The Ogunmuyiwa Engine Cycle P-V Diagram

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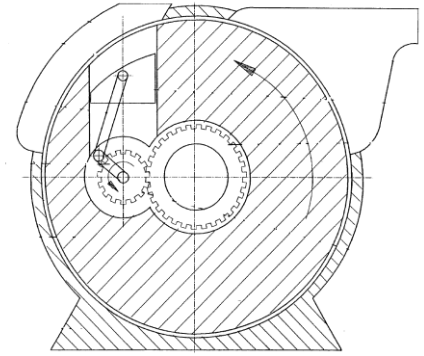

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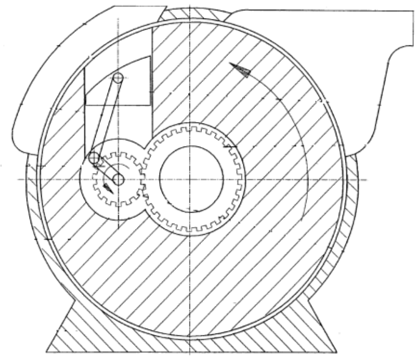
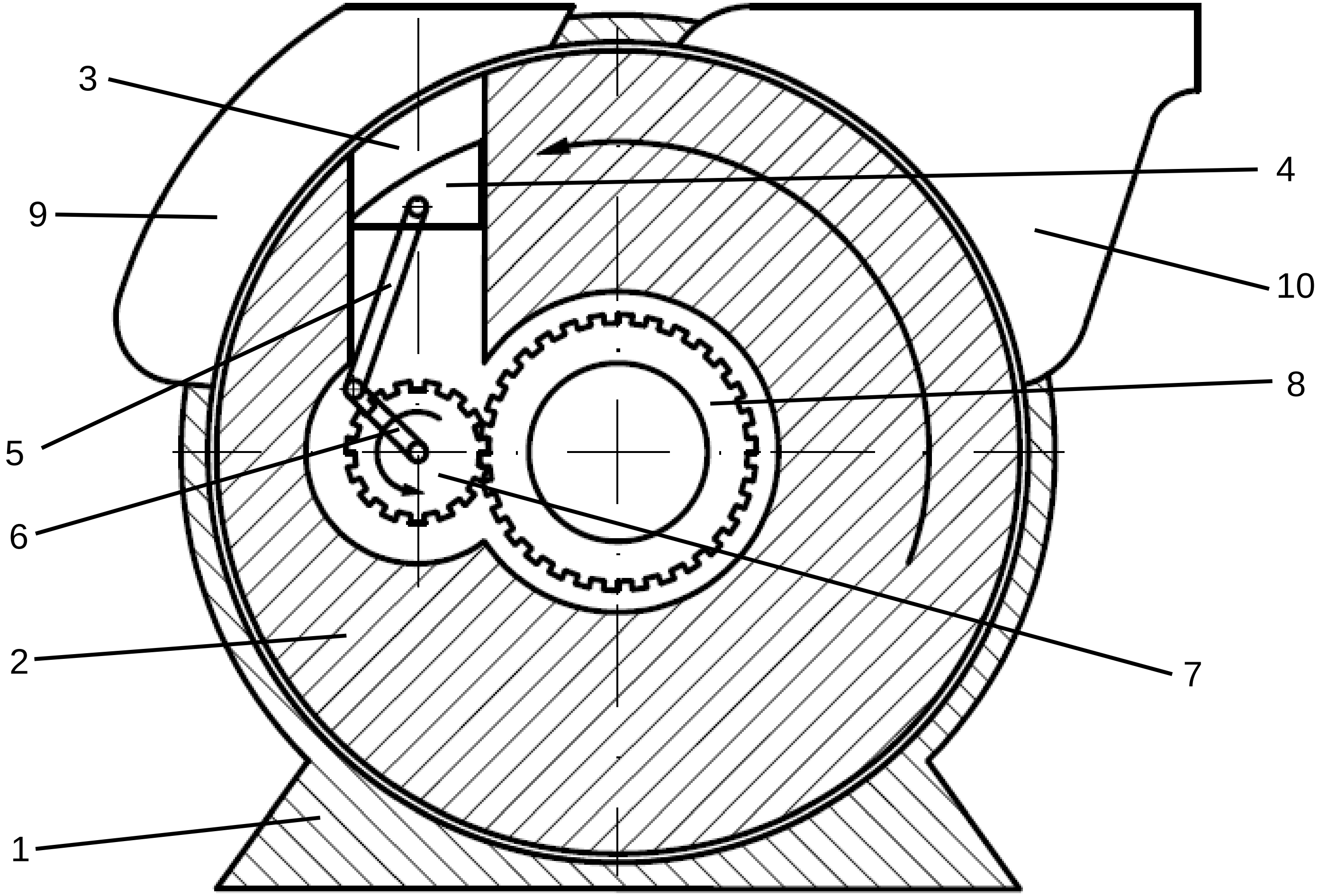
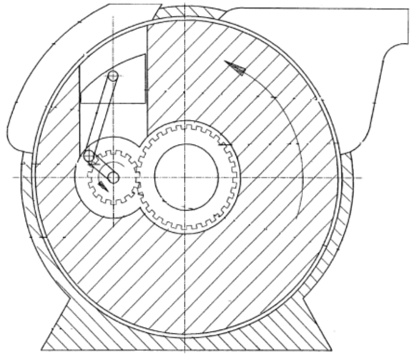


Planetary Reciprocating Piston Engine Description

Basic Concept:

1. Housing
2. Rotor
3. Cylinder
4. Piston
5. Connecting Rod
6. Crankshaft
7. Planet Gear
8. Sun Gear
9. Intake Port
10. Exhaust Port

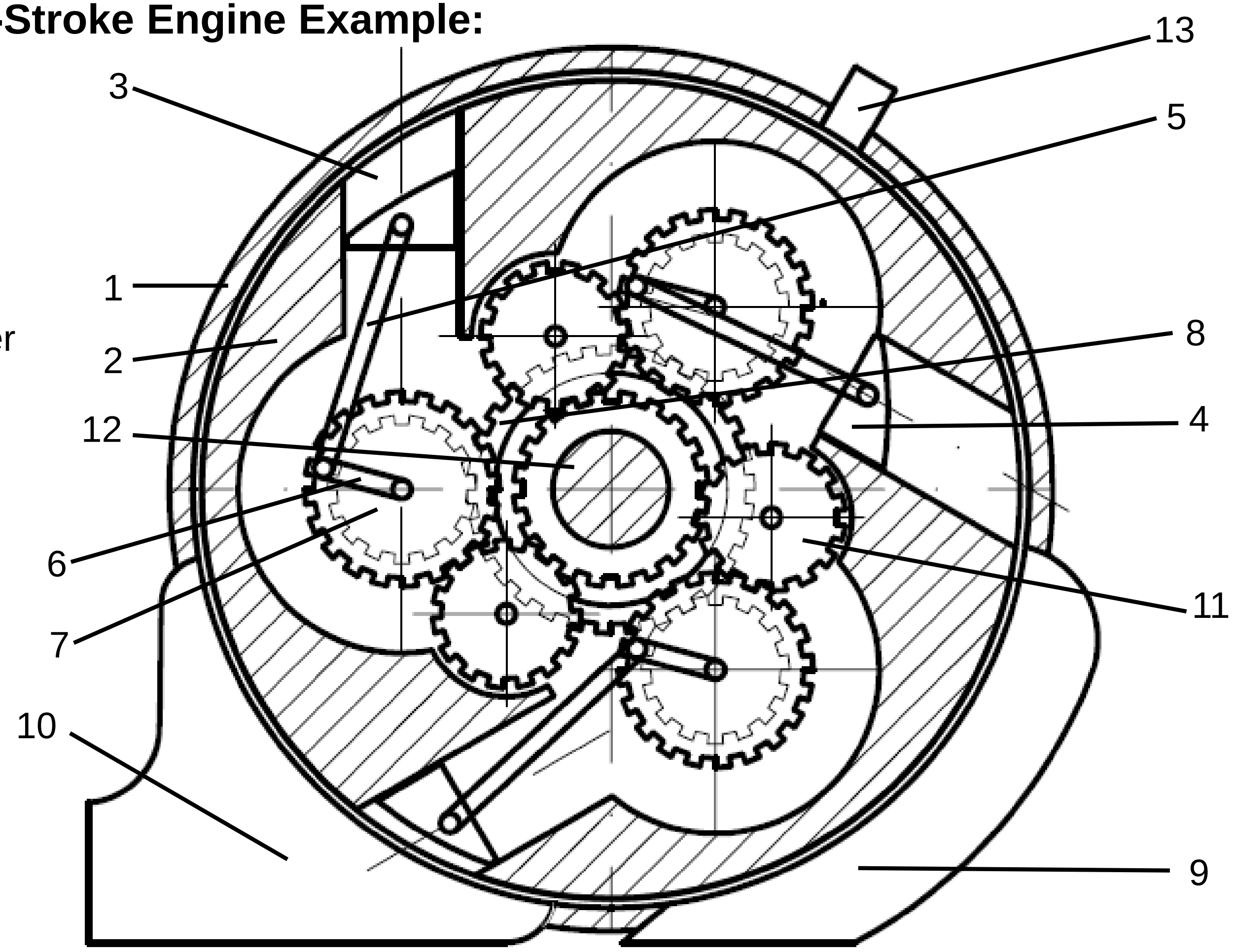


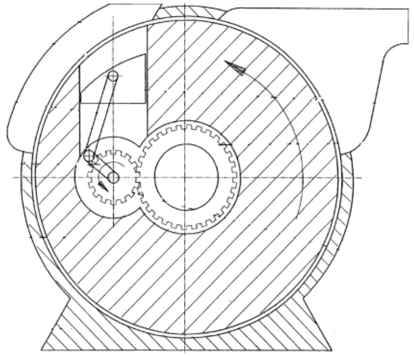


Planetary Reciprocating Piston Engine Description

4-Stroke Engine Example:

1. Housing
2. Rotor
3. Cylinder / Combustion Chamber
4. Piston
5. Connecting Rod
6. Crankshaft
7. Planet Gear
8. Sun Gear
9. Intake Port
10. Exhaust Port
11. Idler Gear
12. Central Output Shaft
13. Ignition / Fuel Injection

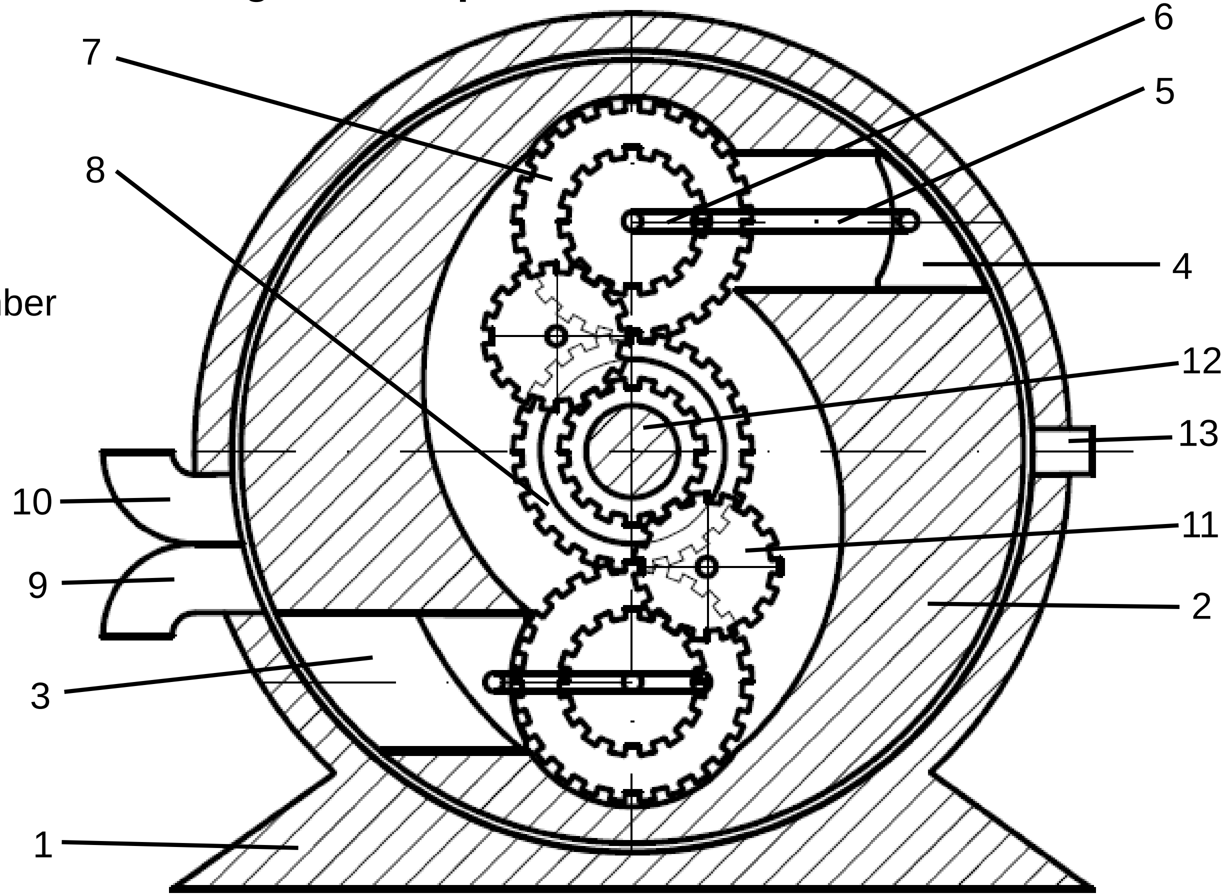


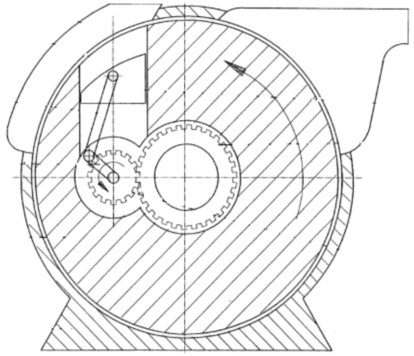


Planetary Reciprocating Piston Engine Description

2-Stroke Engine Example:

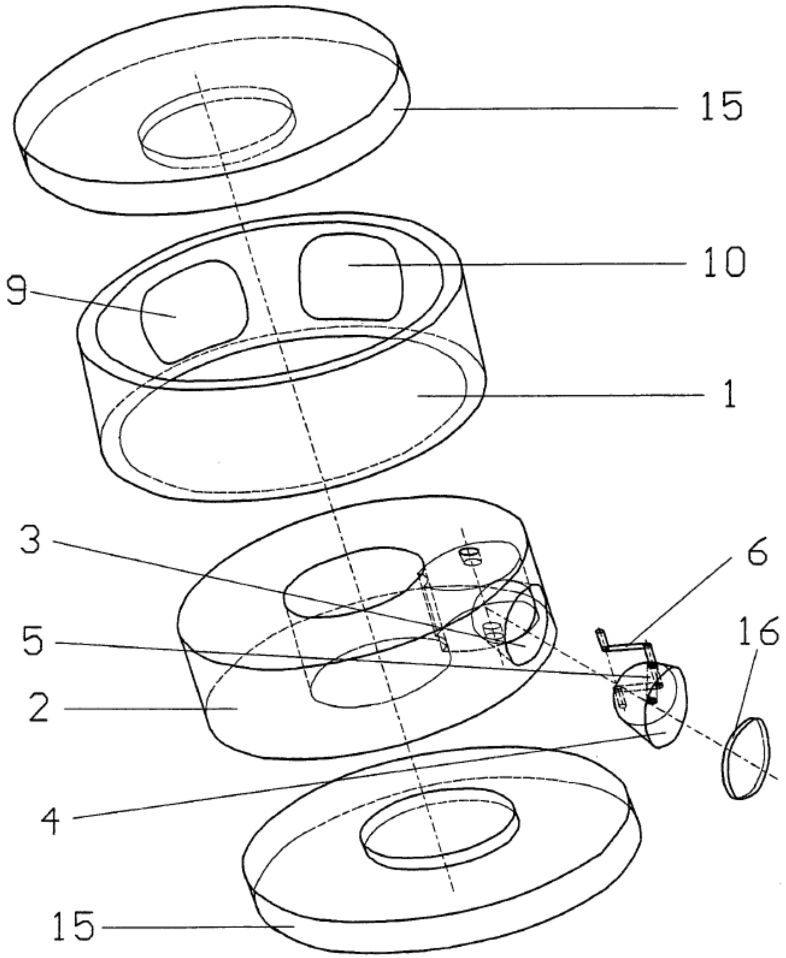
1. Housing
2. Rotor
3. Cylinder / Combustion Chamber
4. Piston
5. Connecting Rod
6. Crankshaft
7. Planet Gear
8. Sun Gear
9. Intake Port
10. Exhaust Port
11. Idler Gear
12. Central Output Shaft
13. Ignition / Fuel Injection

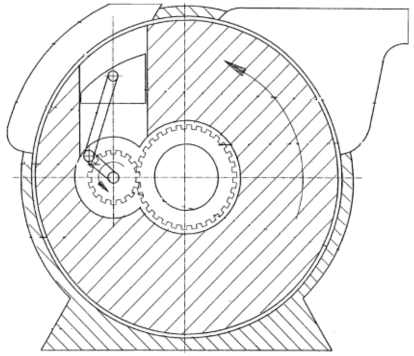




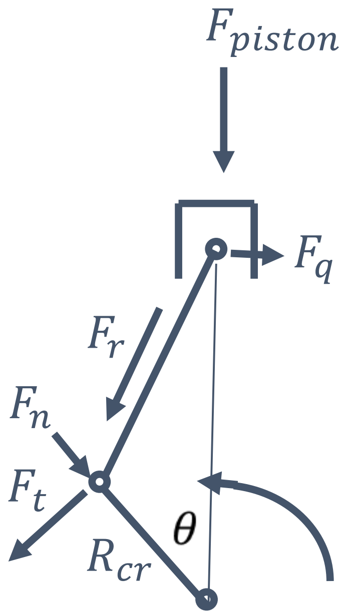
Planetary Reciprocating Piston Engine Description

1. Housing
2. Rotor
3. Cylinder
4. Piston
5. Connecting Rod
6. Crankshaft
9. Intake Port
10. Exhaust Port
15. Housing with Sun Gear
16. Sealing Ring

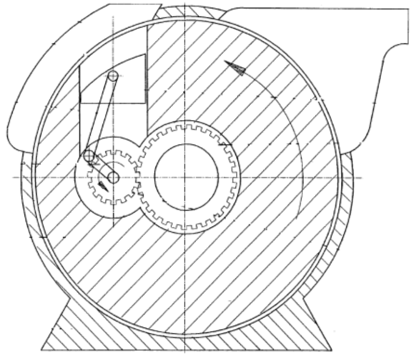




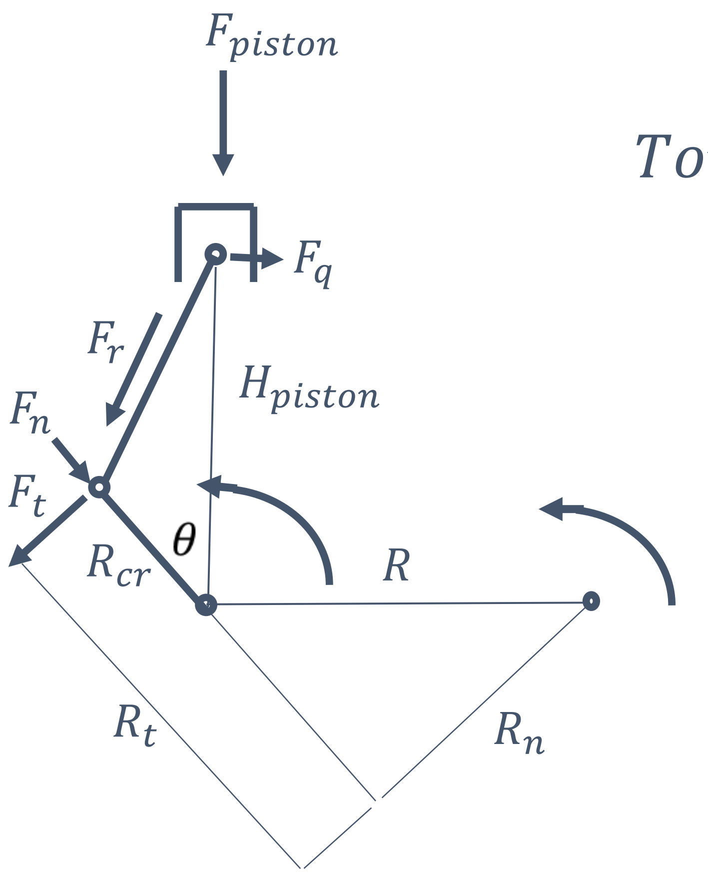
Conventional Reciprocating Piston Engine Analysis



$$Torque = F_t . R_{cr}$$

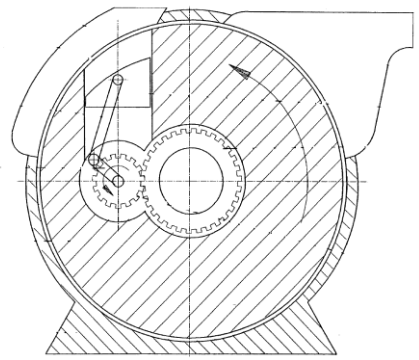


Planetary Reciprocating Piston Engine Analysis



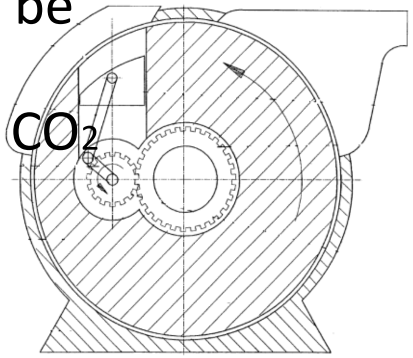
$$Torque = F_t . R_t + F_n . R_n + F_q . H_{piston}$$

$$= F_t . (R_{cr} + R . Sin\theta) + F_n . R_n + F_q . H_{piston}$$

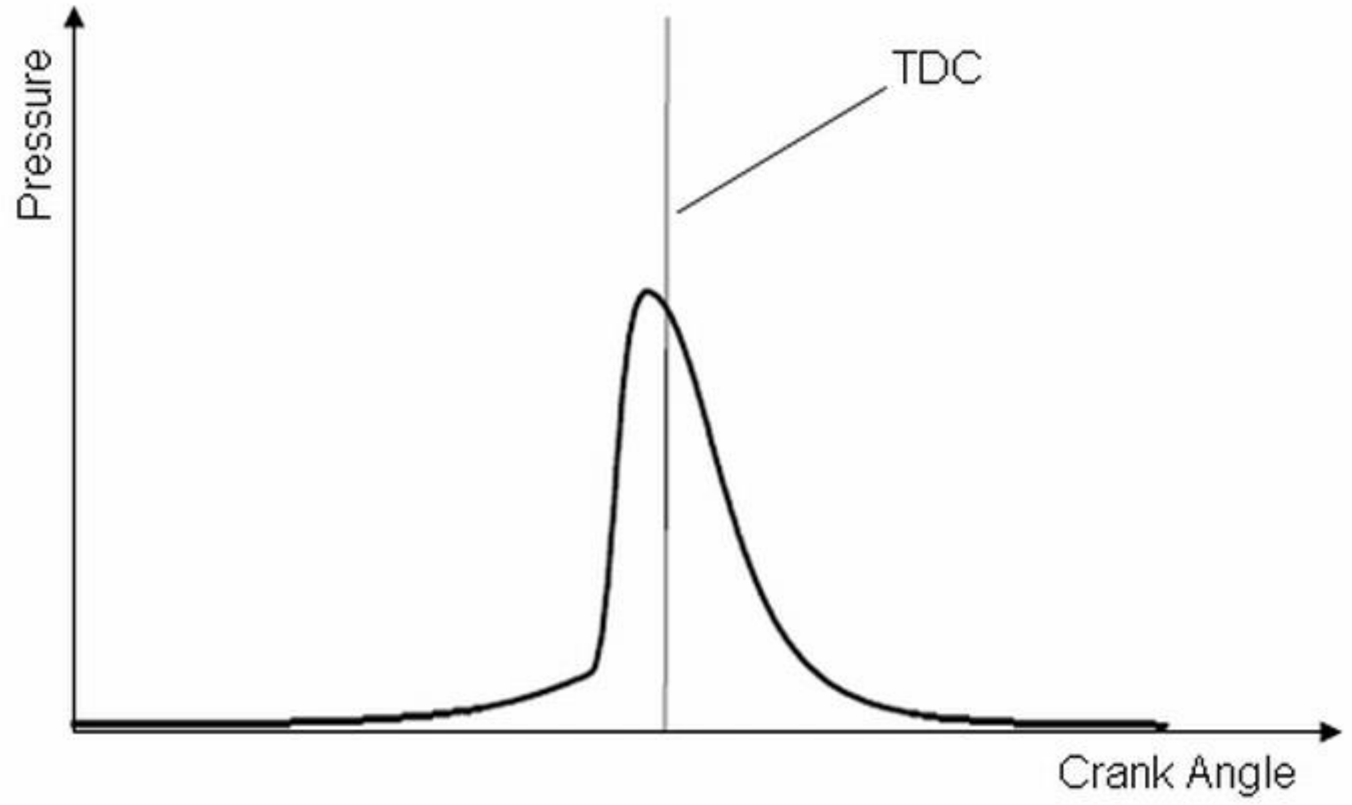


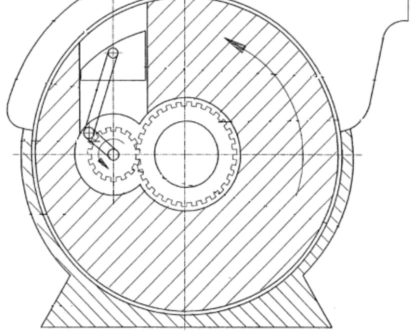
The Ogunmuyiwa Engine Cycle

- The patented "Ogunmuyiwa Engine Cycle" for engines with their cylinder axes arranged substantially tangentially to a circle centered on main shaft axis, enables combustion to be carried out during the compression stroke of the cycle without damaging the engine.
  - In this revolutionary cycle, during the period of combustion of the working fluid on the compression stroke, the burnt gases are successively compressed, causing a temperature increase, which supports the subsequent combustion of the unburnt gases so as to improve the opportunities for achieving a more complete combustion.
  - This provides a combustion cycle independent of the current inhibitive combustion timing constraints to deliver a more complete combustion, enabling higher power densities, higher thermal efficiencies and lower raw HC & CO emissions to be achieved.
  - This will enable vehicle manufacturers to meet the EU 6b, EU 6c and 2020 CO_2 emissions levels with significantly reduced after treatment requirements.



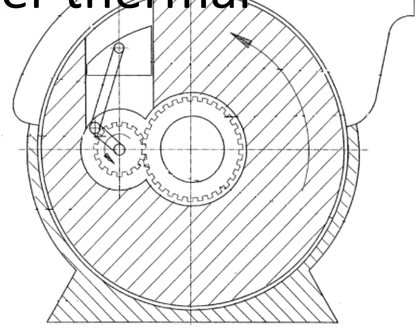
The Ogunmuyiwa Engine Cycle



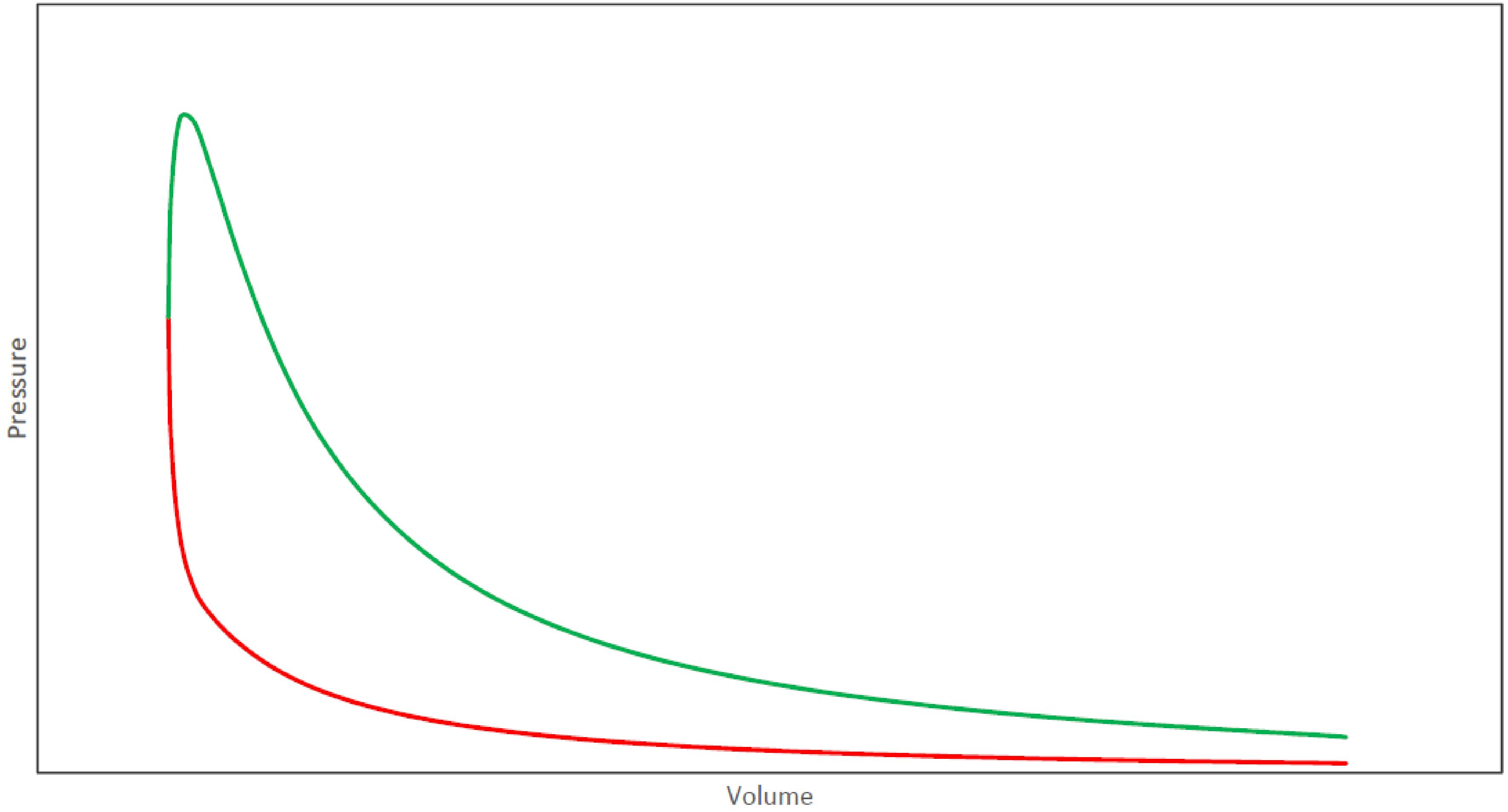


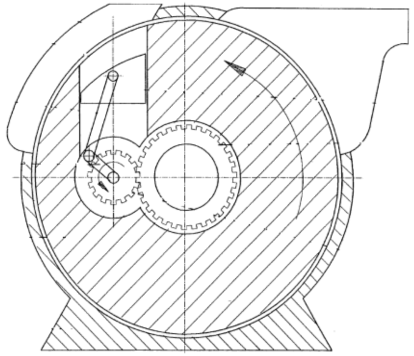
The Ogunmuyiwa Engine Cycle

- The P-V diagram of the Ogunmuyiwa Engine Cycle illustrates the benefits of this cycle over the Otto and Diesel engine cycles:
  - While the work performed on the expansion stroke is still positive, the Ogunmuyiwa Engine Cycle also has significant parts of the compression stroke (at the beginning and the end) where additional positive work is performed;
  - The negative work requirement on the system is therefore limited to the middle part of the compression stroke.
  - This process offers a significant advantage over the Otto and Diesel engine cycles, which have a negative work requirement over the complete compression stroke.
  - This results in the Ogunmuyiwa Engine Cycle achieving a significantly higher thermal efficiency than the Otto and Diesel engine cycles.

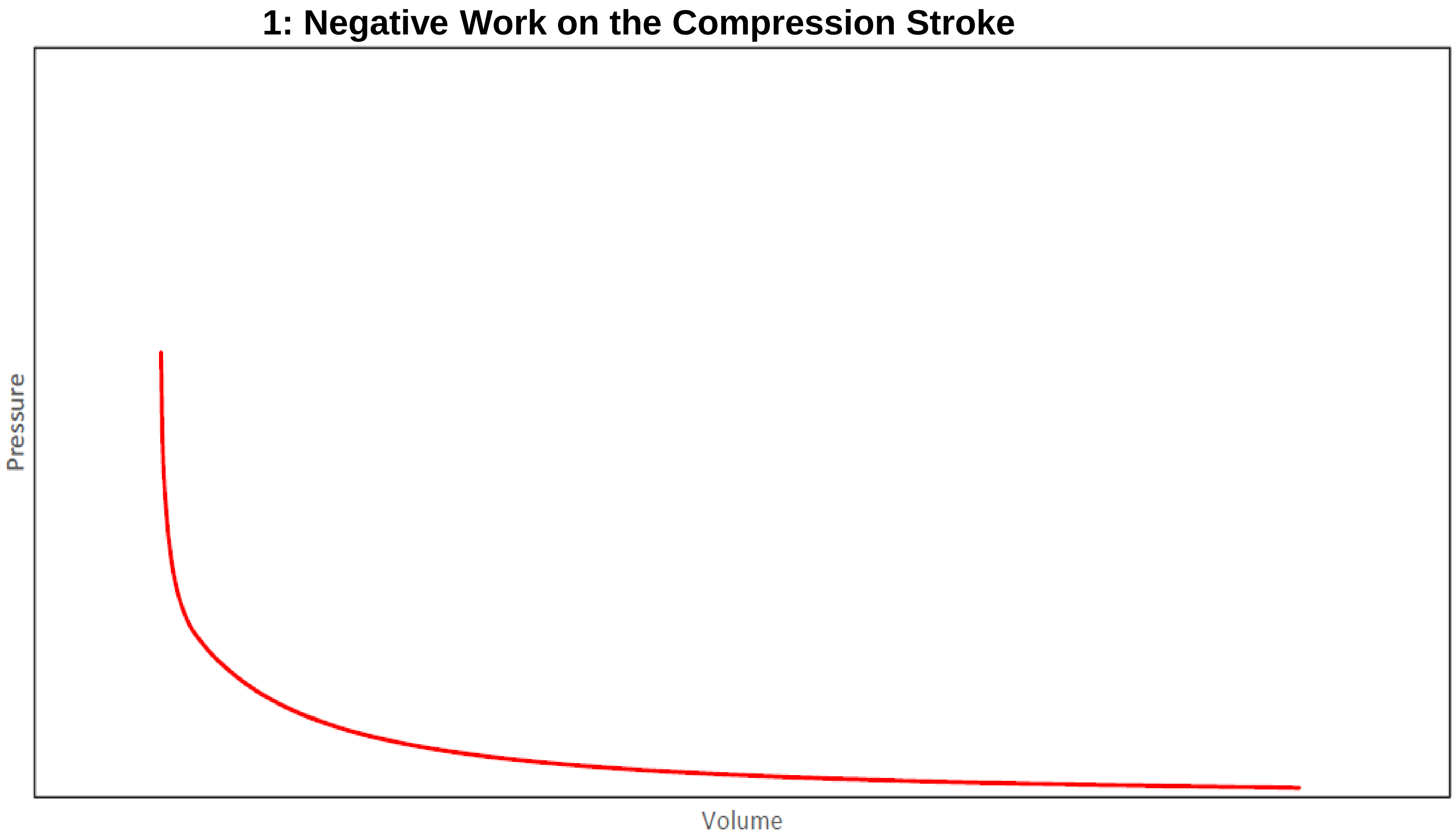


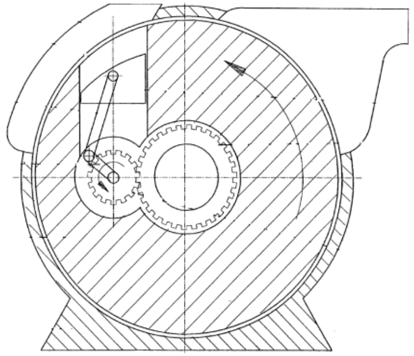
The Otto Engine Cycle P-V Diagram





The Otto Engine Cycle P-V Diagram





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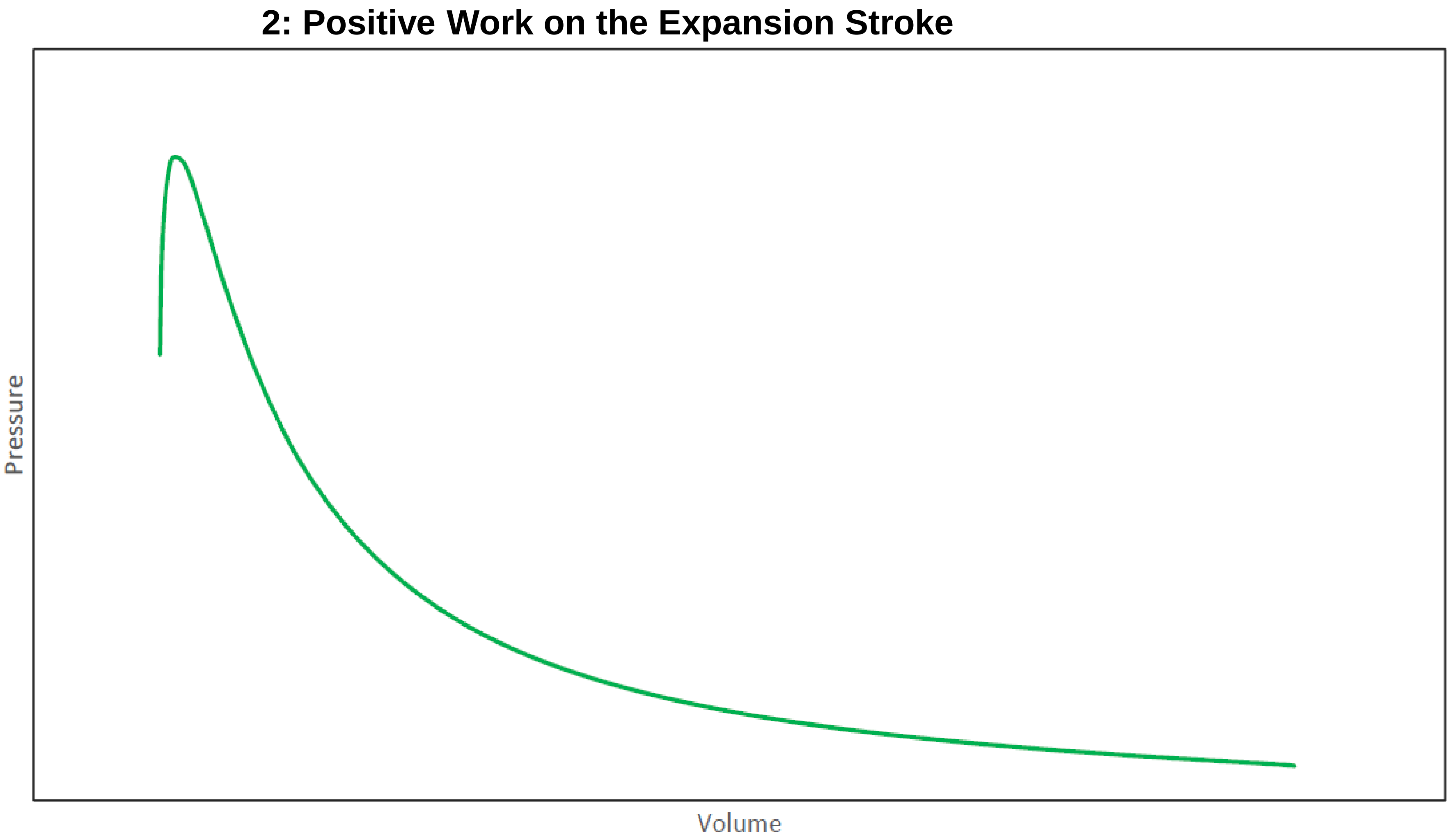
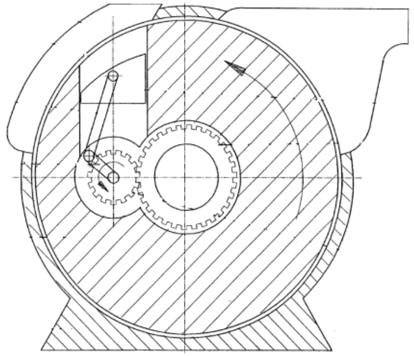
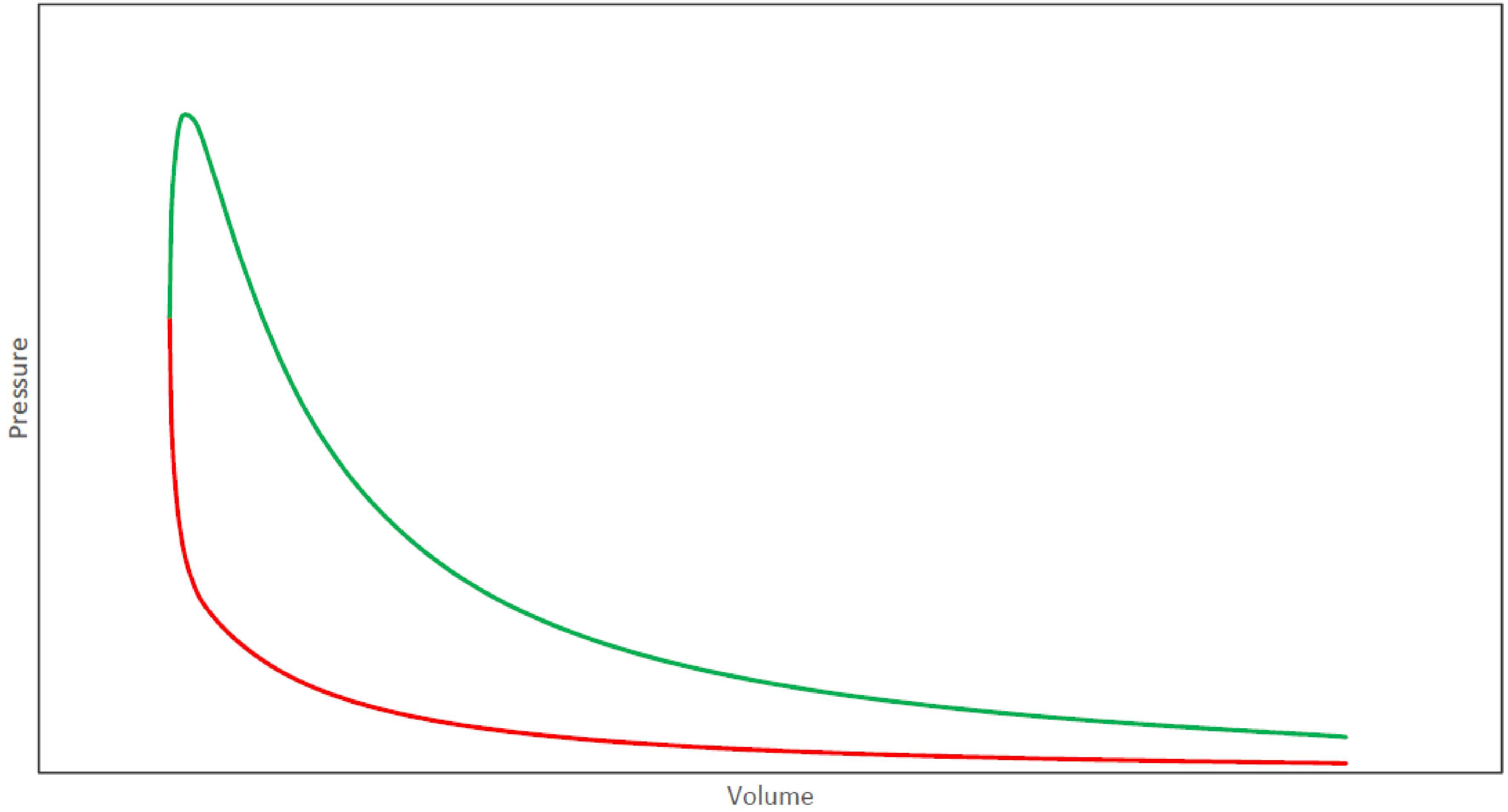
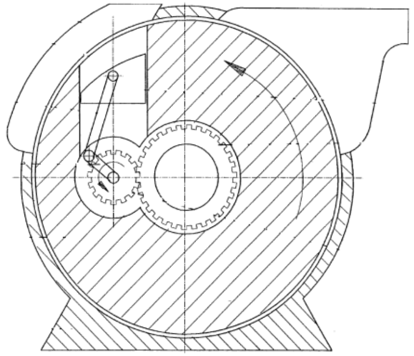


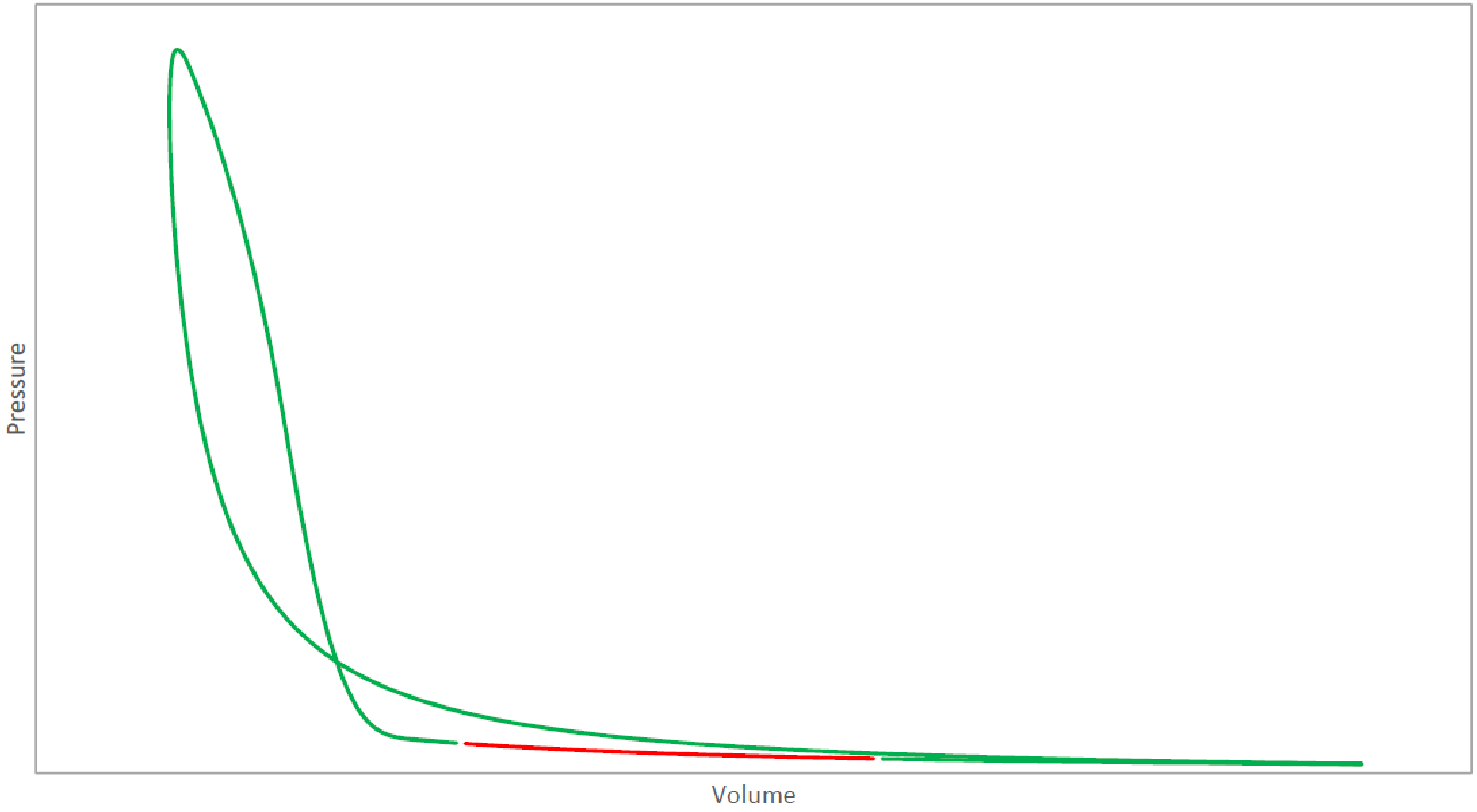


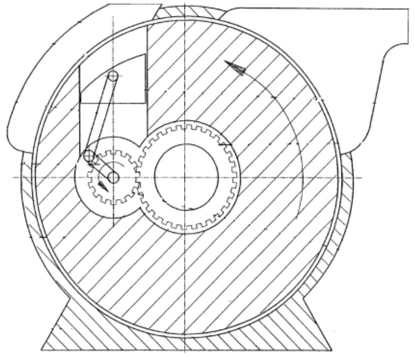
The Otto Engine Cycle P-V Diagram





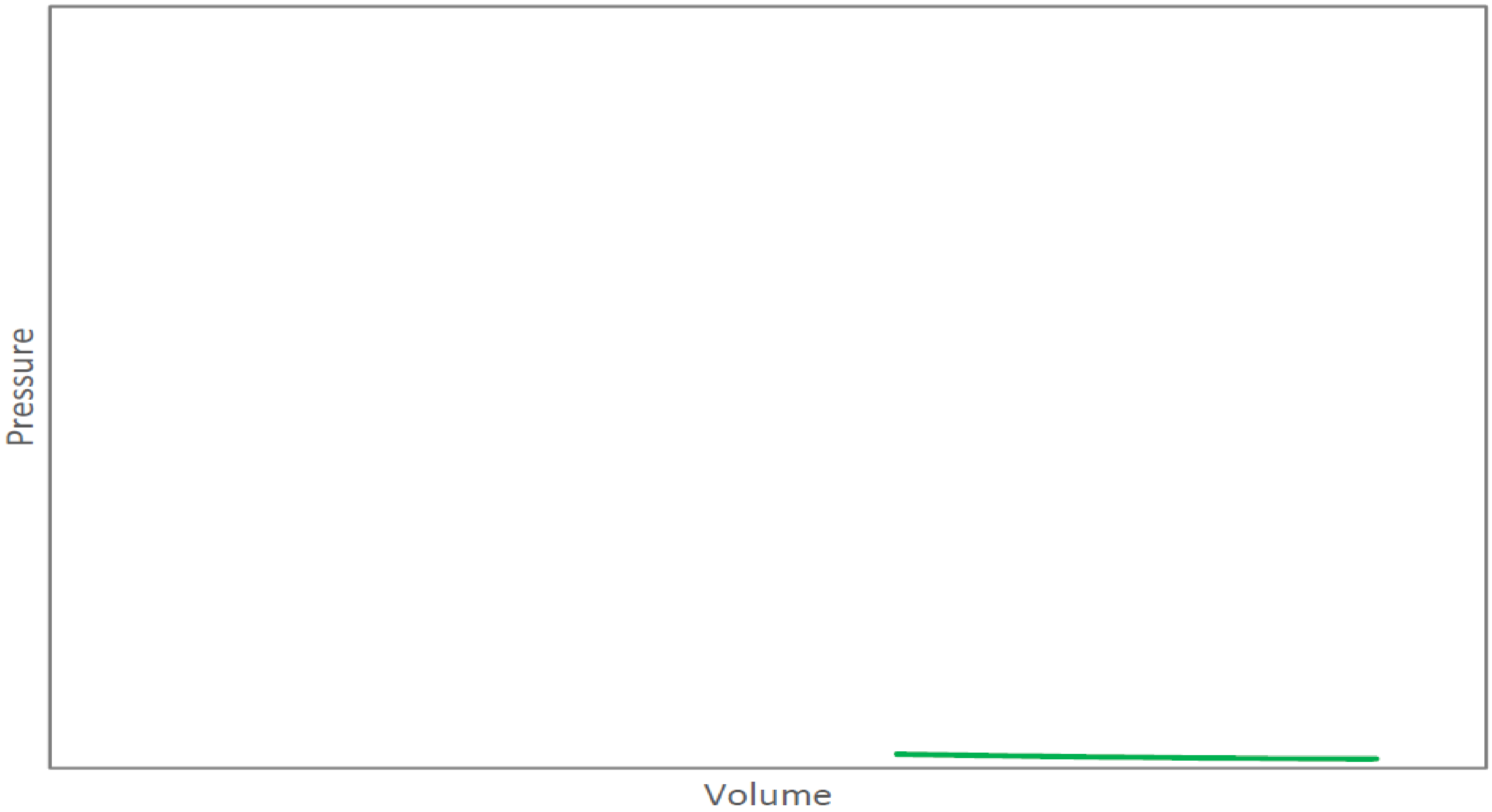
The Ogunmuyiwa Engine Cycle P-V Diagram

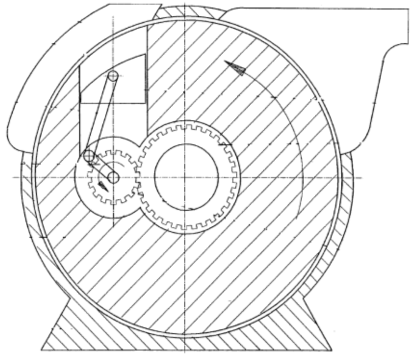




The Ogunmuyiwa Engine Cycle P-V Diagram

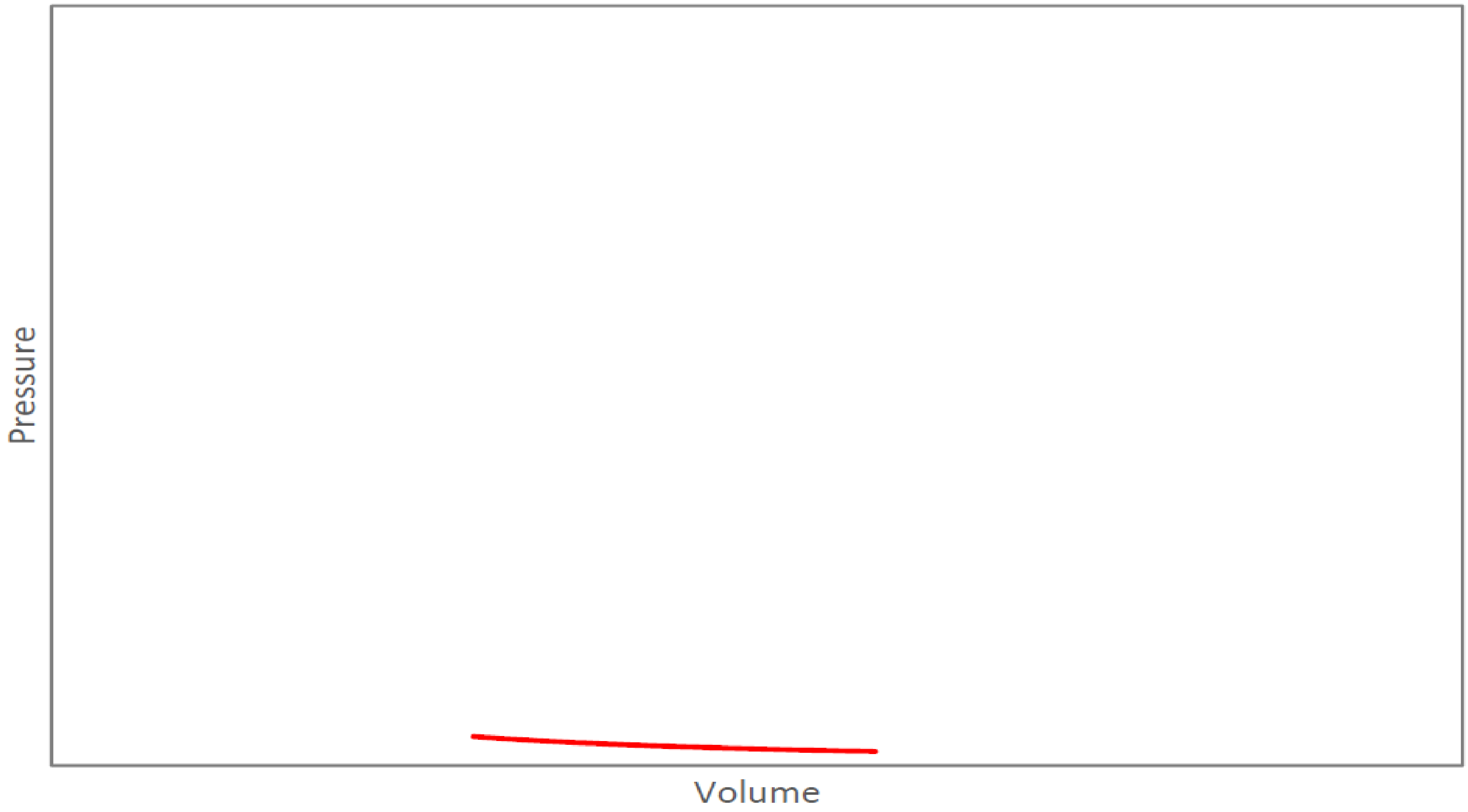
1: Positive Work at beginning of the Compression Stroke

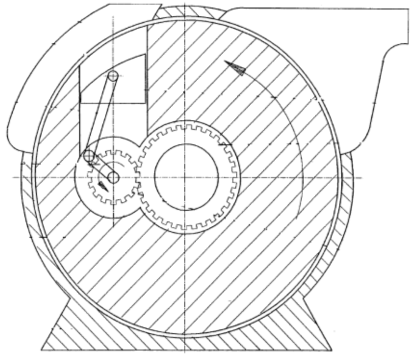




The Ogunmuyiwa Engine Cycle P-V Diagram

2: Negative Work on the Compression Stroke





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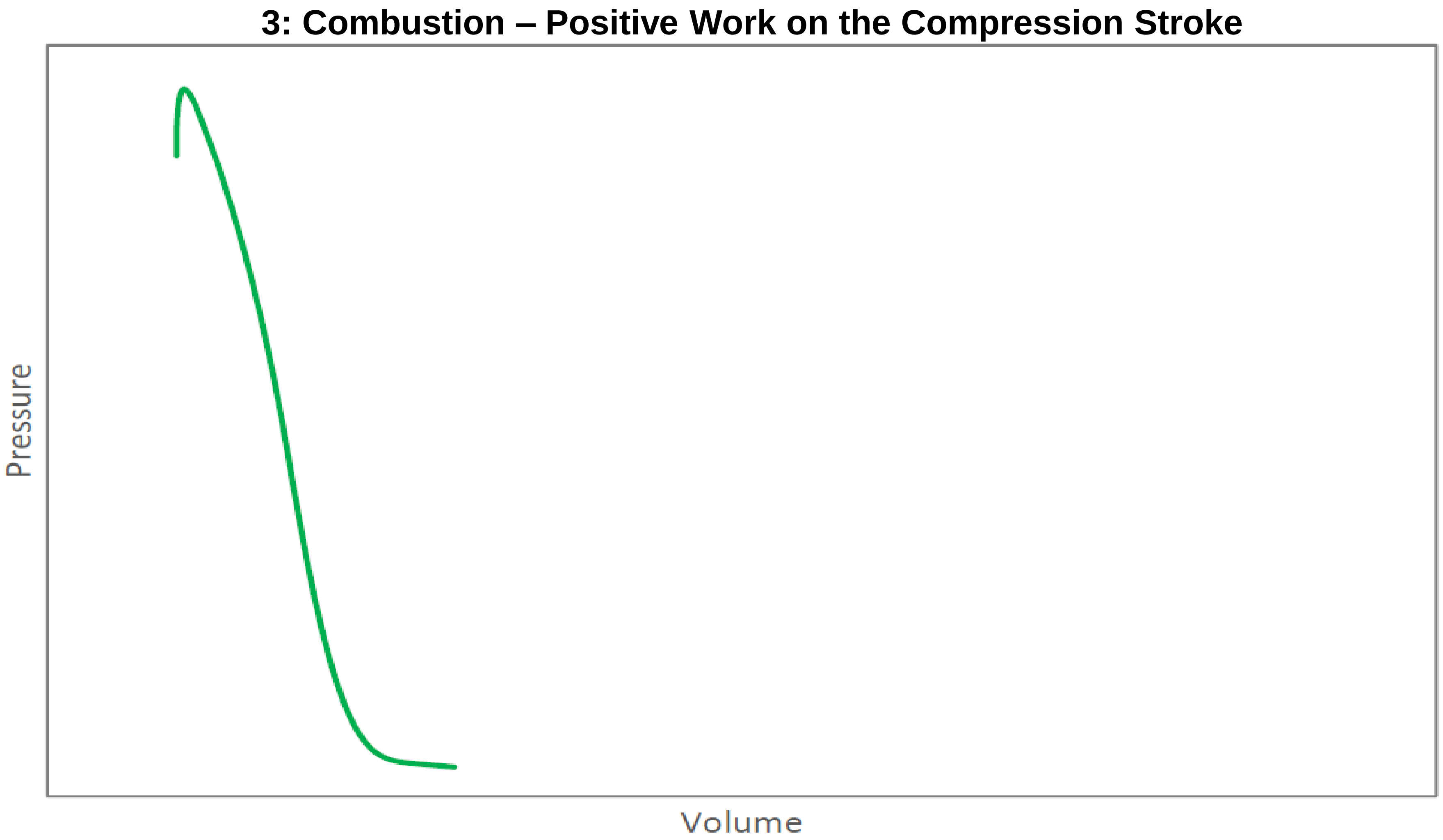

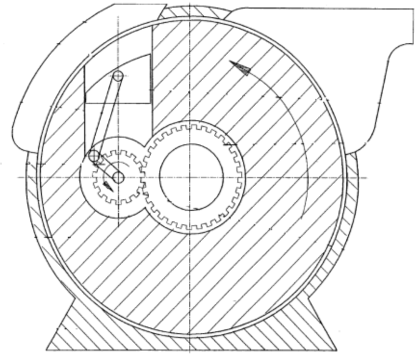

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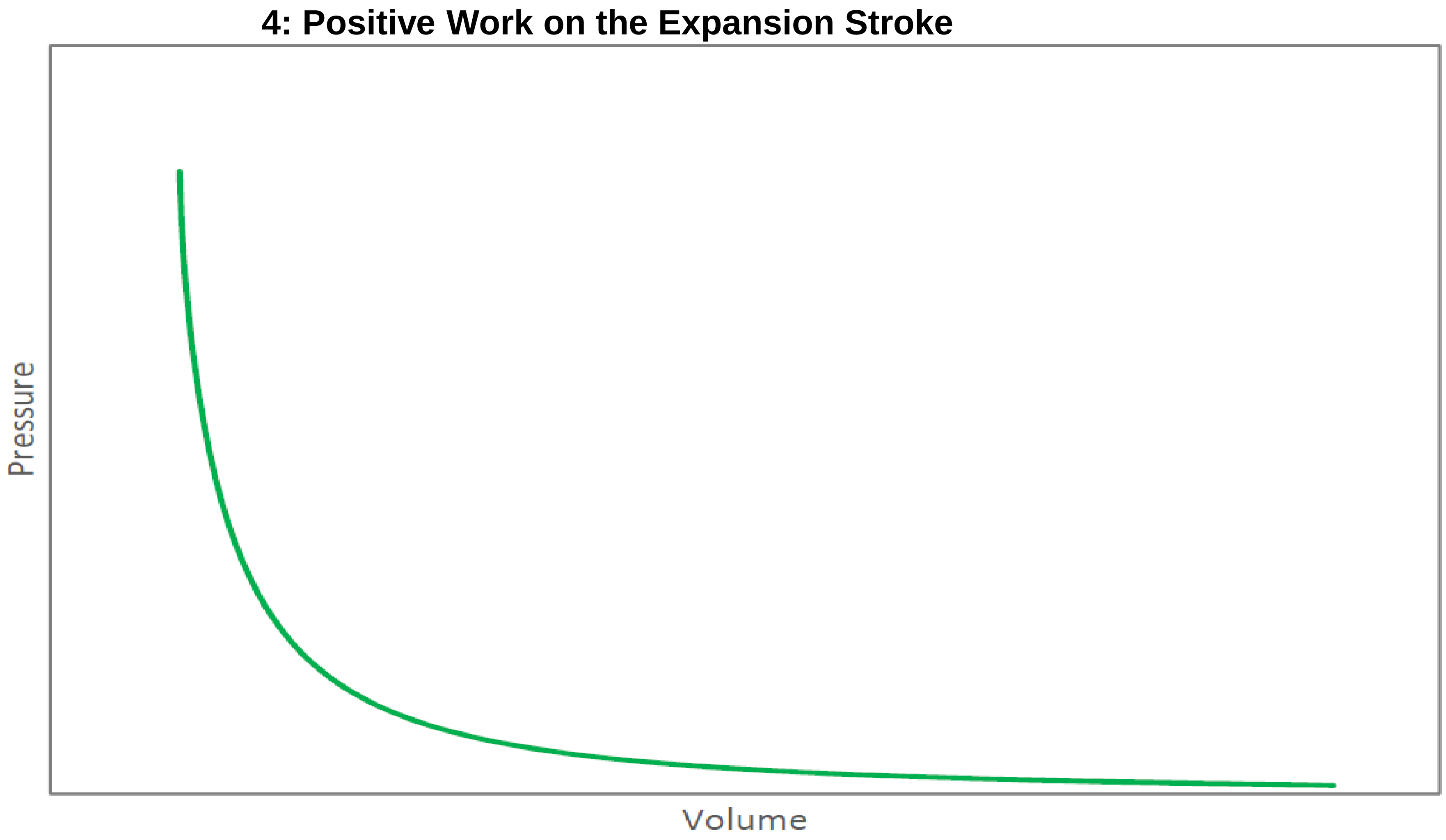

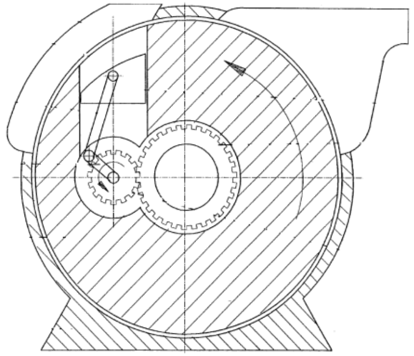

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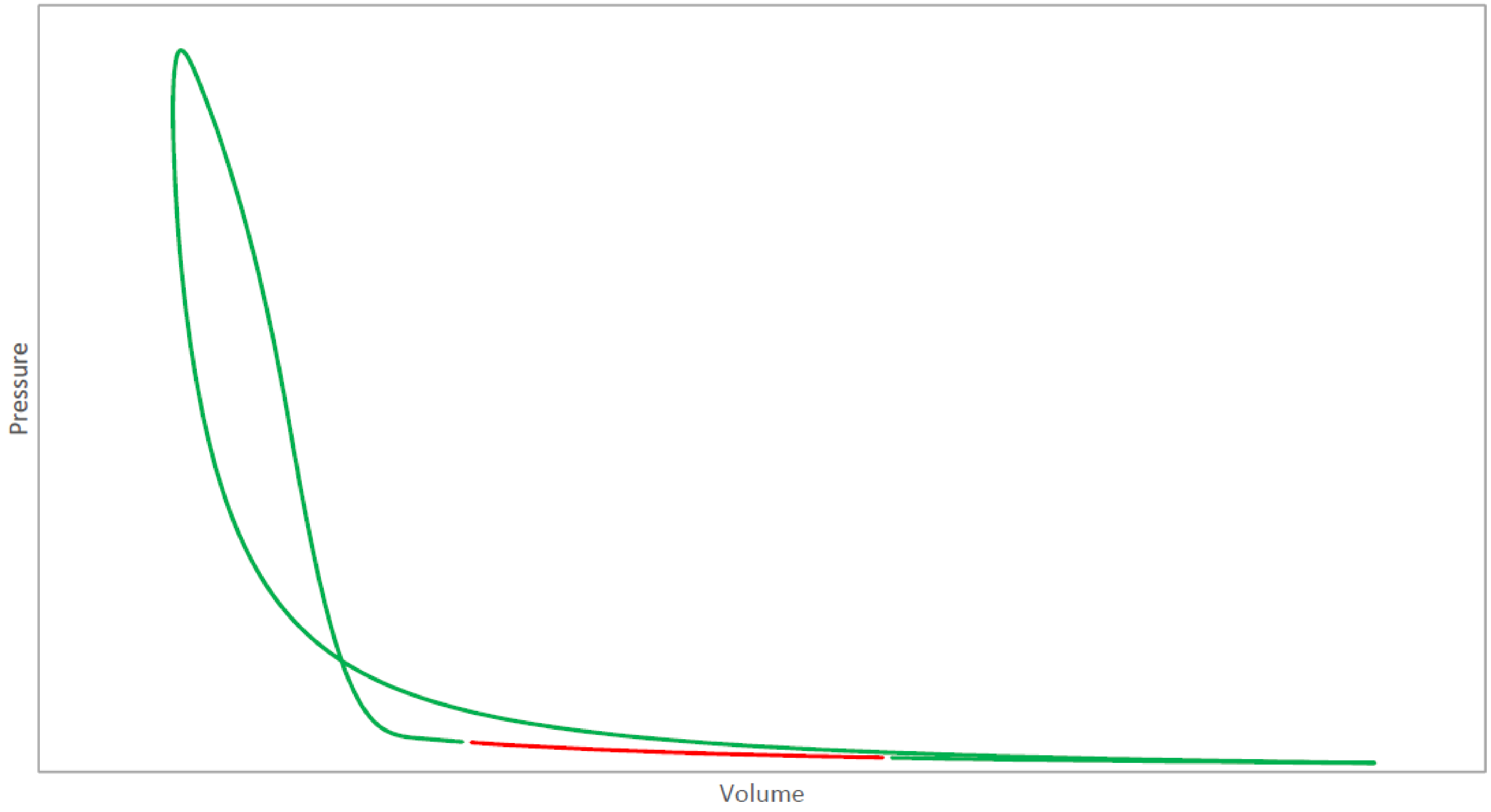
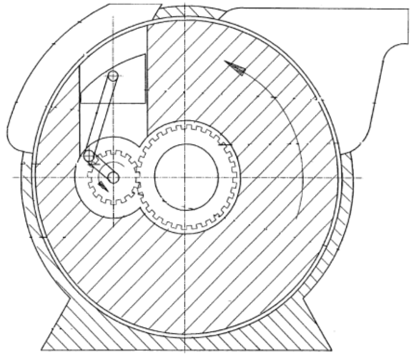
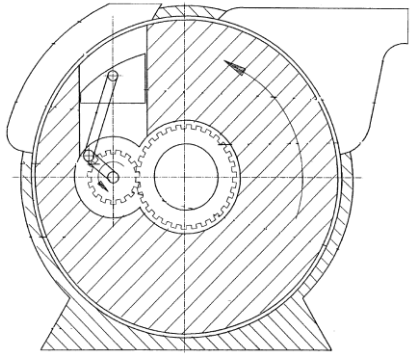




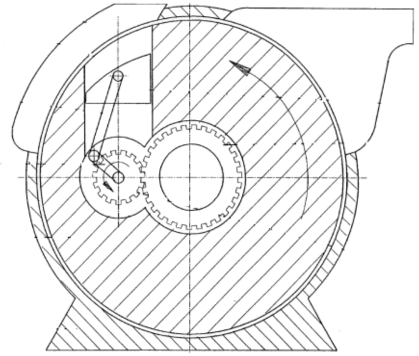
Engine Simulation Example

- 4-Stroke Normal Aspirated Engine:
  - Bore:... 75.125 mm
  - Stroke:.. 74.933 mm
  - Number of Cylinders:........................ 3
  - Engine Capacity:........................... 996 cc
  - Crankshaft Speed:……………………. 5000 rpm
  - Engine Output Shaft Speed:..…….. 7500 rpm
  - Specific Fuel Consumption:............. 98.47 g/kWh
  - Indicated Thermal Efficiency:……….. 82.03 %



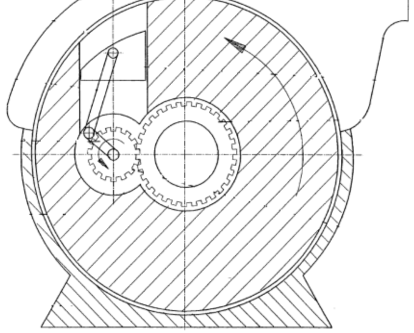
Engine Simulation Example

- 2-Stroke Normal Aspirated Engine:
  - Bore:.. 75.125 mm
  - Stroke:.. 74.933 mm
  - Number of Cylinders:........................ 2
  - Engine Capacity:........................... 664 cc
  - Crankshaft Speed:……………………… 5000 rpm
  - Engine Output Shaft Speed:...…. 10,000 rpm
  - Specific Fuel Consumption:............. 98.65 g/kWh
  - Indicated Thermal Efficiency:……….. 81.88 %



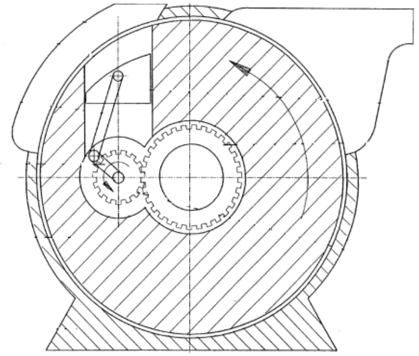
Reference to the Current Dieselgate Situation

- The emissions and fuel economy problems currently faced by OEMs are largely due to the Diesel Engine Cycle (and Otto Engine Cycle) having reached the limits of their development, thus forcing trade-offs between the following attributes:
  - Fuel Economy;
  - Emissions;
  - Engine Performance.



Reference to the Current Dieselgate Situation

- The Ogunmuyiwa Engine Cycle is able to independently optimise these attributes as follows:
  - Fuel Economy:
    - High thermal efficiency due to the geometric advantage of the engine layout;
  - Emissions:
    - Opportunities for achieving a more complete combustion, leading to:
      - Lower raw HC and CO emissions;
      - Reduced after-treatment requirements;
    - Opportunities for innovative combustion strategies for reducing / avoiding NOx;
  - Engine Performance:
    - Robust combustion leads to:
      - Improved transient performance;
      - Reduced calibration effort.



Summary

- While the work performed on the expansion stroke is still positive, the Ogunmuyiwa Engine Cycle also has significant parts of the compression stroke (at the beginning and the end) where additional positive work is performed;
- This enables the Ogunmuyiwa Engine Cycle to achieve a significantly higher thermal efficiency than the Otto and Diesel engine cycles.
- The Ogunmuyiwa Engine Cycle also enables the following attributes to independently optimised:
  - Fuel Economy;
  - Emissions;
  - Engine Performance.