Jan. 6, 1942. J. J. McCARTHY 2,269,084

INTERNAL COMBUSTION ENGINE

Filed May 3, 1941 2 Sheets-Sheet 1

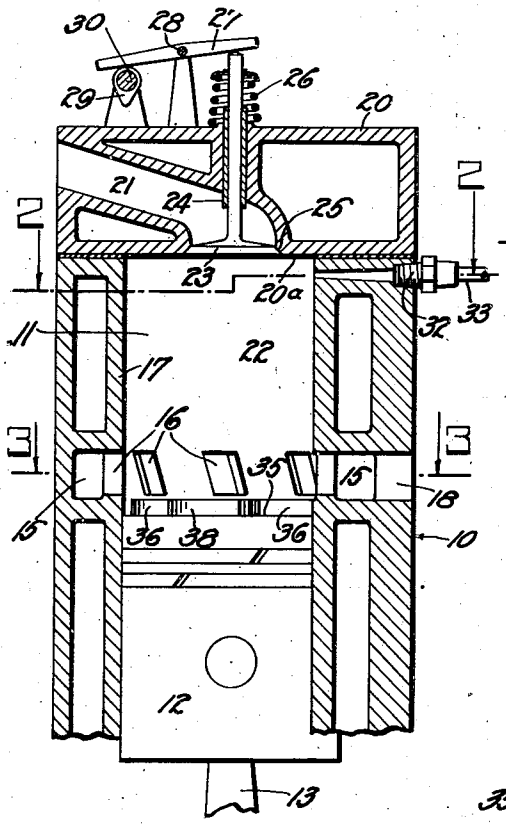


Fig. 1

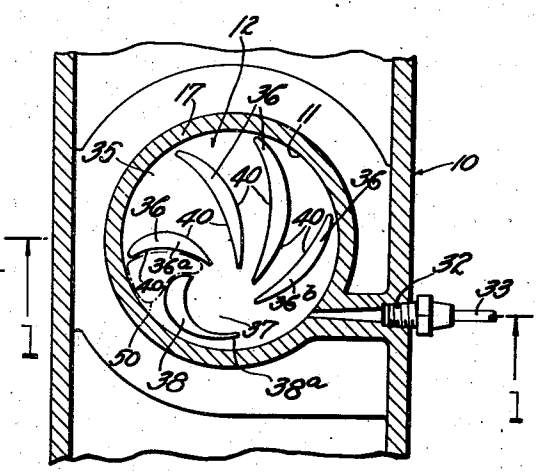


Fig. 2

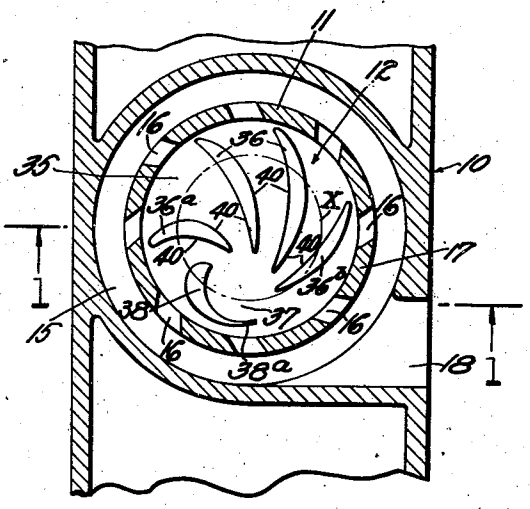


Fig. 3

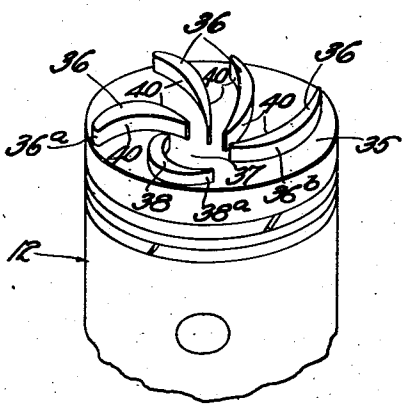


Fig. 4

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INTERNAL COMBUSTION ENGINE

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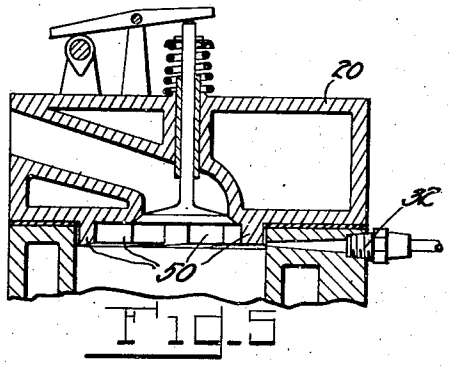


Fig. 5

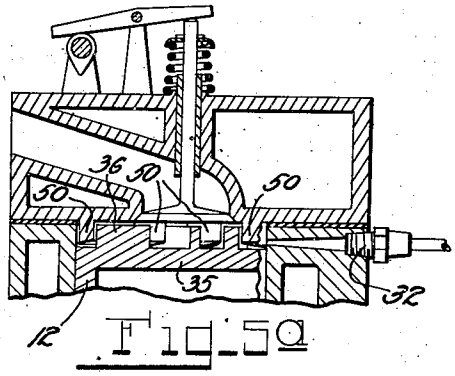


Fig. 5a

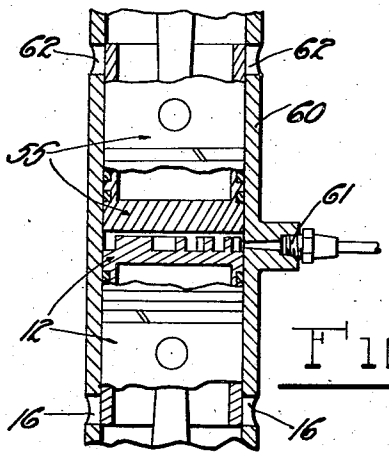


Fig. 6

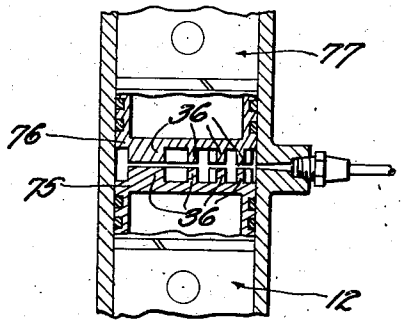


Fig. 8

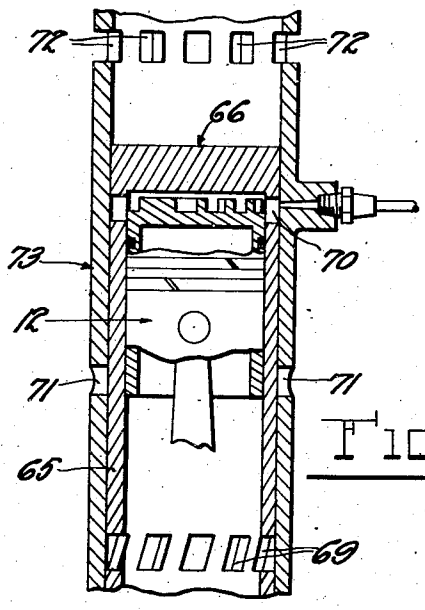


Fig. 7

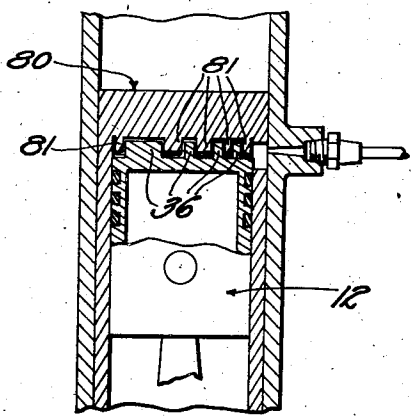


Fig. 9

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UNITED STATES PATENT OFFICE

2,269,084

INTERNAL COMBUSTION ENGINE

John J. McCarthy, Malden, Mass.

Application May 3, 1941, Serial No. 391,729

4 Claims. (Cl. 123—32)

This invention relates to internal combustion engines, and more particularly to engines of the compression-ignition and solid-injection type.

It is a primary aim and object of the present invention to provide for a quicker and more thorough atomization of injected fuel oil in a cylinder than was heretofore possible.

It is another object of the present invention to prevent the injected fuel from hitting against the usually cooled cylinder wall and leave carbon deposits thereon, and instead direct the injected fuel against a hot spot in the combustion chamber.

Briefly, these and other objects of the present invention are accomplished by providing preferably on the head of a working piston in a cylinder a plurality of ribs which are so coordinated as to re-direct the flowing intake air in the cylinder chamber to form a vortex during the inward stroke of said piston. The head of the working piston is further provided with a curved baffle which bounds the vortex over part of its periphery and forms a hot spot in the combustion chamber. Fuel oil is injected into the cylinder and against this baffle before the piston reaches its inner dead center position. More particularly, the injected fuel is so directed against the curved baffle that the same passes first into the vortex and then against said baffle. Part of the injected fuel is thus directly taken up by the vortex and never reaches the baffle, while the other part of the injected fuel reaches the hot baffle where it becomes immediately vaporized and is carried away by the vortex. A highly combustible mixture of air and fuel oil is thus obtained which explodes instantaneously.

Before explaining in detail the present invention it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation, and it is not intended to limit the invention claimed herein beyond the requirements of the prior art.

In the drawings:

Fig. 1 is a fragmentary section through one cylinder of an internal combustion engine which embodies the present invention, the section being taken substantially on the line 1—1 of Fig. 2.

Fig. 2 is a fragmentary section taken substantially on the line 2—2 of Fig. 1.

Fig. 3 is another fragmentary section taken on the line 3—3 of Fig. 1.

Fig. 4 is a fragmentary, perspective view of the working piston in the cylinder shown in Fig. 1.

Fig. 5 is a fragmentary, longitudinal section through a cylinder, illustrating a modified embodiment of the present invention.

Fig. 5a is a section similar to Fig. 5 showing the working piston substantially in its inner position, however.

Fig. 6 is a fragmentary, longitudinal section through a cylinder of an opposed-piston type engine that embodies the present invention.

Fig. 7 is a fragmentary, longitudinal section through a cylinder of another opposed-piston type engine that embodies the present invention.

Fig. 8 is a fragmentary section similar to Fig. 6 and illustrates a modified embodiment of the present invention.

Fig. 9 is a fragmentary section similar to Fig. 7 and illustrates a modified embodiment of the present invention.

Referring to the drawings, and more particularly to Fig. 1 thereof, the reference numeral 10 designates a water-jacketed cylinder block of which one of the cylinders is indicated at 11. As the present invention is fully incorporated in each and every cylinder, only one cylinder will be described in detail hereinafter. Slidable in the cylinder 11 is a working piston 12, having a conventional rod connection 13 with a crank shaft which is suitably mounted in the usual crank case (neither shown). The cylinder block 10 is provided with a cored-out annular passage or chamber 15 (see also Fig. 3) which surrounds each cylinder 11 and communicates with the latter through a plurality of ports 16 in the cylinder wall 17. The annular passage 15 has an inlet 18 which communicates with any suitable intake manifold (not shown). Air, preferably from any conventional supercharger (not shown), is conducted through the intake manifold and the inlet 18 into the annular passage 15, and thence into the cylinder 11 through the ports 16 when the latter are not covered by the piston 12. Mounted on top of the cylinder block 10 is a cylinder head 20 which is provided with an exhaust conduit 21 leading from the interior of the cylinder 11 or "cylinder chamber" 22 into a non-disclosed exhaust manifold. Communication through the exhaust conduit 21 is normally intercepted by an exhaust valve 23 of the poppet type which is suitably guided in a bushing 24 and normally forced into engagement with its seat 25 by means of a suitably applied compression spring

26. The exhaust valve 23 is lifted from its seat 25 during a predetermined portion of each piston cycle by means of a tappet 27 which is suitably journalled at 28 on top of the cylinder head 20 and actuated by a cam 29 on a shaft 30 which may be driven in any suitable manner (not disclosed) in timed relation with the crank shaft. Mounted in the cylinder block 10 is a fuel injector 32 which communicates through a conduit 33 with a suitably operated fuel pump of any conventional type (not shown).

In the present instance, the head 35 of the working piston 12 is provided with a plurality of ribs 36 whose shape and disposition is best shown in Figs. 2, 3 and 4. These ribs 36 converge from adjacent the piston periphery substantially tangentially into a circular space 37 which is partly bound by an arcuate baffle 38. During the inward stroke of the piston 12, the ribs 36 force the somewhat turbulent intake air between them into the circular space 37 where it forms a vortex that brushes past the baffle 38. The baffle 38 is furthermore so shaped and coordinated with the adjacent ribs 36*a* and 36*b* that the intake air between them is also forced substantially tangentially into the vortex and accelerates the same.

The intake ports 16 in the cylinder wall 17 are, not necessarily but preferably, arranged somewhat tangentially of the cylinder 11 (Fig. 3) so that the intake air will whirl in the cylinder chamber 22 substantially about the cylinder axis and in an annular path of which the dot-and-dash line circle *x* in Fig. 3 may, for instance, be the mean diameter. Immediately after the working piston 12 has started on its inward stroke, the whirling air in the cylinder chamber 22 will impinge on the side walls 40 of the ribs 36 and be re-directed thereby into the circular space 37 wherein the re-directed air will form a vortex. The whirling air in the cylinder chamber 22 is thus re-directed into said circular space 37 during the inward stroke of the piston, with the result that the continuously re-directed air increases the whirl of the previously re-directed air in said circular space 37 and also builds up a rapidly whirling air column directly thereabove. When the piston 12 almost reaches its inner dead center position, i. e., just before fuel injection and immediate combustion take place, the air in the circular space 37 obviously attains its greatest turbulence.

In order that the injected fuel is immediately and thoroughly atomized and forms with the vortex a highly combustible charge, the fuel injector 32 directs the fuel stream against the hot baffle 38, whereby the fuel passes first into the vortex and is partly taken up by the same. That part of the fuel which reaches the hot baffle 38 becomes immediately vaporized and is carried away by the vortex. In this manner, the injected fuel is quickly and so thoroughly atomized by the vortex that an instantaneous combustion will take place and all the fuel will be burned without leaving any residue.

While the circular space 37 may be arranged co-axially of the cylinder 11, it is preferable to have this space arranged eccentrically in the manner shown in Fig. 2, for instance, so that the ribs 36 may be disposed over the greater part of the piston head 35 without obstructing the fuel stream from the injector 32. It is also evident from Fig. 2 that the injected fuel moves in the same general direction as the air in the vortex into which it passes. The baffle 38 is provided with an extension 38*a* which is sufficiently long to catch fuel particles which are thrown off the vortex on impact with the same. By this provision no injected fuel will reach the cylinder wall, wherefore no carbon will be deposited there.

For all intents and purposes, the ribs 36 and the baffle 38 could be provided on the inner surface 20*a* (Fig. 1) of the cylinder head 20, in which case the exhaust valve 23 would be located within the circumference of the circular space in which the vortex whirls.

Figs. 5 and 5*a* illustrate a modified construction wherein ribs 50 on the cylinder head 20 fit between the ribs 36 on the head 35 of the working piston 12 which may be exactly like the one shown in Figs. 1 and 4. As shown in Figs. 5 and 5*a*, the ribs 50 are tapered downwardly toward the cylinder axis so that the air is wedged into the circular space 37 on the piston head. One of the ribs 50 on the cylinder head may also fit between the rib 36*a* and the baffle 38 in the manner indicated in dot-and-dash lines in Fig. 2. Of course, no rib is provided on the cylinder head to fit between the rib 36*b* and the baffle 38 (Fig. 2) in order to keep open the fuel injection path from the injector 32 to the baffle 38.

Fig. 6 illustrates another modification in which a second or opposed piston 55 takes the place of the cylinder head 20 in the construction shown in Fig. 1. The two pistons 12 and 55 are operated in any conventional manner, and piston 12 is for all intents and purposes exactly like the piston shown in Figs. 1 and 4. Suitably secured in the cylinder 60 is a fuel injector 61 which at the proper time forces a metered quantity of fuel oil into the vortex between the two pistons. The intake ports 16 in the cylinder 60 may be arranged exactly like those in the cylinder shown in Figs. 1 and 3. Instead of a poppet-type exhaust valve, however, the cylinder 60 is provided with exhaust ports 62 that are uncovered by the piston 55 at the proper times.

Fig. 7 illustrates another modification which differs from the construction shown in Fig. 6 by sliding the piston 12 within the skirt or sleeve 65 of an opposed piston 66. Both pistons 12 and 66 are connected by conventional rods with the same crank shaft (not shown) in a well-known manner. Provided in the sleeve 65 of the piston 66 are longitudinally spaced intake and exhaust ports 69 and 70, respectively, which communicate with corresponding ports 71 and 72, respectively, in the cylinder 73 when the piston 66 is substantially in its outer dead center position.

Fig. 8 discloses a construction which is like the one shown in Fig. 6, except that the air-redirecting ribs 36 and the baffle 38 (Fig. 4) are provided on the heads 75 and 76 of the opposed pistons 12 and 77, respectively.

Fig. 9 discloses a construction which is in all respects like the construction shown in Fig. 7, except that the head of the sleeve piston 80 is provided with ribs 81 that fit between the ribs 36 on the head of the opposed piston 12 when both pistons 12, 80 are substantially in their inner dead center position.

I claim:

1. In an internal combustion engine, the combination of a cylinder having an air-intake port and a head member; a piston member forming a chamber in said cylinder, one of the opposite surfaces of said members being provided with an arcuate baffle near its circumference and a plurality of spaced ribs so tangentially disposed relative to a part of a cylindrical space whose re-

maining part is bounded by said baffle that most of the intake air in said chamber is during the inward stroke of the piston member redirected by said ribs into said space and forms a vortex therein; and an injector in the cylinder for forcing fuel into said vortex and against said baffle when the piston member is substantially in its inner position.

2. The combination in an internal combustion engine as set forth in claim 1, in which said baffle is furthermore so shaped and coordinated with the nearest ribs as to redirect the air therebetween into said space in the direction of the vortex.

3. The combination in an internal combustion engine as set forth in claim 1, in which the injector is disposed in the cylinder wall transversely of the cylinder axis and forces fuel into the vortex in the direction of its whirl and against said baffle.

4. In an internal combustion engine, the combination of a cylinder having an air-intake port and a head member; a piston member in said cylinder, one of the opposite surfaces of said members being provided with a plurality of ribs so coordinated as to redirect the intake air to form a vortex adjacent part of said one surface during the inward stroke of said piston member and a curved baffle bounding the vortex over part of its periphery; and an injector so located in the cylinder as to force fuel into the vortex and against said baffle when the piston member is substantially in its inner position such that the fuel moves in the same general direction as the air in the vortex into which it passes, and said baffle being extended to catch fuel particles thrown off the vortex on impact with the same.

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