Oct. 20, 1936. P. W. PETTER 2,058,350

TWO-STROKE INTERNAL COMBUSTION ENGINE

Filed April 11, 1936 3 Sheets-Sheet 1

Fig. 1.

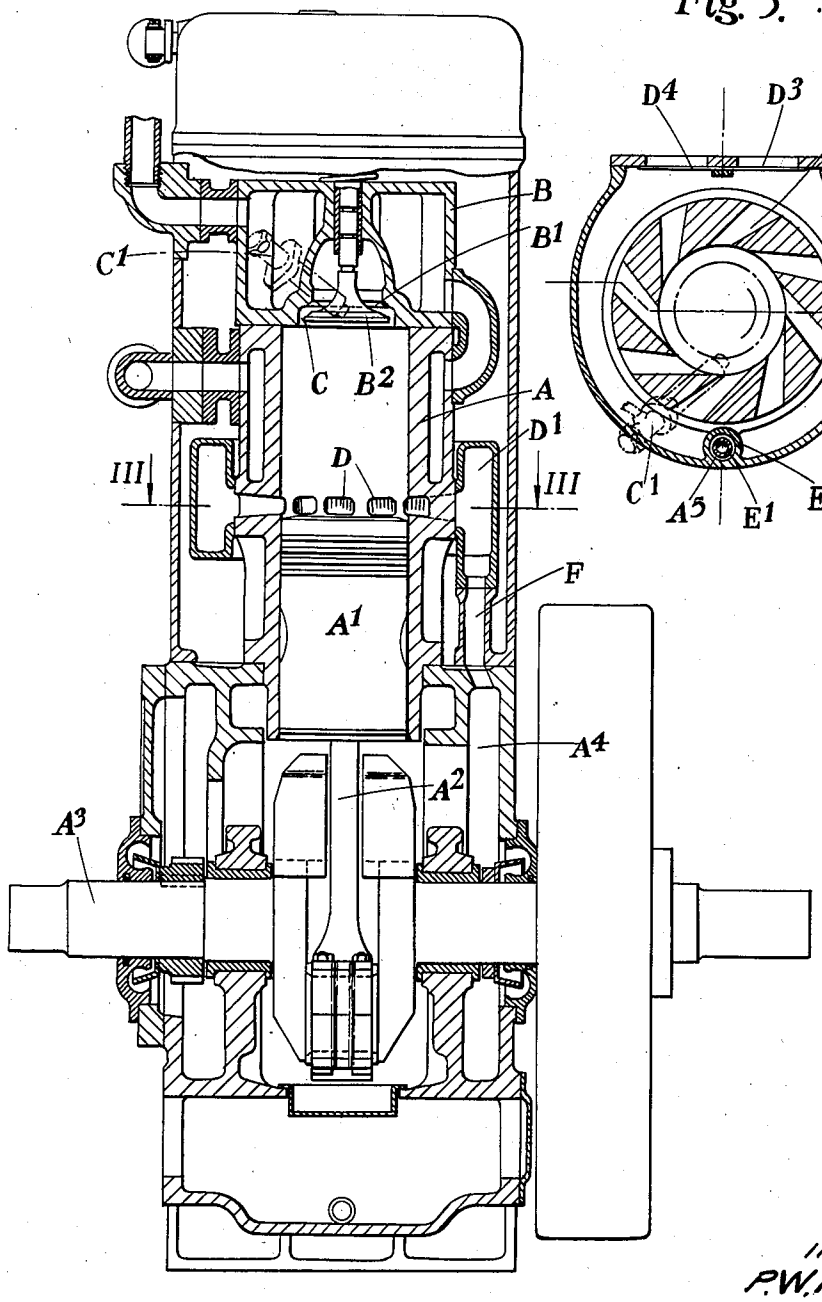


Fig. 3.

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TWO-STROKE INTERNAL COMBUSTION ENGINE

Filed April 11, 1936 3 Sheets-Sheet 2

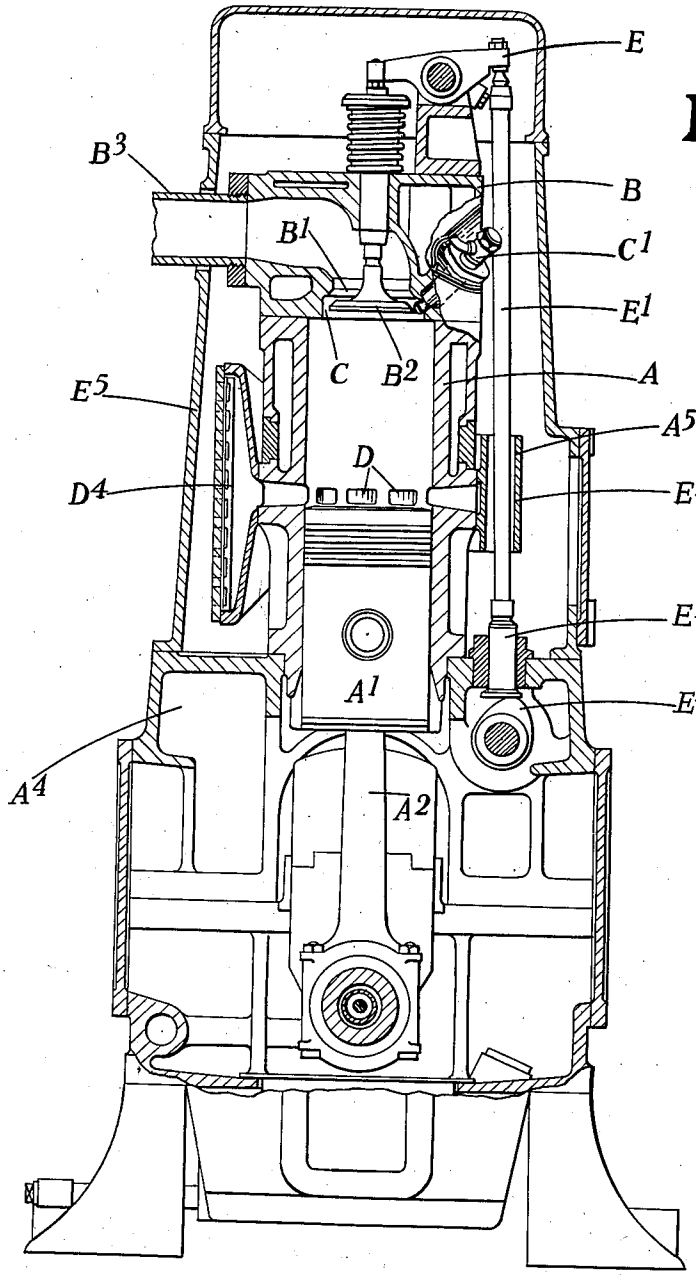


Fig. 2.

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Fig. 4.

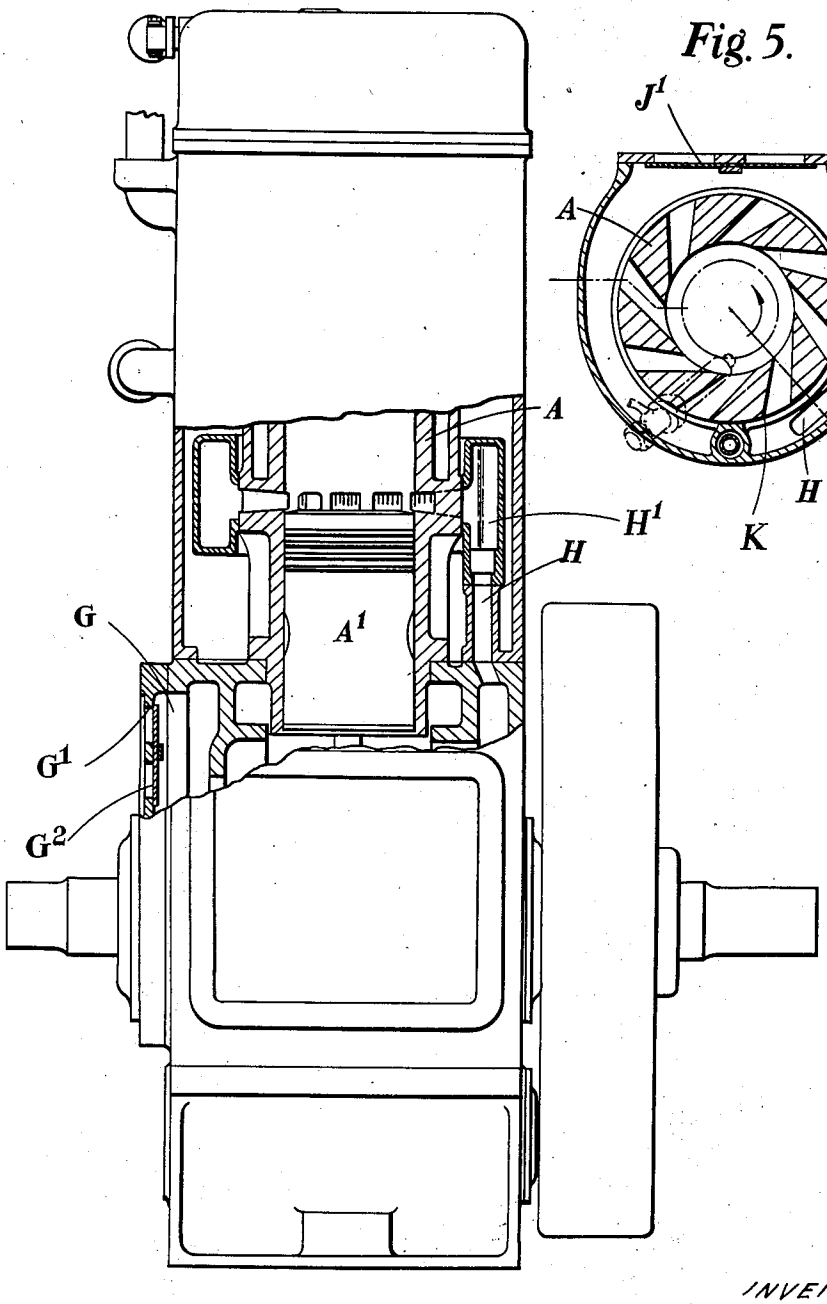


Fig. 5.

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Patented Oct. 20, 1936

2,058,350

UNITED STATES PATENT OFFICE

2,058,350

TWO-STROKE INTERNAL COMBUSTION ENGINE

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Application April 11, 1936, Serial No. 73,945
In Great Britain April 25, 1935

12 Claims. (Cl. 123—65)

This invention relates to two-stroke internal combustion engines and has for its main object to provide an improved construction of the kind in which the suction effect created by the exhaust gases flowing out of the working chamber is utilized during normal running to induce the succeeding charge into the cylinder.

When an engine of this type is being started, that is to say is operating at low speed, the suction effect of the outflowing exhaust gases may not be enough to ensure efficient evacuation, scavenging and induction of the new charge. This difficulty may arise also when the engine is desired occasionally to deal with peak loads causing a temporary reduction in speed. Another object of the present invention is to overcome difficulty arising in such cases.

A two-stroke internal combustion engine according to the present invention is furnished with an air inlet port or ports in the cylinder wall, and a transfer passage through which the said air inlet port or ports, or a port or ports in the cylinder wall and independent of the said air inlet port or ports in the cylinder wall, are in open communication with the crank case into which air is drawn and compressed without intermission at all engine speeds, air being supplied to the cylinder not only indirectly from the crank case through the transfer passage but also directly through the said air inlet ports from an external source, that is to say without previous compression in the crank case. The exhaust gases are preferably discharged from the working chamber through an exhaust port in the cylinder head and controlled by a positively operated exhaust valve, the air being conveniently supplied to the cylinder through a set of air inlet ports which substantially completely surround the cylinder.

Preferably, however, the air inlet port or ports are in open communication, through the transfer passage, with the crank case, and a breather port is provided controlled by a non-return valve past which air can flow from the atmosphere to the air inlet port or ports and to the transfer passage, the crank case being sealed so that crank case compression takes place at all engine speeds.

The invention may be applied to engines of the vaporized charge spark ignition type or to engines of the compression ignition type, but one construction according to the invention and as applied to an engine of the compression ignition type is illustrated by way of example in the accompanying drawings, in which

Figure 1 illustrates the engine partly in vertical section in a plane containing the crankshaft,

Figure 2 is a vertical section at right angles to the crankshaft,

Figure 3 is a sectional plan on the line III—III of Figure 1, but with the outer casing of the cylinder omitted,

Figure 4 is a view similar to that shown in Figure 1 but of a modified construction, and

Figure 5 is a sectional plan through the cylinder ports of Figure 3.

In the construction illustrated in Figures 1, 2, and 3 the engine comprises a cylinder A in the head B of which is provided an exhaust port B^1 controlled by a positively operated poppet valve B^2, the exhaust port B^1 communicating with an exhaust pipe or conduit B^3. The exhaust port B^1 is arranged in a combustion chamber or pocket C whose diameter is less than that of the cylinder bore, say, approximately two-thirds of the internal diameter of the cylinder A, the fuel being injected tangentially into the combustion chamber C by a fuel injection device indicated at C^1. The piston A^1 is connected by a connecting rod A^2 to a crankshaft A^3, the crank case A^4 being sealed for the purpose hereinafter described. Arranged in the cylinder wall is a set of inlet ports D leading from a common annular passage or gallery D^1 the ports D being controlled by the piston A^1 so as to be uncovered thereby towards the end of its outstroke. The passages leading to the air inlet ports D are directed tangentially inwards with respect to the cylinder as shown in Figure 3, the tangential direction of the said passages being the same as that in which the fuel is injected into the internal combustion chamber C by the fuel injection device C^1. The gallery D^1 is furnished with a breather port D^3 which is controlled by a pressure operated non-return valve D^4 of the plate type so that air can be drawn from the atmosphere through the breather port D^3 past the non-return valve D^4 into the gallery D^1.

The exhaust valve B^2 is positively operated through a rocking lever E from a tappet rod E^1 longitudinally movable in a porthole A^5 formed by a sleeve E^2 passing through the gallery D^1, the rod E^1 bearing at its lower end on a plunker E^3 which bears directly on a cam E^4 driven from the crankshaft of the engine. The cylinder is surrendered by an outer casing E^5 which is provided with a suitable opening or openings for the admission of air to the port D^3. The casing E^5 may act as an air intake silencer.

The timing of the exhaust valve B^2 and the opening of the air inlet ports D and the length of the exhaust conduit B^3 are such that at normal

speed, or within the normal speed range of the engine, each exhaust period substantially coincides with an outward pressure surge in the exhaust pipe B^3. Thus, for example, for an engine having a bore of 4½ inches and a stroke of 6½ inches and the normal speed of which is to be in the region of 1,000 revolutions per minute, the exhaust system may comprise a pipe of substantially constant cross-sectional area and approximately 9 feet in length connected directly to the exhaust port B^1 and leading to an expansion chamber or to the atmosphere or to a further pipe the cross-sectional area of which increases progressively towards its outlet end. The exhaust valve B^2 is opened soon after the piston A^1 has passed its mid-position during the firing stroke, say, 86° of crank angle before the outer dead centre. The outward pressure surge which then takes place in the exhaust conduit B^3 evacuates and produces a depression in the cylinder A. The piston A^1 uncovers the air inlet ports D before the end of the firing stroke, say, 45° prior to the outer dead centre. The air charge now rushes into the previously evacuated cylinder, rotating therein due to the tangential arrangement of the air inlet ports D, and scavenges and recharges the cylinder A with a rotating charge. On the succeeding compression stroke, say, 45° of crank angle after the outer dead centre, both the exhaust port B^1 and the air inlet ports D are closed substantially simultaneously and before the return pressure surge in the exhaust conduit B^3 reaches the exhaust port B^1. The compression stroke now continues, the fuel being injected, say 18° of crank angle before the inner dead centre.

At normal speeds of the engine therefore each induction period takes place only during an outward pressure surge in the exhaust conduit B^3 and the return of the exhaust gases from the conduit B^3 due to an inward pressure surge is prevented. At low speeds or during starting, however, the effect produced by the exhaust gases flowing from the cylinder A through the exhaust conduit B^3 may not be sufficient to ensure effective evacuation, scavenging and recharging of the working chamber.

With a view to overcoming this difficulty the crank case A^4, which is sealed as above indicated, is permanently in open communication with the gallery D^1 through an air transfer passage F the cross-section of which is restricted so as to be less than the cross-section available for the flow of air through the breather port D^3 when the non-return valve D^4 is open. As shown, the upper end of the transfer passage F leads into the gallery D^1 at a point adjacent to the breather port D^3.

At normal speeds of the engine the effect created by the exhaust gas flowing out through the exhaust pipe B^3 will cause a depression within the cylinder A so that when the air inlet ports D are uncovered by the piston A^1 the non-return valve D^4 opens and air flows directly from the atmosphere past the non-return valve D^4 and through the air admission ports D into the cylinder, the air rotating within the cylinder in the direction of the arrow shown in Figure 3, that is to say the same direction as that in which the fuel is injected by the device C^1. At low engine speeds or during starting when the effect of the exhaust gases flowing out through the exhaust pipes B^3 may not be sufficient to cause induction of sufficient air past the non-return valve D^4, air is drawn during the instroke of the piston A^1 past the non-return valve D^4 and through the transfer passage F into the crank case A^4. On the succeeding outstroke of the piston A^1 this air is compressed in the crank case and is delivered under pressure through the transfer passage F and air inlet ports D into the cylinder.

Thus, though crank case compression takes place without intermission at all engine speeds and the delivery of air from the crank case A^4 through the transfer passage F is not therefore interrupted even when the normal engine speed has been attained, the necessary air will, at normal running speeds, flow directly from the atmosphere past the non-return valve D^4 to the air inlet ports D. During starting and low engine speeds however when the suction effect created by the exhaust gases flowing out of the working chamber through the exhaust pipe D^3 is not sufficient to induce the air necessary for effectively scavenging and recharging the working chamber, the necessary air is still supplied under pressure from the crank case A^4 through the transfer passage F.

It will therefore be seen that effective scavenging and recharging of the working chamber is ensured throughout the speed range of the engine whilst the necessity for providing either additional apparatus for supplying air to the engine or means for interrupting the supply of air from the crank case through the transfer passage to the cylinder is obviated. Since, in some instances, there may be a tendency for lubricant to find its way from the crank case through the transfer passage to the air inlet ports, means such for example as a baffle or baffles may be provided, say, in the transfer passage or between the transfer passage and the crank case, for the purpose of preventing the upward flow of lubricant from the crank case through the transfer passage.

In the construction illustrated in Figures 4 and 5 the crank case G is furnished with a breather port G^1 automatically controlled by a non-return valve G^2. The crank chamber communicates through a transfer passage H with a chamber H^1 isolated from the chamber J from which the air, flowing from the atmosphere past a non-return valve J^1, enters the cylinders through main air inlet ports J^2 and tangential passages similar to those described with reference to Figure 3. During normal running air enters the cylinder not only directly from the atmosphere through the main air inlet ports J^2 but also indirectly, under pressure, from the crank chamber through the transfer passage H and auxiliary ports K in the cylinder wall. Though at low engine speeds, however, the suction effect of the exhaust gases flowing out of the cylinder may be insufficient to induce sufficient air through the main air inlet ports J^2, the delivery of air continues from the crank chamber through the auxiliary ports K thereby ensuring satisfactory scavenging and recharging of the cylinder.

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

1. In a two-stroke internal combustion engine of the type in which the suction effect created by the exhaust gases flowing out of the working chamber is utilized during normal running to induce the succeeding charge into the working chamber, in combination, a cylinder having at least one air inlet port in the wall thereof and at least one exhaust port, a piston arranged to reciprocate within the cylinder, and a crank chamber into which air is drawn and compressed without intermission at all engine speeds, the crank chamber being in open communication, through a transfer passage, with a port in the

cylinder wall, air being supplied to the cylinder not only indirectly from the crank chamber through the transfer passage but also directly through the inlet port in the cylinder wall from an external source.

2. In a two-stroke internal combustion engine of the type in which the suction effect created by the exhaust gases flowing out of the working chamber is utilized during normal running to induce the succeeding charge into the working chamber, in combination, a cylinder having at least one inlet port in the wall thereof and at least one exhaust port, a non-return valve past which air can flow from the atmosphere to the said inlet port, a piston arranged to reciprocate within the cylinder, and a sealed crank chamber in open communication, through a transfer passage, with a port in the cylinder wall, air flowing past the non-return valve not only into the cylinder but also through the transfer passage into the crank chamber and from which air is delivered back under pressure through the transfer passage to the cylinder, the air being thus drawn into and delivered from the crank chamber without intermission at all engine speeds.

3. In a two-stroke internal combustion engine of the type in which the suction effect created by the exhaust gases flowing out of the working chamber is utilized during normal running to induce the succeeding charge into the working chamber, in combination, a cylinder having at least one inlet port in the wall thereof and at least one exhaust port, a non-return valve past which air can flow from the atmosphere to the said inlet port, a piston arranged to reciprocate within the cylinder, and a sealed crank chamber in open communication with a port in the cylinder wall through a transfer passage the cross-section available for the flow of air through which is less than the cross-section available for the flow of air past the non-return valve when this is open, air flowing past the non-return valve not only into the cylinder but also through the transfer passage into the crank chamber from which air is delivered back under pressure through the transfer passage to the cylinder, the air being thus drawn into and delivered from the crank chamber without intermission at all engine speeds.

4. In a two-stroke internal combustion engine of the type in which the suction effect created by the exhaust gases flowing out of the working chamber is utilized during normal running to induce the succeeding charge into the working chamber, in combination, a cylinder having at least one main inlet port in the wall thereof and at least one exhaust port, a piston arranged to reciprocate within the cylinder, a crank chamber having a breather port, and a non-return valve past which air can flow from the atmosphere through the said breather port into the crank chamber which is in open communication, through a transfer passage, with at least one auxiliary air inlet port in the cylinder wall and independent of the said main air inlet port, air being supplied to the cylinder not only directly through the main air inlet port in the cylinder wall from an external source, but also indirectly from the crank chamber through the transfer passage and auxiliary air inlet port, air being drawn past the non-return valve into the crank case, compressed therein and delivered to the auxiliary inlet port without intermission at all engine speeds.

5. In a two-stroke internal combustion engine of the type in which the suction effect created by the exhaust gases flowing out of the working chamber is utilized during normal running to induce the succeeding charge into the working chamber, in combination, a cylinder having at least one air inlet port in the wall thereof and at least one exhaust port, a piston arranged to reciprocate within the cylinder, and a crank chamber into which air is drawn and compressed without intermission at all engine speeds, the crank chamber being in open communication, through a transfer passage, with the said air inlet port in the cylinder wall, air being supplied to the cylinder not only indirectly from the crank chamber through the transfer passage to the air inlet port, but also directly through the said air inlet port from an external source.

6. In a two-stroke internal combustion engine of the type in which the suction effect created by the exhaust gases flowing out of the working chamber is utilized during normal running to induce the succeeding charge into the working chamber, in combination, a cylinder having at least one inlet port in the wall thereof and at least one exhaust port, a non-return valve past which air can flow from the atmosphere to the said inlet port, a piston arranged to reciprocate within the cylinder, and a sealed crank chamber in open communication, through a transfer passage, with the said inlet port in the cylinder wall, air being drawn past the non-return valve not only into the cylinder but also through the transfer passage to the crank chamber from which air is delivered back under pressure through the transfer passage to the cylinder, the air being thus drawn into and delivered from the crank chamber without intermission at all engine speeds.

7. In a two-stroke internal combustion engine of the type in which the suction effect created by the exhaust gases flowing out of the working chamber is utilized during normal running to induce the succeeding charge into the working chamber, in combination, a cylinder having at least one inlet port in the wall thereof and at least one exhaust port, a non-return valve past which air can flow from the atmosphere to the said inlet port, a piston arranged to reciprocate within the cylinder, and a sealed crank chamber in open communication with the said air inlet port in the cylinder wall through a transfer passage the cross-section available for the flow of air through which is less than the cross-section available for the flow of air past the non-return valve, air flowing past the non-return valve not only into the cylinder but also through the transfer passage into the crank chamber from which air is delivered back under pressure through the transfer passage to the cylinder, the air being thus drawn into and delivered from the crank chamber without intermission at all engine speeds.

8. In a two-stroke internal combustion engine of the type in which the suction effect created by the exhaust gases flowing out of the working chamber is utilized during normal running to induce the succeeding charge into the working chamber, in combination, a cylinder having at least one air inlet port in the wall thereof and at least one exhaust port in the cylinder head, a positively operated exhaust valve controlling the said exhaust port, a piston arranged to reciprocate within the cylinder, and a crank chamber into which air is drawn and compressed without intermission at all engine speeds, the crank chamber being in open communication, through a transfer passage, with at least one port in the cylinder wall,

air being supplied to the cylinder not only indirectly from the crank chamber through the transfer passage but also directly through the inlet port in the cylinder wall from an external source.

9. In a two-stroke internal combustion engine of the type in which the suction effect created by the exhaust gases flowing out of the working chamber is utilized during normal running to induce the succeeding charge into the working chamber, in combination, a cylinder having at least one air inlet port in the wall thereof and at least one exhaust port in the cylinder head, a positively operated exhaust valve controlling the said exhaust port, a piston arranged to reciprocate within the cylinder, and a crank chamber into which air is drawn and compressed without intermission at all engine speeds, the crank chamber being in open communication, through a transfer passage, with the said air inlet port in the cylinder wall, air being supplied to the cylinder not only indirectly from the crank chamber through the transfer passage to the air inlet port, but also directly through the said air inlet port from an external source.

10. In a two-stroke internal combustion engine of the type in which the suction effect created by the exhaust gases flowing out of the working chamber is utilized during normal running to induce the succeeding charge into the working chamber, in combination, a cylinder having air inlet ports in the cylinder wall and extending substantially completely around the cylinder and an exhaust port, a piston arranged to reciprocate within the cylinder, and a crank chamber into which air is drawn and compressed without intermission at all engine speeds, the crank chamber being in open communication, through a transfer passage, with at least one port in the cylinder wall, air flowing into the cylinder not only indirectly from the crank chamber through the transfer passage but also directly through the inlet port in the cylinder wall from an external source.

11. In a two-stroke internal combustion engine of the type in which the suction effect created by the exhaust gases flowing out of the working chamber is utilized during normal running to induce the succeeding charge into the working chamber, in combination, a cylinder having air inlet ports in the wall thereof and extending substantially completely around the cylinder and at least one exhaust port, a non-return valve past which air can flow from the atmosphere to the said inlet ports, a piston arranged to reciprocate within the cylinder, and a sealed crank chamber in open communication, through a transfer passage, with a port in the cylinder wall, air flowing past the non-return valve not only into the cylinder but also through the transfer passage to the crank chamber from which air is delivered back under pressure through the transfer passage to the cylinder, the air being thus drawn into and delivered from the crank chamber without intermission at all engine speeds.

12. In a two-stroke internal combustion engine of the type in which the suction effect created by the exhaust gases flowing out of the working chamber is utilized during normal running to induce the succeeding charge into the working chamber, in combination, a cylinder having main air inlet ports in the wall thereof and extending substantially completely around the cylinder in the wall thereof and at least one exhaust port, a piston arranged to reciprocate within the cylinder, a crank chamber having a breather port, and a non-return valve past which air can flow from the atmosphere through the said breather port, the crank chamber being in open communication, through a transfer passage, with at least one auxiliary air inlet port in the cylinder wall and independent of the said main air inlet port, air flowing to the cylinder not only directly through the main air inlet port in the cylinder wall from an external source, but also indirectly from the crank chamber through the transfer passage and auxiliary air inlet port, air being drawn past the non-return valve into the crank case, compressed therein and delivered to the auxiliary air inlet port without intermission at all engine speeds.

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