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DEVELOPMENT AND EVALUATION OF AN EXHAUST AIR OPERATED VEHICLE JACK

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Abstract— **An air jack for use in raising vehicles from the ground comprising an exercise ball, a hose member which is adapted to connect the exhaust system of a vehicle to the exercise ball and a solenoid valve for preventing the release of exhaust gases, from the ball after it has been inflated. The jack uses pressure of exhaust air to lift the vehicle off the ground. .**

Index terms- **Exhaust gases, Exercise ball, Jack, Solenoid valve, PU pipe, Car.**

I. INTRODUCTION

A traditional vehicle jack is made up of screw thread configuration to reduce the force used to lift the vehicle which carries a great amount of weight. Instead of using manpower to lift the vehicle with the jack, here we use the pressure of the exhaust gas to lift the jack through an inflatable exercise ball using necessary pipes and fitting equipment to channel the gas into the ball so that the pressure of the exhaust gas can be effectively used for some useful work instead of being wasted to the atmosphere.

While making this jack it is of primary importance to keep the cost of the jack to a minimum value. The use of cheap everyday items like exercise ball, waste sink pipe, etc. will ensure that the cost of the working parts is low.

II. CURRENT TECHNOLOGY AVAILABLE

Different types of automotive jacks

- **Scissor Jacks** - A scissor jack is perhaps the most common type of jack we may have encountered as these jacks come with cars. They use a mechanical action to screw in the sides of the jack in a squeezing, "scissor" motion in order to raise the vehicle.

- **Hydraulic Jacks** (these include Floor Jacks and Bottle Jacks) - A hydraulic jack is mainly used in a garage or workshop than in the back of your car. This is mainly due to the large weight and size of these jacks. They are placed under the designated lift point of the vehicle, and the arm of the unit is pumped repeatedly.

- **Hi-lift Jacks** - also known as High Lift and Farm Jacks are versatile Jack when it comes to lifting, levering, or pulling. They are made of a pair of climbing pins that climb the height of the jack via a ratcheting action that is achieved by a manual pumping mechanism.

III. PRESENT WORK

In present, the exhaust air operated jack works on the principle that the exhaust gases are used to inflate an exercise ball to lift the vehicle off the ground for hassle-free changing of tyres.

To achieve this, the exercise ball is inflated by means of pneumatic pipes that attach the exercise ball to the muffler tip. A solenoid valve prevents the backflow of the exhaust gases.

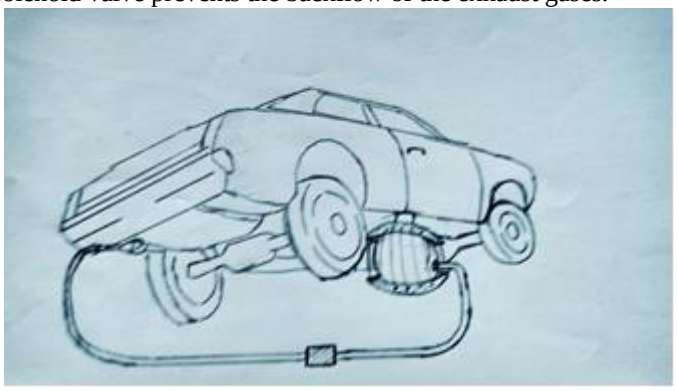

Figure 1: Final Arrangement of the Jack

Here, the aim is to harness the pressure energy of the exhaust gases to achieve some useful work (i.e. to lift the vehicle) instead of being wasted to the atmosphere.

IV. BLOCK DIAGRAM

The following block diagram gives a brief idea of how the exhaust air operated jack will work:

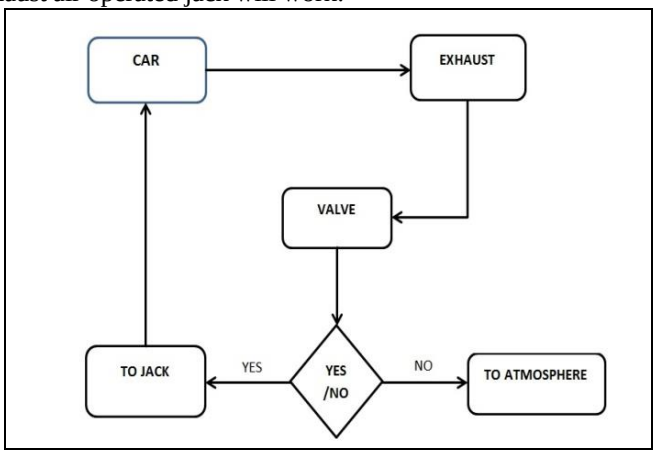

Figure 1: shows the block diagram of the jack

The block diagram gives basic idea that waste gases/exhaust gases from the muffler are used to inflate the exercise ball to lift the car. The flow of exhaust gases is unidirectional that allows quick inflation of the ball and for maintaining this unidirectional flow, a solenoid valve with a manual/automatic override is attached between the exercise ball and the connecting PU pipes.

V. COMPONENTS USED

The primary components of the exhaust air operated jack are as follows:

A. Exercise Ball

An exercise ball, also known as a Swiss Ball, has a diameter of approximately 35 to 85 centimeters (14 to 34 inches) and is filled with air. The air pressure is changed as required and either filling is done with air or the ball is allowed to deflate.

It can handle quite an amount of weight (around 200-250 kg) without failing.

B. Solenoid Valve

A solenoid valve is an electromechanically operated valve. The valve is controlled through an electric current in a solenoid: in case of a two-port valve, the flow is switched on or off; in case of a three-port valve, the flow is switched between the two of the outlet ports. The flow through a solenoid valve is mostly unidirectional.

C. PU (Polyurethane) pipes

To connect the valve, muffler tip, and the exercise ball together to sustain the flow of exhaust gases and to direct them to the exercise ball via the valve, high quality Polyurethane Pipes are used.

These pipes are manufactured to sustain high pressure fluids and are used to direct the flow of high pressure fluids in various pneumatic systems. They range is sizes from 6mm to 16mm (O.D.) and 4mm to 12mm (I.D.). They can sustain temperatures ranging from as low as -20°C to quite high as 70°C and can handle a pressure of about 10bar with a burst pressure of about 2Mpa.

D. AMC Male Connectors (12mm)

These are the push type connectors that have internal retractable teeth that can clench the pipes quite effectively and are used to connect the pipes to the solenoid valve effectively to prevent any leakage that may occur.

They are available in varying thread sizes and inner and outer diameters. They also come in various shapes like ‘T’, ‘Y Union’, and ‘Elbow’ to connect two, maybe three pipes to a valve assembly.

E. Waste Sink Pipe

To carry the exhaust gases from the muffler to the ball via the valve, a waste sink pipe has been used whose one end is attached to the muffler tip and the other end is connected to the valve that carries the exhaust gases to the ball through a network of PU pipes.

The pipe is made up of high quality PVC (Polyvinylchloride) that can sustain the temperature of the exhaust gases quite effectively.

F. Epoxy Adhesive (two component) –

To make the various connections sealed and air tight, an epoxy adhesive is used (here, ARALDITE). These systems consist of a resin and a hardener that can be formulated to offer a wide range of mechanical, thermal, optical and other properties.

While mix ratios differ, they all offer the ability to cure at ambient temperatures or at elevated temperatures for faster cures. Two component epoxies used as an adhesive, sealant, coating or potting compound for a huge variety of applications.

VI. SYSTEM DESCRIPTION

To provide a solid and stable foundation to the exercise ball for lifting the vehicle, a top and bottom spherical casing was fabricated from cast iron. The casing also protects the exercise ball form any potential damage in case it comes into contact with any sharp part under the car body.

The casing has a solid circular ring at the bottom for stabilizing the bottom case and a rectangular top protruding part to provide support for the weight of the car body. To provide protection to the ball from sharp circumferential cutting of the casing, a PU pipe is cut in half and pasted all along the circumference using an epoxy adhesive. The casing has holes drilled hole all over the edge of the circumference for the ropes to go in through to hold the two parts of casing together.

To connect the muffler tip to the valve via a pneumatic PU pipe, a waste sink pipe is used. The PU pipe connected to the waste sink pipe has its other end connected to the valve and all the connections are sealed and made air tight by applying a two component epoxy adhesive.

The final arrangement is made by winding the rope around the spherical caps including the exercise ball placed for the purpose of inflation. The pipe arrangement is connected to the ball and solenoid valve. The pipe arrangement from solenoid valve to the waste pipe is made to stay in place via a metallic clamp.

Figure 2.Final arrangement of the jack.

VII. COMPONENT DATA INTERPRETATION

The specification data of various components of the jack is discussed below:

Exercise Ball

- *Diameter: 85cms*
- *Material: PVC*
- *Pressure limit: 300lbs (approx.)*

PU (Polyurethane) Pipes

- *Diameter: 4mm to 12mm (I.D)*
  6mm to 16mm (OD)
- *Temp. Range: -20°C to 70°C*
- *Pressure: About 10 bar with a burst pressure of about 2MPa*

AMC Male Connector

- *Diameter: 12mm*
- *Shapes: 'T', 'Y Union', and 'Elbow'*

Waste Sink Pipe

- *Material: PVC (Polyvinylchloride)*

VIII. PERFORMANCE ANALYSIS

Following cars have been tested with the exhaust air operated jack and the height lifted with the time taken for the lift has been showed in the following table:

Car Model	*Ground Clearance (In mm)*	*Height Lifted (In mm)*	*Time (In Secs)*
Maruti 800	165	180-300	110-130
Alto 800	160	170- 285	140-180
Tata Nano	180	190-265	200-240

IX. BILL OF MATERIALS

The prime concern of the project was to keep the costs concerned to a minimum and to make the project feasible and at the same time, without any effect on the performance and the efficiency.

COMPONENTS USED	*QUANTITY*	*ESTIMATION OF COST (INR)*
Exercise Ball (85 cms.)	1	630
PU Pipe (dia. 4mm)	1	200
PU Pipe (dia. 5mm)	1	250
Akari 3/2 Solenoid Valve	1	700
AMC Male Connector (12mm)	2	100
Waste Pipe	1	100
Cast Iron spherical caps	2	50
Mild steel plate	1	50
Rope	1	20
Metallic strip	1	10
Araldite epoxy adhesive	1	95
Stainless steel pipe clamp	1	10
TOTAL COST		**2215**

X. RESULT

After carrying out the testing of the jack on various above mentioned vehicles, it was found that the jack performed quite effortlessly and there were no dangers involved.

XI. CONCLUSION

This project eliminates the manual stress and work that is involved in placing the jack under the specific jacking points and then lifting the jack to lift the vehicle. With further improvements, the jack can be made suitable for various needs and can be modified to handle heavy loads like that of an SUV, trucks, etc.

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