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# Analysis of Six Stroke in an Internal Combustion Engine

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***Abstract***

*In the present time, increasing use of auto-vehicles requires more need of fuel and eventually it produces more emissions. But fuel and natural resources are limited in amount. So the aim is to reduce the emissions and fuel consumption in the engines. In that case, six-stroke engine is the great solution. Six-stroke engine is the modified form of four stroke engine. It contains two additional strokes (power stroke by air, exhaust stroke by air). Hence there are two power strokes in a one cycle. The main advantage of six-stroke engine is that fuel consumption is reduced by 40% and thermal efficiency reaches up to 50%.*

***Keywords**: Combustion chamber, air heating chamber, power stroke by air, exhaust stroke by air*

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## INTRODUCTION

### Six-Stroke I.C. Engine

The six stroke engine captures the wasted heat from the four stroke Otto cycle and creates steam which simultaneously cools the engine while providing a free power stroke. This eradicates the need for a cooling system making the engine lighter plus giving 40% amplified efficiency over the Otto cycle. Head technology combines a four stroke engine bottom end with a ported cylinder which closely resembles that of a two stroke, thus 4 + 2 = Six stroke. It has an opposing piston which acts in unison with auxiliary low pressure reed and rotary valves, letting flexible compression and a range of tuning options.

As well as extracting power, the additional stroke cools the engine and removes the need for a cooling system making the engine lighter and giving 40% increased efficiency over the Otto cycle. The pistons in a six stroke engine go up and down six times for each injection of fuel. Figure 1

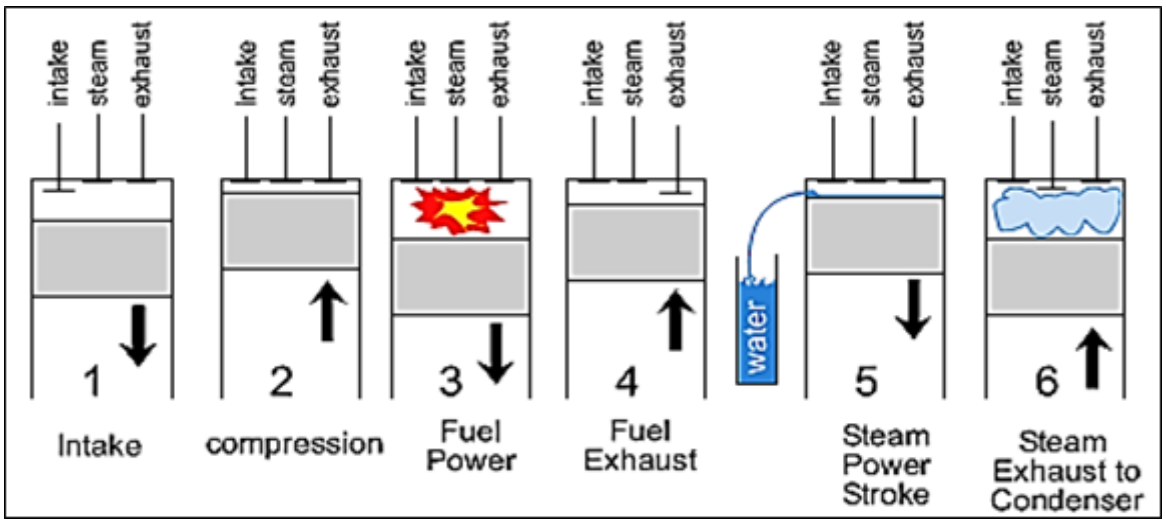


***Fig. 1:** Working of Six Stroke I. C. Engine.*

  

## Currently Notable Six-Stroke Engines

### *Bajulaz Six-Stroke Engine*

The Bajulaz six-stroke engine is identical to a regular combustion engine in design. However, there are amendments to the cylinder head, with two supplementary fixed capacity chambers, a combustion chamber and an air preheating chamber above each cylinder. The combustion chamber takes heated air from the cylinder; the injection of fuel starts an isochoric burn which rises the thermal efficiency related to a burn in the cylinder. Thus, a high pressure is achieved which is released into the cylinder to work the power or expansion stroke. In the meantime, a second chamber which blankets the combustion chamber has its air content heated to a maximum degree by crossing heat through the cylinder wall. This heated and pressurized air is then used to power an additional stroke of the piston[3].Figure 2

The aids of the engine include reduction in fuel consumption by at least 40%, two expansion strokes in six strokes, multi-fuel usage competence, and a histrionic reduction in pollution.[2-4]

The Bajulaz six-stroke engine was invented in 1989 by the Bajulaz S., a company based in Geneva, Switzerland. It has U.S. Patent 4,809,511 and U.S. Patent 4,513,568.

The Bajulaz six-stroke engine features:

1. Reduction in fuel consumption by at least 40%;
2. Two expansion (work) strokes in six strokes;
3. Multifuel, including liquefied petroleum gas;
4. Dramatic reduction in air pollution;
5. Costs comparable to those of a four-stroke engine.

***Fig. 2:*** *Bajulaz Six-Stroke.*

### *Velozeta Six-Stroke Engine*

In a Velozeta engine, during the exhaust stroke, fresh air is injected into the cylinder, which expands by heat and therefore forces the piston down for an additional stroke. The valve intersections have been detached and the two extra strokes using air injection provide for improved gas scavenging. The engine seems to show 40% reduction in fuel consumption and dramatic reduction in air pollution. Its specific power is not much less than that of a four-stroke Gasoline engine. The engine can run on a variety of

fuels, ranging from Gasoline and diesel to LPG. An altered engine shows a 65% reduction in carbon monoxide pollution when compared with the four stroke engine from which it was developed. The engine was developed in 2006 by a team of mechanical engineering students (Aaron Joseph George, Arun K Nair, Boby Sebastian, Krishnaraj U) of the College of Engineering, Trivandrum[2].

***Crower Six-Stroke Engine***

In a six-stroke engine prototyped in the US 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 most engines require an air or water cooling system to discharge is captured and put to use for driving the piston. Crower assessed that his design would lessen fuel consumption by 40% by generating the identical 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. The Crower six-stroke engine was an experimental project that fascinated media attention in 2006 because of an interview given by 75 year old American inventor who applied for a patent on his design. That patent application was subsequently abandoned.[5-7] Leonard Dyer invented the first six-stroke internal combustion water injection engine in 1915, which is very similar to Crower's design. A dozen more similar patents have been issued since then. Dyer's six-stroke engine features:

1. No cooling system required.
2. Improves a typical engine's fuel consumption.
3. Needs a supply of clean water to behave as the medium for the second power stroke.
4. Extracts the additional power from the expansion of steam.

**Construction**

The construction of the present six stroke engine is shown in Figure 3 with the successive strokes.

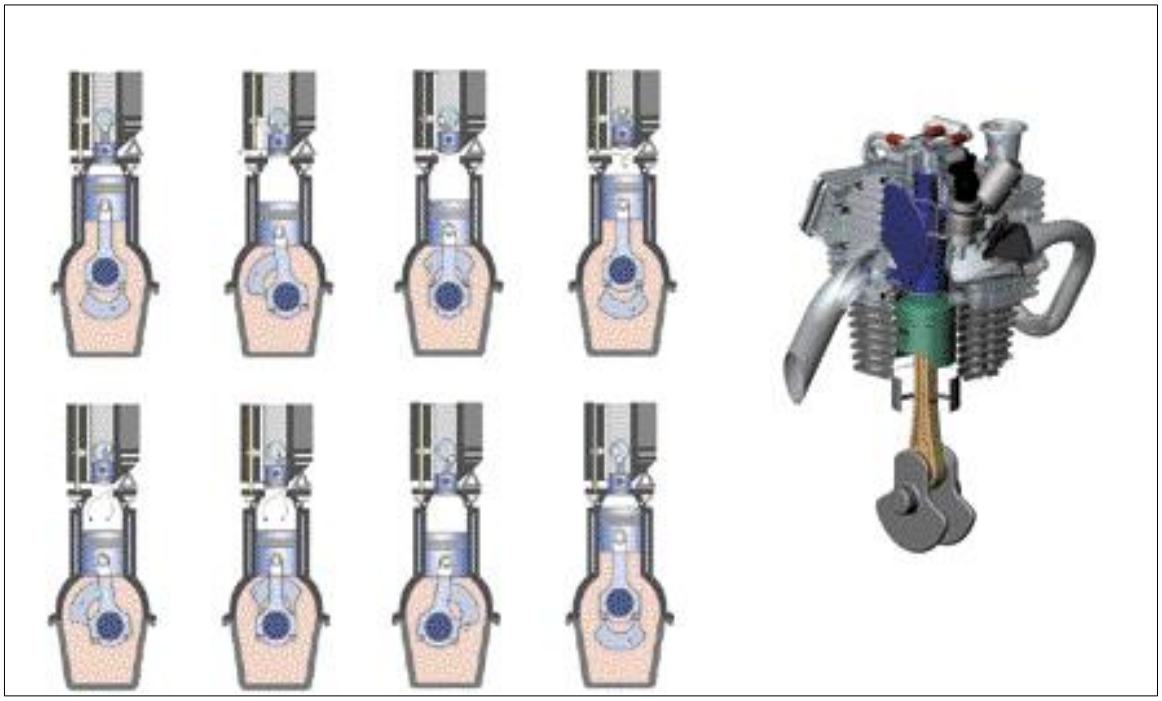

***Fig. 3:*** *The Cross-Sectional View of the Stokes in the Six Stroke Engine.*

## SIX STROKES OF ENGINE

**(*In the six stroke engine, the successive strokes are described as follows with operating condition*.)**

**First Stroke (Suction Stroke)**

Suction of air from atmosphere into the engine cylinder.

**Second Stroke (Compression Stroke)**

Pure air is compressed in air heating chamber.

**Third Stroke (Power Stroke)**

Combustion occurs in the combustion chamber. The flue gases expend in the engine cylinder and power stroke takes place.

**Forth Stroke (Exhaust Stroke)**

Piston moves from BDC to TDC and the flue gases leave the cylinder.

**Fifth Stroke (Power Stroke by Air)**

In this stroke the pure air goes from heating chamber to the cylinder. The piston moves from TDC to BDC.

**Sixth Stroke (Exhaust Stroke by Air)**

The pre-heated air compresses to the combustion chamber and piston moves from BDC to TDC.

## ADVANTAGES OF SIX STROKE ENGINE

1. Reduction in fuel consumption.
2. Dramatic reduction in pollution.
3. Better scavenging and more extraction of work per cycle.
4. Lower mean operating engine temperature.
5. Temperature level for better performance.
6. Less friction; so, less wear and tear.
7. The six-stroke engine does not require any basic modification to the existing engines.

All technological experience and production methods remain unaltered.

## CONCLUSION

The new six stroke engine is the modified simple design than the earlier invention. It uses the exhaust temperature to impart the additional two strokes which eventually reduces the exhaust emission. This eco-friendly design also increases the engine efficiency up to 50% with the reduction of fuel consumption nearly 40% per cycle. Due to the overall mean operating temperature of the cycle, the life of the engine increase. The presented six stroke engine is easily replaceable in the present commercial vehicle due to almost identical construction to the existing design.

## REFERENCE

1. Ganeshan V. *Internal Combustion Engine*.
2. http://www.bajulazsa.com/site/sixstrokeexplanations.html
3. http://www.velozetas.com/site/sixstrokeexplanations;html
4. Study and Analysis of Six Stroke Engine (http://www.ijera.com/papers/Vol4_issue9/Version%201/E49012326.pdf)
5. Design and Analysis of Six Stroke Internal Combustion Engine (http://www.ijsrd.com/articles/IJSRDV2I3631.pdf)
6. http://www.mandieselturbo.com
7. http://www.crankshft design, materials, loads and Manufacturing, by EPI INC.Htm