No. 618,435. Patented Jan. 31, 1899.

G. PALM.

GAS ENGINE.

(Application filed Dec. 18, 1897.)

(No Model.) 2 Sheets—Sheet I.

Fig. 1.

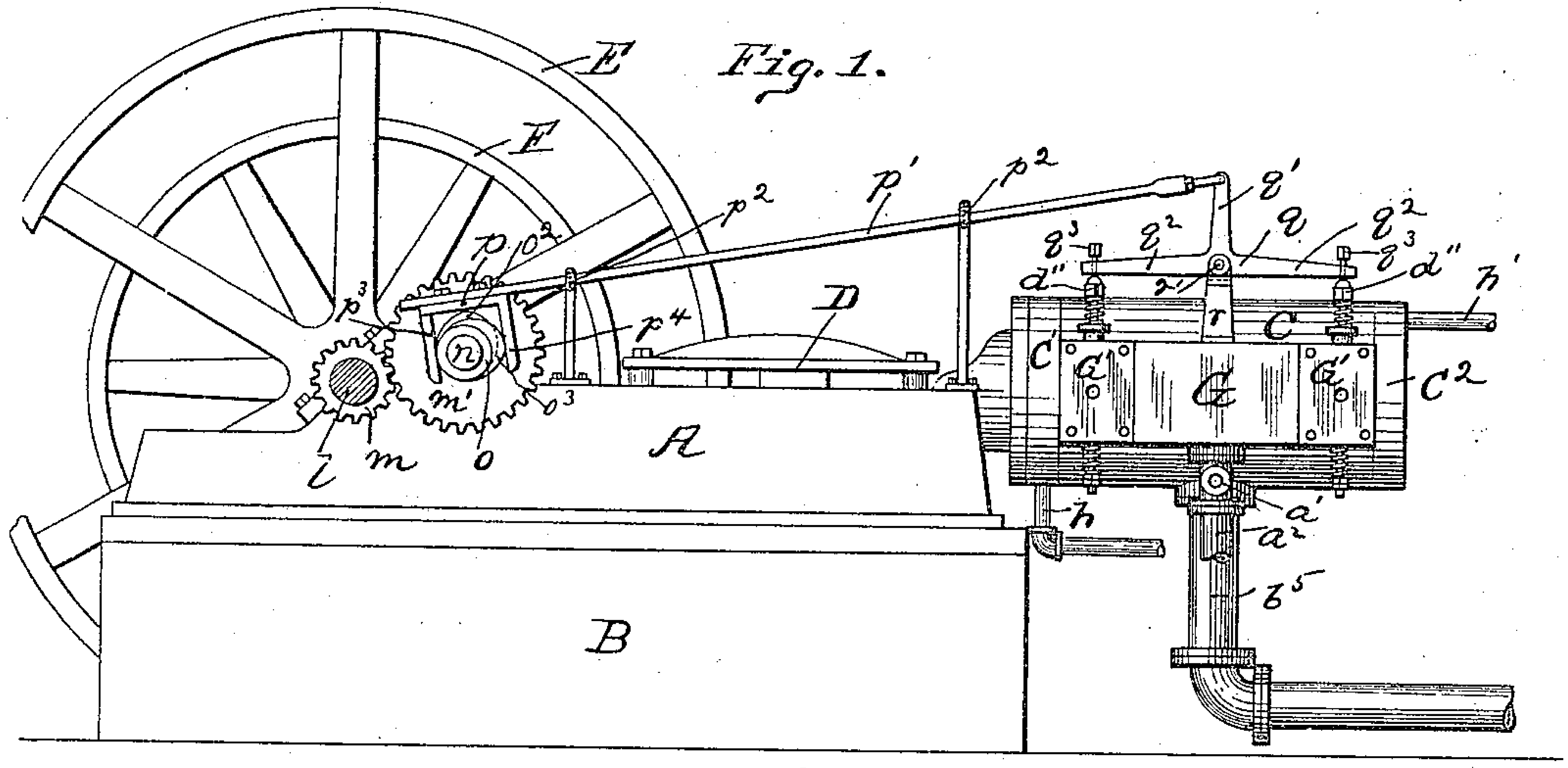


Fig. 2.

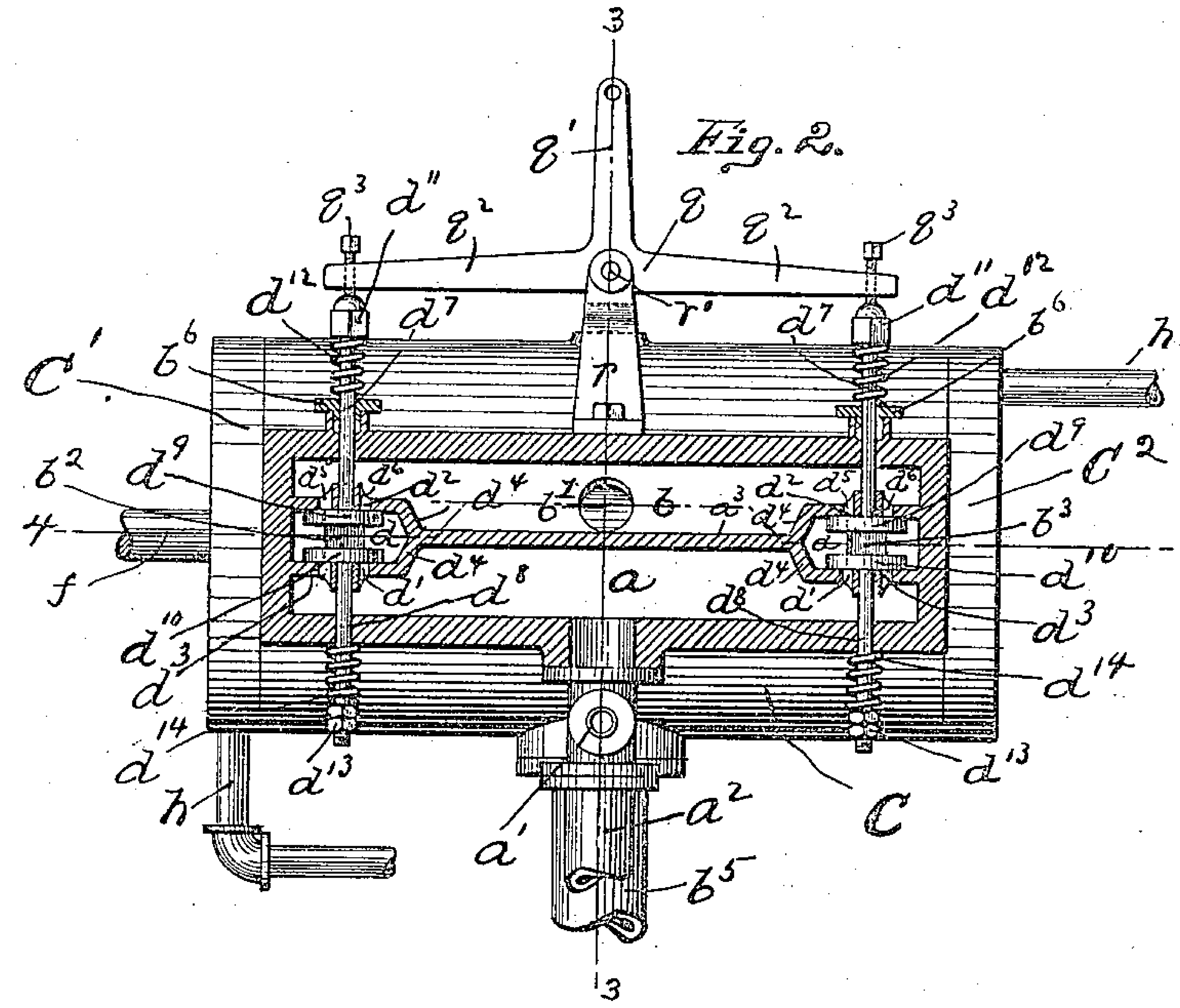
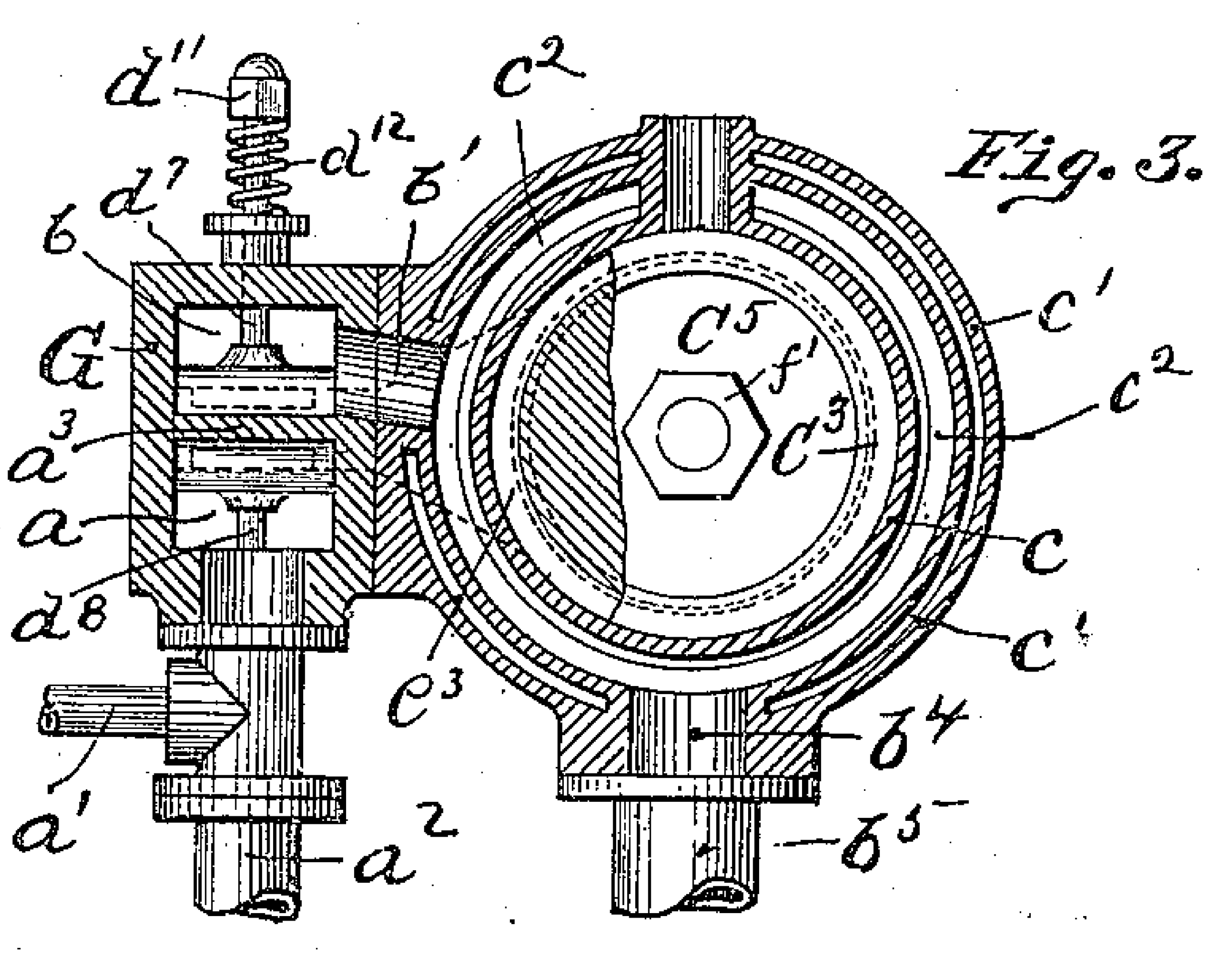


Fig. 3.



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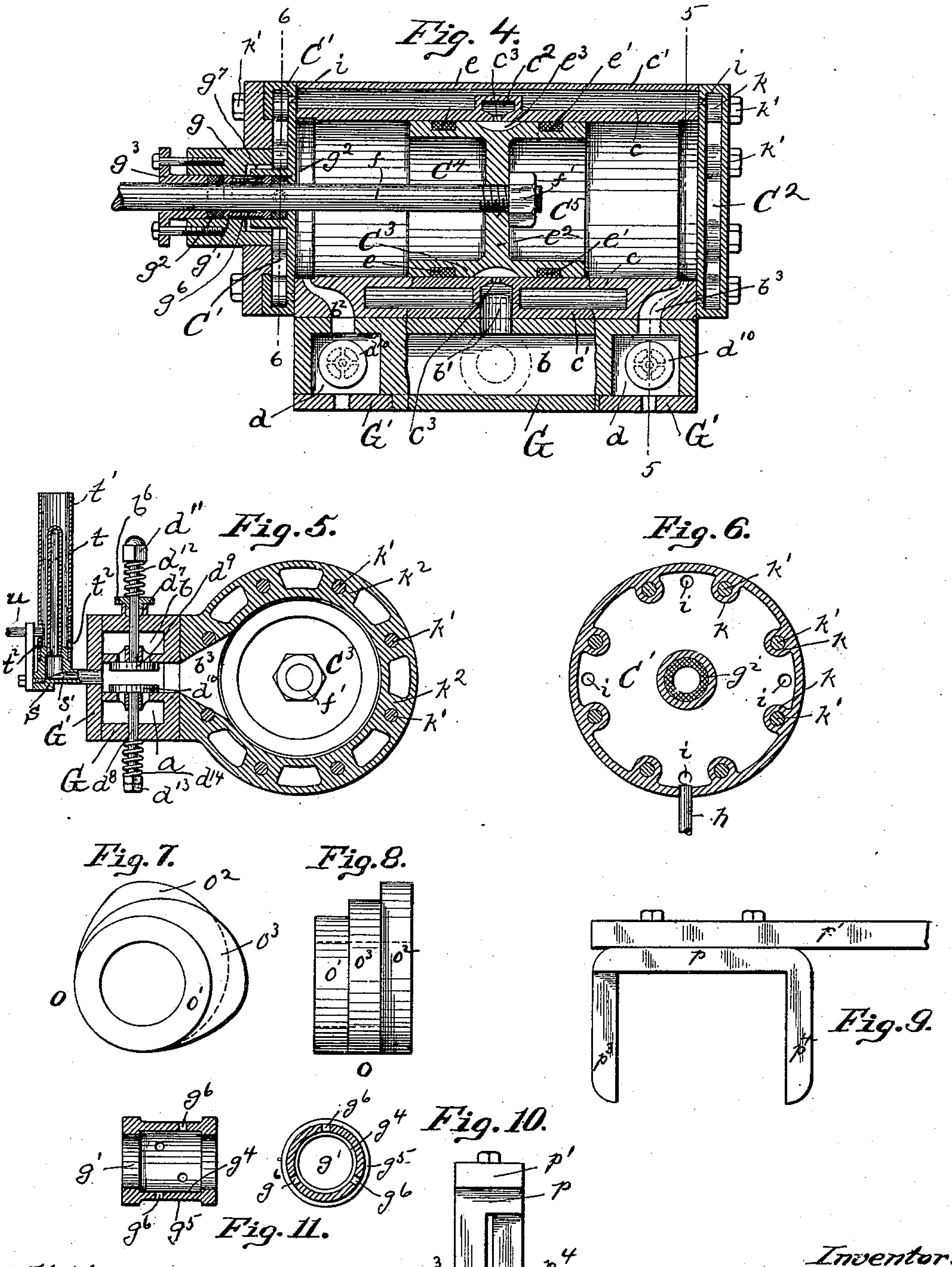

Witnesses.
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UNITED STATES PATENT OFFICE.

GEORGE PALM, OF BUTLER, PENNSYLVANIA.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 618,435, dated January 31, 1899.

Application filed December 18, 1897. Serial No. 662,404. (No model.)

To all whom it may concern:

Be it known that I, GEORGE PALM, a resident of Butler, in the county of Butler and State of Pennsylvania, have invented a new and useful Improvement in Gas-Engines; and I do hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to gas-engines, my chief object being the construction of a simple and practical engine taking explosions at both ends of the cylinder and being so constructed as to take up less space than has heretofore been necessary in the construction of similar engines.

To these ends my invention consists in the novel features which will be more fully hereinafter described and claimed.

In the accompanying drawings, Figure 1 is a side view of the engine. Fig. 2 is a similar view of the cylinder, the valve-box being shown in section. Fig. 3 is a cross-section of the cylinder on the line 3 3, Fig. 2. Fig. 4 is a horizontal section of same on line 4 4, Fig. 2. Fig. 5 is a cross-section on line 5 5, Fig. 4. Fig. 6 is a cross-section of the cylinder-head on line 6 6, Fig. 4. Figs. 7, 8, 9, 10, and 11 are details.

Like letters indicate like parts in each of the figures.

In the drawings, A represents the bed of the engine, and B the foundation upon which it rests.

C is the cylinder; D, the cross-head; E, the fly-wheel, and F the belt or pulley wheel.

The cylinder C is formed of two shells, an inner shell c and an outer shell c', for a purpose more fully hereinafter described. The ends of the cylinder C are closed by the heads C' and C^2. These heads are formed hollow and communicate with the space formed between the two shells c and c' of the cylinder.

The valve-box G is secured to one side of the cylinder and has two main chambers, the lower or mixing chamber a, into which the gas and air are introduced through the pipes a' and a^2, and the upper or exhaust chamber b, from which the exhaust-gases escape by means of the port b'. A diaphragm or wall a^3 extends horizontally across the box G, separating the chambers a and b the one from the other. In the valve-box G are also the two small chambers d d, which communicate with the chambers a and b by means of the valve-controlled ports d' and d^2. These chambers d d are inclosed by the upper and lower walls d^3 and the two inclined walls d^4, which connect the walls d^3 with the wall or diaphragm a^3. In the walls d^3 are formed the aforementioned openings d' and d^2. The webs d^5 extend across these openings to the bearings d^6, through which the valve-stems d^7 and d^8, carrying the valves d^9 and d^{10}, slide. The stems d^7, carrying the exhaust-valves d^9, extend through the stuffing-boxes b^6. Nuts d^{11} are secured to the upper end of stems d^7, and springs d^{12} are interposed between said nuts d^{11} and stuffing-boxes b^2 for the purpose of holding valves d^9 to their seat.

The valve-stems d^8, carrying the valves d^{10}, extend through the lower wall of box G and have at their lower ends the nuts d^{13}. Springs d^{14}, interposed between the outer surface of the box and the nuts d^{13}, act to hold the valves d^{10} to their seats. The outer wall of the box G is cut away at each end, giving access to the valves, and plates G' are bolted to the face of the box, covering said openings. Passages b^2 and b^3, leading from the chambers d d, communicate with the cylinder, one at each end thereof.

The piston C^3 is formed of a hollow shell, in the ends of which are seated the packing-rings e and e'. The hollow piston C^3 is divided into two chambers C^4 and C^5 by the wall e^2, located centrally thereof. This construction allows of a considerable shortening of the cylinder, as in the ordinary construction of engines on this principle the piston is solid, or if hollow has heads closing each end thereof, and accordingly a space must be left at each end of the cylinder in excess of the length required for a full stroke of the piston for the purpose of compressing the air and gas therein previous to an explosion. This construction has, however, other advantages more important. By using the cup-piston I prevent the rapid and high heating of same. The cold gases on entering the cylinder can enter the hollow portion of the piston, and as the piston advances said cold gases are forced therein. This tends to cool the walls of the piston and allows the free circulation of the gases therein. Again, the cup-piston permits the water of the water-jacket to act with more effect as the walls of the cup move in contact with the water-jacket, and consequently the space within said cup is kept cool. In closed hollow pistons there is no circulation therein and the water-jacket does not have the same effect. Furthermore, the cool gases cannot enter said piston. My invention applies whether a double or single cup-piston be employed. A groove e^3 is cut around the outer surface of the piston midway between the packing-rings e and e'. The piston-rod f is threaded into the wall e^2 of the piston and is secured therein by means of a nut f'.

As before stated, the cylinder is formed of an inner shell c and an outer shell c'. The inner shell c is the cylinder proper, or forms the part in which the piston operates. The two shells inclose a water-jacket around the cylinder, which is for the purpose of keeping the cylinder and piston therein of an even temperature. An annular passage c^2 surrounds the inner shell c and extends out into the water-space inclosed between the shells c and c'. This annular passage communicates with the exhaust-chamber b of the valve-box G through the passage b', hereinbefore referred to. A passage b^4 leads from the annular passage c^2 and communicates with the outside of the cylinder, a pipe b^5 being connected therewith to carry away the exhaust-gases.

The cylinder-heads C′ and C^2 are formed hollow, as hereinbefore stated, and communicate with the water-jacket of the cylinder, forming a part thereof. By this construction I provide a circulation of water all around and at both ends of the cylinder and so keep the interior at a practically regular temperature, thus reducing expansion and contraction to a minimum, allowing the piston to work freely in the cylinder at all times.

The cylinder-head C′ is provided with a stuffing-box g, through which the piston-rod f reciprocates. In this stuffing-box g is a ring g', at each end of which is placed the packing material g^2. A cap g^3 is bolted to the outer end of the stuffing-box and keeps said ring and packing in place. This ring g' is formed with two annular grooves or recesses g^4 and g^5, the groove g^4 being cut on the inner surface of the ring and the groove g^5 on the outer surface. Openings g^6 form communication between the two annular spaces g^4 and g^5, and passages g^7 lead from the water-space in the cylinder-head C′ to the water-space g^5 formed around the ring g'. The water flows through the openings g^6 to the annular space g^4 around the piston-rod, and as the water is kept in constant circulation the piston-rod is cooled and kept at an even temperature, so that there is less liability of the rod expanding and sticking in the stuffing-box.

A water-supply pipe h is connected to the bottom of the cylinder-head C′, and a pipe h', connected to the head C^2 near its top, acts to carry away the water after it has coursed through the jacket. A series of openings are formed in the inner shells of the cylinder-heads, as shown at i, allowing free passage of the water from the head C′ to the water-jacket and from thence to the head C^2. Fillets or bosses k are formed in the cylinder-heads around the inner circumference of the shell, through which the bolts k' pass which hold the heads to the cylinder. Fillets or webs k^2 extend across each end of the cylinder from the inner to the outer shells, into which the bolts k' are threaded.

Secured to the shaft l is the pinion m, which meshes into the gear-wheel m', which in turn is secured to the counter-shaft n. This shaft n is mounted in suitable bearings upon the bed-plate A and carries a cam O, which is better shown in Figs. 7 and 8.

A yoke p is secured to one end of rod p', the rod being pivotally secured at its other end to the arm q' of the T-shaped rocker-arm q. The yoke p fits upon the cam O and transmits the motion of the cam-faces to the rocker-arm q through the rod p'. The rod p' is mounted to slide in the guides p^2, secured to the frame or bed A. The T-shaped rocker-arm q is mounted to swing in the bearing r', formed at the upper end of the post r, which is bolted to the upper face of the valve-box G. The rocker-arm q has two horizontally-extending arms q^2, in the ends of which are threaded the set-screws q^3, which press upon the nuts d^{11} when the rocker-arm is operated and act through the valve-stems d^7 to open the exhaust-valves d^9.

The cam O, Figs. 7 and 8, is formed of the hub o' and the two cam-faces o^2 and o^3, which are set at right angles to each other and side by side. The yoke p is formed with two downwardly-extending arms p^3 and p^4, the arm p^3 engaging the cam o^2 and the arm p^4 engaging the cam o^3. The cams are so cut that both arms are always in engagement with the faces of the cams, making a positive movement between the two.

Attached to the plates G′ are the couplings s, to which are secured the tubes t and t'. The tube t is closed at its top and communicates with the passage s' formed in the coupling s, which in turn communicates with the chamber d in valve-box G. The tube t' surrounds the tube t and has openings t^2 at its lower end. A pipe u leads from the main gas-pipe a' (the connection not being shown) and communicates with the interior of the pipe t'. The gas entering the tube t' through the pipe u is kept constantly burning around the tube t, sufficient air entering through the openings t^2 to support combustion. By this means the tube t is kept at a very high heat, and when the air and gas are compressed by the piston into one end of the cylinder the mixture is forced through the ports b^2 or b^3 to the chamber d and from there through the passage s' to the tube t, where the charge is ignited. There are two such igniters, one attached to each of the plates G′, a description of one answering for both.

Having now fully described the several parts of my invention, I will proceed to describe the operation of the same.

My engine is what is commonly known as a "four-cycle" engine, but has an advantage which most engines of like construction have not—that of taking an explosion at each end of the cylinder. The engine is first started by hand or by any suitable power, the air and gas entering through the pipes a' and a^2 to the space a in the lower part of the valve-box. The motion of the piston in the cylinder draws the air and gas into one end of the cylinder, the inlet-valve d^{10} being forced from its seat by the pressure of the air and gas in the chamber a, a vacuum being formed in the cylinder as the piston moves forward. The air and gas enter into one of the spaces d when said valve is thus opened and pass thence through the port b^2 or b^3 to one end of the cylinder. When the piston reverses, it compresses the air and gas thus admitted into one of the chambers C^4 C^5 of the piston. The charge is ignited, as previously explained, causing an explosion of the compressed mixture and forcing the piston to the other end of the cylinder. In the previous backward movement of the cylinder air and gas were taken into the other side in a similar manner and an explosion follows when the mixture is compressed. For instance, supposing the piston, as shown in Fig. 4, were traveling to the right, the air and gas enter through the inlet-port b^2 and fill the space in that end of the cylinder. As the piston returns the charge is compressed in the space C^4 formed in the piston. The cup C^4 of the piston forms with the head of the cylinder the compression-chamber, and the cold gases are forced into said cup for the purpose of cooling same, as fully hereinbefore set forth. The explosion takes place, forcing the piston to the other end of the cylinder. In the meantime air and gas have entered through the other port into the right-hand end of the cylinder, and as the piston is forced back by the explosion of the mixture in the end C^4 of the cylinder the air and gas in the end C^5 are compressed, and when the piston reaches its farthest point the explosion takes place and the piston is forced in an opposite direction. The engine then makes a complete cycle or revolution to allow the exhaust air and gas in both ends of the cylinder to escape, and as one exhausts the other receives a charge, which is afterward compressed ready for the explosion upon the next succeeding cycle. The pinion m upon the main shaft l is half the size of the gear-wheel m', allowing the shaft l to make two revolutions to one revolution of the counter-shaft n. The cams o^2 o^3 upon the shaft n are, as previously stated, set at a quarter or ninety degrees to each other. As the shaft l revolves these cams are brought to act upon the yoke p and through the stem p' rock the lever q. As this lever q is rocked it depresses alternately the stems d^7 of the exhaust-valves. It will be seen by this construction that as the shaft l revolves the shaft n revolves once for every two revolutions of the shaft l. The cams o^2 and o^3 being set at ninety degrees to each other allows a full revolution of shaft l without operating the rocking lever q; but upon the next revolution of the shaft l the cam o^3 operating upon the part p^4 of the yoke forces the stem p' over to the right, operating correspondingly upon the arm q' of rocker q and forcing the valve d^9 in the right-hand end of the cylinder, as shown in Figs. 1 and 2, down, opening said valve and allowing the gases to exhaust into the chamber b, whence they pass through port b' to the annular space c^2 around the inner shell c of the cylinder, from which they escape through the port b^4 and the exhaust-pipe b^5. The cam o^2 operates in a similar manner upon the part p^3 of the yoke to force the other valve d^9, which is shown at the left-hand end of the cylinder in Figs. 1 and 2, open to exhaust the gases from the left-hand end of the cylinder or that corresponding to the end c^4 of the piston. It will thus be seen that the air and gas being taken in through the ports b^2 cause the valves d^{10} to open alternately, allowing the air and gas to enter alternately into opposite ends of the cylinder. As the explosion takes place in one end it compresses the charge in the other, and as the explosion in this other end takes place it forces the gases out through the other port into the space d, whence they escape through the port d^2, the lever q being operated by the cam and yoke to open the valve d^9 corresponding to that end of the cylinder, and the gas then escaping, as previously explained. As the piston reverses the gas escapes from the other end of the cylinder in a similar manner, and fresh air and gas are taken into the end which has just previously been exhausted, the engine making a cycle before being subsequently exploded.

In engines of the ordinary construction, and especially in gas-engines, the parts are liable to expansion due to the sudden explosion of the material and the cooling during an idle cycle. As previously explained, my cylinder is formed in two shells, an inner and an outer, a space being left between the two, forming a water-jacket. Also, as previously explained, the cylinder-heads are formed hollow, allowing for the circulation of the water therein. The water enters through the supply-pipe h into the cylinder-head C' and courses through the space in said head, a portion of the water entering through the ports g^7 and circulating around the piston-rod, as previously explained, the water passing from the head C' through the ports i into the water-jacket formed between the two shells of the cylinder, from which it enters similar ports i to the space formed in the cylinder-head C^2, whence it escapes by means of the exhaust-pipe h'. On account of the sudden expansion and contraction which are usually caused in ordinary engines by the explosions a space is apt to be formed around the piston in the cylinder, allowing a chance for the gases to explode past the piston and into the other end of the cylinder. The cooling of the piston and cylinder by means of the aforementioned water-jacket keeps the temperature of the cylinder and piston about normal; but in case any expansion or contraction should take place and allow some of the exploding mixture to escape past the piston between the piston and cylinder it will collect in the annular space e^3 formed around the piston and will exhaust through the ports c^3 into the space c^2 formed around the inner shell of the cylinder, and thence by means of the port b^4 and pipe b^5 will be carried away, and no part of the mixture which flies past will be allowed to enter the other end of the cylinder. By means of this construction premature firing of the explosive mixture is prevented, owing to the fact that any gases which escape past the piston are carried off to the exhaust and are not allowed to enter the other exploding-chamber.

I do not wish to limit myself to the exact construction illustrated, as that may be varied without departing from the scope of my invention.

What I claim as my invention is—

1. In an engine, the combination of a cylinder, a piston, said piston having an annular groove formed therein, said groove communicating with an annular passage encircling said cylinder, substantially as set forth.

2. In an engine, the combination of a cylinder, a piston, said piston having an annular groove formed therein, a hollow ring around said cylinder, said cylinder having openings therein, whereby said annular groove and hollow ring are made to communicate, substantially as set forth.

3. In an engine, the combination of a cylinder, a piston, said piston having an annular groove formed therein, said groove communicating with an annular passage around said cylinder, said passage communicating with the exhaust, substantially as set forth.

4. In a gas-engine, the combination of a cylinder, a piston, a chamber having ports opening into said cylinder, a diaphragm dividing said chamber into a mixing-chamber and an exhaust-chamber, said diaphragm forming inclosures around the said ports, said diaphragm having openings forming communication between said mixing-chamber and exhaust-chamber and said inclosures, and valves controlling said openings, substantially as set forth.

5. In a gas-engine, the combination of a cylinder, a piston, a chamber having ports opening into said cylinder, a diaphragm dividing said chamber into a mixing-chamber and an exhaust-chamber, said diaphragm having bifurcated portions inclosing said ports, said diaphragm having openings forming communication between said mixing and exhaust chambers and said inclosures, and valves controlling said openings, substantially as set forth.

6. In a gas-engine, the combination of a cylinder, a piston, a chamber having ports opening into said cylinder, a diaphragm dividing said chamber into a mixing-chamber and an exhaust-chamber, said diaphragm having bifurcated portions inclosing said ports, said diaphragm having openings forming communication between said mixing and exhaust chambers and said inclosures, check-valves controlling the openings leading from the mixing-chamber to the cylinder and the openings leading from cylinder to exhaust and connections between the valves controlling the last-mentioned openings and the main shaft, whereby said valves are operated alternately, substantially as set forth.

7. In a gas-engine, the combination of a cylinder, a piston, an exhaust-chamber communicating with said cylinder, valves controlling ports leading from opposite ends of said cylinder to said exhaust-chamber, a rocking lever engaging said valves, a rod connected to said rocking lever, said rod having oppositely-arranged arms therein, and rotatable cams adapted to engage said arms and reciprocate said rod, substantially as set forth.

8. In a gas-engine, the combination of a cylinder, a piston, an exhaust-chamber communicating with said cylinder, valves controlling ports leading from opposite ends of said cylinder to said exhaust-chamber, a rocking lever engaging said valves, a rod connected to said lever, oppositely-arranged arms on said rod out of alinement, and rotatable cams arranged on the quarter with reference to each other adapted to engage said arms, substantially as set forth.

In testimony whereof I, the said GEORGE PALM, have hereunto set my hand.

GEORGE PALM.

Witnesses:
ROBT. D. TOTTEN,
ROBERT C. TOTTEN.