FUTURE TRENDS IN AUTOMOBILES: AIR POWERED VEHICLES

Sapkal Vishal K.[1], Bhamare Punam A.[2], Patil Tanvi P.[3], Sayyad Munija S.[4], Shrikant U. Gunjal[5].

[1,2,3,4] U. G. Student, [5]Asst. Prof. ,Department of Mechanical Engineering, Sandip Foundation's- SITRC, Mahiravani, Nashik, Maharashtra, (India)

ABSTRACT

The latest trend in the automotive industry is to develop light weight vehicles. Light utility vehicles are becoming very popular means of independent transportation for short distances. Every automotive industry is looking to reduce the weight of the vehicle as it helps in the better handling of the vehicle and increases the efficiency of the vehicle. Today, the heavy vehicles are run on the basically petrol & diesel, which producing a large amount of harmful gases like CO2, SO2 etc. which act as the major source for global warming. The Cost and pollution with petrol & diesel vehicles is very high manufacturers to develop vehicles fueled by alternative energies. So research is going on to find a light weight vehicle which does not pollute the environment. One of the alternatives is the use of compressed air to generate power to run an automobile. Due to the unique and environmental friendly properties like compressed air for storing energy is a method that is not only efficient and clean, but also economical. So the air is considered as one of the future fuels which will run the vehicles. This paper provides an overview of air power vehicles in brief and emphasizes the potential advantages and disadvantages of the compressed air technology. And assure that the compressed air is the alternative fuel for the vehicles.

Keywords: Air powered vehicles, Alternative Sources of Energy, clean & highly efficient, Compressed air, light weight, Nonpolluting.

I. INTRODUCTION

Compressed air is the air kept under a pressure that is greater than atmospheric pressure. It serves many domestic and industrial purposes. We know that our world is facing fuel crises now. All kinds of conventional source of fuels are the verge of exhaustion. Gasoline which has been main source of fuel for history of cars is becoming more and more expansive and impractical. These factors are leading car manufactures to develop cars fuel alternative energies. Two hybrid cars took to the road in 2000 & in three or four years fuel-cell-powered cars will roll on to the world's highways.While gasoline prices in the United States have not yet reach their highest point. But cost is not only problem with using gasoline as our primary fuel [1]. It is also damaging to the environment, and since it is not a renewable resource, it will eventually run out. One possible alternative is the AIR POWER VEHICLES.It is hard to believe that compressed air can be used to drive vehicles. However that

is true and "air vehicles" as it popularly knows has caught the attention of research worldwide. It has zero emission and is ideal for city driving condition. MDI (Motor Development International) is one company that holds the international patents for compressed air car.

Compared to fuels like petrol and diesel, 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 car 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 (LUV) (i.e., air car in particular) has been a topic of great interest.

II. NEED OF THE TECHNOLOGY

Today 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 verylimited and due to this tremendous use, fossil fuels are depleting at faster rate. So, in this world of energy crisis, it is inevitable to develop alternative technologies to use renewable energy sources, so that fossil fuels can be conserved. One of the major fields in which fossil fuels are used is Internal Combustion Engine. An alternative of IC Engine is **"AIR POWERED ENGINE"**. It is an engine which will use compressed air to run the engine. It is cheap as it uses air as fuel, which is available abundantly in atmosphere. There are several technical benefits of using this engine, like as no combustion takes place inside the cylinder, working temperature of engine is very close to ambient temperature. This helps in reducing wear and tear of the engine components. Also there is no possibility of knocking. This in turn results in smooth working of engine. One more technical benefit is that there will not be any need for installing cooling system or complex fuel injection systems. This makes the design simpler. Here air is compressed using compressor which in turn uses electricity, to run, which is cheaper and widely used. This adds value to its economic benefits [2]. Also, as discussed earlier, as no combustion takes place which results in smooth working of the engine with minimum wear and tear, this will require less maintenance. So these are some of its economic benefits.

One more interesting thing is that the exhaust temperature of this engine will be slightly less than the atmospheric temperature. So this will help in cooling the environment and if this technology is widely used than it will help in controlling global warming. These are some green bytes associated with this technology. Exhaust gases leaving the engine will be only air having low temperature. So this will eliminate the problem of harmful emissions, in conventional engines. This gives us environmental benefit of using this engine. Also as there will be no thermal radiations produced, radar can't detect these vehicles. So this will help our army too. Also the components used in this are: conventional SI engine, air vessel to store compressed air, and timing circuit are economical. These economical and readily available components make the technology easily adaptable.

III. WORKING PRINCIPLE OF AIR POWER VEHICLES

The principle of compressed-air propulsion is to pressurize the storage tank and then connect it to something very like a reciprocating steam engine of the 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. Thus, making the technology free from difficulties, both technical and medical, of using ammonia, petrol, or carbon disulphide as the working fluid. Manufacturers claim to have designed engine that is 90 percent efficient. The air is compressed at pressure about 150 times the rate the air is pressurized into car tyres or bicycle. The tanks must be designed to safety standards appropriate for a pressure vessel. The storage tank may be made of steel, aluminum, carbon fiber, kevlar or other materials, or combinations of the above. The fiber materials are considerably lighter than metals but generally more expensive. Metal tanks can withstand a large number of pressure cycles, but must be checked for corrosion periodically [3]. A company has stated to store air in tanks at 4,500 pounds per square inch (about 30 MPa) and hold nearly 3,200 cubic feet (around 90 cubic meters) 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 vehicle into an on-board compressor.

IV. ENGINE WORKING

To convert a conventional IC engine into an Air Powered one, few components are to be replaced. First of all replace the **spark plug** with a **pulsed pressure control valve** which can create required pressure. Now the pulsed air firing in this valve is controlled by controlling the supply of electrical signal to the plunger [5]. For this we require an electronic timing circuit which can control the flow of electrical supply to the plunger of this valve. This can be achieved by using PLC circuit. Now speed of the engine will be controlled by controlling this input signal.

Now **fuel tank** is to be replaced with **air vessel**, as it requires pressurized air as input. And two things are to be taken care while designing air vessel:

1) First is its strength to withstand high internal pressure, which exists due to compressed air.
For this outer body of it should be made of a material, having high strength, like carbon fiber.
2) Second is its capacity to store air and its weight.

Now replace **cam** with a **modified cam**. This is to be done, so that both the inlet and outlet valves open and close at the same time. Main advantage of doing this is to achieve better scavenging system. Also this will result in conversion of 4 stroke engine into 2 stroke air engines, which in turn gives us the benefit of low mean effective pressure requirement in addition to other operational benefits.

V. DETAIL WORKING OF ENGINE

The normal 4 stroke SI engine is shown as:

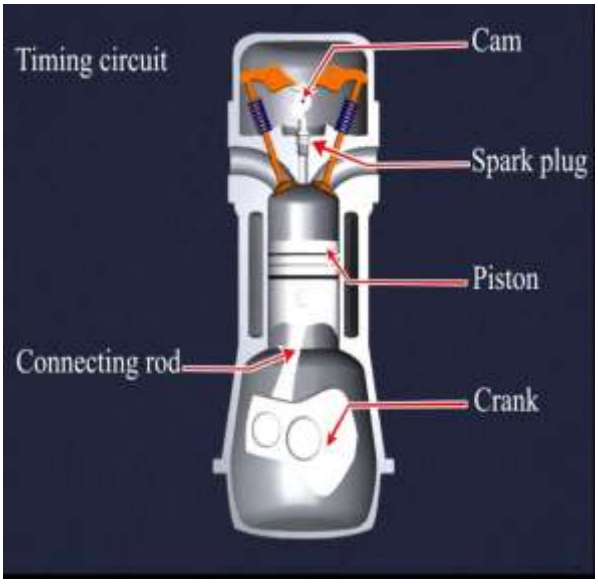

Fig. 1: Stage 1 of Operation

OPERATION:

Initial torque is supplied from the DC exciter motor, and then the engine operation starts.

STAGE 1: When the piston is in the TDC, compressed air is injected through the pulsed air firing valve,which pushes the piston to BDC.

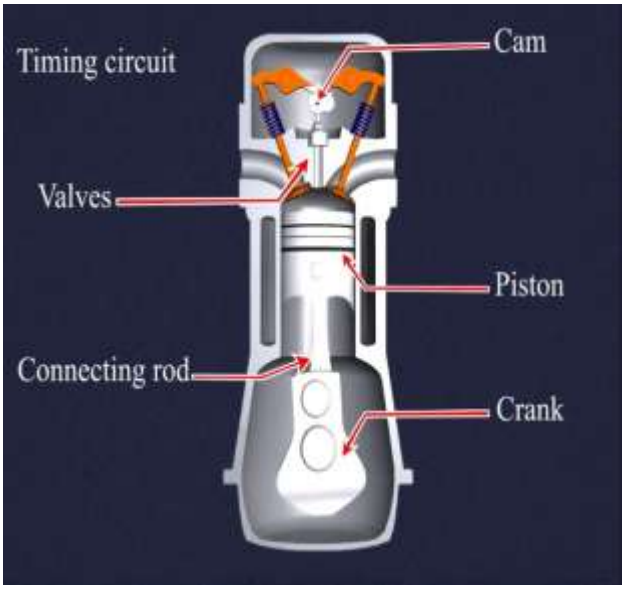

Fig. 2: Stage 2 of Operation

STAGE 2: Due to the motion of the engine and its inertia, the piston moves back to TDC, pushing the air out of the valves.

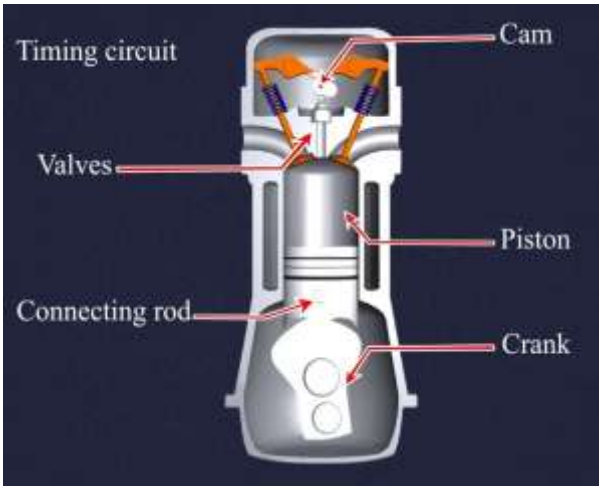

Fig. 3: Stage 3 of Operation

The plunger of the pulsed firing valve is controlled by a timing circuit which is specifically a PLC programmed circuit [5, 6]. It supplies the electronic signals by which the plunger moves so that it opens and closes the pulsed firing valve.

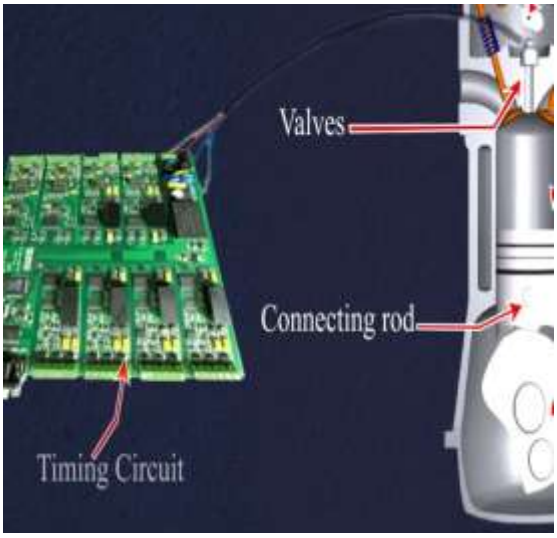

Fig. 4: Electric Control of Crank Shaft

On comparing it with the working of normal SI 4 stroke engine, we can say that:

- **"Stage 1"** of the air engine comprises of the combined operation of "Suction stage" and "Power stage" of the normal 4 stroke SI engine.
- **"Stage 2"** of the air engine comprises of the combined operation of the"Compression stage" and "Exhaust stage" of the normal 4 stroke SI engine.

VI. LAYOUT OF THE ACTUAL WORKING

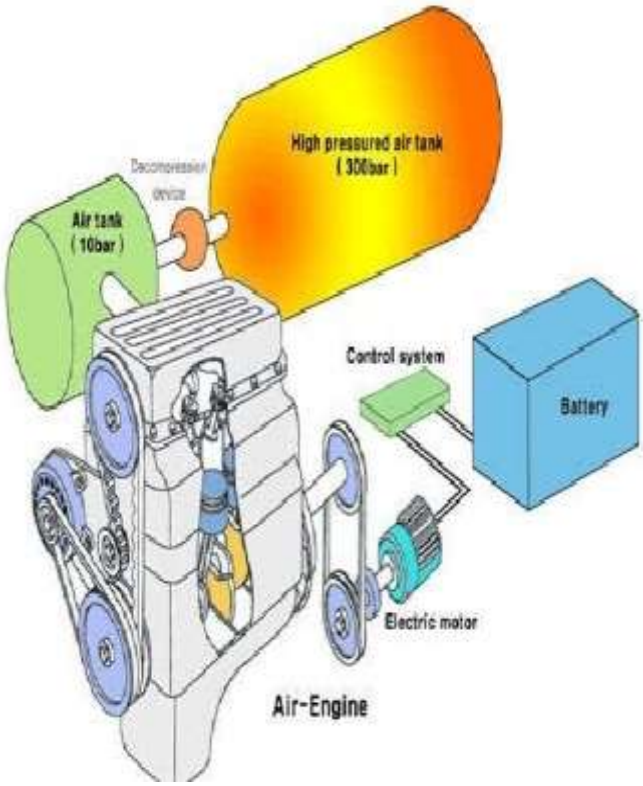

Fig. 5: Layout of Working of Engine

VII. WORKING DETAILS FOR 2 WHEELER

To develop the air powers bike first is to convert a regular scooter to a compressed air moped shown in Fig. 6

Fig. 6: Arrangement of Air Engine on 2 Wheels

This has been done by equipping the scooter with a compressed air engine and air tank. The air bike is created by strapping two high-pressure tanks onto the side of his Puch moped. The tanks are basically scuba tanks. Heuses the electricity from his house to fill the tanks. Thepower is then "stored" there, much like a battery, ready foruse. The tanks used are carbon-fiber tanks of the sort used byfirefighters for oxygen. But still, they're far cheaper thaneven the lead acid battery used in car now. Of course, thecompressor works on electricity, so that's not always a clean power source but recharging options at night or off peak willenhance the chances to use

the power that would be wastedotherwise. The top speed is about 18 mph, and it can only go7 miles before the air pressure runs out and a lot more powercould probably be pulled by tweaking his configuration. Asmall gear on the end of the air drill, connected to the chainof the bike would make a much more elegant solution.

Several companies [5] are investigating and producing prototypes, and others plan to offer air powered cars, buses and trucks. The compressed air is stored in carbon-fiber tanks that are built into the chassis. As the air is released, the pressure drives pistons that power the engine and move the car, and the pistons compress the air into a reservoir so that the process continues. After making a revolution by producing the world's cheapest car-Tata nano, India's largest automaker (Tata Motors) is set to start producing the world's first commercial air-powered vehicle. The "Air Car" will make use of compressed air, as opposed to the gas-and oxygen explosions of internal-combustion models, to push its engine's pistons. Zero Pollution Motors (ZPM) (USA) [1] also expects to produce the world's first air-powered car for the United States by 2010. An earlier version of the car is noisy and slow, and a tiny bit cumbersome but then this vehicle will not be competing with a Ferrari or Rolls Royce and the manufacturers are also not seeking to develop a Formula One version of the vehicle. The aim of air powered vehicles is the urban motorist: delivery vehicles [8], taxi drivers, and people who just use their vehicles to nip out to the shops. The latest air car is said to have come on leaps and bounds from the early model. It is said to be much quieter, a top speed of 110 km/h (65 mph), and a range of around 200 km before you need to fill the tanks up with air.

VIII. WORKING DETAILS FOR 4 WHEELER

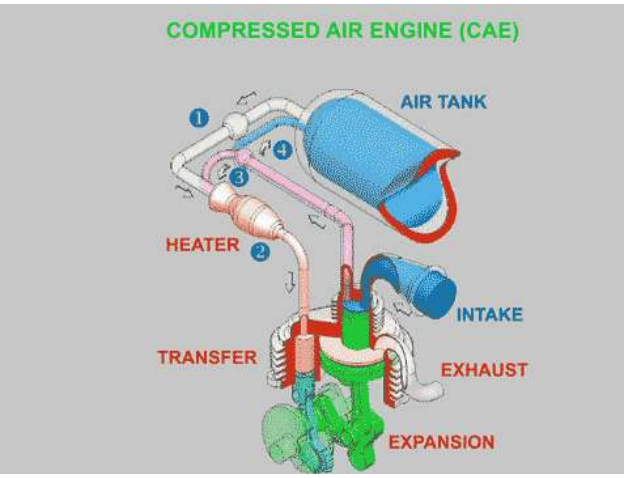

Fig. 7: Working of Engine in Car

Air powered car is worked on the compressed air instead of gasoline. Since the car is working on air there is no pollution. A two cylinder compressed air engine, powers the car. The engine can run either on compressed air alone or act as an internal combustion engine. The compressed sir is stored in the fiber or glass fiber tanks at a pressure 4351 pounds per square inch. The air is fed through an air injector to the engine and flows into a small chamber, which expands the air. The air pushing down on the piston move the crankshaft, which gives the vehicle power

The car is also working on a hybrid version of their engine that can run on the traditional fuel in combustion with air [7]. The change of energy source is controlled electronically. When the car is moving at a speed below 60kph, it runs on the air and at a higher speed it runs on a fuel such as gasoline diesel or a natural gas. Air tank is fixed to the underside of the vehicle can holds about 79gallons (300liters) of air. This compressed air can fuel the car up to 200kms at a top speed of 96.5kmh. When the tanks near empty it can be refilled at a nearest air pump. The car motors requires a small amount of oil 0.8liters worth that have to change just every 50,000kms.

IX. COMPONENTS OF AIR POWERED VEHICLES

9.1 Compressed air tank

An **Air powered 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 use the expansion of compressed air to drive their pistons. One manufacturer claims to have designed an engine that is 90 percent efficient.

9.2 Brake power recovery

It uses one mechanism that stops engine when the car is stationary (at traffic light, junctions etc…), which recover 13% of power used.

9.3 Air filter

Fig. 8: Air Filter

A particulate **air filter** is a device composed of fibrous materials which removes solid particulates such as dust, pollen, mould, and bacteria from the air. A chemical air filter consists of an absorbent or catalyst for the removal of airborne molecular contaminants such as volatile organic compounds or ozone [7]. Air filters are used in applications where air quality is important, notably in building ventilation systems and in engines.

9.4 Electrical system

Only one cable connects all electrical parts i.e. headlight, dashboard light, light inside the car. The electrical system of the car is easy for installation and easy for repair.

9.5 Chassis

Fig. 9: Chassis of Car

A **chassis** consists of an internal framework that supports a man-made object in its construction and use. It is analogous to an animal's skeleton. An example of a chassis is the under part of a motor vehicle, consisting of the frame (on which the body is mounted). If the running gear such as wheels and transmission, and sometimes even the driver's seat, are included then the assembly is described as a rolling chassis.

9.6 Engine

Fig. 10: Air Engine

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9.7 Body

Fig. 11: Body of Air Car

The body is made up of fiber glass and injected foam [7]. It is slightly costly but does not cut like steel and aluminum. It does not rust and light weighted.

X. ADVANTAGES

10.1 In Comparison To Petrol Or Diesel Powered Vehicles "Air Powered Vehicles" Have Following Advantages

- Air, on its own, is non-flammable, abundant, economical, transportable, and storable and most importantly nonpolluting.
- Compressed air technology reduces the cost of vehicle production by about 20%, because there is no need to build a cooling system, fuel tank, spark plugs or silencers.
- High torque for minimum volume. The mechanical design of the engine is simple and robust.
- Low manufacture and maintenance costs as well as easy maintenance. Lighter vehicles would mean less abuse on roads, thus, resulting in longer lasting roads. The price of fueling air powered vehicles will be significantly cheaper than current fuels. When the air is being compressed at reasonable speeds, it heats up. The heat given off during compression could be reclaimed for space heating or water heating, or used in a stirling engine.
- Transportation of the fuel would not be required due to drawing power off the electrical grid. This presents significant cost benefits. Pollution created during fuel transportation would be eliminated.

10.2 In Comparison To Electric Vehicles "Air Powered Vehicles" Have Following Advantages

- Compressed-air vehicles are unconstrained by the degradation problems associated with current battery systems.
- 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 tanks can be disposed of or recycled with less pollution than batteries.

- The tank may be able to be refilled more often and in less time than batteries can be recharged, with refueling rates comparable to liquid fuels.
- 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.

XI. LIMITATIONS

- Very little is known about air powered vehicles thus far.
- Compressed air vehicles likely will be less robust than typical vehicles of today. This poses a danger to users of compressed air vehicles sharing the road with larger, heavier and more rigid vehicles.
- Compressed air has a low energy density comparable to the values of electrochemical lead-acid batteries. While batteries can somewhat maintain their voltage throughout their discharge and chemical fuel tanks provide the same power densities from the first to the last liter, the pressure of compressed air tanks falls as air is drawn off.
- When the air is expanded in the engine, it will cool down *via* adiabatic cooling and lose pressure thus its ability to do work at colder temperatures. It is difficult to maintain or restore the air temperature by simply using a heat exchanger with ambient heat at the high flow rates used in a vehicle, thus the ideal is thermic energy capacity of the tank will not be realized.

XII. APPLICATIONS

FAMILY CARS	VANS
TAXIS	PICK-UPS
MINI-CATS	BIKES

XIII. CASE STUDY

The case study of the air powered vehicles is that the **TATA MINICAT** is developed. The **TATA** Motors is get **collaboration** with the **MDI** (Motor Developments International).The **TATA MINICAT** is get launched on or before **2016**, the price of that car is around **6.50-7.50 lakhs**.

Fig. 12: TATA MINICAT

Also the company PEUGEOT CITROEN in France has doing the work on the air car, its prototype is ready and the car is come in the market in 2016.The MDI is working on air car from 2008.

XIV FUTURE SCOPE

The future scope of the air powered vehicle is that when we driving the car on the road the aerodynamic is affected on the car, if we have done the arrangement on the car that utilizes that air and send it to the air compressor and send to the air engine, so the car does not stop for the reason of refueling.

XV CONCLUSION

Air powered vehicles is a realization of latest technology in automobile field. The air vehicles are a clean, easy to drive, light in vehicles and performance vehicles. It eliminates the use of non-renewable fuels and thereby preventing pollution and step to a healthier environment.

Compressed air for vehicle propulsion is already being explored and now air powered vehicles are being developed as a more fuel-efficient means of transportation. Some automobile companies are further exploring compressed air hybrids and compressed fluids to store energy for vehicles which might point the way for the development of a cost effective air powered vehicles design. Unfortunately there are still serious problems to be sorted out before air powered vehicles become a reality for common use but there is a hope that with the development in science & technology well supported by the environmental conscious attitude and need to replace costly transportation methods, air-powered vehicles will definitely see the light of the day.

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