**Aug. 9, 1938.** C. G. CURTIS **2,126,376**

# TWO-CYCLE DIESEL ENGINE

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Fig. 1

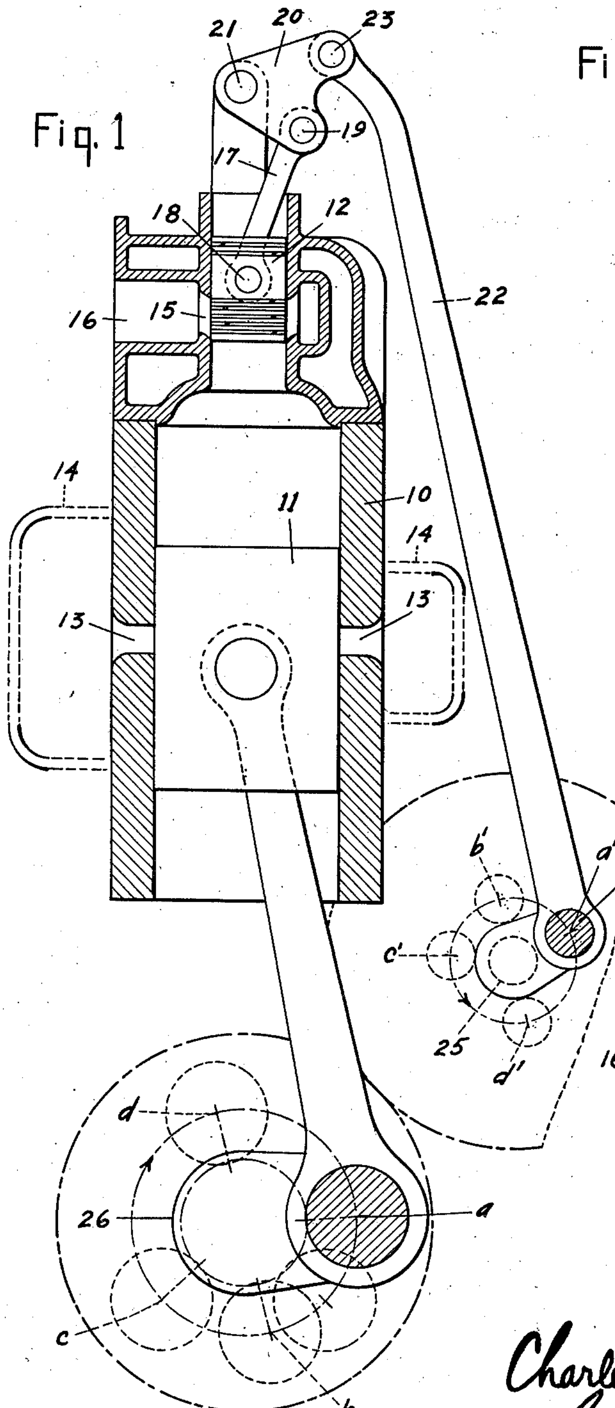


Fig. 2

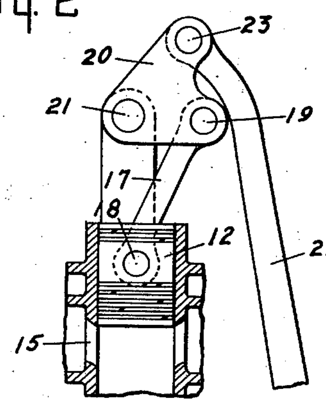


Fig. 3

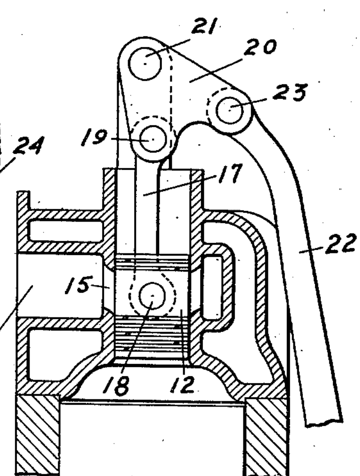


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Fig. 4

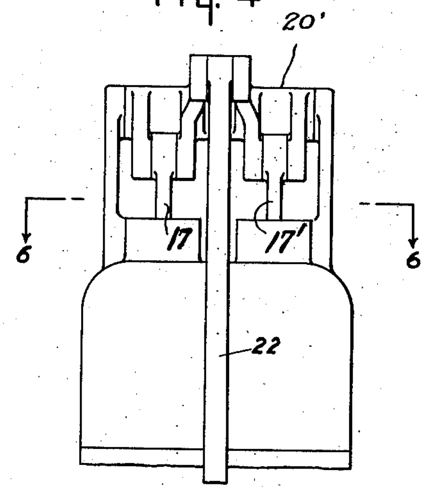
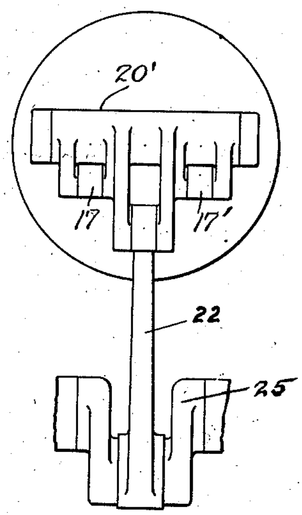



Fig. 5



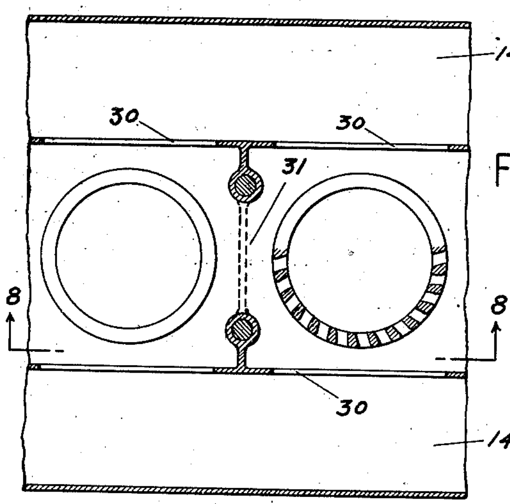




Fig. 7

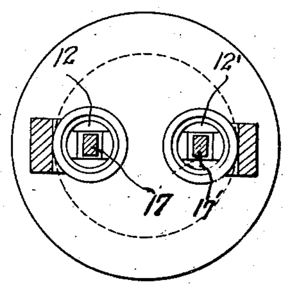



Fig. 6

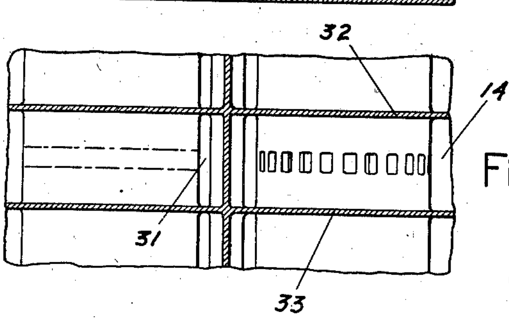



Fig. 8

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# UNITED STATES PATENT OFFICE

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## TWO-CYCLE DIESEL ENGINE

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

Application February 1, 1935, Serial No. 4,515

3 Claims. (Cl. 123—65)

This invention applies particularly to two-cycle engines operating with uniflow scavenging and the main object is to provide exhaust valve mechanism which will give efficient scavenging and a large weight of air in the cylinder and will operate satisfactorily at high speeds and which will be of simple and rugged construction. The specific object is to provide a form of valve which requires no adjustment and will remain tight, but which will have adequate area, will open and close quickly, and which will derive its motion from crankshaft operation.

To accomplish this result I use a piston valve or valves in the combustion end of the cylinder, and I have succeeded in operating this valve or valves by a rocking crank motion, connecting rods and a lay-crankshaft in such a way as to obtain a large port opening with a comparatively small total movement of the valve, and to have the period during which the valve remains open suitable for effecting the necessary pressure drop together with the scavenging. In other words, the valve remains open long enough to drop the pressure and scavenge efficiently. This results in an extremely simple and rugged type of mechanism which can be operated at very much higher speeds than is permissible with poppet valves which require frequent adjustment and re-grinding.

In the accompanying drawings, Figure 1 is a sectional view through the centre of a Diesel engine cylinder with an exhaust piston valve in the head and with the operating mechanism which I provide. This view shows the piston valve about to open.

Fig. 2 shows the piston valve in the open position.

Fig. 3 shows the piston valve in the closed position at the lowest point of the stroke.

Fig. 4 shows my invention as applied to two piston valves in the head instead of one, this view being a side view in elevation.

Fig. 5 is a top view of the same arrangement and

Fig. 6 is a sectional top view taken on the plane 6—6, Fig. 4.

Figs. 7 and 8 show views of the headers and cylinder liners.

In Figure 1 numeral 10 represents the cylinder, 11 the piston and 12 the piston valve, which I prefer to make as small as possible so that at the time combustion takes place and the maximum pressure is in the cylinder the total pressure on the head of the valve shall be as small as possible. At the lower end of the main stroke I provide inlet ports 13 which reach all the way around and are fed by two headers 14 and 14, one on each side of the engine so as to have ample volume of air in the immediate neighborhood of the ports when scavenging takes place. The exhaust ports 15 of the valve are uncovered by the piston as it moves upward, the piston itself being packed with a sufficient number of rings to be perfectly gas tight in its lower position. These exhaust ports reach all the way around the cylinder of the piston valve and discharge into a header or annular passage which leads through to the exhaust opening 16. The piston valve is also provided with piston rings at its upper end so that if there is any pressure in the exhaust belt 16 the gas cannot leak out into the engine room. The piston 12 is operated by a trunk piston rod 17 provided with a wristpin 18 operating in the usual manner. The upper end of the connecting rod is pivoted to a rocking bell crank 20 by a pin 19. The rocking bell crank 20 turns on a fixed pivot 21. I place the pivot 21 in such a position that when the piston valve is in its lower position the piston rod is substantially in the position shown in Fig. 3 and the heavy thrust due to the maximum gas pressure during the cycle is taken on the pins 19 and 21, which pins may be large and provide ample working surface. In other words, the connecting rod is practically on the dead center as shown in Fig. 3. This bell crank I operate by a connecting rod 22 which is pivoted to the bell crank by the pin 23, the lower end of the rod being connected to a crankpin 24 on a lay-crankshaft 25 which is driven by gear or other means directly from the main crankshaft 26 as shown in the drawings. The object of this mechanical arrangement is to enable the exhaust ports 15 to be made as long as possible and yet to have the total stroke of the piston valve as small as possible. As shown in the drawings I have made the portion of the stroke of the valve which is required to open the ports about half the total valve throw, and I secure this ample movement by an arc of movement of the crankshaft which in a two-cycle engine should occupy much less than half the total circular movement. The effect of this mechanism is to greatly intensify the relative port opening movement of the valve compared with the rest of the movement of the valve and to derive this movement from a simple crankshaft.

It also accomplishes the result of taking a large part of the strain off the connecting rod 22 and the crankshaft 25 by having the combustion in the cylinder take place when the connecting rod 17 is on or nearly on the dead centre. By using the upper part of the arc travelled by the lay-crankpin and by the arrangement shown the movement of the valve at the time of opening or at the time of closing is comparatively rapid, while its movement towards the lower end of the stroke is very much slower.

In the drawings the main crank is shown as about 95° back of the lower dead center and at some such point as this—possibly considerably later—I propose to begin opening the exhaust valve so as to let down the gas pressure in the cylinder in ample time before the inlet ports are exposed by the piston and before scavenging should begin. I therefore set the crankpin of the lay-shaft 25 in position *a'* as shown, the bell crank 20 being in the position shown and the lower edge of the piston valve being even with the lower edge of the exhaust ports as shown in Fig. 1 so that the valve is just about to open. The main engine crank turns in a direction clockwise as shown by the arrows, and the lay-crank turns in the opposite direction, so that by the time the main crank has reached the position *b*, the lay-crank has reached a corresponding position *b'* and the piston valve has been drawn up sufficiently to open the exhaust port fully. As the main crank moves from the position *b* to the position *c* which causes the piston to cover and close the inlet ports the lay-crank moves to a corresponding position *c'* and this brings the valve back into the position shown in Fig. 1 just closing it. Cylinder compression therefore begins at this point and the cylinder pressure is equal to the scavenging pressure or approximates it. As the main crank moves from position *c* to position *d'* the lay-crank moves to the corresponding position *d* and brings the valve to its bottom position with all the piston rings resting on the solid part of the valve cylinder so that the valve is gas tight in this position. This position of the valve is shown in Fig. 3. As the main crank passes over the upper dead center combustion takes place and the maximum pressure at that time or soon thereafter comes on the main piston and also on the piston valve, but while the lay-crank has moved up through a considerable arc this has produced only a little movement of the bell crank 20 and as the connecting rod 17 is still operating at practically the dead center, the valve has not gone up materially. The valve does not move materially until the pressure in the main cylinder has very substantially declined.

In order to reduce the stresses on the valve and valve-operating mechanism as much as possible, I arrange the relative areas of the inlet ports and the exhaust ports so that only a small part of the total pressure drop takes place in passing through the inlet port leaving a large proportion of the total pressure drop to be available for causing the flow through the exhaust ports. This not only increases the velocity through the exhaust valve but it enables a smaller piston and smaller exhaust ports to be used. It also results in a higher pressure in the cylinder during scavenging and an increased supercharge at the end of the stroke, provided the exhaust valve is closed in time to permit the scavenging air to flow in as fast or faster than it can flow out through the exhaust valve as the inlet ports are being closed by the piston.

My exhaust piston valve and operating mechanism has also the great advantage that it can be operated at very high speed—much higher than is possible with poppet valves, particularly in a two-cycle engine, and the mechanism is extremely simple and rugged. The closing movement of the piston valve also increases the compression in the cylinder and adds several per cent to the power of the engine. It is also quite important in a high speed engine to have ample scavenging air reservoir capacity for all the inlet ports so that during the period of scavenging, which may not be more than 1/50th of a second, the volume of air surrounding the scavenging ports will be sufficient to feed these ports promptly. For this purpose I provide an air belt 14 and 14 on each side of the cylinder so as to feed the ports on both sides effectively and these air belts or headers are connected by air passages through between the cylinders so as to feed the ports lying between the cylinders.

In the operation of the mechanism in some cases I prefer to use two exhaust piston valves 12, 12', somewhat smaller than the single exhaust valve in the centre. These are shown in top view (Fig. 6) and the operation of the actuating mechanism (which is similar to that already described) will be readily understood by examination of Figs. 4 and 5, the bell crank 20' being forked to take care of the two connecting rods 17, 17' and being driven by a single long connecting rod 22 reaching down to the lay-shaft 25, as shown.

In Figs. 7 and 8, the latter of which is a section taken on the plane 8—8 Fig. 7, I show an arrangement of two headers and cross passages for feeding the air effectually and promptly to the cylinder inlet ports. 14—14 are the two headers. 30—30—30 are openings in the housing walls to permit the air to flow from the headers to the outer walls of the cylinder. The upper wall 32 and the lower wall 33 are carried right across the cylinder so as to make a passage connecting the two headers. To enable the cylinder liners to be close together so as to make as short an engine as possible, I provide openings in the wall of the housing 31 which permits the air to flow from either side into the space surrounding the liner. I also provide openings in the cross wall of the housing so as to permit air to flow from both sides of the wall into the liner which is drawing scavenging air at that instant.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A two-stroke cycle engine comprising a cylinder and piston, a crank and connections for transmitting the reciprocatory movements of said piston to said crank, an inlet port and an exhaust port, and a port-controlling means comprising a piston valve, a bell-crank, a rod connecting an arm of said bell-crank and piston valve, a crank turning at the same speed of revolution as said engine-crank, and a rod connecting the second-named crank and an arm of said bell crank, the arrangement of said cranks and connections being such that the rod connected to said piston-valve and the arm of the bell crank to which it is connected are approximately on dead center at the same time that the engine-crank and its connecting-rod are on dead-center.

2. A two stroke cycle engine according to claim 1, wherein the piston-valve, the port controlled thereby, and the crank-arm which is attached to the piston-valve connecting-rod are so constructed and arranged that the port is opened and closed in that part of the arc of movement of the aforesaid arm in which it is generally at right-angles to its dead-center position and moves the piston valve rapidly, the movement of the piston-valve after the port is closed being effected in that part of the arc of movement of the afore-

said arm in which it approaches dead-center and moves the piston valve most slowly.

3. A two stroke cycle engine comprising a cylinder and piston, a crank and connections for transmitting the reciprocatory movements of said piston to said crank, an inlet port and an exhaust-port, and port-controlling means comprising a piston-valve, a bell-crank, and means timed with the speed of revolution of said engine-crank for oscillating said bell-crank to move said piston-valve to open and close the port controlled thereby, the arrangement of the parts being such that the arm of the bell-crank which is connected to the piston-valve is approximately on dead-center at the same time that the engine-crank and connecting-rod are on dead-center, and such that the piston-valve opens and closes said port in that part of the arc of movement of said arm in which it is generally at right-angles to its dead-center position and moves said piston-valve rapidly, the movement of the piston-valve after the port is closed being effected in that part of the movement of the aforesaid arm in which it approaches dead-center and moves the piston-valve most slowly.

CHARLES G. CURTIS.