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

(11) **EP 1 808 587 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
18.07.2007 Bulletin 2007/29

(51) Int Cl.:
F02B 69/00 *(2006.01)*

(21) Application number: **07106894.4**

(22) Date of filing: **12.03.2002**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR

(30) Priority: **13.03.2001 SE 0100867**

(62) Document number(s) of the earlier application(s) in accordance with Art. 76 EPC:
02703025.3 / 1 383 994

(71) Applicant: **GGP Sweden AB**
573 28 Tranås (SE)

(72) Inventor: **Eriksson, Göran**
662 35, Åmål (SE)

(74) Representative: **Andréasson, Ivar**
Hynell Patenttjänst AB
Patron Carls väg 2
683 40 Hagfors/Uddeholm (SE)

Remarks:
This application was filed on 25 - 04 - 2007 as a divisional application to the application mentioned under INID code 62.

(54) **Modified single-cylinder otto engine**

(57) The present invention relates to a single-cylinder Otto engine for ethanol operation, which engine comprises an engine block (1) with a cylinder (2), a cylinder head (3), a piston (4) disposed movably inside the cylinder, two valves (5, 5') arranged by the cylinder, a carburettor (6) with a removable fuel nozzle (7), and an air filter arrangement (8), wherein the minimum play between the valve end (5A) and its opposing surface (3A; 4A) is between 0.2 - 1 mm, preferably 0.3 - 8 mm, more preferably 0.4 - 0.6 mm, and, the fuel nozzle (7) is provided with an opening (6A), the diameter of which is between 5-20%, more preferably 10-15%, greater than the corresponding opening (6A) for petrol operation; and also to such an engine with a non-removable fuel nozzle (7) and an air filter arrangement (8), wherein the minimum play between the valve end (5A) and its opposing surface (3A; 4A) is between 0.2 - 1 mm, preferably 0.3 - 8 mm, more preferably 0.4 - 0.6 mm, and, the air filter (8) in the intake channel is provided with a choke element (8B) containing a restriction (8A) that reduces the total opening area to 50 - 200 mm^2, preferably 80 - 150 mm^2, more preferably 90 - 120 mm^2.

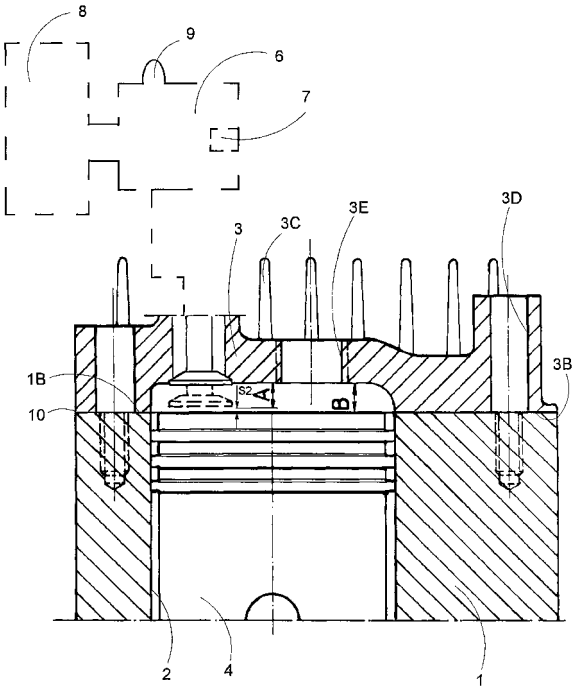

Fig. 1

EP 1 808 587 A2

Description

TECHNICAL FIELD

[0001] This application is a divisional application from EP-A- 02703025.3 and the invention herein relates to a modified single-cylinder Otto engine.

BACKGROUND

[0002] It is generally known that single-cylinder, petrol-driven Otto engines are major environmental culprits. Lawnmowers equipped with such engines come chiefly to mind here. Many different measures have been taken to try to reduce/eliminate the environmental pollution above all from lawnmowers. Amongst other things, lawnmowers have been developed that are operated electrically, either using a flex or rechargeable batteries. Battery-driven lawnmowers have a limitation on their operating time, however, that frequently provides insufficient capacity, and they are also still relatively expensive. Although flex-operated lawnmowers indeed do not have these disadvantages, the flex signifies a practical problem and also a safety risk. It can be stated that this trend in development with regard to lawnmowers has not solved the environmental problems, since the majority of users still want to use fuel-powered lawnmowers.

[0003] To compensate for the environmental problem of fuel-driven lawnmowers to a certain extent, many large-scale users, e.g. local authorities, have gone over to using so-called environmental petrol, which is very expensive (approx. 2 euro/l). It is perceived that this extreme additional cost deters many potential users from buying this propellant.

[0004] An alternative fuel that could solve both the environmental and cost problems is ethanol, which is a bio-fuel with combustion products that are on the whole environmentally friendly and which is priced at roughly the level of normal petrol. However, major manufacturers of single-cylinder Otto engines that are used in lawnmowers state that it is not possible to modify their single-cylinder Otto engines for ethanol operation, in spite of the fact that it has been known for over 100 years that Otto engines can de facto be powered by means of ethanol by using a relatively high compression ratio. Difficulties in cold starting are a general problem with ethanol as a fuel, however. It appears that this problem has contributed to the fact that development with regard to ethanol operation has led to increasingly sophisticated and thus expensive solutions. A sophisticated solution of this kind is previously known for example from US 4,522,173, in which direct injection is used and the piston in the engine is formed in a special manner with the aim of optimizing combustion. US 5,063,883 shows another sophisticated solution, a compensating piston mechanism being provided in connection with the combustion space, which compensating piston mechanism provides the possibility of varying the compression ratio, with the aim of being able to use a fuel like ethanol. Furthermore, reference can be made to WO 82/02576, which shows that a microprocessor is used with a similar aim. It is perceived that such expensive solutions cannot give a satisfactory solution to the problem.

BRIEF DESCRIPTION OF THE INVENTION

[0005] It has proved somewhat surprisingly to be the case that, contrary to the perception of current manufacturers, it is possible to convert a petrol-driven, single-cylinder Otto engine cost-effectively to satisfactorily functioning ethanol operation, by means of producing a modified engine according to the appending claims.

[0006] Thanks to the invention, a modified single-cylinder Otto engine is obtained with which it is possible to use an environmentally friendly propellant. A propellant known by the designation E85, which contains 85% ethanol and 15% petrol, is particularly suitable.

Tests have shown that a drastic reduction in the CO emission can be obtained. Measurements have confirmed that it is possible to obtain a CO emission as low as 0.1% in operation under load. In addition to the environmental advantage, the cost reduction is very large compared with using so-called environmental petrol, since the price of E85 is approx. 1/3 that of environmental petrol. Moreover, it has proved to be the case that the modified engine achieves higher efficiency, resulting in a further reduction in the fuel cost.

[0007] According to further aspects of the invention, it holds good:

- that said carburettor is provided with a pump mechanism, to be able to force fuel to said carburettor,

BRIEF DESCRIPTION OF FIGURES

[0008]

Fig. 1 shows a preferred modified single-cylinder Otto engine according to the invention in cross-section,
Fig. 2 shows an engine according to Fig. 1 in cross-section before modification,

Fig. 3 shows a carburettor for the engine according to Fig. 1 in cross-section,
Fig. 3A shows a nozzle forming part of a carburettor according to Fig. 3,
Fig. 4 shows an alternative modified single-cylinder Otto engine according to the invention in cross-section, and
Fig. 5 shows a preferred air filter forming part of an engine according to Fig. 4.

DETAILED DESCRIPTION

[0009] Fig. 1 shows a single-cylinder Otto engine with an overhead valve according to the invention in cross-section. An engine of this kind occurs extremely commonly mainly in manual lawnmowers, the engine power normally being approx. 3 - 5.5 hp (DIN). They are also common in so-called ride-on lawnmowers[1], but the power is somewhat greater there, approx. 8-9 hp (DIN). The engine comprises an engine block 1 with a cylinder 2. Located on top of the engine block 1 is a cylinder head 3. The cylinder head 3 is provided with cooling fins 3C and an opening 3E for a spark plug. Furthermore, the cylinder head 3 is provided with through holes 3D to screw the cylinder head 3 with its downward facing surface 3B to the cylinder head 1. In the cylinder head 3 are two valve ducts 3F, located inside which are valves 5, 5'. The valves 5, 5' are provided with a valve cone 5B that is intended to interact with a valve seat 5C in the cylinder head 3. Each valve 5 is provided with a flat surface 5A at its end. Situated between the cylinder head 3 and the engine block 1 is a gasket 10. A movable piston 4, which is provided at the top with an essentially flat surface 4A, is located inside the cylinder space 2. The engine also has a cup-type carburettor 6, with a fuel nozzle 7 and a pump mechanism 9. In addition, the engine is provided with an air filter 8. One important aspect of an engine according to the invention is that the play S2 between the valve end 5A and the upper surface 4A of the piston in its upper position is extremely small, preferably approx. 0.4 - 0.6 mm. Another important aspect is that the opening 7A of the nozzle is sufficiently great to permit an adequate fuel inflow. Finally, it is a great advantage that the engine is equipped with a pump mechanism 9 to be able to force fuel into the carburettor on start-up.

[0010] In connection with the modification of a single-cylinder Otto engine provided with an overhead valve according to the invention (see Fig. 2), one starts by laying the engine bare of necessary components such as the plastic cap and tank. The spark plug is then removed so that the spark plug opening (3E) is exposed. Then the engine is turned so that the valves are placed in their most extreme position, i.e. so that both valves (5, 5') are in their most open position a set distance (A) from the cylinder wall in the cylinder head (3). At the same time, it is ensured that the piston (4) is located in its upper extreme position, which according to the example shown here means that the piston top (4A) is on a level with the upper surface (1B) of the engine block (1). In this position the distance (S1) is measured between the valve end (5A) and the piston top (4A). This distance (S1) is also equal to the depth (B) in the cylinder head (3) minus the distance (A) that the valve end (5A) projects from the cylinder wall.

[0011] The minimum distance S 1 between the end 5A of the valve and the lower surface 3B of the cylinder head is normally approx. 2-3 mm, i.e. B - A = S1, which is approx. 2-3 mm. With the aim of obtaining the optimum compression ratio to be able to use ethanol as a propellant, a part of the material in the cylinder head 3 must now be cut so that the play S1 between the piston top 4A and the lower end 5A of the valve is reduced to a modified play S2 of between 0.4 - 1 mm (see Fig. 1). Thus the cylinder head 3 is machined by means of suitable cutting machining (e.g. milling or grinding) so that a greater part of the distance S1 is cut. More often than not, cutting of approx. 2-3 mm is required to have a remaining gap S2 between the valve ends 5A, 5A' and the piston top 4A. When the cylinder head 3 has been machined down and levelled, it is held against the engine block 1 and the engine is turned round to check that no valve end 5A, 5'A strikes against the piston top 4A. If this check turns out well, i.e. the play lies within the preferred range, the cylinder head is fitted to the engine block 1 with a new gasket 10.

[0012] Fig. 3 shows a detailed view of a carburettor according to the invention. The carburettor 6 is provided with a removable (via screw threads) fuel nozzle 7 in a known manner. The carburettor 6 is also provided with a pump mechanism 9, a so-called "primer system" 9. Fig. 3A shows a detailed view of a fuel nozzle 7 for the carburettor 6. It is shown here that the diameter d, opening 7A in the fuel nozzle has been enlarged from approx. 0.6 mm - approx. 0.7 mm, i.e. an increase in the sectional area of more than 30%, for an engine with a power of approx. 4-5 hp. In engines of a somewhat higher power, e.g. 8-9 hp, the diameter d is normally approx. 0.75 mm. The diameter of the existing opening 7A is enlarged by approx. 5-20%, more preferredly approx. 10-15%, which is applicable in principle regardless of the engine's power within the above-mentioned ranges. To ascertain the optimum enlargement, the engine is tested in operation using a number of different fuel nozzles that are provided with different-sized openings. Thus when modifying the engine it is necessary to be equipped with a set consisting of a number of fuel nozzles with openings of different sizes. When the optimum fuel nozzle opening has thus been checked, a corresponding drill is used to enlarge the existing opening 7A to the desired size.

[0013] Fig. 4 shows a so-called side valve engine, in an engine of this kind the valves 5, 5' are arranged in ducts 1A, 1'A in the engine block 1 adjacent to the piston 4. The principles of modification are the same as described above. In this case, however, the valve end 5'A does not move towards the upper surface 4A of the piston but towards a surface 3A inside the cylinder head 3. In the same way, however, it is important to optimize modification of the cylinder head 3

so that the remaining play S2 between the valve top 5'A and the opposing surface 3A remains approx. 0.5 mm. In connection with modification of a single-cylinder Otto engine provided with a supporting valve according to the invention, one starts out however by removing the cylinder head 3. Following removal of the cylinder head 3, the cylinder head 3 and engine block 1 are cleaned of residues of the old gasket 10. The valves are then positioned in their most extreme position, i.e. so that the valve 5' is in its most open position a set distance A from the cylinder wall in the cylinder head 3. In this position, it is measured (for example using a sliding calliper or dial test indicator) how great distance A is. The depth B in the top is then measured. Cutting, levelling and checking then takes place in the same way as above.

[0014] Fig. 5 shows an air filter 8 intended to be used in a carburettor 6 that is provided with a non-removable fuel nozzle. To be able to optimize the fuel/air mixture, the air filter 8 is provided with a choke element 8B that is provided with choke openings 8A. The choke openings are eight in number according to the practical example shown and consist of circular holes with a diameter of 4 mm. The total opening area through these holes is thus approx. 100 mm^2. This means a drastic reduction in the inlet area for feed air, since according to the original design (for petrol operation) the entire intake channel is open in principle for the flow of air, i.e. in the present case where the diameter is 34 mm an open area of between 800-900 mm^2. The area for the fastening screw that penetrates the centre hole (8C) in the choke element (8B) must be deducted here. It is also clear from the figure that the choke element (8B) is cup-shaped, with outer wall parts that are converging, so that the shape of a truncated cone is formed. This shape facilitates a simple, secure and tight fitting of the choke element (8B). It should be made clear that this form of modification is only a necessary alternative when the carburettor 6 is provided with a fixed non-modifiable fuel nozzle.

[0015] In comparative tests that have been carried out, surprisingly good results have been able to be demonstrated with the invention with regard to environmental effects. The results of three different tests carried out are shown below. Test 1 was carried out using Aspen environmental petrol in a new lawnmower. Tests 2 and 3 were carried out on a used lawnmower modified according to the invention. The propellant used in tests 2 and 3 is so-called E85, containing 85% ethanol and 15% petrol.

Test 1

Type of fuel	**Emission**					
Aspen environmental petrol			Carbon monoxide (CO percent by vol.)	Hydrocarbon (HC ppm)	Carbon dioxide (CO_2 percent by vol.)	Oxygen (O_2 percent by vol.)
	Idling speed		0.5	800	7.0	10.1
	Working speed	No-load engine	3.0	248	8.3	6.4
	Working speed	Engine under load	3.4	138	8.4	6.2

Test 2

Type of fuel	**Emission**					
Ethanol 85% Adjustable nozzle, adjusted to low running			Carbon monoxide (CO percent by vol.)	Hydrocarbon (HC ppm)	Carbon dioxide (CO_2 percent by vol.)	Oxygen (O_2 percent by vol.)
	Idling speed					
	Working speed	No-load engine	0.1	787	6.0	12.2
	Working speed	Engine under load	0.1	603	9.0	8.2

Test 3

Type of fuel	Emission					
Ethanol 85% Adjustable nozzle, adjusted to steady running			Carbon monoxide (CO percent by vol.)	Hydrocarbon (HC ppm)	Carbon dioxide (CO_2 percent by vol.)	Oxygen (O_2 percent by vol.)
	Idling speed		1.8	183	8.4	7.6
	Working speed	No-load engine	2.3	168	9.0	5.9
	Working speed	Engine under load	0.1	140	9.0	8.0

[0016] The results show that a modified engine according to the invention under load, using E85 as a propellant, has exceptionally a much lower CO emission than test 1. The CO emission for an engine under load was only 0.1% CO, while a lawnmower operated using Aspen environmental petrol emitted 3.4 % CO when under load. The other values regarding emissions are roughly comparable. The test thus shows that an engine modified according to the invention facilitates a drastic reduction in the environmentally harmful CO emission. We have chosen to focus on the emission levels for an engine under load, since a lawnmower operates de facto under load during the greater period of its operation. However, it can be noted that the CO emission is otherwise also good with regard to an engine modified according to an embodiment of the invention.

[0017] It has also proved to be the case that an engine converted in accordance with the invention can meet the high requirements that apply to obtain environmental labelling according to the Swan standard, ISO 14024. In a test carried out according to test cycle G1 in ISO 8178, by the certified testing institute MTC, the following very good exhaust values were measured for a Briggs & Stratton Intek Edge 55 OHV (without catalyzer) that had been modified according to an embodiment of the invention.

Briggs & Stratton Intek Edge 55 OHV (without catalyzer)					
	CO	**HC**	**CO2**	**NOX**	**BF**
	(g/kWh)	(g/kWh)	(g/kWh)	(g/kWh)	(g/kWh)
Test 1	10.42	2.28	891	7.73	437.5
Test 2	10.27	1.98	906	7.90	443.9
Mean	**10.34**	**2.13**	**898**	**7.82**	**440.7**

[0018] The invention is not restricted to what has been described above, but can be varied within the scope of the following claims. Thus it is perceived inter alia that the invention can also be applied in application areas other than lawnmowers, for example other garden machinery and/or agricultural machinery. Furthermore, it is perceived that the existing play S1 between critical points in the engine can be measured in ways other than those described above, for example by means of laser meters or other existing measuring devices. In certain extreme cases it is also conceivable for the cylinder head to be cut by more than 100% of S1 and to use a thicker cylinder head gasket instead as compensation.

Claims

1. Single-cylinder Otto engine for ethanol operation, which engine comprises an engine block (1) with a cylinder (2), a cylinder head (3), a piston (4) disposed movably inside the cylinder, two valves (5, 5') arranged by the cylinder, a carburettor (6) with a removable fuel nozzle (7), and an air filter arrangement (8), **characterized by** the combination

that

a) the minimum play between the valve end (5A) and its opposing surface (3A; 4A) is between 0.2 - 1 mm, preferably 0.3 - 8 mm, more preferredly 0.4 - 0.6 mm, and,
b) the fuel nozzle (7) is provided with an opening (6A), the diameter of which is between 5-20%, more preferredly 10-15%, greater than the corresponding opening (6A) for petrol operation.

2. Single-cylinder Otto engine according to claim 1, **characterized in that** the carburettor (6) is provided with a pump mechanism (9).

3. Single-cylinder Otto engine according to claim 1 or 2, **characterized in that** said engine is an overhead valve engine, said minimum play (S2) being present between one valve end (5A) and the upper surface (4A) of the piston in its upper position.

4. Single-cylinder Otto engine according to claim 1 or 2, **characterized in that** said engine is a side valve engine, said minimum play (S2) being present between a valve upper end (5A) and a surface (3A) inside the cylinder head (3).

5. Single-cylinder Otto engine for ethanol operation, which engine comprises an engine block (1) with a cylinder (2), a cylinder head (3), a piston (4) disposed movably inside the cylinder, two valves (5, 5') arranged by the cylinder, a carburettor (6) with a non-removable fuel nozzle (7) and an air filter arrangement (8), **characterized by** the combination that

a) the minimum play between the valve end (5A) and its opposing surface (3A; 4A) is between 0.2 - 1 mm, preferably 0.3 - 8 mm, more preferredly 0.4 - 0.6 mm, and,
b) the air filter (8) in the intake channel is provided with a choke element (8B) containing a restriction (8A) that reduces the total opening area to 50 - 200 mm^2, preferably 80 - 150 mm^2, more preferredly 90 -120 mm^2.

6. Single-cylinder Otto engine according to claim 5, **characterized in that** the carburettor (6) is provided with a pump mechanism (9).

7. Single-cylinder Otto engine according to claim 5 or 6, **characterized in that** said choke element (8B) is cup-shaped, preferably having a centrally arranged hole (8C) for fastening.

8. Single-cylinder Otto engine according to claim 7, **characterized in that** said choke element (8B) is arranged with converging outer walls.

9. Single-cylinder Otto engine according to any of the above claims, **characterized in that** said engine is disposed on a lawnmower.

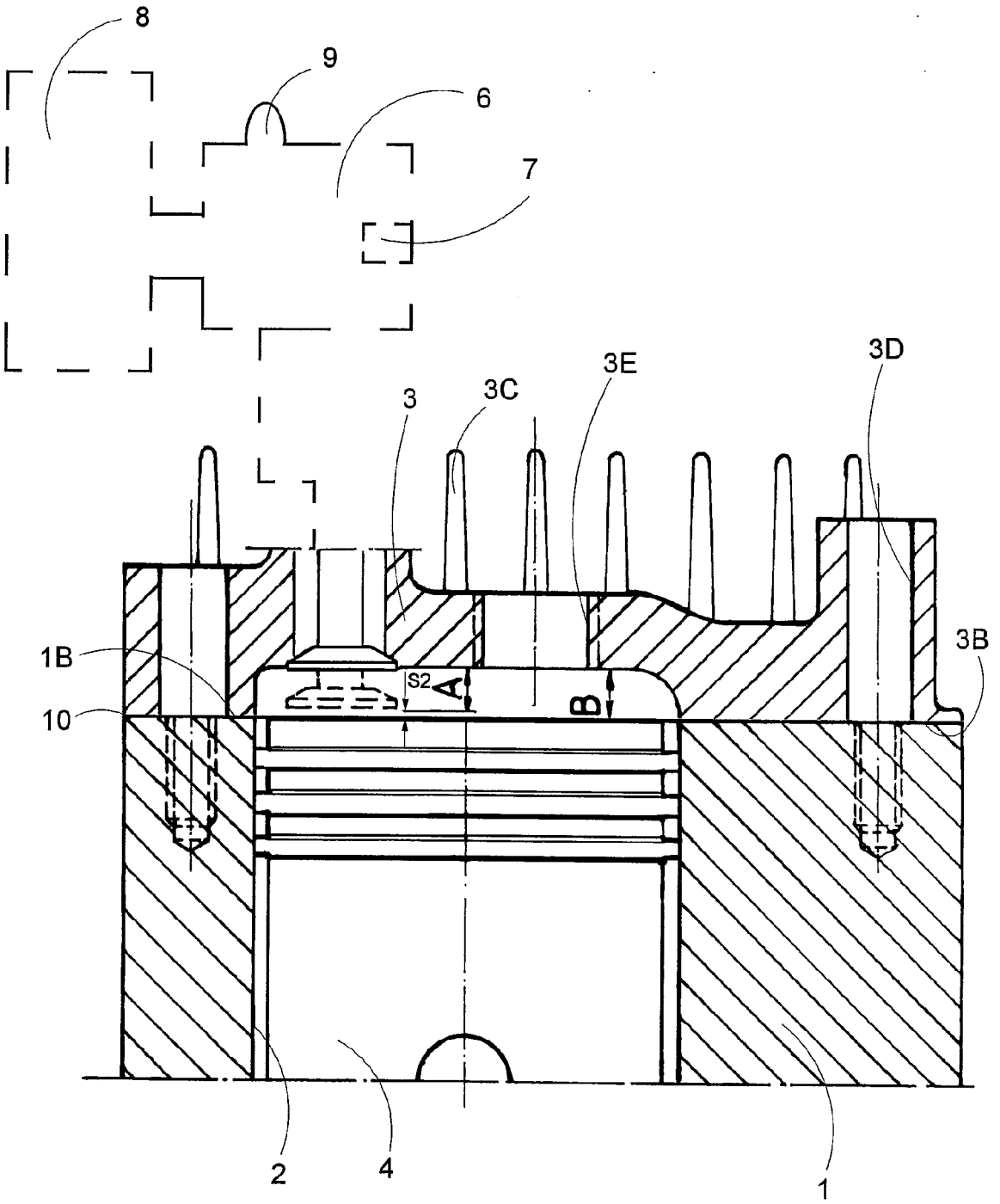

Fig. 1

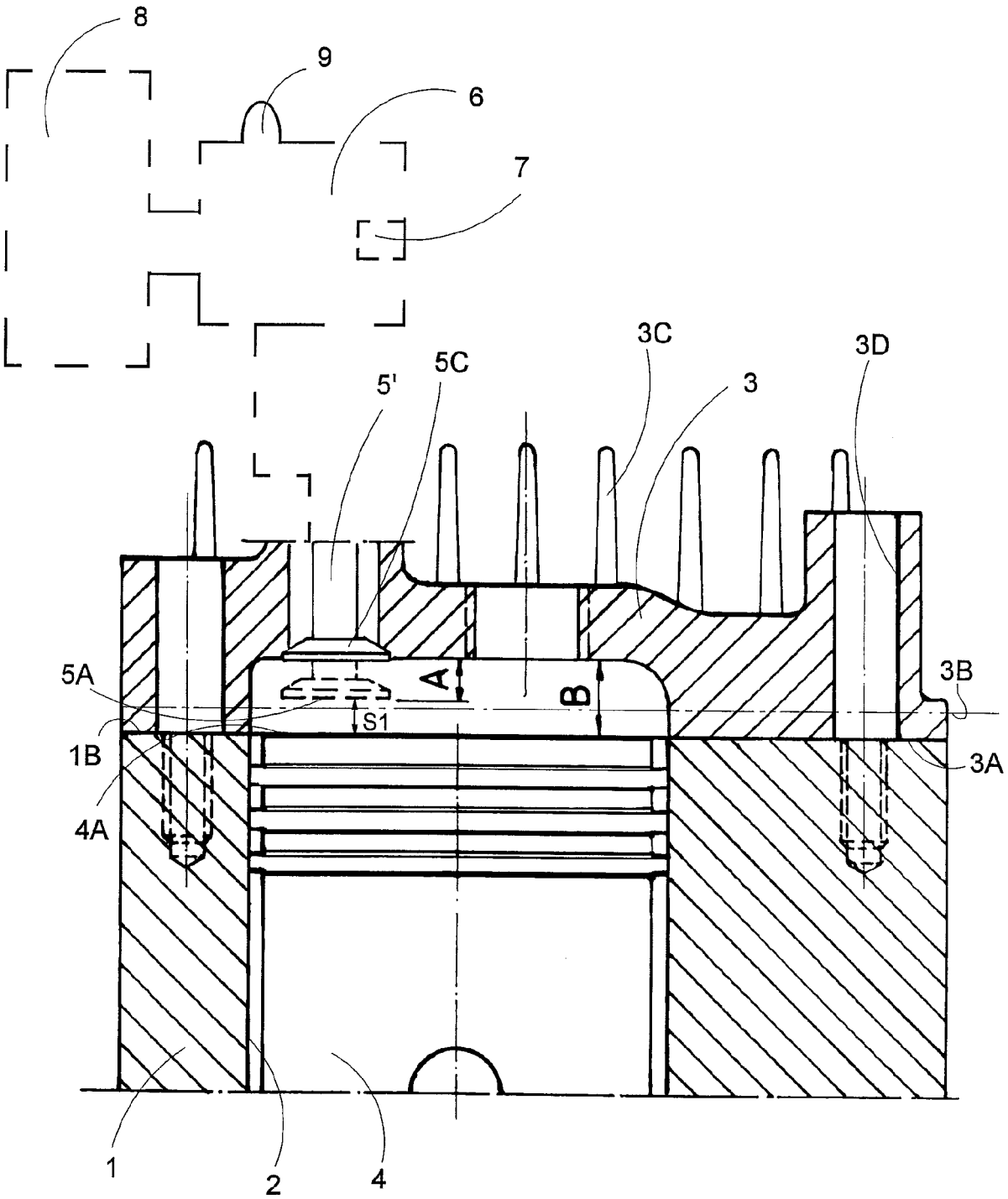

Fig. 2

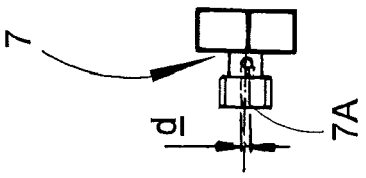

Fig. 3A

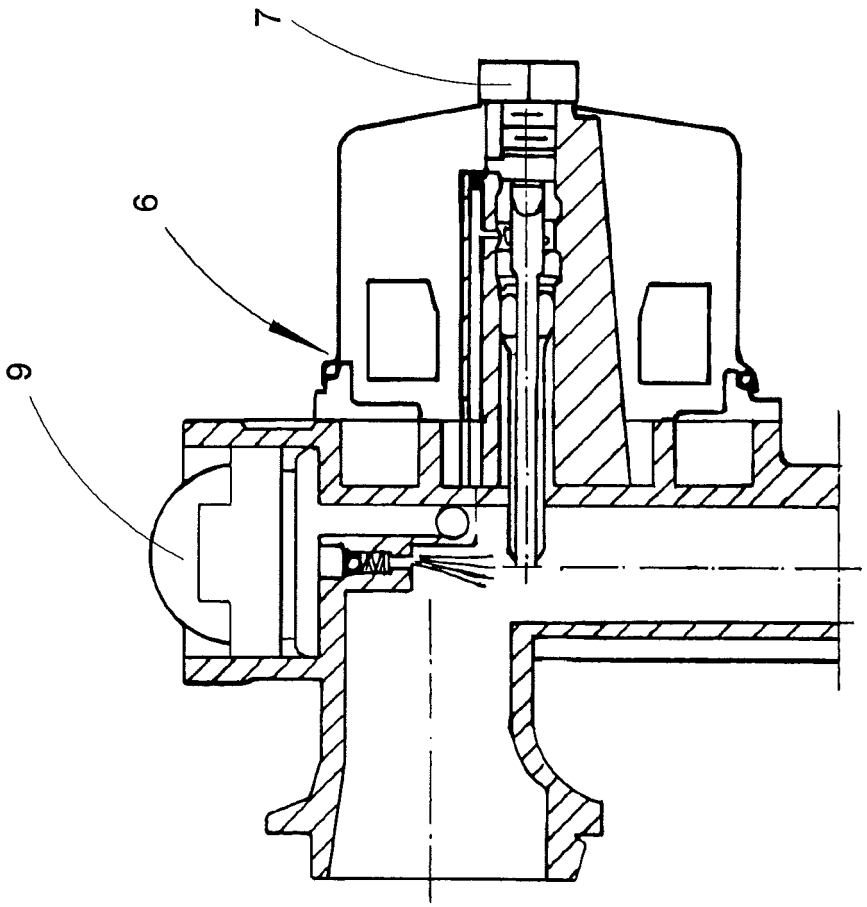

Fig. 3

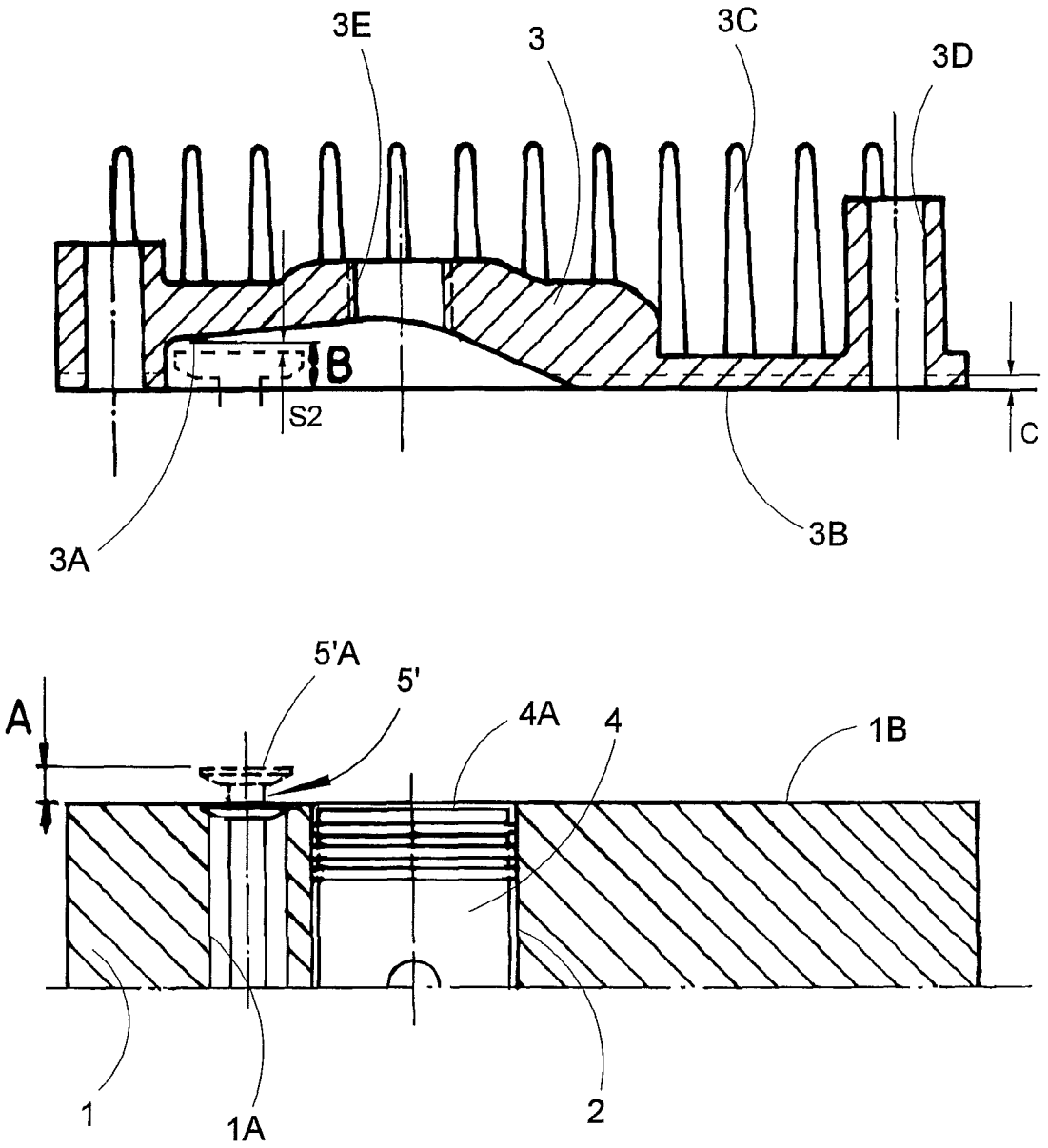

Fig. 4

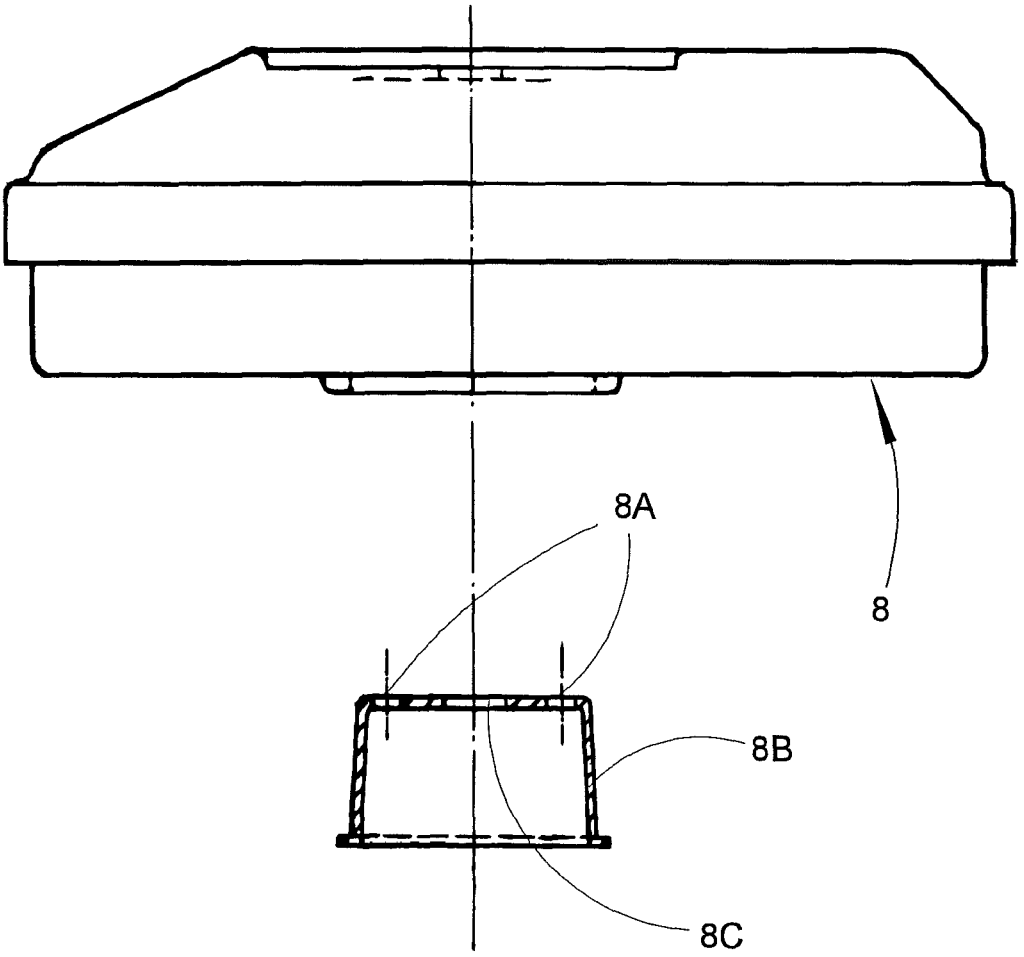

Fig. 5

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 02703025 A **[0001]**
- US 4522173 A **[0004]**
- US 5063883 A **[0004]**
- WO 8202576 A **[0004]**