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Pneumatic Vehicle: Prototype that Function on Pneumatic System

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Abstract: Believe it or not, using compressed air to power vehicles is a real thing. This innovative concept, known as the "pneumatic vehicle," has captured the interest of researchers worldwide. It is hailed for its zero emissions and suitability for city driving. MDI is a company that holds the international patents for this technology. While it may appear to be an eco-friendly solution, the energy needed to compress air must be factored in when assessing its overall efficiency. Despite this, pneumatic vehicles offer promise in reducing urban air pollution over time. These vehicles, also referred to as air-powered or compressed air vehicles, represent a cutting-edge mode of transportation.

Keywords: Pneumatic, Actuator, Solenoid Valve, Cylinder.

1. INTRODUCTION

A pneumatic vehicle operates with the help of an engine that utilizes compressed or pressurised air stored in a tank. Unlike traditional vehicles that mix or combines fuel with air and flames it to power the engine, pneumatic vehicles utilize the pressurised air to drive the pistons. Using compressed or pressurised air for propulsion can be combined with battery electric propulsion in a hybrid system, known as hybrid or the combination of pneumatic and electric propulsion. Moreover, regenerative braking can be utilized alongside this system. Pneumatic cars use compressed air to move instead of gas, which helps reduce pollution and create an eco-friendlier transportation system. The goal of the project is to delve into the world of pneumatic vehicles, showcasing their benefits, obstacles, and possible uses. By conducting extensive research, creating designs, and testing them in experiments, we aim to create a model that proves the practicality and effectiveness of pneumatic vehicles in real-life situations. Pneumatic vehicles are an exciting and inventive form of transportation that uses compressed air for power. In contrast to typical vehicles that depend on gas or batteries, pneumatic vehicles make use of the stored energy in pressurized air to operate their parts and move forward. This

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special technology has many benefits including less carbon emissions, better energy efficiency, and possibly lower costs to run. Pneumatic vehicles use fluid dynamics and compressed air to work. They have a unique pneumatic engine that turns the stored energy of the compressed air into mechanical power. As the air expands, it pushes the engine parts, making them move in a specific way.

This paper has six sections, the literature review discusses about the basics requirements of the components and the factors required while making the vehicle prototype. Methodology sections explains the methods of vehicles movement or the working methods. The procedure sections give the steps of constructing the vehicle prototype. The results and discussions gives the brief description on the output given after the final testing and the future scope explains the future enhancement areas in the field of pneumatic vehicle prototype.

2. LITERATURE REVIEW

The Pneumatic vehicle is a technology progress that allows a car to be operate by compressed air as many ideas and the methods are being discussed below:

Venkatesh Boddapati [1] gives a statement that structures like the compressed air storage tanks to contain technologically advanced carbon fibres to bear high amount of pressure with occupying least volume space corresponding to the specific requirement with the conventional engines devoid of emissions.

S. S. Verma [2] provides a summary of the most recent advancements of a compressed-air vehicle as well as an introduction to many issues and their solutions for compressed-air vehicle technology. In the process of constructing the compressed air vehicle, management of the characteristics of compressed air such as temperature, energy density, input power needed, energy discharge and emission have to be handled if a safe, lightweight and affordable compressed air vehicle is to be manufactured in the near future.

Pramod Kumar [3] has converted the already existing conventional engine into an air powered one, this new technology is easy to adapt. Another benefit is that it uses air as fuel which is available abundantly in atmosphere.

Gopal Sahu [5] provides the idea about that Compressed air as a source of energy in different uses as a non-polluting fuel in compressed air vehicles has attracted the scientist and engineers throughout the centuries. Mentioning that Compressed air as a source of energy in different uses as a non-polluting fuel in compressed air vehicles is something that has captured the interest of scientists and engineers for centuries.

Saurabh Pathak [6] gives the idea about the application of pneumatic power. Pneumatic vehicle will replace the battery operated vehicles used in industries. Pneumatic powered vehicle requires very less time for refuelling as compared to battery operated vehicle.

A.A. Keste [4] he developed a system of double-acting slider-crank mechanism which changes the linear reciprocation of the cylinder piston rod into the oscillatory motion of the driving crank about the piston shaft.

B.R. Singh [7] have described the method in which the vehicle can run without the use of fossil fuels as a source to move the vehicle. He emphasizes on the compressed air driven engine which utilizes compressed air to trigger the engine. An engine is being designed to use the enormous potential of compressed air.

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Lukasz and Milewskia [8] proved that "compressed air powered cars are as viable as any other hybrid vehicles and automobiles that are solely run by electric power from hydrocarbon based fuel or lithium ion batteries." While these manners of energy conserving innovations have minimized battery weight, these electrical batteries weigh a lot and are expensive to replace after every few years with due consideration for environmental friendly disposal. In contrast the compressed air tank is sufficient throughout the lifetime of the car and it is safe even.
Ravi. D [10] Analysed for low carbon climate change and energy security, there is a need to reduce travel demand, shift the model of transport, and introduce technological innovation. One idea put forward by a series of press releases and demonstrations is that a car running from energy stored in compressed air produced by a compressor could feature as the future environmentally friendly vehicle. With respect to the thermodynamic efficiency of a compressed-air car powered by a pneumatic engine—considering the merits of compressed air over chemical storage of potential energy—a view under the most optimistic sets of assumptions should turn out to be very far less efficient than a battery electric vehicle. That generates more greenhouse gases than an ordinary, gas-fuelled car using a lot of coal. But a pneumatic-combustion hybrid does make some technological sense, is dirt cheap, and maybe — in time — it could even compete with the electric.
Creutzig [9] analysed ''the climate change and energy security call for a small decrease in travel demand, modal shift and technological advancement in the transport sector …" Basically, a car using energy stored in the form of compressed air produced by its compressor has been branded as an environmentally friendly transport vehicle of the future through a series of press releases accompanied by demonstrations.

3. METHODOLOGY

The "pneumatic vehicle" functions on basis of alternately power supply i.e. pressurised air to the solenoid valves. Solenoid valves helps to operate the double acting pneumatic actuator which will act as crank and connecting rod. The reciprocating motion of pneumatic cylinder will convert into rotary motion with the help of sprocket and chain which helps in rotating the wheels. So that, the constant motion of the car can be created. A pneumatic vehicle, also known as a pressurised air vehicle, which operates using compressed or pressurised air as the source of power for the generation or creation of motion.

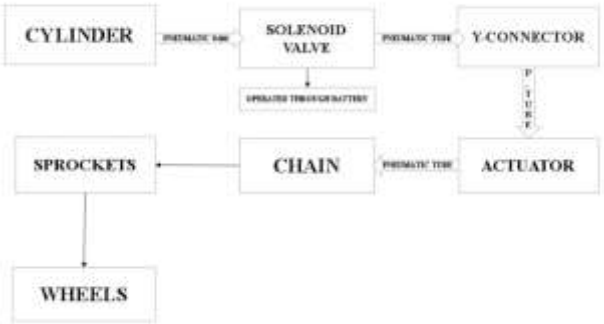

Fig3.1: Flow diagram of pneumatic vehicle

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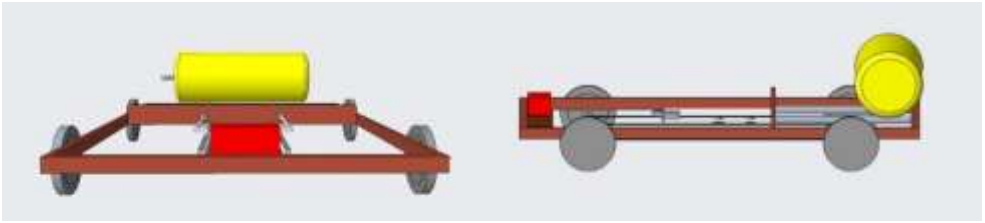

Fig3.2: Front View (3-D design) Fig3.3: Side View (3-D design)

3.1 Components and Specification

Sl.no	Components	Specifications
1	Pneumatic tube	Diameter 10 mm
2	Solenoid valve	5\2type
3	Chain	-
4	Sprockets	Inner diameter 35mm
5	Angle iron	Mild steel
6	Actuator	Stroke length 160mm
7	Y-connector	Inner diameter 10mm
8	Wheels	Diameter 130mm
9	Male connector	Inner diameter 10mm
10	Battery	12 volt
11	Switch	One way
12	Wire	Copper wire, Dia 0.5mm
13	Ball valve	3\8”
14	Tee	Steel, 3\8”
15	Pressure gauge	Measure pressure up to 200psi
16	Cylinder	LPG 5kg

Procedure

The procedure for making pneumatic vehicle is mentioned below:
Step1: Making frame for the prototype according to the requirement.
Step2: Placement of actuator and connecting with chains.
Step3: Working on transmission system (building 4wheel drive system so the power delivered to wheels gets evenly).
Step4: Creating a transmission through chain and sprocket while keeping in mind the diameter of the sprocket and the wheels.
Step4: Doing research on Solenoid Valve (working and function of the valve with the help of electrical connection).
Step5: Connection of solenoid valve to actuators with the help of Y-joint and pneumatic tubes.
Step6: Making a reservoir for compressed air using 5kg LPG cylinder.
Step7: Checking the necessary component functions properly or not on prototype (like: airflow, transmission, ground clearance, functioning of solenoid valve, wheel alignment etc.)
Step7: Testing the proper movement of vehicle prototype.

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Calculation

This calculation is done to find the amount of force exerted during the movement of actuator during the forward and backward movement at certain amount of pressure.

- Diameter of actuator:2cm
- Stroke length:160mm,16cm
- Stroke diameter:10mm,1cm

Therefore, 1kg=9.18N

1N=0.10197kg

So when,

Pressure=30psi,2.109kg\cm^2

For forward direction,

Force = Pressure x Area

= 2.109 x 3.14r^2

= 2.109 x 3.14(1^2)

= 6.625kg, 64.96N

For backward direction,

Force = P x A

= P x (Area of actuator – Area of stroke)

= 2.109 x (3.14 – 0.785)

= 2.109 x 2.355

= 4.966kg, 48.716N

When,

Pressure= 40psi, 2.812kg\cm^2

For forward direction,

Force = P x A

= 2.812 x 3.14

= 8.834kg, 86.66N

For backward direction,

Force = P x A

= 2.812 x 2.355

= 6.622kg, 64.96N

When,

Pressure = 50psi, 3.515kg\cm^2

For forward direction,

Force = P x A

= 3.515 x 3.14

= 11.042kg, 108.322N

For backward direction,

Force = P x A

= 3.515 x 2.355

= 8.277kg, 81.19N

When,

Pressure = 60psi, 4.218kg\cm^2

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For forward direction,
Force = P x A
= 4.218 x 3.14
= 13.25kg, 129.98N
For backward direction,
Force = P x A
= 4.128 x 2.355
= 9.933kg, 97.44N
When,
Pressure = 70psi, 4.921kg\cm^2
For forward direction,
Force = P x A
= 4.921 x 3.14
=15.459kg, 151.65N
For backward direction,
Force = P x A
= 4.921 x 2.355
= 11.58kg, 113.59N

4. RESULT AND DISCUSSION

The result got after experiment on the prototype was very fascinating. As it gives some valuable points that should be noted, got to know that the 5kg LPG cylinder can handle a minimum pressure up to 100psi and maximum up to 140psi and above, also can be used as reservoir for compressed air as shown in fig (5.1). After the successful experiment done as shown in fig (5.2) the ground clearance of 14mm was determined and also experienced the process of converting linear motion into rotatory motion.


Fig5.1: Reservoir


Fig5.2: Conduction of experiment


Fig5.3: Final product

Future Scope
For further development, the project can be developed as-
- The capacity of the cylinder can be changed.
- Compressor can be added.

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- Arduino can be used for the control system.
- Solar panel can be added to charge battery.

5. CONCLUSION

This prototype of pneumatic vehicle represents a significant achievement in the realm of innovative engineering and sustainable transportation solutions. In future, an alternative transportation solution has taken on more urgency as urban centres are struggling with the effects of congestion, pollution, and the challenge of growing population. In the coming generation using the concepts the commercial vehicle can be developed to travel short distances. Moreover, it has zero pollution and the low cost of assembly of the vehicle enhanced its affordability.

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6. REFERENCE

1. Venkatesh Boddapati, S.V.V.Vinod, M.Dora Babu, Air Powered Vehicle – An Eco-friendly Engine, International Journal of IT, Engineering and Applied Sciences Research (IJIEASR), Volume 4, No. 1, January 2015.
2. S. S. Verma, “Latest Developments of a Compressed Air Vehicle: A Status Report,” Vol. 13, Issue 1, Version 1.0, 2013.
3. Research Paper by Pramod Kumar J. ISSN: 0976-6359, March-April 2016, ‘AIR POWERED ENGINE’
4. “Vehicle Operating on Compressed Air by Inversion of Slider Crank Mechanism”; A.A. Keste, S.B. Vise, A.N. Adik, P.R. Borase; IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE); Year-2013.
5. Patel, Murlidhar, Prakash Kumar Sen, and Gopal Sahu. "INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY A REVIEW ON NOISE SOURCES AND METHODS OF REDUCTION OF NOISE IN DIESEL ENGINES."
6. “Compressed air vehicle: a review”; Saurabh Pathak, Kontham Swetha, V.Sreedhar, V.S.V Prabhakar; 4th IRF International Conference, Chennai; 9th March-2014.
7. Yadav, J. P., & Singh, B. R. (2011). Study and fabrication of compressed air engine. SAMRIDDHI: A Journal of Physical Sciences, Engineering and Technology, 2(01), 01-08.
8. Lukasz S, Jaroslav M. Dynamic analysis of compressed air energy storage in the car. JPowerT echnol. 2011;91(1):23-36.

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9. Creutzig F, Papson A, Schipper L, Kammen DM. Economic and environmental evaluation of compressed-air cars. Environ Res Lett. 2009;4(4).
10. Ravi D. Fabrication of compressed air engine. Middle East J Sci Res;20(9):1075-7.