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INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL ENGINEERING
WWW.IJRAME.COM
ISSN (ONLINE): 2321-3051

Vol.6 Issue.5,
May 2018
Pg: -01-11

Design and Fabrication of Compressed Air Vehicle

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***Abstract*— Now days the world faces fuel crisis and pollution problem. Also the conventional fuels are about to end in some years. This necessitates the search for alternative fuels. Compressed air is one of the best alternative fuels which are easily available in atmosphere in abundant form. The main objective of this project is to reduce dependency of vehicle on conventional fuel. The air car is a car currently being developed which is still in the R&D stage all over the world. Compressed air is stored in storage tank with some modifications from the compressor. The running and maintenance cost for air car is less than conventional cars. This is a revolutionary design which is not only ecofriendly, pollution free but also very economical. With some modifications in storage tank, pneumatic cylinder, materials used for chassis it is possible to increase the performance of vehicle.**

***Keywords*—Conventional Fuels, Compressed air, storage tank, compressor, pneumatic cylinder**

I. INTRODUCTION

In a pneumatic system, the working fluid is a gas (mostly air) which is compressed above atmospheric pressure to impart pressure energy to the molecules. This stored pressure potential is converted to a suitable mechanical work in an appropriate controlled sequence using control valves and actuators. Conversion of various combinations of motions like rotary-rotary, linear-rotary and linear-linear is possible. The simplicity in design, durability and compact size of pneumatic systems make them well suited for mobile applications. Pneumatic control system plays very important role in industrial system owing to the advantages of low cost, easy maintenance, cleanliness, readily available, and cheap source, etc. A particularly well suited application for vehicle operating on compressed air is material handling and for visit or in industry.

II. LITERATURE REVIEW

According to Dr.S.S.Thipse, "Compressed air car" he says it is hard to believe that compressed air can be used to drive vehicles, however that is true and the air car as it is popularly known has caught the attention of researchers worldwide. It has zero emission and is ideal for city driving conditions.

That is in practice all credit goes to MDI Company which proved the compressed air car and holds the international patents for the compressed air car. Although it seems to be an environmental-friendly solution, one must consider its well to wheel efficiency. In his paper he has explanation the past researches on this compressed air. One cannot accurately claim that compressed air car as energy and locomotion vector is recent technology. Denis Papen had apparently come up with the idea of using compressed air(Royal Society London

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1687). In1872 the Mekarshi air engine was used for street transit consisting of a single-stage engine, in his forward use of thermodynamics, ensures that the air was heated, by passing it through tanks of boiling water which also increased its range between fill-ups.An easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it.

SaSa Trajokovic "Division of combustion engines" in his doctoral thesis has revealed his opinions and fabrication of compressed air in different ways. As with HEVs, the idea of hybrid pneumatic vehicles is far from new. In 1909, J.K. Broderick filed for a patent titled "Combined internal combustion and compressed air engine". He wrote in his application that his idea was to use compressed air together with an engine used for propelling a vehicle. The purpose of the compressed air is to assist the engine in starting when under heavy load, or when going uphill.

III. METHODOLOGY

- Design aspects
- Required Components
- Fluid Power System
- Pneumatic System
- Material Selection
- Decide the mechanism.
- Problems with Compressed Air
- Problem Definition.
- Select Topology
- Validation

IV. DESIGN ASPECT AND FABRICATION

In this project we are going to calculate the design of the double acting cylinder suitable for our required pressure i.e. 6 bars.

Secondly for modelling of chassis body of the vehicle is fabricated by using welding process to the required length and width of the iron strips and rods.

The remaining spare parts such as 5/2 direction control valve, connectors, polyurethanes cable requires according to our need will be purchased from the outside source.

He required spur gear and chain drive for transmission will be selected on design basis of the rear wheel drive.

The compressor with reservoir is selected of maximum capacity of the reservoir in litres. We have selected the 100 litre capacity reservoir compressor with ½ HP motor mounted onto it for compressing the air up to 12 kg/cm2.

The steering mechanism is of rack and pinion arrangement only to front wheels.

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V. BASIC PRINCIPLE OF PNEUMATIC SYSTEM

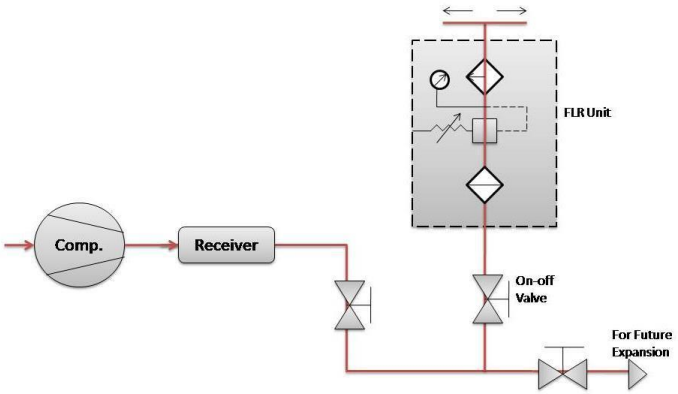

Fig. 1 Basic Pneumatic System

It could be observed that the basic components involved are similar to a hydraulic system. The basic differences between hydraulic and pneumatic systems are that in hydraulic system the input mechanical energy is imparted to the oil is by pump, whereas, in pneumatic systems the working fluid being air, the mechanical energy is imparted to air by a compressor. Further, a hydraulic system usually operates at very high pressures to transmit the large force and power while a pneumatic system operates at low pressures of about 5–7 bar for industrial applications.

- **Pneumatic Cylinder**

Air cylinders are the means of converting our pressure in applied force and straight the motion. An air cylinder consist essentially of a tube sealed both ends by covers and fitted with a piston and piston rod. Compressed sir admitted though a port at one and produces movement of the piston displaced air exhausted though a second port at other end. The theoretical force of thrust available from a cylinder is directly proportional to the area as available pressure.

The majority of air cylinders are designed for working with maximum air pressure of the order of 10 bars, although the usual operating pressure is of the order of 3 bars. An air cylinder may be single acting capable of developing in one direction only, or double acting, acting capable of being pressurized from each and alternately developing an output force in both directions.

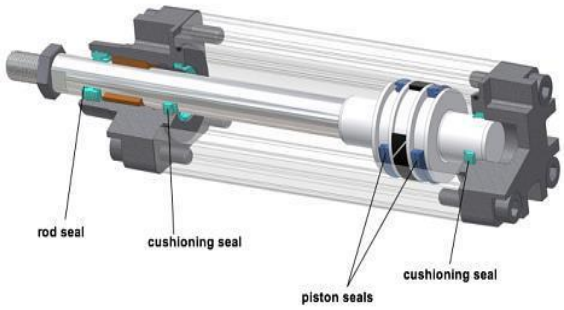

Fig.2 Pneumatic Cylinder

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- **Foot Operated Valve**

Foot operated valve is working as a direction control valve. To control the to and fro motion of a pneumatic cylinder, the air energy has to be regulated, controlled, and reversed with a predetermined sequence in a pneumatic system. Similarly one has to control the quantity of pressure and flow rate to generate desired level of force and speed of actuation.

Fig. 3 Foot Pedal Valve

- **Mechanism**

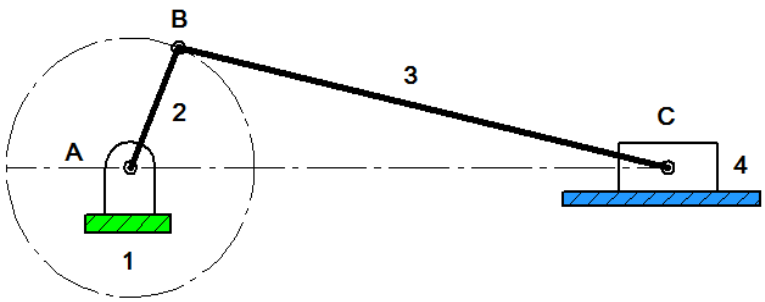

Fig.4 Slider crank mechanism

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 linkage is a four-link mechanism with three revolute joints and one prismatic, or sliding, joint. The rotation of the crank drives the linear movement the slider, or the expansion of gases against a sliding piston in a cylinder can drive the rotation of the crank.

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- Types of slider crank

  - In-line: An in-line slider-crank has its slider positioned so the line of travel of the hinged joint of the slider passes through the base joint of the crank. This creates a symmetric slider movement back and forth as the crank rotates.
  - Offset: If the line of travel of the hinged joint of the slider does not pass though the base pivot of the crank, the slider movement is not symmetric. It moves faster in one direction than the other. This is called a quick-return mechanism.

- **Vehicle Operating on Compressed Air by Inversion of Slider Crank Mechanism**

Calculation of bore and stroke of cylinder, crank length, connecting rod length
Mass of the vehicle (m)=12kg
Weight= m*9.81=12*9.81=117.72N
Weight on each wheel (w)= 117.72/3=39.24N
Coefficient of friction (μ) =0.75
Force of friction (f) = μ*w=0.75*39.24=29.43N
Torque= f*r = 29.43*0.08=2.3544Nm..... (Wheel radius is 8cm)
Torque to overcome friction (t1) = 2.3544*3=7.0632Nm
Assume the vehicle takes the speed of 3m/s in 6sec.
So acceleration= 3/6=0.5m/s^2
Now force to propel the vehicle forward= m*a= 12*0.5=6N
Torque required to propel the vehicle (t2) = 6*0.08=0.48Nm
Total torque (t)=t1+t2=7.0632+0.48=7.5432Nm
Taking length of the crank 5cm perpendicular force to propel the crank= 7.5432/0.05=150.864N
(Force in the connecting rod and gas force are less than this force since they are vector component of this force)
So 150.864= π/4 * d^2 * 0.6..... (Pressure of the system is 6 bars).
D=17.89mm
Taking standard value of diameter of cylinder available in market,
D=25mm
So,
Bore= 25mm
Stroke=100mm
Crank length=50mm
Connecting rod length=100mm

VI. WORKING OF VEHICLE

- First we compress the air with the help of compressor.
- The compressed air is supplied when required.
- The compressed air from Compressor is supplied to pneumatic motor through 5/2 DCV
- After the crank arrangement connecting rod is connected to transfer the motion to the wheels.

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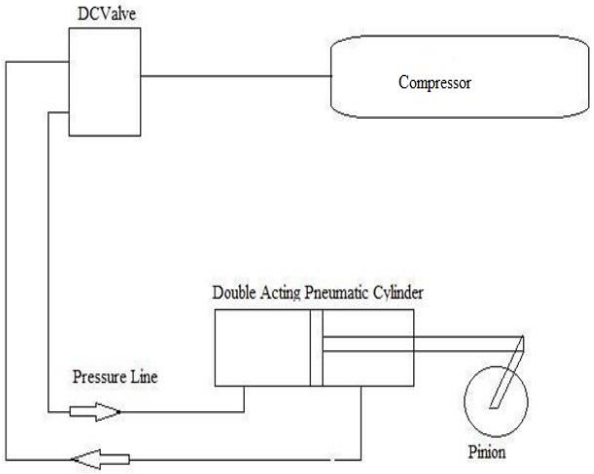

Fig.5 Assembly Layout

A compressed-air vehicle is powered by an air engine, using compressed air, which is stored in a compressor. 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. One manufacturer claims to have designed an engine that is 90 precent efficient. Compressed air propulsion may also be incorporated in hybrid systems, e.g., battery electric propulsion and fuel tanks to recharge the batteries. This kind of system is called hybrid-pneumatic electric propulsion. Additionally, regenerative braking can also be used in conjunction with this system.

In this system a double acting pneumatic cylinder operated as a slider crank mechanism that converts the linear reciprocation of the cylinder piston rod into oscillatory motion of the driver crank about the pinion shaft. The pinion shaft further drives the pinion, which will turn the gear wheel on the output shaft.

The output shaft carries the system that converts the oscillatory motion of the gear into the single direction rotation of the chain vehicle by means of a unidirectional clutch arrangement. The pneumatic linear actuator supplies compressed air by means of an appropriate filter-regulator-lubricator (FRL) unit and a 5/2-Solenoid operated pneumatic direction control valve.

This system is capable of being driven to given intermittent as well as continuous motion to the chain vehicle system.
The system uses pneumatic cylinder, which is fast actuation system, hence the vehicle has fast response. The system incorporates a provision to arrest the stroke of the actuator to a desired level there by deciding the length of travel of the vehicle thus making the system flexible enough to serve the needs of the flexible production system.

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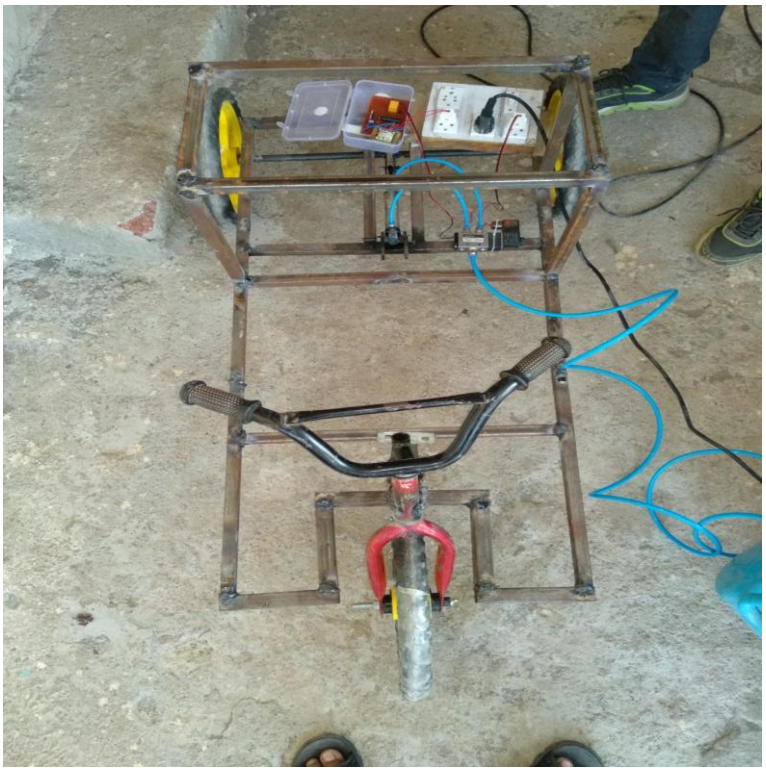

Fig.6 working model

Pneumatic cylinders or air 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

The force exerted by the compressed air moves the piston in two directions in a double acting cylinder. These are used particularly when the piston is required to perform the work not only in the forward movement but also on the return. In principle, the stroke length is unlimited, although buckling and bending must be considered before we select particular size of piston diameter, rod length and stroke length.

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- **3 Wheel Cad Model**

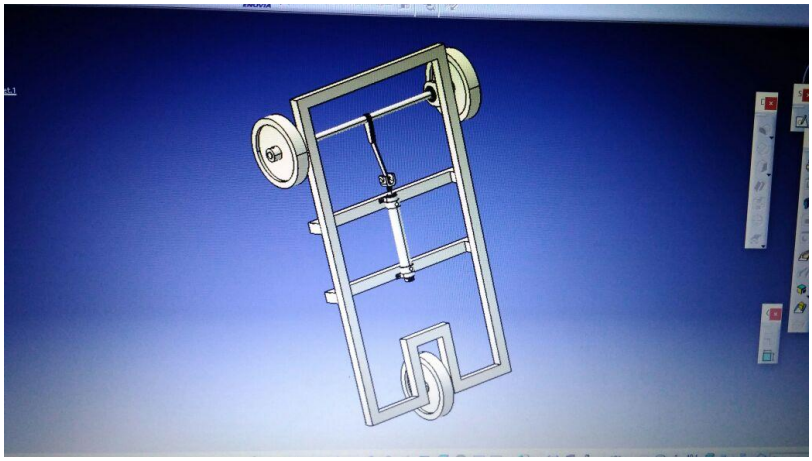

Fig.7 Three Wheel Cad model

- **4 Wheel Cad Model**

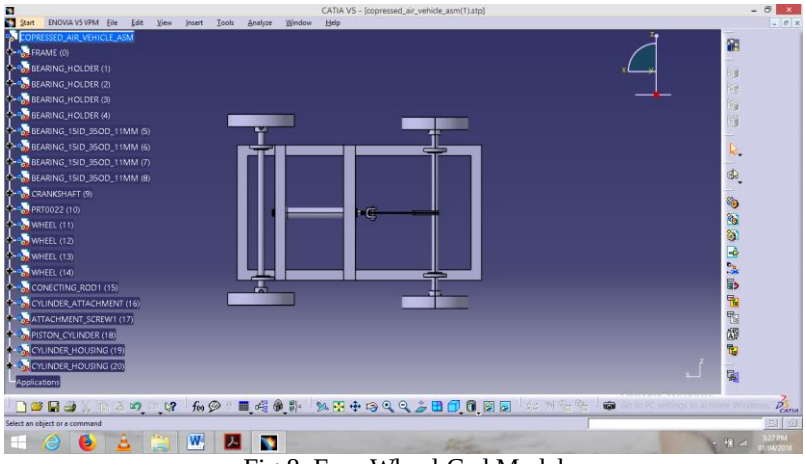

Fig.8 Four Wheel Cad Model

VII. RESULT

Compressed air technology is such a technology which allows engines that are both non-polluting and economical. With the help of non-conventional energy sources such as compressed air engine we may set a milestone in the field of green technology because it is the demand of the time to adopt green technology.

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- **Design Analysis**

6.1.1 Basic Geometry

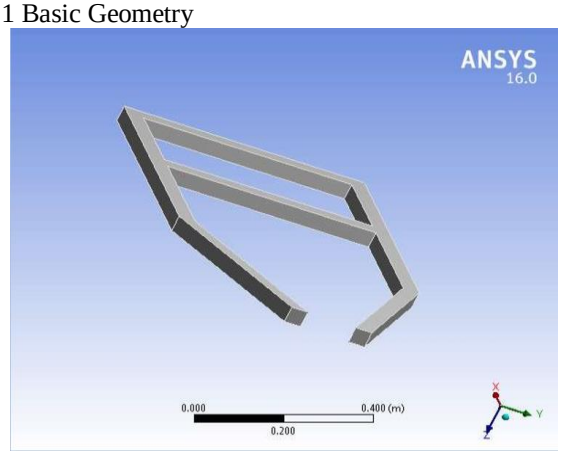


Fig. 9. Basic Geometry

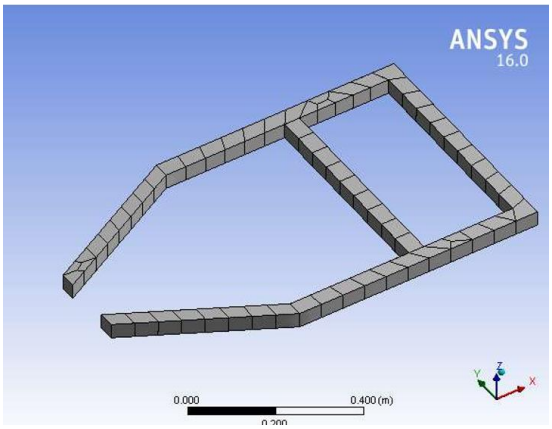
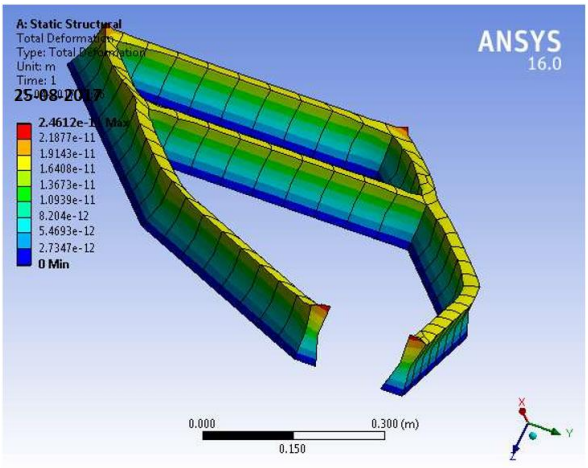


Fig 10. Meshing Geometry



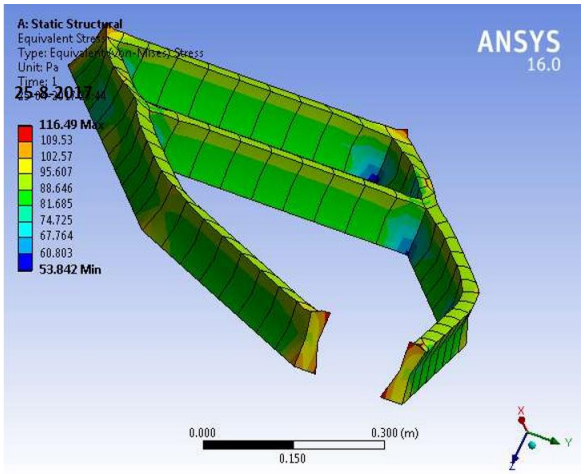


Fig 11. Deformation

. VIII. ADVANTAGES

- Air is non-flammable, plentiful, inexpensive, movable, storable and most importantly non-polluting.
- Compressed air technology cost of vehicle production reduces by about 20%, as there is no need to build a cooling system, fuel tank, spark plugs or silencers.
- The mechanical design structure of the engine is so easy and strong.

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- Low manufacture and maintenance costs as well as simple maintenance.
- Lighter vehicles would mean less misuse on roads, thus, resulting in lifelong roads.
- The price required to fuel the air powered vehicles will be significantly less than current fuels. Pollution created by the fuel transportation would be removed.
- Compressed-air vehicles are comparable in many ways even to electric vehicles and their potential advantages over electric vehicle.

IX. APPLICATIONS

- Compressed air engines were used in trams and shunters, and eventually found a successful niche in mining locomotive.
- Transport category airplanes, such as commercial airliners, use compressed air starters to start the main engines. The air is supplied by the load compressor of the aircraft's auxiliary power unit, or by ground equipment.
- There is currently some interest in developing air cars. Several engines have been proposed for these.
- Three wheeler .
- Motorcycles.
- mopeds.
- cars.

X. CONCLUSION

The Technology of compressed air vehicles is not new. In fact, it has been around for years. Compressed air technology allows engines/ motors that are both non-polluting and economical. We designed 3 wheeled vehicles in order to reduce weight. Unlike conventional transmission systems which include clutch, counter shaft, fly wheel, propeller shaft, differential, our pneumatic motor is coupled to the rear wheel with intermediate gear box which greatly reduces the transmission losses and weight of the vehicle.

It also occupies lesser space compared to a four wheeler. However excessive research is needed to completely prove the technology for both its commercial and technical viability.

After successfully completing the project we conclude that we can use the air as an alternative fuel for conventional fuel. The vehicle is pollution free and Eco friendly. With some modification the performance of the vehicle will be increased. Low initial cost. Transmission losses are reduced. Low weight of vehicle.

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