# Pneumatic Systems

## Introduction

# Characteristics and Applications of Pneumatics

## Advantages

- Availability
- Transport
- Storage
- Temperature
- Explosion Proof
- Clean (when not lubricated)
- Components – simple, inexpensive
- Speed
- Overload Safe

## Disadvantages

- Preparation
- Compression – consistent piston speed
- Force Requirement – 6-7 Bar, 50K N
- Noise – exhaust air

Source – Festo Textbook TP-101 Pneumatics Basic Level

## Characteristics and Applications of Pneumatics

General Characteristics of a Cylinder:

- 2.5 – 320mm diameter
- 1 – 200mm stroke length
- 2(0.45lb-in) – 45000(10116.6lb-in) Newton at 6 Bar (87 PSI)

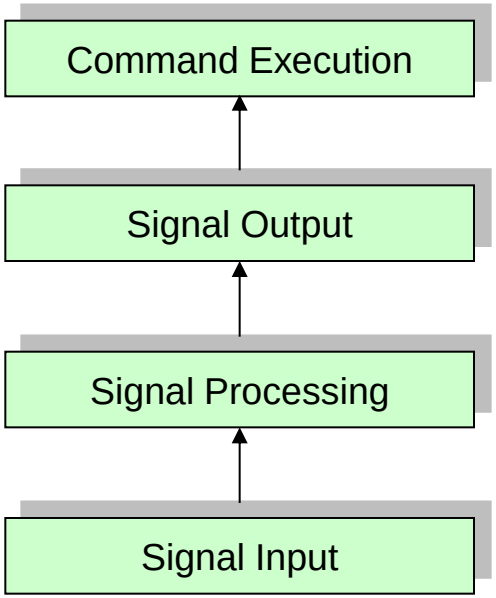
Types of Motion:

- Linear
- Swivel
- Rotary

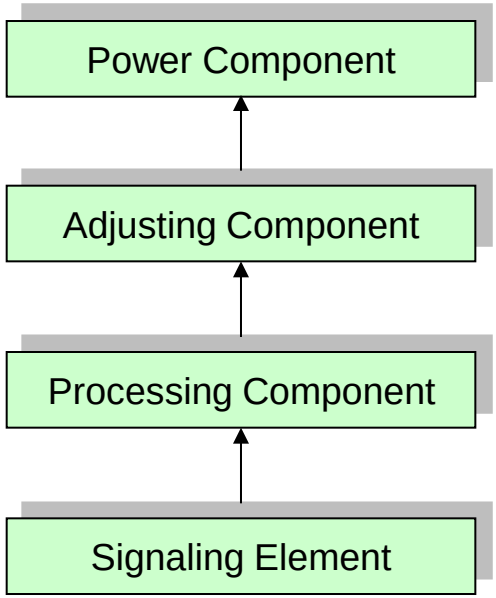
Source – Festo Textbook TP-101 Pneumatics Basic Level

# Characteristics and Applications of Pneumatics

Pneumatic systems consist of an interconnection of different groups of elements.




Signal Flow




Classification of Components

Source – Festo Textbook TP-101 Pneumatics Basic Level

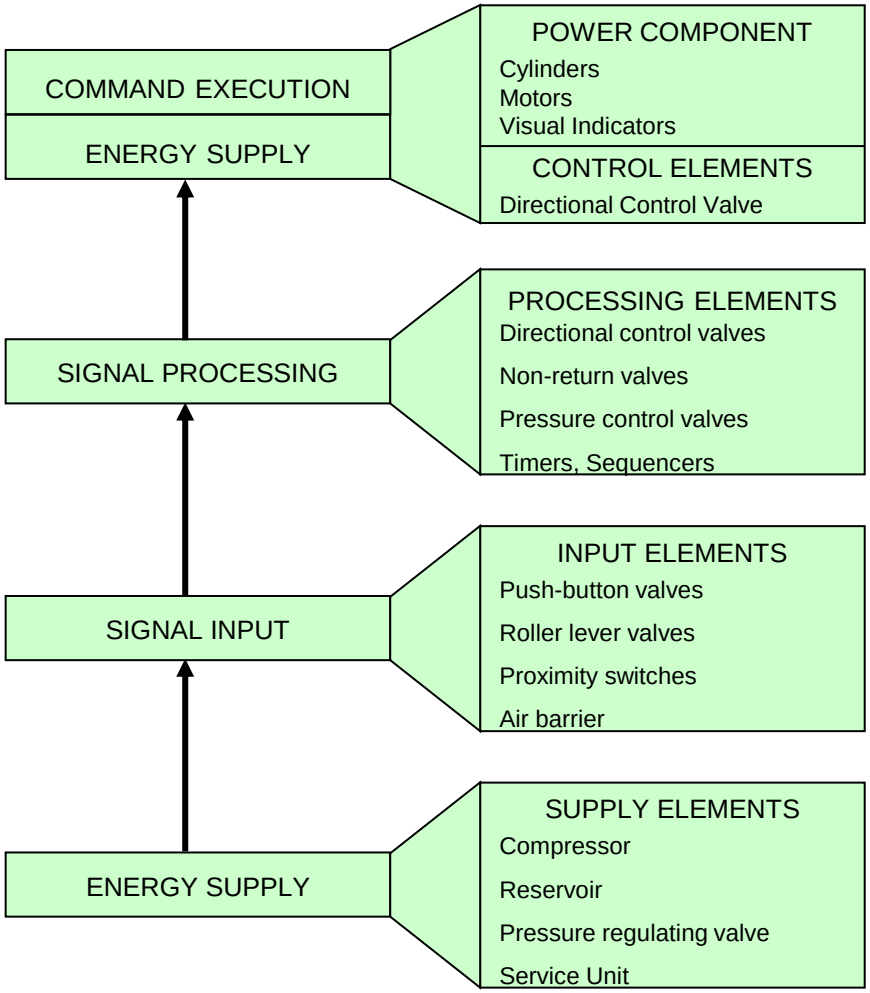
# Characteristics and Applications of Pneumatics

Primary Levels in a pneumatic system:

- Energy Supply
- Input Elements (sensors)
- Processing Elements (processors)
- Control Elements
- Power Components (actuators)

Source – Festo Textbook TP-101 Pneumatics Basic Level

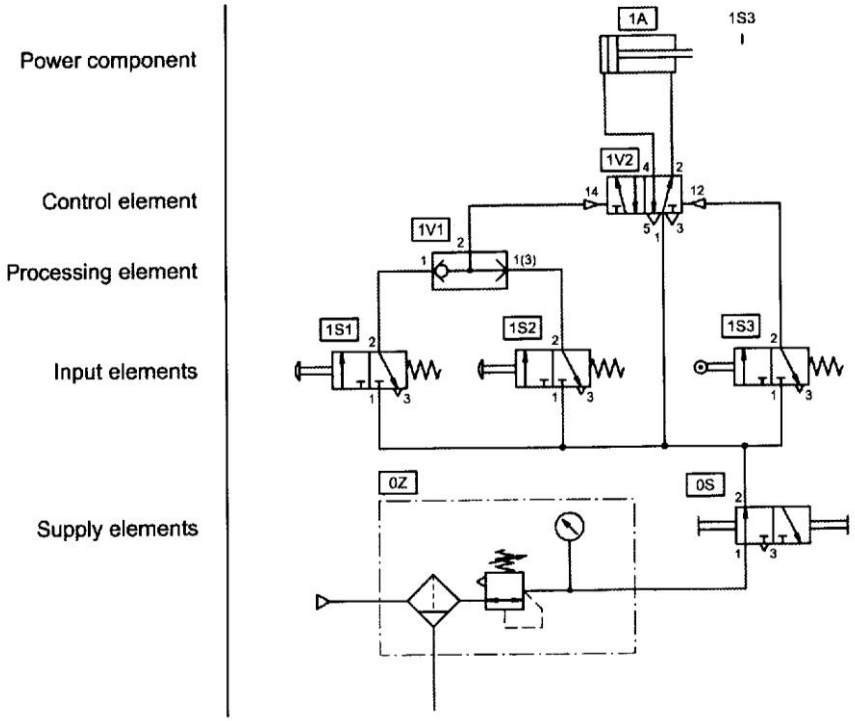
# Characteristics and Applications of Pneumatics




Source – Festo Textbook TP-101 Pneumatics Basic Level

# Characteristics and Applications of Pneumatics

Circuit Diagram & Pneumatic Components




Source – Festo Textbook TP-101 Pneumatics Basic Level

# Components of a Pneumatic System

## 1. Air Generation and Distribution

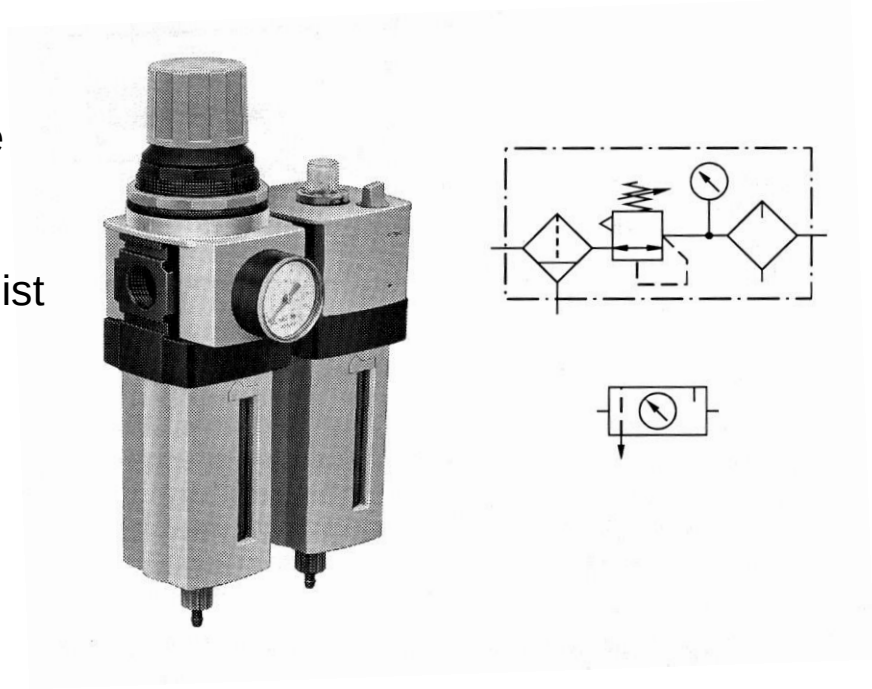
- Usually air is compressed in a separate building
- Distributed inside a factory
- Factors that must be considered:
  - Quantity
  - Type of compressor
  - Pressure requirements
  - Storage
  - Cleanliness
  - Humidity, Temperature
  - Lubrication
  - Line Sizes
  - Drainage points and exhaust outlets
  - Layout of the distribution system

Source – Festo Textbook TP-101 Pneumatics Basic Level

# Components of a Pneumatic System

## Air Generation and Distribution – con't

- Air Service Unit is a combination of:
  - Compressed air filter
    - Removes contaminates and water
  - Compressed air regulator
    - Keeps operating pressure stable
  - Compressed air lubricator
    - Deliver metered quantity of oil mist



Source – Festo Textbook TP-101 Pneumatics Basic Level

## Components of a Pneumatic System

**2. Valves -** Function is to control the pressure or flow rate of pressure media.

- Types:
  - Directional controls valves
    - Input/signaling elements
    - Processing elements
    - Control elements
  - Non-return valves
    - Check valve
    - Shuttle valve
    - Dual pressure valve
    - Quick exhaust
  - Flow control valves
  - Pressure controls valves
    - Pressure limiting valves
    - Pressure regulating valves
    - Pressure sequence valves
  - Shut-off valves

Source – Festo Textbook TP-101 Pneumatics Basic Level

## Components of a Pneumatic System

**3. Processing Elements –** conditions control signals for a task

- Types:
  - Dual pressure valve
    - AND functions
  - Shuttle valve
    - OR functions

**4. Power Components –** actuators

- Types:
  - Linear
    - Single acting
    - Double-acting
  - Rotary
    - Air motor
    - Rotary actuator

Source – Festo Textbook TP-101 Pneumatics Basic Level

# LINES

Hydraulic Pressure Source

Pneumatic

Return to Tank

Pressure Line

Pilot Line

Drain Line

Vertical Jumper

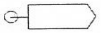
Diagonal Jumper

Flexible Line

Plugs

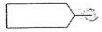
Coupler with Check Valve

A1



Jump-To Label (output)

A2

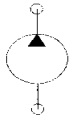


Jump-To Label (input)

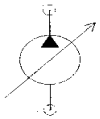


Following slide are courtesy of Yves Tessier, Algonquin College

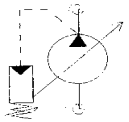
# PUMPS & MOTORS



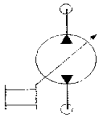
Pump (Max. Flow)



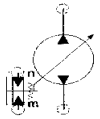
Variable Pump (Max. Min. Flow)



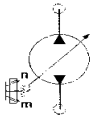
Variable & Compensation Pump
(Max. Min. Flow & Pressure setting)



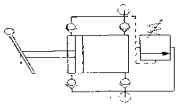
Variable Displacement Pump Manual
(Max. Min. Flow & Pressure setting)



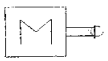

Var. Disp. pump Pressure Comp.
(Max. Min. Flow & Pressure setting)



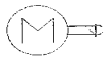

Var. Disp. Pump Servo-valve
(Max. Min. Flow & Press. setting)



Manual Hydraulic Pump



Thermal Motor
(Power & Rotational Speed)



Electrical Motor
(Power & Rotational Speed)

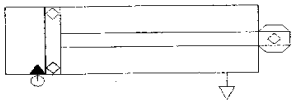


Transmission Shaft
(Length)

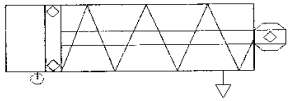
Clutch

Clutch

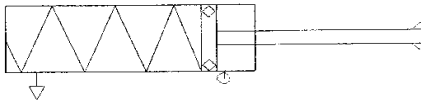
# ACTUATORS



Single-Acting Cylinder



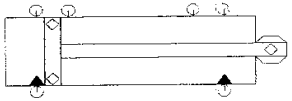
SA Cylinder (spring return)



SA Cylinder (spring extend)

Double-Acting Cylinder

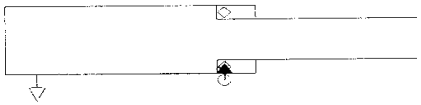
DA 2-Cushion Cylinder



DA Cylinder with multi-ports

Differential Cylinder

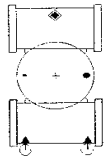
Driver Cylinder (Push)



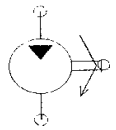
Driver Cylinder (Pull)

Telescopic Cylinder SA

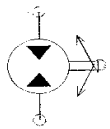
Telescopic Cylinder DA



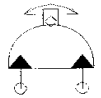
Double Cylinder with Pivot Bearing



Motor 1-Direction



Motor 2-Direction

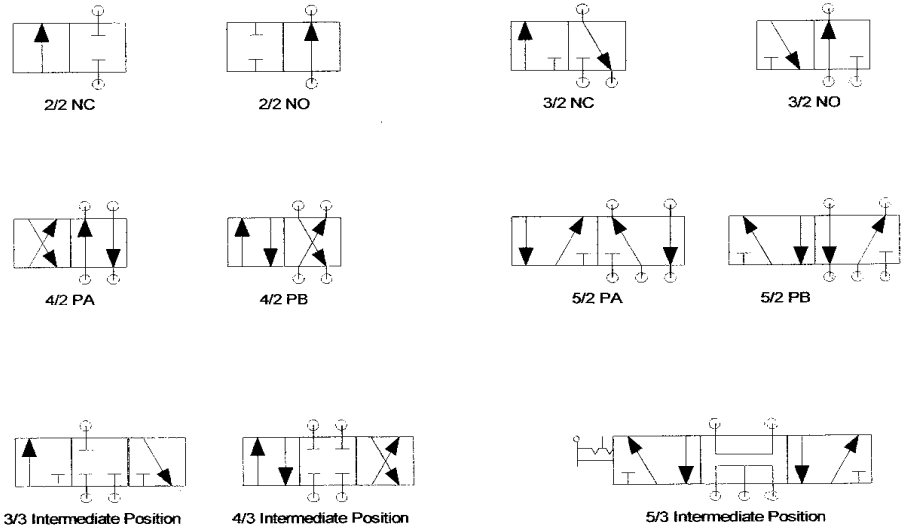


Rotary Actuator

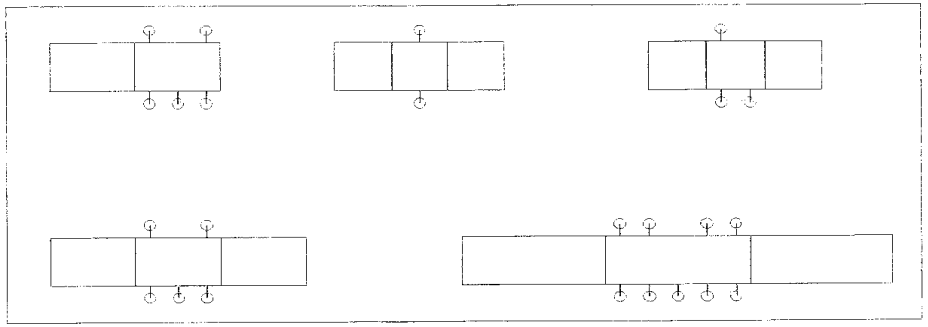
# Directional Control Valves
# ( D. C. V.)

**NC = Normally Closed**
**NO = Normally Open**

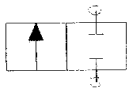
**PA = Pressure to Port A & B to Tank**
**PB = Pressure to Port B & A to Tank**



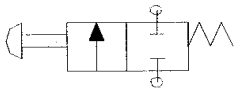

*Build your own*



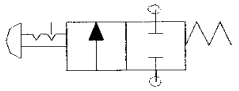
# Controls for D.C.V.



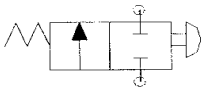
2/2 NC Valve
(Normaly Closed)
2 Ports / 2 Positions
Spool or Envelopes



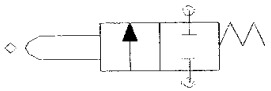
Pushbutton & Spring



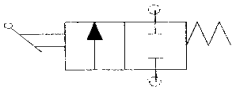
Pushbutton with Detent & Spring



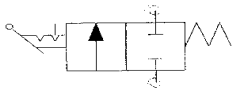
Spring & Pushbutton on NC Spool



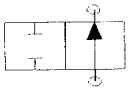
Plunger & Spring



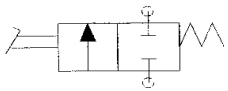
Lever & Spring



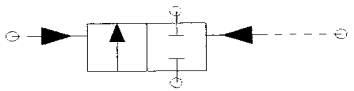
Lever with Detent & Spring



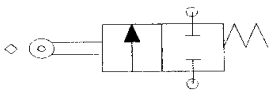
2/2 NO Valve
(Normaly Opened)
2 Ports / 2 Positions
Spool or Envelopes



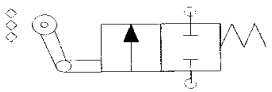
Pedal & Spring



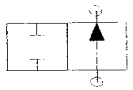
Htdraulic Pilot both Direction



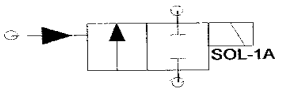
Roller & Spring



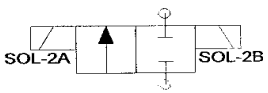
Unidirectional Roller (right)



You can re-configure
the Spool Positions



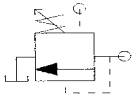

Pilot & Solenoid (Tagname 1A)



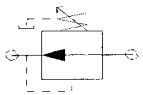

Solenoid (Tag. 2A & 2B)

# Pressure Controls Valves

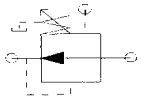
Pressure Relief Valve



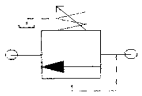
Piloted Pressure Relief Valve



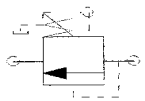
Pressure Reducing Valve



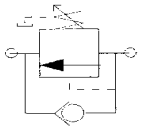
Piloted Pressure Reducing Valve



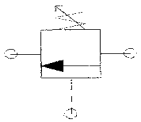
Sequence Valve



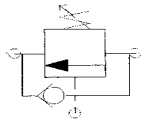
Piloted Sequence Valve



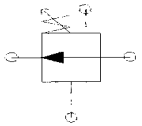
Sequence Valve with Check Valve



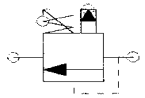
Counter Balance Valve



Counter Balance Valve with Check Valve



Piloted Counter Balance Valve

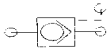


Poppet Relief Valve

# Flow Control Valves


Check Valve


Spring Loaded Check Valve


Pilot-Operated Check Valve


Fixed Throttle Valve

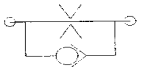

Non-Return (NR) Trottle Valve


Variable Throttle Valve

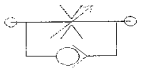

Variable NR Throttle Valve


Compensated Flow Control

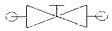

Fine Throttle Valve

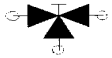

NR Fine Throttle Valve

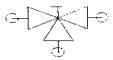

Variable Fine Throttle Valve


Variable NR Fine Throttle Valve

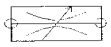

Shut-off Valve NO (2 Orifices)

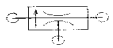

Shut-off Valve NC (2 Orifices)

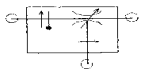

Shut-off Valve NO (3 Orifices)

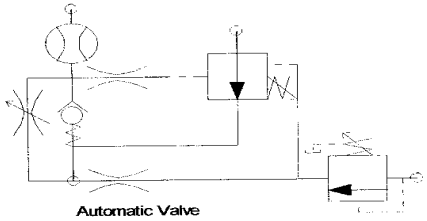

Shut-off Valve NC (3 Orifices)


Shuttle Valve

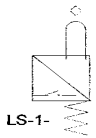

Flow Control


Pressure Compensation
Flow Divider


Pressure & Temperature
Compensation Flow Divider

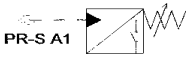

Automatic Valve

# Sensors

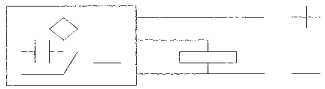



Mechanical Position Sensor


Proximity Sensor




Pressure Sensor

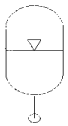


Capacitive Sensor (white for all materials)

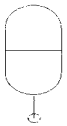
Inductive Sensor (red & blue for steels)

Optical Sensor (cut beam with objects)

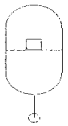
# Accessories



Gas-Loaded with seperator

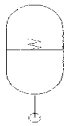


General



Weight-loaded

ACCUMULATORS



Spring loaded

Gas-loaded without seperator

Filter

Air Filter

TS A1

Thermal Switch NO

TS A2

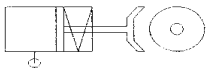
Thermal Switch NC

Pressure Gauge

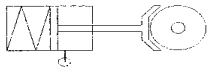
Thermo Meter

Differential Pressure Gauge

Flow Meter

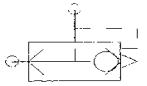


Brake



Brake Type2

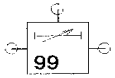
# Accessories



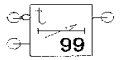
Quick Exhaust Valve

AND Flow Control Valve

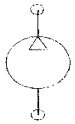
Pneumatic Exhaust Symbol



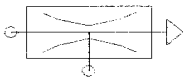

ON Delay Timer



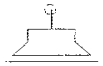

OFF Delay Timer



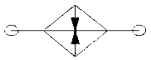
Compressor



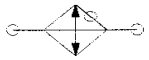
Vacuum Generator



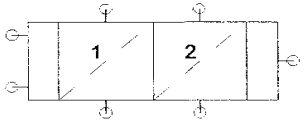
Vacuum Cup



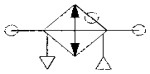
Heater



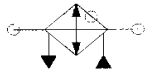
Cooler



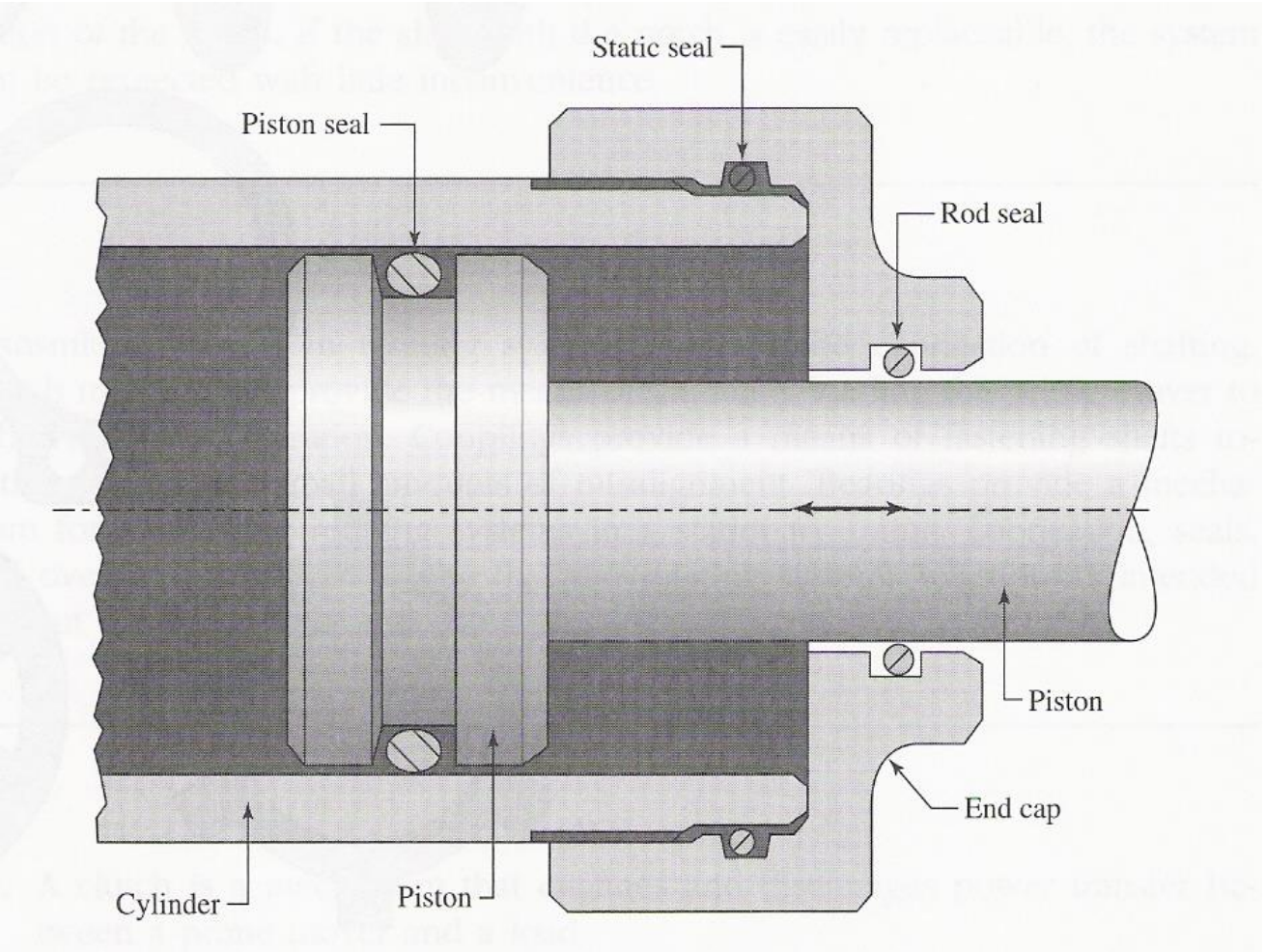

Sequencer



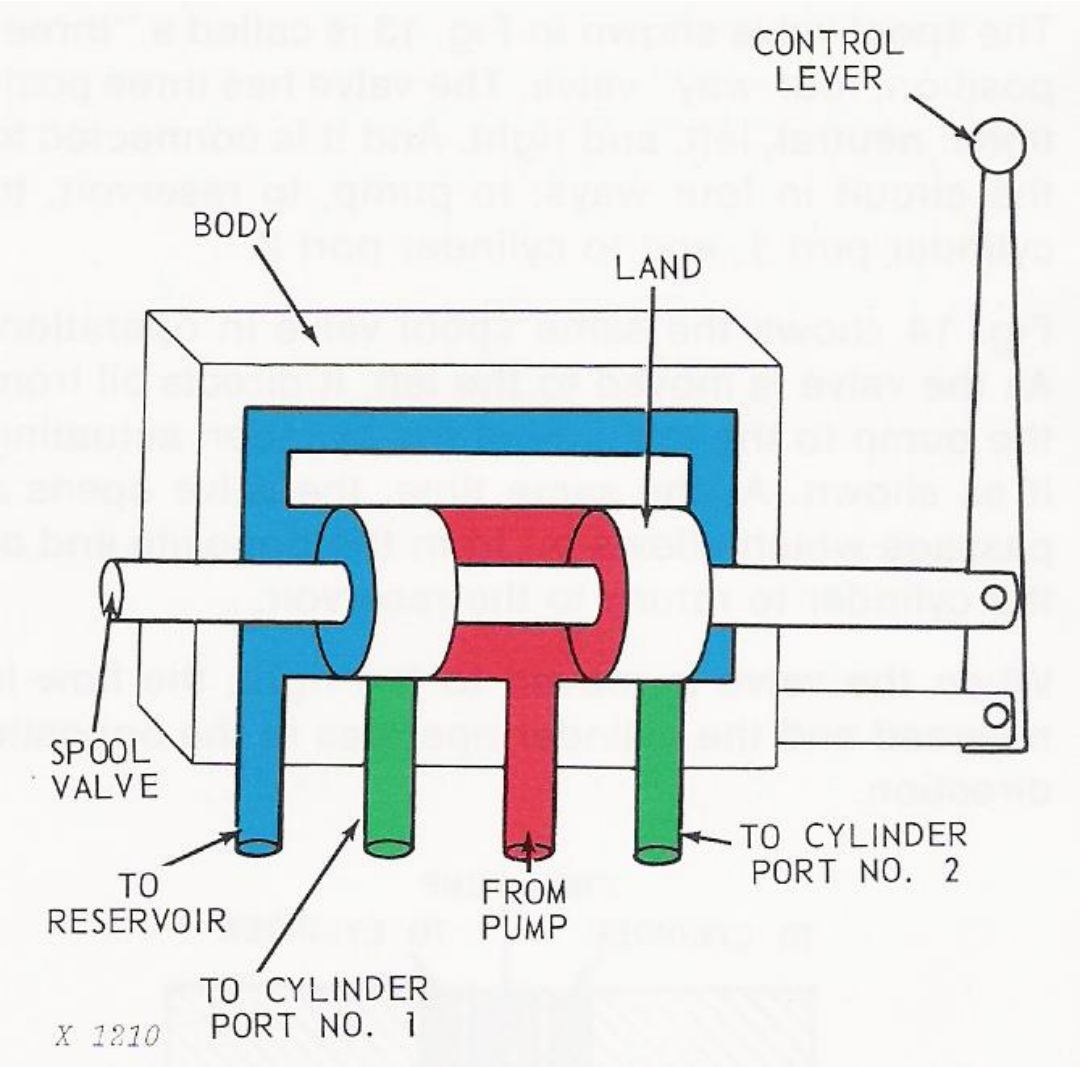
Air Cooler



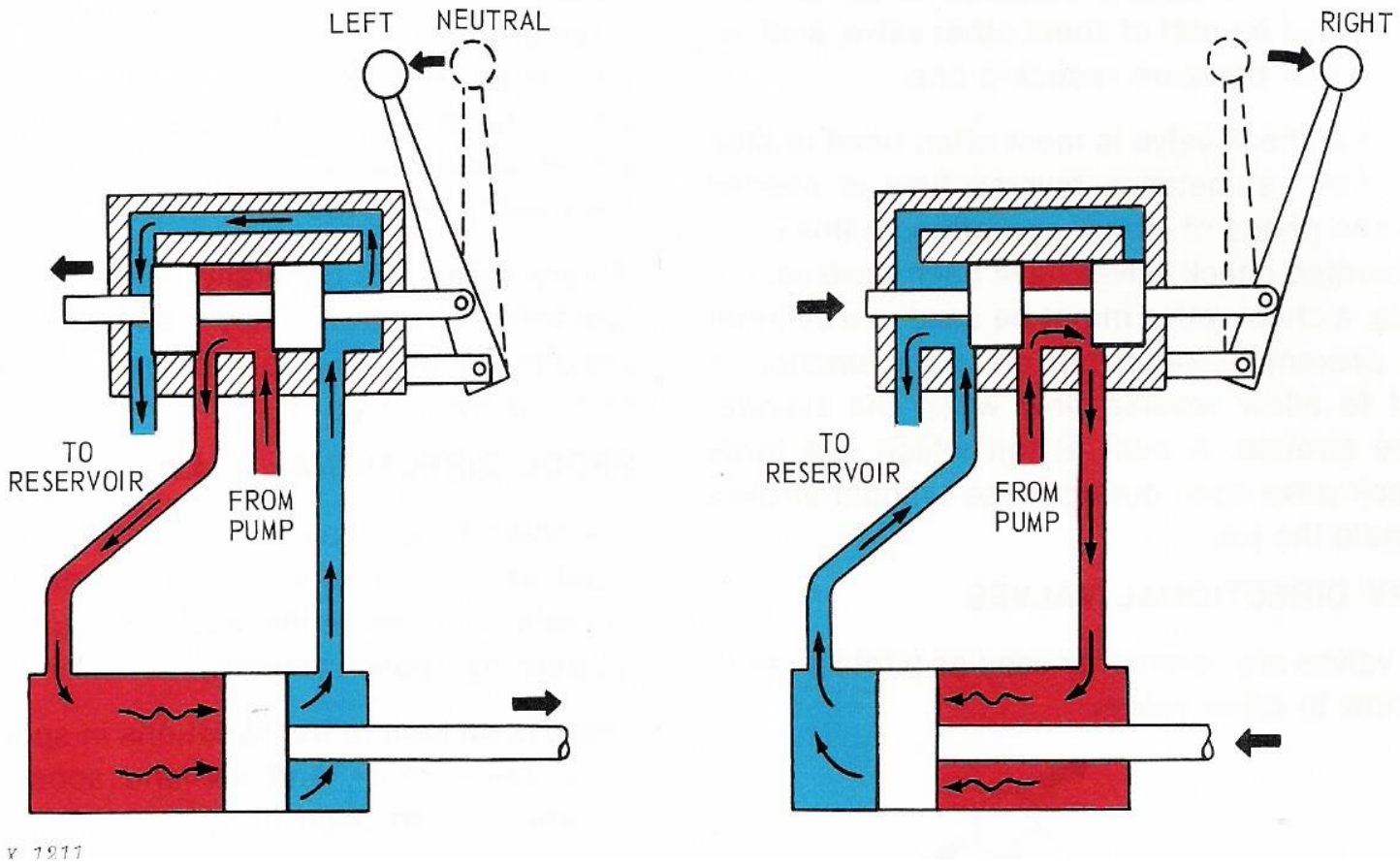
Fluid Cooler



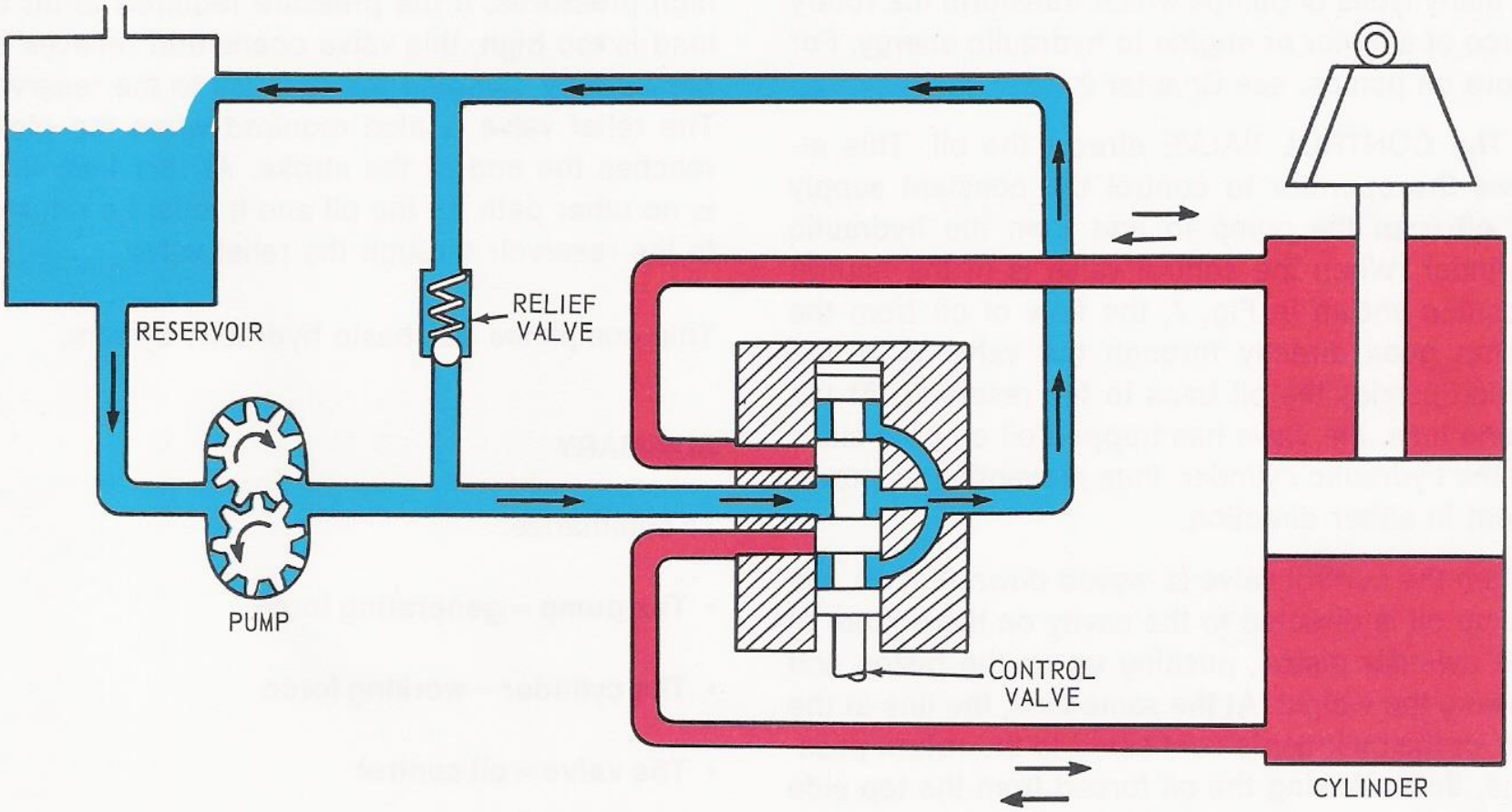

Cylinder Cross Section



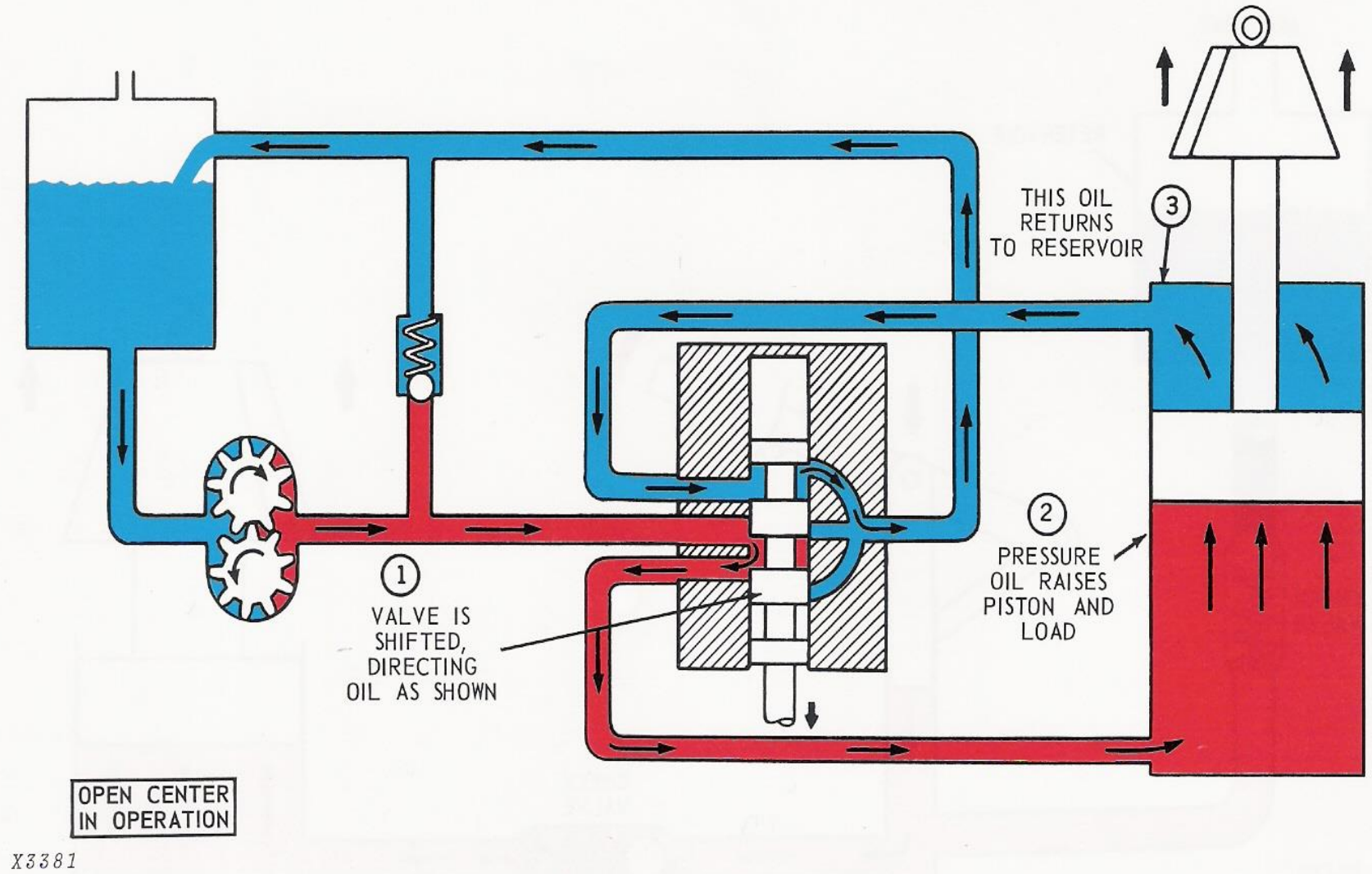

Spool Directional Valve



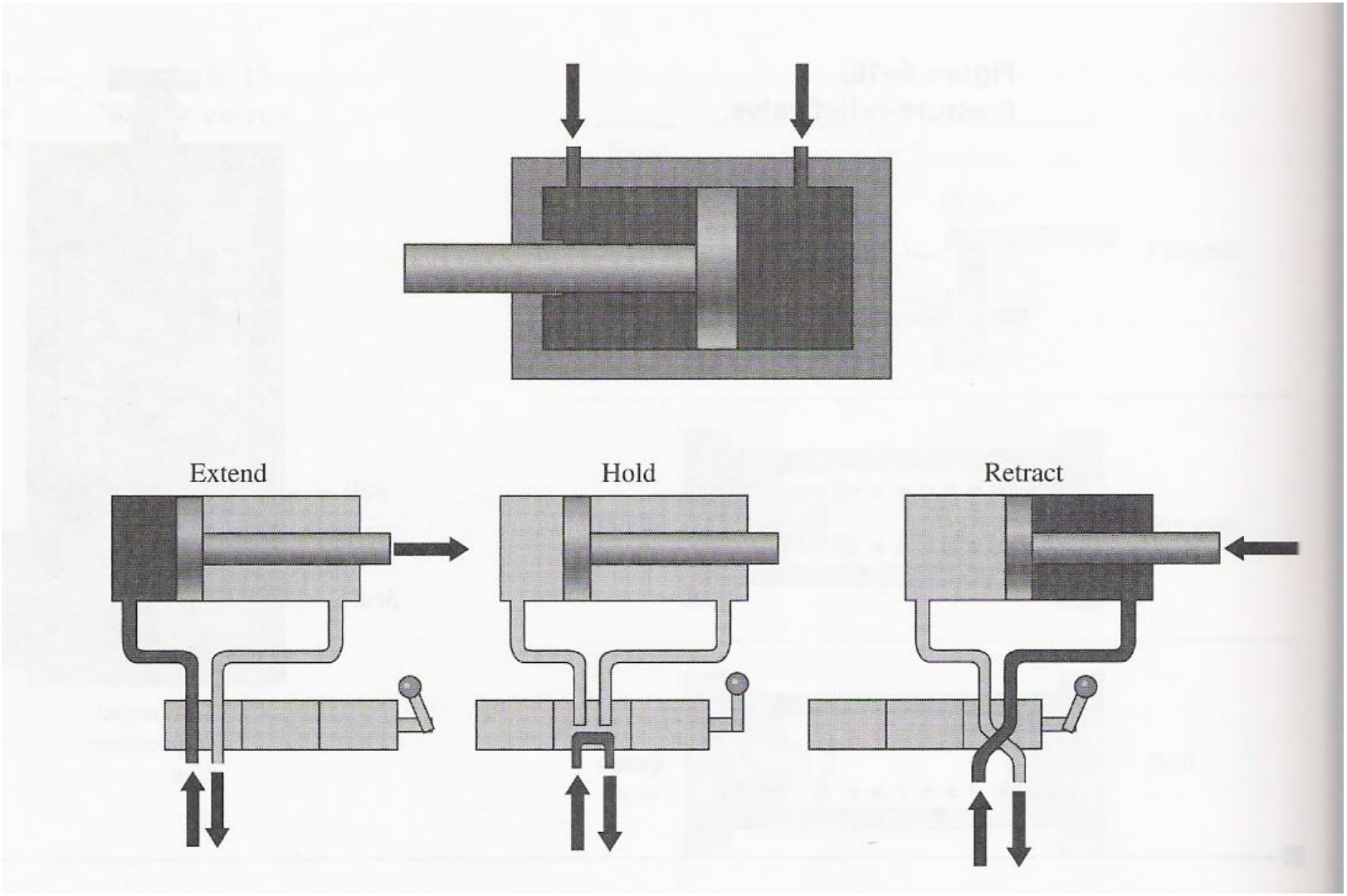

Spool Directional Valve



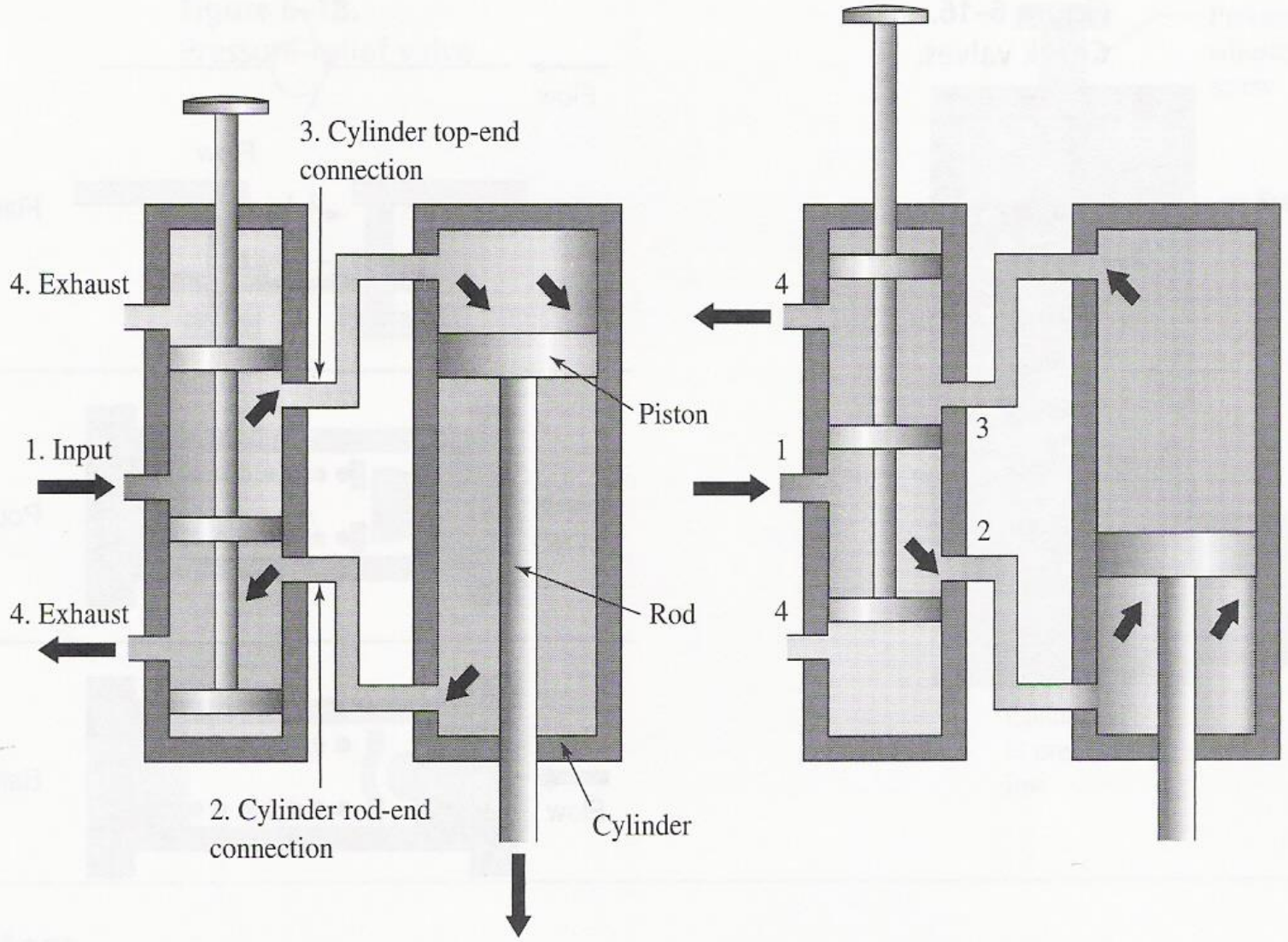

Hydraulic Circuit – Valve in Center Position



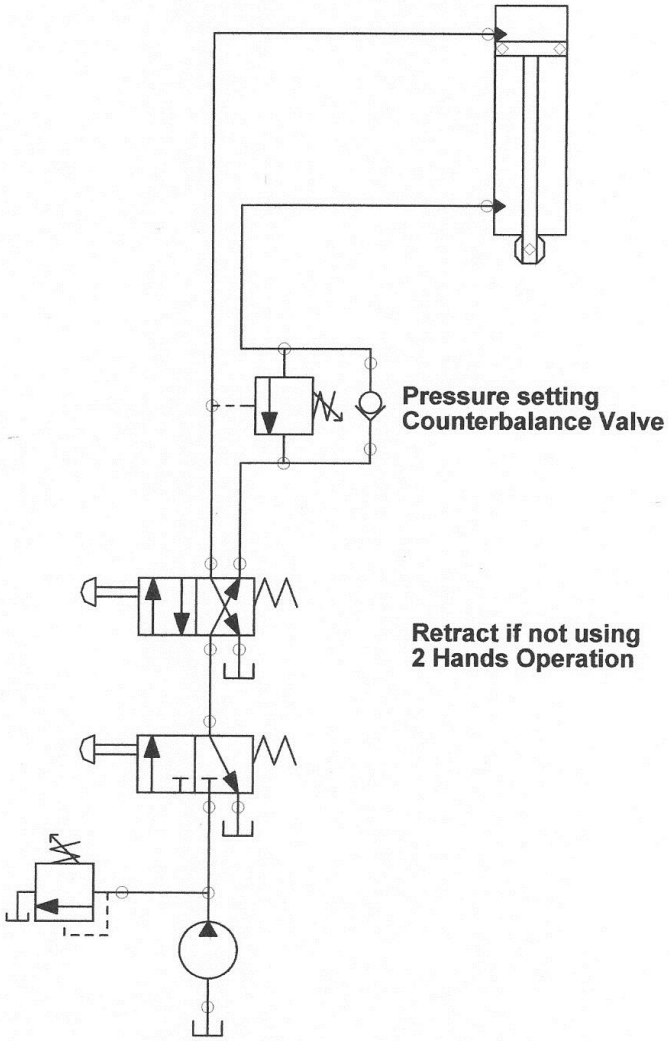

Hydraulic Circuit – Valve in Extend Position




3 Position Spool Valve

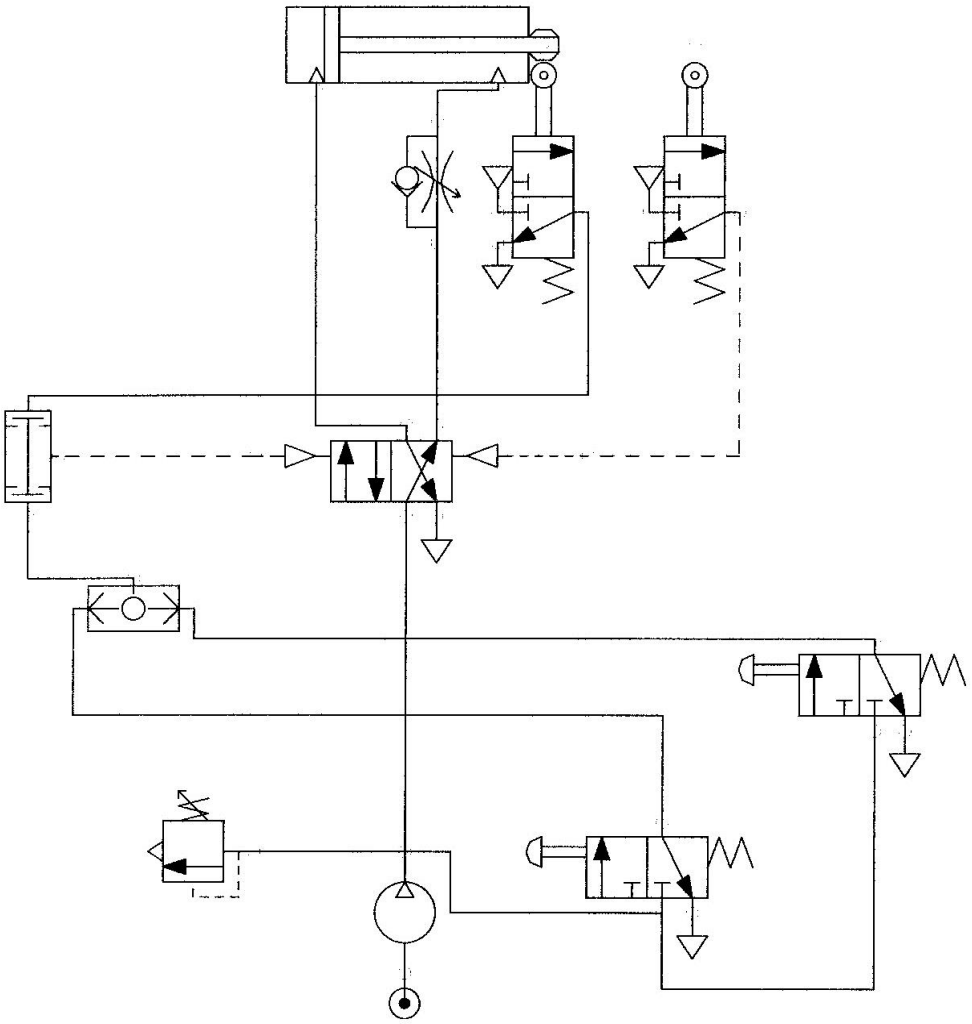



Cross Section of a 3 Position Spool Vavle



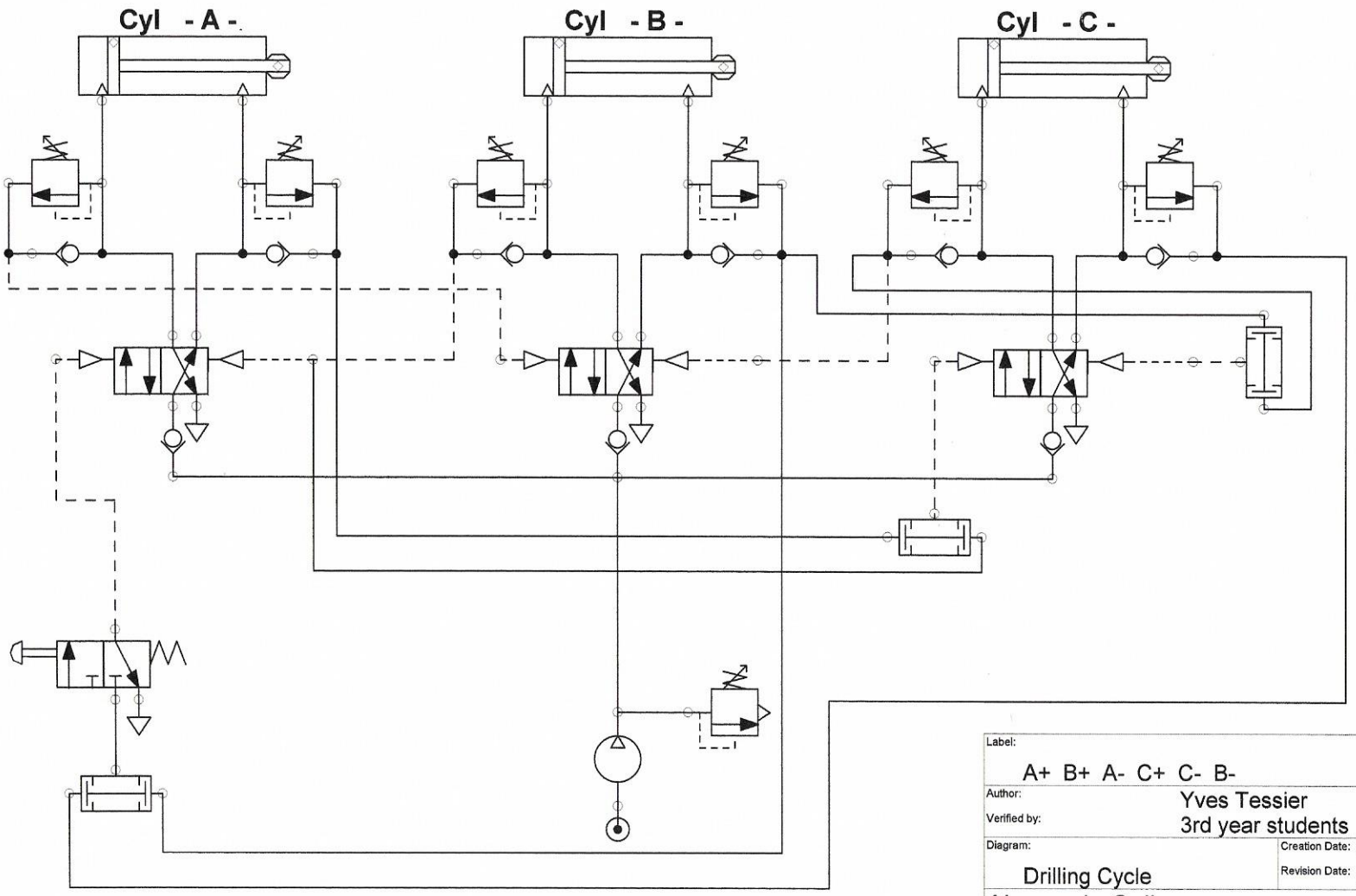

2 Push Button Extend Circuit

## AND + OR + SHUTTLE VALVES



| Qty | Component |
|---|---|
| 3 | 4/2 (14) Valve |
| 1 | 3/2 NC Valve |
| 3 | AND Valve |
| 9 | Check Valve |
| 1 | Compressor |
| 3 | Double-Acting (DA) Cylinder |
| 4 | Exhaust |
| 1 | Pneumatic Pressure Source |
| 1 | Pressure Relief Valve |
| 6 | Sequence Valve |

# A+ B+ A- C+ B- C-




Label: A+ B+ A- C+ C- B-

Author: Yves Tessier

Verified by: 3rd year students

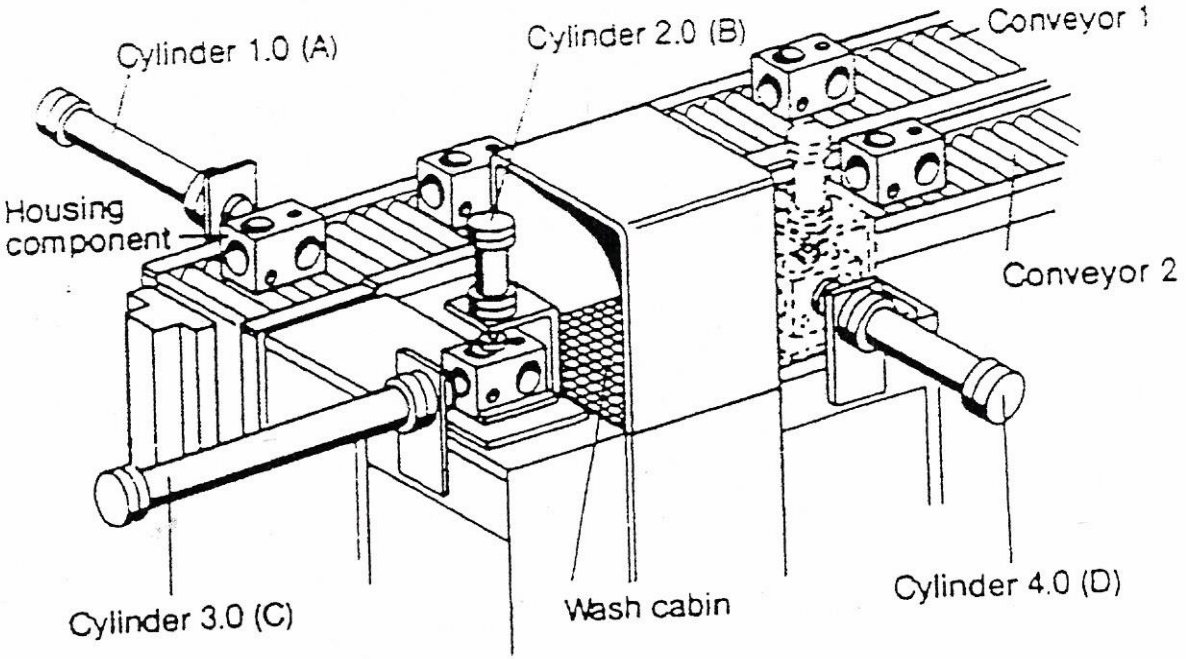
Diagram: Drilling Cycle

Creation Date: 9/14/2008 16:46:44

Revision Date: 9/14/2008 20:15:21

Algonquin College

Number: 3




Housing components are received from a drilling and milling station and are to be cleaned.

Cylinder 1.0 (A) pushes the component to be cleaned from conveyor 1 on to a washing plate. The component is clamped by cylinder 2.0 (B). When the component has been clamped, cylinder 3.0 (C) transports the casting through the wash cabin. At the end of the washing operation, cylinder 2.0 (B) unclamps the component and it is pushed on to conveyor 2 by cylinder 4.0 (D). Cylinder 3.0 (C) returns the washing plate to its initial position. A new cycle can commence.

**Auxiliary conditions:**

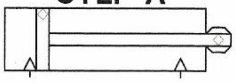
1. The sequence of operations should be performed automatically, the choice being provided for:
   - single cycle
   - continuous cycling

   The start signal is input by means of a start button.

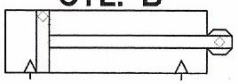
| Qty | Component |
|---|---|
| 1 | 3/2 NC Valve |
| 1 | Compressor |
| 4 | Double-Acting (DA) Cylinder |
| 1 | Exhaust |
| 1 | Pneumatic Pressure Source |
| 1 | Pressure Relief Valve |

# A+ B+ A- C+ B- D+ C- D-

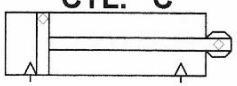
CYL. A



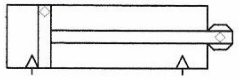
CYL. B

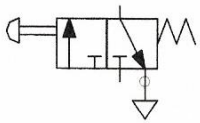


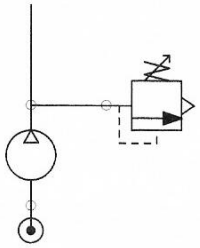
CYL. C



CYL. D







Label: A+ B+ A- C+ B- D+ C- D

Author: Students

Verified by: Yves Tessier

Diagram: Cleaning Station

Creation Date: 9/14/2008 16:46:44

Revision Date: 9/14/2008 20:32:25

Algonquin College

Number: 4