



TOTAL

EQUIPEMENTS

HYDRAULIC AND PNEUMATIC EQUIPMENT

EXP-PR-EQ020-EN

Rev. 0

In this course you will learn:

- Construction and theory
- Hydraulic power supply
- Hydraulic systems components
- Reading hydraulic and pneumatic diagrams
- Hydraulic systems operations
- Hydraulic systems controls and devices
- Applications hydraulic actuated valves and their controls
- Site application well equipment and control

Construction and theory

- **Introduction**

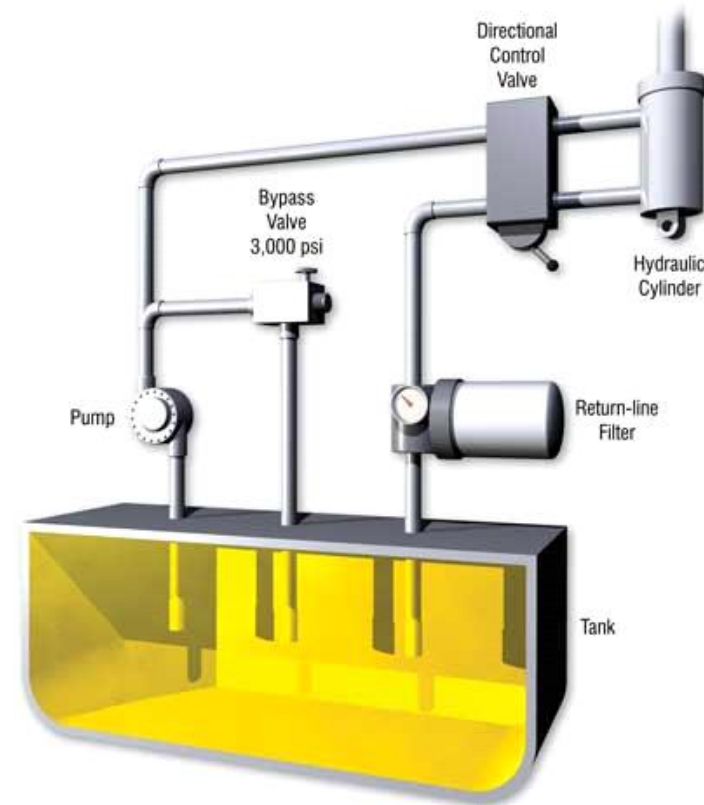
- The commonly called « hydraulic systems » allows the movement of energy from one point to another
- They are employed on our industrial sites
- The hydraulic installation is expensive compared to other types of energy, however it presents several advantages:
 - In rotating version, it authorises speed variation, double direction (forward and reverse)
 - Allows precise control of efforts
 - Proof to ambient adversity
 - High power developed
 - Good association with control devices
 - Flexible in its use

Construction and theory

- **Introduction**

- **Constitution of a hydraulic system**

- A hydraulic circuit works under a certain pressure
 - The energy required is provided either by:
 - Electrical or thermal motor
 - Pneumatic drive « motor » actuated by gas or air
 - Hand
 - The circuit is helped by a pneumatic system with any energy source



Construction and theory

■ Constitution of a hydraulic system

– It is associated with one of these energy sources:

- A pump which **pushes** the fluid taken in a tank and sent to ends devices, going through accessories system, before returning to the “**fluid**” tank
- A circuit distribution

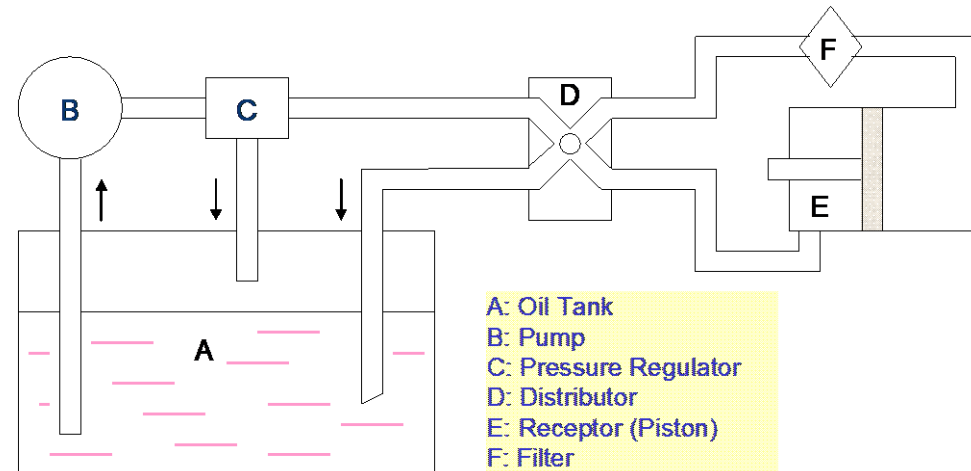
– If end receptors have linear movements, they should be piston actuators

– For other end receptors, they have

to turn, acting as “hydraulic motors” or rotary piston actuator

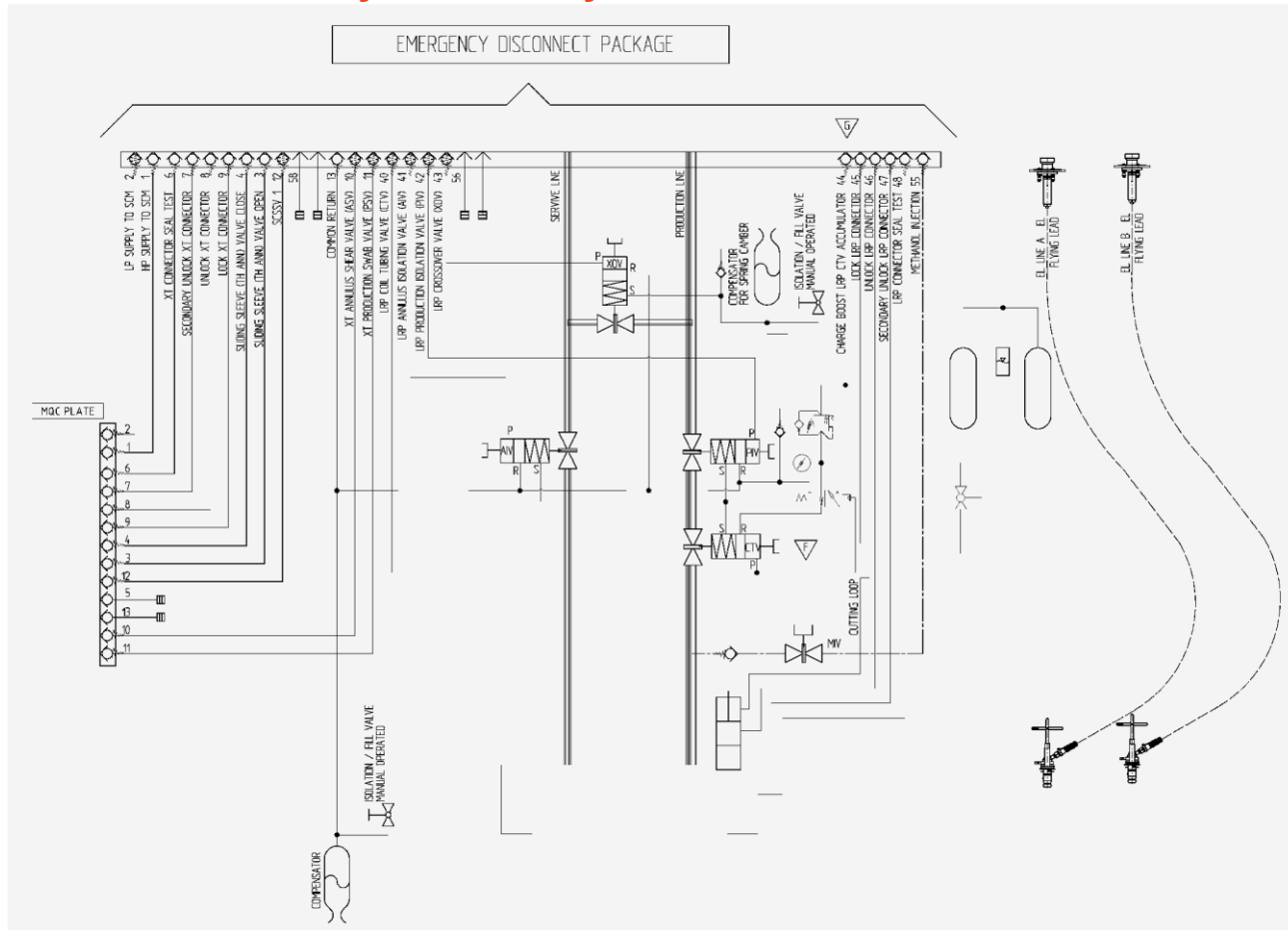
– Add piping, conducts between the hydraulic components, able to resist the working pressure, being rigid, flexible, metallic, etc.

– Add as well piping circuits for commands and control (pneumatic or electric)



Construction and theory

- **Introduction**
 - **Constitution of a hydraulic system**



Construction and theory

- **Basic principles of pneumatics**
 - **What is in the basic compressed air/gas system?**
 - The compressed air system must make compressed air from the air around us
 - It must then make sure that the air it has compressed is:
 - Clean
 - Dry
 - At the correct pressure to be used to do work
 - At the correct temperature to be used
 - Enough for the devices it will operate to do the work

Construction and theory

- **Basic principles of pneumatics**
 - **Things just to know and remember**
 - Air pressure is the force of air pushing against an object
 - When air is only at sea level it presses against everything around it at a pressure of 101.5 kPa
 - When air is compressed, its temperature increases and its volume decreases
 - When air is allowed to expand its temperature decreases and its volume increases and the water vapour in it condenses to water

Construction and theory

- **Basic principles of pneumatics**
 - **Things just to know and remember**
 - Flow rate is a measurement of the amount of fluid that goes through the system or pipe per unit of time
 - **Remember:** Air is a gas and gas is a fluid
 - Humidity is the amount of water vapour in the air
 - Dew point is the temperature at which vapour in the air begins to condense out of the air

Construction and theory

- **Basic principles of pneumatics**
 - **Things just to Know and remember**
 - When air is compressed it gets warmer
 - Water in a pneumatic system will cause corrosion and erosion of the pipe and other components
 - In all air distribution, water is not welcomed. Air dryers, air filters exist at the origin of air distribution
 - Service units have two main components:
 - An air filter to clean any remaining dirt or debris from the air
 - A pressure regulator to make sure the pressure of the compressed air is correct

Construction and theory

- **Basic principles of pneumatics**

- **Remember the pressure units**

- In the (SI), pressure is expressed in pascal (Pa)

- $$1 \text{ Pa} = 1 \text{ N} / 1 \text{ m}^2$$

- As one pascal amounts to a very small pressure, a more convenient unit is often used in our oil & gas industry:

- The **bar**, which is equivalent to 100 000 pascal

- $$1 \text{ bar} = 10^5 \text{ Pa} = 1000 \text{ mbar}$$

- The pound-force per square inch is another unit which is very commonly used in the oil & gas industry, particularly by instrument people: **lbf/in²** or **psi**:

- $$1 \text{ psi} = 6894 \text{ Pa} \approx 69 \text{ mbar}$$

- $$1 \text{ bar} = 14.5 \text{ psi}$$

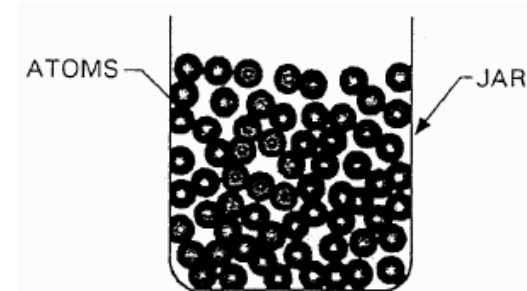
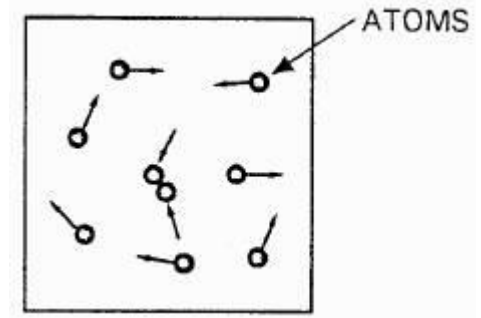


Construction and theory

- **Basic principles of pneumatics**

- **Why do we use hydraulics?**

- For air (or gas) energy is stored in the molecules and the atoms that make up those molecules by pushing them together in a process we call compression
 - When the energy in that compressed air is released its force can be made to do work
 - Hydraulic liquid is not compressible, so it cannot store energy
 - It can only transmit energy
 - The energy comes from the pump in the hydraulic system and can be made to do work

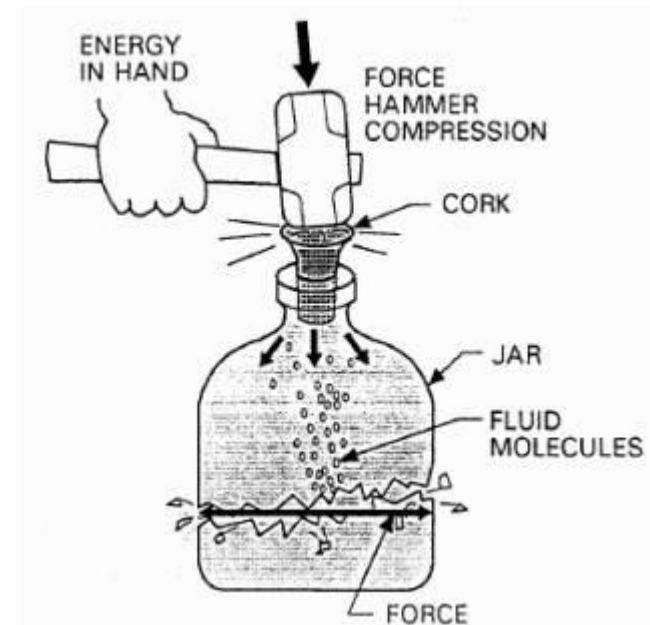


Construction and theory

- **Basic principles of pneumatics**

- **Why do we use hydraulics?**

- This important property of liquids results in a hydraulic system that can be controlled very accurately
 - Energy can be easily and quickly transferred when we try to compress a liquid
 - The transfer occurs with very little loss due to expansion or friction
 - It is good for doing work that needs more energy than pneumatic air pressure



Construction and theory

- **Basic principles of pneumatics**
 - **Hydrostatics pressure and Pascal's Law**
 - **Hydrostatic pressure** on the sea-floor is created by the **weight of water** acting downwards (**topped by the weight of the atmosphere above it**)
 - Pressure on a fluid acts equally in all directions. This discovery is called **Pascal's Law**

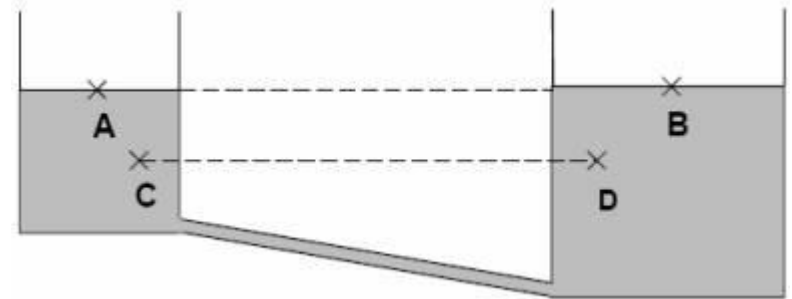
Construction and theory

- **Basic principles of pneumatics**

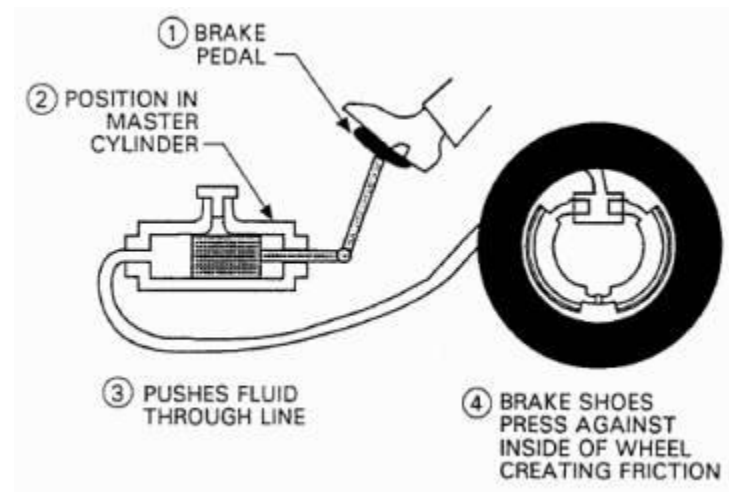
- **Second Pascal's Law**

- In a liquid at rest, the hydrostatic pressure is the same in all points of the same horizontal plane:

$$P_A = P_B, P_C = P_D \text{ and } P_C > P_A, P_D$$



- Hydraulic fluid pressure can be made to lift or push much heavier things than pneumatic air pressure and give **“force”**



Construction and theory

- **Basic principles of pneumatics**

- **What do we mean when we says “hydraulics”**

- The science of hydraulics includes the physical properties of liquids as well as the flow of liquids
 - Some of the hydraulic systems used in plants are:
 - Hydraulic lifts that include jacks
 - Valve actuators
 - Control systems
 - Impact and torque (tightening) tools
 - Dead weight testers for calibrating pressure devices
 - The advantages of hydraulics are:
 - The ease of control, as well as the making and sending of large forces and power through the use of small units
 - Hydraulic cylinders and hydraulic motors can be started from a position at rest with maximum power
 - They can also reverse direction quickly through remote control
 - Hydraulic equipment is self-lubricating and has long service life



Construction and theory

- **Basic principles of pneumatics**

- **How does the hydraulic system work?**

- **Hydraulic power** is the ability of the movement of fluid to do work by applying pressure to the fluid at one point in a system and transmitting the pressure through the fluid to another point
 - Very large output forces can be produced by much smaller input forces
 - **A fluid** system that is adjusted properly gives smooth action
 - Over-pressure conditions are easy to control with automatic pressure release devices
 - Hydraulic power systems can provide both rotary and straight line power transmission
 - In a closed system, the fluid does not exhaust like the air in a pneumatic system. There is very little need to add more hydraulic fluid

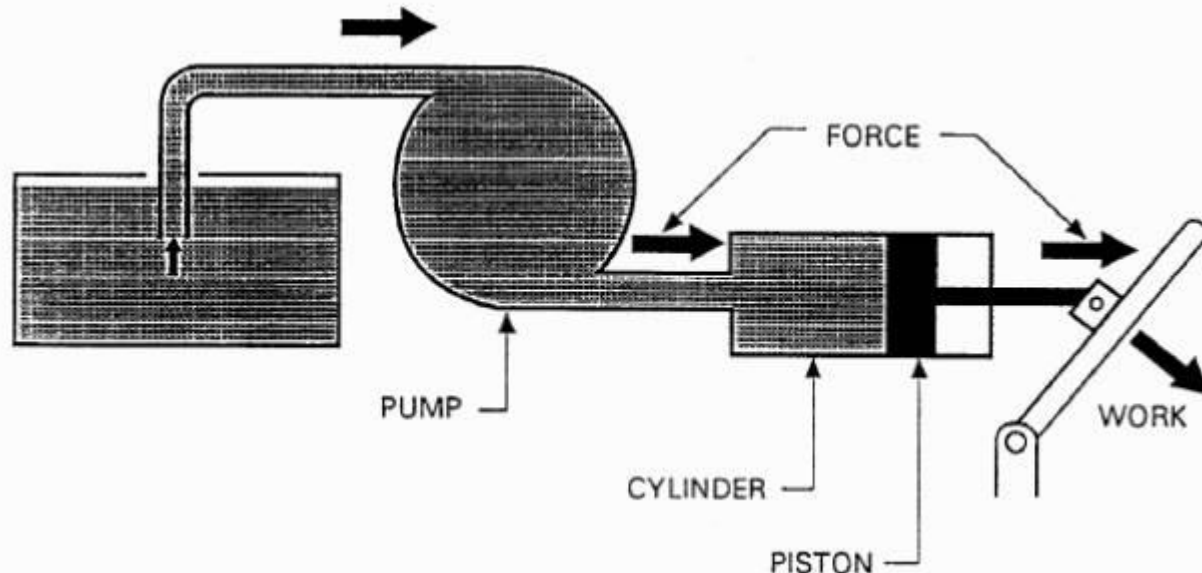


Construction and theory

- **Basic principles of pneumatics**

- **Pascal's Law application (the valves actuators)**

- It shows a hydraulic system with force being applied by a pump which applies a force on the hydraulic fluid
 - The fluid transfers the force to the piston in the cylinder
 - The piston rod applies the force to the lever
 - Work is performed in the movement of the lever

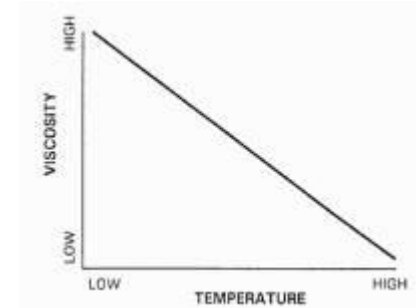


Construction and theory

- **Basic principles of pneumatics**

- **Viscosity**

- One of the most important physical properties of hydraulic fluid is its viscosity which presents the resistance to flow
 - It is a measure of the thickness of a liquid
 - Gasoline which flows easily has a low viscosity
 - Tar which flow slowly has a high viscosity
 - As the temperature of a liquid rises, the viscosity decreases
 - It is important that the viscosity of hydraulic fluid remains as constant as possible over the operating temperature range of the system



Construction and theory

- **Basic principles of pneumatics**

- **Viscosity**

- Hydraulic fluid that flows too easily will leak around pistons and pumps
 - If the fluid leaks around the part without making a seal, there is a loss of pressure and a loss of work force
 - If the viscosity of the fluid is too high:
 - The moving parts will be slow. The system is said to be sluggish
 - The power necessary to do the work will increase
 - The efficiency of the system will decrease

Construction and theory

- **Basic principles of pneumatics**
 - How hydraulic systems differ from pneumatic systems

PNEUMATIC	HYDRAULIC
Uses air (gas) to transfer energy	Uses oil to transfer energy
Cooling of air is a problem	Heating and cooling of hydraulic fluid is a problem
Uses a compressor to make pressure	Uses a pump to make pressure
Gas (air) used is compressible	Liquid used (hydraulic fluid) is incompressible
Uses complex filtering elements	Uses simple filtering elements
System is noisy	System is quiet
It's an open system	It's a closed system
Transmits low forces	Transmits high forces

Hydraulic power supply

- **The hydraulic pumps**

- **Applications**

- The main applications we can encounter on sites:
 - Centralised hydraulic unit for valves actuations
 - Wells controls panel hydraulic headers supplies
 - Starting unit of generators packages
 - Other applications exist, which could be individual power unit for valve, High pressure liquid chemical injection skid,...etc.
 - Like the pneumatic system, the hydraulic system must put energy into the hydraulic fluid
 - In the pneumatic system the compressor adds the energy. In the hydraulic system a pump provides the energy



Hydraulic power supply

- The hydraulic pumps
 - Applications



Hydraulic power supply

- The hydraulic pumps
 - Applications



Hydraulic power supply

- The hydraulic pumps

- Hydraulic Pressure

- It is important to know that **a hydraulic pump does not increase pressure**
 - Pressure develops only as the fluid flow is restricted by resistance to the flow
 - A pump with no piping or other devices on the outlet will pump fluids continuously without ever developing any pressure
 - Resistance to flow is caused by the lines, fittings and all devices in the system

Hydraulic power supply

- **The hydraulic pumps**

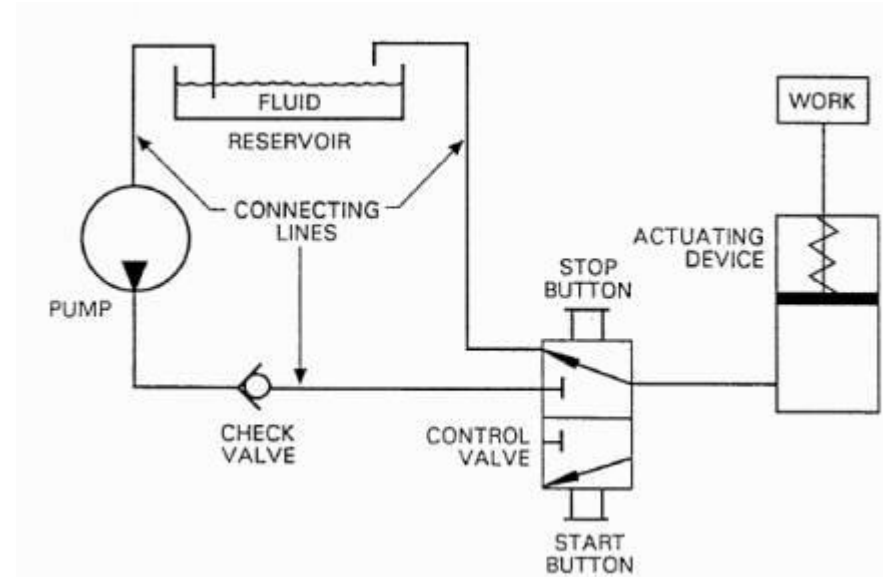
- **Hydraulic Pressure**

- Pressure is controlled by the load (resistance) on the system
 - This is the basic difference between the pneumatic and hydraulic systems
 - There is no pressure in the hydraulic system until the flow of the fluid is opposed by something that needs to be moved to do work
 - Hydraulic fluid leaves the reservoir and goes through the pump
 - At that time the pump must start to work harder to continue the flow of the fluid and push the piston and the weight



Hydraulic power supply

- The hydraulic pumps
 - Hydraulic Pressure
 - In the plant you can hear the pump make a change in sound
 - If you have ever flown in a plane, you may have heard this same sound when the pilot brings up or lets down the wheels of the plane



Hydraulic power supply

- **The hydraulic pumps**

- **Hydraulic Pressure**

- **The hydraulic pump is followed by:**

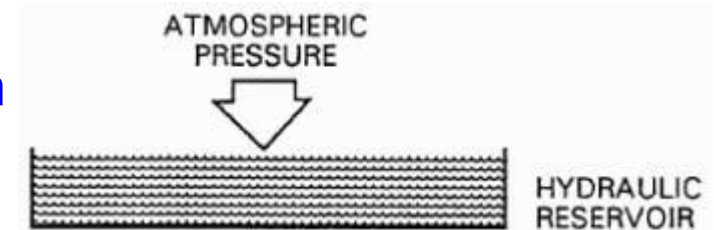
- A reservoir to store the fluid until it is used. This unit does the same job as the receiver in the pneumatic system
 - Valves that direct the pressure of the fluid to the using (end) devices, as in the pneumatic system
 - Actuators and other end devices that react to the pressure of the fluid and do the WORK
 - Hydraulic lines (piping) that circulate the fluid and connect all the parts of the system

Hydraulic power supply

- **The hydraulic pumps**

- **Hydraulic Pump Operation**

- It changes mechanical force and motion into hydraulic energy
 - The mechanical force needed to drive the pump can come from several sources:
 - Electric motors
 - Air motors
 - Diesel engines
 - Manual resource
 - Atmospheric pressure can be an important force in the operation of a pump
 - The atmosphere has weight which pushes down on the fluid in a hydraulic reservoir
 - The atmospheric pressure pushes the fluid into the vacuum until the pressure in the space is equal to the atmospheric pressure

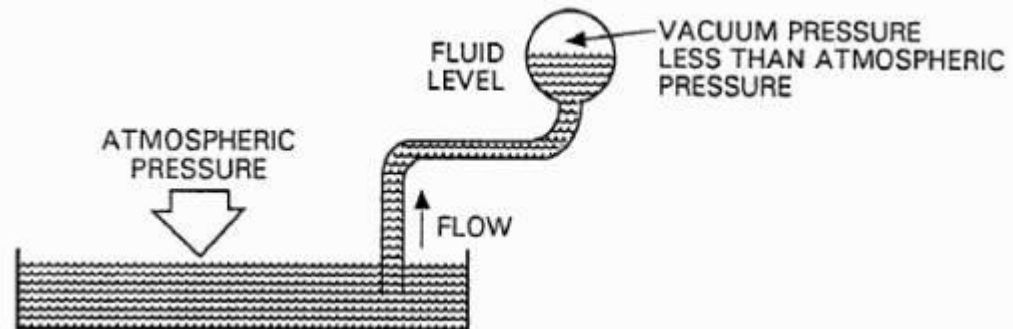


Hydraulic power supply

- **Hydraulic pumps types**

- **Positive and Non-Positive Displacement**

- A non-positive displacement pump mechanically picks up a quantity of fluid at one location and delivers it to another place
 - There is no seal to prevent leakage back into the fluid source
 - A positive displacement pump creates a vacuum or low pressure area as the fluid moving elements rotate within the pump case
 - In the figure:
 - The atmospheric pressure will try to push the fluid into the vacuum
 - When fluid gets to the pump, the fluid moving elements take over to produce flow

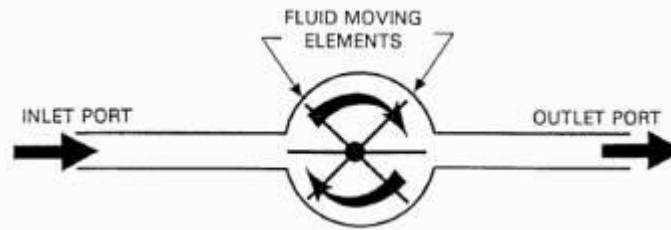


Hydraulic power supply

- **Hydraulic pumps types**

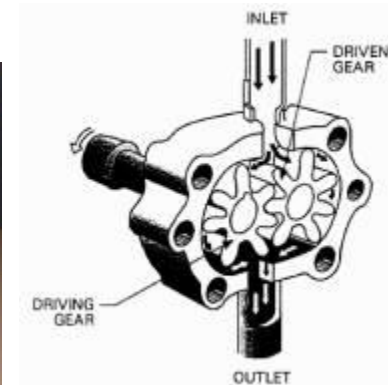
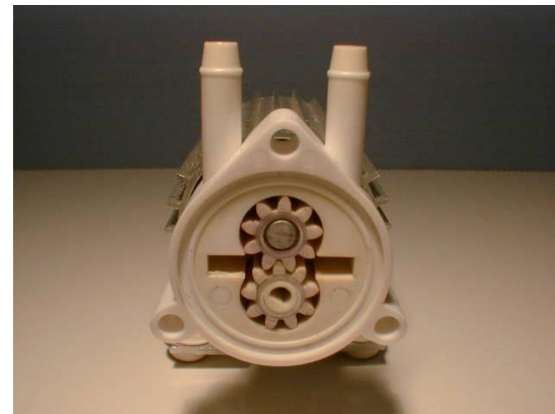
- **Rotary Hydraulic Pumps**

- Rotary hydraulic pumps have internal rotating parts that trap fluid at the inlet port and push it out at the outlet port



- **Gear Pumps**

- It has two or three meshed gears rotating in a casing
 - The drive gear is attached to a drive shaft which is connected to an external power source
 - These pumps are very common, cheap because they are simple and economical to operate

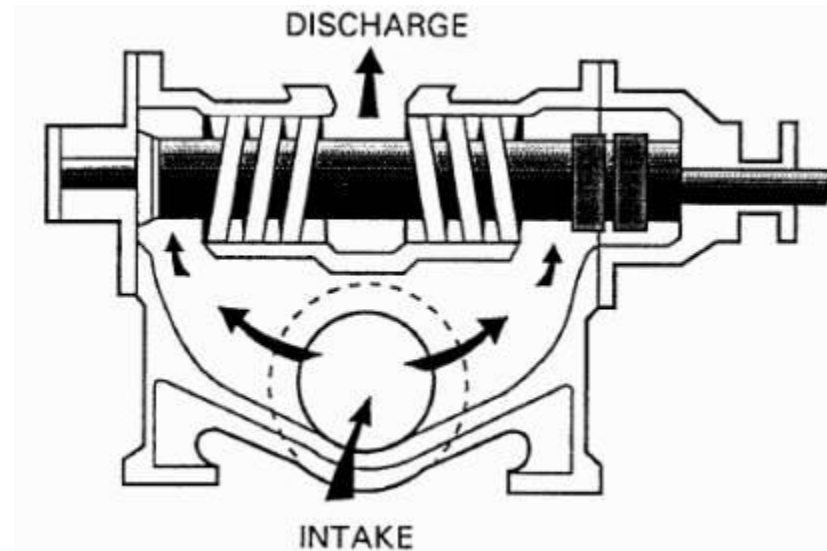


Hydraulic power supply

- **Hydraulic pumps types**

- **Axial Flow Pumps**

- It is more often called a screw pump
 - It has two or more rotating screw elements that trap fluid between the screw vanes and the pump housing
 - The screw elements are designed to take the fluid at the ends of the screw shaft and move it toward the outlet port near the centre of the shaft

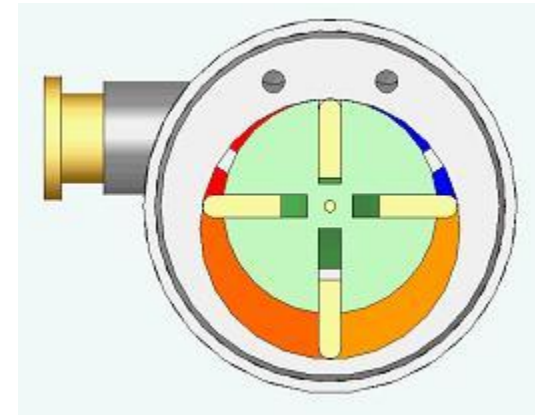
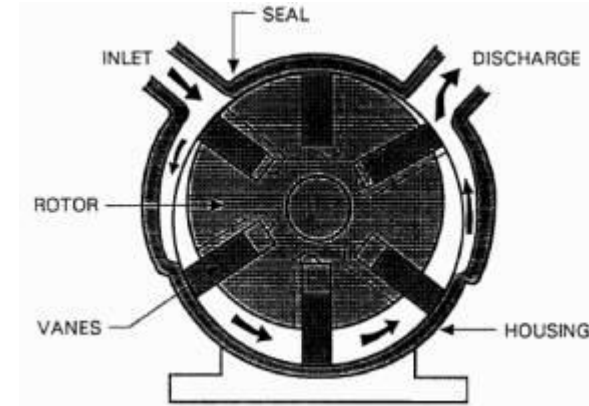
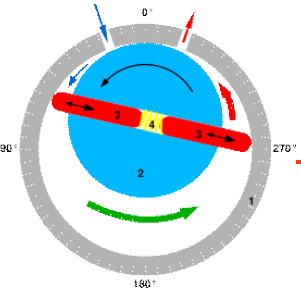


Hydraulic power supply

- **Hydraulic pumps types**

- **Vane Pumps**

- They are often used in hydraulic systems
 - Movable vanes are mounted in slots in the rotor
 - As the rotor rotates, the vanes are forced outward by centrifugal force and press against the pump housing
 - As the vanes pass the inlet port, fluid is trapped in the spaces between the vanes and the pump housing
 - When the fluid reaches the outlet port, it is discharged into the flow side of the hydraulic system



Hydraulic power supply

- **Hydraulic pumps types**

- **Lobe Pumps**

- They are used for movement of large volumes of hydraulic fluid at low pressures
 - The operation of a lobe pump is similar to that of an external gear pump
 - The lobes are much larger than gear teeth
 - There are two or three lobes on each rotor
 - Fluid is trapped between the lobes and the pump housing and transmitted from the inlet port to the outlet port
 - Lobe pumps have more slippage than gear pumps

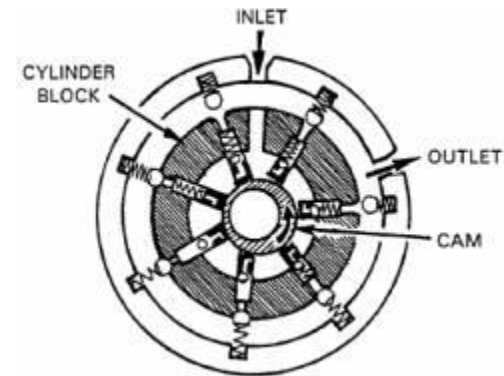


Hydraulic power supply

- **Hydraulic pumps types**

- **Piston Pumps**

- They are very efficient
 - They have low capacity per cycle, but at high speeds, high flows are possible
 - They are more complex and more expensive than other types of hydraulic pumps. They are usually used only on **high** pressure systems
 - **Radial piston pump:**
 - They are normally used for very high pressure at small flows



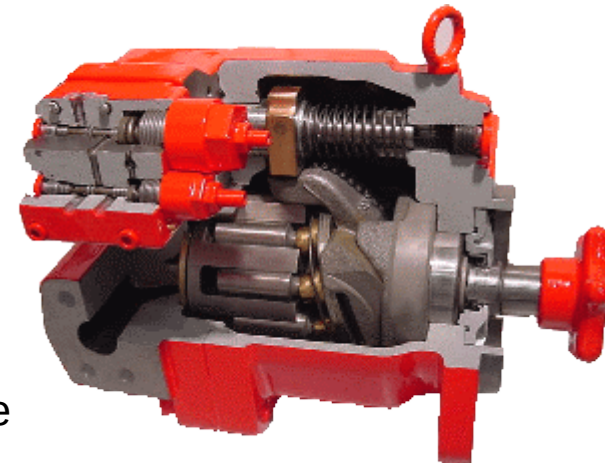
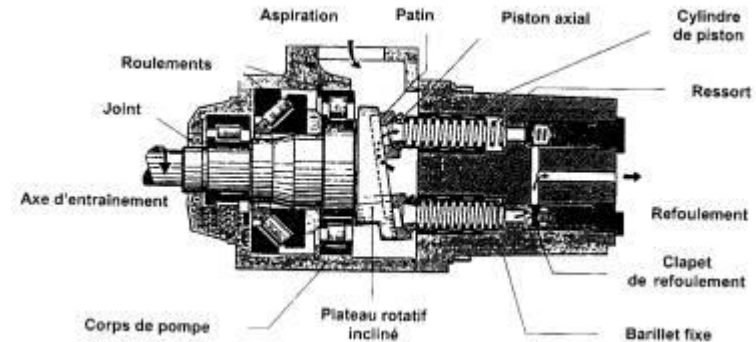
Hydraulic power supply

- **Hydraulic pumps types**

- **Piston Pumps**

- **Axial piston pump**

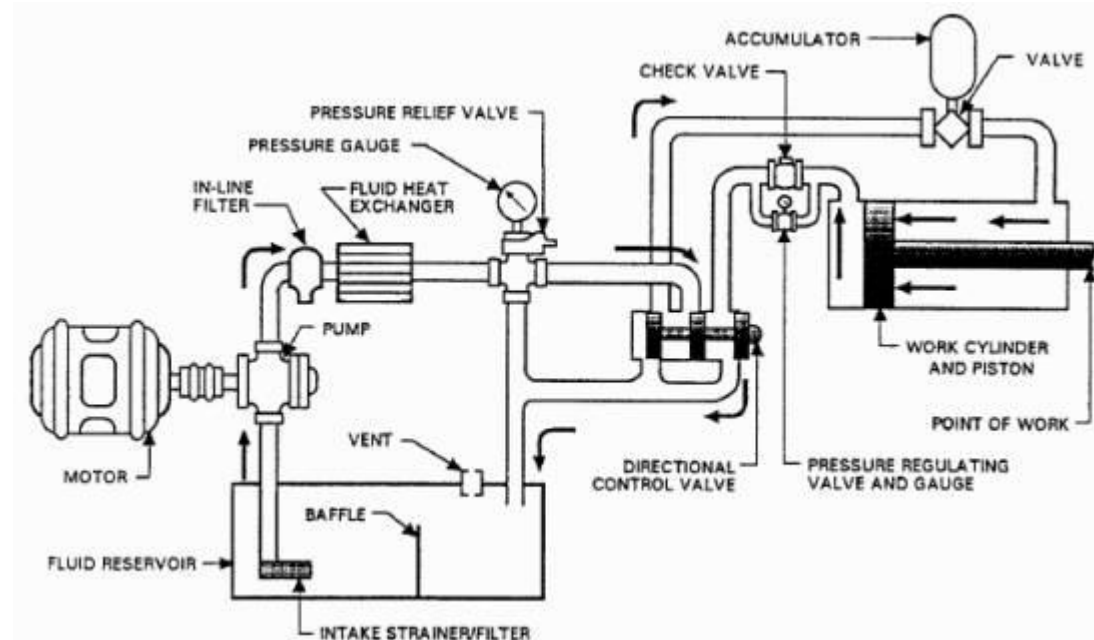
- They have a number of pistons arranged in a circular array within a **housing** which is commonly referred to as a **cylinder block, rotor or barrel**
 - This cylinder block is driven to rotate about its axis of symmetry by an integral shaft that is, more or less, aligned with the pumping pistons
 - Axial piston pump: many designed with a variable displacement mechanism, to vary output flow for automatic control of pressure



Hydraulic systems components

- Introduction to components

- Reservoirs
- Filters and strainers
- Fluid heat exchangers
- Pressure and flow control devices
- Accumulators
- Connecting pipes hoses
- Seals, fittings and connections



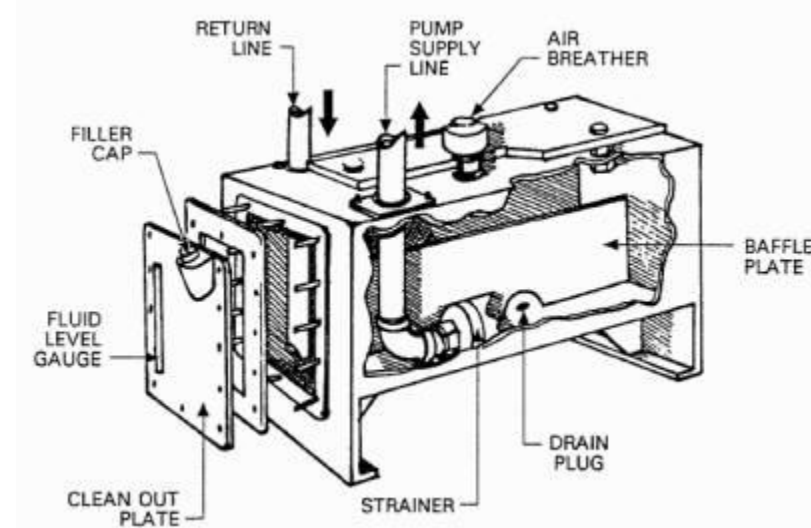
Hydraulic systems components

- **Reservoirs (OIL TANK)**

- The main functions of a reservoir in a hydraulic system are:

- To store a supply of hydraulic fluid
 - To break up foam by separating dissolved air from the fluid
 - To settle out large dirt particles and water
 - To keep the fluid temperature in its operating range
 - The hydraulic fluid reservoir holds excess hydraulic fluid to accommodate volume changes from:

- Cylinder extension and contraction
 - Temperature driven expansion and contraction



Hydraulic systems components

- **Reservoirs (OIL TANK)**

- **Air Breather**

- The filler cap and air breather are sometimes combined into one device
 - The air breather filters the air entering the reservoir
 - The air breather filter must be kept clean
 - If it gets blocked with dirt, a vacuum will come into the reservoir. This will reduce the flow of fluid

- **Fluid Level Gauge**

- It can be a sight glass

- **Baffle Plate**

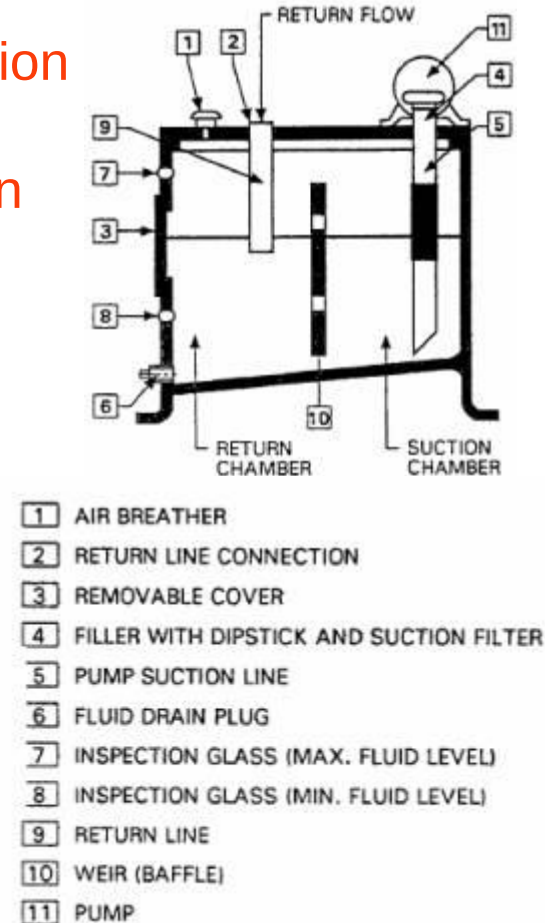
- It separates the return fluid from the supply fluid to the pump. This:
 - Makes a path for the fluid
 - Gives more time for dirt, air and water to separate from the hydraulic fluid
 - Helps to get rid of extra fluid heat before it is recirculated



Hydraulic systems components

- **Reservoirs (OIL TANK)**

- The reservoir is also designed to aid in separation of air from the fluid and also work as a heat accumulator to cover losses in the system when peak power is used
- The reservoir internal (inside) must be large enough:
 - To provide all the fluid necessary for the operation of the system (If the fluid level drops too low, air will enter the system. Foaming will result)
 - To hold all the fluid if the system must be drained for maintenance



Hydraulic systems components

- **Reservoirs (OIL TANK)**

- **Strainer**

- The strainer on the pump supply line keeps dirt out of the pump

- **Drain Plug**

- It is used to remove the fluid from the system

- Water and dirt can be flushed out through the drain plug

- **Clean-out Plate**

- It can be added to a reservoir to make it easier to remove the settled dirt

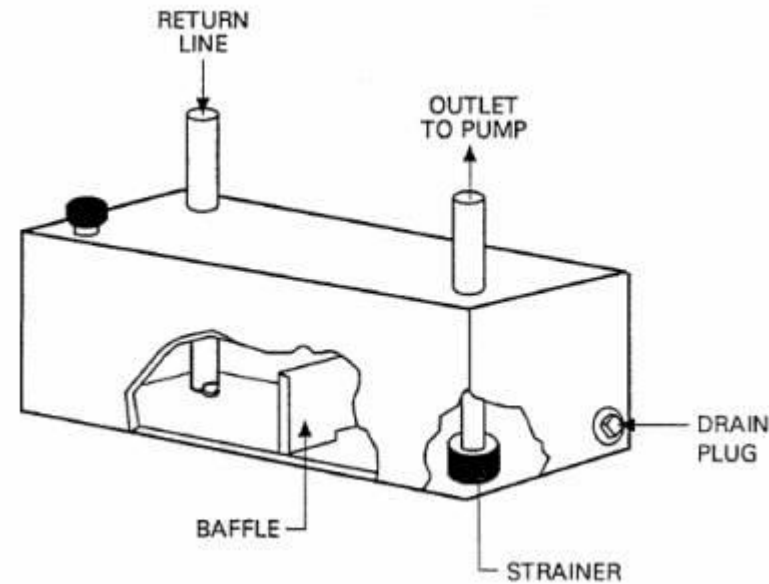
- A new gasket should be used whenever the plate is replaced



Hydraulic systems components

- **Filters and strainers**

- A baffle separates the inlet line side of a reservoir from the outlet line. This helps to keep the particles from going back into the system through the reservoir outlet line
- The particle build-up should be removed from the bottom of the reservoir regularly
- Water in a hydraulic fluid system will settle out in a reservoir. It can be drained off through a drain valve or plug



Hydraulic systems components

- **Filters and strainers**

- **Strainers**

- Strainers are usually a single layer of wire mesh or sheet metal with small holes
 - Their job is to remove larger particles from the fluid
 - Most are made of stainless steel or brass
 - They remove larger particles than filters but a strainer has less resistance to fluid flow
 - Strainers are used on pump suction lines where the pressure is low
 - If suction on a low pressure line is restricted, it can starve the pump and cause cavitation



Hydraulic systems components

- **Filters and strainers**

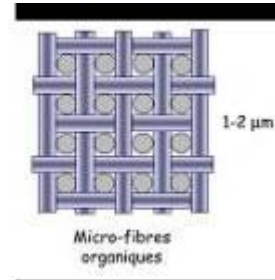
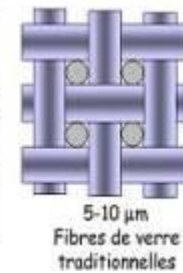
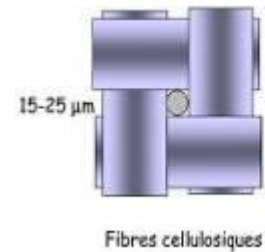
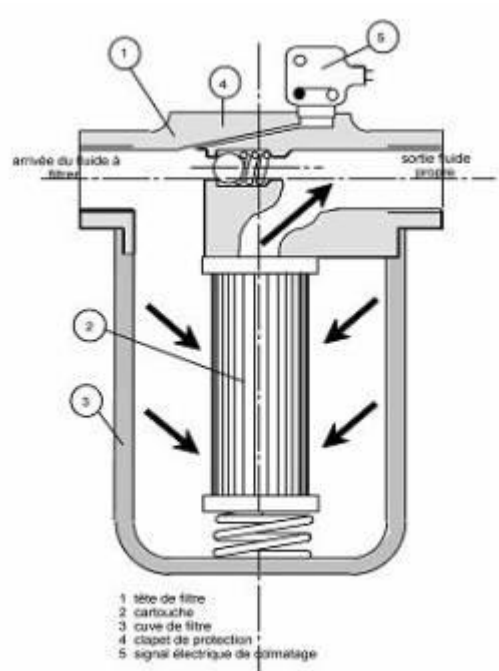
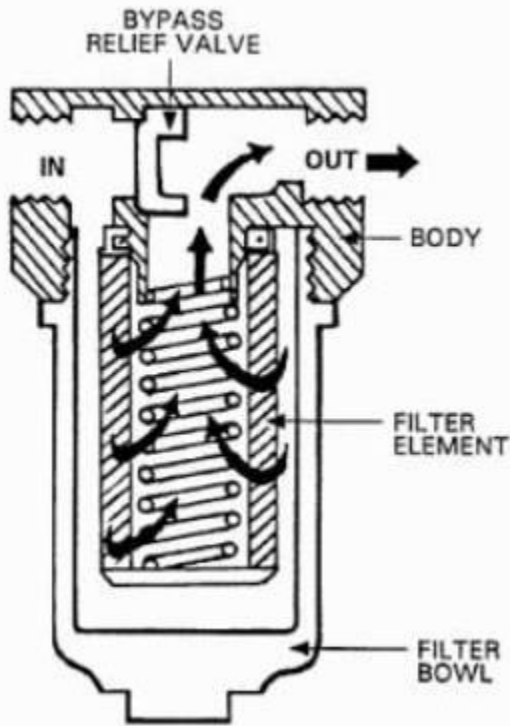
- **Filters**

- Filters may be installed in a hydraulic system wherever it is necessary to protect a device from impurities
 - A filter can be considered a strainer with several layers
 - The opening in the layers gets smaller toward the inside of the filter
 - Filters remove much smaller particles from the fluid stream
 - They can have several layers
 - The filter elements can be made of cloth fibres, metal fibres, glass fibres, metal powder, non-metal powder, paper, or glass



Hydraulic systems components

- **Filters and strainers**
 - **Filters**



Hydraulic systems components

- **Hydraulic pump and driver**

- The purpose of the pump is to make the hydraulic fluid flow
- It changes mechanical force and motion into hydraulic energy
- All pumps used in hydraulic systems are of the positive displacement type

- **Fluid heat exchanger**

- Hydraulic systems operate best when the fluid temperature is kept within a certain range
- However, as the temperature rises, the lubricating ability of the fluid and the pump output are reduced
- A heat exchanger is needed to cool the fluid down enough
- Heat exchangers are of three basic types:
 - Fin fan cooled radiator
 - Finned tube
 - Shell and tube

Hydraulic systems components

- **Pressure and flow control devices**

- **Pressure Relief Valves**

- It is used to correct over-pressure conditions
 - The fluid is vented back to the reservoir
 - Relief valves open when the pressure in the line gets too high
 - Pilot operated relief valves have internal pilots that sense the line pressure
 - Relief valve can be pressure balanced internally. This yields insensitivity to downstream pressure and permits the valve to be used as an accurate back-pressure regulator

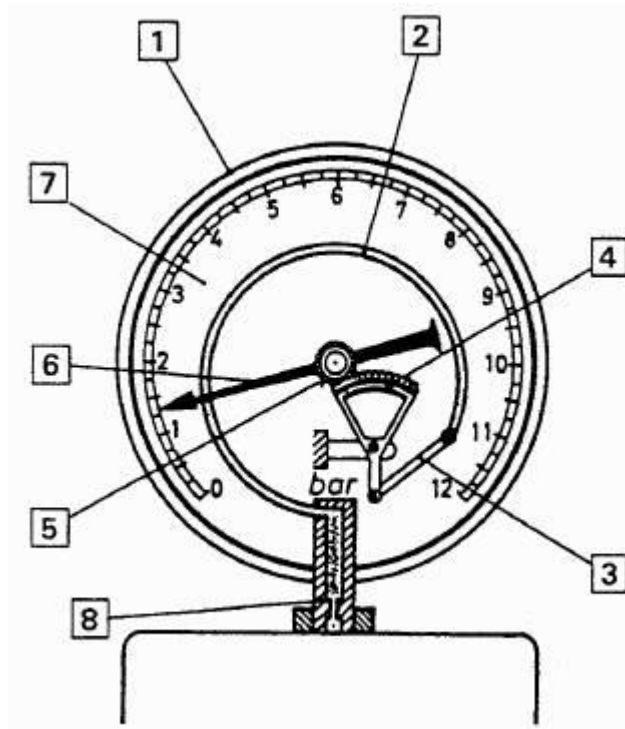


Hydraulic systems components

- **Pressure and flow control devices**

- **Pressure Gauge**

- Pressure gauges are used to show pressure in the system where they are installed



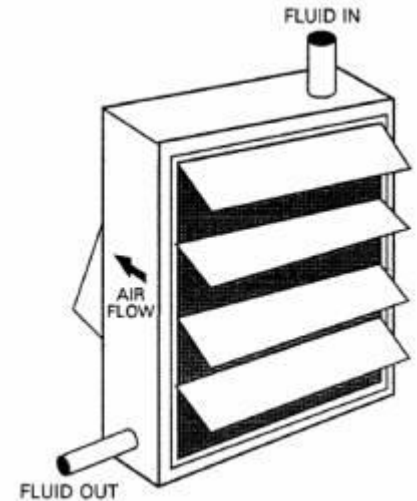
- 1 HOUSING
 - 2 BOURDON TUBE (SPRING TUBE)
 - 3 LINK
 - 4 GEARED SECTOR
 - 5 PINION
 - 6 POINTER
 - 7 SCALE
 - 8 CONNECTION WITH RESTRICTION

Hydraulic systems components

- **Fluid heat exchanger**

- **Fin Fan Cooled Radiator**

- This is similar to a radiator used in a car
 - Tubes carrying the hot fluid pass through a finned core
 - A fan forces cooler air through the core and removes the heat from the fins



- **Finned Tube**

- If only a small amount of heat must be removed or if the quantity of fluid is small, a finned tube heat exchanger is used
 - This is like the fin fan cooled radiator, but it does not have a fan

- **Shell and Tube**

- It is made of a metal outer shell
 - A bundle of tubes is mounted inside the shell

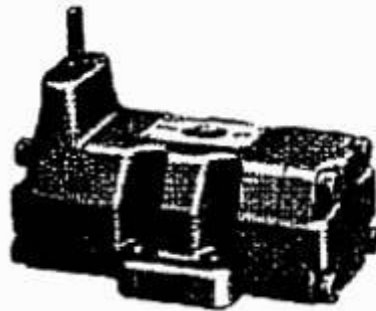


Hydraulic systems components

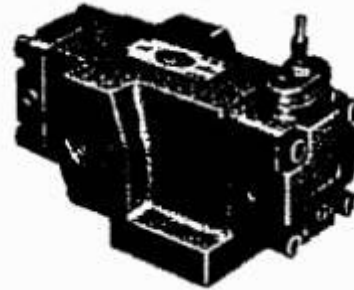
- **Pressure and flow control devices**

- **Pressure Regulating Valve**

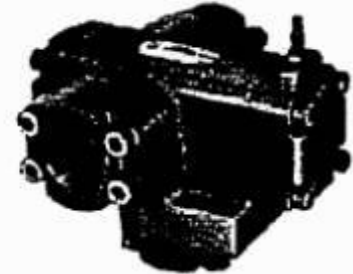
- It reduces the input pressure to whatever wanted output pressure
 - The pressure you want is set on the valve by adjusting the control knob on the valve body
 - Connected downstream the pump, the pressure regulator maintain, at a reduced value, a constant pressure on one hydraulic header



SUBPLATE MOUNTED



THREADED CONNECTIONS



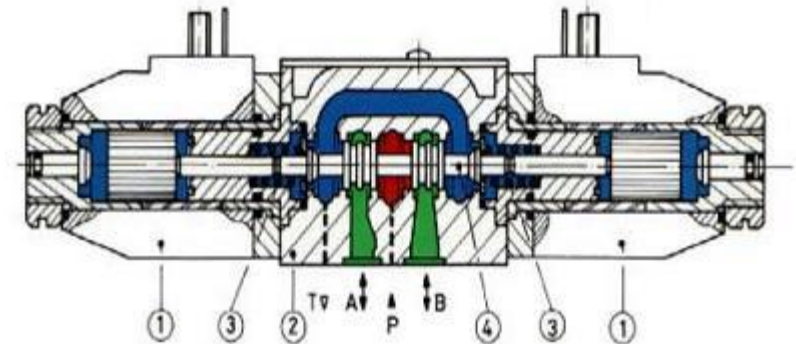
FLANGED CONNECTIONS

Hydraulic systems components

- **Pressure and flow control devices**

- **Distributors**

- They allow the energy distribution, dispatching the hydraulic fluid in the desired direction
 - According to the type of distribution, this devices can be mono or multi directional, regulated or not
 - The fluid flow to adjust the position (or a speed) of the receptor



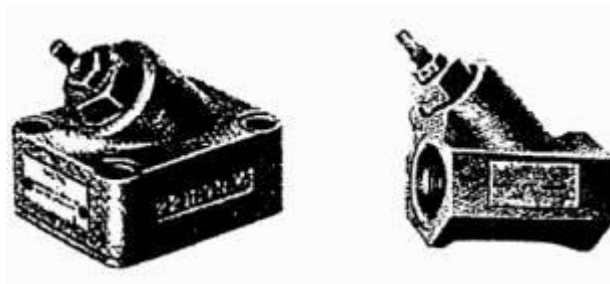
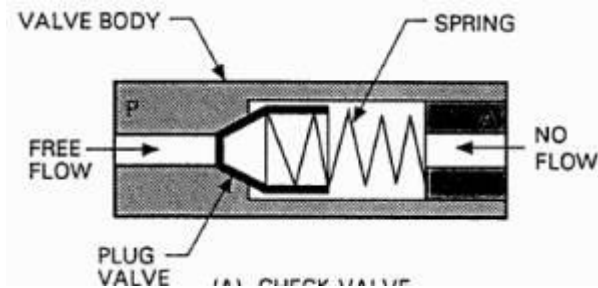
- 1 solénoïdes doigts de gants
- 2 corps du distributeur
- 3 ressort de rappel
- 4 tireur

Hydraulic systems components

- **Pressure and flow control devices**

- **Check and Flow Control Valves**

- The hydraulic system check valve is constructed and operates in the same way as the pneumatic check valve
 - The flow control valve works on the same principle as the check valve except that instead of preventing flow completely, it lets some fluid pass through the valve
 - How much fluid can pass is controlled by the setting of the adjustment knob on the valve body



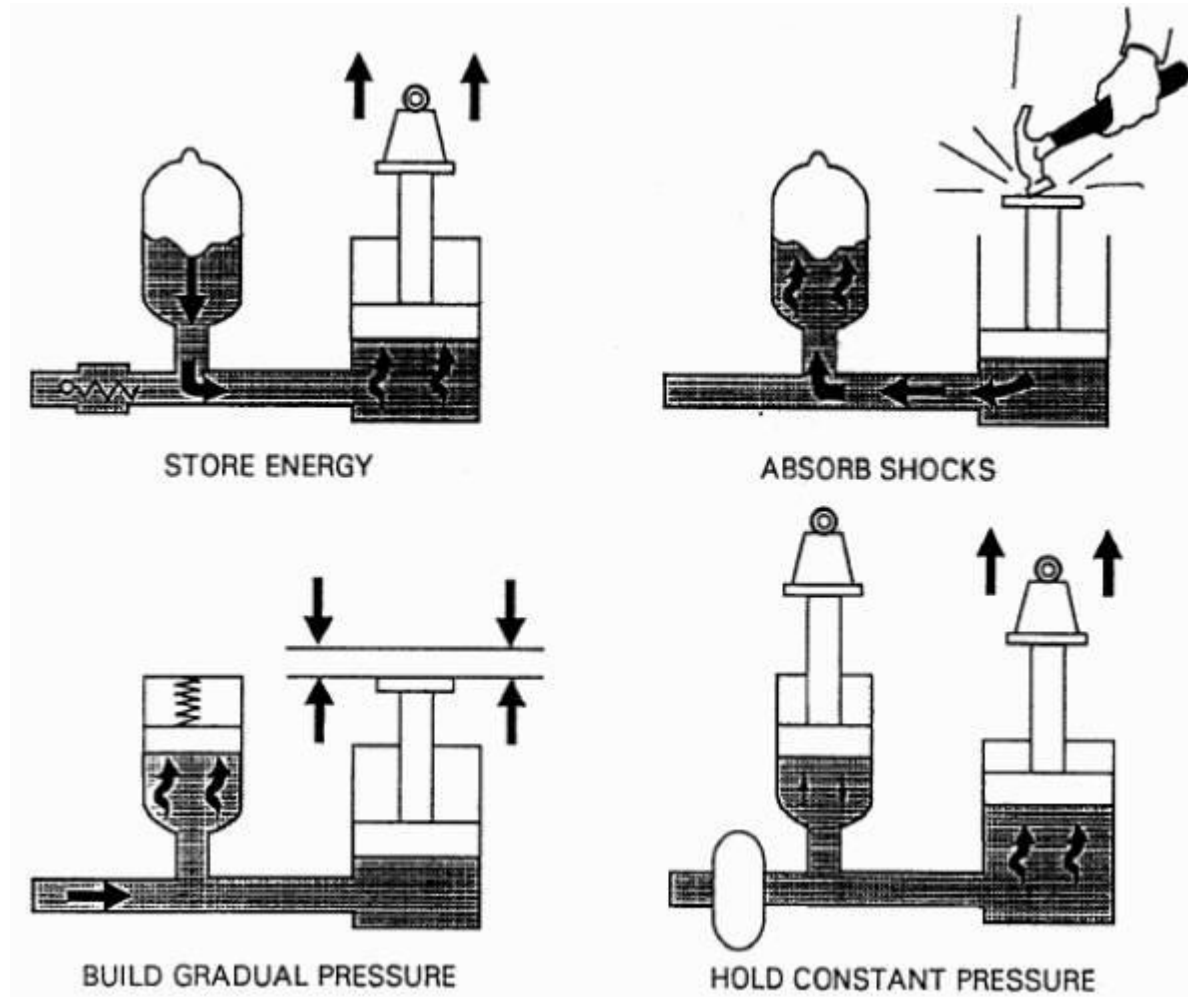
Hydraulic systems components

- **Accumulator**

- It is an energy storage device
- It is a pressure storage reservoir in which a non-compressible hydraulic fluid is held under pressure by an external source
- It is used to supply fluid for a single hydraulic device or a small part of a system
- Not all hydraulic systems need accumulators. They are used only when operating conditions make them necessary
- It can be
 - A spring
 - A raised weight
 - A compressed gas (nitrogen on platforms)
- An accumulator is used in a hydraulic system because
 - The pump doesn't need to be so large to cope with extremes of demand
 - The supply circuit can respond more quickly to any temporary demand and to smooth pulsations

Hydraulic systems components

- Accumulator



Hydraulic systems components

- **Accumulator**

- The four main functions of accumulators are to:
 - Store energy
 - Absorb shock
 - Build gradual fluid pressure
 - Hold a constant fluid pressure

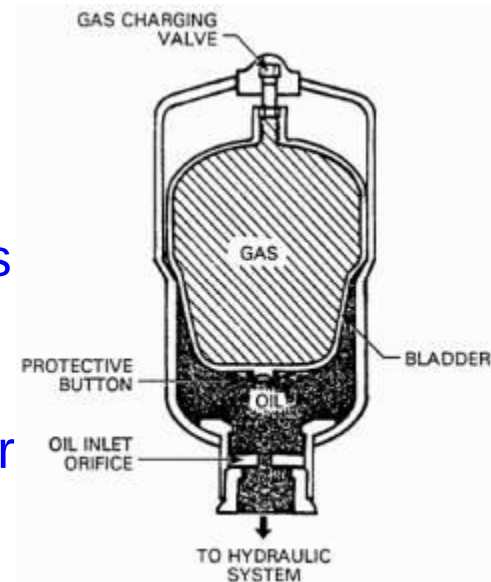
Hydraulic systems components

- **Accumulator**

- Because an accumulator can store energy, it is possible to use a smaller pump for the entire hydraulic system concerned

- **Gas Loaded Accumulators:**

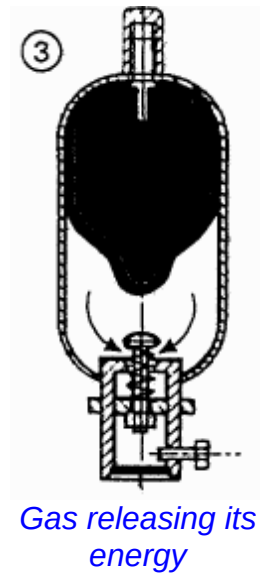
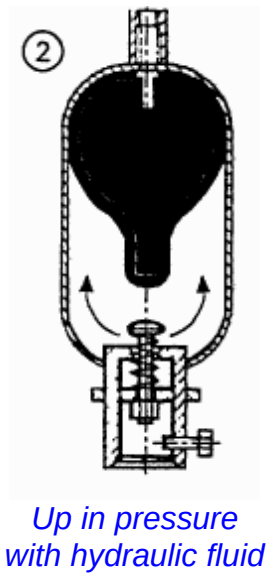
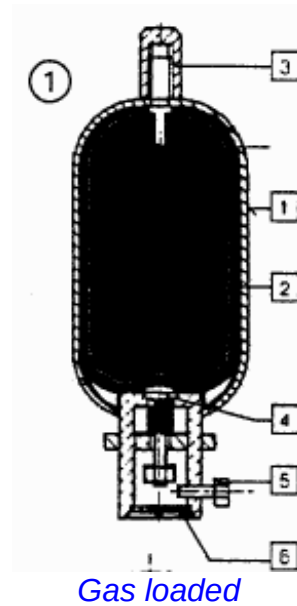
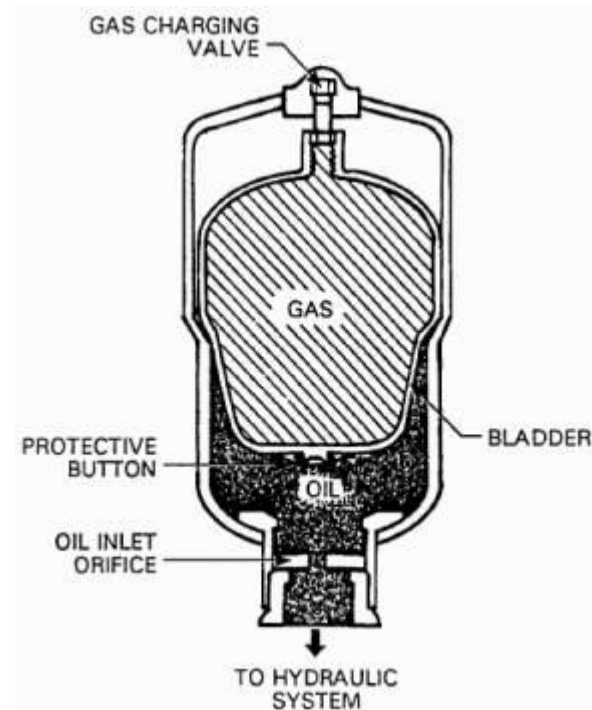
- This is often called a pneumatic accumulator
- Compressed air or nitrogen is usually used as the pressure cushion
- Gas loaded accumulators are either separator type or non-separator type
- The separator type uses some type of separating system (piston, bladder or a diaphragm) between the cushion gas and the hydraulic fluid



Hydraulic systems components

- **Accumulator**

- **Gas Loaded Accumulators:**



- 1 STEEL CONTAINER
- 2 BLADDER
- 3 GAS VALVE
- 4 POPPET VALVE
- 5 VENTING SCREW
- 6 FLUID PORT

Hydraulic systems components

- **Accumulator**

- **Spring type**

- It is similar in operation to the gas charged accumulator above, except that a heavy spring is used to provide the compressive force

- **Raised Weight**

- It consists of a vertical cylinder containing fluid connected to the hydraulic line
 - The cylinder is closed by a piston on which a series of weights are placed that exert a downward force on the piston and thereby energizes the fluid in the cylinder
 - In contrast to compressed gas and spring accumulators, this type delivers a nearly constant pressure, regardless of the volume of fluid in the cylinder, until it is empty



Hydraulic systems components

- **Connecting pipes and hoses**

- **Piping**

- All piping used for hydraulic lines is either carbon steel or stainless steel
 - Carbon steel piping is always used for hydraulic lines in the following situations:
 - On large volume systems
 - On long, straight piping runs
 - Where the lines will not have to be taken apart
 - When piping is more economical than tubing
 - **Stainless steel pipe:**
 - Is used in corrosive atmospheres
 - Is used for low pressure
 - Can be connected by threat connections, but mostly by welding
 - Because of the larger diameters, in general the pipe can be inspected internally after welding



Hydraulic systems components

- **Connecting pipes and hoses**

- **Tubing**

- Hydraulic tubing materials include copper, carbon steel, stainless steel, aluminium and plastic used only on very low pressure systems (pneumatic circuits)
 - Diameter dimensions of tubing define the '**OD**' for Outside Diameter
 - SS Hydraulic tubes are seamless steel precision pipes, especially manufactured for hydraulics
 - The tubes have standard sizes for different pressure ranges and the standard diameters go up to some 100 mm
 - The tubes are supplied in length of 6 m, cleaned, oiled and plugged



Hydraulic systems components

- **Connecting pipes and hoses**

- **Flexible Hose**

- Flexible hose, the best fluid line, are used for:

- High vibration and shock installations
 - Connections to units that move during operation
 - Temporary connections
 - Lines that must be connected and disconnected often
 - Lines in limited or tight areas

- One common use of flexible hydraulic hose in refinery operations is on hydraulic pumps



- To protect the lines from the movement and vibration of the pump, both the pump inlet and outlet lines should have a short section of hose

Hydraulic systems components

- **Seals fittings and connections**

- In general, valves, cylinders and pumps have female threaded bosses for the fluid connection, and hoses have female ends with captive nuts
- A male-male fitting is chosen to connect the two
- Recommendations for assembling fittings:
 - Please do not mix the fittings from different standards (metric and imperial)
 - Fittings could look alike, seem matching, but their thread being different it will be a real disaster trying to assemble them
 - Fitting are not only different with their thread but also by form
 - When starting to screw together, if you feel a resistance, it means they are not on line, do not force, unscrew and restart until feeling a 'smooth approval' from the threads



Hydraulic systems components

- **Seals fittings and connections**

- **Purposes of fittings: Fittings serve:**

- To bridge different standards; O-ring boss to **JIC (hydraulic)**, or pipe threads to **face seal**, for example
 - To allow proper orientation of components, a 90°, 45°, straight, or swivel fitting is chosen as needed
 - They are designed to be positioned in the correct orientation and then tightened
 - To incorporate bulkhead hardware
 - A quick disconnect fitting may be added to a machine without modification of hoses or valves



Hydraulic systems components

- **Seals fittings and connections**

- **Different assembly / sealing methods**

- **Pipe fittings**: it is screwed in until tight, difficult to orient an angled fitting correctly without over or under tightening
 - National Pipe Thread is a US standard for tapered (NPT) or straight (NPS) threads used to join pipe and fittings
 - **O-ring boss (ORB)**: the fitting is screwed into a boss and orientated as needed, an additional nut tightens the fitting, washer and o-ring in place
 - **Flare seal**: Flare Fittings are a type of compression fitting used with metal tubing, usually ductile (soft) copper, though other materials are also used



Hydraulic systems components

- **Seals fittings and connections**

- **Different assembly / sealing methods**

- **Compression fitting**: they are used in to join two tubes or thin-walled pipes together (union fitting)

- In instances where two pipes made of dissimilar materials are to be joined, (most commonly PVC and copper or stainless steel)



Fitting



Union



Male connector



Female connector



Reducer

- The compression fitting is composed of an outer "compression nut" and an inner ring called an "olive" or ferrule

- When the nut is tightened, it clamps-down on the olive, causing it to conform to the circumference of the pipe



Nut



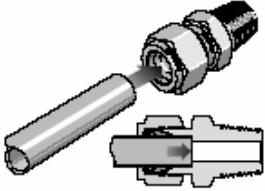
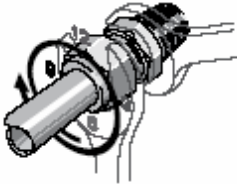
Front ferrule



Back ferrule

Hydraulic systems components

- **Seals fittings and connections**
 - Instructions from swagelok

	Fully insert the tubing into the fitting and against the shoulder; rotate the nut <i>finger-tight</i> .
	Mark the nut at the 6 o'clock position.
	While holding the fitting body steady, tighten the nut one and one-quarter turns to the 9 o'clock position. <i>For 1/16, 1/8, and 3/16 in.; 2, 3, and 4 mm tube fittings, tighten the nut three-quarters turn to the 3 o'clock position.</i>

Hydraulic systems components

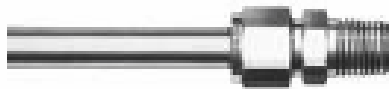
- **Seals fittings and connections**

- **Instructions from swagelok**

- You may disassemble and reassemble Swagelok (and other made) tube fittings many times



Insert tubing with pre-swaged ferrules into the fitting body until the front ferrule seats



Rotate the nut with hand first then with a wrench to the previously pulled-up position; at this point, a significant increase in resistance will be encountered. Tighten slightly with a wrench

Hydraulic systems components

- **Seals fittings and connections**

- **Instructions from swagelok**

- Not apply joint compound or teflon tape to a compression fitting's threads
 - Pipe compound or teflon tape will frequently lead to a leak in the fitting by causing the fitting to loosen as a reaction to the compression
 - In a standard threaded connection, pipe compound and teflon tape act to seal the threads from the water pressure
 - In a compression fitting, the olive will push against the lock nut
 - Joint compound and teflon tape will act, in a compression fitting, as a lubricant rather than a sealant and cause the joint to leak



Hydraulic systems components

- **Seals fittings and connections**

- **Instructions from swagelok**

- Excessive force is avoided in tightening the nut. If the fitting is overtightened, the olive will deform and cause leaks
 - Compression fitting should be "finger tight" and then tightened 1/4 turn with a wrench
 - The fitting should then be tested, and if slight weeping is observed, the fitting should be slowly tightened a bit more until the weeping stops
 - When you disassemble and reassemble such fittings, if you hear "screeeeek – screeeeek" when tightening with your wrench, do not insist, take a new one



Hydraulic systems components

- **Seals fittings and connections**
 - **Other assembly's types**
 - **Face seal**, metal flanges with a groove and o-ring are fastened together
 - **Beam seal**, an expensive metal to metal seal used mostly for aircraft
 - **Swaged seals**, tubes are connected with fittings that are swaged in place (non-serviceable)
 - Use always the adapted Hose, Coupling, Fitting, Tubing, Pipe, etc., when dealing with hydraulic pressure, it is your safety

Reading hydraulic and pneumatic diagrams

- **Reading pneumatic diagrams**
 - **Base to remember for schematic diagrams**
 - A schematic is a line drawing
 - It is drawn to show how a system works
 - Symbols are used instead of pictures
 - The symbols are connected to form a system
 - It helps you to see and describe the parts of the system

Reading hydraulic and pneumatic diagrams

- **Reading pneumatic diagrams**

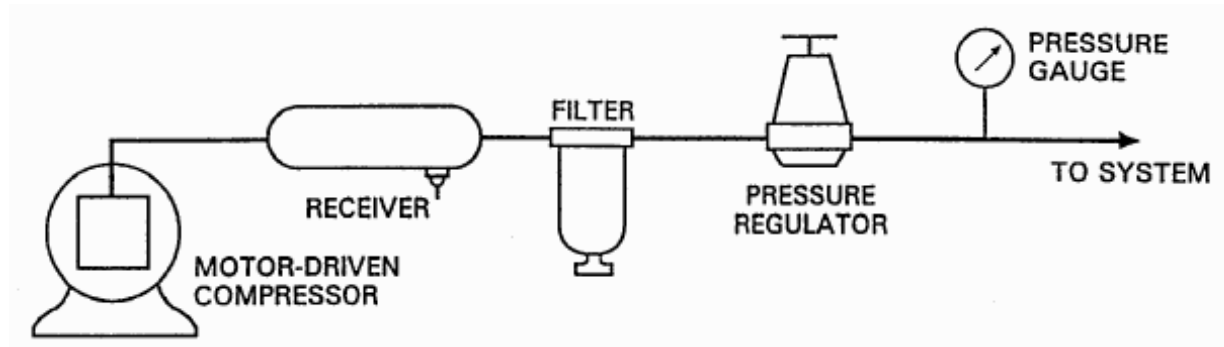
- **Block diagram and schematic diagram (with symbols)**

- Pictorial diagram = block diagram = “childish” diagram

- Schematic diagram = standardised use of symbols
= “true” diagram

- The drawing always shows the system flow from left to right and top to bottom

- Arrows are used to show system flow (air flow)



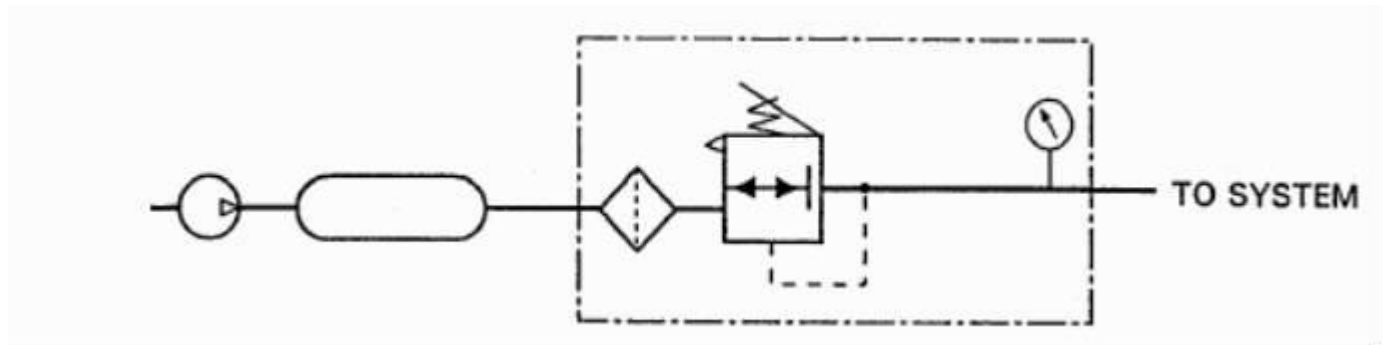
Reading hydraulic and pneumatic diagrams

- **Reading pneumatic diagrams**

- **Block diagram and schematic diagram (with symbols)**

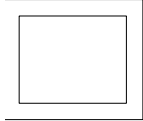
- For schematic diagram the arrows is eliminated

- Dashed rectangle box is used around some of the components to show that they are mounted as one unit in the plant or that all the functions shown inside the box are contained in one component



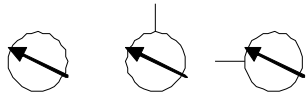
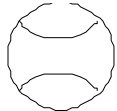
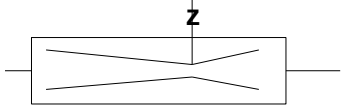
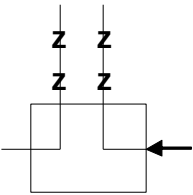
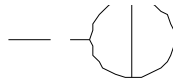
Reading hydraulic and pneumatic diagrams

- **Reading pneumatic diagrams**
 - **Pneumatic symbols**

	Hydraulic oscillator		Pneumatic oscillator
	Electric motor		Internal combustion engine

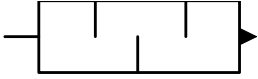
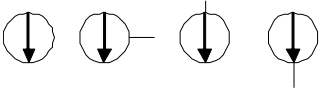
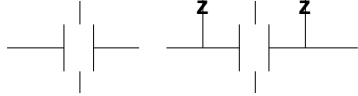
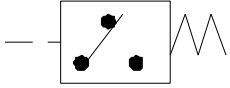
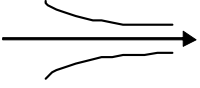
Reading hydraulic and pneumatic diagrams

- **Reading pneumatic diagrams**
 - **Pneumatic symbols**
 - Instruments and Accessories

	Pressure gauge
	Flow meter rate
	Venturi
	Pitot tube
	Float switch

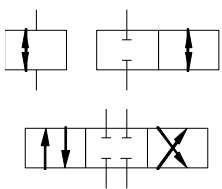
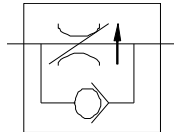
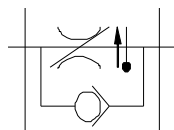
Reading hydraulic and pneumatic diagrams

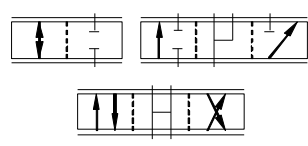
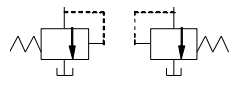
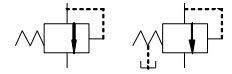
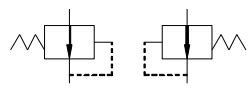
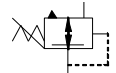
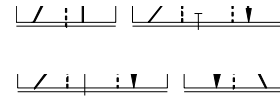
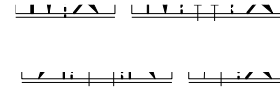
- **Reading pneumatic diagrams**
 - **Pneumatic symbols**
 - Instruments and Accessories

	Muffer
	Temperature gauge
	Flow meter totalising
	Orifice plate
	Pressure switch
	Nozzle

Reading hydraulic and pneumatic diagrams

- **Reading pneumatic diagrams**
 - **Pneumatic symbols**
 - **Valves**

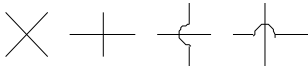
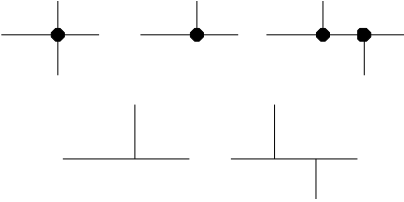
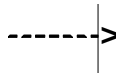
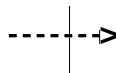
	Ports internally blocked
	Adjustable pressure compensated flow control with bypass
	Adjustable temperature and pressure compensated flow control with bypass

	Flow paths internally open, infinite positioning
	Two-position, snap action with transition
	Pressure relief
	Sequence
	Pressure reducing
	Air-line pressure regulator, adjustable, relieving
	Infinite positioning, three-way
	Infinite positioning, four-way
	Adjustable flow control non-spring return

Reading hydraulic and pneumatic diagrams

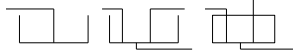
- **Reading pneumatic diagrams**

- **Pneumatic symbols**
 - **Technical Line**

	Enclosure outline
	Air instrument line
	Lines crossing
	Lines joining
	Flow direction hydraulic
	Flow direction pneumatic
	Plain orifice unconnectable
	Plain orifice connectable

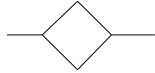
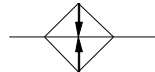
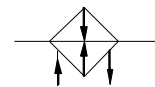
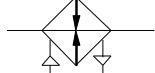
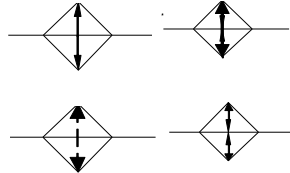
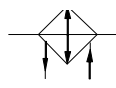
Reading hydraulic and pneumatic diagrams

- **Reading pneumatic diagrams**
 - **Pneumatic symbols**
 - Energy Storage and fluid storage

	Reservoir vented
	reservoir pressurised
	Reservoir pressurised with connecting lines above fluid level
	Reservoir with connecting lines below fluid level. Lines enter or leave below reservoir when essential to circuit function.
	Accumulator, basic symbol
	Accumulator, spring loaded
	Accumulator, gas charged
	Accumulator, weighted
	Receiver for air or other gases
	Energy source hydraulic
	Energy source pneumatic

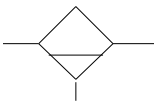
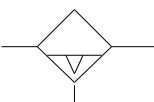
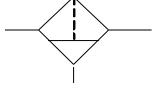
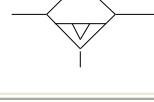
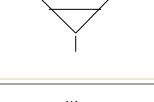
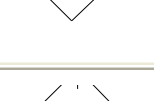
Reading hydraulic and pneumatic diagrams

- **Reading pneumatic diagrams**
 - **Pneumatic symbols**
 - Fluid conditioners

	Basic symbol
	Heater basic symbol
	Heater liquid heating media
	Heater gaseous heating media
	Cooler basic symbols
	Cooler, liquid cooling media
	Cooler, gaseous cooling media
	Filter strainer

Reading hydraulic and pneumatic diagrams

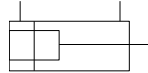
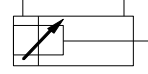
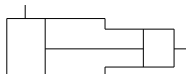
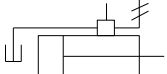
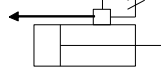
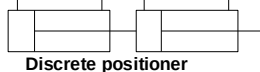
- **Reading pneumatic diagrams**
 - **Pneumatic symbols**
 - Fluid conditioners

	Separator, manual drain
	Separator, automatic drain
	Filter separator, manual drain
	Filter separator, automatic drain
	Dessicator (chemical dryer
	Lubricator, without drain
	Lubricator, manual drain
	Lubricator, automatic drain

Reading hydraulic and pneumatic diagrams

- **Reading pneumatic diagrams**

- **Pneumatic symbols**
 - **Linear devices**

	Double acting cylinder, fixed cushion advance and retract
	Double acting cylinder, adjustable cushion advance only
	Double acting cylinder in which diameter of rod compared to diameter of bore is significant to circuit function
	Pressure intensified
	Servo positioner, hydraulic
	Servo positioner, pneumatic
	Discrete positioner



Reading hydraulic and pneumatic diagrams

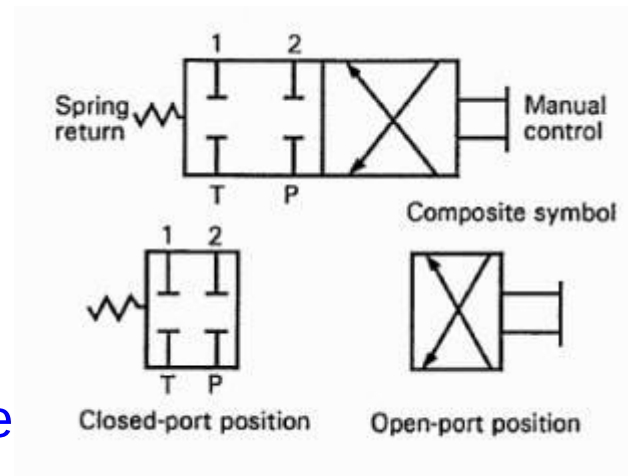
- **Reading pneumatic diagrams**

- **Types of symbols**

- There are two main types of symbols used on the schematic diagram

- The basic symbol which comes from the symbol charts
 - The composite symbol is made by joining some of those symbols into one symbol called a composite. It represents several basic components that work together to perform one function

- Many engineering drawings contain a box in one corner or a list on one of the sheets showing a 'legend'. A legend shows what the symbols mean



Reading hydraulic and pneumatic diagrams

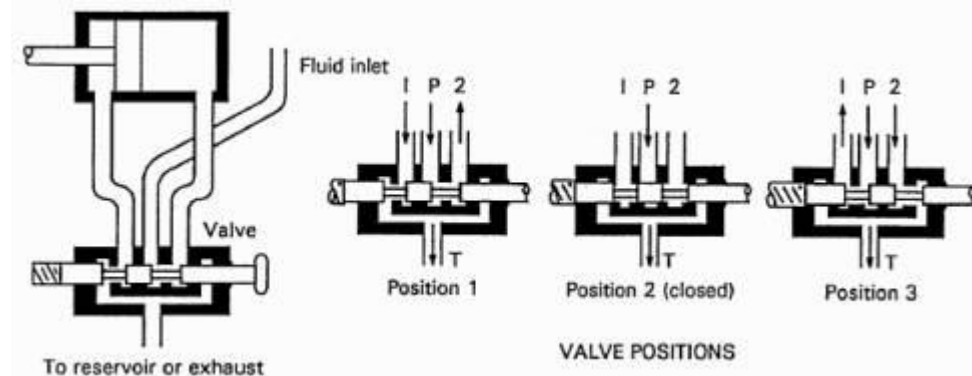
- **Reading pneumatic diagrams**

- **Identify the control elements**

- **You are training as a Control Operator, you should:**

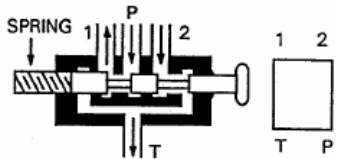
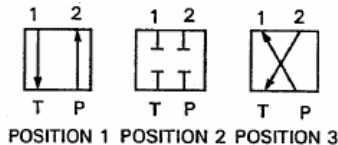
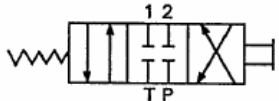
- Concentrate your study of schematics from the approach that you will be controlling the system
 - Know how it is turned ON and OFF, and all procedures for system operation
 - Know how it runs when it is working properly
 - Learn what happens when it is NOT working properly so that you may be alerted to call the maintenance technicians for troubleshooting and repair

- **On your plant, you need to collect all drawings and go around see how it works**



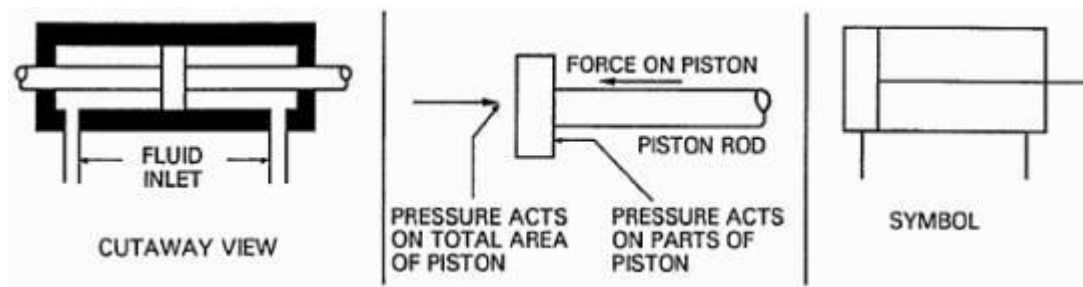
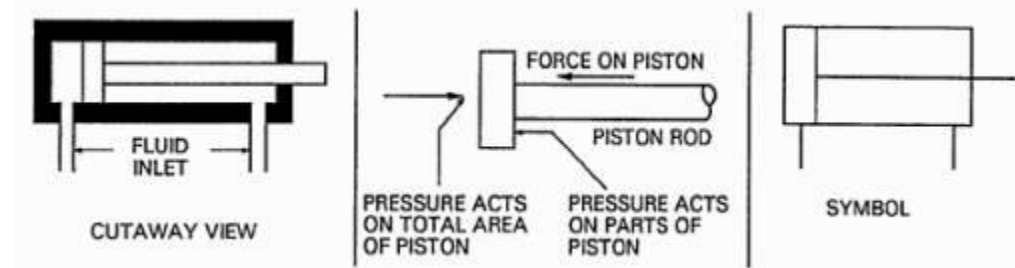
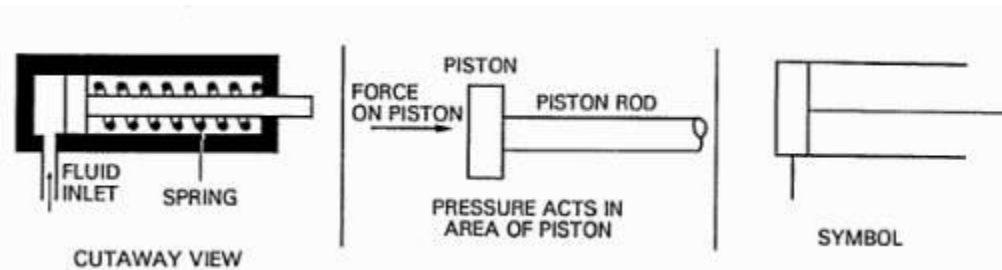
Reading hydraulic and pneumatic diagrams

- **Reading pneumatic diagrams**
 - **Developing valves symbols**
 - To learn what valve symbols mean you must draw them

	Start with a blank symbol for a valve
	Add the ports to the symbol even though the valve itself has three ports on the top of it The symbol has in schematic, always 2 ports on top and 2 on bottom
	Show the flow for all valve positions
	Add the operating mechanism to the symbol. This valve is manually operated with spring return to the closed position
	Combine all the elements into a single symbol

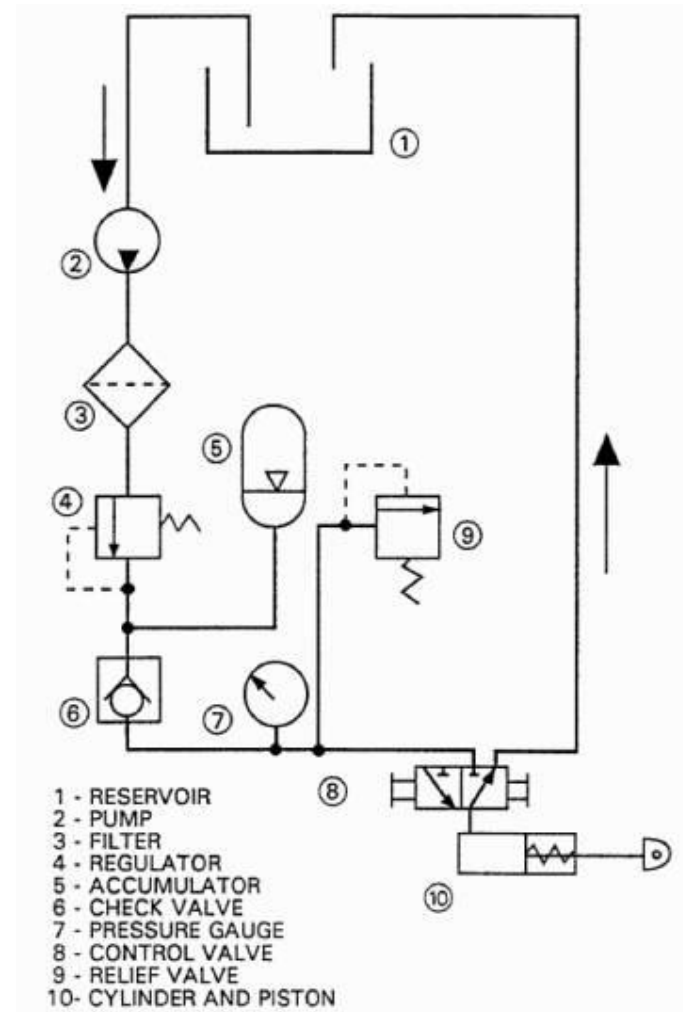
Reading hydraulic and pneumatic diagrams

- **Reading pneumatic diagrams**
 - **Developing valves symbols**
 - Common symbols following the types of cylinder



Reading hydraulic and pneumatic diagrams

- **Reading hydraulic diagrams**
 - **Reading hydraulic symbols**
 - Many of the symbols used in pneumatics and hydraulics are the same or very nearly the same



Reading hydraulic and pneumatic diagrams

- **Reading hydraulic diagrams**

- **Fluid Lines**

- A hydraulic system consists of fluid power devices connected by piping or tubing
 - Piping and tubing are sometimes called:
 - Conductors
 - Working lines
 - Or fluid lines
 - Working lines are the Major fluid lines in a hydraulic system. They are represented on a drawing by a solid line
 - Pilot lines are usually much smaller than working lines. They usually carry the same pressure as the working lines

Reading hydraulic and pneumatic diagrams

- **Reading hydraulic diagrams**

- **Fluid Lines**

- When the internal pilot device operates, it allows the major device to operate
 - Pilot lines are represented by a dashed line
 - Drain or exhaust lines:
 - Are usually small
 - They may be able to carry only low pressures
 - They are represented by a dashed line, but the dashes are shorter than those of a pilot line

Reading hydraulic and pneumatic diagrams

- **Reading hydraulic diagrams**

- **Restrictions**

- Restrictive devices in hydraulic systems are used to:

- Direct energy flow
 - Control energy flow
 - Measure energy flow

- **Quick Disconnects**

- Many hydraulic lines must be often connected and disconnected

- Example: hydraulic brake line running from a truck to a trailer

- A quick disconnect coupling is used on the two connecting lines
 - Energy flows as the pressure of compression is sent through the system



Reading hydraulic and pneumatic diagrams

- **Reading hydraulic diagrams**

- **Fluid pumps**

- The basic symbol for a pump is a circle
 - The lines outside the circle are not part of the symbol. They are connecting lines
 - The dark triangles show the direction of energy flow

- **Fluid motors**

- The basic circle used for pumps is also used for rotary fluid motors
 - The dark triangles again show the direction of energy flow
 - The triangles face the opposite side of the circle, different than they were for pumps
 - The energy flow is away from a pump and it is toward a motor



Reading hydraulic and pneumatic diagrams

- **Reading hydraulic diagrams**

- **Cylinders**

- A cylinder and piston can sometimes be used as a linear action motor
 - It receives energy to drive the piston rod in a straight line to do work
 - It also can be an energy generating source if the piston rod is pushed by an outside mechanical means
 - The piston builds pressure on the fluid inside the cylinder
 - This pressure is sent as energy through the system

Reading hydraulic and pneumatic diagrams

- **Reading hydraulic diagrams**

- **Hydraulic Valves**

- The basic symbol for a hydraulic valve is a rectangle called a valve envelope
 - The envelope is the valve body
 - The lines inside the envelope show the direction of energy flow from the valve inlets to the outlets
 - The inlet and outlet openings are called ports
 - A valve in a system is shown with the internal paths connected as they are in the shelf position

Reading hydraulic and pneumatic diagrams

- **Reading hydraulic diagrams**

- **Reservoirs**

- There are three types of reservoirs used in hydraulic systems:
 - Vented reservoirs
 - Pressurised tanks
 - Vented tanks
 - Drain lines in hydraulic systems usually flow into vented reservoirs
 - Pressure relief valves may drain to an unpressurised tank

- **Miscellaneous Hydraulic Devices**

- Other devices used in hydraulic systems depend upon the purpose of the system and the design of the:
 - Accumulators
 - Fluid Conditioners
 - Prime Movers (Motors)
 - Indicators

Reading hydraulic and pneumatic diagrams

- **Reading hydraulic diagrams**

- **Valve Actuators**

- It is a device that positions the valve
 - It can be electric, pneumatic, hydraulic, motor, spring or manual
 - Sometimes a combination of actuators is used on one valve

- **Pressure Relieving Valves**

- It is used to correct overpressure conditions
 - An unloading valve is used for removing control pressure
 - In pneumatic systems, the gas usually vents to the atmosphere
 - In hydraulic systems, the liquid is vented into a holding tank or it returns to the reservoir

- **Flow conditioning Valves**

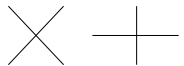
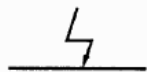
- They allow a specified amount of flow



Reading hydraulic and pneumatic diagrams

- Hydraulic symbols for circuit diagrams

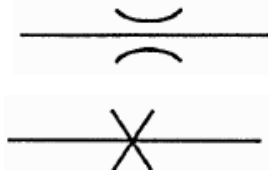
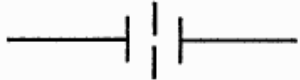
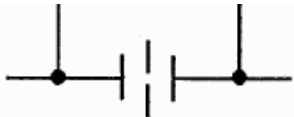
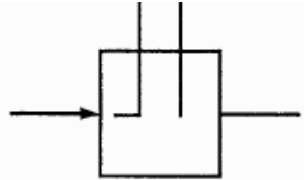
- Hydraulic symbols 1
 - Fluid lines symbols

	Working line
	Pilot line
	Drain line
   	Lines crossing
    	Lines joining
	Flexible line
	Electrical line
	Energy flow

Reading hydraulic and pneumatic diagrams

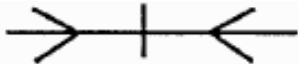
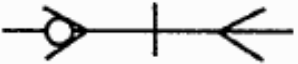
- **Hydraulic symbols for circuit diagrams**

- **Hydraulic symbols 1**
 - Restrictive Devices

	Fixed restrictions
	Orifice plate
	Orifice plate with sensing line
	Pitot tube
	Nozzle

Reading hydraulic and pneumatic diagrams

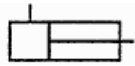
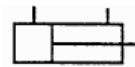
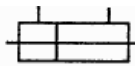
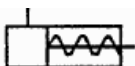
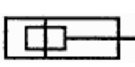
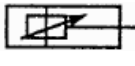
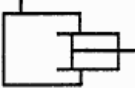
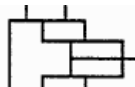
- Hydraulic symbols for circuit diagrams
 - Hydraulic symbols 1
 - Quick disconnect coupling

	Quick disconnect coupling
	Quick disconnect coupling with check valve

Reading hydraulic and pneumatic diagrams

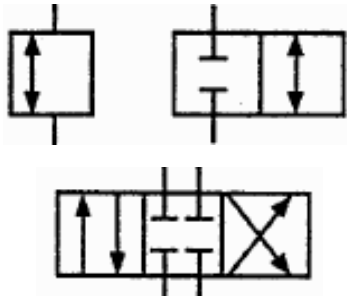
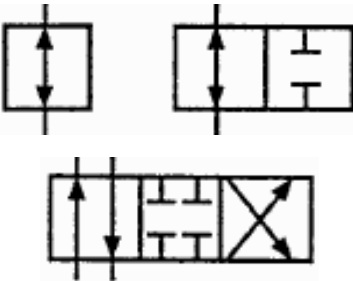
- **Hydraulic symbols for circuit diagrams**

- **Hydraulic symbols 2**
 - **Cylinders**

	Single acting cylinder
	Double acting one rod cylinder
	Double acting cylinder with two rods
	Double acting cylinder with pressure in one direction and spring return
	Cylinder with fixed cushion
	Cylinder with variable cushion
	Telescoping single acting
	Telescoping double acting

Reading hydraulic and pneumatic diagrams

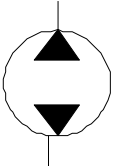
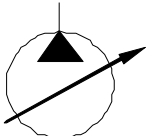
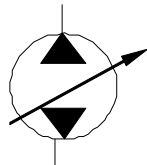
- Hydraulic symbols for circuit diagrams
 - Hydraulic symbols 2
 - Hydraulic valves

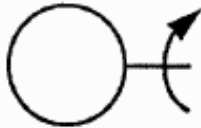
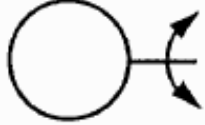
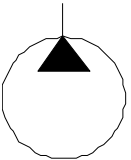
	Hydraulic ports normally closed
	Hydraulic ports normally opened <i>Remember: left side (box or symbol) is the “no power” position for 2-position relay and middle box is the “no power” position for a “- position relay (or valve)</i>

Reading hydraulic and pneumatic diagrams

- Hydraulic symbols for circuit diagrams

- Hydraulic symbols 3
 - Pump symbols

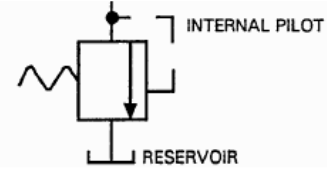
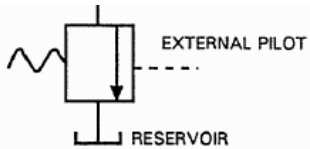
	Fixed displacement pump - energy flow both direction
	Variable displacement pump – energy flow one direction
	Variable displacement pump - energy flow both direction

	Basic pump
	Shaft turns in one direction
	Shaft turns in both directions
	Fixed displacement pump – energy flow one direction

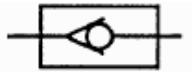
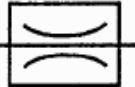
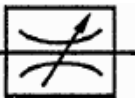
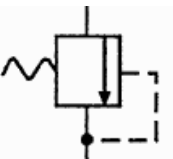
Reading hydraulic and pneumatic diagrams

- Hydraulic symbols for circuit diagrams

- Hydraulic symbols 4
 - Pressure relief valves

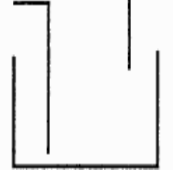
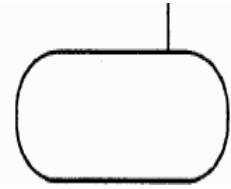
	Relief valve
	Unloading valve

Flow conditioning valve

	Manual block valve
	Pressure actuated block valve
	Check valve
	Fixed flow control valve
	Variable flow control valve
	Pilot actuated pressure regulator

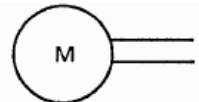
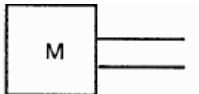
Reading hydraulic and pneumatic diagrams

- **Hydraulic symbols for circuit diagrams**
 - Hydraulic symbols 4
 - Reservoir

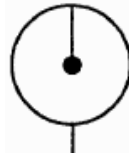
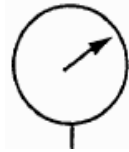
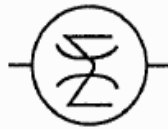
	Vented reservoir with connecting line
	Pressurised tank
	Vent line draining to vented reservoir

Reading hydraulic and pneumatic diagrams

- **Hydraulic symbols for circuit diagrams**
 - **Hydraulic symbols 5**
 - Prime movers

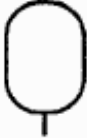
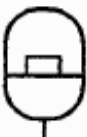
	Electric motor
	Internal combustion engine

Indicators

	Thermometer
	Pressure gauge
	Flow rate meter
	Totalising flow meter

Reading hydraulic and pneumatic diagrams

- **Hydraulic symbols for circuit diagrams**
 - **Hydraulic symbols 5**
 - Accumulators

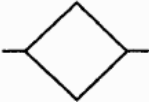
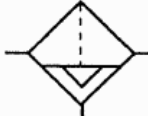
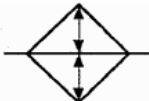
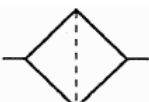
	Basic envelope accumulator
	Spring loaded accumulator
	Gas charged accumulator
	Weighted accumulator

Reading hydraulic and pneumatic diagrams

- Hydraulic symbols for circuit diagrams

- Hydraulic symbols 5

- Fluids conditioners

	Basic envelope		Heat exchanger		Filter separator with automatic drain
	Cooler		Temperature controller		Dryer
			Filter strainer		Lubricator without drain
			Separator with manual drain		Lubricator with manual drain
			Separator with automatic drain		
			Filter separator with manual drain		

Hydraulic systems operations

- **Operator duties**

- **Operators actions**

- **An operator may have to:**

- Tighten badly leaking connections to prevent flooding the plant
 - Make sure the area around the hydraulic equipment is kept clean to avoid possible problems from fire and slippery surfaces due to fluid leakage
 - Add hydraulic fluid to keep the plant running in cases where action must be taken immediately

Hydraulic systems operations

- **Operator duties**

- **Operator checks**

- To keep informed on system conditions while the system is operating, you should:

- Make visual checks of the hydraulic system for leakage
 - Read gauges and level indicators for proper values, and check operating equipment such as pumps for unusual noises
 - Check filters for blockage
 - Monitor the operating temperatures of coolers and heat exchanger
 - Make sure that coolers and heat exchangers are getting a proper supply of cooling air or water
 - Carefully monitor operating pressures to keep system pressures within limits
 - Regularly check the reservoir for fluid loss
 - Check on fluid stored holding tanks



Hydraulic systems operations

- **Operator duties**

- **Causes of system failure**

- The operator should always keep in mind those things most likely to cause a system failure:

- Incorrect operation
 - Low fluid level
 - Fluid leaks
 - Use of wrong hydraulic fluid
 - Gas bubbles (including air) in the system

- **If you have in mind such thinking like “it is not my problem”, “I do not want to have trouble”, only 2 solutions:**

- You are “real” lazy one
 - Or an incompetent

- **In both case you do not merit the title of “Production operator”**

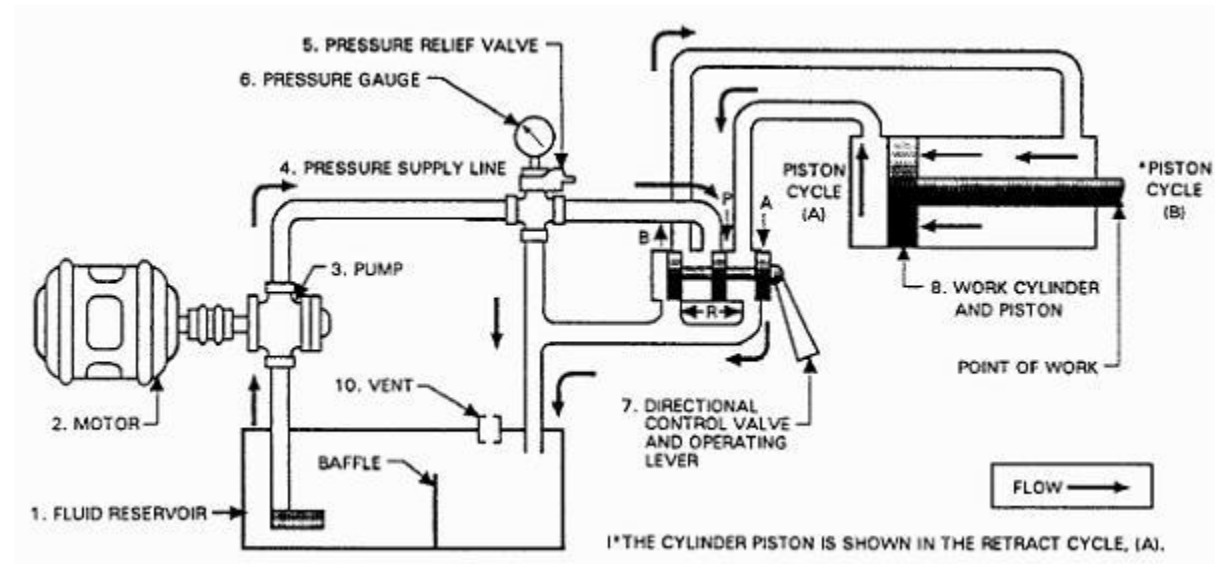


Hydraulic systems operations

- **Hydraulic system flow**

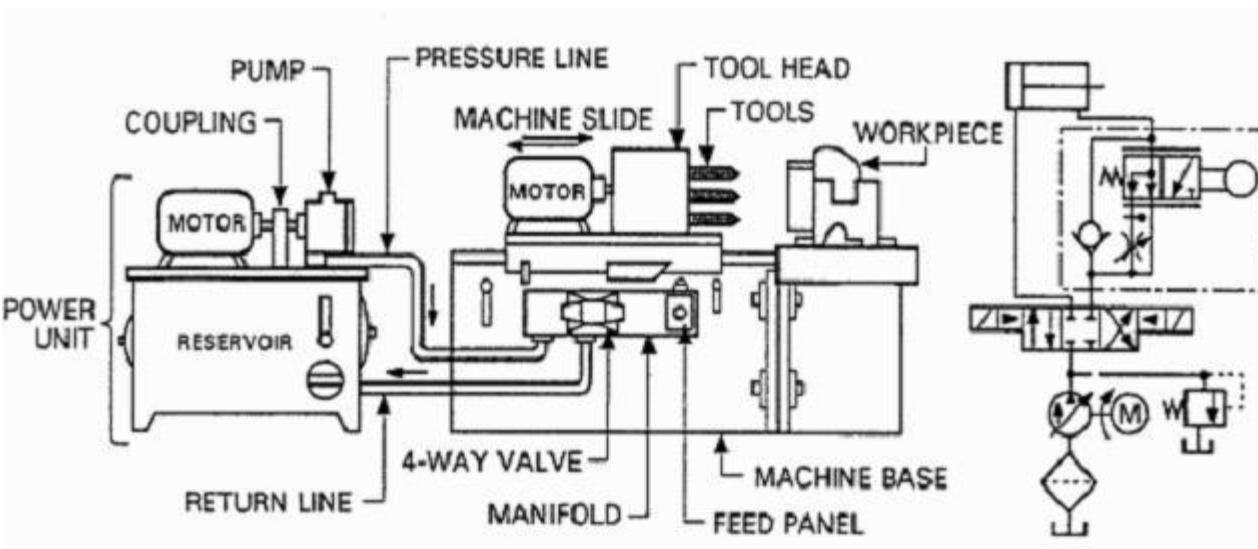
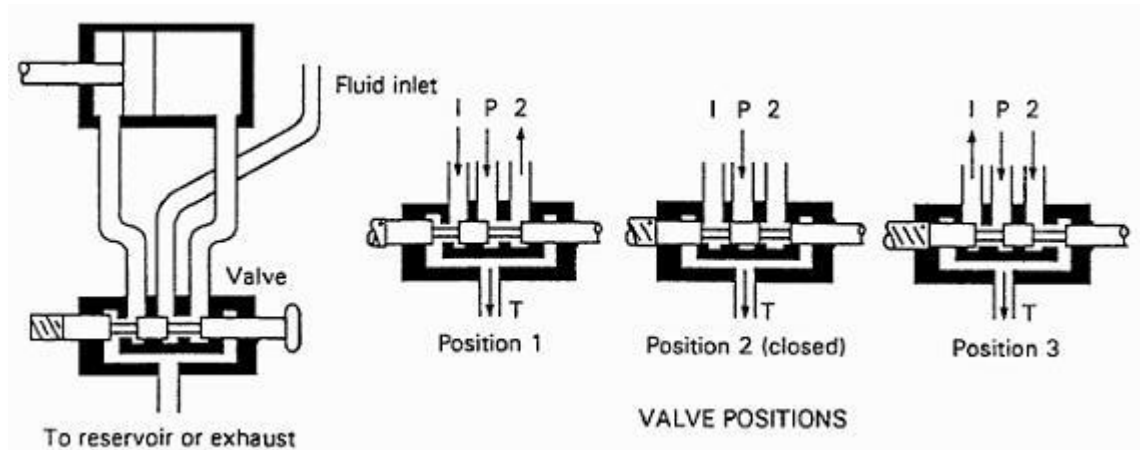
- hydraulic fluid, unlike air in the pneumatic system, always returns to the fluid reservoir to be used again

- For those reasons the pneumatic system is called an **open system** and the hydraulic system is called a **closed system**



Hydraulic systems operations

- Hydraulic system flow

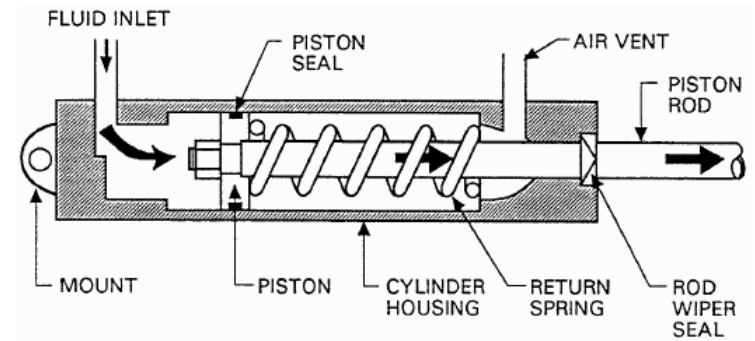


Hydraulic systems operations

- **Hydraulic system flow**

- **Your Car Has Hydraulic Brakes**

- All cars have hydraulic brakes to slow them down and stop them



- When you press on the brake pedal with your foot, you push a piston inside the master brake cylinder housing
 - The piston forces hydraulic fluid through the lines to the brake cylinders at each of the four wheels
 - These cylinders have pistons linked to the brake shoes that press against the wheel brake drums or discs

Hydraulic systems controls and devices

- **Fluid direction and control components**
 - The fluid is controlled by valves which can be operated by hand, mechanical device, pneumatic device, or by electrical device
 - The two main types of fluid direction and control components are:
 - The flow control valve
 - The directional control valve (distributor)

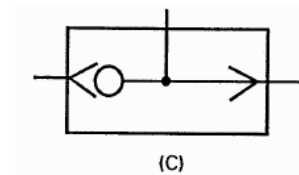
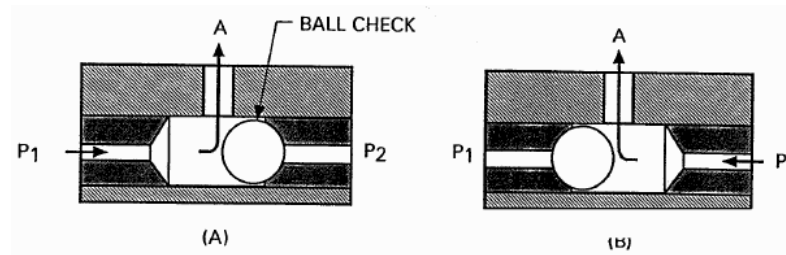
Hydraulic systems controls and devices

- **Fluid direction and control components**

- **Shuttle valve**

- It has two pressure inlet ports and one outlet port

- Air can flow from one inlet port to the outlet port. One inlet port is blocked at all times

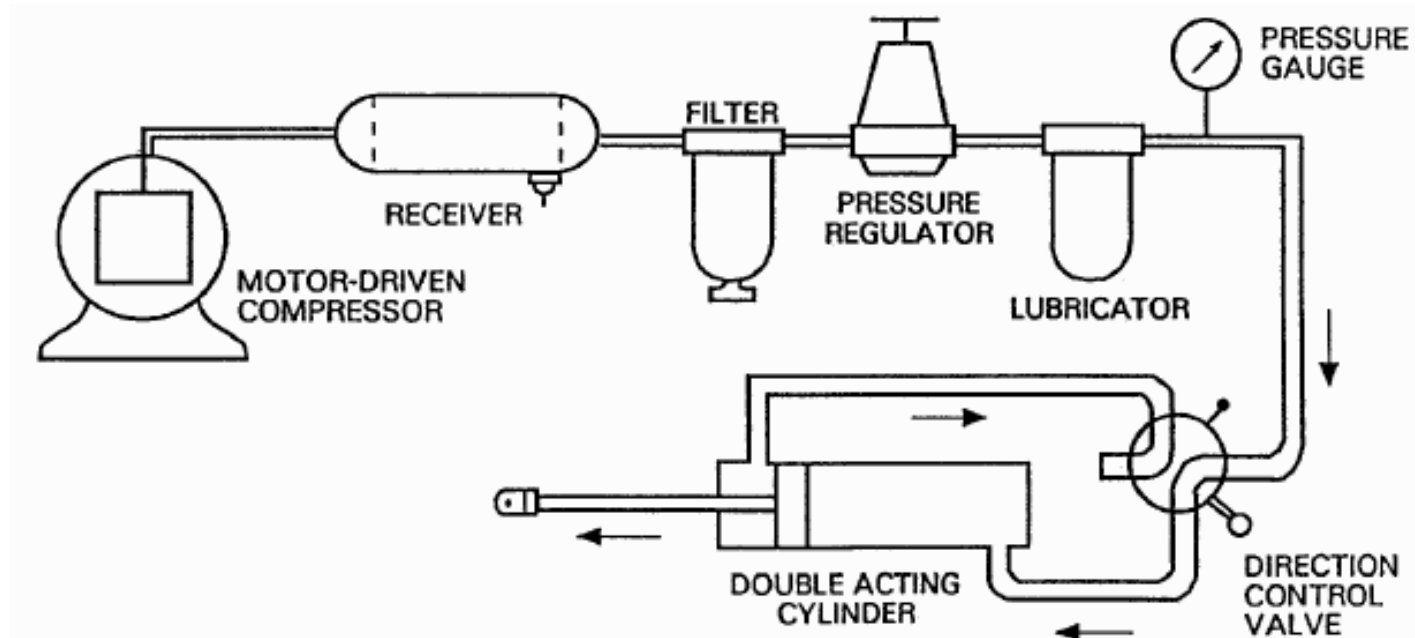


- If pressure is applied to port P1, the ball moves to check flow through P2 and allows fluid to flow to port 'A' (figure A)

- If pressure is applied to port P2, the ball moves to check P1 and allows fluid to flow to port 'A' (figure B). The symbol for the shuttle valve is shown in figure C

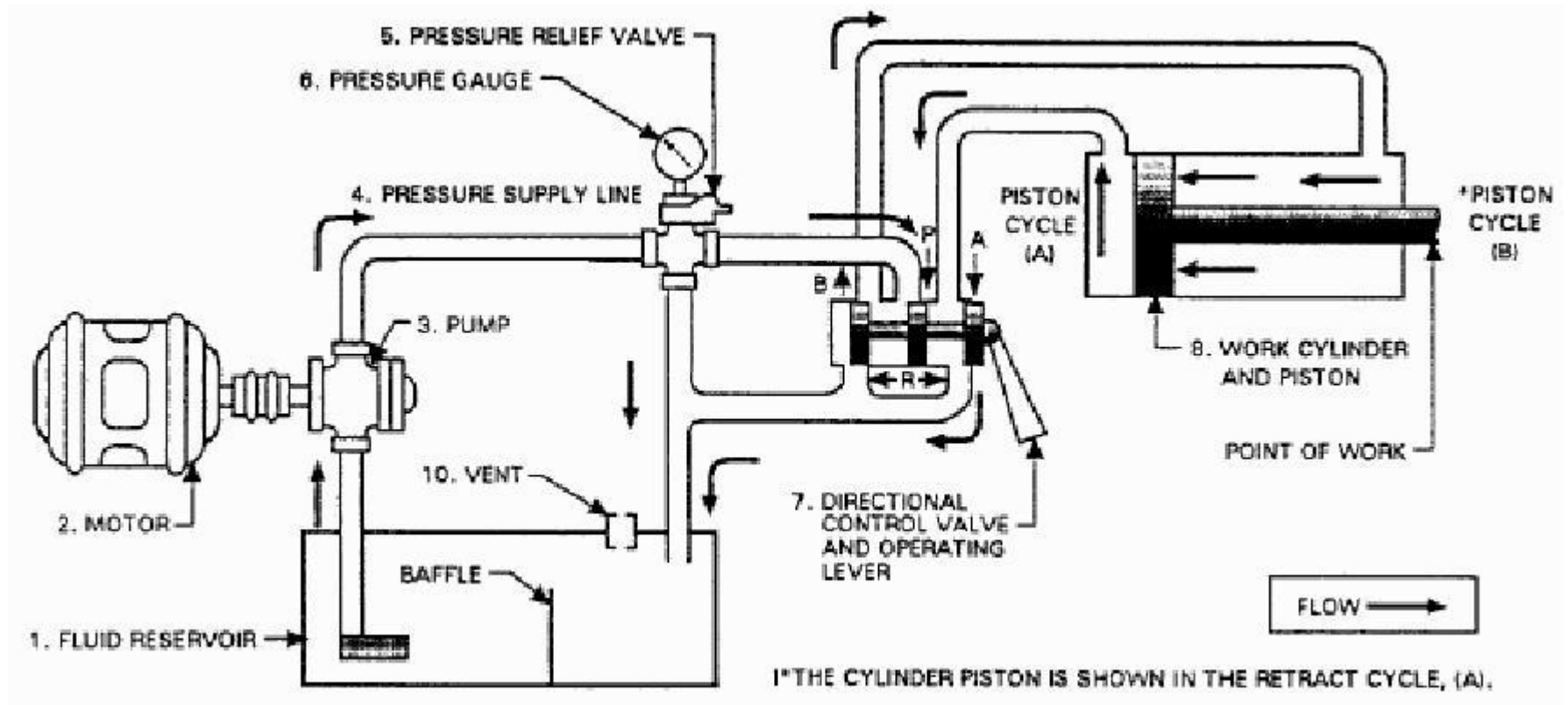
Hydraulic systems controls and devices

- **Fluid direction and control components**
 - **Directional Control Valves (distributor) principle**
 - They make the fluid flows start, stop, or reverse pistons, motors and other equipment



Hydraulic systems controls and devices

- **Fluid direction and control components**
 - **Directional Control Valves (distributor) principle**



Hydraulic systems controls and devices

- **Fluid direction and control components**
 - **Directional Control Valves (distributor) operations**
 - Direction control valves can be operated:
 - Manually
 - Automatically by mechanical devices
 - Automatically by electrical signals
 - Automatically by compressed air
 - Automatically by hydraulic power
 - The uses of the basic valve layout and some of its variations are as follows:
 - To improve the fluid flow
 - To set the maximum pressure for the valve
 - To create a return path for the fluid flow (or exhaust for pneumatic)
 - To control the direction of flow



Hydraulic systems controls and devices

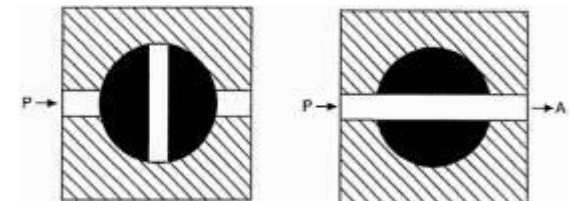
- **Fluid direction and control components**

- **Directional Control Valves (distributor) operations**

- Air in pneumatic, fluid in hydraulic enters and leaves valves through openings in the valve body. These openings are called ports

- Ports are identified by letters:

- P, Fluid inlet port
 - A, B, or C, operating line ports
 - R, S, or T, exhaust line ports (pneumatic)
 - Z, Y, or X, control line ports

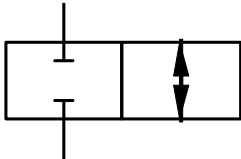
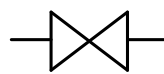


- Directional valves are called two-way, three-way, or four-way valves. Depending on the number of ways the fluid can flow

- The number of ways is learned by counting the ports

Hydraulic systems controls and devices

- **Fluid direction and control components**
 - **Directional Control Valves (distributor) operations**
 - Valves used to turn on and off the flow of fluid to a system are called shutoff valves or block valves
 - They can be used to drain water from an air/liquid receiver or air/liquid line

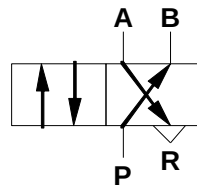
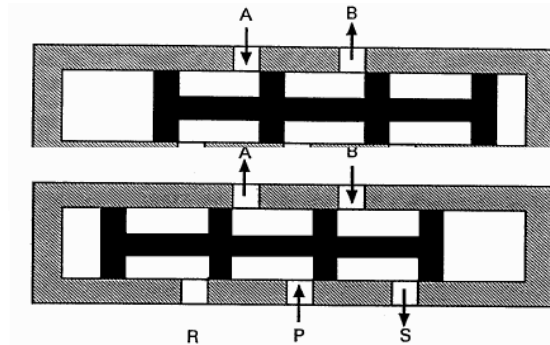
	2 way valve
	2 way valve – simplified symbol

Hydraulic systems controls and devices

- **Fluid direction and control components**

- **Directional Control Valves (distributor) sliding valves**
 - **Piston Spool Valves**

- It contains a piston or spool which slides to one side of the valve body
 - The spools block flow from one port while allowing flow to others



4/2 way valve as per spool valve above

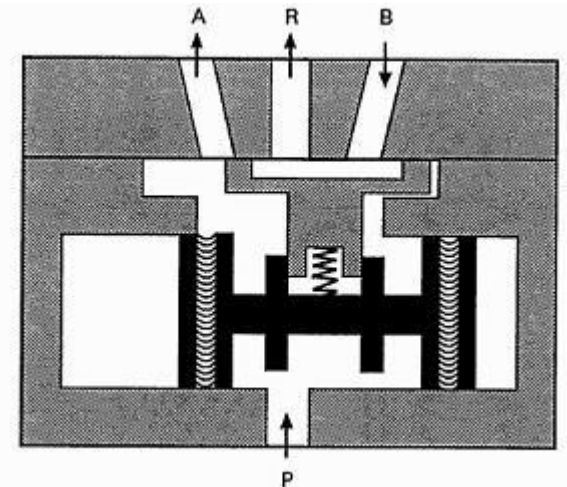
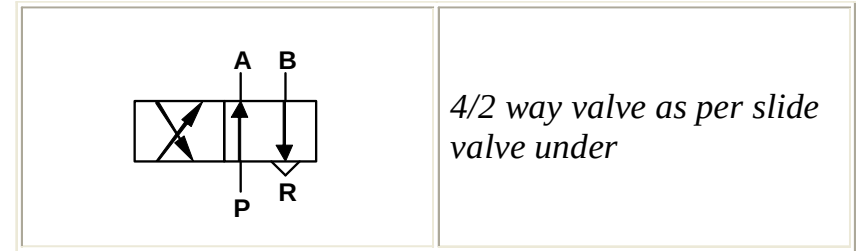
Hydraulic systems controls and devices

- **Fluid direction and control components**

- **Directional Control Valves (distributor) sliding valves**

- **Piston Slide Valves**

- They have a piston which slides back and forth
 - Flow direction is controlled by a slide which opens and closes all ports except port P which remains open



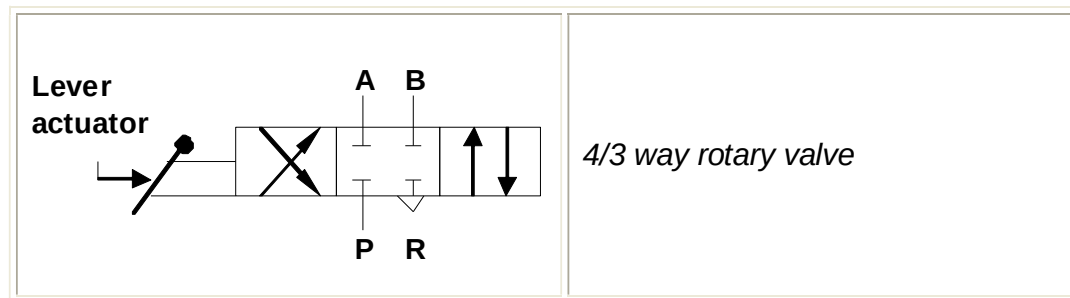
Hydraulic systems controls and devices

- **Fluid direction and control components**

- **Directional Control Valves (distributor) sliding valves**

- **Rotary Valves**

- They are usually 3/3-way or 4/3-way valves
 - The centre position usually blocks all flow
 - Most rotary valves are hand operated
 - A lever is rotated which slides the top part of the valve over the bottom
 - Ports are located inside the valve to give the proper selection of flow directions



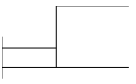
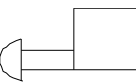
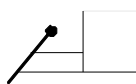
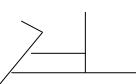
Hydraulic systems controls and devices

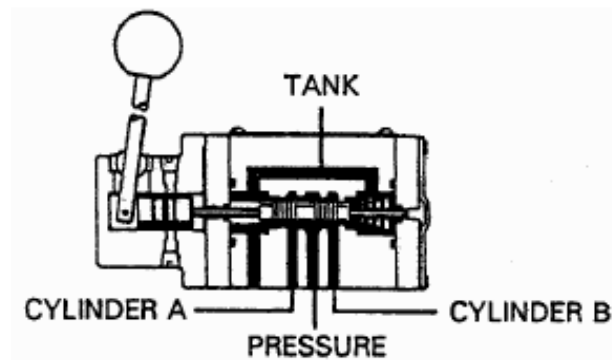
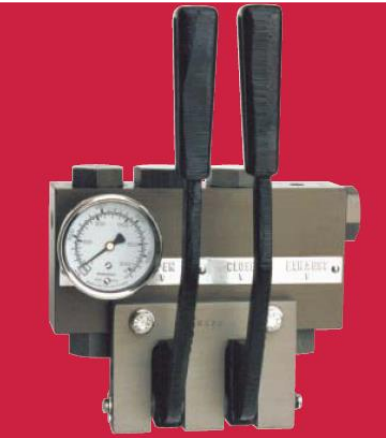
- **Fluid direction and control components**

- **Directional Control Valves (distributor) Valve Actuators**

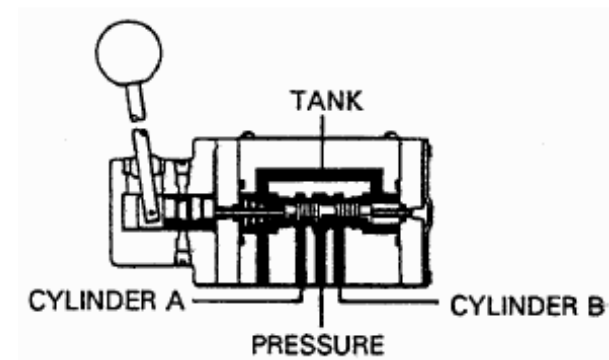
- **Manually operated actuation. They include:**

- Buttons which are pushed or pulled
 - Levers which are turned by hand
 - Pedals which are operated with feet

	General
	Button
	Lever
	Pedal



Spring return stem "in"



Spring return stem "out"

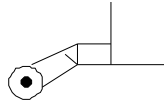
Hydraulic systems controls and devices

- **Fluid direction and control components**

- **Directional Control Valves (distributor) Valve Actuators**

- **Mechanically operated actuation**

- They are operated by mechanical equipment
 - The mechanical operation can come from cams, piston rods in cylinders and other mechanical moving devices which operate the plunger inside the valve
 - Mechanical actuators include: plungers, rollers and springs

	Plunger
	Spring
	Roller
	Idle return roller

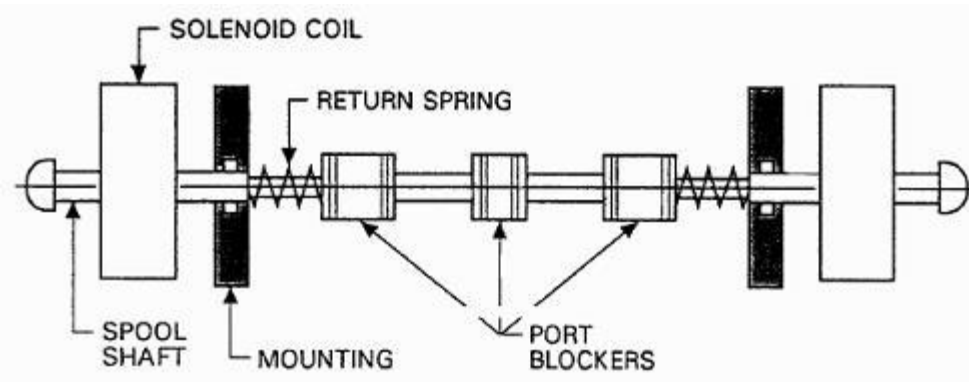
Hydraulic systems controls and devices

- **Fluid direction and control components**

- **Directional Control Valves (distributor) Valve Actuators**

- **Electrically actuated actuation**

- Most hydraulic valves are electrically operated by a solenoid
 - The valve spool is returned to the original position by a spring
 - At each step:
 - Energise left solenoid
 - De-energise, spring returns spool to null
 - Energise right solenoid
 - De-energise, spring returns spool to null



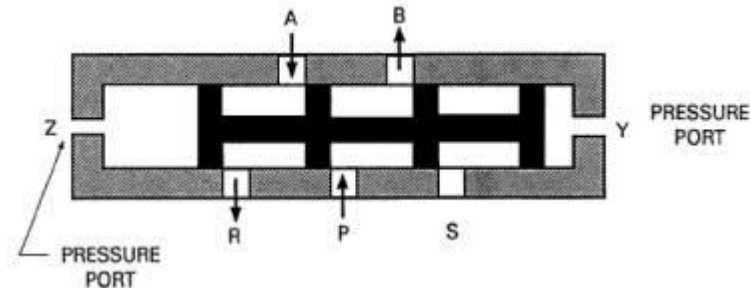
Hydraulic systems controls and devices

- **Fluid direction and control components**

- **Directional Control Valves (distributor) Valve Actuators**

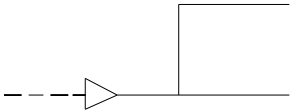
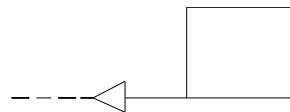
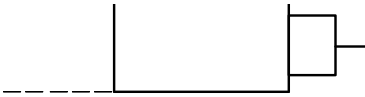
- **Pneumatic operated actuation**

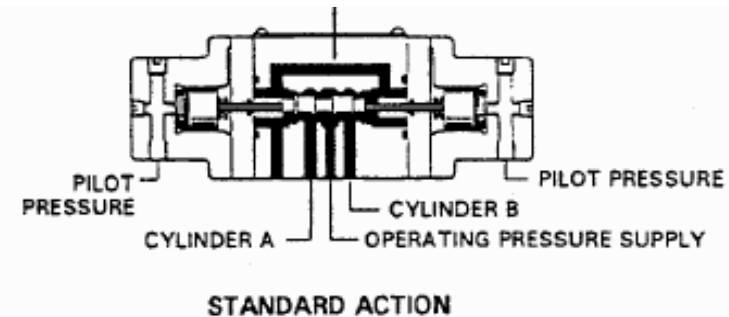
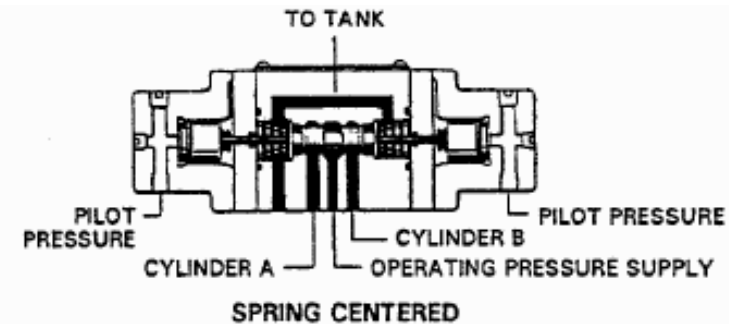
- They are remote actuators which are operated by air pressure
 - These are divided into actuators which operate from positive air pressure (pressure actuators) and those that operate when air pressure is released (bleed actuators)
 - Some actuators operate from a difference in two pressures
 - These valves have a control or pilot line connected to the control port(s)
 - Air pressure is used to move the piston or plunger inside the valve
 - The control pressure is supplied by another valve which may be manually or mechanically actuated



Hydraulic systems controls and devices

- **Fluid direction and control components**
 - **Directional Control Valves (distributor) Valve Actuators**
 - **Pneumatic operated actuation**
 - Symbols for pneumatic actuators

	Pressure
	Bleed
	Differential pressure



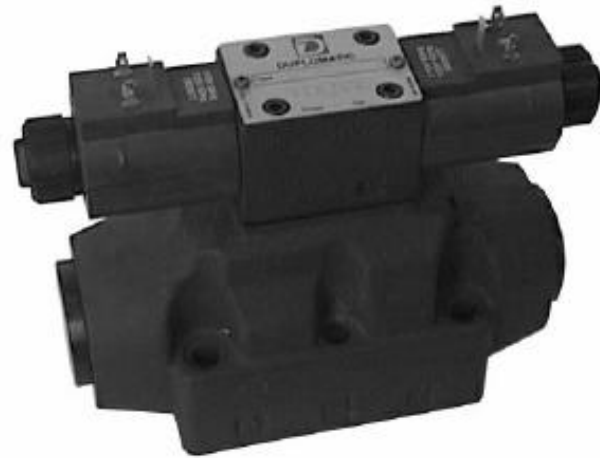
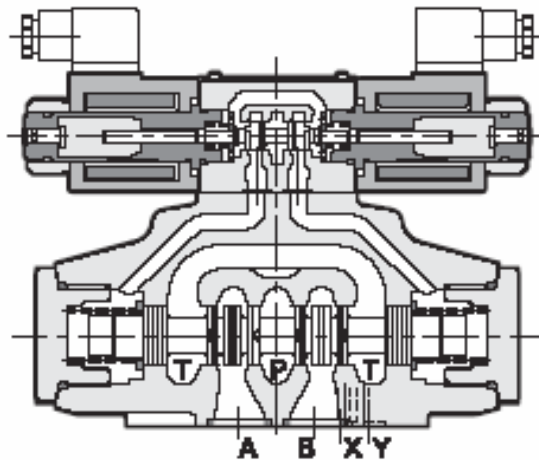
Hydraulic systems controls and devices

- **Fluid direction and control components**

- **Directional Control Valves (distributor) Valve Actuators**

- **Combined actuation**

- The '**piloting**' with hydraulic is possible. It acts the same way as a pneumatic system, just replace the air by hydraulic fluid

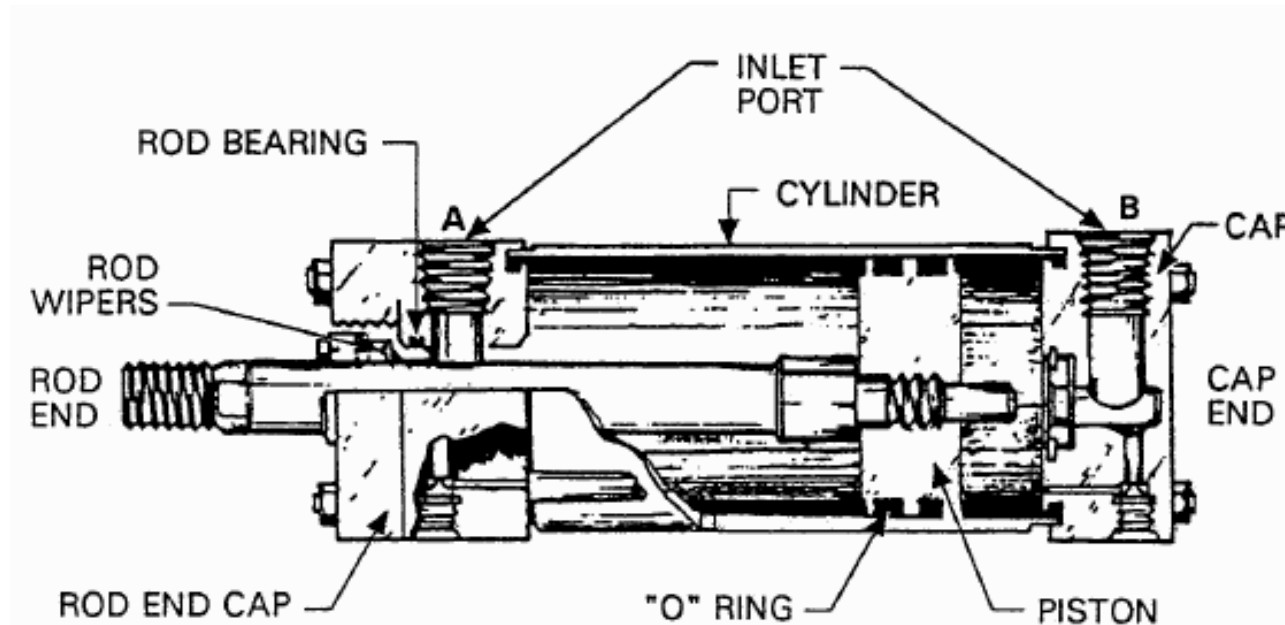


Hydraulic systems controls and devices

- **Hydraulic and devices**

- **Hydraulic Cylinder**

- A cylinder is a device for converting fluid power to straight-line mechanical force
 - It operates like the pneumatic cylinder



Hydraulic systems controls and devices

- **Hydraulic and devices**

- **Hydraulic Cylinder**

- The force of the fluid is converted to mechanical force on the piston which causes the piston to move
 - The movement of the piston causes work to happen
 - Cylinders are normally installed with the cylinder base fixed to a solid structure and the piston rod connected to a device which must be moved
 - There are two basic types of cylinders for hydraulic service:
 - Single-acting cylinders with force in only one direction
 - Double-acting cylinders with force in two directions

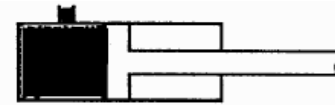
Hydraulic systems controls and devices

- **Hydraulic and devices**

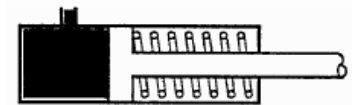
- **Hydraulic Cylinder**

- **Single-Acting Cylinder**

- It uses fluid pressure to apply force in only one direction
 - Usually the fluid pushes on the piston to force the rod out of the cylinder
 - The force of gravity can be used to return the piston and rod to the original position
 - Some cylinders use compressed air or nitrogen in the dry side to provide the force to return the piston to its original status
 - The amount of force depends on the piston area in contact with the fluid
 - A three-way directional control valve is normally used to control the operation of a single-acting cylinder



Load return



Spring return



*GVO-LP-SR
Pneumatic*



*GVO-HP-SR
Hydraulic*



*GVO-LP-FS
Pneumatic*



*GCO-HP-FS
Hydraulic*



*Baker
Wellhead*



Hydraulic systems controls and devices

- **Hydraulic and devices**

- **Hydraulic Cylinder**

- **Single-Acting Cylinder**

- Note the references of manufacturer:
 - LP is for Low Pressure, cylinder to be used in pneumatic up to 7 bars supply
 - HP is for High Pressure, cylinder to be used with hydraulic supply up to 100 bars
 - SR is for Spring Return extending in return
 - FS is for Fail Safe which is done by spring retracting in return
 - Process valves are non only operated linearly but also with “quarter turn” for ball valves
 - Specific actuators, and their appropriated controls, for wellhead valves are presented in last chapter dedicated to well equipment



Hydraulic systems controls and devices

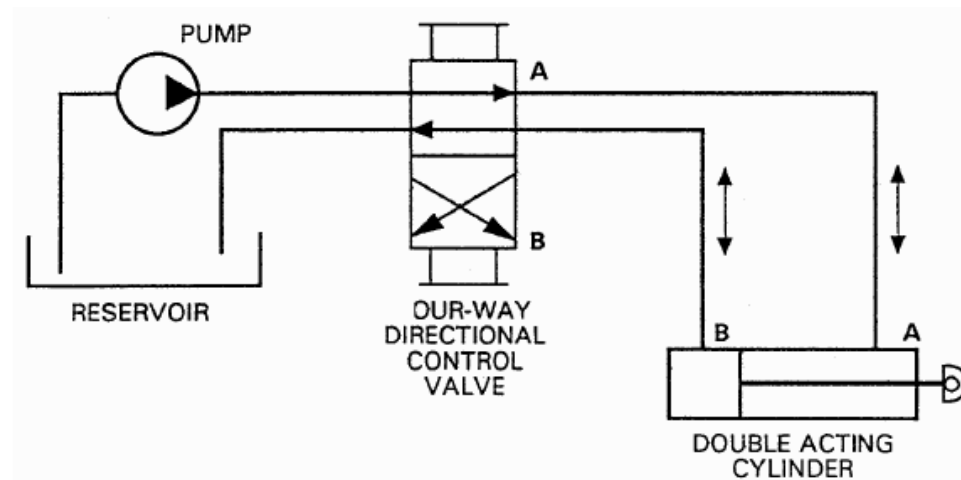
- **Hydraulic and devices**

- **Hydraulic Cylinder**

- **Double Acting Cylinder**



- Hydraulic fluid can be applied to either side of the piston
- The movement (and force) is applied back and forth at the same end of the piston rod
- A double-acting cylinder can also supply a pushing force in both directions by using two piston rods
- A double end cylinder has a rod extending out both ends of the cylinder



Hydraulic systems controls and devices

- **Hydraulic and devices**

- **Hydraulic Cylinder**

- **Double Acting Cylinder**

- Movement in both directions are power strokes. A double end cylinder is also called a double rod cylinder
 - Double-acting cylinders are controlled by a four-way directional valve

The hand-wheel is provided for you, operator to take over from the failure of automatic hydraulic control

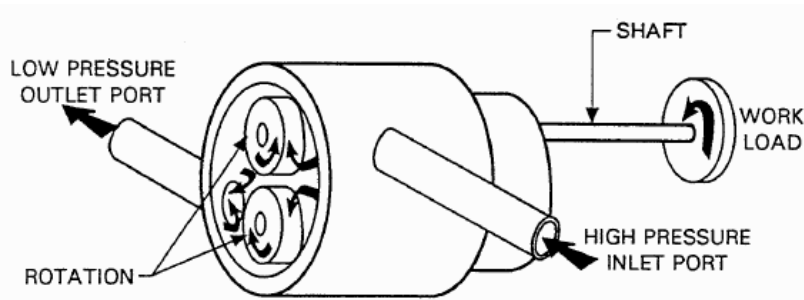
Do not call immediately the maintenance for operating the wheel in your place! There is always a “manual position” in the control system, no excuse to not know it!

Hydraulic systems controls and devices

- **Hydraulic and devices**

- **Hydraulic Motors**

- What are the differences between hydraulic pumps and motors?



PUMP	MOTOR
Non-pressurised fluid is drawn in and pressurised fluid is discharged	Pressurised fluid is forced in and non pressurised fluid is discharged.
Mechanical energy is changed into hydraulic energy	Mechanical energy is transmitted as mechanical energy.
Driven by an outside device.	Driven by an outside device.

- A hydraulic pump makes hydraulic pressure. A hydraulic motor uses it

Hydraulic systems controls and devices

- **Hydraulic and devices**

- **Hydraulic Motors**

- High pressure hydraulic fluid from a hydraulic pump enters the inlet port of the motor
 - The fluid rotates the motor elements inside the motor housing
 - The rotation of the internal motor elements rotates the shaft connected to one of the elements
 - The shaft is mechanically connected to a work load. Rotary mechanical motion is provided to the load
 - Low pressure hydraulic fluid leaves through the motor outlet port and returns to the reservoir



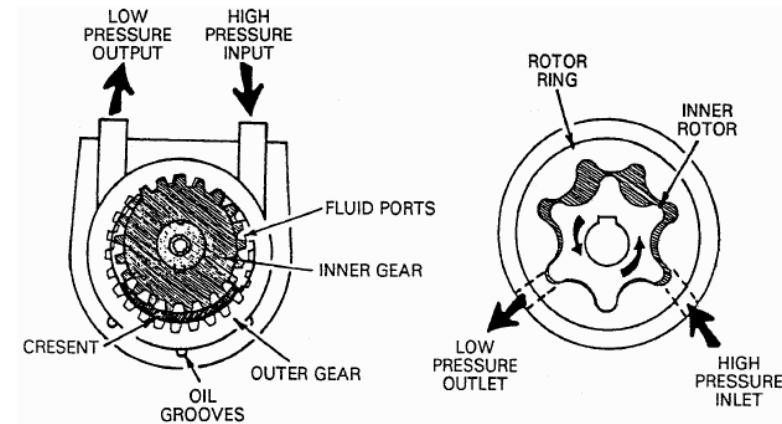
Hydraulic systems controls and devices

- **Hydraulic and devices**

- **Hydraulic Motors**

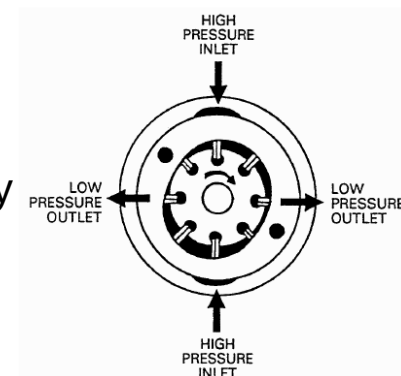
- **Gear-type Motors**

- They are widely used because they are, simple, small in size and economical to operate
 - They can be used for rotary motion in either direction by reversing the inlet and outlet ports



- **Vane-type Motors**

- The vanes are held against the motor housing by springs
 - In a motor the fluid flow against the vanes is necessary to drive the rotor. No centrifugal force is produced until the rotor turns
 - If the vanes are not against the housing, the fluid will flow past the vanes with no effect on the rotor



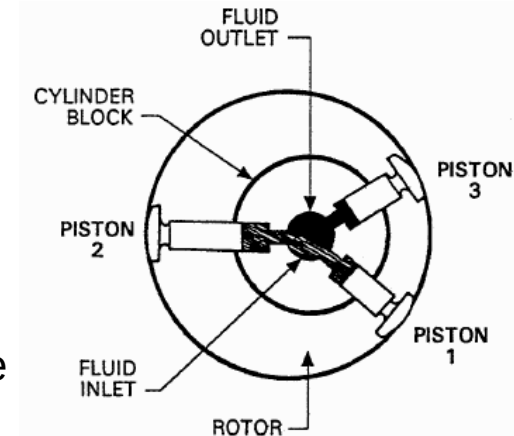
Hydraulic systems controls and devices

- **Hydraulic and devices**

- **Hydraulic Motors**

- **Piston-type Motors**

- They are used in high pressure hydraulic systems or in systems needing high speeds
 - They are more complex, more expensive and need more maintenance than other types
 - A radial piston motor operates in reverse of a pump
 - High pressure fluid is forced into the cylinders and drives the piston outward
 - The piston pushing against an off-centre rotor causes the cylinder block to rotate
 - A drive shaft attached to the cylinder block rotates
 - The drive shaft rotates the work receiving device



Hydraulic systems controls and devices

- **Hydraulic and devices**

- **Rotary actuator**

- The rotating drive is turned by a high pressure fluid flow
 - The low pressure fluid flow leaves the actuator and returns to a hydraulic reservoir
 - The main difference between motor and actuator is that the latest never makes a full revolution (from 90° to 330°)
 - In refineries and gas plants these actuators are used to open and close pipeline valves
 - Most rotary actuators are of two types:
 - Vane rotary actuator
 - Piston rotary actuator



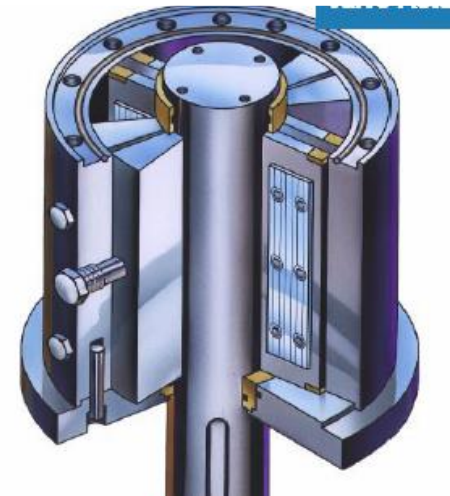
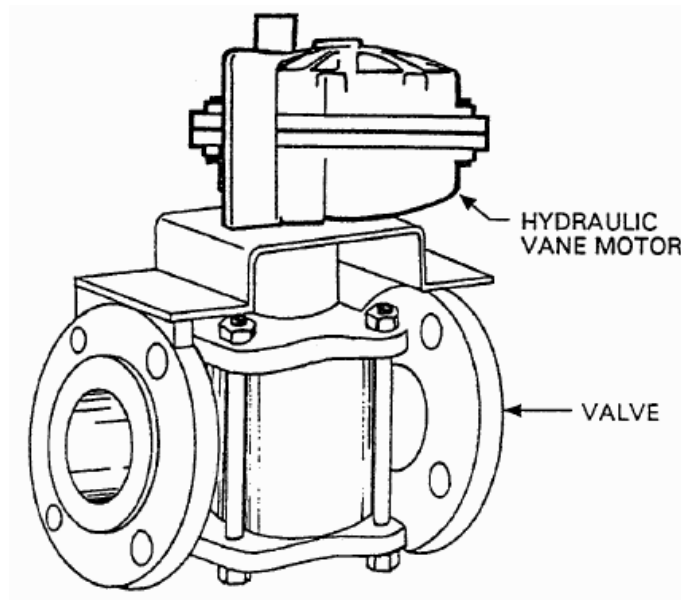
Hydraulic systems controls and devices

- **Hydraulic and devices**

- **Rotary actuator**

- **Vane hydraulic rotary actuators**

- An output shaft is connected to the “rotor” which moves through 90°
 - The control equipment and accessories are identical to other types of actuators



Hydraulic systems controls and devices

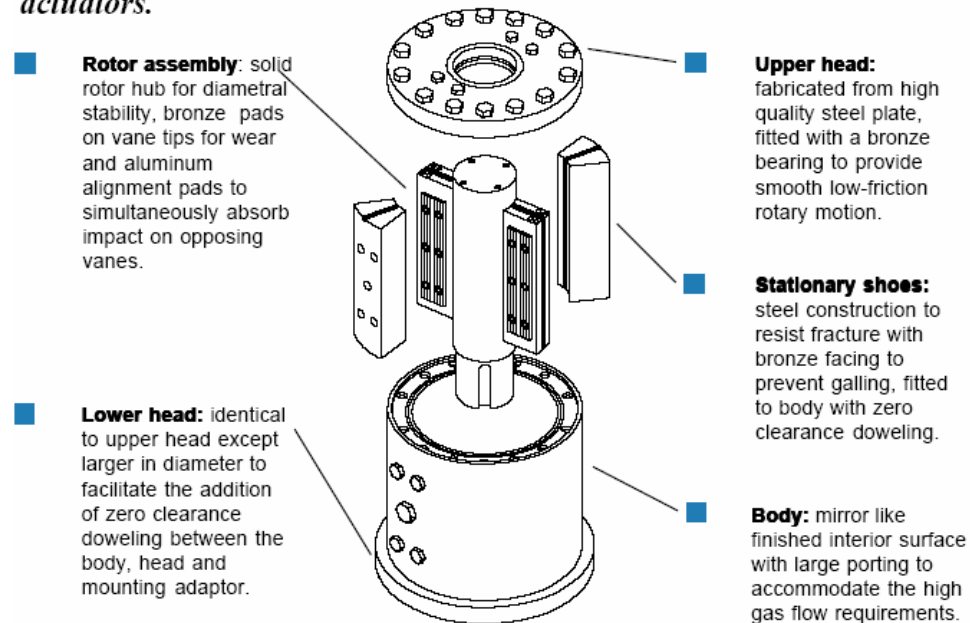
- Hydraulic and devices

- Rotary actuator

- Vane hydraulic rotary actuators

- An output shaft is connected to the “rotor” which moves through 90°
 - The control equipment and accessories are identical to other types of actuators

Our unique double vane, balanced torque design is the principle behind the power, speed and reliability of Shafer HS-Series actuators.



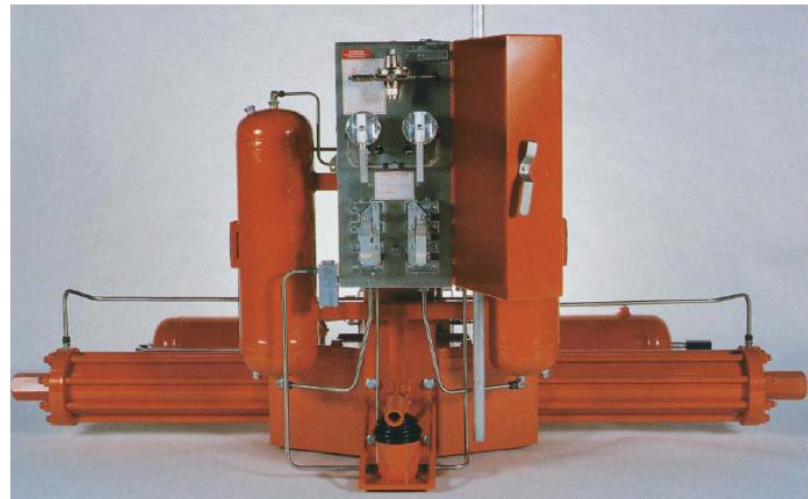
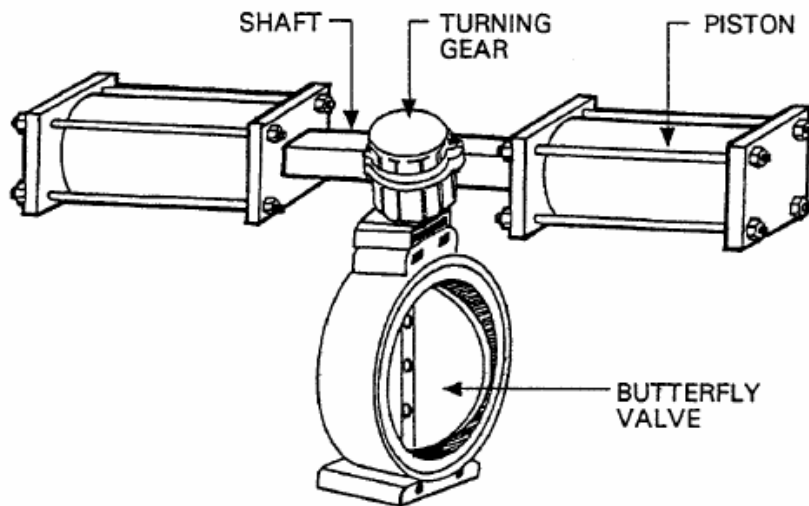
Hydraulic systems controls and devices

- **Hydraulic and devices**

- **Rotary actuator**

- **Piston-type Actuator**

- It transforms a linear action into rotary motion
 - The unit is provided with a hand-pump for takeover control in case of its failure
 - So, as operator, if you are not confident with the automatic control learn at least the manual control operation...



Hydraulic fluids

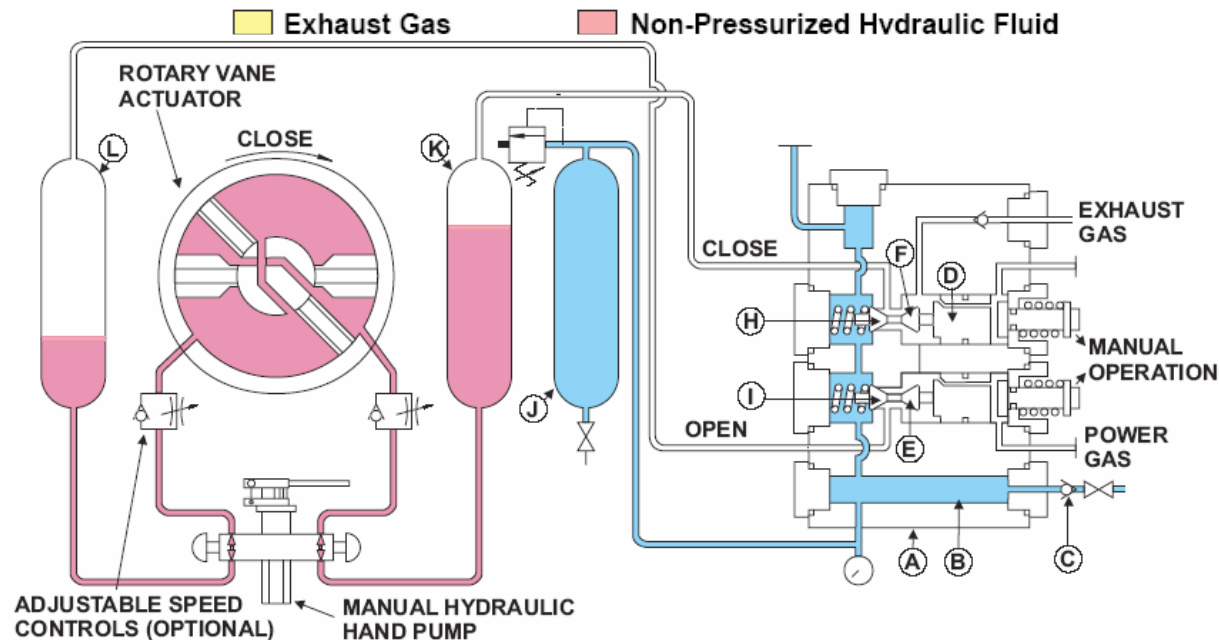
- **What is hydraulic fluid?**

- The main job of a hydraulic fluid is to send the force and energy applied at one point in the system to the point where you want the mechanical action to take place
- The fluid should also lubricate the hydraulic components that it passes through
- Hydraulic fluids are supplied for all types of system and the fluid used depends on the system operating conditions
- All hydraulic fluids approved for use in the petroleum industry are fire resistant
- If you are asked to fill the system with fluid, you must be sure that you use the proper kind of fluid

Applications hydraulic actuated valves and their controls

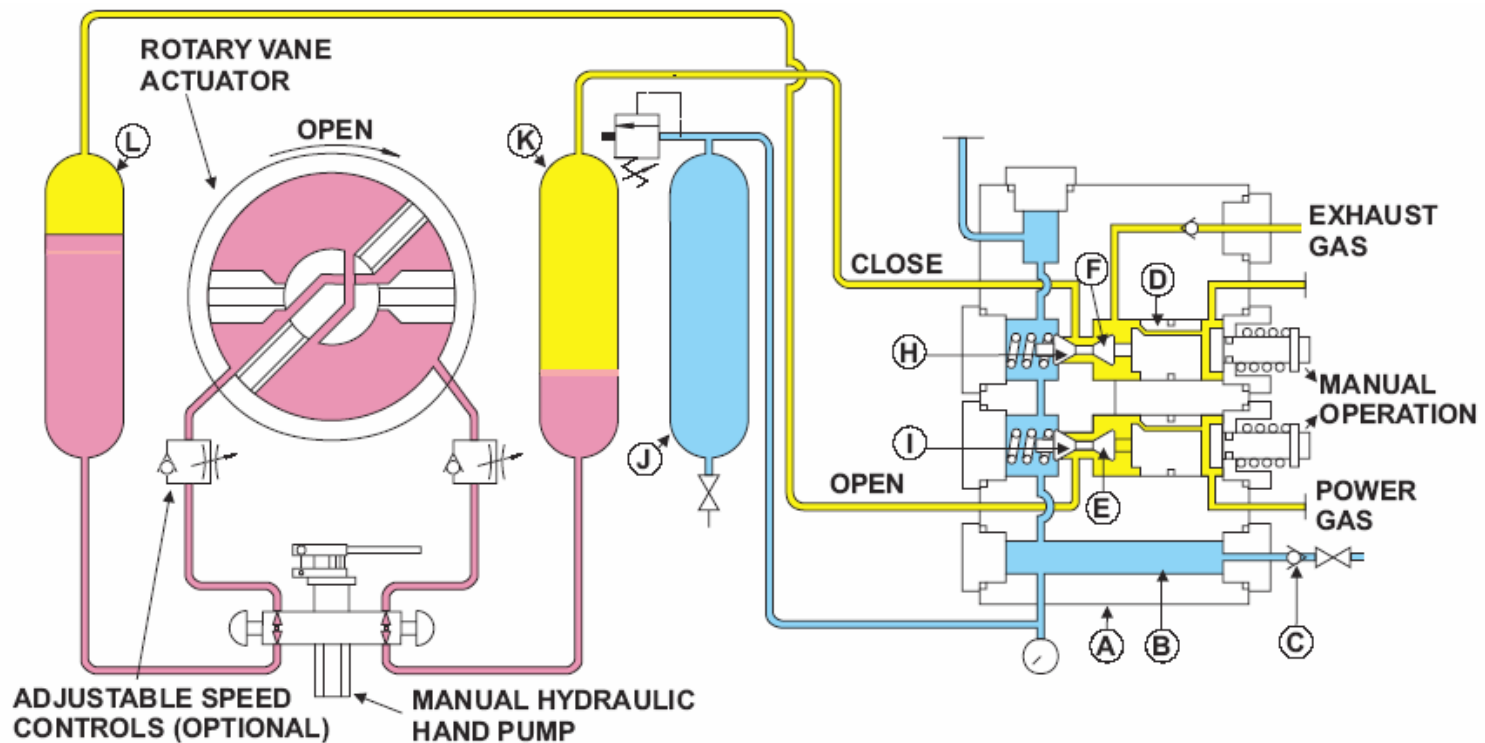
- **Rotary actuator manual operation**

- The Shafer Manual Poppet Block Control is designed for local operation of Shafer valve actuators using power gas or oil to stroke the actuator
- The basic operation is as follows:
 - Sequence 1 – Valve fully open



Applications hydraulic actuated valves and their controls

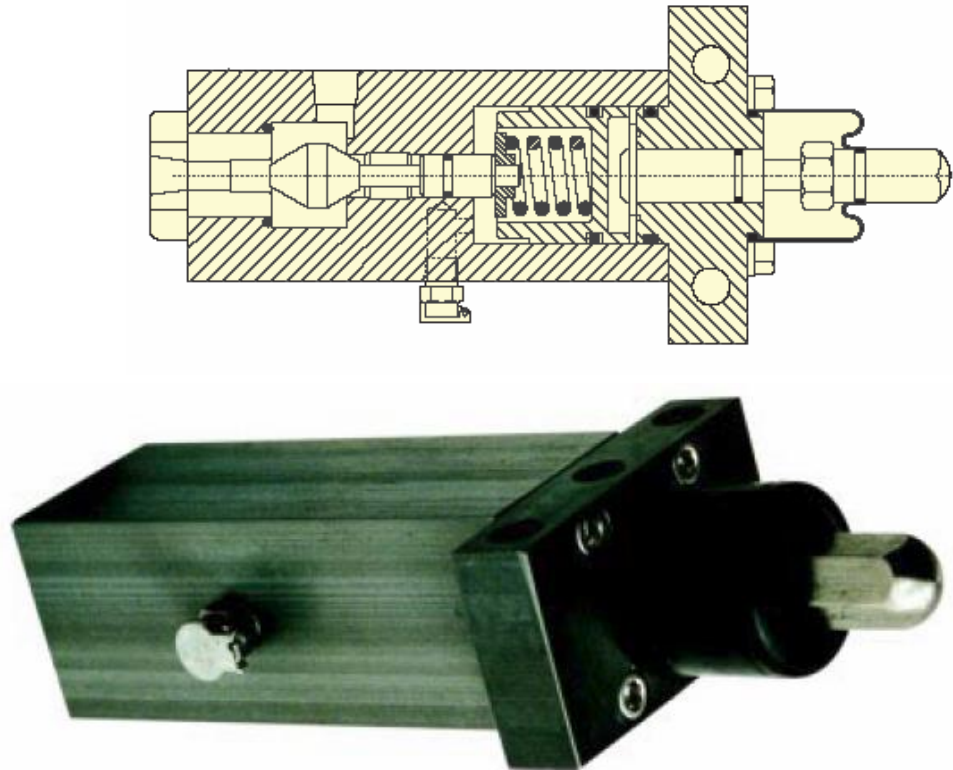
- **Rotary actuator manual operation**
 - The basic operation is as follows:
 - Sequence 3 – Valve fully closed



Applications hydraulic actuated valves and their controls

- **Rotary actuator pilot operation**

- The same process valve, pilot operated, just to see the action of an ESD 'relay'

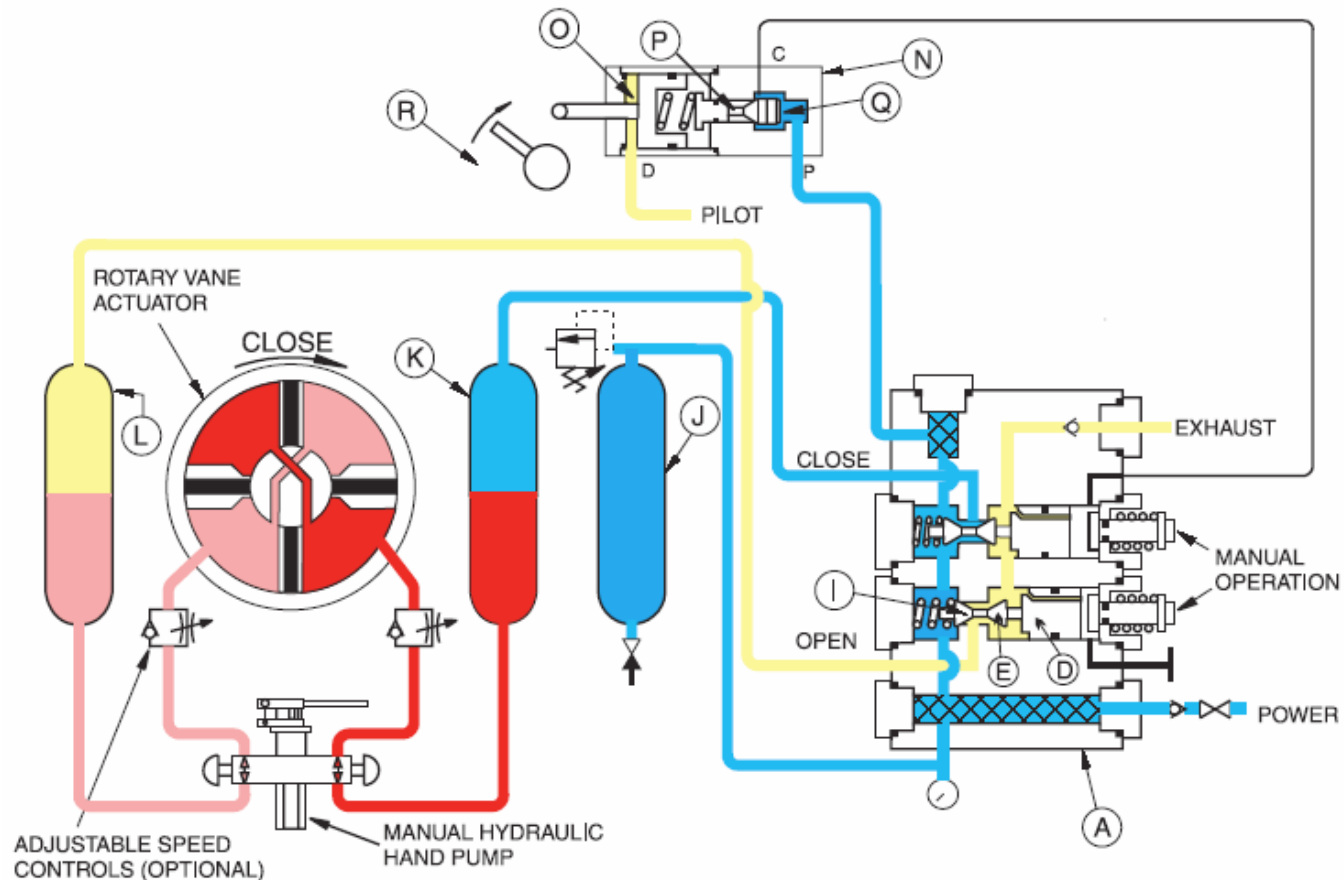


- This pilot relay can be actuated by any mean in the Process ESD network

148 **TOTAL**

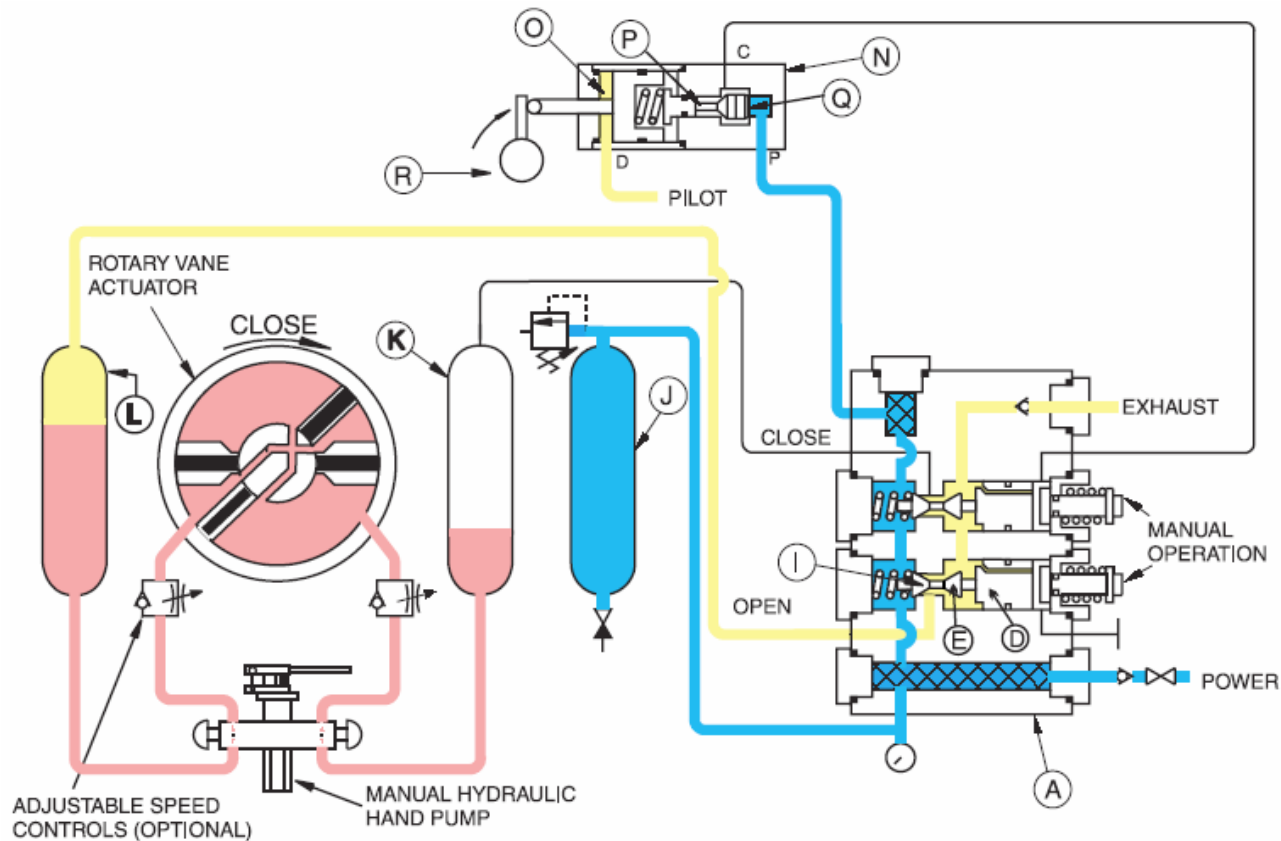
Applications hydraulic actuated valves and their controls

- **Rotary actuator pilot operation**
 - **Sequence 2 – valve closing**



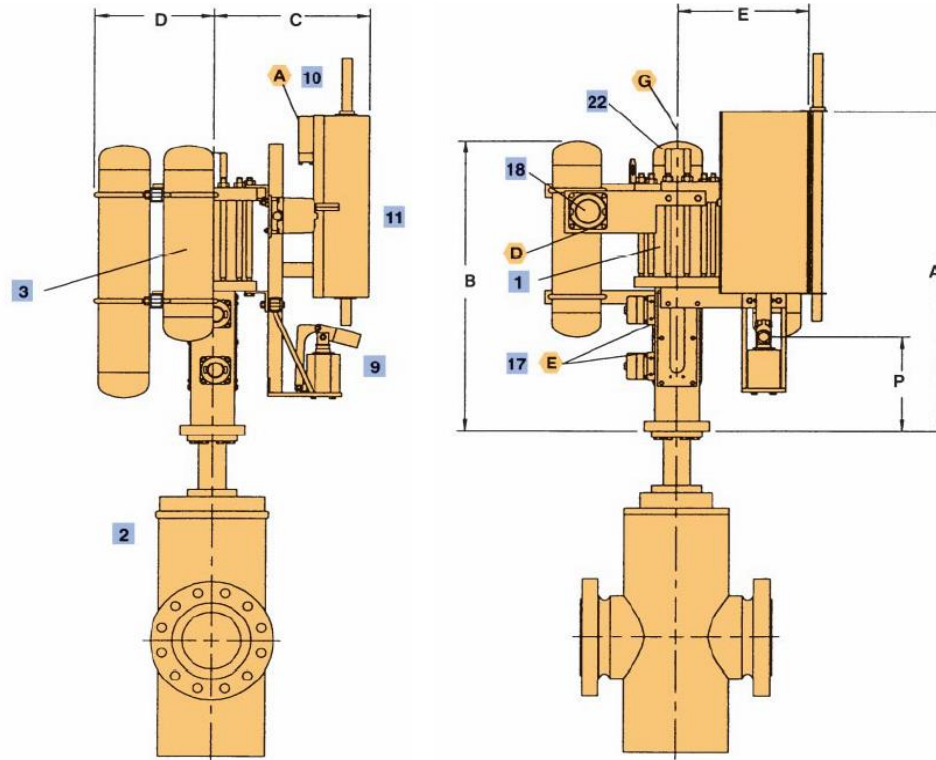
Applications hydraulic actuated valves and their controls

- **Rotary actuator pilot operation**
 - **Sequence 3 – Valve fully close**



Applications hydraulic actuated valves and their controls

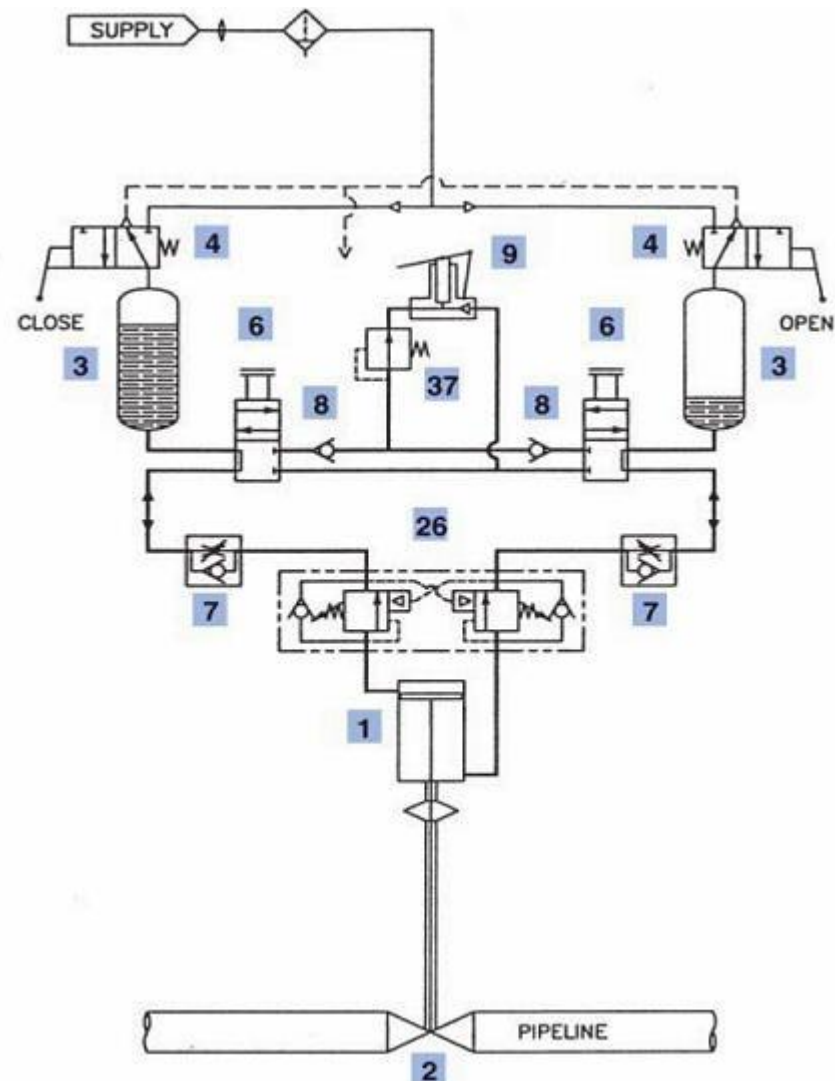
- Linear actuator operation



List of components				Connections	
1	Operator	10	Supply Filter	A	Supply ½" NPT
2	Line Valve	11	Control Panel	D	Electrical 1" NPT
3	Gas/hydraulic Tank	17	Limit Switch	E	Electrical ¾" NPT
4	3-way Valve Manual	18	Junction Box	G	Supply ½" NPT
6	Selector Valve	22	Volume Tank		
7	Speed Control Valve	26	Locking Block		
8	Check Valve	37	Hand-pump Safety Valve		
9	Hand-pump				

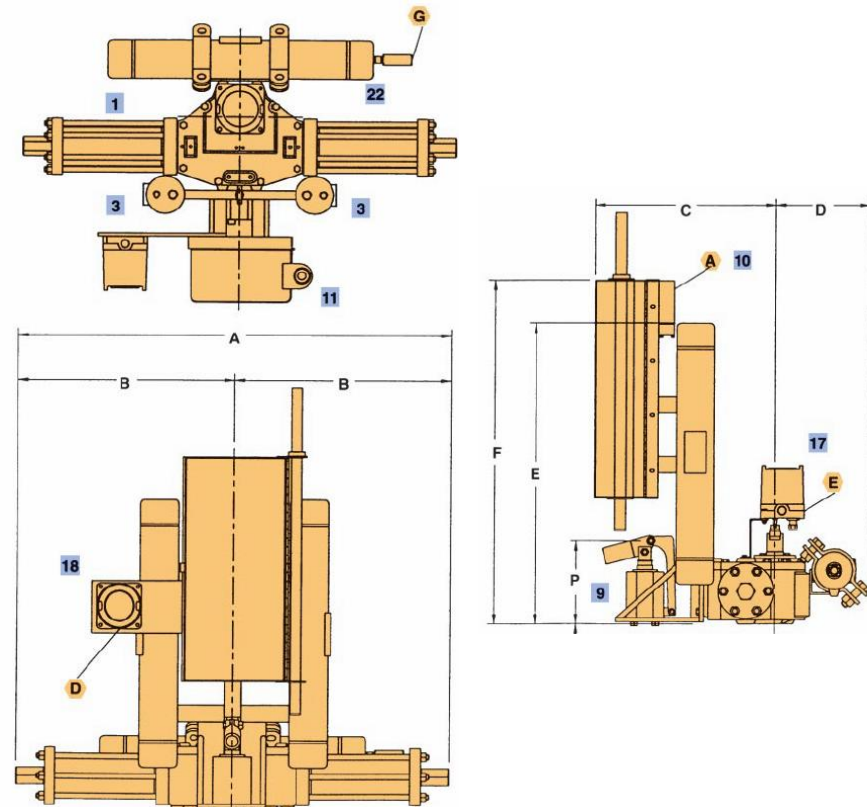
Applications hydraulic actuated valves and their controls

- Linear actuator operation



Applications hydraulic actuated valves and their controls

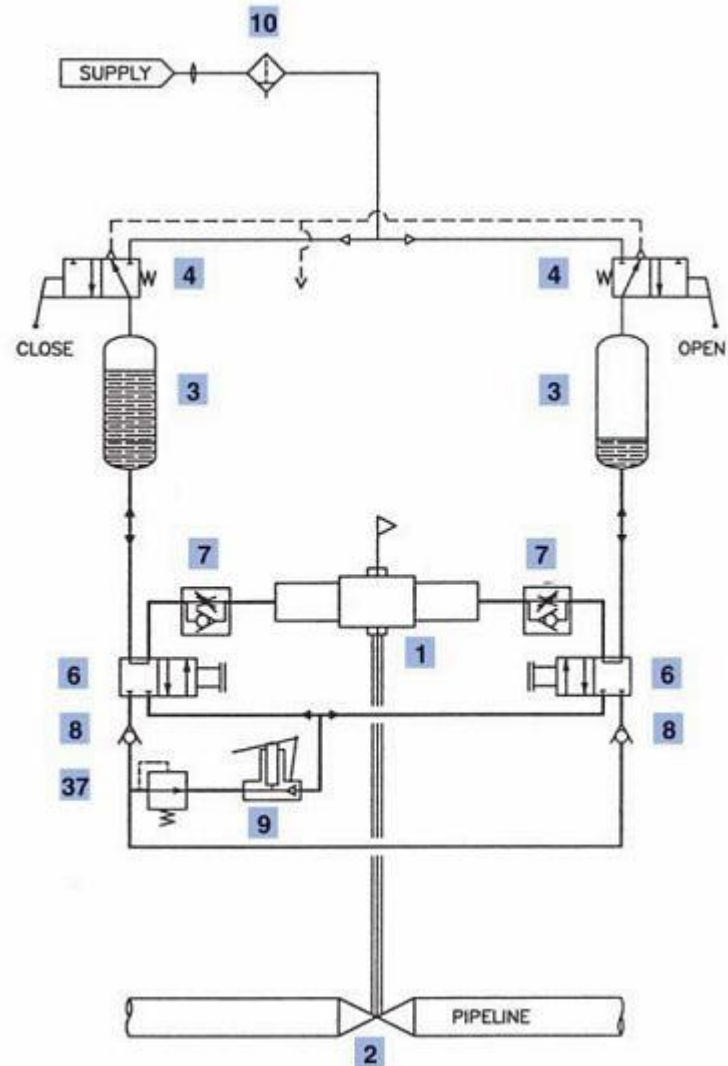
- Rotary piston actuator ope



List of components				Connections	
1	Operator	10	Supply Filter	A	Supply ½" NPT
2	Line Valve	11	Control Panel	D	Electrical 1" NPT
3	Gas/hydraulic Tank	17	Limit Switch	E	Electrical ¾" NPT
4	3-way Valve Manual	18	Junction Box	G	Supply ½" NPT
6	Selector Valve	22	Volume Tank		
7	Speed Control Valve	26	Locking Block		
8	Check Valve	37	Hand-pump Safety Valve		
9	Hand-pump				

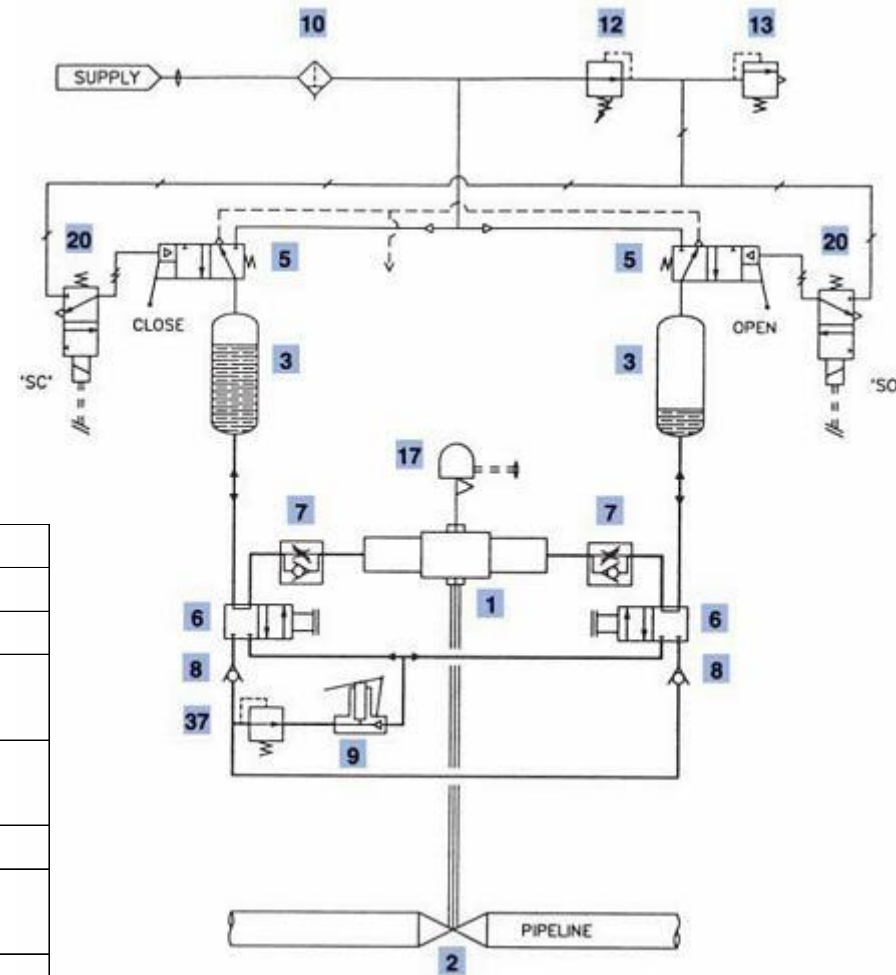
Applications hydraulic actuated valves and their controls

- Rotary piston actuator operation
 - Rotary piston manual actuated



Applications hydraulic actuated valves and their controls

- Rotary piston actuator operation
 - Rotary piston Electric operation

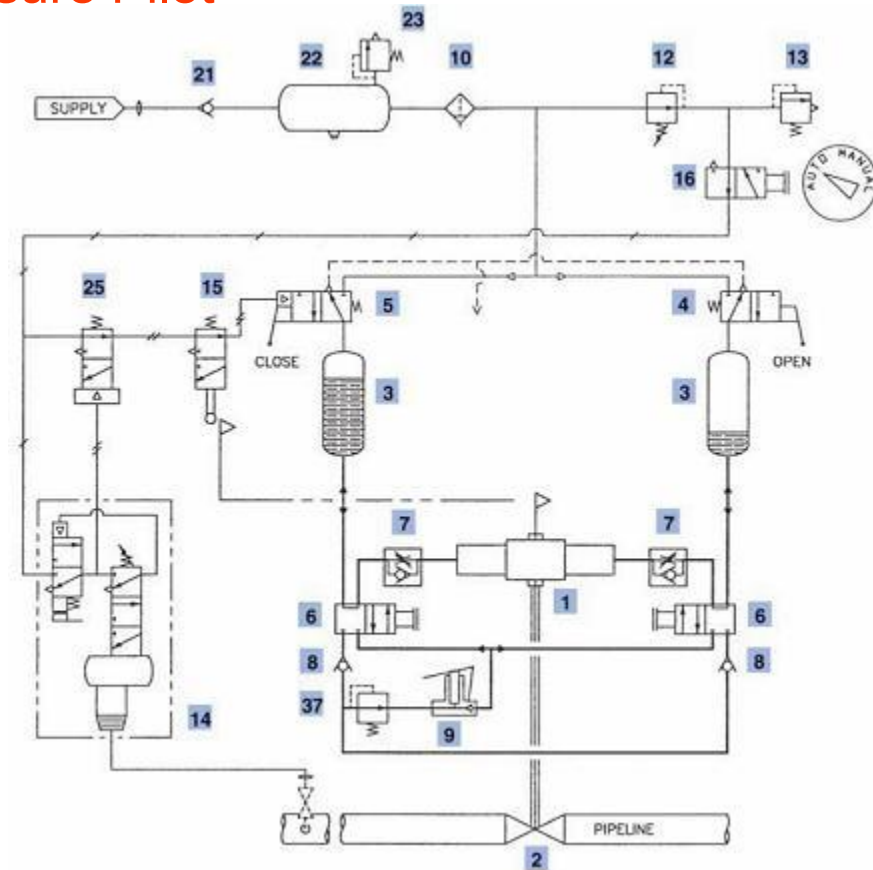


List of components				Connections	
1	Operator	9	Hand-pump	A	
2	Line Valve	10	Supply Filter	D	
3	Gas/hydraulic Tank	12	Regulator	E	
4	3-way Valve Manual	13	Relief Valve	G	
6	Selector Valve	17	Limit Switch		
7	Speed Control Valve	20	Solenoid Valve N.C.		
8	Check Valve	37	Hand-pump Safety Valve		

Applications hydraulic actuated valves and their controls

- **Rotary piston actuator operation**
 - Rotary piston, Fail Close by Pressure Pilot

List of components				Connections	
1	Operator	12	Pressure Regulator	A	Supply ½” NPT
2	Line Valve	13	Relief Valve	D	Electrical 1” NPT
3	Gas/hydraulic Tank	14	Pressure Pilot	E	Electrical ¾” NPT
4	3-way Valve Manual	15	End of Stroke Device	G	Supply ½” NPT
5	3-way Valve manual / Pilot	16	Manual Selector Valve		
6	Selector Valve	21	Check Valve		
7	Speed Control Valve	22	Volume Tank		
8	Check Valve	23	Relief Valve		
9	Hand-pump	25	Reversing Relay		
10	Supply Filter	37	Hand-pump Safety Valve		



Applications hydraulic actuated valves and their controls

- **Rotary piston actuator operation**

- **Rotary piston, Valve positioning**

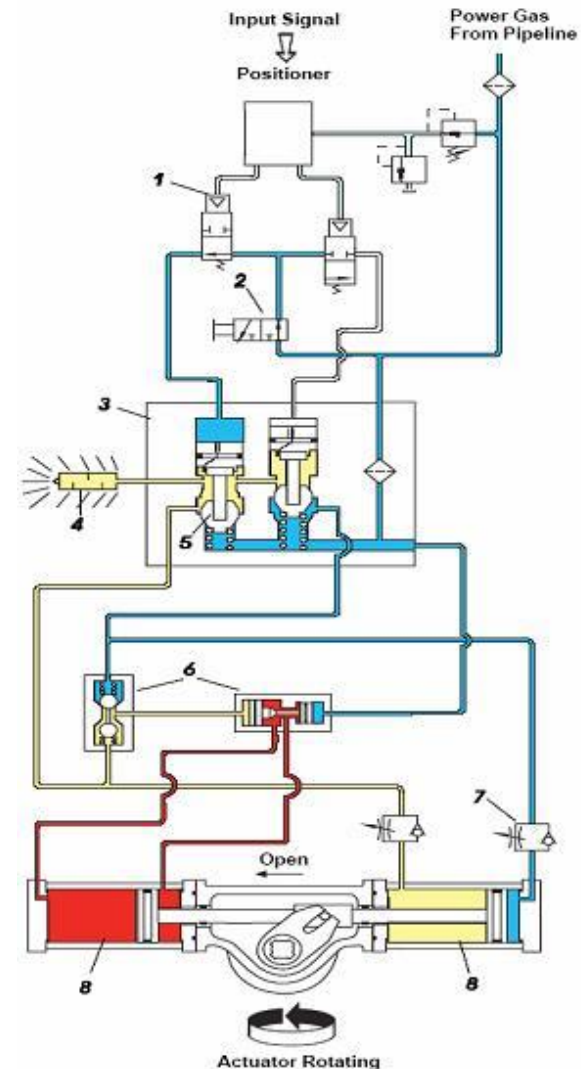
- The Shafer **Valve Positioning System** consists of three integral components:

- A pneumatic or electric positioner
 - A valve actuator
 - A quarter-turn valve



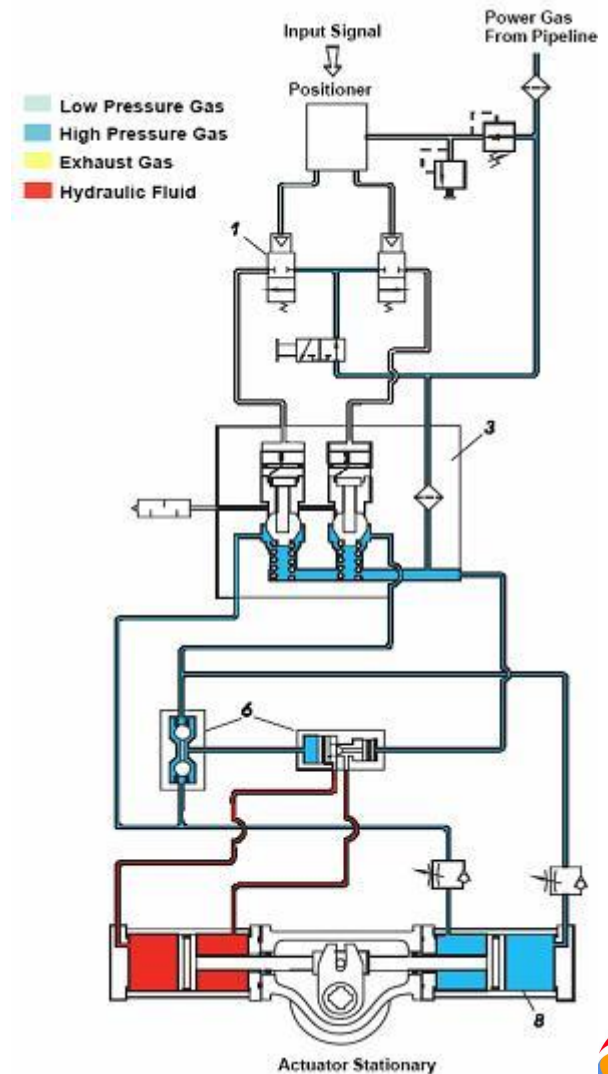
Applications hydraulic actuated valves and their controls

- **Rotary piston actuator operation**
 - Rotary piston, Valve positioning
 - Dynamic state actuator rotating

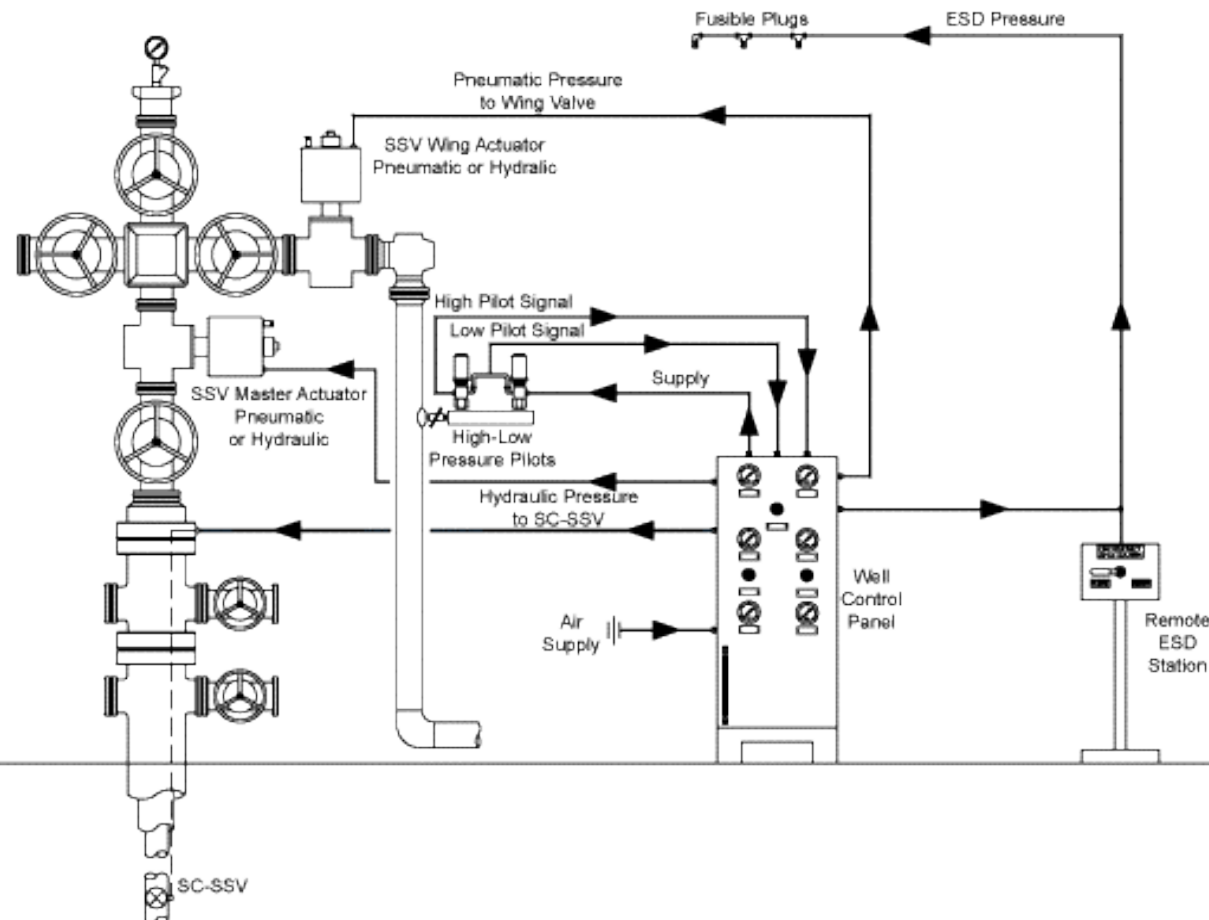


Applications hydraulic actuated valves and their controls

- **Rotary piston actuator operation**
 - **Rotary piston, Valve positioning**
 - Static position actuator stationary

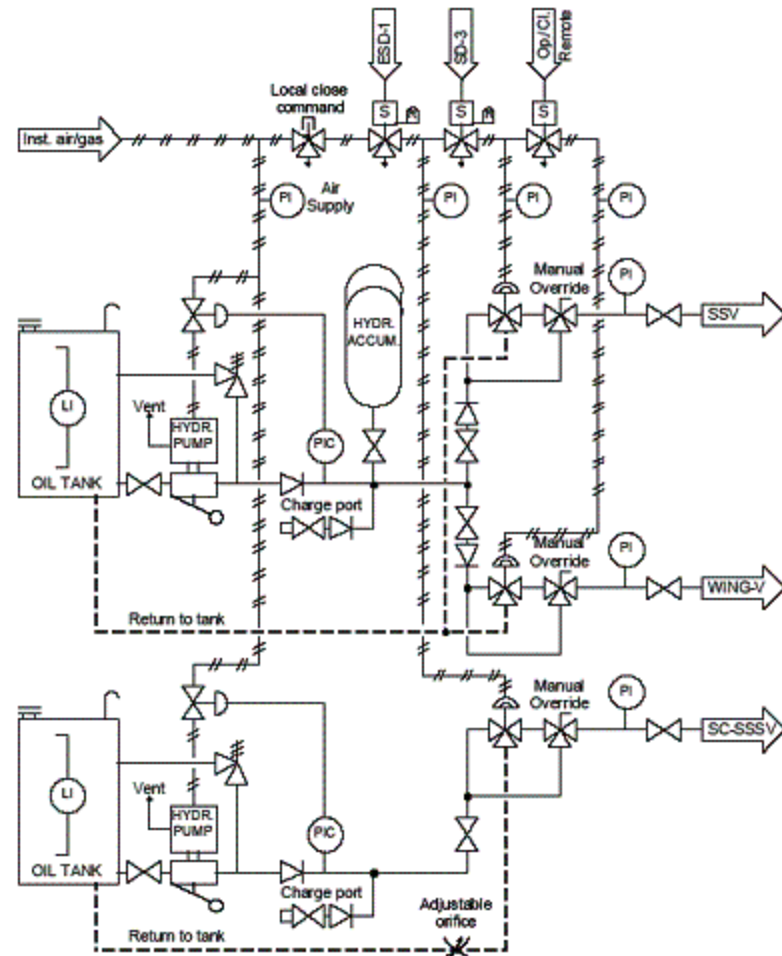


Site application well equipment and control



Site application well equipment and control

- Typical well control panel
 - Typical Well Control
 - ‘Classic’ hydraulic circuits with:
 - Oil tank
 - Hydraulic pump pilot control valves safety devices
 - Accessories and the lines towards the 3 ‘basic’ well control
 - Valves

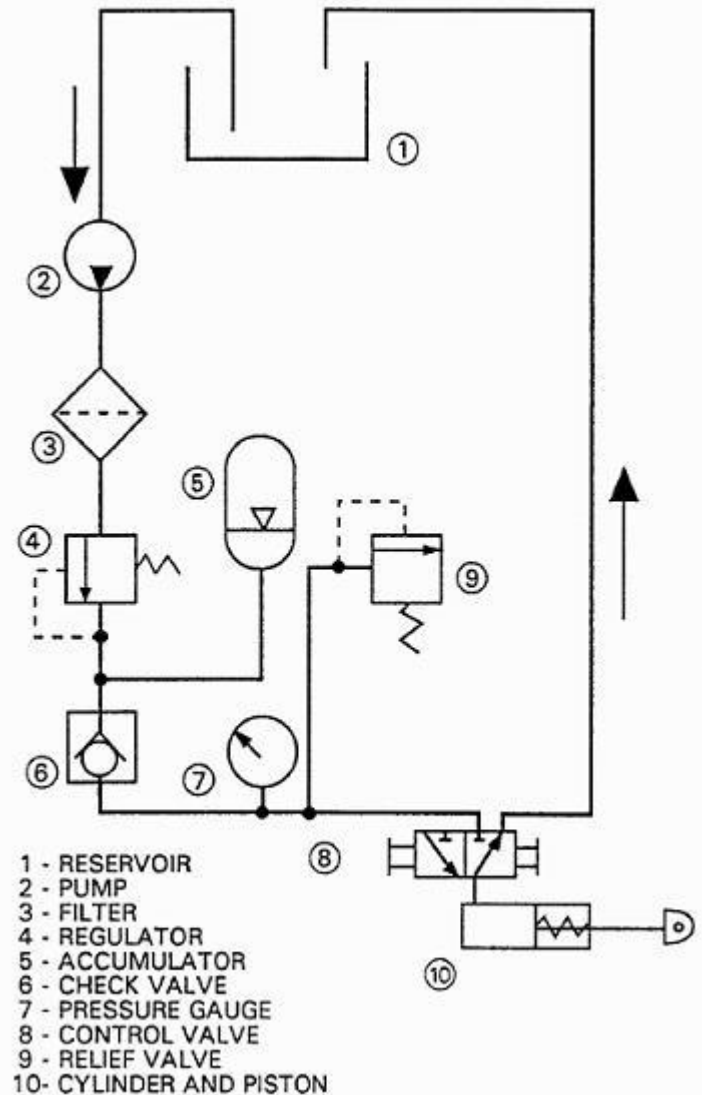
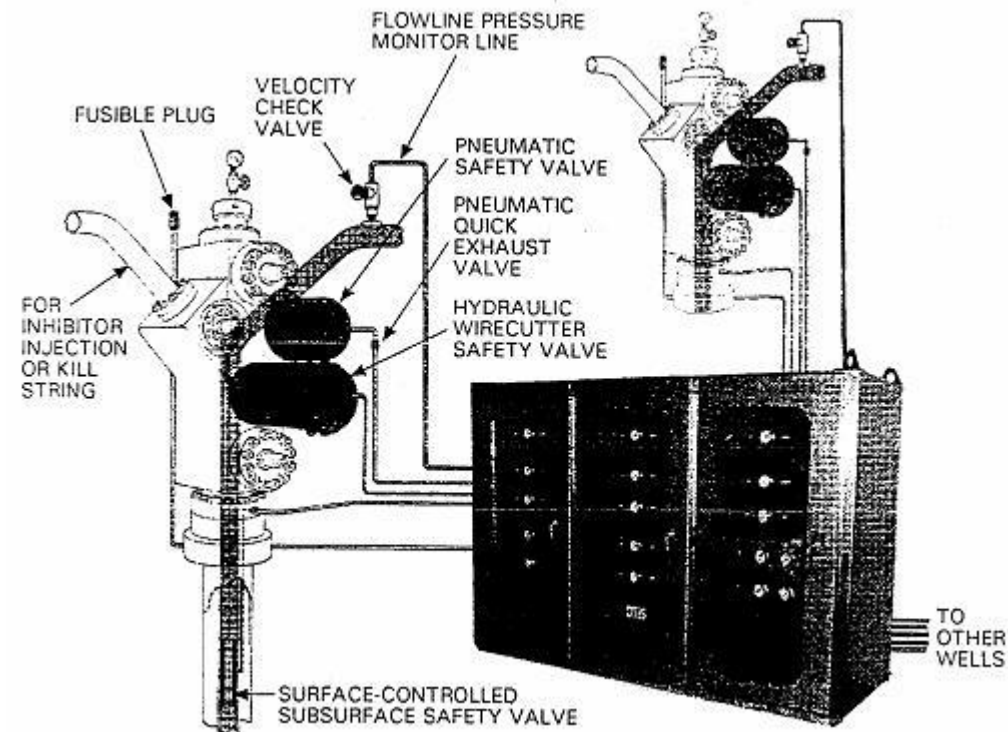


Note 1: electric logic treatment and pneumatic interface shown are for exempli gratia only and do not denote COMPANY's preference.

Note 2: total independence of DHSV and SSV command circuit is show for exempli gratia only and does not denote COMPANY's preference over DHSV hydraulic return to open drains.

Site application well equipment and control

- Typical well control panel
 - Typical Well Control



Site application well equipment and control

- **Typical well control panel**

- **Rules for Well Control Panel Functional requirement**

- The wellhead control (WHCP) panel shall be linked to the platform control and safety systems for remote monitoring and control of the wells
 - It shall be of fail-safe design so that all concerned safety valves shall move to their safety position
 - The (WHCP) shall be used to operate and control the wells subsurface and surface safety valves

	SCSSV - DHSV	SSV – MV	WV - Wing Valve
Control signal failure action	Close	Close	Close
Power fluid failure action	Close	Close	Close
Open / Close local command	Yes	Yes	Yes
Local reset after ESD	Yes	Yes	Yes (1)
Partial stroking facility	No	No	No
ESD signal test facility	Yes	Yes	Yes
Open / Close remote authorisation	Yes	Yes	Yes
Open remote control	No	No (2)	(2)
Open remote control	Yes	Yes	Yes
Open / Close status in CCR (3)	Yes	Yes	Yes

Site application well equipment and control

- **Typical well control panel**

- **Rules for Well Control Panel Functional requirement**

- **Control functions**

- Local Control:

- A manual “OPEN/CLOSE” device shall be available for each DHSV, SSV and wing valve
 - It shall directly act on the hydraulic fluid circuitry and shall be lockable in the “CLOSE” position
 - Demand for local closing of the valve shall always override the command from the control and safety system
 - Opening the valve shall only be possible if the safety system controlled pilot is energized
 - **Downhole Valve:** some high pressure wells may require a “soft starting” device for DHSV’s



Site application well equipment and control

- **Typical well control panel**

- **Rules for Well Control Panel Functional requirement**

- **Control functions**

- Remote Control

- Wellhead valves shall be remotely controlled by means of solenoid controlled pilot valves
 - Solenoid valves will be monostable
 - Pilots will be 3-way/2-position
 - Valves shall move to their safety or 'fail to' positions in case control signal, electrical power supply or power fluid is lost
 - **Wing valves:** when PCS control is required, a second solenoid controlled pilot valve shall be installed in series with the one used for safety



Site application well equipment and control

- **Typical well control panel**

- **Rules for Well Control Panel Functional requirement**

- **Control functions**

- Local Reset

- After a shutdown, X-mas tree valves must be reset locally after solenoid pilot valves have been re-energized by the SSS
 - This “RESET” function can be combined with the local control by means of a 3-way valve, push to close/pull and hold till pressurized to open, spring return to safety position when pilot pressure is lost
 - **Wing valve:** local reset is required in case of safety shutdown only
 - Remote opening shall be possible when wing valve is closed voluntarily by the PCS



Site application well equipment and control

- **Typical well control panel**

- **Rules for Well Control Panel Functional requirement**

- **Control functions**

- Solenoid Valve Test

- Wellhead valves control panel shall provide the capability for testing the signal from the safety system
 - The switch shall have two positions: “NORMAL” and “ESD OVERRIDE”
 - It shall be spring return to the “NORMAL” position and the key shall be locked in the “ESD OVERRIDE” position
 - In the “ESD OVERRIDE” position the solenoid controlled pilot shall be bypassed so as to allow the solenoid to be de-energized without moving the valve to its safety position
 - A “TEST” status shall be sent to the relevant safety system by means of a pressure switch
 - Electrical contact shall be Single Pole Double Throw (SPDT)



Site application well equipment and control

- **Typical well control panel**

- **Rules for Well Control Panel Functional requirement**

- **Control functions**

- Interlocks

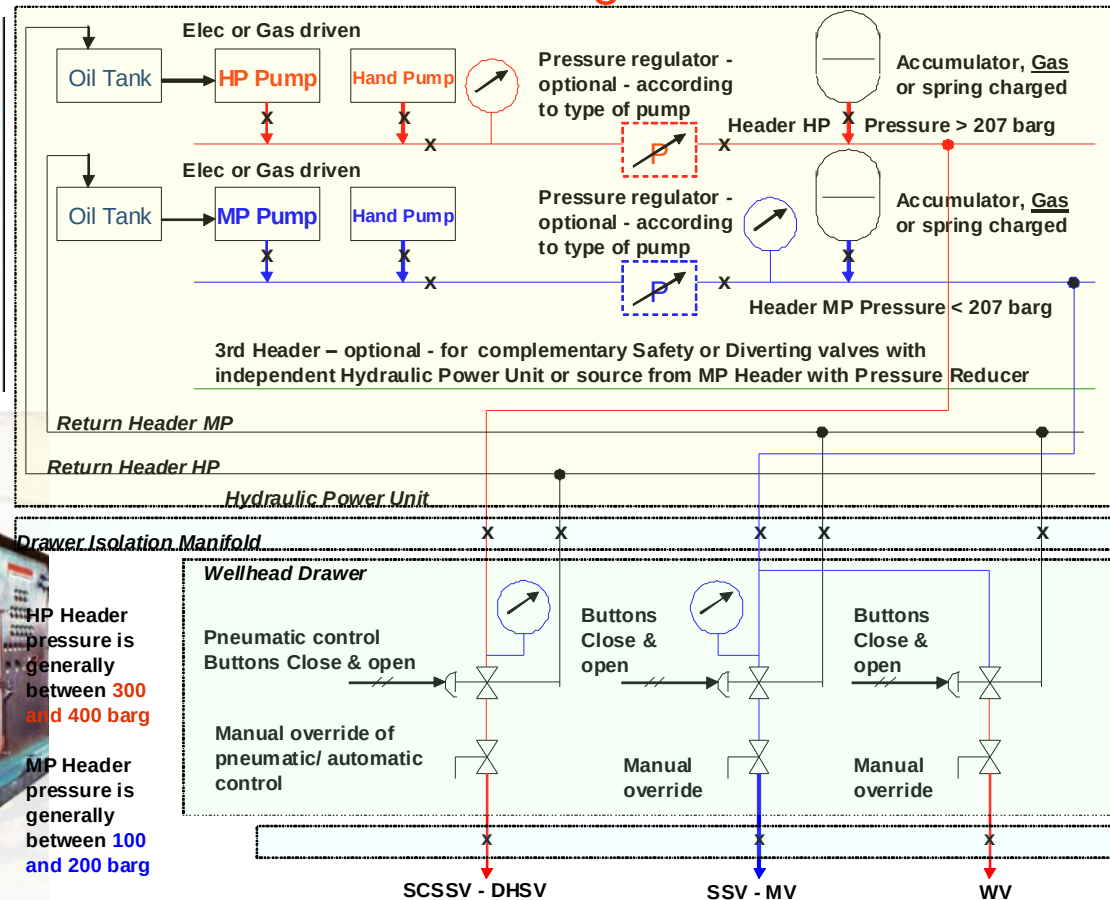
- Wellhead valves shall always be operated in sequence: DHSV shall open before master and wing valves and close after them
 - Time delays between actuation of the different valves are normally handled by the safety system
 - Local interlocking between DHSV and SSV's shall also be provided
 - This shall close the SSV, or prevent the SSV from opening, in case of loss of pressure in the DHSV control line
 - A throttle valve shall be installed on each DHSV return line for adjusting the closing speed



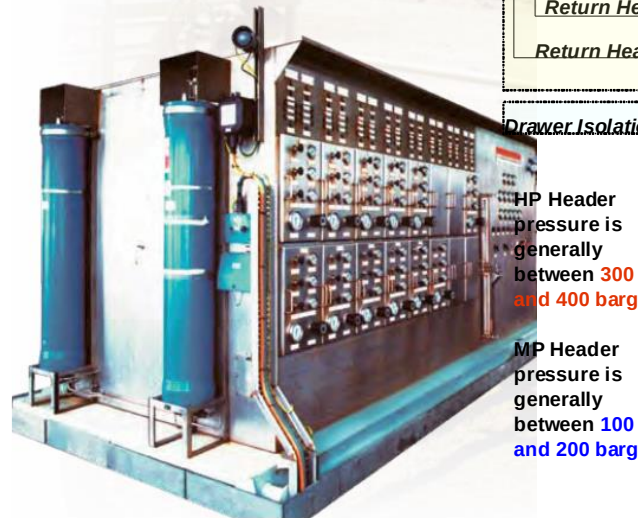
Site application well equipment and control

- Typical well control panel

- Typical Well Control Panel Block Diagram Distribution



And 'X' drawers different types: production, injection, oil or gas or water.... One well = one drawer



- Typical Well Control Panel Block Diagram Distribution

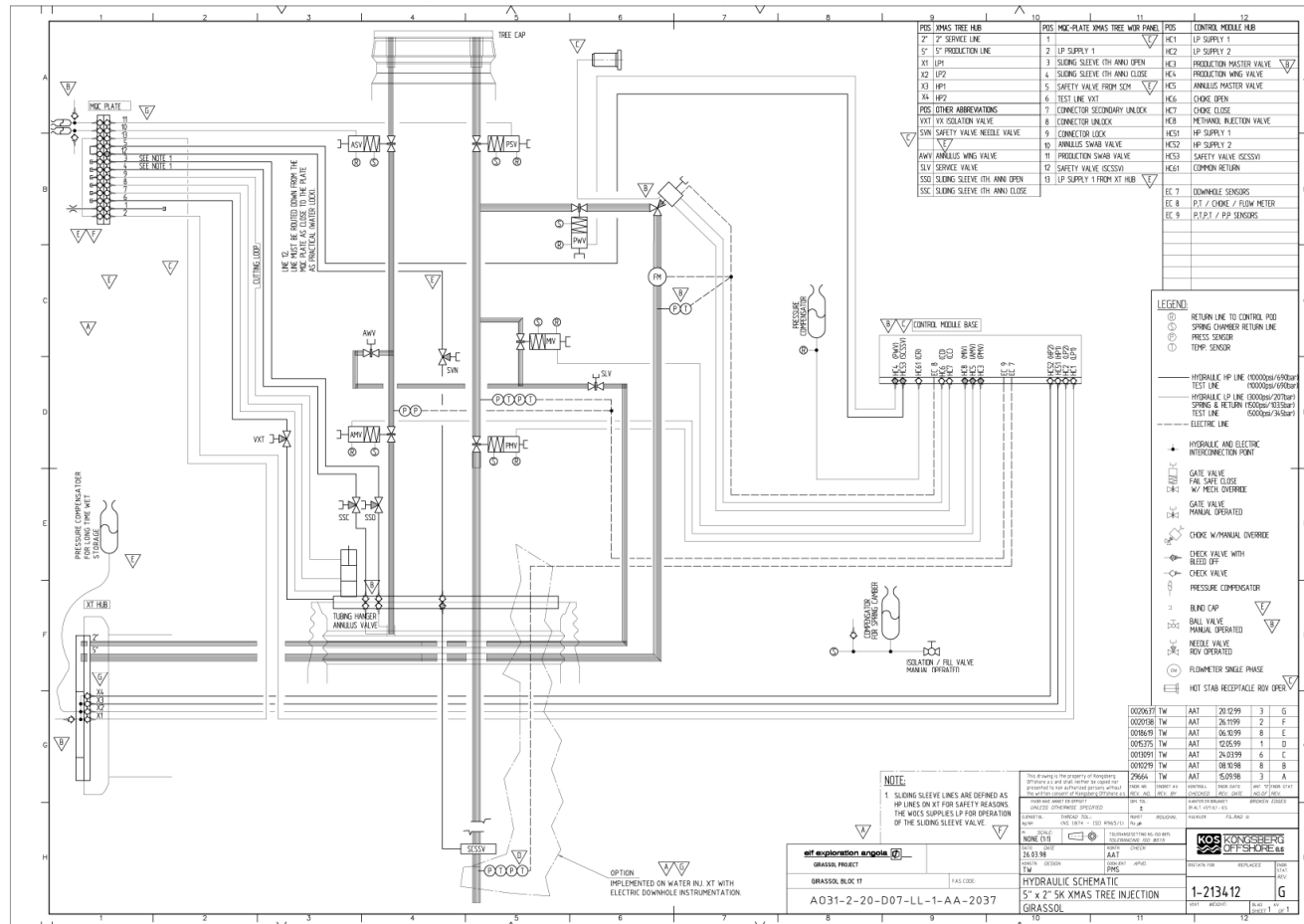


- Typical Well Control Panel Block Diagram Distribution



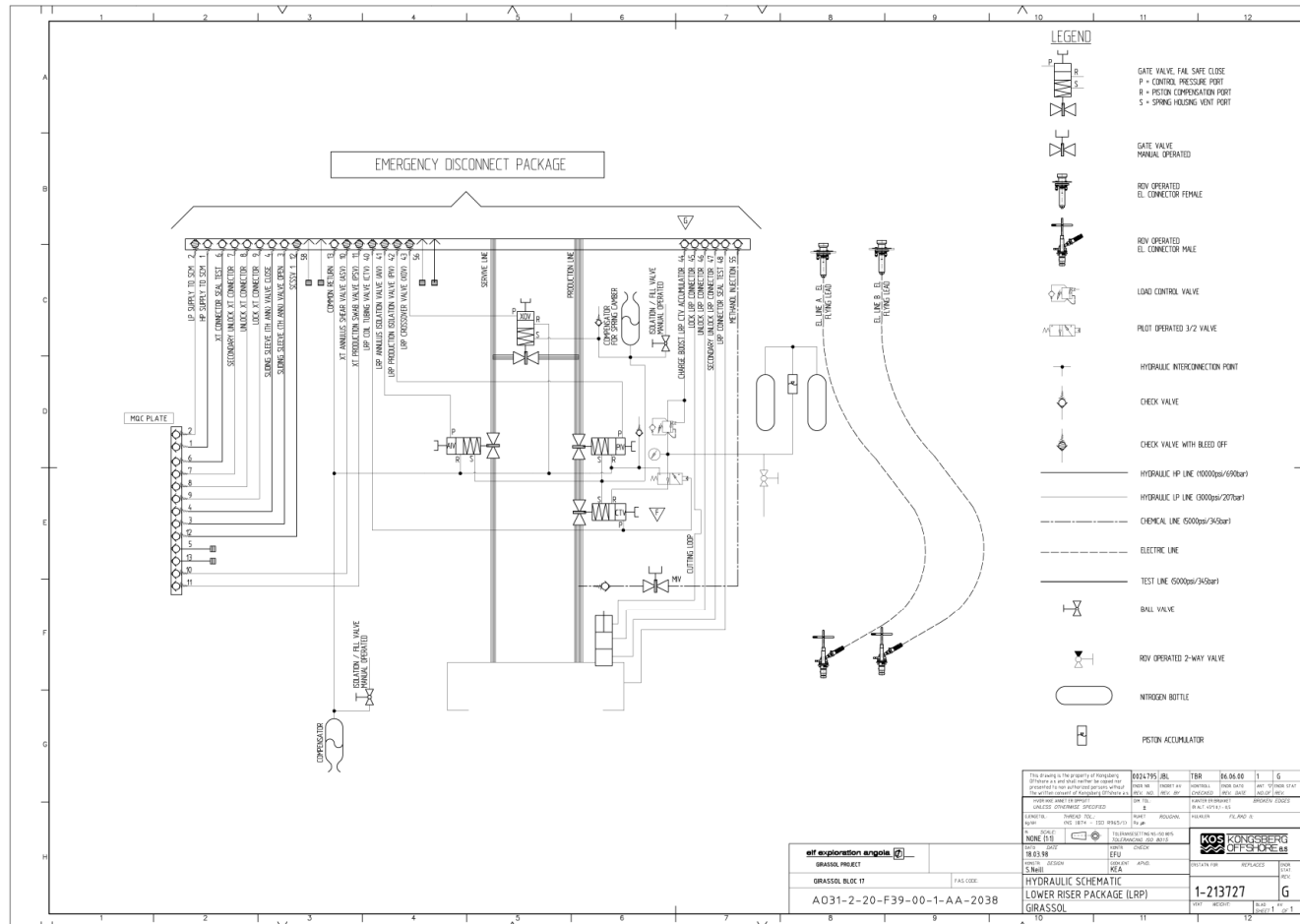
Site application well equipment and control

- Typical well control panel
 - Typical Well Control Panel Block Diagram Distribution



Site application well equipment and control

- Typical well control panel
 - Typical Well Control Panel Block Diagram Distribution

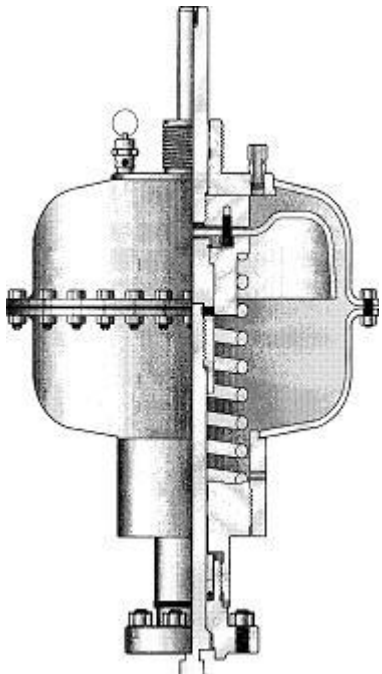


Site application well equipment and control

- **Typical well control valve and actuators**

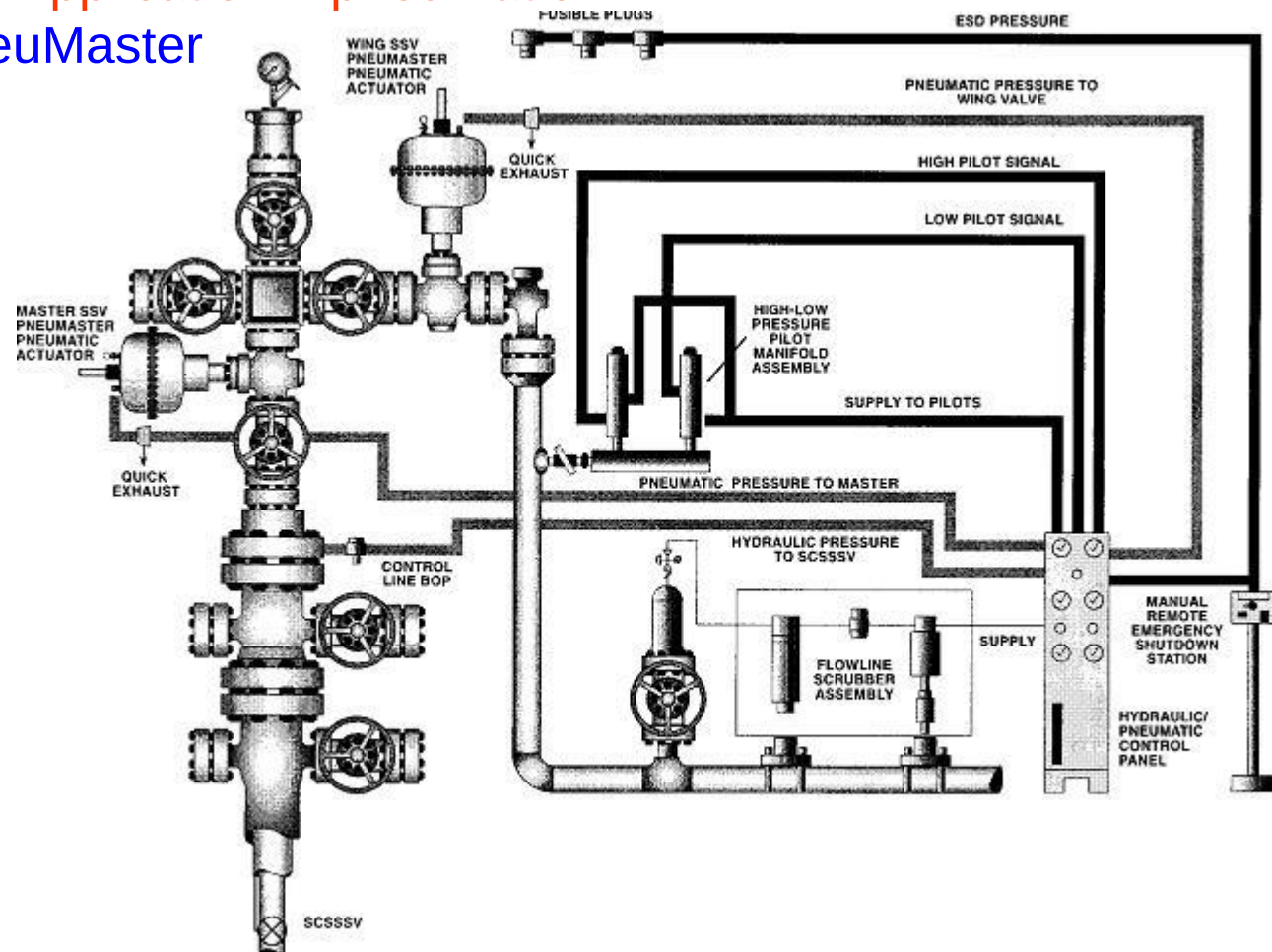
- **Surface Application – pneumatic**
– **PneuMaster**

- It is ideal for both wellhead and shut-down valves
 - It delivers simplicity, low weight, durability, and ease of maintenance
 - Feature Benefits:
 - Visual indication of position provided by the rising stem
 - Light weight
 - External pressure relief device
 - Fail-safe design



Site application well equipment and control

- Typical well control valve and actuators
 - Surface Application – pneumatic
 - PneuMaster

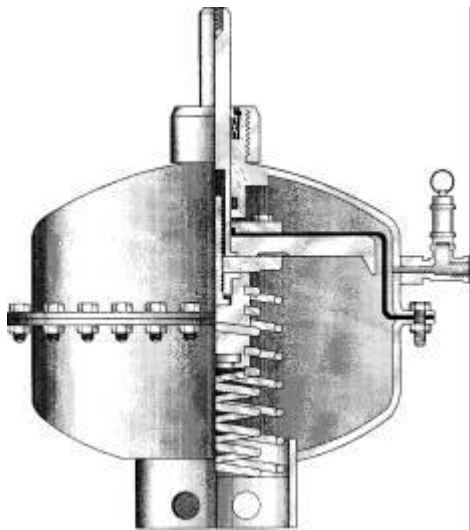


Site application well equipment and control

- **Typical well control valve and actuators**

- **Surface Application – pneumatic**
 - **Dia-Flex Tandem**

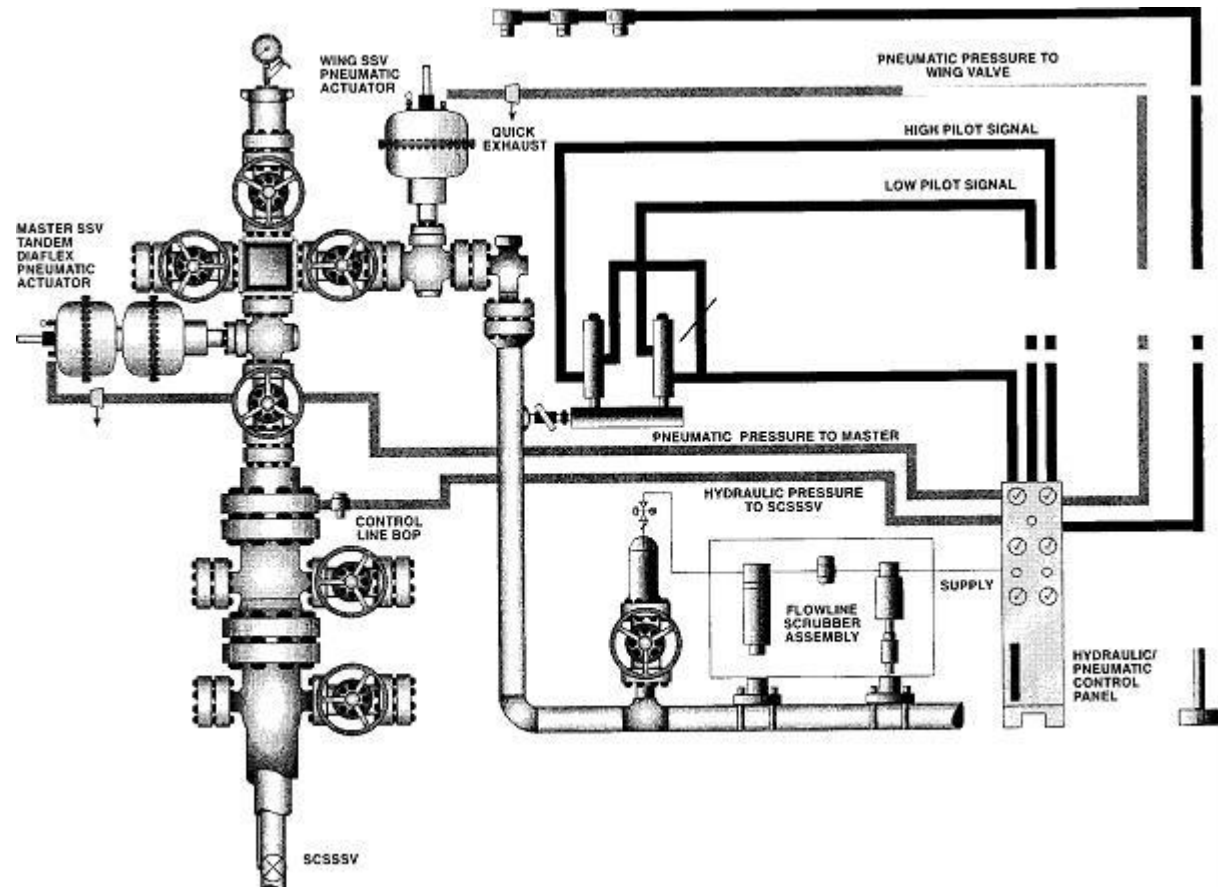
- It features an easily renewed poly-pak seal around the rising stem
 - It does not require disassembly for dynamic seal/replacement
 - Featured Benefits:



- Eliminates the dynamic o-ring problems with a diaphragm
 - Utilizes an easily renewed poly-pak seal that provides easy seal replacement
 - Lighter in weight than the piston type design
 - Universal adaptability to any Baker Oil Tools' bonnet assembly without bonnet adapter kits
 - Dual-wound opposed springs External safety relief device Fail-safe design

Site application well equipment and control

- Typical well control valve and actuators
 - Surface Application – pneumatic
 - Dia-Flex Tandem



Site application well equipment and control

- **Typical well control valve and actuators**

- **Surface Application – pneumatic**

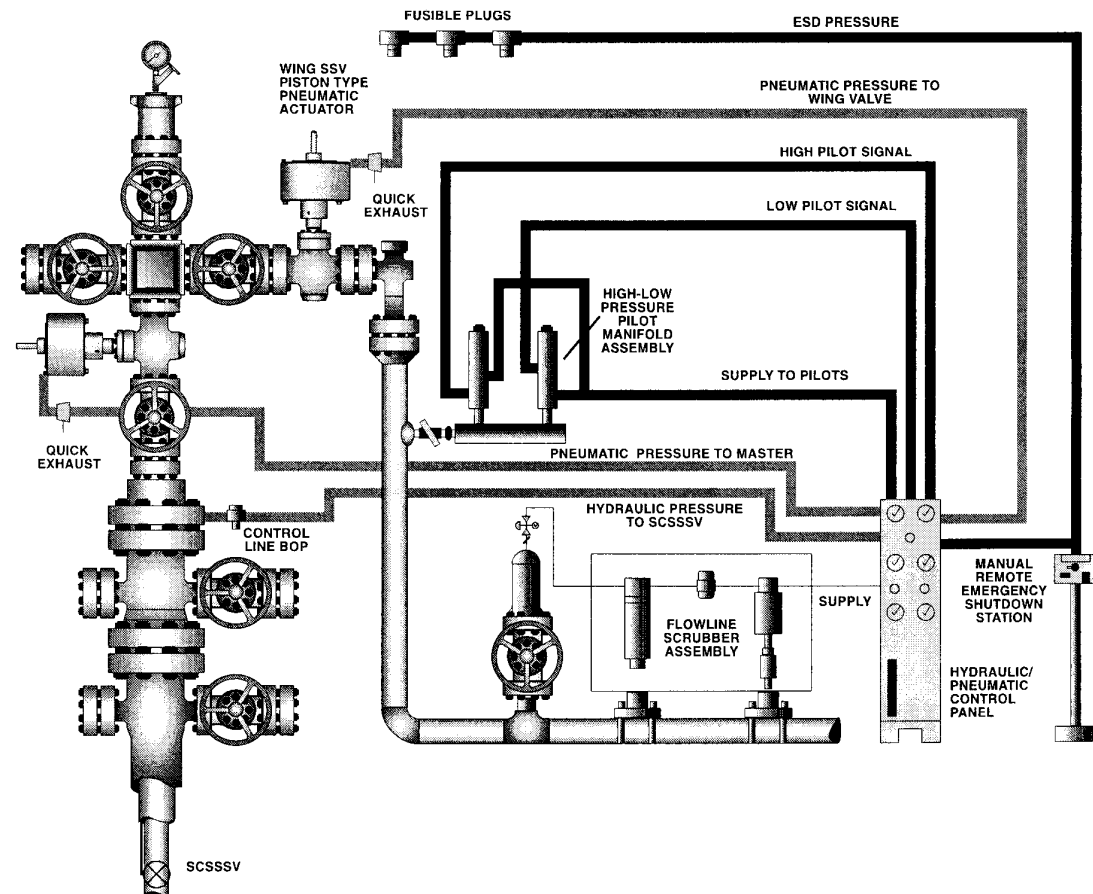
- **Piston Type**

- the Pneumatic Piston-Type Actuator supplies a downward thrust upon application of pneumatic pressure from an external source
 - Features Benefits:
 - Compact design, removable within own working space
 - Universal adaptability
 - Visual indication produced by rising stem
 - Dual opposed wound springs
 - One-piece lock ring (stainless steel)
 - External safety relief device
 - Fail-safe design



Site application well equipment and control

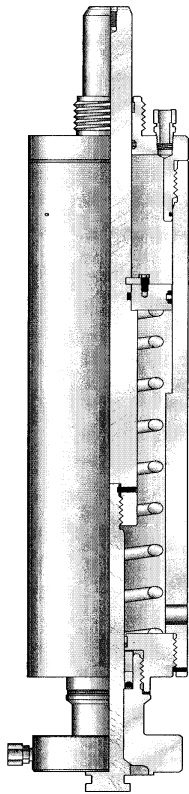
- Typical well control valve and actuators
 - Surface Application – pneumatic
– Piston Type



Site application well equipment and control

- **Typical well control valve and actuators**

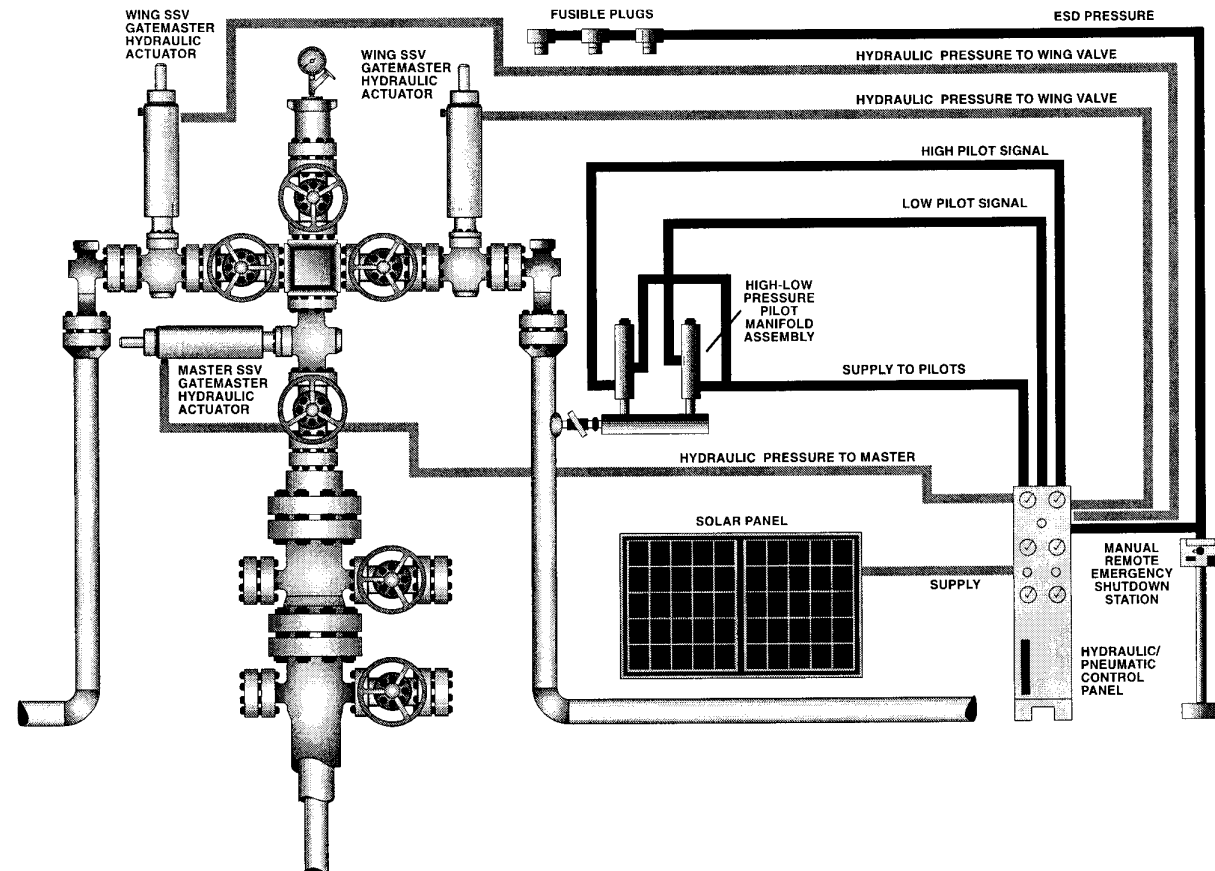
- **Surface Application – Hydraulic**
– **GateMaster**



- It delivers reliable fail-safe performance on gate valves
- It is used for low pressure wellhead applications and is mounted to the upper master and dual wing valves
- It is designed to be used in conjunction with the Master Series bonnets mounted on 2" - 4" (50.8 mm - 101.6 mm) gate valves
- Features Benefits
 - Visual indication of position provided by the rising stem
 - Universal one-piece housing
 - External pressure relief device
 - Fail-safe design

Site application well equipment and control

- Typical well control valve and actuators
 - Surface Application – Hydraulic – GateMaster

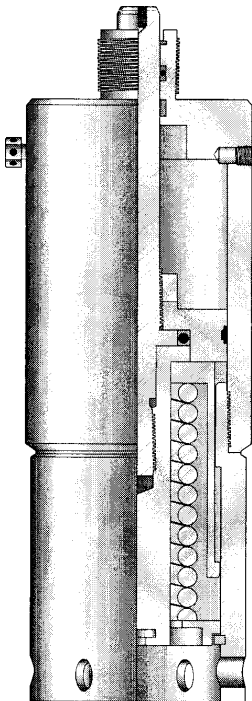


Site application well equipment and control

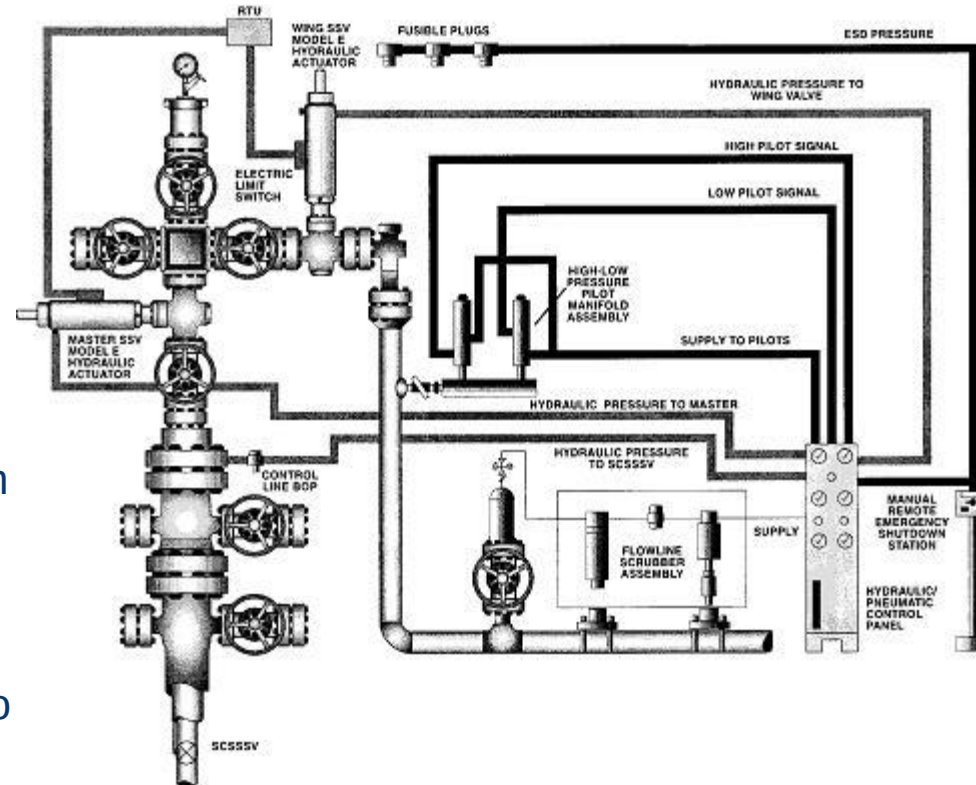
- **Typical well control valve and actuators**

- **Surface Application – Hydraulic**

- **Model « E » Actuator**



- It is equipped with side mount limit switches that provide valve position to a remote control station
- It is short in profile and intended for valves from 2-1/2" - 6-5/8" (63.5 mm - 168.27 mm)
- The line pressures up to 689 bars

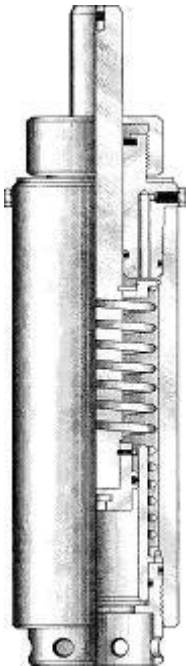


Site application well equipment and control

- **Typical well control valve and actuators**

- **Surface Application – Hydraulic**

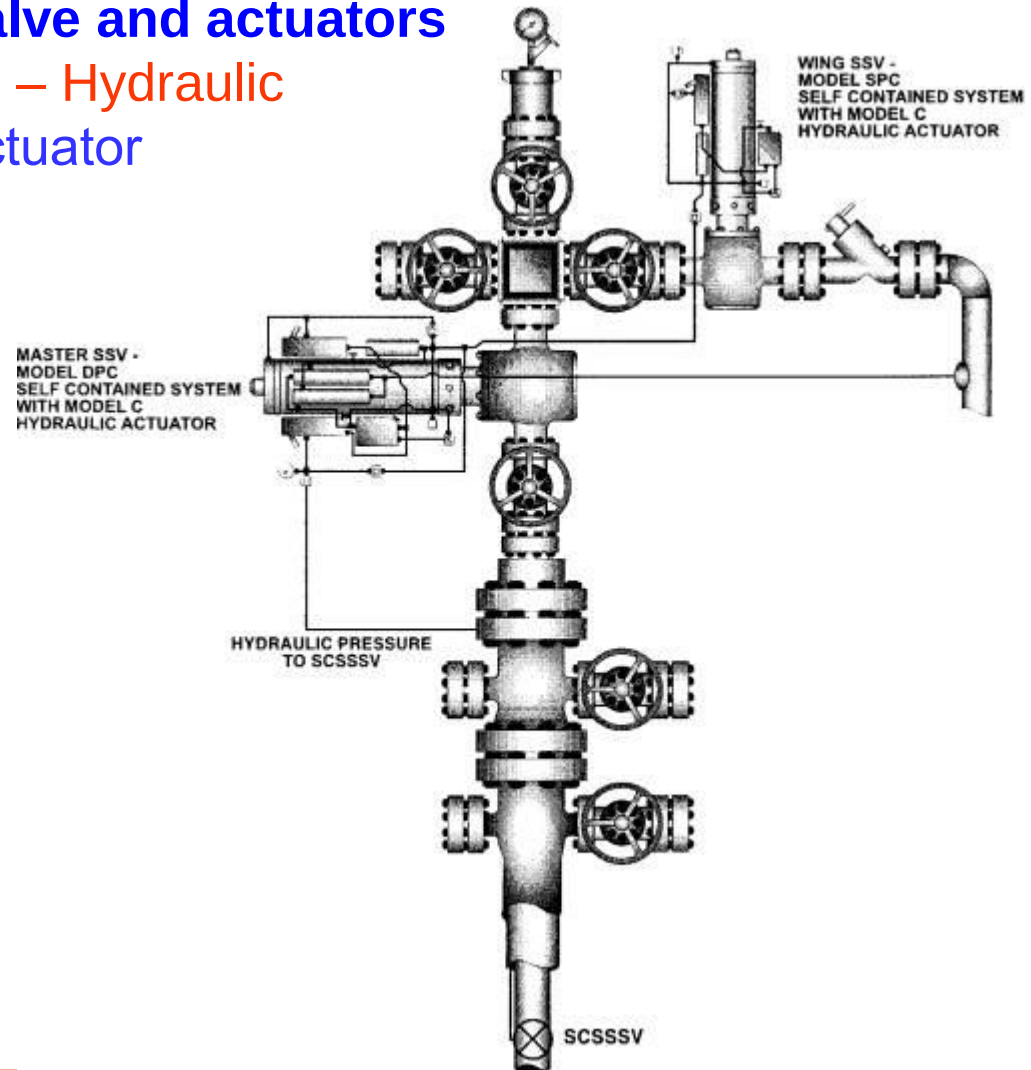
- **Model « C » Actuator**



- It is beneficial in harsh desert, offshore and jungle environments
- It is controlled by a self-contained system
- Once mounted, it becomes the power unit assuring complete valve closure or opening, upon loss of control pressure
- It operates valves from the 1-13/16"- 4-1/16" (46.03 mm – 26.8 mm) range with operating pressures up to 689.4 bars

Site application well equipment and control

- Typical well control valve and actuators
 - Surface Application – Hydraulic
 - Model « C » Actuator



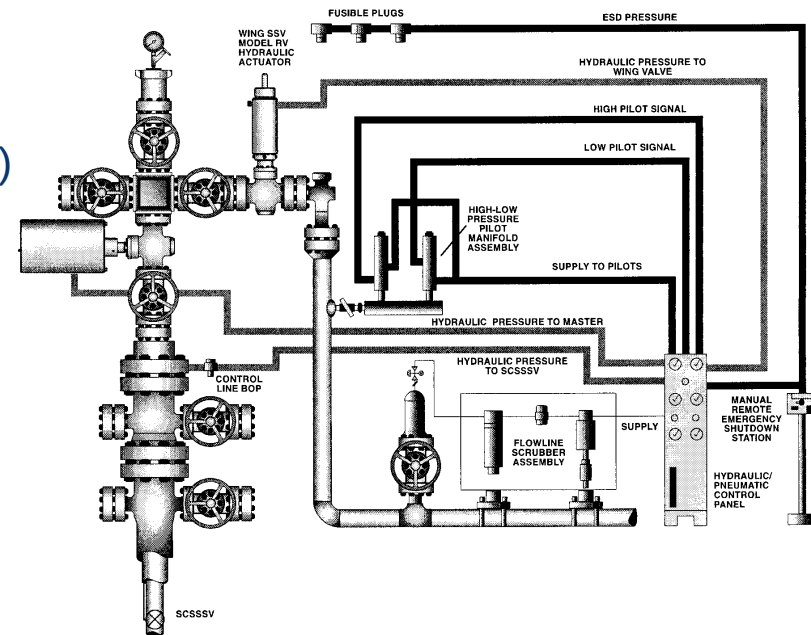
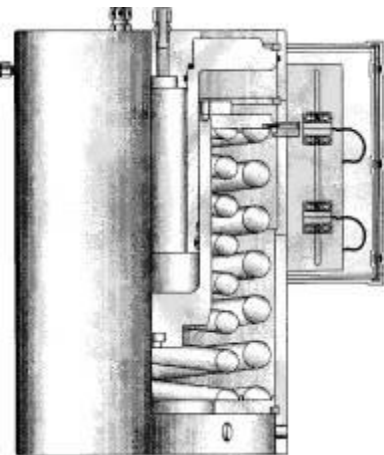
Site application well equipment and control

- **Typical well control valve and actuators**

- **Surface Application – Hydraulic**

- **Model « CSWC» Actuator – Coil Spring Wire-Cutting**

- It is widely used for fail-safe shut-in during extended wireline operations
 - It utilizes a patented translating cylinder and is available in a 5" or 7" (127 mm or 177.8 mm) piston size
 - The pistons operate gate valves from 4" to 6" (301.6 mm or 152.4 mm) range and accommodate operating pressures up to 1034.4 bars

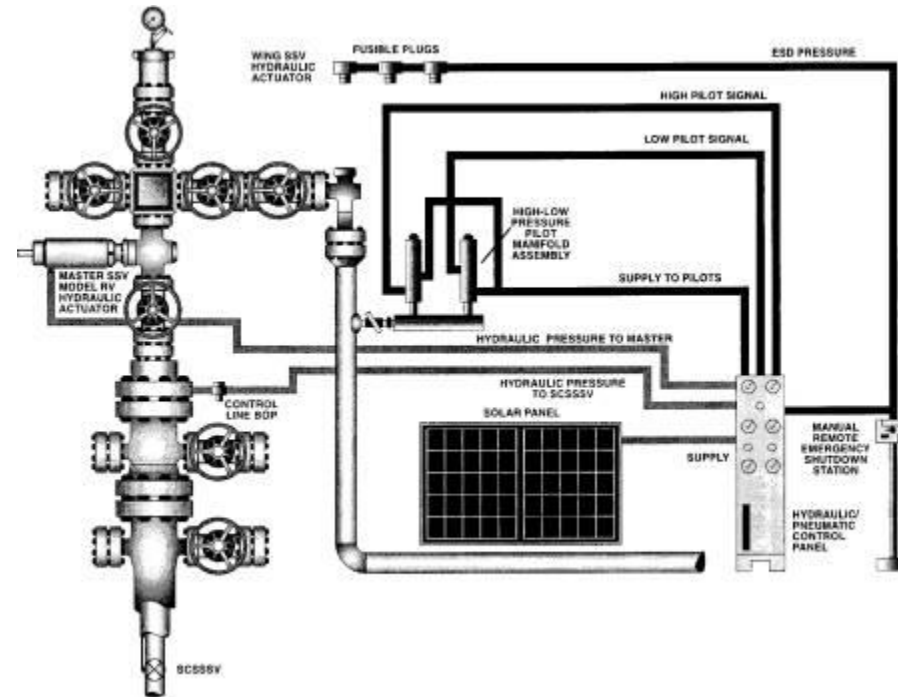
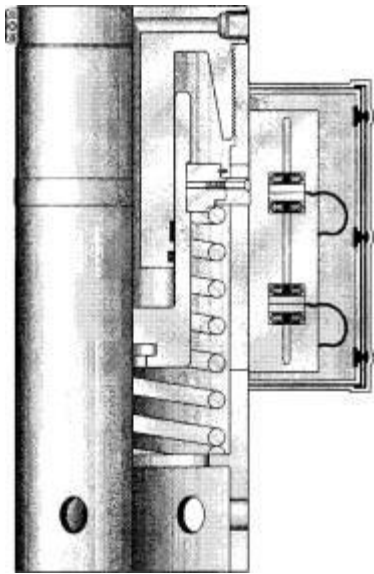


Site application well equipment and control

- **Typical well control valve and actuators**

- **Surface Application – Hydraulic**
– **Model « RV» Actuator**

- It is designed to minimize the cost and size of safety systems
- It operates 2" -4" (50.8 mm - 101.6 mm) valves and accommodates pressures up to 345 bars
- The Model RV Actuator Design is chosen due to its short profile



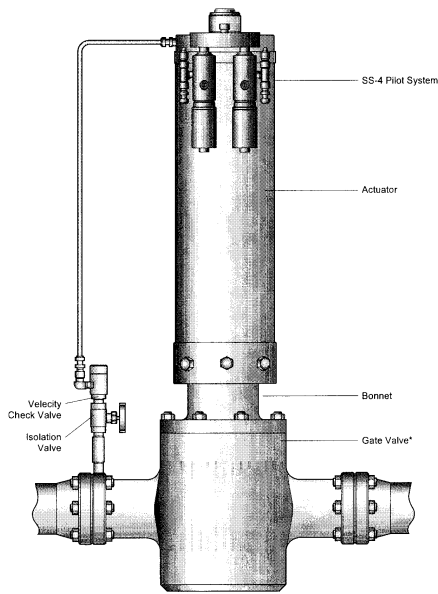
Site application well equipment and control

- **Typical well control valve and actuators**

- **Surface Application – Hydraulic**

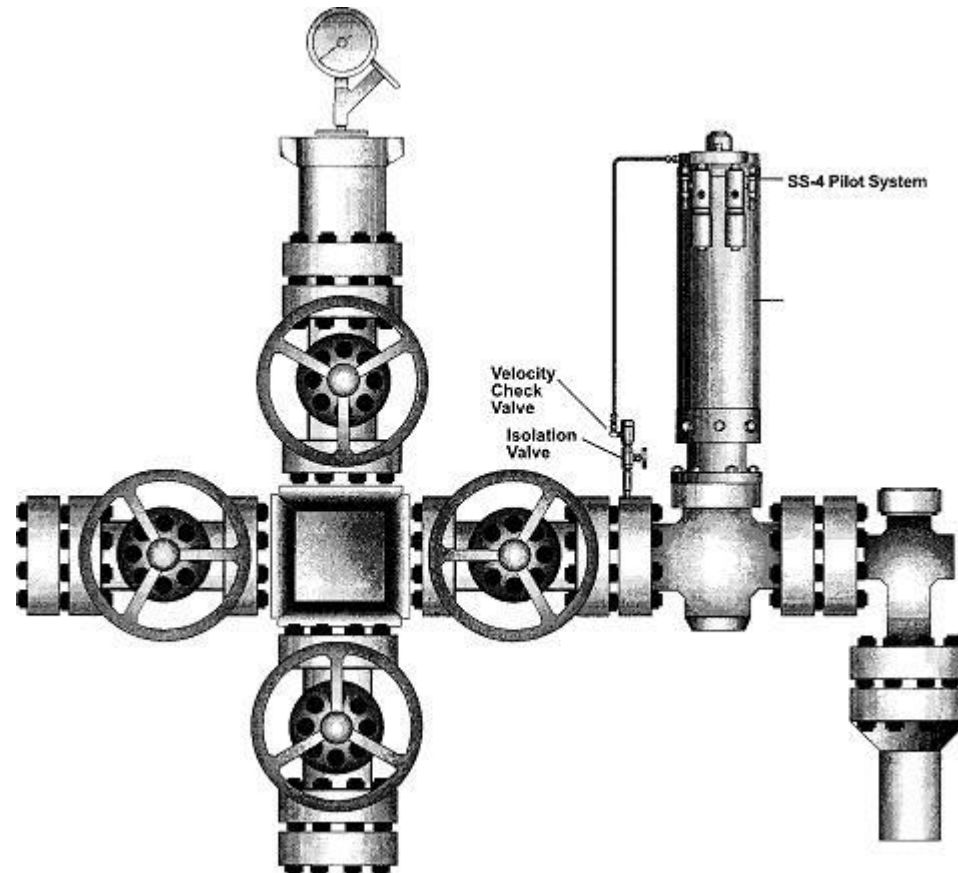
- **Model «LPO: Line Pressure Operated» Actuator with model “C”**

- The "LPO" Surface Safety System is designed for precision well control in situations where local supervision is minimal and external power sources are not available
 - Features Benefits
 - Configured for gate valve sizes from 1-13/16" - 8" (406.3 mm - 203.2 mm) with working pressures up to 344.8 bars
 - Alleviates need for an external power source
 - Minimizes system monitoring High/low pilots and components are externally mounted for ease of calibrating and servicing
 - Stainless steel wetted parts provide years of reliable service for model SS4 high and low-pressure pilots
 - External safety relief device protects actuator from over pressurization
 - Pilot design includes interchangeable spools allowing easy field conversion from high-to-low or low-to-high pressure



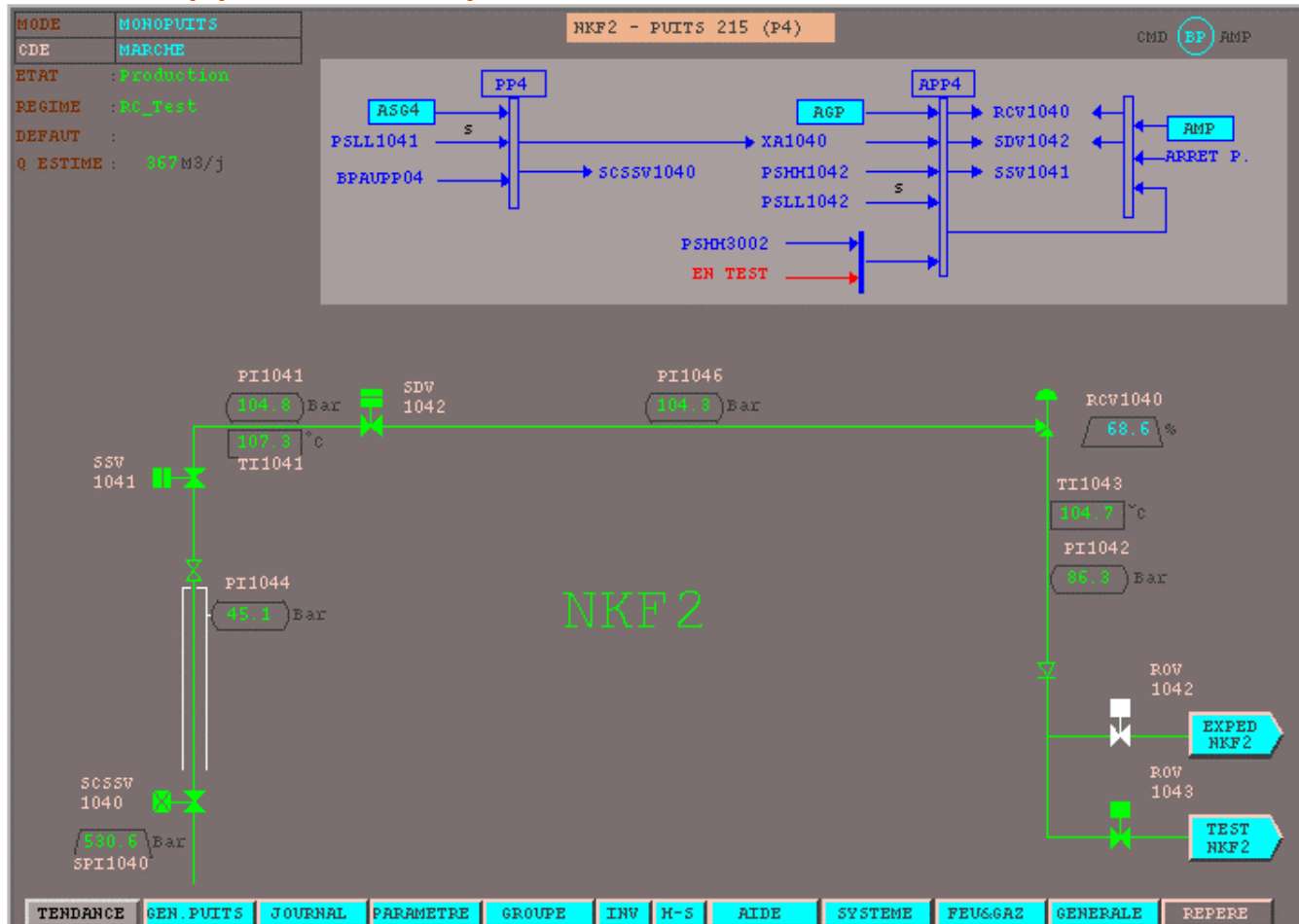
Site application well equipment and control

- **Typical well control valve and actuators**
 - **Surface Application – Hydraulic**
 - Model «LPO: Line Pressure Operated» Actuator with model “C”



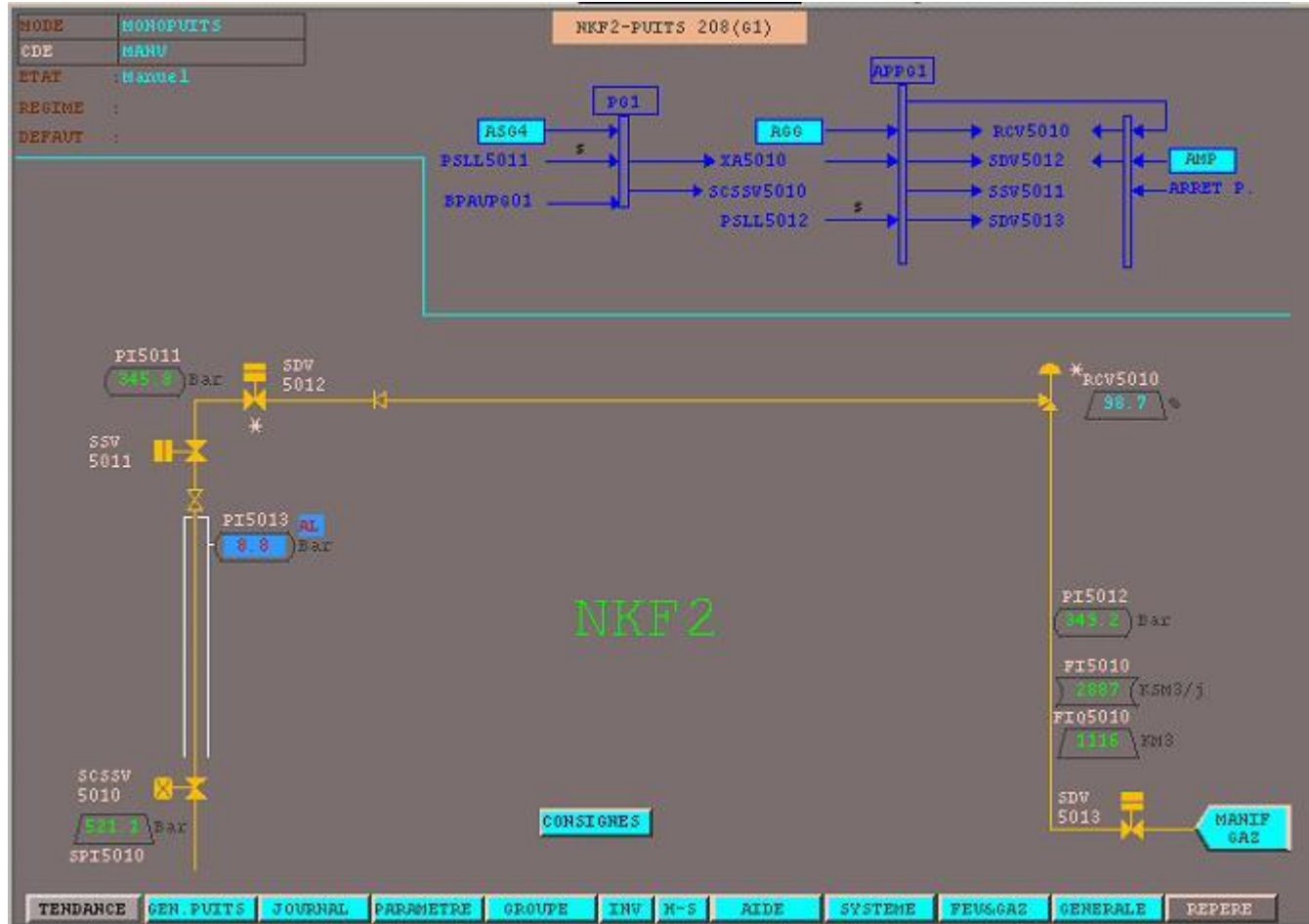
Site application well equipment and control

- Typical well control valve and actuators
 - Surface Application – pneumatic



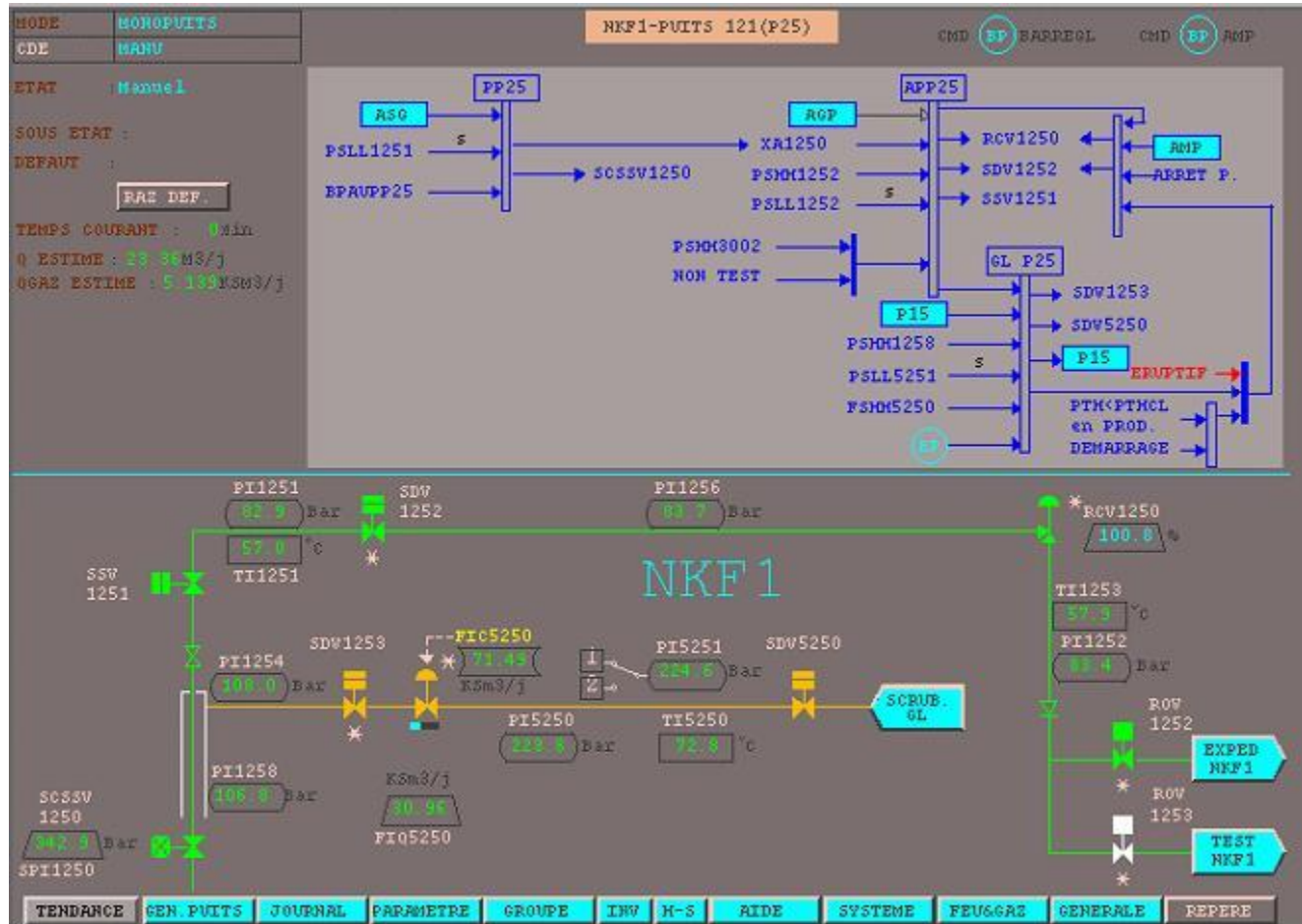
Site application well equipment and control

- Typical well control valve and actuators
 - Surface Application – pneumatic



Site application well equipment and control

- Typical well control valve and actuators
 - Surface Application – pneumatic



Other hydraulic systems and units

- **Chemical injection systems**

- **Chemical injection skid with a 4500 litres tank**

- Distribution panels with flow control valves with remote operation
 - Compact units using Air Driven Pumps
 - Customised systems with high accuracy dosing rates



- **Multi Point Chemical Injection System**

- Type: Constant Flow, Multi Point Chemical Injection System
 - Application: Off shore
 - Media : Corrosion Inhibitor, wax Inhibitor



- **Wax Inhibitor Injection**

- Chemical injection system using electrically driven Diaphragm Metering Pump and other necessary components to inject chemical (Wax) at desired rate and pressure



Other hydraulic systems and units

- **Valve test bench**

- **Applications of Test bench**

- Type: Test Bench for Valves
 - Application: Pressure Testing of various valves
 - Calibration of safety valves
 - Clamping: Manual / Hydraulic
 - HPU: Pneumatic/ Hydraulic



- **The Pressure safety valve test bench has two main parts:**

- High pressure control panel for Nitrogen with a max operating pressure of 690 bars and 5 ranges of safety pattern gauges with over pressure protection devices
 - Valve clamping bench for Flanges up to 16 in size



Other hydraulic systems and units

- **Dead weight tester**



- **Hydraulic hand pumps**



- **Hydraulic power applications**

