Unit IV Class IV

Accumulators

Definition

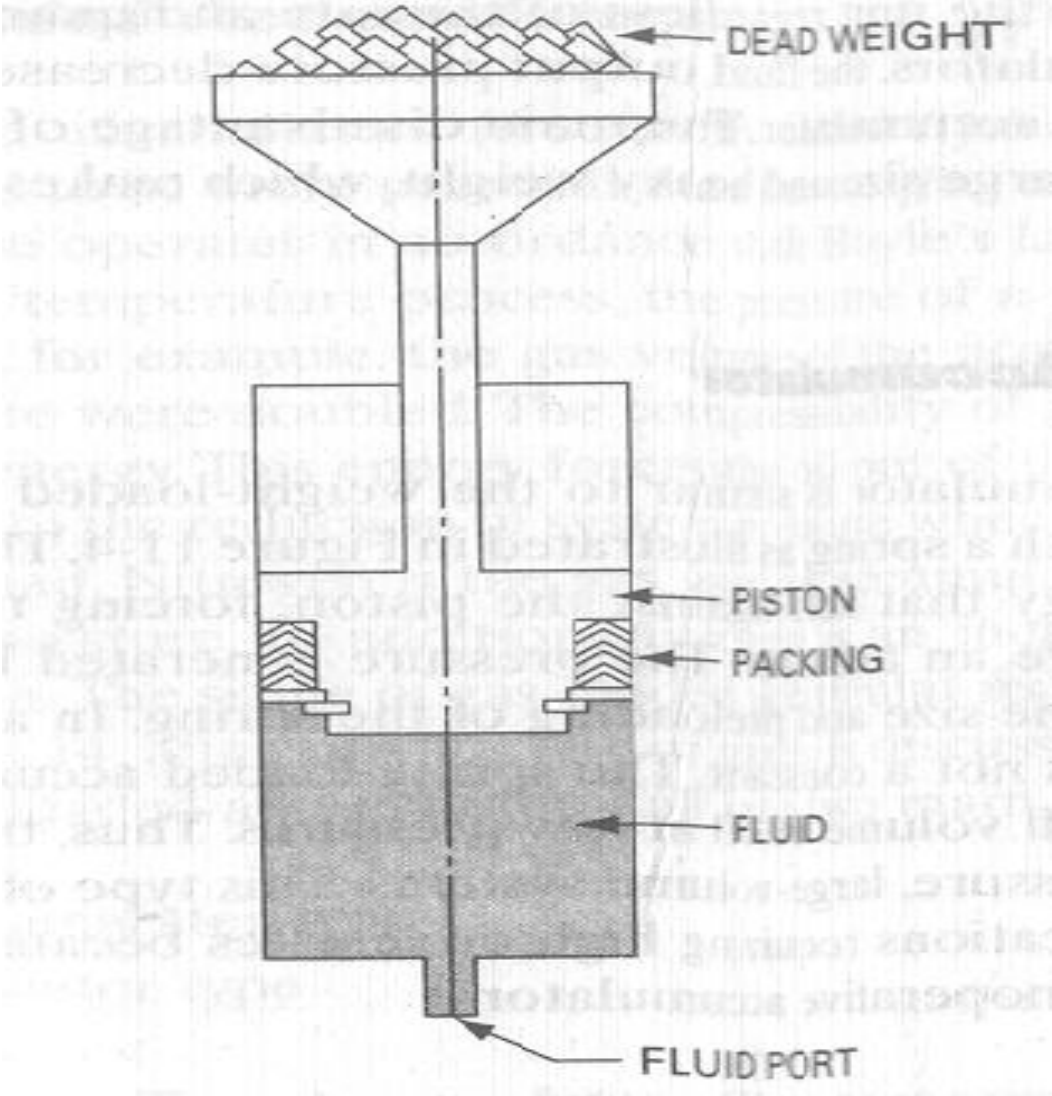
- An accumulator is a device that stores potential energy by means of either gravity, mechanical springs or compressed gas.

- Accumulator is hydraulic device that stores the pressure energy of liquid (oil, water, etc.) by converting it into pressure energy of gas (nitrogen gas).

TYPES

1. Weight-loaded or gravity type
2. Spring-loaded type
3. Gas-loaded type
    1. Non separator type
    2. Separator type
        1. Piston Type
        2. Diaphragm Type
        3. Bladder Type

WEIGHT-LOADED ACCUMULATOR

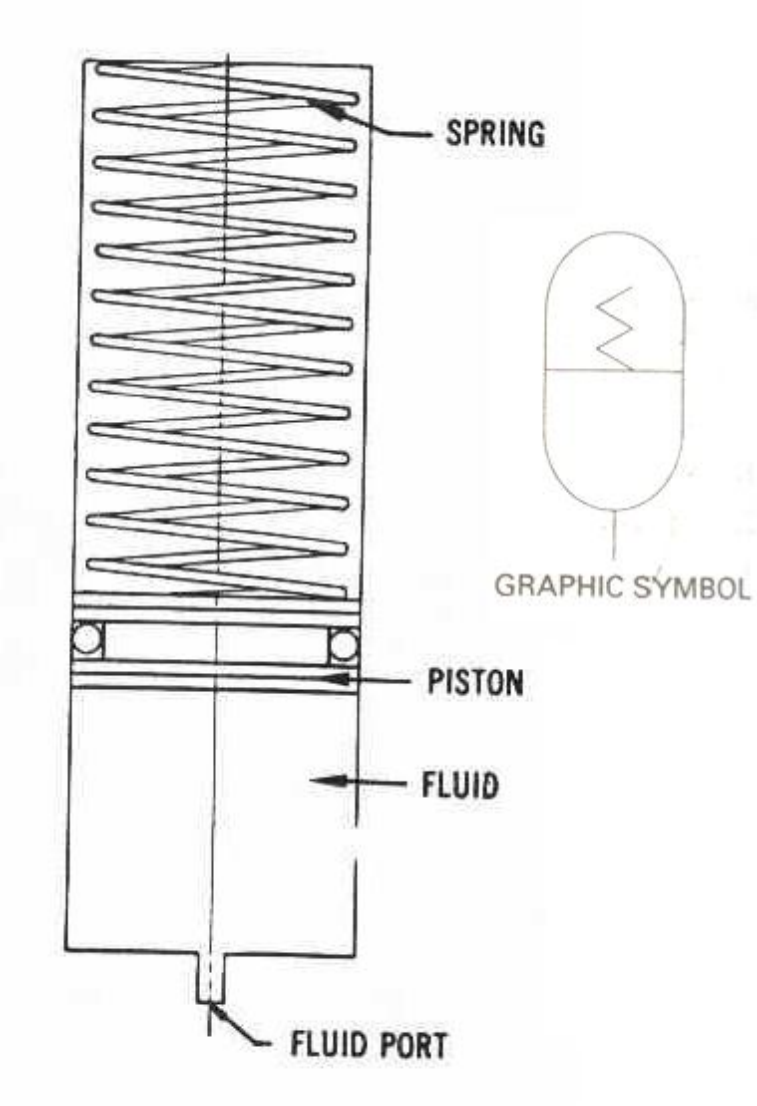


• This type of accumulator creates a constant fluid pressure throughout the full volume output.

• Thus 100% of the fluid is useful at full system pressure.

•**Main disadvantage** of this type of accumulator is extremely large size and heavy weight, which makes unsuitable for mobile equipment.

SPRING-LOADED ACCUMULATOR



•The compressed spring is the source of energy that act against the piston.

•The spring loaded accumulator typically delivers a relatively small volume of oil at low pressure.

•This type of accumulator should not be used for applications requiring high cycle rates the spring will fatigue resulting in an inoperative accumulator.

Gas loaded accumulator

Gas loaded accumulators is also called as **hydro pneumatic** accumulators.

The gas loaded accumulator type operates in according to boyle's law of gasses,

Nitrogen is the gas used in accumulator because it **contains no moisture**.

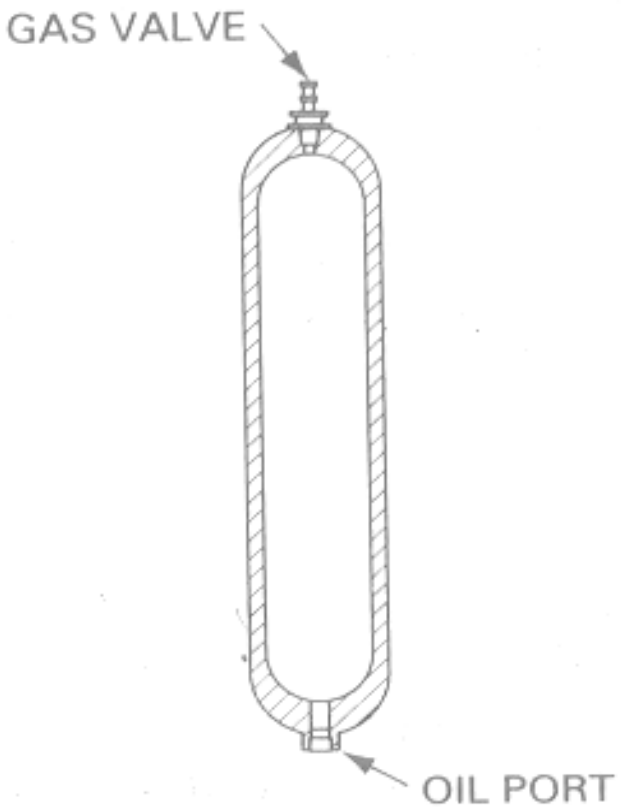
Nitrogen is an **inert gas** and thus will not support combustion.

Gas loaded accumulator

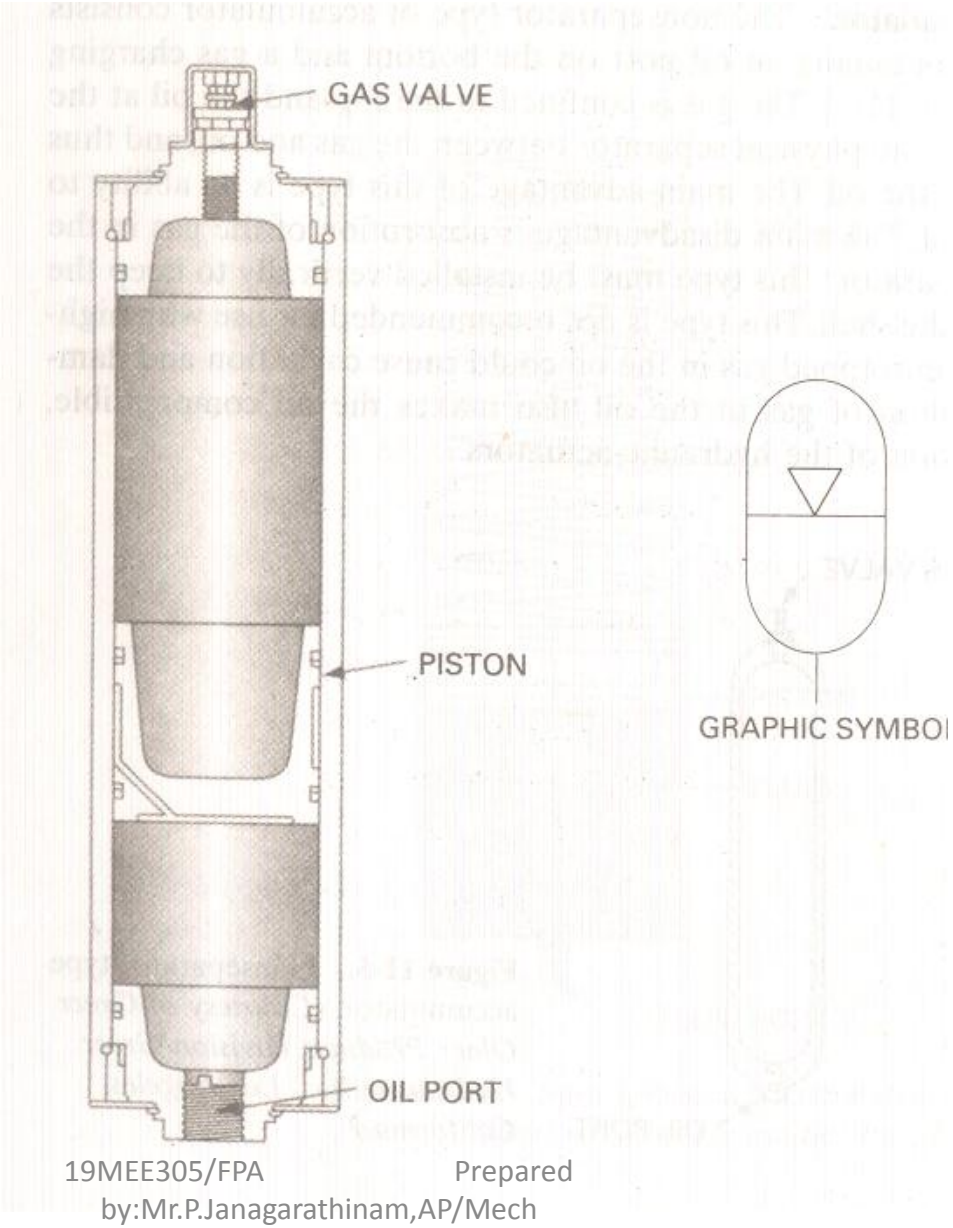
1.Non separator type

2.Separator type
    1.Piston Type
    2.Diaphragm Type
    3.Bladder Type

GAS-LOADED ACCUMULATOR NON SEPERATOR TYPE



PISTON TYPE



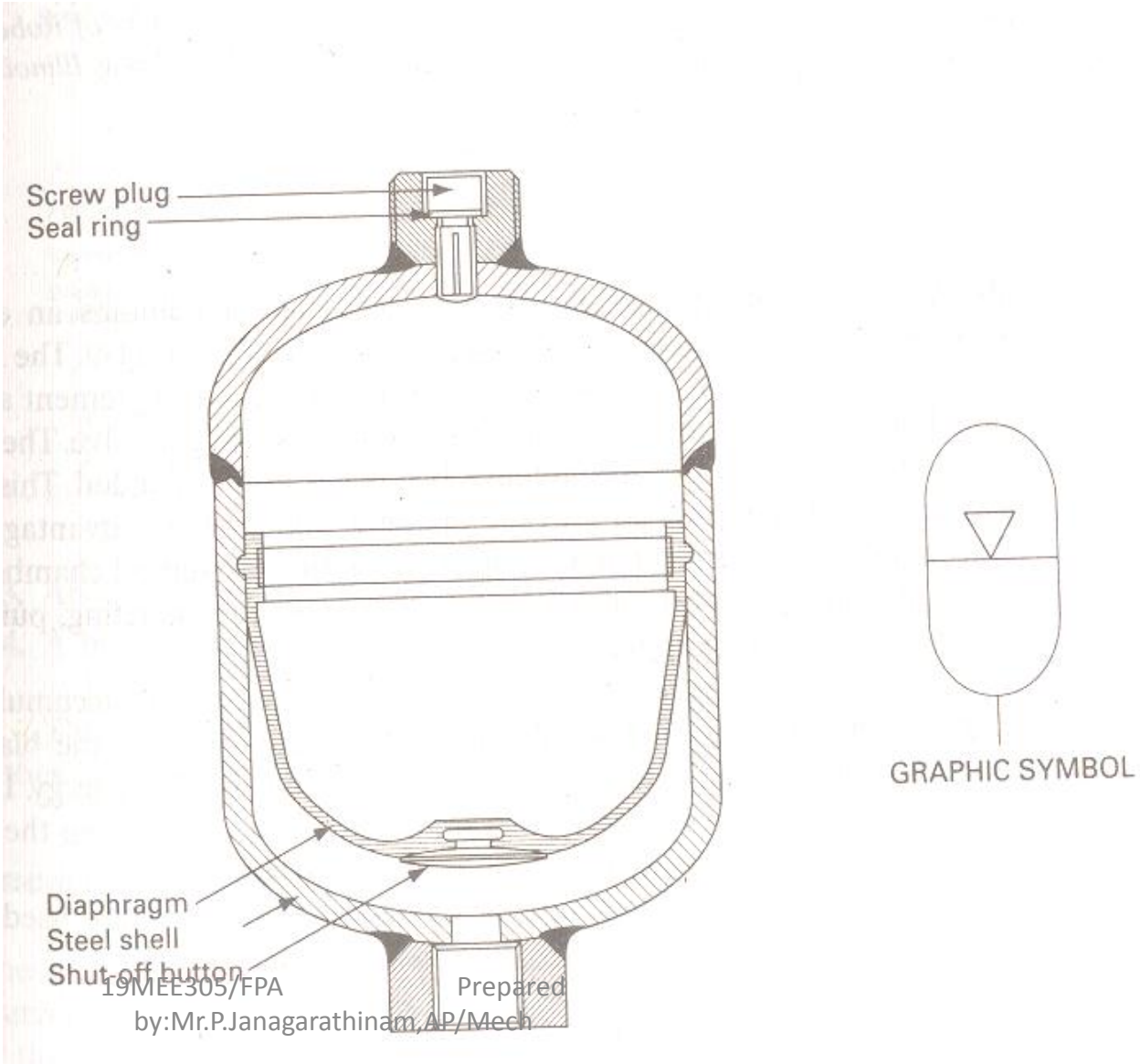
•The gas-charged piston accumulator has a free-floating piston with seals to separate the liquid and gas.

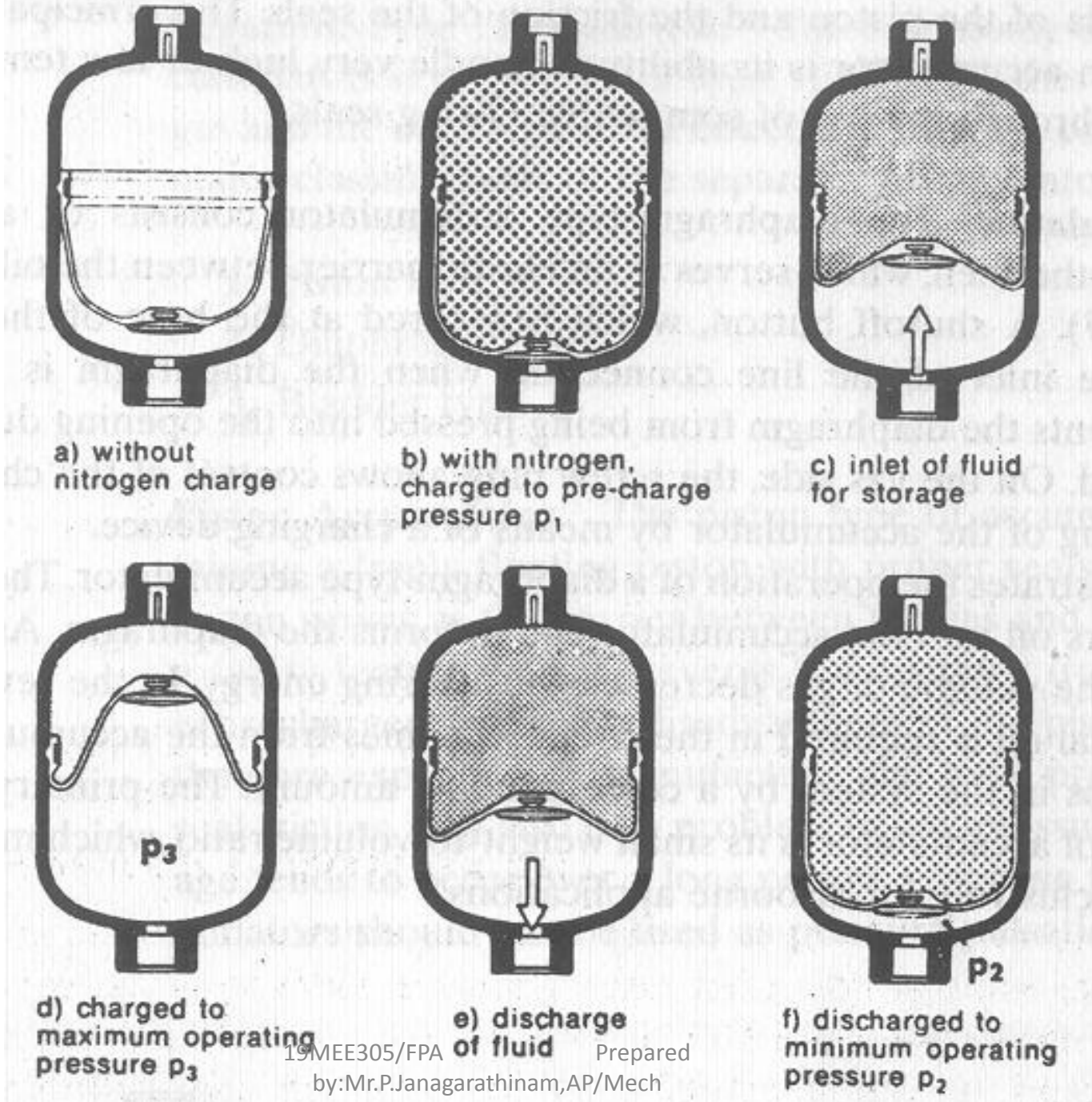
•Its ability to handle very high or low temperature system fluids.

•A gas-charged piston accumulator can cost twice as much as an equal-sized bladder type.

GAS-LOADED ACCUMULATOR
SEPERATOR TYPE

DIAPHRAGM TYPE



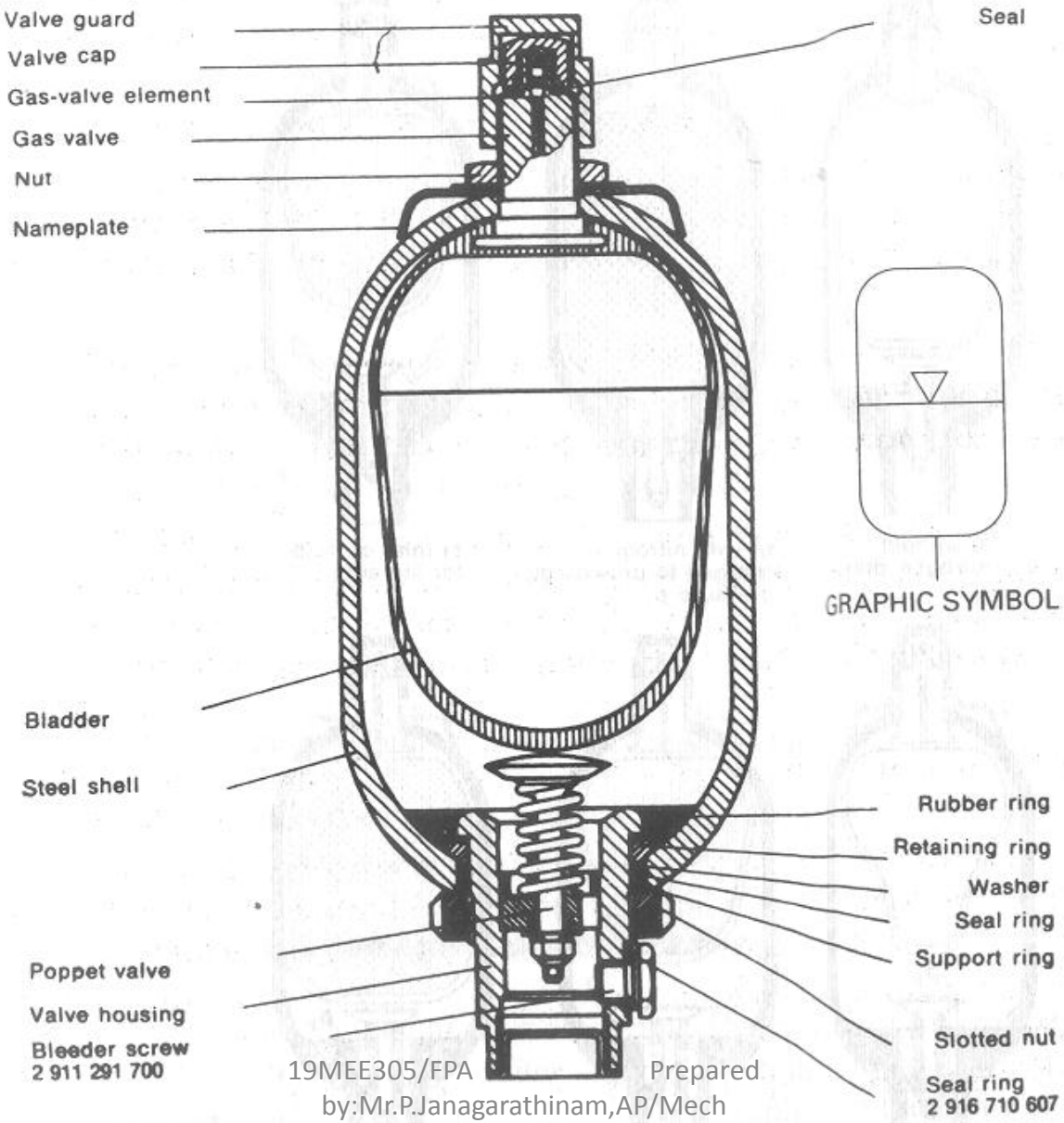

a) without nitrogen charge
b) with nitrogen, charged to pre-charge pressure p_1
c) inlet of fluid for storage
p_3
d) charged to maximum operating pressure p_3
e) discharge of fluid
p_2
f) discharged to minimum operating pressure p_2

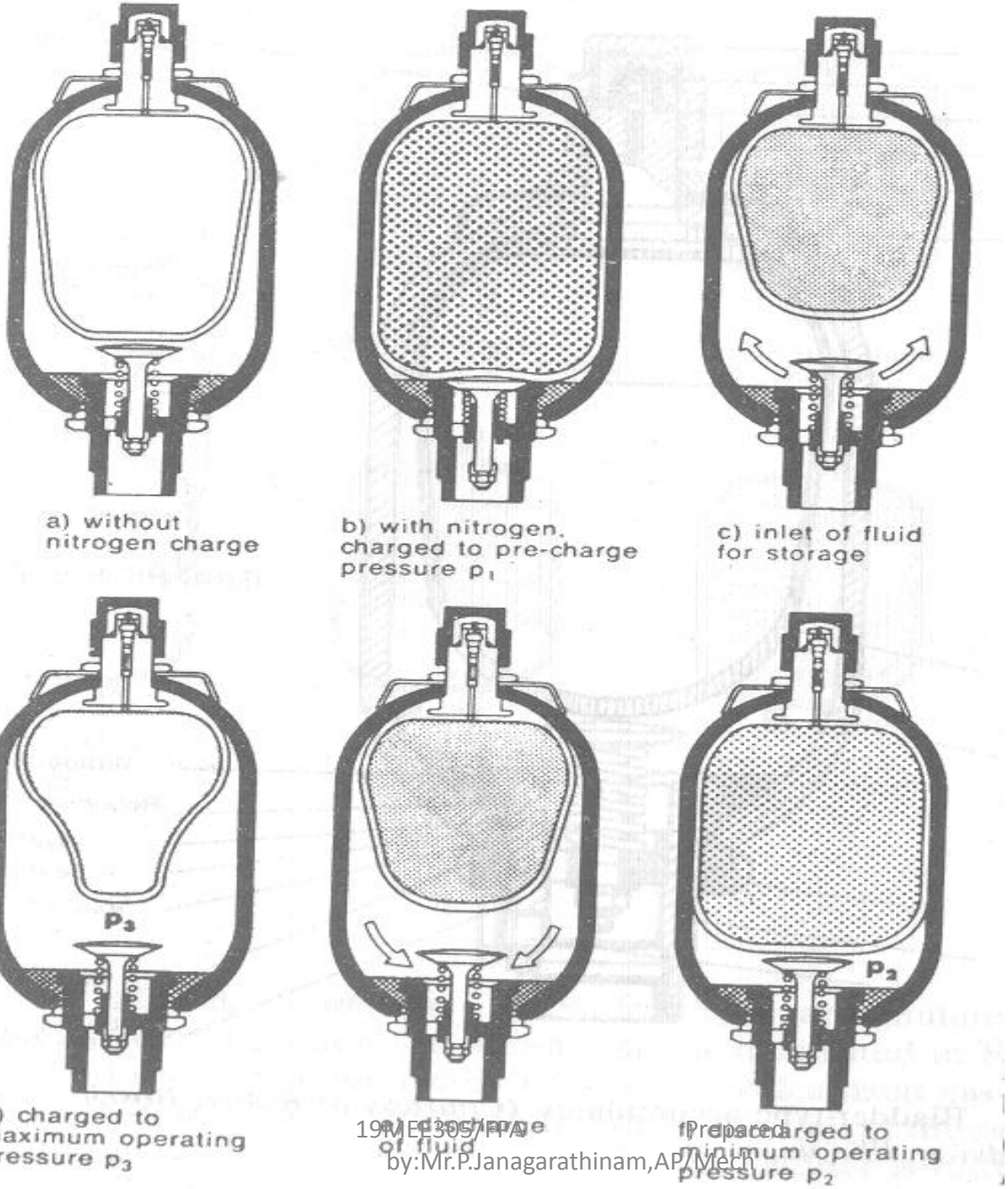
•Many accumulators now use a rubber bladder to separate the gas and liquid.

•As the pressure increases the volume of gas decreases ,thus storing energy.

•The top-repair style on the right is now available and makes bladder replacement simple and fast.

BLADDER TYPE




a) without nitrogen charge
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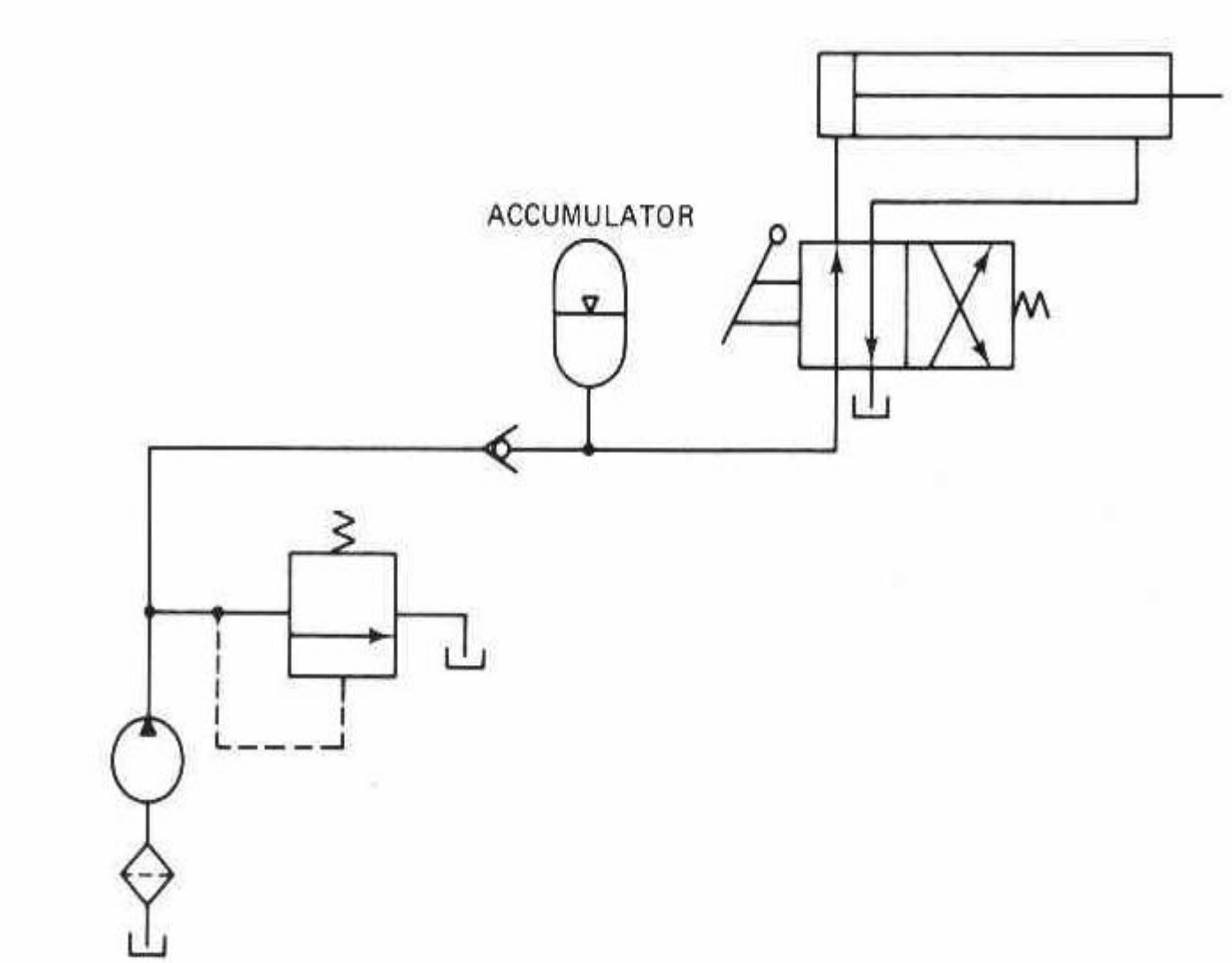
c) inlet of fluid for storage
d) charged to maximum operating pressure p_3
p_3
e) discharge of fluid
f) Precharged to minimum operating pressure p_2
p_2

In this bladder type accumulator is the light weight bladder provides quick response for pressure regulating, pump pulsation and shock damping applications.

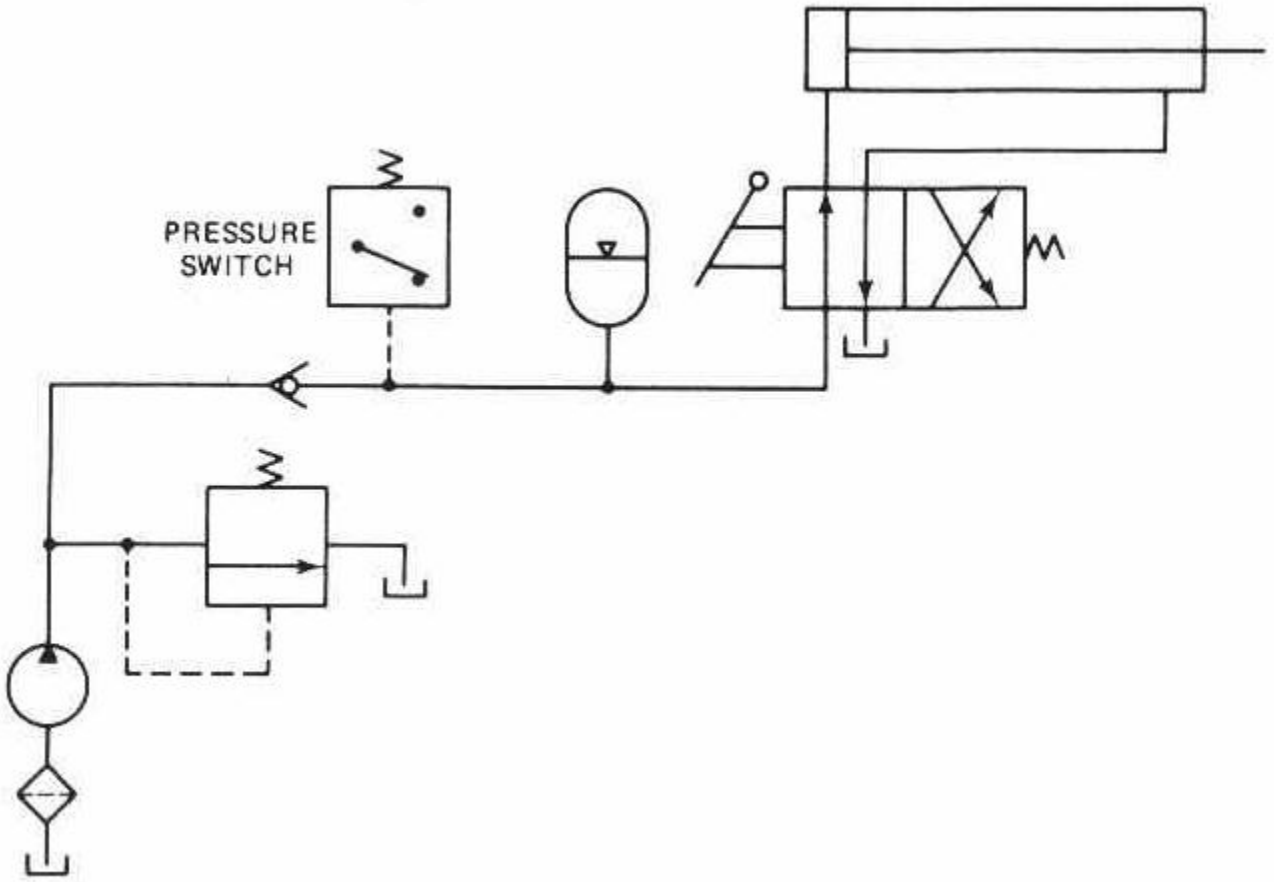
Four basic application where accumulators are used in hydraulic system

1. An auxiliary power source
2. A leakage compensator
3. An emergency power source
4. A Hydraulic Shock Absorber

Accumulator as an auxiliary power source.

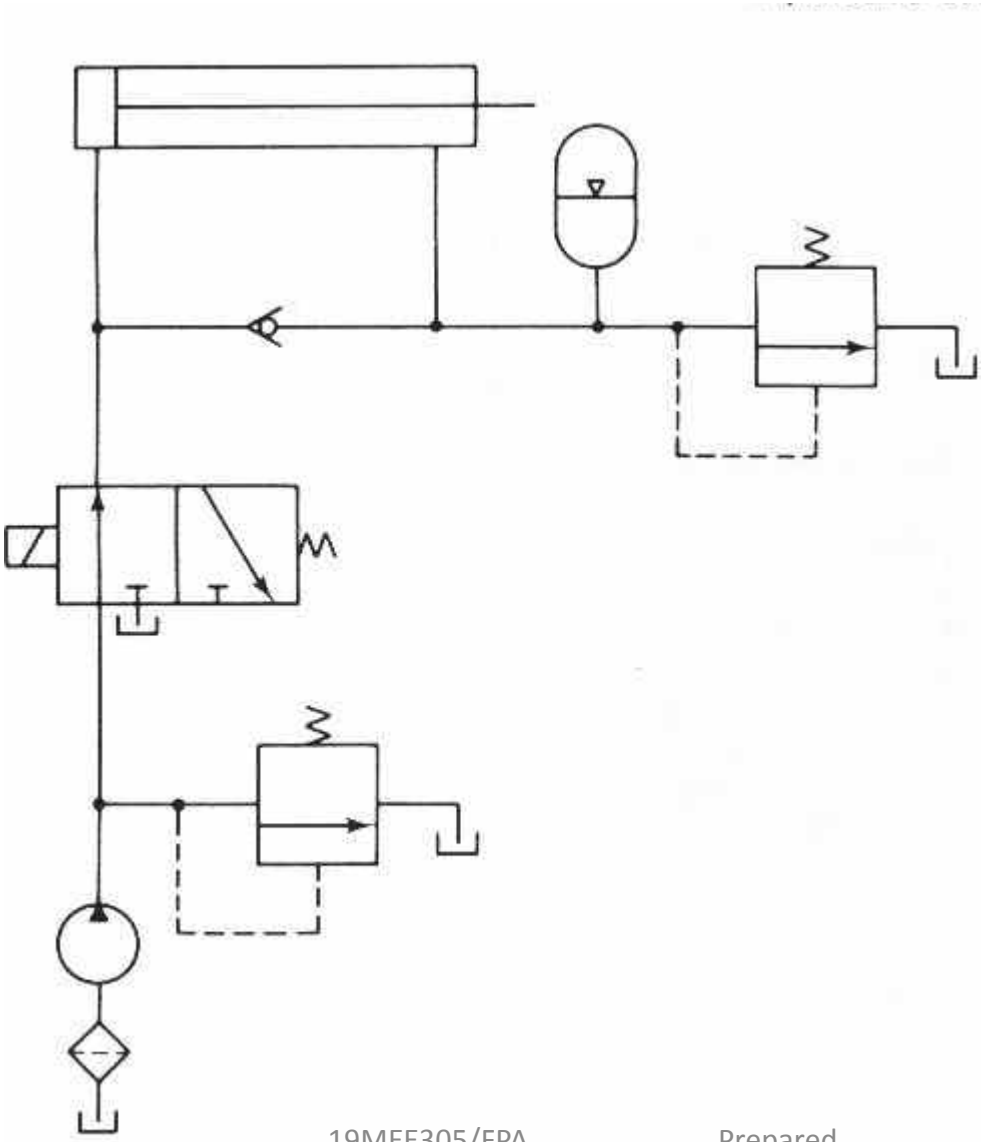


Accumulator as a leakage compensator.

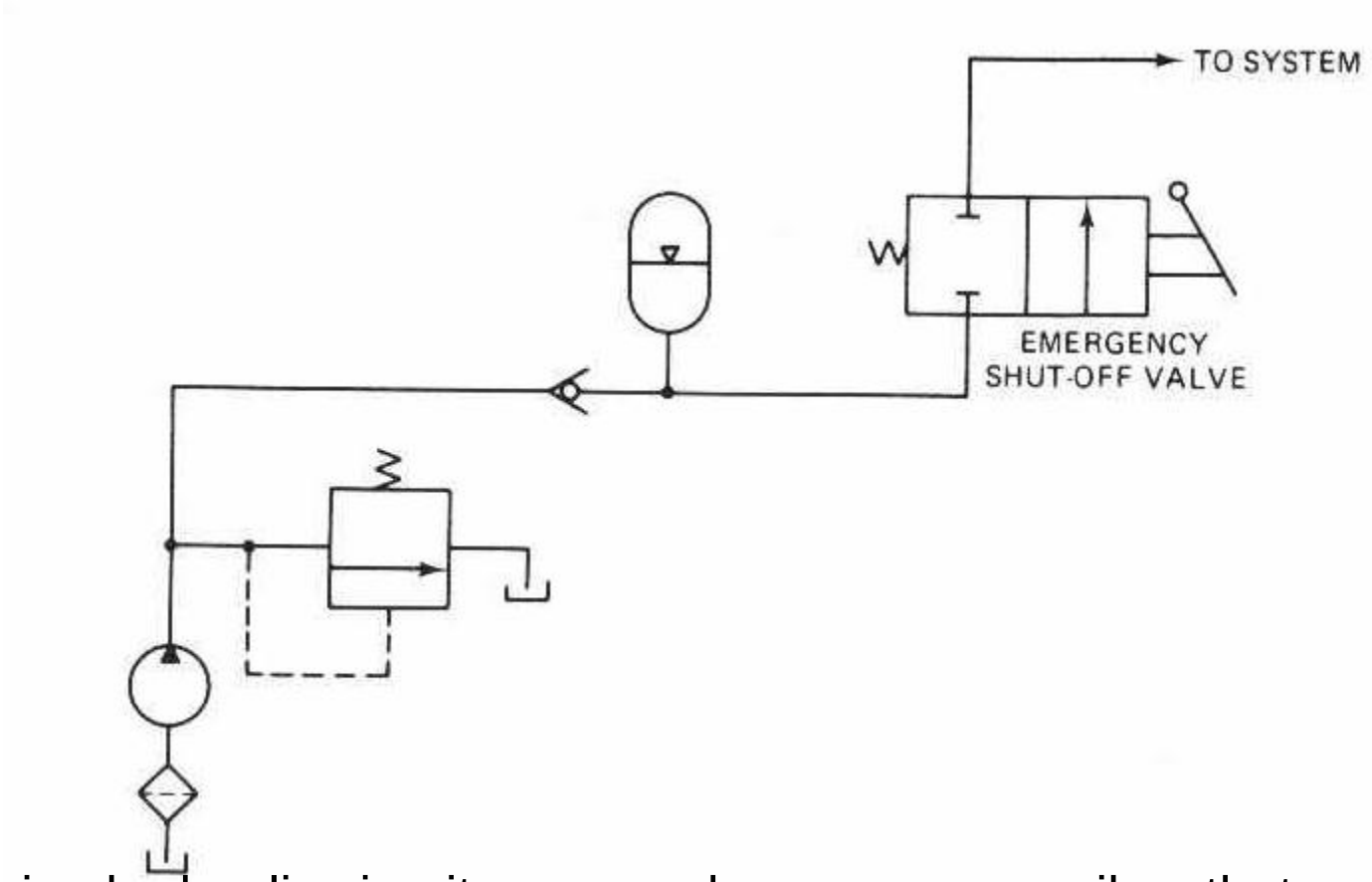


If leakage at the valve or cylinder seals allows pressure to drop about 5%, the pressure switch shifts the directional control valve to pressurize the cylinder cap end and build pressure back to maximum.

Accumulator as an emergency power source.



Accumulator as a hydraulic shock absorber



Fast-moving hydraulic circuits can produce pressure spikes that cause shock when flow is stopped abruptly. Accumulators can be installed in such shock-prone circuits to reduce damaging pressure and flow spikes to an acceptable rate -- or eliminate them completely. (Accumulators can handle other pressure-spike concerns with some valve additions for special instances.)

Sizing of accumulator

Analysis of Weight-Loaded Type Accumulators

Capacity of accumulator : The maximum ount of energy that the accumulator can store known as the capacity of the accumulator.

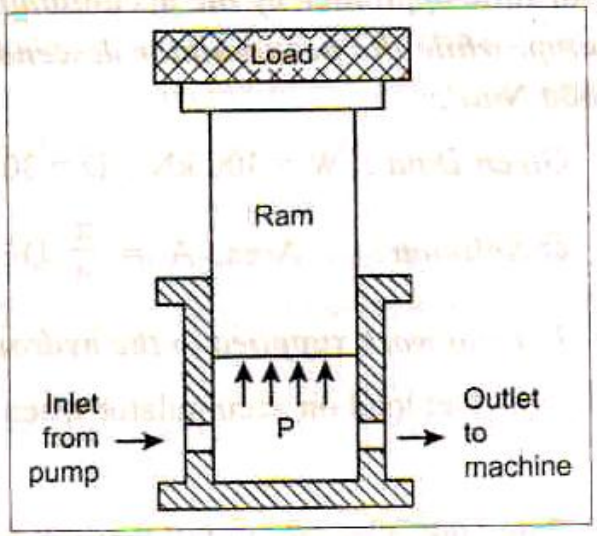


Fig. 8.12. Weight-loaded type accumulator

Derivation :

Let A = Area of the sliding ram = $\frac{\pi}{4} D^2$,

D = Diameter of the ram,

L = Stroke or lift of the ram,

P = Intensity of pressure of hydraulic fluid supplied by the pump, and

W = Total weight of the ram including the weight of the dead-load on the ram.

We know that, $W = P \times A$

Work done in lifting the ram = W × Lift of ram

$= W \times L = P \times A \times L$ [$\because W = P \times A$]

But, $\left\{\begin{matrix}\text{Work done in}\\ \text{lifting the ram}\end{matrix}\right\} = \left\{\begin{matrix}\text{Energy stored in}\\ \text{the accumulator}\end{matrix}\right\} = \left\{\begin{matrix}\text{Capacity of the}\\ \text{accumulator}\end{matrix}\right\}$

$\therefore$ **Capacity of the accumulator = P × A × L**

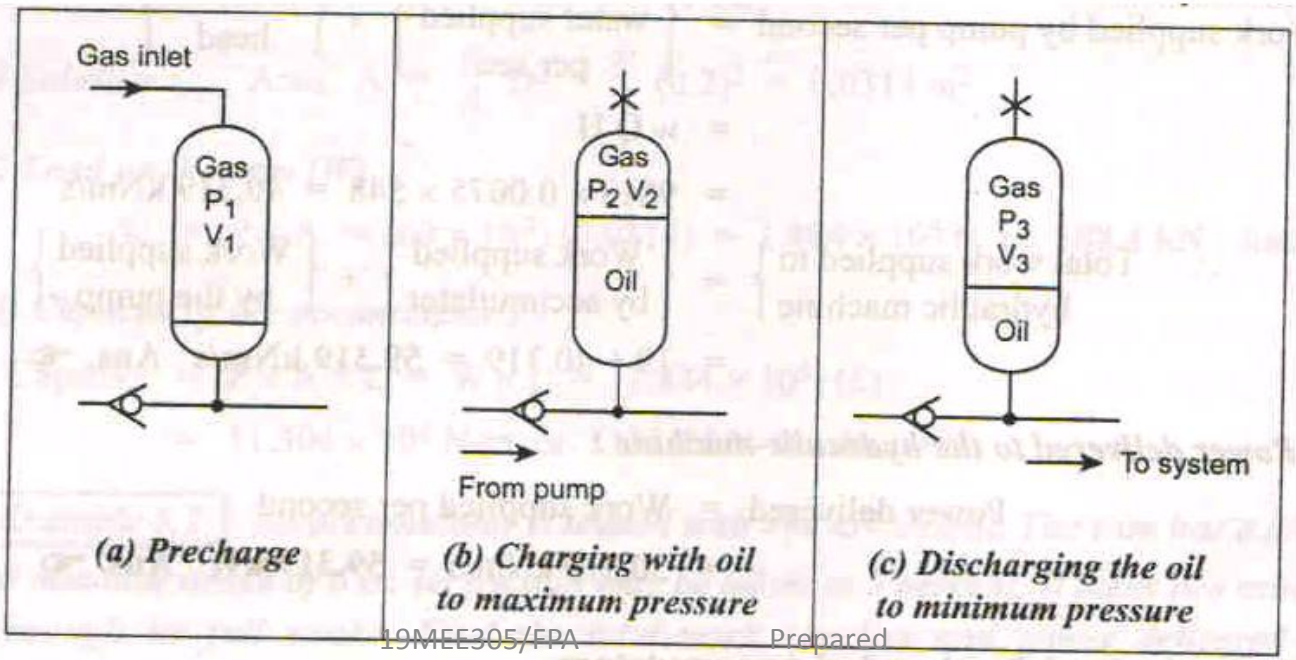
$= P \times$ Volume of accumulator

The rate of discharge determines whether the process is isothermal or adiabatic. If the rate of discharge is quick, the expansion process can be assumed to be adiabatic $P_1V_1^{\gamma} = P_2V_2^{\gamma}$). Isothermal ($P_1V_1 = P_2V_2$) relations can be used for compression if the rocess is slow.

precharge pressure should be selected so that use is made of all liquid in the accumulator.

$$\left.\begin{matrix}\text{Size or total volume}\\ \text{of the accumulator}\end{matrix}\right\} = \left\{\begin{matrix}\text{Volume of the compressed}\\ \text{gas supplied}\end{matrix}\right\} + \left\{\begin{matrix}\text{Volume of the liquid}\\ \text{required by the system}\end{matrix}\right\}$$

compressed gas volume is a function of the charge and discharge time. The required colume can be determined from the performance of the accumulator.

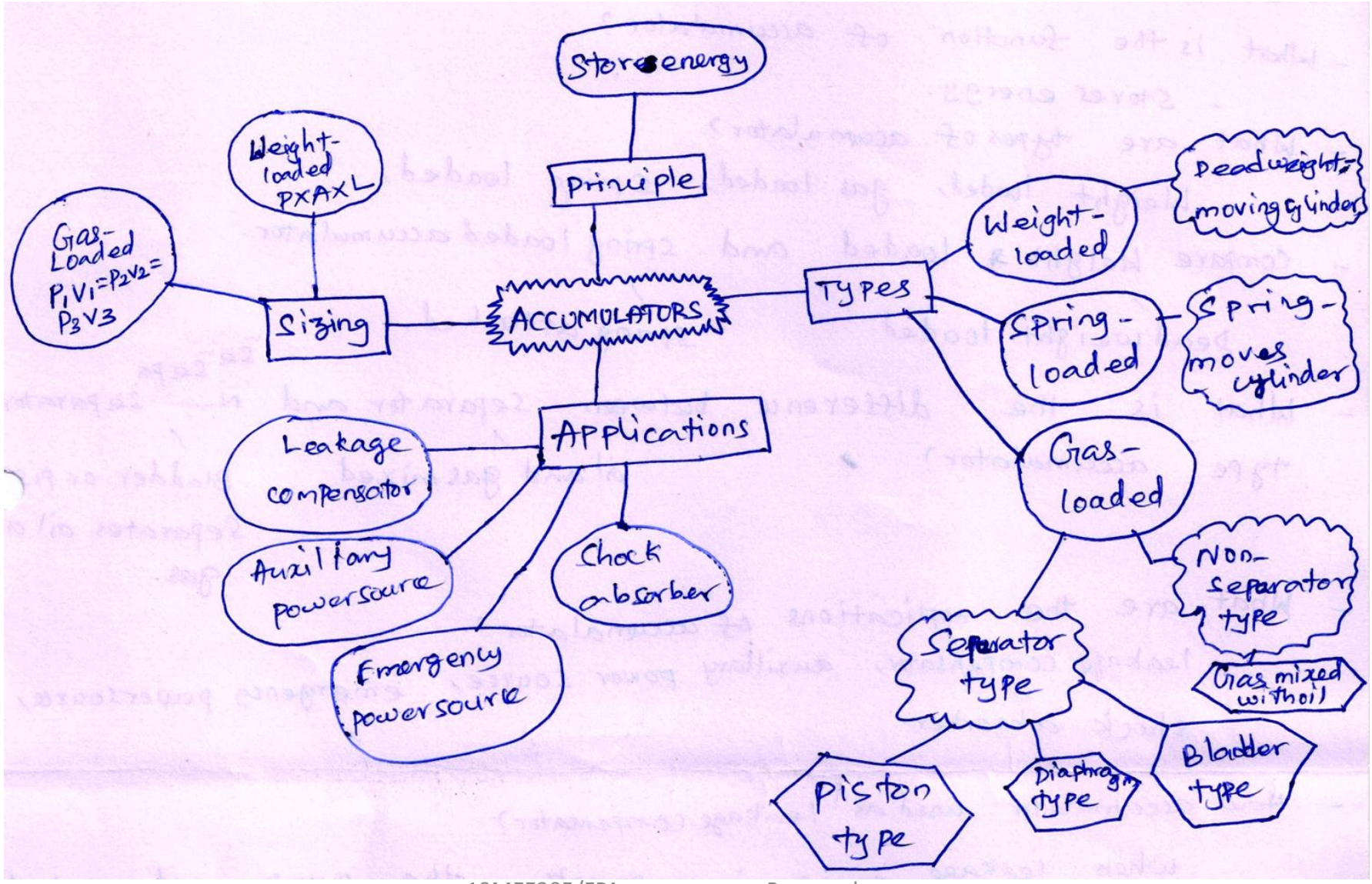


Three states of the accumulator operation

Annexure II - Questions

1. What is the function of accumulator?
2. What type of accumulator operates at constant pressure?
3. What types of gas is used in accumulator?
4. Why are non-separator type accumulator preferred in hydraulics system?
5. What are the applications of accumulator?

Annexure III - Mind Map



Annexure IV - Summary

- A **accumulator** is a pressure storage reservoir in which a non-compressible hydraulic fluid is held under pressure by an external source.
- An accumulator enables a hydraulic system to cope with extremes of demand using a less powerful pump, to respond more quickly to a temporary demand, and to smooth out pulsations.
- It is a type of energy storage device.
- **TYPES**
  - Weight-loaded or gravity type
  - Spring-loaded type
  - Gas-loaded type
- Applications
  - Auxiliary power source
  - Emergency power source
  - Shock observer
  - Leakage compensator

Annexure V – MCQ

1. A weight loaded accumulator:

A. loses pressure as fluid discharges. B. gains pressure as fluid discharges.

C. stays the same pressure as fluid discharges.

2. A spring loaded accumulator:

A. loses pressure as fluid discharges. B. gains pressure as fluid discharges.

C. stays the same pressure as fluid discharges.

3. Gas charged accumulators use:

A. oxygen. B. nitrogen.

C. argon. D.Hydrogen

4. The most common accumulator circuit is:

A. supplementing pump flow. B. making up for system leaks.

C. emergency power supply. D. Adding pressure

5. Precharge pressure should be checked at least every:

A. 1-2 month. B. 2-3 months. C. 3-6 months. D. 4-8 months

Answer

1. A weight loaded accumulator:

A. loses pressure as fluid discharges. B. gains pressure as fluid discharges.

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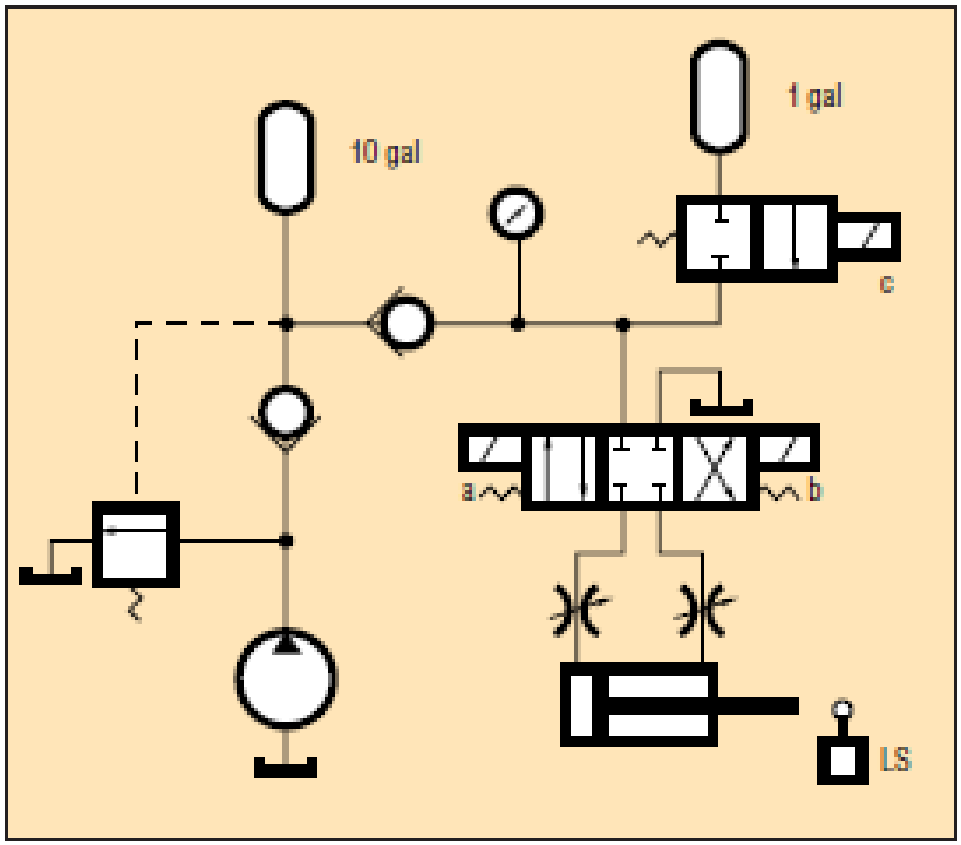
Higher Order Question

Explain the use of accumulator in the circuit.



Traverse and clamp

This arrangement of a large and small accumulator acts similar to a hi-lo circuit for rapid traverse and clamp. Fluid from the large accumulator combines with pump output to extend the cylinder rapidly. Fully extending the cylinder trips the limit switch to actuate solenoid (*c*). The small accumulator then maintains high clamping pressure on the cylinder for a timed period, during which the pump recharges the large accumulator. Any fluid lost by the small accumulator will also be replaced during this time.