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Concept of 3-Cylinder Engine

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***Abstract*: The 3-cylinder engine consist of three cylinders, two cylinder of same volume called HIGH-PRESSURE CYLINDERS (fired cylinders) both connected to third cylinder called LOW-PRESSURE CYLINDER of about twice the volume than the volume of each of the fired cylinders. The fired cylinder uses both fuel and steam for producing work output. It uses the heat of exhaust gases to generate steam from water which is further used as a working fluid for additional Power stroke. And hence both the fired cylinders work in a six stroke cycle. Furthermore the exhaust of both fired cylinders at every exhaust stroke is not rejected to atmosphere rather it is passed to LOW-PRESSURE cylinder where the additional expansion of exhaust products take place thereby giving extra power strokes. The above-described property of 3-cylinder engine causes the expansion ratio of medium in the engine is two times greater than the compression ratio. There is increased in Specific power and specific torque generated and also increased in fuel efficiency .It results in less fuel consumption. It uses the heat of exhaust gases which is usually lost in a engine. Around 30-40 % of energy is lost along the exhaust gases and 30-40 % is lost in cooling the engine. This 3-cylinder engine also reduce the heat use for cooling the system as water injected decrease the peak temperature of the cylinder walls.**

***Keywords:* 3-cylinder engine, combined working, water injection, crankshaft and additional expansion.**

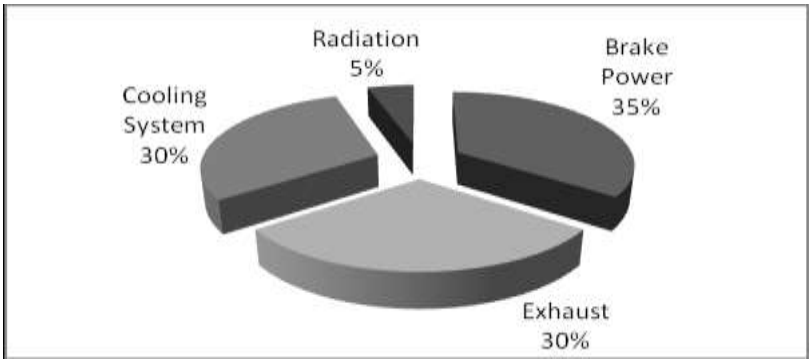
I. INTRODUCTION

This Paper consist the description of 3-cylinder engine, an uniquely designed IC engine having improved Thermal efficiency and work output. As the engine consist of 3 cylinders two of same size and volume called "High-Pressure" cylinder (Fired cylinders) and one of twice the volume of fired cylinders, it is called "Low-Pressure" cylinder. These cylinders concentrate on different task. Therefore the working of 3-cylinder engine can be divide into two:

1- Fuel combustion and steam expansion in High-Pressure cylinders (Fired cylinders).

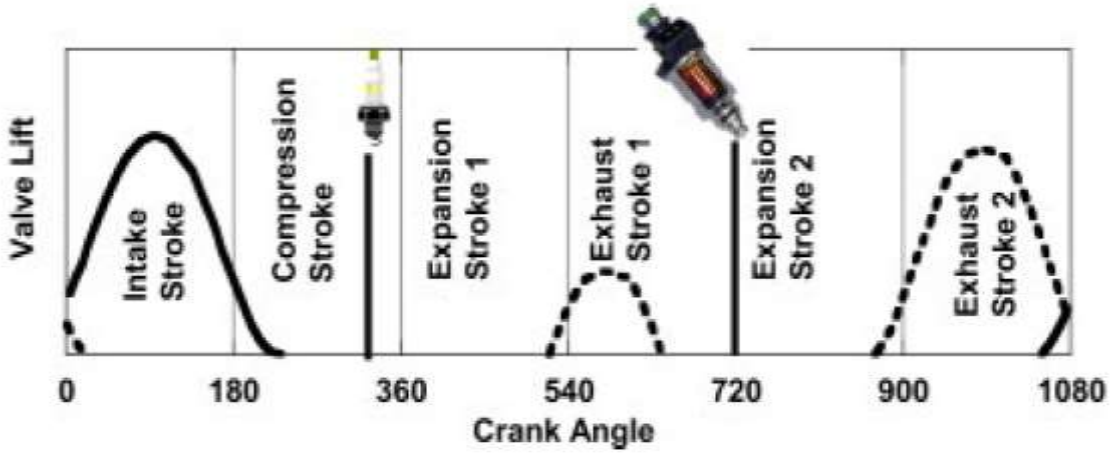
2- Additional expansion of exhaust products in Low- Pressure cylinder.

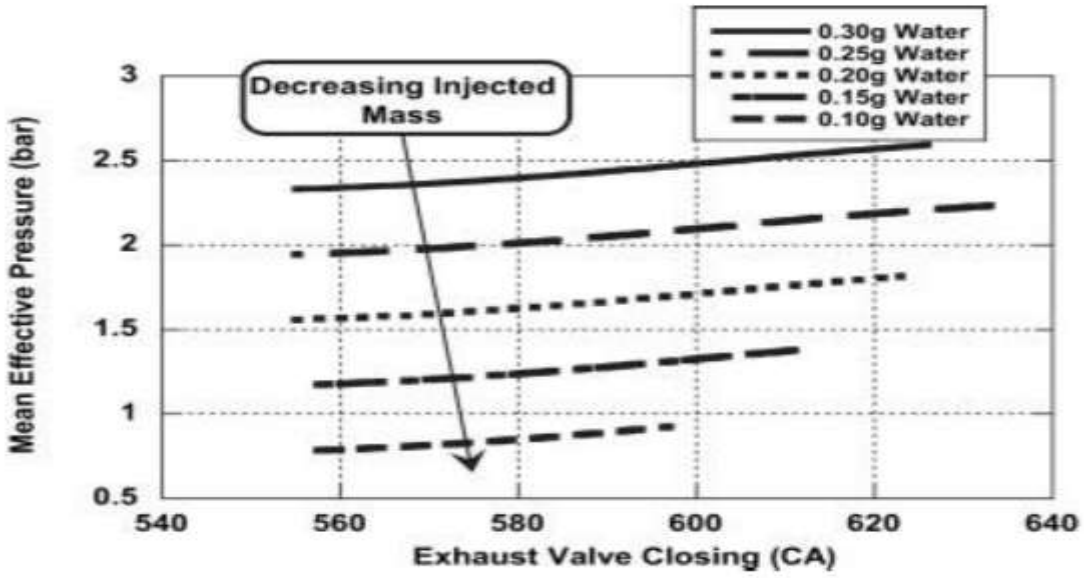
Working in High-Pressure cylinders: - In an internal combustion engine approximately 30 to 40% of energy (Heat) is converted into useful mechanical work. The remaining heat is expelled to the environment through exhaust gases and engine cooling systems. It means approximately 60 to 70% energy losses as a waste heat through exhaust (30% as engine cooling system and 30 to 40% as environment through exhaust gas). Exhaust gases immediately leaving the engine can have temperatures as high as 842-1112°F [450-600°C]. Consequently, these gases have high heat content, carrying away as exhaust emission. Fig. show total energy distributions from internal combustion engine.



This 3-cylinder engine effort to utilize the heat content of exhaust products and to also reduce the heat losses in cooling system. High-Pressure cylinders first intake air-fuel charge through intake valves, compressed the charge and burned it to produce Power stroke like in a conventional Four stroke engine.

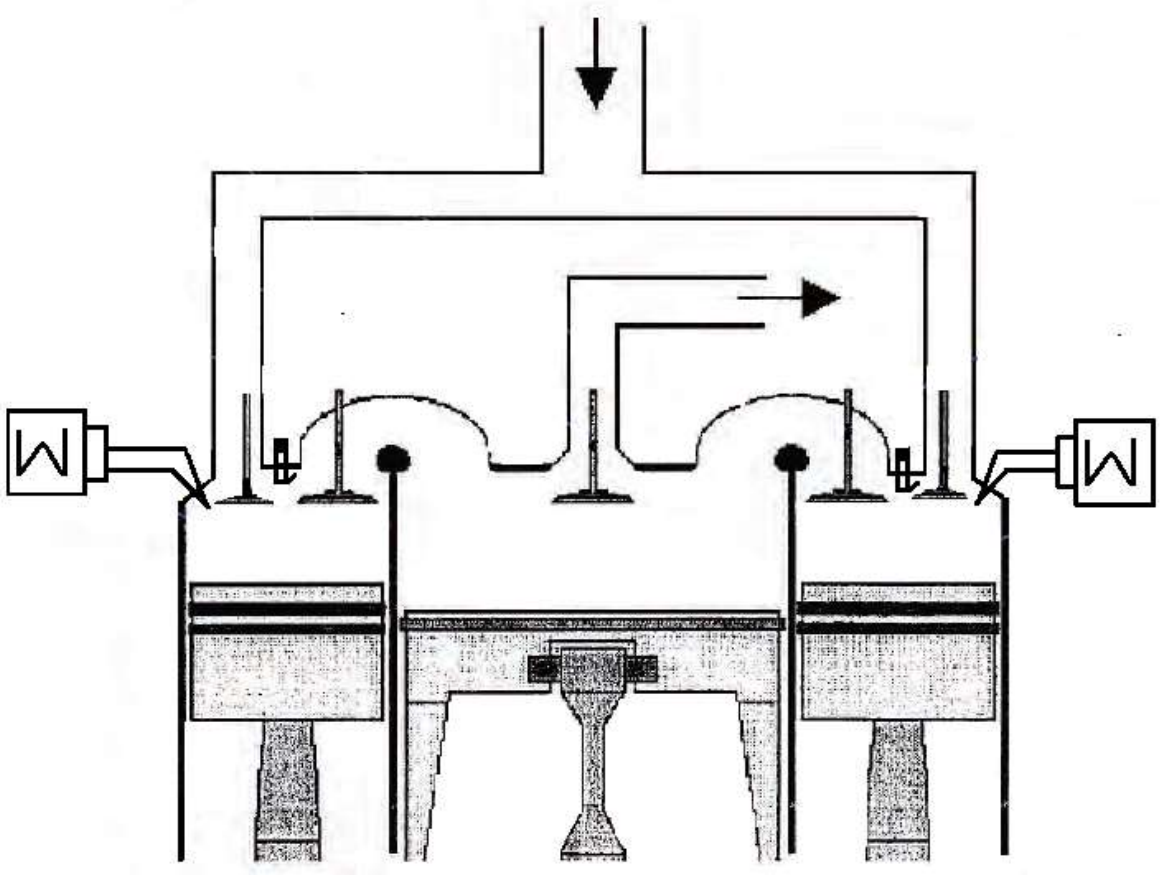
Just at the end of exhaust stroke high pressurized and preheated water is injected directly into super-heated cylinder. Through hot gases and from the heat of cylinder walls, the water immediately changes its phase into steam as the temperature of the hot gases is high. Steam works as a working fluid which expands up to 1600 times pushing the piston down. This movement gives additional two stroke for the same cycle. In this cycle, there is no need of external cooling system as the water will cools the system. Like this way, both the high-pressure cylinders works in a Six-stroke cycle.





Mean effective pressure due to second expansion with water injection in HP cylinder

Working in Low-Pressure cylinder: - The **high expansion ratio** will ensure a "high" conversion of the thermal energy into mechanical work. Normally in an engine expansion ratio is same as that compression ratio, therefore in order to increase expansion ratio an Additional degree of freedom is added to engine. By adding a low pressure cylinder of twice the volume of high-pressure cylinder. After the power stroke gases are not removed from them on the exhaust manifold and thence to the atmosphere, but are subject to additional expansion in the Low- Pressure cylinder . Only after a further expansion stroke in the low-pressure cylinder occurs exhaust to the atmosphere in the next piston stroke. In which there is additional expansion of exhaust products. The above-described property of 3-cylinder engine causes the expansion ratio of medium in the engine is two times greater than the compression ratio.

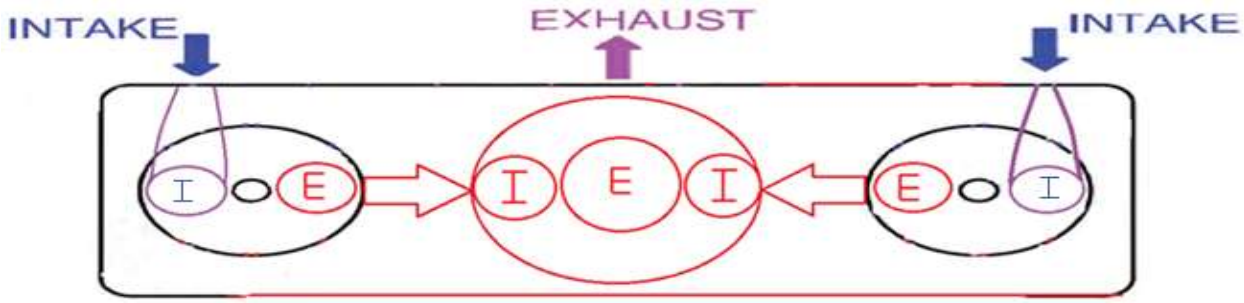


Tab. 1. The order of work of the 3-cylinder engine

Stroke No.	Process in the fired cylinder	Process in the cylinder of additional expansion (LP cylinder)	Process in the fired cylinder
1	Fuel **intake**	exhaust to the atmosphere	power
2	**compression**	additional work during expansion of the medium	outlet into the additional cylinder
3	**power**	exhaust to the atmosphere	Steam expansion
4	**outlet into the additional cylinder**	**additional work during expansion of the medium**	Steam exhaust
5	Steam expansion	exhaust to the atmosphere	Fuel **intake**
6	Steam exhaust	additional work during expansion of the medium	**compression**
...	Fuel **intake**	exhaust to the atmosphere	**power**
...	**compression**	additional work during expansion of the medium	**outlet into the additional cylinder**
	power	exhaust to the atmosphere	Steam expansion
...	**outlet into the additional cylinder**	**additional work during expansion of the medium**	Steam exhaust
...	Steam expansion	exhaust to the atmosphere	Fuel **intake**
...	Steam exhaust	additional work during expansion of the medium	**compression**
...	Fuel **intake**	exhaust to the atmosphere	**power**
...	...	...	...

II. ENGINE MODIFICATION

Engine cylinder head:



Crankshaft:

In four stroke engine, the crankshaft rotates about 720 degree while the camshaft rotates 360 degree to complete one cycle. But in 3- cylinder engine the crankshaft must rotate 1080 degree to rotate the camshaft 360 degree to complete one cycle. Thus the gear ratio of will be 3:1 instead 2:1 which is of four stroke engine.

The teeth of gear in crankshaft will be 18 and in camshaft the gear teeth will be 54 .The gear used in this is helical type gear which gives high speed and high speed rotation.

OLD NEW

Camshaft:

When camshaft rotates 360 degree in 3-cylinder engine, the cam has been divided into 60 degree among the six-strokes. There are two exhaust stroke, one will be at the time of fourth stroke through which hot gases or burnt gases are left out and the second one is at the six stroke which pushes the steam out.

OLD

NEW

Cams and camshaft:

Cam Follower:

The shape of follower which is used in four stroke engine is flat from the bottom. But when reducing the duration of opening the valve from 900 degree to 600 degree only then the shape of the follower must be changed from flat to 01.

Advantages of 3-Cylinder Engine:

1. More energy is extracted from the expansion stroke in six strokes.

2. Torque is increased by 35%.

3. Efficiency is also increased.

4. Reduction in pollution.

5. Reduction in fuel consumption.

6. Lower engine temperature so no need of extra cooling system.

7. High expansion ratio.

III. CONCLUSION

Due to water injection, the cooling system is improved. It enables lower engine temperature and high expansion ratio due to additional expansion of exhaust products, therefore increases its overall efficiency. This is the main advantage of 3-cylinder engine.

Using this technology by the automobile industry, marine industry, Defence sector, Aviation industry etc would have a tremendous impact on the environment and world economy, assuming up to 40% reduction in the fuel consumption and 60% to 90% in polluting emissions.

REFERENCES

[1] Excerpts from Beare technology.

[2] Pandiyaranjan V, Pandian M.C., Malan E from Experimental Investigation on Heat Thermoelectric Systems for Greener Vehicles, www.greencarcongress.com (accessed 27/11/2011).

[3] P.K. Nagg, Engineering Thermodyanamics.

[4] Randal, M., *Audi A4 Owners Workshop Manual. Jan 2005 to Feb 2008*, ISBN 978 1 844258857, Haynes Publishing, Sparkford 2010.

[5] Basshuysen, R. van, Schaefer, F., *Internal Combustion Engine. Handbook, Basics, Components, Systems and Perspectives*, SAE International, Warrendale 2004.