Reciprocating Compressor

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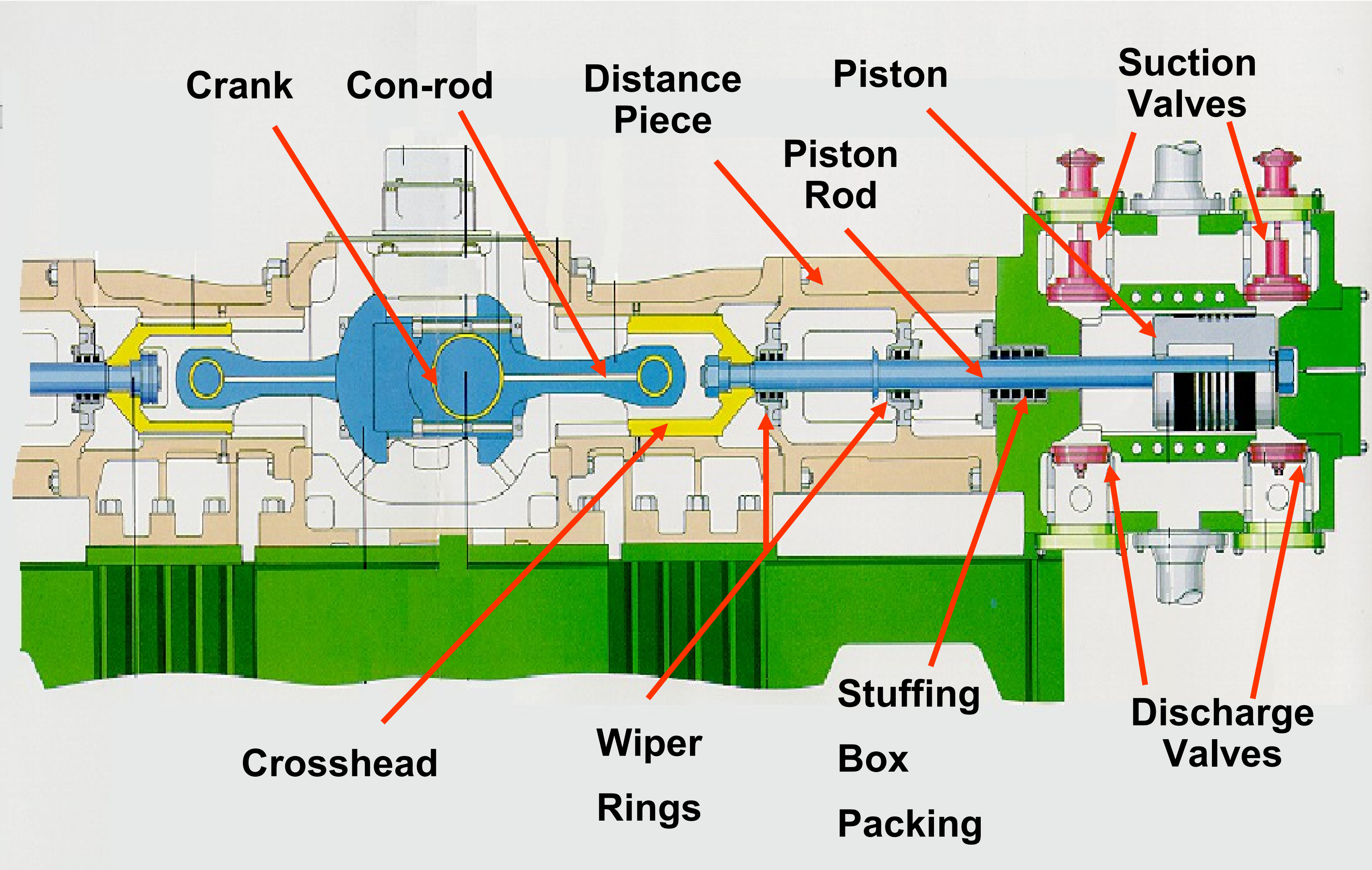
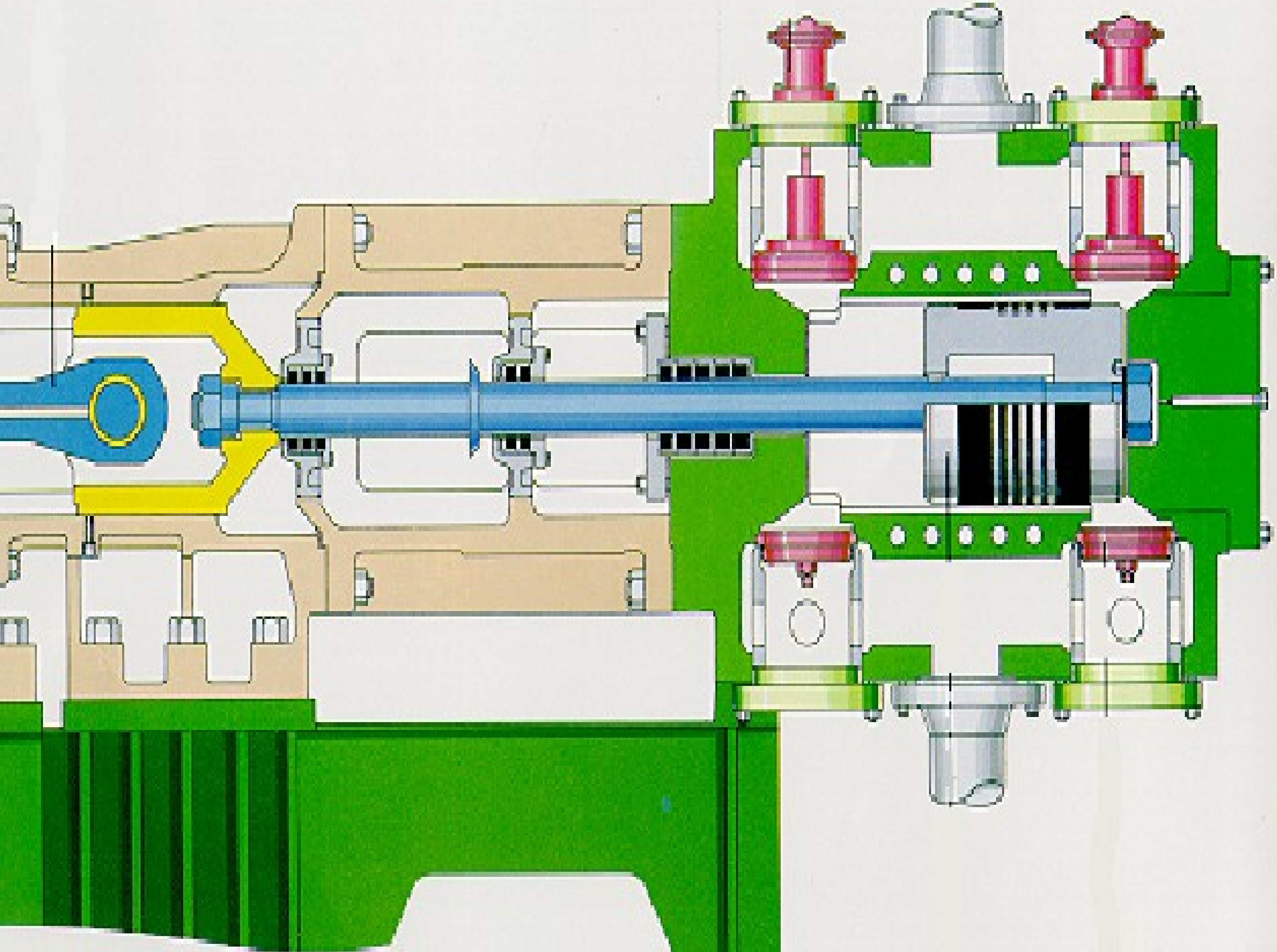
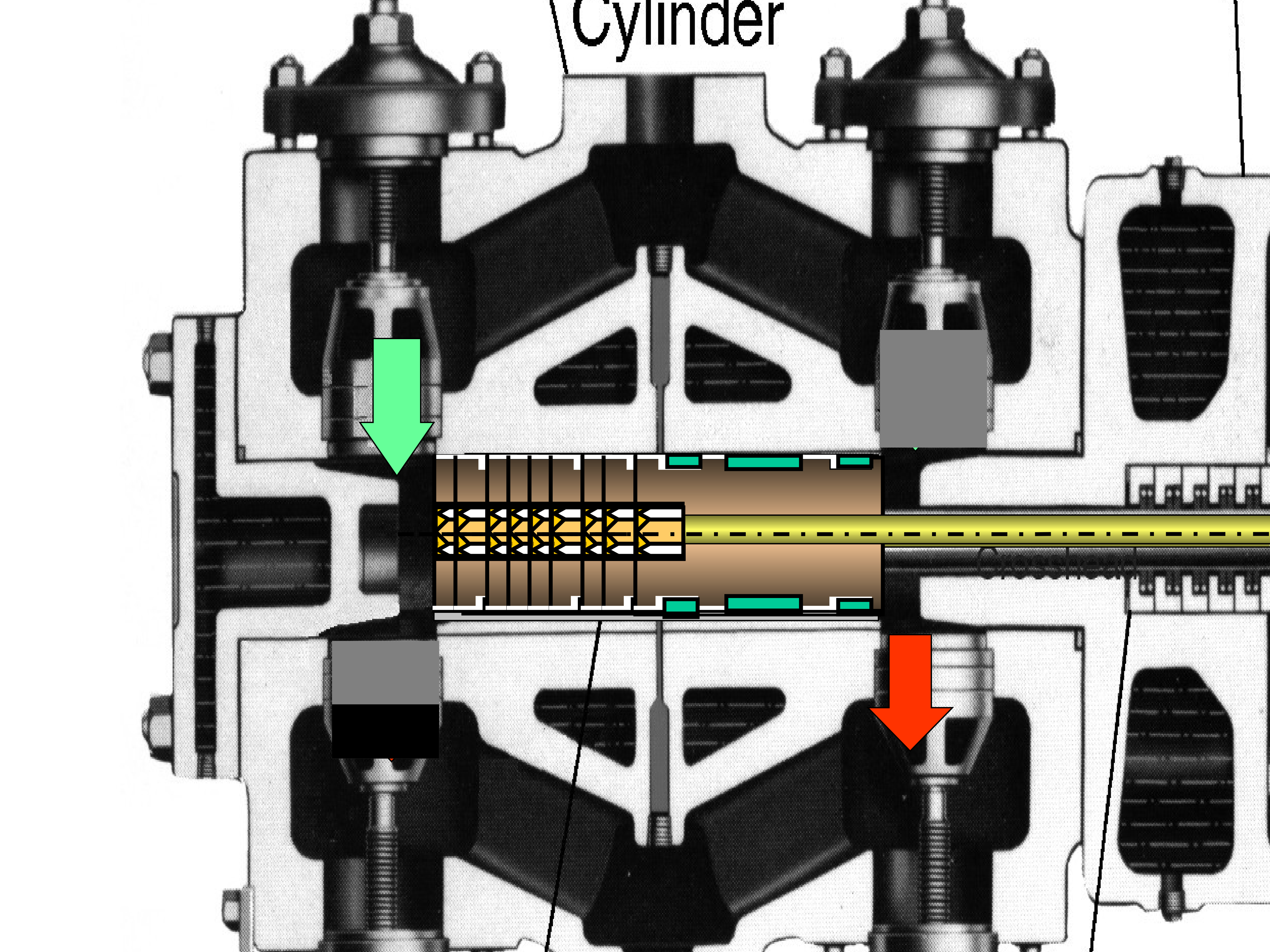
RECIPROCATING COMPRESSORS

Compressors

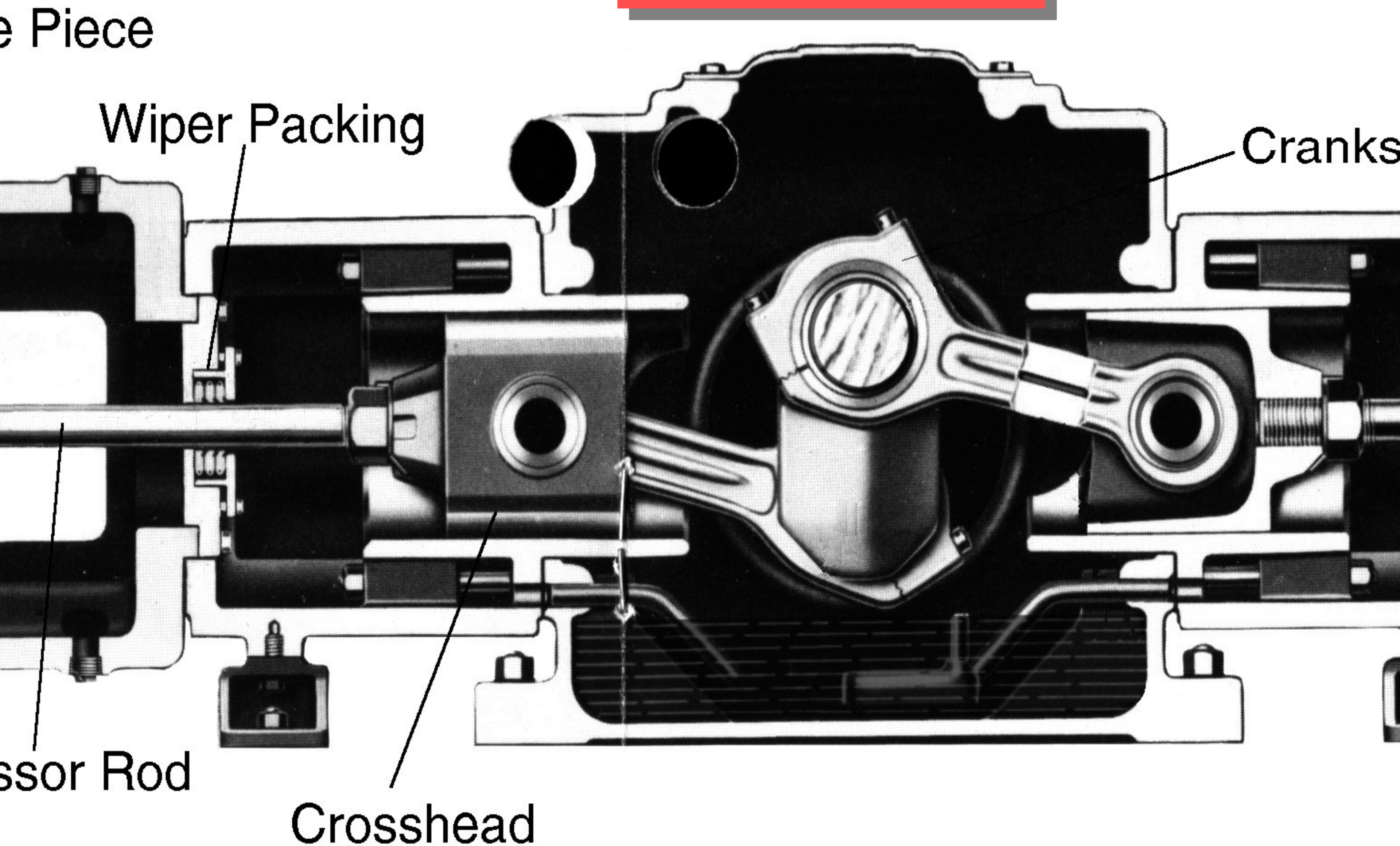
	Reciprocating	Centrifugal	Axial
Pressure P	V. HIGH	HIGH	LOW
Flow Rate Q	LOW	HIGH	V. HIGH
S .R .V	YES	NO	NO
Efficiency	LOW	HIGH	V. HIGH
Maint. cost	V. HIGH	LOW	LOW
Pulsation	YES	NO	NO
Surging	NO	YES	YES


Crank
Con-rod
Distance Piece
Piston
Suction Valves
Piston Rod
Crosshead
Wiper Rings
Stuffing Box Packing
Discharge Valves

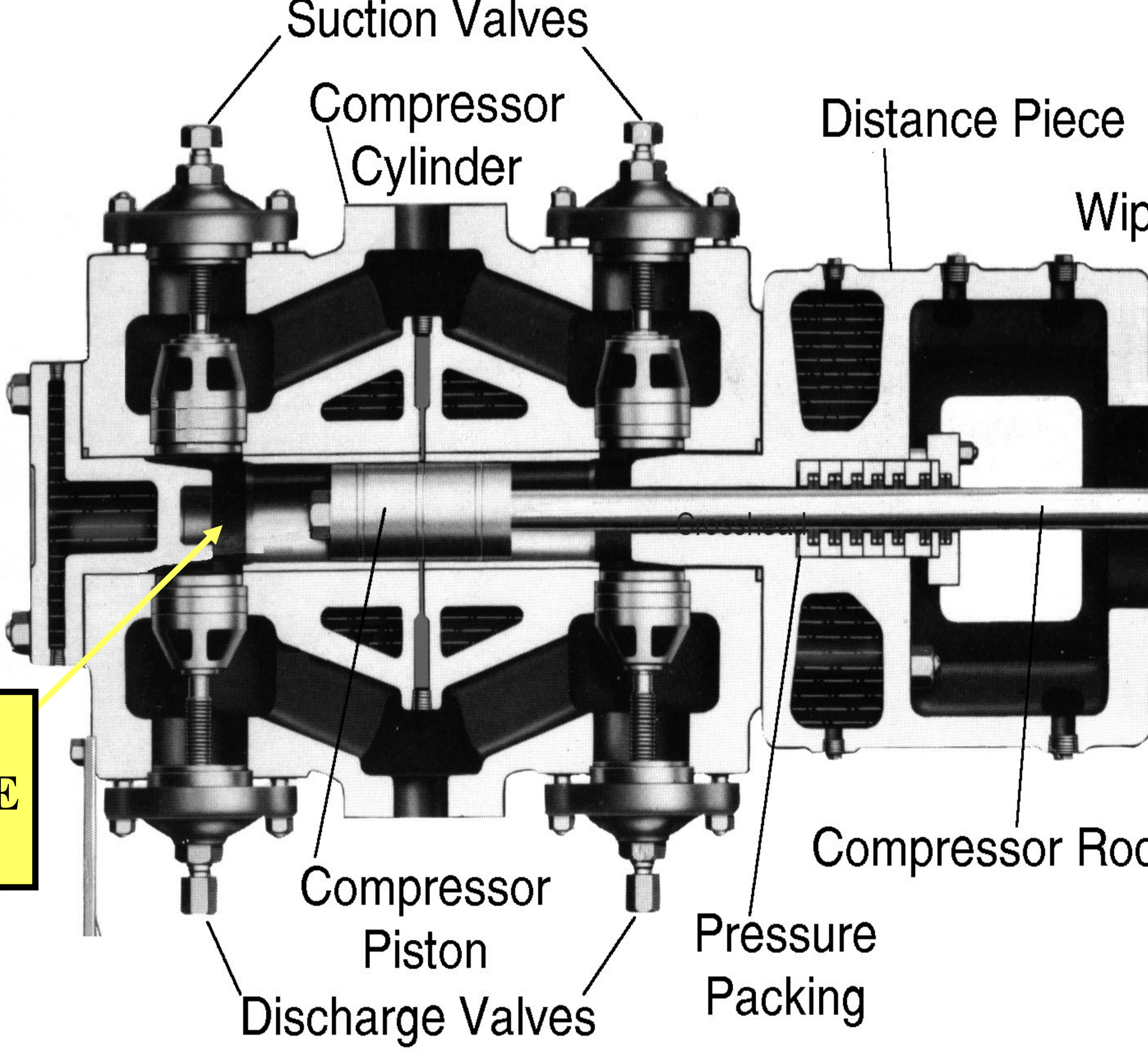



Cylinder
Crosshead

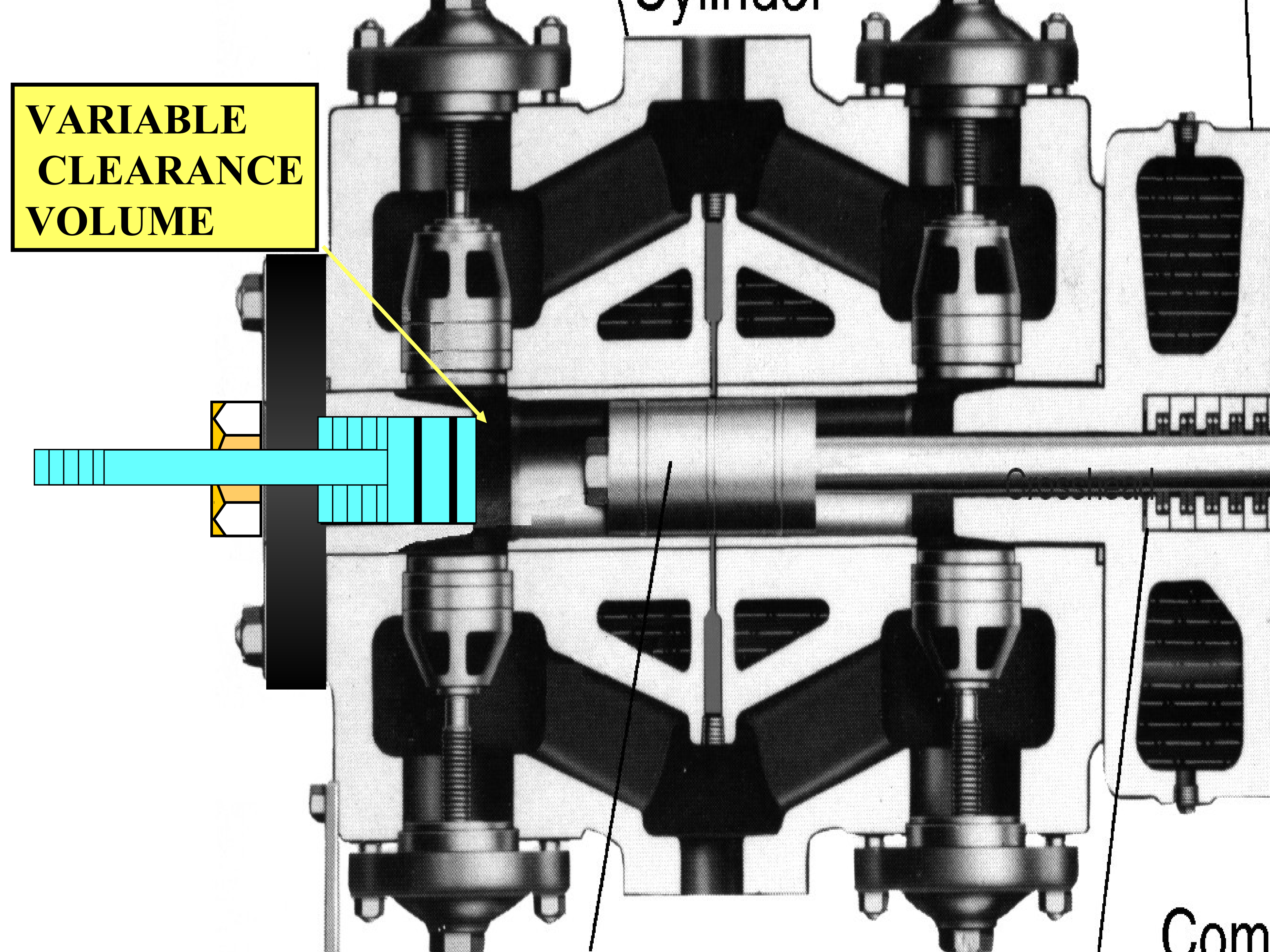
POWER END



GAS END



FIXED CLEARANCE VOLUME


VARIABLE
CLEARANCE
VOLUME
Crosshead

RECIPROCATING COMPRESSORS: FLOW RATE REGULATION

- VARIABLE CLEARANCE
- SUCTION VALVE UNLOADERS
- VARIABLE SPEED
- BYPASS

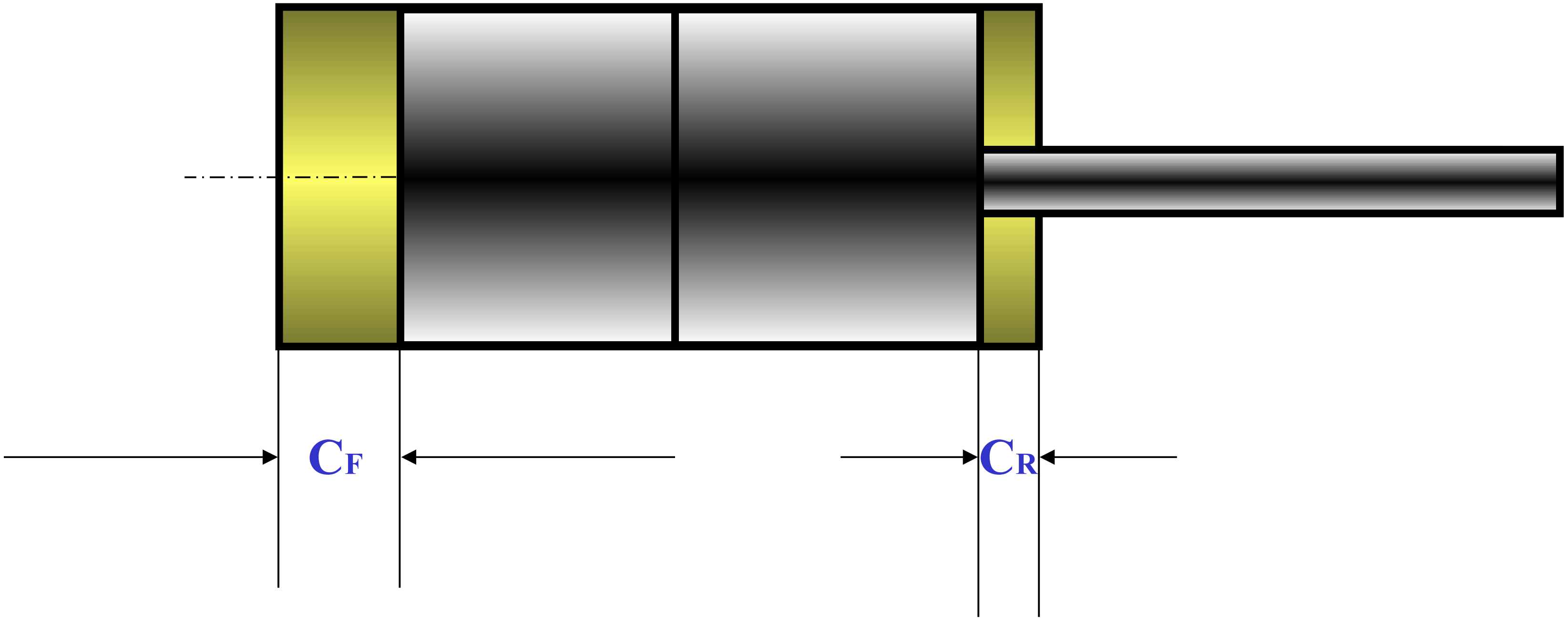
• VARIABLE CLEARANCE

Before operating

C = Total Clearance Volume = $C_F + C_R$

$$C_F = \frac{2}{3}C$$

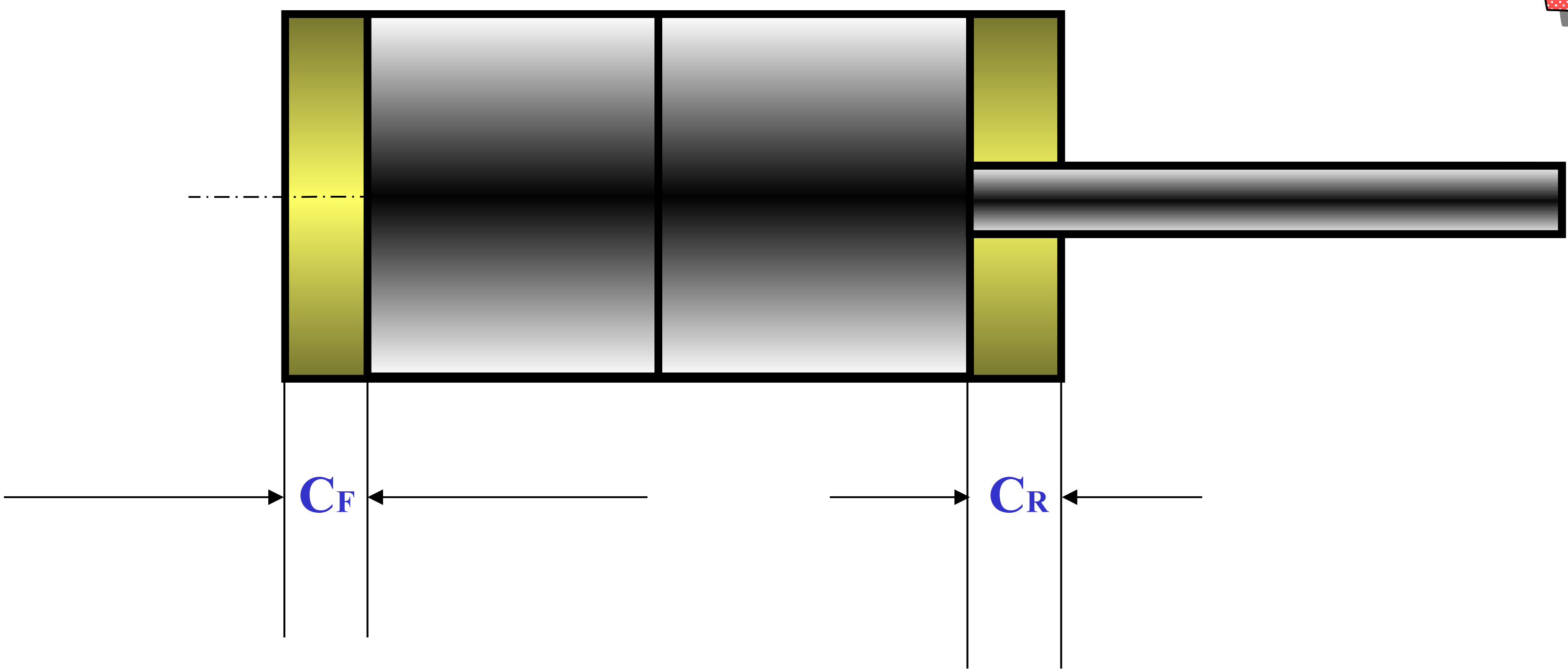
$$C_R = \frac{1}{3}C$$



After operating

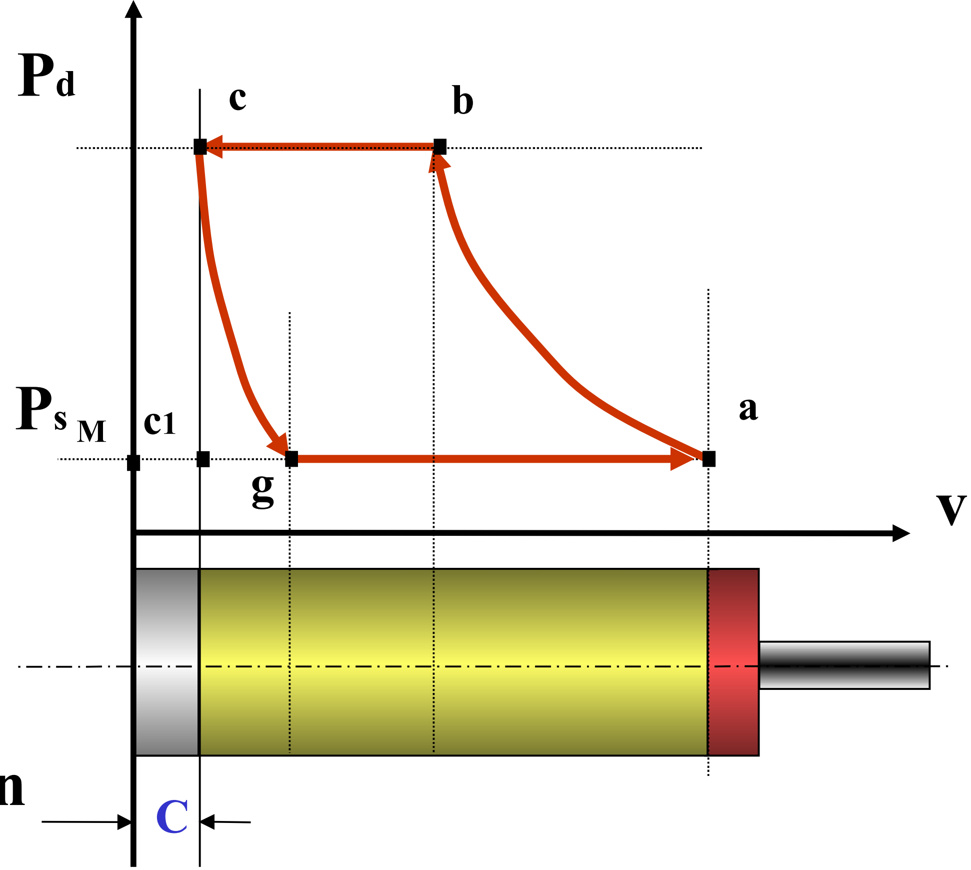
$$C_F = \frac{1}{2} C$$

$$C_R = \frac{1}{2} C$$



EFFECT OF CLEARANCE VOLUME

At



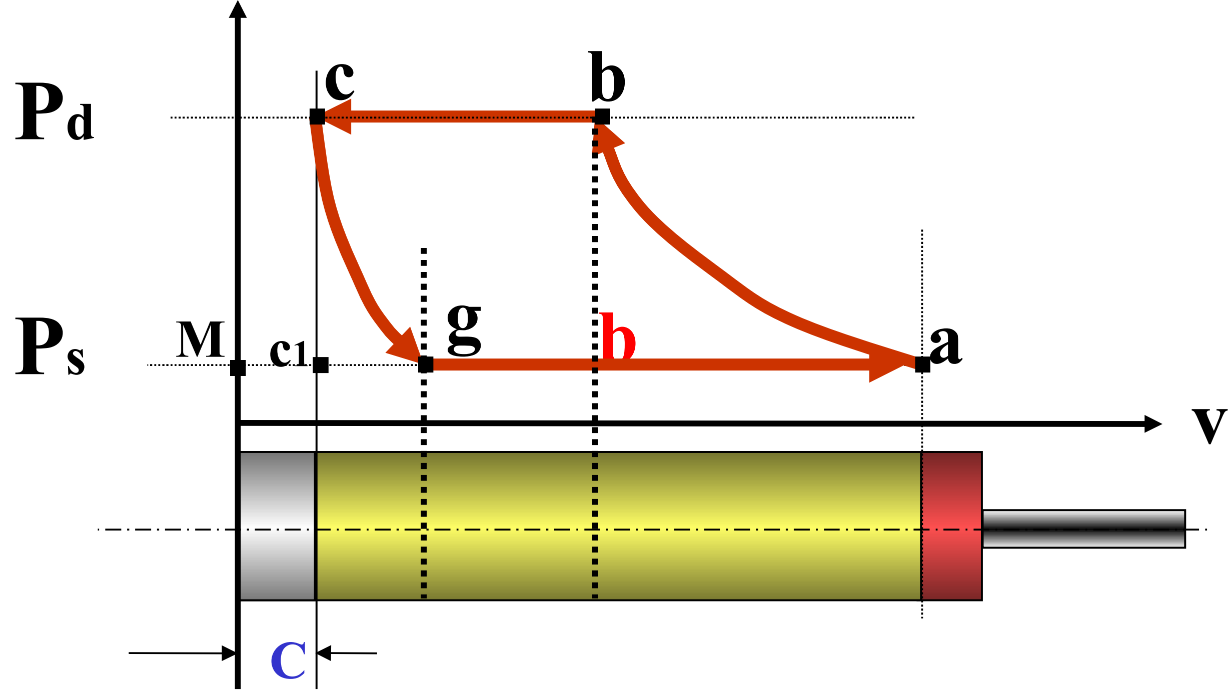
Point **a** **suction valves closed**

Point **b** **discharge valves open**

Point **c** **discharge valves closed**

Point **g** **suction valves open**

C = Clearance volume

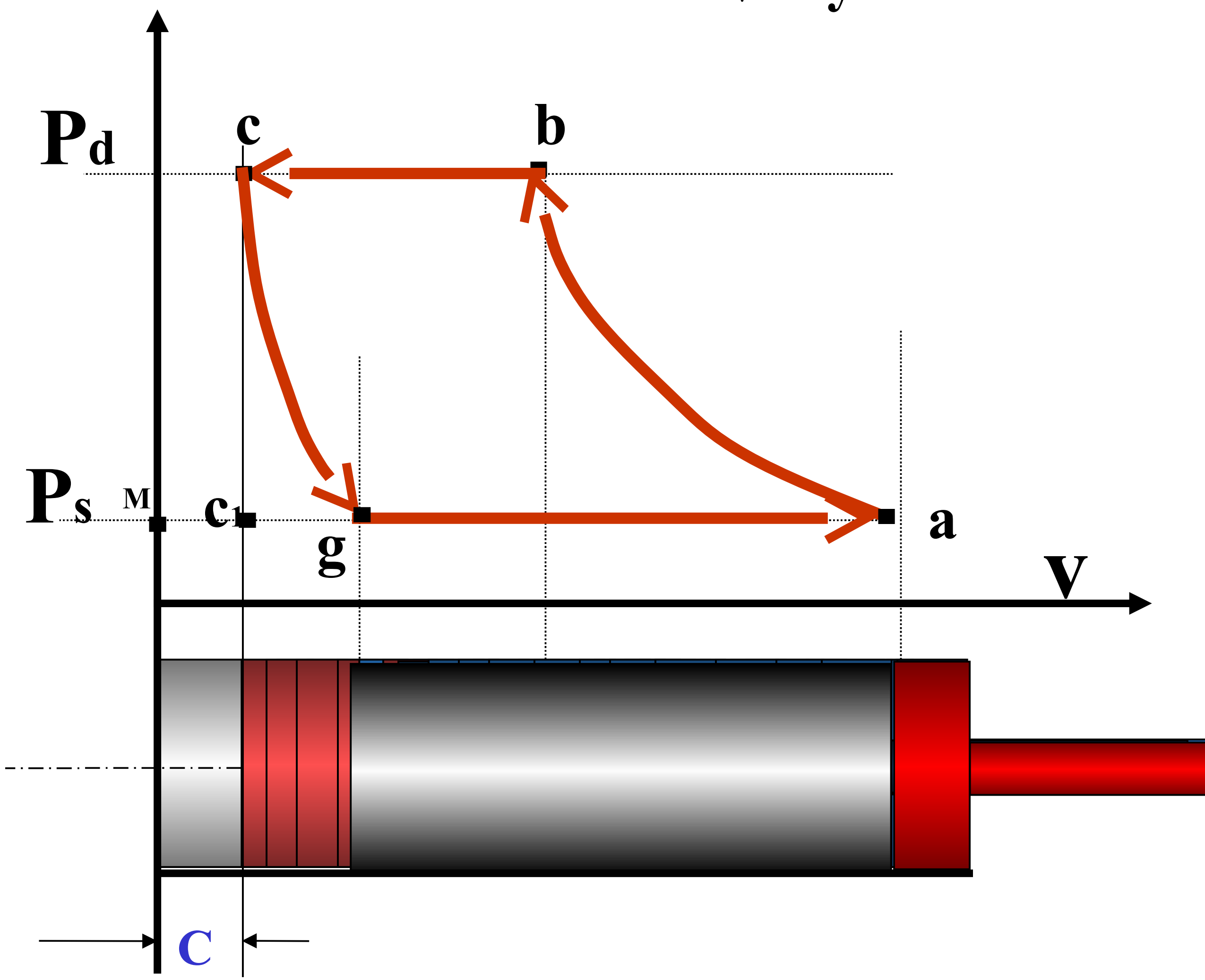


Pressure ratio $= \dfrac{P_d}{P_s}$)ABSOLUTE(

Volumetric efficiency $= \dfrac{V_{ag}}{V_{cylinder}} = \dfrac{ag}{aM}$

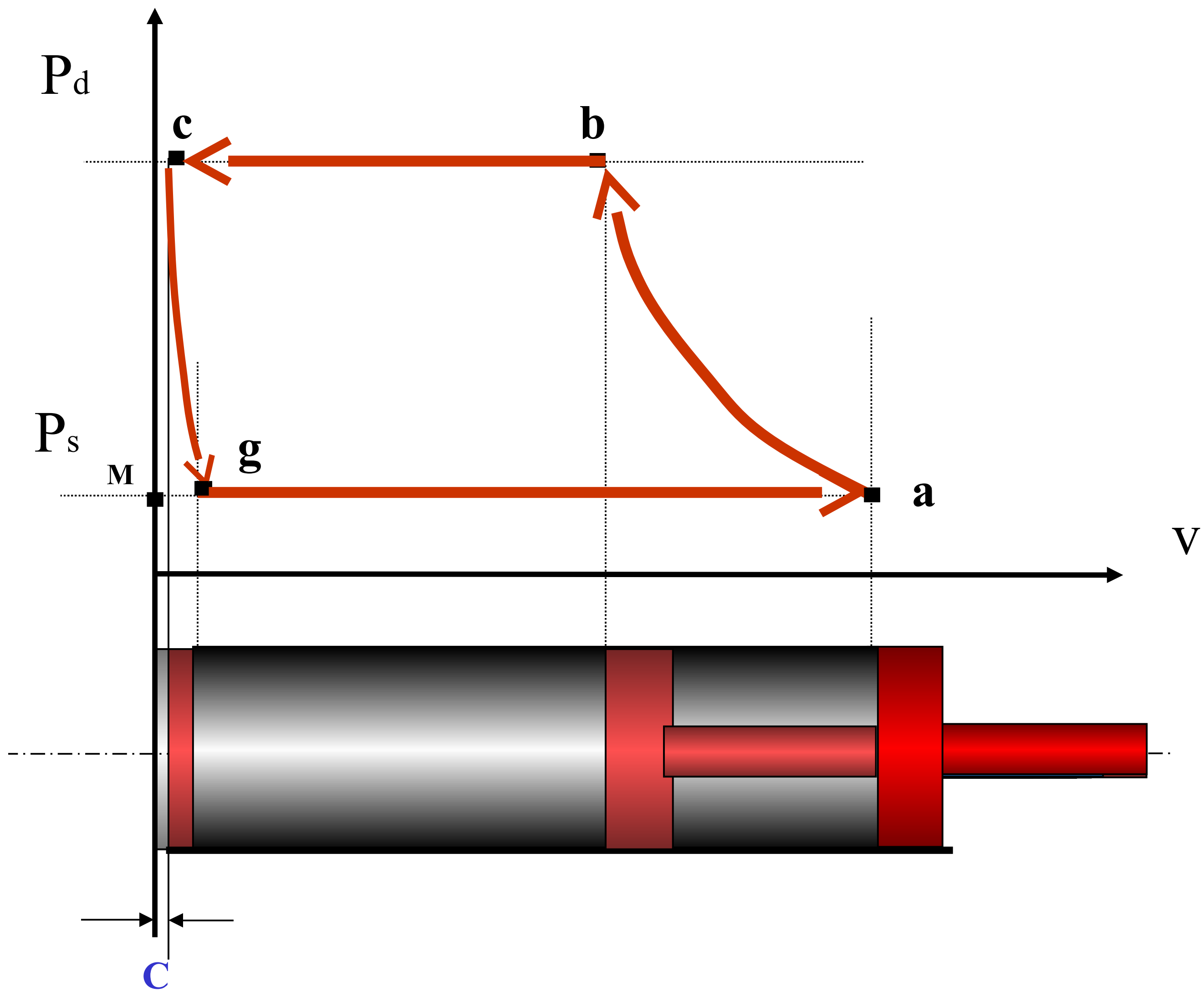
Compression ratio $= \dfrac{V_{cylinder}}{V_{bM}} = \dfrac{aM}{bM}$

Volumetric efficiency $= \dfrac{V_{ag}}{V_{cylinder}} = \dfrac{ag}{aM}$

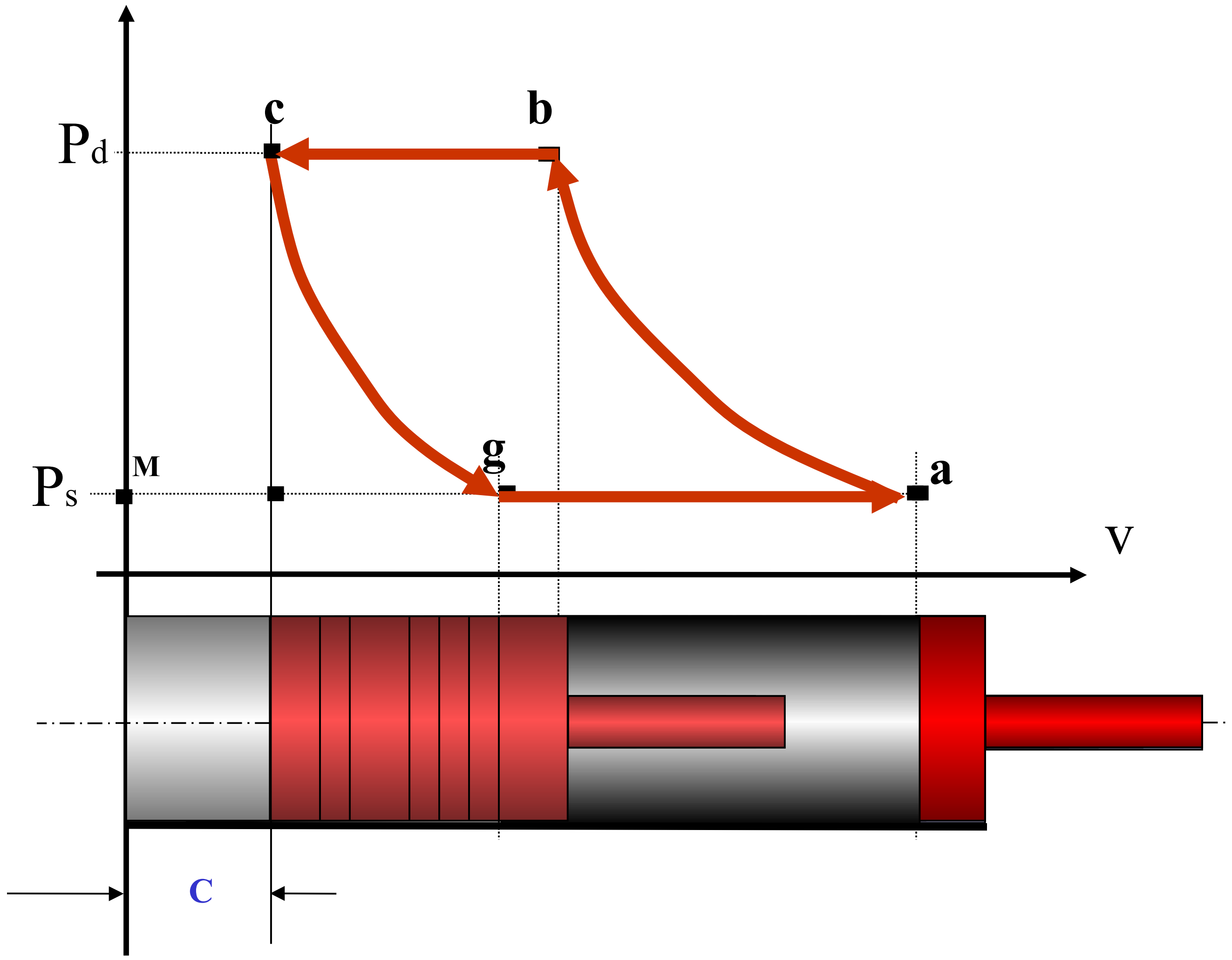


Volumetric efficiency

$$= \frac{V_{ag}}{V_{cylinder}} = \frac{ag}{aM}$$

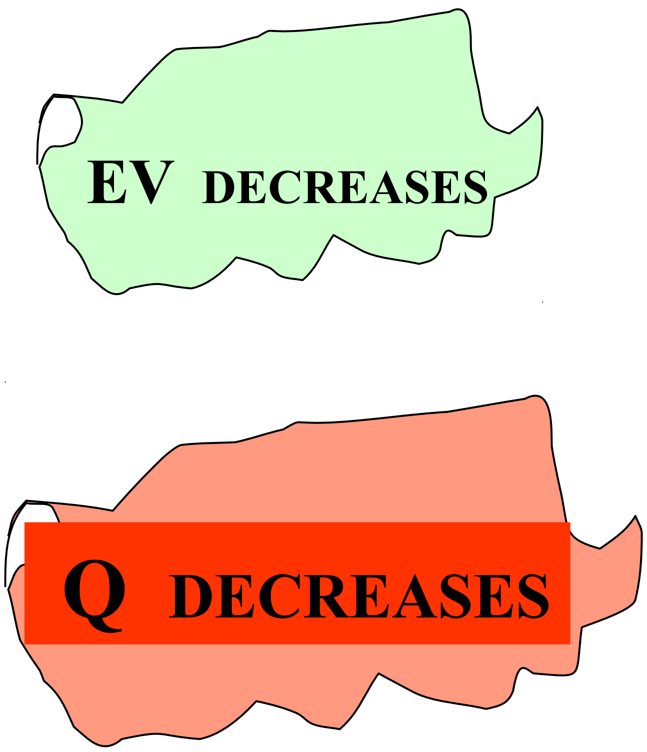


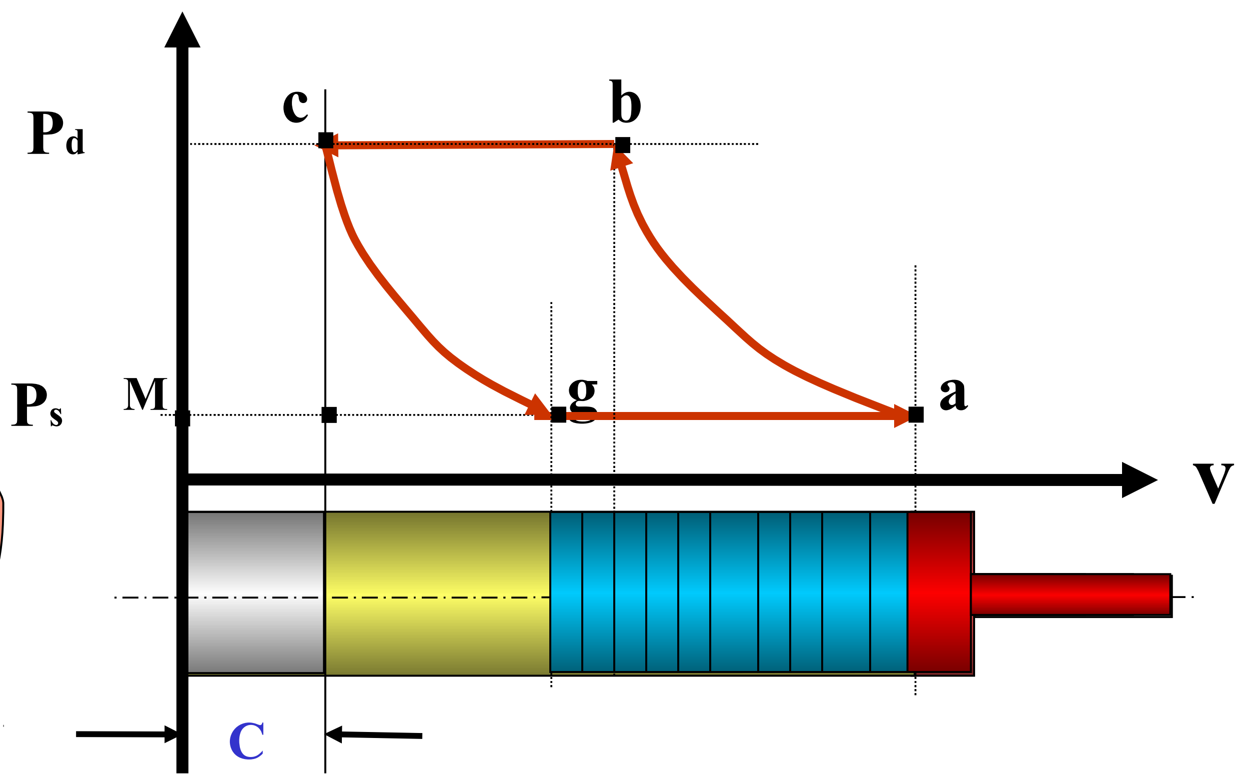
Volumetric efficiency $= \dfrac{V_{a\,g}}{V_{cylinder}} = \dfrac{a\,g}{a\,M}$



If C Increased suction valves will open at)(g

Volumetric efficiency $= \dfrac{V_{ag}}{V_{cylinder}} = \dfrac{ag}{aM}$





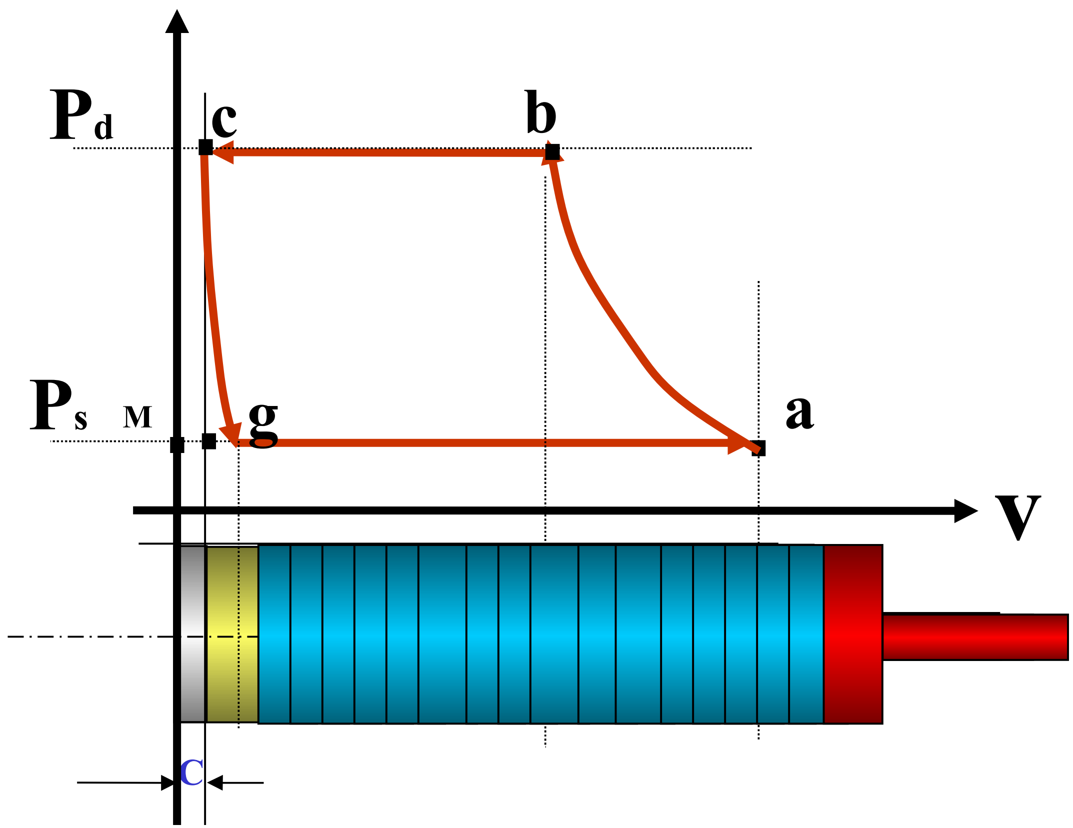
If C Decreased suction valves will open at

)(d

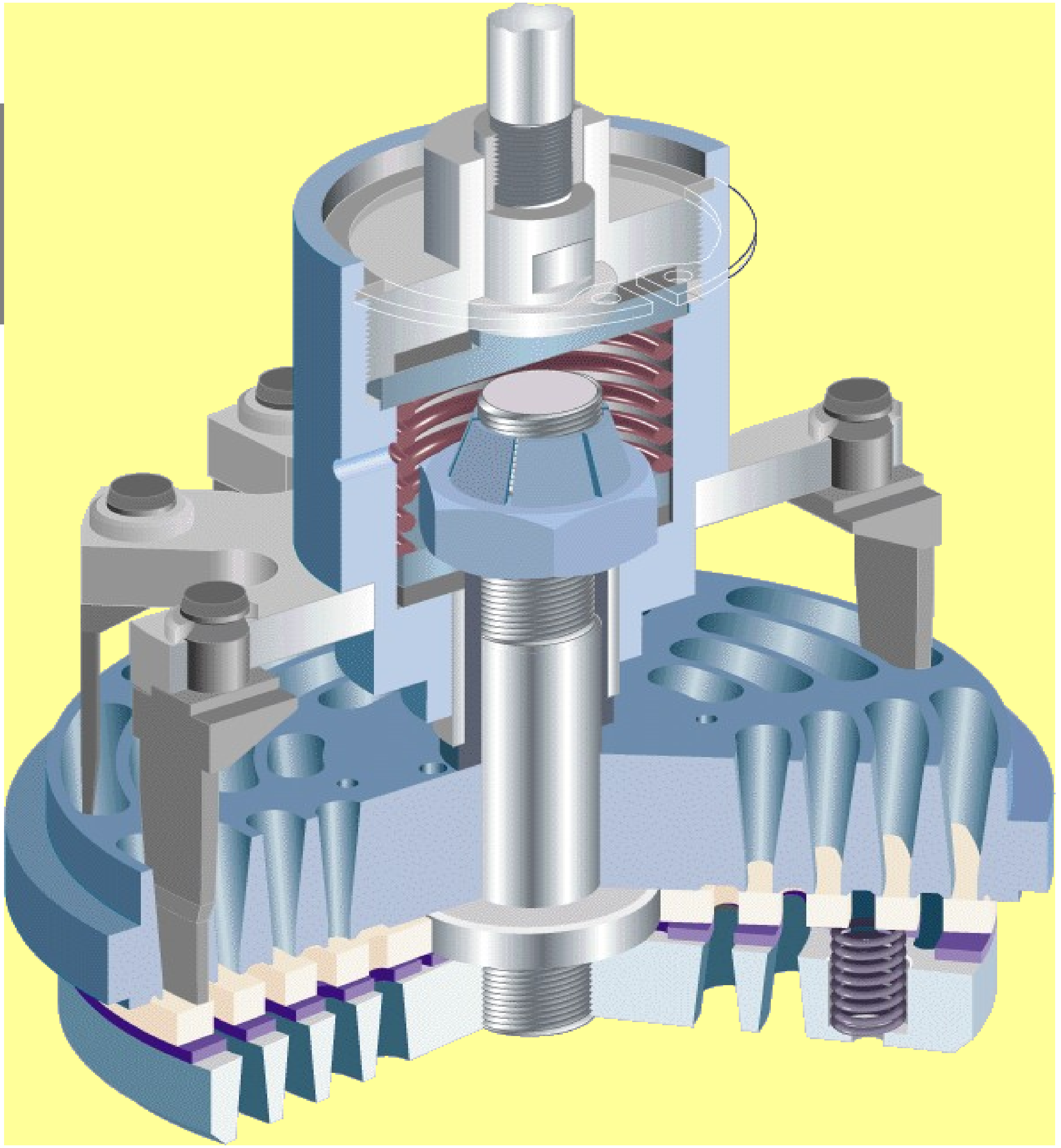
Volumetric efficiency $= \dfrac{V_{a\,g}}{V_{cylinder}} = \dfrac{a\,g}{a\,M}$

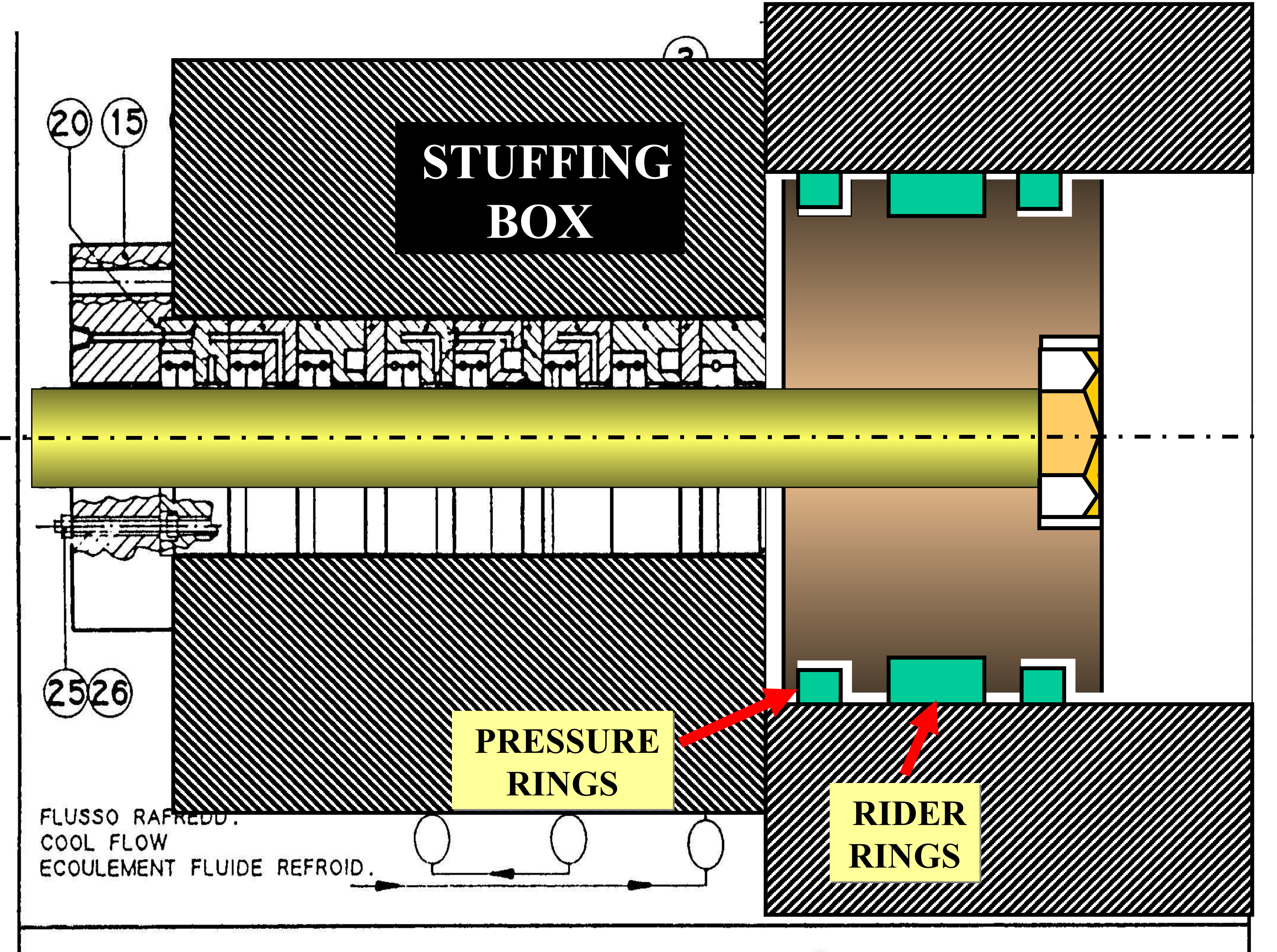
EV INCREASES

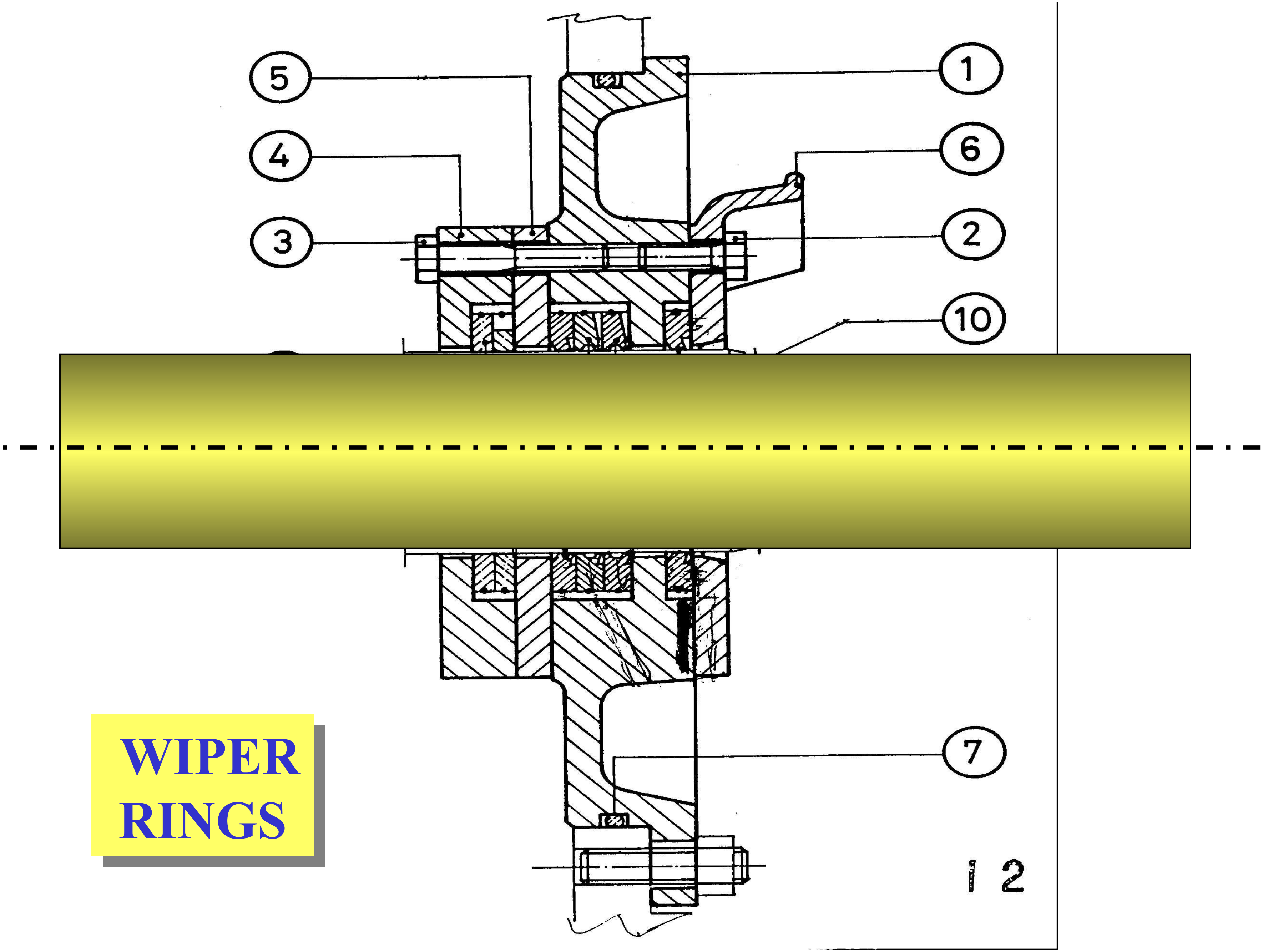
Q INCREASES



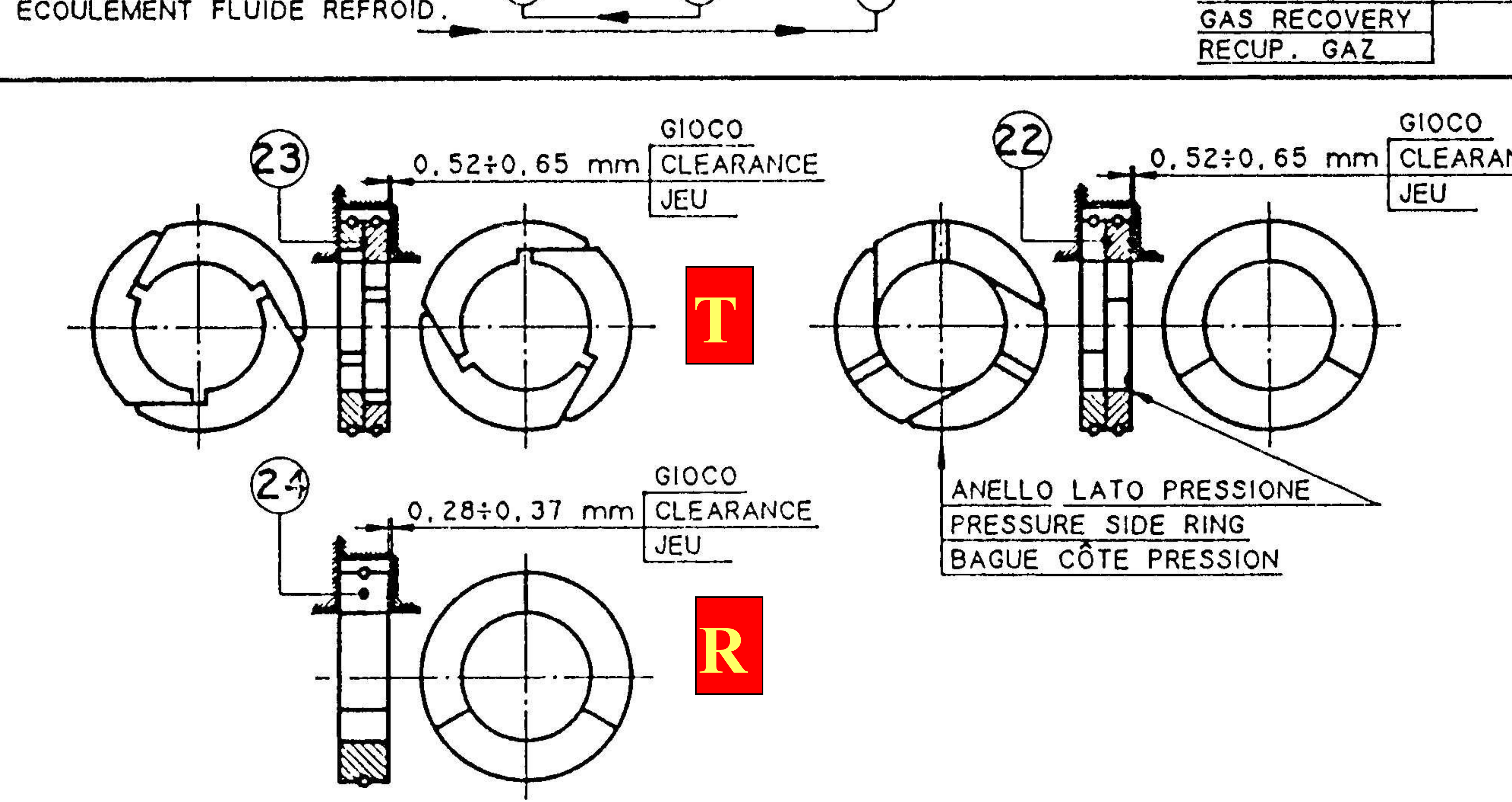
•SUCTION VALVE UNLOADERS




STUFFING BOX
PRESSURE RINGS
RIDER RINGS
20
15
25
26
FLUSSO RAFREDD.
COOL FLOW
ECOULEMENT FLUIDE REFROID.



WIPER RINGS



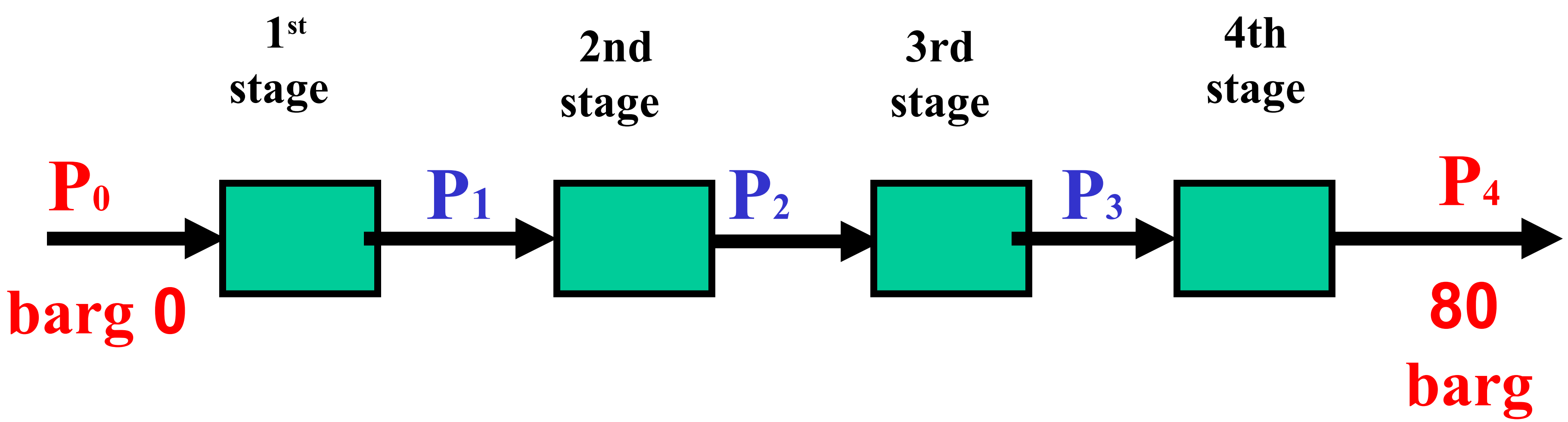
T **TANGENTIAL RINGS**

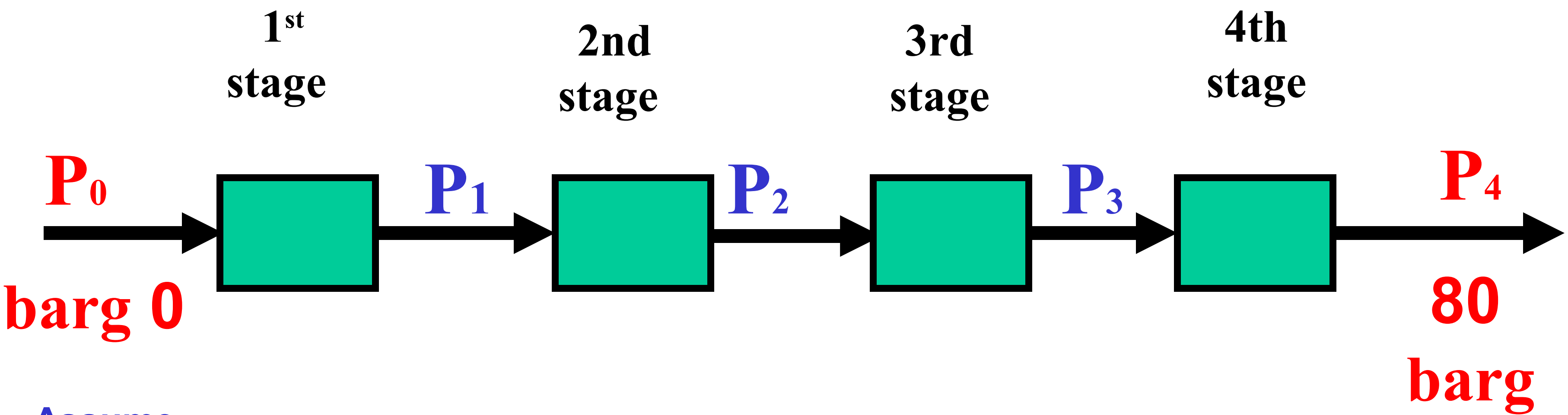
R **RADIAL RINGS**

RECIPROCATING COMPRESSORS INTERMEDIATE PRESSURES

Example 1

Stages Reciprocating Air comp has 4 outlet pressure P4 = 80 barg what are the intermediate pressures





Assume

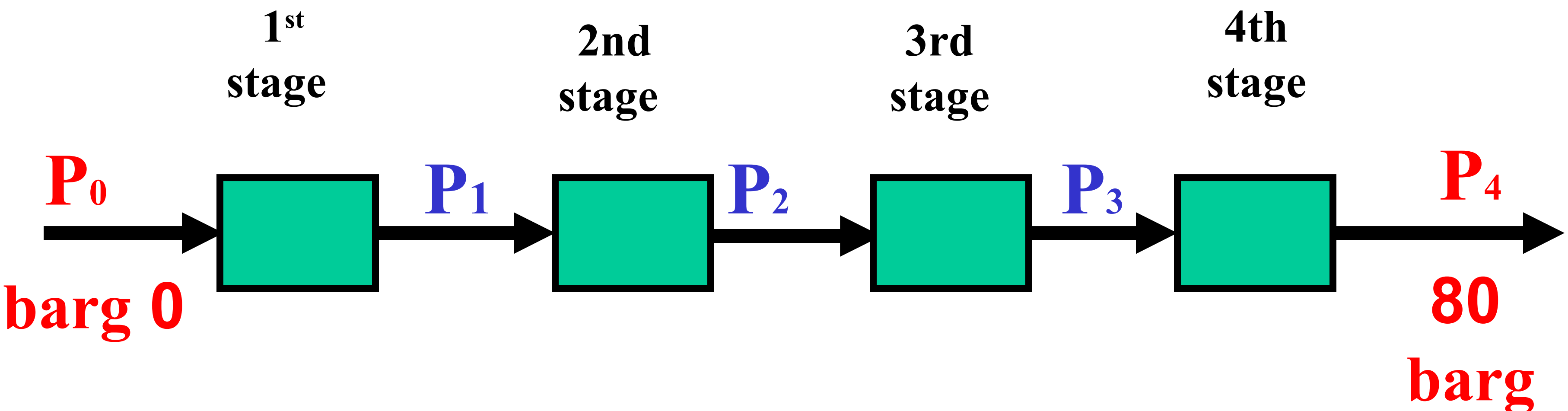
.R is The equal Pressure Ratio between stages **AND** $= RT \; \dfrac{P_4}{P_0}$

$$= R \quad \frac{P_1}{P_0} = \frac{P_2}{P_1} = \frac{P_3}{P_2} = \frac{P_4}{P_3}$$

$$R^4 = \frac{P_4}{P_0} \qquad \textbf{BUT} \qquad = RT \; \frac{P_4}{P_0}$$

Generally

$$\therefore \; R^4 = RT \;\Rightarrow\; R = \sqrt[4]{RT} \;\Rightarrow\; R = \sqrt[N]{RT}$$



$$RT = P_4 / P_0 = (80 + 1) / (0 + 1) = 81 / 1 = 81$$

$$R = \sqrt[N]{RT} = \sqrt[4]{81} = 3$$

$$P_1 = R * P_0 = 3 * 1 = 3 \text{ bara} = 2 \text{ barg}$$

$$P_2 = R * P_1 = 3 * 3 = 9 \text{ bara} = 8 \text{ barg}$$

$$P_3 = R * P_2 = 3 * 9 = 27 \text{ bara} = 26 \text{ barg}$$

$$P_4 = R * P_3 = 3 * 27 = 81 \text{ bara} = 80 \text{ barg}$$

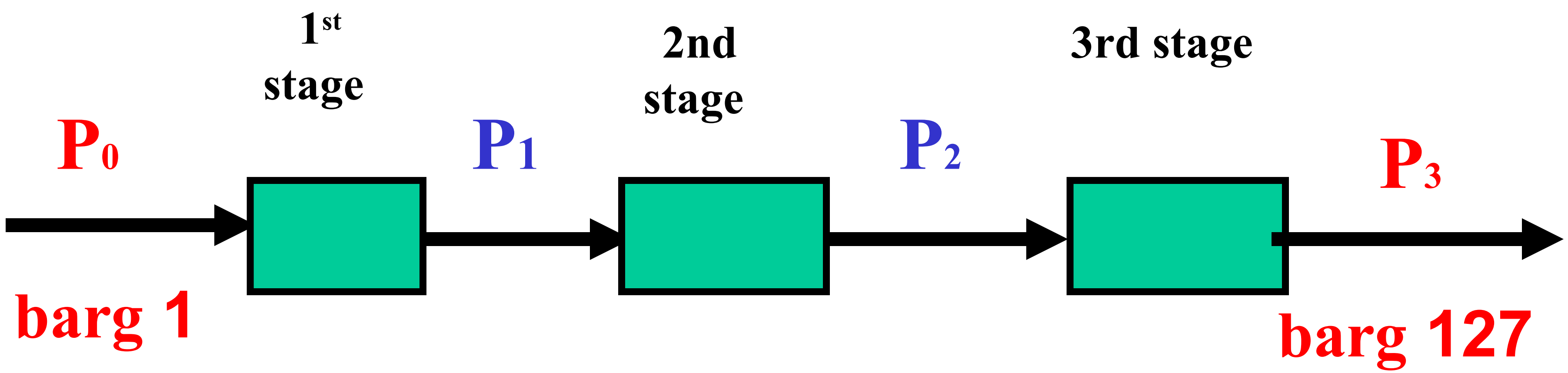
Example 2

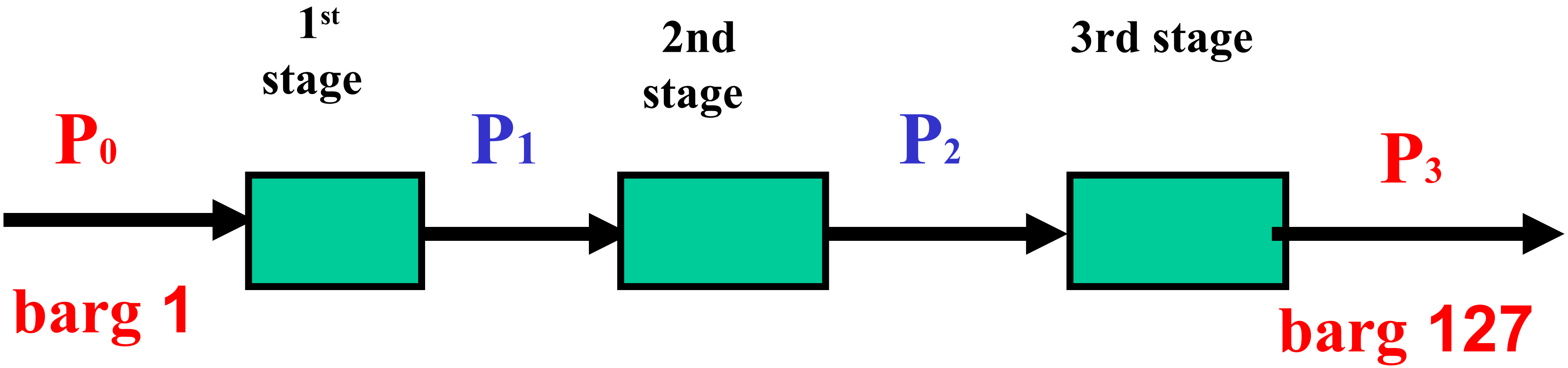
Stages Reciprocating Gas compressor 3 has

Outlet pressure $P_3 = 127$ barg

Inlet pressure $P_0 = 1$ barg

what are the intermediate pressures





Assume

$$R = \frac{P_1}{P_0} = \frac{P_2}{P_1} = \frac{P_3}{P_2} \Rightarrow R^3 = \frac{P_3}{P_0}$$

$$RT = \frac{P_3}{P_0} \quad \textbf{BUT} \quad R^3 = \frac{P_3}{P_0}$$

$$\therefore R^3 = RT \Rightarrow R = \sqrt[3]{RT}$$

$$RT = R^3 = \frac{P_3}{P_0} = \frac{(1+127)}{(1+1)} = \frac{128}{2} = 64$$

$$R = \sqrt[N]{RT} = \sqrt[3]{64} = 4$$

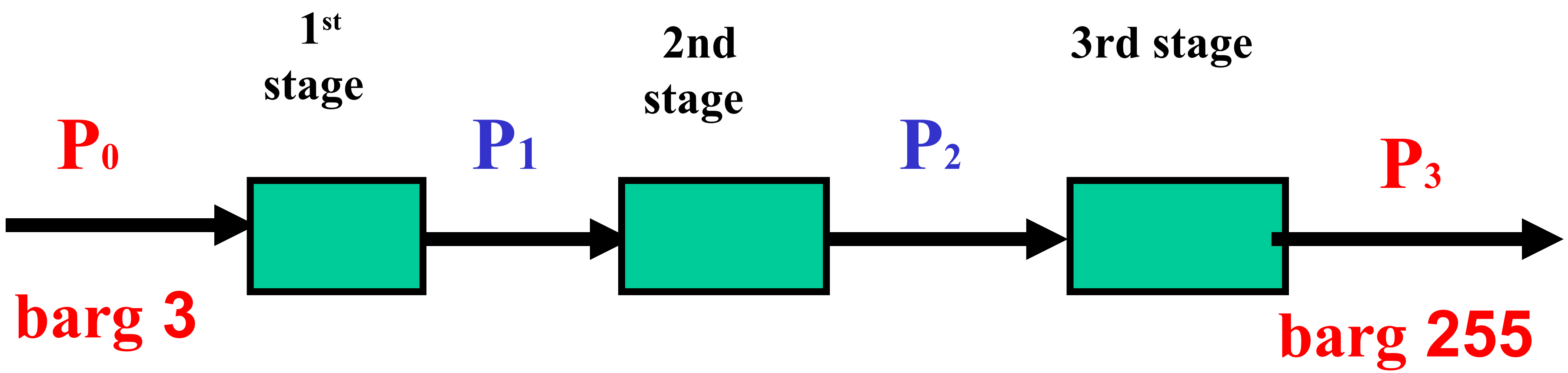
P1 = R * P0 = 4 * 2 = 8 bara = 7 bar g

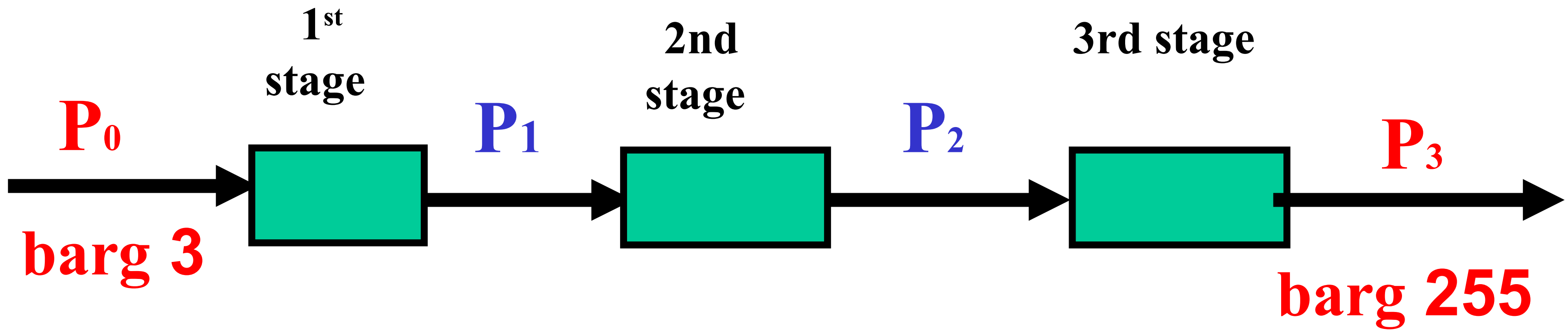
P2 = R * P1 = 4 * 8 = 32 bara = 31 bar g

P3 = R * P2 = 4 * 32 = 128 bara = 127 bar g

Example 2

Stages Gas compressor has 3
Outlet pressure = 255 bar g
Inlet pressure = 3 bar g
What are the intermediate pressures





$$RT = R^3 = \frac{P_3}{P_0} = \frac{(1+255)}{(3+1)} = \frac{256}{4} = 64$$

$$R = \sqrt[N]{RT} = \sqrt[3]{64} = 4$$

$$P1 = R * P0 = 4 * 4 = 16 \text{ bara} = 15 \text{ bar g}$$

$$P2 = R * P1 = 4 * 16 = 64 \text{ bara} = 63 \text{ bar g}$$

$$P3 = R * P2 = 4 * 64 = 256 \text{ bara} = 255 \text{ bar g}$$

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