(No Model.) 2 Sheets—Sheet 1.

B. F. KADEL.

GAS OR GASOLINE ENGINE.

No. 374,968. Patented Dec. 20, 1887.

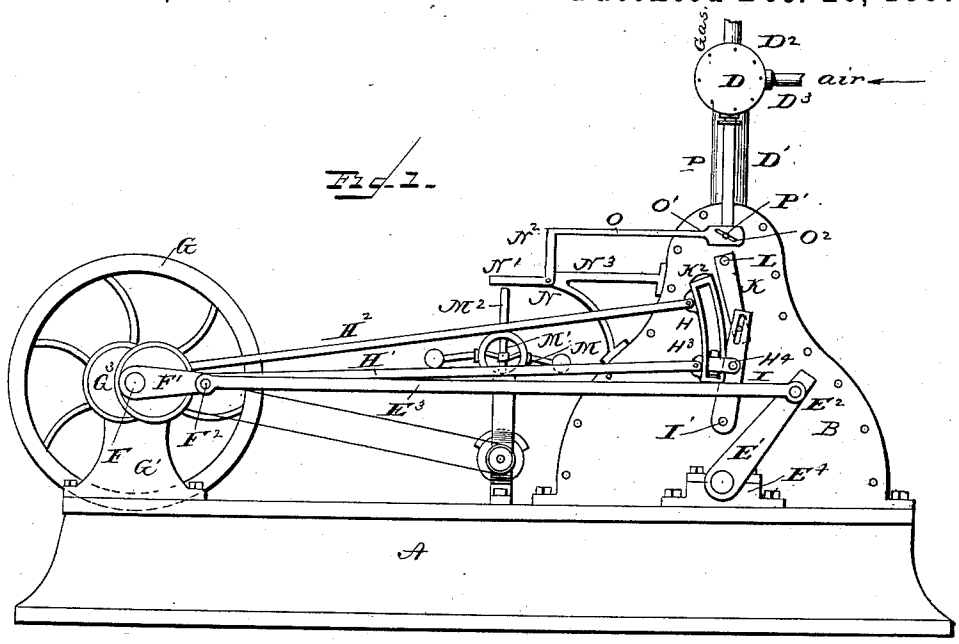


Fig. 1.

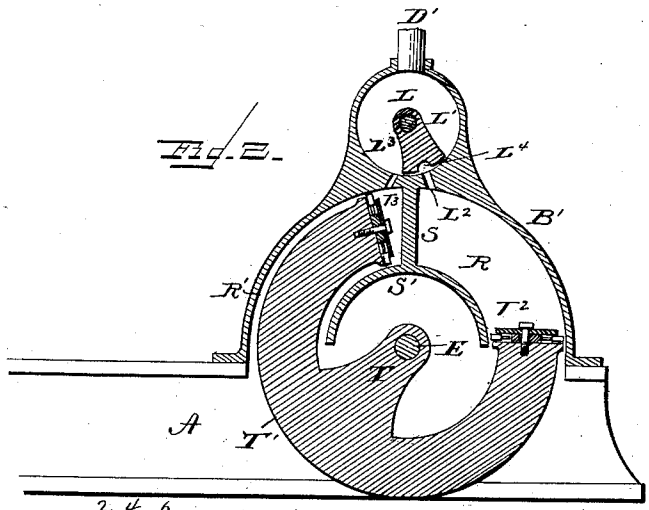


Fig. 2.

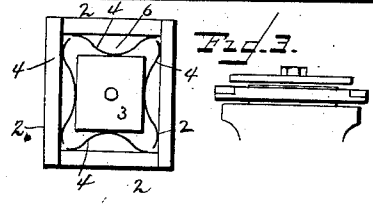


Fig. 3.

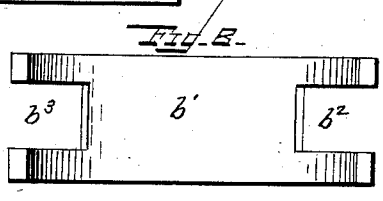


Fig. 4.

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Fig 5

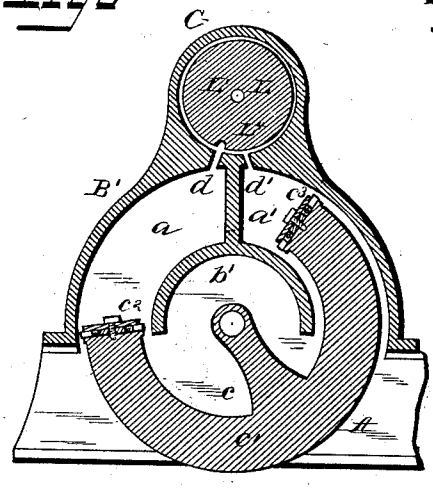


Fig 7

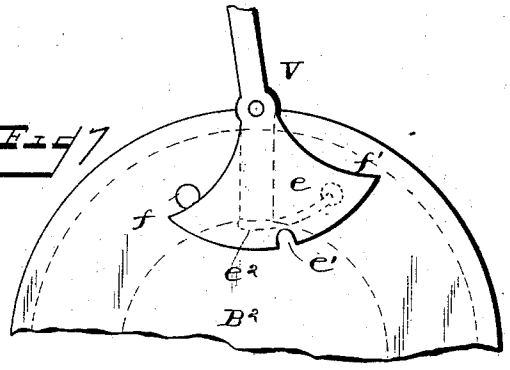


Fig 6

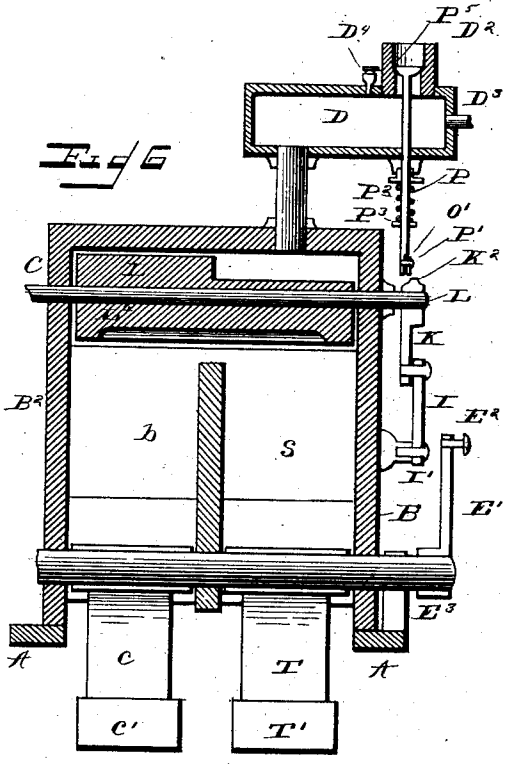
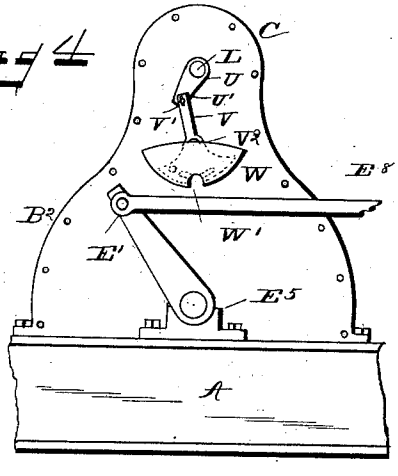


Fig 4



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UNITED STATES PATENT OFFICE.

BENJAMIN F. KADEL, OF ROCK FALLS, ILLINOIS.

GAS OR GASOLINE ENGINE.

SPECIFICATION forming part of Letters Patent No. 374,968, dated December 20, 1887.

Application filed March 7, 1887. Serial No. 230,057. (No model.)

To all whom it may concern:

Be it known that I, BENJAMIN F. KADEL, a citizen of the United States, residing at Rock Falls, in the county of Whiteside and State of Illinois, have invented certain new and useful Improvements in Gas or Gasoline Engines, of which the following is a specification.

My invention pertains to gas or gasoline engines, my improvements consisting, first, in the compact arrangement of a compound pumping-cylinder and a compound power-cylinder and mechanism for conveying the gas from the former to the latter; second, in novel means for regulating the supply of gas; third, in the use of novel means for igniting the gas at the proper moment, one igniter serving for the discharge at either end of the cylinder or for two or more cylinders.

My invention consists, really, of four cylinders, two of which are for the purpose of introducing the gas into the engine, and which are hereinafter referred to as the "pumping-cylinders," and two in which the gas is discharged, which I will refer to hereinafter as the "power-cylinders."

In the drawings, Figure 1 is a side elevation of the left-hand or pumping-cylinder side of my invention. Fig. 2 is a section in the line *x x* of Fig. 1, showing the pumping-cylinders and valve-chest of the engine. Fig. 3 is a detached view of the piston-head of one of the cylinders. Fig. 4 is a side elevation of the right-hand or power-cylinder side of my invention, exhibiting only the cylinder and valve-chest and igniting apparatus. Fig. 5 is a section in the line *y y* of Fig. 4, exhibiting the power-cylinders and valve-chest of the engine. Fig. 6 is a cross-section in the line *z z* of Fig. 1. Fig. 7 is a detached view of the igniting mechanism of my invention with the casing W removed. Fig. 8 is the inner curved wall of the power-cylinders, exhibited from the under side thereof.

A, Fig. 1, is the bed, to which the engine is secured and upon which it rests.

B is the casing, which forms the outer perpendicular wall of the pumping-cylinders and one of the end walls of the valve-chest C.

D is a cylindrical chamber in which the gas or gasoline comes in contact with the air, said chamber D communicating with the valve-chest C by means of the pipe D′.

D^2 is the pipe by means of which the gas is conveyed to the chamber D, which may be done through a continuation of the pipe D^2 or by means of a reservoir (if gasoline is used) situated a few inches above the chamber D and communicating with it by means of the pipe D^2.

D^3 is a pipe through which the required quantity of air is admitted to the chamber D.

E is an oscillating shaft journaled in the boxes E^4 and E^5, Fig. 4, which are secured to the bed A.

Upon the shaft E is keyed the crank E′, on the crank-pin E^2 of which is loosely fastened one end of the pitman E^3, the other end of which is in like manner loosely connected with the crank-pin F^2 of the crank F′, keyed on the shaft F, journaled in the bearing G′, secured to the bed A, the oscillating motion of the crank E being thus converted into a rotary motion in the shaft F.

On the shaft F is the fly-wheel G and the eccentrics G^2 and G^3, pivotally connected by means of the rods H′ and H^2 with the link H, which is moved up or down in the usual way by a lever. (Not shown.) The block H^3 is held loosely within the link H by the projection H^4, which is pivotally attached to the arm I. The arm I is pivoted at the point I′ to the casing B, and has at its upper end the slot I^2, in which plays an anti-friction roller located on the crank-arm K, which is keyed on the shaft L, journaled in the end walls of the valve-chest. By this means the arm I is given an oscillating motion, which is communicated by it to the arm K and shaft L. The engine is reversed by moving the link H up or down, as is required.

M is the usual ball-governor, operated in the usual way from the shaft F. The block M′ of the governor, in which is rigidly fixed the rod M^2, is moved up or down correspondingly as the motion of the governor is slow or fast. Resting on the upper end of the rod M^2 is the long arm N′ of the bell-crank lever N, which is fulcrumed on the bracket N^3, rigidly attached to the casing of the engine. To the upper end of the short arm N^2 of the lever N is pivoted one end of the rod O, the other end of such rod being formed into the head O′, in which is the diagonal slot O^2. The rod P extends through the chamber D and operates a valve, P^5, in the

lower part of the inlet-pipe D^2, which will be more fully dwelt upon hereinafter.

On the lower end of the rod P is the anti-friction roller P′, acting in the slot O^2 and connecting the rod P loosely with the head O′ of the rod O. Immediately below the head O′, and on the upper end of the arm K, is the cam-shaped projection K^2. As the arm K oscillates, the projection K^2 raises the head O′, and with it the rod P, sufficiently to open the inlet-valve P^5 and admit the gas to the chamber D. As the velocity of the engine increases, the governor-balls are raised, causing a corresponding lowering of the block M′ and rod M^2. The support being withdrawn from the long arm N′ of the lever N, it likewise falls, at the same time moving the short arm N^2, rod O, and head O′ backward, the backward motion of the head O′, by reason of the roller P′ and diagonal slot O^2, having at the same time a slight upward movement, placing such head O′ almost or quite out of the reach of the projection K^2, whereby the rod P is raised only slightly or not at all and little or no gas is admitted to the chamber D. As the motion becomes slower a contrary effect takes place.

In Fig. 2, R and R′ are the power-cylinders of my engine, having for their outer curved walls the casing B′, (which also forms the circular casing of the valve-chest C,) for their inner curved walls the semicircular plate T′, concentric with the outer walls of said cylinders, and having for their outer perpendicular wall the casing B, Fig. 1, and for their inner perpendicular wall the partition S^2, Fig. 6.

S is the mutual cylinder-head.

On the shaft E is rigidly fixed the arm T, carrying the piston T′, which forms the arc of a circle and is likewise concentric with the curved cylinder-walls.

On either end of the piston T′ are the piston-heads T^2 and T^3, the peculiar formation of which will be more fully shown hereinafter.

L′ is the valve, fixed rigidly on the shaft L and oscillating therewith, which admits the gas into the cylinders R and R′ alternately through the ports L^2 and L^3, the valve L′ being provided on its lower surface with the groove L^4.

In Fig. 3, (the upper part of which is a plan view of the piston-head with the cap 1 removed,) 1 is the cap or top plate, secured to the piston T′ by means of the threaded bolt 5. 2 2 2 2 are four independent plates loosely joined together by being halved at their ends and resting upon the end of the piston T′, the outer edges of such plates being in contact with the walls of the cylinder. Within the plates 2, and separated from them by the space 6, is the plate 3, also resting on the end of the piston, the bolt 5 passing through the center thereof. The plate 3 projects slightly above the plates 2, and the cap 1 rests entirely upon it, thus leaving the plates 2 free to a lateral motion. Between the outer edges of the plate 3 and each of the plates 2 is a spring, 4, of any required tension, which serves to keep such plates 2 at all times in close contact with the walls of the cylinder.

In Fig. 4, B^2 is the casing forming the outer perpendicular walls of the power-cylinders and of that end of the valve-chest opposite to the end formed by the casing B. L is the oscillating shaft before mentioned, on which is keyed the arm U, the crank-pin U′ of which plays in the slot V′ of the lever V, fulcrumed on the casing at the point V^2, the lever V thus receiving an oscillating movement from the arm U, the object of which will be given in detail hereinafter. W is a casing secured to the casing B^2 of the engine, which incloses the igniting apparatus, (more fully shown in Fig. 7,) the casing W being provided with the annular recess W′. The shaft E has a connection with the shaft F, similarly as in Fig. 1, by means of the crank E^6, crank-pin E^7, pitman E^8, &c.

In Fig. 5, *a* and *a′* are the power-cylinders, formed by the outer curved wall or casing B′, the inner curved wall *b′*, the outer perpendicular wall or casing B^2, and the inner perpendicular wall S^2, Fig. 6, which forms a partition between the pumping and power cylinders. *b* is the cylinder-head of the cylinders *a* and *a′*. *c* is an arm rigidly fixed on the shaft E and in a line longitudinally with the arm T of the pumping-cylinder piston. On the outer end of the arm *c* is fixed the arc-shaped piston *c′*, concentric with the curved walls of the cylinders, and provided with the cylinder-heads c^2 and c^3, which are of similar formation to the cylinder-heads T^2 and T^3. L′ is the valve already mentioned, which fills that entire portion of the valve-chest C which is directly above the power-cylinders *a* and *a′*, with the exception of that part wherein is cut the groove L^4, (more clearly shown in Fig. 6,) the object of this being to prevent the gas from entering either power-cylinder at the same time that it is entering the corresponding pumping-cylinder when first introduced into the engine. The necessity of this will become clearer when I describe the operation of my invention. *d* and *d′* are the ports through which the gas is introduced into the cylinders *a* and *a′*. The gas being ignited in the power-cylinders in the upward stroke of the piston-head, there is sufficient space left between such piston-head and the cylinder-head *b* for the reception of the charge. The inner curved wall *b′* of the power-cylinders is provided with the recesses b^2 and b^3, Fig. 8, extending about one-third the distance from either end of such wall *b′* to the mutual cylinder-head *b*, thus providing an escape for the discharged gases.

In Fig. 6 the only portion not already described is the valve P^5 in the lower end of the inlet-pipe D^2, and operated, as before specified, by the rod P. If the weight of the valve P^5 and accompanying mechanism is not sufficiently heavy to hold it in place, a coiled spring, P^2, supported by the pin P^3, may be

used. D^4 is an oil-cup communicating with the chamber D, by means of which oil can be introduced into such chamber, and, mingling therein with the gas, be conveyed with it to the interior of the engine, lubricating all portions thereof.

The lever V, Fig. 7, which has been already mentioned, is formed at its lower end into the head *e*, operating tightly between the casings B^2 and W, Fig. 4, such head *e* being provided with the recess *e'*. In the inner side of the head *e* is the groove e^2, (dotted lines,) communicating at its center with the recess *e'* and at either end, alternately, with ports *f* and *f'*, which open into the cylinders *a* and *a'*, respectively, as the head *e* is swung from side to side by the oscillation of the arm V. The recess *e'* is at all times wholly or in part in communication with the outer air by means of the recess W' in the casing W. Beneath the recess W' is placed the gas or other jet, (not shown,) the flame therefrom passing up through the recesses W' and *e'*, groove e^2, and ports *f* and *f'* alternately, as it is required to ignite the gas in the cylinders *a* and *a'*.

The operation of my invention is as follows: Supposing the chamber D to be filled with the proper mixture of gas and air, the wheel G is turned forward, causing the arm E' and shaft E to oscillate in the direction of such wheel, resulting, also, in a downward movement of the piston-head T^3 and a corresponding upward motion of the piston-head T^2, the air which filled the cylinder R being forced through the port L^2, groove L^4, and port *d* into the corresponding power-cylinder, *a*, and through the escape b^3 in the wall *b'*. At the same time the piston-head T^3, in its downward course, draws after it the gas through the pipe D', valve-chest C, and port L^3. As the piston-head T^3 nears the end of its downward stroke the arm K is oscillated toward the wheel G, as before shown, causing the shaft L and valve L' to oscillate in the same direction until the groove L^4 of such valve covers the port L^3. At the same time the head O', rod P, and valve P^5 are raised by the projection K^2, and a fresh supply of gas is admitted to the chamber D. The oscillation of the shaft L has at the same time caused the arm U and upper arm of the lever V of the igniter to oscillate forward, resulting in a backward movement of the head *e*, admitting the flame to the chamber *a*, in the manner already shown; but, the chamber being not yet charged with gas, no explosion takes place. As the wheel G continues its revolution the piston-head T^3 returns to its former position, forcing the gas through the port L^3, groove L^4, and port *d'* into the corresponding power-cylinder, *a'*, the piston-head c^3 of which is also making its upward stroke, compressing the gas in the upper part of the cylinder *a'* until it is ignited by the groove e^2 being once more brought into contact with the port *f'*. Meanwhile the cylinder R has become filled with a fresh supply of gas, ready to be forced into the cylinder *a* at the next stroke, and, the valve P^5 having been once more opened, fresh gas has been admitted to the chamber. The engine being now filled with gas, the motion becomes automatic.

It is evident that the ports *d* and *d'* of the power-cylinders should be closed at all times, except when the cylinders are being charged through them with the gas, as the charging of one cylinder and the explosion in the other take place at one and the same time.

The compactness of my engine and the use of gasoline in operating it render it valuable as a portable engine, greatly surpassing in cheapness of manufacture and cost of running the former portable steam-engine.

The piston T' and arm T may be made of cast-iron and in one piece, as may likewise the piston *c'* and arm *c*, increasing the cheapness of manufacture thereof.

Where the power is applied at one end only of the cylinder, it is necessary to make all the parts of double the strength which is required in my engine to meet the force of one stroke, which equals in power two of mine.

By journaling the shaft E on the bed of the engine instead of in the casing, a large amount of wear and strain is prevented.

What I claim as my invention, and desire to secure by Letters Patent of the United States, is—

1. In a gas or gasoline engine, the pumping-cylinders R and R' and power-cylinders *a* and *a'*, provided, respectively, with the oscillating pistons T' and *c'*, mutually fixed on the shaft E, and provided, further, with means of communication from the former to the latter, substantially as shown, and for the purpose specified.

2. In a gas-engine, the combination of the chamber D, provided with inlet-pipes D^2 and D^3, the pipe D', valve-chest C, oscillating valve L', provided with the groove L^4, ports L^2 and L^3, cylinders R and R', piston T', arm T, and shaft E, the ports *d* and *d'*, cylinders *a* and *a'*, piston *c'*, and arm *c*, oscillating the shaft E, substantially as shown, and for the purpose described.

3. In a gas-engine, the cylinders *a* and *a'*, provided with ports *f* and *f'*, oscillating piston *c'*, and escape-ports b^2 and b^3 in the wall *b'*, substantially as shown, and for the purpose named.

4. In a gas or gasoline engine, the valve L', cylindrical above the cylinders *a* and *a'* and cam-shaped above the cylinders R and R', and provided with the groove L^4, serving as a conductor of the gas from the cylinders R and R' to the cylinders *a* and *a'*, respectively, substantially as shown, and for the purpose described.

5. In a gas-engine, in combination with the shaft F, eccentrics G^2 and G^3, rods H' and H^2, link H, and block H^3, pivotally secured to the arm I, the arm I, slot I^2, arm K, provided

with a friction-roller to operate in the slot I^2, shaft L, and valve L′, substantially as shown, and for the purpose specified.

6. In a gas-engine, the combination of the valve P^5, rod P, roller P′, slot O^2, cross-head O′, lever N, bracket N^3, and governor M, substantially as shown, and for the purpose described.

7. In a gas engine, the oscillating arm V, provided with the head *e*, recess *e′*, groove e^2, casing W, provided with the recess W′, and port *f*, substantially as shown, and for the purpose mentioned.

8. In a gas or gasoline engine, the oscillating arm V, provided with the head *e*, recess *e′*, groove e^2, casing W, recess W′, and ports *f* and *f′*, substantially as shown, and for the purpose named.

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Witnesses:
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ISAAC I. BUSH.