June 10, 1958 H. T. M. RICE 2,838,035

INTERNAL COMBUSTION ENGINE

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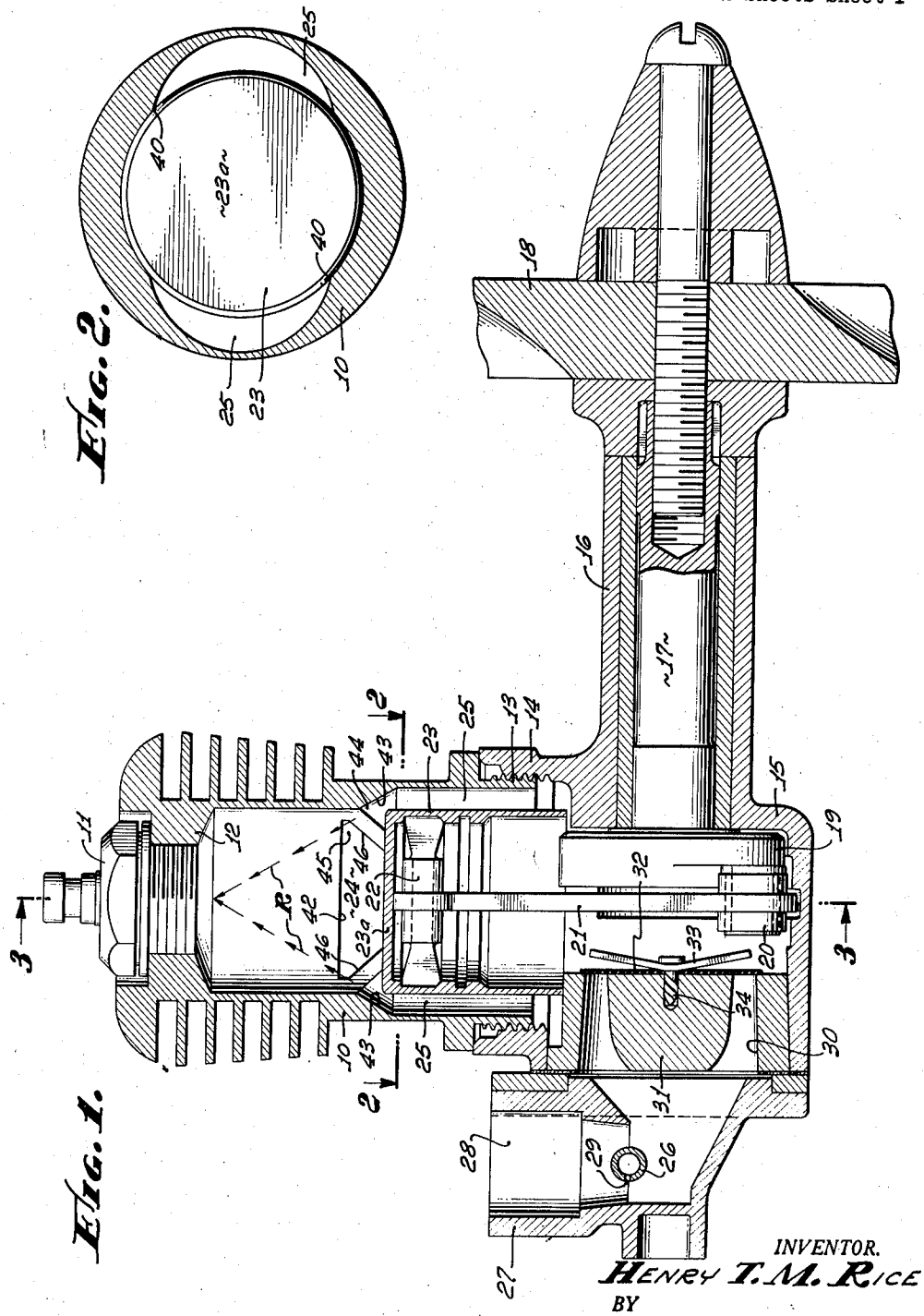


Fig. 2.

Fig. 1.

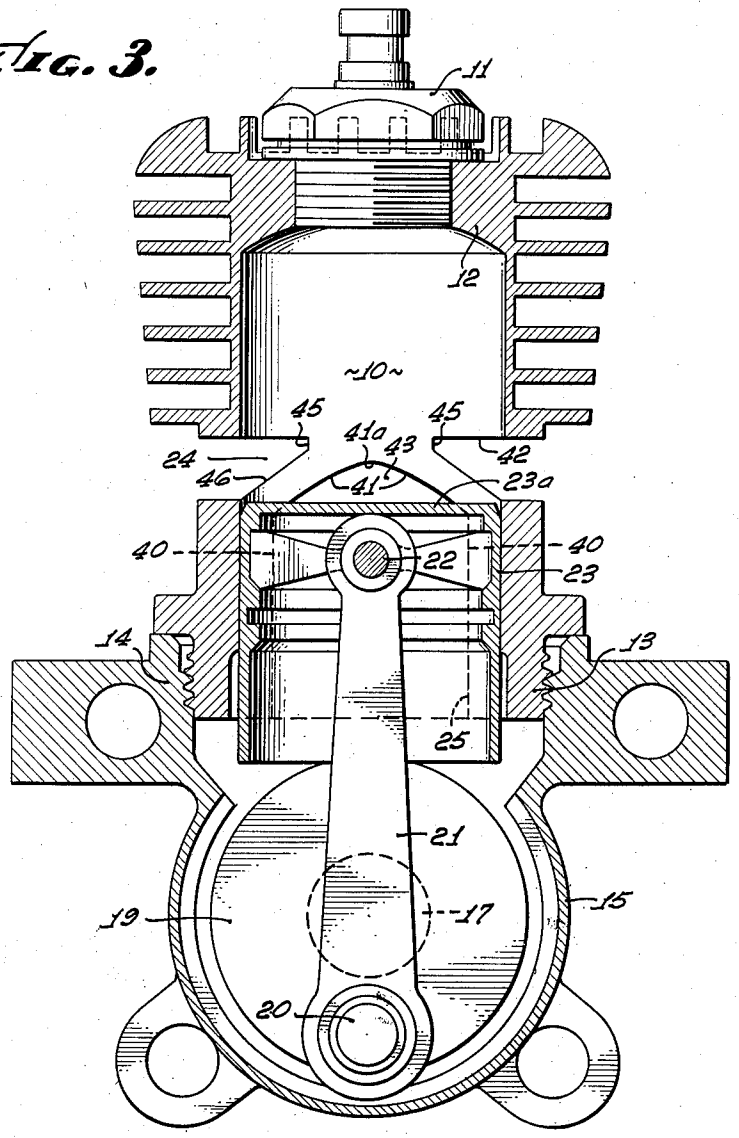
INVENTOR.
HENRY T. M. RICE
BY
Bernard Kriegel
ATTORNEY.

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FIG. 3.



INVENTOR.
HENRY T. M. RICE
BY
Bernard Kriegel
ATTORNEY.

United States Patent Office 2,838,035 Patented June 10, 1958

2,838,035

INTERNAL COMBUSTION ENGINE

Henry T. M. Rice, San Gabriel, Calif., assignor to Chemi-nol Corporation, Los Angeles, Calif., a corporation of Delaware

Application February 1, 1956, Serial No. 562,705

7 Claims. (Cl. 123—65)

The present invention relates to prime movers, and more particularly to internal combustion engines of the reciprocating type.

In certain kinds of two-cycle internal combustion engines, exhaust ports are provided in the cylinder wall, which are uncovered by the piston to permit the escape of exhaust gases and cause a reduction of the pressure in the cylinder to the extent at which a fuel charge can pass thereinto. Intake ports or passages may also be uncovered by the piston soon after the opening of the exhaust ports, to allow entry of the fuel charge into the cylinder and cause such charge to assist in expelling the exhaust gases.

Heretofore, particularly in small two-cycle engines, the fuel charge entering the cylinder through the intake ports has been directed across the piston at a sharp angle to its axis, causing some of the fuel charge to be lost through the exhaust ports. In addition, the manner of fuel charge entry into the cylinder results in incomplete discharge of exhaust gases through the exhaust ports, with consequent reduction in the power output of the engine. To minimize as much as possible interference and comingling between the fuel charge and exhaust gases, both the inlet passages or ports and exhaust ports have been made relatively narrow, which hinders the escape of spend gases from the cylinder and also limits the quantity of fuel charge entering the cylinder, all of which reduces the maximum power output of the engine.

Accordingly, it is an object of the present invention to prevent, or at least minimize considerably, loss of fuel through the exhaust ports of a two-cycle internal combustion engine.

Another object of the invention is to provide a two-cycle internal combustion engine, in which the fuel charge entering the engine cylinder through the intake ports or passages is caused to scavenge the exhaust gases from the cylinder more completely, while comingling between the fuel charge and exhaust gases is reduced considerably, resulting in a much cleaner fuel charge in the engine cylinder.

A further object of the invention is to provide a two-cycle internal combustion engine having inlet ports controlled by the engine piston, in which such inlet ports are of much bigger area than was heretofore available, thereby enabling the power of the engine to be increased and providing greater volumetric engine efficiency.

An additional object of the invention is to provide a two-cycle engine having exhaust ports with a much greater initial opening area than was heretofore available, thereby facilitating the rapid dissipation of the exhaust gases upon opening of the exhaust ports. In this connection, the more rapid dissipation of the exhaust gases makes it possible for the inlet ports to be opened by the piston at an earlier point in the operating cycle of the engine.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a longitudinal section through a two-cycle engine embodying the invention;

Fig. 2 is an enlarged cross-section taken along the line 2—2 on Fig. 1;

Fig. 3 is an enlarged section take along the line 3—3 on Fig. 1.

The engine specifically disclosed in the drawings is of the two-cycle type, and has been particularly designed for use by hobbyists, as, for example, for operating a powered airplane or automobile. However, the engine is of more general application.

The engine includes a cylinder 10 having a glow or spark plug 11 threaded into the cylinder head 12, the lower portion of the cylinder skirt being constituted as a threaded pin 13 threadedly received within a companion box 14 in the crankcase 15. The crankcase has a bearing support 16 extending in one direction in which a crankshaft 17 is rotatably mounted, this crankshaft being suitably coupled to the mechanism which is to be rotated, such as the propeller 18 of a model airplane. The crankshaft terminates in a crank arm 19 within the crankcase, which has a crank pin 20 receiving the big end of a connecting rod 21, the other end of the connecting rod being mounted on the wrist pin 22 of a piston 23 reciprocable in the cylinder 10.

The engine is of the two-cycle type, its cylinder having a pair of diametrically opposed exhaust ports 24 establishing communication between its interior and exterior, and also a pair of diametrically opposed inlet passages 25 running lengthwise of the lower portion of the cylinder. Each inlet passage 25 opens into the crankcase 15 at its lower end and into the cylinder at its upper portion between the exhaust ports 24. Fuel for the engine passes through a suitable fuel line 26 into the carburetor 27, which is suitably secured to the crankcase, the carburetor having an air inlet 28 into which air will pass for flow down past a side port 29 in the fuel line, drawing the fuel from the line and comingling therewith. The air and fuel mixture then flows through axial passages 30 in a fuel valve body 31, suitably secured to the crankcase 15, past a thin reed or disc 32, and into the crankcase, from where the fuel can flow upwardly through the inlet passages 25 into the cylinder 10 under the control of the piston 23.

The thin reed 32 functions as a one-way check valve, allowing fuel to flow from the inlet passages 30 into the crankcase 15, but preventing any fluid from passing in the reverse direction by closing against the valve body 31 over the passages 30. The check valve or reed disc 32 is secured to the valve body 31 by a stop 33 that diverges in a direction away from the valve body, which is suitably secured to the latter by a rivet or pin 34 passing through the center of the stop 33 and the reed 32. The stop 33 limits the extent of deflection of the reed 32 in a fuel passage opening direction.

As disclosed in the drawings, the piston 23 is at its crank end dead center, in which the piston head 23a is disposed below the upper ends of the inlet passages or ports 25 and the exhaust ports 24. When in this position, the inlet and exhaust ports are fully open, the exhaust gases having passed outwardly through the ports 24. The fuel charge from the crankcase 15 passes upwardly through

the inlet passages **25** into the cylinder **10**, the piston **23** moving upwardly as the crankshaft **17** rotates to close the inlet pasages 25 and then the exhaust ports 24, and then compressing the fuel charge in the cylinder against the cylinder head **12**, until the piston reaches the top of its stroke. The charge becomes ignited by the plug **11**, moving the piston **23** downwardly in the cylinder, such motion being transmitted through the connecting rod **21** and crankshaft **17** to the propeller **18**. As the piston **23** approaches its crank end dead center position, it uncovers the exhaust ports **24**, allowing the exhaust gases to pass outwardly therethrough. It then moves downwardly to a still greater extent in the cylinder, uncovering the upper ends of the intake passages **25**, which permits an additional fuel charge to pass upwardly into the cylinder **10**.

As specifically disclosed in the drawings, the diametrically opposed exhaust ports **24** are disposed substantially ninety degrees to the diametrically disposed inlet or intake ports **25**. It is to be noted that the exhaust ports **24** and the inlet ports **25** are axially displaced from one another, but that they overlap one another in arcuate or circumferential directions. Thus the longitudinal edges **40** of each inlet port 25 lie along lines that intersect the exhaust ports **24** to a substantial extent. In this manner, the exhaust passages **24** and inlet ports **25** are made of a greater arcuate extent than heretofore, but the fuel flowing through the inlet passages 25 into the cylinder **10** is still prevented from discharging into the exhaust ports **24**. Such objective is accomplished by tapering the sides **41** of the upper portion of each inlet passage toward each other, these sides terminating at a location **41***a* below the upper edges **42** of the exhaust ports. The inner tapered wall **43** of the upper portion of each inlet passage is directed upwardly generally along the line R at a relatively shallow angle to the axis of the cylinder, the fuel discharging from the upper end 44 of each inlet passage being directed against the cylinder head 12 or the ignition plug **11** in the cylinder head. In fact, the fuel discharges against the cylinder head or plug at the axis of the cylinder **10**.

In view of the arcuate overlapping of the exhaust ports 24 and the intake ports 25 and to prevent interference between the two, the upper portions **45** of the exhaust ports are made much wider, or of much greater arcuate extent, than was heretofore provided, the sides **46** of each exhaust port tapering downwardly toward each other in a direction generally parallel to the tapered sides **41** of the inlet ports **25**. Because of this arrangement, the piston **23** initially uncovers a much greater exhaust port area as the piston is moving downwardly in the cylinder on its power stroke, causing the exhaust gases to be dissipated more rapidly and more completely as the piston moves to its crank end dead center positions. The scavenging of the exhaust gases from the cylinder **10** is facilitated by the fuel entering the cylinder through the inlet ports **25**, as the piston moves downwardly to uncover their upper ends **44**. It is to be noted that the fuel charge is aimed along the lines R past the exhaust ports **24** and toward the head **12** of the cylinder at the axis of the latter. The fuel charge engages the cylinder head portion **11**, **12** and then spreads laterally and moves downwardly along the cylinder, pushing the exhaust gases down from the cylinder head to the exhaust ports **24**, thoroughly ejecting the exhaust gases from the cylinder. However, the piston **23** will have moved upwardly across the upper ends **41***a* of the inlet passages and across the upper ends **42** of the exhaust ports, to close them, before any fuel can be discharged from the exhaust ports. The directing or shooting of the fuel charge upwardly against the cylinder head portions **11**, **12** of the engine prevents it from spreading transversely across the cylinder, to be lost partially through the exhaust ports 24.

By virtue of the overlapping relationship between the exhaust and inlet ports **24**, **25**, the inlet ports can be made of a larger area and width, which permits a greater quantity of fuel charge to be ejected into the cylinder. In view of the fact that the exhaust ports **24** have been

arcuately extended, they are of a much larger area, upon being initially opened by the downwardly moving piston **23**, permitting dissipation of the exhaust gases from the cylinder to occur at a more rapid rate, which makes it possible to dispose the upper ends **41***a* of the intake ports **25** closer to the upper ends **42** of the exhaust ports, in which the intake ports are opened earlier as the piston **23** moves downwardly in the cylinder **10** on its power stroke. Such earlier opening of the intake ports **25** also insures the presence of a greater ejection of fuel into the cylinder, securing a greater horsepower output for the same size engine, and providing an engine with a greater volumetric efficiency.

In the operation of the engine, the piston **23** moves downwardly on its power stroke. When the head end 23*a* of the piston passes immediately below the upper ends **42** of the exhaust ports **24**, the latter are opened to a very great extent, because their upper portions **45** are much wider than exhaust ports heretofore available. This results in a greater initial dissipation of the exhaust gases through the open exhaust ports **24**. As soon as the head end of the piston uncovers the upper ends of the inlet ports **25**, the fuel charge is directed in the opposite streams R toward the cylinder head **12** and at the axis of the cylinder, the fuel charge spreading in a laterally outward direction across the cylinder head, and forcing the exhaust gases downwardly and out through the exhaust ports **24**. The piston **23** then moves upwardly to close the inlet ports **25** and then to close the exhaust ports **24**, compressing the fuel charge against the head, which is ignited when the piston is at substantially its uppermost position adjacent the cylinder head. The piston is then moved down in the cylinder on its power stroke, and as it moves below the exhaust ports **24**, they are opened, to provide a very large area for the dissipation of the exhaust gases, whereupon the inlet ports **25** are again opened to permit another fuel charge to be discharged up against the head of the cylinder, which spreads out again and drives the spent gases downwardly and out through the exhaust ports **24**, the piston **23** moving back up again to cover both sets of ports **24**, **25**.

Because a fuller exhaust is secured as a result of the larger initial exhaust port openings, and as a result of the scavenging action of the fuel in being discharged against the cylinder head portion **12**, to drive the exhaust gases downwardly out of the cylinder, a cleaner charge is provided in the cylinder on its compression stroke, which is ignited to create a greater pressure and a greater force in the cylinder than is secured when the compressed charge consists of a mixture of fuel and exhaust gases.

The inventor claims:

1. In an internal combustion engine: a cylinder having a head portion; a piston reciprocable in said cylinder; said cylinder having an exhaust port and a fuel inlet port arcuately displaced from said exhaust port; said piston being movable along both of said ports to open and close said ports; said inlet port having its sides converging toward each other in a direction toward said head portion and its discharge end portion inclined to the axis of the cylinder and lying in a path intersecting said cylinder head portion, whereby fuel discharged from said inlet port will strike said cylinder head portion, said inlet port providing an inclined nozzle of progressively increasing width as said inlet port is uncovered by said piston.

2. In an internal combustion engine: a cylinder having a head portion; a piston reciprocable in said cylinder; said cylinder having a pair of diametrically opposed exhaust ports and a pair of diametrically opposed fuel inlet ports arcuately displaced from said exhaust ports; said piston being movable along all of said ports to open and close the same; said inlet ports having their discharge end portions inclined to the axis of the cylinder and lying in paths intersecting said cylinder head portion, each of said inlet ports having its sides converging toward said

head portion, whereby fuel discharged from said inlet ports will strike said cylinder head portion with each of said inlet ports providing an inclined nozzle of progressively increasing width as said inlet port is uncovered by said piston.

3. In an internal combustion engine: a cylinder having a head portion; a piston reciprocable in said cylinder; said cylinder having a pair of diametrically opposed exhaust ports and a pair of diametrically opposed fuel inlet ports arcuately displaced from said exhaust ports; said piston being movable along all of said ports to open and close the same; said inlet ports having their discharge end portions inclined to the axis of the cylinder and lying in paths intersecting said cylinder head portion at the axis of said cylinder, each of said inlet ports having its sides converging toward said head portion, whereby fuel discharged from said inlet ports will converge toward each other and strike said cylinder head portion at the cylinder axis with each of said inlet ports providing an inclined nozzle of progressively increasing width as said inlet port is uncovered by said piston.

4. In an internal combustion engine: a cylinder having an upper head portion; a piston reciprocable in said cylinder; said cylinder having a plurality of exhaust ports and a plurality of fuel inlet ports between said exhaust ports; said piston being movable along all of said ports to open and close the same; the upper ends of said exhaust ports being closer to said upper head portion than said inlet ports; said exhaust ports being of greater arcuate extent at their upper portions than at their lower portions and said inlet ports being of lesser arcuate extent at their upper portions than at their lower portions, whereby said exhaust ports arcuately overlap said inlet ports; said inlet ports extending above the lower portions of said exhaust ports; said inlet ports having their upper end portions inclined to the axis of said cylinder and lying in paths intersecting said cylinder head portions, whereby fuel discharged from said inlet ports will strike said cylinder head portions, each of said inlet ports providing an inclined nozzle of progressively increasing width as said inlet port is uncovered by said piston.

5. In an internal combustion engine: a cylinder having an upper head portion; a piston reciprocable in said cylinder; said cylinder having a plurality of exhaust ports and a plurality of fuel inlet ports between said exhaust ports; said piston being movable along all of said ports to open and close the same; the upper ends of said exhaust ports being closer to said upper head portion than said inlet ports; said exhaust ports being of greater arcuate extent at their upper portions than at their lower portions and said inlet ports being of lesser arcuate extent at their upper portions than at their lower portions, whereby said exhaust ports arcuately overlap said inlet ports; said inlet ports extending above the lower portions of said exhaust ports; said inlet ports having their upper end portions inclined to the axis of said cylinder and lying in paths intersecting said cylinder head portion at the axis of said cylinder, whereby fuel discharged from said inlet ports will converge toward each other and strike said cylinder head portion at the cylinder axis, each of said inlet ports providing an inclined nozzle of progressively increasing width as said inlet port is uncovered by said piston.

6. In an internal combustion engine: a cylinder having an upper head portion; a piston reciprocable in said cylinder; said cylinder having an exhaust port and an inlet port; said piston being movable along said ports to open and close the same; the upper end of said exhaust port being closer to said upper head portion than said inlet port; said exhaust port being of greater arcuate extent at its upper portion than at its lower portion and said inlet port being of lesser arcuate extent at its upper portion than at its lower portion, whereby said exhaust port arcuately overlaps said inlet port; said inlet port extending above the lower portion of said exhaust port; said inlet port having its discharge end portion inclined to the axis of the cylinder and lying in a path intersecting said cylinder head portion, whereby fuel discharged from said inlet port will strike said cylinder head portion, said inlet port providing an inclined nozzle of progressively increasing width as said inlet port is uncovered by said piston.

7. In an internal combustion engine: a cylinder having an upper head portion; a piston reciprocable in said cylinder; said cylinder having a plurality of exhaust ports and a plurality of fuel inlet ports between said exhaust ports; said piston being movable along all of said ports to open and close the same; the upper ends of said exhaust ports being closer to said upper head portion than said inlet ports; said exhaust ports being of greater arcuate extent at their upper portions than at their lower portions, with the sides of each exhaust port tapering downwardly toward each other between said upper and lower portions; said inlet ports being of lesser arcuate extent at their upper portions than at their lower portions, with the sides of each inlet port tapering upwardly toward each other between their upper and lower portions; said exhaust ports arcuately overlapping said inlet ports and said inlet ports extending above the lower portions of said exhaust ports; said inlet ports having their upper end portions inclined to the axis of said cylinder and lying in paths intersecting said cylinder head portion, whereby fuel discharged from said inlet ports will strike said cylinder head portions, each of said inlet ports providing an inclined nozzle of progressively increasing width as said inlet port is uncovered by said piston.

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