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INJECTION INTERNAL COMBUSTION ENGINE WITH FUEL INJECTION INTO A COMBUSTION CHAMBER
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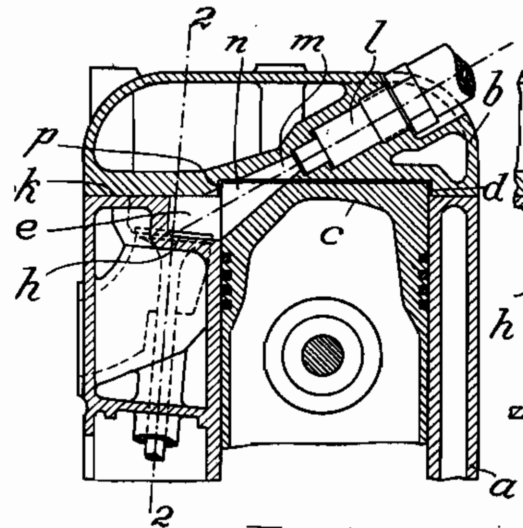

Fig.1.

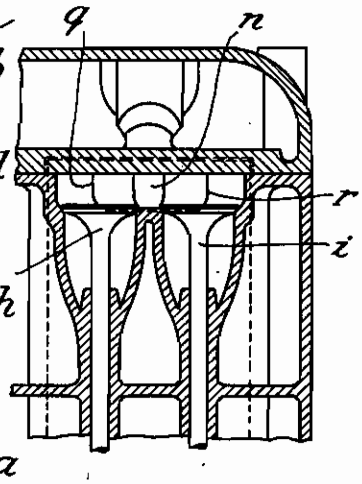

Fig.2.

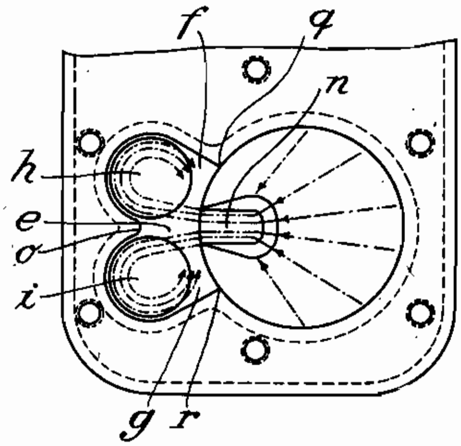

Fig.3.

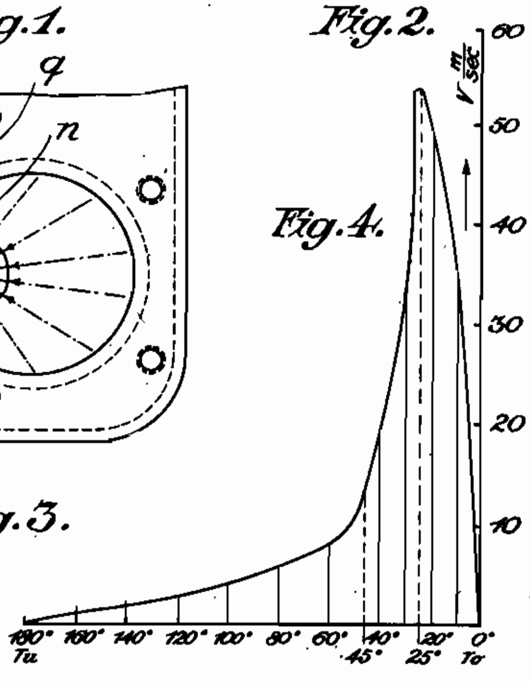

Fig.4.

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INJECTION INTERNAL COMBUSTION ENGINE WITH FUEL INJECTION INTO A COMBUSTION CHAMBER

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This invention relates to an injection internal combustion engine with fuel injection into preferably a lateral combustion chamber constructed as a valve chest and controlled by the piston, and it consists substantially in that the lateral combustion chamber during the first part of the compression stroke communicates with the cylinder space practically unthrottled i. e. unthrottled or almost unthrottled, whereas, before the end of the compression stroke, it is cut off from the cylinder space during the duration of the injection and combustion procedures owing to passing of the piston. Machines with one or more cylinders come into question preferably with more than one valve for each cylinder. There may be several, but preferably one injection nozzle leading to the combustion chamber.

The invention also relates to an injection internal combustion engine with injection of the fuel into a lateral combustion chamber constructed as valve chest and controlled by the piston, in which the lateral combustion chamber shut off from the cylinder space at the end of the compression stroke or connected therewith only by a narrowed throttle cross-sectional area is constructed as valve chest for the vertical admission and discharge valves arranged side by side. The invention enables the use of a lateral combustion chamber serving as valve chest with particular advantage in injection internal combustion engines. As there is an almost unthrottled cross-sectional area between the combution chamber constructed as valve chest and the cylinder space during the greater part of the stroke, a good filling and complete scavenging of the interior of the cylinder is ensured. Moreover, the advantages of the engine with divided or separated combustion chamber are at the same time preserved because, owing to the cutting off of the lateral combustion chamber from the cylinder space by means of the piston in proximity to the upper dead centre position of the piston, a high inflow speed into the lateral combustion chamber and consequently an effective mixing of air and fuel in this combustion chamber are rendered possible, and furthermore a considerable increase in pressure is attainable in the combustion chamber as compared with the cylinder space with the result of a good atomization, distribution and combustion of the fuel air mixture passing into the cylinder space.

The invention may be applied to drop valves, but is of primary importance for the use of vertically arranged valves. Such valves present the advantage, as compared with drop valves and the like, that they allow a lower overall height of the engine, a constant valve motion and consequently a smooth operation of the valve gear, a fewer number of packing points and a simple cylinder head and lower cost of production. However, such valves, especially when admission and exhaust valves are to be arranged vertically side by side, presented difficulties in the case of injection internal combustion engines in as far as the necessary high compression conditions and the thorough mixing of the fuel and air necessary for good combustion could only be attained with difficulty. It was, moreover, impossible to attain such dimensions that a perfect filling of the cylinder and expulsion of the waste gases could take place. All these difficulties are overcome by the invention in spite of the use of two valves arranged vertically side by side.

It is advisable to construct the combustion chamber serving as valve chest as a whirling chamber or as a double whirling chamber, in which the air forced therein carries out a gyrating motion about the axis of the valve or valves.

To produce a particularly high speed of flow and a strong throttling between the lateral combustion chamber and the cylinder space, the lateral combustion chamber is shut off from the cylinder space by the piston already before the end of the compression stroke (for example 25° before the upper dead centre position of the piston or sooner), in such a manner that it communicates with the cylinder space only through a recess or aperture in the piston or in the cylinder head.

The fuel is preferably injected into the lateral combustion chamber in substantially the same direction as the air flowing into the combustion chamber through a narrowed connecting crosssectional area formed at the end of the compression stroke between the cylinder space and the lateral combustion chamber. For assisting the ignition and the preparation of the fuel the fuel injection is preferably directed against the heat accumulating parts of the combustion chamber, for example against the hot valve discs arranged in the lateral combustion chamber.

The invention also relates to a particularly advantageous form of construction of the combustion chamber as whirling chamber, and of the injection passage extending from the nozzle.

An embodiment of the invention is illustrated by way of example in the accompanying drawing, in which:

Fig. 1 is a cross-section through the cylinder,

Fig. 2 is a longitudinal section through the valve chest,

Fig. 3 is a plan view of the engine with cylinder head removed, and

Fig. 4 and example of a diagram for the speed of the air flowing over into the lateral combustion chamber in dependency upon the crank position.

In Fig. 1 *a* is the cylinder, *b* the cylinder head, *c* the piston which in its upper position enters into a cylindrical recess *d* which is preferably arranged in the cylinder head. The combustion chamber *e* is arranged laterally in the cylinder casing and has in plan view a shape approximately corresponding to the figure "3" with part chambers *f* and *g*, in which the admission and exhaust valves *h* and *i* are arranged. These valves are slightly inclined towards the cylinder axis, the lower wall of the combustion chamber, accommodating the valve seats, sloping correspondingly downwards towards the interior of the cylinder. The combustion chamber is bordered at its upper end by a packing surface *k* of the cylinder head.

The fuel is injected into the lateral combustion chamber *e* through an injection passage and through an injection nozzle *l* arranged at an incline in the cylinder head. The injection passage is formed partly by a tapered bore *m* in the cylinder head and partly (in the upper dead centre position of the piston) by an inclined recess *n* in the piston.

It can be seen from Fig. 3, that the injection passage terminates in the lateral combustion chamber between the valves opposite the projection *o* of the wall forming the boundary of the combustion chamber.

The engine operates in the following manner:

During the greater part of the piston stroke the lateral combustion chamber *e* is connected with the cylinder space by a wide, almost unthrottled, rectangular aperture between the edges *q* and *r*, as shown particularly in Fig. 3. Thus, there is a wide passage cross-sectional area available between the cylinder space and the lateral combustion chamber for the suction air sucked through the valve *h* or for the exhaust gases expelled through the valve *i*. Consequently a good filling and an as far as possible complete expulsion of the exhaust gases from the cylinder are attained. During the upward movement of the piston the lateral combustion chamber *e* is controlled by the piston in the last portion of the compression stroke, for example in such a manner that the upper edge *p* of the piston commences to shut-off the combustion chamber at 45° before the upper dead centre position and, at 25° before the dead centre position (that is about 5% of the piston stroke from the upper dead centre position), enters into the recess *d* in the cylinder head. At this moment the lateral combustion chamber is almost closed by the piston and communicates with the cylinder space or with the recess *d* in the cylinder only through the inclined recess *n* in the piston. Fig. 4 shows the speed diagram of the air flowing over from the interior of the cylinder into the lateral combustion chamber. From the commencement of the shutting off of the combustion chamber by the piston the speed of the overflowing air increases rapidly until, at the end of the shutting off motion (about 25° before the dead centre position is reached), the air speed has attained its maximum value.

As the air is pushed from the cylinder space into the combustion chamber constructed as whirling chamber and valve chest, the air eddies, indicated in dotted lines in Fig. 3, are produced during the last portion of the compression stroke. At the same time the air current is divided up by the e. g. projecting edge o and caused to carry out oppositely directed turning movements about the axes of the part chambers *f* and *g* or of the valves *h* and *i*.

At the same time also the injection of the fuel commences at about 25° before the upper dead centre position is reached, the fuel being thoroughly mixed with the air both on its passage to the nozzle through the whirling chamber and also in the whirling chamber itself. The fuel jet is injected against the lower wall viz. against the projecting edge o of the rear closing wall of the combustion chamber between the valves *h* and *i* through the injection passage *m*, *n* in an inclined downward direction approximately corresponding to that of the overflowing air, the jet being deflected against the valves by the dividing air currents. As the valve discs have a relatively high temperature and are uncooled, they serve at the same time for assisting the preparation and ignition of the fuel, so that, in conjunction with the thorough mixing of the air with the fuel, a rapid ignition and a clean combustion are ensured. The injection of the fuel is approximately ended when the piston reaches its upper dead centre position.

By the combustion commencing with a short ignition delay an increase of pressure is produced in the lateral whirling chamber, which increased pressure, owing to the strong throttling which exists between the whirling chamber and the cylinder space up to about 25° after the upper dead centre position has been passed, that is as long as the communication between the two spaces is effected merely by the recess *n* in the piston, ensures a strong ejection and consequently an effective distribution of the mixture of the whirling chamber in the cylinder space. This scavenging of the whirling chamber is terminated at approximately 20 to 25° after the passing of the dead centre position. At this moment the upper edge *p* of the piston begins to uncover the wide aperture between the whirling chamber and cylinder space, so that a practically unthrottled communication is established between the two spaces, and an unimpeded expansion of the gases for combustion can take place.

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