

July 4, 1939.

C. D. HOWARD

2,164,522

INTERNAL COMBUSTION ENGINE

Filed Jan. 22, 1938

3 Sheets-Sheet 1

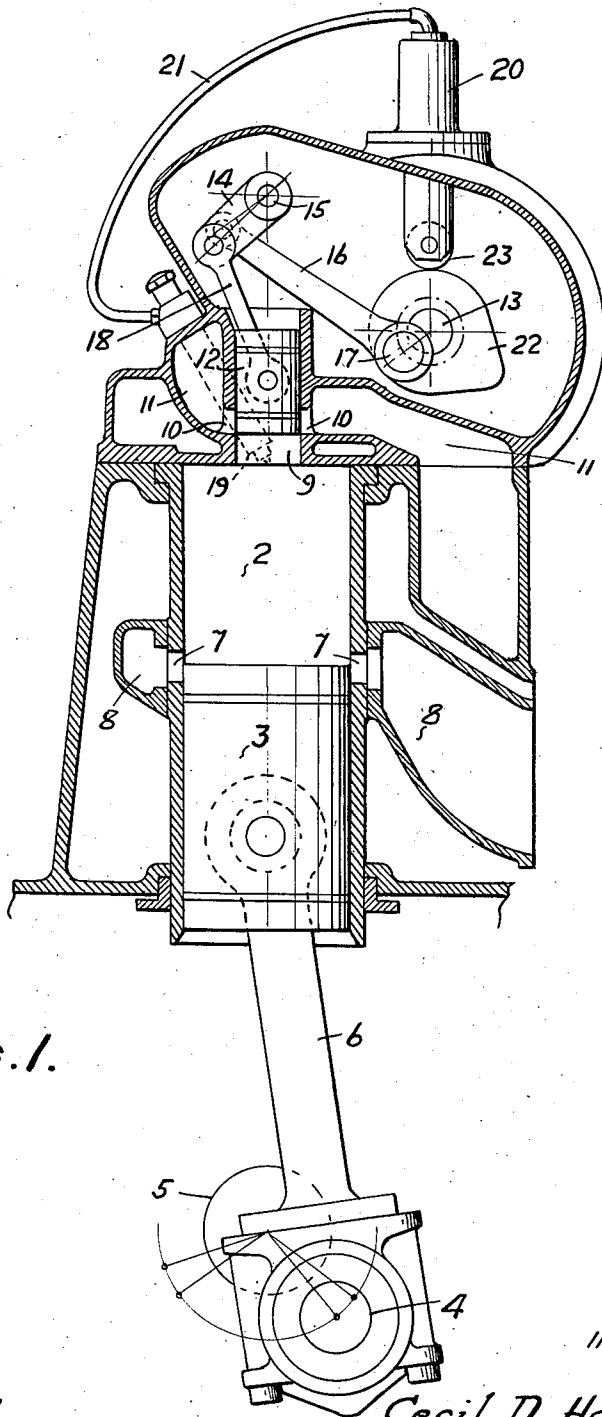


FIG. 1.

WITNESS:

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3 Sheets-Sheet 2

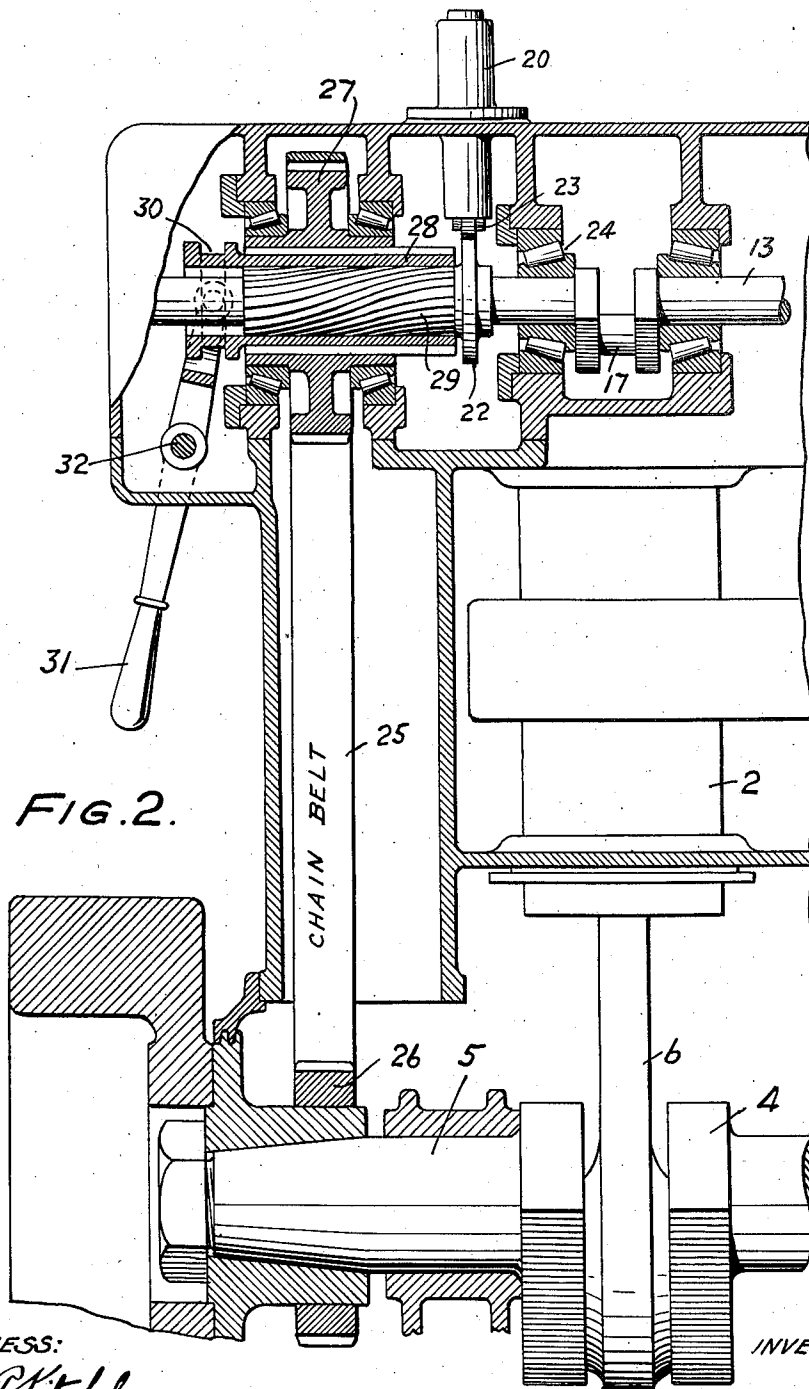


FIG. 2.

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3 Sheets-Sheet 3

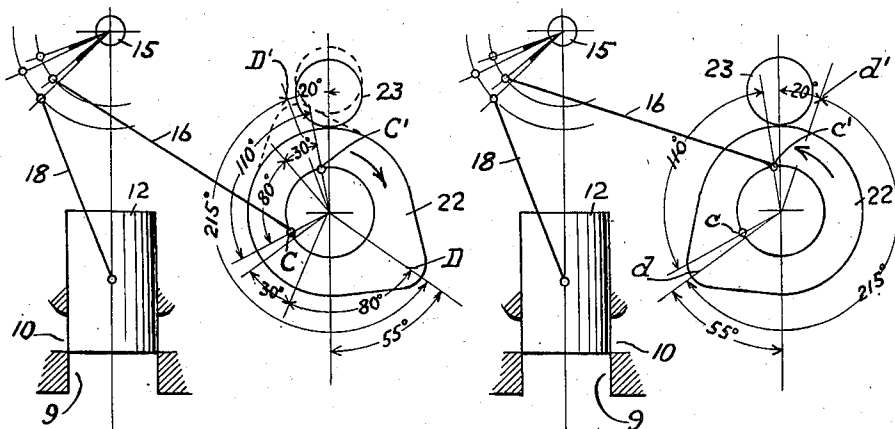
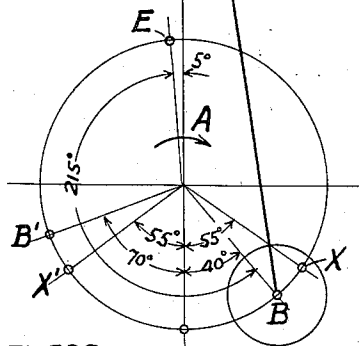


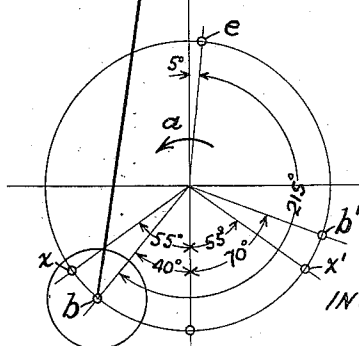
FIG. 3.



WITNESS:

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FIG. 4.



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UNITED STATES PATENT OFFICE

2,164,522

INTERNAL COMBUSTION ENGINE

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Application January 22, 1938, Serial No. 186,386

3 Claims. (Cl. 123—41)

This invention relates to an improvement in internal combustion engines, and more particularly to valve and fuel injector operating mechanism for engines of the Diesel type and operating on the two stroke cycle, and so arranged as to enable such engines to be readily reversed.

The mechanism in accordance with this invention will be found to possess at once high efficiency and extreme simplicity.

Generally speaking, the mechanism will comprise a crank shaft, in driven relationship with the main crank shaft and connected on the one hand with a slide valve through, for example, a toggle mechanism, and on the other hand carrying means, as a cam, for actuation of fuel injection means, as a fuel pump. The mechanism as a whole is so arranged as to permit the engine to be operated with either right or left hand rotation, at will.

Having now indicated in a general way the nature and purpose of this invention, I will proceed to a detailed description of a preferred embodiment thereof with reference to the accompanying drawings in which:

Figure 1 is a sectional view of an internal combustion engine of the Diesel type and embodying this invention.

Figure 2 is a sectional view of the engine shown in Figure 1, taken at right angles to the showing of Figure 1.

Figures 3 and 4 are timing diagrams, respectively, for right and left hand rotation of the engine shown in Figures 1 and 2.

Referring more particularly to Figures 1 and 2, 2 indicates a working cylinder within which is a piston 3 connected to a crank 4 of a crank shaft 5, through a connecting rod 6. The working cylinder is provided with exhaust ports 7 communicating with an exhaust passage 8 and adapted to be controlled by the piston 3, as is usual in Diesel engines of the two cycle type. Opening in the head of the cylinder 2 is a valve cylinder 9, provided with ports 10 communicating with a passage or receiver 11 for scavenging air, which may be supplied from any suitable source of supply. Within the valve cylinder 9 is a piston valve 12, adapted to control the ports 10.

The valve 12 is driven from a crank shaft 13, mounted adjacent to the valve cylinder, by means of a toggle, comprising a rocker arm 14 on a suitably mounted fulcrum pin 15, a connecting rod 16 pivotally connected to the rocker arm and to a crank 17 on the crank shaft 13 and a link 18 pivotally connected to the rocker arm and to the piston valve 12.

A fuel injection nozzle 19 is let into the working cylinder 2 adjacent to the valve cylinder 9 and is connected to a fuel pump 20 through a conduit 21. The fuel pump 20 is mounted adjacent to the crank shaft 13 and is adapted to be operated by a cam 22, mounted on the shaft 13, and which acts upon a cam follower 23 carried on the end of the pump piston rod.

The crank shaft 13 is supported by suitable bearings, as roller bearings 24, and is adapted to be driven from the main crank shaft 5 through a chain 25 which engages with a sprocket 26 on the crank shaft 5 and with a sprocket 27, engaged with the crank shaft 13 through a slidable sleeve 28, to which the sprocket is splined by straight splines and which is engaged with the shaft 13 through spiral splines 29. The outer end of the sleeve 28 is grooved, as at 30, for engagement by the forked end of a hand lever 31, mounted on a suitable fulcrum pin 32.

As will now be obvious, when the engine is in operation rotation of the crank shaft 13, driven from the main crank shaft 5, will effect operation of the piston valve 12 and of the fuel pump 20. The crank 17 and the cam 22 will be so set that the engine may be readily reversed by stopping, rotating the shaft 13 independently of the main shaft 5 and restarting. The shaft 13 is readily rotated independently of shaft 5 by manipulating hand lever 31 to slide sleeve 28 relative to sprocket 27, with respect to which it is non-rotatable, and which will result in rotation of shaft 13 due to the spiral splined connection between the shaft and sleeve.

The timing of the engine will be apparent from the diagrams comprising Figures 3 and 4, which respectively illustrate timing for right and left hand rotation.

Referring now to Figure 3 and assuming that the shaft 13 rotates at the same speed and in the same direction as the main crank shaft 5 as is usual in two stroke cycle engines, and that the engine is to be operated in right hand direction, as shown by the arrow A, the main crank 4 is in the position B for opening of the scavenging ports 10 by the piston valve 12; which for illustration is taken as 40° above lower dead center. The crank 17 of the shaft 13 is in the position C and the lobe of the fuel pump operating cam 22 is in the position D. As the main crank 4 moves to the point B' of closing of the scavenging ports 10, the crank 17 moves up to the position C'. In this movement amounting to 110° the piston valve 12 has opened the ports 10 and closed them again.

The point of fuel injection E is shown at 5°

before top dead center which is 215° after the point B at which the scavenging ports 10 are opened. When the crank 4 is moved up to the position E, the lobe of the cam 22 has moved 215° from the point D to the point D', which is 20° before top dead center on which the fuel pump with its cam follower 23 is assumed to be located.

The lobe of the fuel cam 22 is so designed that when it reaches the point D' it will have moved the fuel pump through one-half of its stroke, as indicated in dotted lines, Figure 3, and the pump is so designed that at this point, which is 5° before top dead center of the crank 4, it begins the injection of fuel into the working cylinder through the fuel nozzle 19.

As will appear, the exhaust ports 7 will be automatically controlled by the working piston 3. They will be opened when the crank 4 is at the position X, 15° ahead of the point of opening of the scavenging ports 10, and will be closed when the crank 4 is at the position X', 15° ahead of the point of closing of the scavenging ports 10.

Referring now to Figure 4, in which the various positions of the main crank, cam 22, etc. are shown, when the engine is running in reverse with left hand rotation, it will be noted that when the main crank 4 is at the point b for opening of the scavenging ports, the crank 17 is at c', that the lobe of the cam 22 is at d and that when the main crank has moved up 215° , the lobe of the fuel cam 22 is at the point d', 20° before top dead center and since the lobe of the fuel cam is symmetrical, the cam follower is moved up as in right hand rotation. It follows that the scavenging ports close when the crank 4 has reached the point b' and the crank 17 is at c, while the exhaust ports are opened when the main crank is at the point x and they close when the main crank is at the point x'.

In order to have the crank 17 and the cam 22 in correct angular relation to the main crank 4, for left hand rotation, it is only necessary to rotate the shaft 13 to advance the cam 22 and crank 17 a distance of 30° , which is readily accomplished by manipulation of lever 31, as described. The reason for the 30° advance will be readily understood from the fact that the main crank 4 moved 80° from the position B to the position b for opening of the scavenging ports. Such movement would bring the crank 17 up 80° , or 30° short of the desired position c. The fuel cam 22 would likewise be moved up 80° or 30° short of its desired position d. Hence, it is necessary to advance the crank 17 and cam 22 an additional 30° .

It will be understood that it is not intended that this invention be limited to the details herein given for illustrative purposes, since it will be obvious that various modifications in detail may be made without departing from the scope of this invention.

What I claim and desire to protect by Letters Patent is:

1. In an internal combustion engine, in combination, a working cylinder, a working piston, a main crank shaft, means operably connecting said piston and main crank shaft, a passage communicating with the interior of the cylinder, a

valve adapted for the control of said passage, a fuel nozzle let into said cylinder, a second shaft, means affording a driving connection between said main crank shaft and said second shaft, means affording an operating connection between said second shaft and said valve, a fuel pump positioned adjacent said second shaft, means carried by said second shaft for actuating said fuel pump, a conduit affording communication between said fuel pump and said fuel nozzle, means for rotating said second shaft independently of said main crank shaft to simultaneously change the timing of the valve and fuel pump so that the engine will run in reverse direction.

2. In an internal combustion engine, in combination, a working cylinder, a working piston, a main crank shaft, means operably connecting said piston and main crank shaft, a passage communicating with the interior of the cylinder, a valve adapted for the control of said passage, a fuel nozzle let into said cylinder, a second crank shaft, means affording a driving connection between said main crank shaft and said second crank shaft, means affording an operating connection between said second crank shaft and said valve, a fuel pump positioned adjacent said second shaft, means carried by said second shaft for operating said fuel pump, a conduit affording communication between said fuel pump and said fuel nozzle and means for rotating said second crank shaft independently of said main crank shaft through an arc of approximately 30° to simultaneously change the timing of the valve and the fuel pump so that the engine will run in a reverse direction, said valve and fuel pump being timed for reverse operation of the engine on rotation of said second crank shaft independently of said main crank shaft through an arc of approximately 30° .

3. In an internal combustion engine, in combination, a working cylinder, a working piston, a main crank shaft, means operably connecting said piston and main crank shaft, a passage communicating with the interior of the cylinder, a slide valve adapted for the control of said passage, a fuel nozzle let into said cylinder, a second crank shaft, a sleeve spirally splined on said second crank shaft, a driven element slidably splined on said sleeve, driving connections between said main crank shaft and said driven element, means comprising a toggle affording an operating connection between said second crank shaft and said slide valve, a fuel pump positioned adjacent said second crank shaft, a cam carried by said second crank shaft for actuating said fuel pump, a conduit affording communication between said fuel pump and said fuel nozzle, and means for moving said sleeve longitudinally relative to said driven element a distance such as to rotate said second crank shaft independently of said main crank shaft through an arc of approximately 30° to simultaneously change the timing of the valve and the fuel pump so that the engine will run in a reverse direction, said valve and fuel pump being timed for reverse operation of the engine on rotation of said second crank shaft through an arc of approximately 30° .

CECIL D. HOWARD.