Jan. 16, 1945. C. G. CURTIS 2,367,565

TWO-CYCLE INTERNAL-COMBUSTION ENGINE

Filed June 17, 1943 3 Sheets-Sheet 1

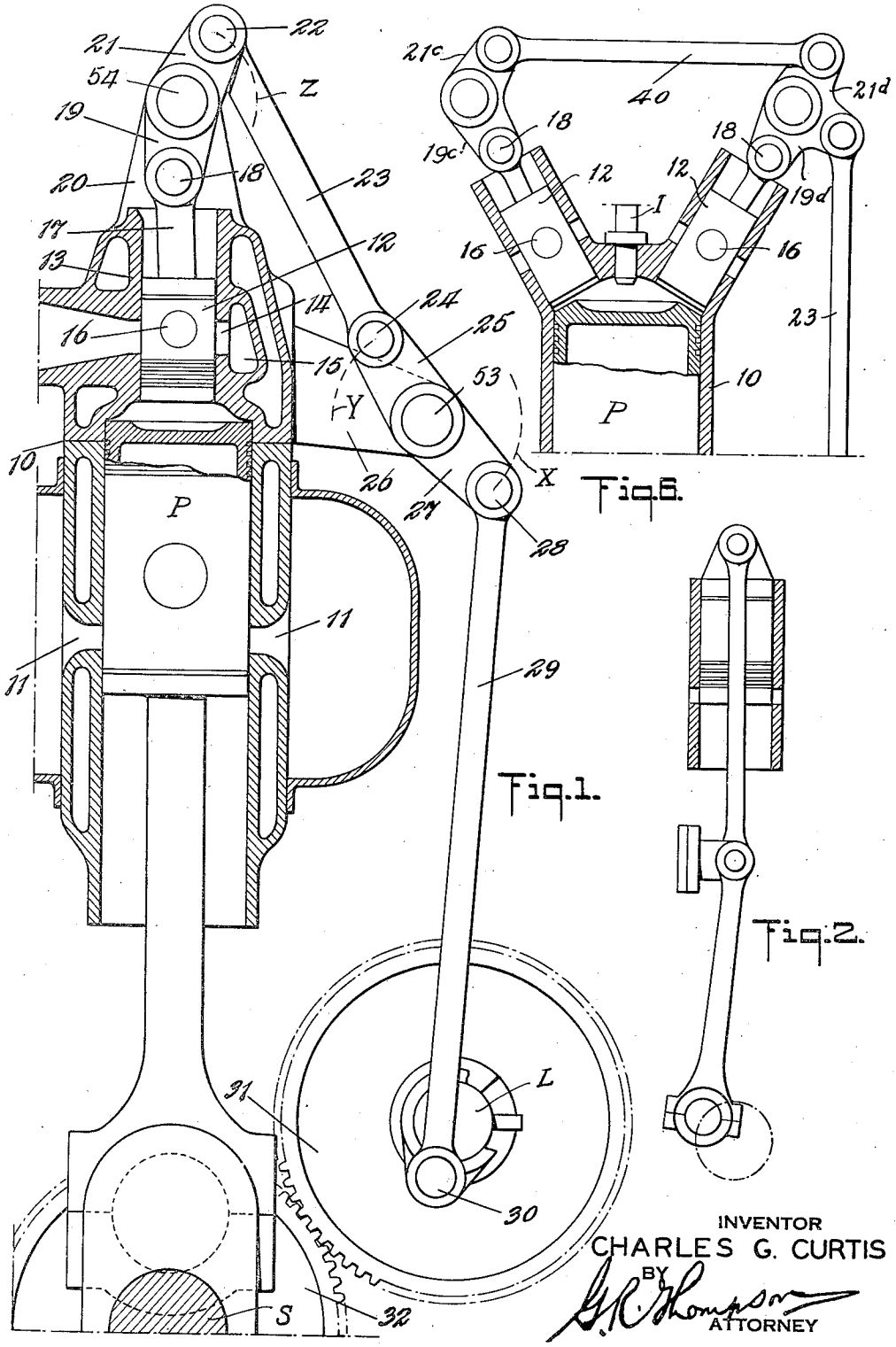


Fig.6.

Fig.1.

Fig.2.

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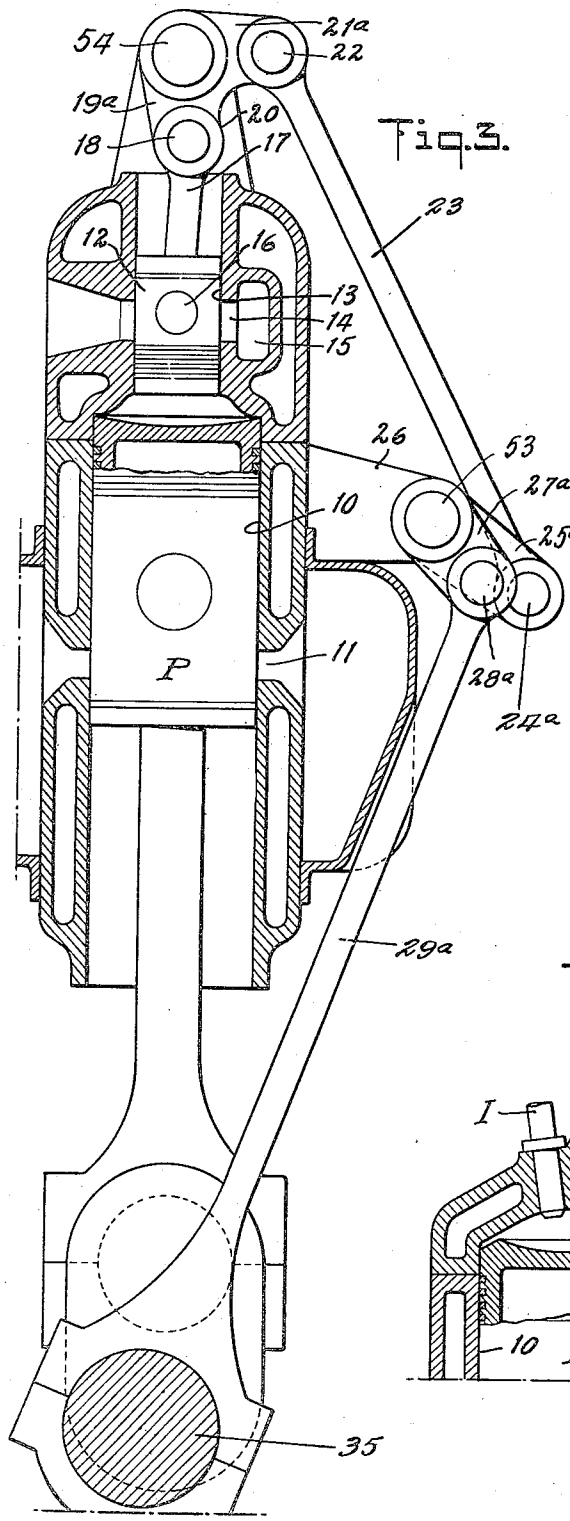


Fig. 3.

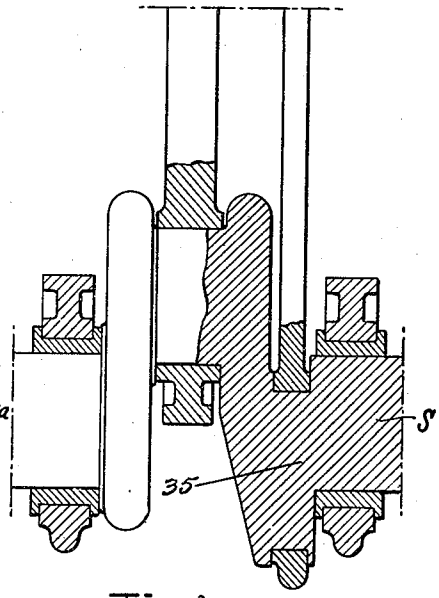


Fig. 4.

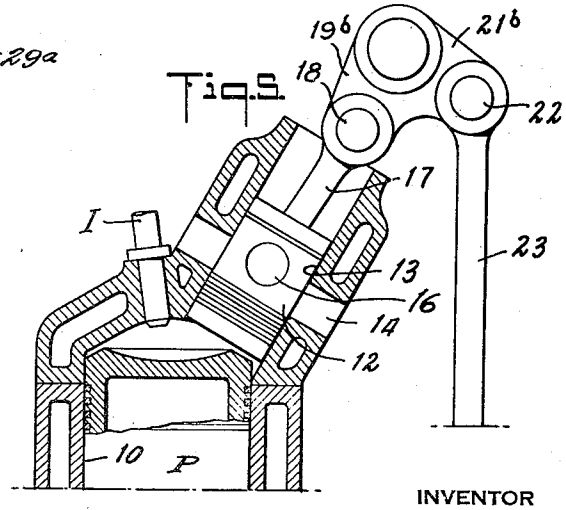


Fig. 5.

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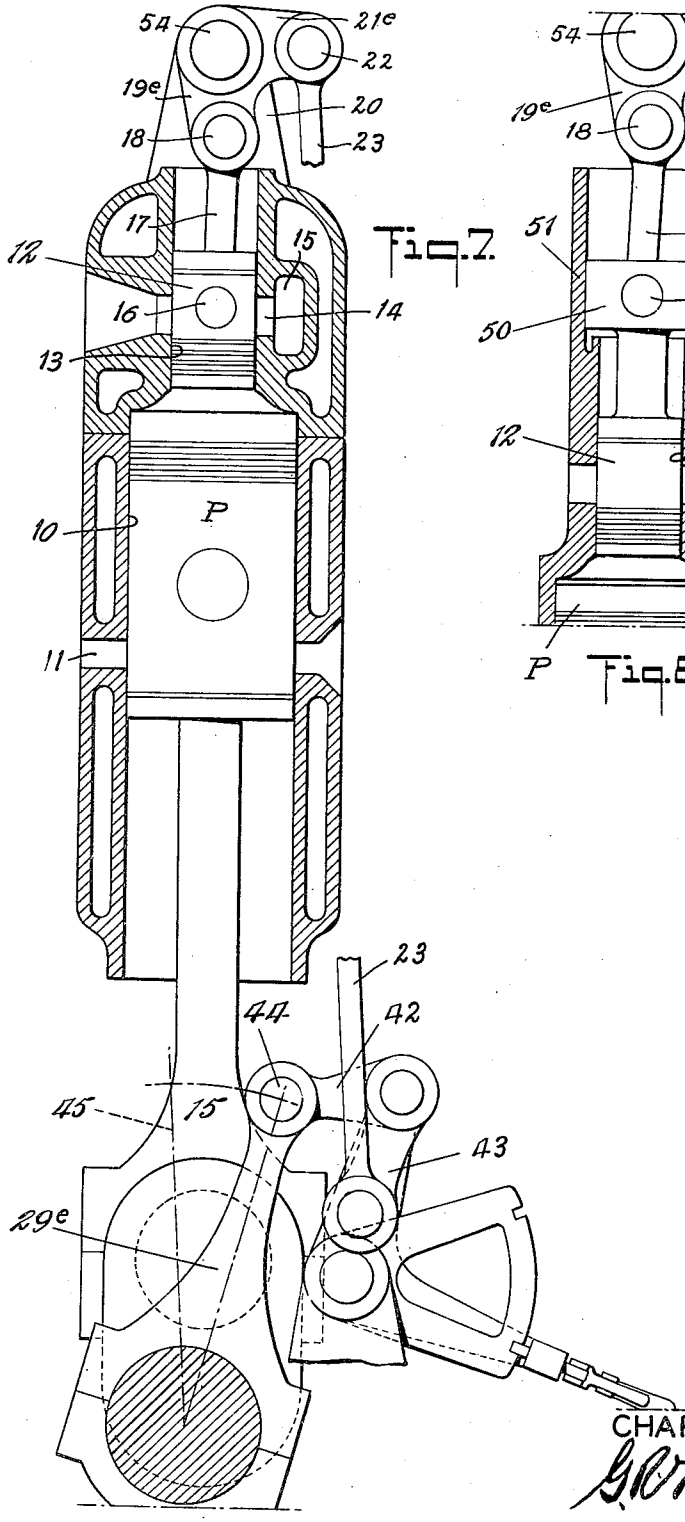


Fig. 7.

Fig. 8.

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TWO-CYCLE INTERNAL-COMBUSTION ENGINE

Charles G. Curtis, New York, N. Y.

Application June 17, 1943, Serial No. 491,107

6 Claims. (Cl. 123—65)

This invention applies particularly to the uniflow type of Diesel engine, having inlet ports at the bottom of the stroke and an exhaust piston valve or valves at the top of the stroke, the especial object being to provide a valve mechanism which will cause the exhaust ports to open and close quite quickly, which will enable the ports to be of sufficient area and to accomplish this with a piston valve which has a comparatively short stroke, that is to say, a stroke considered short compared with the axial length of the exhaust ports.

I have described in my United States Patent No. 2,126,376 issued August 9, 1938, how this result can be accomplished to a certain degree. My present invention is designed to accomplish this in a more effective way and to obtain a very considerable port area, particularly with a piston valve smaller in diameter than the main cylinder, to have the total stroke of the valve as short as possible and yet carry sufficient number of piston rings and to have these piston rings all, or most of them, in contact with the cylinder until the pressure in the cylinder has largely declined so that the leakage can be taken care of by less than the total number of piston rings.

Referring to the drawings:

Figure 1 is a sectional view through the axis of the cylinder and piston valve showing the mechanism for operating such a valve from a lay shaft.

Fig. 2 shows the usual way of operating an exhaust piston valve by crank connection with the engine shaft, crossheads and the yoke at the top of the piston valve. This figure shows how small a port area is obtainable by this arrangement compared with the arrangement shown in Fig. 1.

Fig. 3 is a vertical section through the axis of the shaft showing the main bearings, crankpin bearing and an eccentric drive.

Fig. 4 is a sectional vertical view through the crankshaft and eccentric of Fig. 3.

Fig. 5 is a modified form of my invention in which the exhaust cylinder is set on one side at any angle so as to enable the spray nozzle to be set at or near the center of the cylinder.

Fig. 6 is an arrangement in which I provide two piston valves set at an angle to the axis of the cylinder with the spray nozzle between them in the center with the mechanism for operating both valves in unison.

Fig. 7 is a sectional view showing the eccentric drive and my mechanism for reversing.

Fig. 8 is a sectional view of the exhaust valve provided with crosshead to take the side thrust.

In Figure 1 numeral 10 represents the cylinder, and letter P the piston 11 represents the inlet ports covering the entire circumference of the cylinder at the bottom of the stroke; 12 the piston valve working in the small cylinder 13. 14 represents the exhaust ports which extend all the way around the cylinder 13. I have shown these ports of greater axial length than the inlet ports 11. If the exhaust piston valve 12 be made equal to half the diameter of the main piston P, the total exhaust port area can be made something like two-thirds of the total inlet port area, which has been found to be more than ample to give good results with uniflow scavenging. The piston valve 12 is shown in the closed position with a sufficient number of piston rings in place to be gas-tight. The exhaust ports 14 discharge into a hood or header 15 extending around the valve cylinder 13 and of ample area to permit the outflow of gas into the exhaust passage without objectionable restriction.

One advantage of this arrangement is that the exhaust belt or hood 15 can be made of ample area at all points of the circumference, whereas in the opposed piston engine where side rods operating a yoke are used, there is material restriction to the gas flow due to the side rods.

The valve piston 12 is provided with a wrist pin 16 which is grasped by a connecting rod 17, the upper end of which connects with a crankpin 18 carried by a crank 19 (19*a*, 19*b*, 19*c*, 19*d*, or 19*e*, Figs. 3–8, inclusive). This crank is pivoted on a suitable part of the engine structure, as for example uprights 20 attached to the cylinder head, provided with large bearings to take the thrust. Attached to the arm 19 is another arm 21 (21*a*—21*e*, Figs. 3–8, inclusive) carrying a crankpin 22. This crankpin is connected by a connecting rod 23 with a crankpin 24 mounted upon an arm 25 which is pivoted at the bearing 53 in fixed support 26. Attached to arm 25 is another arm 27 carrying a crankpin 28, and this crankpin is connected by the long connecting rod 29 with the crankpin 30 of a crank or lay shaft L which is driven by gearing 31 and 32 from the main engine shafts.

Crankpin 18 is set so that when the piston valve 12 is at the end of its stroke, it will be at or near the dead center positions so that when maximum pressure occurs in the combustion chamber 10 the heavy thrust on the piston valve 12 will be taken on the bearings in the uprights 20. This will avoid any great strain being applied through the crank arm 21 to the connect-

ing rod 23 which is normally under compression.

Similarly crank pin 24 is set at or near the dead center in line with the bearing 53 carried by the support 26, so that whatever thrust comes on the pin 24 will be much reduced on the pin 23. As the pin 24 moves away from the dead center position or approximately dead center position the long connecting rod 29 operates under tension.

The crank 30 on the lay shaft L is shown near the bottom of its stroke, this position corresponding to the position of the piston valve 12 also shown at the bottom of its stroke. As the crank 30 begins to revolve, it pushes the arm 27 in the direction shown by the dotted curve X. As this arm 27 is integral with the arm 25 this carries the pin 24 away from the dead center position as shown by the dotted curve Y. As the pin 24 first moves away from the position indicated, it imparts very little motion to the connecting rod 23, so that the pin 22 is moved only a short distance in the direction shown by the dotted line Z. This causes the pin 18 to move only a small amount and this pulls the connecting rod 17 upward carrying with it the piston valve 12 to a slight extent. The piston valve 12 therefore moves very slowly in the beginning and the piston rings remain in contact with the cylinder 13 below the exhaust ports 14 while the main piston P is moving a substantial amount and the pressure in the cylinder is substantially reduced. The combined motions continue with an ever increasing velocity of the piston valve 12 until a point has been reached where the edge of the piston valve passes the lower edge of the exhaust ports 14 and begins to expose them. By this time the motion of the piston valve 12 has become very rapid and as it continues the rapidity further increases. The result is that the ports 14 open very quickly giving the necessary area for dropping the pressure and later for good scavenging. Similarly, the ports 14 will close very quickly after the crankpin 30 has passed its top dead center.

This arrangement has important advantages. It permits a large exhaust area to be had with a small diameter piston valve and with a short stroke. It permits the piston rings to remain below the exhaust ports 14 when the piston valve 12 moves up until the cylinder pressure has largely declined. It enables the exhaust ports to be opened much more quickly than in the usual arrangement shown in Fig. 2. Similarly, it enables the ports 14 to be closed more quickly giving a better supercharge. By using a small diameter piston valve I am enabled to keep the maximum total pressure on the piston valve 12 when combustion takes place down to a comparatively small figure, and by using what amounts to a toggle or equivalent mechanism for operating the piston valve, I am enabled to have the major part of the pressure carried on the pivots and uprights so that the pressure or pull exerted on the rods 23 and 29 is quite small. In this way the rods 23 and 29 and other parts of the valve mechanism can be made quite light so as to be largely free from inertia. As the mechanism moves away from the dead center position the pull or push on the rods 23 and 29 would greatly increase were it not for the fact that by that time the cylinder pressure has largely declined.

Fig. 2 drawn for the same length of stroke of the piston valve 12, Fig. 1, shows that a very small port height is obtainable with a given angle of valve opening, the same angle as that shown in Fig. 1, namely about 55 degs. on either side of dead center. The exhaust port area, by the arrangement shown in Fig. 2 is less than 50% of that shown in Fig. 1. In order to give ample time to bring about the pressure drop in the cylinder, I set the crankpin 30 about 15 degs. ahead of that of the main crankshaft S so that the exhaust ports 14 will open before the inlet ports 11, and will close at or about the time the inlet ports close, thus giving maximum supercharge with sufficient scavenging period. Another advantage of this arrangement is that the operating mechanism is all outside of the framing of the engine. It does not have to pass through the air belt and all the parts are very light and readily accessible. Moreover, the engine requires no cross heads and costs materially less per horse power and is much shorter.

In Fig. 3 I have shown a modification in which the rod 23 operates under tension like the rod 29 of Fig. 1. The pin 24*a* takes the place of the pin 24 in Fig. 1, and the connecting rod 29*a* instead of being operated from a lay shaft is driven by an eccentric 35 on the main shafts, the eccentric also in this case being set about 15 degs. ahead so as to open the exhaust ports 14 considerably ahead of the inlet ports 11 and permit the cylinder pressure to drop before the scavenging ports 14 open. The force required to move the rod 29*a* in this arrangement is so small that the throw of the eccentric 35 can be made quite small and the eccentric strap quite narrow, thus taking up a very short length on the shaft.

In Fig. 5 I have shown a modified arrangement of the valve piston valve 12, in which the valve is set at an angle on one side of the cylinder 10, partly to permit the injection nozzle I to be placed at or near the center of the combustion chamber and partly to enable the operating mechanism to be better arranged.

In Fig. 6 I have shown two exhaust piston valves 12, smaller in diameter than the piston-valve in Fig. 1, but having sufficient exhaust area to give the desired result, these piston valves being connected together by arms 19*c*—21*c* and 19*d*—21*d* and the connecting rod 40 so as to operate in unison.

In Fig. 7 the eccentric rod 29*b* takes the place of the eccentric rod 29*a* in Fig. 3 and a bell crank 42 which takes the place of the bell crank 25*a* is pivoted on the end of the rocking arm 43, so that the pivot 44 can be thrown to the left to the point indicated by the dotted line 45. This rocking arm 43 can be set by hand or by power to either the position shown or the position shown by dotted line 45. In the position shown, the piston valve 12 will start to open in a certain length of time, say 15° before the main piston P discloses the inlet ports 11, and the piston valve 12 will close again on the return stroke of the main piston as the latter closes the inlet ports. The other position of the pin 44, as in the design, will enable the engine to turn in the opposite direction and to open the exhaust ports 14 15° ahead of the inlet port opening.

In Fig. 8 the piston valve 12 is carried up to a crosshead 50 operating in lubricated guides 51. This crosshead connected with the bell crank 19*e*—21*e*. The object of this crosshead 50 is to take the side thrust and relieve the piston valve 12. At the bottom of the crosshead stroke I provide a groove 52 for collecting excess oil flowing down from the crosshead, and I provide

means for draining this groove or pocket so as to prevent this oil getting on to the piston valve.

What is claimed is:

1. In a two-cycle uniflow internal combustion engine, a cylinder, a piston valve at the cylinder head, a crank-shaft, means mechanically driven from the crankshaft for moving the piston valve with greater rapidity at the exhaust or outer end of its stroke and with less rapidity at the inner end of the stroke, and mechanical means interposed between said piston-valve driving means and the crank-shaft operating to increase the aforesaid greater rapidity and to decrease the aforesaid less rapidity of movement of the piston valve at the two ends of its stroke, so that a long port opening is obtained without involving too long a stroke of the piston-valve.

2. In a two-cycle uniflow internal combustion engine, a cylinder, a piston valve at the cylinder head, a rocking member or bell crank acting to move the piston valve, a crank-shaft, mechanical means driven from the crankshaft operating to move the piston valve when one of the arms of the bell crank is at or near its dead center; a secondary rocking member or bell crank mechanically driven from the engine shaft and mechanically connected with the other bell crank, the parts being arranged so that the arm of the secondary bellcrank is at or near the dead center when the piston valve is closed, and the differential movement of the piston at the two ends of its stroke is intensified by the compound action of the bell cranks.

3. In a two-cycle uniflow internal combustion engine, a cylinder, a piston valve at the cylinder head, a rocking member or bell crank acting to move the piston valve, a crank-shaft, mechanical means driven from the crankshaft operating to move the piston valve when one of the arms of the bell crank is at or near its dead center; a secondary rocking member or bell crank mechanically driven from the engine shaft and mechanically connected with the other bell crank, the parts being arranged so that the arm of the secondary bell crank is at or near the dead center when the piston valve is closed, and the differential movement of the piston at the two ends of its stroke is intensified by the compound action of the bell cranks, and an eccentric on the crankshaft for driving a secondary bell crank.

4. In a two-cycle uniflow internal combustion engine, a cylinder, a piston valve at the cylinder head, a rocking member or bell crank acting to move the piston valve, a crankshaft, mechanical means driven from the crankshaft operating to move the piston valve when one of the arms of the bell crank is at or near its dead center; a secondary rocking member or bell crank mechanically driven from the engine shaft and mechanically connected with the other bell crank, the parts being arranged so that the arm of the secondary bell crank is at or near the dead center when the piston valve is closed, and the differential movement of the piston at the two ends of its stroke is intensified by the compound action of the bell cranks, and a lay crankshaft geared to the main crankshaft for driving said secondary bell-crank, a lay shaft being driven through a member with a lost motion arranged to time the valve mechanism correctly so as to give the proper lead to the valve opening over the inlet port opening, whichever way the engine is turning.

5. In a two-cycle uniflow internal combustion engine, a cylinder having inlet ports at the bottom of the stroke and an exhaust piston valve at the top of the cylinder, means for operating the piston valve at a greater velocity at the top or port opening part of its movement than at the bottom or port closing part of its movement, so as to secure a large port opening relative to the length of the exhaust piston stroke, an eccentric on the engine crankshaft and means for mechanically connecting the eccentric with the mechanism for operating the valve.

6. In a two-cycle uniflow internal combustion engine, a cylinder having inlet ports at the bottom of the stroke and an exhaust piston valve at the top of the cylinder, means for operating the piston valve at a greater velocity at the top or port opening part of its movement than at the bottom or port closing part of its movement, so as to secure a large port opening relative to the length of the exhaust piston stroke, an eccentric on the engine crankshaft, means for mechanically connecting the eccentric with the mechanism for operating the valve, and means for changing the angle at which the eccentric operates so as to change the time of the exhaust valve opening for reversal.

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