

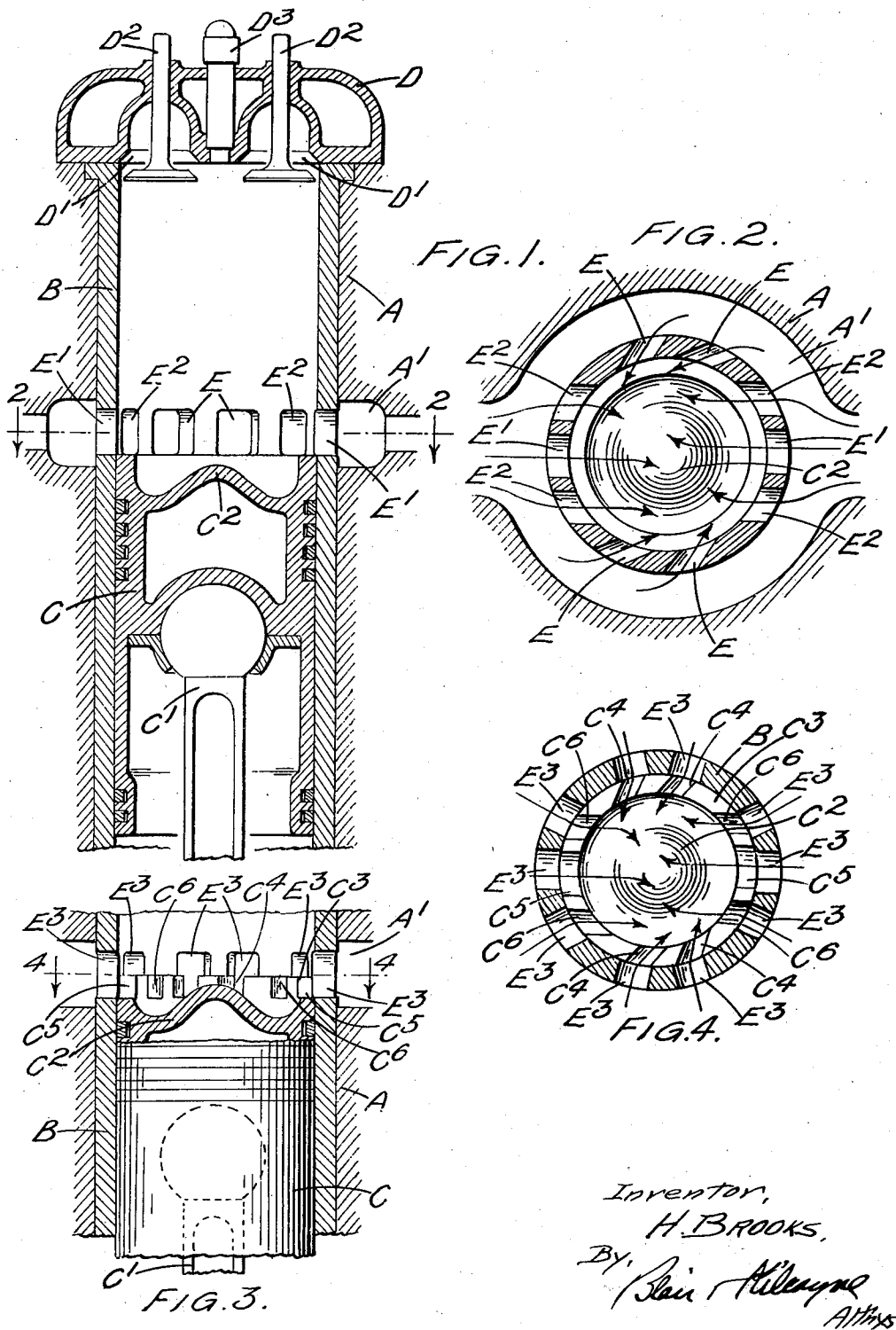
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SCAVENGING OF THE CYLINDERS OF TWO-STROKE INTERNAL COMBUSTION ENGINES

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SCAVENGING OF THE CYLINDERS OF TWO-STROKE INTERNAL COMBUSTION ENGINES

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This invention relates to internal combustion engines operating on the two-stroke cycle of the type in which the exhaust port or ports are situated in or adjacent to the cylinder head while inlet ports are formed in the cylinder wall where they will be uncovered by the piston at the end of its outstroke so that during the scavenging period the scavenging air entering through the scavenging ports in passing through the swept portion of the cylinder to the exhaust port or ports drives the burnt gases out before it through the exhaust port or ports.

It has been proposed in engines of the above type to provide two rings of scavenging ports lying one above the other so as to be uncovered successively by the piston, the upper ring of ports being so formed that the air flows radially through them and is deflected upwards by a deflecting surface on the piston with the object of providing a core of air to drive out the core of burnt gases surrounding the cylinder axis, while the ports in the lower ring all enter the cylinder in the same tangential direction so that the air flowing through them is caused to rotate about the cylinder axis with the object of driving out the gases surrounding the core above referred to.

The object of the present invention is to provide an improved engine of the type referred to, the invention being more particularly applicable to engines in which the scavenging air is delivered under pressure by a blower or other means.

To this end in an internal combustion engine of the type referred to according to the present invention having a ring of scavenging ports adapted to be uncovered simultaneously by the piston towards the end of its outstroke, the arrangement is such that the air flowing through the ring of scavenging ports, in addition to promoting general turbulence due to the air entering the cylinder through different ports in the ring being caused to flow at different angles relative to the radial direction, also causes the charge as a whole to rotate about the cylinder axis.

Thus, while the air entering the cylinder through the majority of these scavenging ports may be caused to flow in the same tangential direction to cause the rotation of the charge as a whole within the cylinder, air entering the cylinder through each of the remaining scavenging ports may be caused to flow either in an opposite tangential direction or substantially radially, the arrangement being such, however, that the resultant of the air flowing through all the

scavenging ports causes rotation of the air charge about the cylinder axis.

The scavenging ports are conveniently arranged symmetrically in the cylinder wall, that is to say so that for each port through which the air flows into the cylinder in a tangential direction there is a diametrically opposite port through which the air flows into the cylinder in a similar tangential direction and at a similar angle relatively to the radial direction, while where the air entering through certain ports flows radially, each port through which the air flows radially into the cylinder lies diametrically opposite to another similar port through which air flows radially into the cylinder.

In an arrangement according to the invention, rotational movement of the whole charge tends to cause a delayed action of the air on entry to the cylinder and to cause the air to form a stratum at the bottom of the cylinder first and then to move up the swept portion of the cylinder, thus reducing to a minimum the risk of the air mixing with the hot inert gases being driven before it and assisting the flow of the inert gases as a mass through the exhaust port or ports.

The scavenging ports are conveniently so constructed and arranged that the charge tends to enter the cylinder through them in directions lying in a plane normal to the cylinder axis.

The desired directions of flow of air entering the cylinder through the various scavenging ports may be caused either by forming each port so that the air flows therethrough in the desired direction or by providing slots in the circumferential part of the piston crown which cooperate with scavenging ports in the cylinder wall at the end of the outstroke of the piston and are formed so as to direct air flowing therethrough into the cylinder in the desired directions, or by a combination of these two arrangements. Where slots are provided in the piston crown as above described this tends to improve cooling of the piston crown.

The form of the combustion chamber of an engine according to the invention may vary but the invention is more particularly applicable to engines in which the combustion chamber is formed between the end of the piston and the cylinder head. In this case, the piston crown may be so formed as to provide at the end of the compression stroke a combustion chamber the axial depth of which increases progressively from the axis of the cylinder towards the circumference thereof, a fuel injector being situated sub-

stantially at the axis of the cylinder and formed so as to direct fuel radially outwards towards the circumference of this combustion chamber.

The invention may be carried into practice in various ways but two constructions according to the invention are illustrated somewhat diagrammatically by way of example in the accompanying drawing, in which

Figure 1 is a longitudinal section through the cylinder of one construction of engine according to the invention,

Figure 2 is a section on the line 2—2 of Figure 1,

Figure 3 is a longitudinal section showing an alternative arrangement according to the invention, and

Figure 4 is a section on the line 4—4 of Figure 3.

In the construction illustrated in Figure 1, the engine comprises a cylinder, indicated at A, formed with a scavenging belt A¹ and containing a liner B within which reciprocates a piston C coupled to a connecting rod C¹. Formed in the cylinder head D which closes the upper end of the cylinder are two exhaust ports D¹ controlled by poppet valves D² while a fuel sprayer D³ is situated in the cylinder head coaxial with the cylinder.

Formed in the liner B is a series of scavenging ports communicating with the scavenging belt A¹ and comprising two pairs of diametrically opposite ports E each formed so that the air will flow into the cylinder therethrough tangentially and will tend to rotate in an anti-clockwise direction, a pair of diametrically opposite inlet ports E¹ through which the scavenging air will tend to flow into the cylinder radially, and two further pairs of ports E² situated on either side of the ports E¹ and arranged so that the air tends to flow therethrough in a direction parallel to the direction of flow through the ports E¹. The piston C uncovers the scavenging ports at the end of its outstroke, in which position it is shown in Figures 1 and 2, and the valves D² are so operated as to be opened before the scavenging ports open and to close approximately at the same time as the scavenging ports are closed by the piston.

As will be seen, the air flowing through the ports E and two of the ports E² enters the cylinder tangentially so as to tend to cause the air charge to rotate within the cylinder in an anti-clockwise direction in Figure 2, the angle of entry of the charge through the ports E and E² relatively to the radial direction not being however the same for all these ports. The air entering through the ports E¹ on the other hand tends to flow into the cylinder truly radially while that entering through the other two ports E² flows into the cylinder in a direction tending to cause the air charge to rotate therein in the clockwise direction. The total effect of the air entering through the various ports, however, is to cause the air charge to rotate bodily about the cylinder axis in an anti-clockwise direction while the effect of the air entering radially or in a direction tending to cause clockwise rotation is to superimpose upon the anti-clockwise rotary motion of the charge a general turbulence within itself.

As will be seen, the piston crown C² is so formed as to provide at the end of the compression stroke a combustion chamber whose axial depth increases from the axis of the cylinder towards the circumference, and the fuel sprayer D³ is

so constructed as to direct the fuel substantially radially from the centre towards the circumference of the combustion chamber so formed.

In the modified construction illustrated in Figure 3, the remaining parts of which may be constructed and arranged similar to the corresponding parts of the construction shown in Figures 1 and 2, the piston crown is provided at its circumference with an axially extending rim C³ provided with a series of slots C⁴, C⁵, C⁶ which correspond in position to a series of scavenging ports E³, the arrangement being such that the bases or lowest parts of these slots lie in substantially the same plane as the lower edges of the ports E, E¹, E² when the piston is at the end of its outstroke as clearly shown in Figure 3. In this construction the scavenging ports E³ all extend radially but it will be seen that the arrangement is such that part of the scavenging charge flowing through the ports E³ then flows through the slots C⁴, C⁵, C⁶ and that the slots C⁴ extend in the same directions as the ports E in the construction shown in Figures 1 and 2, the slots C⁵ extend in the same directions as the ports E¹ and the slots C⁶ extend in the same directions as the ports E² in the construction shown in Figures 1 and 2, whereby the parts of the air charge which flow through the slots C⁴, C⁵, C⁶ are caused to enter the cylinder in approximately the same directions as the parts of the charge which flow through the correspondingly arranged ports in Figures 1 and 2, as indicated by arrows. With this arrangement it will also be seen that improved cooling of the piston crown tends to be obtained.

With an engine according to the present invention improved scavenging and more efficient expulsion of the burnt gases with retention of a greater proportion of the scavenging air within the cylinder and more adequate cooling of the piston crown tends to be obtained, while the improved turbulence of the whole charge facilitates efficient combustion.

It is to be understood that the constructions diagrammatically illustrated in the drawing are given by way of example only and that constructional details may be modified without departing from this invention.

What I claim as my invention and desire to secure by Letters Patent is:

1. A two-stroke cycle internal combustion engine including in combination a cylinder containing a piston and having formed therein a ring of scavenging ports adapted to be uncovered simultaneously by the piston towards the end of its outstroke, a cylinder head closing the end of the cylinder and containing at least one valve-controlled exhaust port, and means whereby the air flowing through different ports in the ring of scavenging ports is caused to flow at different angles relatively to the radial direction so as to promote general turbulence while having a resultant which causes the charge as a whole to rotate about the cylinder axis.

2. A two-stroke cycle internal combustion engine including in combination a cylinder containing a piston and having formed therein a ring of scavenging ports adapted to be uncovered simultaneously by the piston towards the end of its outstroke, a cylinder head closing the end of the cylinder and containing at least one valve-controlled exhaust port, and means whereby the air entering the cylinder through the majority of the scavenging ports is caused to flow in the same tangential direction to cause rota-

tion of the charge as a whole about the cylinder axis while air entering the cylinder through each of the remaining scavenging ports is caused to flow substantially radially or in an opposite tangential direction so as to superimpose a general turbulence on the rotation of the charge as a whole.

3. A two-stroke cycle internal combustion engine including in combination a cylinder containing a piston and having formed therein a ring of scavenging ports adapted to be uncovered simultaneously by the piston towards the end of its outstroke, and a cylinder head closing the end of the cylinder and containing at least one valve-controlled exhaust port, the scavenging ports being so formed that the air entering the cylinder through the majority of the scavenging ports is caused to flow in the same tangential direction to cause rotation of the charge as a whole about the cylinder axis while air entering the cylinder through each of the remaining scavenging ports is caused to flow substantially radially or in an opposite tangential direction so as to superimpose a general turbulence on the rotation of the charge as a whole.

4. A two-stroke cycle internal combustion engine including in combination a cylinder containing a piston and having formed therein a ring of scavenging ports adapted to be uncovered simultaneously by the piston towards the end of its outstroke, and a cylinder head closing the end of the cylinder and containing at least one valve-controlled exhaust port, the scavenging ports being arranged symmetrically in the cylinder and so formed that the air entering the cylinder through the majority of the scavenging ports is caused to flow in the same tangential direction to cause rotation of the charge as a whole about the cylinder axis while air entering the cylinder through each of the remaining scavenging ports is caused to flow substantially radially or in an opposite tangential direction so as to superimpose a general turbulence on the rotation of the charge as a whole.

5. A two-stroke cycle internal combustion engine including in combination a cylinder containing a piston and having formed therein a ring of scavenging ports adapted to be uncovered simultaneously by the piston towards the end of its outstroke, and a cylinder head closing the end of the cylinder and containing at least one valve-controlled exhaust port, slots being formed at different angles in the circumferential part of the crown of the piston opposite the scavenging ports whereby the air flowing through different ports in the ring of scavenging ports is caused to flow at different angles relatively to the radial direction so as to promote general turbulence while having a resultant which causes the charge as a whole to rotate about the cylinder axis.

6. A two-stroke cycle internal combustion engine including in combination a cylinder containing a piston and having formed therein a ring of scavenging ports adapted to be uncovered simultaneously by the piston towards the end of its outstroke, and a cylinder head closing the end of the cylinder and containing at least one valve-controlled exhaust port, slots being formed at different angles in the circumferential part of the crown of the piston opposite the scavenging ports whereby the air entering the cylinder through the majority of the scavenging ports is caused to flow in the same tangential direction to cause rotation of the charge as a whole about the cylinder axis while air entering the cylinder

through each of the remaining scavenging ports is caused to flow substantially radially or in an opposite tangential direction so as to superimpose a general turbulence on the rotation of the charge as a whole.

7. A two-stroke cycle internal combustion engine including in combination a cylinder containing a piston and having formed therein a ring of scavenging ports adapted to be uncovered simultaneously by the piston towards the end of its outstroke, a cylinder head closing the end of the cylinder and containing at least one valve-controlled exhaust port and an axially extending rim on the piston crown provided with slots positioned at different angles and lying opposite the scavenging ports and so formed that the air flowing through different ports in the ring of scavenging ports is caused by the slots to flow at different angles relatively to the radial direction so as to promote general turbulence while having a resultant which causes the charge as a whole to rotate about the cylinder axis.

8. A two-stroke cycle internal combustion engine including in combination a cylinder containing a piston and having formed therein a ring of scavenging ports adapted to be uncovered simultaneously by the piston towards the end of its outstroke, a cylinder head closing the end of the cylinder and containing at least one valve-controlled exhaust port and an axially extending rim on the piston crown provided with slots positioned at different angles and lying opposite the scavenging ports and so formed that the air entering the cylinder through the majority of the scavenging ports is caused to flow in the same tangential direction to cause rotation of the charge as a whole about the cylinder axis while air entering the cylinder through each of the remaining scavenging ports is caused to flow substantially radially or in an opposite tangential direction so as to superimpose a general turbulence on the rotation of the charge as a whole.

9. A two-stroke cycle internal combustion engine including in combination a cylinder containing a piston and having formed therein a ring of scavenging ports adapted to be uncovered simultaneously by the piston towards the end of its outstroke, and a cylinder head closing the end of the cylinder and containing at least one valve-controlled exhaust port, slots being formed at different angles in the circumferential part of the crown of the piston opposite the scavenging ports whereby the air entering the cylinder through the majority of the scavenging ports is caused to flow in the same tangential direction to cause rotation of the charge as a whole about the cylinder axis while air entering the cylinder through each of the remaining scavenging ports is caused to flow substantially radially or in an opposite tangential direction so as to superimpose a general turbulence on the rotation of the charge as a whole, the scavenging ports being arranged symmetrically in the cylinder and the slots being arranged symmetrically in the piston.

10. A two-stroke cycle internal combustion engine including in combination a cylinder containing a piston and having formed therein a ring of scavenging ports adapted to be uncovered simultaneously by the piston towards the end of its outstroke, a cylinder head closing the end of the cylinder and containing at least one valve-controlled exhaust port and an axially extending rim on the piston crown provided with slots positioned at different angles and lying opposite the scavenging ports and so formed that the air flow-

- ing through different ports in the ring of scavenging ports is caused by the slots to flow at different angles relatively to the radial direction so as to promote general turbulence while having a resultant which causes the charge as a whole to rotate about the cylinder axis, the scavenging ports being arranged symmetrically in the cylinder and the slots being arranged symmetrically in the piston.
- 10 11. A two-stroke cycle internal combustion engine including in combination a cylinder containing a piston and having formed therein a ring of scavenging ports adapted to be uncovered simultaneously by the piston towards the end of its outstroke, a cylinder head closing the end of the cylinder and containing at least one valve-controlled exhaust port and an axially extending rim on the piston crown provided with slots positioned at different angles and lying opposite the scavenging ports and so formed that the air entering the cylinder through the majority of the scavenging ports is caused to flow in the same tangential direction to cause rotation of the charge as a whole about the cylinder axis while air entering the cylinder through each of the remaining scavenging ports is caused to flow substantially radially or in an opposite tangential direction so as to superimpose a general turbulence on the rotation of the charge as a whole, the scavenging ports being arranged symmetrically in the cylinder and the slots being arranged symmetrically in the piston.
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