

STUDENT FEEDBACK FORM

Student: Matthew Rawlings

Assessment: Pneumatics and Hydraulics 2

Course: HNC Instrumentation Engineering

This section details the *extent* to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills		
Engagement with a wide range of independently sourced literature from internet and books. Selection of relevant and credible sources. Harvard referencing system applied to a good standard – well done for improving since the previous assignment.	20	14
2. Knowledge and Understanding Skills		
Competent knowledge of the basic underlying concepts of fluid power device construction and operation. Exhibits very good understanding and is able to explain gathered knowledge well. Good use of images and well explained circuit diagrams. Used figures are referred to in the writing. Calculations are complete and correct. Good interpretation of circuits and how the pressures and various operations relate to circuit behaviour	50	35
3. Cognitive and Intellectual Skills		
	0	
4. Practical Application Skills		
Able to interpret requirements of system design, build effective solutions and problem solve.	20	14
5. Transferable Skills for Life and Professional Practice		
Work is accurate, coherent, fluent, well-structured and organised. Work is relevantly linked to industry setting. Report presentation has improved since previous assignment – well done, but there is more to improve on.	10	6

Assessment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)

Late Submission Penalties (tick if appropriate)

Up to 1 week late (40% Max)

Over 1 week late (0%)

69 %

Matthew Rawlings Hydraulics and Pneumatics Assignment 2

by Matthew Rawlings

Submission date: 19-May-2022 03:55PM (UTC+0100)

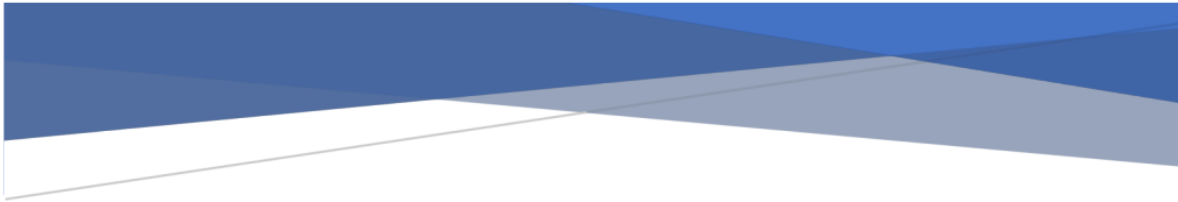
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69% overall grade

HNC INSTRUMENTATION ENGINEERING

Pneumatics and Hydraulics

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** 'Assignment 2' on the cover page would be useful **

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Introduction

Pneumatic and Hydraulic systems are used in various industrial systems. The two systems used fluid and air to produce power and movement. Valves and other systems are a vital part of an industrial environment. Industries use these systems on a daily basis in order for smooth operation. Safety and reliability are an important aspect of all systems and selecting the correct system will determine these factors with many more in consideration. There are many different methods and techniques to controlling a process. This paper explores the need for systems such as pneumatic and hydraulic systems in global industrial environments including oil and gas and explore the components involved in carrying out such operations.

(Library.AutomationDirect, 2022)

(Vector Solutions, 2017)

*A useful context to the components
and systems discussed in the report*

Task 1 – Actuator Construction and Operation

Actuators are a common component in pneumatic and hydraulic circuits though there are different types which operate in different ways. Two examples are linear and rotary actuators. There are multiple types of linear actuator which operate in a similar way in extension and contraction. Double acting, single acting, telescopic and spring return are all types of linear actuator. A double acting linear actuator is the most common type of actuator, using two ports either side of a diaphragm as a means of movement. This type of cylinder is utilised in many industries such as vehicles and machinery in closing doors and moving mechanical arms. It is used in production industries such as oil and gas in valve operation, opening and closing.

Good examples

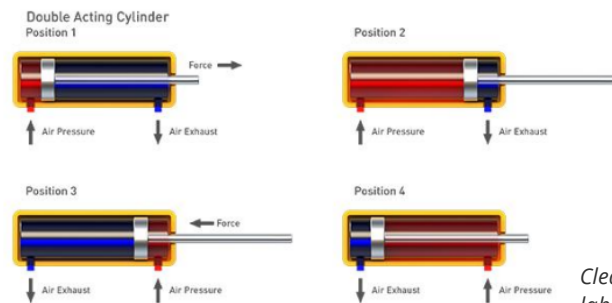


Figure 1 - Double acting linear cylinder

Clear diagram with correct figure labelling. In-text referencing for figures is better in the actual figure label.

(Pneumatics Team, 2017)

Shown in figure 1 (Pneumatics Team, 2017) is a double acting cylinder with an example of operation. Position 1 is a typical resting position for this cylinder, retracted, awaiting a pressure change. Following an increase in pressure to the back port, the piston extends as a result of force against a rubber diaphragm. In position 2, the piston is fully extended and the chamber is full of pressure having exhausted the area in front of the diaphragm. In this position, the actuated component will be at either 0% or 100% depending on the set up. At position 3, a solenoid or directional control valve will have switched the flow of air or hydraulic fluid and the piston will begin to retract, the Piston then returns to its initial position where it can be operated again. Though it is a common type of cylinder, it can not be held in a midway position which is its main limitation though its push-pull operation can be applicable to many different industries.

Can it be anywhere

between 0% and 100% ?

Clear operation

Rotary actuators are also used in pneumatics and hydraulics. A pneumatic rotary actuator uses compressed air to generate its operating energy. Some are designed specifically to remotely control valves. The air can be supplied from a main airline which runs through a site. The air is cleaned using filters and regulated using pressure regulators. This is also the case when using hydraulic fluid as a power source. A pneumatic rotary actuator uses one or multiple chambers with a diaphragm or piston. Depending on which of the previous is used, the air pressure forces the diaphragm or piston which operates a rotary action. One type of rotary actuator is a rack and pinion. This consists of a circular gear which operates a linear gear or the rack. When operated, the rack is pushed by the force created by air or hydraulic pressure upon a piston or diaphragm. When operated, the circular gear or pinion will turn, acting as an actuator for a rotary valve. The linear motion created by the rack is converted into rotary action by the pinion. (CMC Marketing, 2020)

Detailed operation



*Great cutaway
image - annotation?*

Figure 2 - Rotary Actuator

(Tameson, 2022)

Often two pistons and racks are installed on the opposite side of each other to increase the operating torque as seen in figure 2. In a double acting actuator, two chambers are used on the sides are filled with air which push the pistons to the centre. In returning the system to original position, the centre of the chamber must be pressurised. (Tameson, 2022)

*Good device
construction comments
with reference to the
figure.*

The previous actuators are designed to withstand and operate at specific pressures which are predetermined by the manufacturer or as specified if being made for a company. Regulations and legislations have to be followed when using the previous actuators. The *Pressure Systems Safety Regulations 2000* of the HSE states that it "covers the safe design and use of pressure systems." (HSE, 2000) This applies to all manufacturers producing products used in pressurised systems.

Good note of applicable legislative requirements

Task 2 – Actuator Calculations

A) System pressure needed

$$P = \frac{F}{A} = \frac{30 \times 10^3}{\left(\frac{\pi \times 0.14^2}{4}\right)} = 1.949 \times 10^6 = \mathbf{1.949MPa} \quad \square$$

B) Force pulled with same given pressure

$$\left(\frac{\pi \times 0.14^2}{4}\right) - \left(\frac{\pi \times 0.05^2}{4}\right) = 0.0134$$

$$F = P \times A = 1.949 \times 10^6 \times 0.0134 = 26.18 \times 10^3 = \mathbf{26.18 KN} \quad \square$$

C) Time taken to fully extend

$$Time = \frac{Distance}{Speed}$$

$$\left(\frac{\pi \times 0.14^2}{4}\right) \times 0.15 = 2.31 \times 10^{-3} = 2.31 \text{ Litres}$$

$$\frac{2.31}{6} = 0.385 \text{ minutes} \times 60 = \mathbf{23.1 seconds} \quad \square$$

D) Velocity on outstroke

$$Speed = \frac{Distance}{Time} = \frac{0.15}{23.1} = \mathbf{0.0065m/s} \quad \square$$

E) Time taken to fully retract

$$Time = \frac{Distance}{Speed}$$

$$0.0134 \times 0.15 = 2.01 \times 10^{-3} = 2.01 \text{ Litres}$$

$$\frac{2.01}{6} = 0.335 \text{ minutes} \times 60 = \mathbf{20.1 seconds} \quad \square$$

F) Speed of retraction

$$Speed = \frac{Distance}{Time} = \frac{0.15}{20.1} = \mathbf{0.0075m/s} \quad \square$$

G) Power on outstroke

$$Power = \frac{Workdone}{Time} = \frac{PAx}{t} \quad Workdone = Force \times Distance$$

$$Power = \frac{30 \times 10^3 \times 0.15}{23.1} = \mathbf{194.8 WATTS} \quad \square$$

All calculation results are correct

Task 3 – Circuit Analysis

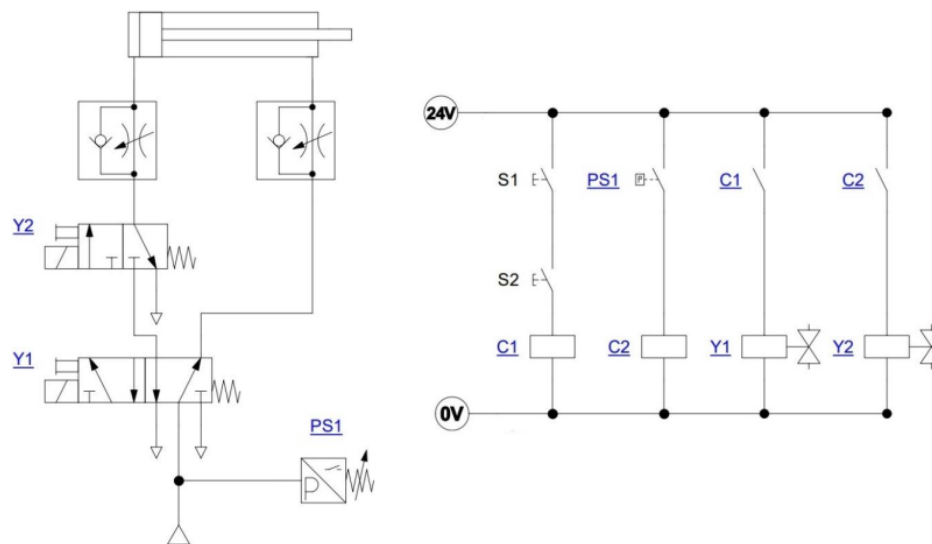


Figure 3 - Electro-Pneumatic Circuit

*Two hand operation
identified along with
potential hazard*

Pictured is an electro-pneumatic circuit utilising multiple components which link in operation. In the circuit is a pneumatic supply, pressure switch, directional control valves, unidirectional flow controllers and a double acting linear actuator. The electrical circuit consists of a 24-volt supply and ground, push buttons, coils, a pressure switch, relay contacts and solenoids. The pressure switch, PS1 operates at 9 bar while the system runs at 10 bar.

S1 and S2 are push buttons, acting as a safety interlocking system to avoid entrapment. Once S1 and S2 are closed by the operator, coil C1 is energised which closes the associated relay contact, energising solenoid Y1. As seen in the diagram, Y1 moves the directional control valve, applying pressure to the second valve but pressure will not pass as Y2 has not been operated and the system may not have reached 9 bar to operate PS1. Once 9 bar has accumulated in the system, PS1 closes, energising coil C2, closing the relay contact and energising solenoid Y2. This moves the second solenoid across, allowing pressure to the back of the cylinder, extending the rod for the desired application.

Methodical sequence

Once the function is carried out, the operator can release S1 and S2 which de-energises C1 and Y1, redirecting the pressure to the front of the cylinder, retracting the component. Upon releasing the push buttons S1 and S2, C1 is de-energised so Y1 returns to its original position.

Completed circuit - good

A relay is a common component used in electro-pneumatic circuits. A relay is a mechanical switch which is operated by an electromagnetic field. A small current is used to create a magnetic field which can switch the relay, controlling a much larger current. The construction consists of a coil wound round an iron core to increase the magnetic attraction. The coil creates the electromagnetic field when subjected to current, attracting the armature.

Good intro

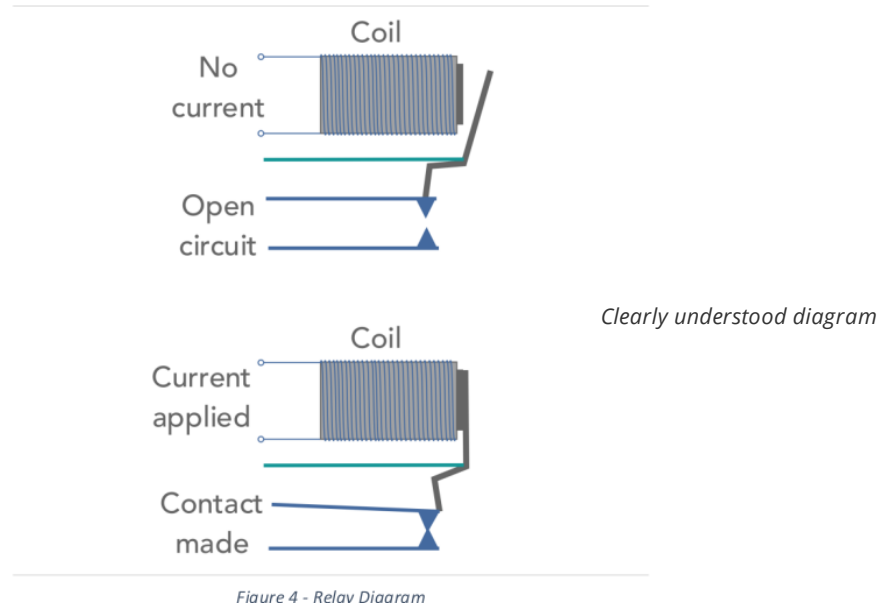


Figure 4 - Relay Diagram

(electronicsnotes, 2022)

The armature is the moving component of the relay as it is the element which opens and closes. The assembly has an attached spring which returns the armature to its original position when the current is no longer present. The contacts complete the relay and are operated by the movement of the armature. There are different types of relays which are known as normally open and normally closed or energise to open or energise to close. This arrangement depends on the set up of the system which the relay is installed in. Relay banks were used in control systems and are large groups of relays which carried out a similar function to a PLC. There are multiple types of relays which are all used in electro-pneumatic systems such as power relays which can operate using a current of “*power loads 10-50 amperes or more*” (StudyElectrical, 2021). Time delay relays are also used in electro-pneumatic systems. “*The contacts might not open or close until some time interval after the coil has been energized. This is called delay-on-operate.*”

Delay-on-release means that the contacts will remain in their actuated position until some interval after the power has been removed from the coil.” (StudyElectrical, 2021)

The timing of these actions may be a fixed parameter of the relay, or adjusted by a knob on the relay itself, or remotely adjusted through an external circuit.

Informative writing that links to published sources.

Task 4 – Circuit Design

Box detection Electro-Pneumatic circuit

Circuit before introducing pressure.

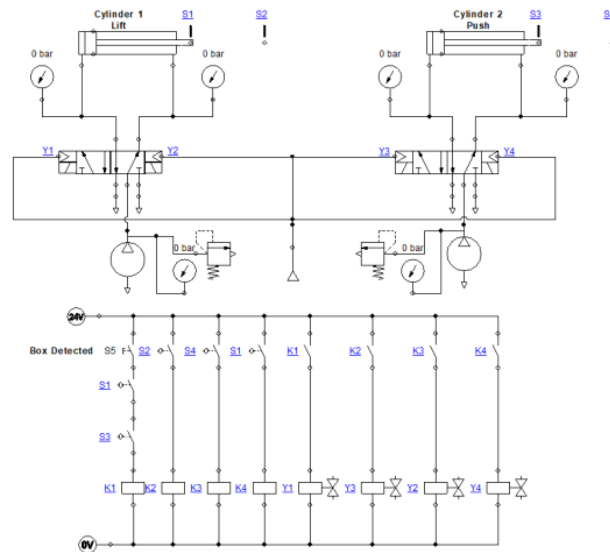


Figure 5 - Electro-Pneumatic system before power

A neat and well presented circuit. In the interest of efficiency- a single pneumatic source would be sufficient.

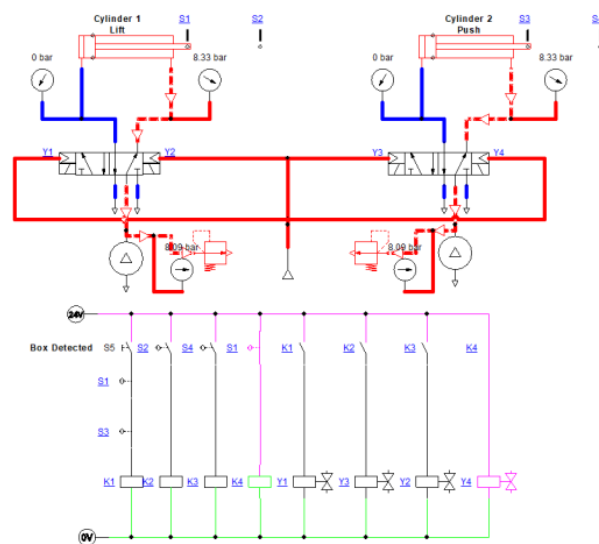


Figure 6 - Powered system

Various stages of operation clearly shown

S1 is closed, energising K4 and Y4 but S5 or the box detection S5 is not closed.

Once a box is detected Cylinder 1, the lift cylinder extends, meeting S2, energising K2 and Y3, extending Cylinder 2 or the push cylinder.

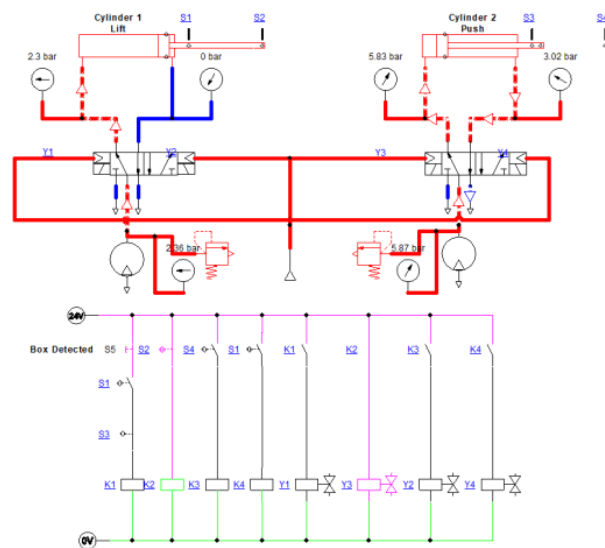


Figure 7 - Box detected

Cylinder 1 fully retracts, meeting S1, energising K4 and Y4, retracting Cylinder 2.

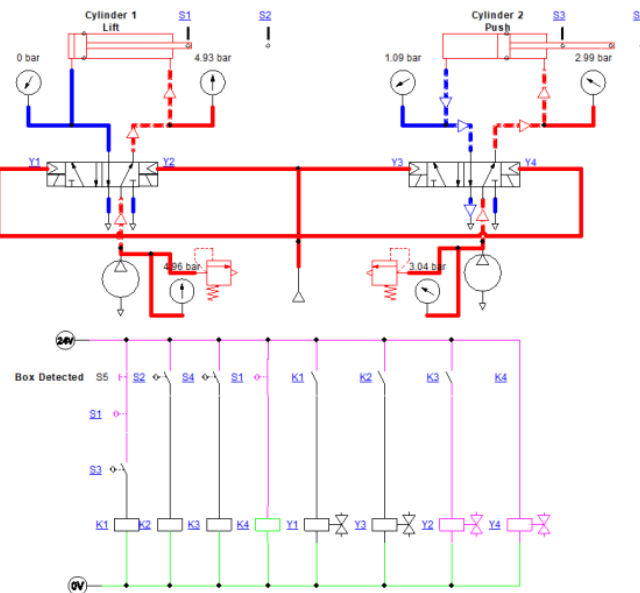


Figure 8 - Cylinders Retracting

Box moved, S5 open, system returns to resting state, pressure venting through pressure relief valves.

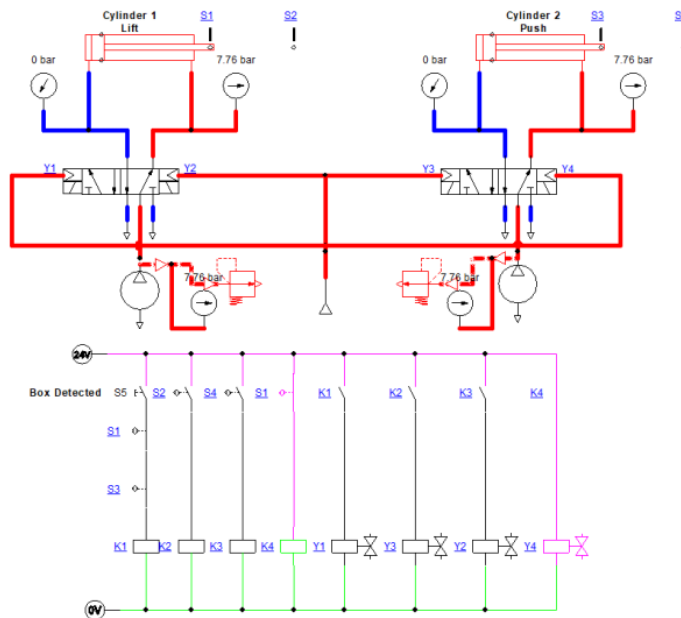


Figure 9 - System at resting state

This system was designed for the transportation of cardboard boxes at the end of a production line. The systems operation is based on the detection of a box and response it gives to moving the box. Cylinder 1 as seen is named the lift cylinder as it lifts a detected box off a conveyor belt. The operation of the circuit cannot be initiated until a box is detected and both cylinders are fully retracted. S5 operates as the detection aspect, with S1 and S3 acting as interlocks, ensuring the cylinders are fully retracted. Once each of these are satisfied, coil K1 is energised, allowing power to solenoid Y1, which operates the control valve for cylinder 1, extending this component. Limit switch, S2, positioned at the end of the extension is triggered which energises a coil, K2 and solenoid Y3, moving the control valve for cylinder 2, extending this. Cylinder 2 is the push cylinder which pushes the lifted box to the end of production. Once cylinder 2 is fully extended, it meets S4, energising K3 and Y2, retracting cylinder 1 which. Once cylinder 1 has fully retracted, S1 is met which energises K4 and Y4, retracting cylinder 1. This part of the circuit is specified in the design specification as a required function. As demonstrated, this operates per specification. Air compressors provide the pneumatic system with pressure with pressure relief valves for safety. Pressure gauges have been fitted in the system also for monitoring and safety reasons.

Detailed description of operations

Hydraulic clamping circuit

The following figures show and explain the operation of a hydraulic circuit designed in Automation Studios.

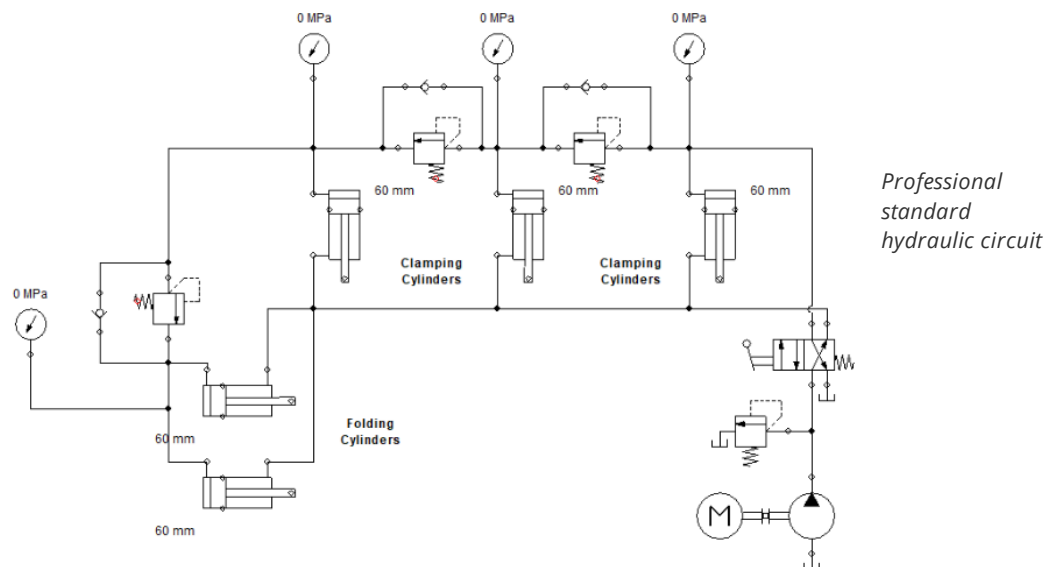


Figure 11 - System before operating

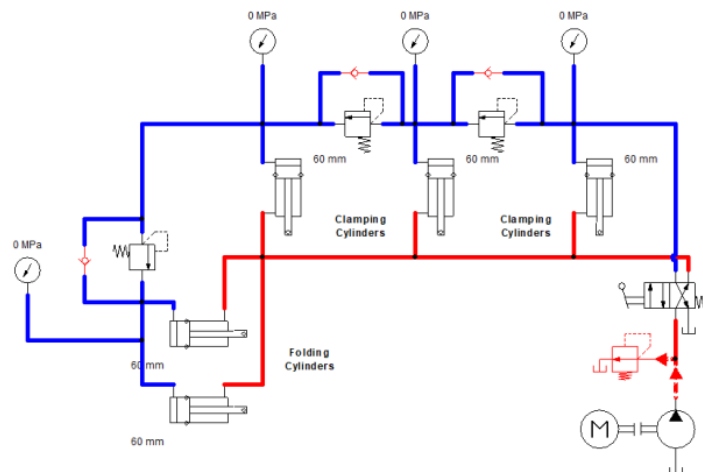


Figure 10 - System at resting state

Figure 10 shows the hydraulic circuit before operating the manual lever.

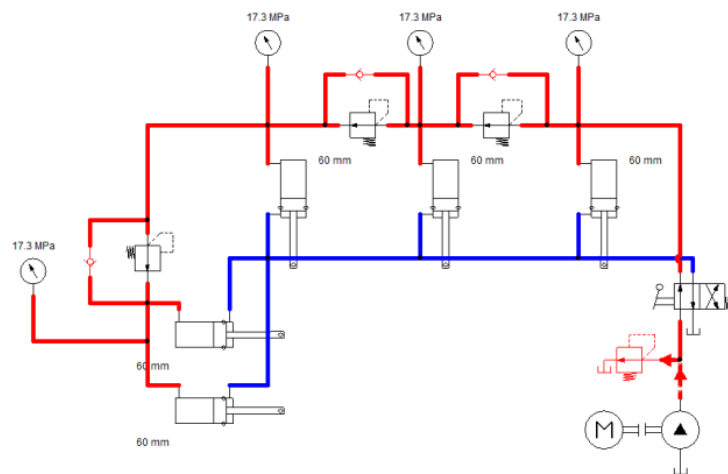


Figure 12 - Hydraulic system in operation

Shown in figure 12 is the system in operation. Cylinder 1, 2 and 3 clamp the steel, while cylinders 4 and 5 bend the metal to the desired shape after cylinders 1, 2 and three are at full pressure.

Figure 12 shows the system at complete operation. A hydraulic pump takes fluid from a reservoir and uses an electric motor as means of rotation. A pressure relief valve is used before the system in the event of over pressuring will operate, saving the system from damage. A control valve is manually moved by an operator using a lever to initiate the function of the system. Upon using the lever, the spring return control valve switches the flow of oil from the front of the clamping cylinders to the back of these. A sequence valve is fitted after the cylinders as a means of restricting flow until the pressure is high enough. The clamping cylinders operate individually to ensure the clamping force is as strong as is required. Once the sheet metal is firmly clamped, a sequence valve allows fluid flow to the folding cylinders. Once the cylinders have fully extended, the manual lever can be operated to return the cylinders to a resting state. In parallel with the sequence valves are check valves or non-return valves so that the hydraulic fluid can drain back into a reservoir, connected to the directional control valve. This system operates as per the specification as the design states that all clamping cylinders should operate in a sequential manor with a pair of cylinders operating to bend the steel. As demonstrated, these requirements are met along with inputted safety features.

*Detailed
description of
operations*

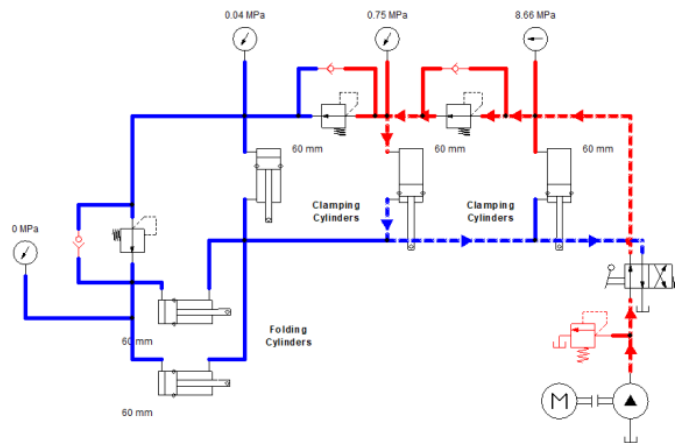


Figure 13 - Sequential operation

Figure 13 shows the sequential operation of the clamping cylinders and the operation of the sequence valves. At the first valve a pressure of 8.66MPa is observed, compared to the second where 0.75MPa is observed and >0.1MPa on sequence valves in series 3 and 4.

(Correct operation of both circuits observed in simulation lab - JM)

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Well populated reference list that links to the main body.

The report order should be: Cover page, Contents, Figure List, Intro, Main body, Conclusion, References, Bibliography (if used)

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*Useful list- see comment on
previous pages.*

Matthew Rawlings Hydraulics and Pneumatics Assignment 2

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

69/100

PAGE 1

Text Comment. 69% overall grade

Text Comment. * 'Assignment 2' on the cover page would be useful *

PAGE 2

PAGE 3

Text Comment. A useful context to the components and systems discussed in the report

PAGE 4

Text Comment. Good examples

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Text Comment. Can it be anywhere between 0% and 100% ?

Text Comment. Clear operation

Text Comment. Detailed operation

PAGE 5

Text Comment. Great cutaway image - annotation?

Text Comment. Good device construction comments with reference to the figure.

Text Comment. Good note of applicable legislative requirements

PAGE 6

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Text Comment. All calculation results are correct

PAGE 7

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Text Comment. Completed circuit - good

Text Comment. Good intro

PAGE 8

Text Comment. Clearly understood diagram

Text Comment. Informative writing that links to published sources.

PAGE 9

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Text Comment. Various stages of operation clearly shown

Text Comment. Detailed description of operations

Text Comment. Professional standard hydraulic circuit

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