



PUMPS

1- Function Of Pumps

2- Pumps Classification

3- Code and Standards



1- Function Of Pumps

- A wide variety of pumps are used in petroleum industry.
- A pump is used to increase the total energy content of a liquid in the form of pressure increase.

The pumps are used to perform one of the following jobs:

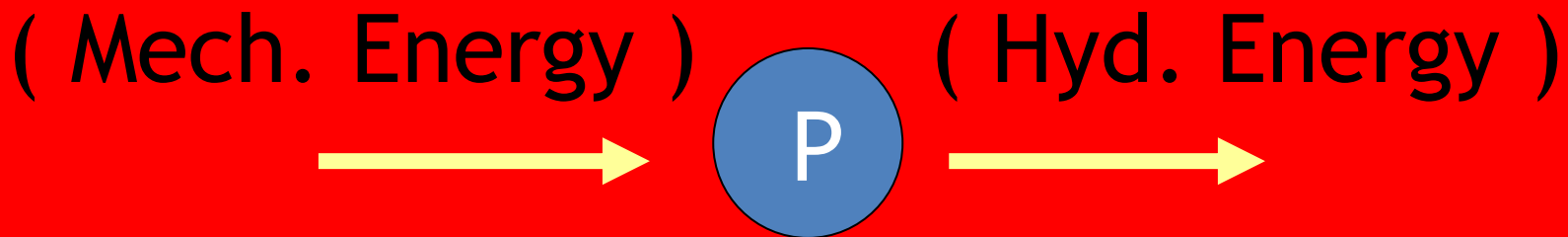
- Move liquids from low level to high level
- Move liquids from low pressure location to high pressure location
- Hydraulic Systems
- To increase the flow rate of a liquid



Definition

Pump is used to convert

Mechanical Power into Hydraulic Power





Pump Drives

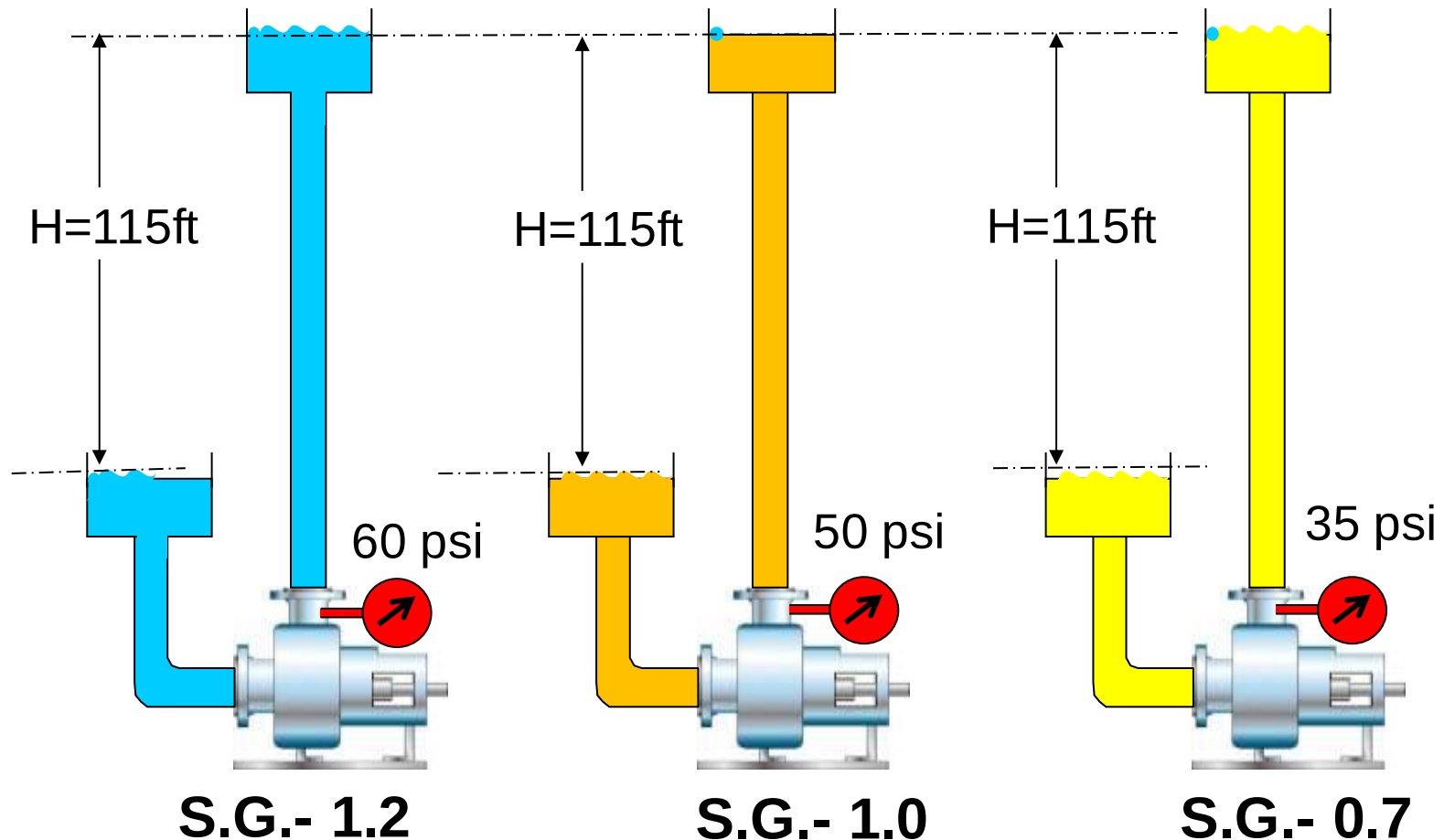
The source of power for a pump could be

1. Electric motor,
2. Gas or diesel internal combustion engine,
3. Steam turbine,
4. Gas turbine

Small pumps may be operated by hand or foot, by air pressure or another fluid pressure, or an electromagnet.



Pressure is dependent on the (specific gravity) of the liquid
Head is totally independent of (specific gravity) of the liquid





2- Pumps Classification

CENTRIFUGAL

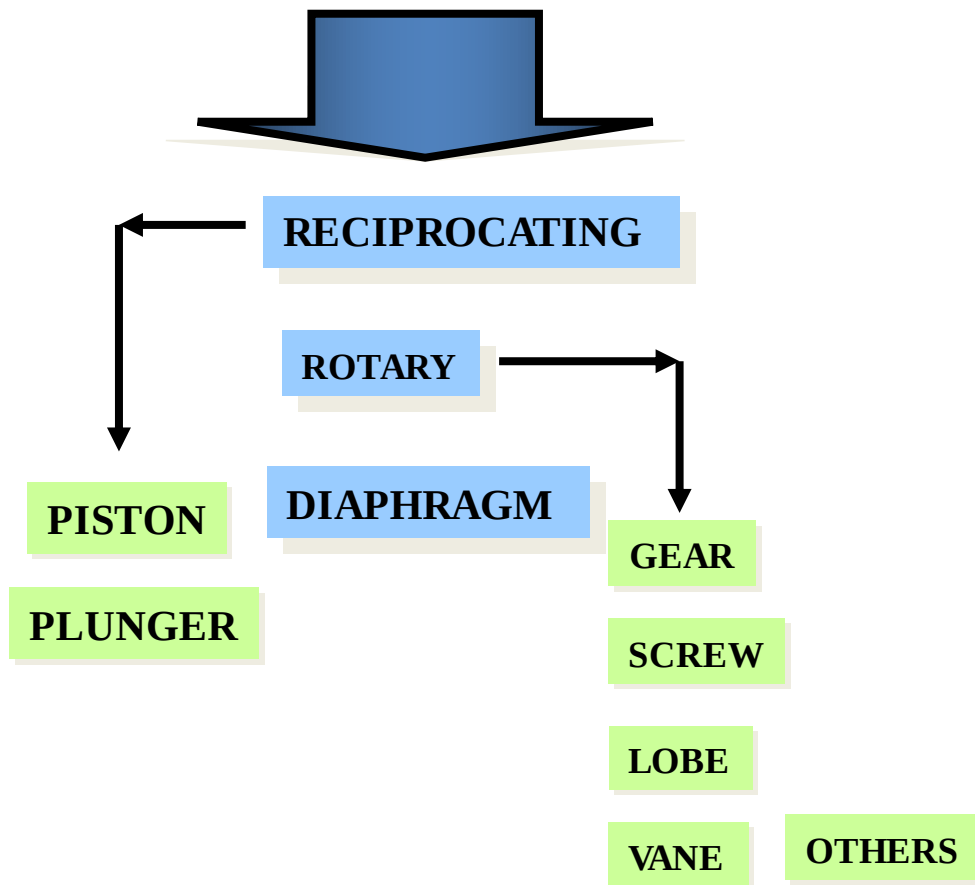
MANY TYPES

POSITIVE DISPLACEMENT

OTHERS

JET

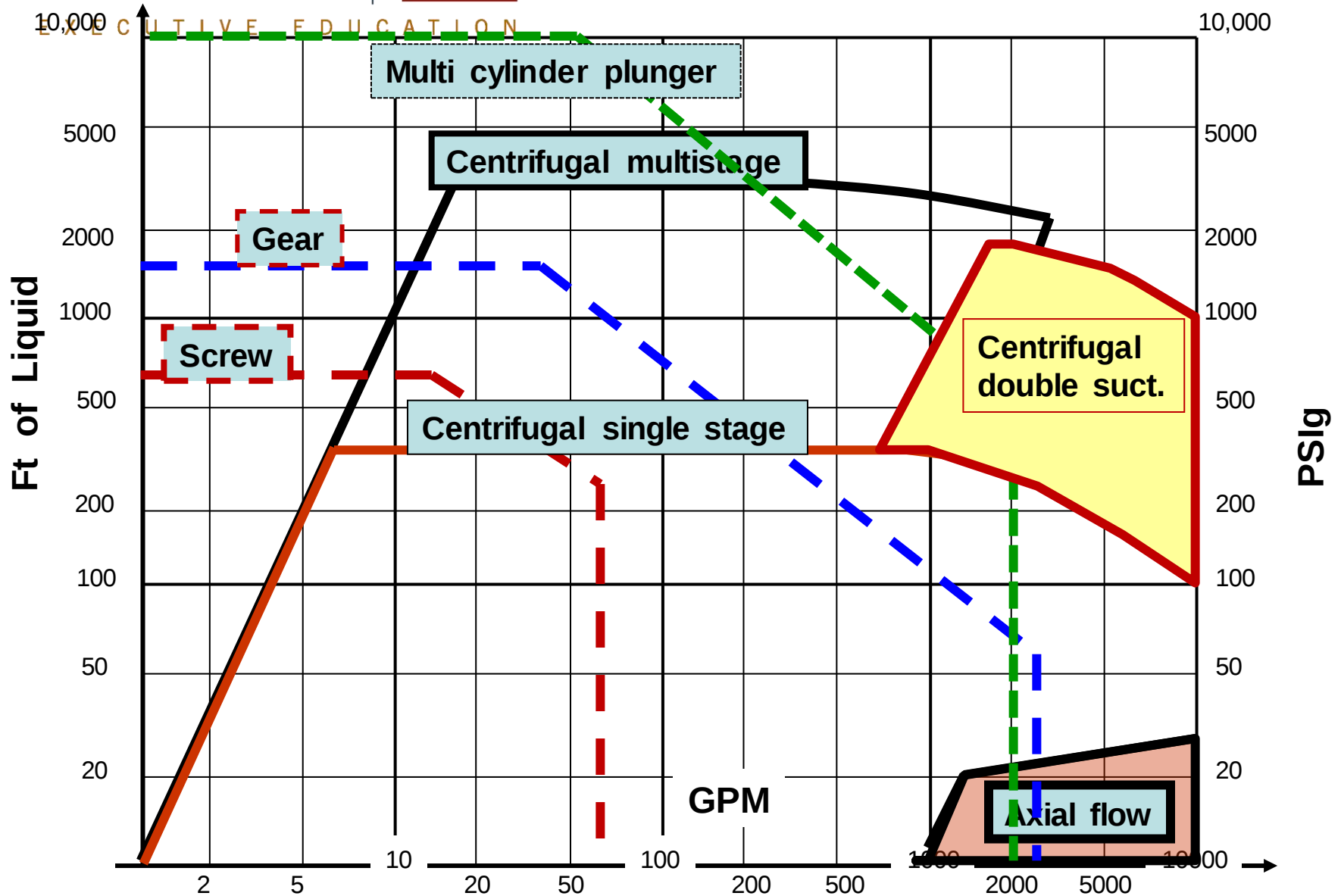
LIQUID RING





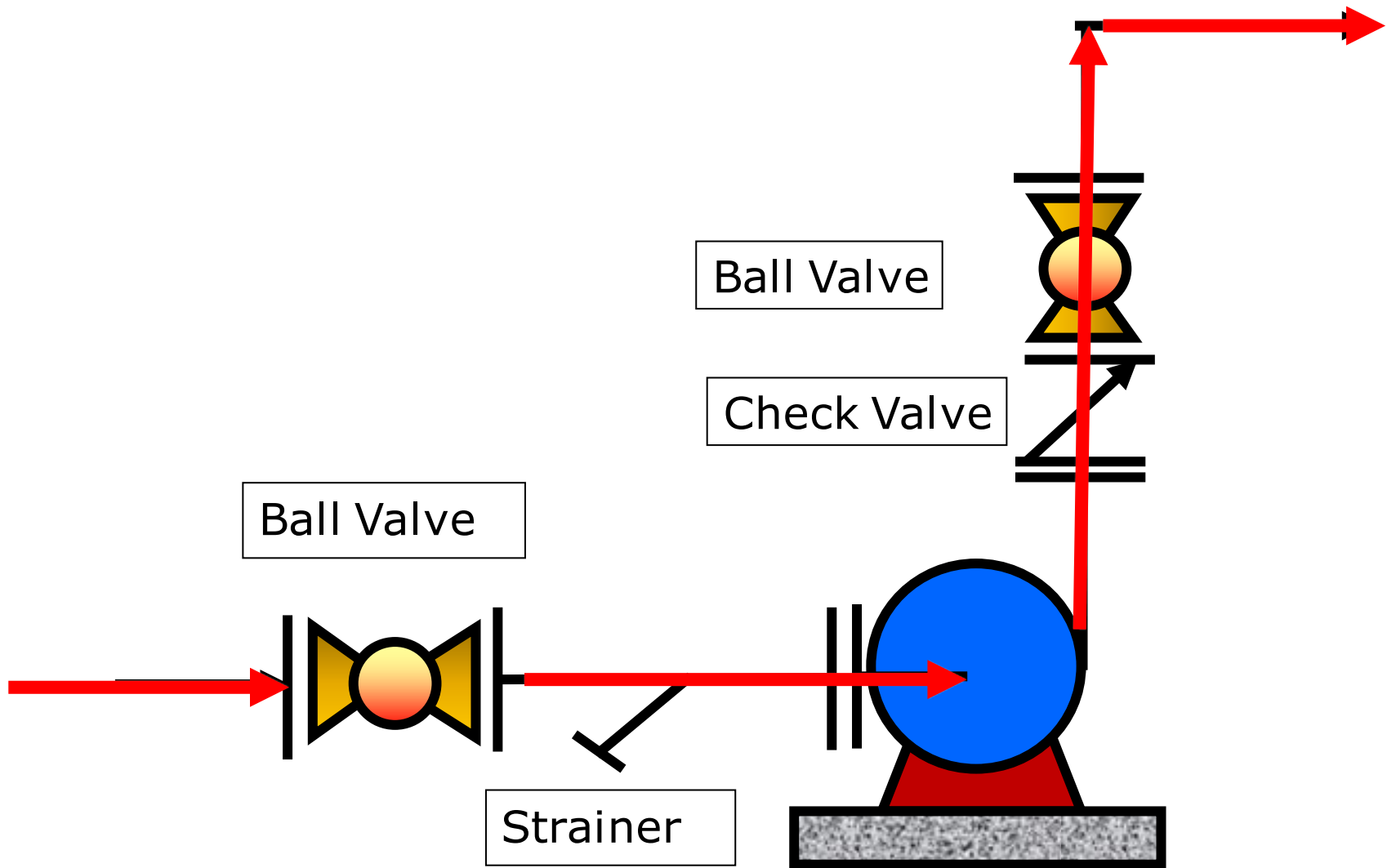
Main Types Pumps

	Positive D.P.	Centrifugal	Axial Flow
Pressure P	V. HIGH	HIGH	LOW
Flow Rate Q	LOW	HIGH	V. HIGH
S .R .V	YES	NO	NO
Efficiency	HIGH	MEDIUM	V. HIGH
Maint. cost	V. HIGH	LOW	LOW
Pulsation	YES	NO	NO



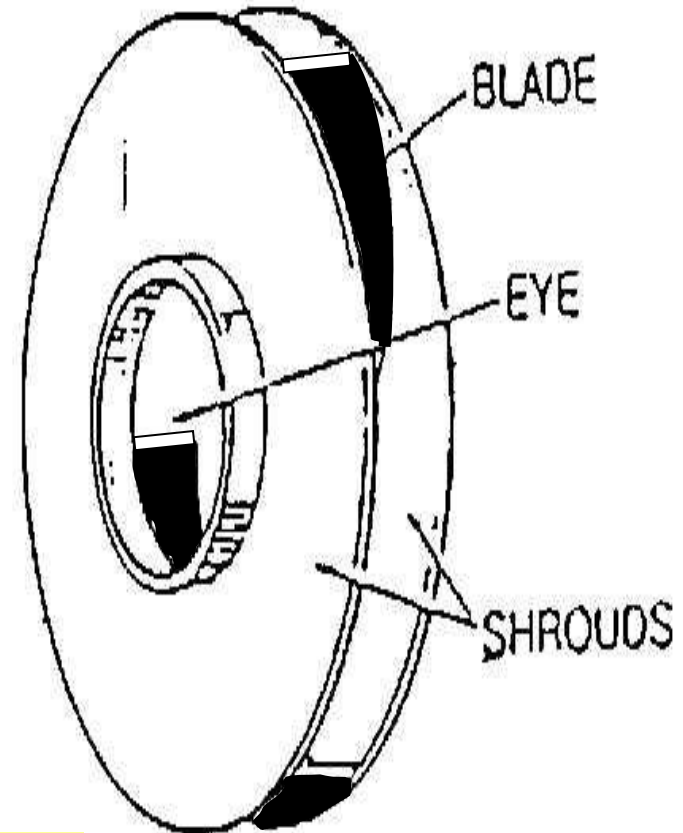
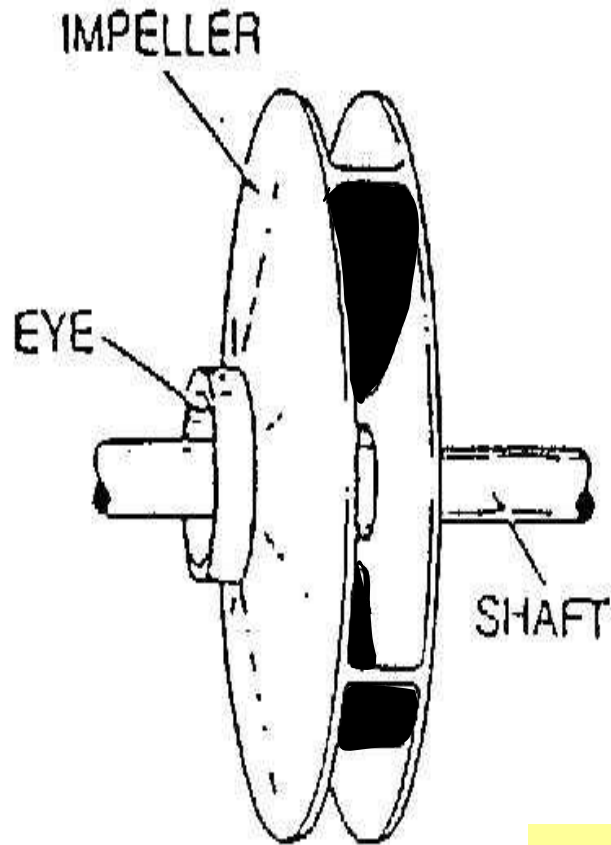


- Centrifugal pumps





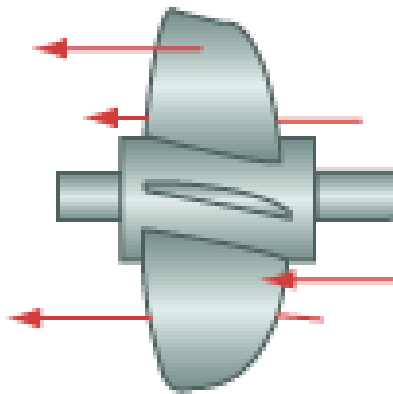
- Centrifugal pumps



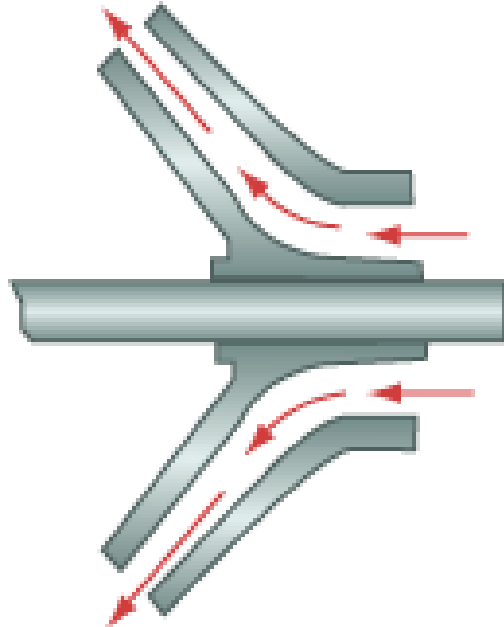
Closed impeller



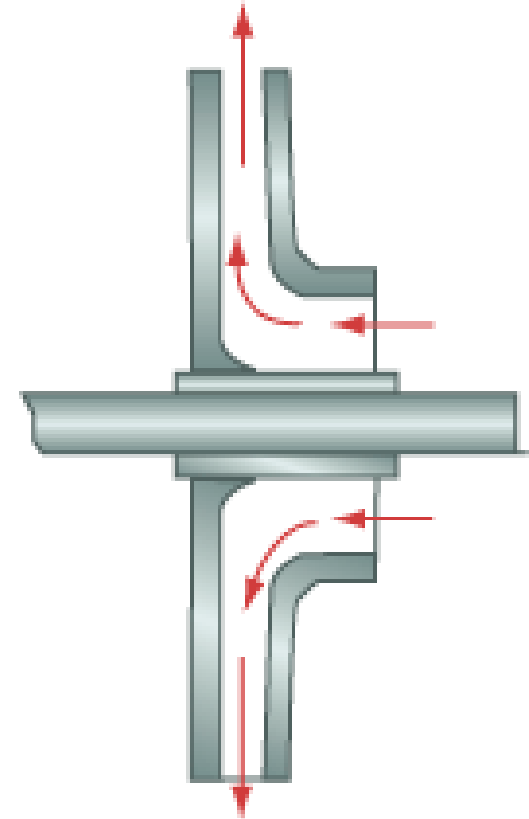
- Centrifugal pumps



Propeller



Turbine



Impeller



- **Centrifugal pumps**



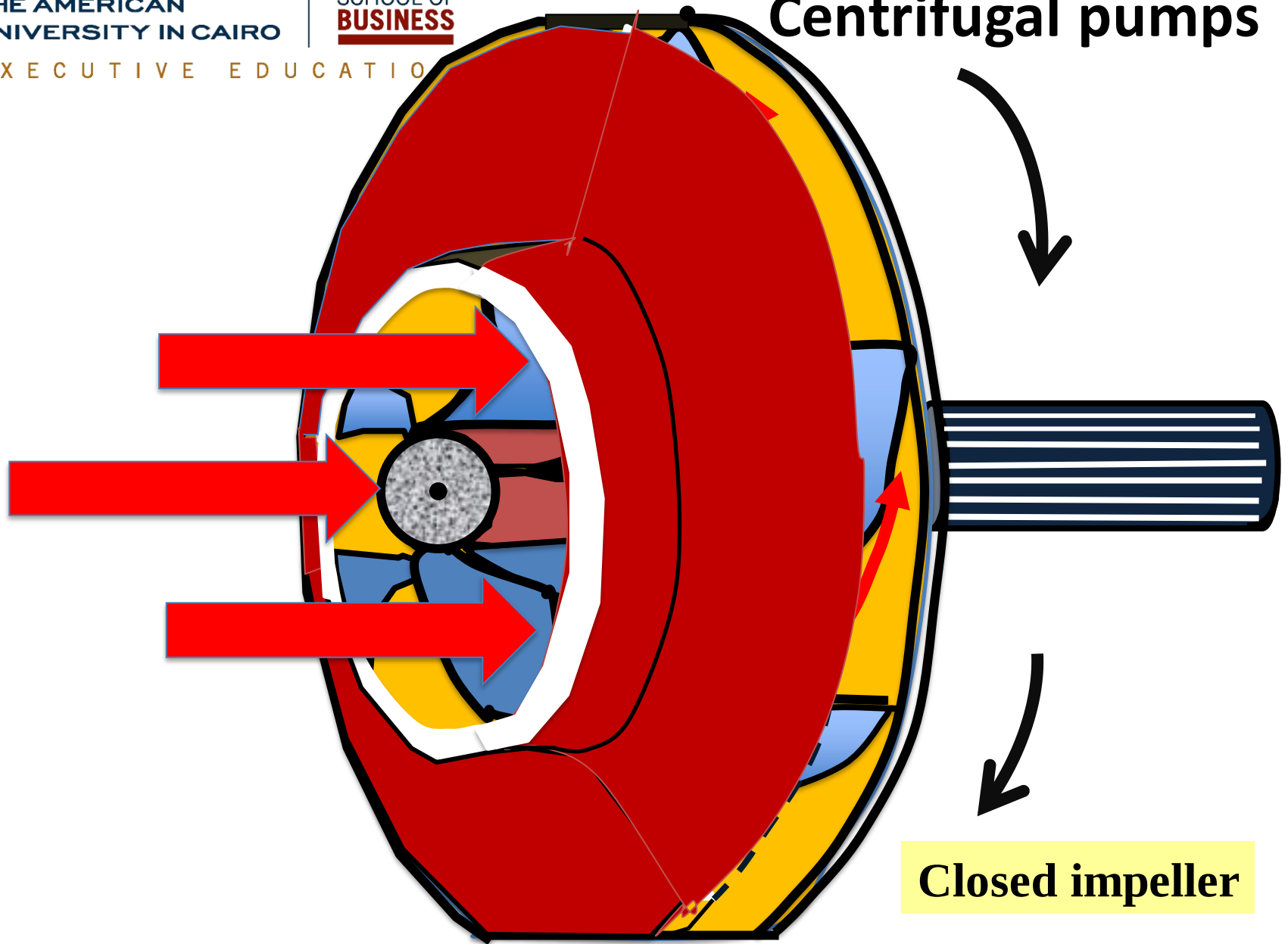
Open impeller



Semi open impeller



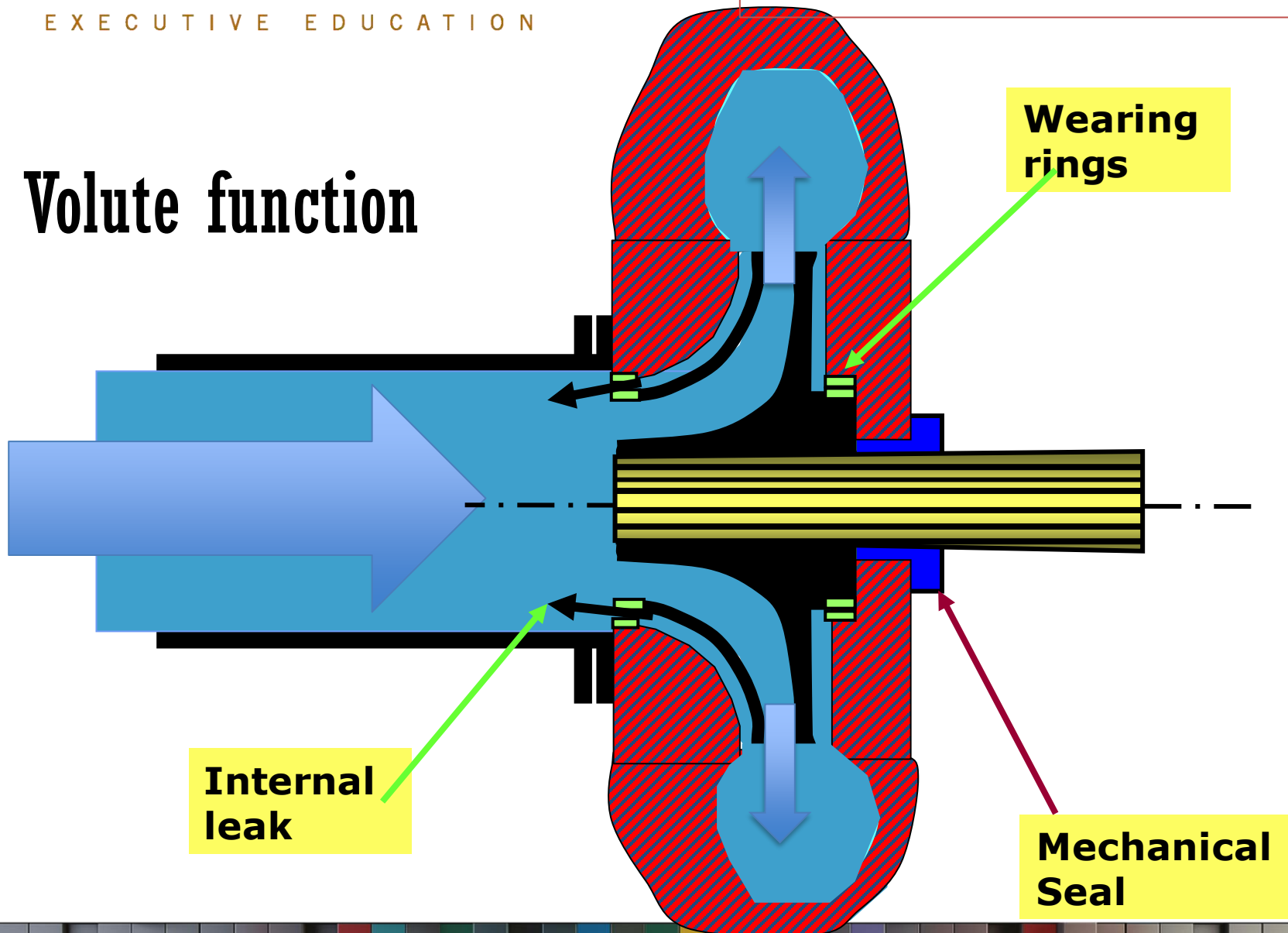
Centrifugal pumps





- Centrifugal pumps

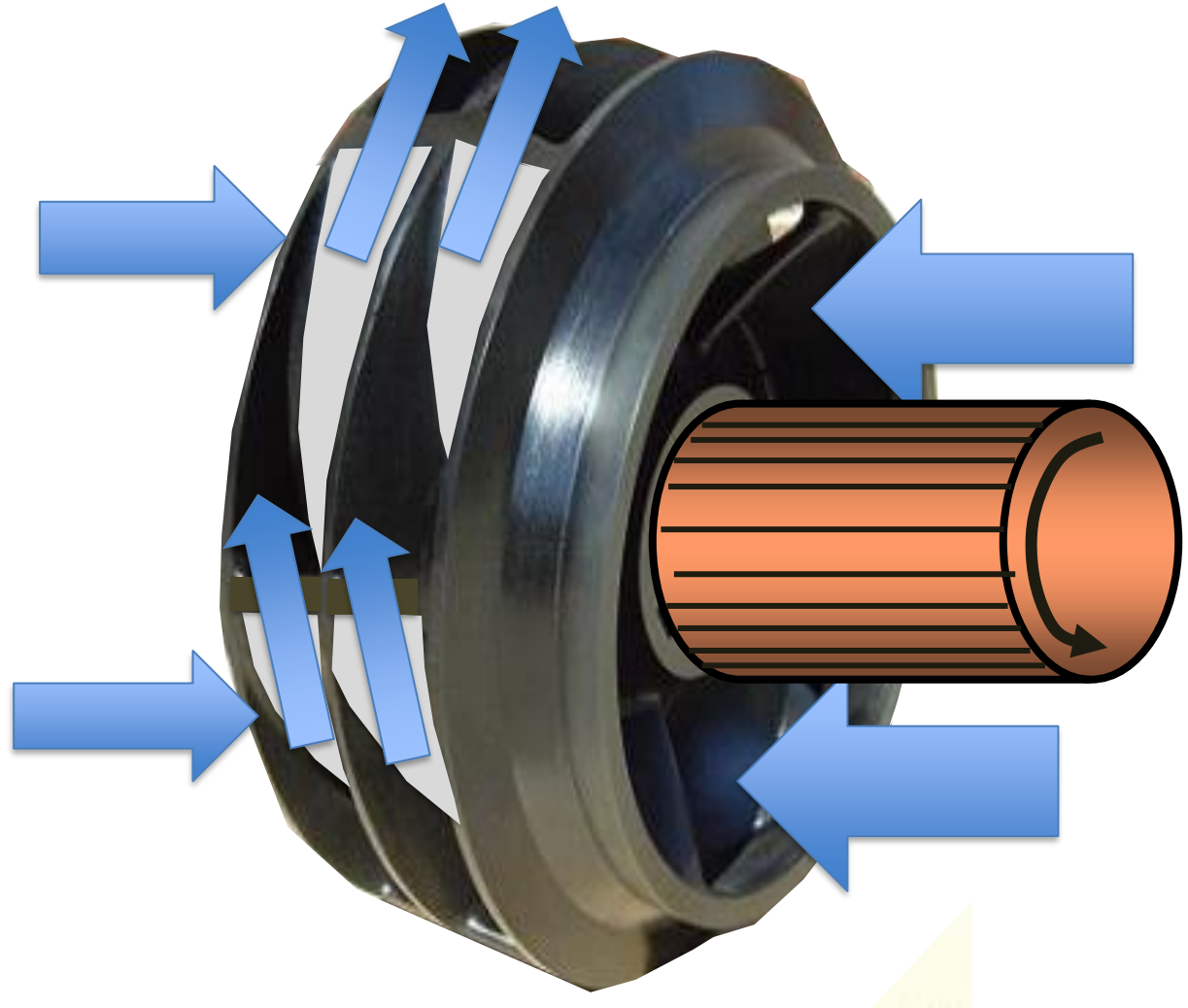
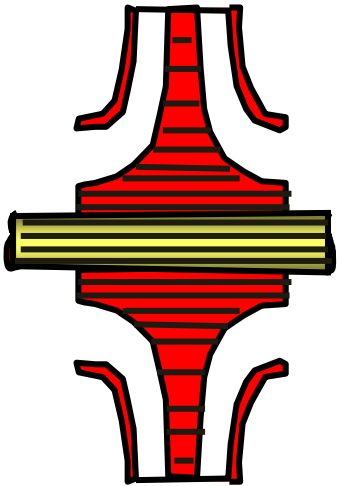
Volute function





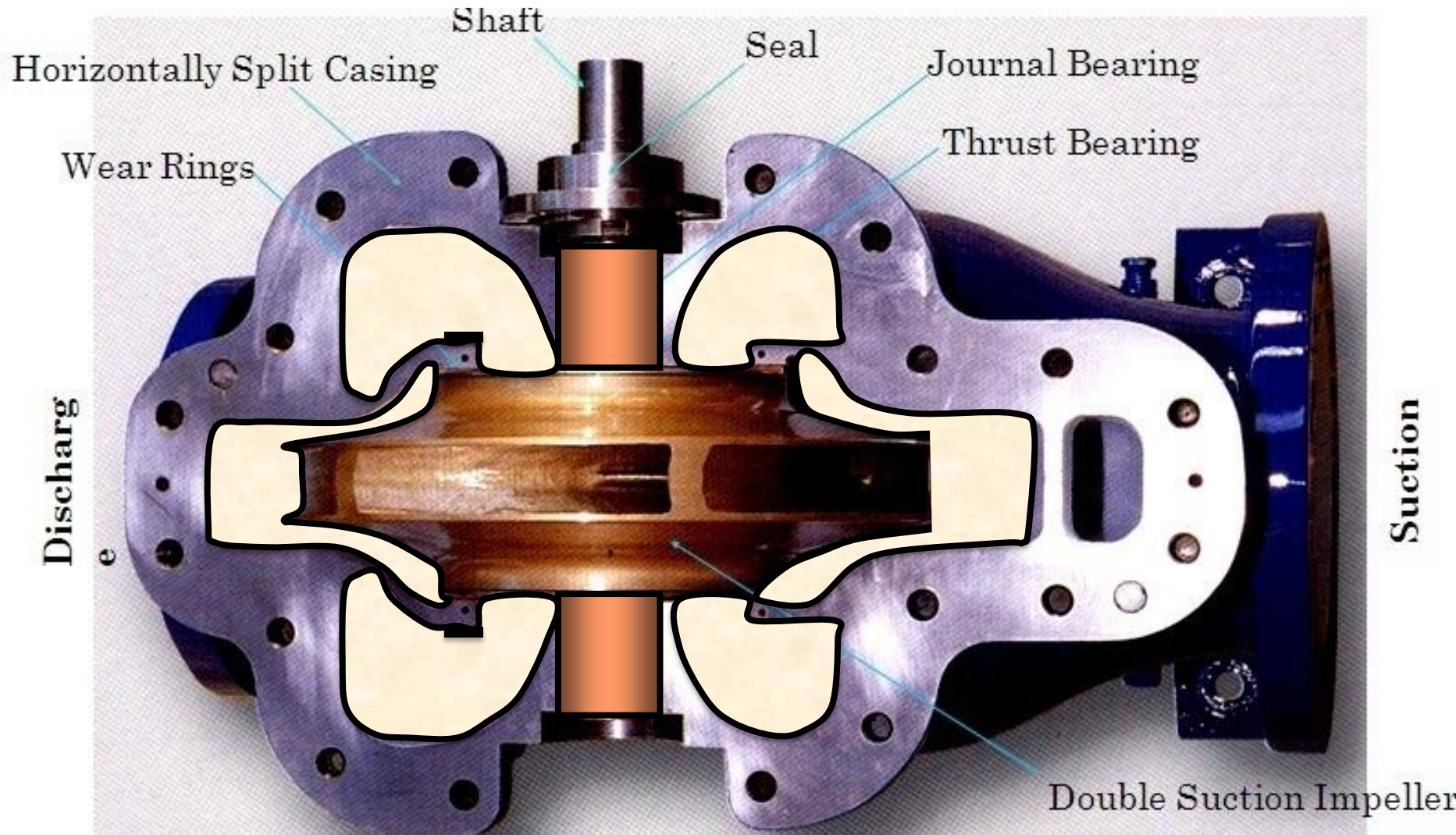
- Centrifugal pumps

Double suction impeller





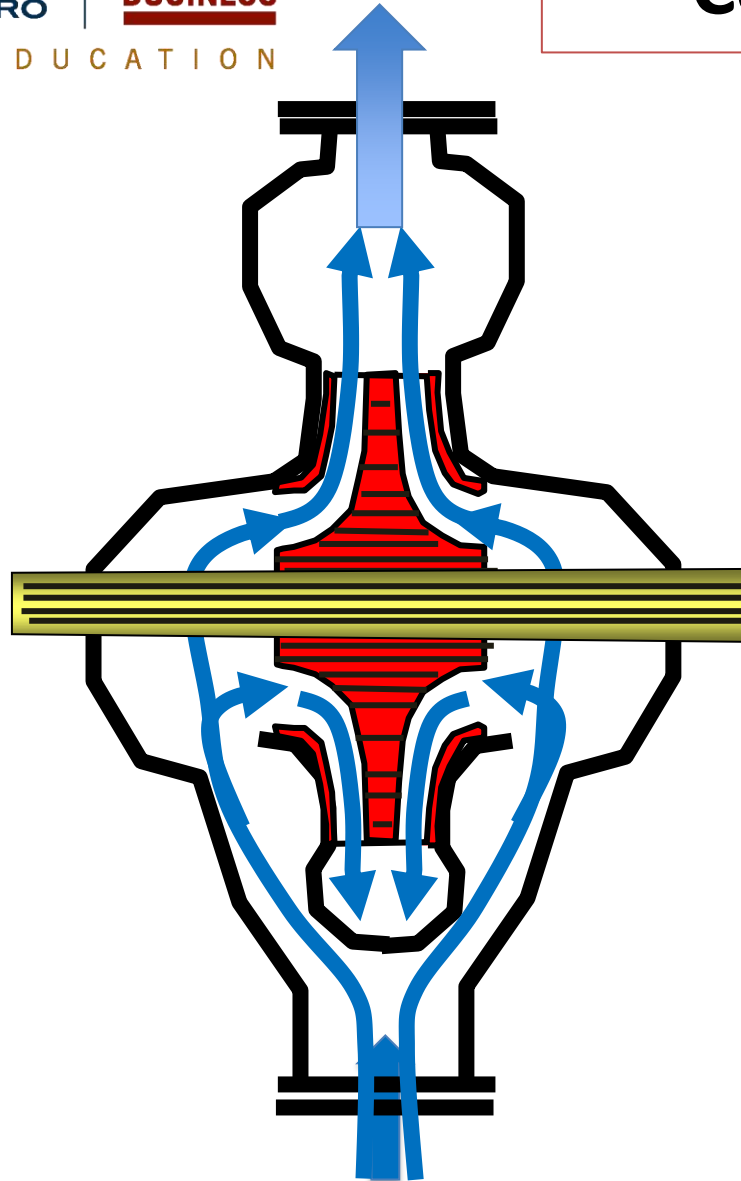
- Centrifugal pumps





- Centrifugal pumps

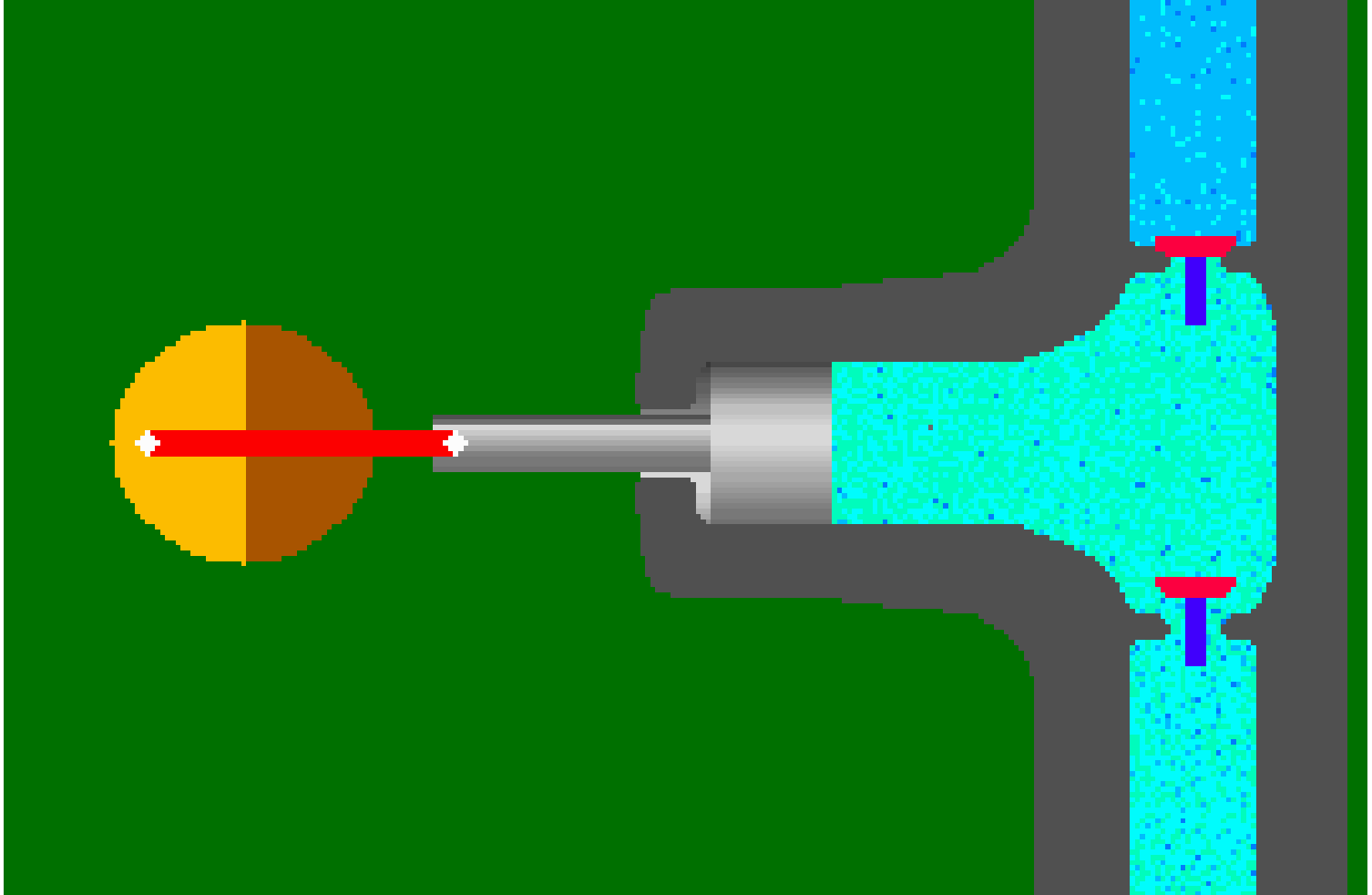
Double suction impeller





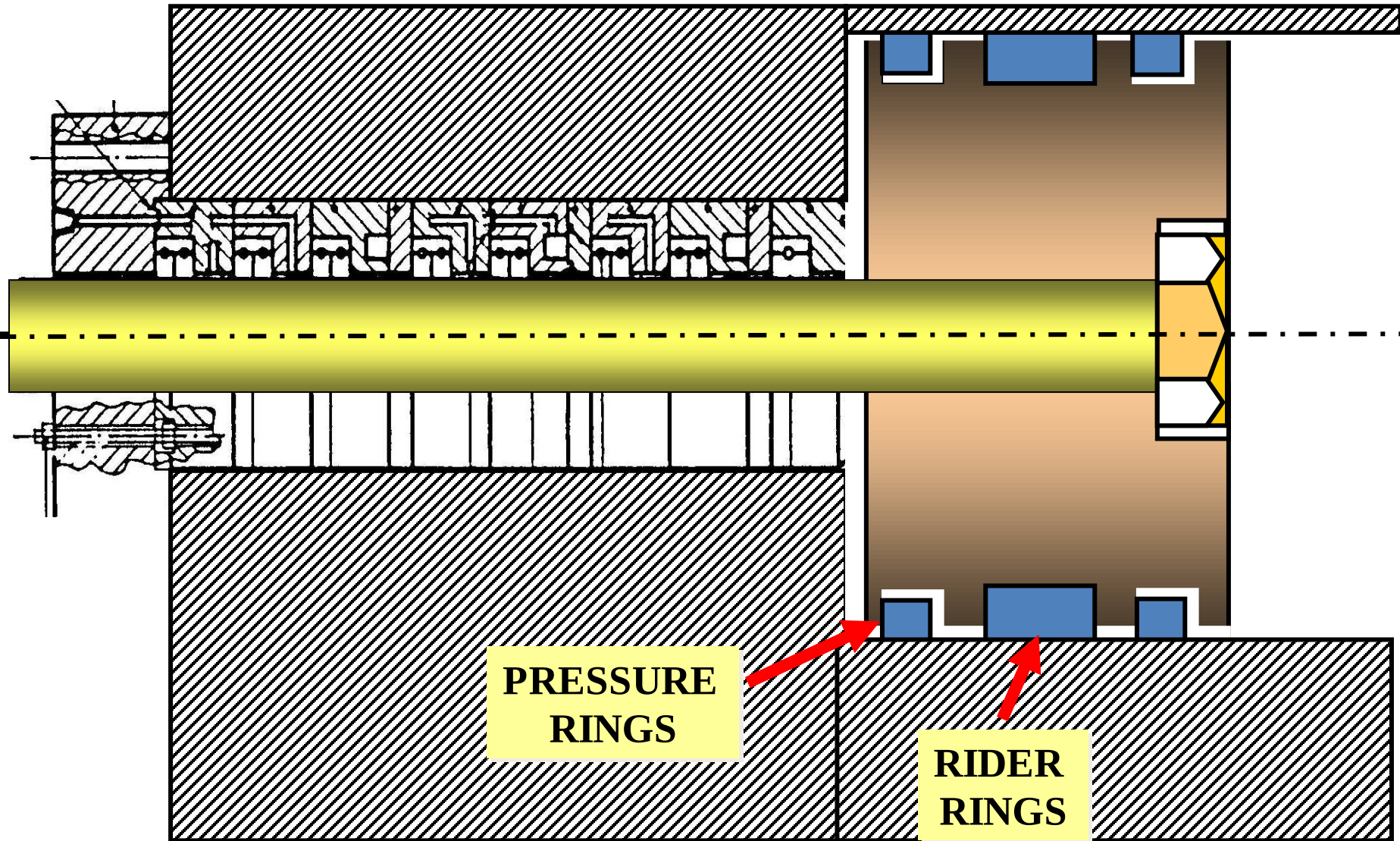
- # Reciprocating Pumps

Piston



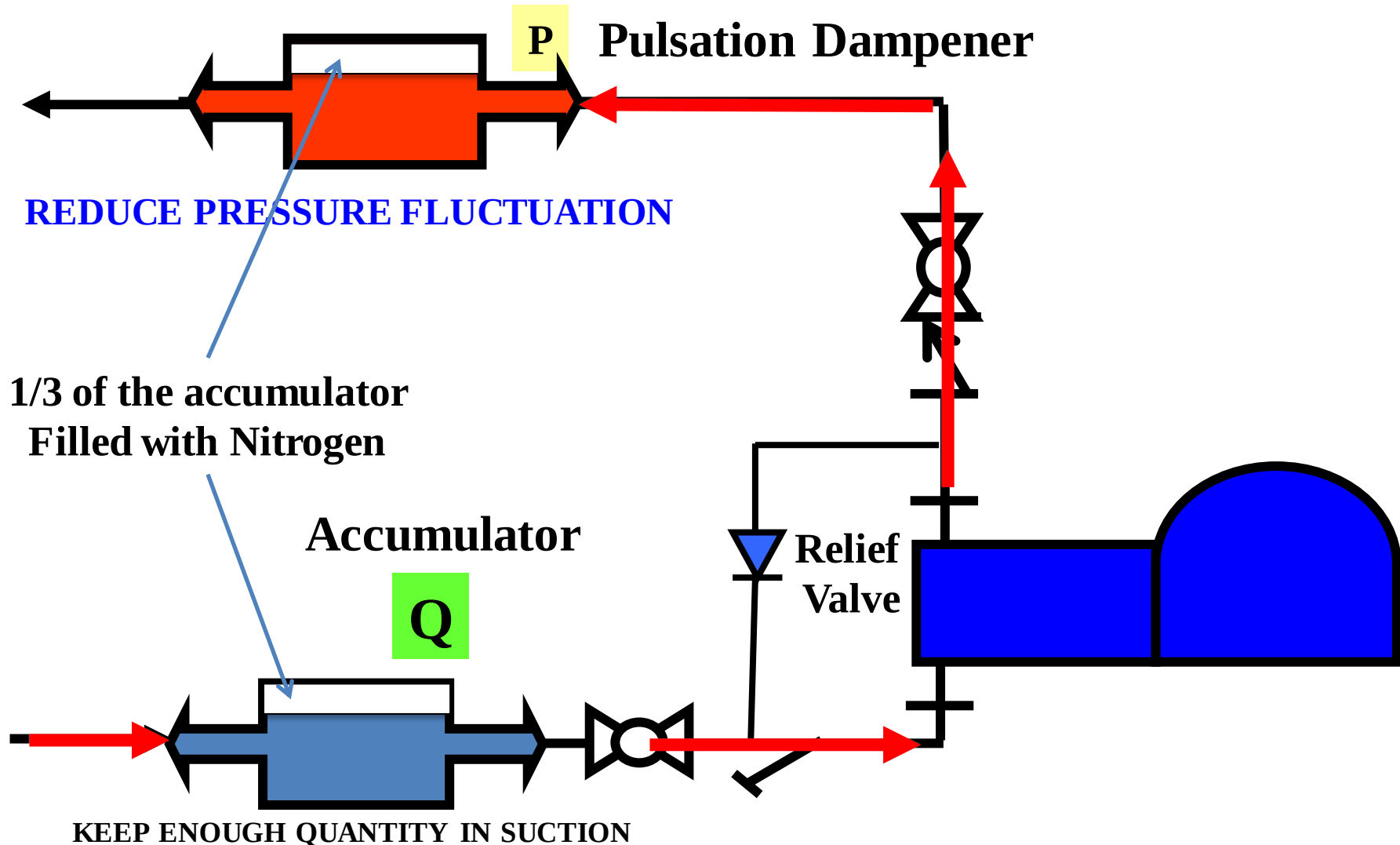


- # Reciprocating Pumps





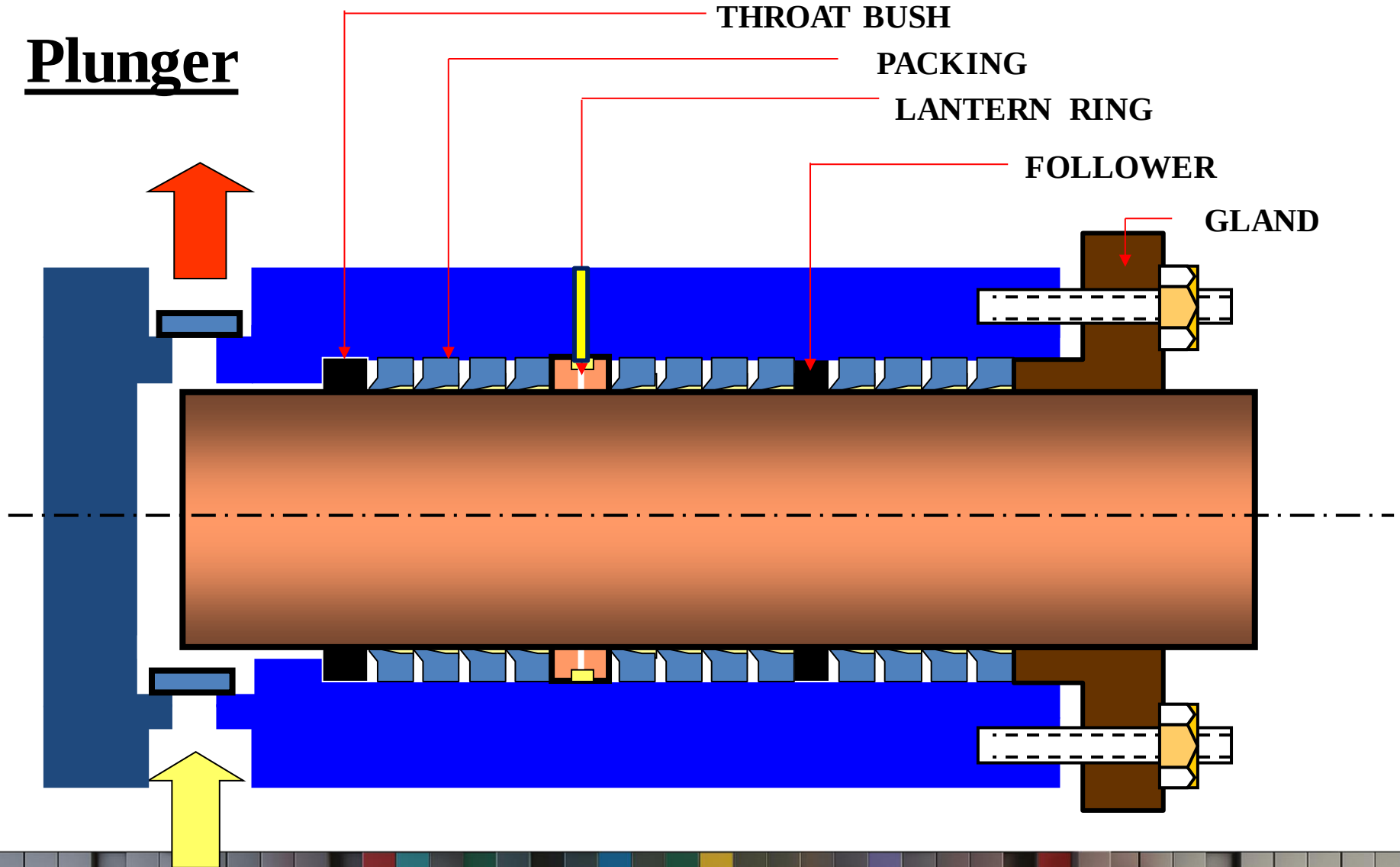
- Reciprocating Pumps





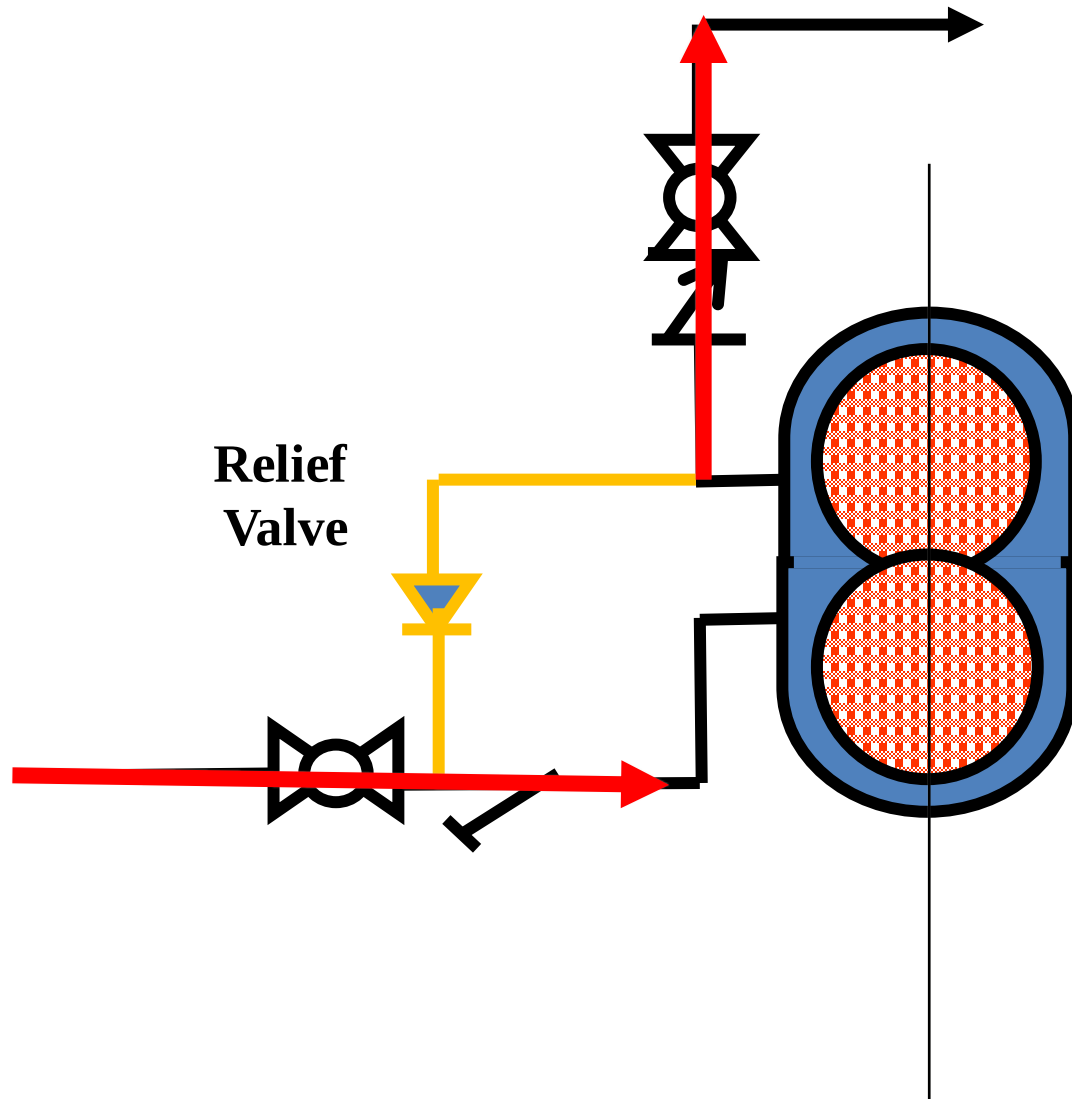
- # Reciprocating Pumps

Plunger





- Rotary pumps





3- Code and Standards

Centrifugal Pumps

API 610

ASME B73.1 & B73.2 Most common pumps

API 685 Seal less Pumps

Liquid Ring Vacuum Pumps

API 681

Positive Displacement Pumps

API 674 Reciprocating

API 675 Controlled volume

API 676 Rotary

Firewater Pumps

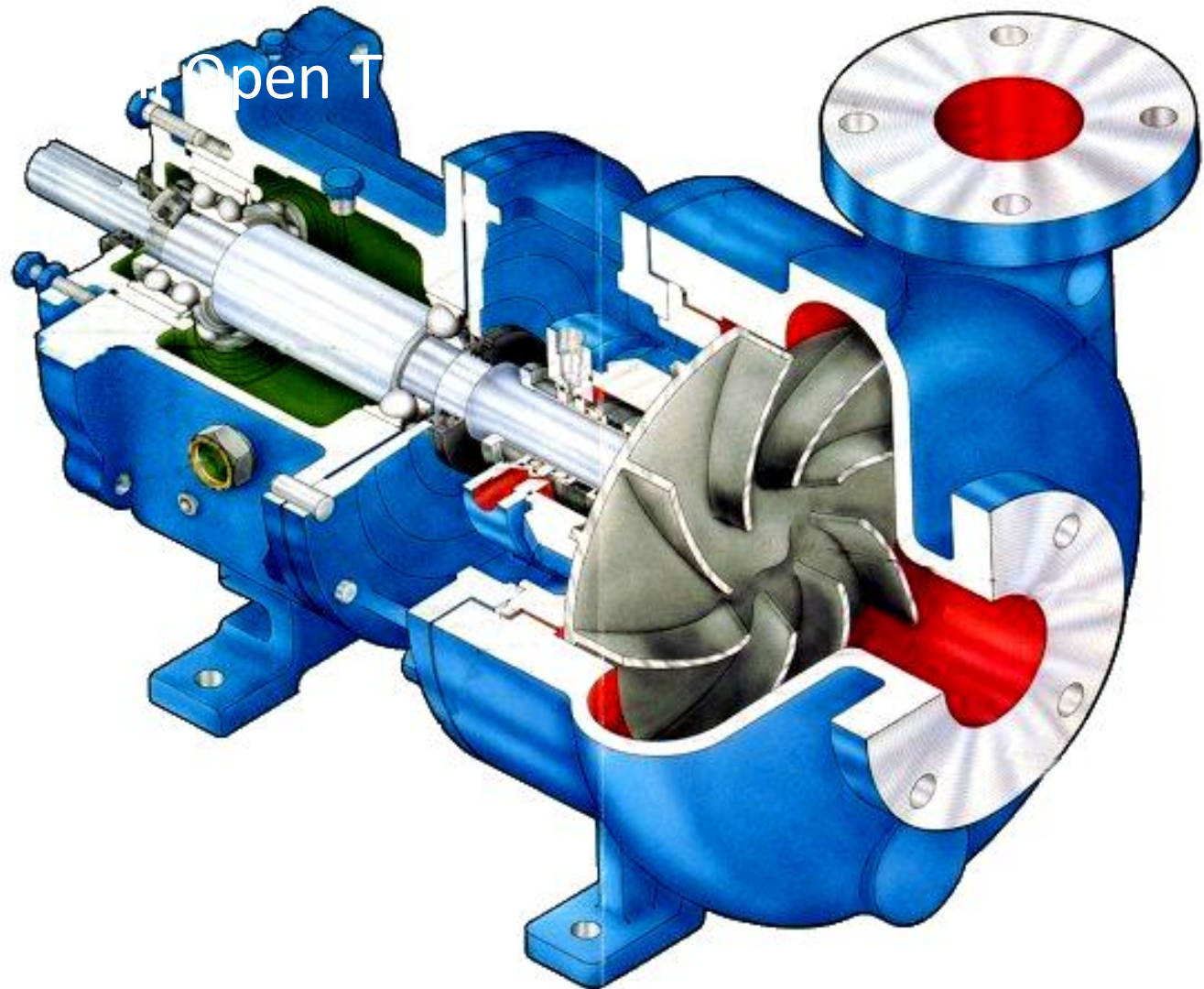
NFPA 20



Centrifugal pumps



Centrifugal pumps

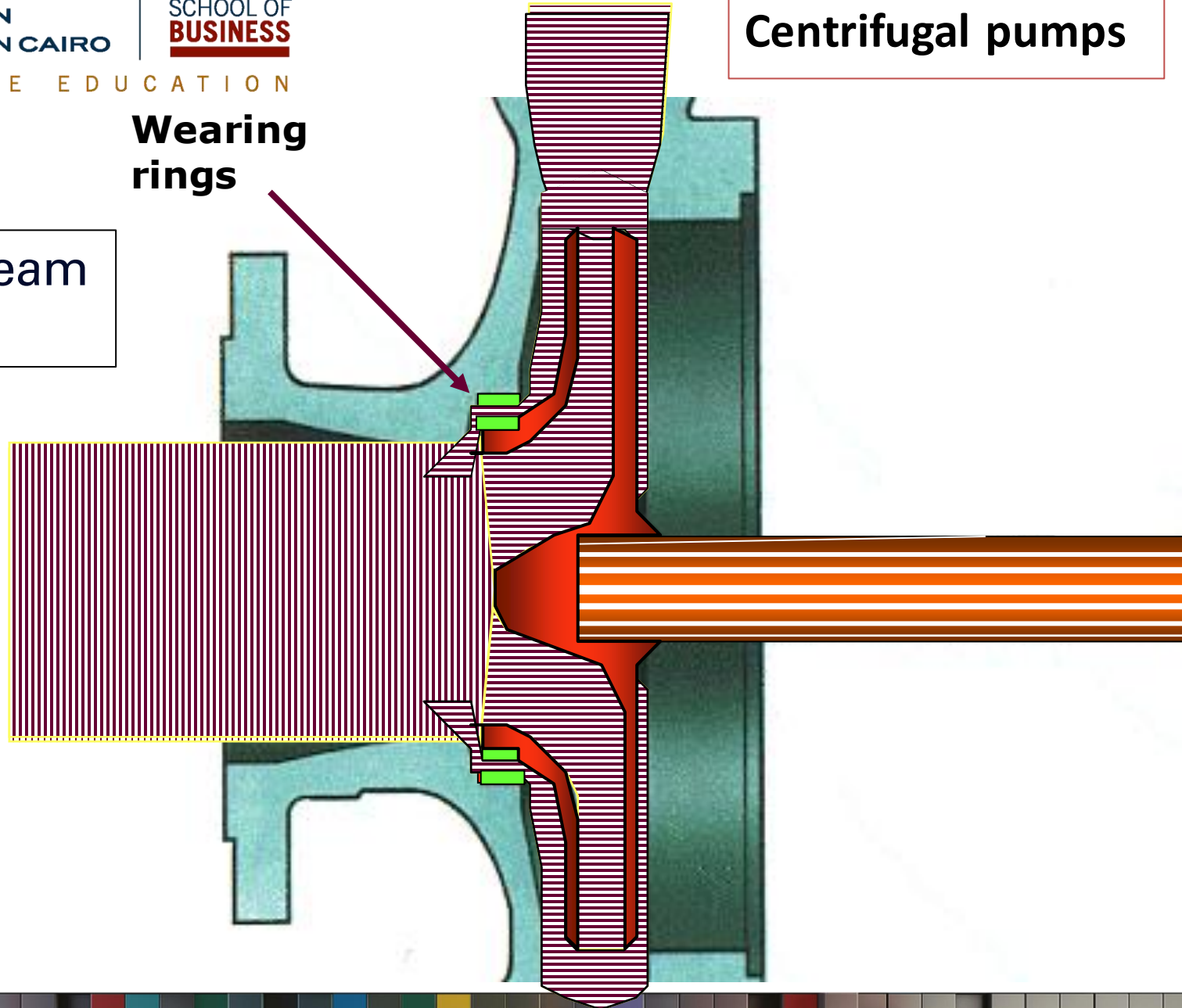




Centrifugal pumps

Hanged Beam
Impeller

Wearing
rings





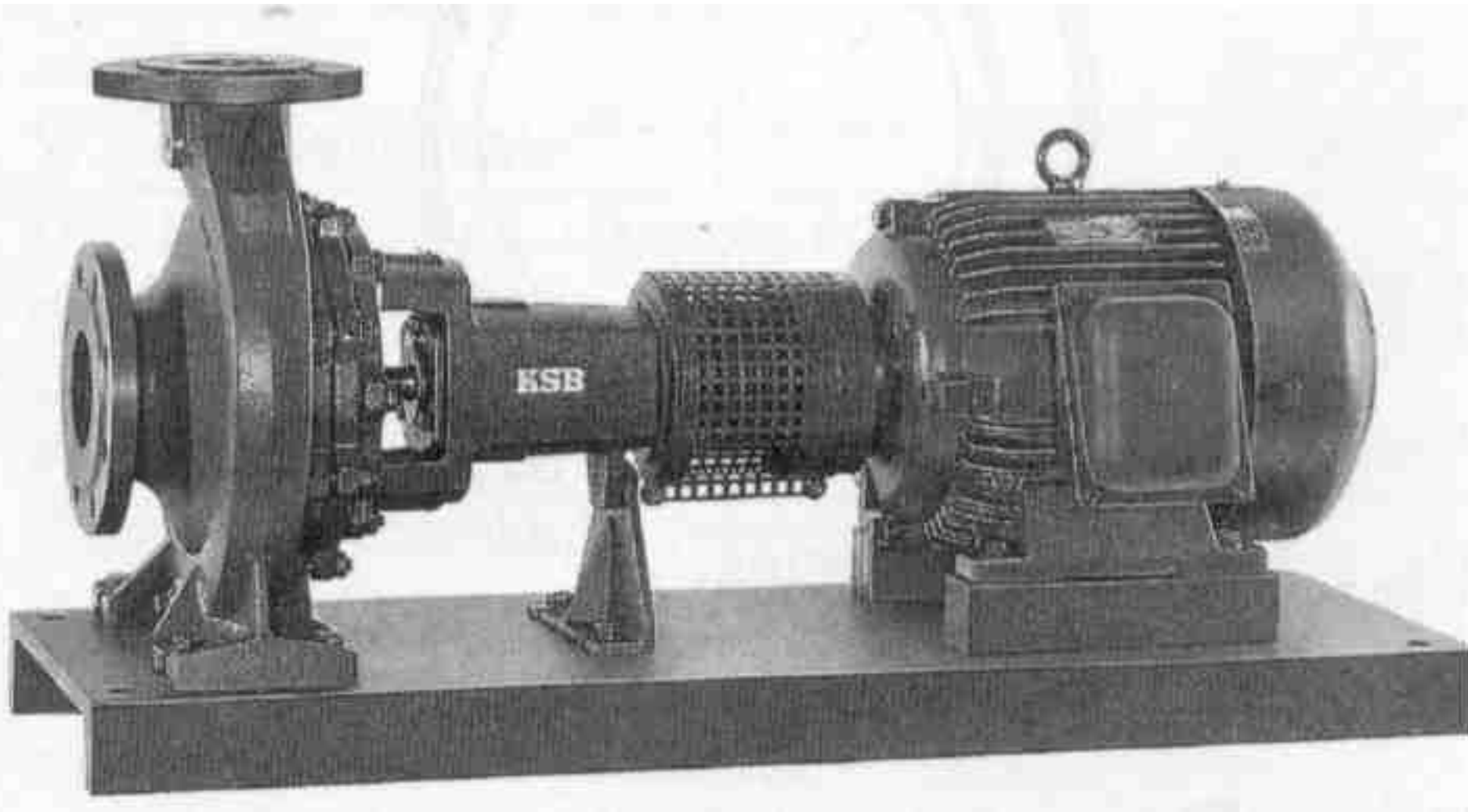
Centrifugal pumps

Volute casing





Centrifugal pumps

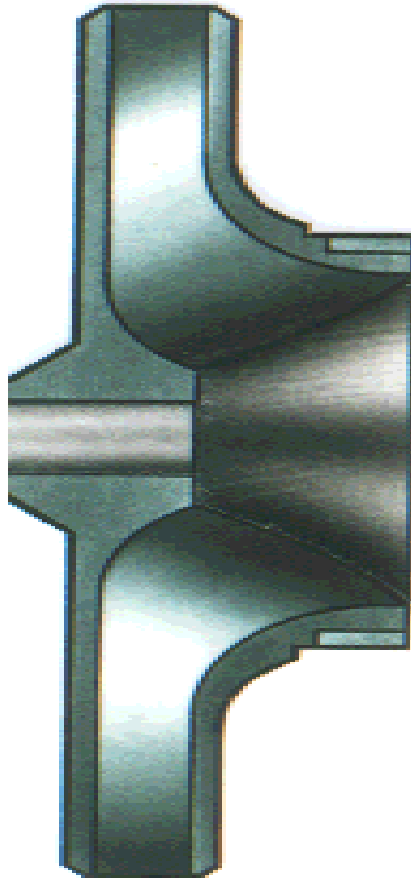




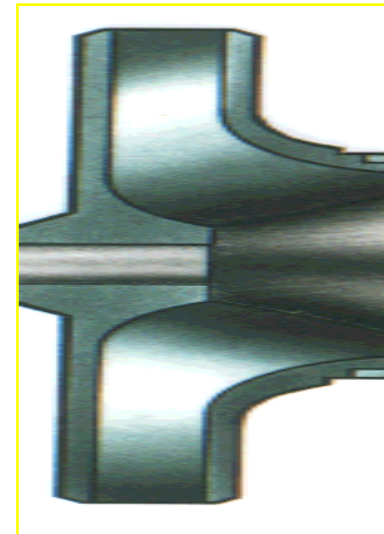
Impellers Classification



**High Head
Low Flow**



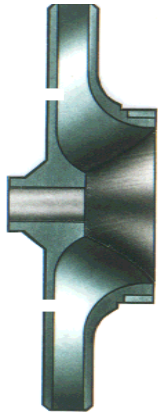
**High Head
High Flow**



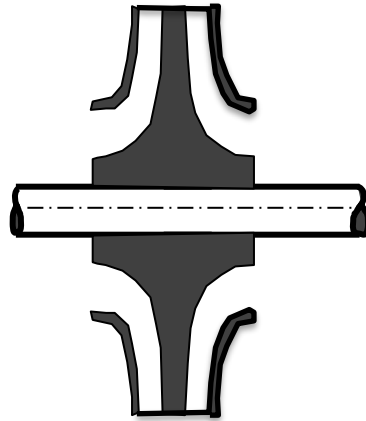
**Very high Flow
Very Low Head**



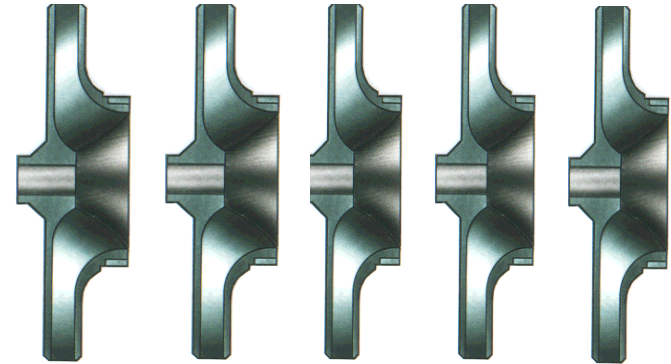
SOME TYPES OF CENTRIFUGAL PUMPS



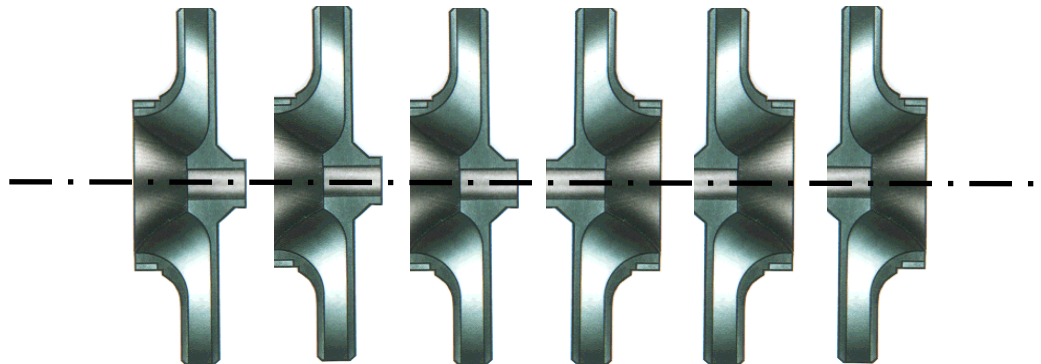
SINGLE IMPELLER



**DOUBLE SUCTION
IMPELLER**



MULTI STAGE



**MULTI STAGE
Opposite**



Seals

- All pumps developed pressure to pump the liquid.
- The pressurize liquid must be contained by a seal to prevent leakage around the drive shaft .
- There are many types of seals that are used in many types of pump. E.g.
 - **Wearing ring**
 - **Packing**
 - **Mechanical seal**



Centrifugal pumps

- Some wear or erosion will occur at the point where the impeller and the pump casing nearly come into contact.
- This wear is due to the erosion caused by liquid leaking through this tight clearance and other causes.
- As wear occurs , the clearances become larger and the rate of leakage increases.
- Eventually, the leakage could become unacceptably large and maintenance would be required on the pump.
- To minimize the cost of pump maintenance, many centrifugal pumps are designed with wearing rings.



Wear Ring Clearance

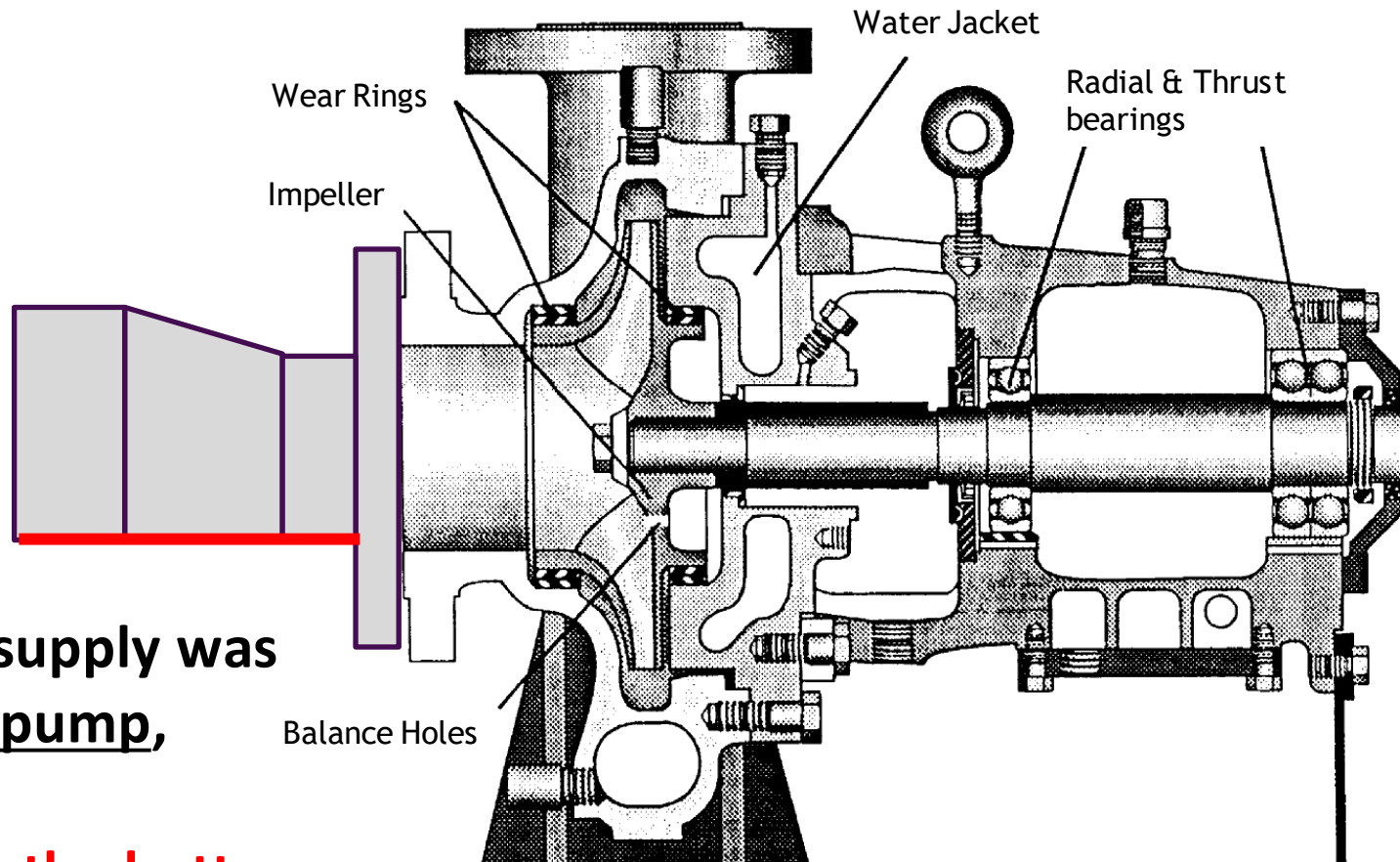
The following factors does affect the wear ring clearance:

1. The impeller size – There is certain value for each size range given by the pump manufacturer
2. The liquid is clean or contaminated with solid particles, the particle size and the concentration
3. The pump RPM



Eccentric Reducer

Reducer

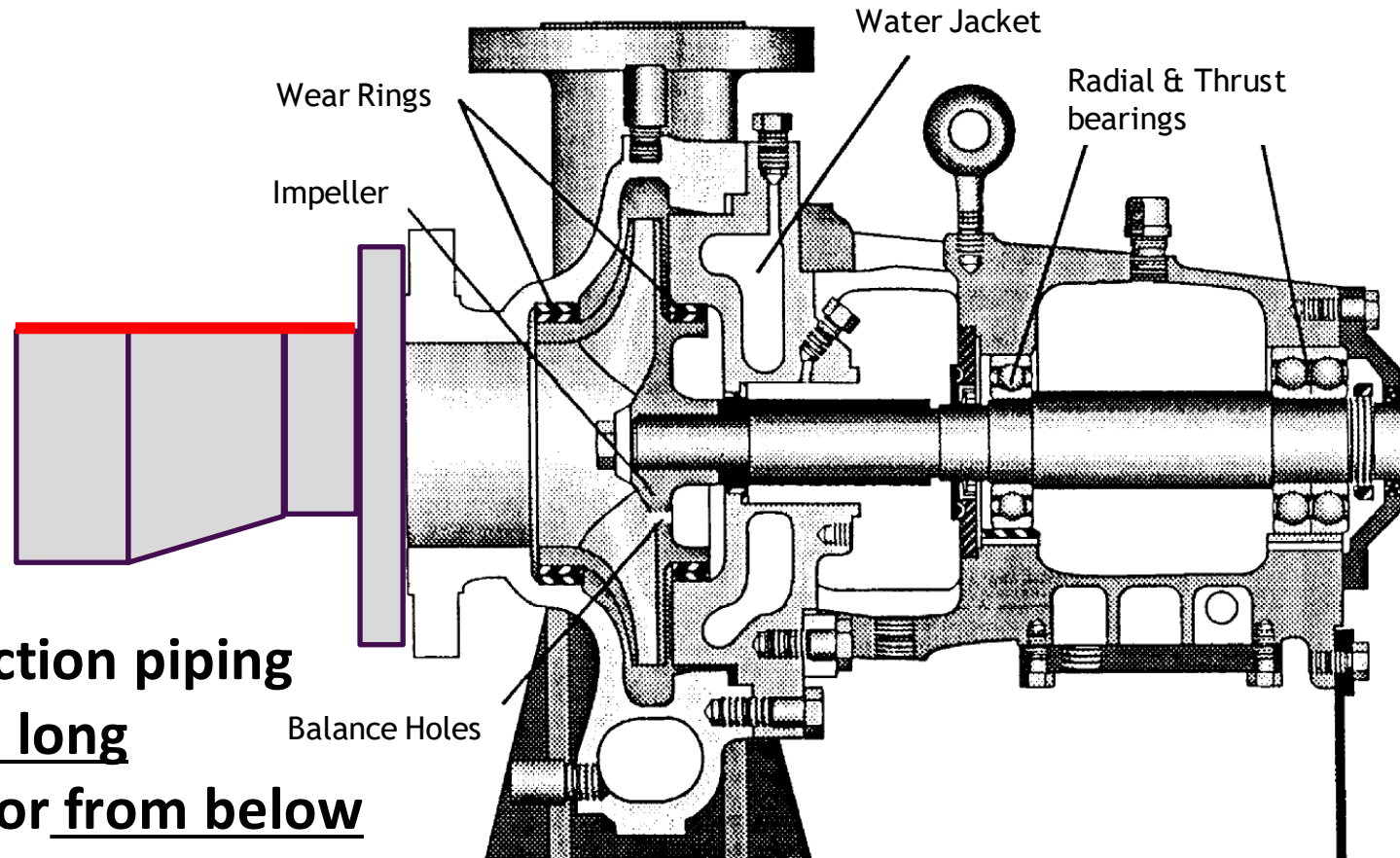


If the source of supply was
from above the pump,

flat should be at the bottom.

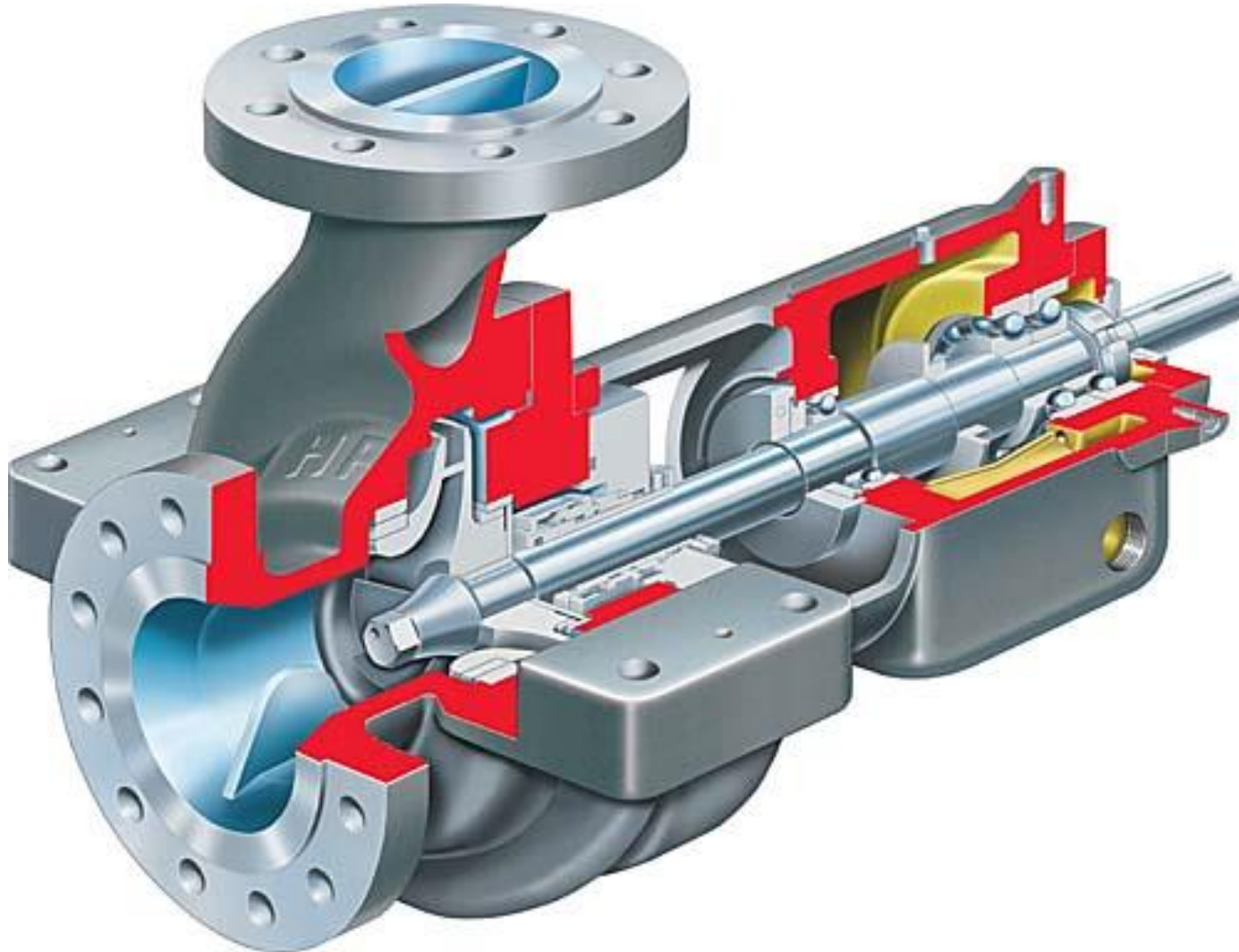


Eccentric Reducer



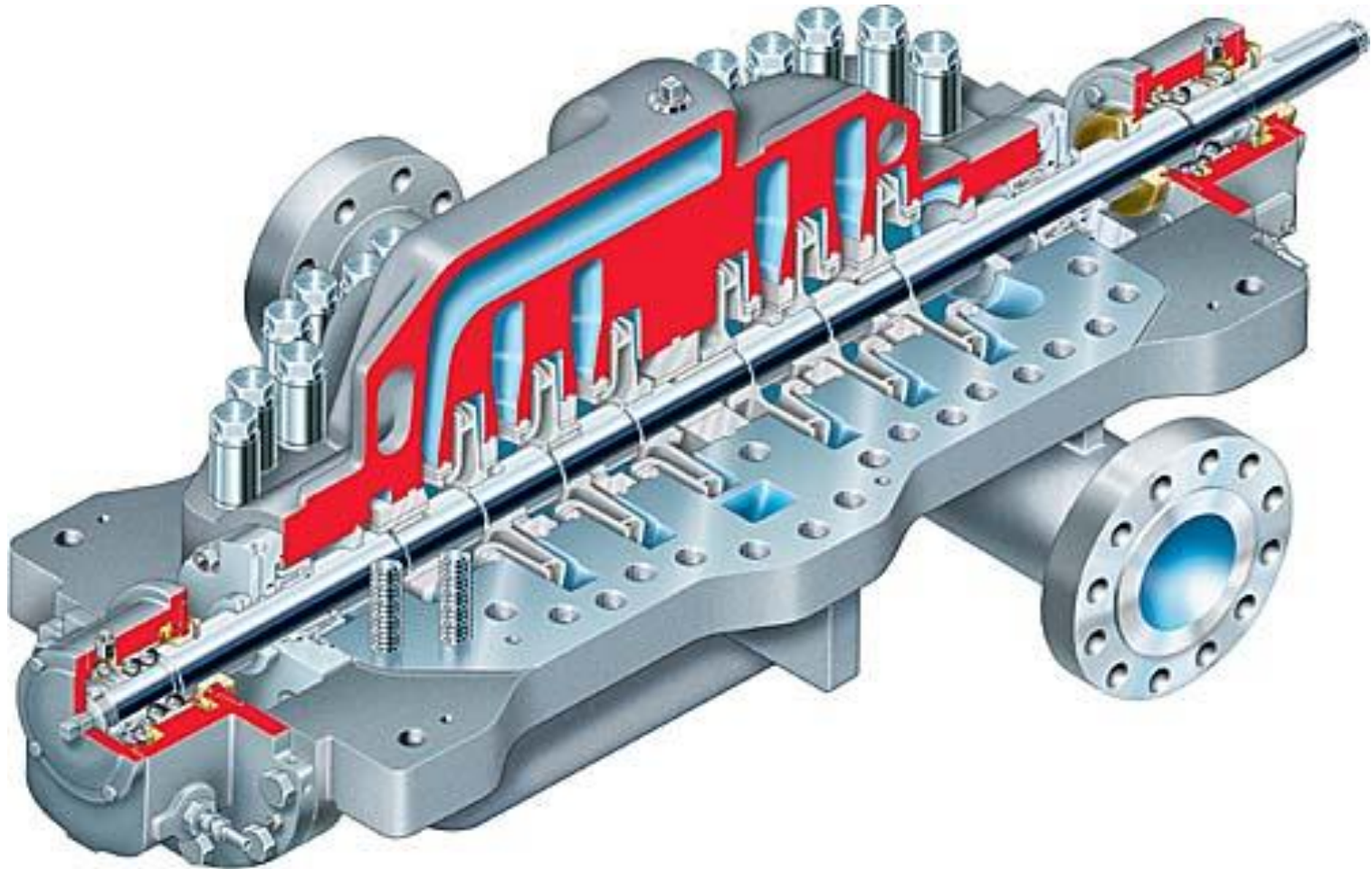
If the pump suction piping entered after a long horizontal run or from below the pump,

flat should be at the top



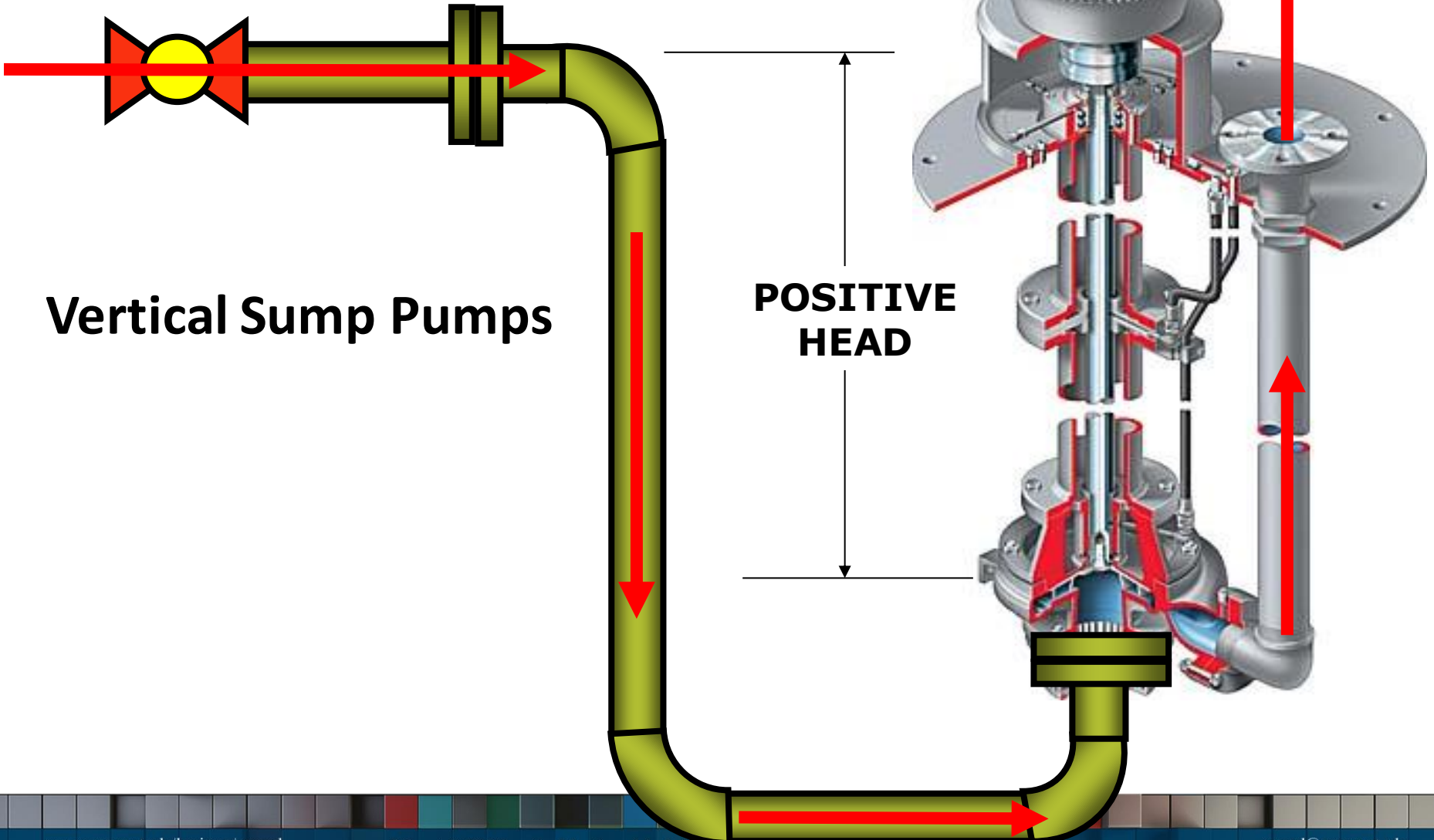


Horizontal Split Case Feed Pump





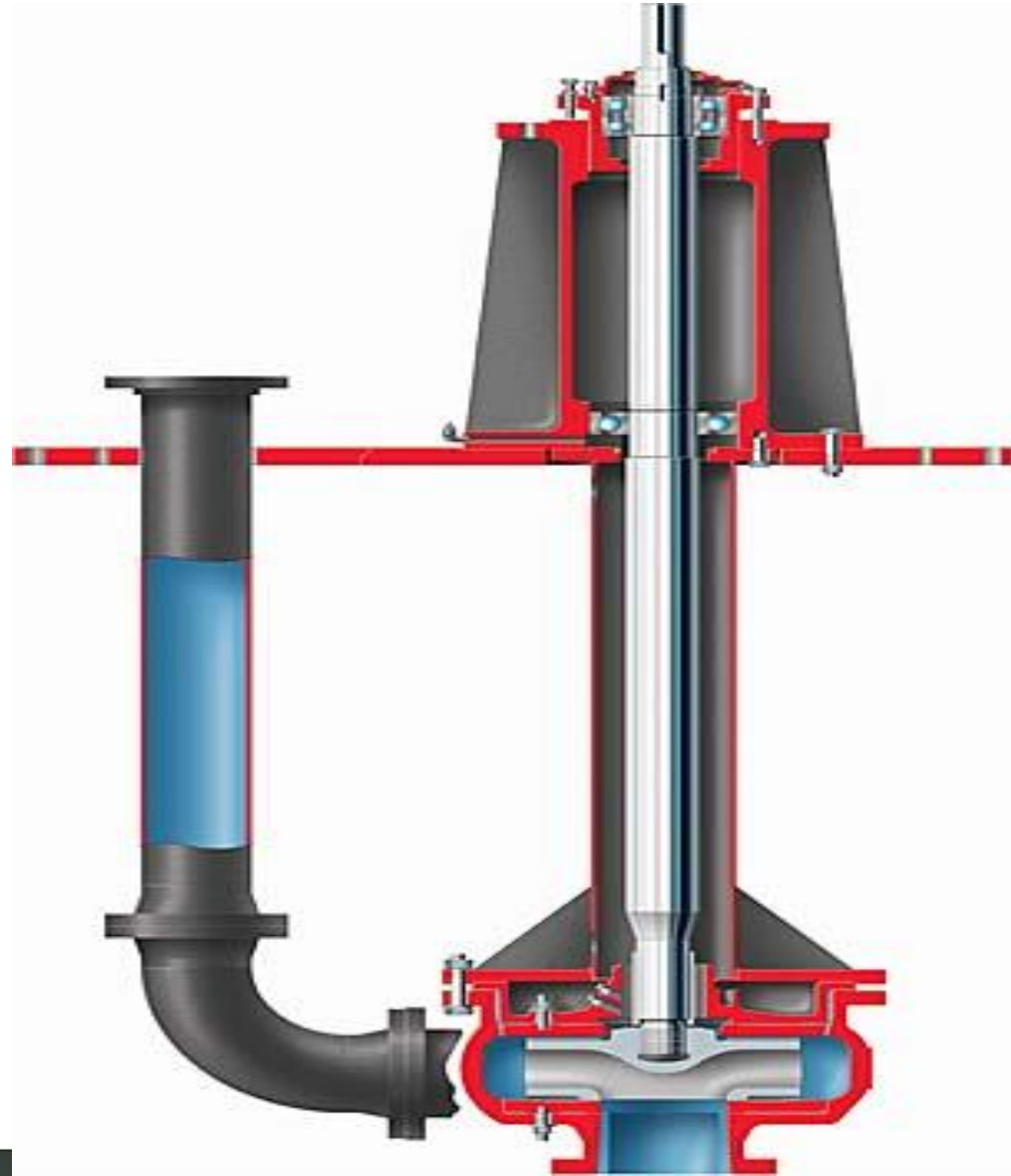
Vertical Sump Pumps





Vertical Cantilever Pump

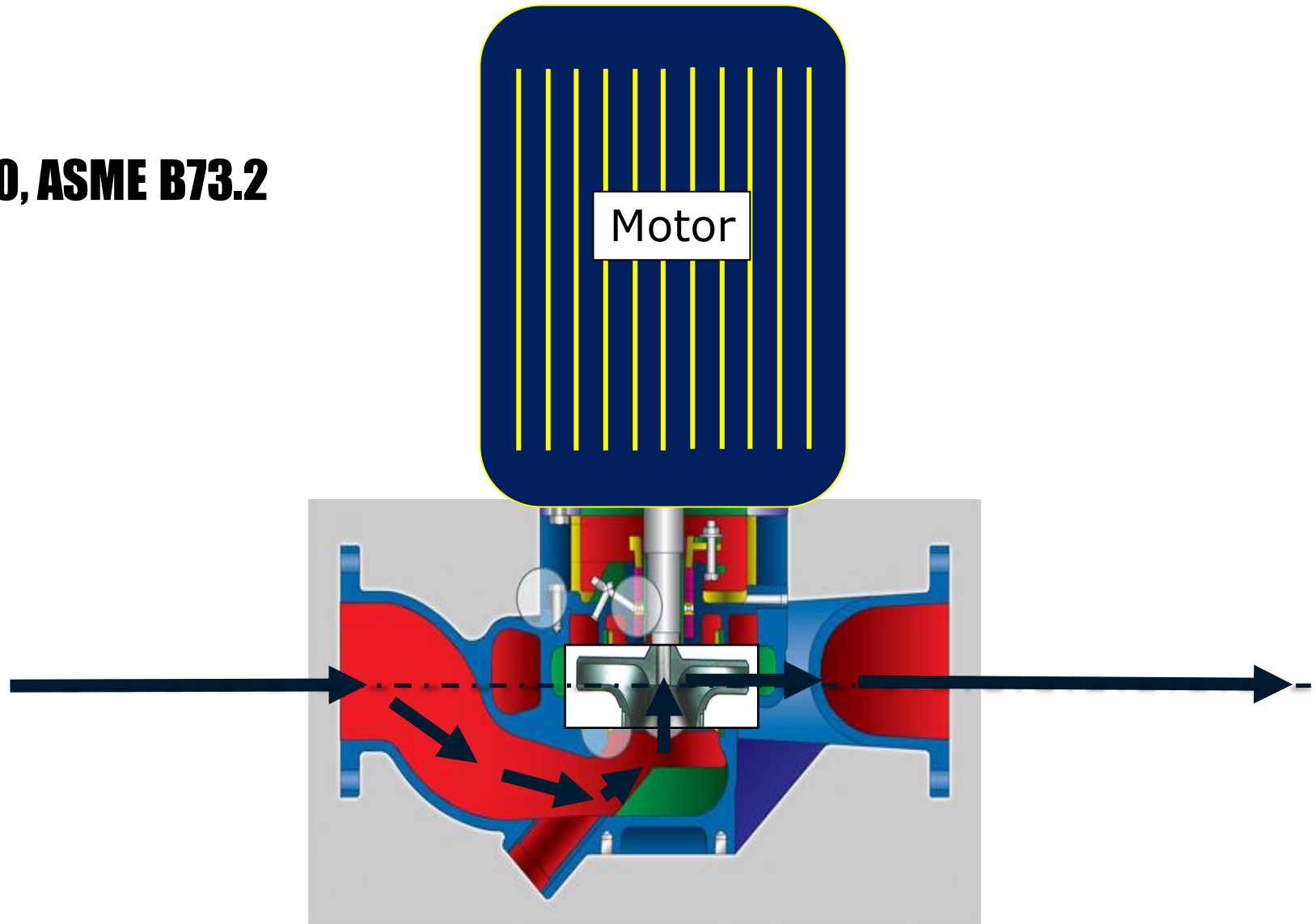
Slurry Applications

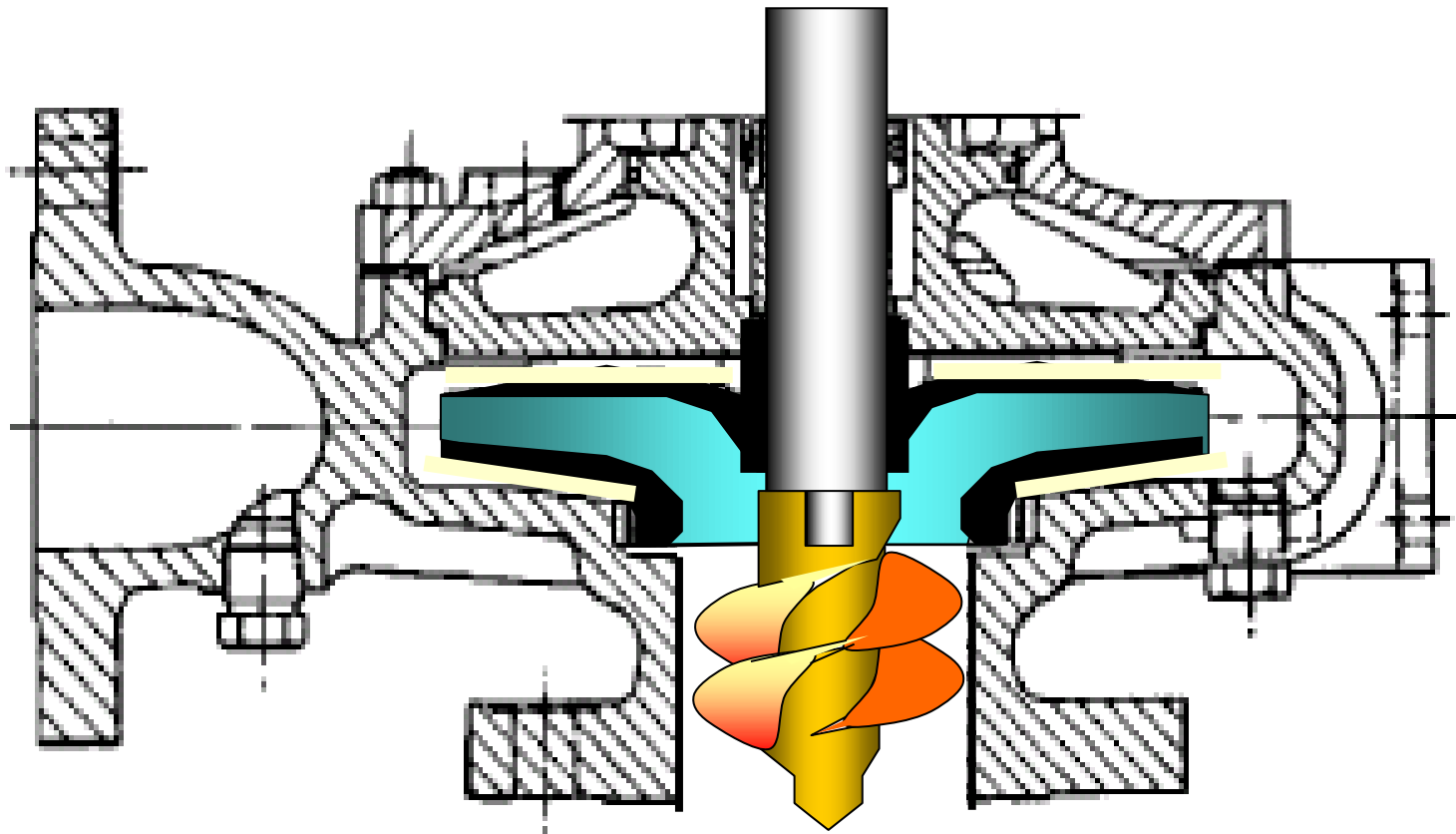




Vertical Inline Centrifugal

API 610, ASME B73.2





INDUCER



Sundyne Pumps

Driver

Coupling

Gearbox

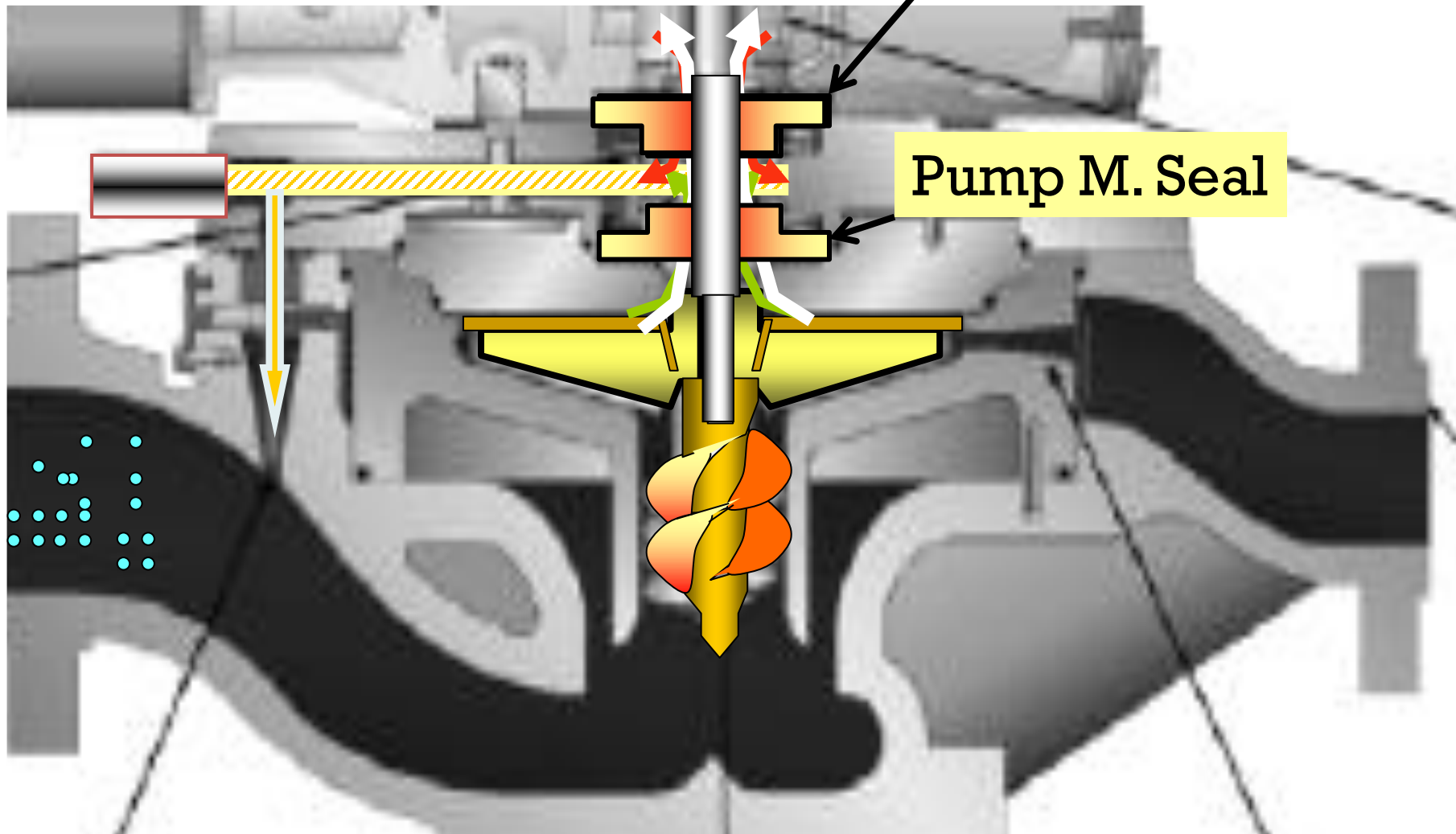
Pump

**One impeller
with Gear box
, High speed
Pumps**





Gearbox M. Seal





PUMPS AFFINITY LAWS

IF THE PUMP SPEED CHANGES FROM

N_1 TO N_2

THE FLOW RATE WILL BE

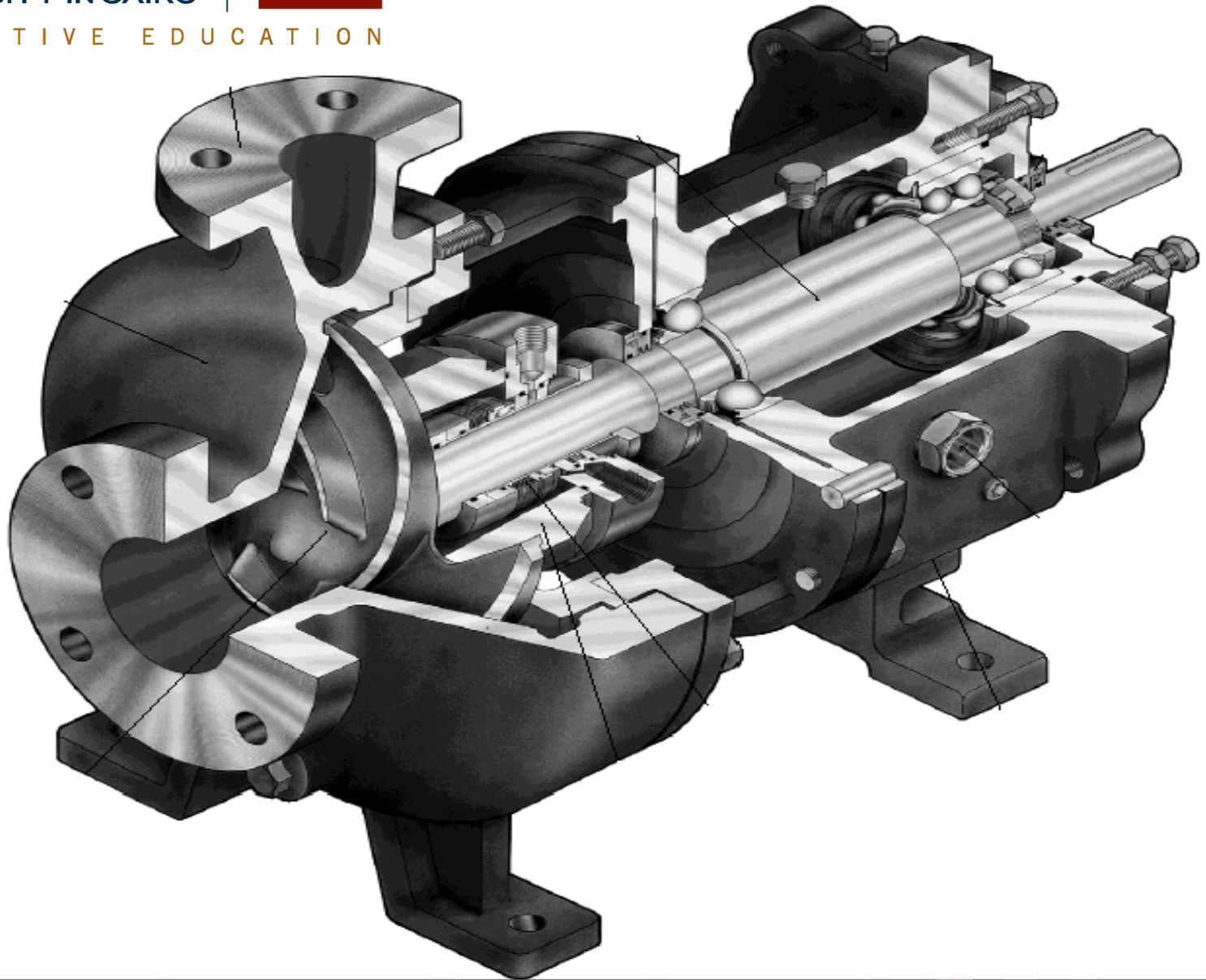
$$\frac{Q_2}{Q_1} = \left[\frac{N_2}{N_1} \right]$$

THE DISCH PRESS. WILL BE

$$\frac{P_2}{P_1} = \left[\frac{N_2}{N_1} \right]^2$$

THE HORSEPOWER WILL BE

$$\frac{HP_2}{HP_1} = \left[\frac{N_2}{N_1} \right]^3$$

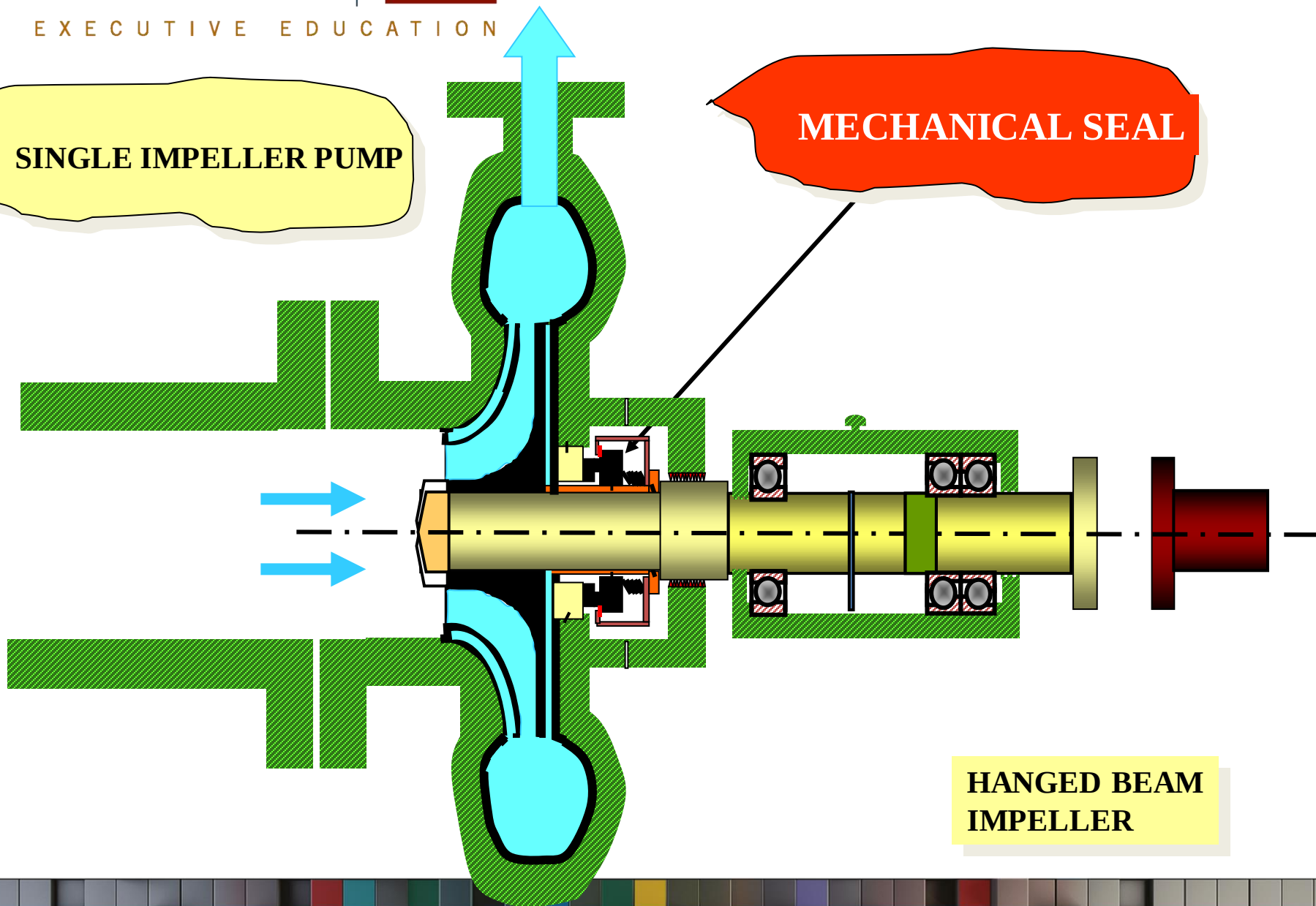




SINGLE IMPELLER PUMP

MECHANICAL SEAL

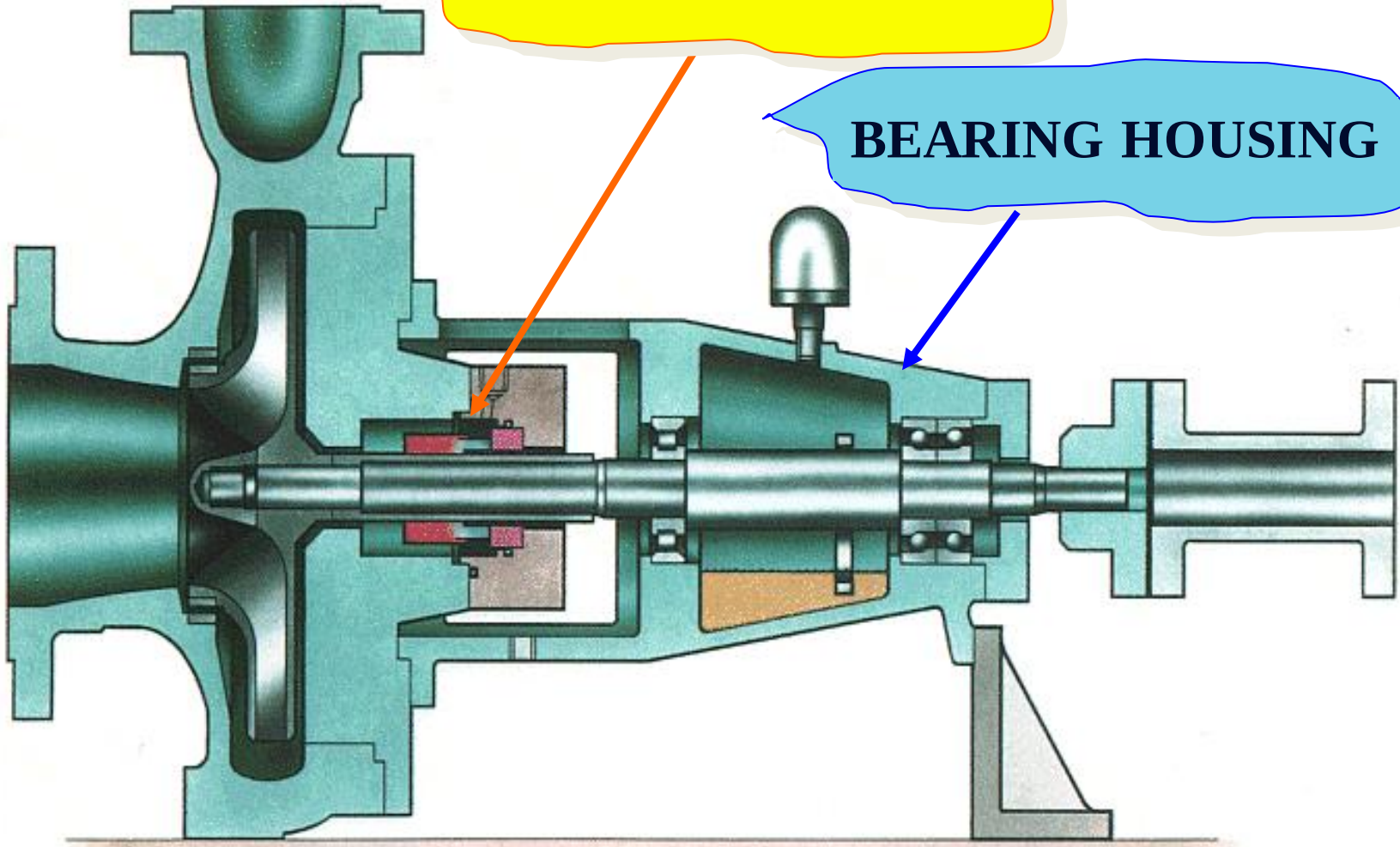
**HANGED BEAM
IMPELLER**





MECHANICAL SEAL

BEARING HOUSING

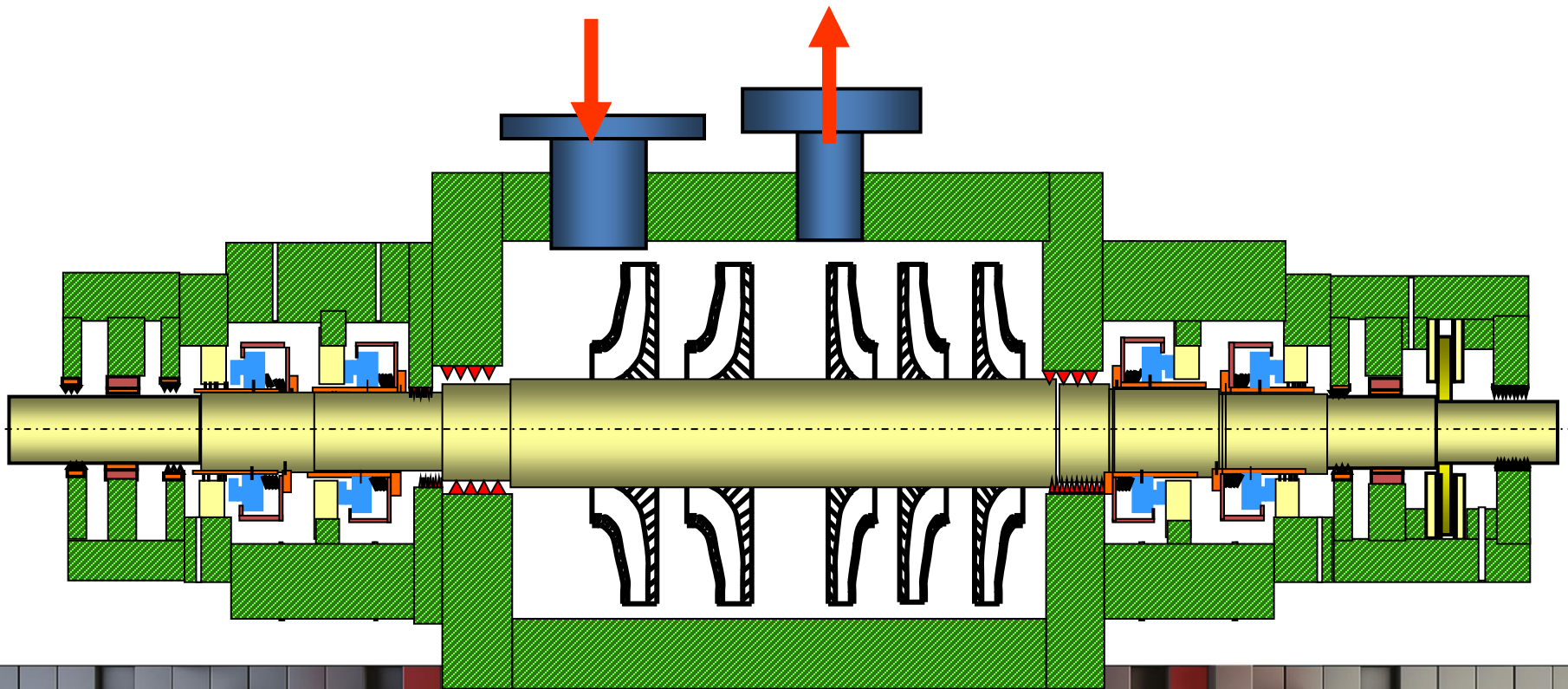




SPLIT TYPE PUMPS

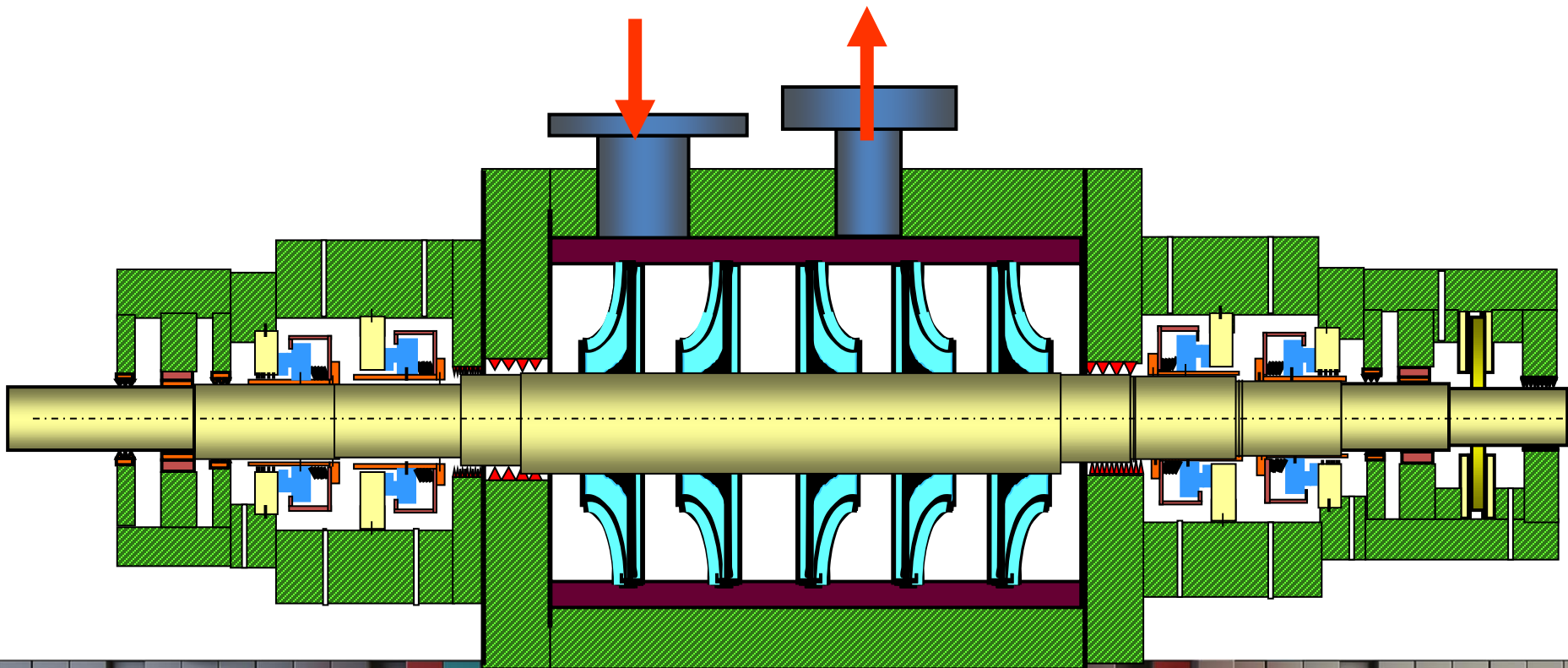
1- Horizontally Split

High Flow Medium pressure





2- Vertically Split (Double Barrel) high pressure and medium Flow





Pump

Turbine

MOTION

MOTION

**HYDRAULIC
ENERGY**

**HYDRAULIC
ENERGY**



THE AMERICAN
UNIVERSITY IN CAIRO

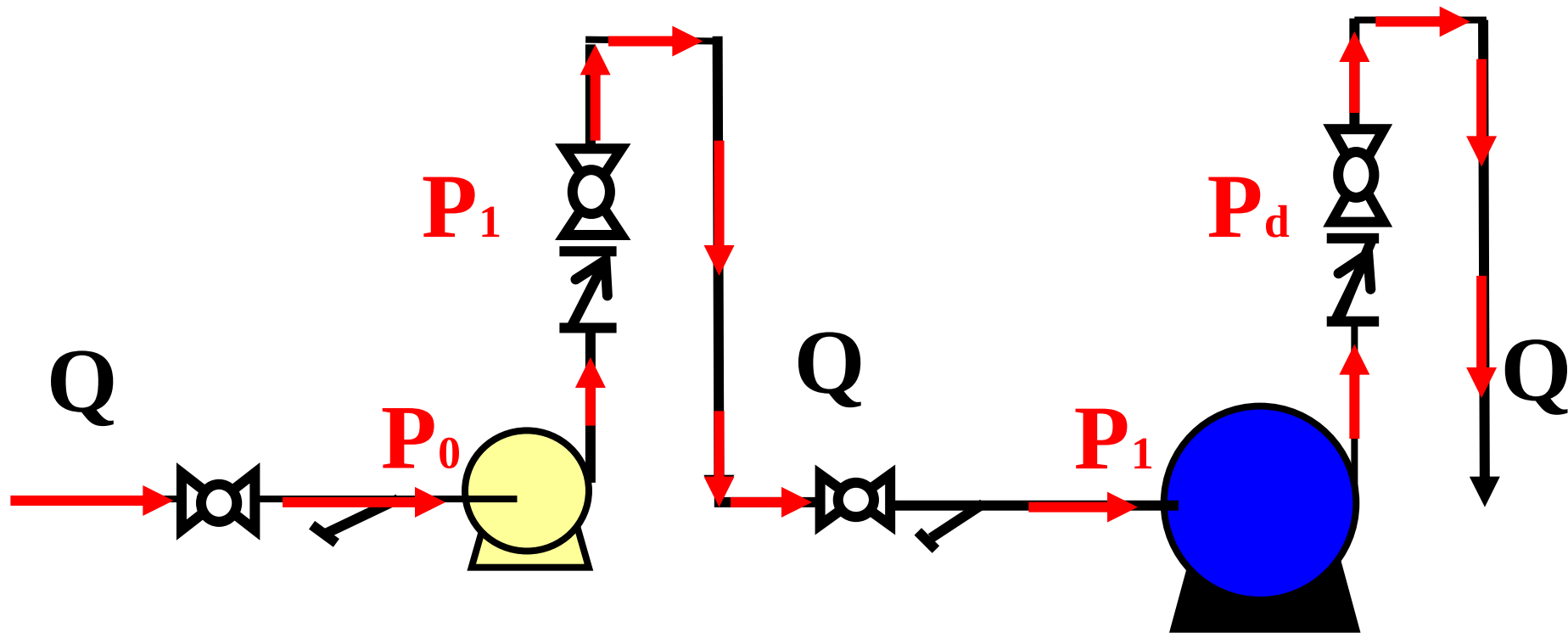
SCHOOL OF
BUSINESS

EXECUTIVE EDUCATION

Pumps arrangement

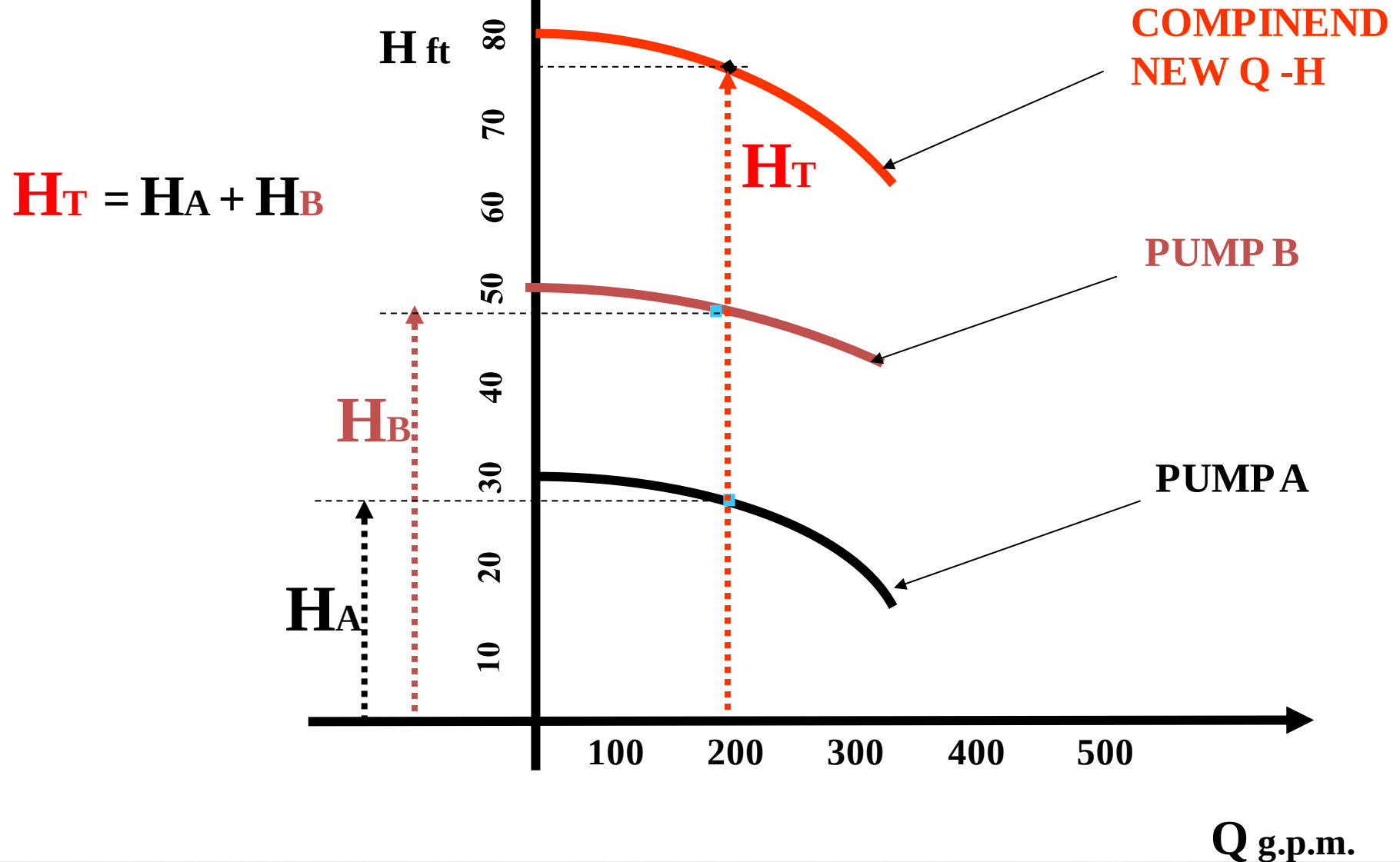


Centrifugal pumps in series



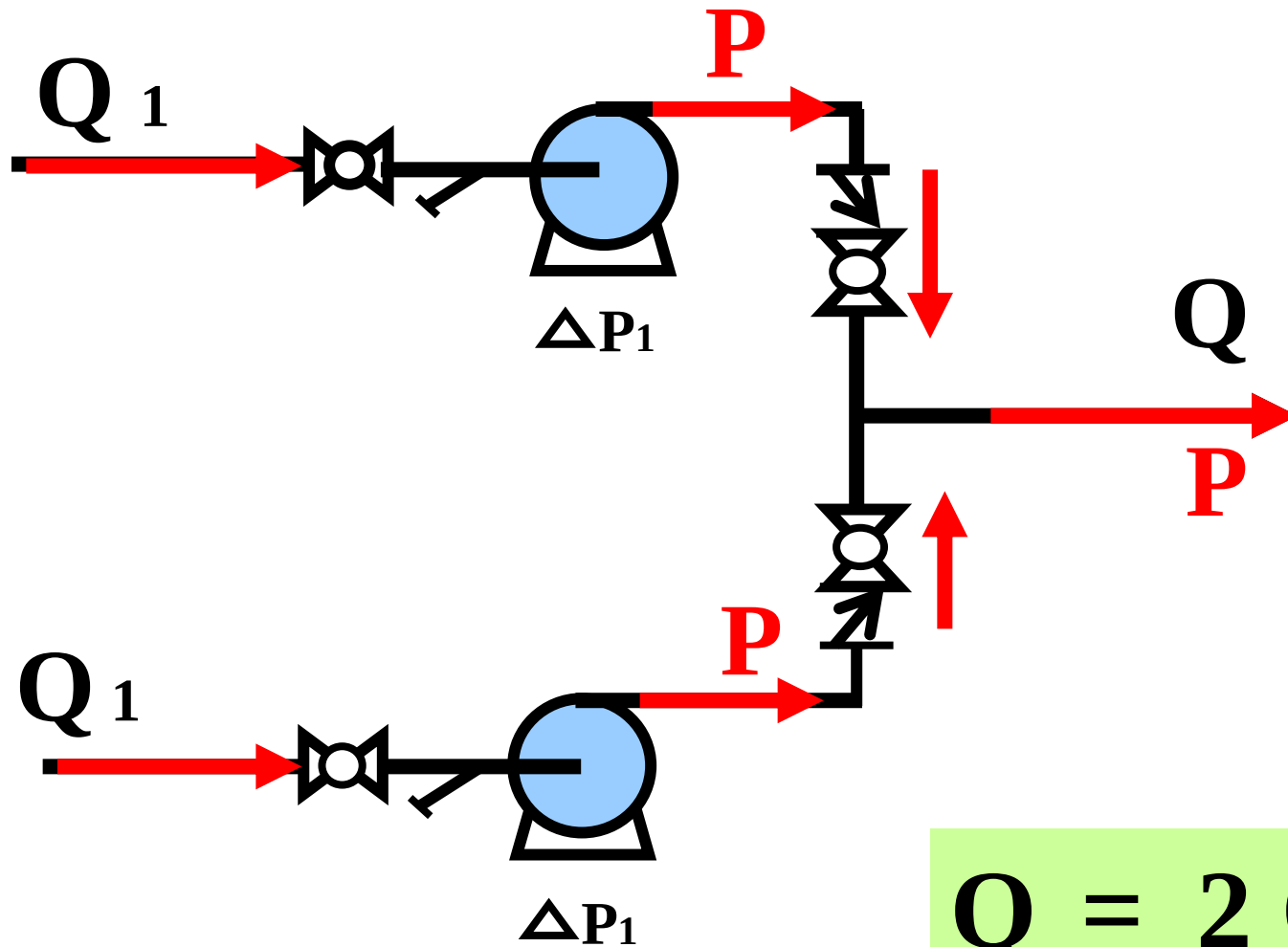
$$P_d = P_1 + \Delta P$$

ΔP





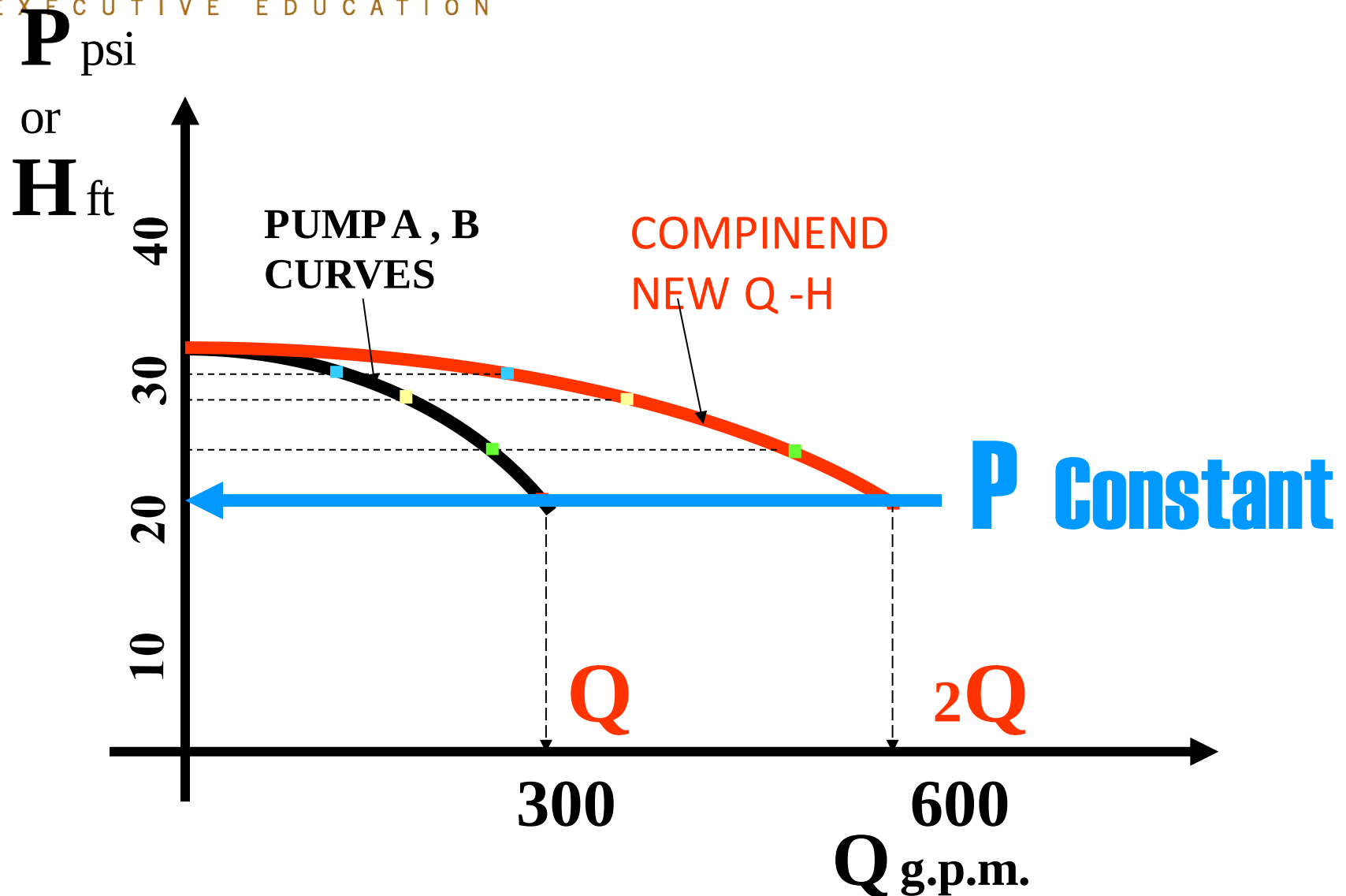
Centrifugal pumps in parallel



$$Q = 2 Q_1$$



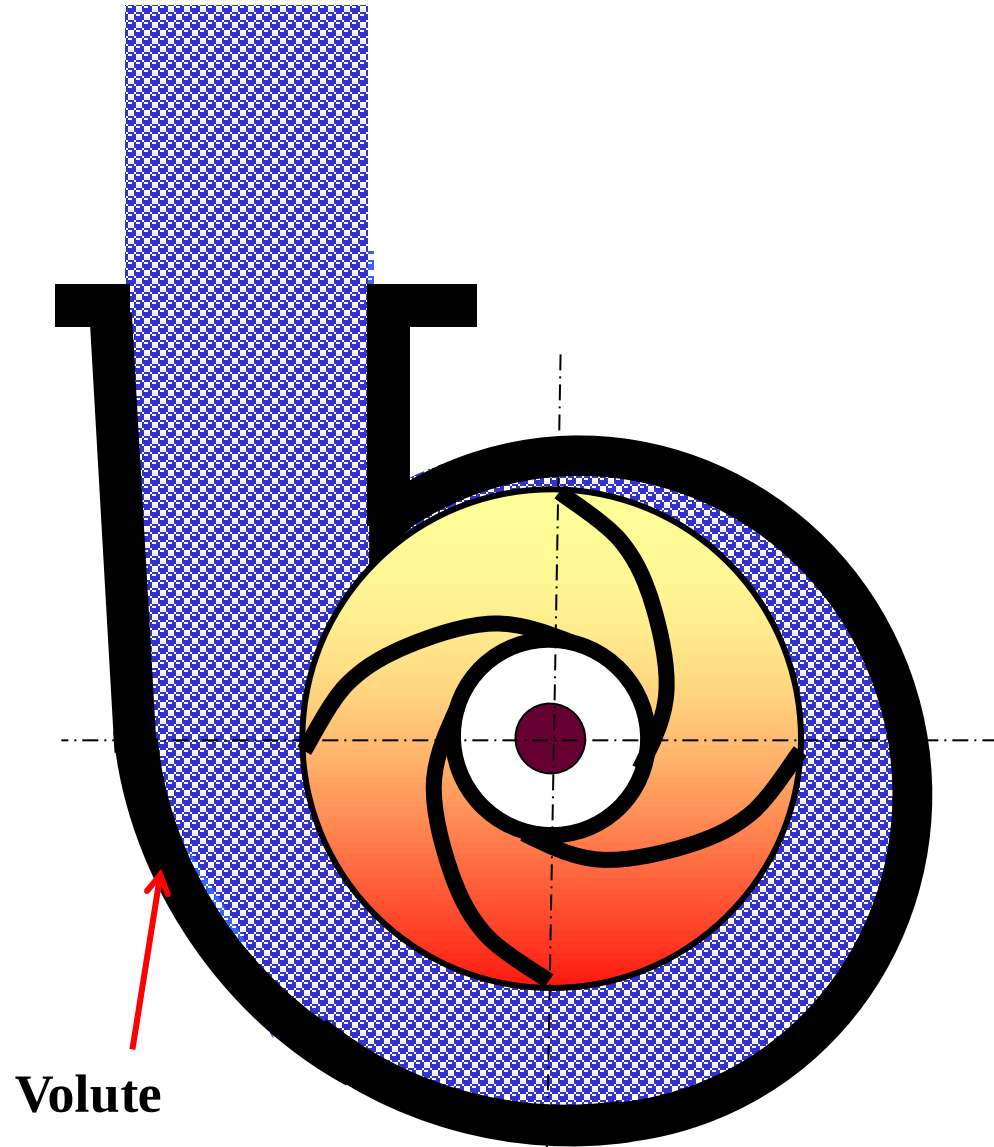
Centrifugal pumps in parallel

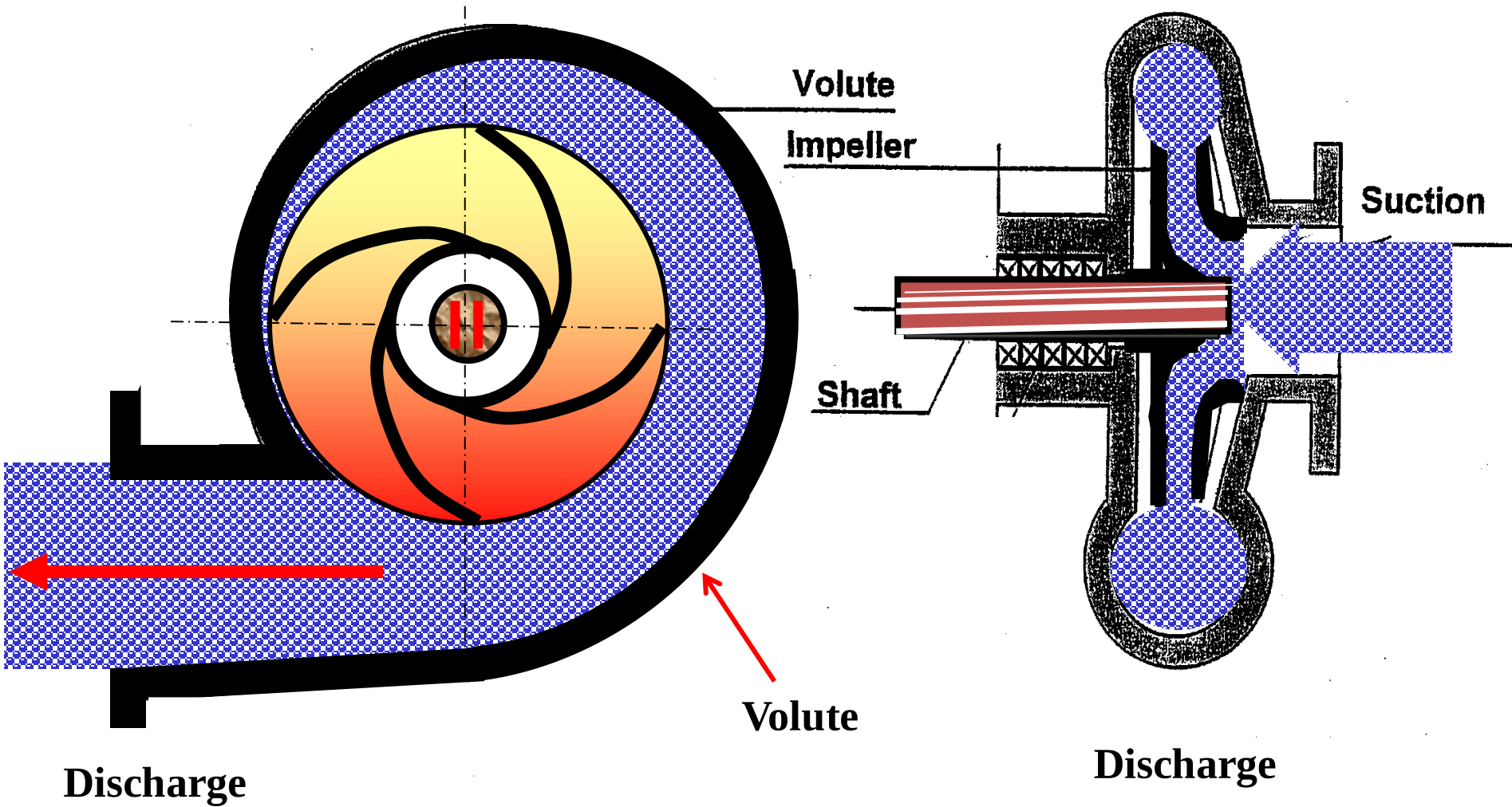




**Volute function is to convert
most of the Velocity energy
to pressure**

$$P = (V^2/2g)$$







FLUIDS FLOW
KINAMATIC ENERGY

P1

P2

Plus

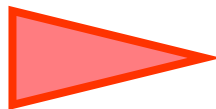
Thermal energy

$$\frac{V_1^2}{2g} + \frac{P_1}{\rho}$$

CONSTANT

$$\frac{V_2^2}{2g} + \frac{P_2}{\rho}$$

$$V_2 < V_1$$



$$P_2 > P_1$$



TOTAL ENERGY DIMENTIONS

$$\frac{V^2}{2g} = \frac{\left(\frac{\text{ft}}{\text{sec}}\right)^2}{\frac{\text{ft}}{\text{sec}^2}} = \frac{\cancel{\frac{\text{ft}^2}{\text{sec}^2}}}{\cancel{\frac{\text{ft}}{\text{sec}^2}}} = (\text{ft})$$

$$\frac{P}{\text{density}} = \frac{\frac{\cancel{\text{Lb}}}{\text{ft}}^2}{\frac{\cancel{\text{Lb}}}{\text{ft}^3}} = \frac{\text{ft}^3}{\cancel{\text{ft}^2}} = (\text{ft})$$



Impeller velocity diagrams

Velocity of liquid

(effect of flow tangential to the blade trim)

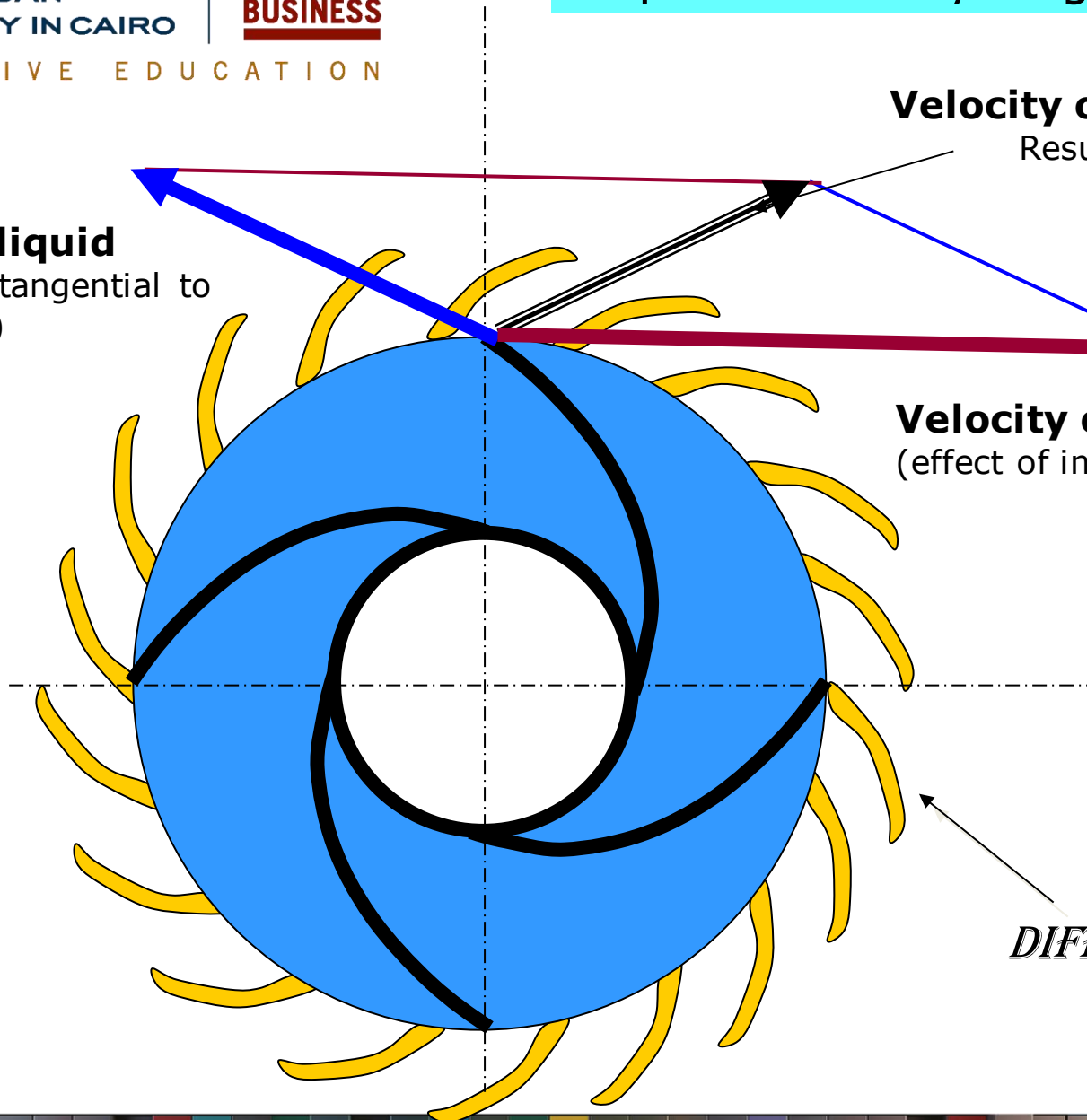
Velocity of liquid

Result

Velocity of liquid

(effect of impeller rotation)

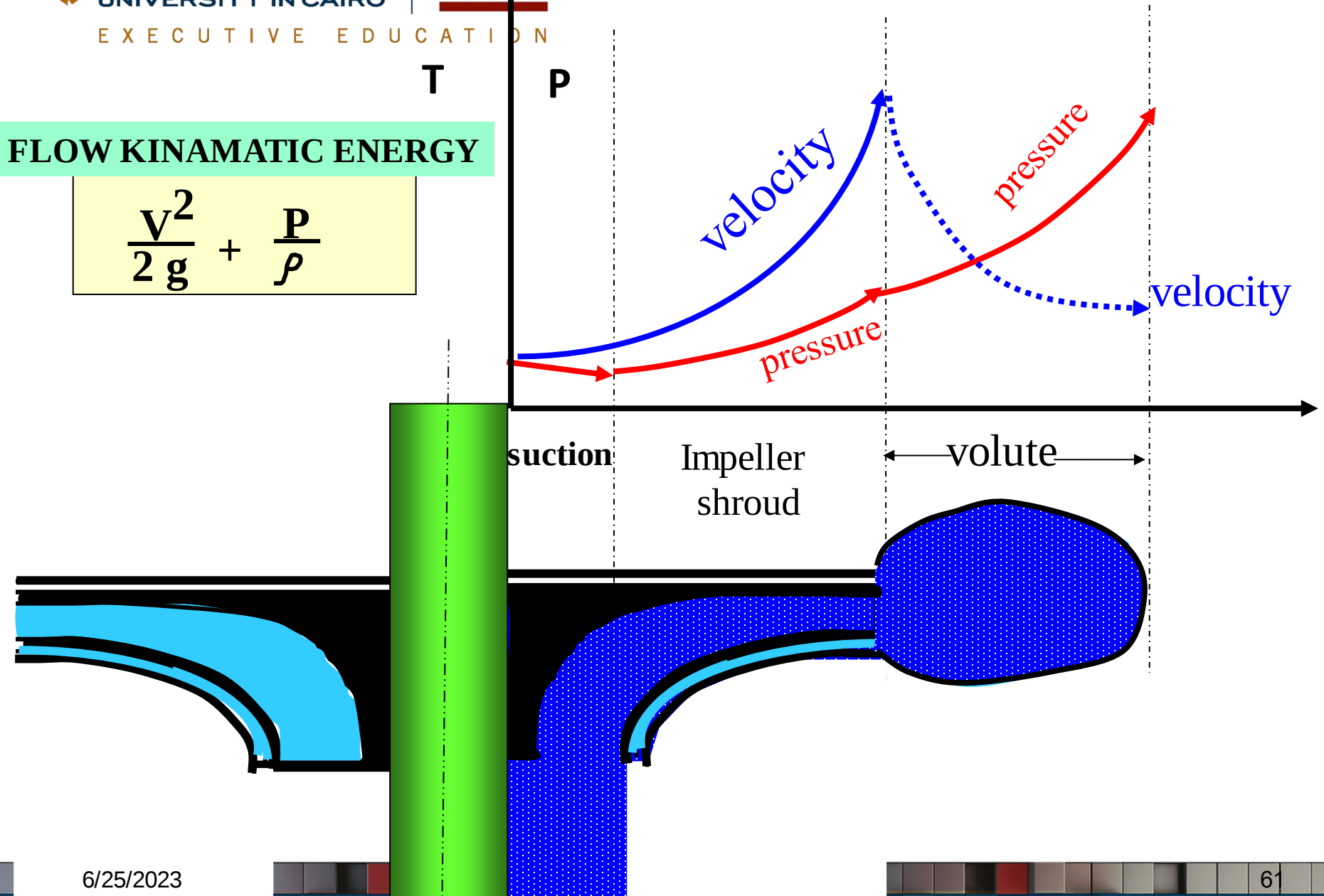
DIFFUSER





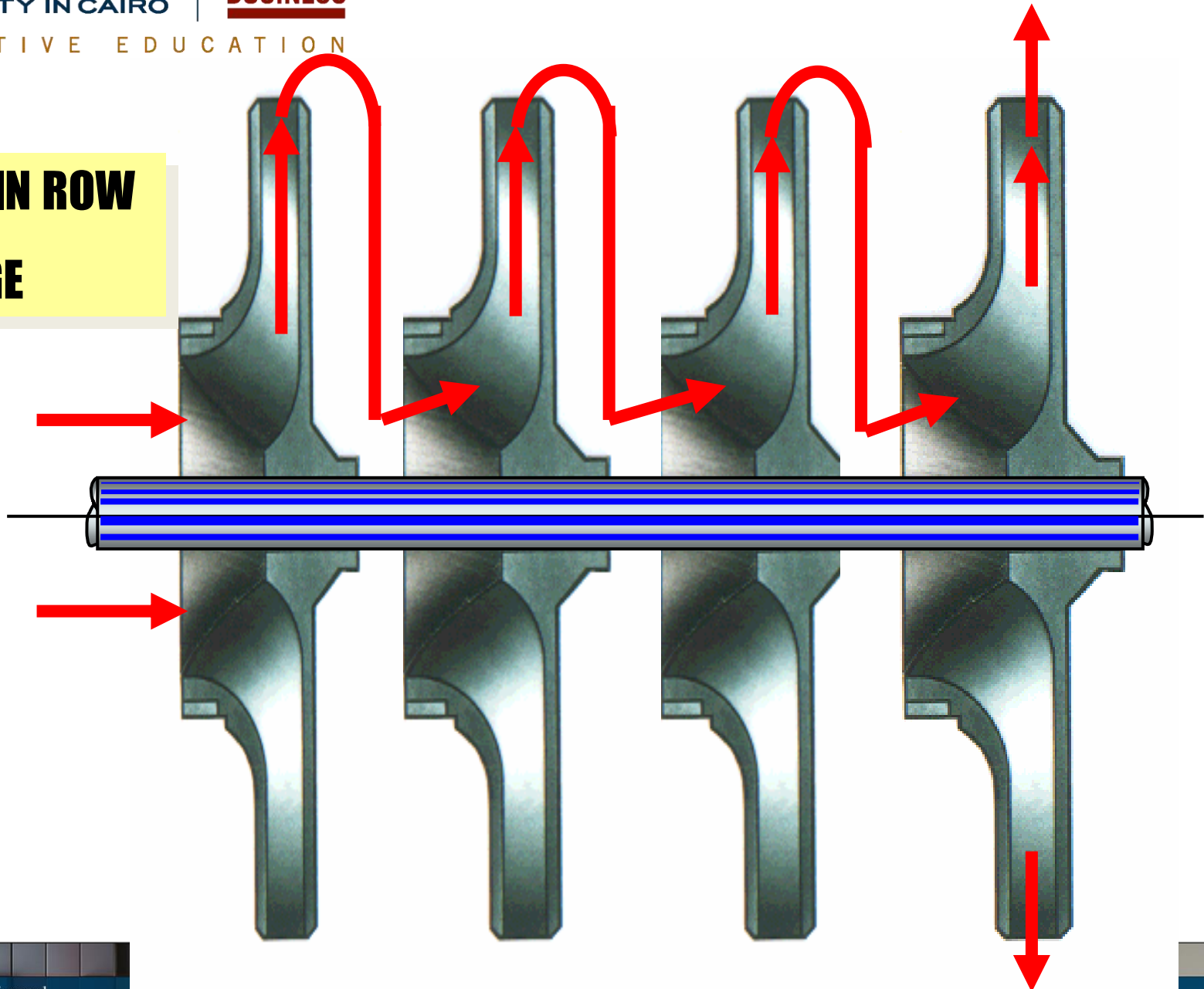
FLOW KINAMATIC ENERGY

$$\frac{v^2}{2g} + \frac{P}{\rho}$$





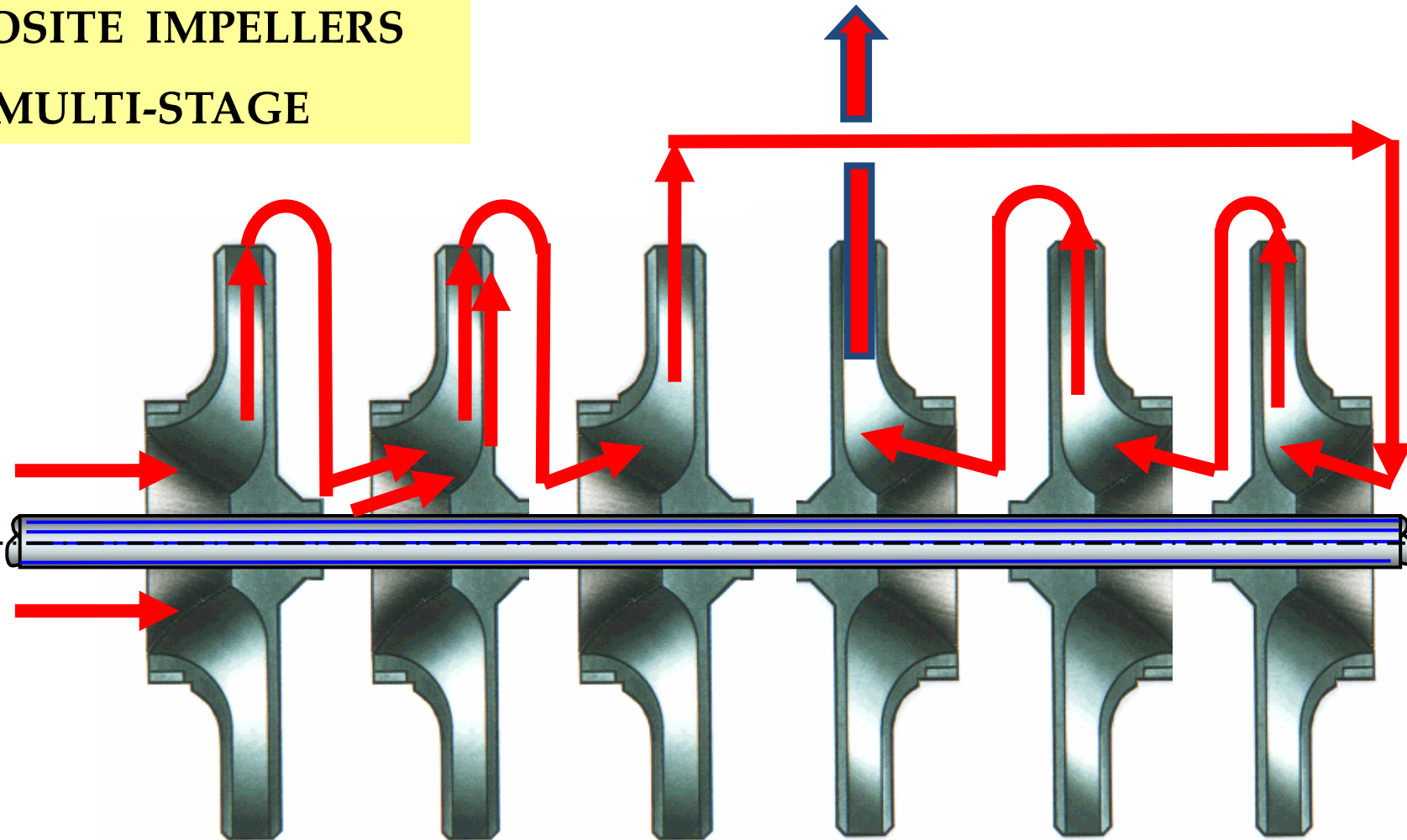
IMPELLERS IN ROW MULTI-STAGE





OPPOSITE IMPELLERS MULTI-STAGE

Pump outlet





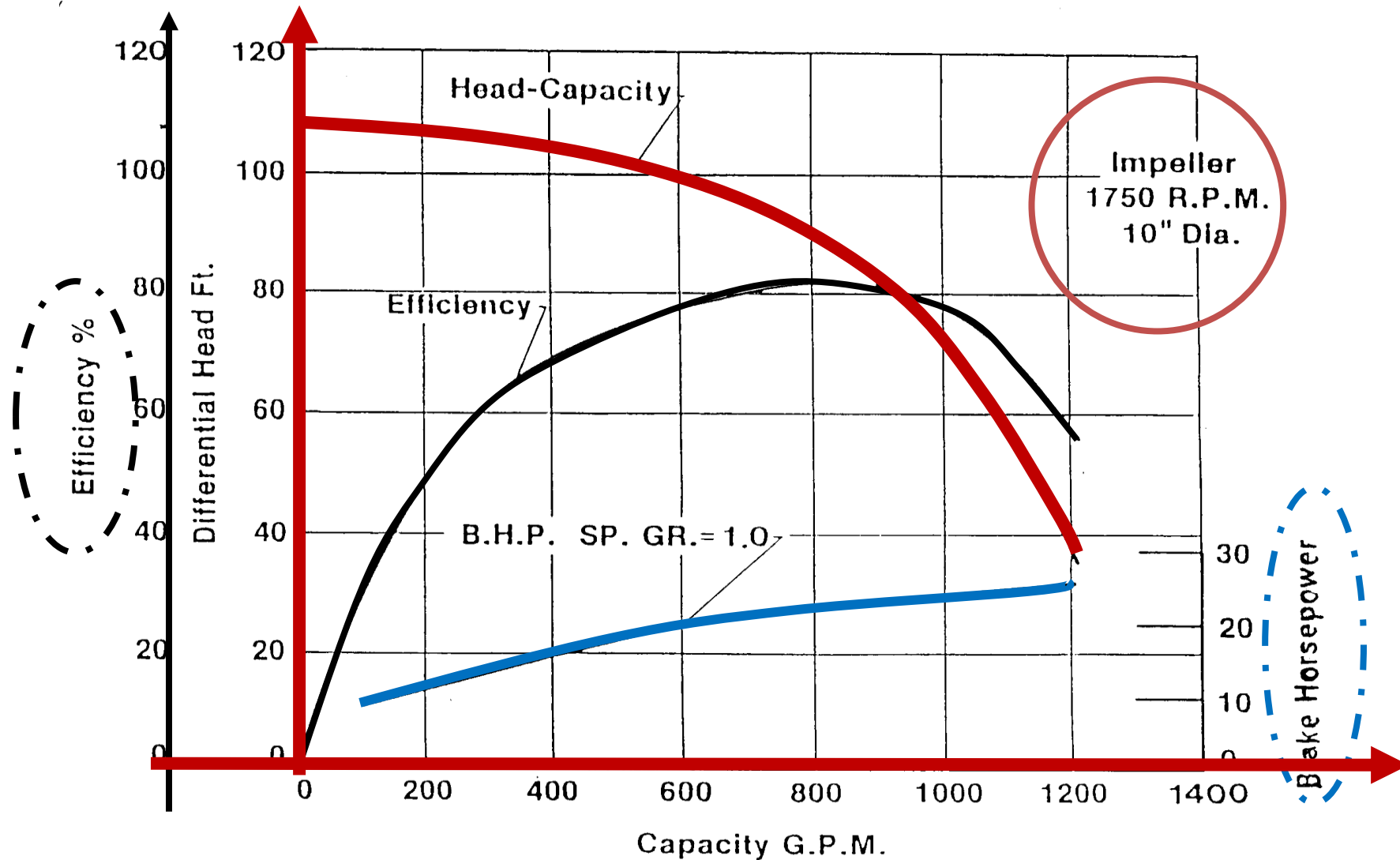
1- Centrifugal pumps Performance curve

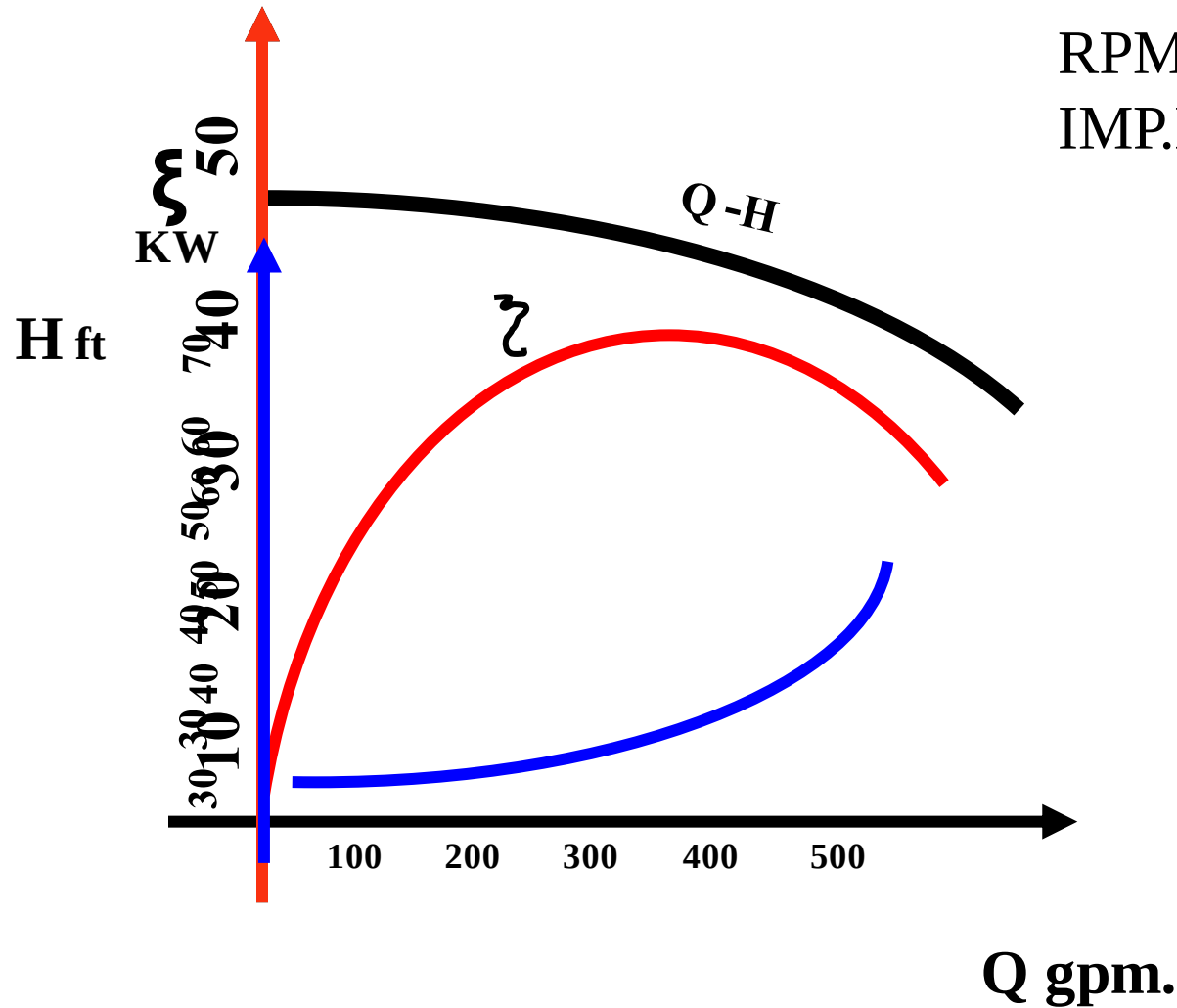
2- Pumps Specific speed

3- Pumps Horse Power

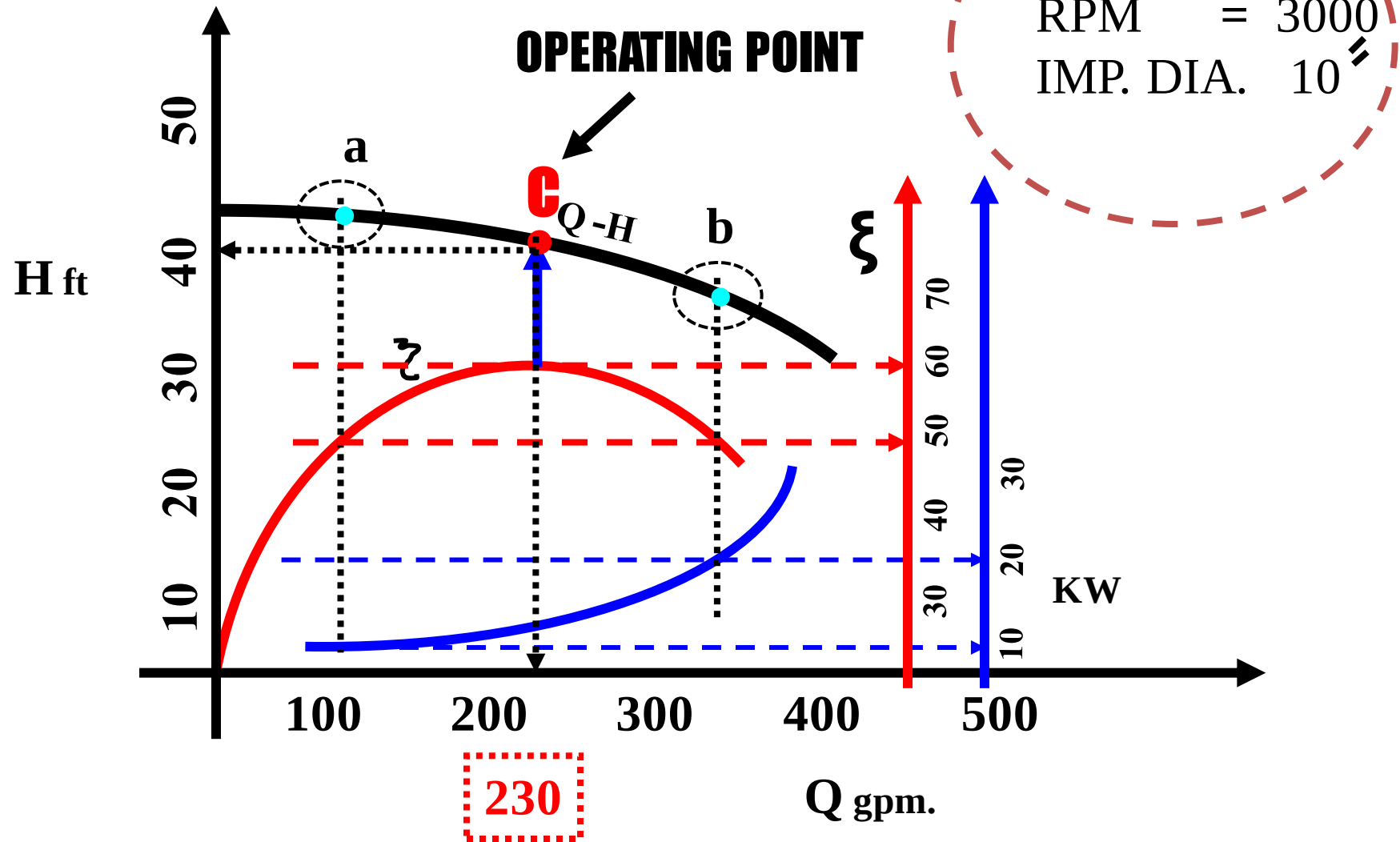


Centrifugal Pump Performance Curve (Q-H)



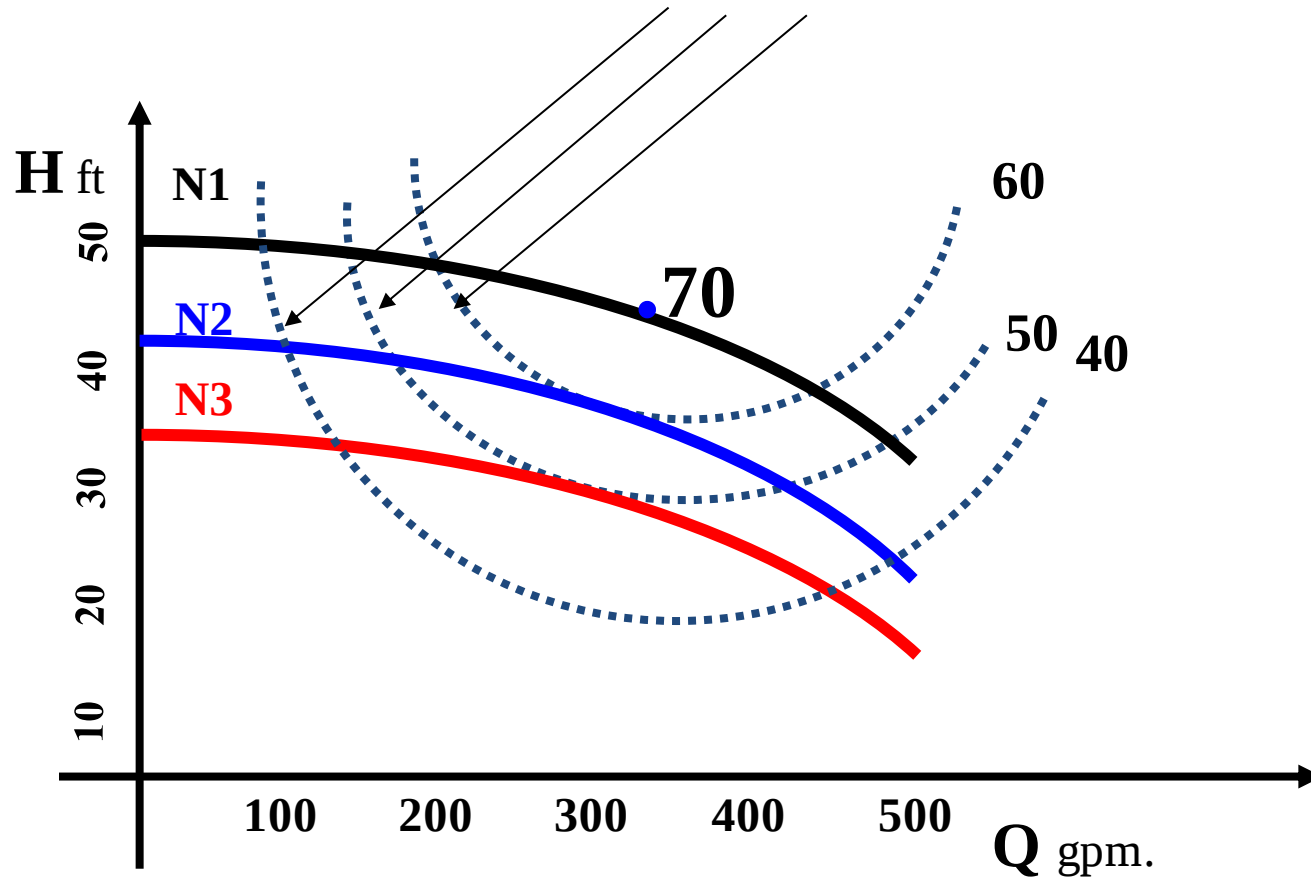


RPM = 3000
IMP.DIA = 10 Inch



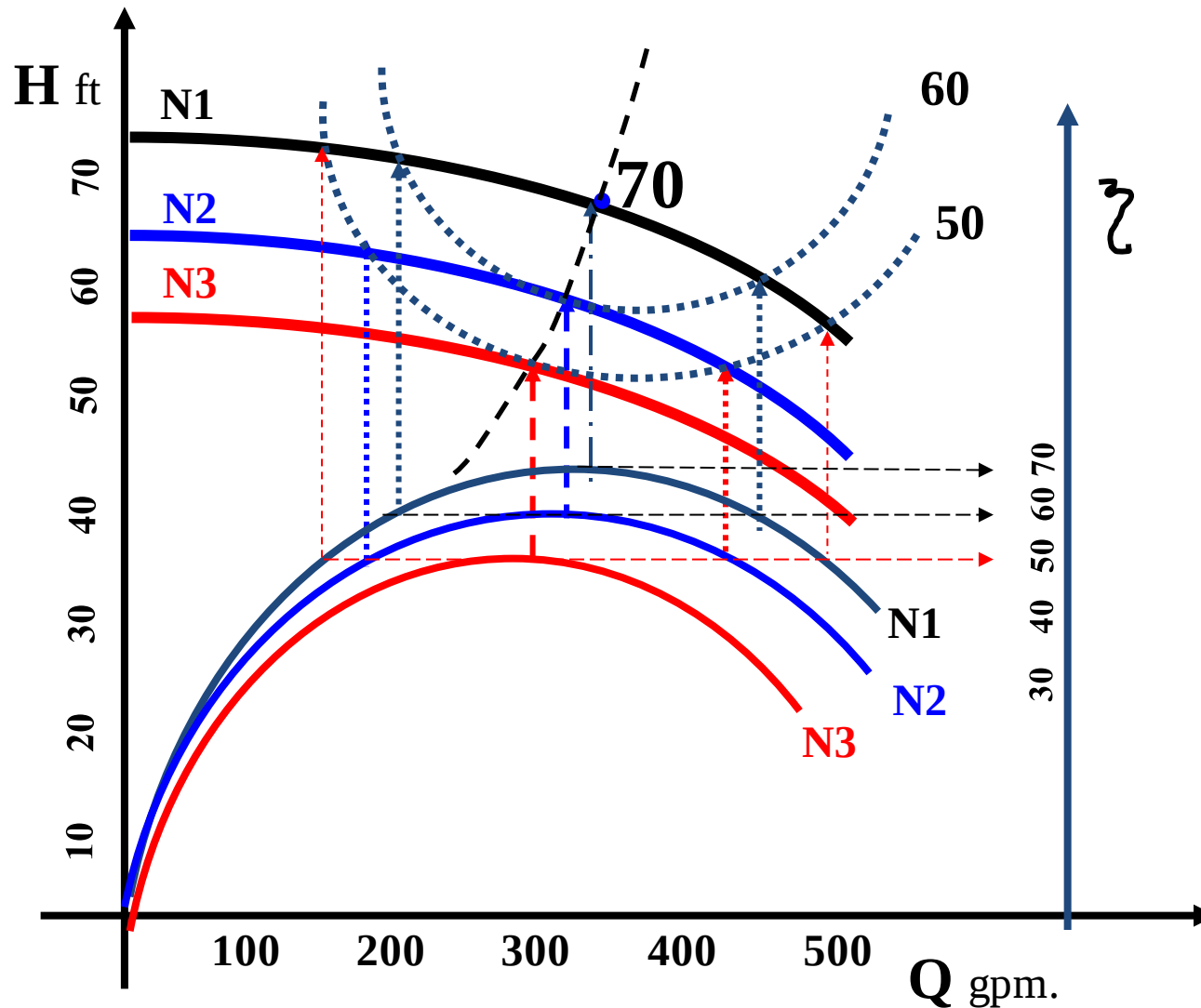


Iso- Efficiency Curves





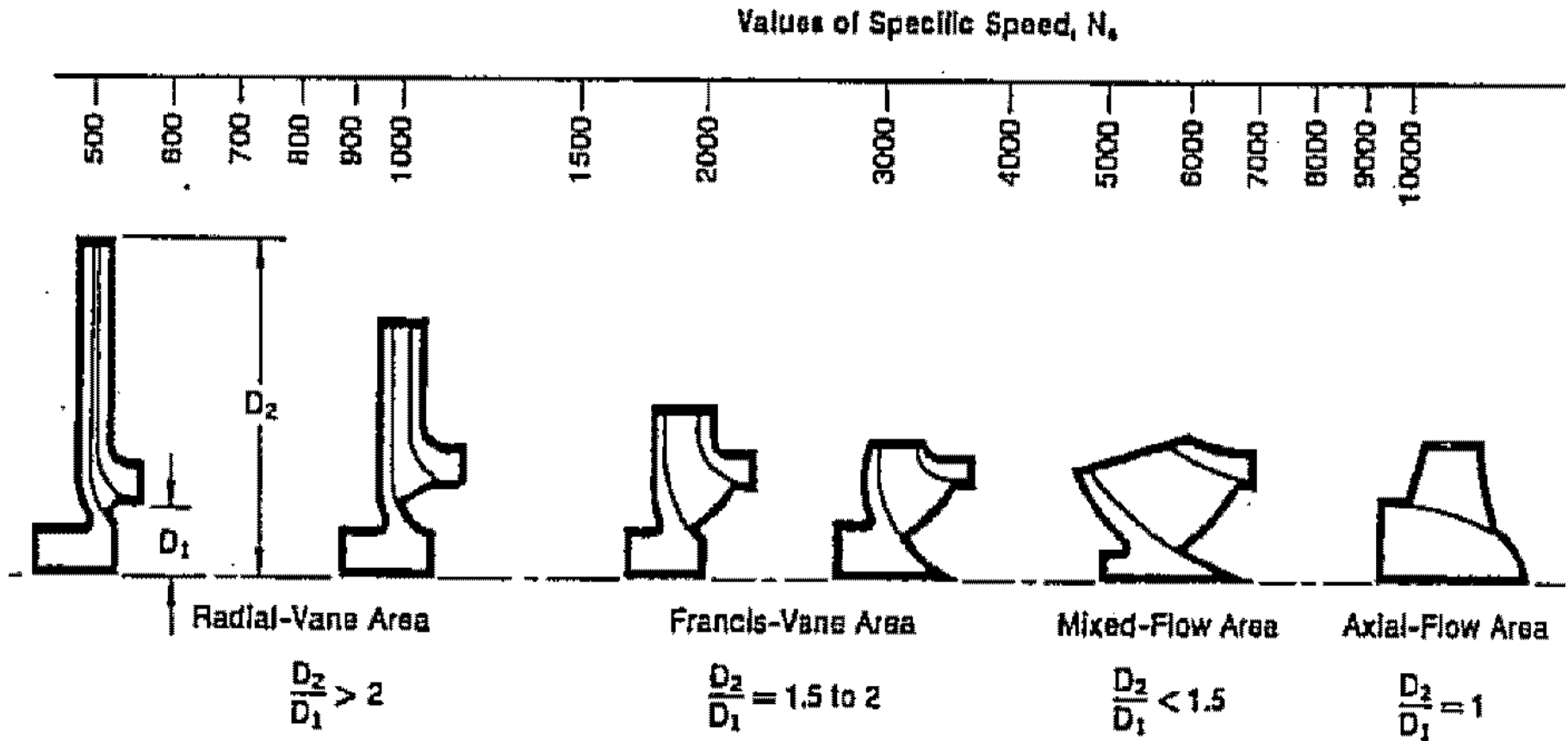
Iso- Efficiency Curves



Pump (RPM) N1 > N2 > N3



Specific Speed



Impeller Design vs Specific Speed **foot system**

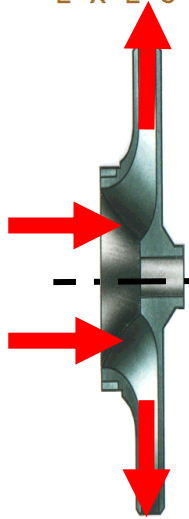


Classification of Centrifugal Pumps

- **Radial Flow** - a centrifugal pump in which the pressure is developed wholly by centrifugal force.
- **Axial Flow** - a centrifugal pump in which the pressure is developed by the propelling or lifting action of the vanes of the impeller on the liquid.
- **Mixed Flow** - a centrifugal pump in which the pressure is developed partly by centrifugal force and partly by the lift of the vanes of the impeller on the liquid.

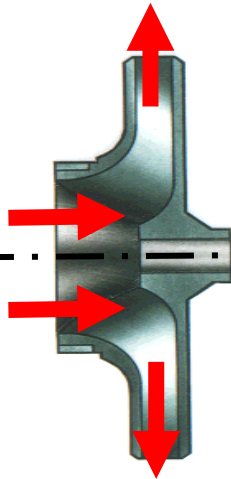


Pumps Specific Speed N_s



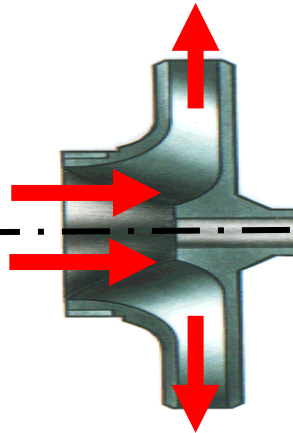
RADIAL

$N_s = 500$



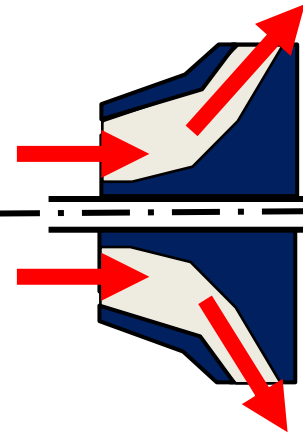
FRANCES

800



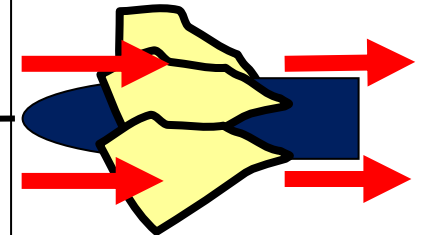
CAPLAN

1200



MIXED FLOW

2000



PROPELLER

3000

$$N_s = \frac{N Q^{1/2}}{H^{3/4}}$$

N_s = Dimensionless Number



$$N_s = \frac{N Q^{1/2}}{H^{3/4}}$$

N = RPM

Q = Flow Rate (Gallons. Per Min).

H = Head **Per Impeller** (Feet)

or

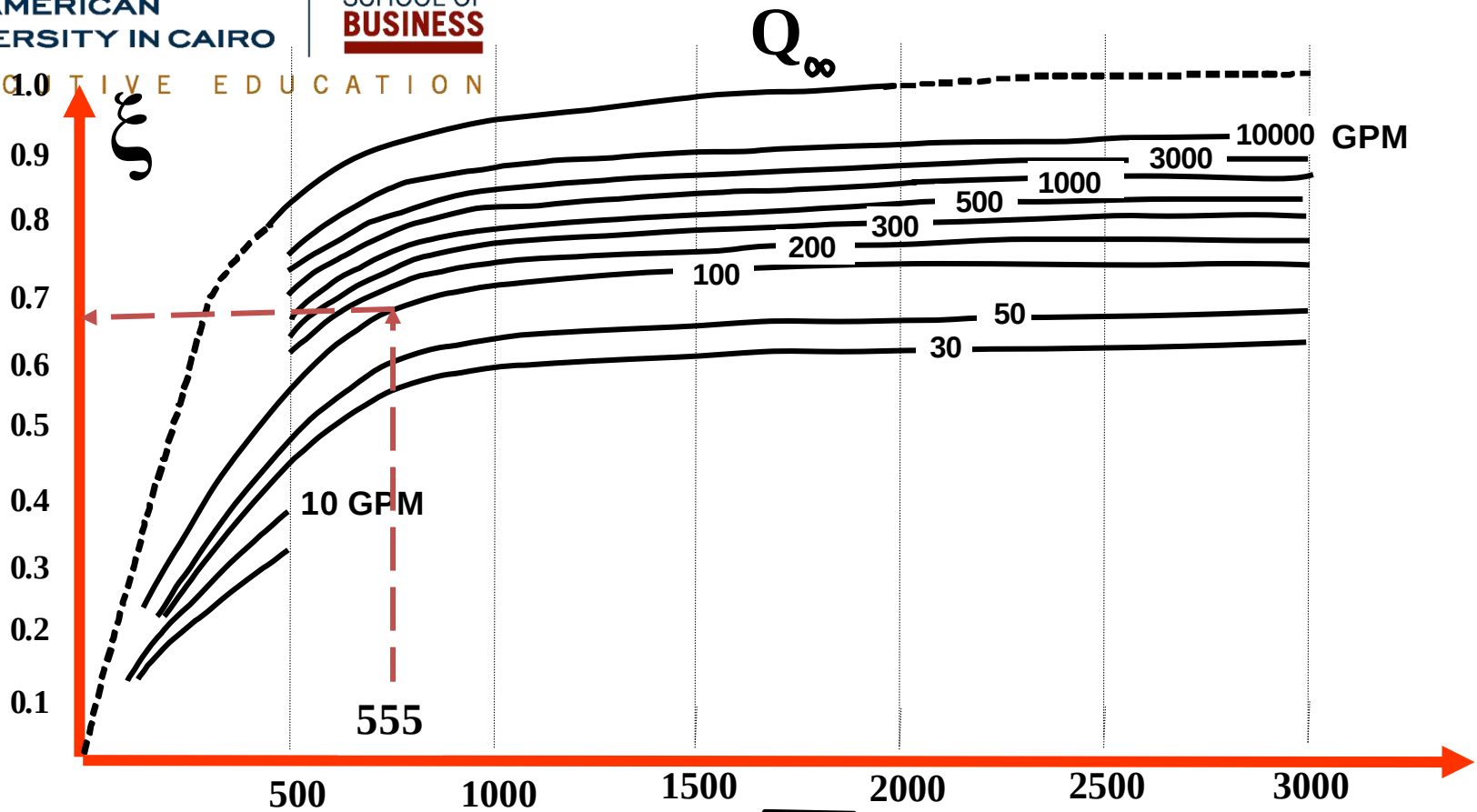
$$N_s = \frac{N Q^{1/2}}{H^{3/4}}$$

N = RPM

Q = Flow Rate (m³/ sec).

H = Head **Per Impeller** (Meter)

Note: Specific speed derived using cubic meters per second and meters multiplied by a factor of 51.6 is equal to specific speed derived using U.S. gallons per minute and feet. The usual symbol for specific speed in U.S. units is N_s .



IF

N = 1500 RPM

Q = 100 GPM

H = 81 FT/ Impeller

$$N_s = \frac{N \sqrt{Q}}{H^{3/4}}$$

$$N_s = \frac{1500 \sqrt{100}}{81^{3/4}}$$

$$N_s = \frac{15000}{27} = 555$$



	EFFICIENCY											
	1	2	3	4	5	6	7	8	9	10	11	12
Qgpm Ns	5	10	30	50	100	200	300	500	1000	3000	10000	>
200	14	19	20	22	24							
300	21	25	29	33	39							
400	26	31	35	39	45							
500	31	34	42	47	53	56	61	64	66	70	73	81
600			45	50	56	59	64	67	70	73	76	84
700			49	54	60	63	67	71	73	76	79	88
800			51	55	63	65	69	73	75	79	81	91
900			53	58	65	68	72	74	77	81	83	93
1000			55	60	66	69	73	75	79	83	85	94
1100			56	61	67	70	74	77	81	84	87	95
1200			57	63	69	72	75	78	82	85	87	95
1300			57	63	69	72	75	78	82	85	87	95
1400			57	63	69	72	75	78	82	85	87	95
1500			58	64	70	72	77	79	82	85	87	95
>1500			60	65	72	75	77	80	84	87	90	97



MOTOR PUMP POWER

WHP = WATER HORSEPOWER

BHP = BREAK HORSEPOWER

$$WHP = \frac{P Q}{\eta}$$

$$BHP = \frac{P Q}{\eta}$$

WHERE

P = PUMP DIFF. PRESSURE

Q = PUMP FLOW RATE

η = PUMP EFFICIENCY



$$\text{WHP} = 0.037 \text{ P Q}$$

$$\begin{aligned} \text{P} &= \text{bar} \\ \text{Q} &= \text{M}^3/\text{hr} \end{aligned}$$

$$\text{BHP} = 0.037 \frac{\text{P Q}}{\xi}$$

$$\text{WHP} = 0.00058 \text{ P Q}$$

$$\begin{aligned} \text{P} &= \text{psi} \\ \text{Q} &= \text{GPM} \end{aligned}$$

$$\text{BHP} = 0.00058 \frac{\text{P Q}}{\xi}$$

$$1 \text{ HP} = 75 \text{ kg. m / sec}$$

$$1 \text{ HP} = 550 \text{ Ib. ft /sec}$$

$$\text{WHP} = \frac{\text{Q.P}}{75}$$

$$\text{WHP} = \frac{\text{M}^3 / \text{hr} \left[\text{Kg / cm}^2 \right]}{75}$$

$$\text{WHP} = \frac{\text{m}^3}{\text{sec} * 3600} * \frac{\left[\text{Kg} \right] \frac{100*100}{\text{m}^2}}{75}$$

$$\text{WHP} = \frac{100*100}{3600 * 75} * \frac{\left[\text{Kg} \right] \text{m}}{\text{sec}}$$

$$\text{WHP} = 0.037 \frac{\left[\text{Kg} \right] \text{m}}{\text{sec}}$$



CALCULATE MOTOR HP. FOR

EXAMPLE

$$N = 3000$$

1-PUMP (A) HAS D.P = 20 PSI
 Q = 2000 GPM

2-PUMP (B) HAS D.P = 400 PSI
 Q = 100 GPM

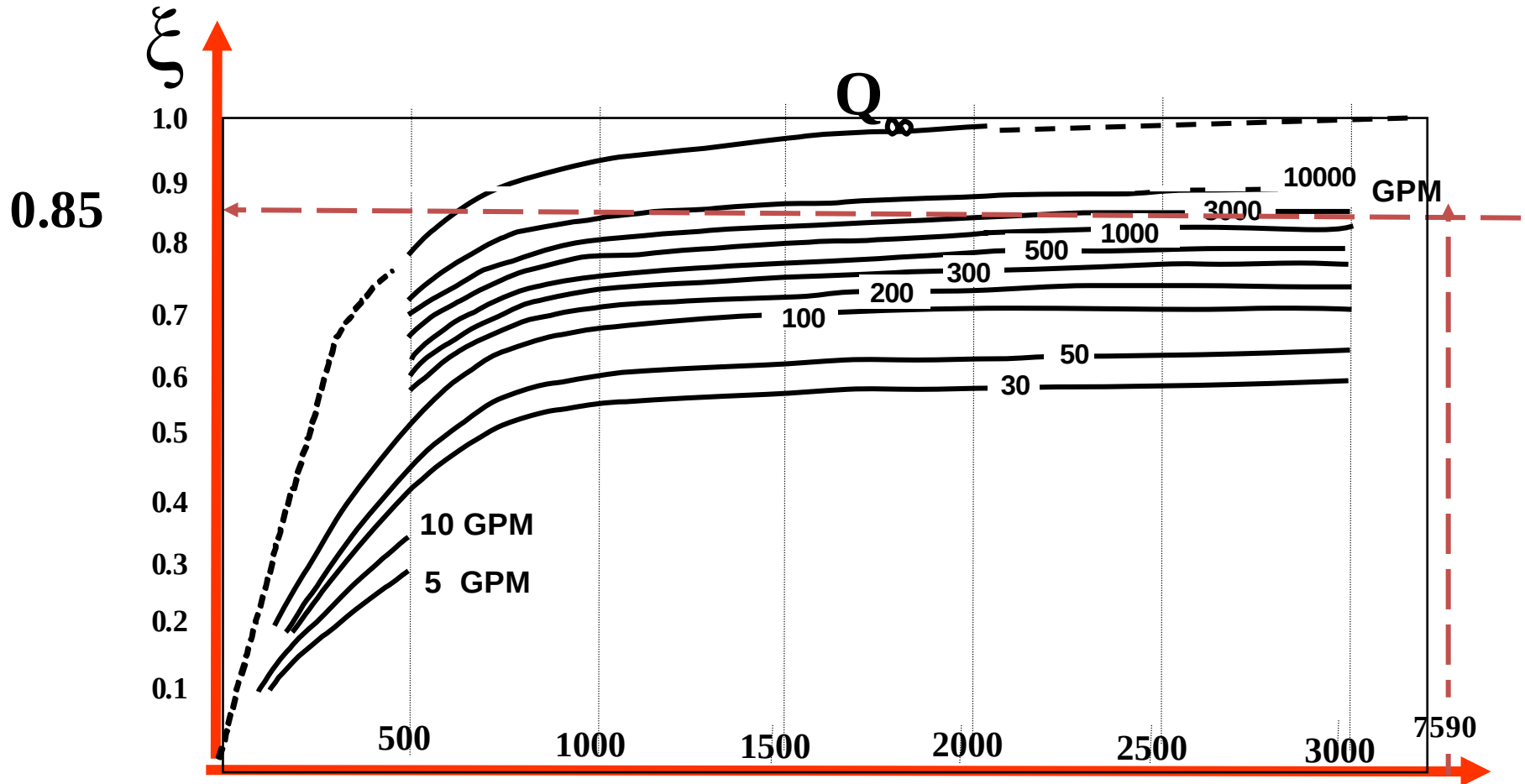
FOR BOTH PUMPS

$$\text{WATER. HP.} = 0.00058 * 20 * 2000 \quad \text{HP.}$$

$$= 23.2 \quad \text{HP}$$



PUMP (A) NS



$$Q = 2000 \quad \text{GPM}$$

$$H / \text{Imp} = 20 * 2.31 = 46.2 \quad \text{ft}$$

$$N_s = \frac{3000 \sqrt{2000}}{46.2^{3/4}}$$

$$N_s = 7590$$



PUMP **A**

$$N = 3000 \text{ RPM}$$

$$\text{D.P/impeller} = 20 * 2.31 = 46.2 \text{ ft}$$

$$Q = 2000 \text{ GPM}$$

$$N_s = \frac{N Q^{1/2}}{H^{3/4}}$$

$$N_s = \frac{3000 * 2000^{1/2}}{46.2^{3/4}} = \frac{3000 * 44.7}{17.66} = 7590$$

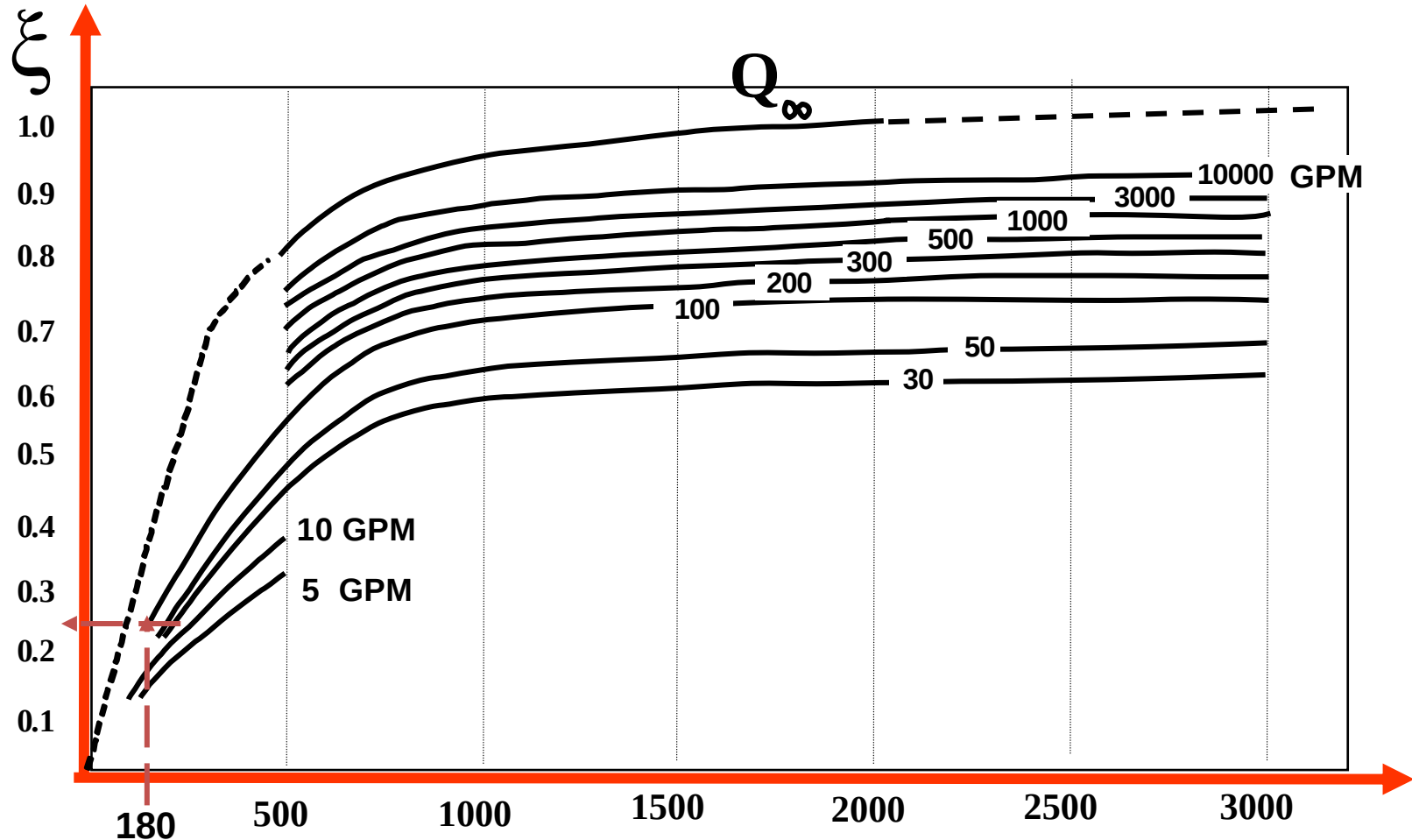
$$\xi = 0.85$$

$$\text{BRAKE HP} = 23.2 / 0.85 = 27 \text{ HP.}$$

$$\text{Motor HP} = 27 * 1.2 = 33 \text{ HP}$$

PUMP (B)

N = 3000



Q = 100 GPM

H/ Imp = 400 * 2.31 = 924 ft

$$N_s = \frac{3000 \sqrt{100}}{924^{3/4}}$$

N_s = 180



PUMP B

$$N = 3000 \text{ RPM}$$

$$N_s = \frac{N Q^{1/2}}{H^{3/4}}$$

$$\text{D.P./impeller} = 400 * 2.31 = 924 \text{ ft}$$

$$Q = 100 \text{ GPM}$$

$$N_s = \frac{3000 * 100^{1/2}}{924^{3/4}} = \frac{3000 * 10}{167.7} = 180$$

$$\xi = 0.25$$

$$\text{BRAKE HP} = 23.2 / 0.25 = 97 \text{ HP.}$$

$$\text{Motor HP} = 97 * 1.2 = 116 \text{ HP}$$



Net Positive Suction Head

NPSH



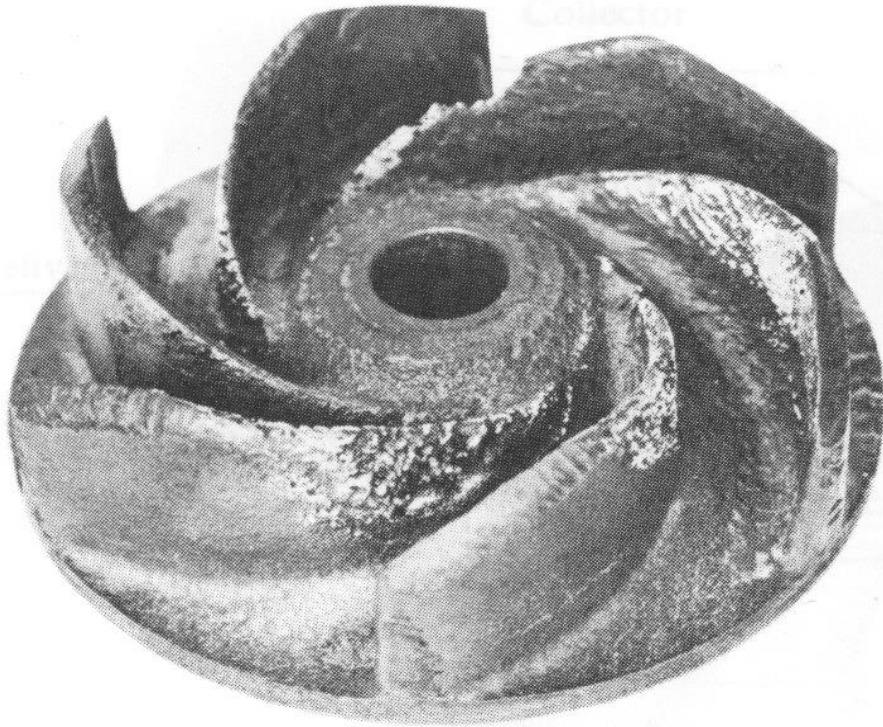
Examples of Cavitation Damage

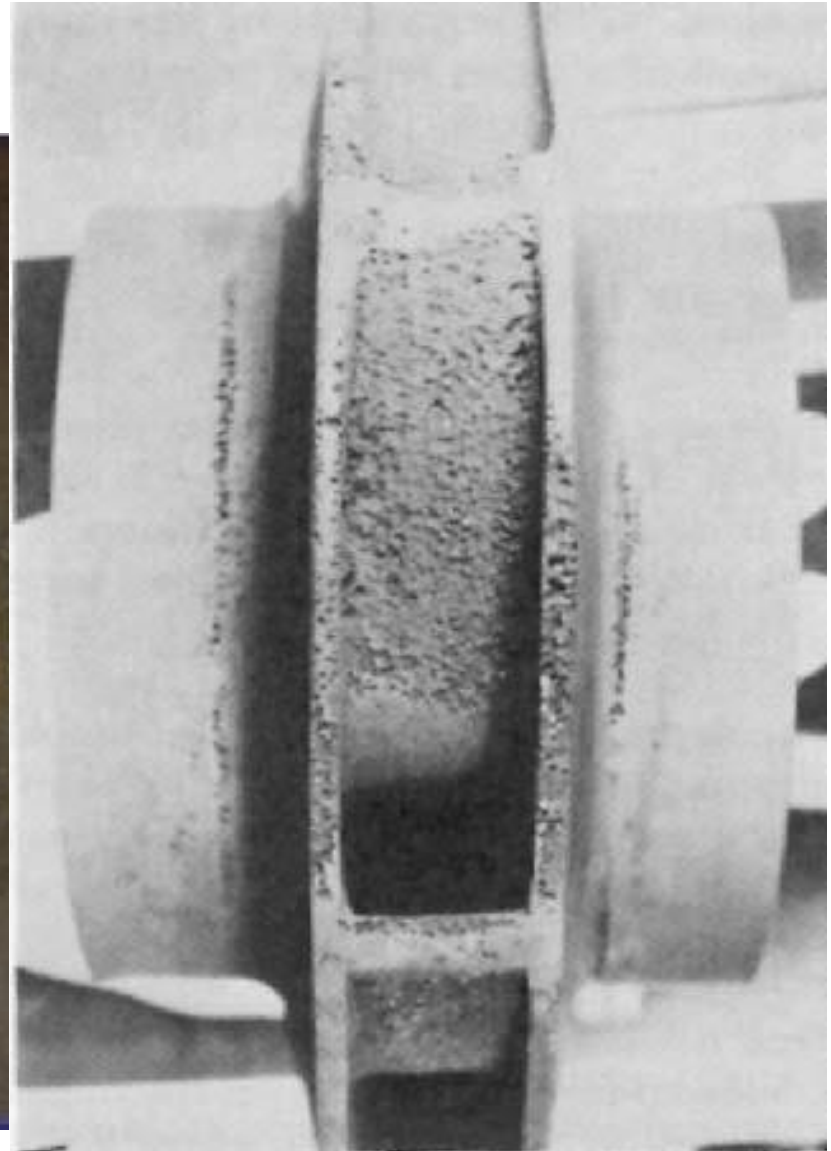
- Increase of noise and vibration, resulting in shorter seal and bearing life.
- Erosion of surfaces, especially when pumping water-based liquids.

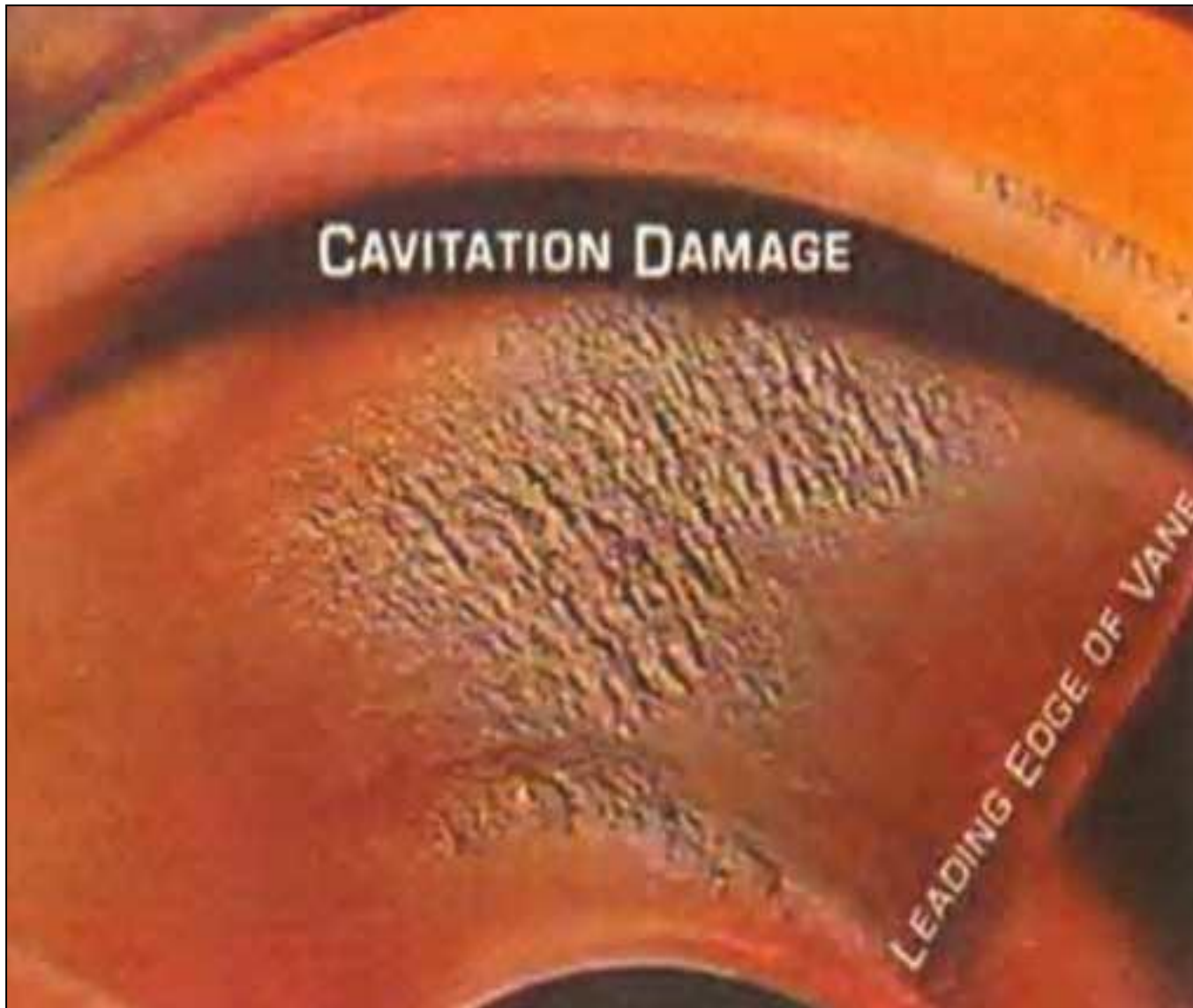




Cavitation









CAVITATION CAN OCCUR
in

***CENTRIFUGAL
PUMPS***

AND

***POSITIVE DISPLACEMENT
PUMPS***

WHEN

$NPSHA < NPSHR$



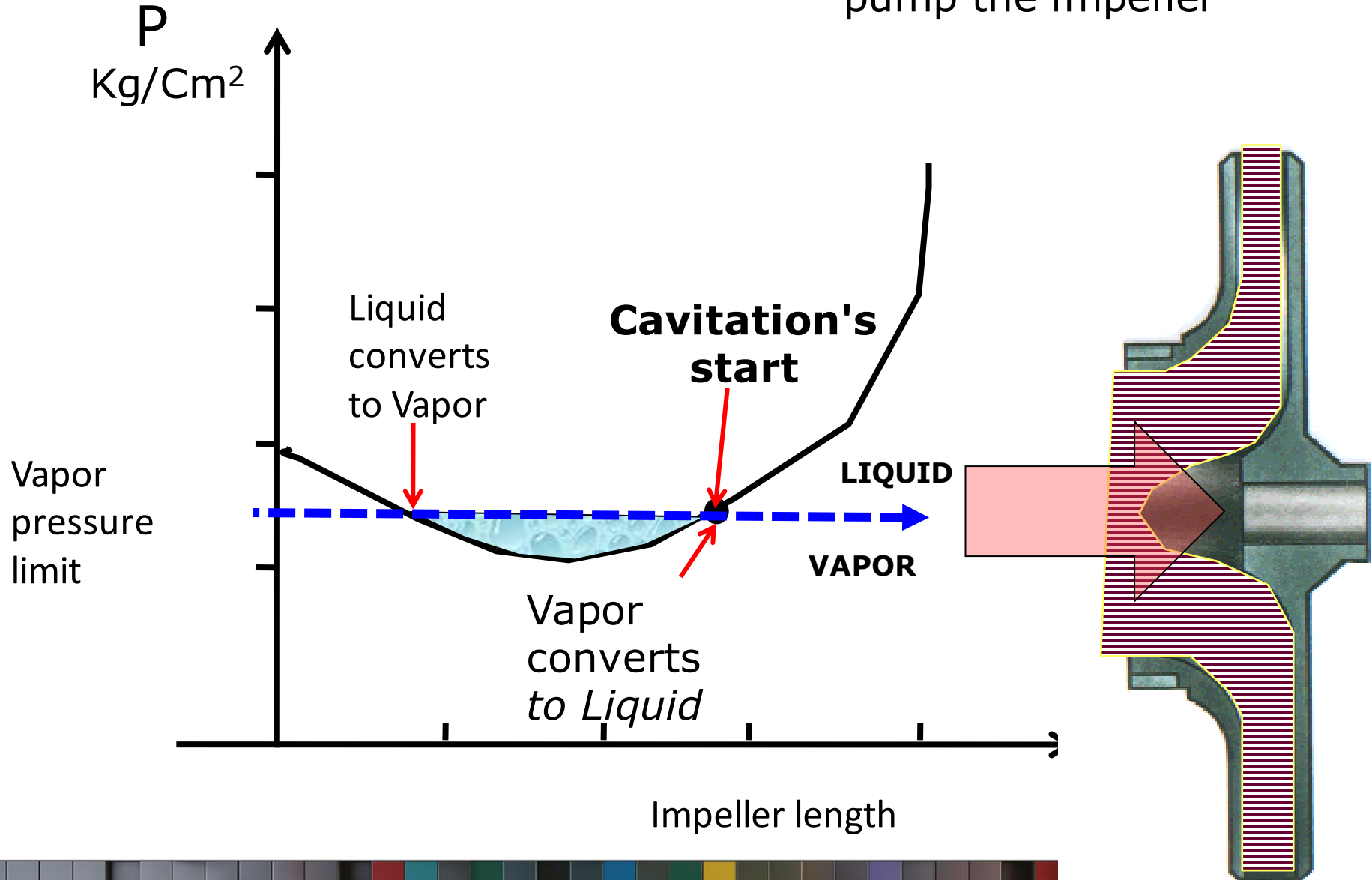
WHAT IS CAVITATIONS PHENOMENON

It is an action of fluid vapor attack on the parts of equipment which produce:

Suction pressure less than
Vapor pressure of the pumped fluid.



Vapor Pressure Graph through pump the impeller





This action will cause:

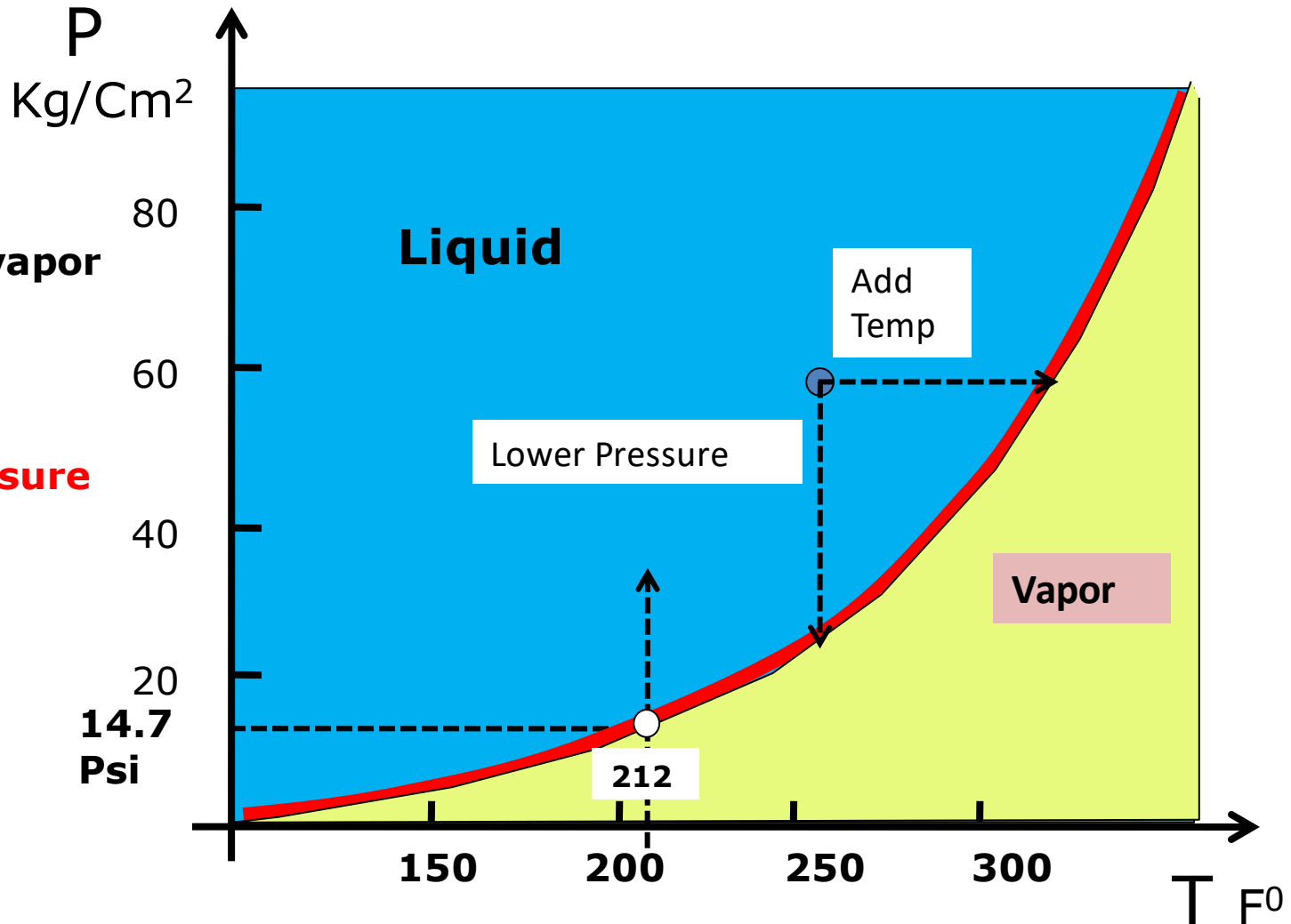
loss of the weakest component element
of suction parts material due to bubble
explosion on the surface of suction
parts causing cavities .

Vapor bubble explosion on
the parts surface could be

60,000 psi.



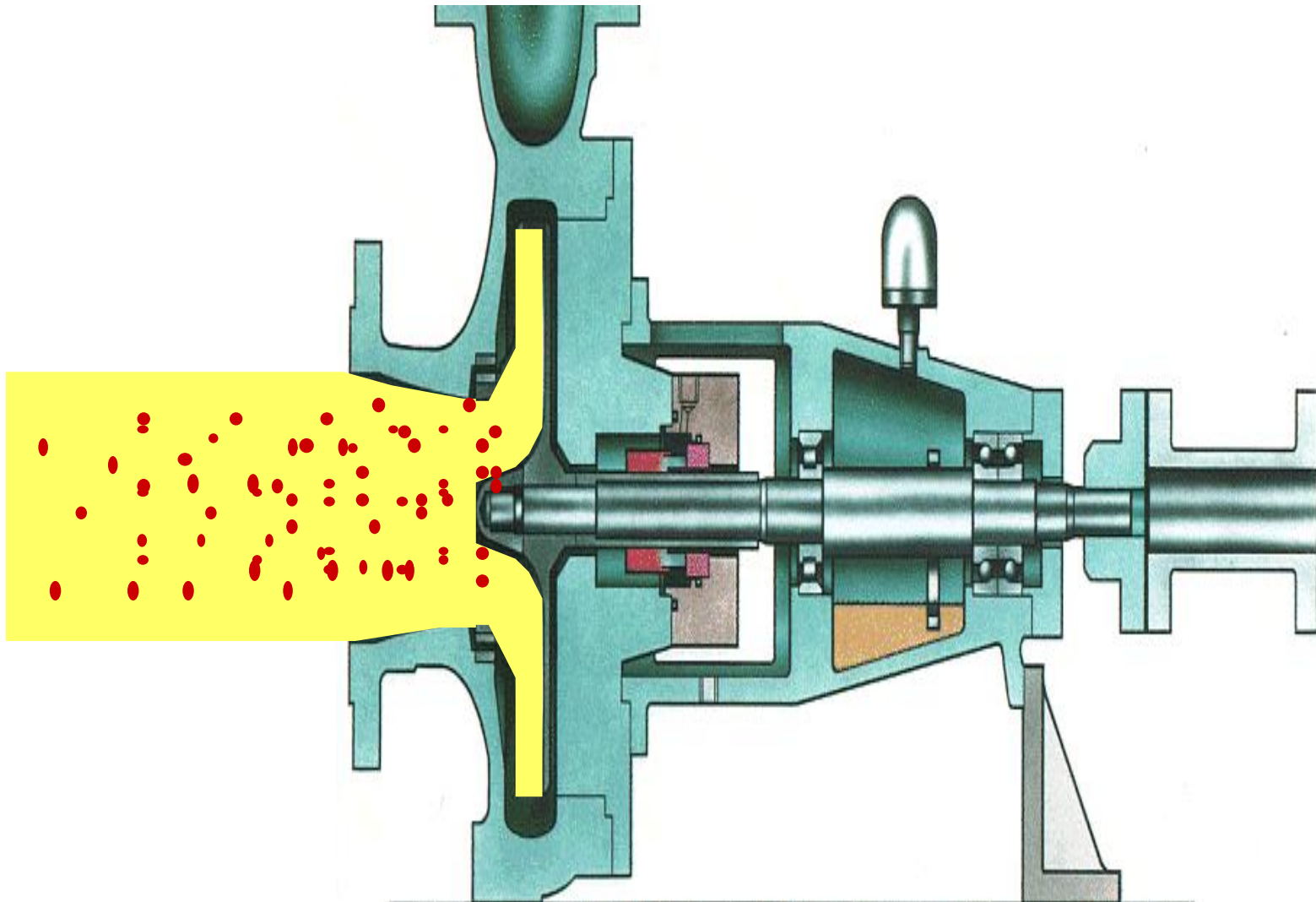
Water Vapor Pressure Graph

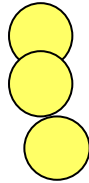
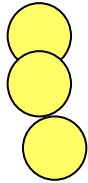
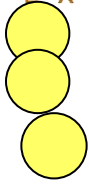


**Liquid covert to vapor
by two methods**

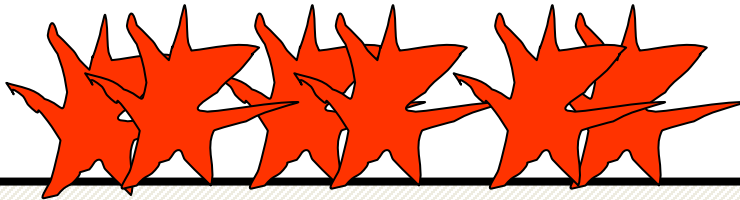
1- Add Temp

2- Decrease Pressure



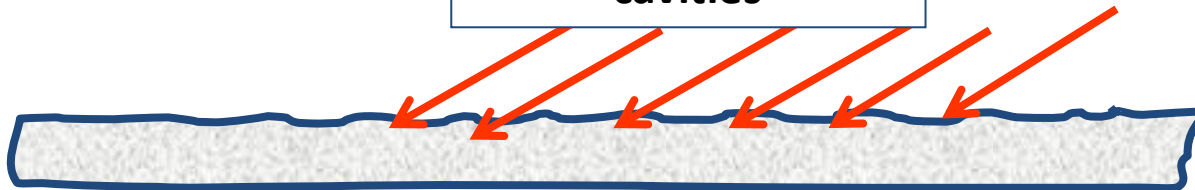


FLUID VAPOR BUBBLES



Pump suction parts

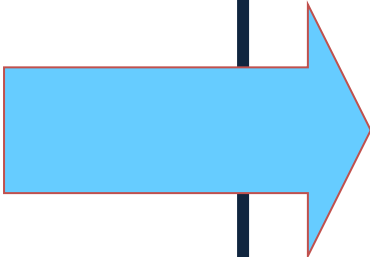
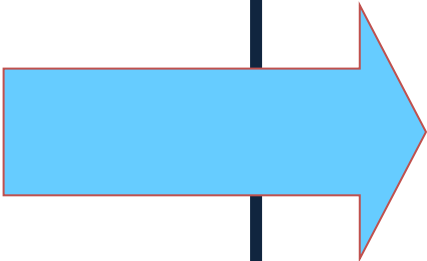
cavities



Pump suction parts After attack



LOST ELEMENTS IN SUCTION PARTS

SUCTION PARTS MATERIAL	THE WEAKEST ELEMENT (LOST ELEMENT)
CARBON STEEL CAST IRON STIANLESS STEEL	 CARBON
BRONZ BRASS	 ZINC



What is Cavitation Effect

1- CENTRIFUGAL PUMPS

**Impeller deterioration
Decrease discharge pressure
Decrease pump flow rate
Increase vibration level
Bearings & M/S failure**

2- RECIPROCATING PUMPS

**Suction valve
Spring rupture
~~detention~~
Decrease discharge
Decrease pump flow
rate
Cylinder Head
Damage**



NPSH

1- NET POSITIVE SUCTION HEAD *REQUIRED*

YOU CAN GET FROM PUMP MANUAL

2- NET POSITIVE SUCTION HEAD *AVAILABLE*

YOU CAN CALCULATE FROM PUMP SITE

3- TO AVOID SUCTION CAVITATION

$$\text{NPSHA} > \text{NPSHR}$$



What is the parameters affecting NPSHA

SUCTION PIPE LENGTH

SUCTION PIPE DIAMETER

LIQUID SPECIFIC GRAVITY

INTERNAL SURFACE OF SUCTION PIPE

LIQUID SURFACE ALTITUDE

VAPOR CONTAMINATION

SUCTION PIPE LEAKS

SUCTION PRESSURE

LIQUID TEMPERATURE

LIQUID VISCOCITY

LIQUID VAPOR PRESURE



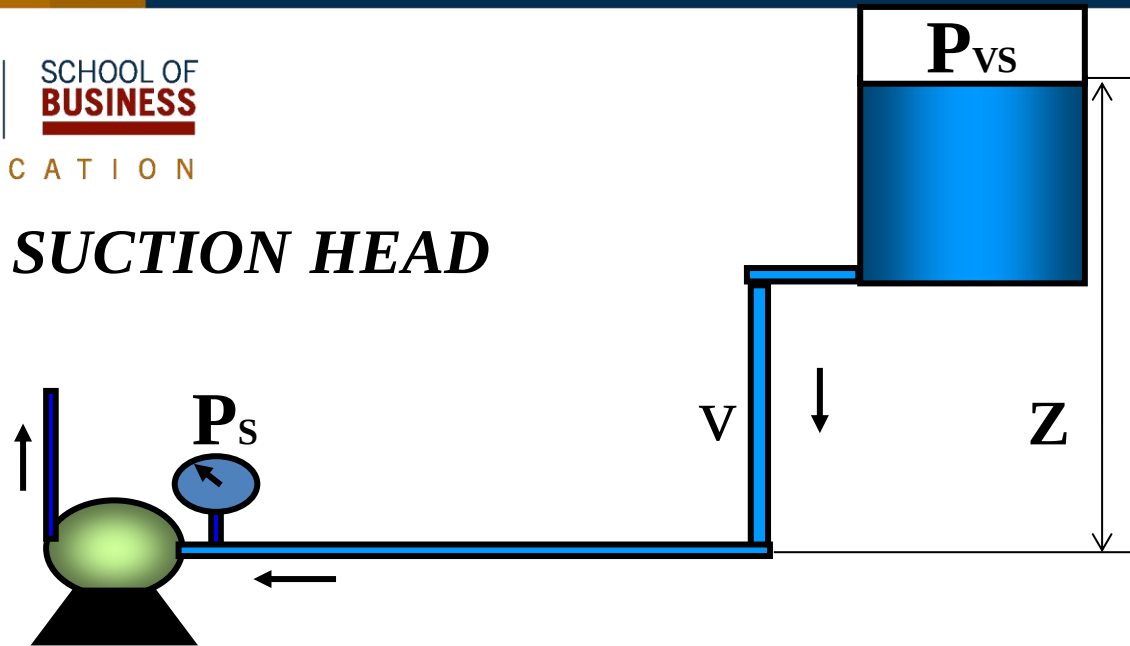
How To Improve **NPSHA**

Shorten The Suction Pipe
Increase Suction
Length
Decrease Suction Liquid
Temperature
Decrease Suction Negative
Head
Increase Suction Positive
Head
Stop the Piping Suction
Reflow The

Suction Pipe



NET POSITIVE (+) SUCTION HEAD



Z	liquid surface height	ft
P_{sv}	Vessel pressure	psig
P_s	Pump suction pressure	psig
V	liquid velocity	ft/sec
P_f	Friction Pressure drop	psi
P_a	Atm. Pressure	psi
V_p	Vapor pressure	psia
$Sp.gr$	liquid specific gravity	
h_L	Suction head loss	ft
g	32.2	ft/sec.sec

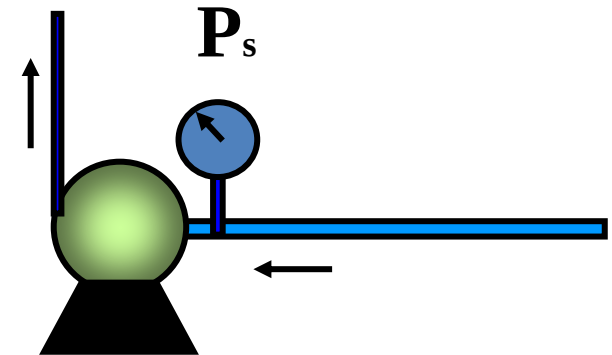


NPSHA

Is

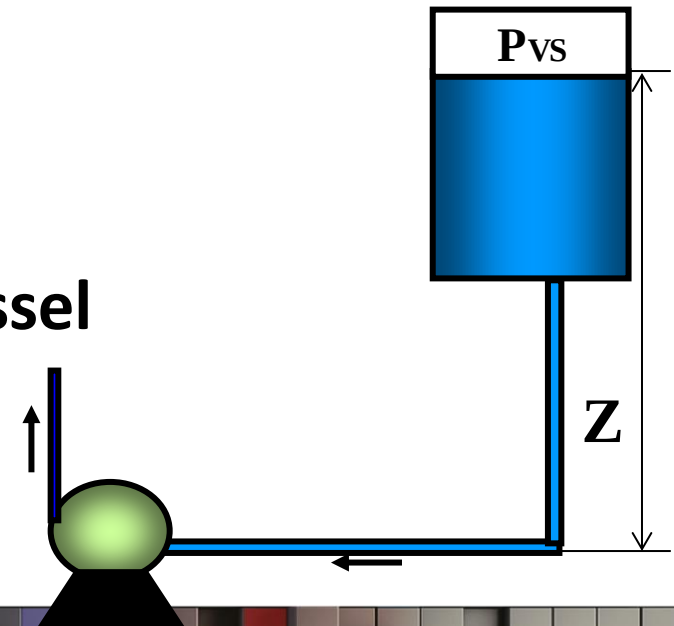
Not

- The Suction Gauge Pressure



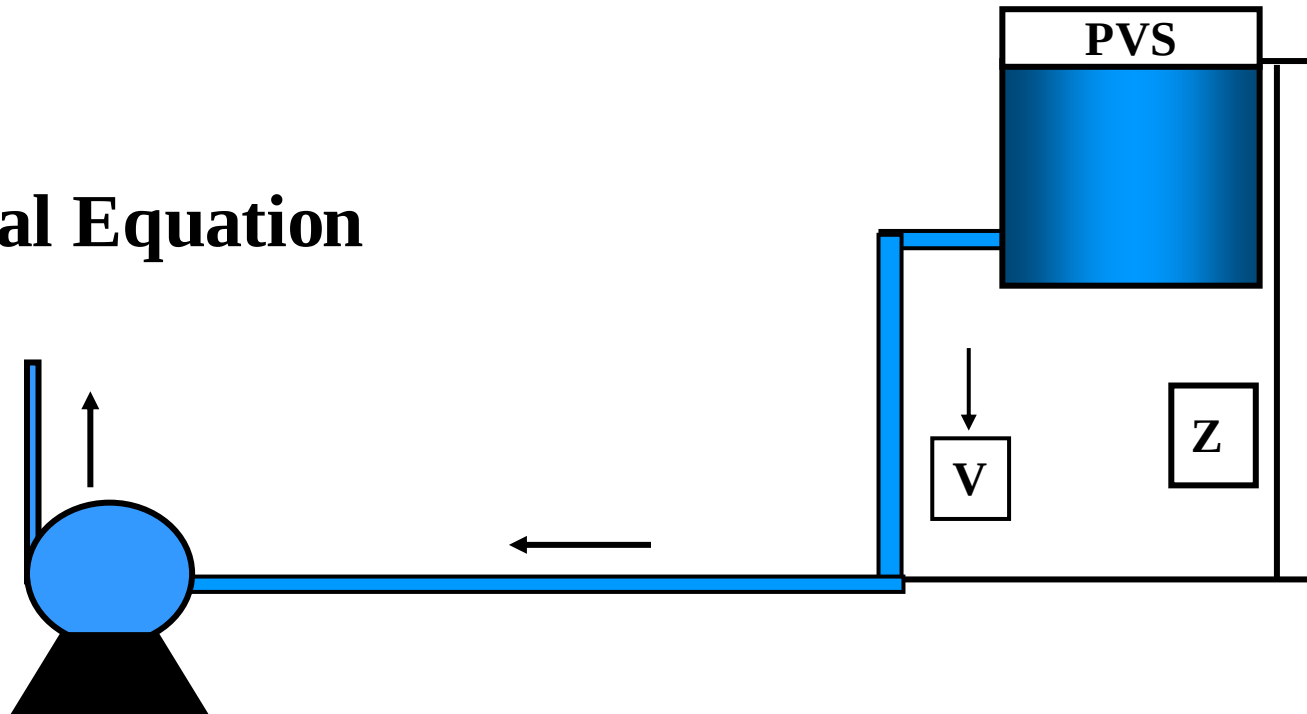
OR

- Liquid Level In The Suction Vessel





General Equation



$$\text{NPSHA} = Z + \frac{V^2}{2g} + \frac{\{ (P_{vs} + P_a) - P_p \} \cdot 2.31}{\text{Sp.gr}} - h_L$$



1

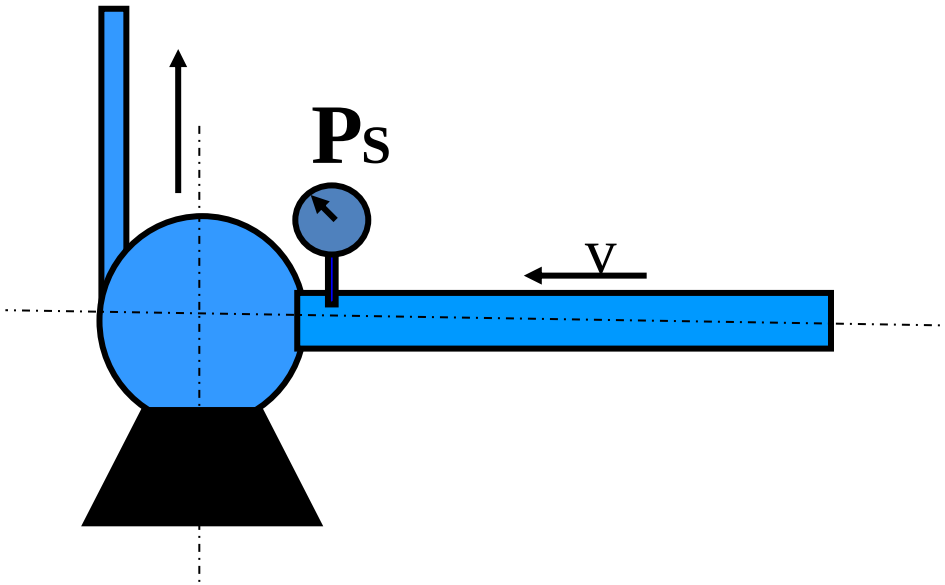
IF The Suction pressure
is known

$$\frac{P_s}{\text{Sp.gr}} = \frac{P_{\text{sva}}}{\text{Sp.gr}} + Z - h_L$$

$$\text{NPSHA} = Z + \frac{V^2}{2g} + \frac{\{ P_{\text{sva}} - V_p \} 2.31}{\text{Sp.gr}} - h_L$$



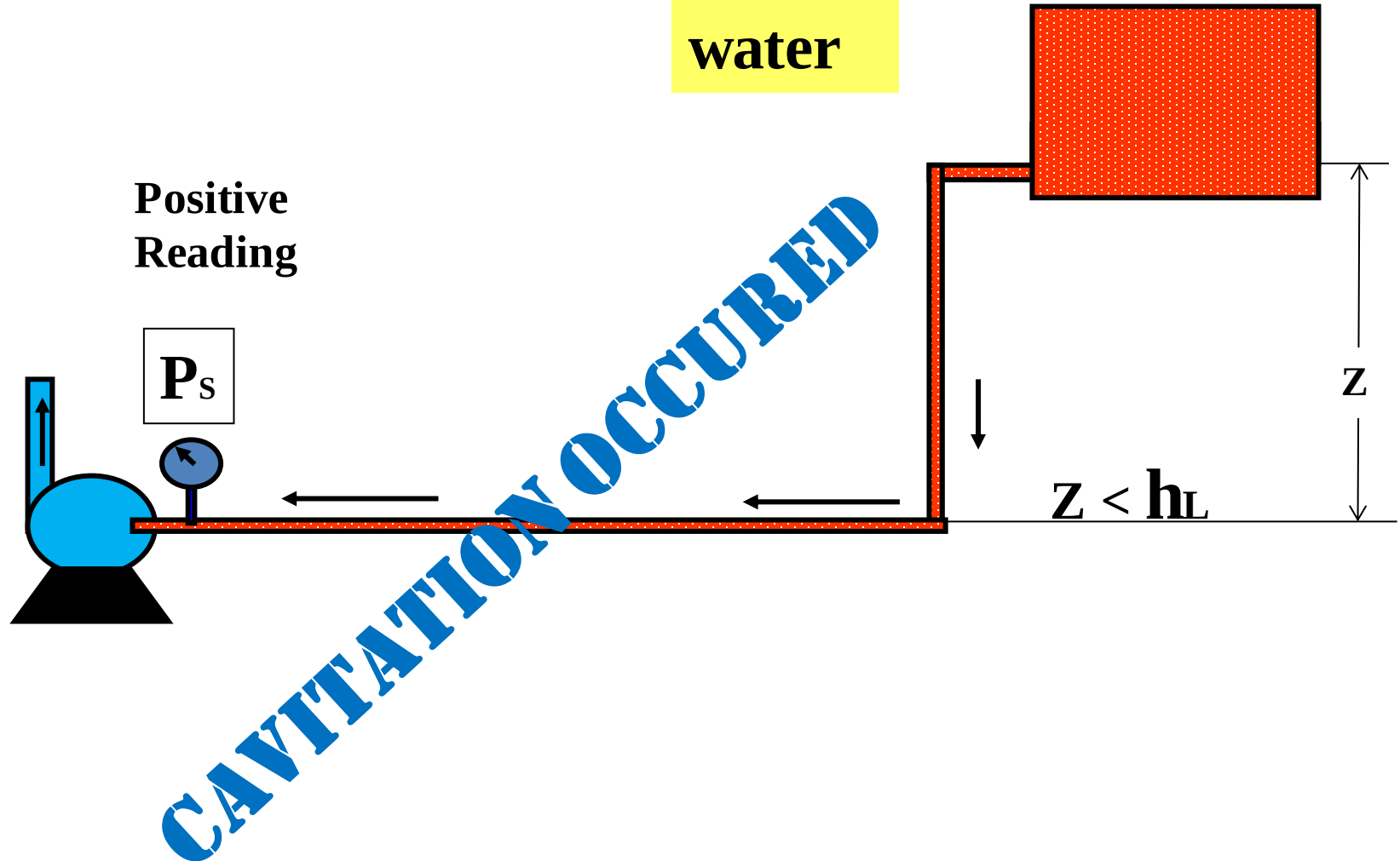
If The Suction pressure
is known



$$NPSHA = \frac{V^2}{2g} + \frac{\{ P_{sa} - V_p \} 2.31}{Sp.gr} \quad (ft)$$

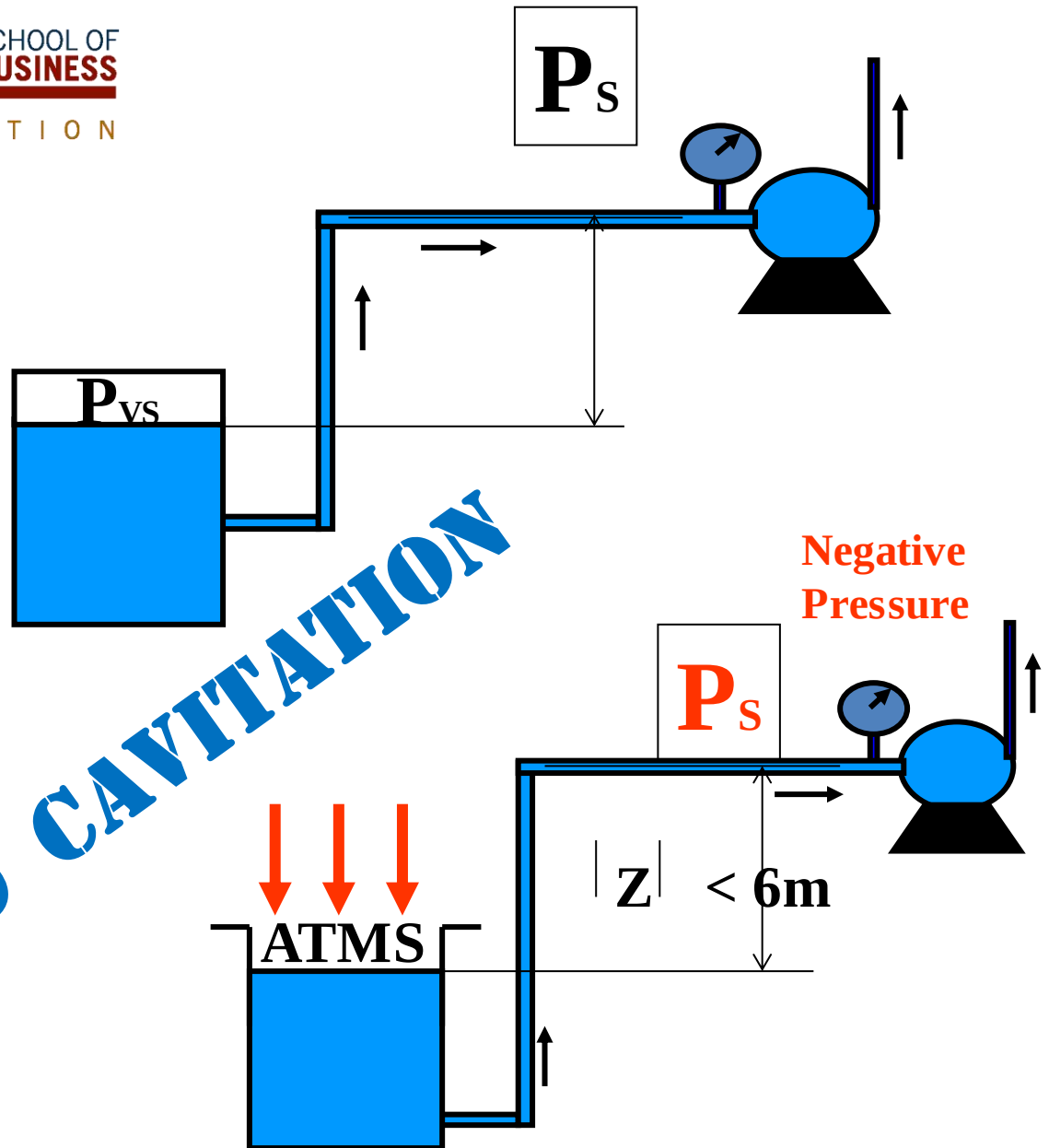


Boiled
water





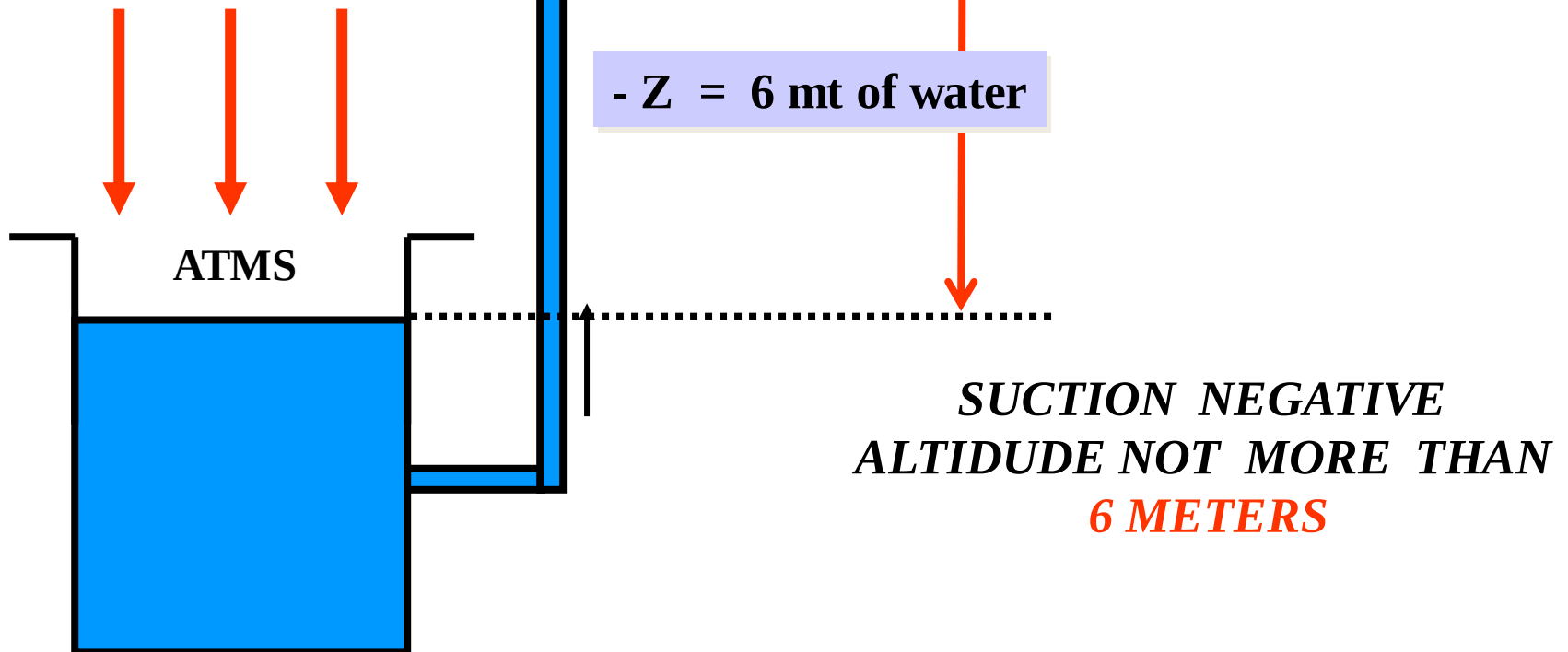
NO CAVITATION





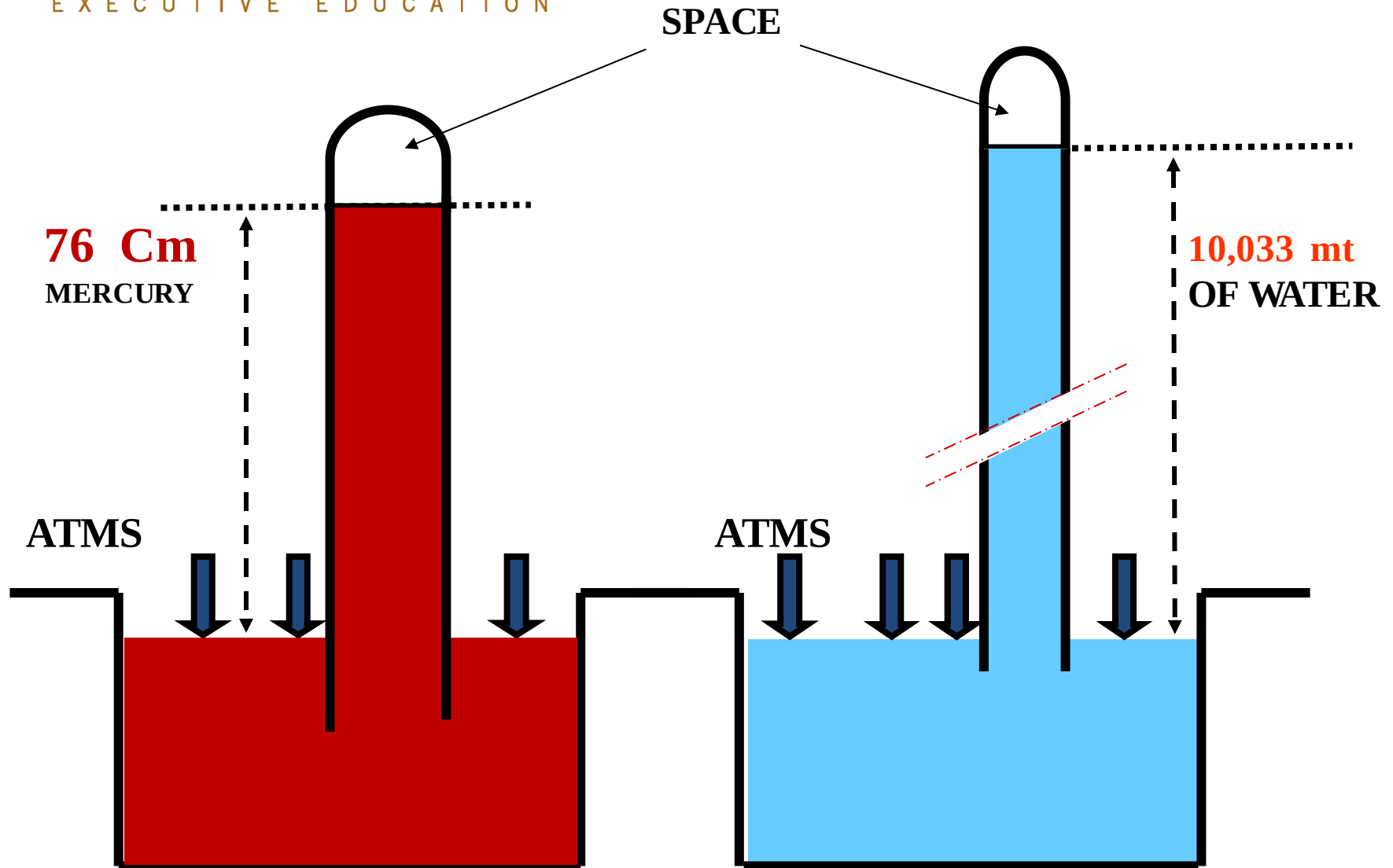
FOR ANY TYPE OF PUMPS

Practically



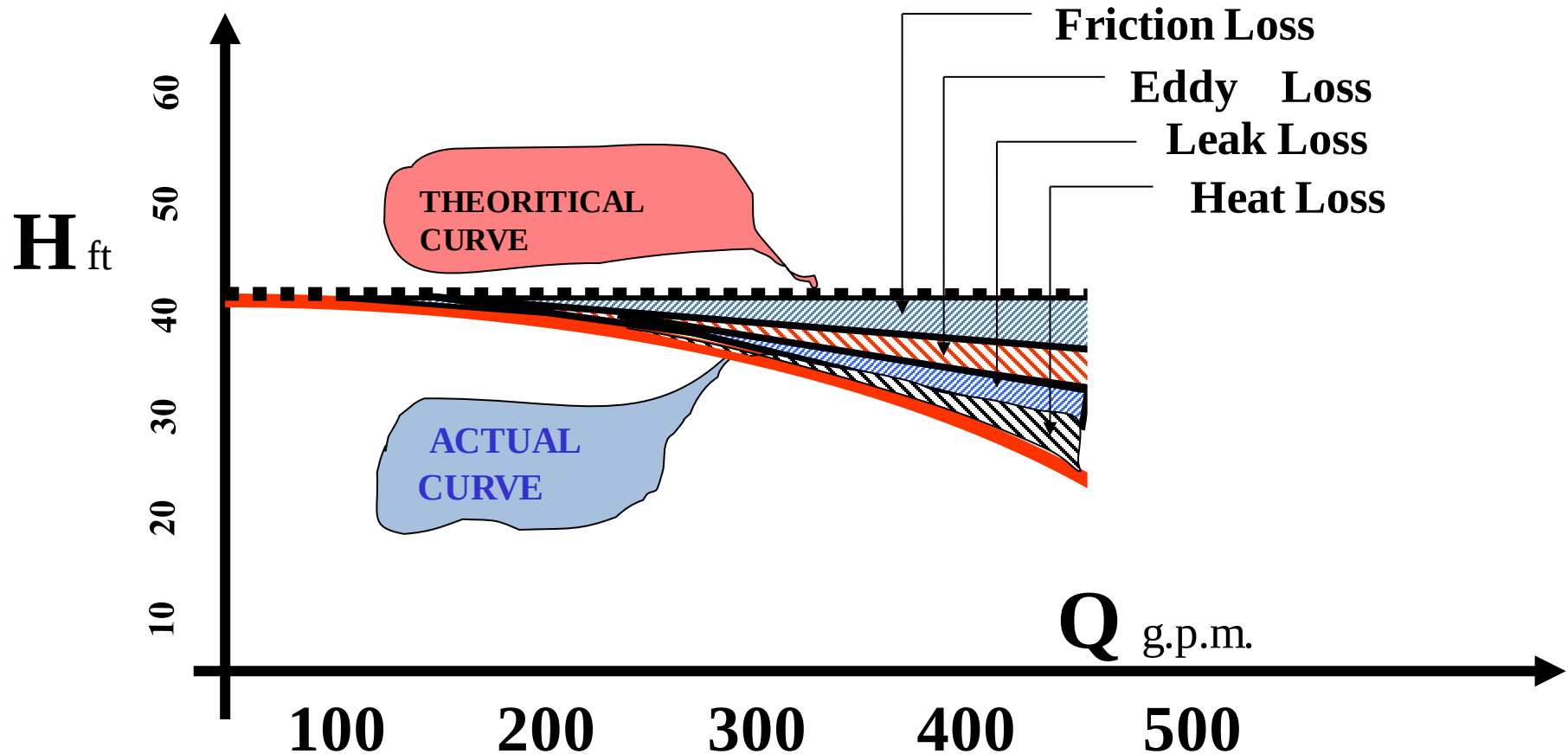


ATMOSPHERIC
PRESSURE





Centrifugal Pumps Losses





WHAT IS VAPOR PRESSURE

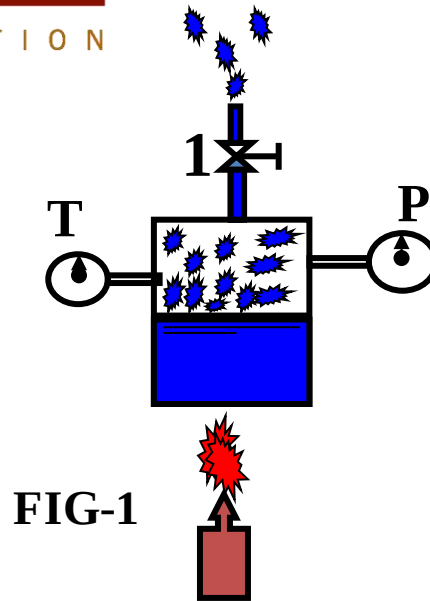


FIG-1

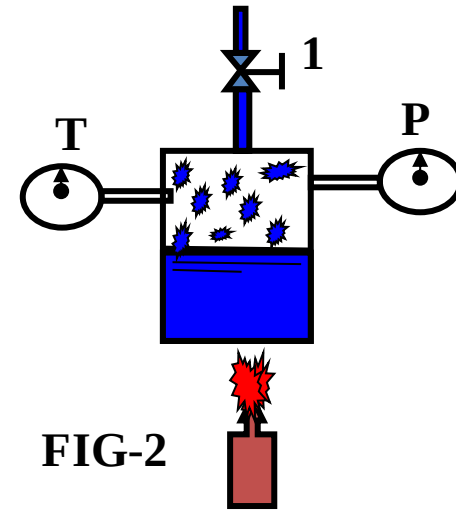
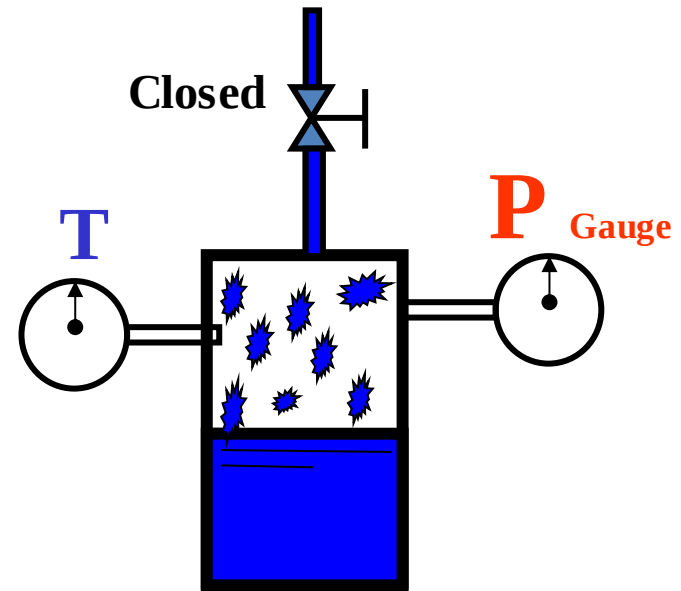
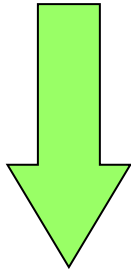


FIG-2

- 1- Heat up a little of water in a pot up to boiling point 100 C (valve 1 is opened)
- 2- Take off the heating source, simultaneously close valve 1.



Cool Down



3- During cooling down, Start to record the **P Gauge** relevant to **Temp.**

4- Apply Absolute pressure Equation .

$$P_{\text{Absolute}} = P_{\text{gauge}} + 1$$

(bar)



$$V_{\text{apor}} P_{\text{ressure}} = P_{\text{Gauge}} + 1$$

(bar) absolute

5- Record the Absolute Liquid vapor pressure.

Temp C	100	95	90	80	70	15
P Gauge	0	- 0.1	- 0.3	- 0.5	- 0.7	- 0.98
Vapor Pressure	1	0.9	0.7	0.5	0.3	0.02

Crude oil level is **8 feet** above center line
of a pump , Vessel pressure is **Atmospheric**

Vp is **4 psia** Sp gr. is **0.8**

Friction loss : **12 ft** of liquid

Atmospheric pressure is **14.7 psia** (Neglect velocity head)

Solution

$$\begin{aligned}
 \text{NPSHA} &= Z + \frac{\{ (P_{sv} + P_a) - V_p \} 2.31}{\text{Sp.gr}} - h_L \\
 &= 8 + \frac{\{ (0 + 14.7) - 4 \} 2.31}{0.8} - 12 \\
 &= 8 + 31 - 12 \\
 &= 27 \text{ (ft)}
 \end{aligned}$$

Compare with NPSHR



PUMPS AFFINITY LAWS

IF THE PUMP SPEED CHANGES FROM

N_1 TO N_2

THE FLOW RATE WILL BE

$$\frac{Q_2}{Q_1} = \left[\frac{N_2}{N_1} \right]$$

THE DISCH PRESS. WILL BE

$$\frac{P_2}{P_1} = \left[\frac{N_2}{N_1} \right]^2$$

THE HORSEPOWER WILL BE

$$\frac{HP_2}{HP_1} = \left[\frac{N_2}{N_1} \right]^3$$



Exercise

- Find the flow rate, head and power for a centrifugal pump that has increased its speed $N_1 = 1000 \text{ rpm}$ TO $N_2 = 1100 \text{ rpm}$
- Given data:

$$HP_1 = \underline{123 \text{ kW}}$$

$$H_1 = \underline{100 \text{ m}}$$

$$Q_1 = \underline{1 \text{ m}^3/\text{s}}$$

$$Q_2 = \frac{n_2}{n_1} \cdot Q_1 = \frac{1100}{1000} \cdot 1 = \underline{\underline{1,1 \text{ m}^3/\text{s}}}$$

$$H_2 = \left(\frac{n_2}{n_1} \right)^2 \cdot H_1 = \left(\frac{1100}{1000} \right)^2 \cdot 100 = \underline{\underline{121 \text{ m}}}$$

$$HP_2 = \left(\frac{n_2}{n_1} \right)^3 \cdot HP_1 = \left(\frac{1100}{1000} \right)^3 \cdot 123 = \underline{\underline{164 \text{ kW}}}$$



PUMPS AFFINITY LAWS

Initial N_1 OR D_1	1000
New N_2 OR D_2	1500

Initial Q_1 Flow rate	120
Initial P_1 Pressure	10
Initial HP_1 Horse power	100

New Q_2 Flow rate	180
New P_2 Pressure	23
New HP_2 Horse power	338

N = PUMP RPM

D = PUMP IMPELLER DIAMETER



THE AMERICAN
UNIVERSITY IN CAIRO

SCHOOL OF
BUSINESS

EXECUTIVE EDUCATION

ROTARY PUMPS



Rotary Pumps

- Rotary pumps provide constant flow over varying pressures
 - Flow is directly proportional to speed.
- Rotary pumps can handle solids (e.g., cherries and olives), slurries, and a variety of liquids. If wetted, they offer self-priming performance.
- They also offer continuous and intermittent reversible flows and can operate dry for brief periods of time.

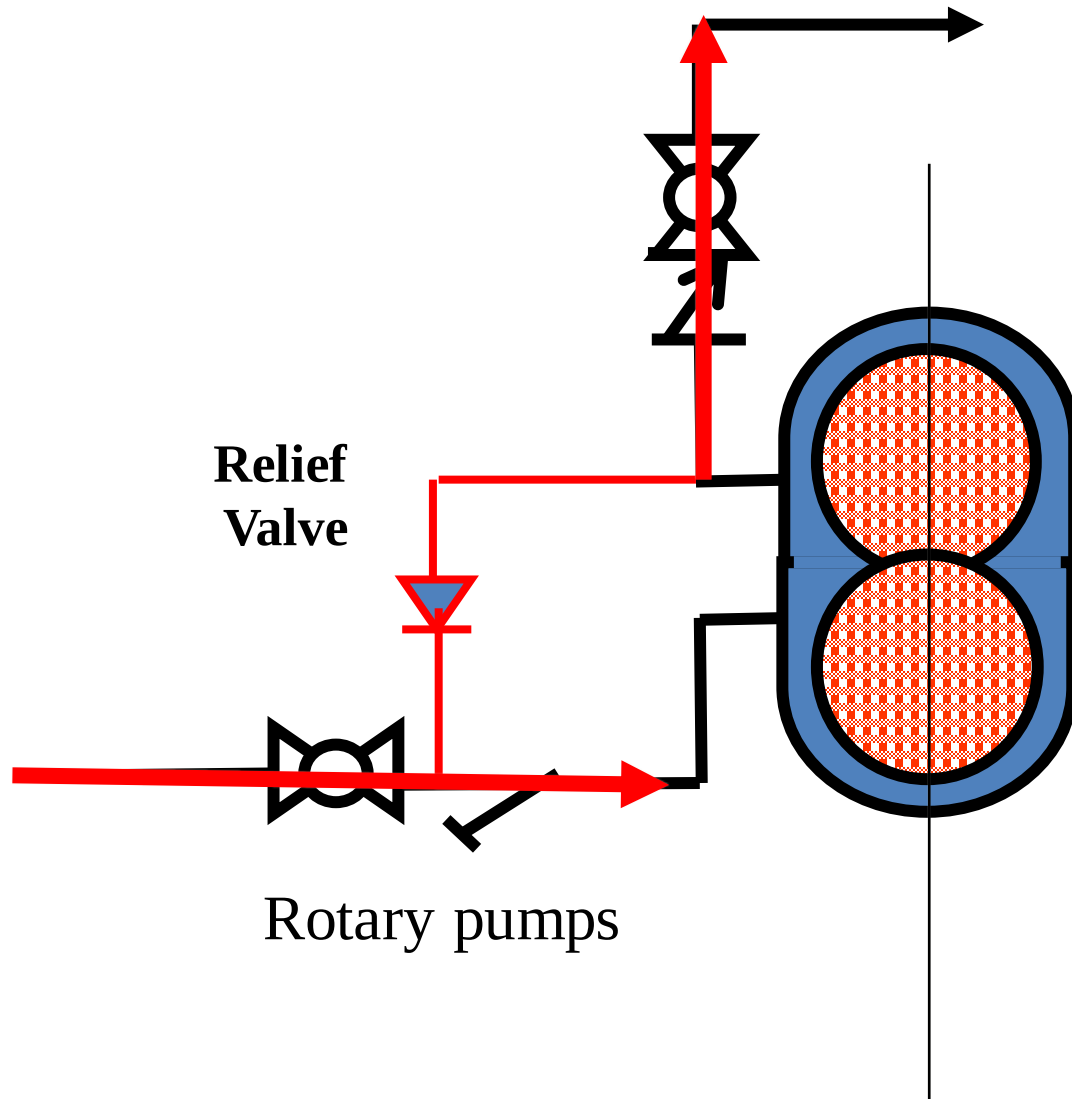


- Flow is relatively independent of changes in process pressure, too, so output is constant and continuous.
- As a general rule, rotary pumps require very little maintenance.
- Rotary pumps deliver high pressure liquid without the pulsations that occur in reciprocating pumps.
- Pressure relief should be installed in the discharge line before the discharge valve. If the discharge valve is inadvertently closed, excessively high pressures could be produced, which could cause damage to the pump or piping.



Basic Features

- **Gear pumps use close running clearances to:**
 - Seal suction from discharge pressure
 - Enable self-priming
 - Provide increasing volumetric efficiency with increasing viscosity





External Gear Pump

- External gear pumps are a popular pumping principle and are often used as lubrication pumps in machine tools, in fluid power transfer units, and as oil pumps in engines.
- External gear pumps can come in single or double (two sets of gears) pump configurations with spur, helical, and herringbone gears.
- External gear pumps have close tolerances and shaft support on both sides of the gears.
- This allows them to run to pressures beyond 200 BAR, making them well suited for use in hydraulics.

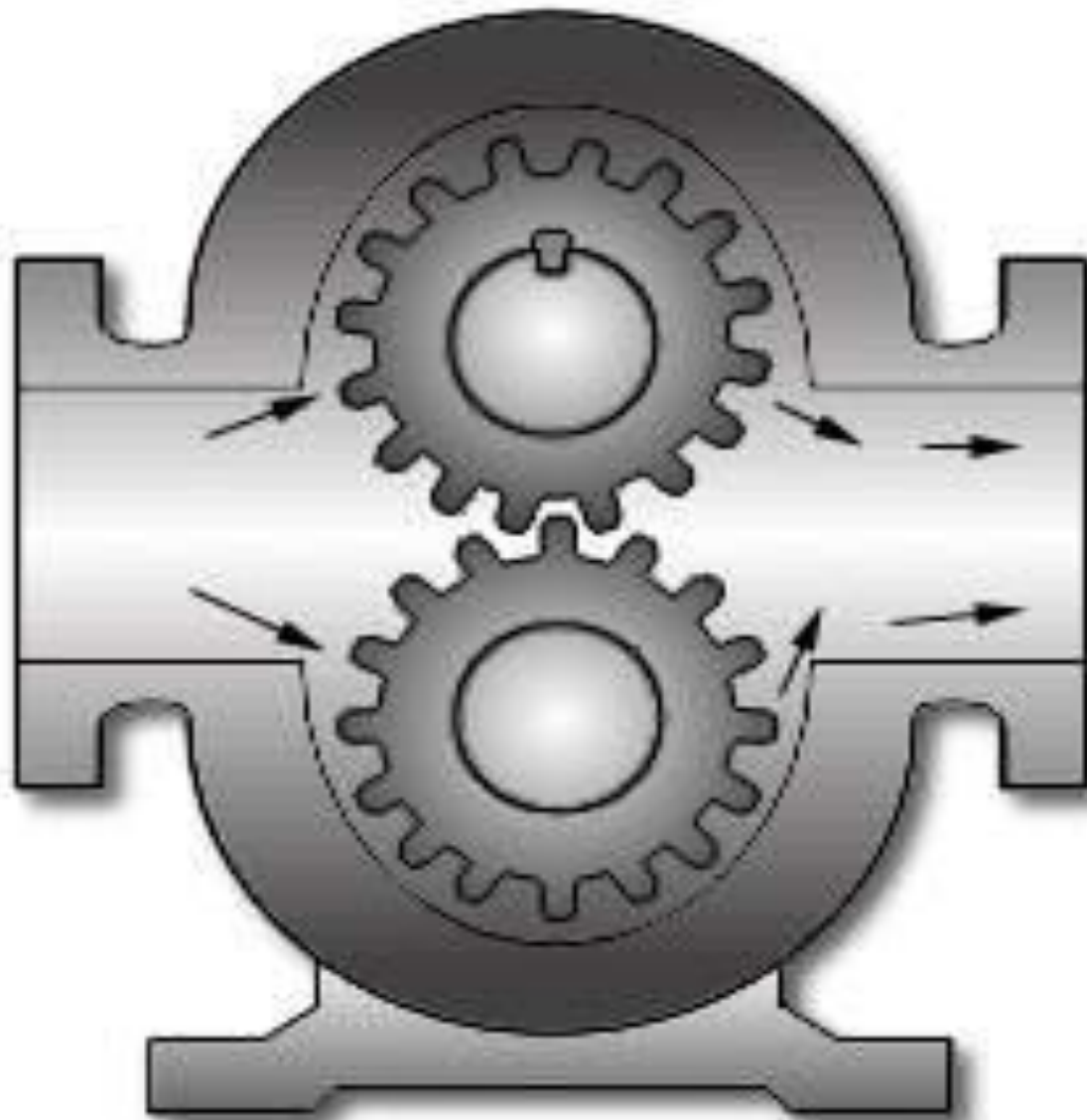


External Gear Pump

- With four bearings in the liquid and tight tolerances, they are not well suited to handling abrasive or extreme high temperature applications.
- Tighter internal clearances provide for a more reliable measure of liquid passing through a pump and for greater flow control.
- Because of this, external gear pumps are popular for precise transfer and metering applications involving polymers, fuels, and chemical additives.

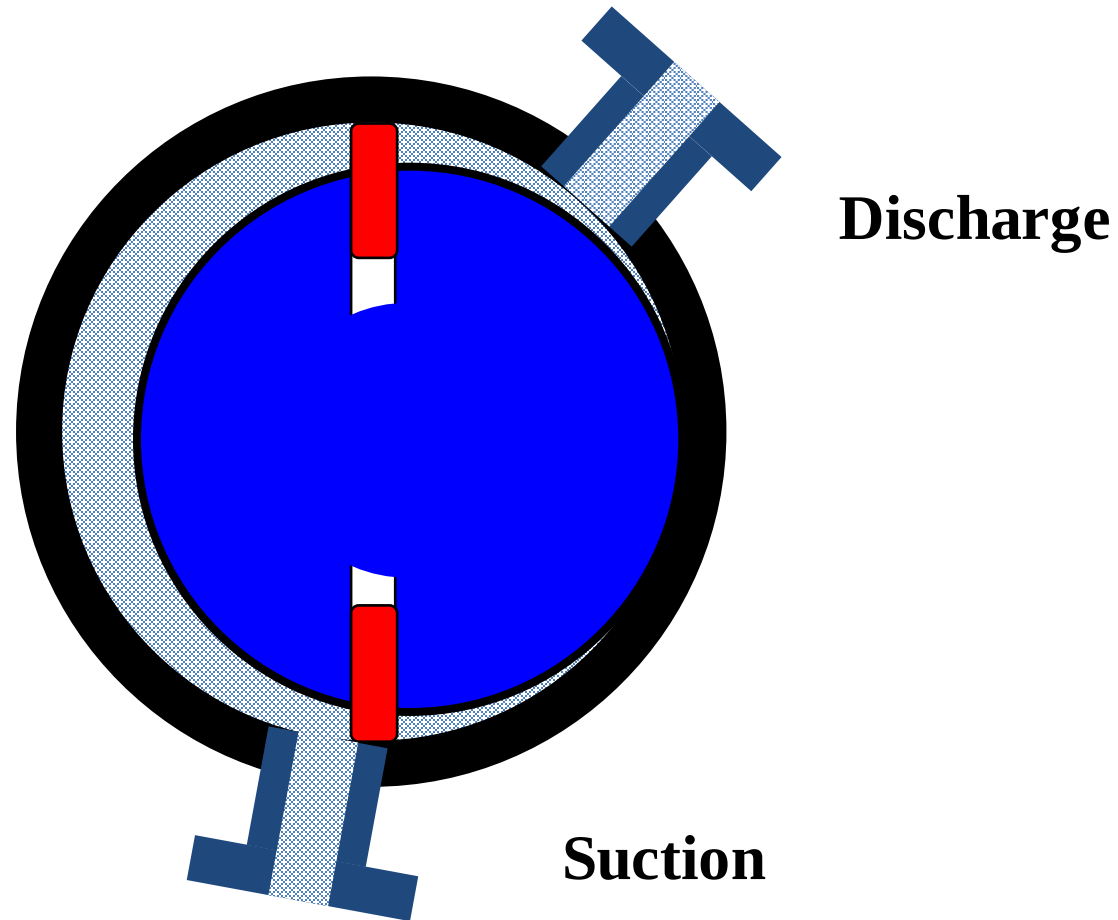


External Gear Pump



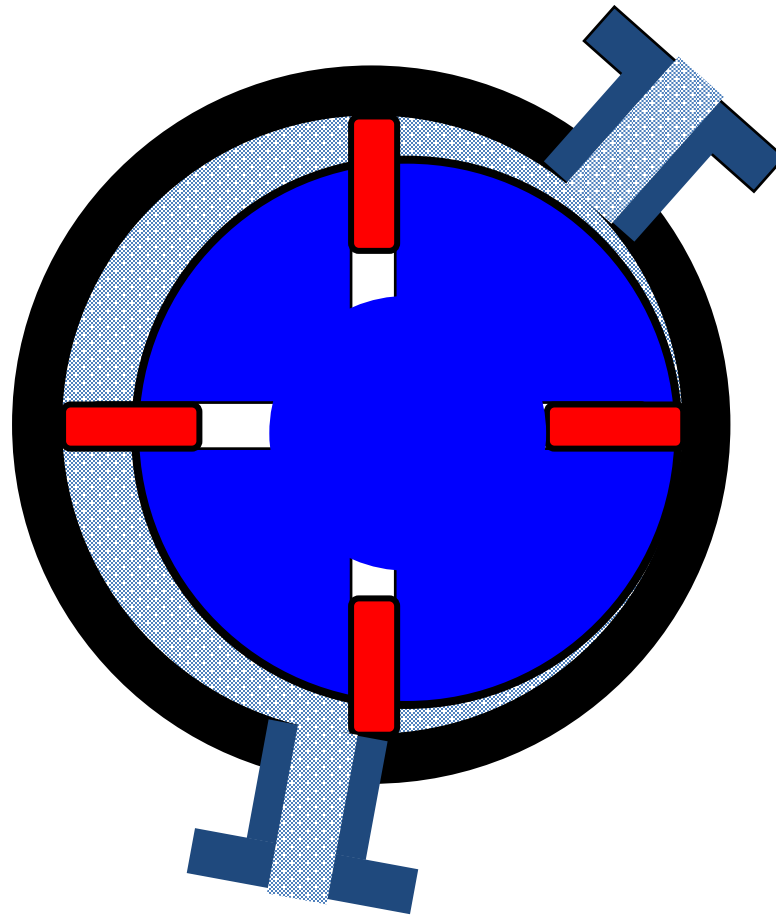


Rotary Vane Pump





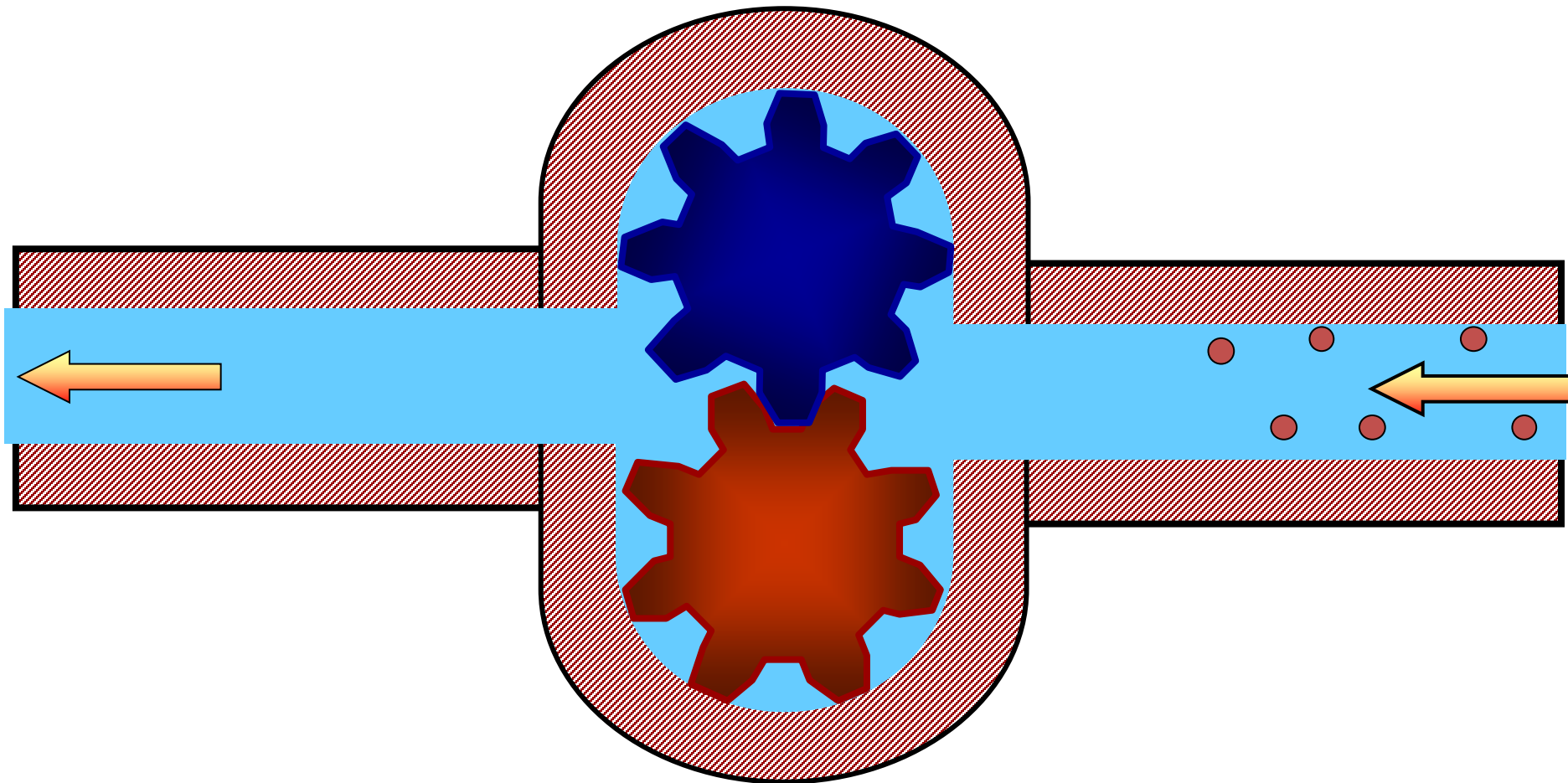
Rotary Vane Pump





ROTARY PUMPS

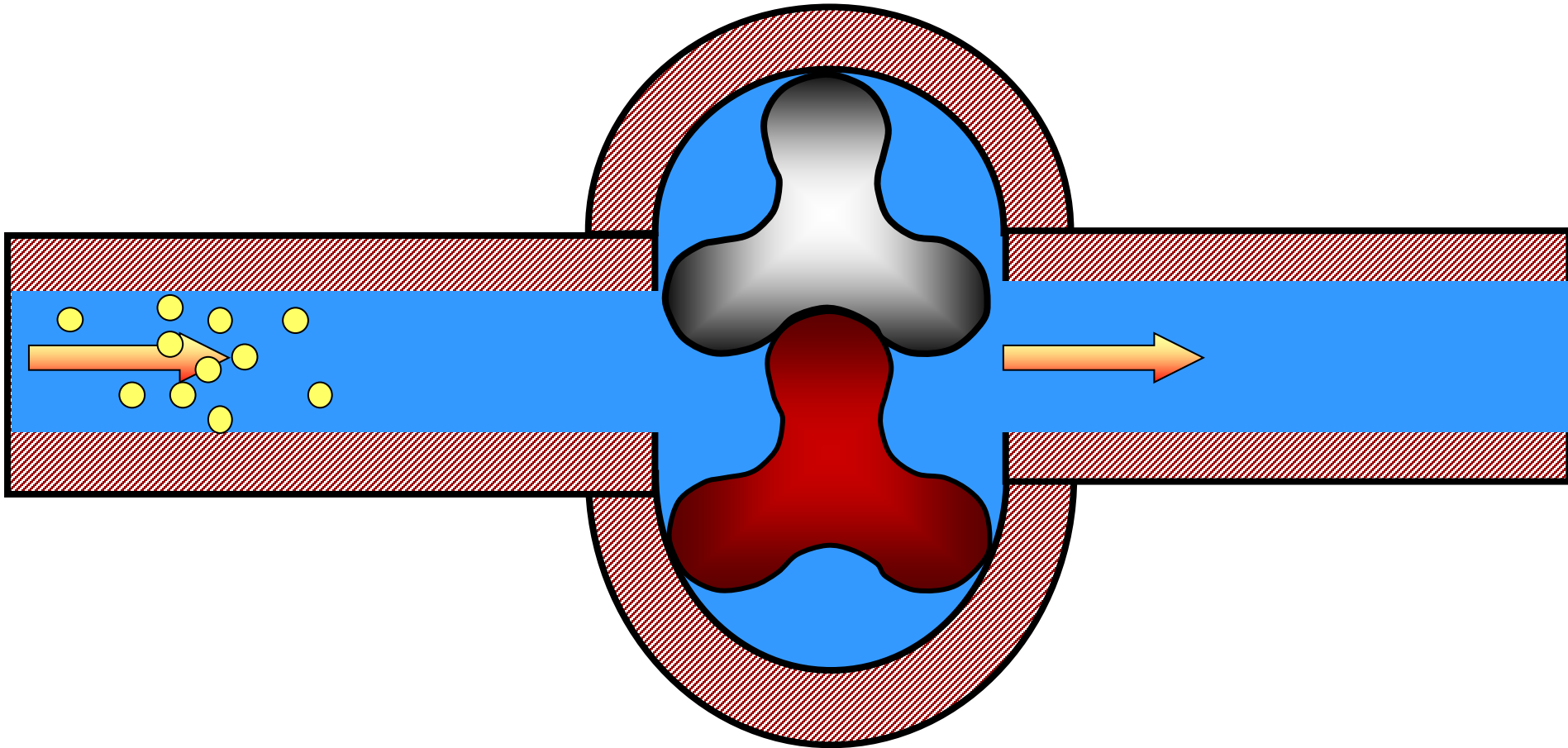
External Gear



THE FLUID IS TRAPPED BETWEEN ROTOR AND CASING

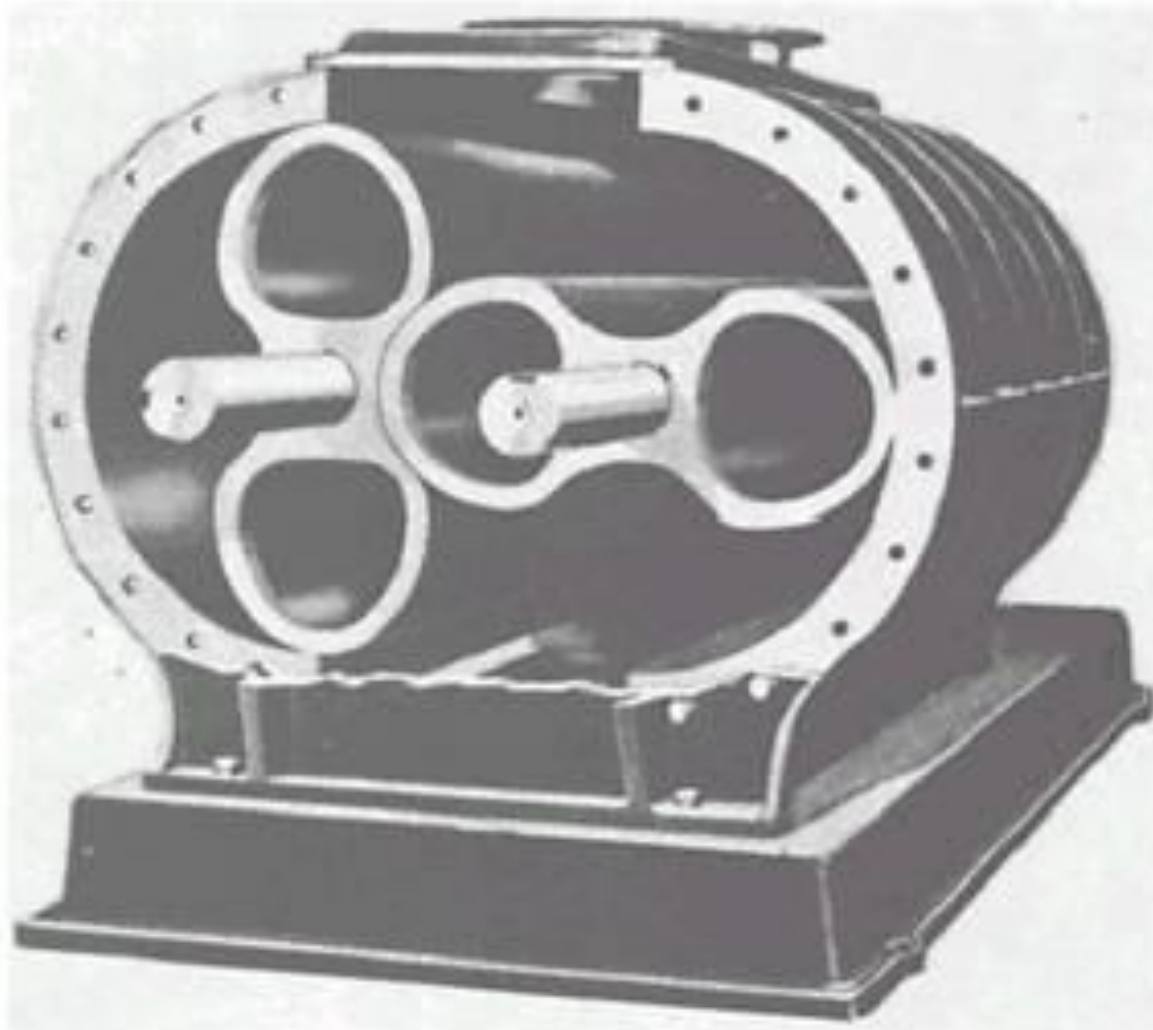


THREE LOBE PUMPS



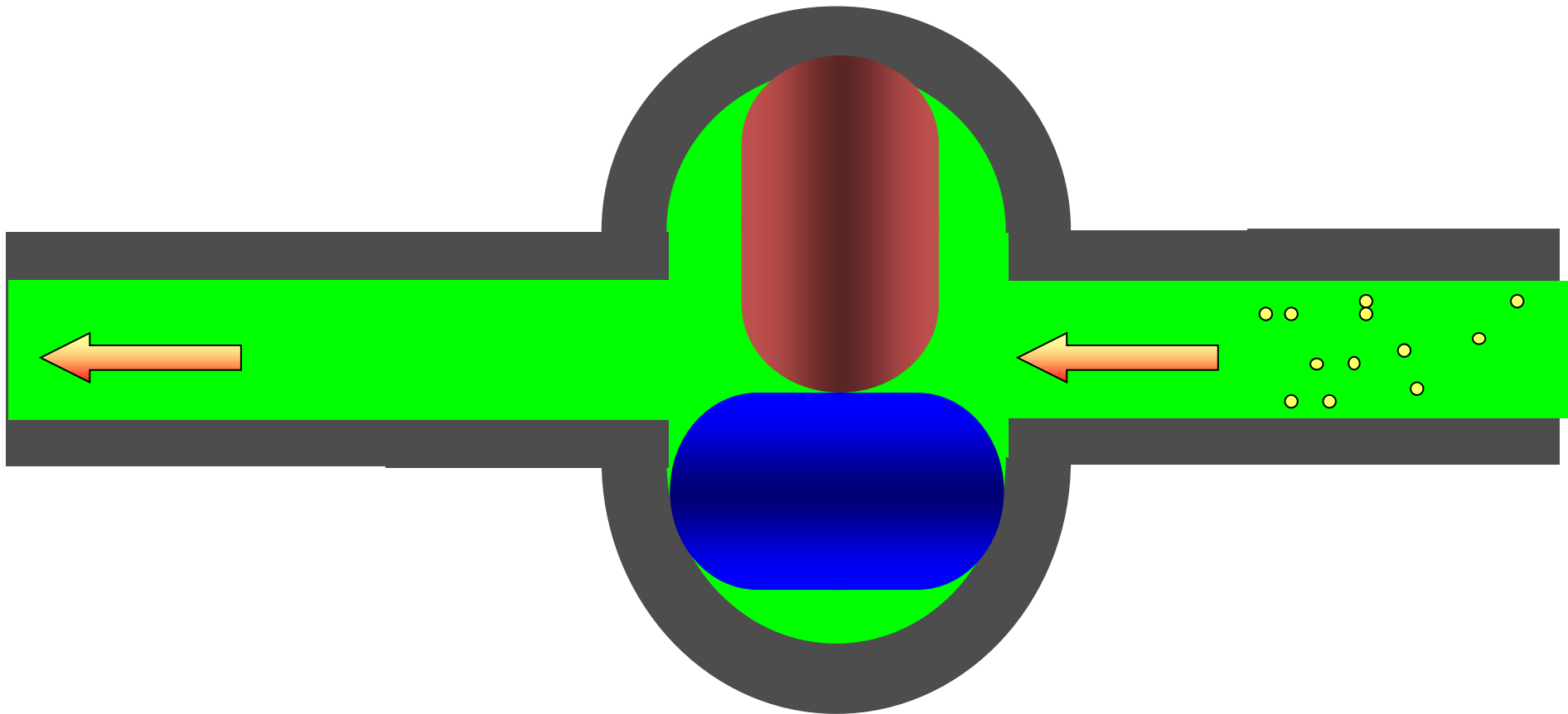


Rotary Twin-lobe Pump



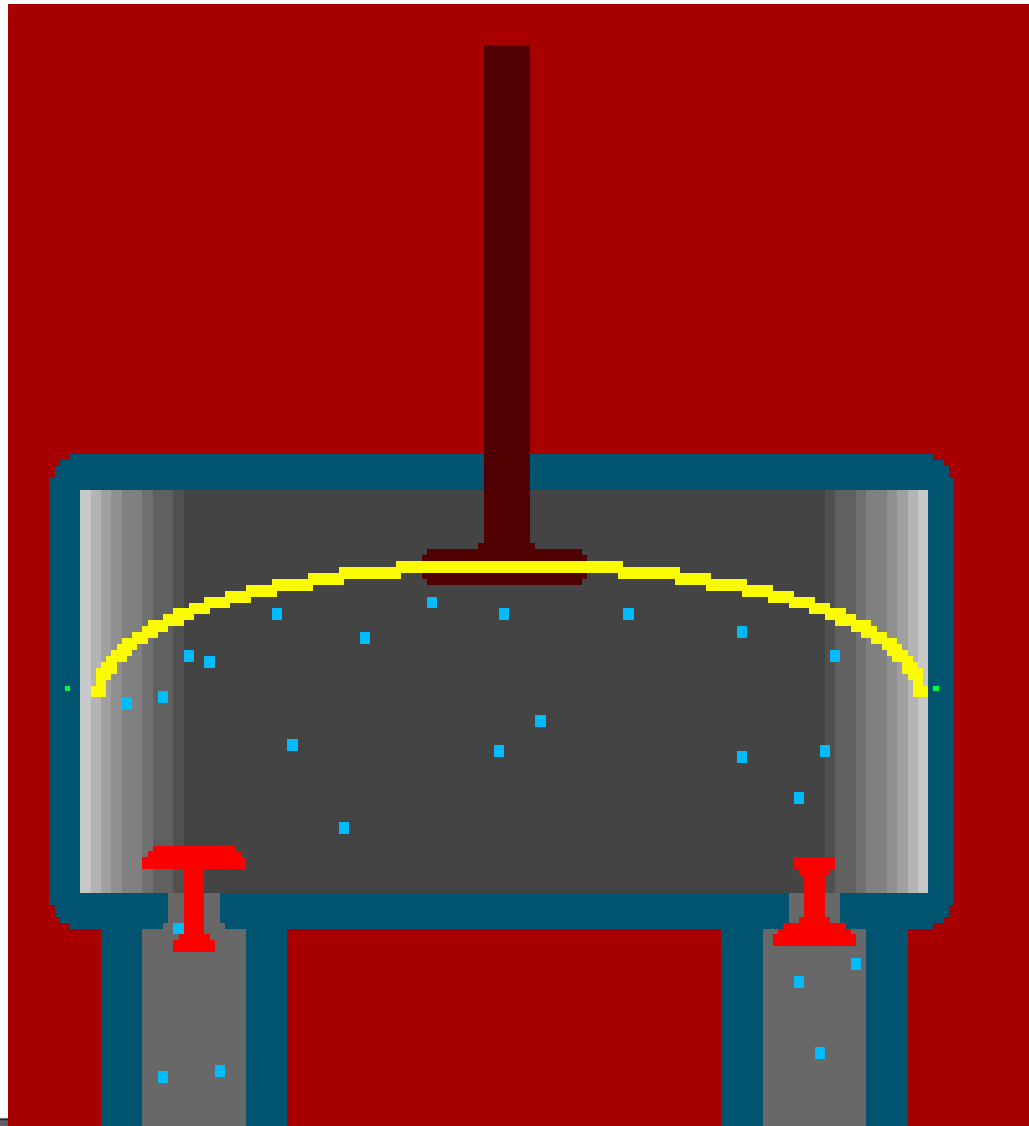


TWO LOBE PUMPS





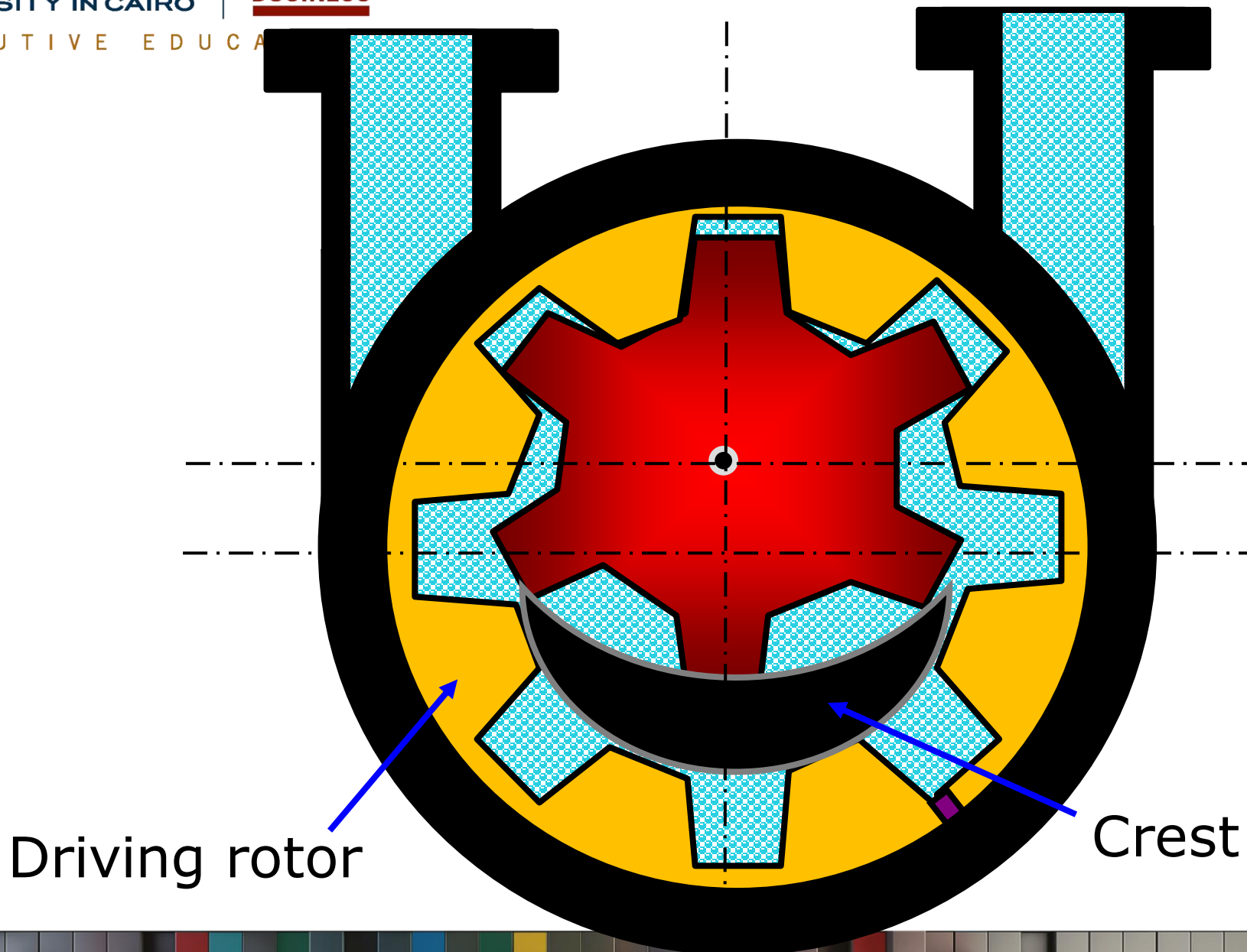
Diaphragm pump





Internal Gear

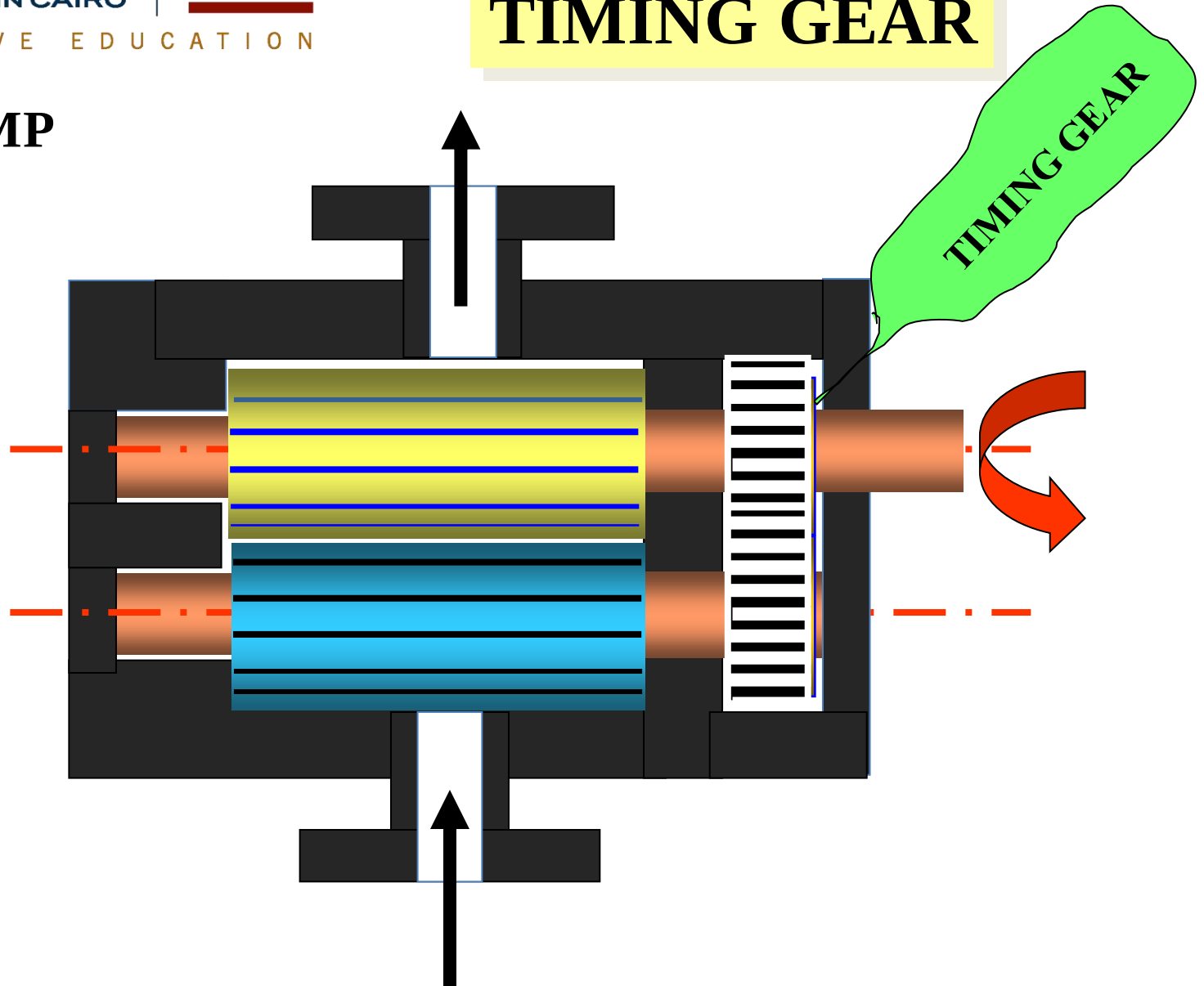






TIMING GEAR

GEAR PUMP



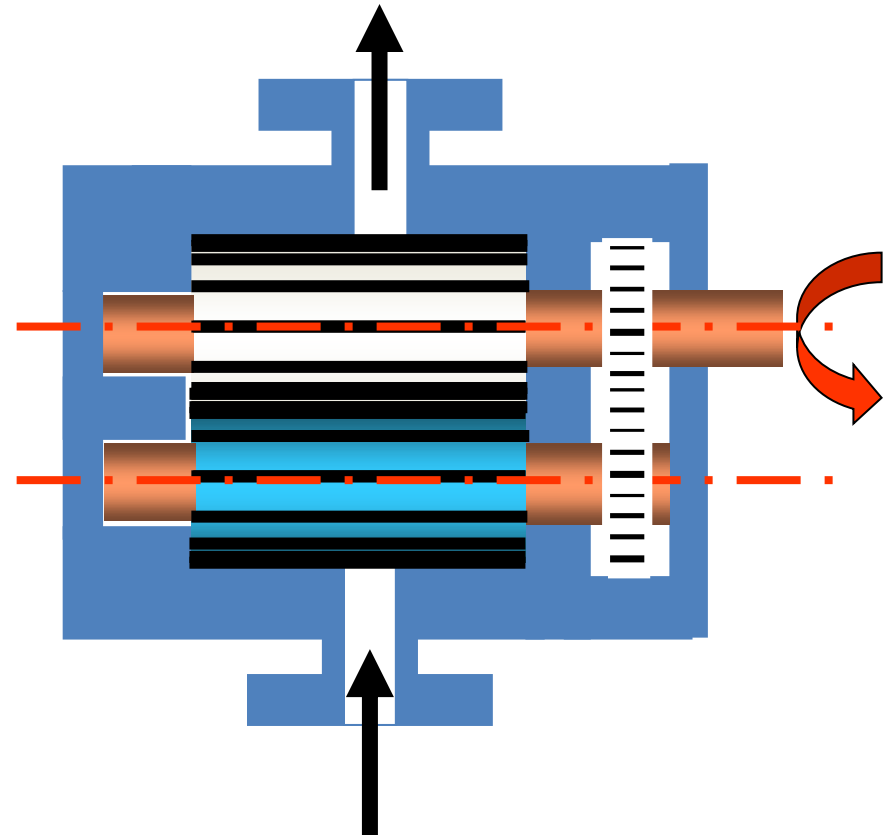


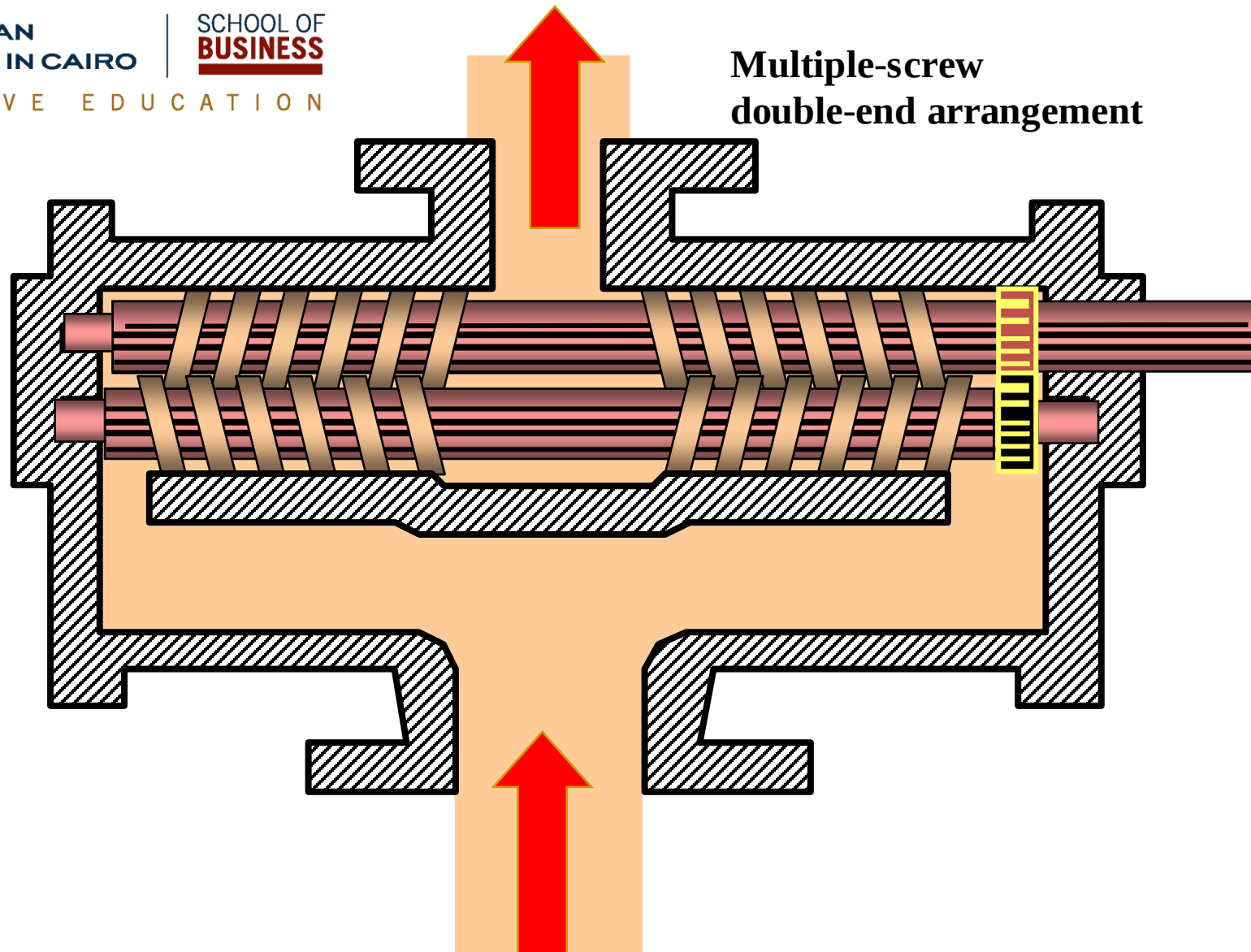
TIMING GEAR FUNCTION

**1- TRANSMIT MOTION
TO OTHER ROTOR**

**2- KEEPS NO CONTACT
BETWEEN ROTORS**

**3- PREVENT WEAR
BETWEEN ROTORS**







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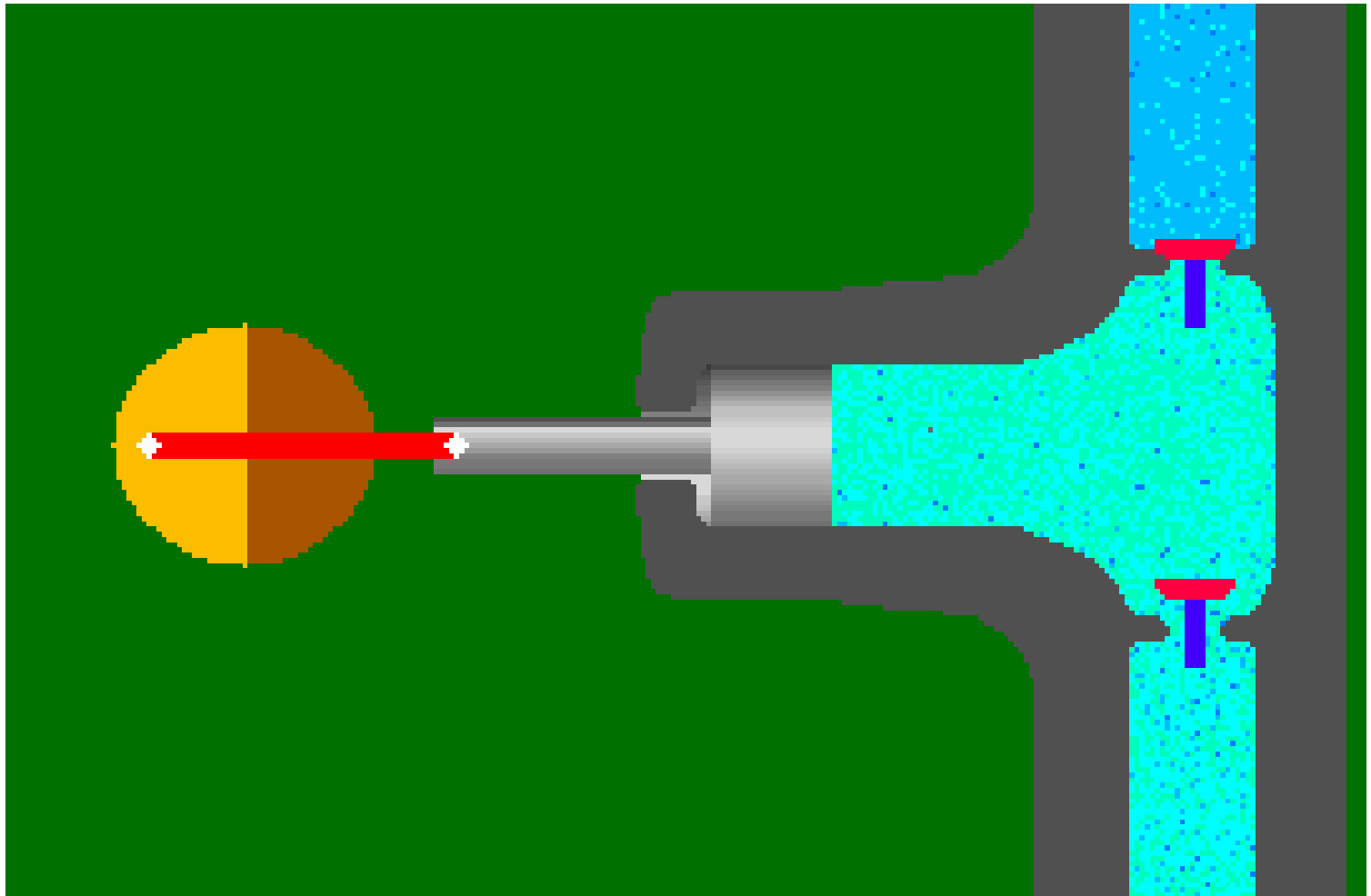
EXECUTIVE EDUCATION

RECIPROCATING PUMPS



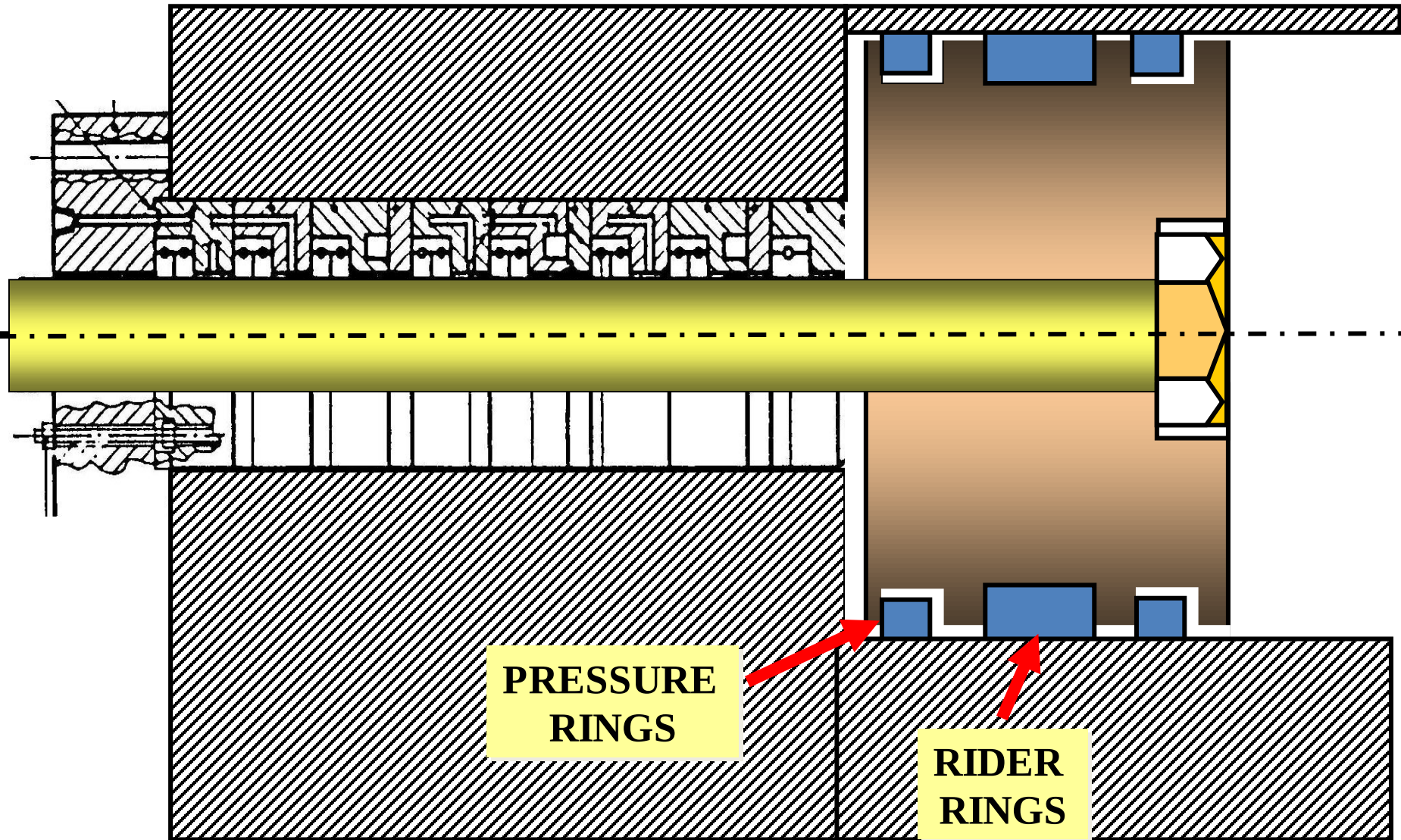
Reciprocating Pump

Piston





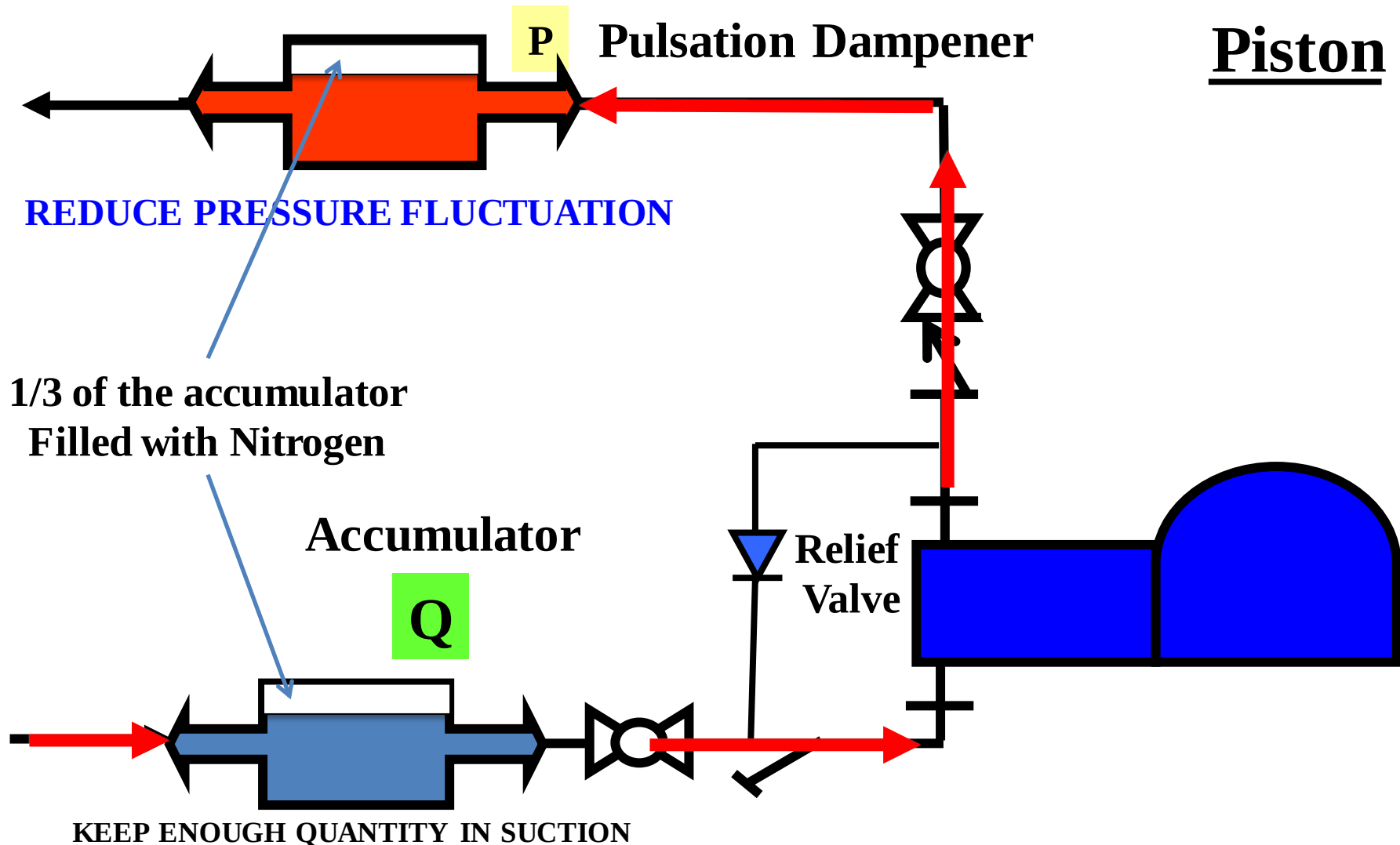
Reciprocating Pump





Reciprocating Pump

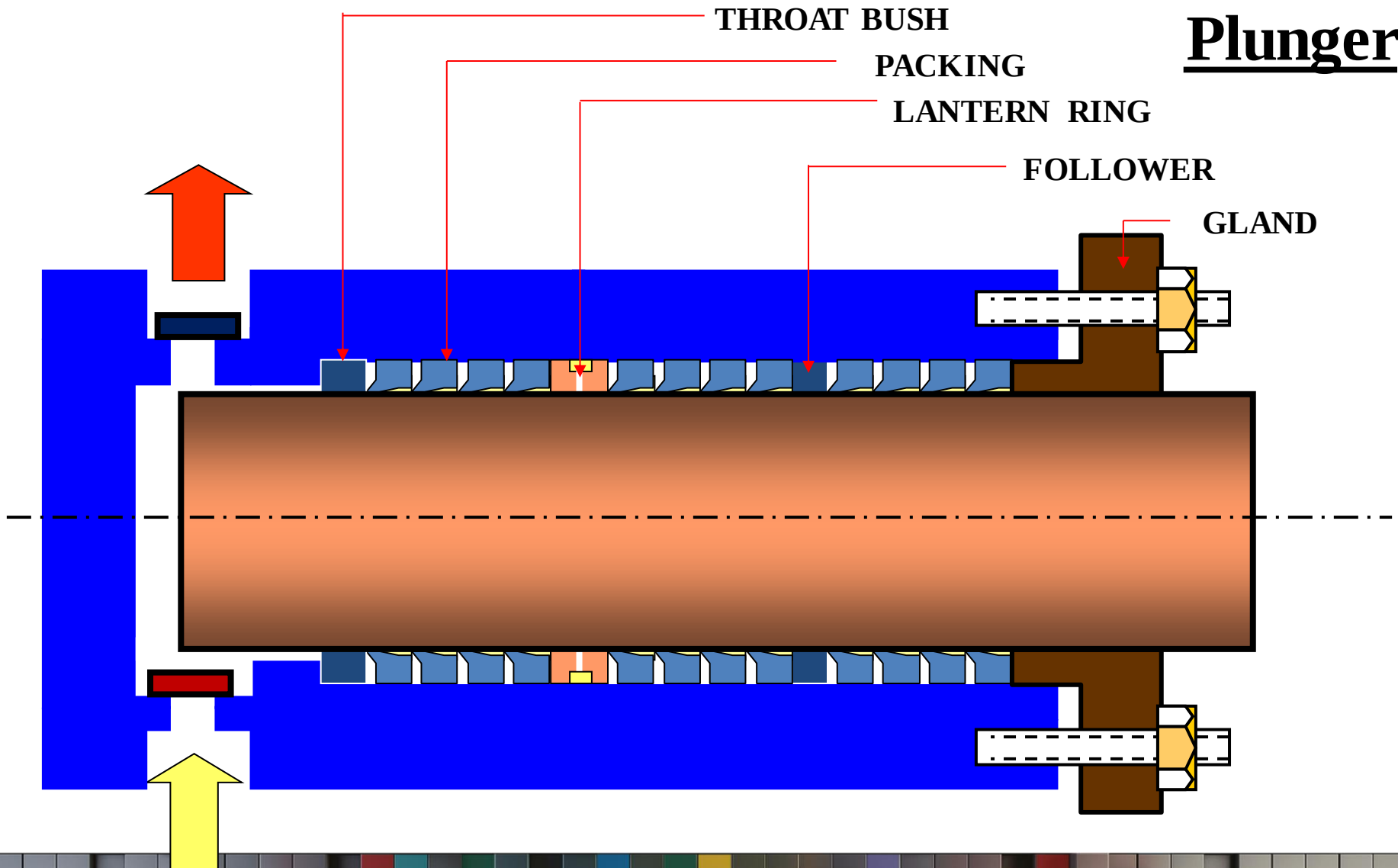
Piston





Reciprocating Pump

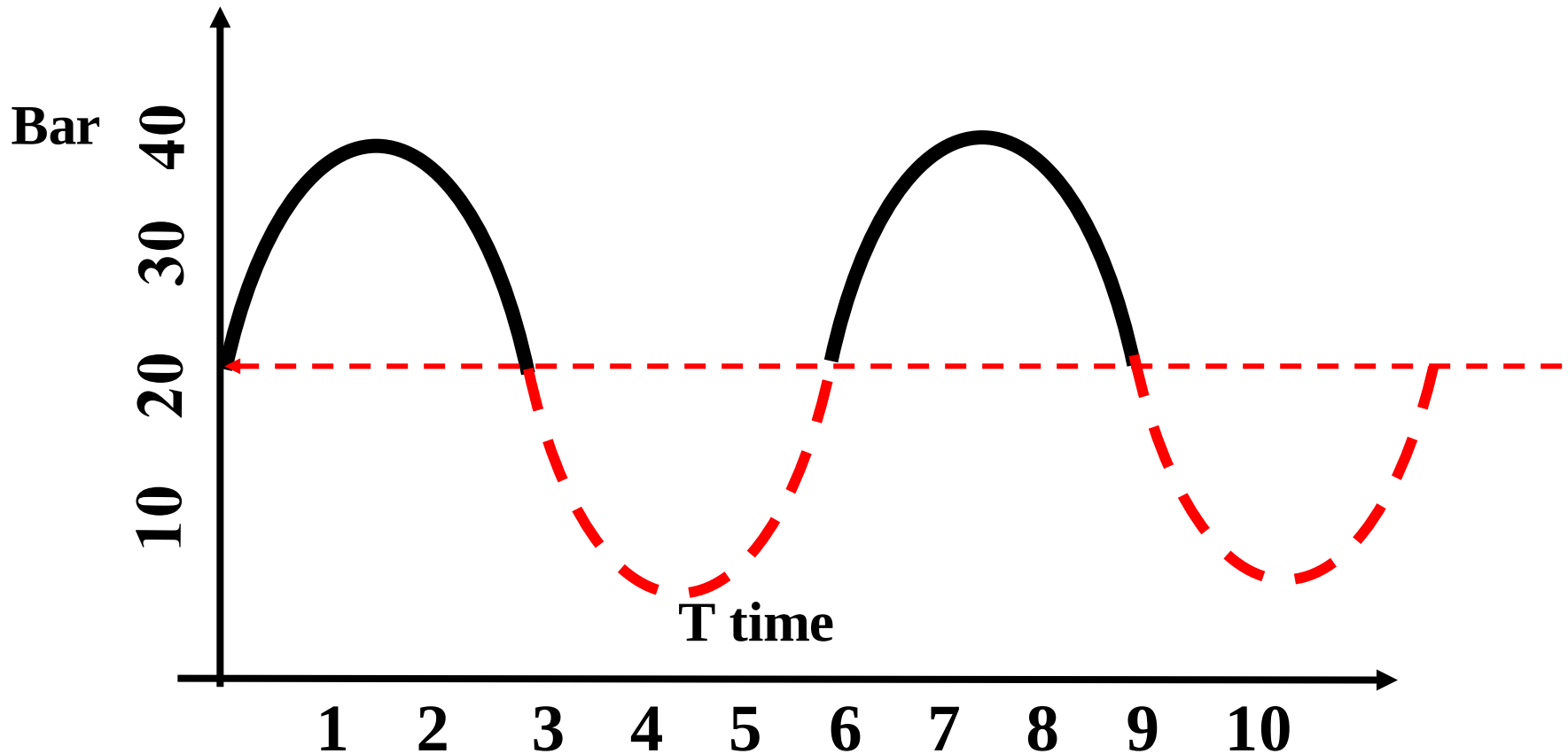
Plunger





Single Plunger Pump

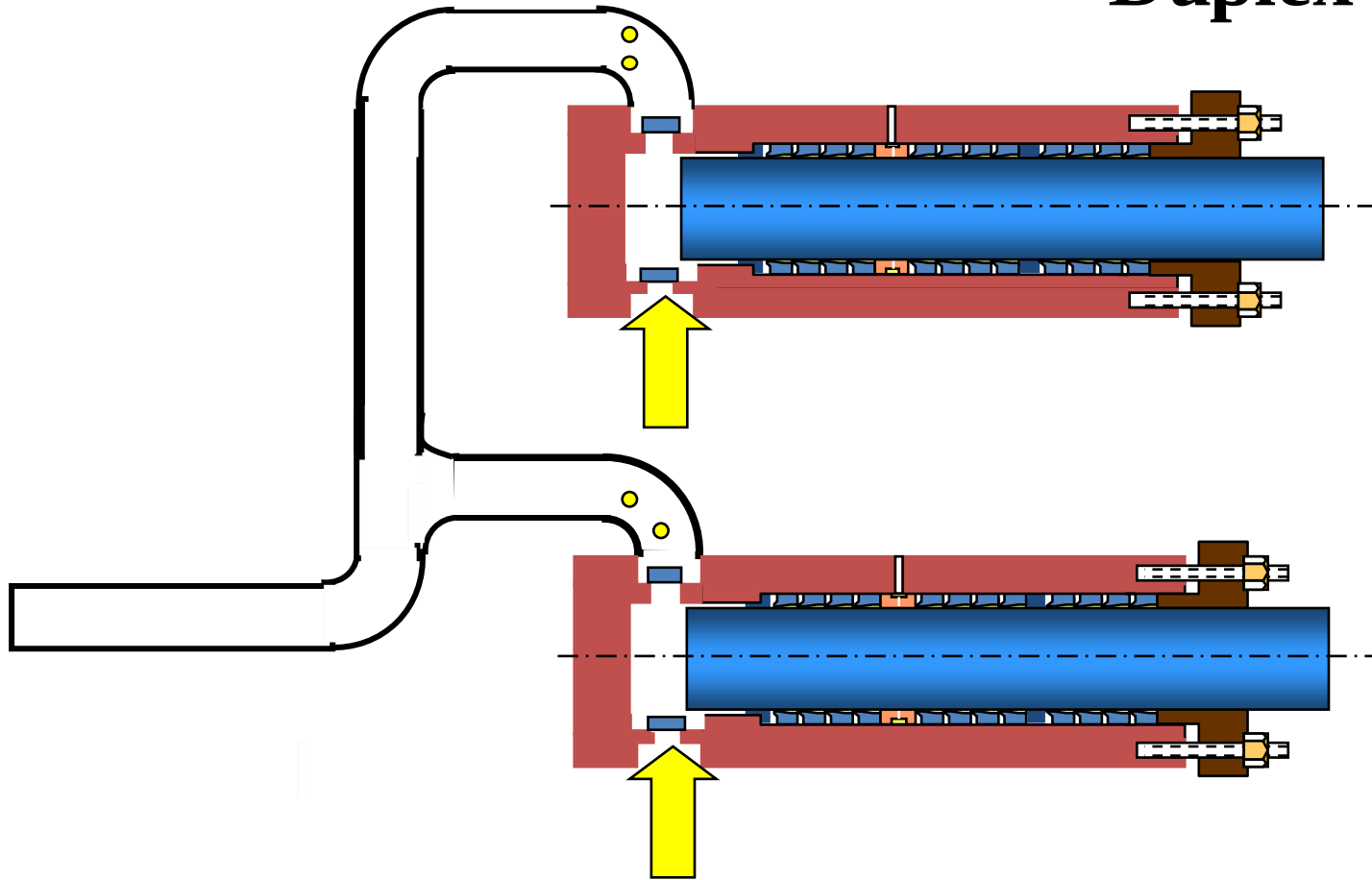
PRESSURE





Reciprocating Pump

Duplex Pump

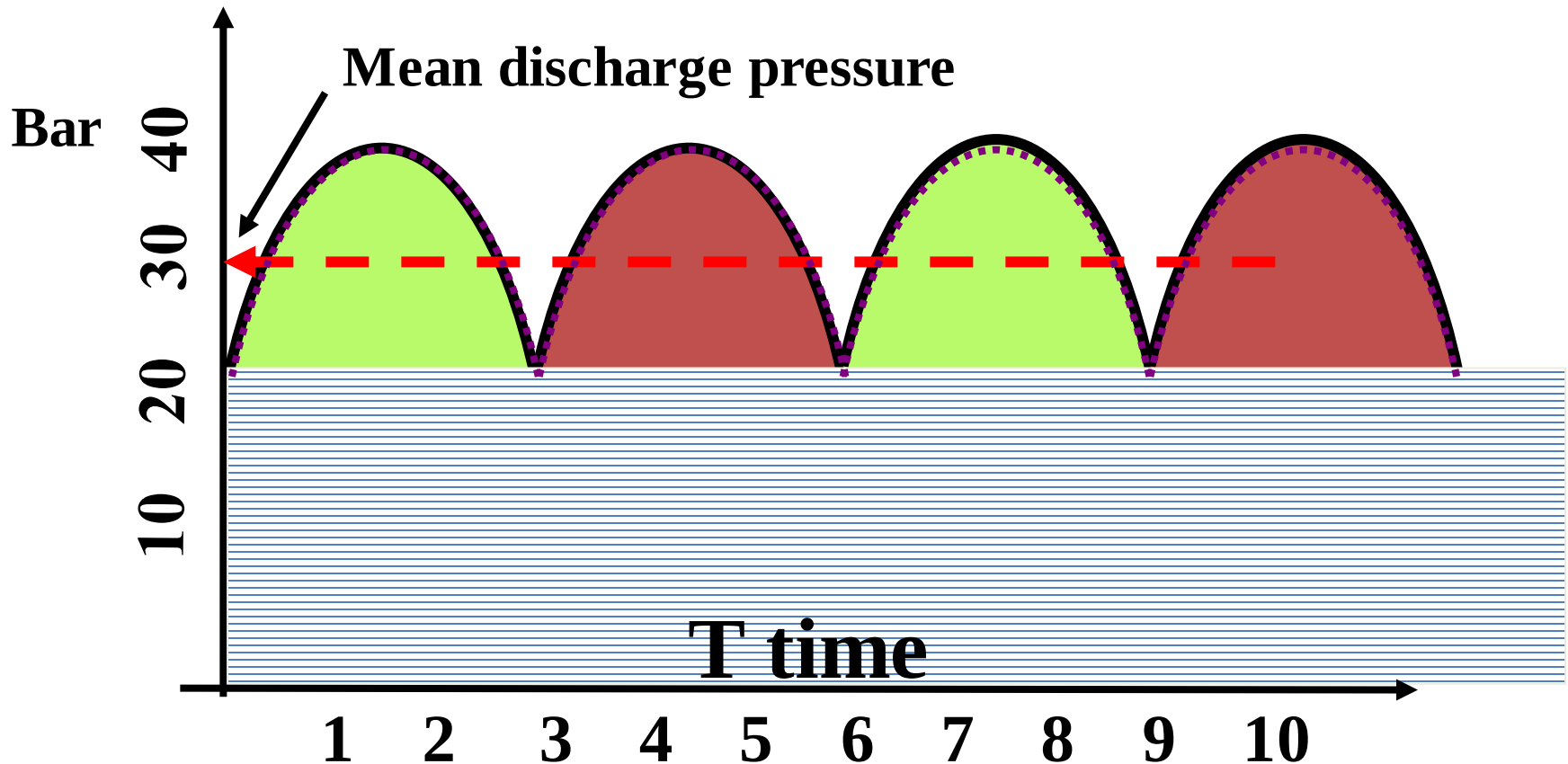




Reciprocating Pump

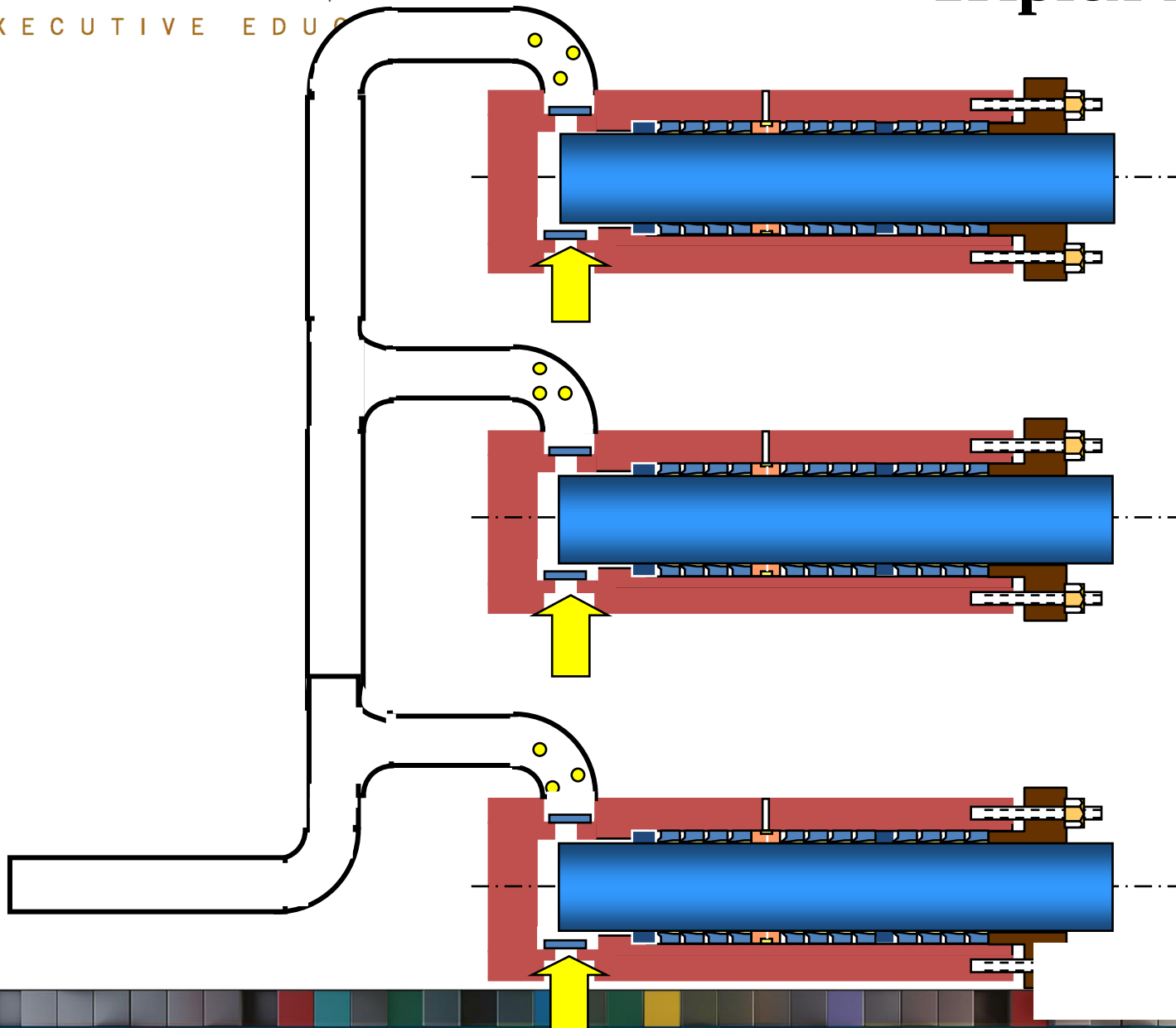
Duplex Pump

PRESSURE



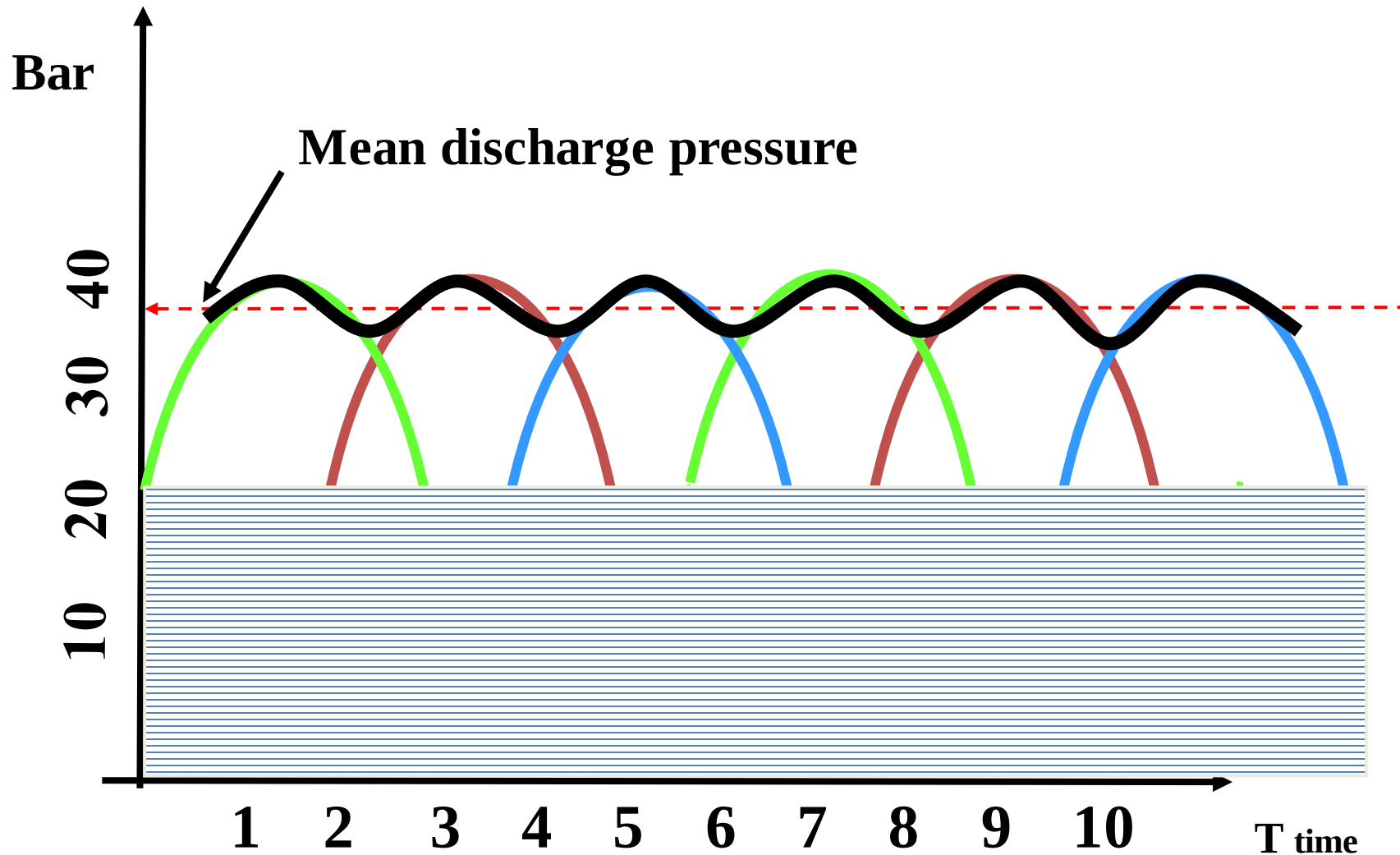


Triplex Pump



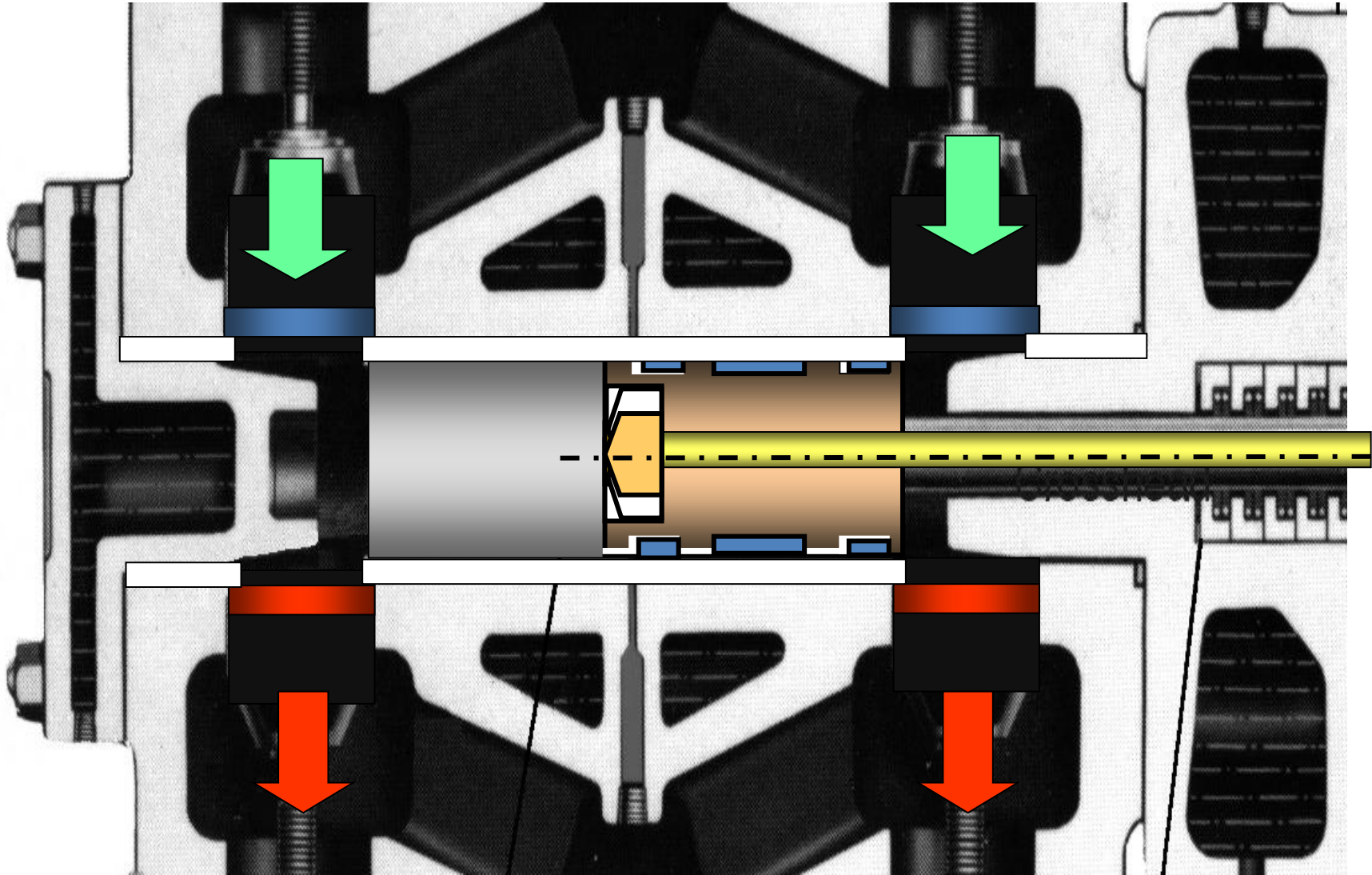


Triplex Pump





Reciprocating Pump





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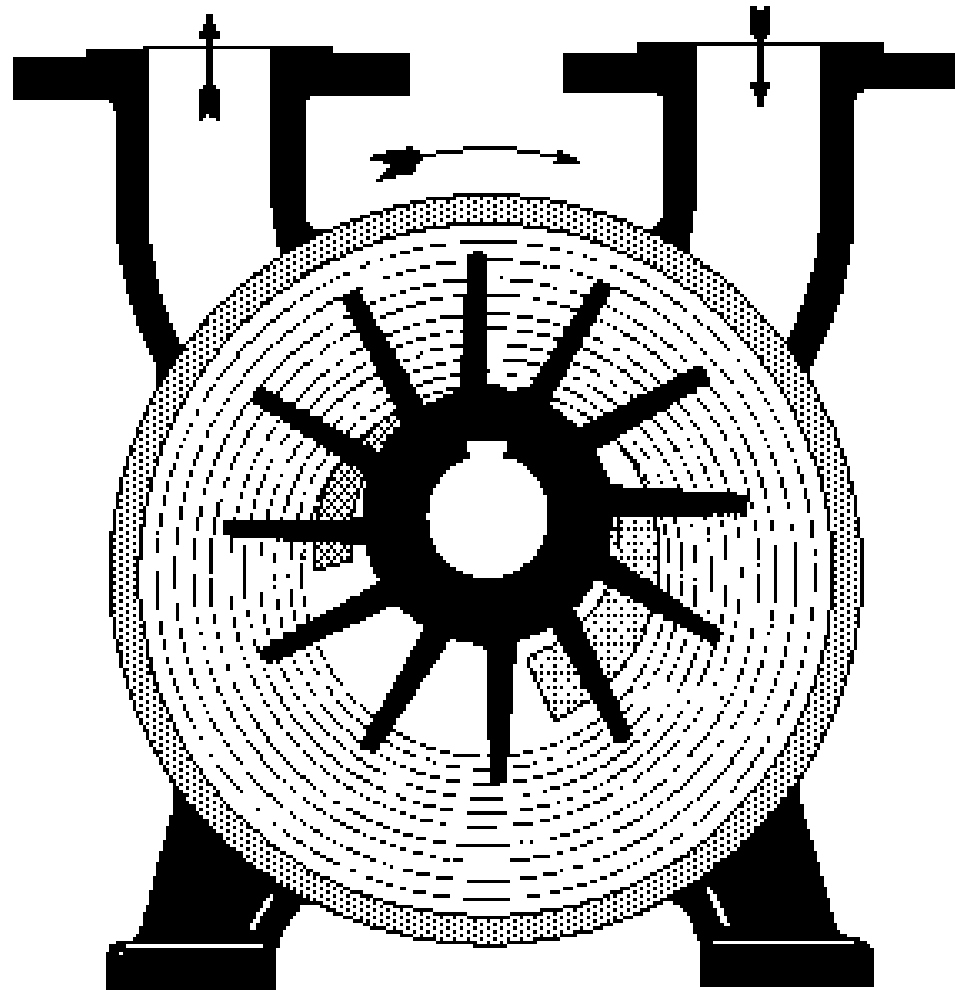
Vacuum Pump



Vacuum Pump

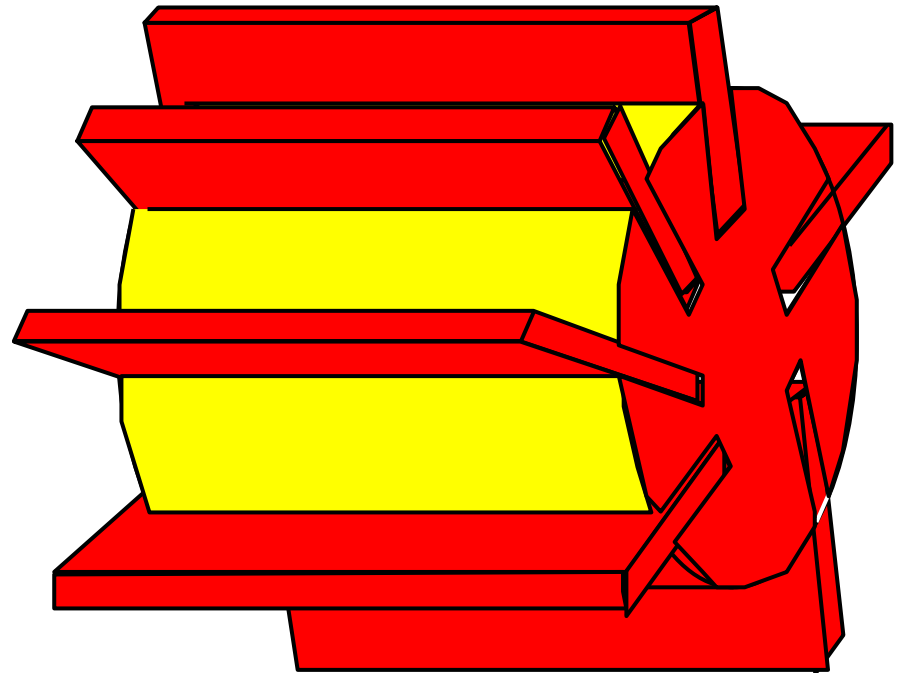
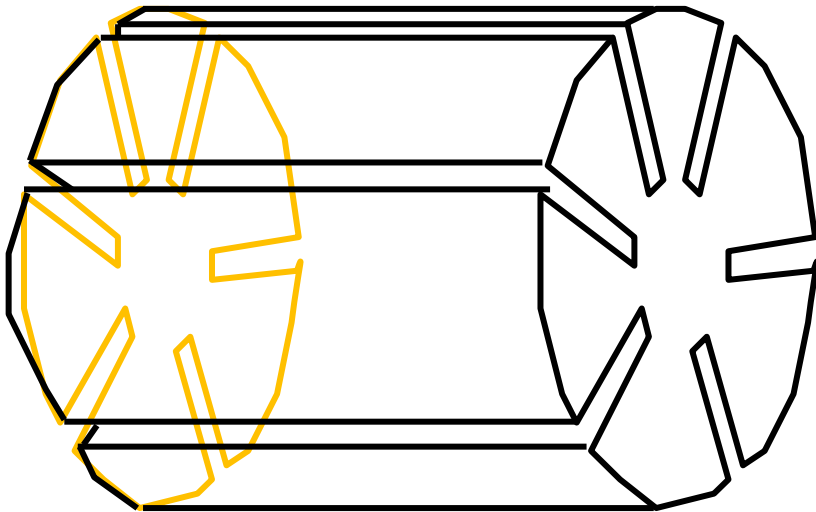
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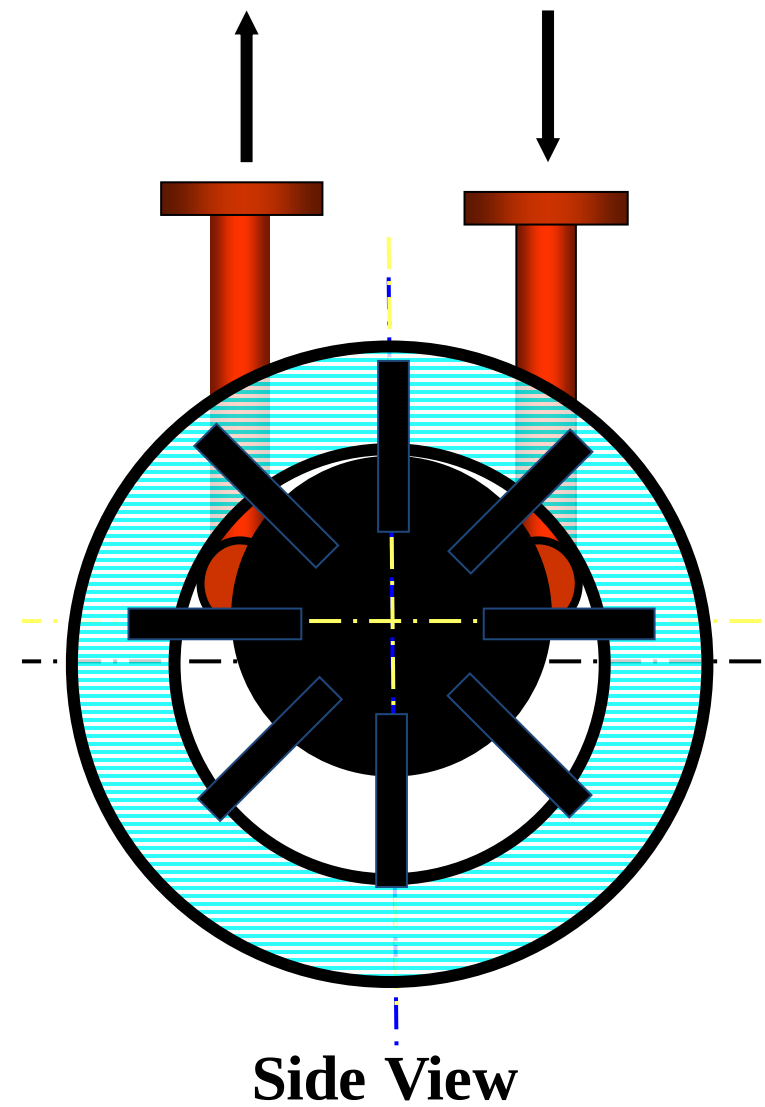
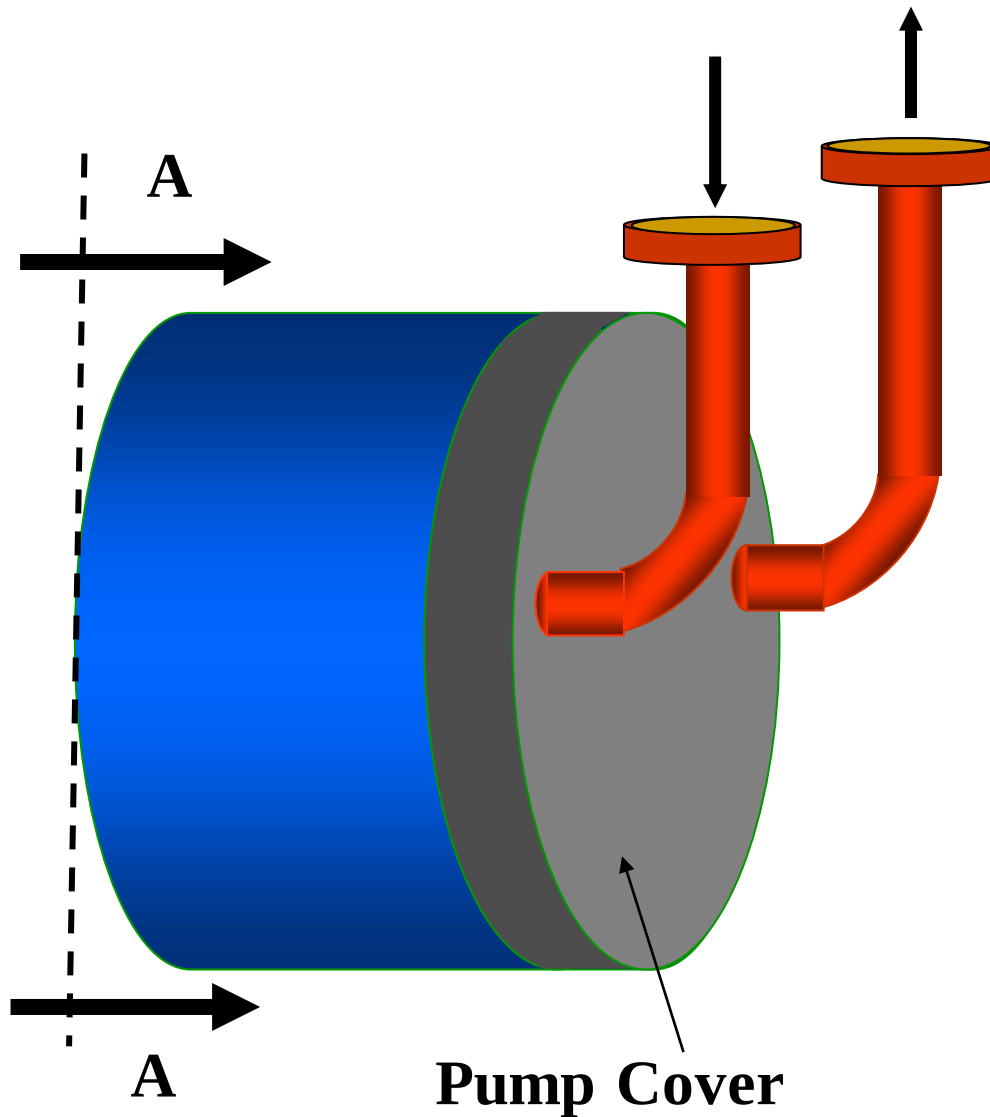
LIQUID RING
Compressors





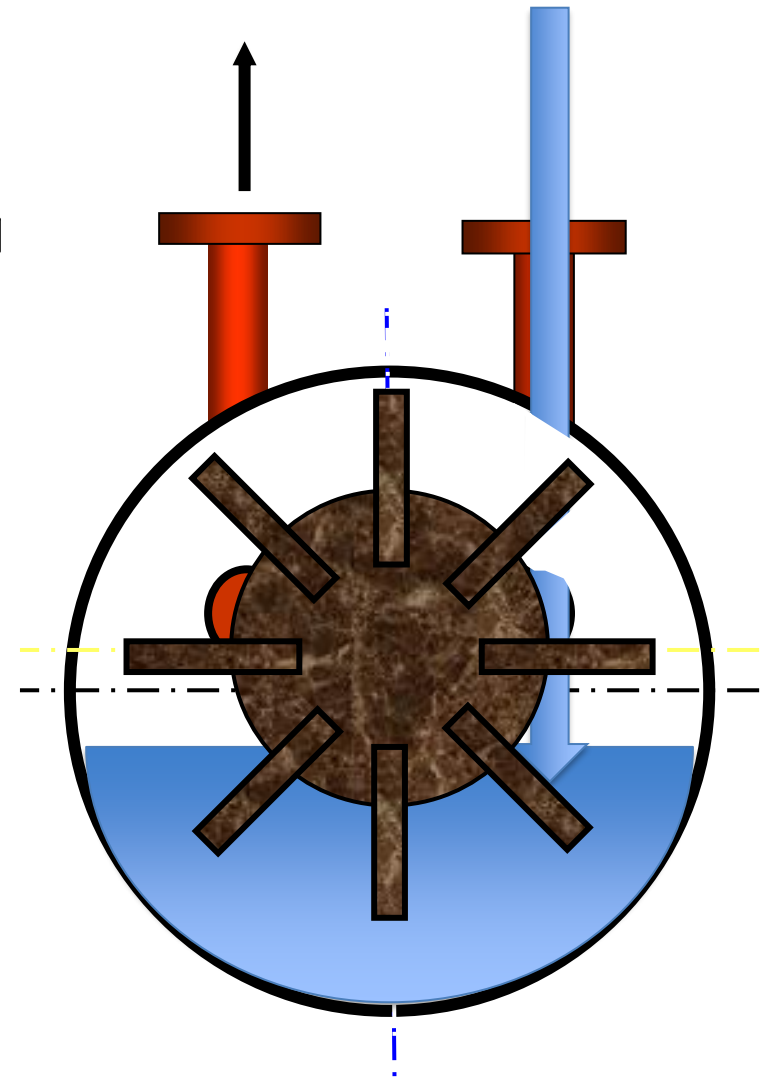
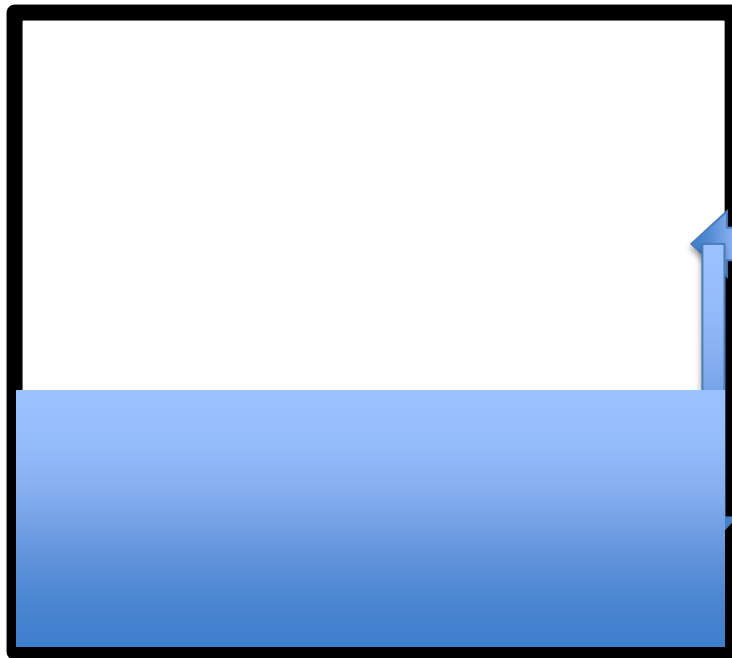
Rotor with Fixed Vans



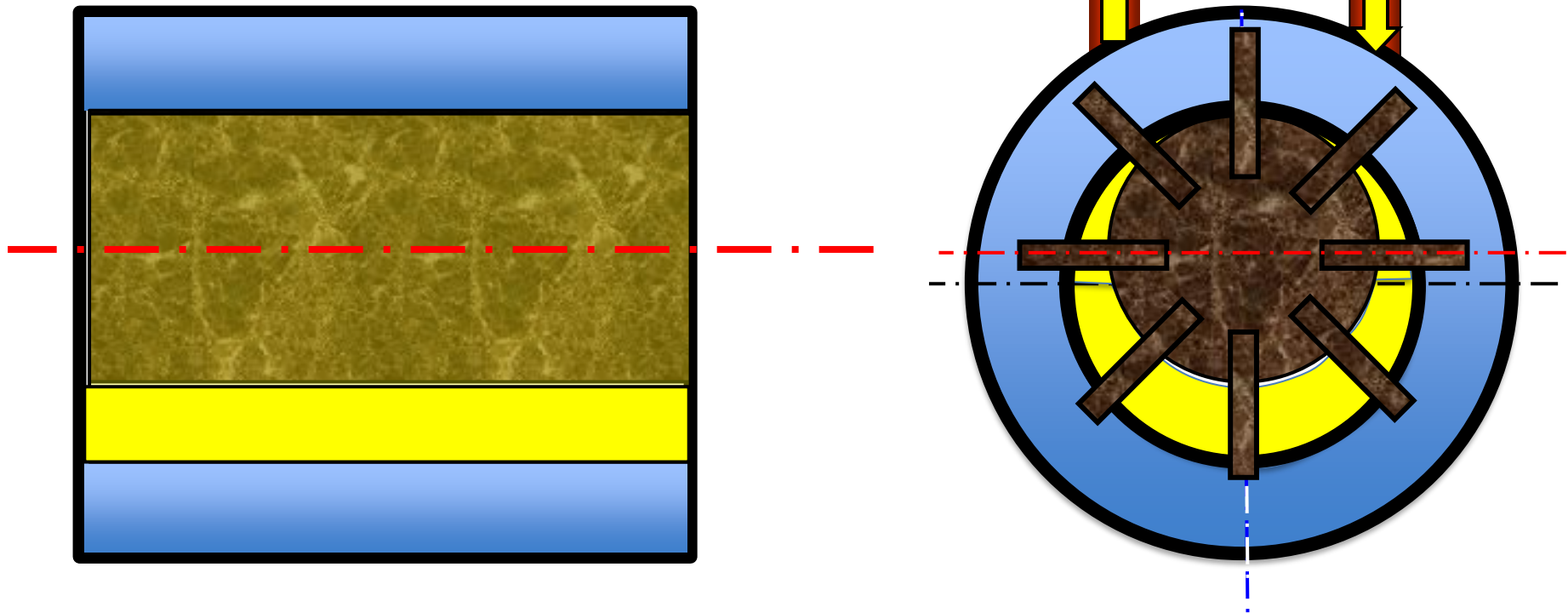




**Fill liquid volume According
to manual instruction**



Side View



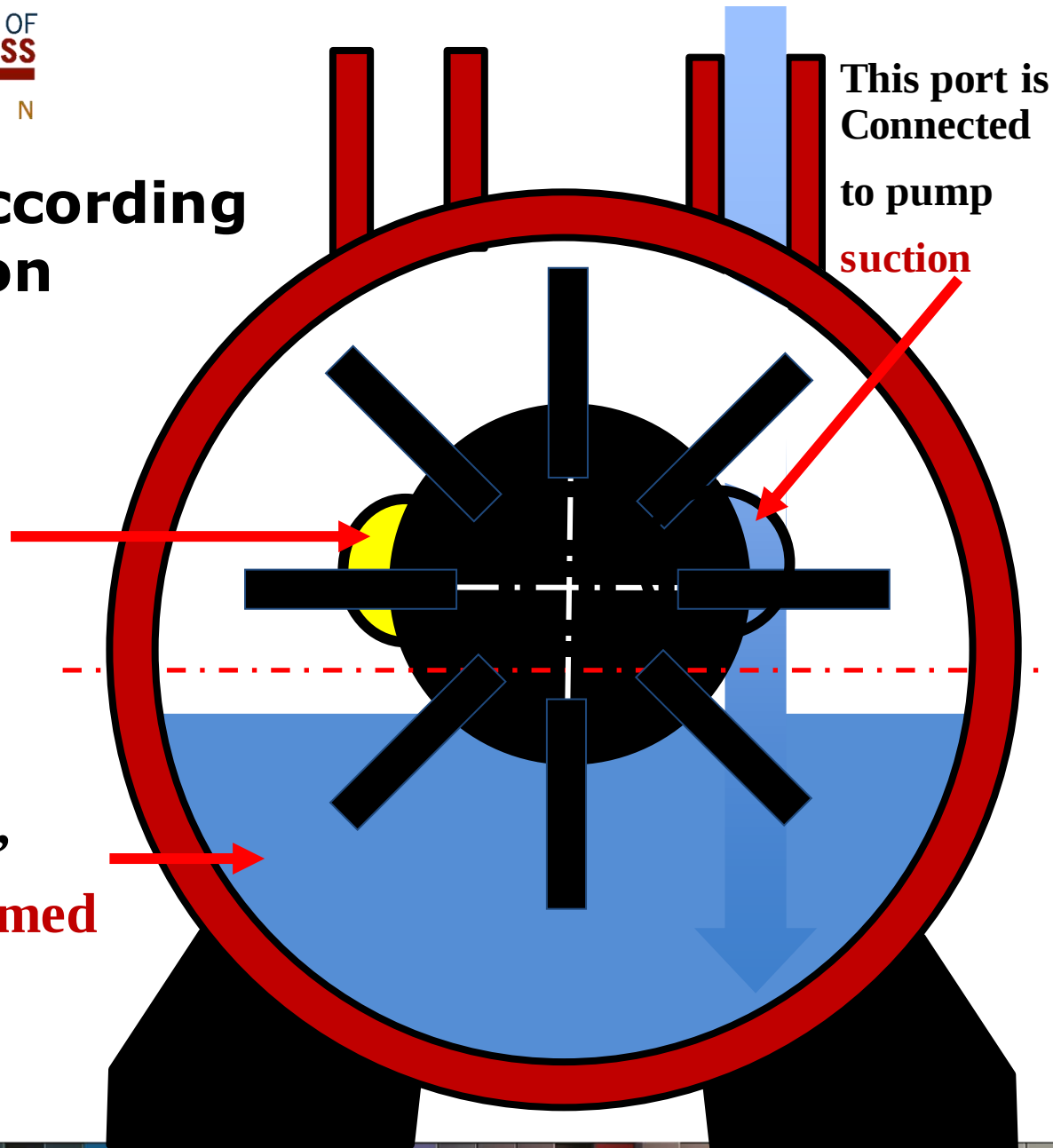
Side View



**Fill liquid volume According
to manual instruction**

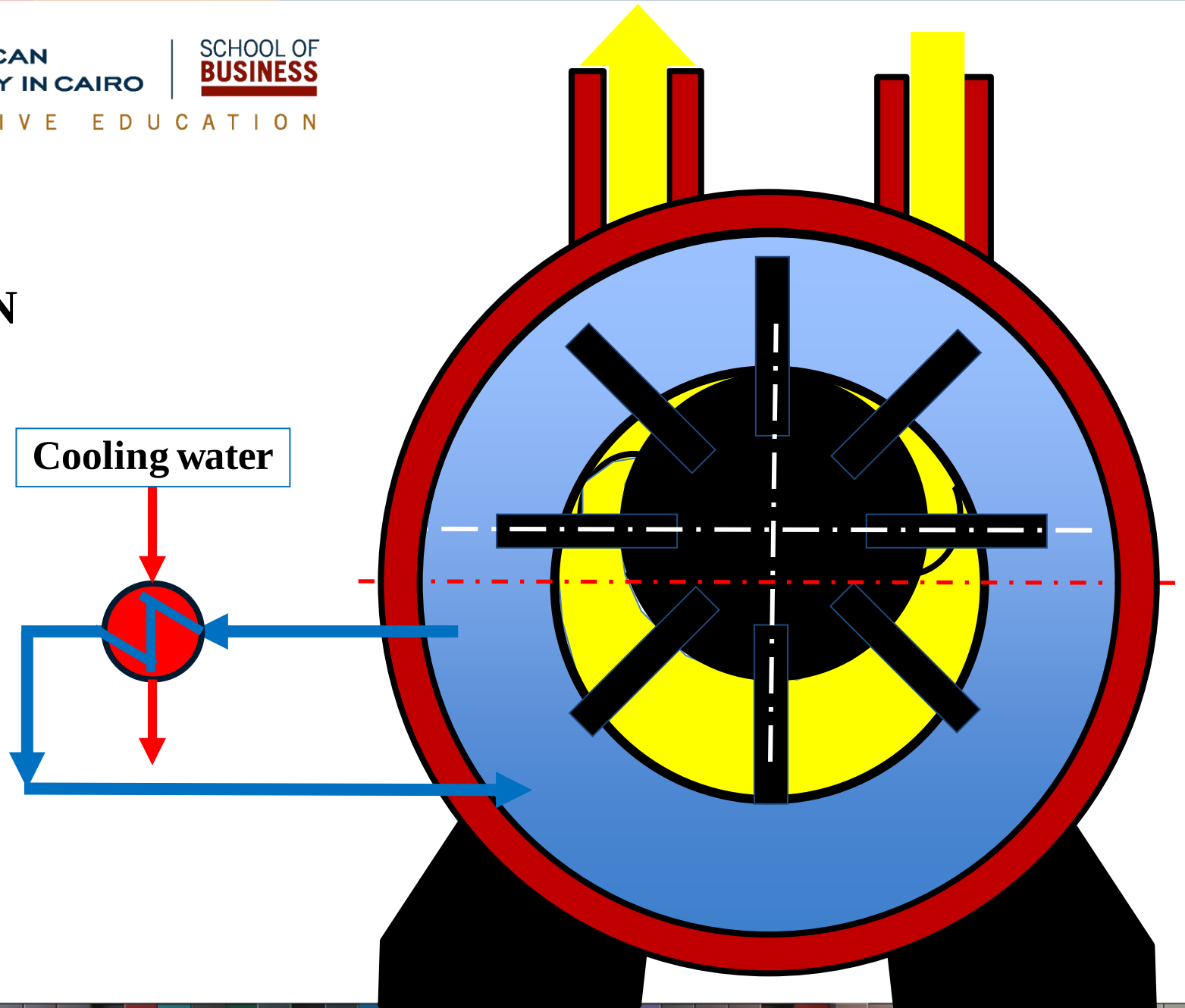
**This port is connected
to pump **discharge****

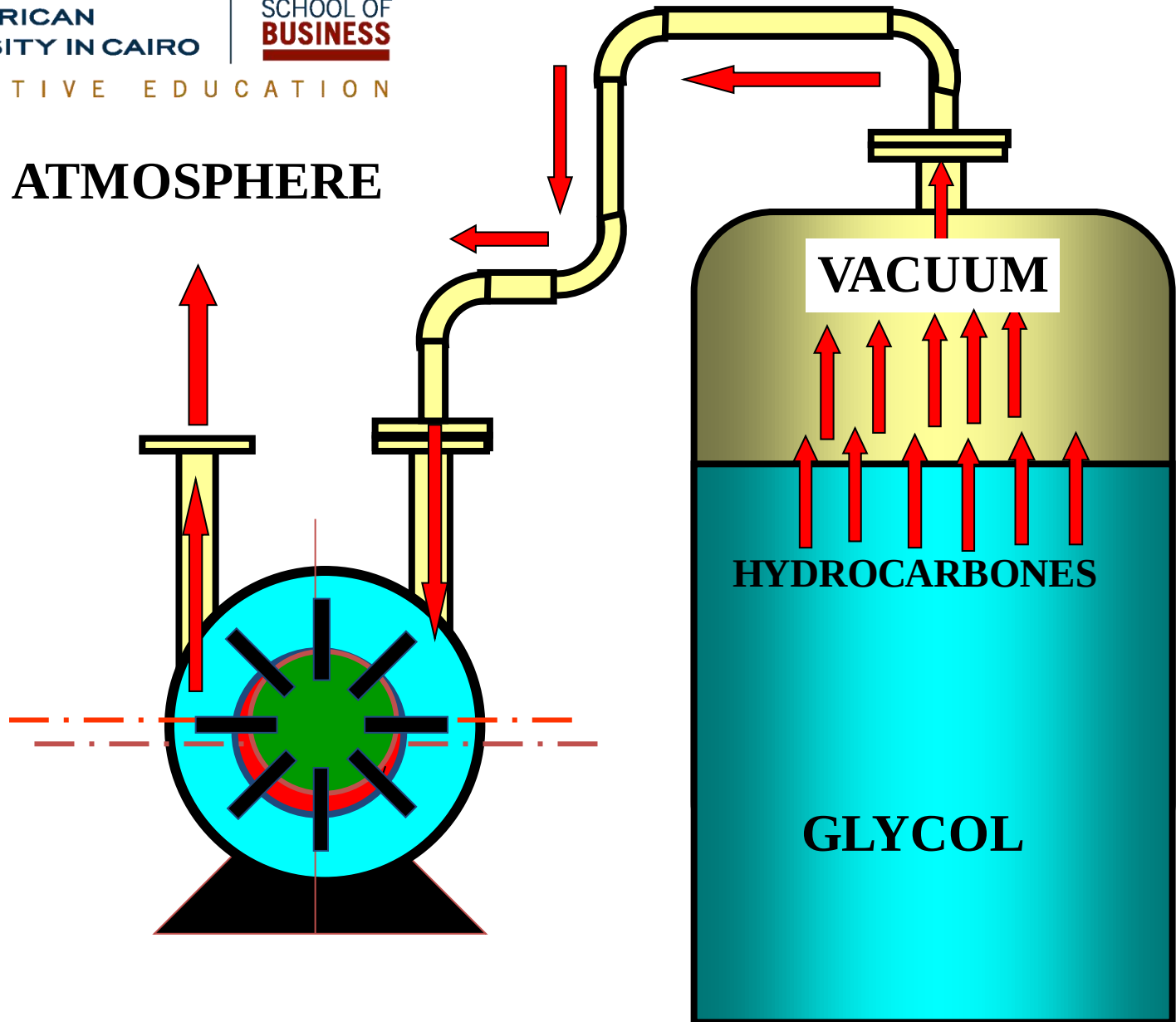
**Due to centrifugal force,
a liquid ring will be formed**





AFTER ROTATION







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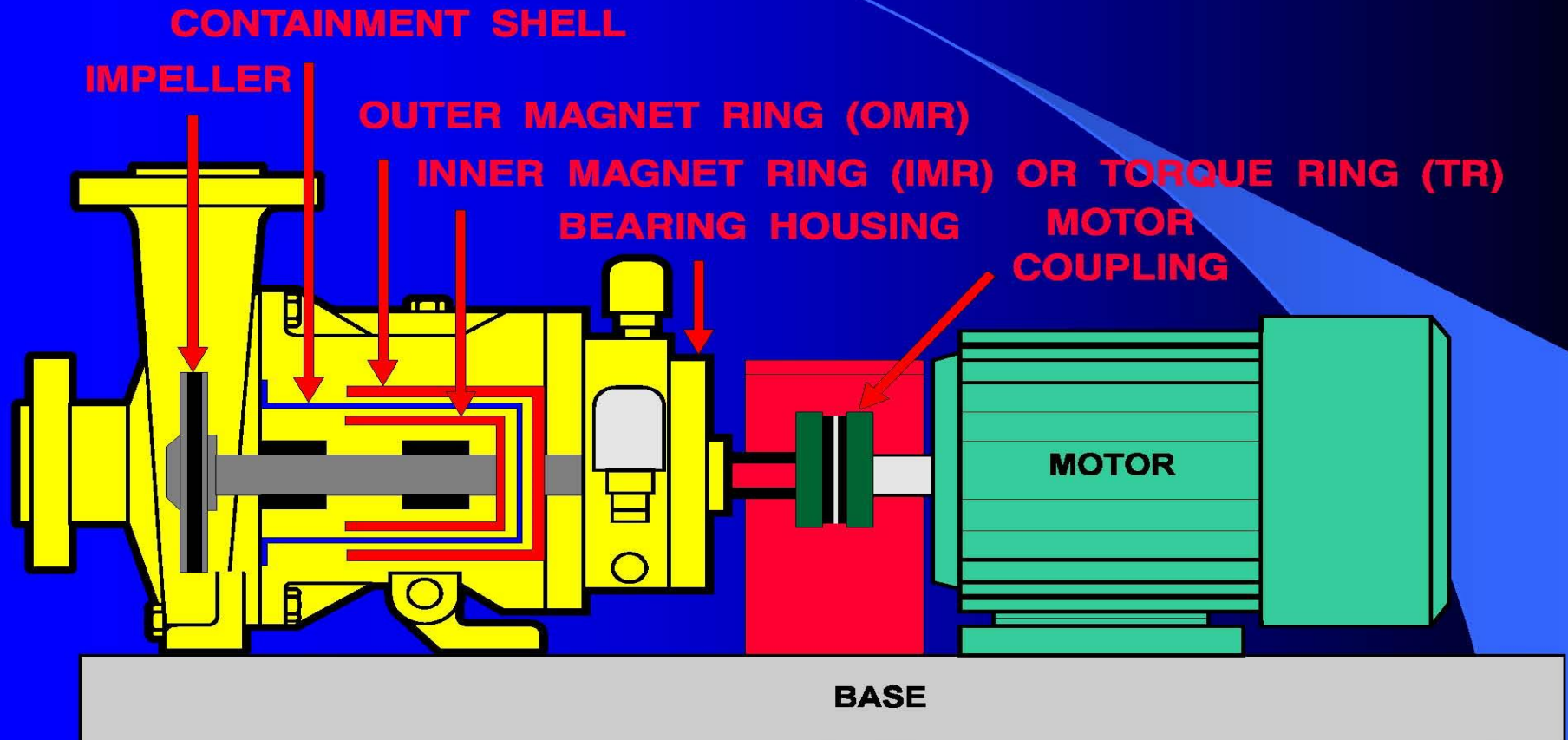
EXECUTIVE EDUCATION

Seal Less Pumps



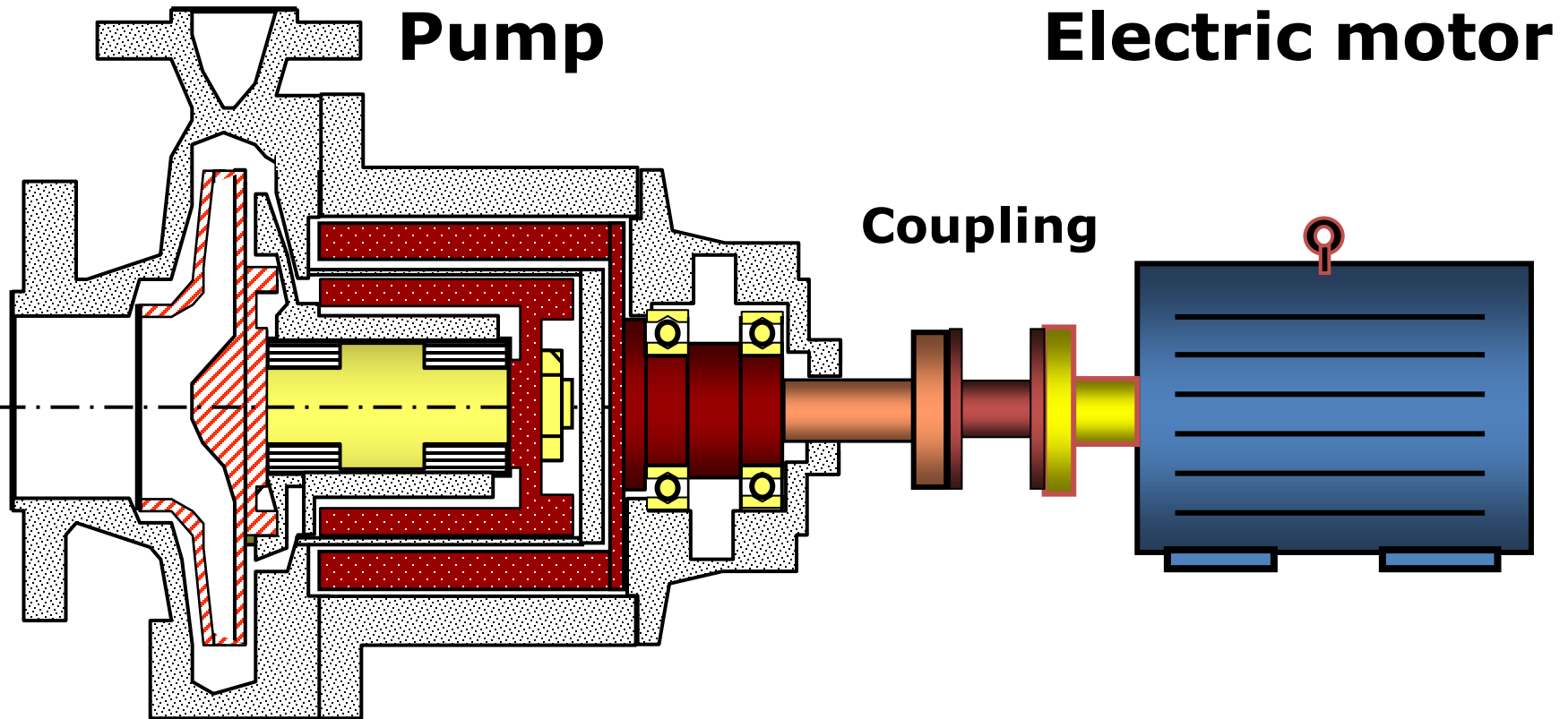
Seal Less Pumps

Mag Drive Pumps



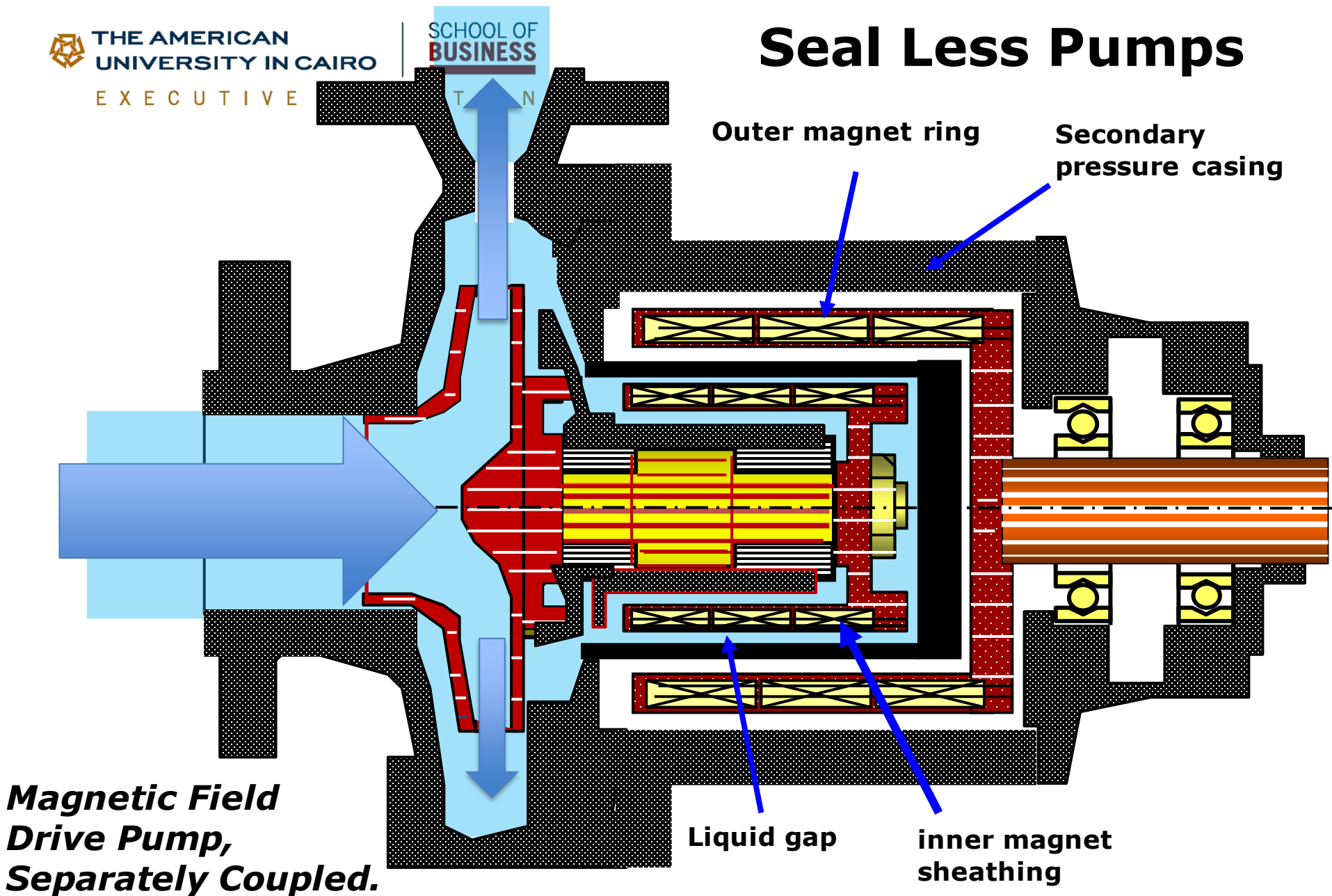


Seal Less Pumps



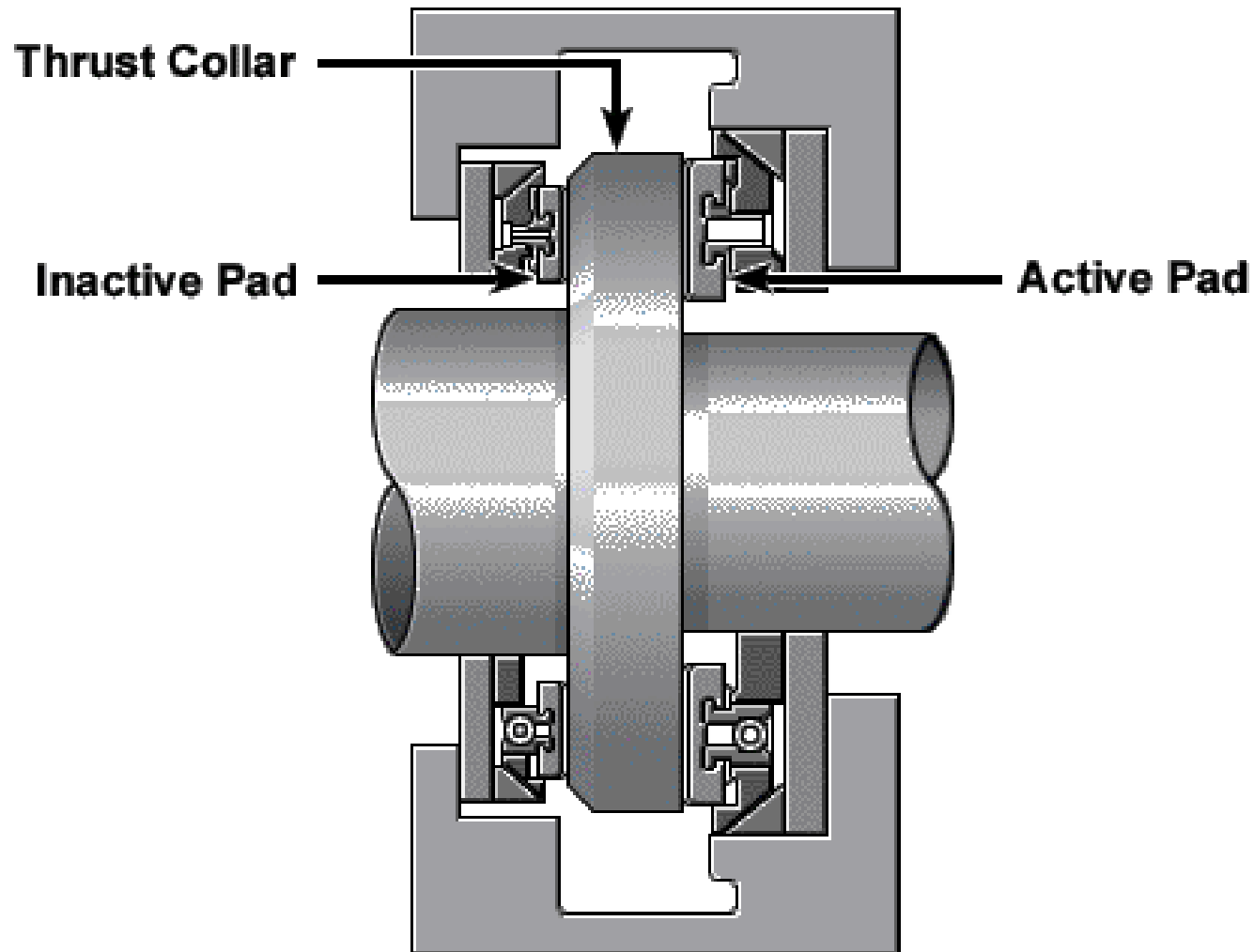


Seal Less Pumps



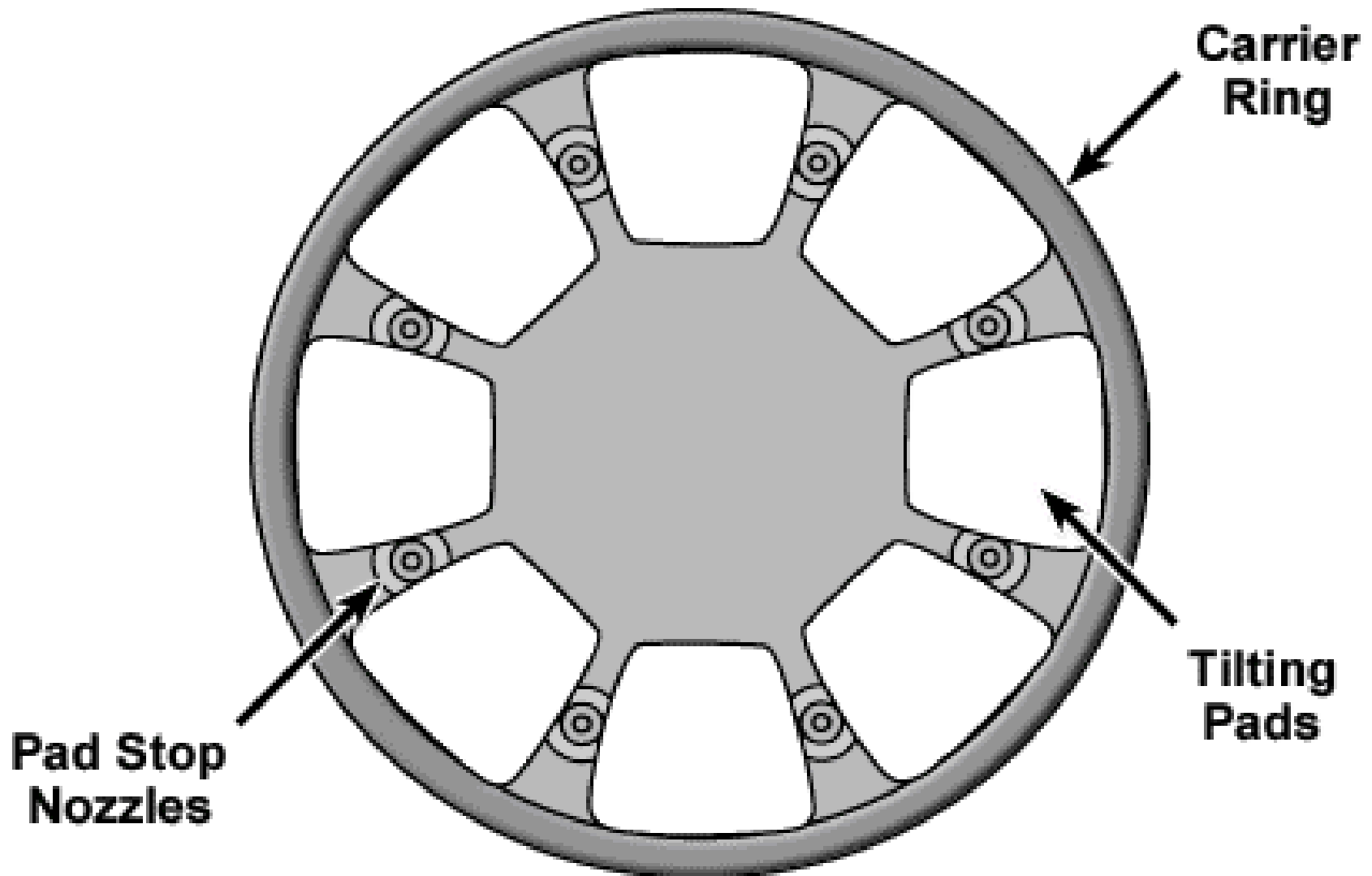


Thrust Bearing



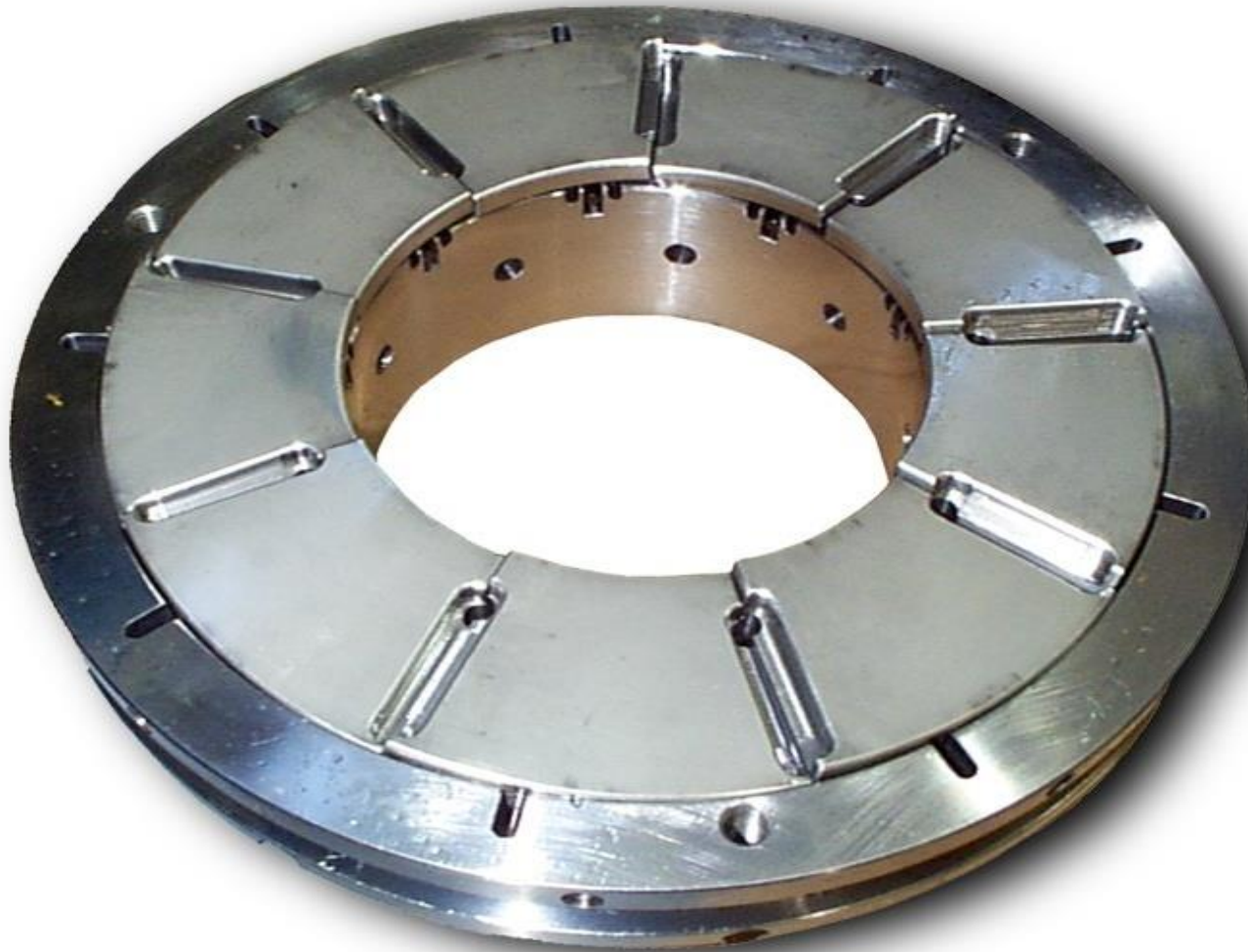


Thrust Bearing Details





Titan 130 Thrust Bearing



TR98285

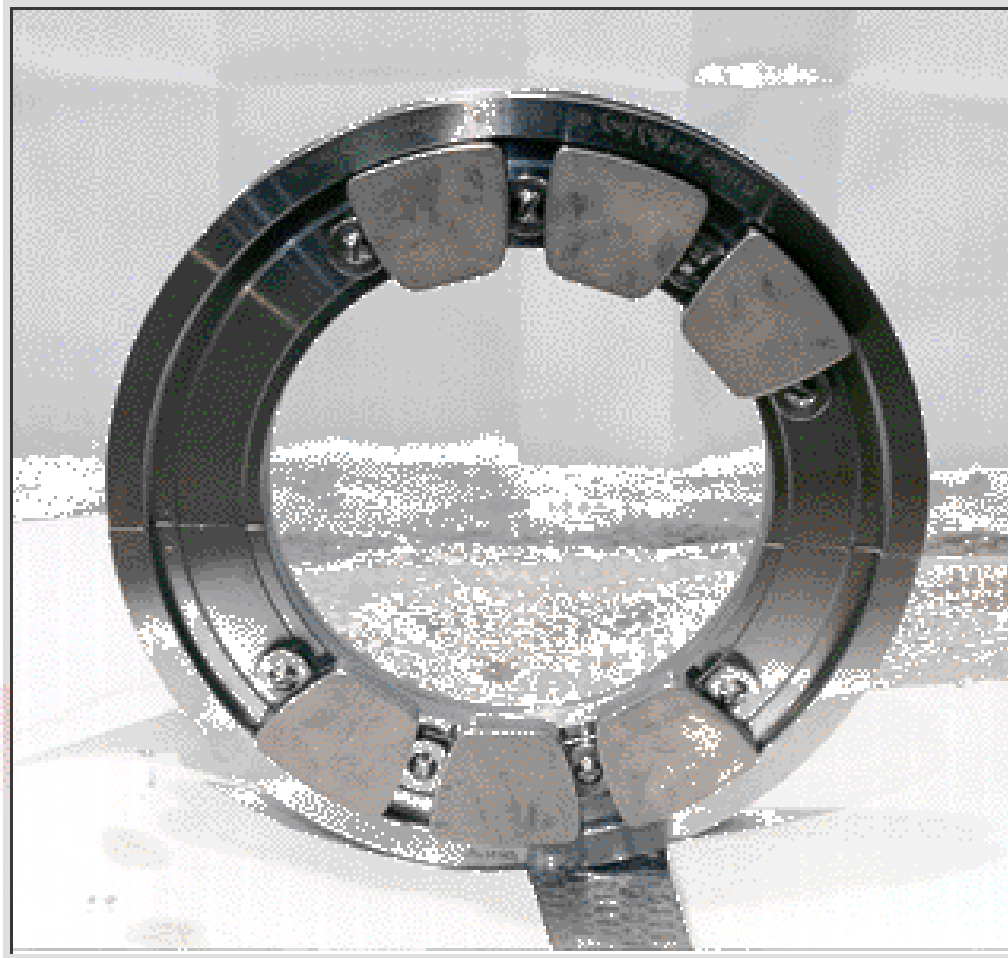


Active Thrust Bearing





Inactive Thrust Bearing





Radial Tilt-Pad Bearing

AXIAL POSITION
PROXIMITY PROBE

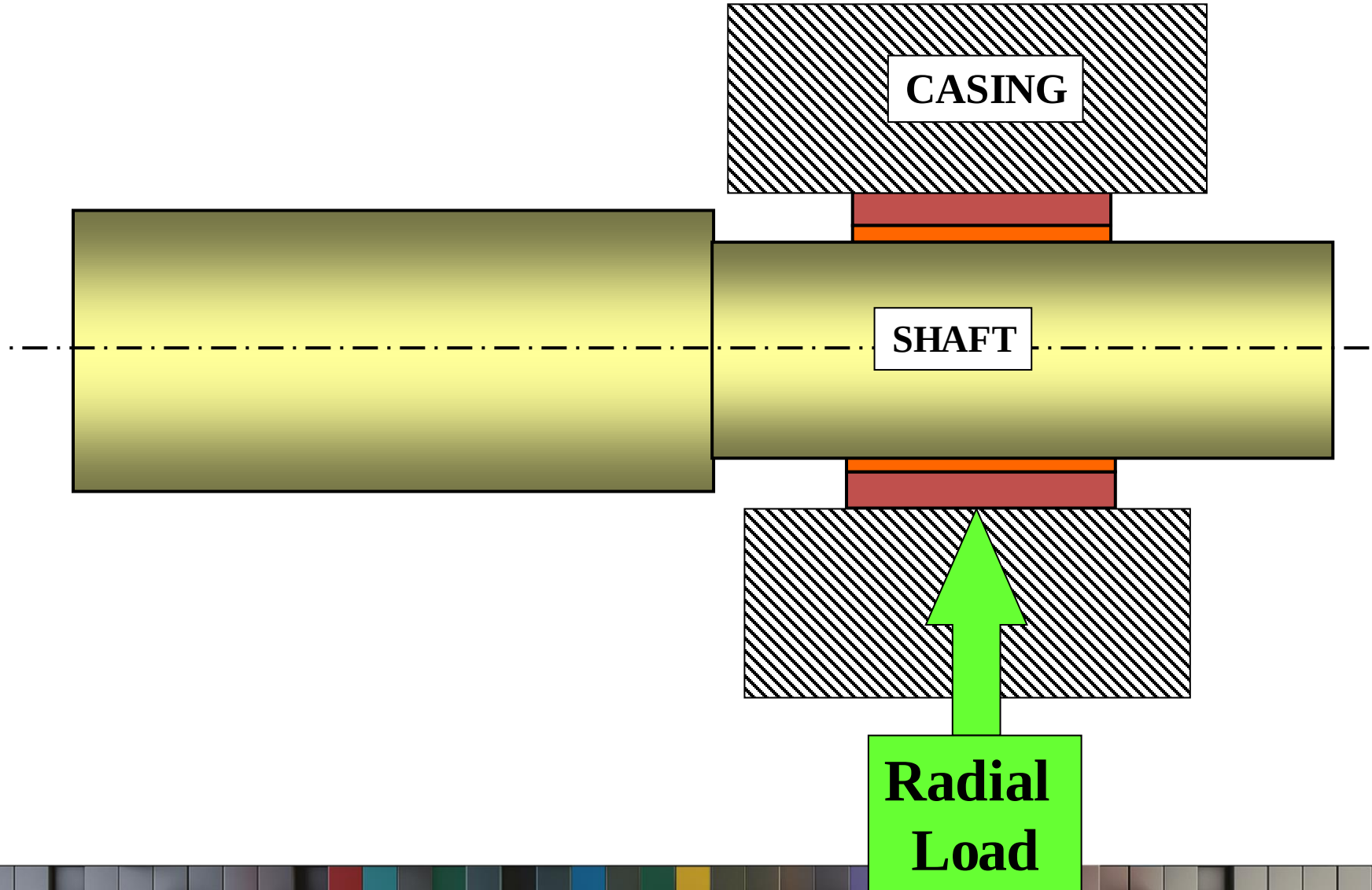
RADIAL
VIBRATION
PROBES



TR98287



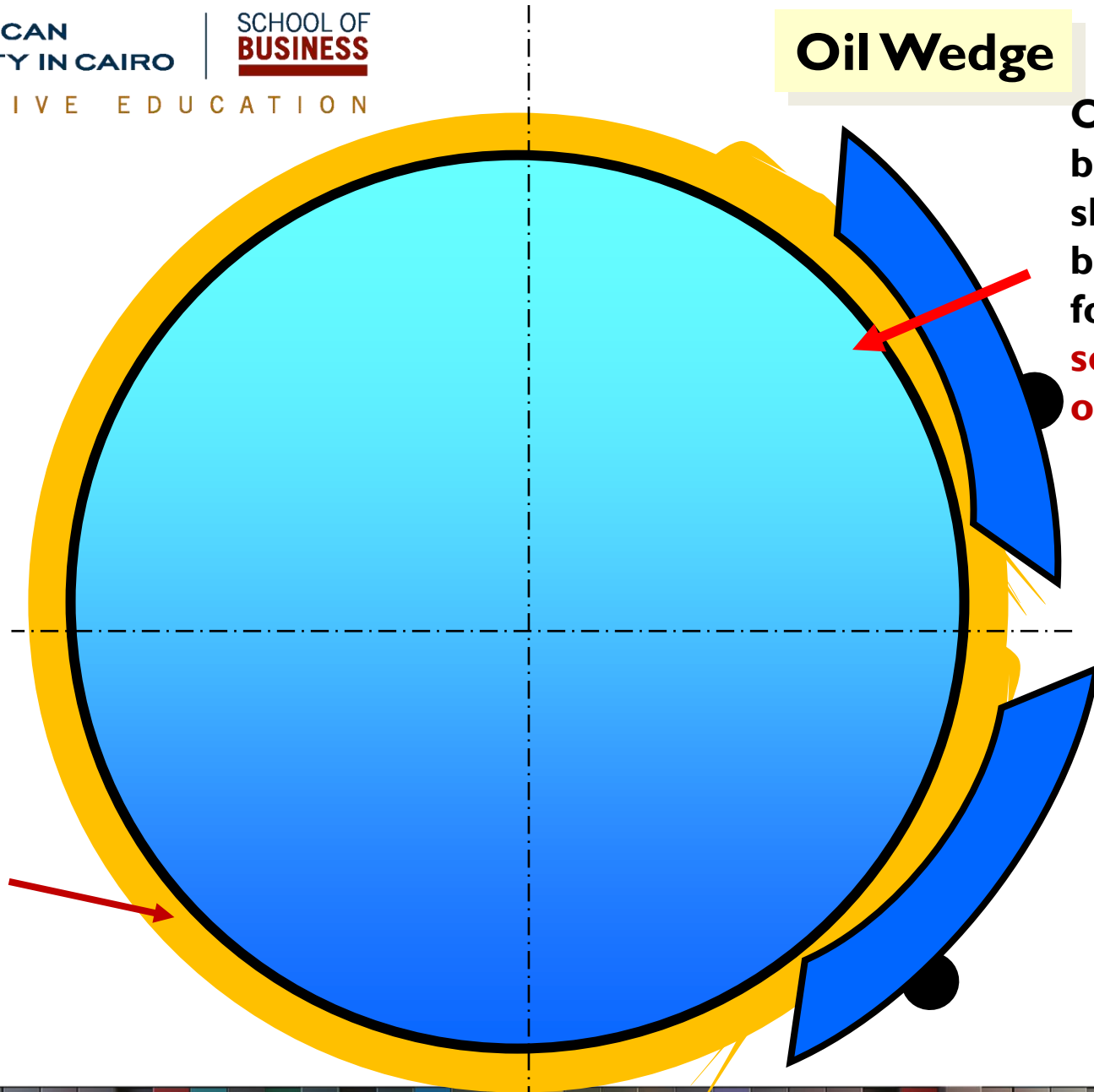
RADIAL TILTING PAD BEARING





Oil Wedge

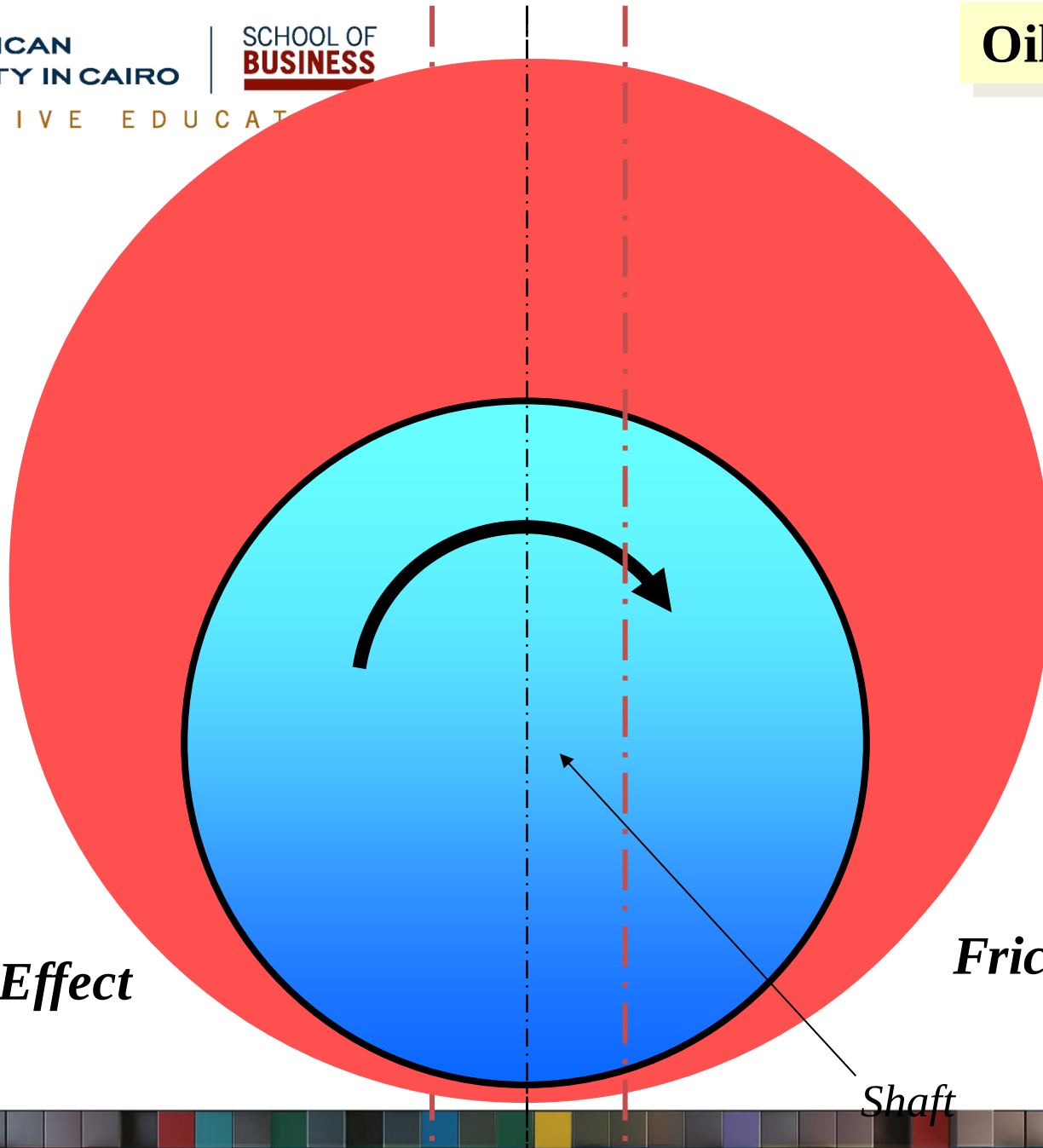
Oil squeeze
between
shaft and
bearing pad
forming a
solid
oil wedge



Due to
Oil
Surface
Tension,
And high
speed,
The Oil
adhere to
the shaft
Forming
an
Oil Ring



Oil Wedge



Oil Wedge Effect

Friction Effect

Shaft



RADIAL TILTING PAD BEARING

