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CONSTRUCTION AND TESTING OF COMPRESSED AIR VEHICLE

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CHAPTER – 1

INTRODUCTION

1. INTRODUCTION

Development of new technologies in the field of locomotion in automobiles is crucial in the quest to find new ways to make a vehicle perform. The current state of automobiles requires combustion of fossil fuels such as petrol, diesel, etc. to make the pistons move. Earth faces a difficult time ahead. With the fast depleting natural resources like coal and fossil fuels, we shall face a shortage of fuels very soon. Thus, the trips and tours that we take now days so conveniently shall not be possible any more. The fuel prices shall rise so fast that common people could not afford them anymore. That is why there is dire need of an alternate source of fuel.

With the help of this project we, are going to demonstrate that air can be successfully used as an alternative to the traditional fossil fuels, which are petrol diesel and CNG. Air is the most abundant resource that is available to us and can be used without the fear of being depleted.

Air has the property of being highly compressible. Hence, we can compress large quantity of air into a small space and hence use the energy stored in the tanks over time to help commute from one place to another. Another good advantage of compressed air is that it is not flammable.

1.1 GOALS AND OBJECTIVES

Project work was targeted to design and develop a vehicle that would run on compressed air and keep costs down while also having zero emissions.

What we achieved?

After completion of development and assembly phase we have a three-wheeler compressed air vehicle which can be used to as a means of transportation while expelling no harmful gases into the atmosphere and keeping costs of making and Fueling significantly low. This car is totally eco friend ly and Effective method with reduced price tag. It is very easy to manage and repair. Also the runni ng cost of the vehicle is very less. The car is non flammable because there is no combustion taking place in the cylinder of the engine. Also the cost of manufacturing is very low.

Motivation: Why this project was undertaken?

The current situation of usage fossil fuels for vehicle to perform is one that would not be able to sustain in the coming years. In order to find a solution that is both cheap and eco-friendly we need to start changing our approach of looking at the immediate alternative and start implementing new technologies to test their viability and figure out which one can last for long-term application. There is barely air to breathe and we have already polluted a major amount of air so in this 21st Century we must come up with alternatives and better ideas to not pollute the air and also enjoy the travelling process.

It is worldwide burning problem to find out best alternatives of fuel oil & to make sustainable energy future. The current study made in the year 2004, predicts that if the oil is consumed at the current rates, then by 2020, we will be consuming 80% of the entire available resource. This necessitates the search for alternative of oil as energy source or preserving it by tapping some other alternatives such as non-conventional energy sources, battery operated vehicles, photocells etc. and to convert their output into mechanical energy, which may alternatively preserve oil source. The worldwide researches are also going on for other alternatives such as use of Hydrogen Fuel Cell (which is presently very costly), use of bio-diesel or use of compressed air vehicle engines which may be made of light material.

Method: How it was carried out?

Firstly, the vehicle was designed and the list of components and raw material was crafted for the compressed air vehicle and the costing was estimated. Once these processed were concluded, the components and raw materials were purchased in order of requirement to prepare a working model of the same.

1.2 OVERVIEW OF THE TECHNICAL AREA

For evaluating the performance of the vehicle, various parameters will be taken into account. Efficiency while low will fulfill to prove that such a technology is indeed viable. Approach for this project was simple but also technical. The vehicle would use simple parts and work on the principle s we learn in thermodynamics. The difference would be that instead of fuel having to be combusted and the making the engine run, we will use compressed air that would make the pistons move the same way as combustion would.

Figure: Model in development phase

The effect would be the same but instead of harmful gases such as CO and Co2 being released on the environment from the exhaust as a byproduct, our vehicle would just expel the same air that was used to run it. Zero emission was the main ideology kept in mind and that is what we have been able to accomplish.

1.3 OVERVIEW OF THIS PROJECT

The developed compressed air vehicle will be helpful in testing various parameters related to alternative sources of fuel in vehicles taking pollution and efficiency factors into account. Also, through surveying done on various materials that would be used in the final model helped in keeping the total weight of the vehicle low and total cost of construction were also kept within economic estimates that were made during the project's inception.

Main aim of present research work is to design Compressed Air Engine and develop it for functional use in a 3 wheeled car. It shall require design and development of an engine which can run on compressed air and convert compressed air energy to shaft work for producing adequate torque. This will definitely be zero pollution / emission free air engine. Air is a natural resource that can be compressed at filling stations and cylinders of smaller size with lightweight can be filled at filling stations. The concept of micro or mini compressed air engine can be one of the best alternatives for light vehicles, if it runs using air alone and thus causing no pollution.

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CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

Literature review plays a crucial role in laying down the groundwork for further development in the field of science and technology. Research publications available in the field of compressed air vehicle – its development, application and implementation were studied.

In the project, running of a single 4 stroke engine by a compressed gas, one of the basic requirement was to modify a 4 stroke engine in such a way that instead of mixing of fuel with air and burning it in the engine to drive a piston with hot expanding gases. It will use the expansion of air to move the piston. In it there is no combustion held in engine therefore there will be no pollution in exhaust.

The effects of inhaling particulate matter have been studied in humans and animals and include asthma, lung cancer, cardiovascular issues, and premature death. There are, however, some additional products of the combustion process that include nitrogen oxides and sulphur and some uncombusted hydrocarbons, depending on the operating conditions and the fuel-air ratio. PM, carbon monoxide, sulphur dioxide, and ozone, are regulated as criteria air pollutants under the Clean Air Act to levels at which human health and welfare are protected. Other pollutants, such as benzene and butadiene, are regulated as hazardous air pollutants who see missions must be lowered as much as possible depending on technological and practical considerations. Significant contributions to noise pollution are made by internal combustion engines. Automobile and truck traffic operating on highways and street systems produce noise.

Noise pollutionis excessive, displeasing human, animal, or machine-created environmental noise that disrupts the activity or balance of human or animal life. But this all has not stop the Automotive production down the ages and there requirements of wide range of energy-conversion systems. These include electric, steam, solar, turbine, rotary, and different types of piston-type internal combustion engines. There reciprocating-piston internal -combustion system, operating on a four-stroke cycle, has been the most successful for automobiles, while diesel engines are widely used for truck sand buses.

The gasoline engine was originally selected for the automobile due to its flexibility over a wide range of speeds. Also, the power developed for a given weight engine was reasonable; it could be produced by economical mass-production methods and it used a readily available, moderately priced fuel--gasoline.

2.2 SURVEY

Compressed air vehicles have been developed by various large scale automobile OEMs before. The se include TATA Motors, Citroen, Toyota, etc. While many companies tried to implement it but did not find it to be profitable so they only maintain them as prototypes. Gasoline is already the fuel of the past. It might not seem that way as you fill up on your way to work, but the petroleum used to make it is gradually running out. It also pollutes air that is becoming increasingly unhealthy to breathe, and people no longer want to pay the high prices that oil companies are charging for it. Automobile manufacturers know all of this and have spent lots of time and money to find and develop the fuel of the future.

Most of researches are going on and Hydrogen cell cars are developed, but they are not cost effective. The bio diesel studies are also going on but it has its' own limitations as it is to be blended with existing fuel up to the maximum of 20 % blending. Other natural energy sources are also being tapped like photocell power stations, or battery operated vehicles etc.

An air engine, using compressed air, which is stored in a tank, powers a compressed-air vehicle (CAV). Instead of mixing fuel with air and burning it in the engine to drive pistons with hot expanding gases; compressed-air vehicles use the expansion of compressed air to drive their pistons . At first glance, the idea of running a car on air seems almost too good to be true. If we can use air as fuel, why think about using anything else? Air is all around us. Air never runs out. Air is nonpolluting. Best of all, air is free.

Unfortunately, air alone cannot be used as a fuel. First, energy has to be stored in it by squeezing the air tightly using a mechanical air compressor. Once the compressed air is released, it expands This expanding air can be used, for example, to drive the pistons that power an engine. The idea of using compressed air to power a vehicle is not new: Early prototypes of an air-powered vehicle go back to the middle of the 19th century, even before the invention of the internal combustion engine.

Studies are also going on for compressed air turbines. Wind Mills, Compressed air tools such as pneumatic cutter, hammer etc are also run on compressed air with high RPM rotors based on principle of turbine.

2.3 CONCLUSION

A Compressed-air engine is a pneumatic actuator that creates useful work by expanding compressed air. An air engine, using compressed air, which is stored in a tank, powers a compressed-air vehicle. 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. They have existed in many forms over the past two centuries, ranging in size from hand held turbines up to several hundred horsepower.

CHAPTER 3

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PROBLEM DEFINITION

3.1 PROBLEM DEFINTION

The objective of the project is to use of compressed air as a source of fuel in IC engine. For this modification in engine are needed. The engine is a conventional 4 stroke single cylinder IC engine of Platina 100cc. the increase level of pollutants in the environment and the inflating prices of petrol and diesel from the basis of study of various source of alternative fuel.

The investigation and study of an unconventional source of fuel carried out to establish its advantages and limitation over gasoline and to determine its application. A four stroke singe cylinder IC engine is identified. The modification of the engine is required to get greater power output when using compressed air. The performance was measured using an air compressor with air being supplied to the engine from the inlet.

In order to evaluate the feasibility of the compressed air vehicle, we have to develop a way to be a ble to find a balance between what would be considered a reasonable speed and reasonable range.

Figuring out a solution for this problem will need research in the areas of material strength, weight & durability, tire dimensions, air pressure to be set for vehicle to operate, pipes of various dimensions & strengths to find out which would work best. We will also have to conduct various tests to find out how the vehicle performs in real world conditions.

Presently, there are many designs, which have all been made by larger OEMs. In order to take into account the economic constraints of this project, we will observe various materials, equipment and components so that we can achieve highest possible efficiency and quality at least possible cost.

Air Storage & Refueling The cars are designed to be filled up at a high-pressure pump and thus the tanks must be designed to safety standards appropriate for a pressure vessel. The storage tank may be made of metal or composite materials. The fiber materials are considerably lighter than metals but generally more expensive. Metal tanks can withstand a large number of pressure cycles, but mus t be checked for corrosion periodically. It may be possible to store compressed air at lower pressure using an absorption material within the tank. Absorption materials such as activated carbon , or a metal organic framework is used to store compressed natural gas at 500 psi instead of 4500 psi, which amounts to a large energy saving. One company stores air in tanks at 4,500 pounds per square inch and hold nearly 3,200 cubic feet of air.

The tanks may be refilled at a service station equipped with heat exchangers, or in a few hours at home or in parking lots, plugging the car into the electrical grid via an on-board compressor. The Tata/MDI air car version had 4,350 psi in its tanks, which would require stations to install new high -tech air pumps, a difficult investment for station owners. As thought by engineers and designers, the storage tank would be made up of carbon fiber to reduce the car's weight and prevent an

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explosion, in case of a direct collision. Carbon-fiber tanks are capable of containing air pressure up to 4500 psi, something the steel tanks are not capable of. For fueling the car tank with air, the compressor needs to be plugged into the car, which would use the air that is around to fill the compressed air tank. This could be a slow process of fueling; at least until air cars are commonly used by people, after which high-end compressors would be available at gas stations that would fuel the car in no time at all.

3.2 REQUIREMENTS

The components required for completion of project are as follows –

1. Chassis/Frame
2. Tires
3. Cylinders
4. Pressure regulators
5. Steering
6. High pressure pipes
7. Seat
8. Pneumatic paddle

CHAPTER 4
DESIGN AND DEVELOPMENT

4.1 INTRODUCTION

In this chapter the design and development is carried out in two phases.
PHASE 1: The Design Phase.
PHASE 2: The Development Phase.

4.1.1 The Design Phase

The Design Phase is carried out using Auto CAD software. The parts used in Air Compressed Vehicle are designed using Auto CAD software 2013.

Figure 4.1 Auto CAD Software used

4.1.2 Introduction to Software

AutoCAD is a commercial software application for 2D and 3D computer-aided design (CAD) an d drafting — available since 1982 as a desktop application and since 2010 as a mobile web- and cloud-based app marketed as AutoCAD 360.

Developed and marketed by Autodesk, AutoCAD was first released in December 1982, running on microcomputers with internal graphics controllers. Prior to the introduction of AutoCAD, most commercial CAD programs ran on mainframe computers or minicomputers, with each CAD operator (user) working at a separate graphics terminal. AutoCAD is used across a wide range of industries, by architects, project managers, engineers, graphic designers, and other professionals. It is supported by 750 training centers worldwide as of 1994.

As Autodesk's flagship product, by March 1986 AutoCAD had become the most ubiquitous CAD program worldwide.[4]

4.1.3 Design of Frames

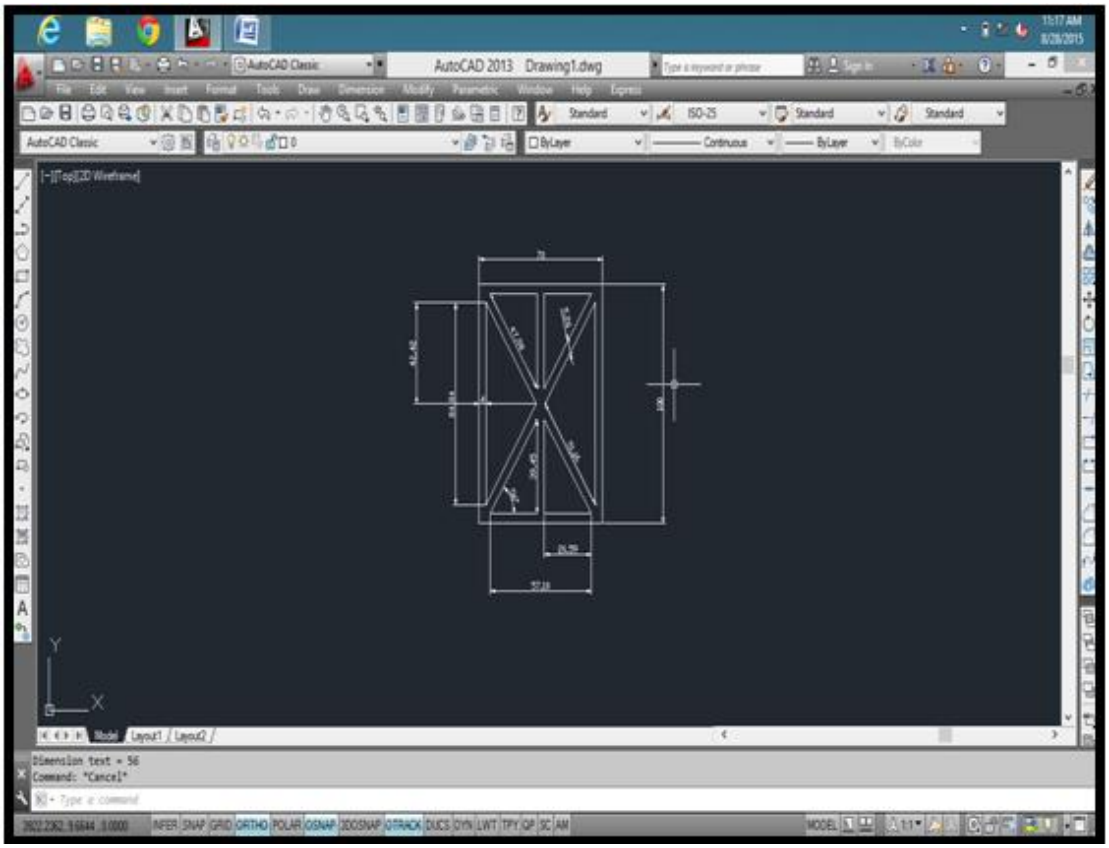

Figure: Initial Design of Chassis in Auto CAD

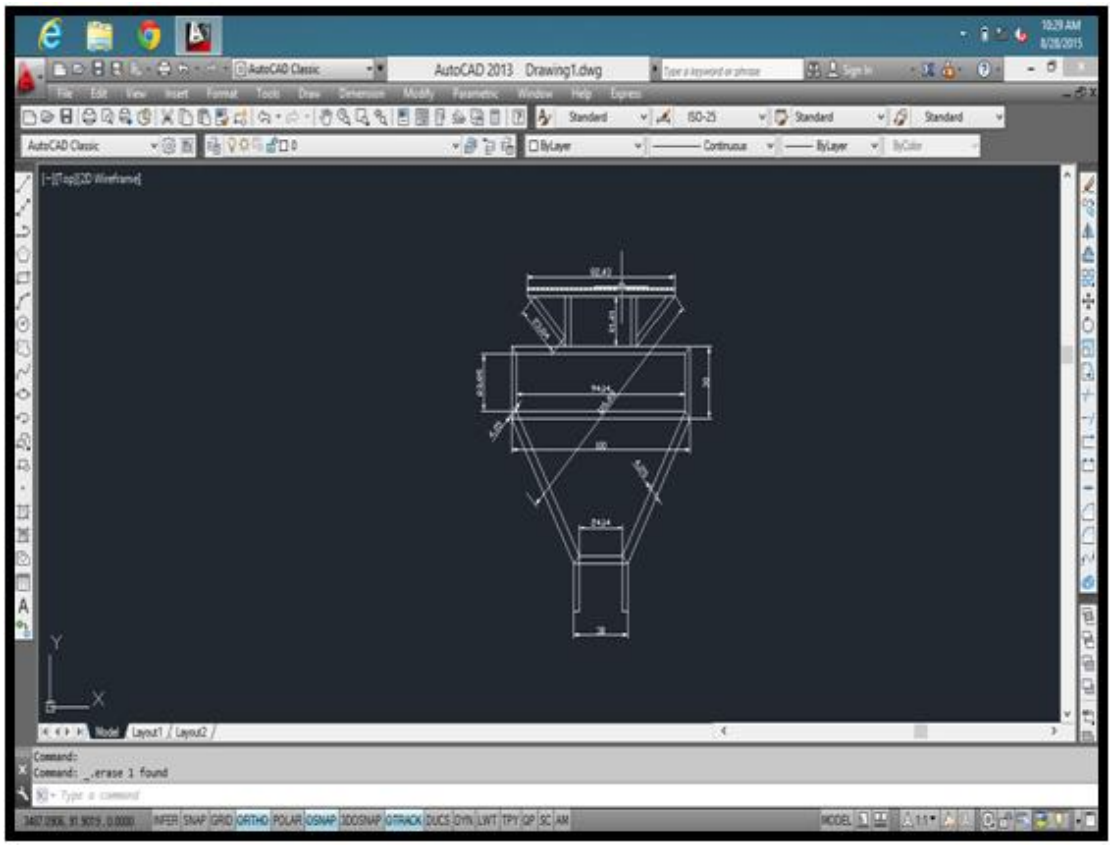

Figure: Final Design of Chassis on Auto CAD

Fossil fuels (i.e., petroleum, diesel, natural gas and coal), which meet most of the world's energy demand today, are being depleted rapidly. Also, their combustion products are causing global problems, such as the greenhouse effect, ozone layer depletion, acid rains and pollution, which are posing great danger for our environment, and eventually, for the total life on our planet.

These factors are leading automobile manufacturers to develop cars propelled by alternative energies. Hybrid cars, Fuel cell powered cars, Hydrogen fueled cars will be soon into the market be cause of it. One possible alternative is the Air-Powered Car. Air, which is abundantly available and is free from pollution, can be compressed to higher pressures at a very low cost, is one of the prime option since whereas so far all the attempts made to eliminate the pollution has however reduced it, but complete eradication is still rigorously pursued. Compressed air utilization in the pneumatic applications has been long proven. Air motors, pneumatic engines, actuators and other equipments are in use. Compressed air was also used in some of the vehicle for boosting the initial torque. Compressed air has been used since the 19th century [10] to power mine locomotives, and was previously the basis of naval torpedo propulsion. The major problem with this car is the lack of torque produced by the "engines". The costs involved to compress the air to be used in a vehicle are inferior to the costs involved with a normal combustion engine.

Air is abundant, economical, transportable, storable and, most importantly, nonpolluting. The

technology involved with compressed air reduces the production costs of vehicles with 20%, because it is not necessary to assemble a refrigeration system, a fuel tank, spark plugs or mufflers. Air itself is not flammable.

The mechanical design of the motor is simple and robust. The tanks used in an air-compressed motor can be discarded or recycled with less contamination than batteries.

The tanks used in a compressed air motor have a longer lifespan in comparison with batteries, which, after a while suffer from a reduction in performance. Refueling can be done at home using an air compressor or at service stations. Reduced vehicle weight is the principle efficiency factor of compressed air car.

The rate of self-discharge is very low opposed to batteries that deplete their charge slowly over time. Therefore, the vehicle may be left unused for longer periods of time than electric cars. Lower initial cost than battery electric vehicles when mass-produced. Compressed air is not subject to fuel tax. Lighter vehicles would result in less wear on roads. The price of fueling air-powered vehicles may be significantly cheaper than current fuels.

4.2 FUNCTIONAL DECOMPOSITIONS

Work Division into Sub Assemblies

The entire work is categorized into 5 phases. Each phase consists of a series of operations followed by the next phase. Several changes were made in the design depending upon the physical stability of the car.

a) Preparatory Work Detailed study of the project, formulating the methods, Design preparation, abstract preparation, project formulation.

b) Sub Assembly:

1 Parts accumulation, inspecting the components, pre-processing of components.

2 Pre-processing of the prepared design.

3 Fabrication, Painting, Testing.

4 Evaluation.

4.3 CONCEPT AND DESIGN

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 a way to store energy. When the gas expands again, that energy is released to do work. That is 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 will 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 refueling and will probably take up to two hours for a complete refill. If the idea of an air car

catches on, air refueling 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.

Since compressed air is not flammable, we do not need huge engine structures to keep in mind the burning of fuel and we can considerably reduce the size of engine block. Since the compressed air only needs a basic mechanism to power the piston compressed air cars are going to be lighter and more agile than conventional cars.

Safety claims for lightweight vehicle air tanks in severe collisions have not been verified. North American crash testing has not yet been conducted, and skeptics question the ability of an ultra light vehicle assembled with adhesives to produce acceptable crash safety results. Shiva Vencat, vice president of MDI and CEO of Zero Pollution Motors, claims the vehicle would pass crash testing and meet U.S. safety standards. He insists that the millions of dollars invested in the Air Car would not be in vain. To date, there has never been a lightweight, 100-plus mpg car, which passed North American crash testing. Technological advances may soon make this possible, but the Air Car has yet to prove itself, and collision safety questions remain.

Compressed air energy storage is a way to store energy generated at one time for use at another time using compressed air. At utility scale, energy generated during periods of low energy demand (off-peak) can be released to meet higher demand (peak load) periods. Small-scale systems have long been used in such applications as propulsion of mine locomotives. Large-scale applications must conserve the heat energy associated with compressing air; dissipating heat lowers the energy efficiency of the storage system.

Much like electrical vehicles, air powered vehicles would ultimately be powered through the electrical grid. Which makes it easier to focus on reducing pollution from one source, as opposed to the millions of vehicles on the road?

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. The engine can be massively reduced in size. In air compressed cars low manufacture and maintenance costs as well as easy maintenance. 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.

But the principal disadvantage is the indirect use of energy. Energy is used to compress air, which – in turn – provides the energy to run the motor. Any conversion of energy between forms results in loss. For conventional combustion motor cars, the energy is lost when oil is converted to usable fuel – including drilling, refinement, labor, storage, eventually transportation to the end-user.

For compressed-air cars, energy is lost when electrical energy is converted to compressed air, and when fuel, either coal, natural gas or nuclear, is burned to drive the electrical generators. Energy collectors such as dams, wind turbines and solar collectors are expensive and have their own problems in manufacture, pollution, transport and maintenance.

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Chassis Design Parameters

Chassis Fabrication: Chassis is made by triangular angular incorporating arc welding at various sections. It includes:

1. Lap joint welds
2. Butt welds
3. T joint welds.

The end joints are 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.

a) Wheel Mounting After the completion of chassis, wheels are mounted; two on the front side and one on the rear side. Inclination is provided between the front and rear side of the chassis frame for steering compensation.

b) Rear Wheel Settings

The rear wheel is given priority because power drive and braking system are given to this wheel. The wheel spindle is aligned with the wheel centre. This is given supports on either side of the wheel. The spindle is extended on either side of the wheel. One side is for power transmission compensation and the other side is for brake setup compensation. Rests of the components are mounted on the chassis at the requisite positions according to the design parameters. A number of modifications were done in the design during the tests performed after installation of each and every module.

Figure: Pneumatic Motor

Power Transmission:

The power transmission undergoes the following processes. Air is stored in the tank at a pressure of

11.03 bar. From the tank, a regulator synchronizes airflow. This maintains pressure to the downstream. The gear is engaged on the first gear and a hand Clutch is provided by extending the lever across the chassis. A pneumatic paddle has been used to regulate the amount of air that would be going through the piston of this 100 cc engine.

Figure: Entire view of the Transmission

Components as long as there is a pressure difference between the reservoir and the required operating pressure. Controlled discharge from the tank is proportional to the release of butterfly valve. From there, air is boosted to the pneumatic wrench inlet. Hence, this compressed air expands at the rotor blades where its pressure energy is converted to rotational energy of the rotor. Ultimately spindle connected to the rotor is given drive in turn is given to the rear wheel.

Figure: Drum Brake

Figure: Rear Wheel

Suspension System:

The suspension points of the vehicle for a chassis should be considered before the chassis itself. Suspension and all the chassis requirements will involve much compromise. For this text into consideration, we thought of coil spring type of suspension. This is because the vehicle weight is so much optimized because of internal physics involving in the propulsion of the Compressed Air Car as well they store energy and subsequently releases it. These can easily withstand the weight excreted and avoid uneven forces on the tire causing loss of traction.

It absorbs the shocks and disturbances created while the vehicle is in dynamic phase.

This also protects the tanks, which are stored with compressed air while the vehicle is passing through any ditches or bumps. This is the simple suspension system attached for Compressed Air Car.

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Figure: Workers helping in Adjusting Steering Column.

Steering System:

Like most things in a car, the concept of steering is simple -you turn the steering wheel, the front wheels turn accordingly, and the car changes direction. How that happens though is not quite so simple. So for our project Compressed Air Car we used Rack And Pinion type Steering System. In a rack and pinion toothed bar with the tie rods attached to each end. On the end of the steering column, a simple pinion gear meshes with the rack. When you turn the steering wheel, the pinion gear turns, and move the rack from left to right. Changing the size of the pinion gear alters the steering ratio.

This steering mechanism follows the Ackerman's Steering Principle, which is very best, suited for our project to eliminate the weight of the vehicle because of the simple construction of the steering mechanism.

Figure: Steering Linkages

Schematic Diagram Approach

1. Chassis: chassis is the under part of a motor vehicle, consisting of the frame (on which the body is mounted). A chassis consists of an internal framework that supports a manmade object in its construction and use. An example of a chassis is the underpart of a motor vehicle, consisting of the frame (on which the body is mounted). If the running gear such as wheels and transmission, and so metimes even the driver's seat, are included, then the assembly is described as a rolling chassis.

In the case of vehicles, the term rolling chassis means the frame plus the "running gear" like engine , transmission, drive shaft, differential, and suspension. A body, which is usually not necessary for integrity of the structure, is built on the chassis to complete the vehicle.

2. Seat:-A seat is a place to sit, referring to the area sat upon as opposed to other elements like armrests.Made or used for sitting on, such as a chair or stool.

3. Steering:- Steering is the collection of components, linkages which allow a vehicle to follow the desired course. An exception is the case of rail transport by which rail tracks combined together with railroad switches provide the steering function.

4. Wheels: A circular object that revolves on an axle and is fixed below a vehicle or other object to

enable it to move over the ground. We have used e-rickshaw wheels, as these are more compactable for our air car.

Figure:-rickshaw Wheels

5. Chain Drive: - Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles.

6. Air tank: - Air tank is a way to store energy generated at one time for use at another time using compressed air. At utility scale, energy generated during periods of low energy demand (off-peak) can be released to meet higher demand (peak load) periods. Small-scale systems have long been used in such applications as propulsion of mine locomotives. Large scale applications must conserve the heat energy associated with compressing air-dissipating heat lowers the energy efficiency of the storage system.

Figure: Assembly of Air Cylinders

7. Engine block: - A cylinder block is an integrated structure comprising the cylinder of a reciprocating engine and often some or all of their associated surrounding structures like coolant passages, intake and exhaust passages and ports, and crankcase.

Figure: Assembly of Drive Chain and Engine

CHAPTER 5

TESTING AND DEPLOYMENT

This research aims to examine the performance of a car, which takes air as the working medium. Air car is a car currently being developed which is still in the R&D stage all over the world. Review on the availability and the impact of the fossil fuels in the present and future generations led us to design a vehicle, which runs by renewable energy sources. As the world is hard pressed with the energy and fuel crisis, compounded by pollution of all kinds, any technology that brings out the solution to this problem is considered as a bounty.

In one of such new technologies, is the development of a new vehicle called as "Compressed Air Car", which does not require any of the known fuels like petrol, diesel, CNG, LPG, hydrogen etc., this works on compressed air. This replaces all types of until date known fuels and permanently solves the problem of pollution, since its exhaust is clean and cool air. Though some of the renewable energy sources like solar energy, bio fuels are currently in practice, we focused on pneumatic technology. Since pneumatic applications are wide all over, the world, basic components and other equipment are easily available and the fabrication is not so tough.

The basic principle involved in this concept is that compressed air is capable enough to provide sufficient thrust, which in turn can propel the car. This report is a detailed description of the fabrication, working and testing of the compressed air car.
The car does not speed up as much but runs at a descent speed, which is enough for the car to move forward. The car's exhaust being air is non-toxic, eco friendly.

This car being just a normal working model and if the car is developed in further future with more amenities and is funded more this concept can be the future for all the passenger carrying service.

Specification of the Engine Used:

Type	Single cyl, 2-valve, DTS-I with ExhausTEC
Capacity	102 cc
Bore x Stroke (mm)	47 X 58.8
Max. Power (Ps @ RPM)	8.2 ps @ 7500 rpm
Max. Torque (Nm @ RPM)	8.6 Nm @ 5000 RPM
Starting	Kick + Electric Starter
Top Speed	90 Kmph (internally tested)
Carburetor	PTE 16 Manual choke
Transmission	4 speed All down
Frame	Tubular Single Down Tube with Lower Cradle frame

Fossil fuels (i.e., petroleum, diesel, natural gas and coal), which meet most of the world's energy demand today, are being depleted rapidly. Also, their combustion products are causing global problems, such as the greenhouse effect, ozone layer depletion, acid rains and pollution, which are posing great danger for our environment, and eventually, for the total life on our planet. These factors are leading automobile manufacturers to develop cars propelled by alternative energies. Hybrid cars, Fuel cell powered cars, Hydrogen fueled cars will be soon into the market as a result of it. One possible alternative is the Air-Powered Car.

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Compressed air has been used since the 19th century [10] to power mine locomotives, and was previously the basis of naval torpedo propulsion. The major problem with this car is the lack of torque produced by the "engines". The costs involved to compress the air to be used in a vehicle are inferior to the costs involved with a normal combustion engine. Air is abundant, economical, transportable, storable and, most importantly, nonpolluting.

The technology involved with compressed air reduces the production costs of vehicles with 20% be cause it is not necessary to assemble a refrigeration system, a fuel tank, spark plugs or mufflers. Air itself is not flammable. The mechanical design of the motor is simple and robust. The tanks used in an air-compressed motor were discarded or recycled with less contamination than batteries. The tanks used in a compressed air motor have a longer lifespan in comparison with batteries, which, after a while suffer from a reduction in performance. Refueling was done at home using an air compressor or at service stations. Reduced vehicle weight is the principle efficiency factor of compressed air car.

The rate of self-discharge is very low opposed to batteries that deplete their charge slowly over time . Therefore, the vehicle may be left unused for longer periods of time than electric cars. Lower initial cost than battery electric vehicles when mass-produced. Compressed air is not subject to fuel tax. Lighter vehicles would result in less wear on roads. The price of fueling air-powered vehicles may be significantly cheaper than current fuel.

5.2 Comparative study and validation

Comparison of several types of green car basic characteristics (Values are overall for vehicles in current production and may differ between types.

Currently some new technologies regarding compressed air cars have emerged. A Republic of Korean company has created a pneumatic hybrid electric vehicle car engine that runs on electricity and compressed air. The engine, which powers a pneumatic-hybrid electric vehicle (PHEV) [10] [13], works alongside an electric motor to create the power source. The system eliminates the need for fuel, making the PHEV pollution-free. The system is controlled by an ECU in the car, which controls both power packs i.e. the compressed-air engine and electric motor. The compressed air drives the pistons, which turn the vehicle's wheels. The air is compressed, using a small motor, powered by a 48-volt battery, which powers both the air compressor and the electric motor. Once compressed, the air is stored in a tank. The compressed air is used when the car needs a lot of energy, such as for starting up and acceleration. The electric motor comes to life once the car has gained normal cruising speed. The PHEV system could reduce the cost of vehicle production by about 20 per cent, because there is no need for a cooling system, fuel tank, spark plugs or silencers.

5.3 Testing and Performance

The power output is simply the inlet enthalpy minus the discharge enthalpy times your mass flow rate.

Tentative selection of model (chain size):

$$\mathbf{T = W*F*K}$$

W = Total weight of conveyed object (including pallet) except chain.

F = Coefficient of friction:

$$\mathbf{F=F1+F2}$$

K = Chain speed coefficient

Calculation of required HP

HP = T * V / 33,000 * N

T: Maximum chain tension
L: Length
W: Total weight of conveyed object. Except chain
F1: Coefficient of friction between chain and guide when transferring.
F2: Coefficient of friction between chain and conveyed object when accumulating
F3: Coefficient of friction between chain and guide when accumulating
M: Weight of chain (lbs/FT)
HP: Required power

V: Chain speed (FPM).
N: Transition efficiency of drive unit

We uses 2 air tanks of capacity 100 pounds each which run our car for 8 minutes.

Calculations:

No. of Cylinders = 2 of 100 psi each

Time = 2.5 minutes / cylinder

Speed = 1.5 m/s

Distance covered= 250 m

Initial Pressure (p1)= 100 kpa

Initial Temperature= 27 degree Celsius = 300 k

Now, Cylinder Volume (*V) = πr2h*

= 3.14 x (0.0619)^2 x (0.0419)

= 5.04 x 10^-4 mm^3

Clearance Volume (Vs) = 9 x 10^-5 mm^3

$$r = \frac{\text{Volume Of Cylinder + Clearance Volume}}{\text{Clearance Volume}}$$

r = 5.04 x 10^-4 / 9 x 10^-5 = 6.6

Now, Specific heat capacity for air (γ) = 1.4

So, Efficiency of engine = 1.1 / r^(γ-1) = 0.5299

η = 52.99%

Break Power = $\frac{2\pi N\Gamma}{60}$

BP = 3.7129 HP

Now, input work done (Indicated Power) = $\frac{\text{Output Work Done}}{\eta}$

Indicated Power (X) = 3851.670 Nm = 7.006 HP

Friction Loss = BP – IP = 3.2931 HP

PERFORMANCE

a) Road Testing

Car was tested at various pressures of compressed air keeping the vehicle dynamics into consideration. Maximum permissible load was tested and the result depicted fair values. Brake tests were conducted and the joint efficiencies were observed. They withstood the impacts and could resist the jerks.

b) Leak Testing

Leak testing is required by most codes prior to initial operation and each piping system must be tested to ensure leak tightness. The field test is normally a hydrostatic leak test. There are several other types of testing depending on service fluid and there are six different testing methods that can be used at most construction sites.

1. Hydrostatic testing which uses water under pressure.

2. Pneumatic testing which uses gas or air under pressure.

3. In-service testing which involves a walk down for leakage when the system is put into operation.
4. Vacuum testing which uses negative pressure to check for leakage.

5. Static head testing, which is normally done for, drain piping with water with a known static head pressure left in a standpipe for a set period of time.

6. Tracer leak method for inert gas leak detection.

c) Pneumatic Leak Testing

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The fluid medium used for pneumatic testing is compressed air. The test pressure by code is usually 1.1 times the design line pressure. Pneumatic testing involves the potential hazard of releasing energy stored in the compressed gas. Care must be taken by gradually increasing pressure in steps up to the test pressure, holding only as long as the code requires, then reducing to the design pressure for inspection of the joints. The inspection of joints is done utilizing a soapy water mix that bubbles when air is escaping.

d) Soap solution test

This is one of the simplest and cheapest methods to spot the leaks in a pneumatic circuit. A soap solution is prepared and is applied at all the joints, fixtures of the hoses, valves, reservoir connections and other sensitive parts. This solution is applied after the tanks are filled to a rated level. All the valves are opened and air starts rushing through the connections. Whenever there is a leak present, with the movement of air molecules, soap bubble s start emerging at the leak spot. Thus, the leak spot is observed.

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CHAPTER 6

CONCLUSION AND FUTURE ENHANCEMENTS

It's important to remember that while vehicles running on only compressed air might seem like a distant dream, but they still have public interest due to their environmental friendly nature. Efforts should be to make them light, safe, cost effective and economical for deriving. The storage of compressed air (initially as well as during journey) with all benefits like no heating, high energy density and provisions to make use of cooling produced during adiabatic expansion during the energy release have to be taken care off in a much more controlled manner. Electric-powered cars and bikes already available on the market put a strong competition to compressed air car not only in terms of cost but also in terms of their environment friendly role. The technology still looks distant but that has not deterred inventors from working on it.

Compared to batteries, compressed air is favorable because of a high energy density, low toxicity, fast filling at low cost and long service life. These issues make it technically challenging to design air engines for all kind of compressed air driven vehicles. To meet the growing demand of public transportation, sustainable with environmental consciousness, people are in the search for the ultimate clean with zero-emissions. Many concept vehicles were proposed that run on everything from solar power to algae, but most of them are expensive and require hard-to-find fuels .

Compressed air vehicle project in the form of light utility vehicle been topics of great interest for the last decade and many theoretical and experimental investigations have appeared on the subject in the literature. Many largest car manufacturers all over the world have taken up the lead in this direction based on the initial technological concept of the pioneer-the French company Motor Development International in the field. In 2008, India's largest car manufacturer also announced that it would begin production of world's first commercial vehicle to run on nothing but compressed air.

The car was sa id to achieve speeds of up to 68 mph with a range of 125 miles between fill-ups, all for less than $13,000. Unfortunately, the dates for the air car's much-publicized release in both Indian and American markets have come and gone with no word about when the vehicle might actually hit the streets. Tata says that the first "proof of the technical concept" phase of the program is now complete with "the compressed air engine concept having been demonstrated in two Tata Motors vehicles." Phase two, which involves, "completing detailed development of the compressed air engine into specific vehicle and stationary applications," is now underway and, "the two companies are working together to complete detailed development of the technology and required technical processes to industrialize a market ready product application over the coming years."

In Europe inventors have made a simple air engine, thus opening a new field for compressed air car technology. These engines allow cars to run on compressed air instead of fuel. The air, super compressed and powerful, pumps the pistons in the car instead of small gas explosions. Pumping air

instead of exploding gasoline means these cars have zero emission motors–no pollution, no oil. In addition, current average family cost of fuel is 60 dollars a week and half that for a hybrid car. The new air engines will give a whole week of driving for a few dollars. The company, MDI plans to sell this clean fuel vehicle and a compressed air hybrid in Europe for less than 15,000 dollars in near future

To refit scooters with an air-compression motor that is about three-quarters of a foot in diameter. In the engine's schematics, a tank of compressed air fires into the chambers of a turbine whose axis is set off center from its housing. The vanes of the turbine extend as they rotate, allowing the chambers to accommodate the volume of air as it expands and contributes to the drive. Unlike the Air Car, the retrofitted scooters would run off the pressure it takes to fill a tire at the gas station. Although they are hoping to eventually solve engineering problems related to torque and range for the scooters (which currently only hold enough air to travel 18 miles), it might be a while until they can really solve the emissions problem.

As gasoline and other major fuels used presently in Internal combustion engines releases unburnt gasses in the environment and are counted in the major sources of pollution , air propelled engine can be used as cleaner , pollution free source of energy or small distance travel. It can be used as a power source in industries where diesel or gasoline engine can be costlier issue, or to reduce pollution. On river banks to collect water, power pneumatic systems. As it is an air propelled engine , so it needs a constant supply of compressed air continuously for uninterrupted working.

Again, if used in vehicles for short distance travelling, it cannot provide much speed to the vehicle a s a higher air pressure would be needed which would further increase the size of compressed air cyli nder and thus weight of the vehicle.

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