Development of Automatic Material Storage and Retrieval System

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ABSTRACT- The Development of Automatic Material Storage and Retrieval system is a prototype model and used Mechatronics principle for developing this work. In this model the materials are placed on a platform and transported from the ground floor to upstairs using a Three Pneumatic cylinder. These cylinders are controlled through the solenoid operated directional control valve by the PLC controller. There are three magnetic reed sensors are placed in each floor for the purpose of stopping the platform. The materials are transmitted from one floor to another floor by selecting the switch in the keyboard.

Keywords- PLC, Pneumatic Cylinder, Directional Control Valve, Sensors

I. INTRODUCTION

Automated storage system sometimes known as ASRS or AS//RS made of variation of computer controlled systems that automatically place and retrieve the loads from a set of storage location in a facility with a precision, accuracy and speed. An Automated Storage and Retrieval System (AS/RS) is a combination of equipment and controls that handle, store and retrieve materials as needed with precision, accuracy and speed under a defined degree of automation. Systems vary from smaller automated systems to larger computer controlled storage/retrieval systems totally integrated into a manufacturing and/or distribution process.

Generically speaking, AS/RS refers to a variety of computer-controlled methods for automatically depositing and retrieving loads to and from defined storage locations. Within an AS/RS environment one would find one or more of the following technologies:

- Unit-load AS/RS – Machines that store large loads (usually 1,000+ pounds), typically on pallets with storage rack structure, reaching 100 feet or more tall.
- Mini-load AS/RS – Operating the same as a unit-load AS/RS, a mini-load AS/RS handle lighter loads, usually weighing less than 1,000 pounds
- Vertical lift modules (VLMs) – VLMs consist of a column of trays in the front and back of the module with an automatic inserter/extractor in the center that stores and retrieves the required trays
- Shuttles – Shuttles are used for the automated handling of totes, trays, cartons or all three in the same system – for either warehousing or manufacturing.
- Horizontal carousels – Ideal for storing small parts and pieces, horizontal carousels are comprised of a series of bins that rotate horizontally around a track.
- Vertical carousels – Rotating vertically, like a Ferris wheel, vertical carousels house a series of shelves or carriers to provide high-density storage.
- Cube-based storage – Ultra-high density goods-to-person piece picking system which utilizes robots to store and retrieve inventory bins from a cubical storage grid.

II. CONSTRUCTION

The prototype model consists of

1. PLC Based controlled system
2. Double acting air cylinder
3. Magnetic Reed Sensor unit
4. Solenoid Operated Directional Control Valve
5. MS fabricated stand
6. Flow Control Valve

1. PLC Based controlled system:
Keyence PLC is used to control all the mechanism. It has 8 inputs and 4 outputs. The operating voltage is 24V DC. Switches and Sensors are connected to the input of the PLC and solenoid coil is connected to the output of the PLC. The model of PLC is M64Q and the current capacity is 6 amps. The Keyence PLC is shown in figure 1

Fig -1 Keyence PLC

2. Double Acting Air Cylinder:
In this cylinder two ports A and B and is used to transmit the load from one station another station. The movement of slide is depends upon the pressure of air in each port. The Double Acting Air Cylinder is shown in figure 2

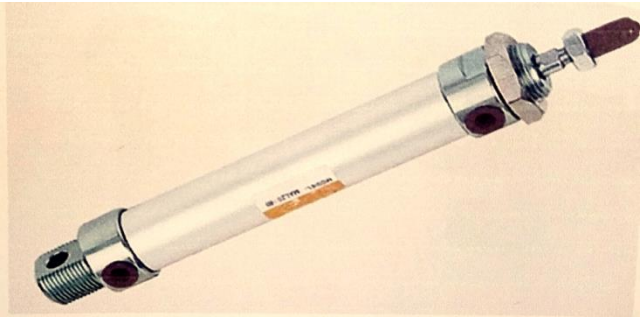


Fig -2 Double Acting Air Cylinder

3. Magnetic Reed Sensor Unit:

This unit consist of plastic plate in which the magnetic sensor is mounted on the left hand side of the unit. The height of the plastic plate can be adjusted with the help of bolt and nuts in order to set the minimum gap between the magnet and magnetic sensor. The magnetic sensors are used for limiting the position of the elevator cabin. Three sensors are mounted on the plastic plate as shown in figure 3

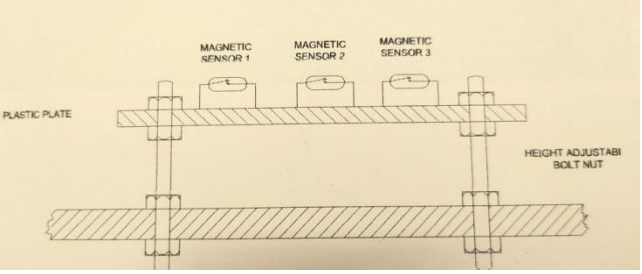


Fig-3 Magnetic Reed Sensor Unit

4. Solenoid Operated Directional Control Valve: Solenoid operated valves are electro mechanical device and the mechanical movement is obtained energizing the electrical coil. Thus by energizing and de energizing the coil the direction of air flow will change. The solenoid is controlled by PLC and is shown in figure 4

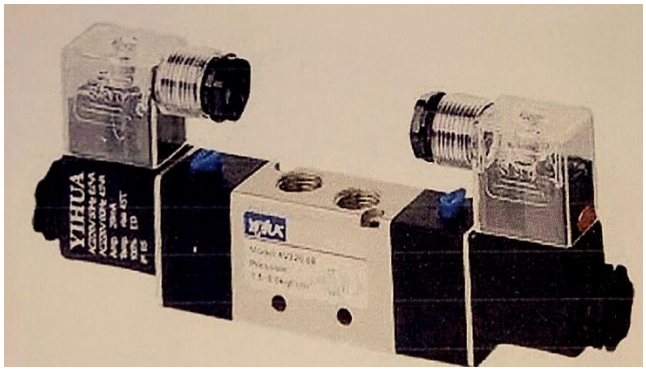


Fig-4 Solenoid Operated Directional Control Valve

5. MS Fabricated Stand:

The overall size of the unit is 300mm x 600mm x 900mm (L X B XH).This prototype model is fabricated using 25x25mm x 3mm thickness L angle channel of mild steel material and developed the unit as per design drawings using welding and abrasive cutting process. The figure shown the MS stand

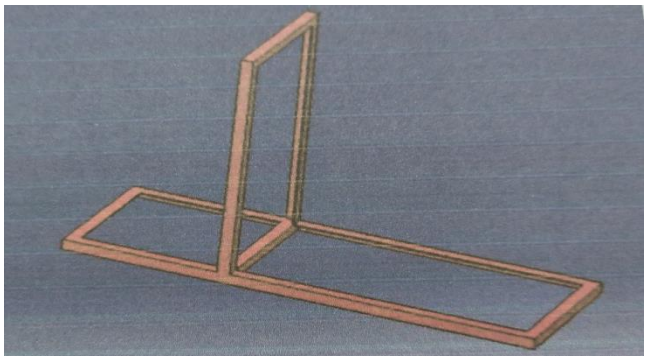


Fig-5 MS Fabricated Stand

6. Flow Control Valve:

The flow control valve is connected on the port A of air cylinder for the forward movement control and at the same time reverse movement is free from flow control. This type of control is called meter in type flow control valve and is shown in figure 6

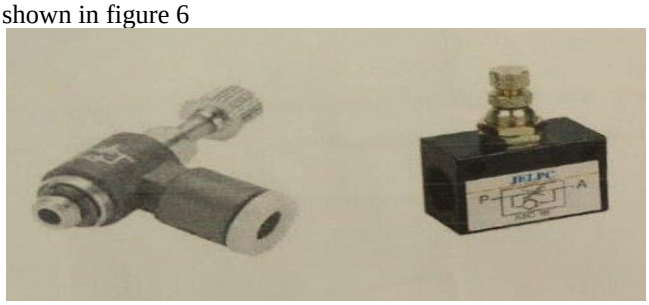
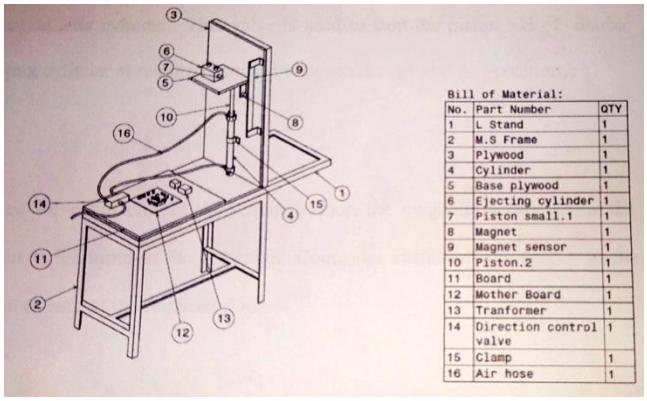


Fig – 6 Flow Control Valve

III. WORKING PRINCIPLE

The PLC controls the solenoid coil of the directional control valve to actuate the cylinder. The Cabin is fixed in the cylinder to move up and down. To start the operation, the material is placed inside the cabin and the ON switch is pressed in the switch board. This switch sends the 24V DC signal to the input of the PLC. Controller gives the output signal as per the program and drive the solenoid of the directional control valve through the 24V relay.



Bill of Material:

No.	Part Number	QTY
1	L Stand	1
2	M.S Frame	1
3	Plywood	1
4	Cylinder	1
5	Base plywood	1
6	Ejecting cylinder	1
7	Piston small.1	1
8	Magnet	1
9	Magnet sensor	1
10	Piston.2	1
11	Board	1
12	Mother Board	1
13	Tranformer	1
14	Direction control valve	1
15	Clamp	1
16	Air hose	1

Fig-7 Automatic Material Storage and Retrieval System

To transfer the materials from one place to another place there are three cylinders are used, one cylinder is used for vertical axis movement for up and down of the material, the second cylinder is moving in horizontal direction to assist the third cylinder of gripping cylinder. When the switch is pressed, the second cylinder moves towards the cabin and the gripper cylinder clamp the material. After the clamping the job, the material is elevated with third cylinder. After reaching the required floor, the second cylinder moves towards the cabin and place the material by declamping the gripping cylinder. Here the 5/3 solenoid operated directional control valve is used for vertical axis cylinder. This valve is used to stop the piston rod of double acting cylinder at required position between the forward and return position. When the cabin crosses the required floor, the magnetic sensor sends the signal to the input of the controller. Controller switch off the supply to the solenoid coil at the required floor. The required floor is selected by pressing the push button in the switch board. The pressure required to operate the system is 5 to 6 bar.

Electrical Wiring Diagram- The electrical wiring diagram is shown below

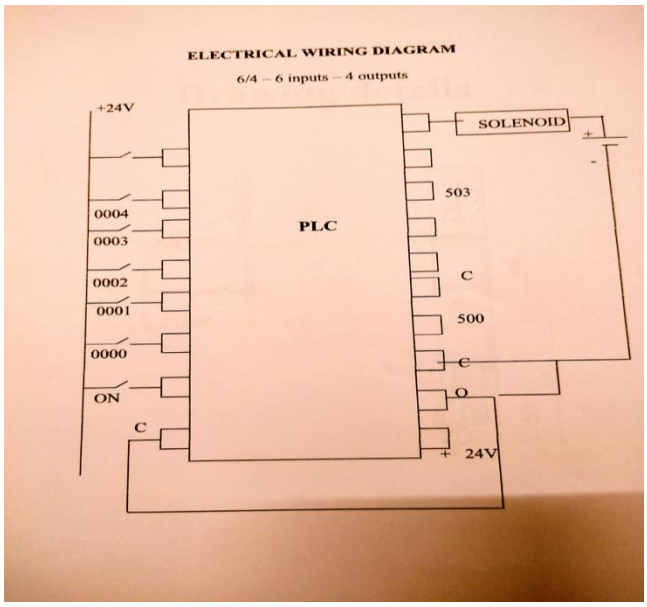


Fig-8 Electrical Wiring Diagram

IV. ADVANTAGES

1. The operation is faster compared to other mechanical drive.
2. Continuous operation is possible without stopping
3. Easy to maintain and repair
4. Operation cost is less
5. Simple in Construction

V. DISADVANTAGES

1. High torque cannot be obtained
2. Load carrying capacity is less
3. High Noise due to compressed air, silencer may be used to reduce the noise

VI.APPLICATIONS

1. Warehouses of different businesses such as Amazon Flip kart etc.
2. Chemical Industries.
3. Libraries.
4. Large scale pharmacies.

VII. FUTURE MODIFICATION

This prototype model using electro pneumatic control system can be replaced by electro hydraulic control system in order to handle large area with heavy weight of materials for actual use in real time applications.

VIII. CONCLUSION

The Programmable Logic Controller is used here is latest version for programming to implement the automation. This automatic control for working of this system in real time mode of prototype model. The successful function of this model IS to minimize the cost in automation control together with simplified design and reduce labor cost for material discharging and also saves the time to deliver the materials effectively.

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