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A Review on Pneumatic Operated Train Door System

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Abstract - *Train passenger door is the key system for operation and maintenance on urban rail train. In this paper, we analysis passenger door system of urban rail train working process and establish working model. Firstly, we used the method of parameters estimation to get physical parameter of door on different working condition. Today energy conservation is the need of every industry, transportation field. So we have taken challenge to make project in this Train field to support energy conservation system. Using rotating wheel energy is used for getting positive outcomes of project.*

Key words: *Door control system, fault diagnosis, principal component analysis (PCA*)

INTRODUCTION:

Locomotive is any type of self-propelled vehicle used by railroad to pull or push other type of rolling stock, including passengers, freight. An India is an extensive country. Now day‟s railway playing a vital role in transport of freight and passengers. Trains are the veins of our country. Indian railway network is one of the largest railway network in the world. Today the growth is phenomenal and the network have a route length of 62,458 Km, with 7116 station. It has fleet of 8268 locomotive 29,501 Coaches, 3291 Electronic multiple units & 3, 46,394 wagons. Today energy conservation is the need of every industry, transportation field. So we have taken challenge to make project in this Train field to support energy conservation 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 simplerepetitive 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. Conversion of various combinations of motions like rotary-rotary, linear-rotary and linear-linear is possible. The simplicity in design, durability and compact size of pneumatic systems make them well suited for mobile applications. These features make them versatile and find universal applications including robotics, aerospace technology, production and assembly of automotive components (power steering, chassis and engine assembly), CNC machines, food products and packaging industry, bomb deployment units and fabrication process of plastic products.

LITERATURE SURVEY:

Lin Shuai et all (1): Train passenger door is the key system for operation and maintenance on urban rail train. In this paper, we analysis passenger door system of urban rail train working process and establish the mathematical model. Firstly, we use the method of parameter estimation to get physical parameters of doors on different working condition. Then fault diagnosis experiment is done to train passenger door with principal component analysis and rough set theory. In the end, we verify fault diagnose accuracies under different time settings of opening and closing profile with the test rig.

S.M.Bashi et all(2): The pneumatic actuator represents the main force control operator in many industrial applications, where its static and dynamic characteristics play an important role in the overall behavior of the control system. Therefore improving the dynamic behavior of the pneumatic actuator is of prime interest to control system designers. This paper is a review of literature that related of the pneumatic actuator systems. In particular, the innovations in different control strategies applied to pneumatic actuators along with the modeling, controlling and simulation techniques developed for different applications of pneumatic actuators are reviewed. The review concentrates also on the analysis, investigation, performance, practical constraints, nonlinearities, uncertainties and the new applications of the pneumatic actuators.

Wonkyong Kim et all (3): There are many EMU lines in Korea. But only one type has been applied to passenger side door. This type is so called "Pocket sliding type". This type has some week points. To begin with, it is not good for decreasing the noisy from the outside of carbody. And the second time, if some obstacles are put between sliding door, only driver can operate re-open door switch manually in driver's cab. This type is so dangerous for passengers. So many people want to the new door type that have no defect. KRRI joined forces with ANT corporation for pneumatic plug door system. This type will be good for decreasing the noisy,

passenger's safe. The project was started at the last year on November and finished on June, this year. In this paper, we will deal with the role of cylinder, complex planetary gear, door control unit, dynamic mechanism, and the report of FEM, type test. This paper will contribute to the electric motor control plug door system.

Saurabh Shakya et all(4): Indian Railways is India's national railway system. Operated by the Ministry of Railways, IR carried 8.107 billion passengers (more than 22 million passengers per day), transported 1.101 billion tons of freight, and had 8,500 stations in the 2015-16 fiscal year.[2] It is the fourth-largest railway network in the world by size, with 119,630 kilometres (74,330 mi) of total track[4] and 92,081 km (57,216 mi) of running track over a 66,687-kilometre (41,437 mi) route at the end of 2015-16.[2] Forty-five per cent of its routes are electrified [5] with 25 kV AC electric traction.[2] Its track is mostly broad gauge, with short stretches of metre- and narrow-gauge track. Thirty-seven percent of its routes are double- or multi-tracked. [5] IR operates long-distance and suburban rail systems, and ran an average of 13,313 passenger trains daily in 2015-16.

The trains have a five-digit numbering system. Mail or express trains, the most common types, run at an average speed of 50.9 kilometres per hour (31.6 mph). [6] At the end of 2015-16, IR's rolling stock consisted of 254,006 freight wagons, 70,241 passenger coaches and 11,122 locomotives (39 powered by steam, 5,869 by diesel fuel and 5,214 by electricity).[2] IR owns locomotive- and coach-production facilities at several locations in India. The world's eighth-largest employer, it had 1.33143 million employees at the end of 2015-16.[3] IR had earnings of ₹1.683 trillion (US$26 billion) in 2015–2016, consisting of ₹1.069 trillion (US$17 billion) in freight revenue and ₹442.83 billion (US$6.9 billion) in passenger revenue, and an operating ratio of 90.5 per cent in 2015-16. IR's Research Design and Standards Organisation (RDSO) undertake research, design and standardisation. The railway has undertaken several initiatives to upgrade its ageing infrastructure and improve its quality of service. The Indian government plans to invest ₹9.05 trillion (US$140 billion) to upgrade IR by 2020. Hence we decided to take challenge to make project in this Train field to support energy conservation.

CONSTRUCTION & DESIGN:

The construction of Train wheel operated compressor is very simple & compact. Basically it is assembly of Base frame Wheel, Piston-Cylinder, and Air reservoir.

Material	Weight	Diameter	Quantity
Mild Steel	1Kg	100mm	4

1. Base Frame

Base frame is made of Fabrication angle. Supported angles are joint under base frame, where the motor & valve is located. Then piston supporter is mounted. Use: The use of the base frame is to give Support & Stability to all project components.

Length	Width	Thickness
250mm	150mm	2mm

2. Door

Door Size:

Weight Calculation of door:

Area=A=L×W =250×150
Volume =V=L×W×t =250×150×2
V=75000mm^2
Weight = V× ρ =75000 × 7850 =588750000 × 10^-9
=0.5887 kg

The door is opened & closed on the base frame at the centre. A piston connection is given at the backside of the door due to which the door moves in both directions. Use**: For** comfort entry & exit to public.

3. Wheel

Material	Weight	Diameter	Quantity
Mild Steel	1Kg	100mm	4

Fig1.Train Wheel

By gas cutting a round shape locomotive wheel is made. Then rolling shaft is attached at the centre line of wheel & connecting rod is fixed at the periphery of wheel. Use: To give power and Rotary motion to Connection rod.

4. Air Receiver Tank.

Fig2. Receiver Tank

Part name	Material	Capacity	Shape	Quantity
Tank	Mild Steel	10 to 15 liters	Cylindrical	1

Air tank is made of Mild steel. A hole is drilled at the upper side & threading is done to keep the pressure gauge, and then fix two ends using welding & make an input & output air connection. All pressurize air come in tank from various cylinders through the pipe connection.

Use: To store pressurize compressed air & supply this pressurize air for various use when required.

5. Motor:

Part Name	Capacity	Quantity
DC motor	12Volt, 5Amp,	1

Fig 3. DC Motor

6. Double Acting Cylinder:

Sliding force required for weight of cylinder is 1 kg.We select the cylinder.

Type	Bore	Stroke	Pressure	Material
Double Acting Cylinder	20mm	50mm	1.108Bar	Mild Steel

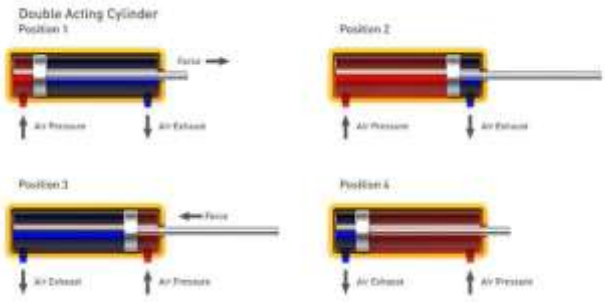

Fig4.Double acting cylinder

Here we have used double acting cylinder. It is the pneumatic actuator, which is actuated using compressed air. The Force exerted by the compressed air moves the piston in two directions in a double acting cylinder. In principle, the stroke length is unlimited, although buckling and bending must be considered before we select a particular size of piston diameter, rod length and stroke length. The double acting cylinder consists of 1) Cylinder tube, 2) Piston unit, 3) Double cup packing on piston, rod packing of „O"rings, 4) Bronze rod guide, Piston rod, 6) End covers (flanges) 7) Port connection, 8) Cushion assembly. The cylinder is manufactured from aluminium solid bar with central bore on lathe machine. It is then made smooth internally using method of honing and lapping. It contains piston and piston rod, which reciprocatesto and fro with the application of high pressure air. The piston is fitted with the piston ring which is made of Teflon rubber to make perfect compression of the air. The material used for various parts differs for different types of cylinders depending upon applications.

7. Air circulating devices:

The compressed air is stored in an air receiver from which air is drawn out in to the consumer point by means of pipe line. While laying out the pipe line for the system, one should take sufficient care and pay attention to see that the pressure drop from the generating point to the point of consumption remains as low as possible. For economical reason, it is always better if the total drop of pressure is kept limited to a maximum value of 0.1 bar or even less. The following factors are taken into account while selecting pneumatic pipeline and other air- line installations:-

1) Pressure of compressed air in the lines.
2) Total flow rate per unit time through the line.
3) Permissible pressure drop in the line.
4) Types of tube material and types of line fitting.
5) Length and diameter of tube or other pipelines.
6) Working environment.

Considered the above factors we have selected the flexible hose tubes of 1/8"diameter.

8. Transmission System

The mechanical power produced by prime over I used to drive various machines in the workshop and

factories. A transmission system is the mechanism. The rotary motion of the motor is transmitted to the operative element to provide an operative working or auxiliary motion. When the required motion is rotary; the transmission takes place through mechanisms that transfer Rotary motion from one shaft to another. Transmission of the motion from the external source to the operative element can take place through Mechanical elements such as chains etc.

8.1. Chain

A chain device consists of an endless chain wrapped around two Sprockets. The C plates Chain consists of a number of links connected by pin joints while the Sprockets are toothed wheels with a special profile for the teeth. The chain drives intermediate between belt and gear device. All automobile especially two wheelers the chain drive is used for transmission power generated by the engine to rear wheel is used for following reasons.

1. The efficiency of chain drive is high at times as high as 98%
2. A chain drive dose not slip
3. Although they generate noise, they present no fire Hazards and are unaffected by high temperature or atmospheric condition.
4. Chain drive is more compact then Belt or Gear Drive.

The chain drives requires proper maintenance particularly lubrication and slack adjustment. However chain can be easily replaced. Roller chain drives is used in two wheeler for transmission of power. There are five parts of roller chain.

1. Pin 2. Bushing 3. Roller 4. Inner plates 5. Outer plate

The pin is press fitted to two outer link plates while the bush is press to inner link plates. The bush and the pin form a swivel joint and the outer link are freely fitted on bushes and during engagement, turn with the teeth of the sprocket wheels. This result is rolling friction instead of sliding friction between the roller and sprocket teeth and reduces wear. The pins bushes and rollers are made of alloy Steel.

9. 5/2 Direction Control Valve:

Part Name	Capacity	Quantity
5/2 Direction Control Valve	1	10 Bar

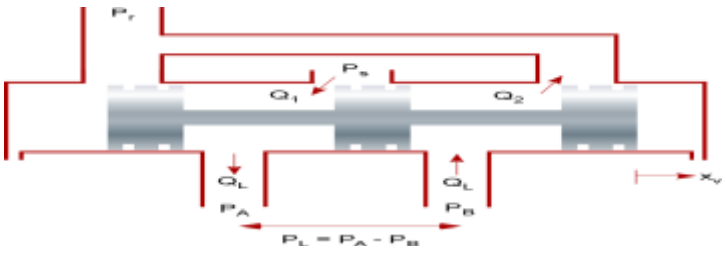

Fig 5.5/2 Direction control valve

Fig6.Symbol of 5/2 DCV

Its basic symbol is as shown the control of the to and fro motion of a pneumatic cylinder, the air energy has to be regulated, controlled, and reversed with a predetermined sequence in a pneumatic system. Similarly one has to control the quantity of pressure and flow rate to generate desired level of force and speed of actuation. To achieve these functions, valves are used to- (i) Start and stop pneumatic energy, (ii) Control the direction of flow of compressed air, (iii) Control the flow rate of the compressed air and (iv) Control the pressure rating of the compressed air. A direction control valve has two or three working positions generally. They are: 1) Neutral or zero position 2) Working position the positions are mostly numbered as 0,1,2. Direction control valves are designated to indicate both the number of ways as well as the number of working positions such as 4/2, 3/2,5/2 means 5 ways / 2positions. Here we have used 5/2 direction control valve. In this design of direction control valve, 5 openings are provided. This ensures easy exhausting of the valve along with the two positions i.e. ON and OFF. Here the spool slides inside the main bore and according that the spool position is made ON or OFF due to the fact that the spool gets connected to the open side or the closed side of the air opening.

10. Basic Principle Of Pneumatic System:

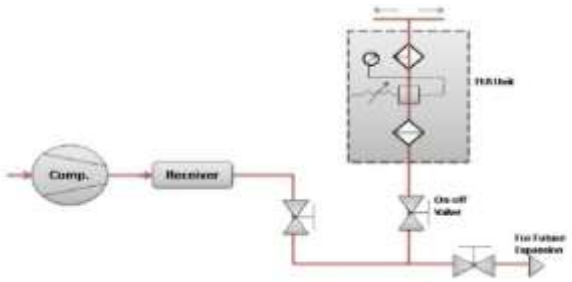

Fig 7.Principle Of Pneumatic System

The basic layout of a pneumatic system is shown in fig..It could be observed that the basic components involved are similar to a hydraulic system. The basic differences between hydraulic and pneumatic systems are that in hydraulic system the input mechanical energy is imparted to the oil is by pump, whereas, in pneumatic systems the working fluid being air, the mechanical energy is imparted to air by a compressor. Further, a hydraulic system usually operates at very high pressures to transmit the large force and power while a pneumatic system operates at low pressures of about 5 – 7 bar for industrial applications. The major components of the pneumatic systems are:

1. A compressor of appropriate capacity to meet the compressed air requirements.

2. A receiver to store the compressed air.
3. Air distribution lines to distribute the air to various components of the system.
4. Filter lubricator regulator (FLR) unit for conditioning of air and regulation of pressure.
5. Pneumatic control valves to regulate, control & monitor the air energy.
6. Pneumatic actuators.
7. Air driers.

WORKING:

The train wheel operated compressor for various systems is work on law of energy conservation. The law states that " energy neither can be created nor destroy but it may transform from one form of energy to another, so sum of energy in its various forms remains constant in the universe." As the train starts moving, the wheel starts rotating. The connecting rod that is fixed on the periphery of the wheel also starts to rotate with wheel. This rotary motion is further converted in to reciprocating motion with the help of piston cylinder arrangement that is connected at the other end of the connecting rod.

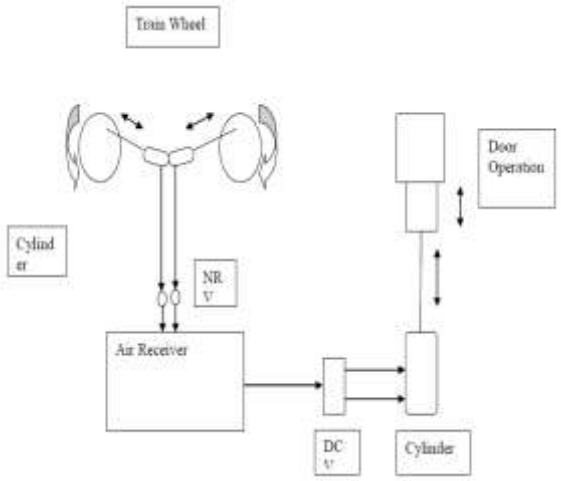

Fig 8.Working Model

When piston start reciprocating in the cylinder t creates suction as it moves towards (B.D.C.) Bottom dead centre, air enter in the cylinder from one hole which is provided with a N.R.V. & when the piston moves towards (T.D.C.), it compresses the air and this operation is continuous and discharge is obtained in air reservoir tank. When we operate lever control valve, air come from air reservoir tank to Air piston utilize. This Pressurize air pushes & Pull to the piston in reciprocating motion causes the opening & closing of the Door.

EXPECTED PROJECT OUTCOME:

Compressed air is utilizing for opening & closing the Door- Windows of the train. It can be also used for AC system & refrigeration system by using pulse tube mechanism to store the food like fish, vegetable etc. Compressed air is used for Supporting Breaking system in emergency, by arranging many piston & cylinder in large capacity. It can also used to clean the train, cooling the radiator of engine. It is used for generation of electricity with the help of turbine mechanism to operate lighting, Horn, etc.

FURTHER MODIFICATION:

1) We can drive more than one piston & cylinder on one shaft by using crank.
2) We can use screw compressor instead of piston & cylinder arrangement.
3) By using plus tube mechanism air can be use for Refrigeration & AC system.
4) By using Crankshaft on wheel shaft, we can compress the air instead of mounting Wheel.
5) More capacity tanks mounted to store large amount of air.
6) Safety valve can be used for safety of air tank.

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