

# MAGNETO-PNEUMATIC SUSPENSION SYSTEM

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**ABSTRACT** - Day by day there have been advancement in technologies and features in the automobile segment and newer models come to market rapidly. But still there has been use of the conventional (telescopic and coil suspension) in most of the automobiles running on Indian roads, which do not provide much comfort, stability and more jerks and shocks are felt on rough and bumpy roads. There is a need for introduction of a type of suspension with little modification so as to provide better ride comfort and stability giving a good driving experience even on rough road by absorbing maximum no of jerks and shocks thereby reducing it to be transferred to the body.

Our aim is to create a suspension system which provides excellent better ride quality by implementing the concepts of both magnetism & pneumatics, where this combination is used for providing better ride comfort, stability and convenience. This system absorbs maximum number of shocks and jerks thereby reducing the transfer of them to the body of the vehicle. Mainly our focus is on the magnetism part which is added as a value to the normal Air Suspension System.

## 1. INTRODUCTION

The vehicle suspension system is the mechanism that serves to connect the car body with the wheels of the car. It has the ability to transmit to the road surface all forces acting on the car.

The role of the car suspension is to link elastic between the frame or the car body and bridges, or directly with the car wheels. Suspension transforms the shocks in oscillations with amplitude and frequency endurable by passengers and dampens oscillations, avoiding resonance.

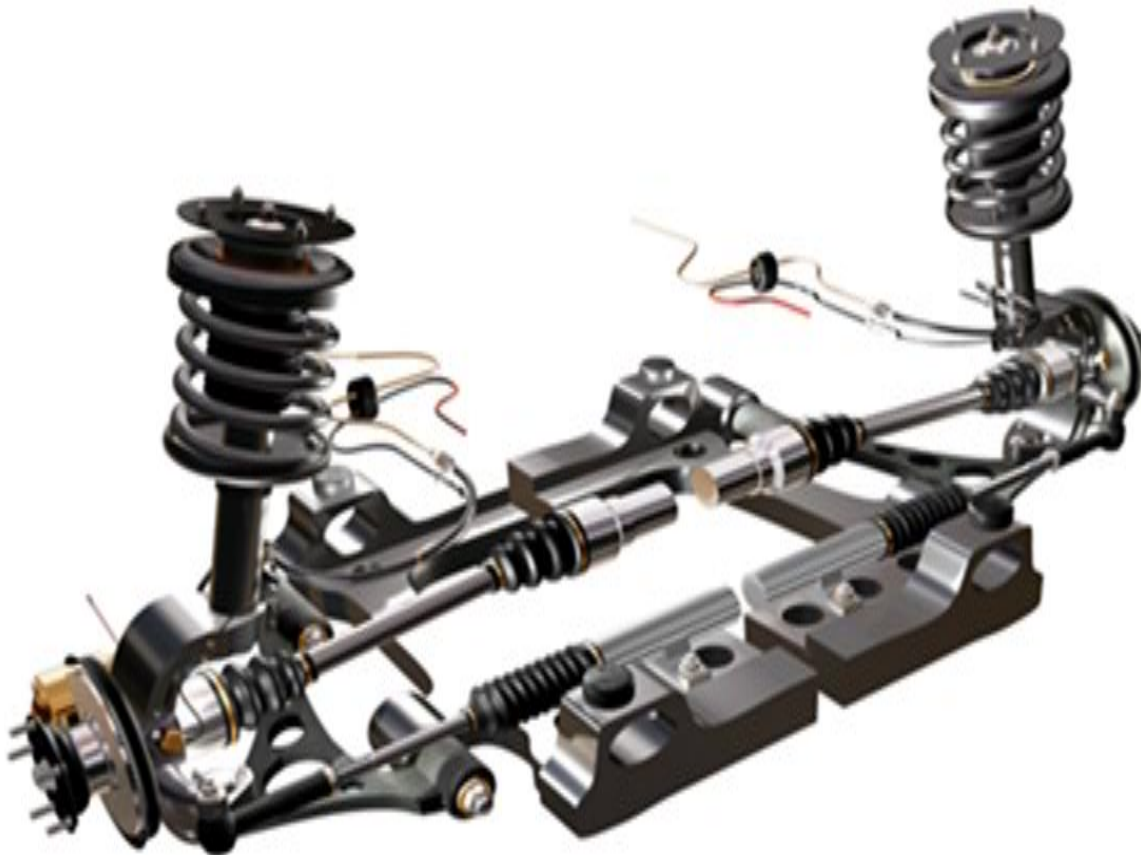


Figure 1: Suspension System of Automobile

## 1.1 PROJECT DESCRIPTION AND DEFINITION:

Conventional Suspension System has a separate spring and dampener to absorb the shock; also the wheels are linked that means the movement of the wheel on one side effect the movement of the wheel on the other side. So it gives rise to gyroscopic effect and wheel wobbling occurs. Due to this, it produces excess strain on the body of person sitting in the vehicle and provides inconvenient driving experience.

Basically, Suspension system is the system of tires, tire air, springs, shock absorbers and linkages that connects a vehicle to its wheels and allows relative motion between the two. Suspension systems must support both road holding/handling and ride quality, which are at odds with each other. The tuning of suspensions involves finding the right compromise. It is important for the suspension to keep the road wheel in contact with the road surface as much as possible, because all the road or ground forces acting on the vehicle do so through the contact patches of the tires.

## 1.2 PROBLEM SOLUTION:

We have developed a Magneto-Pneumatic Suspension System which works on the the concepts of Mechanics, Control Engineering and Magnetism. As the name suggest we have used magnet and compressed air to develop this suspension system. It allows the wheel to move up and down with the minimal effect of the other. Camber does not change due up of down movement of wheels.

We are installing the powerful magnets in the air suspension system with powerful. Also, initial cost and maintenance cost is low compared to the conventional suspension system. The neodymium magnets are installed in the air bellow such that like poles of magnet face each other; which provides repulsive effect so as to minimize the transfer of jerks and shocks to the vehicle body hence, providing stability to the vehicle.

## 1.3 AIM AND OBJECTIVES:

### 1.3.1 AIM:

To develop a vehicle suspension system which is a combination of both magnetism and pneumatics, where the magnetism part play a role of creating repulsion effect by placing two permanent magnets in same polarity, thereby reducing the transfer of jerks and shocks to the vehicle body while the pneumatic part play the role of providing ride comfort and stability to the vehicle.

### 1.3.2 OBJECTIVES:

- To provide drive comfort.
- To increase stability of vehicle.
- To reduce the transfer of jerks and shocks to the vehicle body.
- To identify and set benchmarks for design.
- Designing of components.
- To select a suitable materials.
- Organizing project flow.
- Manufacturing of prototype.
- Application in service.

## 1.4 Working Principle:

Magneto-Pneumatic Suspension System (MPSS) works on the principle of both magnetic repulsion effect and pneumatic air pressure working simultaneously where pneumatic system acts as a primary suspension system while magnetic repulsion effect acts as a supportive secondary suspension system.

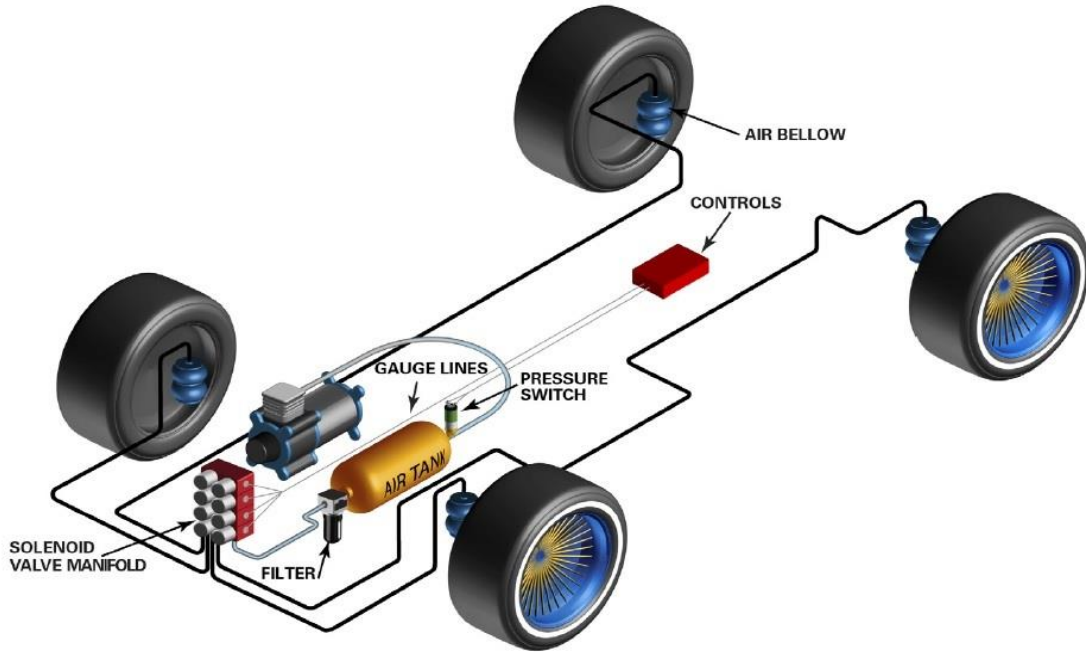
## 1.5 EQUIPMENTS REQUIRED FOR THE PROJECT

- Air Spring (Single Convolution Bellow)
- Air Compression Unit
- Manual Lever Valve
- Solenoid Valve
- Tube and Fittings
- Neodymium Magnet N52

- Pressure Gauge
- Electronic Control Unit (ECU)
- Remote Control Unit (RCU)
- Height Sensor
- Pressure Sensor

**2. DESIGN AND OPERATION OVERVIEW**

**2.1 MODEL (MAGNETO-PNEUMATIC SUSPENSION)**



*Figure 2: 3-Dimensional Model of Suspension System*

**2.2 COMPONENT DETAILS**

**2.2.1 Air Spring (Single Convolution Bellow)**

- Single convolution bellows provides an excellent cushioning effect and offer exceptionally good lateral movement. For this reason they are particularly suitable for use in buses and passenger cars but are also used on Lorries and trailers.
- The single convolution type is of 142 mm in diameter, 155 mm height and covered by two steel disc rings.



*Figure 3: Single Convolution Bellow*

### 2.2.2 Air Compression Unit

- A machine which draws in air at atmospheric pressure then compresses it to pressures higher than atmospheric and delivers it at a rate sufficient to operate pneumatic tools or equipment.
- Apparatus consists of air tank, pressure relief valve, oil less air compressor, air dryer-filter-regulator unit and 1/4" air exhaust from air tank. It also features auto start-stop function at required psi. An AC power supply is necessary for the operation.

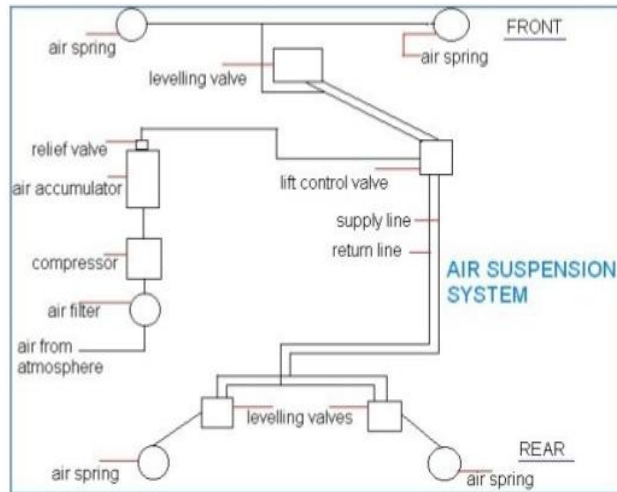


Figure 4: Air Compression Unit and Air flow Diagram

### 2.2.3 Manual Lever Valve

- Two manual lever type valves have been used, one for inflation and one for deflation purpose. The thread of the valve is of internal type and both 1/4" as well as 1/8" is used whereas the tube fitting side is of 8 mm diameter.



Figure 5: Manual Lever Valve

### 2.2.4 Tube and Fittings

- A 6 mm internal diameter and 8 mm external diameter tube is used.
- Various fittings like the elbow type, T type, Y type, straight type etc, are used.
- Thread diameter is either 1/4" or 1/8" and hole of 8 mm for the tube fitting.



Figure 6: Tube and Fittings

### 2.2.5 Neodymium Magnet N52

A neodymium magnet (also known as NdFeB, NIB or Neo magnet), the most widely used type of rare-earth magnet, is a permanent magnet made from an alloy of neodymium, iron and boron to form the Nd<sub>2</sub>Fe<sub>14</sub>B tetragonal crystalline structure. Neodymium magnets are metal, and they are colored silver, like most other metals. Hematite is not a metal, although it has some metal atoms in it. It is instead a mineral, formed primarily of iron oxide, specifically, the Fe<sub>2</sub>O<sub>3</sub> oxide, which is common iron rust. Usually there are other elements mixed with it. Hematite magnets vary in color from red to gray to black.

- Here, 25 mm diameter and 25 mm thickness neodymium magnet of grade N52 is used in this project.



Figure 7: Neodymium Magnet N52

### 2.2.6 Solenoid Valve

A solenoid valve is a combination of two basic functional units:

- A solenoid (electromagnet) with its core
- A valve body containing one or more orifices

Flow through an orifice is shut off or allowed by the movement of the core when the solenoid is energized or de-energized. ASCO valves have a solenoid mounted directly on the valve body. The core is enclosed in a sealed tube, providing a compact, leak-tight assembly.





*Figure 8: Solenoid Valve*

### 2.2.7 Electronic Control Unit (ECU)

- The Electronic Control Unit is the heart of the system and is connected with the single components on the vehicle by means of a 35-pole or 25-pole plug-in terminal. The ECU is located in the driver's cab and controls one or more of the electrical systems or subsystems in a vehicle.
- Together with a plug-in terminal for connecting the ECAS ECU for trailers to the other components, the ECU is mounted on the trailer's chassis in a protective housing. This protective housing corresponds to the ABS-VARIO System.
- The ECU contains a microprocessor which processes digital signals only. A memory managing the data is connected to this processor. The outlets to the solenoid valves and to the indicator lamp are switched via driver modules.



*Figure 9: Electronic Control Unit*

### 2.2.8 Remote Control Unit (RCU)

- By means of the RCU the driver can influence the vehicle's level within the permissible maximum limits. However, this can only be done whilst the vehicle is either stationary or has not exceeded the driving speed parameter.
- The control keys for changing the level are accommodated in a handy housing. Contact with the ECU is established via coiled cable and a socket on the vehicle.
- The function of RCU is to raise and lower chassis depending upon the load variation.



Figure 10: Remote Control Unit

### 2.2.9 Height Sensor

- From the outside, the height sensor looks similar to WABCO's conventional leveling valve which means that it can often be fitted in the same location on the vehicle frame (the pattern of the two upper mounting bores is similar to that of the leveling valve).
- The sensor housing contains a coil in which an armature is moved up and down. Via a connecting rod, the armature is connected to a cam on the lever's shaft.



Figure 11: Height Sensor

### 2.2.10 Pressure Sensor

- The pressure sensor produces a voltage output which is proportional to the pressure present. The measuring range lies between 0 and 10 bar; a pressure of 16 bar must not be exceeded.
- The signal voltage is sent to the ECU via a connecting plug. Furthermore, the sensor must receive a supply voltage from the ECU via a third conductor.
- The cable harness must be encased in a hose or similar material in such a way that the housing - which is otherwise waterproof - can "breathe".



Figure 12: Pressure Sensor

### 3 WORKING OF MAGNETO-PNEUMATIC SUSPENSION SYSTEM

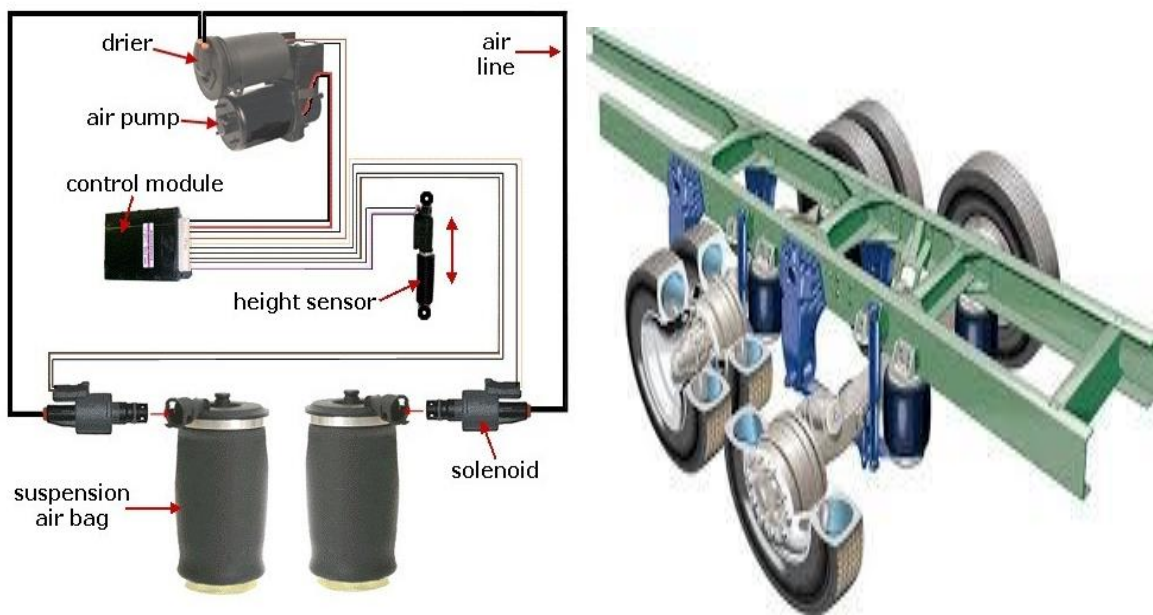


Figure 13: Working of Magneto- Pneumatic Suspension System

- Magneto-pneumatic suspension system is a type of vehicle suspension powered by an engine-driven compressor. This compressor pumps the air into a flexible bellows. The air pressure inflates the bellows, and raises the chassis from the axle.
- Also, the Neodymium magnet N52 is placed at the end of each bellow in such a way that like poles of magnets are faced towards each other in each bellow; which provides the repulsive effect to minimize the transfer of jerks and shocks to the vehicle body. Hence, providing stability to the vehicle. Neodymium magnets have higher remanence, much higher coercivity and energy product, but often lower Curie temperature than other type of magnets.





Figure 14: Neodymium Magnet N52 fixed on each end of the bellow (like poles of magnets are placed towards each other to produce repulsive effect)

- With the use of the Neodymium Magnet N52 the load on the bellow decreases during the operation which increases the reliability of the suspension system. Also, considerable maintenance cost can be avoided.
- At first, the compressed air is charged by air compressor to the air spring (single convolution bellow) through the solenoid valve. The air compressor is engine-driven and stores the compressed air in the tank. Also, solenoid is electromechanically actuated by micro-controller present in the electronic control unit of the automobile.
- Electronic Control Unit constantly monitors the incoming signal given by pressure sensor and converts the signals into values; depending upon the value it actuates the solenoid valve.



Figure 15: Testing of Air Spring (Single Convolution Bellow) with Compressor and Sensors

- When the tire hits the obstruction, there is a reaction force. Height sensor contains a coil in which armature is moved up and down. Armature is connected to a cam on the lever's shaft via connecting rod. Hence it senses the height and provides the signal to the ECU; so ECU provides feedback to maintain the desired height of the automobile.

## CONCLUSION

Implementation of Magneto-Pneumatic Suspension in the 4-wheel automobiles gives better ride comfort and driving experience thereby reducing the transfer of shocks and jerks to the sprung weight of automobile vehicles.

## FUTURE SCOPE:

- System can be made more compact and light in weight.
- More powerful magnets than the neodymium magnets can be used.
- Controllers like PLC's, Micro-Controllers can be advanced to the system to automatically control variable pneumatic pressure.
- Information regarding the suspension can be displayed to the driver through multimedia display screen

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