Jan. 3, 1961 J. EHRLICH 2,966,900

PORT-CONTROLLED TWO-STROKE INTERNAL COMBUSTION ENGINES

Filed July 25, 1957 3 Sheets-Sheet 1

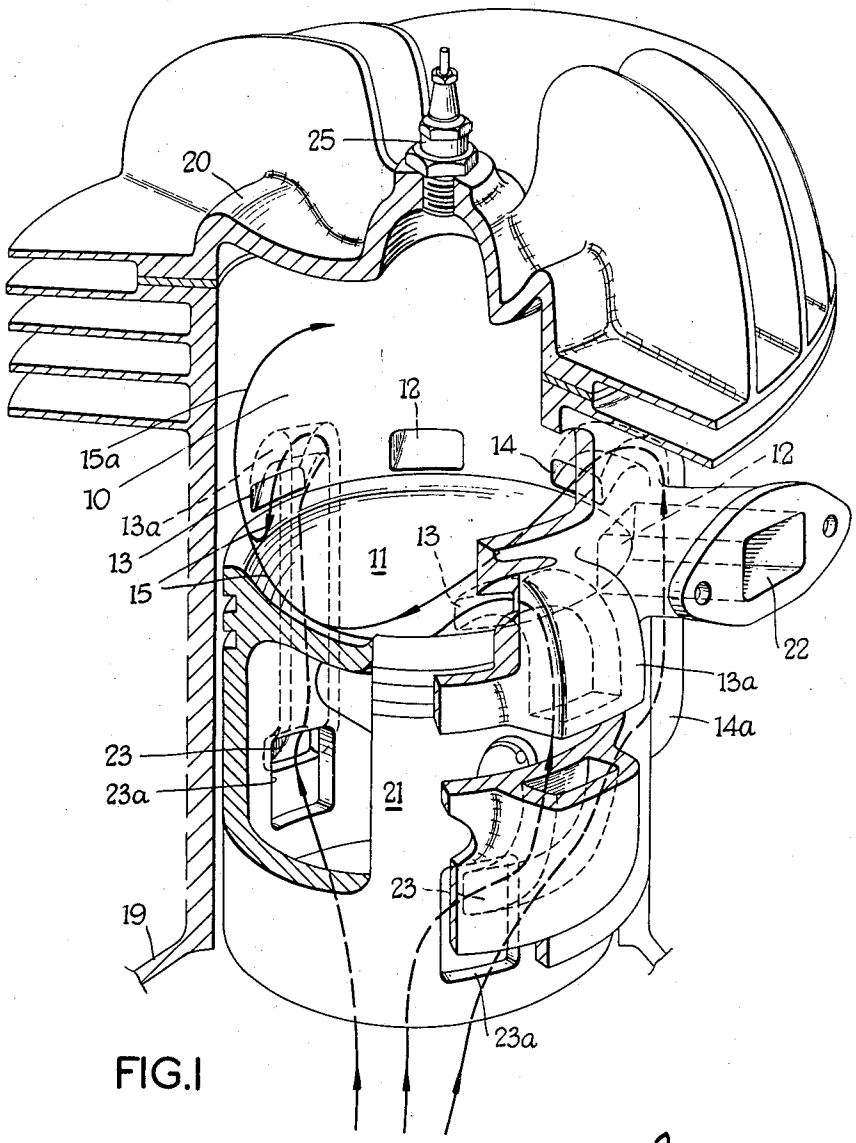


FIG.1

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PORT-CONTROLLED TWO-STROKE INTERNAL COMBUSTION ENGINES

Filed July 25, 1957 3 Sheets-Sheet 2

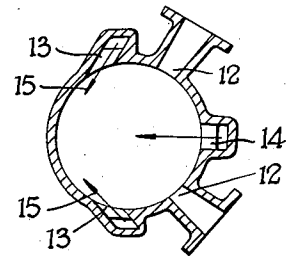


FIG. 2

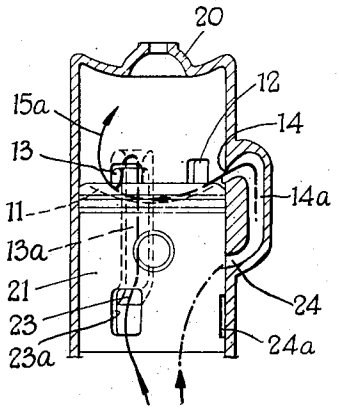


FIG. 3

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PORT-CONTROLLED TWO-STROKE INTERNAL COMBUSTION ENGINES

Filed July 25, 1957 3 Sheets-Sheet 3

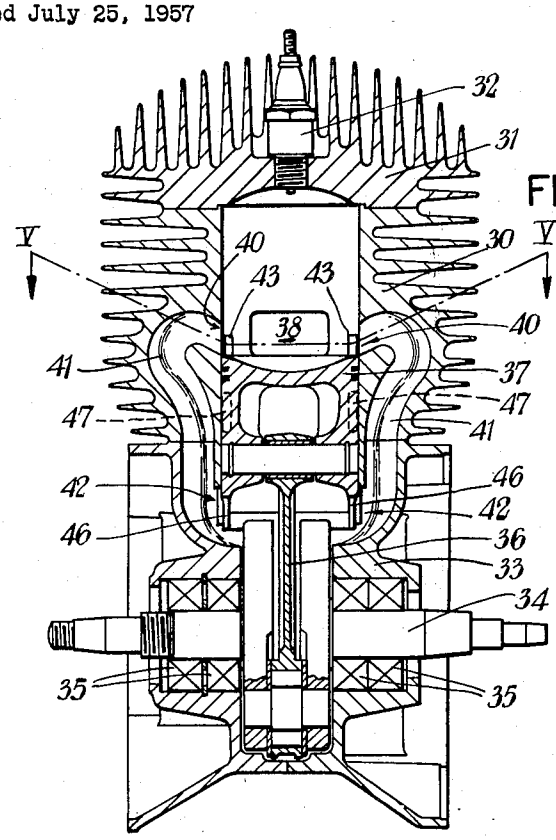


FIG.4

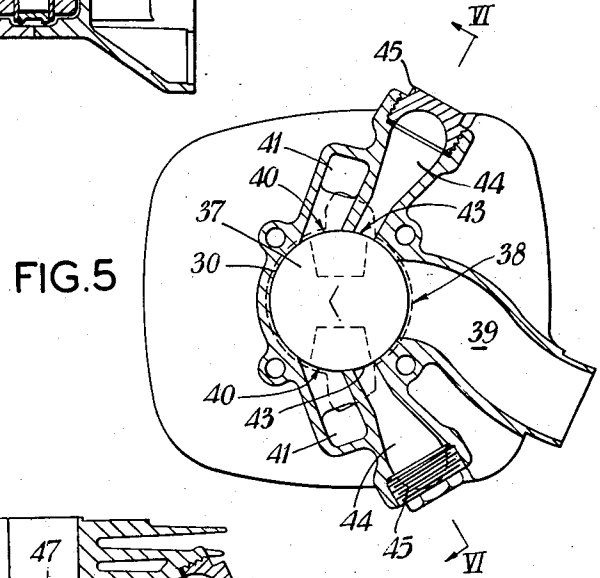


FIG.5

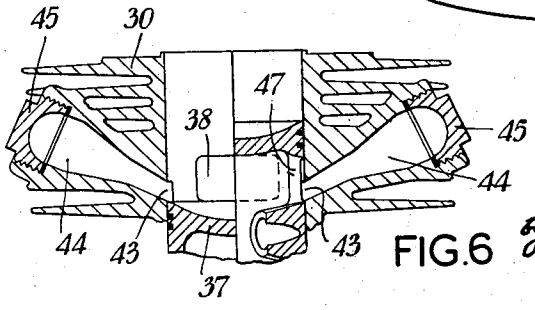


FIG.6

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United States Patent Office 2,966,900 Patented Jan. 3, 1961

2,966,900

PORT-CONTROLLED TWO-STROKE INTERNAL COMBUSTION ENGINES

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Claims priority, application Great Britain July 25, 1956

11 Claims. (Cl. 123—73)

The present invention concerns improvements in and relating to port-controlled two-stroke internal combustion engines, and has as an object to improve the efficiency of scavenging and charging in such engines.

Engines of this kind are provided, in the wall of the cylinder, with exhaust ports and entry ports for scavenging air, which are uncovered as the piston descends during the combustion stroke. The term "scavenging air" in this specification is intended to include the fuel-air mixture which is introduced in this way into the cylinders of engines which are provided with a carburettor.

In some such engines, the head of the piston is concave and the transfer ports and the ducts leading thereto are such that the scavenging air is directed downwardly into the bowl-shaped face of the piston and backwardly away from the exhaust ports. The gas is then deflected upwardly by the rear part of the piston face, and moves up the rear wall of the cylinder towards the cylinder head, simultaneously displacing the exhaust gases through the exhaust port or ports. In such engines, there may be provided one or more exhaust ports and one or more entry ports, all the ports being directed towards the back wall of the cylinder.

On the exhaust ports being opened, the pressure in the cylinder decreases rapidly and "overshoots," producing a momentary negative pressure at the exhaust ports behind the outrushing exhaust gases. There is a tendency, common to all two-stroke engines for some of the charge freshly admitted through the transfer ports to be lost due to this negative pressure, and in the past, the exhaust systems of such engines have commonly been designed to reduce this loss by suppressing or minimising the negative pressure wave. Properly used, however, this momentary negative pressure may be made to assist in virtually complete scavenging of the exhaust gases, without a part of the freshly admitted charge being drawn immediately out of the cylinder. This undesired tendency is reduced by the positive deflection upwards of the entering charge in the way referred to, and it is an object of the present invention to reduce still further the tendency for the cylinder to be undercharged at the commencement of the compression stroke.

A further advantageous feature of engines in which the cool, entering charge is directed on to the face, i.e. hottest part of the piston, is that the efficiency of cooling is much increased, and this feature may be retained in engines according to the present invention.

According to the invention there is provided a port-controlled two-stroke internal combustion engine having a combustion space defined within a cylinder between a cylinder head and the top face of a piston reciprocable in the cylinder and having in the wall of the cylinder at least one exhaust port and at least one main entry port for scavenging air, these ports being so located that they are first uncovered by the piston and opened to the combustion space during the latter part of the combustion stroke of the piston and the main entry port being in

communication with means for supplying thereto scavenging air under pressure, wherein there is further provided in the wall of the cylinder at least one additional entry port which is more remote from the cylinder head than is the said main entry port and is thereby first uncovered by the piston and opened to the combustion space at a correspondingly later time during the combustion stroke, the additional entry port also being in communication with the same means for supplying thereto air under pressure, said means including a container for air under pressure.

In one type of engine according to the invention, the main entry port is in communication with the interior of a crank-case of the engine, which constitutes the said container, and the scavenging air supplied to the main entry port is compressed in the crankcase by the movement of the piston during the combustion stroke. In another type of engine embodying the invention, the crank-case operates as a receiver of scavenging-air blower or compressor means and thus again constitutes the said container.

In one preferred embodiment of an engine of either of these types and according to the invention, the additional entry port is at one end of a channel or duct of which the other end communicates with the interior of the crank-case through a port in the cylinder wall which port is covered by the piston during the whole of that part of the movement of the piston between those two positions in which, respectively, the main entry port and the additional entry port are first uncovered by the piston.

In another preferred embodiment of an engine of either of these types and according to the invention, the additional entry port opens into an otherwise closed reservoir and the side of the piston is formed with a slot or aperture such that during part of the combustion stroke, before the main entry port is uncovered by the piston, the reservoir is in communication through the slot or aperture with the interior of the crank-case whereas at all positions of the piston between those two positions at which, respectively, the main entry port and the additional entry port are first uncovered by the piston and opened to the combustion space, the additional entry port is covered by the piston and the reservoir is thereby isolated from the interior of the crank-case.

Preferably, for the reasons outlined above, the face of the piston is concave and scavenging air is directed downwardly through the main and the additional entry ports and towards a part of the cylinder wall directly opposite the exhaust port.

Preferably, also, all the ports lie in a single ring about the cylinder, and those of their edges which are remote from the cylinder head lie in a common plane which is normal to the axis of the cylinder.

In either case, therefore, the duct or reservoir respectively, in communication with the additional entry port is filled with air under pressure during part of the compression stroke, before the main entry port is uncovered by the piston and opened to the combustion space, but during the short interval between the opening the main entry port and the opening of the additional entry port to the combustion space, the duct or reservoir is shut off from the interior of the crankcase. Therefore, when the pressure in the crankcase falls, due to the opening of the main entry port and the admission of the charge into the cylinder, the pressure reduction does not affect the duct or reservoir for the additional entry port, which serves as a reservoir of air under pressure until the additional entry port is opened and the air is released into the cylinder, where due to its momentum in a direction away from the exhaust port, it prevents, or at least substantially reduces, loss of charge due to the momentary negative exhaust pressure.

If the piston face is concave, the cylinder head is preferably convex, in order to reduce the dead space at the top of the cylinder. It is of advantage, however, if the part of the cylinder head from which the sparking plug or fuel-injection nozzle, as the case may be protrudes is recessed relative to the generally convex form. This provides, in the region where combustion begins, a small and compact dead-space which is advantageous in light running of the engine.

The number of exhaust, main entry and/or additional entry ports provided may, of course, be greater than one.

Two embodiments of the invention are shown by way of illustration in the accompanying drawings, in which:

Figure 1 shows a diagrammatic perspective view of a cylinder of an engine according to the invention, with part of the cylinder wall broken away to show the interior,

Figure 2 is a diagrammatic cross-section of the cylinder at the level of the ports,

Figure 3 is a diagrammatic vertical section through the cylinder and the cylinder head, to show the piston and the ports,

Figure 4 is a vertical sectional view of a second embodiment of an engine according to the invention,

Figure 5 is a cross-sectional view taken on the line V—V of Figure 4, and

Figure 6 is a vertical sectional fractional view taken on the line VI—VI of Figure 5, respective left- and right-hand halves of Figure 6 showing a piston of the engine at the end of its combustion stroke and at an earlier point during that stroke.

In Figure 1, the interior of a cylinder **10**, provided with a cylinder head **20**, may be seen through the broken-away cylinder wall. The concave upper face **11** of a piston **21** may be seen in its lowest position and the general arrangement of two exhaust ports **12**, two main entry ports **13** on either side of the exhaust ports and an additional entry port **14** between the exhaust ports is also shown.

The main entry ports **13** and ducts **13***a* which connect with them from outside the cylinder are formed to direct the fresh charge downwardly into the concave face of the piston **11** and backwardly towards the rear wall of the cylinder **10**, as shown by the arrows **15**. The charge is then deflected upwardly against the rear wall and into the upper part of the cylinder, as shown by the continuation **15***a* of the arrows **15**. The additional entry port **14** also directs the additional charge downwardly on the concave piston face and backwardly towards the rear wall of the cylinder. The heights of the ports are such that as the piston descends during its combustion stroke, the ports are opened in the order **12**, **13**, **14** and are preferably such that the port **14** opens as the exhaust pressure at the ports **12** goes momentarily negative.

The ports **12**, **13** and **14** in the wall of the cylinder point downwardly into the concave face **11** of the piston. The exhaust ports **12** open outwardly into exhaust ducts **22**. The ports **13** open outwardly into the ducts **13***a* which in turn open into lower ports **23** in the lower end of the cylinder, and the skirt of the piston **21** has a corresponding slot or window **23***a* such that the port **23** is in communication with the interior of the cylinder and the crankcase **19**, of which only a part is shown and which constitutes a container for scavenging air under pressure, when the ports **13** are opened and for a sufficient length of time before. The port **14** opens outwardly into a duct **14***a* which in turn opens into a lower port **24** (shown in Figure 3 but not in Figure 1) in the cylinder wall. A corresponding window **24***a* in the skirt of the piston provides that the port **24** is opened to the interior of the crank-case during part of the descent of the piston, but is closed between the moments of opening of the ports **13** and the port **14**.

The inner surface of the cylinder head **20** is convex except in the vicinity of a fuel injection nozzle or, as in the engine illustrated in Figure 1, a sparking plug **25**, where it is recessed.

The operation of the engine has been explained above, but it may be noted in addition that the small additional charge introduced into the cylinder through the additional entry port **14** tends to remain in the concavity of the piston face, ensuring that when the piston ascends and compresses the charge, the part of the charge in the immediate vicinity of the fuel injection nozzle (or the sparking plug **25**, as the case may be) is relatively uncontaminated by residual unexpelled exhaust gases from the previous cycle.

In the diagrammatic transverse section of the cylinder shown in Figure 2, the backward-pointing direction of the main transfer ports **13** may be seen.

Figure 3, which is a diagrammatic vertical section of the cylinder and cylinder head, shows ports **12**, **13** and **14** and the piston **21** formed with a concave face **11**.

The engine illustrated in Figures 4, 5 and 6 comprises an externally-finned cylinder block **30** to the upper end of which is secured an externally-finned cylinder head **31** provided with a sparking plug **32**. The cylinder block **30** is secured in position on a crank-case block **33**, which serves as a container for scavenging air under pressure and within which a crankshaft **34** is journalled in bearings **35**. On the crankshaft **34** is journalled the big end of a piston rod **36**, of which the little end is journalled within a piston **37** which is reciprocable within the cylinder formed within the cylinder block **30**.

An exhaust port **38** leads from the cylinder into an exhaust duct **39** (see Figure 5). The main entry ports **40** in the wall of the cylinder are in communication through a pair of ducts or channels **41**, formed within the cylinder block **30** and the crank-case block **33**, with corresponding ports **42** opening from the interior of the crank-case. Also formed in the wall of the cylinder are a pair of additional entry ports **43**, through which the cylinder is in communication with a pair of reservoirs **44** formed in the cylinder block **30** and closed at their ends remote from the ports **43** by a pair of plugs **45**.

The face of the piston **37** is concave and the reservoirs **45** and the ducts **41**, in the vicinity of the ports **40**, are directed downwardly so that air entering the cylinder is directed on to the face of the piston and (as can be seen in Figure 6) towards the part of the cylinder wall which is remote from the exhaust port **38**.

The lower edge of the skirt of the piston is slotted at **46**, whereby the ports **42** remain uncovered even when the piston is at its lowest position. The side of the piston is further formed with two ports **47**, whereby, during a part of the stroke of the piston whilst the main entry ports **40** are covered, the additional entry ports are uncovered and the reservoirs **44** are in communication not with the combustion space above the piston but with the interior of the crank-case, below the piston, as is shown in the right-hand half of Figure 6.

Briefly, the working cycle is as follows: As the piston **30** rises from its lowest position, the ports **43**, **40** and **38** are closed in that order, and the charge of scavenging air (as it has been termed in this specification, though it is in fact a fuel-air mixture) is compressed within the cylinder and is ignited by means of the sparking plug **32** at the appropriate moment, after which the piston descends again. However, whilst the piston is still rising, air is drawn into the space behind it, either through an inlet port or valve (not shown) or from blower or compressor means (also not shown). As the piston then descends, the air behind the piston and in the ducts **41** is compressed, and, as the ports **47** of the piston skirt pass the additional entry ports **43**, the reservoirs **44** are also filled with compressed air before the ports **43** are again covered, when the reservoirs **44** are again isolated. As the piston **37** continues to descend, first the exhaust port **38**, by virtue of its greater height, is uncovered to allow the escape of the exhaust gases, and then the main entry

ports 40 are uncovered, allowing the compressed air in the ducts 40 and below the cylinder to discharge into the cylinder and drive out the exhaust gases still remaining there.

As explained the outrushing exhaust gas tends to cause a momentary negative pressure behind it, and to draw some of the new charge out of the cylinder through the exhaust port 38, or, alternatively, to re-enter the cylinder itself. However, as the piston continues to descend, and preferably at about the moment when the pressure goes negative, the additional entry ports 43 are uncovered and the compressed air contained in the reservoirs 44 enters the cylinder and, due to its momentum in a direction away from the exhaust port, prevents, or at least substantially reduces, the negative-pressure effect, thus ensuring a virtually complete expulsion of the exhaust gas and an equally complete re-charging of the cylinder with fresh fuel-air mixture, so that a fully effective filling is obtained, without loss of charge through the exhaust port.

The direction of movement of the piston then again reverses, and the working cycle is repeated.

It will be appreciated that the number and the arrangement of the ports may be varied within the scope of the invention, and that although, in the two embodiments which have been described by way of example, the crankcase is used as a scavenging air receiver, this is not an essential feature of the invention, which may be incorporated with any of the known arrangements for providing a supply of scavenging air.

It will further be apparent that although, in the two illustrated embodiments of the invention, the air drawn into the crank-case behind the piston contains an admixture of fuel provided by carburettor means (not shown in the drawings), the invention is equally applicable in port-controlled two-stroke engines of the fuel-injection type, and is of great utility in both petrol and diesel engines.

What I claim is:

1. A port-controlled two-stroke internal combustion engine comprising a cylinder, a cylinder head, a piston reciprocable in the cylinder and, within the cylinder, a combustion space defined between the cylinder head and a face of the piston, there being provided in the wall of the cylinder at least one exhaust port and at least one main entry port for scavenging gas, these ports being so located that they are first uncovered by the piston and opened to the combustion space during the latter part of the combustion stroke of the piston, and there being provided in communication with the main entry port a container which is adapted to contain, and to supply to the main entry port, scavenging gas under pressure, wherein there is further provided in the wall of the cylinder at least one additional entry port which is more remote from the cylinder head than is the said main entry port and is thereby first uncovered by the piston and opened to the combustion space at a correspondingly later time during the combustion stroke, there being also provided in communication with the additional entry port reservoir means which is in communication with the said container during one part of the combustion stroke of the piston, and which is isolated from the said container during the whole of a later part of the combustion stroke during which later part the piston moves between those two positions of the piston in which, respectively, the main entry port and the additional entry port are first uncovered by the piston and opened to the combustion space.

2. A port-controlled two-stroke internal combustion engine comprising a cylinder, a cylinder head, a piston reciprocable in the cylinder, a crankcase, and, within the cylinder, a combustion space defined between the cylinder head and a face of the piston, there being provided in the wall of the cylinder at least one exhaust port and at least one main entry port for scavenging gas, these ports being so located that they are first uncovered by the piston and opened to the combustion space during the latter part of the combustion stroke of the piston and the crankcase being in communication with the main entry port and adapted to receive, and to supply to the main entry port, scavenging gas, under pressure, wherein there is further provided in the wall of the cylinder at least one additional entry port which is more remote from the cylinder head than is the said main entry port and is thereby first uncovered by the piston and opened to the combustion space at a correspondingly later time during the combustion stroke, there being also provided in communication with the additional entry port reservoir means which is in communication with the crankcase during one part of the combustion stroke of the piston and which is isolated from the crankcase during the whole of a later part of the combustion stroke during which later part the piston moves between those two positions of the piston in which, respectively, the main entry port and the additional entry port are first uncovered by the piston and opened to the combustion space.

3. A port-controlled two-stroke internal combustion engine comprising a cylinder, a cylinder head, a piston reciprocable in the cylinder, a crankcase adapted to have drawn into it, and compressed within it by the piston during the combustion stroke thereof, gas for use in the engine as scavenging gas and, within the cylinder, a combustion space defined between the cylinder head and a face of the piston, there being provided in the wall of the cylinder at least one exhaust port and at least one main entry port for scavenging gas, these ports being so located that they are first uncovered by the piston and opened to the combustion space during the latter part of the combustion stroke of the piston and the crankcase being in communication with the main entry port and adapted to contain, and to supply to the main entry port, the scavenging gas under pressure, wherein there is further provided in the wall of the cylinder at least one additional entry port which is more remote from the cylinder head than is the said main entry port and is thereby first uncovered by the piston and opened to the combustion space at a correspondingly later time during the combustion stroke, there being also provided in communication with the additional entry port reservoir means which is in communication with the crankcase during one part of the combustion stroke of the piston and which is isolated from the said container during the whole of a later part of the combustion stroke during which later part the piston moves between those two positions of the piston in which, respectively, the main entry port and the additional entry port are first uncovered by the piston and opened to the combustion space.

4. An engine as claimed in claim 2, wherein the said reservoir means is a duct having two ends constituted respectively by the additional entry port and by another port so located in the cylinder wall as to be uncovered by, and more remote from the cylinder head than the face of, the piston during the said one part of the combustion stroke thereof, and thereby in communication with the said crankcase, and to be covered by the piston, and thereby isolated from the crankcase, during the whole of the said later part of the combustion stroke of the piston.

5. An engine as claimed in claim 3, wherein the said reservoir means is a duct having two ends constituted respectively by the additional entry port and by another port so located in the cylinder wall as to be uncovered by, and more remote from the cylinder head than the face of, the piston during the said one part of the combustion stroke thereof, and thereby in communication with the said crankcase, and to be covered by the piston and thereby isolated from the crankcase, during the whole of the said later part of the combustion stroke of the piston.

6. An engine as claimed in claim 2, wherein the said reservoir means which communicates with the additional entry port is otherwise closed, and the side of the piston is formed with an opening through which, during the said one part of the combustion stroke, the reservoir is in communication with the interior of the crankcase whereas

during the whole of the said later part of the combustion stroke the additional entry port is covered by the piston and the reservoir means is thereby isolated from the interior of the crankcase.

7. An engine as claimed in claim 3, wherein the said reservoir means which communicates with the additional entry port is otherwise closed, and the side of the piston is formed with an opening through which, during the said one part of the combustion stroke, the reservoir is in communication with the interior of the crankcase whereas during the whole of the said later part of the combustion stroke the additional entry port is covered by the piston and the reservoir means is thereby isolated from the interior of the crankcase.

8. A port-controlled two-stroke internal combustion engine comprising a cylinder, a cylinder head, a piston reciprocable in the cylinder, a crankcase, and, within the cylinder, a combustion space defined between the cylinder head and a face of the piston, there being provided in the wall of the cylinder at least one exhaust port and at least one main entry port for scavenging gas, these ports being so located that they are first uncovered by the piston and opened to the combustion space during the latter part of the combustion stroke of the piston and the crankcase being in communication with the main entry port and adapted to receive, and to supply to the main entry port, scavenging gas under pressure, wherein there is further provided in the wall of the cylinder at least one additional entry port which is more remote from the cylinder head than is the said main entry port and is thereby first uncovered by the piston and opened to the combustion space at a correspondingly later time during the combustion stroke, there being also provided a duct having two ends constituted respectively by the additional entry port and by another port so located in the cylinder wall as to be uncovered by, and more remote from the cylinder head than the face of, the piston during one part of the combustion stroke thereof and thereby in communication with the said crankcase, and to be covered by the piston, and thereby isolated from the crankcase during the whole of a later part of the combustion stroke during which later part the piston moves between those two positions of the piston in which, respectively, the main entry port and the additional entry port are first uncovered by the piston and opened to the combustion space, whereby reduction of the pressure of the gas in the crankcase, due to uncovering of the main entry port by the piston, is prevented from significantly reducing the pressure of the gas within the said duct prior to the additional entry port being in turn uncovered by the piston and opened to the combustion space.

9. A port-controlled two-stroke internal combustion engine comprising a cylinder, a cylinder head, a piston reciprocable in the cylinder, a crankcase adapted to have drawn into it, and compressed within it by the piston during the combustion stroke thereof, gas for use in the engine as scavenging gas and, within the cylinder, a combustion space defined between the cylinder head and a face of the piston, there being provided in the wall of the cylinder at least one exhaust port and at least one main entry port for scavenging gas, these ports being so located that they are first uncovered by the piston and opened to the combustion space during the latter part of the combustion stroke of the piston and the crankcase being in communication with the main entry port and adapted to contain, and to supply to the main entry port, scavenging gas under pressure, wherein there is further provided in the wall of the cylinder at least one additional entry port which is more remote from the cylinder head than is the said main entry port and is thereby first uncovered by the piston and opened to the combustion space at a correspondingly later time during the combustion stroke, there being also provided a duct having two ends constituted respectively by the additional entry port and by another port so located in the cylinder wall as to be uncovered by, and more remote from the cylinder head than the face of, the piston during one part of the combustion stroke thereof and thereby in communication with the said crankcase, and to be covered by the piston, and thereby isolated from the crankcase during the whole of a later part of the combustion stroke during which later part the piston moves between those two positions of the piston in which, respectively, the main entry port and the additional entry port are first uncovered by the piston and opened to the combustion space, whereby reduction of the pressure of the gas in the crankcase, due to uncovering of the main entry port by the piston, is prevented from significantly reducing the pressure of the gas within the said duct prior to the additional entry port being in turn uncovered by the piston and opened to the combustion space.

10. A port-controlled two-stroke internal combustion engine comprising a cylinder, a cylinder head, a piston reciprocable in the cylinder, a crankcase, and, within the cylinder, a combustion space defined between the cylinder head and a face of the piston, there being provided in the wall of the cylinder at least one exhaust port and at least one main entry port for scavenging gas, these ports being so located that they are first uncovered by the piston and opened to the combustion space during the latter part of the combustion stroke of the piston and there being provided in communication with the main entry port a container which is adapted to receive, and to supply to the main entry port, scavenging gas under pressure, wherein there is further provided in the wall of the cylinder at least one additional entry port which is more remote from the cylinder head than is the said main entry port and is thereby first uncovered by the piston and opened to the combustion space at a correspondingly later time during the combustion stroke, there being also provided in communication with the additional entry port a reservoir which is otherwise closed, the piston being formed in its side with an opening through which, during one part of the combustion stroke of the piston, the additional entry port is in communication with the crankcase whereas during the whole of a later part of the combustion stroke during which later part the piston moves between those two positions of the piston in which, respectively, the main entry port and the additional entry port are first uncovered by the piston and opened to the combustion space, whereby reduction of the pressure of the gas in the crankcase, due to uncovering of the main entry port by the piston, is prevented from significantly reducing the pressure of the gas within the said reservoir prior to the additional entry port being in turn uncovered by the piston and opened to the combustion space.

11. A port-controlled two-stroke internal combustion engine comprising a cylinder, a cylinder head, a piston reciprocable in the cylinder, a crankcase, adapted to have drawn into it, and compressed within it by the piston during the combustion stroke thereof, gas for use in the engine as scavenging gas and, within the cylinder, a combustion space defined between the cylinder head and a face of the piston, there being provided in the wall of the cylinder at least one exhaust port and at least one main entry port for scavenging gas, these ports being so located that they are first uncovered by the piston and opened to the combustion space during the latter part of the combustion stroke of the piston and there being provided in communication with the main entry port a container which is adapted to contain, and to supply to the main entry port, scavenging gas under pressure, wherein there is further provided in the wall of the cylinder at least one additional entry port which is more remote from the cylinder head than is the said main entry port and is thereby first uncovered by the piston and opened to the combustion space at a correspondingly later time during the combustion stroke, there being also provided in communication with the additional entry port a

reservoir which is otherwise closed, the piston being formed in its side with an opening through which, during one part of the combustion stroke of the piston, the additional entry port is in communication with the crankcase whereas during the whole of a later part of the combustion stroke during which later part the piston moves between those two positions of the piston in which, respectively, the main entry port and the additional entry port are first uncovered by the piston and opened to the combustion space, whereby reduction of the pressure of the gas in the crankcase, due to uncovering of the main entry port by the piston, is prevented from significantly reducing the pressure of the gas within the said reservoir prior to the additional entry port being in turn uncovered by the piston and opened to the combustion space.

References Cited in the file of this patent

UNITED STATES PATENTS

960,797	Blair	June 7, 1910
1,530,864	Vaughan	Mar. 24, 1925

FOREIGN PATENTS

759,044	France	Nov. 7, 1933
441,668	Great Britain	Jan. 23, 1936
566,458	Great Britain	Jan. 1, 1945
699,393	Great Britain	Nov. 4, 1953
641,847	Germany	Feb. 15, 1937