(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 048 784**
A2

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: **80830103.0**

(22) Date of filing: **01.12.80**

(51) Int. Cl.³: **F 02 B 75/02**

(30) Priority: **26.09.80 IT 4975180**

(43) Date of publication of application: **07.04.82**
Bulletin 82/14

(84) Designated Contracting States: **AT BE DE FR GB NL SE**

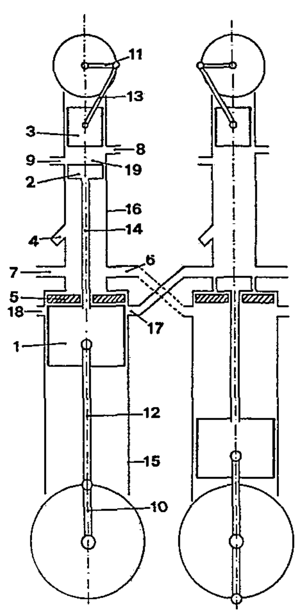
(71) Applicant: **Billitteri, Natale, Via Umberto Giordano, 51, Palermo (IT)**

(72) Inventor: **Billitteri, Natale, Via Umberto Giordano, 51, Palermo (IT)**

(74) Representative: **Mascioli, Alessandro, Prof.Dr., c/o A.N.D.I. Associazione Nazionale degli Inventori Via Lima, 35, I-00198 Roma (IT)**

(54) **High efficiency alternating endothermic engine with a new thermodynamic cycle.**

(57) Alternating endothermic engine with a new thermodynamic cycle in which the combustion chamber volume is kept constant for the period required for complete combustion of the operating fluid. In this way, higher maximum pressure is achieved for a pre-established and calculable period so as to obtain a more elevated tangential component and thus a higher engine torque for the same heat absorption and fuel consumption as in current engines. At the same time dangerous emissions are sharply reduced, while internal cooling is effected with reduced heat loss and energy savings.



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High efficiency alternating endothermic engine with a new thermodynamic cycle

This invention concerns a new high efficiency alternating endothermic engine based on a new thermodynamic cycle as well as eventual transformation of existing engines.

As is well known, current endothermic engines transform thermal energy into work through pressure.

However, these engines have the disadvantage of involving detonation and dissociation and therefore of requiring the presence of oxidation inhibitors in the fuel (antidetonants in OTTO cycle engines).

Detonation is harmful in that, as an instantaneous combustion (foreseen in the ideal OTTO cycle), it occurs at the wrong moment since it affords maximum pressure in the instant in which the piston is at zero velocity, with the connecting rod perpendicular to the crank arm of the drive shaft, and thus the engine moment is zero.

Dissociation occurs in the engine to create very rapidly alternating dissociations and reassociations as long as the specific dissociation temperature of the reagents is maintained. By continuing until the exhaust valve is opened, this leads to incomplete combustion since some of these reagents escape still unburned.

Oxidation inhibitors allow a higher compression ratio to be used, but slow down combustion velocity and cause atmospheric pollution, for the OTTO cycle.

The aim of this patent is the elimination of the disadvantages described above so as to obtain an engine with high energy efficiency and considerable reduction of harmful exhaust gases.

This goal is achieved by keeping the combustion chamber volume constant for the period required for complete combustion of the operating fluid. In this way, higher maximum pressure is achieved for a pre-established and calculable period so as to obtain a more elevated tangential component and thus a higher engine torque for the same heat absorption and fuel consumption as in current engines.

According to this invention the engine consists of a piston or other suitable device advancing with pre-established and calculable movement as a function of the type and the required performance. This movement occurs through crank mechanisms, cams, rockers or the like positioned or controlled by any type of kinematic chain.

In this way the invention tends to consider detonation as useful rather than harmful in that occurring after the Maximum Dead Point (M.D.P.), it does not shove the piston but rather pushes it without the characteristic spark knock. With the use of suitable devices, this may even lead to spontaneous ignition of suitably prepared fuel mixtures.

In fact, by causing combustion after the M.D.P. and interrupting the dissociations-reassociations equilibrium until the temperature is lowered (the increased pressure compensates), combustion is completed within favourable limits.

This is achieved by injecting at the most favourable moment during the dissociation equilibrium a measured quantity of incombustible liquid (water, for example). In vaporizing, this then lowers the temperature in the combustion chamber and also allows the cooling equipment to be reduced or eliminated.

A preferred but non-limiting variant of this invention, which may be realized in one or more cylinders, is schematized in enclosed drawings figures 1 and 2.

Figure 1 shows a vertical section of a two cycle supercharged variant of the engine with controlled ignition, composed of two coupled cylindrical elements each showing two diameters.

Figure 2 shows two variants of the new theoretical thermodynamic cycle, one for controlled ignition (solid line) and one for spontaneous ignition (dashed line).

With regard to the details of figure 1, each element of the engine is composed of a cylinder with two diameters 15 and 16 separated by a diaphragm with a tight stuffing box 5 designed to protect the engine crank mechanism 10 with connecting rod 12 from contamination of the coolant and to seal pistons 1 and 2 in their phases of aspiration and compression of the scavaging air. In piston 2's descending phase, this is followed by piston 3, connected through connecting rod 13 to crank arm 11, leading to a crank mechanism approximately 90^{o} out of phase with that of 10. In this way, the volume of combustion chamber 19 is kept nearly constant up to approximately 40^{o} from the M.D.P., where ignition and the onset of combustion occur through spark plug 8. The controlled ignition may be anticipated or retarded as in current engines, or the same effect may be achieved by regulating the air intake in the spontaneous ignition variants. Soon after, at the corrent moment, liquid is injected from 9 and in vapourizing lowers the temperature, limits dissociation-reassociation and causes the pressure to increase, using the temperature of the exhaust gases and cylinder walls as well. Contemporaneously, piston 1 sealed with diaphragm 5 begins aspiration through port or valves 18.

At the end of its descending phase, piston 2 covers the exhaust 7 and intake 6 ports, leading to wash out with previously compressed air.

In its ascending phase, piston 2 (which is joined to piston 1 via rod 14) covers ports 6 and 7. Liquid or gaseous fuel is then injected through injector 4, compression occurs and the cycle is repeated.

The wash out operation is greatly facilitated in the engine with two coupled cylinders at 180°, as in figure 1, and air feed is likewise favoured. The above-mentioned coupling of the two cylindrical elements is effected through exhaust ports 17 and 7 for compressed air.

The diagram in figure 2 illustrates the thermodynamic cycle of the controlled ignition engine: 1-2, aspiration; 2-3, compression; 3-4, maintenance of the achieved pressure; 4-5, instantaneous combustion; 5-6, continuation of combustion; 6-7, expansion; 7-2-1, discharge.

The above refers to a theoretical cycle of a four cycle supercharged engine. Of course, this invention covers application in current normally aspirated engines as well.

Figure 2 also shows the spontaneous ignition possible using suitable fuels, in the dashed line variant 3-3'-5.

Of course, while the principle of this invention remains the same, the forms of realization and the particulars of construction may vary widely from that described and illustrated here, without however going beyond the bounds of this invention.

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Claims:

1. Alternating endothermic engine with new thermodynamic cycle characterized in that combustion chamber volume is kept constant for the period required for complete combustion of the operating fluid and that a higher maximum pressure is achieved for a pre-established and calculable period so as to obtain a more elevated tangential component and thus a higher engine torque for the same heat absorption and fuel consumption as in current engines, with striking reduction of dangerous emissions.

2. Engine according to claim 1, characterized in that detonation occurs after the Maximum Dead Point (M.D.P.) to render it useful rather than harmful since the piston is not shoved but rather pushed without the characteristic spark knock; with suitable devices, this may even allow spontaneous ignition of suitably prepared fuel mixtures.

3. Alternating endothermic engine according to claims 1 and 2, characterized in that a measured quantity of an incombustible like water is injected at the most opportune moment during combustion to lower the temperature in the combustion chamber, leading to the possibility of reducing or eliminating the cooling equipment.

4. Alternating endothermic engine according to claims 1, 2 and 3, characterized in that each element consists

of a cylinder with two diameters 15 and 16 separated by a diaphragm with a tight stuffing box 5 designed to protect engine crank mechanism 10 with connecting rod 12 from contamination of the coolant and to seal pistons 1 and 2 in their phases of aspiration and compression of the scavaging air; in piston 2's descending phase, this is followed by piston 3 connected through connecting rod 13 to crank arm 11, leading to a crank mechanism approximately 90° out of phase with that of 10 so that the volume of combustion chamber 19 is kept nearly constant up to approximately 40° from the M.D.P., where ignition and the onset of combustion occur via spark plug 8; soon after liquid is injected from 9 at the opportune moment which vapourizes and lowers the temperature to limit dissociation-reassociation and increase the pressure, using the temperature of the exhaust gases and cylinder walls as well; contemporaneously piston 1 sealed with diaphragm 5 begins aspiration through port or valves 18; at the end of the descending phase, piston 2 (joined to piston 1 via rod 14) covers ports 6 and 7, liquid or gaseous fuel is injected through injector 4, compression occurs and the cycle is repeated.

5. Alternating endothermic engine according to claims 1, 2, 3 and 4, characterized in that controlled ignition may be anticipated or retarded as in current engines or the same effect may be achieved by regulating air intake in the spontaneous ignition variants.

6. Alternating endothermic engine with controlled ignition characterized by the following thermodynamic cycle: 1-2, aspiration; 2-3, compression; 3-4, maintenance of the achieved pressure; 4-5, instantaneous combustion; 5-6, continuation of combustion; 6-7, expansion; 7-2-1, discharge.

7. Alternating endothermic engine according to claim 1, characterized by spontaneous ignition, with suitable fuels, according to the thermodynamic cycle shown by dashed line 3-3'-5.

The entire invention is substantially as described and illustrated and has the specified aims.

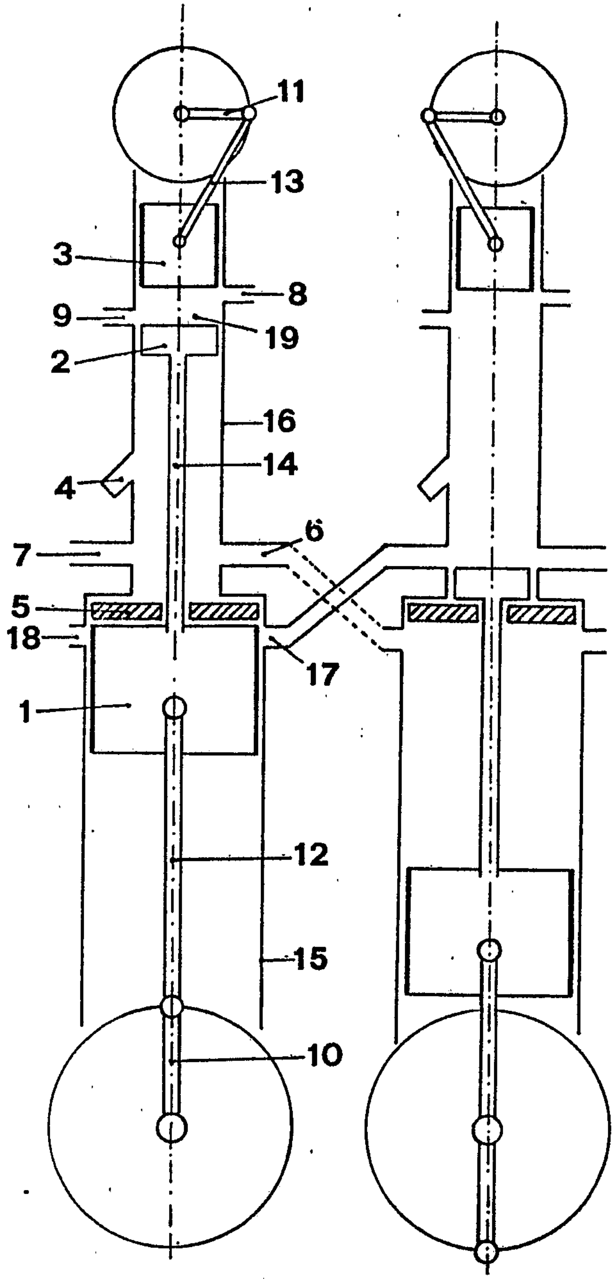

FIG.1

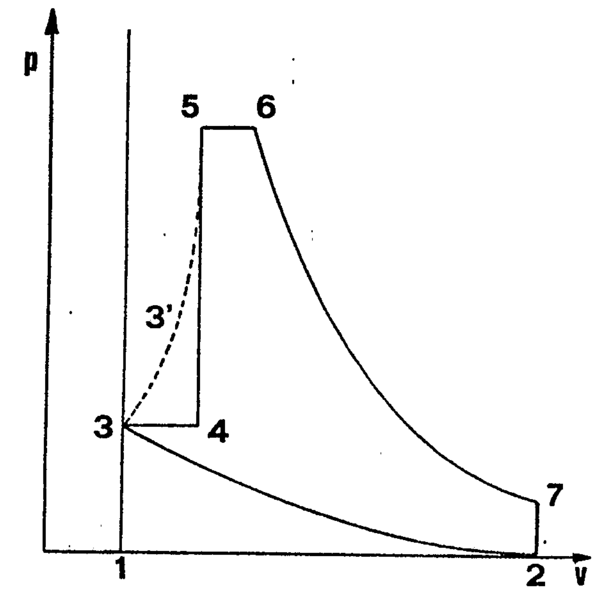

FIG.2