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"Design and Fabrication of Pneumatic Conveyor System"

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Abstract-*Pneumatic conveying system is a conventional material handling system like belt conveyor or chain conveyor. The main advantage of pneumatic conveying system is that material is transferred in close loop, thereby preventing the environmental effect on the material and vice versa. In these topic different parameters like air velocity, pressure, particle size and shape, distance to be conveyed, which govern the design of the system, are described. The research work carried out on the pneumatic conveying system in the last decade considering these parameters are also presented. No standard procedure is available for the design of pneumatic conveying system. As the configuration of the system changes, variable involved also changes, and one has to change the design considerations based on the applications. So there is wide scope for experimentation in the field of pneumatic conveying system.*

The material handling mechanism is achieved by reciprocating the double acting cylinder which is controlled by solenoid operated 5/2 way DC valve which is actuated by ON/OFF relay control system. Here the linear motion of the piston rod is converted to rotary motion of the belt conveyor through the chain and sprocket wheel Mechanism.

In this project we are going design a system where the moving roller of the conveyor is powered by an pneumatic cylinder. Pneumatic cylinder will starts reciprocating and then a power plate with holes on it starts to roll on sprocket. Due to power given by cylinder piston and power plate sprocket starts rotating unidirectional. Hence our belt conveyor is also starts rolling.

Keyword- Pneumatic, Velocity, Pressure, Pneumatic Cylinder, Conveyor.

1. INTRODUCTION:

1.1 Problem Statement :

Pneumatic system use pressurized gases to transmit and control power as the name implies pneumatic systems typically use air as fluid medium because air is a safe, low cost and readily available fluid. It is particularly safe environments where an electrical spark could ignite leaks from the system components. There are several reasons for considering the use of pneumatic system instead of hydraulic system liquid exhibit greater inertia than gases. Therefore in hydraulic system the weight of the oil is a potential problem. To design and development a material handling system for automation or semi automation of industries by using pneumatic control system which is used for low cost automation.

1.2 Objective :

The pneumatic conveyor is a new design to replace conventional roller conveyor. Conventional roller conveyor uses motor drive and gives continuous motion. But in pneumatic conveyor system we are desired to achieve intermediate traverse of conveyor belt so as to achieve step by step feed with the help of pneumatic cylinder. In this project a prototype model is prepared where belt conveyor is placed on rollers. The shaft of one of the roller is coupled to sprocket and sprocket is rotated through power plate. The power plate is connected to pneumatic cylinder and is actuated by solenoid valve. So the intermediate rotation is achieved due to reciprocation of the pneumatic cylinder.

1.3 Belt Conveyor:

Conveyor is used in many industries to transport goods and materials between stages of a process. Using conveyor systems is a good way to reduce the risks of musculoskeletal injury in tasks or processes that involve manual handling, as they reduce the need for repetitive lifting and carrying. Belt conveyor system is the transportation of material from one location to another location. Belt conveyor has high load carrying capacity (up to 30000 t/h), large length of conveying path (up to 3-4 km), simple design, easy maintenance and high reliability of operation. Belt conveyor system is also used various industries such as the material transport in foundry shop like supply and distribution of molding sand, moulds and removal of waste, coal and mining industry, sugar industry, agricultural industry, bagasse industry, fuel industry etc.

1.4 Pneumatic System:

Pneumatic systems form the most primitive and distinct class of mechanical control engineering. They are classified under the term 'Fluid Power Control', which describes any process or device that converts, transmits, distributes or controls power through the use of pressurized gas or liquid. In a pneumatic system, the working fluid is a gas (mostly air) which is compressed above atmospheric pressure to impart pressure energy to the molecules. This stored pressure potential is converted to a suitable mechanical work in an appropriate controlled sequence using control valves and actuators. Pneumatic systems are well suited for the automation of a simple repetitive task. The working fluid is abundant in nature and hence the running and maintenance cost of these systems are exceptionally low. All fluids have the ability to translate and transfigure and hence pneumatic systems permit variety of power conversion with minimal mechanical hardware.

2. CONSTRUCTION:

This project consists of

1) Belt conveyor assembly
2) ON/OFF relay control
3) 24VDC power supply
4) Sprocket wheel with Power plate
5) Pneumatic cylinder with solenoid valve

3. WORKING PRINCIPLE:

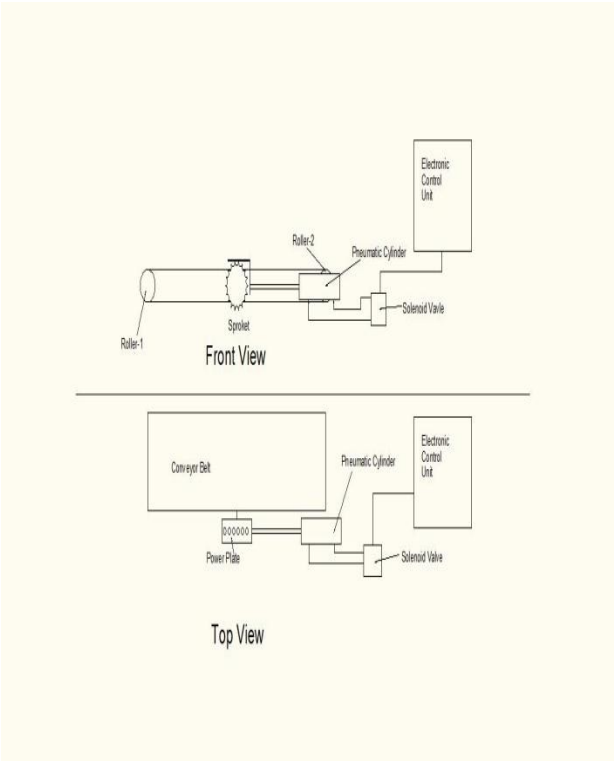

Fig- 1: Block Diagram of Project

Before starting the operation of material handling system set the working pressure from the compressor outlet. Connect the 230 AC power supply to the female electrical plug in order to supply the electrical power to the relay control system and hence the solenoid valve direct the air supply to the double acting cylinder. The piston in the air cylinder reciprocate to and fro .This reciprocate motion is converted to rotary motion with help of ratchet wheel mechanism.

When the solenoid coil is ON, the valve changed the direction of air to the double acting cylinder. Thus the valve reciprocates to and fro continuously till power is cut off .This reciprocate motion is converted to rotary motion with help of ratchet wheel mechanism and the nylon belt moves over the driving and driven pulley.

3.1 Circuit Diagram:

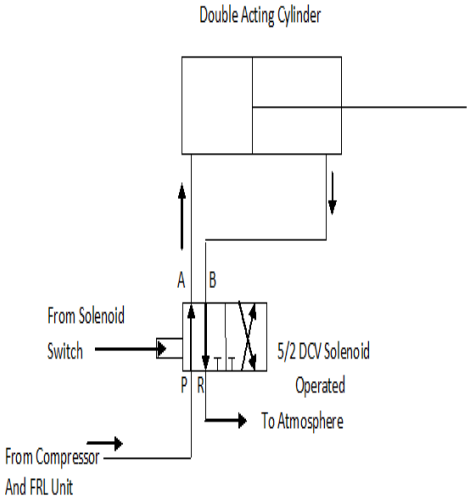

Fig- 2: Circuit Diagram of Project

3.2 Microcontroller Unit:

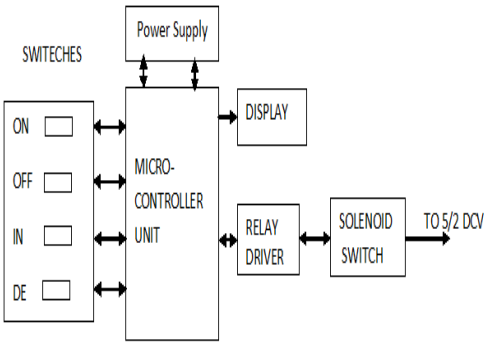

Fig.-3: Block Diagram control unit

4. DESIGN CALCULATIONS:

4.1 Double acting pneumatic cylinder :

Given data:
Selecting Cylinder: $25 * 150$
Volume of air exhaust = stroke $*$ area of piston
$= 150 * \frac{\pi}{4} * 25^2$
$= 73631.0778\ m^3$
Area of piston = $\frac{\pi}{4} * 25^2 = 490.873\ mm^2$
Outstroke force (F) = pressure $*$ Area of cylinder
$= 0.4 * 490.873$
$= 196.349\ N$
Piston rod area A1 = $\frac{\pi}{4} * d^2$
$= \frac{\pi}{4} * 8^2$
$= 50.20\ mm^2$
Effective area = piston area- piston rod area
$= 490.873 - 50.20$
$= 440.673\ mm^2$
In-stroke force = $P * A$
$=0.4 * 440.673$
$=176.2692\ N$

4.2 Design of Sprocket:

For Z=18
From table no 14.1
Pitch, P=9.525
Width between inner plates, b_1=5.72
Roller diameter, d_1=6.35
Transverse pitch, p_t=10.24

1. Pitch circle diameter

$$D = \frac{p}{\sin(180/z)} = \frac{9.525}{\sin(180/18)}$$
$= 54.85$ mm

2. Top diameter (D_a)

$(D_{a)max}=D+1.25p-d_1$
$=54.85+1.25*9.525-6.35$
$=60.4$ mm

3. Root diameter
$D_f=D-2r_1$
But roller seating radius (r_1)
$(r_1)_{max}= 0.505d1+ 0.069\sqrt[3]{d1}$
$= 0.505*6.35+ 0.069\sqrt[3]{6.35}$
$= 3.33$ mm
$D_f = D - 2r_1$
$= 54.85-2*3.33$
$= 48.19$mm

4. Tooth flank radius $(r_e)_{max} = 0.008d1(Z2 + 180)$
$=0.008 * 6.35\ (182 + 180)$
$= 25.6$ mm

$(r_{e)min} = 0.12d1(Z + 2)$
$= 0.12 * 6.35\ (18 + 2)$
$= 15.24$ mm

5. Roller seating angle
$(\acute{\alpha})_{max}= (120 - 90/Z)$
$= (120 - 90/18)$
$= 115$
$(\acute{\alpha})_{min}= (140 - 90/Z) = 140 - 90/18$
$= 135$

6. Tooth height above the pitch polygon
$(h_a)max= 0.625\ p - 0.5d1 + 0.8p/Z$
$= 0.625 * 9.525 - 0.5 * 6.35 + 0.8 * 9.525/18$
$= 3.2$ mm
$(h_a)min = 0.5(p - d1)$
$= 0.5(9.525 - 6.35)$
$= 1.58$ mm

7. Tooth side radius (r_x) = p

8. Tooth width $bf1= 0.95b_1$
$= 0.95 * 5.72$
$= 5.434$ mmv
9. Tooth side relief (ba) = 0.1p
$= 0.1 * 9.525$
$= 0.9525$ mm

5. CONCLUSION:

By doing this project we gained the knowledge of working of pneumatic system and how automation can be effectively done with the help of pneumatic system.
It is concluded that any automation system can be done with the help of electro pneumatic system.
We have successfully completed the project work at our Institute.
By doing this project work, we understood the working principle and uses of various valves, switches, relays etc.

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