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Threats in Piston Engine Efficiency Embrace

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ABSTRACT

In piston engine, engine efficiency would be remaining around 60% to 70%. There is need to upgrade efficiency by using present day technology for saving valuable fossil fuel and valuable time and material. Could there something follow able from the piston pump design? In this research paper similar techniques have been shown to improve efficiency over 90% from present efficiency to save precious time, material and industrial mechanical floating fortunes.

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Let's have an overview on basic piston engine cycle:

In a reciprocating engine (Fig. A), a piston moves back and forth in a cylinder. The linear motion of the piston is converted to the rotation of a shaft by means of a crankshaft mechanism. The piston moves between the top center (TC) and bottom center (BC). When the piston is at the top, the volume in the cylinder is minimum and it is called clearance volume Vc, the maximum volume, reached when the piston is at BC, is called total volume Vt, and the difference (Vt – Vc = Vs) is the swept volume Vs. Fig. A (right) illustrates a typical pressure-volume diagram for a reciprocating engine.

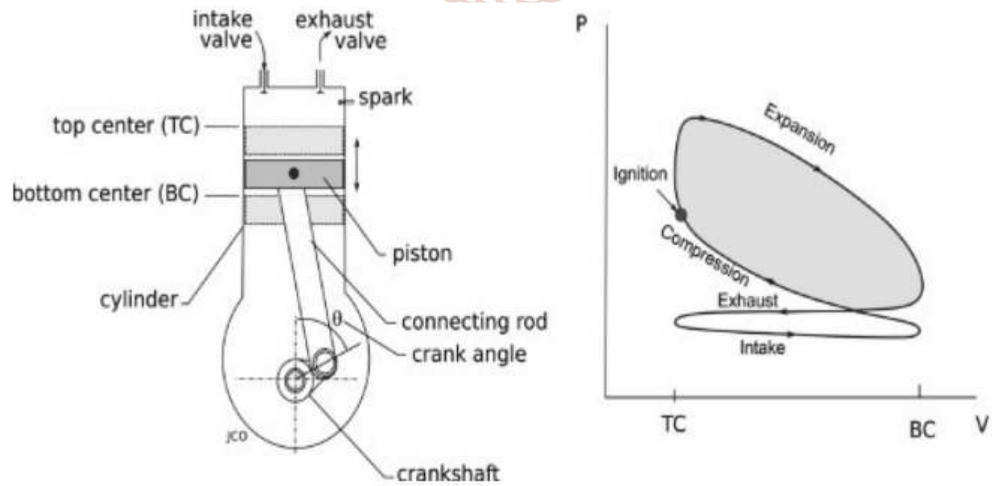

Figure A. Geometry of a reciprocating engine (left). Pressure-volume diagram for a reciprocating engine (right).

Let's have an overview on basic piston engine work:

Most reciprocating engines operate in a four-stroke cycle. In it, the piston sweeps the volume four times (up, down, up, down) while the shaft goes through two revolutions (see Fig. 3.13). The strokes are:

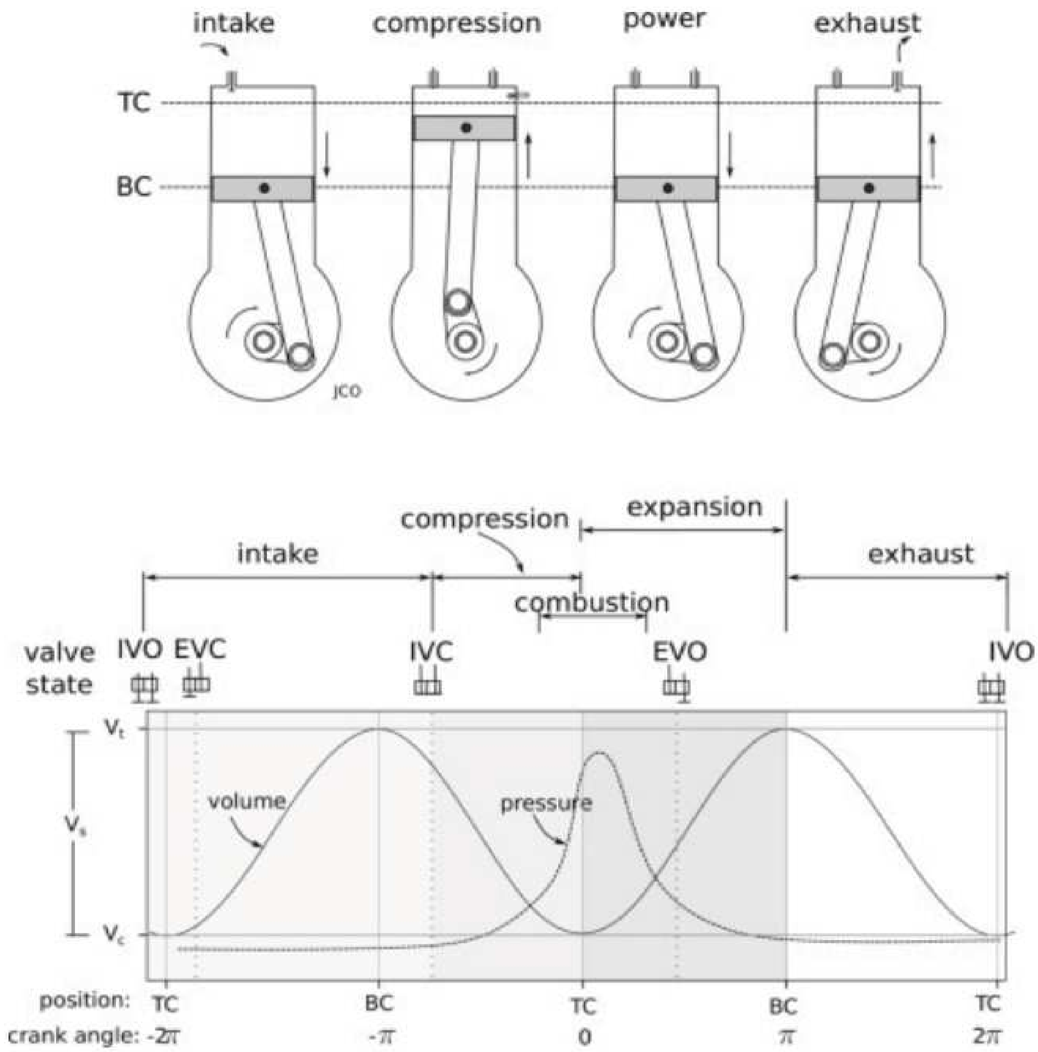

Figure B. Four strokes: intake, compression, power (expansion), and exhaust (top). Pressure and volume plotted against crank angle (bottom).

Intake stroke: The cylinder moves from TC to BC. The intake valve is open and fresh fuel–air mixture goes into the cylinder.

Compression stroke: The valves are closed and the piston moves upwards, reducing the volume available and thus increasing the pressure. Near the end of this stroke, the combustion starts either triggered by a spark (in spark ignition engines) or self-induced by the pressure levels (as in compression ignition engines). Once the combustion starts, the pressure rises rapidly.

Power stroke (expansion): The piston descends from TC, pushing the crank mechanism and therefore rotating the shaft. The work done during this stroke is larger than the one required during the compression stroke. Once the piston approaches BC, the exhaust valve opens, allowing the combustion products to escape.

Exhaust stroke: The piston moves up towards TC, and with the exhaust valve opened the combustion products finish exiting the cylinder.

Fig. B (bottom) illustrates the pressure and volume variation as a function of crank angle. The volume follows a sinusoidal pattern, as expected in the slider crank mechanism formed by the piston, connecting rod, and crank.

The pressure exhibits a sudden rise during the combustion phase. Observe the timing in the intake valve opening and closing (labelled IVO, IVC) as well the exhaust valve opening and closing (EVO, EVC). You can imagine that timing of the valves and of the start of combustion play a major role in the engine operation.

Overall efficiency of this design is from 60% to 70% which converts linear motion into Circular motion.

Let's have an overview on basic piston pump design:

Piston pumps: A piston pump is superficially similar to a motor car engine, and a simple single cylinder arrangement was shown earlier in Figure C. Such a simple pump, however, delivering a single pulse of fluid per revolution, generates unacceptably large pressure pulses into the system. Practical piston pumps therefore employ multiple cylinders and pistons to smooth out fluid delivery, and much ingenuity goes into designing multicylinder pumps which are surprisingly compact. The displacement of a piston pump can be easily calculated

$$Q = (\text{number of pistons}) \times (\text{piston area}) \times (\text{piston stroke}) \times (\text{drive speed})$$

Figure C shows one form of radial piston pump. The pump consists of several hollow pistons inside a stationary cylinder block. Each piston has spring-loaded inlet and outlet valves. As the inner cam rotates, fluid is transferred relatively smoothly from inlet port to the outlet port.

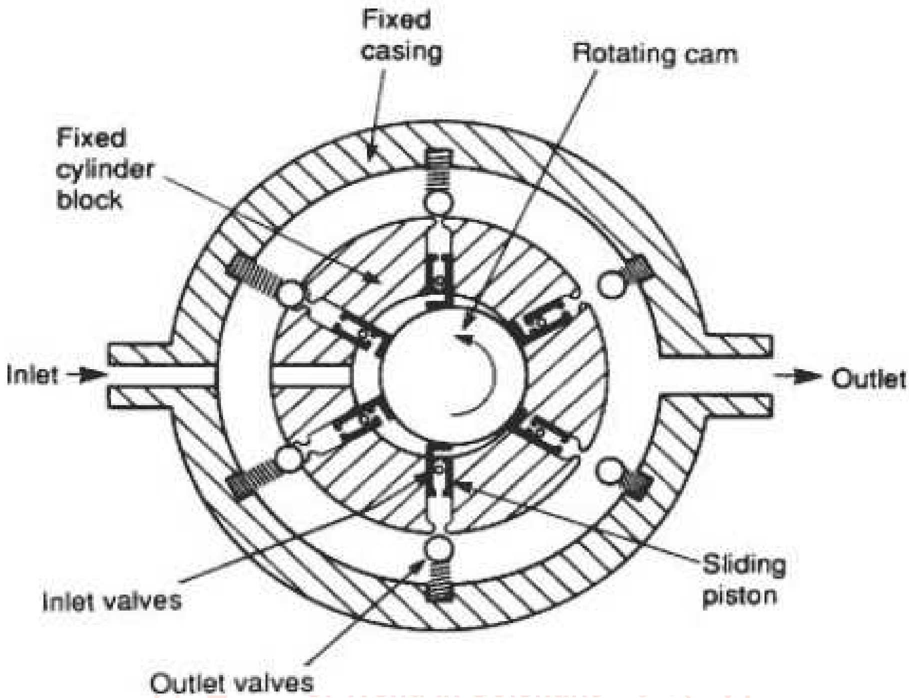

Figure C: Radial Piston Pump

The pump of Figure C uses the same principle, but employs a stationary cam and a rotating cylinder block. This arrangement does not require multiple inlet and outlet valves and is consequently simpler, more reliable, and cheaper. Not surprisingly most radial piston pumps have this construction. Like gear and vane pumps, radial piston pumps can provide increased displacement by the use of multiple assemblies driven from a common shaft.

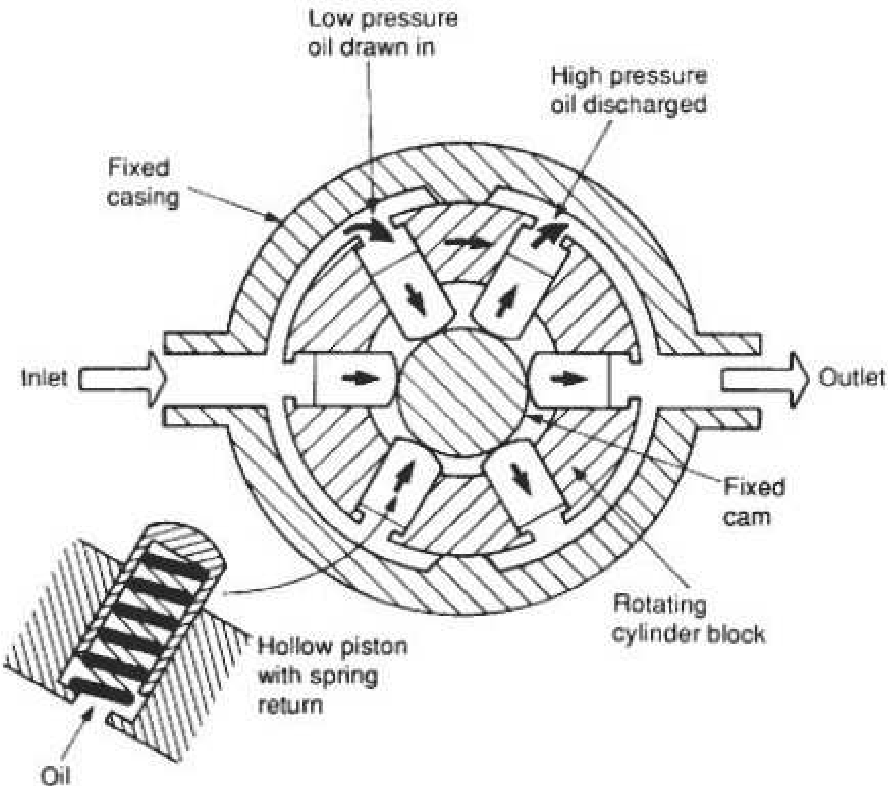

Figure: Piston pump with stationary cam and rotating block

Overall efficiency of this design is from 98% which converts Circular motion into linear motion.

Now if we convert piston pump in to reversable design which could convert linear motion into circular motion it could act as piston engine with similar function of piston engine but with higher 98% efficiency which is much higher than 60% efficiency of traditional piston engine.

Conclusion:

In nut shell, by using above piston pump machine design technology for the piston engine, efficiency could be improved from 60 % to 90 % overall after applying few needed changes in engine cycle.

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