

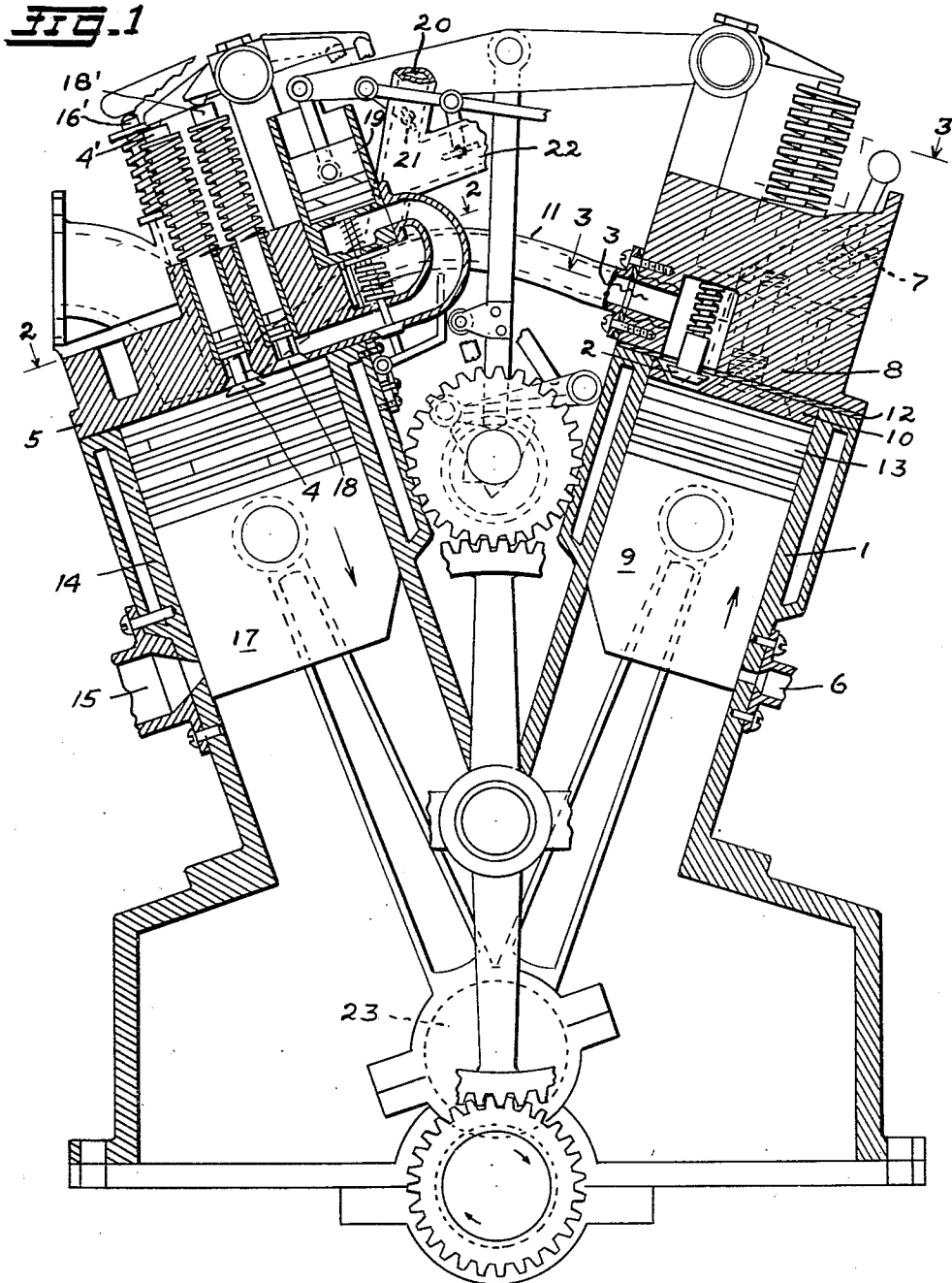
Nov. 6, 1956

C. E. CASS
TWO STROKE CYCLE INTERNAL COMBUSTION
ENGINE WITH PUMP COMPRESSION

2,769,435

Filed Feb. 28, 1951

2 Sheets-Sheet 1



INVENTOR

Charles E. Cass

Nov. 6, 1956

C. E. CASS
TWO STROKE CYCLE INTERNAL COMBUSTION
ENGINE WITH PUMP COMPRESSION

2,769,435

Filed Feb. 28, 1951

2 Sheets-Sheet 2

FIG. 2

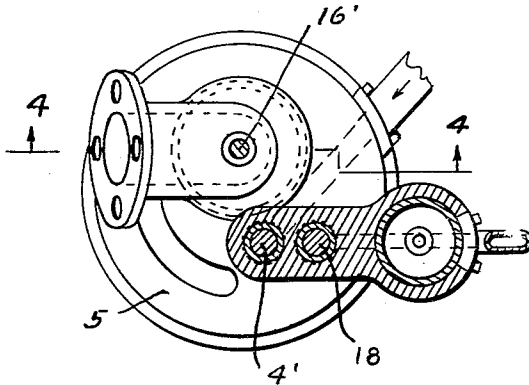


FIG. 3

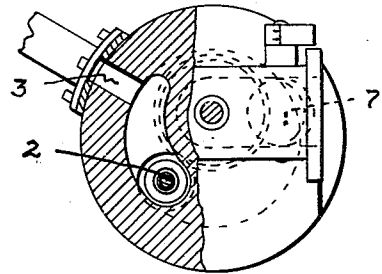
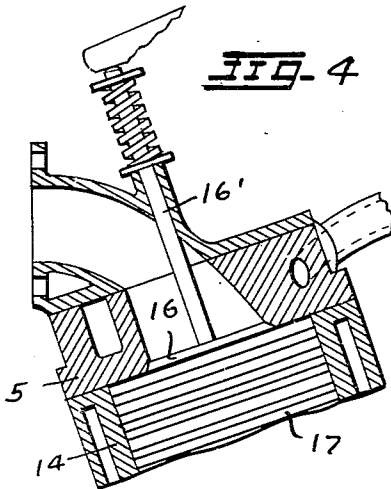


FIG. 4



INVENTOR

Charles E. Cass

1

2,769,435

TWO STROKE CYCLE INTERNAL COMBUSTION ENGINE WITH PUMP COMPRESSION

Charles E. Cass, Roseburg, Oreg.

Application February 28, 1951, Serial No. 213,109

9 Claims. (Cl. 123—68)

This invention relates to the production of power in internal combustion engines of the reciprocating piston type, arranged as shown in the accompanying drawings and more fully described as follows:

Its objectives are better fuel economy and the use of gasoline, oil fuel or alcohol in lightweight engines.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth or be apparent in the following description thereof, and in the accompanying drawings, in which:

Figure 1 is a sectional elevation taken through cooperative fuel-combustion and air-compressing cylinders of the engine.

Figure 2 is a fragmentary plan view taken at the line 2—2 in Figure 1.

Figure 3 is a partly sectional view taken at the line 3—3 in Figure 2.

Figure 4 is a section taken at the broken line 4—4 in Figure 2.

A divided cycle is used, with primary and secondary cylinders 1 and 14 respectively. The primary cylinders 1 compress air to the desired high pressure, forcing the air through a check valve 2 into and through a transfer passage 3 to the transfer valve 4 in the secondary cylinder head 5. I prefer that the primary cylinder have an auxiliary port 6 at the outer end of piston travel, to admit extra air.

A damper 7 provided in the air intake passage 8 to the head of the primary cylinder 1 is closable as a valve to shut off the air supply through the passage 8, whereby the outward (suction) stroke of the piston 9 in the cylinder 1 may create a high degree of vacuum in the cylinder until the piston uncovers the port 6 as the stroke ends. The damper 7 is arranged to be closed only during a starting of the engine when the engine parts are relatively cold, and the effect is to provide such a high velocity impact flow of air into the rarified air of the cylinder through the open port 6 as the suction stroke ends as will so preheat the air charge in the cylinder that the addition to the air of the heat of compression in the succeeding compression stroke will provide the delivery of air to the secondary (power) cylinder 14 through the passage 3 at such a relatively high temperature that a starting of the "cold" engine may be readily effected without need for the more complicated auxiliary starting devices heretofore used in the art. After the started engine is running "hot," the valve 7 is opened and left open, and the port 6 thereafter functions to insure the provision of the fullest possible charge of air at substantially atmospheric pressure in the chamber of the cylinder 1 at the end of each suction stroke.

The primary piston 9 and the cylinder head 10 and the passage 3 may be appropriately insulated, as respectively indicated at 11 and 12 and 13, to provide for a maximum retention of the heat of compression provided with the air delivered directly through the passage 3 to the corresponding secondary cylinder 14 which comprises a working cylinder of the engine. The air intake valve for the

2

passage 8 and the discharge valve 2 for the compressor cylinder 1 are of the spring-loaded type, and are operative at ports in the cylinder head to reduce terminal (compression) clearance to a minimum, it being noted that the valve for the passage 8 is under mechanical control and that the valve 2 comprises a pressure-opened check valve.

A working (secondary) cylinder 14 provides a combustion-and-expansion chamber having its capacity at the end of the power stroke greater than the capacity of the compression chamber of the compressor (primary) cylinder 1 at the end of an air-intake stroke, whereby the temperature and pressure of the exhaust gases are less than if the air compression ratio in the compressor equaled the working expansion ratio in the power cylinder, and an important improvement in the efficiency of the use of the hydro-carbon fuel results. In the present structure, the ratio of the capacity of the power cylinder to that of the compressor cylinder is approximately 1.5 to 1.

Part of the exhaust gas passes through ports 15 in the secondary cylinder at the outer end of piston travel, to give rapid exit of exhaust, and reduce heat load on exhaust valve, which opens after piston uncovers exhaust port 15. On the exhaust stroke, piston 17 travels almost to cylinder head 5 forcing out nearly all burned gas and leaving a very small combustion space, exhaust valve 16 closes before secondary piston 17 reaches inner end of piston travel, the fuel charge is admitted into the combustion chamber through valve 18 at or near inner end of secondary piston travel. Then compressed air charge is admitted into the combustion chamber through valve 4 mixing with the fuel thereby diffusing and diluting the fuel charge and rapidly bringing the mixture to high pressure, also adding some heat by impact of the air stream.

The valves 4 and 16 and 18 of the power cylinder are of the poppet type and respectively have usual spring-loaded stems 4' and 16' and 18' which are operative in appropriate cyclic synchronism from the engine shaft.

I prefer to supply the fuel for each power cylinder 14 from an individual pump, such as the piston pump 19, which draws partially carbureted fuel from a carburetor (not shown) through a passage 20 provided with an adjustable control valve 21 which is cooperative with a valve in a branch passage 22 for varying the proportion of air in the air-borne fuel delivered to and from the pump 19 comprising the throttle control for the fuel supply to the power cylinder. This fuel-throttling control does not alter the compression ratio in the power cylinder as the power output of the engine varies.

Combustion in the power cylinder 14 starts in that part of the mixture that had the best proportion of fuel and air, and continues as heated fresh air is supplied by the primary piston 1 through the open said transfer valve until transfer valve 4 closes, or the fuel content is consumed. The crank pins 23 are so arranged that the secondary piston 17 is traveling outward while the primary piston is still on the compression stroke supplying air to the secondary cylinder 14. I prefer about 40° lag in the primary crank pin. The action of the piston 9 of the air compressor cylinder 1 preferably lags behind the action of the piston 17 of the power cylinder 14 by about 40°, this being accomplished in the present structure, in which the pistons of the respective cylinders are operative from the same crank pin, by disposing the unitarily related cylinders 1 and 14 to have their axes intersecting in the axis of the common crank shaft at an included angle of the order of 40°, this relation being shown in Figure 1 of the drawings in which, in terms of the indicated direction of rotation of the crank shaft, the piston 17 has begun its working stroke and the compression stroke of the piston 9 remains to be completed, both by reason of the disposal of the common crank pin

3

axis in the bisection line of said lag angle. The required synchronized control of the four poppet valves of the assembly is effected by rocker arms which are actuated through push-rod and cam and gear connections with the crank shaft, in accordance with the indicated arrangement of Figure 1.

In the present engine, the full compression of the combustion-supporting air before fuel is introduced into it permits the operation of the engine at an optimum compression ratio which is greater than that possible in a working cylinder in which fuel is added before compression is completed; the present power cylinder is able to operate at the relatively high compression ratio of about 12 to 1. The operation of this engine at such a high compression ratio is made possible by the novel feature that the fuel is introduced into the power cylinder as exhaust ends and before the precompressed and heated air is introduced from the air compressor 1. Also, noting by reference to the relation of parts shown in Figure 1 of the drawings, that the fuel valve has just closed and that the air supply valve from the compressor has just opened, it will be understood that combustion has been initiated by the inflow of hot compressed air into the confined space between the piston and the cylinder head.

I claim:

1. In an internal combustion engine, a power cylinder having a piston reciprocatively operative therein, an air compression cylinder having a piston reciprocatively operative therein, means providing a passage directly connecting the cylinders solely through their heads for a direct delivery of compressed air from the compression cylinder to the power cylinder, a normally closed spring-loaded pressure-controlled check valve operative in the inlet end of said passage, a normally closed spring-loaded poppet valve operative at the discharge end of said passage, an inlet port for fuel under pressure at the head of the power cylinder, a normally closed spring-loaded poppet valve operative at said fuel inlet port, and means arranged for actuation in cyclic synchronism with the movement of the piston of the power cylinder to successively open the fuel inlet valve and the air inlet valve when and after the piston has reached the limit of its stroke adjacent the head.

2. A structure in accordance with claim 1 having a pump means supplying partially carbureted hydrocarbon fuel at the fuel inlet port whereby the compressed air subsequently received by the cylinder through the opened air inlet port is arranged to progressively supply a major portion of the required combustion-supporting air to the delivered fuel.

3. In an internal combustion engine, a power cylinder having a piston reciprocatively operative therein, an air compression cylinder having a piston reciprocatively operative therein, means providing a passage directly connecting the cylinders solely through their heads for a direct delivery of compressed air from the compression cylinder to the power cylinder, a normally closed spring-loaded pressure-controlled check valve operative in the inlet end of said passage, a normally closed spring-loaded poppet valve operative at the discharge end of said passage, an inlet port for fuel under pressure at the head of the power cylinder, a normally closed spring-loaded poppet valve operative at said fuel inlet port, an exhaust port provided in the head of the power cylinder, a normally closed spring-loaded poppet valve operative at said exhaust port, and mechanical means arranged for actuation in cyclic synchronism with the movement of the piston of the power cylinder to sequentially open and close the exhaust valve as the piston approaches the end of its stroke adjacent the cylinder head and to open the fuel inlet valve substantially at said end of the piston stroke and to finally open the air inlet valve during a portion of the return stroke of the piston.

4. In an internal combustion engine, a power cylinder

4

having a piston operative therein, an air compression cylinder having a piston operative therein for providing compressed air at a relatively high pressure, means providing an air-delivery passage directly connecting the cylinders solely at their heads, normally closed check valves at the extremities of said passage, a normally open intake duct terminating at an intake port in the head of said air compression cylinder, a normally closed spring-loaded intake check valve at said intake port for opening during subatmospheric pressure conditions in the cylinder, a normally open valve in said duct for setting to shut off the air supply through the duct during a starting of the engine, and an unvalved air intake port in the cylinder side intermediately of its length.

5. A structure in accordance with claim 4 having a pump means deriving partially carbureted hydrocarbon fuel from a carburetor and delivering the same at the fuel inlet port, and means beyond the pump adjustable to vary the amount of air in the carbureted fuel delivered at said fuel inlet port.

6. In an internal combustion engine, a power cylinder having a piston operative therein, an air compressor cylinder having a piston operative therein for providing the power cylinder with solely compressed air at a relatively high pressure while retaining the heat of its compression, means providing an air-delivery passage directly connecting the cylinders at their head ends, normally closed check valves at the extremities of said passage, a duct providing an intake port at the head end of said air compression cylinder, a normally closed spring-loaded intake check valve at said intake port for opening during sub-atmospheric pressure conditions in the cylinder, a manually adjustable choke valve in said duct for setting to shut off the air supply through the duct during a starting of the engine and an unvalved air intake port in the side of the compressor and arranged for its uncovering by the retracted compressor piston while the latter is at substantially the end of its intake stroke.

7. In an air compressor, a cylinder having a piston operative therein for providing compressed air at a relatively high pressure, means providing an air-delivery passage from the cylinder head, a normally closed pressure-controlled check valve operative at the intake end of said passage, a normally open air supply duct terminating at a port in the head of said cylinder, a normally closed spring-loaded poppet valve operative at said port for opening during sub-atmospheric pressure conditions in the cylinder, an unvalved air supply port in the cylinder side intermediately of its length and arranged for its uncovering by the retracted piston for directly connecting the cylinder with the atmosphere for the admission of air to the cylinder between its head and the piston during a limited portion of the piston suction stroke, and a normally open shut-off valve in said air supply duct arranged for its setting to temporarily and fully shut off the air supply through the duct for a charging of the cylinder with air received solely through said side supply port and before compression.

8. In an internal combustion engine of the two-stroke cycle type, a power cylinder having a piston operative therein, an air compressor cylinder having a piston operative therein for providing the power cylinder with solely compressed air at a relatively high pressure which retains the heat of its compression, means providing an air-delivery passage directly connecting the cylinders at their head ends, normally closed check valves at the extremities of said passage, a duct providing an intake port at the head end of said air compression cylinder, a normally closed spring-loaded intake check valve at said intake port for opening during sub-atmospheric pressure conditions in the cylinder, a normally open valve in said duct for setting to shut off the air supply through the duct during a starting of the engine, and means operative to initiate the delivery of carbureted fuel to the power cylinder at the end of the exhaust stroke of its piston and be-

5

fore the admission of the compressed air from the compressor cylinder to the power cylinder.

9. In an internal combustion engine, a power cylinder having a piston operative therein in exhaust and working strokes thereof, an air compression cylinder having a working space which is appreciably less than the working space of the power cylinder and having a piston operative therein with its suction and compression strokes of the same length as the strokes of the piston in the power cylinder, means providing an air-delivery passage directly connecting the cylinders solely at their heads, normally closed check valves at the extremities of said passage, an intake duct terminating at an intake port in the head of said air compression cylinder, a normally closed spring-loaded intake check valve at said intake port for opening during sub-atmospheric pressure conditions in the cylinder, and an unvalved air intake port in the cylinder side intermediately of its length and directly connected with atmosphere.

References Cited in the file of this patent

UNITED STATES PATENTS

543,094 Hopkins ----- July 23, 1895

583,075
633,878
673,109
675,796
682,567
733,350
1,126,613
1,137,142
1,250,950
1,305,581
1,536,780
1,891,083
2,058,705
2,349,967
2,383,565
2,674,401

96,726
194,697

6

Niebling ----- May 25, 1897
Mewes ----- Sept. 26, 1899
Bronder ----- Apr. 30, 1901
Schumm et al. ----- June 4, 1901
Reichenbach ----- Sept. 10, 1901
Wallmann ----- July 7, 1903
Brandstetter et al. ----- Jan. 26, 1915
Johnson ----- Apr. 27, 1915
Bolton ----- Dec. 25, 1917
Wolfard ----- June 3, 1919
Ensign ----- May 5, 1925
Dodge ----- Dec. 13, 1932
Maniscalco ----- Oct. 27, 1936
Javal ----- May 30, 1944
Rose ----- Aug. 28, 1945
Mallory ----- Apr. 6, 1954

FOREIGN PATENTS

Switzerland ----- Nov. 28, 1921
Great Britain ----- July 7, 1924