DESIGN AND FABRICATION OF PNEUMATIC RAILROAD SWITCH

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Abstract: *In general, the lot of human efforts are required to shift the main rail from branch rails. This is done by using lever operated principle. It is also a time consumption process. It may be operated by implementing pneumatic principle. The lever may be replaced by a pneumatic cylinder. The compressed air is given to the cylinder. The piston connected to one of the rail extends, which causes that rail to engage with the main rail. When the air is released, the piston causes the adjacent rail to engage with the main rail. This method may be effectively used instead of the existing system. This will lead to the reduction of human effort and time consumption.*

Key Words: *Air Compressor, Pneumatic Cylinder, Direction Control Valve, Hoses, Rail tracks.*

1. INTRODUCTION:

A railroad switch, turnout or points is a mechanical installation enabling railway trains to be guided from one track to another, such as at a railway junction or where a spur or siding branches off[1].

The switch consists of the pair of linked tapering rails, known as points (switch rails or point blades), lying between the diverging outer rails (the stock rails). These points can be moved laterally into one of two positions to direct a train coming from the narrow end toward the straight path or the diverging path. A train moving from the narrow end toward the point blades (i.e. it will be directed to one of the two paths depending on the position of the points) is said to be executing a facing-point movement[2,3].

Unless the switch is locked, a train coming from either of the converging directs will pass through the points onto the narrow end, regardless of the position of the points, as the vehicle's wheels will force the points to move. Passage through a switch in this direction is known as at railing-point movement[4].

A switch generally has a straight "through" track (such as the main-line) and a diverging route. The handedness of the installation is described by the side that the diverging track leaves. Right-hand switches have a diverging path to the right of the straight track, when coming from the narrow end, and a loft-handed switch has the diverging track leaving to the opposite side[5,6].

A straight tracks not always present; for example, both tracks may curve, one to the left and one to the right or both tracks may curve, with differing radii, while still in the same direction.

2. PRINCIPLE OF WORKING COMPONENTS:

AIR COMPRESSOR:

An air compressor is a device that converts power (usually from an electric motor, a diesel engine or a gasoline engine) into kinetic energy by compressing and pressurizing air, which, on command, can be released in quick bursts. The method of air compression may be either positive-displacement or negative-displacement type.

Figure 1. Air Compressor

Positive displacement

Positive-displacement air compressors are operated by forcing air into the chamber, whose volume is decreased to compress the air. Piston-type air compressors are used for pumping air into an air chamber through the use of the constant motion of pistons. The one-way valves are used to guide air into a chamber, where the air is compressed. Rotary screw compressors is also a positive-displacement compressor by matching two helical screws

that, when turned, guide air into a chamber, whose volume is decreased as the screws turn. Vane compressors have slotted rotor with varied blade placement to guide air into a chamber and compress the volume. This type of compressors delivers a fixed volume of air at high pressure. Common types of positive displacement compressors include piston compressors and rotary screw compressors.

PNEUMATIC CYLINDERS:

Pneumatic cylinders are mechanical devices, which use the power of compressed gas to produce a force in a reciprocating linear motion.

Like hydraulic cylinders, the prime over forces the piston to move in the desired direction. The piston rod transfers the force to the object to be moved. Engineers sometimes prefer to use pneumatics, because they are quieter, cleaner, and do not require large amounts of space for fluid storage.

Because the operating fluid is a gas, leakage from a pneumatic cylinder will not drip out and contaminate the surroundings, making pneumatics more desirable where cleanliness is a requirement.

Figure 2. Pneumatic Cylinder

Double-acting cylinders

Double-acting cylinders (DAC) use the force of air to move in both extends and retract strokes. They have two ports to allow air such that, one for outstroke and one for in stroke. Stroke length for this design is not limited; however, the piston rod is more vulnerable to buckling and bending. Additional calculations should be performed as well.

DIRECTION CONTROL VALVE:

Directional control valves are one of the most fundamental parts in hydraulic machinery as well and pneumatic machinery. They allow fluid flow into different paths from one or more sources. They usually consist of a spool inside a cylinder which is mechanically or electrically controlled. The movement of the spool restricts or permits the flow, thus it controls the fluid flow. The spool (sliding type) consists of lands and grooves. The lands block oil flow through the valve body. The grooves allow oil or gas to flow around the spool and through the valve body. There are two fundamental positions of directional control valve namely normal position where valve returns on removal of actuating force and other is working position which is position of a valve when actuating force is applied. There is another class of valves with three or more position that can be spring centered with two working position and abnormal position.

Figure 3. Direction Control Valve

HOSE:

A hose is a flexible hollow tube is designed to carry fluids from one location to another. Hoses are also sometimes called pipes or more generally as tubes. The shape of a hose is usually cylindrical.

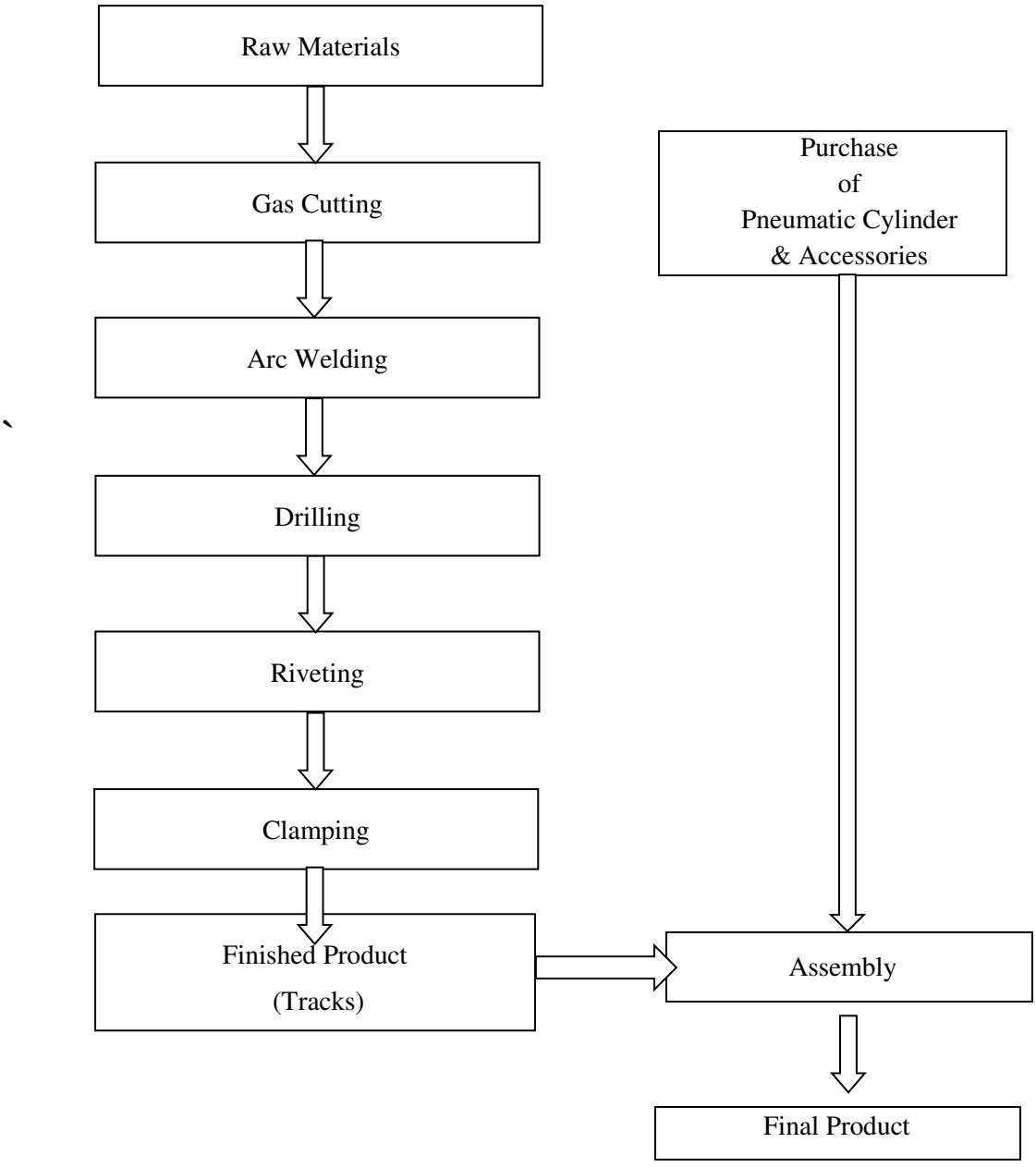
Hose design is based on a combination of application and performance. Common factors are size, pressure rating, weight, length, straight hose or coil hose and chemical compatibility. Hoses are made from one material or a combination of materials.

Figure 4. Hose

Reinforced rubber hose

The hoses can be reinforced with fibers or steel cord to with stand high pressure. Commonly used reinforcement methods are braiding, spiraling, knitting and wrapping of fabric plies. The reinforcement increases the pressure resistance but also the stiffness. The corrugations or bellows are used to obtain flexibility. Usually circumferential or helical reinforcement rings are applied to maintain these corrugated or bellowed structures under internal pressure.

3. METHODOLOGY:



4. DESIGN CALCULATION:

TRACK (RAILS):

Material: Mild Steel Rod
Density: 7860 kg/m^3

Main Line

Length (L) = 200 mm
Breadth (B) = 17.5 mm
Thickness (T) = 5 mm

Inter Line

Length (L) = 100 mm
Breadth (B) = 17.5 mm
Thickness (T) = 5 mm

Area of the track (A) = 2(L×B) + 2(l×b)
= 2(200×17.5) + 2(100×17.5)
= 10500 mm^2
(A) = 0.0105 m^2

Volume of the track (V) = 2(L×B×T) + 2(l×b×t)
= 2(200×17.5×5) + 2(100×17.5×5)
(V) = 5.25×10^{-5} m^3

DOUBLE ACTING CYLINDER:

Bore Diameter of the cylinder (D) = 40 mm
Length of the cylinder piston rod (L) = 125 mm
Diameter of the piston rod (d) = 17.5 mm

Effective Piston Force

$(F_{max}) = (\pi\times P\times D_p^2)/4 - f$
$= (\pi\times5\times10^5\times(40\times10^{-3})^2)/4 - 0$ [Neglecting friction force]
(F_{max}) = 628.318 N

Thrust generated by the cylinder during Extension stroke

Thrust $(f_1) = (\pi/4)\times D^2\times P$
$= (\pi/4)\times(40\times10^{-3})^2\times(5\times10^5)$
(f_1) = 628.318 N

Thrust generated by the cylinder during Retraction stroke

Thrust $(f_2) = (\pi/4)\times(D^2-d^2)\times P$
$= (\pi/4)\times((40\times10^{-3})^2-(17.5\times10^{-3})^2)\times(5\times10^5)$
(f_2) = 508.054 N

5. RESULT AND DISCUSSION:

It is based on the principle of pneumatic actuation i.e., the pneumatic cylinder is actuated by simply shifting the direction of the stream of compressed air either into the rod end or into the flange end of the double acting cylinder. So that the cylinder piston can be extended or retracted.

In this method, the air from atmosphere is compressed to about 5 bar pressure with the help of an air compressor. Such a compressed air is then passed into the 2-position 5-way direction control valve. It is then sent through the hose to enter into the double acting cylinder. This constitutes the following two process.

PART DRAWING:

Figure 5. Rails

Figure 6. Direction Control Valve

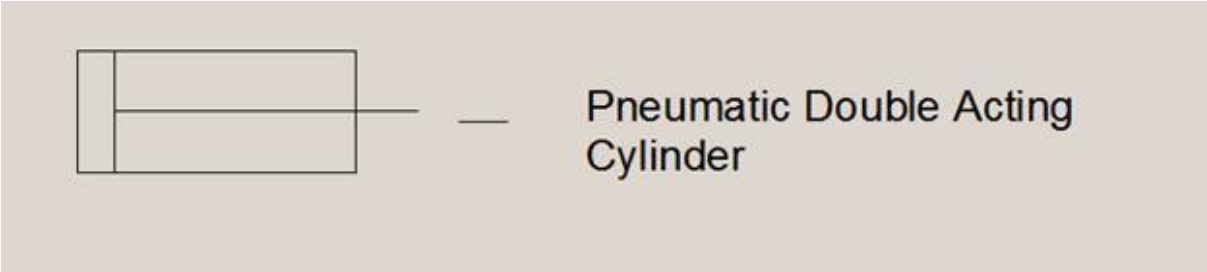


Figure 7. Pneumatic Cylinder

EXTENSION:

During this process, air from the compressor is passed into the flange end of the double acting cylinder by simply shifting the manually operated lever of direction control valve to extreme left position. It extends the piston to the new position. This action is followed by the shifting of sub track to engage with the main track 1.

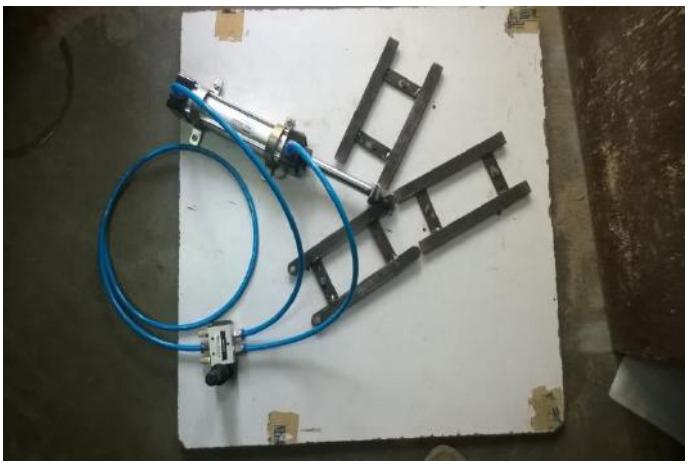


Figure 10. Position for Extension

RETRACTION:

During this process, air from the compressor is passed into the rod end of the double acting cylinder by simply shifting the manually operated lever of direction control valve to extreme right position. So the air enters into the rod end, this in turn causes the piston to retract. This action is followed by the shifting of sub track to engage with the main track 2.

The air silencers are used along with direction control valve to nullify the effect of sound. Plug fittings are also used to prevent the leakage of air from the hoses.

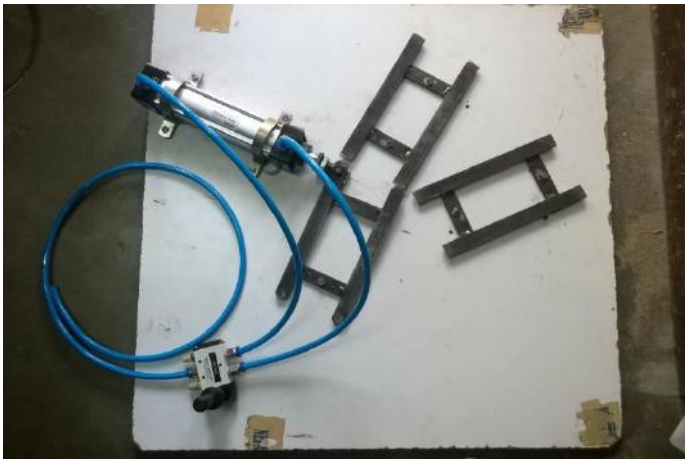


Figure 11. Position for Retraction

6. CONCLUSION:

Thus the design and fabrication of pneumatic rail road switch is done in the best and cheapest way. As stated earlier, it contains the following benefits or advantages over manually operated type and electrically operated type.

- Simplicity of design and control
- Reliability
- Safety

- Running cost is less when compared to electrical system
- Reduce the man effort as in lever operated system
- Less maintenance cost

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