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Design and Fabrication of Single Cylinder Six Stroke Engine over Single Cylinder Four Stroke Engine

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Abstract – One of the most difficult challenges in engine technology today is the urgent need to increase engine thermal efficiency. Higher efficiencies mean less fuel consumption and lower atmospheric emissions per unit of work produced by the engine. The six stroke engine is thermodynamically more efficient. Thus the Engine seems to show reduction in fuel consumption dramatic reduction in Air pollution.

Keywords— Efficiency, Fuel consumption, Air pollution, Power, Thermodynamic

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1. INTRODUCTION

The quest for an engine which having the same or more power with higher fuel efficiency than the existing ones has started before many years. As a result of all these researches a new engine concept is formed, which is a six stroke engine. Lot of research works are conducting on this topic nowadays and already six types of six stroke engines were discovered yet. Of these the resent developed three six stroke engines, i.e., Beare head, Bruce crowers and Velozeta's are undergoing tremendous research works [3].

During every cycle in a typical four stroke engine, piston moves up and down twice in the chamber, resulting in four total strokes and one of which is the power stroke that provides the torque to move the vehicle[4]. But in a six stroke engine there are six strokes and out of these there are two power strokes. The automotive industry may soon be revolutionized by a new six-stroke design which adds a second power stroke, resulting in much more efficiency with less amount of pollution.The term six stroke engine describes two different approaches in the internal combustion engine, developed since the early 1880s [2], Thus we have designed modified cam-lobe and timing chain sprocket to increase number of strokes per cycle.

2. LIMITATIONS OF 4 STROKE ENGINE

In four stroke engine, the piston executes four complete strokes within the cylinder, and the crankshaft completes two revolutions for each thermodynamic cycle [5]. The disadvantages of the four-stroke cycle are lower efficiency, pollution is more in four stroke engine, very less heat utilization, cooling system is required.

3. WORKING OF SIX STROKE ENGINE

Six Stroke Engines are similar to a conventional Four Stroke internal combustion engine, except its feature is that it provides an additional power stroke and exhaust stroke. The six strokes that will takes place in our engine are Suction, Compression, Expansion, Exhaust, Air suction, Air Exhaust respectively. The first four strokes work on the basis of Otto cycle or Diesel cycle. The heat of combustion which is left over after the exhaust stroke (4^{th} stroke) is used to create an additional expansion stroke. Air or water can be used as the fuel for the fifth stroke. In this case, we are injecting air as a fuel in fifth stroke.

In fifth stroke, air is injected into the combustion chamber at the end of exhaust stroke, it expands due to the heat inside the combustion chamber. The expansion of air forces the piston to move down from TDC to BDC, hence creating the power stroke.In sixth stroke, air with all remaining unburnt gases are thrown out at a time hence we get better scavenging which keeps the engine clean and also increases volumetric efficiency.

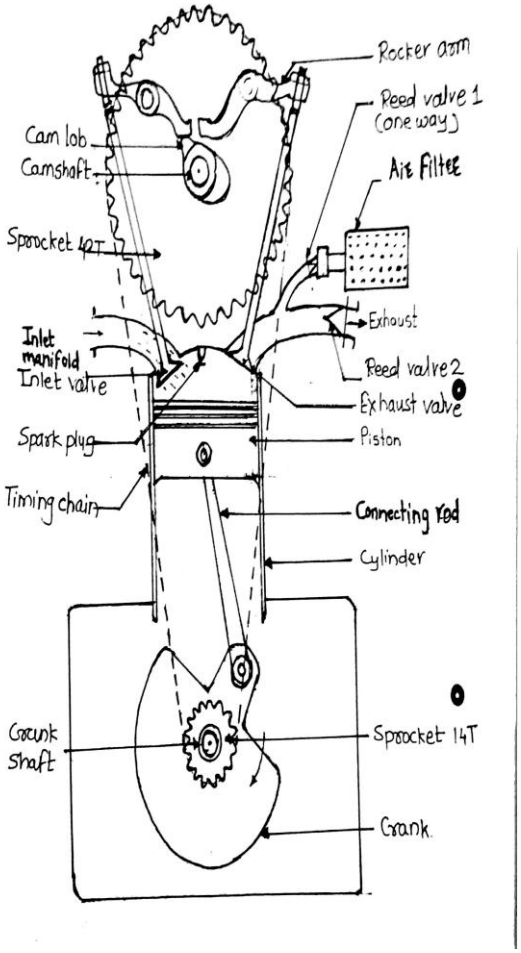


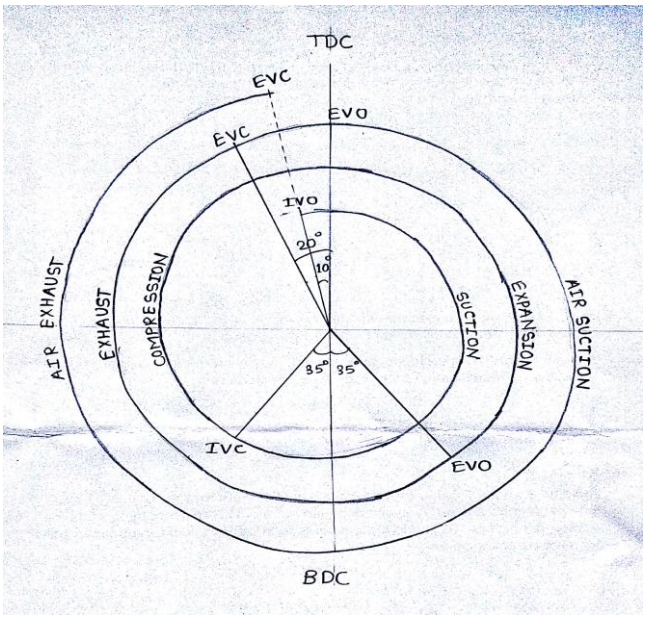
Fig. 3.1- Six stroke engine model

4. MODIFICATIONS IN FOUR STROKE ENGINE

In the six stroke engine the crankshaft has 1080 degrees of rotation for 360 degree rotation of the camshaft per cycle. Hence their corresponding sprockets are having teeth in the ratio 3:1. In the original four stroke engine the teeth of the sprockets of the crankshaft and the camshaft were in 2:1 ratio [1].

In the six stroke engine the 360 degrees of the cam has been divided into 60 degrees among the six strokes. The valve provided at the exhaust has to be kept open during the fourth, fifth and the sixth stroke. The cam has been made double lobed in order to avoid the hitting of the exhaust valve with the piston head.

We have changed the valve timings of the original four stroke engine to design two lobes of cam for exhaust valve. Thus, newly formed valve timing diagram is shown below -



Abbreviations used in figure-
TDC - Top Dead centre
BDC - Bottom Dead Centre
IVO - Inlet Valve Open
IVC - Inlet Valve Closed
EVO - Exhaust valve Open
EVC - Exhaust Valve Closed

Fig. 4.1- valve timing diagram of six stroke engine

4.1. Parts modified –

A. Camshaft -

Selection of Material –

EN8 with hardness 45 HRC

Manufacturing process –

Firstly, we have measured dimensions of the camshaft of four stroke engine to design new cam-lobes of six stroke engine. By using valve timing diagram, we decided dwell and rise periods of the inlet and exhaust cams for opening and closing of the valves.Then cam-lobe profile is generated. We have fabricated it by using wire cutting process.

Original camshaft of 4 stroke engine is grinded upto the internal diameter of the cam-lobes manufactured and these cam-lobes are press fitted on that grinded shaft. This assembly is fixed together by using key between them.

Inlet cam-lobe-

Base circle diameter -25 mm

Valve lift - 6 mm

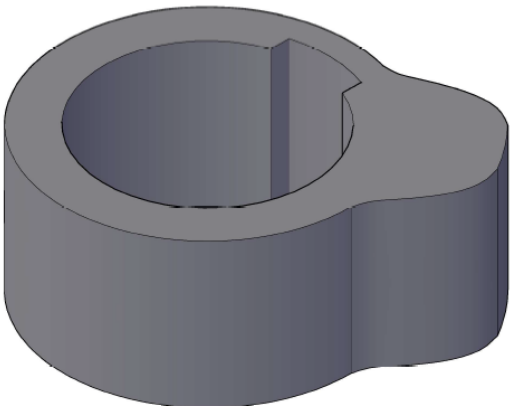


Fig. 4.1.1.Inlet cam-lobe

Exhaust cam-lobe –

Base circle diameter -25 mm

Valve lift - 6 mm

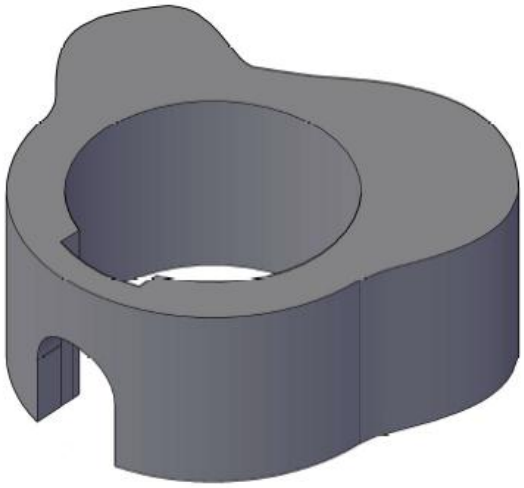


Fig. 4.1.2. Exhaust cam-lobe

B .Sprocket-

Selection of Material –

EN8 with hardness 40 HRC

Dimensions -:

No. of teeth	-	48
Module	-	6.629 mm
Pitch circle diameter	-	97.495 mm
Dedendum	-	93.854 mm
Addendum	-	101.354 mm

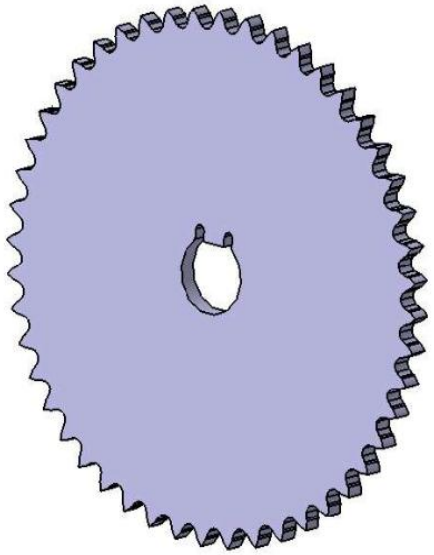


Fig. 4.1.3. Design of Timing chain Sprocket

2 .Secondary air induction system-

The secondary air induction system, supplies the air which is used during the fifth and sixth stroke. During the fifth stroke air from the air filter is sucked into the cylinder through the secondary air induction line. The reed valve opens to permit the air flow. During the sixth stroke, the air is removed through the exhaust manifold. The reed valve opens and the reed valve closes during this stroke. The inlet valve remains closed during these strokes.

5. RESULTS AND DISCUSSIONS

We have modified the parts in Four stroke engine i.e. camshaft and sprocket mainly to increase two strokes by using same amount of fuel as in four stroke engine. To check whether the results will come out as expected by us, we are going to take following tests.

5.1 Performance tests-

We are going to take two tests i.e. Engine load test and pollution test on the six stroke engine and on the same four stroke engine from which the six stroke was developed[1][3].

The load test will be conducted by using brake drum dynamometer. The engines will be tested for 320 rpm and 640 rpm under the same loading conditions [1]. The time for consumption of 10cc of the fuel will be noted during the experiment. The % vol. of CO in

exhaust gas during idling will be tested to check the pollution level of the engines.

5.2. Expected outcomes-

- Reduction in fuel consumption per cycle upto 30% to 40% [1].
- Reduction in pollution upto 50% to 60% [1].
- Better scavenging and more work per cycle.
- Better utilisation of heat.

6. LIMITATIONS

- Complex head design
- Complex cam design for exhaust (due to 2 exhaust strokes)
- Thermodynamically the engine is stable, yet the designing of parts becomes more and more complex as the torque requirement increases.

7. CONCLUSION-

As we know that, till the date pollution is becoming a great environmental issue as it directly affects on the human health. But still there are not any special improvements in automobiles which are basically main cause of air pollution. Only improvements of the current technology can help it progress within reasonable time and financial limits. The six-stroke engine fits perfectly into this view. Its adoption by the automobile industry would have a tremendous impact on the environment and world economy. Better fuel economy and cleaner burning longer service intervals and considerably reduced tooling costs when compared with a conventional four-stroke design we expect that, efficiency increased by the upto 35 %.

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