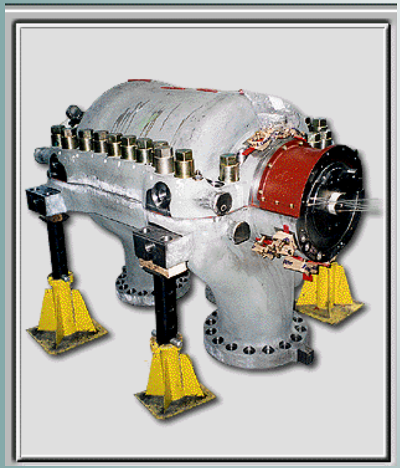
Centrifugal Compressors



Construction and Maintenance

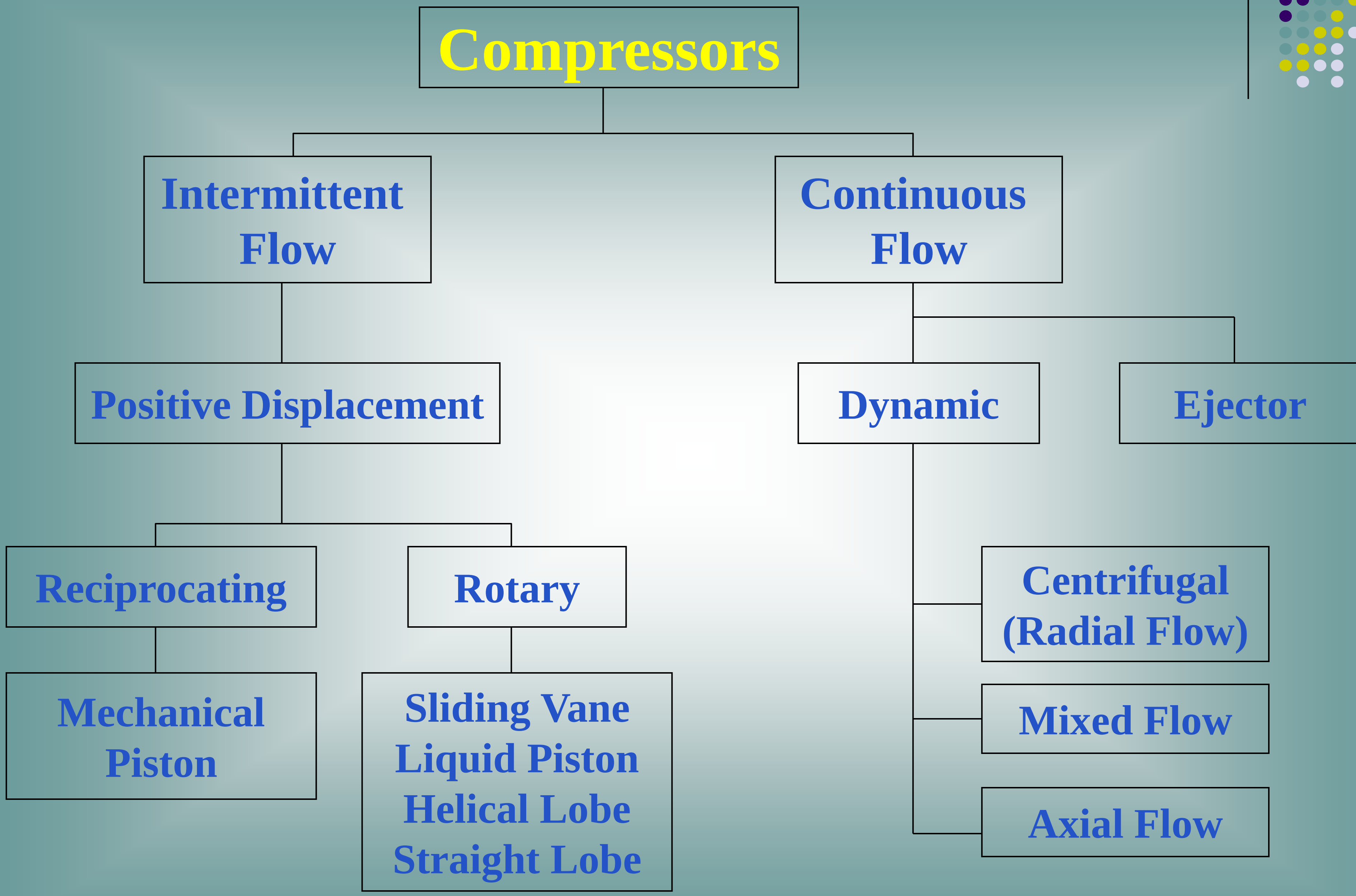
Presented by: S. H. Butt

CONTENTS

- Compressor
- Compressor Types
- Centrifugal Compressor
- Centrifugal Compressor Construction
- Centrifugal Compressor Instrumentation
- Centrifugal Compressor Auxiliaries
- Maintenance Philosophy
- Compressor Assembly / Disassembly CBT
- Alignment
- Maintenance Tips / Safety Precautions

Compressor

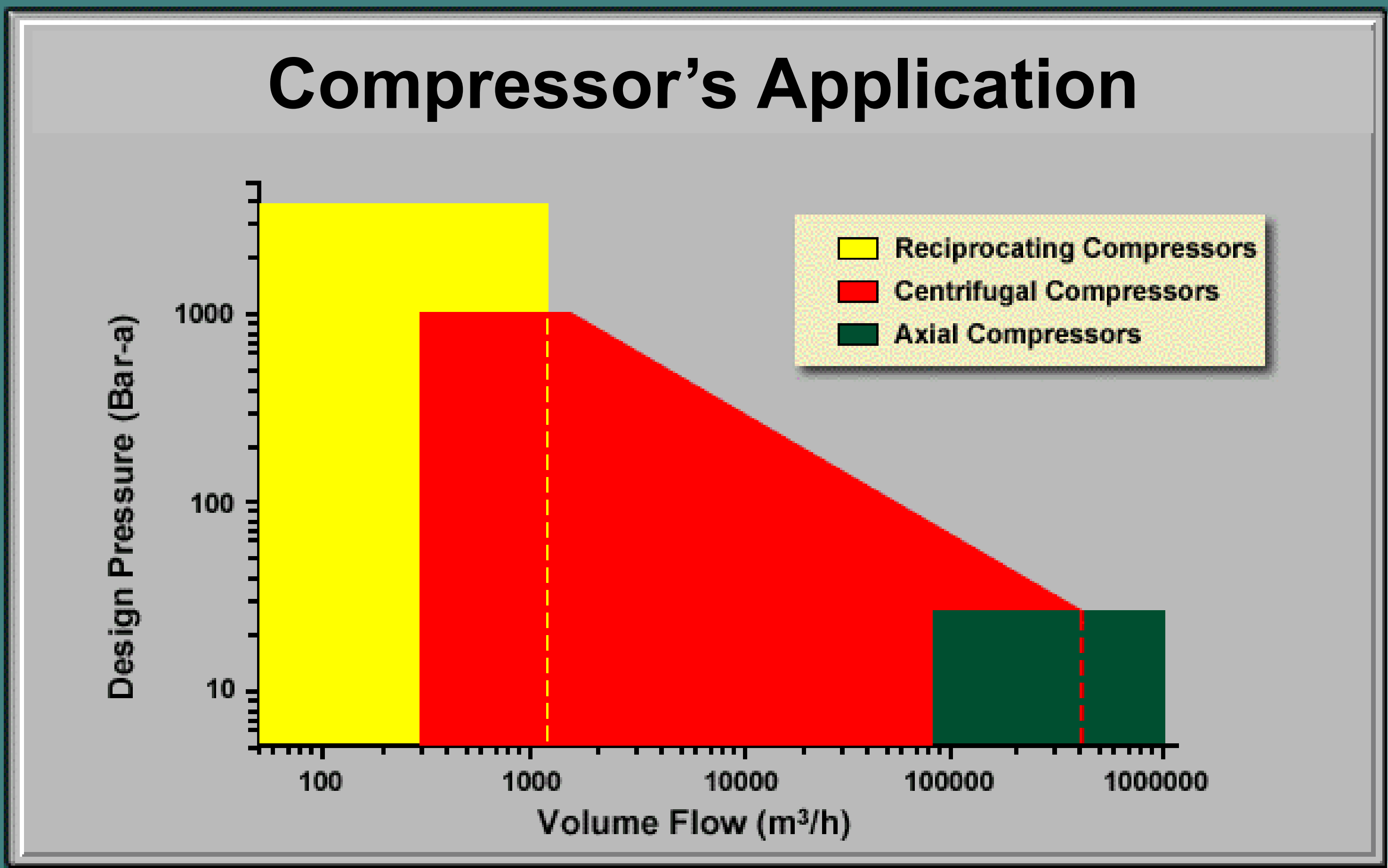
- A compressor is a device used to increase the pressure of a compressible fluid.
- The inlet and outlet pressure are related corresponding with the type of compressor and its configuration.
- Application of compressed gas vary from home refrigerator to large petrochemical plant installations.


Compressors
Intermittent Flow
Continuous Flow
Positive Displacement
Dynamic
Ejector
Reciprocating
Rotary
Mechanical Piston
Sliding Vane
Liquid Piston
Helical Lobe
Straight Lobe
Centrifugal (Radial Flow)
Mixed Flow
Axial Flow

Centrifugal Compressor

- Centrifugal Compressor
  - Dynamic Compressors which are based on the principle of imparting velocity to a gas stream and then converting this velocity energy into pressure energy are termed as Centrifugal Compressors'.

Compressors Application



Main Components

- **Impeller**
  - The part of centrifugal compressor that moves the gas is the impeller. As the impeller rotates, it moves the gas toward the outer rim of the impeller and thus its velocity increases.

- **Diffuser**
  - As the gas leaves impeller, it flows into a passage-way called the diffuser. The diffuser being larger in volume, the velocity of gas decreases and its pressure increases.

- **Volute**
  - Gas passes from diffuser into the volute. In the volute, the conversion of velocity energy to pressure energy continues.

Centrifugal Compressor Types
(On The Basis of Stages)

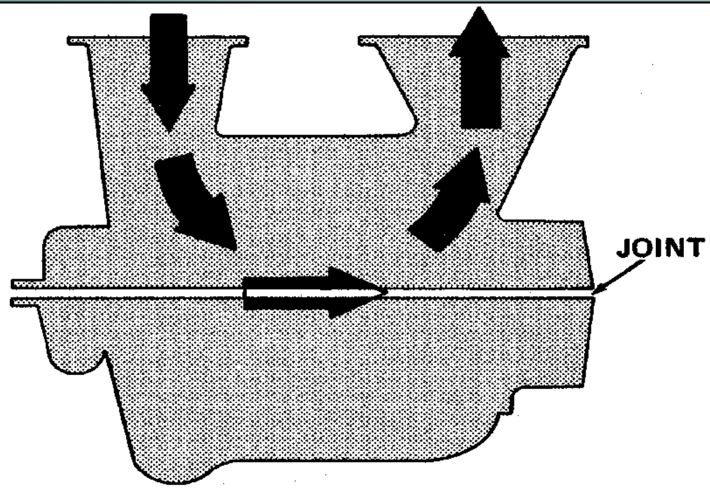
- Single - Stage Centrifugal Compressor
  - As name refers, Single Stage Compressor employs only one impeller to impart energy into the gas.
- Multi - Stage Centrifugal Compressor
  - A multi-stage compressor employs more than one impeller to impart energy into the gas.
  - The velocity is added to gas by the impeller of each stage. This velocity is converted into pressure within the diffuser. Thus, each impeller adds to the total energy (pressure) of the gas.

Multi – Stage Centrifugal Compressor

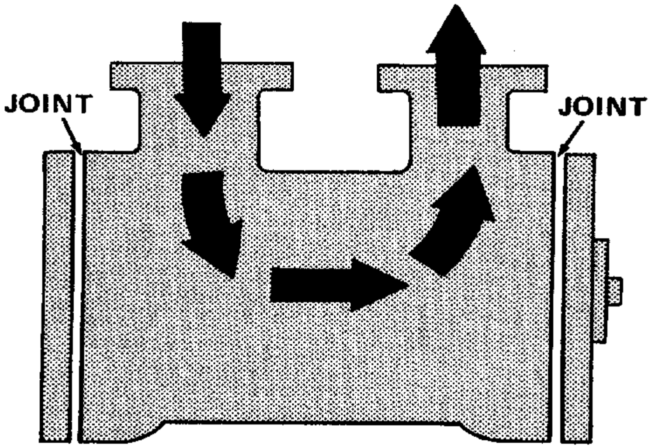
- Multi – Stage Centrifugal Compressors are available in different arrangements, each having distinct flow path and characteristics.
  - Straight-Through Flow
  - Double Flow
  - Side Streams
  - Iso-Cooling (cooling between stages)
  - Double Iso-Cooling
  - First Section Double-Flow
  - Back-to-Back
  - Back-to-Back with Recirculation Feature

Centrifugal Compressor Types
(On the Basis of Casing Design)

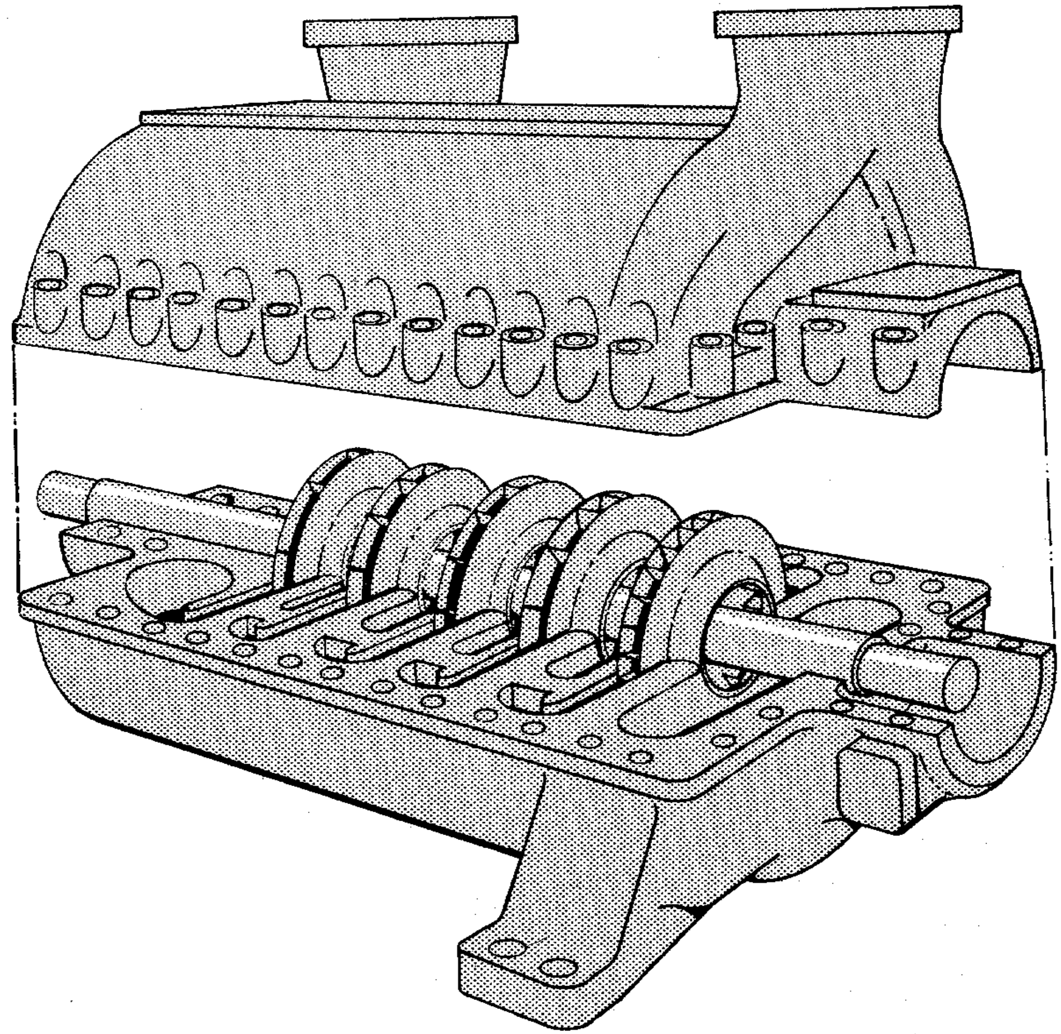
- Horizontally split casing.
  - This design is generally used at low pressure up to 60 bar.
  - The two halves of the casing are joined at the horizontal centerline by hydraulically tightened stud bolts and nuts.
  - Horizontally split casing is preferred as accessibility to compressor internals' is easier.



HORIZONTALLY SPLIT



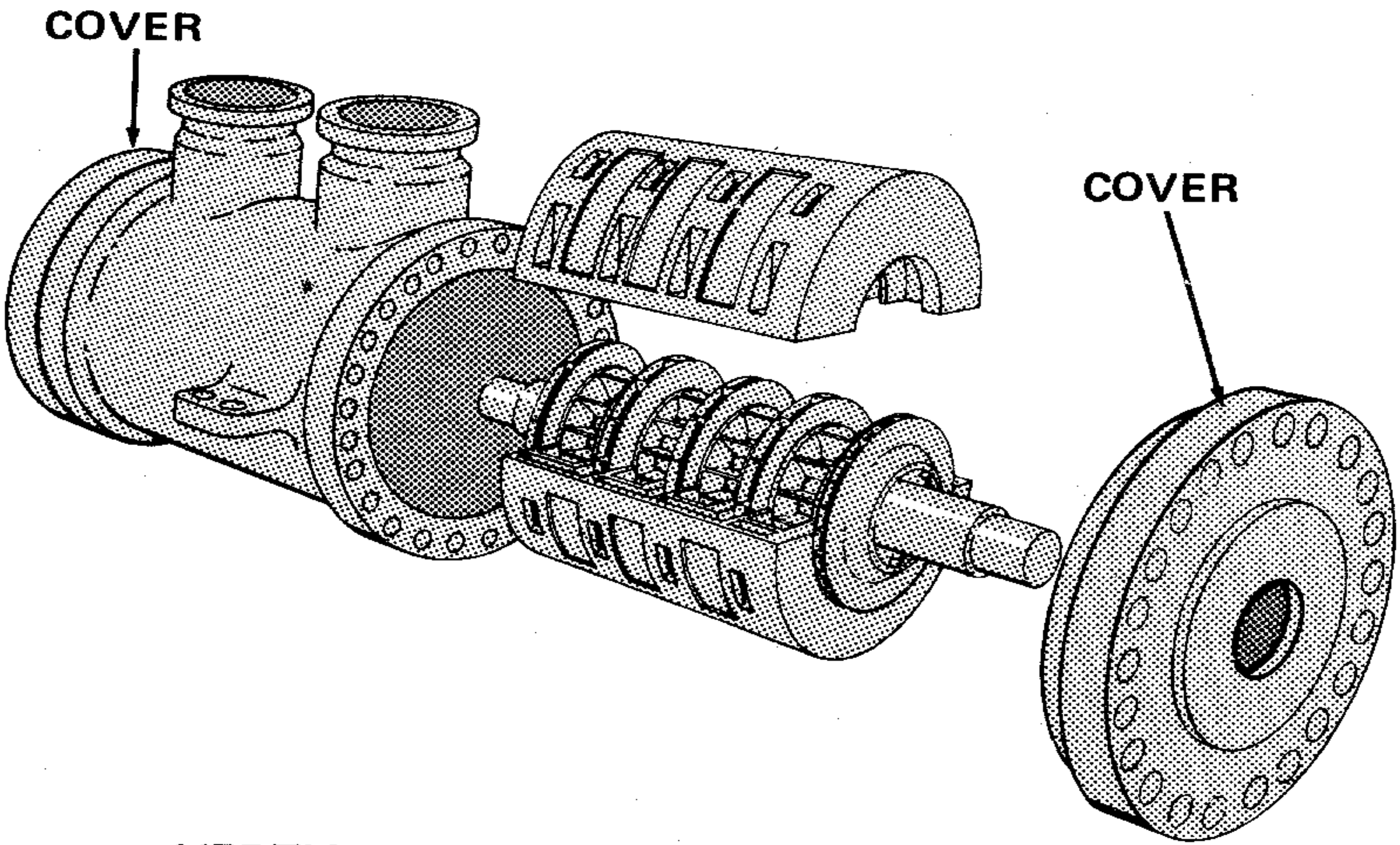
VERTICALLY SPLIT



HORIZONTALLY SPLIT CASING

Centrifugal Compressor Types
(On the Basis of Casing Design)

- Vertically split casing.
  - When a compressor is used for moderate to high pressures, to minimize the chances of leaks, a vertically split casing is used.
  - The casing is either cylindrical or bell shaped, depending upon the pressure rating.
  - Diaphragms halves are placed into split cylinder halves called Barrel.



VERTICALLY SPLIT CASING

Nomenclature

GE Nuovo Pignone Compressor TAG

(A)	(B)	(C)	(D)	(E)	(F)	(G)
2 – 3	M	C	L	45	7	A (200 bar-a)
D	B	C	L	30	6	B (350 bar-a)
	P	C	L	100	2	C (500 bar-a)
	S	R	L	60	3	D (700 bar-a)
						E (>700 bar-a)

A - Index "2" or "3" are referred to the number of inlet - "D" stands for double inlet with equal condition

B - TYPE OF CASING M = middle split B = barrel P = pipeline S = single volute

C - TYPE OF IMPELLER C = closed R = open (twisted blade)

D - DIAPHRAGM TYPE L = free vortex

E - SIZE OF IMPELLER (diameter in cm)

F - NUMBER OF IMPELLERS

G - CLASS OF CASING - TEST PRESSURE (for BCL only)

Compressor Rotor Assembly

- The main rotating components of a typical centrifugal compressor are described below:
  - **Rotor Shaft**
    - The shaft serves as the main element of the rotor, transmitting the torque from the driver to the impellers. The largest diameter is located in the middle of the shaft and supports the impellers and spacer pieces.
  - **Impeller**
    - The impellers add energy (velocity) to the gas.

Compressor Rotor Assembly

Impeller Types

- **Open Impellers**
  - These are used for large heads and small to large flow in single stage compressors only. The flow is least controlled.
- **Semi-enclosed Impellers**
  - These are used for large flow, usually in single stage compressors, or as the first stage in multistage compressors.
- **Enclosed impellers**
  - Multistage compressors usually have enclosed impellers. The flow of gas is best controlled in enclosed impellers. To prevent vibration the impeller is shrunk onto the shaft and prevented from turning on the shaft by a key and is well balanced.

Compressor Rotor Assembly

- **Thrust Collar**
  - The thrust collar transmits the rotor thrust to the thrust bearings and fixes the axial position of the rotor. It is hydraulically shrink fitted on the rotor shaft.
- **Balance Drum**
  - The centrifugal compressor rotor is subjected to an axial thrust during operation. The balance drum compensates for the majority of this thrust.
- **Spacers**
  - Spacers located between the impellers determine the axial position of each impeller. It also provides a sealing surface for the labyrinth seals located between impellers and also protects the shaft from seal rub and corrosion.

Diaphragms Assembly

- Multistage centrifugal compressor contains diaphragms located between impellers. Adjacent walls of the diaphragm form a passage called the diffuser that guides gas into the next impeller.
- Diaphragms are split horizontally and these halves are machined to fit into the casing.
- Grooves are machined on the faces of these diaphragm halves for elastomers so as to avoid inter stage leakage.

Guide Vanes

- The gas that leaves an impeller passes though the diffuser passage. In the return passage, guide vanes guide it into the next impeller.
- The inlet guide vanes can be adjustable. With adjustable guide vanes, the angle of gas flow into the eye of the impeller can be controlled. In this way capacity of compressor can be controlled.

Inter Stage Seals

Rotor shaft passes through the diaphragms. Since diaphragms and rotor are not attached to each other, the gas can flow from higher-pressure region to the lower pressure region through the space between shaft and diaphragms. Seals are used between the shaft and the diaphragms to prevent leakage. The most common type of seal used for this purpose is labyrinth seal.

Inter Stage Seals

- Labyrinth Seal
  - It is a set of metal rings or teeth that encircle the shaft but do not touch it. The rings or teeth are made of soft metal, and are sharp so that in case of accidental contact, less friction is generated and shaft is prevented from damage.
  - Labyrinth seals are available in the following configurations:
    - Plain Labyrinth Seal
    - Step Labyrinth Seal
    - Abradable Labyrinth Seal

Inter Stage Seals

- **Labyrinth Working Principle**

  The spacers between the teeth form labyrinth passage. As the gas enters the space between teeth, eddies are formed. It slows the gas velocity and changes direction. The resulting turbulence resists the flow of gas.

Inter Stage Seals

- Characteristics
  - Labyrinth Seal does not prevent all leakage. If the gas velocity is high, some of the gas does not change direction in the seal but skips between the teeth and the shaft in straight line. Where gas is flowing at high velocity interlocking labyrinth seal is used. i.e. Labyrinth Seal interlocks with shaft teeth.
  - These seals are used in areas where it is acceptable to allow leakage. Labyrinth seals are therefore widely used as inter stage seals because the pressure difference between stages is normally low enough for labyrinth seal to be effective.

Shaft End Seals

Shaft End Seals serve the following three purposes:

- Increase compressor efficiency
- Prevent process gas contamination
- Avoid contact between the process gas and the lube oil

Shaft End Seals

- Labyrinth Seal
  - Labyrinth seal may also be used as shaft end seals. These seals are used when no leakage of poisonous or explosives gases to the atmosphere is allowed.
  - The space between the seals can be injected with a buffer gas at a pressure higher than the process gas pressure. This solution is used when no leakage of a potentially poisonous or explosive gas to the atmosphere is allowed

Shaft End Seals

- Oil Seal
  - Oil seals consist of steel rings with babbitted bores, like bearing. They are free to move radially as the shaft moves. They have lapped surfaces on their mating faces.
  - Seal oil is injected between the one inner ring on the compressor side and the outer rings at a pressure slightly higher than that of the gas pressure. Some of the oil flow inside the casing, which is drained away as contaminated seal oil or sour oil.

Shaft End Seals

- **Mechanical Seal**
  - Mechanical seal is a positive type of seal and is used in flammable and toxic services. A conventional Mechanical Seal is consists of following parts:
  - Carbon Ring
  - Rotating Seal Ring (Seat)
  - Stationary Sleeve
  - Springs and Spring Retainer

Oil is injected into the seal to keep the two faces apart during operation. This oil gets contaminated with the process gas and therefore drained away as ‘contaminated oil’

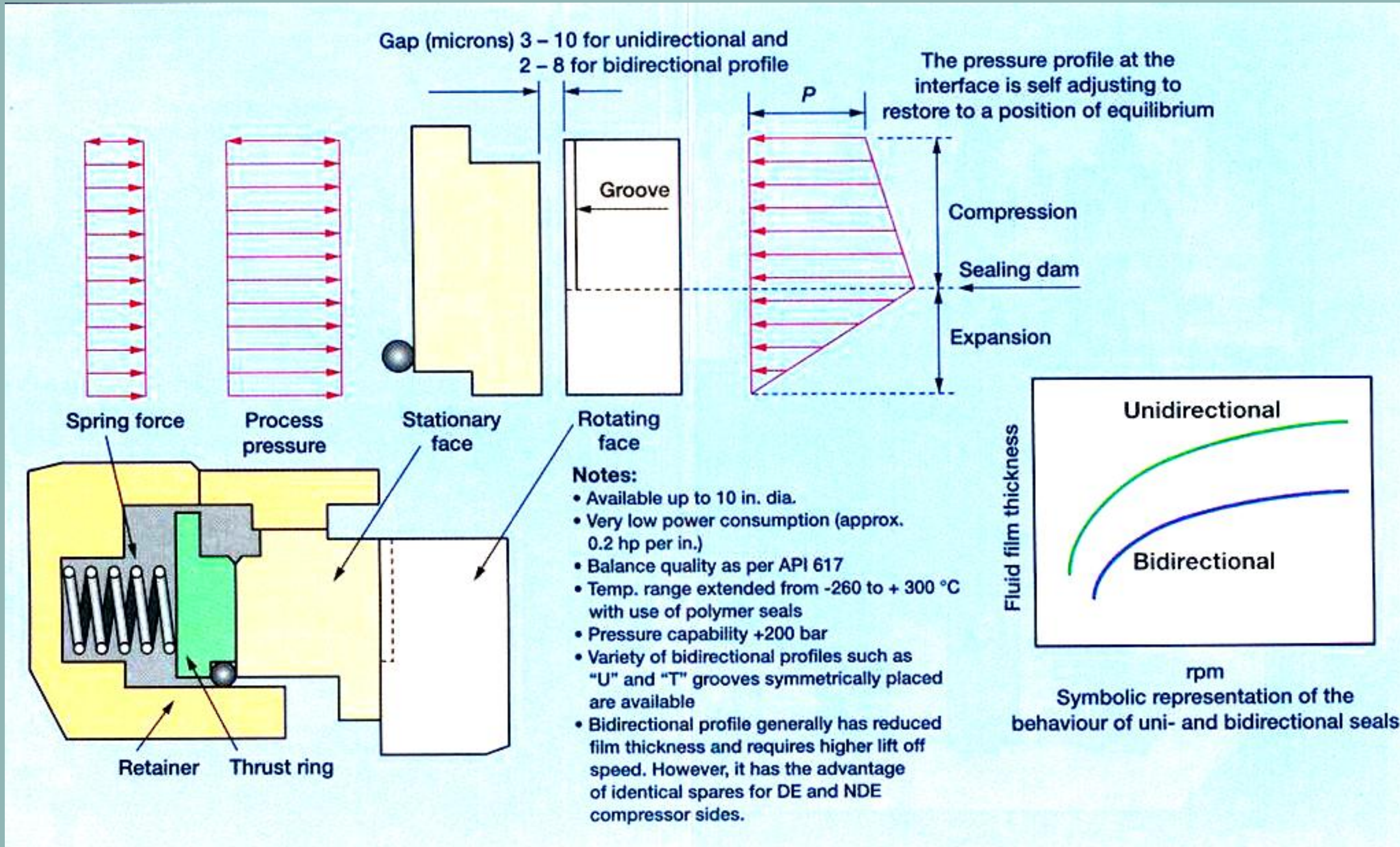
Shaft End Seals

- Dry Gas Seal
  - Main parts of Dry Gas Seal are same as that of normal Mechanical Seal. However, rotating seat is manufactured from tungsten carbide or silicon carbide and it is profiled with a series of spiral grooves. Depth of grooves ranges between 0.0025 to 0.01 mm
  - When the compressor is pressurized, sealing dam seals the gas. When compressor is running, gas enters the spiral grooves and its pressure increases as it travels in. This increases in pressure forces the two faces apart approx. by 3 microns, and maintains this operating clearance.

Shaft End Seals

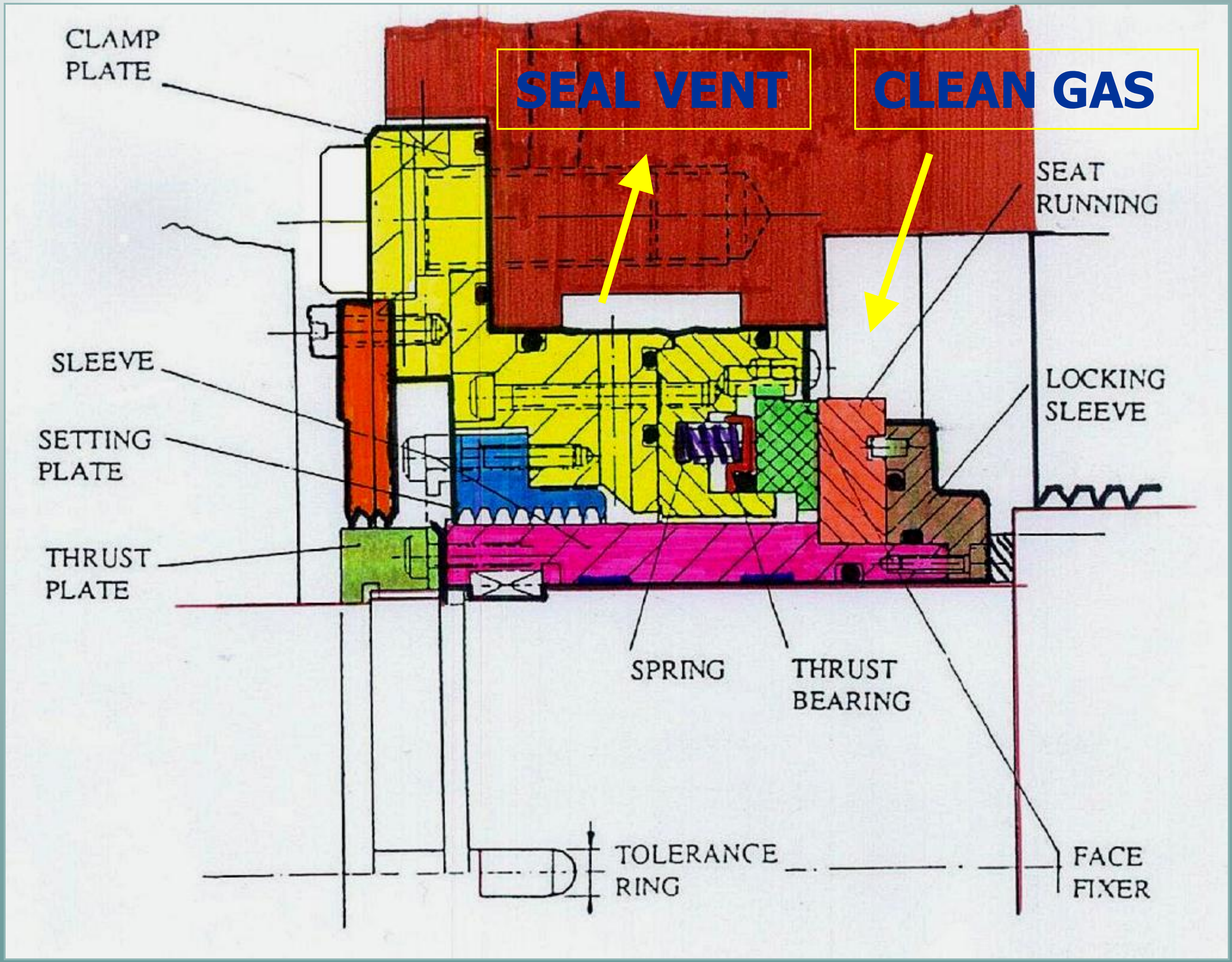
- Dry Gas Seal eliminated many problems, which the operators were experiencing with oil seals. Major advantage is a reduction in contamination of the process gas that commonly occurs with the use of seal oil.
- Consequently, there is an increased efficiency and a cost reduction in compressor usage.
- Dry Gas Seals are available as Single, Tandem and Triple Dry Gas Seal units according to the number of seal rings.
- The single Dry Gas Seal is used mainly for carbon dioxide or non toxic applications.

DGS Working Principle



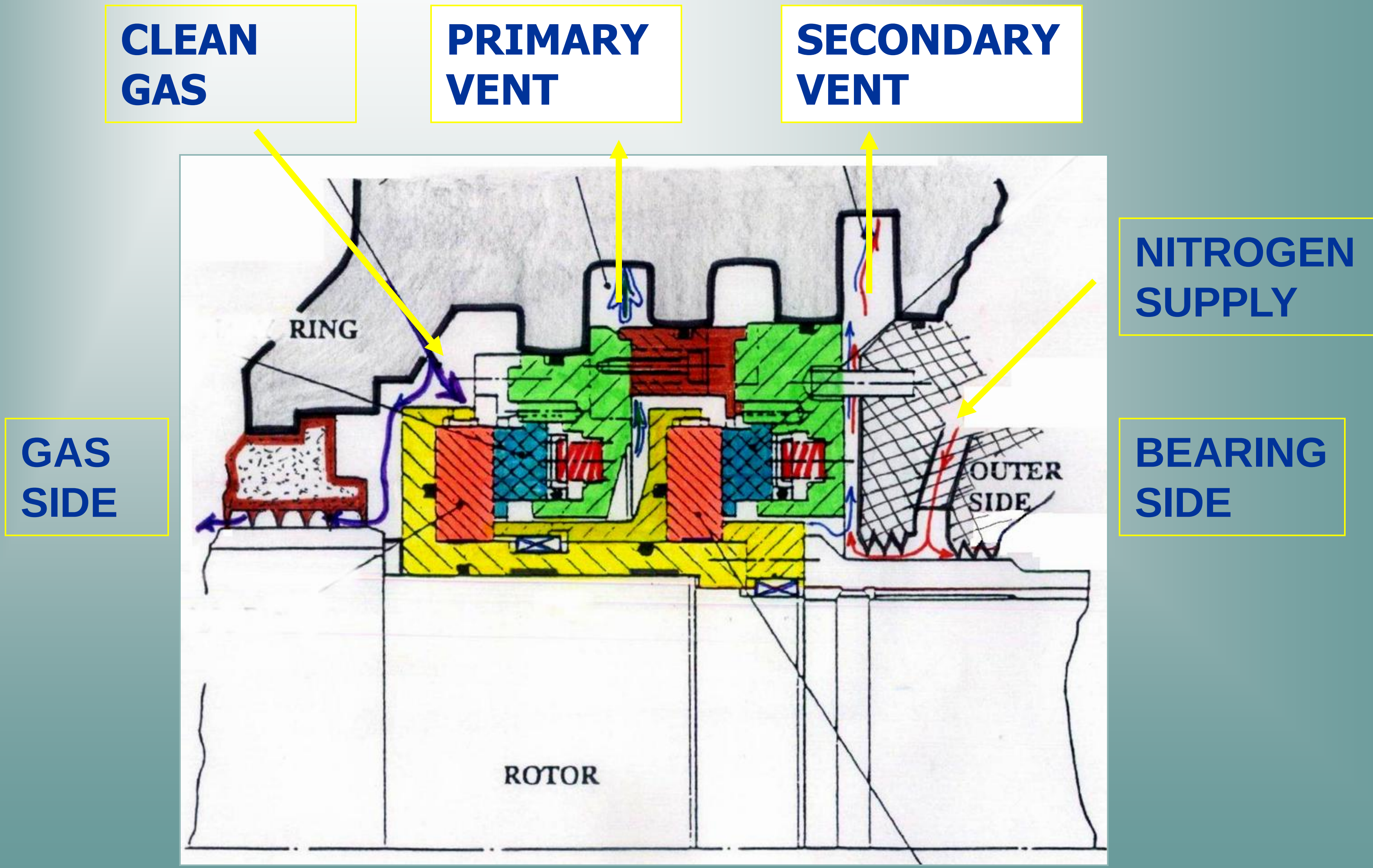
DGS Installed in CO2 Comp.

BEARING SIDE

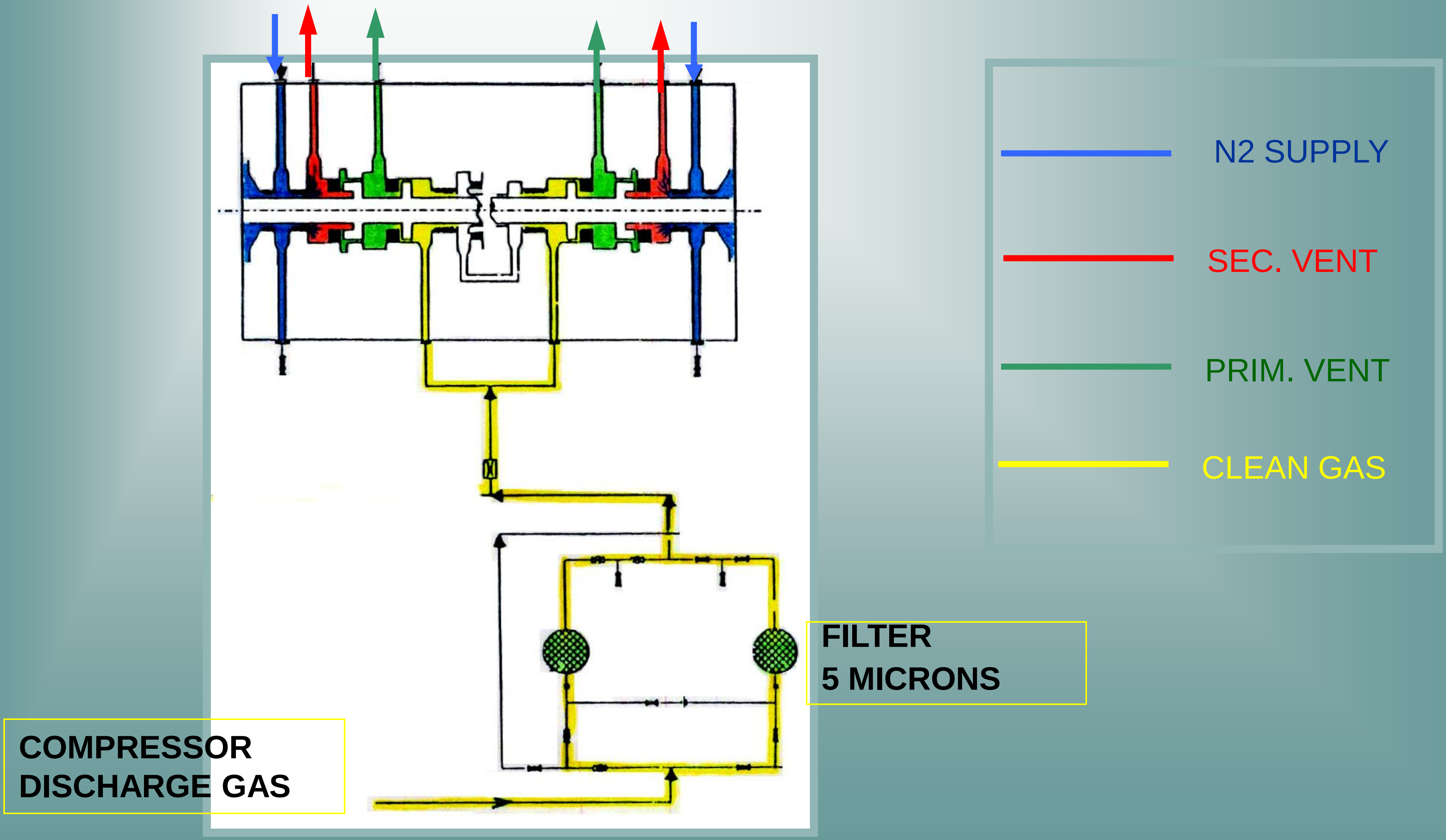


GAS SIDE

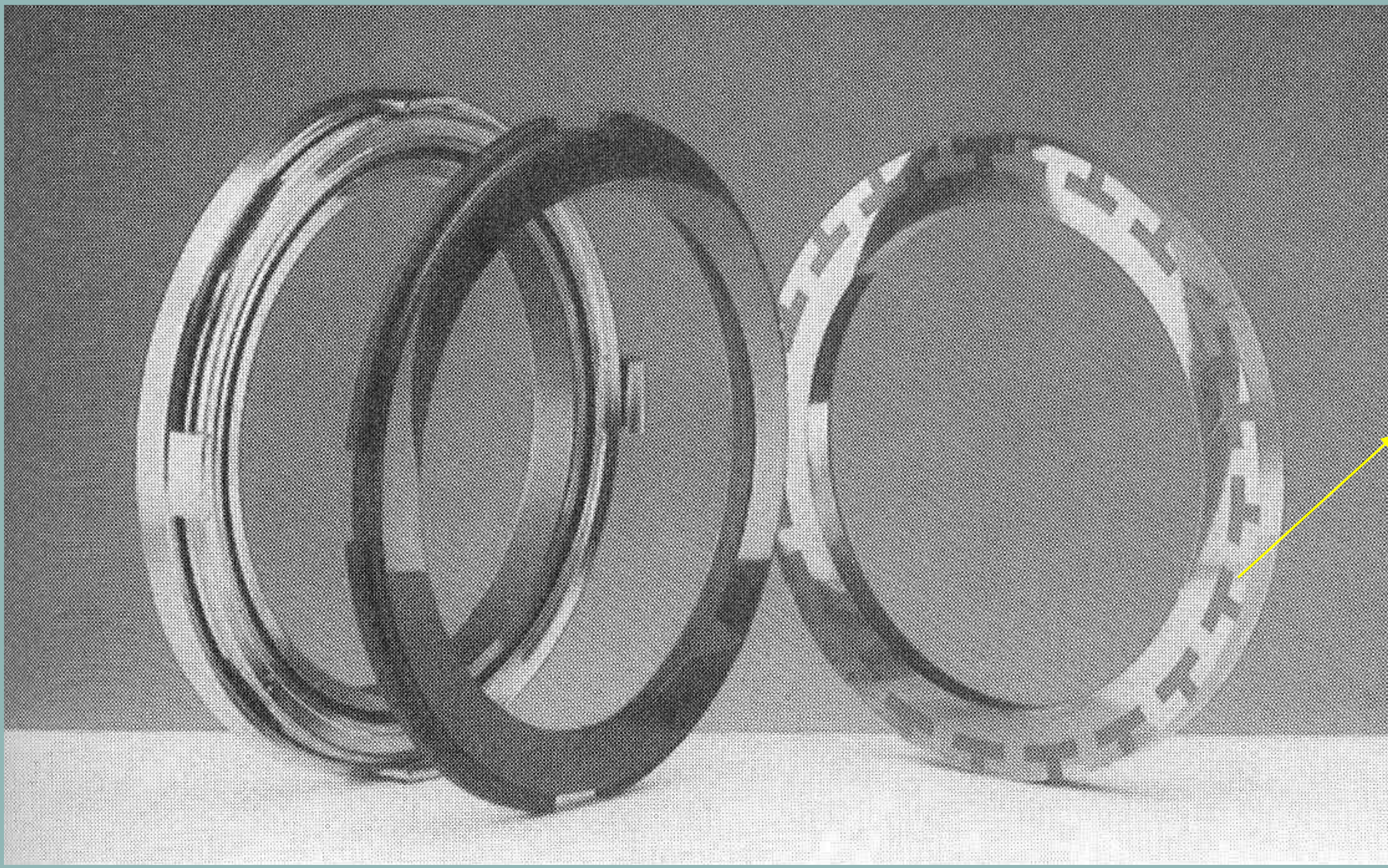
DGS Installed in Syn. Gas Comp.



DGS Sealing System (Syn Comp)



Bidirectional DGS



Bidirectional T - Grooves

DGS Common Problems

- Injection Gas Contamination
- Failure of Elastomers
- Chemical Incompatibility

Compressor Bearings

Centrifugal Compressors are equipped with journal and thrust bearings.

- Journal Bearing
  - The Rotor is supported at each end by Journal Bearings. Journal Bearings are hydrodynamic bearings with tilting pads. Each pad develops an oil pressure wedge that support the weight of the rotor.
  - A tilting pad is a steel block with a pivot button on its back that allow the pad to tilt within the bearing seat. The bearing pad’s surface is coated with a thin layer of white babbit metal (alloy of Lead & Tin).

Compressor Bearings

- Recently bearing manufacturers have developed a new design of bearing pad. This new bearing pad has flexure pivot tilt instead of rocking pivot tilt. The one-piece construction of this particular tilt pad bearing eliminates the multi-piece construction and thus reduces the manufacturing tolerances.
- A thermocouple is embedded into the selected pad to measure the bearing’s pad metal temperature.
- Journal Bearings are also available in sleeve type construction

Compressor Bearings

- **Thrust Bearing**
  - One of the most critical components of a centrifugal compressor is the thrust bearing. Axial thrust is generated in a centrifugal compressor by the pressure rise through the impellers.
  - Major portion of the axial thrust is countered by either a balancing drum or by placing impellers in a back-to-back arrangement. In either case, the small residual load is carried by the thrust bearing.
  - Thrust bearing must also be designed to withstand the thrust reversals that may occur during normal operating conditions.

Couplings

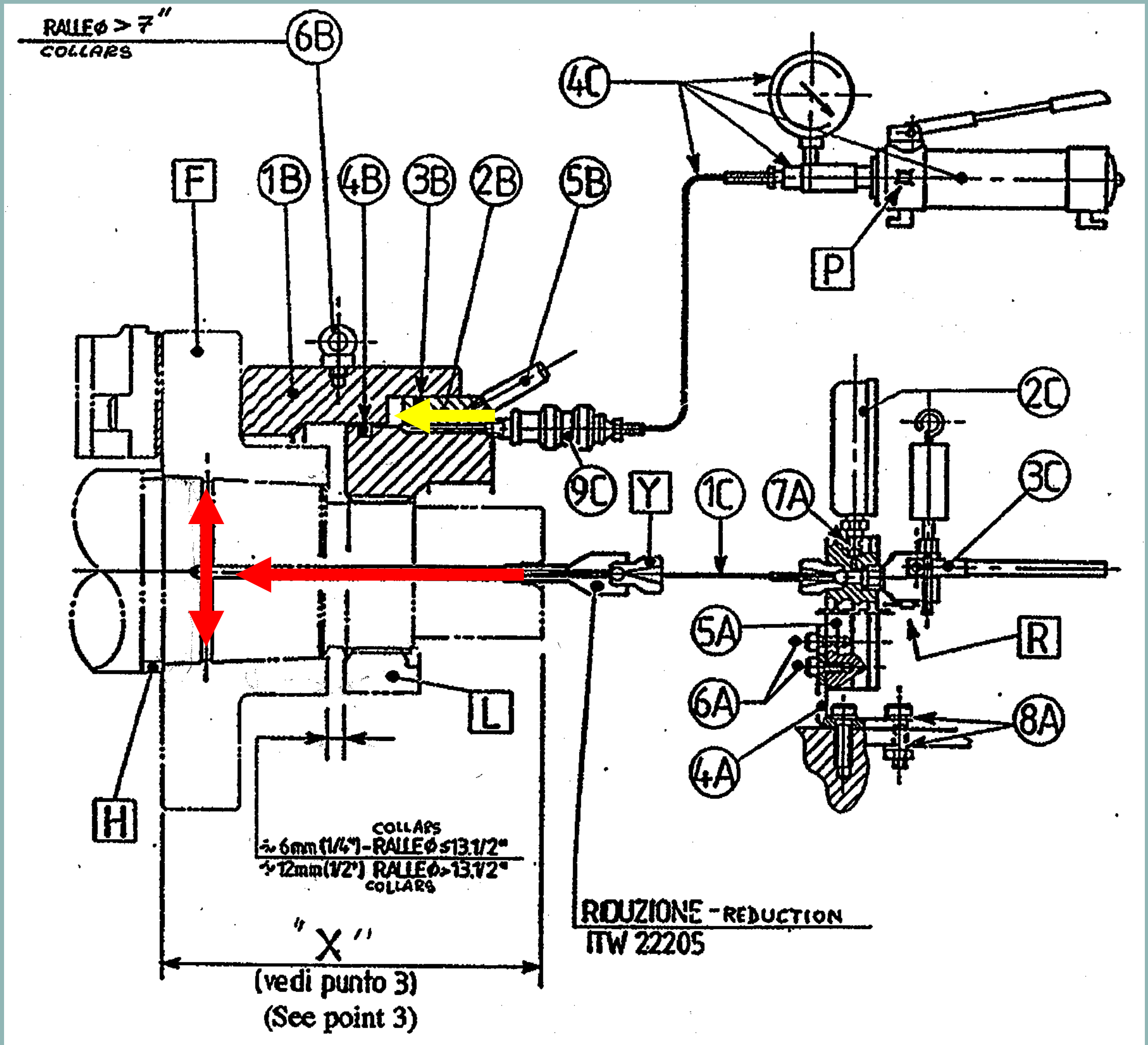
Couplings are the connecting elements between the compressor and its prime mover or between compressor’s different stages.

- Construction
  - In a particular flexible Shim Pack Coupling, there are two hubs, one installed to each shaft end, a spacer and the flexible elements located between the spacer and hubs.
  - Previously ‘Keyed Hubs’ were designed but now hubs are mostly hydraulically shrink fitted on the tapered shaft end.

Couplings

- Coupling Functions
  - Efficient transmission of mechanical power from one shaft to the other.
  - To compensate all types of misalignment without inducing abnormal stresses and load on connected equipment and without significant loss of power.
  - To compensate the axial movement of the coupled shafts, preventing either shaft from exerting excessive thrust on the other.

Hub /Coller Mounting Tools



Oil responsible for expanding the hub

Oil responsible for pushing the hub

Compressor Instrumentation

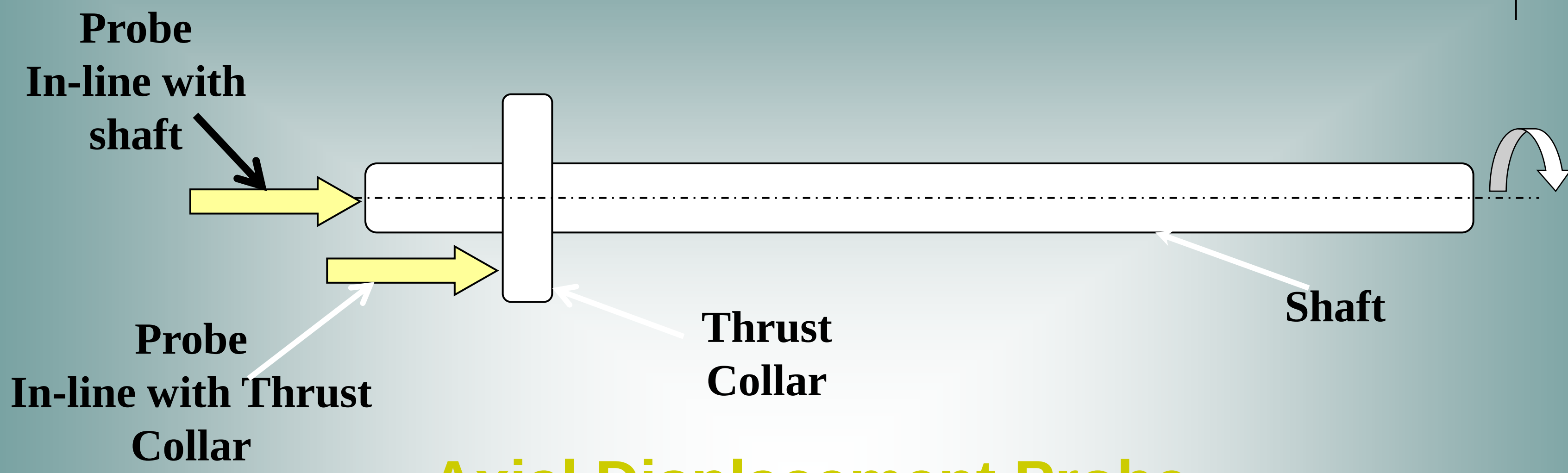
The instrumentation installed on centrifugal compressors is essential for checking their performance and activate a protection system if necessary. Compressor manufacturers employ a variety of instruments for monitoring rotor radial vibration, axial displacement of the rotor and bearing temperature.

Compressor Instrumentation

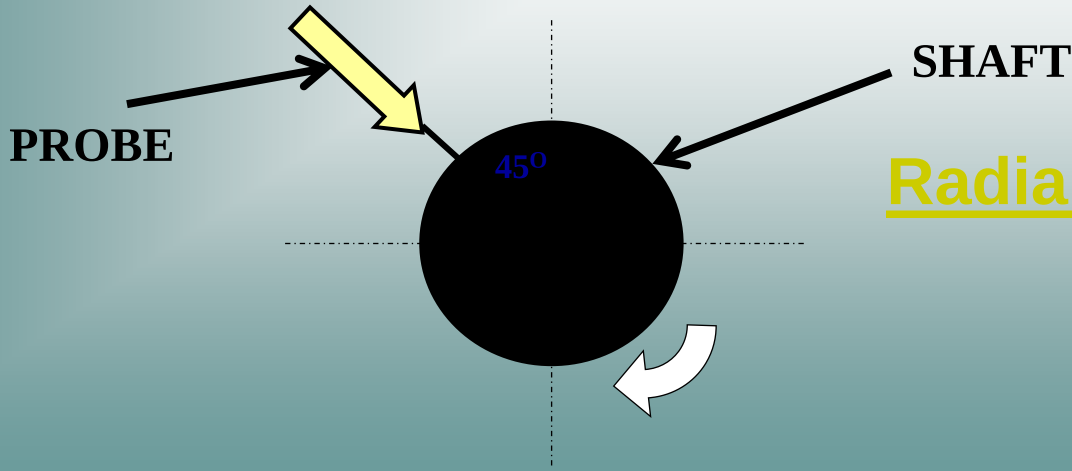
- Vibration Probes
  - Proximity probes are used to detect both radial vibrations and axial displacement of the rotor. These probes should be firmly secured to the compressor casing and should be positioned close to the shaft for accurate readings.
- Thermo elements

  Journal bearings and thrust bearing temperatures can be obtained by the following two way:
  - By inserting a thermo element in one or more pads close to the bearing white metal.
  - By immersing a thermo element in the compressor oil discharge pipe.

Probe Position

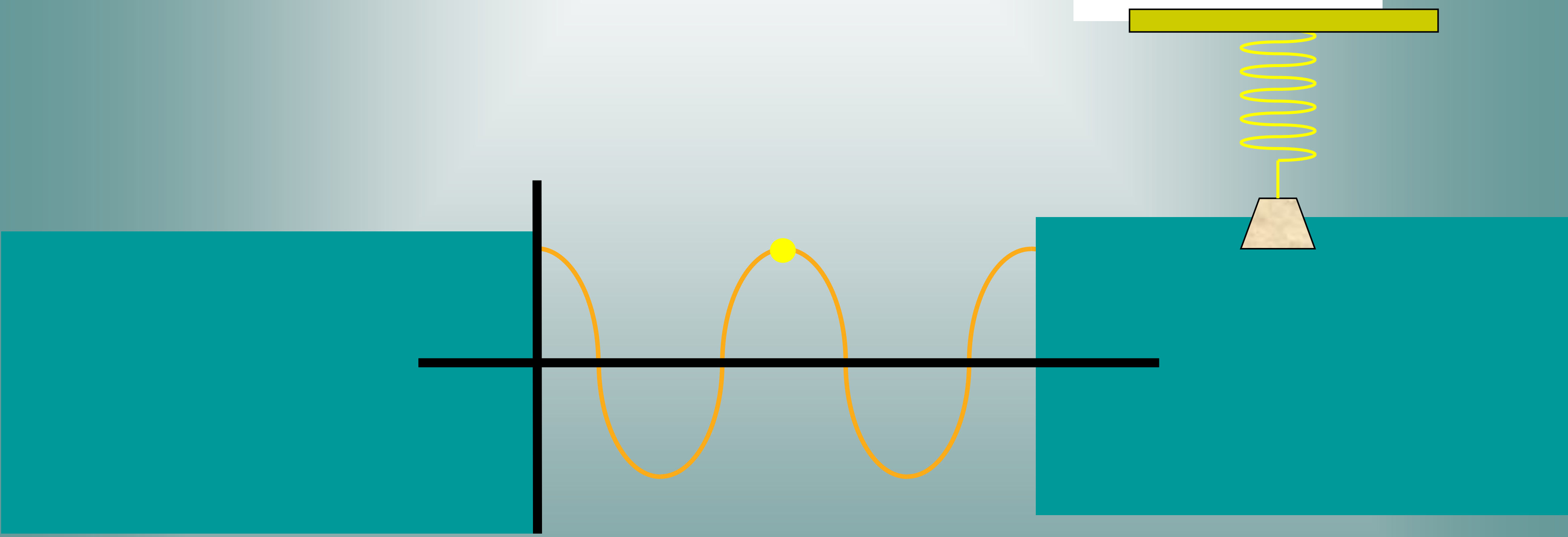


Axial Displacement Probe

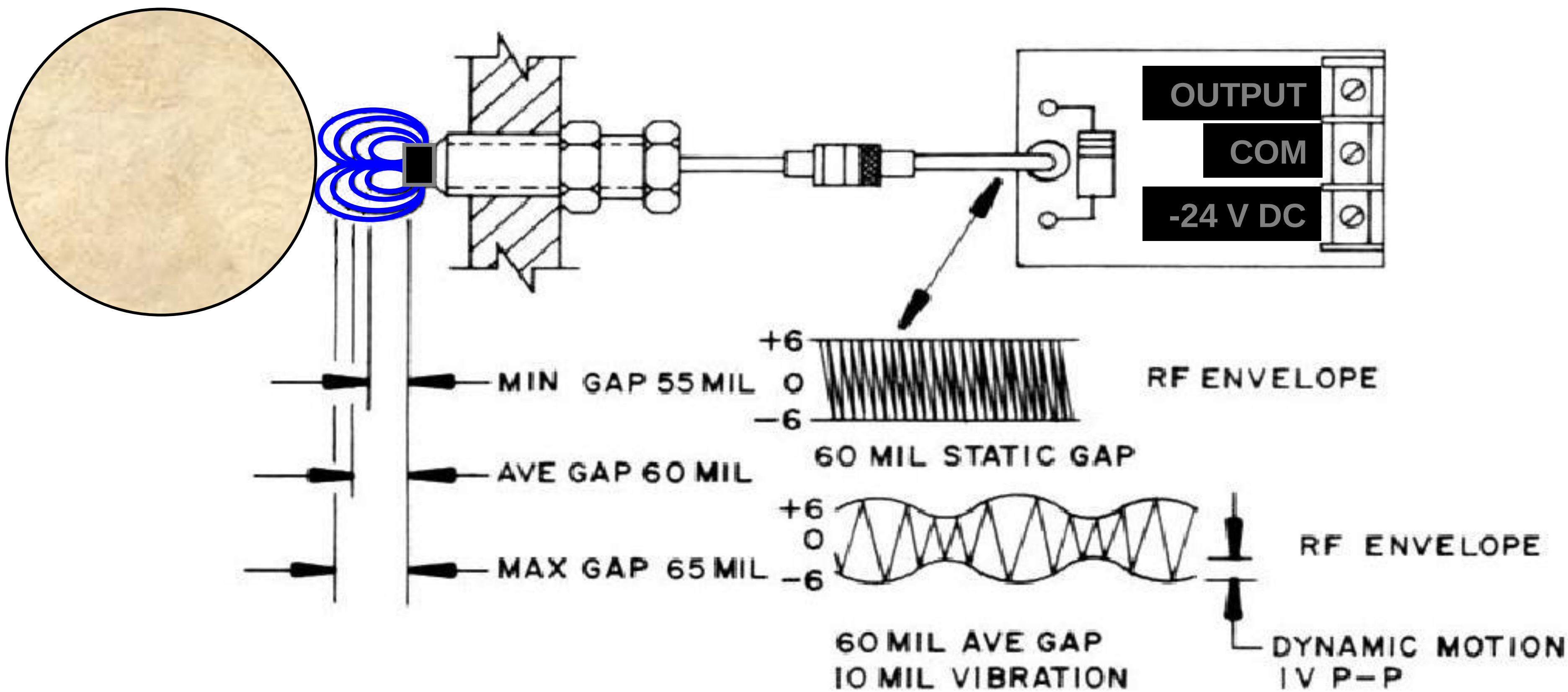


Radial Vibration Probe

SPRING MASS SYSTEM

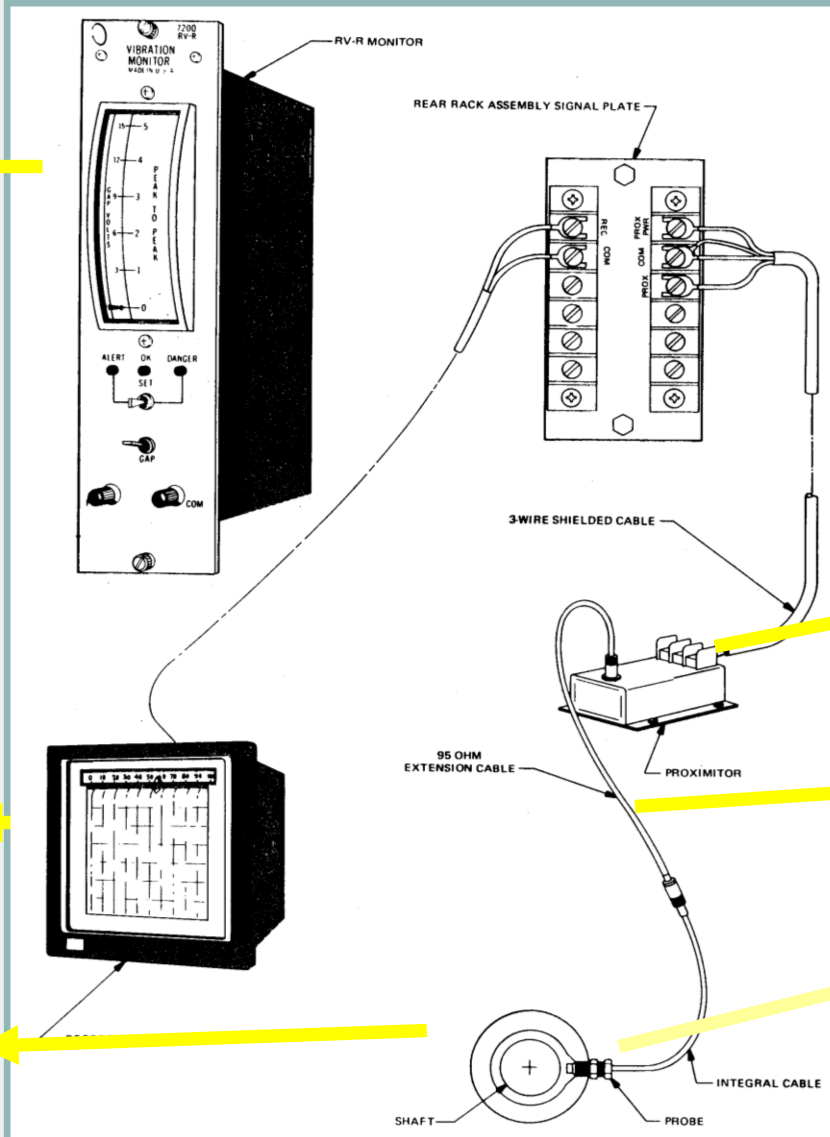


Sensing Signal



Vibration Monitoring System

Display



Trend Recorder

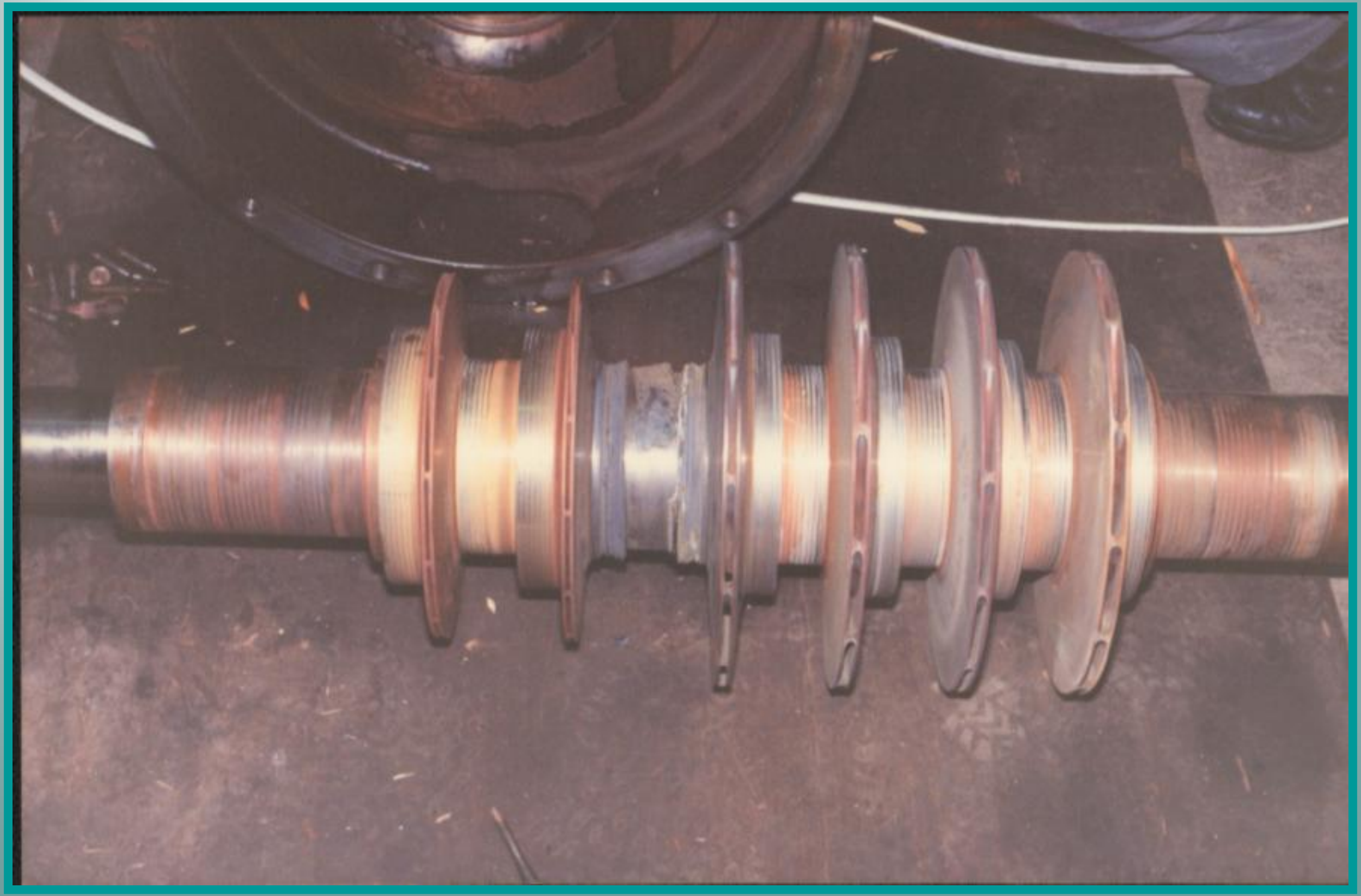
Rotor

Oscillator Modulator (Driver)

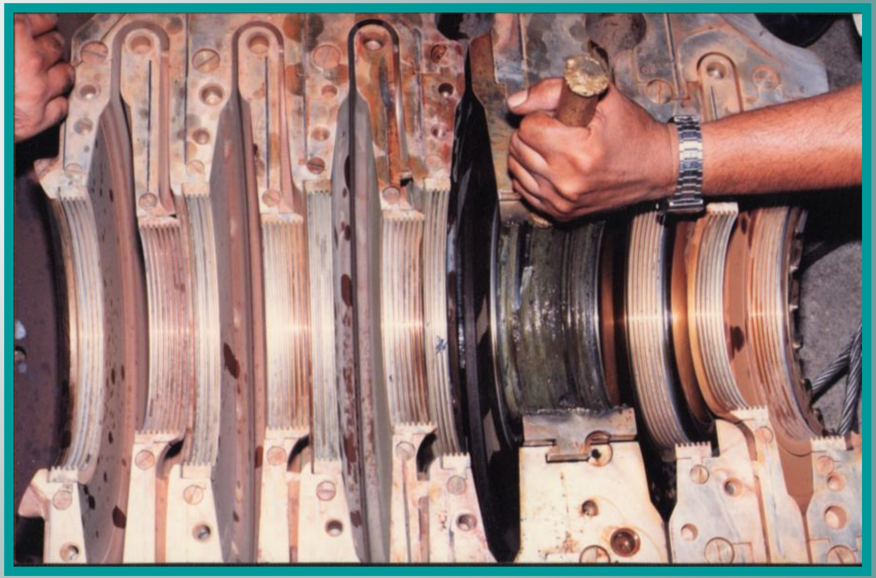
Extension Cable

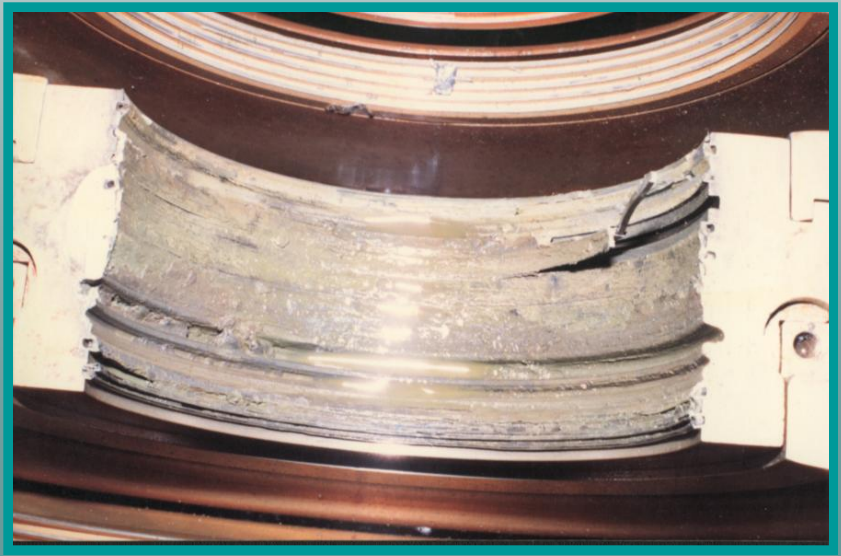
Proximity Probe / Eddy Current Probe

Rotor Damage



Diaphragm / Seals Damage





Compressor Instrumentation

- Antisurge Sysytem
  - The purpose of the antisurge control system is to keep the operating point, at each respective speed, from surpassing the surge limit line. At the same time, the antisurge control system allows the compressor to maintain a safe working range.
  - The control system accomplishes this task by opening the antisurge valve at the appropriate moment. If this system is not used, instability can occur, which can potentially damage the compressor.

Compressor Lubrication System

- Lube oil is used to create lift by forming a film of oil between the shaft and bearings and to cool the bearings.
- Maintaining correct oil viscosity is very important. Good oil viscosity works to maintain the correct operating characteristics of bearings, improves rotor dynamics behavior and reduces compressor vibrations.
- The same trouble may occur if the oil flow to the bearings is insufficient or if dirt is present in the oil.

Compressor Lubrication System

- Lubrication circuit consists of the following components:
  - Oil Tank
  - Oil Pumps
  - Oil Filters
  - Oil Coolers
  - Pressure Control Valve (PCV)

Maintenance Concept

- Troubleshooting
  - Correct installation of centrifugal compressor units and a maintained inspection schedule enhance machine operation, minimizes the risk of shutdowns and emergencies. However, when problems arise, it is extremely important to identify the possible causes and accordingly to take appropriate remedies.

Maintenance Philosophy

The maintenance philosophy may be divided into the following three types:

- Major Maintenance
  - Major maintenance refers to accessing the internal parts of the compressor, such as the rotor, diaphragm bundle and internal labyrinth seals.
- Minor Maintenance
  - Minor maintenance refers to accessing such area as the journal and thrust bearings and the shaft end seals.

Maintenance Philosophy

- Preventive Maintenance
  - Preventive maintenance consists of precautionary actions that occur at prescribed inspection intervals and routine check periods. These inspections are conducted to prevent possible equipment breakdown or failure during operation.
  - Depending upon the specific compressor component, preventive maintenance inspections and actions vary in regard to their prescribed performance intervals.
  - Consult compressor’s maintenance manuals for specific preventive maintenance actions and their intervals.

Compressor Maintenance

- Abnormal Noise and Vibrations
  - Probable causes may be misalignment, coupling failure, unbalanced rotor, worn out or loose bearings
- Journal Bearing Failure
  - Journal bearing failure can be attributed to improper lubrication, incorrect bearing clearance, presence of any crush

Compressor Maintenance

- Thrust Bearing Failure
  - Consider excessive thrust or improper lubrication as potential causes of failure of the thrust bearing.
  - Bearing failure can also be happened due to faulty bearing fitting and axial probe setting.

Compressor Maintenance

- Seal Failure
  - Excessive machine vibrations can contribute to oil seal ring failure. Insufficient oil supply can also damage the oil seals.
  - In case of dry gas seal, incorrect seal assembly, excessive vibrations and dirty gas can cause severe damage to the seal.

Alignment

Bringing the rotating members of driver and driven machine in line / desired line is referred as Alignment

- Radial alignment
  - Radial Vertical Alignment
  - Radial Horizontal Alignment
- Axial Alignment
  - Axial Vertical Alignment
  - Axial Horizontal Alignment

Important Tips for Alignment

- Always carry out the alignment job in the early part of the day. This will help in precluding the error, which can occur due to sunlight.
- Shims should be kink free. Also try to keep the number of shims as less as possible.
- Before alignment, always ensure that there is no “soft footing” in the machine. If it exists, remove it prior to align.
- Before decoupling the machine, always take alignment reading. It serves as a reference reading, as some time it becomes difficult to get the desired readings.

Important Tips for Alignment

- Connected piping / supports have a tendency to induce stresses in the machines during operation if they are not properly designed. If machine gets misaligned during operation, review the connected piping and supports.
- Do not expect symmetrical thermal growth in unsymmetrical machines.
- If the machine to be aligned has six feet, it should be aligned by Graphical Method.

Maintenance & Safety Tips

- Arrange all tools necessary for service in a container near the machine.
- Use the set of special tools supplied by manufacturer.
- Isolate the compressor from the process gas.
- Isolate electrically the equipment.
- Make sure that the driver cannot be started.
- During assembly, fully comply with assembly drawings. Follow bolt torque sequence and torque values given in the instruction manual.

Maintenance & Safety Tips

- Lift, by some millimeters, the upper half – casing by means of lifting screws only.
- Rest the rotor on wooden V-notch stand. Cover the V-notch with soft gasket material.
- Clean the rotor with proper thinner/kerosene oil in a ventilated place.
- Do not remove diaphragms unless found damaged.
- Do not remove any part of the rotor except for the thrust collar.

Maintenance & Safety Tips

- Do not use a chisel to remove gaskets attached to the surface. Carefully slide a blade between gasket and surface. Damaging to the compressor-sealing surface can be avoided in this way.
- If the bearings are found damaged, perform thorough cleaning to avoid further damage due to contamination of oil by metallic particles.
- Use soft hammer during replacement of labyrinth seal. Do not force it, it is advisable to remove and adjust.

Maintenance & Safety Tips

- Do not attempt to expand the hub without some restraint for the hub.
- Avoid injury from high pressure oil leaks by wearing heavy gloves and a face shield.
- When the rotor is supported by the internal labyrinths, it must not be moved or the labyrinth will be damaged.
- Take care not to damage the bearings thermocouple leads and the cables of proximity probes.

Maintenance & Safety Tips

- Cover up all the pipe openings, when bearing casing halves are dismantled during major or minor machine maintenance.
- When hoisting system are used, ensure that they are perfect. Best practice is to check all these equipment before the commencement of any major maintenance.
- Copper based anti-seize compounds can cause corrosion failures and should never be used.
- While lifting the bearing casing upper covers, take care not to damage the flat faces.

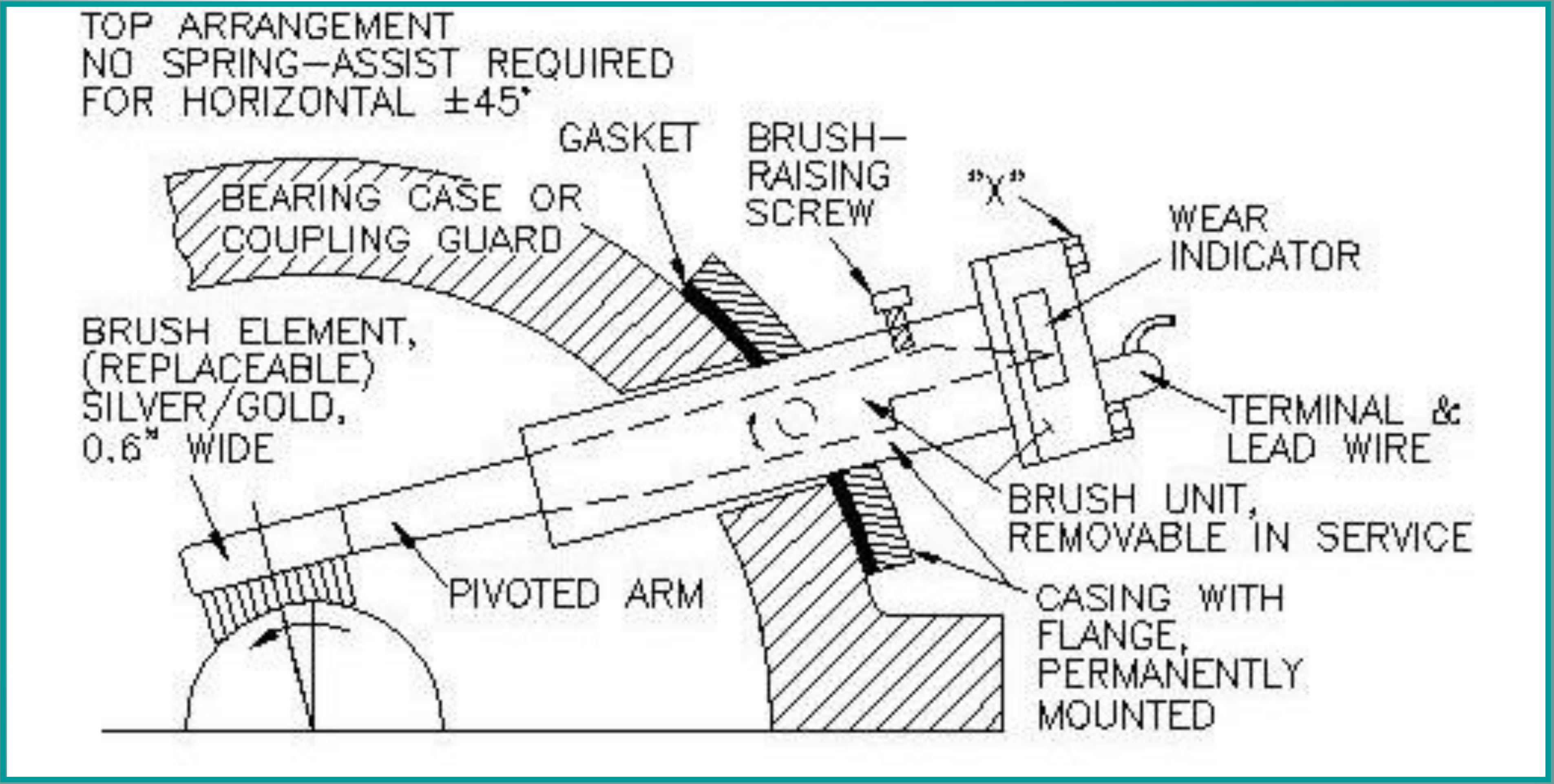
Maintenance & Safety Tips

- During assembling, apply equal amount of liquid sealant on the flat faces.
- During assembling of horizontal split casing, follow the studs tightening sequence from center to extreme sides.
- While adjusting the rotor float, always keep the shim behind the active side thrust bearing. Ensure the installed shim should be kink free.
- Always use appropriate design bridge to hold the rotor, when complete bearing block is required to be removed.

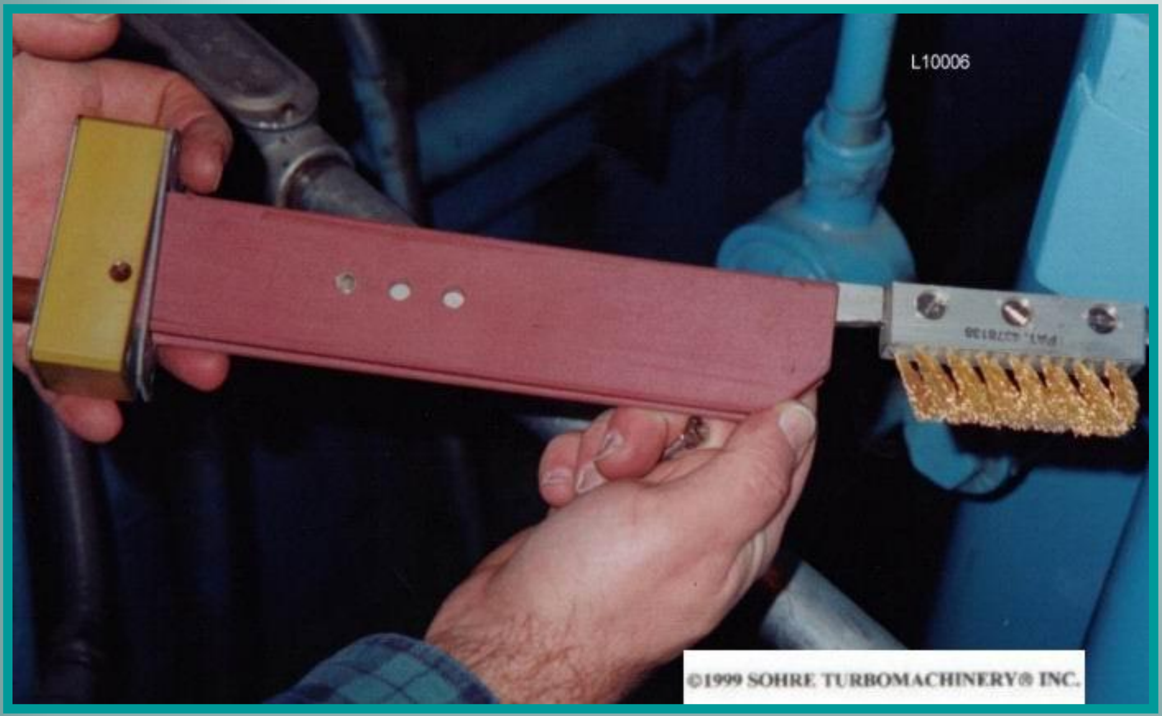
Maintenance & Safety Tips

- Always keep the seal oil run down tanks in a good condition.
- Flush the lube oil circuit thoroughly if any maintenance job is done. Best practice is to replace all the cartridge filters.

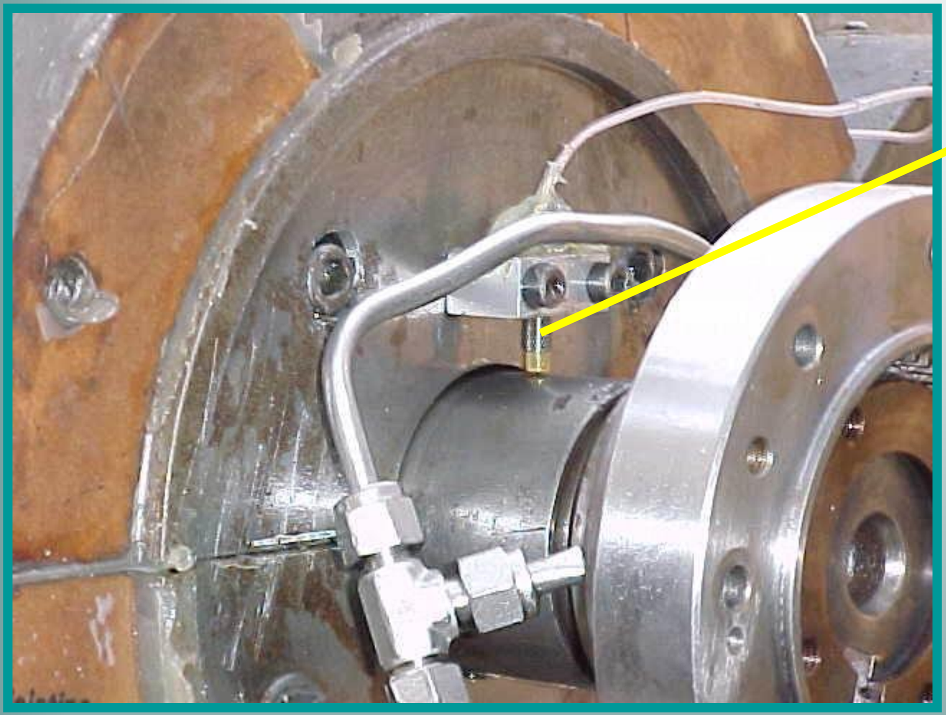
Anti Static Brush



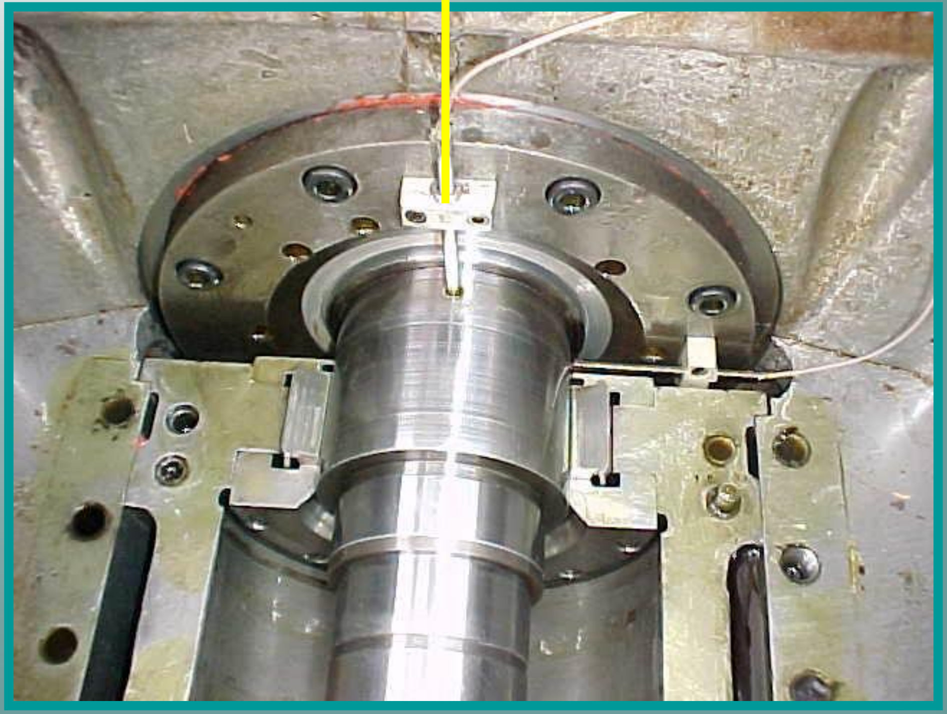
Anti Static Brush



Anti Static Brush



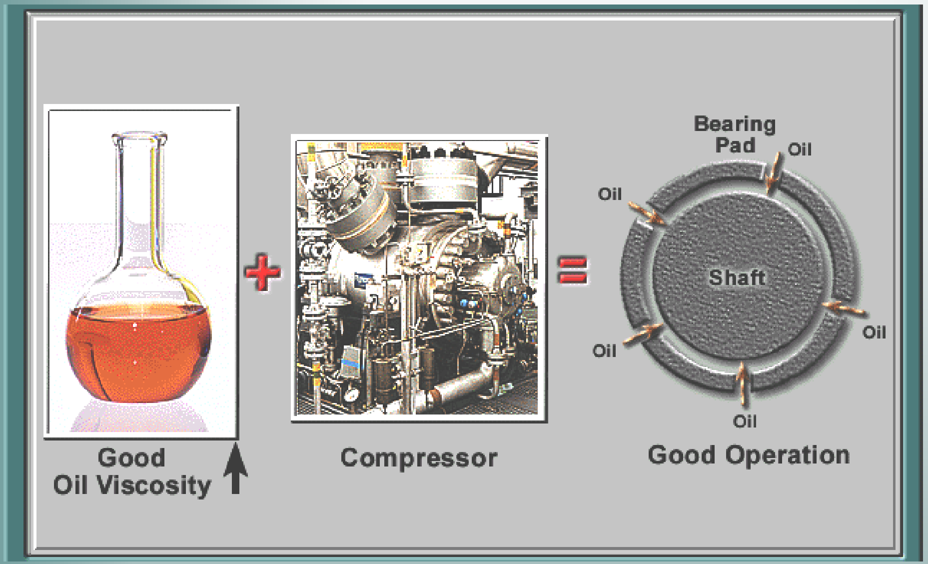
Anti Static Brush

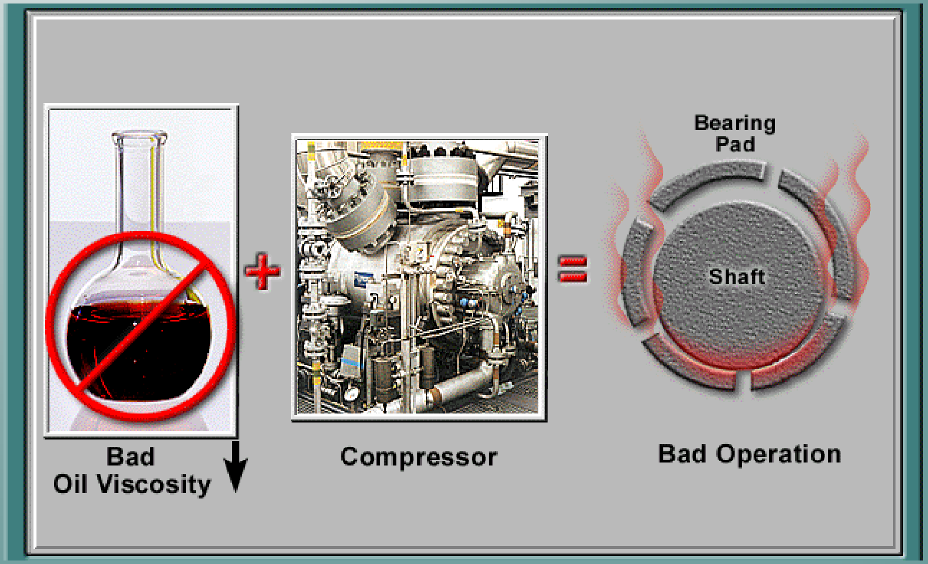


Centrifugal Compressor

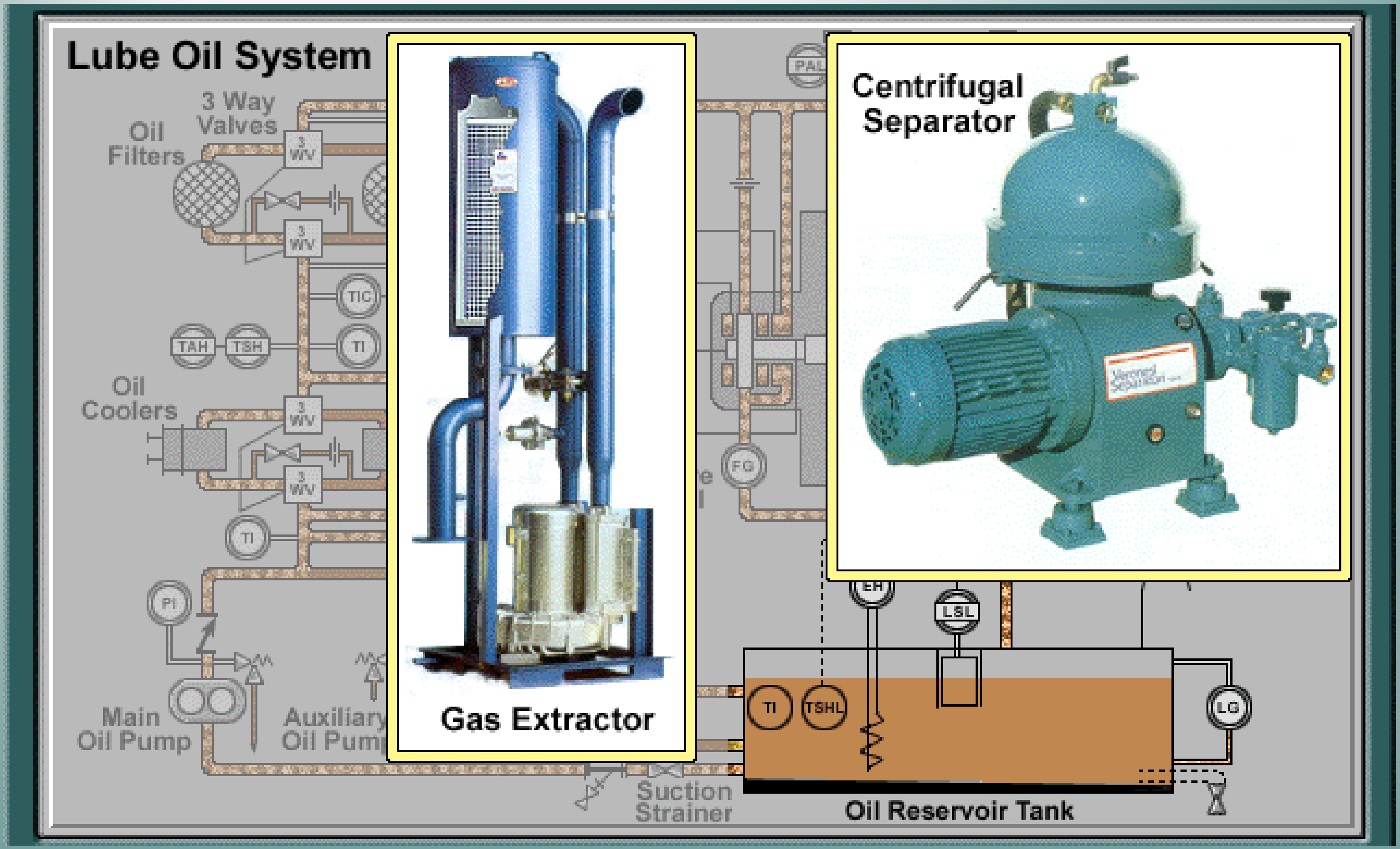
End Show

Bearings Lubrication

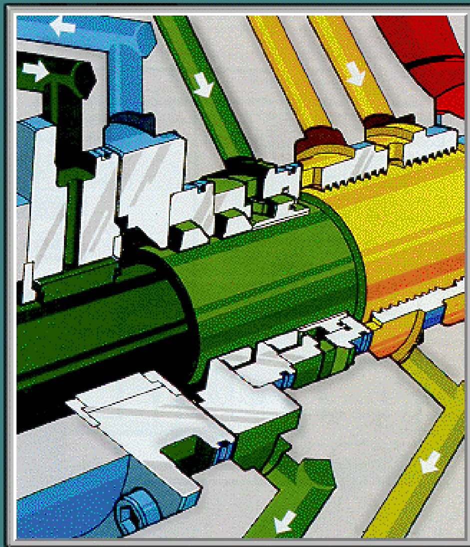




Bearings Lubrication



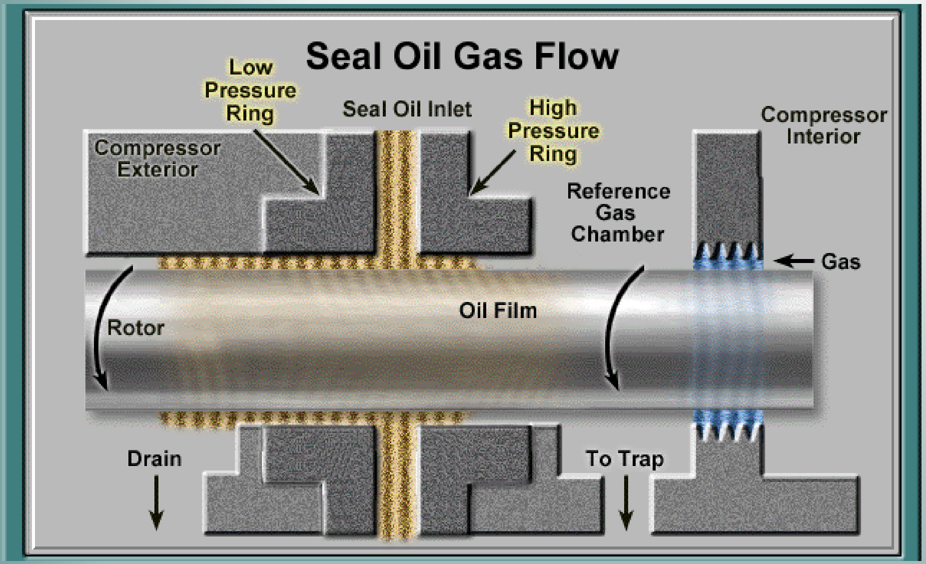
Shaft End Seal

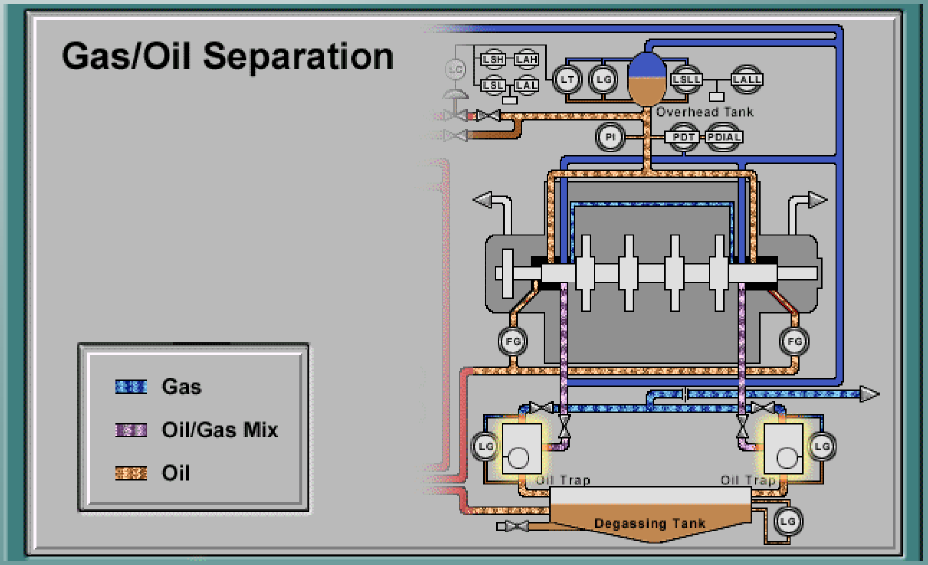


Shaft End Seal System

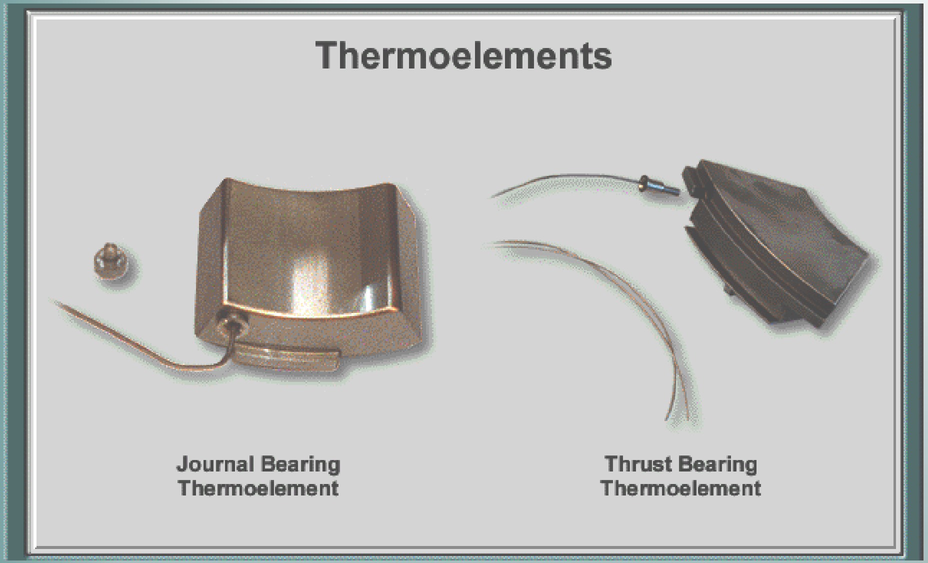
- Avoid leakage of process gas
- Increase compressor efficiency
- Prevent process gas contamination
- Avoid contact between process gas and lube oil

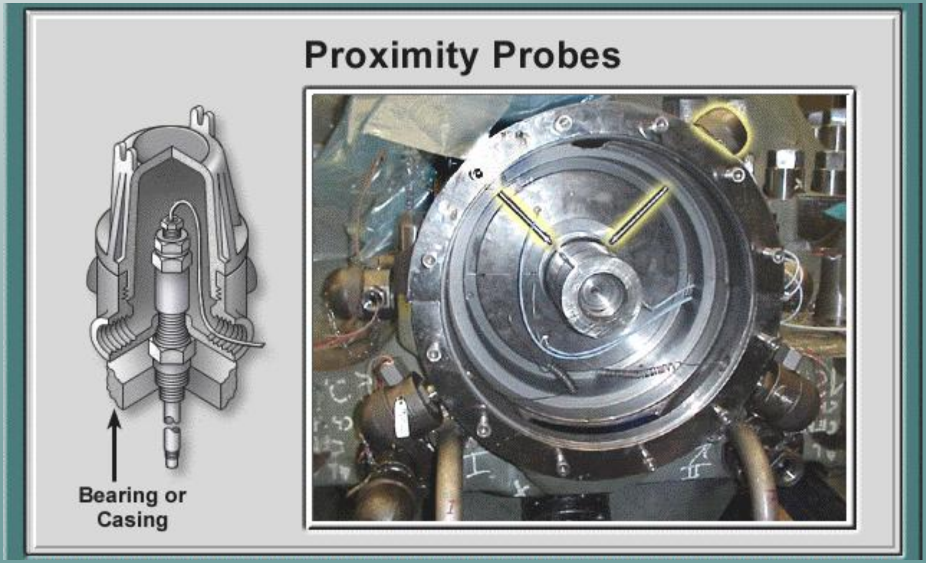
Shaft End Seal



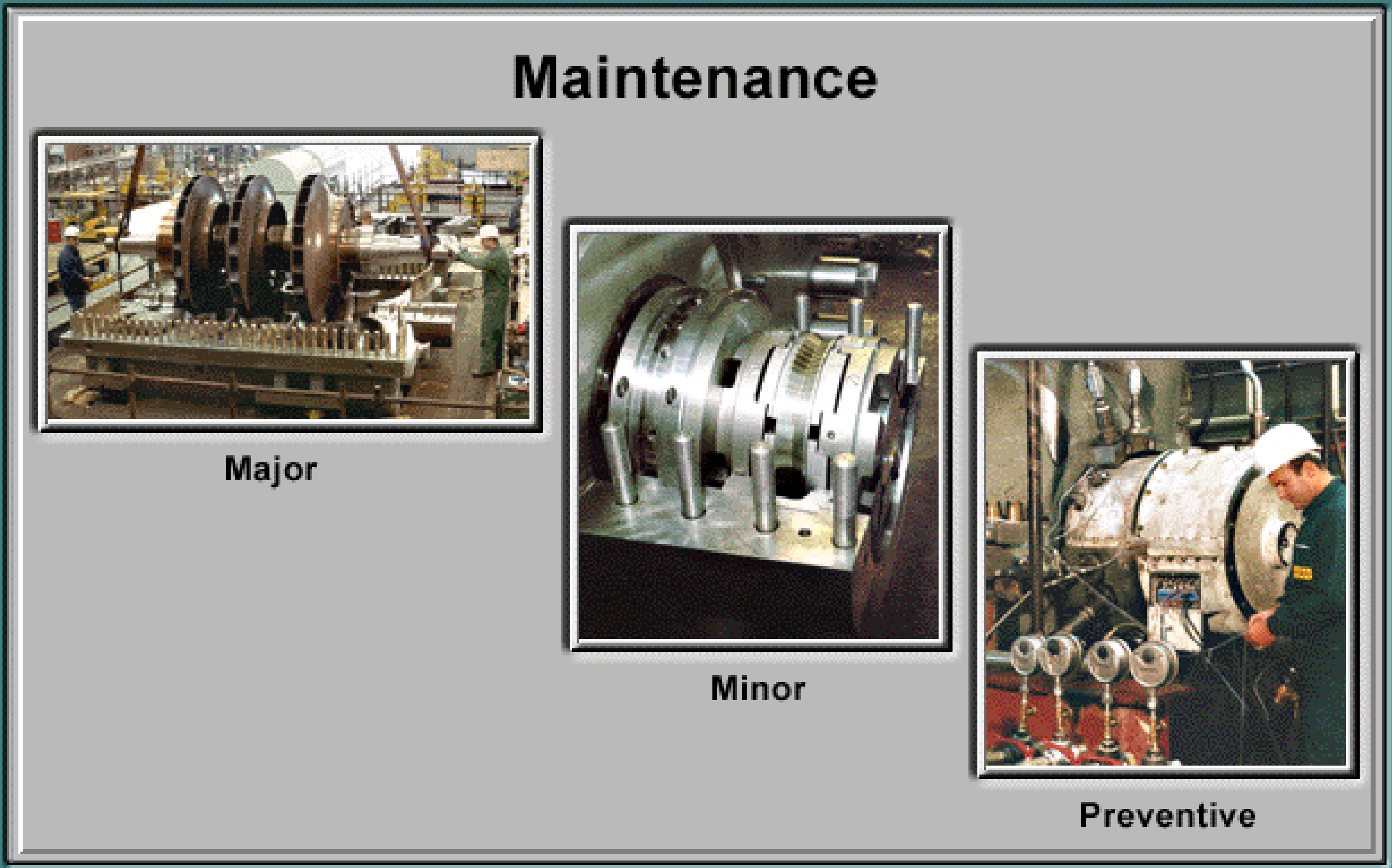


Proximity Probes (Radial)



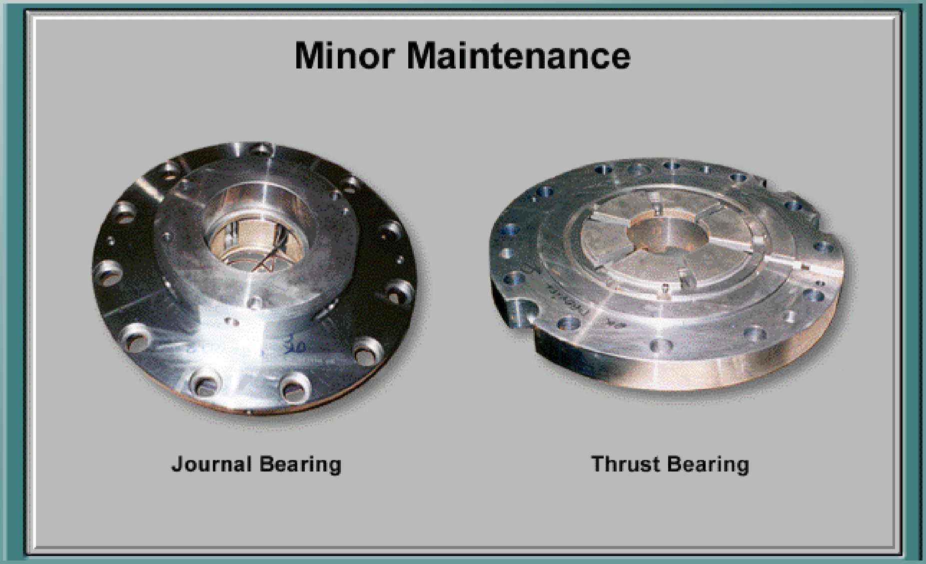


Compressor Maintenance

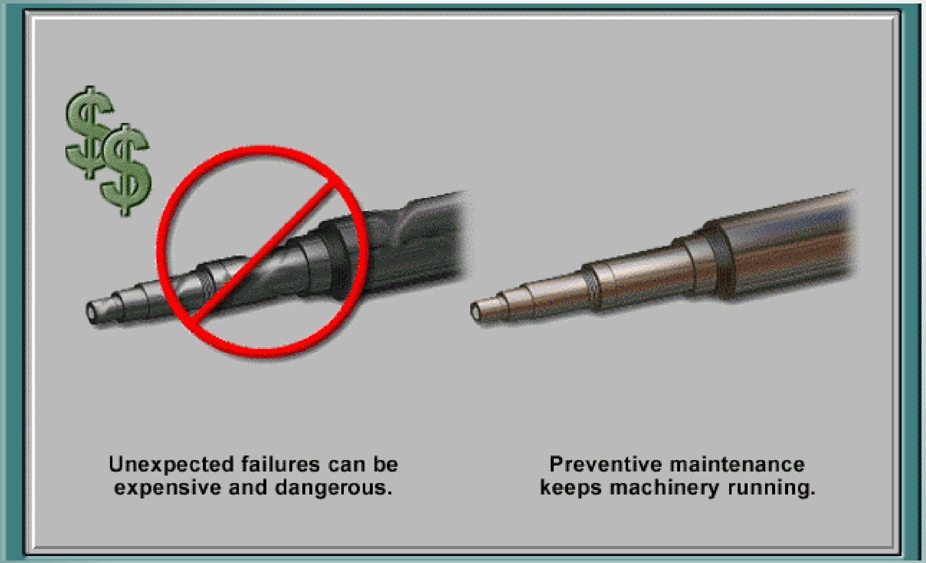


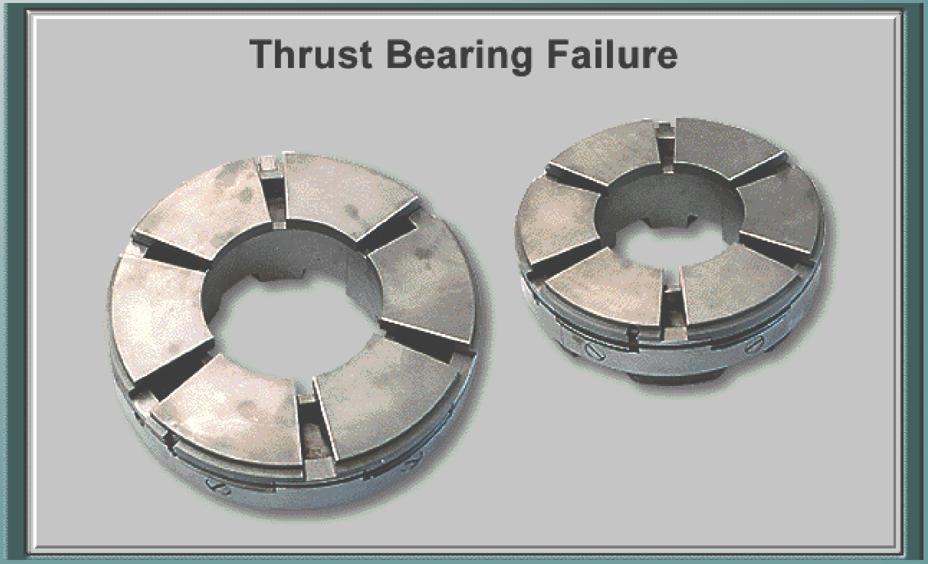
- Major Maintenance
- Minor Maintenance
- Preventive Maintenance

Compressor Maintenance

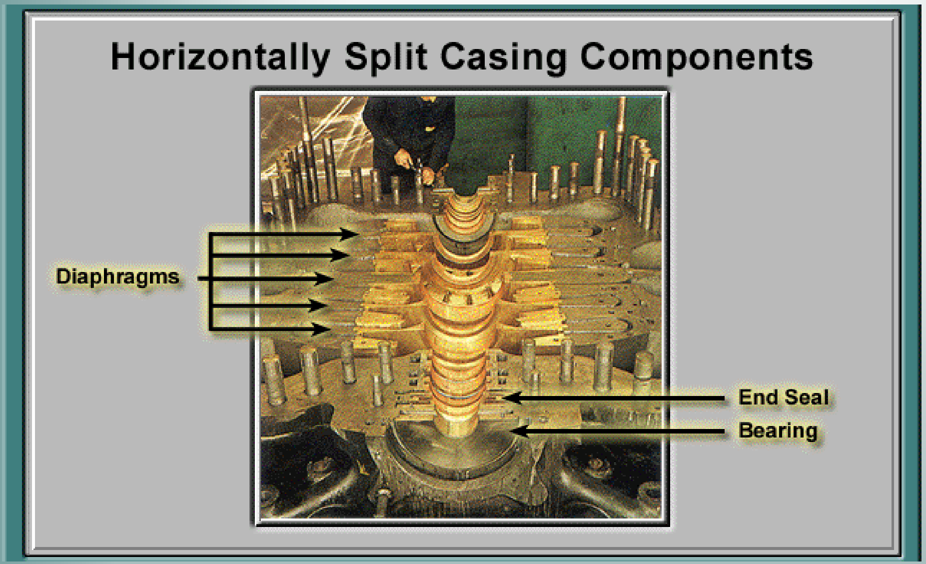


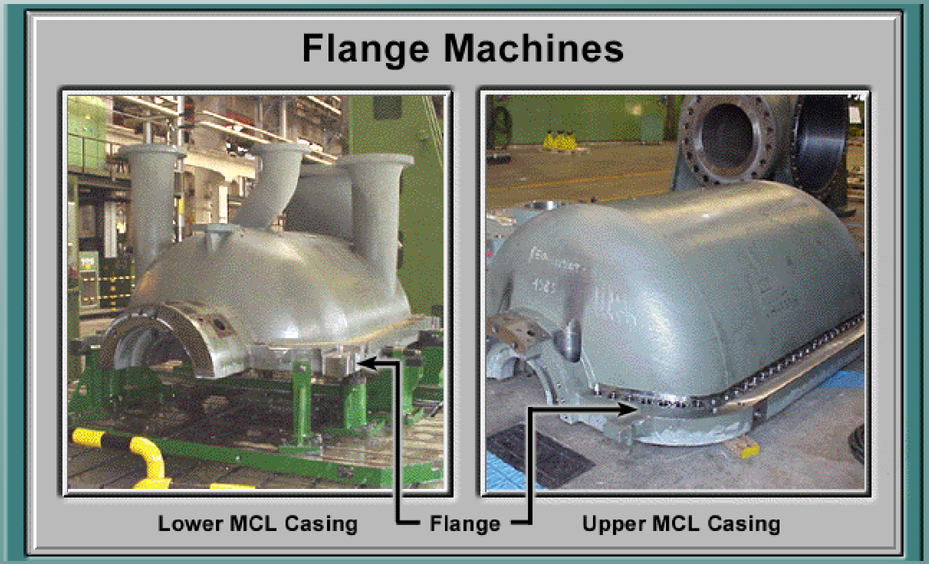
Compressor Maintenance





Centrifugal Compressor Types

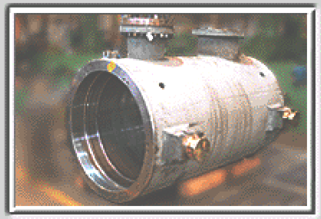




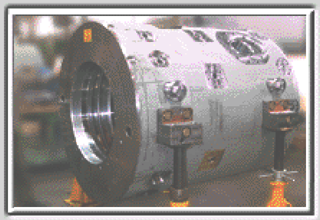
Horizontal Split Casing

Centrifugal Compressor Types

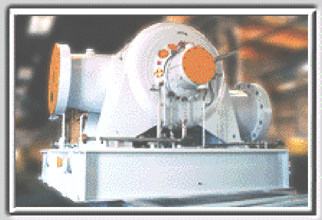
Vertically Split Casings



BCL Compressor

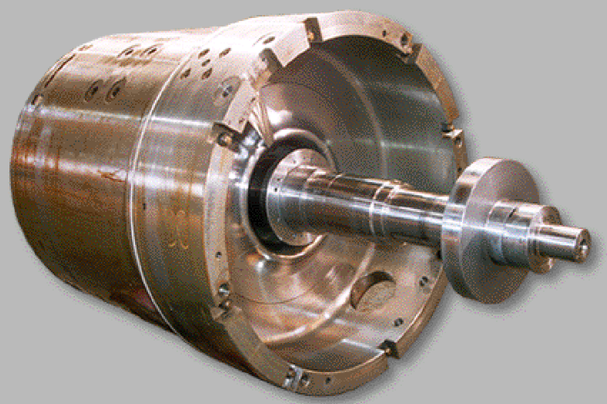


BCL-VHP Compressor



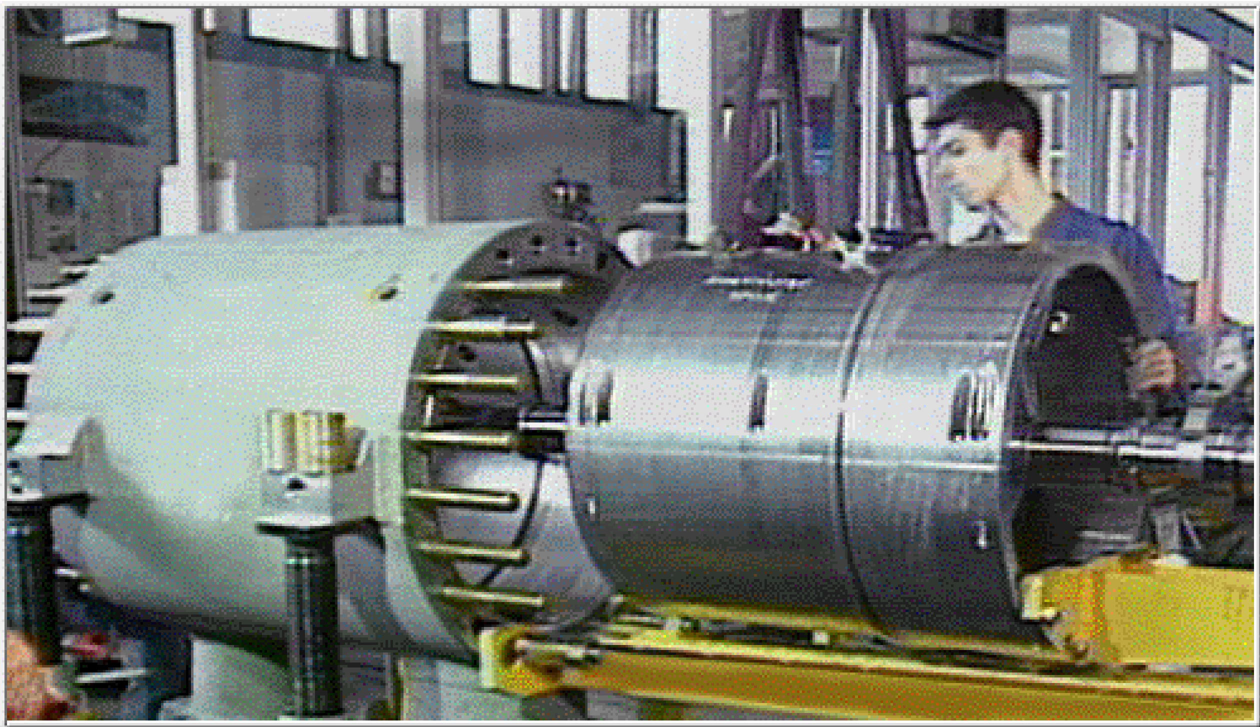
PCL Compressor

Compressor Bundle

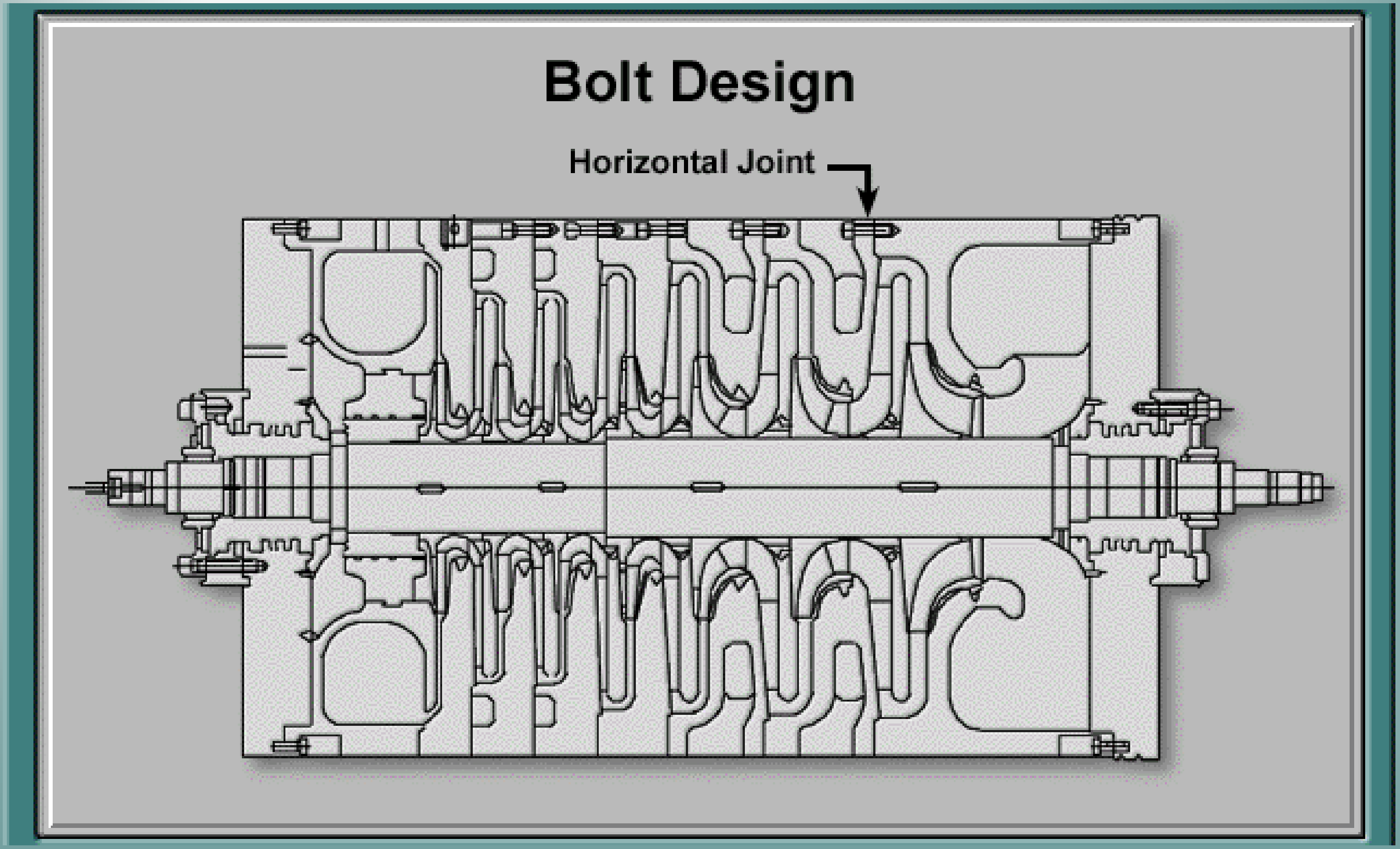


Centrifugal Compressor Types

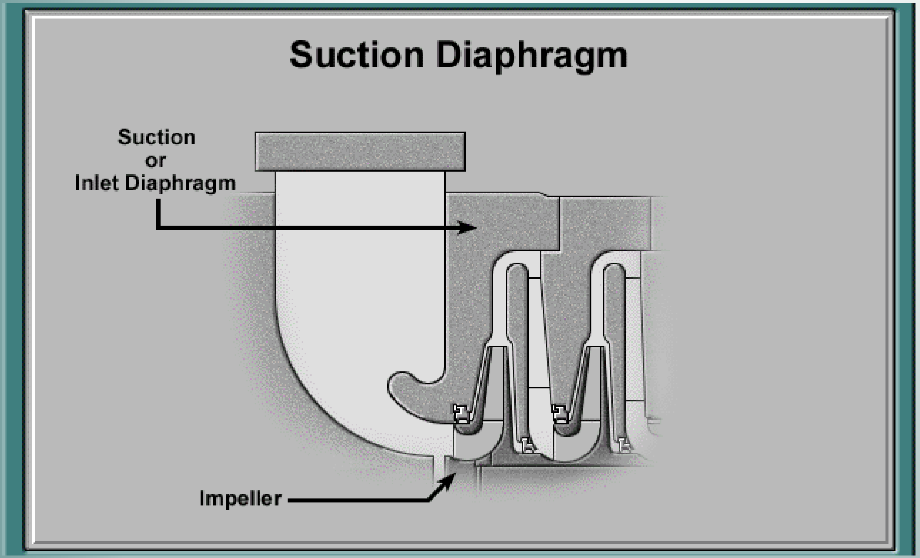
Vertical Split Casing
(Bundle or Barrel Pulling)

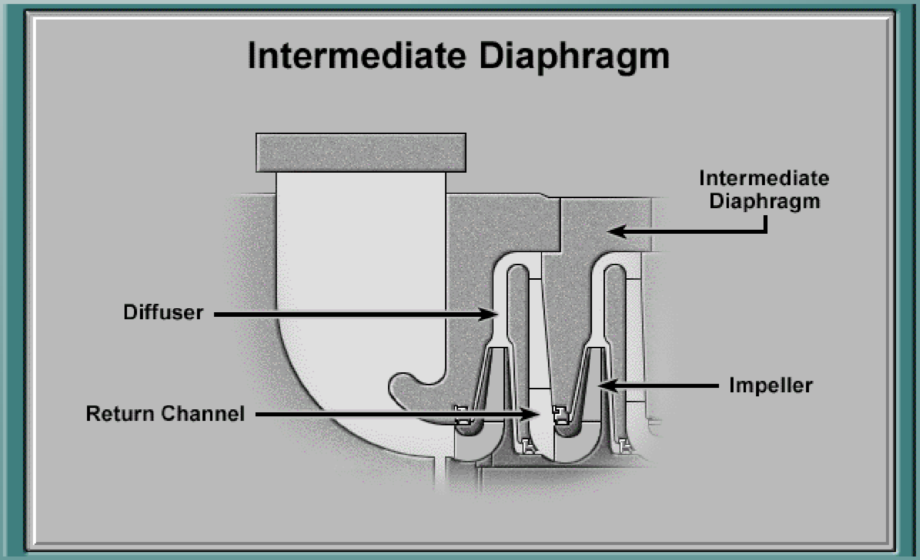


Barrel Construction

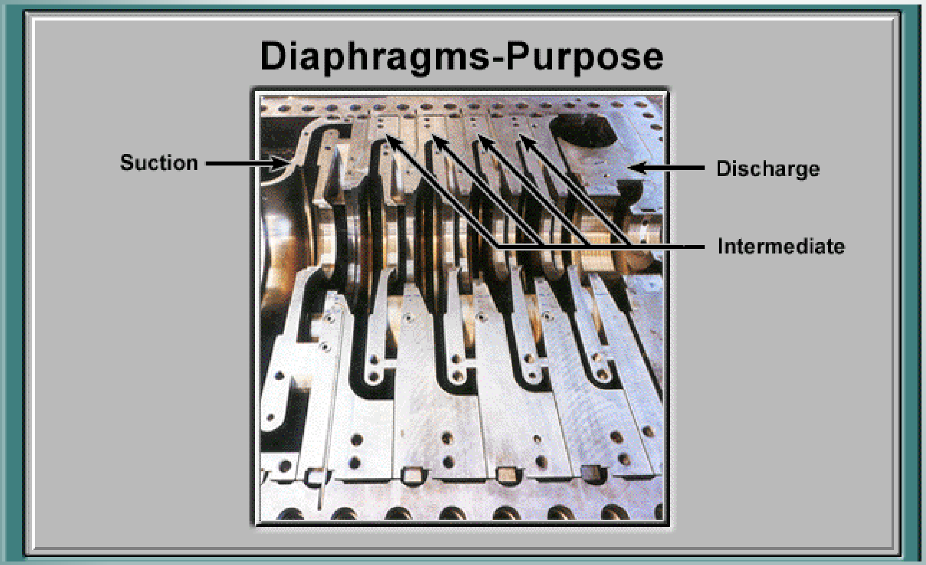


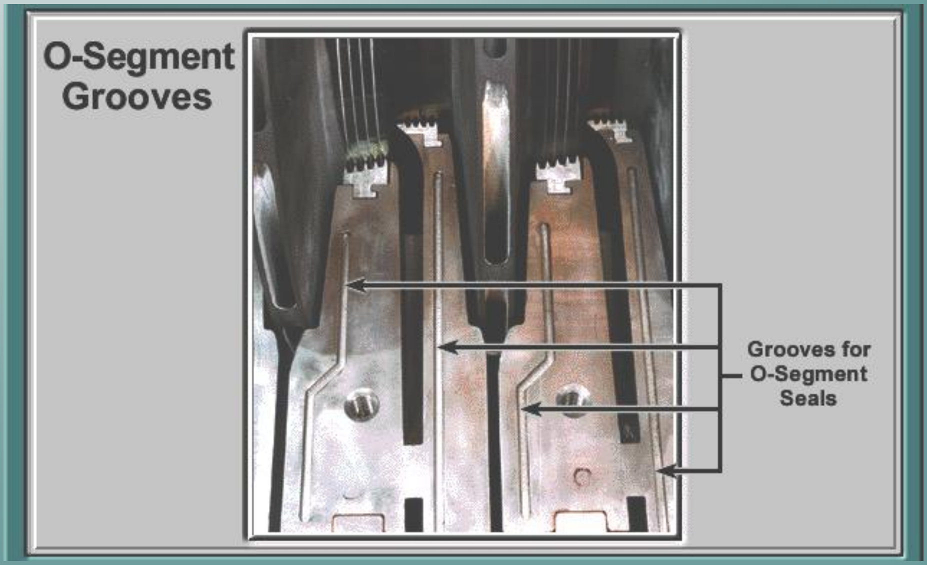
Compressor Diaphragms





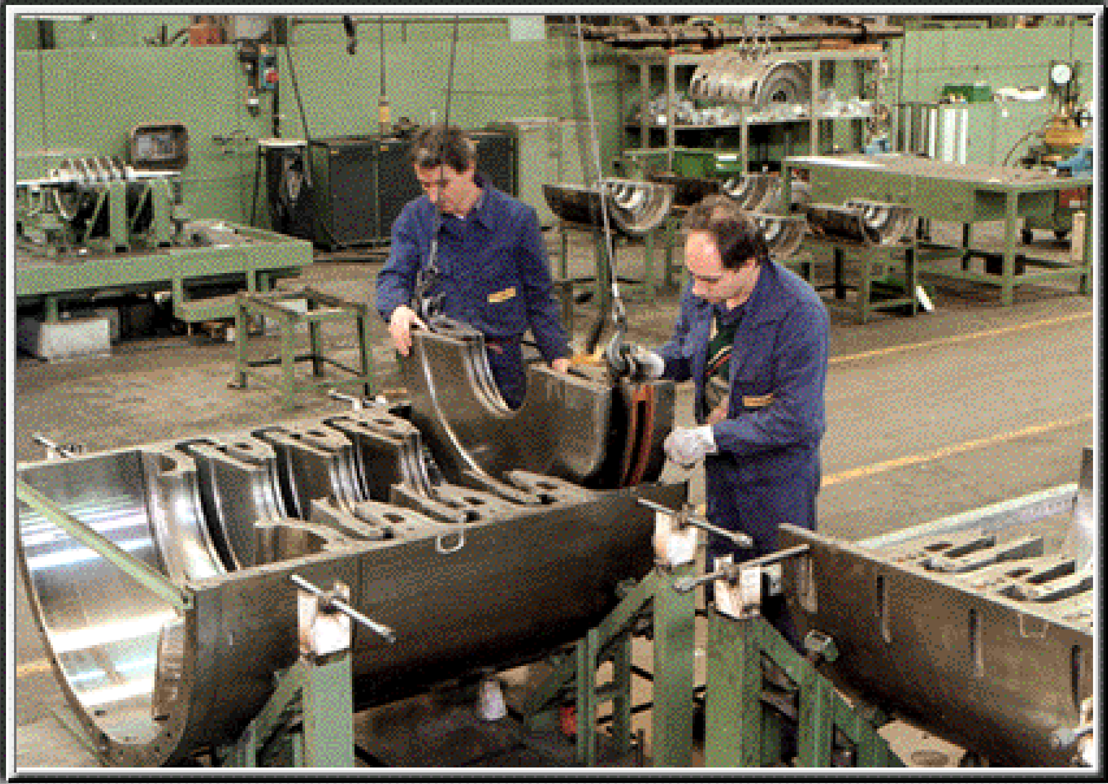
Compressor Diaphragms



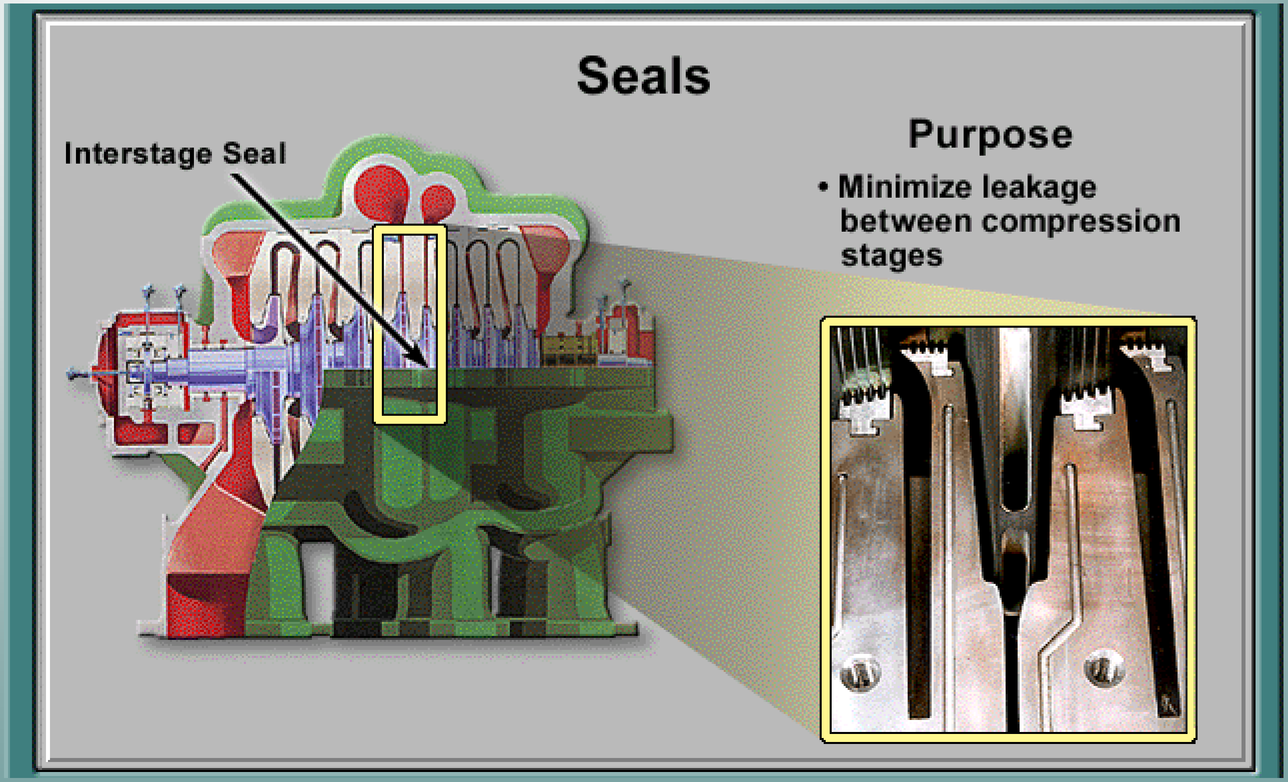


Barrel Construction

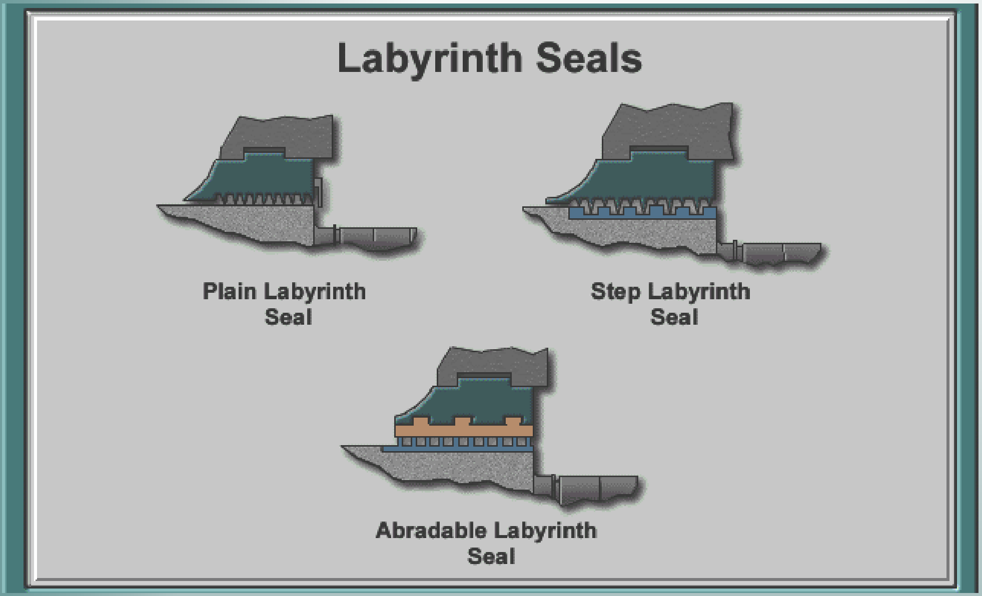
Diaphragm Installation

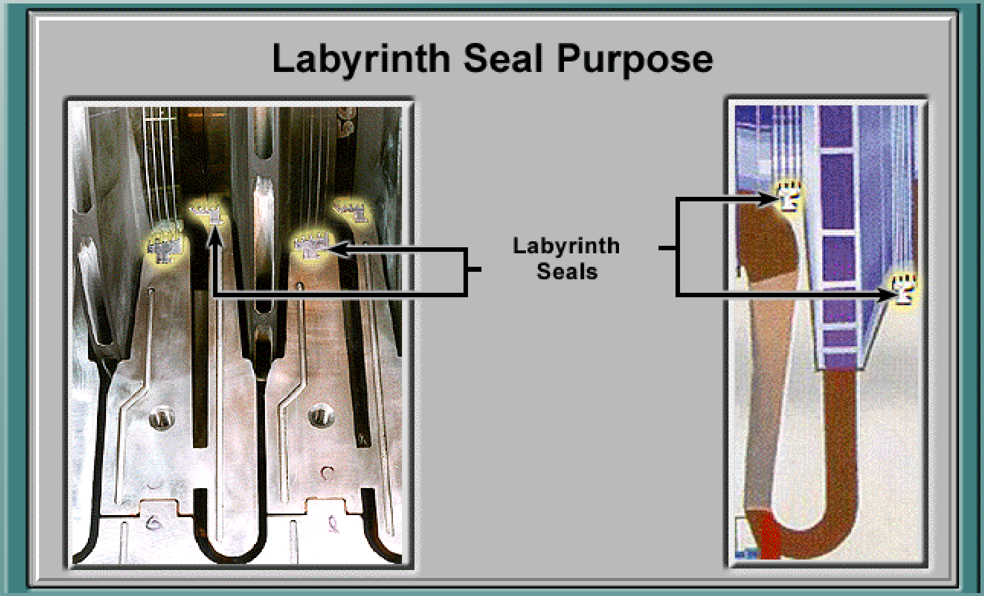


Inter Stage Seals

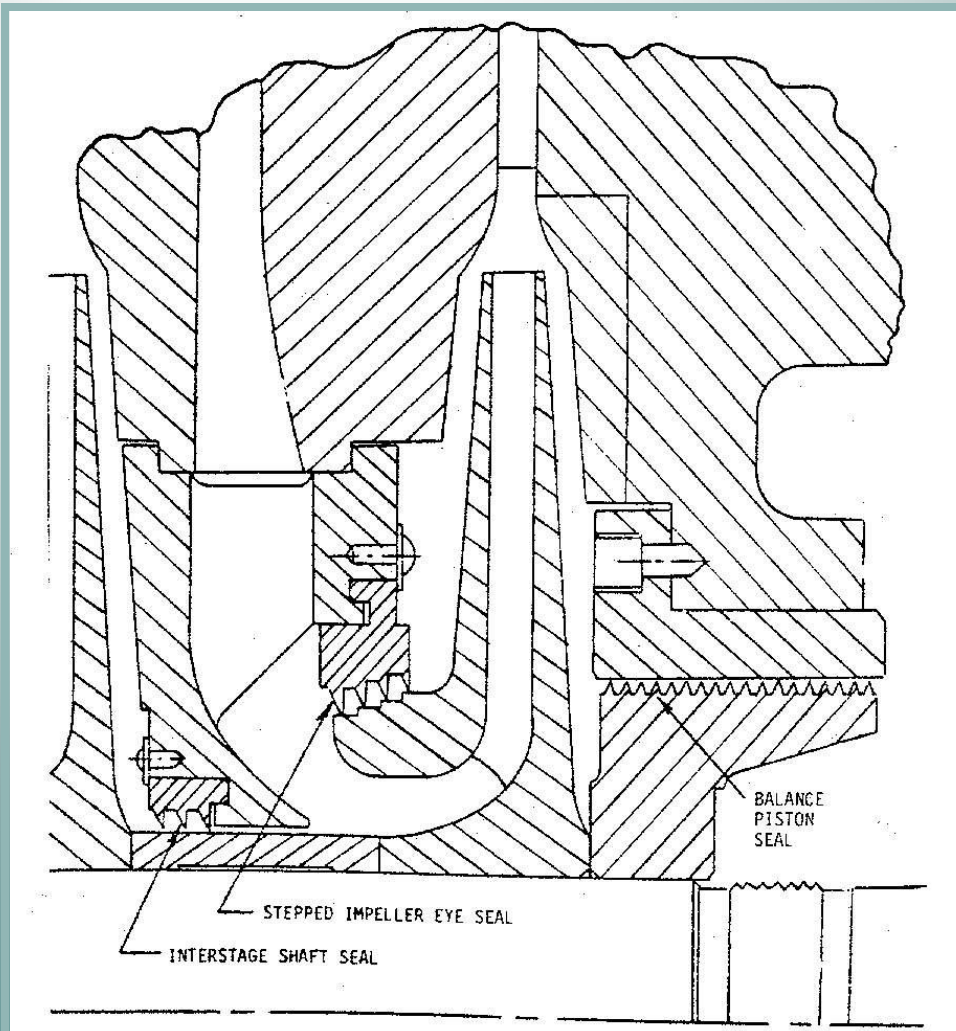


Labyrinth Seals

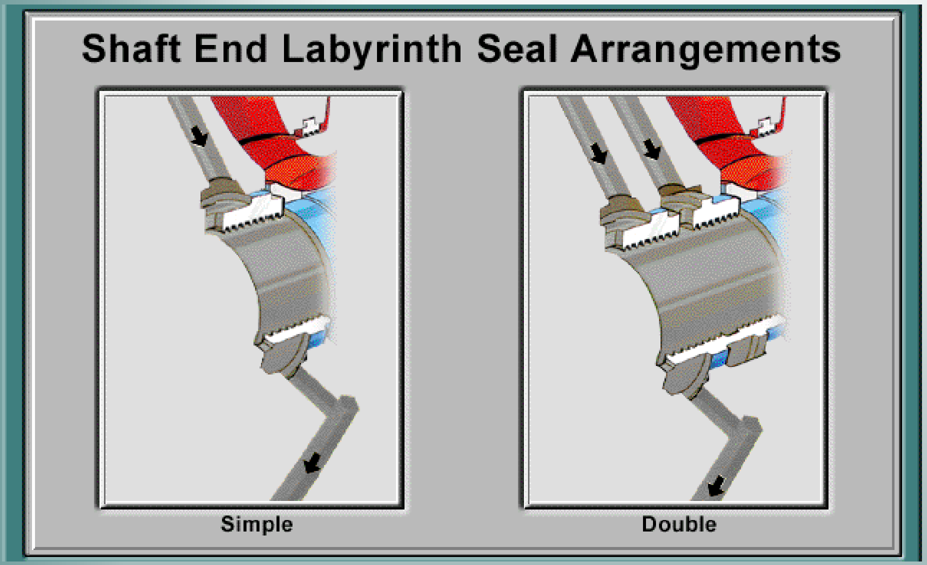


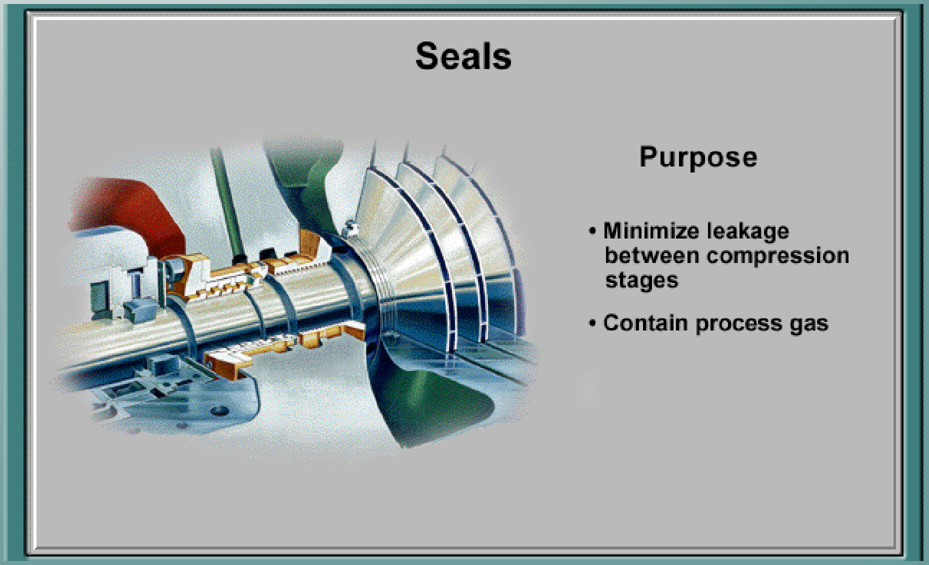


Labyrinth Seals

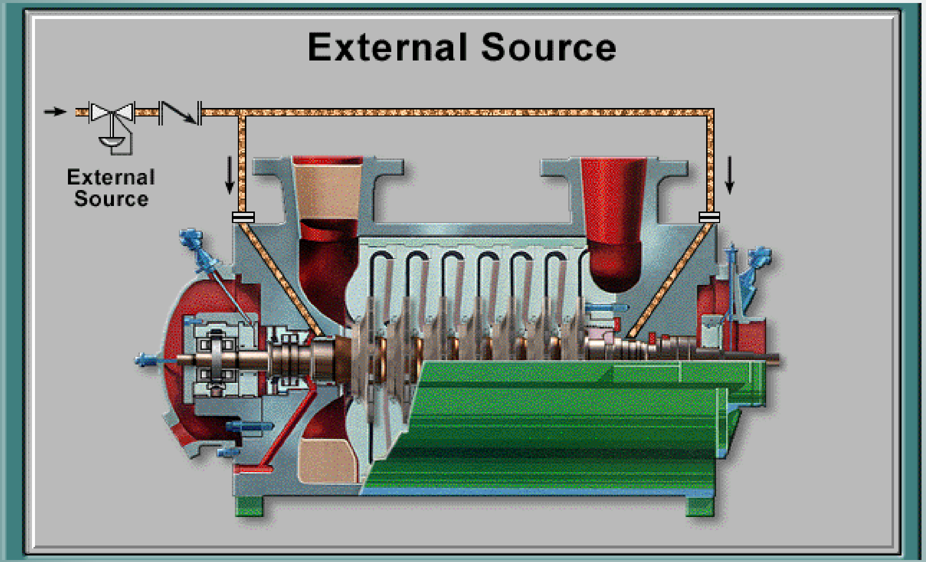


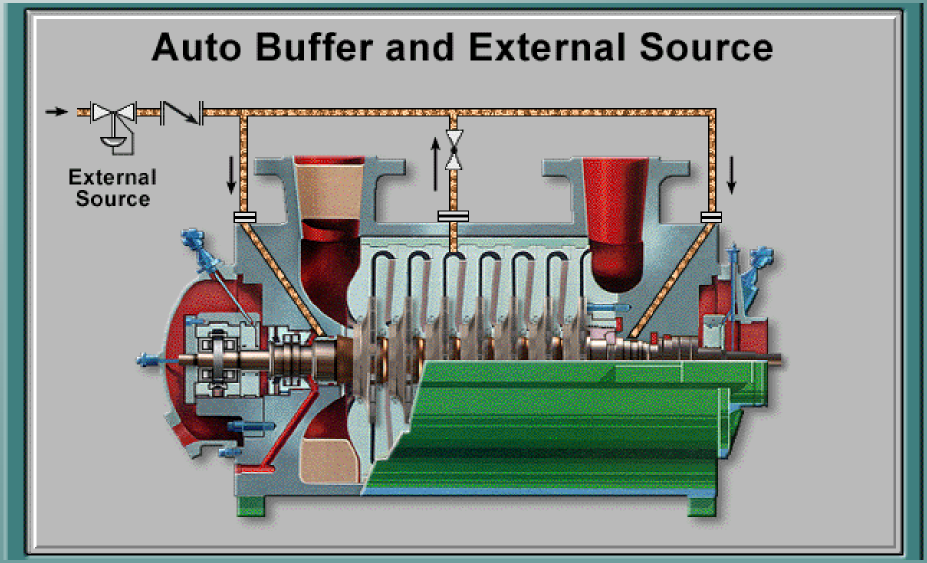
Rotor End Seals



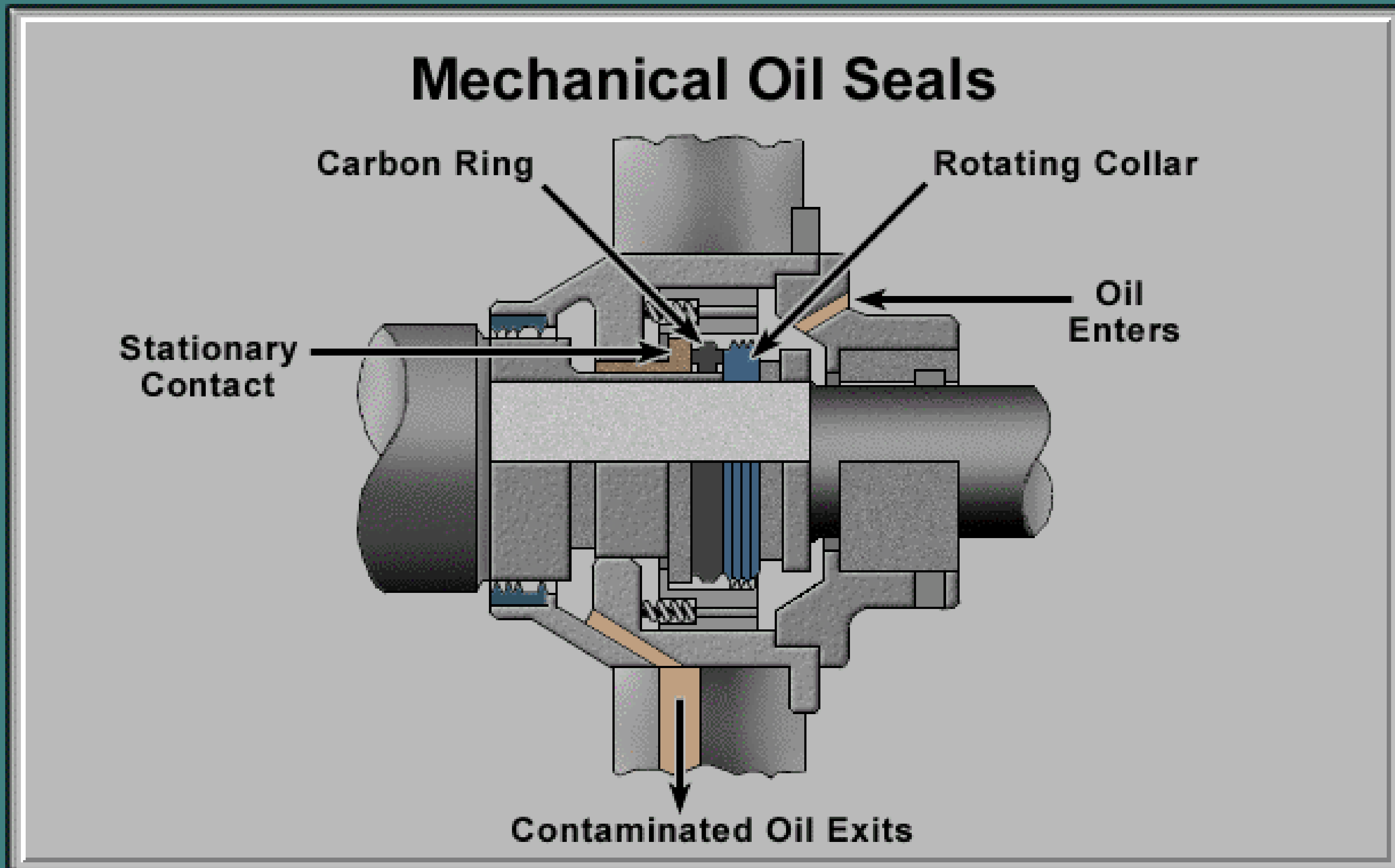


Shaft End Seal

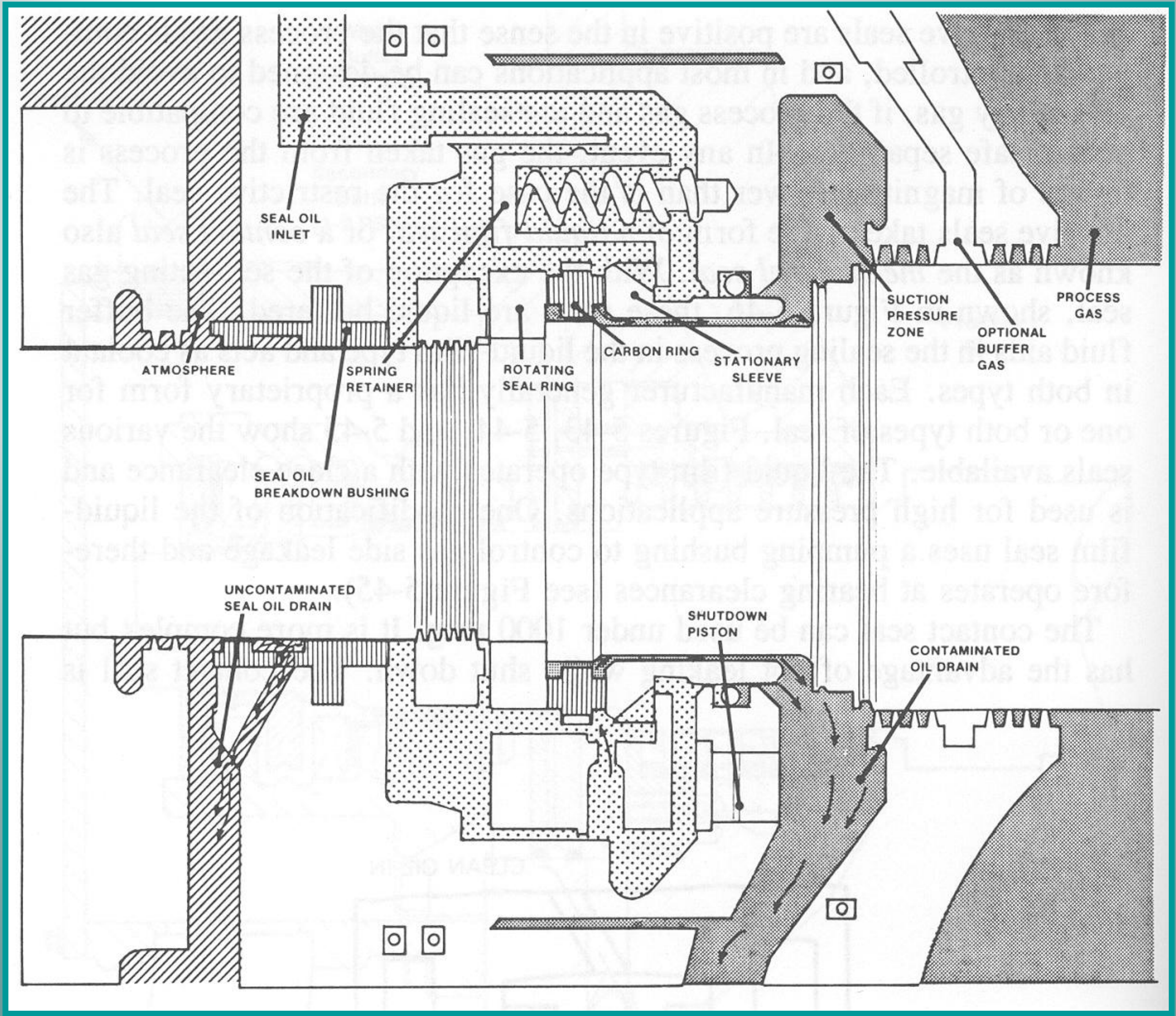




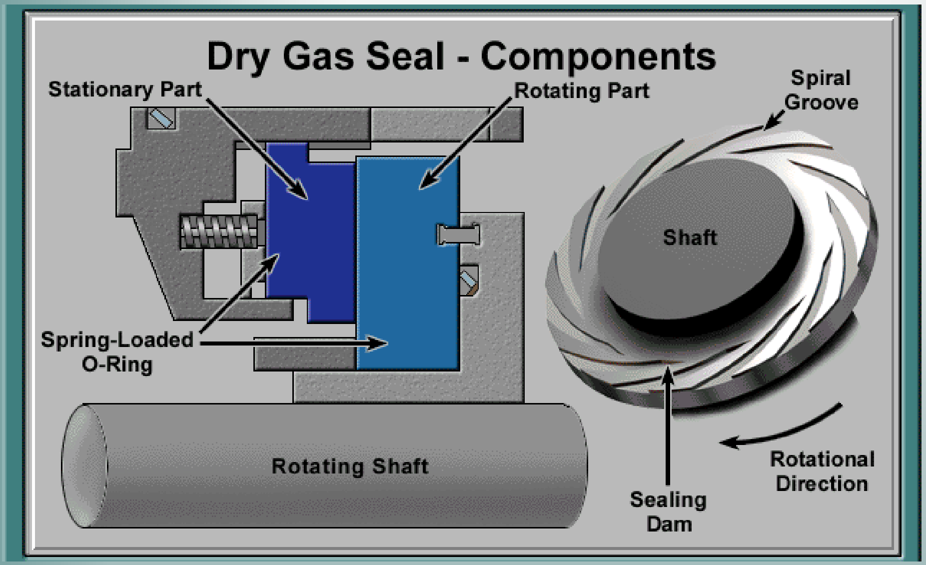
Mechanical Oil Seals

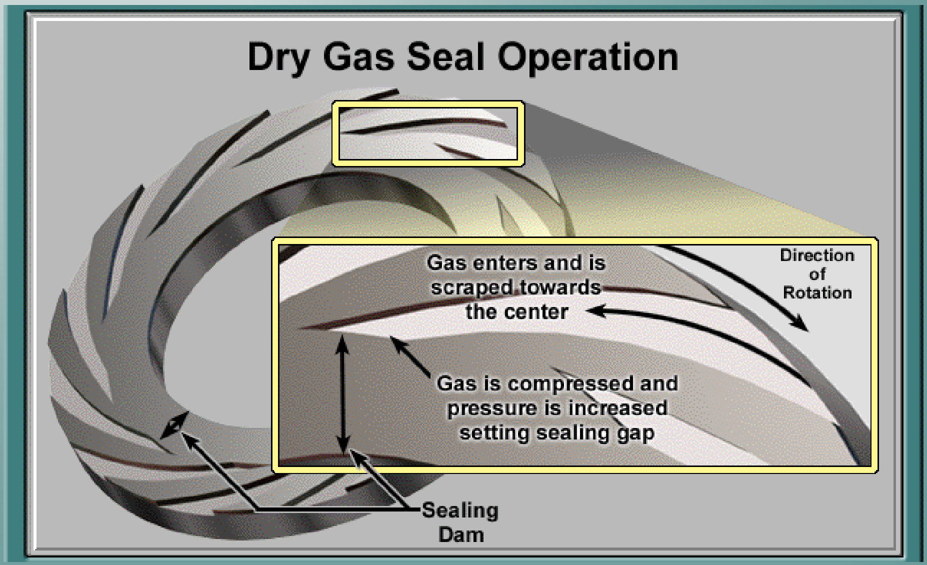


Mechanical Seal

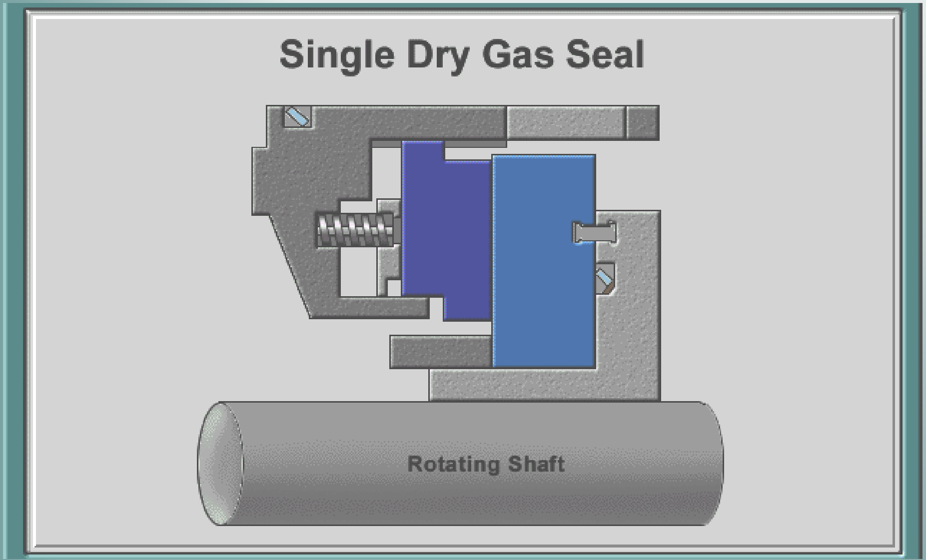


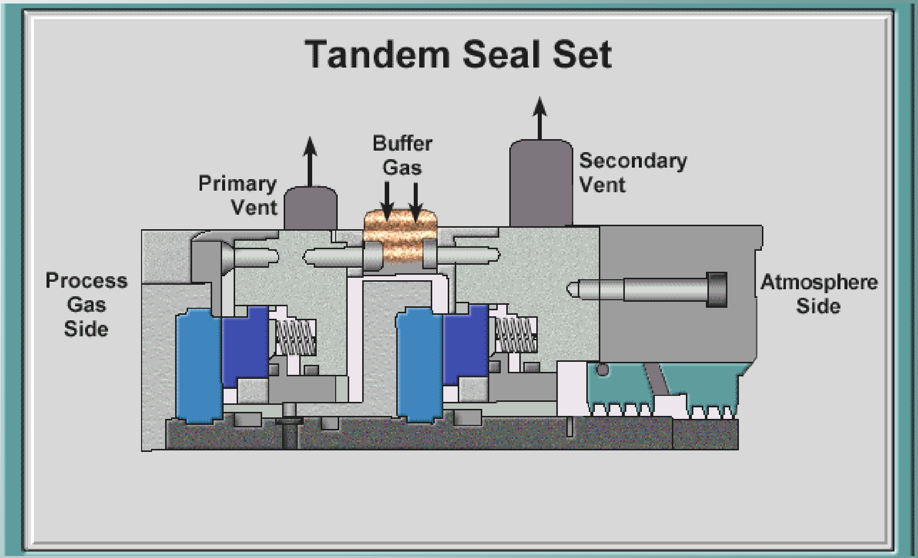
Dry Gas Seals

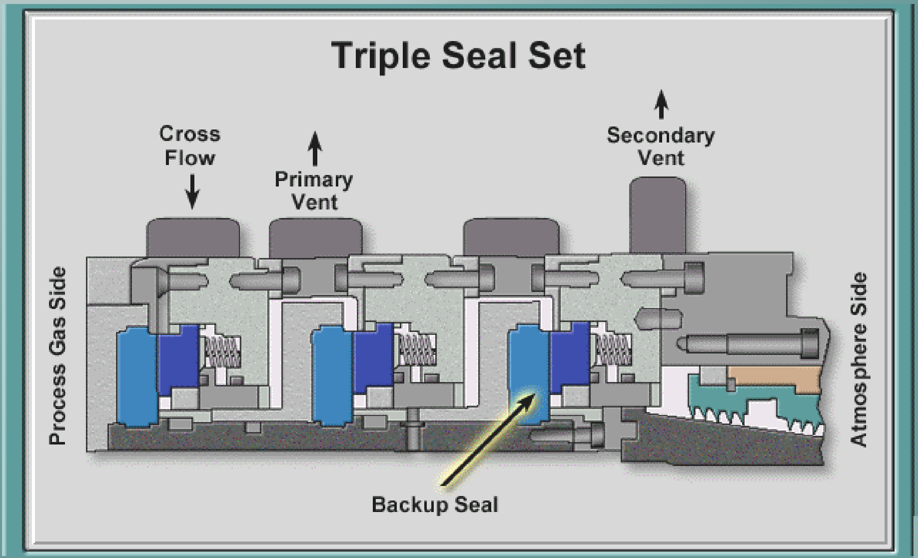




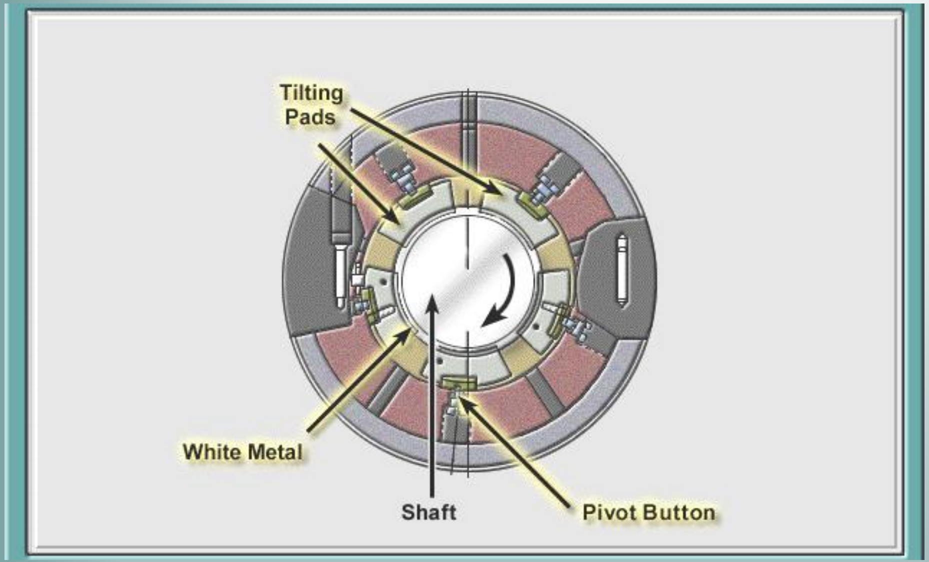
Dry Gas Seals



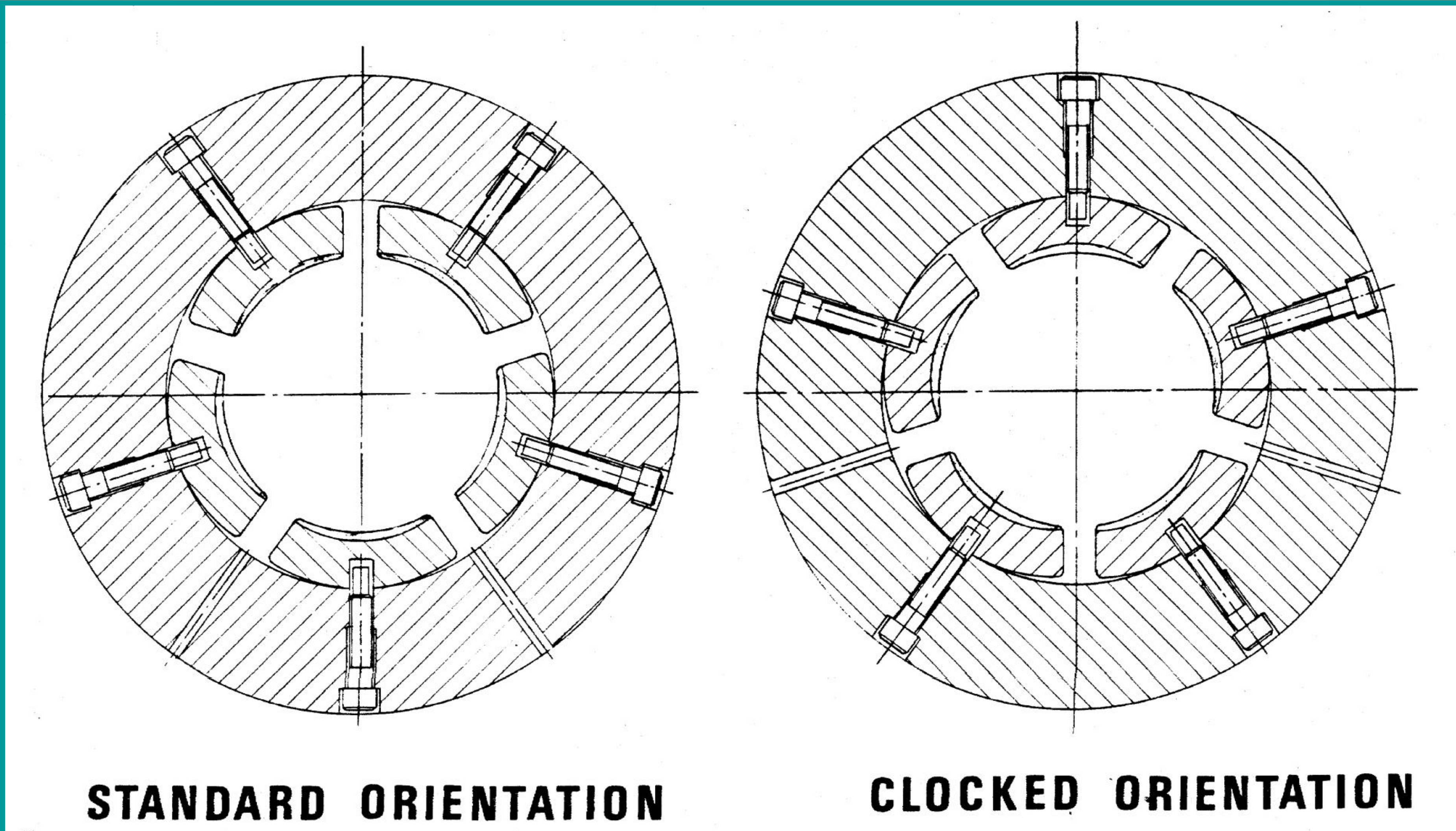




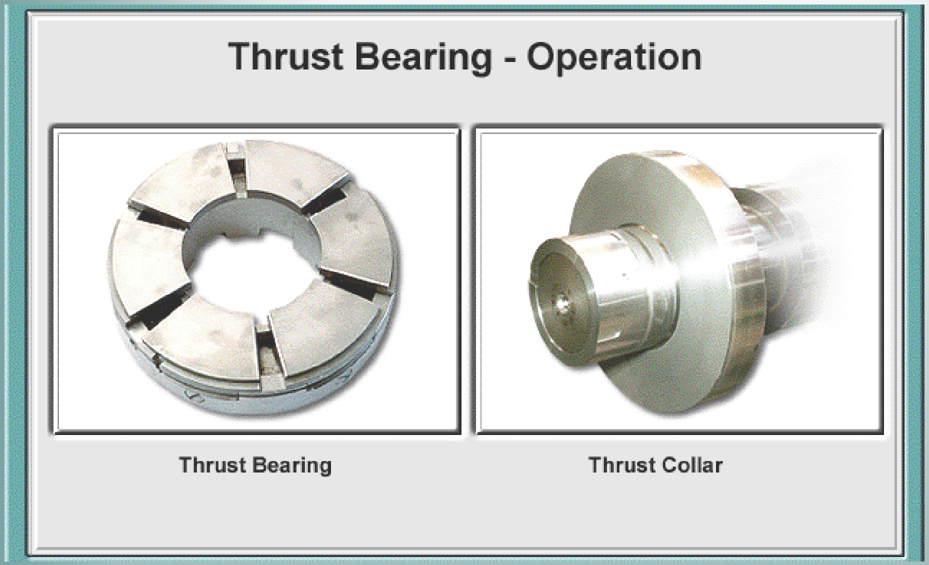
Radial Bearing



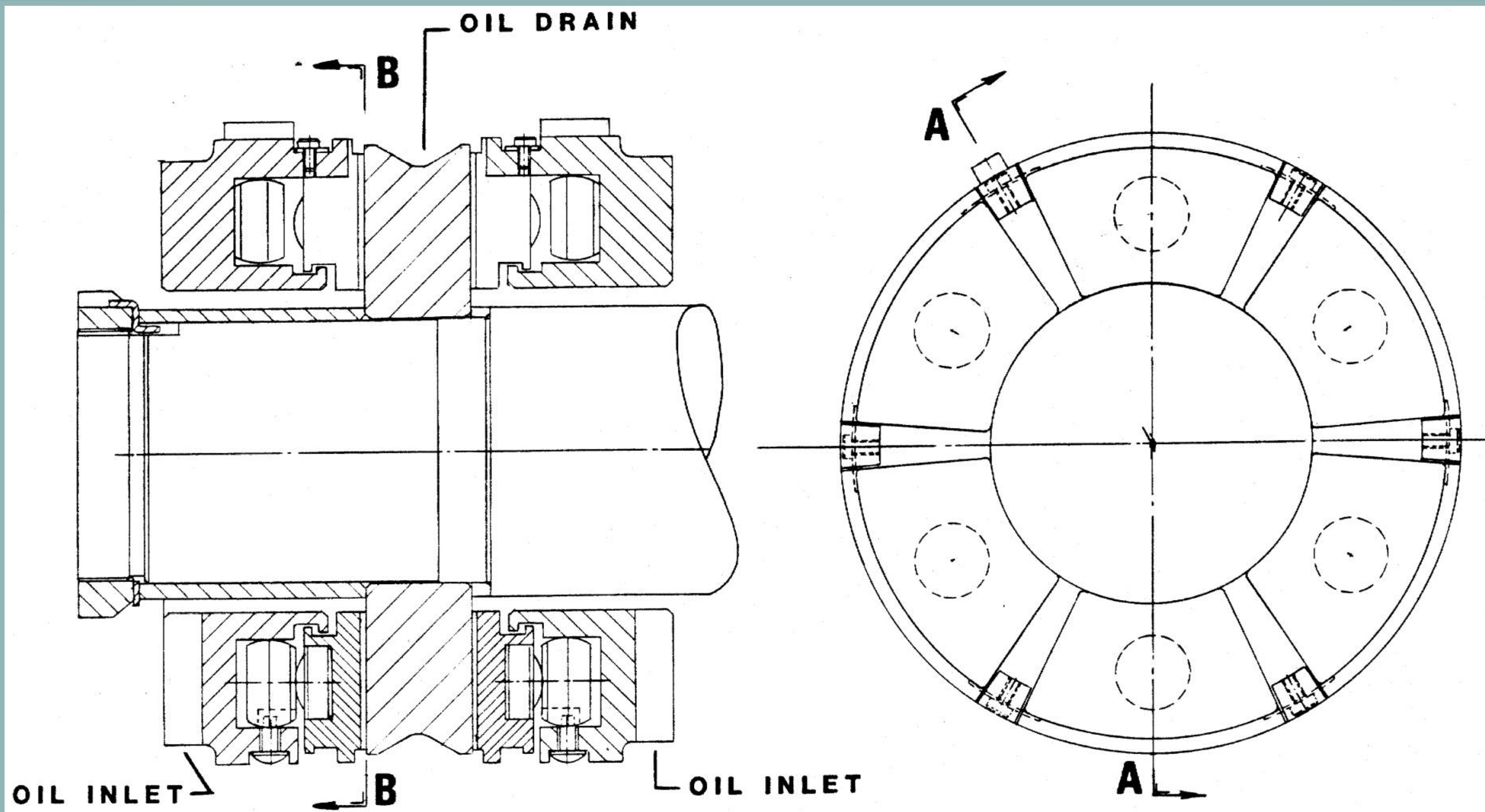
JOURNAL BEARING ARRANGEMENT



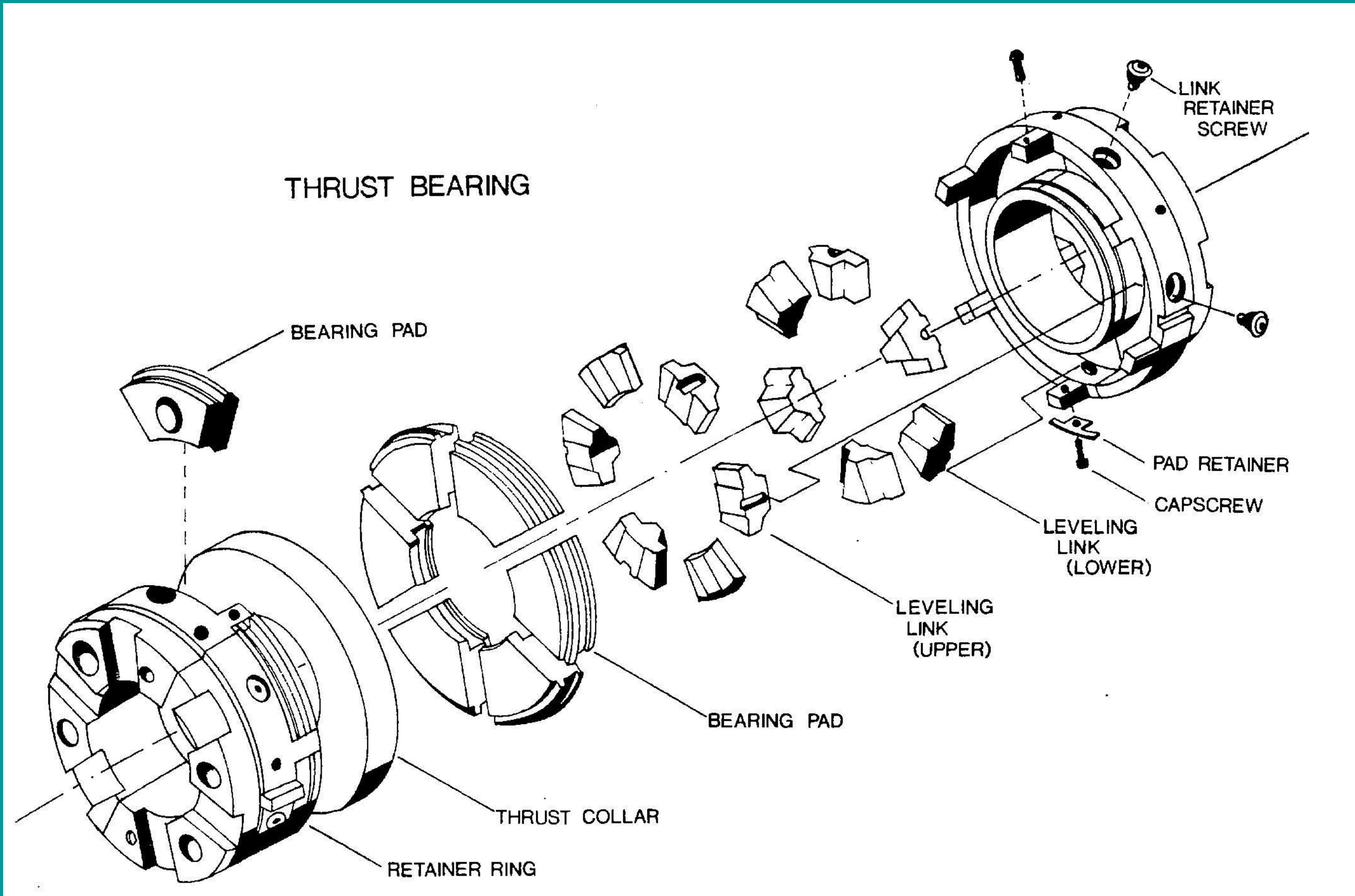
Thrust Bearing



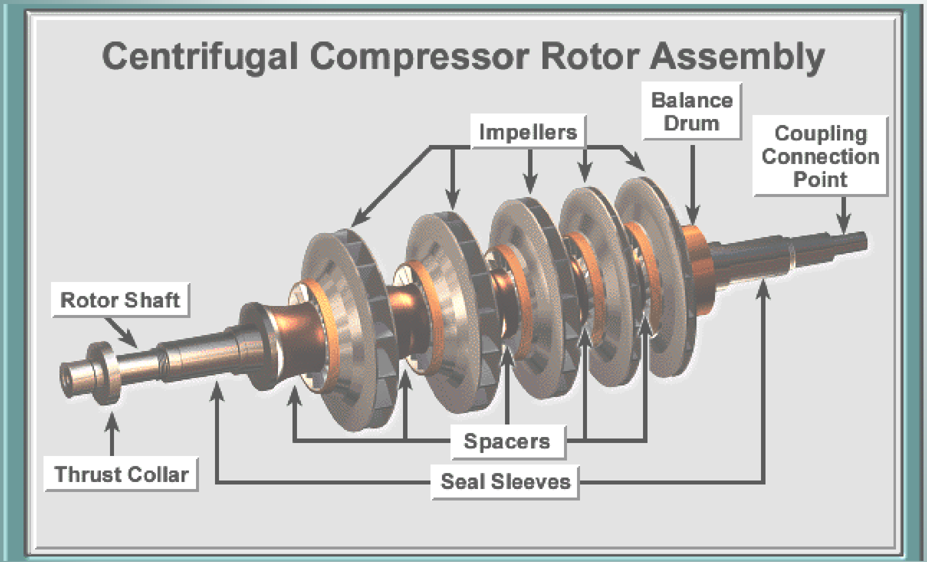
THRUST BEARING ARRANGEMENT

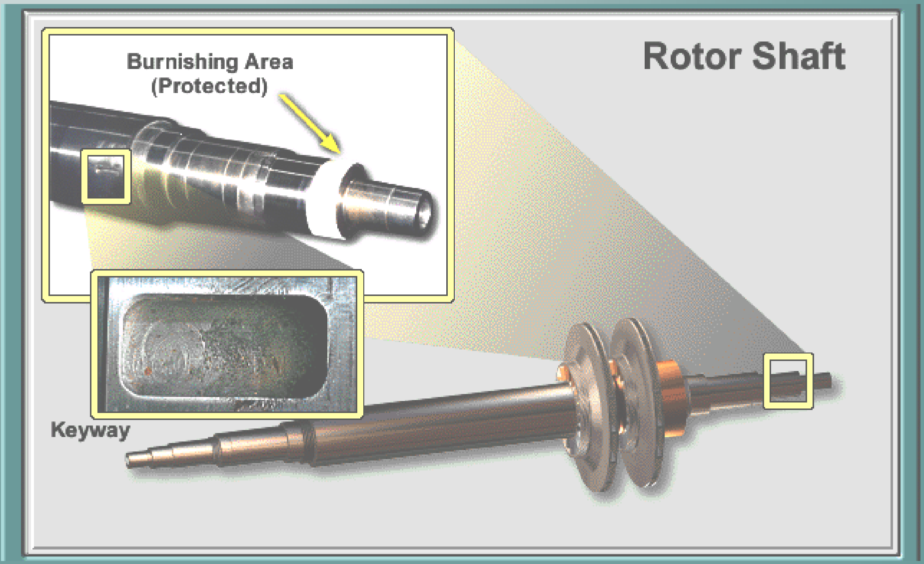


THRUST BEARING EXPLODED VIEW

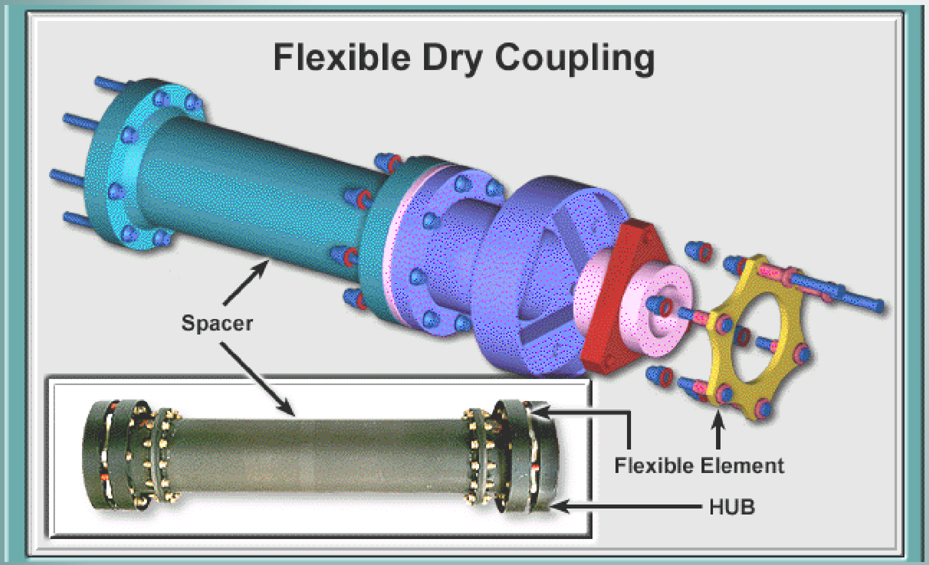


Rotor Assembly

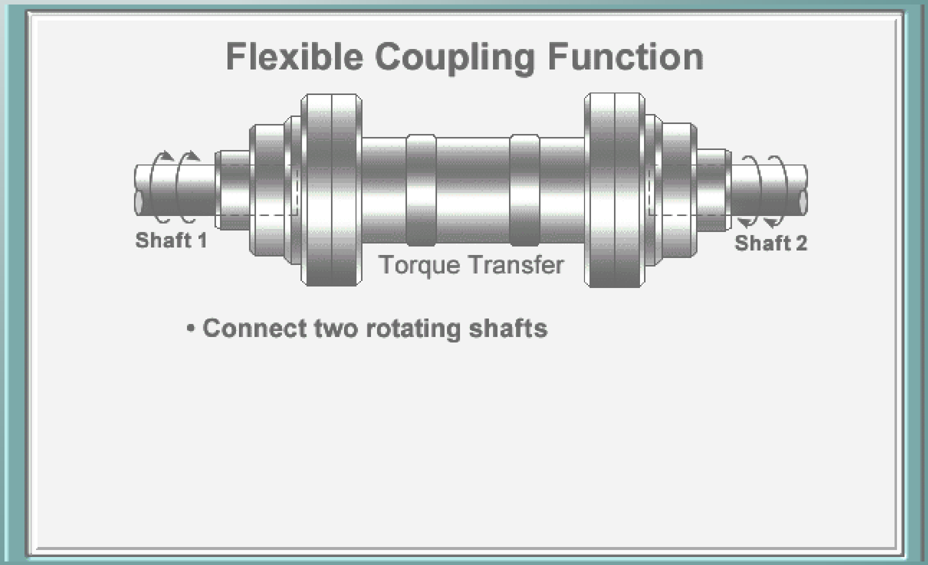




Coupling

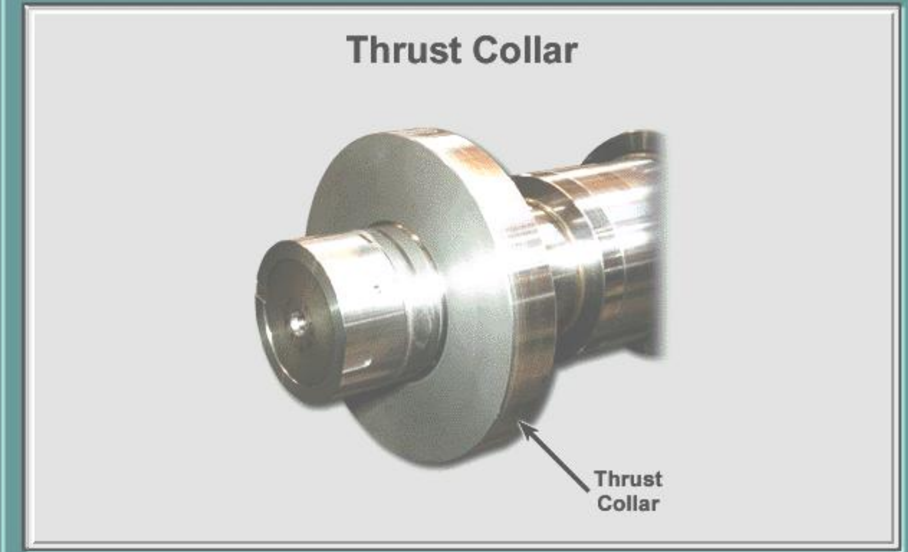


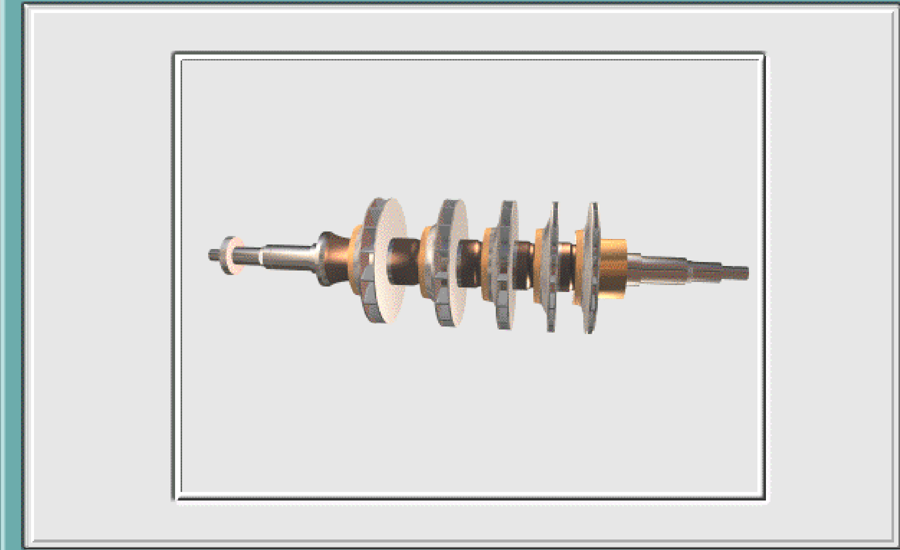
Flexible Dry Coupling
Spacer
Flexible Element
HUB



Flexible Coupling Function
Shaft 1
Torque Transfer
Shaft 2
• Connect two rotating shafts

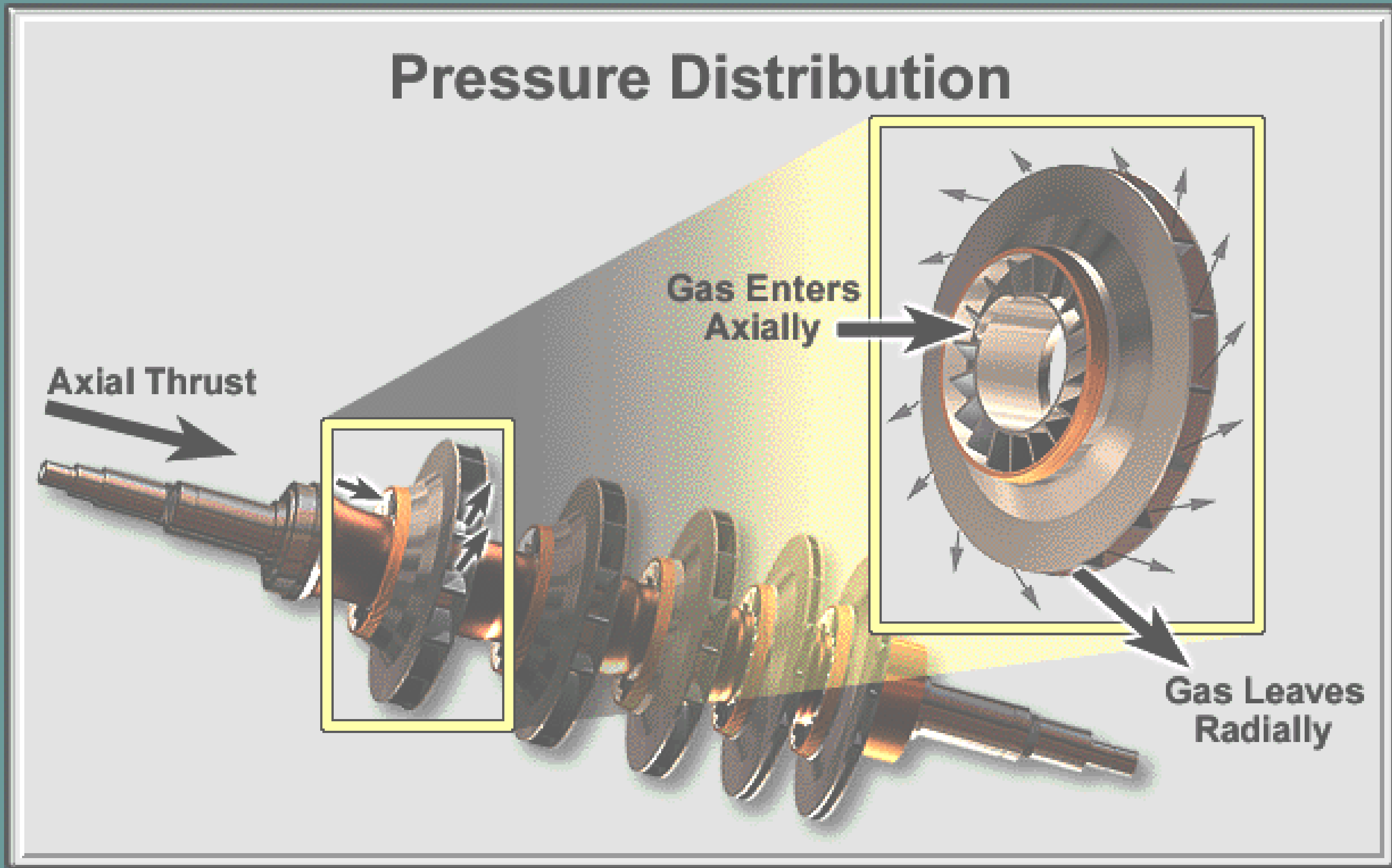
Thrust Collar



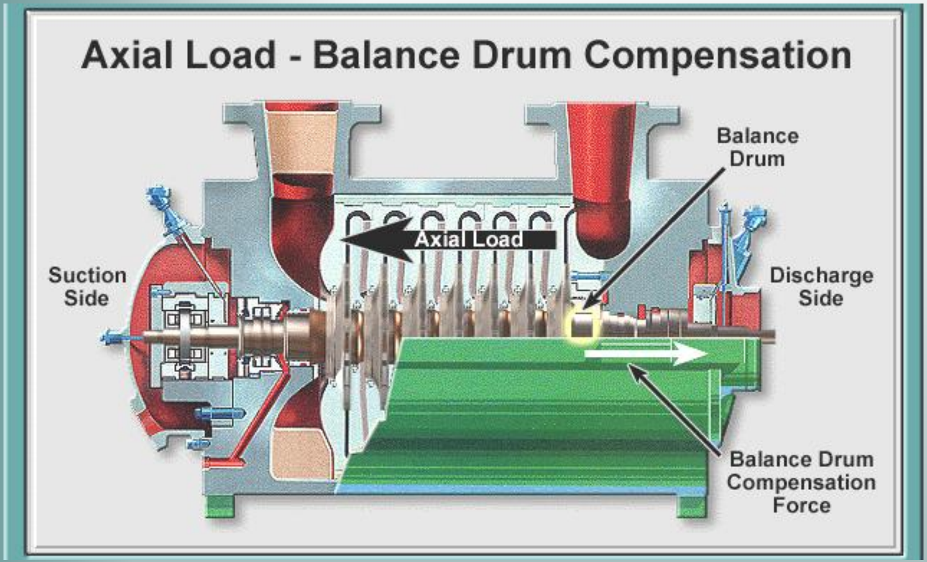


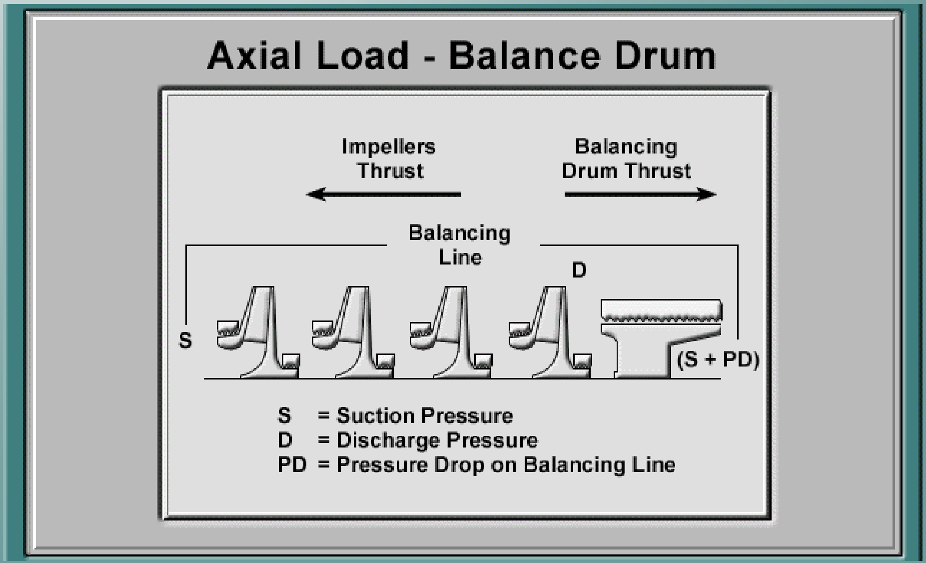
Axial Compressors

Axial Thrust

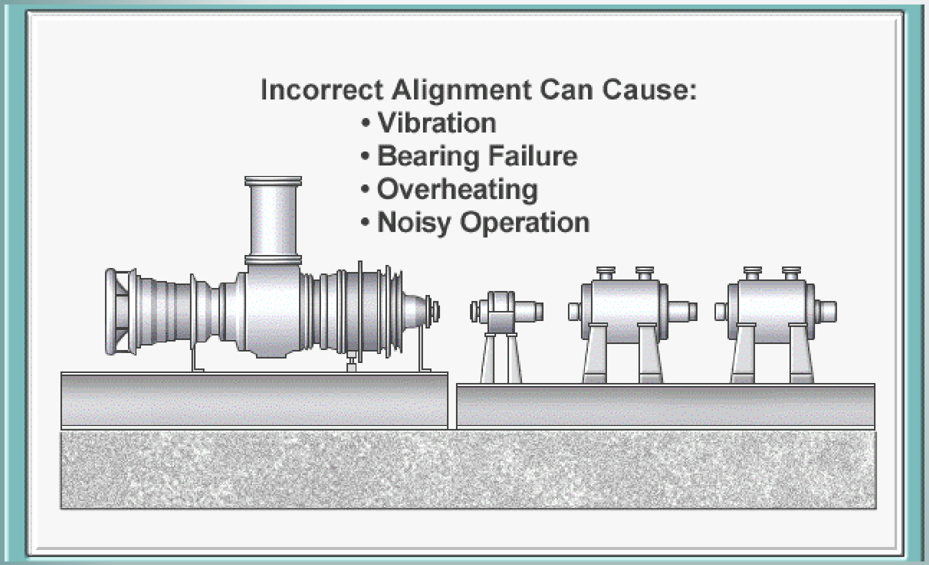


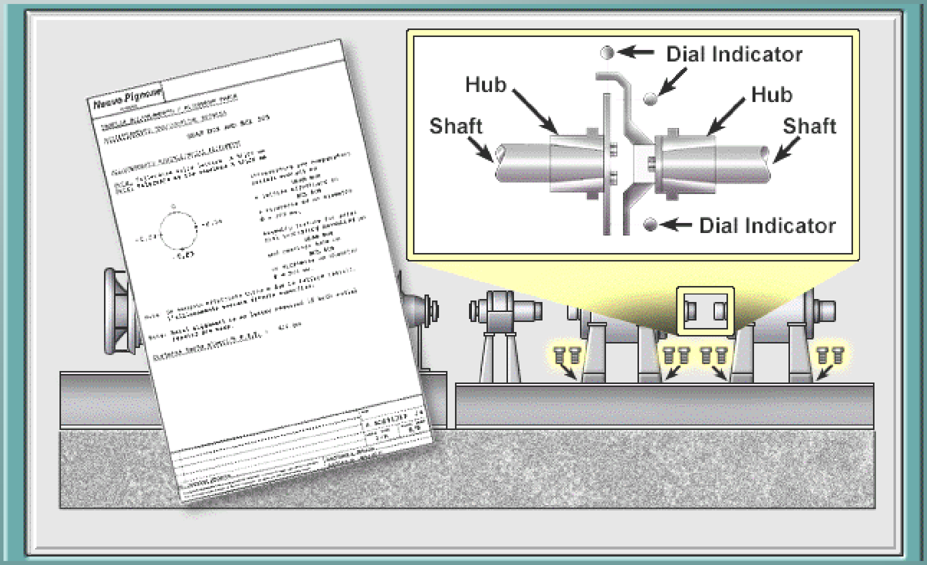
Balance Drum



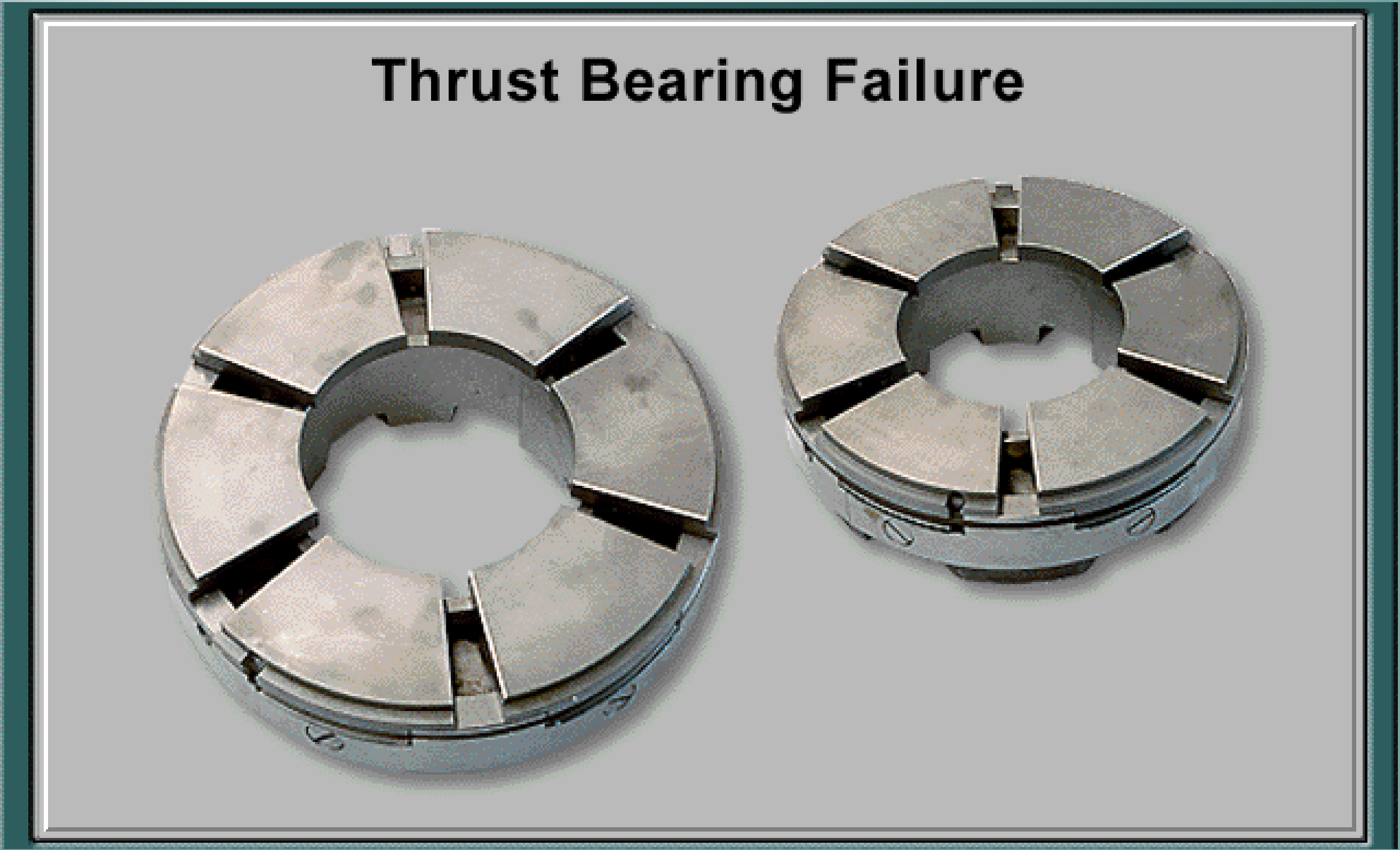


Train Alignment

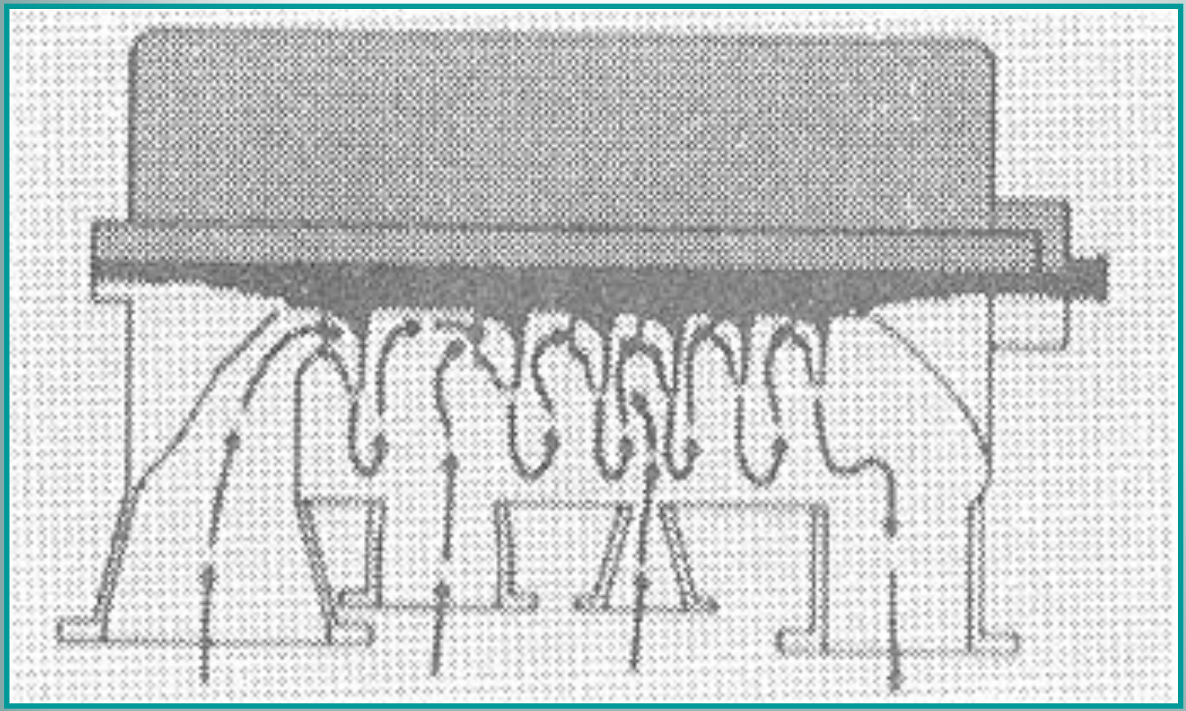




Thrust Bearing Failure

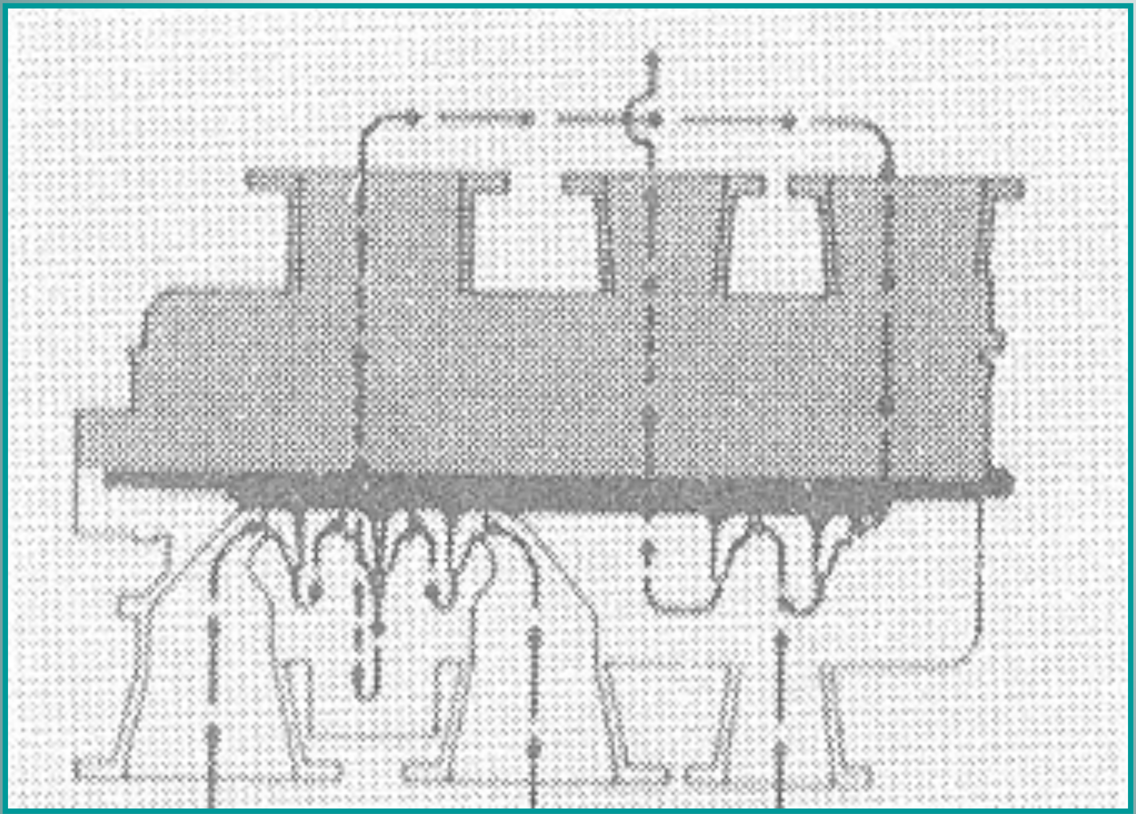


Side Stream



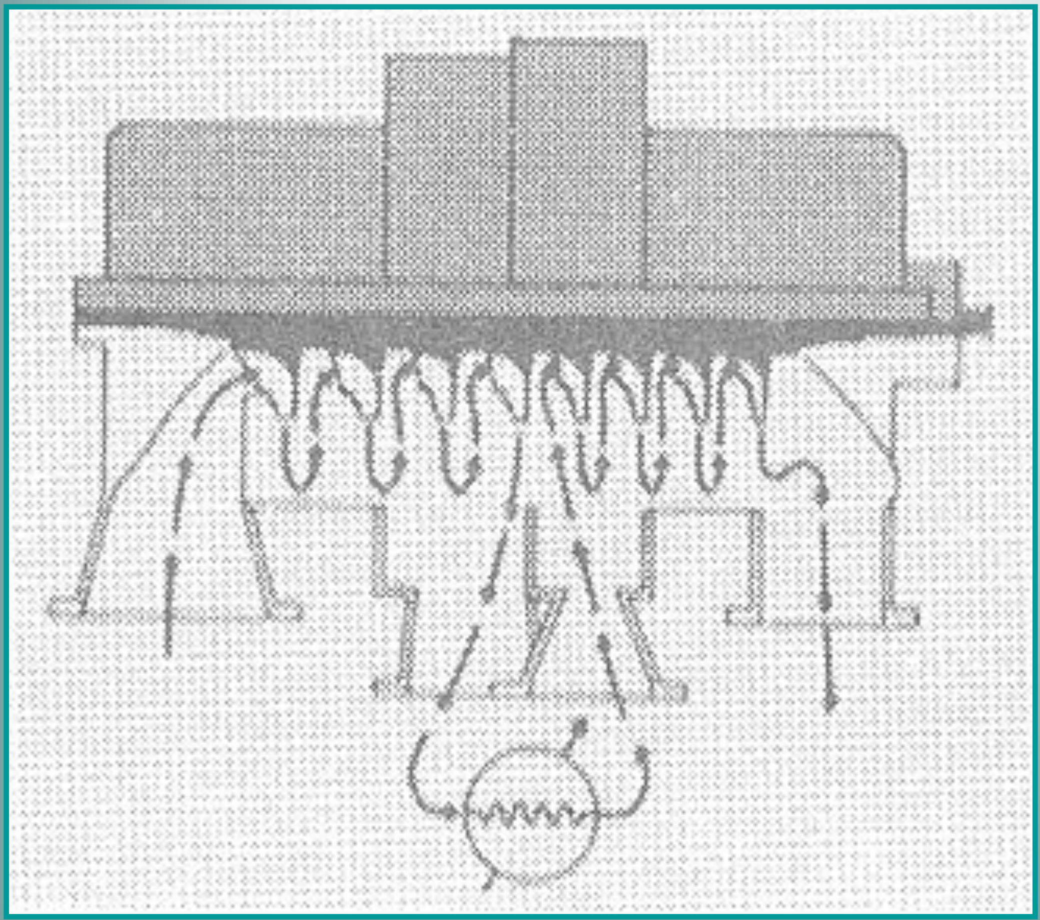
Side Stream Nozzles permit introducing or extracting gas at selected pressure levels

First Section Double-Flow



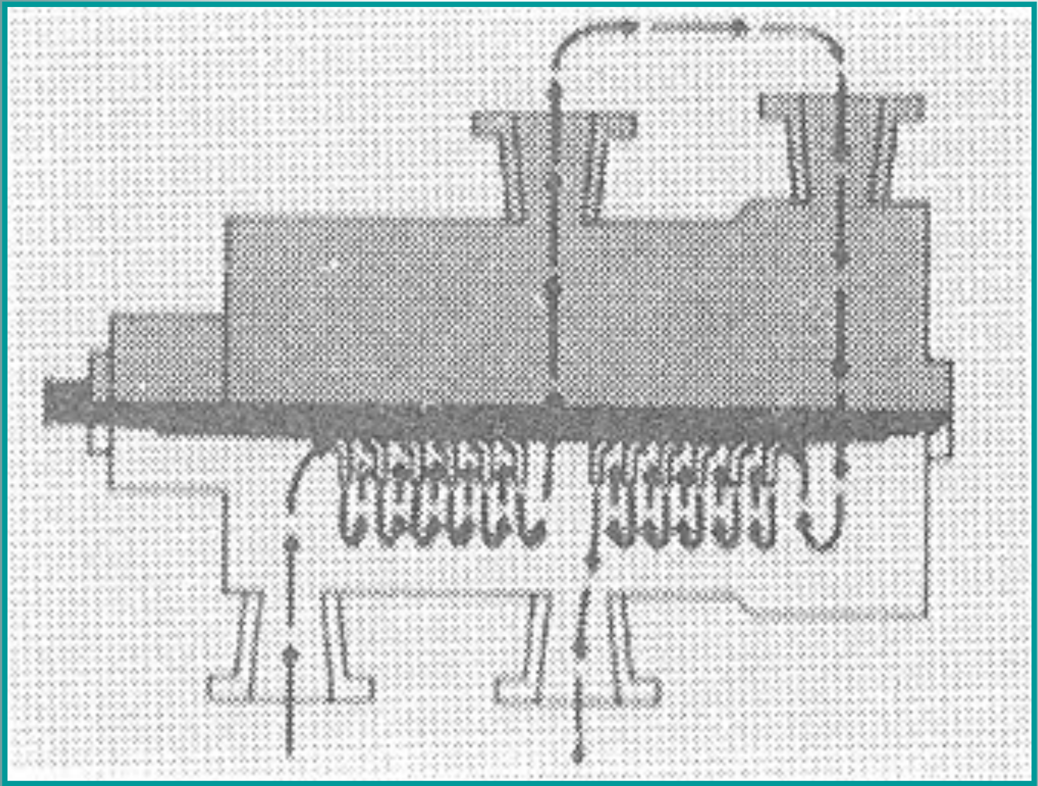
Capacity of this compressor is significantly increased by arranging double-flow compression in the first section

Iso-Cooling



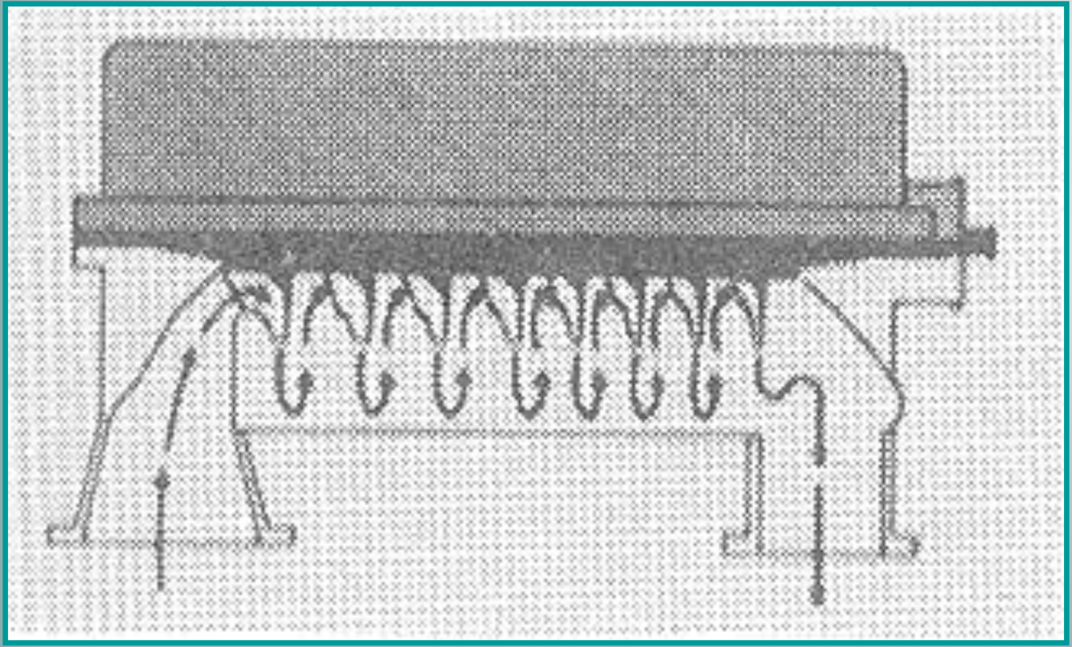
When gas temperature within the compressor reaches 200 to 400 F, efficiency is improved and compressor intake power reduced by cooling

Back-to-Back



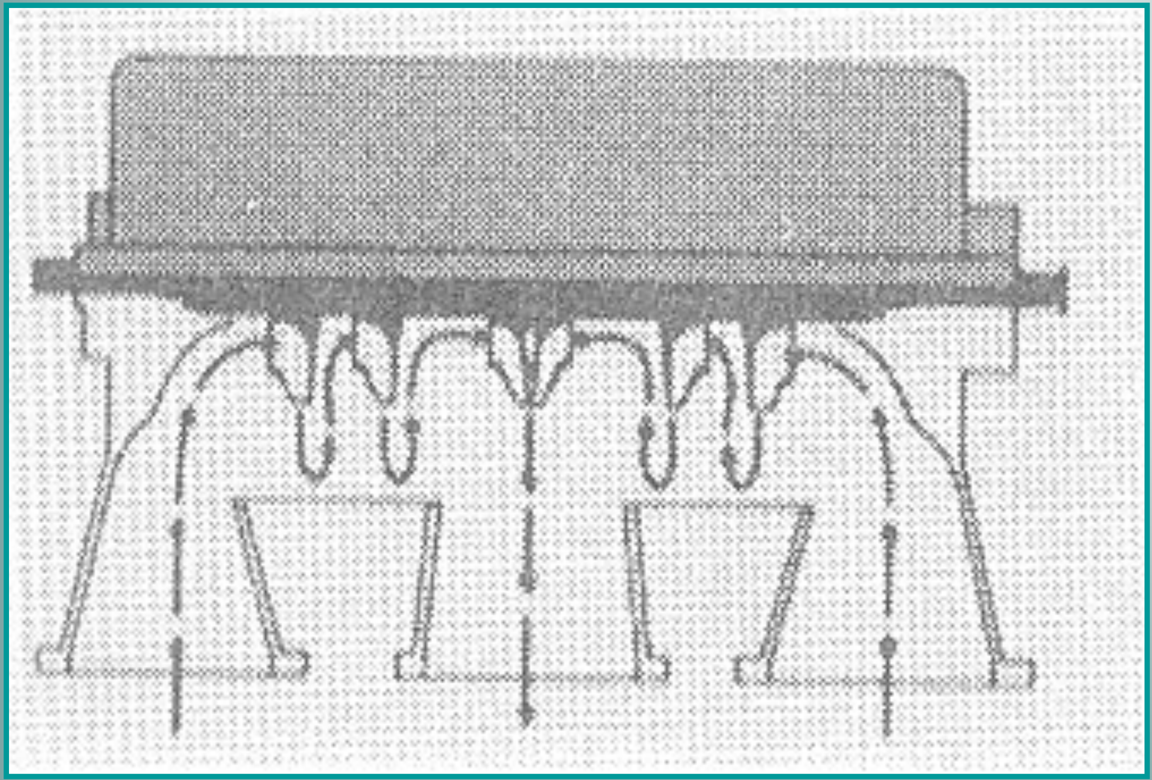
Minimizes thrust when high pressure rise is to be achieved within one casing.

Straight-Through Flow



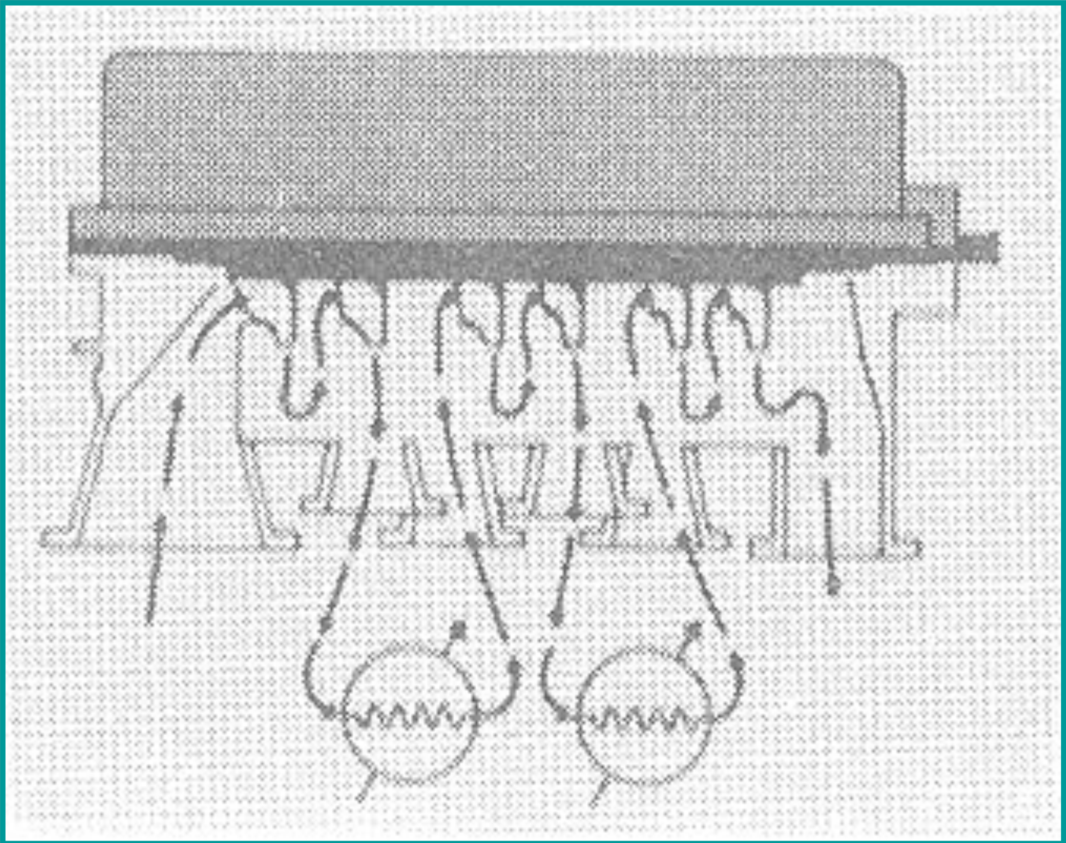
A conventional arrangement. May employ as many as 12 stages

Double-Flow



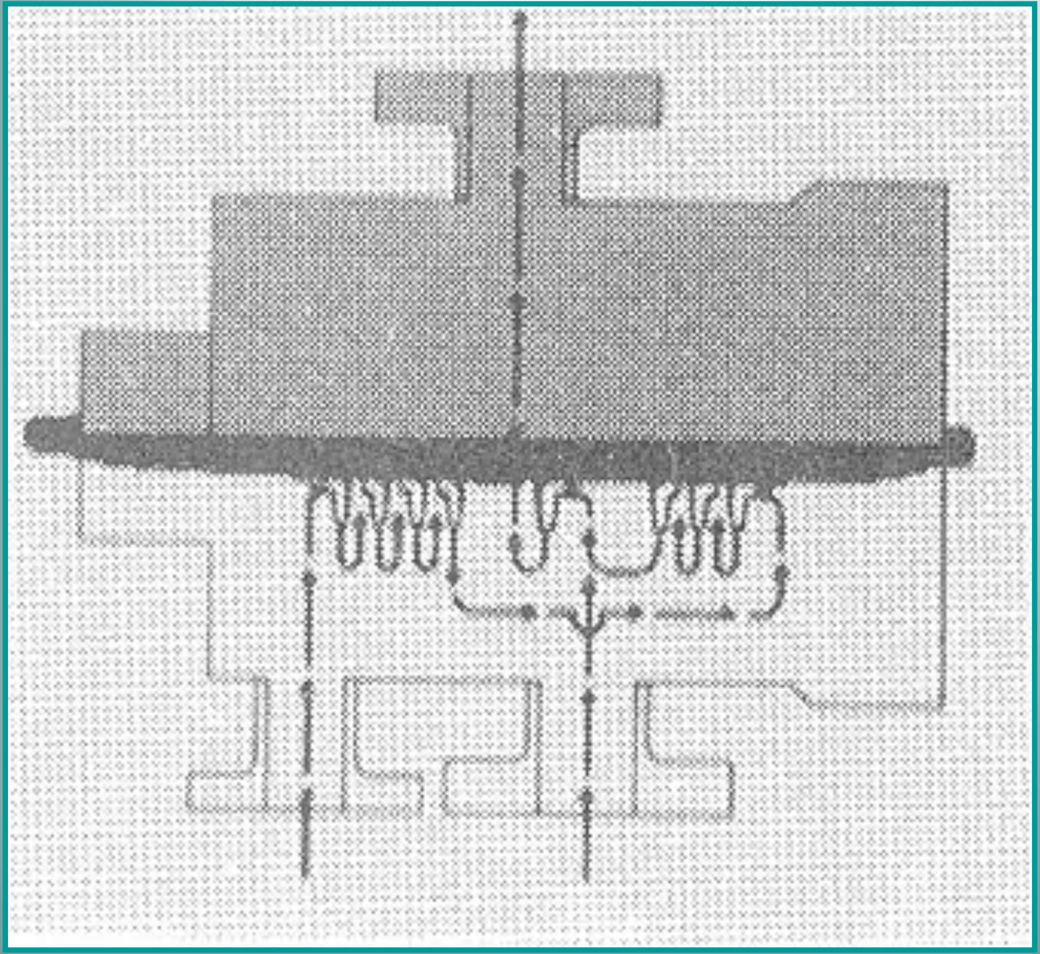
Double the possible maximum flow capability of the compressor.

Double Iso-Cooling



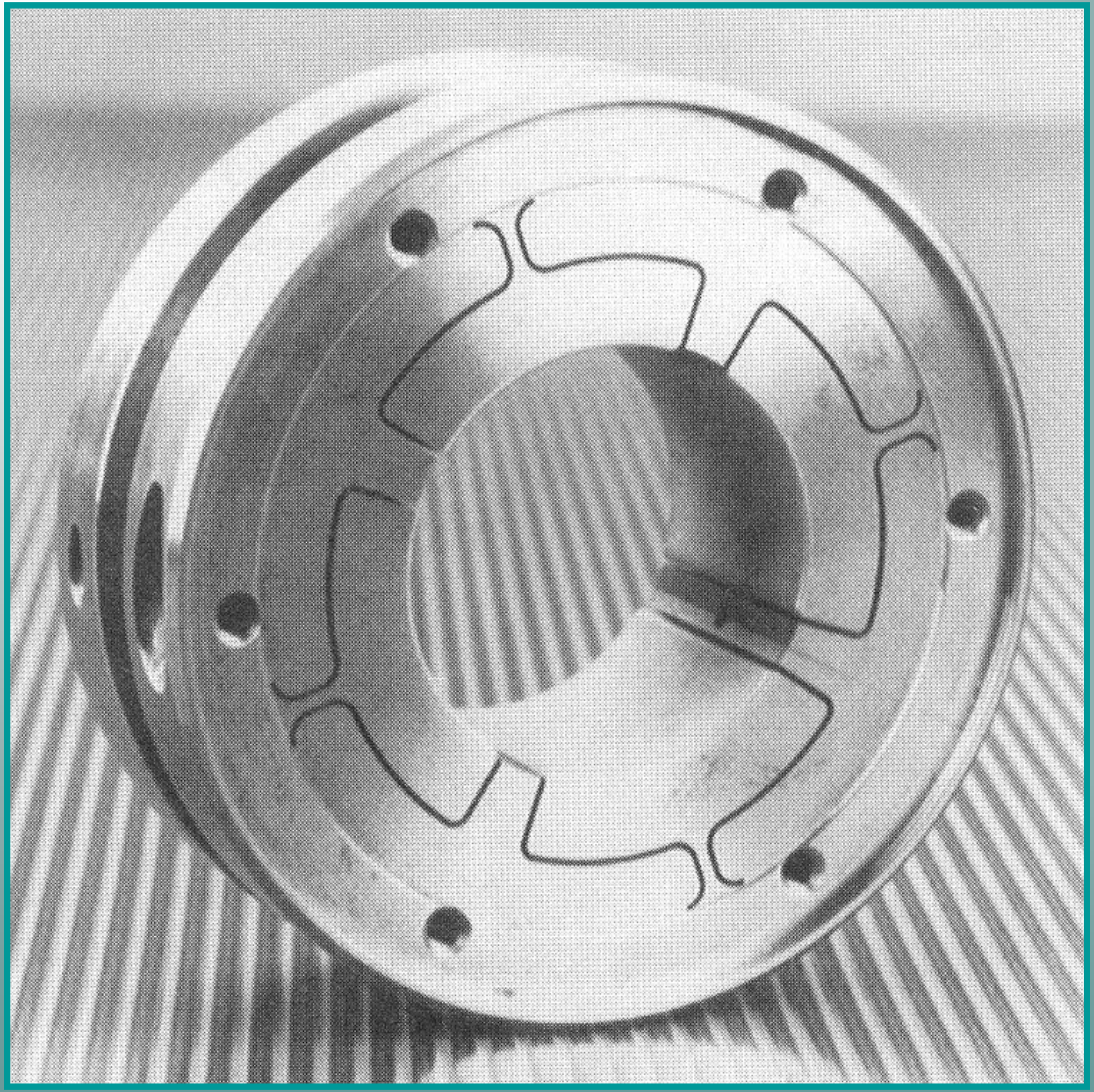
High molecular mass gases such as chlorine, heat much more rapidly during compression. For the compression of such gases, this arrangement is employed

Back-to-Back plus Recirculation

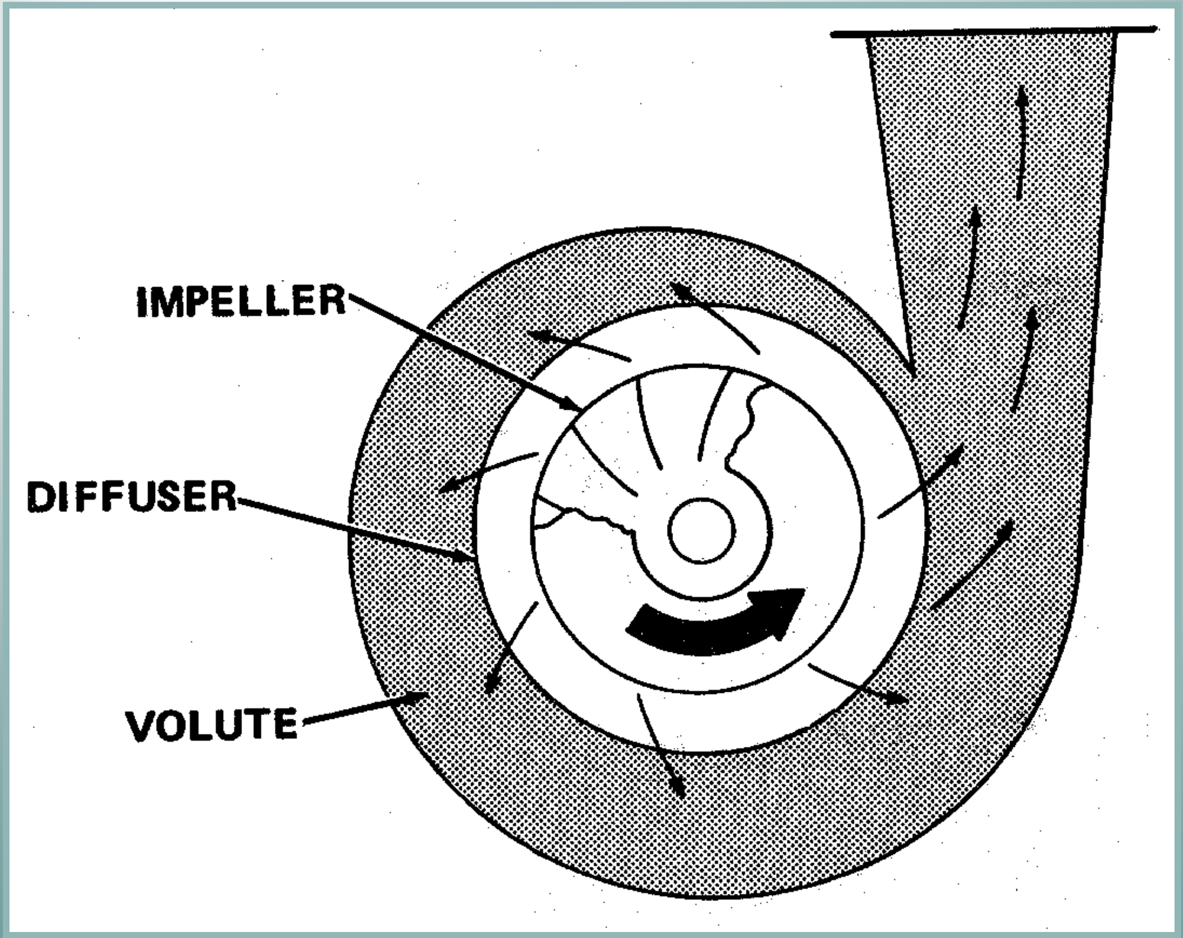


This unit is typical for combined feed gas and circular service. Last stage flow is combined with recycle flow.

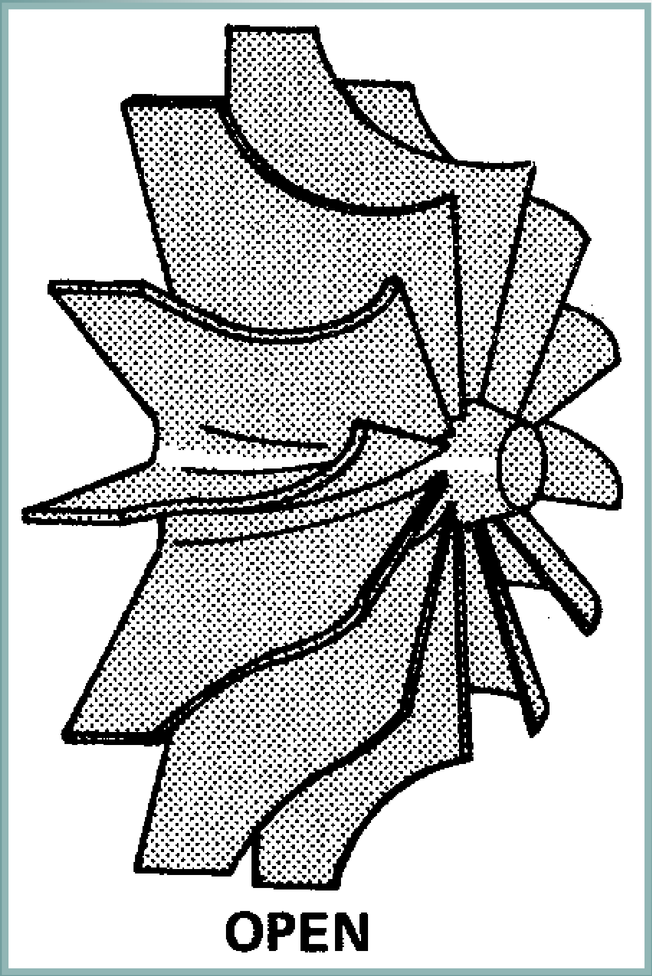
Flexure Pivot Tilt Pad Bearing

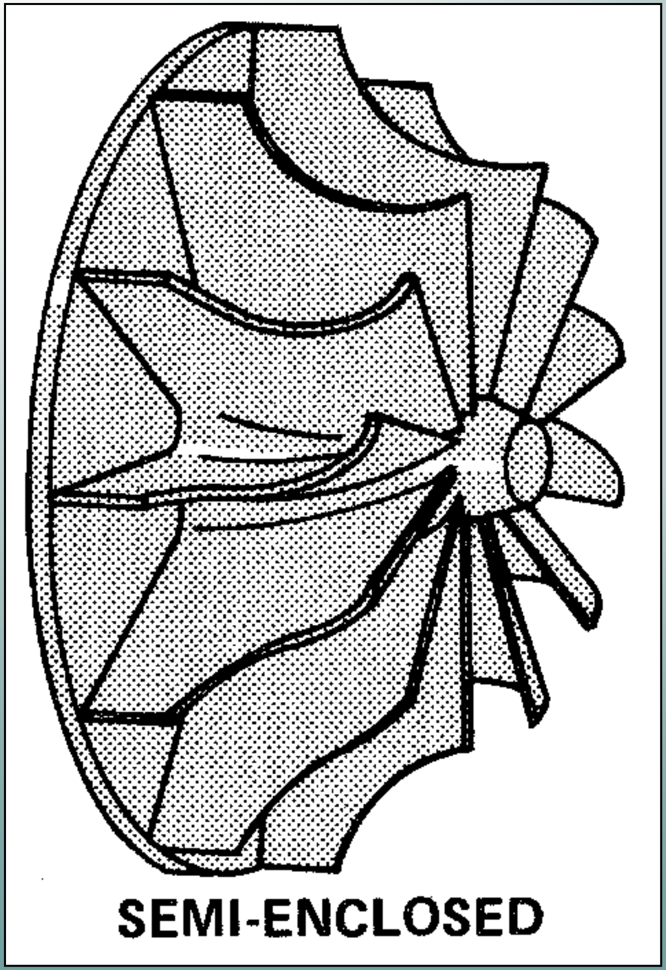


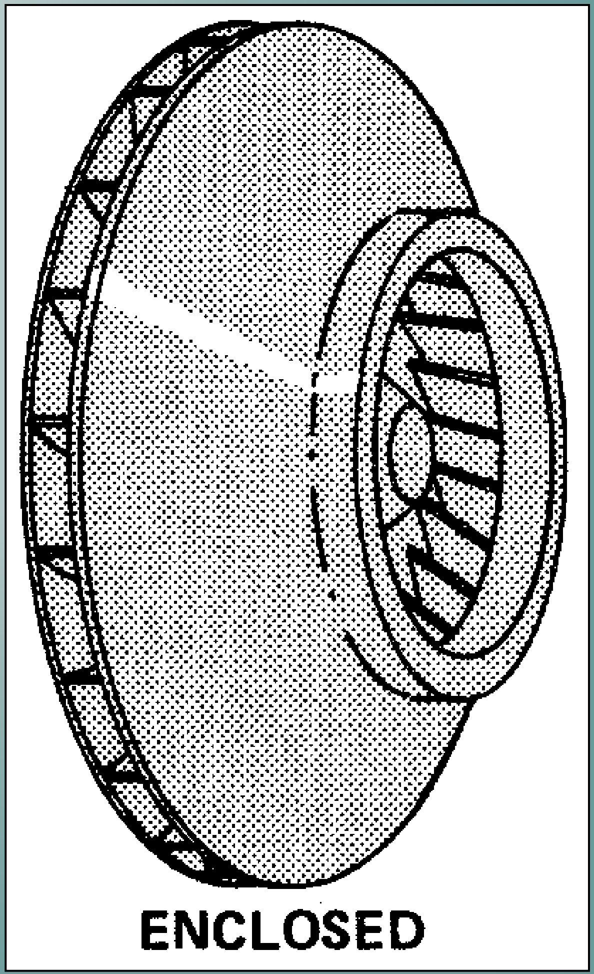
Compressor Main Components



Impeller Types

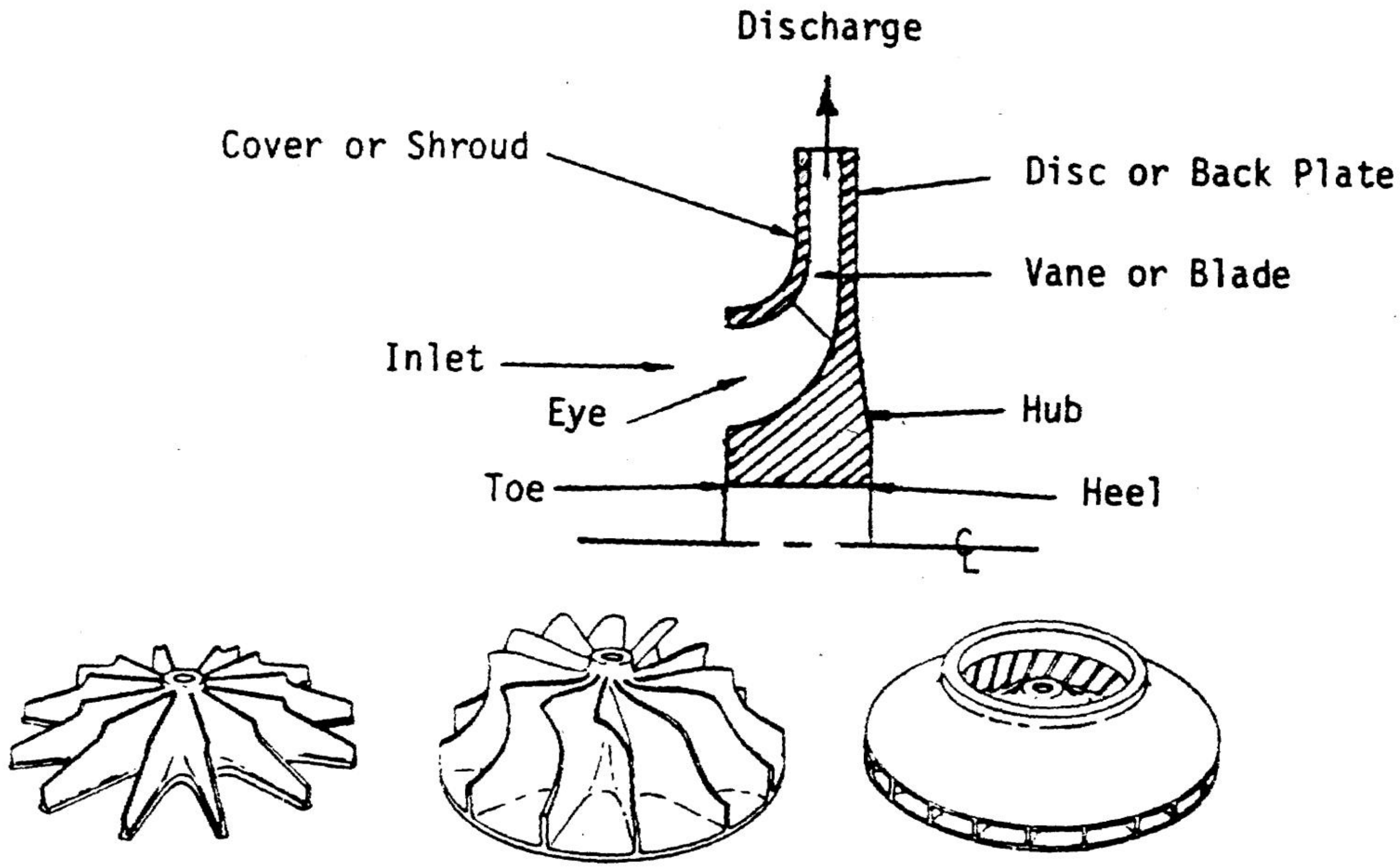




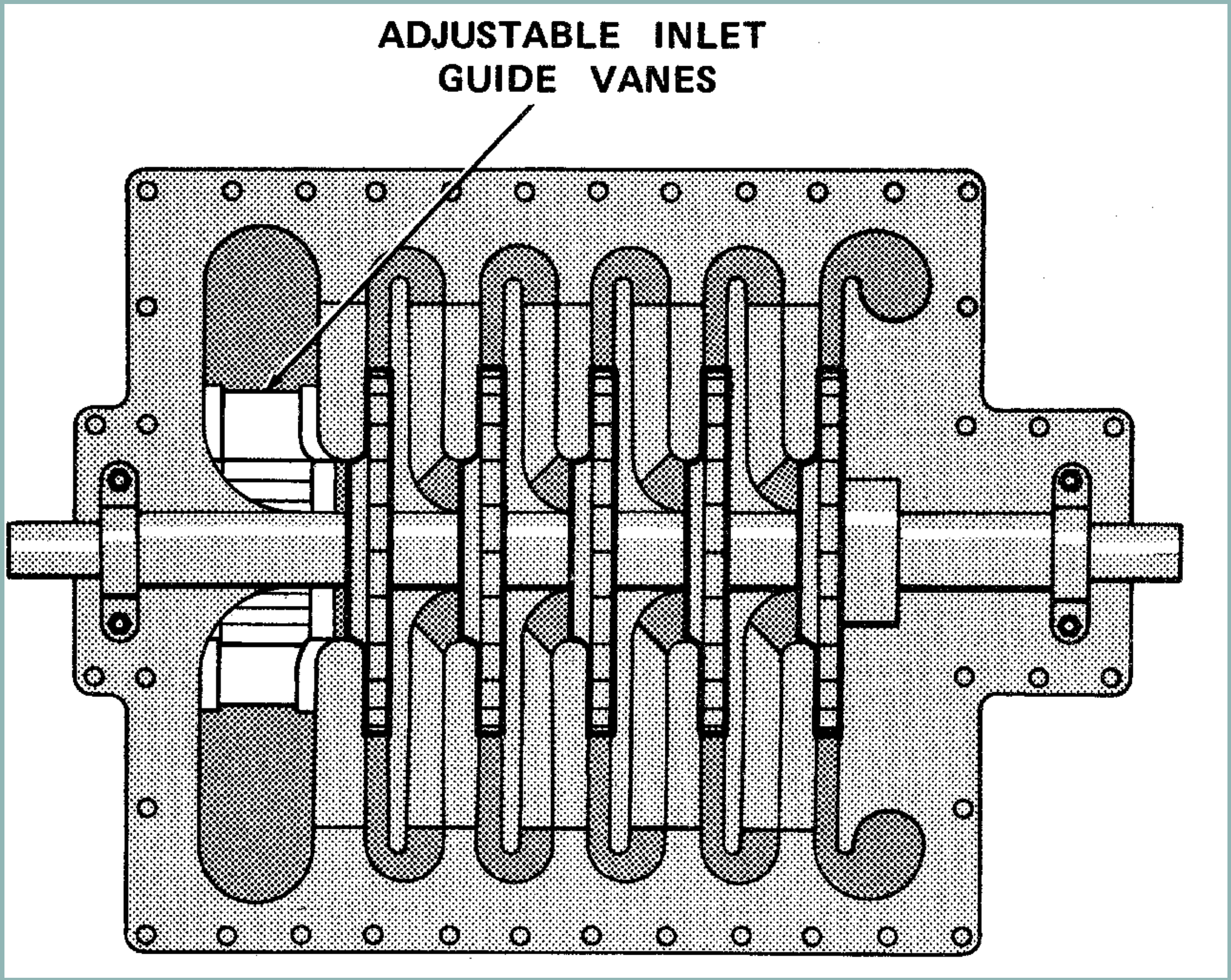


Impeller Nomenclature

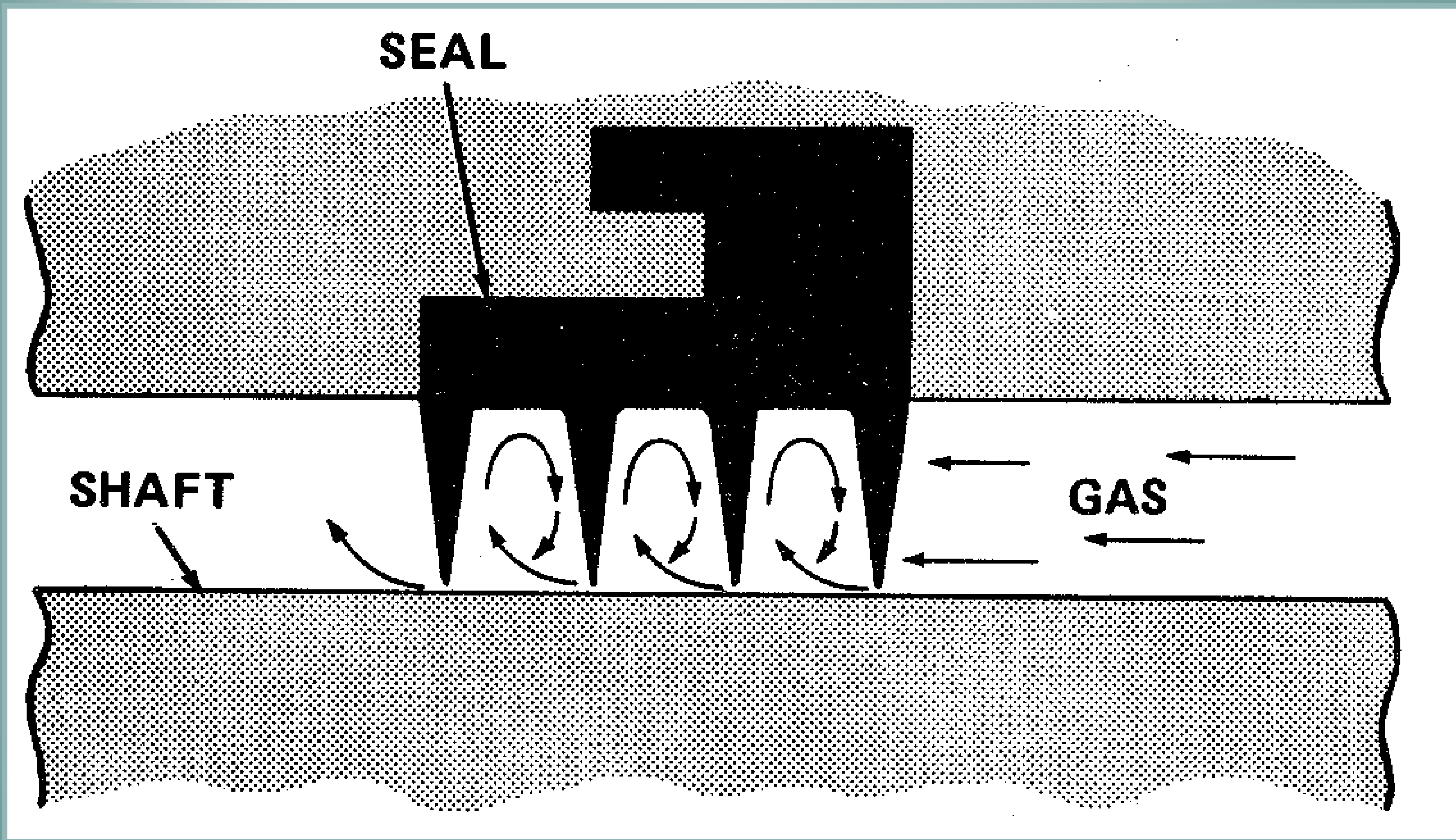
Impeller nomenclature:



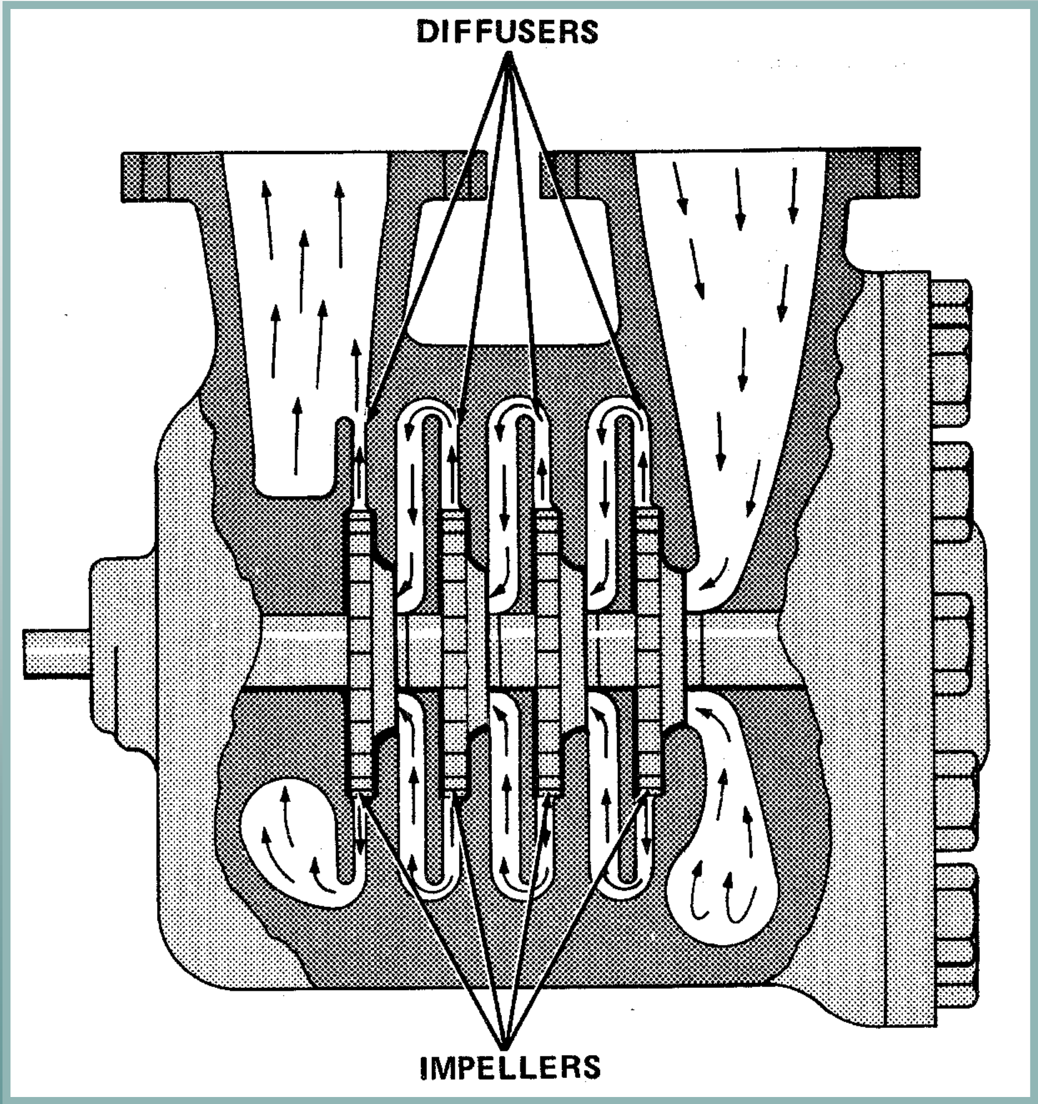
Guide Vanes



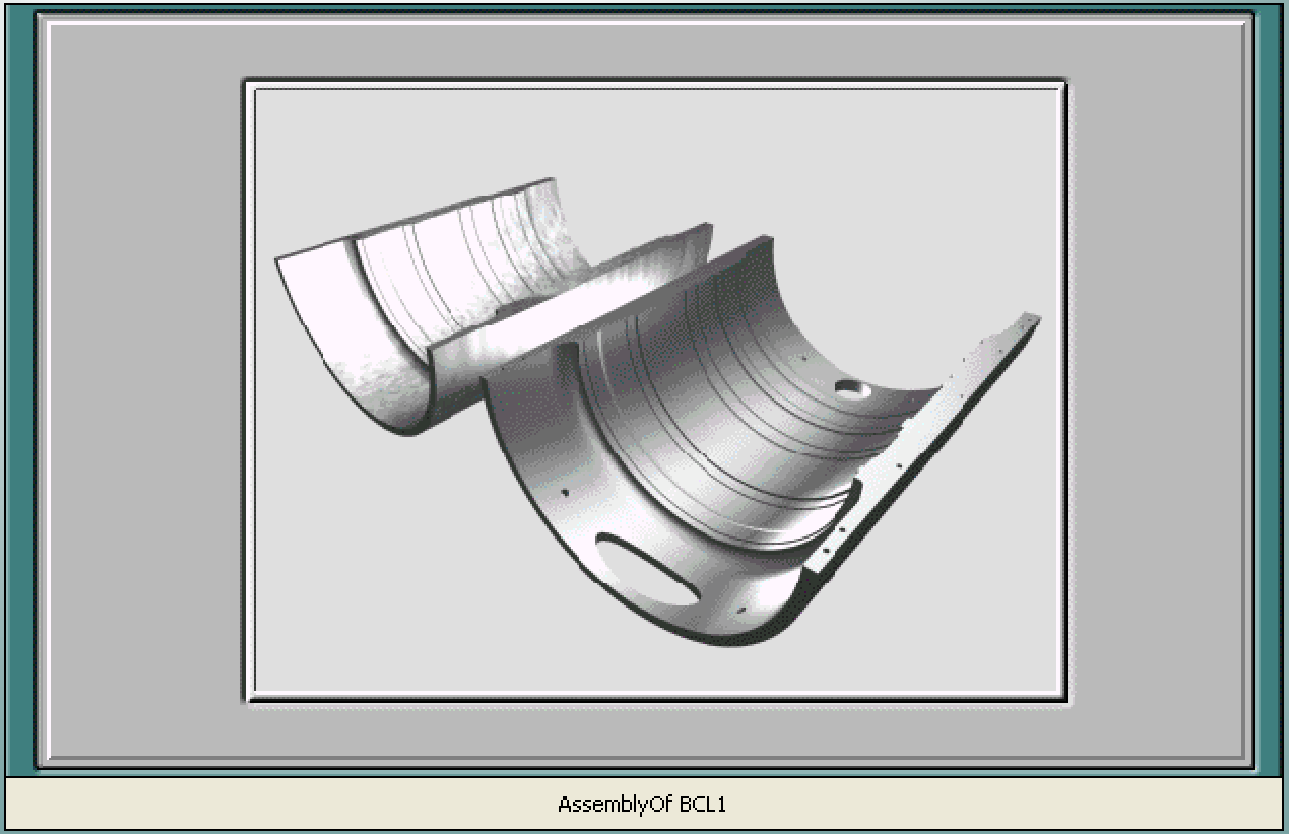
Labyrinth Working Principle



Multi Stage Compressor



BCL Assembly



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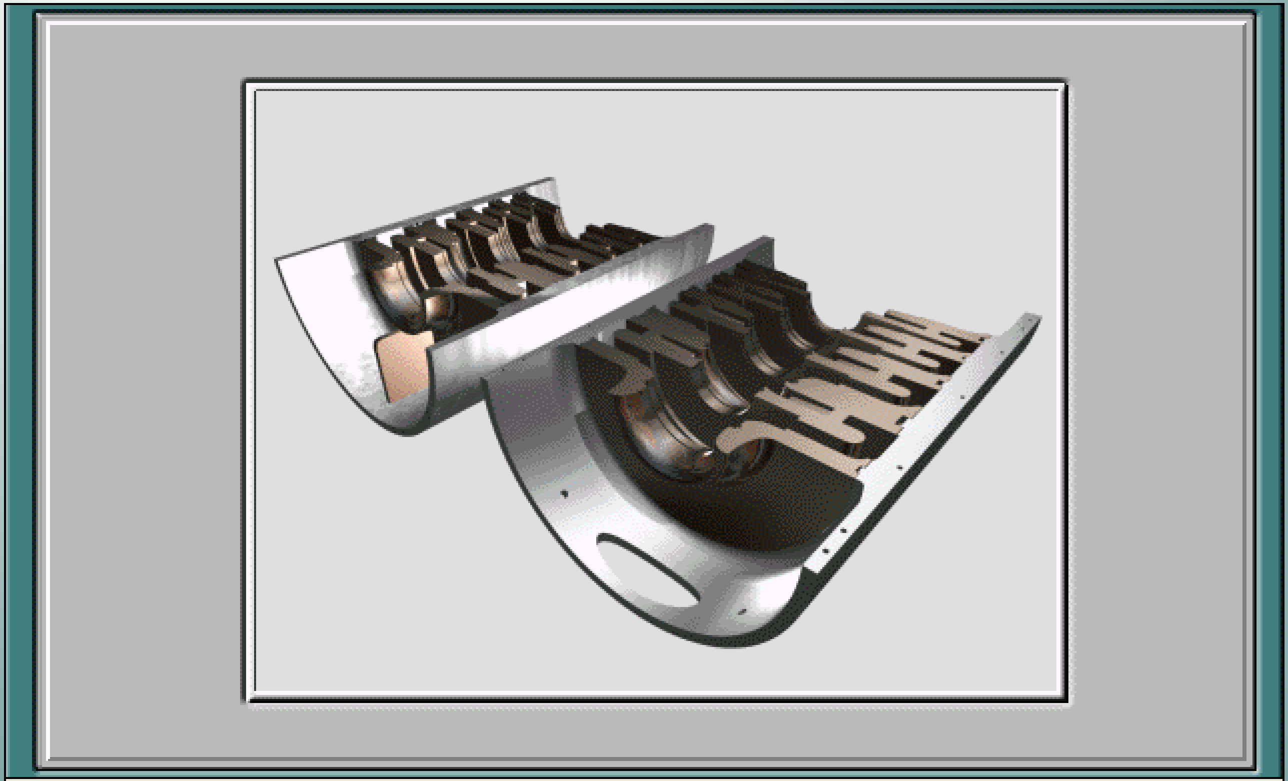
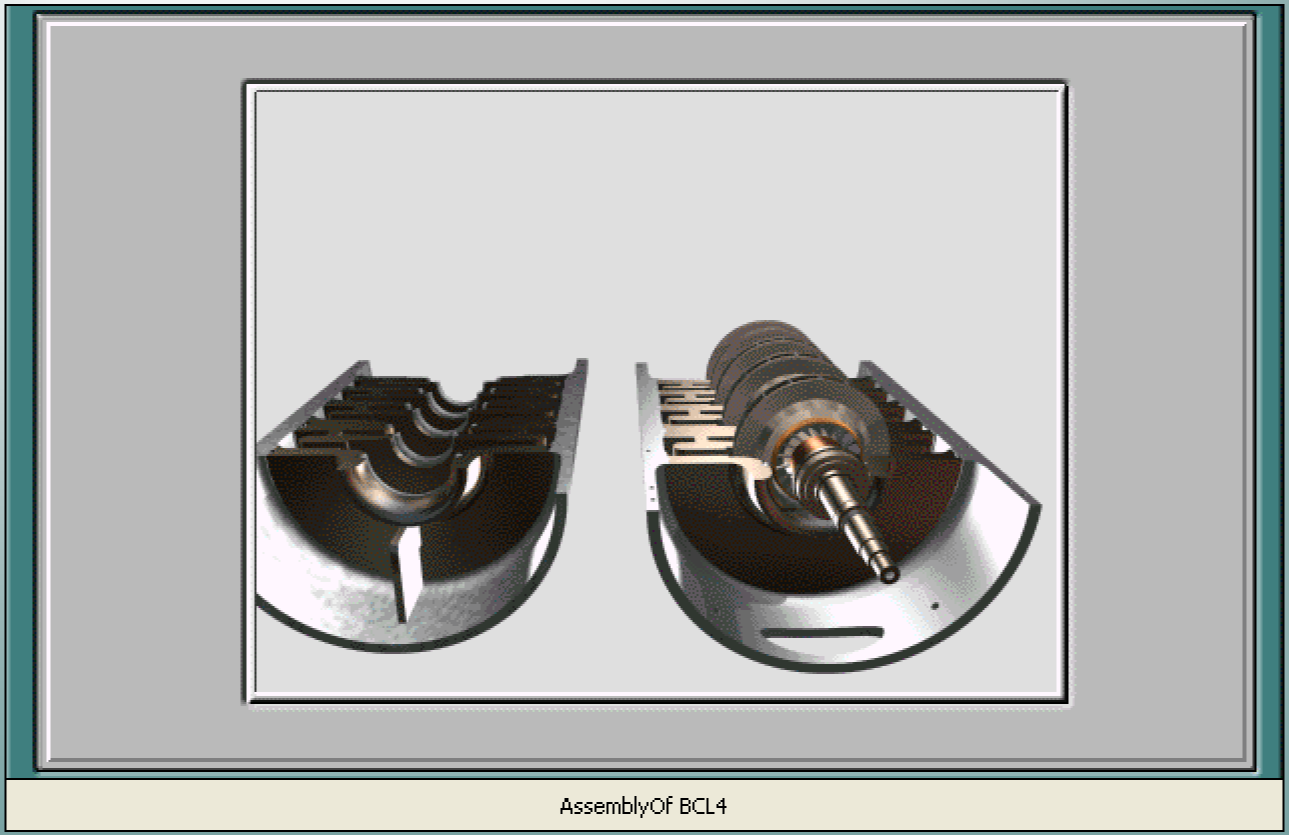


AssemblyOf BCL2

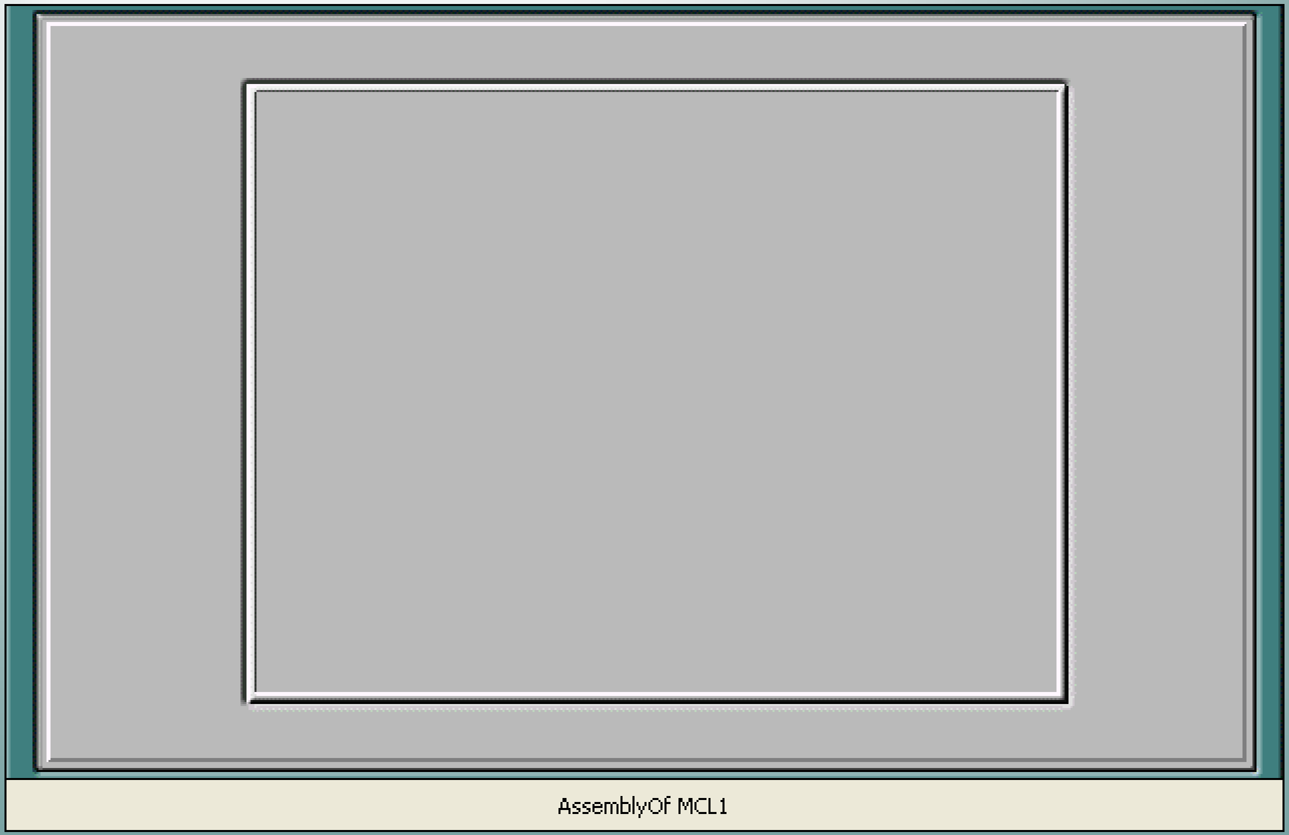
BCL Assembly

AssemblyOf BCL3

BCL Assembly



MCL Assembly



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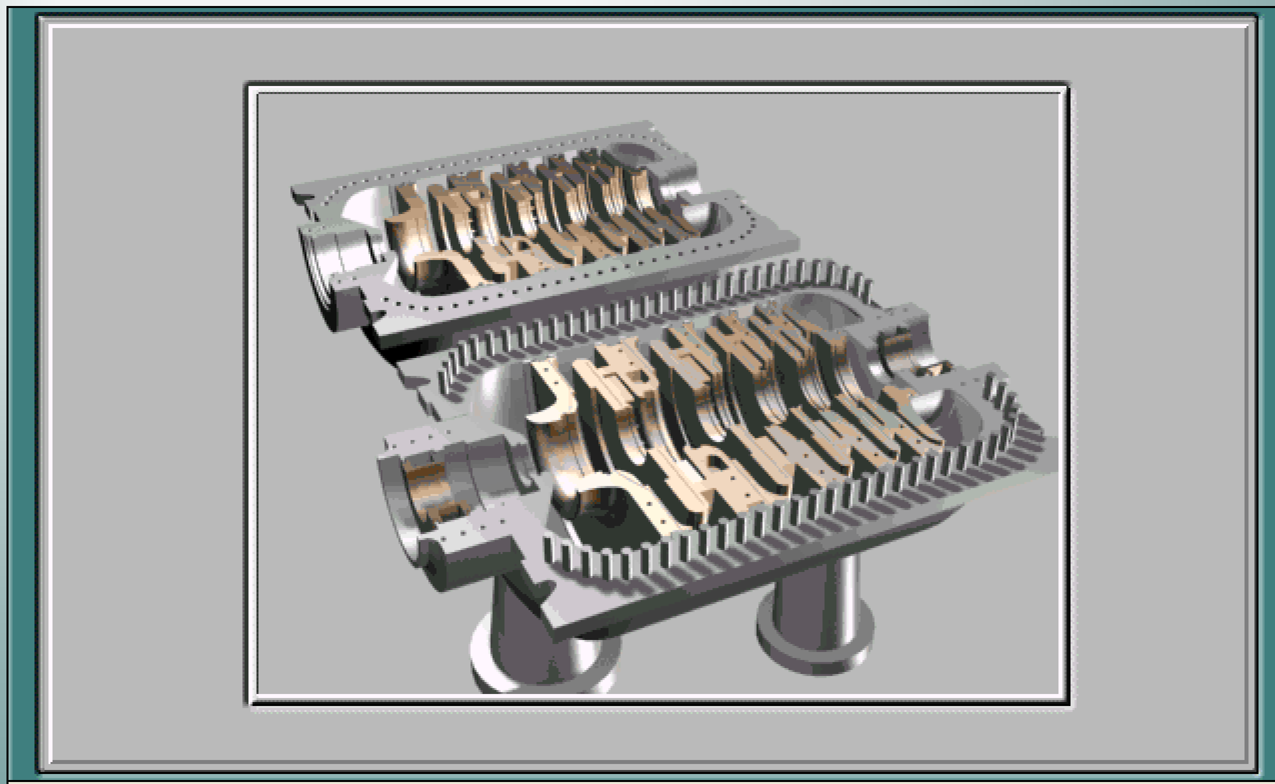
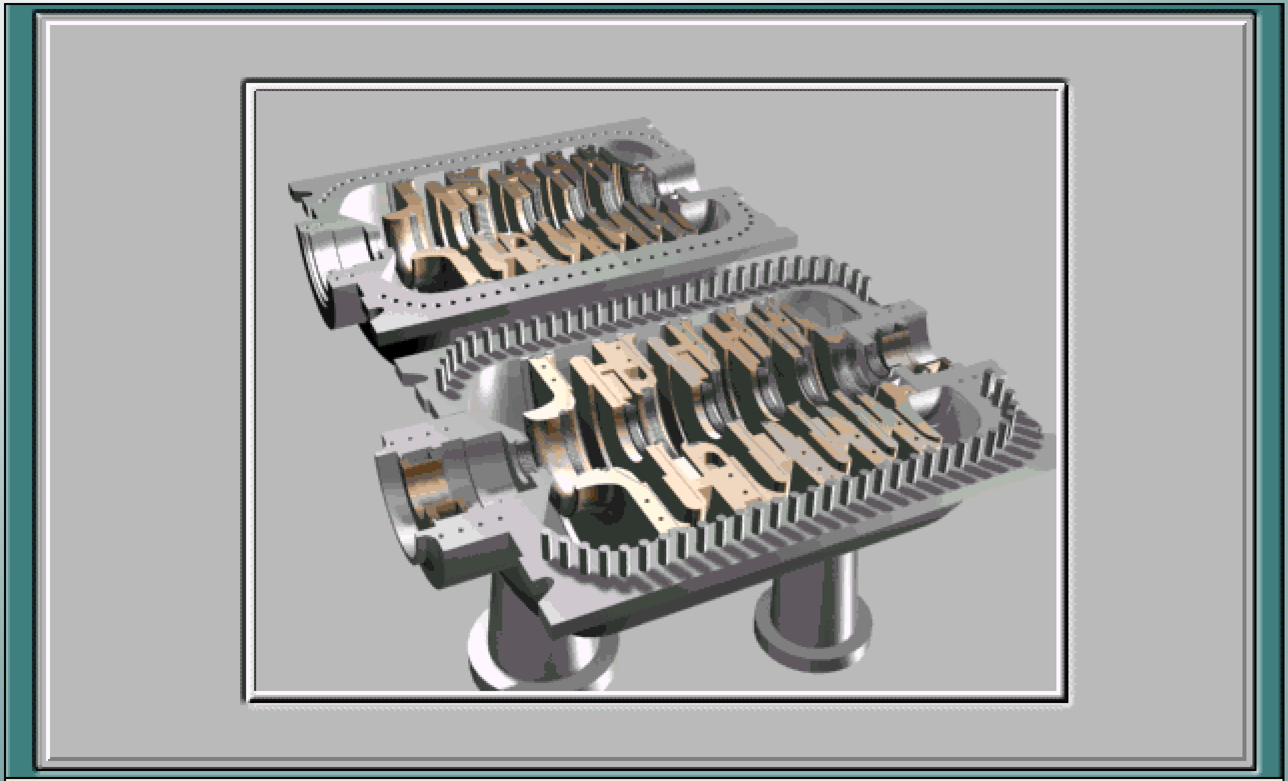


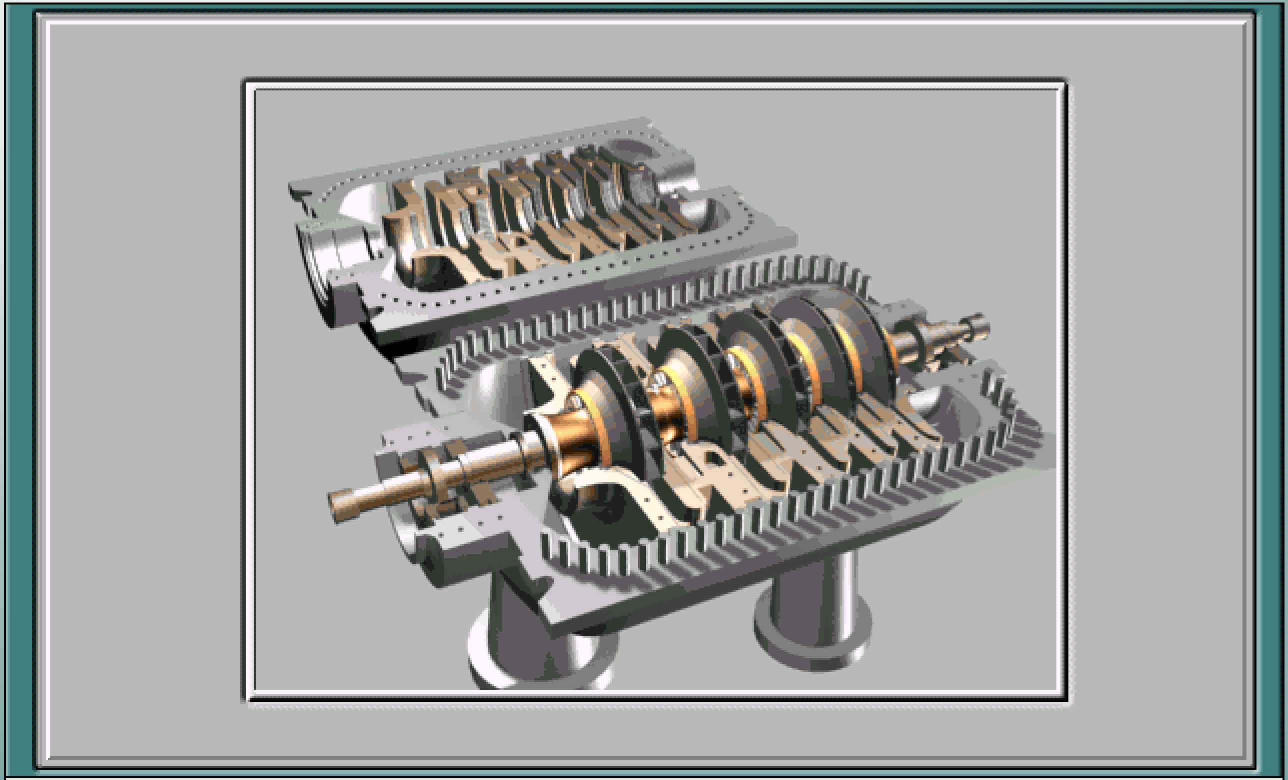
AssemblyOf MCL2

MCL Assembly



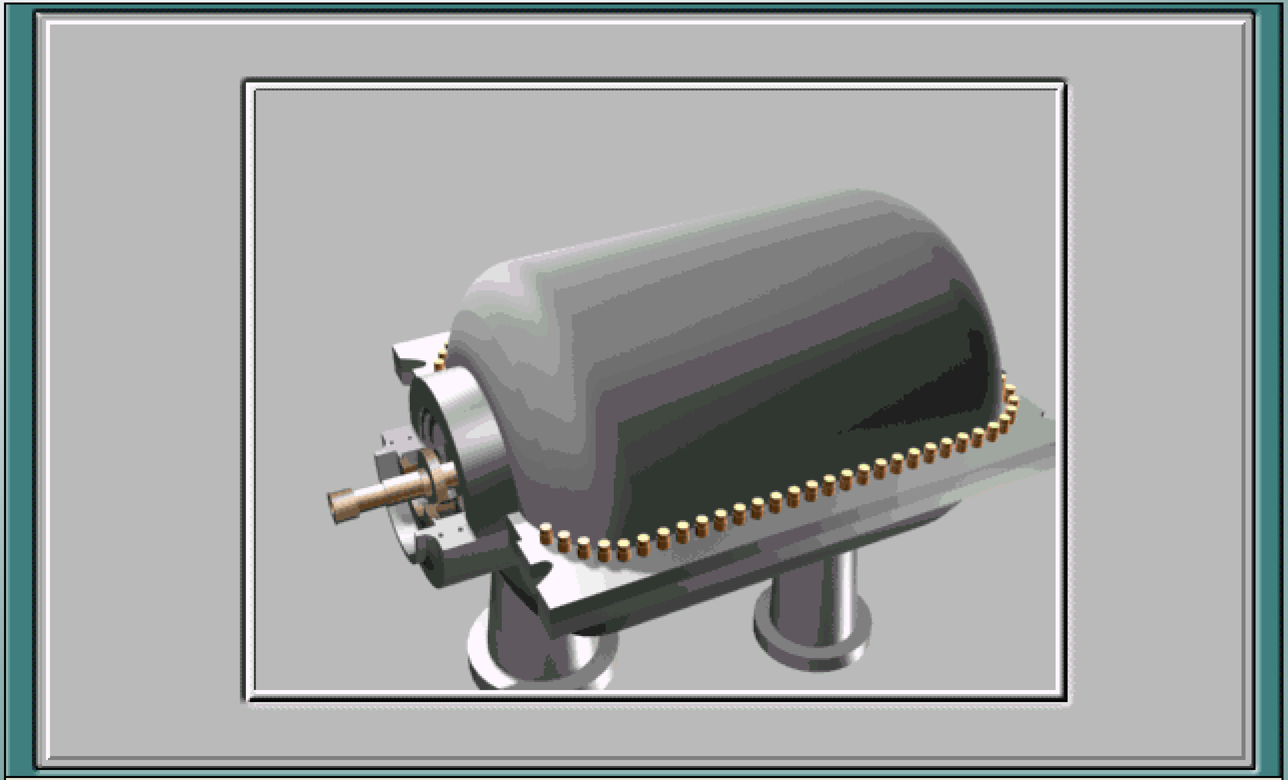
AssemblyOf MCL3

MCL Assembly



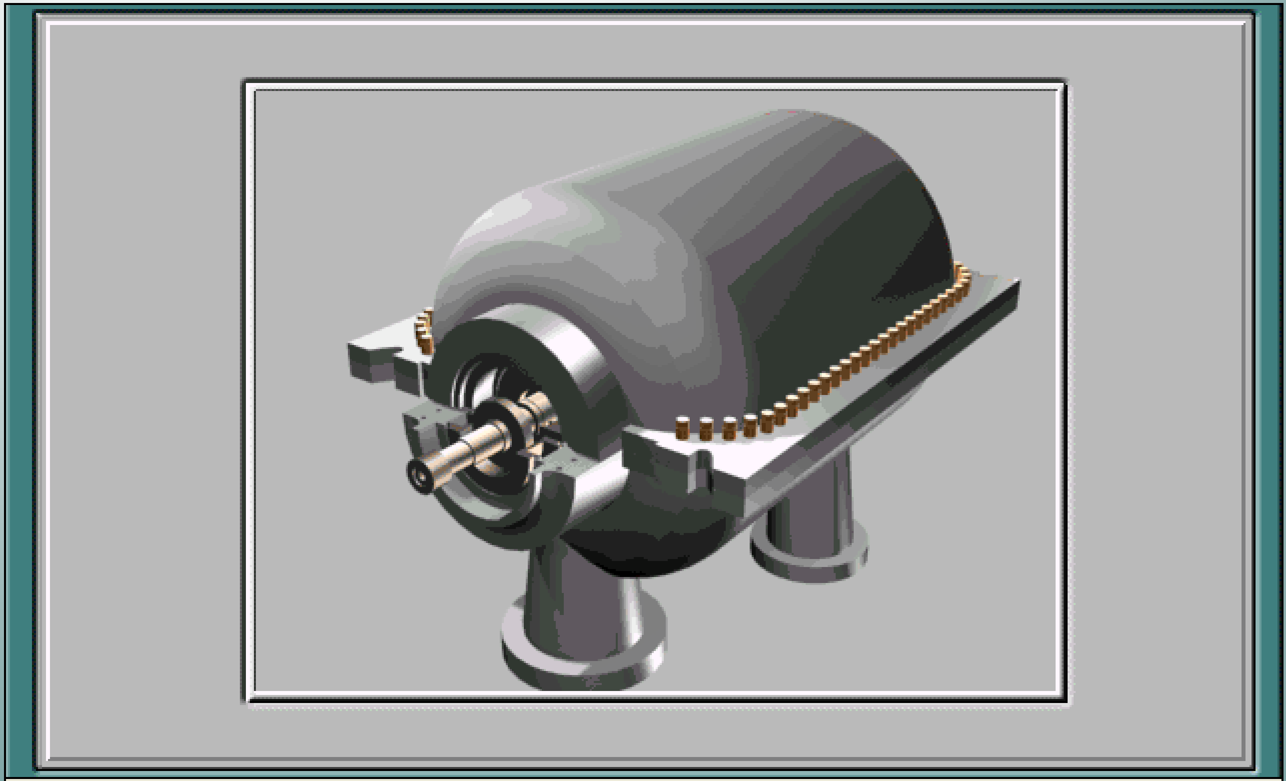
AssemblyOf MCL4

MCL Assembly



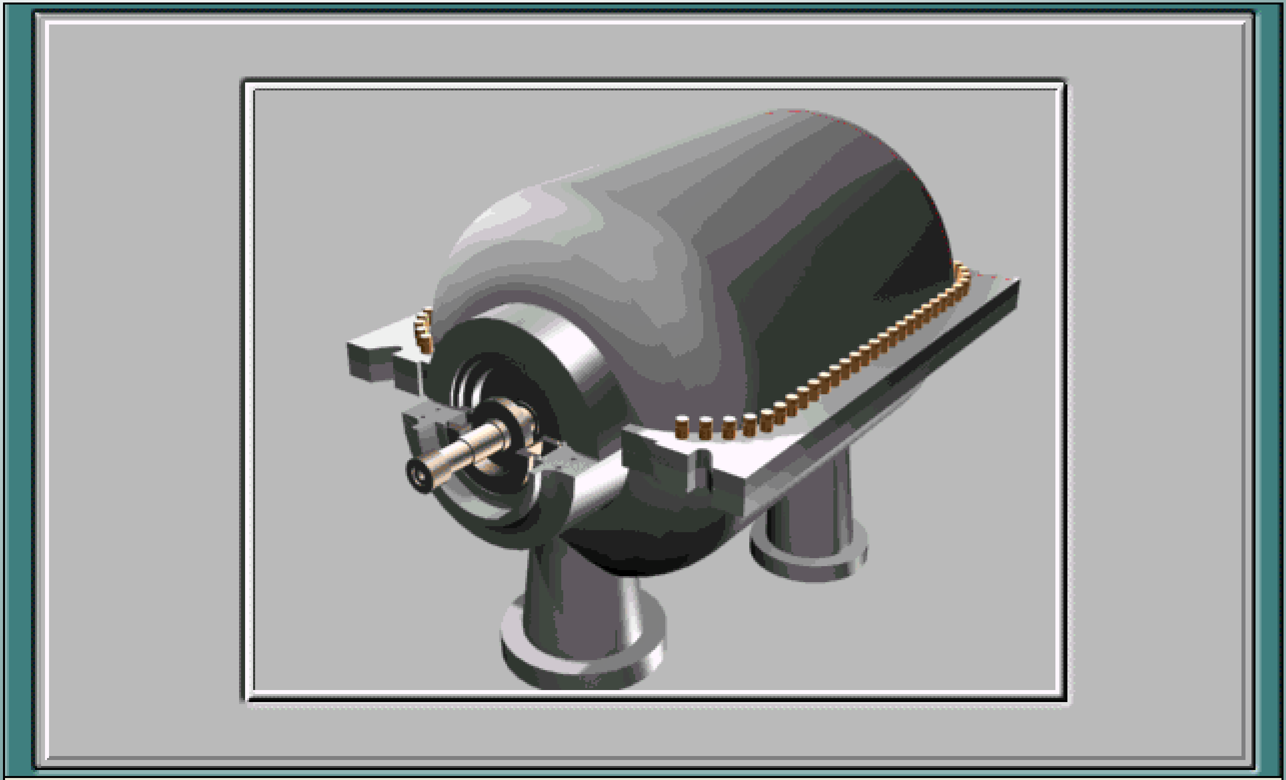
AssemblyOf MC5

MCL Assembly



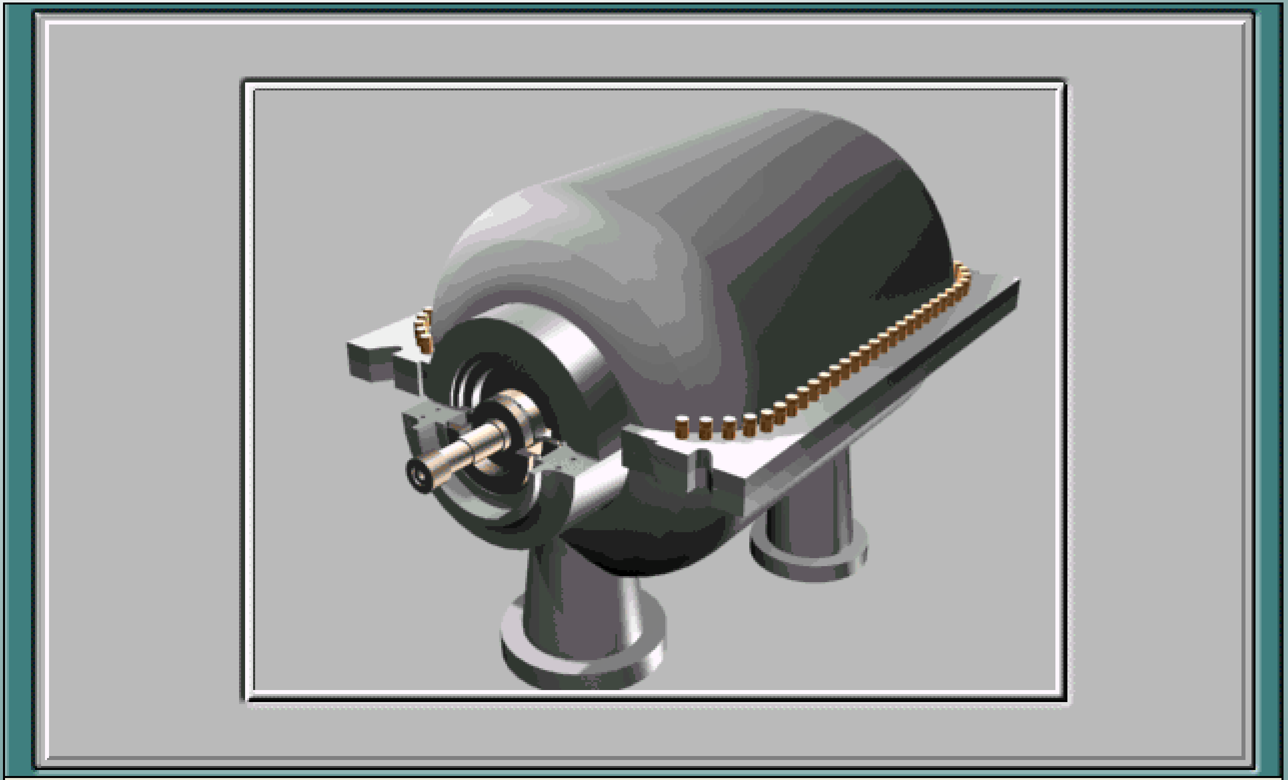
AssemblyOf MCL6

MCL Assembly



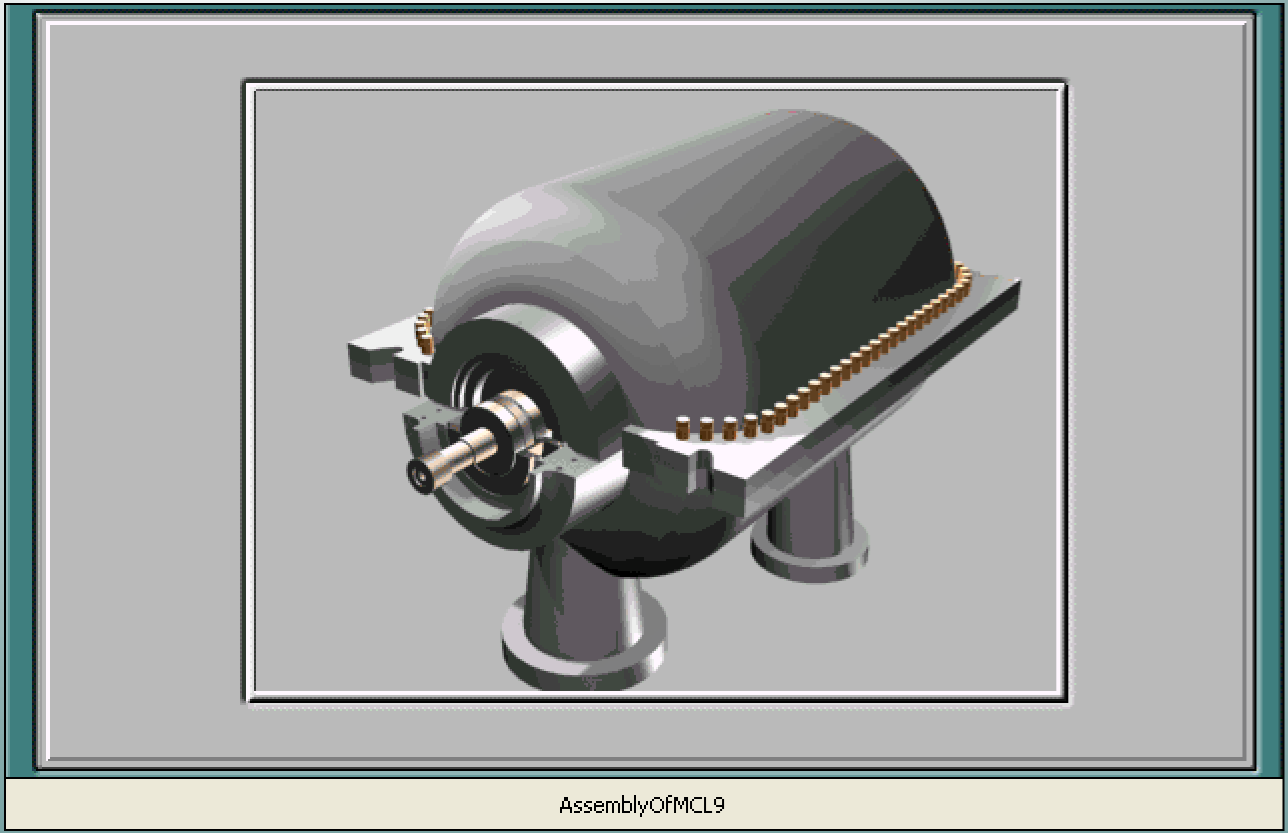
AssemblyOf MCL7

MCL Assembly

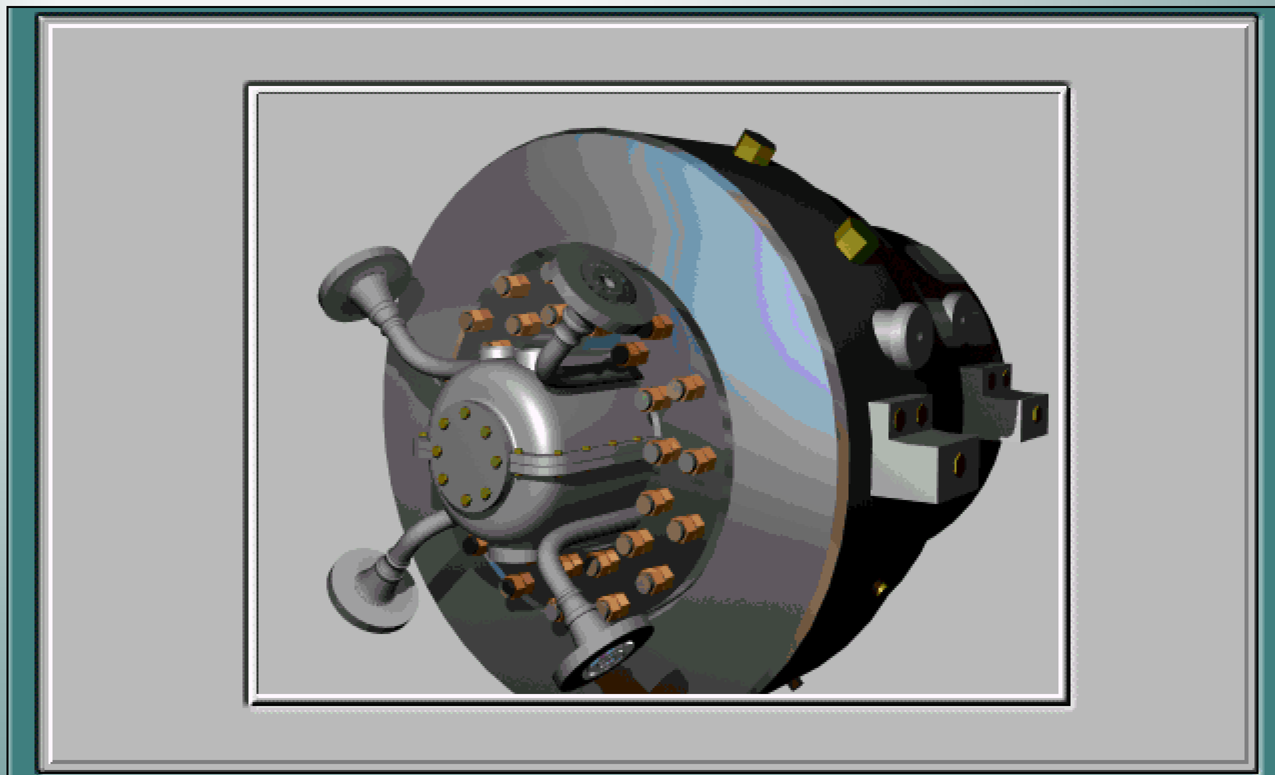


AssemblyOfMCL8

MCL Assembly

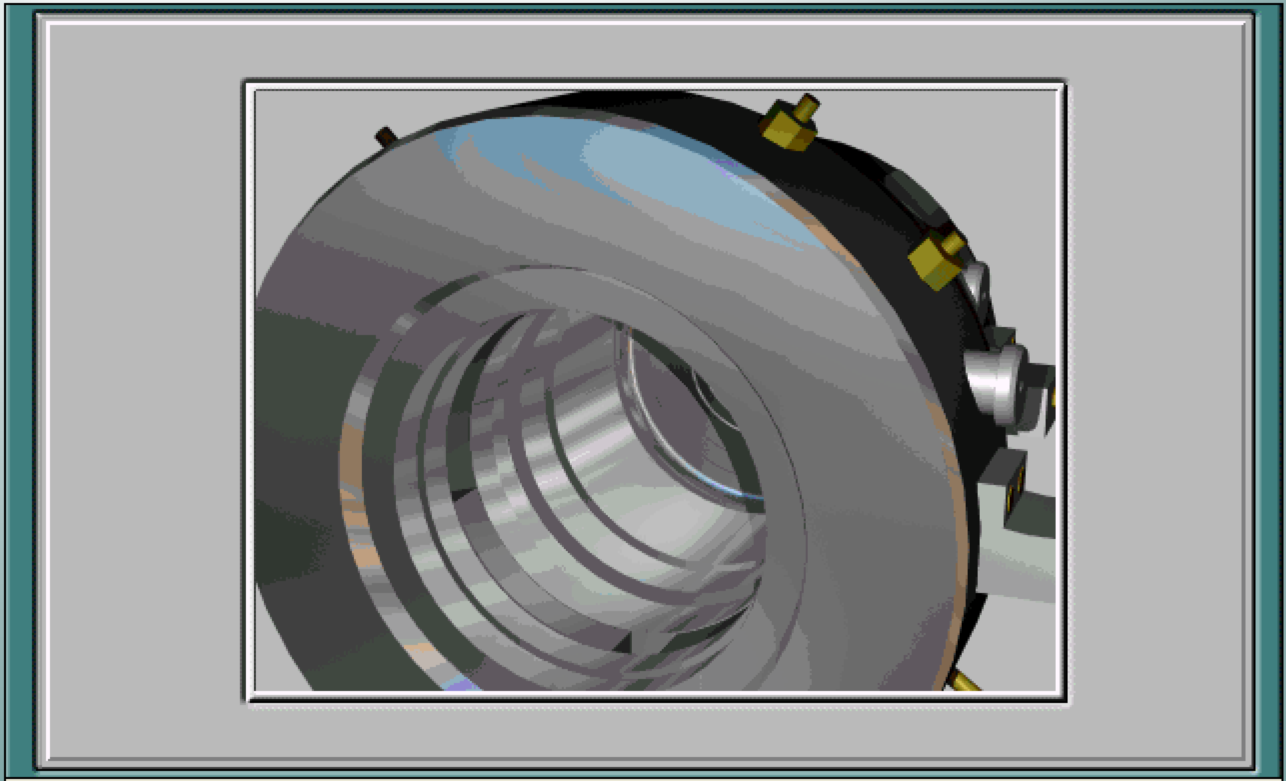


BLP Assembly



AssemblyOf BLP1

BLP Assembly



AssemblyOf BLP2