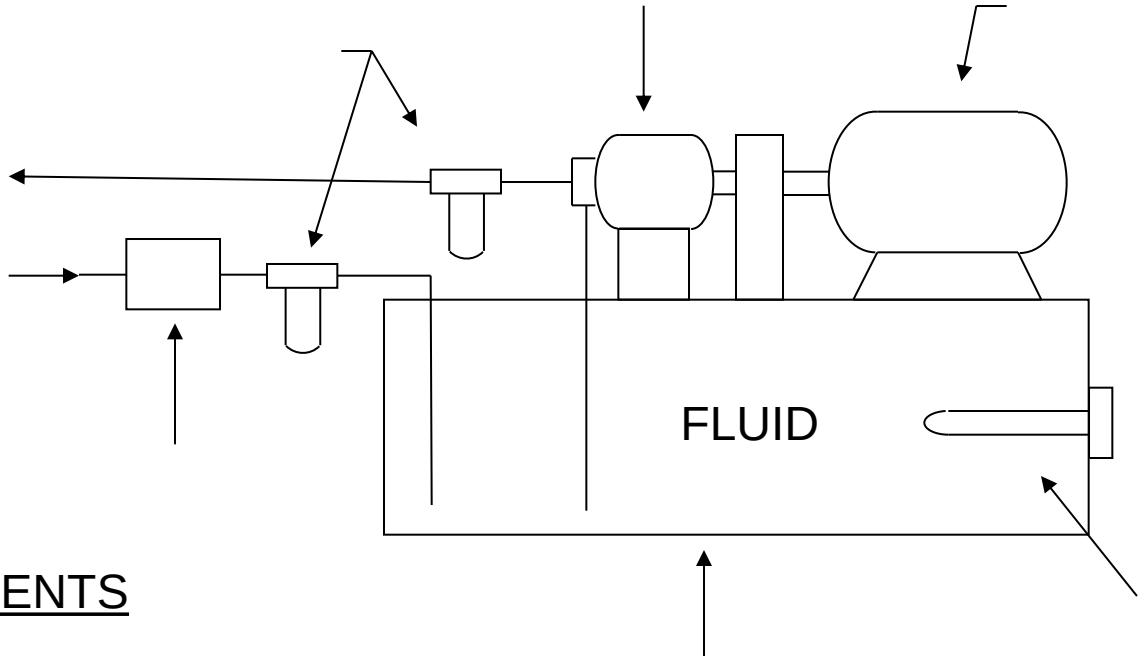
Hydraulic Systems

Components of a Hydraulic System

Hydraulic Components

Power Unit



ADDITIONAL COMPONENTS

- .
- .
- .
- .

Hydraulic Components

Reservoir

The function of a reservoir (tank) is to:

1. Store fluid.
2. .
3. .
4. .
5. May give positive pressure to pump inlet.
6. Provide a place to mount other components.

Reservoir Layout

Pump on Top

- Convenient place to mount motor.
- Pump must generate enough vacuum to lift fluid.
- Common but not a good design.

Pump at Side

- Common design.
- Pump inlet always filled with fluid but vacuum is present when running.
- Extends service life of pump.

Pump at Bottom

- Best design.
- Pump inlet always filled with fluid and under some pressure.

Hydraulic Components

Pump and Motor

The function of the pump and motor is to:

1. .

Various types of pumps available

- Typically positive displacement.
- Gear, Sliding Vane, and Piston.
- Pumps are sized based on the application.

Prime Mover – AC/DC Motor

- Usually AC motor.
- Sized (in HP) to provide pump enough torque to generate correct flow and pressure.

Hydraulic Components

Pumps

A hydraulic pump is a pump that converts mechanical force into hydraulic fluid power.

Pumps create flow. It works on the principle of displacement.

Displacement – moving fluid from one place to another.

2 Types of displacement:

1. Think water-wheel
2. Traps fluid

_____ displacement pumps are a MUST for high pressure systems.

Hydraulic Components

Pumps

2 Types of Positive Displacement Pumps:

1. Fixed
   - Moves the same amount of volume with every cycle.
   - Volume is only changed when the speed of the pump is changed.

2. Variable
   - Can vary the volume with every cycle at the same speed.
   - Can be used to maintain a constant pressure in a system.

Hydraulic Components

Pumps

Types of Hydraulic Pumps

The three most common types of pumps are:

1. _____
   - Internal
   - External

2. _____
   - Balanced
   - Unbalanced

3. _____
   - Axial
   - Radial

Hydraulic Components

Pumps

Pump Delivery, Pressure and Speed

- Pumps are rated by volume, i.e.. GPM

But….more information is required!

- Back pressure
  - The pressure the pump can withstand and still produce the volume rated.
- Pump speed
  - Flow is directly proportionally to speed

Example: 1000 IGPH at 2500 PSI at 1800 RMP

Hydraulic Components

Pumps

Pump Efficiency

Efficiency is classified into three rating:

1. _____ Efficiency
   - Ratio of actual output vs. theoretical output

2. _____ Efficiency
   - Ratio of the overall efficiency vs. the volumetric efficiency

3. _____ Efficiency
   - Ratio of the hydraulic power output to the mechanical power input

Hydraulic Components

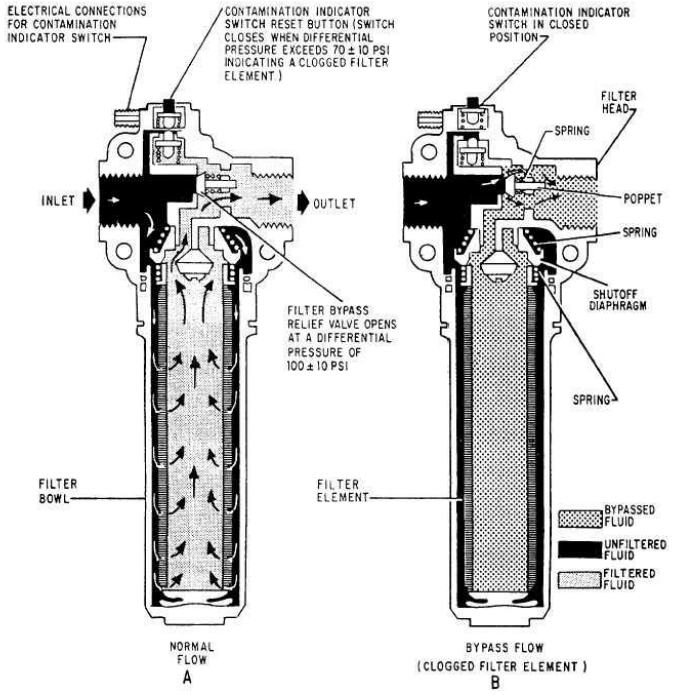
Filters

The function of the filter is to:

1. .
2. .

Sources of contamination:

- .
- .
- .
- Poor plumbing installation.
- Dirt from piston rods.



http://www.tpub.com/content/construction/14050/img/14050_246_1.jpg

Hydraulic Components

Heaters and Coolers

The function of heater and cooler is to:

1. Keep the fluid temperature within a desirable range.

Heat is generated from wasted energy. Any horsepower put into the circuit that does not do useful work wastes energy.

- Up to 15% of input power is wasted
- Pressure drops across various equipment.
- Bypass fluids in pumps and valves.

Coolers or heat exchangers remove excess heat.

- Hot hydraulic fluid looses it's viscosity so not as effective.
- Hot hydraulic fluid may catch fire.
- Reservoir is a natural cooler.

Heaters add heat to the fluid.

- Typically immersion type
- Cold fluid can impair movement of valves and cylinders.

Hydraulic Components

Hydraulic Fluid

The function of hydraulic fluid is to:

1. 2. 3.

Hydraulic Components

Valves

The function of the DC valve is to:

1. Stop or block fluid flow.
2. Allow fluid flow.
3. Change direction of fluid flow.

Types of DC Valves

- Check valves
- Pilot operated check valves.
  - Allow reverse flow.
- Similar selection to pneumatic DC valves.

Types of Pressure Valves

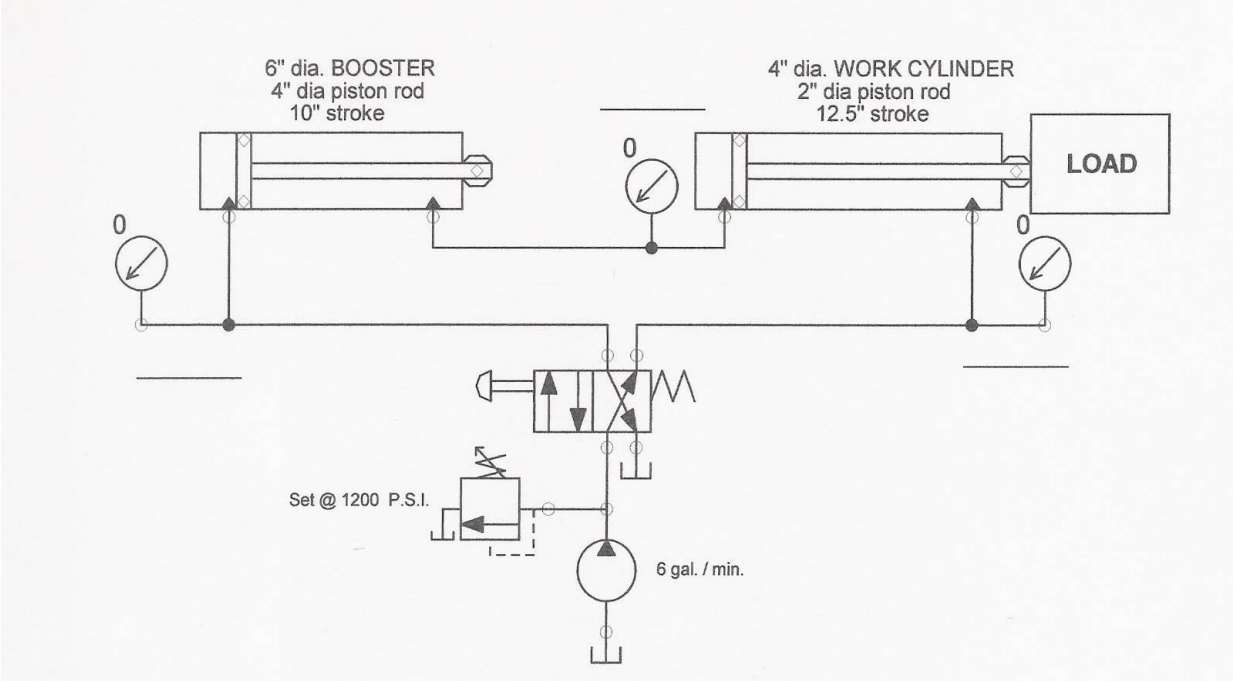
- Relief valves
  - Protect the system from excess pressure
- Direct acting relief valve
  - Very fast
  - Can leak at low pressure (<150psi)
- Pilot operated relief valve
  - Allows only excess fluid to return to tank

Hydraulic Components

Boosters

The function of the booster (intensifier) is to:

1. .



Hydraulic Components

Accumulators

A device which stores the potential energy of an incompressible fluid held under pressure by an external source against some dynamic force.

Dynamic forces:

1. Gravity
2. Mechanical spring
3. Compressed gasses

The _____ potential energy in the accumulator is a _____ secondary source of fluid power.

- Capable of _____the pressure when there is a _____ increase or decrease of oil demand in the circuit

Hydraulic Components

Accumulators

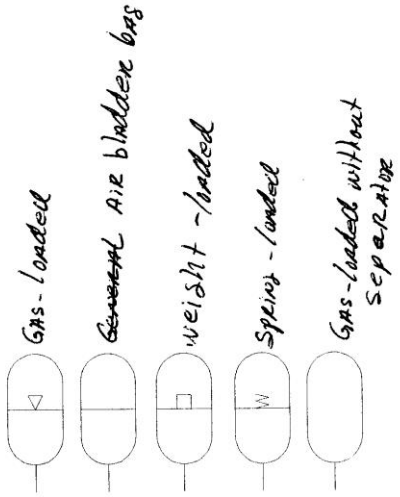
6 Main Reasons for using an Accumulator:

1. .
2. .
3. .
4. .
5. .
6. .

Hydraulic Components

Accumulators

Accumulator



The accumulator is used to stabilize the pressure when there is an increase or decrease of the oil demand in a circuit.

The accumulator is not functional, it serves as a graphic symbol to be incorporated in your diagrams. Therefore, the simulation parameters have no influence on the simulation.

Simulation parameters

Charging Pressure	Pressure in the accumulator when the pressure in the circuit is null.
Minimum Pressure	Minimum pressure needed for the circuit to work. At that pressure, the accumulator starts loading.
Maximum Pressure	Maximum pressure needed for the circuit to work. At that pressure, the accumulator is fully loaded.
Gas Type	Type of gas used in the bladder of the accumulator. Nitrogen is the most commonly used.
Total Volume	Nominal volume of the accumulator.

Weight - loaded : - The oldest type of accumulator,
- can only be used vertically,
- provides a constant fluid pressure throughout the full volume output,
- extremely large in size and very heavy, unsuitable for mobile equipment.

Spring - loaded : - Similar to the weight accumulator, except that the piston is pre-loaded with a spring,
- the pressure exerted on the fluid is not constant,
- should not be used for applications requiring high cycle rates because the spring will fatigue and lose its elasticity,
- for low volume at low pressure,
- can be used in the vertical or horizontal position.

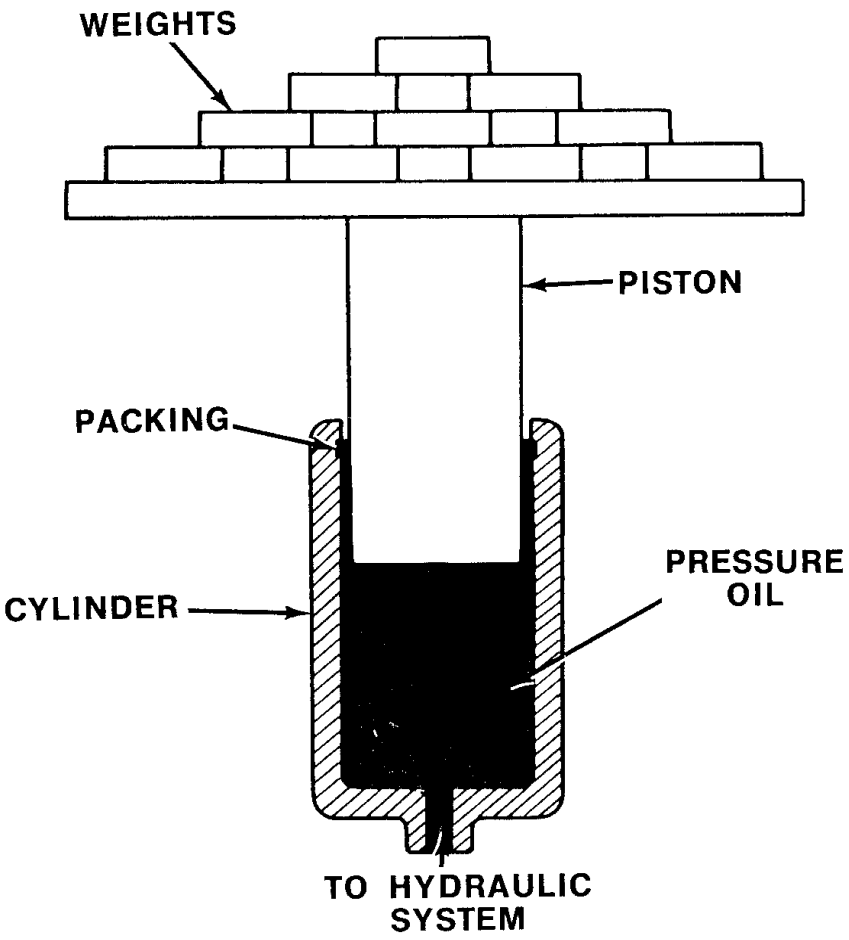
Gas bladder - loaded : Also called hydro-pneumatic accumulators,
- the compressibility of gases accounts for the storage of potential energy,
- this energy forces the oil out of the accumulator when the gas expands due to the reduction of system pressure. (Boyle's law of gases)
example: an actuator rapidly moves a load

2 main categories: separator and non-separator type.

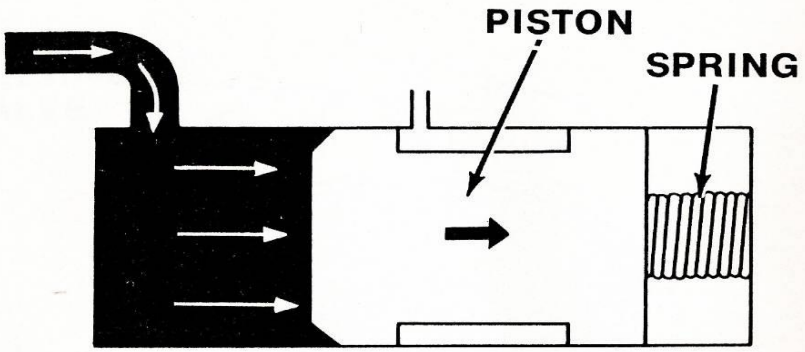
The **non-separator type** consist of a fully enclosed shell containing an oil port on the bottom and a gas charging valve on the top,
- the gas pushes directly on the oil,
- advantage: can handle large volume of oil,
- disadvantage: -absorption of gas in the oil and makes the oil compressible,
-can only be used vertically.

The **separator type** has 3 classification : Piston, Diaphragm and Bladder type.
- Most common and accepted type used in industries,
- has a physical barrier between the gas and the oil and can use compressibility of the gas.
- the piston type consist of a cylinder with a free floating piston with O-rings,
- the diaphragm type consists of a diaphragm secured in the shell which serves as an elastic barrier between the oil and the gas,
- the bladder type has an elastic barrier (bladder) between the gas and the oil.

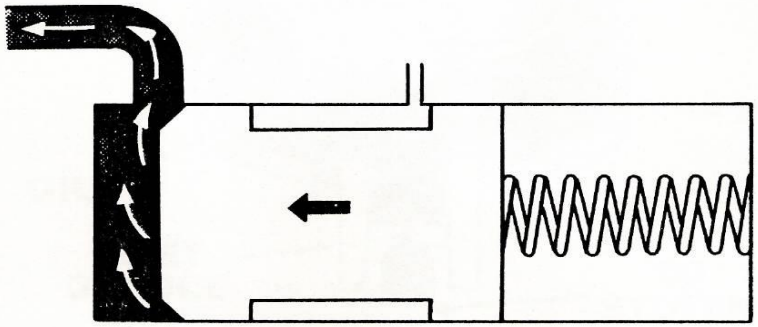
WEIGHT-LOADED ACCUMULATOR



SPRING-LOADED ACCUMULATORS (1)

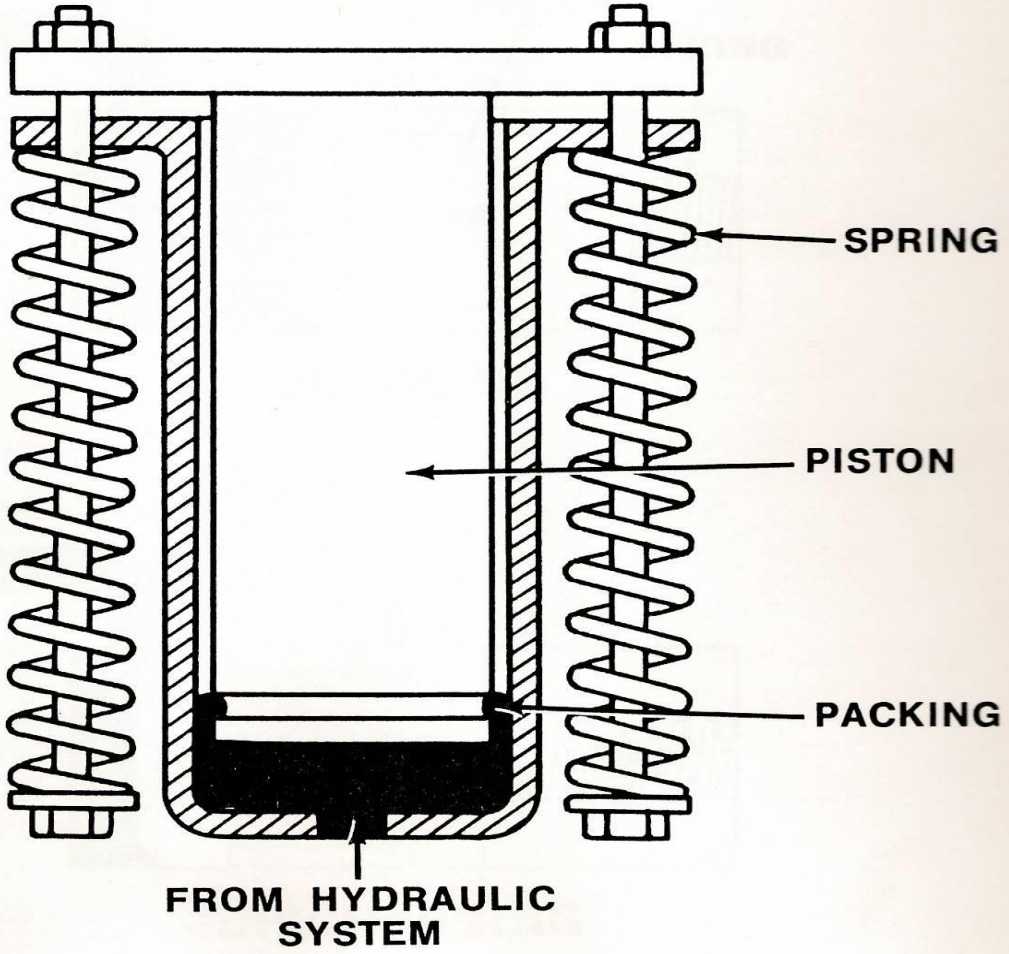


CHARGING

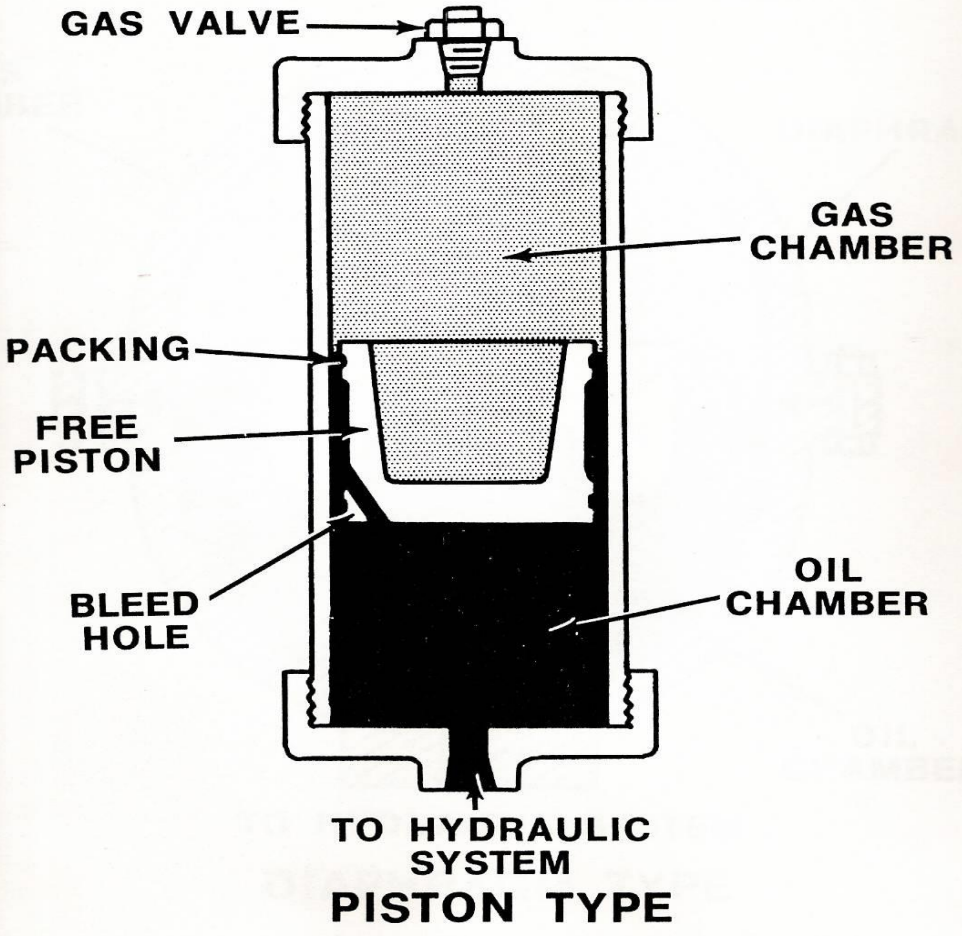


DISCHARGING

SPRING-LOADED ACCUMULATORS (2)

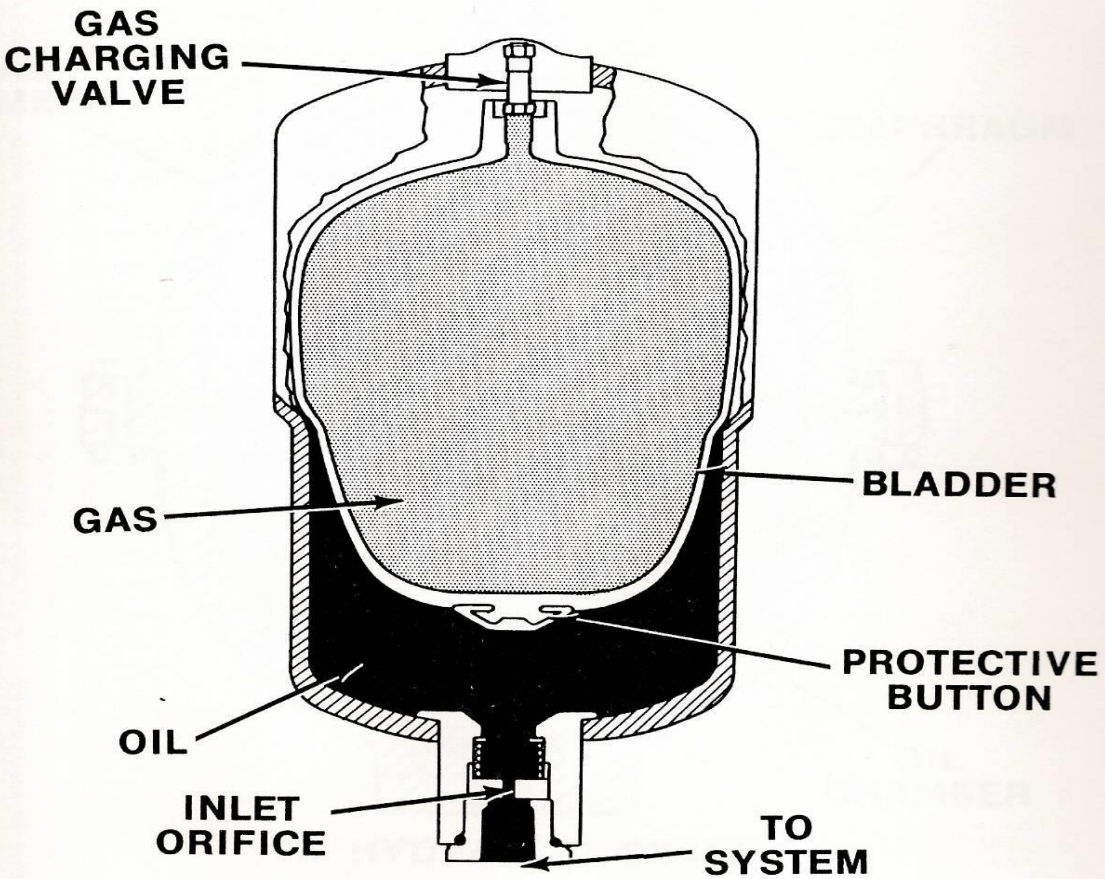


PNEUMATIC ACCUMULATORS (1)



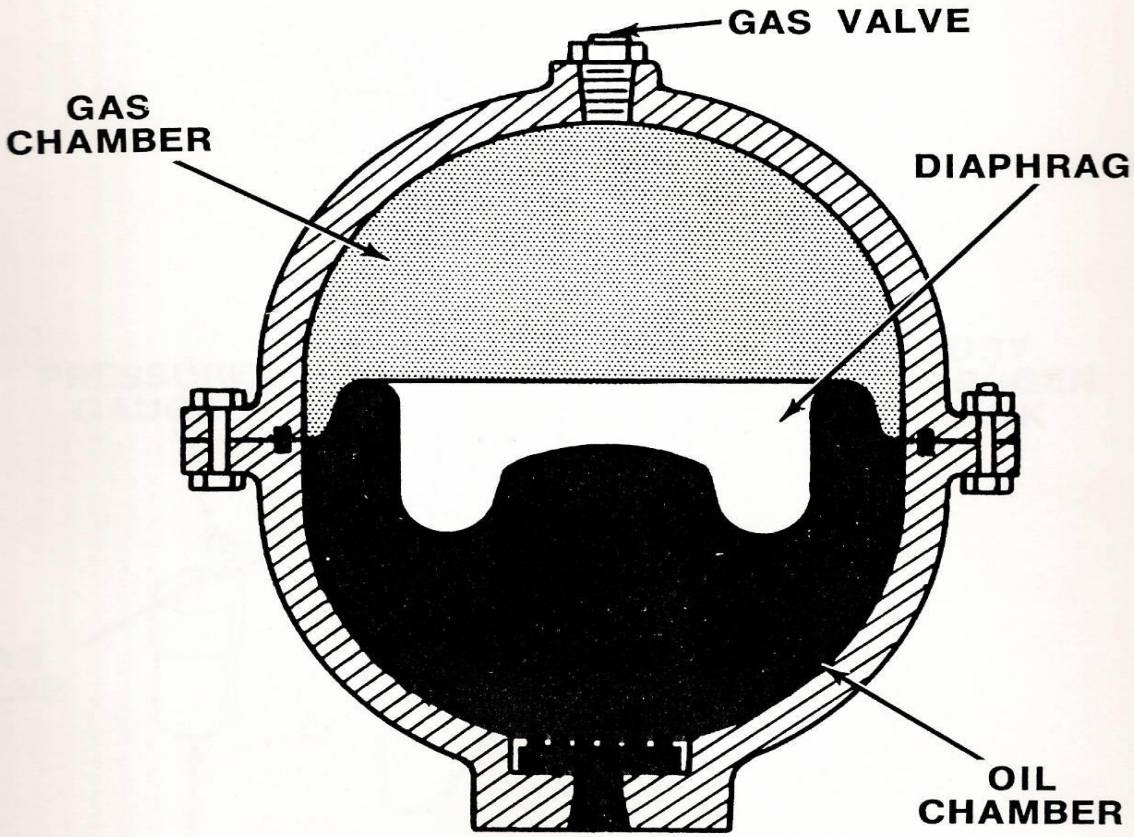
PISTON TYPE

PNEUMATIC ACCUMULATORS (2)



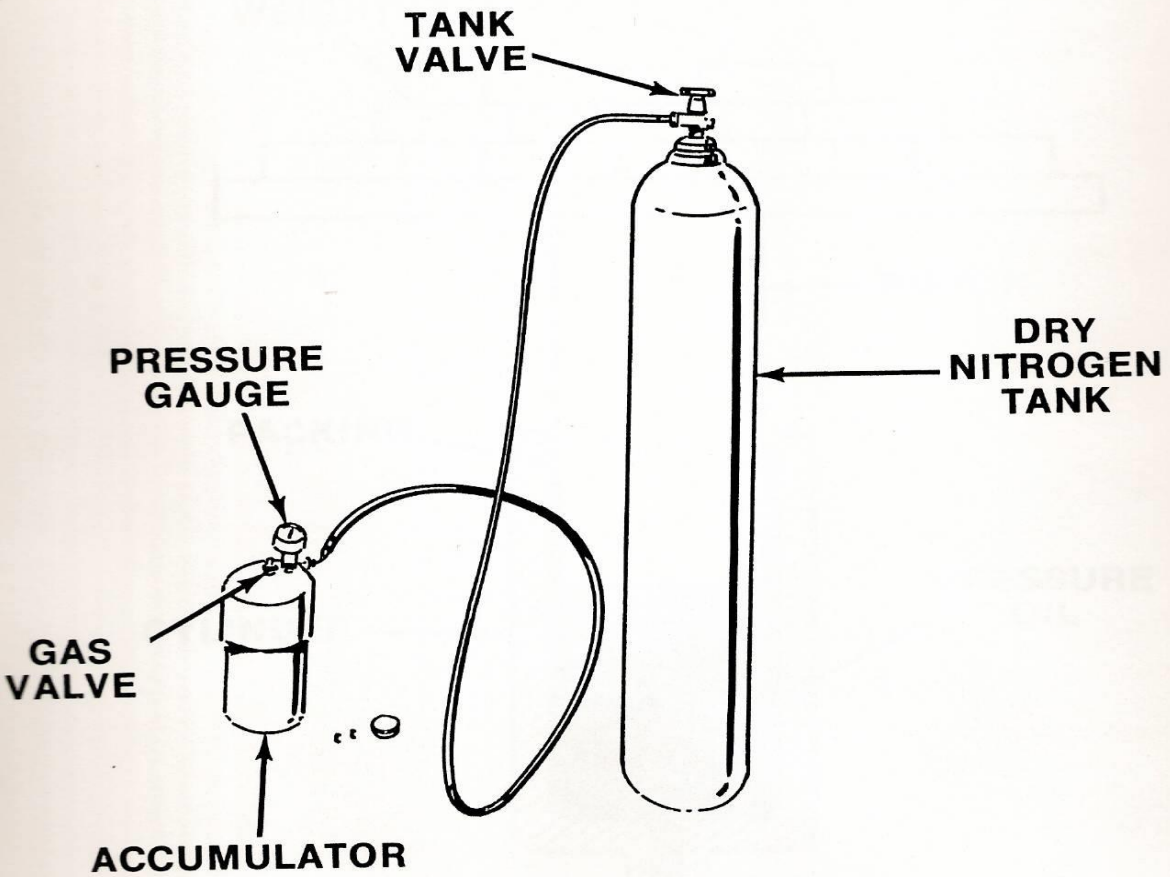
BLADDER TYPE

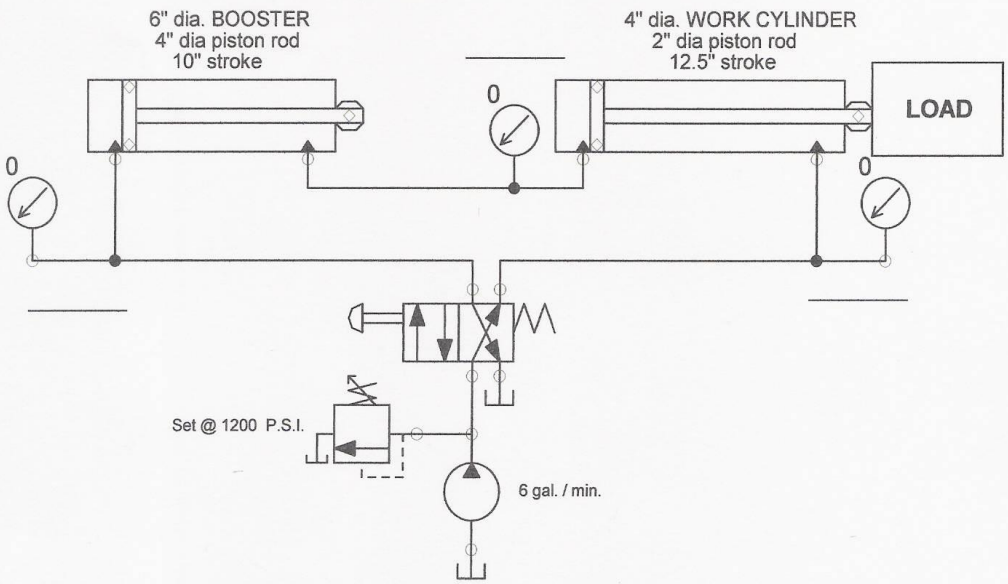
PNEUMATIC ACCUMULATORS (3)



DIAPHRAGM TYPE

PRECHARGING ACCUMULATORS





(Write the pressure beside all 3 pressure gages on the circuit diagram when cylinders extending under full load)

What maximum LOAD can the WORK CYLINDER push ?

How long in SECONDS will it take to push the load 12.5" ?

Example

3 Ton Car Hoist

8 US GPM at 1800 RPM with pressure relief set at 1000 psi

1. What is the actual minimum cylinder size required?

2. At what speed will the hoist raise the car?

3. Compare Work-In to Work-Out

4. Compare Mechanical HP to Hydraulic HP

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1. What is the actual minimum cylinder size required?

Example

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1 USG = 231cu inches

Example

3 Ton Car Hoist

8 US GPM at 1800 RPM with pressure relief set at 1000 psi

3. Compare Work-In to Work-Out

Work-In	Work-Out
Vd x PSI	Cyl. Lift / rev x F
Vd = 1848 cu in/min / 1800 RPM Vd = 1.0267 cu in/rev	1.0267 cu in/rev / 6 sq in x 6000lbs 0.17116 in/rev x 6000lbs 1026.7 in-lb / rev
1.0267 cu in/rev x 1000psi 1026.7 in-lb / rev	

Example

3 Ton Car Hoist

8 US GPM at 1800 RPM with pressure relief set at 1000 psi

4. Compare Mechanical HP to Hydraulic HP

Hydraulic HP

Mechanical HP

1HP=33000lb raised 1ft in 1 min
or 550lbs raised 1ft in one sec.