

Modification of Radial Engine-Design and Analysis of Circular 'V' Engine

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ABSTRACT:

The conventional IC engines are an integral part of present day vehicles. The IC engine used in modern day cars and heavy vehicles is both heavy and space consuming. By modifying the engine suitably we can rectify this defect for better running of the vehicle. Radial engines were used in aircrafts and fighter planes before the introduction of jet engines. Radial engines were not used in all cars because they are not very fuel efficient and air cooling system was not suited for roads. The main objective of this project is to introduce a new modification in radial engines which can be used in four wheelers and heavy vehicles. The modified radial engines can provide excellent torque and power output compared to its predecessor. In the modified radial engine the cylinders are inverted and the cams are present in the outer side. This design is much more efficient than its earlier version and is very much compact in size. Lighter materials like Aluminium are used for reducing the weight of the vehicle in the front end. This results in a much balanced aerodynamic vehicle which is stable while cornering. Radial engines are also known for their acceleration and hence can be used in heavy vehicles for better load carrying capabilities. A modified version of a water cooling system and turbo-charger are used for reducing space and better power output. Hence for better safety, better fuel efficiency and better torque characteristics this design can be implemented in all four wheelers and heavy vehicles.

INTRODUCTION:

India was the fourth largest motor vehicle manufacturer in the world in 2016. Indian auto manufacturers produced a record 23.96 billion motor vehicles in 2015-16(Apr.-mar), including 3.22 million passenger vehicles.

India is the largest manufacturer of three-wheelers (934 000 in 2015-16) and the seventh largest manufacturer of commercial vehicles (811 000 in 2016). Nowadays many numbers of four wheelers are introduced to satisfy customer needs. Car users have also increased due to more comfort, safety and easier way of purchasing cars. But the one thing is now a day car itself the space increasing concepts are not in a clear conclusion. We discuss about the technologies implemented in the cars and what are the concepts to be changed in the cars for increasing space. Four wheelers like cabs, taxi and travel cars are used more by people, for their daily works and it is important to increase their comfort. Passengers need more space in their cars for their comfort and convenience and increasing the passenger capacity in the cars reduces the need for another vehicle. Vehicle manufacturers introduce new technologies to improve fuel efficiency, safety, comfort to sustain in the market. In that point of view, our project aims to reduce the space in the engine compartment by modifying the engine for increasing fuel efficiency and space in four wheelers. Modern day vehicles are equipped with electronic and IC components for safety and intelligent vehicle driving. To provide space for these components it is necessary to reduce the space occupied by the engine compartment. This is achieved by replacing the conventional inline engines with a modified version of the radial 'v' engine. The reduction in space in the front increases the loading capacity of the rear of the vehicle providing stability.

PROBLEM IDENTIFICATION:

Normal internal combustion engines are rectangular shaped and have many irregular patterns in it. The weight of the components also increases the gross weight of the vehicle.

Most of the space is occupied by the engine compartment like cylinder block, cylinder head, crank case, flywheel, turbo charger and cooling system such as radiator and other accessories. These are the components which are occupying more and more space in engine compartment so it reduces the space in driver and passenger compartment. And also it will reduce the mileage speed of the vehicle so these are the major problem which is not solved in now a day modern vehicles.

SOLUTION FOR PROBLEM:

Radial engine is in the shape of circular and the engines are in patterned position so the space is reduced by using this engine. Radial engine is mostly used in aero plane and aircraft so it has good performance efficiency but has more fuel consumption one. We have to modify the radial engine and used in the four wheeler (cars) and reduce the engine compartment area and increase the space in the passenger compartment. These will satisfy the driver and passenger needs and to increase the efficiency of the vehicle like pick up speed. So we take concentration in engine compartment and modify the engine model to reduce the space in engine block.

BENEFITS OF THE SOLUTION:

Compared to normal IC engine used in four wheelers are much more in space and weight, by changing the radial engine some benefits are mentioned below

- » More number of spaces will be reducing in engine compartment.
- » Efficiency will be increased.
- » Overall weight will be decreased.

METHODOLOGY:

Modification of radial engine is to increase the performance by changing the cam shaft position and flip the direction of piston cylinder inward to the engine block for easy cooling and lubrication purpose. In radial engine lubrication process are commonly for all cylinder block but in our engine there are separate lubrication and also separate cooling system to each and every cylinder block. Individual lubrication and cooling process increases efficiency of the engine and decrease the fuel consumption. Reduce the space in the engine by shifting the flywheel inside the engine and change the material properties of engine block to decrease the weight of overall engine. It has four cylinders blocks which are parallel to each other so named as "CIRCULAR 'V' ENGINE".

There are two types of crank shaft in our engine one is sub-crank and another one is main crank. When sub-crank is attached with connecting rod which collects the piston power inside the cylinder block and transfers the power to the main crank through power booster rod. And our new idea is the main crank which is outside of the engine (atmospheric friendly) fixed Centre of the engine block and it is connected with cam shaft and flywheel. Sub-crank powers are directly comes to Main crank shaft (through power booster rod) that collect all four cylinders power and stores the power with the help of flywheel, main crank are connected by power booster rod. This modification helps to increase the efficiency of the engine by changing the position of cam shaft which are placed Centre of engine block (inside) by increasing the speed of valve opening and closing help to speed up the piston cylinder for working stroke and re-arrange the piston cylinder direction inside the engine block with each other of cam shaft. The radial configuration was very commonly used for aircraft engines before gas turbine engines became predominant. It was very big in size because of its cylinder arrangements. So this type of engines are not coming to the four wheelers (cars). Our project is discussed about to modify the radial engine and develop in the four wheelers for driver and passengers comfort to increasing the space in the cars. Normally radial engines have more than 4 cylinders so we also designed 4 cylinder engine named as circular 'v' engine based on the car dimension requirements. Compared to normal radial engine circular v engine is the closed loop engine and all the components are assembled inside the engine this is one of the advantage for this engine. So the circular V engine is designed and develops based on the four wheeler specification.

DESIGN AND MODIFICATION OF RADIAL ENGINE-CIRCULAR 'V' ENGINE:

Design of our project is done in PTC CREO 3.0 software.

There are different steps for designing a components which are listed below,

- (i) 2D modelling
- (ii) 3D solid modelling
- (iii) Analysis

2D modelling:

2D modelling is the first step to develop the design component in two dimensional views. Design and drafting 2D model of the circular V engine components based on the radial engine specification.

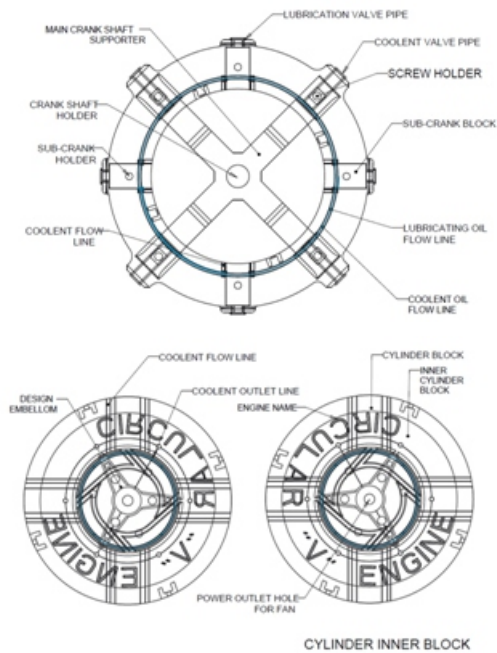


Fig 1. 2D Design of cylinder inner and outer block

3D MODELLING:

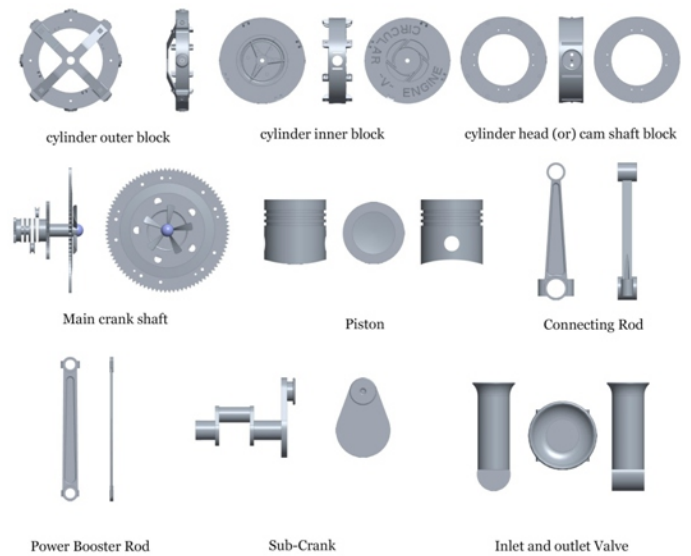
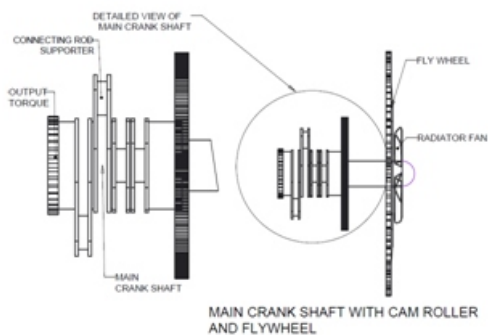
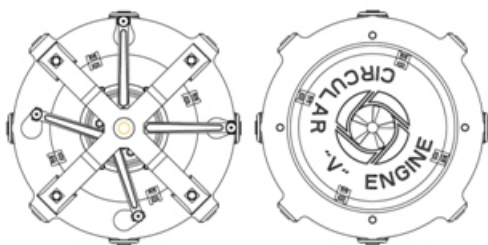


Fig 2. Overall component in the engine.



2D design of Main crank shaft



Conceptual 2D design of circular V engine

ASSEMBLY OF CIRCULAR 'V' ENGINE:

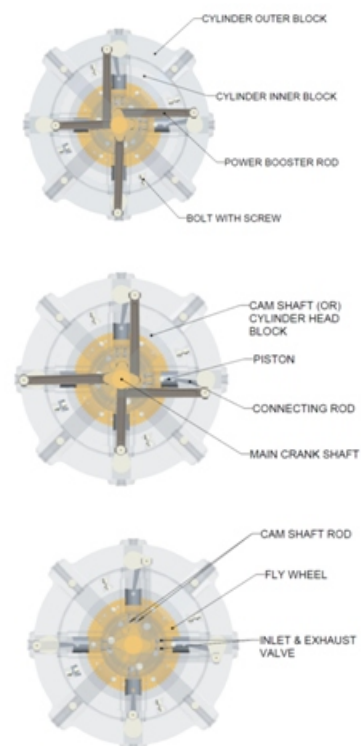
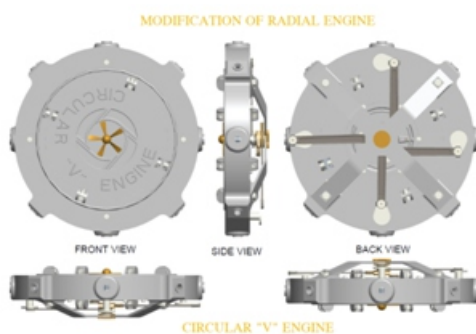
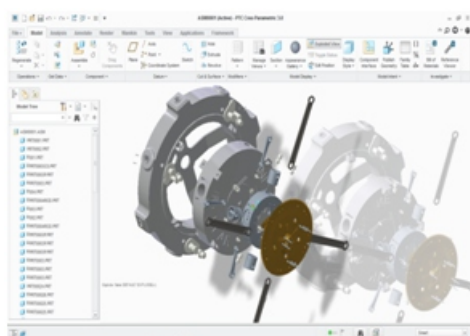


Fig 3. Assembly section



Full assembly section.



Exploded view of assembly section in software.

Therefore, the normal cars having the length of 4.275 in meter and 2.038 meter in width, from this dimension engine block occupy $\frac{1}{4}$ of the total space which means 1.785 meter in width and 1.06 meter in length. so we rectify that problem by design the circular V engine occupy space in car of 1.325 meter in width and 0.95 meter in length so we reduce 0.46 meter in width and 0.11 meter in length. From this modification we increase the space in driver and passenger compartment.

Efficiency calculation:

Four main derivations are calculated below,

Cylinder Swept Volume (V_c):

$V_c = \text{Cylinder Area} \times \text{Stroke Length}$

$V_c = A_c \times L = \pi/4(d_c)^2 \times L$

$d_c = 75\text{mm} = 7.5\text{cm}$ $L = 8.8\text{mm} = 8.8\text{cm}$

$V_c = \pi/4 \times (6)^2 \times 8.8$ $V_c = 389\text{cc}$

Indicated Power (i_p):

$I_p = ((i_{mep}) L A n K) / (60 \times 1000)$

$A = 28.2\text{cm} = 0.282\text{m}$

$I_{mep} = P_m \times L \times A \times N$

$P_m = 60\text{ bar}$

$= 60 \times 0.08 \times 0.282 \times 2000 = 21\text{ kN/m}^2$

$I_p = 21 \times 0.08 \times 0.282 \times 2000 \times 4 / 60 \times 1000$

$= 0.069 \times 106\text{ W}$ $I_p = 69\text{ kW}$

Brake Power (b_p):

$b_p = ((b_{mep}) L A n K) / (60 \times 1000)$

b_{mep} for radial engines is 850 kPa – 1500kPa

$b_p = (85 \times 0.088 \times 0.282 \times 2000 \times 4) / 60,000$ $b_p = 58\text{ kW}$

frictional losses:

$f_p = i_p - b_p = 69 - 58$ $f_p = 9\text{ kW}$

Engine mechanical efficiency:

$\eta_m = (\text{Engine Brake Power}) / (\text{Engine Indicated Power}) = b_p / i_p$

$= b_p / (b_p + f_p) = 58 / 69$ $\eta_m = 0.85 = 85\%$

Based on the radial engine specification, we calculate the efficiency for circular V engine such as indicated power and brake power normal radial engine have 80% efficiency based on the IP & BP in our modification we increase the efficiency 5% more than the normal engine by modify the cylinder bore and cylinder area and then modify the valve timing mechanism.

Graphical report for efficiency: based on the design and derivation we calculate the velocity and acceleration for our engine using creo3.0 software.



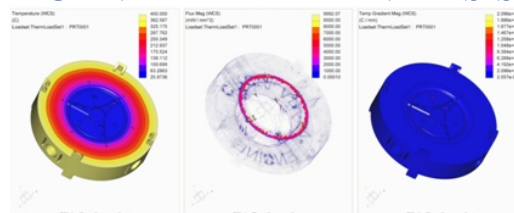
Engine is in idle



Engine is in acceleration

ANALYSIS:

STATIC AND THERMAL ANALYSIS:



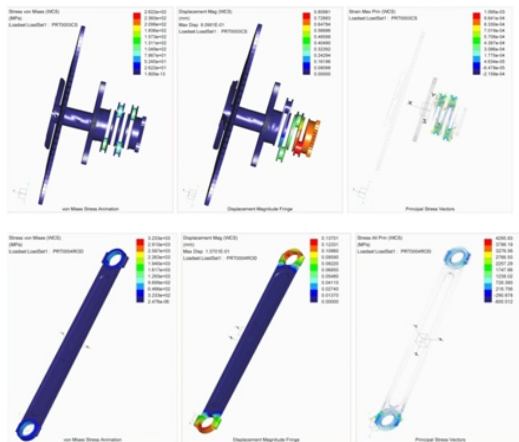


Fig 4. Analysis of cylinder block, main crank shaft and power booster rod

VIBRATION ANALYSIS:

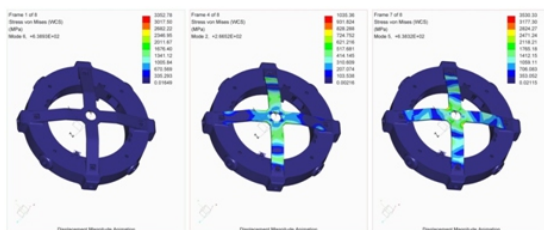


Fig 5. Vibration analysis of cylinder outer body

Finally we analyse the engine components based on the normal radial engine specification and compare the engines stress, strain and displacement. In our design static and thermal analysis are much better than normal radial engine because of changing the material properties and designing. Vibration analyses are calculated to check the cylinder block vibration for four wheelers comfort.

Conclusion:

After completing the design and analysis work we conclude the result that the modification of radial engine (circular V engine) is more comfort for four wheelers because of its design and its analysis report.



Fig 6. Future scope

So the new innovation of our project "circular V engine" is more suitable for car engine compartment and it will reduce more number of spaces and also has better efficiency to the vehicle.

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