COMPOUND ENGINE

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Abstract

Compound Engine Development and the novel method of cylinder filling, piston stop study, dual heat path, piston cooling, combustion chamber pressure development in the constant volume phase, stress containment in the non moving piston, emissions with the direct injection installation.

This development's intention is to answer the question of alternate method of production of mechanical power from the expanding medium.

The field of interest is dominated exclusively by the conventional Four Stroke, conventional Two Stroke and to smaller degree the Wankel engine with the first two existing in both low compression and Diesel configuration engine and Wankel as low compression only.

Those engines are present throughout the broad range of commercial applications since the since the turn of the 20 th century.

The Compound Engine Development and Compound Engine patents address the means and methods of exchange of spent or burned gasses for the fresh charge of air or fuel–air mixture in the two stroke configuration using the circular cross section pistons like the conventional Four and Two Stroke engines mentioned above and the practical method of stopping the piston mid cycle that will create a constant volume combustion chamber for the duration of the combustion process.

Keywords: *cylinder filling, constant volume combustion chamber, dual heat path, non moving piston, swash plate, efficiency gains*

In this authors view the Two Stroke configuration will succeed only if two of the following conditions are accomplished.

No 1, Effective Displacement over 70 %.
The Effective Displacement which is the displacement utilized when all the intake and exhaust widows are fully closed by the piston.
The Compound Engine configuration allows for the Effective Displacement of over 70 % of total displacement as suggested by the stroke of the piston.
That above mentioned figure in the best conventional Two Stroke engines stands now at about 55 %.
At 50 % effective displacement the Two Stroke engine advantage over the conventional Four Stroke engine is virtually non existent and what is remaining is only power to weight ratio and the cost of manufacturing advantage due to the non existence of the valve drive train mechanism.

No 2, Displacement Utilization.

The key to the higher Displacement Utilization that will provide the major advantages to the Two Stroke operation lies in the windows configuration Fig 2. Since the conventional Two Stroke engine positions all the windows at the bottom of the cylinder than it is impossible to replace the gasses with the small windows and regardless of the windows size the top portion of the cylinder remains difficult to reach.

Typically the gasses seeking the shortest path aerodynamically would flow from intake to the exhaust windows directly leaving the large portion of the gasses in the cylinder unchanged. In the end significant percentage of burned gasses remain in the cylinder up to 10 % leaving the remaining 90 % for Displacement Utilization.

In the Compound Engine configuration it is possible to have effective Displacement Utilization as high as 95 % or better with good exchange of gasses because the intake windows are positioned on one and of the cylinder and the exhaust windows are positioned in the other end allowing for the through flow. The Displacement Utilization comparison figure 3.

That is achieved by the use of two diameter piston Fig 2 that will open one set of windows with larger diameter and the other set of windows with the smaller diameter of the same piston having the intake and exhaust widows positioned at the opposite ends of the cylinder. In case of the engine configured with direct fuel injection gasoline or diesel and slight overflow of fresh air the Displacement Utilization of 95 to 98 % can be realized in Compound Engine configuration.

The second part of the Compound Engine Developments and the Compound Engine patents deals with the replacement alternative to the crankshaft and connecting rod system used exclusively throughout the engine industry excluding the Wankel engine.

The issue of transforming the reciprocating linear motion into the rotary motion is resolved by the Swash Plate Cam existing in some narrow applications in the industry at the present.

The Swash Plate Cam allows the customization of the linear to rotary movement transfer pattern to the needs of the internal combustion engine as opposed to the conventional crankshaft where the transfer pattern is non symmetrical sinusoid with no room for optimization whatsoever.

The conventional crankshaft movement does not match the combustion and pressure change pattern in the cylinder necessitating the ignition timing advance as much as 30% or more at the high power settings allowing for the pressure rise before the TDC producing the negative horsepower and allowing the piston to lower before the combustion and pressure has risen causing the further loss of efficiency.

These problems are addressed in the Compound Engine with Swash Plate Cam drive mechanism fig.1 where the piston is allowed to stop for the duration of combustion eliminating the need for the timing advance this change alone is credited according to the studies of some American Universities to provide the unprecedented 25 % in efficiency gain. The piston stop and dwell is accomplished by incorporating the flat portion on the cam profile.

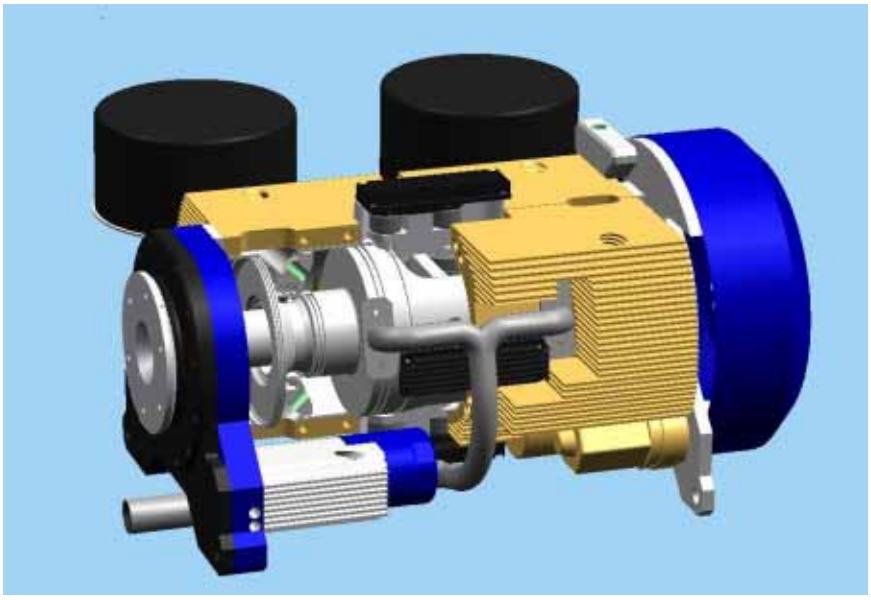

Figure 1. Compound Engine with Swash Plate Cam

As per the study conducted by the author all the mechanical cam configurations known throughout the industry are unsuitable for the engine applications except the mechanical configuration utilized in Compound Engine and included in the Compound Engine Corporation Patents.

Compound Engine Corporation Patents Summary:

United States Patent No 6,461.393
This patent deals mainly with the Compound Engine two diameter piston configuration, a swashplate cam
Drive spark plug ignition engine.

United States Patent No 6,895,907
This patent deals mainly with the same engine in diesel configuration, crankshaft drive and blower for the inducement of the flow of gasses.

United States Patent No 6,904.878
This patent deals mainly with the same configuration as previous including the swashplate.

United States Patent No 6,955.143
This patent deals mainly with the same configuration as previous patents including the opposite flow direction of the gasses induced by blower similar to the "Detroit Diesel "
Compound Engine with conventional crankshaft Fig 2, 3, 4, 5, 6, 7.

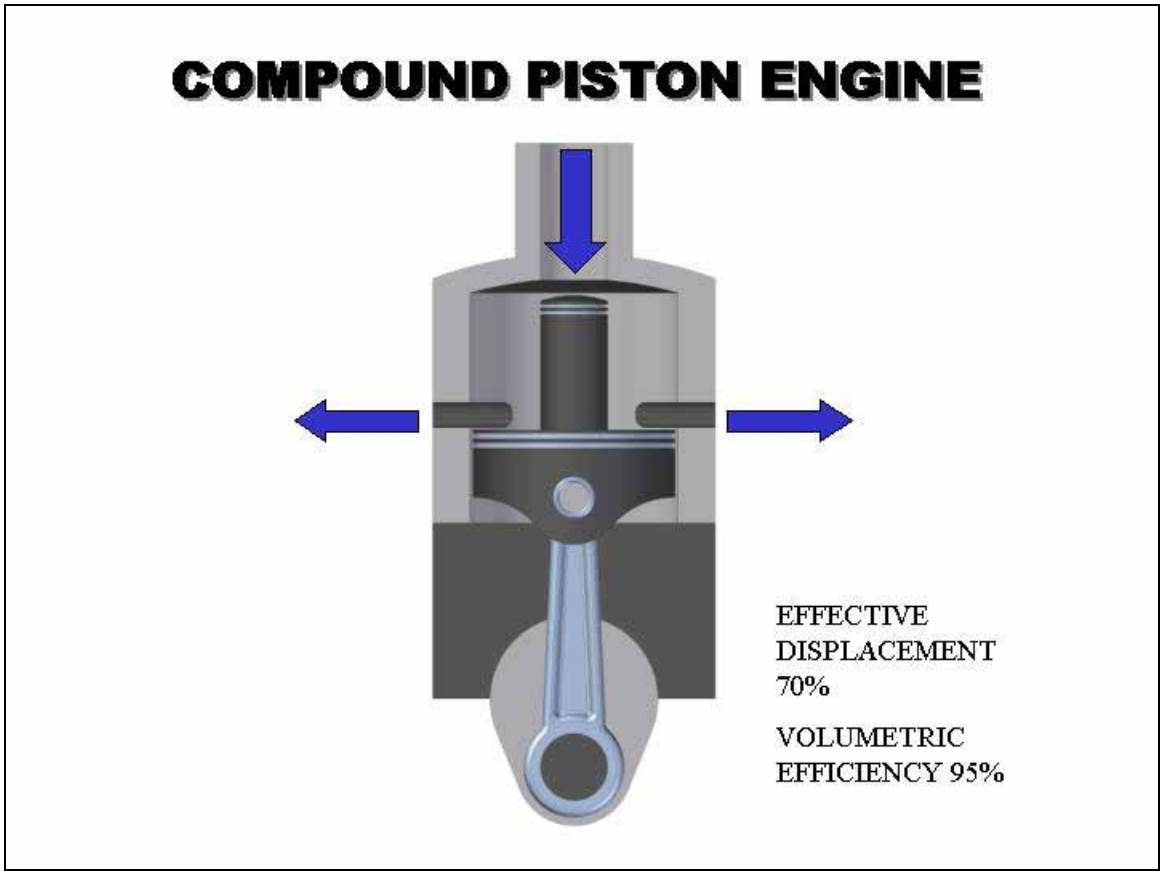

Fig. 2 Compound Engine with Two Diameter Piston

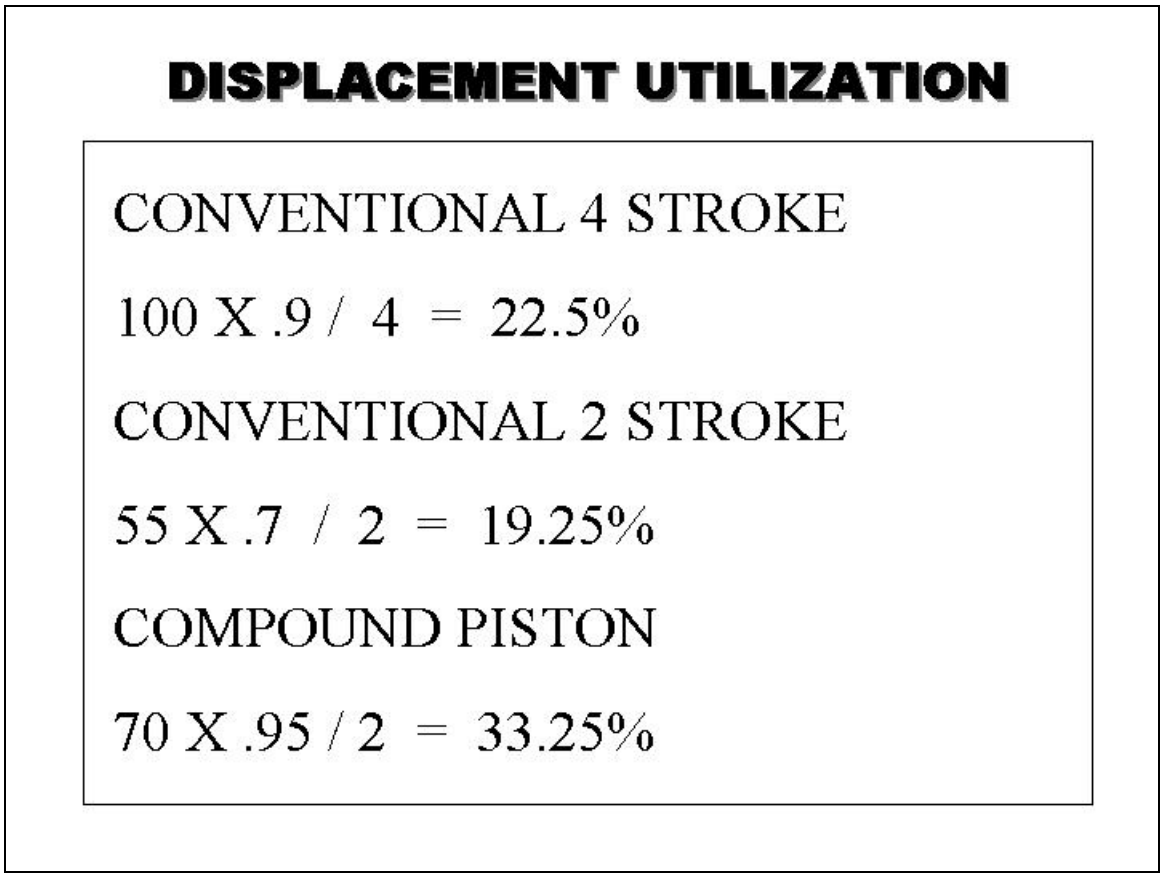

Fig. 3 Displacement Utilization Comparison

Fig. 4 1000 cc Compound Engine

Fig. 5 1000 cc Compound Engine Blower Installation

Fig. 6 Two Diameter Pistons, Intake and Exhaust Lines

Fig 7 Blower and Intake Configuration

This engine will not realize the advantages of the piston stop. However it will utilize the two-diameter piston Fig 2 Fig 6. providing the working surface as the larger piston surface area minus the surface area of the smaller piston. The larger piston bore is opening the exhaust windows at the bottom of it's stroke and the smaller piston is opening the intake windows at the same time Fig 2. providing the through flow through the cylinder area for efficient exhaust of the burned gases and the fresh mixture or air induction into the cylinder.
The low-pressure blower is required to introduce the fresh mixture or air into the intake windows and cylinders.
Fig 5. No valves or valve train is used and the piston cylinder lubrication is accomplished in the same manner as the conventional 4 strokes.
Higher Volumetric efficiency than the conventional 2-stroke engine is expected with the basic simplicity of the design that does not have the valves and the valve drive mechanism.

Manufacturing developments:

At the present time the Compound Engine Corporation is testing the Gasoline version of Compound Engine 1200 cc displacement two cylinders with the swash plate cam drive producing the 10 degrees dwell angle for piston stop.
The second engine currently being manufactured is a 1000 cc Compound Diesel Engine two cylinder " V " configuration with the conventional crank shaft and proprietary balancing mechanism.