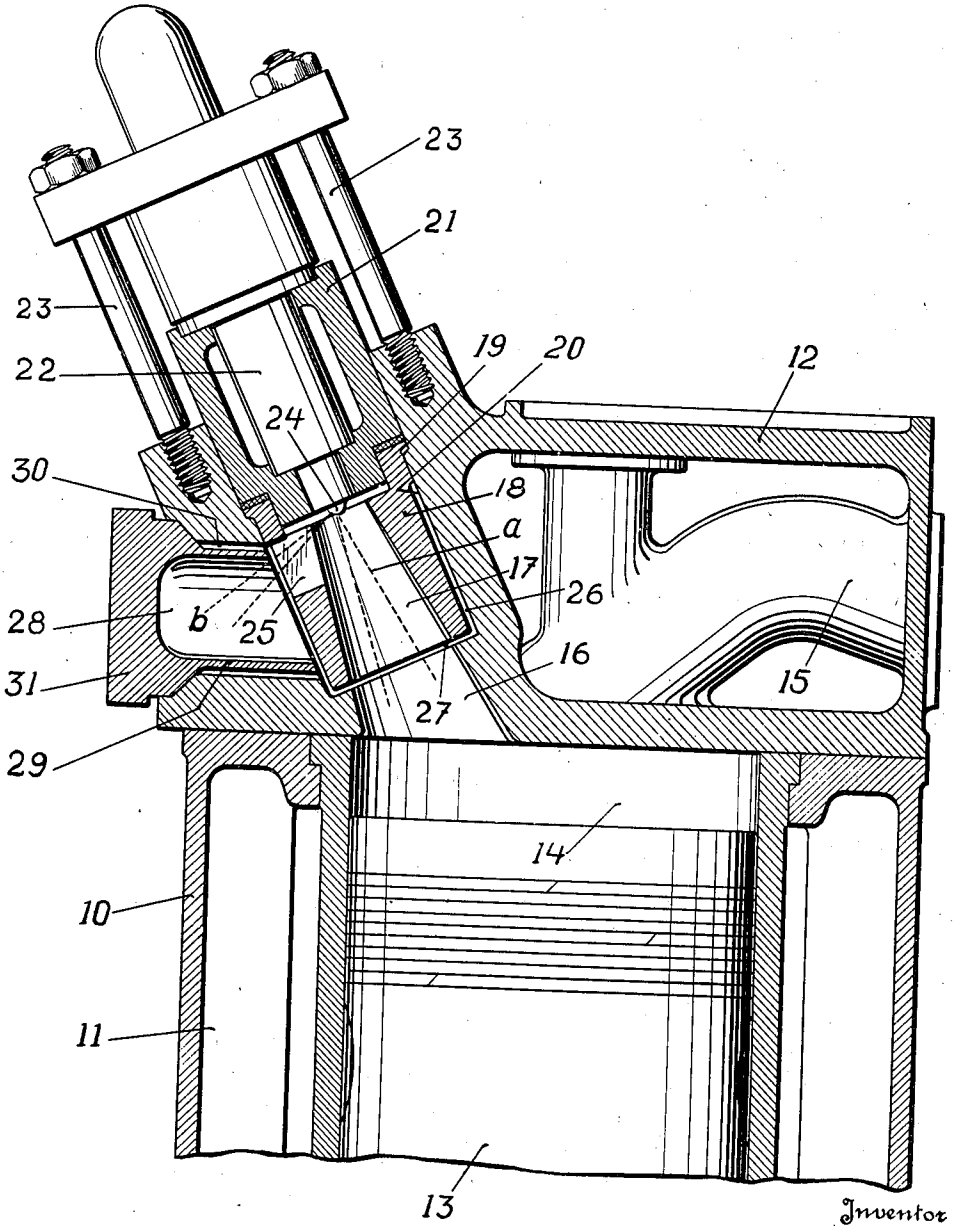
Oct. 29, 1935. H. FISCHER 2,019,298

INTERNAL COMBUSTION ENGINE

Filed April 25, 1932



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Patented Oct. 29, 1935 2,019,298

UNITED STATES PATENT OFFICE

2,019,298

INTERNAL COMBUSTION ENGINE

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Application April 25, 1932, Serial No. 607,271

4 Claims. (Cl. 123—32)

This invention relates to internal combustion engines of the type wherein the fuel, ordinarily oil, is injected into an air charge previously admitted to the combustion space.

One object of the present invention is the provision of an improved engine of this type which will operate smoothly and efficiently throughout a wide range of speed. This I have accomplished by the use of a novel combination and arrangement of parts which function to effect an unusually prompt and sure ignition of the fuel charge substantially at the instant of fuel injection and to effect an early and complete combustion of the fuel without producing an explosive effect. The ignition lag characteristic of the Diesel cycle has thus been substantially eliminated, making possible efficient operation at relatively high speeds, and at the same time the explosive effect characteristic of the Otto cycle has been avoided, thus keeping the mechanical stresses within relatively low limits so as to permit the safe use of a relatively light construction.

Another object is the provision of improved means for effecting a violent turbulence of the fuel and air charge during combustion so as to promptly effect a complete and thorough mixture thereof and thereby insure complete combustion of the fuel within a very early stage of each working stroke.

Other more specific objects and advantages will appear from the following description of an illustrative embodiment of the present invention.

The single figure of the accompanying drawing is an axial sectional view of the head end of an engine cylinder constructed in accordance with the present invention.

The engine selected for illustration is designed to carry out a four stroke cycle, but the invention may be applied with equal advantage to engines of the two stroke cycle type.

The cylinder shown at 10 is provided with the usual water jacket 11 and with a water cooled head 12 with which the reciprocating piston 13 coacts to form the expansible combustion space or chamber 14. The cylinder is also equipped with the usual inlet and exhaust valves (not shown) each of which controls communication between the chamber 14 and one of the usual pair of conduits 15 formed in the head.

An inwardly flaring throat 16, formed in the head 12, communicates with the chamber 14 and forms in effect an extension or continuation of a longitudinally tapered pre-combustion chamber 17. Chamber 17 is preferably formed in a plug 18 whose upper end is slightly enlarged and flanged, as at 19, so as to seat firmly against an internal shoulder within a pocket 20 formed in the cylinder head. The plug 18 is retained in place by a hollow plug 21 adapted to receive and support the fuel injection nozzle 22, both plugs 18 and 21 and nozzle being secured in the pocket 20 by an appropriate clamp structure, including the bolts 23.

Except for a detail hereinafter mentioned, the nozzle 22 is of a type commonly employed for injecting fuel under pump pressure. In this instance the nozzle 22 is arranged to project an oil spray *a* into and axially of the chamber 17, the tip 24 of the nozzle being provided with an auxiliary orifice designed to direct an auxiliary oil spray *b* through a narrow slot 25 formed in the side of the plug 18.

Except for the upper supporting end thereof, the plug 18 is spaced from the interior walls of the pocket 20 to provide a narrow peripheral clearance space 26 and end clearance space 27, so as to effectively check transmission of heat to the water cooled cylinder head and thereby maintain the plug 18 at a relatively high temperature during operation of the engine, and also for an additional purpose which will later appear. The clearance spaces 26 and 27 are of a width approximating the width of the slot 25.

A second pre-combustion chamber 28 is provided, disposed to receive fuel from that auxiliary spray *b* projected through the side slot 25. Chamber 28 is formed in a sleeve like member 29 positioned within a side opening 30 formed in the cylinder head 12 with the sleeve preferably spaced from the walls of the opening so as to maintain the walls of the sleeve at a relatively high temperature. The sleeve 29 is supported by an integral head 31 securely fixed within the outer shouldered end of the opening 30. The inner open end of the chamber 28 communicates directly with the peripheral clearance space 26 surrounding the plug 18.

The stroke of the piston 13 is preferably such that, at compression dead center, it barely avoids contact with the inner face of the head 12, so that practically all of the air has been displaced from the space 14 within the cylinder proper, although some departure from that condition will not defeat the purposes of the present invention.

In the drawing the piston 13 is moving upwardly on a compression stroke compressing the fresh air charge ahead of it into the throat 16 and chamber 17, and through the clearance spaces 26 and 27 and slot 25 into the chamber 28.

Just before compression dead center, fuel under pump pressure is injected through the nozzle 22 to form the sprays *a* and *b*. The fuel injection preferably begins about ten degrees ahead of dead center, although this timing may be advanced or retarded in accordance with variations in engine speed. For higher speeds an earlier injection is desirable.

The fuel contained in the spray *b* is heated to an ignition temperature during its passage between the hot walls of the slot 25 so that some of it is immediately ignited as it contacts the air in the pre-combustion chamber 28. Furthermore, the turbulence produced in the chamber 28 by the high velocity flow of air thereinto through the narrow clearance spaces 26 and 27 and slot 25 produces a thorough mixture of the air with the fuel in spray *b* causing rapid combustion thereof. The instantaneous rise in pressure, resulting from this early ignition, and the maintenance of that pressure by the rapid combustion in chamber 28, causes the chamber 28 to discharge forcibly through the clearance spaces 26 and 27 into the throat 16 and also, to a lesser degree, through the slot 25 into the pre-combustion chamber 17.

In the meantime the fuel contained in the simultaneously formed spray *a* absorbs heat from the walls of the chamber 17 and its temperature is thereby increased so as to prepare the same for quick burning. It is ordinarily ignited by the hot gases discharged into chamber 17 through the slot 25, as a result of the early ignition in the chamber 28, before the temperature thereof has increased sufficiently to produce auto-ignition.

An unusually prompt ignition of the fuel in both sprays is thus effected. Explosive burning, with consequent excessive peak pressures, are avoided however, and this I attribute largely to the fact that combustion of all of the fuel in the spray *a* is impossible until each particle thereof is brought into intimate contact with air in sufficient volume to support combustion, a condition attainable only by thoroughly mixing the fuel and air.

In this instance combustion continues as the piston 13 starts downwardly on a working stroke and permits the hot gases to expand against it into the space 14. During this flow of unburned fuel and air from the chamber 17 through the throat 16, the unburned fuel and air from the chamber 28, passing at high velocity through the clearance spaces 26 and 27, also enter the throat 16, causing a severe turbulence therein which is effective to thoroughly mix the unburned fuel and air and produce rapid and thorough combustion.

Turbulence is also produced in the upper end of the chamber 17 by the admission of the hot gases thereto through slot 25, so as to thoroughly clean the nozzle tip 24 of any fuel adhering thereto. The downward flow through the chamber 17 also insures complete burning of any fuel deposits on the interior walls thereof.

Although the relationship of the volumes contained in chambers 17 and 28 and of the slot 25 and clearance spaces 26 and 27 is dependent upon many factors inherent in the design, I have attained excellent results with parts proportioned as indicated on the drawing in an engine having pistons of four and three quarters inches in diameter with a six and one half inch stroke.

Various changes may be made in the embodiment of the invention hereinabove specifically described without departing from or sacrificing the invention as defined in the appended claims.

I claim:—

1. In an internal combustion engine of the oil burning type the combination of a cylinder, a piston reciprocable therein coacting therewith to form a combustion space, an auxiliary chamber, a throat providing unrestricted communication between said chamber and space, means for forming a fuel spray in said chamber, a second auxiliary chamber, means for admitting fuel to said second chamber and a communication between said chambers including a restricted passage encircling said first named chamber through which said second auxiliary chamber discharges its contents at high velocity into said throat to thereby create a turbulence within the discharge from said first named auxiliary chamber.

2. In an internal combustion engine of the oil burning type the combination of a cylinder, a piston reciprocable therein coacting therewith to form a combustion space, an auxiliary chamber arranged to discharge into said space, means for forming a fuel spray in said chamber, a second auxiliary chamber, means for admitting fuel to said second chamber, and a communication between said chambers including means encircling said first named chamber for directing the discharge from said second chamber into the discharge from said first named chamber to create a turbulence therein.

3. In an internal combustion engine of the oil burning type the combination of a cylinder, a piston reciprocable therein coacting therewith to form a combustion space, an auxiliary chamber having uncooled walls and arranged to discharge its contents into said space, means for directing a fuel spray into said chamber, a second auxiliary chamber having uncooled walls, means for admitting fuel to said second chamber, and a communication between said chambers including means encircling said first named chamber for directing the discharge from said second chamber into the discharge from said first named chamber.

4. In an internal combustion engine the combination of a cylinder having a head, a piston reciprocable in said cylinder and coacting with said head to form a combustion space, said head having a pocket formed therein, a hollow open ended plug fixed in and open to said pocket and forming an auxiliary chamber, said head having a throat leading from said pocket to said space and communicating with said chamber, said head having a side opening therein communicating with said pocket, a second hollow open ended plug fixed in said opening and forming a second auxiliary chamber communicating with said pocket, a slot formed in the side of said first named plug, fuel injection means for directing a fuel spray into said first named auxiliary chamber and for directing a second spray through said slot into said second auxiliary chamber, and a narrow clearance space between said first named plug and pocket through which the discharge from said second auxiliary chamber is directed into the discharge from said first named auxiliary chamber.

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