

Aug. 6, 1968

O. F. CHRISTNER

3,395,679

TWO-CYCLE ENGINE AND CYLINDER BLOCK THEREFOR

Filed Aug. 17, 1966

3 Sheets-Sheet 1

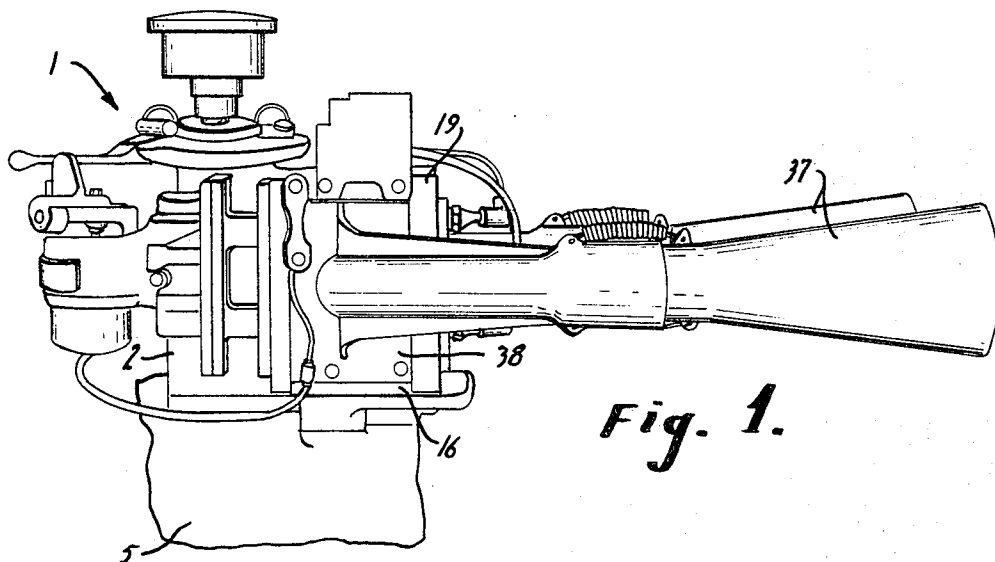


Fig. 1.

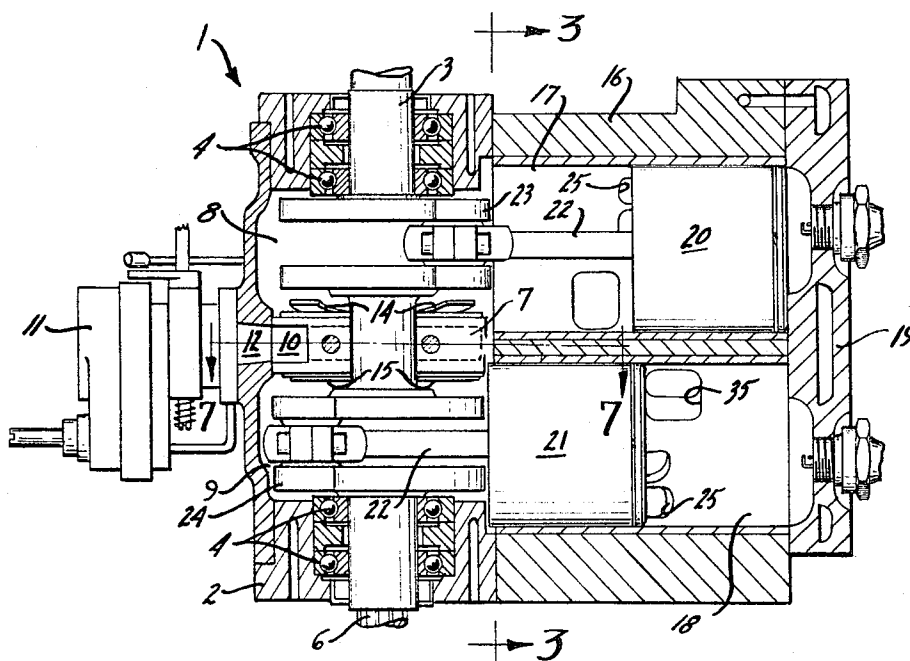


Fig. 2.

INVENTOR
OVAL F. CHRISTNER

BY
Andrus & Starke
ATTORNEYS

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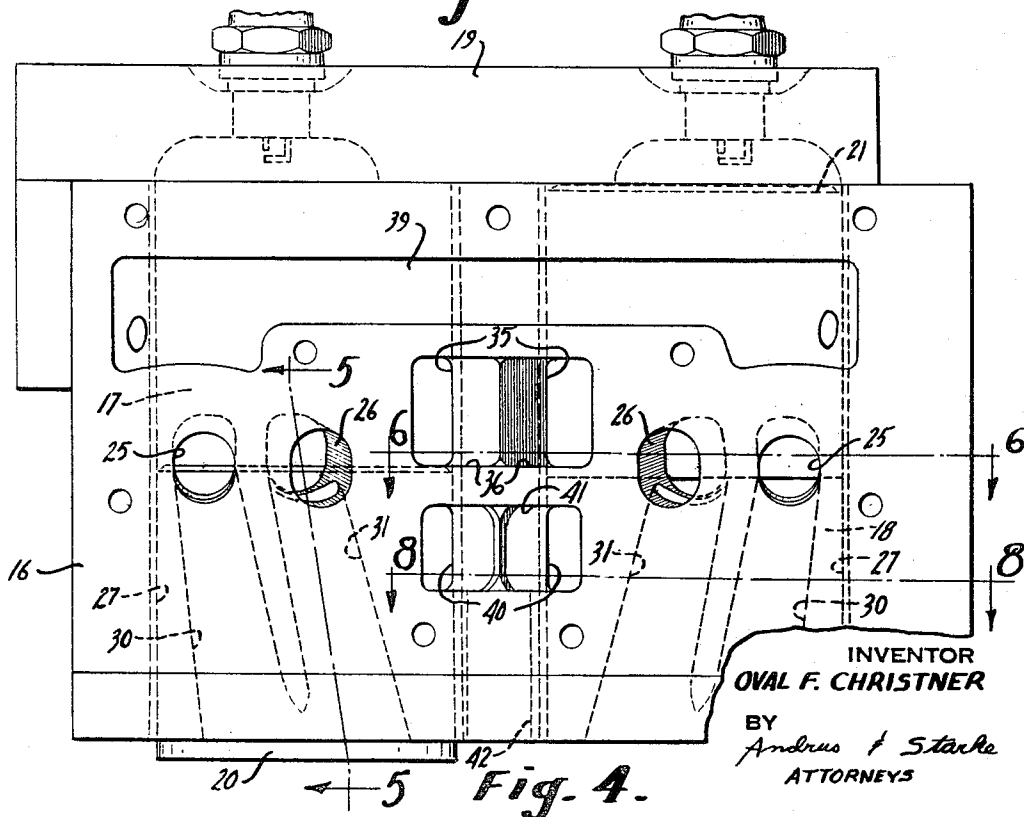
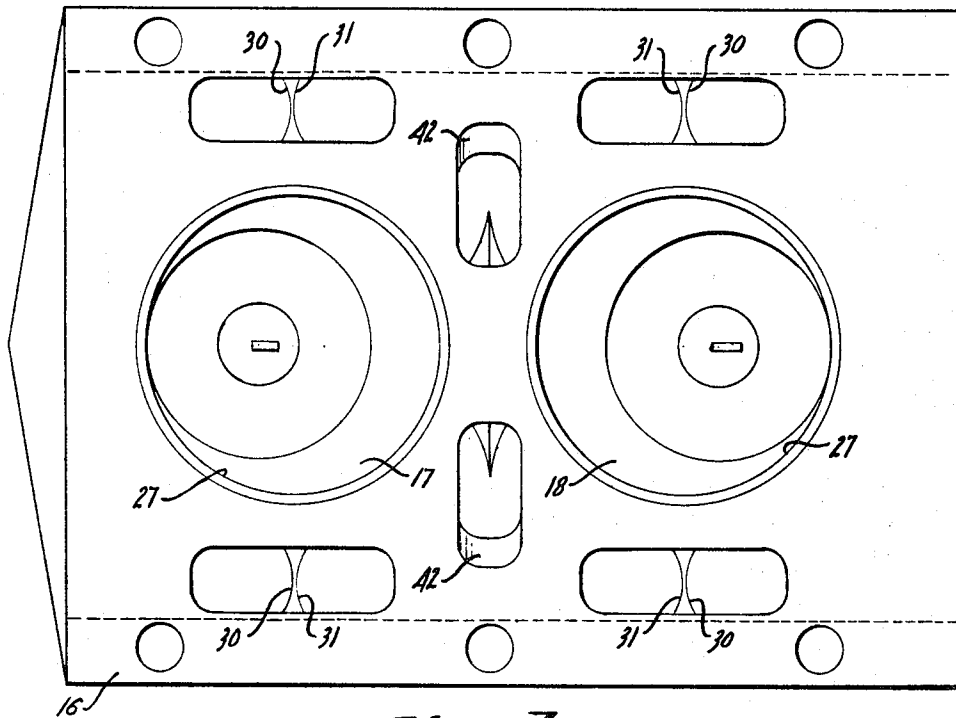
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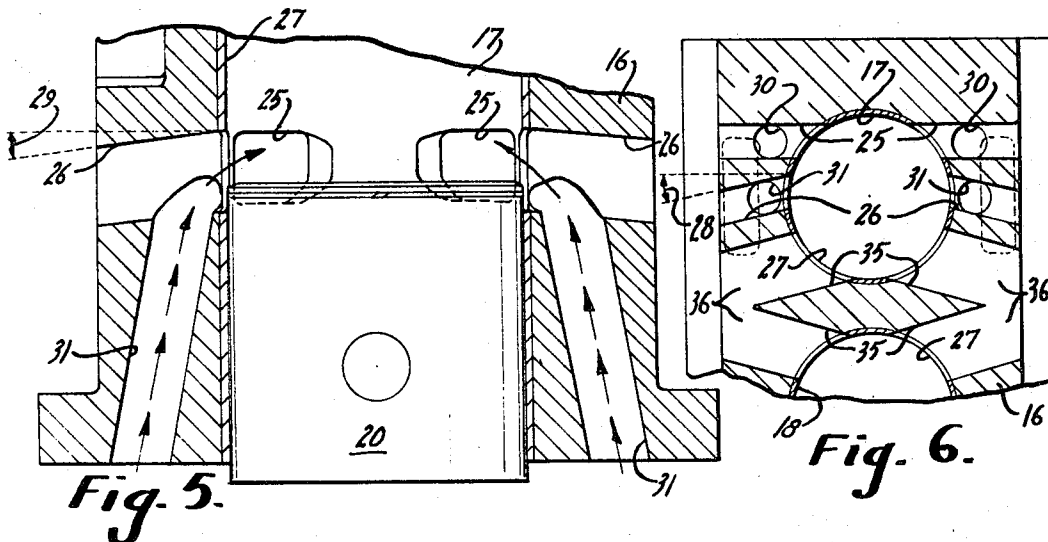
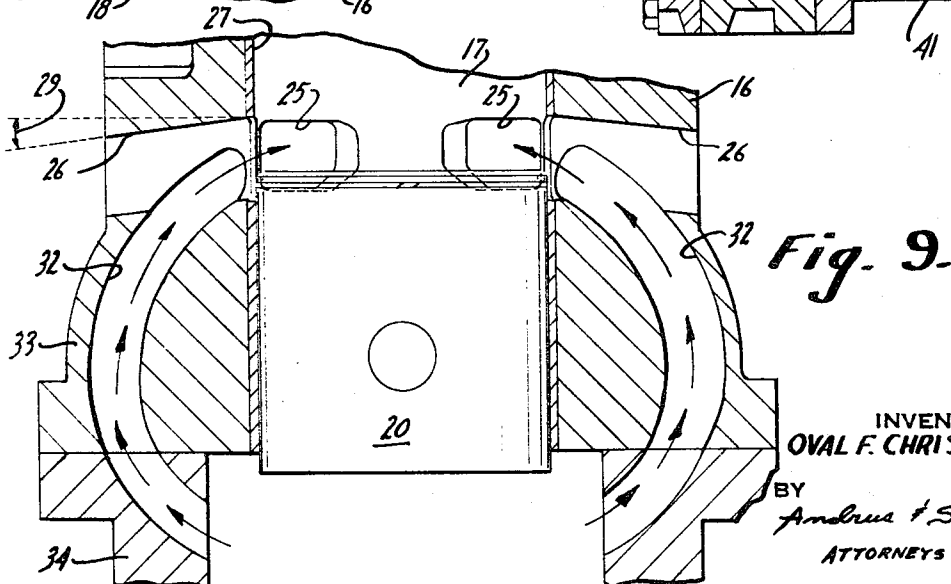
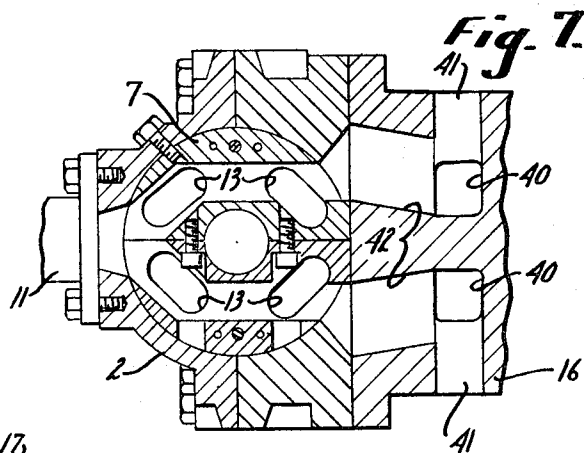
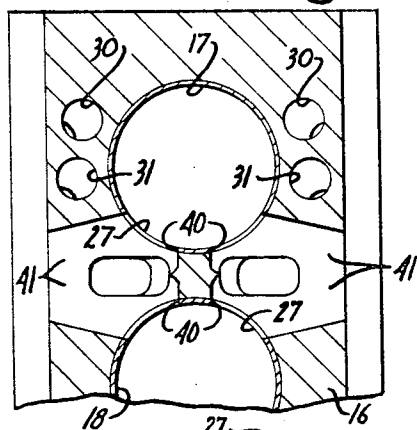


Fig. 8.



INVENTOR
OVAL F. CHRISTNER
BY
Andrus & Starke
ATTORNEYS

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TWO-CYCLE ENGINE AND CYLINDER BLOCK THEREFOR

Oval F. Christner, Quincy, Ill., assignor, by mesne assignments, to Brunswick Corporation, Chicago, Ill., a corporation of Delaware

Filed Aug. 17, 1966, Ser. No. 572,997

9 Claims. (Cl. 123—73)

ABSTRACT OF THE DISCLOSURE

The cylinder block for a two-cycle engine having two cylinders or multiples of two cylinders disposed in line or in a bank and firing alternately is provided with scavenging or inlet ports and exhaust ports opening toward opposed sides of the block for each cylinder. The opposed scavenging or inlet ports communicate with a crankcase chamber for the corresponding cylinder through corresponding transfer passages disposed along each side of the block. The exhaust ports for each cylinder are disposed angularly to provide for convergence of the corresponding ports of the respective cylinders into a common exhaust passage opening from each side of the block. The scavenging or inlet ports, transfer passages, exhaust ports and exhaust passages respectively are all symmetrically disposed with respect to a common plane containing the cylinder axes.

This invention relates to two-cycle internal combustion engines having two cylinders or multiples of two cylinders disposed in line or in a bank such that the pistons in adjacent cylinders of a given multiple fire alternately.

The invention contemplates an engine having an improved cylinder block adapted for use with a tuned exhaust system. The cylinder block includes passage means providing for increased induction of fuel mixture into the crankcase and an arrangement of inlet ports and transfer passages providing a more complete scavenging of the cylinders. It is generally an object of the invention to increase the power output for an engine of given cylinder bore and piston strokes.

The drawings furnished herewith illustrate the best mode for carrying out the invention as presently contemplated and set forth hereinafter.

In the drawings:

FIG. 1 is generally a side elevation of a two-cycle, two cylinder, alternately firing engine in accordance with this invention and is shown mounted on the drive shaft housing of an outboard motor;

FIG. 2 is an enlarged sectional view of the engine of FIG. 1 taken generally on a plane through the axes of the cylinders;

FIG. 3 is a further enlarged view taken generally on line 3—3 of FIG. 2 and shows the underside of the cylinder block with the pistons removed;

FIG. 4 is an enlarged side elevation of the cylinder block with the head block secured in place and the adjacent pistons shown in opposed extreme positions;

FIG. 5 is a partial sectional view taken generally on line 5—5 of FIG. 4;

FIG. 6 is a reduced partial sectional view taken generally on line 6—6 of FIG. 4;

FIG. 7 is a partial sectional view taken generally on line 7—7 of FIG. 2;

FIG. 8 is a reduced partial sectional view taken generally on line 8—8 of FIG. 4; and

FIG. 9 is a sectional view similar to that of FIG. 5 and shows an embodiment wherein curved or arcuate transfer passages are employed.

Referring to the drawings, the engine 1 includes the crankcase 2 which rotationally supports the vertically dis-

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posed crankshaft 3 in the spaced end bearings 4. The engine 1 is mounted on an outboard motor housing 5, shown only in part, which encloses the drive shaft 6 connected to the lower end of crankshaft 3.

Intermediate the crankcase bearings 4 the crankshaft 3 is further supported by the combined center bearing and valve unit 7 which divides the crankcase 2 into separate upper and lower crankcase chambers 8 and 9. The unit 7 includes an internal passage 10 adapted to receive the engine fuel mixture from the carburetor 11 through the crankcase opening 12. The passage 10 within unit 7 communicates with the respective crankcase chambers 8 and 9 through the ports 13 provided in the respective end walls of unit 7. The flow of fuel mixture through the ports 13 from passage 10 into the respective crankcase chambers 8 and 9 is controlled by the reed valves 14 and 15 mounted on the outside of the respective end walls of unit 7 within the corresponding chambers 8 and 9.

The cylinder block 16 is secured to the crankcase 2 of the engine and includes the vertically spaced cylinder bores 17 and 18 the forward ends of which open into the corresponding crankcase chambers 8 and 9. The opposite ends of the cylinders 17 and 18 are closed by the head block 19 secured to the cylinder block 16.

The pistons 20 and 21 are disposed for reciprocation within the corresponding cylinders 17 and 18 and are connected by the rods 22 to the corresponding crankshaft throws 23 and 24 in crankcase chambers 8 and 9 respectively. The crankshaft throws 23 and 24 are diametrically opposed or spaced circumferentially 180° to typify the engine as alternately firing.

The fuel mixture is directed into the cylinders 17 and 18 by two pairs of symmetrically opposed inlet or scavenging ports 25 and 26 which open into the respective cylinders. When viewed in the direction of the cylinder axes as best shown in FIG. 6, the pair of opposed ports 25 for each cylinder are generally aligned with each other along a transverse plane generally normal to the common plane containing the cylinder axes and are adapted to direct the flow of fuel mixture adjacent to the outer wall portion 27 of the respective cylinders. The opposed ports 26 are angularly related and disposed at an angle relative to adjacent ports 25 as shown in FIG. 6 to provide that the flow streams issuing therefrom are directed to a location intermediate the cylinder axis and wall portion 27 and converge to at least partially intersect with the flow streams from ports 25. For the engine here under consideration, the desired flow stream direction was attained when the ports 26 were disposed at an angle of about 15° to a transverse plane normal to the common plane of the cylinder axes as shown by the angle 28 in FIG. 6. The impingement of the opposing flow streams of fuel mixture from the opposed ports 25 and 26 starts the loop for scavenging of the cylinder and the net effect of the directions of these ports should provide that the main flow body of the loop will begin at a location generally midway between the cylinder axis and the wall portion 27 of the corresponding cylinder and that the entering flow streams be confined to the outer half portion of the cylinder so as not to interfere with the return portion of the loop which moves downwardly through the inner half portion of the cylinder. As perhaps shown best in FIG. 5, the ports 25 and 26 are directed upwardly at an angle to the cylinder wall to impart to the respective flow streams an upwardly directed component of force to direct the scavenging loop upwardly. The desired loop characteristics are attained when ports 25 and 26 are inclined at an angle of approximately 7½° relative to a horizontal plane as generally shown by the angle 29 in FIG. 5.

The respective ports 25 and 26 communicate with the crankcase chambers 8 and 9 respectively through corresponding transfer passages 30 and 31 which are sym-

metrically disposed in the cylinder block 16 relative to the common plane of the cylinder axes. As perhaps best shown in FIG. 5, the transfer passages 30 and 31 are inclined inwardly in the direction of the corresponding inlet ports 25 and 26 to minimize the introduction of turbulence in the flow stream of fuel mixture at the transition bend from transfer passage to inlet port.

The embodiment of FIG. 9 shows an alternative form of transfer passage 32 which is arcuate to minimize the transition bend at the juncture of the transfer passage and inlet port. The arcuate transfer passage 32 as formed in the cylinder block 33 is provided with a continuing portion in the crankcase member 34. In the construction of FIG. 9, the compressed fuel mixture moves outwardly into the transfer passage 32 when the descending piston 20 uncovers the inlet ports 25 and 26 rather than upwardly and counter the direction of piston travel as in FIG. 5.

The exhaust products of engine 1 leave the respective cylinders 17 and 18 by way of the pair of symmetrically opposed exhaust ports 35 which open from the inner half portion of the cylinders. The exhaust ports 35 are disposed at an angle relative to the cylinders to provide for convergence of exhaust ports from the respective cylinders on each side of block 16 into passages 36 which open from the respective sides of the block.

When the engine 1 is operated with a tuned exhaust system an exhaust diffuser or megaphone 37 is secured on each side of block 16 in communication with the respective passages 36. The tuned exhaust megaphones 37 are supported from the sides of block 16 by a mounting plate 38 which serves also as a closure for coolant passages 39 and the outer open ends of the fuel mixture inlet ports 25 and 26.

To assure maximum induction of fuel mixture into the crankcase chambers 8 and 9 commensurate with the power capabilities of engine 1, additional induction facility is provided in the form of a pair of symmetrically opposed, piston controlled induction ports 40 which open into each of the cylinders 17 and 18. The ports 40 are disposed angularly relative to the cylinders similarly as the exhaust ports 35, as perhaps best shown in FIG. 8.

The induction ports 40 for the respective cylinders 17 and 18 converge on each side of cylinder block 16 into the ducts 41 which open to the respective sides of the block and are closed off by the exhaust megaphone mounting plates 38.

The ducts 41 which communicate with the induction ports 40, in turn communicate with the corresponding induction passages 42 which extend downwardly within the cylinder block 16 between the respective cylinders and communicate directly with carburetor 11 through the internal passage 10 of the combined bearing and valve unit 7. As generally shown in FIG. 7, the induction passages 42 are inclined inwardly toward the cylinders to minimize turbulence at the transition bend between the passages and corresponding ducts 41.

In the operation of engine 1, the fuel mixture is drawn into the crankcase chamber during the upward induction stroke of the corresponding piston. The upwardly moving piston gives rise to a pressure reduction in the corresponding crankcase chamber and when the pressure differential across the reed valves is adequate to overcome reed tension, the reed flexes to an open position to admit the fuel mixture. The fuel mixture continues to be drawn into the crankcase chamber past the reed valves as the piston continues to move upwardly. When the upwardly moving piston uncovers the induction ports 40 in the cylinder wall, an additional increment of fuel mixture is drawn into the crankcase chamber directly from carburetor 11 through the internal passage 10 of valve unit 7 and the induction passages 42 to supplement the induction flow past the reed valves and thereby further pack the crankcase chamber to increase the volumetric efficiency of the crankcase induction cycle. In the

early portion of the downward or power stroke of the piston, the ports 40 are again covered and the pressure in the crankcase chamber increases to reduce the pressure differential across the reed valves. When the reed tension is able to overcome the reducing pressure differential, the reed valves close.

Following closure of the reed valves and the induction ports 40, the fuel mixture in the packed crankcase chamber is compressed by the piston as the piston continues to move downwardly on the power stroke. As the piston approaches the bottom dead center position, the piston uncovers the inlet or scavenging ports 25 and 26 allowing the compressed fuel mixture to flow from the crankcase chamber via the symmetrical routes through the transfer passages 30 and 31 into the cylinder ahead of the piston.

The fresh charge of fuel mixture entering the cylinder ahead of the piston courses the cylinder in a scavenging loop, as generally shown by the flow arrows in FIG. 2, moving first upwardly in the outer half portion of the cylinder, then across the top of the cylinder adjacent to the head block 19, and finally downwardly toward the piston in the inner half portion of the cylinder, whereby to scavenge or force out any remaining combustion products from the previous explosion.

When the piston moves upwardly within the cylinder on its induction stroke, the piston covers first the inlet ports and then the exhaust ports and then proceeds to compress the fresh charge of fuel mixture. Meanwhile the crankcase chamber is being refilled as hereinbefore described. The compressed fuel mixture in the cylinder is ignited just before the piston reaches the top of its stroke and the resulting explosion within the cylinder drives the piston downwardly.

As the piston moves downwardly within the cylinder on its power stroke, the new charge of fuel mixture in the crankcase chamber is being compressed as previously described. As the piston approaches the bottom of its stroke, the exhaust ports 35 are uncovered by the piston and the spent charge still under considerable pressure leaves the cylinder.

When exhaust megaphones 37 of proper dimension are employed, the exhaust flow from the cylinder results in a powerful pressure wave which moves through the megaphones. This pressure wave is reflected at the open end of the megaphones as a train of suction waves which return to the cylinder. Since the inlet or scavenging ports 25 and 26 are uncovered by the piston immediately following the opening of the exhaust ports, it is likely that the reflected suction waves materially assist the scavenging loop in the scavenging of the cylinder. Since the engine 1 is alternately firing, the events in the respective cylinders will result in two power strokes for each revolution of the crankshaft 3.

The cylinder block of this invention with its symmetrically disposed ports and passages lends itself readily to accepted manufacturing operations. The blocks may be cast with cored passages and the ports added by standard machining practices. While the invention was described in connection with a two cylinder engine, it is equally applicable to larger engines having multiples of two cylinders disposed either in line or in bank wherein the pistons in adjacent cylinders of a given multiple move oppositely and are alternately fired. With its supplemental induction capacity, its good breathing characteristics relative to scavenging and exhaust as provided by the symmetrically disposed ports and passages, and when outfitted with a properly tuned exhaust system, the engine of this invention was found to deliver over 30% more power over an engine of generally similar size and without any increase in cylinder bore or piston stroke.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

I claim:

1. In a cylinder block for a two-cycle internal combustion engine with said block having at least one multiple of two cylinders adapted to fire alternately, said block further containing at least a pair of inlet and exhaust ports respectively for each cylinder, said inlet and exhaust ports respectively for each cylinder opening toward opposed sides of the cylinder block and disposed symmetrically with respect to a common plane containing the cylinder axes.

2. The invention as set forth in claim 1 wherein said block further contains transfer passages communicating with said inlet ports and exhaust passages communicating with said exhaust ports, said transfer and exhaust passages respectively being disposed symmetrically with respect to the common plane containing the cylinder axes.

3. The invention as set forth in claim 2 wherein said block is secured to a crankcase having a precompression chamber corresponding to each cylinder and opening into the adjacent portion of said cylinder, and said block further contains induction ports opening into each cylinder for communication with said precompression chamber and induction passages communicating with said induction ports, said induction ports and induction passages respectively being disposed symmetrically with respect to the common plane containing the cylinder axes.

4. In a two-cycle internal combustion engine, a cylinder block containing at least one multiple of two cylinders adapted to fire alternately, the adjacent portions of each said cylinder having a pair of exhaust ports opening toward opposed sides of the cylinder block, said exhaust ports of each cylinder being angularly disposed with respect to the corresponding side of the cylinder block to provide for convergence of the corresponding ports of the respective cylinders into a common exhaust passage opening from each side of the block.

5. The invention as set forth in claim 4 wherein the engine is adapted for a tuned exhaust system and an exhaust diffuser communicates with each of the exhaust passages.

6. In a two-cycle internal combustion engine having at least one multiple of two cylinders, a crankcase rotatably carrying a crankshaft and having chambers corresponding to the cylinders, a cylinder block secured to the crankcase and containing said cylinders with the cylinders opening into the corresponding crankcase chambers, a piston reciprocally disposed in each cylinder and connected to the crankshaft in the corresponding crankcase chamber, the pistons in the respective cylinders moving in opposition to each other to provide for alternate firing of the cylinders, a carburetor, induction valve means opening into the respective crankcase chambers and communicating with the carburetor to supply a fuel mixture

for precompression within said chambers, said cylinder block having scavenging ports opening toward opposed sides of the block for each cylinder and transfer passages placing the scavenging ports in communication with the corresponding crankcase chambers, said cylinder block further containing a pair of exhaust ports opening toward opposed sides of the block for each cylinder, the exhaust ports of each cylinder being angularly related to provide for convergence of the corresponding ports of the respective cylinders into a common exhaust passage opening from each side of the cylinder block, said scavenging ports, transfer passages, exhaust ports and exhaust passages respectively being symmetrically disposed with respect to a common plane containing the cylinder axes.

7. The invention as set forth in claim 6 wherein the cylinder block further contains induction ports opening toward opposed sides of the block for each cylinder, said induction ports for each cylinder being angularly disposed with respect to the corresponding side of the cylinder block to provide for convergence of the corresponding induction ports of the respective cylinders into a common duct on each side of the block, said ducts communicating directly with the carburetor through induction passages provided on each side of the block, said induction ports, ducts and passages respectively being symmetrically disposed with respect to a common plane containing the cylinder axes.

8. The invention as set forth in claim 6 wherein the symmetrically disposed transfer passages are arcuate to minimize turbulence at the transition bend between said passages and the corresponding scavenging ports.

9. The invention as set forth in claim 2 wherein the inlet ports are disposed on an angle with respect to a plane normal to the cylinder axis to provide the flow stream into the cylinder with a component of force toward the outer end of the cylinder, and the transfer passage for each said inlet port is inclined toward the cylinder wall in the direction of the flow stream.

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