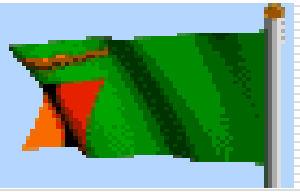
KAFUE GORGE REGIONAL TRAINING CENTRE



Course: Applied Industrial Hydraulics

Basic Electro Hydraulics Component Symbols and Circuits

Lecturer: Dean L Musukwa, B.Eng; MEIZ, REng.

TEVETA
Technical Education, Vocational and Entrepreneurship Training Authority

ISO 9001 SYSTEM CERTIFICATION SGS UKAS MANAGEMENT SYSTEMS 005

www.kgrtc.org.zm

info@kgrtc.org.zm

Content

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1. Application of Hydraulics
2. Parts of a Hydraulic System
3. Hydraulic Components Symbols
4. Hydraulic Circuit Illustration
5. Electrical Control of hydraulic circuits
6. Electro-hydraulic Circuit illustration

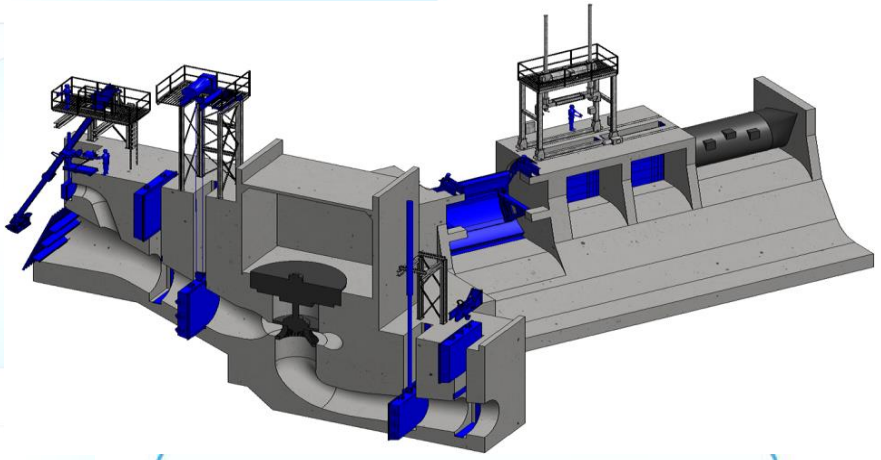
Lesson Objectives

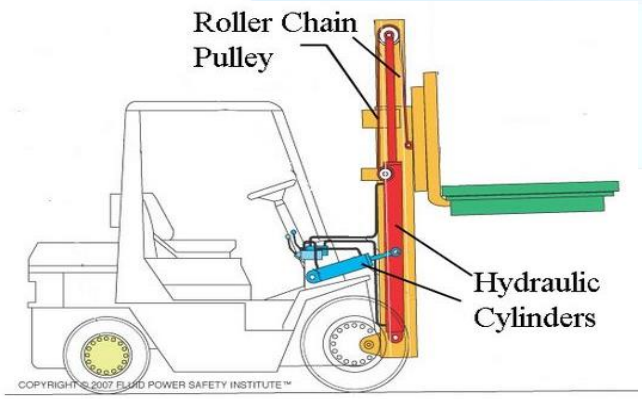
At the end of this lesson, Learners should be able to:

- Identify components and symbols of hydraulic and electrical control circuits
- Construct basic electro-hydraulic circuits
- Simulate designed circuits on FESTO software to ascertain correct operation

1. Application of Hydraulics

- **Mobile Hydraulics**
  - Earth moving equipment
  - Folk Lift Truck, Car Jacks, etc
- **Stationary Hydraulics**
  - Hydropower waterways gates
  - Hydropower Governor System, etc





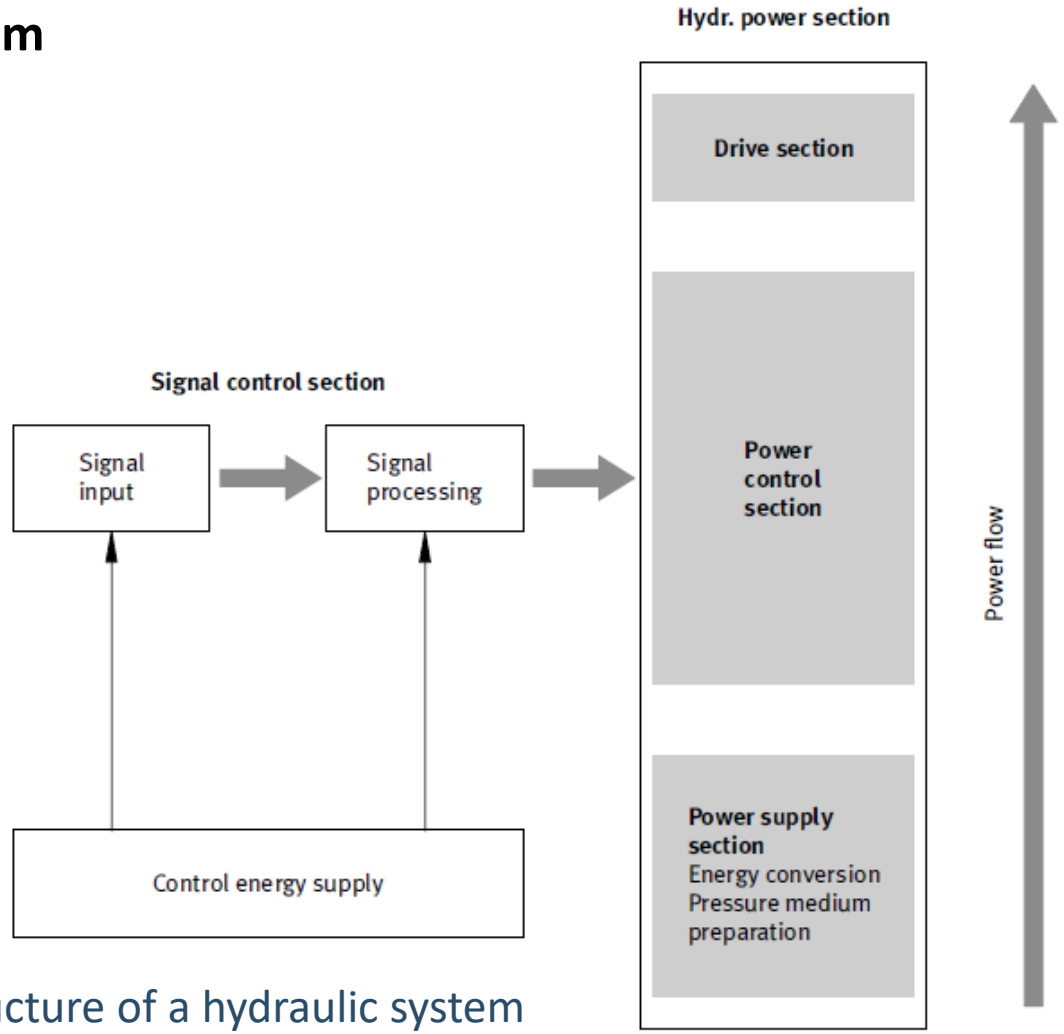
2. Parts of a Hydraulic System

Representation of a Hydraulic System

A Hydraulic system can be divided into two sections:

(a) Signal control section, and

(b) Hydraulic power section



Diagrammatic representation of the structure of a hydraulic system

2. Parts of a Hydraulic System

Signal control section

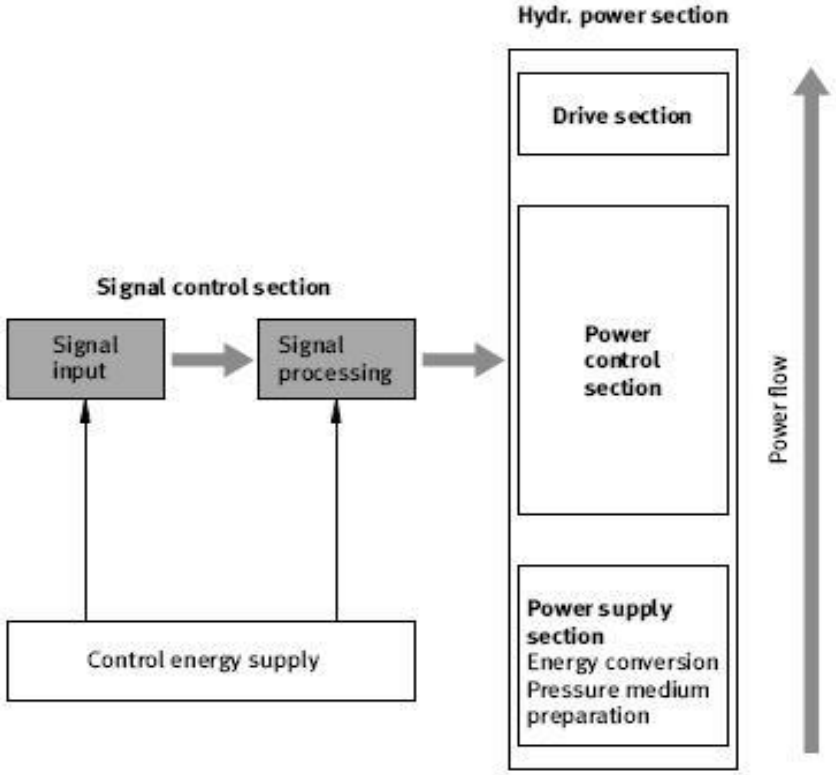
The Signal section is divided into signal input **(sensing)** and signal processing **(processing).**

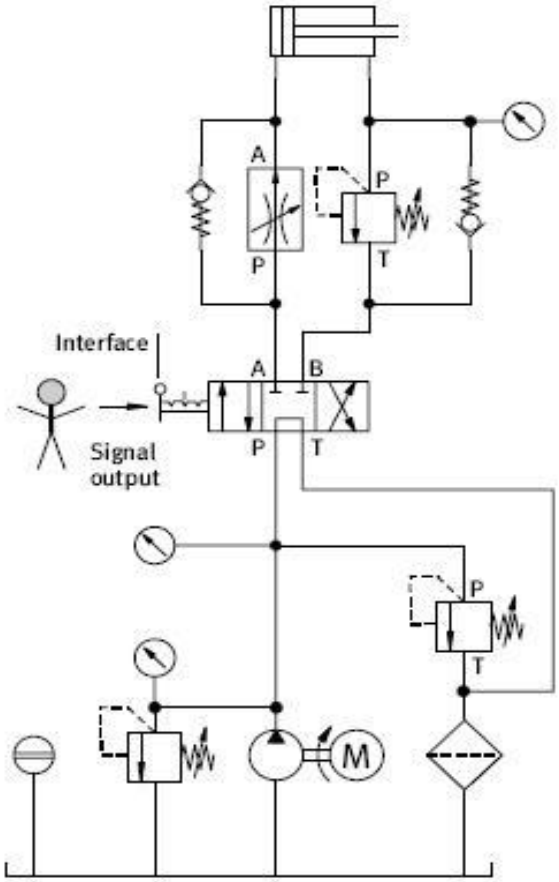
Signal input can be:

- Manual
- Mechanical
- Contactless

Signal can be processed by:

- Operator
- Electricity
- Electronics
- Pneumatics
- Mechanics
- Hydraulics

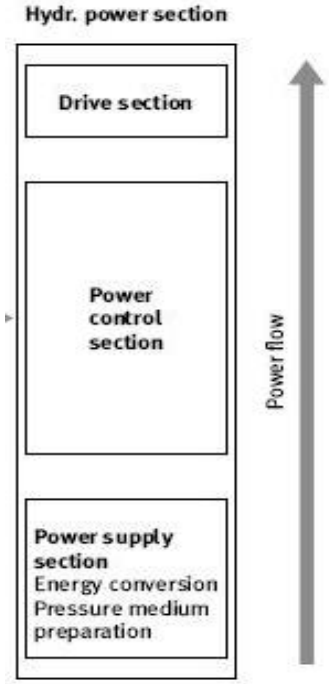


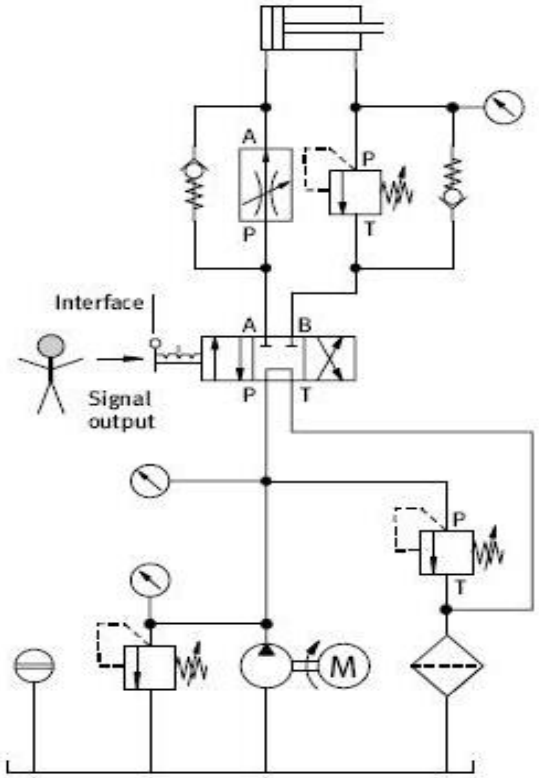


2. Parts of a Hydraulic System

The Hydraulic power section – has three sections:

- Power supply section
- Power control section
- Drive section





Power supply section - energy conversion : electrical->mechanical->hydraulic:

Power supply components are -

- Electric motor/ or gas engine
- Coupling
- Pump
- Pressure indicator
- Protective Circuitry

Components used to condition the fluid are:

- Filter
- Cooler /or Heater
- Thermometer
- Pressure gauge
- Reservoir
- Filling level indicator

2. Parts of a Hydraulic System

Power control section

The fluid power is supplied to the **drive section** by the **power control section** . Components used are:

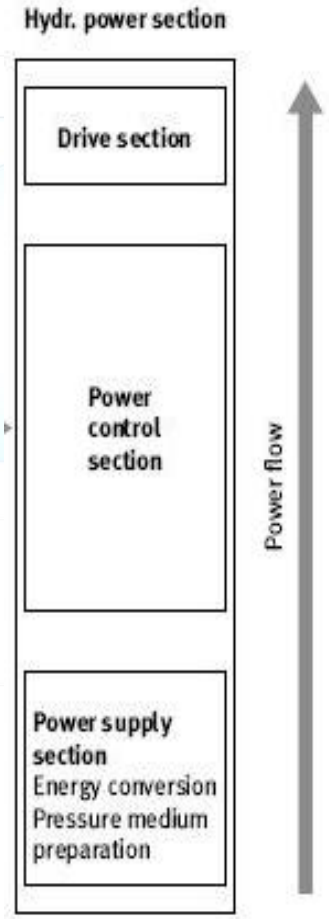
- Direction control valves
- Pressure valves
- Non-return valves
- Flow control valves

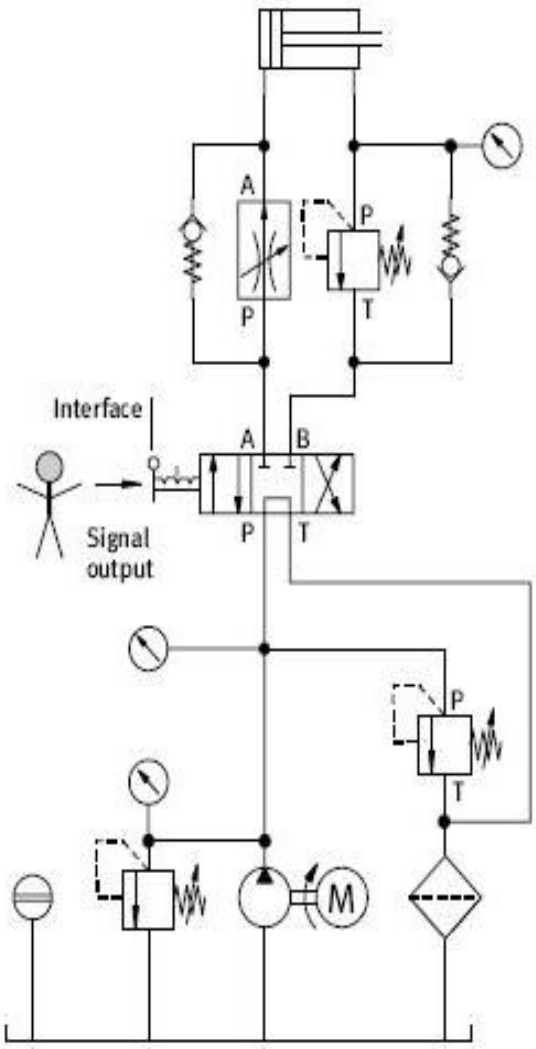
Drive section

This is the part that executes the various working movements of a machine or equipment.

The drive components are:

- Cylinders
- Motors





3. Hydraulic Components Symbols

Use of Circuit Symbols

- Circuit symbols are used for components to enable clear representation of hydraulic systems in diagrams
- A symbol identifies a component and its function
- The symbols in this course are based on DIN ISO 1219
- The most important symbols are dealt with in this basic hydraulics course.

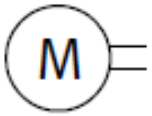
3.1 Transfer of energy and condition of the pressure medium

Introduction

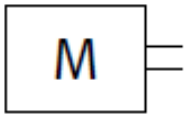
These symbols are used in circuit diagrams for energy transfer components and condition of pressure medium

– hydraulic pressure source

– electric motor



– non-electric drive unit



3. Hydraulic Components Symbols

Transfer of energy and condition of the pressure medium

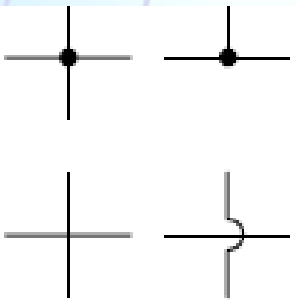
– pressure, power, return line

– control (pilot) line

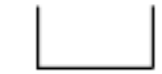
– flexible line

– line connection

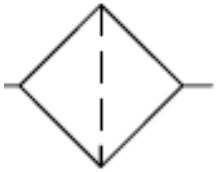
– lines crossing



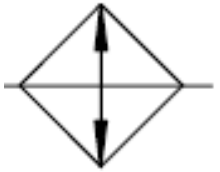
– reservoir



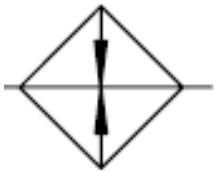
– filter



– cooler

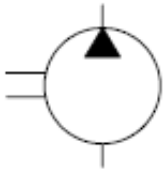
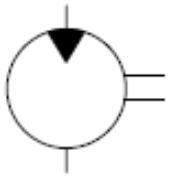
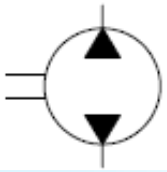
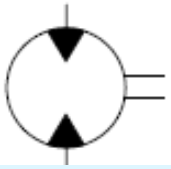


– heater

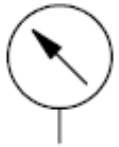
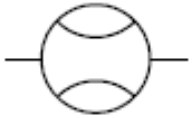
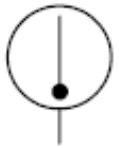
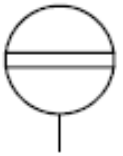


3. Hydraulic Components Symbols

3.2 Pumps and Motors

Hydraulic pump	Hydraulic motor	Type of Fluid
Hydraulic pumps with fixed displacement	**Hydraulic motors with fixed displacement**	
– with one flow direction 	– with single direction of rotation 	▲ Fluids
– with two flow directions 	– with two directions of rotation 	△ Gases

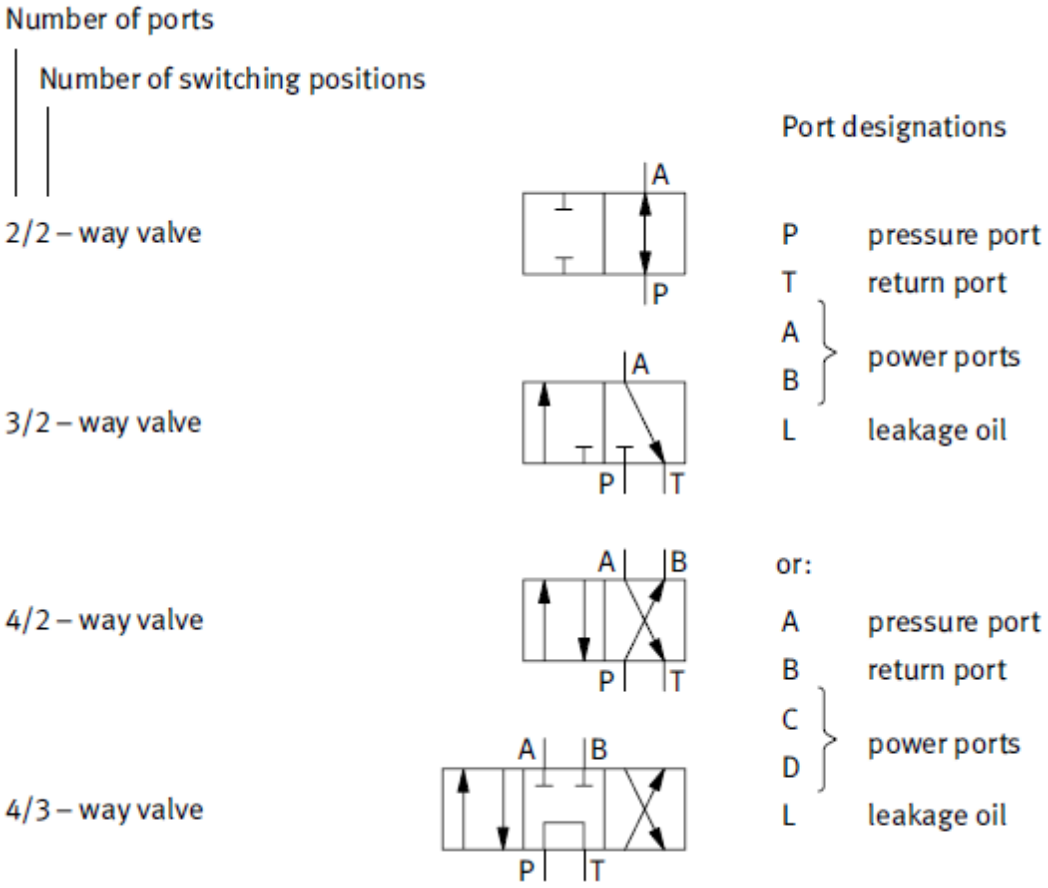
3.3 Measuring Devices

– pressure gauge 	– flow meter 
– thermometer 	– filling level indicator 

3. Hydraulic Components Symbols

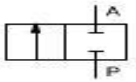
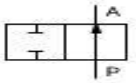
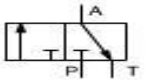
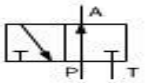
3.4 Direction Control Valves (DCV)

- Squares with arrows inside are used for DCV symbol
- Number of squares indicate number of switching positions
- Arrows within squares indicate flow direction and how the ports are interconnected in various switching positions
- P, T, R, A, B, L designations or labels denote ports (A, B, C, D, E, …. Is sometimes used)
- The **rest position** is defined as the position automatically assumed by the valve in the absence of an actuating force.

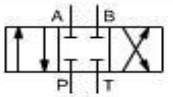
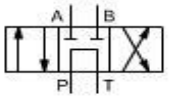


3. Hydraulic Components Symbols

- **Direction Control Valves (DCV) – Normally closed/Normally open - 2/2way and 3/2way**

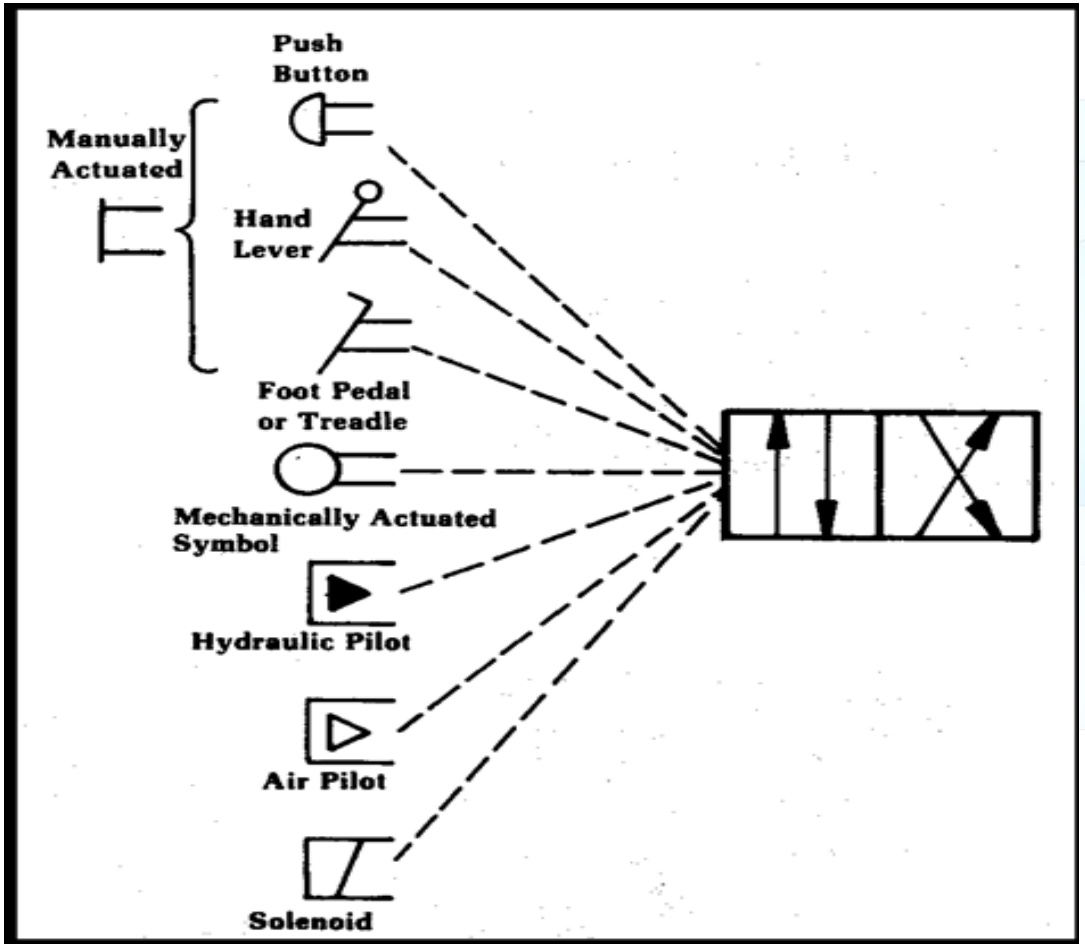
way valve	normal position	symbol
2/2	normally closed (P, A)	
2/2	normally open (P - A)	
3/2	normally closed (P, A - T)	
3/2	normally open (P - A, T)	

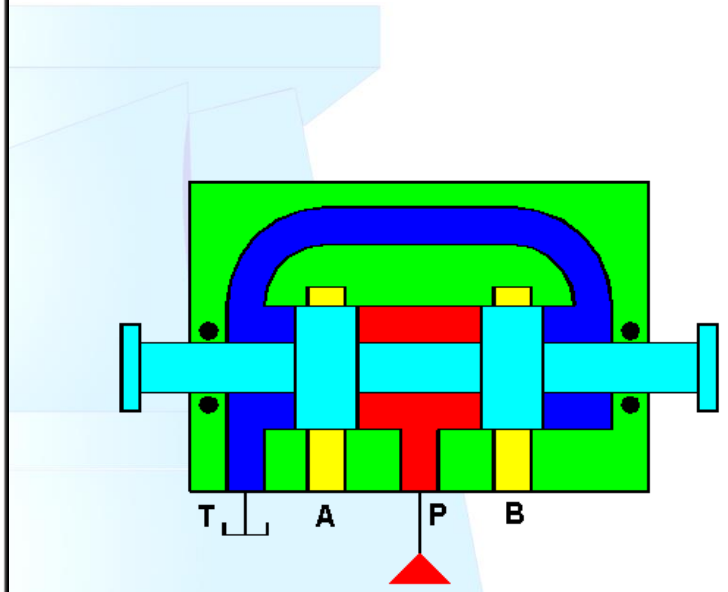
- **Direction Control Valves (DCV) – 4/3 way mid position closed or pump recirculation**

way valve	mid position	symbol
4/3	closed (P, A, B, T)	
4/3	pump recirculation (P - T, A, B)	

3. Hydraulic Components Symbols

- Direction Control Valves (DCV) – Method of Actuation

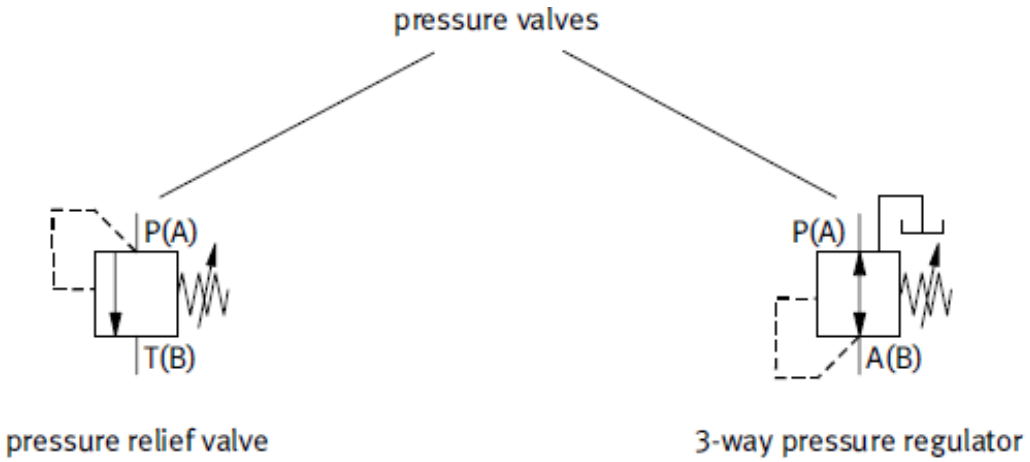




3. Hydraulic Components Symbols

3.5 Pressure Valves

- Square used for symbol
- Ports labels used: P, T or A,B
- Position of valve inside square indicates whether valve is normally open or normally closed
- Are either fixed or adjustable pressure setting
- Divided into **Pressure relief valve** and **pressure regulator**

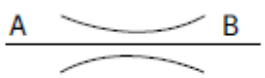


Fixed or Adjustable ,Example: Pressure Relief valve

3. Hydraulic Components Symbols

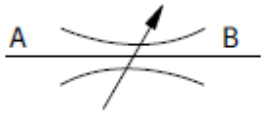
3.6 Flow Control Valves

- Provide means to adjust speed of the drive component



set

set



adjustable

Throttle

adjustable

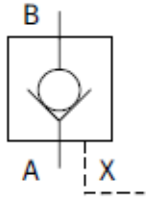
Orifice

3.7 Non-return valves and shut-off valves

spring loaded

unloaded

shut-off valve



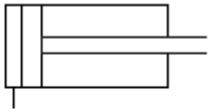
pilot-controlled non-returned valve

3. Hydraulic Components Symbols

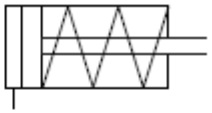
3.8 Hydraulic actuators

Single acting cylinders

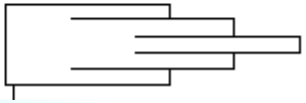
single acting cylinder,
return by external force

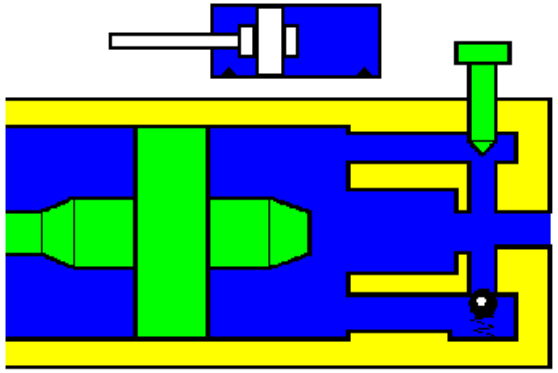


single acting cylinder,
with spring return



single acting telescopic cylinder

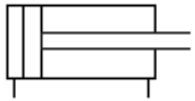




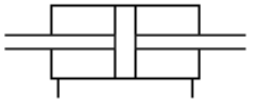
Cylinder
Cushioning

3.9 Non-return valves and shut-off valves

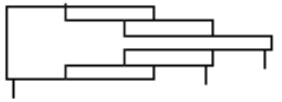
double-acting cylinder
with single piston rod



double-acting cylinder
with through piston rod

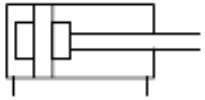


double-acting telescopic cylinder

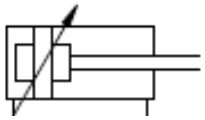


double-acting cylinder
with single end position cushioning

double-acting cylinder
with end position cushioning at both ends



double acting cylinder
with adjustable end position cushioning
at both ends

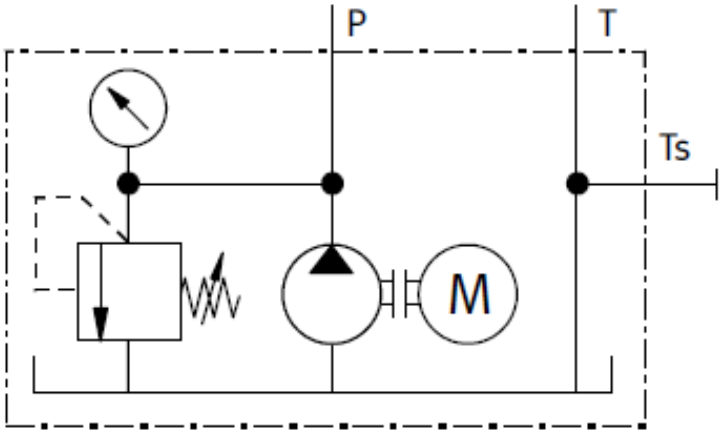


3. Hydraulic Components Symbols

3.10 Combination of Devices

If several devices are brought together in a single housing, the symbols for the individual devices are placed into a box made up of broken lines from which the connections are ready for plugging

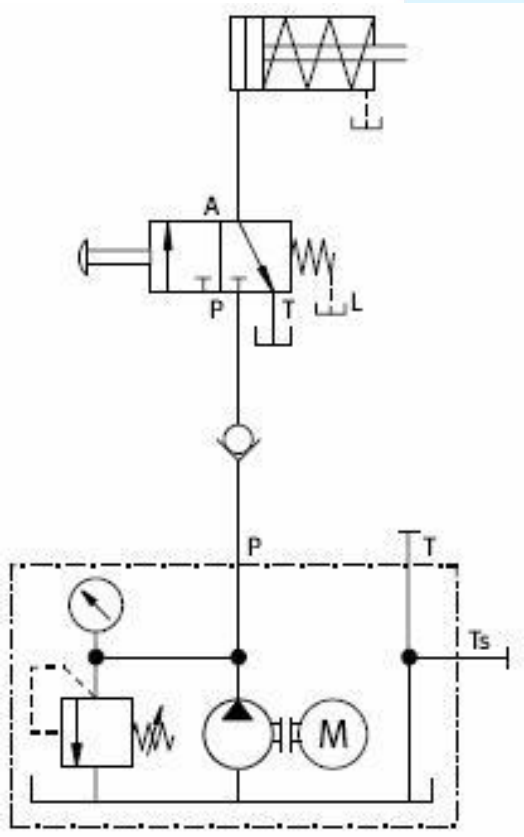
Example:



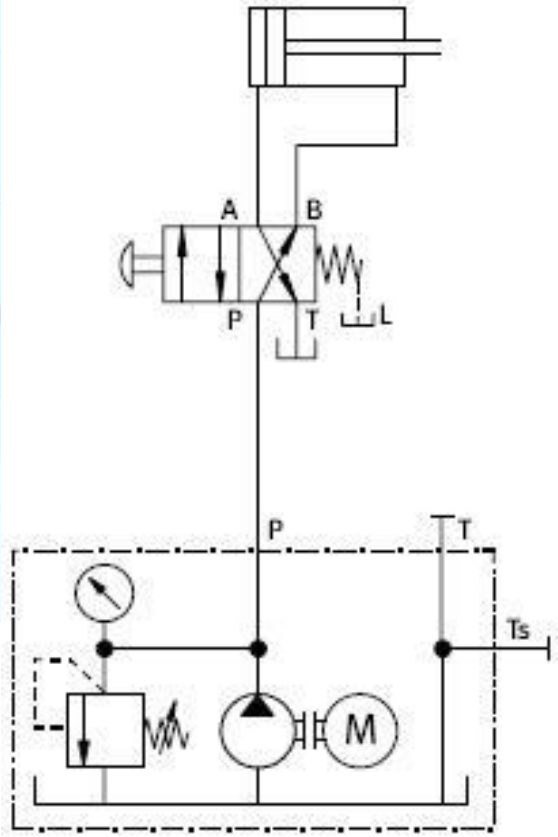
Hydraulic power pack

4. Hydraulic Circuit Illustration

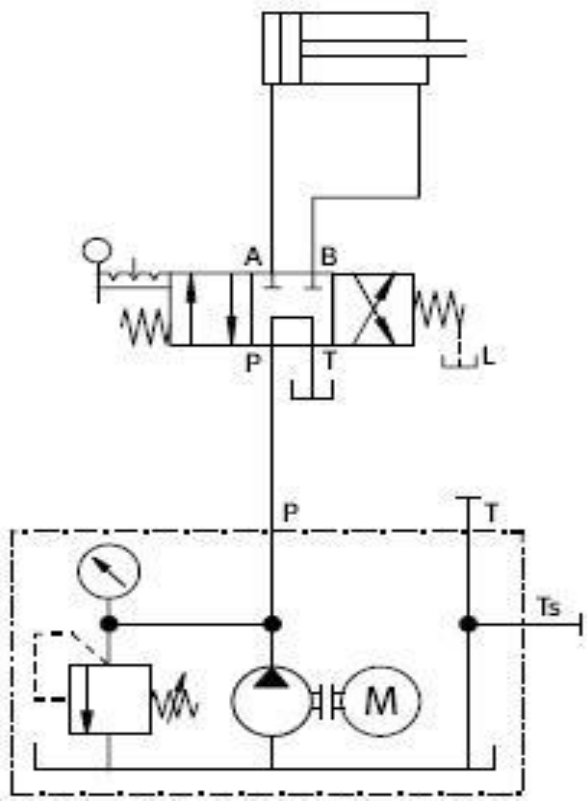
- Circuit with 3/2-way valve



- Circuit with 4/2 –way valve



- Circuit with 4/3-way valve - pump by-pass (re-circulating)



5. Electrical Control of hydraulic circuits

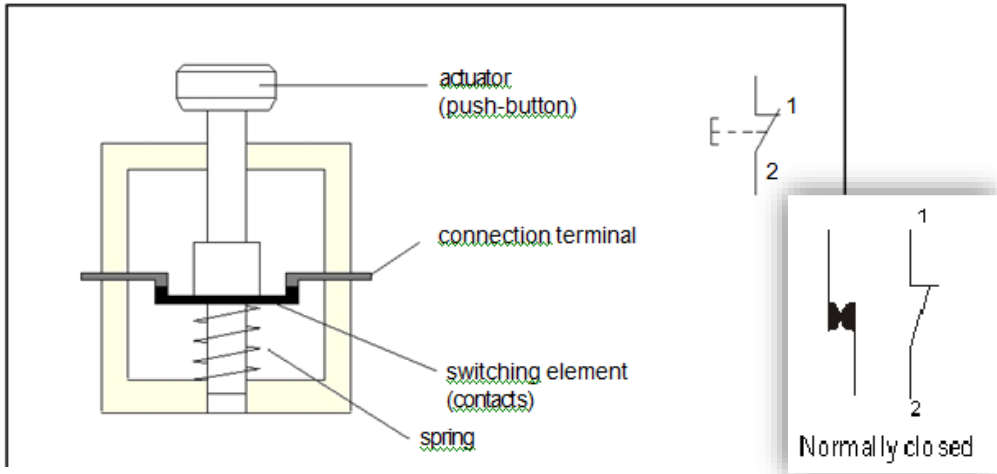
5.1 Control Power Supply

- Usually 24 V DC.

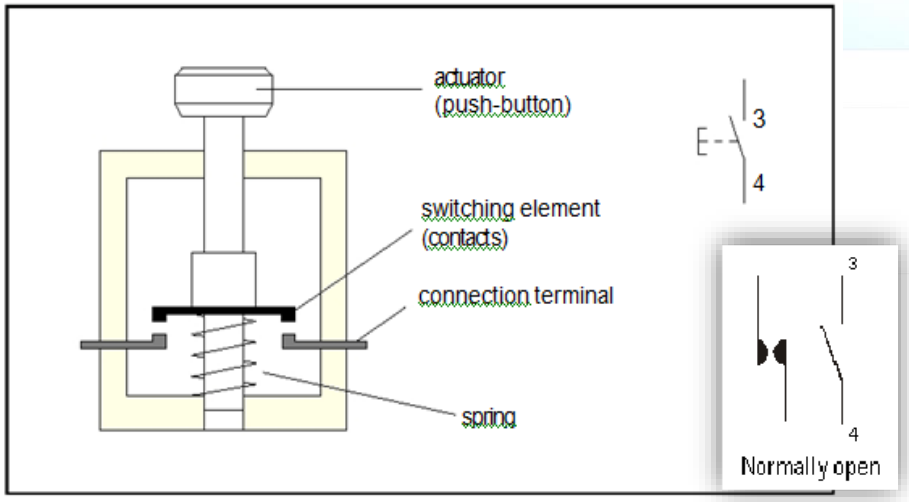
5.2 Push Button and Switches

- Normally open contact
- Normally closed contact
- Change over contact

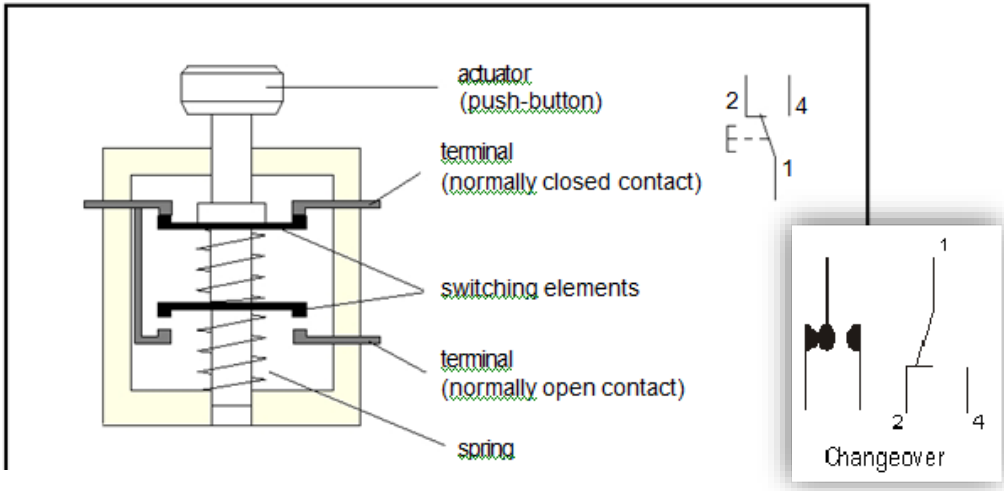
Normally closed contact: sectional view and circuit symbol



Normally open contact: sectional view and circuit symbol



Changeover contact: sectional view and circuit symbol

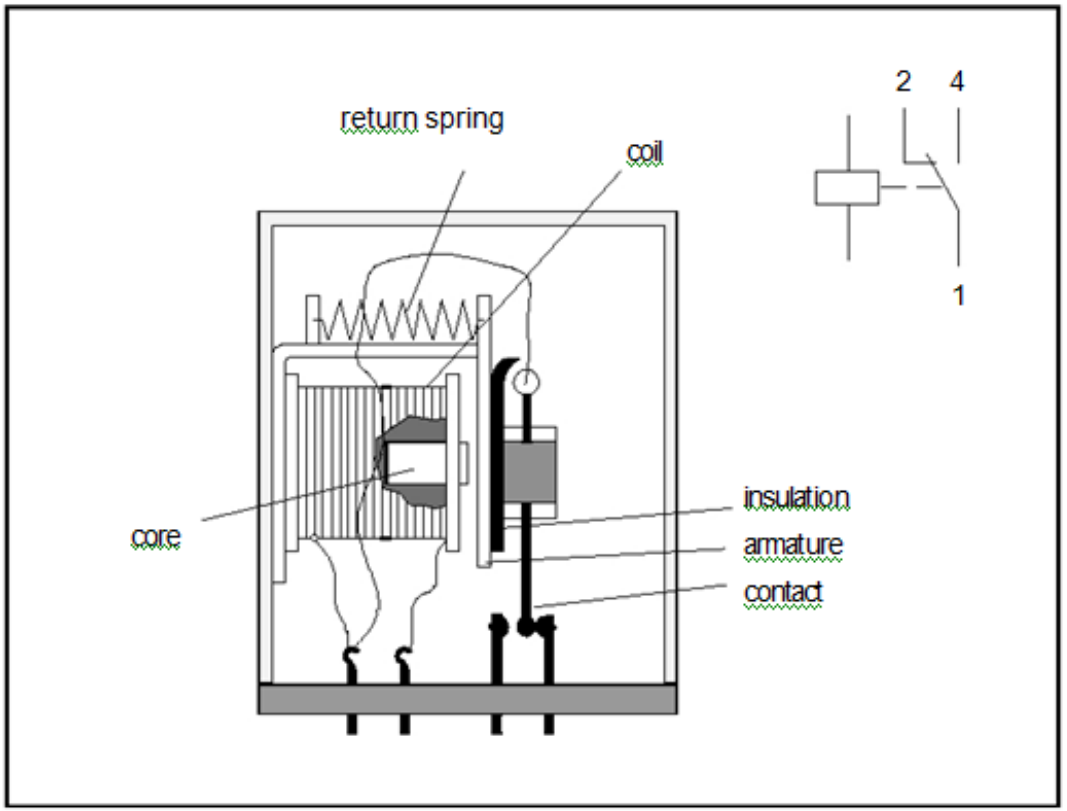


5. Electrical Control of hydraulic circuits

5.3 Relays and Relay Contacts

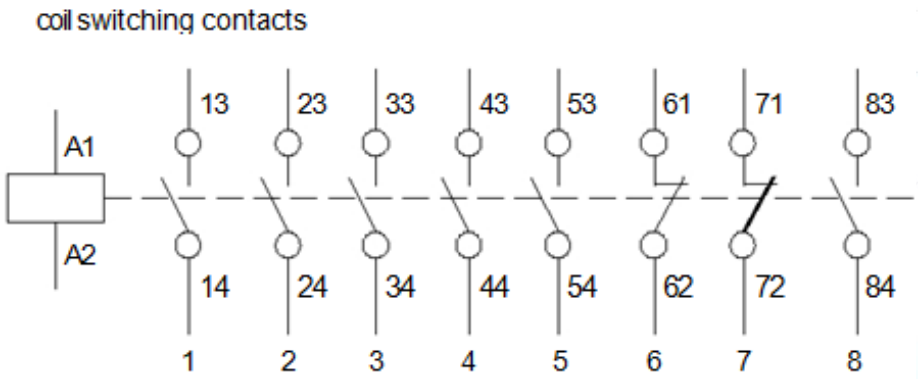
- Relays are designated K1, K2, K3 etc.
- Coil terminals are designated A1 and A2.
- Contacts switched by the relay are also designated K1, K2, resp., etc. in circuits

Relay: sectional view and circuit symbol



5. Electrical Control of hydraulic circuits

Circuit symbols and terminal designations of a relay



Function numbers for relays

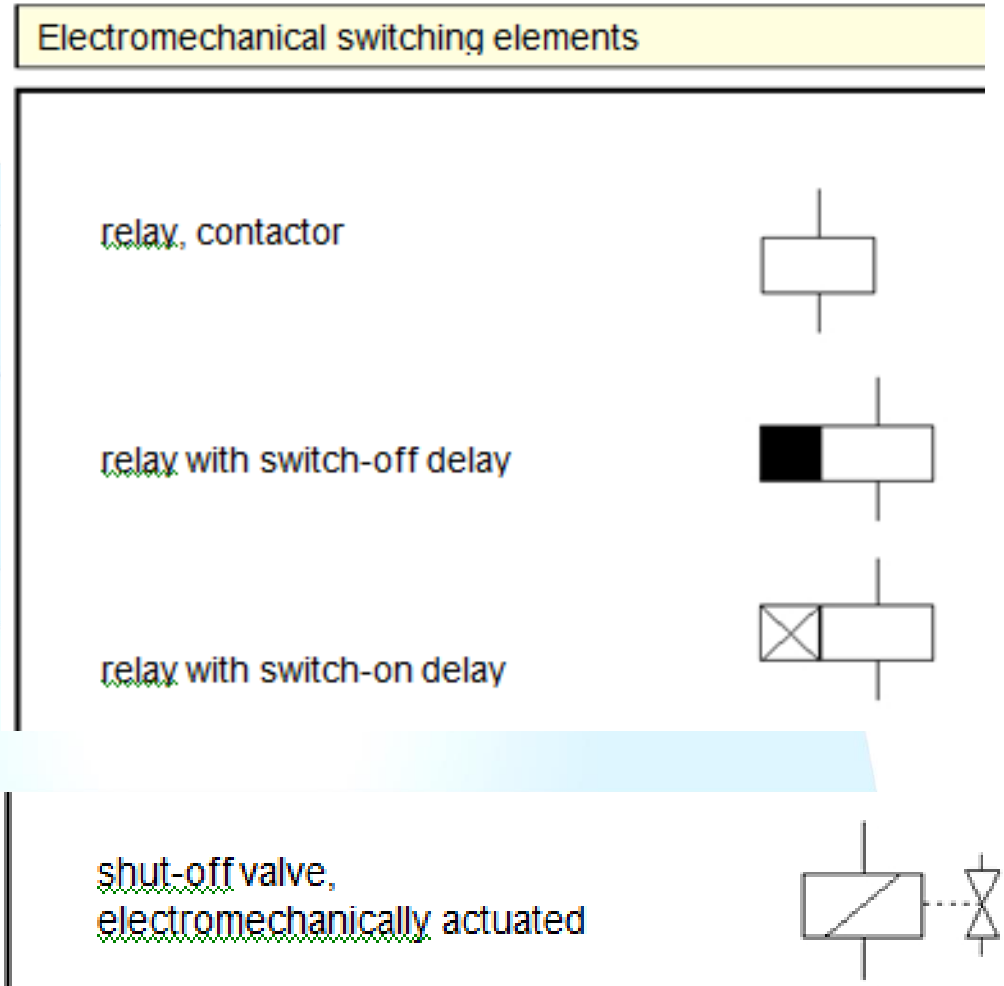
1	2		normally closed contact
3	4		normally open contact
5	6		normally closed contact, time delay
7	8		normally open contact, time delay
1	2	4	changeover contact
5	6	8	changeover contact, time delay

Terminals of the auxiliary contacts (relay contacts) are designated by two digit numbers:

- the first digit is the ordinal(position) number
- the second digit is the function number

5. Electrical Control of hydraulic circuits

5.4 Relay operation types

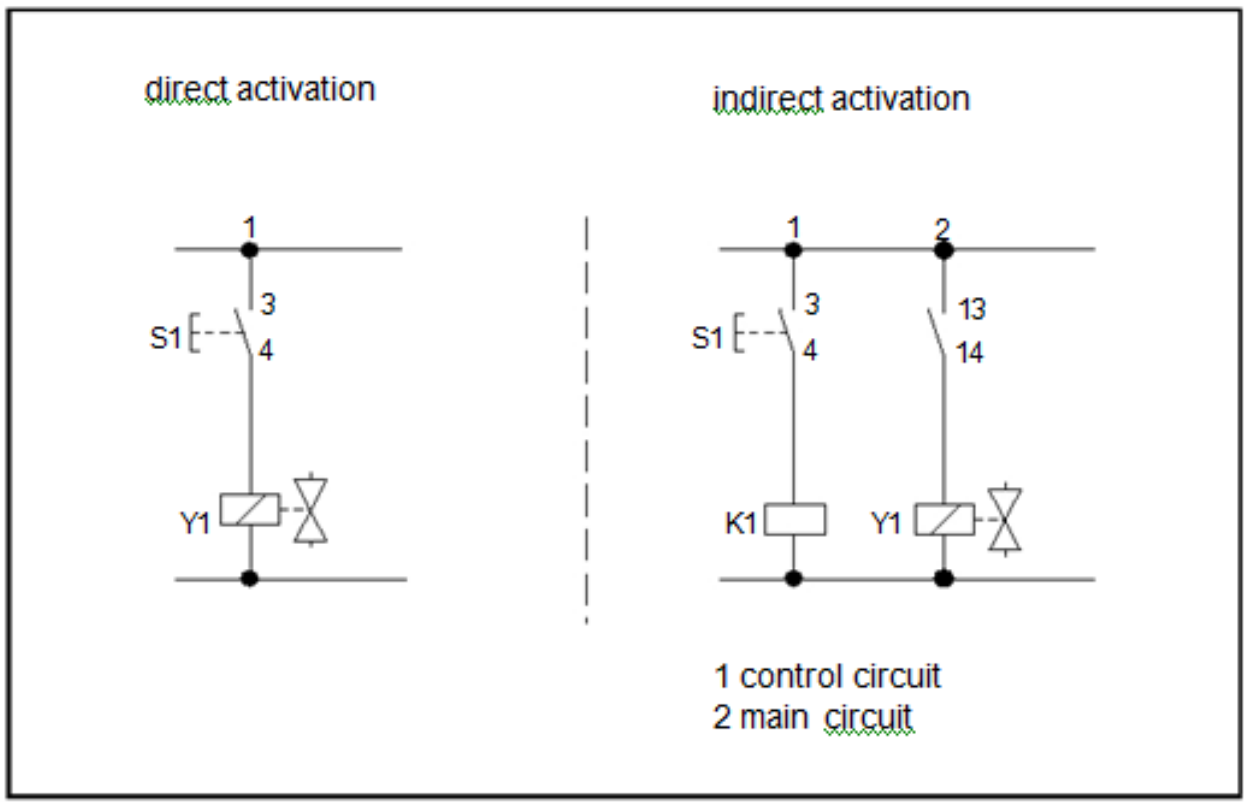


5.5 Representation of solenoid operated direction control valve

5. Electrical Control of hydraulic circuits

5.4 Electrical control circuit illustration

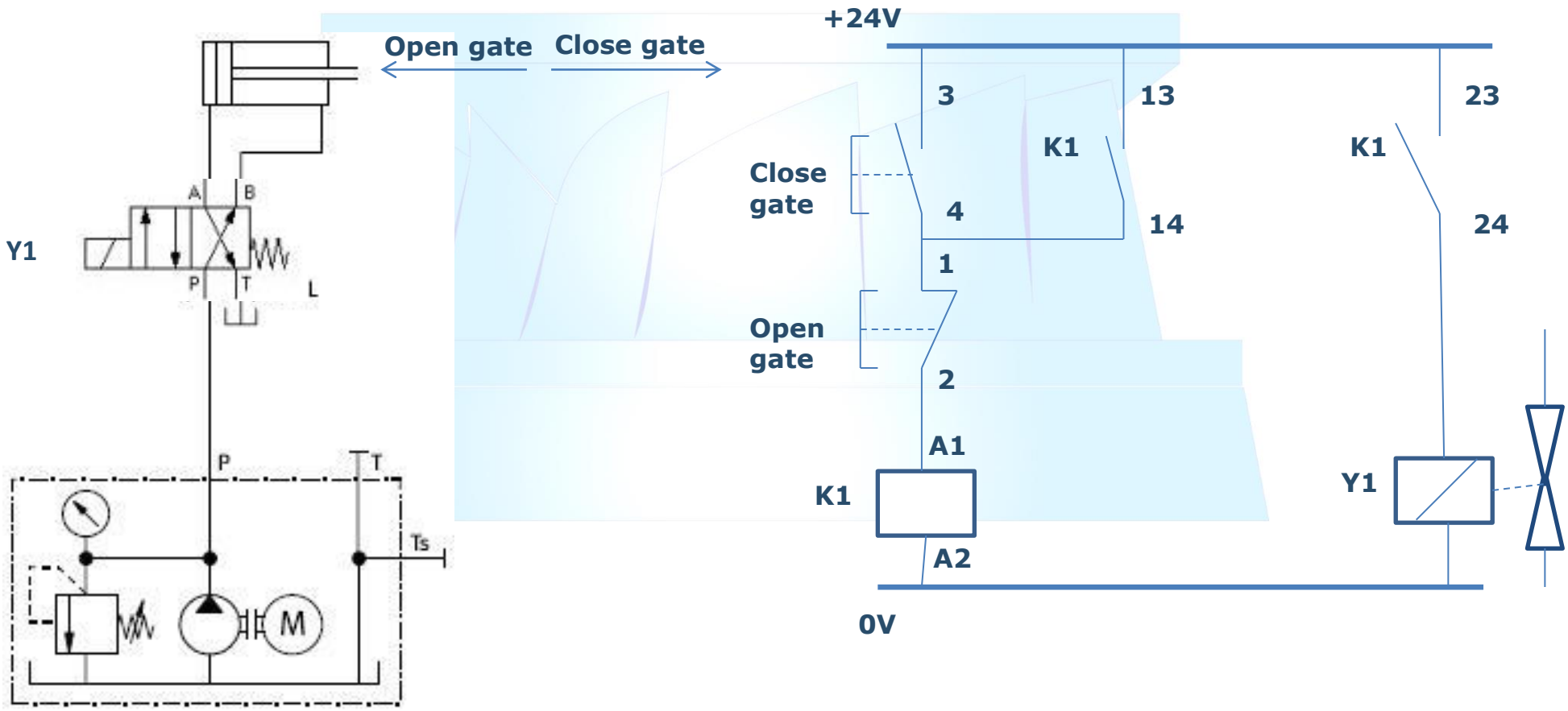
Direct and indirect activation



6. Electro-hydraulic Circuit illustration

5.3 Electro hydraulic circuit for operating a hydropower gate for water intake canal

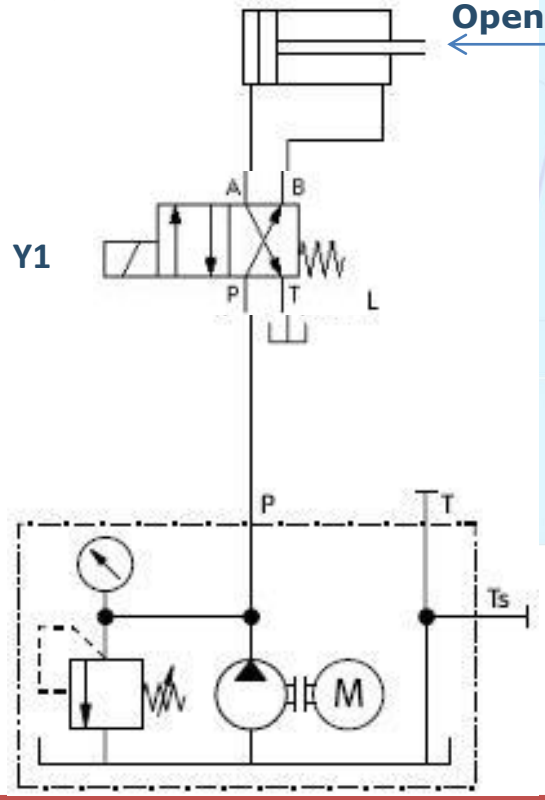
- Hydraulic circuit
- Electrical control circuit



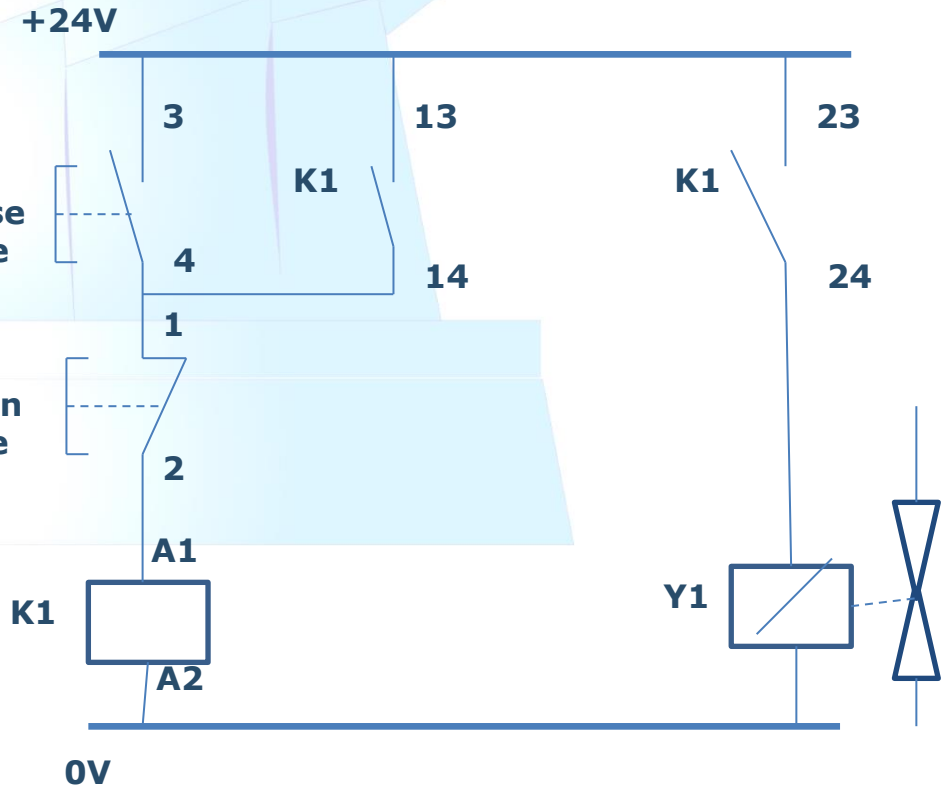
6. Electro-hydraulic Circuit illustration

Exercise: Reproduce and simulate the provided Electro hydraulic circuit for hydropower gate operation using the FESTO software and ascertain that the circuit will operate as intended.

- Hydraulic circuit



- Electrical control circuit



Thank You