United States Patent [19]

Jaulmes

[11] **3,881,454**

[45] **May 6, 1975**

[54] **TWO STROKE ENGINE CONSTRUCTION**

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[73] Assignee: **Ateliens de La Motobecane**

[22] Filed: **Mar. 8, 1974**

[21] Appl. No.: **449,446**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 297,861, Oct. 16, 1972.

[52] **U.S. Cl.** ..... **123/73 B**; 123/73 R; 123/73 PP; 123/65 P

[51] **Int. Cl.** **F02b 33/07**

[58] **Field of Search** ..... 123/73 R, 73 B, 73 CB, 123/73 FA, 73 PP, 65 P, 65 PD

[56] **References Cited**

UNITED STATES PATENTS

3,687,118 8/1972 Nomura ..... 123/73 B

Primary Examiner—Wendell E. Burns

Attorney, Agent, or Firm—McGlew and Tuttle

[57] **ABSTRACT**

A two stroke engine includes a cylinder having a piston slidable therein and with an exhaust port on one side communicating with the cylinder. Air is let and compressed in a sealed crankcase. A pair of main scavenging passages communicate the crankcase with ports in the cylinder on each side of the exhaust port and symmetrically in respect to a diametrical plane of the cylinder passing through the exhaust port center, and an auxiliary scavenging passage opens in a port symmetrically oppositely arranged from the exhaust port, in which passage there is located a fuel injector. The piston is reciprocatable to open and close the exhaust, main and auxiliary scavenging passage communicates at one end with the crankcase at least as long as the auxiliary scavenging port is uncovered by the piston.

10 Claims, 10 Drawing Figures

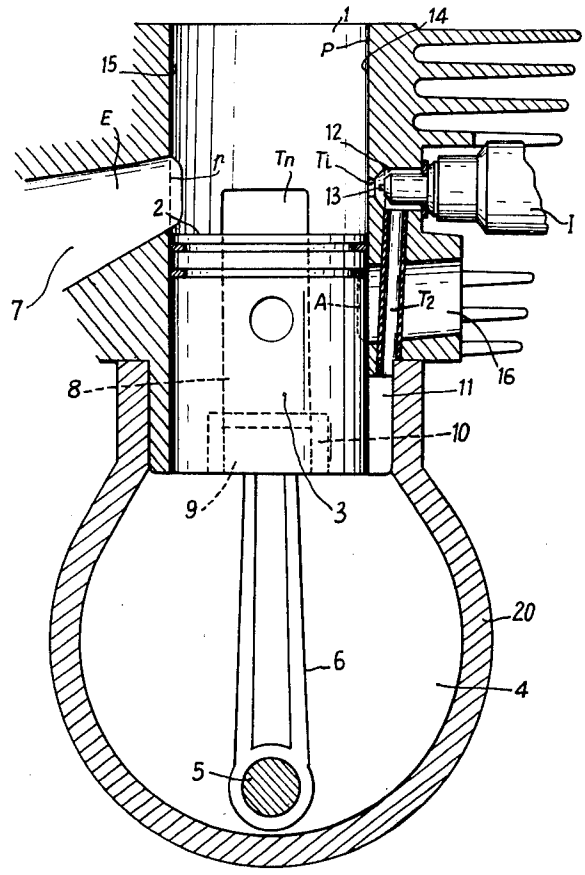


Fig:1

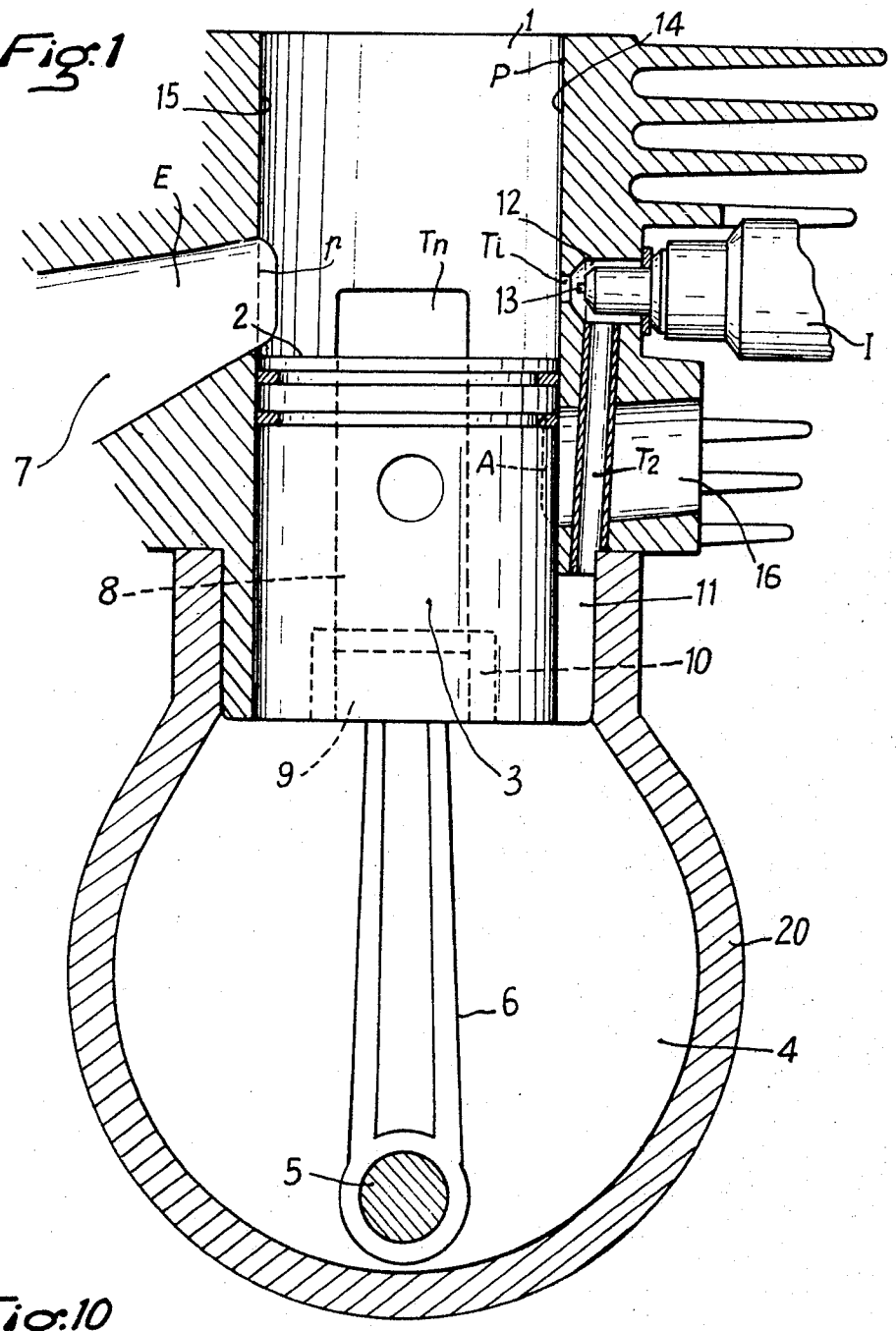

1
14
P
15
E
12
Tn
Ti
13
I
2
7
A
T2
16
8
11
10
9
3
20
6
4
5

Fig:10

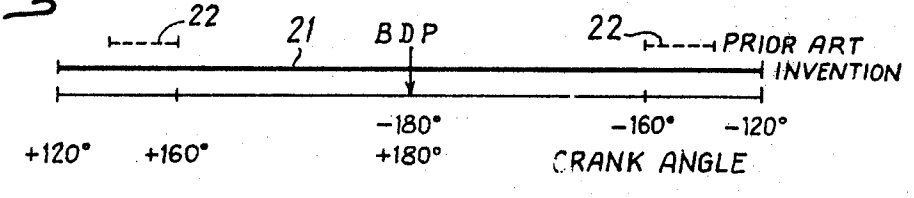

22
21
BDP
22
PRIOR ART
INVENTION
+120°
+160°
-180°
+180°
-160°
-120°
CRANK ANGLE

Fig:2

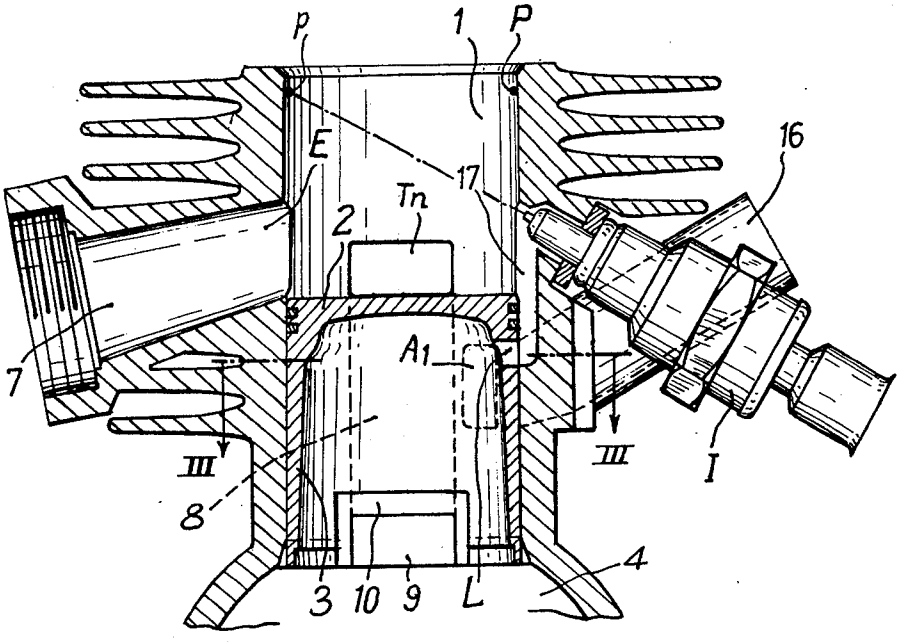


Fig:3

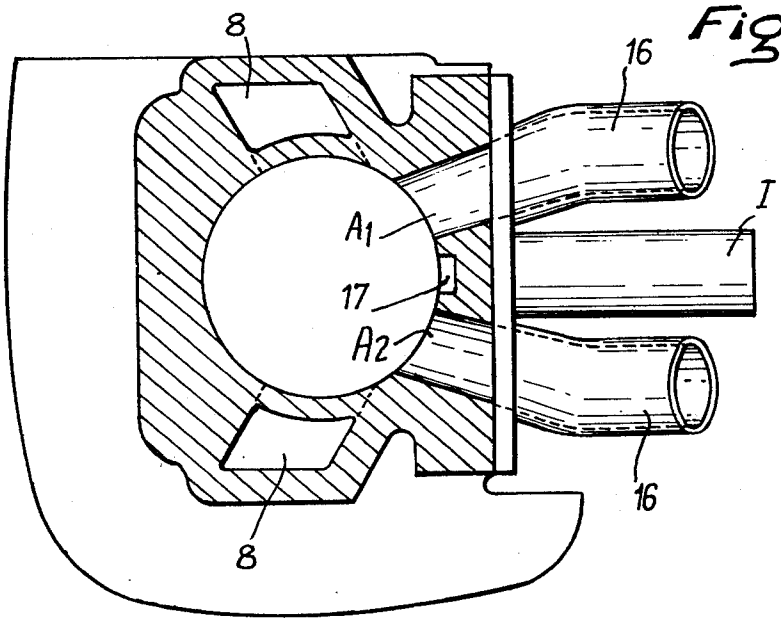


Fig:4

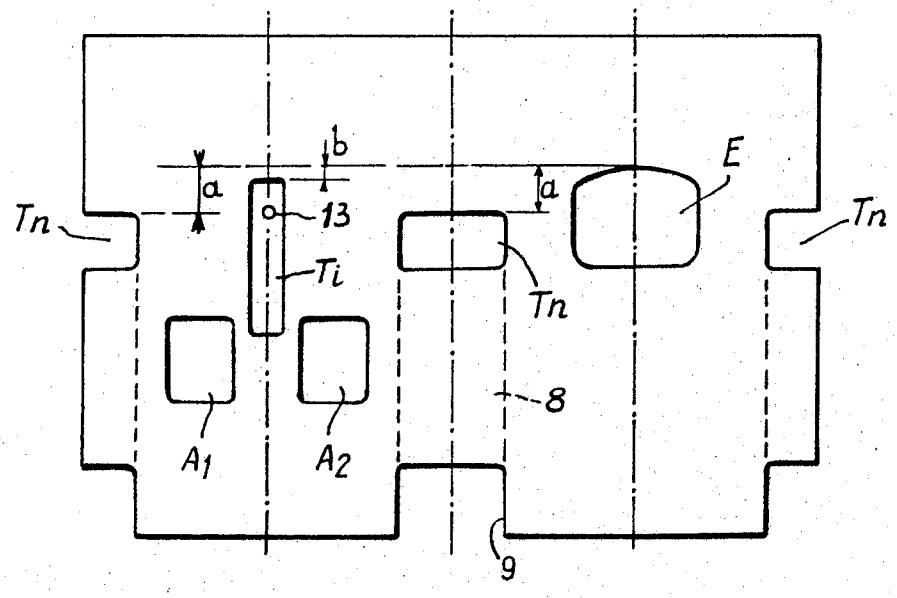


Fig:5

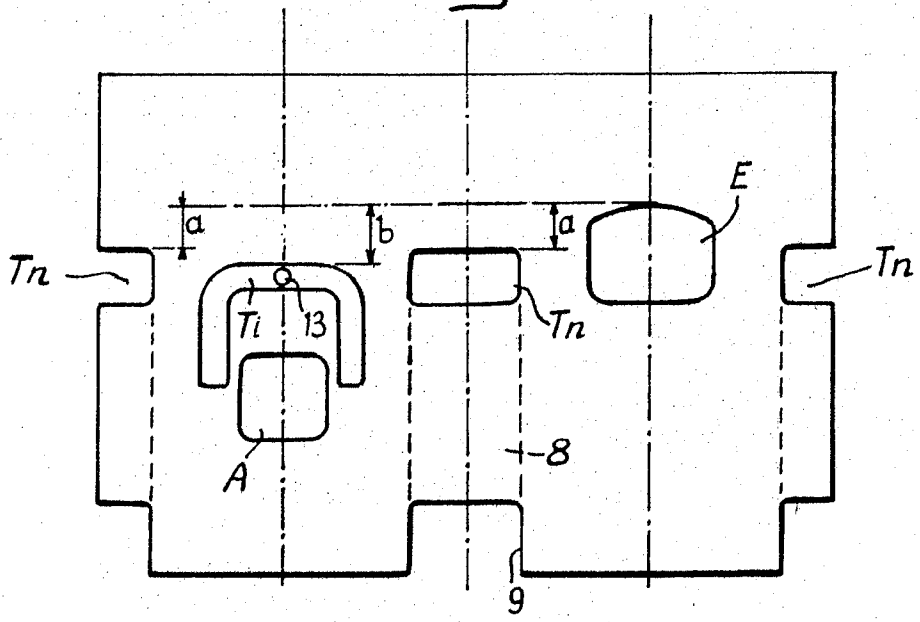


Fig: 6

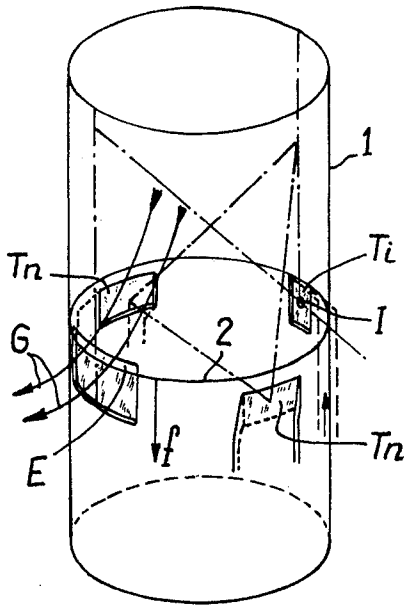


Fig: 8

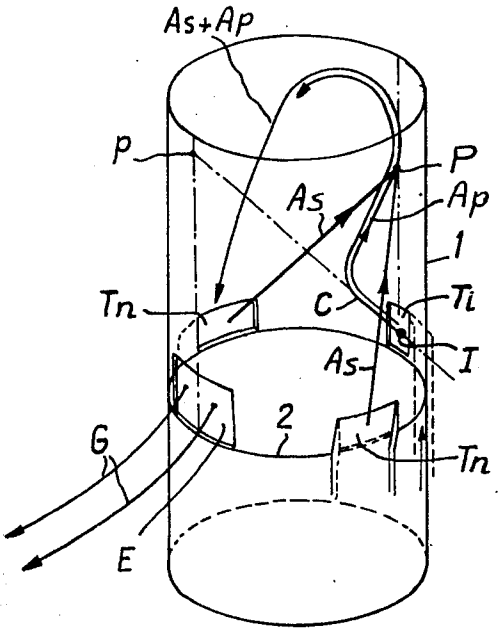


Fig: 7

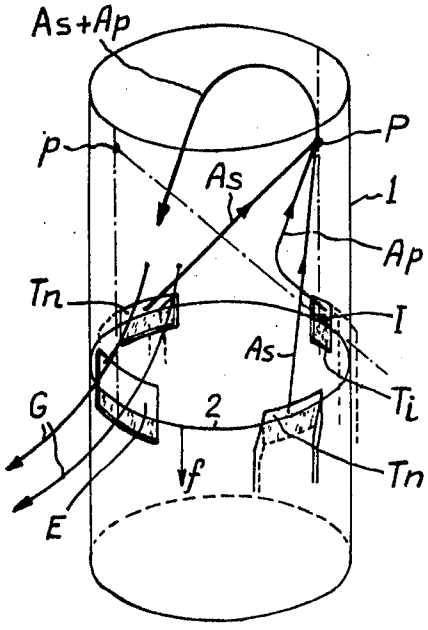
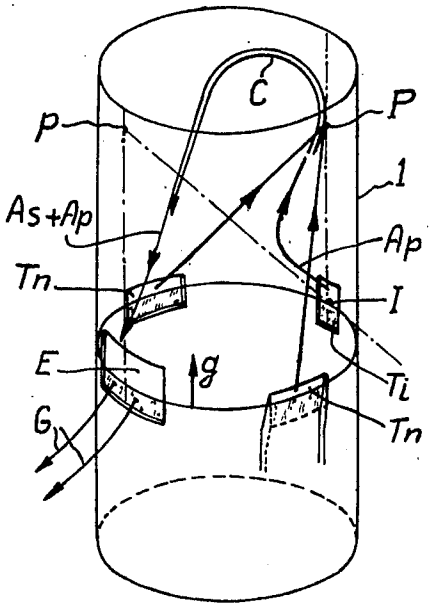


Fig: 9



TWO STROKE ENGINE CONSTRUCTION

BACKGROUND OF THE INVENTION

This application is a continuation-in-part of the co-pending application Ser. No. 297,861 filed on Oct. 16, 1972.

This invention relates to the construction of a new and useful two stroke internal combustion engine of the crankcase compression type having direct fuel injection and an improved scavenging and fuel-air intermixing system designed to provide substantially complete combustion of the driving mixture, so as to provoke only a very weak atmospheric pollution, and ensure a minimum of fuel consumption.

DESCRIPTION OF THE PRIOR ART

In a two stroke engine comprising a sealed crankcase and an air intake passage communicating with said crankcase through an intake port which is opened and closed by the reciprocating piston, a scavenging system of a known type employs a flat-topped piston and the separation between the fresh gases and the burnt or exhaust gases is effected by an arrangement of at least two main scavenging passages communicating the sealed crankcase with the cylinder through at least two main scavenging ports open in the side wall of the cylinder and arranged to be opened and closed by the piston. The main scavenging ports are so disposed that they direct their air flow symmetrically with respect to that diametral plane of the cylinder which passes through the center of the exhaust port, which plane is hereinafter referred to as "the plane of symmetry of the cylinder." The main scavenging air flows converge on a point on the generatrix of the cylinder which is diametrically opposite to the generatrix passing through the center of the exhaust port. The cool gases then go upwards towards the head of the cylinder, pushing the burnt gases in front of them, and describe a loop analogous to that which they would have followed around a deflector disposed on the top of the piston.

It has also been proposed, e.g., in U.S. Pat. No. 3,687,118 to NOMURA, to use an auxiliary scavenging port located substantially opposite the exhaust port and so disposed that its air flow is directed towards a second point on at least approximately the generatrix passing through the center of the exhaust port. The auxiliary scavenging port communicates through an auxiliary scavenging passage with the air intake passage, the arrangement being such that the piston opens the auxiliary scavenging port only slightly before the intake port is opened, so that communication between the crankcase and the cylinder via the auxiliary scavenging port and passage is established only for a very minute time interval.

Moreover it is taught in the above mentioned specification that the air intake port is opened by the piston only a certain period of time after the piston is at its bottom dead point, as illustrated by the dotted curve in FIG. 2 of the said Specification. Consequently the auxiliary scavenging passage definitely does not communicate with the crankcase when the piston is at its bottom dead point, in which position the compression of the air in the sealed crankcase is at a maximum. The auxiliary scavenging air flow therefore does not benefit of this maximum pressure and is practically only fed by the air which has accumulated in the air intake passage, which limits its efficiency.

The above mentioned U.S. Pat. No. 3,687,118 also describes injection means having its head located in said auxiliary scavenging passage.

SUMMARY OF THE INVENTION

The primary object of the present invention is to provide an improved construction of a two stroke internal combustion engine of the crankcase compression type, including a cylinder, a piston disposed in the cylinder for reciprocal motion therein, a sealed crankcase, air intake passage means communicating with said crankcase through an air intake port, an exhaust port which is open in the side wall of the cylinder and opened and closed by the piston, at least two main scavenging passages communicating said crankcase with the cylinder through at least two main scavenging ports wich are open in the side wall of the cylinder and opened and closed by the piston, said main scavenging ports being disposed symmetrically with respect to a diametral plane of the cylinder passing through the center of the exhaust port, and so directed that the air flows therefrom coverage towards a first point located on a first generatrix of the cylinder diametrically opposite to a second generatrix passing through the center of the exhaust port, an auxiliary scavenging passage of smaller cross-section than that of the main scavenging passages and opening at one end into the cylinder through an auxiliary scavenging port which is opened and closed by the piston and is located substantially opposite the exhaust port and arranged to direct its air flow towards a second point located substantially on the second generatrix, and fuel injection means located in the auxiliary scavenging passage and having its axis directed towards said second point.

According to the present invention the auxiliary scavenging passage communicates at its other end with said crankcase at least as long as the auxiliary scavenging port is uncovered by the piston. The auxiliary scavenging air flow is thus fed from the air under compression in the crankcase as long as the auxiliary scavenging port stays open, which ensures an efficient scavenging of the burnt gases.

In a preferred arrangement, the fuel injection means acts to deliver fuel only after at least some of the main scavenging ports have started to deliver air and preferably the auxiliary scavenging port is uncovered by the piston before the main scavenging ports are opened, so that the fuel injected is first diluted in the air from the auxiliary scavenging port then meets a curtain of pure air from the main scavenging ports which is almost perpendicular thereto, to carry it towards the said first point.

When the invention is applied to a conventional engine having its air intake controlled by the operation of the piston, the air intake port is formed in the cylinder and preferably, for reasons of symmetry, disposed on the cylinder side opposite the exhaust port, that is to say on the same genetrix as the small auxiliary scavenging passage. On the other hand, the lower orifice of the auxiliary scavenging passage must be below the top of the air intake port.

To overcome this difficulty, in a preferred embodiment, the auxiliary scavenging passage comprises a small cross-section tube which crosses the air intake duct to connect the capacity of the crankcase to a

chamber in which the injector is positioned and which opens into the cylinder through the said auxiliary scavenging port.

In another embodiment, there is provided either an auxiliary scavenging passage sub-dividing into two symmetrical branches which encircle a single air intake port and rejoin at their upper parts, or two symmetrical air intake ducts disposed on either side of a single auxiliary scavenging passage, and opening into two air intake ports. This latter arrangement ensures good cooling of the injector which is thus enclosed by the two air ducts.

In a simplified embodiment, there is a single air intake port and a single non-divided auxiliary scavenging passage, this port and this passage being slightly angularly displaced with respect to each other.

The fuel injection is started when the piston is about its bottom dead point, after the main scavenging ports have been opened. Of course the injection will be stopped at a position of the piston which will vary depending on the load of the engine. Preferably, the injector is electronically controlled.

For an understanding of the principles of the invention, reference is made to the following description of typical embodiments thereof as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawing:

FIG. 1 is an axial sectional view of a preferred embodiment of the invention,

FIG. 2 is a partial axial sectional view of a second embodiment of the invention,

FIG. 3 is a transverse sectional view taken along the line III—III of FIG. 2,

FIG. 4 is a developed view of the interior wall of the cylinder of the engine shown in FIG. 2 and 3.

FIG. 5 is a view similar to FIG. 4 of another embodiment of the invention,

FIGS. 6–9 are schematic perspective diagrams illustrating four successive phases of operation of an engine constructed in accordance with the invention, and

FIG. 10 is a diagram illustrating the operation of the auxiliary scavenging passage in accordance with the invention, compared to that of the known art.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

First referring to FIG. 1, the two stroke internal combustion engine comprises a cylinder 1 having a piston 3 with a flat-topped portion 2 disposed therein for reciprocal motion. A crankcase 20 is formed beneath the cylinder and encloses a sealed chamber 4 which is herein below referred to as "the crankcase." The piston 3 is connected to a crank shaft 5 by a connecting rod 6.

The cylinder 1 is provided with an exhaust port E, into which an exhaust duct 7 opens, and two main scavenging ports Tn which are disposed symmetrically with respect to the "plane of symmetry of the cylinder" as defined hereabove. Only one port T*n* is shown in FIG. 1. Such plane comprises a first generatrix 14 of the cylinder and a second generatrix 15 which is diametrically opposite to the first one 14 and passes through the center of the exhaust port E. The internal side wall of the cylinder 1 also includes an auxiliary scavenging port T*i* which is located substantially opposite the exhaust port E. that is to say its center lies substantially in the plane of symmetry of the cylinder. The exhaust port E, main scavenging T*n* and auxiliary scavenging port T*i* are opened and closed in time sequence by the piston 3.

Two main scavenging passages 8 open at one end into the main scavenging ports T*n* respectively, and at the other end into ports 9 formed in the bottom portion of the cylinder 2. Notches 10 are formed in the bottom portion of the wall of the piston 3 and are so arranged that the ports 9 stay uncovered for the entire stroke of the piston, even if the latter is in its bottom dead point as shown in FIG. 1. Under these conditions, the main scavenging ports T*n* are permanently communicating with the crankcase 4.

A chamber 12 is formed in the wall of the cylinder 1 and opens into the auxiliary scavenging port T*i*. Chamber 12 communicates through a tube T2 with an elongate recess 11 formed in the bottom part of the internal side wall of the cylinder. Said recess 11 opens into the crankcase 4, so that the auxiliary scavenging port Ti stays in communication with the crankcase whatever the position of the piston 3. The cross-section of tube T2 is smaller than that of the main scavenging passages 8.

The auxiliary scavenging port T*i* is so located in the wall of the cylinder that is opened by the piston before the main scavenging ports T*n* are opened in the stroke of the piston towards the bottom dead point.

The axis of the tube T2 can be either substantially parallel to the axis of the cylinder or slightly inclined with respect to the last said axis, as shown in FIG. 1. The tube T2 can be simply engaged with a close fit in a bore in the wall of the cylinder, which makes the manufacture very economical.

An injector I has its head 13 positioned in the chamber 12, in front of the auxiliary scavenging port T*i* and substantially flush with the internal surface of the sidewall of the cylinder. It has been found that the best results are obtained with an injection having an atomization angle of the order of 30° (angle at the apex of the cone of atomization). The fuel injected is started only after the main scavenging ports T*n* are opened by the piston. Preferably, the injector is electronically controlled.

An air intake duct 16 opens into the cylinder through an air intake port A, which is opened and closed by the piston 3 and, when opened, communicates the duct 16 with the crankcase 4, wherein the air is compressed by the piston during its stroke towards the bottom dead point.

The center of the air intake port A is located substantially on the same generatrix 14 as the auxiliary scavenging port T*i* for reasons of symmetry, and tube T2 diametrically crosses the duct 16.

The main scavenging ports T*n* are so oriented that their air flows converge towards a point P on the first generatrix 14. On the other hand the auxiliary scavenging port T*i* is arranged to direct its air flow towards a second point *p* somewhere on the second generatrix 15. Moreover the injection head is so arranged that the axis of the atomization cone is directed towards the point *p*, which can eventually be positioned within the contour of the exhaust port E, as shown in FIG. 1.

The operation will now be explained in reference to FIGS. 6 to 10.

FIG. 6 corresponds to the end of the explosion phase. The piston is going down as shown by the arrow *f* and

its top 2 still entirely masks the main and auxiliary scavenging ports T*n* and T*i*. The exhaust port E begins to be uncovered and the burnt gases G begin exiting through port E. The injector I, still masked by the piston, is well protected from the high temperature gases.

In FIG. 7, the piston keeps going down. The exhaust port E is further opened and the injector I is still closed. The main and auxiliary scavenging ports T*n* and T*i* are partially uncovered, T*i* being opened before T*n*. A flow of pure primary air A*p* is directed from T*i* towards point *p*. This flow is fed through the recess **11** and tube T2 from the air which is being compressed in the crankcase **4** by the descending piston. On the other hand two converging flows A*s* of secondary air are directed from the main scavenging ports T*n* towards point P. These flows A*s* deviate the primary air flow A*p* and create a screen or cushion of air behind the burnt gases G.

In FIG. **8**, the piston is close to its bottom dead point and the injector I starts atomizing fuel in the primary air flow A*p* resulting in a mixture which is rich in fuel. The auxiliary scavenging port is still in communication with the crankcase where the compression is about at its maximum. The atomization of the liquid fuel is therefore improved with respect to the known art and the nozzle of the injector is kept clean of carbon deposits. The jet of fuel further meets the secondary air flows A*s* which complete the dilution of the fuel, deflect it and carry it towards point P, thus ensuring complete filling of the cylinder with combustible mixture. Moreover the burnt gases are separated from the fresh ones by the curtain formed by primary and secondary air flows.

FIG. **9** illustrates the situation when the injector I has just been closed. The piston is now going up as shown by the arrow *g*. Ports E, T*n*, T*i* are still open and the remainder of the burnt gases is being evacuated.

The diagram in FIG. **10** illustrates one of the main differences between the prior art and the invention. In this diagram the crank angle is in abcissa and is marked positive when the piston is going down towards its bottom dead point, and negative when the piston is going up towards its top dead point. Consequently the bottom dead point BDP corresponds to both + 180° and − 180°.

The heavy solid line **21** shows the period of which the auxiliary scavenging passage, comprising chamber **12**, tube T2 and recess **11**, communicates the cylinder **1** with the crankcase **4** according to the invention. This period is actually that for which the auxiliary scavenging port T*i* is uncovered by the piston and extends from about + 120° to − 120°.

In the prior art, for the auxiliary scavenging passage to communicate the cylinder with the crankcase, it is necessary that both the auxiliary scavenging port and the air intake port should be opened. As the air intake port is not open for absolute values of the crank angle greater than about 140°, the cylinder to crankcase communication through the auxiliary scavenging passage is established for only very short periods, as shown by the dotted lines **22** in FIG. **10.** In particular the auxiliary scavenging port is cut off from the crankcase when the piston is close to its bottom dead point and fuel injection is started. This is exactly the time when a high pressure primary air flow is the most desirable to improve fuel injection, atomization and intermixing, and clean up the injector nozzle.

FIGS. **2** to **4** show another embodiment of the invention, wherein the auxiliary scavenging passage is constituted by an elongate recess **17** formed in the internal side wall of the cylinder **1.** A port L formed through the wall of the piston **3** communicates the recess **17** with the crankcase **4.** In FIG. **2,** the piston **3** is supposed to be at its bottom dead point and it can be seen that communication between the recess **17** and the crankcase **4** is established at least as long as the top of the recess, which plays the part of the auxiliary scavenging port, is uncovered by the piston. Therefore the auxiliary scavenging operates the same way as in the first described embodiment.

Two air intake ducts **16** are symmetrically disposed on either side of the recess **17** and open into two air intake ports A1 and A2. The injector I is disposed between the two ducts **16.**

FIG. **4** shows that the top of the auxiliary scavenging port is located a distance *b* below the top of the exhaust port E; while the top of the main scavenging ports T*n* is a distance *a* below the top of the exhaust port, and *a* is greater than *b*, that is the primary air A*p* is injected before the secondary air A*s*, as in the embodiment of FIG. **1.**

This second embodiment also preserves symmetry and offers the advantage of good cooling of the injector which is disposed between the two air intake ducts.

In another embodiment shown in FIG. **5,** there is a single air intake duct (not shown) opening into a single air intake port A. The auxiliary scavenging passage T*i* divides into two branches which enclose port A. Symmetry is still preserved. Moreover, distance *a* is lesser than distance *b*, that is the auxiliary scavenging port T*i* is opened after the main scavenging ports T*n* when the piston goes down towards its bottom dead point.

In a simplified embodiment not shown the auxiliary scavenging passage is not divided and there is a single air duct and port. The passage and port are then slightly angularly displaced with respect to each other.

The distribution arrangement described and shown, by effectively preventing the contamination of the fresh gases by the burnt gases, and by improving the scavenging of the cylinder, ensures an almost complete combustion of the driving mixture, being denoted on the one hand by an obvious economy in fuel, and on the other hand by a reduction of the atmospheric pollution which incompletely burnt exhaust gases cause.

These important results are demonstrated by pratical trails which have given the following results.

The proportion of unburnt gases in the exhaust is only 1/1000 – 2/**1000.** The carbon monoxide content in the exhaust gases is of the order of 1 %.

Finally, the specific consumption is of the order of 200 – 230 grams per horsepower-hour, instead of 400 grams, that is to say that it is reduced substantially by half.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principle of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. In a two stroke combustion engine of the crankcase compression type, including a cylinder, a piston disposed in the cylinder for reciprocal motion therein, a sealed crankcase, air intake passage means communicating with said crankcase through an air intake port,

an exhaust port which is open in the side wall of the cylinder and opened and closed by the piston, at least two main scavenging passages communicating said crankcase with the cylinder through at least two main scavenging ports which are open in the side wall of the cylinder and opened and closed by the piston, said main scavenging ports being disposed symmetrically with respect to a diametral plane of the cylinder passing through the center of the exhaust port, and so directed that the air flows therefrom coverage towards a first point located on a first generatrix of the cylinder diametrically opposite to a second generatrix passing through the center of the exhaust port, an auxiliary scavenging passage of smaller cross-section than that of the main scavenging passages and opening at one end into the cylinder through an auxiliary scavenging port which is opened and closed by the piston and is located substantially opposite the exhaust port and arranged to direct its air flow towards a second point located substantially on the second generatrix, and fuel injection means located in the auxiliary scavenging passage and having its axis directed towards said second point, the improvement consisting in that the auxiliary scavenging passage communicates at its other end with said crankcase at least as long as the auxiliary scavenging port is uncovered by the piston.

2. An engine according to claim **1,** in which the injection means starts to deliver fuel only after at least some of the main scavenging ports have started to deliver air.

3. An engine according to claim **1,** in which the auxiliary scavenging passage comprises a small cross-section tube which crosses the air intake tube to connect the capacity of the crankcase to a chamber in which the injector is positioned and which opens into the cylinder through the auxiliary scavenging port.

4. An engine according to claim **3,** in which the axis of the small section tube is substantially parallel to the axis of the cylinder.

5. An engine according to claim **3,** in which the axis of the small section tube is slightly inclined relative to the axis of the cylinder.

6. An engine according to claim **1,** including two air intake ducts opening into the cylinder through two air intake ports which are opened and closed by the piston, said intake ports being symmetrical with respect to the plane of symmetry of the cylinder and being on either side of the auxiliary scavenging passage.

7. An engine according to claim **1,** in which the air intake port is opened and closed by the piston, and said auxiliary scavenging passage is divided in two in its lower part to form two branches on either side of said intake port.

8. An engine according to claim **1,** in which the air intake port is opened and closed by the piston, said intake port an said auxiliary scavenging passage being slightly angularly displaced relative to one another.

9. An engine according to claim **1,** in which the angle at the apex of the cone of atomization of the injector is around 30°.

10. An engine according to claim **2,** in which the auxiliary scavenging port is so located that it is opened by the piston in its stroke towards bottom dead point before the main scavenging ports are opened.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,881,454 Dated May 6, 1975

Inventor(s) Eric E. Jaulmes, et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Assignee should read -- Ateliers De La Motobecane --.

Signed and Sealed this

twenty-seventh Day of *January 1976*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks