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(54) **Heat engine provided with a fuel injector**

Brennkraftmaschine mit einem Kraftstoffeinspritzventil

Moteur thermique équipé d'un injecteur de combustible

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- **PATENT ABSTRACTS OF JAPAN vol. 012, no. 182 (M-702), 27 May 1988 & JP 62 291462 A (TOYOTA MOTOR CORP), 18 December 1987,**

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Description

[0001] The present invention relates to a fuel-injected heat engine, in particular but not exclusively of the compression-ignition (diesel) type used in commercial vehicles.

[0002] It is known that injectors for supplying fuel to heat engines comprise a spray assembly adapted to inject the fuel into a combustion chamber of an associated cylinder, and an electrohydraulic control assembly; these assemblies are normally coaxial to one another and integrated in a common casing of elongate tubular shape.

[0003] The injector is mounted in the engine cylinder head, preferably in a position coaxial to the associated cylinder, with the spray assembly arranged to pass through a wall of the cylinder head upwardly bounding the combustion chamber as disclosed e.g. in GB-A-2 289 313; the injector extends axially into the tappet housing between the valve springs.

[0004] The solution with a central injector coaxial to the associated cylinder is optimum for combustion but results in the use of four valves per cylinder (and the associated springs); therefore, the problems in respect of space requirements have proven to be particularly critical and give rise to substantial difficulties in the mounting and dismounting operations.

[0005] In other known solutions, the coaxial arrangement of the injector is dispensed with and the valves are disposed on an inclined axis; however, these solutions, which are more advantageous with regard to space requirements, are disadvantageous with respect to combustion.

[0006] If the injector emerges at the top of the engine through the tappet cover, another disadvantage arises from the fact that an oil seal has to be provided between the injector and the tappet cover and, optionally, a water seal between the cooling chamber of the cylinder head and the injector seating.

[0007] Furthermore, the fastening of the injector in its seating is generally complicated and inconvenient.

[0008] DE-A-4 332 119 discloses a fuel injector having a spray assembly extending along an axis and an electro-hydraulic assembly extending transversely to said axis.

[0009] The object of the present invention is to devise a fuel-injected heat engine, which makes it possible to eliminate the disadvantages of the aforementioned known engines.

[0010] This object is achieved by a fuel-injected heat engine as claimed in claim 1.

[0011] With a view to a better understanding of the present invention a preferred embodiment will be described non-restrictively by way of example below, with reference to the accompanying drawings, in which:

invention, and

Figure 2 is a view in elevation and in partial section, on an enlarged scale, of the injector in Figure 1.

5 **[0012]** With reference to Figure 1, the reference numeral 1 generally denotes a heat engine, only part of which is illustrated.

[0013] The engine 1 comprises a cylinder head 2, suitably made of a light alloy, which has a lower wall 3 upwardly bounding the combustion chamber (not shown) of the cylinders (also not shown), and defines upwardly a tappet housing 4 in which is accommodated a valve-control assembly 5 of known type. The engine 1 comprises four valves 6 per cylinder, two of which are shown in Figure 1.

[0014] The tappet housing 4 is closed upwardly by a cover (not shown) and is bounded downwardly by a substantially horizontal intermediate bottom wall 7 of the cylinder head 2, which forms a support for the valve springs 8.

[0015] The engine 1 also comprises an injector 9 for each cylinder.

[0016] Each cylinder 9 (Figure 2) comprises a spray assembly 10 and a control assembly 11.

25 **[0017]** The spray assembly 10 has a vertical axis coincident with the axis of the associated cylinder and comprises a tubular casing 14 which is made of a number of parts to facilitate assembly and machining, and which is provided with an axial cavity 15. The casing 14 has a lower end portion 16 of reduced diameter, which is mounted in a seating 17 passing through the wall 3 and which is provided end nozzles 18 communicating with the associated combustion chamber.

30 **[0018]** The spray assembly 10 further comprises a needle-type shut-off member 19 (hereinafter designated "needle 19") which slides in the cavity 15 and which is intended to co-operate with the nozzles 18 in a fluidtight manner, and a piston 22 sliding fluidtightly in a pressure chamber 23 defining an upper end portion of the cavity 15. The piston 22 and the needle 19 are provided with respective stems 24, 25 intended to co-operate with one another end on.

35 **[0019]** The needle 19 is urged downwards, i.e. towards the closed position, under the action of the piston 22 subjected to the pressure in the chamber 23 and of a spring 26 accommodated in the cavity 15 of the casing 14 coaxially to the stems 24, 25.

[0020] The needle 19 is provided with an intermediate annular thrust surface 27 of smaller area than the section of the piston 22, which faces downwards into a second pressure chamber 28 provided in the casing 14.

[0021] According to the present invention, the control assembly 11 extends transversely with respect to the axis A of the spray assembly 10.

55 **[0022]** In particular, the assembly 11 comprises a solenoid valve 30 of known type and which, therefore, will not be described in detail. The solenoid valve comprises an elongate outer body 31 extending integrally from an

Figure 1 is a partial section of a heat engine provided with an injector in accordance with the present

upper portion of the casing 14 and provided with an axial cavity 32 having an axis B orthogonal to the axis A, and a moving element 33 sliding axially in the cavity 32.

[0023] The cavity 32 communicates at one of its ends with the pressure chamber 23 through a passage 34 which is of narrow diameter and which is intended to be connected at its opposite end to a fuel-recirculating passage 34 (not shown) through a connector 35.

[0024] The moving element 33 comprises a ball-type shut-off member 36 intended to co-operate in a fluidtight manner with a tapered seating 37 leading into the passage 34 so as to isolate from the latter the cavity 34 and, therefore, the connector 35.

[0025] Finally, the injector 9 comprises a connector 40 for the inlet of fuel under high pressure. The connector 40 is secured to a lower extension 41 of the body 31 of the solenoid valve 30 and communicates with a feed passage 42 provided in the extension 41 itself and extending along an axis C which is inclined with respect to the axes A and B, towards the connection zone of the body 31 with the solenoid valve 30 and the casing 14. The passage 42 is connected to the pressure chamber 23 by a passage 43 of narrow diameter, and to the second pressure chamber 28 by a passage 44.

[0026] Owing to its special geometry, the injector 9 can be wholly accommodated in an intermediate chamber 45 of the cylinder head 2 situated between the lower wall 3 and the bottom wall 7 of the tappet housing 4. The chamber 45 communicates with the exterior of the engine through a lateral opening 46 in the cylinder head 2, which enables the injector 9 to be installed and the feed and recirculation pipes to pass therethrough, as well as a control cable (not shown) for the solenoid valve 30.

[0027] The injector 9 is secured in its installation position by a setscrew 50 with an axis A, which screw is installed through the bottom wall 7 of the tappet housing 4 and which acts at one of its ends against an upper bearing surface 52 of the casing 14 disposed transversal to the axis A and intersected by this latter. The screw 50 is screwed into an axial hole 53 of a bush 54 which, in turn, is screwed into a through-hole in the wall 7.

[0028] The bush 54, which is suitably made of steel, is interposed between the screw 50 and the wall 7 (of light alloy) so as to obviate damage to the latter as a result of repeatedly screwing and unscrewing the screw 50 for maintenance operations.

[0029] The diameter of the hole 55 makes it possible to machine the injector seating 17 in the wall 3 of the cylinder head 2.

[0030] The screw 54 advantageously has an annular seating 56 for a sealing ring 57 which co-operates with the bush 54 so as to prevent any leakage of oil from the tappet housing 4.

[0031] The mode of operation of the injector 9, which is known per se, is as follows.

[0032] The needle 19 is held in the closed position by the spring 26 and by the hydraulic pressure acting on the piston 22, which prevail over the hydraulic pressure

acting on the surface 27 of the needle 19. When the solenoid valve 30 is energised, the first pressure chamber 23 is connected to the recirculation passage; therefore, the piston 22 is free to move upwards so as to enable the needle 19 to open under the action of the hydraulic pressure prevailing in the second pressure chamber 28 on the surface 27, which action prevails over the elastic reaction of the spring 26.

[0033] When the solenoid valve 30 is de-energised, the pressure in the first chamber 23 increases again to the feed value and the resultant force exerted by the piston 22, added to that of the spring 26, overcomes the hydraulic force acting on the needle 19, thereby inducing the closure of the latter.

[0034] The numerous advantages achieved with the present invention are evident from a study of the features of the engine 1 and, in particular, of the injector 9 designed in accordance therewith.

[0035] Firstly, as a result of the transverse arrangement of the control assembly 11 with respect to the spray assembly 10 of the injector 9, the introduction of the injector 9 itself into the tappet housing 4 is obviated but allows an arrangement of the spray assembly 10 coaxial to the respective cylinder. This makes it possible to effect savings in the mounting and dismounting times, and to facilitate the connection of the pipes and the cable to the injector.

[0036] Furthermore, the fastening of the injector 9 itself is facilitated, since by means of the screw 50 or another equivalent member it is possible to apply a purely axial force on the spray assembly 10.

[0037] The screw 50 can be actuated from the tappet housing 4 by means of a conventional implement.

[0038] The arrangement of the control assembly 11 in the chamber 45 makes it possible to reduce the thermal stress on the assembly 11 itself. Any loss of fuel does not contaminate the engine oil. The passages inside the injector are of shorter length and, therefore, the pressure losses are reduced. Moreover, as the drilling lengths are less, the diameter of the spray assembly can be reduced. Finally, the dimensions of the moving elements inside the injector 9 are reduced.

[0039] Finally, it is evident that the engine 1 and the injector 9 can be subject to modifications and variants which do not depart from the scope of protection defined by the claims.

[0040] In particular, the control assembly 11 can extend in a direction which is transverse but not orthogonal to the axis A of the spray assembly 10. Moreover, the injector 9 can be secured in the cylinder head 2 by means of a conventional clamping bracket instead of the screw 50.

Claims

1. A fuel-injected heat engine (1) provided with at least one cylinder and with a cylinder head (2) accommo-

dating at least one injector (9) associated with said cylinder, the injector (9) extending along an axis (A) and provided with end nozzle means (18) and with shut-off means (19) which are associated with said nozzle means (18) and which can move along said axis (A), and an electrohydraulic control assembly (11) for said shut-off means (19), said control assembly (11) extending transversely with respect to said axis (A) of said spray assembly (10), said cylinder head (2) comprising a lower wall (3) delimiting said cylinder and defining upwardly a tappet housing (4) having a bottom wall (7); said cylinder head (2) having at least one intermediate chamber (45) situated between said bottom wall (7) of said tappet housing (4) and said lower wall (3), said injector (9) being wholly accommodated in said intermediate chamber (45) below said bottom wall (7).

2. An engine according to claim 1, **characterised in that** said cylinder head (2) has at least one lateral opening (46) communicating with said intermediate chamber (45).
3. An engine according to claim 1 or 2, **characterised in that** said spray assembly (10) comprises a casing (14) provided with a bearing surface (52) opposite said nozzle means (18) and disposed transversely to said axis (A) and intersected by the axis (52) itself.
4. An engine according to claim 3, **characterised by** comprising means (50) for locking said injector (9), which are associated with said bottom wall (7) of said tappet housing (4) and which co-operate with said bearing surface (52) of said injector (9).
5. An engine according to claim 4, **characterised in that** said locking means comprise a setscrew (5) arranged to pass through said bottom wall (7) of said tappet housing (4).
6. An engine according to any of the preceding claims, **characterised in that** said control assembly (11) has an axis (B) which is orthogonal with respect to said axis (A) of said spray assembly (10).

Patentansprüche

1. Brennkraftmaschine (1) mit Kraftstoffeinspritzung, die mit mindestens einem Zylinder und mit einem Zylinderkopf (2) versehen ist, der mindestens einen Einspritzer (9) aufnimmt, der zu dem Zylinder gehört, wobei sich der Einspritzer (9) entlang einer Achse (A) erstreckt und mit einer Enddüseneinrichtung (18) und mit einer Schließeinrichtung (19), die zu der Düseneinrichtung (18) gehört und sich entlang der Achse (A) bewegen kann, und einer elek-

tro-hydraulischen Steueranordnung (11) für die Schließeinrichtung (19) versehen ist, wobei sich die Steuereinrichtung (11) transversal in bezug auf die Achse (A) der Sprühanordnung (10) erstreckt, der Zylinderkopf (2) eine untere Wand (3) umfasst, die den Zylinder begrenzt und nach oben ein Stößelgehäuse (4) definiert, das eine Bodenwand (7) aufweist; wobei der Zylinderkopf (2) mindestens eine Zwischenkammer (45) aufweist, die zwischen der Bodenwand (7) des Stößelgehäuses (4) und der unteren Wand (3) positioniert ist, wobei der Einspritzer (9) vollständig in die Zwischenkammer (45) unter der Bodenwand (7) aufgenommen ist.

2. Maschine nach Anspruch 1, **dadurch gekennzeichnet, dass** der Zylinderkopf (2) mindestens eine seitliche Öffnung (46) hat, die mit der Zwischenkammer (45) in Verbindung steht.
3. Maschine nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Sprühanordnung (10) ein Gehäuse (14) aufweist, das mit einer Lagerfläche (52) gegenüber der Düseneinrichtung (18) versehen ist und transversal zu der Achse (A) angeordnet ist und durch die Achse (52) selbst geschnitten wird.
4. Maschine nach Anspruch 3, **gekennzeichnet durch** eine Arretiereinrichtung (50) zum Arretieren des Einspritzers (9), die zu der Bodenwand (7) des Stößelgehäuses (4) gehört und mit der Lagerfläche (52) des Einspritzers (9) zusammenwirkt.
5. Maschine nach Anspruch 4, **dadurch gekennzeichnet, dass** die Arretiereinrichtung eine Justierschraube (50) umfasst, die so angeordnet ist, dass sie durch die Bodenwand (7) des Stößelgehäuses führt.
6. Maschine nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Steueranordnung (11) eine Achse (B) aufweist, die orthogonal in bezug auf die Achse (A) der Sprühanordnung (10) ist.

Revendications

1. Moteur thermique à injection de carburant (1) doté d'au moins un cylindre et d'une culasse (2) dans laquelle est logé au moins un injecteur (9) associé audit cylindre, l'injecteur (9) s'étendant le long d'un axe (A) et étant pourvu de moyens formant buse d'extrémité (18) et de moyens d'obturation (19) qui sont associés auxdits moyens formant buse (18) et qui peuvent se déplacer le long dudit axe (A), et d'un ensemble de commande électrohydraulique (11) pour lesdits moyens d'obturation (19), ledit ensemble de commande (11) s'étendant suivant une direc-

tion transversale par rapport audit axe (A) dudit ensemble de pulvérisation (10), ladite culasse (2) comprenant une paroi inférieure (3), qui délimite ledit cylindre, et définissant, vers le haut, un logement de poussoir de soupape (4) comportant une paroi de fond (7); ladite culasse (2) présentant au moins une chambre intermédiaire (45) située entre ladite paroi de fond (7) dudit logement de poussoir de soupape (4) et ladite paroi inférieure (3), ledit injecteur (9) étant entièrement logé à l'intérieur de ladite chambre intermédiaire (45) en dessous de ladite paroi de fond (7).

2. Moteur selon la revendication 1, **caractérisé en ce que** ladite culasse (2) possède au moins une ouverture latérale (46) communiquant avec ladite chambre intermédiaire (45). 15
3. Moteur selon la revendication 1 ou 2, **caractérisé en ce que** ledit ensemble de pulvérisation (10) comprend un carter (14) doté d'une surface d'appui (52) se trouvant à l'opposé desdits moyens formant buse (18), qui est positionnée transversalement audit axe (A) et croisée elle-même par l'axe (A). 20 25
4. Moteur selon la revendication 3, **caractérisé par le fait qu'il** comprend des moyens (50) pour bloquer ledit injecteur (9), qui sont associés à ladite paroi de fond (7) dudit logement de poussoir de soupape (4) et qui coopèrent avec ladite surface d'appui (52) dudit injecteur (9). 30
5. Moteur selon la revendication 4, **caractérisé en ce que** lesdits moyens de blocage comprennent une vis de calage (5) agencée d'une manière la faisant passer à travers ladite paroi de fond (7) dudit logement de poussoir de soupape (4). 35
6. Moteur selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ledit ensemble de commande (11) présente un axe (B) qui est orthogonal par rapport audit axe (A) dudit ensemble de pulvérisation (10). 40

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