Oct. 1, 1963 E. C. KIEKHAEFER 3,105,474

TWO-CYCLE INTERNAL-COMBUSTION ENGINE

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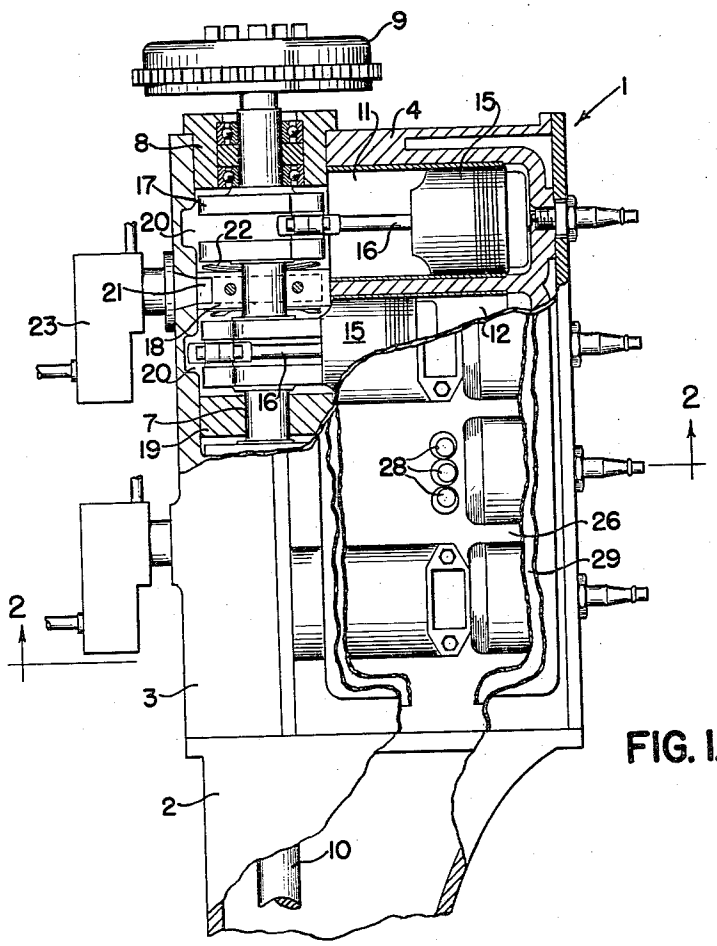


FIG. 1.

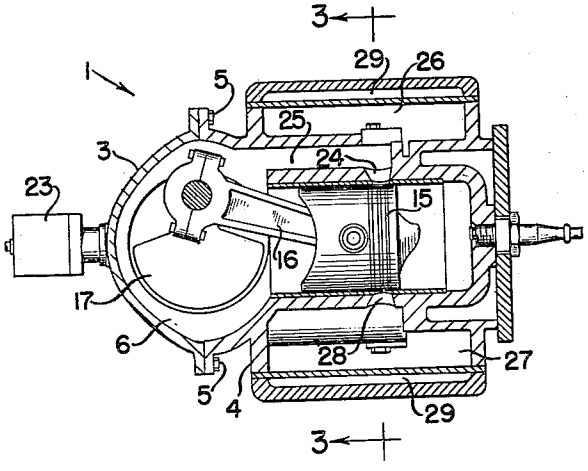


FIG. 2.

INVENTOR.
ELMER C. KIEKAEFER
BY
ANDRUS & STARKE
Attorneys

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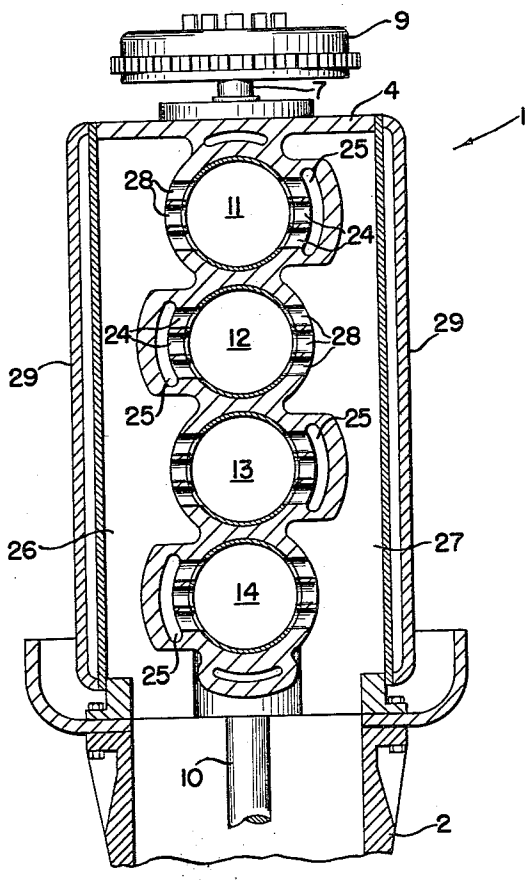


FIG. 3.

INVENTOR.
ELMER C. KIEKAEFER
BY
ANDRUS & STARKE
Attorneys

United States Patent Office

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TWO-CYCLE INTERNAL-COMBUSTION ENGINE

Elmer C. Kiekhaefer, Cedarburg, Wis., assignor, by mesne assignments, to Kiekhaefer Corporation, Chicago, Ill., a corporation of Delaware

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4 Claims. (Cl. 123—59)

This invention relates to two-cycle, internal-combustion engines and more particularly to the fuel intake and exhaust manifolding of multi-cylinder, two-cycle engines.

Ordinarily the cylinders of a two-cycle engine, disposed in-line or in a bank, all exhaust to one side of the cylinder block while the fuel for combustion is received from the opposed side of the block. In operation the exhaust side of the block becomes relatively hot while the intake side remains relatively cool. The temperature differential between opposed sides of the block may reach as high as 500° F. introducing thermal stresses which may distort or otherwise damage engine parts. It is generally an object of this invention to provide a two-cycle engine structure wherein the temperature differential between opposed sides of the block is substantially reduced or virtually eliminated resulting in a substantial symmetry of thermal expansion as between the sides of the engine.

According to this invention, the block of a two-cycle, internal-combustion engine comprises at least one bank of a plurality of cylinders disposed in line. Each cylinder of the bank is provided with a fuel inlet and opposed exhaust outlet which open to the respective sides of the bank. The fuel inlets and exhaust outlets of the several cylinders respectively alternate on adjacent cylinders between the respective sides of the bank to provide a substantial symmetry of thermal expansion from one side of the engine to the other.

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

In the drawings:

FIG. 1 is a side elevation with parts broken away and sectioned of a two-cycle, internal-combustion engine which embodies the invention;

FIG. 2 is a section taken generally on line 2—2 of the engine of FIG. 1; and

FIG. 3 is a section taken generally on line 3—3 of FIG. 2.

Referring to the drawings, the multi-cylinder, two-cycle engine 1 is shown mounted on the upper end of a drive shaft housing 2 of an outboard motor, not shown, and includes the crankcase member 3 and cylinder block 4 which are secured together by a plurality of bolts 5 to provide a closed crankcase 6. The crankshaft 7 extends vertically through the crankcase 6 and is journally supported within suitable bearing units 8 disposed at the upper and lower extremities of the engine between crankcase member 3 and the cylinder block 4. The crankshaft 7 carries the flywheel 9 at the upper end thereof and is drivingly connected at the lower end thereof to a drive shaft 10 extending downwardly within the drive shaft housing 2.

The multi-cylinder engine 1 is shown as having a bank of four in-line cylinders 11, 12, 13 and 14 within each of which a piston 15 is slidably disposed. A connecting rod 16 connects the respective pistons 15 to the corresponding cranks 17 spaced longitudinally of the crankshaft 7. The cranks 17 are spaced angularly with respect to the axis of crankshaft 7 to provide the desired firing order for the respective cylinders.

Upper and lower bearing members 18, disposed intermediate cranks 17 for the upper and lower pairs of cylinders, and the central bearing member 19 are disposed in the crankcase 6 and divide the crankcase into separate crankcase chambers 20 corresponding to the respective cylinders. Each bearing member 18 is provided with a fuel induction passage 21 which opens into the adjacent chambers 20 through suitable ports, not shown, controlled by reed valves 22. The fuel mixture for engine combustion enters passage 21 from a carburetor 23 carried by the crankcase member 3.

In the operation of the engine 1, the valves 22 control the flow of fuel mixture into the chambers 20 in accordance with piston travel. The valves are opened for induction of fuel into a given chamber 20 with each upstroke of the corresponding piston 15 and closed during each downstroke of the piston. The downwardly moving piston effects a precompression of the fuel charge drawn into the chamber 20.

The respective cylinders are provided with fuel inlet ports 24 which open into a corresponding transfer passage 25. The transfer passages 25 are formed in the cylinder block 4 and project into and extend through either of the exhaust cavities 26 and 27 as will be explained hereinafter. Each passage 25 extends adjacent and generally parallel to the corresponding cylinder and places the cylinder in communication with the corresponding crankcase chamber 20. As shown in the drawings, the inlet ports 24 and the transfer passages 25 alternate to opposed sides of the cylinder bank as between adjacent cylinders in the bank.

Each of the respective cylinders of engine 1 are provided with exhaust ports 28 in the wall of the cylinders oppositely from the inlet ports 24. The exhaust ports 28, like inlet ports 24, alternate to opposed sides of the cylinder bank as between adjacent cylinders in the bank and open into exhaust cavities 26 and 27 formed in the block 4 on the respective sides of the bank of cylinders. Exhaust cavities 26 and 27 are closed off by water-cooled plate assemblies 29 and communicate with the drive shaft housing 2 which conducts the exhaust products from the engine 1.

With the exhaust ports 28 of adjacent cylinders in engine 1 opening to opposed sides of the cylinder block into exhaust chambers 26 and 27 respectively, the relatively hot exhaust products from the engine cylinders move to both sides of the block 4 for conduction from the engine. As a result, the respective sides of engine 1 are substantially uniformly heated by the exhaust gases to provide a substantial symmetry or balance of thermal expansion from one side of the engine to the other and substantially eliminate problems due to distortion of engine parts.

Since the fuel inlets 24 of adjacent cylinders also alternate to opposed sides of the cylinder block 4, the thermal balance from one side of the engine to the other remains undisturbed. With the transfer passages 25 projecting into the exhaust chambers 26 and 27, a heat interchange may be expected to take place between the relative hot exhaust gases within the chambers and the relatively cool fuel mixture moving within the passages to enhance engine efficiency.

The arrangement of this invention with the exhaust ports 28 of adjacent cylinders opening to opposed sides of the cylinder bank, offers more room than is ordinarily available in engines where the exhaust ports all open to one side of the block so it becomes physically possible to bring out separate exhaust pipes for each cylinder if it is desired to tune the exhaust of each cylinder to attain maximum power output. It will be noted, too, that the arrangement of this invention results in an engine structure which is equally wide to either side of a plane through the axis of the several cylinders in the

bank which is of considerable assistance when designing and styling a cowl for the engine.

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 two-cycle internal-combustion engine having at least one bank of a plurality of cylinders disposed in line, each cylinder having a fuel inlet and opposed exhaust outlet in the cylinder wall opening to the respective sides of the bank, said fuel inlets and exhaust outlets respectively alternating on adjacent cylinders between the respective sides of the bank to provide for substantial symmetry of thermal expansion from one side of the engine to the other in operation.

2. In a two-cycle internal-combustion engine, a cylinder block having a bank of a plurality of cylinders disposed in line and an exhaust cavity on each side of the cylinder bank, each cylinder having a fuel inlet and an exhaust outlet, said exhaust outlets respectively alternating on adjacent cylinders between the respective sides of the bank and opening into the corresponding exhaust cavity to provide for a substantial symmetry of thermal expansion from one side of the engine to the other in operation.

3. The invention as set forth in claim 2 wherein the fuel inlet for each cylinder is disposed oppositely from the exhaust outlet.

4. In a two-cycle internal-combustion engine, a crankcase, a cylinder block adapted to be joined to the crankcase and having a bank of a plurality of cylinders disposed in line and an exhaust cavity on each side of the cylinder bank, said crankcase having separate chambers corresponding to each cylinder and said chambers being adapted to receive a fuel mixture for precompression, each cylinder having a fuel inlet and opposed exhaust outlet, said fuel inlet and exhaust outlet respectively alternating on adjacent cylinders between the respective sides of the bank and said exhaust outlets opening into the respective exhaust cavities, and transfer passages respectively connecting the crankcase chambers and fuel inlet of the corresponding cylinders for conducting the fuel mixture to the cylinders and extending through the exhaust cavities, said passages and adjacent exhaust cavities placing the relatively cool fuel mixture and the relatively hot exhaust gases into heat interchange relationship whereby to enhance engine efficiency.

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