H. JUNKERS.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JAN. 2, 1913.

1,127,772.

Patented Feb. 9, 1915.

2 SHEETS—SHEET 1.

Fig. 1.

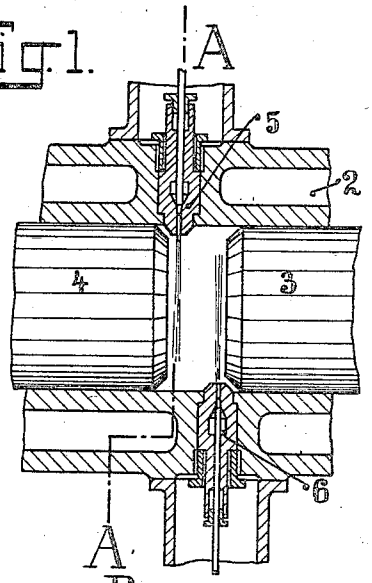


Fig. 2.

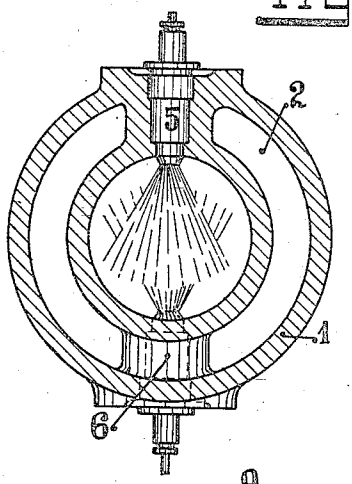


Fig. 3.

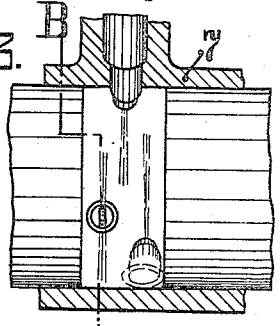


Fig. 4.

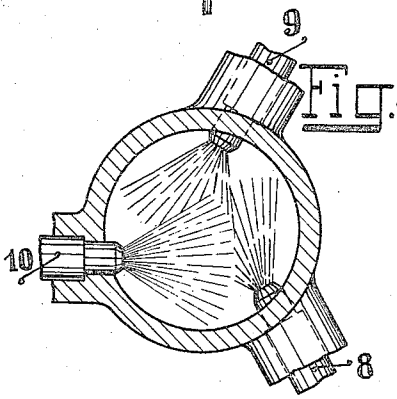


Fig. 5.

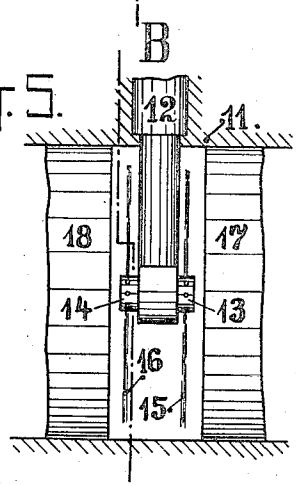
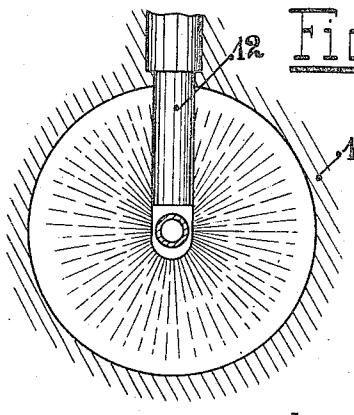


Fig. 6.



Witnesses:

C. B. Schroeder

Vincent Lorraese

Inventor:

Hugo Junkers

by Pennie Davis Goldsborough

Attorneys

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2 SHEETS—SHEET 2.

Fig. 7

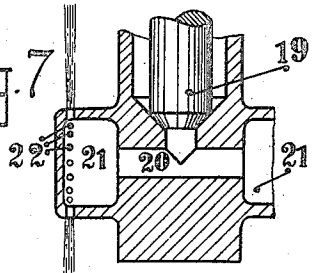


Fig. 8

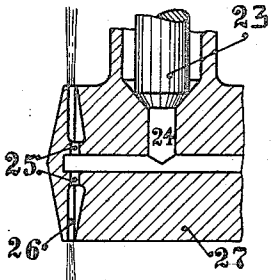


Fig. 9

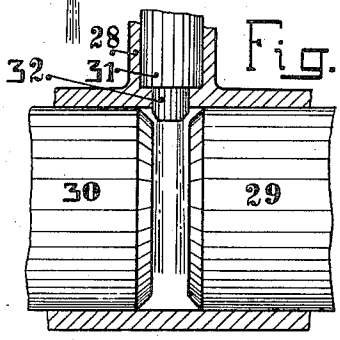


Fig. 10

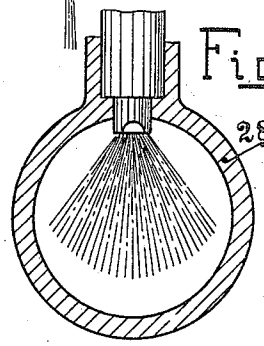


Fig. 11

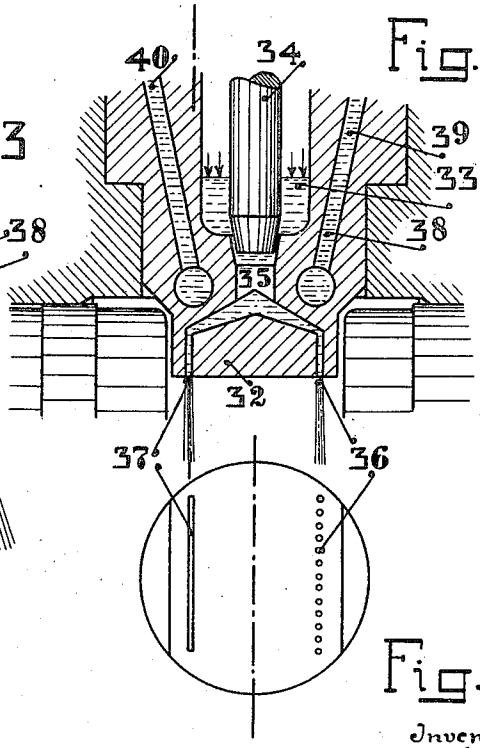


Fig. 13

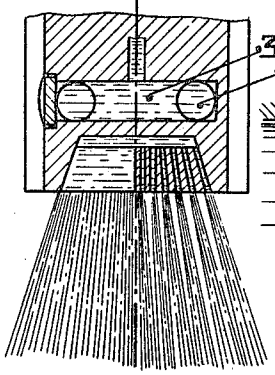


Fig. 12

Witnesses:

C. B. Schroeder

Vincent Saracco

Inventor:

Hugo Junkers

by Pennie, Davis, Goldsborough

Attorneys

UNITED STATES PATENT OFFICE.

HUGO JUNKERS, OF AIX-LA-CHAPELLE, GERMANY.

INTERNAL-COMBUSTION ENGINE.

1,127,772. Specification of Letters Patent. Patented Feb. 9, 1915.

Application filed January 2, 1913. Serial No. 739,621.

To all whom it may concern:

Be it known that I, HUGO JUNKERS, a subject of the King of Prussia, residing at No. 68 Bismarckstrasse, Aix-la-Chapelle, in the Kingdom of Prussia, Empire of Germany, have invented certain new and useful Improvements in Internal-Combustion Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to internal combustion engines and particularly to the method of and means for introducing fuel into the cylinder of such an engine. The invention is of special utility in internal combustion engines employing crude oil as the fuel and having two pistons reciprocating in opposite directions in a cylinder.

In internal combustion engines as heretofore constructed, it has been the common practice to introduce the fuel at a single point and this has often resulted in imperfect consumption of the fuel because an insufficient amount of air becomes mixed with the fuel. This characteristic has been particularly objectionable in engines having two oppositely reciprocating pistons with which it has been the practice to inject the fuel into the middle of the space within the cylinder and between the adjacent ends of the pistons. This is explained, I believe, by the fact that in operating such an engine the air compressed between the two pistons follows the pistons as they move away from each other to the same degree in both directions, so that the air in the middle of the space into which the fuel was injected remains substantially at rest. The imperfect consumption of fuel within the cylinder not only results in decreased power, but also causes choking of the fuel-injecting nozzles, as the residue of the partially consumed fuel becomes deposited upon the surrounding walls, particularly in the openings in the injecting nozzle where the air is insufficient to cause its consumption. In accordance with the present invention, these objectionable features of internal combustion engines as heretofore constructed are overcome by the injection of the fuel into the cylinder at a plurality of points which are spaced apart in the direction of the length of the cylinder. Preferably, the fuel is injected into the space within the cylinder between the adjacent ends of the pistons at equal distances on opposite sides of the center of that space. I prefer to inject the fuel as near as possible to the adjacent ends of the pistons when the latter are in their innermost positions, for by this arrangement I attain several important advantages. If the fuel is injected in the form of thin sheets or layers close to the ends of the pistons, a body of compressed air lies between the two sheets of fuel; when the pistons move outwardly, this compressed air follows them, and in doing so, it must pass through the sheets of fuel so that the air and fuel become thoroughly mixed. As the pistons continue their outward movement the carbon dioxid, which is generated as the fuel is consumed, remains close to and moves outwardly with the pistons so that it will not interfere with the consumption of the fuel injected into the cylinder during the next cycle of operations. Furthermore, in some cases I prefer to provide a plurality of fuel-injecting nozzles spaced apart in the direction of the length of the cylinder and so arranged that the fuel injected thereby is directed not exactly toward the center of the cylinder, but along the line of chords, whereby the mixture of fuel and air within the cylinder is given a spiral or circular motion and more thorough mixing of the air and fuel is effected.

The preferred embodiment of the invention is illustrated in the accompanying drawings, in which—

Figures 1 and 2 are longitudinal and transverse sections of a portion of a gas engine; Figs. 3 and 4 are similar views showing a different arrangement of the nozzles; Figs. 5 and 6 are views similar to Figs. 1 and 2 illustrating a further modification of the arrangement of the nozzles; Figs. 7 and 8 are detail views showing constructions which may be employed in the nozzle shown in Fig. 5; Figs. 9 and 10 are views similar to Figs. 1 and 2 showing a single nozzle arranged for introducing the fuel in two sheets, and Figs. 11, 12 and 13 are views on an enlarged scale of the nozzle shown in Fig. 9.

Referring first to Figs. 1 and 2, the cylinder 1 is provided with a cooling jacket 2 and within the cylinder are two pistons 3 and 4 which are adapted to reciprocate in opposite directions. In Fig. 1, the two pistons are shown in their innermost position, and it will be noted that there is free space

within the cylinder between the adjacent ends of the two pistons. Two nozzles 5 and 6 are provided projecting through the walls of the cylinder 1 and its jacket. In Figs. 1 and 2, the two nozzles are shown as displaced in the direction of the axis of the cylinder. They are located at equal distances on opposite sides of the center of the space between the two pistons. Also, the two nozzles are shown as located on opposite sides of the cylinder. The outlets from the nozzles are arranged to spread the fuel issuing therefrom in the form of thin sheets, as is indicated in the drawings. These two sheets of fuel lie close to the ends of the pistons 3 and 4, and between them is a body of compressed air of substantial size.

In Figs. 3 and 4, three nozzles 8, 9 and 10 are provided projecting through the cylinder walls 7 and into the space between the pistons. These nozzles are displaced in the direction of the axis of the cylinder and are arranged to deliver the fuel in thin sheets which together approximate the size of the cylinder. The three nozzles shown in Figs. 3 and 4 are not directed radially inward, but instead are disposed in the direction of chords of the cylinder. As a result of this arrangement of the nozzles, the blasts of fuel from the nozzles will cause the fuel and the air within the cylinder to take up a circular motion. The production of this circular movement of the air and fuel within the cylinder is assisted by arranging the nozzles at a slight inclination to the axis of the cylinder.

In Figs. 5 to 8, a different arrangement of the nozzle is shown. This nozzle projects to the center of the space within the cylinder and between the pistons and is provided with two outlets or sets of outlets on opposite sides thereof, which outlets inject the fuel into the cylinder in the form of two layers, the fuel of each layer being directed radially outward. In Fig. 5, 11 indicates the cylinder, 12 the nozzle, and 13 and 14 the outlets from this nozzle. These outlets direct layers of fuel 15 and 16 radially outward close to the faces of the pistons 17 and 18.

In Fig. 7, a valve is shown at 19 controlling the flow of fuel into a passageway 20 in the end of the nozzle 12, from which passage the fuel passes into the chambers 21. Each of these chambers is provided with a multiplicity of small openings 22 disposed in a plane transversely of the cylinder. In Fig. 8, the end 27 of the nozzle is provided with a T-shaped duct 24 into which the fuel is forced past the valve 23, and from the end of this duct radial holes 25 lead to a circular channel 26 from which the fuel is passed through a thin radial slot into the cylinder.

Nozzles of the character herein indicated are cooled to a certain degree by being passed through the cooling jacket of the cylinder, but for machines operated by crude oil, I have found it desirable to provide additional means for cooling the nozzle. For this purpose I employ a circulation of cooling water and lead this water into the extreme end of the nozzle. Such a construction is shown in Figs. 11 and 13. These figures, together with Figs. 9 and 12, also show another advantageous feature consisting in arranging one nozzle to inject the two separated sheets of fuel into the cylinder. The cylinder is shown at 28 and the pistons at 29 and 30, these pistons being arranged to reciprocate in opposite directions. The end 32 of the nozzle 31 projects into the space within the cylinder between the adjacent ends of the two pistons. The fuel 33 is fed into the chamber of the nozzle 31 and is forced past the valve 34 into a divided passage 35 which leads to outlets 36 and 37 spaced apart lengthwise of the cylinder. The outlet at the right of Figs. 12 and 13 is shown as consisting of a plurality of small holes arranged in line, while that at the left is shown as consisting of a narrow slot. In order to provide for cooling the nozzle, and particularly for cooling the portion thereof which projects into the cylinder, the nozzle is provided with a bore or passage 38 which extends around the passage 35 for the fuel and cooling water is carried to and from the passage 38 by ducts 39 and 40. The cooling water may be water taken from the jacket of the cylinder, or it may be fresh cold water fed directly into the nozzle.

In all of the several forms of my invention herein illustrated and described, it will be seen that the fuel is injected into the space within the cylinder and between the adjacent ends of the two pistons in the form of sheets or layers which are separated in the direction of the length of the cylinder so that a body of compressed air is inclosed between the two or more layers of fuel. As before indicated these layers of fuel are preferably arranged to lie close to the ends of the pistons when the latter are in their innermost positions, as a result of which a more thorough mixing of the air and fuel takes place during the outward movement of the pistons.

What I claim is:

1. In an internal combustion engine, the combination of a cylinder structure, two pistons therein reciprocating lengthwise of the cylinder in opposite directions and having the space between them forming an explosion chamber common to the two pistons, and means for introducing fuel into said explosion chamber in two sheets substantially transverse to the cylinder structure and spaced apart in the direction of the length thereof; substantially as described.

2. In an internal combustion engine, a cylinder, two pistons reciprocating therein

in opposite directions, there being free space within the cylinder and between the pistons, and means for introducing fuel transversely into the cylinder between the adjacent ends of the pistons at two points spaced apart in the direction of the length of the cylinder; substantially as described.

3. In an internal combustion engine, the combination of a cylinder, two pistons reciprocating therein in opposite directions, there being free space within the cylinder between the adjacent ends of the pistons, and means for introducing fuel into the cylinder in two sheets substantially transverse to the cylinder at opposite sides of the center of the space between adjacent ends of the pistons; substantially as described.

4. In an internal combustion engine, the combination of a cylinder structure, two pistons therein reciprocating lengthwise of the cylinder in opposite directions and having the space between them forming an explosion chamber common to the two pistons, and means for introducing fuel into the cylinder at two points located on opposite sides of the center of the space between the adjacent ends of the pistons; substantially as described.

5. In an internal combustion engine, the combination of a cylinder structure, two pistons reciprocating therein in opposite directions and having the space between them forming an explosion chamber common to the two pistons, and means for introducing fuel into said explosion chamber in the direction of chords of the cylinder structure and at points spaced apart in the direction of the length of the cylinder structure; substantially as described.

6. In an internal combustion engine, the combination of a cylinder, two pistons reciprocating therein in opposite directions, there being free space within the cylinder between the adjacent ends of the pistons, and means for introducing fuel into the cylinder in two sheets located substantially transverse to the cylinder at opposite sides of the center of the space between adjacent ends of the pistons and in the direction of chords of the cylinder; substantially as described.

7. In an internal combustion engine, the combination of a cylinder, two pistons reciprocating therein in opposite directions, there being free space within the cylinder between the adjacent ends of the pistons, a single nozzle projecting through the wall of the cylinder and into said space, and two outlets from said nozzle spaced apart lengthwise of the cylinder and elongated crosswise of the cylinder for introducing the fuel in the form of two substantially parallel sheets; substantially as described.

8. In an internal combustion engine, the combination of a cylinder, two pistons reciprocating therein in opposite directions, there being free space within the cylinder between the adjacent ends of the pistons, two nozzles projecting through the wall of the cylinder and into said space and spaced apart lengthwise of the cylinder and passages for a cooling medium formed in said nozzles adjacent to the outlet ends thereof; substantially as described.

In testimony thereof I have signed my name to this specification in the presence of two subscribing witnesses.

HUGO JUNKERS.

Witnesses:
EMIL WERGIEN,
HERMANN FISCHER.