Fabrication of Pneumatic Vehicle

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Abstract

Light utility vehicles are becoming increasingly popular as a means of autonomous transportation for short distances. Rising fuel costs and concerns about pollution from petroleum and diesel-powered vehicles are pushing manufacturers to explore alternative energy sources. One such innovation is the development of air-powered vehicles that utilize compressed air as a clean and sustainable energy source. Engineers are focusing on harnessing pneumatic power to drive light utility vehicles, reducing reliance on fossil fuels and minimizing environmental impact. These vehicles offer a promising solution for urban and industrial transport, providing an eco-friendly alternative while maintaining efficiency and reliability. This air-powered vehicle project is based on pneumatic principles, using compressed air to generate motion. It consists of a pneumatic system incorporating two pneumatic cylinders that convert linear motion into rotary motion, enabling continuous movement. The vehicle's design includes four free-wheel sprockets and a metallic chassis, ensuring stability and durability. A chain drive mechanism efficiently transmits mechanical power, further enhancing the vehicle's performance. The use of compressed air as an energy source presents several advantages, including lower emissions, reduced operating costs, and increased energy efficiency. By eliminating the need for conventional fuels, air-powered vehicles contribute to a greener future while showcasing the potential of pneumatic technology in sustainable transportation.

INTRODUCTION

Light weight vehicles are the next advancement in the development of automobiles. Reducing the weight of the vehicle has many advantages as it increases the overall efficiency of the vehicle, helps in improving maneuverability, requires less energy to stop and run the vehicle. The latest researches are going on around the world in order to come up with innovative ideas. But global warming is also one of the problems which is affecting the man. The temperature of the earth is increasing drastically and this in turn is causing climatic changes. The fossil fuels are widely used as a source of energy in various different fields like power plants, internal & external combustion engines, as heat source in manufacturing industries, etc. But its stock is very limited and due to this tremendous use, fossil fuels are diminishing at faster rate. So, in this world of

energy crisis, it is necessary to develop alternative technologies to use renewable energy sources, so that fossil fuels can be conserved

The first compressed air vehicle was established in France by a Polish engineer Louis Mekarski in 1870. It was patented in 1872 and 1873 and was tested in Paris in 1876. The working principle of Mekarski's engine was the use of energy stored in compressed air, another application of the compressed air to drive vehicles comes from Uruguay in 1984, where Armando Regusci has been involved in constructing these machines. He constructed a four-wheeler with pneumatic which travelled 100 km on a single tank in 1992. The Air Car was developed by Luxembourg-based MDI Group founder and former Formula One engineer Guy Negre is which works on compressed air vehicle (CAV).

Because of global problems such as greenhouse effect, ozone layer depletion, acid rain, air pollution our total life of our planet is reducing day by day. These factors are leading automotive technology and development of alternative energy sources. Some of them are electrical powered, solar powered, hydrogen powered, etc. but before we utilize and Compressed air is having energy stored within. This energy can be converted into required output by expanding it to atmospheric pressure. This air without external chemical or physical support is having potential to generate output work. As it is green and clean type of energy environment and roadside issues can be neglected. We are planning to replace four stroke fossil fuel engines with air charged rotary engines. Without any complexity, we are planning to develop three vane type rotary engines with rotor diameter of 30±2 mm for automotive use. And we are planning to introduce new materials to amplify life and workability of machine as prescribed below.

2. LITERATURE REVIEW

[1]. A particularly wellsuited application for vehicle operating on compressed air is material handling and for visitors in industry. Compressed air storage energy (CASE) is a promising method of energy storage, with high efficiency and environmental friendliness [2]. Compressed air is regarded as fourth utility, after electricity, natural gas, water and the facilitating production activities in industrial environment [3]. Unfortunately production of compressed air solely for pneumatic vehicle is not affordable but in manufacturing industries compressed air is widely used for many applications such as cooling, drying, actuating and removing metal chips. In addition, as a form of energy, compressed air represents no fire or explosion hazards; as the most natural substances, it is clean and safe and regarded as totally green [4]. The performance of air car is explain in [8] in which the importance of the impact of the fossil fuels in the present and future generations is explained which led them to design a new vehicle which runs by renewable energy sources. Compressed air vehicle are more suitable for low speed, short range and flammable environment [9, 10].An inventor, JemStansfield, has been able to convert a regular scooter to a compressed air moped [10]. The moped has top speed of about 18 mph and could go 7 miles before its air pressure ran out [10]. During literature survey it is observed that compressed air vehicles has many potential advantages over electric vehicles which includes no degradation problems of batteries, time required for refueling the tank, easy disposal of compressed air tank without causing any pollution as with the batteries [10].Hence in order to overcome the above stated problems there is a need of eco-friendly vehicles using compressed air as a working medium in future. In this work a sincere effort is made to develop Vehicle operating on compressed air by inversion of slider crank mechanism.

Yadav et al. [4], compressed air was used as fuel to run an engine. The compressed air engine was modified with pneumatic cylinder, pneumatic solenoid valve, and compressor. In the proposed model, the input was connected with air compressor. The study showed that about 3m3 air at 30 bar pressure gave a mileage equal to 1 liter petrol and cost of production of compressed air was much lower than that of petrol, this proved it less costly. The engine designed was thus eco-friendly, pollution free and also economical. Wang et al. [5] presented the applications of compressed air on an engine to run a motorcycle. A 100cc four-stroke internal combustion engine was revised to a twostroke air compressed engine. The compressed air engine motorcycle was examined at different valve timings, gear reduction ratios and different air pressures.

At lower pressure of 5 bar, the maximum speed was 28.9 kmh-1 travelling 2.5 km, whereas at high pressure of 9 bar the maximum speed attained was 36.5 kmh-1 travelling 1.7 km. Vishal et al. [6] proposed that air powered engine could be an alternative of internal combustion engine. Two stroke engine gave 18 mph maximum speed while running on compressed air. Experiment showed that air powered engine was efficient and contributed to pollution free environment. Verma [7], an analysis on problems related to compressed air engine was done. Zero emission of harmful gases was the greatest advantage. Results of analysis showed that compressed air vehicle was a bit distant dream for actual practice, but in laboratories researches were very rigorously going on. Kumar et al. [8], a compressed air engine was proposed which used the energy of reciprocating piston to rotate the output shaft. Simulation showed inlet pressure was directly proportional to velocity and inversely proportional to cycle time. Sharma et al. [9], a single cylinder engine was modified to make it work on compressed air. Pneumatic cylinder and solenoid valve were the main components introduced to the modified engine. The study showed that indicated power was directly proportional to load. Boddapati et al. [10], modified a four stroke engine to a two stroke engine. The first stroke was suction/power stroke while the second was exhaust stroke. A cam was designed to set the inlet air timing for an air engine. Furthermore, 5 bar of pressure gave 850 rpm with mechanical efficiency of 80%. Baig et al. [11], a 100cc internal combustion engine was modified to an air compressed engine. The engine was improved from a four stroke engine to a two stroke engine. Engine speed of 3000 rpm was obtained at a maximum pressure of 8 bar and temperature of 15ºC

3.COMPONENTS

The components that are used in the project COMPRESSED AIR VEHICLE

Are as follows.

- Air tank
- Air gun
- Chain drive
- Sprockets
- Frame
- Pressure gauge

4. PRODUCT DESCRIPTION

4.1 AIR TANK

Air compressor vehicle

Tank capacity =5 Kg/cm^2 or 0.5 M.Pa

Tank thickness =2 mm.

$$\text{Hoop stress} = \frac{\text{PxD}}{2\text{t}}$$

$$= \frac{0.5x250}{2*2}$$

$$= 31.25M.Pa$$

The tank is made upon steel materials.it is having 125 M.Pa yield limit. In this work operating pressure is 31.25 M.pa. So design is safe limit.

4.2 SHAFTAND EQUIPMENT

Total weight of equipment is 8 Kg.

The load will acts on shaft of vehicle. The vehicle is having four wheels. Each wheels caries equal load. The shaft dia is 16 mm.

Shaft is arranged as overhanging beam. T is having two cantilever portions and another one simple supported.

Load on each wheel is 2 Kg or 20 N.

Moment of inertia for circular section= $\mathbf{I = \pi D^4 / 64}$

$$= \frac{3.14x16\text{^}4}{64} = 3215.36m^4$$

$$\frac{M}{I} = \frac{\sigma}{Y}$$

$$\frac{20*60}{3215.36} = \frac{\sigma}{8}$$

$$stress = 2.8M.Pa$$

Shaft is safe limit.

4.3 PNEUMATIC CYLINDER

Design of pneumatic cylinder

Stroke of cylinder =250 mm.

Bore diameter =16 mm.

Maximum pressure is 10 Bar.

For one stroke of piston rod, chain travel distance is 250 mm.

Free wheel diameter =50 mm.

Perimeter of freewheel is =3.14*50

=157 mm.

For one stroke =250/157=1.6 times of complete rotation.

4.4 SPEED CALCULATION

Wheel diameter=100 mm. for 1.6 times of wheel, its travelling distance can be calculate below.

=3.14*100*1.6 =502 mm.

For one stroke of motion, vehicle can travel with 0.5 m.

Stroke travel speed is 250per 5 sec.

Speed of vehicle is 50mm/sec or 0.18 KMPH.

For one stroke, required air is =250*16^2*3.14/4

=50240 mm^3.

=0.05 m^3

Mass of air required =1.225*0.05

=0.06125 Kg.

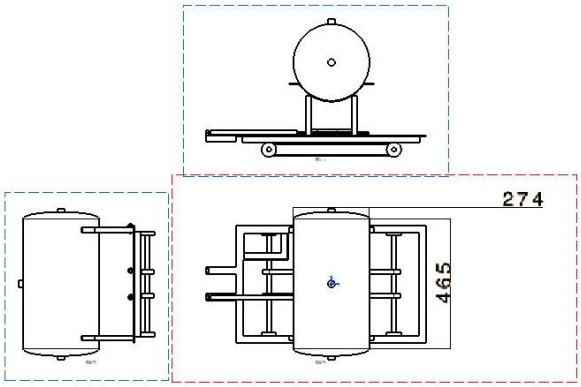

Fig 4.1: Air car with dimensions.

4.5 WHY? MILD STEEL?

The term 'mild steel' is also applied commercially to carbon steels not covered by standard specifications. Carbon content of this steel may vary from quite low levels up to approximately 0.3%. Generally, commercial 'mild steer' can be expected to be readily weldable and have reasonable cold bending properties but to specify 'mild steel' is technically inappropriate and should not be used as a term in engineering. Mild steel is the most widely used steel which is not brittle and cheap in price. Mild steel is not readily tempered or hardened but possesses enough strength.

4.6 MILD STEEL COMPOSITES

- ✓ Mild steel contains –C45
- ✓ Carbon 0.35 to 0.45 % (maximum 0.5% is allowable)
- ✓ Manganese 0.60 to 0.90 %
- ✓ Silicon maximum 0.40%
- ✓ Sulfur maximum 0.04%
- ✓ Phosphorous maximum 0.04%
- ✓ Mildest grade of carbon steel or mild steel contains a very low amount of carbon - 0.05 to 0.26%
- ✓ Tensile strength – 63-71 kgf/mm^2
- ✓ Yield stress -36 kgf/mm^2
- ✓ Izod impact valve min -4.1 kgf m
- ✓ Brinell hardness (HB) – 229

5. FABRICATION PROCESS

Manufacturing processes are the steps through which raw materials are transformed into a final product. The manufacturing process begins with the creation of the materials from which the design is made. These materials are then modified through manufacturing processes to become the required part. Manufacturing processes can include treating (such as heat treating or coating), machining, or reshaping the material. The manufacturing process also includes tests and checks for quality assurance during or after the manufacturing, and planning the production process prior to manufacturing.

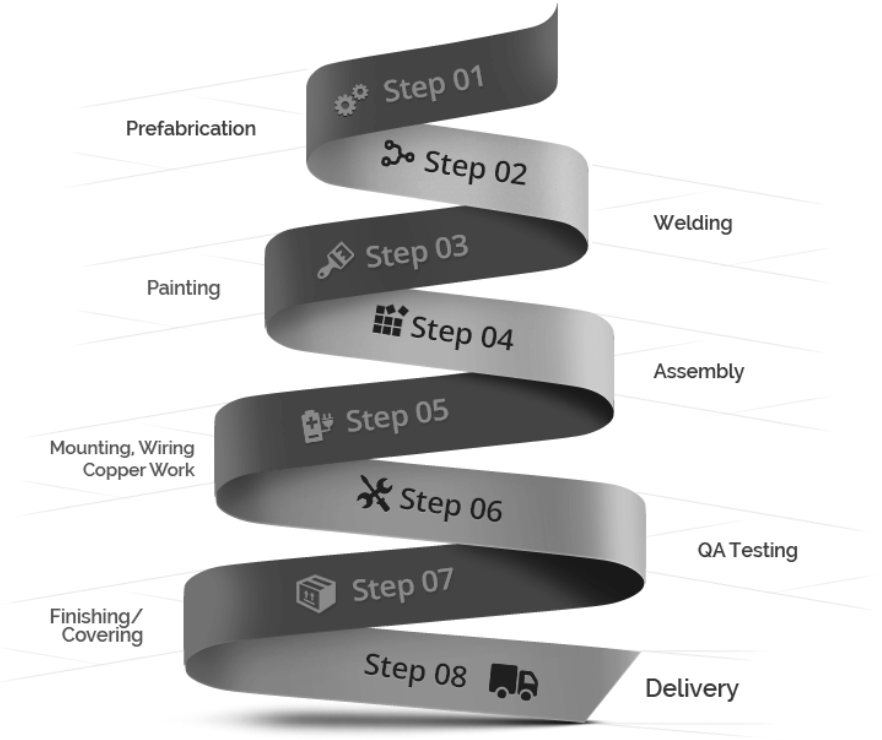

Fig 5.1 Fabrication process

5.1 Fabrication Processes

These are secondary manufacturing processes where the starting raw materials are produced by any one of the previous manufacturing processes desired. Its assembly involve joining pieces either temporary or permanent. So that they would be perform the necessary function. The joining can be achieved by either or both of heat and pressure joining materials. Many of the steel structure construction, we see are first rolled and then joined together by a fabrication process are

- Gas welding
- Electric arc welding
- Electrical resistance welding
- Thermo welding
- Brazing welding
- Soldering welding
- Cold welding

5.2 Material removal processes:

These are also a secondary removal manufacturing process, where the additional unwanted material is removed in the form of chips from the blank material by a hard tools so as to obtain the final desired shape.

Material removal is normally a most expensive manufacturing process. Because more energy is consumed and also a lot of waste material is generated in this process. Still this process is widely used because it deliver very good dimensional accuracy and good surface finished. Material removal process are also called machining processes. Various processes in this category are

- Turning
- Drilling
- Shaping and planning
- Milling
- Grinding
- Broaching
- Sawing
- Trimming

1 WELDING

Welding is a process of joining two metal pieces by the application of heat. Welding is the least expensive process and widely used now a days in fabrication. Welding joints different metals with the help of a number of processes in which heat is supplied either electrically or by mean of a gas torch. Different welding processes are used in the manufacturing of Auto mobiles bodies, structural work, tanks, and general machine repair work. In the industries, welding is used in refineries and pipe line fabrication. It may be called a secondary manufacturing process.

2. INSPECTION

Critical appraisalinvolvingexamination ,measurement, testing, gauging, and comparison of materials or items. An inspection determines if the material or item is in proper quantity and condition, and if it conforms to the applicable or specified requirements. Inspection is generally divided into three categories: (1) Receiving inspection, (2) In-process inspection, and (3) Final inspection. In quality control (which is guided by the principle that "Quality cannot be inspected into a product") the role of inspection is to verify and validate the variancedata; it does not involve separating the good from the bad.

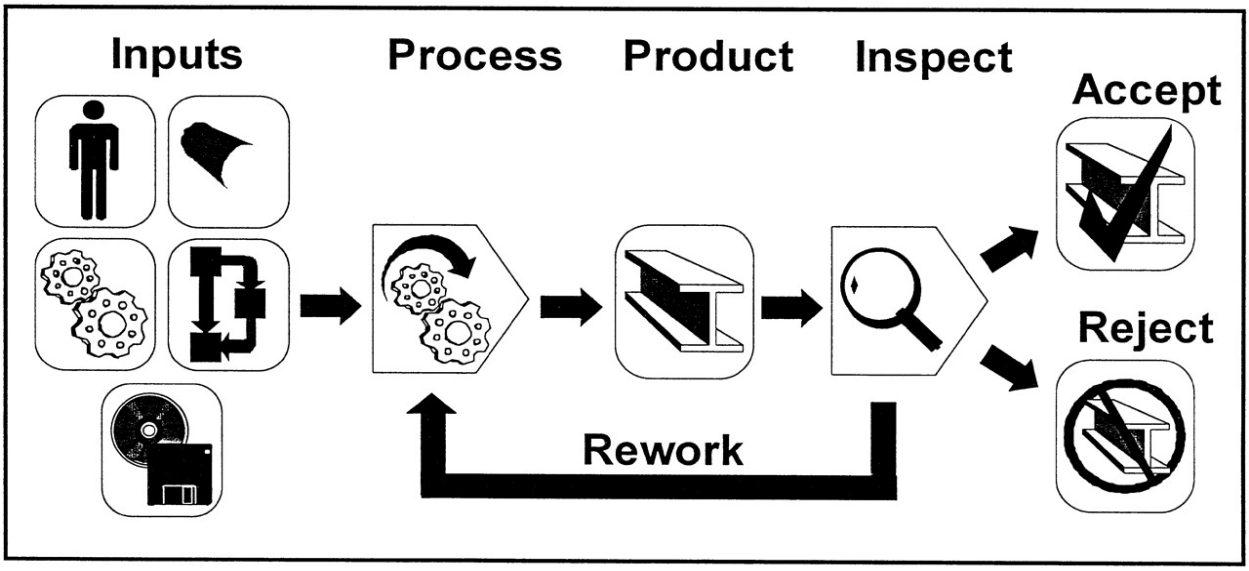

Fig 5.11 Assembly

3.ASSEMBLY

An assembly line is a manufacturing process (most of the time called a progressive assembly) in which parts (usually interchangeable parts) are added as the semi-finished assembly moves from work station to work station where the parts are added in sequence until the final assembly is produced. By mechanically moving the parts to the assembly work and moving the semi-finished assembly from work station to work station, a finished product can be assembled much faster and with much less labor than by having workers carry parts to a stationary piece for assembly.

4. WORKING PRINCIPLE

The compressed air vehicle consists of the air storage tank which stores the compressed air inside the tank. Then there is a gate valve for the controlling of the compressed air into the next part of the system. This vehicle also consists of a non-return valve, pneumatic (gun) drill, shafts and chain drive and sprocket mechanism.

The compressed air stored in the tank enters the gate valve which is placed near the handle for the comfort of the driver, when the gate valve is opened the air enters the pneumatic drill (gun) for the actuation or the motion of the vehicle.

This vehicle is designed as a tri-wheeler for the better comfort and easier handling of the vehicle. The compressed air enters the air gun through a gate valve by which the shaft is driven and by the chain sprocket mechanism the power from a shaft is transmitted to the other shaft or the rear wheel shaft thus making the vehicle driven.

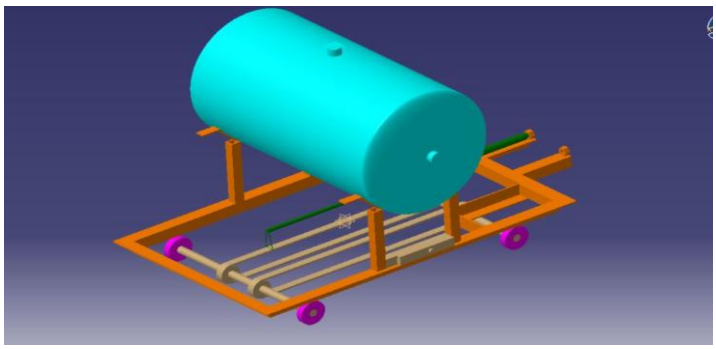

Fig 6.1 Working Principle

6.2LIST OF MATERIALS

Sl. No.	PARTS	Qty.	Material
1	Air tank	1	M.S
2	Air gun	1	-
3	Pressure gauge	1	-
4	Chain drive	2	M.S
5	Sprockets	4	M.S
6	Shafts	-	M.S
7	Frame	-	M.S
8	Hoses	-	PU tubes
9	Bearing & bearing cap	6	-
10	Wheels & chair	3	-
11	NRV	1	-

Table 6.1 List of Materials

7.1ADVANTAGES

1. compressed air to store the energy instead of batteries. Their potential advantages over other vehicles include:

2. Reducing pollution from one source, as opposed to the millions of vehicles on the road.

3. Transportation of the fuel would not be required due to drawing power off the electrical grid. This presents significant cost benefits.

4. Compressed air technology reduces the cost of vehicle production.

5. There is no need to build a cooling system, fuel tank, Ignition Systems or silencers.

6. The mechanical design of the engine is simple and robust.

7. Low manufacture and maintenance costs as well as easy maintenance.

8. Compressed-air tanks can be disposed of or recycled with less pollution than batteries.

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

10. Lighter vehicles would mean less abuse on roads resulting in longer lasting roads.

11. The price of fueling air powered vehicles will be significantly cheaper than current fuels.

12. Refueling can be done at home using an air compressor.

7.2DISADVANTAGES

1. Like the modern car and most household appliances, the principal disadvantage is the indirect use of energy.

2. Refueling the compressed air container using a home or low-end conventional air compressor may take as long time.

3. Only limited storage capacity of the tanks. So we not take drive on long time.

7.3APPLICATIONS

1. Aerospace Applications
2. Automotive Applications
3. Food and Beverage Applications
4. Two wheeler Applications
5. Four wheeler Applications.

7.4 MODEL VIEW

Fig 7.1 Top view

Fig 7.2 Front view

CONCLUSION

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. We feel that the project work is a good solution to bridge the gates between the institution and the industries.

We are proud that we have completed the work with the limited time successfully. The **DESIGN AND FABRICATION OFCOMPRESSED AIR VEHICLE**is working with satisfactory conditions. We can able to understand the difficulties in maintaining the tolerances and also the quality. We have done to our ability and skill making maximum use of available facilities.

In conclusion remarks of our project work, let us add a few more lines about our impression project work. Thus we have developed a **"COMPRESSED AIR VEHICLE".**

FUTURESCOPE

The idea of using compressed air as a fuel source for running an engine, seems too good to be true. But actually, it is a fantastic idea as air is abundantly available, it is non-polluting and it is free.
In future, the solar energy can also be used to produce electricity for the air to be compressed at the initial stage which will also reduce the use of coal and burning of it, which causes tremendous carbon emission.
It has Low manufacturing cost and as there is no carbon residual the maintenance costs is also less and feasible.
Many automobile companies are making their effort in orderto build compressed air vehicle. Research is going in orderto cope up with the losses that are coming due totransformation of energy. Compressed air could be the bestalternative in order to drive vehicles in future.
In collaboration with India's Tata Motors and Paris based Air France, an alternative fuel vehicle was developed by Motor Development International. It works on the compressed air. The Air engine works with the help of two linked cylinders. The manufacturing of these plants has been set up in Sardinia, Italy and it will be available in India soon.
The same study is carried out with other gases having more compressibility and more energy density. Development is more consent on the storage tanks.

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