Jan. 6, 1970 J. J. DINEEN 3,487,818

SHORT STROKE TWO-CYCLE ENGINE

Filed Jan. 25, 1968 2 Sheets-Sheet 1

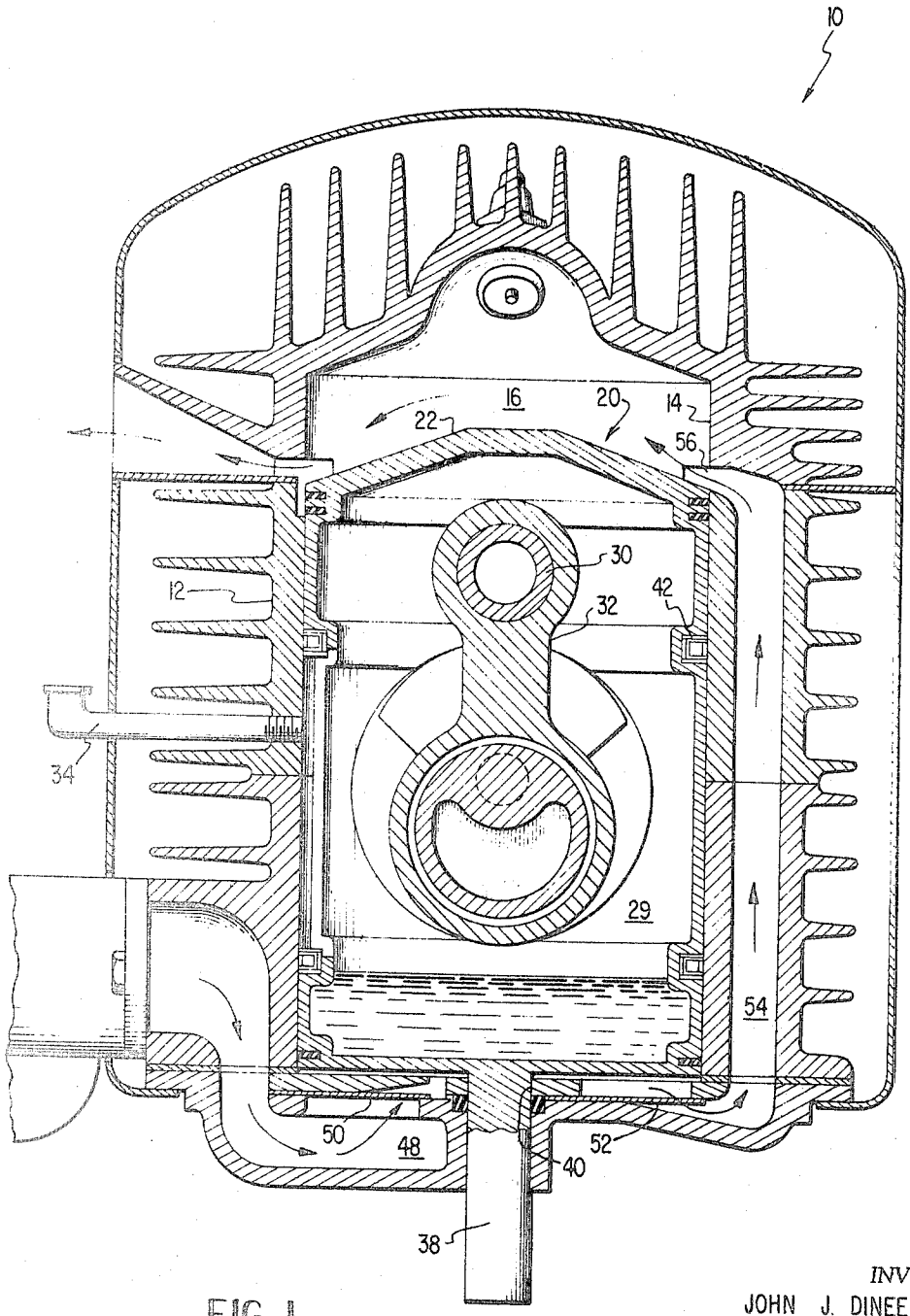


FIG. 1

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FIG. 3

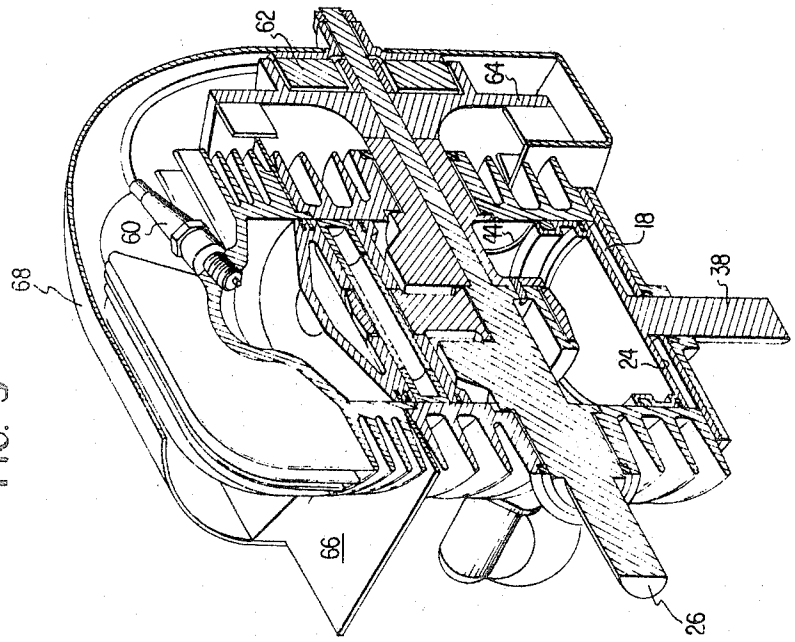
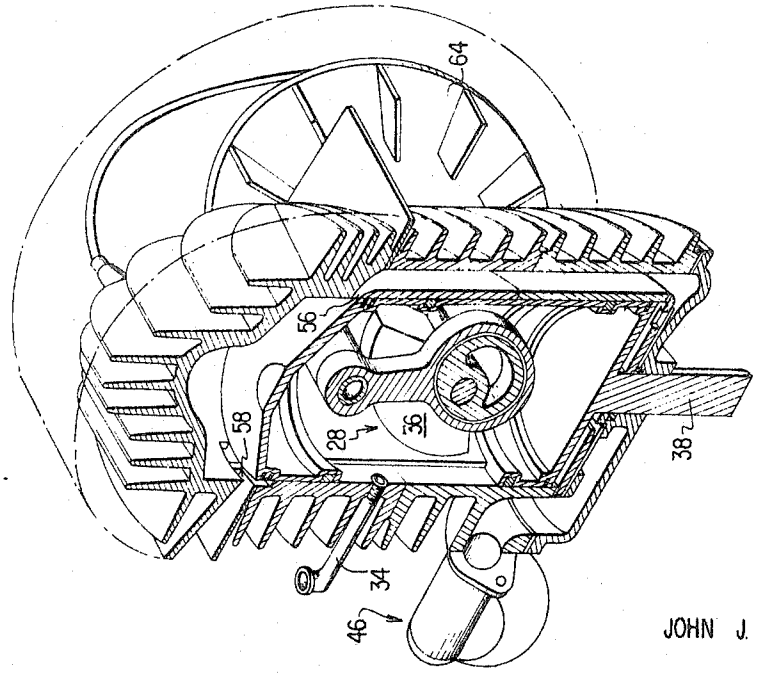



FIG. 2

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3,487,818

# SHORT STROKE TWO-CYCLE ENGINE

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U.S. Cl. 123—71 13 Claims

## ABSTRACT OF THE DISCLOSURE

The disclosure is directed to a two-cycle engine having a high bore-stroke ratio in which a hollow piston having opposed pumping and combustion heads is disposed for reciprocation in a single cylinder. The hollow piston interior contains the crankcase and lubricating oil therefor whereby the oil may be maintained separate from the fuel system.

The short stroke engine herein disclosed provides for efficient scavenging of the combustion chamber without the necessity of providing a looped scavenging flow path.

## BACKGROUND OF THE INVENTION

The invention relates to two-cycle engines of the type wherein a single piston, having opposed piston heads, reciprocates in a single cylinder. The invention is further characterized in that the mechanism for converting reciprocating to rotary motion is contained within the piston. Exemplary of the general class of engines with which the invention is concerned are the disclosures appearing in U.S. Patents 1,042,505 and 1,318,471.

Conventional two-cycle engines provide reliable lightweight power plants whose overall advantages are well-known as evidenced by their widespread usage in outboard motors, lawn mowers, power saws, etc. Notwithstanding their obvious popularity, two-cycle engines of the type presently available are uneconomical particularly at low throttle settings due to their high fuel and oil consumption rates.

The high fuel consumption is due, in part, to the necessity of establishing a flow path in the combustion cylinder that will bring the fresh charge above the burnt charge to insure proper scavenging. The flow path is pre-established, for a particular combustion chamber configuration, to produce maximum power output while maintaining losses at a minimum due to both the inlet and outlet combustion ports being open at the same time. The pre-established flow path is normally provided either by staggering the inlet and outlet ports or forming a deflector on the piston head whereby the incoming charge will be caused to loop through the combustion chamber rather than short circuiting directly between the ports. Accordingly, which ever of these methods is utilized to insure proper scavenging at maximum power output settings, it is apparent that at lower power settings a greater proportion of the fresh charge will be lost.

The high oil consumption rate of conventional two-cycle engines is due, primarily, to the fact that the oil supplied for lubrication is mixed with the fuel and is burned, preventing its re-use. Additionally, the maintenance of a proper fuel-oil ratio is critical to avoid overheating and possible seizure on the one hand and a smoking exhaust coupled with carbon deposition and plug fouling, on the other.

In many instances it is desirable to provide, in addition to the rotating power take-off, a reciprocating drive take-off from a two-cycle engine to drive various accessories such as sabre saws, air compressors and the like. The usual manner of providing such a reciprocating take-off involves a lost-motion connection between the driving piston and output member such as illustrated in



U.S. Patent 2,545,999. Previous attempts to couple a reciprocating output member directly to a working piston have been generally unsuccessful due to the fact that the output member must extend through the combustion chamber wall where high pressures make it virtually impossible to obtain a tight seal thus resulting in a loss of compression.

In known two-cycle engines of the type shown in U.S. Patent 1,042,505 the passageway interconnecting the pumping and combustion chambers is valved by the combustion piston head and the passageway remains in open communication with the pumping chamber at all times resulting in the volume of the transfer passage being added to the residual or clearance volume of the pumping chamber. This arrangement greatly reduces the efficiency of the pumping chamber which is reflected in decreased engine performance.

## SUMMARY OF THE INVENTION

A primary object of the invention is to provide a light, compact two-cycle engine having greatly reduced fuel and oil consumption rates.

Another object is to provide a reciprocating power take-off that is integral with the working piston of a two-cycle engine but which does not require sealing means sufficient to withstand combustion pressures.

It is among the further objects of the invention relating to two-cycle engines to provide separate fuel and lubrication systems; to provide an internally cooled piston; to provide an engine that generates relatively low bearing loads; to provide an integrated pumping chamber having greatly reduced residual or clearance volume; to provide an improved air cooling system; and to provide a positive induction system having a minimal residual volume.

The foregoing and other objects are achieved by the novel engine herein disclosed which includes a single piston having opposed piston heads mounted for reciprocation within a single cylinder. The opposed piston heads cooperate with opposite ends of the cylinder to define oppositely disposed combustion and pumping chambers. The engine crankcase and the lubrication therefor are contained wholly within the cylinder and between the piston heads thus obviating the necessity of mixing oil with the fuel.

The engine herein disclosed has a very high bore-stroke ratio which may be on the order of 4:1. Because of the extremely short stroke, as compared to conventional engines, the combustion chamber inlet and exhaust ports may be located at a common level and the chamber properly scavenged without the necessity or desirability of inducing a loop flow path within the chamber. Thus, the shortest flow path between inlet and exhaust ports which would be fatal to the conventional long stroke engine having a bore stroke ratio in the range of 1:1–5:3 is actually desirable in an engine of the type herein disclosed having a very high bore-stroke ratio. Because of the fact that looping of the incoming charge is not required more complete scavenging, at all power settings, is obtained resulting in more economical fuel consumption. Additionally, because the incoming charge is not looped through the chamber, it passes in more intimate cooling contact with the combustion piston head which may have a generally symmetrical cross-sectional configuration.

Since the crankcase is totally enclosed within the cylinder and between the piston heads, lubricating oil is only required therein and need not be mixed with the fuel resulting in a substantial reduction in oil consumption and carbon deposition. The motion conversion mechanism within the piston also includes a counterweight which not only reduces main bearing loads but induces a circulation

of oil mist which removes heat from the hot combustion piston head and transfers it to the cooler pump piston head and piston walls.

The reciprocating power take-off is formed integrally with the pump piston head end of the piston and extends through a wall of the pumping chamber which, because of the lower pressures developed therein, may be readily sealed.

The passageway intercommunicating the pumping and combustion chambers is valved not only by the combustion piston head at the combustion chamber end thereof but also at the pumping chamber end whereby the volume of the passageway is not added to the residual volume of the pumping chamber.

A unique air cooling system is disclosed herein which includes baffle means coacting with a centrifugal type fan in such manner as to direct incoming cooling air across the crankcase and pumping portion of the cylinder before exhausting the same over the hot combustion cylinder portion.

## DESCRIPTION OF THE DRAWINGS

The manner in which the foregoing and other objects are achieved will become more apparent from the ensuing description considered in conjunction with the drawings wherein:

FIGURE 1 is a cross-sectional elevation of an engine constructed in accordance with the invention;

FIGURE 2 is a perspective view of the engine, sectioned as in FIGURE 1; and

FIGURE 3 is a view similar to FIGURE 2 wherein the section is taken at right angles to that of FIGURE 2.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

A two-cycle engine **10**, constructed in accordance with the present invention, includes a finned cylinder **12** whose inner bore **14** is divided into combustion and pumping chambers **16**, **18** by a single reciprocating piston **20** having opposed combustion and pumping piston heads **22**, **24**.

The reciprocating motion imparted to piston **20** during the power stroke thereof is connected to a rotary output or crankshaft **26** by motion conversion means **28** located within cylinder **12** and between piston heads **22** and **24** thus forming a complete crankcase **29** within the piston. Motion conversion means **28** comprises a wrist pin **30** and connecting rod **32** interconnecting the piston and crankshaft. Oil to lubricate motion conversion means **28** and to provide for the internal cooling of the piston may be admitted to the crankcase via a suitable fitting **34**. Counterweights **36** are contained within the piston crankcase and not only alleviate main bearing loads imposed on crankshaft **26** journalled in the peripheral cylinder wall but also act to convey oil mist to the hot working head **22** to transfer heat therefrom to the cooler pump head, piston wall and cylinder wall.

A reciprocating power take-off shaft **38** is formed integrally with pump head **24** and extends through sealed opening **40** in pumping chamber **18**. It will be noted that combustion gas pressures are thus directly usable for driving accessories requiring a reciprocating input without creating additional loads on the crankshaft bearings.

Oil control rings **42** are carried by piston **20** to seal crankcase **29** from the pumping and combustion chambers. Because of the extremely short stroke length of piston **20**, the oil control ring adjacent the combustion end thereof may be so positioned that the same lies below the combustion chamber inlet and exhaust ports at the upper extremity of the stroke. It will be apparent therefore that the oil control rings are in constant circumferentially continuous sealing contact with the cylinder bore at all times which prevents any oil from being lost into the combustion port areas as would be the case if the upper ring passed over the ports. Additionally, these rings return the oil that splashes through the openings **44** provided in the piston wall for installation of the crankshaft and connecting rod.



Carburetor **46** supplies the fuel charge to pumping chamber **18** via passage **48** controlled by a conventional reed valve **50** on the upstroke of piston **20**. On the downstroke of the piston, the charge flows through reed valve **52** into passageway **54** and, as the combustion chamber inlet port **56** is uncovered, into combustion chamber **16** to force the burnt charge out exhaust port **58**. It is of particular importance that the scavenging flow path is permitted to follow the generally symmetrical contour of the combustion piston head which not only acts to cool the same but because a looped path is not induced, short circuiting at low power settings is eliminated.

Upon the next upstroke of the piston, the fresh charge is compressed and ignited by spark plugs **60** after which time the cycle described is repeated.

A magneto **62** and centrifugal blower **64** are mounted on crankshaft **26**. A generally planar baffle **66** is positioned adjacent the upper end of the cylinder and cooperates with curved baffle **68** and blower **64** to direct incoming cooling air across the lower and intermediate cooler portions of the finned cylinder before the flow direction of the same is reversed to exhaust across the upper hotter portions of the cylinder.

Although a specific embodiment of the invention has been described, numerous modifications within the scope of the appended claims will be suggested to those skilled in the art.

I claim:

**1.** A two-cycle engine comprising; a cylinder, a hollow piston mounted for reciprocation within the bore of said cylinder and having piston heads at opposite ends thereof, said piston heads and corresponding end portions of said cylinder defining aligned pumping and combustion chambers, each of said chambers having valved inlet and exhaust ports, sealing means carried by said piston for reciprocating movement therewith wholly intermediate the ports in the respective chambers for constantly sealing the hollow interior of said piston from said chambers at all piston positions, a rotary output shaft journalled in said cylinder and extending through the interior of said piston, reciprocating-to-rotary motion conversion means positioned within said piston and interconnecting the same with said shaft, means for introducing lubricant into the sealed interior of the piston, passage means interconnecting the exhaust of the pumping chamber and the combustion chamber inlet, and means for introducing a fuel change to the pumping chamber.

**2.** The engine of claim **1** wherein the bore-stroke ratio of said engine is at least 2:1.

**3.** The engine of claim **2** wherein the combustion chamber inlet and exhaust ports are located in a substantially common plane and the piston head working in said combustion chamber is substantially symmetrical in cross-section.

**4.** The engine of claim **2** including cooling fins on said cylinder, a fan mounted on said shaft, and baffle means mounted on said engine for directing incoming cooling air across the pumping chamber end of the cylinder and exhausting the same across the combustion chamber end thereof.

**5.** The engine of claim **2** including a counterweight mounted on said shaft within said hollow piston.

**6.** The engine of claim **2** including a reciprocating output shaft integral with said piston and extending through a wall of said pumping chamber.

**7.** The engine of claim **2** wherein said combustion chamber inlet and exhaust ports are valved by said piston and said pumping chamber inlet and exhaust ports are provided with individual pressure actuated valves.

**8.** The engine of claim **2** wherein said sealing means are maintained in constant circumferentially continuous contact with said cylinder bore.

9. A two-cycle engine comprising; a piston having opposed combustion and pumping heads mounted for reciprocation within a cylinder bore and defining therewith opposed combustion and pumping chambers and a crankcase intermediate said chambers, inlet and exhaust ports in said combustion chamber occupying a substantially common plane, said combustion head valving said ports and being substantially symmetrical in cross-section whereby the scavenging flow tends to follow the shortest path between said ports, seal means in constant sealing engagement between said piston and cylinder bore for isolating said crankcase from said ports at all piston positions, fuel passage means interconnecting the outlet of said pumping chamber and the inlet of said combustion chamber, valve means controlling communication between said pumping chamber and passage means, and means for supplying fuel to said pumping chamber.

10. The engine of claim 9 wherein the bore-stroke ratio of said engine is at least 3:1.

11. The engine of claim 10 including means for drawing cooling air across the pumping chamber and crankcase portion of said engine and exhausting the same across the combustion chamber portion.

12. The engine of claim 11 including a rotary output shaft, and means within said crankcase connected to said shaft for rotating the same.



13. The engine of claim 12 including a reciprocating output shaft integral with said piston and extending through a wall of said pumping chamber.


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WENDELL E. BURNS, Primary Examiner

U.S. Cl. X.R.

123—41.65, 41.66, 74, 197

# UNITED STATES PATENT OFFICE

# CERTIFICATE OF CORRECTION

Patent No. 3,487,818 Dated January 6, 1970

Inventor(s) John J. Dineen

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In Column 4, line 50: Please change "change" to --charge--.

SIGNED AND
SEALED
JUN 23 1970

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents