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Design of Pneumatic Powered Bicycle

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***Abstract*: The world today heavily relies on fossil fuels for power consumption. Each and every day the demand keeps increasing but the supply is only available in a limited quantity. It is only a matter of time that fossil fuels will be completely used up and no longer available. Thus, a lot of research and experimentation is being done in various fields, which rely on fossil fuels, to come up with alternatives. Transportation is one area that uses a lot of fossil fuels and it needs to be addressed quickly. One area of interest is powering motorbikes using pneumatic systems. Pneumatic systems are those that work with pressurized air as their source of fuel. The objective of this paper is to design a pneumatic powered cylinder for bicycles. Contrary, to motorbikes the purpose is to get boosted power (thrust) only for limited period of time when required. Examples may include doing uphill cycling, carrying extra weight, closing in to the finishing line in racing, etc. The project mainly involves proper selection of air tank, pneumatic hose, and air regulator. The ultimate goal is to have a green environment by reducing emission gasses and reducing the reliance of fossil fuels.**

***Keywords*: Compressed air, cylinder, sprocket and key, pneumatic hose.**

1. Introduction

Fossil fuels meet most of the world's energy demand today, and they are being depleted rapidly. Their combustion leads to production of greenhouse gases which leads to climate change. Most of the transportation vehicles use fossil fuels as their primary source of energy. Eco–friendly commuting means such as bicycle requires us to do work to provide energy, and most of us don't want to reach our destination exhausted. In this paper, we will be modifying components so that they may fit a normal bicycle. Components such as an engine, air tank, pneumatic hose and regulator. Air tank will store the compressed air awaiting entry into the chamber of the air engine. The flow will be controlled via the regulator. The engine will utilize this pressurized air to produce the necessary power.

1) History

The first compressed-air vehicle was devised by Bompas, a patent for a locomotive being taken out in England in 1828. There were two storage tanks between the frames, with Conventional cylinders and cranks. It is not clear if it was actually built. (Knight, 1880). The first recorded compressed-air vehicle in France was built by the Frenchmen Andraud and Tessie of Motay in 1838. A car ran on a test track at Chaillot on the 9th July 1840, and worked well, but the idea was not pursued further. In 1848 Barin von Rathlen constructed a vehicle which was reported to have been driven from Putney to Wandsworth (London) at an average speed of 10 to 12 mph. At the end of 1855, a constructor called Julienne ran some sort of vehicle at Saint-Denis in France, driven by air at 25 atmospheres (350 psi), for it to be used in coal mines. Compressed air locomotives were used for haulage in 1874 while the Simplon tunnel was being dug. An advantage was that the cold exhaust air aided the ventilation of the tunnel. The compressed-air locos were soon withdrawn due to a number of accidents, possibly caused by icing in the pipes of the brakes, which were also worked by compressed air.

2) Objectives

The following are the objectives for the project:

- To design a pneumatic powered cylinder mechanism for a bicycle
- Designed to achieve a thrust when operated.

2. Literature Review

Hu C., Yu C. and Sung C. (2013) published an article, "Experimental Investigation on the Performance of a Compressed-Air Driven Piston Engine". In the article they discussed some of the short comings of the CAE, ranging from excess need of air flow to low performance in regard of speed. This pivoted us to make our engine an auxiliary unit on a bicycle.

Patnaik S. (2015). "Compressed air is kept under a pressure that is greater than atmospheric pressure. The Density of air is 1.126 Kg/m3 at 1 atm. (1.01325 bar).A compressed-air vehicle is powered by an air engine, using compressed air, which is stored in a tank. Instead of mixing fuel with air and burning it in the engine to drive pistons with hot expanding gases, compressed air vehicles (CAV) use the expansion of compressed air to drive their pistons. For example, the first mechanically-powered submarine, the 1863 Plongeur used a compressed air engine. The laws of physics that the gases will

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fill any given space. The easiest way to see this in action is to inflate a balloon. The elastic skin of the balloon holds the air tightly inside, but the moment you use a pin to create a hole in the balloon's surface, the air expands outward with so much energy that the balloon explodes. Compressing a gas into a small space is a way to store energy. When the gas expands again, that energy is released to do work. That's the basic principle behind what makes an air cargo".

Roy J. Meyers's Air Car. In 1930 The Science and Mechanics Journal published in its January issue an article called "Compressed Air Motor Runs Car". Roy J Meyers designed the car with four fuel tanks that will drive the car for 500 miles at a speed of 35 miles. The car had an electric heater running on a battery and generator to heat the air up 200 lbs pressure (13.79 bar). The engine resembled radial plane engine and took Mr. Meyers six years to develop.

Devashish Tiwari (2018), this paper explores the effective application of pneumatic power. Pneumatic vehicle will replace the battery operated vehicles used in industries. Pneumatic powered vehicle requires very less time for refueling as compared to battery operated vehicle.

3. Project Specifications

The pneumatic system can be implemented on any type of bicycle with only adjustments required for the stands. The specifications for the pneumatic system.

1) Parts Specifications Part

- *Sprocket*: Regular bicycle sprocket attached to the engine shaft
- *Hose Pneumatic*: Hoses used which work with pressurized air
- *Cylinder*: Container filled with pressurized air to be used as fuel
- *Regulator:* Used to control the pressure of the air that enters the engine
- *Clamp*: Used to hold the cylinder in place by clamping it with the bicycle frame
- *Stand:* Used to hold the engine in place behind the bicycle seat and is supported with vertical stands to hold the weight.

4. Analysis Procedure

1) Geometry

First generate the geometric model of the pneumatic powered bicycle parts from CATIA into Ansys software.

2) Define Materials

Define a library of materials for Analysis. In this Analysis of parts, selected materials as per requirements. These materials can be selected from the engineering data available in Ansys software.

3) Generate Mesh

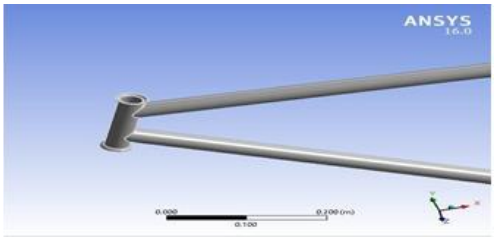
Now generate the mesh. This divides the drawing into finite number of pieces. It will show the number of nodes and elements present in the drawing after meshing is completed.

4) Apply Boundary conditions

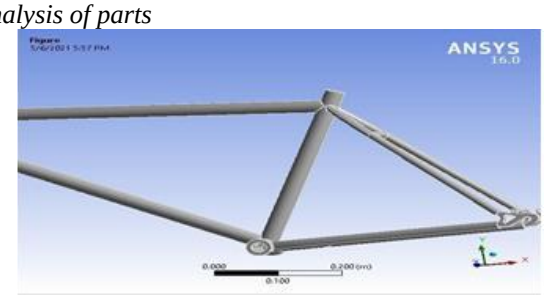
Simply supported boundary conditions are considered for the Parts. In this case both the ends of the parts are given fixed support and the load on the part is applied at the bottom leaf in upwards direction.

5) Obtain solution and generate results

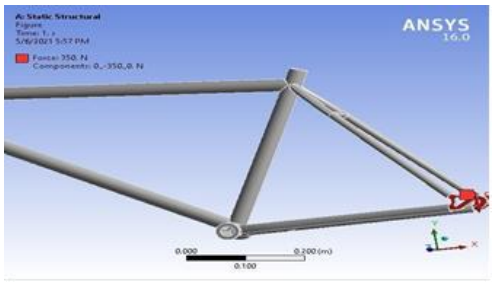
Now obtain the solution for the stress, deformation and elastic strain and generate the results.



6) Analysis of parts



By using ANSYS software Stress distribution of various parts of bicycle were found out. These Parts were:



CAD Model Assembly of Bicycle

7) Working of Model

The High Pressure (designed) air is filled inside a pressure tank /Air tank. This air is basically provides the driving force to the piston. Air from pressure tank is made to flow through 4 way 2 position pneumatic valve. This valve basically control the flow of High Pressure air to the cylinder. In one position it allows the high pressure air to flow on forward side of piston inside a cylinder while as air from back side is allowed to pass to atmosphere. Due to this piston travels from one end to

another piston which came to another end pushes the pneumatic valve to change its position due to change in position of valve now air flow goes to back side & pushes piston again to come to initial position. This movement of piston again releases the pneumatic valve to change its position and in this way piston movement of to & from is carried out. Piston rotates crank through connecting rod & power from this crank is given to wheel through belt or chain drive.

5. Conclusion and Future Scope

There is no fossil fuel being consumed and thus no harmful gases being exhausted. The implementation of the system on the bike is easy and can be done for any other type of bicycle. However, a few modifications would be required in order to accomplish that the design of this project mainly involved selection of the right components for the system. Going through the possible options, we opted for an engine to work as the core component. After acquiring the components, certain modifications were required in order for the system to work under pneumatic power. The engine was the one important component that required the correct modifications.

1) Future Scope

In future research, we can modify the structure and increase the velocity and load carrying capacity. And then increase the overall performance. A solar panel can be used for self-charging, gearing system can be added to control speed, and the braking system can be improved. Alternative for solenoid can be used to decrease battery usage.

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