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FABRICATION AND PERFORMANCE EVALUATION OF COMPRESSED AIR VEHICLE

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Abstract: Compressed air can be used to run the vehicle, which becomes an alternative fuel for vehicles and a substitute for petroleum products and thus the emission from vehicles is stopped. The compressed air vehicles are known as zero emission vehicles as the fuel used is air and the exhaust from engine is also air but in the compressed air vehicle the engine cam shaft is modified such that compressed air enters the engine in one stroke and leaves the engine in the next stroke. During air admission into the cylinder the inlet valve is opened and the exhaust valve is closed and during the exhaust stroke the air supply is stopped by closing the inlet valve and the exhaust valve is closed. So, for the above operations to occur the cam is to be modified as per the requirement. When the above modification is done on the cam shaft, the continuous admission and exhaust of air takes place, resulting in continuous running of engine and the vehicle moves.

I. INTRODUCTION

In recent years, reduction of pollution from vehicles is the major issue that the world is focused on. It is said that vehicles consume more amount of oxygen than the people in the world consume.

And as the petroleum products are depleting due to increase in number of vehicles to meet the growing demand of public transportation, there is a need to replace them. These petroleum products are now a day's extensively used in various fields of modern world. They are being consumed at such a quick rate that in few decades they may get extinct. The extensive use of petroleum products has resulted in hazardous pollutions which lead to effects like Global Warming.

In the recent years most of the researchers are focusing on compressed air engines which work similar to conventional IC engines [1], some works on engines with modified intake and exhaust system for piston type compressed air engine [2].To decrease the intensity of emissions from conventional I.C engines Compressed air vehicles need to be encouraged even though electrical vehicles are available but the limitation with it is charging and unit cost [3, 4]. The power and efficiency observed [5] and it is important to improve the efficiency and performance characteristics of Aero engines.

Novelty of the work:

In this work camshaft one side end lobe is converted into two sides of lobes so that four stroke engine will be converted into two stroke engine. CATIA V5 design software is used for developing two sides of lobes on camshaft, after this fabrication is processed accordingly.

Testing and performance: After the design and modification of cam shaft, it is placed in the place of conventional cam shaft. This cam shaft is driven by the crank shaft through chain drive. This modified engine is then connected to air compressor where compressed air is supplied.

The engine is tested with various pressures ranging from 2 to 5 bars and various loads to calculate performance characteristics like torque break power etc.

Working Methodology: The modifications that are required to be done on the cam shaft are designed in CATIA V5 software as per the requirement of CAV.

Specifications of cam shaft are 5mm , Dwell angle is 20 degrees (between outward and return strokes) .Dwell angle 60 degrees (between two lobes of cam).

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Draft sheet of modified cam shaft:

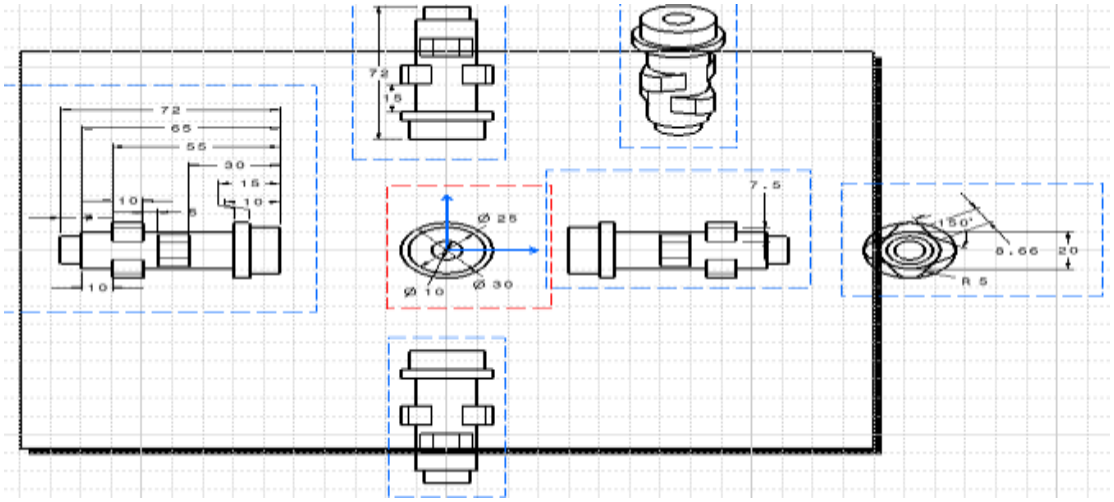

Figure 1: Draft sheet of modified cam shaft

According to the modification of Camshaft it is to be done by CATIA-V5. Modifications are made according to the cam lift, dwell angle. Screenshot of modified shaft is shown below:

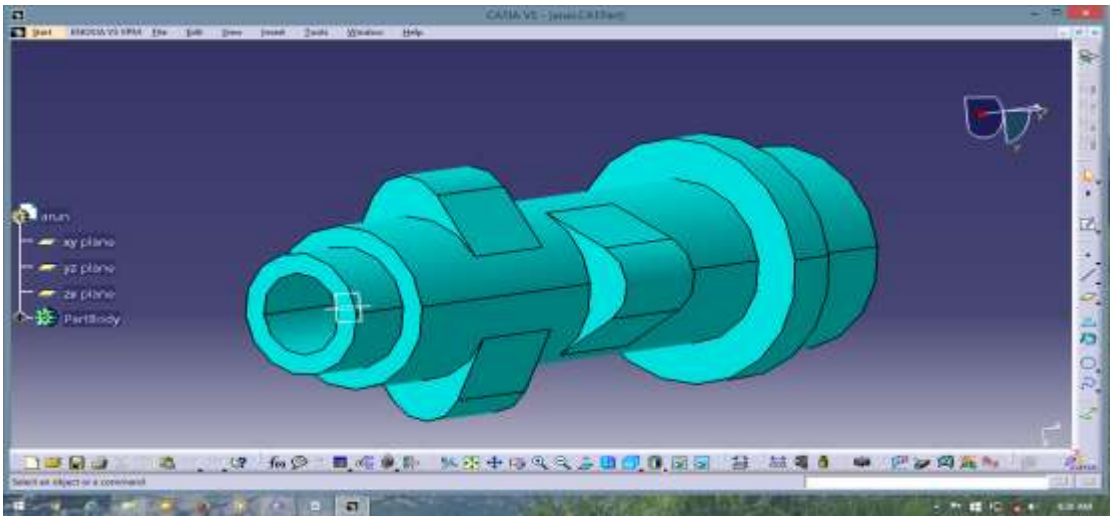

Figure 2: Modified shaft in CATIA V5

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Figure 3: Actual Camshaft

Figure4: Screenshots of Modified Camshaft

After designing the camshaft, according to the modification in order to run vehicle with compressed air. It is undergone for manufacturing of two sides of lobes. Now this modified camshaft will be inserted by removing Old. After these changes air enters into the cylinder when inlet valve is opened and leaves when the exhaust valve opened. So four stroke engine will be converted into two stroke engine.

Fig5: Air cylinder

Air pressure cylinder: In this project compressed air is carried in a cylinder on the vehicle and is supplied to the engine, there the air expands and pushes the piston down and crank shaft is rotated, so that the vehicle moves.

From this cylinder pressurized air sent to engine cylinder, it can sustain up to 14bar pressure. The pressure of air is adjusted through lever according to the type of load acted over the vehicle.

Testng And Results : After the design and modification of cam shaft, it is placed in the place of conventional cam shaft. This cam shaft is driven by the crank shaft through chain drive. This modified engine is then connected to air compressor where compressed air is supplied.The engine is tested with various pressures ranging from 2 to 5 bars and various loads to calculate performance characteristics like torque, brake power etc**.**

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Figure 6 Brake test setup

As brake power is one of the important performance characteristics of any engine. In order to evaluate B.P of modified vehicle that runs with compressed air required to make a new setup that will give the B.P .So the above said setup exclusively made to calculate brake power.

Figure 7: Screenshot of CAV and test setup

The modified camshaft vehicle chain connected to test setup to find out brake power , so at different loads and pressures performance characteristics have been found out.

OBSERVATIONS: CAV along with brake test setup was connected to a compressor and compressed air was supplied at .

Readings at 4 bars:

a pressure of 4 bars and 3 bars and readings like load applied and rotations per minute (RPM) of the shaft were noted at 1, 2, 3 and 4 gears

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S.NO:	LOAD S1	LOAD S2	GEAR	RPM
1	6.3	3.1	1	70
2	6.3	3.1	2	117
3	6.3	3.1	3	133
4	6.3	3.1	4	164

Table 3: Readings at 4 bars

From above readings the following quantities can be calculated:

1. Torque (T): T = (S1-S2) ×9.81× (D+t)/2 (Newton- meter)

Where S1 and S2 are the loads

D is diameter of pulley i.e 35mm=0.035 mts

t is thickness of rope i.e 20mm=0.020 mts

(D+t)/2 = 0.0275 mts

1 kgF = 9.81 Newton

1. Brake power (B.P):

$$B.P = \frac{2\pi NT}{60} \text{ watts}$$

Where N is RPM

T is torque

2. Indicated power (I.P):

$$I.P = \frac{PVN}{60} \times 1000 \text{ watts}$$

Where P is pressure in $\frac{N}{m^2}$ i.e 1 bar = 10^5 $\frac{N}{m^2}$

V is volume of cylinder i.e 100×10^{-6} m^3

3. Efficiency (ŋ):

$$ŋ = \frac{B.P}{I.P} \times 100$$

4. Linear velocity (V):

$$V = \frac{2\pi Nr}{60} \times \frac{18}{5} \text{ Kmph}$$

Where r = radius of CAV wheel i.e 0.3 m

1 meter per second = $\frac{18}{5}$ Kmph

From above readings and formulae the following are calculated:

Torque = 0.864 N-m

S.NO:	GEAR	I.P	B.P	Efficiency
1	1	46.67	6.33	13.55
2	2	78	10.6	13.6
3	3	88.67	12.03	13.57
4	4	109.33	14.84	13.56

Calculations at 4 bars

The maximum velocity of CAV is calculated to be 18.55 KMPH.

READINGS AT 3 BARS:

S.NO:	LOAD S1	LOAD S2	GEAR	RPM
1	6.7	4.2	1	42
2	6.7	4.2	2	76
3	6.7	4.2	3	101
4	6.7	4.2	4	128

Readings at 3 bars

From above readings and formulae the following are calculated:

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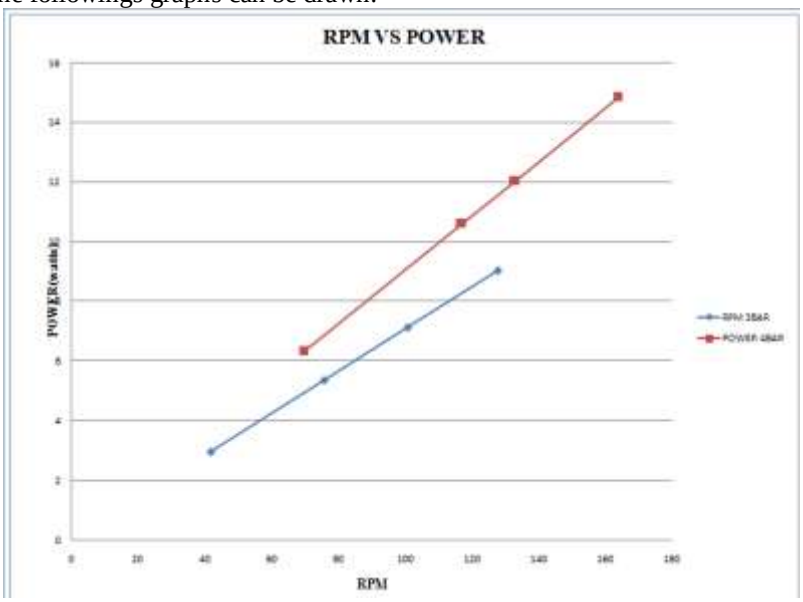
Torque = 0.675 N-m

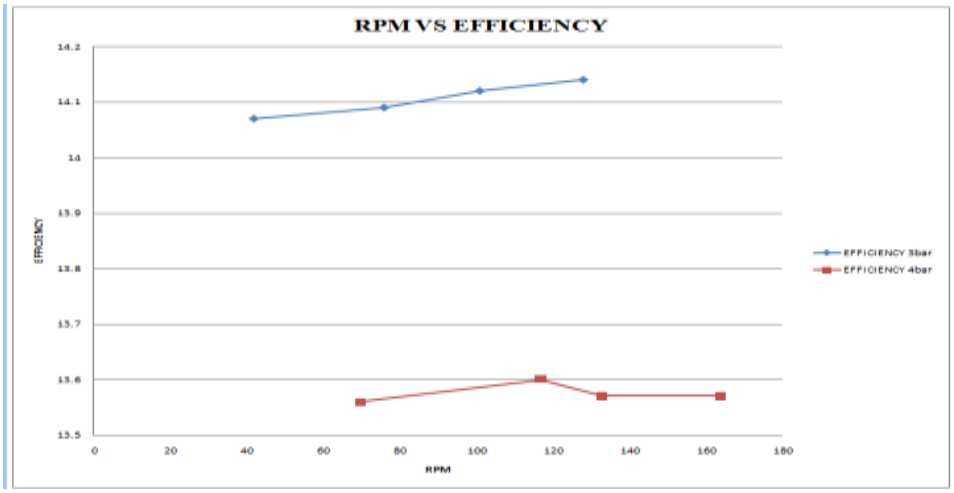
S.NO:	GEAR	I.P	B.P	Efficiency
1	1	21	2.97	14.07
2	2	38	5.37	14.09
3	3	50.5	7.14	14.12
	4	64	9.05	14.14

Table 6: Calculations at 3 bars

The maximum velocity of CAV is calculated to be 14.4 KMPH.
From the above calculations the followings graphs can be drawn:



Graph 2:PRM Vs POWER



Graph 3: Rpm Vs Efficiency

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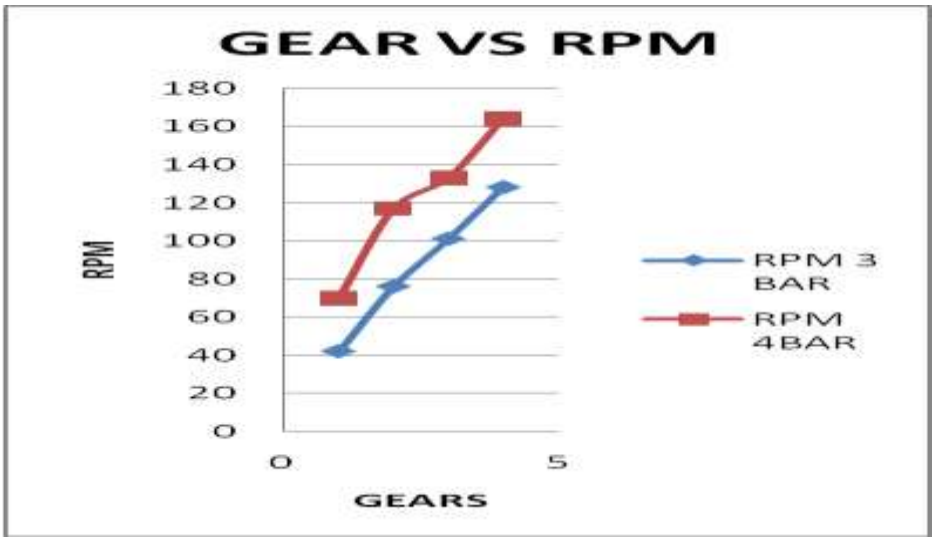
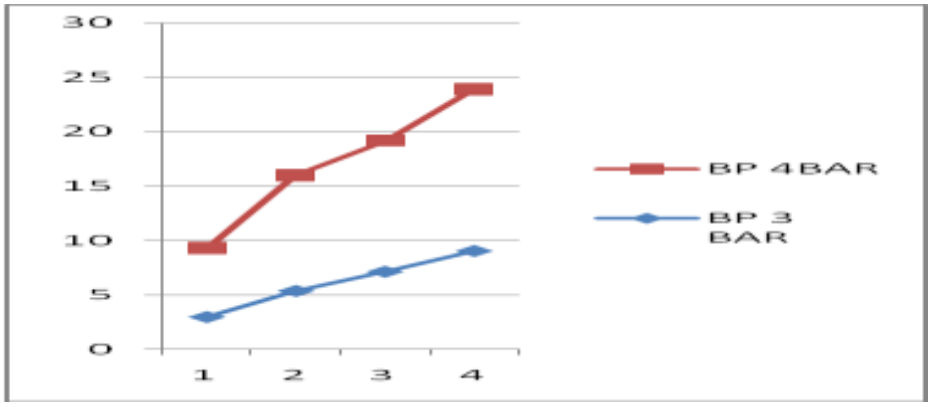


Graph 4: Gear Vs rpm



Graph 4: Brake Pressure at 3 and 4 bar

II. CONCLUSIONS

1) Compressed air vehicle which uses air as fuel can replace conventional vehicles which make use of petroleum products and CAV can be expected to be a future vehicle for a common man.
2) CAV encounters both fuel crisis and pollution form vehicles as the compressed air is non-combustible and non-polluting, As the air is abundantly available in nature the fuel cost is also reduced and as there is no combustion life span of engine increases.
3) As higher temperature are not reached in the engine which results in low maintenance cost and are economical. CAVs are very eco-friendly.
4) However, CAV has limitations like low speed, low load carrying capacity, distanced travelled by CAV mainly depends on the pressure at which the air is stored and how it is utilized to its best.
5) The performance of a CAV can be improved by reducing weight of the vehicle and optimizing the size of the cylinder for the specific purpose that it is being used i.e for public or goods transportation and also the type of vehicle i.e two or four wheeler.
6) CAV performance can also be increased reducing the weight of components of vehicle like the chassis, gear box, suspension system, steering and wheels.

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