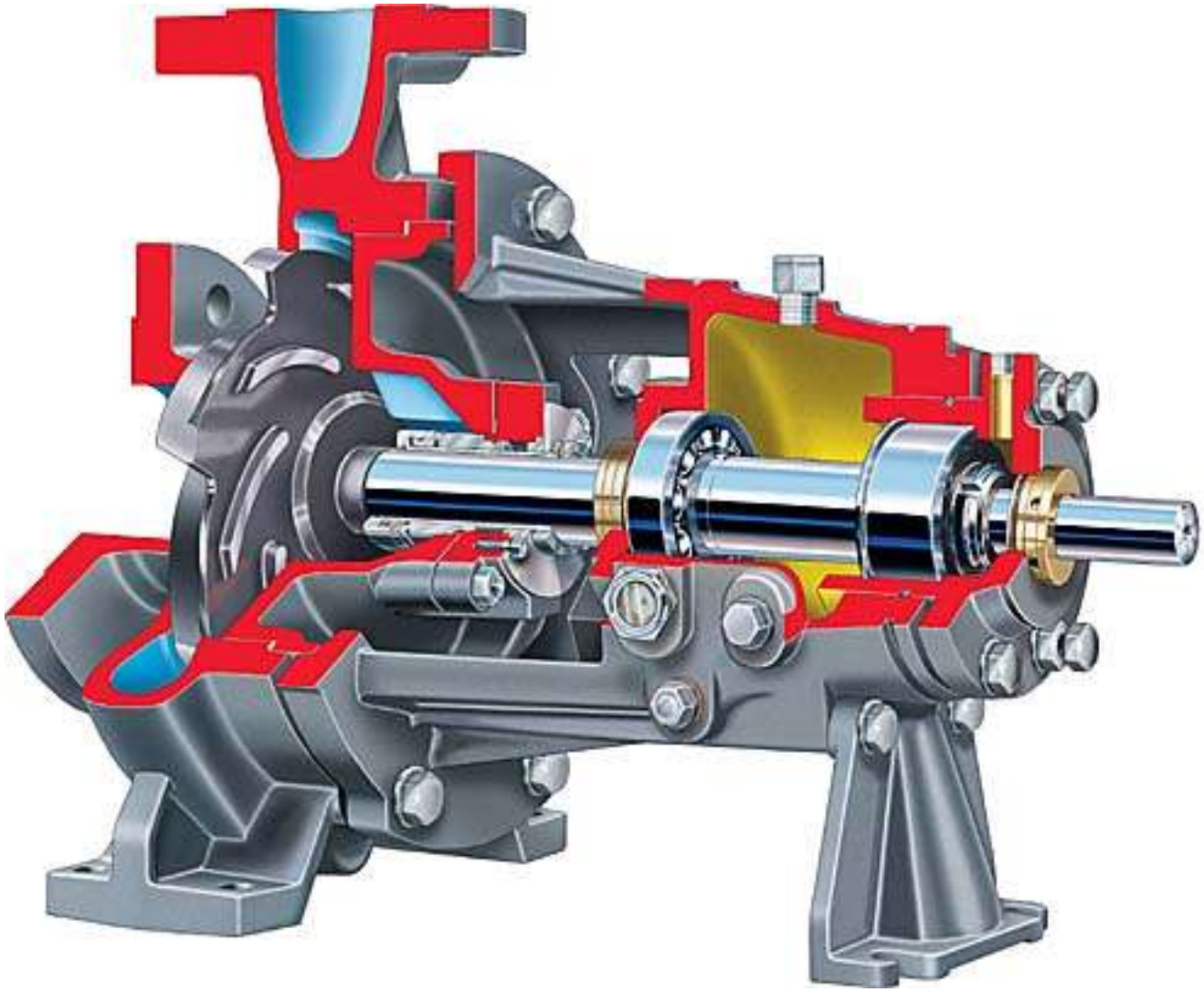
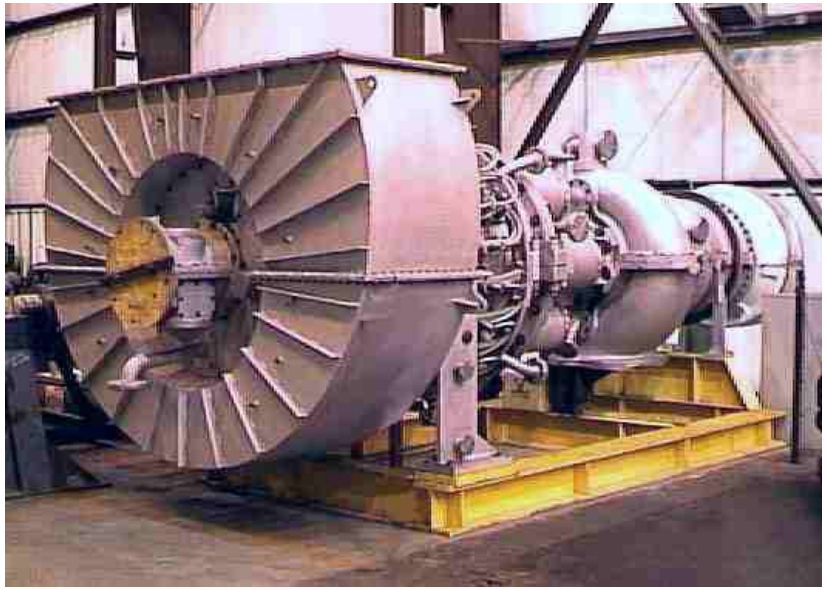
MECHANICAL TECHNOLOGY

ENGINEERING COMPONENTS

- BEARINGS
- SEALS
- FASTENINGS

ROTATING EQUIPMENT

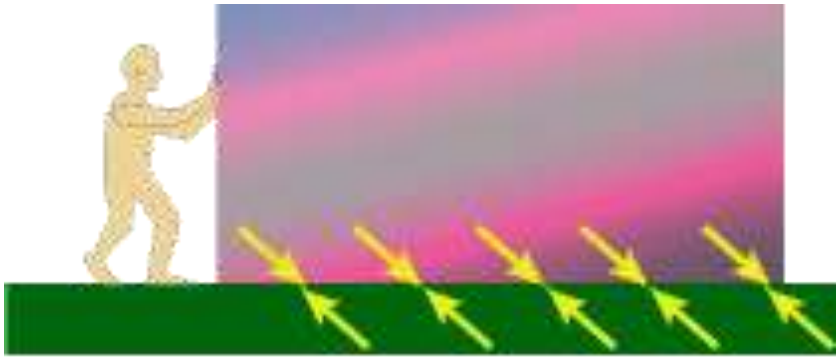




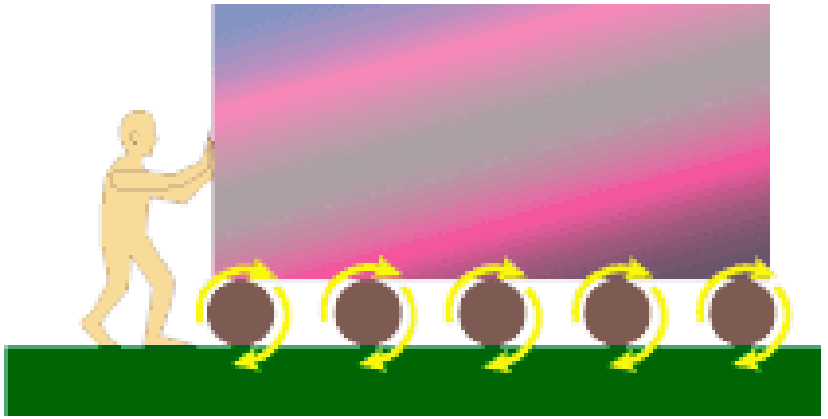
BEARINGS

Any drive which includes a rotating or reciprocating shaft uses bearings to support and locate the shaft while still allowing movement with minimum friction

Sliding friction



Rolling friction



Bearing Loads

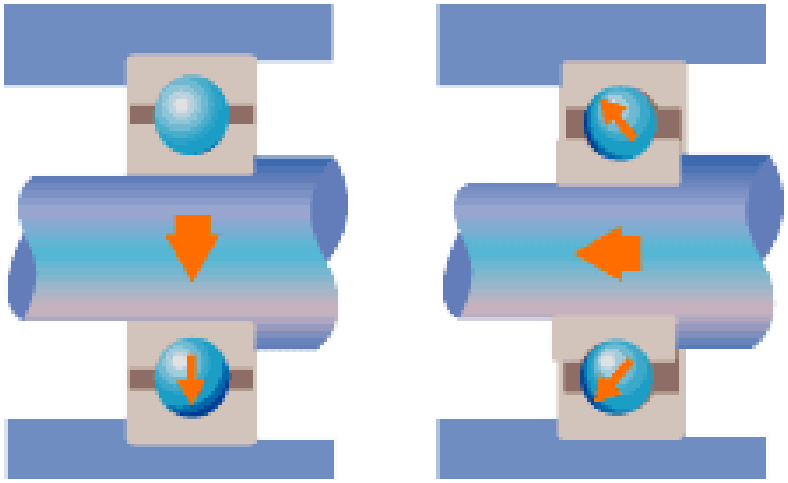
The rolling element bearing is subject to forces from gears, pulleys, or other components.

These forces simultaneously act on the bearing from many different directions.

The direction in which force is exerted on the bearing helps identify the type of *load* on the bearing:

Bearing Loads

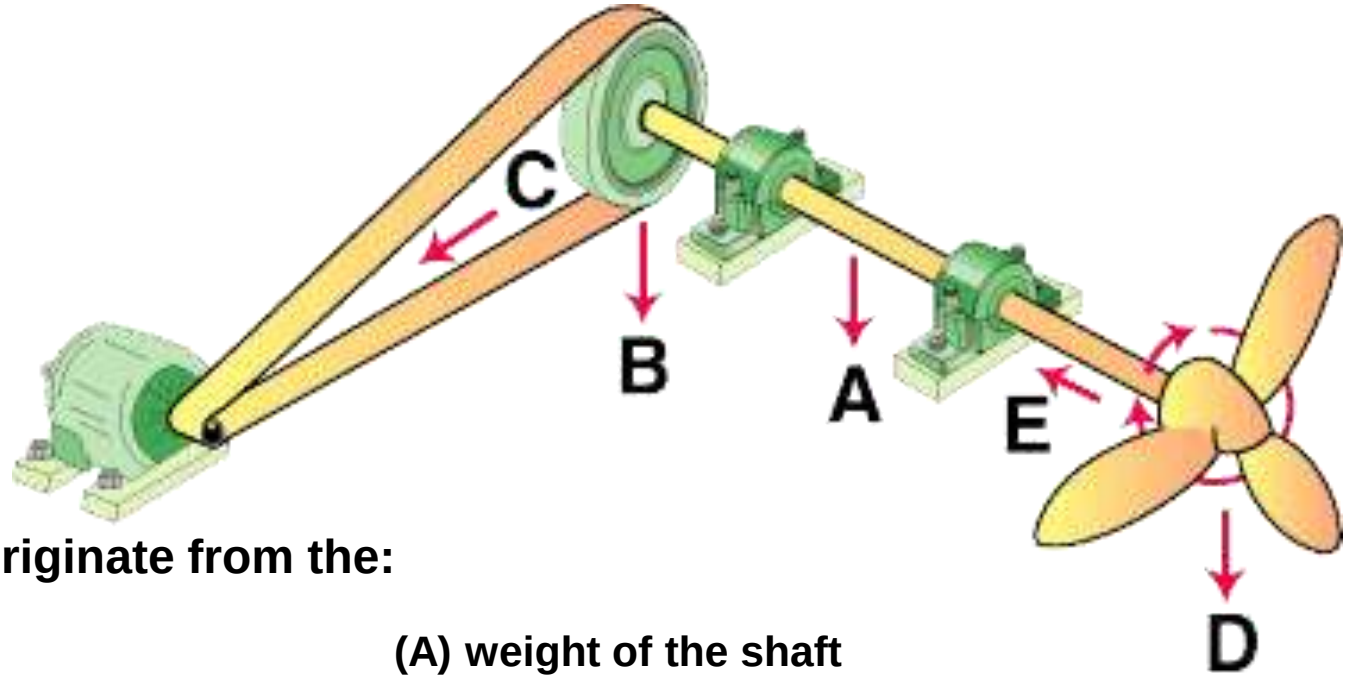
Radial loads are exerted on the bearing on a plane perpendicular *(90°)* to the shaft.



Axial loads, or thrust loads, are exerted on the bearing on a plane parallel to the centre of the shaft.

Combination loads exert both a radial and axial load on the bearing.

The illustration below shows a shaft mounted fan driven by a belt and powered by a motor. Two bearings support the shaft and are subjected to loads as follows:



Radial loads originate from the:

(A) weight of the shaft

(B) weight of the pulley

(C) tension of the belt

(D) weight of the propeller

(E) propeller rotation

BEARINGS

ROLLING ELEMENT BEARINGS

Bearings reduce friction by providing smooth metal balls or rollers, and a smooth inner and outer metal surface for the balls to roll against.

These balls or rollers "bear" the load, allowing the device to spin smoothly.

Rolling Element Bearing Classifications

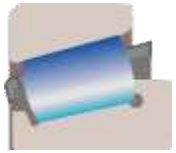
The rolling elements are formed as standard geometric shapes which include:

Balls

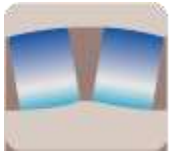
Cylindrical Rollers

Needle Rollers

Tapered Rollers



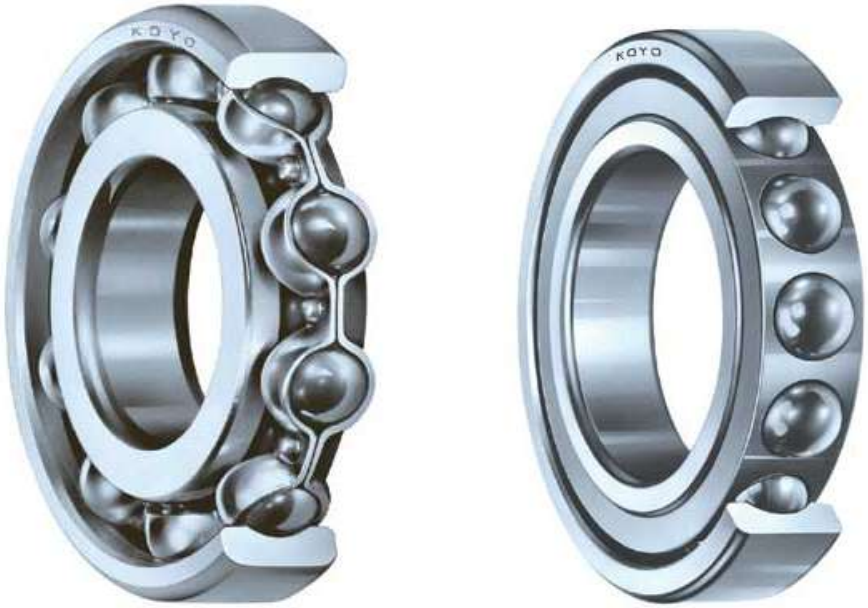
Spherical Rollers



The geometric shape of these rolling elements are used to define the classification, or name, of each rolling element bearing type. Ball bearings use perfectly round balls as their rolling elements, cylindrical roller bearings use cylindrical rollers, etc.

Ball Bearings

Ball bearings, as shown below, are probably the most common type of bearing.These bearings can handle both radial and thrust loads, and are usually found in applications where the load is relatively small.



In a ball bearing, the load is transmitted from the outer race to the ball, and from the ball to the inner race. Since the ball is a **sphere**, it only contacts the inner and outer race at a very small point, which helps it spin very smoothly. But it also means that there is not very much contact area holding that load, so if the bearing is overloaded, the balls can deform or squish, ruining the bearing.

Roller Bearings

Roller bearings like the one illustrated below are used in applications like conveyer belt rollers, where they must hold heavy radial loads. In these bearings, the roller is a cylinder, so the contact between the inner and outer race is not a point but a line. This spreads the load out over a larger area, allowing the bearing to handle much greater loads than a ball bearing. However, this type of bearing is not designed to handle much thrust loading.

Ball Thrust Bearing

Ball thrust bearings like the one shown below are mostly used for low-speed applications and cannot handle much radial load. Turntables use this type of bearing.

Roller Thrust Bearing

Roller thrust bearings like the one illustrated below can support large thrust loads. They are often found in gear sets like car transmissions between gears, and between the housing and the rotating shafts.

Tapered Roller Bearings

Tapered roller bearings are designed to carry maximum combinations of radial and thrust loads simultaneously.

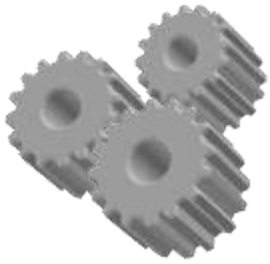
Spherical Roller Bearings

Spherical roller bearings are self-aligning bearings designed for heavy radial loading.

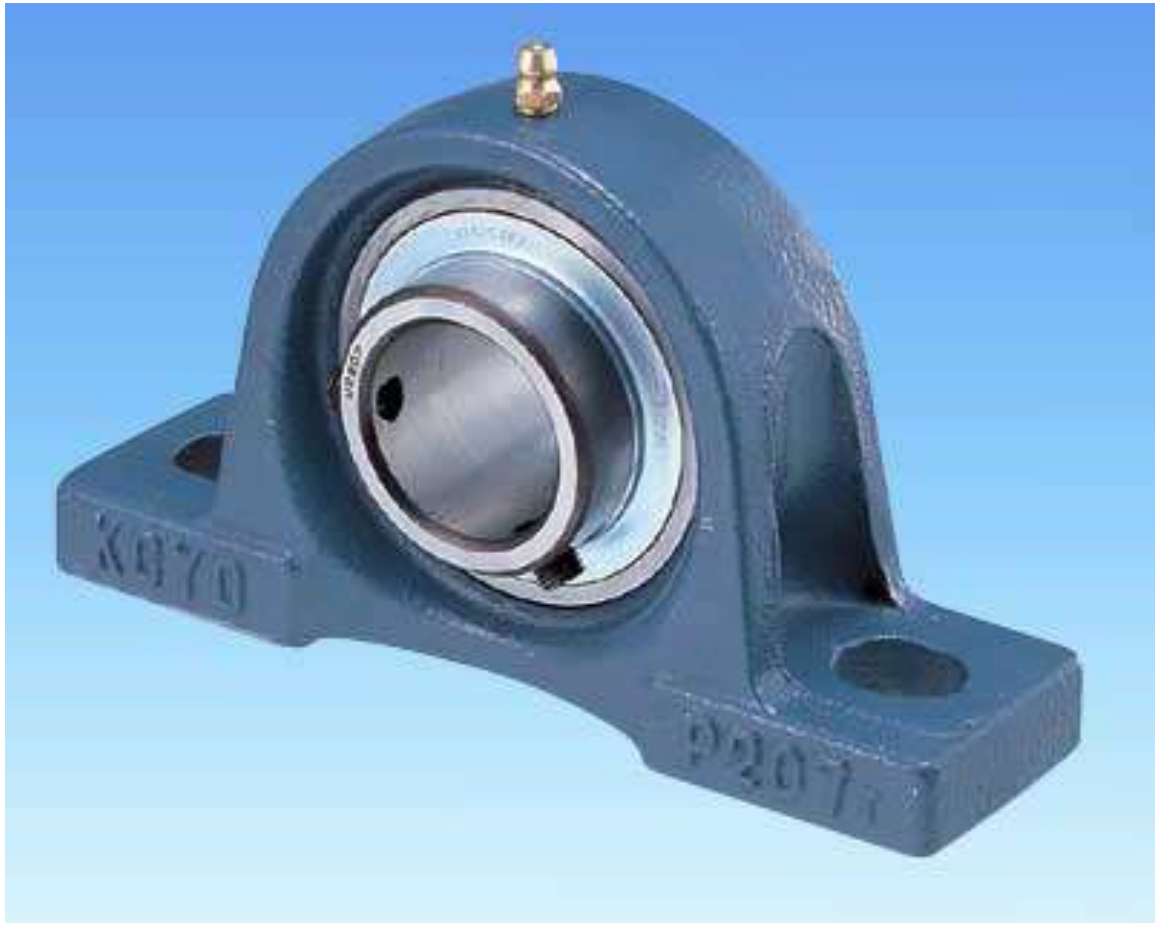
They automatically compensate for large angular errors (shaft misalignments).

Needle bearings feature smaller cross-section, higher load-carrying capacity, greater rigidity and lower inertia forces that facilitate size and weight reductions in machinery.

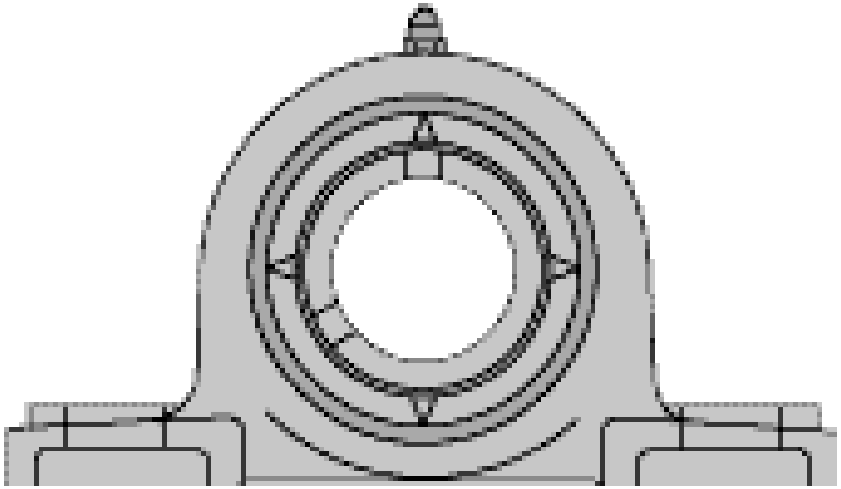
Designed to withstand oscillation, perform under severe conditions and interchange with sliding bearings.



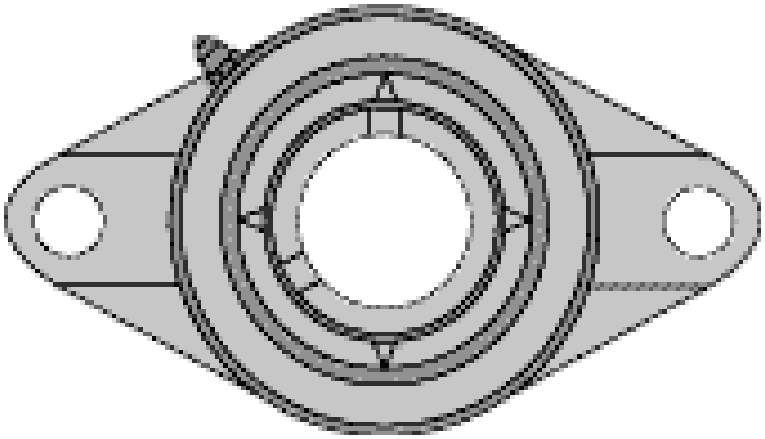
Mounted Unit Bearings



Types of Mounted Units

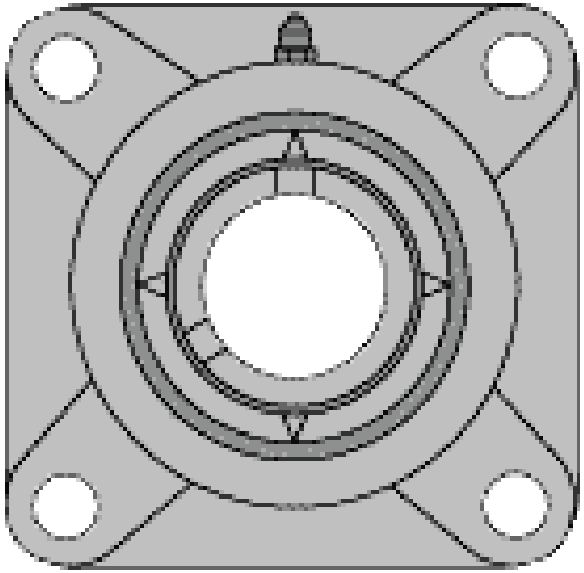


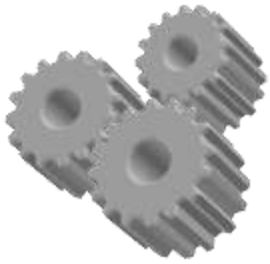
Pillow Block Unit



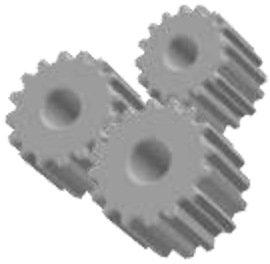
Two-Bolt Flange Unit

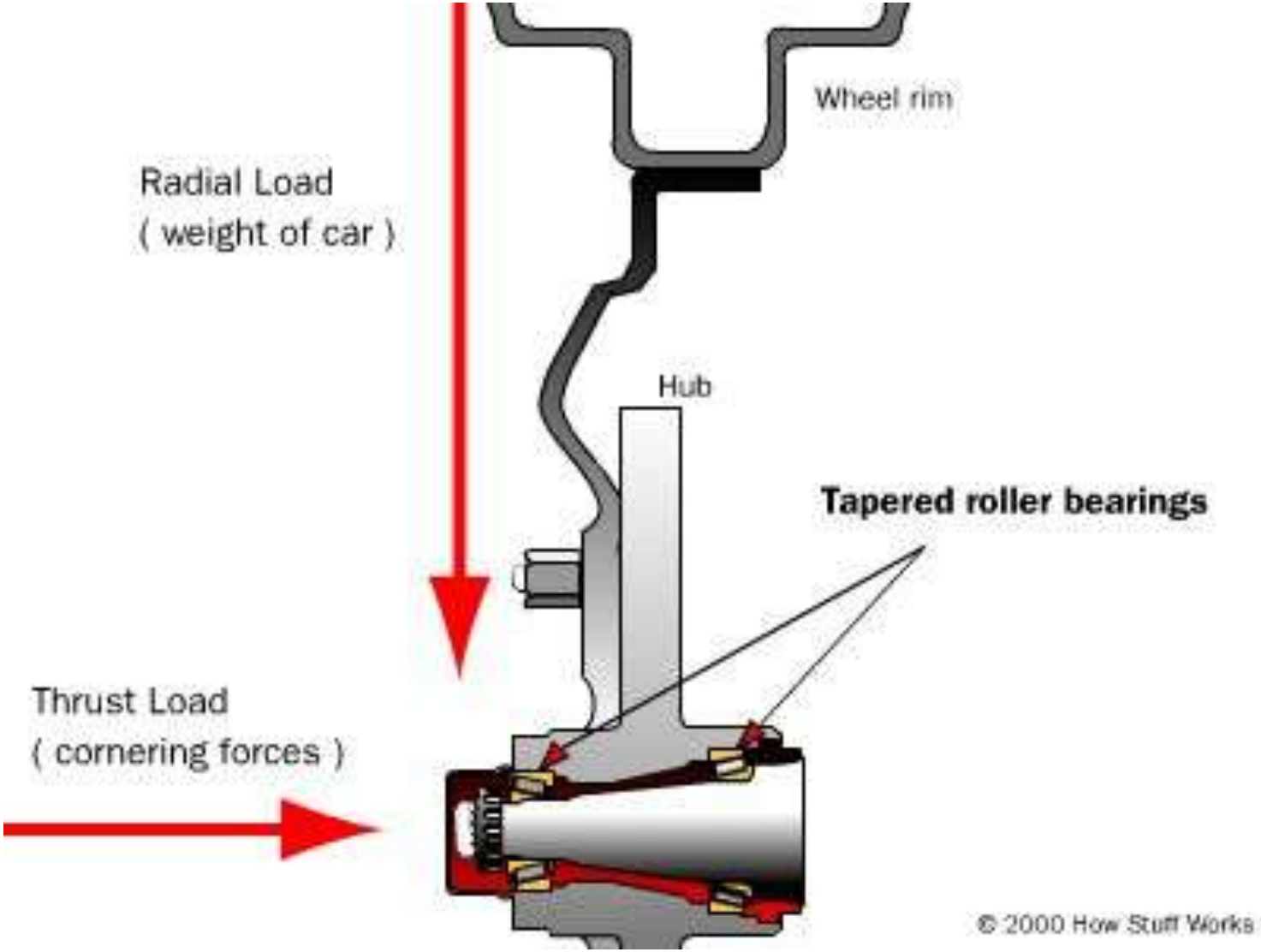
Four-Bolt Square Flange Unit





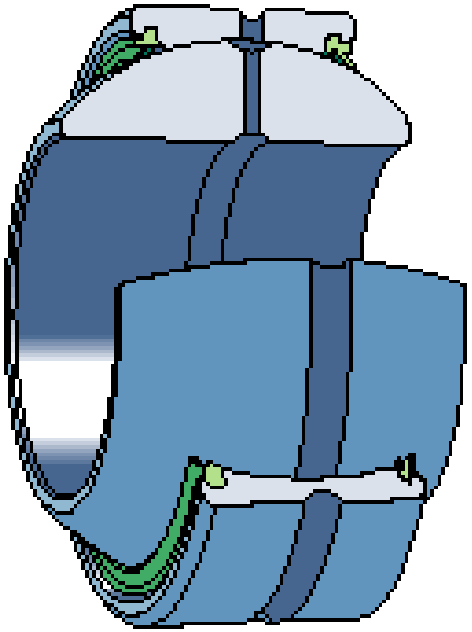
TTE



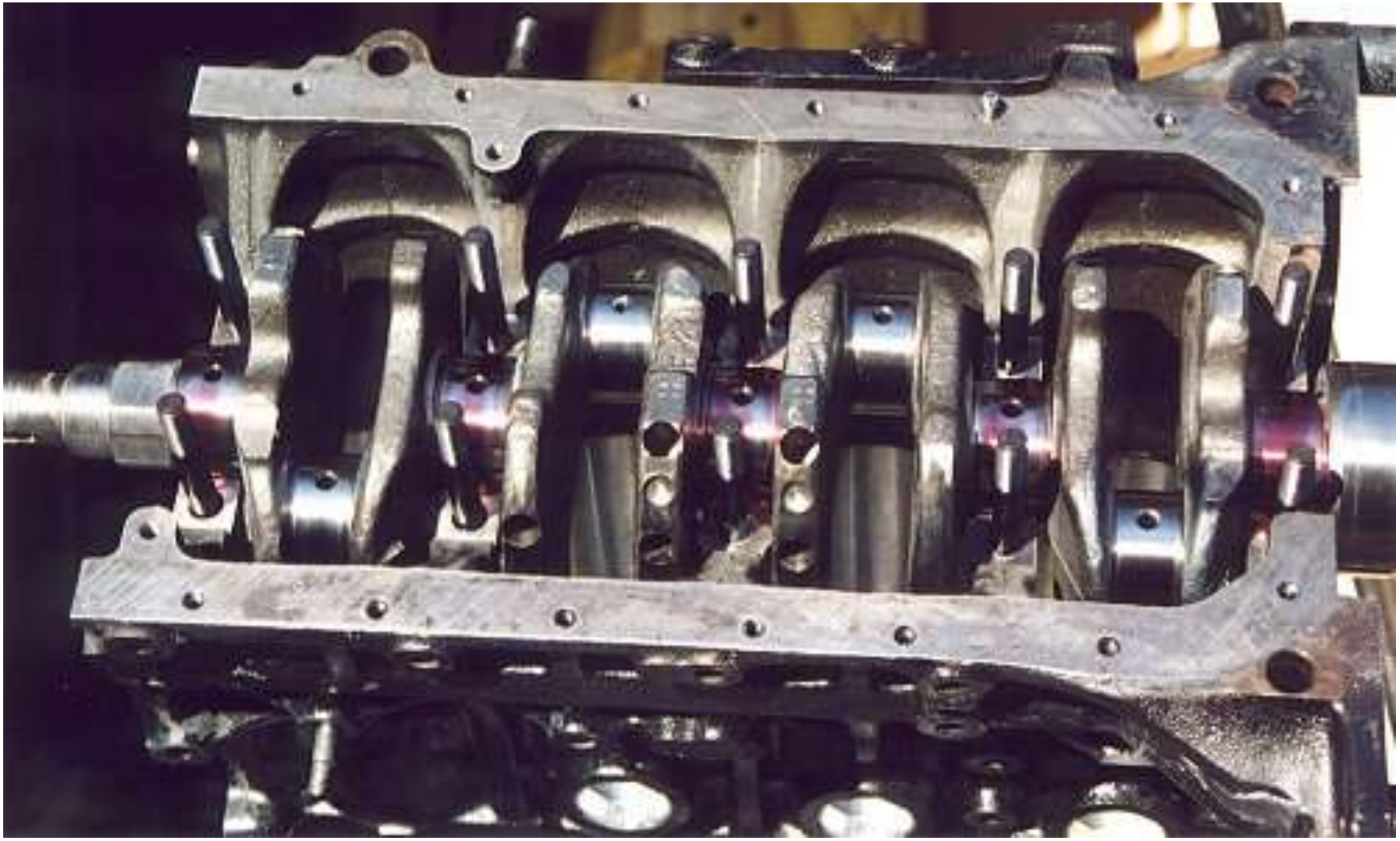

Wheel rim
Radial Load
(weight of car)
Hub
Tapered roller bearings
Thrust Load
(cornering forces)
© 2000 How Stuff Works

BEARINGS

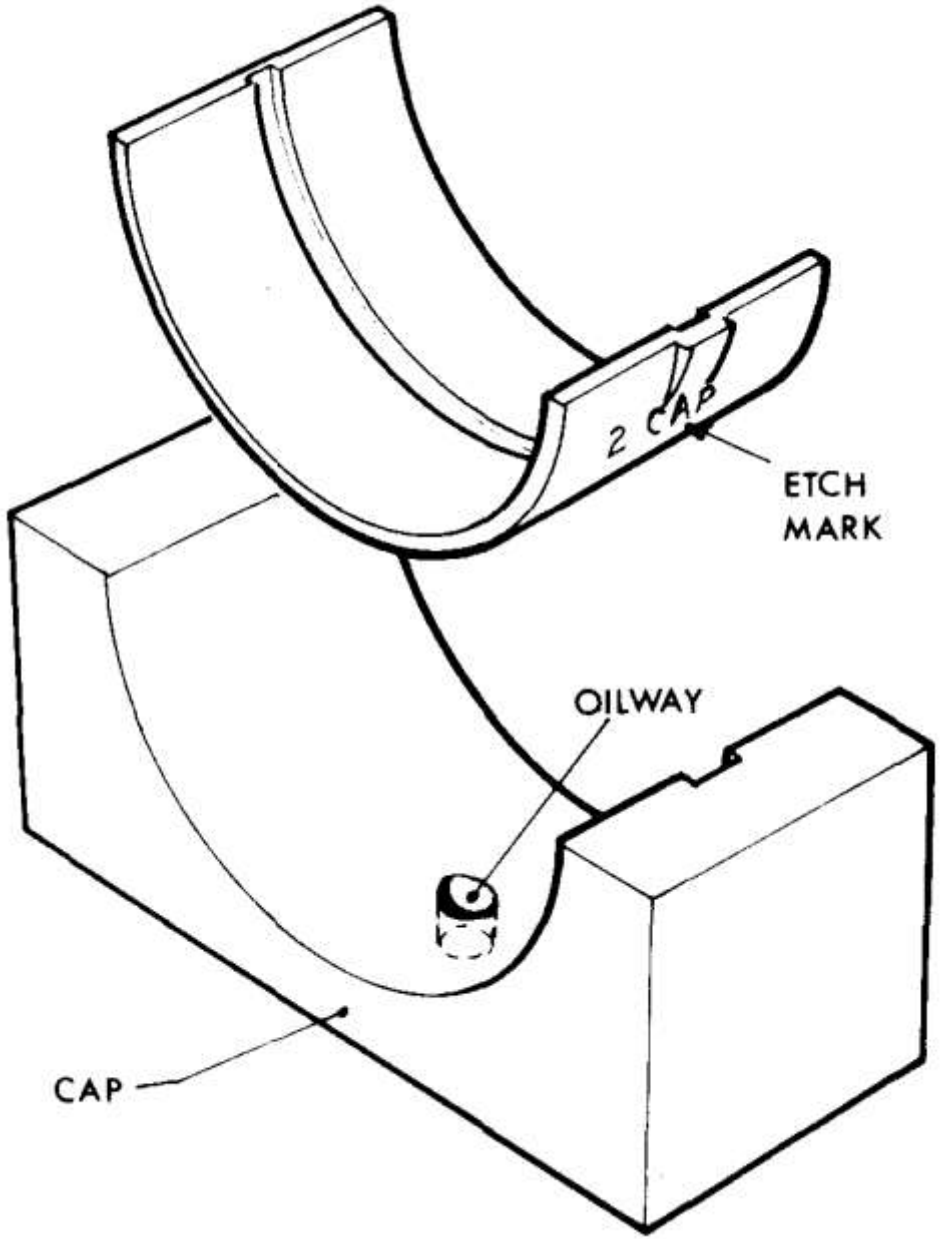
SLEEVE BEARINGS

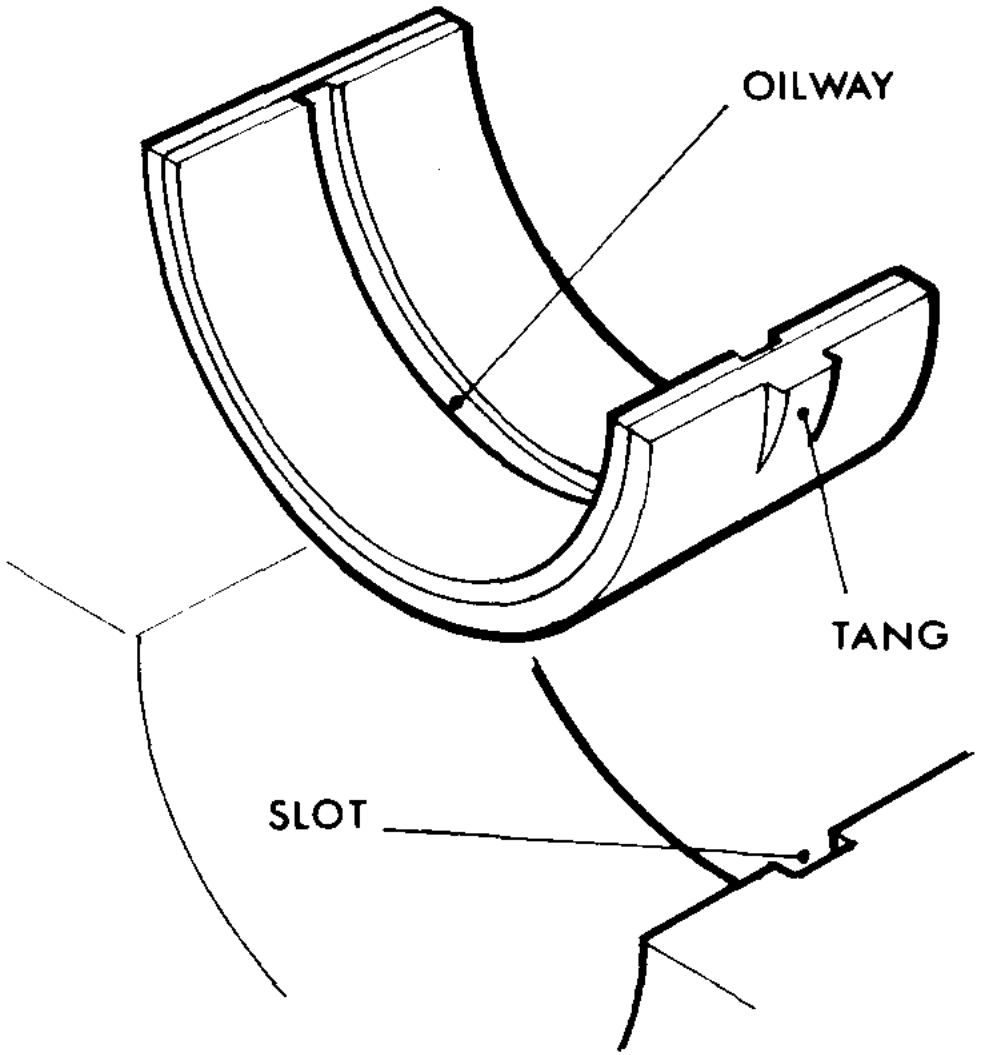


Sleeve bearings have no rolling elements so each surface slides relative to one another. This sliding action creates more heat than rolling element bearings thus RPM is often a limiting factor.



THIN WALL BEARING




OILWAY
TANG
SLOT


BEARING INSTALLATION AND REMOVAL

Tough Steel addresses 80% of all Bearing Failures - contamination and low lubrication levels

Bearing Life

Many factors have a profound affect on the actual life of the bearing.

Some of these factors are:

Temperature
Lubrication
Improper care in mounting resulting in:
- **Contamination**
- **Misalignment**
- **Deformation**

As a result of these factors, an estimated *95%* of all failures are classified as premature bearing failures.

Bearing load ratings are established on the results of laboratory rolling contact fatigue tests.

Real world conditions such as misalignment, vibration, shock loading, insufficient or inefficient lubrication, extremes of temperature, or contamination, will decrease the life expectancy of the bearings.

If these conditions are severe, they may lead to premature failure of the bearings.

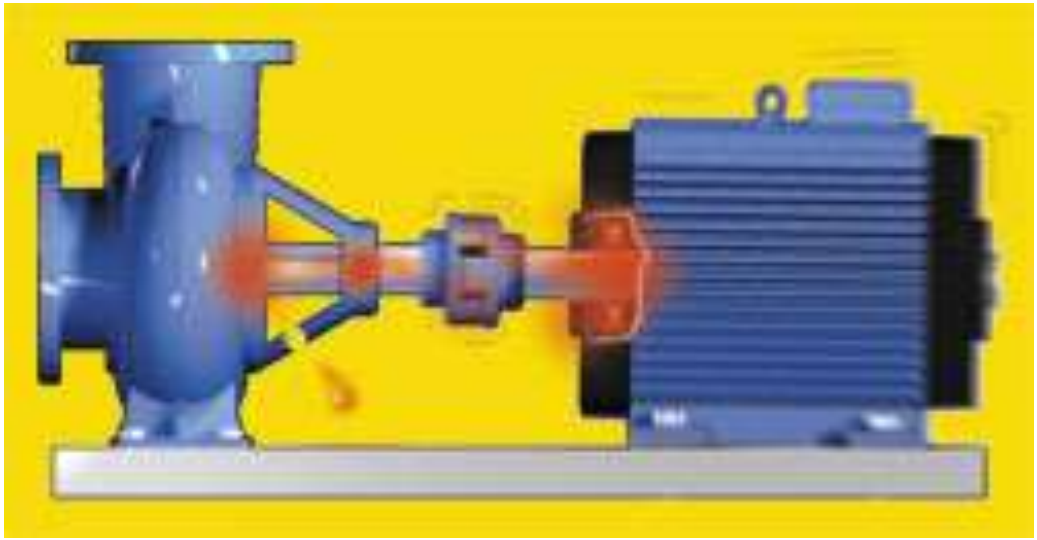
Bearing failure

Only a fraction of all bearings in use fail, and the main reasons are:

Poor lubrication
Contamination
Faulty mounting
Careless handling
Fatigue
Wear
Fretting
Corrosion
Indentations
Electrical pitting
Smearing
Cracking
Flaking

Incorrect installation

Misalignment



Misalignment of equipment causes :
Vibration
Strain/stress
Overheating
Resulting in bearing breakdown

Overpressurization of the bearing shields – When grease is added to a grease cavity, grease volume and cavity pressure increase. Damage can occur to the shield on a single- or double-shielded bearing during regreasing if the grease is added too fast. When the motor is placed into service, the grease will thermally expand.

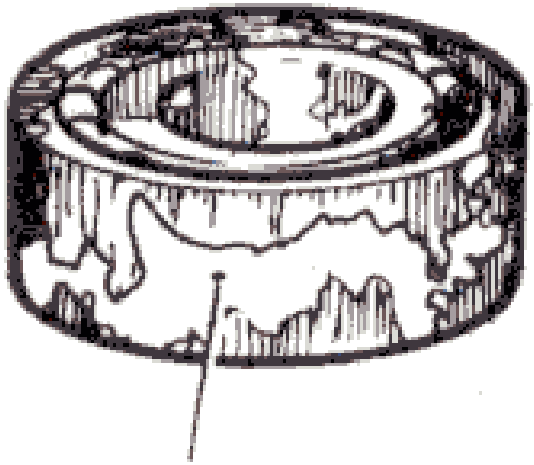
If the grease cavity is full, thermal expansion can create damaging pressure on the bearing shields.

Some serviceable wheel bearings should be replaced as a set. Do not take short cuts by not replacing seals or outer races.

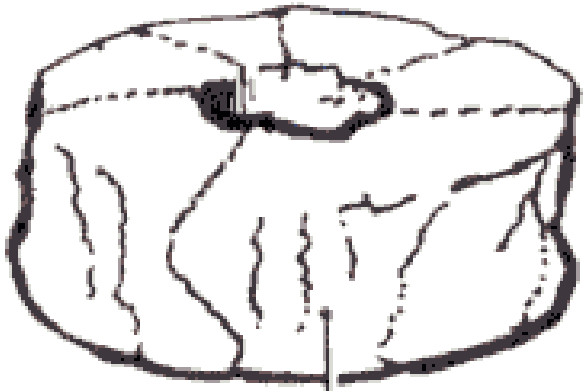

TimGilles.com

Bearing Fluting

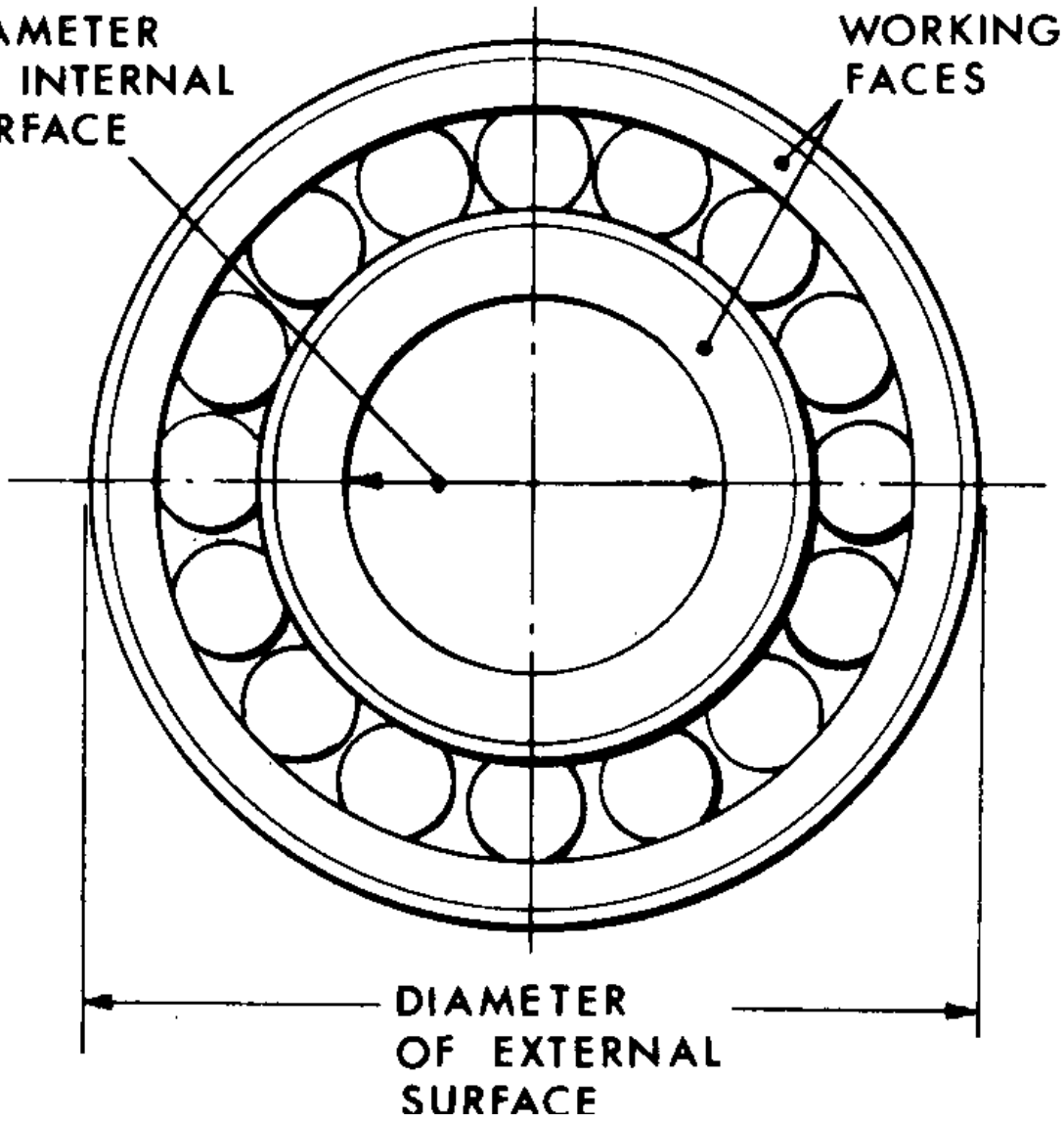
The picture shows flaking due to faulty mounting. The mounting force has passed through the balls and made indentations in the raceway, causing flaking.

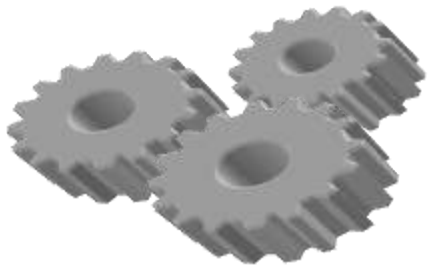


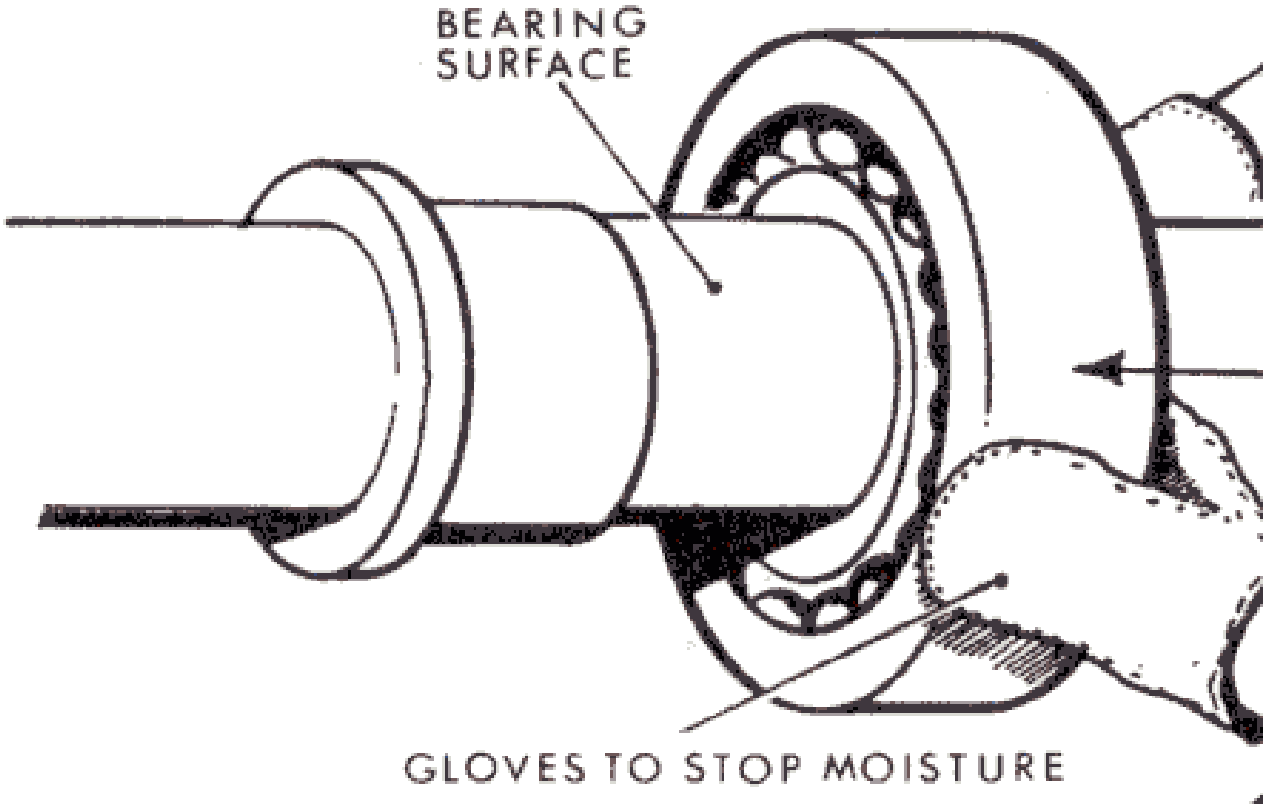
PROTECTED WITH GREASE

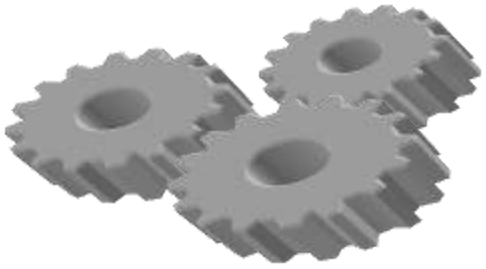


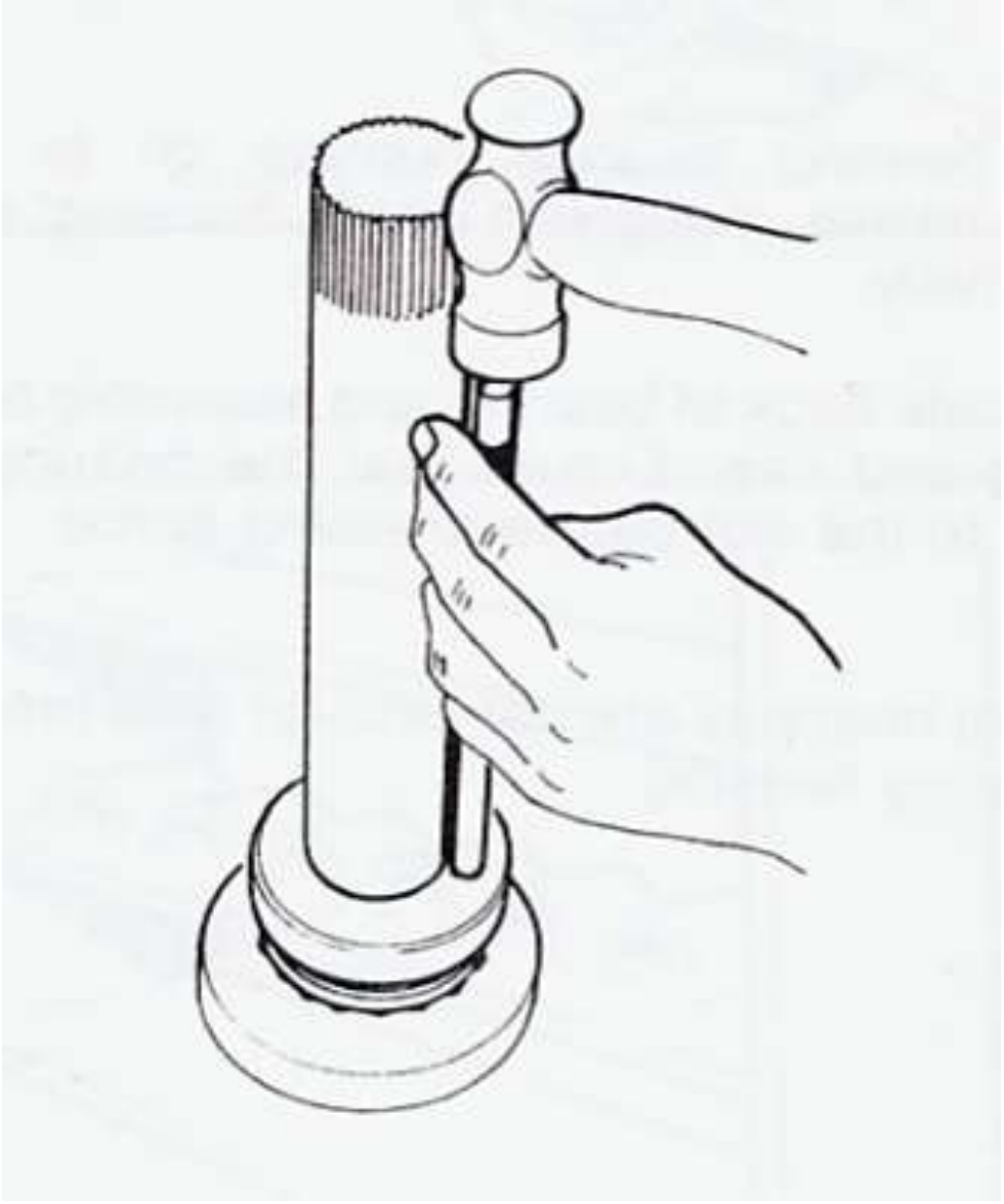
WRAPPED IN GREASE PROOF PAPER

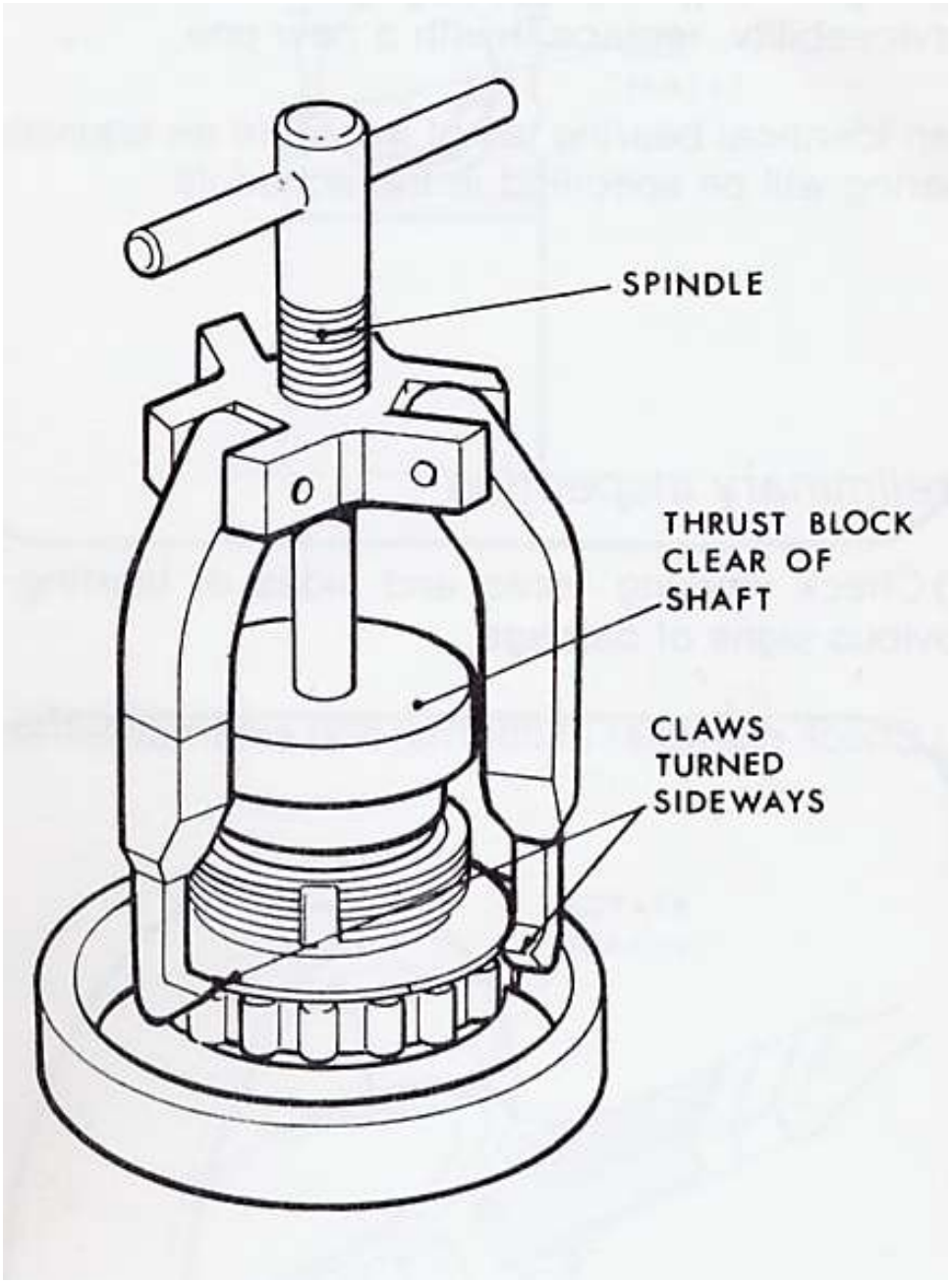

DIAMETER
OF INTERNAL
SURFACE
WORKING
FACES
DIAMETER
OF EXTERNAL
SURFACE

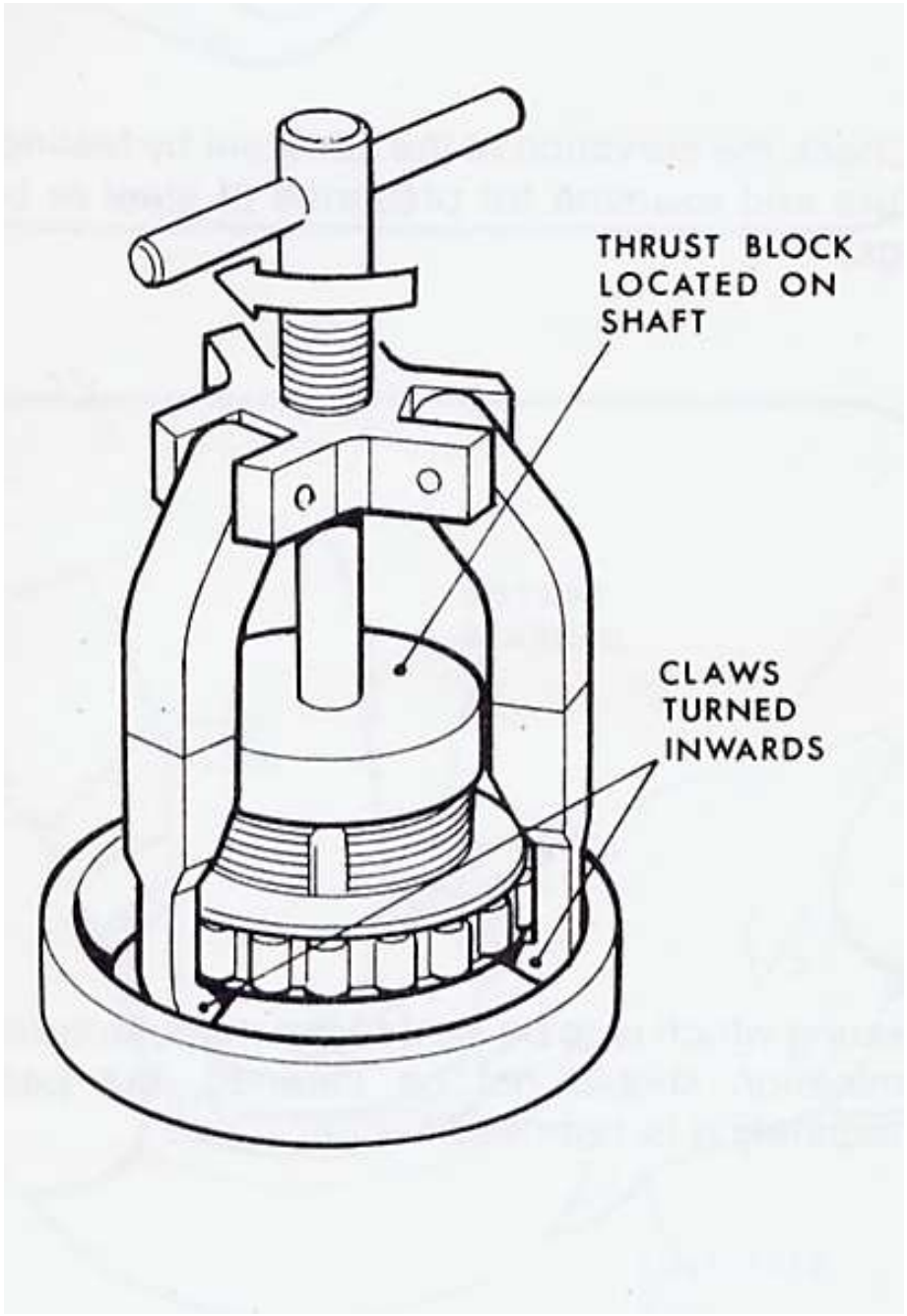


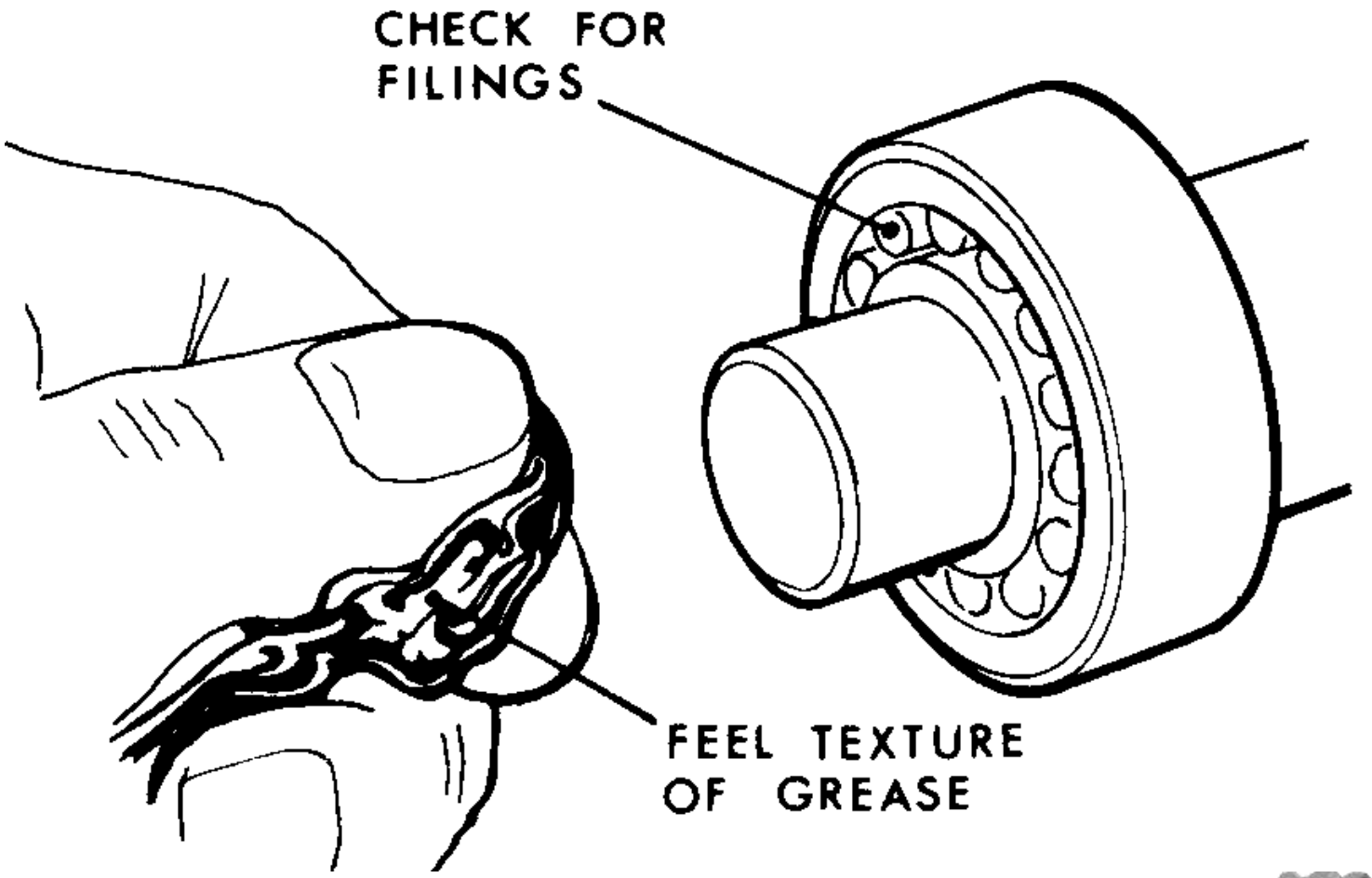

BEARING
SURFACE
GLOVES TO STOP MOISTURE

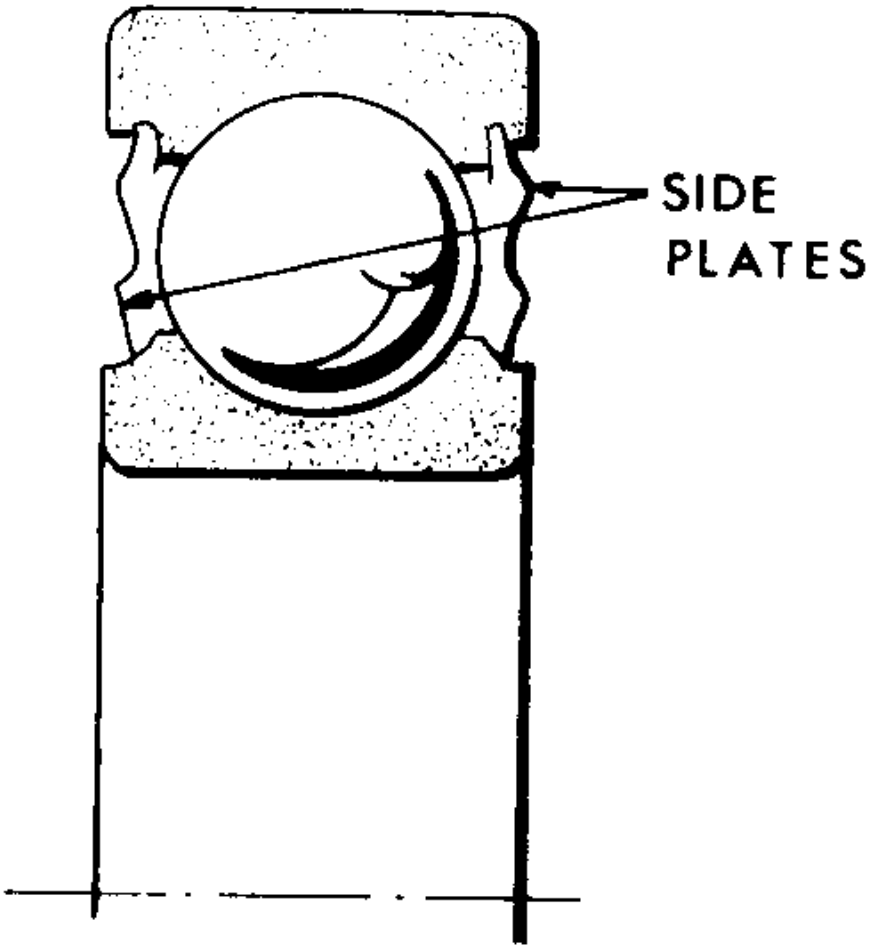


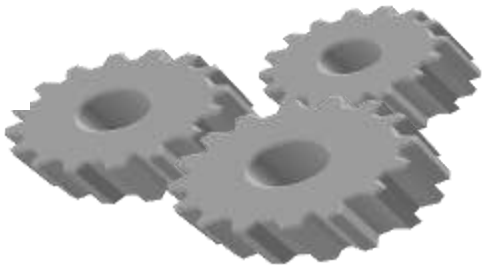


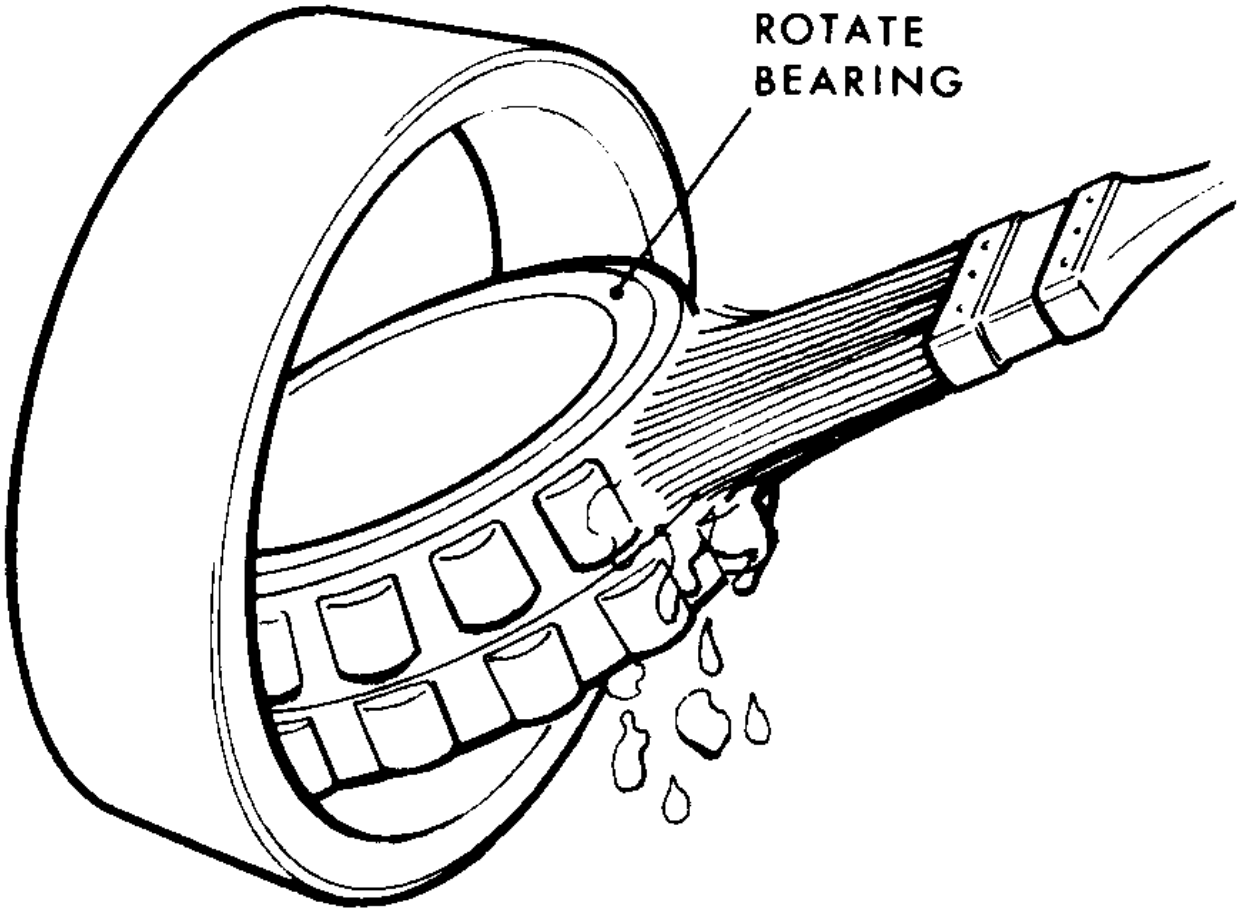

SPINDLE
THRUST BLOCK
CLEAR OF
SHAFT
CLAWS
TURNED
SIDEWAYS

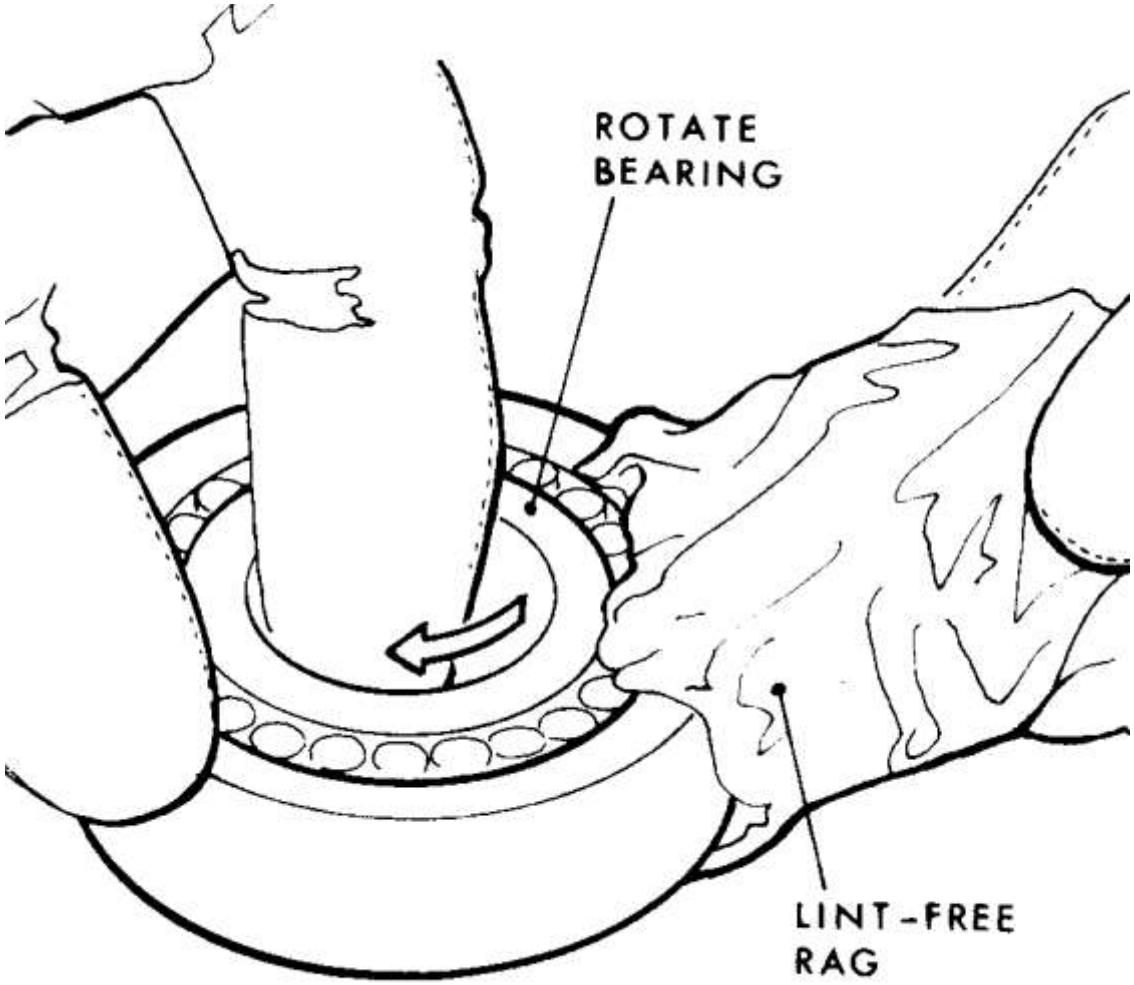

THRUST BLOCK
LOCATED ON
SHAFT
CLAWS
TURNED
INWARDS

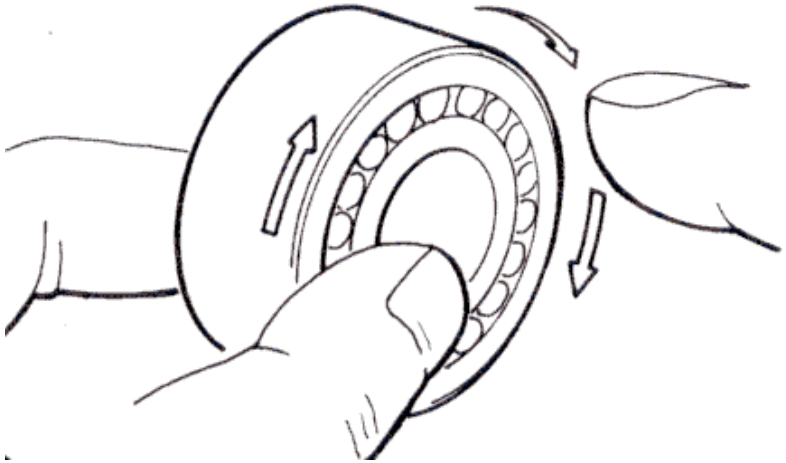

CHECK FOR
FILINGS
FEEL TEXTURE
OF GREASE

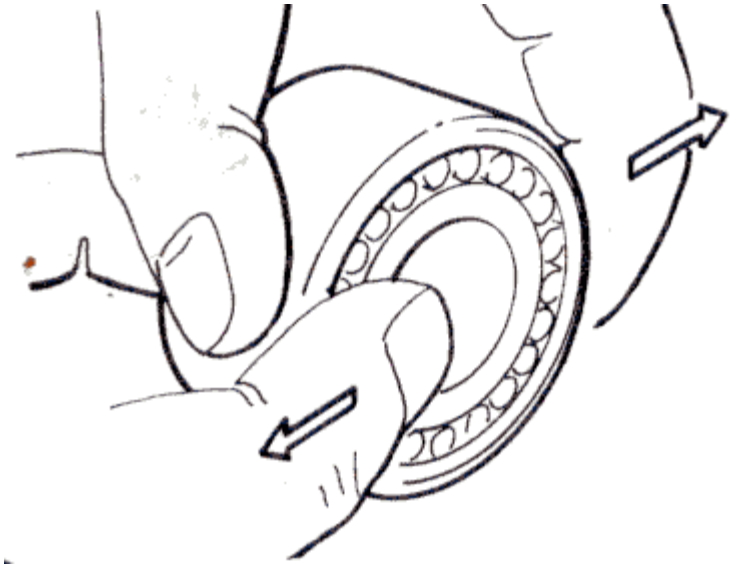

SIDE
PLATES

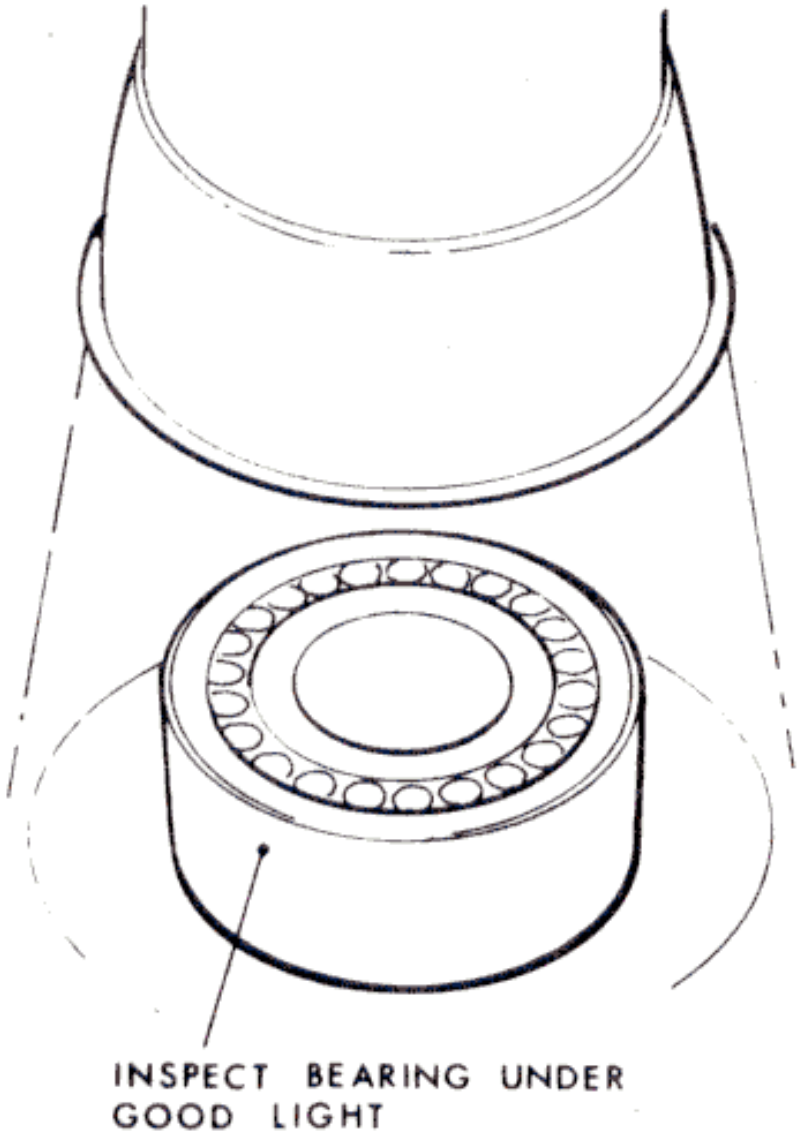


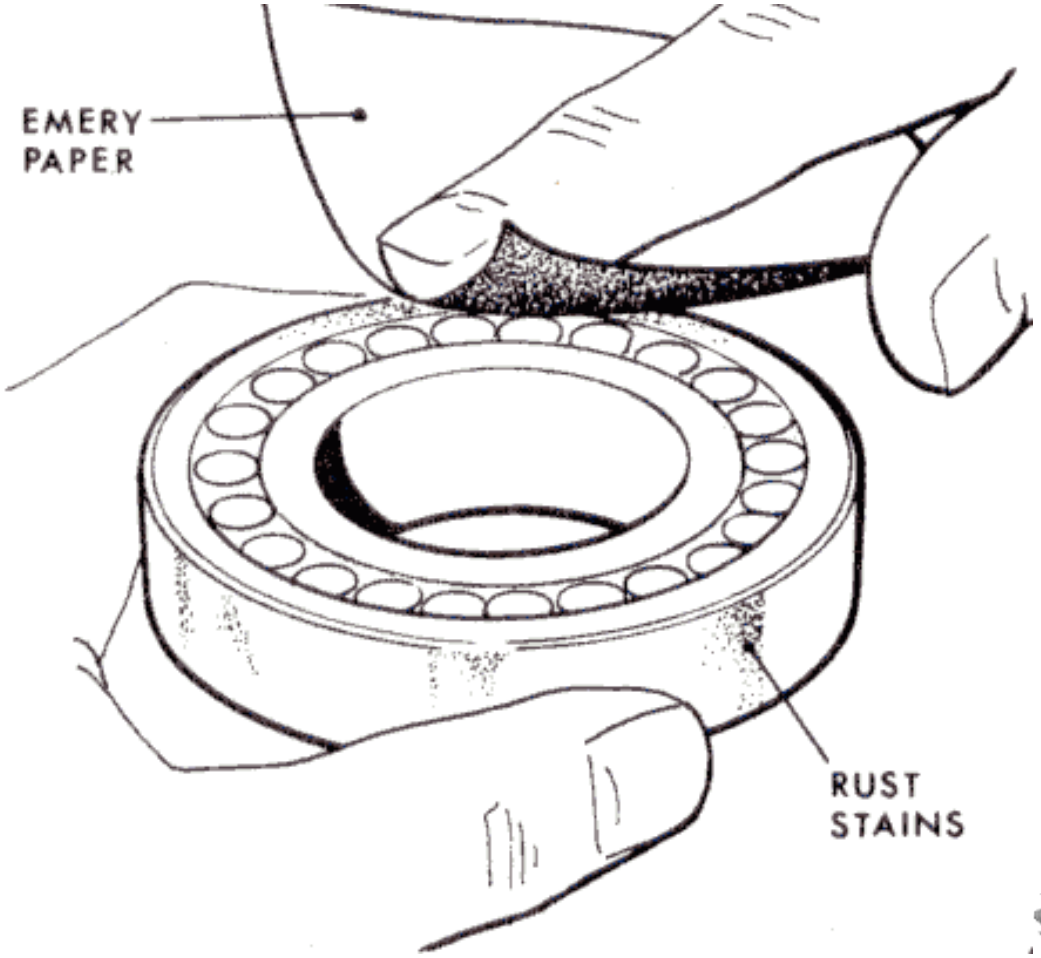

ROTATE
BEARING

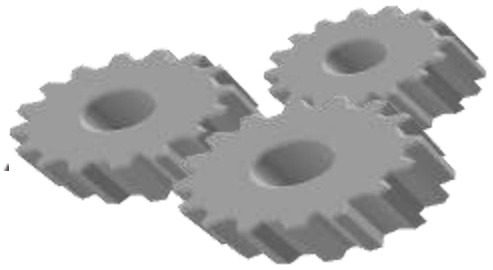

ROTATE
BEARING
LINT-FREE
RAG

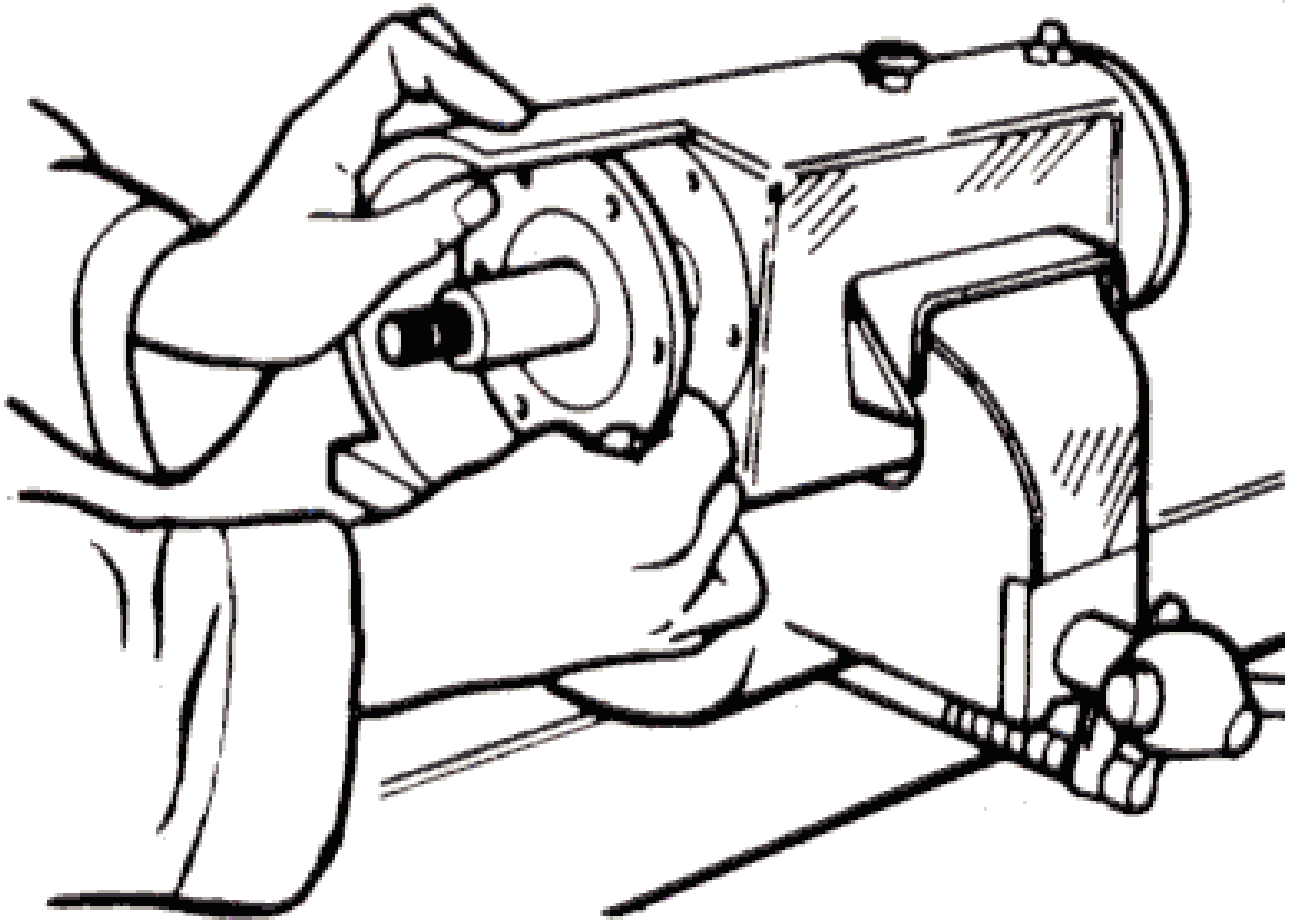


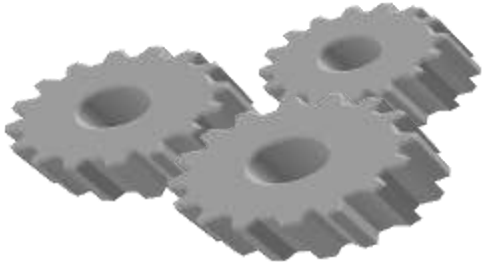


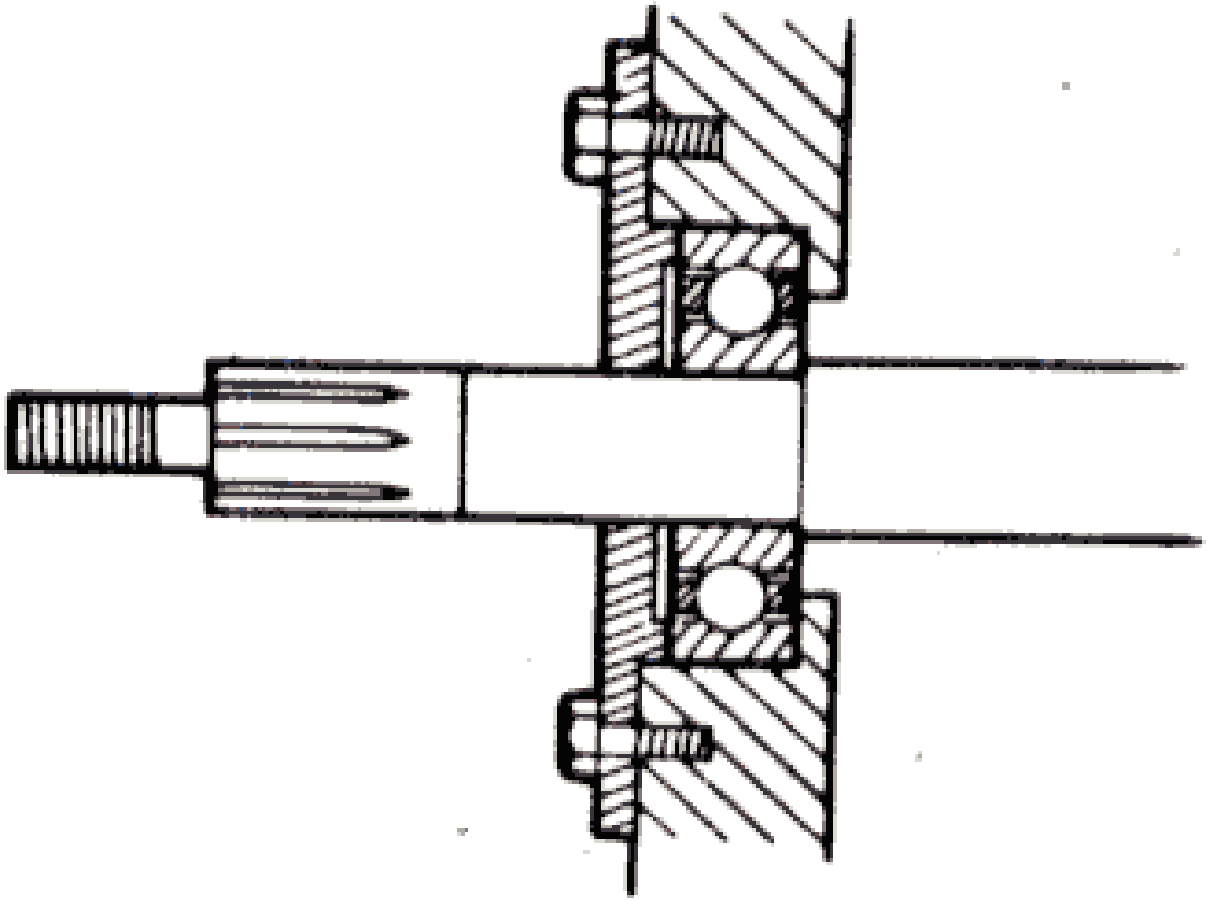

INSPECT BEARING UNDER
GOOD LIGHT

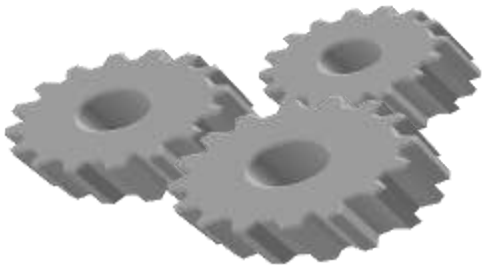

EMERY
PAPER
RUST
STAINS

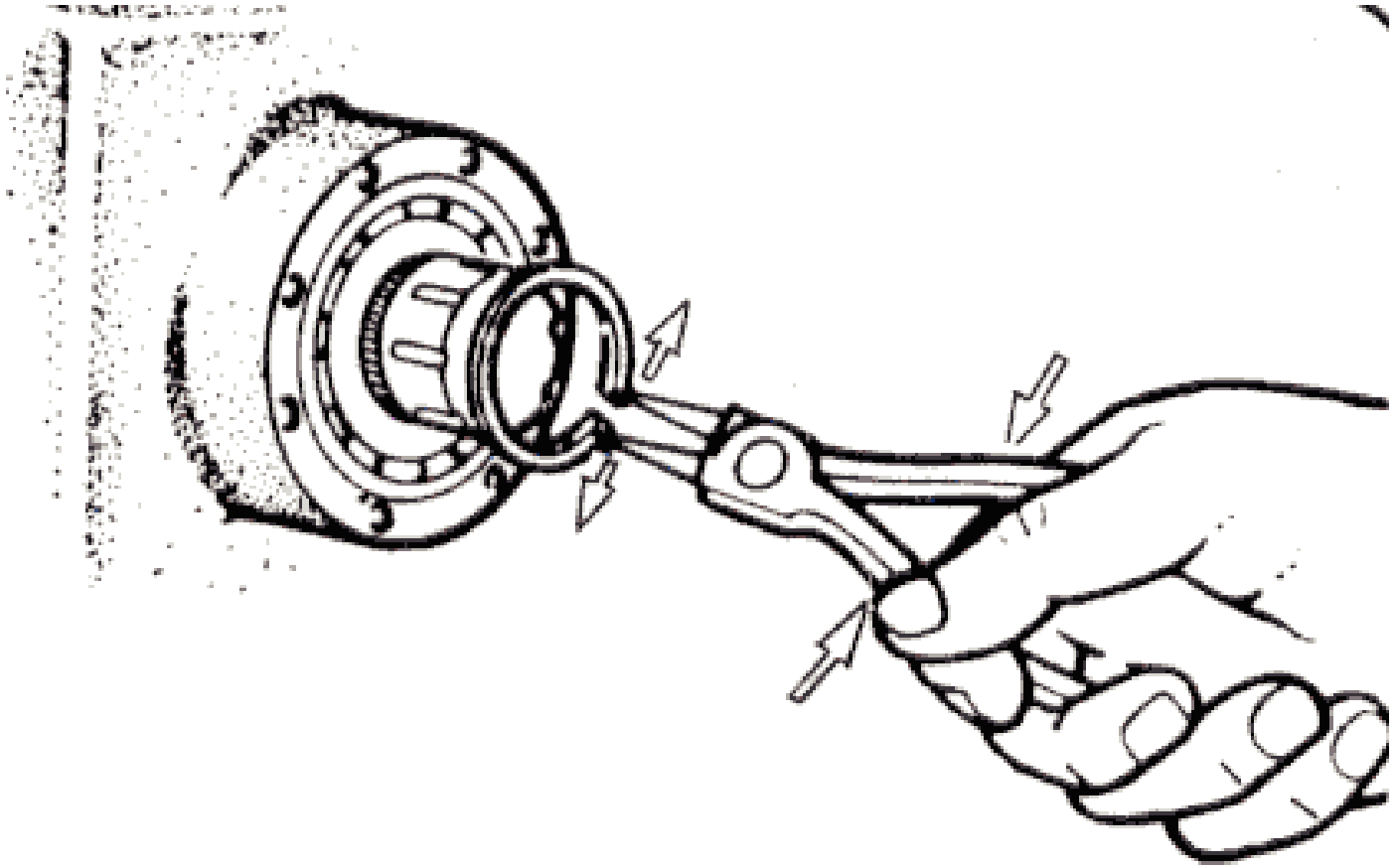


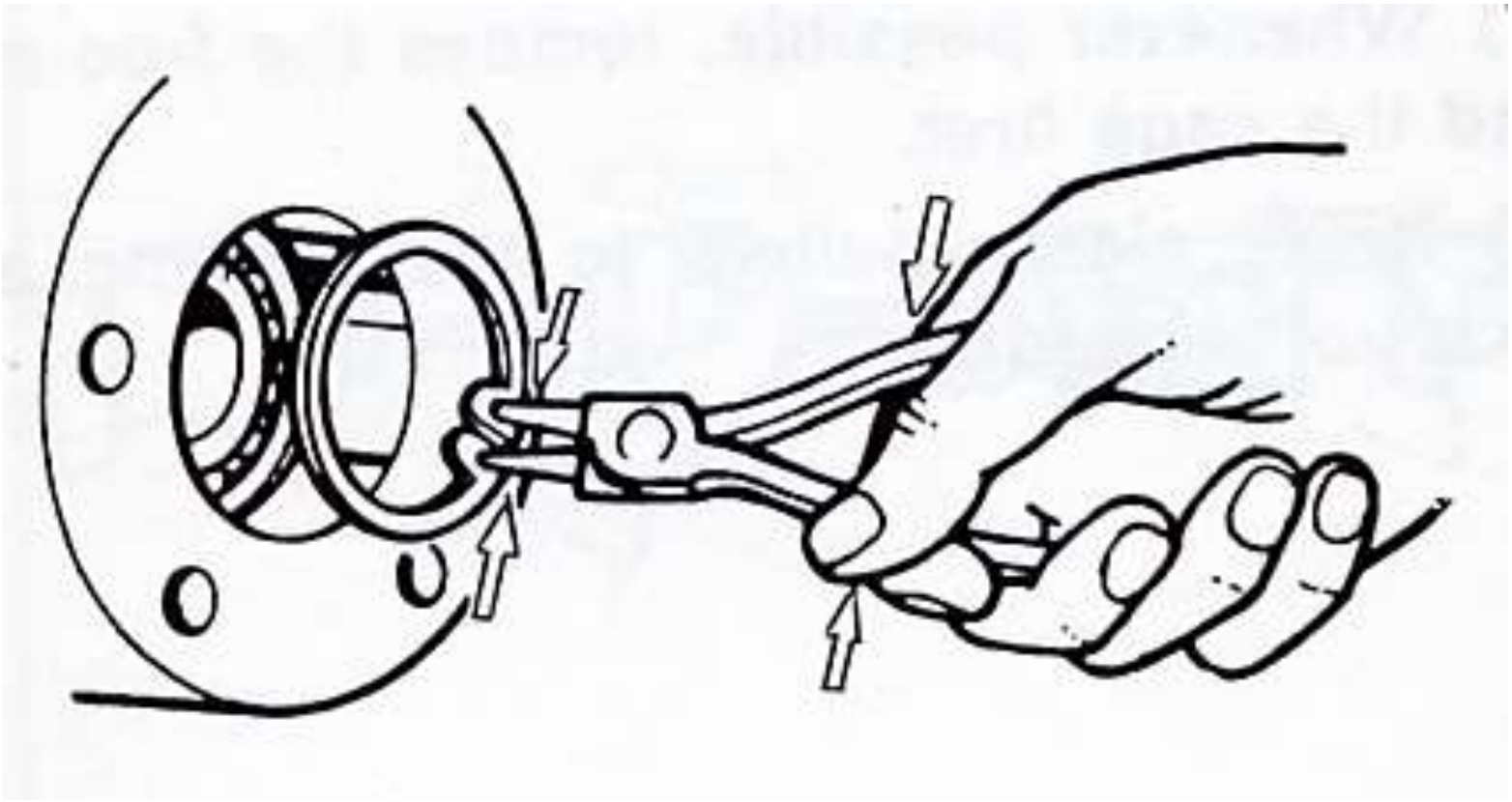


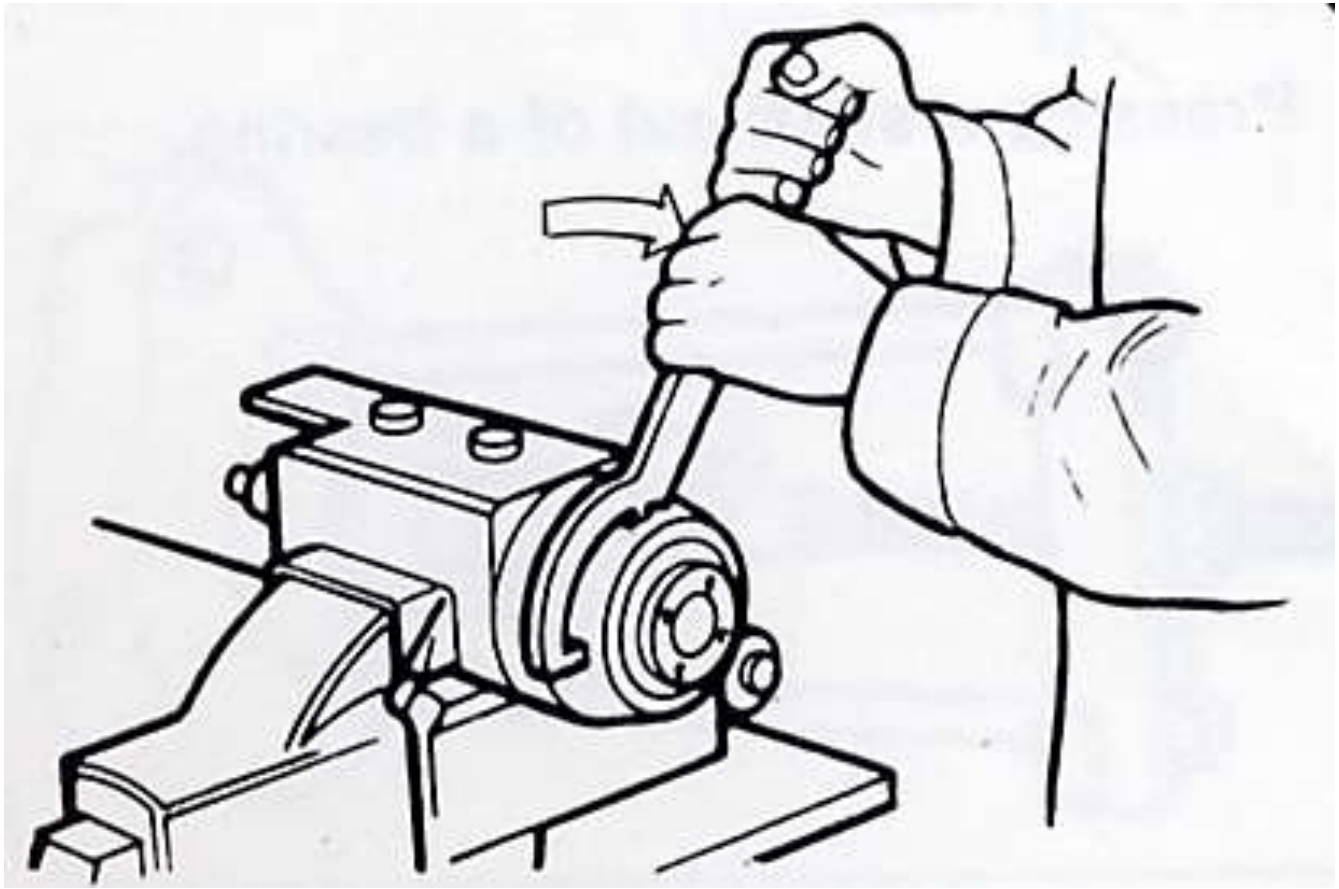


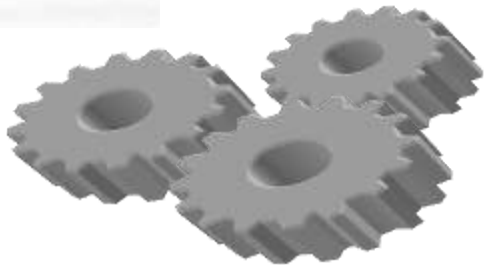


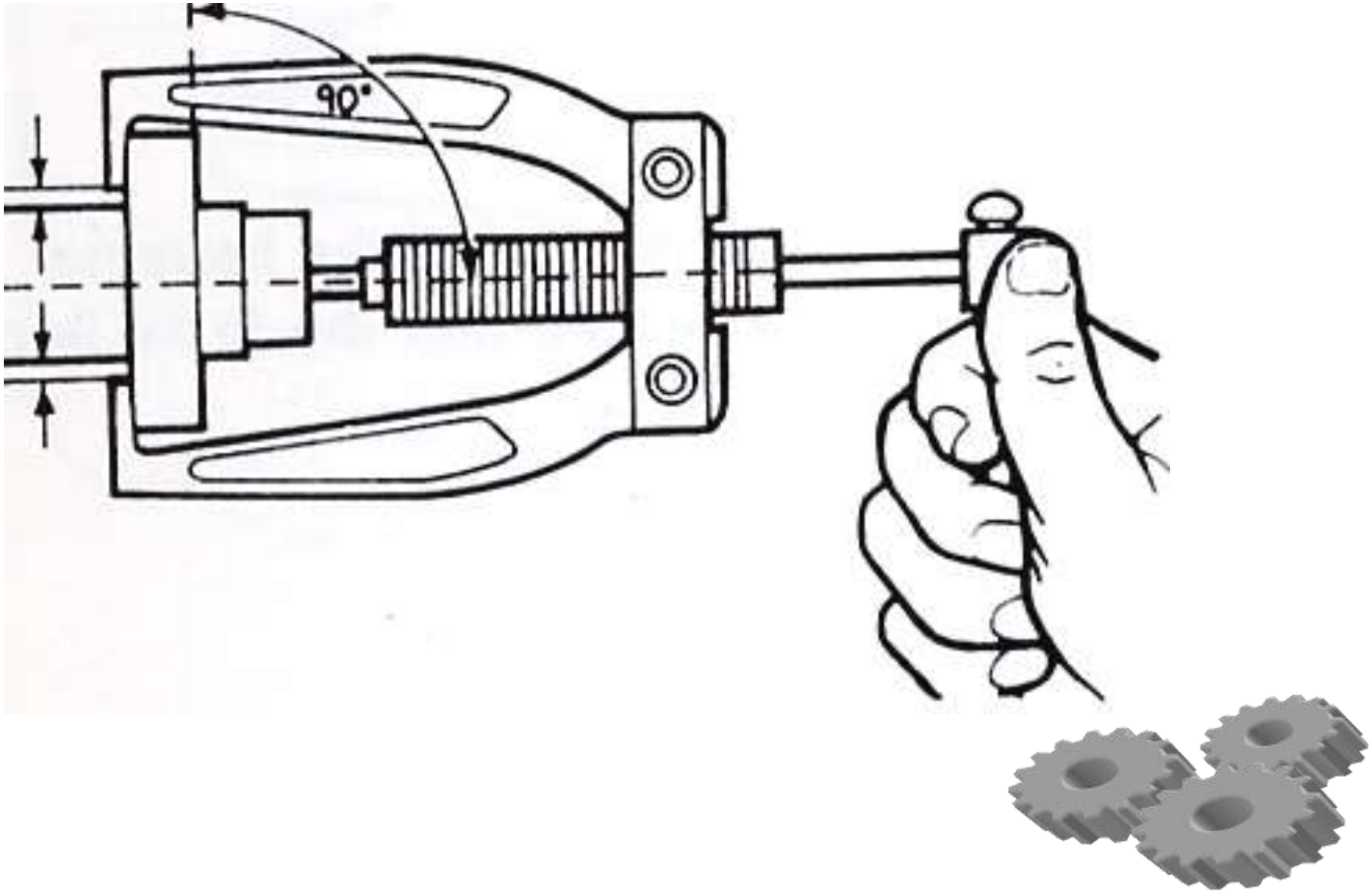


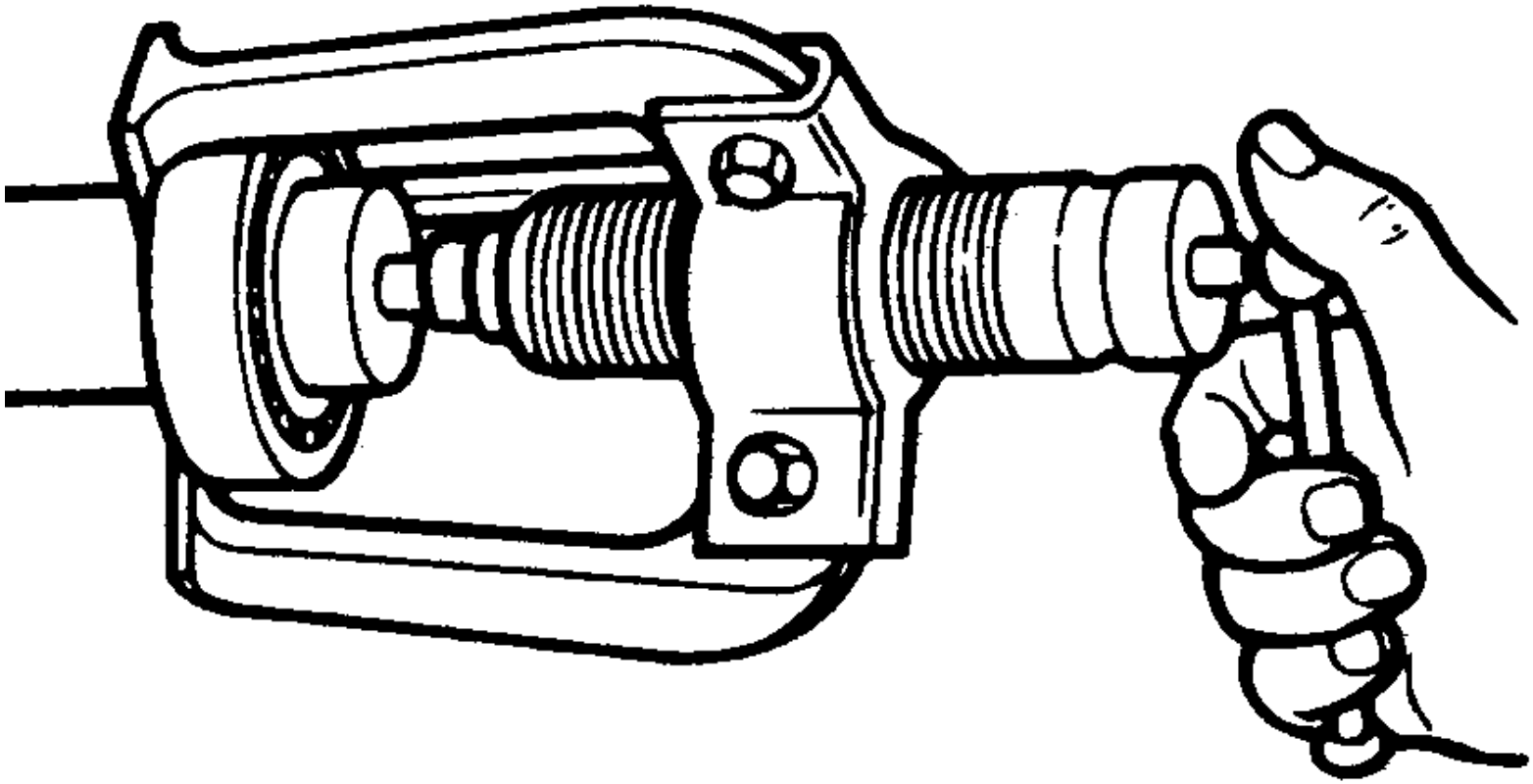


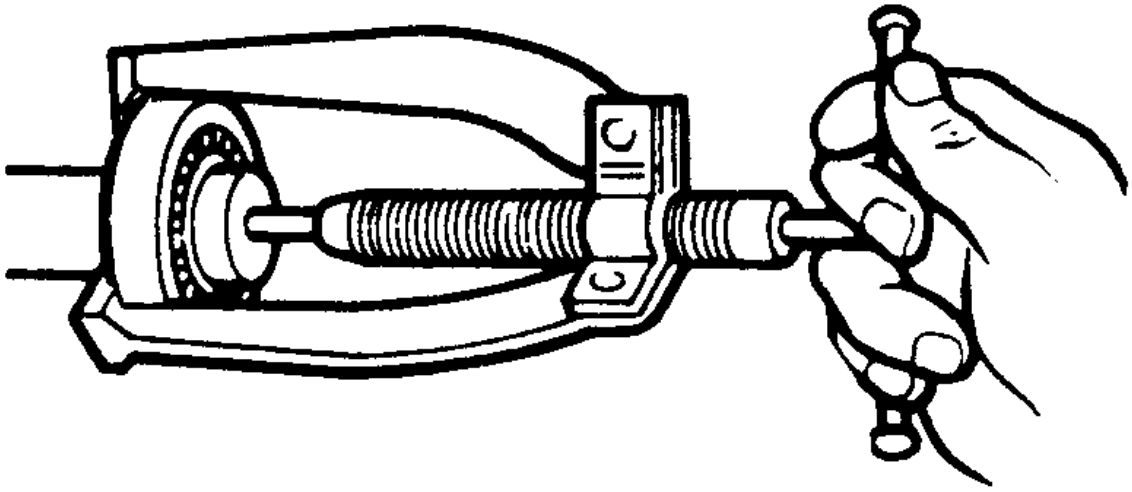


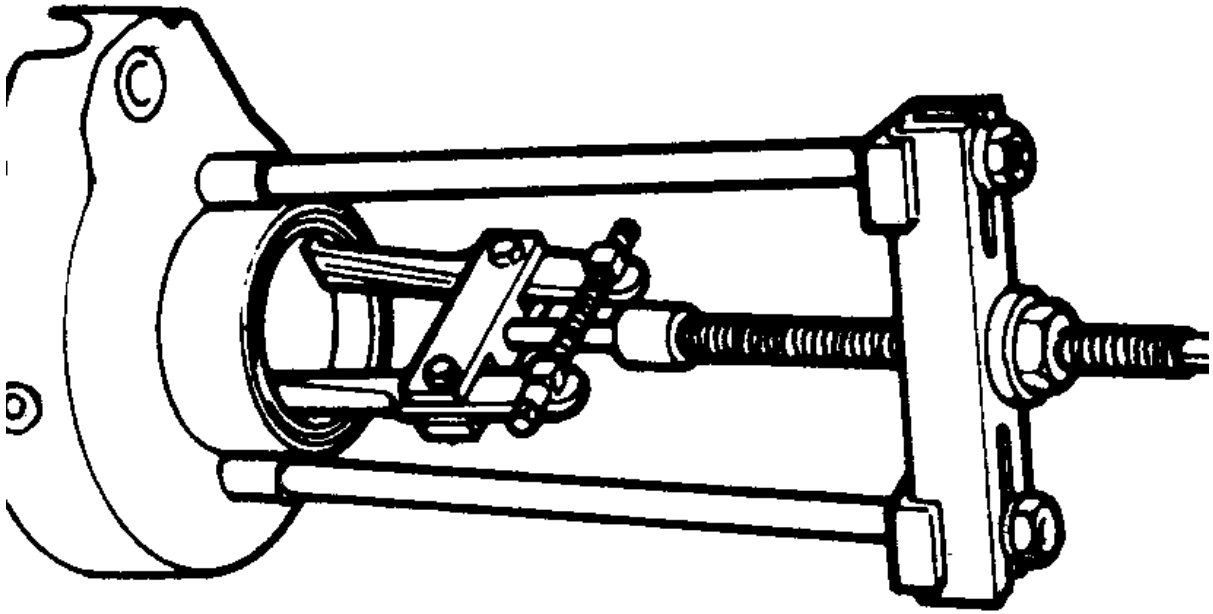


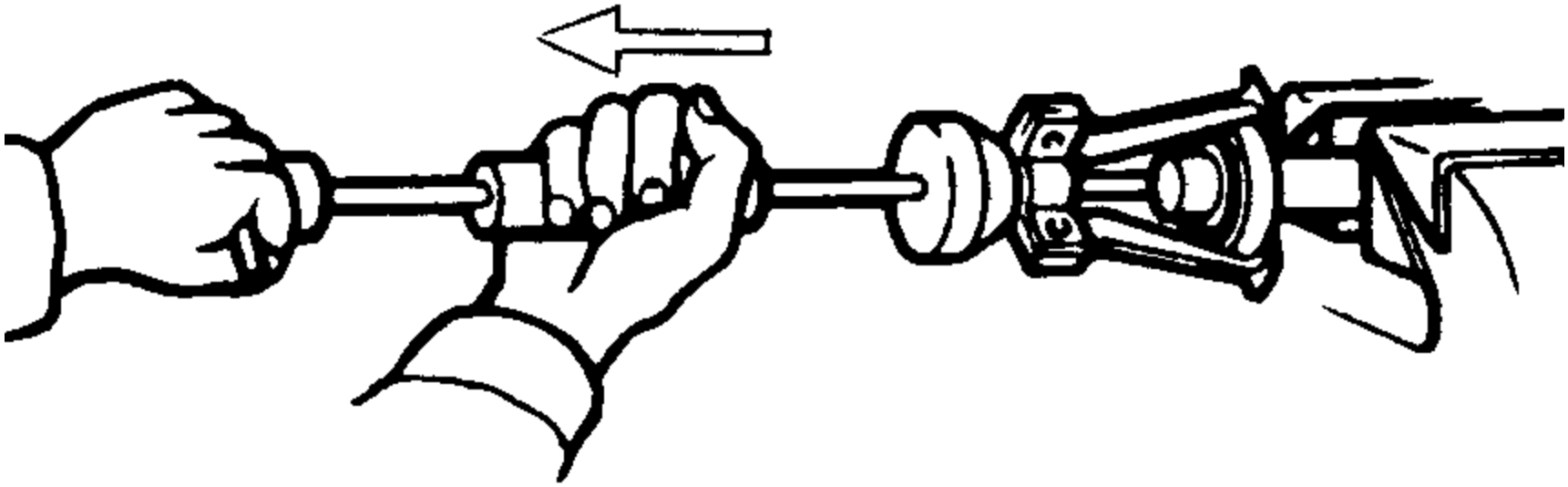


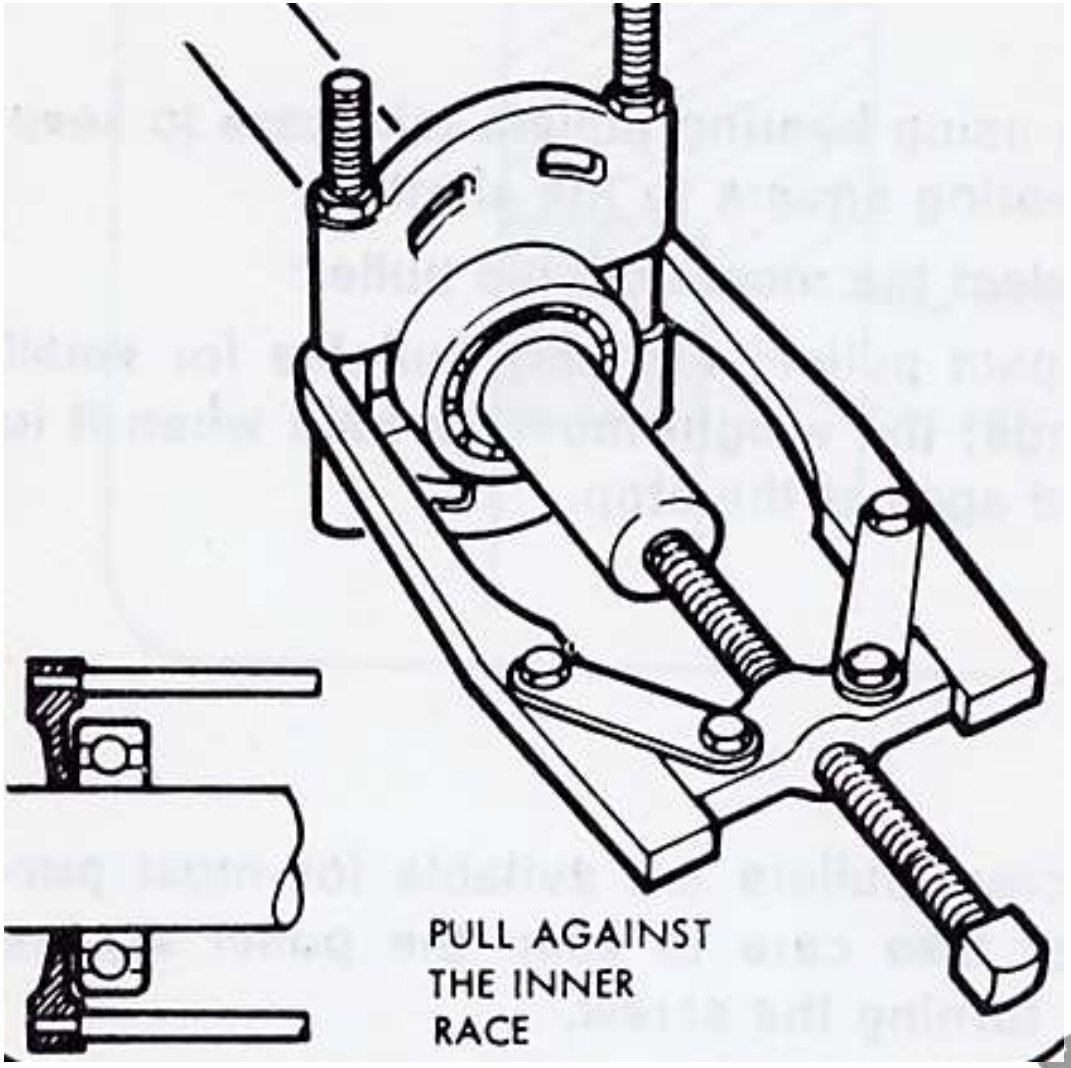

90°

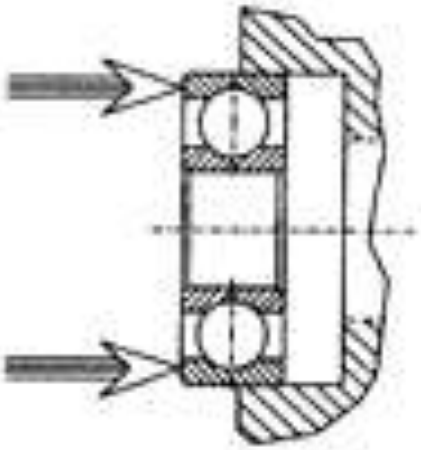


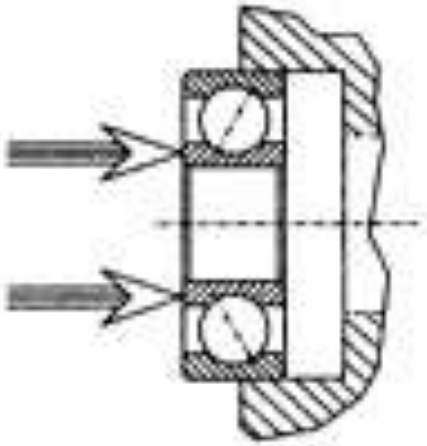






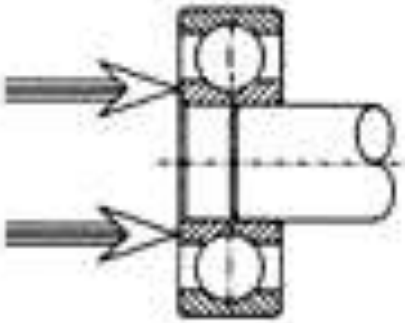

PULL AGAINST
THE INNER
RACE

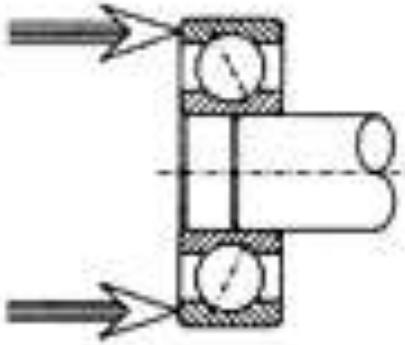


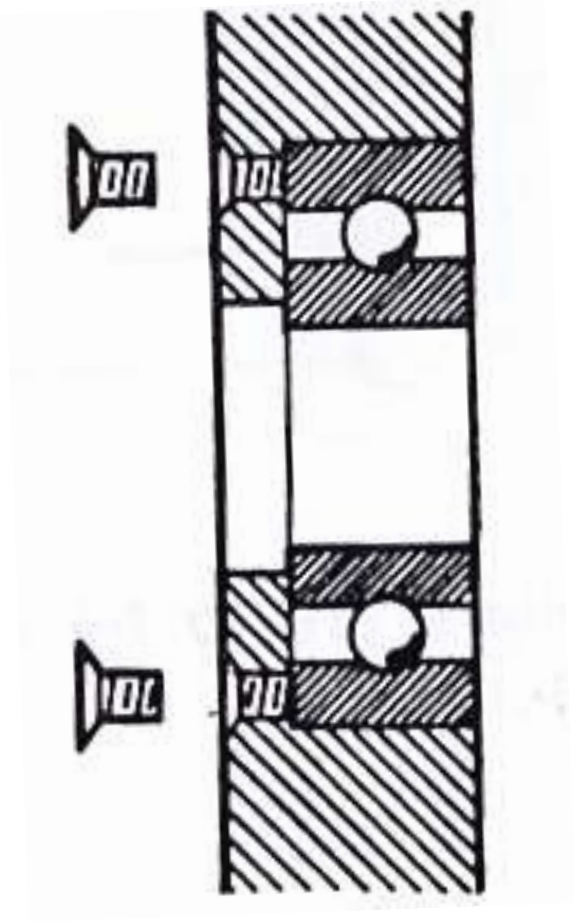


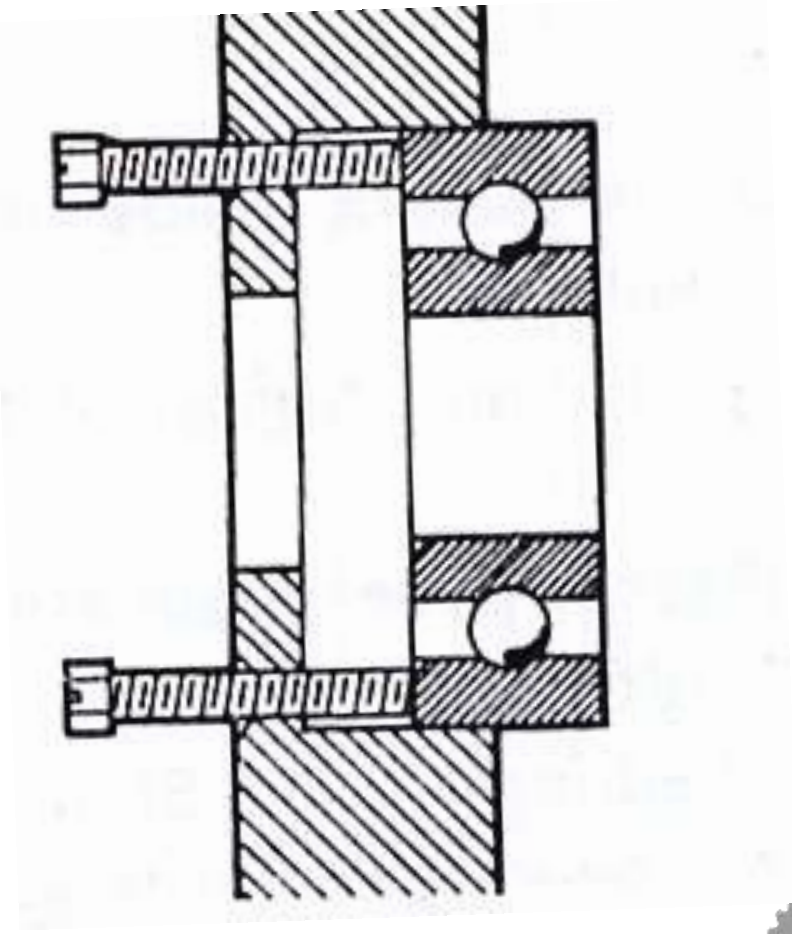
DO

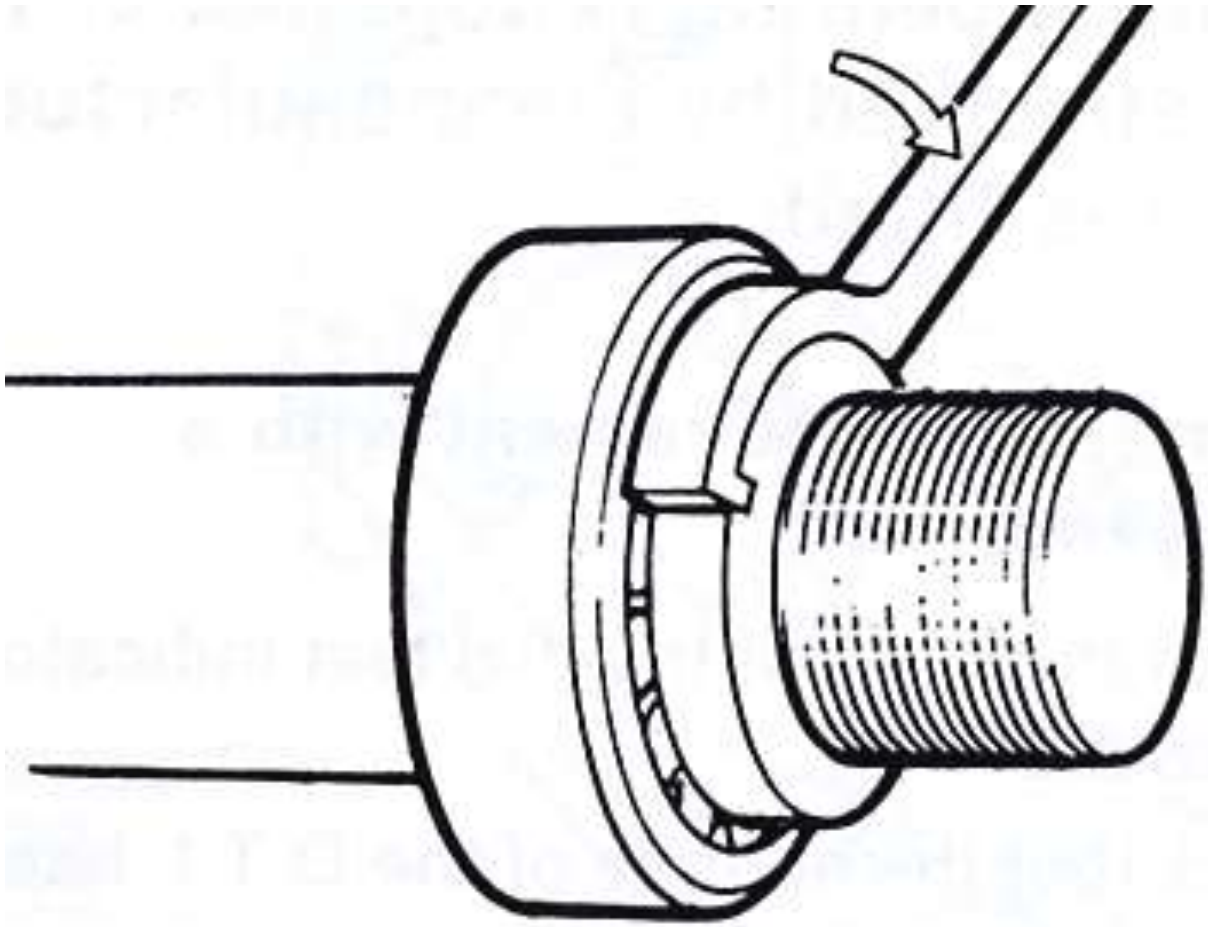
DON'T

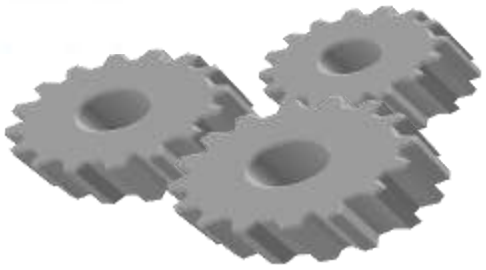


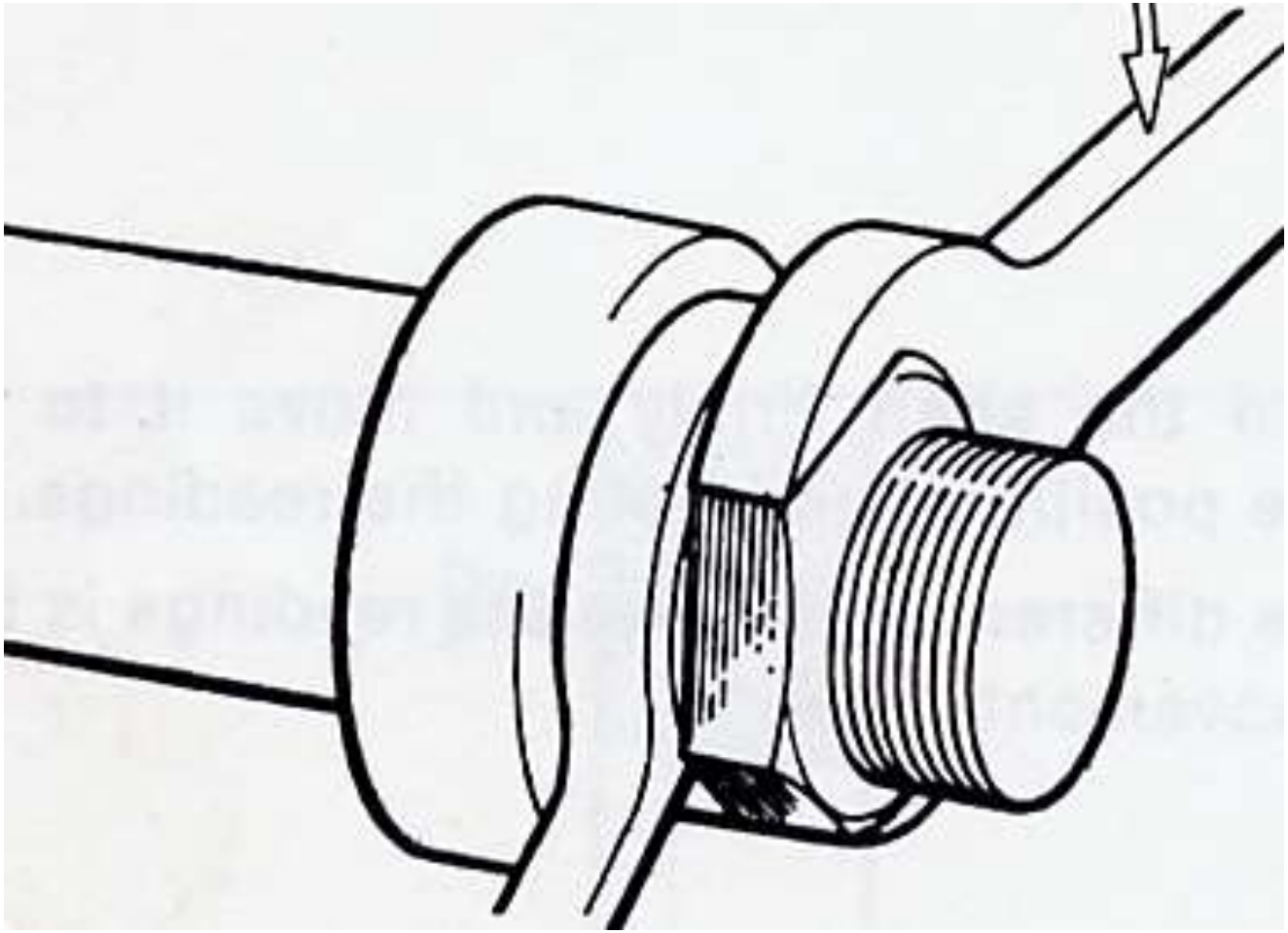


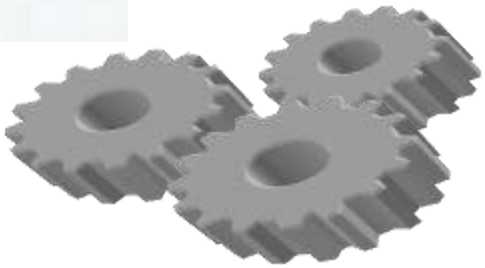


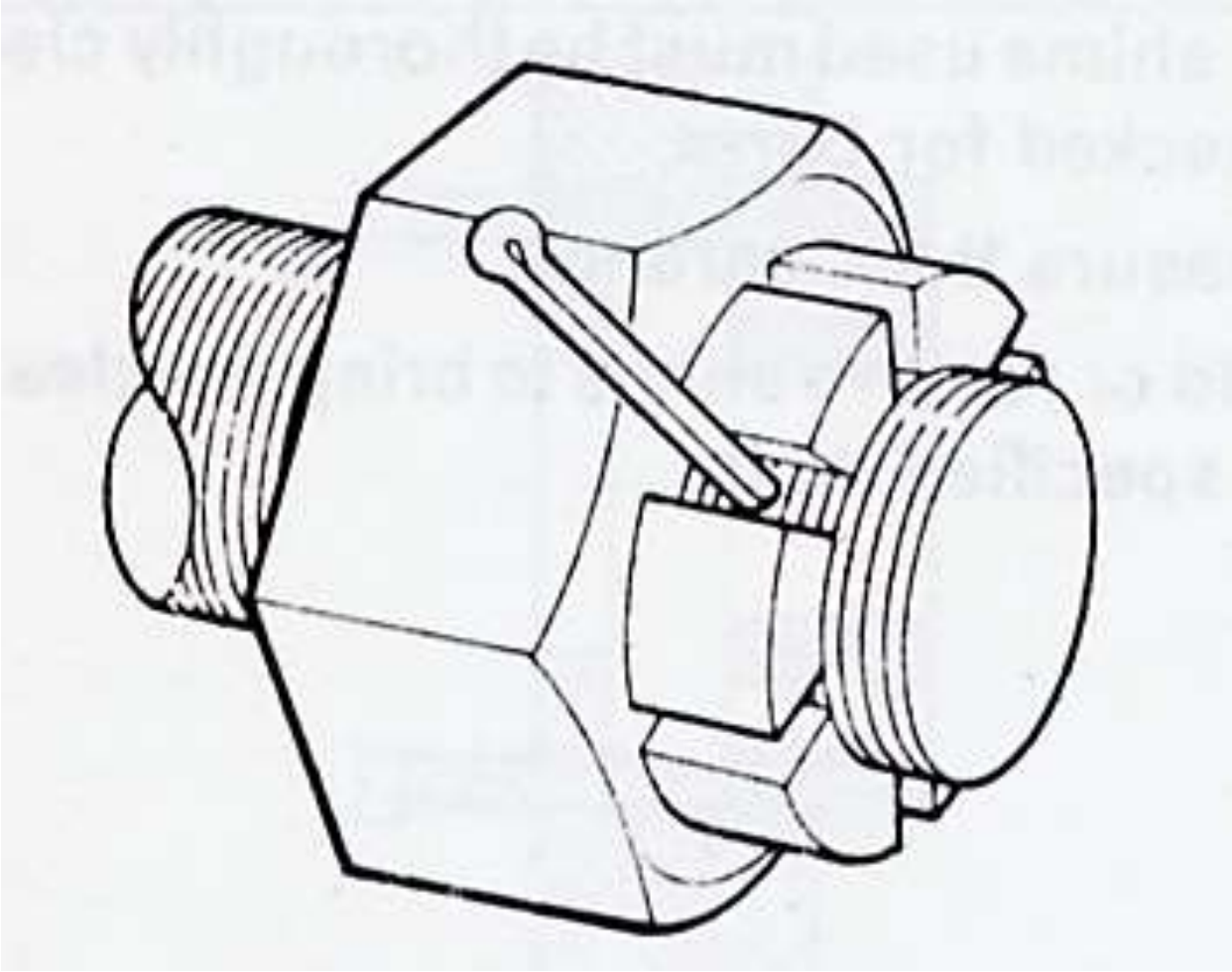




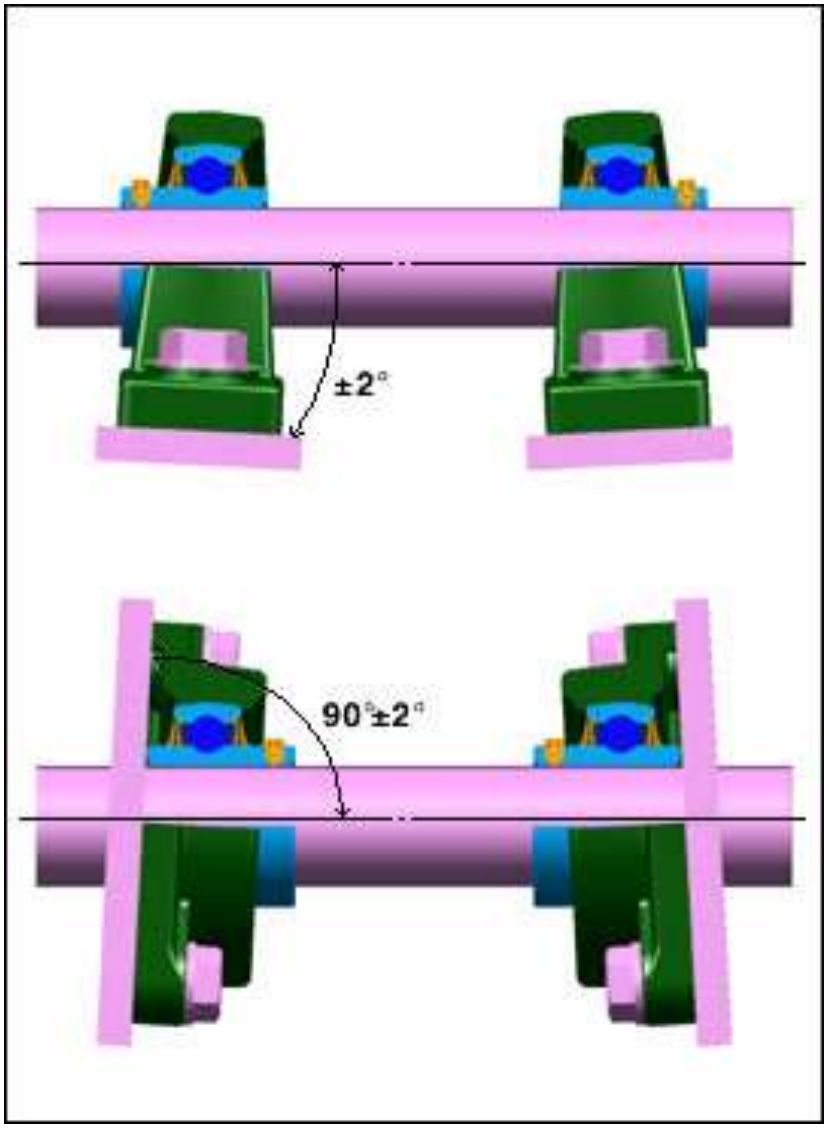


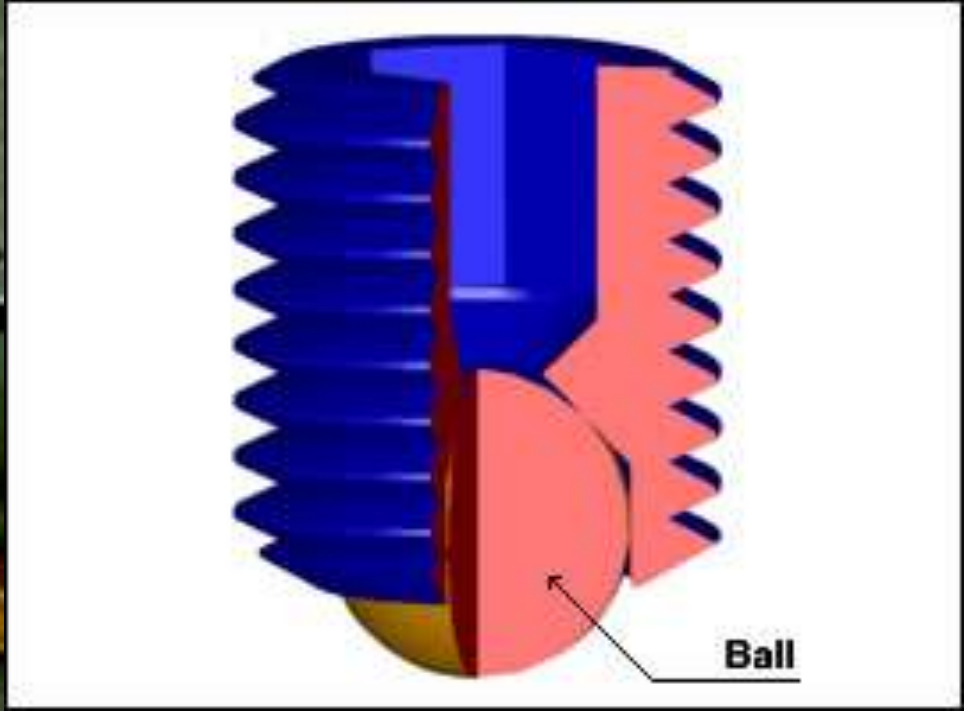


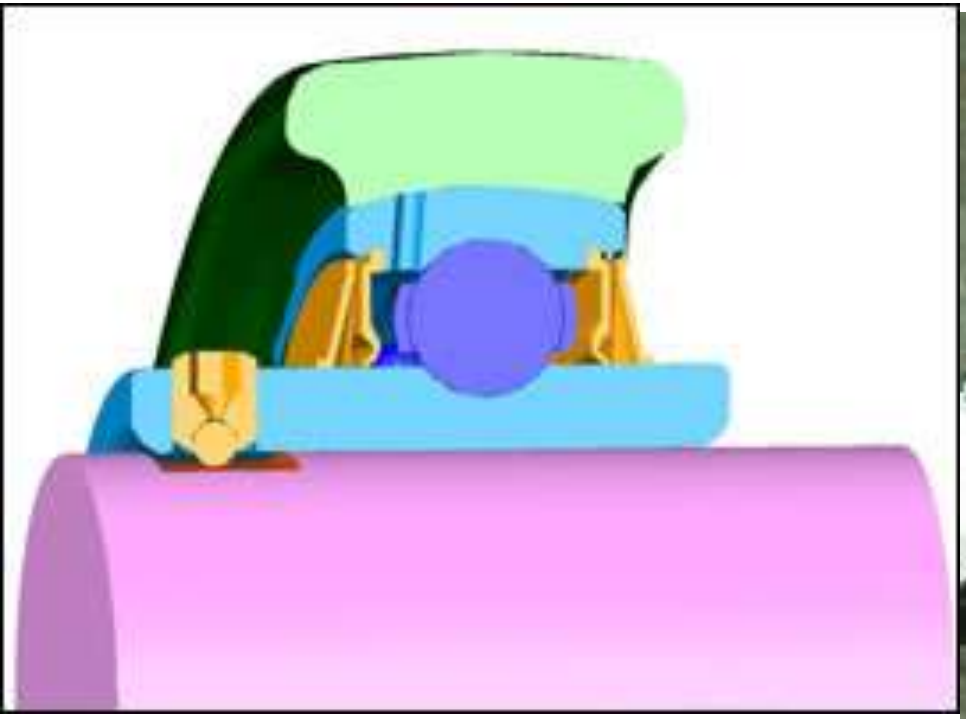


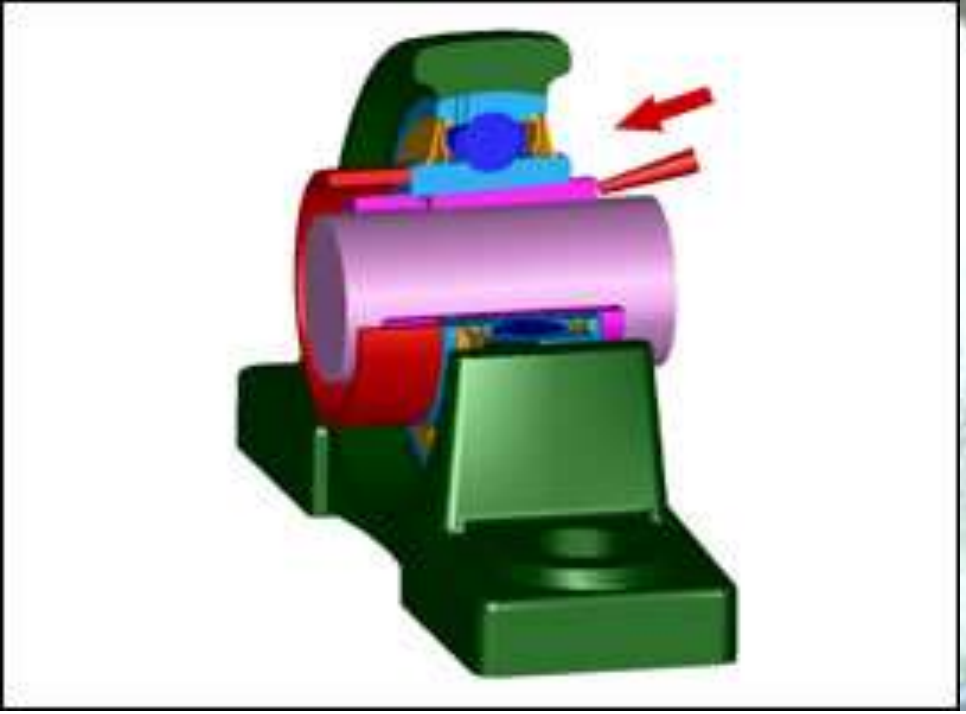


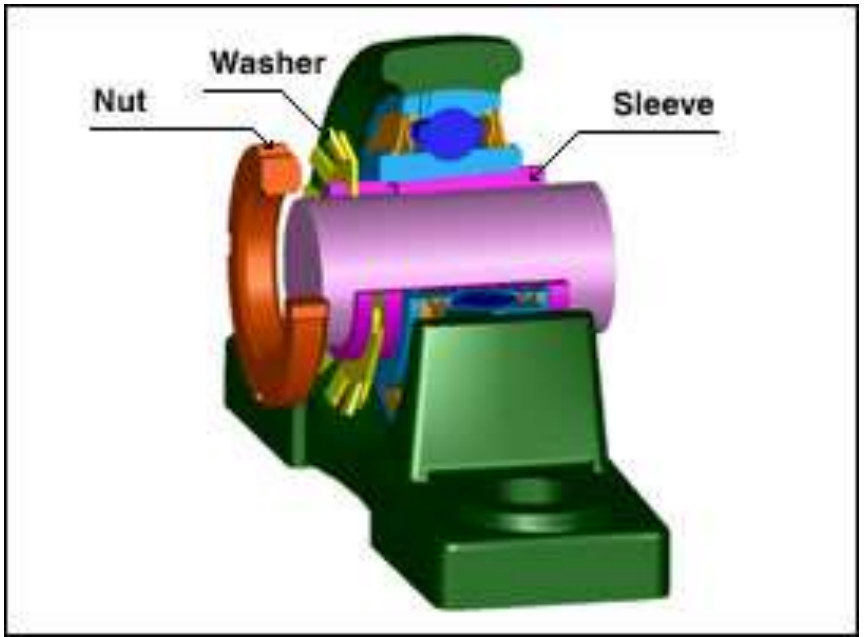

NTN
P206


±2°
90°±2°

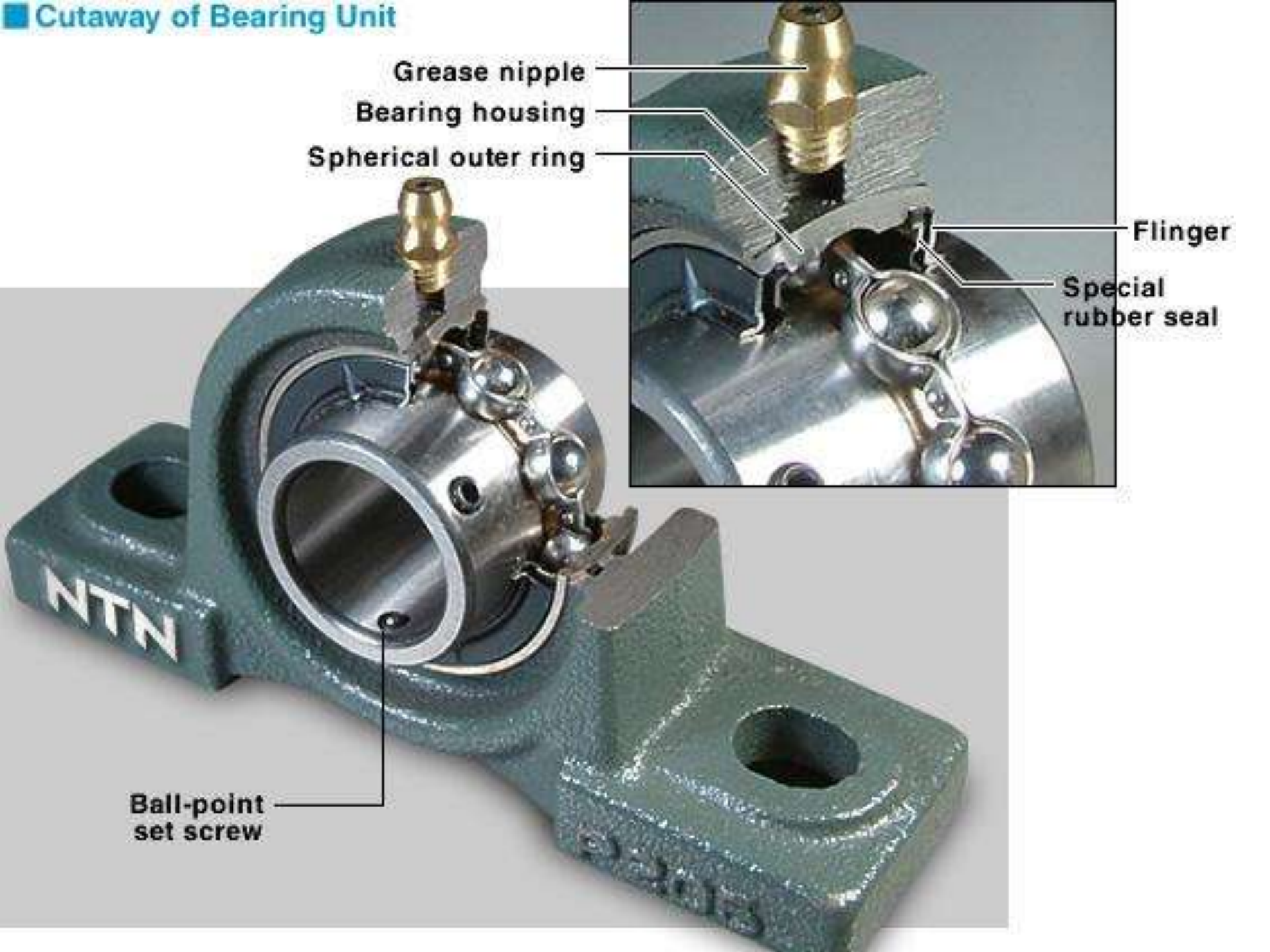

Ball

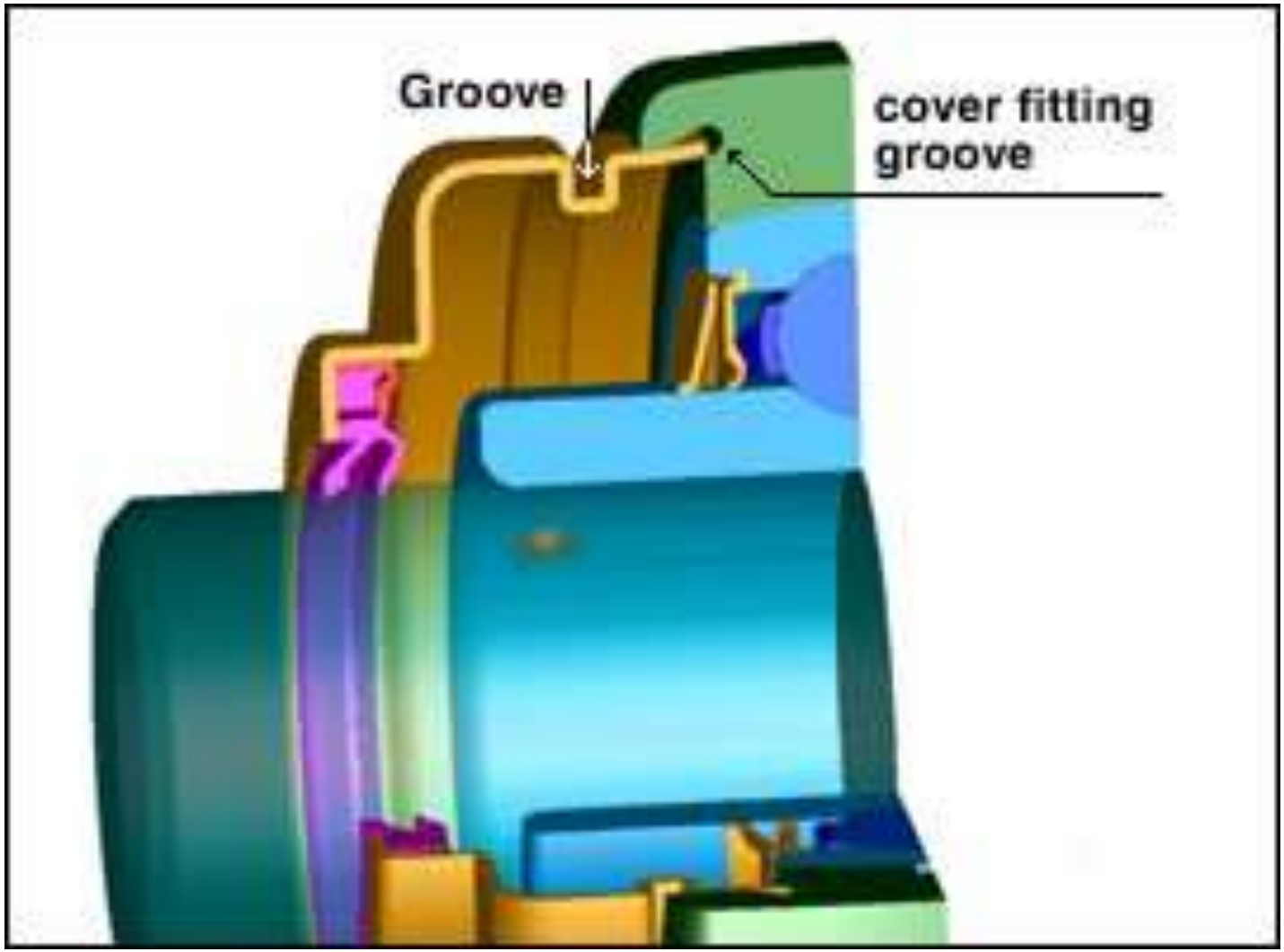


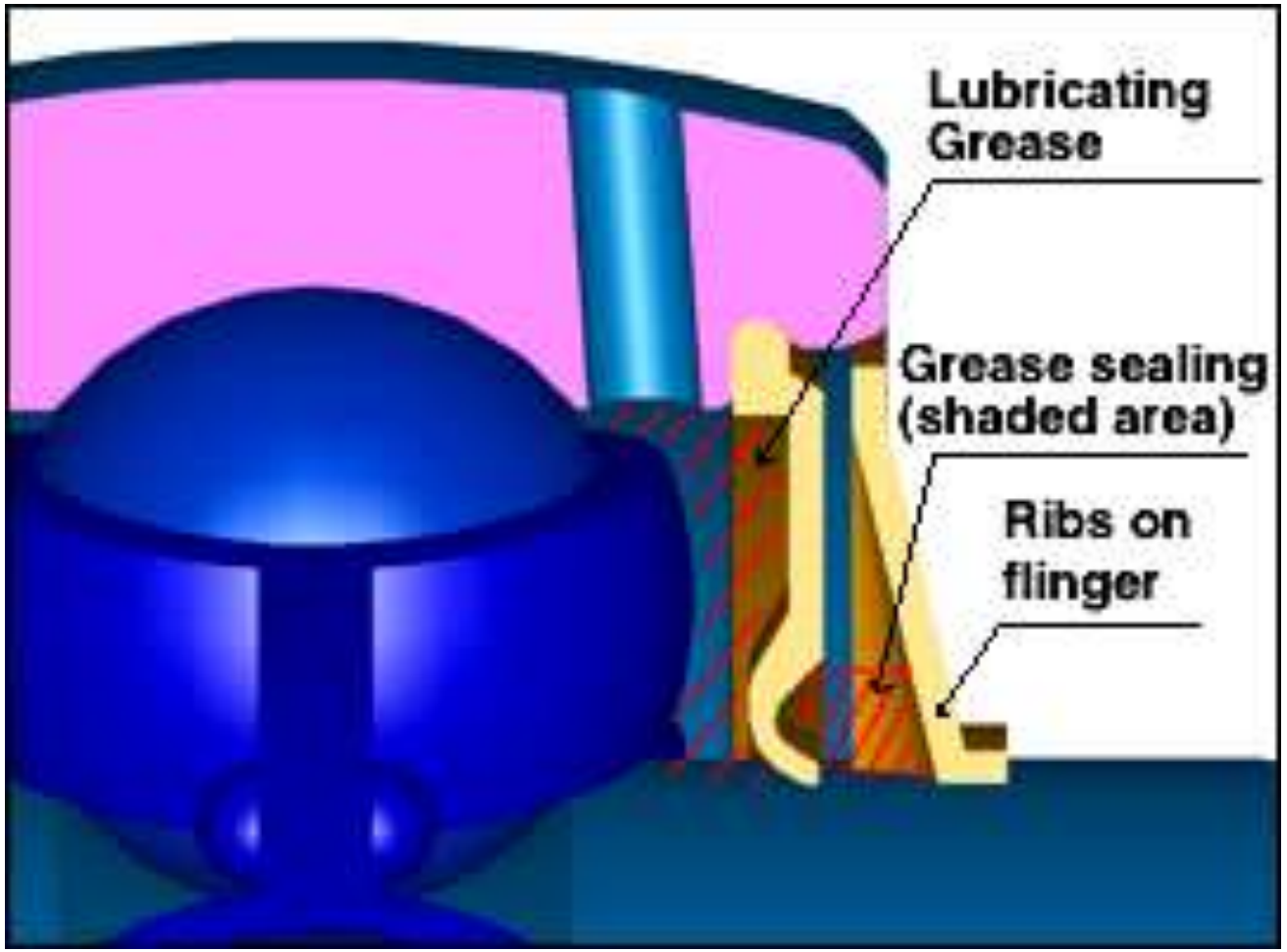


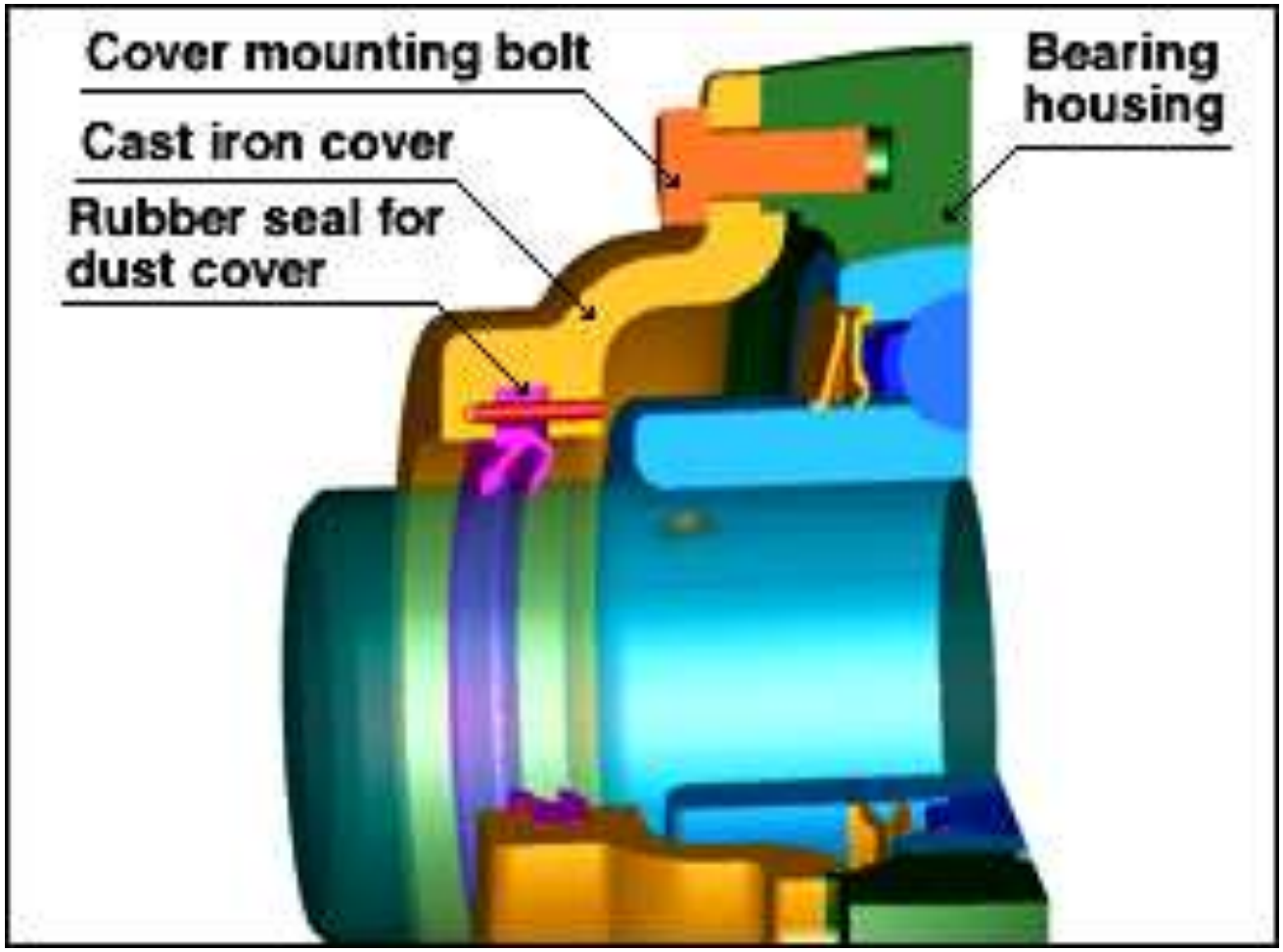

Washer
Nut
Sleeve

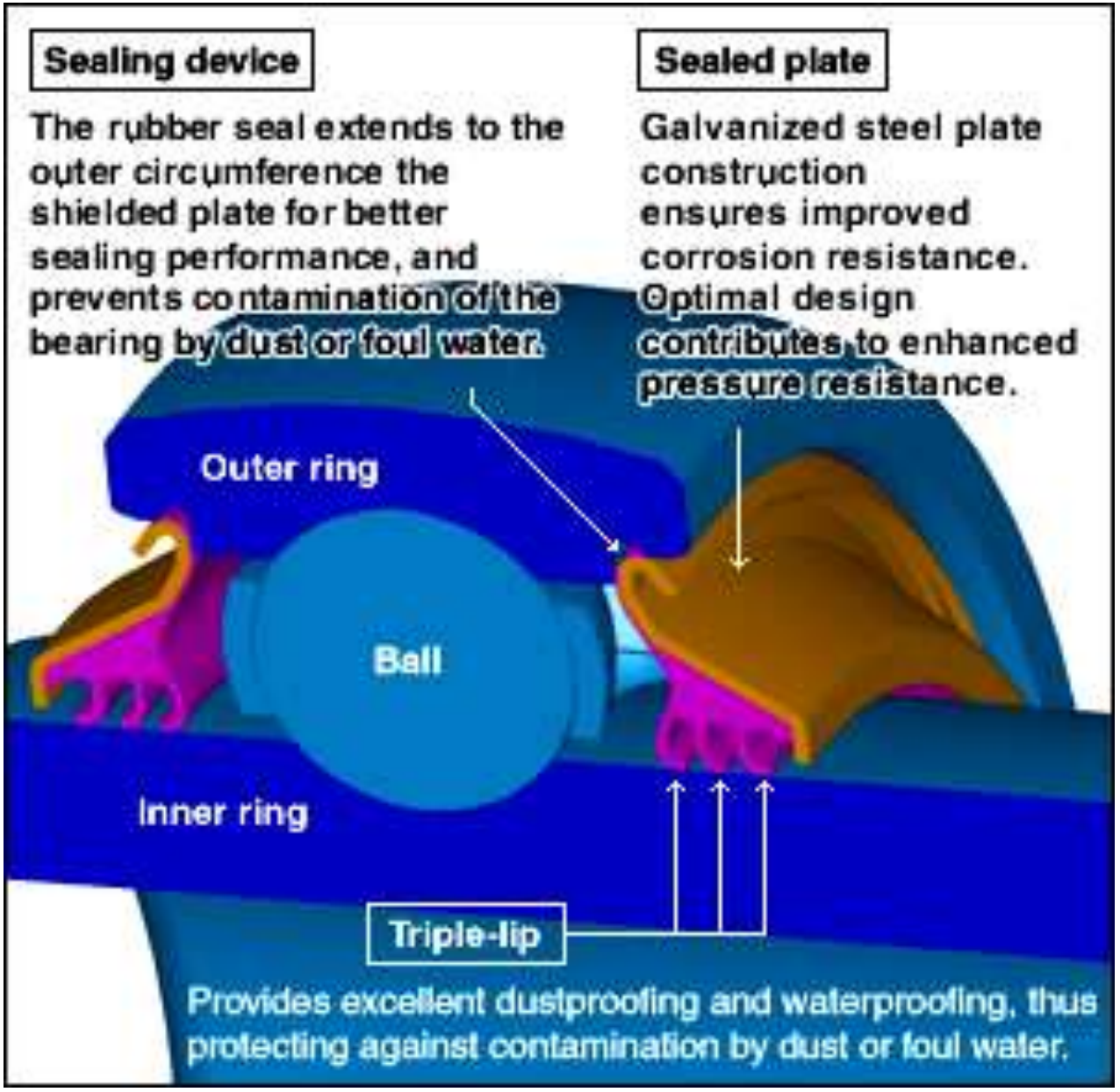
Cutaway of Bearing Unit

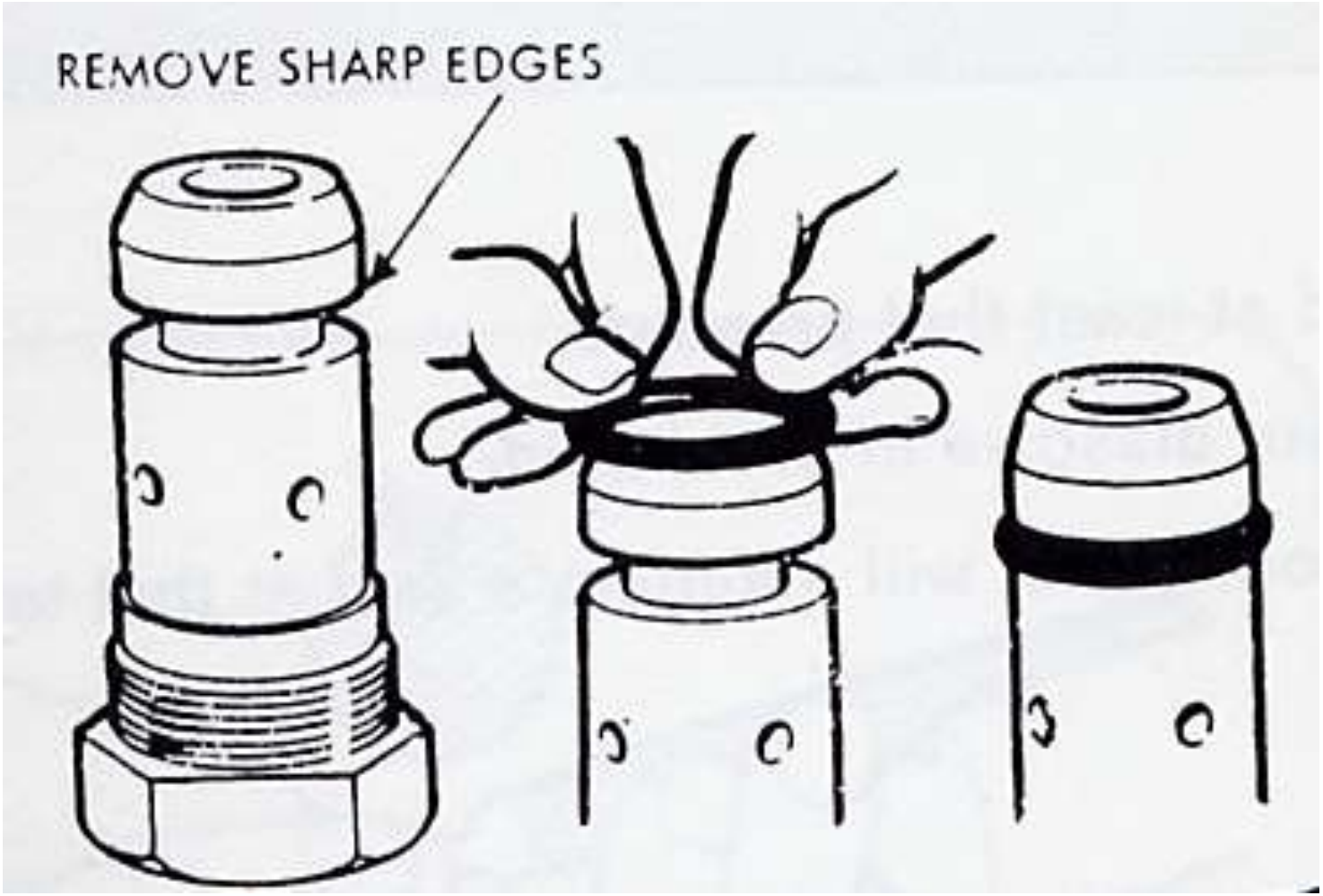


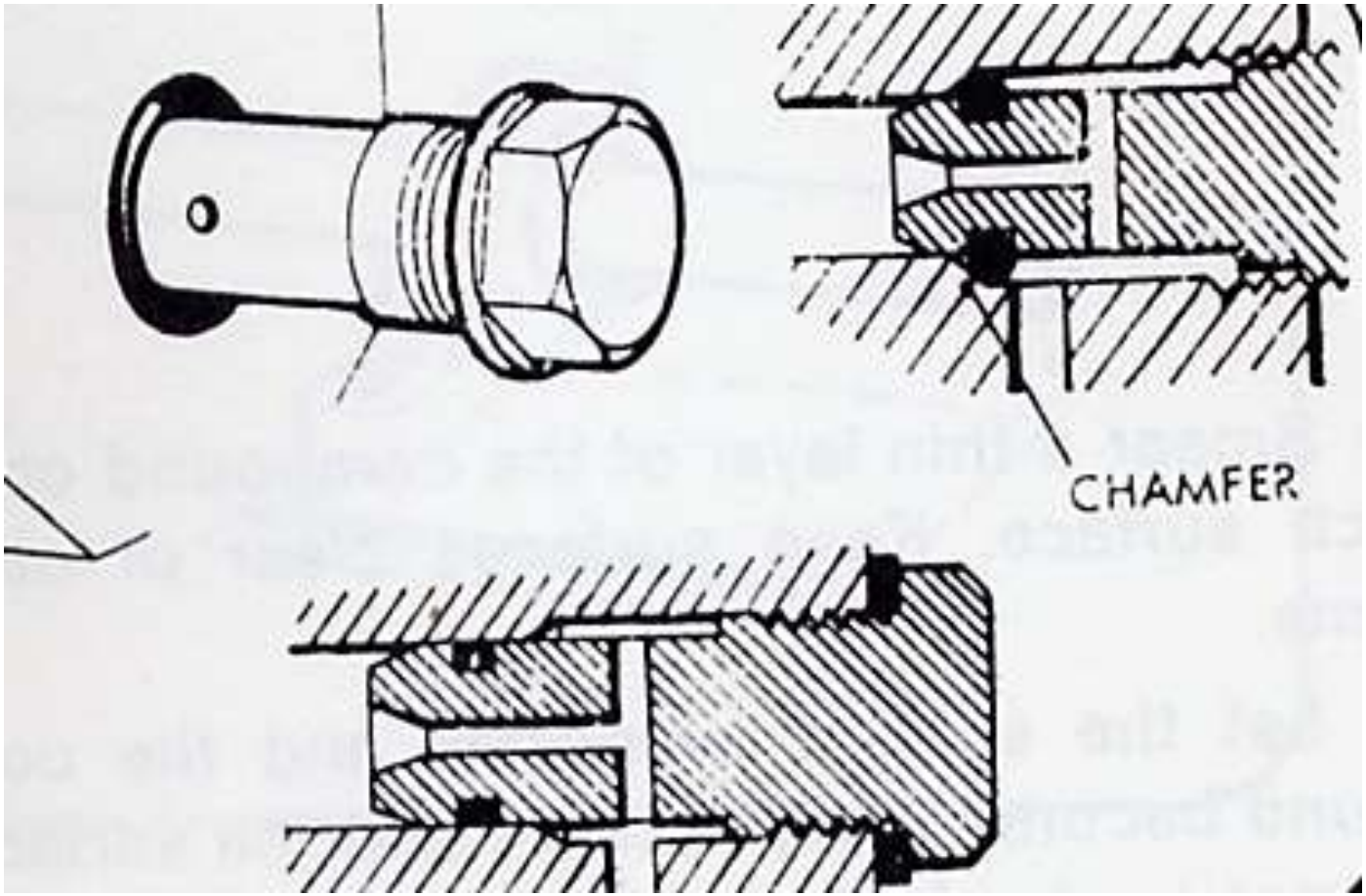

Groove
cover fitting
groove

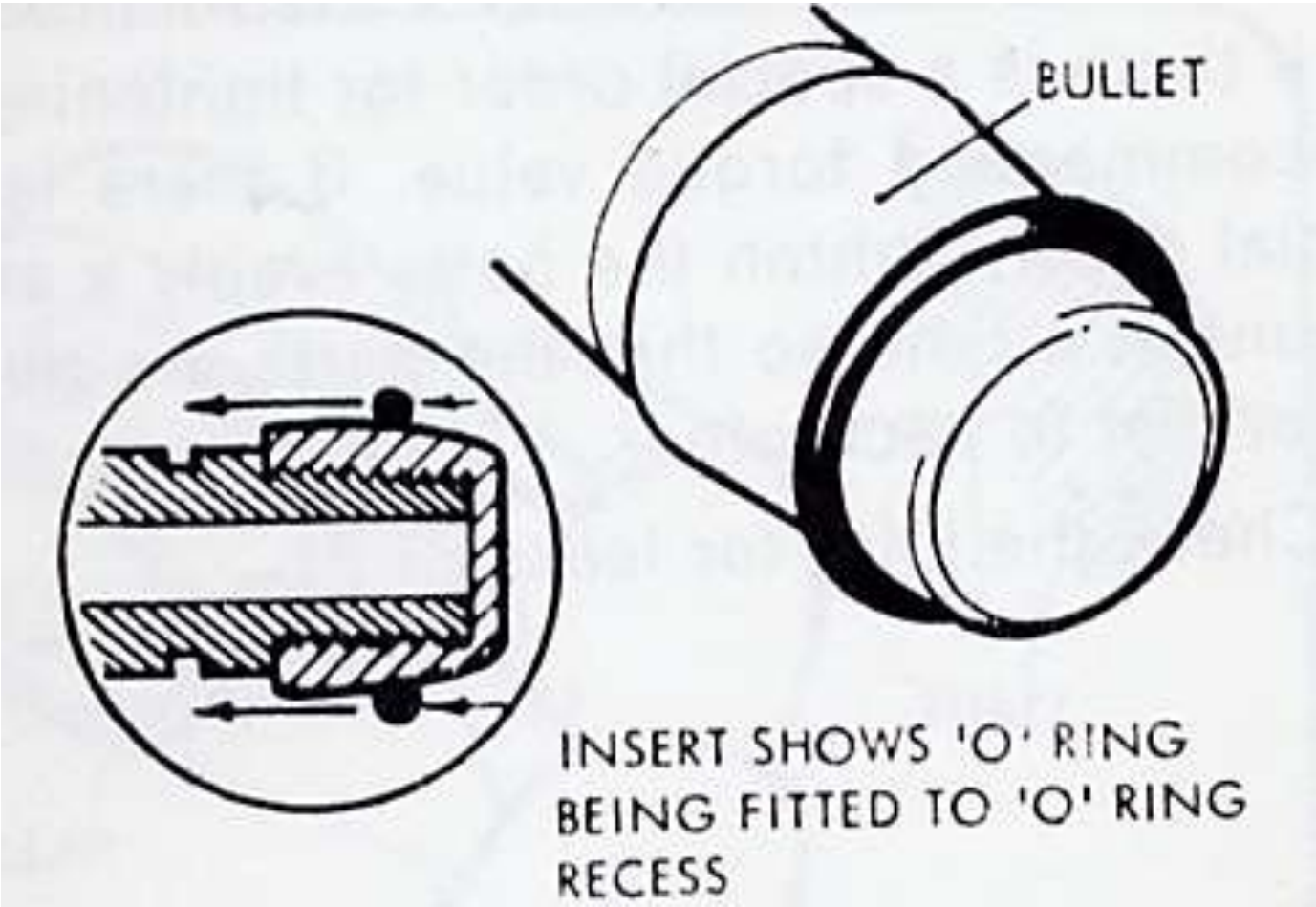

Lubricating
Grease
Grease sealing
(shaded area)
Ribs on
flinger

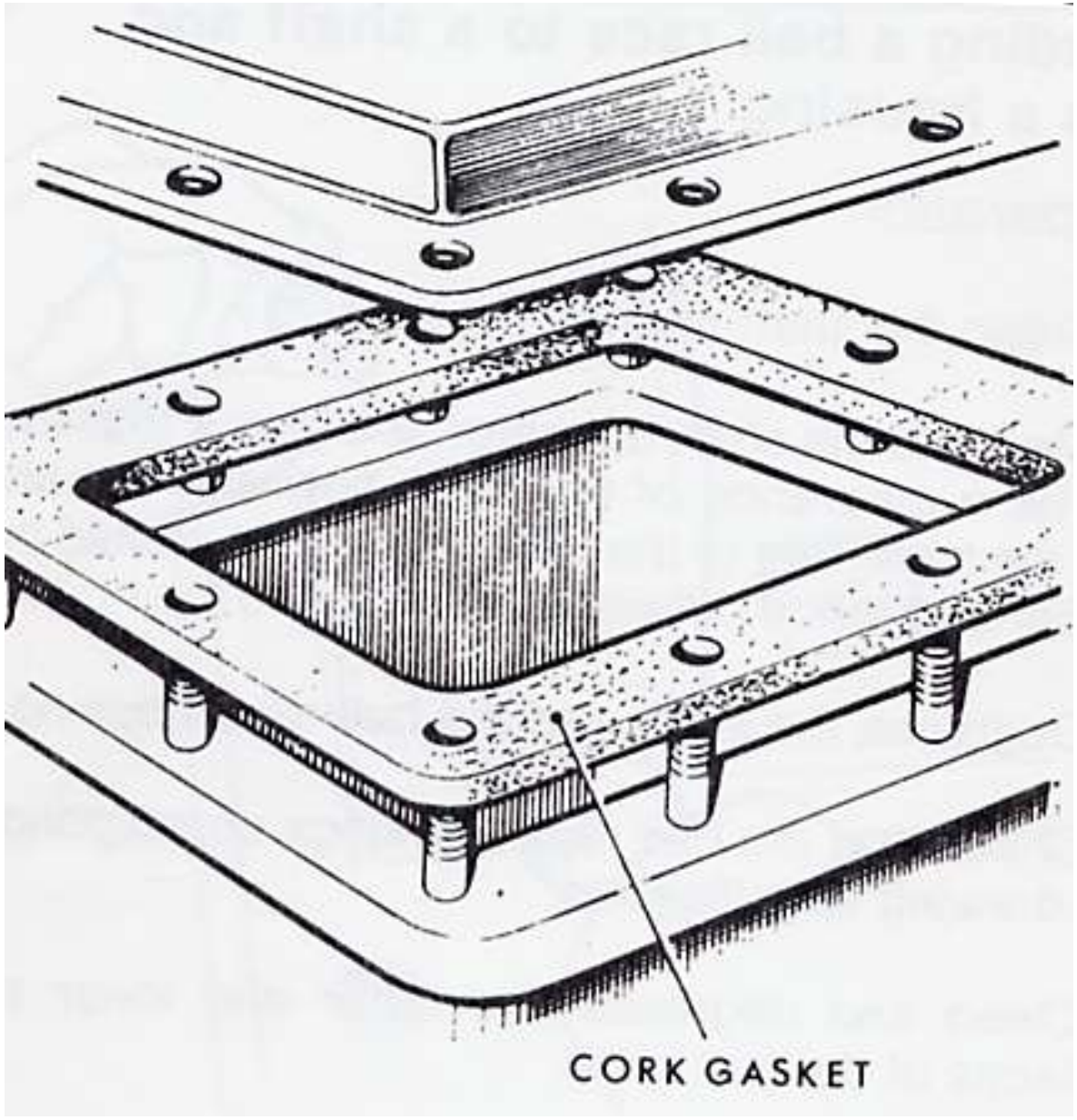

Cover mounting bolt
Cast iron cover
Rubber seal for dust cover
Bearing housing

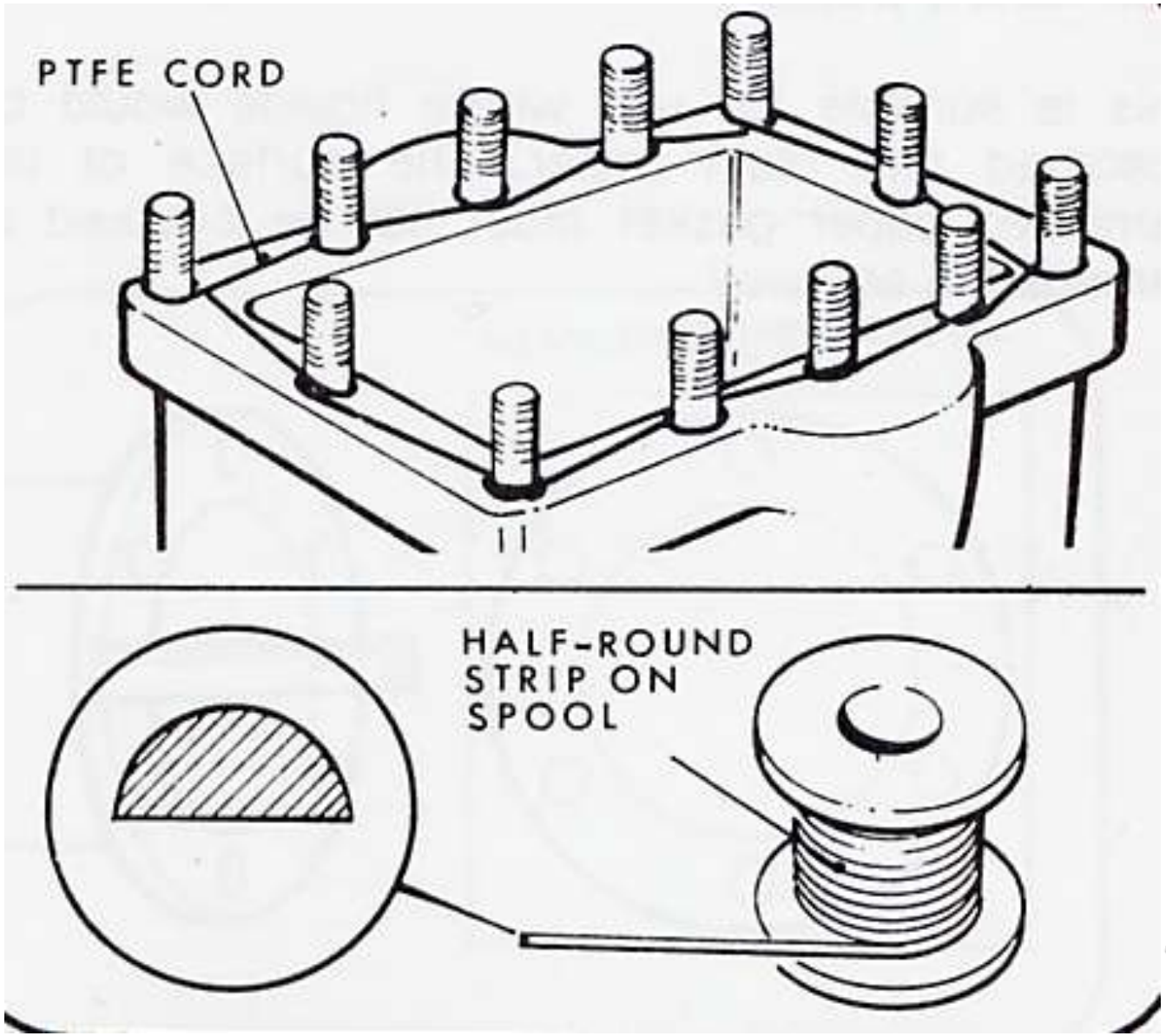

Sealing device
The rubber seal extends to the outer circumference the shielded plate for better sealing performance, and prevents contamination of the bearing by dust or foul water.
Sealed plate
Galvanized steel plate construction ensures improved corrosion resistance. Optimal design contributes to enhanced pressure resistance.
Outer ring
Ball
Inner ring
Triple-lip
Provides excellent dustproofing and waterproofing, thus protecting against contamination by dust or foul water.

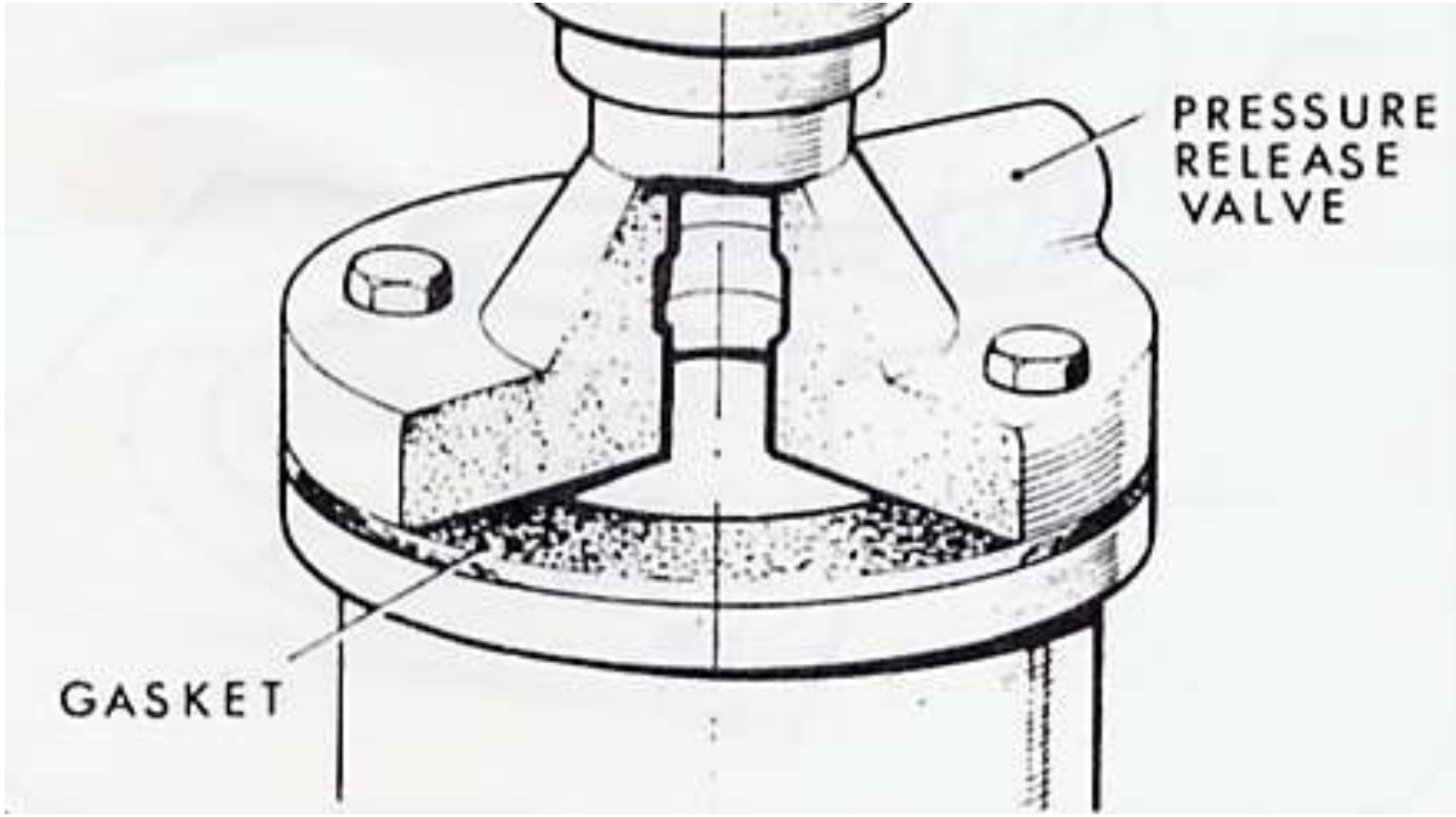

REMOVE SHARP EDGES

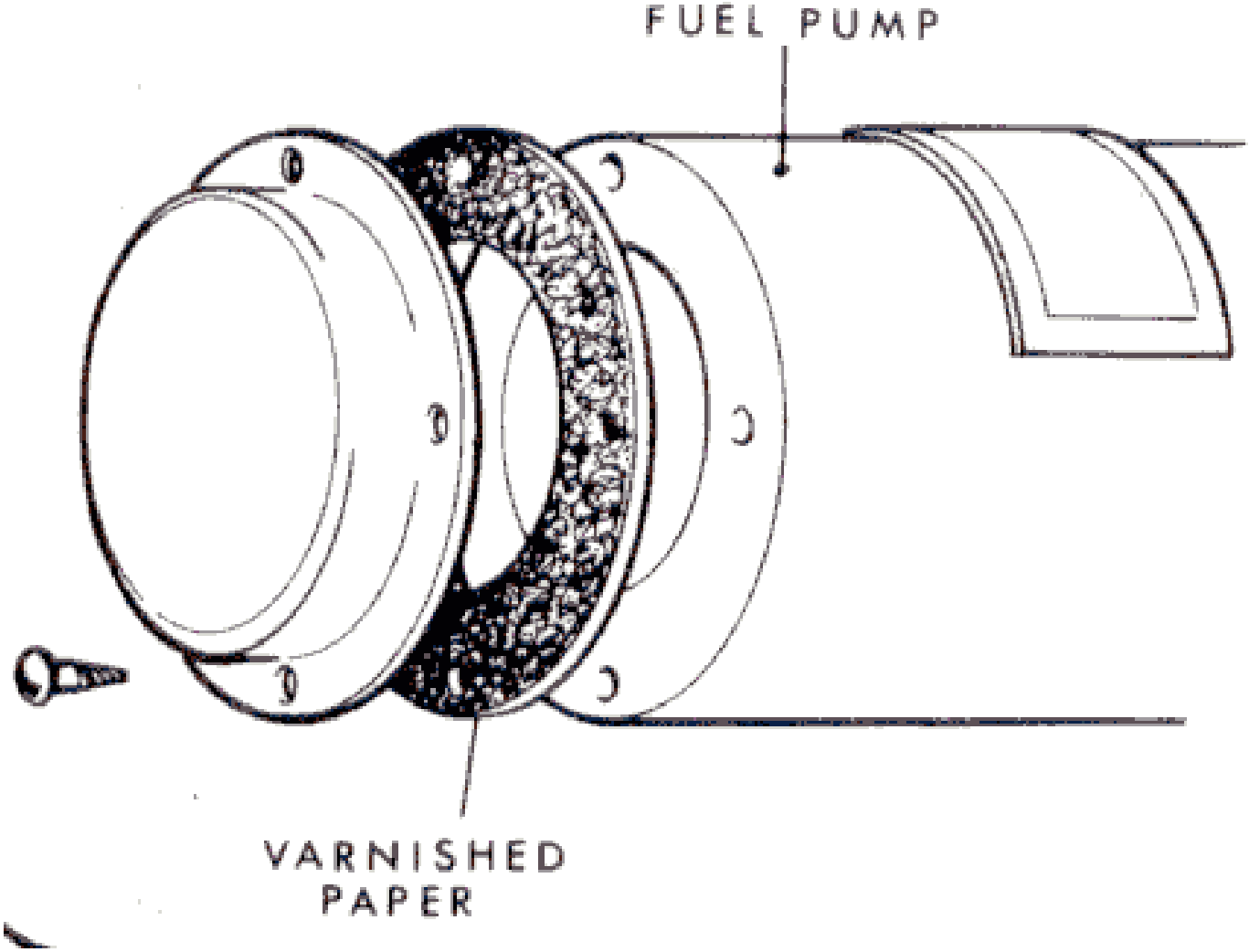

CHAMFER

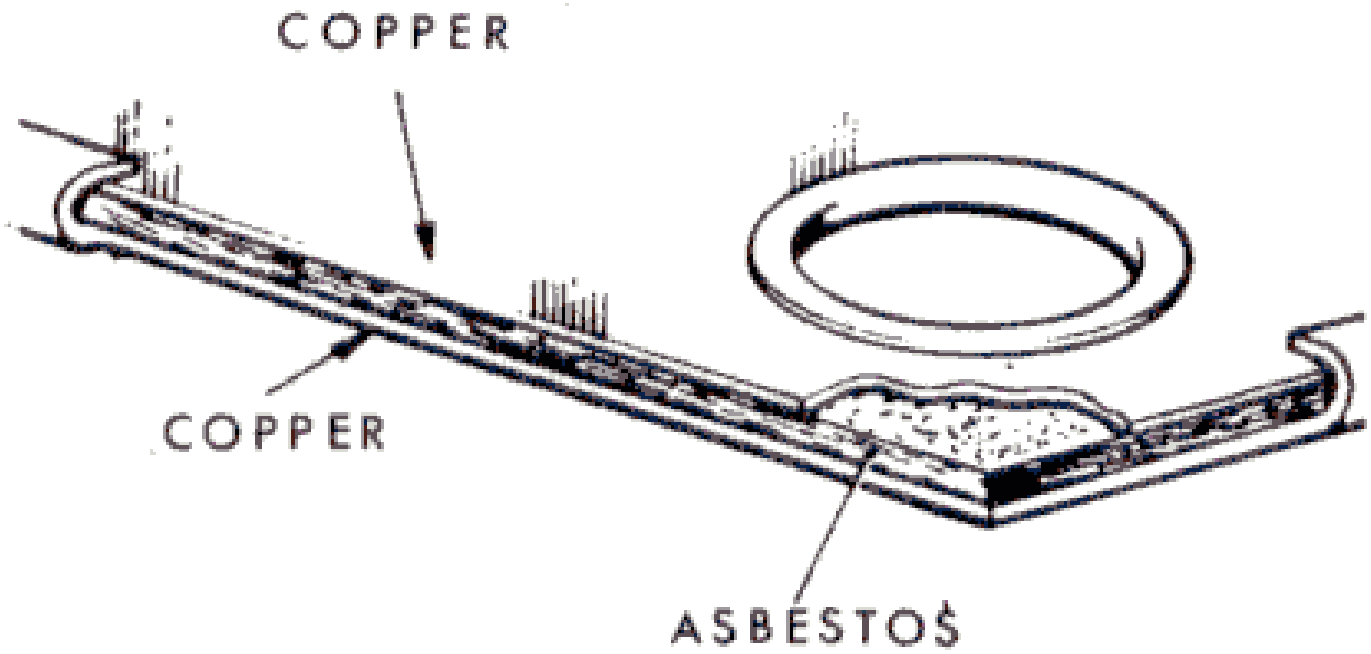

BULLET
INSERT SHOWS 'O' RING
BEING FITTED TO 'O' RING
RECESS

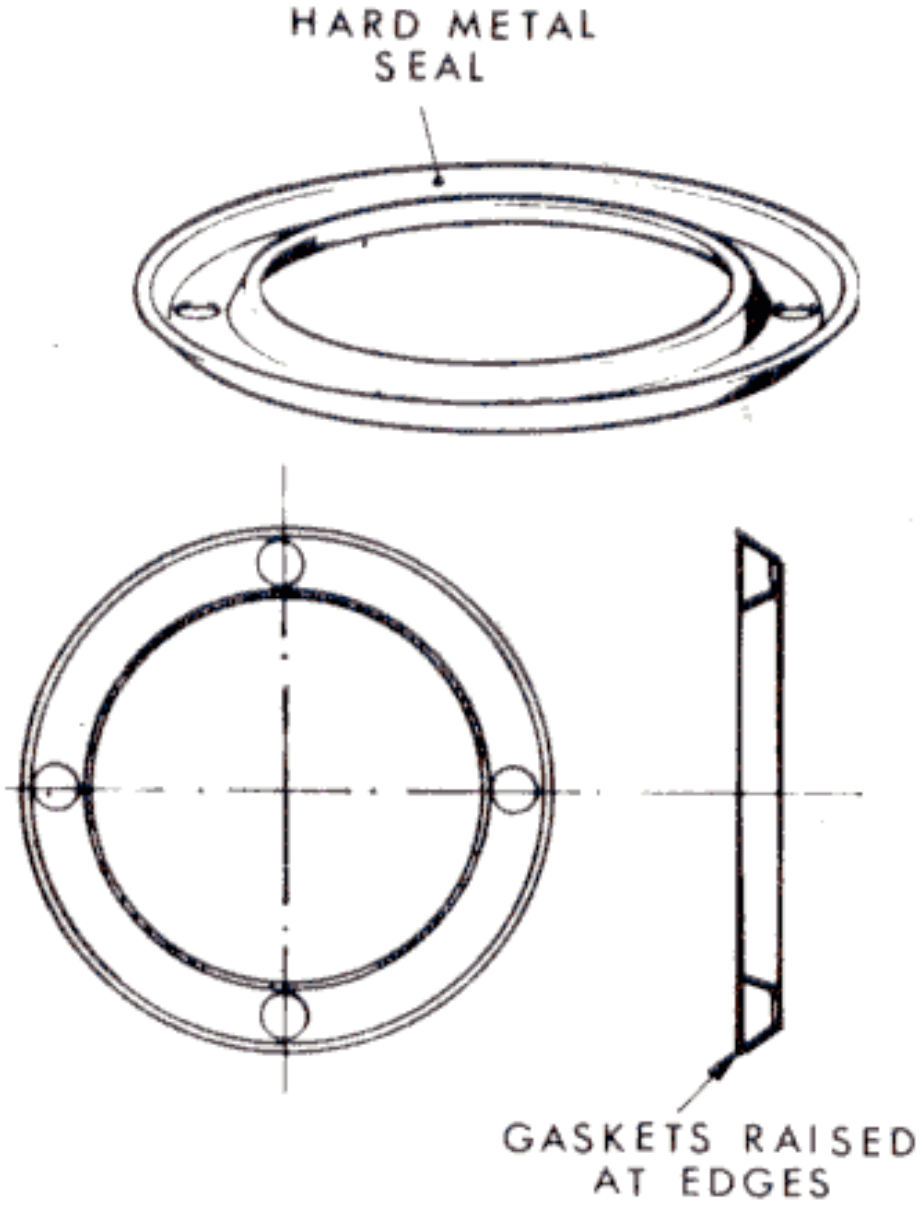

CORK GASKET

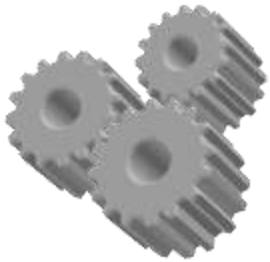

PTFE CORD
HALF-ROUND
STRIP ON
SPOOL

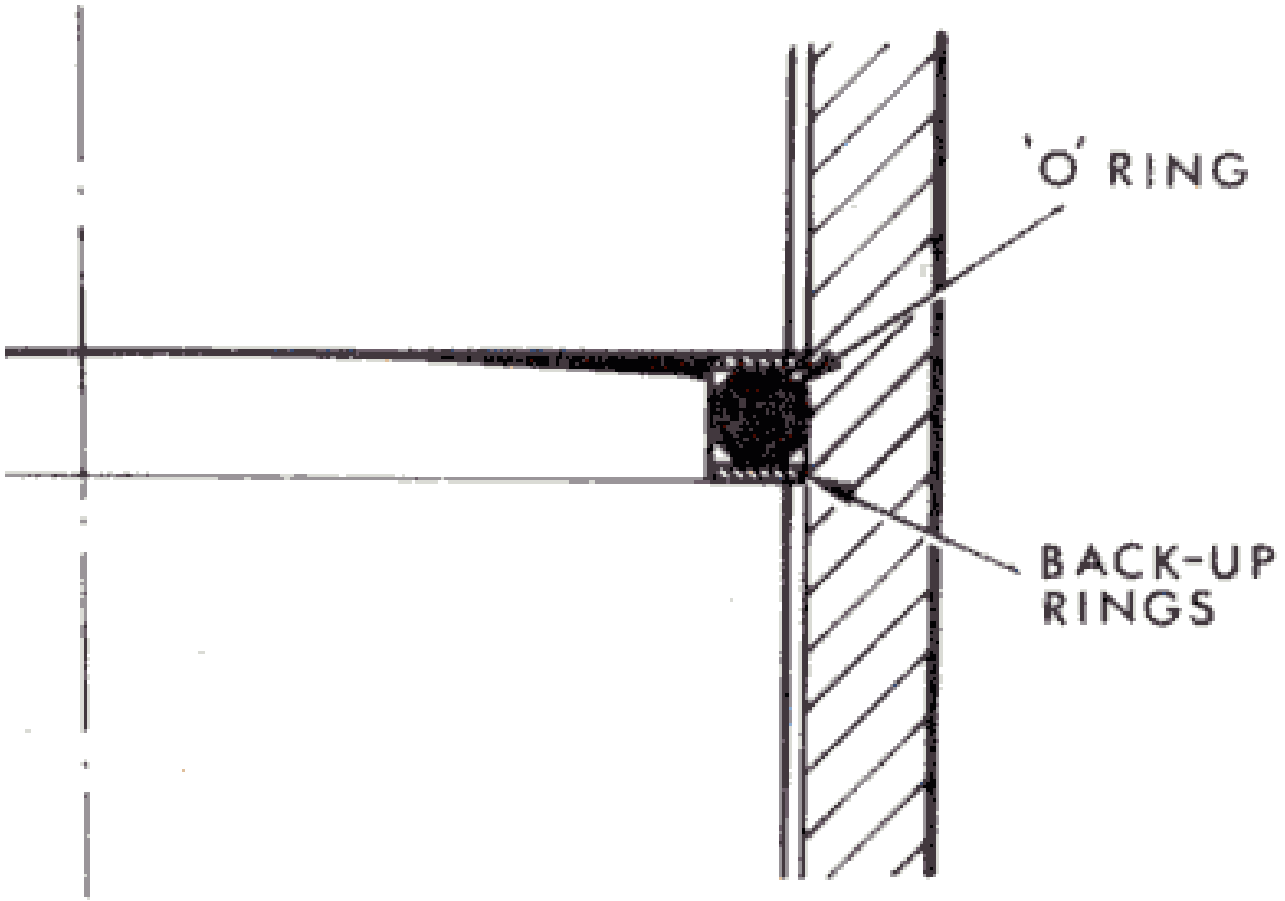

PRESSURE
RELEASE
VALVE
GASKET


FUEL PUMP
VARNISHED
PAPER


COPPER
COPPER
ASBESTO$

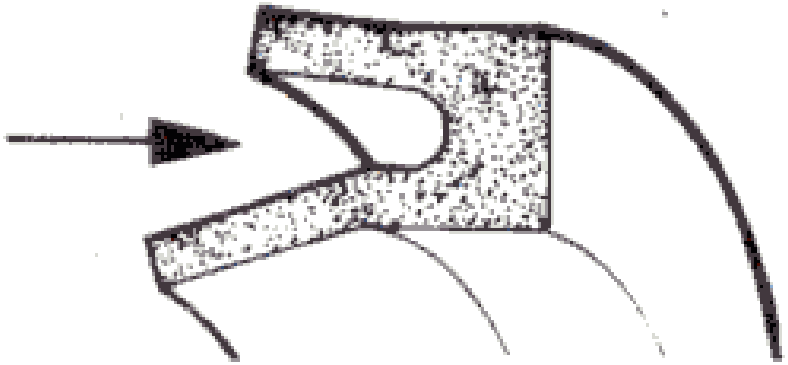

HARD METAL
SEAL
GASKETS RAISED
AT EDGES

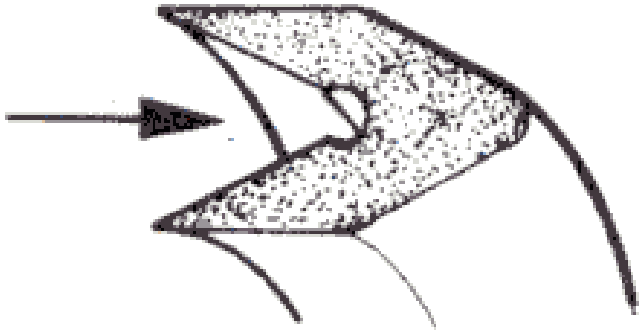


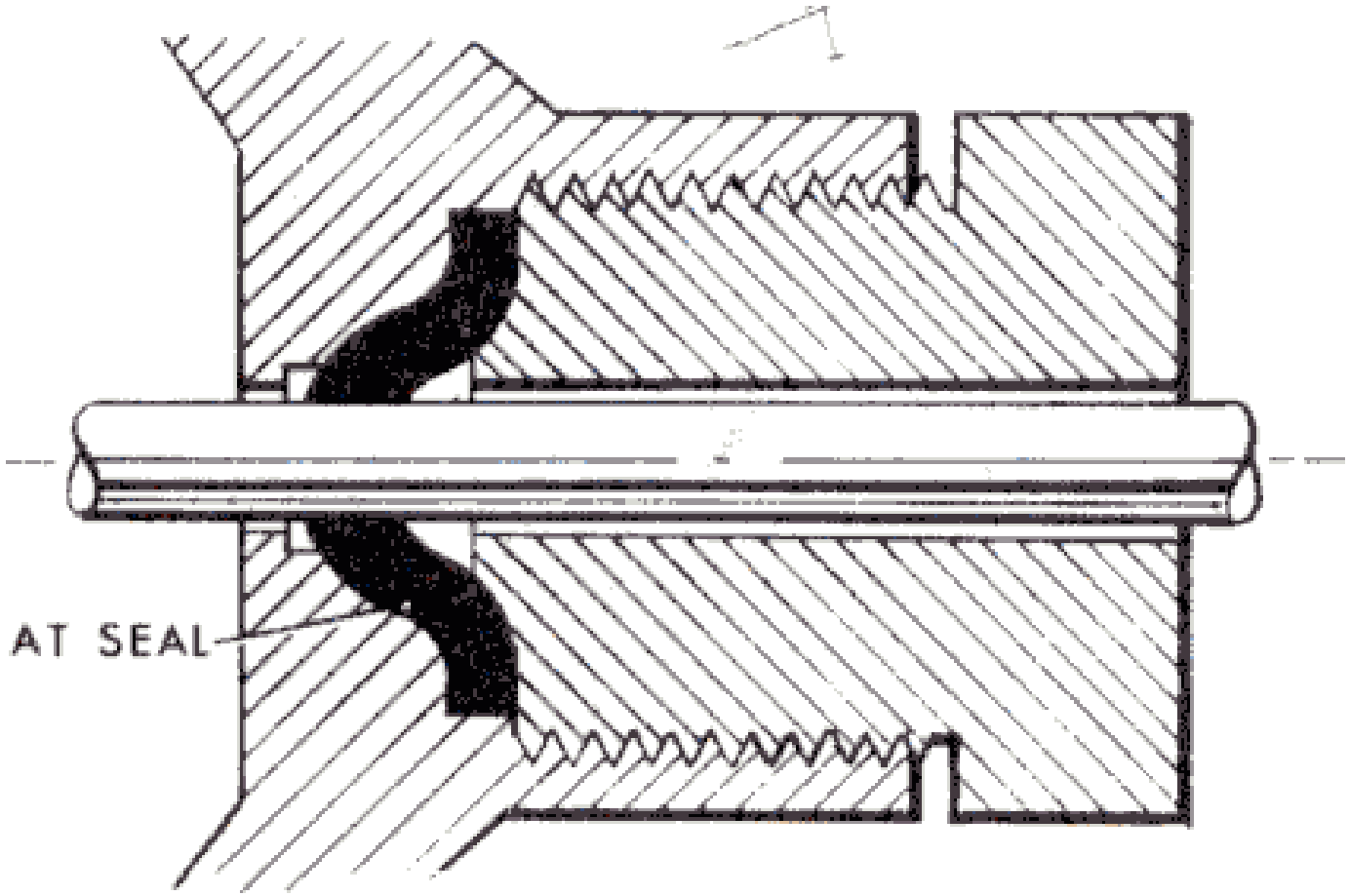

'O' RING
BACK-UP
RINGS

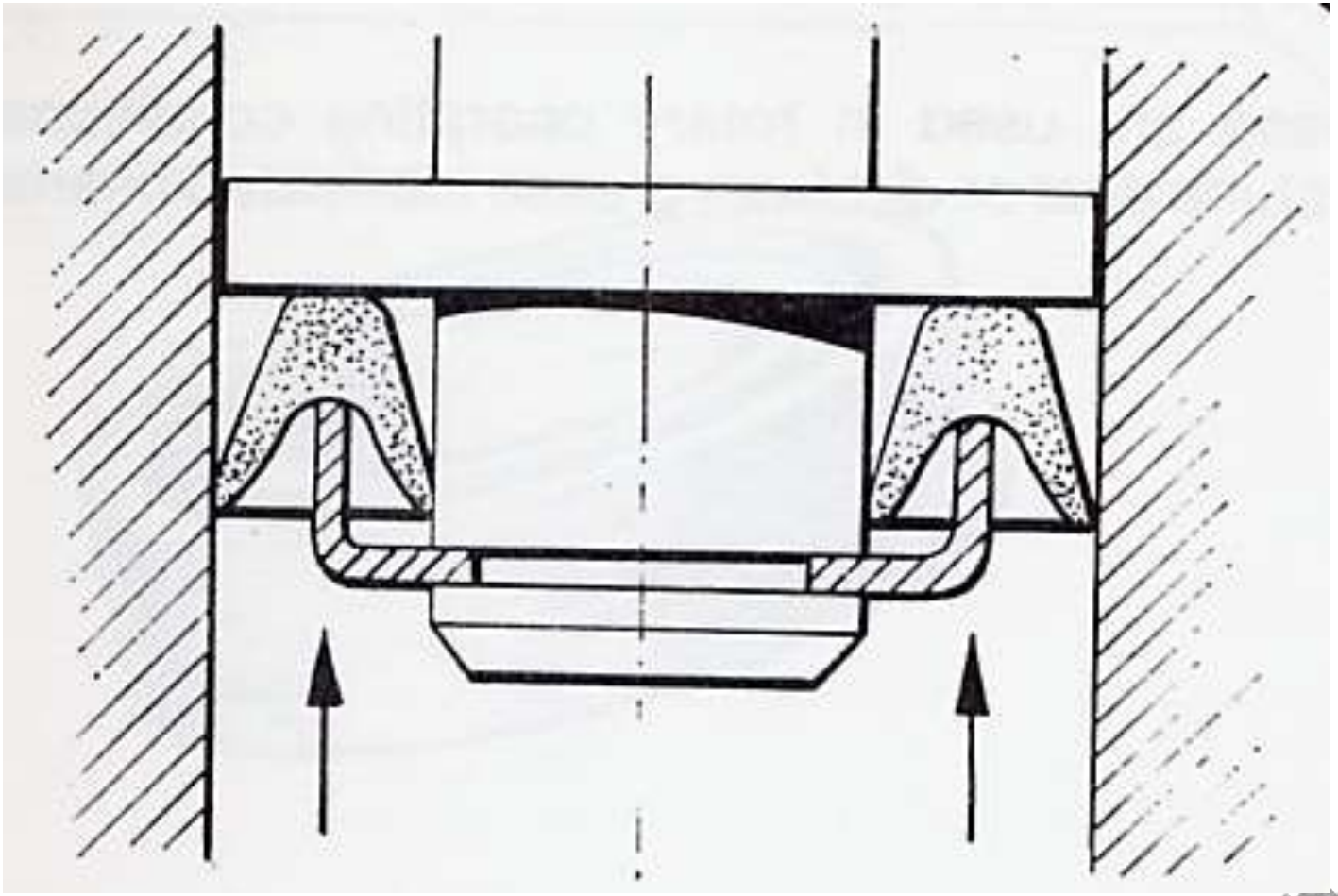
TWO TYPES MOULDED SEAL

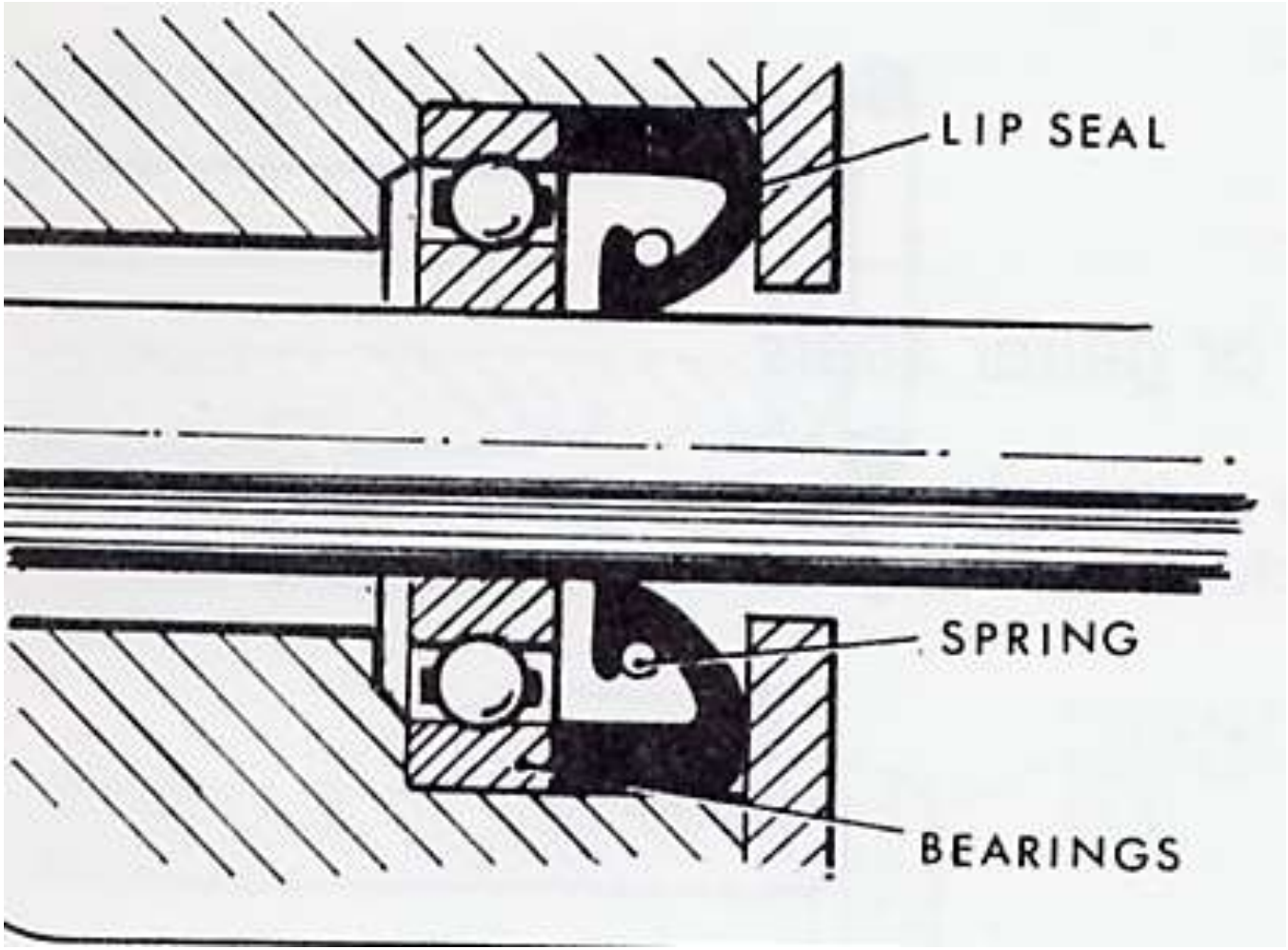
PRESSURE
DIRECTION

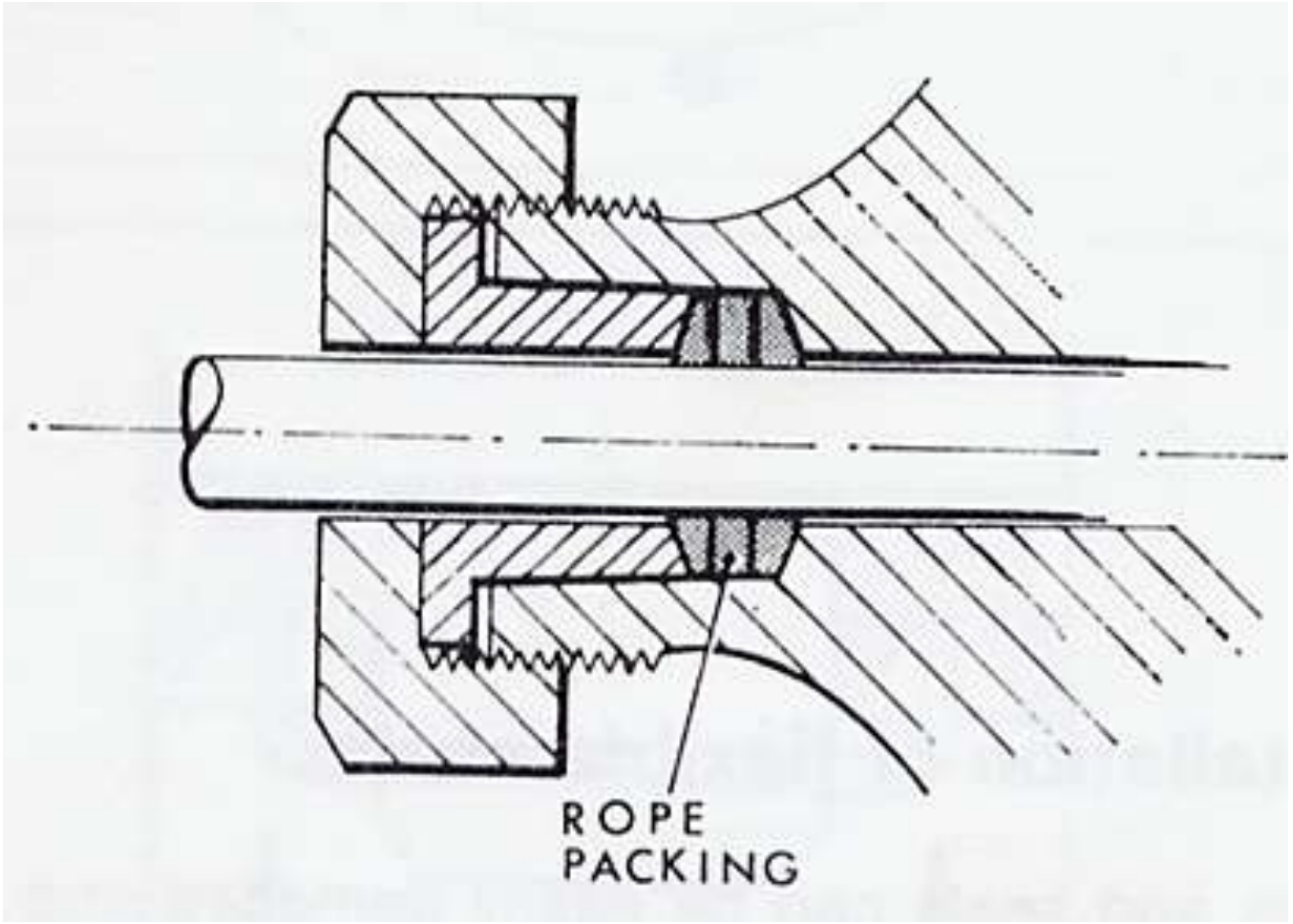


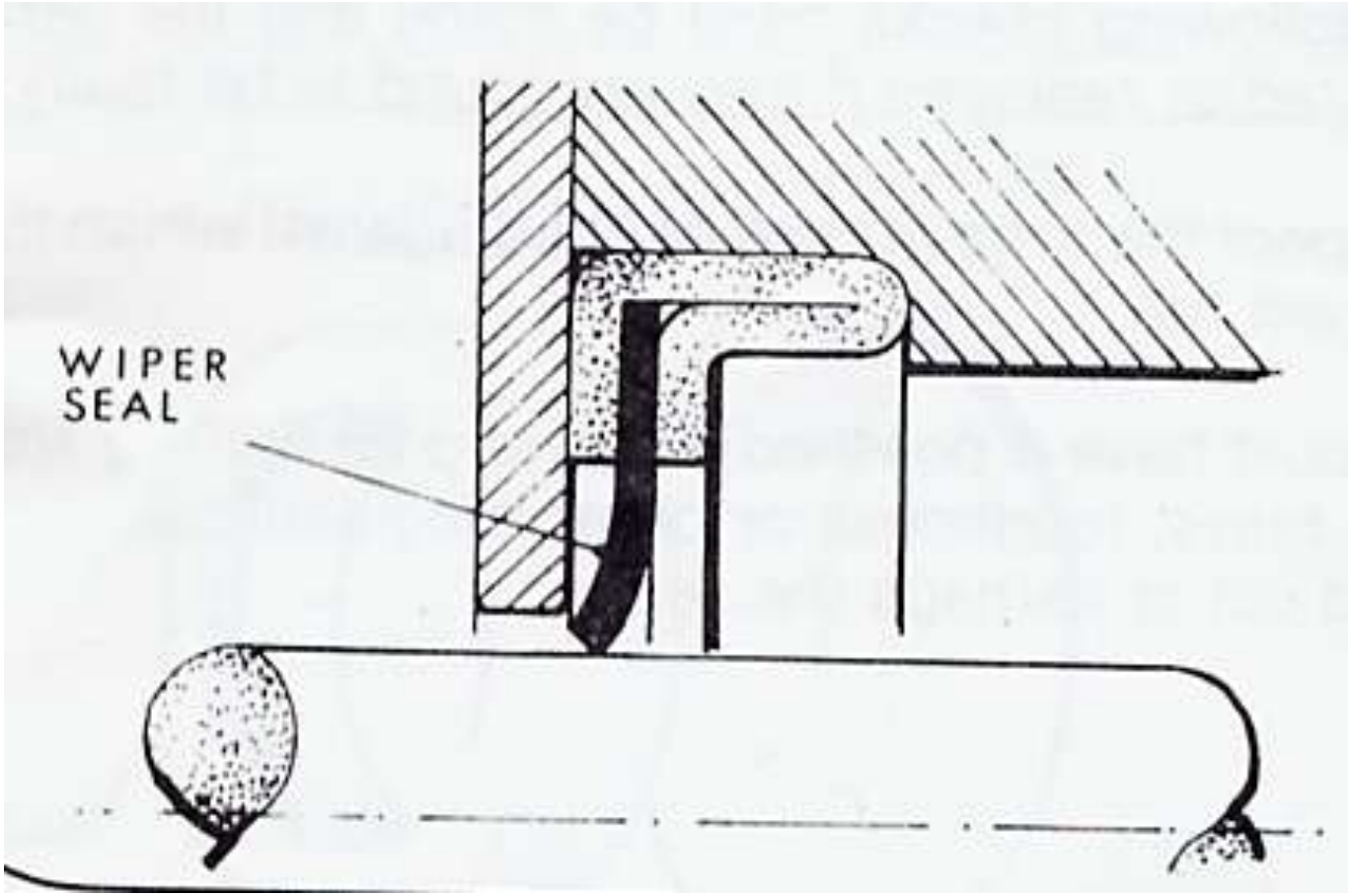


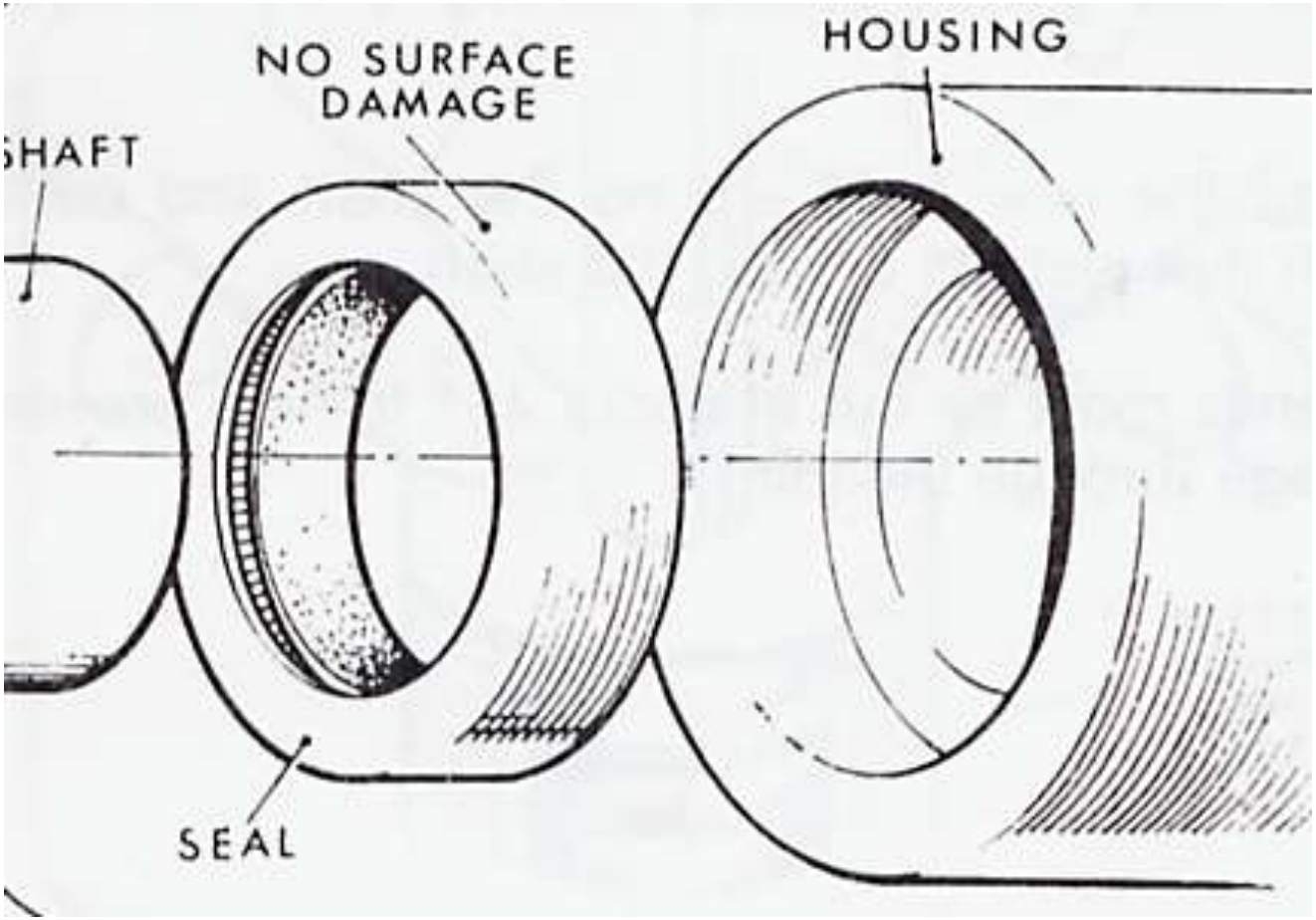

AT SEAL

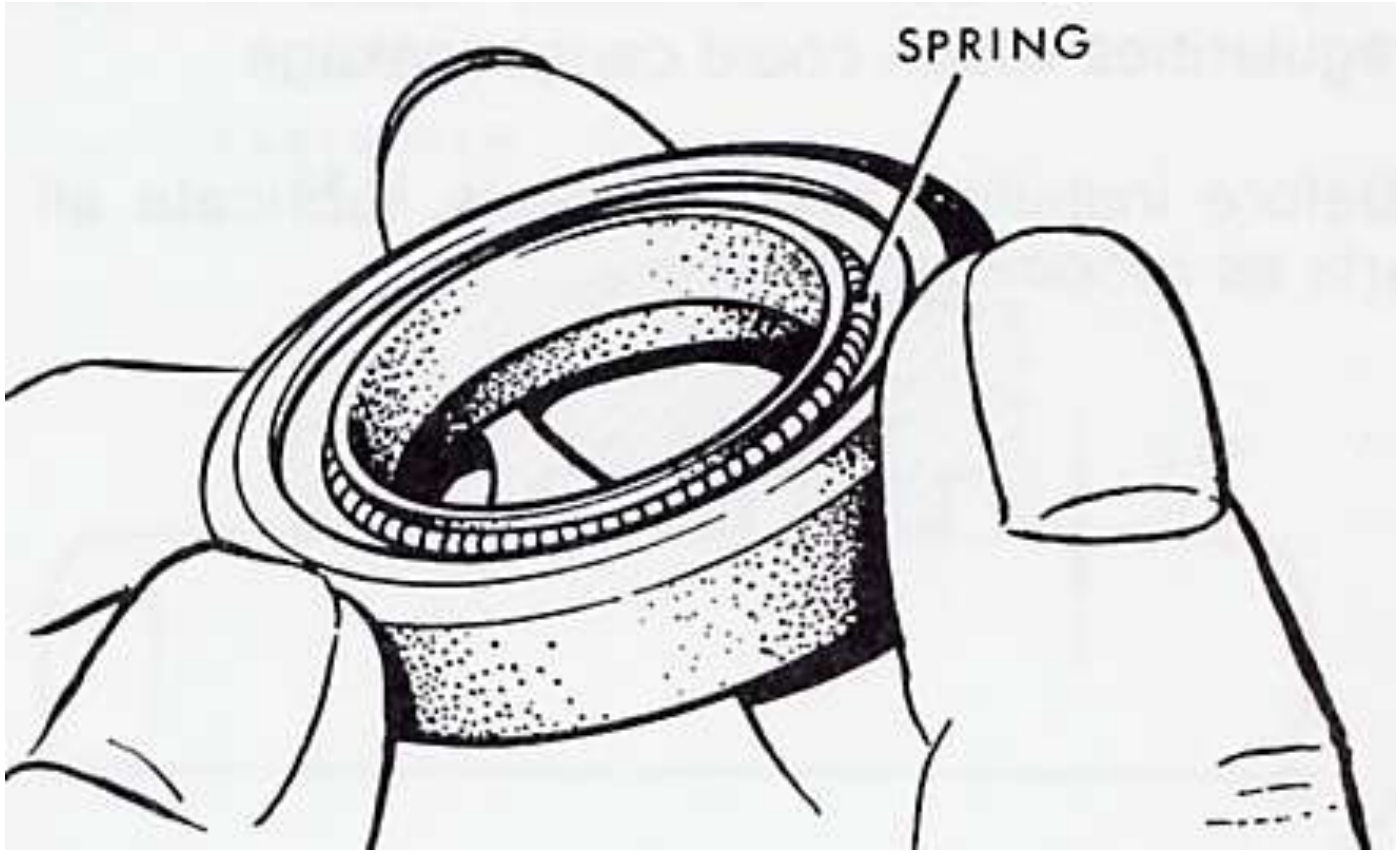


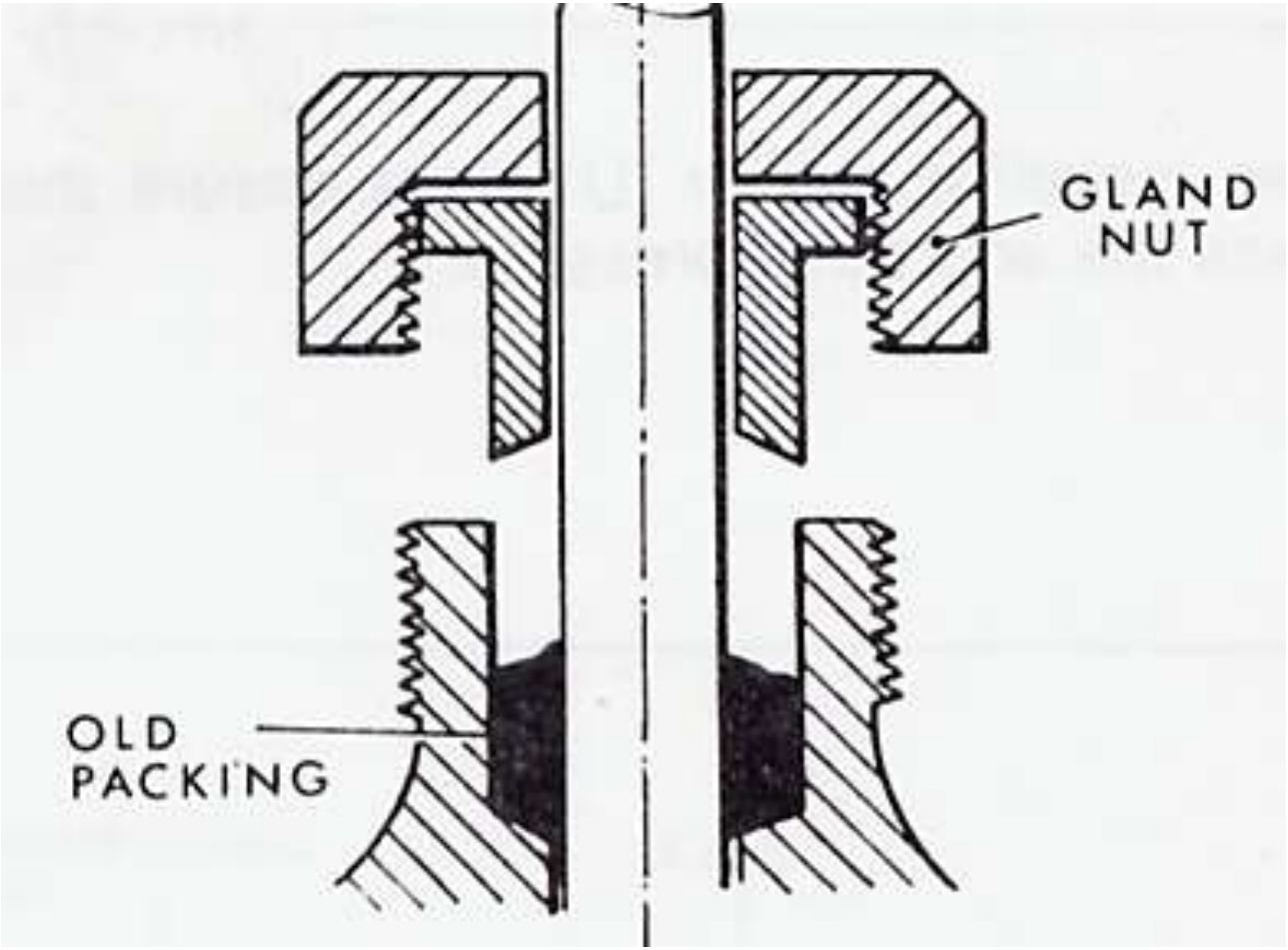

LIP SEAL
SPRING
BEARINGS

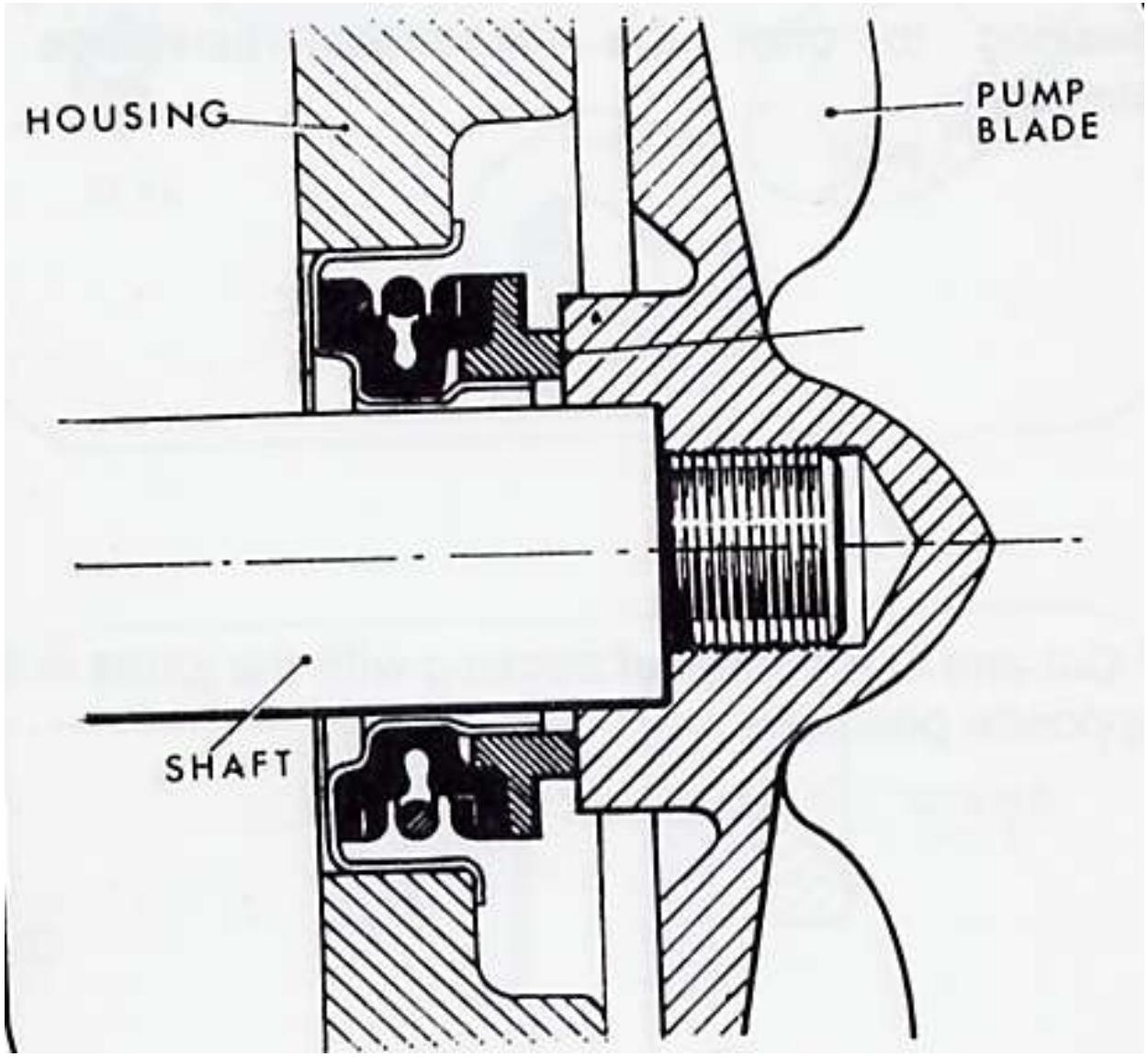

ROPE
PACKING

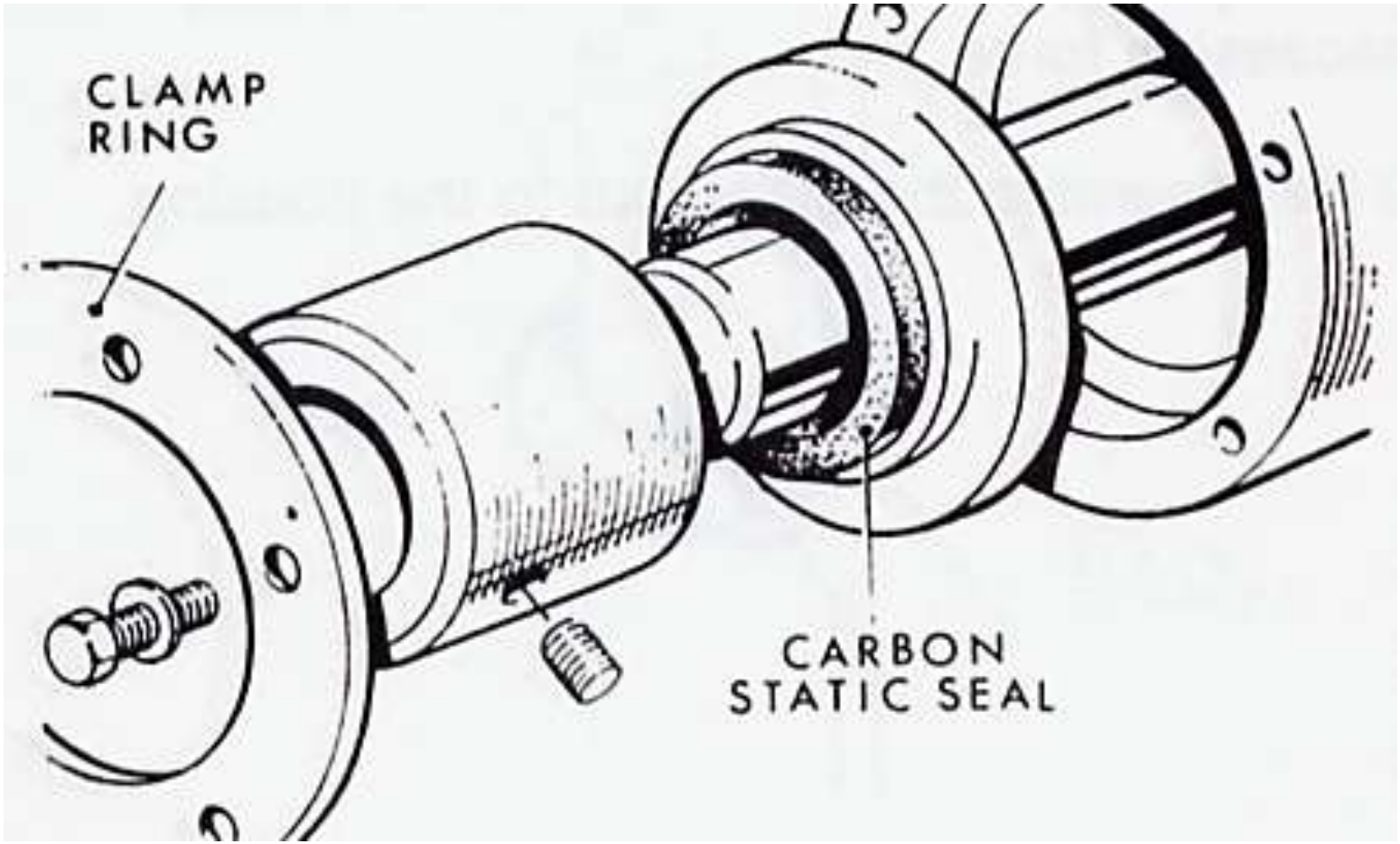

WIPER
SEAL


NO SURFACE
DAMAGE
HOUSING
SHAFT
SEAL


SPRING


GLAND
NUT
OLD
PACKING


HOUSING
PUMP
BLADE
SHAFT

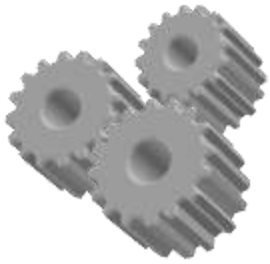

CLAMP
RING
CARBON
STATIC SEAL

ROTARY SEALS

Every item of rotating plant and equipment - from a humble lawn sprinkler to a jet engine or massive hydroelectric power scheme - relies on rotary sealing systems to keep it working safely and efficiently.

The four main points to consider are:

- Bearing protection
- Lubricant retention
- Exclusion of contaminants
- Safeguarding the environment by minimising leakage of media.



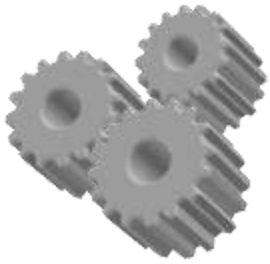
'O' RINGS

The humble 'O' ring is an exceptionally versatile sealing device. Applications ranging from garden hose couplings to critical aerospace duties make it the world's most popular volume produced seal.

HYDRAULIC SEALING COMPONENTS

Hydraulic sealing components provides the optimum sealing solutions for almost every hydraulic application - from the most accurate instruments and control actuators up to the heaviest forging and extrusion presses.

Each product has been specially developed and proven to give optimum equipment performance with a long trouble-free operating life.

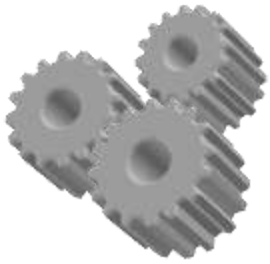


EXPANSION JOINTS & BELLOWS

Most industrial plant and machinery needs flexibility to maintain efficient and safe operation:

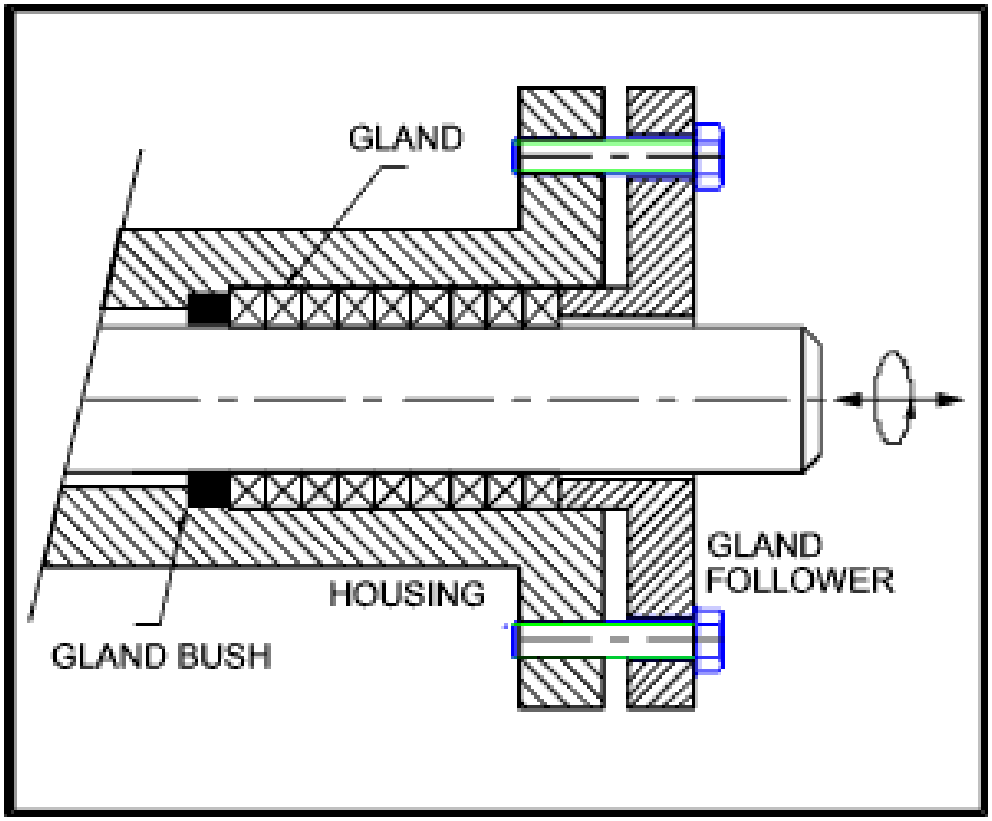
Flexible protectors to contain lubricants and shroud exposed mechanisms that operate in aggressive environments.

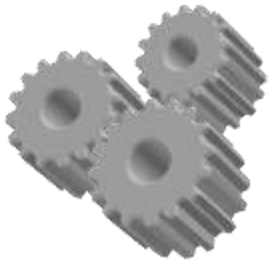
Flexible connectors to absorb thermal movement, isolate vibration and compensate for misalignment in ductwork and piping.

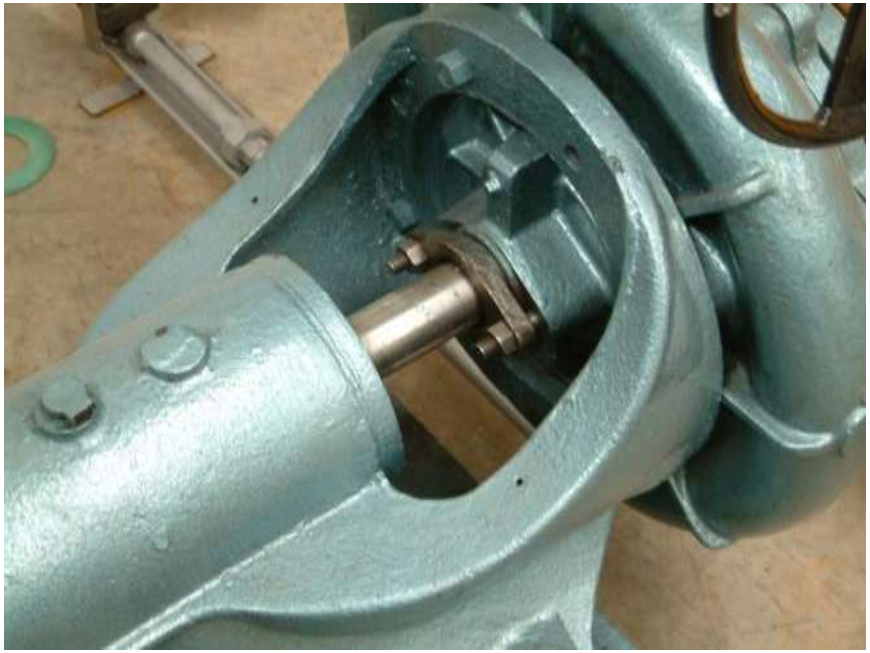


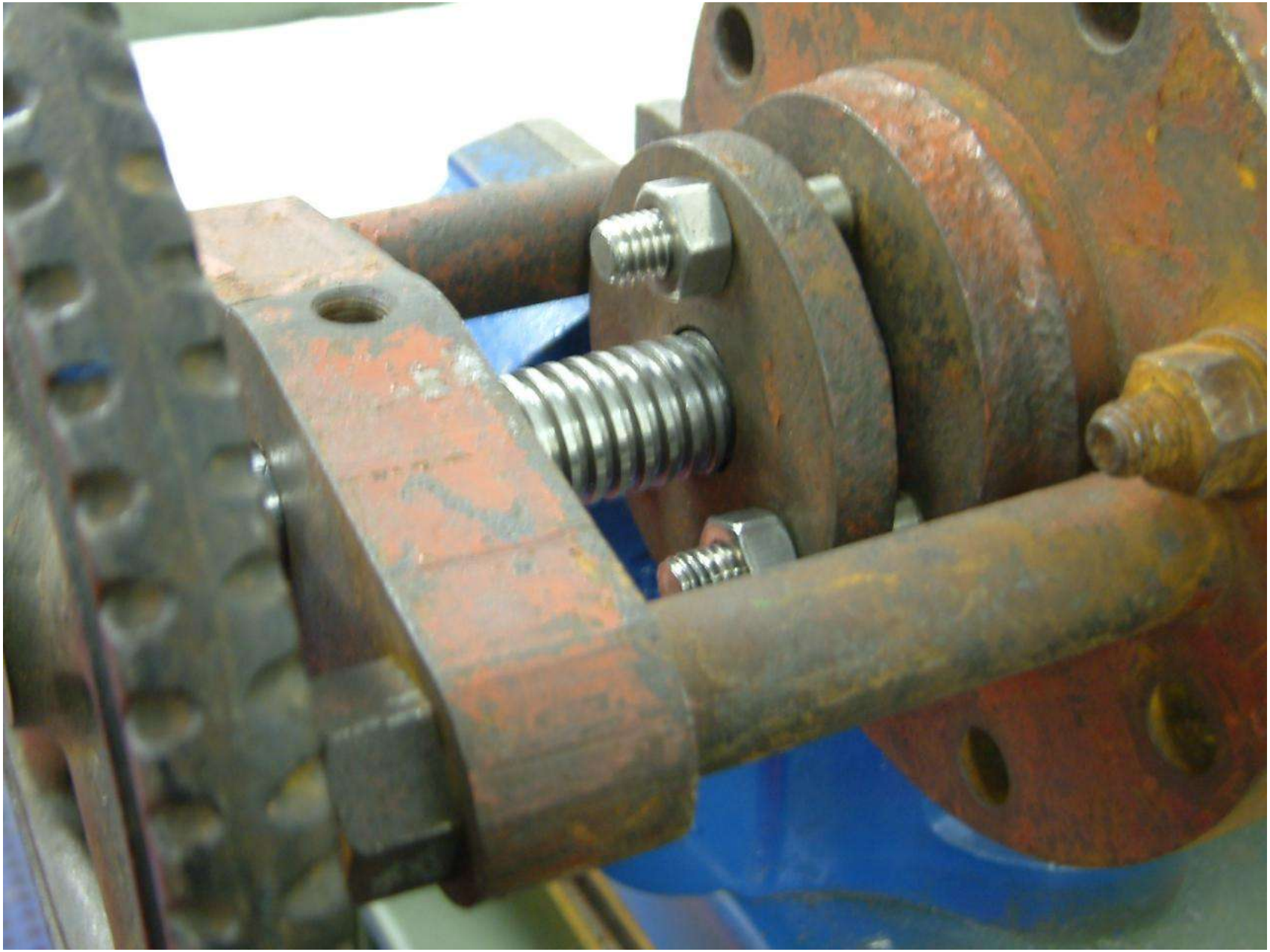
Typical Packed Gland Arrangement

The packed gland is used primarily for sealing process valve shafts (axial movement) and for process pump shafts(rotary movement). The packed gland has provided a low tech. convenient solution throughout the history of engineering. In modern times the packed gland is being replaced by more exotic solutions.









MECHANICAL SEALS

Mechanical seals - from simple single-spring units with a rubber diaphragm, to the largest split cartridge types.
Between them, these are capable of solving shaft sealing problems on rotary equipment such as pumps, compressors, mixers and agitators in many industries:

- Chemical and petrochemical
- Water and waste treatment
- Power generation
- Marine
- Mining
- Pulp and paper processing

  Food processing (including sugar industry).