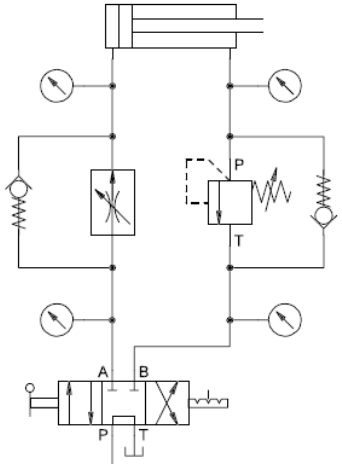

بسم الله الرحمن الرحيم

Hydraulic & Pneumatic Circuits



Tanta University

Faculty of Engineering
Mechanical power
Engineering Dept.

Lecture (7)

on

Basic Circuits and Sizing Hydraulic Components

By

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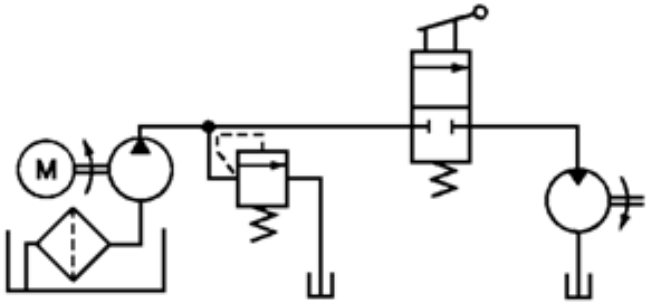
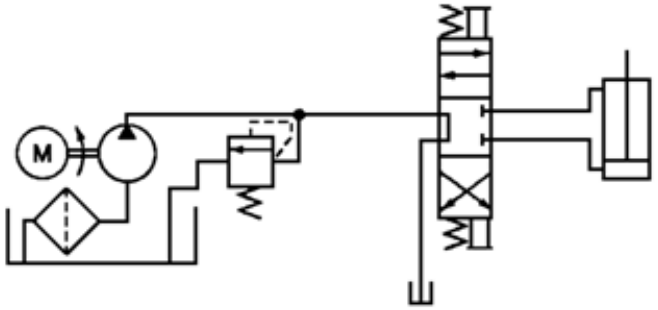
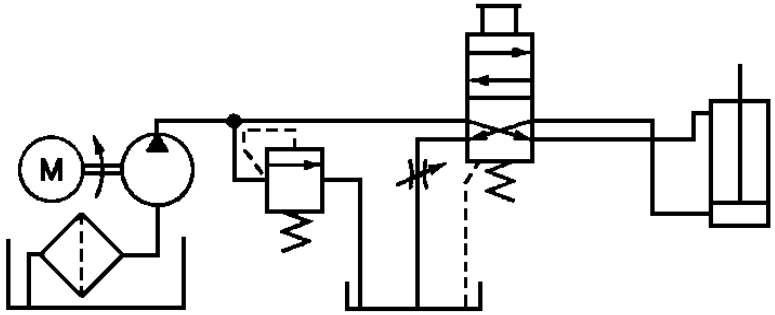
Constant Flow Systems (C-Q)



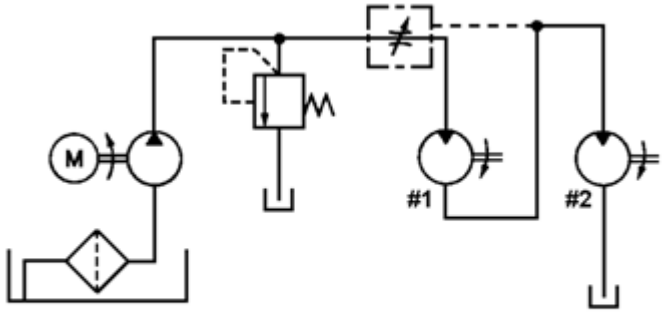
Simple *C-Q* circuit



C-Q circuit with open-center control valve and pilot operated relief valve



C-Q circuit; meter-out control

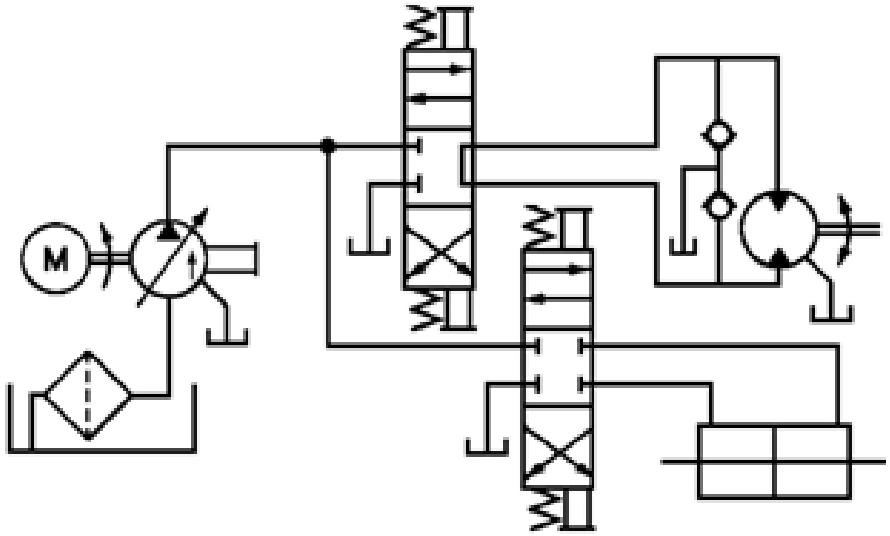


C-Q conveyor circuit with flow control valve

The conveyor regulates flow to #1 motor and bleeds excess flow to #2 motor, allowing it to slightly lead #1, keeping the conveyor drive chain tight.

Constant Pressure Systems (C-P)

- Constant torque output regardless of variations in speed.
- With both valves in the center position, flow through the system is negligible and the pump supplies only make-up oil.
- The power loss is also small. The use of pressure-compensated variable displacement pumps eliminates the need for both relief and unloading valves, since the pump compensates to limit system pressure.



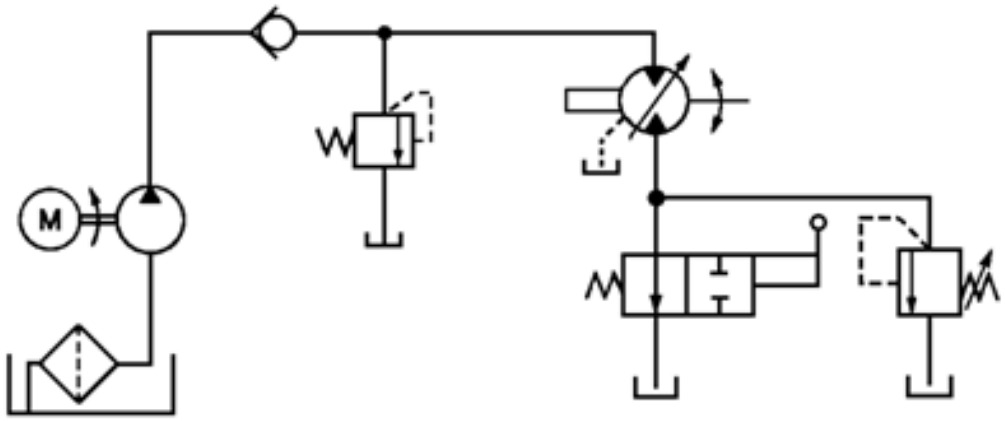
C-P circuit with two actuators

- Relief valves or hydraulic fuses are usually installed, however, to protect the system against:
  - ✓ Hydraulic shocks,
  - ✓ Thermal expansion of the fluid,
  - ✓ Possible malfunction of the pressure compensation mechanism in the pump.

Constant Horsepower Systems (C-Hp)

$$\text{Output Horsepower} = p.Q = T.N = \text{Constant}$$

- An in-line check prevents the motor from driving the pump when the load resistance is over capacity.
- A braking valve in the exhaust line is controlled by a manually operated two-way control valve.
- Setting the motor at maximum displacement will cause it to generate maximum torque at minimum speed.



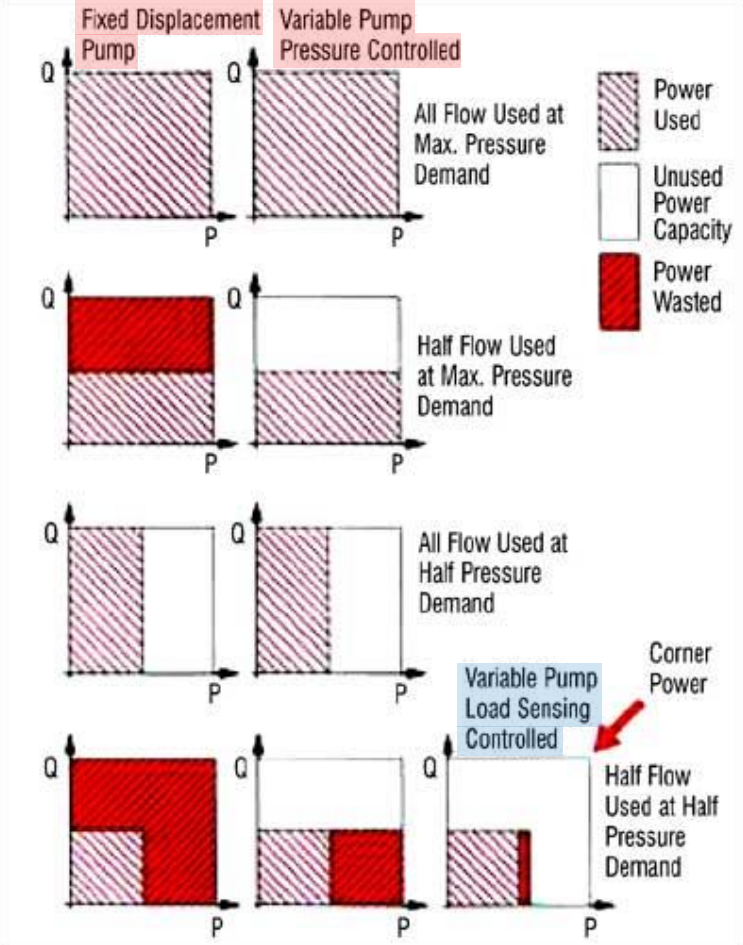
C-Hp output circuit

- Reducing the displacement will cause an increase in rpm accompanied by a decrease in torque such time as the torque is not sufficient to sustain rotation. At this displacement, the load resistance will stall the motor.

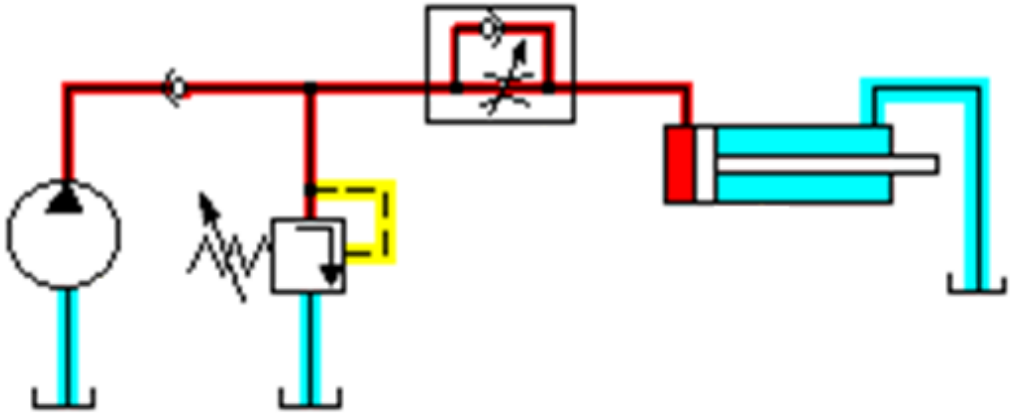
Load Sensing Systems

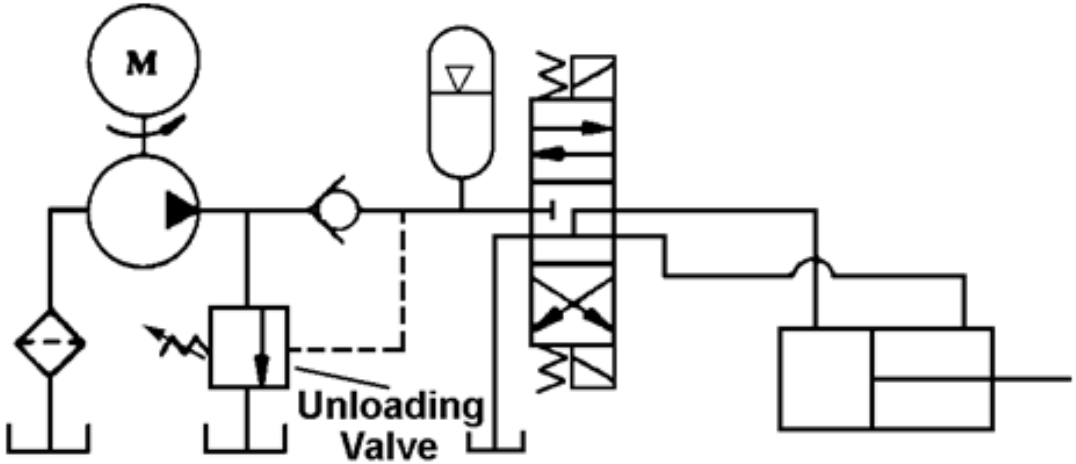
- In a certain application requires a capacity flow of 75 L/min at 172 bar.
- If a partial load required a pressure of only 89 bar, and a metered flow rate of 34 L/min.
- The flow valve would direct 34 L/min against the load resistance and the remaining 41 L/min would flow across the relief valve at 172 bar with a resulting **16 hp loss**. This energy would be lost in the form of heat.
- The traditional closed-center system under the same condition would deliver only the required 34 L/min, but at the destroke pressure of 172 bar, thereby causing a 83 bar pressure drop across the control valve with a resulting additional **6.4 hp loss** in the form of heat.

Load Sensing Systems



Load Sensing Systems

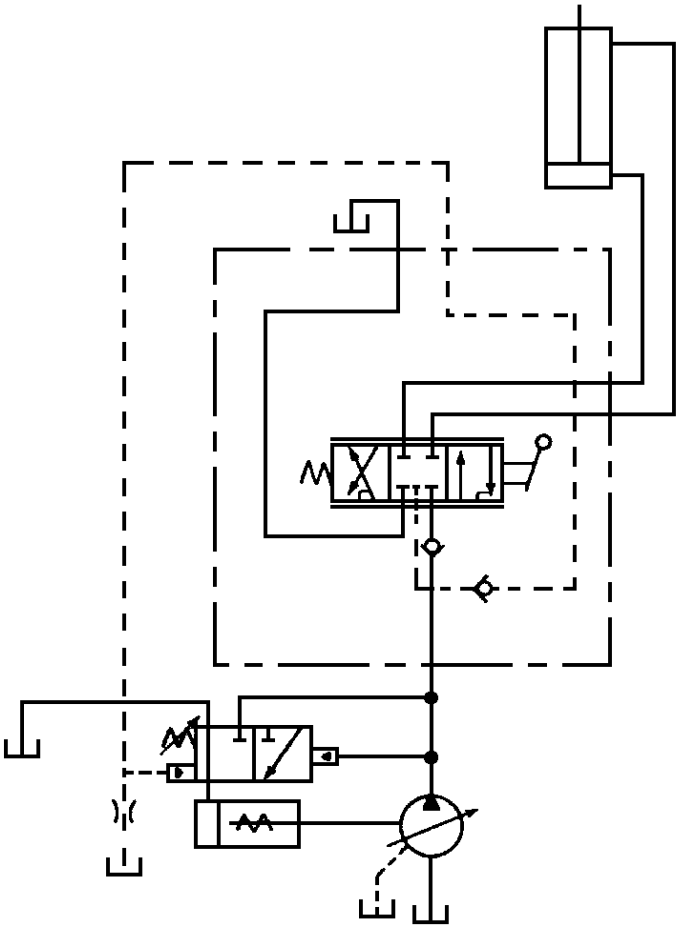


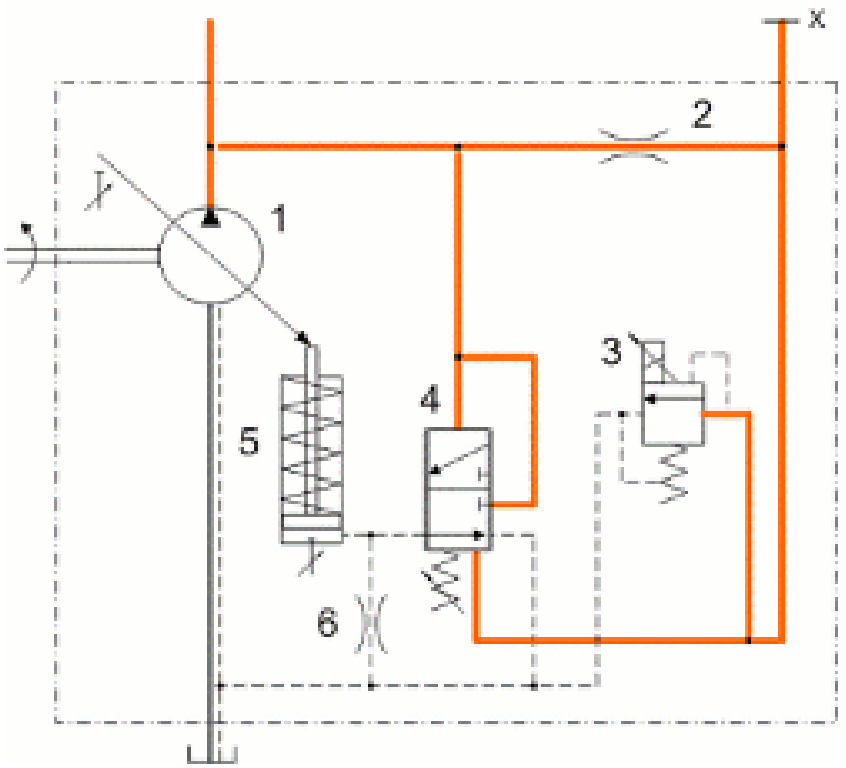


Load Sensing Systems

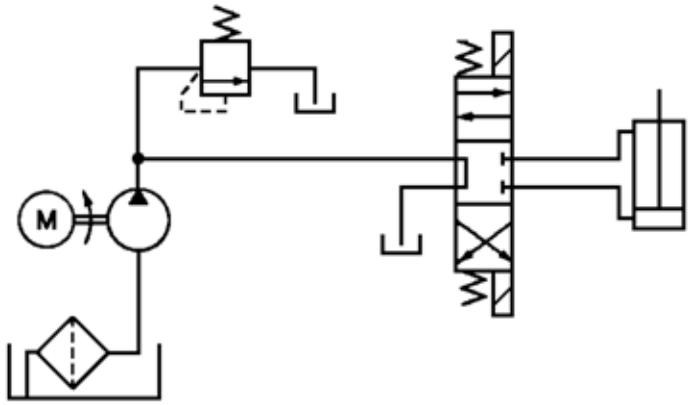
- The load-sensing system that uses a variable displacement pump has the destroking mechanism set at 13.8 bar,
- This is accomplished by having a separate pilot line from the work port used to establish the minimum pressure to move the load resistance, plus an amount necessary to provide make-up oil for leakage and serve other pilot and auxiliary needs in the system.
- The variable displacement pump would be destroked at 102.8 bar rather than at 172 bar, and deliver 34 L/min to the actuator while permitting only 13.8 bar pressure drop across the control valve with a resulting *only* **1.065 hp loss** in the form of heat. .

Load Sensing Systems



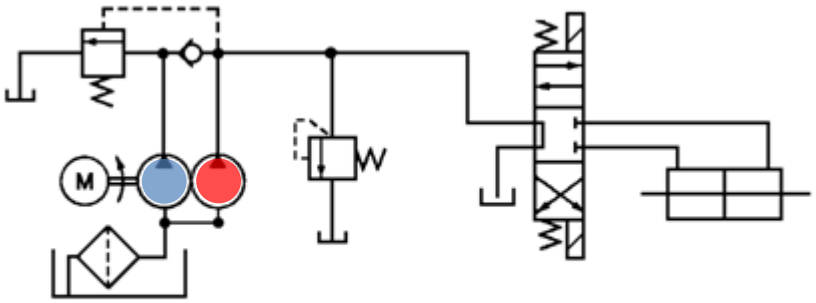


Unloading Circuits



Open-center circuit with linear actuator

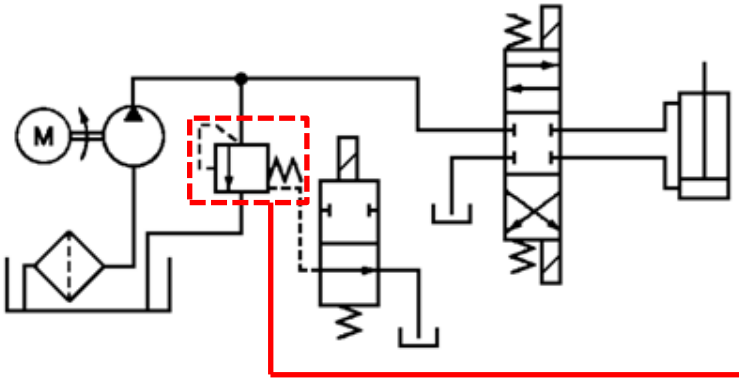
The open-center control valve is probably the simplest example used to unload a circuit when the control valve is in the center position



High-low unloading circuit

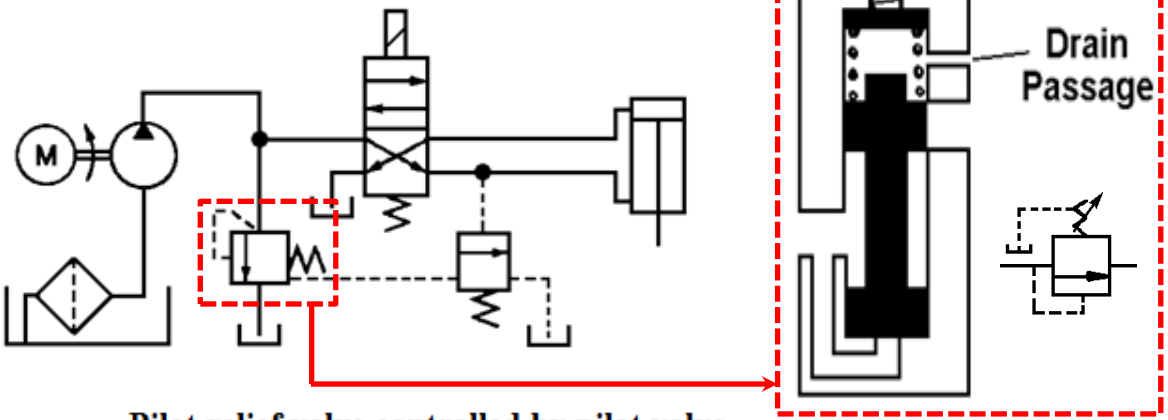
The open-center control valve is used to unload both pumps to drain when the control valve is in the center position.

Unloading Circuits



Pilot relief valve controlled by solenoid

When the four-way cylinder control valve is centered, the two-way solenoid valve is energized and opens the pilot drain from the relief valve.

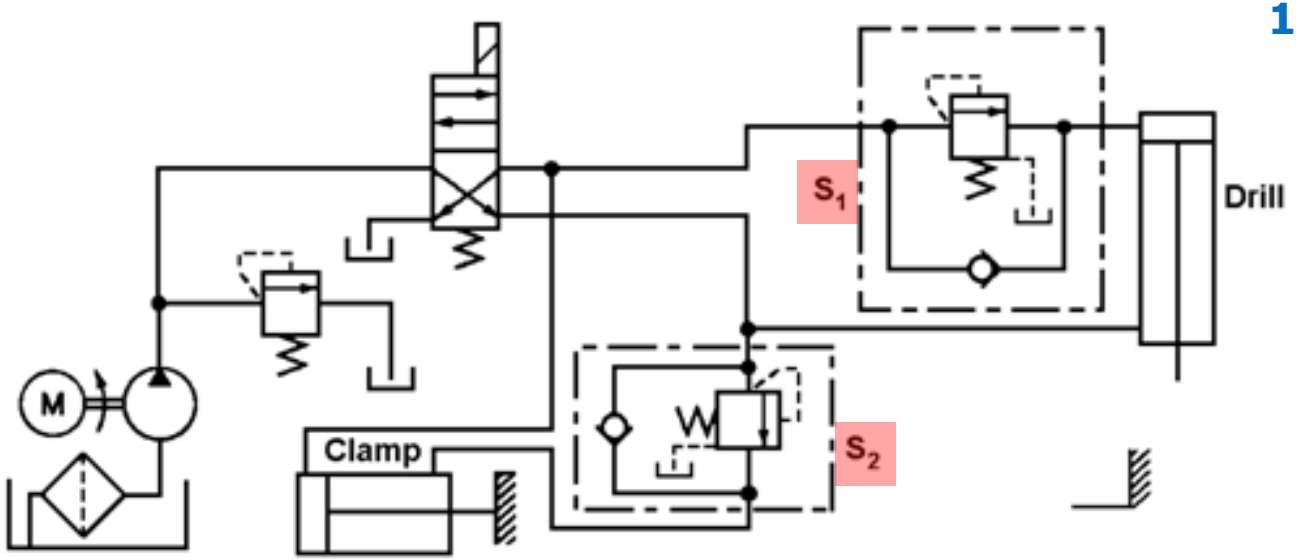


Pilot relief valve controlled by pilot valve

A pilot relief valve controlled by a second pilot operated pressure relief valve.

Basic Circuits

Sequencing Circuits



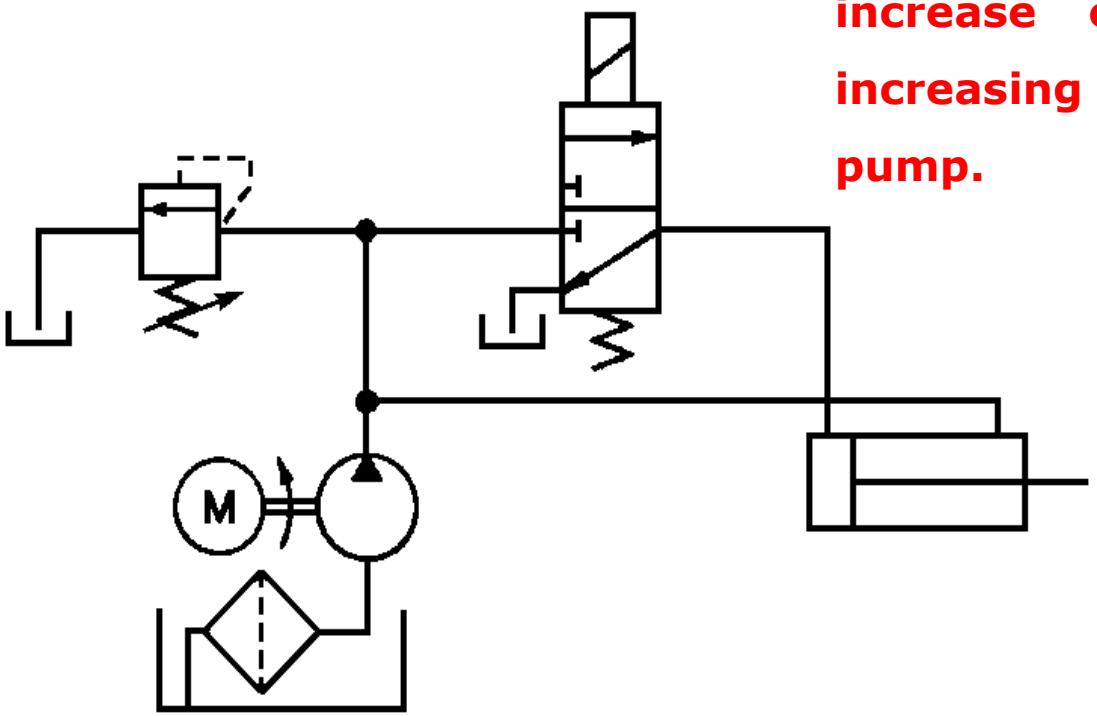
Presence step sequence circuit

1. Events can be ordered using unequal loading against cylinders of equal area by using electrical limit switches.

2. Using an independent cam operated switches to shift control valves to order cycle operations in the desired way.

Basic Circuits

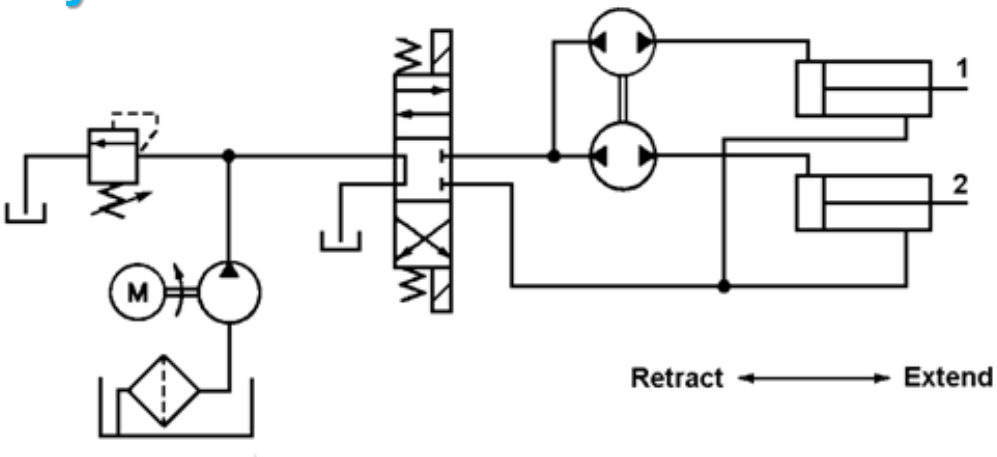
Regenerative Circuits



Regenerative circuits make use of the differential areas between the blank and rod ends of cylinder actuators to increase cylinder velocity without increasing the flow rate from the pump.

Basic Circuits

Synchronous Circuits



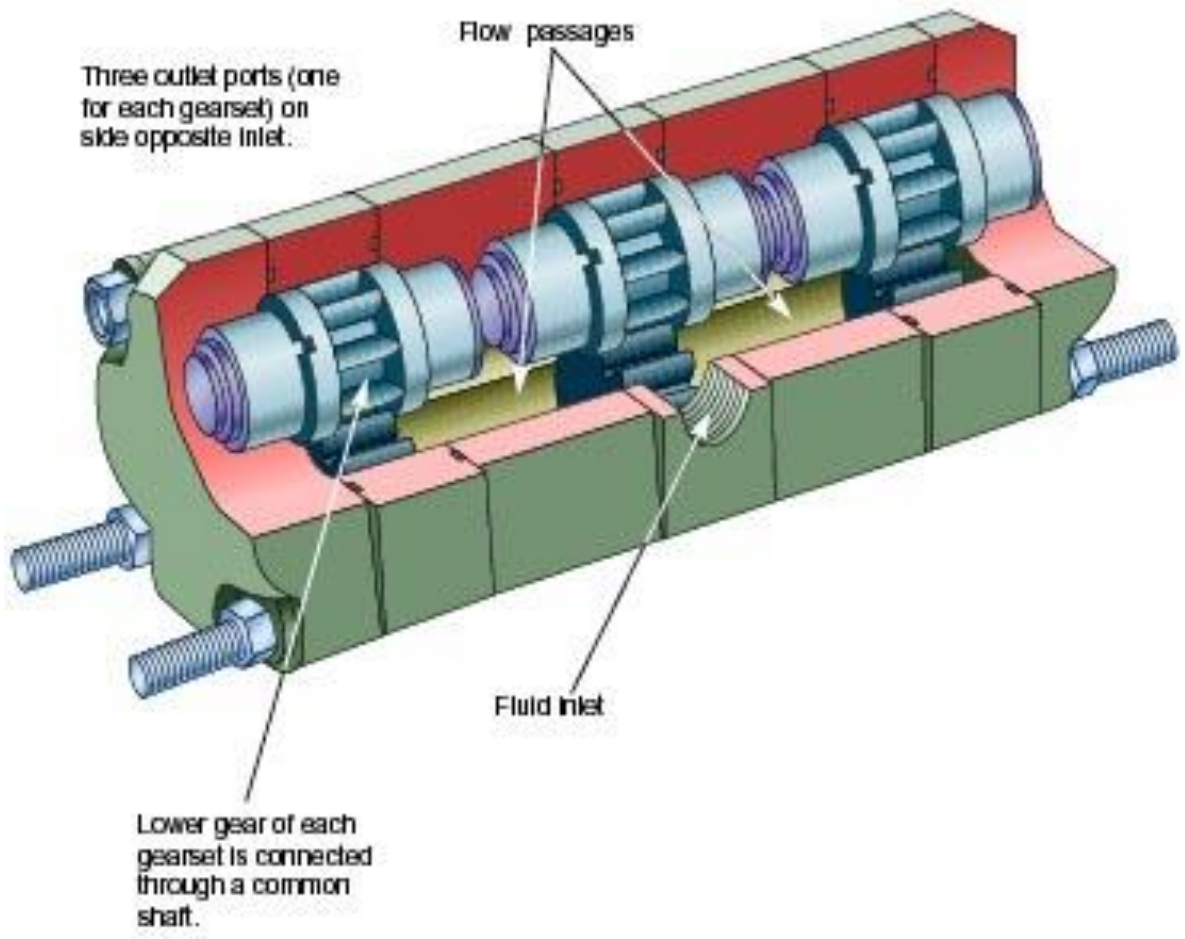
Synchronous circuit using flow divider

1. Using a mechanical link between both cylinders or rotary actuators together.
2. meter an equal amount of fluid to each circuit by using two fixed displacement fluid motors of equal volume or a flow divider.

Basic Circuits

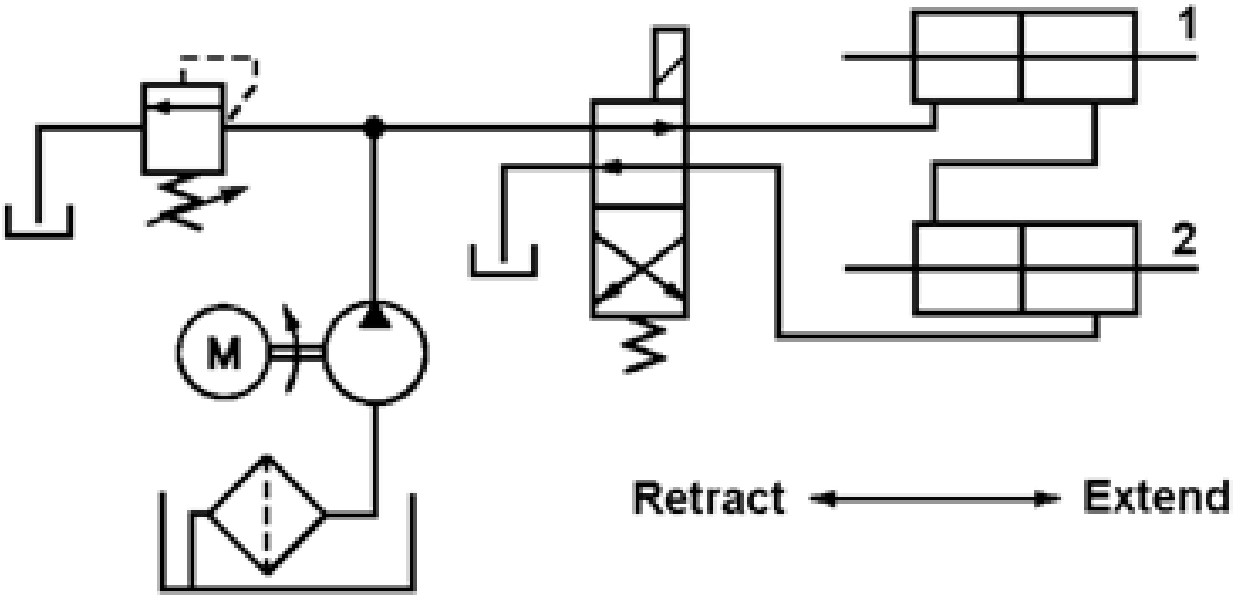
Synchronous Circuits

Flow Divider



Basic Circuits

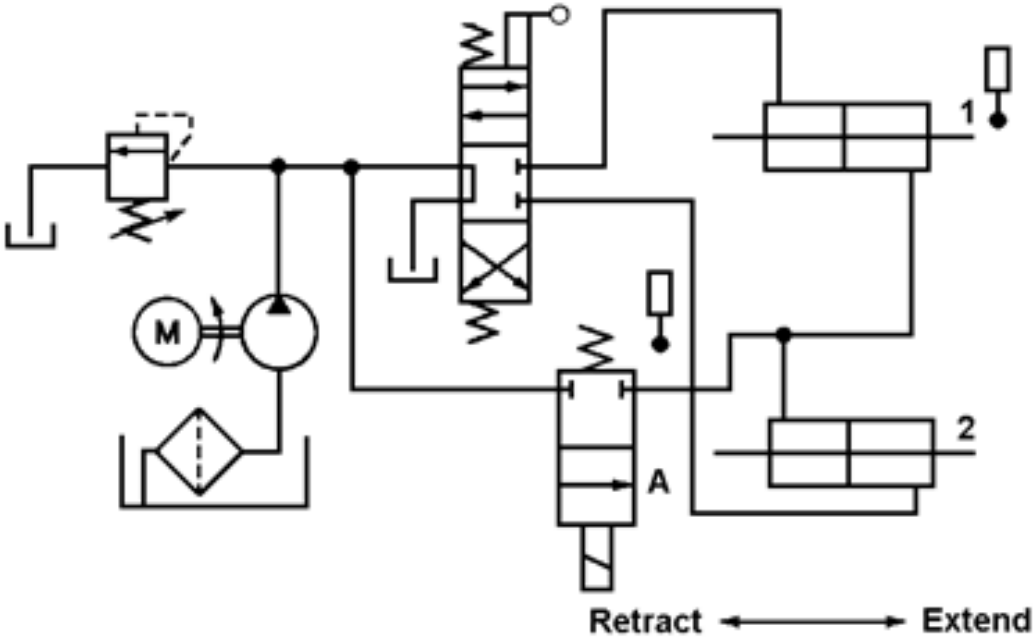
Synchronous Circuits



Synchronous circuit using equal area cylinders

Basic Circuits

Synchronous Circuits



Replenishing synchronous circuit

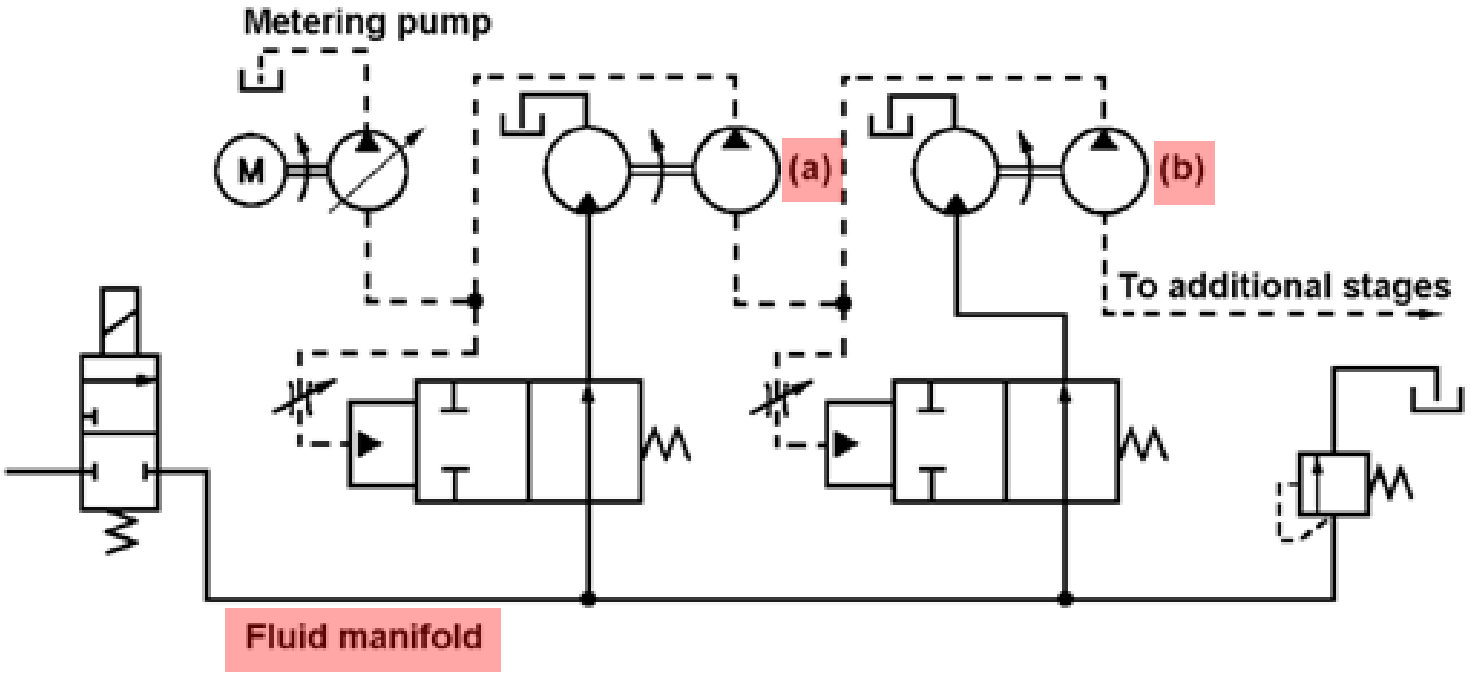
Correction for minor variation in synchronization at the end of each cycle can be made by using a replenishing circuit to supply make-up oil for that lost due to leakage.

On extension, if cylinder 1 bottoms first, it contacts a limit switch energizing solenoid valve A, which supplies additional fluid to fully extend cylinder 2.

On retraction, if cylinder 2 bottoms first, it contacts a limit switch energizing solenoid valve A, which supplies additional fluid to retract cylinder 1.

Basic Circuits

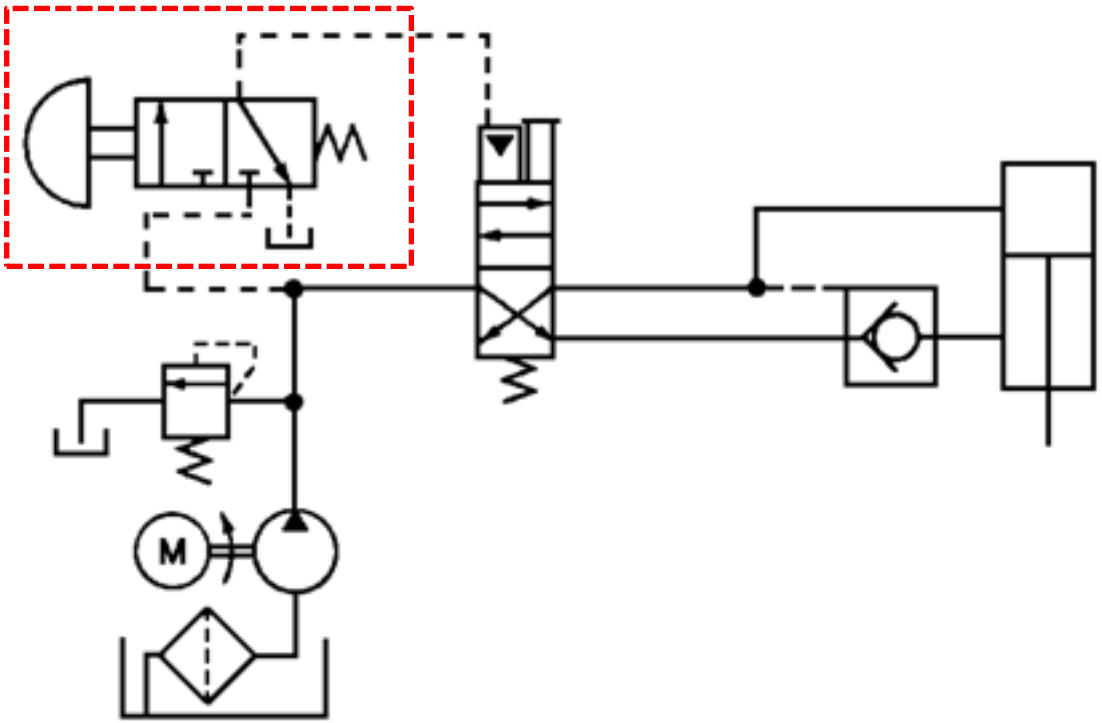
Synchronous Circuits



Conveyor fluid motor control circuit

Basic Circuits

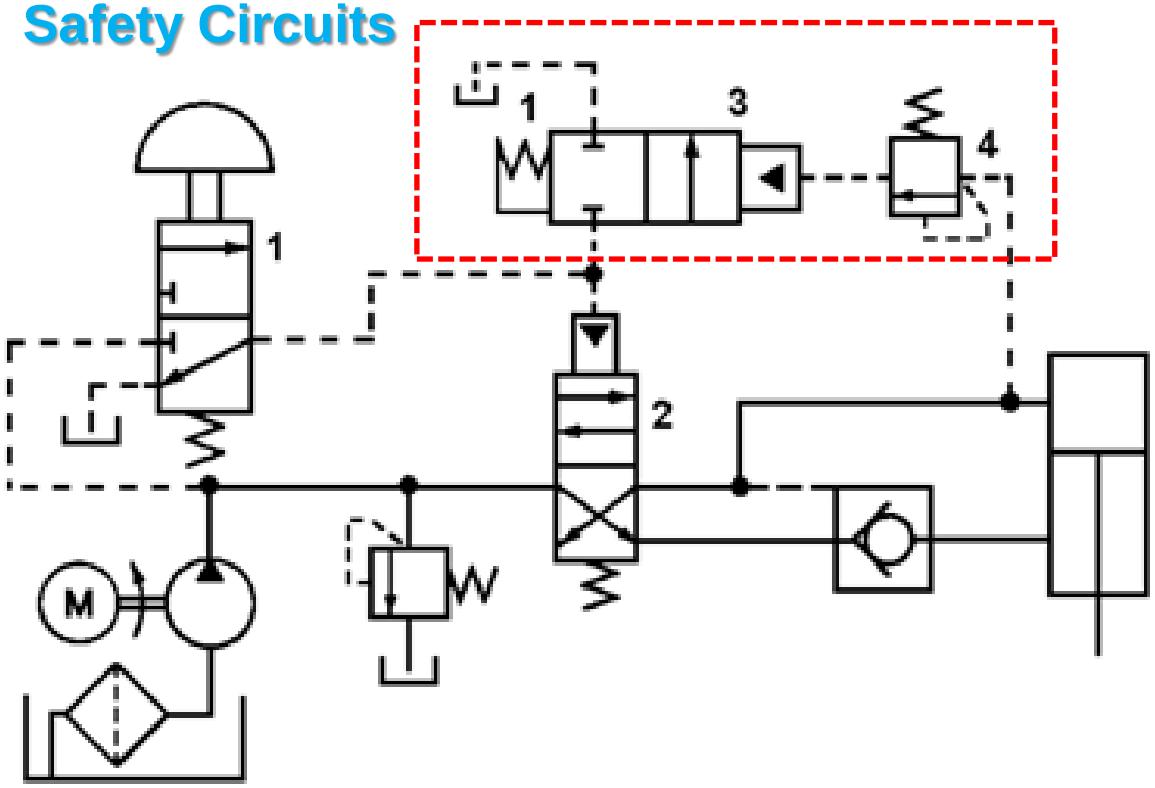
Safety Circuits



Fail-safe circuit

Basic Circuits

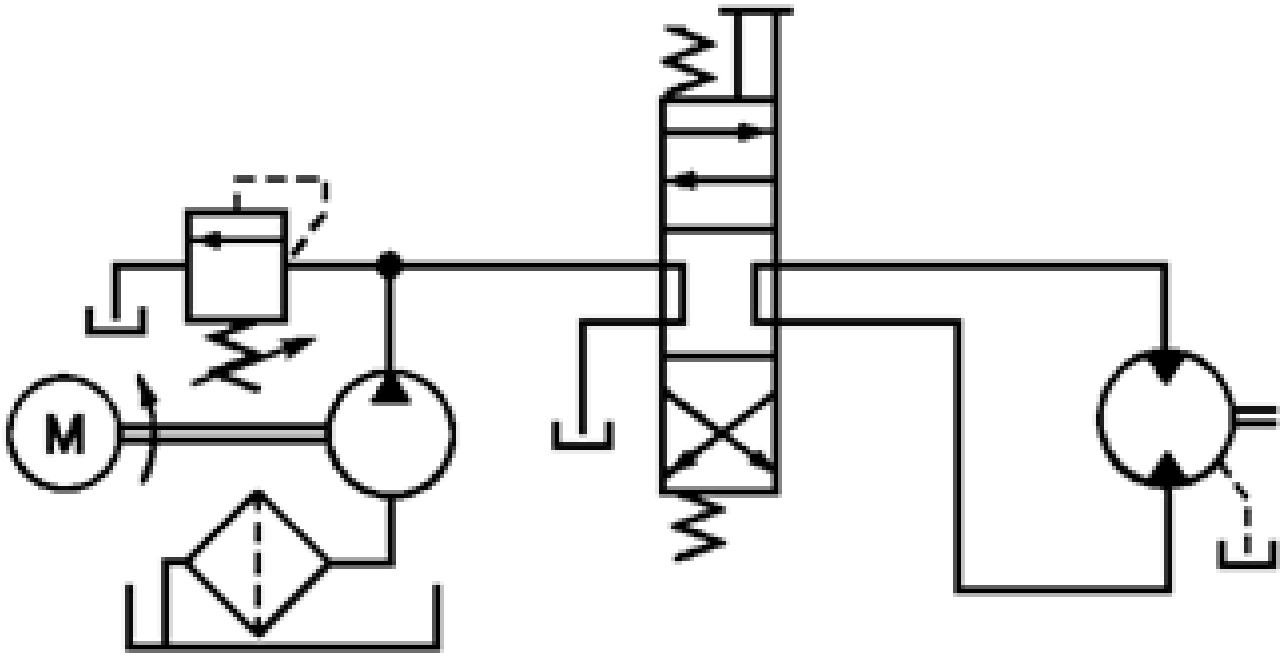
Safety Circuits



Fail-safe circuit with overload protection

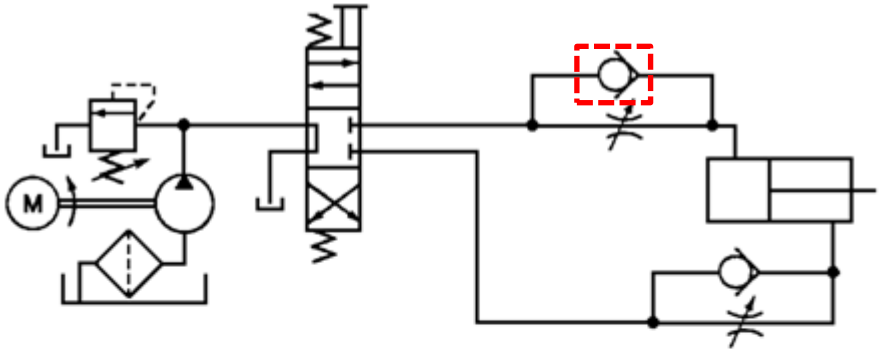
Operating the three-way manual control valve will have no effect on the circuit unless detented overload valve 3 is reset manually.

Open-Center Versus Closed-Center Circuits

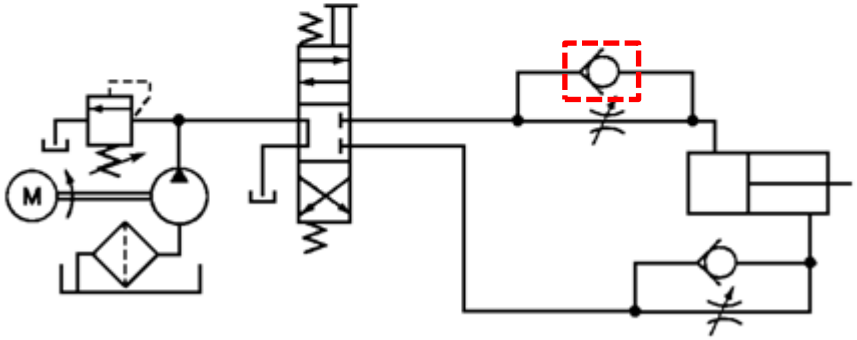


Open-center circuit with rotary actuator

Open-Center Versus Closed-Center Circuits

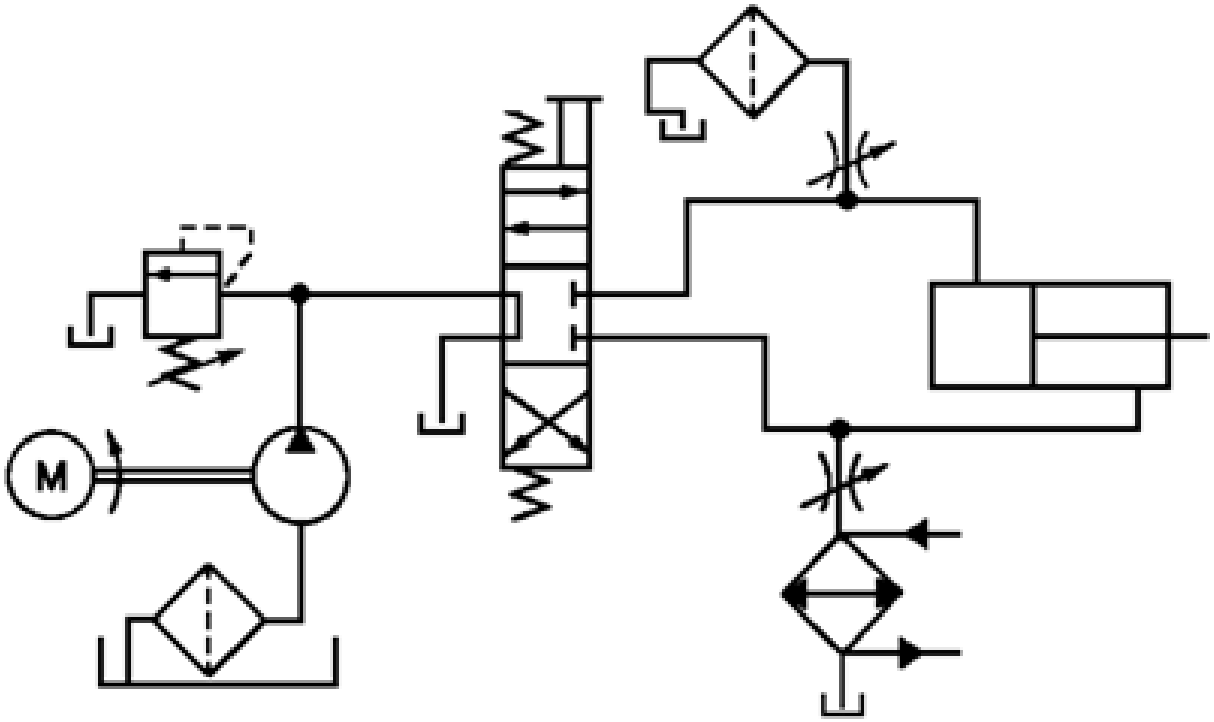


Open-center meter-in circuit



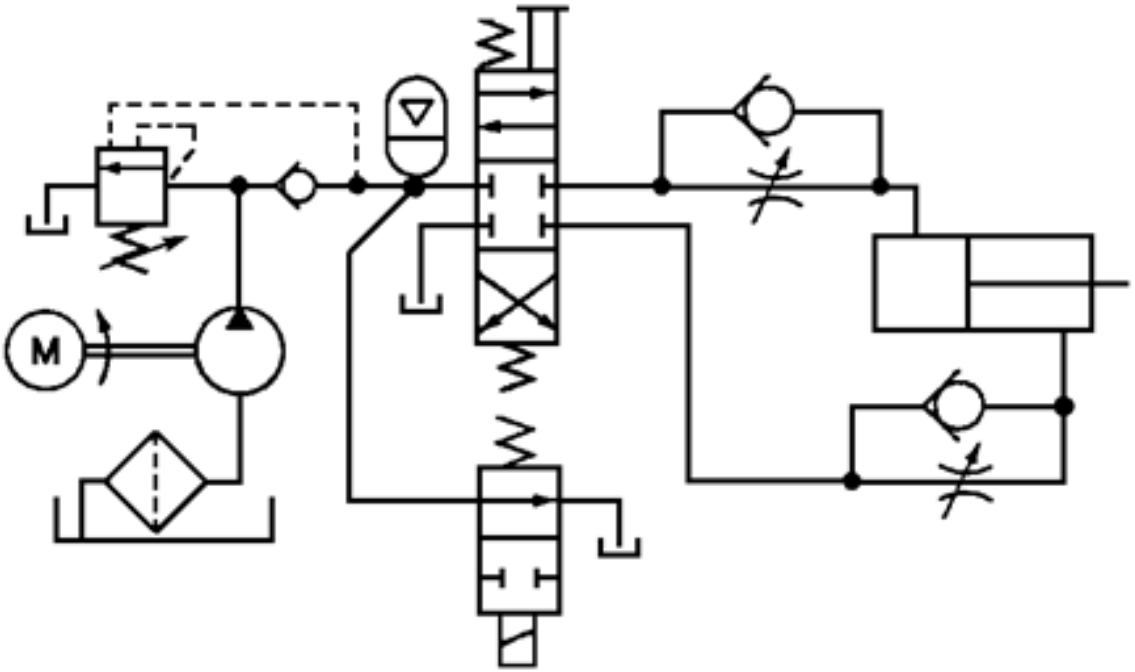
Open-center meter-out circuit

Open-Center Versus Closed-Center Circuits



Open-center bleed-off circuit with filter and heat exchanger

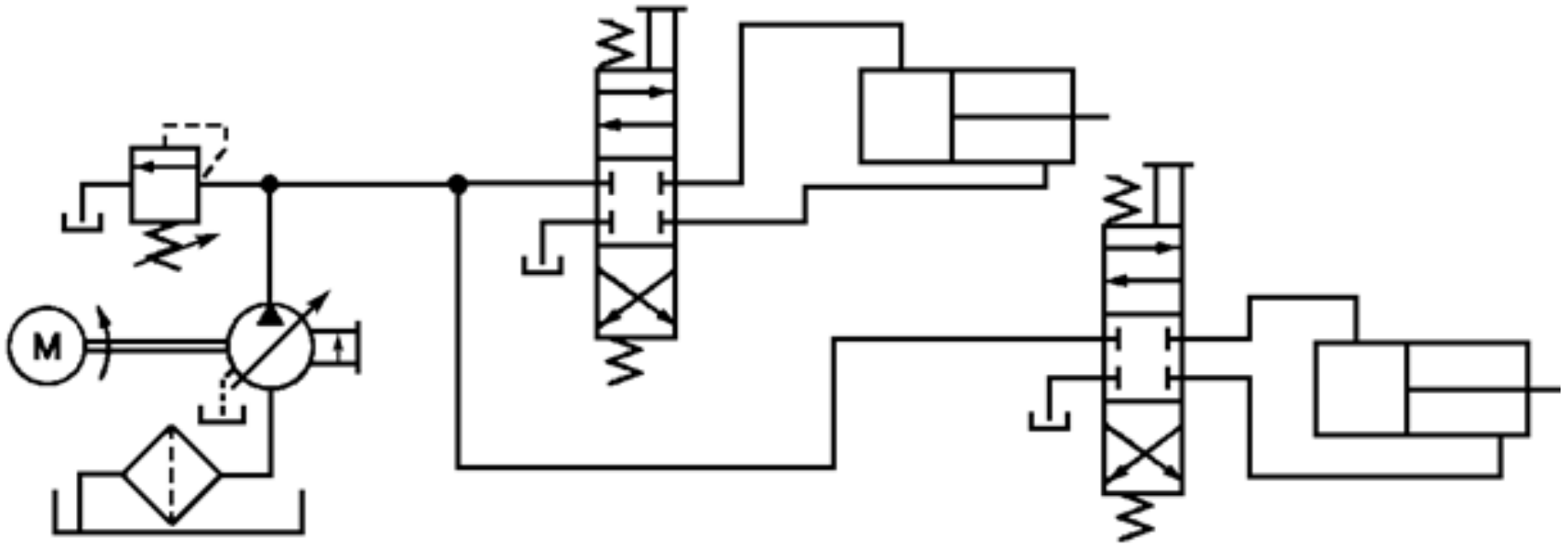
Open-Center Versus Closed-Center Circuits



Closed-center accumulator circuit

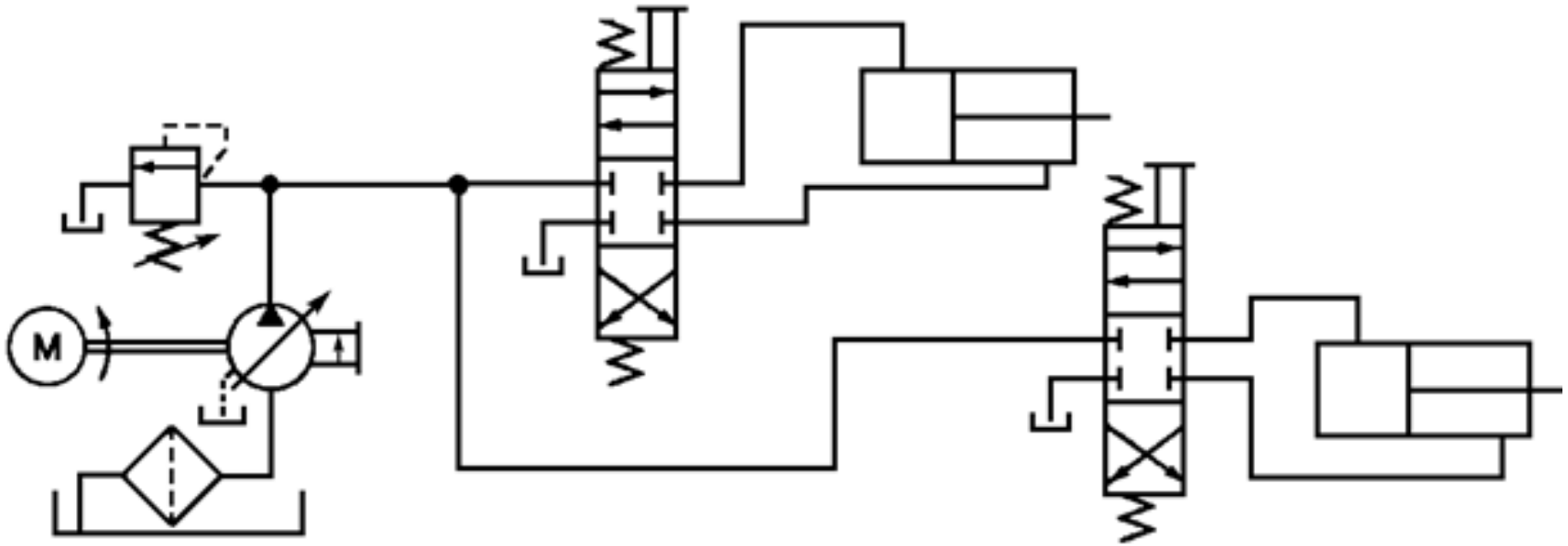
The two-way safety solenoid valve drains the accumulator when the system is turned off.

Open-Center Versus Closed-Center Circuits



Closed-center circuit with variable displacement pressure compensated pump

Open-Center Versus Closed-Center Circuits



Closed-center circuit with variable displacement pressure compensated pump


Thank You