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DESIGN AND FABRICATION OF PNEUMATIC JACK FOR AUTOMOBILE

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ABSTRACT: *The main target of project is to improve version of a mini pneumatic jack. This will be more efficient for the user. This machine is pneumatic powered which has low co-efficient of friction. A pneumatic cylinder erected provides power to lift up the Jacky. This is a pneumatic powered machine and requires no other means of power to operate. The required components are Compressor, Pneumatic cylinder, Solenoid, Control circuit and Jack.*

INTRODUCTION

NEED FOR AUTOMATION:

Automation can be achieved through computers, hydraulics, pneumatics, robotics, etc., of these sources, pneumatics form an attractive medium for low cost automation. The main advantages of all pneumatic systems are economy and simplicity. Automation plays an important role in mass production. Nowadays almost all the manufacturing processes are being made automatic in order to deliver the products at a faster rate. The following reasons affirms the benefits of automation,

- To achieve mass production
- To reduce man power
- To increase the efficiency of the plant
- To reduce the work load
- To reduce the production cost
- To reduce the production time
- To reduce the material handling
- To reduce the fatigue of workers
- To achieve good product quality
- Less maintenance

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PNEUMATICS:

The word 'pneuma' comes from Greek and means wind. The word pneumatics is the study of air movement and its phenomena is derived from the word pneuma. Today pneumatics is mainly understood to means the application of air as a working medium in industry especially the driving and controlling of machines and equipment.
Pneumatics has for some considerable time between used for carrying out the simplest mechanical tasks in more recent times has
Played a more important role in the development of pneumatic technology for automation.
Pneumatic systems operate on a supply of compressed air which must be made available in sufficient quantity and at a pressure to suit the capacity of the system. When the pneumatic system is being adopted for the first time, however it wills indeed the necessary to deal with the question of compressed air supply.The key part of any facility for supply of compressed air is by means using reciprocating compressor. A compressor is a machine that takes in air, gas at a certain pressure and delivered the air at a high pressure.Compressor capacity is the actual quantity of air compressed and delivered and the volume expressed is that of that of the air at intake conditions namely at atmosphere pressure and normal ambient temperature.
The compressibility of the air was first investigated by Robot Boyle in 1962 and that found that the product of pressure and volumes of particular quantity of gas.

The usual written as

$$PV = C \quad (\text{or}) \; P_iV_i = P2V2$$

In this equation the pressure is the absolute pressured which for free is about 14.7Psi and is of courage capable of maintaining a column of mercury, nearly 30 inches high in an ordinary barometer. Any gas can be used in pneumatic system but air is the mostly used system now a days.

SELECTION OF PNEUMATICS:

Mechanization is broadly defined as the replacement of manual effort by mechanical power. Pneumatic is an attractive medium for low Cost mechanization particularly for sequential (or) repetitive operations. Many factories and plants already have a compressed air system, which is capable of providing the power (or) energy requirements and control system (although equally pneumatic control systems may be economic and can be advantageously applied to other forms of power).
The main advantages of an all pneumatic system are usually Economic and simplicity the latter reducing maintenance to a low level. It can have out standing advantages in terms of safety.

PNEUMATIC POWER:

Pneumatic systems use pressurized gases to transmit and control power. Pneumatic systems typically use air as the fluid medium because air is safe, low cost and readily available.

THE ADVANTAGES OF PNEUMATICS:

1. Air used in pneumatic systems can be directly exhausted back
In to the surrounding environment and hence the need of special reservoirs and no-leak system designs are eliminated.
2. Pneumatic systems are simple and economical
3. Control of pneumatic systems is easier

THE DISADVANTAGES OF PNEUMATICS:

1. Pneumatic systems exhibit spongy characteristics due to compressibility of air.
2. Pneumatic pressures are quite low due to compressor design limitations(less that 250 psi).
PRODUCTION OF COMPRESSED AIR
Pneumatic systems operate on a supply of compressed air, which must be made available. In sufficient quantity and at a pressure to suit the capacity of the system. When pneumatic system is being adopted for the first time, however it wills indeed the necessary to deal with the question of compressed air supply. The key part of any facility for supply of compressed air is by means using reciprocating compressor. A compressor is a machine that takes in air, gas at a certain pressure and delivered the air at a high pressure. Compressor capacity is the actual quantity of air compressed and delivered and the volume expressed is that of the air At intake conditions namely at atmosphere pressure and normal ambient temperature. Clean condition of the suction air is one of the factors, which decides the life of a compressor. Warm and moist suction air will result increased precipitation of condense from the compressed air.

COMPRESSOR MAY BE CLASSIFIED IN TWO GENERAL TYPES.
1. Positive displacement compressor

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2. Turbo compressor
Positive displacement compressors are most frequently employed for
Compressed air plant and have proved highly successful and supply air for pneumatic control application.
The types of positive compressor
1. Reciprocating type compressor
2. Rotary type compressor

Turbo compressors are employed where large of air required at low discharge pressures. They cannot attain pressure necessary for pneumatic control application unless built in multistage designs and are seldom encountered in pneumatic service.

RECIPROCATING COMPRESSORS:

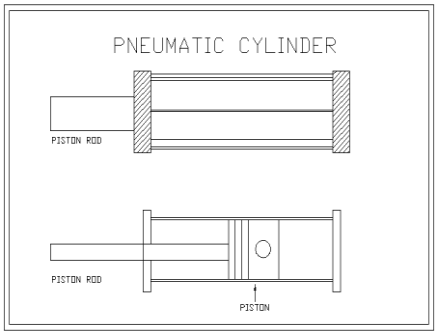
Built for either stationary (or) portable service the reciprocating compressor is by far the most common type. Reciprocating compressors lap be had is sizes from the smallest capacities to deliver more than 500m^3/min.In single stage compressor, the air pressure may be of 6 bar machines discharge of pressure is up to 15bars.Discharge pressure in the range of 250bars can be obtained with high pressure reciprocating compressors that of three & four stages. Single stage and 1200 stage models are particularly suitable For applications, with preference going to the two stage design as soon as the discharge pressure exceeds 6 bars, because it in capable of matching the performance of single stage machine at lower costs per driving powers in the range.

ULTIMATE AIM

The pneumatic jack can be widely used in low cost automation in manufacturing industries. The weight lifting is quick and effortless, which reduces the physical fatigue (tiredness) felt by the worker.

PNEUMATIC CYLINDER

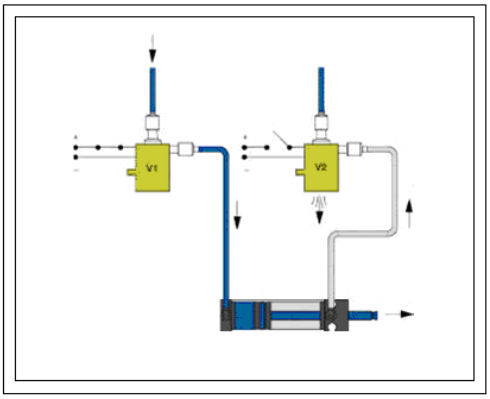
Pneumatic cylinders impart a force by converting the potential energy of compressed gas into kinetic energy. This is achieved by the compressed gas being able to expand, without external energy input, which itself occurs due to the pressure gradient established by the compressed gas being at a greater pressure than the atmospheric pressure. This air expansion forces a piston to move in the desired direction.



Pneumatic cylinders can be moved both inwards and outwards by compressed air. Cylinders of this type are called double-action
Cylinders.

Cylinders also exist which can only be moved pneumatically in one direction. The return movement is caused by a spring. Cylinders of this type are called "single-action cylinders". The compressor cylinder is a single-action cylinder.

In order to move a cylinder in both directions, two of the valves contained in the kit are required.



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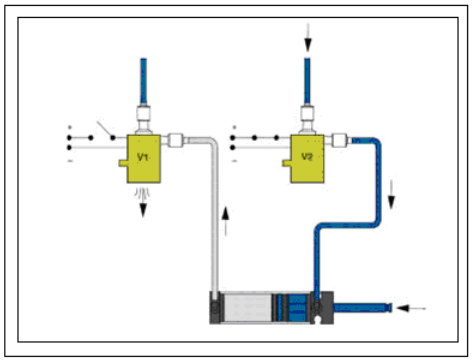
To move the cylinder outwards, valve V1 must be open (the coil is supplied with electric current) and valve V2 closed (no current flowing).



To move the cylinder inwards, valve V2 is open and valve V1 closed. The diagram also makes it clear why vent "R" on the valve is required. Without this vent, the cylinder would be unable to move as the same pressure would be exerted on both sides of the piston and the air would not be able to escape. The pneumatic system uses manually or electrically operated valves to control direction of movement. Directional control valves can be operated by hand lever or electric solenoid to maintain an adjustable travel rate. The internal porting or spool of the directional control valve regulates airflow.

To extend the cylinder piston, air flows into the directional valve pressure port, through the flow control valve, and into the cylinder. As pressure builds in one end of the cylinder and the rod starts to extend, air exhausts out the opposite end of the cylinder. The flow control valve on the end of the cylinder restricts exiting airflow, which builds pressure to slow rod movement.

The exhausting air passes through the flow control valve and the directional control valve located at the end of the cylinder and exhausts to the atmosphere. When the cylinder retracts, the flow control valve at the end of the cylinder controls the flow, and the first valve allows air freely through.

Some cylinders have a cushion on one or both ends of travel. This cushion is a flow control valve that does not operate until the cylinder piston reaches a certain point in the cylinder. Then, the cushion restricts airflow to slow the cylinder movement. This allows it to move to the end of its travel at a slower speed. This adjustment is normally on the end of the cylinder head. See the air piping schematic to see what specific controls are provided with this equipment.

Because pneumatic systems always contain moisture from the air, the system should not be allowed to freeze. Freezing can damage the seals and control surfaces, allowing air leakage past valves, or locking a valve from operating.

Check valves may be inserted in the line to be sure the cylinder will stay in the desired position and not drift. This is useful in case some part is leaking, or there is a loss of air pressure in the plant system.

NEEDS FOR PNEUMATIC POWER

Pneumatic system use pressurized gases to transmit and control power as the name implies pneumatic systems typically use air as fluid medium because air is a safe, low cost and readily available fluid. It is particularly safe environments where an electrical spark could ignite leaks from the system components.
There are several reasons for considering the use of pneumatic system instead of hydraulic system liquid exhibit greater inertia than gases. Therefore in hydraulic system the weight of the oil is a potential problem. To design and development a material handling system for automation or semi automation of industries by using pneumatic control system which is used for low cost automation.

3.2 VALVES
SOLENOID VALVE
The directional valve is one of the important parts of a pneumatic system. Commonly known as DCV; this valve is used to control the direction of air flow in the pneumatic system. The directional valve does this by changing the position of its internal movable parts.

This valve was selected for speedy operation and to reduce the manual effort and also for the modification of the machine into automatic machine by means of using a solenoid valve.

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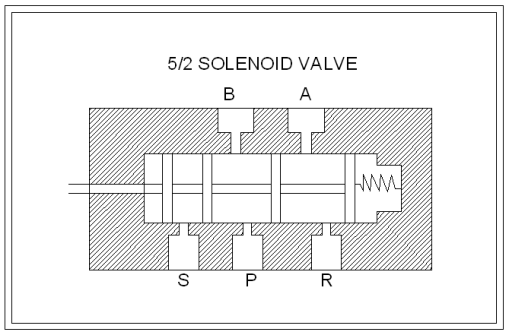
A solenoid is an electrical device that converts electrical energy into straight line motion and force. These are also used to operate a mechanical operation which in turn operates the valve mechanism. Solenoid is one is which the plunger is pulled when the solenoid is energized.

The name of the parts of the solenoid should be learned so that they can be recognized when called upon to make repairs,to do service work or to install them.



PARTS OF A SOLENOID VALVE

1. Coil

The solenoid coil is made of copper wire. The layers of wire are separated by insulating layer. The entire solenoid coil is covered with a varnish that is not affected by solvents, moisture, cutting oil or often fluids. Coils are rated in various voltages such as 115 volts AC,230volts AC,460volts Ac,575 Volts AC.6Volts DC,12Volts DC,
24 Volts DC,115 Volts DC &230Volts DC.they are designed for such
Frequencies as 50Hz to 60Hz.

2. Frame

The solenoid frame serves several purposes. Since it is made of laminated sheets, it is magnetized when the current passes through the coil. The magnetized coils attract the metal plunger to move. The frame has provisions for attaching the mounting. They are usually bolted or welded to the frame. The frame has provisions for receivers, the plunger. The wear strips are mounted to the solenoid frame, and are made of materials such as metal or impregnated less Fiber cloth

3. Solenoid plunger

The solenoid plunger is the mover mechanism of the solenoid. The plunger is made of steel laminations which are riveted together under high pressure, so that there will be no movement of the lamination with respect to one another. At the top of the plunger a pin hole is placed for making a connection to some device. The solenoid plunger is moved by a magnetic force in one direction and is usually returned by spring action.Solenoid operated valves are usually provided with cover either the solenoid or the entire valve. This protects the solenoid from dirt and other foreign matter, and protects the actuator. In many applications it is necessary to use explosion proof solenoids.

WORKING OF SOLENOID VALVE:

The solenoid valve has 5 openings. These ensure easy exhausting of 5/2Valve.the spool of the 5/2 valve slide inside the main bore according to spool position: the ports get connected and disconnected.
The working principle is as follows.

Position-1

When the spool is actuated towards outer direction port 'P' gets
Connected to 'B' and 'S' remains closed while 'A'gets connected to 'R'.

Position-2

When the spool is pushed in the inner direction port 'P' and 'A'
Gets connected to each other and 'B' to 'S' while port 'R'remains closed.

SOLINOID VALVE (OR) CUT OFF VALVE:

The control valve is used to control the flow direction is called cut off valve or solenoid valve. This solenoid cutoff valve is controlled by the electronic control unit. In our project separate solenoid valve is used for flow direction of vice cylinder. It is used to flow the air from compressor to the single acting cylinder.

3.2.2 Flow control valve:

In any fluid power circuit, flow control valve is used to control the speed of actuator. The flow control can be achieved by varying the area of flow through which the air in passing.
When area is increased, more quantity of air will be sent to actuator as a result its speed will increase. If the quantity of air entering into the actuator is reduced, the speed of the actuator is reduced.

3.2.3 Pressure control valve:

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The main function of the pressure control valve is to limit (or) Control the pressure required in a pneumatic circuit.
Depending upon the method of controlling they are classified as

1. Pressure relief valve
2. Pressure reducing valve

3.3.5 Hoses:
Hoses used in this pneumatic system are made up of polyurethane. These hose can with stand at a maximum pressure level of 10 $x10^5 N/m^{2.}$

3.3.6. Connectors:
In our system there are two type of connectors used. One is the
Hose connector and the other is the reducer. Hose connectors normally comprise an adopt hose nipple and cap nut. These types of connectors are made up of brass (or) aluminum (or) hardened pneumatic steel.

3.4 CONTROL UNIT:
The pneumatic jack machine. Air-operated device used for many small operations. It is a portable one. Compressed air is the source of energy for this device. The compressed air is allowed. Here the compressed air from the compressor firstly enters the Control unit. In the control unit the pressure of the air is controlled.

3.5 PRESSURE GAUGE:
Pressure gauges are usually fitted with the regulators. So the air Pressure adjusted in the regulator is indicated in the pressure Gauge, is the line pressure of the air taken to the cylinder. 3.6.JACK A jack is a mechanical device used as a lifting device to lift heavy loads or apply great forces. Jacks employ a screw thread or hydraulic cylinder to apply very high linear forces.
A mechanical jack is a device which lifts heavy equipment. The most common form is a car jack, floor jack or garage jack which lifts vehicles so that maintenance can be performed.
A pneumatic jack is a hydraulic jack that is actuated by compressed air - for example, air from a compressor - instead of human work. This eliminates the need for the user to actuate the hydraulic mechanism, saving effort and potentially increasing speed. Sometimes, such jacks are also able to be operated by the normal hydraulic actuation method, thereby retaining functionality, even if a source of compressed air is not available.

DESIGN OF EQUIPMENT AND DRAWING

4.1 **PNEUMATIC COMPONENTS AND ITS SPECIFICATION**

The pneumatic jack machine consists of the following components to full fill the requirements of complete operation of the machine.

1. Double acting pneumatic cylinder
2. Solenoid valve
3. Flow control valve
4. Connectors
5. Hoses

1. Double acting pneumatic cylinder:

Technical Data

Stroke length: cylinder stroke length 100mm =0.1m
Piston rod : 10mm =10 $X10^{-3}$m
Quantity : 1
Seals : Nitride (Buna-N) Eastover
End cones : Cast iron
Piston : EN-8
Media : Air
Temperature: 0-80°C
Pressure Range: $8N/m^2$

2. Solenoid Valve

Technical data

Size : $0.635x10^{-2}$m
Part size : $G0.635x10^{-2}$m
Maximum pressure: 0-10 $x10^5 N/m^2$
Range

Quantity: 1

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3. Flow control valve:

Technical data

Port size: 0.635 x 10^{-2} m
Pressure: 0-8 x10^5 N/m^2
Media : Air
Quantity: 1

4. Connectors

Technical data

Max working pressure : 10 x10^5 N/m^2
Temperature : 0-100°C
Fluid media :Air
Material :Brass

5. Hoses

Technical data

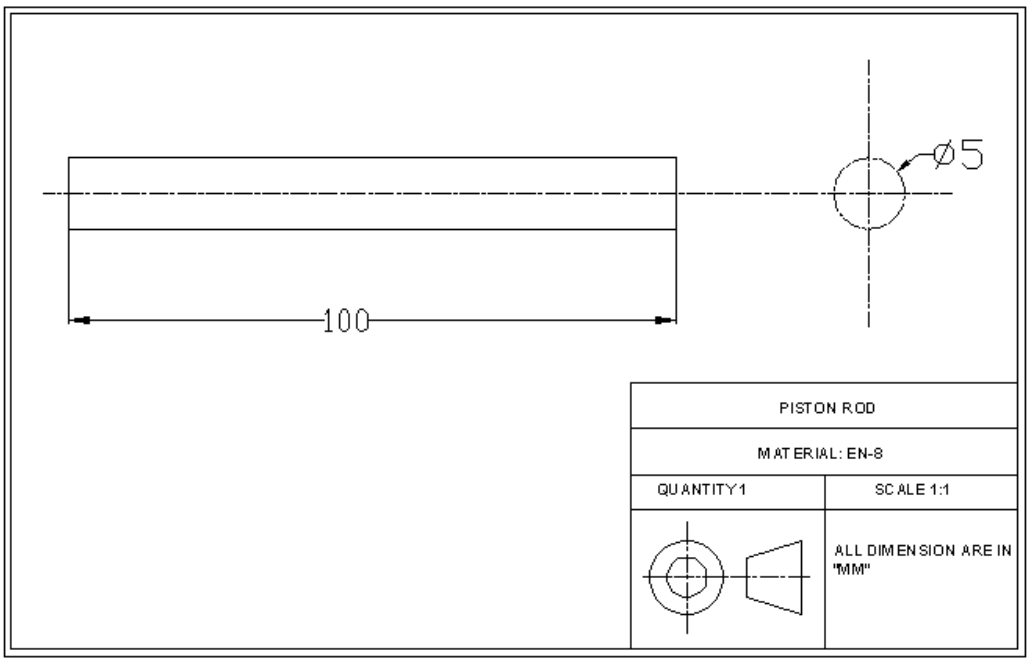
Max pressure : 10 x10^5 $_{N/m}{}^2$
Outer diameter : 6mm =6 x 10^{-3} m
Inner diameter : 3.5mm =3.5 x10^{-3}m

Pneumatic unit

Type of cylinder : Double acting cylinder
Type of valve : flow control valve &solenoid valve
Max air pressure : 8 x10^5 N/m^2

4.3 DESIGN CALCULATION

Max pressure applied in the cylinder (p) : 8 x10^5N/m^2
Area of cylinder (A) : (3.14/4*(D^2)
: 80.38mm^2
: 80.38 X $10^{-4}m^2$
Force exerted in the piston (F) : Pressures applied X area Of cylinder.



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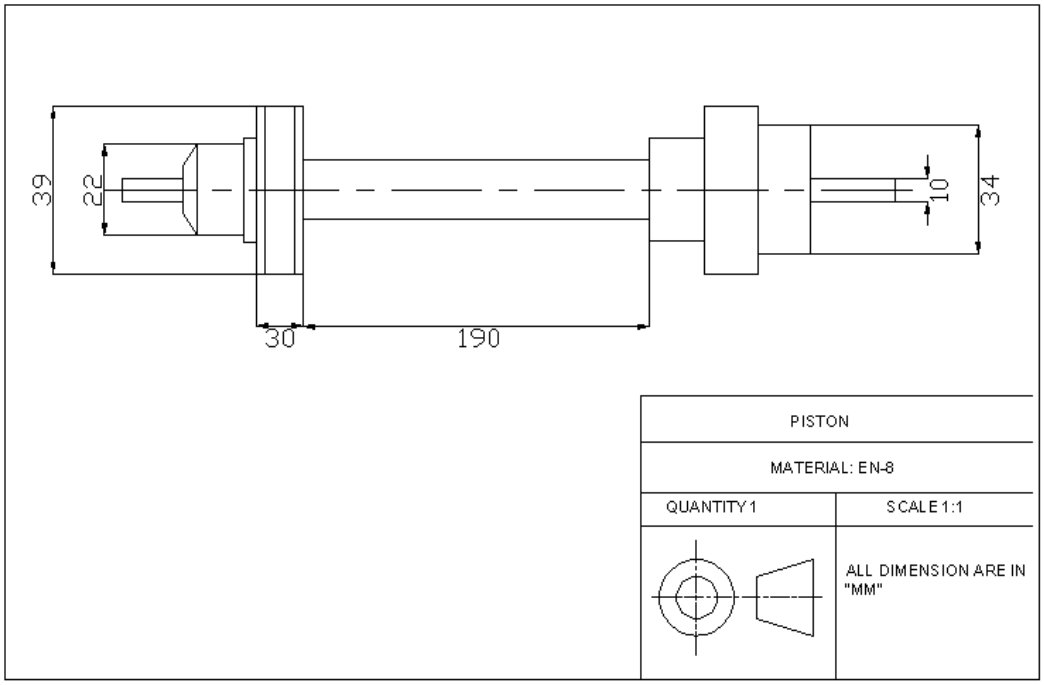
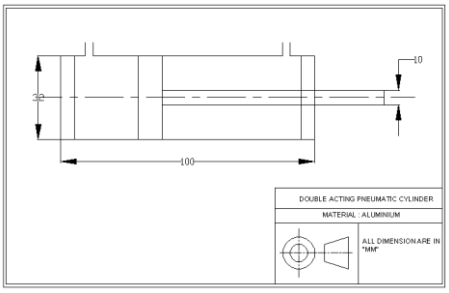
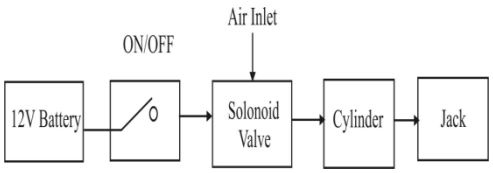
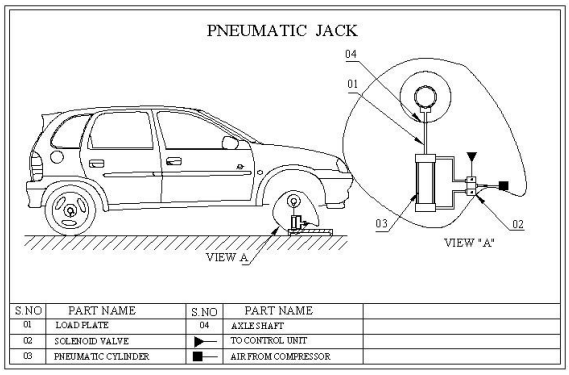




BLOCK DIAGRAM



FABRICATION OF PNEUMATIC JACK



METHOD OF FABRICATION:

Here the pneumatic jack is worked with the help of pneumatic power. The name of jack is "pneumatic jack" To carry the vehicle load for working in the automobile workshop and in the service station.

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WORKING PRINCIPLE

The working medium adopted is compressed air. The compressed air is transmitted through tubes to pneumatic cylinder where power is converted into reciprocating motion. The reciprocating motion is obtained by using an electrically controlled solenoid valve. The input to the solenoid valve is given through the control unit. The reciprocating motion transmitted to the jack through the piston which moves on the cylinder. The jack is placed under the vehicle chassis, where the vehicle to be lifted. The vehicle can be lifted when the solenoid valve is switched. The vehicle over the jack gets the reciprocating motion through the piston which is connected to the jack. Thus using a pneumatic jack the vehicle can be lifted with ease in operation.

- Power can be easily transmission
- Less loss in transmission
- A single compressor can supply power to many pneumatic Jacky.
- Low cost
- Easy to work and reduces the manual stress

DEMERITS

Need separate compressor.

APPLICATIONS

Used in automobile service stations and can also used in vehicles instead of screw jack.

FACTORS DETERMINING THE CHOICE OF MATERIALS

The various factors which determine the choice of material are discussed below.

1. **Properties:**

The material selected must posses the necessary properties for the proposed application. The various requirements to be satisfied

Can be weight, surface finish, rigidity, ability to withstand environmental attack from chemicals, service life, reliability etc.

The following four types of principle properties of materials decisively affect their selection

a. Physical
b. Mechanical
c. From manufacturing point of view
d. Chemical

The various physical properties concerned are melting point, thermal

Conductivity, specific heat, coefficient of thermal expansion, specific gravity, electrical conductivity, magnetic purposes etc.

The various Mechanical properties Concerned are strength in tensile,

Compressive shear, bending, torsional and buckling load, fatigue resistance, impact resistance, eleastic limit, endurance limit, and modulus of elasticity, hardness, wear resistance and sliding properties.

The various properties concerned from the manufacturing point of view are,

- Cast ability
- Weld ability
- Surface properties
- Shrinkage
- Deep drawing etc.

2. Manufacturing case:

Sometimes the demand for lowest possible manufacturing cost or surface qualities obtainable by the application of suitable coating substances may demand the use of special materials.

3. Quality Required:

This generally affects the manufacturing process and ultimately the material. For example, it would never be desirable to go casting of a less number of components which can be fabricated much more economically by welding or hand forging the steel.

4. Availability of Material:

Some materials may be scarce or in short supply.it then becomes obligatory for the designer to use some other material which though may not be a perfect substitute for the material designed.the delivery of materials and the delivery date of product should also be kept in mind.

5. Space consideration:

Sometimes high strength materials have to be selected because the forces involved are high and space limitations are there.

6. Cost:

As in any other problem, in selection of material the cost of material plays an important part and should not be ignored.

Some times factors like scrap utilization, appearance,and non-maintenance of the designed part are involved in the selection of proper materials.

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CONCLUSION

The project carried out by us made an impressing task in the field of automobile and automobile workshops. It is very usefully for the workers to work in the automobile workshop are in the service station.

This project has also reduced the cost involved in the concern. Project has been designed to perform the entire requirement task which has also been provided.

BIBLIGRAPHY

1. Design data book -P.S.G.Tech.
2. Pneumatic handbook -R.H.warrning
3. Machine tool design handbook –Central machine tool Institute, Bangalore.
4. Strength of Materials -R.S.Kurmi
5. Manufacturing Technology -M.Haslehurst.

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