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FUEL INJECTION FOR INTERNAL COMBUSTION ENGINES

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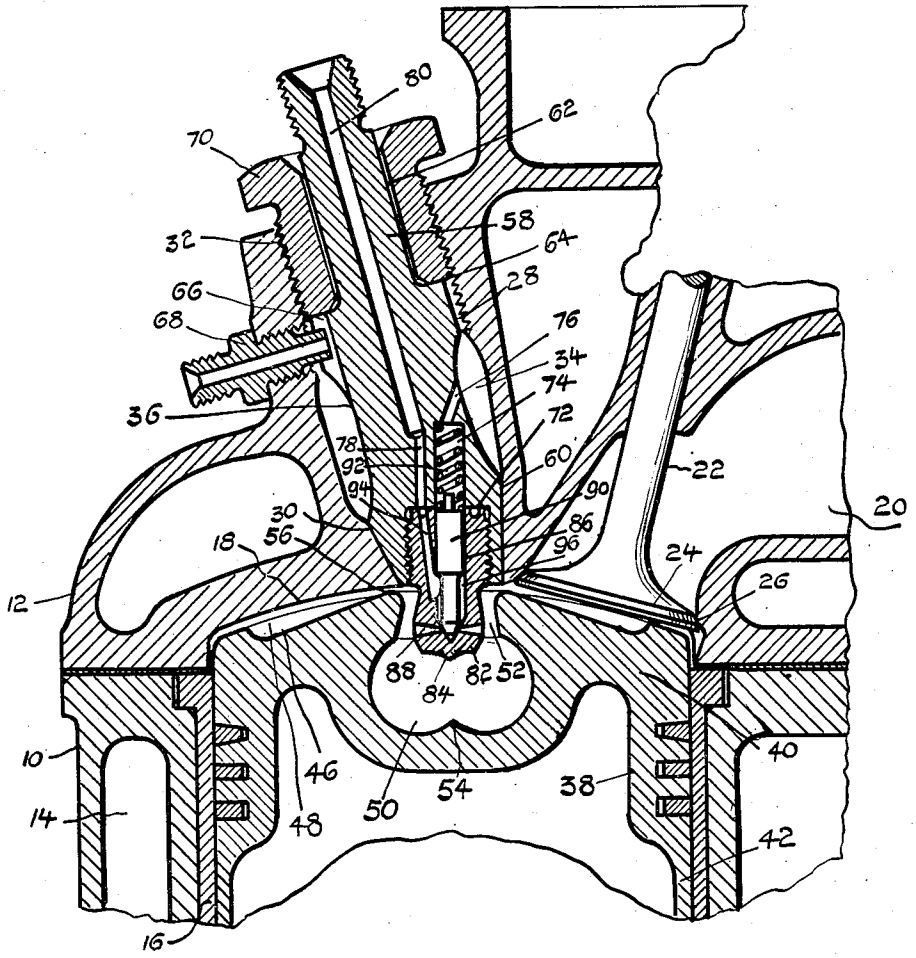

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FUEL INJECTION FOR INTERNAL COMBUSTION ENGINES

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This invention relates to fuel injectors for internal combustion engines.

An object of the invention is to provide a fuel injection system for an internal combustion engine wherein air velocity created during the compression stroke of a piston initially carries fuel into a pre-combustion chamber in the head of the piston and upon ignition and utilization of all air in the pre-combustion chamber the accompanying pressure rise causes a high velocity gas flow in the opposite direction past the fuel inlet resulting in carrying additional fuel finely atomized into the toroidal main combustion chamber where the remainder of the air is used to complete the combustion.

Another object of the invention is to provide a fuel injection system for an internal combustion engine wherein a fuel nozzle in the head of a cylinder is received in the throat of a pre-combustion chamber in the head of a piston reciprocal in the cylinder and wherein the relationship of the pre-combustion chamber and particularly the throat thereof to the nozzle is such as to initially create a velocity sweeping past the outlet of the nozzle into the pre-combustion where ignition takes place accompanied by a rise in pressure resulting in a high velocity gas flow in an opposite direction past the inlets into the main combustion chamber.

A feature of the invention is a removable member in the head of a cylinder supporting a nozzle protruding into the cylinder and received in the throat of a pre-combustion chamber arranged in the head of a piston movable in the cylinder.

Another feature of the invention is the particular contour of the nozzle and the throat of the pre-combustion chamber and their relationship to one another.

Yet another feature of the invention is the utilization of a low pressure fuel injection wherein air under high velocity seizes the fluid as distinguished from the conventional where fuel under high pressure is injected into the air.

With these and other objects and features in view which may be incident to the improvements, the invention consists in the parts and combinations thereof to be hereinafter set forth and claimed with the understanding that the several necessary elements comprising my invention, may be varied in construction, proportions and arrangement, without departing from the spirit and scope of the appended claims.

The single figure is a vertical sectional view of a cylinder for an internal combustion engine partly broken away and a head therefor illustrating the invention as applied.

Referring to the drawings for more specific details of the invention, 10 designates a cylinder of an internal combustion engine, and 12 indicates the head thereof. As shown, the cylinder is water jacketed as indicated at 14 and has an inner lining 16. The head has a concavity 18 facing the interior of the cylinder, and an exhaust passage 20 and intake not shown opening through the concavity preferably adjacent the circumference thereof, and a valve 22 mounted for reciprocation in the head controls

the flow of gases through the passage 20. The valve 22 is of a conventional type having a head 24 normally resting on a seat 26. The head 12 also has an opening 28 therethrough communicating with the concavity 18 slightly off center of the concavity. This opening is characterized in that one end adjacent the concavity 18 has its wall beveled as at 30. Its other end is internally threaded as at 32 and intermediate the beveled and threaded wall portions the diameter of the opening is enlarged to provide an annular passage 34. The purpose of this passage is to receive and support an injector per se indicated generally at 36 and to be hereinafter described.

A piston 38 reciprocal in the cylinder has a head 40 and a skirt 42 carrying conventional piston rings 44. The head has a convexed face complementary to the concavity in the cylinder head and a concentrically disposed annular concavity 46 providing in combination with the concavity 18 and the wall of the cylinder a main combustion chamber 48, and arranged within the head of the piston slightly off center is a pre-combustion chamber 50 having a throat 52 opening centrally of the annular concavity 48.

The pre-combustion chamber is preferably globular in general contour and has on its inner wall a raised conoidal surface 54 oppositely disposed with relation to the throat, and the throat 52 is characterized in that it has a greater diameter at its entrance to the pre-combustion chamber than at its entrance to the main combustion chamber and that its entrance to the main chamber is flared to blend with the inner rim of the annular concavity 48 to provide in combination therewith a constricted lip 56, the purpose of which will hereinafter appear.

The fuel injector 36 includes a plug 58 having a tapered end 60 complementary to the beveled or tapered portion 30 of the wall of the opening 28. The other end 62 of the plug is reduced in diameter to provide a shoulder 64 having a slot 66, for the reception of a hollow pin 68 threaded in the wall of the opening. The pin 68 serves to locate the plug 58 in the opening 28 so that the tapered end of the plug seats snugly in the beveled portion of the opening, and a retaining nut 70 received by the threads 32 in the outer end of the opening bears against the shoulder 64 and serves to wedge the plug against the beveled portion of the opening with sealing effect.

A chamber 72 in the tapered end of the plug communicates with a concentrically disposed bore 74, which, in turn, communicates by way of a duct 76 with the annular passage 34. The chamber also has communication by way of a duct 78 with a passage 80 extended axially through the plug and adapted to be connected to a low pressure pump, not shown.

A nozzle 82 threaded in the chamber 72 protrudes into the main combustion chamber and is received in the throat 52 of the pre-combustion chamber. The nozzle is characterized in that it is bulbar in general contour having an enlarged diameter adjacent its free end and a decreased diameter at its neck root. The free end is conoidal, as shown at 84, and the body is contoured to correspond to the contour of the throat with substantial clearance. The nozzle has a valve chamber 86 aligned with the bore 74 in the plug 62 and equi-spaced radial ports 88 preferably flared and opening at the enlarged diameter of the nozzle. A needle valve 90 slidable in the valve chamber is urged by a spring 92 seated in the bore 74 to close the ports and a duct 94 connects the valve chamber 86 to an annular passage 96 which in turn communicates with the passage 78 leading to the axial passage 80.

In a normal operation upon combustion on the exhaust stroke, the main and pre-combustion chambers are

emptied. On the intake stroke the cylinder is filled with new combustion air.

On the compression stroke as the piston 40 approaches the nozzle 82 the lips 56 on the head of the piston receives the bulbous tip of the nozzle with small clearance resulting in a vigorous movement of air sweeping into the pre-combustion chamber 50. This high velocity movement of the air past the fuel orifices carries fuel into the pre-combustion chamber. If a low pressure injection pump is used at the moment when the piston reaches the bulbar tip of the nozzle during the compression stroke, a low pressure injection starts and such pressure is adequate because the fuel does not of necessity penetrate the combustion air to any appreciable amount. No atomization is required since the high velocity of the air passing the orifices 83 assures excellent distribution and atomization of the fuel and furthermore the high velocity of the air lowers the pressure forward of the orifices. In other words, contrary to the conventional, the air is seeking the fuel rather than the fuel seeking the air.

The burning of the fuel starts with a very short ignition lag because the air used for atomization has a temperature already higher than the ignition temperature of the fuel, and the following fluid is burned in nascent as the fast moving air ignites, cracks and burns the fuel as fast as it leaves the nozzle.

After the piston passes top dead center and all the air in the pre-combustion chamber is utilized for combustion, the accompanying pressure rise results in a high velocity gas flow in the opposite direction past the fuel orifices carrying fuel finely atomized into the toroidal main chamber utilizing the remainder of the air to complete the combustion.

By using a low pressure injection pump the termination of injection is determined by the piston movement to be effective at the moment the lips of the piston uncovers the bulbar tip of the nozzle in the power stroke, the injection must be completed. The maximum duration of injection is determined by the time the piston covers the tip of the nozzle.

Although this invention has been described in connection with certain specific embodiments, the principles involved are susceptible of numerous other applications that will readily occur to person skilled in the art. The invention is therefore to be limited only as indicated by the scope of the appended claims.

Having thus described the invention what I claim as new and desire to secure by Letters Patent is:

1. In an internal combustion engine, a cylinder, a head therefor, a removable plug in the head, a fuel nozzle supported on the plug and protruding into the cylinder having an outwardly flared body and radially disposed ports, a piston reciprocable in the cylinder, a pre-combustion chamber in the piston having a throat commensurate to and receiving the nozzle and a spring pressed valve for control of the fuel flow.

2. In an internal combustion engine, a cylinder, a head therefor having a cavity facing the chamber of the cylinder, a piston reciprocal in the cylinder, an annular cavity in the top of the piston oppositely disposed with relation to the cavity in the head and providing in conjunction therewith a toroidal main combustion chamber, a pre-combustion chamber in the piston having an inwardly flared throat opening concentrically of the annular cavity, a removable plug in the head of the cylinder, a fuel nozzle having an outwardly flared body and outwardly flared ports on the plug and extending into the main combustion chamber and received by the throat, and a spring pressed valve in the nozzle for control of the ports.

3. In an internal combustion engine, a cylinder, a head thereon and a piston movable in the cylinder, a toroidal cavity in the top of the piston providing in conjunction with the head a main combustion chamber, a pre-combustion chamber in the head of the piston having an inwardly flared throat opening concentrically of the toroidal cavity, a removable plug in the head of the cylinder, a fuel nozzle supported by the plug and received by the throat having an outwardly flared body and outwardly ports and a spring pressed valve in the nozzle for control of the ports.

4. In an internal combustion engine, a cylinder, a head thereon and a piston movable in the cylinder, a toroidal cavity in the top of the piston providing in conjunction with the head a main combustion chamber, a pre-combustion chamber in the head of the piston having a throat providing communication between the combustion chambers and characterized in that it is contracted at its entrance to the main combustion chamber and flared inwardly, a plug compression sealed in the head of the cylinder, a fuel nozzle supported thereby having an outwardly flared body and radially disposed outwardly flared orifices and a spring pressed valve in the nozzle for control of the orifices.

5. In an internal combustion engine, a cylinder, a head for the cylinder having a cavity facing the interior of the cylinder and a piston movable in the cylinder, a toroidal cavity in the top of the piston providing in conjunction with the cavity in the head, a main combustion chamber, a pre-combustion chamber in the head of the piston having a throat providing communication between the chambers characterized in that the diameter to the throat is greater at its entrance of the pre-combustion chamber than at its entrance to the main combustion chamber, a plug compression sealed in the head having a chamber therein and a fuel inlet communicating with the chamber, a nozzle fitted in the chamber in the plug having a greater diameter adjacent its tip than at its neck and radially disposed orifices flared outwardly at the greater diameter and a spring pressed valve in the nozzle for control of the orifices.

6. In an internal combustion engine having a cylinder, a head therefor and a piston reciprocal in the cylinder, a toroidal cavity in the head of the piston providing in conjunction with the head a main combustion chamber, a precombustion chamber in the piston, a throat providing communication between the combustion chambers characterized in that the wall defining the throat is flared inwardly and provides in conjunction with the wall defining the toroidal cavity in the piston a pronounced lip at the entrance of the throat, a fluid nozzle supported by the head and received by the throat characterized in that it has a greater diameter adjacent its tip than of its neck and that the clearance between the nozzle and throat is variable, radially disposed outwardly flared orifices in the nozzle arranged substantially at the greater diameter of the nozzle, and a spring pressed valve in the nozzle for control of the orifices.

7. An internal combustion engine comprising a cylinder, a head thereon having a concaved surface facing the interior of the cylinder and a piston reciprocal in the cylinder having an annular cavity opposite the concaved surface of the head, a main combustion chamber between the head and the piston, a pre-combustion chamber in the piston, having an inwardly flared throat providing communication between the chambers, an annular lip at the entrance of the throat, a fuel nozzle supported on the head and received by the throat, the nozzle having a greater diameter adjacent its free end than at its neck, radially disposed outwardly flared orifices in the nozzle, and a spring pressed valve in the nozzle for control of the orifices.

8. An internal combustion engine comprising a cylinder, a head on the cylinder and a piston reciprocable in the cylinder, a main combustion chamber, a pre-combustion chamber in the piston, a throat providing communication between the chambers, the wall defining the throat being flared inwardly of the pre-combustion chamber and a fuel nozzle supported by the head and received by the

throat, the wall of the nozzle being flared outwardly from the neck thereof so that the clearance between the throat and nozzle may be variable during both the compression and retractile stroke of the piston, and a valve in the nozzle for control of fluid flow through the nozzle.

9. A fuel injector including a body having a fuel supply passage therein, a conical head on one end of the body, a shoulder on the other end of the body for reception of a compression member, a chamber in the conical head, a fluid nozzle supported in the chamber, an axial bore in the nozzle, radially disposed outwardly flared orifices communicating with the axial bore, a spring pressed plunger in the bore, a passage connecting the bore to the fuel supply passage through the body means for venting the bore and a needle carried by the plunger for control of the orifices.

10. An internal combustion engine comprising a cylinder, a head on the cylinder and a piston reciprocal in the cylinder, a main combustion chamber, a pre-combustion chamber in the piston, a throat connecting the chambers characterized in that it has a small diameter at its opening into the main combustion chamber and a relatively large diameter at its opening into the pre-combustion chamber, a fuel nozzle supported on the head and received by the throat having a small diameter at its root and a relatively large diameter adjacent its free end, the relation of the throat to the nozzle being such as to provide a variable clearance whereby a high constant velocity of fuel impregnated air and gas is attained in both directions of movement of the piston.

11. In an internal combustion engine a cylinder, a head therefor, a piston reciprocal in the cylinder, a main combustion chamber, a pre-combustion chamber in the head of the piston having a throat providing communication between the chambers and characterized in that it has an annular lip at its opening into the main combustion chamber of smaller diameter than the diameter of its opening into the pre-combustion chamber, a fuel nozzle supported on the head and received by the throat having an outwardly flared body commensurate with the throat and a tip having outwardly flared ports therein and a valve in the nozzle for control of fluid flow through the nozzle.

References Cited in the file of this patent

UNITED STATES PATENTS

1,633,541	Braren	June 21, 1927
2,488,857	Firing	Nov. 22, 1949
2,505,999	Smith	May 2, 1950
2,619,078	Witzky et al.	Nov. 25, 1952
2,692,586	Kaniut et al.	Oct. 26, 1954

FOREIGN PATENTS

485,862	Germany	Nov. 9, 1929
489,782	Germany	Jan. 22, 1930
175,433	Switzerland	Feb. 28, 1935

OTHER REFERENCES

Ser. No. 251,007, Wiebicke (A. P. C.), published May 11 ,1943.