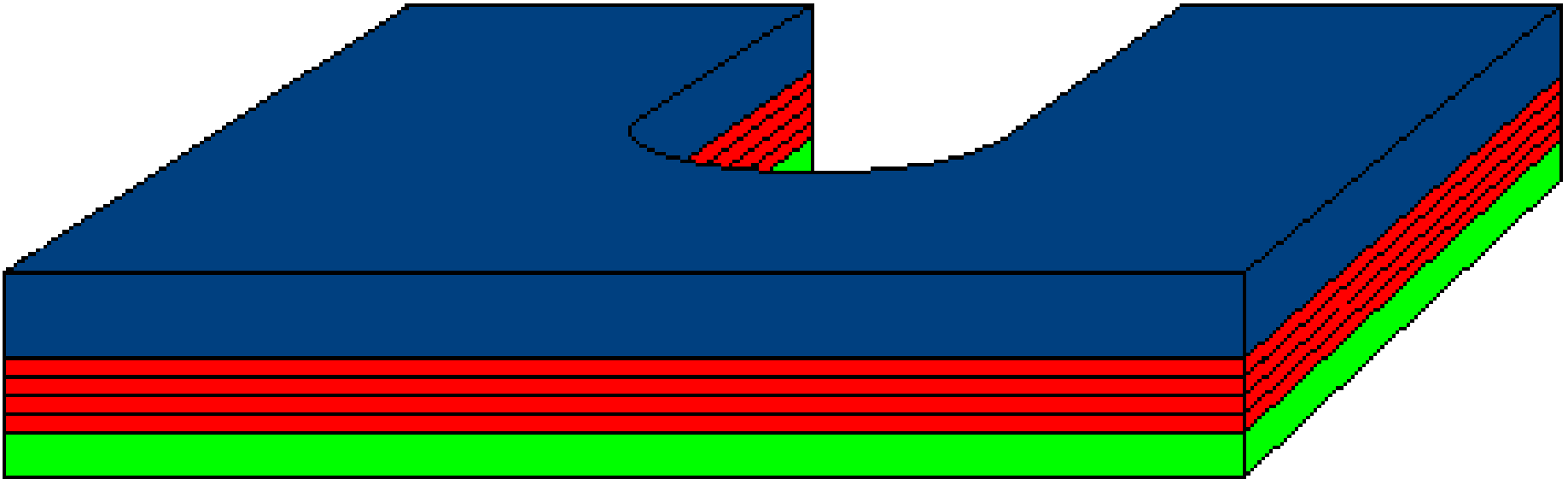
C=4"x4",

D=5"x5"

(0.0005" through .125" thick)

Spacers, mild or stainless steel, are 1/4" or greater in thickness.

Shim Pack



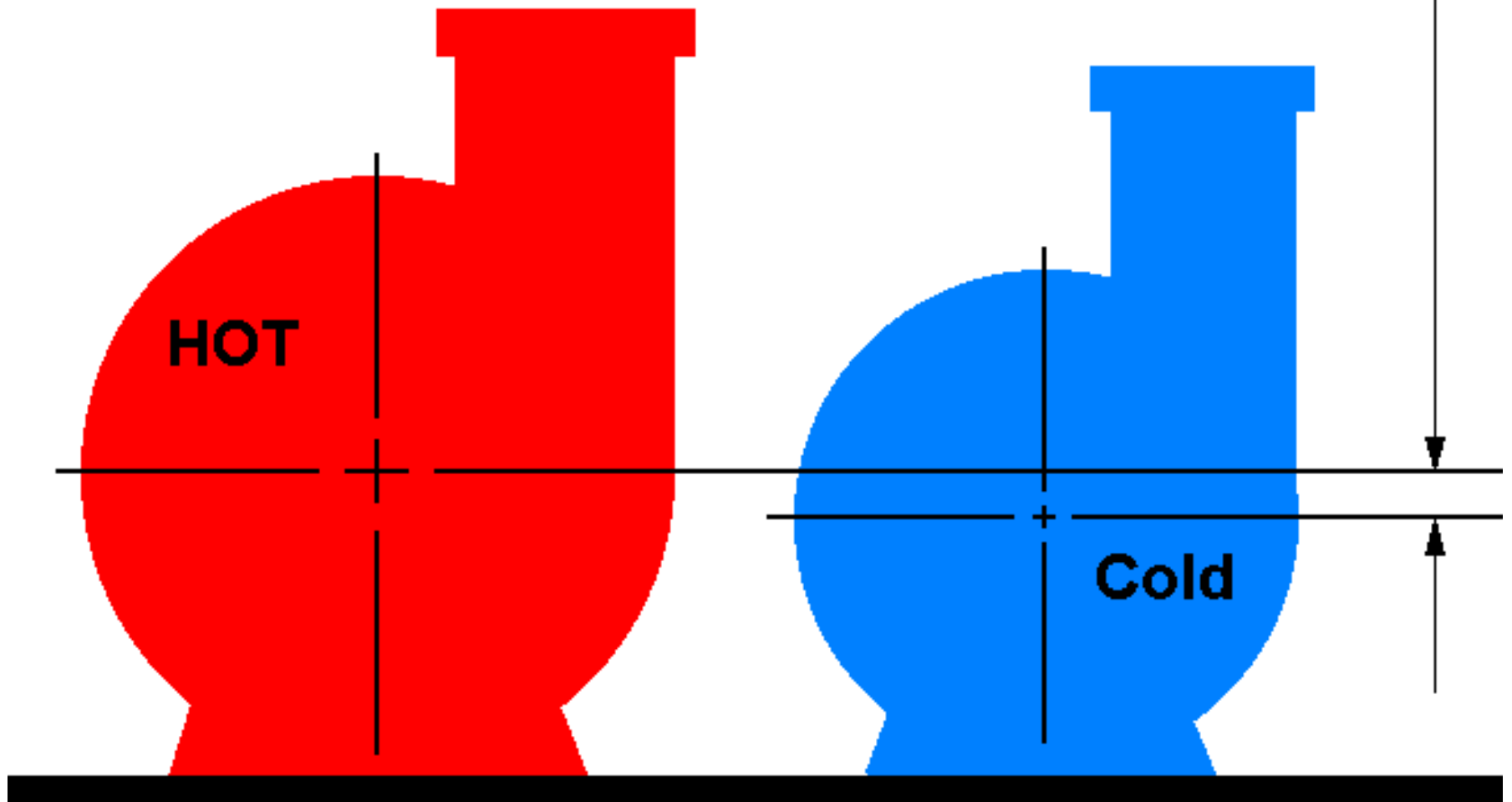
Blue is the 1/8" shim

Red are the thinnest shims

Green is the second thickest shim

Heat

Thermal Height Gain



Heat



Motor Shaft

Pump Shaft

Red is hot

Blue is cold

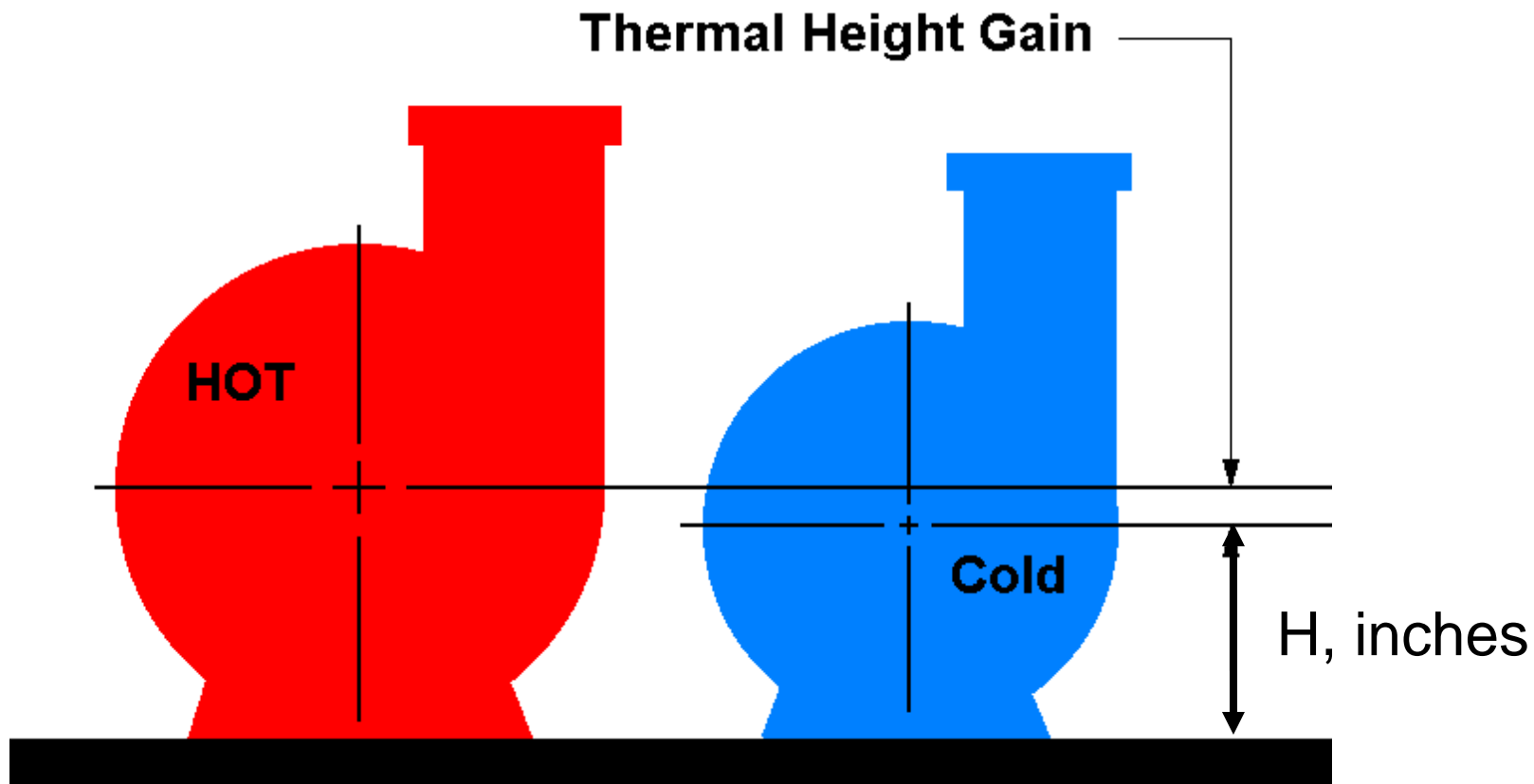
Pump shaft height goes up with heat

Align cold pump shaft low by the amount of the calculated thermal height gain

Predicting Thermal Change

For cast iron pumps: $THG = H \times \Delta t \times 0.0000063$

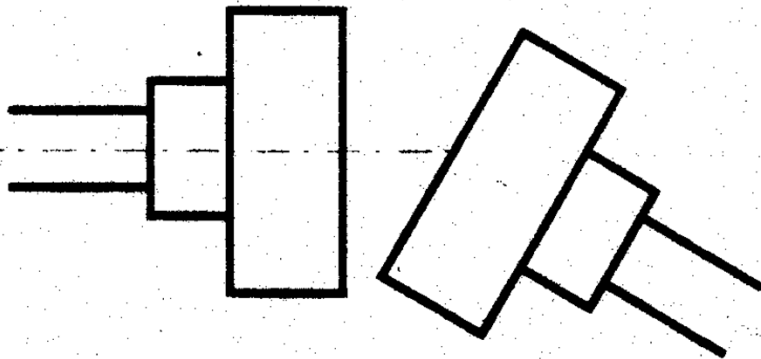
Example: a cast iron pump with a shaft 12" above the baseplate at 70F rises about 0.012" at 230F



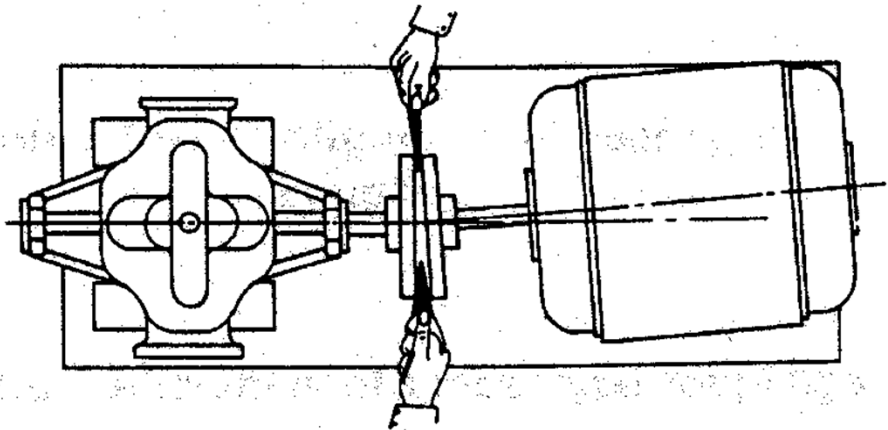
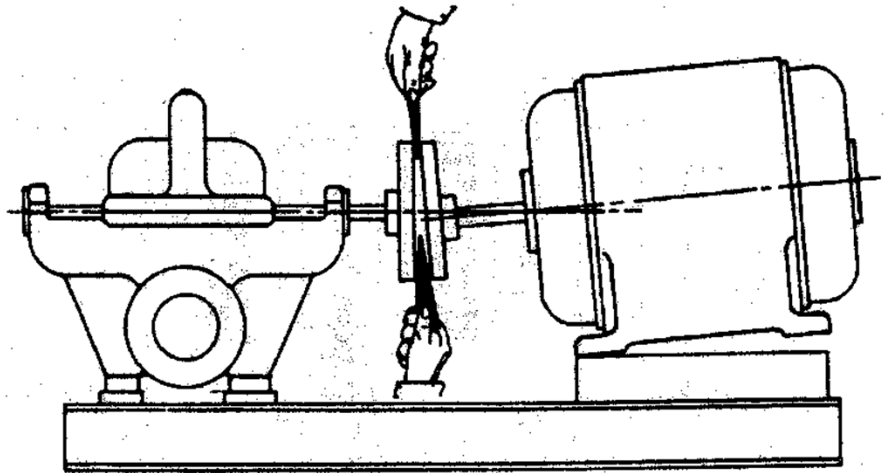


Types of Misalignment

Angular Misalignment

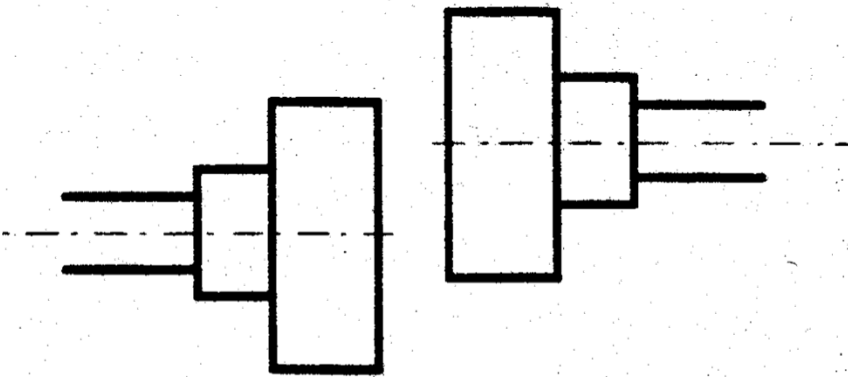


“Face” misalignment:
Shafts are not on the
same axis

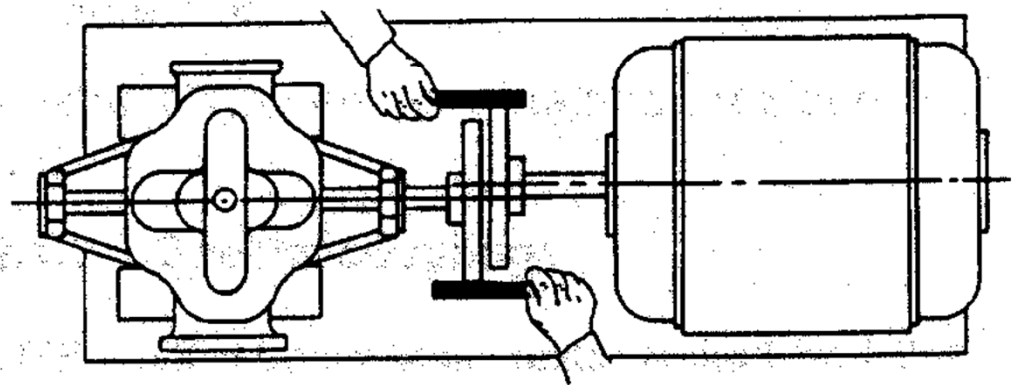
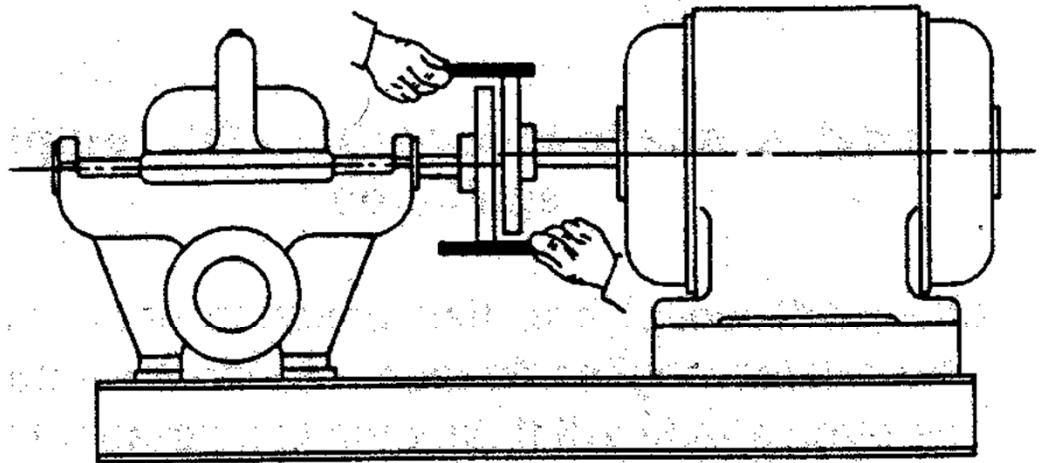


Using a taper gage

Parallel or Offset Misalignment

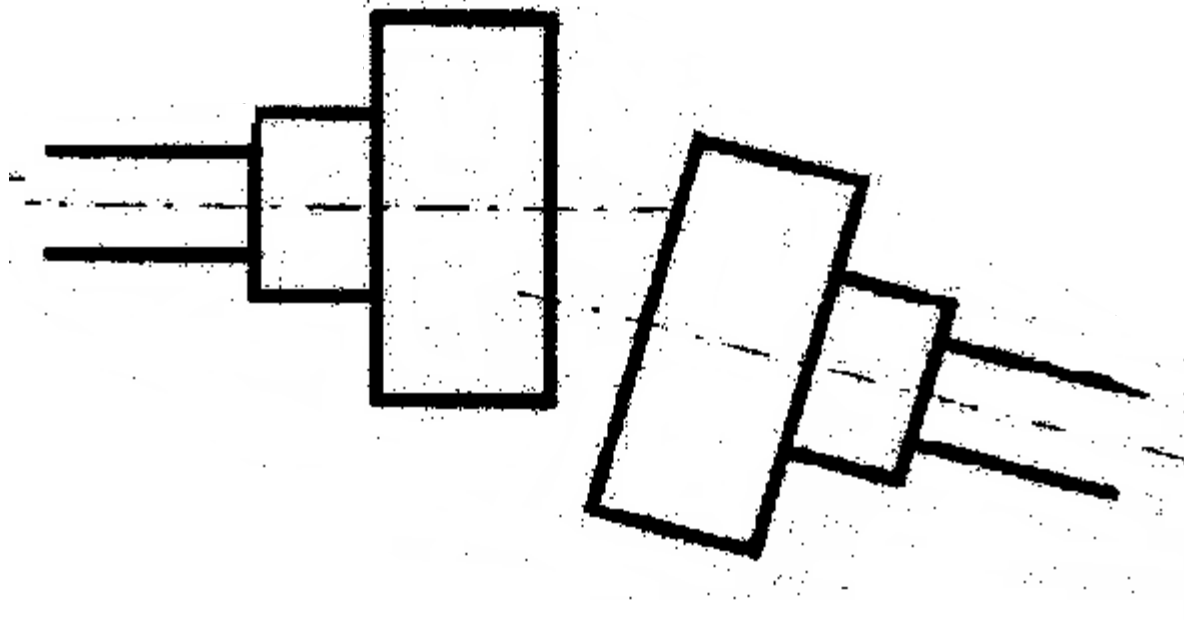


“Rim” misalignment:
Shafts are parallel, but
not on the same axis



Using a straight edge

Combination of Both



How close is close enough? **

RPM	Parallel Misalignment	Angular Misalignment*
1200	0.0025" - 0.004"	0.005" – 0.008"
1800	0.002" – 0.003"	0.003" – 0.005"
3600	0.001" – 0.0015"	0.002" – 0.003"

*per 10" diameter of coupler

**See your coupling manufacturer's data sheet



Alignment Methods

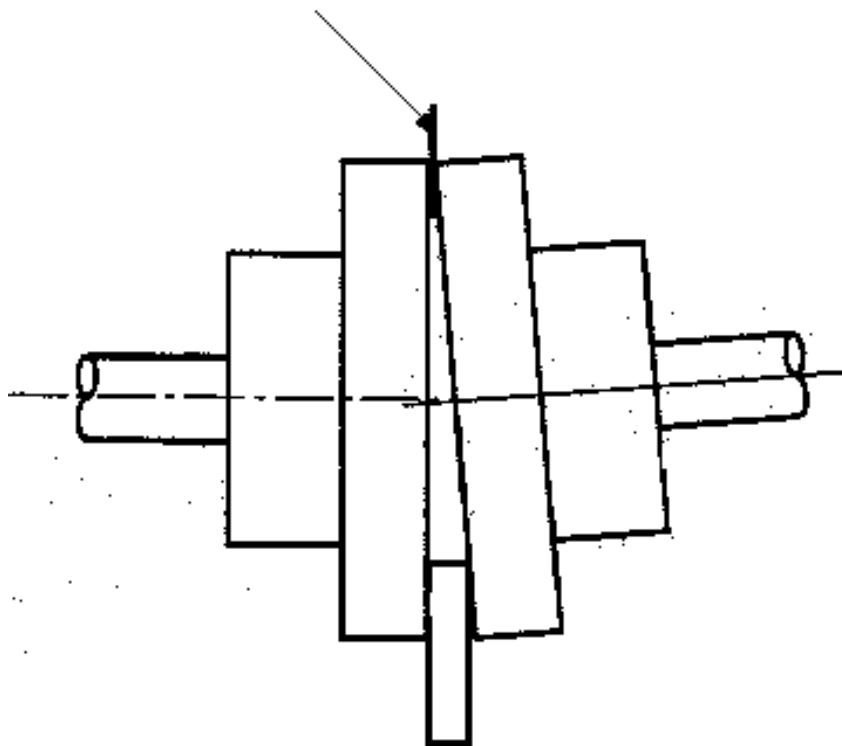
Alignment Methods

1. Straight Edge (rough alignment)
2. Dial Indicator
3. Laser and computer

(Always lock out the motor, and isolate the pump before starting any maintenance procedure!)

Straight Edge & Thickness Gauge

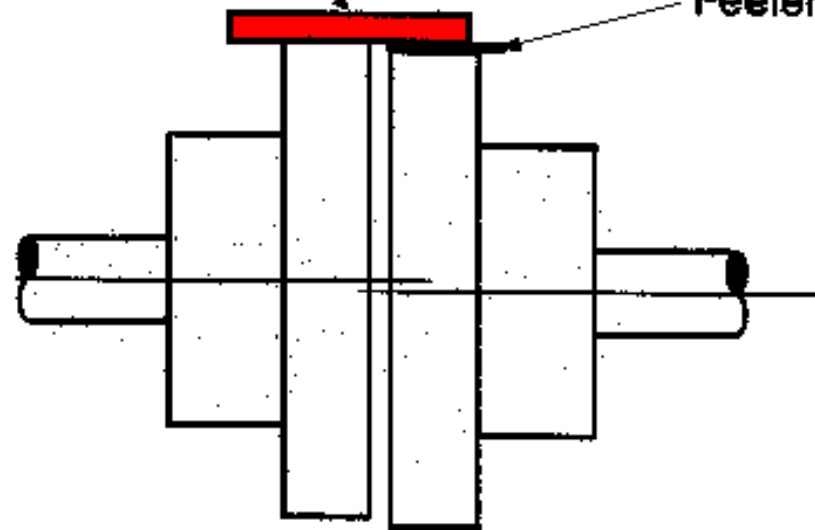
Feeler gauge



Angular misalignment

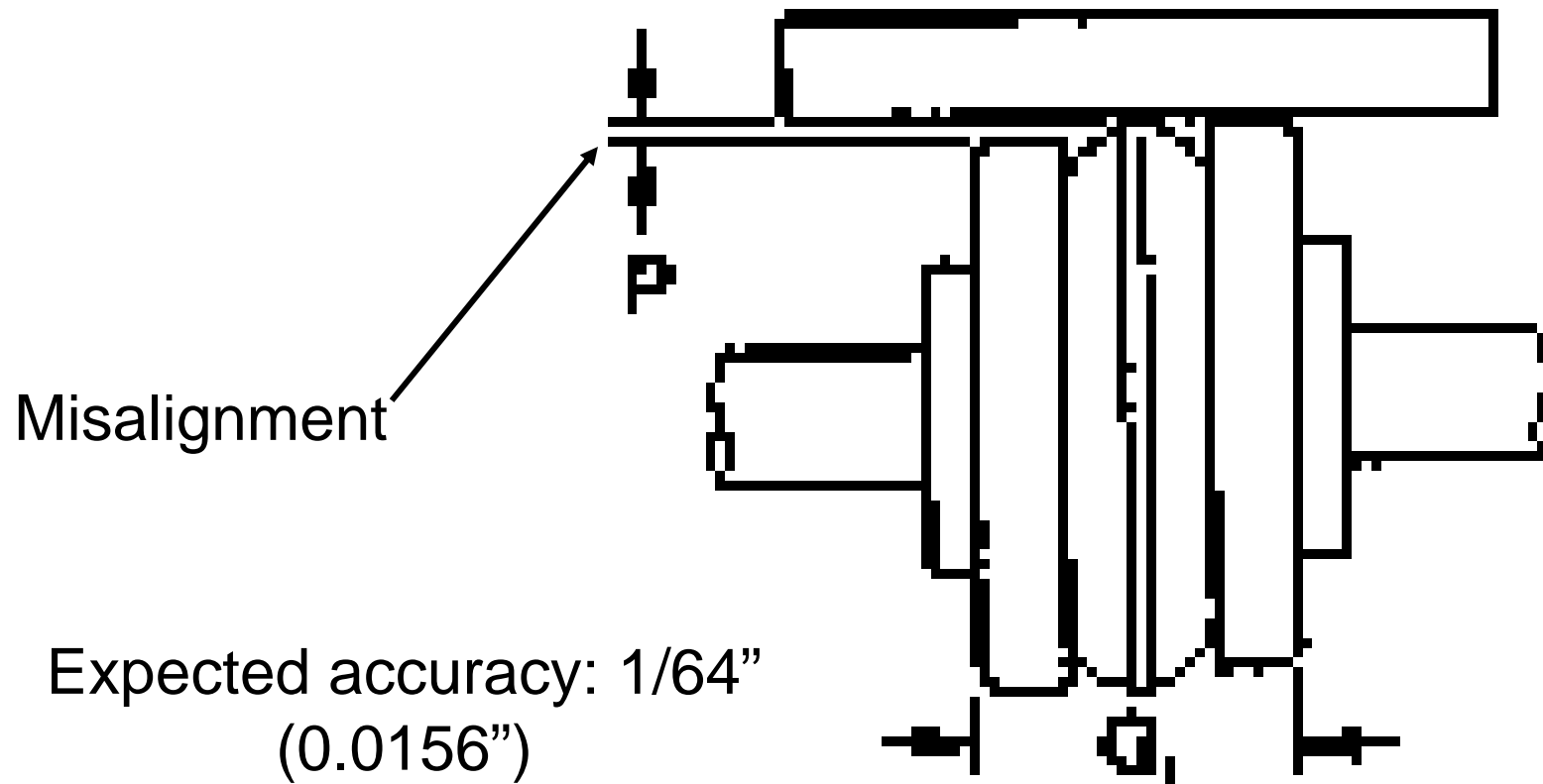
Straight edge

Feeler gauge

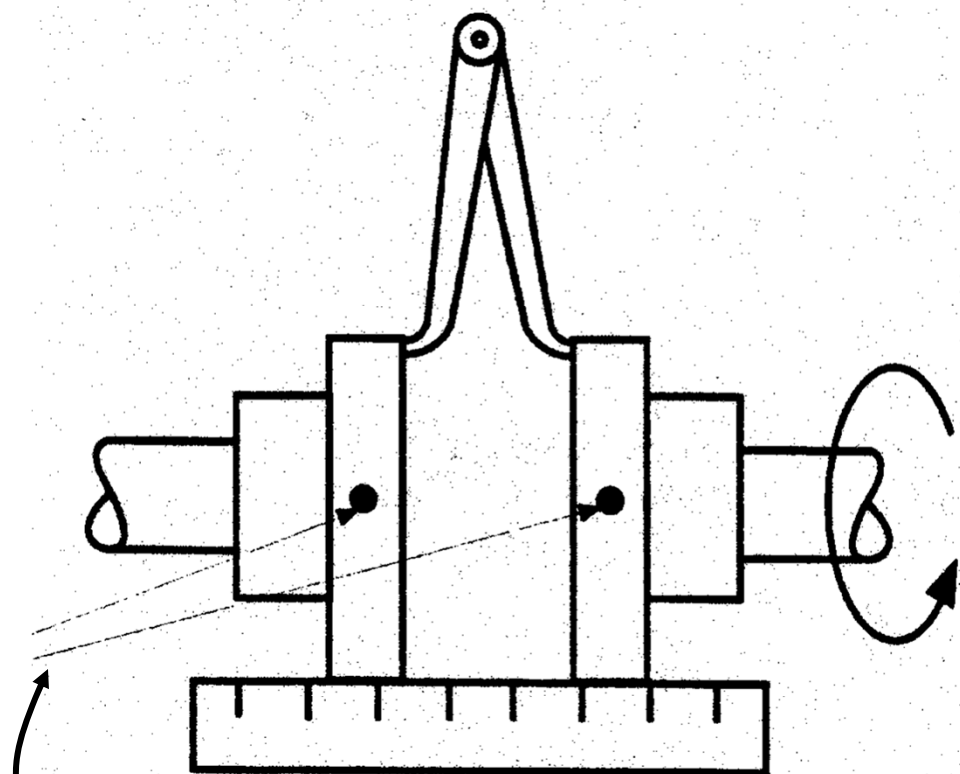


Parallel misalignment

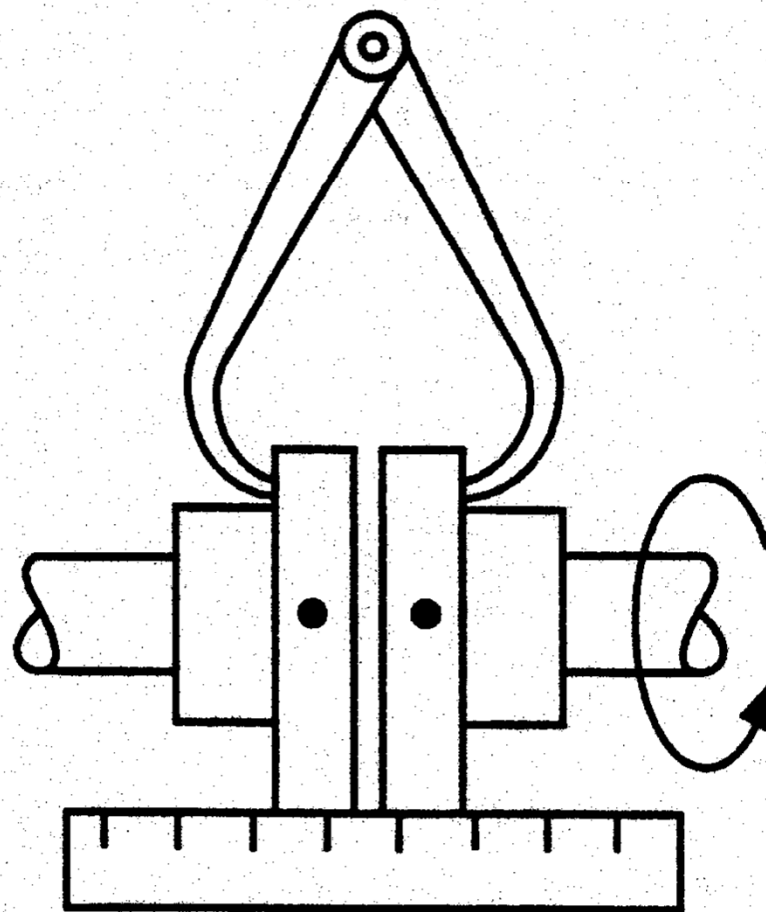
Parallel Alignment



Angular Misalignment

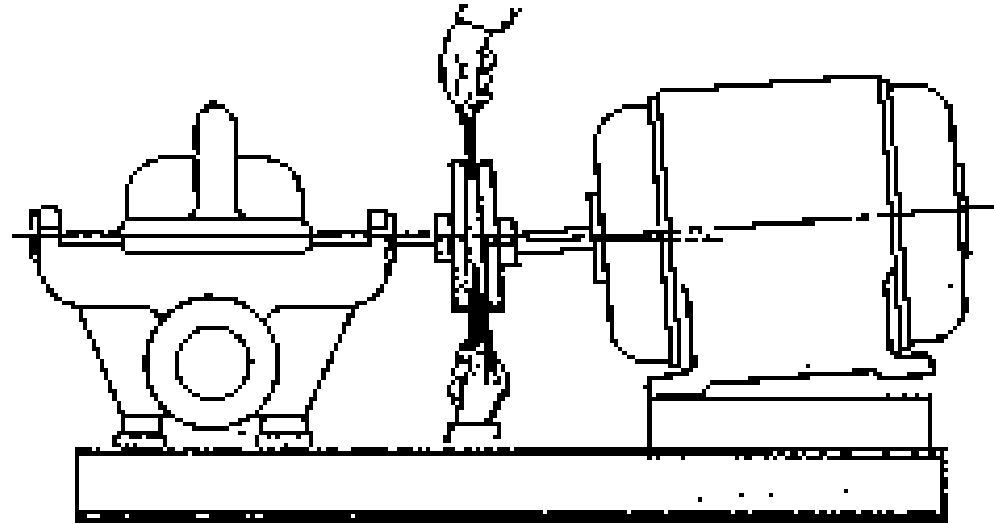


Always rotate them together!

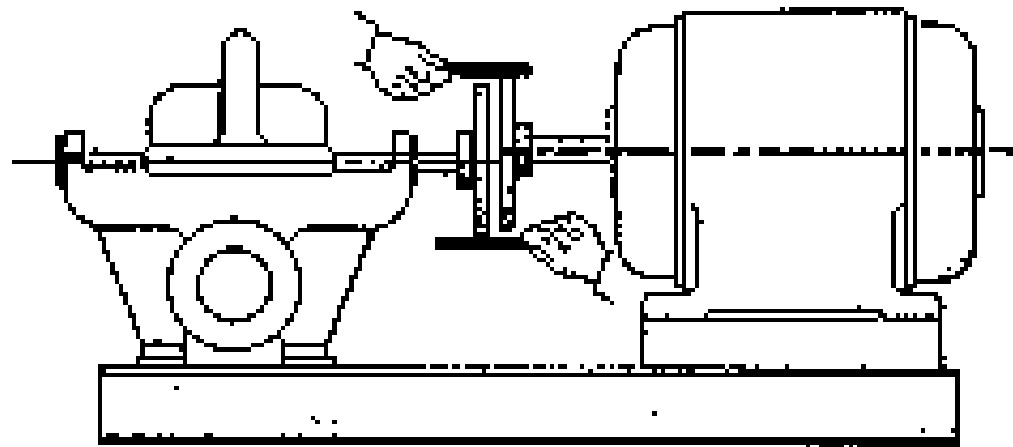


Alignment Sequence

1.
Vertical
Angular

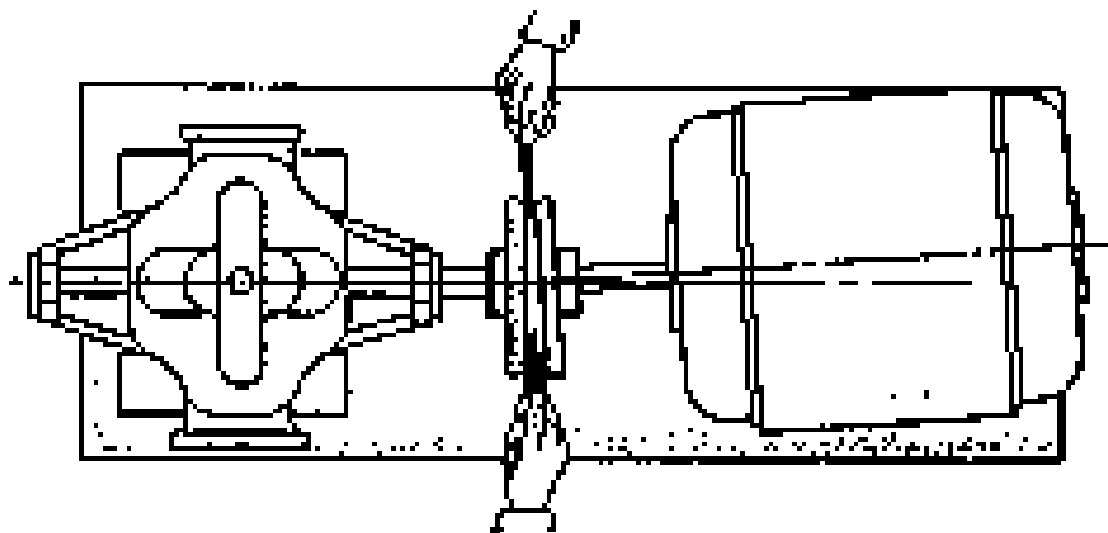


2.
Vertical
Parallel

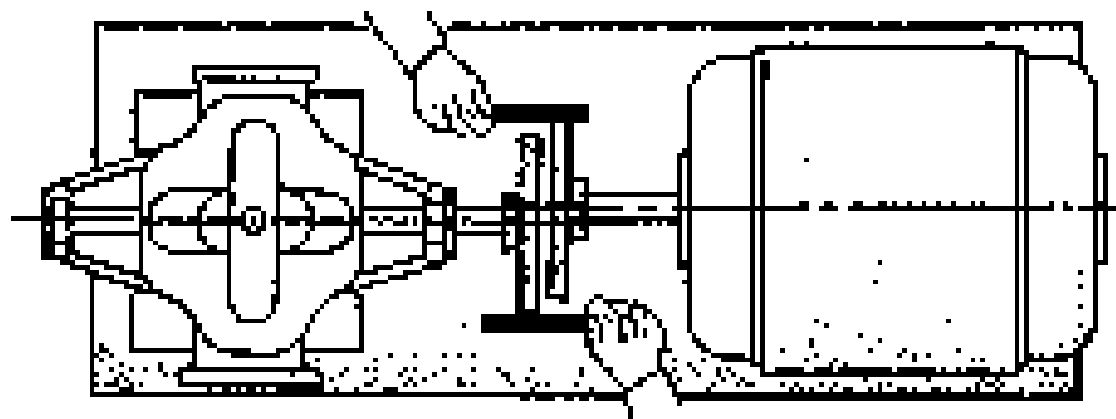


Alignment Sequence

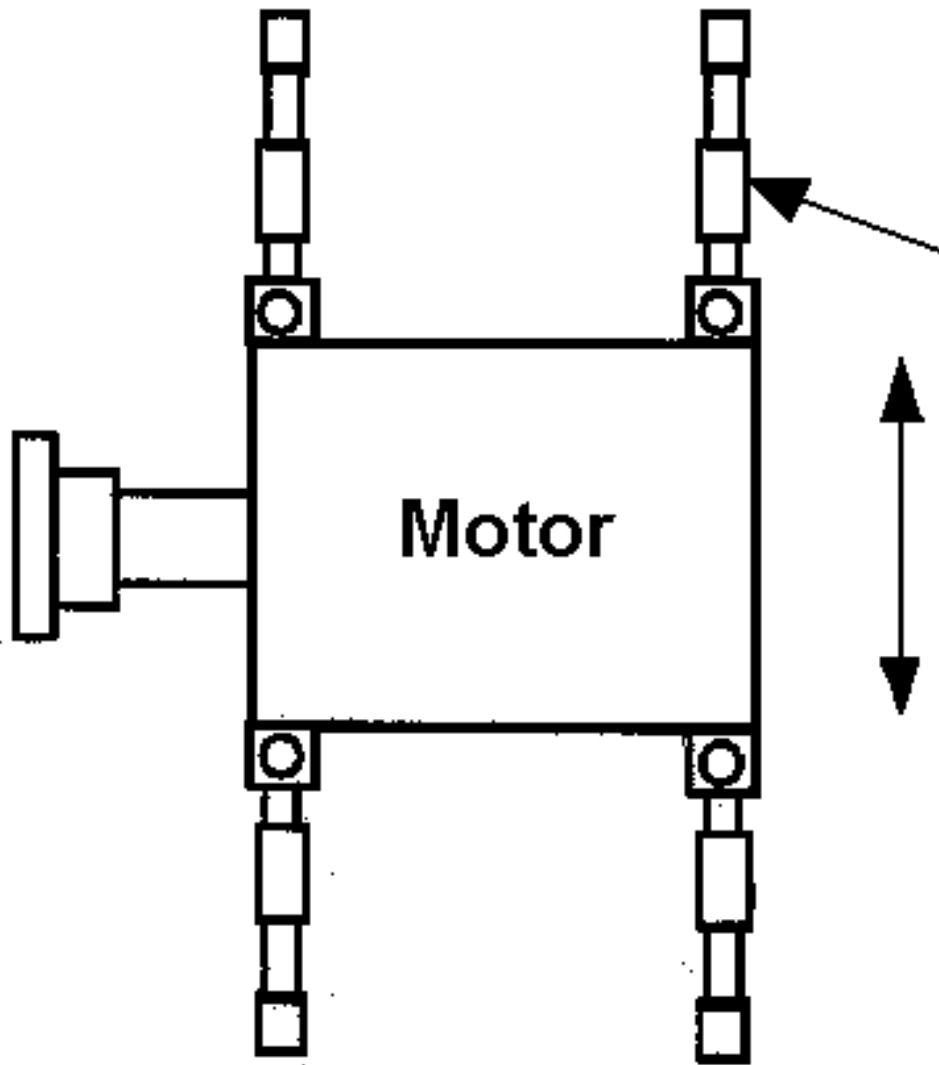
3.
Horizontal
Angular



4.
Horizontal
Parallel



Move the motor, not the pump

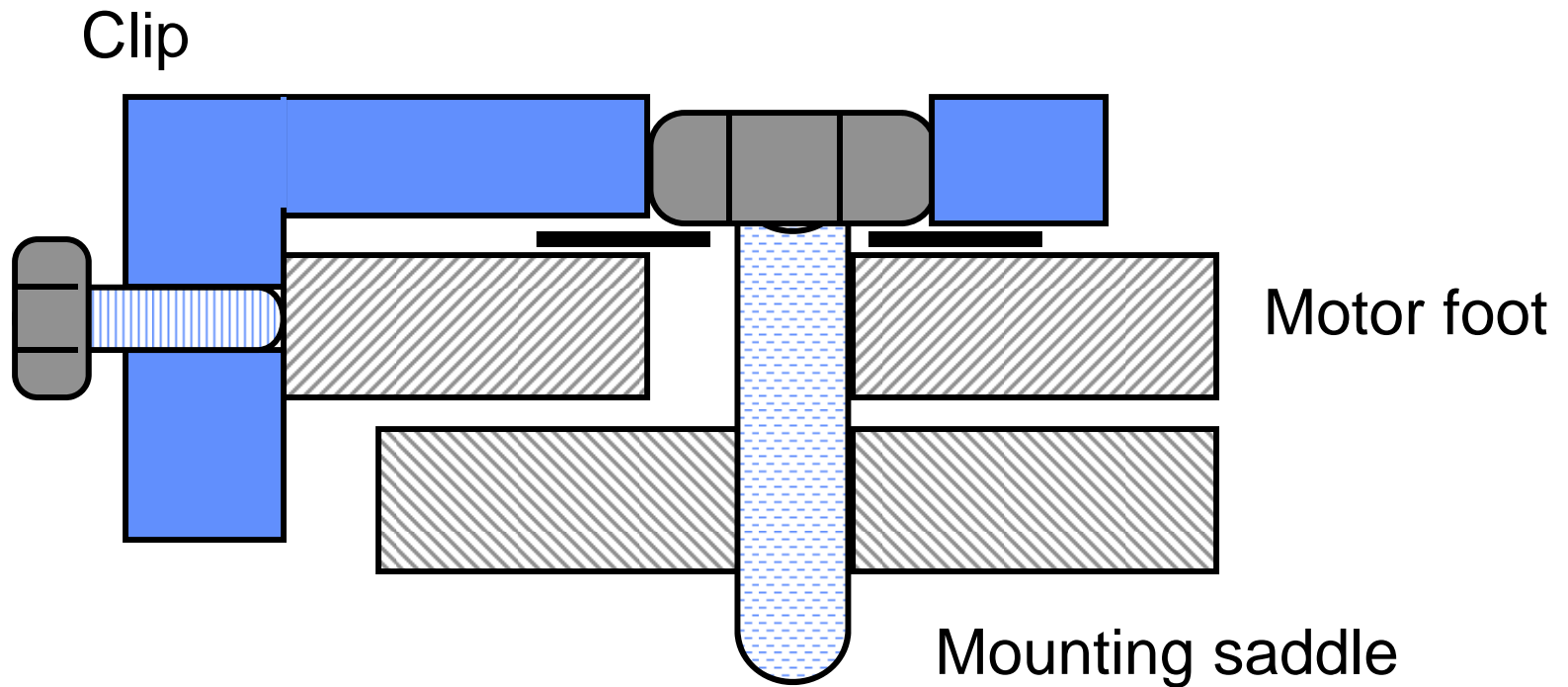


Alignment blocks
available on larger
pump bases.

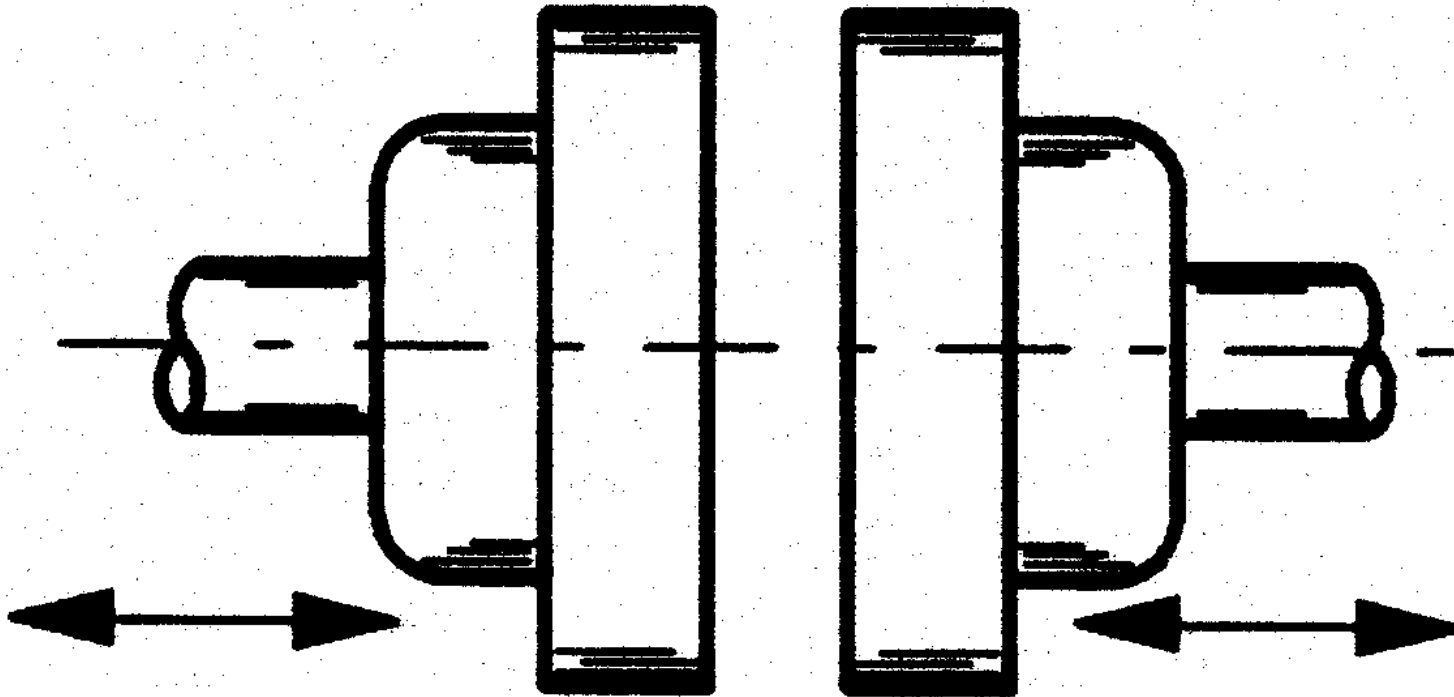
Jackscrew

Movement

What if you don't have jacks?



Caution



Axial movement

Alignment Methods

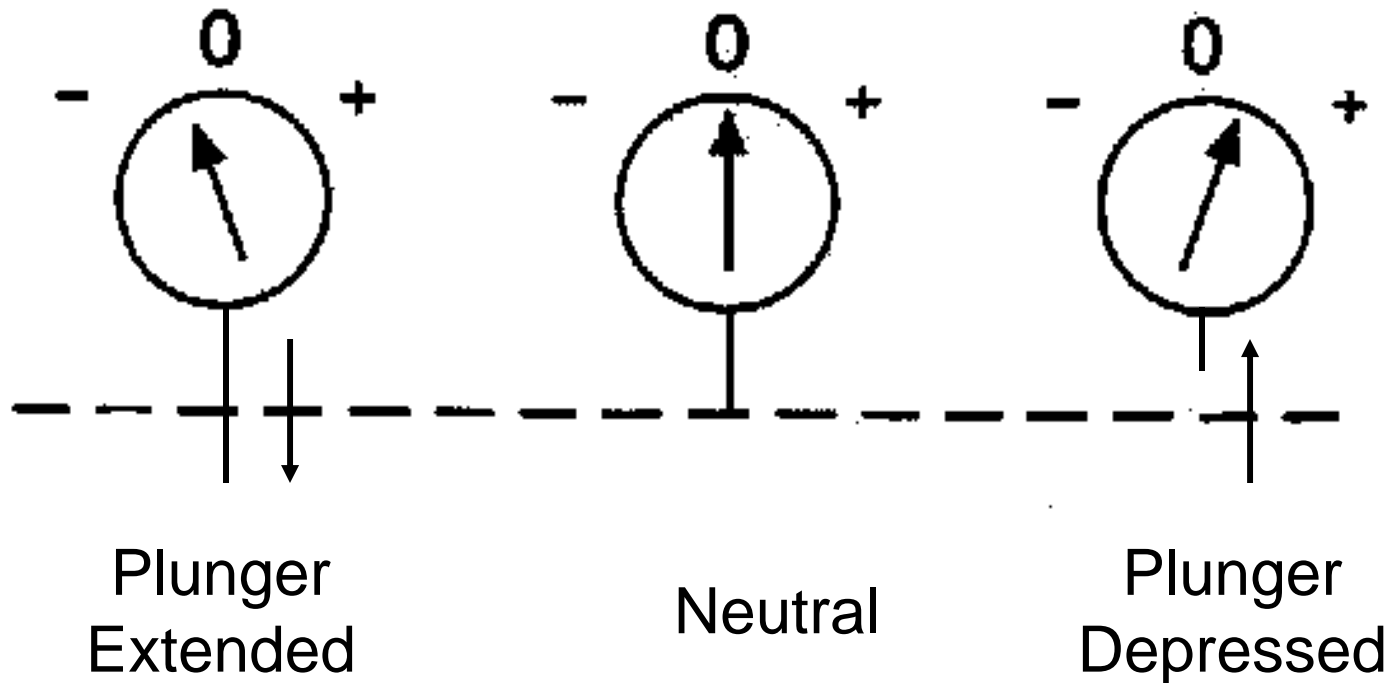
Straight Edge

Dial Indicator

Laser

Dial Indicator Alignment

Dial operation:



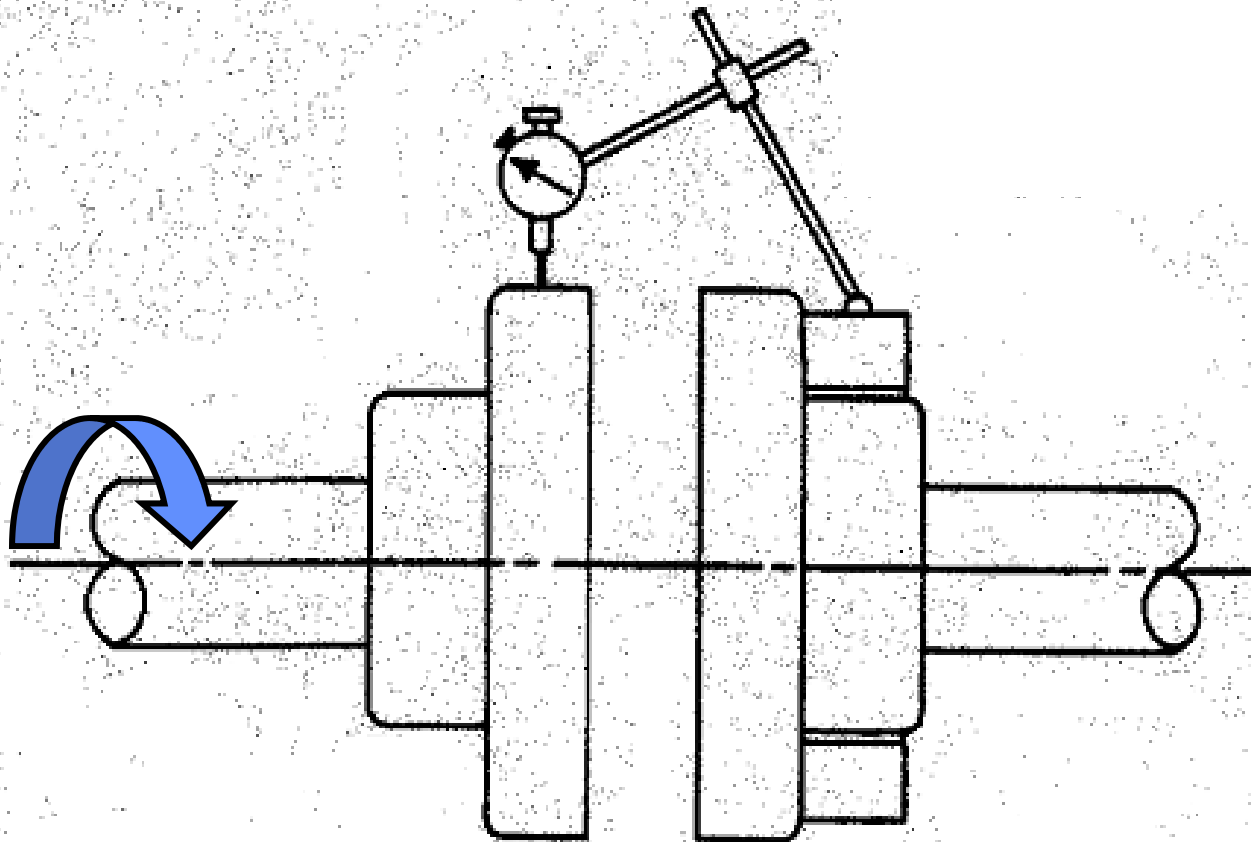
Expected accuracy: 0.001"

Dial Indicator Alignment

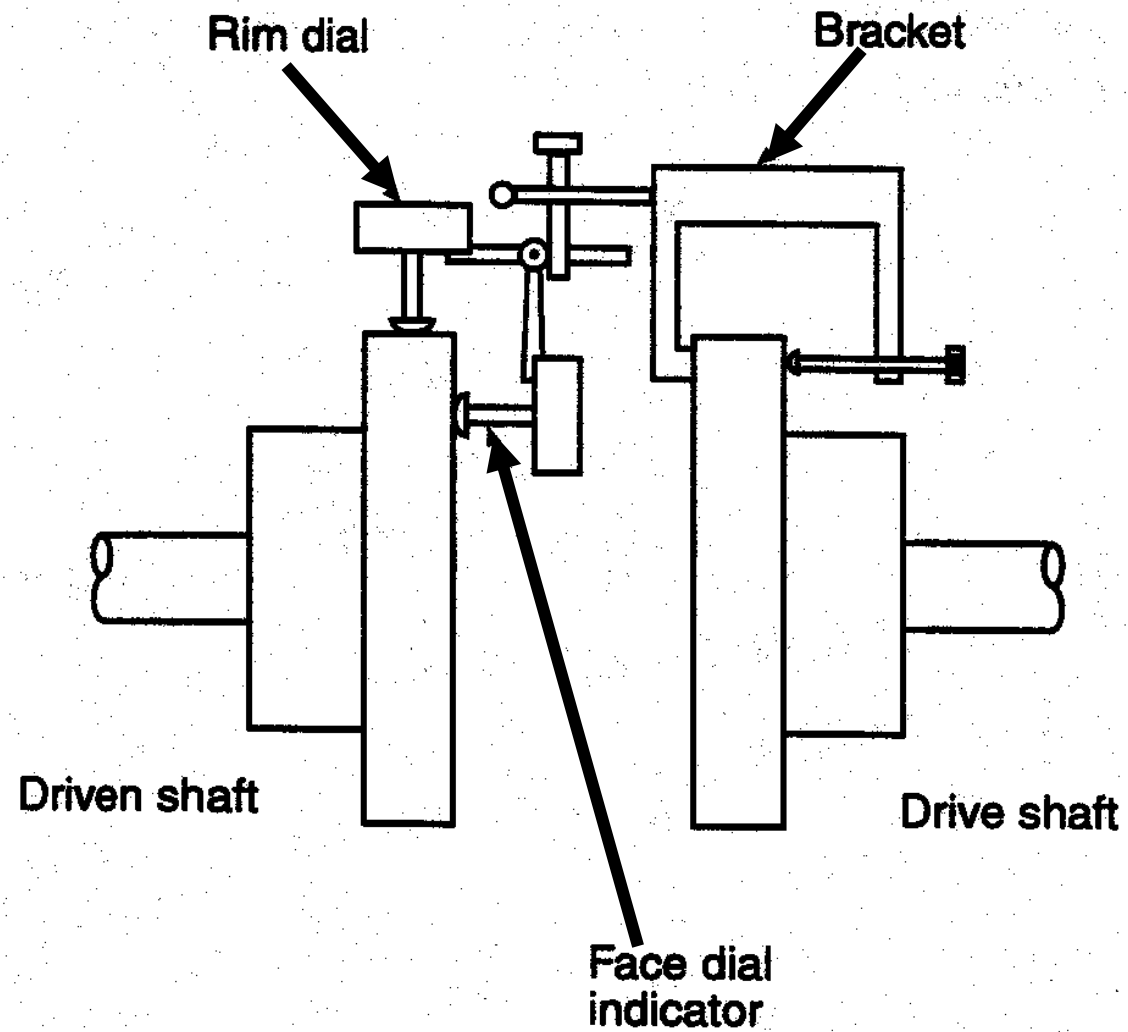
Dial operation:

- The dial indicator is a precision measuring instrument; take care while handling it
- A rough alignment (straight edge method) should be done prior to the dial indicator alignment to minimize the possibility of the dial bottoming out or running off the surface
- Set the dial securely at a right angle to the surface to be measured

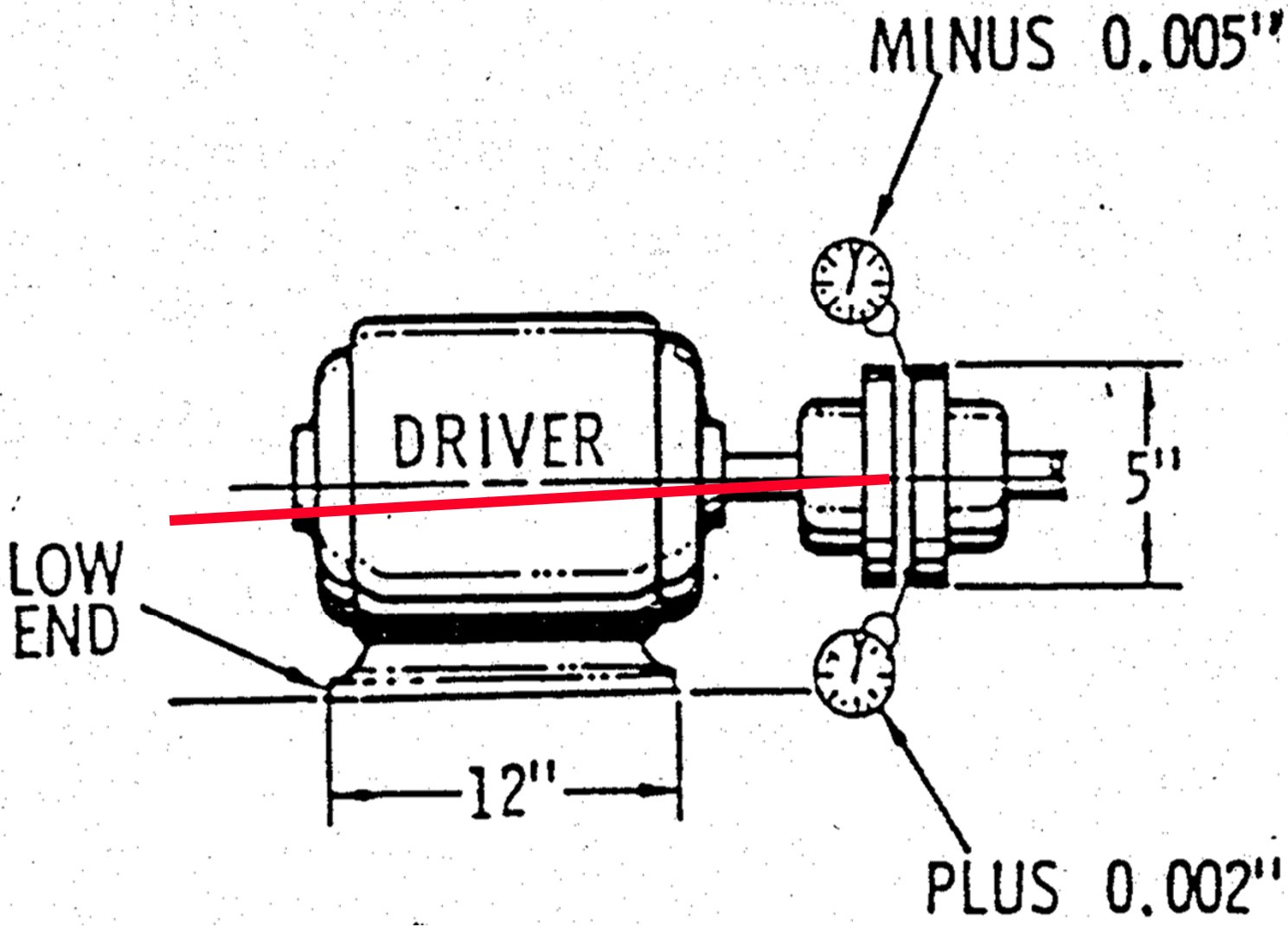
Measuring Shaft Run Out



Typical Attachments



Taking Face Readings



Total Indicator Runout, “TIR”

The difference between readings at:

12:00 and 6:00 o'clock, (vertical misalignment)

or

3:00 and 9:00 o'clock, (horizontal misalignment)

Note:

If one reading is positive, and the other is negative, subtraction is algebraically the same as addition.

Face Readings

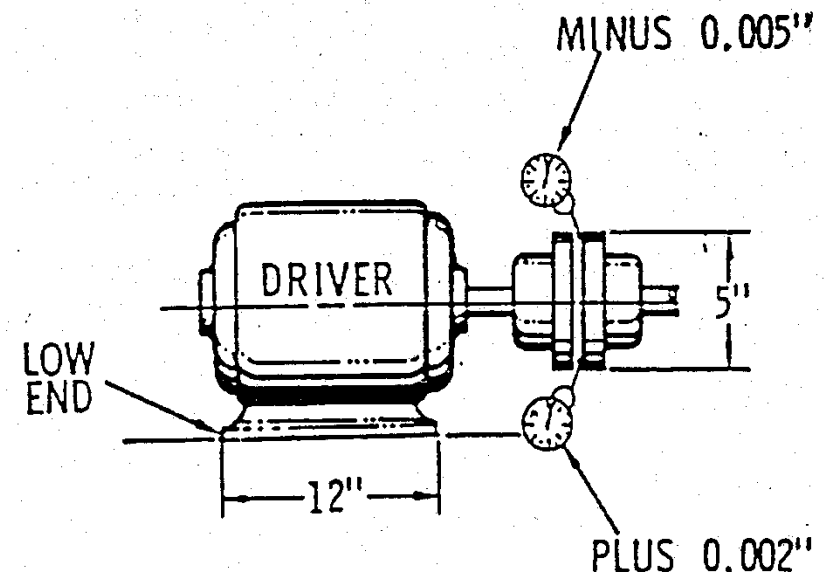
Formula for **angular misalignment**:

Shims required = TIR x distance between holes / coupling diameter

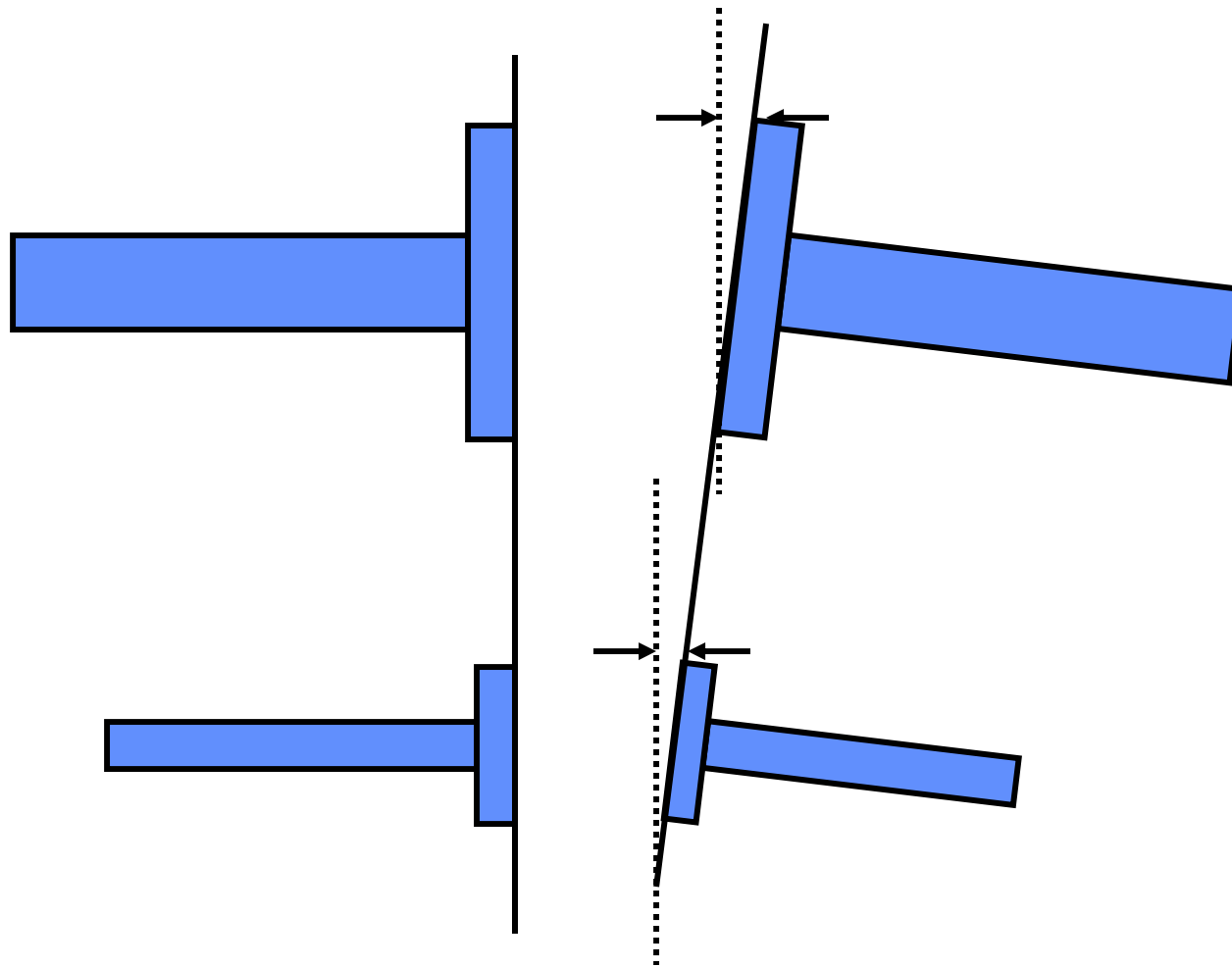
Shims required = $0.007'' \times 12'' / 5''$

Shims required = $0.017''$

(note that these shims are for under the rear of the motor)



Coupler Diameter Effect



Face Method

Calculation math review:

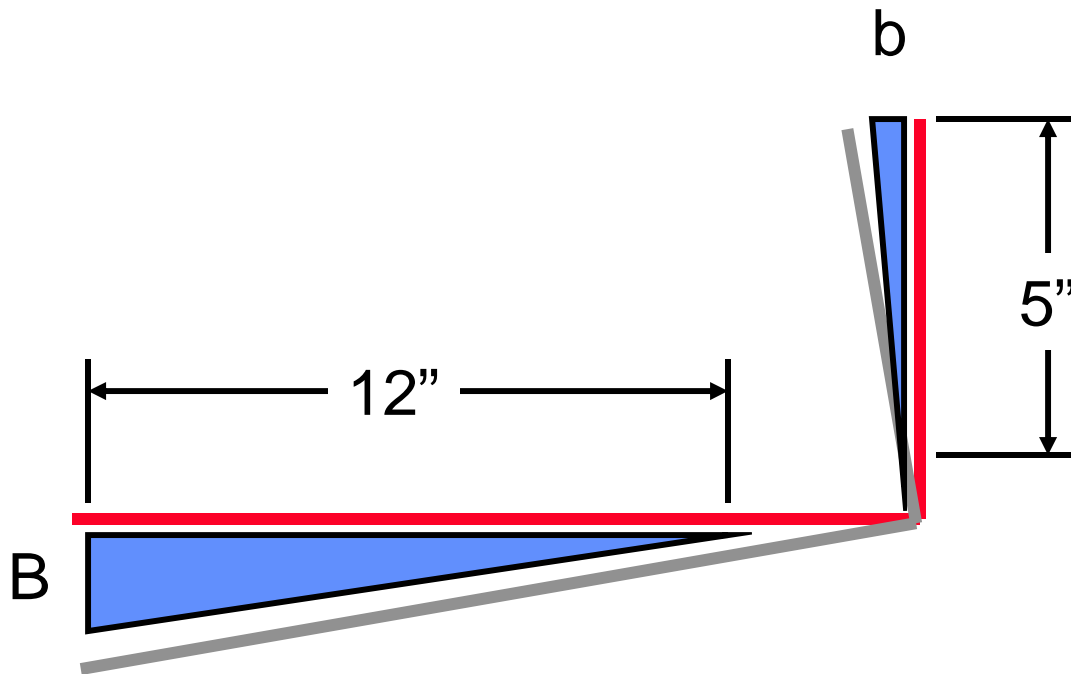
$$a=5$$

$$A=12$$

$$b=0.007''$$

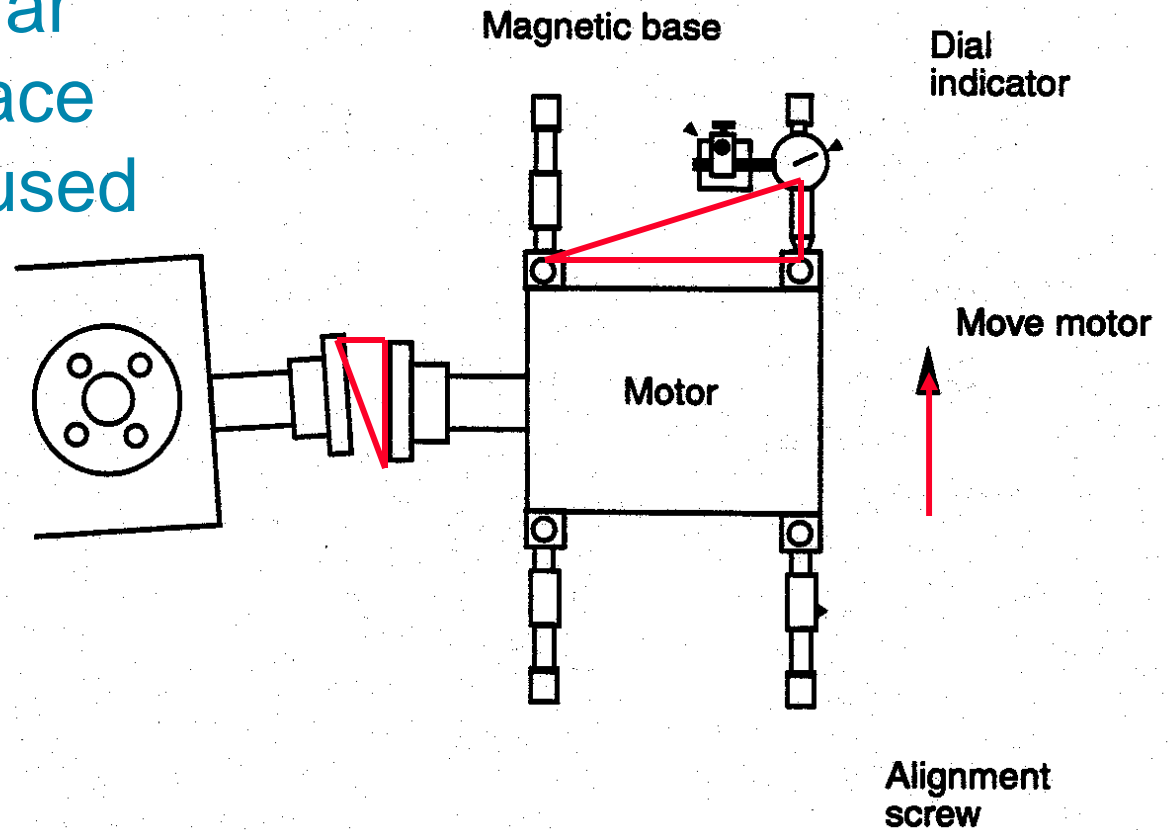
$$B=.007 \times 12 / 5$$

$$B=0.017''$$

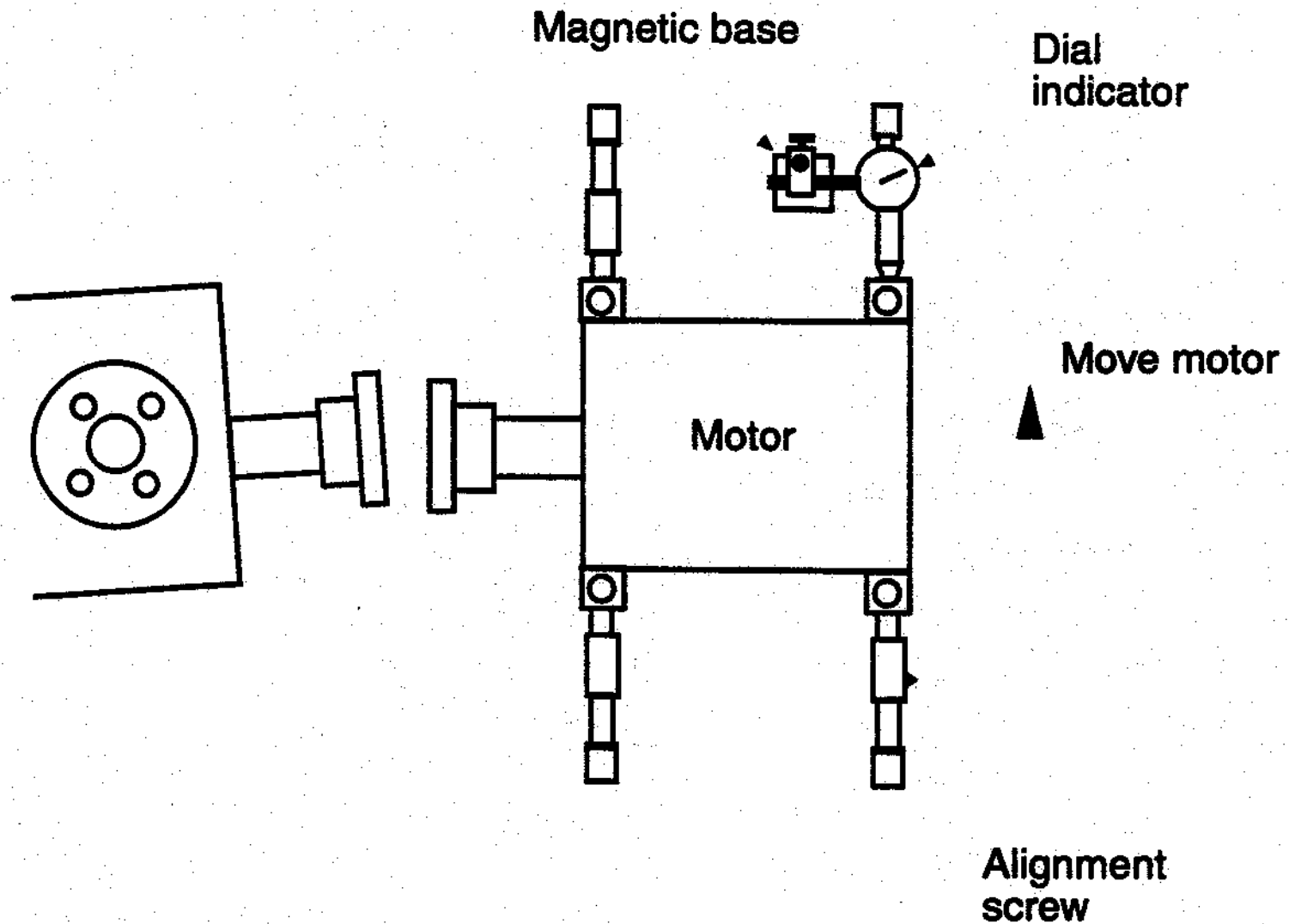


Face Method

The previous calculation was for vertical angular misalignment. The face method can also be used to determine the horizontal angular misalignment.



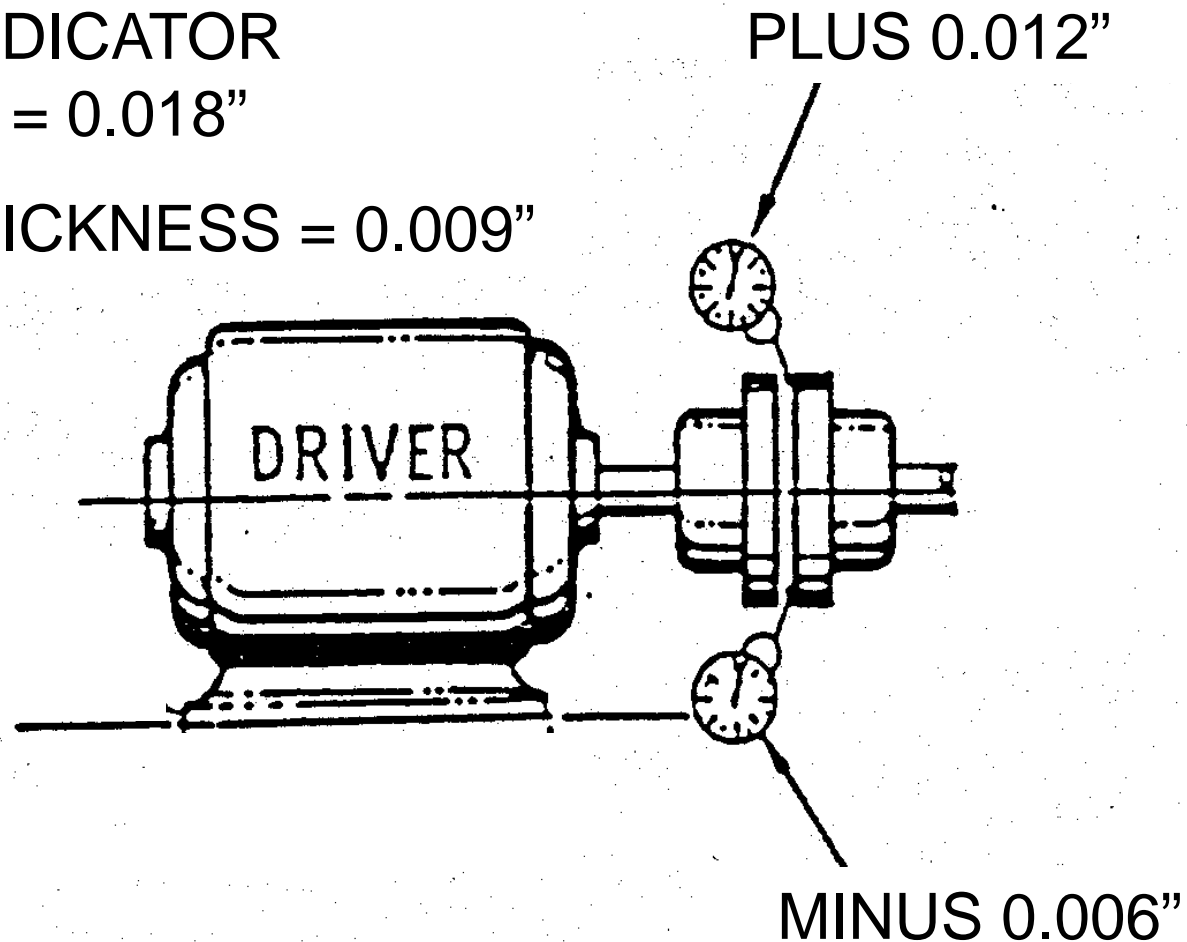
Dial Indicators on the Baseplate



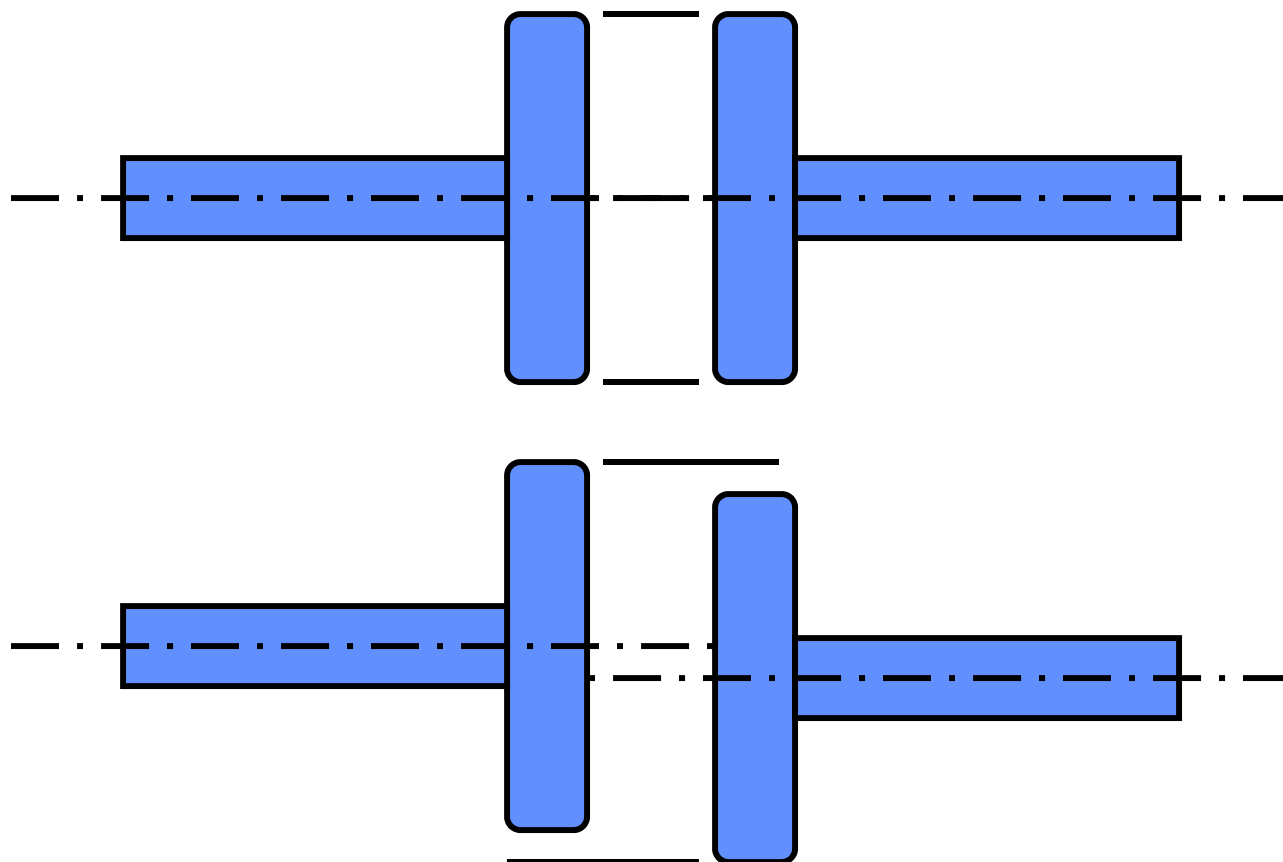
Taking Rim Readings

TOTAL INDICATOR
RUNOUT = 0.018"

SHIM THICKNESS = 0.009"



Rim Shim=1/2 Runout

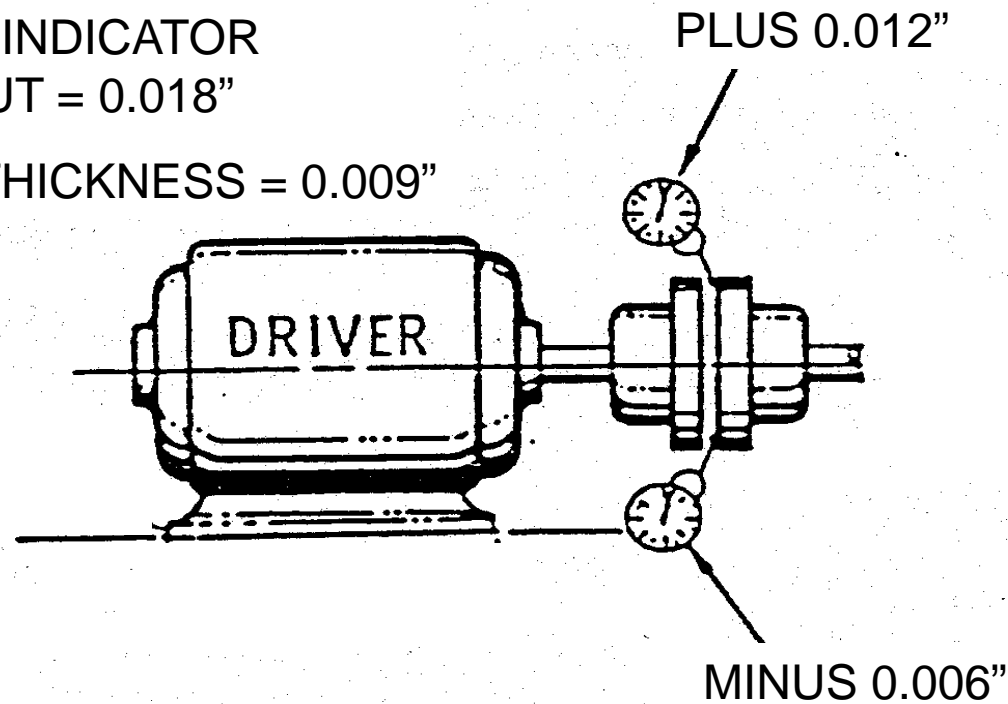


Rim Shim

- The 0.009" shims go under all of the motor feet
- The rim method can also be used to determine the sideways movement required

TOTAL INDICATOR
RUNOUT = 0.018"

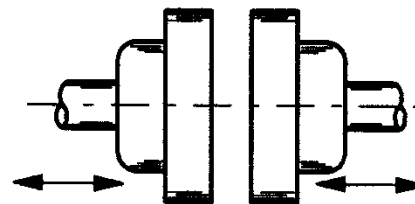
SHIM THICKNESS = 0.009"



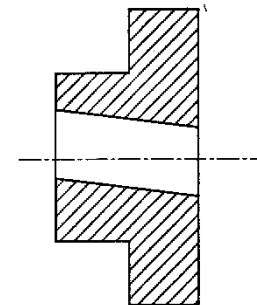
Dial Indicator Alignment

Remember:

- Always make sure the pump is bolted down when taking dial indicator readings
- Match mark the coupling halves and rotate them together when taking readings
- Beware of defective couplings and runout
- Beware of end float



Axial movement



Alignment Methods

Straight Edge

Dial Indicator

Laser

Laser

- A laser alignment uses an absolutely straight laser beam with a prepackaged kit including a user interface, beam transmitter, deflector units, and fixtures.
- Laser beams may be:
 - Class 1 (invisible)
 - Class 2 (visible)



Laser

Advantages:

- Dial indicator bracket sag is not a concern
- Good for long spans
- Consistent, accurate results: 0.0002" expected

Limitations:

- Higher initial cost
- Sensitive to heat
- Must be regularly calibrated



Alignment Calculation:

Step 1. Vertical Angular

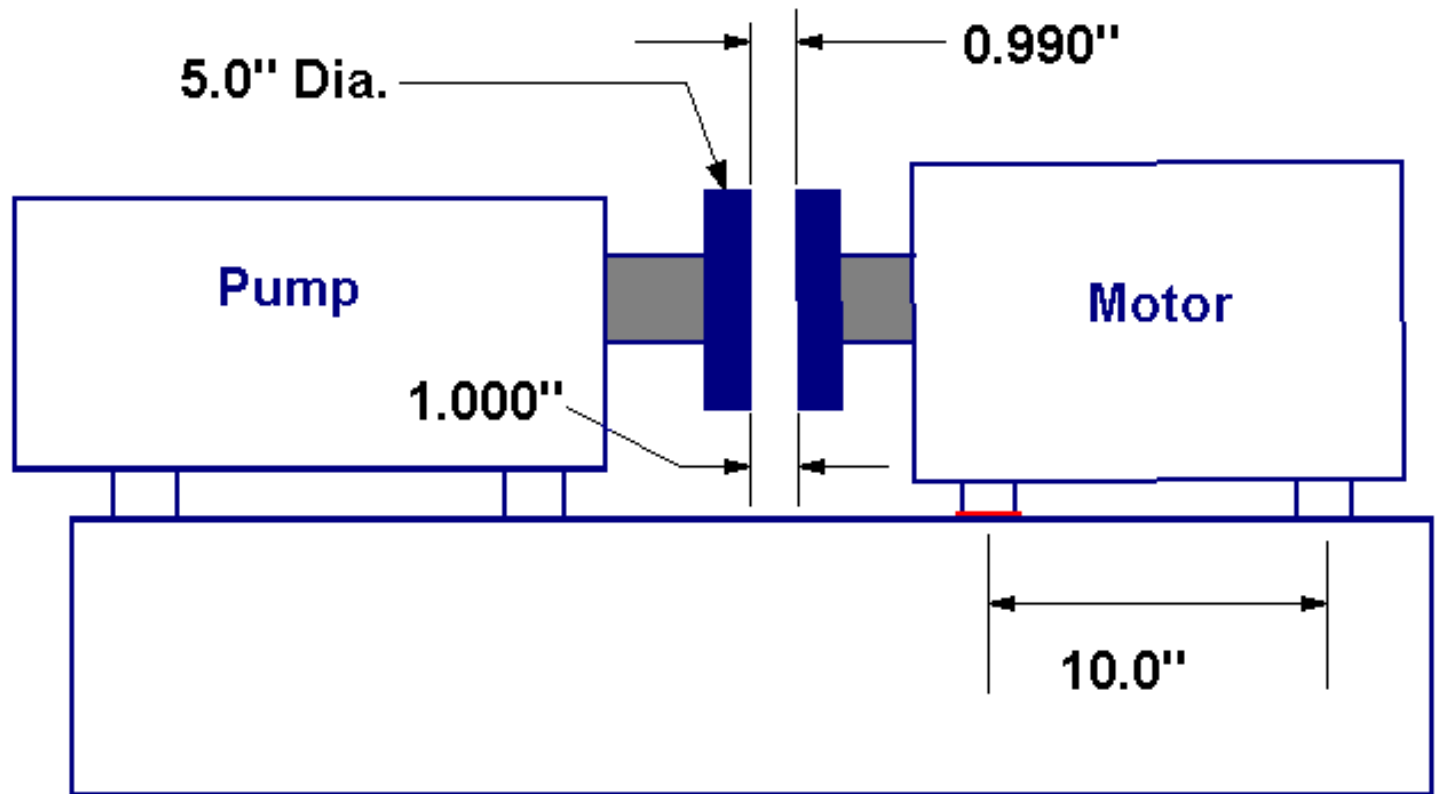
Step 2. Vertical Parallel

Steps 3&4. Horizontal



Alignment Calculation:

Step 1.
Vertical
Angular



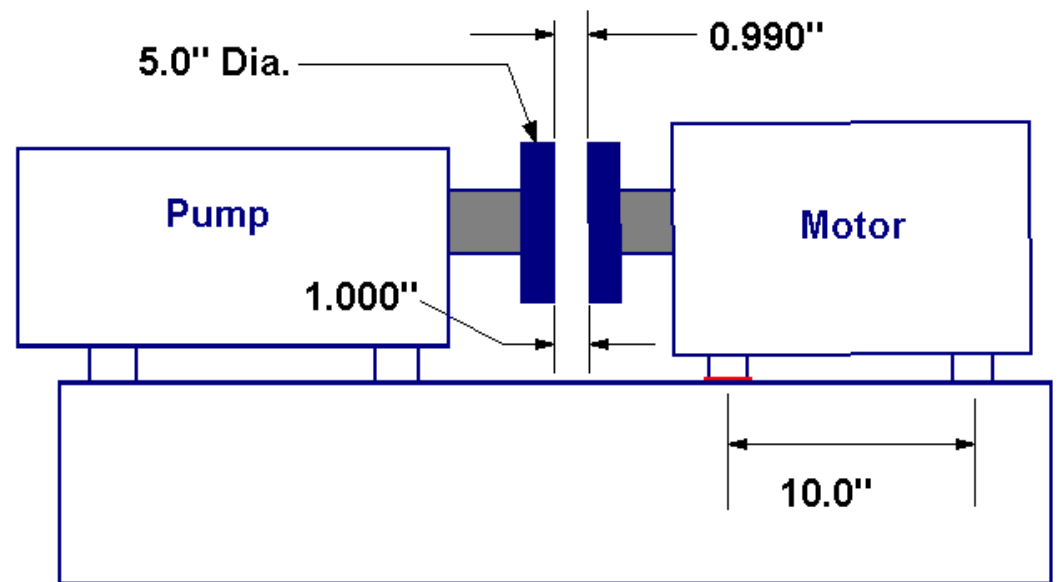


Alignment Calculation: Step 1. Vertical Angular

$$\text{Shim} = \frac{\text{TIR} \times \text{motor dim.}}{\text{cplg. dim.}}$$

$$\text{Shim} = 0.010'' \times 10''/5''$$

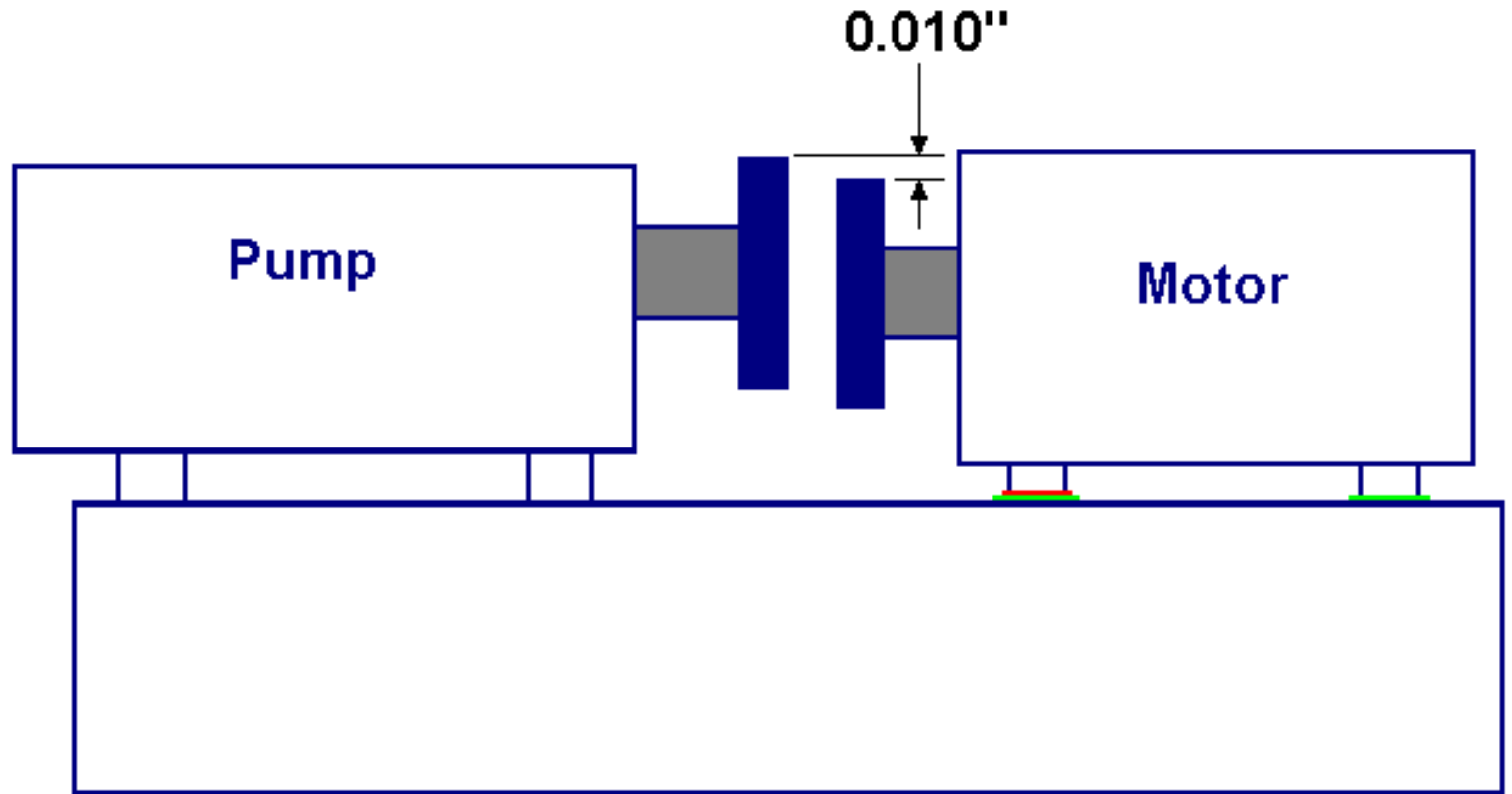
$$\text{Shim} = 0.020''$$





Alignment Calculation:

Step 2.
Vertical
Parallel



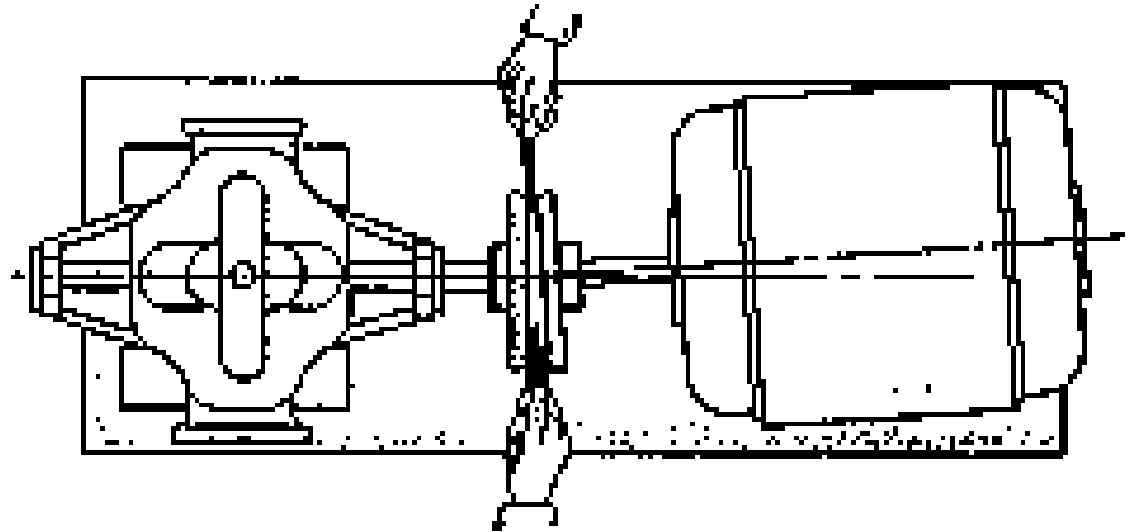


Alignment Calculation: Steps 3&4. Horizontal

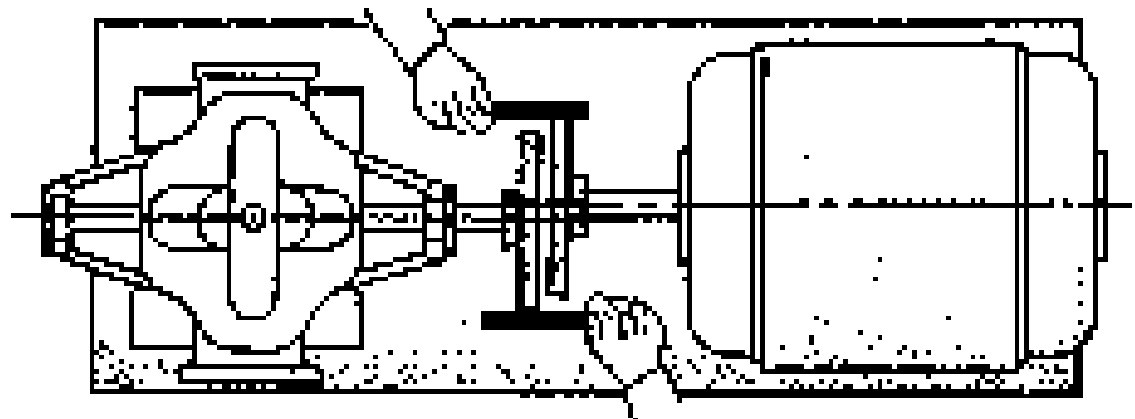
No shims required,
calculate or move until angular
and parallel alignment are
achieved

Alignment Sequence

3.
Horizontal
Angular



4.
Horizontal
Parallel



Comments?
Questions?
Observations?