VEHICLE OPERATING ON COMPRESSED AIR BY INVERSION OF SLIDER CRANK MECHANISM

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Abstract: This paper describes the working of a cycle which works on pneumatic power. A pneumatic cycle uses compressed air as a source of energy for locomotion. In this system a single acting pneumatic cylinder is operated as a slider crank mechanism which converts the linear reciprocation of the cylinder piston rod into oscillatory motion of the driver crank about the pinion shaft.. These stated problems in this paper are overcome by a pneumatically operated cycle which has low weight, takes less time for refueling and requires less maintenance. The Hybrid Bicycle can either be pedaled manually or be run on compressed air. Compressed air is used to turn the real wheel through a slider crank mechanism via a chain and sprocket. The actuation of the pneumatic piston used in the slider crank mechanism is controlled by a 5/2 pneumatic directional control valve which in turn is actuated by a push button through cam and follower arrangement connected to the crankshaft. This ensures that the pneumatic piston expands for half the revolution and contracts for the other half. A push button valve actuates this mechanism and a flow control valve is used for speed control.

Key Words: Pneumatic Cylinder, Sprocket, Solenoid Valve, Pressure Gauge, Slider Crank Mechanism

INTRODUCTION

The first compressed air vehicle was established in France by a Polish engineer Louis Mekarski in 1870. It was patented in 1872 and 1873 and was tested in Paris in 1876. The working principle of Mekarski's engine was the use of energy stored in compressed air to increase gas enthalpy of hot water when it is passed through hot water. Another application of the compressed air to drive vehicles comes from Uruguay in 1984, where Armando Regusci has been involved in constructing these machines. Light weight vehicles are the next advancement in the development of automobiles. Reducing the weight of the vehicle has many advantages as it increases the overall efficiency of the vehicle, helps in improving maneuverability, requires less energy to stop and run the vehicle. The latest researches are going on around the world in order to come up with innovative ideas. But global warming is also one of the problems which is affecting the man. The temperature of the earth is increasing drastically and this in turn is causing climatic changes. The fossil fuels are widely used as a source of energy in various different fields like power plants, internal & external combustion engines, as heat source in manufacturing industries, etc. But its

stock is very limited and due to this tremendous use, fossil fuels are diminishing at faster rate. So, in this world of energy crisis, it is necessary to develop alternative technologies to use renewable energy sources, so that fossil fuels can be conserved. One of the major source of the pollution is the smoke coming out from the automobiles. So an alternative way of producing the running the vehicle must be made so that we can prevent further damage to the earth. The alternative sources of energy availableare solar, electric, atmospheric air etc. Air acts like a blanket for the earth. It is the mixture of gasses, which makes it neutral and non-polluting. It has the property to get compressed to a very high pressure and retain it for a long period of time. It is cheap and can be found abundantly in the atmosphere. So it can be used as an alternative fuel for the automobiles. Much research is going on in this field and scientists are trying to improve the effectiveness of this technology. It is experimentally found that the efficiency of the vehicle ranges from 72-95%. So this can be considered as one of the preferable choices to run the vehicle.

It is hard to believe that compressed air can be used to drive vehicles. However that is true and "air bicycle" as it popularly knows has caught the attention of research worldwide. It has zero emission and is ideal for city driving condition. This review study reveals aim is to run the bicycle with help of compressed air, it will try to achieve a 20 km/h speed and range of refilling compressed air is after running of 10-15 km.

THE HISTORY OF COMPRESSED AIR VEHICLES

- 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.
- Louis Mékarski built a standard gauge self-contained tramcar which was tested in February 1876 on the Courbevoie-Etoile Line of the Paris Tramways Nord (TN), where it much impressed the current president and minister of transport Maréchal de MacMahon. The tramcar was also shown at the exhibition of 1878 as it seemed to be an ideal transport method, quiet, smooth, without smoke, fire or the possibility of boiler explosion.
- 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.

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OBJECTIVE

This thesis is based on a research project started in the beginning of 2006. The research in this work was conducted in close cooperation with Cargine AB, the company developing the pneumatic valve actuating system used in the project. The objective of the project is to study the new pneumatic hybrid concept and its different modes of engine operation. During the first two years of the project fundamental engine experiments were conducted in order to increase the understanding of the operating principle of the different engine modes associated with pneumatic hybridization and the parameters affecting their performance. It was soon realized that an engine model was necessary in order to understand the phenomena that control the pneumatic hybrid. The last couple of years of the project were mainly devoted to modeling of both a pneumatic hybrid engine and a pneumatic hybrid vehicle. The objective was to more thoroughly investigate the different parameters affecting the pneumatic hybrid engine performance and to examine the potential of reduction in fuel consumption for a pneumatic hybrid vehicle.

METHODOLOGY

For the project summarized in this thesis an approach of both experimental and theoretical nature was chosen. During the first two years of the project, extensive experimental research was conducted with the aim to investigate the feasibility of the pneumatic hybrid concept. The second half of the project was mainly devoted to development of models based on results from engine experimental data. The order of the work conducted in the project, first experiments then modeling, was determined based on the fact that studies done by other researchers until the start of the project were of theoretical nature. Therefore, as a proof of concept it was determined to be more appropriate to start with studies based on experiments and then use the knowledge gained from these experiments in order to develop more realistic models.

COMPONENTS

1.PNEUMATIC PISTON

Pneumatic actuators are the devices used for converting pressure energy of compressed air into the mechanical energy to perform useful work. In other words, Actuators are used to perform the task of exerting the required force at the end of the stroke or used to create displacement by the movement of the piston. The pressurised air from the compressor is supplied to reservoir. The pressurized air from storage is supplied to pneumatic actuator to do work.

2.THE SOLENOID VALVE

A solenoid valve is an electro mechanical valve for use with liquid or gas. The valve is controlled by an electric current through a solenoid coil. Solenoid valves are the most frequently used control elements in fluidics. Their tasks are to shut off, release, dose, distribute or mix fluids. They are found in many application areas. For controlling the air flow in and out of the engine we use a 3/2 pilot operated normally closed valve.

The specifications of the valve are the following:

- Orifice: 12mm.
- Operating pressure range: 2-10bar
- Flow rate: 3000Litres/minute
- Coil width: 32mm.
- Voltage: 24V DC
- Duty cycle: Continuous

The construction and the working of the 3/2 solenoid valve can be explained with the help of the following diagram:

The figure shows the operation of a pilot operated 3/2 pneumatic valve. The solenoid operates the small pilot valve directly. Because this valve has a small area, a low operating force is requires. The pilot valve applies line pressure to the top of the control valve causing it to move down, closing the exhaust port. When it contacts the main valve disc there are two forces acting on the valve stem. The pilot valve applies a downwards force of P×D, where P is the line pressure and D is the area of the control valve. Line pressure also applies an upwards force P×E to the stem, where E is the area of the main valve. The area of the control valve, D, is greater

than area of the main valve E, so the downwards force is the larger and the valve opens. When the solenoid de-energizes, the space above the control valve is vented. Line and spring pressure on the main valve causes the valve stem to rise again.

3.SPROCKETS

A sprocket is a profiled wheel with teeth, cogs, or even sprockets that mesh with a chain, track or other perforated or indented material. The name 'sprocket' applies generally to any wheel upon which radial projections engage a chain passing over it. It is distinguished from a gear in that sprockets are never meshed together directly, and differs from a pulley in that sprockets have teeth and pulleys are smooth.

4.PRESSURE GUAGE SYSYEM

The pressure gauges are used to measure or display the pressure at the position at which the pressure gauge is installed. There are different ranges of the pressure gauges.0 to10 bar pressure gauges are used in this project. A “T”shaped female connector is used to install the pressure gauges in the system and it also holds the pressure gauge at position.

5.PUSH BUTTON

A push-button is a simple switch mechanism for controlling the flow of compressed air. Buttons are typically made out of hard material, usually plastic or metal. The surface is usually flat or shaped to accommodate the human finger or hand, so as to be easily depressed or pushed. Buttons are most often biased switches, though even many un-biased buttons (due to their physical nature) require a spring to return to their un-pushed state.

6.AIR TUBES AND CONNECTORS

The air tubes is used to connect the components involved in the passage of compressed air . It is used to connect the cylinder to solenoid valve and the solenoid valve to cylindrical head. Connectors are used to connect the pipes with the components used in the project . The type of connectors used is one touch male connector which has an internal socket,the specification of the thread is BSPTR1/2. the outer diameter is 21.5mm and inner diameter is 12mm

WORKING

Pneumatic cylinders are mechanical devices which use the power of compressed air to produce a force in a reciprocating linear motion or cylinders which converts pneumatic power into mechanical power. Compressed air forces the piston to move in the desired direction. During the initial pedaling of the cycle, flywheel rotates which is connected to pneumatic cylinder. The pneumatic cylinders are used for filling the compressed air in tank. An air valve with start button is provided that when opened gives high pressure air to crank mechanism. The compressed air having high pressure drives the piston forward and backward and this motion is transferred to flywheel and the cycle moves forward. The flywheel rotates continuously and stop valve is used for stopping the cycle where we need .

SLIDER CRANK MECHANISM

The Slider-crank mechanism is used to transform rotational motion into translational motion by means of a rotating driving beam, a connection rod and a sliding body. In the present example, a flexible body is used for the connection rod. The sliding mass is not allowed to rotate and three revolute joints are used to connect the bodies. While each body has six degrees of freedom in space, the kinematical conditions lead to one degree of freedom for the whole system.A slider crank mechanism converts circular motion of the crank into linear motion of the slider. In order for the crank to rotate fully the condition L> R+E must be satisfied where R is the crank length, L is the length of the link connecting crank and slider and E is the offset of slider . A slider crank is a RRRP type of mechanism i.e. It has three revolute joints and 1 prismatic joint. The total distance covered by the slider between its two extreme positions is called the path length. Kinematic inversion of slier crank mechanisms produce ordinary an white work quick return mechanism.

CONCLUSION

The technology of compressed air vehicles is not new. In fact, it has been around for years. Compressed air technology allows engines that are both nonpolluting and economical. This paper explores the effective application of pneumatic power. Pneumatic vehicle will replace the battery operated vehicles used in industries. Pneumatic powered cycle requires very less time for refueling as compared to battery operated vehicle. This is totally clean, light weight, can work in hazardous environment and requires less maintenance.

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