
PUMPS

PRINCIPLES OF PUMP OPERATION

Pumps are used to move any substance which flows or which can be made to flow. Most pump are used to move water, oil and other liquids.

A pump is device which uses an external source of power to apply a force to a fluid in order to move it from one place to another. Every pump has a **POWER END** and a **FLUID END**.

When a pump delivers energy to a liquid, it usually causes an increases in pressure, called **HEAD**.

PUMP TERMINOLOGY

Net Positive Suction Head – is a suction pressure minus the vapor pressure expressed in feet of liquid at the pump suction.

Suction Head – means the total pressure of liquid entering the pump

Discharge Head – means the pressure of liquid leaving the pump.

Total Head – difference between suction head and discharge head.

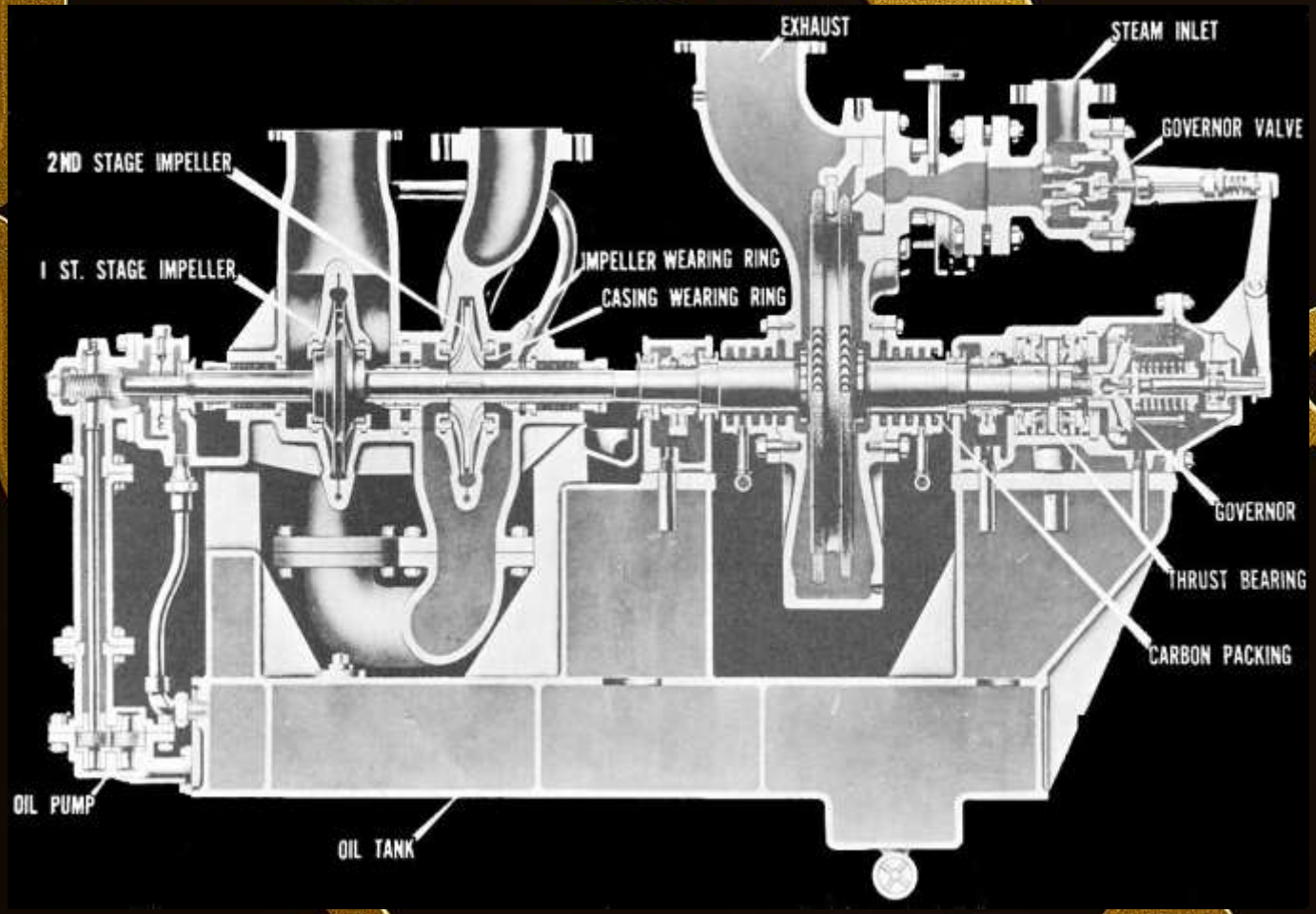
Types of Pumps

- Centrifugal Pumps
- Propeller Pumps
- Variable stroke pumps
- Reciprocating pump
- Positive displacement rotary pumps
- Eductors.

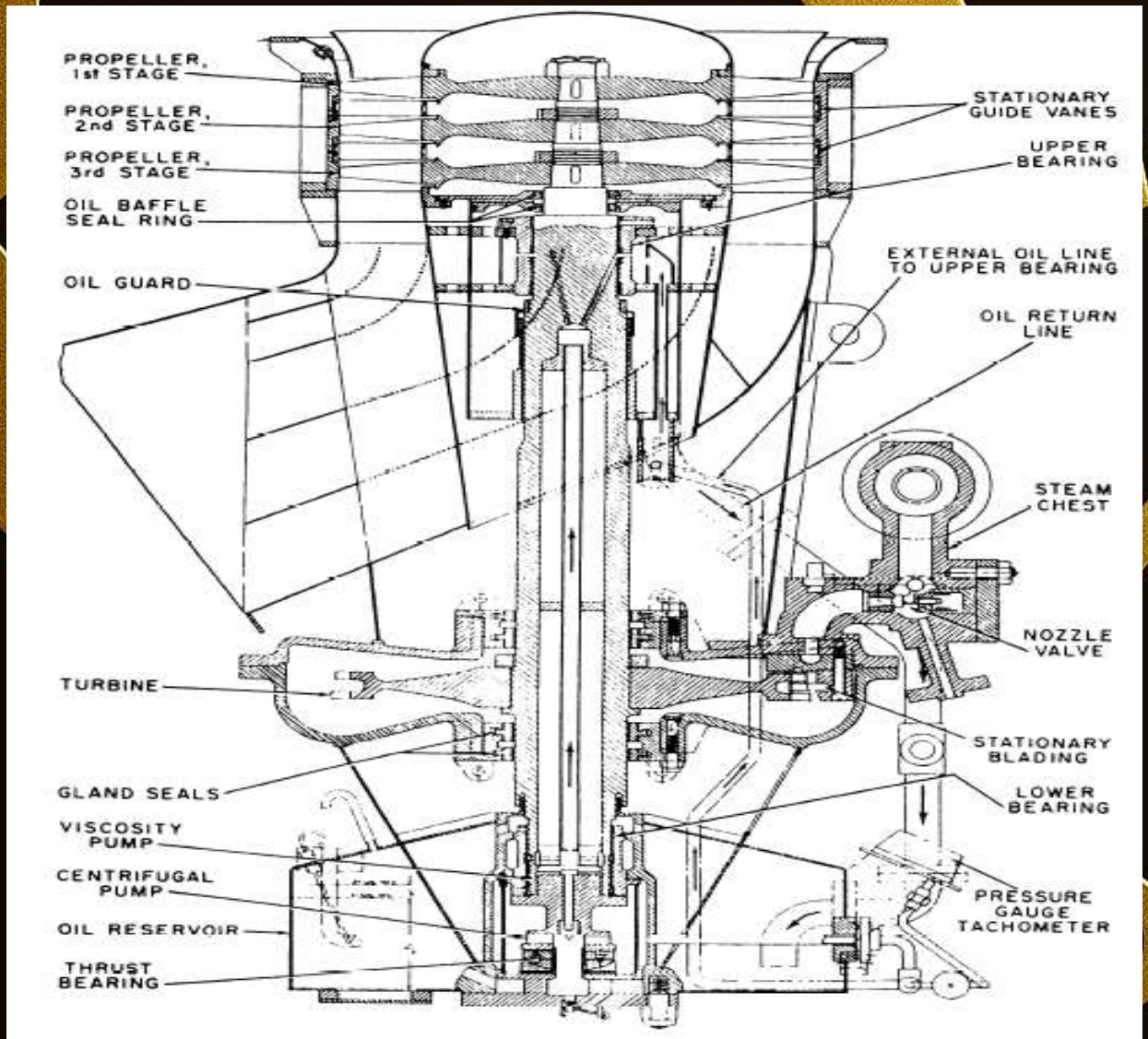
II. PUMP TYPES

- A. <u>Non-positive Displacement Pumps</u>
- 1. Centrifugal
- 2. Propeller
- 3. Jet / Eductor

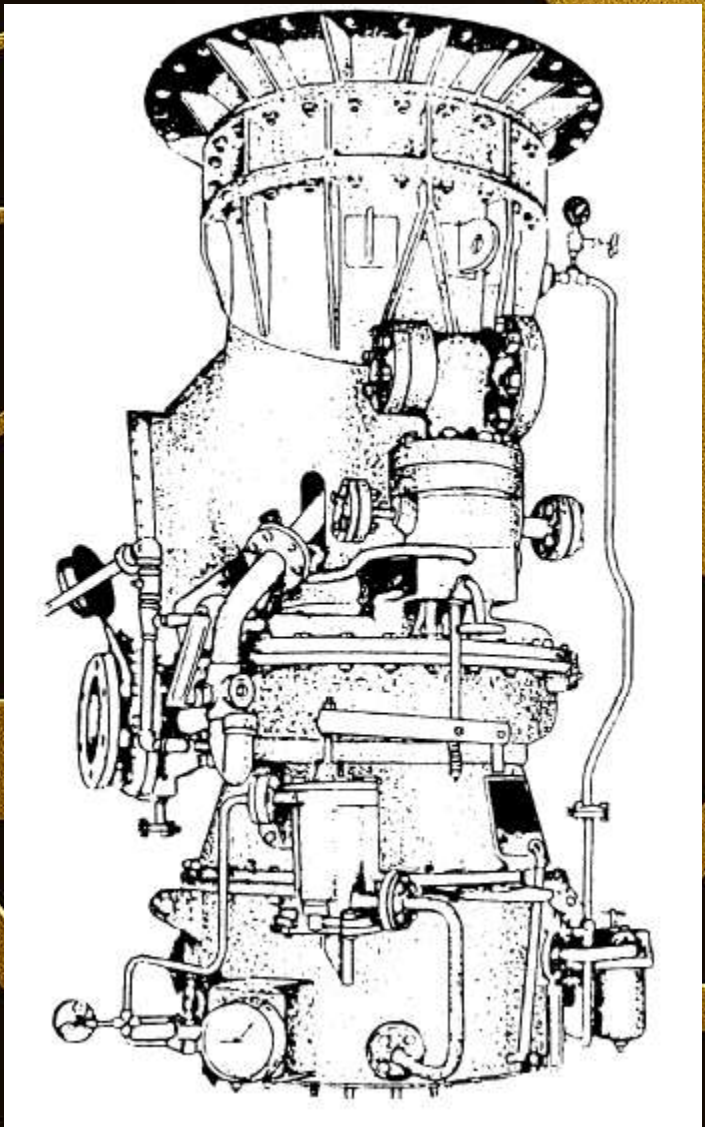
Centrifugal pump



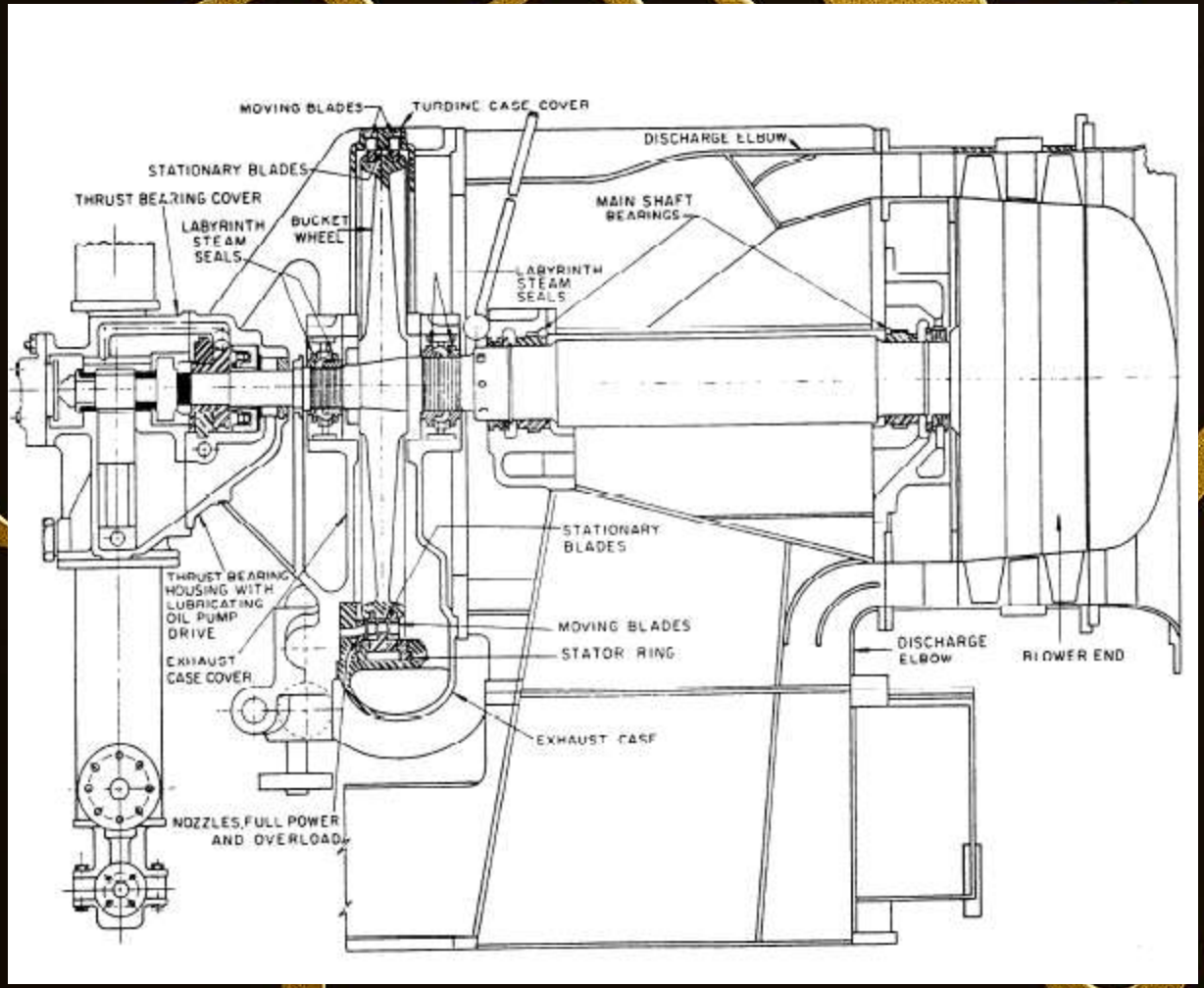
PROPELLER TYPE PUMP



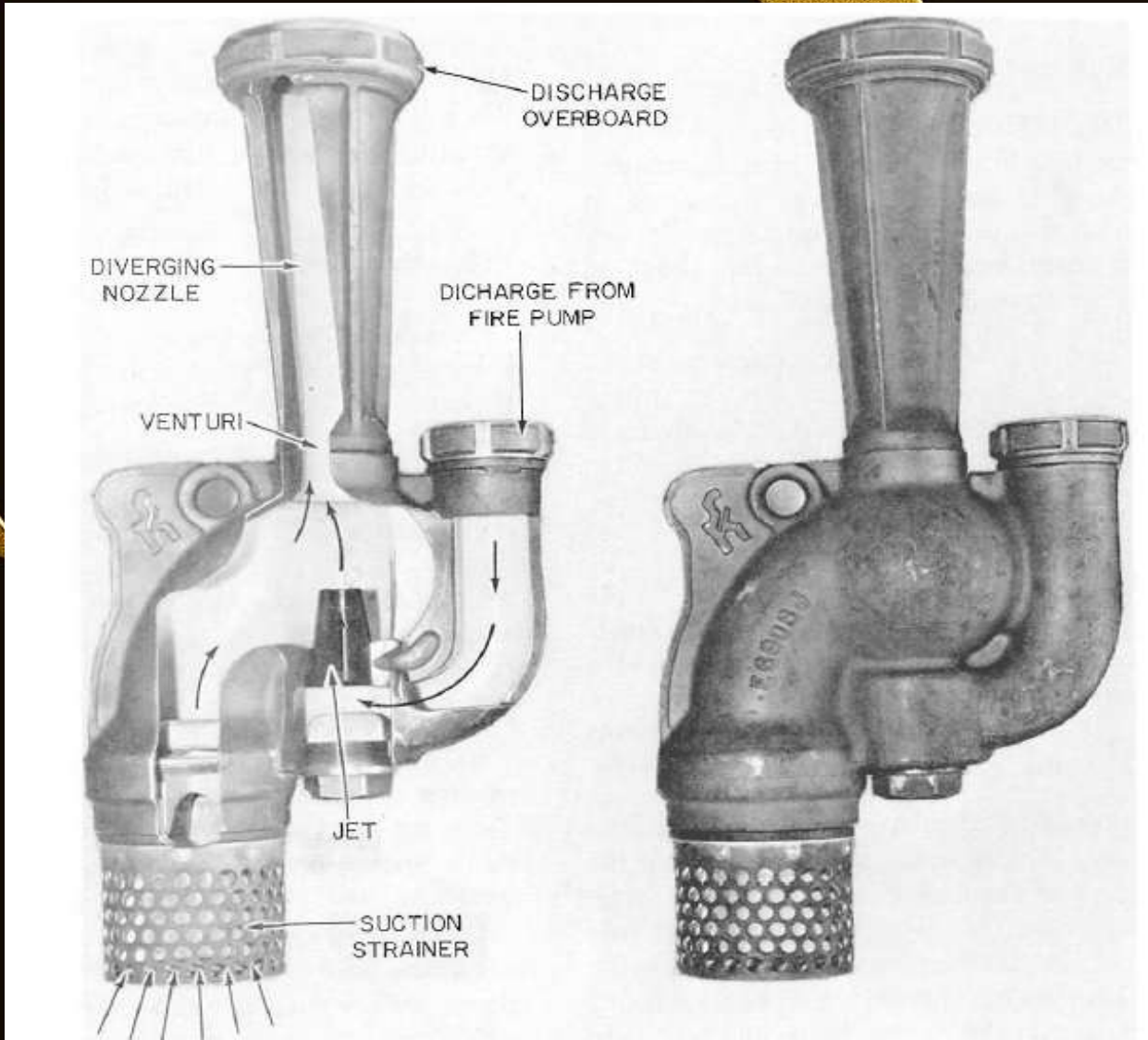
PROPELLER TYPE PUMP



PROPELLER TYPE PUMP



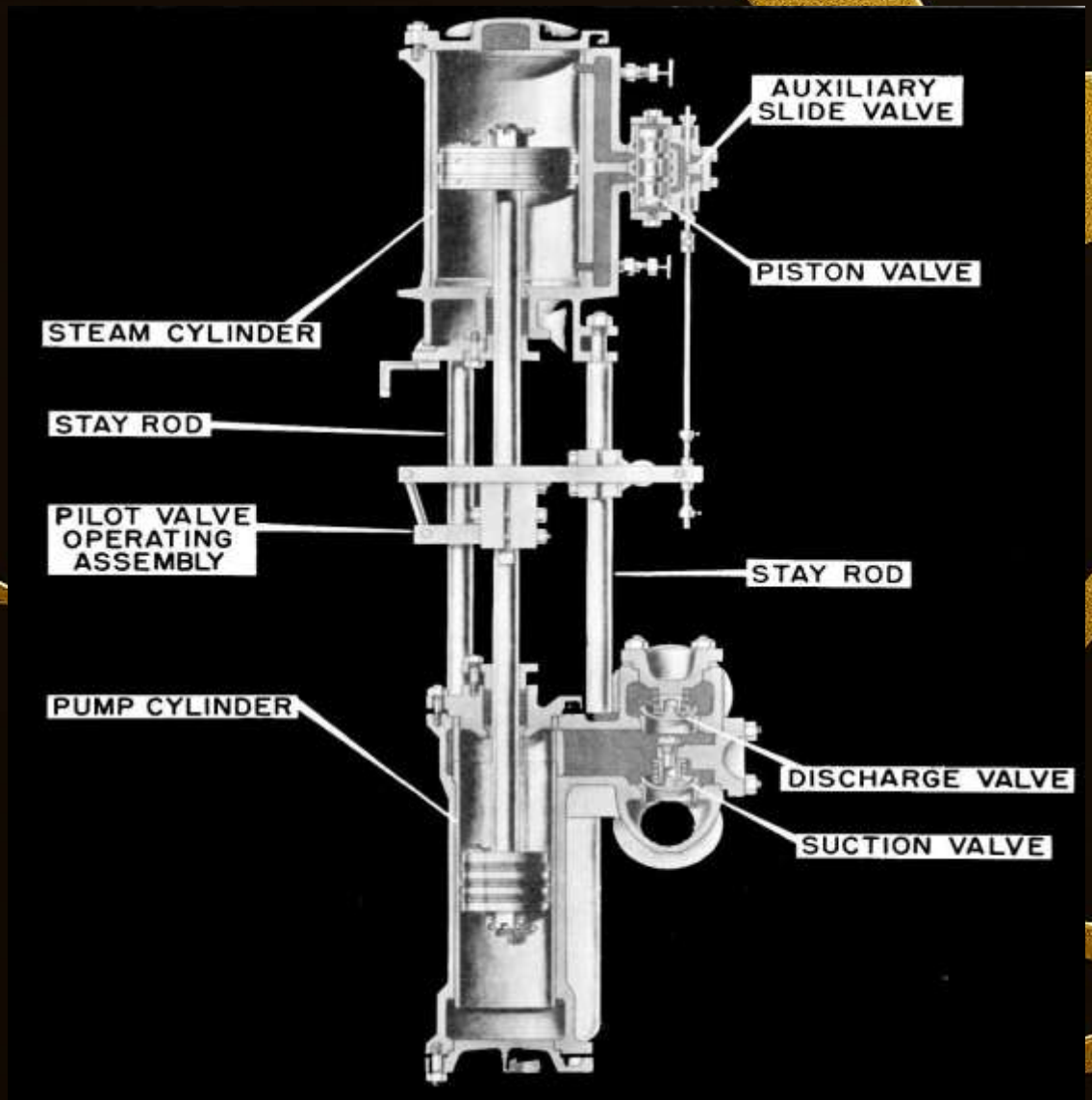
JET/EDUCTORS



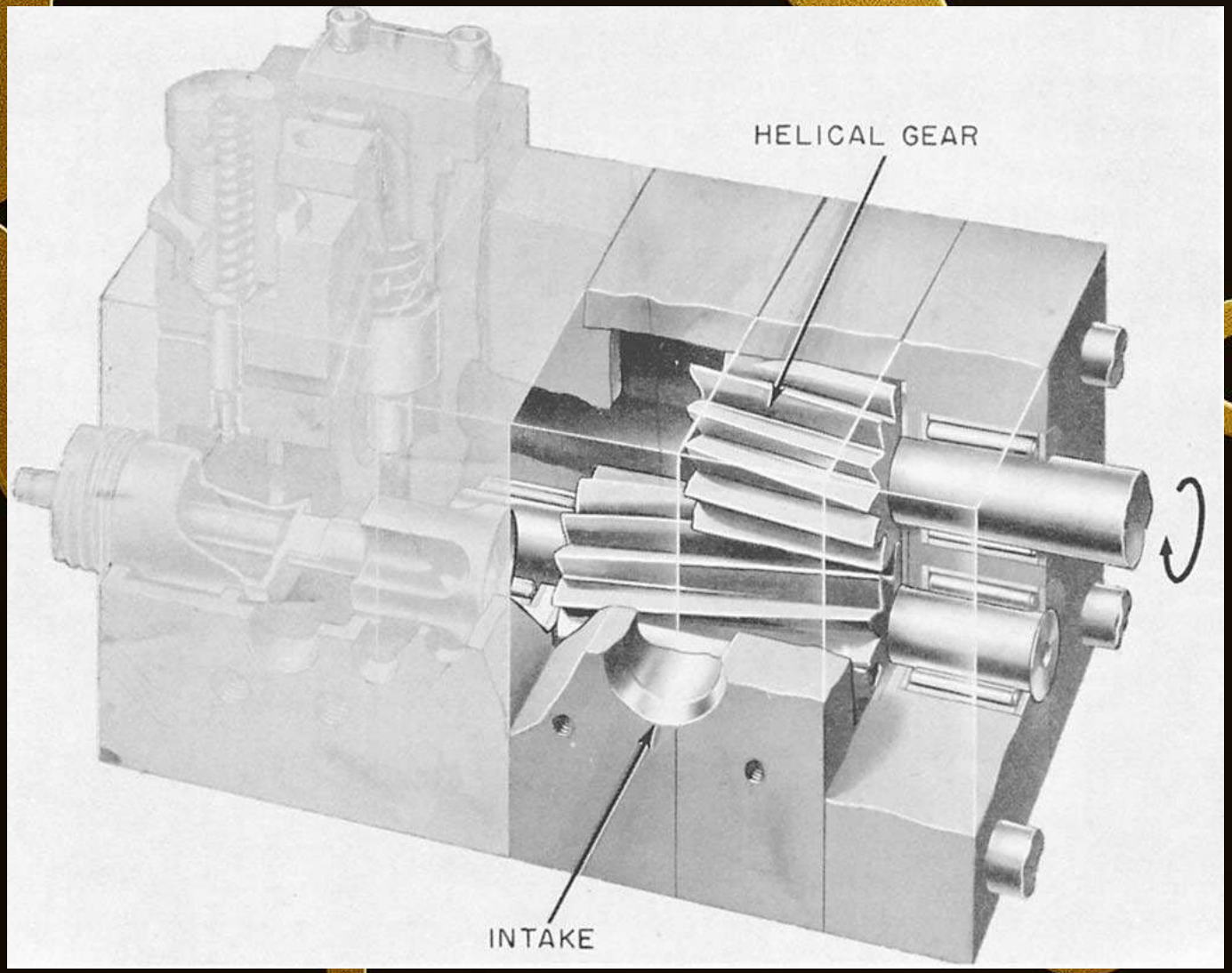
III. PUMP TYPES

- B. **Positive Displacement**
  - 1. Reciprocating
  - 2. Gear
  - 3. Screw
  - 4. Axial piston
  - 5. Rotary vane

RECIPROCATING PUMP

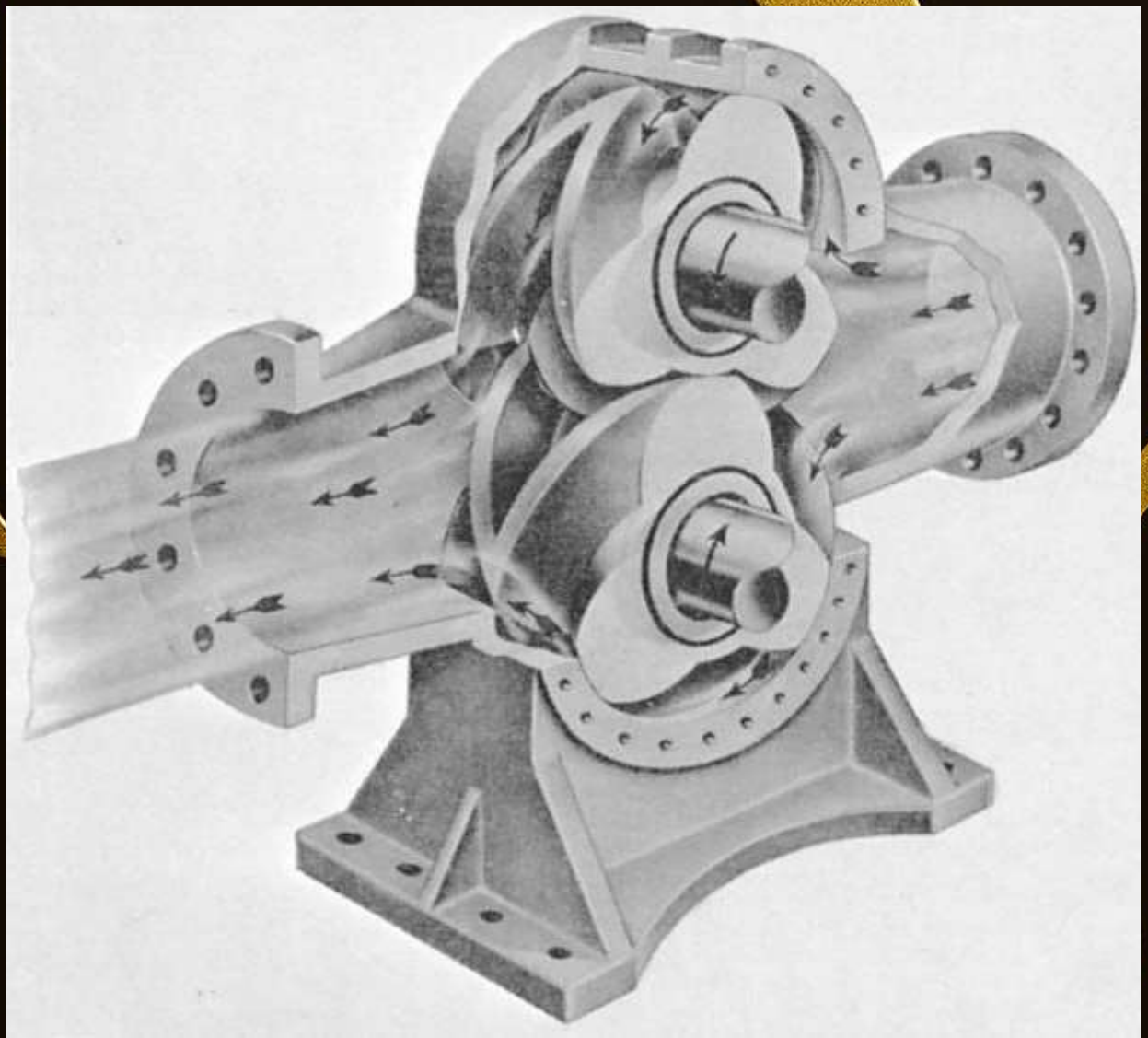


HELICAL GEAR PUMP

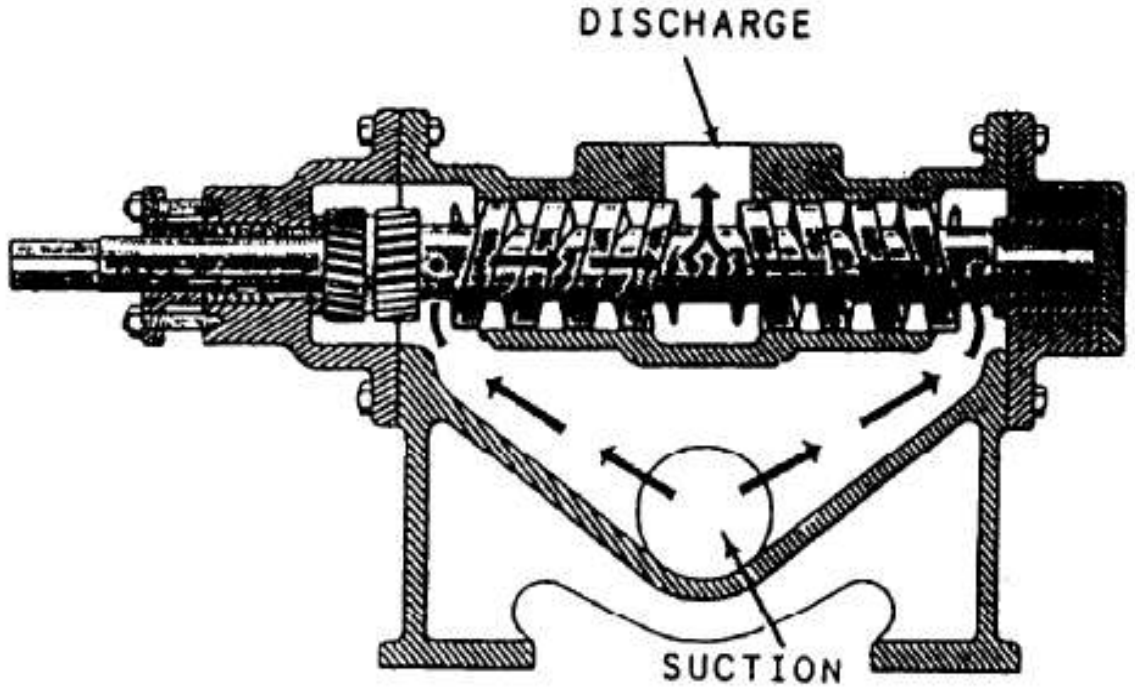


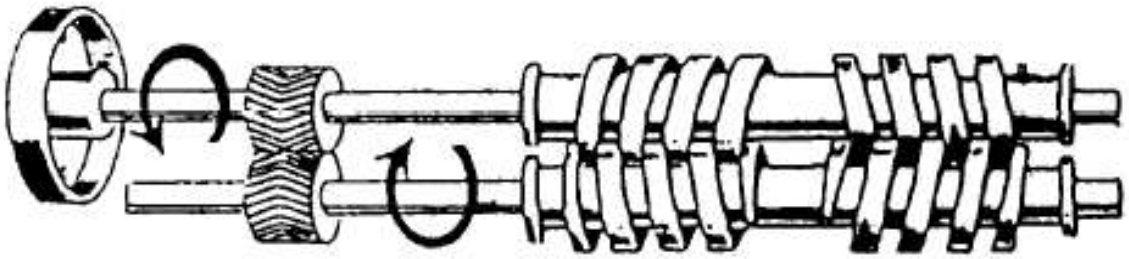
LOBE PUMP

(a type of simple gear pump)

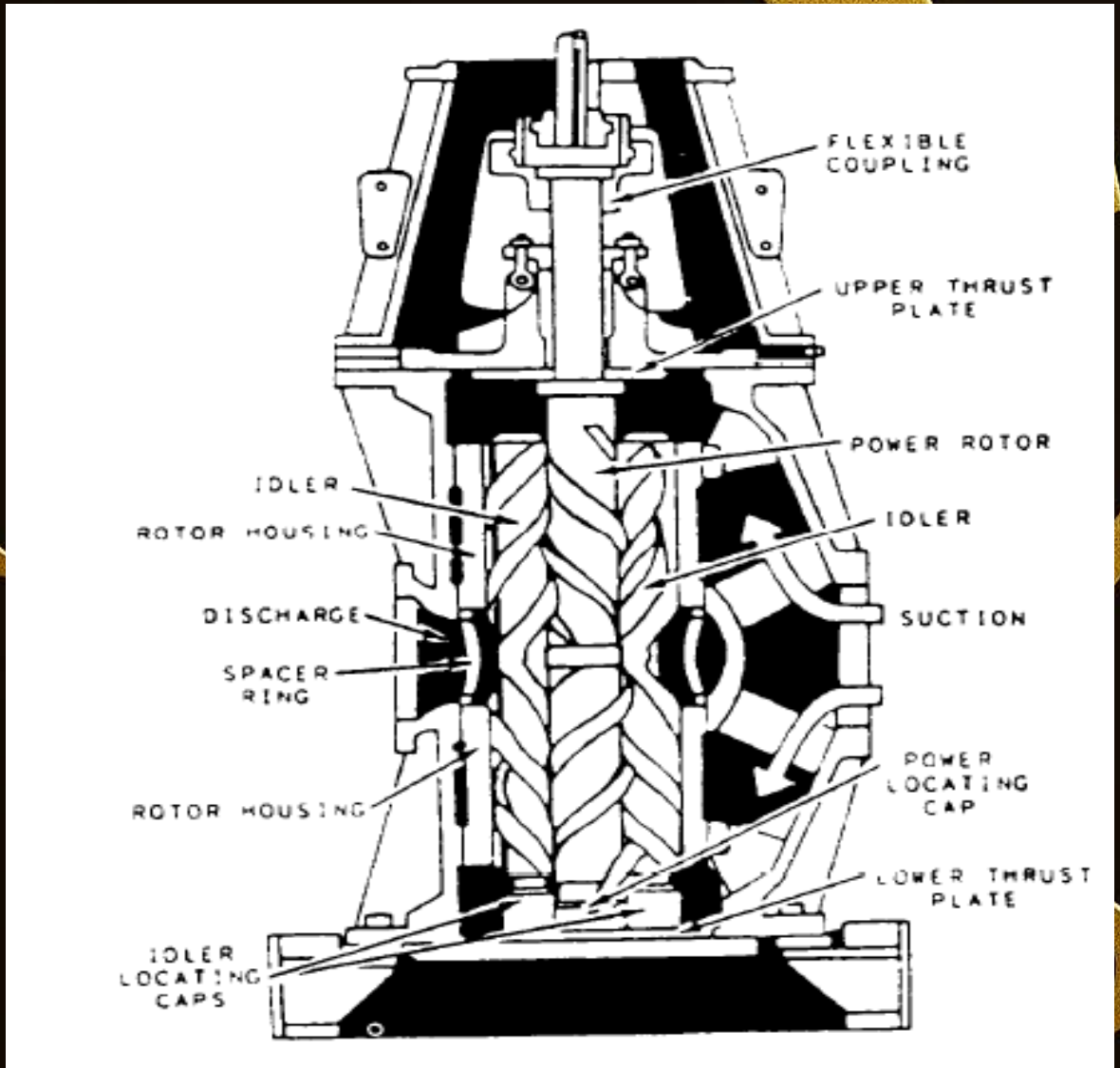


DOUBLE-SCREW TYPE PUMP

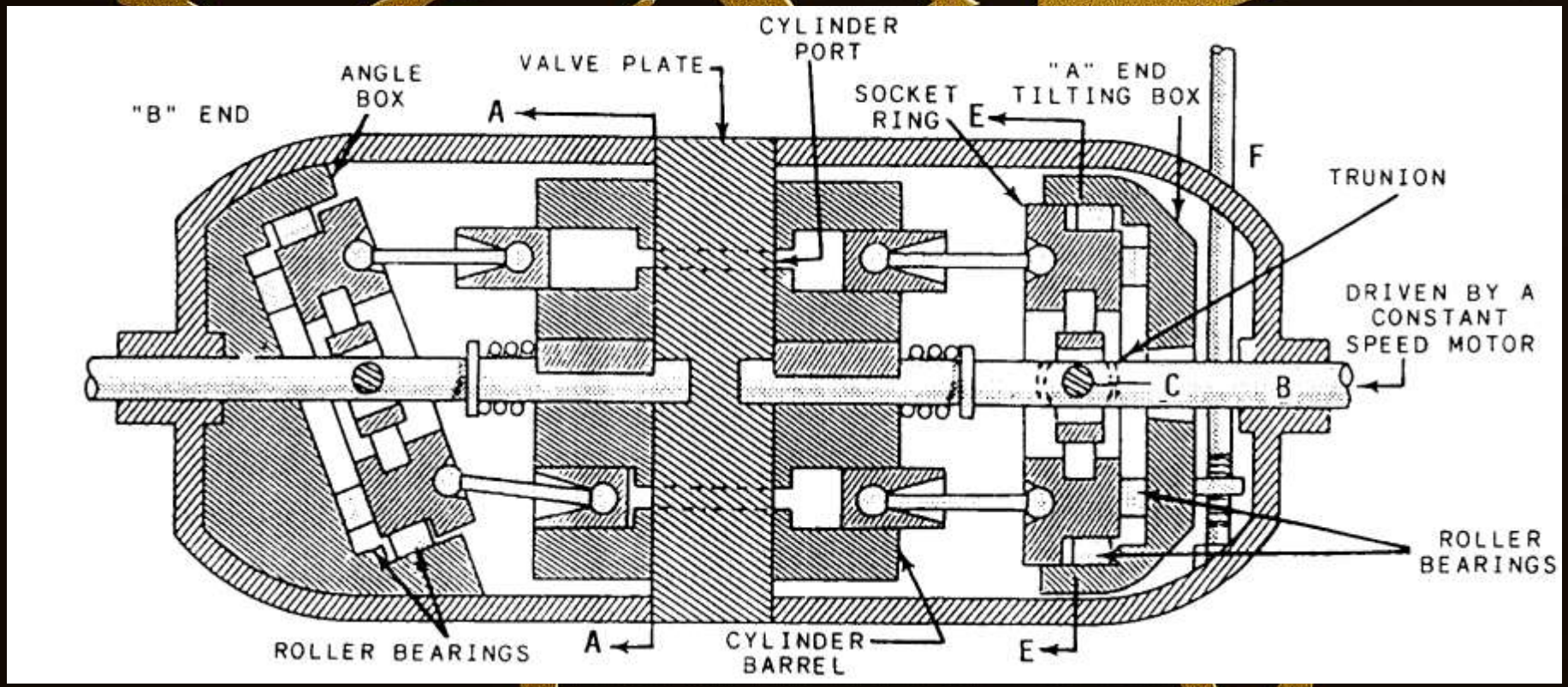




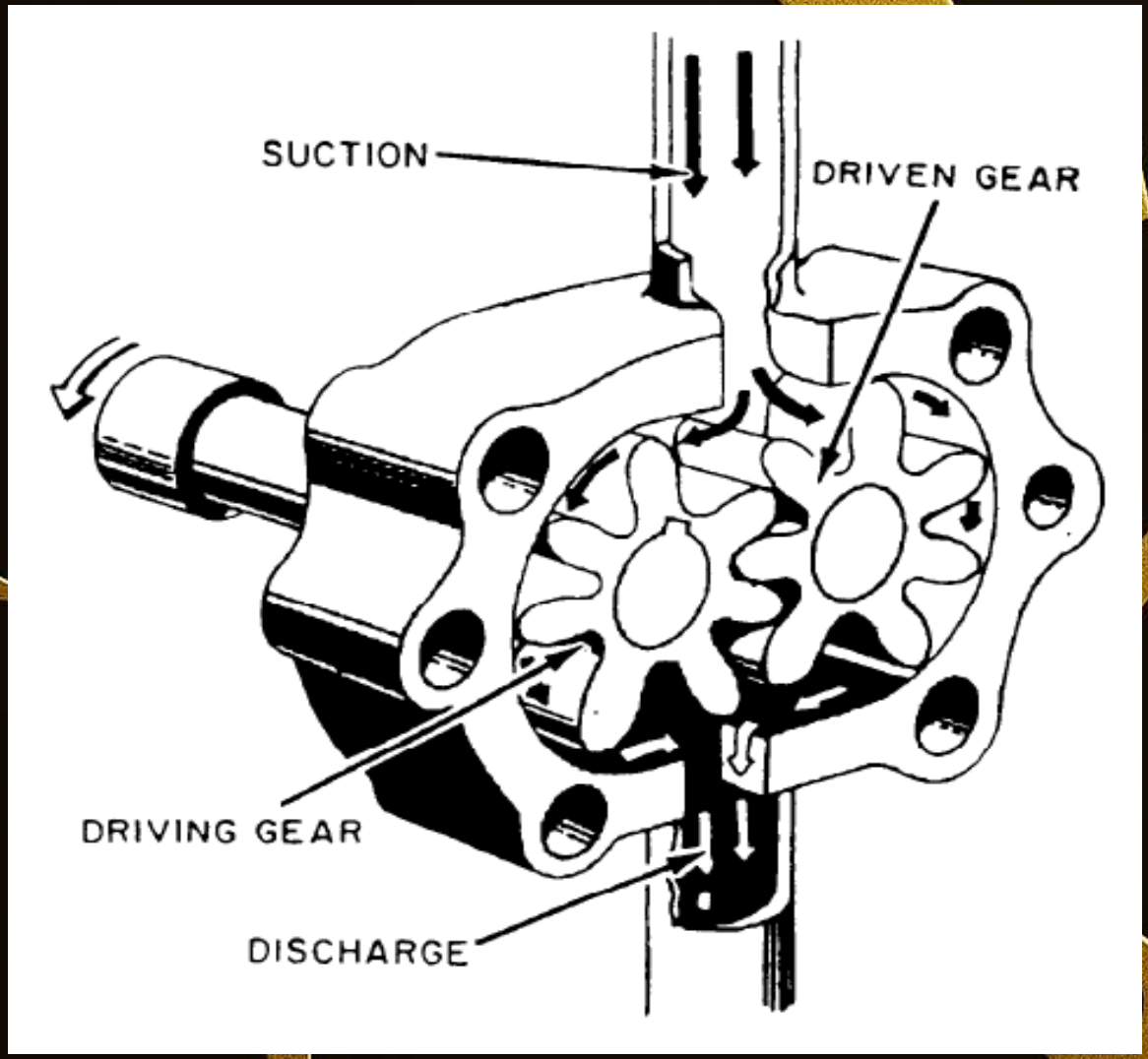
TRIPLE-SCREW TYPE PUMP



VARIABLE STROKE AXIAL PISTON PUMP



ROTARY PUMP

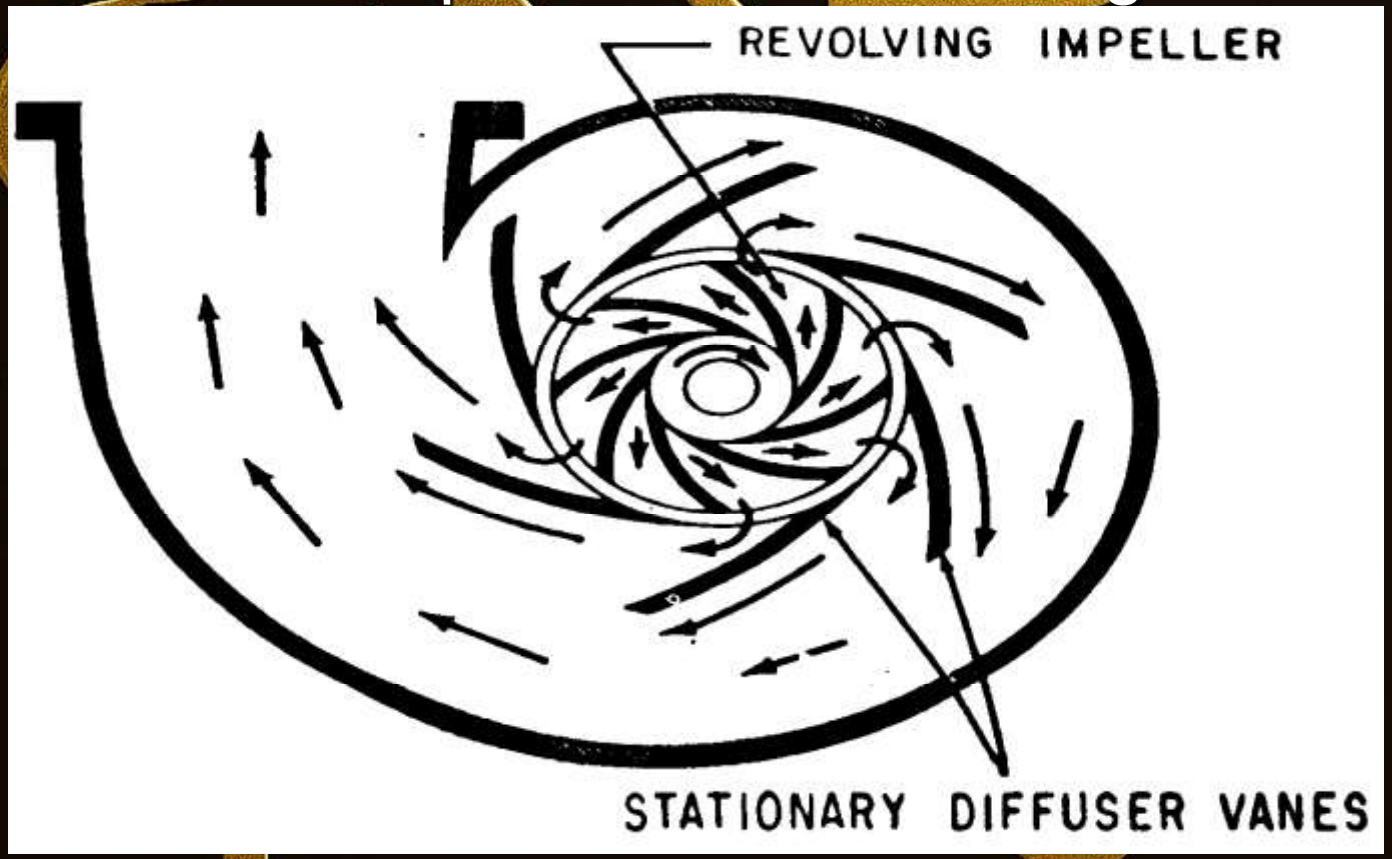


IV. PUMP TYPE BY ITS APPLICATION

- A. ***Non-positive Displacement Pumps***
- 1. *Centrifugal pumps*
- a. Single or multiple stage, depending on application/use
- b. Lend themselves to systems whose flow can be regulated, such as condensate, thermostatic recirculation, feed rate and recirculation, or constant discharge pressure control systems.
- c. Can operate under low or no flow conditions for short periods of time with little or no ill effects.

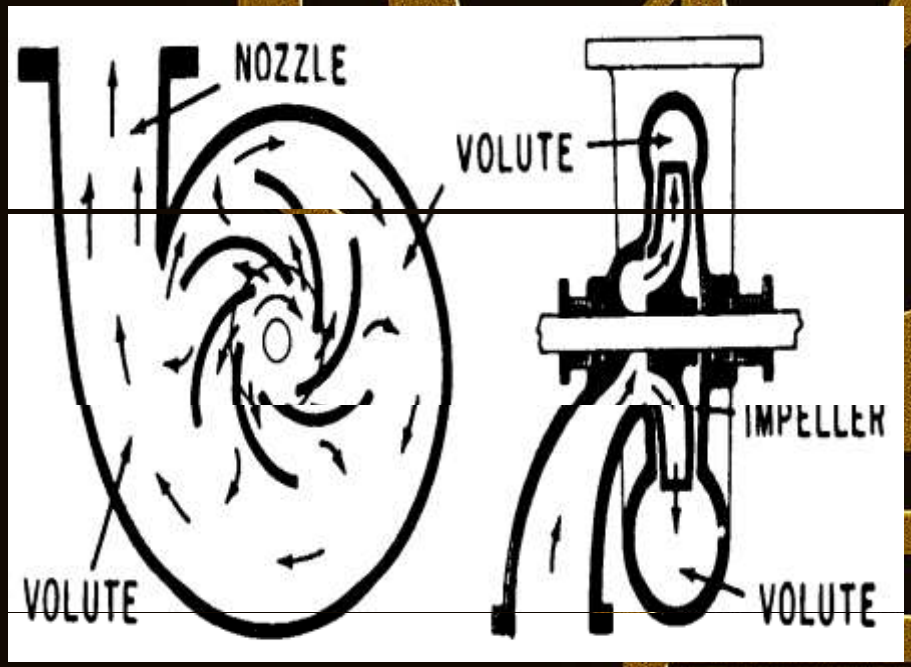
Centrifugal Pump

The centrifugal pump uses the throwing force of a rapidly revolving IMPELLER. The liquid is pulled in the center or EYE of the impeller and is discharged at its outer rim.

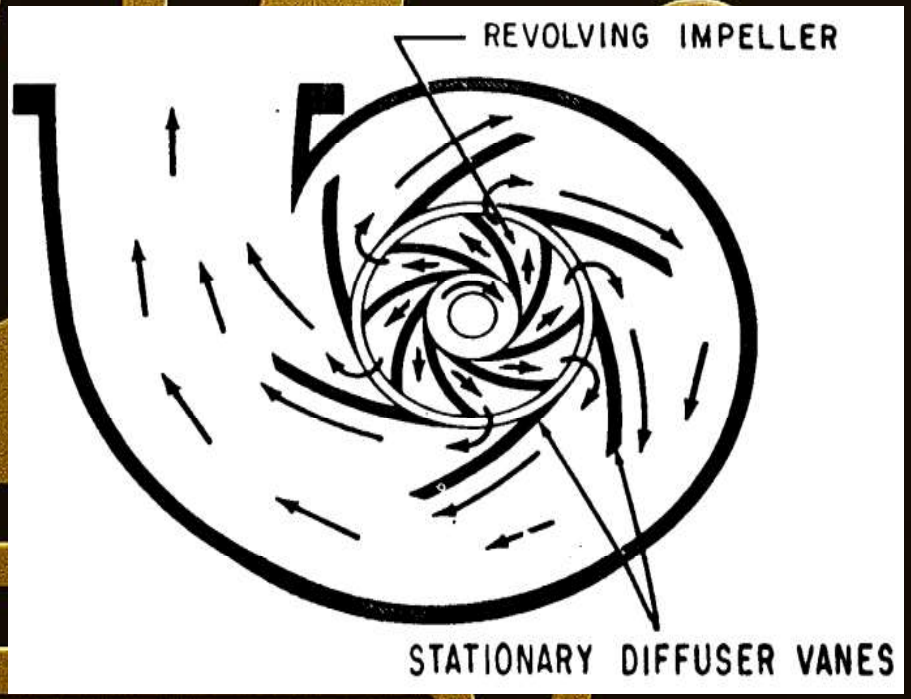


Centrifugal Pump

As the liquid reaches the outer rim with increased velocity, it is slowed down by a volute or series diffusing passages. As the velocity decreases, its pressure increases.



Volute type



Diffuser type

Classification of Centrifugal Pump

-Single (one impeller) or Multistage (two or more)

-Horizontal or Vertical (depends on shaft position)

-Single or Double suction

-Closed (have sidewalls) or Open (no sidewalls)

Centrifugal Pump

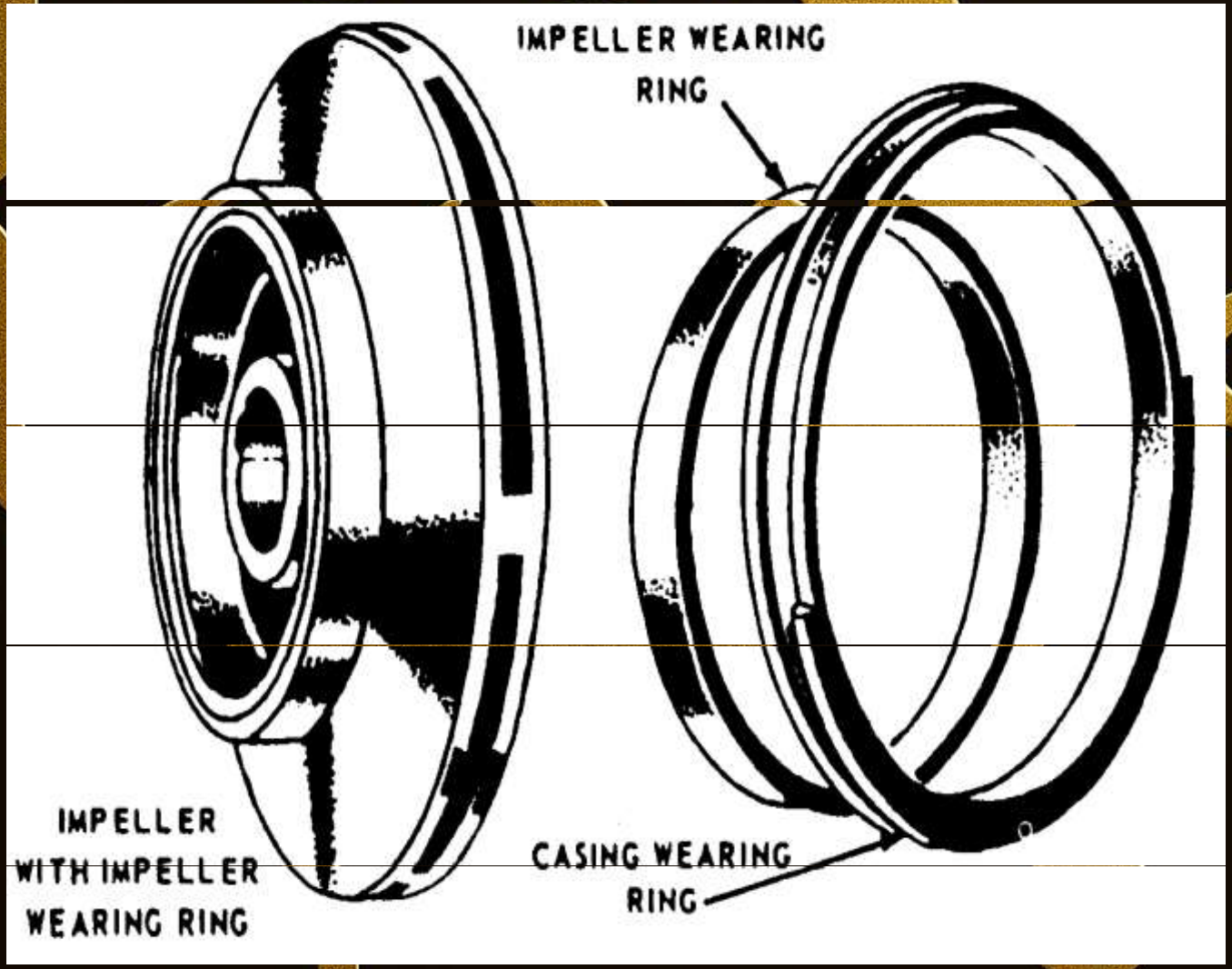
To eliminate the need to renew an entire pump and impeller due to close clearances, IMPELLER and CASING WEARING RINGS are installed.

Recirculation lines are installed to prevent overheating.

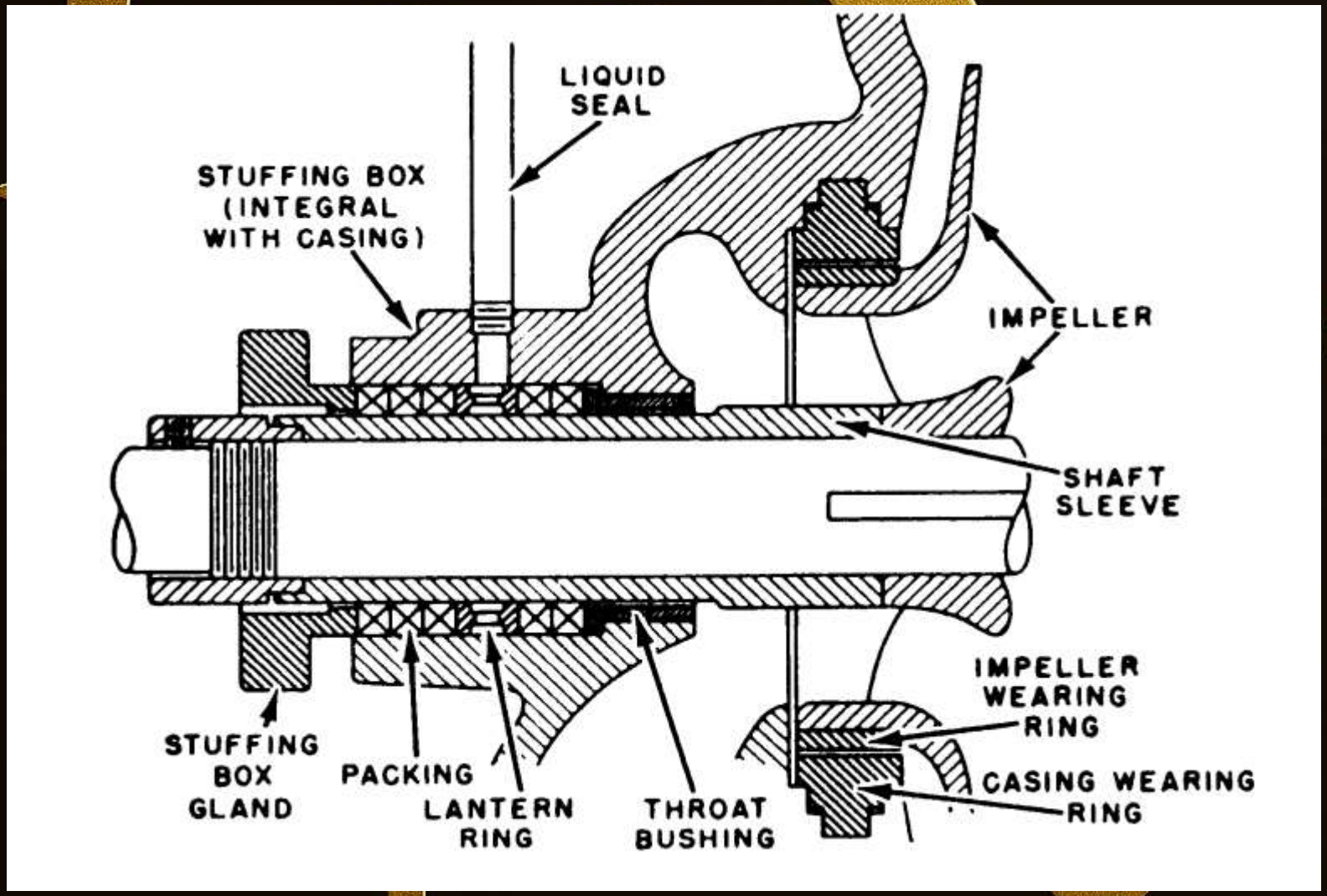
A lantern ring (spacer) is inserted between the rings of packing in the stuffing box to allow liquid seal and lubrication of shaft packing.

Mechanical seals are used instead of packing in a several pumps. Spring pressure keeps the rotating seal face snug against the stationary seal face, and a static seal is formed. Seal faces are made of carbon material.

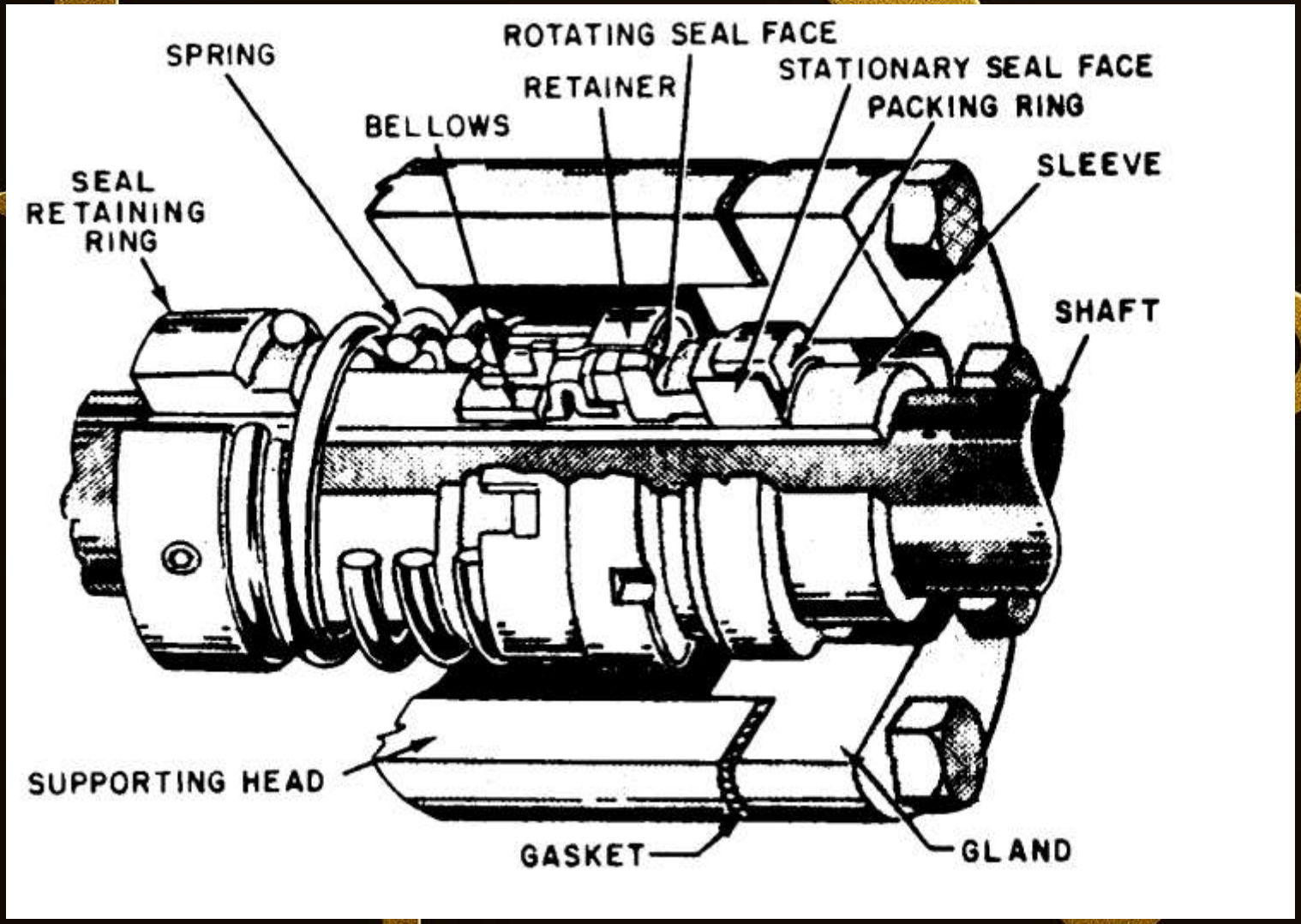
IMPELLER AND WEARING RINGS



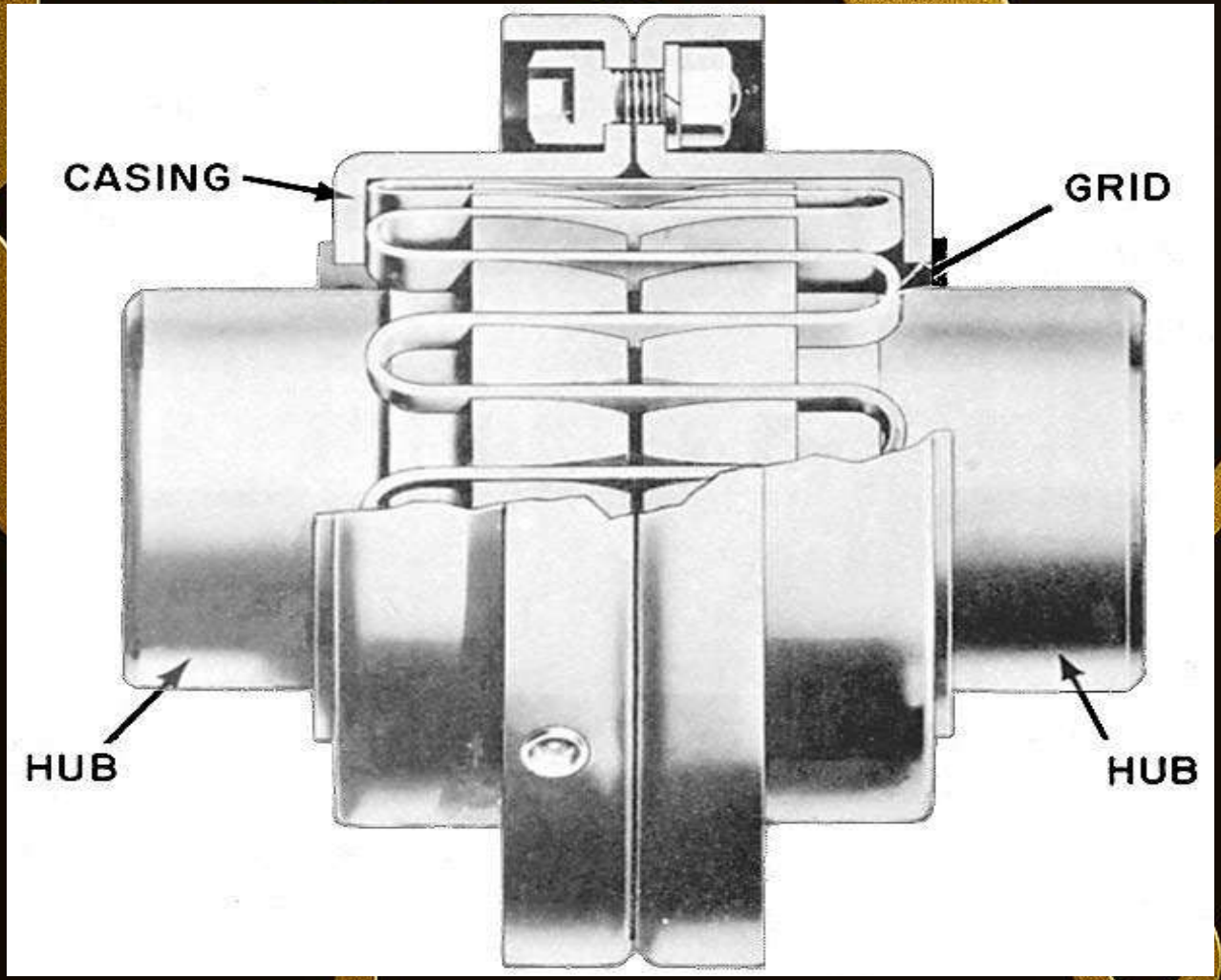
PACKING AND STUFFING BOX



MECHANICAL SEAL



FLEXIBLE COUPLING



Pump Maintenance & Care

REPACKING: Water lubrication of pump packing is extremely important! Ensure shaft or sleeves are smooth when repacking! Pack light and allow liberal leak-off. Allow a 30 min operation before leak-off adjustment to allow time for packing to run-in and swell. Tighten one flat every 30 min at a time until desired leak-off is attained. Uneven packing will cause overheating and score the shaft.

Pump Maintenance & Care

MECHANICAL SEALS: These are rapidly replacing conventional packing as means to control pump leakage. Replace mechanical seals whenever seal is removed for any reason or when leakage rate exceeds 5 drop per minute.

Mechanical shaft seal are positioned on the shaft by stub or step sleeves. Shaft sleeves are chamfered on outboard ends for easy mechanical seal mounting.

Flexible or flange couplings to allow for slight misalignment.

Pump Maintenance & Care

WEARING RING RENEWAL: In deciding whether wearing rings needs renewing, you must consider the capacity & discharge pressure of the pump. On low pressure pumps, wearing ring diametric clearance may be 0.015 to 0.030 inch more than designed value. And for high pressure pumps (75psi & above), clearance wear of 0.030 to 0.050 inch. Generally you should renew wearing rings when wear is at least **0.015 inch**.

Pump Troubleshooting

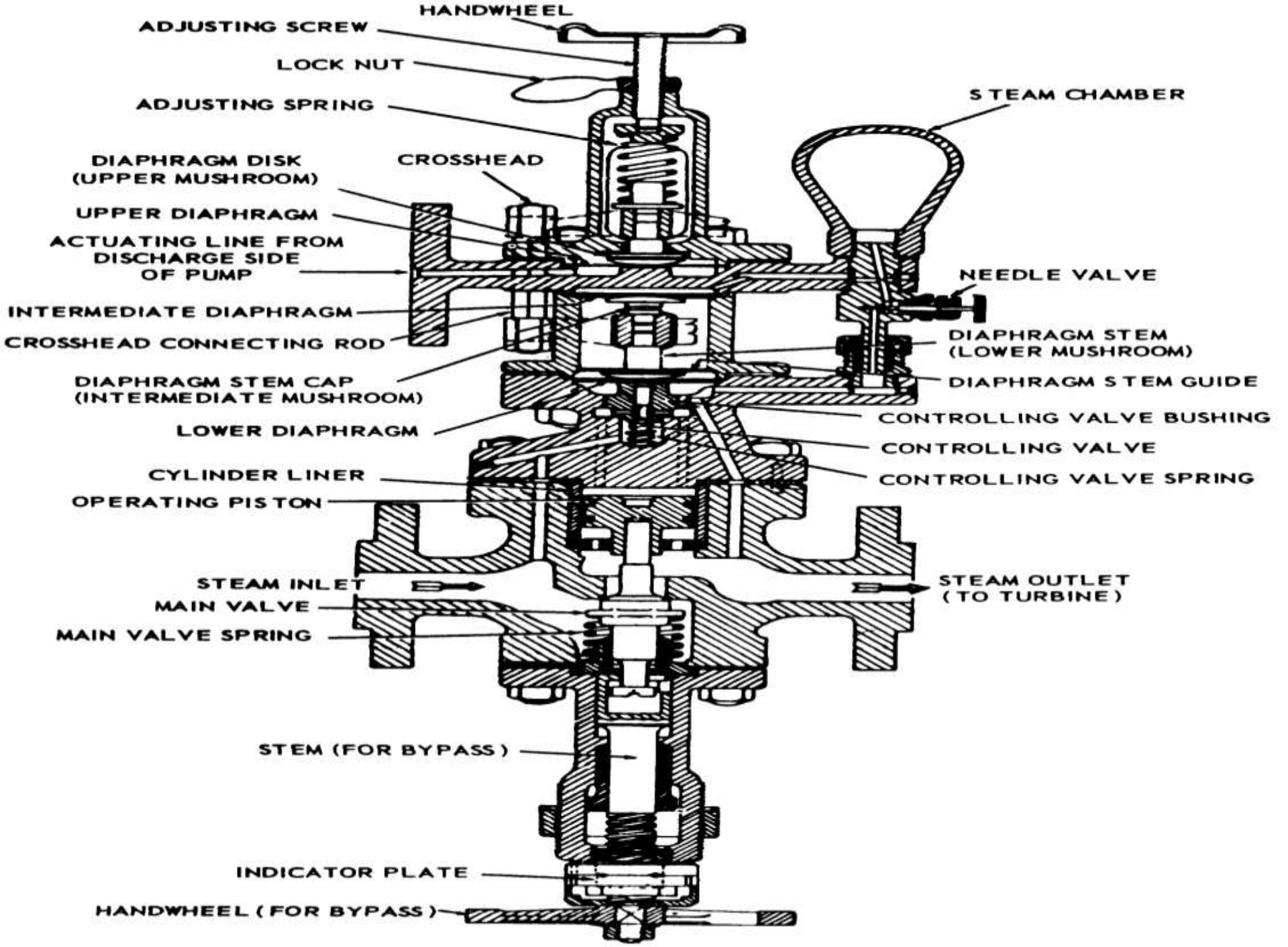
DOES NOT DELIVER ANY LIQUID, it could be: Insufficient priming, speed of pump, excessive discharge pressure (misalignment) excessive suction lift, clogged impeller passages, wrong direction of rotation, clogged suction screen, ruptured suction line, or loss of suction pressure.

INSUFFICIENT CAPACITY: Air leakage into suction line or stuffing box, insufficient speed of pump, excessive suction lift, excessive discharge pressure, and mechanical defects such as worn wearing rings, impellers, stuffing box packing, or sleeves.

Centrifugal Pump Controls

These pump are normally fitted with Constant-Pressure Governor, to maintain constant pump discharge under varying conditions of load. It's operation is very similar to that used on fuel oil/lube oil service pumps, fire pumps and so on. It's prime difference is the size of the upper diaphragm.

Two opposing forces, fluid from the pump discharge is led through an actuating line to the space below the upper diaphragm creating a UPWARD opposing force. An adjusting spring creates the DOWNWARD force on the upper diaphragm. As discharge pressure increases, upward force overcomes downward force thereby closing down on the controlling valve while acting against preset spring tension and vice-versa.


HANDWHEEL
ADJUSTING SCREW
LOCK NUT
ADJUSTING SPRING
STEAM CHAMBER
DIAPHRAGM DISK (UPPER MUSHROOM)
CROSSHEAD
UPPER DIAPHRAGM
ACTUATING LINE FROM DISCHARGE SIDE OF PUMP
NEEDLE VALVE
INTERMEDIATE DIAPHRAGM
CROSSHEAD CONNECTING ROD
DIAPHRAGM STEM (LOWER MUSHROOM)
DIAPHRAGM STEM CAP (INTERMEDIATE MUSHROOM)
DIAPHRAGM STEM GUIDE
CONTROLLING VALVE BUSHING
LOWER DIAPHRAGM
CONTROLLING VALVE
CYLINDER LINER
CONTROLLING VALVE SPRING
OPERATING PISTON
STEAM INLET
STEAM OUTLET (TO TURBINE)
MAIN VALVE
MAIN VALVE SPRING
STEM (FOR BYPASS)
INDICATOR PLATE
HANDWHEEL (FOR BYPASS)

IV. PUMP TYPE BY ITS APPLICATION (cont.)

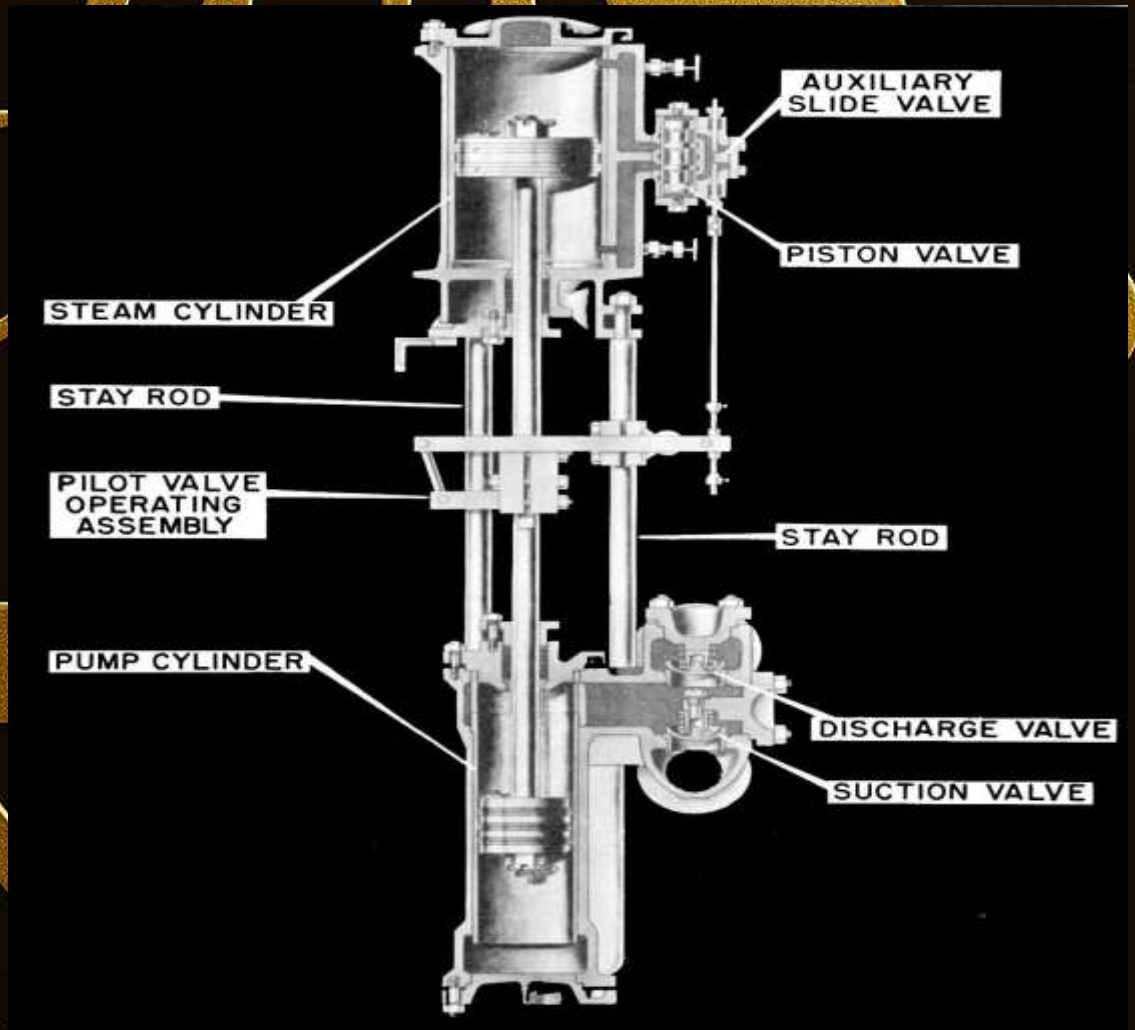
- 2. ***Propeller pumps***
- a. High volume, relatively low speed application
- b. Single propeller shrunk, keyed and bolted onto a tapered shaft, turbine or electric motor driven
- c. Capable of delivering 1200 gpm to 45,000 gpm at low pressures, usually less than 8 PSIG.
- d. Exclusively used for main and auxiliary condenser saltwater circulation and emergency bilge suction.

IV. PUMP TYPE BY ITS APPLICATION (cont.)

- B. ***Positive Displacement Pumps***
- 1. ***Reciprocating***
- a. Single or multiple cylinder, typically a double-acting pump.
- b. Steam powered, though adaptable for operation with low pressure air.
- c. Utilized for emergency feed, bilge pumps, ballast/de-ballast, fuel transfer and stripping.

RECIPROCATING PUMP

Moves liquid by a plunger or piston, travelling back and forth inside a cylinder.



Classification of Reciprocating Pumps

- Direct or indirect acting
- Simplex (single) or Duplex (double)
- Single or Double acting
- High or Low pressure
- Vertical or horizontal

Construction of Reciprocating Pumps

The power end consists of a bored cylinder in which the steam piston reciprocates. The pilot valve operating rod admits steam into the power end cylinder.

The liquid end consists of piston (often called a plunger) and a cylinder. A valve or water chest is attached to the liquid cylinder with the suction and discharge valve.

IV. PUMP TYPE BY ITS APPLICATION (cont.)

- 2. ***Gear***
- a. Exclusively utilized for flammable viscous liquids such as fuel and lubricating oils.
- b. Pumps constructed utilizing either: conventional spur gears, single helical, double helical or loge type gears.
- c. Application: Typically for cargo fuel or lube oil transfer. Can also be found in ancillary applications such as handcrank fuel/lube transfer pumps, steering gear, "A-end", pitch control oil, diesel engine mounted fuel boost pumps and diesel engine lube oil service pumps.

IV. PUMP TYPE BY ITS APPLICATION (cont.)

- 3. ***Screw***
- a. Double and triple screw pumps are the most popular varieties in use today. Output proportional to pump speed.
- b. Steam turbine or electric motor driven.
- c. Typically used for lube oil, fuel oil and controllable pitch service along with fuel oil transfer.
- d. Can be vertically or horizontally mounted. Also lends itself to function as a reduction gear "attached pump".

IV. PUMP TYPE BY ITS APPLICATION (cont.)

- 4. *Axial piston, variable displacement/stroke ("Waterbury" type)*
- a. Rotary "cylinder" containing multiple pistons (the "A End") whose stroke may be changed by tilting the "A End" cylinder block, thus varying the pump capacity at will.
- b. Corresponding rotary "cylinder block" containing multiple pistons (the "B End) whose stroke is fixed by tilting the "B End" cylinder block at the maximum angle

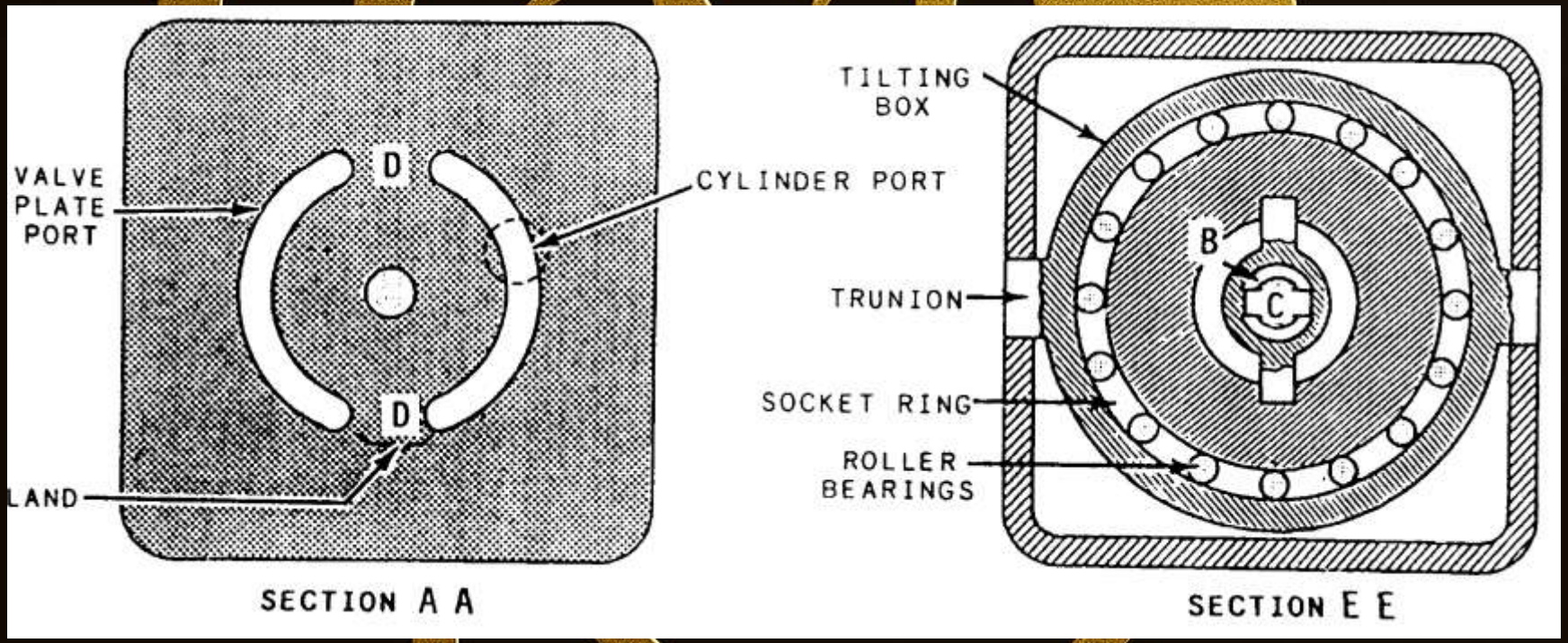
IV. PUMP TYPE BY ITS APPLICATION (cont.)

- c. Both units ("A" and "B" ends) combination suction/discharge valve plates are piped in parallel, hence the hydraulic power generated by the "A" end drives the "B" end, producing an infinite range of "B" end speeds. It also enables the "B" end to reverse its direction when the "A" end cylinder block/tilt block is tilted in the opposite direction.

IV. PUMP TYPE BY ITS APPLICATION (cont.)

- d. Application of the Axial piston variable displacement type pump is typical in steering gear, gun train and elevation systems, anchor windless equipment, flight deck and high capacity bomb elevators and missile launcher drive and elevation hydraulics.

Axial piston, variable displacement/stroke

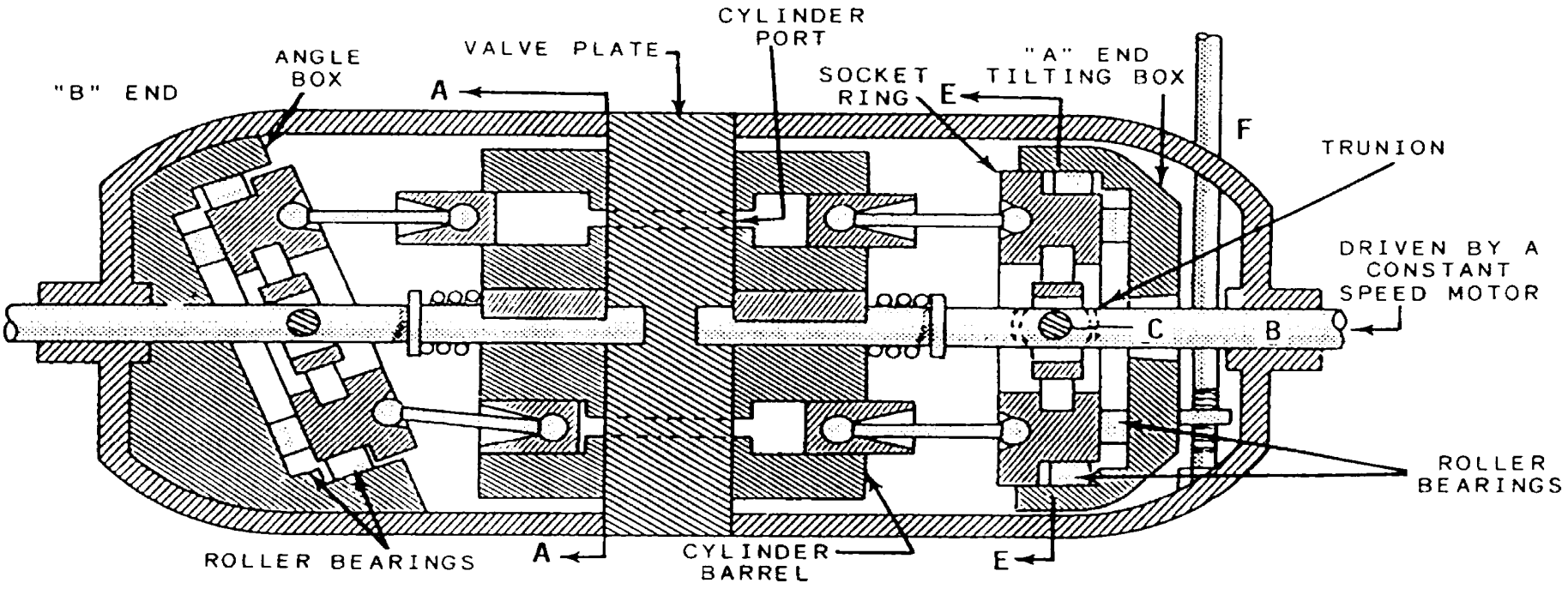


VARIABLE STROKE PUMP

- Also called variable displacement pumps.
- Commonly used as part of an electro-hydraulic transmission.
- There are two types:
- 1) Variable Stroke Axial-Piston Pump
- 2) Variable Stroke Radial-Piston Pump

VARIABLE STROKE AXIAL-PISTON PUMP

- Axial-Piston pump: consists of a cylinder barrel, a piston rod connected to a socket ring that rides on a thrust bearing carried by a casting called the TILTING BLOCK.

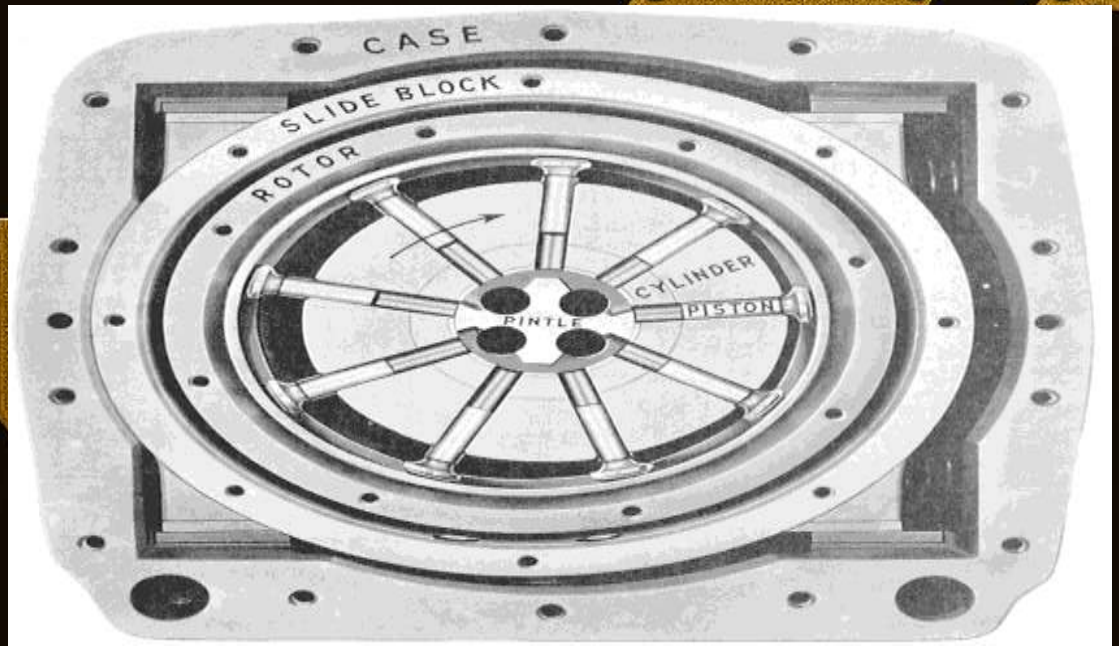


VARIABLE STROKE AXIAL-PISTON PUMP

- When the tilting block is at a right angle to the shaft, while the pump is rotating, the pistons do not reciprocate; therefore no pumping takes place.
- When the tilting block is tilted away from the a right angle, however, the pistons reciprocate and liquid is pumped.
- Commonly used in Anchor windlass, cranes, winches and power transmitting unit in electro-hydraulic steering.

VARIABLE STROKE RADIAL-PISTON PUMP

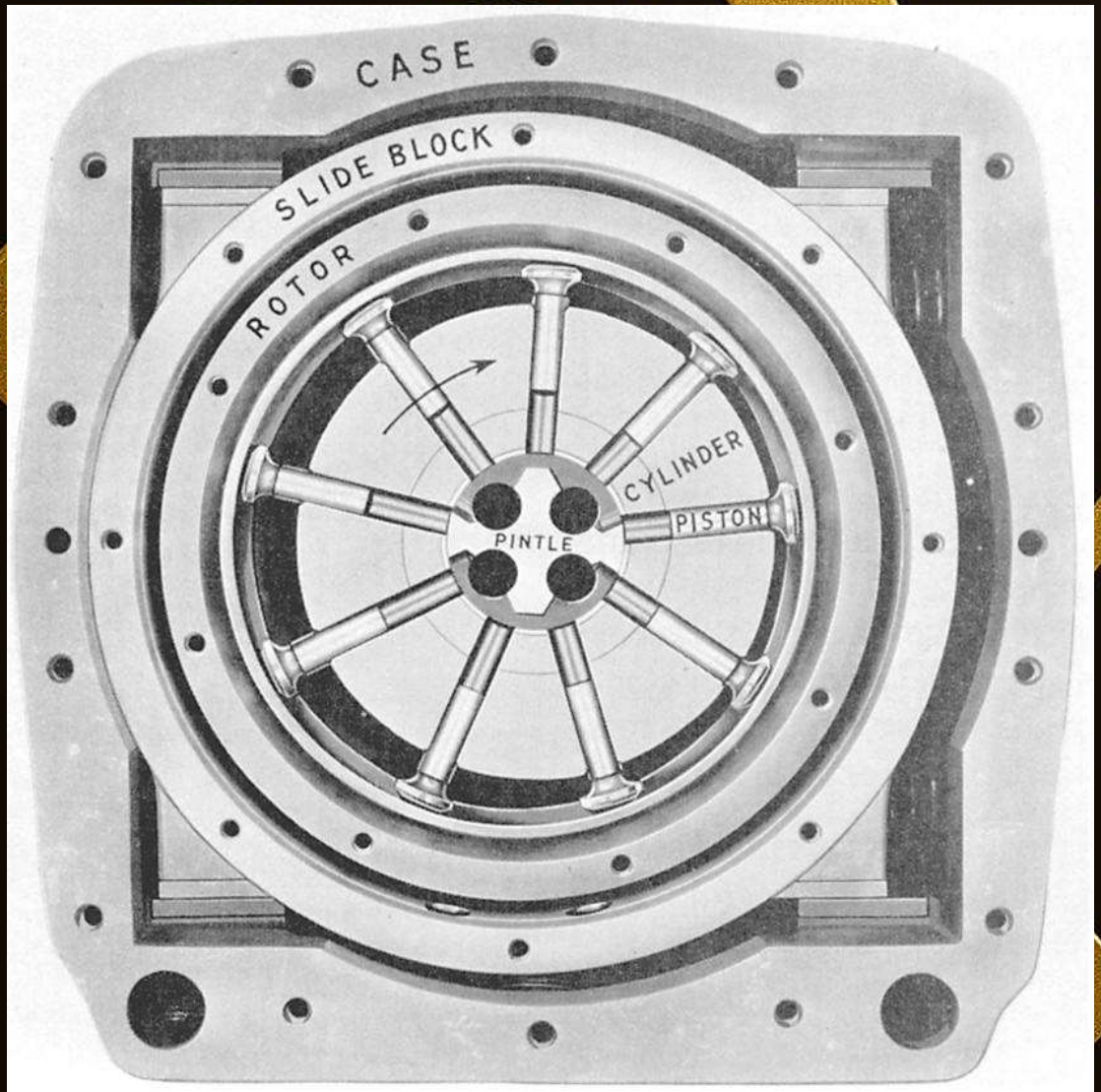
- Radial-Piston pump: consist of cylinders arranged radially in a cylinder body, plungers or pistons extend outward from each cylinder and are pinned at their outer ends to slippers which slide around inside of a rotating floating ring and housing.



VARIABLE STROKE RADIAL-PISTON PUMP

- The floating is so constructed that it can shifted off center from the pump shaft.
- When the floating ring is centered, or in the neutral position while the pump is rotating, the pistons do not reciprocate and does not pump.
- When the floating ring is forced off the center, the pistons reciprocates and liquid is pumped.

VARIABLE STROKE RADIAL-PISTON PUMP



IV. PUMP TYPE BY ITS APPLICATION (cont.)

- 5. *Rotary vane pump*
- a. Consists of an offset pump rotor set in an eccentric casing.
- b. Pump vanes are installed parallel to the rotor axis, symmetrically around the rotor circumference. When the rotor turns the pump vanes are forced outward against the eccentric casing causing fluid to be pumped.
- c. Applications include: JP-5 service and transfer, fuel oil transfer, bilge and ballast pumping.

THE END!