Design and Fabrication of Pneumatic based gear shifter for two-wheeler applications

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Abstract

In this paper, a pneumatic based gear shifting mechanism was designed for two-wheeler application. It was designed in order to make the gear shifting smoother, to have a better control over the steering, to reduce the effort of the driver and to reduce the gear shifting timing. During a race time, where a few milli second can change the result of the race, it is very important not to lose any time. During that time pneumatic based gear shifting mechanism could be a good contender in order to save the time.

1. INTRODUCTION

The system which is operated with air or other gaseous media to deliver or to control power is known as pneumatic system. It may be used to power machines or to control or regulate machines. In order to raise the pressure of the air to the required level quite slowly a compressor is required. The energy stored in the compressed air is transmitted through piping in a controlled manner to a pneumatic actuator to perform some useful work.

A great advantage of pneumatic system is that, like hydraulic systems, they can easily generate linear motion through the basic actuator cylinder. To control the speed with an ease a control valve is being used. However, pneumatic systems are not suitable for obtaining uniform motion. Operating pressures in pneumatics are generally much lower than those used in hydraulics. Pneumatic systems are generally designed as low-pressure systems and hence are capable of generating only small-magnitude forces economically unlike hydraulic systems.

The basic linear actuator is a cylinder as shown in Figure 1. An air cylinder is a simple, low-cost, easy-to-install device that is ideal for generating powerful linear movement. Air cylinders are versatile and fast acting, and with the use of special seals they can withstand ambient temperatures even up to 250^0c.

An elementary cylinder consists of a body containing a movable piston of diameter D and a rod of diameter d connected to the piston. End caps are fastened to the cylinder body barrel. The rod passes through a hole in one end of the cylinder. A double-acting cylinder has its either end ports (X and Y) through which air can enter or exit. If pressure is applied to port X, with port Y venting, the piston extends with a theoretical force (thrust) equal to the product of applied pressure and effective area of the piston excluding upon which the pressure acts. Thus, reciprocating linear motion can be obtained quite easily through this simple arrangement. Other important factors of concern with regard to the cylinder operation are its air consumption, speed, stroke length and piston rod buckling.

2. CONSTRUCTIONAL DETAILS

Pneumatic cylinders are built in both single- and double -acting versions. Pneumatic cylinders may be of either die-cast construction or tube-and-cap design. The cut away view of a simple double-acting cylinder and their functions must be studied to know how the cylinder operates

The factors concerning the design of a cylinder are its style, size, cost, duty, materials, mounting arrangements, and suitability for proximity sensing. In the 'sealed for life' type cylinders, the piston may be pre-greased for life using an appropriate the type of grease and can be operated with non-lubricated air. On the other hand, the life of the 'serviceable' type cylinders can be extended by replacing worn seals and re-greasing. These cylinders can be dismantled and reassembled by the user. The manufacture's literature should always be checked to make sure that the cylinder is appropriate for the service conditions.

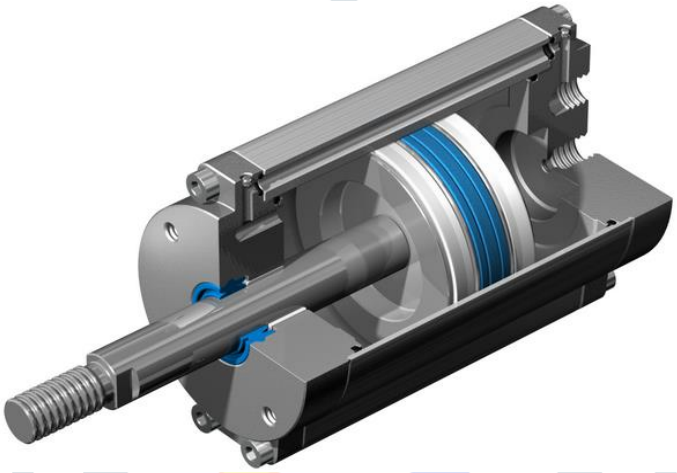

Figure 1. Cut-section of a Pneumatic Actuator

3. PNEUMATIC VALVES AND CONTROL CIRCUITS

Pneumatic Valves

In fluid power systems, high pressurized fluid is responsible for the transmission of power. In order to regulate the flow of fluid, control valves are required. A pneumatic control valves are devices to control direction of flow or rate of flow or pressure of the compressed air.

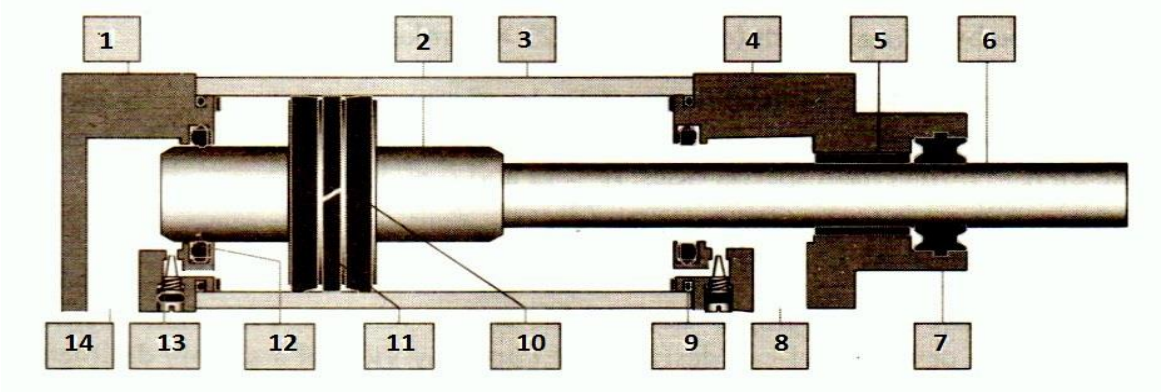

Figure 2 Parts of Pneumatic Actuator

1. Rear ends cover
2. Cushion sleeve
8. Front port
9. Barrel seal

3. Barrel
4. Front end cover
5. Guide bush
6. Piston
7. Road wiper seal
10. Piston seal
11. Wear ring
12. Cushion seal
13. Cushion screw seal
14. Rear port

3/2 Directional Control Valves

A 3/2-directional control (DC) valve has three controlled connections and two switching positions. This valve can be built with a ball popper or disc popper or spool type design, and with or without an internal pilot valve. There are two versions of 3/2-DC valves, classified according to the way the pressure port is maintained in the normal position. The two versions are: normally closed (NC) type and normally open (NO) type. In the NC 3/2-DC valve, the pressure port is blocked in the normal position. But in the NO type, the pressure port is open working port in the normal position. The 3/2-way valves can be used to control single-acting cylinders and other valves. In most designs, a 3/2-DC valve can be adapted for use either as No type or as NC type. The terms NO and NC contacts are also used in electrical circuits where they denote entirely different functions. For instance, an NO contact in an electrical circuit is a contact that is open when not actuated, thus inhibiting the energy flow. You should not get confused with such difference in representations.

Pneumatically Actuated 5/2 Control Valves

The functioning of this valve is similar to the manually actuated 5/2-DC valve except the method of actuation. Here a pilot port 14 is readily available to apply the compressed air and to actuate the valve pneumatically. In the normal position, paths from port 1 to port 2 and from port 4 to port 5 are open and the exhaust port 3 is closed. In the actuated position, paths from port 1 to port 4 and from port 2 to port 3 are open and the exhaust port 5 is closed. Port designation 14 indicates that the application of air to this port connects port 1 to port 4.

4. WORKING OF PNEUMATIC GEAR SHIFT

The compressed air cylinder is fitted with the solenoid valve at the openings. The circulation pipes are connected from the solenoid to the pneumatic actuator. The required quantity of air is sent into the actuator with the required pressure. The pressure required for the movement of the piston in cylinder is known by experimenting. Pressure should not be so high that it damages the parts of the actuator. The main motive of the whole system is to actuate the linear push pull Pneumatic actuator. So, the air is fed into the push pull type actuator through a double Solenoid 5/3 control valve with one end for expansion and other for retraction.

The main problem the stormed the whole team was how to bring the actuator to neutral or mean position after actuation. One way was to use a three-position cylinder but this idea was later on dropped due to non-availability in the local market. So, another way out was found by one of the team members. An extra Solenoid control valve was used to cut the air supply to the main solenoid so that the actuator can return to its mean position because of no pressure inside the cylinder.

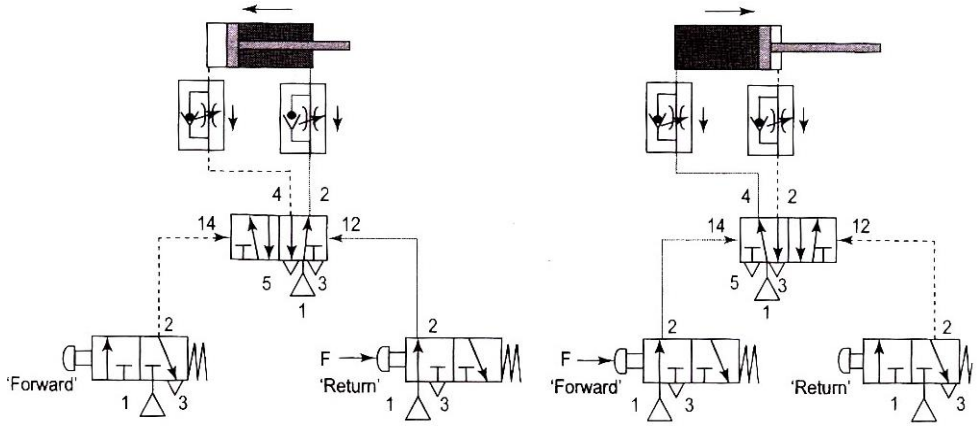

Figure 3. Schematic Representation of the Process

So, when any one of the DPDT switches mounted on near the handle is pressed the Solenoid comes into action and opens the control valve to actuate a gear shift.

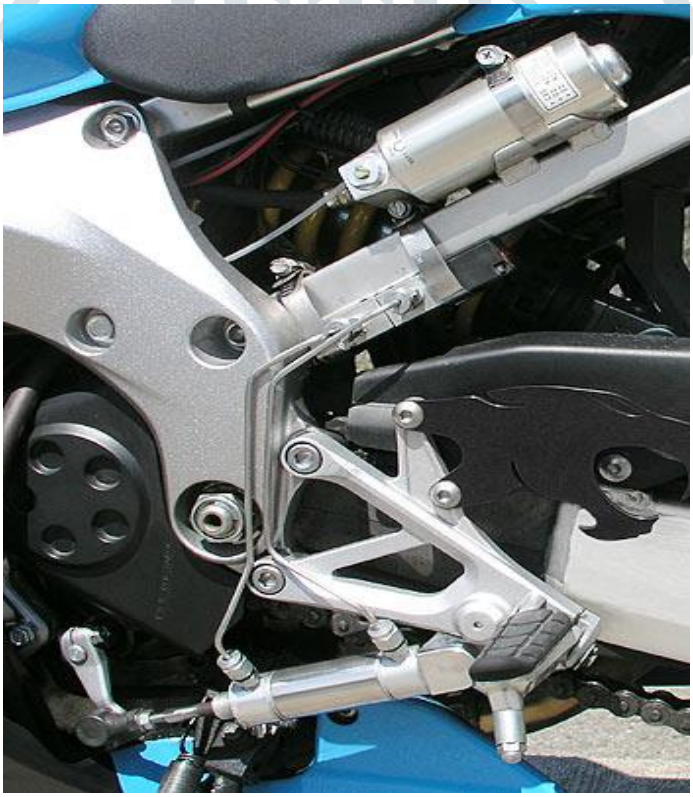

Figure 4. Arrangement of Pneumatic Gear Shifter

6. DESIGN OF PNEUMATIC ACTUATOR

The Pneumatic Actuator is modeled in CREO. The screenshots are given below:

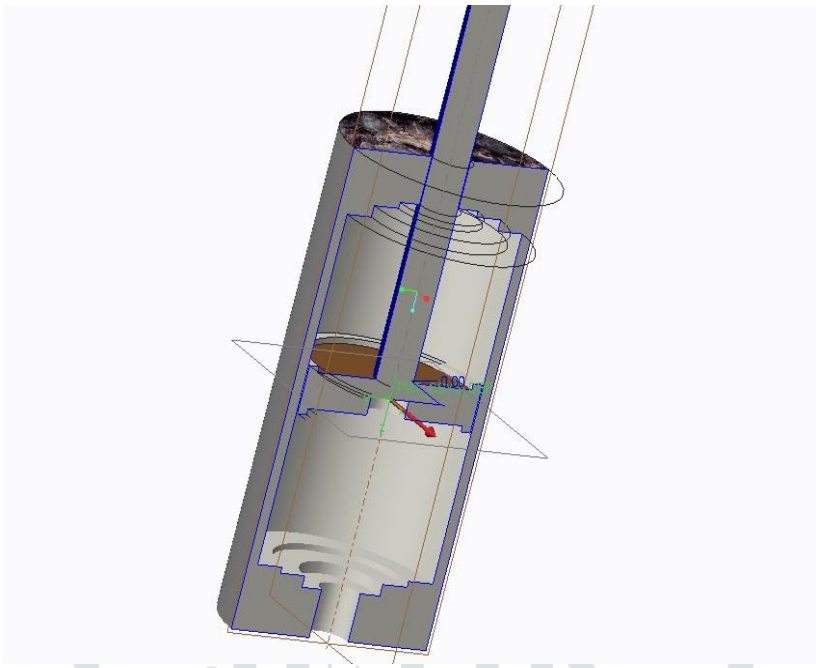

Figure 5. Snapshot of the Model showing Inner Surfaces

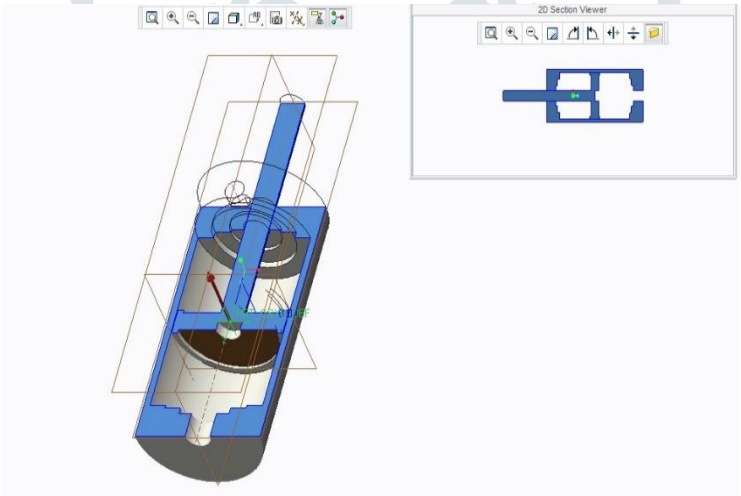

Figure 6. Snapshot of the Model Cut-Section view

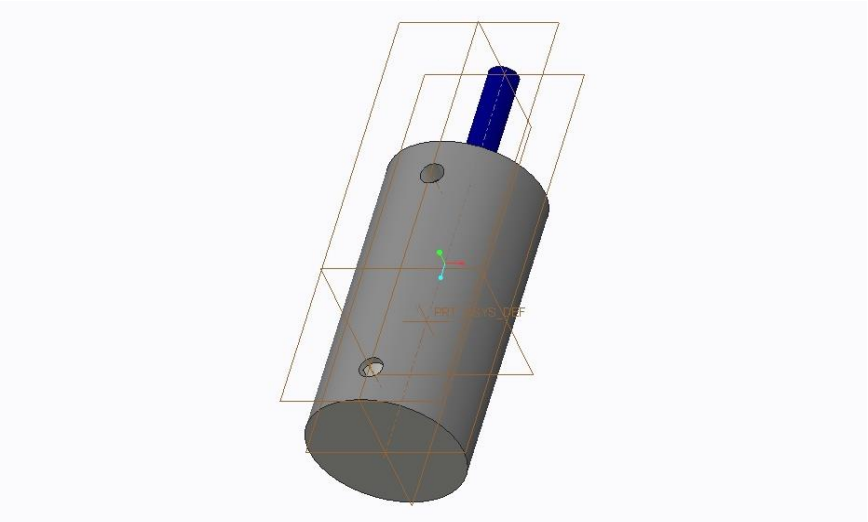

Figure 7. Snapshot of the Model Full view

7. CONCLUSION & FUTURE WORK

Through this work the following conclusions were made:

- Present work involves the development and implementation of semi-automatic transmission for two-wheeler with gears.
- The application of this mechanism leads to simple and effective method for shifting gear.
- This mechanism makes the driving process easier and more comfortable.
- The driver can concentrate more on driving than the shifting of gear. This avoids the accidents.
- Present system reduces the strain to the driver while shifting the gears.
- The system is reliable and cost effective when it is produced in large scale.

The Pneumatic Gear shifting mechanism can be practically implemented on a two-wheeler with gears.

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