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A Review: Six Stroke Internal Combustion Engine

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***Abstract*: A Six Stroke Engine is that in which the power is obtained twice in a cycle of six strokes. This engine generates more power with higher fuel efficiency than the existing engines. As a result, a new engine concept is formed, which is a six stroke engine. Lot of research work has been conducted on this topic nowadays. In a typical four stroke diesel engine, Piston moves up and down twice in the cylinder during one rotation of crank. The power stroke is obtained once during the two cycles that generates the torque to move vehicle. In Six stroke engine the power stroke is obtained two times out of six strokes. The automobile industry is now seeking for the best six-stroke design which adds one more power stroke which results more efficiency and better utilization of the fuel. The main advantages of six stroke engine are two power strokes in the six stroke cycle, reduction in fuel consumption by 30-40 percent, dramatic reduction in pollution, adaptability to different fuel operation. Development of Six stroke engines by the automobile industry would have a tremendous impact on the environment and economy. The developed six stroke engines, Beare head, Bruce crowers and Velozeta's are undergoing tremendous research works.**

In this paper the concept, features and the comparative discussion on six-stroke diesel engine is done.

***Keywords*: Internal Combustion Engine**

1. Introduction

The six-stroke engine is a type of internal combustion engine with an advance feature of more power generation some complexity intended to make it more efficient and utilize the fuel. These engines almost consist of similar components as that of the four stroke engine with addition of two more valves. The working concept is similar to the actual internal reciprocating combustion engine as a reciprocal movement which is converted into a rotating movement by means of a connecting rod and of a crankshaft.

The brief explanation of working of the four stroke engine is it consists of two cycles. In first stroke is suction as the piston moves down air-fuel is intake after the 180-degree rotation of the crank the piston moves up and compresses the fuel mixture this is the compression stroke. When the piston comes to close to the dead centre the fuel an ignition plug ignites the mixture by means of a spark which provokes a sudden rise of temperature and of pressure. This is known as the power stroke and as the fuel burn the piston permits the combustion gases to expand the piston moves down with high torque. The piston moves down fast and again comes up meanwhile the exhaust valve opens and all the burned gases are exhausted. The diesel engine uses a comparable principle where the difference resides in the way of introducing the fuel, which, in this case, is directly injected into the compressed, and therefore hot air, and flames up then spontaneously [1].

The six-stroke engine is a radical hybridization of two and four stroke engine that the top portion of two stroke engines and the bottom rather the middle section of a four stroke engine. In six-stroke cycle, two parallel functions occur in two chambers which result in eight event cycle: four events internal combustion cycle and four event external Combustion cycles.

The first cycle of four events is of external combustion.

- Pure air intake in the cylinder.
- Pure air compression in the heating chamber.
- Keeping pure air pressure in closed chamber where a maximum heat exchange occurs with the combustion chambers walls, without direct action on the crankshaft.
- Expansion of the super-heated air in the cylinder, work.

During this four event's cycle, the pure air never comes in direct contact with the heating source.

The second cycle of four events is of internal combustion.

- Re-compressions of pure heated air in the combustion chamber.
- Fuel injection and combustion in closed combustion chamber, without direct action on the crankshaft.
- Combustion gases expanding in the cylinder, work.
- Combustion gases exhaust.

During these four events, the air comes in direct contact with the heating source.

2. Principle of Six-Stroke Engine

The six-stroke engine describes a number of approaches in IC engine to utilize the waste heat from the 4-stroke diesel cycle or Otto cycle and use it to generate more power. Generally, the one compression and one power strokes are added to cycle which higher the thermal efficiency and reduces the fuel consumption. The piston in six-stroke engine moves up and down six times for each injection of fuel. The first four strokes are same as that of the 4-stroke engine after the exhaust the fuel-air mixture is again compressed and burned gases are removed

during the sixth stroke. The glowing combustion chamber allows the optimal burning of any fuel and calcinate the residues.

The first stroke of the six-stroke cycle, i.e. the admission of the air or of the air-fuel mixture, involves only low pressure admission cylinders. The third and fourth strokes of this same cycle, i.e. the second compression and the first expansion of the combustion gases respectively, involve only high pressure combustion cylinders. The final discharge of the combustion gases under low pressure, which represents the sixth stroke of the cycle, involves only low pressure admission cylinders and low pressure discharge cylinders.

The engine shows 30-40 percent reduction in fuel consumption and also economical. The engine can also use variety of fuel. As the engine has two powers stroke that gives the efficient burning of the fuel and lower the pollution [3].

3. Analysis of Six Stroke Engine

The six-stroke engine consists of six stroke and these are shown in figure. Each figure shows the movement of the air-fuel mixture, valves and piston. The name of the components are,

1. Intake valve
2. Heating chamber valve
3. Combustion chamber valve
4. Exhaust valve
5. Cylinder
6. Combustion chamber
7. Air heating chamber
8. Wall of combustion chamber
9. Fuel injector
10. Heater plug

A. Stroke-1

The inlet valve is kept open. Due to cranking, Piston moves downward which results in the formation of a pressure difference due to which pure air enters the cylinder.

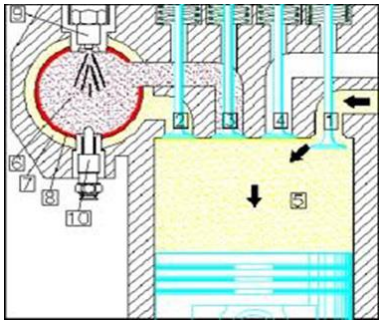

Fig. 1. Intake of pure air in cylinder

B. Stroke-2

The inlet valve closes and the heating chamber valve opens. The piston moves upward due to cranking forcing air into heating chamber. The air at this stage is converted to high pressure.

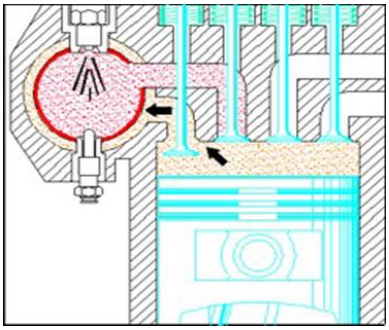

Fig. 2. Compression of pure air in heating chamber

C. Stroke-3

The combustion chamber valve opens and gases of combustion enter the cylinder.

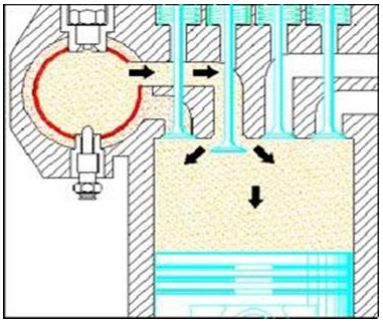

Fig. 3. Release of combustion gases in the cylinder

D. Stroke-4

The exhaust valve opens. The piston moves upwards and the exhaust gases are removed via this valve.

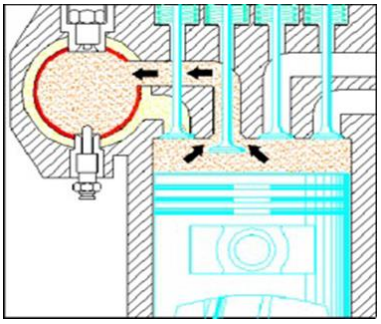

Fig. 4. Recompression of the pure air in chamber

E. Stroke-5

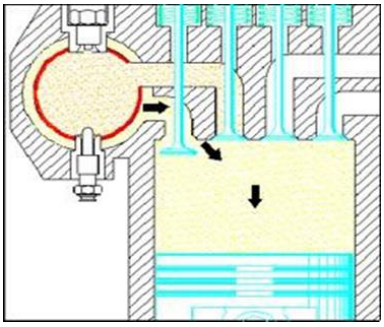

Fig. 5. Release of pure air into cylinder

The chamber valve opens and the pure air now at high pressure and high temperature enters the cylinder which does work on the piston and hence it moves downward resulting in the 2nd power stroke.

F. Stroke-6

Finally, the combustion chamber valve opens. The piston moves upwards forces the pure air into the combustion chamber [4].

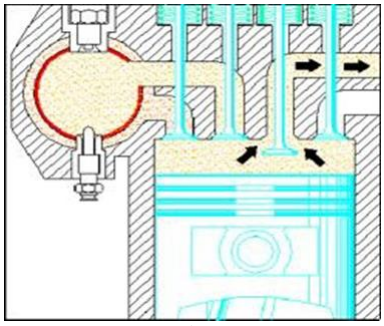

Fig. 6. Exhaust of combustion gases

4. Major Inventors of Six-Stroke Engine

A. Beare Head

The term "Six Stroke" was coined by the inventor of the Beare Head, Malcolm Beare of Australia. The technology combines a four stroke engine bottom end with an opposed piston in the cylinder head working at half the cyclical rate of the bottom piston. Functionally, the second piston replaces the valve mechanism of a conventional engine [5].

B. Bruce Crowers

In a six-stroke engine prototyped in the United States by Bruce Crower, water is injected into the cylinder after the exhaust stroke and is instantly turned to steam, which expands and forces the piston down for an additional power stroke. Thus, waste heat that requires an air or water cooling system to discharge in most engines is captured and put to use driving the piston [6]. Crower estimated that his design would reduce fuel consumption by 40% by generating the same power output at a lower RPM. The weight associated with a cooling system could be eliminated, but that would be balanced by a need for a water tank in addition to the normal fuel tank. Leonard Dyer invented the first six-stroke internal combustion water injection engine in 1915, very similar to Crower's design. A dozen more similar patents have been issued since.

Dyer's six-stroke engine features:

- No cooling system required
- Improves a typical engine's fuel consumption
- Requires a supply of pure water to act as the medium for the second power stroke.
- Extracts the additional power from the expansion of steam.

C. Velozeta's

In a Velozeta engine, fresh air is injected into the cylinder during the exhaust stroke, which expands by heat and therefore forces the piston down for an additional stroke. The valve overlaps have been removed and the two additional strokes using air injection provide for better gas scavenging. [5]

5. Advantages and Disadvantages

An operating efficiency is of approximately 50%, hence the large reduction in specific consumption. The specific power of the six-stroke engine will not be less than that of a four-stroke petrol engine, the increase in thermal efficiency compensating for the issue due to the two additional strokes. Chemical, noise and thermal pollution are reduced. There occurs no problem in combustion due inflammability difference in six stroke engine. Better combustion and expansion of gases that take place over 540° of crankshaft rotation, 360° of which is in closed combustion chamber, and 180° for expansion. It has less inertia due to the lightness of the moving parts [6].

It has also some disadvantages as brake power & indicated power per cycle per cylinder is comparatively lesser. The Engine size increases due to number of cylinders & additional components. These engines are complex in design and hence higher manufacturing cost [7].

6. Conclusion

From the above data the concept and working of the six-stroke engine can be understood. Six stroke engines with all the desired qualities as better from four stroke engines will be hitting the market soon. Reducing fuel consumption and pollution without any effect on performance will reassessed the concept of automobile. 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 good impact on the environment and world economy.

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