

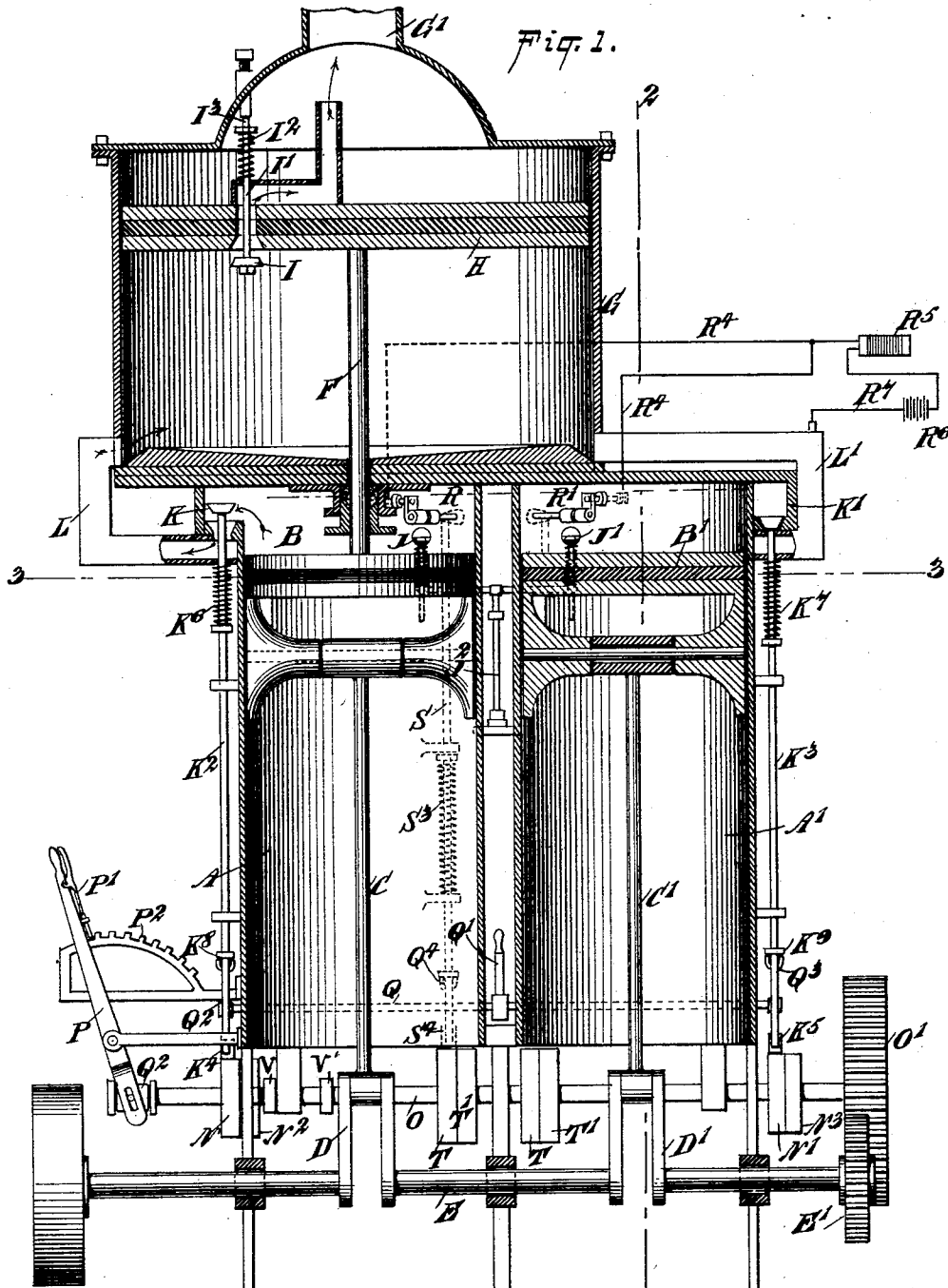
(No Model.)

2 Sheets—Sheet 1.

E. P. WOILLARD.
GAS OR VAPOR ENGINE.

No. 586,409.

Patented July 13, 1897.



WITNESSES:

William F. Gaebel.
Geo. G. Hostetler.

INVENTOR

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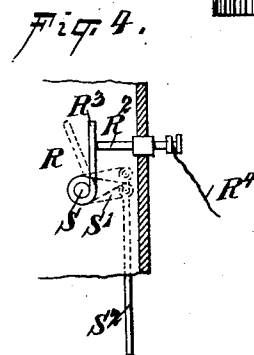
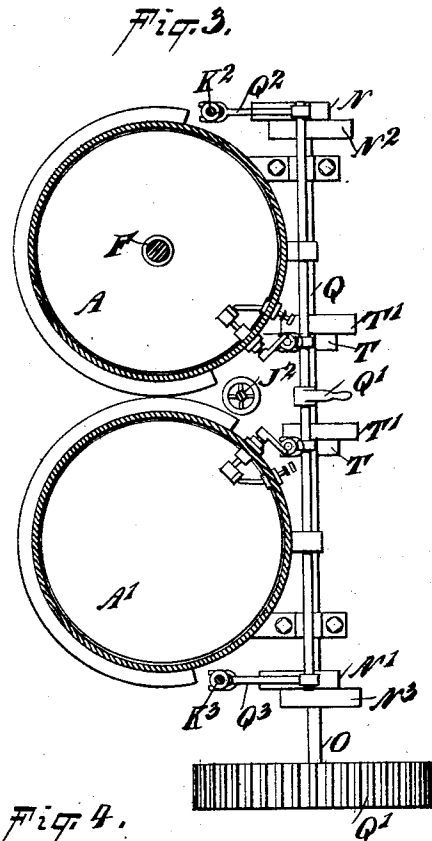
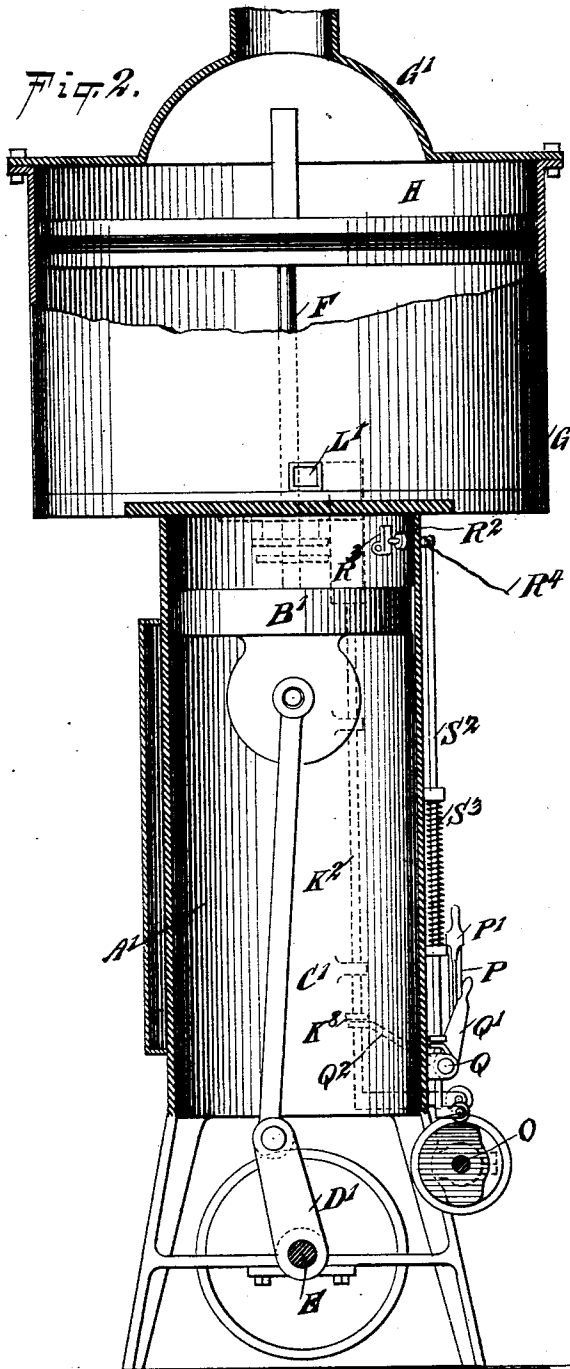
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UNITED STATES PATENT OFFICE.

EUGENE P. WOILLARD, OF SUGDEN, FLORIDA.

GAS OR VAPOR ENGINE.

SPECIFICATION forming part of Letters Patent No. 586,409, dated July 13, 1897.

Application filed April 15, 1896. Serial No. 587,625. (No model.)

To all whom it may concern:

Be it known that I, EUGENE P. WOILLARD, of Sugden, in the county of Dade and State of Florida, have invented certain new and useful Improvements in Gas or Vapor Engines, of which the following is a full, clear, and exact description.

The object of the invention is to provide certain new and useful improvements in engines using gas, oil, vapor, or other explosive mixtures as the motive agent, and whereby the latter is utilized expansively to the fullest advantage, and to produce a double-acting tandem engine having a high-pressure impulse in one direction and a low-pressure or compound-expansion impulse in the other direction, so that every stroke is a working stroke.

The invention consists of certain parts and details and combinations of the same, as will be fully described hereinafter and then pointed out in the claims.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the figures.

Figure 1 is a sectional side elevation of the improvement. Fig. 2 is a transverse section of the same on the line 2 2 of Fig. 1. Fig. 3 is a sectional plan view of the same on the line 3 3 of Fig. 1, and Fig. 4 is an enlarged transverse section of the igniting device.

The improved engine is provided with two high-pressure cylinders A A', arranged one alongside the other and containing the pistons B B', respectively connected by pitmen C C', respectively, with crank-arms D D', respectively secured on the main driven shaft E of the engine, as is plainly shown in Fig. 1. The two pistons B B' reciprocate in unison—that is, they have a similar up-and-down movement—but impulses are alternately given to the said pistons by alternate explosion of gaseous mixtures in the upper or working ends of the cylinders, the lower ends thereof being open, as shown in Fig. 1.

The piston B in the high-pressure cylinder A is provided with an upwardly-extending piston-rod F, passing through suitable stuffing-boxes into a low-pressure cylinder G, containing a piston H, rigidly connected with the piston-rod F. The cylinder G is in aline-

ment with the cylinder A, and its piston H is provided with an exhaust-valve I for connecting the lower part of the cylinder with the top part thereof at the time the piston H 55
nears the end of its upper stroke. When the valve I is open, the products of combustion contained in the lower part of the cylinder G can pass to the upper end thereof and through a smoke-stack G' to the atmospheric air, carrying along with them the residue of burned gases from explosion-chambers in cylinders A A' alternately through passages L L', as the valves K K' are still open to the 60
end of the upper stroke. This valve I is normally held to its seat on the piston H, and for this purpose I provide the valve with a valve-stem I', pressed on by a spring I² and adapted to engage a fixed point I³, held on the smoke-stack G', forming the cover of the cylinder G, as indicated in Fig. 1. Now it will be seen that when the piston H moves into an uppermost position then the stem I' in 65
moving against the stop I³ causes an opening of the valve I, so that the products of combustion in the lower end of the cylinder G can pass to the top thereof and out to the atmospheric air by way of the smoke-stack G'. 70

In the upper or working ends of the cylinders A A' are arranged the automatic inlet-valves J J', respectively connected with a suitable source of gas, vapor, or like fluid, forming an explosive mixture to act as a motive agent in the working ends of the cylinders A 75
A' against the pistons B B' to force the same downward. The inlet-valves J J' are both automatic and are opened by the suction of the pistons B and B', respectively, when drawing in their new charges of air and vapors. 80
The valves J and J' can be set to admit more or less air and vapor, and for this purpose the valves are held on a vertically-adjustable spring-pressed rod J². (Shown in Fig. 1.) The working ends of the cylinders are also 85
provided with exhaust-valves K K', respectively, serving to connect the upper ends of the cylinders A A' with the lower end of the low-pressure cylinder G to permit the products of combustion from the high-pressure 90
cylinders to pass into the lower end of the low-pressure cylinder G to act expansively on the piston H thereof, so as to drive the latter upward. 95
100

The valves K K' are opened alternately and positively from the engine-shaft E during the whole length of the upper stroke, and for this purpose I provide said valves K K' with valve-stems K² K³, respectively, carrying at their lower ends vertical rollers K⁴ K⁵, respectively, having peripheral engagement with cams N N', respectively, fastened on a cam-shaft O, connected by a large gear-wheel O' with a pinion E' on the main driven shaft E. The shaft O makes one revolution to two revolutions of the shaft E. The cams N N' are arranged in opposite directions relatively to one another, so that the cam N opens the valve K at the time the valve K' is in a closed position and the cam N' opens its valve at the time the valve K is in a closed position.

Now when the engine is in the position shown in Fig. 1 and the pistons B B' commence their downward stroke then an explosion of the previously-drawn-in mixture in the working end of the cylinder A' gives an impulse to the piston B' to rotate the shaft E, and during the downward movement of the two pistons B B' the piston B draws in a new charge of explosive mixture, and on the return stroke of the pistons this charge in the cylinder A is compressed, the valve K then being closed. During the return stroke of the piston B' the valve K' is open full length of stroke, so that the products of combustion of this cylinder pass through the exhaust-channel L' into the lower end of the cylinder G, and as the piston H is now beginning its return stroke an impulse is given to this piston in an upward direction by the expansion of the products of combustion acting on said piston. On the next downward stroke of the pistons B B' an explosion takes place in the cylinder A to give an impulse to the piston B, and during the downstroke of the piston B' a new charge is drawn in through the automatic valve J', which is compressed on the return stroke of the piston B'. During the full length of the return stroke of the piston B the valve K is opened by the action of the cam N, so that the products of combustion in the cylinder A can pass through the channel L and cause the products of combustion to act expansively on the under side of the piston H to give an impulse to the latter in an outward direction. Thus it will be seen that an impulse is given to the engine during the downstroke of the piston in either of the high-pressure cylinders A A', and an impulse in an upward direction is given to the engine by the products of combustion acting expansively in the low-pressure cylinder G on the piston H. Thus the motive agent is utilized to the fullest advantage, first in the high-pressure cylinders and then in the low-pressure cylinder, as above explained.

If it is desired to reverse the engine, I shift the shaft O longitudinally, so as to bring the cams N N' out of register with the friction-rollers K⁴ K⁵ and bring the said friction-roll-

ers in register with a second set of cams N² N³, extending in opposite directions to their mates N N'. By this arrangement the valves K K' are opened and closed in a reverse order.

In order to shift the shaft O longitudinally, I provide one end of the shaft O with a sleeve O², engaged by a lever P, carrying a hand-lever P', adapted to lock said lever P in place on a notched segment P², as shown in Fig. 1. The sliding motion of the shaft O is limited by stop-collars V V' on opposite sides of a shaft-bearing, as indicated in Fig. 1. In order to hold the shaft O in gear with the shaft E while shifting said shaft O, I make the gear-wheel O' wider than the gear-wheel E', so that upon shifting the shaft the gear-wheels O' and E' always remain in mesh.

In order to hold the valves K K' normally to their seats, I provide springs K⁶ K⁷, coiled on the stems K² K³ and pressing on collars thereon. (See Fig. 1.) In order to enable the operator to hold the valves K K' in an open position, I provide a shaft Q', journaled in suitable bearings and carrying a hand-lever Q' under the control of the operator. On this shaft are secured arms Q² Q³, adapted to engage collars K⁸ K⁹, secured on the stems K² K³, so that the operator on swinging the lever Q' laterally can cause a lifting of the stems K² and K³, so as to move the valves K K' off their seats.

It is expressly understood that the exhaust-valves K K' are held open during the full length of their upstroke, and the exhaust-valve I in low-pressure piston H opens on the latter nearing the end of its "upstroke," so that while finishing the balance of its stroke up there is a clear passage alternately from the explosion-chambers in the upper ends of the cylinders A A' through the passages L L' and through the exhaust-valve I in low-pressure piston H out into the stack, so that the residue would be discharged that otherwise would be left in the explosion-chambers after the pistons B B' have reached the ends of their strokes. This residue if left would interfere with drawing in the new charges of air and vapors through the automatic valves J J', as the residue would be under pressure and would prevent the automatic working or opening of the valves J J'.

In order to insure a proper igniting of the explosive mixtures in the working ends of the cylinders A A', I provide igniting devices R R', held in said cylinders A A', respectively. As the igniting devices are alike in construction, it suffices to describe but one in detail.

Each device, as shown in Fig. 4, is provided with a fixed electrode R² and an oscillating electrode R³, adapted to make and break contact with the fixed electrode R². The electrode R² is connected at the outside of the cylinder by a wire R⁴ with a coil R⁵, connected with a suitable source of electricity R⁶, connected by a wire R⁷ with the cylinders or other part of the engine to complete the cir-

cuit. The oscillating electrode R^3 is secured on a shaft S , mounted to turn in suitable bearings on the wall of the cylinder and connected at its outer end by a crank-arm S' with a vertically-disposed rod S^2 , pressed on by a spring S^3 and carrying at its lower end a friction-roller S^4 in peripheral contact with a cam T , fastened on the cam-shaft O . Now it will be seen that when the cam-shaft O is rotated from the main driving-shaft then the two cams T for the igniting devices $R R'$ actuate the oscillating electrodes R^3 alternately to make and break contact and to cause a spark for igniting the mixture compressed in the working end of the cylinder, as previously explained.

A second set of cams T' is necessary for the friction-rollers S^4 of the two igniting devices for reversing the engine, it being understood that the said cams are arranged diametrically opposite to their mates, similarly to the cams $N N^2$ and N' and N^3 . The positions of the various cams relatively to one another are indicated in Fig. 3.

The operation of reversing the engine is as follows: The hand-lever Q' is pulled down, turning the shaft Q and its arms $Q^2 Q^3$, whereby the valve-rods K^2 and K^3 will be raised sufficiently to clear the cams $N N' N^2 N^3$. The same movement causes the arms $Q^4 Q^5$ on the shaft Q to raise the rods S^2 out of the path of travel of the cams $T T'$. The hand-lever P is then thrown over to shift the shaft O longitudinally, bringing the rods K^2 , K^3 , and S^2 into operative relation to the cams N^2 , N^3 , and T' . The lever Q' is raised to release the said rods, so that the springs K^6 , K^7 , and S^3 will hold the rods in contact with the cams. As the cams N^2 , N^3 , and T' are arranged diametrically opposite to their mates N , N' , and T , the exhaust-valves and igniting devices will be caused to act in a reversed manner. If the engine is reversed while running, the spark will ignite the explosive mixture before the piston reaches the end of its compression stroke, so that the explosion will send the piston back (by the premature ignition) and the engine will then run in the opposite direction, the ignitions following each other at regular intervals after the engine has been started running in the opposite direction.

It will be observed that the working stroke of the low-pressure piston H is in the opposite direction to the working strokes of the high-pressure pistons B and B' , or, in other words, the high-pressure pistons work on their out-stroke and exert a push on the crank during the working stroke, while the low-pressure piston works on the instroke and exerts a pull on the crank during its working stroke.

Having thus fully described my invention, I claim as new and desire to secure by Letters Patent—

1. An explosive-engine, comprising high-pressure cylinders containing reciprocating pistons, a low-pressure cylinder containing a piston rigidly connected to one of the high-

pressure pistons, the working chambers of the said low-pressure cylinder and of the corresponding high-pressure cylinder being located between the respective pistons so that impulses will be imparted to said pistons in opposite directions and means for discharging the exhaust from the high-pressure cylinders into the low-pressure cylinder, substantially as described.

2. An explosive-engine, comprising a cylinder, a piston therein, a valve controlling a port communicating with the cylinder, an igniting device, a rotatable shaft operated by the engine, operative connections extending to said shaft from the said valve and from the igniting device, two sets of juxtaposed actuating devices, such as cams, located on said shaft and adapted to engage said connections, said actuating devices being laterally movable in unison and each actuating device being arranged diametrically opposite to the other actuating device of the same set, and means for shifting said actuating devices into registry with either one or the other actuating device of each set, whereby the engine may be reversed, substantially as described.

3. An explosive-engine, comprising a cylinder, a piston therein, a valve controlling a port communicating with the cylinder, an igniting device, a rotatable shaft operated by the engine, operative connections extending to said shaft from the said valve and from the igniting device, two sets of juxtaposed actuating devices, such as cams, located on said shaft and adapted to engage said connections, said actuating devices being laterally movable in unison and each actuating device being arranged diametrically opposite to the other actuating device of the same set, means for removing said operative connections from the path of travel of said actuating devices, and means for shifting said actuating devices to bring each of the above operative connections into registry with either one or the other actuating device of each set, whereby the engine may be reversed, substantially as described.

4. An explosive-engine, comprising a driven shaft having two cranks extending in the same direction, two high-pressure cylinders containing pistons each of which is connected to one of said cranks, a low-pressure cylinder containing a piston rigidly connected to one of the high-pressure pistons the working chambers of the low-pressure cylinder and its companion high-pressure cylinder being located between the respective pistons so that impulses will be imparted to said pistons in opposite directions, and means for discharging the exhaust from the high-pressure cylinders into the low-pressure cylinder, substantially as described.

5. An explosive-engine, comprising a high-pressure cylinder containing a piston, a low-pressure cylinder likewise containing a pis-

ton, a connection whereby the exhaust from
the high-pressure cylinder may pass to the
working chamber of the low-pressure cylinder,
an exhaust-valve controlling a through-
5 passage in the low-pressure piston, said valve
opening into the working chamber of the low-
pressure cylinder, and a stationary stop se-

cured to the cylinder and adapted to open
said valve substantially as described.

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Witnesses:

R. E. SERJEANTSEN,
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