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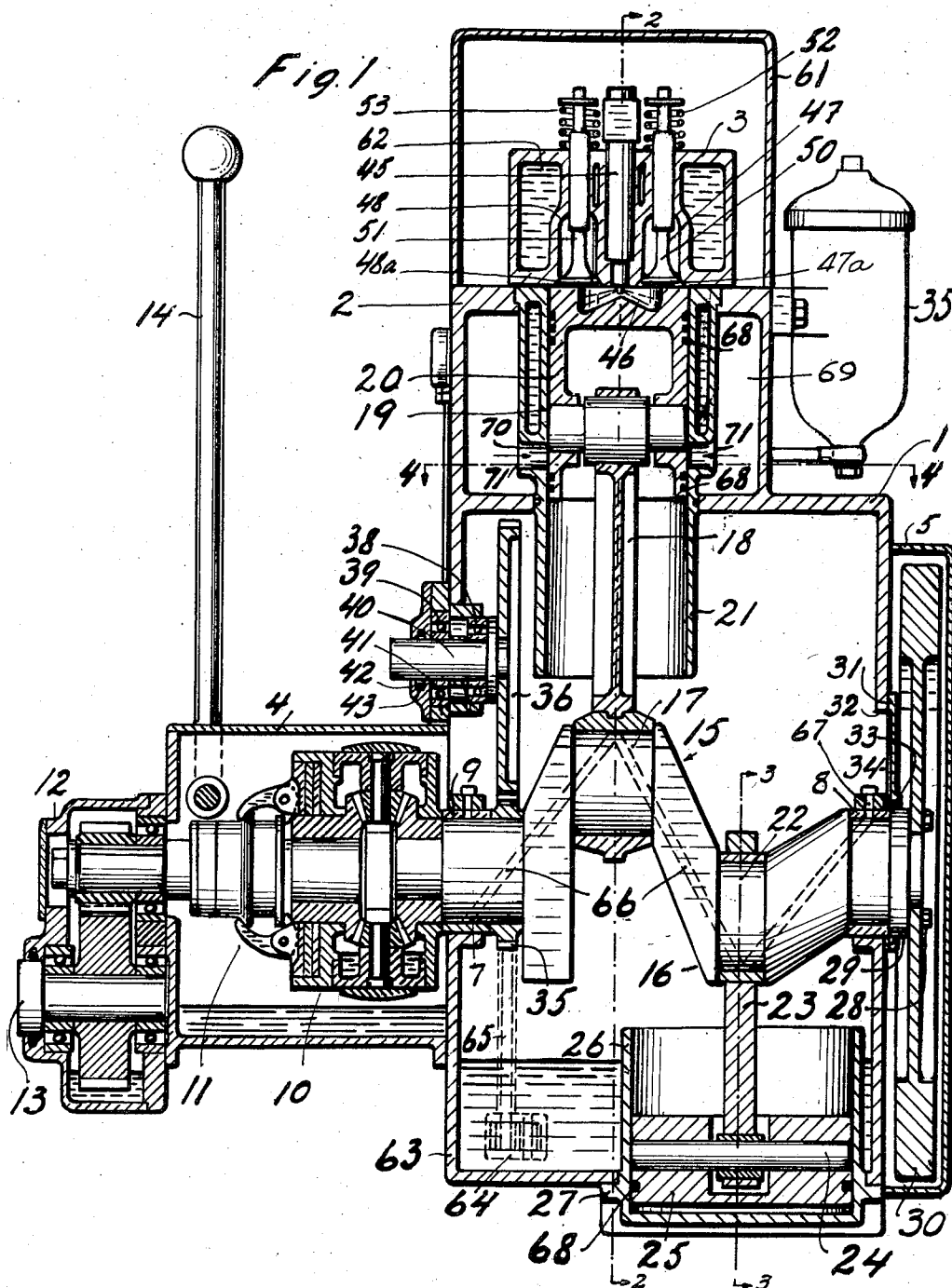
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INTERNAL COMBUSTION ENGINES

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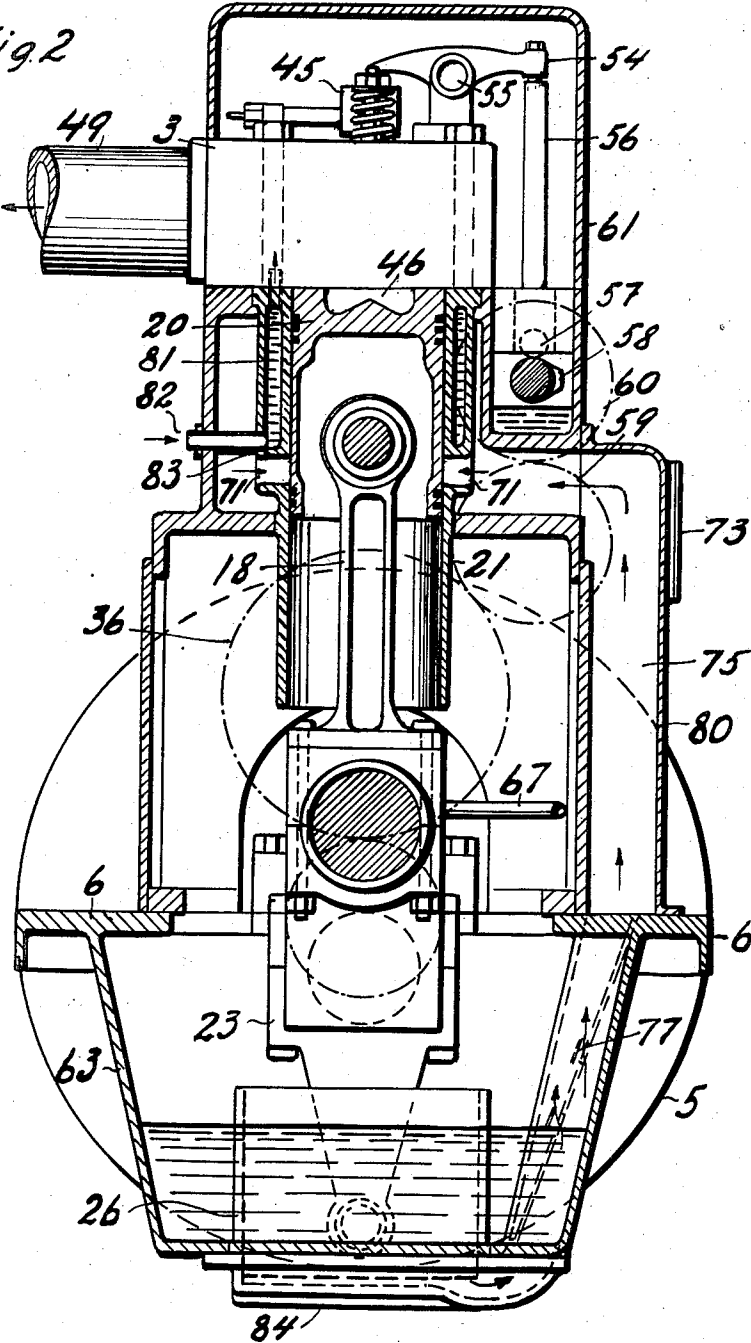
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Fig. 2



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Fig. 3

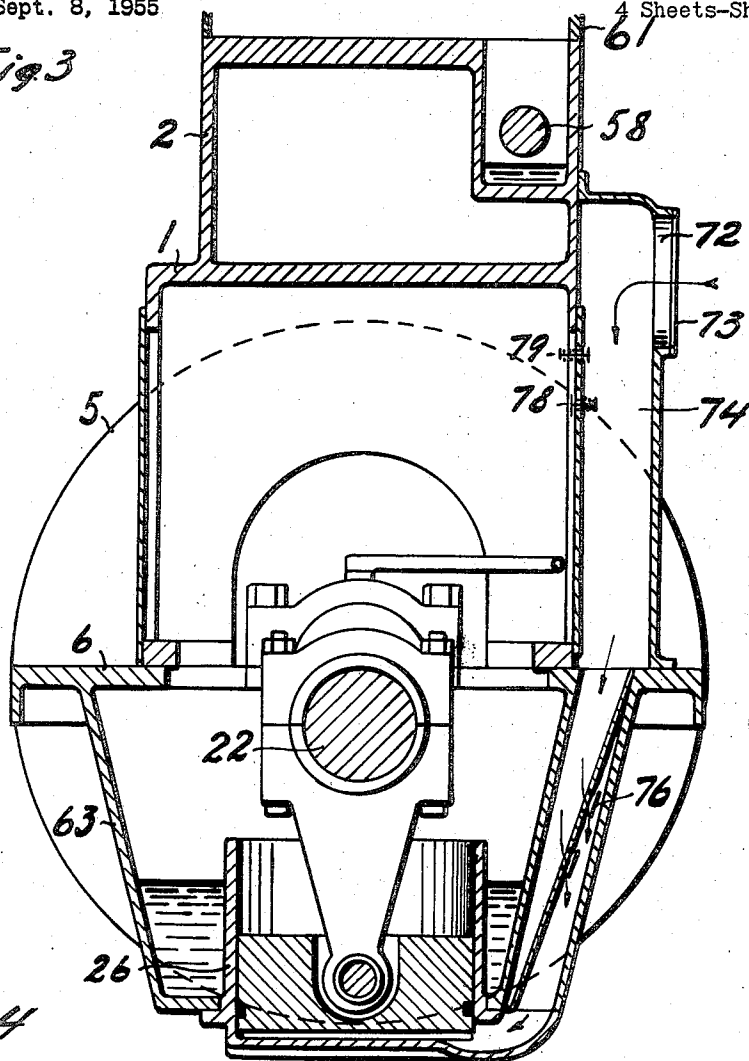
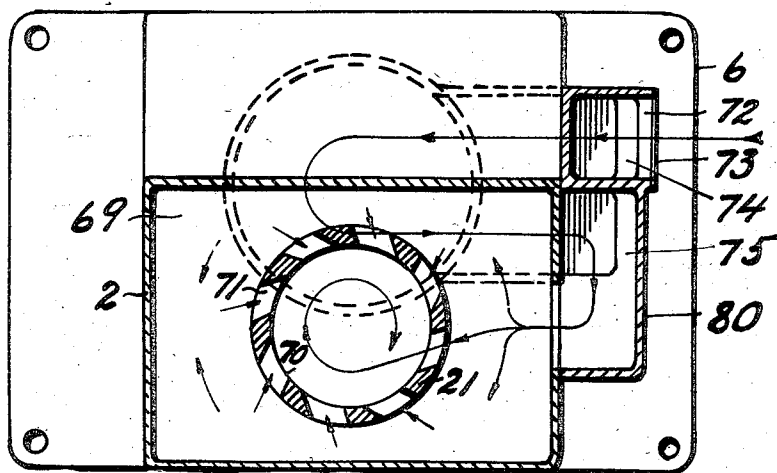


Fig. 4



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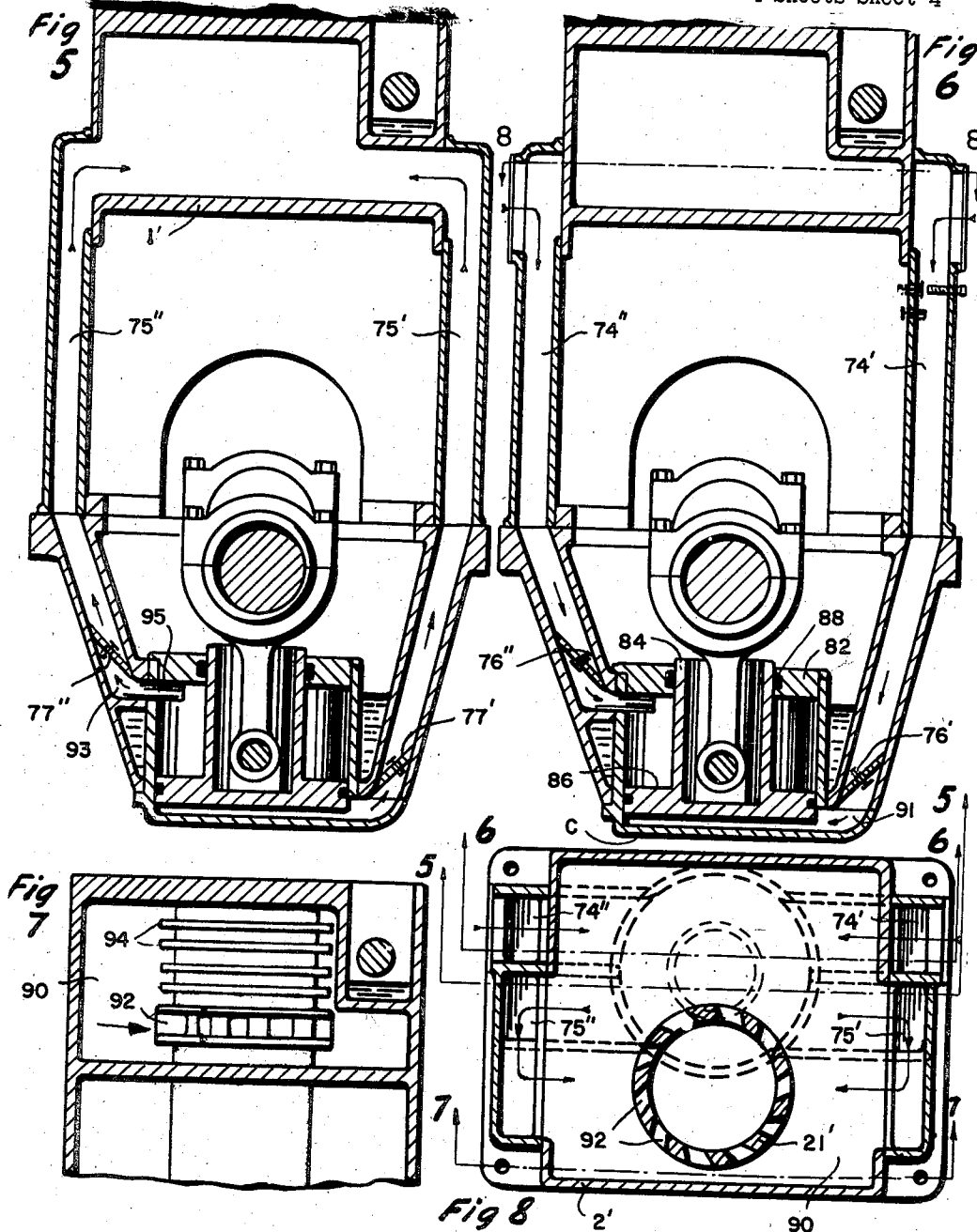
B. A. DE WAERN

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INVENTOR.

B. A. De Waern

BY

Ames, Smith & Harding

ATTORNEYS

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2,855,910

INTERNAL COMBUSTION ENGINES

Bror Algor de Waern, Bromma, Sweden

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11 Claims. (Cl. 123—41.17)

The present invention generally relates to internal combustion engines, and more specifically to two-stroke-type internal combustion piston engines of the kind comprising a piston-type compressor adapted through the medium of an air receiver to feed scavenging and combustion air under pressure to the power cylinder or cylinders.

The invention has for its objects to provide an internal combustion engine which is small in size and weight as compared to its attainable maximum output, which is highly efficient and thus economical in operation, which is comparatively simple in construction, is easily operated and readily assembled and disassembled for repair or for the replacement of parts, and which is, at the same time, vibrationless and extraordinarily reliable in operation.

Two-stroke piston-type engines cooperating with one or more piston-type compressors which are arranged in such a manner as to be operated directly by the crankshaft and with the pistons of the power cylinder and the compressor cylinder moving in opposition to counterbalance each other so that, during the compression stroke of the power piston, the compressor piston feeds scavenging air under pressure to a receiver which communicates directly with the operating cylinder through lateral ports uncovered by the power piston as it approaches its bottom dead center, have been found to involve many advantages in comparison with more conventional two-stroke internal combustion engines, inter alia a comparatively high maximum output relative to the exterior dimensions of the engine, simplicity of construction and vibrationlessness, since the power and compressor pistons are so dimensioned and disposed as, in operation, substantially to outbalance each other.

However, the previously known engines of the type referred to also involve various drawbacks one of which is associated with the scavenging efficiency, a second with the lubrication, a third with the cooling characteristics and a fourth with the ventilation of the crankcase.

For an elucidation of these conditions, reference may suitably be made to the engine of this kind which is disclosed in my prior U. S. Patent specification No. 2,406,491. In this engine, the air box or receiver is disposed unilaterally in the upper portion of the crankcase, at a lower level than the combustion chamber of the power cylinder with which the receiver communicates through a valve controlled passage and an intake port in the cylinder wall. The outer end of the power cylinder is completely closed, and the exhaust port for the combustion gases and scavenging air is situated adjacent to the bottom end of the combustion chamber, at or near the level of the air intake port so as, in the same manner as the latter, to be uncovered by the piston near the bottom dead center of its power stroke. Thus the cylinder will be scavenged by air passing transversely therethrough, and it has been found that the closed top portion of the cylinder will not have time to get completely scavenged before the exhaust port is covered again by the piston on its compression stroke, but will thus form a pocket in

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which a residue of combustion gas is trapped together with the fresh combustion air so that the latter will be non-desirably impurified decreasing the efficiency of the engine.

In addition, in the engine of the U. S. Patent specification No. 2,406,491 above referred to, two compressors are used one of which operates as a crankcase compressor whereas the other is separated from the crankcase and adapted to feed air in excess into the receiver. As is well known, when the crankcase is utilized as a compression chamber for scavenging and combustion air, the favorable combination splash and pressure-feed lubrication system cannot be applied since the air within the crankcase must not then be impurified with oil particles resulting from the splash lubrication. Therefore, it will be necessary to provide for direct pressure lubrication of all movable parts which operate in the air present within the crankcase, and the latter must be kept substantially dry, and this requirement complicates to a rather large extent the design and construction of the engine. Further, when the crankcase is used as a compression chamber for the combustion air, the temperature control of the engine will be rendered more difficult. During the starting period the heating of the engine should take place as rapidly as possible which may be accomplished in conventional engines by cutting off or reducing the crankcase ventilation, and this cannot be made, of course, where the crankcase is used as a compression chamber in which case it will be necessary either to tolerate an extended heating period or to provide for pre-heating the combustion air which, again, involves complication of the engine design.

Finally, when the receiver or air box is disposed within the crankcase or in close proximity thereto, i. e. below the cylinder block proper, the scavenging air cannot be effectively utilized for cooling purposes which is, of course, a desideratum.

The engine according to the present invention is designed to combine a number of favorable features whereby all of the drawbacks above referred to are overcome and an engine displaying extraordinarily favorable operating characteristics is created, as stated below.

Accordingly, a further object of the present invention is to provide an engine of the kind specified in which the air compressor is sealed in a gas-tight manner from the interior of the crankcase and operates, in a manner known per se, with its piston moving in opposition to the piston of the power cylinder. This feature enables the application of the combination splash and pressure-feed type lubrication system.

A further object of the present invention is to provide an engine of the kind specified which combines with the feature of the preceding paragraph the subsidiary feature that the receiver or air box is disposed in the cylinder block proper and surrounds the combustion chamber of the power cylinder. This feature enables the receiver to cooperate with the power cylinder in the manner of a heat exchanger whereby before entering the cylinder the scavenging air will flow in contact with the outer wall surface of the cylinder and cool the latter, and will, at the same time, be heated itself, which arrangement simplifies the cooling of the engine and improves its efficiency of operation.

A further complementary object in combination with the two preceding ones is to provide an engine of the kind stated in which at least one exhaust port for combustion gases and scavenging air is provided in the top end of the power cylinder so as to cause the latter to be scavenged longitudinally, in a manner also known per se. This arrangement excludes the formation of a pocket in which combustion gases are retained intermixed with the combustion air,

Further objects and advantages of the invention will be set forth or become apparent from the following description in conjunction with the accompanying drawings illustrating, by way of example only, a preferred embodiment thereof in the form of a two-stroke cycle single-cylinder diesel-type engine associated with a single-acting scavenging air compressor and including a combination splash and pressure-feed lubrication system and controllable forced crankcase ventilation, the engine illustrated being particularly adapted for use as a light though powerful marine engine for comparatively light craft. In the drawings:

Fig. 1 is a longitudinal sectional elevation of the engine, certain internal parts being illustrated in side view.

Fig. 2 is a vertical cross section taken along the line 2—2 in Fig. 1, certain parts being illustrated in end view.

Fig. 3 is a vertical cross section taken along the lines 3—3 in Fig. 1, certain elements being omitted in order to illustrate more clearly the design of other elements, particularly the load-carrying framework of the engine.

Fig. 4 is a horizontal cross section taken along the line 4—4 in Fig. 1.

Figure 5 is a vertical cross-section through a modified form of the engine shown in Figure 3 and taken on the trace 5—5 shown in Figure 8;

Figure 6 is a vertical cross-section through the modified form of the engine taken on the trace 6—6 shown in Figure 8;

Figure 7 is a fragmentary vertical section through the modified form of the engine taken on the trace 7—7 shown in Figure 8; and

Figure 8 is a horizontal cross-section taken on the trace 8—8 shown in Figure 6.

Figs. 1 and 2 show the engine with its power piston at its top dead center, which is presumed to be the case also in Fig. 3 whereas in Fig. 4 the power piston is assumed to be situated at its bottom dead center.

Throughout the various figures, the same parts have been designated by like reference numerals.

Referring now to the drawings more specifically, the engine illustrated therein comprises a load-carrying framework consisting of the crankcase 1 and the cylinder block proper 2 having a cylinder head 3. The block 2 is preferably composed of steel plates welded together, and is suitably welded to the crankcase 1 also consisting of steel plates welded together. This all-welded construction renders the framework extremely rigid and of a strength sufficient to enable the same to be of skeleton design with large lightening and service openings which permit parts, even the crankshaft assembly, to be passed therethrough for replacement or repair, without the necessity of dismantling the engine framework. The openings in the walls of the engine framework are closed by detachable cover plates or other elements in which bearing or other mounting elements may be arranged, as required, as will appear particularly from Fig. 1. Attached to the rear end wall of the engine framework is a transmission case 4 and secured to its front end wall is a flywheel cover 5, the framework being provided along its two sides with suitable mounting rails 6.

The engine crankshaft is denoted by 7 and is mounted in a front main bearing 8 and a rear main bearing 9. The transmission case 4 contains a brakeable differential 10 and a reversing gear 11, and a reduction gearing 12 is provided in association therewith for transmitting torque to the output shaft 13. The reversing gear is operated by a manual control lever 14.

The crankshaft 7 has two cranks 15 and 16 disposed as close to each other as possible along the crankshaft and angularly displaced by a fixed angle of 180°. Mounted on the crank pin 17 of one of these cranks, 15, is a connecting rod 18 the opposite end of which is mounted on a piston pin 19 which is, in its turn, mounted in an engine piston 20 which is movable in

an engine cylinder 21 which is detachably mounted in corresponding openings in the cylinder block 2 and crankcase 1. The end of the engine cylinder facing the interior of the crankcase is open.

Mounted on the crank pin 22 of the second crank, 16, is a connecting rod 23 the opposite end of which is mounted on a piston pin 24 disposed in a compressor piston 25 moving in an air compressor cylinder 26 which is removably secured in an opening in the bottom of the crankcase 1, the cylinder 26 being supported therefrom by a flange or collar 27 engaging the outer surface of the crankcase and being secured thereto in any suitable fluid-tight manner.

Mounted on the front end of the crankshaft 7 projecting through the front wall of the crankcase 1 is the engine flywheel 30 which is secured to a collar 29 of the crankshaft by bolts 28 (only one such bolt being shown in Fig. 1). In this instance, this crankshaft end is passed through a hole in a cover plate 31 being in any suitable gas-tight manner secured to the front wall of the crankcase 1 and serving to seal its service opening 32 through which the whole crankshaft assembly can be introduced or removed after releasing the cover plate 31 from the crankcase wall. The cover plate 31 is provided with a centrally disposed annular depression or groove in which a sealing ring 33 engaging the collar 29 in a fluid-tight manner is held by means of a retaining washer 34 secured to the inner surface of the cover plate 31.

Keyed to the crankshaft 7 between the rear main bearing 9 and the engine crank 15 is a toothed pinion 35. In constant mesh with this pinion is a spur gear 36. The gear 36 has a rearwardly extending axle 37 which, by means of two ball bearings 38, 39, is mounted in a sleeve 40 which is inserted in a hole in the rear end wall of the crankcase 1 to the outer surface of which said sleeve is secured and sealed by means of a mounting flange 41. Sealing around the axle 37 projecting through the crankcase wall is accomplished by means of a sealing ring 42 inserted in an inner peripheral groove of an annular washer 43. The gear ratio between the pinion 35 and the gear 36 is such as to cause the latter to rotate at half the speed of the crankshaft. Driven from the gear 36 in a manner not illustrated in the drawings is the fuel injection pump 44 which through a fuel filter 35 mounted on the engine framework and suitable conduits not shown feeds fuel to the fuel injector or nozzle 45 which is detachably mounted in the cylinder head with its longitudinal axis aligned with the axis of the power cylinder 21 and opening into the combustion chamber 46 of the cylinder, above the center of the head of the piston 20.

The cylinder head 3 is generally box-shaped and is detachably secured to the cylinder block 2 so as to close by its bottom the open top end of the power cylinder 21. The bottom of the cylinder head 3 is provided with two exhaust ports 47a and 48a situated, one in front and one in rear of the fuel injector 45, and through these exhaust ports the combustion chamber of the power cylinder 21 communicates with two exhaust passages 47, 48, respectively, which within the cylinder head are merged into a common exhaust manifold or pipe 49 connected to one lateral wall of the cylinder head 3. Said exhaust ports 47a and 48a are formed with valve seats for two exhaust valves 50 and 51, respectively, which are thus disposed near the periphery of the cylinder bore. The valves are loaded by valve springs 52, 53, respectively, urging the valves towards their closed position in the conventional manner, the timed simultaneous opening of the valves and their timed opening periods being ascertained by a valve operating mechanism which comprises a double valve rocker 54 which is mounted on a fulcrum pin 55 and has the valve raising movements imparted to it by a push rod 56 having a cam follower 57 cooperating with a corresponding cam on a camshaft 58 journaled in the cylinder block and rotated from the crankshaft 7 at the same speed as the latter through the pinion

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35, the spur gear 36, and intermediate spur gear 59 in constant mesh with the gear 36 and having a pitch diameter the same as that of pinion 35, and a spur gear 60 keyed to the camshaft 58 and also having the same pitch diameter as pinion 35. The valve mechanism is enclosed together with the cylinder head 3 in a detachable rocker cover 61. The camshaft 58 is provided at its rear end with means (not shown), such as a removable handle, for starting the engine by hand. Further, the camshaft can suitably be arranged to operate a centrifugal governor for controlling the supply of fuel and/or air to the engine. The cylinder head 3 is further provided with cooling-water passages 62 exteriorly of the exhaust ports and passages 47, 48.

The lower portion of the crankcase 1 forms an oil pan or sump 63, and the circulation pump 64 of the combination splash and pressure feed lubrication system is, in the conventional manner, disposed in this oil sump and adapted through a diagrammatically indicated transmission 65 to be driven from the pinion 35 of the crankshaft 7. The circulation pump 64 feeds lubrication oil to the crankshaft main and crankpin bearings through passages drilled through the crankshaft components, as illustrated diagrammatically at 66, and which are drained to the sump 63 through a pipe 67 projecting from the front main bearing 8. From the cranks lubricating oil will be thrown, by centrifugal action on rotation of the crankshaft, into the inner ends of the cylinders, to piston pin bearings and other movable parts disposed within the crankcase so as to lubricate such parts, in the conventional manner.

Both power and compressor pistons are equipped with piston rings 68, both compression rings and oil-control rings, as required.

In the cylinder block 2, and surrounding the power cylinder 21 removably inserted therein, a peripherally closed air jacket 69 is arranged which serves as a so-called receiver for the scavenging and combustion air which on the compression stroke of the power piston 20 is delivered by the air compressor on the compression stroke of the compressor piston. The receiver 69 is in direct communication with the interior of the power cylinder 21 through a circular row of air intake openings 70 which are uncovered by the power piston 20 as it nears its bottom dead center. These openings terminate a circular row of passages 71 directed substantially tangentially relative to the cylinder wall so as to cause the scavenging air admitted into the cylinder 21 to form a helical vortex about the axis thereof (as indicated by the arrows in Fig. 4), this vortex forcing out the gases of combustion through the exhaust ports situated near the periphery of the top end of the cylinder 21 as soon as these ports have been opened by the exhaust valves 50 and 51. The exhaustion of the gases and cleaning of the cylinder walls will thus be extremely efficient, and only pure combustion air will be left in the power cylinder 21 to be compressed by the piston after the exhaust valves 50, 51 have been reclosed.

The compressor cylinder 26 at its outer end communicates, on one hand, with a fresh-air intake 72 (Fig. 3) situated at the upper portion of the crankcase 1, on one side of the engine, this intake being provided with a fine-meshed air strainer 73, and, on the other hand, with the receiver 69 surrounding the power cylinder 21 (Fig. 2), through two separate ducts 74 and 75, respectively, extending upwardly over one lateral wall of the crankcase and being equipped with non-return valves 76 and 77, respectively, adapted to open in the inlet and outlet directions, respectively, these valves being preferably of the flap-type. These valves 76 and 77 should be disposed as close as possible to the compression chamber of the compressor cylinder to the end of minimizing the dead space of the compressor cylinder 26. The portion of the discharge duct 75 from the compressor situated between the outlet valve 77 and the receiver chamber 69

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has a relatively large capacity so as to form an active portion of the effective receiver space whereby, if desired, the receiver space 69 surrounding the power cylinder 21 can be reduced in size, or the effective receiver capacity is favorably increased. In the corresponding manner, the portion of the intake duct 74 to the compressor situated between the air intake 72 and the inlet valve 76 also has a relatively large capacity so as to form an induction pocket. This feature enables a very satisfactory ventilation of the interior of the crankcase 1 which is accomplished in that, on each compression stroke of the piston 25, a small portion of the air present in said intake duct 74 is induced into the crankcase 1 by said piston 25 through a non-return valve 78 inserted in the crankcase wall. On the induction stroke of the compressor piston 25, on the other hand, the crankcase is vented to the intake duct 74 through a second non-return valve 79 inserted in the crankcase wall and opening in the opposite direction relative to the non-return valve 78. The venting valve 79 is disposed at as high as possible a level in the crankcase wall so as to cause the air exhausted therethrough to contain as small an amount of oil as possible. The air inlet valve 78 is situated vertically below and close to the venting valve 79 and is associated with a suitable baffle, pocket or the like, as indicated diagrammatically at 86, for collecting any oil accompanying the air emerging from the air outlet or venting valve 79 situated thereabove so as to cause such oil to be returned into the crankcase 1 and thus prevent harmful amounts of oil from being carried with the intake air into the compressor. It is true that the air thus vented from the crankcase is not perfectly clean as it is brought by the scavenging air into the receiver 69 and as it enters the power cylinder 21 from this receiver, however, this will be of no practical importance since the amount of such slightly impurified air from the crankcase will never exceed a few percents of the total amount of scavenging air. On the contrary, this slight dilution of the scavenging air with crankcase air entails the further advantage, in that a certain degree of upper motor lubrication will be obtained in the power cylinder 21. Further, the ventilation valve arrangement 78, 79 is preferably provided with a manual control enabling the ventilation of the crankcase to be cut out or adjusted in order in all conditions of engine operation to obtain or maintain the optimum temperature in the crankcase, and particularly to shorten the heating period after cold-starting the engine. The intake and discharge ducts 74, 75 extend in close side-by-side relation vertically across one lateral side of the engine frame and are formed in a unitary casing 80 which is attached to or integral with the engine framework, as illustrated in Figs. 2 to 4. It is, of course, possible with minor modifications, inter alia of the internal compressor lubrication and crankcase ventilation, to utilize a double-acting piston compressor arranged substantially in the manner just described for the single-acting one, the intake and discharge ducts for one of the compression chambers of the compressor cylinder being then suitably arranged on one lateral side of the engine, and the corresponding ducts for the other compression chamber on the other lateral side of the engine.

In the embodiment illustrated in the accompanying drawings the air passing through the receiver 69 also serves for cooling the power cylinder 21 externally, and in this case the cylinder 21 may suitably be provided with cooling fins or ribs (not shown). The power cylinder, in addition, is provided with cooling-water passages 81, the cooling water flowing into these passages through a pipe 82 inserted through the wall of the cylinder block 2 and passing through the receiver 69 and connected to a water-inlet opening 83 in the cylinder water-jacket so that water flows through the passages or jacket 81 in the direction indicated by the arrows in Fig. 2. According to a modified embodiment not illustrated in the draw-

ings, the power-cylinder air-cooling fins or ribs, where present, may be combined with guide vanes so disposed as to cause the air, after having cooled the external cylinder surfaces, to enter the power cylinder 21 substantially tangentially to create the afore-mentioned vortex flow of scavenging air within the cylinder.

Also the compressor cylinder 26 is preferably provided with external cooling fins or ribs, suitably both peripherally and on the underside of its bottom, as indicated at 84.

The operation of the engine illustrated in the drawings will be substantially as follows (see the air-flow paths indicated by the arrows in Figs. 2 to 4):

At the beginning of the power stroke of the engine (Fig. 2) the power piston 20 and the compressor piston 26 are in their top dead centers (outermost positions), the receiver 69, 75 being filled with air under pressure and the combustion chamber 46 with fuel-air mixture and the exhaust valves 50, 51 of the power cylinder 21 being closed. As the fuel-air mixture in the combustion chamber 46 is ignited due to the high compression temperature, the power piston 20 is launched downwards performing its power stroke, and its movement is transmitted in the conventional manner to the crankshaft 7 which, at the same time, pulls the compressor piston 25 upwards in its cylinder 26 causing the compressor to induce air through the fresh-air intake 72, the intake duct 74 and the compressor inlet valve 76, a small amount of air being vented from the crankcase 1 through the venting valve 76 and mixing with the intake air. Near the end of its power stroke, the bottom dead center, the piston 20 uncovers the ports 70 of the scavenging passages 71 admitting scavenging air under pressure from the receiver 69 into the power cylinder 21 the exhaust valves 50, 51 of which have just been opened. The scavenging air forms a vortex within the cylinder 21 and flows longitudinally therethrough expelling the combustion gases and scavenging air in excess through the exhaust valves and the exhaust pipe 49.

On its immediately thereupon following upward or compression stroke (on which the crankshaft system is rotated by the accumulated flywheel energy) the power piston 21 first covers the ports 70 of the scavenging passages 71, the exhaust valves 50 and 51 close the exhaust ports 47a, 48a, and the compression stroke is completed to the position shown in Figs. 1 and 2, i. e. to the top dead center, on which stroke the compressor piston 25 compresses and feeds the air previously induced into the receiver system 75, 69 through the outlet or discharge valve 77 in the discharge duct 75, the non-return valve 76 in the intake duct 74 being maintained in its closed position. Owing to the pressure reduction created within the crankcase 1, the ventilation air inlet valve 78 will open and admit a small amount of fresh air into the crankcase 1 whilst the venting valve 79 is kept closed. Thereafter, the operating condition of the engine is again the same as it was at the beginning of the preceding power stroke. The open-circuit flow-path of the scavenging air is clearly indicated by the arrow-pointed line in Fig. 4.

In Figures 5 and 6 there is shown a modified form of the engine shown in Figures 3 and 4. In these figures there is shown a crankcase 1' mounting a cylinder block 2' similar to those shown in Figures 3 and 4. In this form of the invention, however, there is provided a pair of intake ducts 74' and 74'' on opposite sides of the engine. These ducts are similar to the ducts 74 described in connection with Figures 3 and 4. These ducts are provided with valves 76' and 76'', respectively (only 76' being shown in the drawing), and supply air to a compressor cylinder 80 mounted in the manner of the compressor cylinder 26 described in connection with Figures 1 and 3.

In the form of the invention shown in Figures 5 and 6 the compressor is a double acting compressor and the cylinder 80 is provided at its upper end as viewed in the figure with a close off plate 82 slidably engaging a skirt 84 extending from a piston head 86 affixed to a

connecting rod 23' mounted on the crank shaft 22'. The connecting rod 23' and the crank shaft 22' are substantially identical to the equivalent parts described in connection with Figures 1 and 3. The plate 82 is provided with a sealing ring 88 providing a seal in cooperation with the piston skirt 84.

A pair of exhaust ducts 75' and 75'' are provided with non-return valves 77' and 77'' (only the valve 77'' being shown in the drawing) and carry air compressed by the compressor piston acting within the cylinder 80 to a chamber 90 surrounding the engine cylinder 21'. The intake duct 74' and the exhaust duct 75' both communicate with the space 91 below the compressor cylinder 80. The intake duct 74'' and the exhaust duct 75'' both communicate with the space 93 connected with the upper portion of the space within the compressor cylinder through a port 95 in the compressor cylinder 80. From the foregoing, it will be evident that the arrangement provides a double acting compressor having intake and discharge ducts for the compression chambers on either end of the compressor cylinder extending in close side by side relation substantially vertically across each lateral side of the engine.

The compressed air in the chamber 90 flows around the engine cylinder 21 and past cooling fins 94 provided on the external cylinder surfaces serving to cool the engine cylinder. The engine cylinder is provided with substantially tangentially arranged intake ports 92 providing vortex-like flow of scavenging air through the cylinder.

The crankcase is vented to the intake duct 74' through a ventilation valve 79' in the manner described in connection with the equivalent parts in Figure 3. In Figure 5 there is shown an adjusting screw 96 provided with a locking nut 98 and extending adjacent to the head of the valve 79' in order to provide an adjustable limitation of the stroke of the valve thereby providing a manual control of the crankcase ventilation.

What is claimed is:

1. An internal combustion engine of the two-stroke-cycle type and comprising in combination at least one power cylinder, a combustion chamber in said cylinder, a power piston reciprocable in said cylinder, a crankcase, a crankshaft mounted in said crankcase and operably connected with said piston, scavenging air inlet means disposed in the wall of said cylinder near the bottom end of said combustion chamber to be uncovered by said power piston as, on its power stroke, it approaches its bottom dead center, a receiver for scavenging air under pressure surrounding the combustion chamber of said power cylinder and sealed from said crankcase, said receiver communicating directly with said cylinder through said scavenging air inlet means, valve controlled exhaust port means disposed in the top end of said power cylinder to cause scavenging to occur in the direction of the axis of said cylinder, a compressor cylinder disposed in said crankcase but with its compression chamber sealed therefrom, atmospheric-air intake means communicating with said compressor cylinder, compressed-air discharge means communicating with said compressor cylinder and said receiver but sealed from said intake means and from said crankcase, and a compressor piston reciprocable in said compressor cylinder and operably connected with said crankshaft, the angular crank-displacement between said power piston and said compressor piston being approximately 180°, whereby said compressor is adapted on its compression stroke, and on the simultaneous compression stroke of said power piston, to feed atmospheric scavenging air under pressure into said air receiver.

2. An engine as claimed in claim 1 in the form of an overhead-valve engine having said compressor mounted at the bottom of the crankcase and in which said compressor cylinder communicates at its top end, on one hand, with an atmospheric-air intake situated at the upper portion of said crankcase and, on the other hand, with

said receiver surrounding said power cylinder, through two separate ducts extending upwards across one lateral wall of said crankcase, said ducts having inserted therein non-return valves adapted to open in the air inlet and discharge directions, respectively.

3. An engine as claimed in claim 2 in which said non-return valves in said compressor ducts are disposed as close as possible to the compression chamber of said compressor cylinder in order to minimize the dead space of said compressor cylinder.

4. An engine as claimed in claim 2 in which said non-return valves in said compressor ducts are disposed as close as possible to the compression chamber of said compressor cylinder, and the portion of said compressor intake duct situated between said atmospheric-air intake and said intake-duct non-return valve is arranged to form a substantial air-pocket, ventilation and venting non-return valves inserted in the crankcase wall in the portion of said compressor intake-duct between said atmospheric air intake and said intake-duct non-return valve, crankcase ventilation being effected in that, on each compression stroke of said compressor piston, a small portion of the air present in said intake duct is induced into said crankcase by said piston through the ventilation non-return valve inserted in the crankcase wall, and the crankcase, on the induction stroke of said compressor piston, being vented to said intake duct through the venting non-return valve also inserted in said crankcase wall.

5. An engine as claimed in claim 4 in which, of said non-return valves inserted in said crankcase wall, said venting valve is disposed at as high as possible a level in said crankcase wall, and said ventilation non-return valve is disposed vertically below and closely spaced from said venting valve and is associated with means for collecting any oil accompanying the air vented through said venting valve so as to cause such oil to be returned into said crankcase.

6. An engine as claimed in claim 5 in which said ventilation valve arrangement is associated with a manual

control enabling the ventilation of said crankcase to be cut out or adjusted.

7. An engine as claimed in claim 2 in which said compressor intake and discharge ducts extend in close side-by-side relation substantially vertically across one lateral side of the engine.

8. An engine as claimed in claim 2 modified to include a double-acting instead of a single-acting compressor and having the intake and discharge ducts for the compression chambers on either end of said compressor cylinder extending in close side-by-side relation substantially vertically across either lateral sides, respectively, of the engine.

9. An engine as claimed in claim 1 in which the air fed into said receiver serves also for cooling said power cylinder externally, said cylinder being provided, for this purpose, with cooling fins on its external surfaces in contact with said air.

10. An engine as claimed in claim 9 in which said cooling fins are associated with guide vanes so disposed as to cause the air, after having cooled the external cylinder surfaces, to enter the power cylinder substantially tangentially to create a vortex-like flow of scavenging air through said cylinder.

11. An engine as claimed in claim 1 in which said compressor cylinder is provided externally with cooling fins.

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