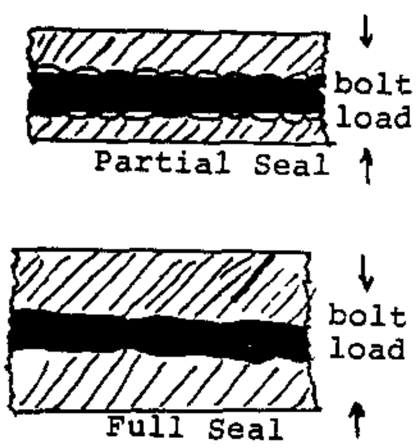
Mechanical Equipment - Course 430.1

SEALING DEVICES

There are three main methods by which a seal is made whether or not motion is involved. These are packings, gasketing and mechanical sealing. Each has its own specific use although some can serve double duties.

Taking first of all gaskets we must establish what a gasket is supposed to accomplish. In piping and machinery we have a problem of making pressure tight joints between two rigid elements. This can be done without the use of gaskets but requires the surfaces to be mated perfectly. In very large machines, ie, turbines or large pumps, this in fact is possible and not unusual to find these metal-to-metal or face-to-face joints. However these conditions rarely exist on smaller pumps or piping flanges so a gasket of some nature is used. Because they are designed to give, gaskets make up for imperfections of the average joint.

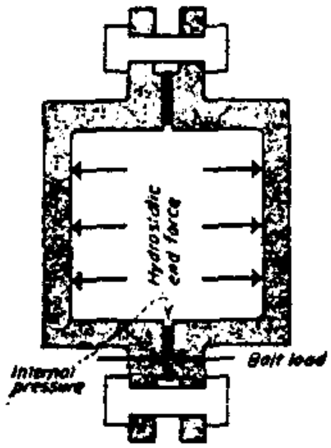
A gasket is a static seal by which a positive leak tight joint is made. In order to do this it must have two apparently conflicting properties. It must be soft enough to flow by compression into the hills or valleys of the joint face, Figure 1, and strong enough to resist internal pressures attempting to blow it out from between the joint faces.



Gasket Must Be Capable of Flowing, When Under Bolt Load, Into All Irregularities to Form a Full Seal

Figure 1

The compressability of a gasket will depend upon the service it is to be used in and hence the bolt load. It is of utmost importance that a plain gasket be thick enough to fill the irregularities and yet thin enough to give as little surface area as possible for the pressurized fluid to act upon. Another consideration to be taken into account is the I.D. of the gasket with respect to that of the joint. As seen in Figure 2, if the gasket is smaller than the flange then internal pressure acts on the flange faces and attempts to separate them thus reducing the squeeze on the gasket material. The closer the I.D. of the gasket is to that of the ftange then the lesser is the tendency to separate the joint.



When I.D. of Gasket is Greater Than Flange I.D.
Hydrostatic End Force Reduces Squeeze on Gasket

Figure 2

There are many materials available for gaskets. The selection is dependent upon the service conditions. The basic criterion are temperature, pressure and fluid being conveyed in the system. Some of the more common gasket materials are given below.

Asbestos - probably the most widely used material where heat is involved. It is pressed, woven, compounded and reinforced to give service qualities. It is supplied in bulk or in preformed or precut shapes.

Rubber - ideal gasket material because it is elastic and squeezes into joint with comparatively light bolt loading. Natural rubber is used mostly for hot or cold water, sometimes low pressure steam or gas. Synthetic rubber stands up to higher temperatures and some can be used in oil applications.

Silicone rubber or elastomers have excellent heat resistant qualities and good low temperature flexibility. Good with some oils but not solvents or steam-under pressure.

Plastics - ie, teflon or Kel-F good for high temperatures or corrosive fluids or replacing synthetic or natural rubber (Figure 3).

Woven asbestos, stainless steel core.

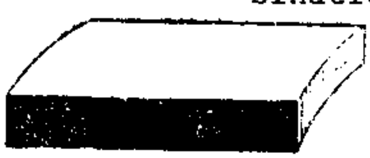
Stainless steel insert.

Woven asbestos compressed core.

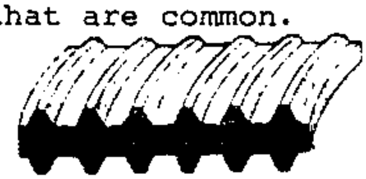
Typical Fillers in Teflon Jackets

Figure 3

Metals - pressure, temperature and corrosion resistance determines the materials and their construction. Lead, tin, copper, aluminum, brass, monel, nickel, silver, steel, platinum are all used for gaskets. Some examples are shown in Figure 4, to show the different shapes and combinations that are common.



Plain Solid

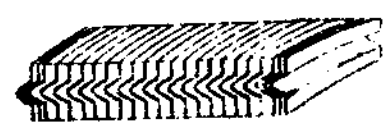


Serrated

Corrugated

Profile-Clad

Double Jacketed



Spiral-Wound

Metal Gaskets Showing Some Typical Configurations
Top Row - Plain Metal,
Bottom Row - Cladded or Filler Type Constr.

Figure 4

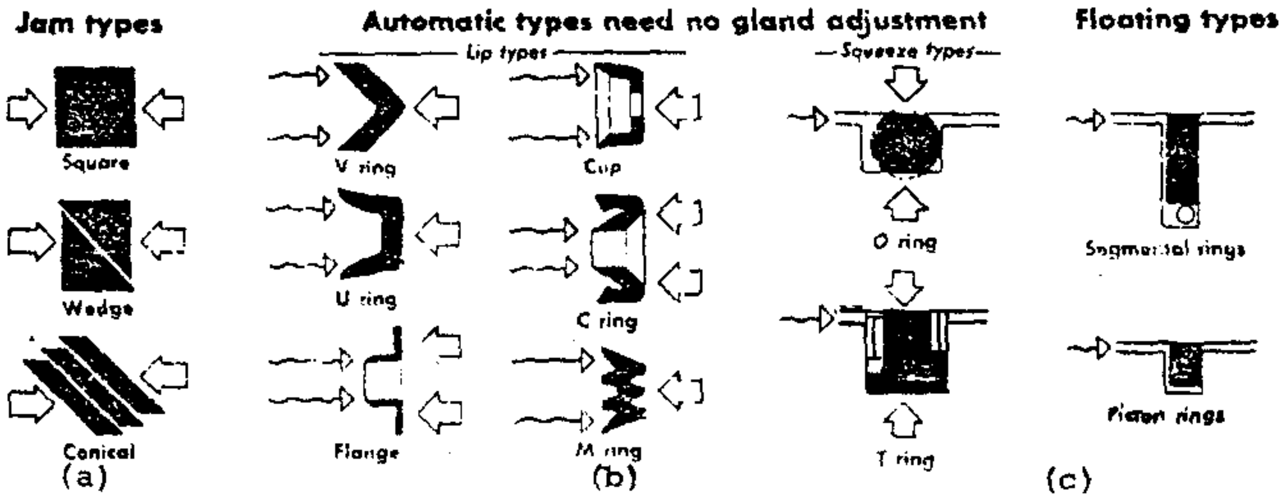
Let us now look at the problem of sealing moving components such as is found in pumps either rotating or reciprocating or helical found in valves. This problem is normally solved by using either packing or mechanical sealing devices.

Packing is a dynamic seal producing a relatively leak tight joint. By this we mean that packing throttles leakage not stop it altogether. This is because packing acts like a bearing and must be lubricated like one. Lubrication may come from a slight or controlled leakage from within themachines or in emergencies from a saturant in the packing. If these are not possible then packing must be lubricated in some other way as dry packing runs hot, hardens and either scores the shaft or allows excess leakage like any other bearing failure.

Packings fall into three broad classes. First there is the jam type (Figure 5 (a)) which includes any packing that is jammed into a stuffing box and adjusted from time to time by tightening the gland (Figure 6). These are normally braided, twisted, woven or laminated asbestos, cotten, rubber, leather, etc.

Secondly there is the automatic type (Figure 5(b)) which do not usually need gland adjustment. The fluid sealed supplies the pressure by forcing packing against a wearing face. They can be further divided into lip types and squeeze type. Common lip types are "U" or "V" ring, cup, flanged, etc. The squeeze type is the "O" ring.

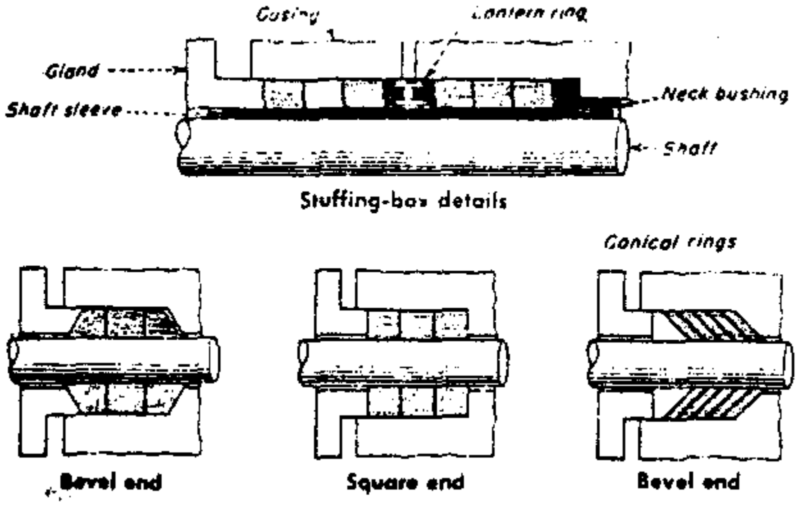
Third is the floating type (Figure 5(c)). These include segmental rings of carbon, metal, plastics, etc, held around the shaft by springs etc.



Types of Packings

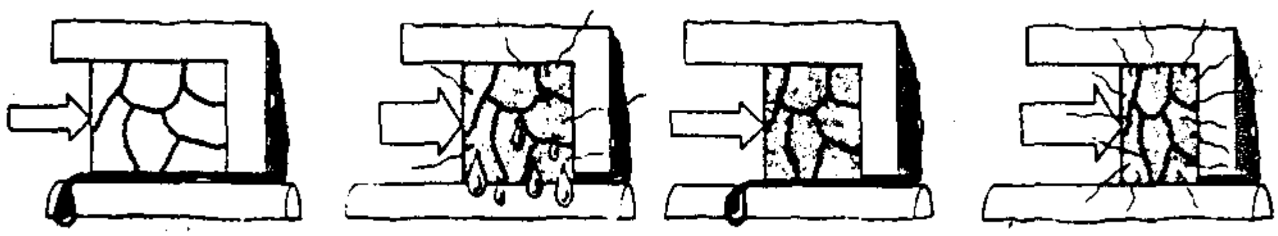
Figure 5

Lubrication of packing is achieved by allowing leakage along the moving member or by supplying a fluid to the gland so that it may travel along the shaft. This latter method is achieved by means of a lantern ring as shown in Figure 6. When there is no fluid leakage then packing must be capable of supplying the lubrication. This is done by saturating the packing with a lubricant. When this lubricant has been consumed through use, Figure 7, the packing becomes dry and brittle. At this point it must be replaced. It is quite common to find the first one or two rings of packing adjacent to the gland ring requiring renewal most frequently (Figure 8) as this is where the gland packing ring exerts its greatest force.



Types of Stuffing Boxes Showing Variations

Figure 6



(a) New Packing

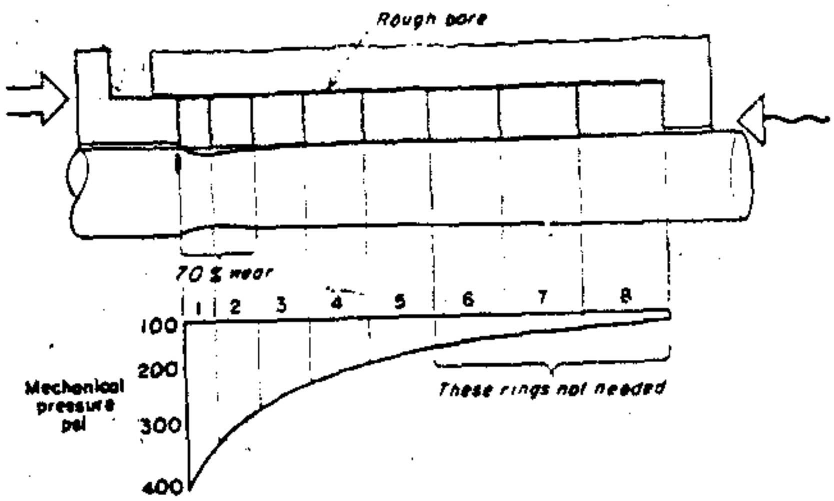
(b) No Fluid Leakage: Saturant Oozes Out.

(c) Fluid Lubricates.

(d) No Saturant Left.

Saturant In Packing Deteriorates Through Use When No Lubricant Is Supplied From Machine

Figure 7

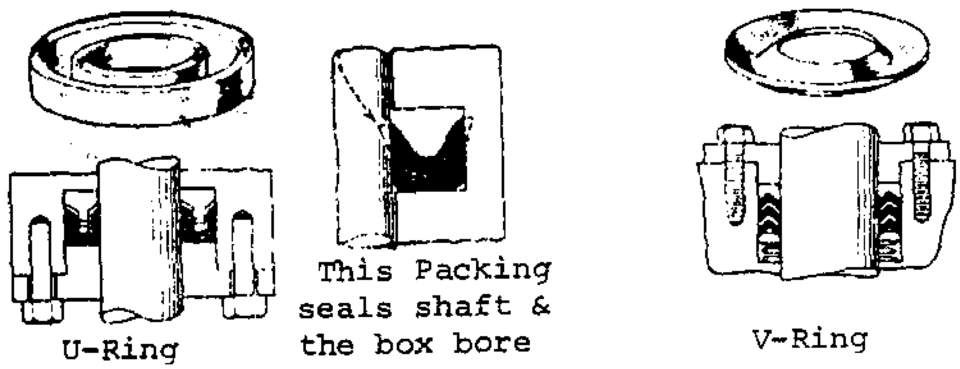


Load on Packing is Highest at Gland Ging and Hence These Packing Rings Need Most Frequent Replacing

Figure 8

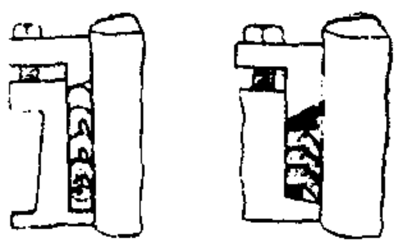
The use of automatic types helps to eliminate much of the human error in adjusting the jam type packing correctly. It is designed to make a seal by using the pumped fluid pressure. In some of the lip type packing small adjustments are required. Both variations are shown in Figure 9 and 10.

Lip Interference



Lip Type Packing Requiring No Gland Adjustment

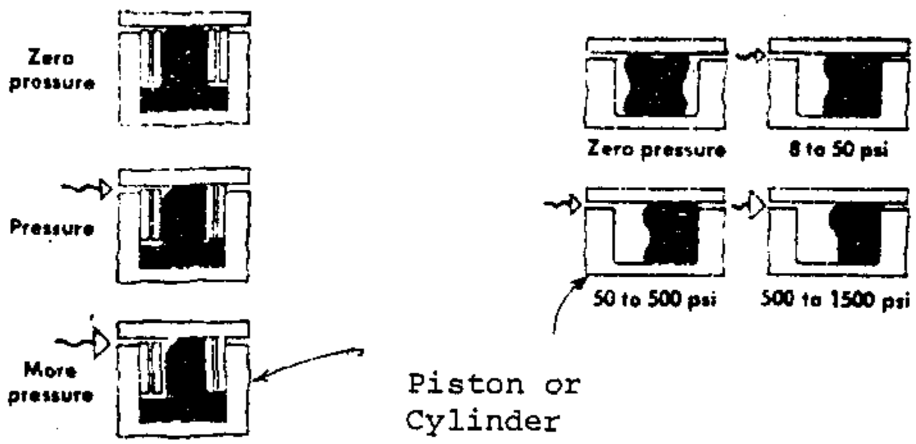
Figure 9



Lip Type Packing Requiring Gland Adjustment

Figure 10

The automatic squeeze type has an interference built into the ring causing it to be squeezed against the sliding and static surfaces without the use of the pumped fluid pressure. One of the drawbacks of the "O" ring is that under high pressures extrusion will occur due to internal fluid pressure. If this occurs the life of the ring will be shortened. The use of the back up rings is one method of reducing this effect (Figure 11).

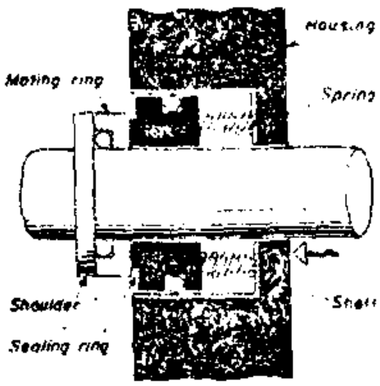


Squeeze Type "O" Ring Packing Showing the Effect of Pressure and the Use of Back-Up Rings

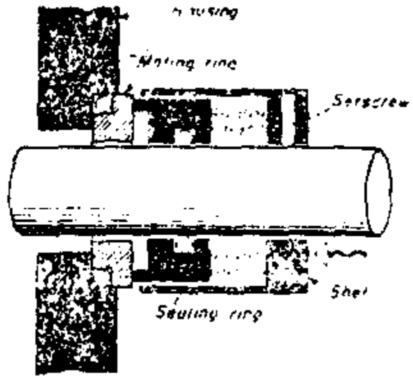
Figure 11

The third method of producing a seal is by means of a mechanical seal. It produces a positive leak tight seal. The various types of mechanical seals will be dealt with at level three and it is only intended to give a very basic description here.

The basic mechanical seal has two rings with wearing faces at right angles to the shaft. One ring is fastened to the shaft and revolves with it and the other is stationary and is held against the machine casing. The sealing ring is held against the stationary ring by means of a spring or springs and keeps a constant sealing pressure at the face. The sealing face can be very small and therefore minimum friction. Figure 12 shows the two basic types of mechanical seals.



Stationary Seal



Rotating Seal

Two Basic Types of Mechanical Seals

Figure 12

ASSIGNMENT

1. What is a gasket?
2. What is the most common material used for gaskets?
3. What are the types of packings?
4. What are the two basic types of mechanical seals?

G.S. Armstrong