

# A Review Paper on Pneumatic Operated Collapsible Steering System

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**Abstract** - The pneumatic operated collapsible steering system which reduces frontal injury to the driver in case of frontal accidents. Our project deals with the idea of implementing collapsible steering column in the car which helps to absorb the impact experienced to the driver at the time of accident. By considering this collapsible steering system we presenting a new idea of pneumatic operated collapsible system.

**Key Words:** Pneumatic operated collapsible steering system (PCS).

## 1.INTRODUCTION

A steering column is mechanical system which is connecting the steering wheel to the mechanism of the front wheels of an automobile. A commonly steering column can transmit the work effort from the driver to the front wheels by the correcting decision of driver. The various function can be performed by the steering column mechanism are as follows:

- (1) To guide the front wheels.
- (2) Give right direction to the front wheel as given by the driver.
- (3) It acts as a support to the steering wheel.

In this paper we can collapse the steering column by using pneumatic operated piston-cylinder arrangement. This piston-cylinder arrangement can be operated by using 5/3 direction control valve from the limit switch which is placed in front of the vehicle. If any body strikes to the vehicle at front side then it can automatically activate the limit switch and it gives quick signal to the 5/3 direction control valve and then it can operate the piston-cylinder arrangement thus the steering gets lowered within the fraction of seconds.

## 2.COLLAPSIBLE STEERING COLUMN

Generally a steering column is a long hollow or rigid shaft that is connected from steering wheels to the steering rack and pinion gear box. In older vehicle this steering column is the only mechanism that used to control vehicle. Thus the design of this steering rod is

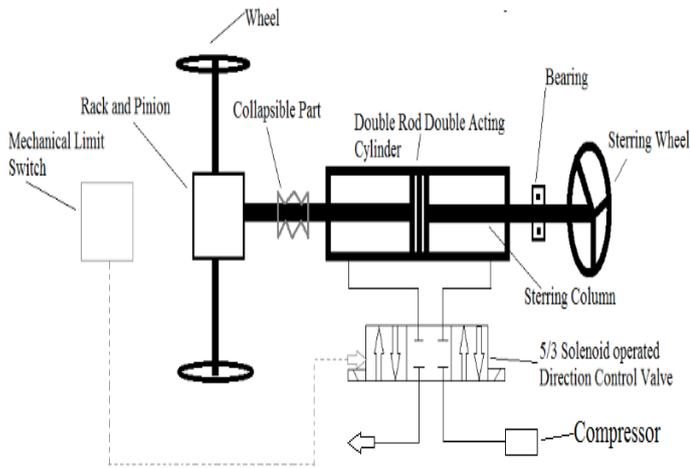
not so safe at the time of accidents. At the time major accidents this column impact to the driver and thus in this way driver get injured. A collapsible steering mechanism is a system which reduces to frontal impacts on driver by collapsing a part of the system. The collapsible steering column can absorb most of the frontal impacts being transferred towards the driver. The existing collapsible columns consist of the inner and outer sleeves which are engaged together by using steel bearing in between two sleeves. These steels bearing are pressed into sleeves and all this assembly can be covered with strong resin which is acting safeguard to steering column. At time of accidents as impact on steering rod increases then these both inner and outer sleeves moves into each other in this way collapsible action can be takes place.

## 3.Working of Pneumatic Operated Collapsible Steering System

In this paper we give new idea about collapsing the steering column by using pneumatic piston-cylinder arrangement.

Whenever a vehicle get accident limit switch gets active and then signal passes through the 5/3 solenoid operated direction control valve. It has four chamber upper two valves connected in inlet and outlet to the pneumatic cylinder and lower two valves one connected in compressor and another one open to the atmosphere.

Whenever circuit get complete compressor get signal to increase cylinder pressure steering mechanism moves away from driver, between double acting double rod cylinder and rack & pinion mechanism we have compressible part which can easily compressed whenever steering mechanism pressure increases afterword's when mechanism settle down remaining pressure exit to the atmosphere.



**Fig -1:** Pneumatic Operated Collapsible Steering System

The pneumatic collapsible steering mechanism consists of following important parts.

- 1) Limit Switch
- 2) Direction Control Valve
- 3) Double Acting Pneumatic Cylinder
- 4) Solenoid Valve
- 5) Rack and Pinion

Detailed review on each part:

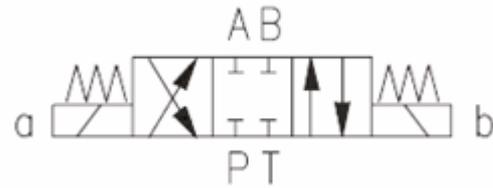
1) Limit Switch:-

A limit switch is an electromechanical device that consists of an actuator mechanically linked to a set of contacts. When an object comes into contact with the actuator, the device operates the contacts to make an electrical connection.

Limit switch is one type of "Contact Sensor", In that there is Normally Open Contact & Normally Close Contact. Limit Switches is used mainly for Safety Purpose.

2) Direction Control Valve:-

Directional control valves are one of the most fundamental parts in hydraulic machinery as well as 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.



**Fig -2:** Solenoid Operated Direction Control Valve

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 3 or more position that can be spring centered with 2 working position and a normal position.

Directional control valves can be classified according to-

- Number of Ports
- Number of Positions
- Actuating Methods
- Type of Spool.

Example: A 5/2 directional control valve would have five ports and two spool positions.

- Number of Ports

Ports are the one which helps the liquid to flow through them. Mainly there are 4 ports P-pump, t-tank or oil sump, A&B- flow of liquid to inlet and outlet of tank.

- Number of Positions

Including the normal and working positions which a valve spool can take there are types like two position, three position and proportional valve.

- Actuating Methods

Manually, Mechanically, Hydraulically and Solenoid Operated.

a) Manually Operated

Manually operated valves work with simple levers or paddles where the operator applies force to operate the valve. Spring force is sometimes used to recover the position of valve. Some manual valves utilize either a lever or an external pneumatic or hydraulic signal to return the spool.

### b) Mechanically Operated

Mechanically operated valves apply forces by using cams, wheels, rollers, etc., hence these valves are subjected to wear.

### c) Hydraulically Operated

A hydraulically operated DCV works at much higher pressures than its pneumatic equivalent. They must therefore be far more robust in nature so are precision machined from higher quality and strength materials.

### d) Solenoid Operated

Directional valve, 5/3 sliding spool type, solenoid operated, showed on neutral position on figure (a). P is pressure inlet, A and B are utilization ports, TA and TB are return ports. When solenoid (magnet) A is energized, the spool is pulled to left, connecting the ports P to A and the ports B to TB. When solenoid B is energized, the spool is pulled to right, connecting P to B and A to TA. They are widely used in the hydraulics industry. These valves make use of electromechanical solenoids for sliding of the spool. Because simple application of electrical power provides control, these valves are used extensively. However, electrical solenoids cannot generate large forces unless supplied with large amounts of electrical power. Heat generation poses a threat to extended use of these valves when energized over time. Many have a limited duty cycle. This makes their direct acting use commonly limited to low actuating forces. Often a low power solenoid valve is used to operate a small hydraulic valve (called the pilot) that starts a flow of fluid that drives a larger hydraulic valve that requires more force. A bi-stable pneumatic valve is typically a pilot valve that is a 3 ported 2 position detented valve. The valve retains its position during loss of power, hence the bi-stable name. Bi-stability can be accomplished with a mechanical detent and 2 opposing solenoids or a "magna-latch" magnetic latch with a polarity sensitive coil. Positive opens and negative closes or vice versa. The coil is held in position magnetically when actuated.

- Type of Spool

Spool is of two types namely sliding and rotary. Sliding spool is cylindrical in cross section, and the lands and grooves are also cylindrical. Rotary valves have sphere-like lands and grooves in the form of holes drilled through them.

### 3) Double Acting Pneumatic Cylinder:-



**Fig -3:** Double Acting Pneumatic Cylinder

Double-acting cylinder (DAC) use the force of air to move in both extend and retract strokes. They have two ports to allow air in, 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.

#### Construction of Double Acting cylinder

Depending on the job specification, there are multiple forms of body constructions available

- Tie rod cylinders: The most common cylinder constructions that can be used in many types of loads. Has been proven to be the safest form.
- Flanged-type cylinders: Fixed flanges are added to the ends of cylinder, however, this form of construction is more common in hydraulic cylinder construction.
- One-piece welded cylinders: Ends are welded or crimped to the tube, this form is inexpensive but makes the cylinder non-serviceable.
- Threaded end cylinders: Ends are screwed onto the tube body. The reduction of material can weaken the tube and may introduce thread concentricity problems to the system.

#### 1) Material

Upon job specification, the material may be chosen. Material range from nickel-plated brass to aluminium, and even steel and stainless steel. Depending on the level of loads, humidity, temperature, and stroke lengths specified, the appropriate material may be selected.

## 2) Mounts

Depending on the location of the application and machinability, there exist different kinds of mounts for attaching pneumatic cylinders.

### Type of Mount Ends

Rod End	Cylinder End
Plain	Plain
Threaded	Foot
Clevis	Bracket-single or double
Torque or eye	Trunnion
Flanged	Flanged, Clevis etc.

## 4) Solenoid Valve:-

A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid: in the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports. The solenoid assembly consists of a coil, plunger, and sleeve assembly. In a normally closed valve, a plunger return spring holds the plunger against the orifice, preventing flow through the valve. When the coil is energized, a magnetic field is produced, raising the plunger and allowing flow through the valve. When the ignition switch is turned on, a small electric current is sent through the starter solenoid. This causes the starter solenoid to close a pair of heavy contacts, thus relaying a large electric current through the starter motor, which in turn sets the engine in motion.



Fig -3: Solenoid Valve

### How does a solenoid work?

A solenoid is simply a specially designed electromagnet. A solenoid usually consists of a coil and a movable iron core called the armature. Here's how it works. When current flows through a wire, a magnetic field is set up

around the wire. If we make a coil of many turns of wire, this magnetic field becomes many times stronger, flowing around the coil and through its center in a doughnut shape. When the coil of the solenoid is energized with current, the core moves to increase the flux linkage by closing the air gap between the cores. The movable core is usually spring-loaded to allow the core to retract when the current is switched off. The force generated is approximately proportional to the square of the current and inversely proportional to the square of the length of the air gap. Solenoids are inexpensive, and their use is primarily limited to on-off applications such as latching, locking, and triggering. They are frequently used in home appliances (e.g. washing machine valves), office equipment (e.g. copy machines), automobiles (e.g. door latches and the starter solenoid), pinball machines (e.g. plungers and bumpers), and factory automation.

## 5) Rack and Pinion:-

A rack and pinion is a type of linear actuator that comprises a pair of gears which convert rotational motion into linear motion. A circular gear called "the pinion" engages teeth on a linear "gear" bar called "the rack"; rotational motion applied to the pinion causes the rack to move relative to the pinion, thereby translating the rotational motion of the pinion into linear motion. A generating rack is a rack outline used to indicate tooth details and dimensions for the design of a generating tool, such as a hob or a gear shaper cutter. For example, in a rack railway, the rotation of a pinion mounted on a locomotive or a railcar engages a rack between the rails and forces a train up a steep slope. For every pair of conjugate involute profile, there is a basic rack. This basic rack is the profile of the conjugate gear of infinite pitch radius. ( i.e. a toothed straight edge.)

## 3. CONCLUSIONS

We conclude that the Pneumatic operated collapsible steering system is very unique and easy solution to avoiding or preventing human accident as well as their damages. It is very easy to implement in any four wheel or any heavy vehicle also have very cheap in cost. This is an advance mechanism for future and present also for preventing accidents. The main advantages of pneumatic steering are that provides working space for proper functioning of air bag.

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