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.

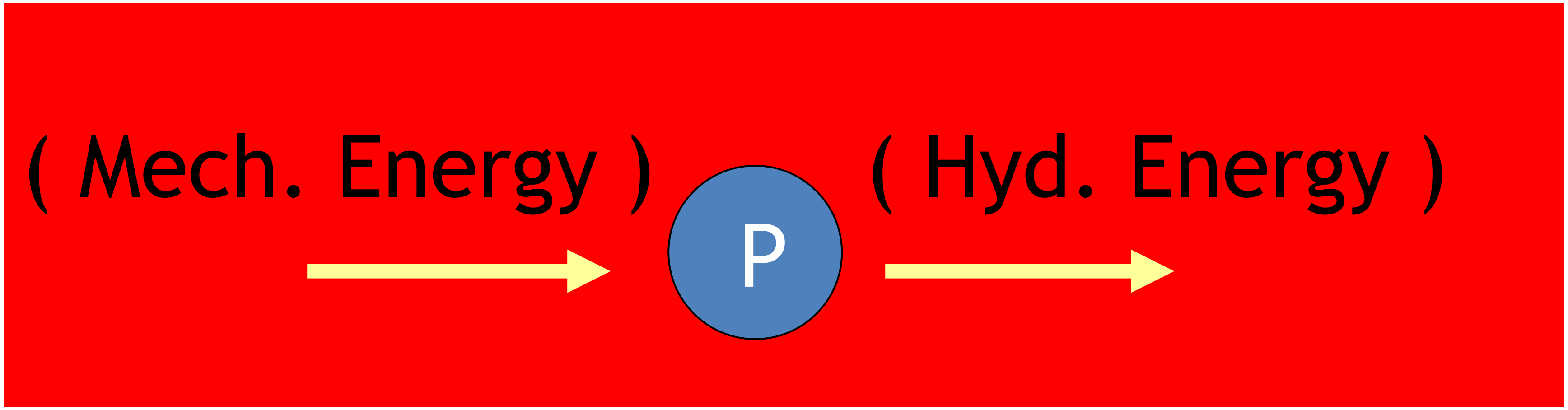
The pumps are used to perform one of the following jobs:

-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

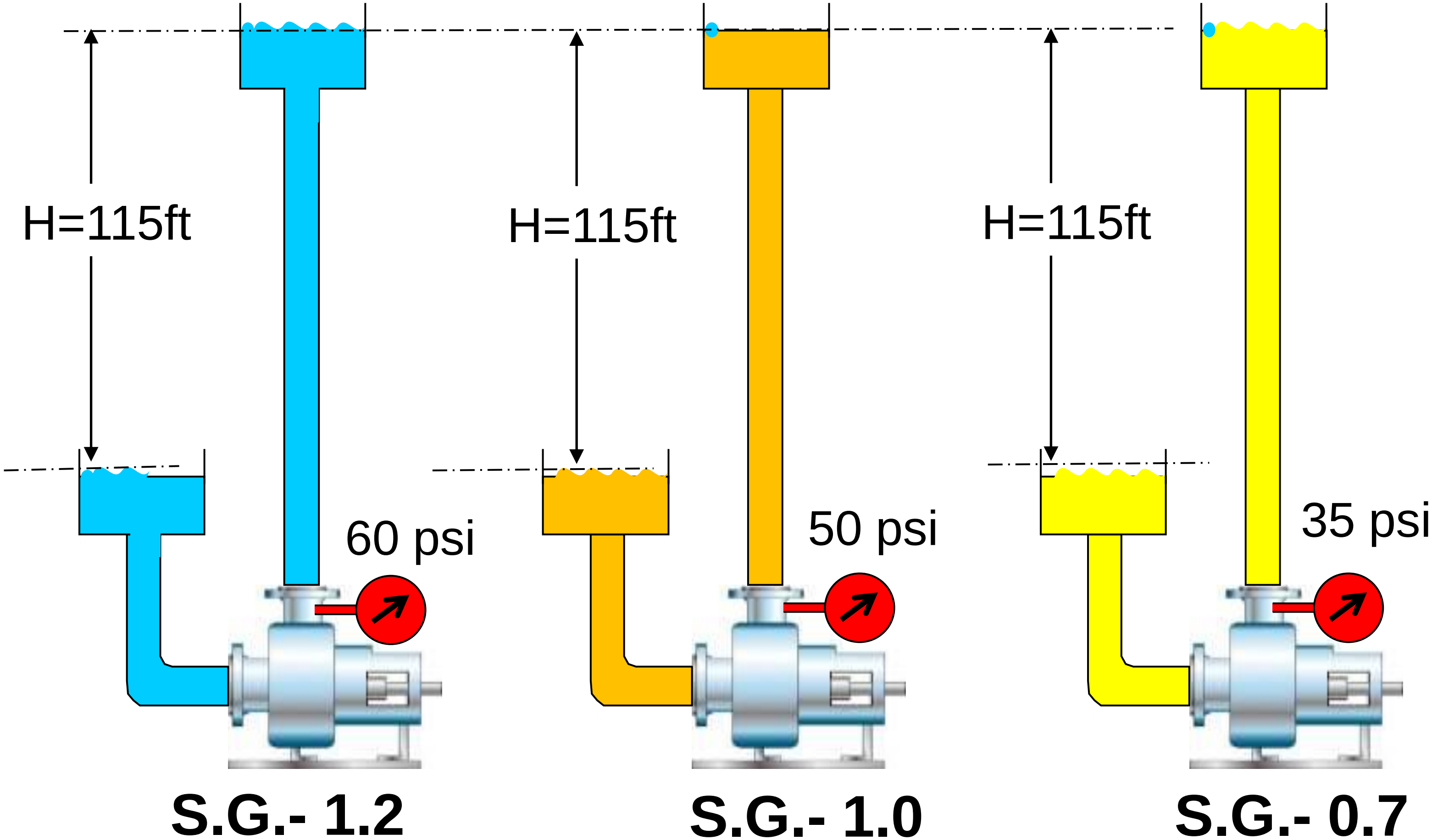
The source of power for a pump could be

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

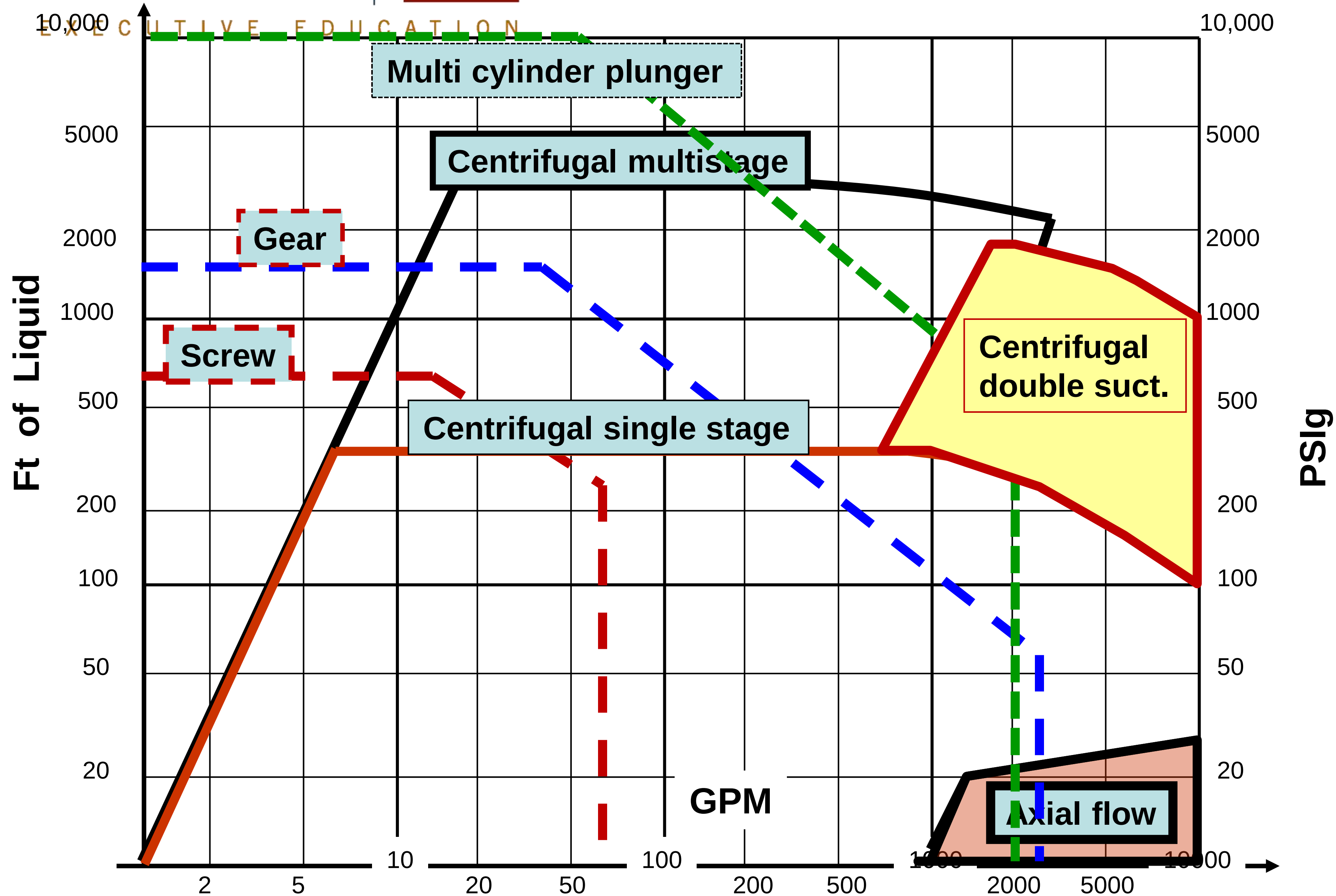
- RECIPROCATING
  - PISTON
  - PLUNGER
- ROTARY
  - GEAR
  - SCREW
  - LOBE
  - VANE
  - OTHERS
- DIAPHRAGM

OTHERS

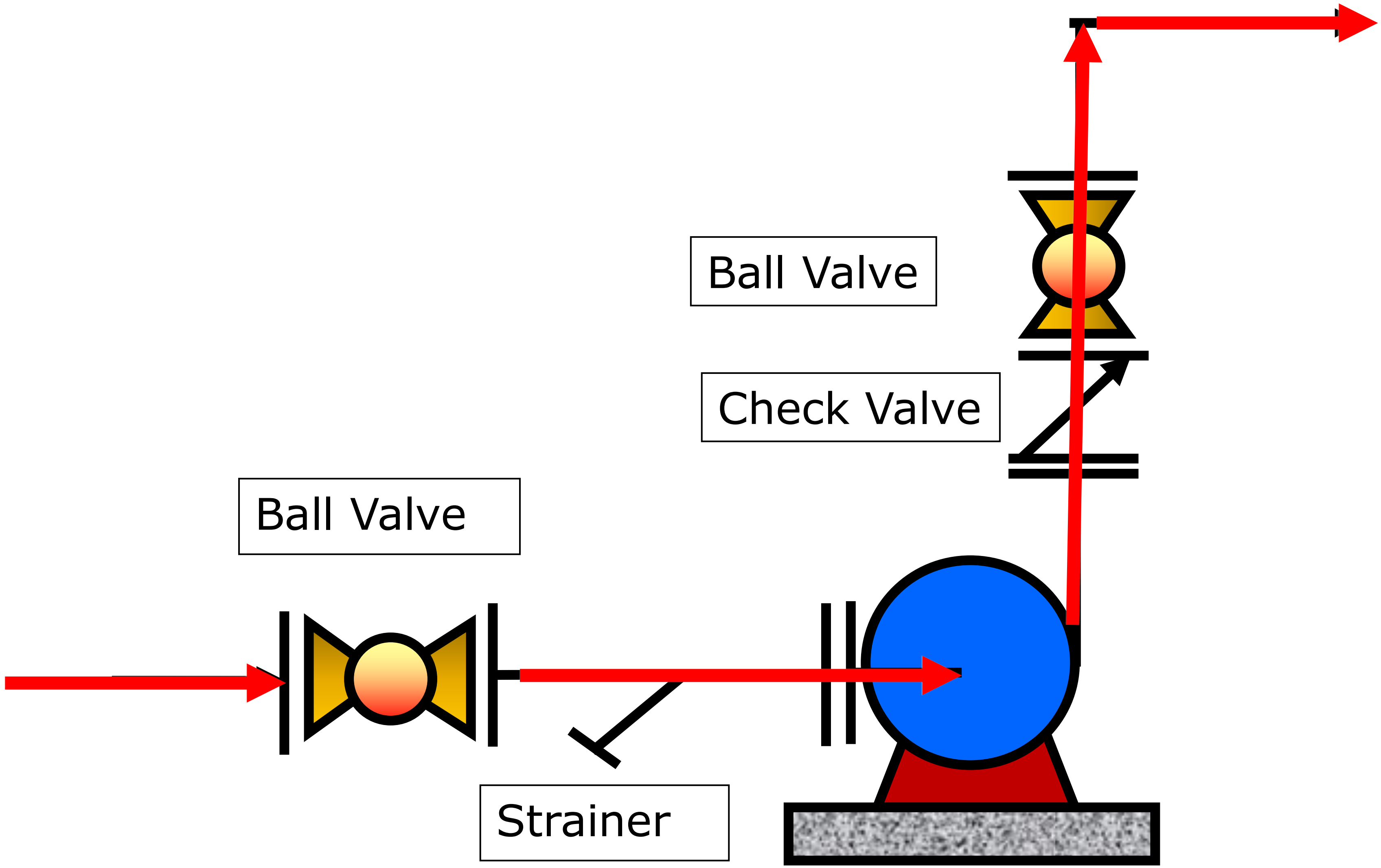
- JET
- LIQUID RING

Main Types Pumps

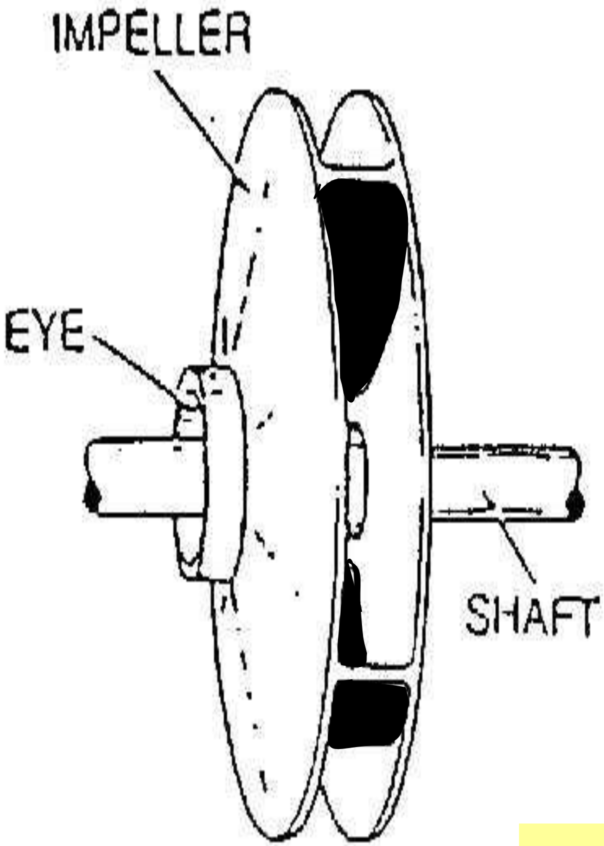
	Positive D.P.	Centrifugal	Axial Flow
Pressure P	V. HIGH	HIGH	LOW
Flow Rate Q	LOW	HIGH	V. HIGH
S .R .V	YES	NO	NO
Efficiency	HIGH	MEDIUM	V. HIGH
Maint. cost	V. HIGH	LOW	LOW
Pulsation	YES	NO	NO

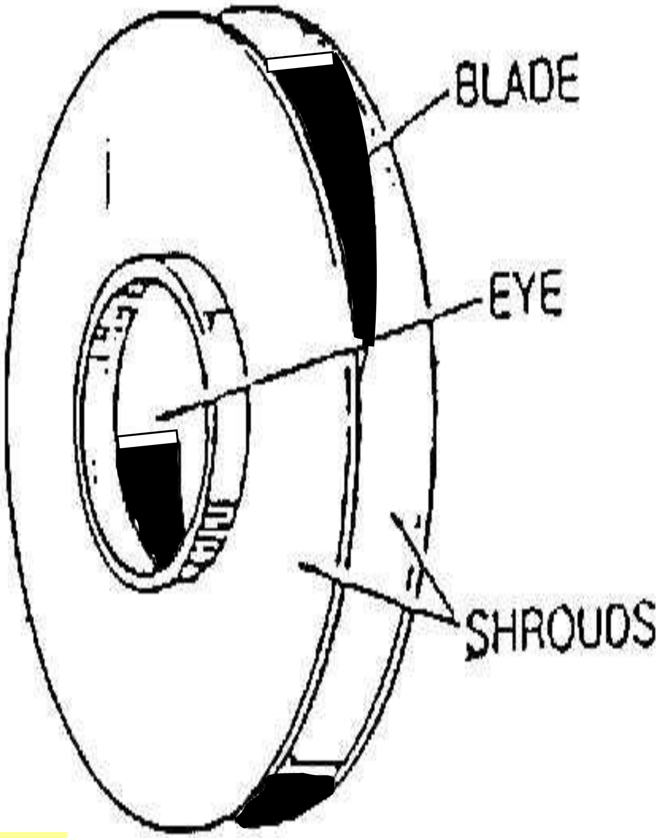

Multi cylinder plunger
Centrifugal multistage
Gear
Screw
Centrifugal single stage
Centrifugal double suct.
Axial flow
Ft of Liquid
PSIg
GPM
10,000
5000
2000
1000
500
200
100
50
20
2
5
10
20
50
100
200
500
1000
2000
5000
10000

- Centrifugal pumps



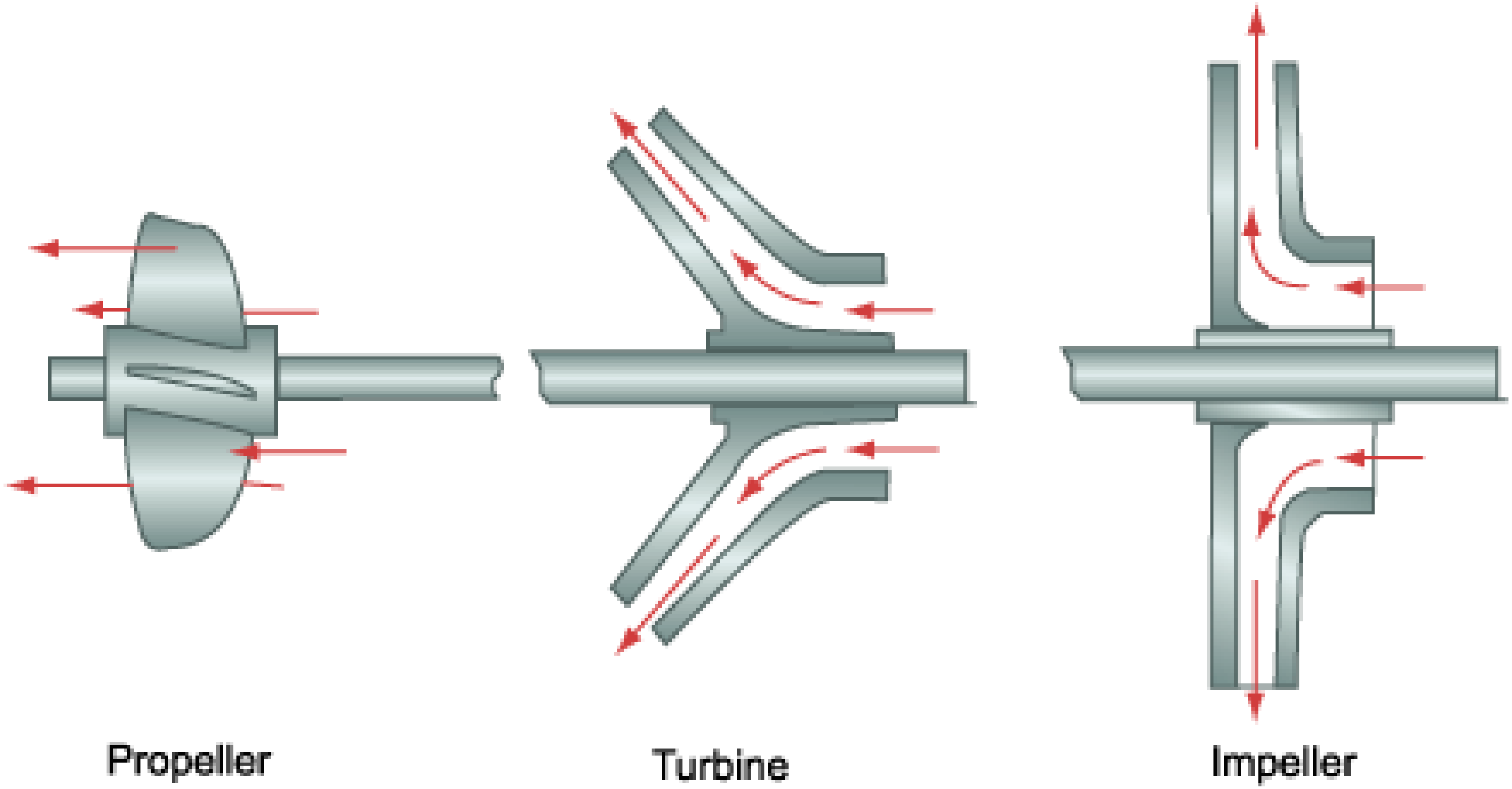
- **Centrifugal pumps**





Closed impeller

- Centrifugal pumps

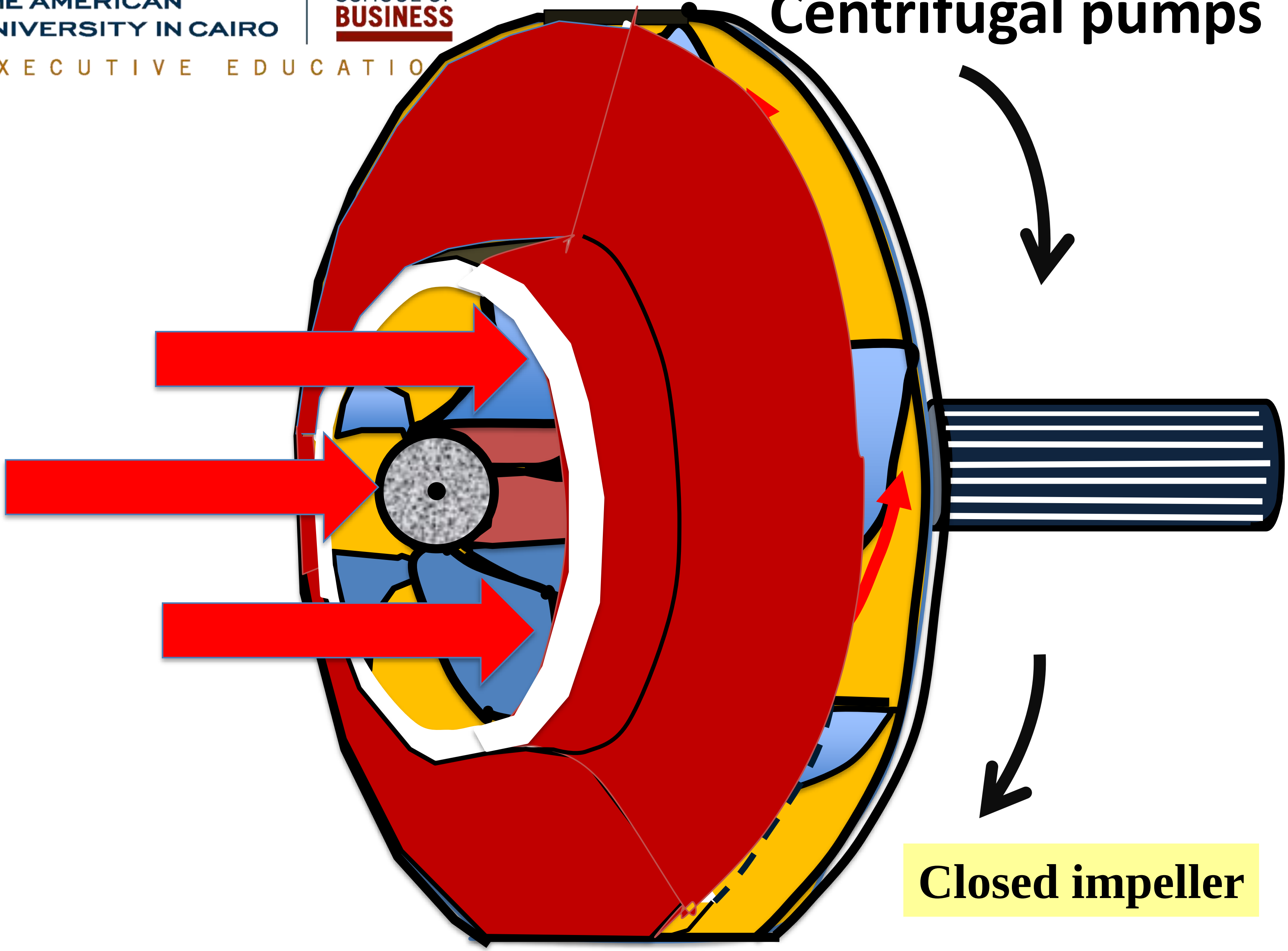


- Centrifugal pumps

Open impeller

Semi open impeller

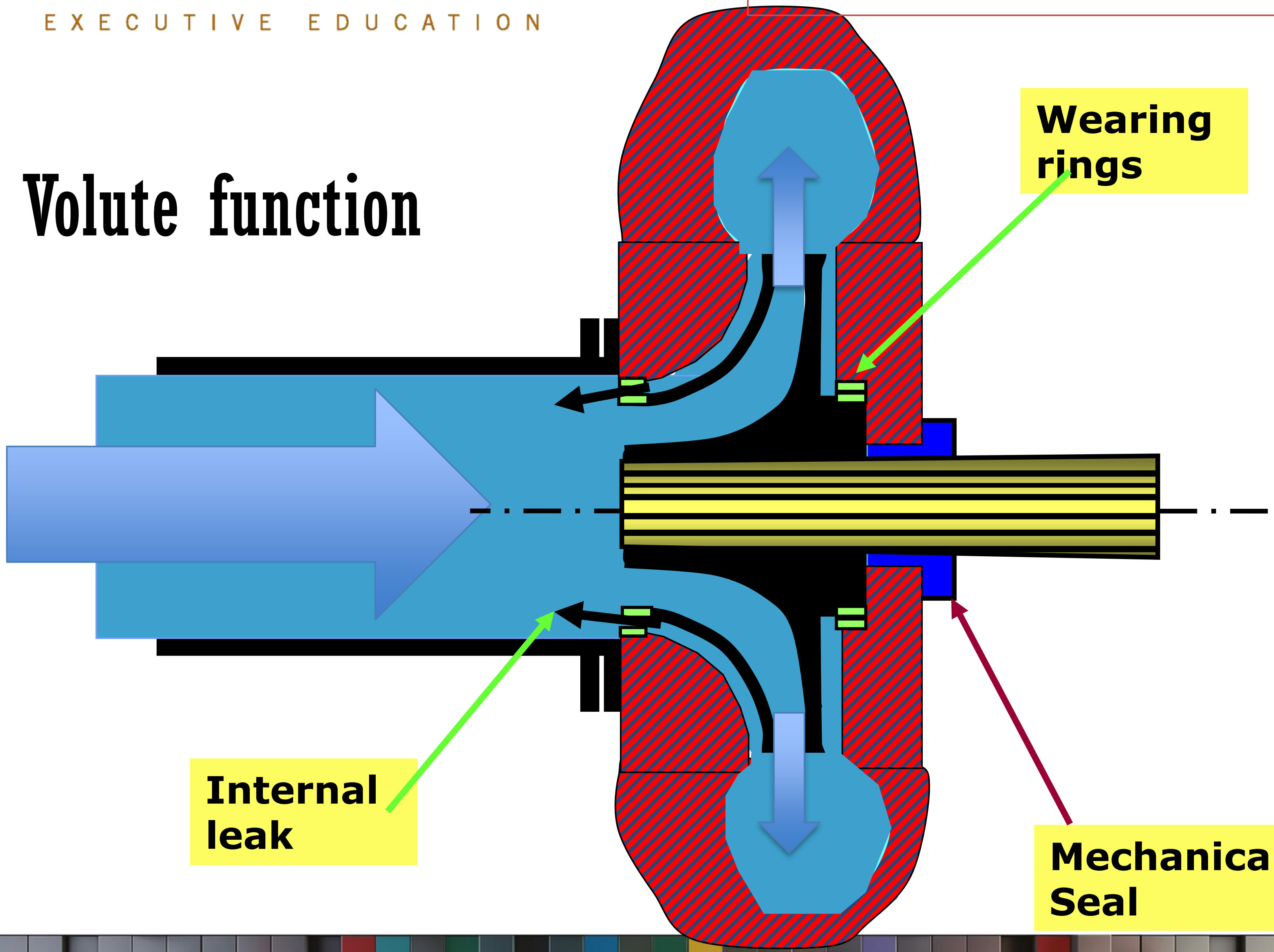
Centrifugal pumps



Closed impeller

- Centrifugal pumps

Volute function



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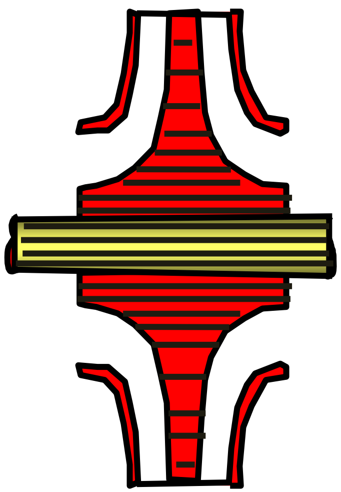
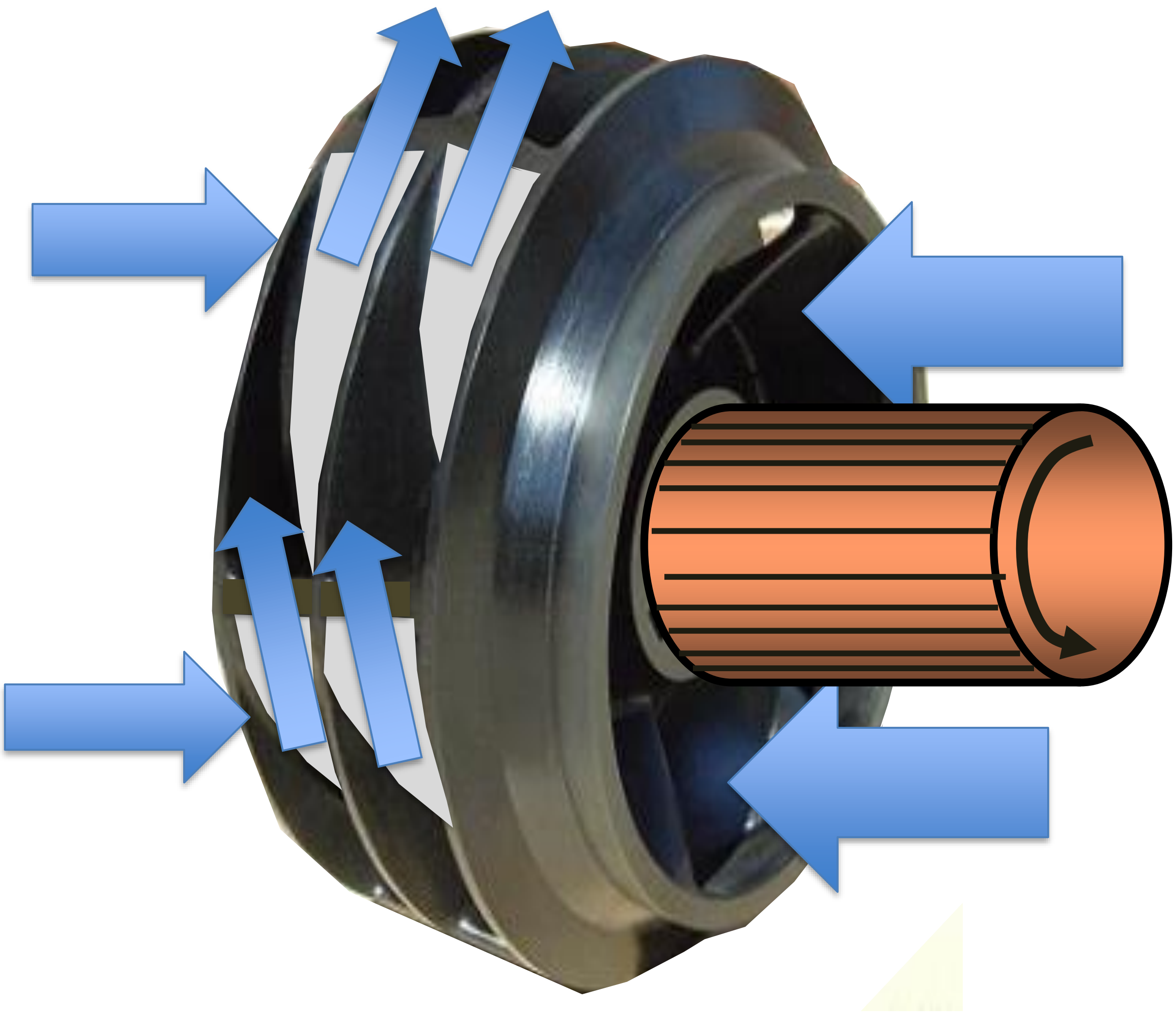
- **Centrifugal pumps**

Double suction impeller





• Centrifugal pumps

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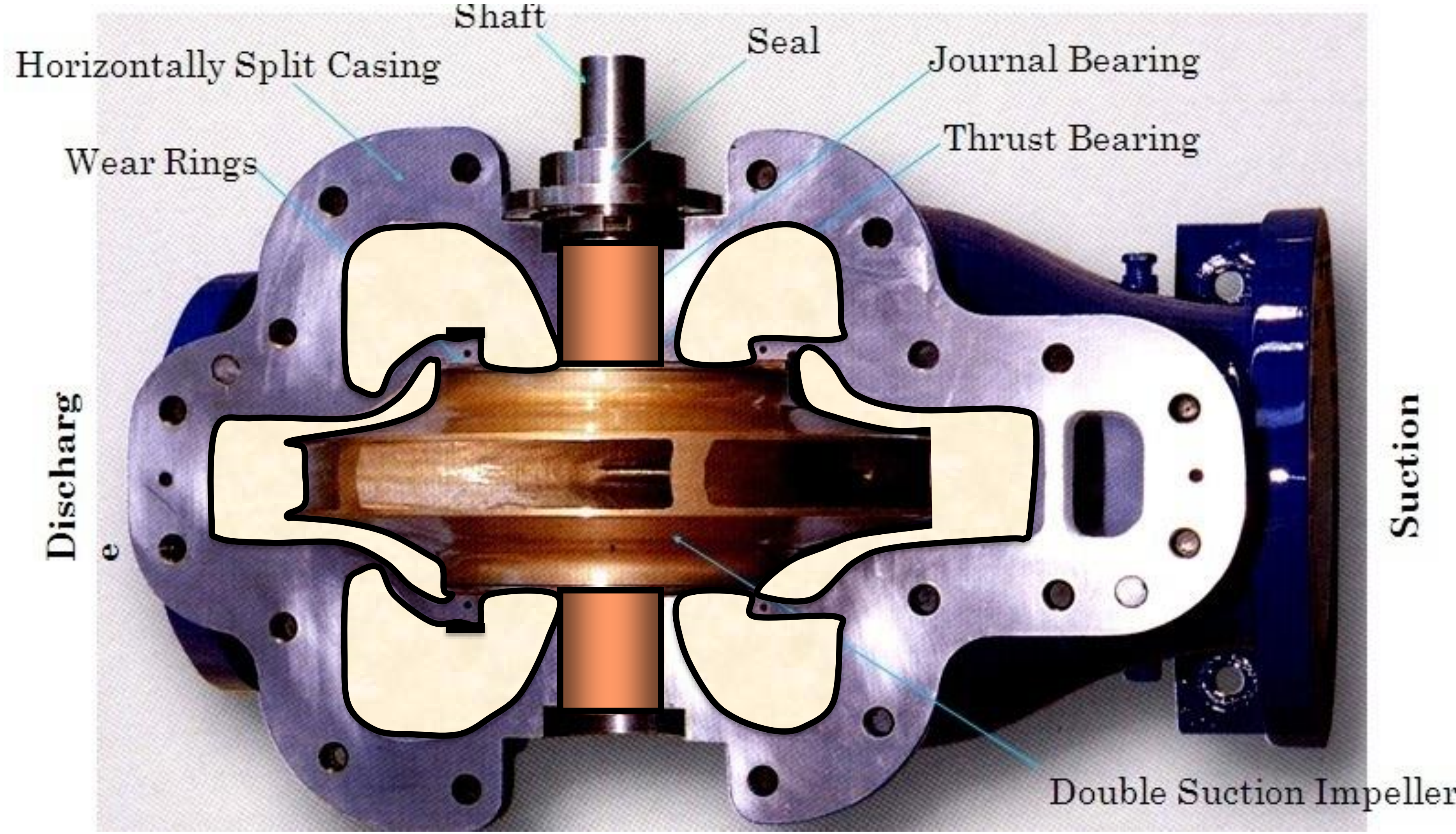
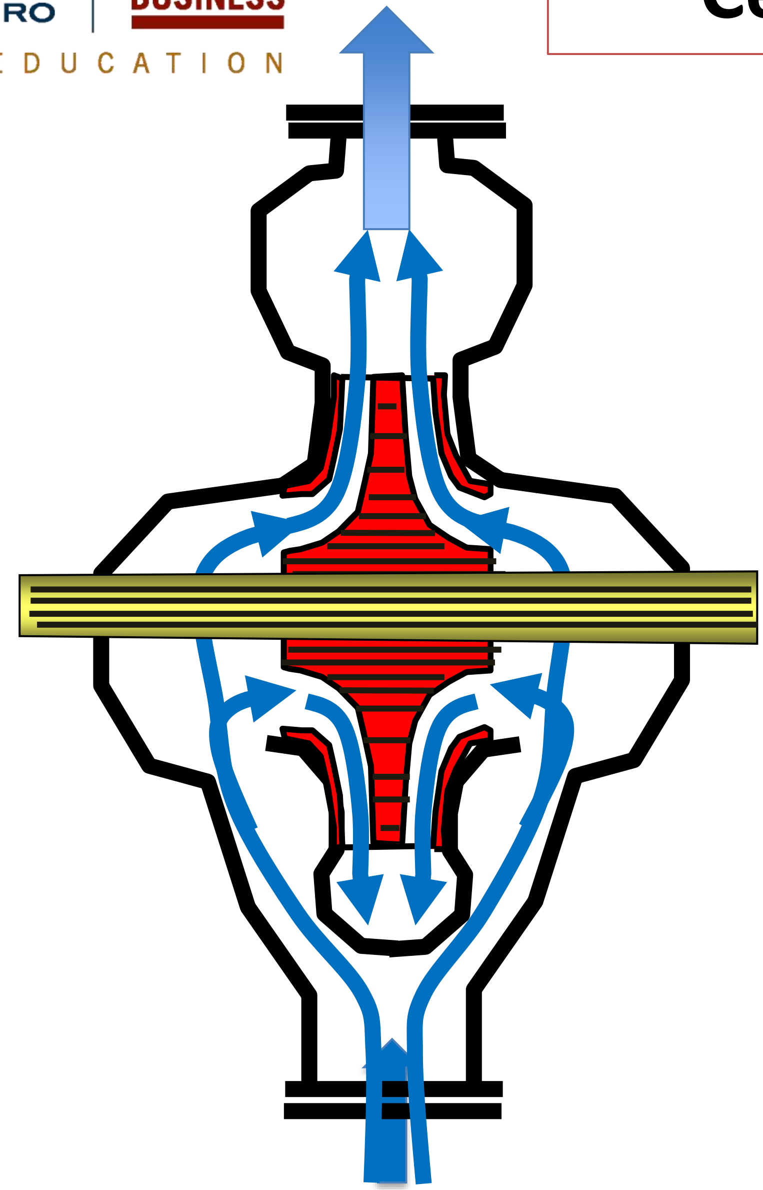


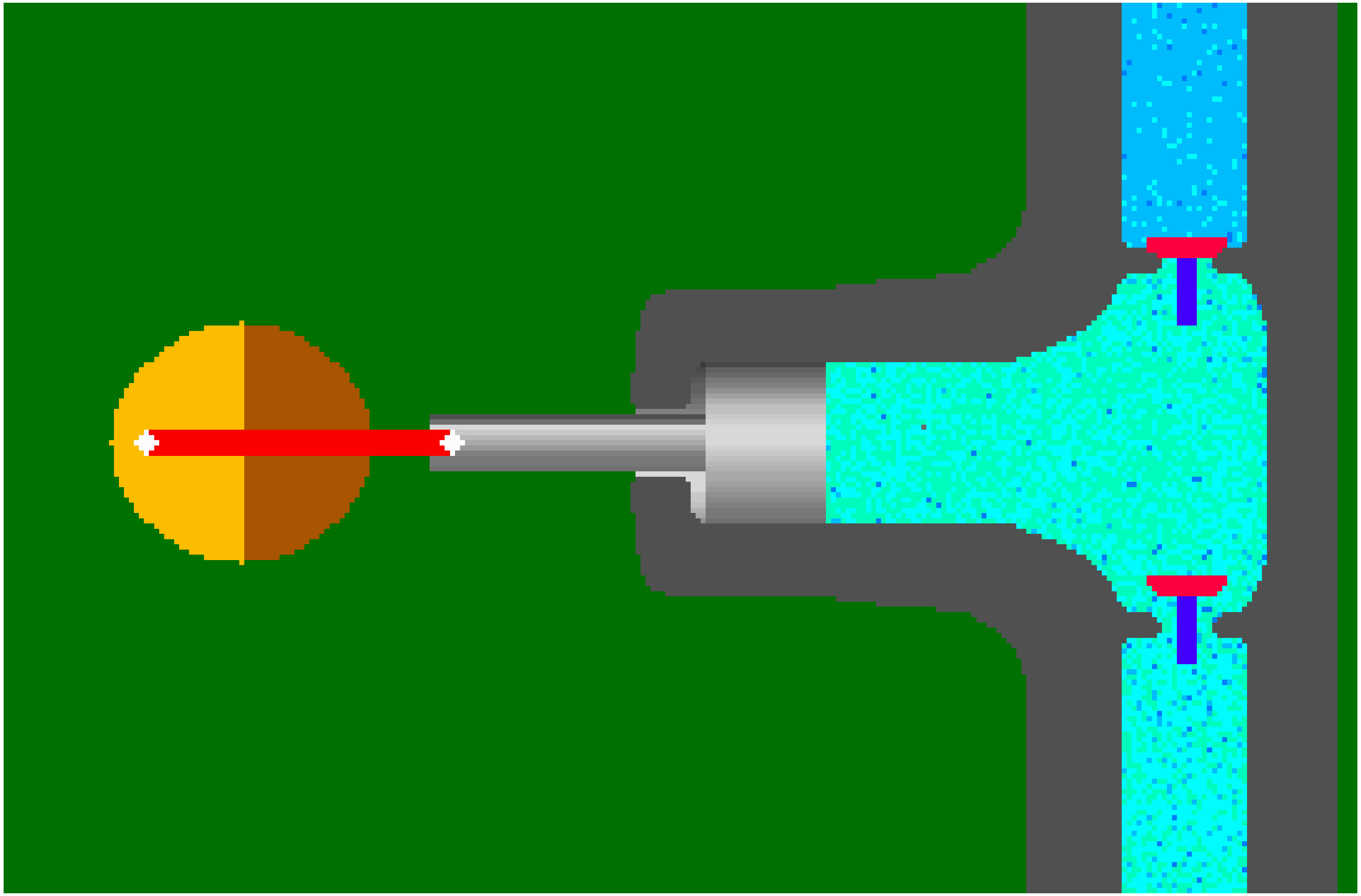
- Centrifugal pumps

Double suction impeller



- **Reciprocating Pumps**

Piston



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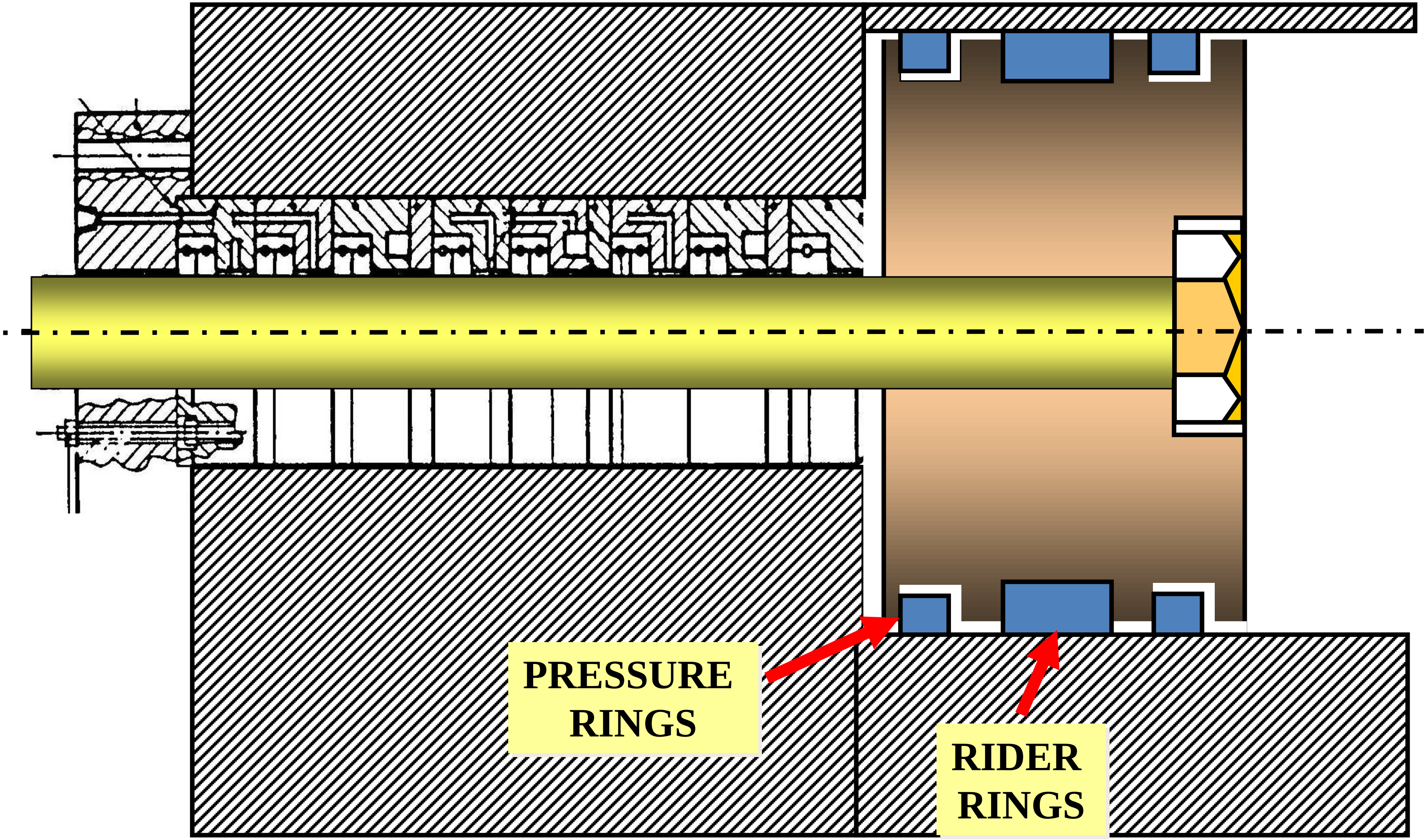
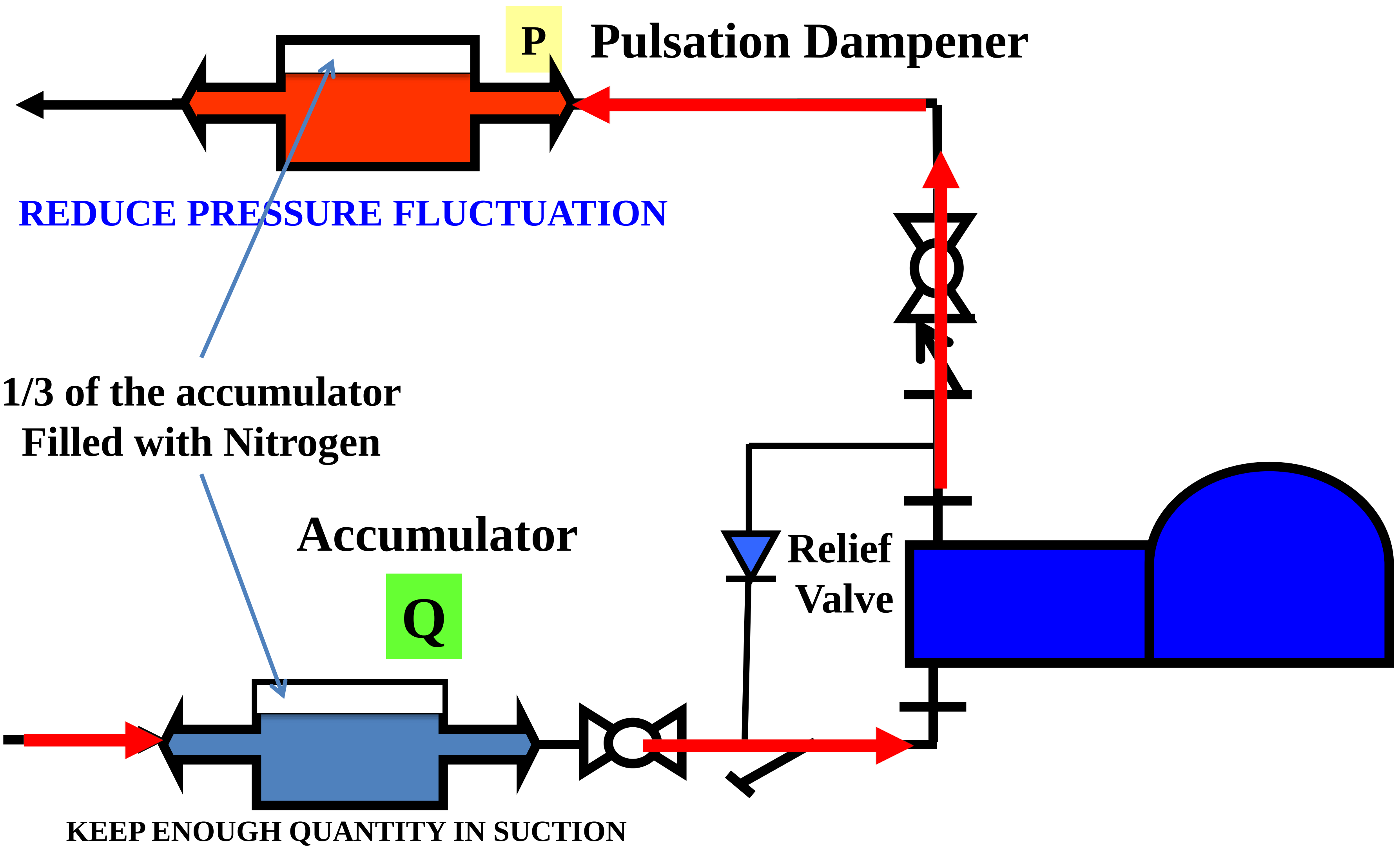
• Reciprocating Pumps

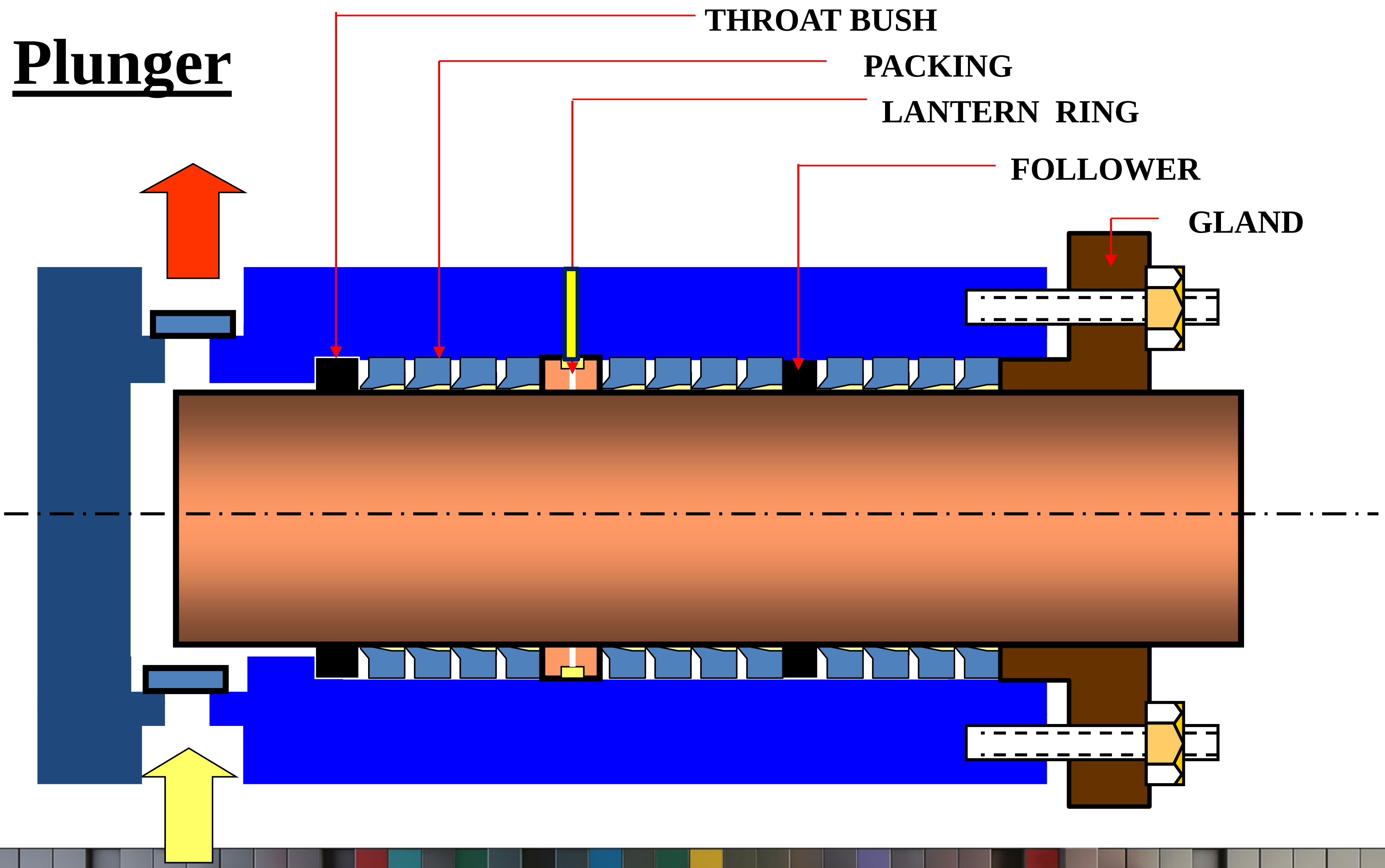


• Reciprocating Pumps

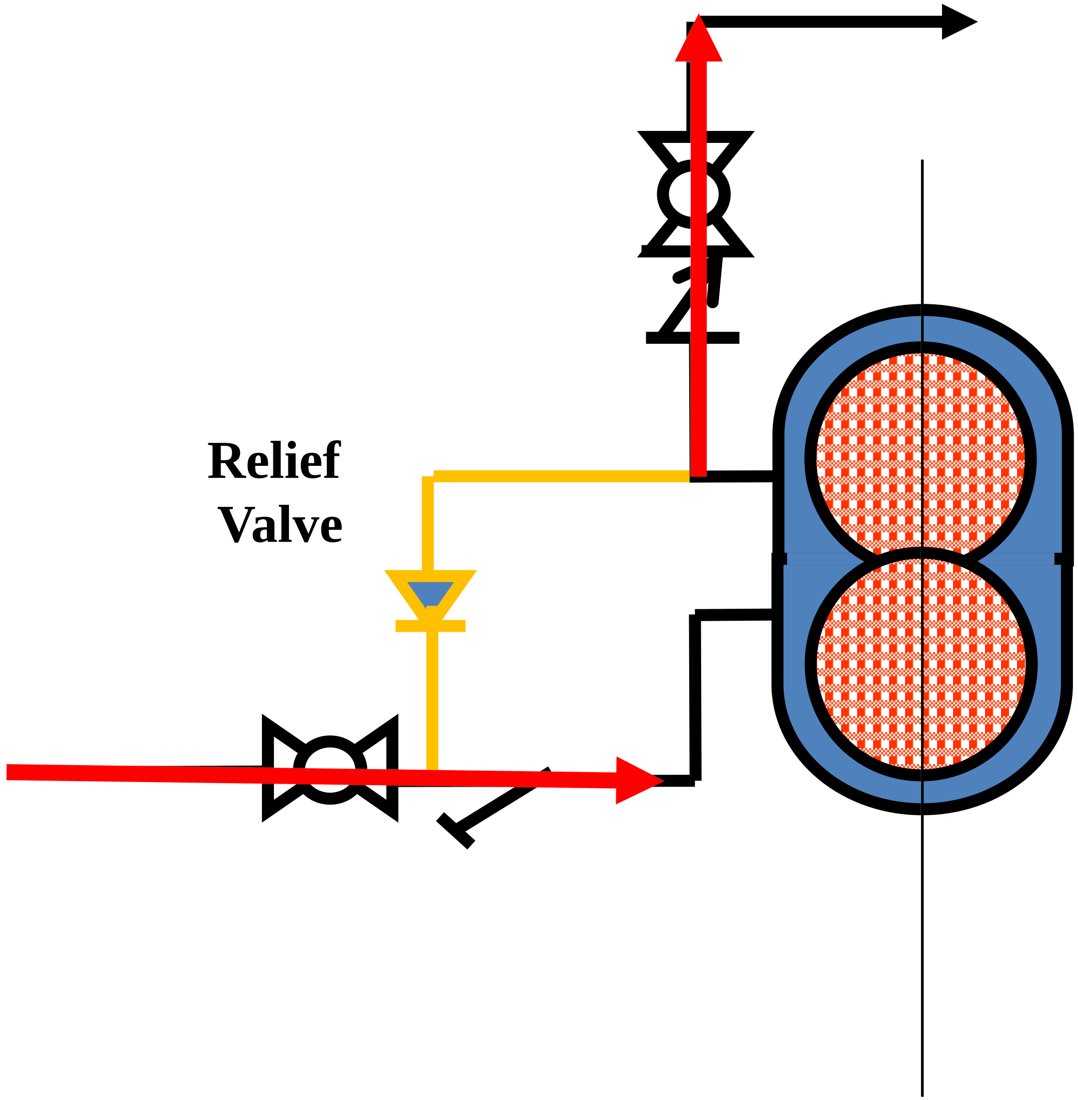


• Reciprocating Pumps

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

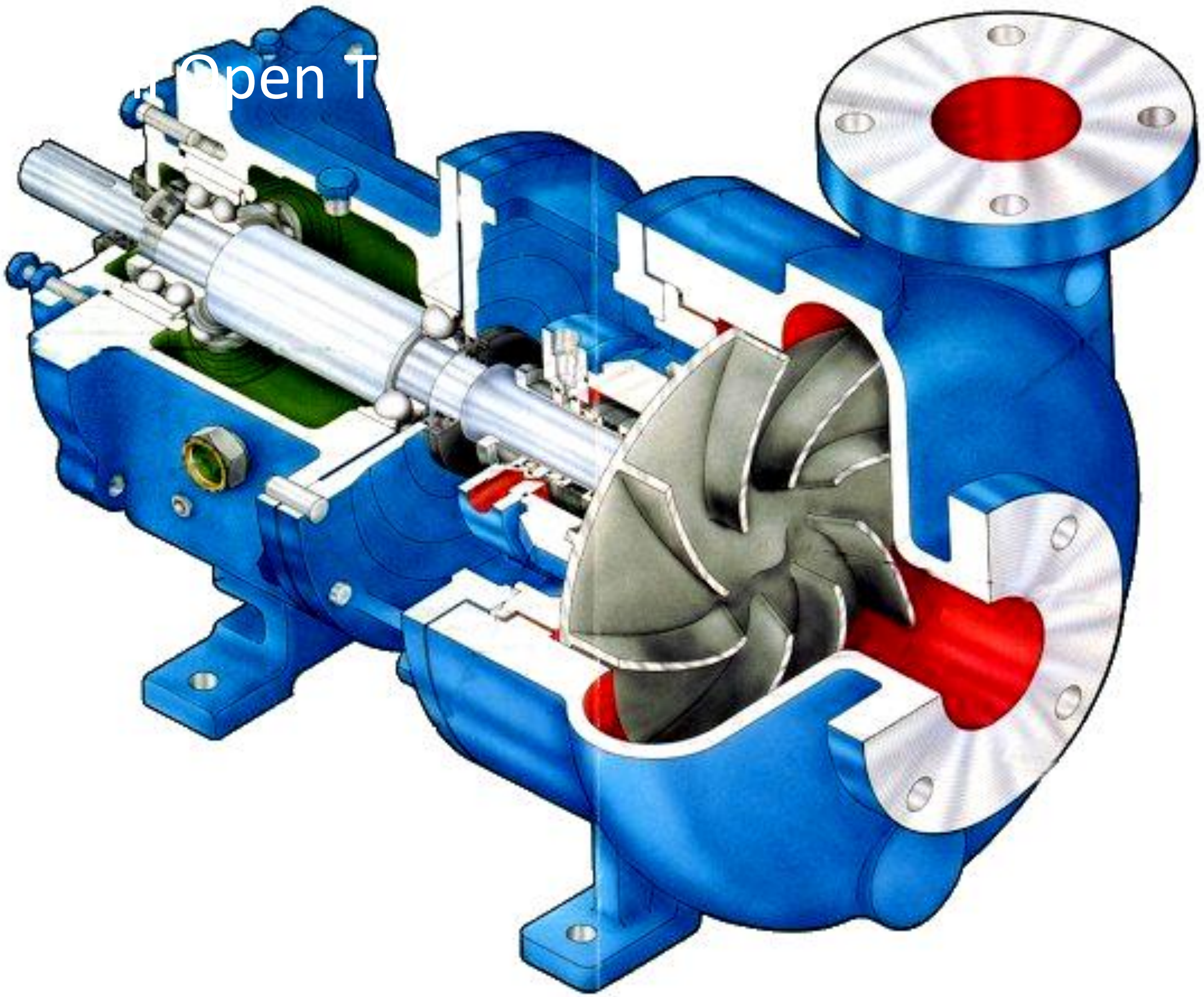
API 676 Rotary

Firewater Pumps

NFPA 20

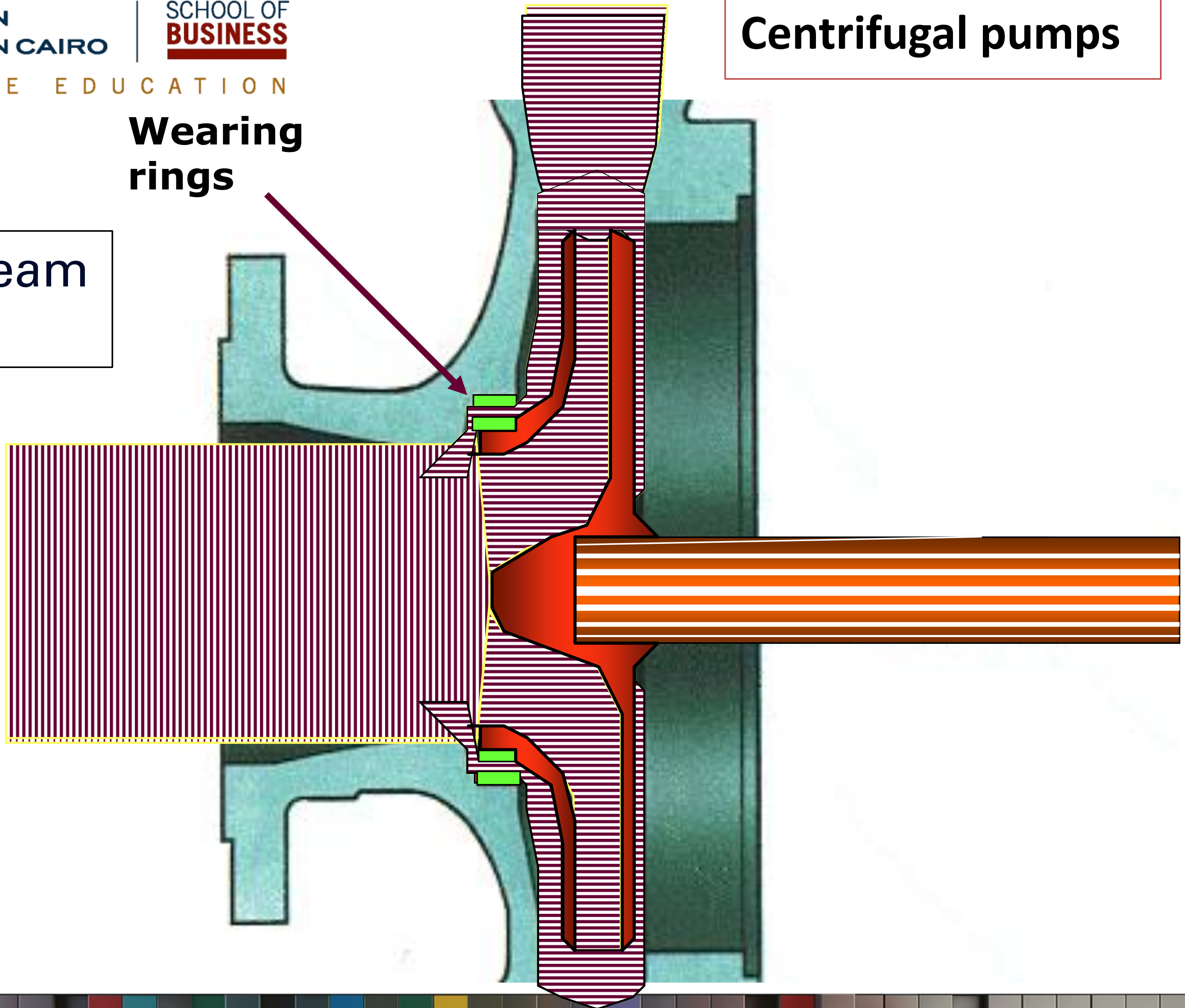
Centrifugal pumps

Centrifugal pumps



Centrifugal pumps

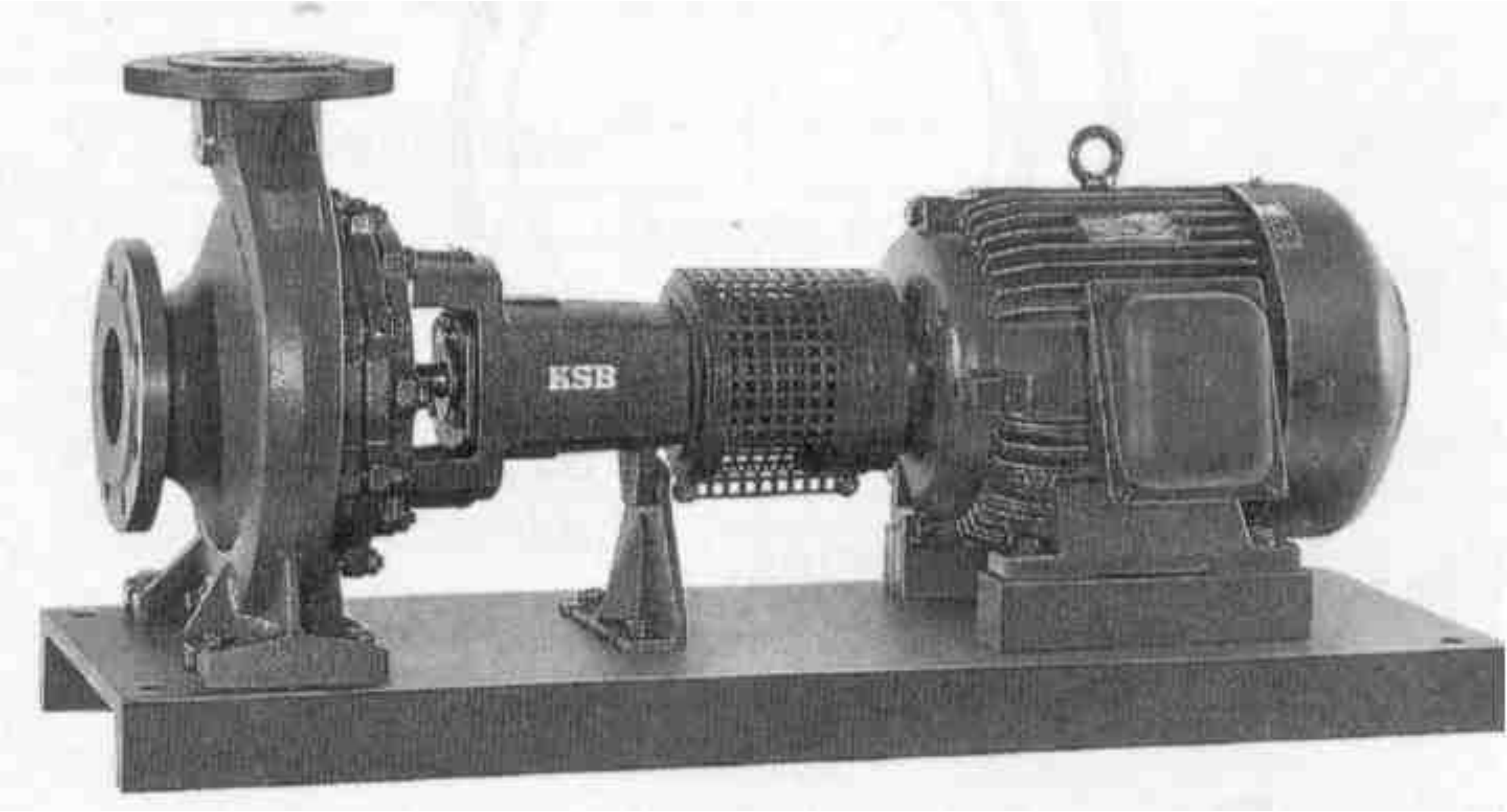
Hanged Beam Impeller



Centrifugal pumps

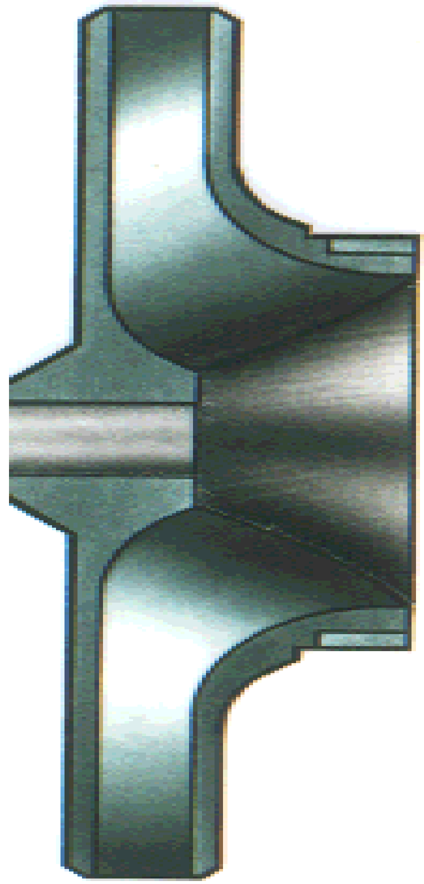
Volute casing

Centrifugal pumps

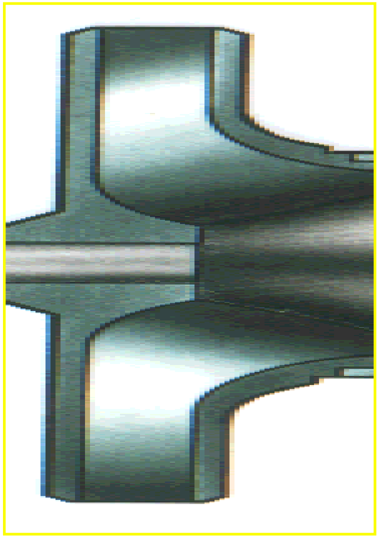


Impellers Classification

High Head
Low Flow

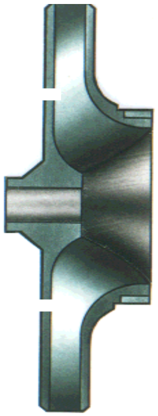


High Head
High Flow

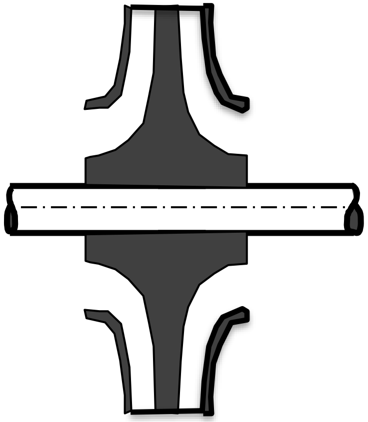


Very high Flow
Very Low Head

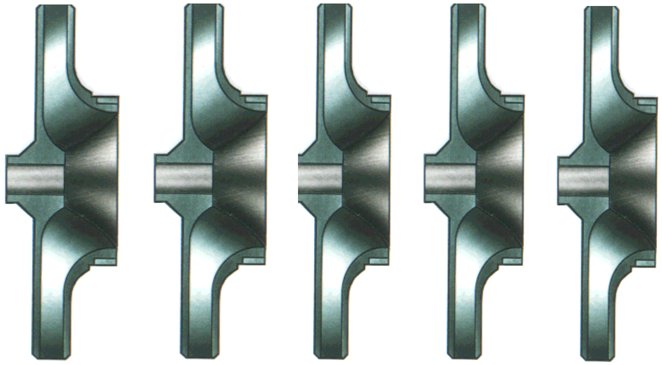
SOME TYPES OF CENTRIFUGAL PUMPS



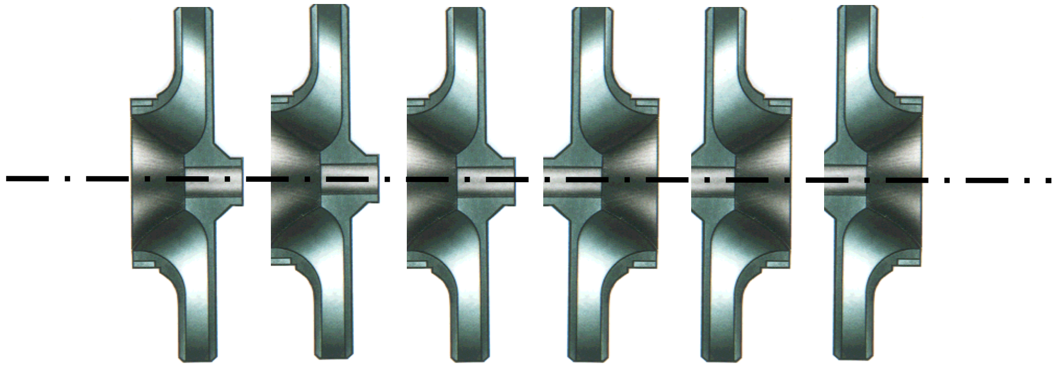
SINGLE IMPELLER



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.

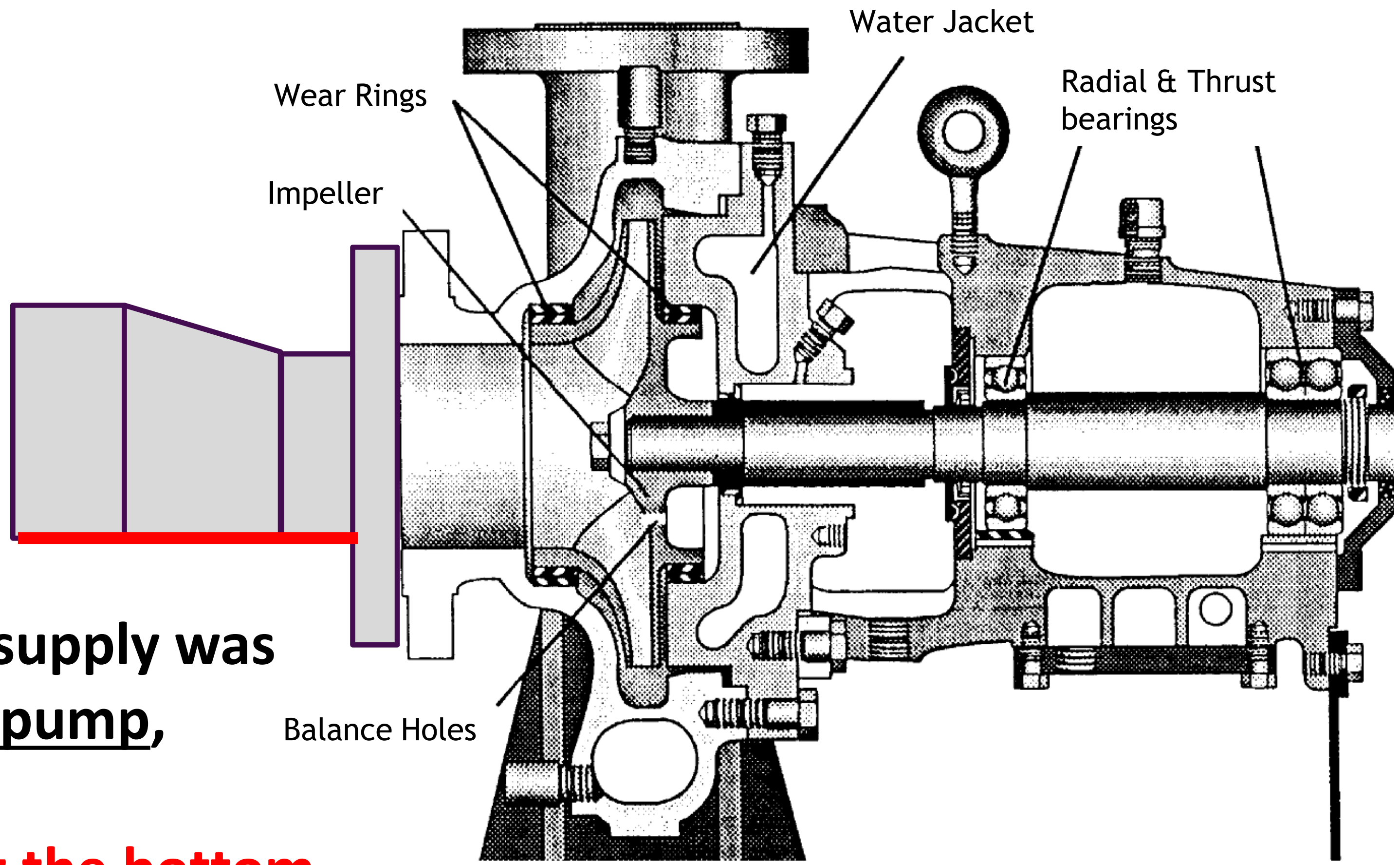
Wear Ring Clearance

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

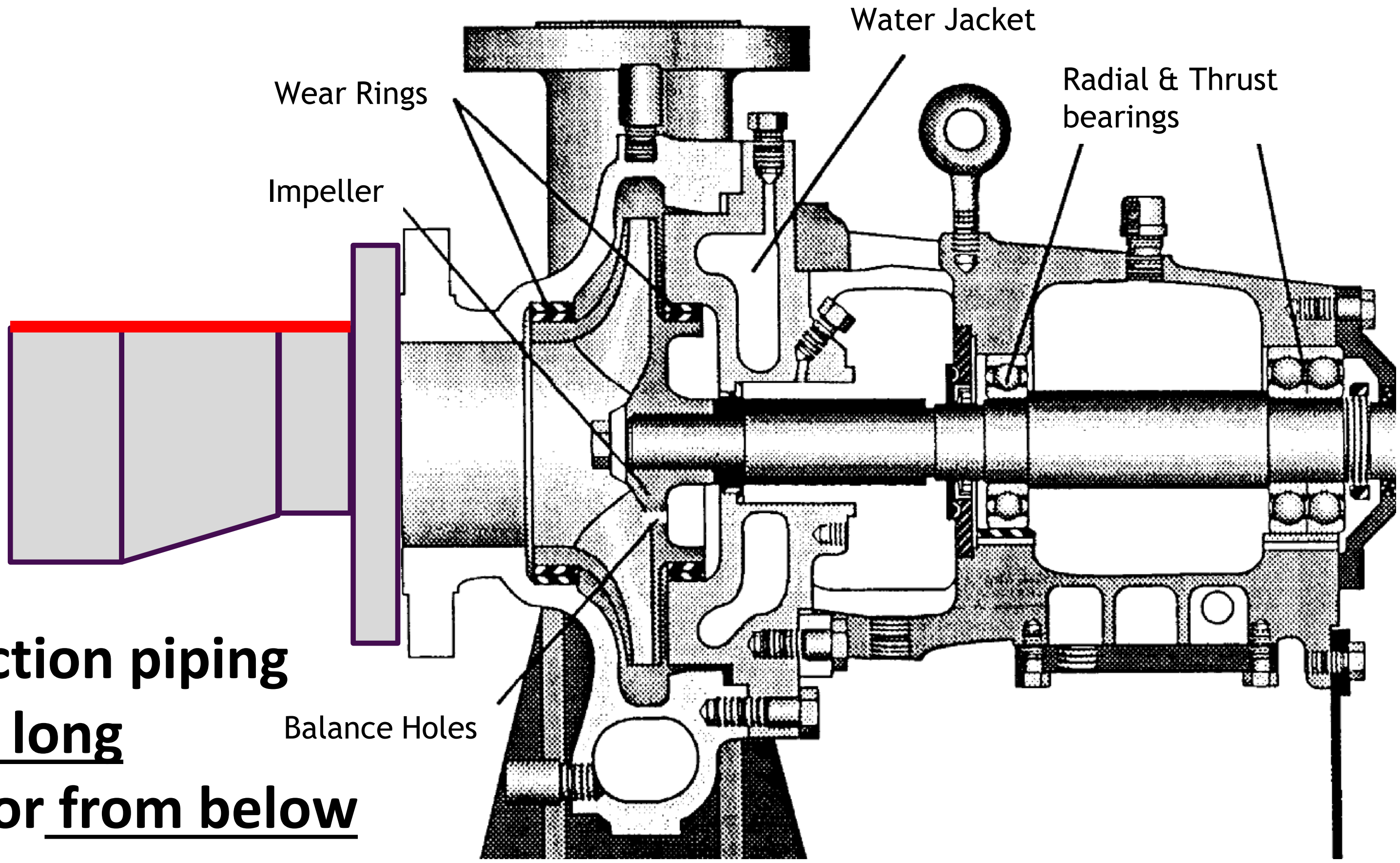
Reducer



If the source of supply was from <u>above the pump</u>,

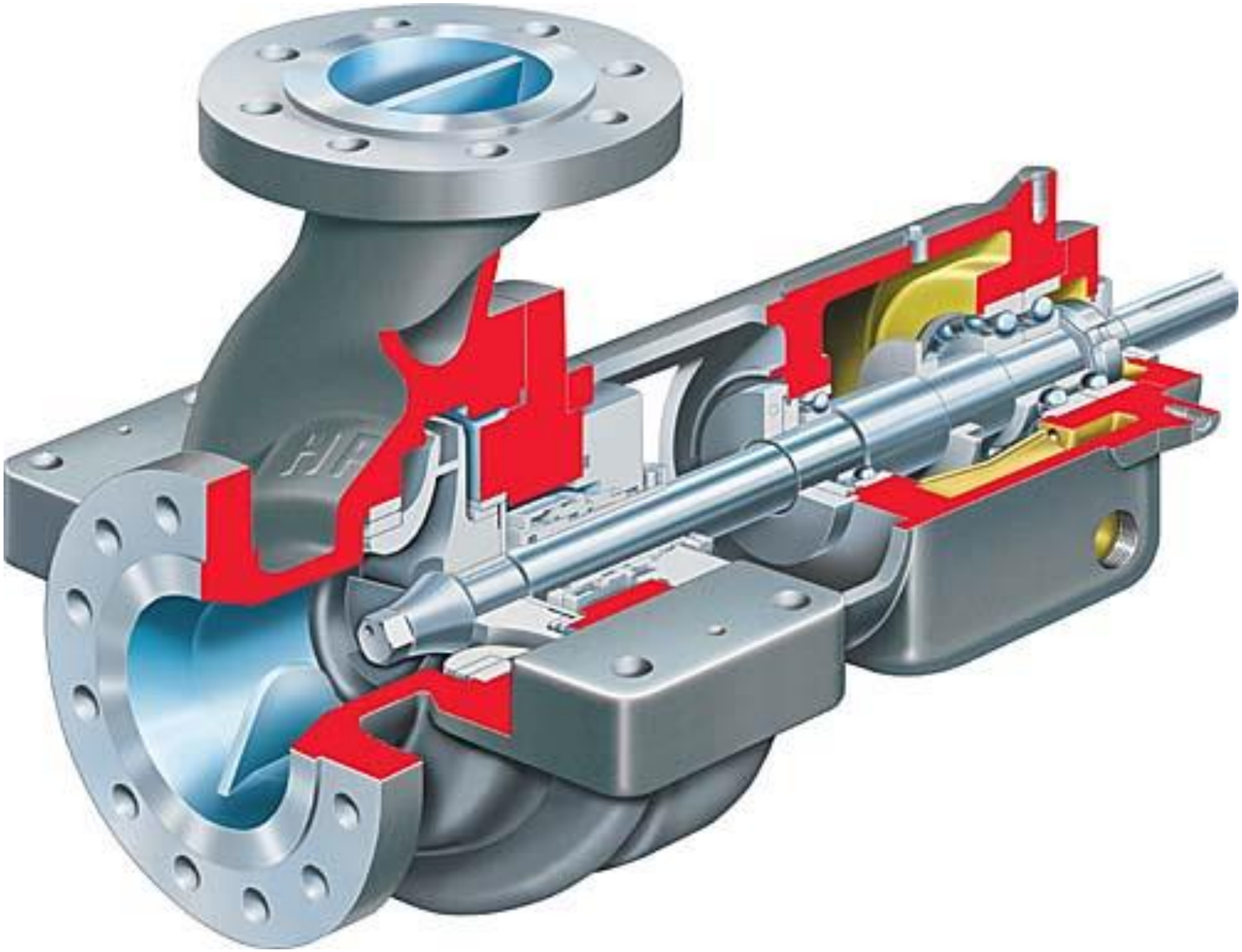
<u>flat should be at the bottom.</u>

Eccentric Reducer

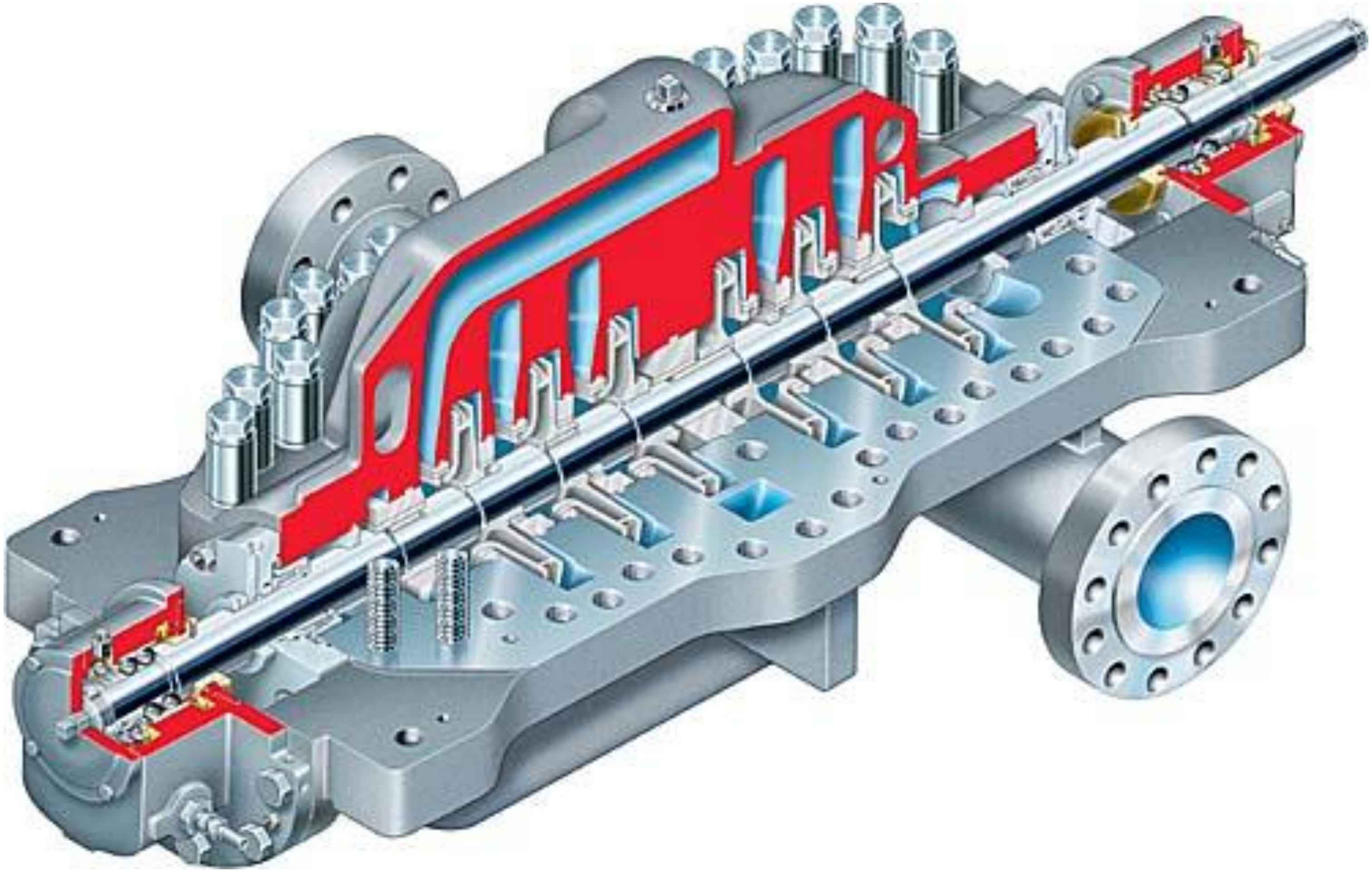


If the pump suction piping entered after <u>a long horizontal</u> run or <u>from below the pump,</u>

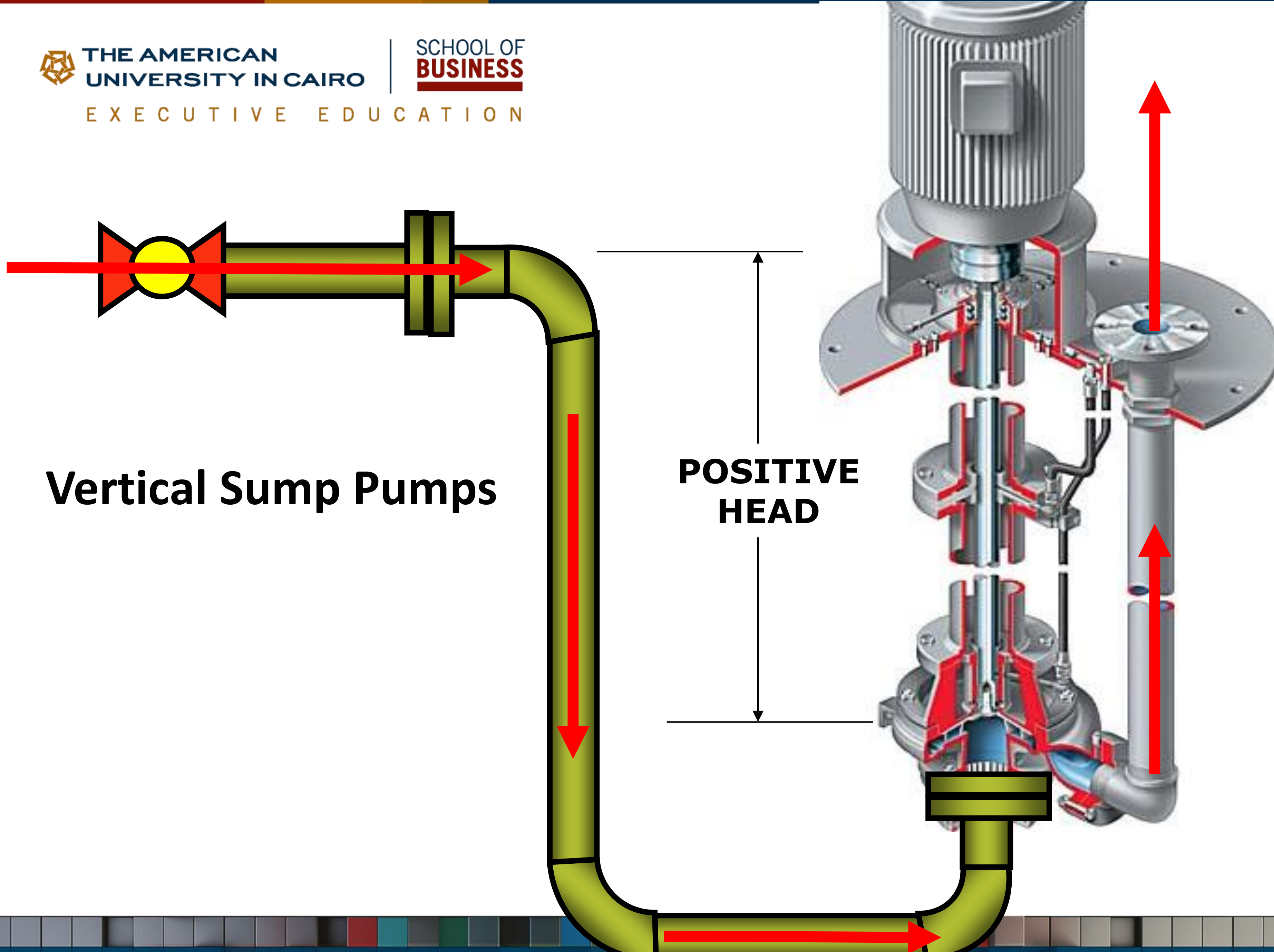
<u>flat should be at the top</u>



Horizontal Split Case Feed Pump

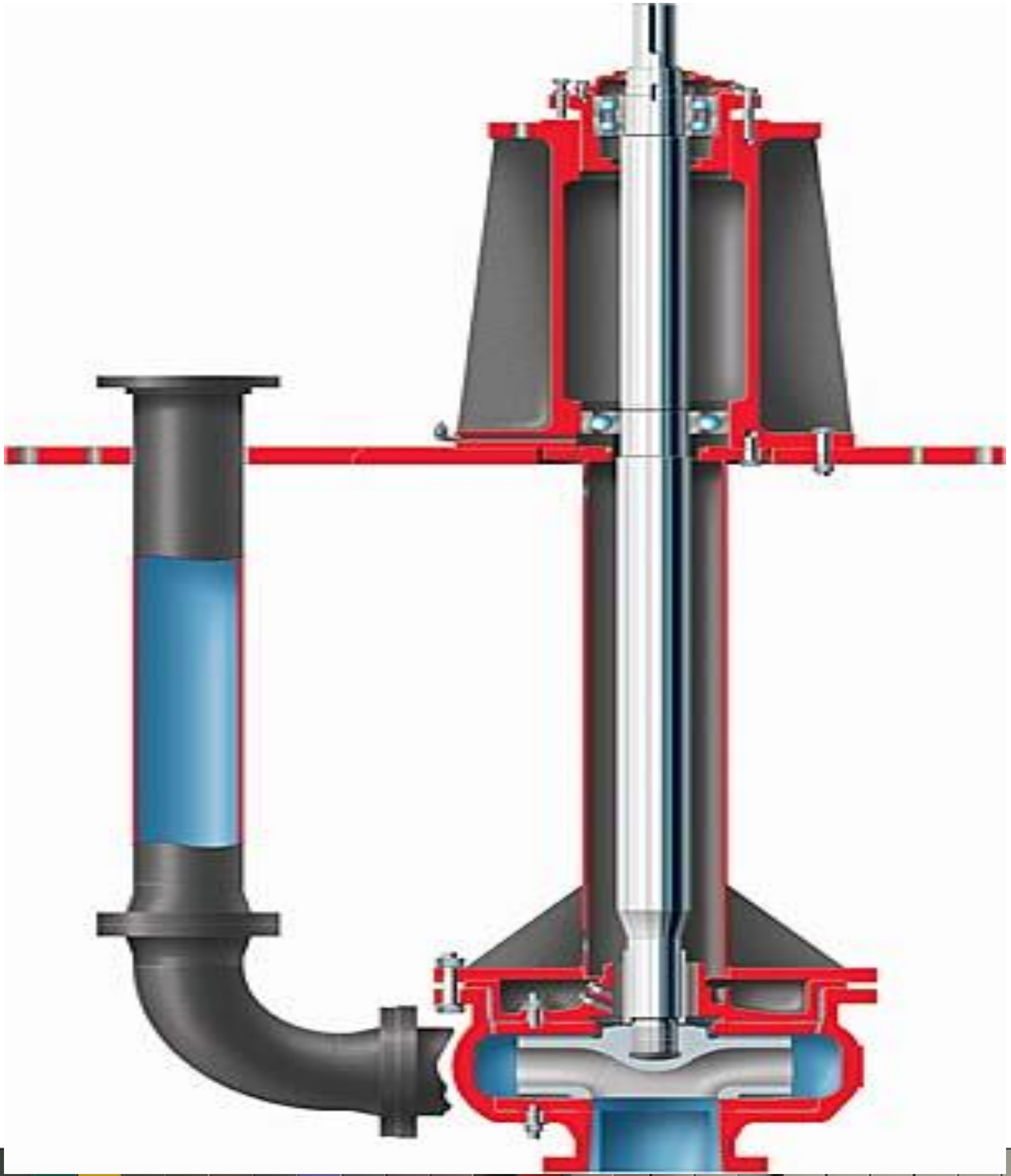


Vertical Sump Pumps



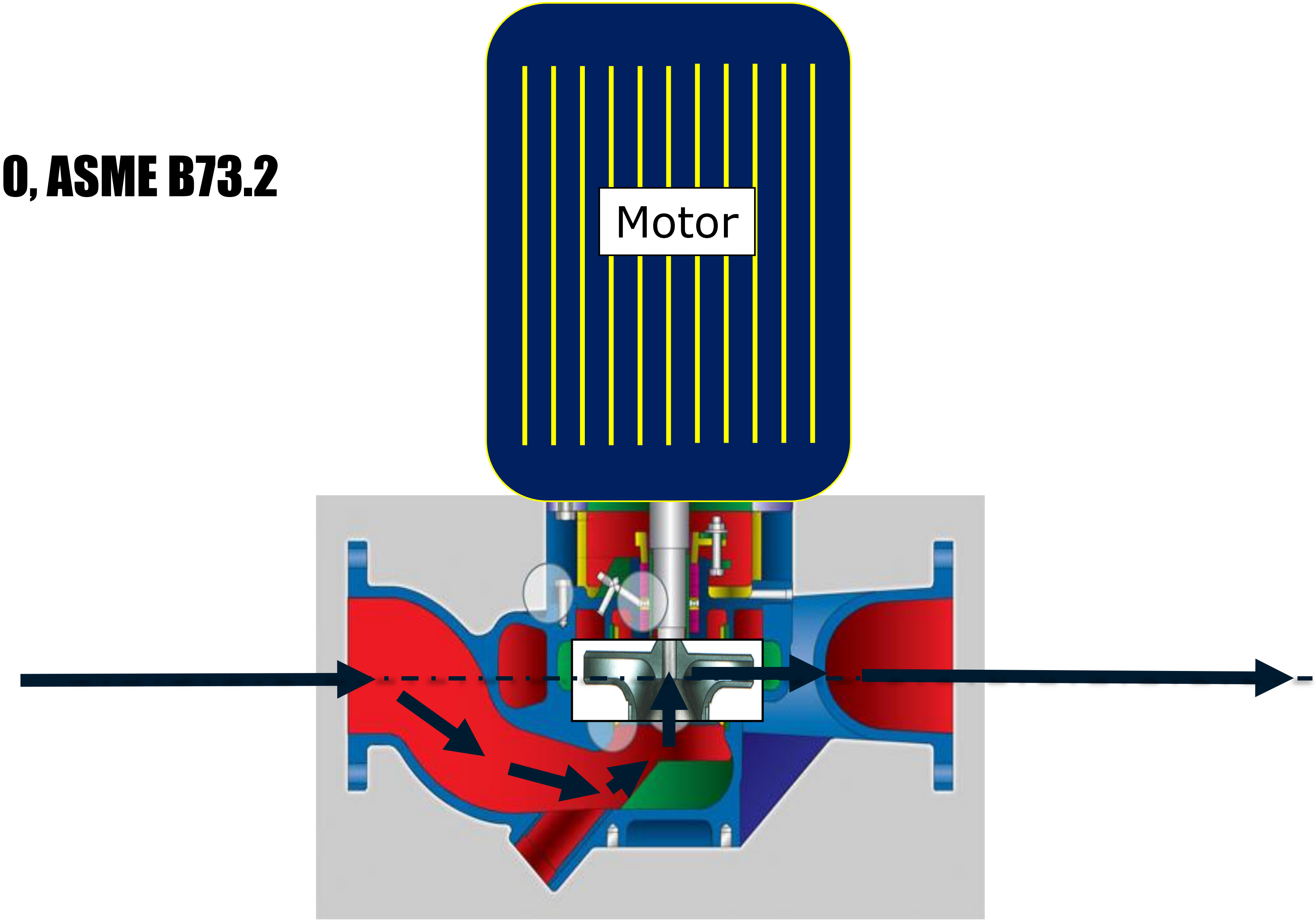
Vertical Cantilever Pump

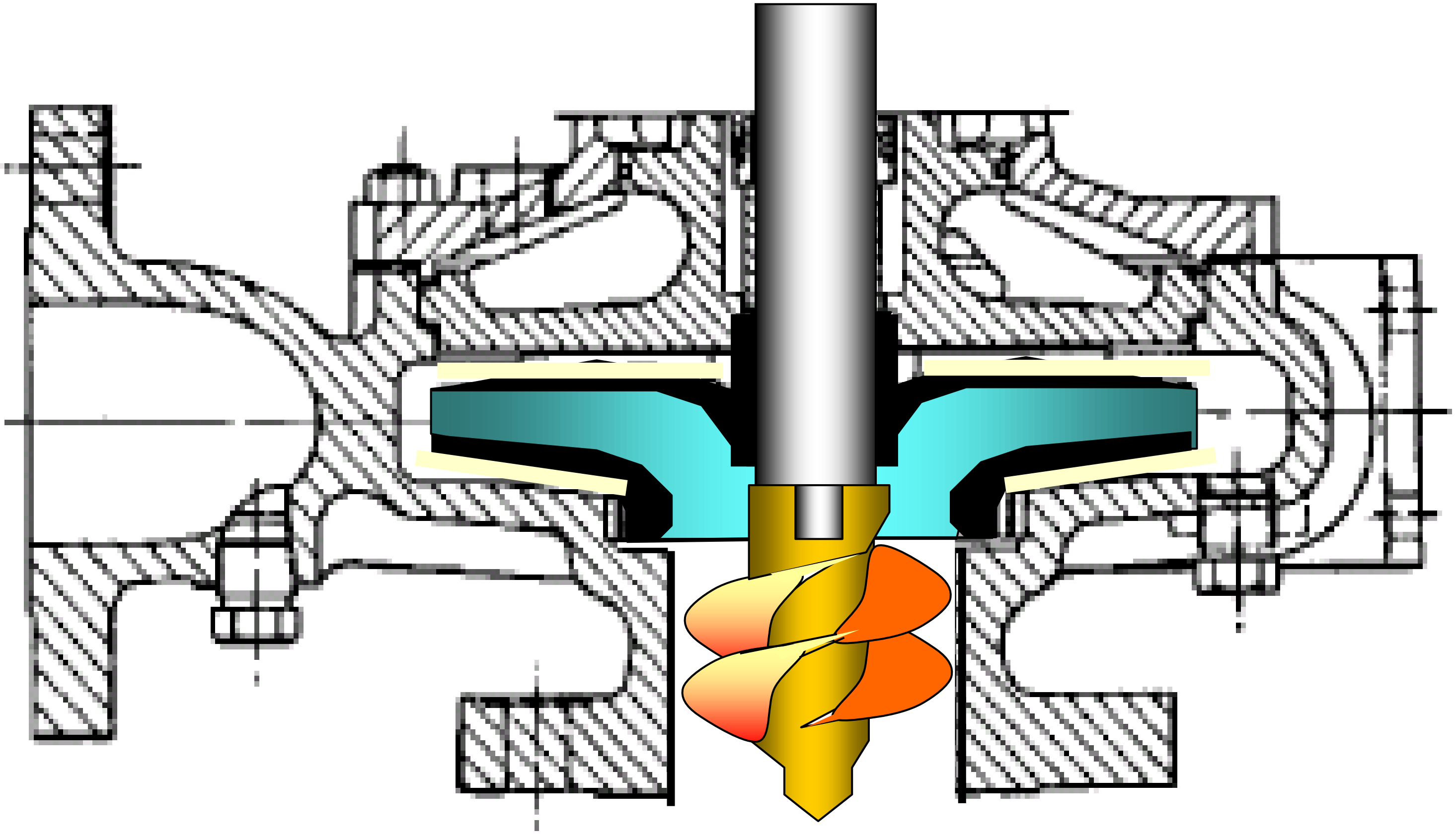
Slurry Applications



Vertical Inline Centrifugal

API 610, ASME B73.2





INDUCER

Sundyne Pumps

Driver

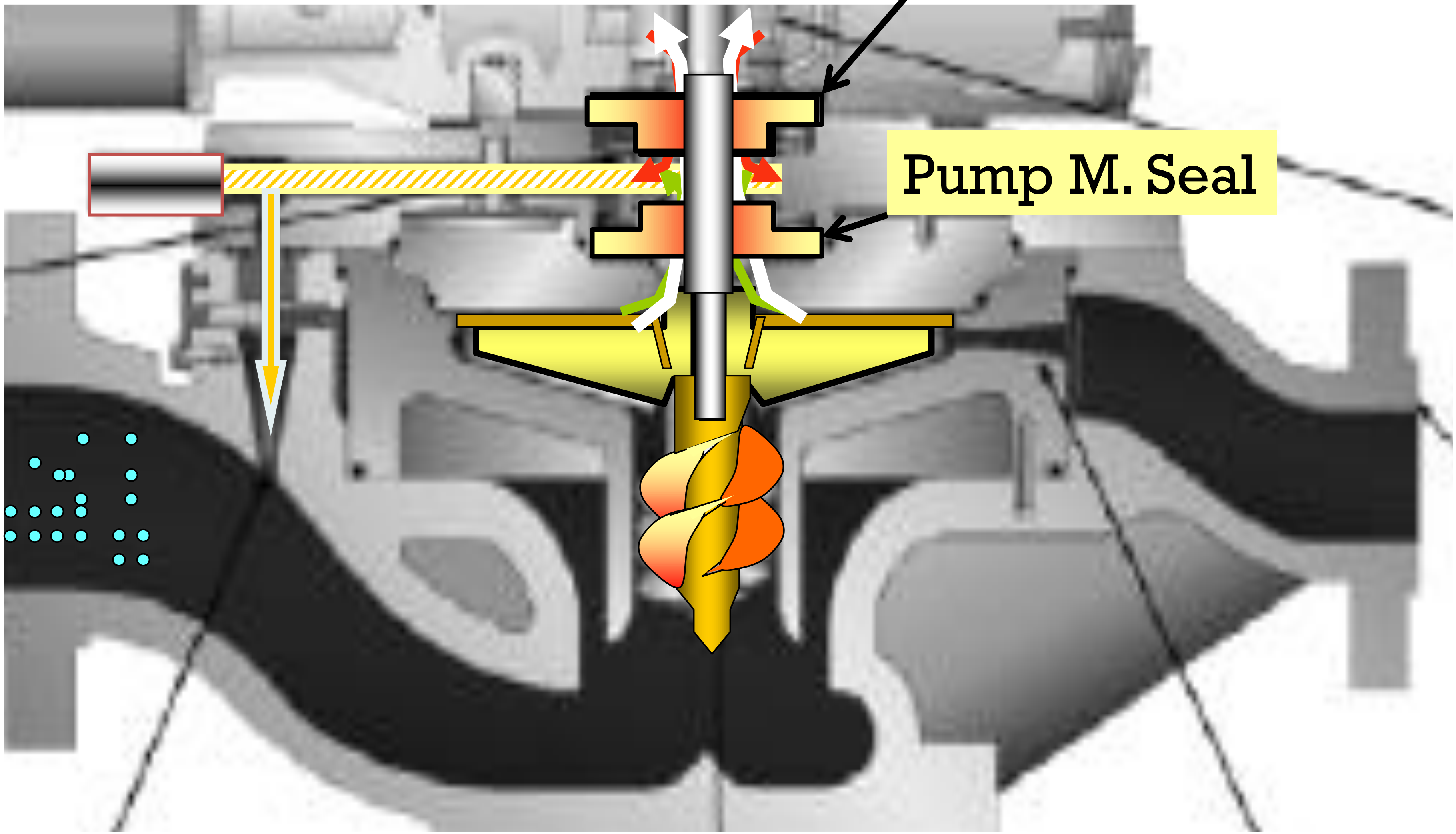
One impeller with Gear box , High speed Pumps

Coupling

Gearbox

Pump

Gearbox M. Seal



PUMPS AFFINITY LAWS

IF THE PUMP SPEED CHANGES FROM N_1 TO N_2

THE FLOW RATE WILL BE

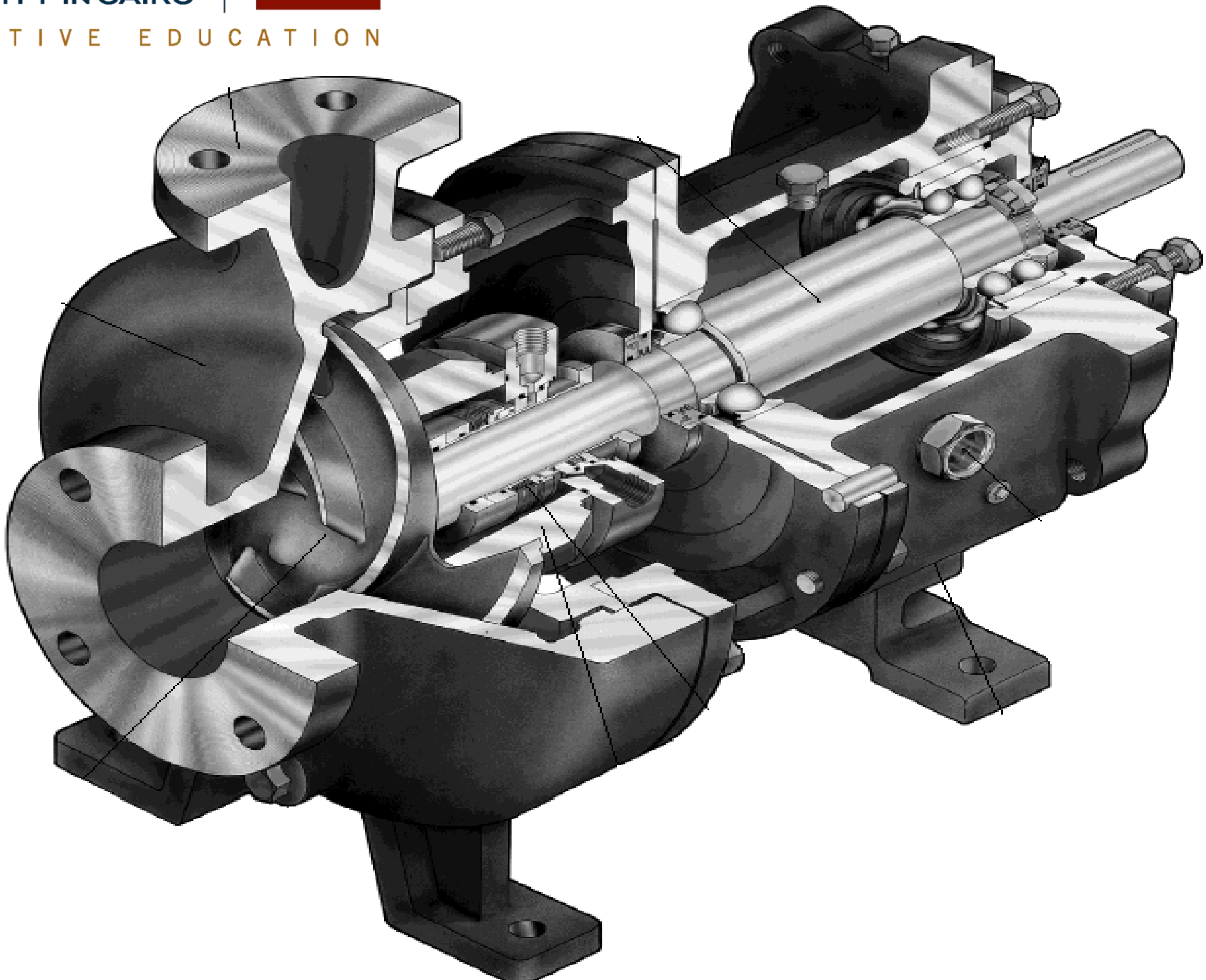
$$\frac{Q_2}{Q_1} = \left[\frac{N_2}{N_1}\right]$$

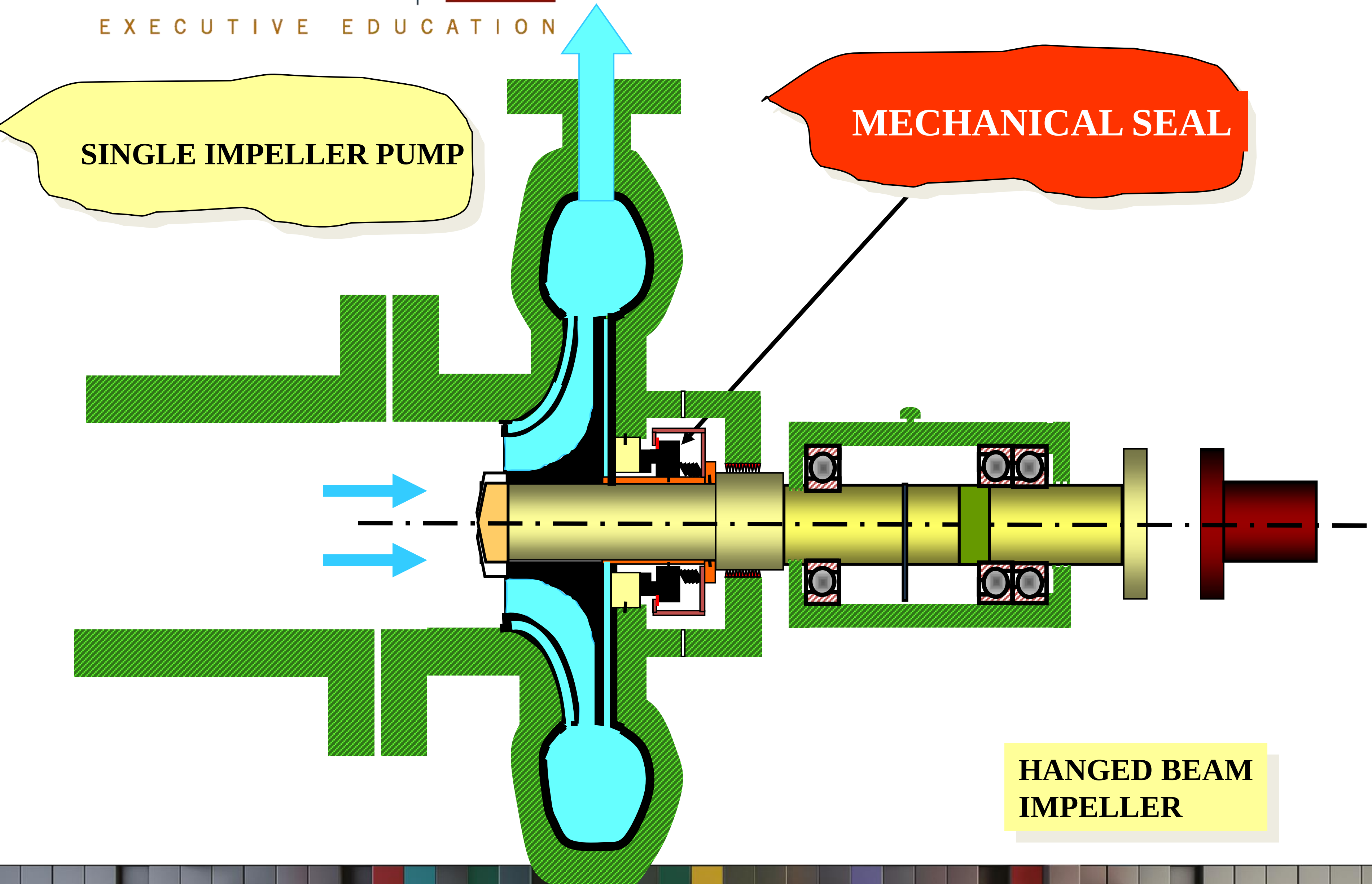
THE DISCH PRESS. WILL BE

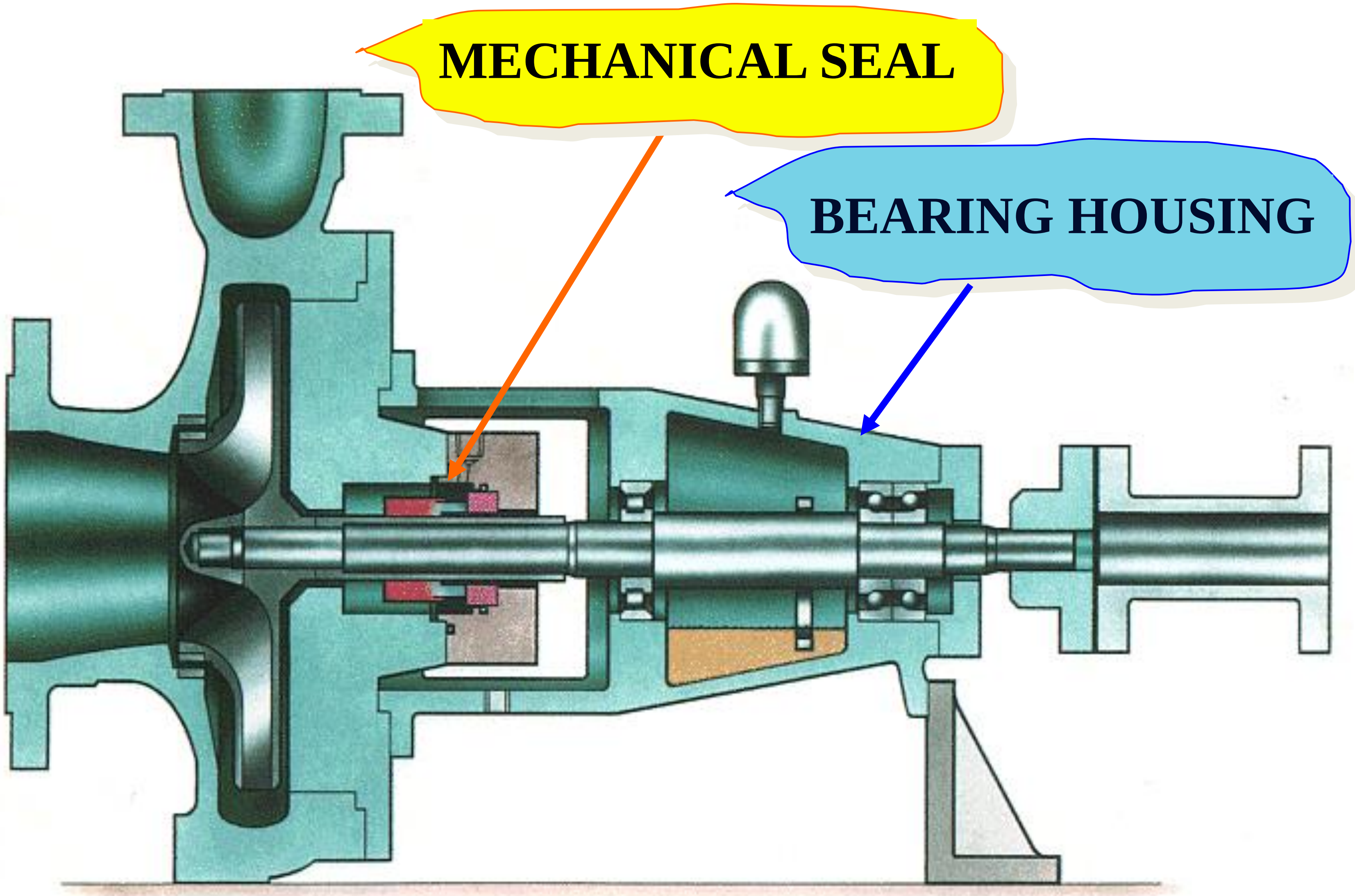
$$\frac{P_2}{P_1} = \left[\frac{N_2}{N_1}\right]^2$$

THE HORSEPWER WILL BE

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



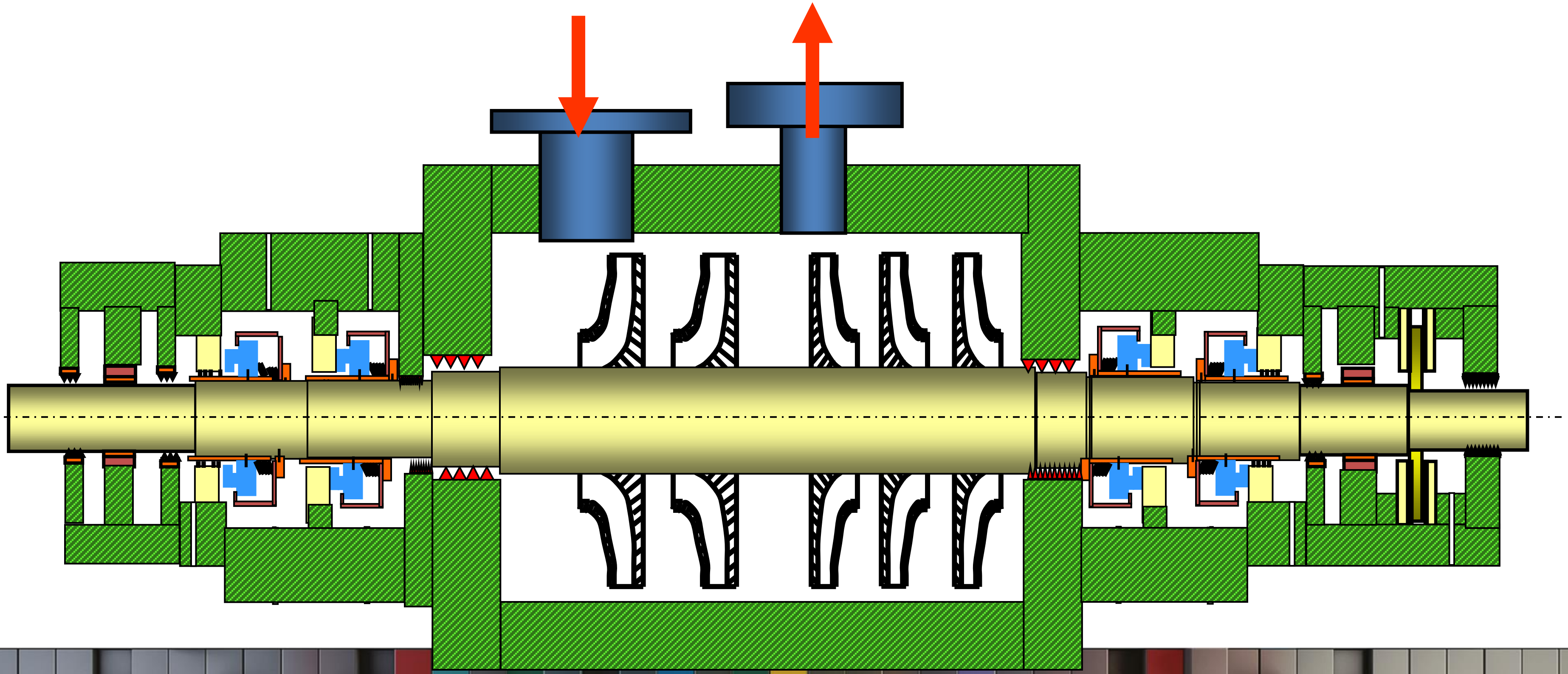

SINGLE IMPELLER PUMP
MECHANICAL SEAL
HANGED BEAM IMPELLER


MECHANICAL SEAL
BEARING HOUSING

SPLIT TYPE PUMPS

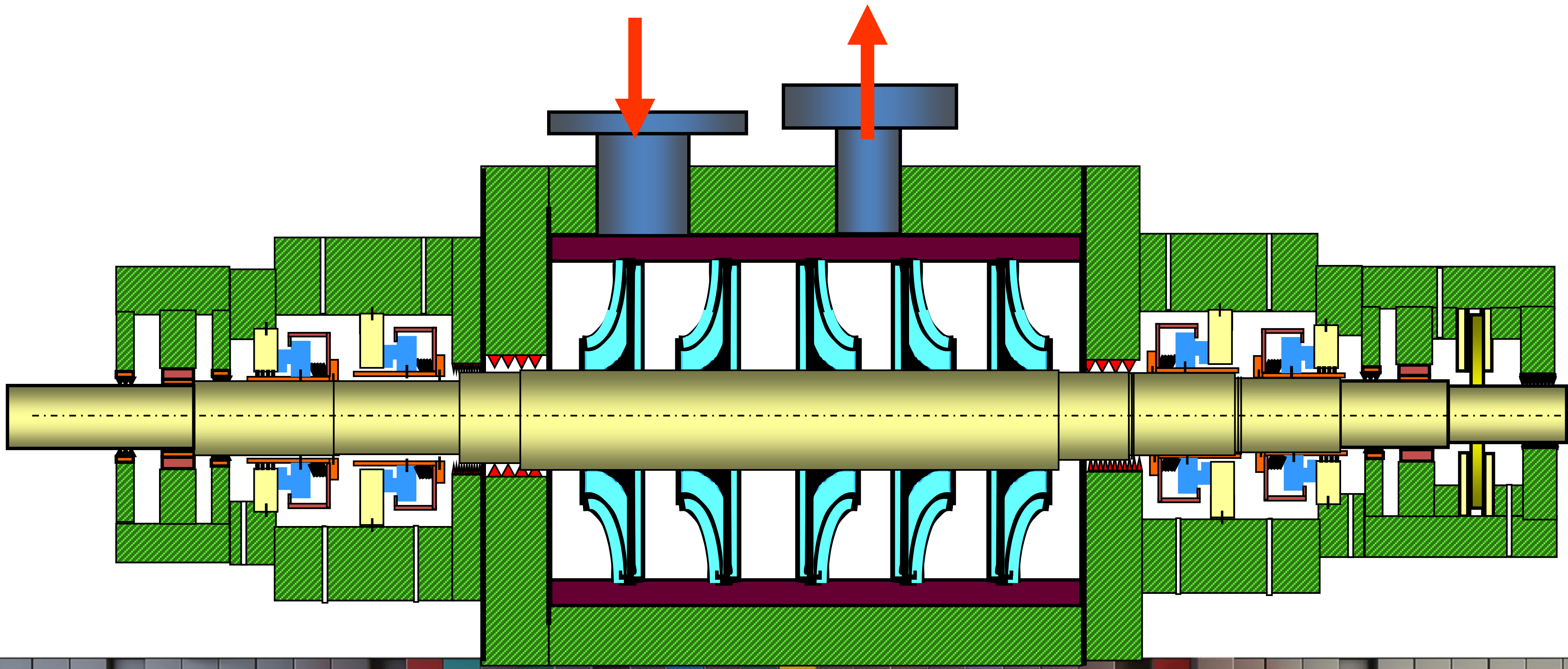
1- Horizontally Split

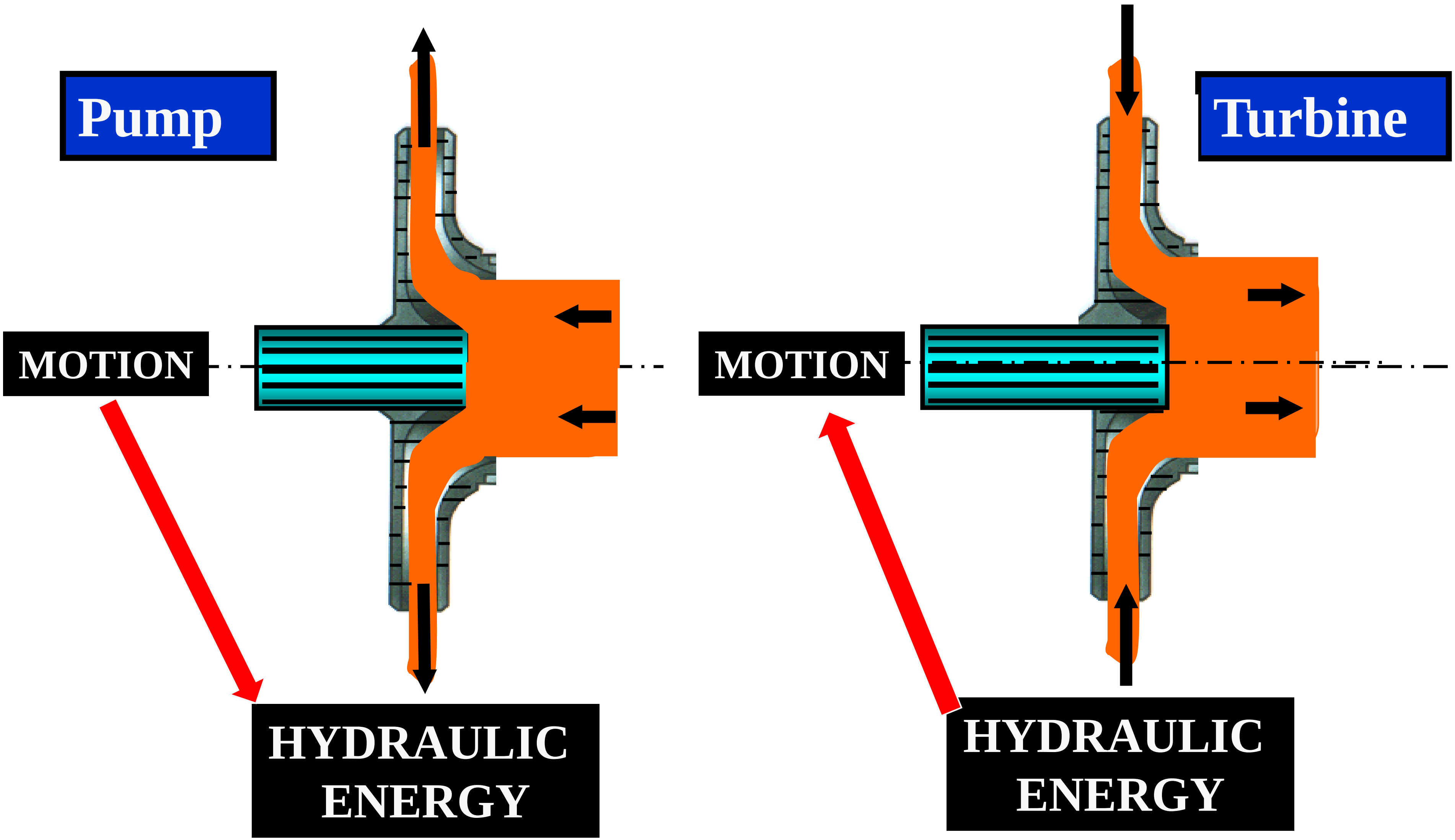
High Flow Medium pressure



2- Vertically Split (Double Barrel)

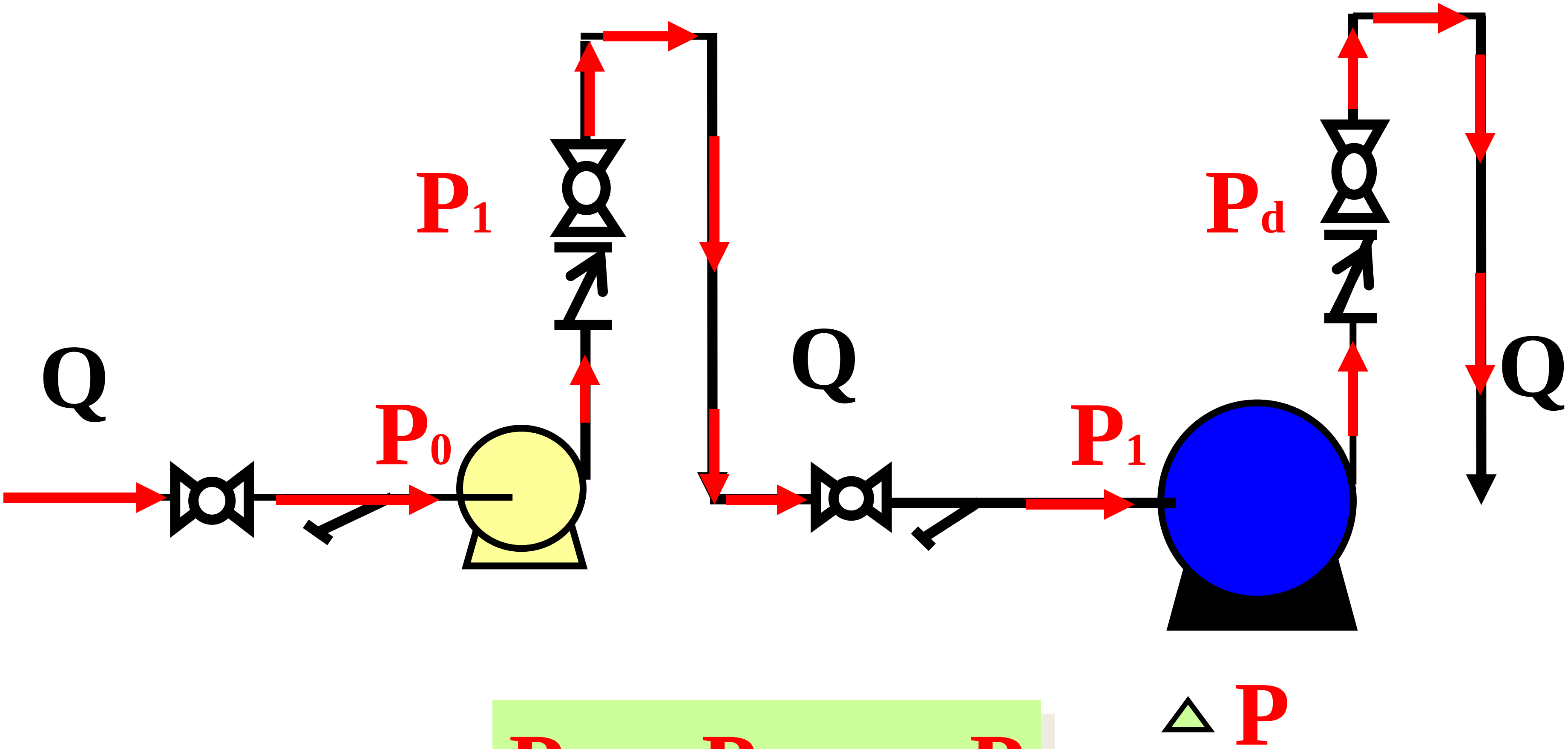
high pressure and medium Flow




Pump
Turbine
MOTION
MOTION
HYDRAULIC ENERGY
HYDRAULIC ENERGY

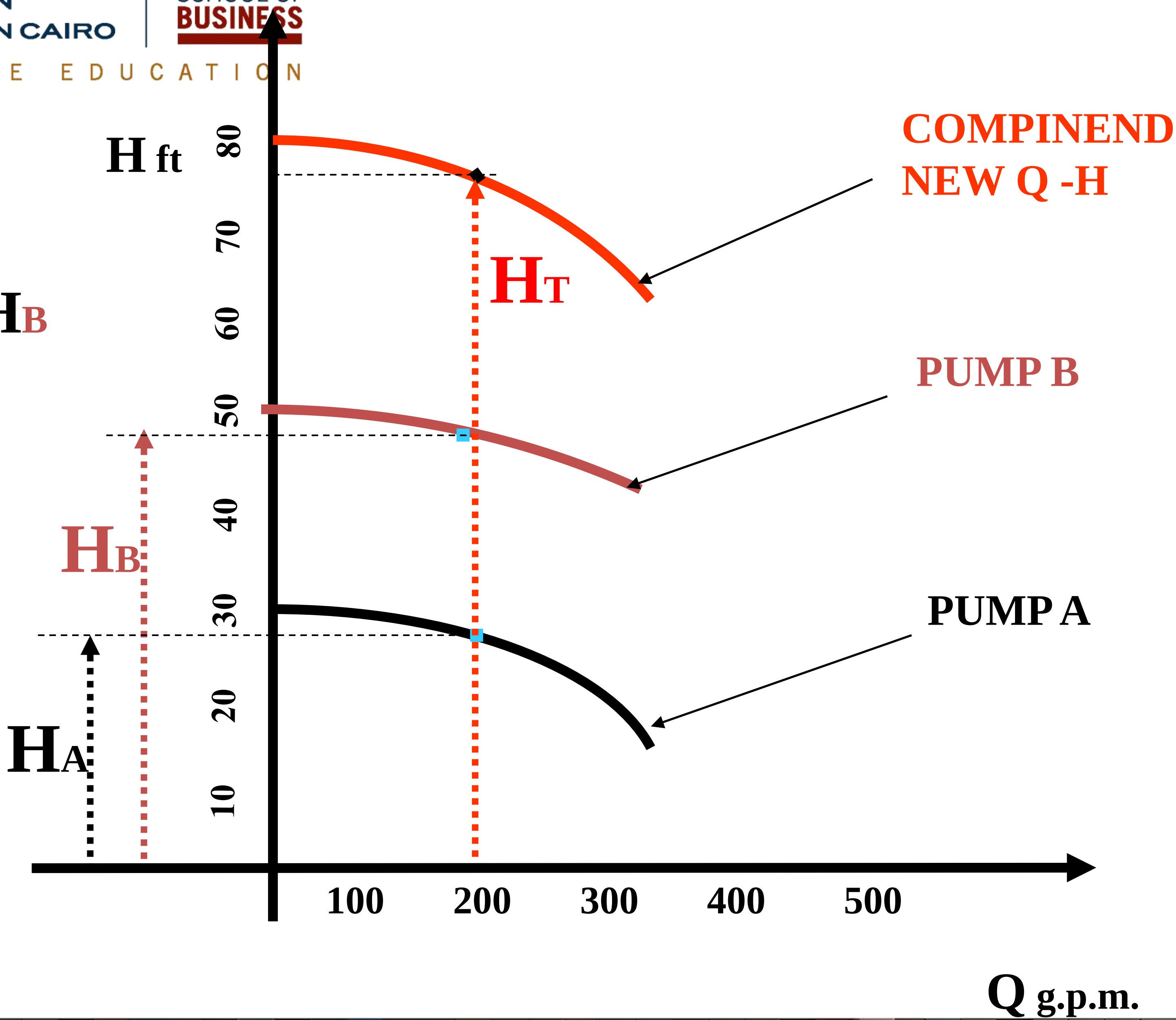
Pumps arrangement

Centrifugal pumps in series

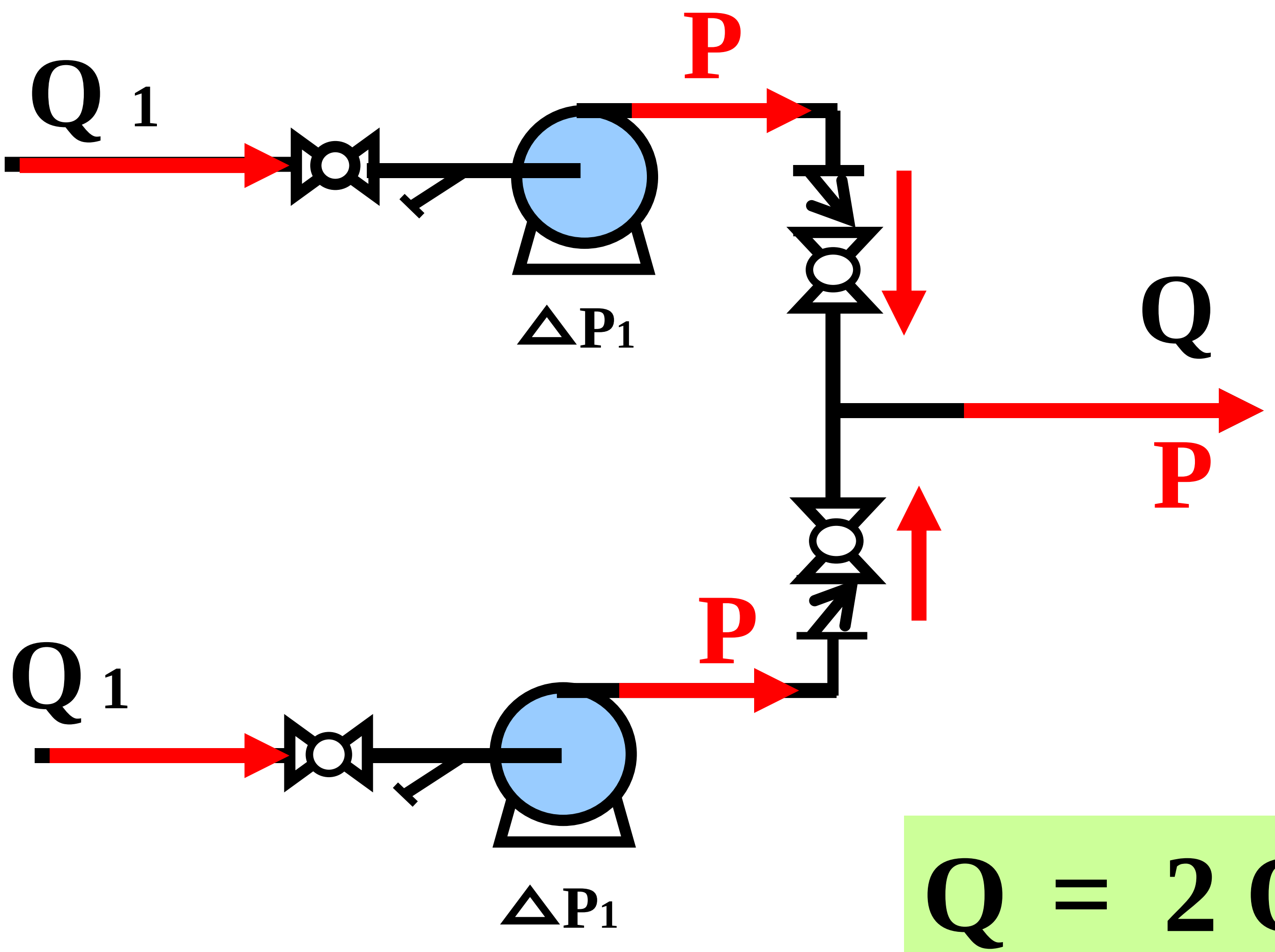


$$P_d = P_1 + \triangle P$$

$$H_T = H_A + H_B$$

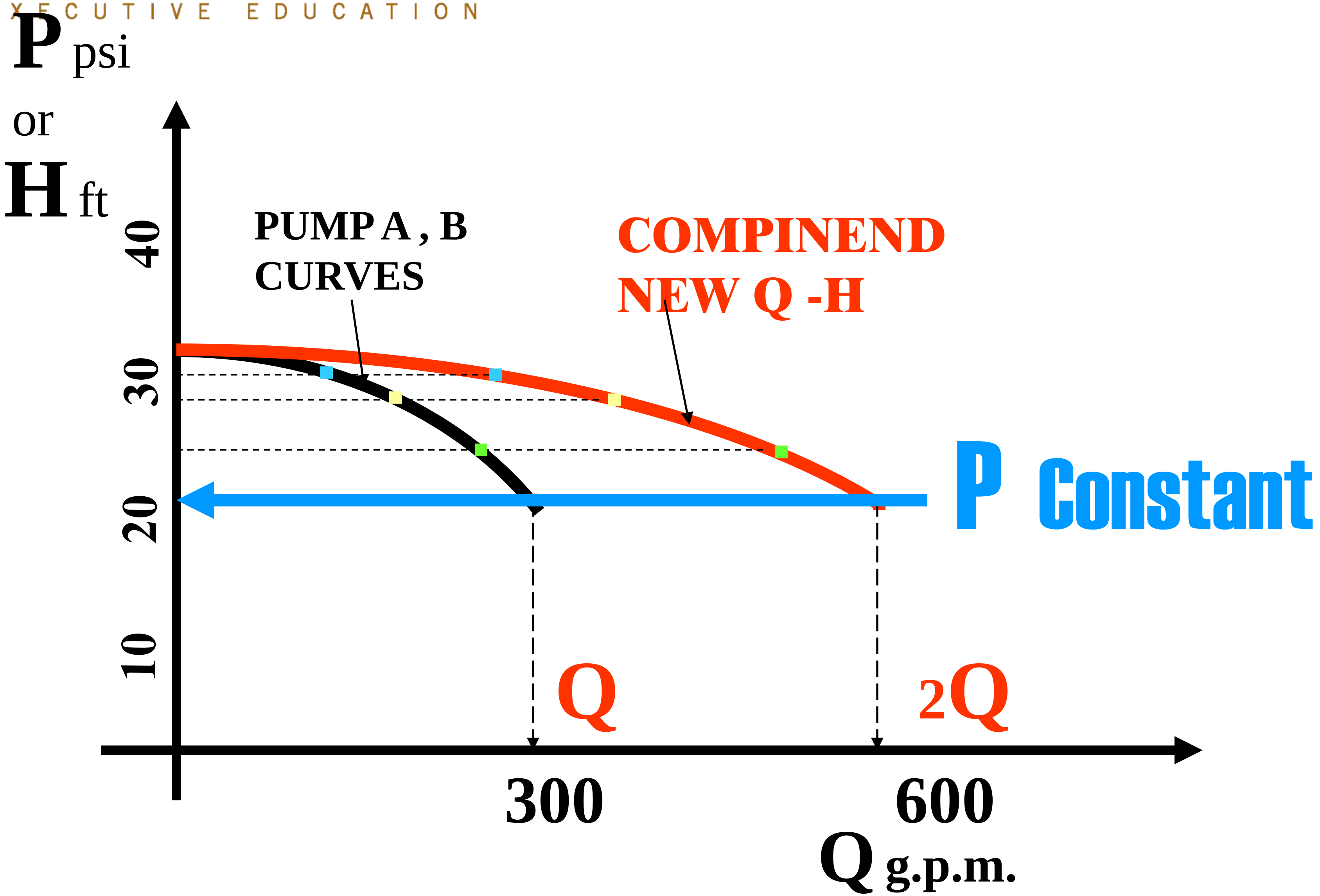

H ft
80
70
60
50
40
30
20
10
COMPINEND
NEW Q -H
HT
PUMP B
HB
PUMP A
HA
100
200
300
400
500
Q g.p.m.

Centrifugal pumps in parallel



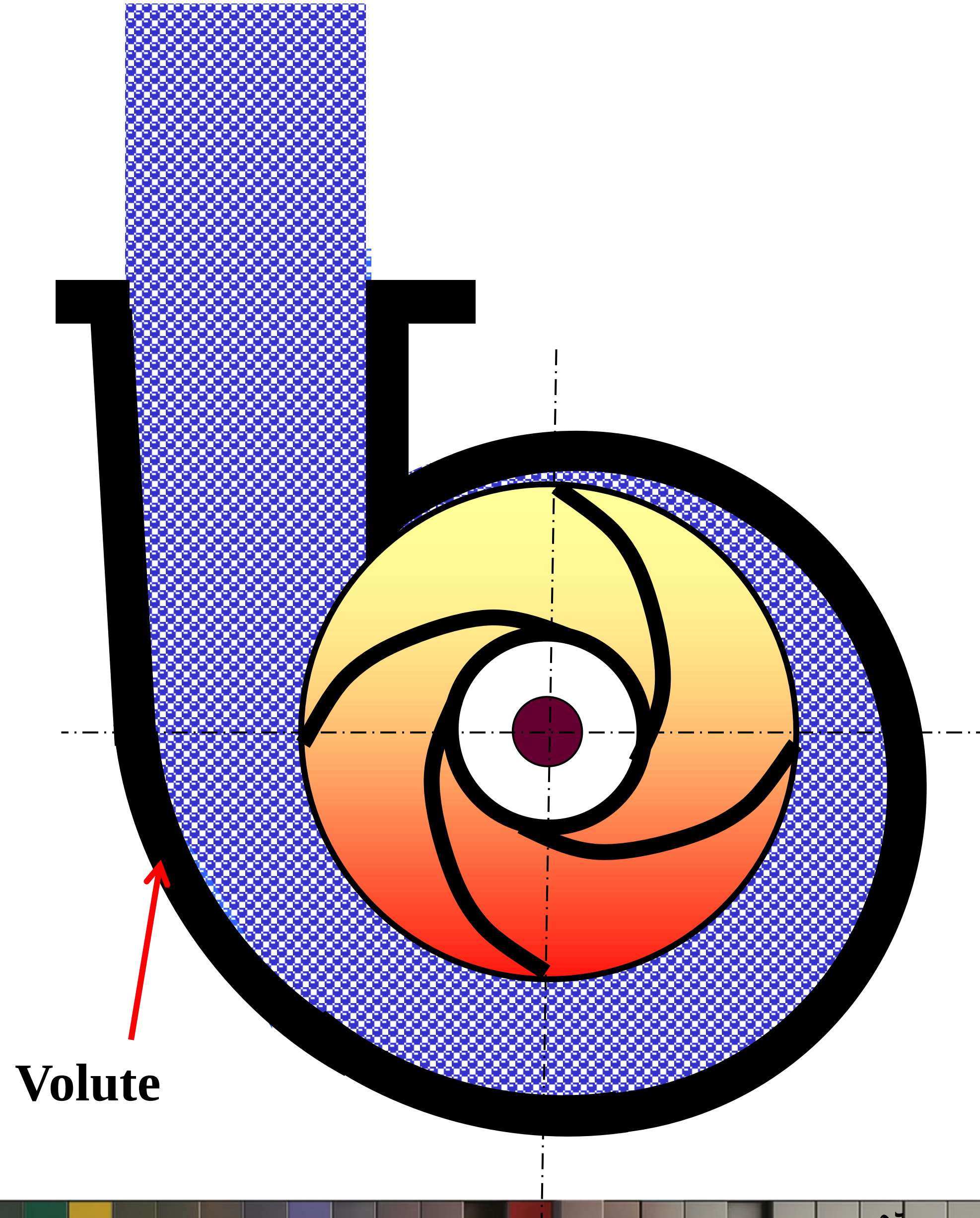
$$Q = 2Q_1$$

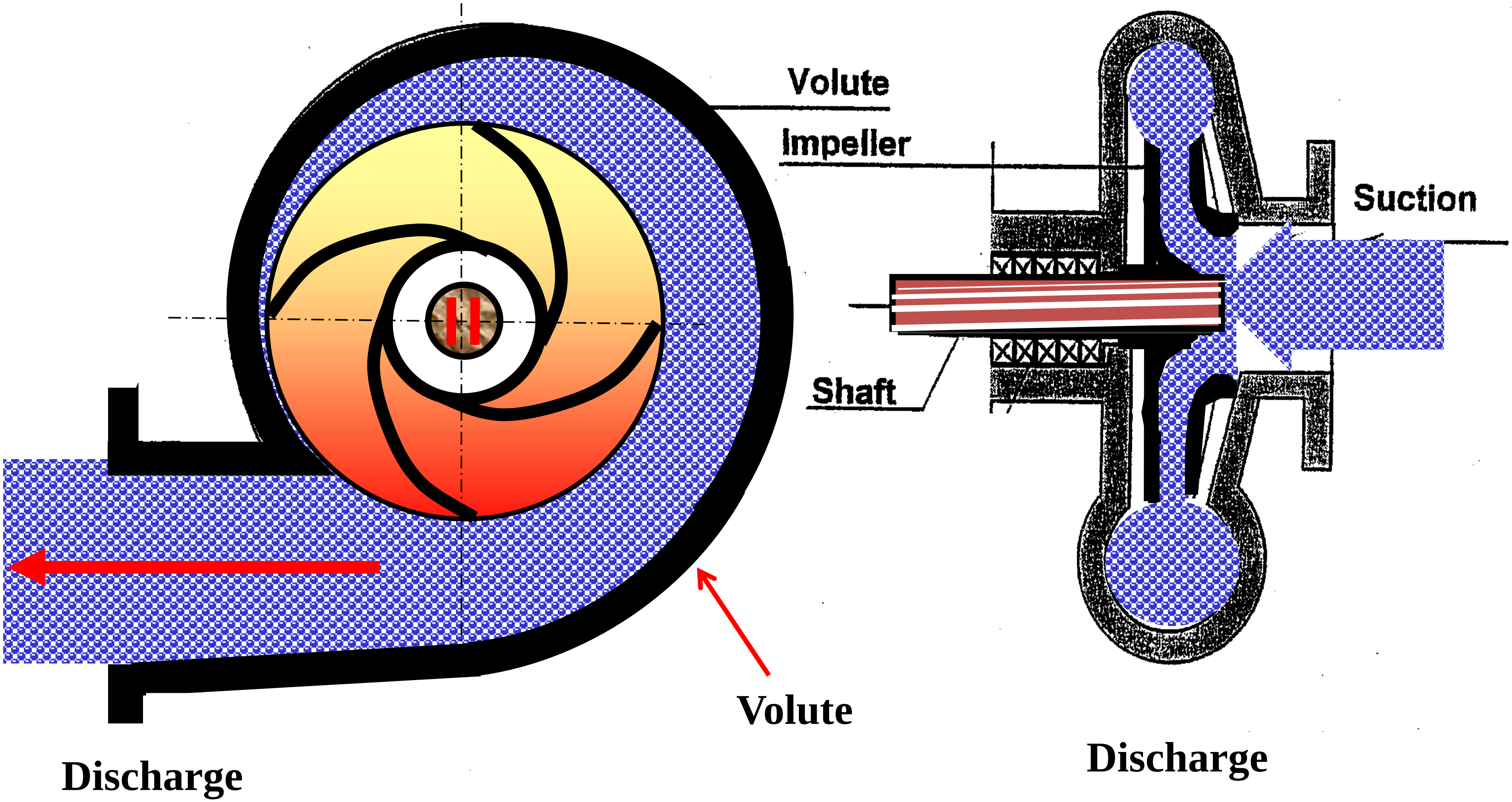
Centrifugal pumps in parallel



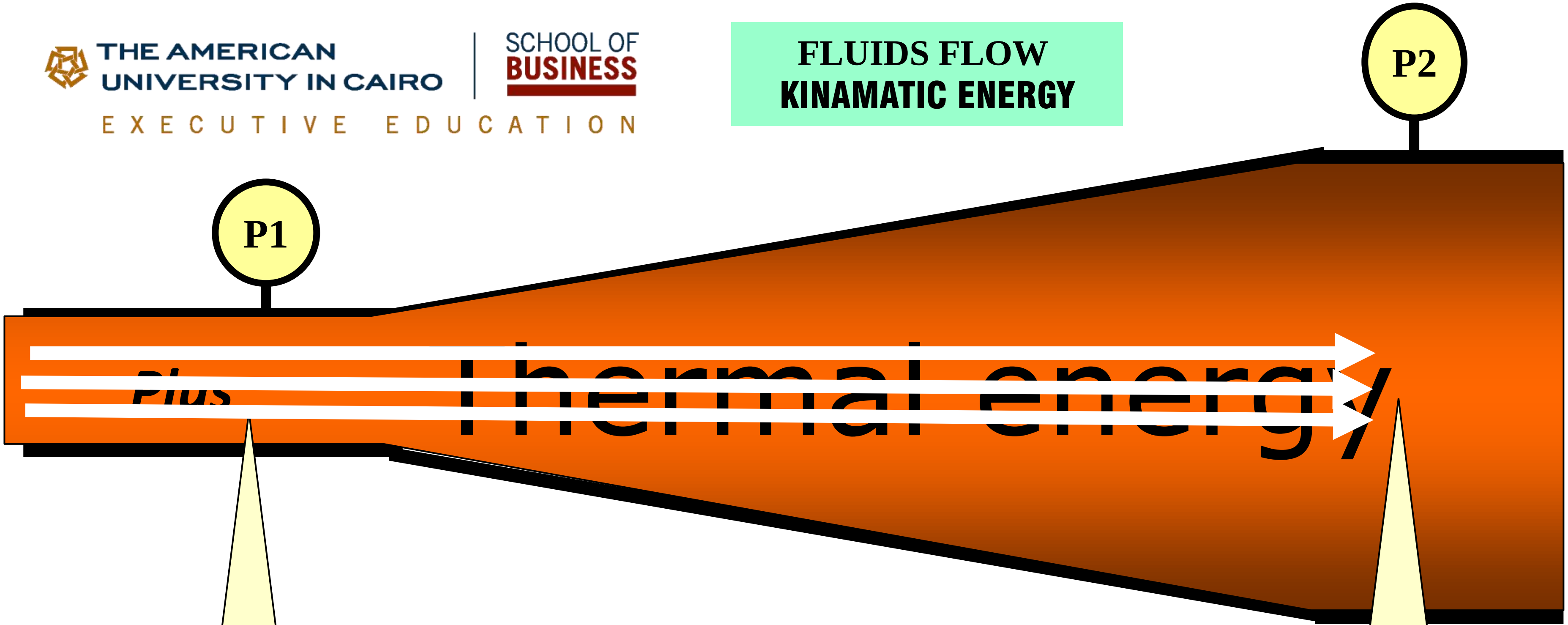
Volute function is to convert most of the Velocity energy to pressure

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




Volute
Impeller
Suction
Shaft
Volute
Discharge
Discharge

FLUIDS FLOW
KINAMATIC ENERGY



$$\frac{V_1^2}{2g} + \frac{P_1}{\rho} \quad \text{CONSTANT} \quad \frac{V_2^2}{2g} + \frac{P_2}{\rho}$$

$$V_2 < V_1 \quad \Rightarrow \quad P_2 > P_1$$

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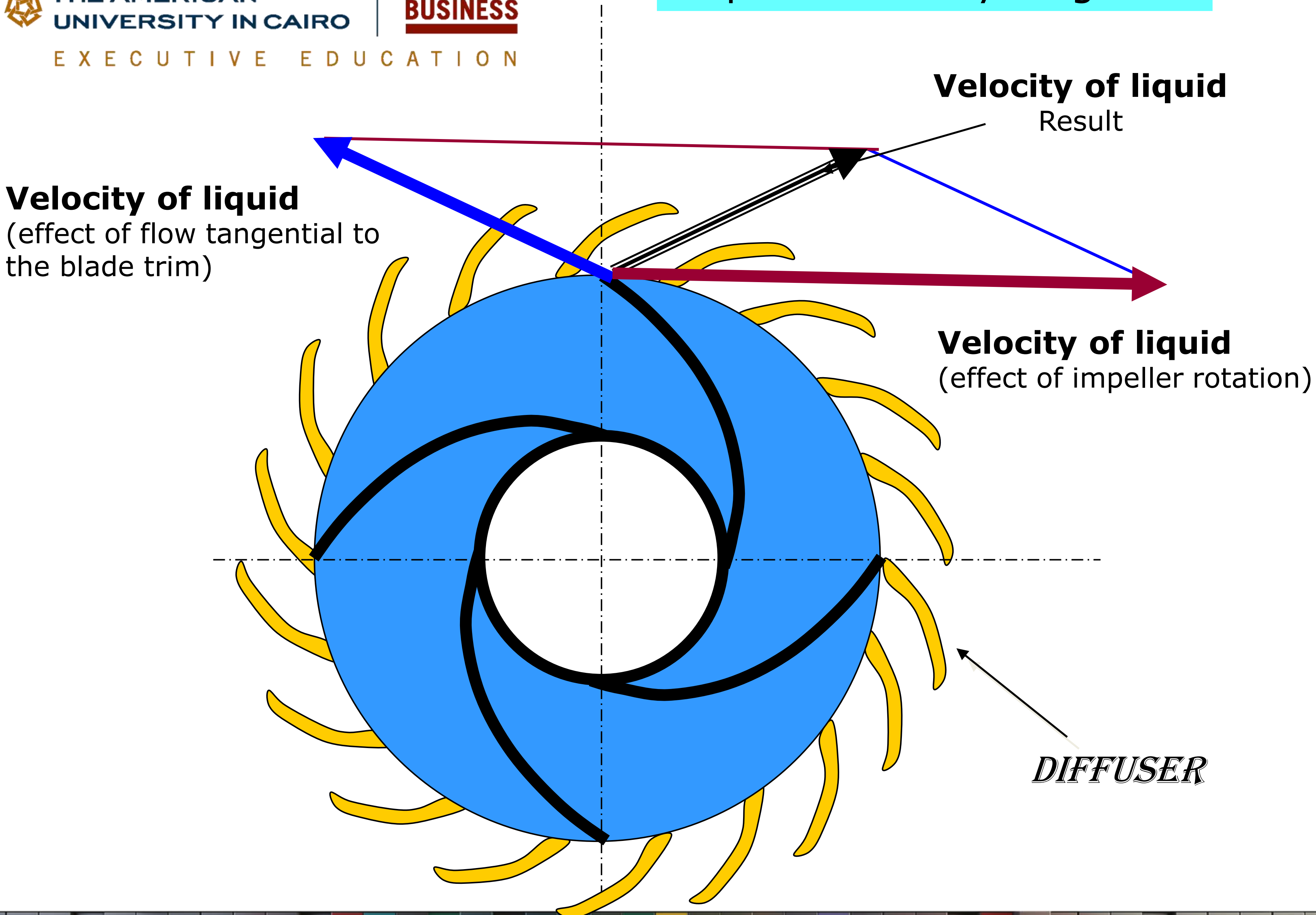
TOTAL ENERGY DIMENTIONS

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

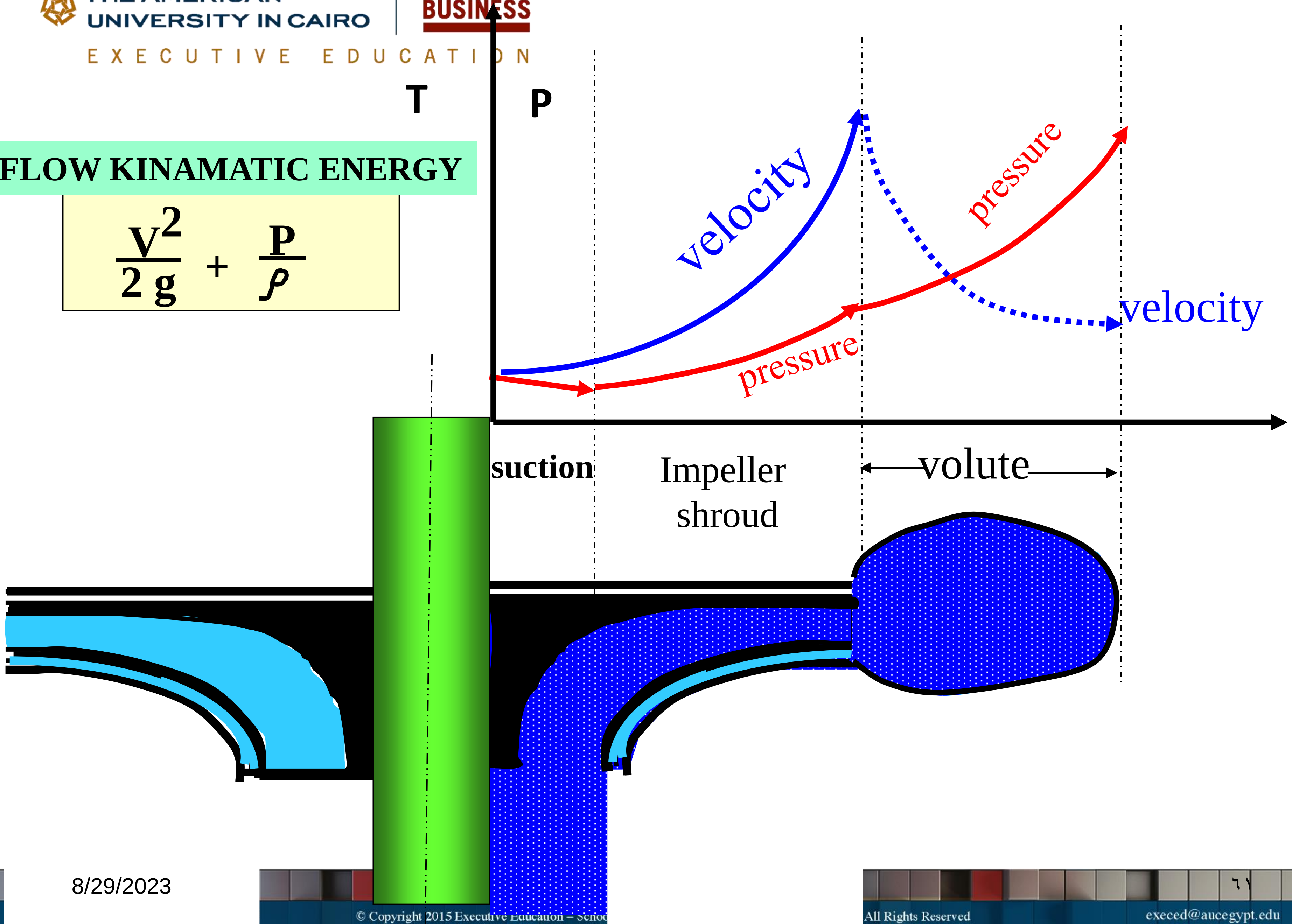
$$\frac{P}{density} = \frac{\frac{Lb}{ft^2}}{\frac{Lb}{ft^3}} = \frac{ft^3}{ft^2} = (ft)$$

Impeller velocity diagrams



FLOW KINAMATIC ENERGY

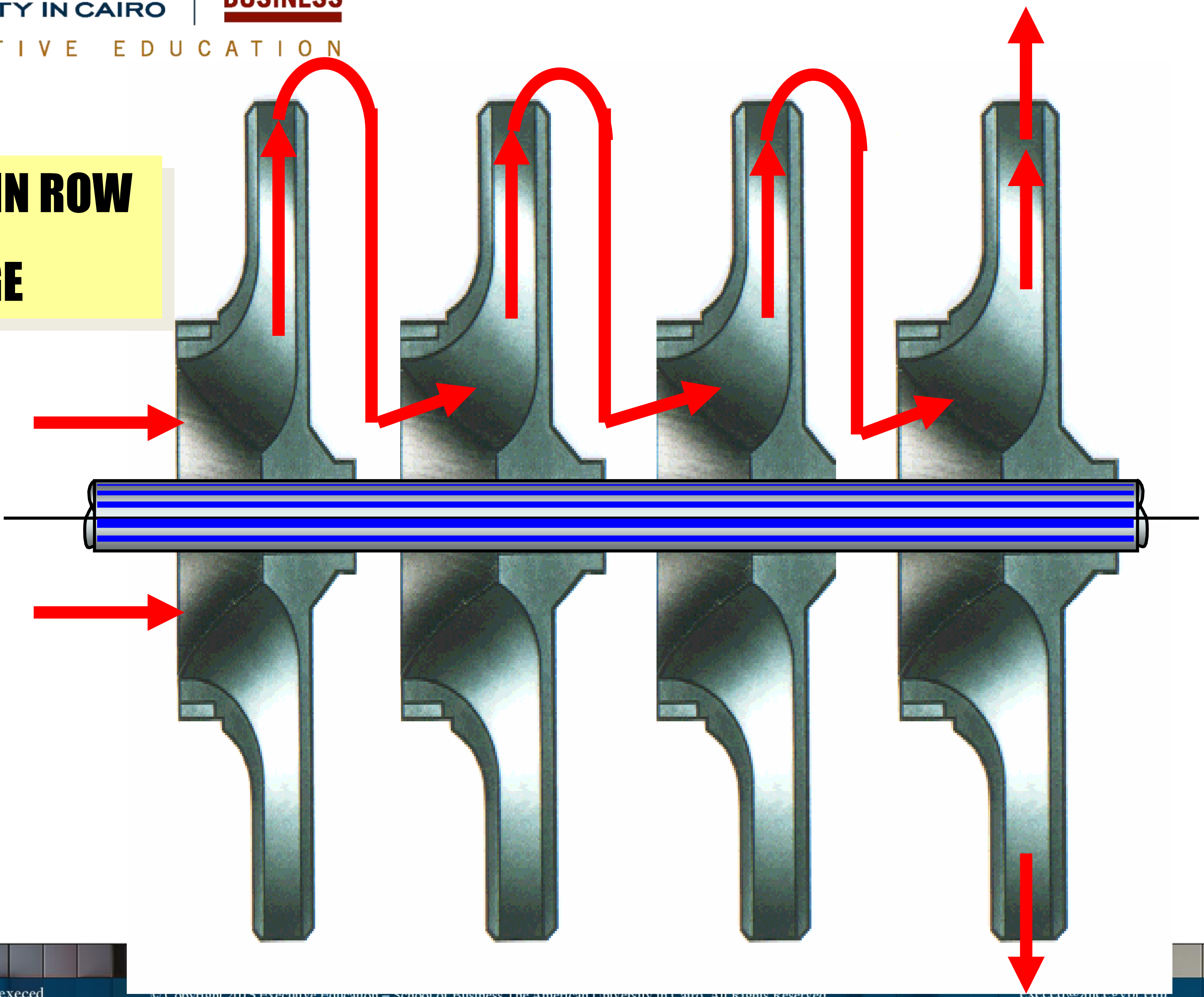
$$\frac{V^2}{2g} + \frac{P}{\rho}$$



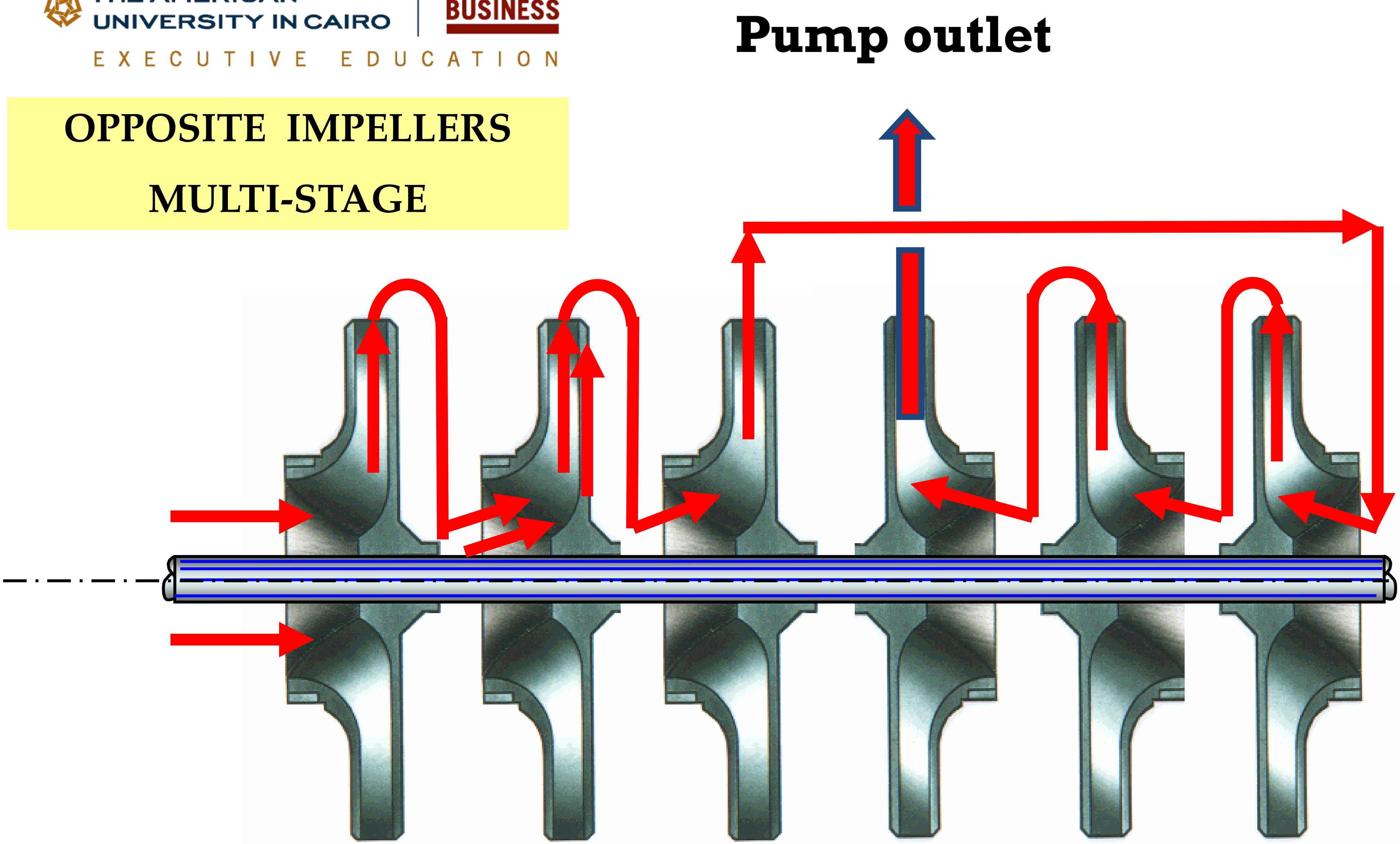
execed@aucegypt.edu

IMPELLERS IN ROW

MULTI-STAGE



OPPOSITE IMPELLERS MULTI-STAGE

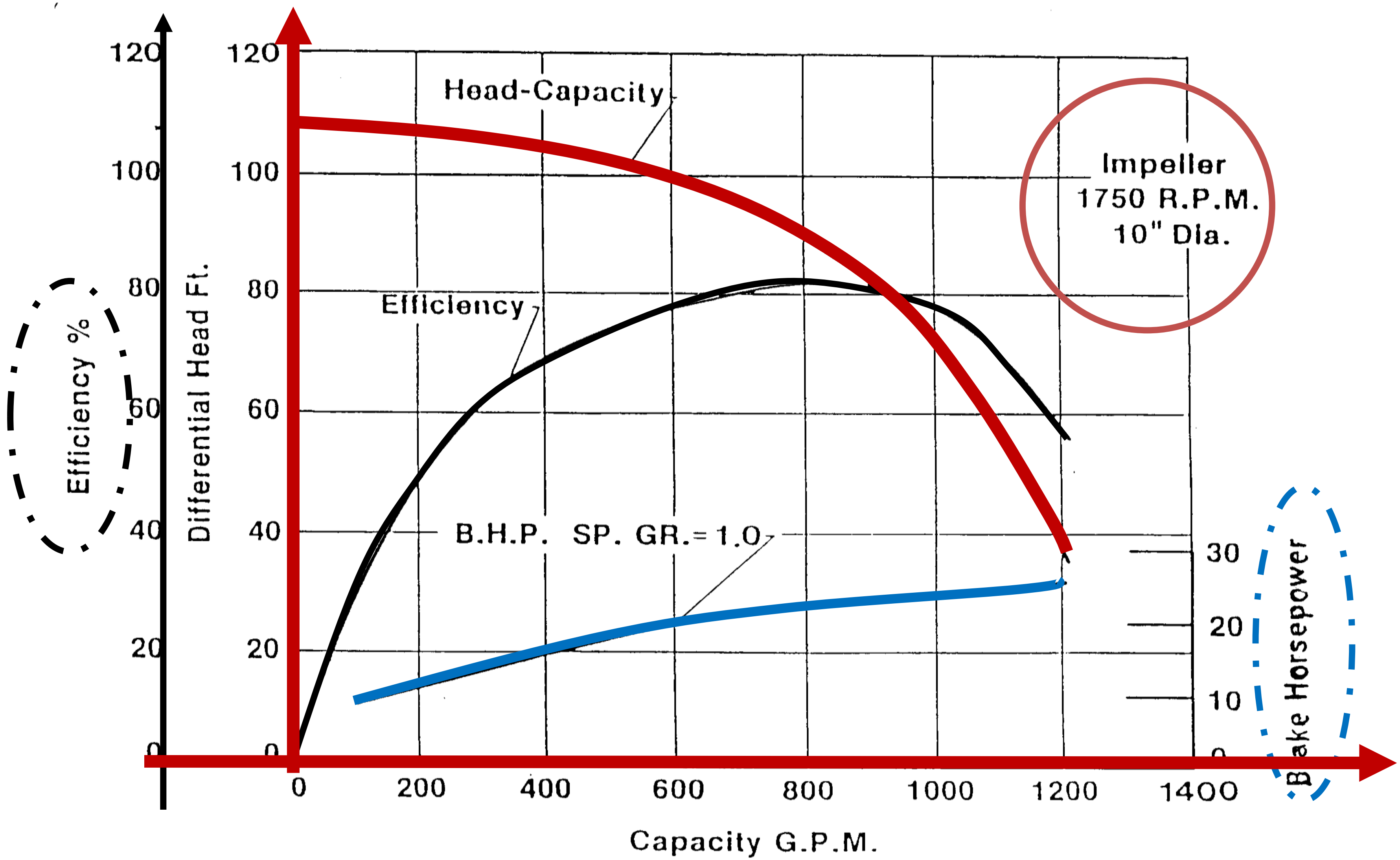


1- Centrifugal pumps Performance curve

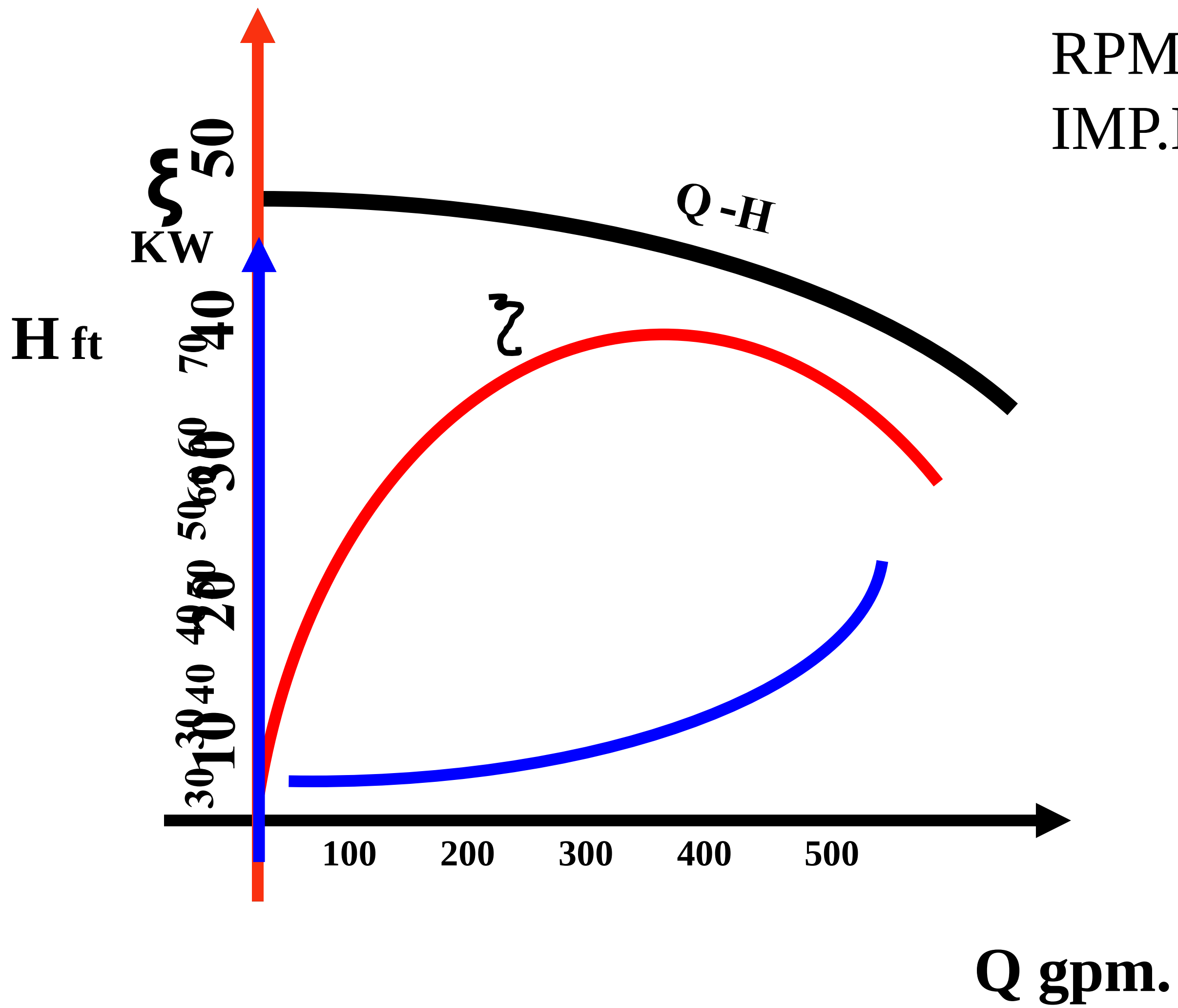
2- Pumps Specific speed

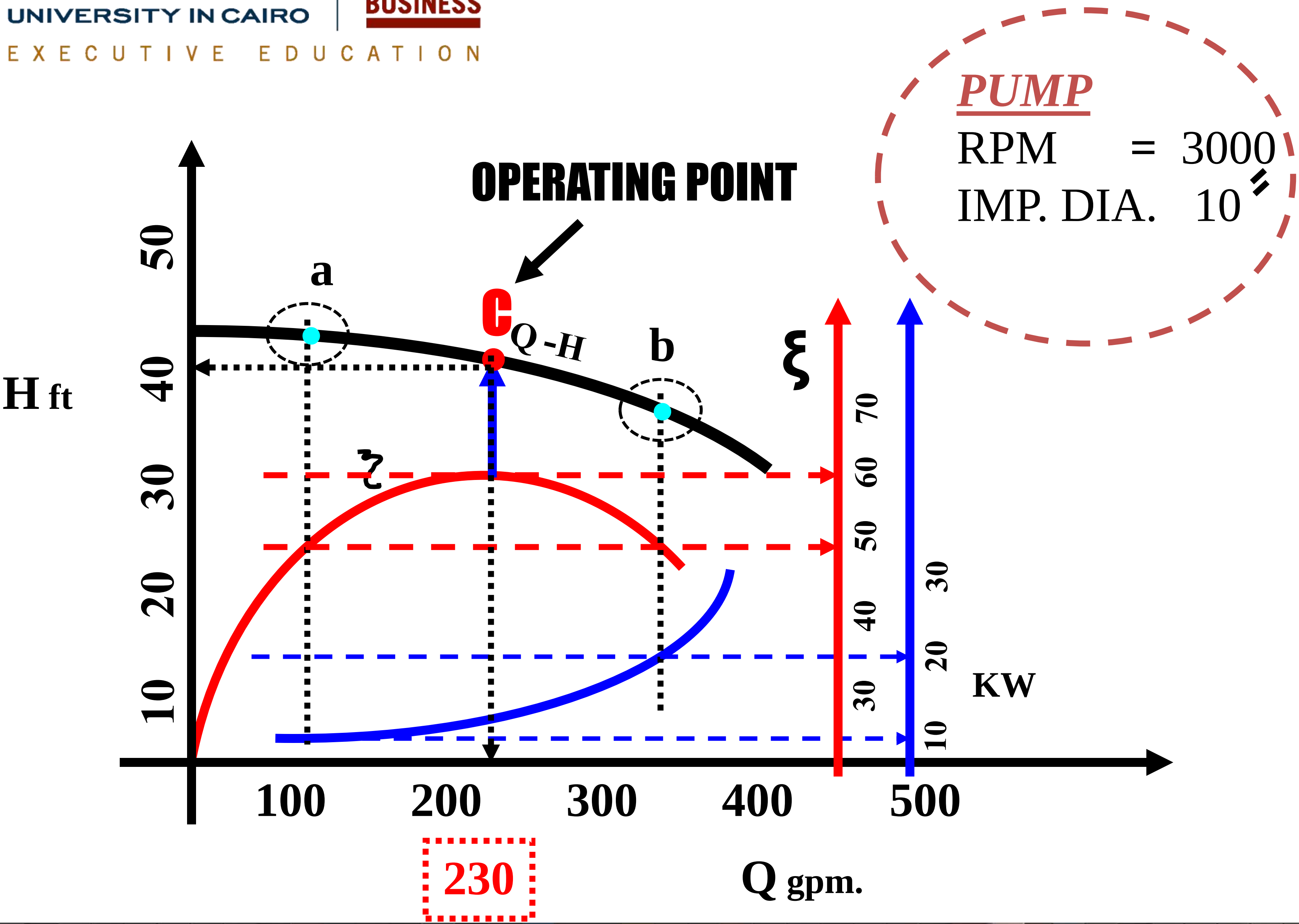
3- Pumps Horse Power

• Centrifugal Pump Performance Curve (Q-H)

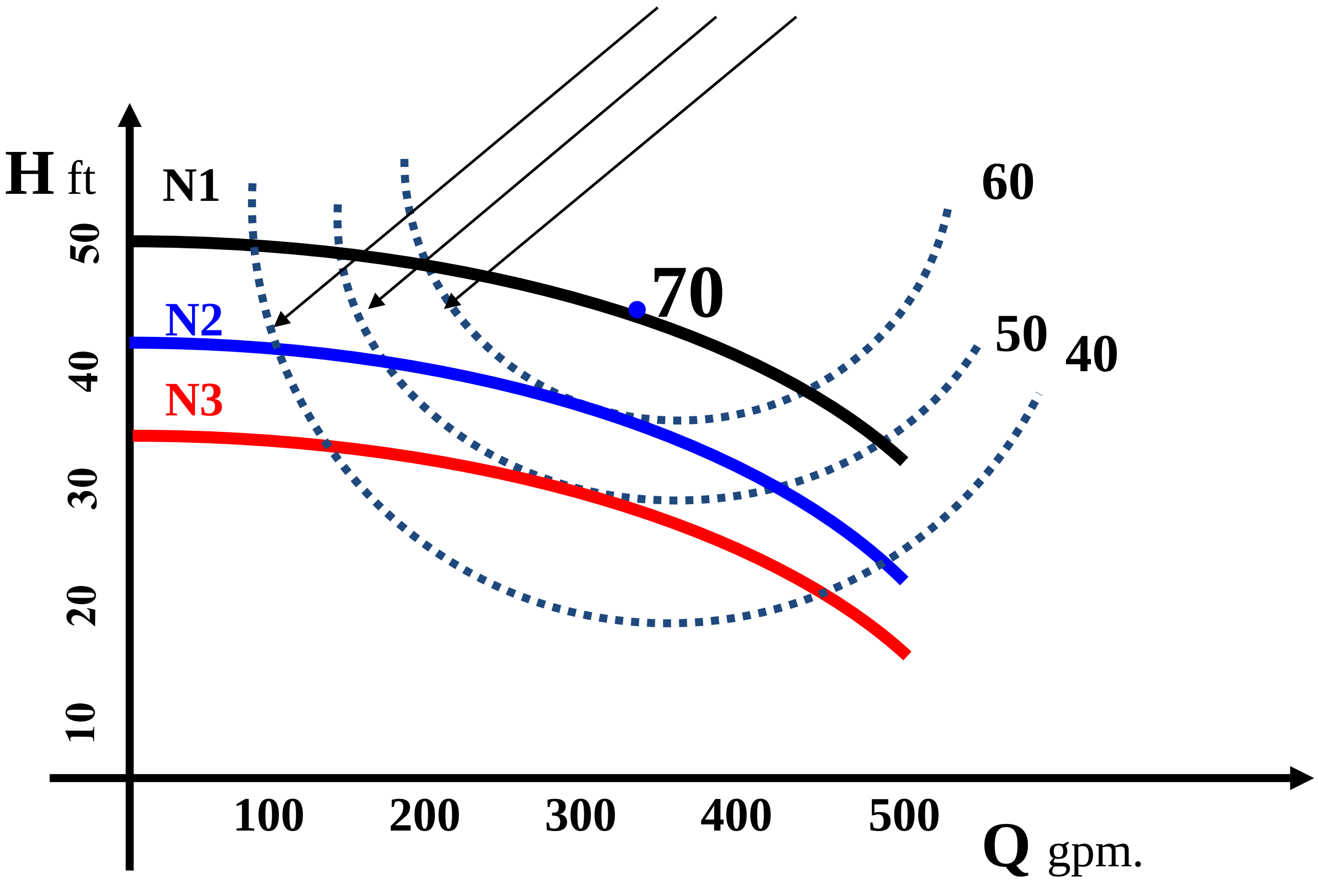


RPM = 3000
IMP.DIA = 10 Inch

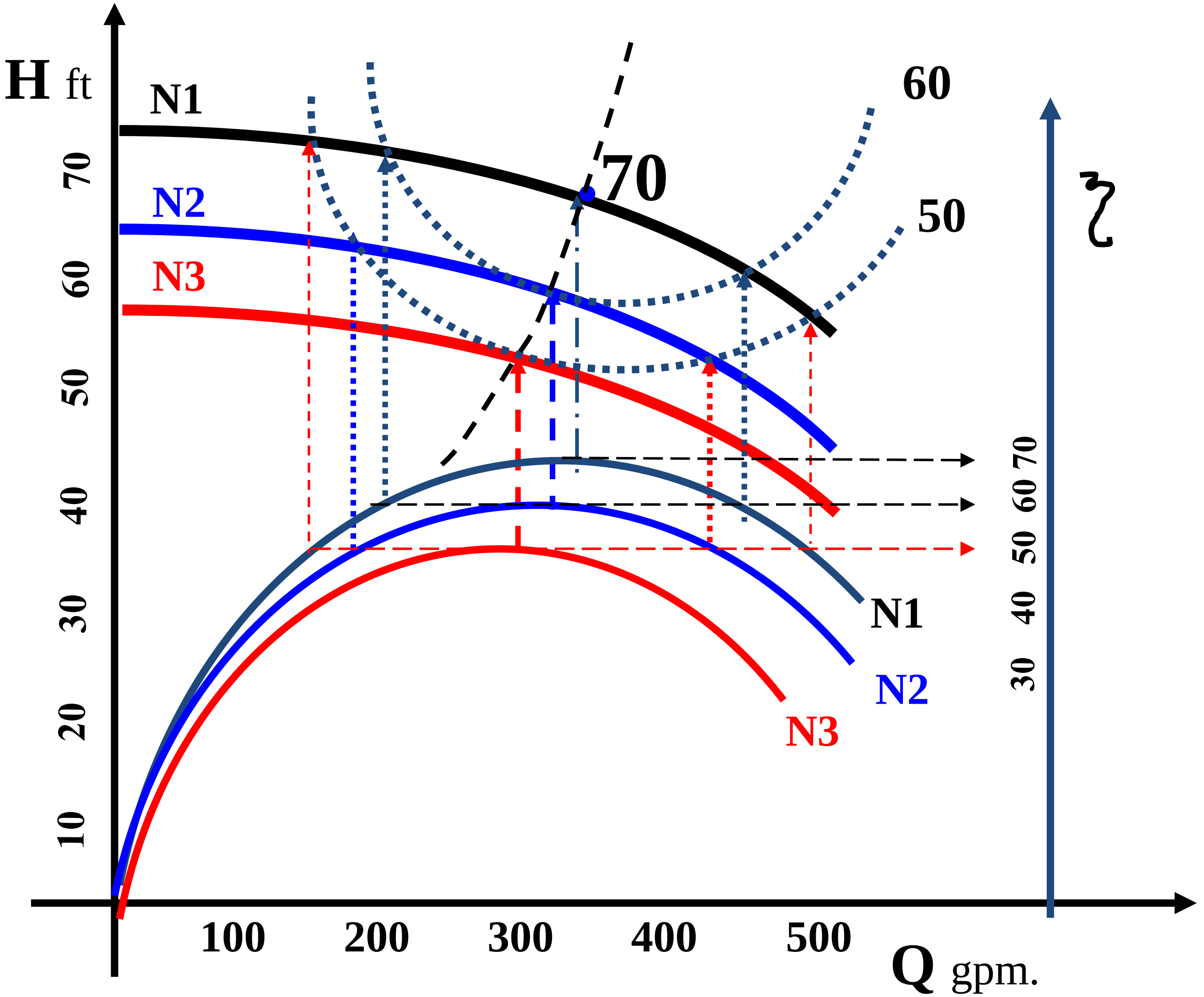



PUMP
RPM = 3000
IMP. DIA. 10"
OPERATING POINT
a
C
Q -H
b
ξ
H ft
50
40
30
20
10
70
60
50
40
30
30
20
10
KW
100
200
300
400
500
230
Q gpm.

Iso- Efficiency Curves

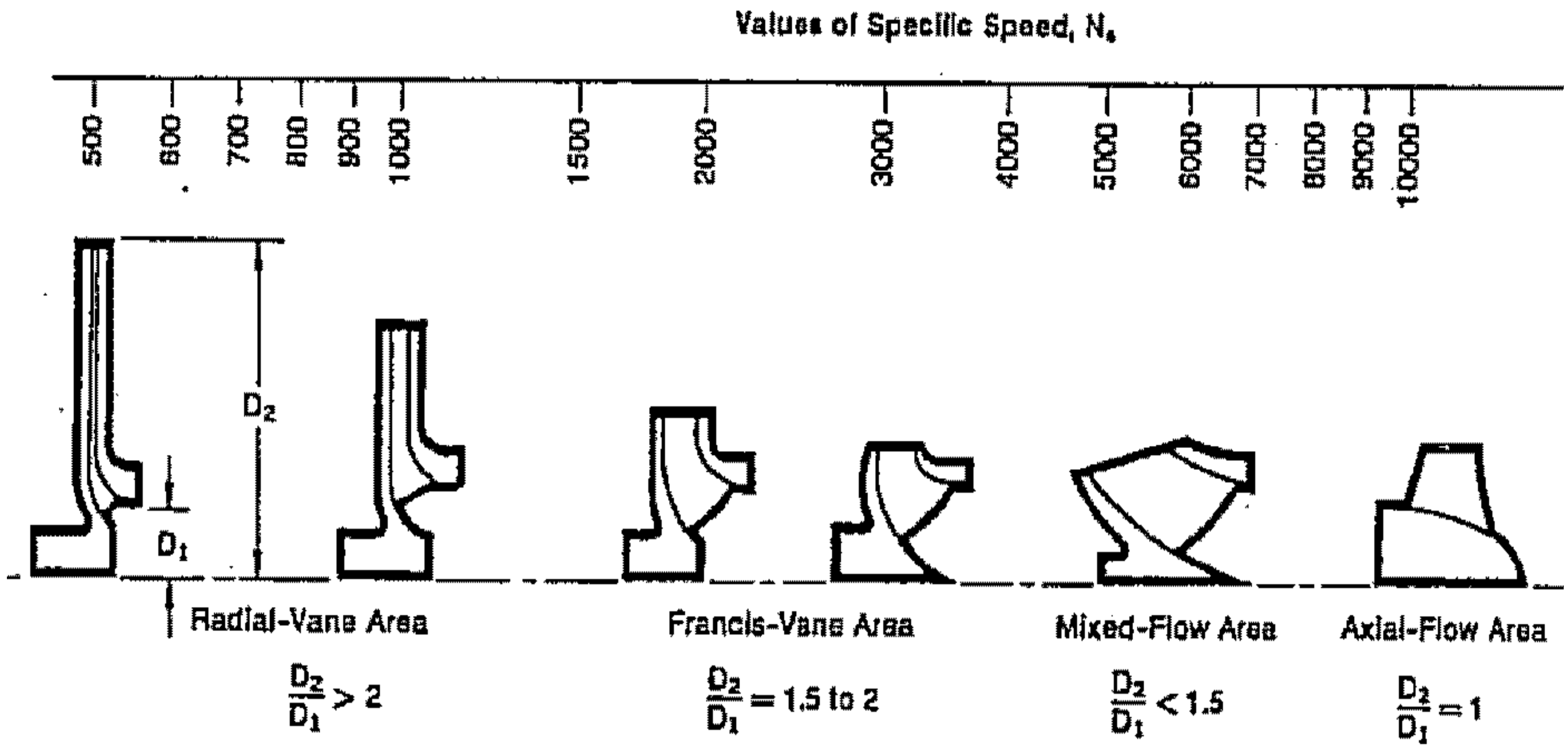


Iso- Efficiency Curves



Pump (RPM) N1 > N2 > N3

Specific Speed



Impeller Design vs Specific Speed **foot system**

Classification of Centrifugal Pumps

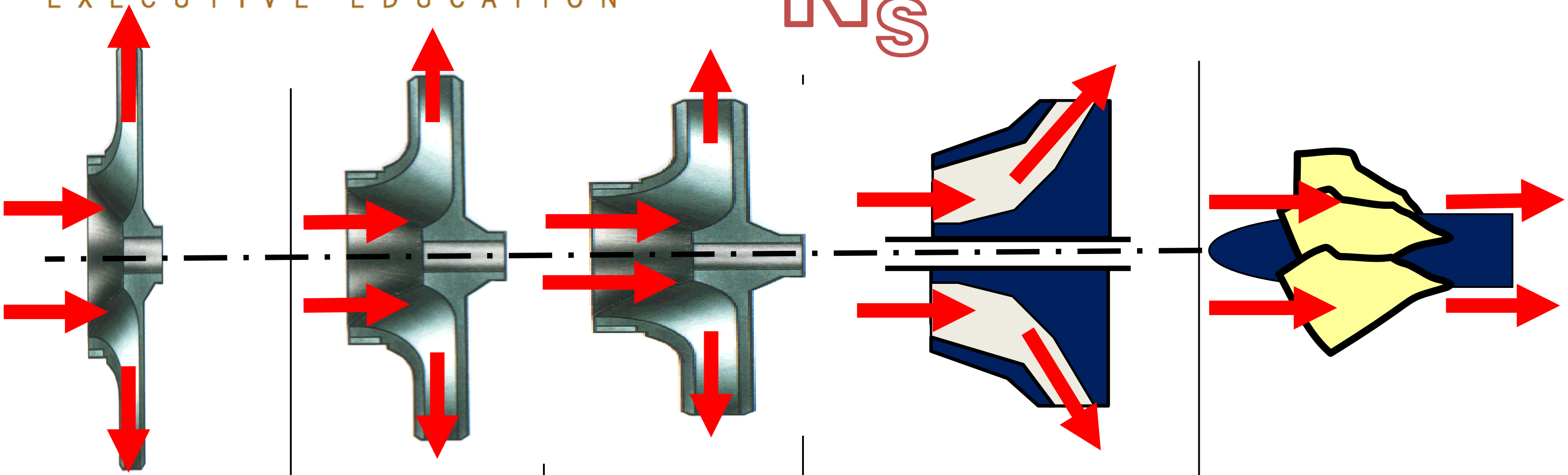
- Radial Flow - a centrifugal pump in which the pressure is developed wholly by centrifugal force.

- 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	FRANCES	CAPLAN	MIXED FLOW	PROPELLER
N_S =	500	800	1200	2000	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

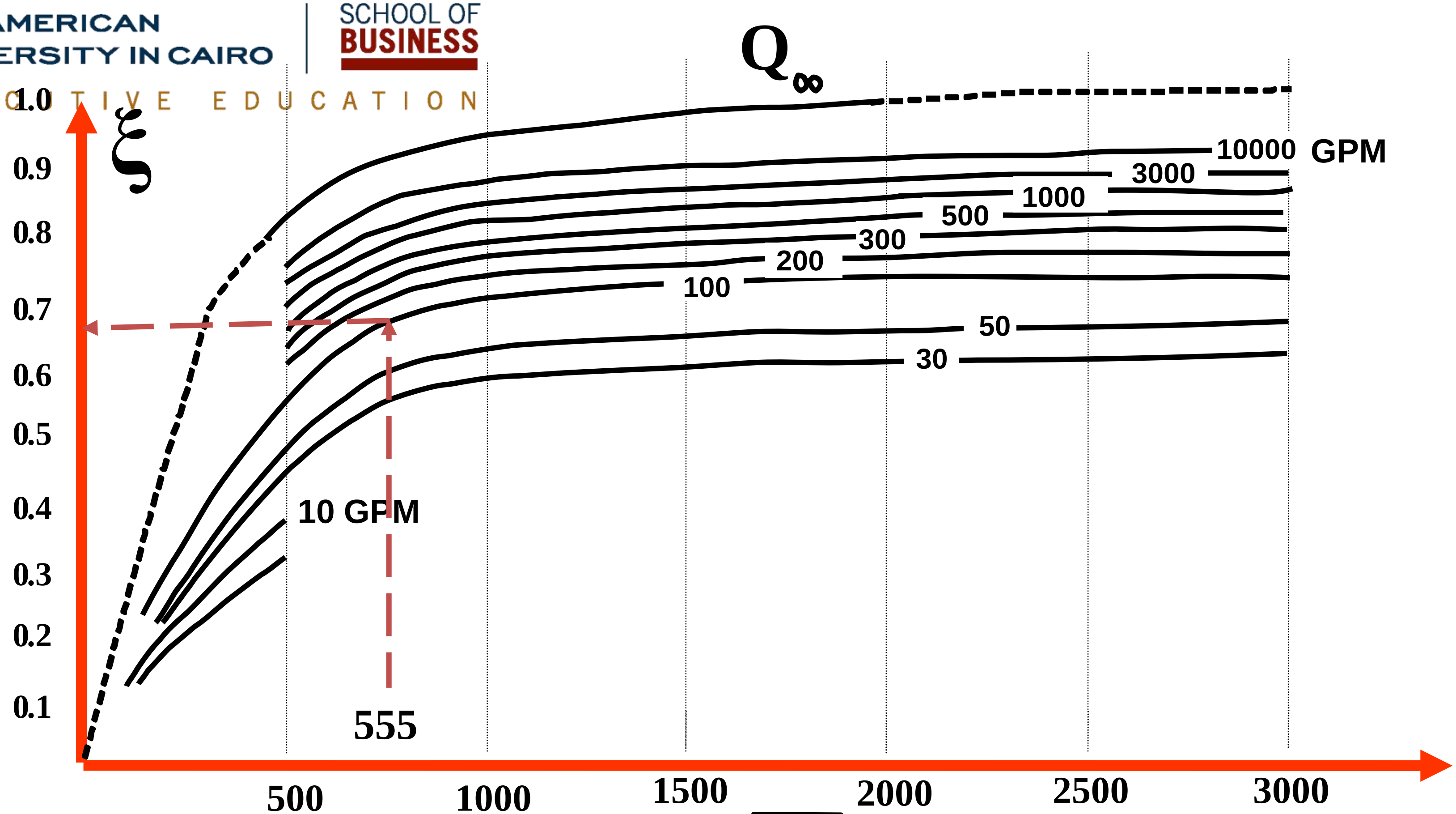
$$N_s = \frac{N\,Q^{1/2}}{H^{3/4}}$$

N = RPM

Q = Flow Rate (m^3/ 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 *Ns*.



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

IF

N = 1500 RPM

Q = 100 GPM

H = 81 FT/ Impeller

$$N_S = \frac{1500\sqrt{100}}{81^{3/4}} \qquad N_S = \frac{15000}{27} = 555$$

	EFFICIENCY											
	1	2	3	4	5	6	7	8	9	10	11	12
Ns \ Qgpm	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

$$W\,HP = P\,Q$$

$$B\,HP = \frac{P\,Q}{\xi}$$

WHERE

P = PUMP DIFF. PRESSURE

Q = PUMP FLOW RATE

ξ = PUMP EFFICINCY

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$1\ HP = 75\ kg.m/sec$

$1\ HP = 550\ lb.ft/sec$

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

$$WHP = \frac{M3/hr \left[Kg/cm2 \right]}{75}$$

$$WHP = \frac{m3}{sec * 3600} * \frac{\left[Kg \right]}{m2} \frac{100*100}{75}$$

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

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

$$WHP = 0.037\ P\ Q$$

$P = bar$

$Q = M^3/hr$

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

$$WHP = 0.00058\ P\ Q$$

$P = psi$

$Q = GPM$

$$B\ HP = 0.00058 \frac{P\ Q}{\xi}$$

CALCULATE MOTOR HP. FOR

EXAMPLE

N = 3000

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

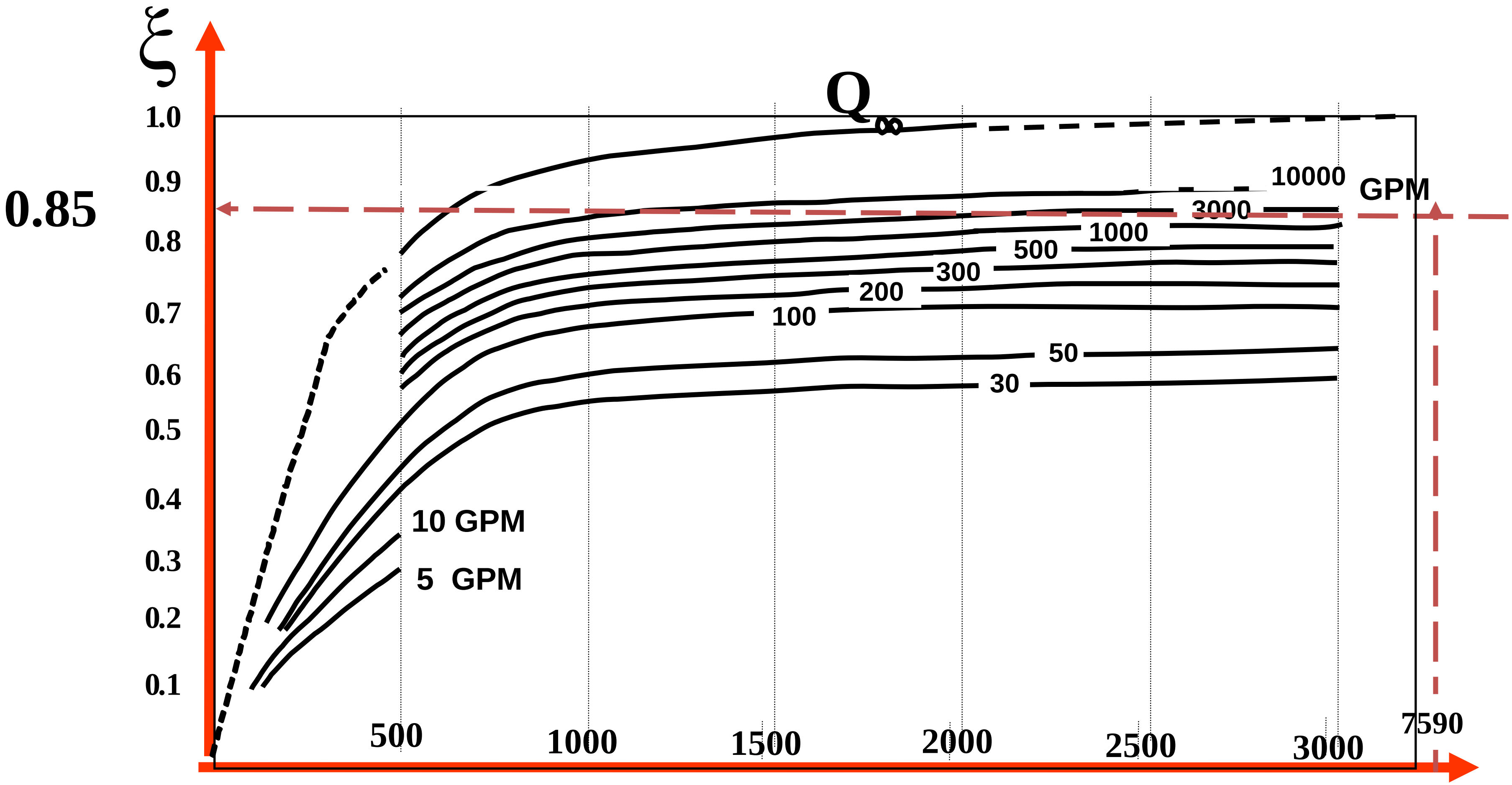
2-PUMP (B) HAS D.P = 400 PSI
Q = 100 GPM

FOR BOTH PUMPS

WATER. HP. = 0.00058 * 20*2000 HP.

= 23.2 HP

PUMP (A) NS



Q = 2000 GPM

H / Imp = 20 * 2.31 = 46.2 ft

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

$$N_S = 7590$$

PUMP A

N = 3000 RPM

D.P/impeller = 2O*2.31 = 46.2 ft

Q = 2000 GPM

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

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

$$§ = 0.85$$

BRAKE HP = 23.2/0.85 = 27 HP.

Motor HP = 27 * 1.2 = 33 HP

NS

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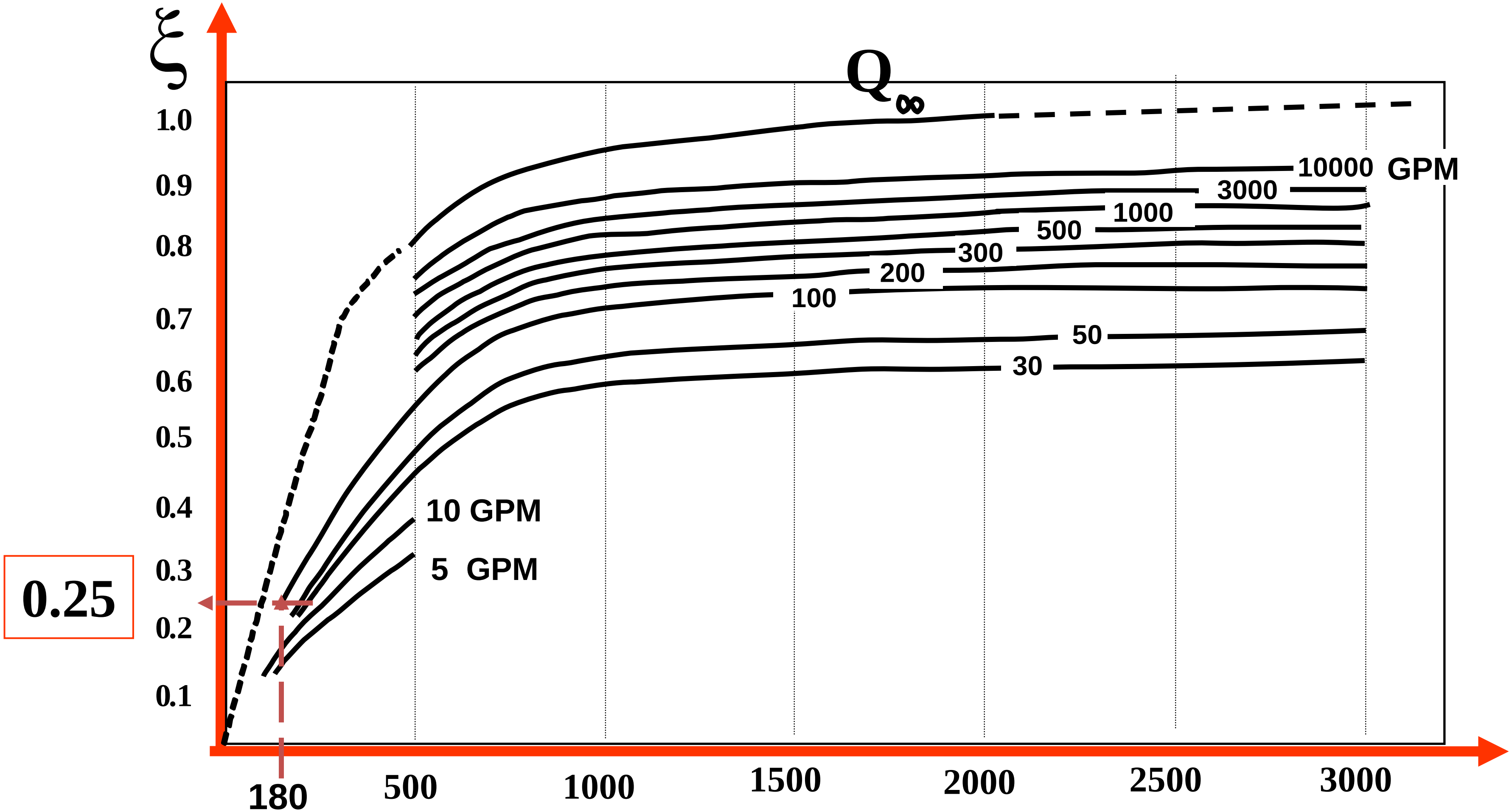
PUMP (B)

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 RPM

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

D.P/impeller = 400 * 2.31 = 924 ft

Q = 100 GPM

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

§ = 0.25

BRAKE HP = 23.2 /0.25 = 97 HP.

Motor HP = 97 * 1.2 = 116 HP

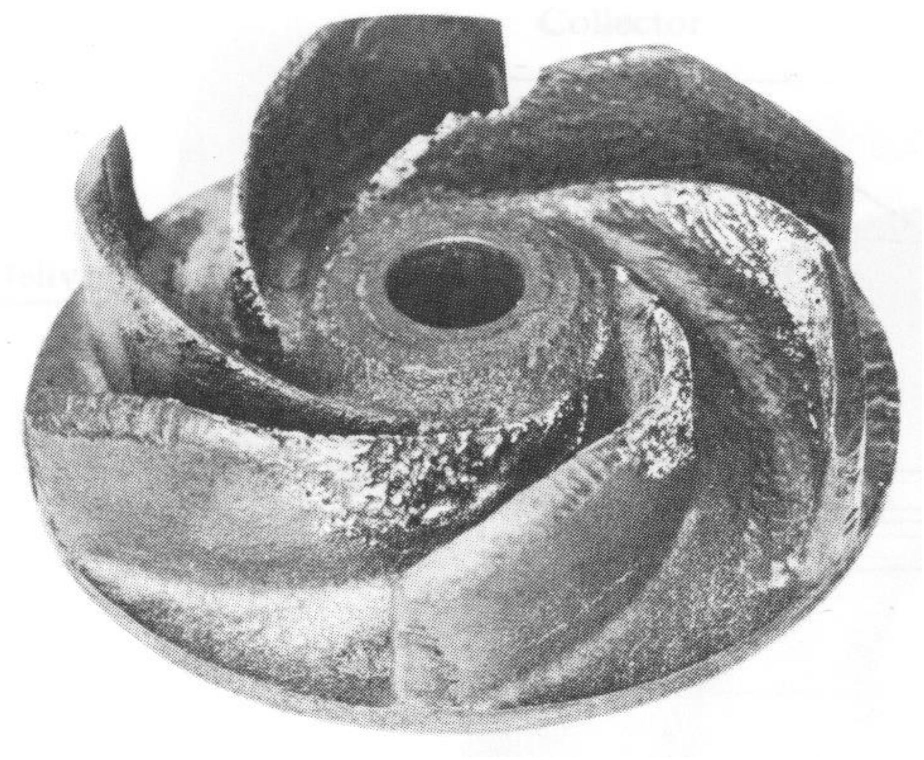
Net Positive Suction Head

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




on
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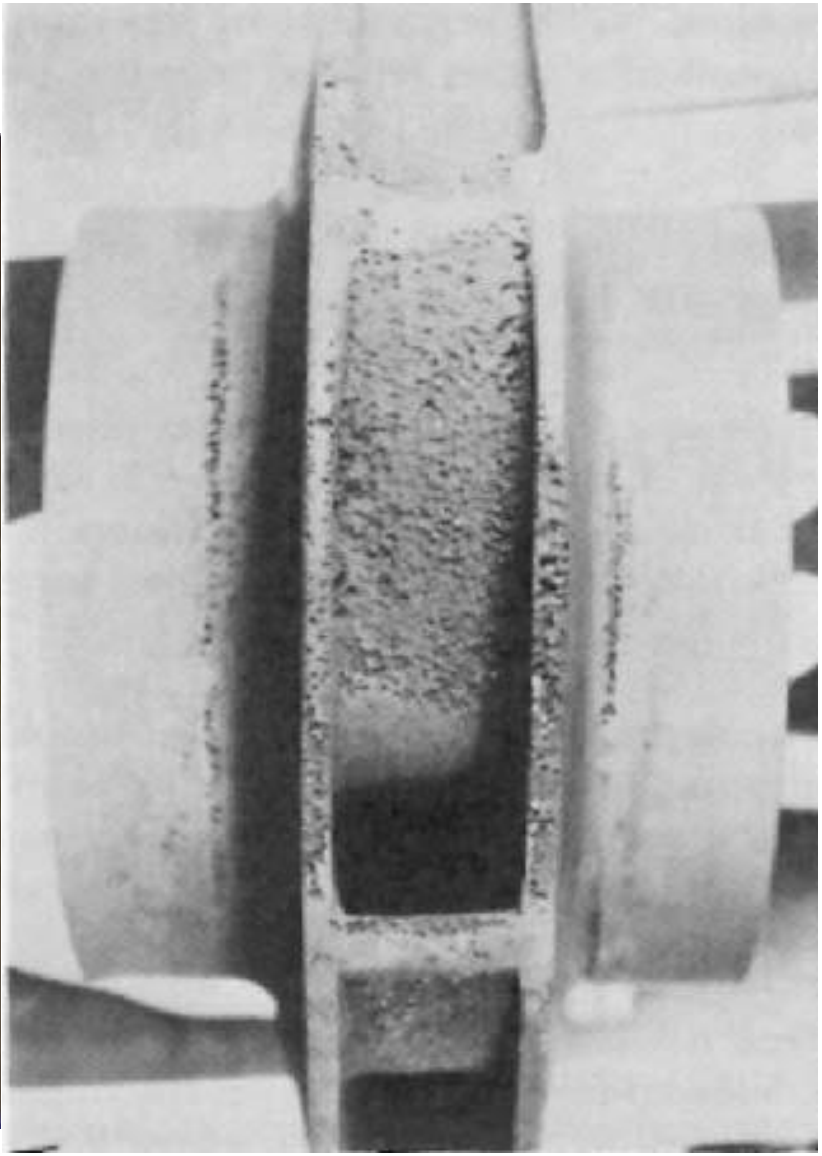
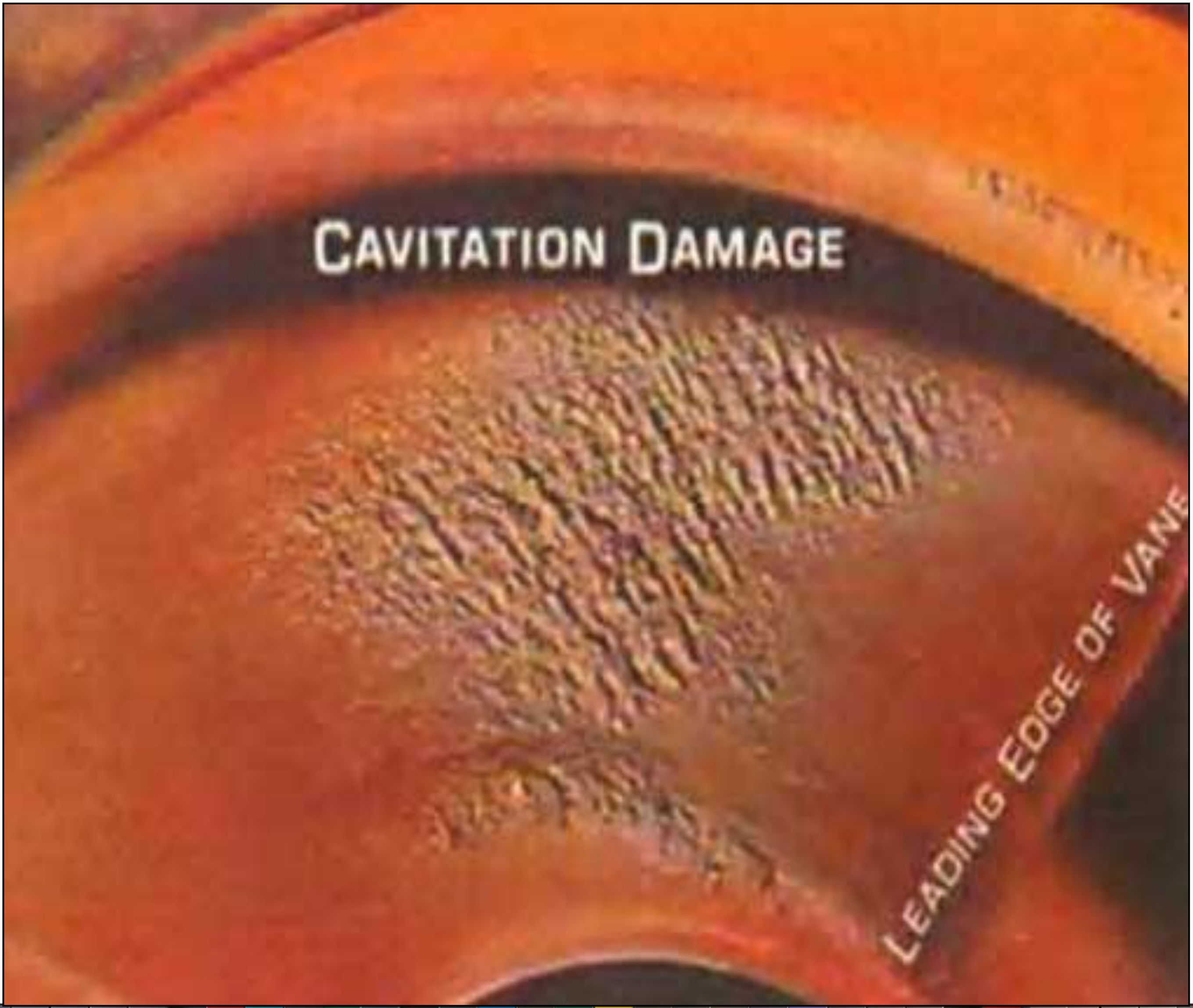



CAVITATION DAMAGE
LEADING EDGE OF VANE

CAVITATION CAN OCCUR in

CENTRIFUGAL PUMPS

AND

POSITIVE DISPLACEMENT PUMPS

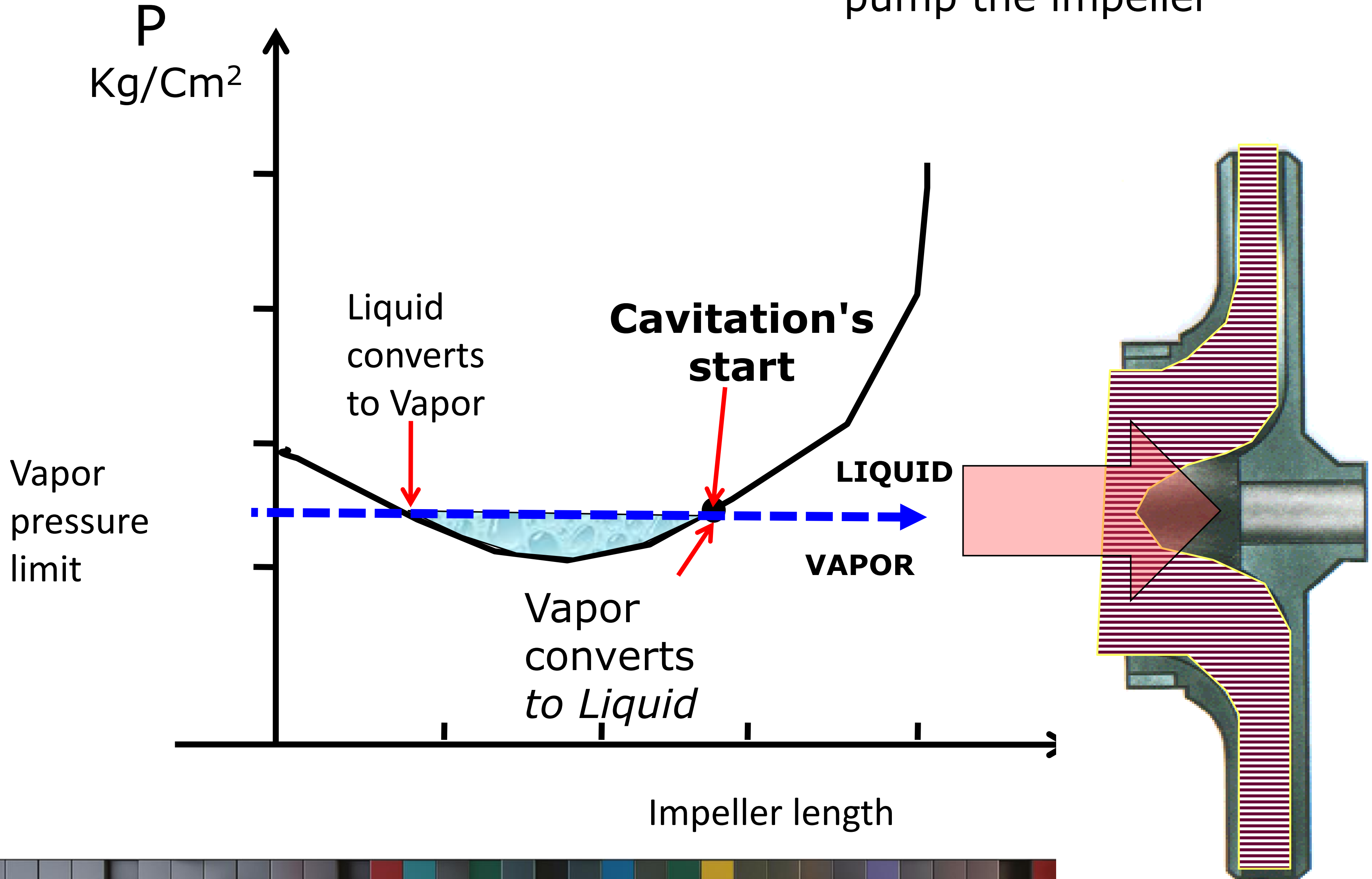
WHEN **NPSHA < NPSHR**

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

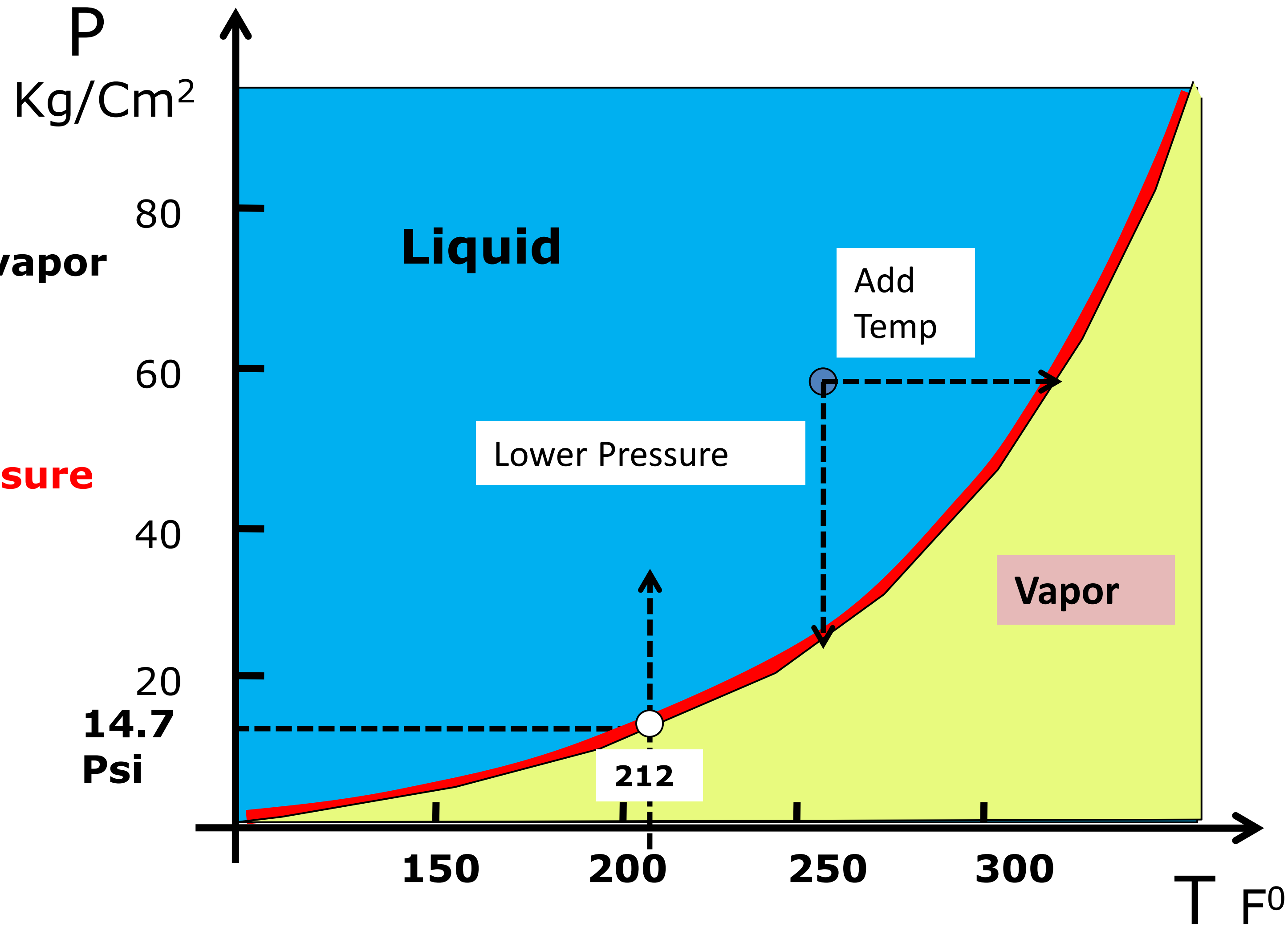
60,000 psi.

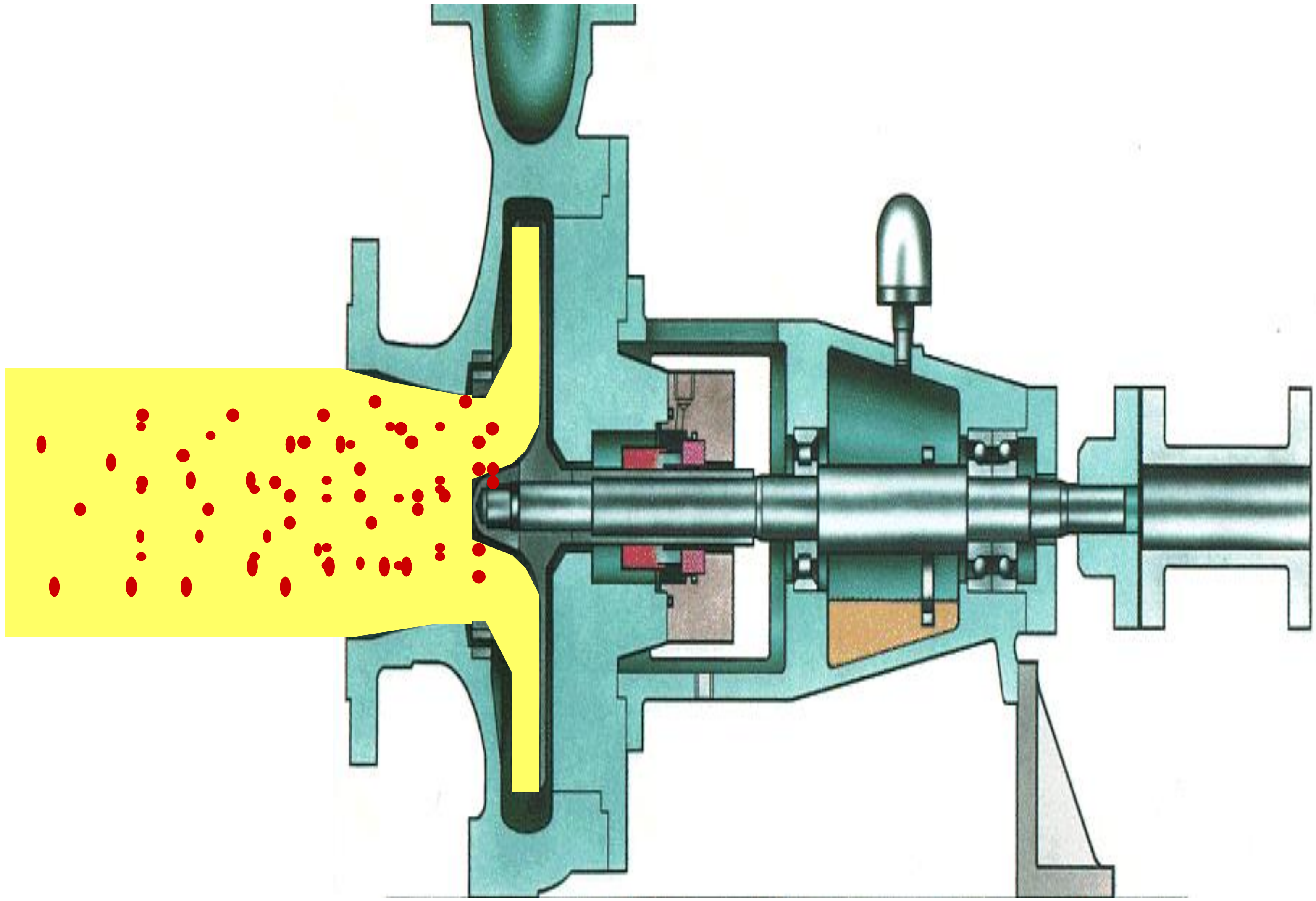
Water Vapor Pressure Graph

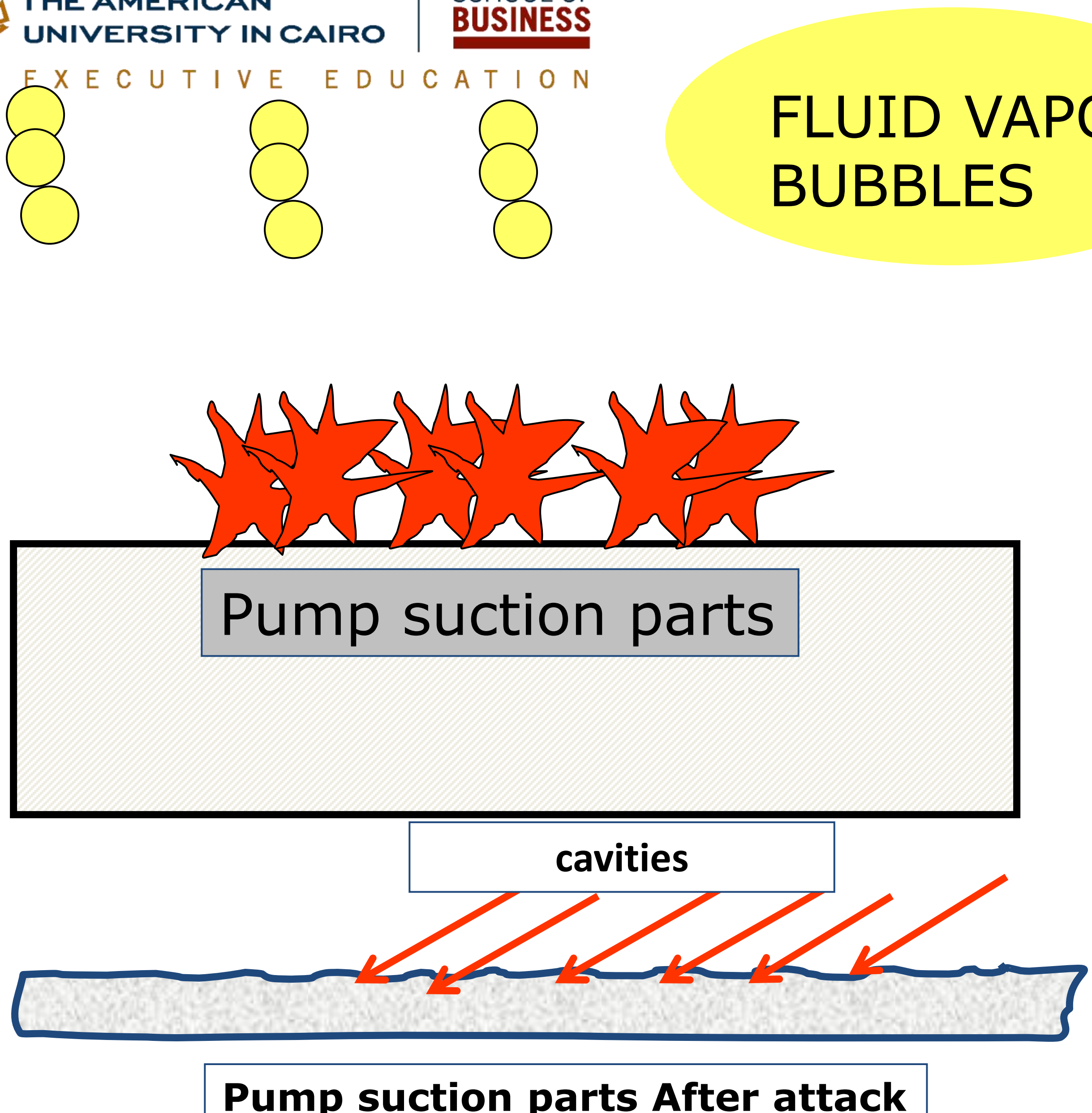
Liquid covert to vapor by two methods

1- Add Temp

2- Decrease Pressure






FLUID VAPOR BUBBLES
Pump suction parts
cavities
Pump suction parts After attack

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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 deteriorations
Decrease discharge pressure
Decrease pump flow rate
Spring Rupture
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

NPSHA > 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 Length

Increase Suction Pipe Size

Decrease Suction Liquid Temp.

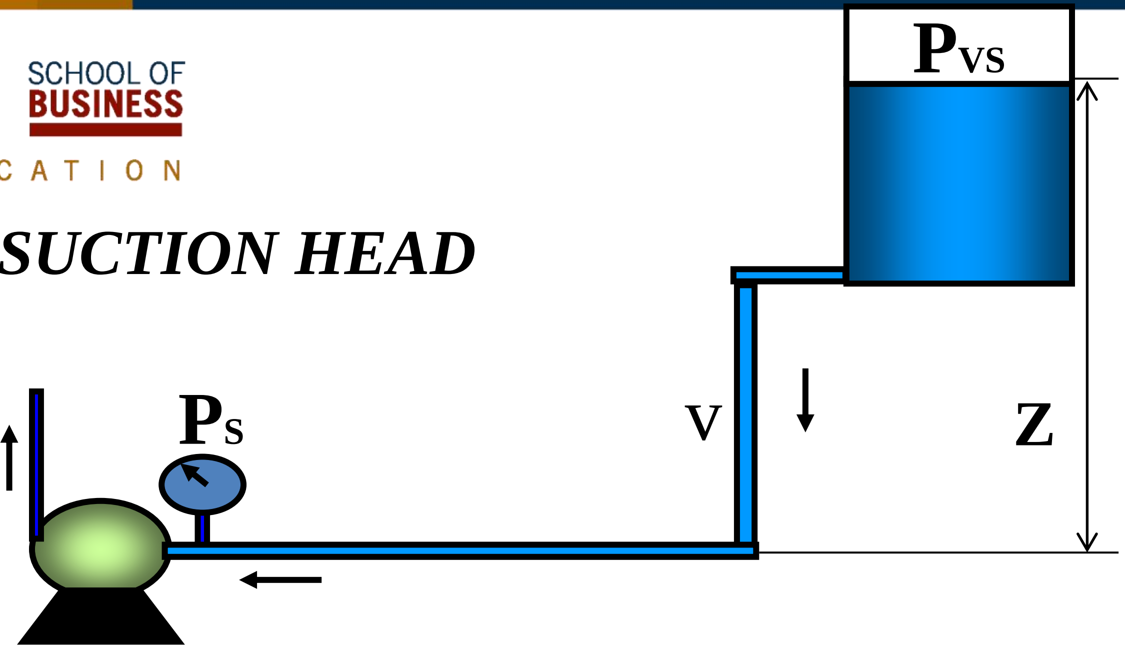
Decrease Suction Negative Altitude

Increase Suction Positive Altitude

Stop The Piping Suction Leaks

Renew 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
$S_{p.gr}$	liquid specific gravity	
h_L	Suction head loss	ft
g	32.2	ft/sec.sec

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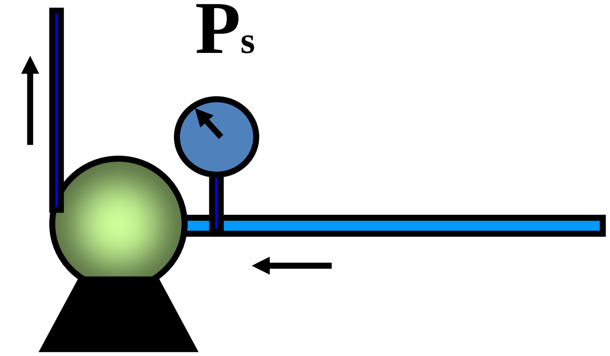
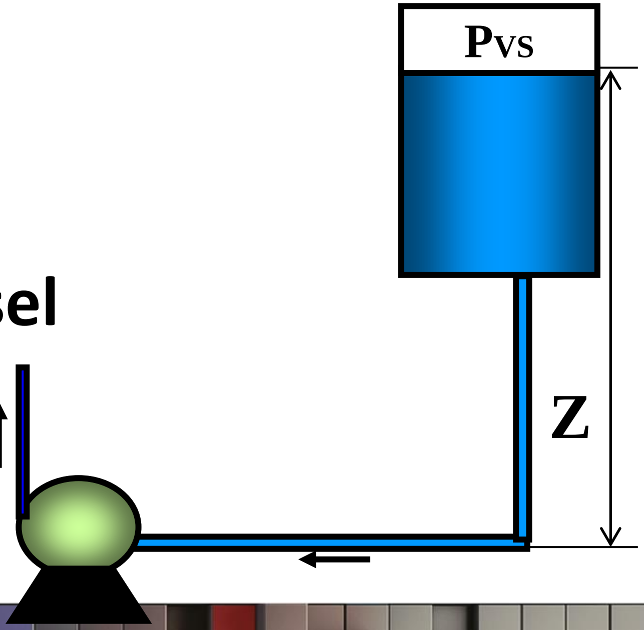
NPSHA Is Not

- The Suction Gauge Pressure

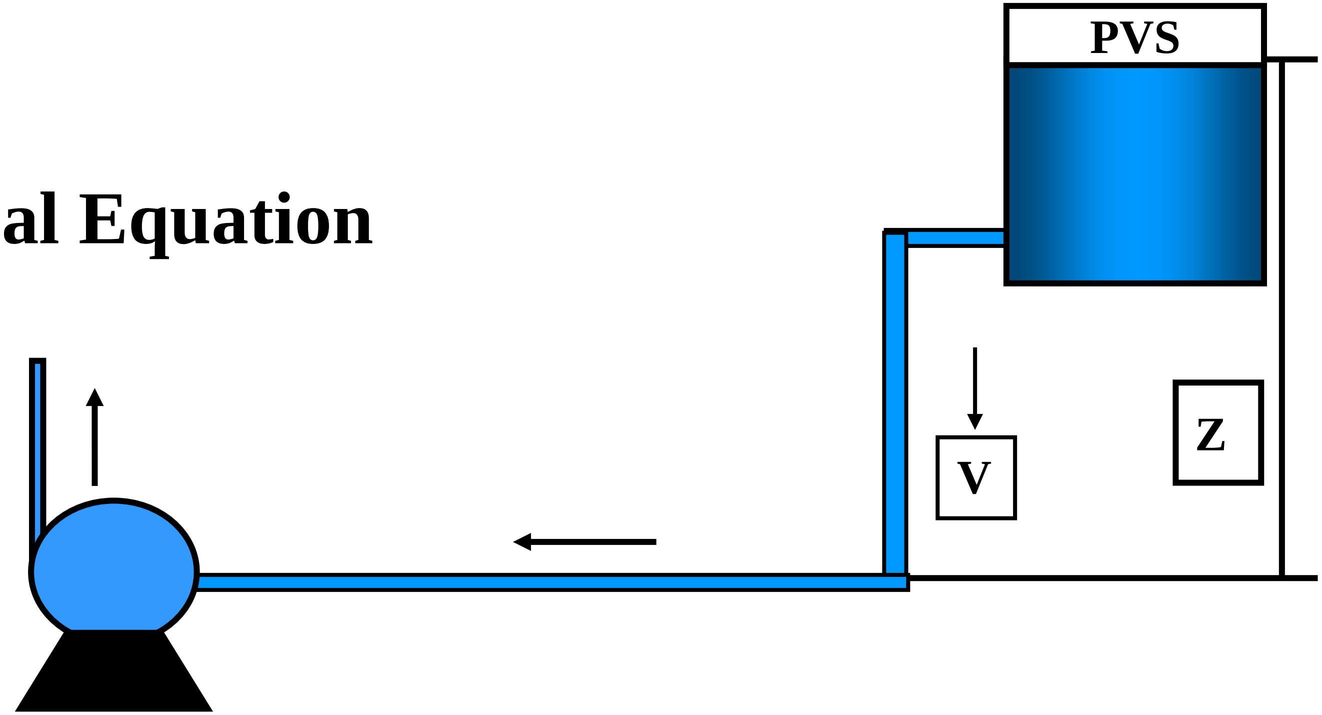


OR

- Liquid Level In The Suction Vessel



General Equation



$$\textbf{NPSHA} = Z + \frac{V^2}{2g} + \frac{\{(P_{vs} + Pa) - Vp\}\ 2.31}{Sp.gr} - h_L$$

1

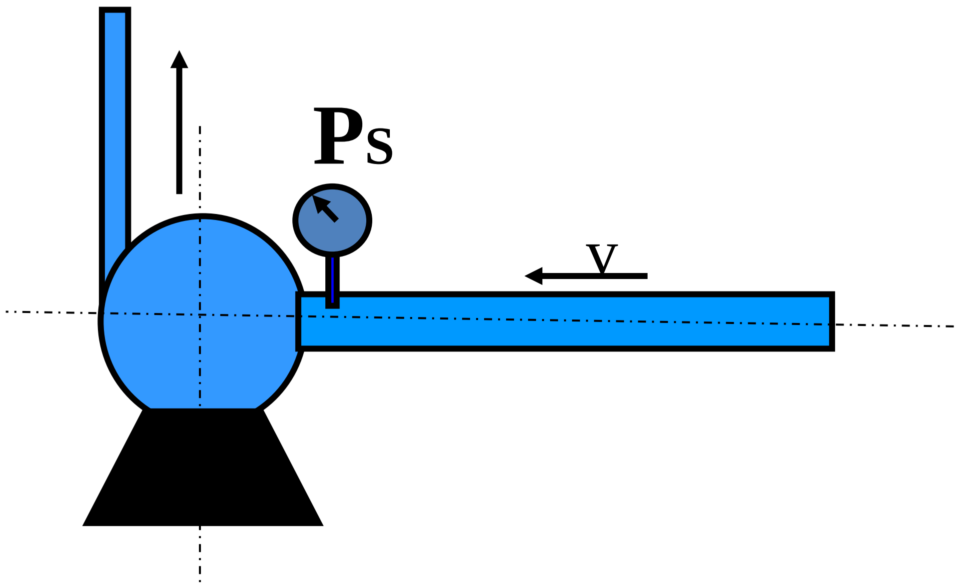
IF The Suction pressure is known

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

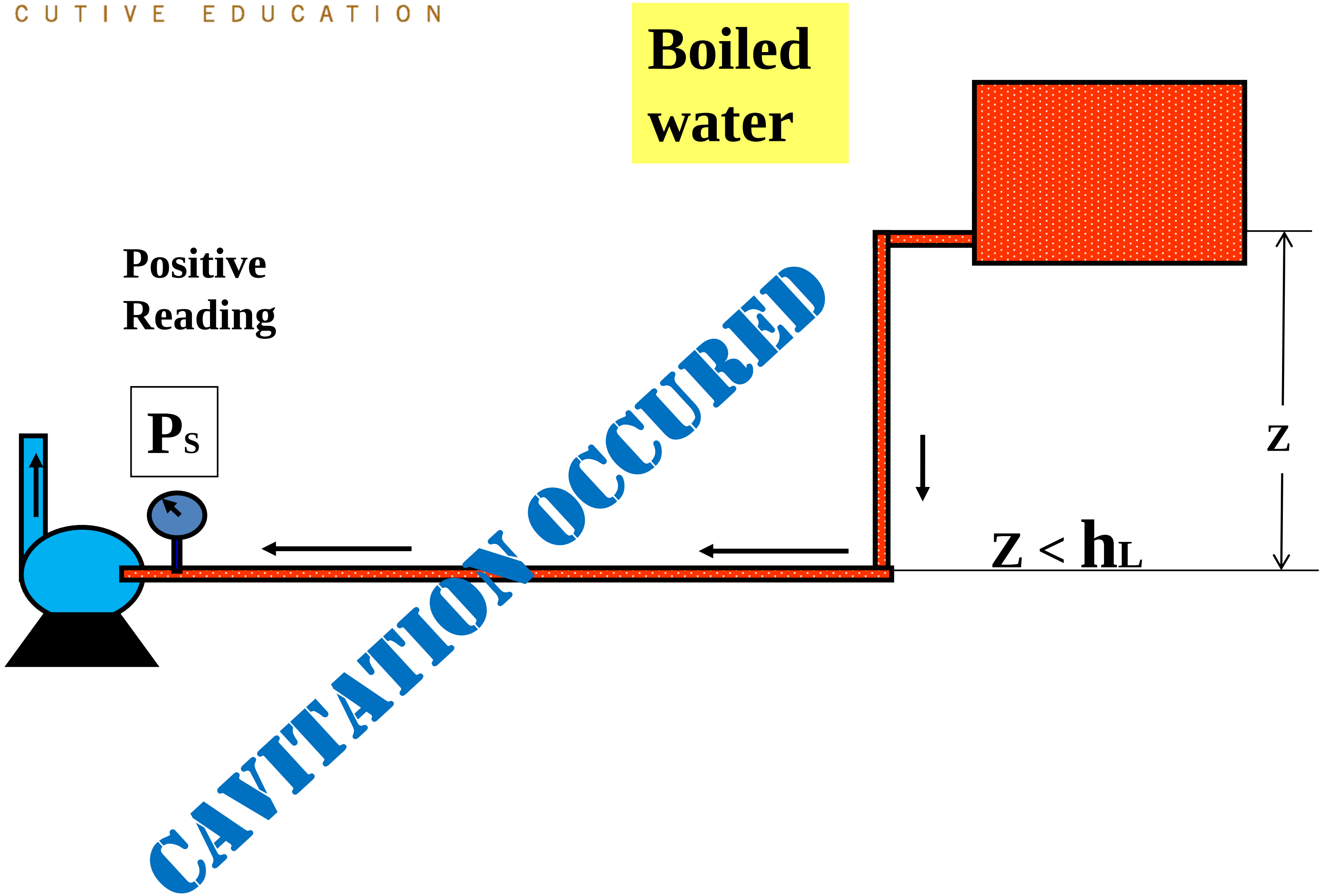
$$\text{NPSHA} = Z + \frac{V^2}{2g} + \frac{\{P_{sva} - V_p\}\,2.31}{Sp.gr} - h_L$$

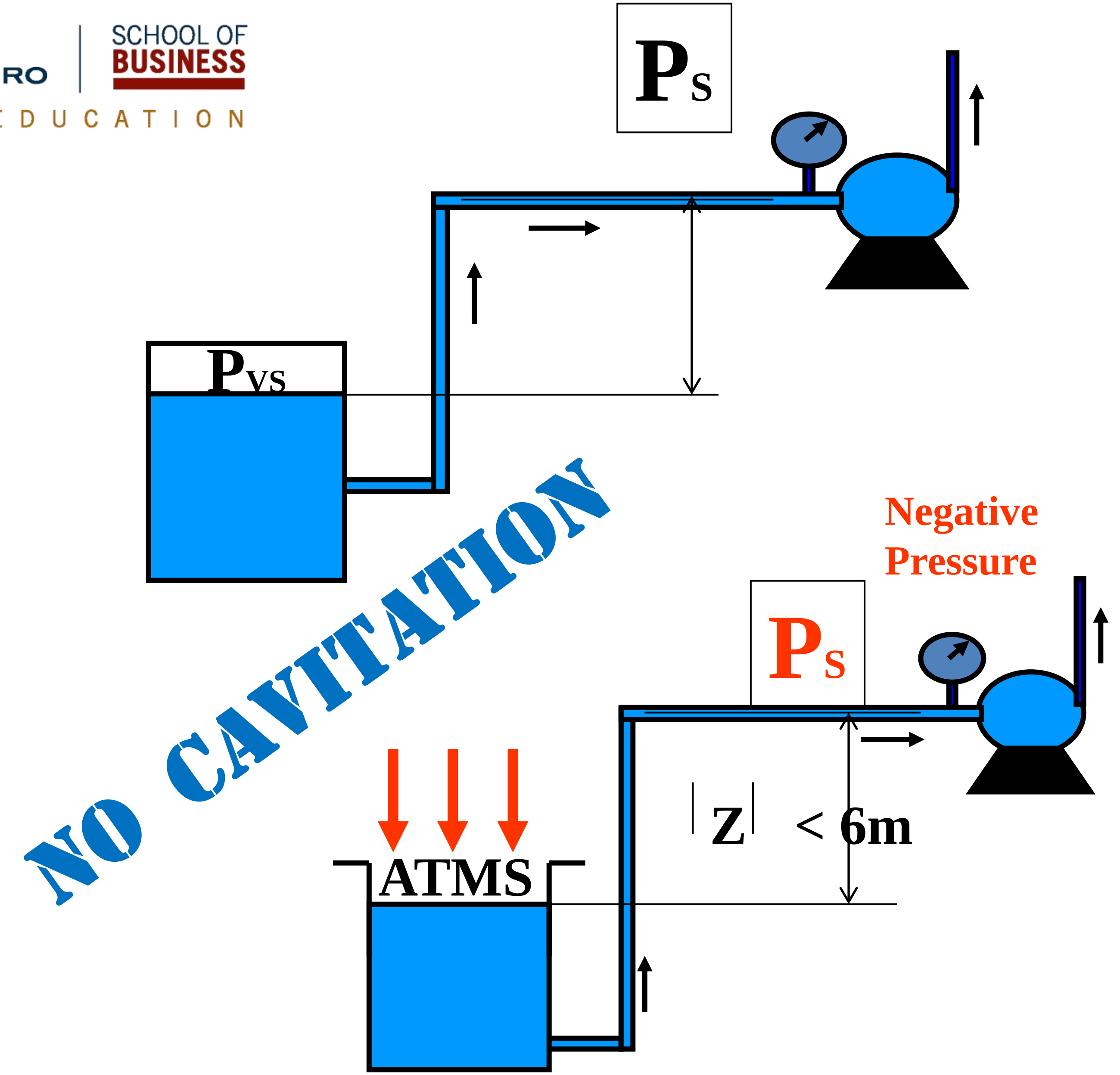
2

If The Suction pressure is known



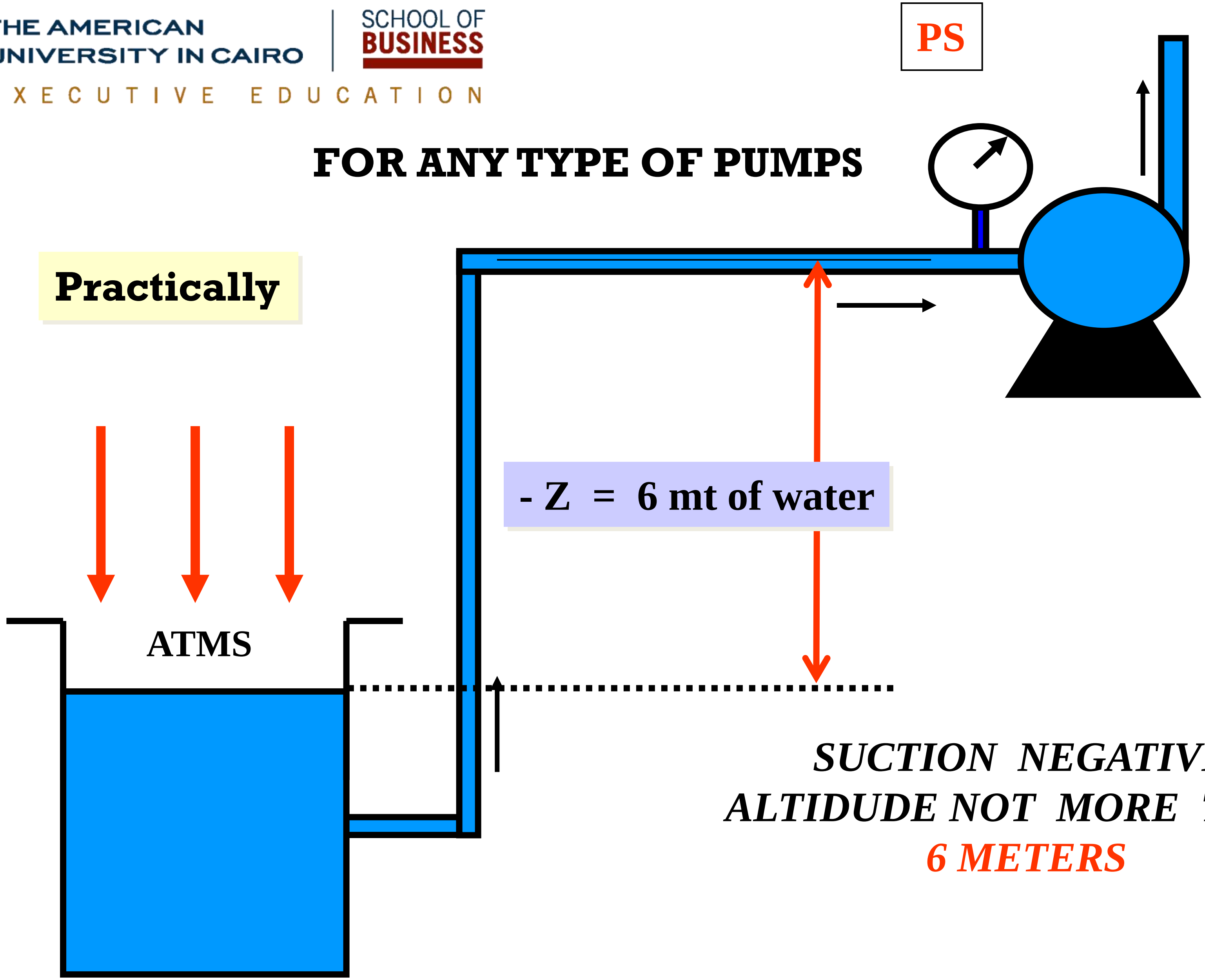
$$NPSHA = \frac{V^2}{2g} + \frac{\{ P_{sa} - V_p \} \, 2.31}{Sp.gr} \quad (ft)$$


Boiled water
Positive Reading
Ps
CAVITATION OCCURED
Z
Z < hL


Ps
Pvs
NO CAVITATION
Negative Pressure
Ps
ATMS
|Z| < 6m

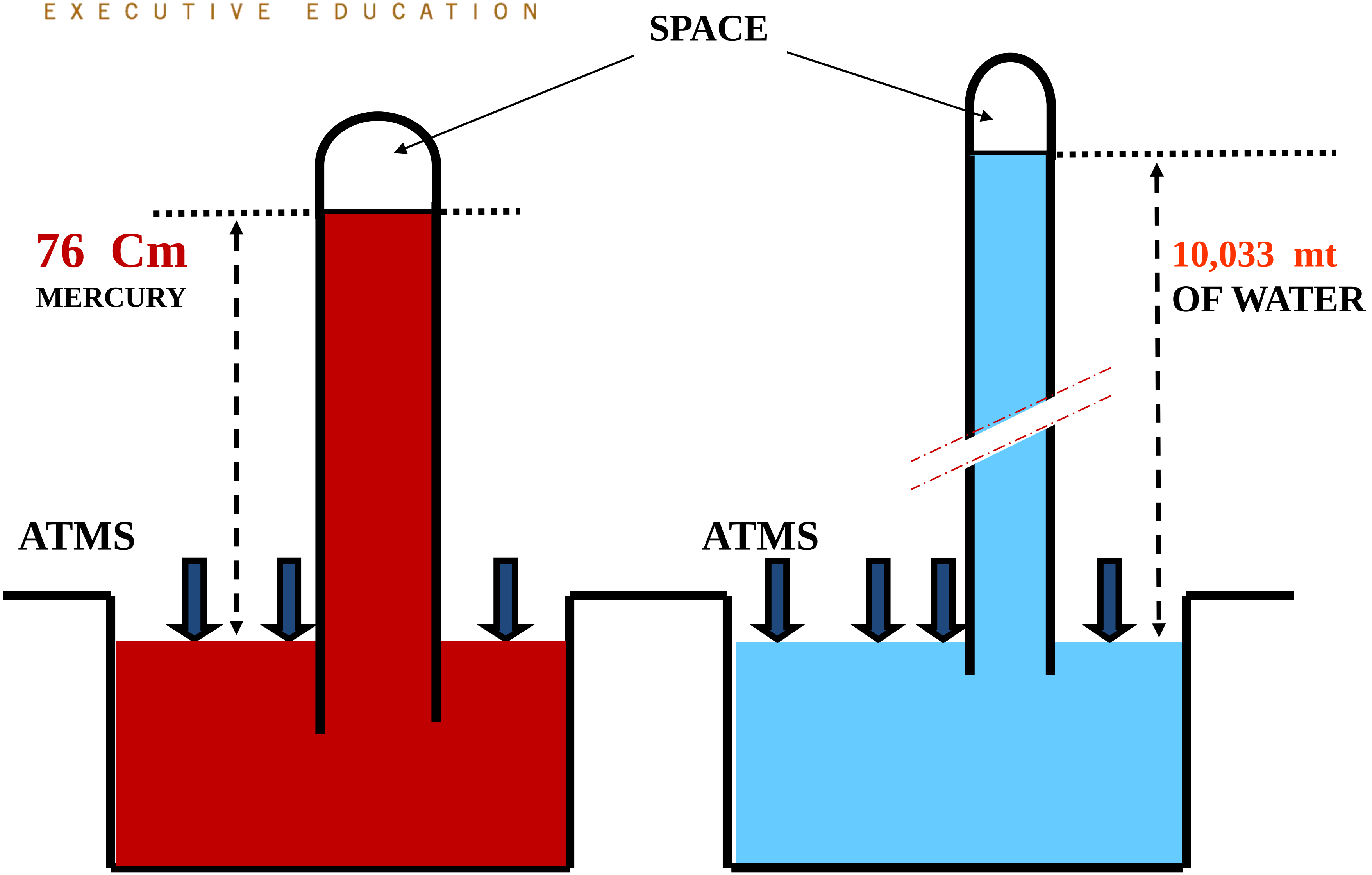
FOR ANY TYPE OF PUMPS

Practically

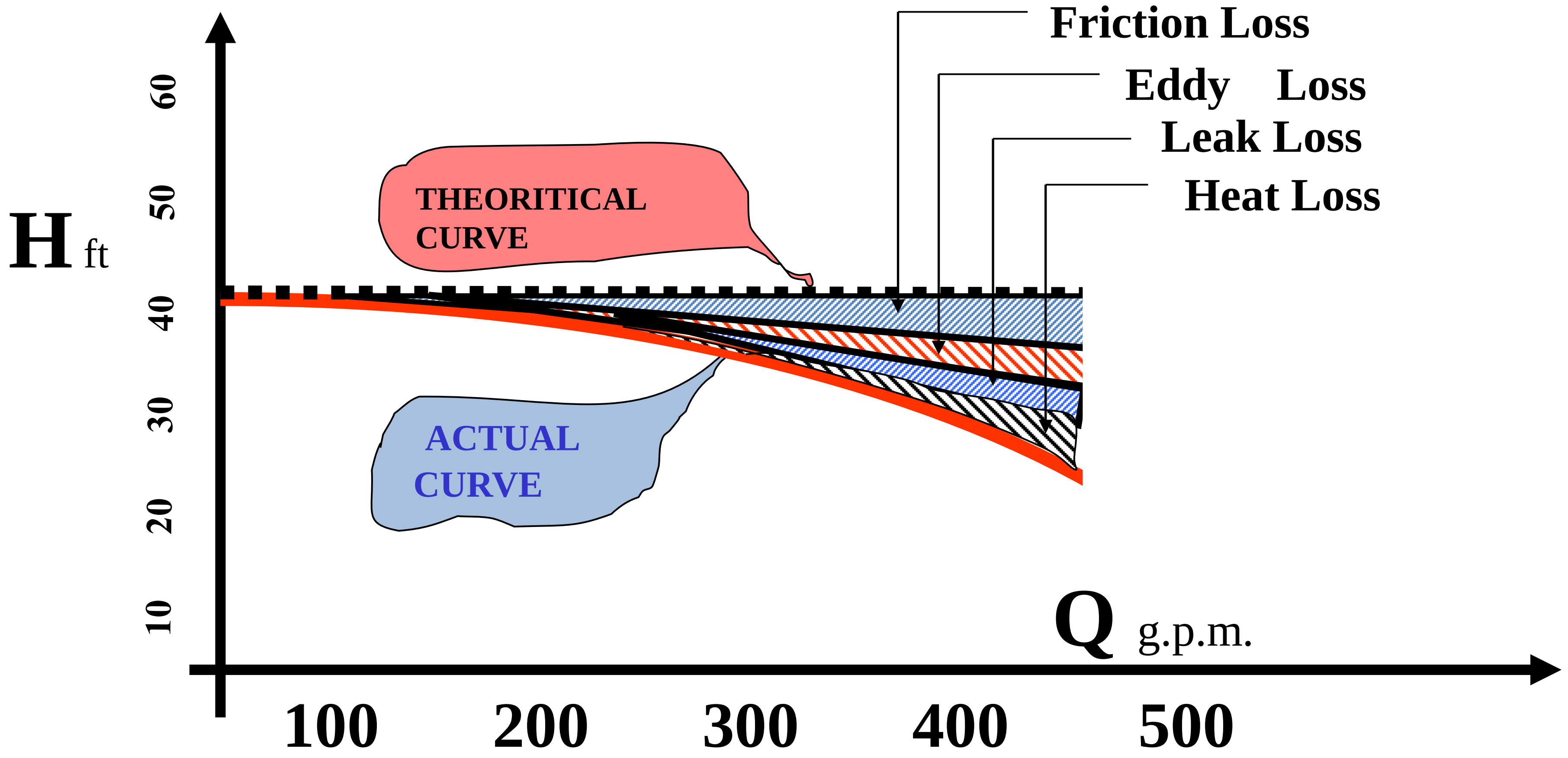


SUCTION NEGATIVE ALTIDUDE NOT MORE THAN 6 METERS

ATMOSPHERIC PRESSURE



Centrifugal Pumps Losses



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WHAT IS VAPOR PRESSURE

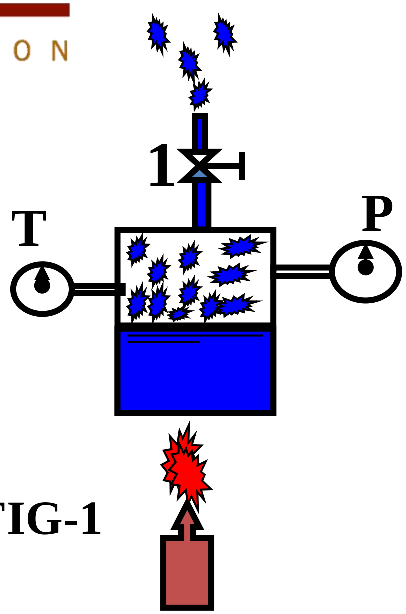


FIG-1

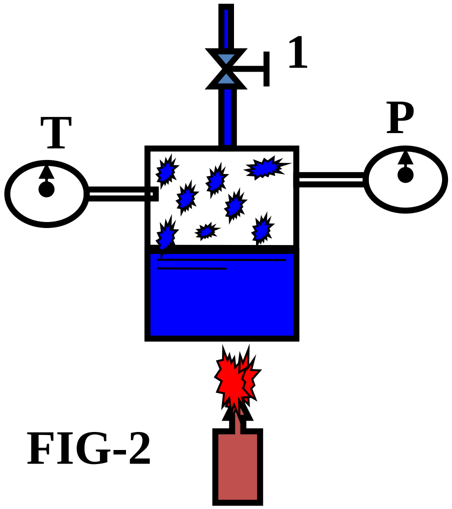
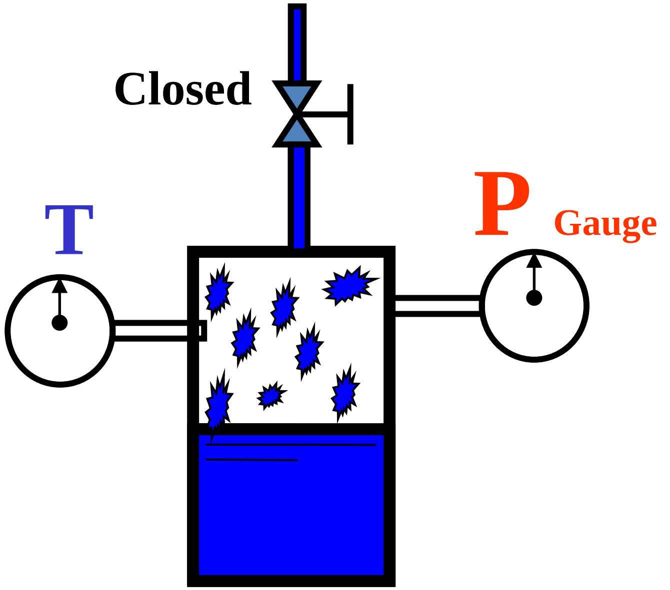


FIG-2

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 .

$$P_{\text{Absolute (bar)}} = P_{\text{gauge}} + 1$$

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

(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
$V_{apor}\,P_{ressure}$	1	0.9	0.7	0.5	0.3	0.02

Examples

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

$$NPSHA = Z + \frac{\{(Psv + Pa) - Vp\}\, 2.31}{Sp.gr} - hL$$

$$= 8 + \frac{\{(0 + 14.7) - 4\}\;\; 2.31}{0.8} - 12$$

$$= 8 + 31 - 12$$

$$= +27 \;\; (ft)$$

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 HORSEPWER 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 rpm** TO **N_2 = 1100 rpm**
- Given data:

HP_1 = 123 kW **H_1 = 100 m** **Q_1 = 1 m³/s**

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

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

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

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PUMPS AFFINITY LAWS

Initial **N1** OR **D1**	1000
New **N2** OR **D2**	**1500**

Initial Q1 Flow rate	**120**
Initial P1 Pressure	**10**
Initial HP1 Horse power	**100**

New Q2 Flow rate	**180**
New P2 Pressure	**23**
New HP2 Horse power	**338**

N = **PUMP RPM**
D = **PUMP IMPELLER DIAMETER**

ROTARY PUMPS

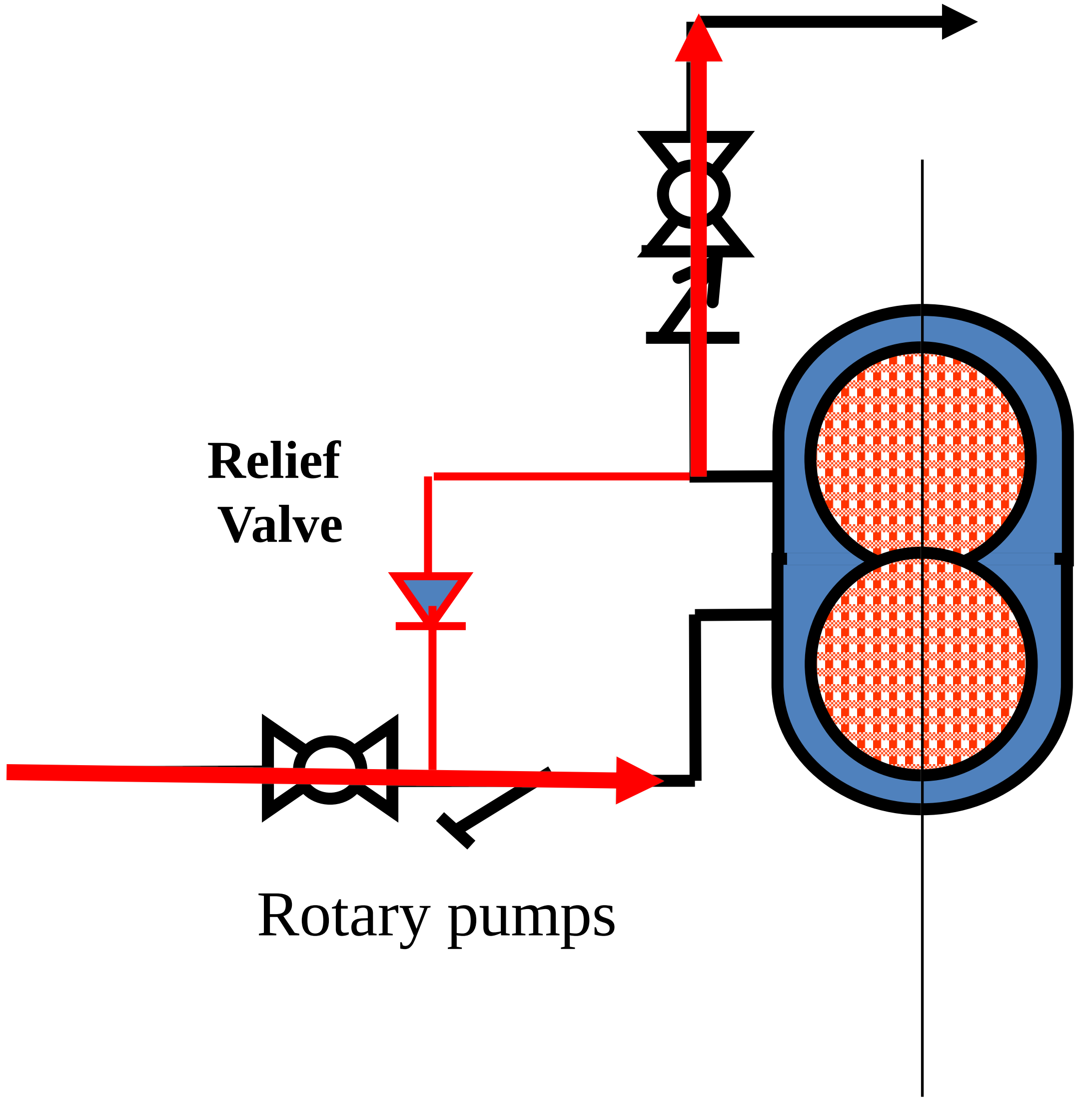
Rotary Pumps

- 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



Rotary pumps

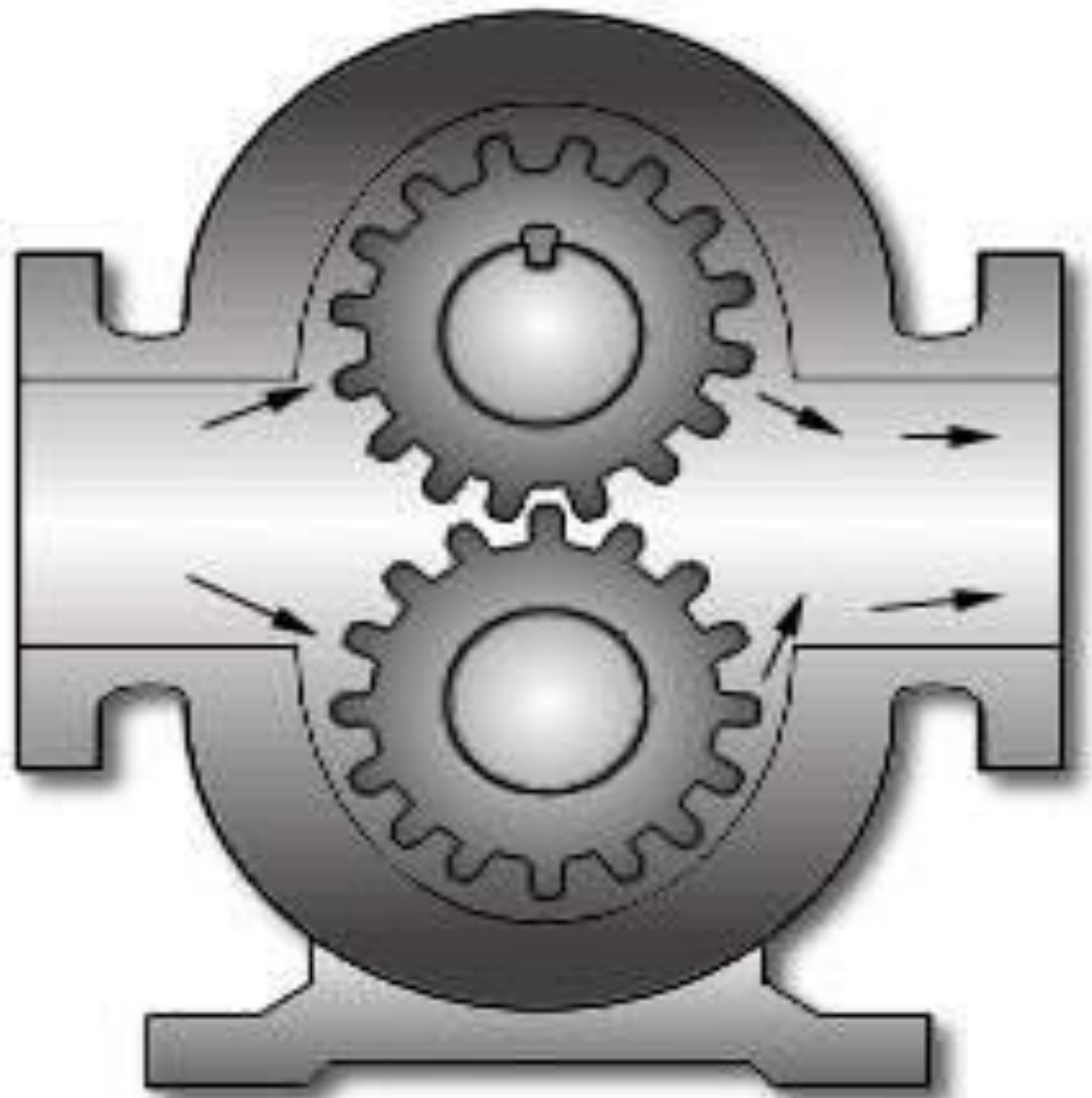
External Gear Pump

- 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.

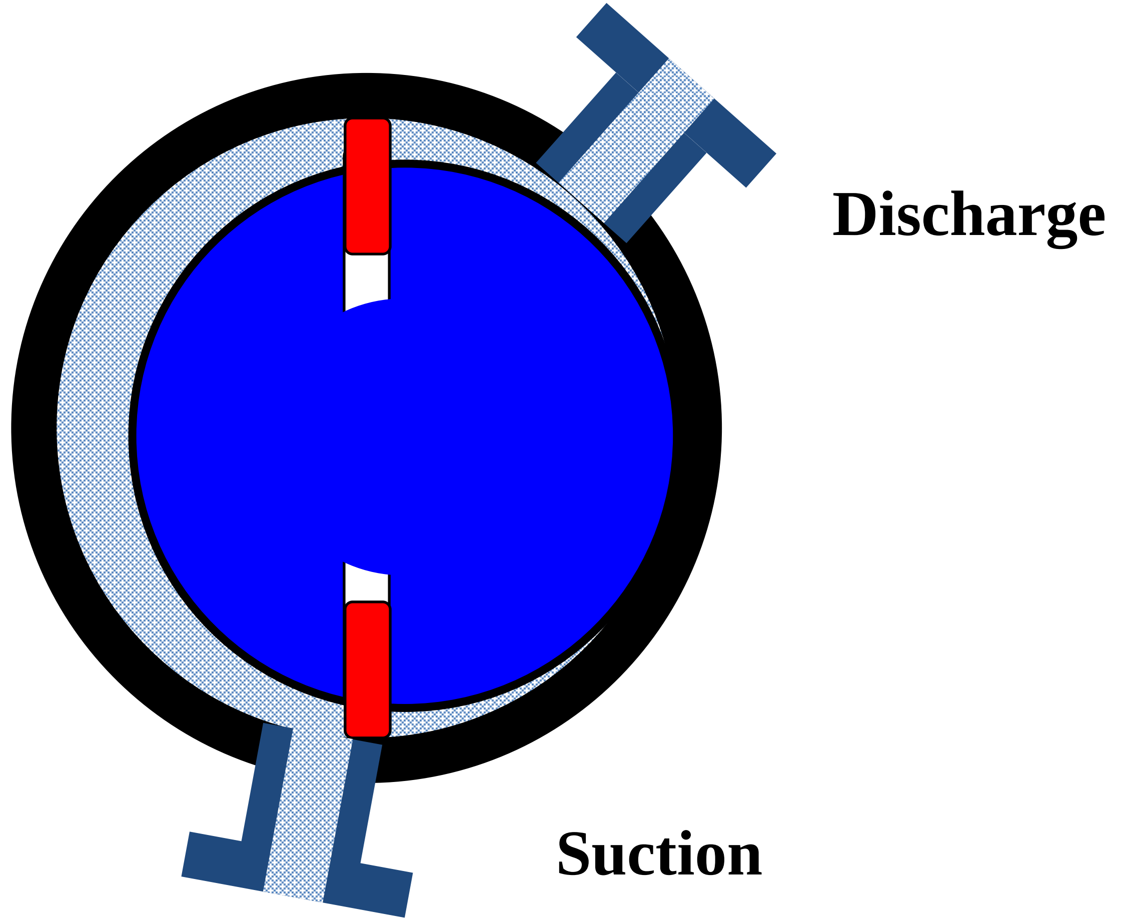
External Gear Pump

- 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.

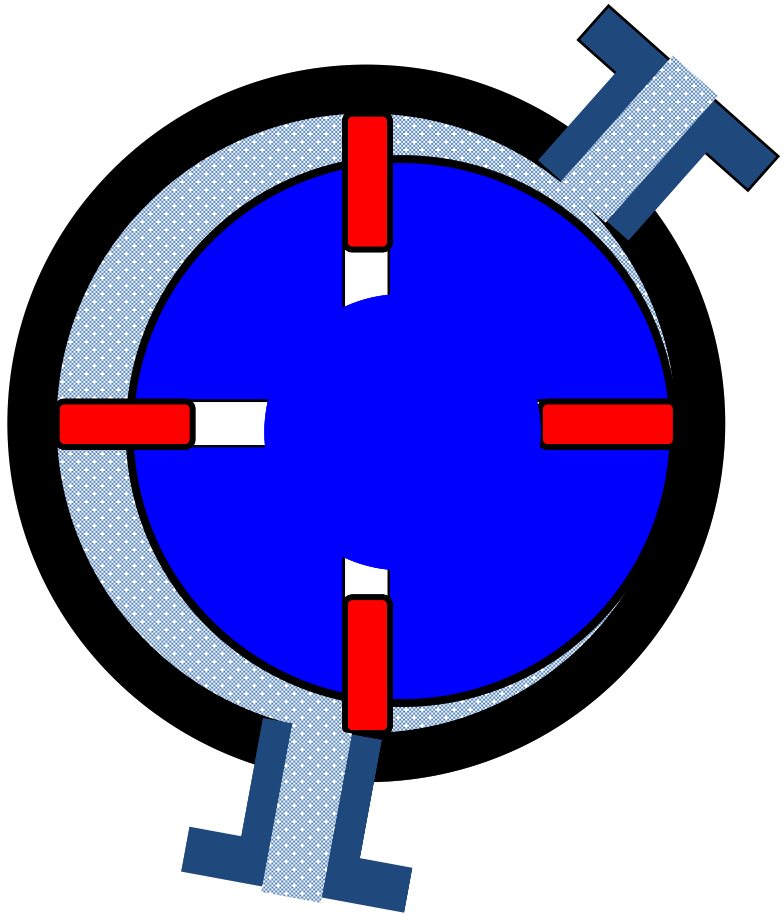
External Gear Pump



Rotary Vane Pump

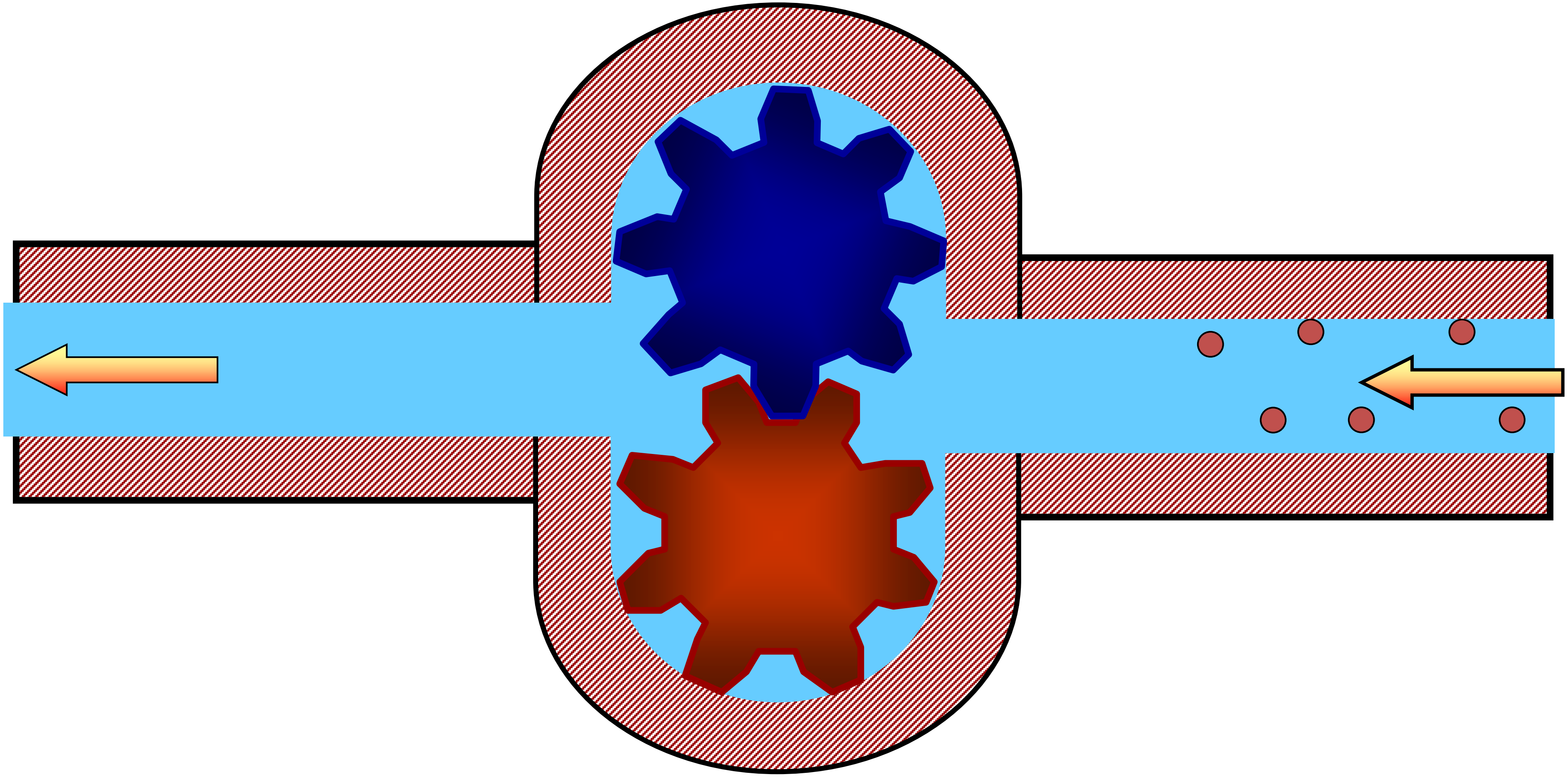


Rotary Vane Pump



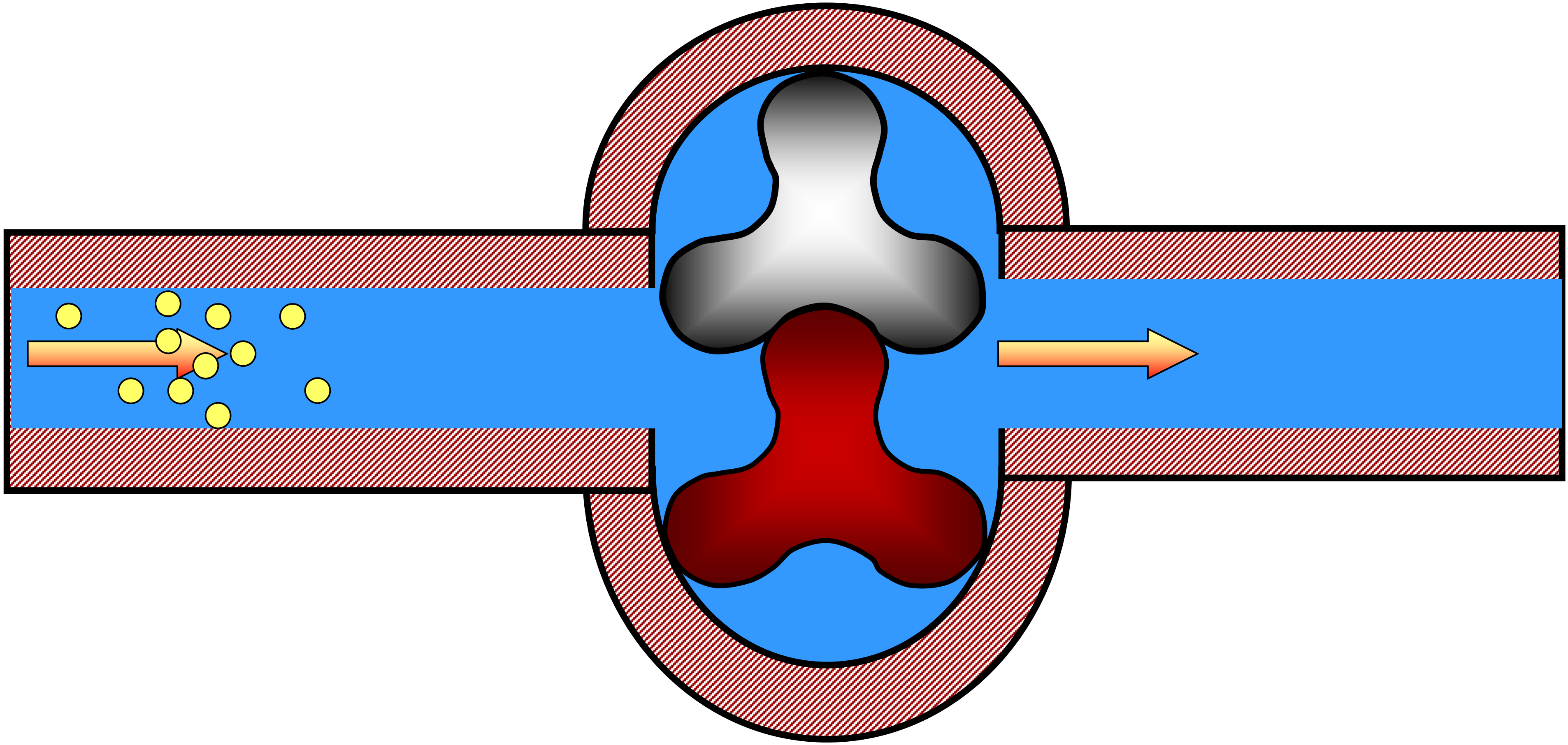
ROTARY PUMPS

External Gear

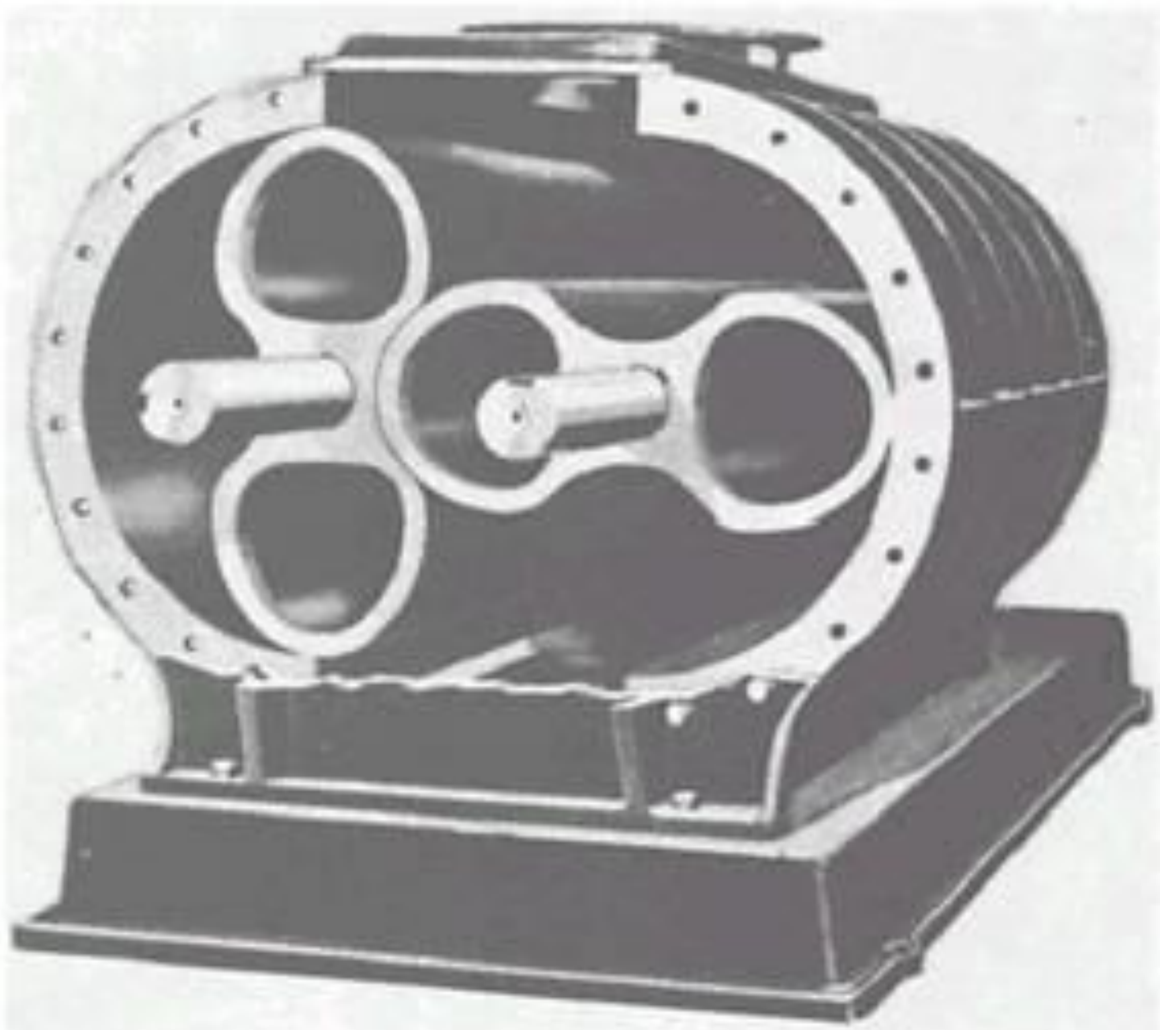


THE FLUID IS TRAPPED BETWEEN ROTOR AND CASING

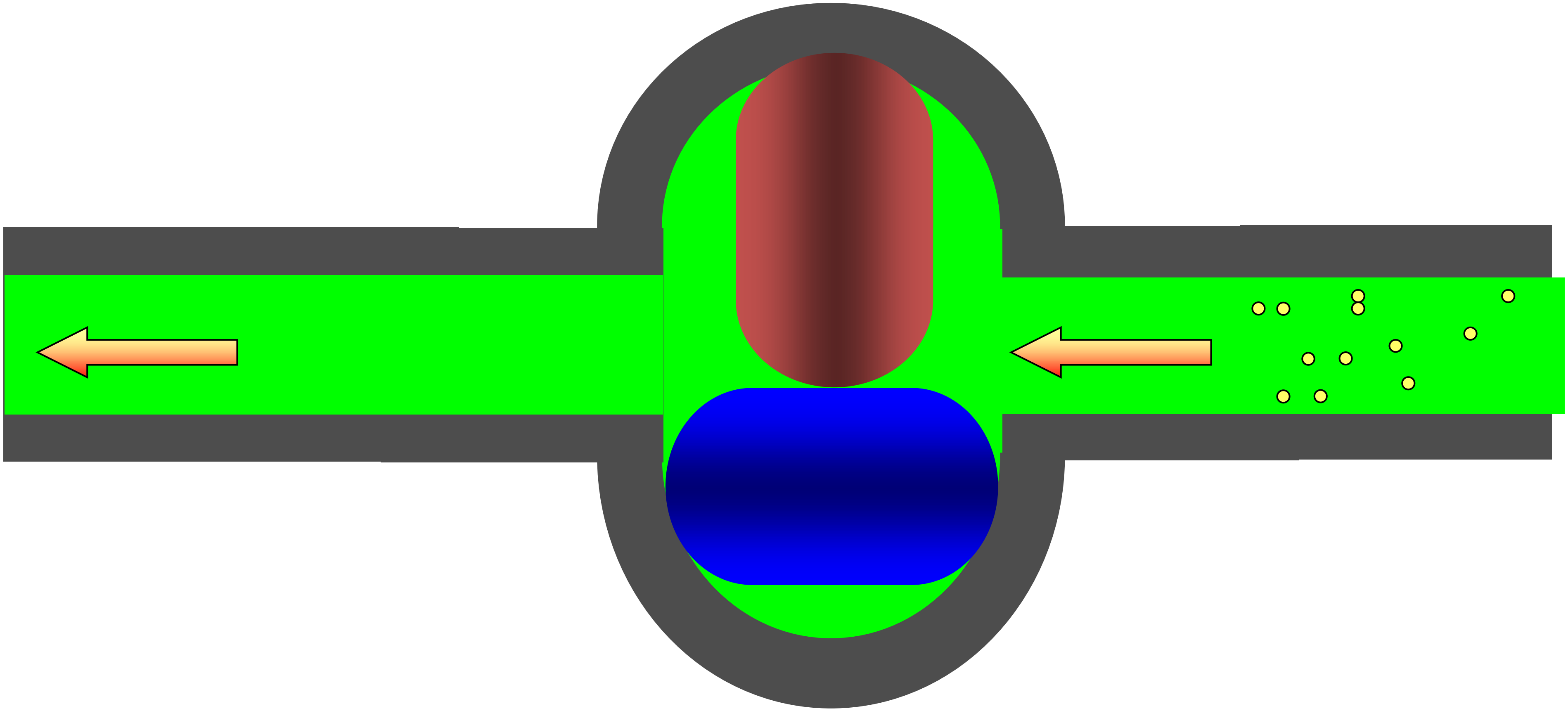
THREE LOBE PUMPS



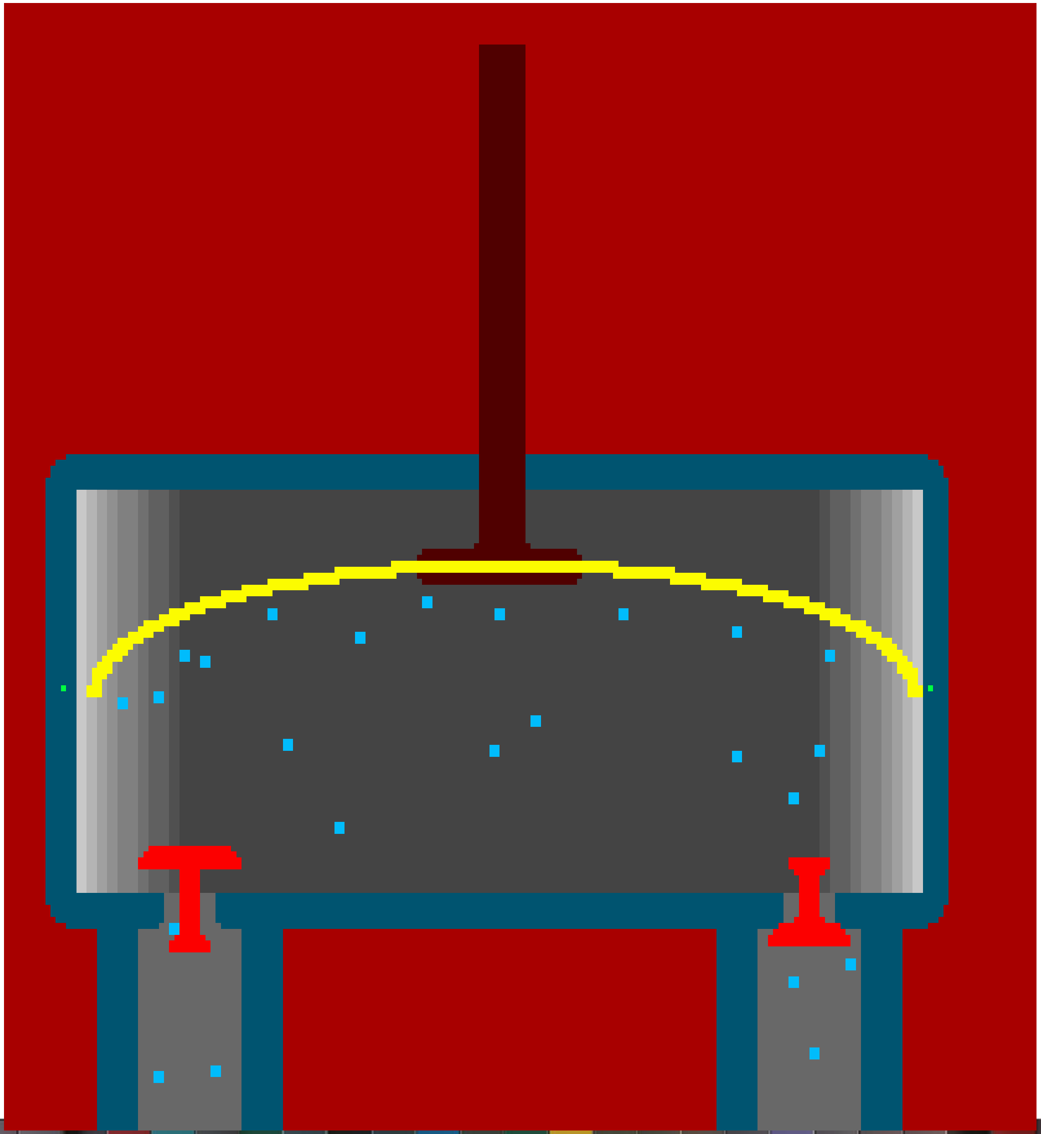
Rotary Twin-lobe Pump



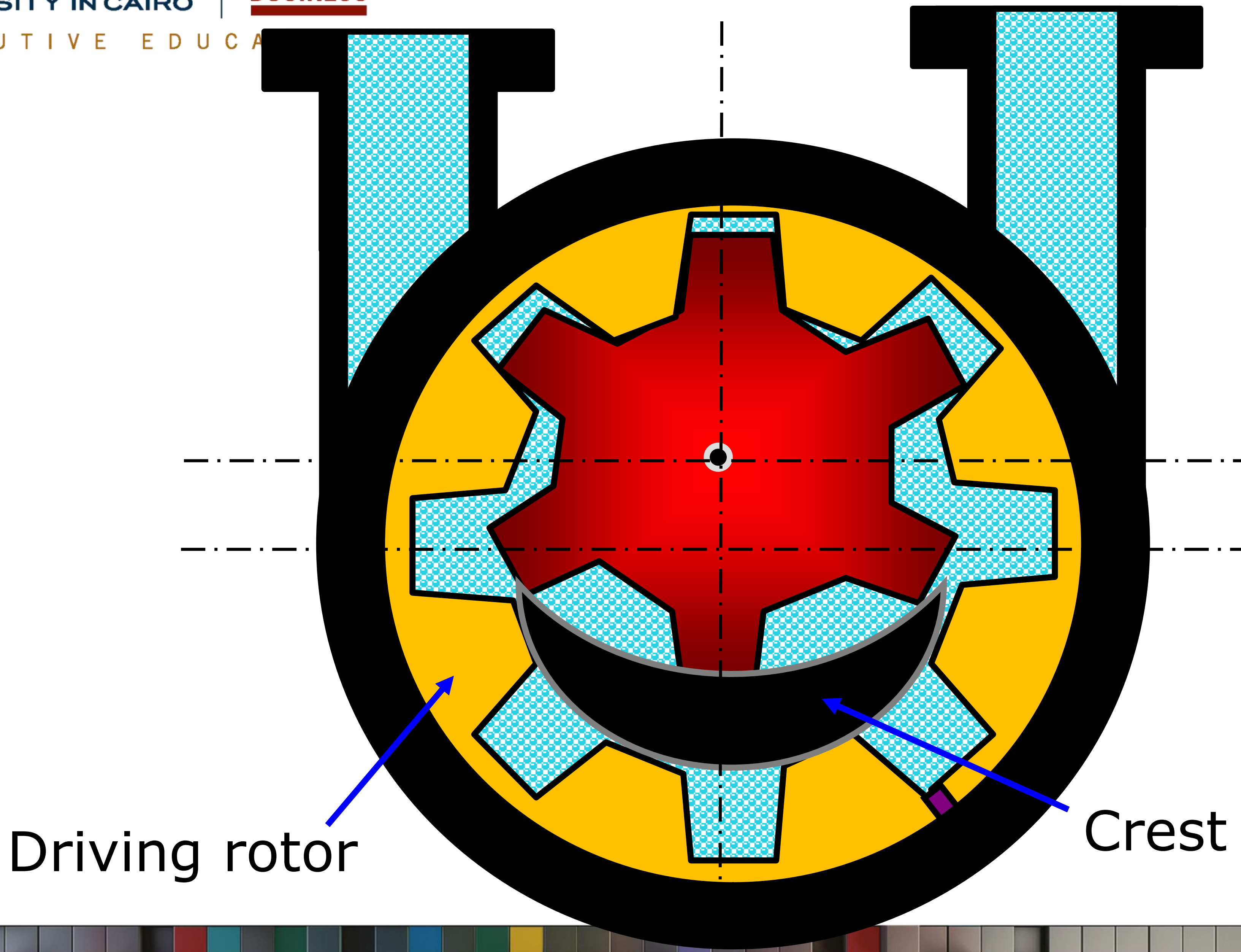
TWO LOBE PUMPS



Diaphragm pump

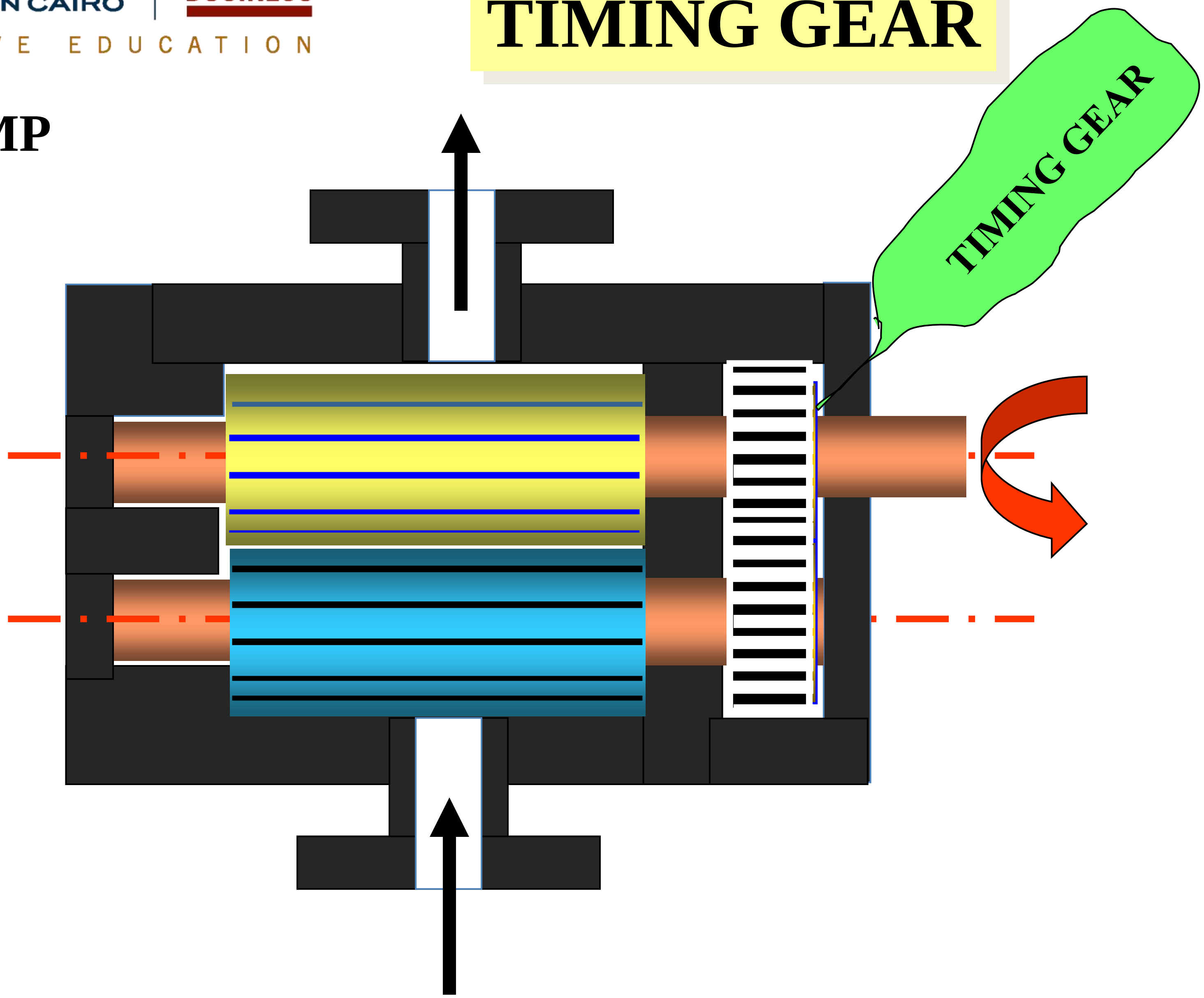


Internal Gear


Driving rotor
Crest

TIMING GEAR

GEAR PUMP

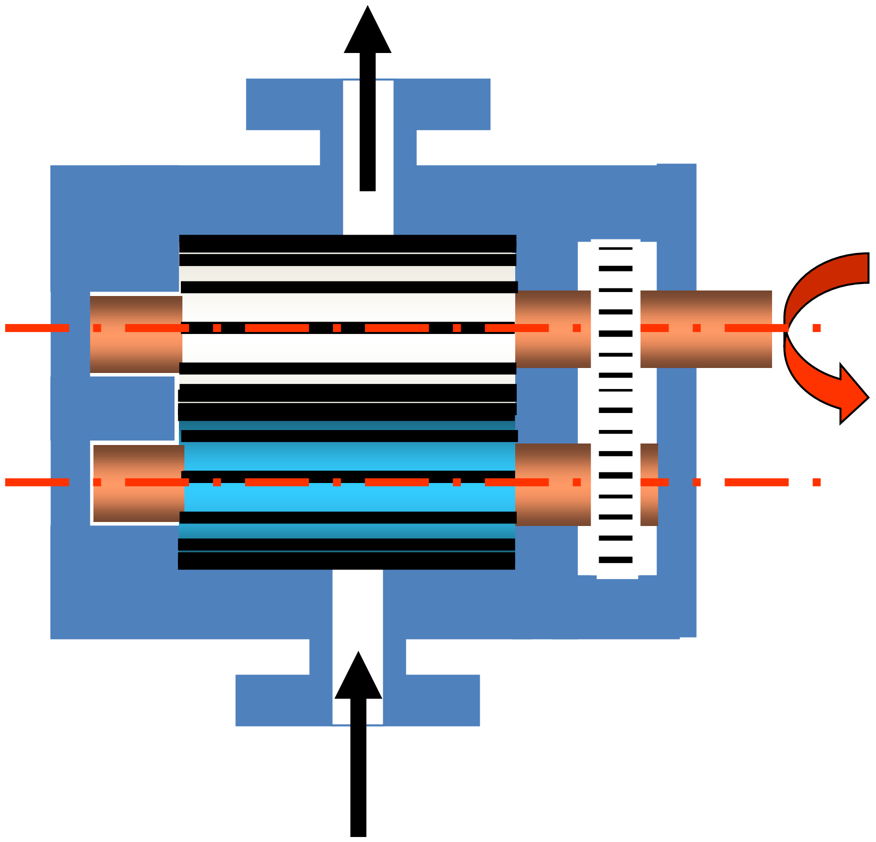


TIMING GEAR FUNCTION

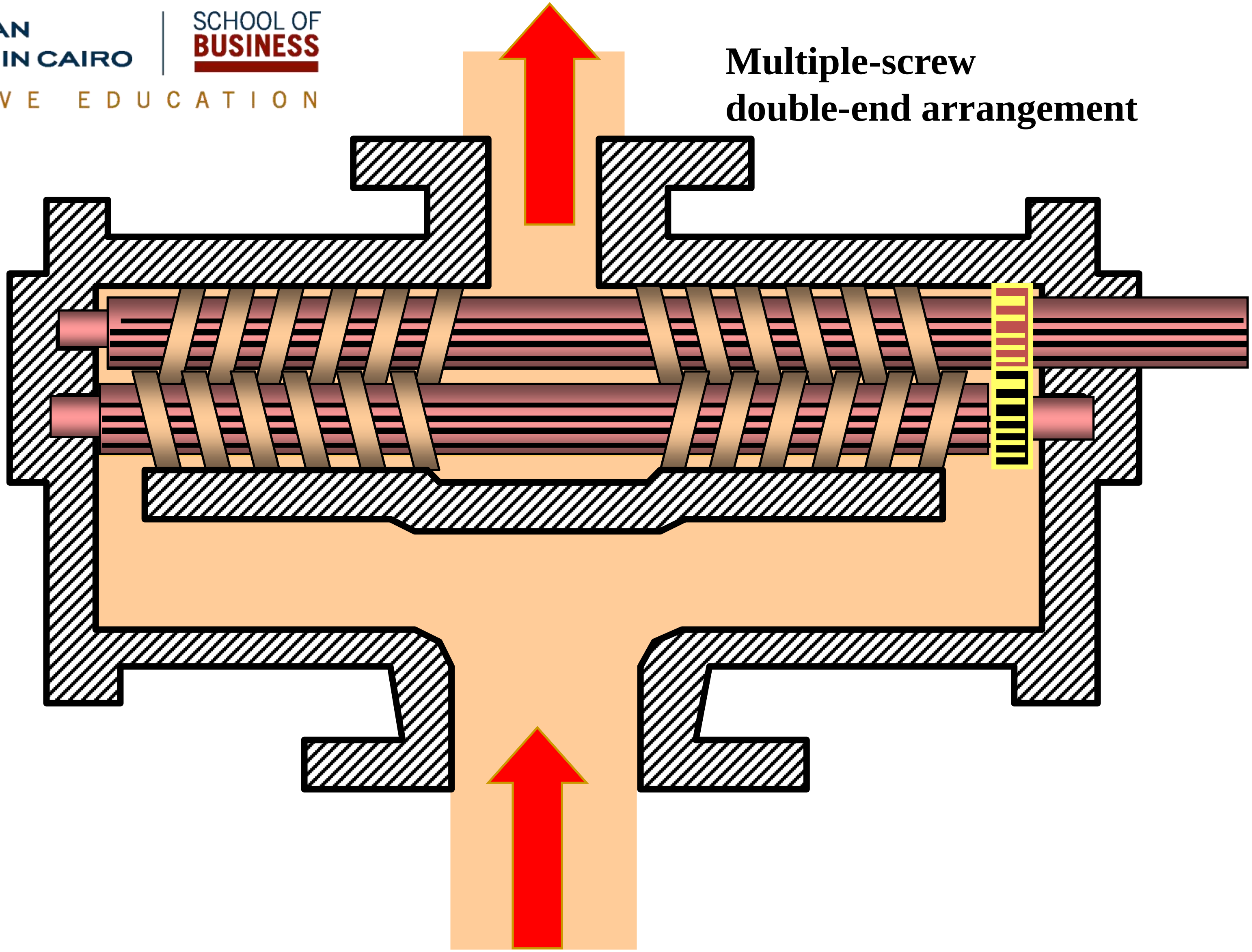
1- TRANSMIT MOTION TO OTHER ROTOR

2- KEEPS NO CONTACT BETWEEN ROTORS

3- PREVENT WEAR BETWEEN ROTORS



Multiple-screw double-end arrangement



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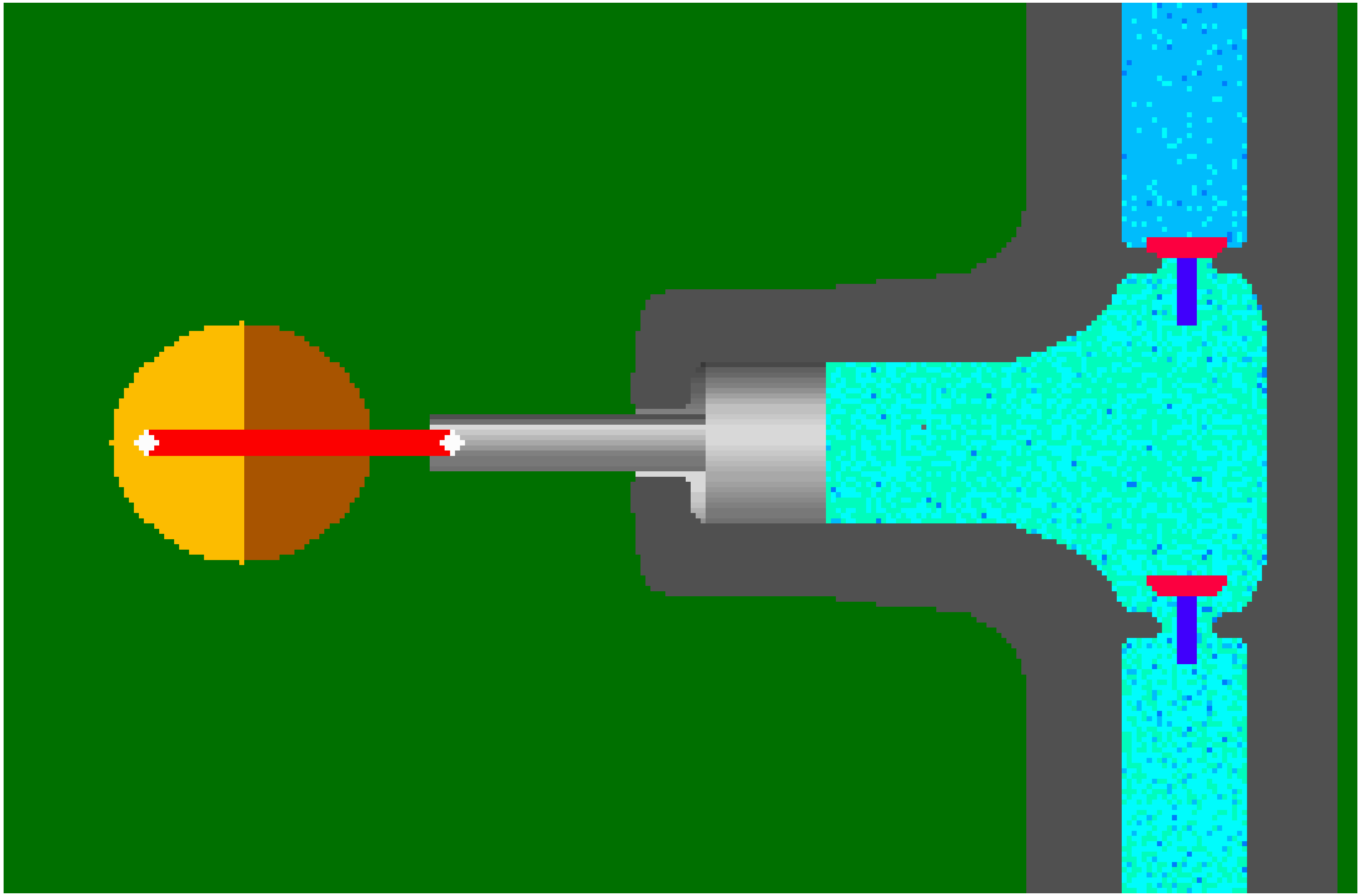
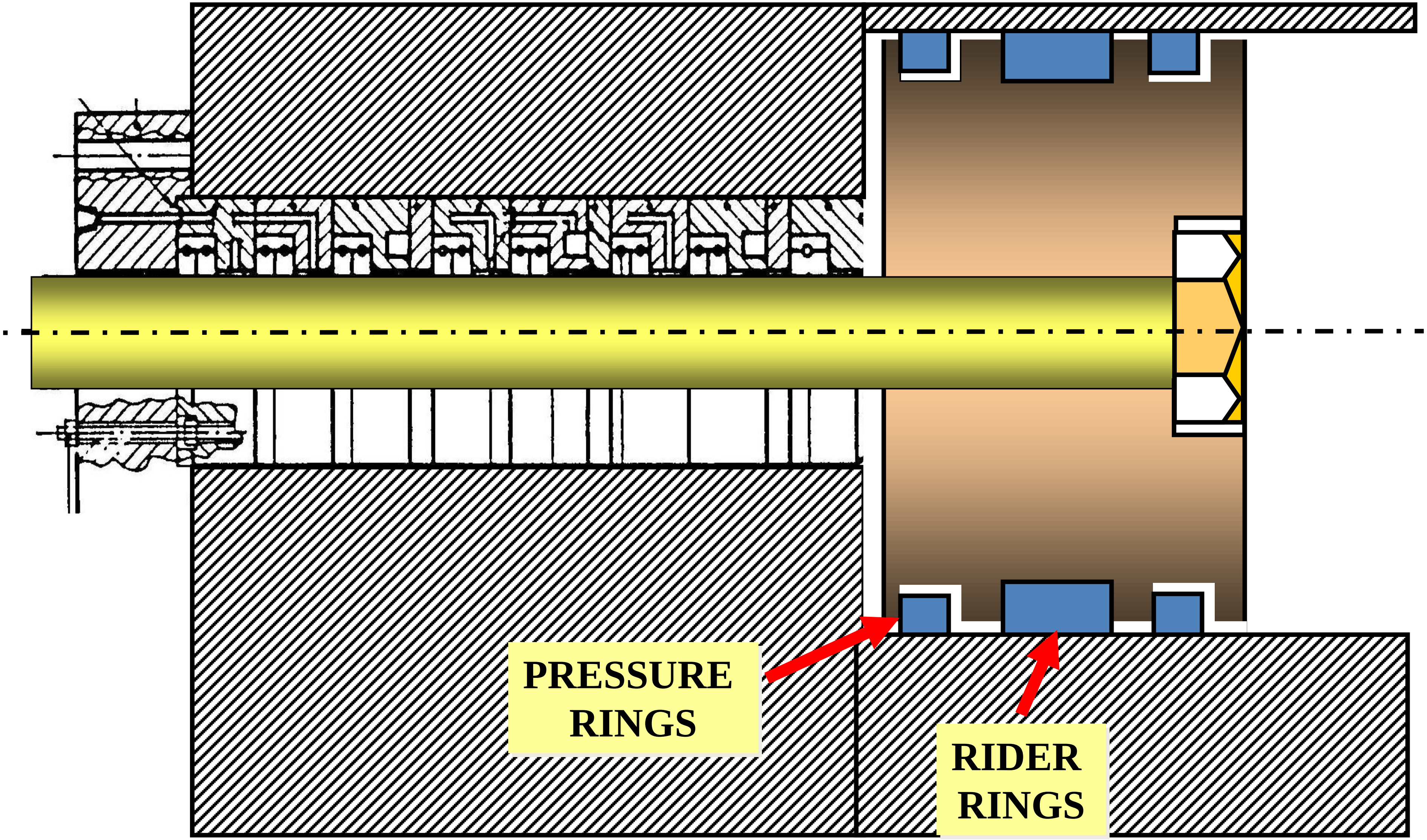
RECIPROCATING PUMPS

Reciprocating Pump

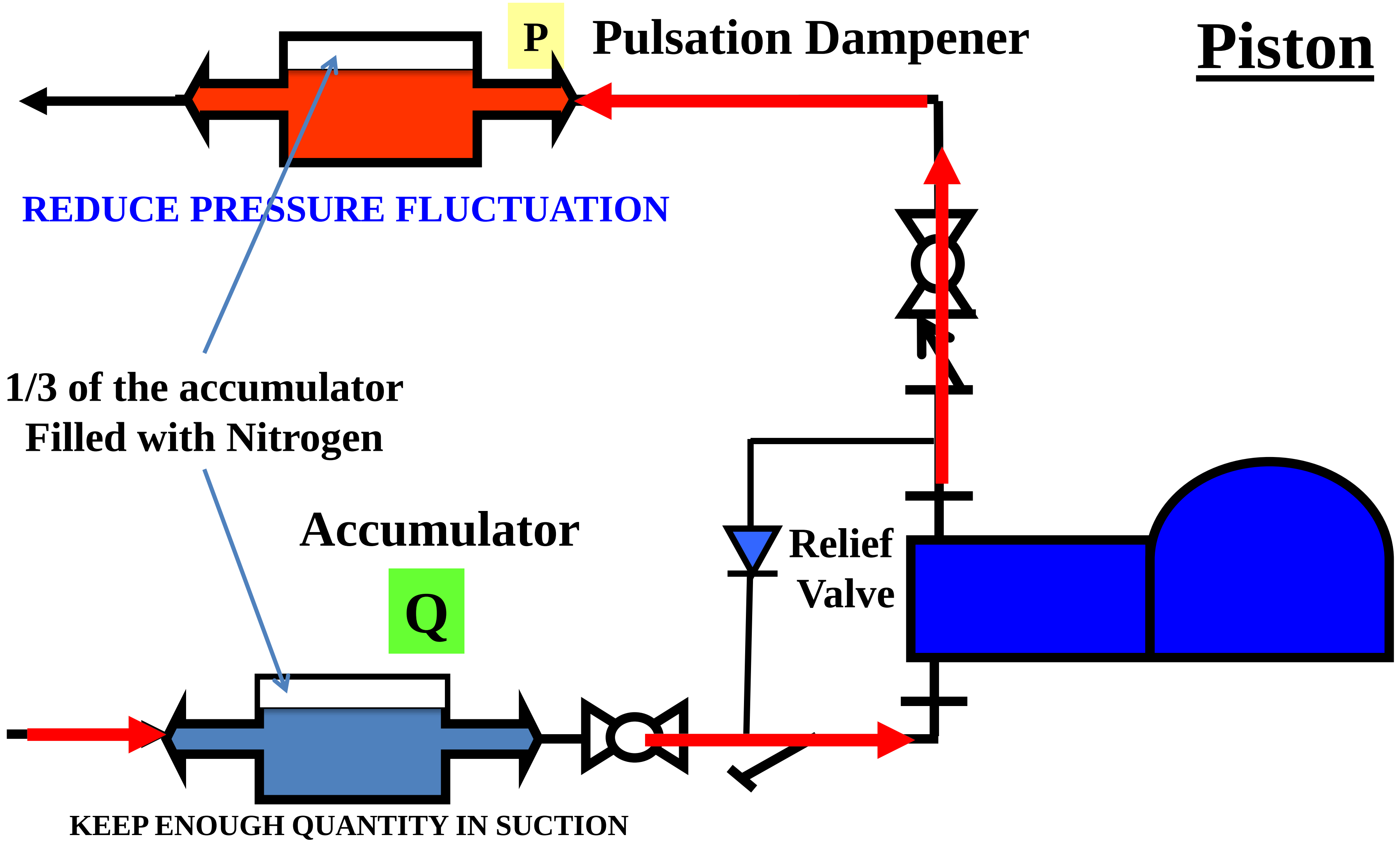
Piston



Reciprocating Pump

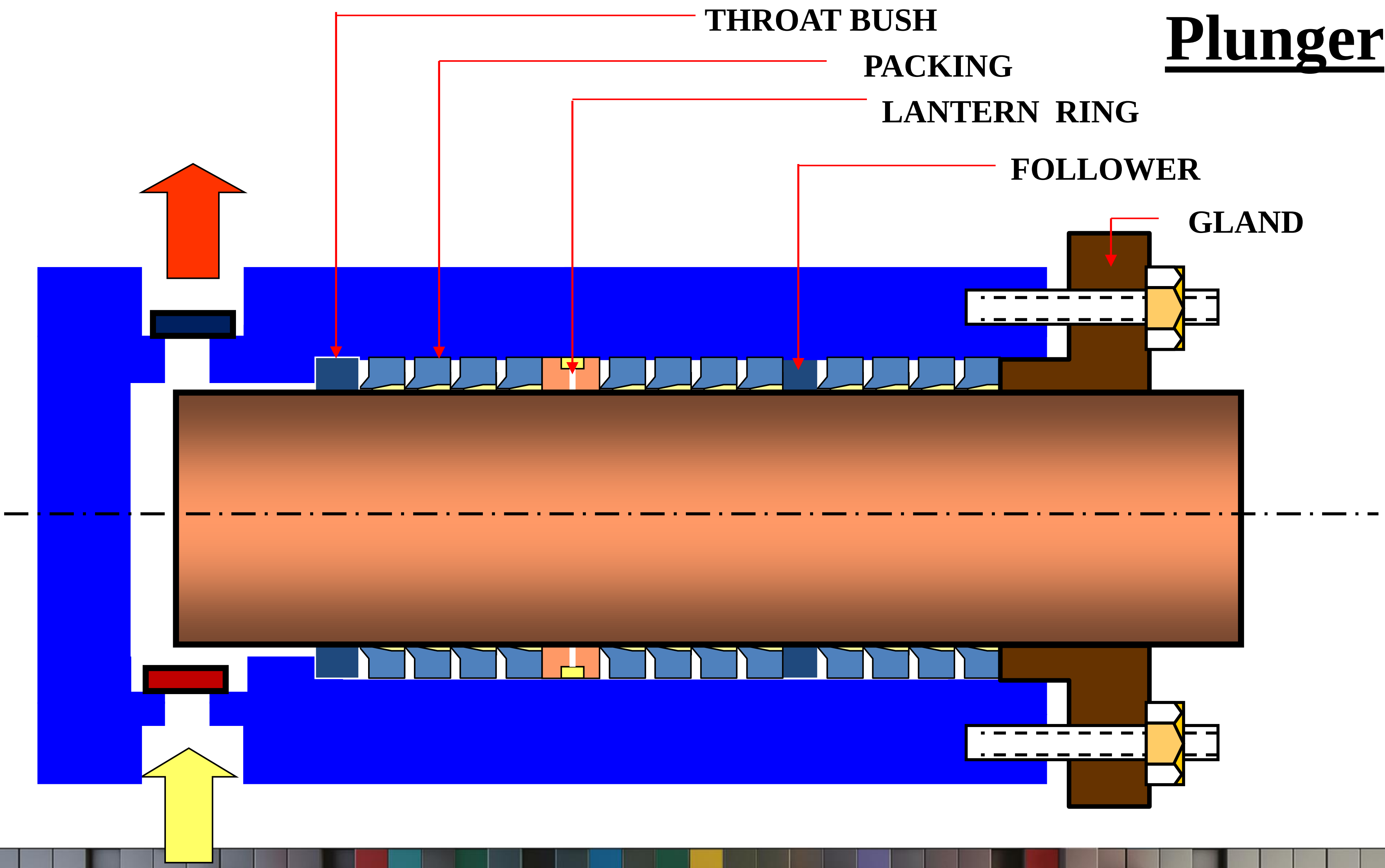


Reciprocating Pump

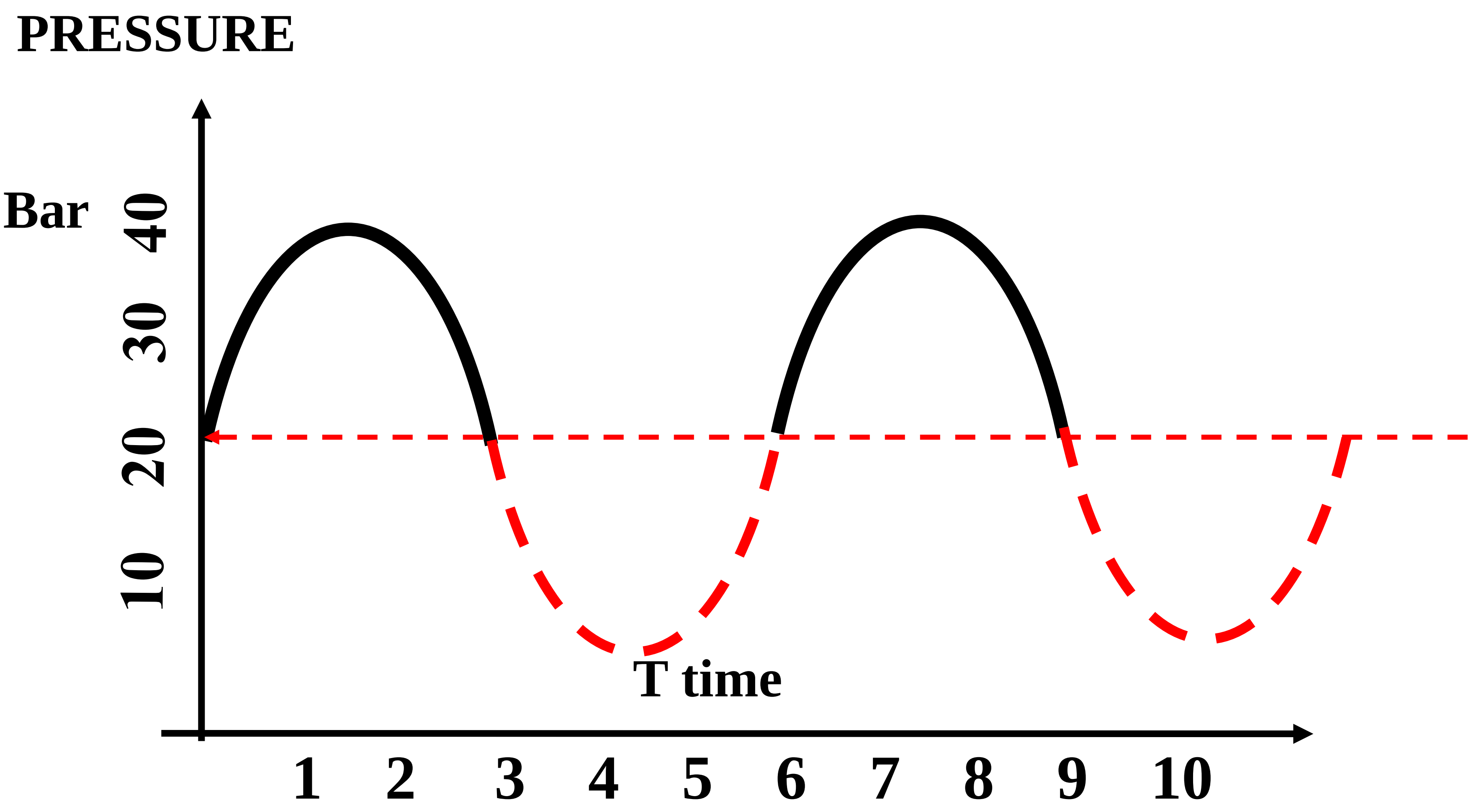


Reciprocating Pump

Plunger

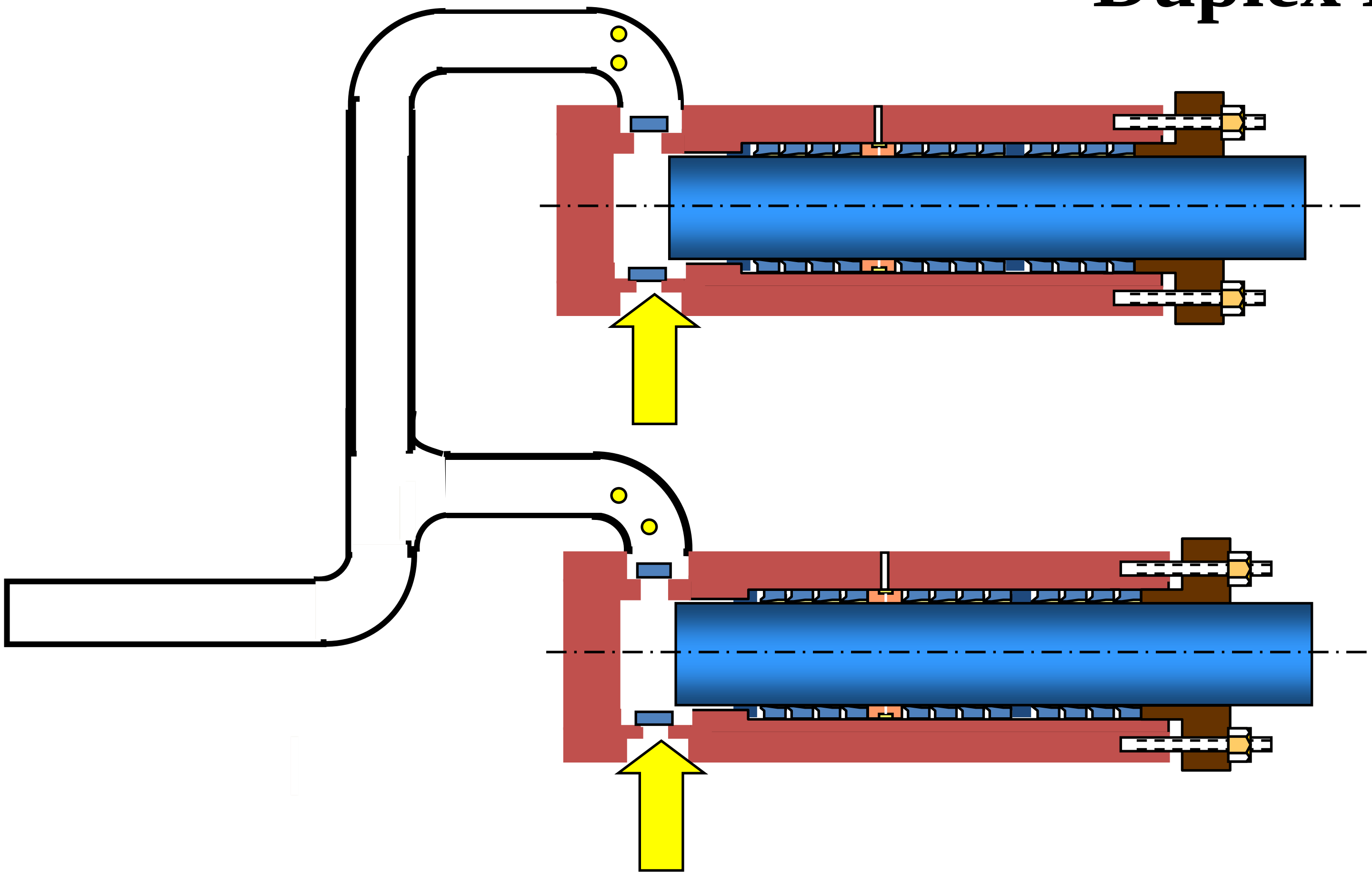


Single Plunger Pump



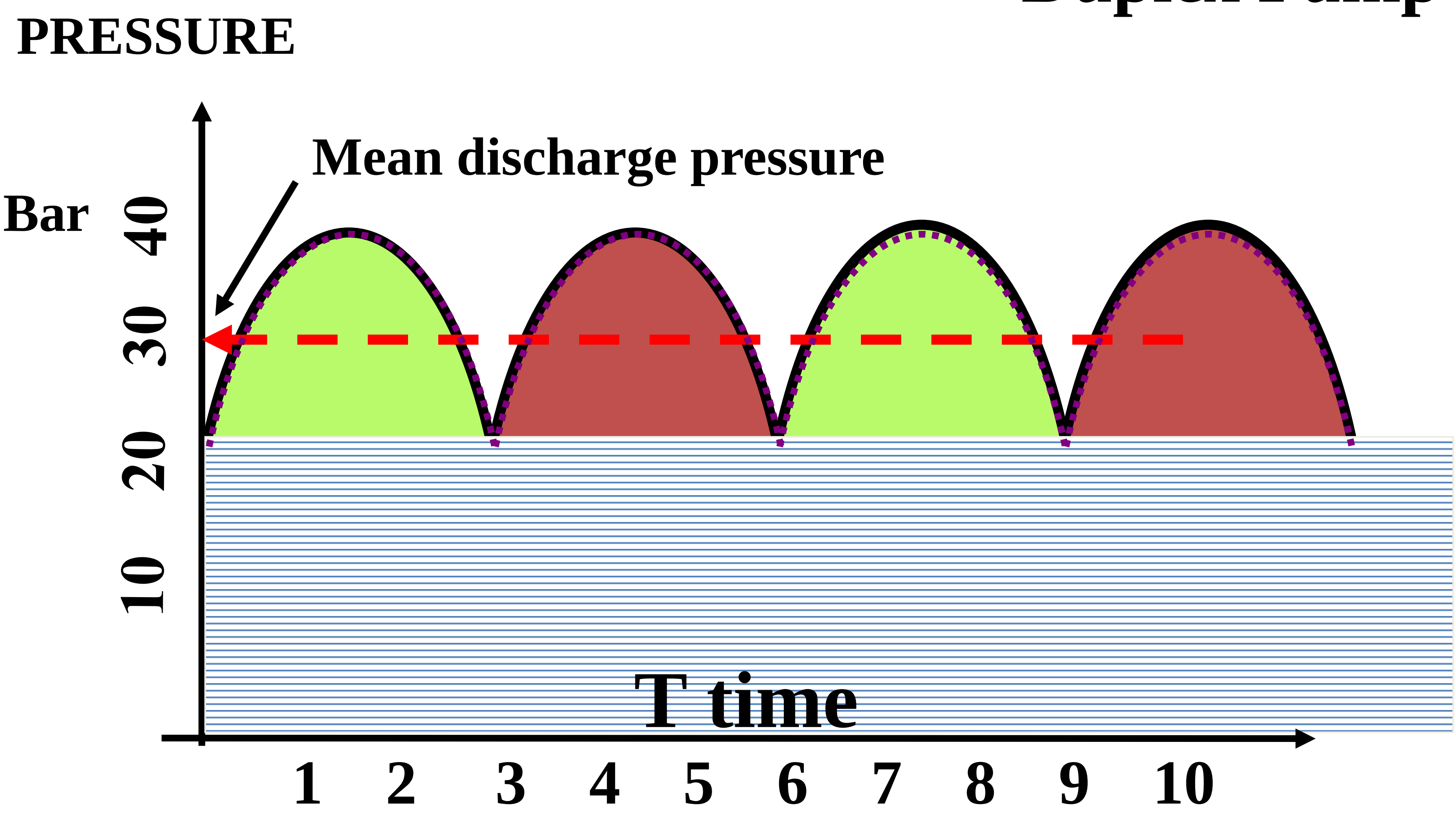
Reciprocating Pump

Duplex Pump

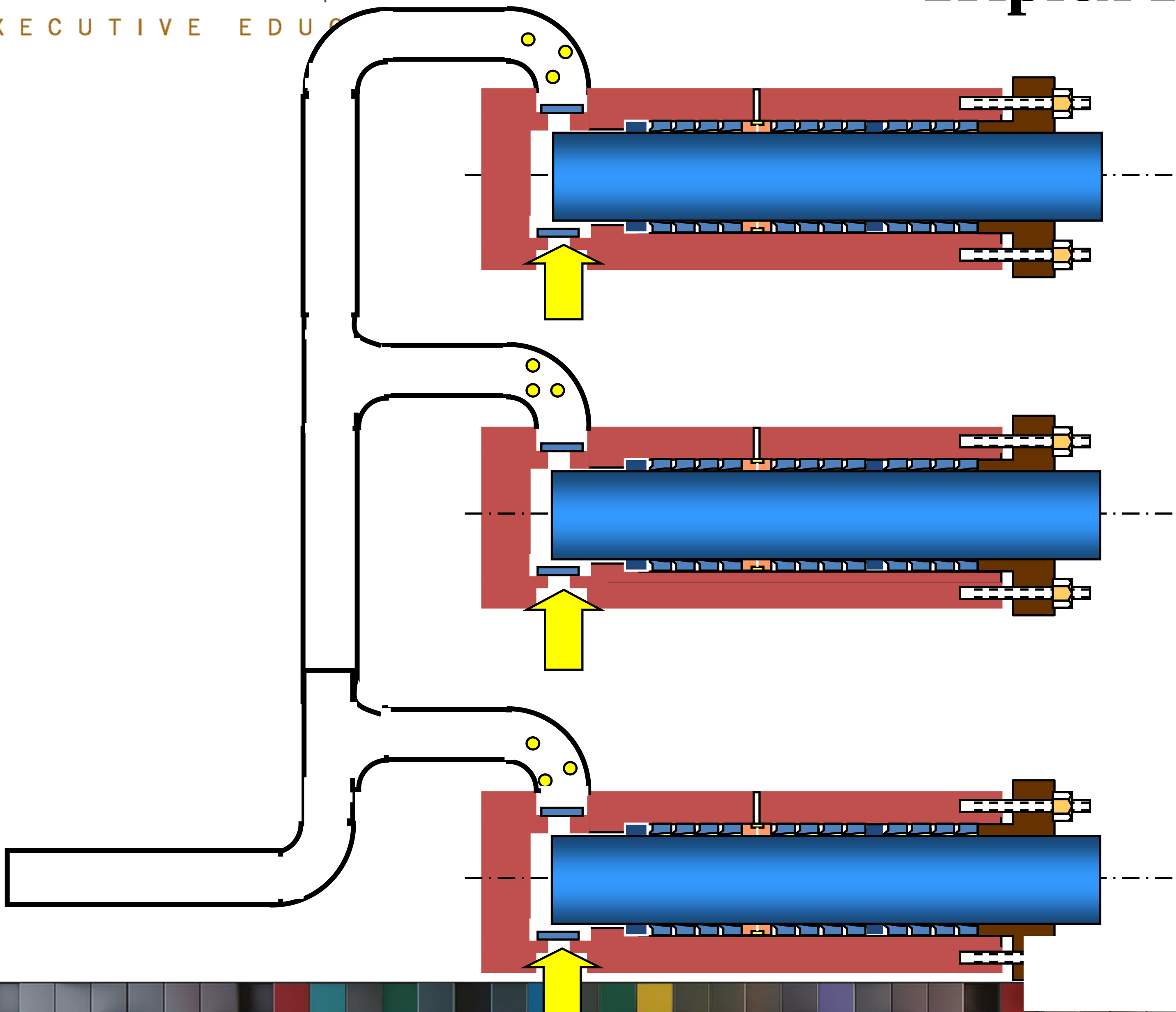


Reciprocating Pump

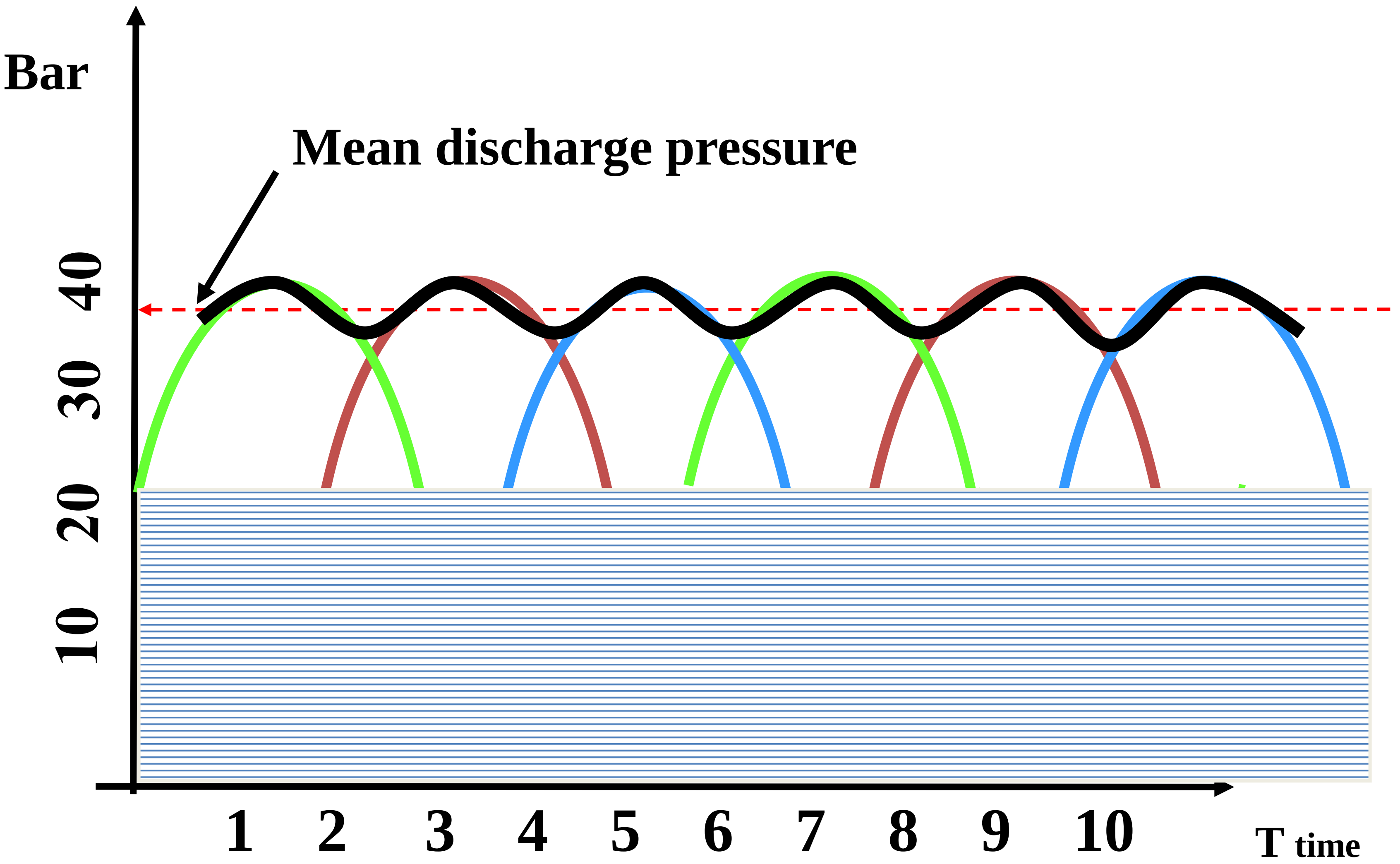
Duplex Pump



Triplex Pump



Triplex Pump



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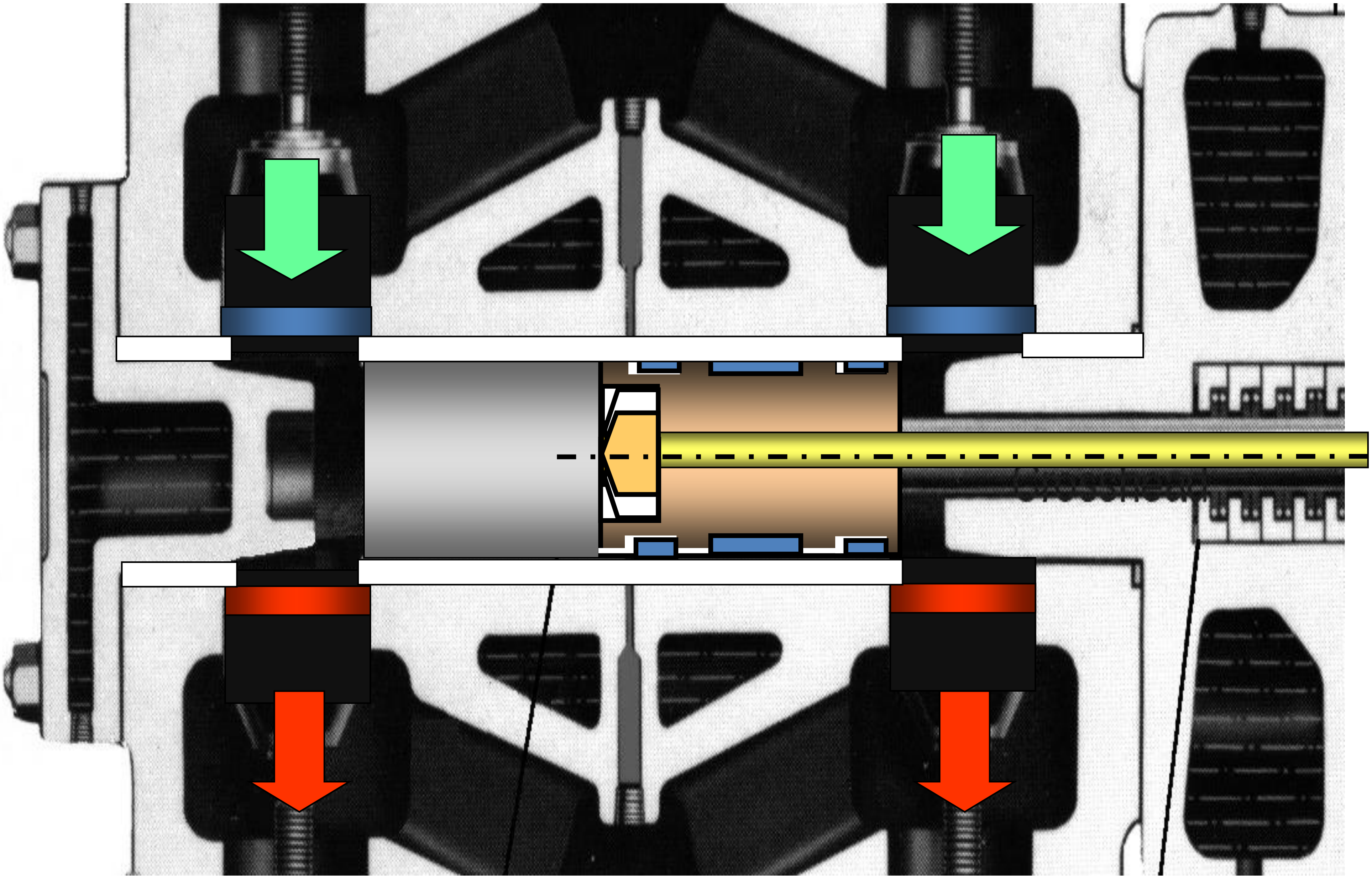
Reciprocating Pump

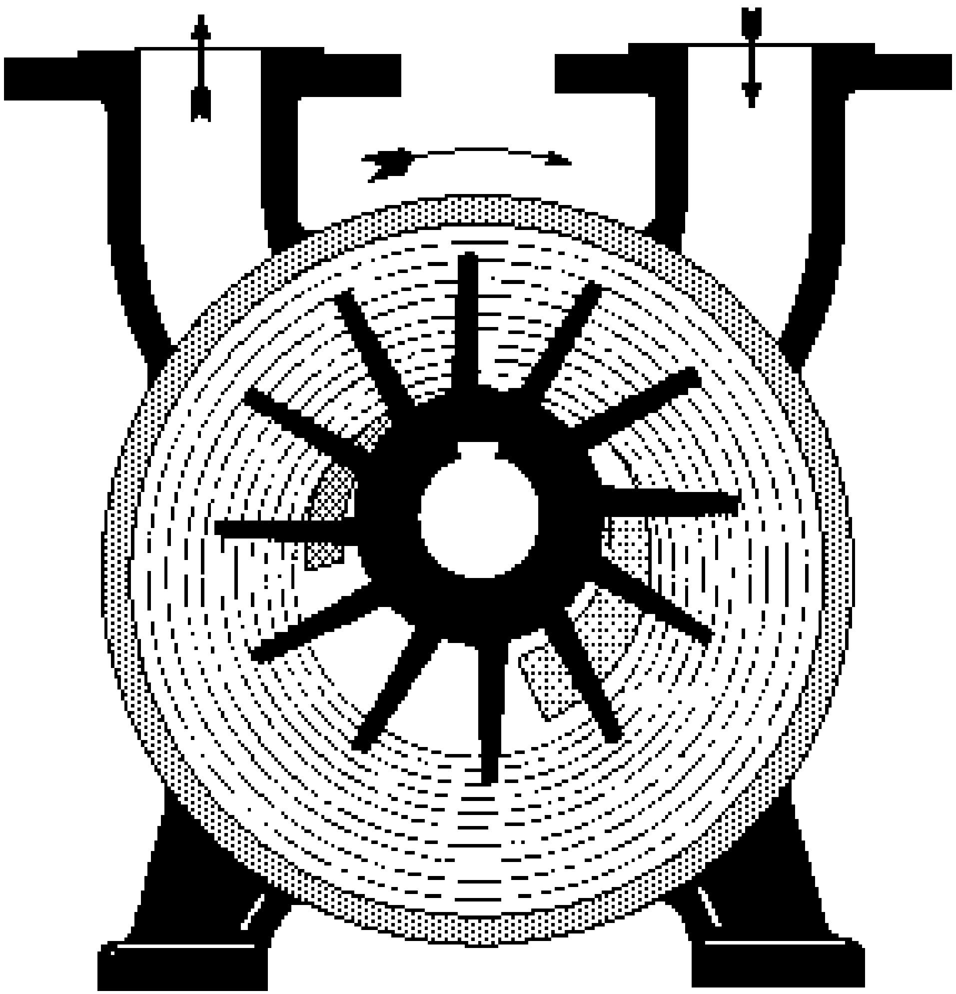


Vacuum Pump

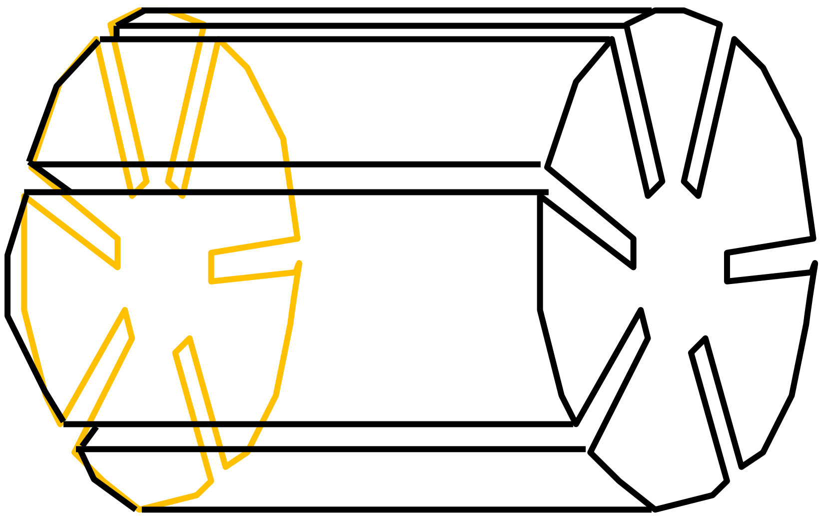
Vacuum Pump

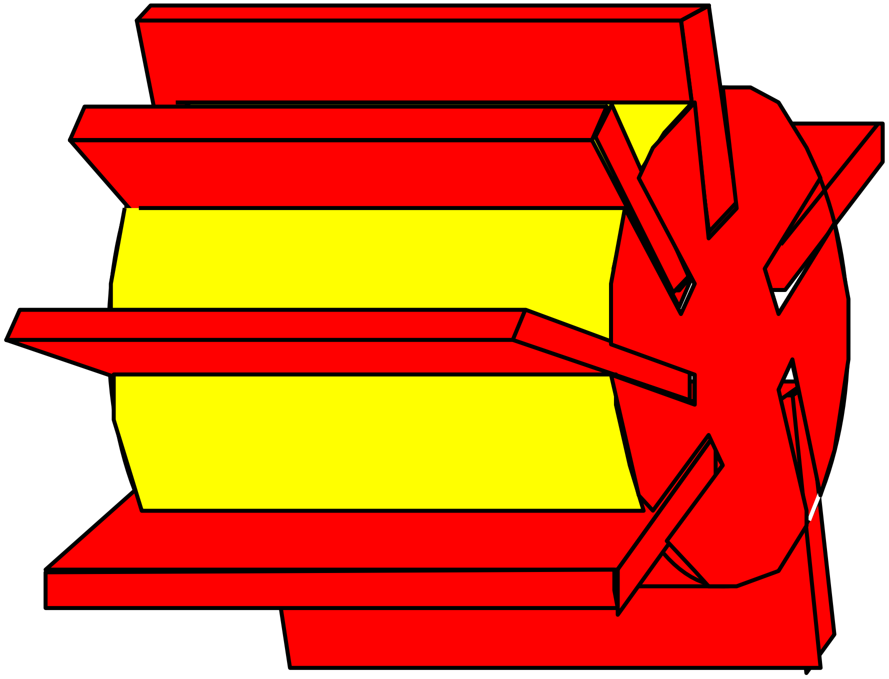
OR

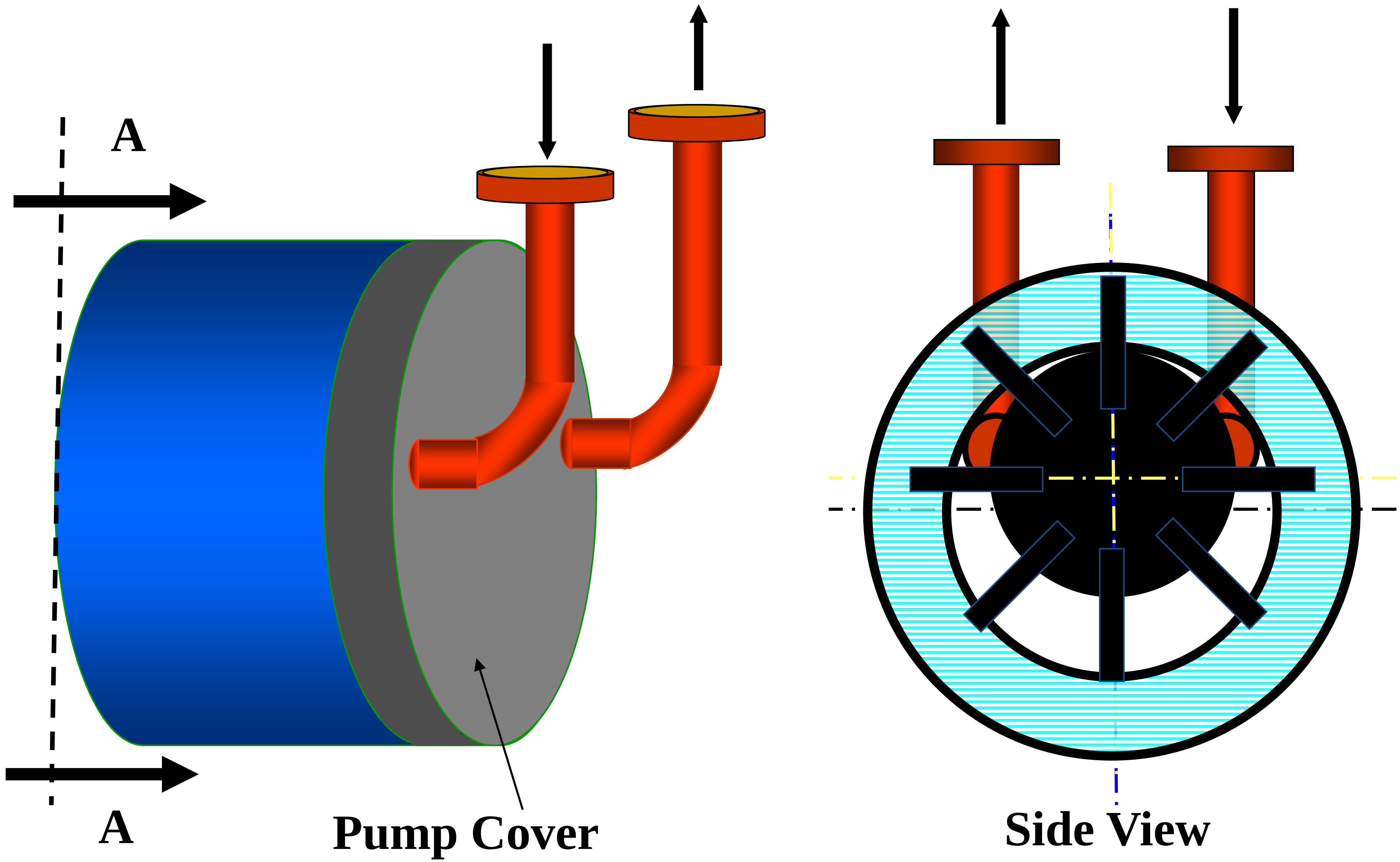
LIQUID RING Compressors



Rotor with Fixed Vans






A
A
Pump Cover
Side View

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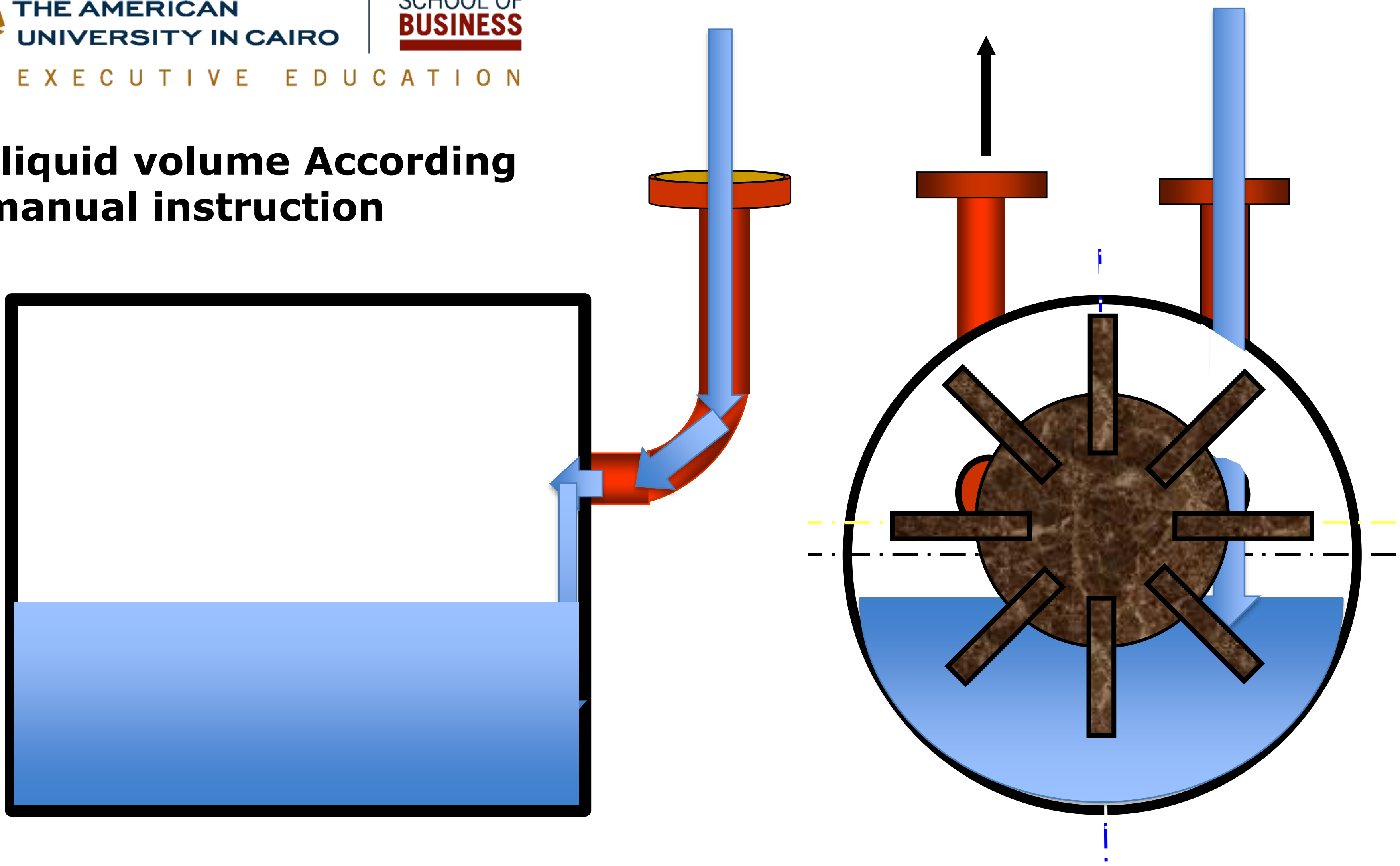
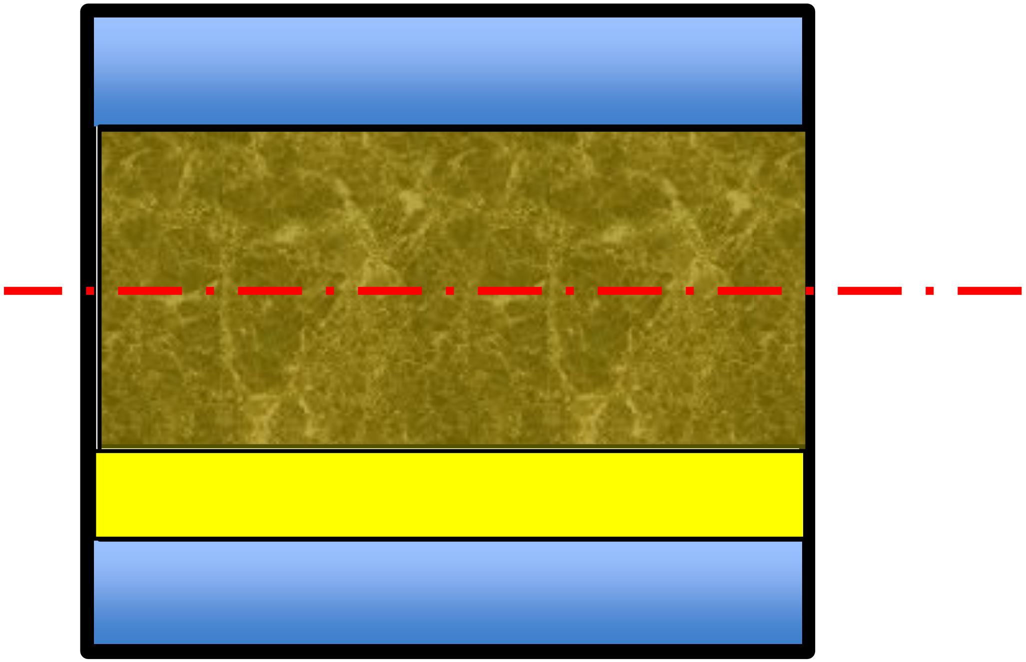
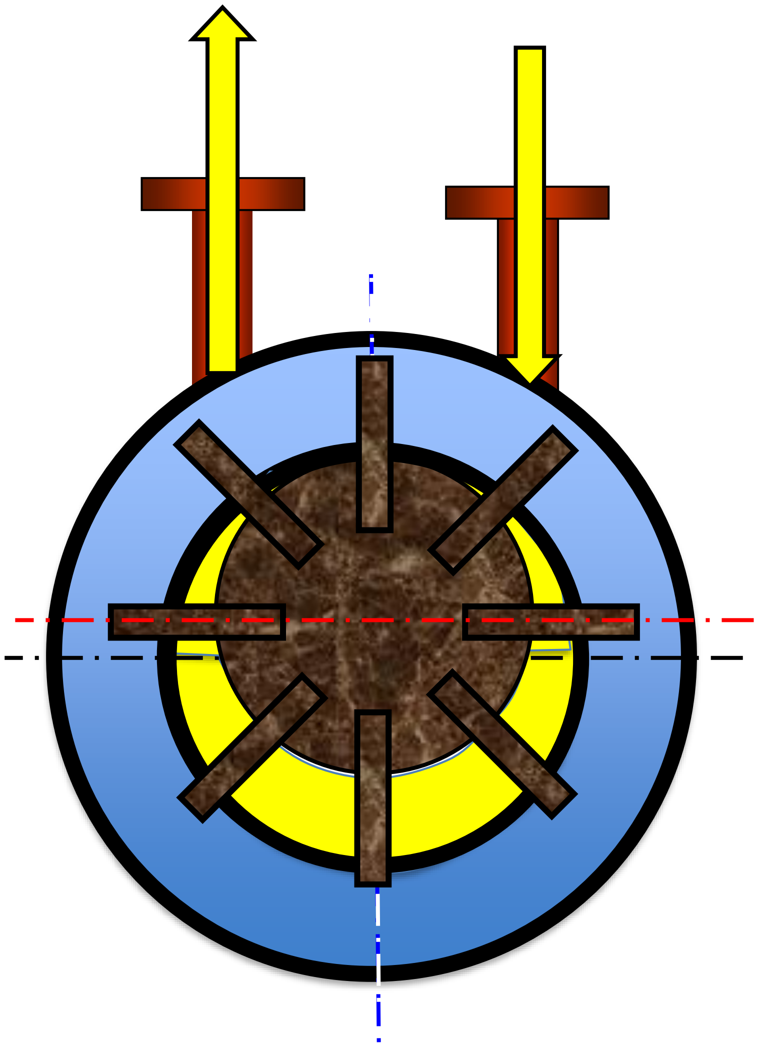
Fill liquid volume According to manual instruction



Side View



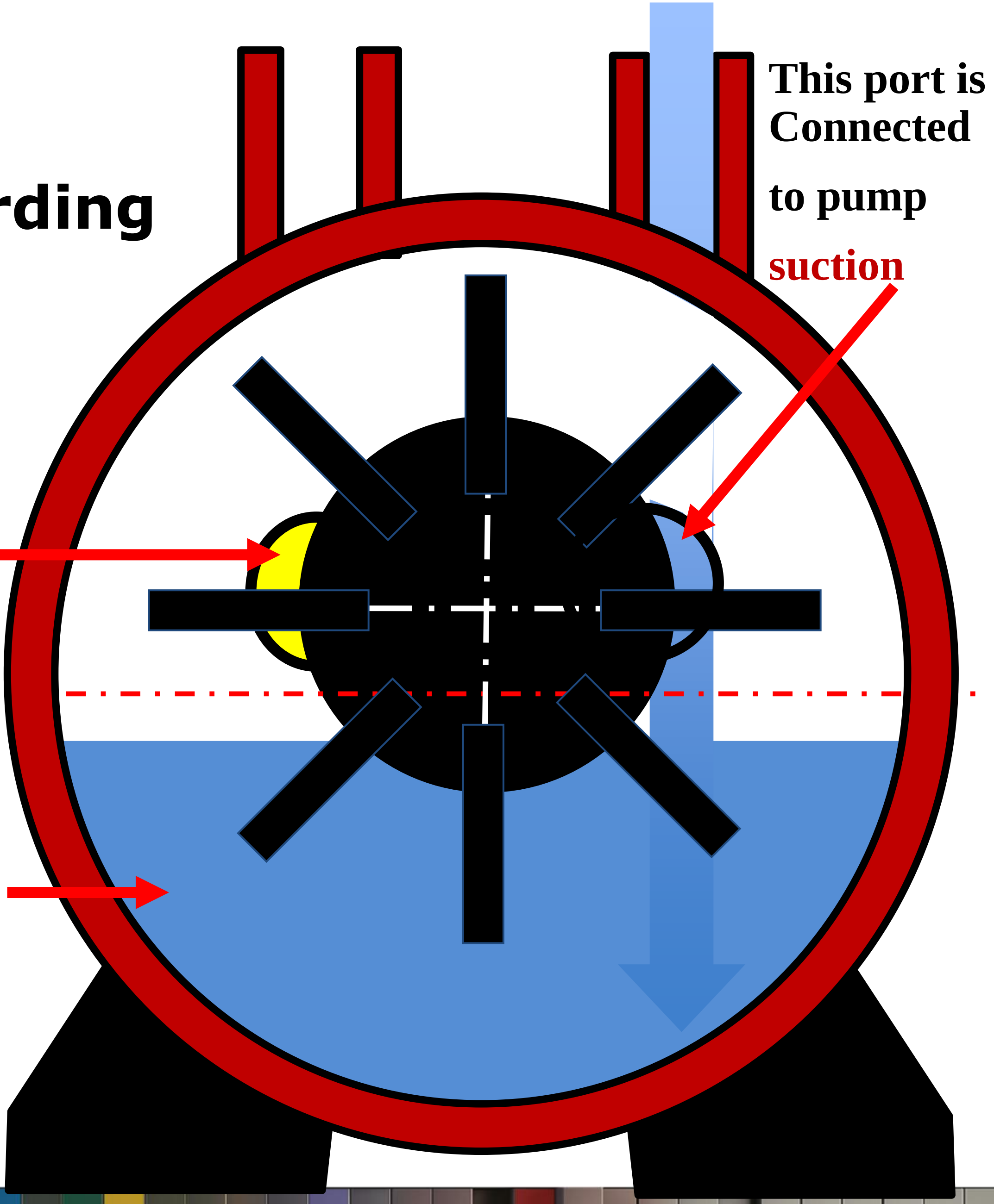


Side View

Fill liquid volume According to manual instruction

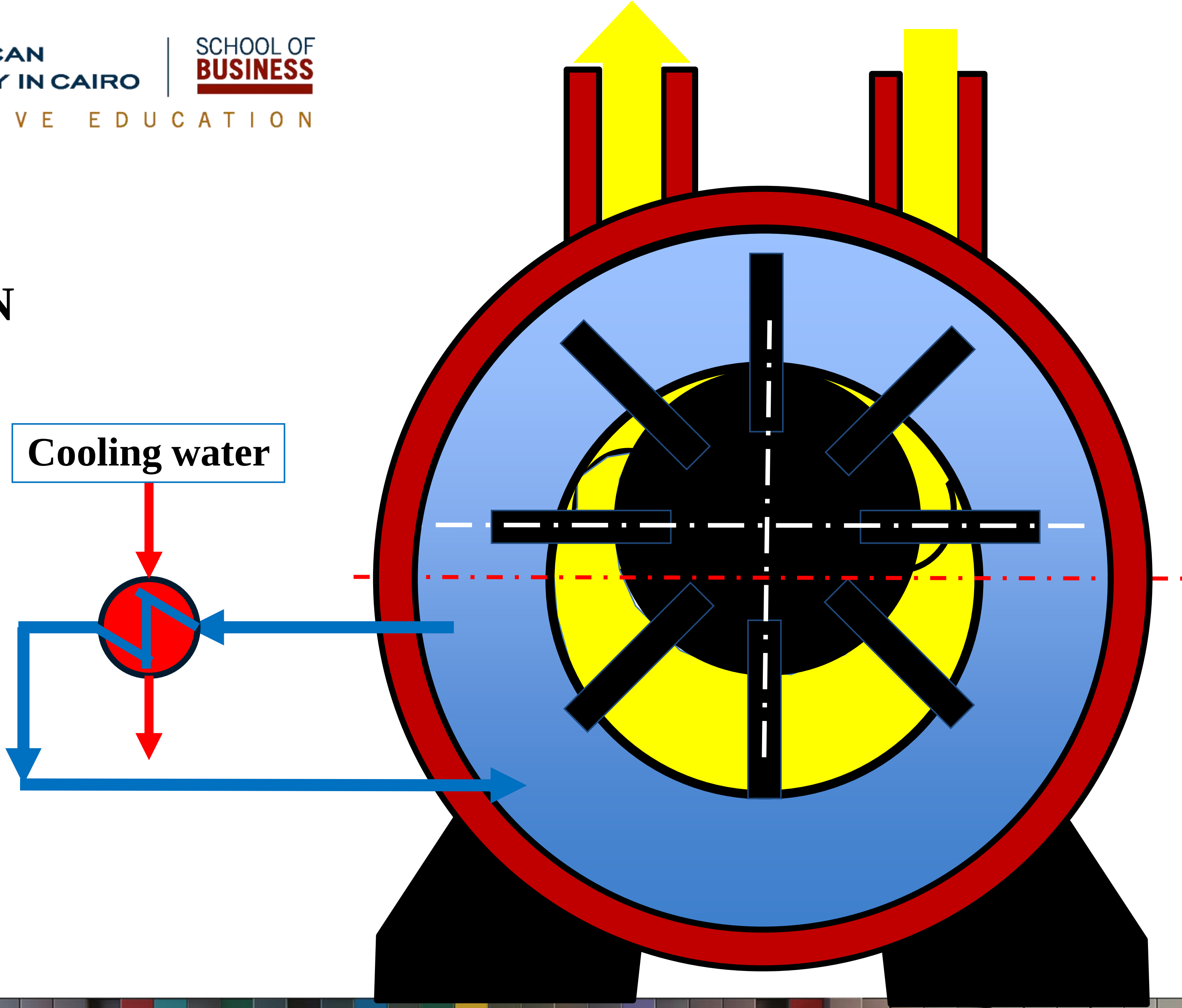
This port is connected to pump **discharge**

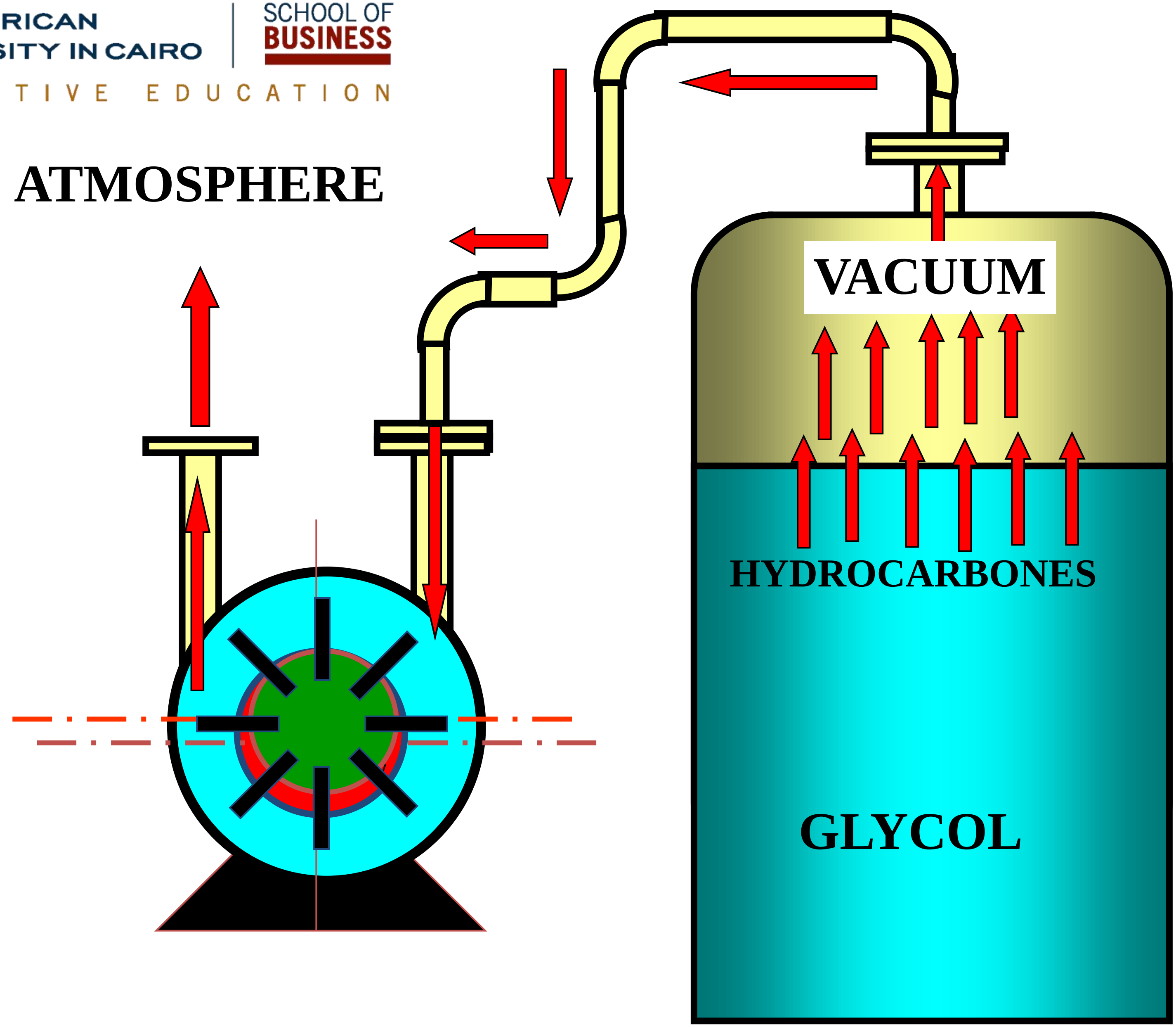
Due to centrifugal force, **a liquid ring will be formed**



This port is Connected to pump **suction**

AFTER ROTATION

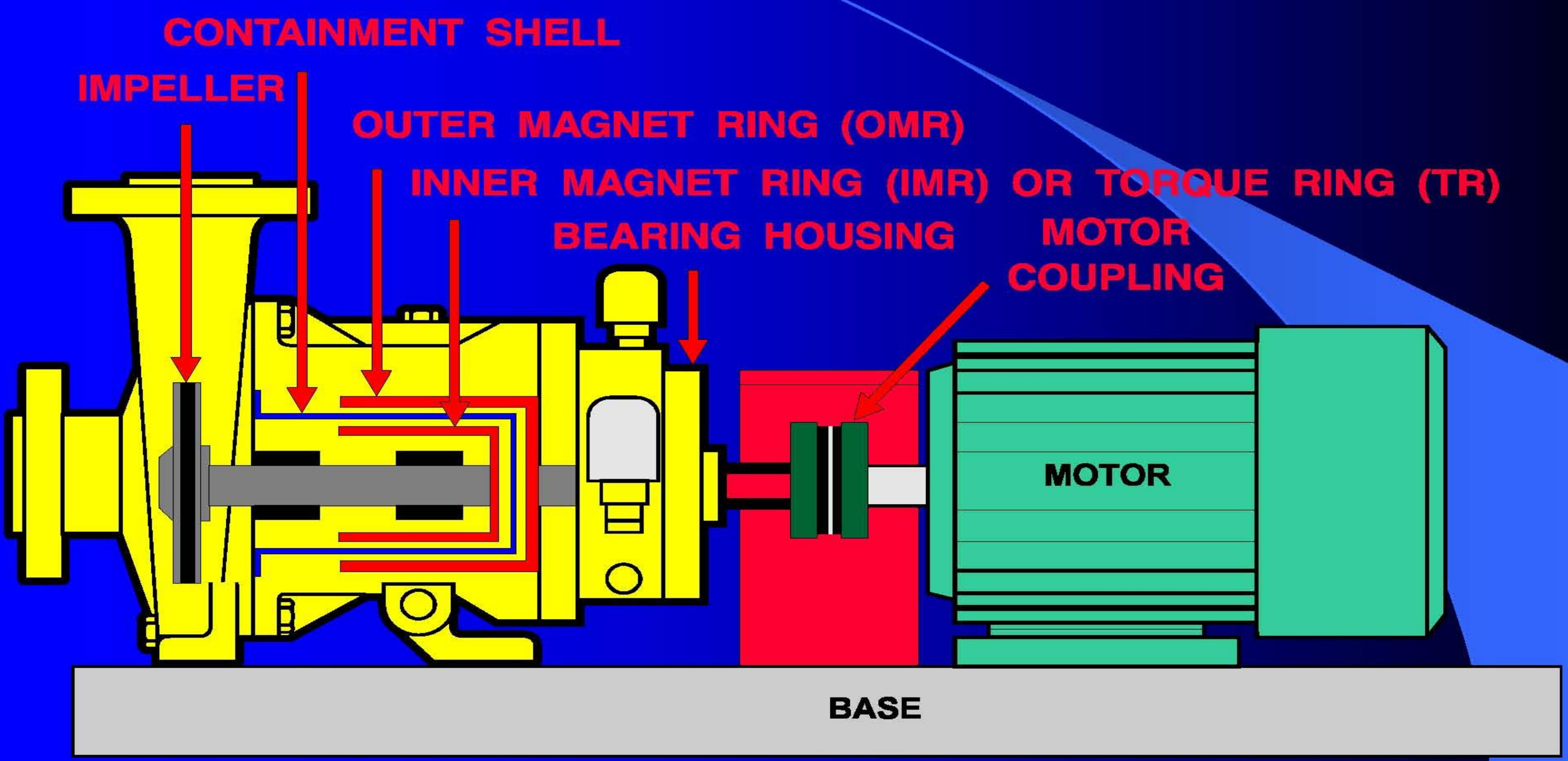



ATMOSPHERE
VACUUM
HYDROCARBONES
GLYCOL

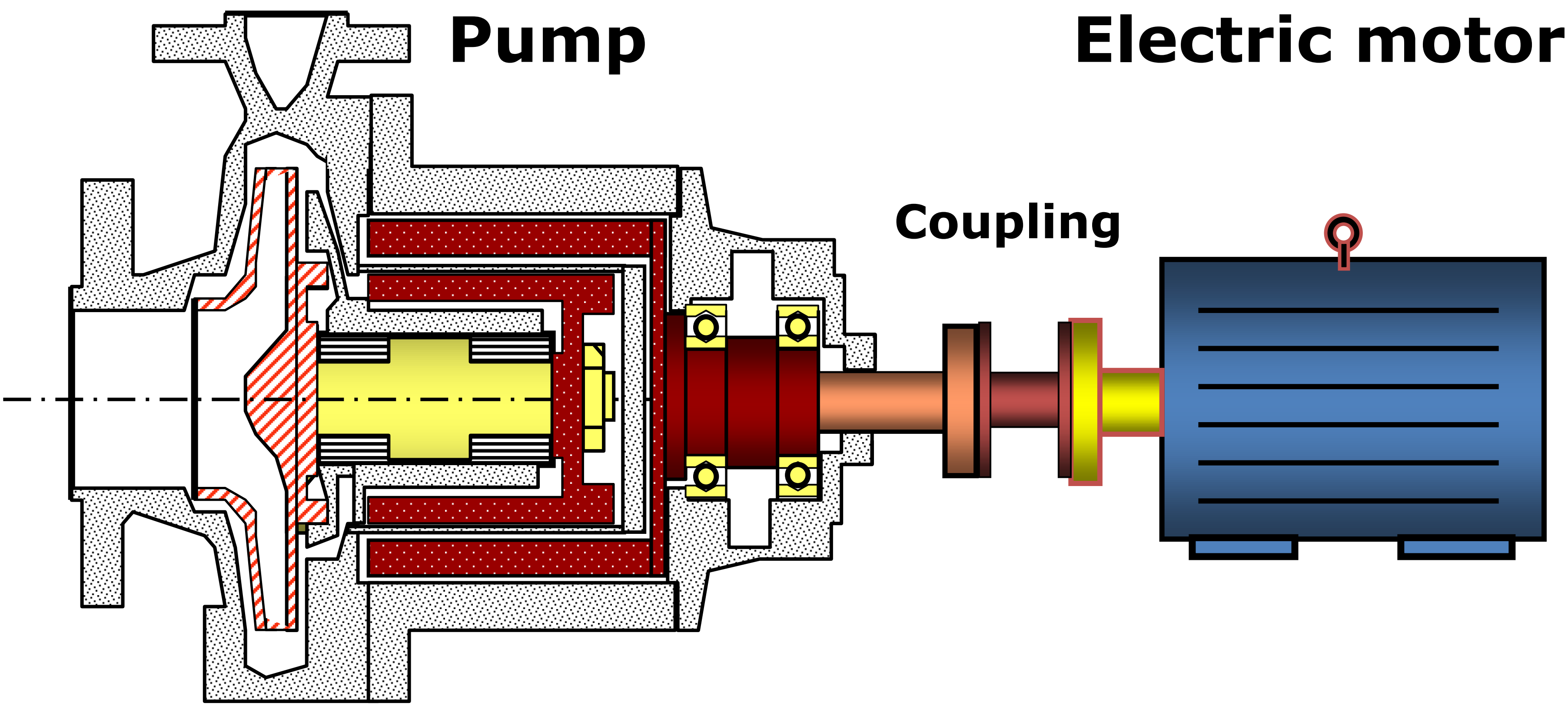
Seal Less Pumps

Seal Less Pumps

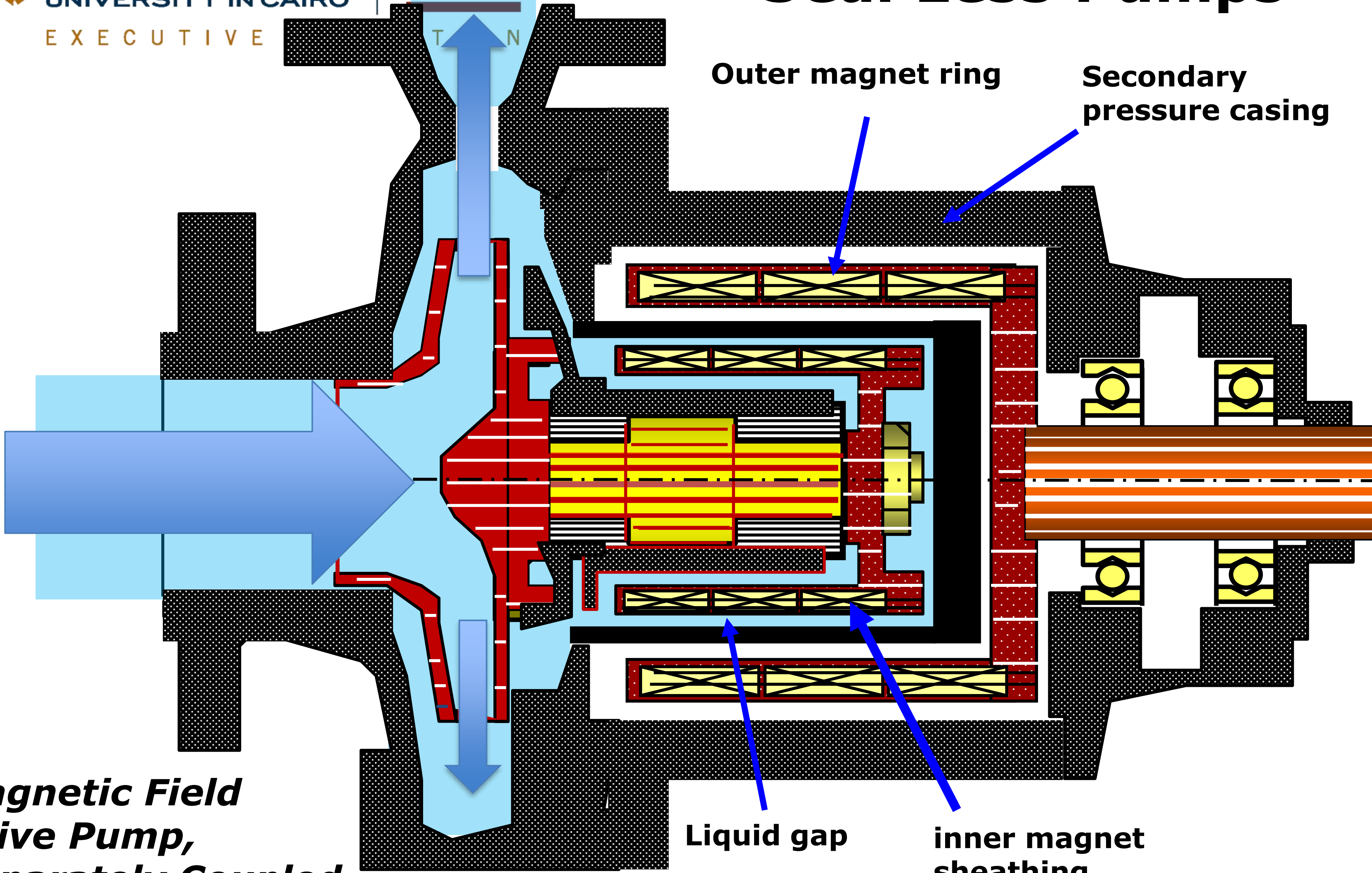
Mag Drive Pumps



Seal Less Pumps



Seal Less Pumps



Magnetic Field Drive Pump, Separately Coupled.

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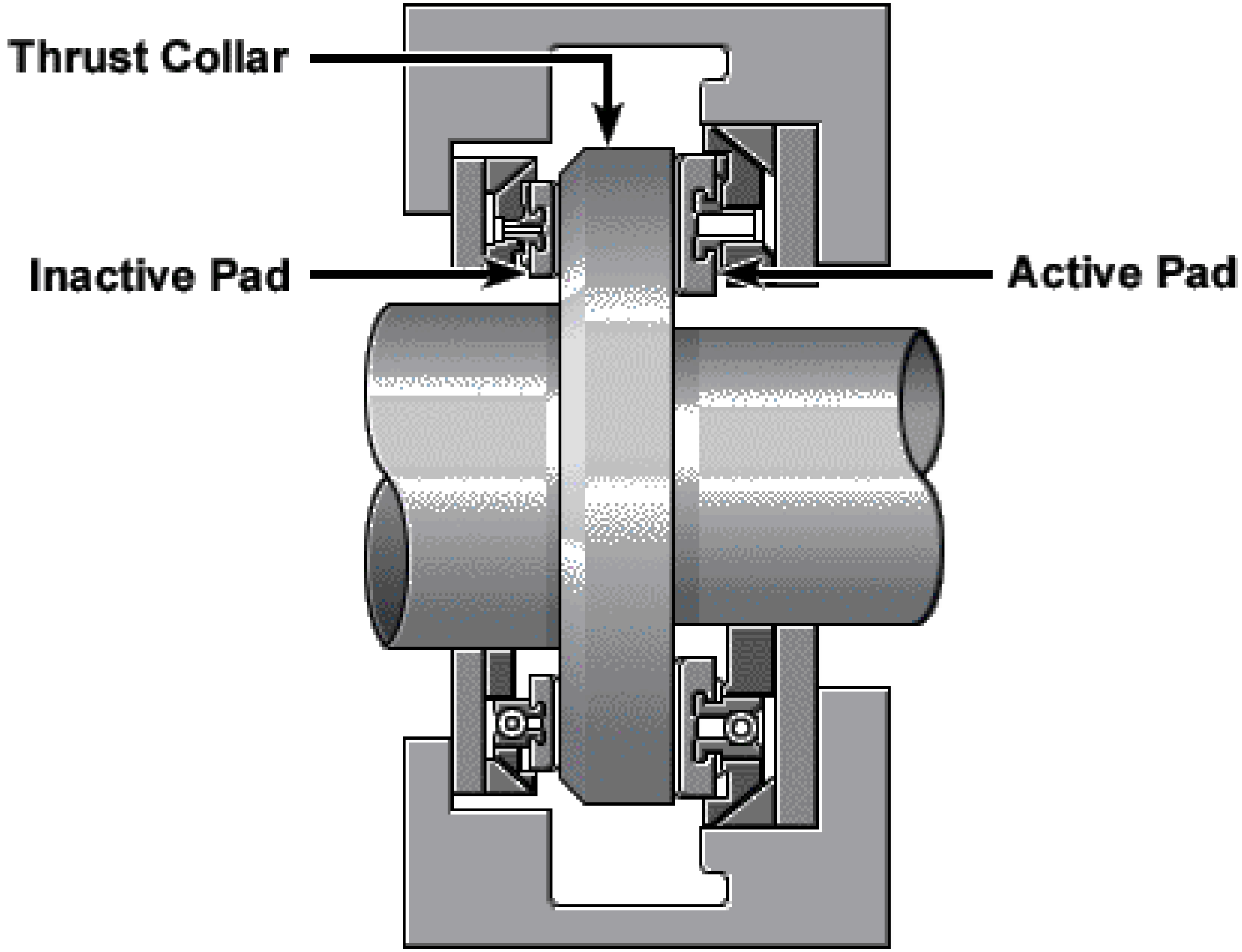
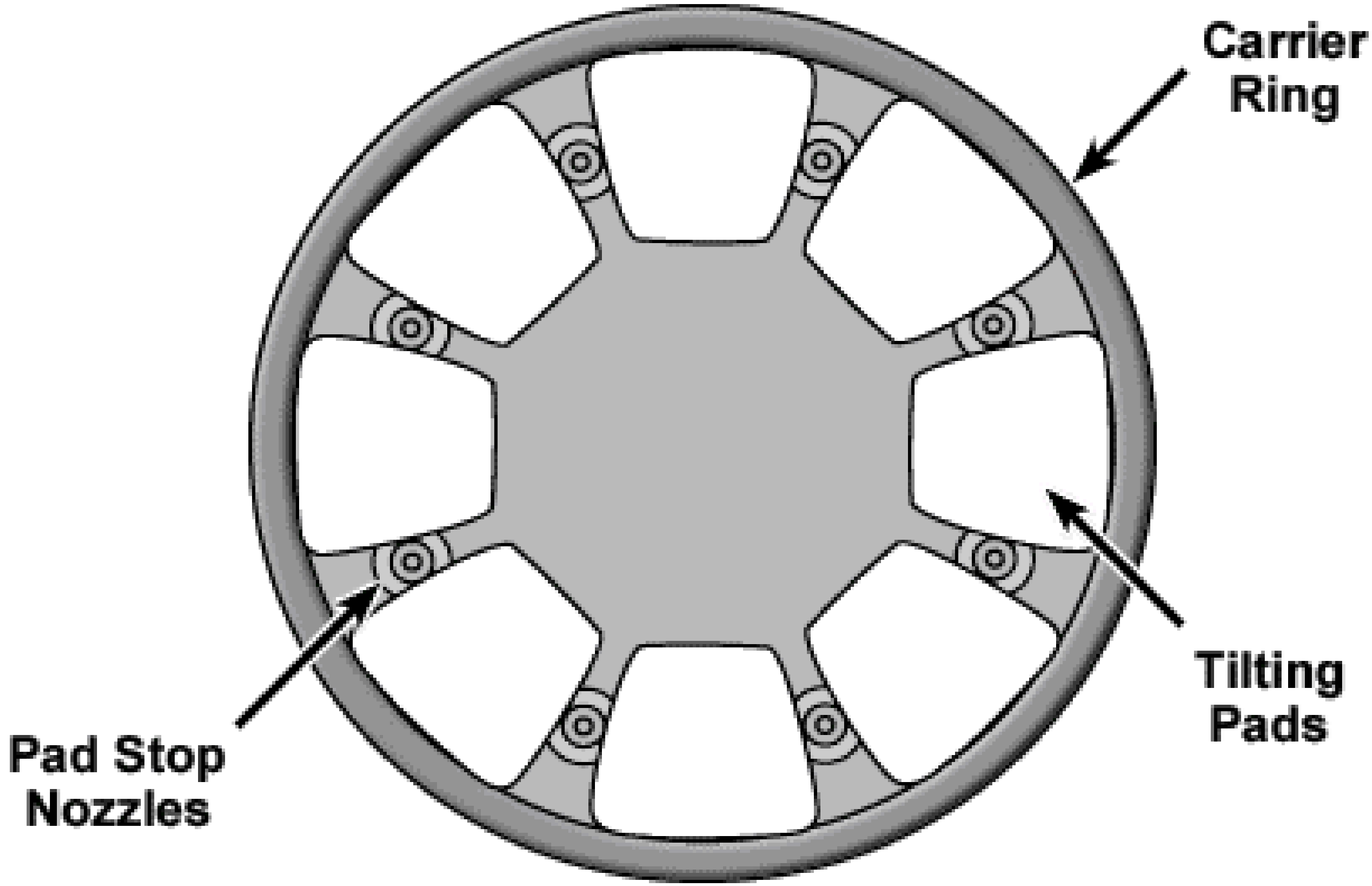
Thrust Bearing



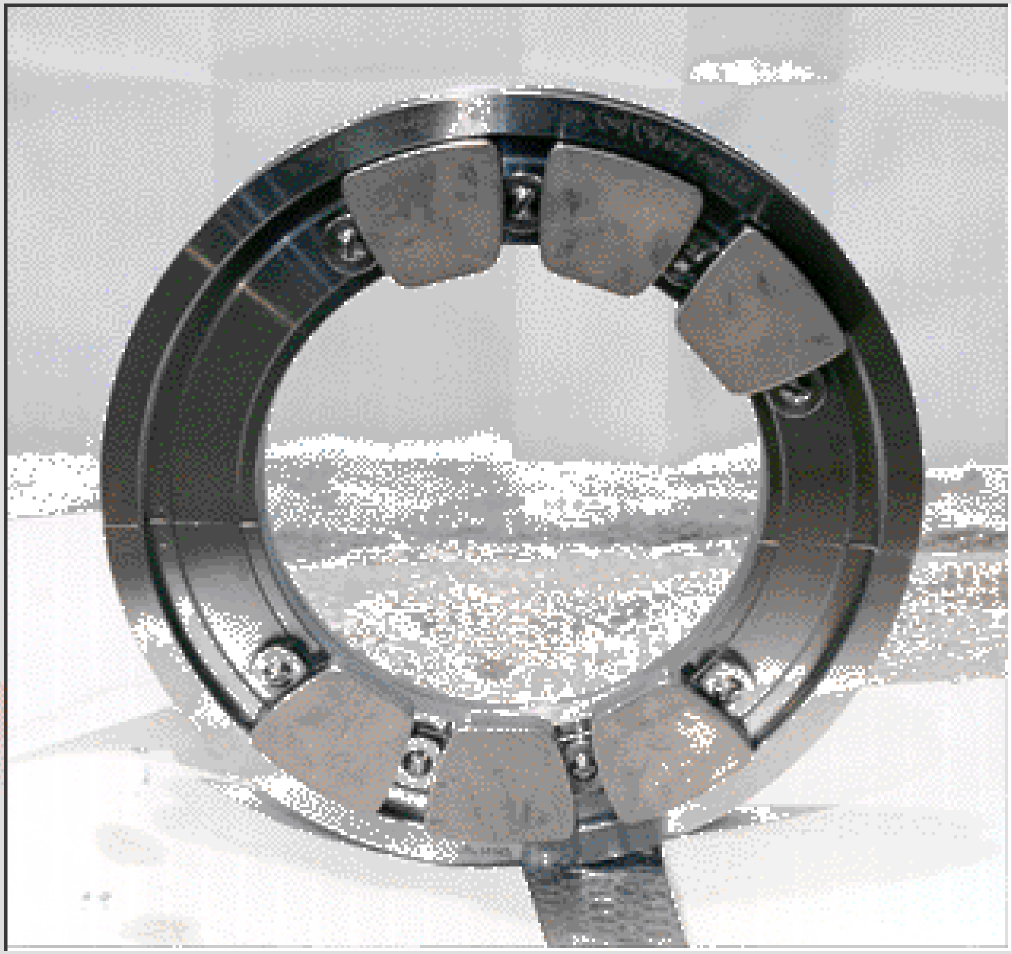
Thrust Bearing Details



Titan 130 Thrust Bearing

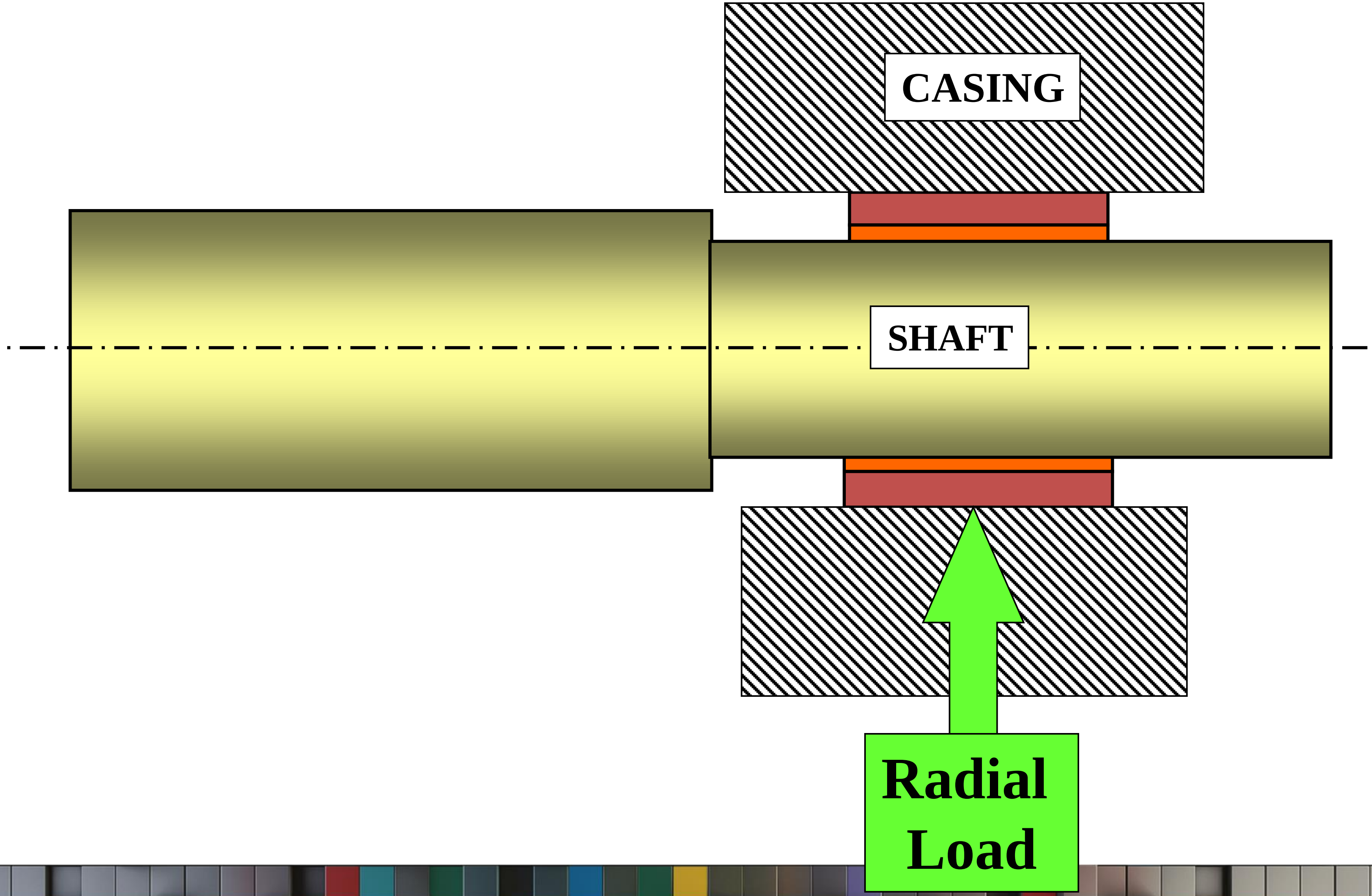
Active Thrust Bearing

Inactive Thrust Bearing



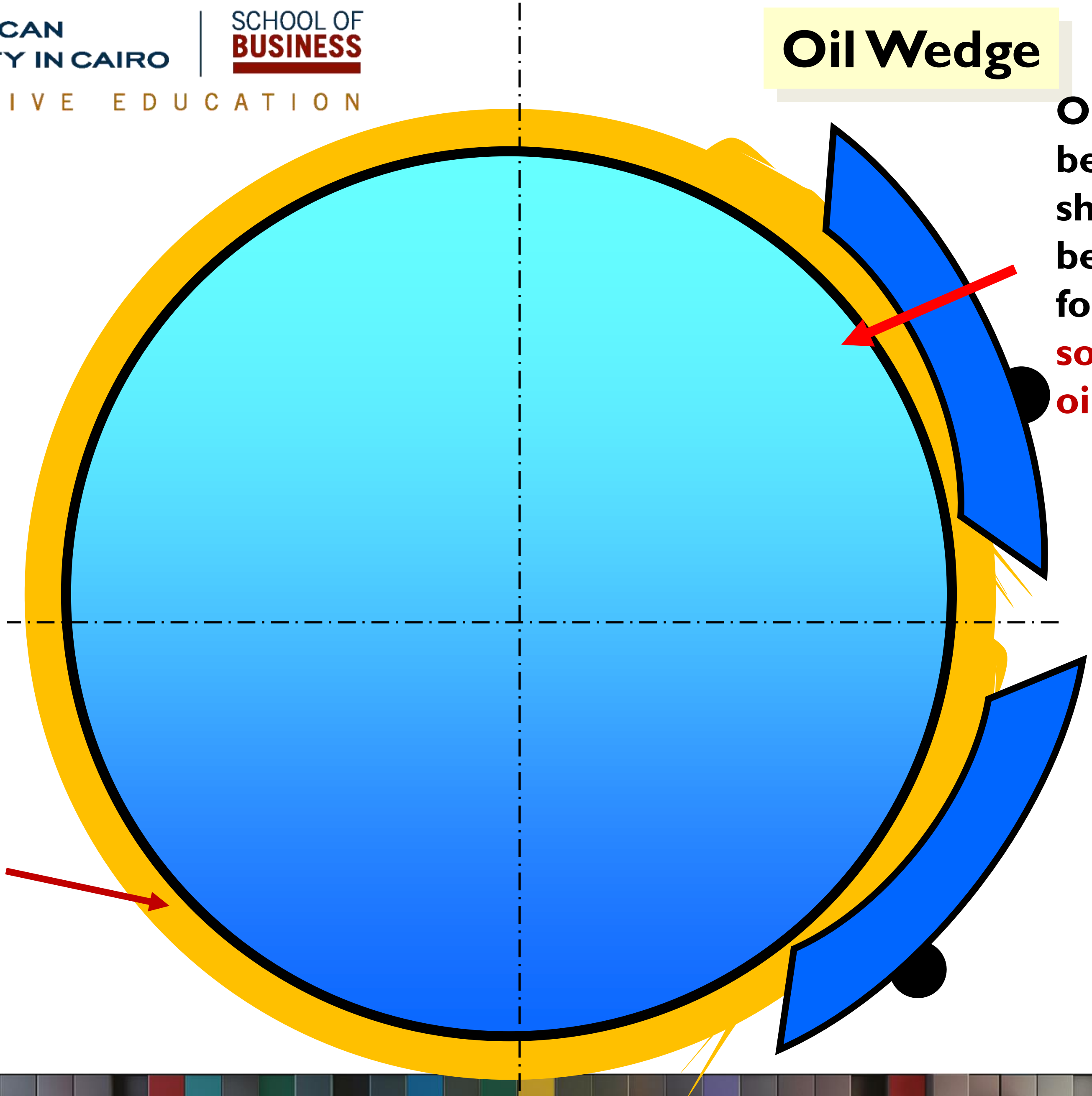
Radial Tilt-Pad Bearing

RADIAL TILTING PAD BEARING



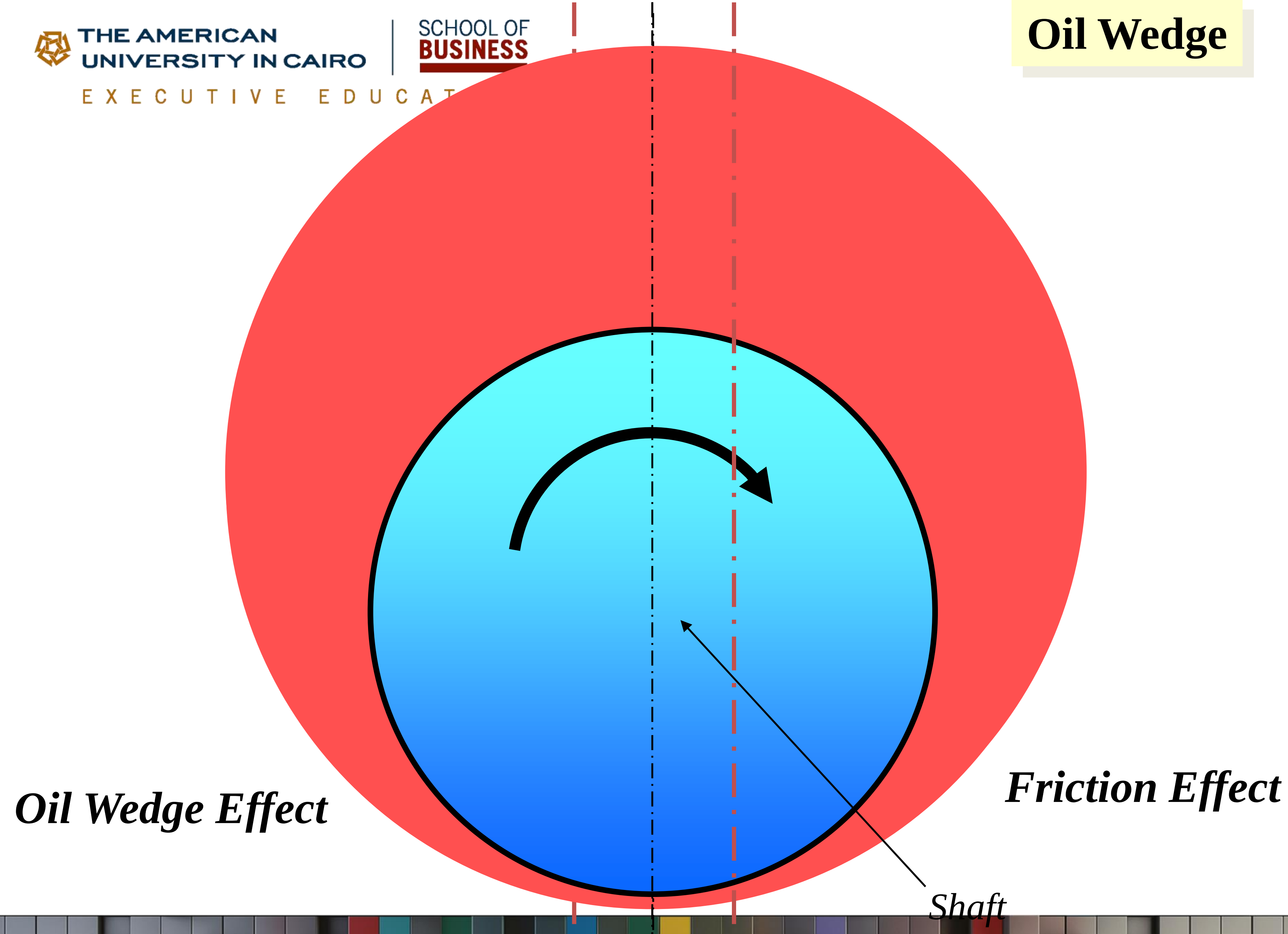
Oil Wedge

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



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

Oil Wedge



RADIAL TILTING PAD BEARING