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Design and Fabrication of Compressed Air Vehicle

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Abstract:

Compressed air as a source of energy in different uses in general and as a nonpolluting fuel in compressed air vehicles has attracted scientists and engineers for centuries. Efforts are being made by many developers and manufacturers to master the compressed air vehicle technology in all respects for its earliest use by the mankind. The present paper gives a brief description of how a compressed air vehicle using this technology was made. While developing of this vehicle, control of compressed air parameters like temperature, energy density, requirement of input power, energy release and emission control have to be mastered for the development of a safe, light and cost effective compressed air vehicle in near future.

Keywords:

compressed air vehicle, technological trends, energy input, energy released, emission control, storage & fueling, temperature.

INTRODUCTION:

A compressed-air engine is a pneumatic actuator that creates useful work by expanding the compressed air and converting the potential energy into motion. (A pneumatic actuator is a device that converts energy into motion.) The motion can be rotary or linear, depending on the type of actuator. Compressed Air Engine (CAE) are fueled by compressed air, which is stored in a tank at a high pressure. A Compressed Air Vehicle (CAV) uses this compressed-air engine as its mechanism for propulsion. . Compressed air vehicle project in the form of light utility vehicle (LUV) (i.e., air car in particular) has been a topic of great interest for the last decade and many theoretical and experimental investigations The difference between the compressed air engine and IC engine is that instead of mixing fuel with air and burning it to drive pistons with hot expanding gases, CAE's use the expansion of previously compressed air to drive their pistons.The greatest advantages of compressed air vehicle are, no burning process and no waste gas discharge to the surrounding environment. It can be said as a green environmental protection vehicle with near zero pollution in the metropolitan cities.

With the policy of energy conservation and environment protection. The engines of compressed air cars are piston type, vane type, rotary type and the piston engine. At present, the piston engine power system has some disadvantages such as complex structure, easy wearing, high noise and low efficiency. Therefore, to develop and optimize engine power system is the key technique for compressed air vehicles.

HISTORY:

The first air powered vehicles were actually trains. The Mekarski air engine, the Robert Hardie air engine and the Hoadley-Knight pneumatic system were used in the 1800's to power locomotives.In 1925, an article appeared in the Decatur Review about a man named Louis C. Kiser who converted his gasoline powered car to run on air. Lee Barton Williams in 1926 claimed to have invented the first air car.

Williams was from Pittsburg and claimed the car started on gasoline but after 10 mph it switched to compressed air only.In 1931, the Hope Star of Hope, Arkansas ran an article about Roy J. Meyers of Los Angeles inventing the first air car.In 2007, Tata Motors introduced the MDI CityCat developed by Guy Nègre as the first commercial air car. As of 2009, two more models of MDI air cars have been showcased.

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Fig: Air car by H. K. Porter Company in 18th century

WORKING:

This engine works like a diesel engine. At the end of compression stroke, a very high-pressure air at room temperature is injected into the cylinder. Injection of air by electro-mechanical injection.System is governed by the cam dwell during which the piston also dwells. As the in cylinder hot and compressed air mixes with the externally injected relatively cold and compressed air, injected at relatively higher pressure than the inside pressure, the mixture tries to attain a common equilibrium temperature. As the temperature of this mixture falls down, expansion takes place.The high inside mixture pressure imparts a very heavy blow on the head of the piston, which is then set in motion and the engine runs. No combustion takes place; it is the expansive forces, which make the engine run shows the block diagram of the engine.

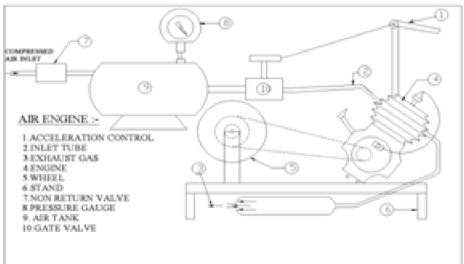

Fig: Block Diagram

The laws of physics dictate that uncontained gases will 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 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 car move.

The first air cars will have air compressors built into them. After a brisk drive, you'll be able to take the car home, put it into the garage and plug in the compressor. The compressor will use air from around the car to refill the compressed air tank. Unfortunately, this is a rather slow method of re-fuelling and will probably take up two hours for complete refill. If the idea of an air car catches on, air re- fuelling stations will become available at ordinary gas stations, where the tank can be refilled much more rapidly with air that's already been compressed. Filling your tank at the pump will probably take about three minutes.

This air car will almost certainly use the Compressed Air Motor (CAM). Air cars using this engine will have tanks that will probably hold about 78 liters of compressed air. The vehicle's accelerator operates valve on its tank that allows air to be released into a pipe and then into the motor, where the pressure of the air's expansion will push against the vanes and turn the rotor. This will produced enough power for speeds of about 15-20 kilometers per hour.

Type of vehicle/powertrain	Fuel economy (mpg equivalent)	Range	Production Cost for given range	Reduction in CO2 compared to conventional
Conventional ICE	10-78 Long	(400-600 mi)	Low	0%
Biodiesel	18-71 Long	(360-540 mi)	Low	100%
All-electric	battery	Shorter (73-150 mi)	High	varies
Compressed air	30-60	380 mi	Medium	100 %

Table: comparative study with existing kind and C.A.V

Particulars of components used in this vehicle:

•6mm, 8mm, 10mm bolts for brake, seat and angular fixtures.

•Grinding and metal cutting for minor parts are done using a portable grinding machine.

•6mm drills with a hand drill, 8mm and 10mm drills with an upright drilling machine.

• Wheel rim dia. : 280mm.

• Wheel dia. : 380mm.

• Wheel width : 75mm.

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- Front track length : 1070mm.
- Ground clearance : 280mm.
- Tank thickness : 3mm.
- Bearing OD : 35mm.
- Bearing : 15mm.
- Bearing thickness : 10mm
- Over-all length : 2340mm.
- Over-all height : 1060mm.
- Over-all width : 1290mm.

Power specification of designed C.A.V:

It takes minimalist power in making the transport possible in doing that we found the following data to not only power up our vehicle but also to achieve a target to cut down travel to make the vehicle affordable by everyone.

Input power consumption	79.2 Watts
Time of filling(for 2 cylinders)	6 minutes
Cost of filling(@unit charge 5/-)	Rs. 0.32
Air consumption	340 l/min
Cylinder storing pressure	11.03bar
Working pressure	6.2bar
Cylinder storing capacity each	38lts
Output power	2.169 kW

Fig: Details of CAV

FABRICATION

Chassis is made by arc welding at various sections for the Rectangular cross sections. It includes:

- Lap joint welds
- Butt welds
- T joint welds

The end joints re butt welded and some internal angular sections are lap welded. The steering column support is given by welding a hollow shaft with a T weld to the front frame of the chassis.

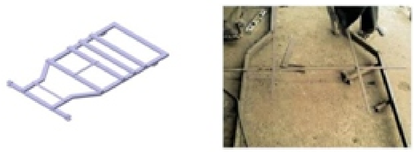

Fig: Designed and fabricated chassis of the CAV

The steering of a vehicle is so arranged that the front wheels will roll truly without any lateral slip. The function of the steering system is to convert the rotary movement of the steering wheel into angular turn of the front wheels. To keep effective control on the moving vehicle throughout its range of speed irrespective of the load and road conditions.The steering system of a vehicle should fulfill the following requirements:

1. It should multiply the effort applied on the steering wheel by the drivers.

2. The mechanism should have self-adjusting effect so thatwhen the driver releases the steering wheel after negotiating the turn, the wheel should try to achieve straight ahead position.

3. It should not transmit road shocks to steering wheel.

TIMING GEAR MODIFICATION:

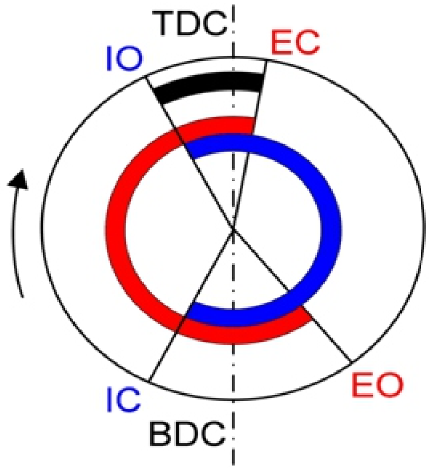

Fig: Valve timing diagram

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Valve timing is as follows:

Inlet valve open: 10 degrees before TDC Exhaust valve open: 20 degrees before BDC Inlet valve close: 10 degrees after BDC Exhaust valve close: 5 degrees after TDC Pressure of compressed air: 150 Psi
RPM of crankshaft: 650-700 RPM

PROBLEMS FACED DURING DESIGNING

• Availability of components of desired specification in market as per the design.

• To vary the output speed.

• To prevent the air leakage.

SOLUTIONS ADAPTED

• As per market survey conducted by us we have selected the components with nearest possible specifications as per our design to get the desired power.

• With the use of air tight joints formed by the connectors we prevent the leakage of air.

Applications

(a) Mopeds

• Jem Stansfield, an English inventor has been able to convert a regular scooter to a compressed air moped. This has been done by equipping the scooter with a compressed air engine and air tank.

(b) Buses and Locomotives

• MDI makes Multi CATs vehicle that can be used as buses or trucks. RATP has also already expressed an interest in the compressed-air pollution-free bus.

ADVANTAGES:

1.Major advantage of using compressed engine is that a pure compressed air vehicle produces no pollution at the tailpipe.
2. Use of renewable fuel.
3.Compressed-air technology reduces the cost of vehicle production by about 20%, because there is no need to build a cooling system, fuel tank, Ignition Systems or silencers.
4. Air, on its own, is non-flammable.
5.The engine can be massively reduced in size.
6.Low manufacture and maintenance costs as well as easy maintenance.
7.The air tank may be refilled more often and in less time than batteries can be recharged, with re- filling rates comparable to liquid fuels.
8.Lighter vehicles cause less damage to roads, resulting in lower maintenance cost.
9.The price of filling air powered vehicles is significantly cheaper than petrol, diesel or biofuel. If electricity is cheap, then compressing air will also be relatively cheap.

CONCLUSION:

The model designed by us is a small scale working model of the compressed air engine. When scaled to higher level it can be used for driving automobiles independently or combined (hybrid) with other engines like I.C. engines. The technology of compressed air vehicles is not new.

Compressed air technology allows for engine that are both non-polluting and economical. After ten years of research and development, the compressed air vehicle will be introduced worldwide. Unlike electric or hydrogen powered vehicles, compressed air vehicles are not expensive and do not have a limited driving range.

Compressed air vehicles are affordable and have a performance rate that stands up to current standards. To summit up, they are non-expensive cars that do not pollute and are easy to get around in cities. The emission benefits of introducing this zero emission technology are obvious At the same time the well to wheels efficiency of these vehicles need to be improved.

This is a revolutionary car which is not only eco- friendly, pollution free, but also very economical. This addresses both the problems of fuel crises and pollution. However excessive research is needed to completely provethe technology for both its commercial and technical viability.

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Fig: Compressed Air Vehicle

FUTURE SCOPE:

Compressed air vehicles are our near future and advancements in the presented project can be taken up by doing some ideal methods like:

1.Inserting an intermediate compressor after the gas exits the engine and compress the air again to the reservoirs.

2.Making a hybrid engine comprised of multiple ways of powering up the vehicle like gasoline and compressed air; electric and compressed air; re- cyclic modules etc.

3.Making the chassis light weight by selecting proper materials can also greatly affect the efficiency of the CAV.

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