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Design Simulation and Development of Sequential Pneumatic Circuit For Industrial Applications

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Abstract – *In fourth industrial revolution automation play a vital role. Automation is the science of designing and building mechanism useful for real life applications. Automation has been defined as the use of control system such as pneumatics, hydraulics, electrical, electronics and computer to control industrial machinery and process reducing use of human effort. Now adays more and more industrial application use pneumatic system instead of hydraulics and electromotive because of continuous availability of compressed air and they may operative in flammable condition without igniting or exploding. Pneumatic system is more applicable because of their simplicity, reliability and area of operations. This project work consists design simulation and development of cascade pneumatic sequential circuit.*

Key Words*: *Automation, Simulation, Hydraulic system, Pneumatic Sytem.

1.INTRODUCTION

Pneumatic is a branch of engineering that deals with study of compressed air /inert gas and their use in engineering applications. The word pneumatics derived from the Greek pneuma meaning breath or air. Pneumatics is the application of compressed or pressurized air to power machine to control or regulate them. Pneumatics also defined as branch of fluid power that deals with generation, transmission and control of power using pressurized air. In a pneumatic system compressed air using as working fluid for power transmission. An air compressor converts mechanical energy of primover in to pressure energy of compressed air. Compressed air is used for desired work. Pneumatic cylinder, air cylinder are mechanical devices which use the power of compressed gas to produce a force in a reciprocating linear motion. Direction control valves are used to control direction of actuation of pneumatic cylinder. In industrial application pneumatics are preferred because they are quitter, cleaner and do not require large amount space for storing as operating fluid is gas.

In industrial application simulation play a vital role in pre-production. Effective pneumatic system requires effective working simulation. Fluid SIM is a software tool for creating simulating hydraulic, pneumatic, electro-hydraulic, electro-pneumatic digital electronic system.

Main aim of project work is design simulate and development of pneumatic cascade sequential circuit A+B+B-A-configuration. Pneumatic diagram describes the relation between each pneumatic components as per equipment of pneumatic system.

2 LITERATURE REVIEW

1. Design and Fabrication of Sequencing Circuit with Single Double Acting Cylinder.

Author: V.G. Vijaya

Aim of project work is construction of pneumatic device assembly for press fitting a pin to a hole. For press-fitting a pin to hole using a pneumatic device accomplishes a cylinder and a button to operate it. In this work pneumatic cylinder actuated such a way that only when both palm button 3-way valves are operated nearly simultaneously. The main motto of work is to press fit a pin to hole using pneumatic devices by economically and to ensure the operator's safety. Designed and fabricated "sequencing single, double acting cylinder" helps to know how to achieve low-cost automation.

2. Design and Development of Pneumatic Punching Machine

Author: Anand Kumar Singh, Mitesh L Pate

Hand operated punching has many advantages and disadvantages, like hand punching has accuracy and job availability but due to late work complete, accident and high cost, alternate source of operation started. Pneumatic punching machine give us high accuracy with before time completion and second most important, it is not dangerous and second does not worry about slot of jobs. In this work solid works software used to develop solid model of the pneumatic punching machine. Pneumatic punching machine fabricated using various pneumatic components double acting cylinder solenoid valve.

3. Design of Pneumatic Vice

Author: Swapnil B. Lande, Tushar S. Shahane, Mitesh M. Deshmukh, Mahesh D. Mange,

This work consist design and develop a model prototype of pneumatic power vice. Fabricate the model of same. Test the

model under different conditions of load, and pressure of compressed air. Design a system which will be able to clamping and unclamping the job using compressed air. This project uses double acting cylinder with compressed air to optimize the work of holding the job rigidly and operation has easy accesses to clamping and unclamping the job.

4. Design and Fabrication of Pneumatic Car Lifter

Author: Shubham Gump Alwar, Darshan Dhabarde, Shubham Gade, Amit Kalhane, Vishnu Nair, Prof. Praful Randive.

In this work fabrication is based on pneumatics which deals with the study and application of pressurized air to produce mechanical motion. This fabricated model consists of a small size reciprocating air compressor which is driven by the battery used in four-wheeler, an air tank to store the compressed air, and a pneumatic control valve which regulates the air flow and double acting cylinder used as a jack which performs lifting. The main target of this r project is to fabricate compact version of pneumatic power car lifter. This will be more efficient for the local car service provider as well as car users. This machine is pneumatic powered which has low coefficient of friction. A pneumatic cylinder erected provides power to lift of the jack. This is a pneumatic powered machine and requires energy to run the pneumatic pump. The required components are compressor, pneumatic cylinder, control circuit and jack. Pneumatic systems used pressurized fluid to transmit and control power. Pneumatic systems typically use air as the fluid medium which is free in nature.

5. Design and Construction of Automated Stamping Machine for Small Scale Industries

Author: Mauton Gbededo and Olayinka Awopetu

This work consist design and produce a low-cost automated stamping machine as a modification to the existing coding machine and inject printers used in large-scale food packaging industries which are controlled by Programmable Logic Control and are quite expensive. Design and fabricate a machine with improved technical efficiency and technology simplicity than the existing stamping machines through the introduction of belt and rollers to increase the speed of the machine and also the incorporation of a pneumatics control systems to perform automatic stamping through an inserted rubber ink and build/manufacture a product that complies with food regulatory body in Nigeria.

6. Automatic Bar Bending Machine using Pneumatic System

Author: R. Sasikala, M. Rakshana, T. Thinaa, P. Thirupponvel, D. Vasanth

The main aim of this project is to automate the bar bending process using pneumatic system to reduce the cost and enhance the productivity. Conventional Methodologies involve major labour work, layout setup, high cost etc. Hence to reduce labour cost, Automation is preferred. This work consists develop an automatic bar bending machine pneumatic system. The hardware consists of pneumatic cylinder, dc motor mounted with shaft, Arduino controller, relay and rod for bending purpose.

7. Pneumatic Can Crusher

Author: Bhavik Ranjan Kathe

Main aim of project work is design and development of pneumatic can crusher. This project involves the process of designing the different parts of the crusher machine considering the forces and ergonomic factor for people to use. This project mainly about generating a new concept of can crusher that would make easier to bring anywhere and easier to crush cans. This machine is basically working on the principle of Single Slider Crank Mechanism which is the heart of this machine and it converts rotary motion into a reciprocating machine to crush the Cans/Plastic bottles.

3 METHODOLOGY

Methodology is one of the most important elements to be considered to make sure the fluent of the project and get expected result. In other words the methodology can be described as framework where it contains the elements of the work based on the objectives and a scope of the project. A good framework can get the overall view of the project and get the data easily. This included literature study, Design of pneumatic cascade circuitA+B+B-A-, simulation using Fluid SIM software,

fabrication of pneumatic sequential system and cost analysis.

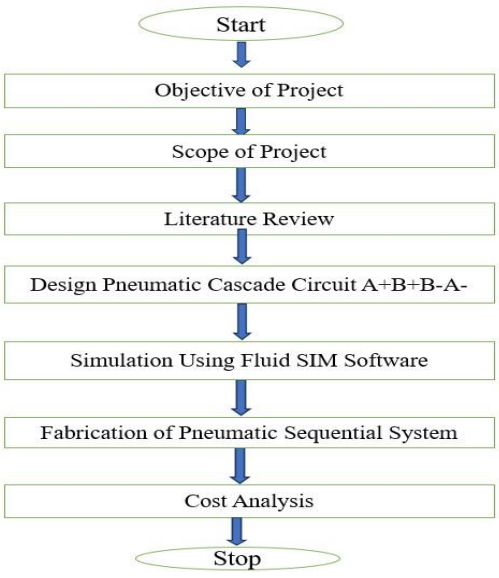

Fig 1: Project Methodology

4. WORK DONE

A pneumatic system consists two-cylinder cylinder A extend first then only cylinder B extend. Cylinder A return only after cylinder B retracted fully.

Flow Chart for Pneumatic Circuit Design

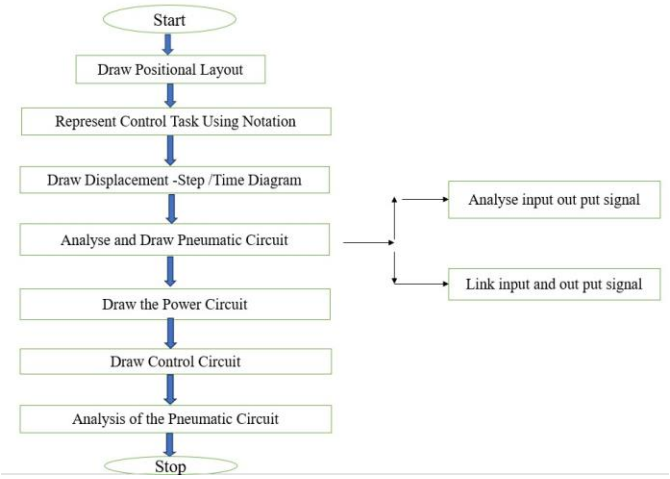

Fig 2: Flow Chart for Pneumatic Circuit Design

Step 1: Positional layout

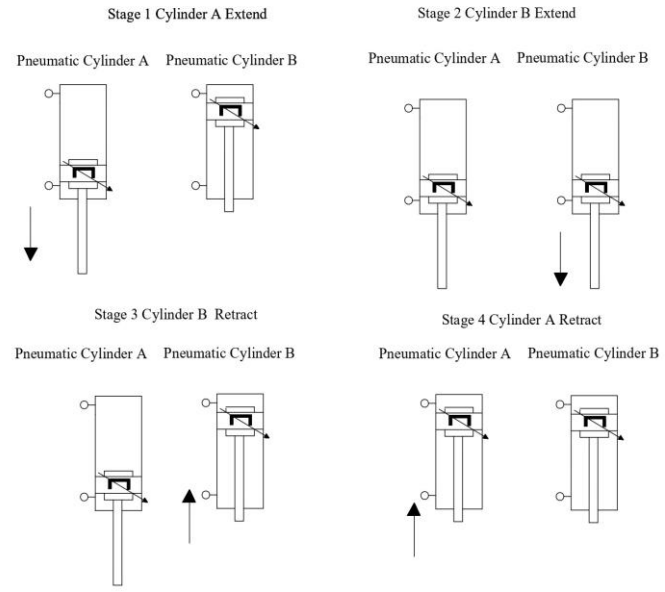

Fig 3: PZsitional Layout

Step 2: Represent Control Task Using Notation

Cylinder A advancing is designated as A+

Cylinder A retracting is designated as A-

Cylinder B advancing is designated as B+

Cylinder B retracting is designated as B-

The sequencing of pneumatic cylinder is A+B+B-A-

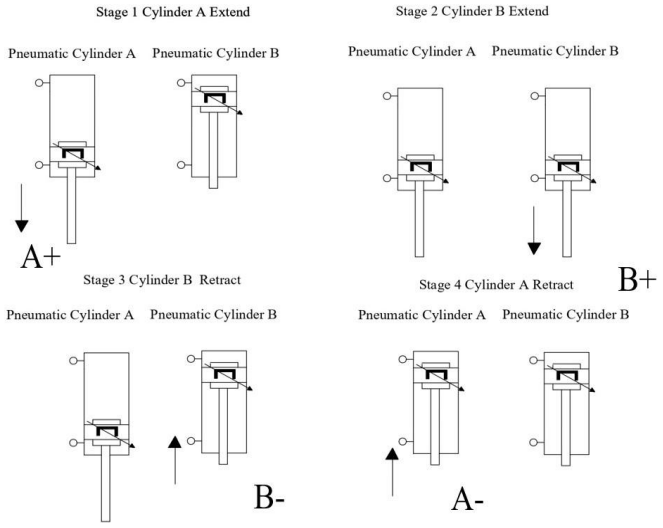

Fig 4: Positional Layout with Notation

Step 3: Displacement –Step Diagram

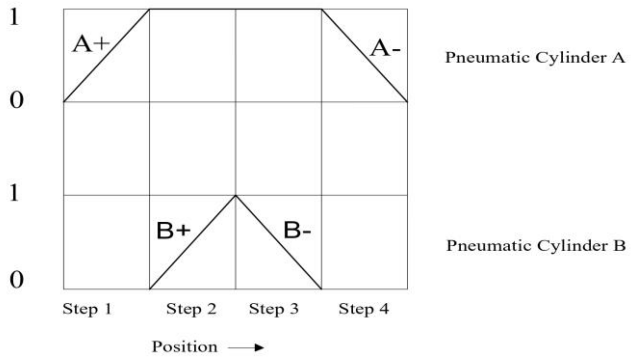

Fig 5: Displacement -Step Diagram

Step 4: Displacement –Time Diagram

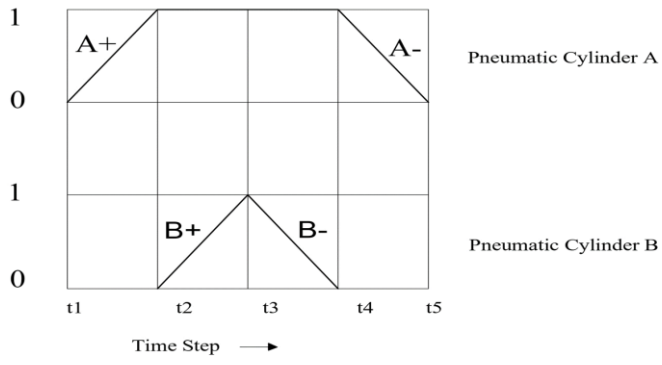

Fig 6: Displacement -Time Diagram

Step 5: Analyse and Draw the Pneumatic Circuit

Step 5.1 Analyse input and Output Signal

Input Signals

Cylinder A:Limit switch at home position a0

Limit switch at home position a1

Cylinder B:Limit switch at home position b0

Limit switch at home position b1

Output Signal

Forward motion of cylinder A(A+)

Return motion of cylinder A(A-)

Forward motion of cylinder B(B+)

Return motion of cylinder B(B-)

Step 5.2 Displacement Step diagram linked to input output signal

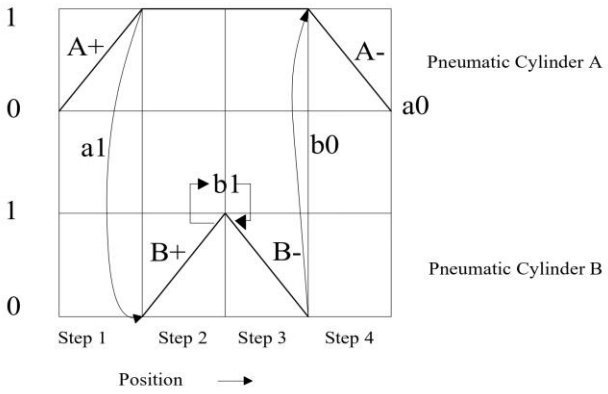

Fig 7: Displacement Step diagram linked to input output signal

A+ generate sensor signal a1, which is used for movement B+

B+ generate sensor signal b1, which is used for group changing

B- generate sensor signal b0, which is used for movement A-

A- generate sensor signal a0, which is used for group changing

Step 6: Pneumatic Cascade Circuit A+B+B-A-

Operating Sequence =A+B+B-A-

No of groups =2

Group 1: A+B+

Group 2: B-A-

No of pressure line=No of group=2

Selection of valve

No of piolet operated 5/2 valve=No of cylinders =2

No of limit valve=No of cylinderx2=2x2=4

No of cascade valve = No of group -1=2-1=1

Components of Pneumatic Sequential System

Sl No	Components	Nos
1	3/2 Push Button Spring Valve	1
3	5/2 Double Piolet Valve	3
4	3/2 Roller Spring Valve	4
5	Pneumatic Double Acting Cylinder	2
6	Flow Control Valve	4

Table 1: Components of Pneumatic Sequential System

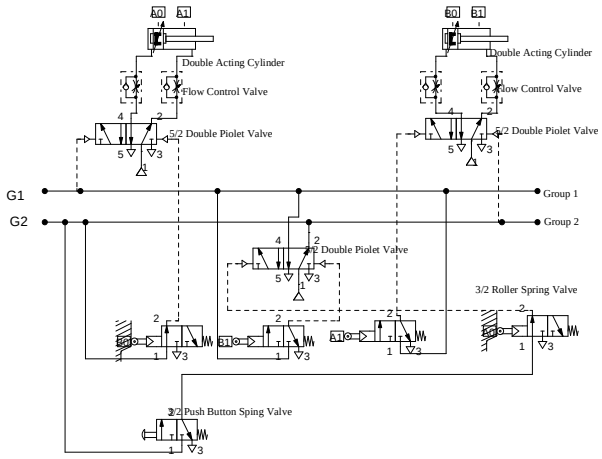

Fig 8: Pneumatic Cascade Circuit A+B+B-A-

First Cycle A+B+ Group 1 Selected

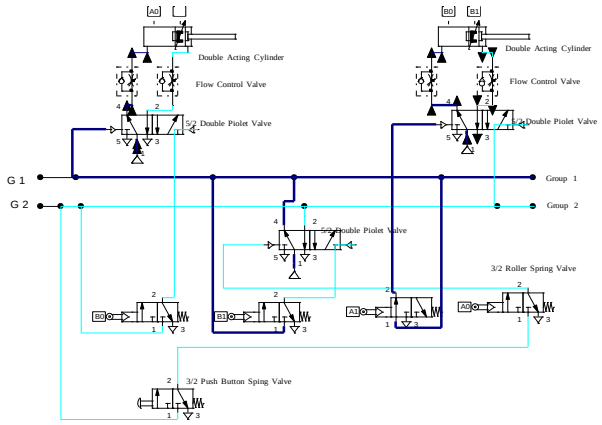

Fig 9: Pneumatic Cascade Circuit A+B+

Second Cycle B-A- Group 2 Selected

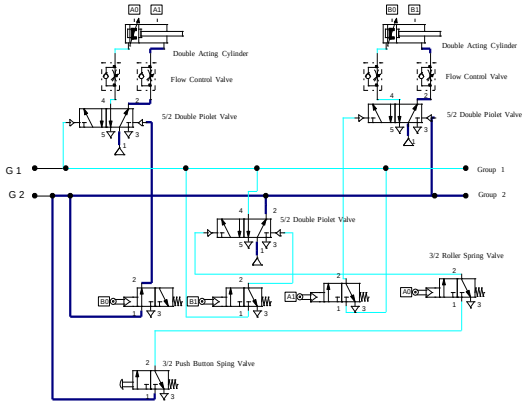

Fig 10: Pneumatic Cascade Circuit B-A-

Group Changing Valve

For grouping changing cascade valve 5/2 double piolet valve using

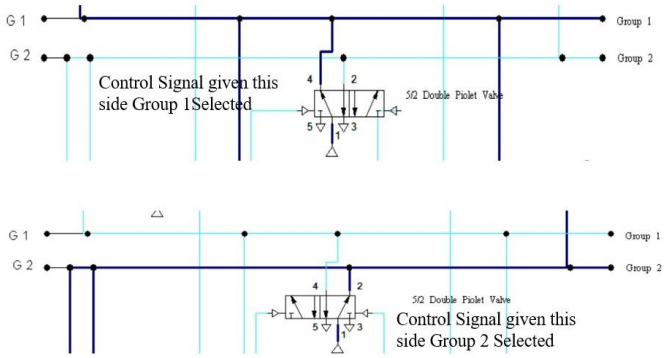

Fig 11: Group Changing Valve

Arrangement of Limit Switch and Start Button

3/2 Roller spring valve are using as limit switches and 3/2 push button spring valve using for actuating limit switches

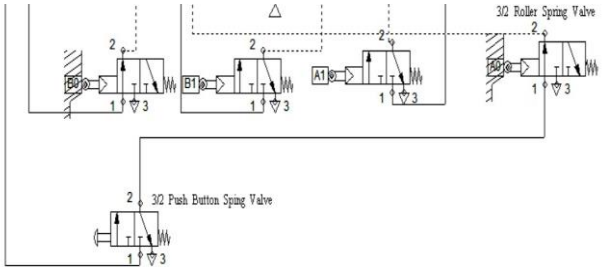

Fig 12: Arrangement of Limit Switch

Power Circuit –Pneumatic Cylinder

5/2 Double Piolet valve used for actuating double acting cylinder. Flow control valve used to control flow of compressed air in to cylinder.

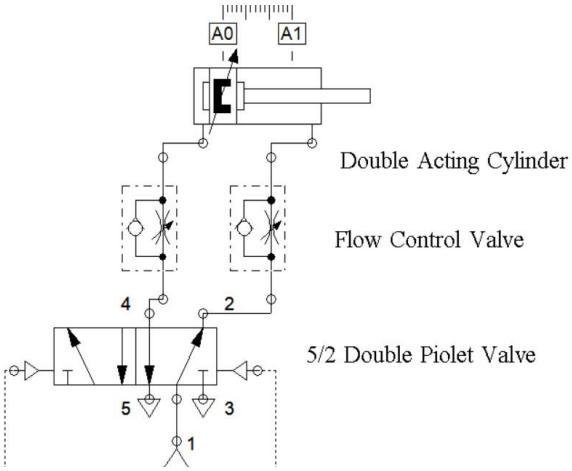

Fig 13: Power circuit 5/2 Double Piolet operated DCV

Development of A+B+B-A- Circuit

Description of components

1. Pneumatic Cylinder

Size: Diameter 32 mm Stroke length 50mm

Max Pressure: 1.0 MPA

Material: Aluminum

Piston rod material: carbon steel

Working Temperature: 20~80°C

Pressure Resistance: 13.5kgf/cm^2

Fig 14: Pneumatic Cylinder

2. 5/2 Double Piolet Valve

Design: Spool type

Pressure:1 to 10Kg/cm^2

Temperature : 5 to 55^0 c

Piston Port Size: PT1/8

Fig 15: 5/2 Double Piolet Valve

3. 3/2 Way Flat Push Button Pneumatic Mechanical Valve

Position and Way No: 2 Position 3 Way

Pipe Thread Diameter: ¼ PT

Fixing Hole Diameter: 5mm

Working Pressure Range: 1.5 - 8kgf/cm^2

Fig 16: 3/2 Push Button Valve

4. 3/2 Roller Spring Valve

Fig 17: 3/2 Roller Spring Valve

5. Flow Control Valve

Inner Diameter (Blue End): 6mm

Fig 18: Flow Control Valve

6. Pneumatic Air Filter Regulator

Operating Fluid: Air

Pressure Gauge Size: 1.6” x 1” (DXT)

Pressure Gauge Range: 0-1MPa

Joint Pipe Bore: G1/4"

Fig 19: Pneumatic Air Filter Regulator

7. Pneumatic Air Compressor Tubing

Material: Polyurethane

Size: 6mm OD x 4 ID

Thickness 0.75mm

Fig 20: Pneumatic Air Compressor Tubing

8. Quick Connector Pneumatic Air Fittings

Size: 6MM Pipe X 1/8 Thread

Fig 21: Quick Connector

9. 6mm 3way T Quick Joint

Material: Polyurethan

Size:6mm

Fig 22: Quick Connector

10. 4 Ways Push in Air Pneumatic Fitting Connector

Size :6mm

Fig 23: 4 Way Pneumatic Connector

11. 6mm Tube 1/4" BSP Thread Pneumatic Connector

Size :6mm ¼ BSP Thread

Fig 24: Quick Connector

12. Brass Connector 8mm 1/4 BSP Hose Pipe Fitting Male and Air Pipe Adapter Joint Pneumatic Connector

Fig 25: Brass Connector

13. 1/8 Inch Silencer and 1/4 Inch Silencer

Fig 26: Pneumatic Silencer

Fig 27: Assembly of Model

Cost Analysis

Sl No	Item	Unit/Cost	Total No	Cost/RS
1	Pneumatic Cylinder	2000	2	4000
2	5/2 Double Piolet Valve	1281	3	3843
3	3/2 Push Button Valve	1319	1	1319
4	3/2 Roller Spring Valve	750	4	3112
5	Flow Control Valve	153	4	612
6	Pneumatic Air Filter Regulator	499	1	499
7	Pneumatic Air Compressor Tubing	239	5m	239
8	Brass Connector	114	1	114
9	6mm 3way T Quick Joint	35	5	175
10	4 Ways Push in Air Pneumatic Fitting Connector	589	1	589
11	1/8 Inch Silencer	16	7	112
12	1/4 Inch Silencer	30	4	120
13	Qick Connector 1/4inchx6mm	20	17	340
14	Qick Connector 1/8inchx6mm	10	18	180
15	Miscellaneous Expense			1500
Total Cost				16754

Table 2: Components Cost

5. FUTURE WORK

Electro-pneumatic is commonly used in many areas of industrial low-cost automation. It is widely used in production, assembly, pharmaceutical, chemical etc. Electro-pneumatic control system consists of electrical control system operating pneumatic power system. Solenoid valve is used as the interface between electrical and pneumatic system. Future work is developing an electro-pneumatic circuit for pneumatic sequential circuit A+B+B-A-

Simulation of electrical ladder diagram easily converted in to a PLC programming ladder diagram for above sequential motion and simulated using Fluid Sim -Pneumatic software.

6.CONCLUSIONS

Most of the practical pneumatic systems involve the use of multiple actuators (cylinders, semi-rotary actuators, etc) which when operating in specified sequences carry out the desired control tasks. In multicylinder applications A+B+B-A- has wide applications.Sheet metal operation in a press shop, a stamping operation is to be performed using a stamping machine. The work piece has to be first clamped under the stamping station. Then the stamping tool gets in to position and performs the stamping operation. The work piece must be unclamped only after the operation is completed. The cascade system provides a straightforward method of designing sequential circuits. It will always give a workable circuit.

REFERENCES

[1] V.G.Vijaya "Design and Fabrication of Sequencing Circuit with Single Double Acting Cylinder". International Journal of Innovative Research in Science, Vol. 2, Issue 11, November 2013.

[2] Anand Kumar Singh, Mitesh L Pate"Design and Development of Pneumatic Punching Machine" International Journal for Technological Research in Engineering Volume 4, Issue 11, July-2017

[3] Swapnil B. Lande, Tushar S. Shahane, Mitesh M. Deshmukh, Mahesh D. Mange "Design of Pneumatic Vice" International Journal for Technological Research in Engineering Volume 7, Issue 5, January-2020

[4] Shubham Gump Alwar, Darshan Dhabarde, Shubham Gade, Amit Kalhane, Vishnu Nair, Prof. Praful Randive. "Design and Fabrication of Pneumatic Car Lifter" IJARIIE Vol-4 Issue-2 2018

[5] Mauton Gbededo and Olayinka Awopetu "Design and Construction of Automated Stamping Machine for Small Scale Industries" International Journal of Engineering Research & Technology (IJERT) Vol. 6 Issue 12, December – 2017

[6] R.Sasikala, M. Rakshana, T. Thinaa, P. Thirupponvel, D. Vasanth "Automatic Bar Bending Machine using Pneumatic System" International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075 (Online), Volume-9 Issue-5, March 2020

[7] Bhavik Ranjan Kathe "Pneumatic Can Crusher" International Research Journal of Engineering and Technology (IRJET) Volume 7 Issue 5 May 2020.

[8] M. Papoutsidakis A. Chatzopoulos D.Tseles "Hydraulics and Pneumatics: A Brief Summary of their Operational Characteristics" Journal of Multidisciplinary Engineering Science and Technology (JMEST) Vol. 5 Issue 10, October – 2018.

[9] Mr.Mayur D. Thorat Prof.Patil A.R. "Design and Analysis of Pneumatic Pick & Place Mechanism" IJSRD - International Journal for Scientific Research & Development| Vol. 7, Issue 05, 2019 | ISSN (online): 2321-0613.

[10] Thokale Manoj, Kothwal Satish, Kotkar Rahul, More Suyog, Pawase Mahesh. "Design and fabrication of pneumatic bar bending machine" International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 03 | Mar -2017.

[11] Jagadeesh T "Pneumatics: Concepts, Design and Applications" Universities Press (India) Private Limited ISBN:9788173719417.

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Mr.Jibi.R. Currently working as an Assistant Professor in the mechanical engineering department at AWH Engineering College Calicut Kerala India. He has published 13 International journals and presented two articles in international conference. He has more than 11 years experience in teaching and one-year Industrial experience in Press tool and Mold making. His