Aug. 25, 1942. O. ERICKSON 2,294,332

INTERNAL COMBUSTION ENGINE

Filed July 8, 1940 2 Sheets-Sheet 1

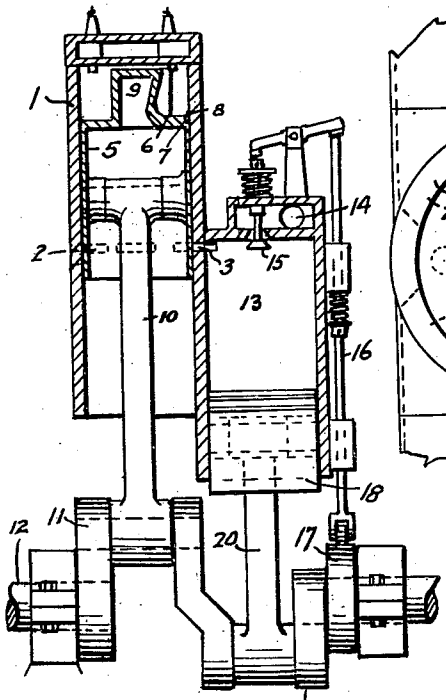

Fig. 1.

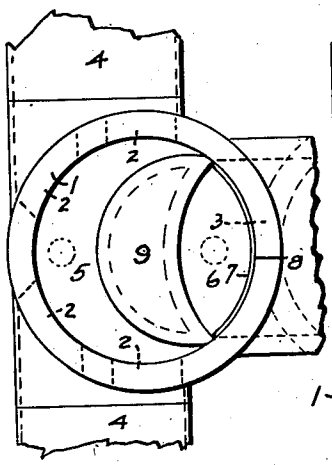

Fig. 2

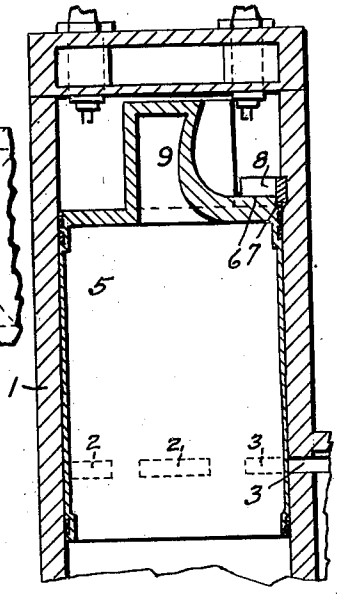

Fig. 3

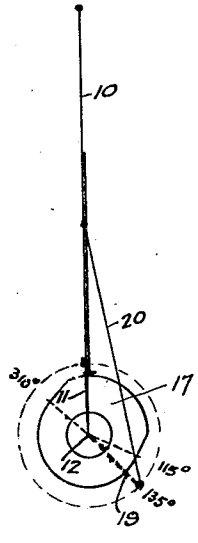

Fig. 4

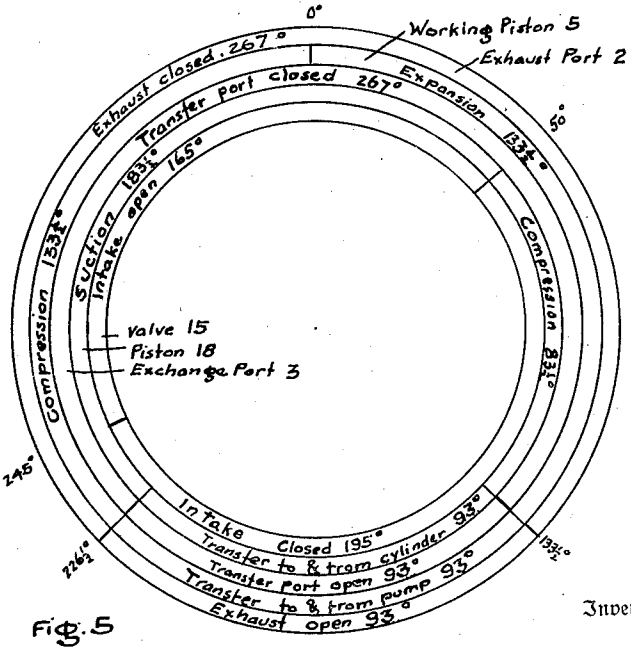

Fig. 5

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INTERNAL COMBUSTION ENGINE

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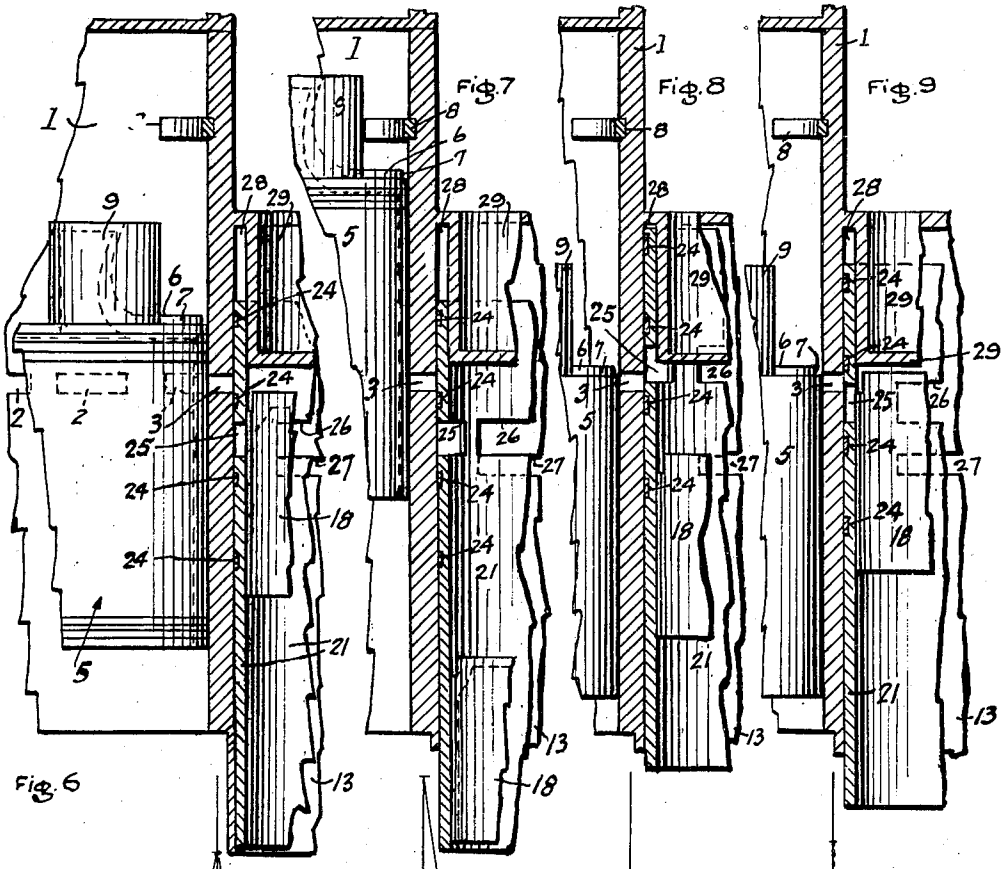

Fig. 6

Fig. 7

Fig. 8

Fig. 9

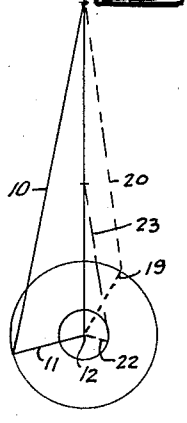

Fig. 10

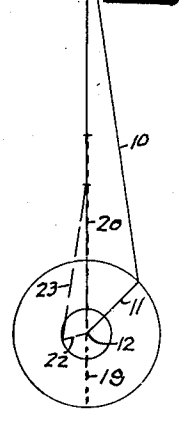

Fig. 11

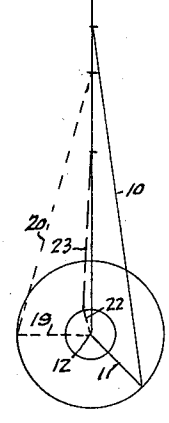

Fig. 12

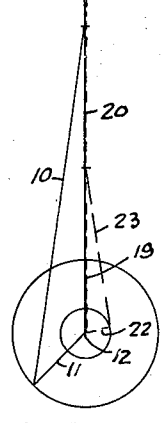

Fig. 13

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UNITED STATES PATENT OFFICE

2,294,332

INTERNAL COMBUSTION ENGINE

Oscar Erickson, Puyallup, Wash.

Application July 8, 1940, Serial No. 344,329

5 Claims. (Cl. 123—70)

This invention relates to internal combustion engines and especially to that class thereof employing a pump cylinder for each working cylinder, whereby each working cylinder has an explosion for every revolution of the crank shaft.

This invention refers, more specifically, to certain improvements in the engine patented by me on December 6, 1932, and numbered 1,890,148. The invention relates to the arrangement or setting of the crank for the pump cylinder in relation to that of the working cylinder, as well as to details in the structure of the various parts of the engine.

The objects of this invention are, first, to secure a more perfect combustion of the explosive vapor and a consequent decrease in the rate of gasoline consumption; second, whereby, with proper mixture of the fuel vapor, the combustion is completed within the working cylinder and no flame issues from the exhaust; third, even, with a slightly faulty mixture, the flame cannot pass from the working cylinder, through the exchange port, into the pump cylinder; fourth, the elimination of leakage in the pump cylinder due to warpage and wear of the sleeve therein; fifth, the removal of pressure from the working cylinder on the sleeve; sixth, to provide means for keeping the exchange groove in the piston free from carbon; and seventh, to provide an engine of simple construction, in which the speed can be perfectly controlled and which may be readily adapted for airplane use.

I attain these and other objects by the devices, mechanisms and arrangements illustrated in the accompanying drawings, in which—

Fig. 1 is a vertical longitudinal section of a single pair of cylinders forming a power unit of my engine, showing the working piston at the upper end of its stroke and the pump piston approaching the lower end of its suction stroke; Fig. 2 is a plan view of the working cylinder with the cap removed and showing the piston therein; Fig. 3 is an enlarged section, similar to Fig. 1, of the working cylinder and piston; Fig. 4 is a diagram showing the angular relation of the working piston, pump and intake valve cam, when the parts are in the positions shown in Fig. 1; Fig. 5 is a diagrammatic representation of the simultaneous actions of the exhaust, the working piston, the exchange port, the pump, and the intake port; Figs. 6, 7, 8 and 9 represent portions of a variation of my engine, in which a sleeve valve is used in the pump cylinder and the poppet valve shown in Fig. 1 is eliminated, and showing the relation of the various parts when the sleeve is just opening the intake port (Fig. 6); has just closed the intake port (Fig. 7); the exchange port has just been opened (Fig. 8); and is about to be closed (Fig. 9); and Figs. 10, 11, 12, and 13 are diagrammatic views showing the angular relation of the working piston, pump, and sleeve eccentric when the parts are in the positions shown in Figs. 6–9, inclusive, respectively.

Similar numerals of reference refer to similar parts throughout the several views.

The engine illustrated in the drawings comprises a single unit composed of a working cylinder and a pump cylinder, it being understood that any number of such units may be arranged together to form a complete engine.

The working cylinder 1, is provided at a suitable predetermined vertical position in its walls with a series of exhaust ports 2 and with a single exchange port 3, all said ports 2 and 3 lying in a common plane. As seen in Fig. 2 I prefer to provide four such exhaust ports 2, which lead directly into the two exhaust manifolds 4. The exhange port 3 leads into the upper end of the hereinafter described pump cylinder.

The upper edge of the working piston 5 which reciprocates within the cylinder 1 acts as the valve for the exhaust ports 2 and the exchange port 3. The piston 5 is provided with a raised surface 6 opposite the exchange port 3, but said raised surface does not contact the wall of the cylinder 1 but is separated therefrom by a narrow arcuate groove 7, which may be about ⅛" deep and not more than $\frac{1}{32}$" wide, and which is adapted to prevent the flame of the exhaust gases from passing with the gases through the exchange port 3 into the pump cylinder. The lower surface of the groove 7 is at the same level on the piston 5 as the upper surface of the portion of the piston adjacent the several exhaust ports 2. Therefore, the opening and closing of the exhaust ports 2 is simultaneous with the opening and closing of the exchange port 3.

At the upper part of the cylinder 1 I provide an arcuate insert 8, projecting about $\frac{1}{32}$" into the cylinder 1 and positioned over the groove 7, above described, and in such position that, when the piston 5 is at the upper end of its stroke, the said insert 8 will enter the groove 7 and free it of any carbon which might have accumulated thereon during the working stroke.

The piston 5 is provided with a crescent-shaped baffle 9 (Figs. 1–3) said baffle being positioned with its concave side opposite to the exchange port 3 and extending upward above the piston 5. The concave wall of this baffle 9 rises

from the raised surface 6 on a streamline concave curve in order to guide the fresh vapor mixture upward and away from the exhaust ports 2 at the time of the simultaneous exhaust and exchange of gases through the ports 2 and 3 respectively.

The piston 5 has, of course, the usual connecting rod 10 by which it is connected to the crank 11 of the engine shaft 12. The longitudinal position of the said exhaust and exchange ports 2 and 3 in the cylinder 1 is such that the piston 5 starts to uncover or open them when the crank 11 is 133½° down from its upper dead center, which said point is 1½° before the pump piston has reached the upper end of its stroke. This arrangement keeps the ports 2 and 3 open while the crank 11 is turning through its lower 93° of turn and keeps them closed through the remaining 267°.

The pump cylinder 13 is closely adjacent the working cylinder 1, and its upper end is adjacent to the upper line of the exchange port 3. In the form of my invention illustrated in Figs. 1, 4 and 5 I control the intake passage 14 from the carbureter by means of a poppet valve 15, operated in the usual manner by springs and a push rod 16 riding on a cam 17 mounted on the engine shaft 12. The piston 18 is provided with suitable rings and is connected to the crank 19 by means of the connecting rod 20. The length of the crank 19 is equal to that of the crank 11 of the working piston 5, and is set at 135° is advance thereof, that is to say, when the crank 11 is at its upper dead center the crank 19 is 135° past its upper dead center. The cam 17 (Fig. 4) is set on the shaft 12 in such manner that it begins to open the intake valve 15 when the main crank 11 is 65° past its lower dead center or 115° before it reaches its upper dead center, and the pump crank 19 is 20° past its upper dead center. The cam 17 holds the valve 15 open while the shaft 12 turns through 165°, thus closing the said valve when the crank 19 is 5° past its lower dead center, and the working crank 11 is 50° past its upper dead center.

Thus the action of this engine is as follows: Beginning with the crank 19 at its upper dead center, the crank 11 is at 45° past its lower dead center and the cylinder 1 is and has been exhausting its gases through the ports 2 and receiving fresh gases from the pump by the exchange port 3. These ports 2 and 3 are closed by the piston 5 when the crank 19 has moved through 1½°. The piston 5 has, however, been moving up faster than the piston 18, with the resulting slight increase in the pressure over the pump piston 18. When the crank 19 has moved through an additional 18½° to 245° (as shown in Fig. 5), the valve 15 opens and the pump draws in a fresh supply of explosive fuel, while the working piston 5 is compressing the gases in the cylinder 1 for the succeeding 115° when it reaches the upper end of its stroke. The explosion of the compressed gases then occurs in cylinder 1, the pump still drawing in fresh fuel for the next 45° when the piston 18 reaches the lower end of its stroke. But since the motion of the piston is so rapid, the vacuum in the pump continues to draw in fuel until the intake valve 15 closes 5° later. Upon closing of the valve 15, the pump compresses the fuel gases therein while the crank 19 is passing through 83½° at which time the burning gases in the cylinder 1 have been completely consumed, while the shaft 12 has been turning through 133½°. The piston 5 now uncovers the exhaust ports 2 and releases what pressure is remaining in the cylinder 1 and also opens the exchange port 3, thus permitting some of the exhaust gases to pass into the pump cylinder 13 to mix with the fuel vapor therein. The valve 3 remains open during the next 93° of turn of the shaft 12, the working piston 5 continuing its downward passage for 46½° and the piston 18 continuing upward, forcing the fresh fuel gases from the pump into the cylinder 1 through the exchange port 3. Then the piston 5 starts upward, closing the ports 2 and 3 when it has passed through the next 46½ °. The piston 18 reaches the upper end of its travel when the port 3 is still slightly open, and the cycle begins again.

It will be observed that at the point of the beginning of the exhaust, above described, the exhaust gases passing through the exchange port 3 into the pump are choked by having to pass through the narrow groove 7, in the edge of the piston, into the port 3, thus preventing any actual flame from passing into the pump, if there should be any flame remaining in the cylinder 1. Also it will be observed that the fresh exchange gases passing from the pump cylinder are blown upward in the cylinder 1 by the concave curved wall of the crescent baffle 9, thereby preventing their loss through the open exhaust ports 2.

The variation of my invention, illustrated in Figs. 6–13 differs from the above-described engine in the following respects: The poppet valve is eliminated and a sleeve valve is provided in the pump cylinder having ports for registration with an intake port and with the above-described exchange port 3, and the length of time that the intake port is open is reduced from 165° to 150°. The setting of the cranks 11 and 19 is the same as above described, namely 135° apart.

The sleeve 21 is operated by an eccentric represented by a crank 22, in Figs. 10–13, and a connecting rod 23. The particular construction of these parts is not shown in the drawings as they will be readily understood by those acquainted with the art. The sleeve 21 fits in the cylinder 13, having rings 24 engaging the said cylinder and located above and below the ports in the sleeve to prevent leakage due to wear or warping of the said sleeve 21. The sleeve 21 is provided with an exchange port 25 in line with the exchange port 3 from the cylinder 1, and with an intake port 26 lying in the same plane as the port 25 but alined with the intake port 27 in the wall of the cylinder 13. The intake port 27 is suitably connected to a carburetor and its position is such that the port 26 connects with or opens the port 27 when the eccentric center is 105° past its upper dead center (Figs. 6, 10) at which time the pump crank 19 is 30° past its upper dead center and the working crank 11 is 75° past its lower dead center, the piston 5 being above the exchange port 3 and compressing the gases in the cylinder 1. The intake port remains open for 150° when the eccentric center is 75° past its lower dead center (Figs. 7, 11) at which time the pump crank 19 is at its lower dead center and the working crank 11 is 45° past its upper dead center. Also the relation between the location of the exchange port 3 and the intake port 27 is such that, depending on the eccentricity of the eccentric center, the exchange port 25 of the sleeve 21 (which is in alinement with the intake port 26 of the sleeve 21) has been open for some

time when the crank 11 is at 133½° below its upper dead center and the burnt gases in the cylinder 1 are injected through the exchange ports 3 and 25 (Figs. 8, 12) and remain open during the entire 90° turn of the shaft 12 (Figs. 9, 13) when the pump piston 18 reaches the top of its stroke and the exchange port is about to be closed. The sleeve 21 extends above the port 25 a sufficient distance to permit at least one ring 24 above the port 3 when the sleeve is at its lowest position, and this upper portion passes up into a deep annular recess 28 formed between the wall of the cylinder 13 and a cup-shaped cap 29, leading down from the upmost position of the sleeve 21 (Fig. 8), inside the sleeve, to a point adjacent the pump piston 18 at the upper end of its stroke (Fig. 9).

The above described sleeve-valve engine follows the same cycle as the poppet valve engine but the point of opening and closing the intake valve 26, 27 are brought 15° closer together and the length of time that it remains open is correspondingly shortened to 150°. The valve engine is arranged with its intake valve open through 165° as its intended use is for airplanes while the sleeve engine is intended for use on automobiles, and similar uses.

Having described my invention, what I claim is:

1. In an engine of the class described, the combination of a working cylinder with piston, connecting rod, crank, and shaft and a pump cylinder with piston, connecting rod, and crank on the same shaft, the crank for the pump being set at 135° in advance of the crank for the working piston; exhaust ports controlled by said working piston and located at substantially the point where the working piston is when its crank is at 135° from the upper dead center, whereby the working cylinder is exhausting, the piston in the working cylinder has its minimum travel and the piston in the pump cylinder has its maximum travel; and a similarly controlled exchange port connecting the working and pump cylinders at the same time that the said exhaust ports are opened, said exchange port functioning to provide for the introduction of exhaust gases from the working cylinder into the pump cylinder and then the introduction of fuel including said exhaust gases into the working cylinder.

2. In an engine of the class described, the combination with a working cylinder and a pump cylinder; of an exchange port in the wall of said working cylinder connecting with with said pump cylinder; a working piston in said working cylinder; and an arcuate flame extinguishing groove in the upper edge of said piston and contiguous with said exchange port, said groove permitting exhaust gases to pass from said working cylinder to said pump cylinder and eliminating the passage of any flame to said pump cylinder.

3. In an engine of the class described, the combination with a working cylinder and a pump cylinder; of an exchange port in the wall of said working cylinder connecting with said pump cylinder; a working piston in said working cylinder; an arcuate flame extinguishing groove in the upper edge of said piston and contiguous with said exchange port, said groove permitting exhaust gases to pass from said working cylinder to said pump cylinder and eliminating the passage of any flame to said pump cylinder; and an arcuate insert in the working cylinder wall, extending into said cylinder and adapted to enter said groove when the piston is at the upper end of its stroke to maintain the groove clear of obstructions.

4. In an engine of the class described, the combination with a working cylinder and a pump cylinder having an exchange port therebetween; of a piston in said working cylinder adapted to cover and uncover said exchange port; a baffle member extending upwardly from said piston and operatively positioned relative to said exchange port, the horizontal surface of the piston adjacent said exchange port being at a higher level than the remaining horizontal surface of the piston; and an arcuate flame extinguishing groove located in the raised horizontal surface of the piston, said groove permitting exhaust gases to pass from said working cylinder to said pump cylinder and eliminating the passage of any flame to said pump cylinder.

5. In an engine of the class described, the combination with a working cylinder and a pump cylinder; of an exchange port in the wall of said working cylinder connecting with said pump cylinder; a working piston in said working cylinder; and an arcuate flame extinguishing groove having a maximum width of $\frac{1}{32}$ of an inch and positioned in the upper edge of said piston and contiguous with said exchange port, said groove permitting exhaust gases to pass from said working cylinder to said pump cylinder and eliminating the passage of any flame to said pump cylinder.

OSCAR ERICKSON.