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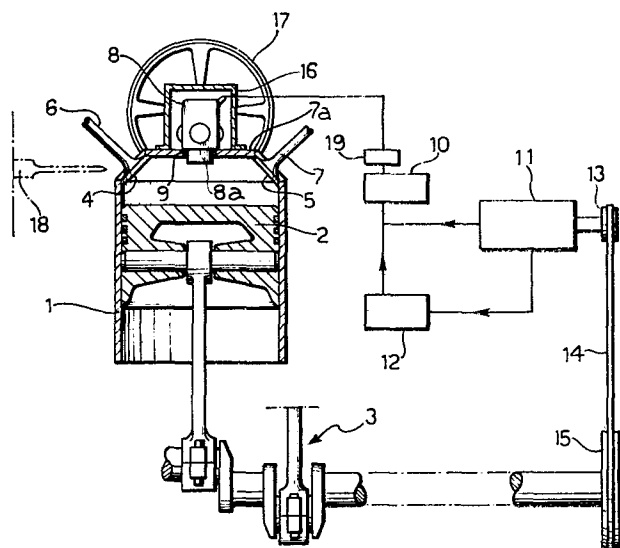
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⑤4 Reciprocating steam engine.

57) A reciprocating engine, particularly for selfpropelled vehicles, in which the working fluid is steam generated directly in the cylinders (1) of the engine. For this purpose, each cylinder (1) is provided with a generator (8) of microwaves having a frequency which rapidly vaporises a predetermined quantity of water, preferably atomized, introduced into the cylinder (1).



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Reciprocating Steam Engine

The present invention relates to a reciprocating engine, particularly but not exclusively for self-propelled vehicles, of the type including at least one cylinder within which a piston is movable axially and which is provided with inlet and exhaust ports in which respective valve members are operable, an electrical circuit including a voltage source, a capacitive-discharge ignition system, and a distributor.

This invention seeks to solve the problem of providing a reciprocating engine of the aforesaid type which has structural and functional characteristics similar to, and a performance comparable with, a reciprocating internal combustion engine without, however, requiring the combustion of petrol or similar combustible petroleum derivatives for its operation.

It is known that, in order to solve this problem, several attempts have been made to use hydrogen as the main fuel, proposing that the hydrogen be obtained from water by electrolysis. These attempts have remained merely suggestions, because it is recognised that it is highly uneconomic to supply the hydrogen necessary for the operation of the engine and because of the considerable difficulties involved in making an internal combustion engine which will run on hydrogen.

The idea fundamental to solving this problem is that of using a vapour, particularly steam, as the working fluid for driving a reciprocating engine of the aforesaid type, the necessary vapour being generated within the or each cylinder of the engine.

On the basis of this idea, and in accordance with the present invention, there is provided a reciprocating engine of the type specified, characterised in that it includes means for admitting a predetermined

quantity of water, preferably in atomised form, to said at least one cylinder, and a generator of microwaves of a predetermined frequency in the range 5 to 10 GHz, having its outlet communicating with said at least one cylinder, the microwave generator being connected electrically to the electrical circuit and supplied for between 10 and 25 microseconds with a current of a power and voltage suitable for the emission of microwaves having said predetermined frequency.

In accordance with a second aspect of the invention, the microwave generator comprises a magnetron which is fixed to the said cylinder and encased by shielding material suitable for blocking possible emission of secondary radiation.

The reciprocating engine of the present invention includes, to advantage, a forced ventilation system for cooling the magnetron.

For the efficient operation of the reciprocating engine of this invention, the moment at which the microwaves are emitted into the cylinder is of particular importance in achieving the required and desired vaporisation. It has been found that the best results are achieved when such an emission of microwaves occurs between 65° and 55° before the top dead centre position of the piston.

The quantity of water which must be admitted to the cylinder to operate the reciprocating engine of this invention is substantially the same as that of the fuel (petrol) required for the operation of an internal combustion engine having the same functional and structural characteristics.

The conversion of such a quantity of water into steam occurs in a very short time interval (8 to 12 microseconds) while it is well known that, in an internal combustion engine, the flame propagates through the air-petrol mixture in not less than 25

microseconds. The rapidity of the conversion into steam also results from the rapid decrease in the volume of the chamber into which the atomised water and the microwaves have been admitted, since the
5 displacement of the piston towards its top dead centre position enhances the interaction of the water droplets with the microwaves, boosting the effect of the latter.

It should be noted that, when pure water is
10 admitted to the cylinder, it is preferable that the microwaves generated by the magnetron should have a frequency of the order of 9 GHz. Since it is desirable to ensure that the valve units in the inlet and exhaust ports are lubricated, a very small quantity
15 of oil may be added to the water admitted to the cylinders (an oil/water ratio of, for example, 1/1000 to 1/100 is sufficient for this purpose). In this case, the microwaves generated by the magnetron preferably have a frequency f about 6 to 7 GHz.

20 With microwaves having a frequency of 5 to 7 GHz, the rapid vaporisation of the water is ensured even when it has added to it small quantities of, for example, antifreeze and/or colorant pigments provided for fiscal reasons.

25 In a reciprocating engine according to the invention having four cylinders, each cylinder is provided with a microwave generator of the aforesaid type and the four microwave generators are connected in an entirely conventional manner to the distributor
30 of the electrical circuit of the engine itself.

Besides all the advantages immediately noticeable from what has been described above, it should be pointed out that a reciprocating steam engine according to this invention, which may be defined as a
35 reciprocating engine with internal vaporisation, offers the not inconsiderable advantage of discharging water into the environment as a liquid and/or vapour,

thus eliminating any possibility of atmospheric pollution.

5 A reciprocating steam engine according to this invention is described below with reference to the appended drawing in which it is shown schematically.

A reciprocating steam engine according to this invention comprises, in a simplistic form, a cylinder 1, within which is axially movable a piston 2 with a fluid-pressure seal, which is connected
10 kinematically to a crankshaft 3 in a conventional manner.

The cylinder 1 is provided conventionally with respective inlet and exhaust ports 4, 5 within each of which valves 6, 7 are operable.

15 A microwave generator, schematically indicated 8, is fixed releasably to the head 1a of the cylinder 1 by conventional means. This generator 8 is able to generate and to emit microwaves with a frequency in the range 5 to 10 GHz, and is preferably constituted by a magnetron.
20

Of the magnetrons commercially available, it is found that model BLM-311 made by the VARIAN Company (USA) is particularly useful, and its known electrical characteristics are given below:

25	- microwave frequency	9-10 GHz
	- peak power output (mimimum)	65 kW
	- voltage:	14 V
	- maximum current:	1.5 A

The magnetron 8 has its outlet 8a facing into
30 the cylinder 1 through an aperture 9a. The magnetron 8 is connected electrically to a conventional distributor 19 forming part of the electrical circuit of the engine. This circuit comprises essentially an electronic capacitive-discharge ignition system,
35 schematically indicated 10, a dynamo 11, and a battery 12 of the type normally used in the electrical circuits of internal combustion engines. The dynamo 11 is

is driven by the crankshaft 3 to which it is connected, as shown schematically, by means of a pulley 13, belt 14 and pulley 15. Advantageously, the electronic capacitive-discharge system 10 is of the type illustrated in Figure 1 of U.S. Patent No. 3,453,492 of 1st July, 1969 in the name GIANNI ABRAMO DOTTO.

Since it is found that, for good operation of the reciprocating engine of the invention, the magnetron 8 must be excited for a period of between 10 and 25 microseconds, the electronic capacitive-discharge circuit 10 is provided with a capacitor having a capacitance of at least 10 mF.

A casing, indicated 16, is fixed conventionally and releasably to the head 1a of the cylinder 1 to surround the magnetron 8. This casing 16 is made from a material suitable for shielding any possible secondary emission of radiation from the magnetron.

A forced ventilation unit, schematically indicated 17, cools the magnetron during operation of the reciprocating engine of the invention, while a liquid injector device, schematically indicated 18, may be provided to introduce a predetermined quantity of water, preferably in atomized form, to the cylinder 1 through the port 4, when it is desired to use such an injector device.

The operation of the reciprocating engine of this invention is as follows.

When the piston 2 descends towards its bottom dead centre position, a predetermined quantity of atomized water is drawn (or introduced by the injector 18) into the chamber formed between the piston and the cylinder head. This quantity of water is substantially equal to the quantity of fuel (petrol) which would be drawn into a cylinder of a conventional internal combustion engine with the same structural and functional characteristics. During the subsequent rise of the piston (compression stroke), between 65°

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and 55° before it reaches its top dead centre position, the magnetron 8, suitably excited by the electrical circuit described above, emits a beam of microwaves of predetermined frequency into the cylinder 1. It
5 should be noted that the magnetron 8 has an internal filament which is continuously energised by the battery or the dynamo. Only when it is necessary (65° to 55° before the top dead centre position in the compression stroke) is the magnetron fed with current at a voltage
10 suitable for the emission of microwaves of the desired predetermined frequency.

These microwaves rapidly (within 10-25 microseconds) cause the vaporisation of the water which has previously been drawn or injected into the cylinder. The rate
15 at which the water changes its state is also affected by the fact that the volume of the chamber defined between the piston and the upper head of the cylinder gradually diminishes during the compression stroke so that the interaction of the microwaves with the
20 water molecules is gradually enhanced, with a result comparable to a terminal microwave "boosting" effect.

With the change of state of the water (in a ratio of about 1 to 10), the steam generated in the cylinder 1 reaches considerable pressure, in correspondence
25 with the top dead centre position, so as to ensure the operation of the reciprocating engine of this invention (a 4-stroke operation). On the return stroke of the piston towards its top dead centre position, the spent steam is discharged through the
30 valve 7.

It should be noted that this discharge largely comprises water in the vapour and/or liquid states.

If pure water is fed into the cylinder 1, it is preferable to generate microwaves having a
35 frequency of 9 GHz in order to achieve a vaporisation time of the order of 12 microseconds.

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If the water used has added to it small quantities of oil for lubricating the valve seats of the cylinder 1 (with oil/water ratios of about 1/1000 to 1/100) and/or antifreeze and/or colorant pigments for fiscal purposes, it is preferable to use microwaves with a frequency of the order of 5-7 GHz.

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CLAIMS

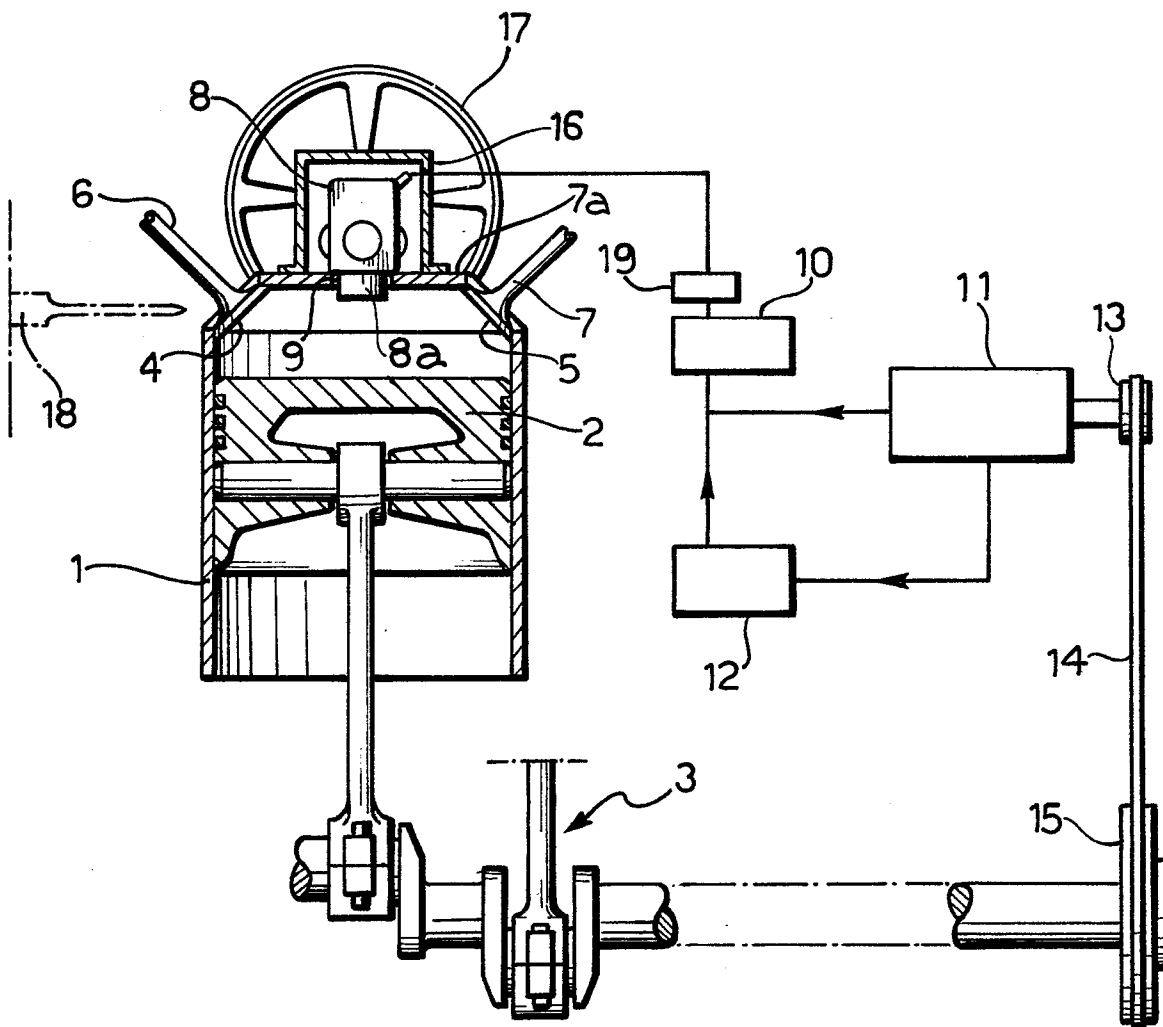
1. Reciprocating engine, particularly for self-propelled vehicles, of the type including at least one cylinder (1) within which a piston (2) is movable axially, and which is provided with inlet and exhaust ports (4,5) in which respective valve members (6,7) are operable, and an electrical circuit including a voltage source (11, 12), a capacitive-discharge ignition system (10) and a distributor (10), characterised in that the engine further includes:

- means (4,6,18) for admitting a predetermined quantity of water into said at least one cylinder(1),
- a generator (8) of microwaves having a predetermined frequency in the range 5-10 GHz, having its outlet (8a) communicating with said at least one cylinder (1), the microwave generator (8) being connected electrically to the electrical circuit (10,11,12,19) and supplied for between 10 and 25 micro-seconds in each cycle of piston reciprocation with a current at a voltage suitable for the emission of microwaves having said predetermined frequency.

2. Reciprocating engine according to Claim 1, characterised in that the microwave generator comprises a magnetron (8) arranged in a casing (16) of material suitable for shielding possible secondary emissions of radiation.

3. Reciprocating engine according to Claim 2, characterised in that it further includes a forced ventilation unit (17) for cooling the magnetron (8) during operation of the engine.

4. Reciprocating engine according to Claim 2 or Claim 3, characterised in that the magnetron (8) emits microwaves in the frequency range 5-10 GHz to the cylinder (1) between 65° and 55° before the piston (2) reaches its top dead centre position in a compression stroke.





European Patent
Office

EUROPEAN SEARCH REPORT

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Application number
EP 81 83 0121

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	<u>DE - A - 2 240 426</u> (KOHLER) * Page 3, line 27 to page 4, line 26 *	1	F 01 B 29/12 F 01 K 21/02

A	<u>DE - A - 2 440 659</u> (PLEYZIER) * Page 2, line 13 to page 3, line 7 *	1	

A	<u>US - A - 4 220 005</u> (CUTTS)		
A	J. BAUMEISTER: "Standard Handbook for Mechanical Engineers", seventh edition 1967 MCGRAW-HILL BOOK COMPANY NEW YORK (US) pages 4-15, 4-17		TECHNICAL FIELDS SEARCHED (Int.Cl. ³) F 01 B F 01 K

			CATEGORY OF CITED DOCUMENTS
			X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited for other reasons
			&: member of the same patent family, corresponding document
The present search report has been drawn up for all claims			
Place of search The Hague	Date of completion of the search 17-02-1982	Examiner BAATH	