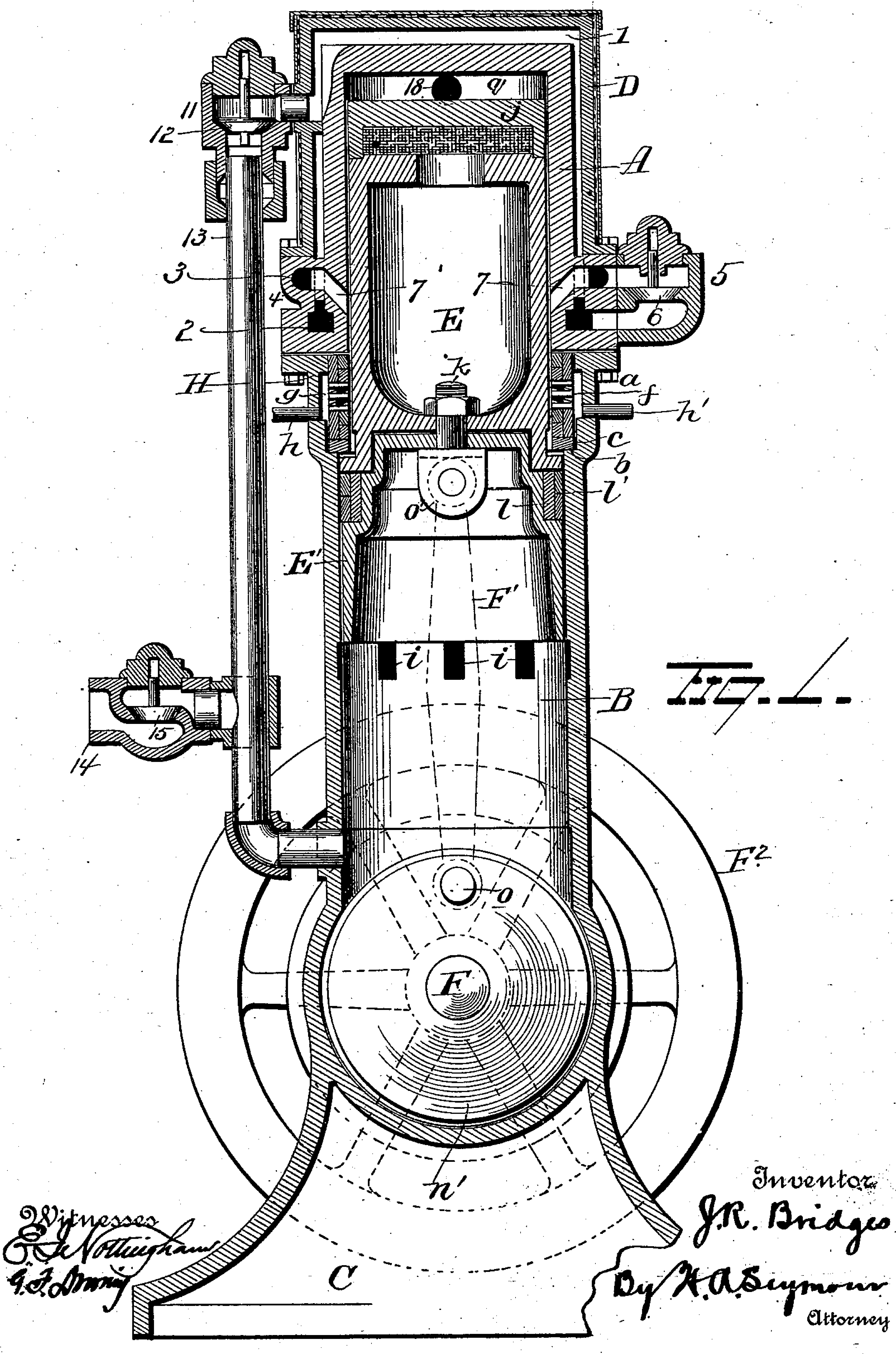
(No Model.)

3 Sheets—Sheet 1.

J. R. BRIDGES.

EXPLOSIVE GAS ENGINE.

No. 548,772. Patented Oct. 29, 1895.



(No Model.) 3 Sheets—Sheet 2.

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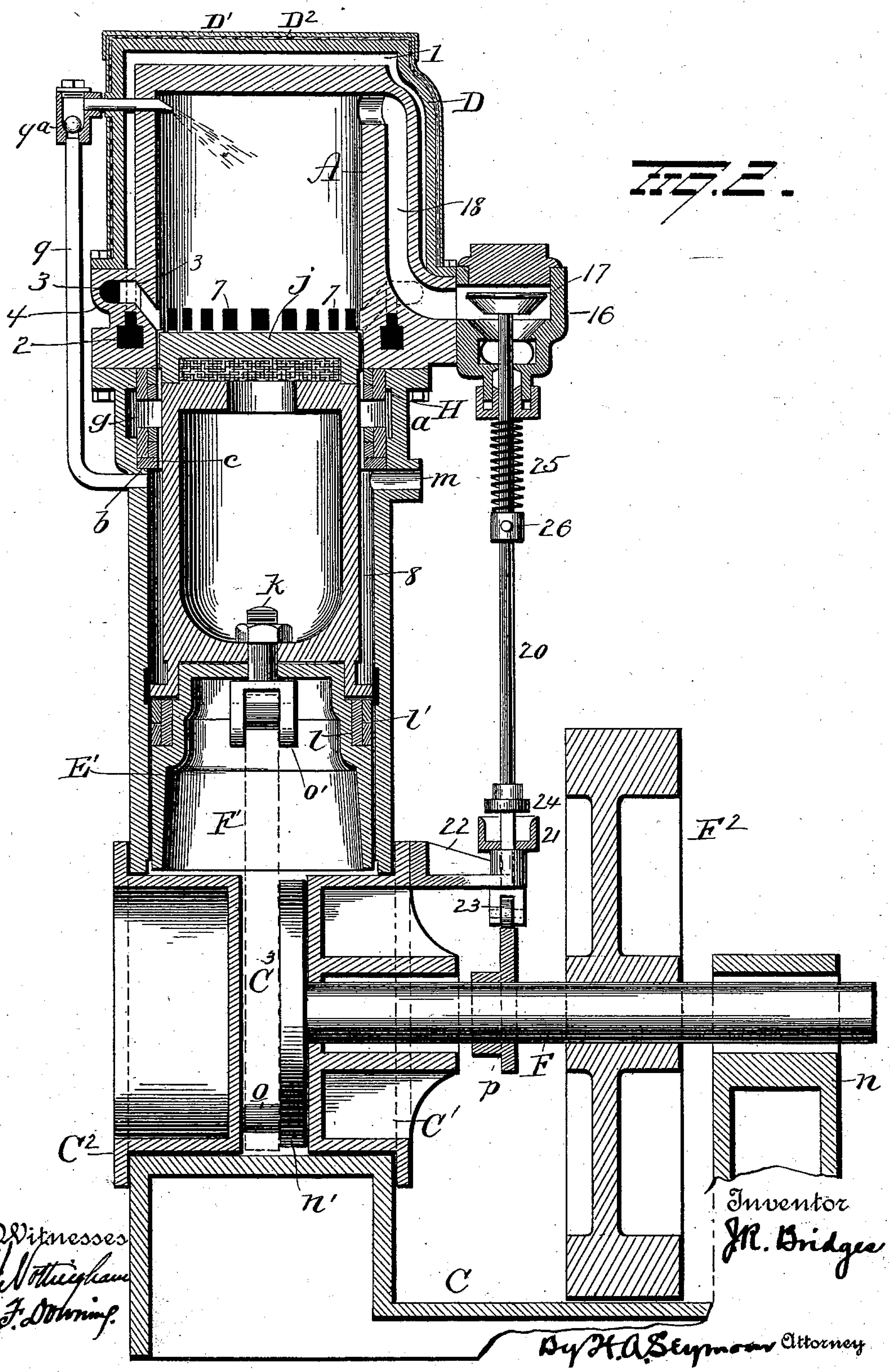

Witnesses
G. L. Nottingham
G. F. Downing

Inventor
J. R. Bridges
By H. A. Seymour Attorney

ANDREW B. GRAHAM. PHOTO-LITHO. WASHINGTON. D.C.

(No Model.)

3 Sheets—Sheet 3.

J. R. BRIDGES.

EXPLOSIVE GAS ENGINE.

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Fig. 3.

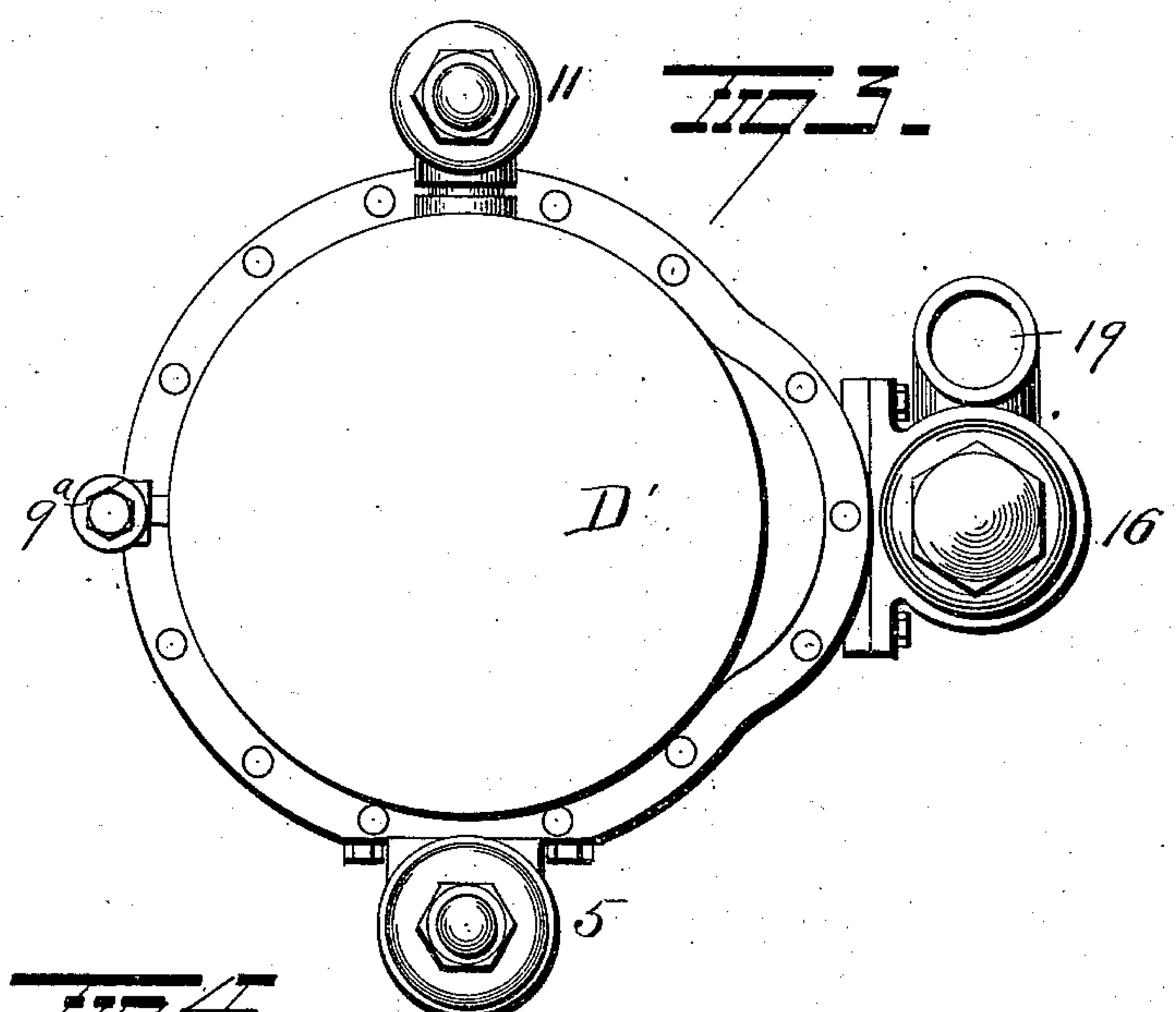


Fig. 4.

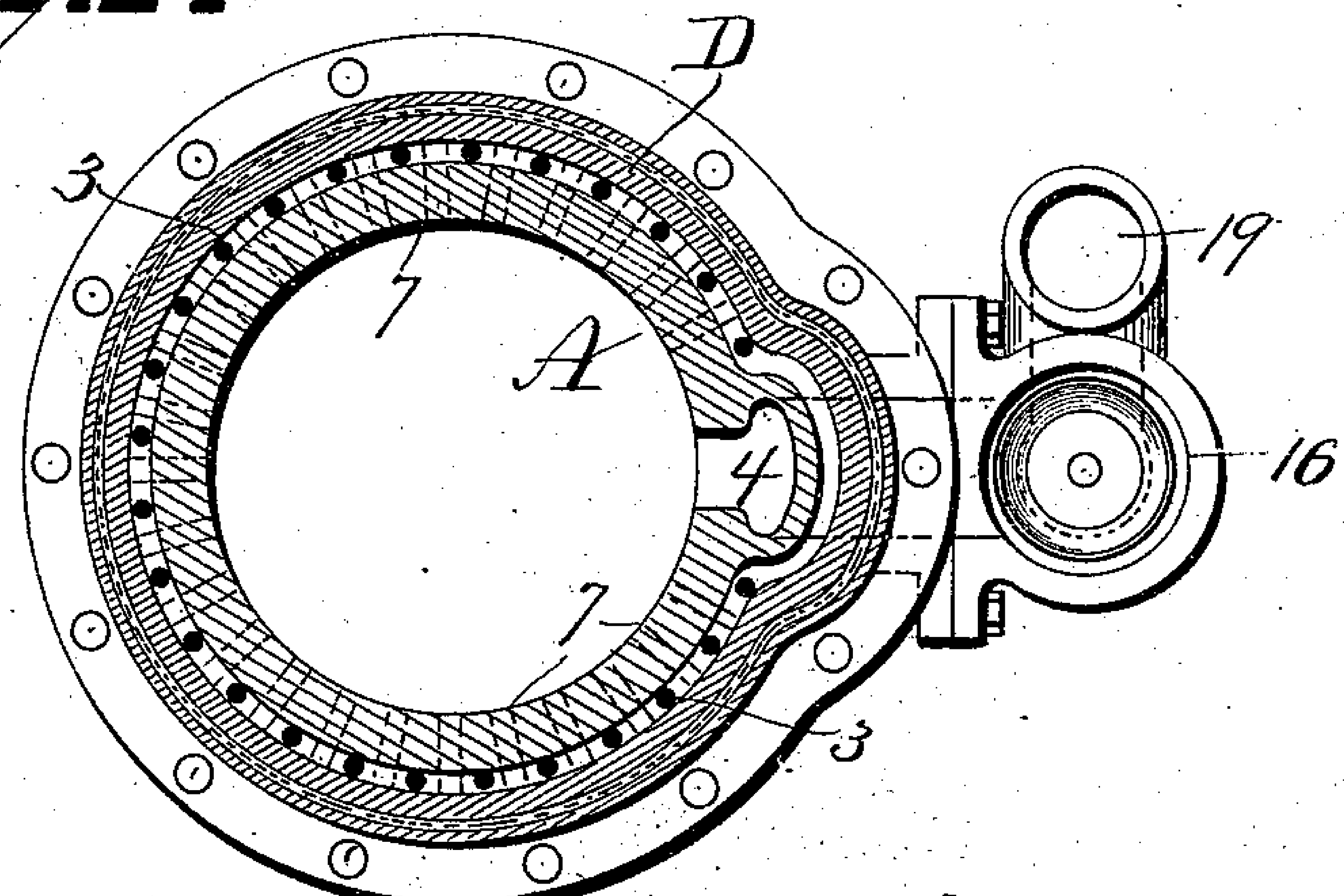
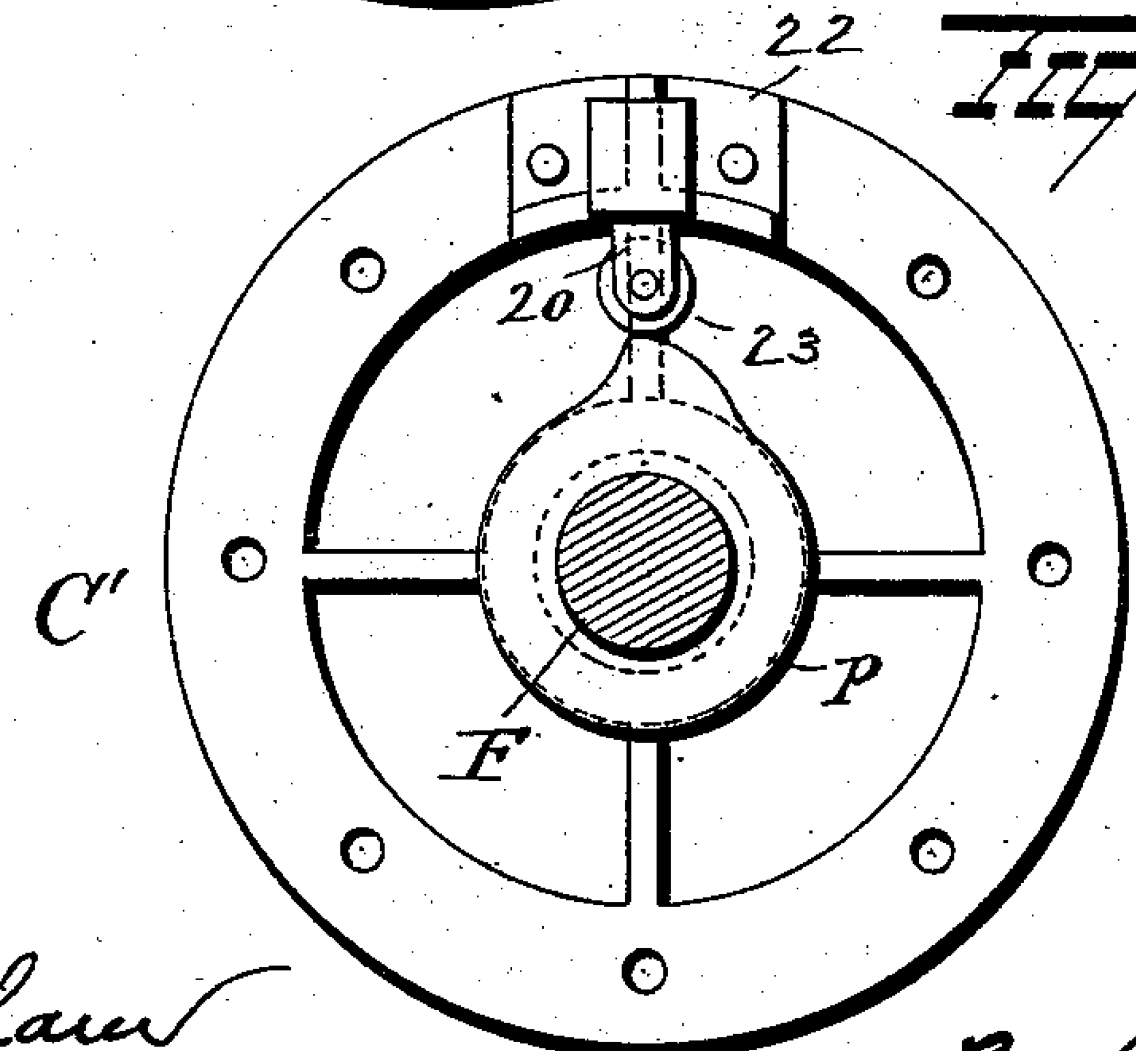


Fig. 5.



Witnesses
E. E. Nottingham
G. F. Downing

Inventor
J. R. Bridges
By H. A. Seymour
Attorney

ANDREW B. GRAHAM, PHOTO-LITHO. WASHINGTON, D.C.

UNITED STATES PATENT OFFICE.

JOHN R. BRIDGES, OF FINDLAY, OHIO.

EXPLOSIVE-GAS ENGINE.

SPECIFICATION forming part of Letters Patent No. 548,772, dated October 29, 1895.

Application filed April 28, 1893. Serial No. 472,231. (No model.)

To all whom it may concern:

Be it known that I, JOHN R. BRIDGES, a citizen of the United States, residing at Findlay, in the county of Hancock and State of Ohio, have invented certain new and useful Improvements in Explosive-Gas Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to an improvement in explosive-gas engines.

In gas-engines at present in use the cylinder is surrounded by a jacket of water, the water circulating in openings cored out in the cylinder-casting. This is necessary, as the cylinder and piston are constructed as are those of ordinary steam-engines, and if not kept at a low temperature, that they may be properly lubricated, they would in a very short time be so cut and worn that they would be useless. This may be better realized when it is remembered that the heat engendered at the moment of the explosion of the gas and air is nearly 1,500° centigrade, (about 2,700° Fahrenheit.) This temperature falls a half or two-thirds during the stroke of the piston, but at any point is entirely too hot for any wearing-surface to stand, if left uncooled.

It is admitted by every authority that fully fifty-one per cent. of the heat of the expanded gases is lost through the cooled cylinder-walls, thirty-one per cent. exhausted, and only about sixteen per cent. converted into useful effect, the balance being lost from other parts of the engine. This loss of fifty-one per cent. must remain as long as gas-engines have their cylinders jacketed with water, and that will be necessary as long as they are constructed as at present.

Most gas-engines in use are so constructed that they obtain an impulse only at each two revolutions of the crank. When an explosion has been effected, the piston is forced to the end of its stroke, doing work and storing up sufficient momentum or energy in the very heavy balance-wheel to carry the piston through its following three operations or strokes. Then the piston is retracted, exhausting the consumed gases from the cylinder; but usually about one-third is left in the end of the cylinder, which space is designated the "explosion-chamber." The exhaust-valve then closes, and a fresh charge of gas and air is drawn into the cylinder by the second forward stroke of the piston. Then the piston is again returned to its first position, the charge in the meantime being compressed, thus completing the fourth stroke. Then follow the same operations as before.

There is another class of gas-engines built which obtain an impulse at each revolution; but such engines have not been satisfactory, inasmuch as there is either too much burned gas left in the cylinder or there is a loss of gas by its following the burned gases out of the exhaust when too much air and gas are allowed to enter the cylinder in driving out the consumed gases. These engines are very large for the power obtained, as it is impossible to clean out the cylinder properly, and the charge is too greatly adulterated with the burned and inert gases.

It is the object of my present invention to remedy, in a very great measure, the losses attendant on the present construction of explosive-gas engines and to produce such an engine in which the cylinder will not be unduly cooled and in which the large water-jacket heretofore employed will be dispensed with.

A further object is to construct an explosive-gas engine in such manner that a great amount of energy heretofore lost with other constructions will be saved.

A further object is to so construct an explosive-gas engine that the deposit of carbon on the walls of the cylinder in which the explosion takes place will be prevented.

A further object is to construct an explosive-gas engine in such manner that a small charge of air and gas may be used and compressed to the ordinary pressure before igniting it and at the same time obtain the usual initial pressure.

A further object is to construct a gas-engine in such manner as to avoid the use of oil as a lubricant in the main cylinder.

A further object is to provide simple means for cleaning out the burned gas without the loss of gas.

A further object is to reduce the size and cost of manufacture of a gas-engine without reducing the power of the same.

A further object is to produce a gas-engine constructed in such manner that fuel will be economized without reducing the efficiency of the engine.

A further object is to produce an explosive-gas engine which shall be cheap to manufacture, simple in construction, and efficient in the performance of its functions per horse-power developed.

With these objects in view the invention consists in certain novel features of construction and combinations and arrangements of parts, as hereinafter set forth, and pointed out in the claims.

In the accompanying drawings, Figure 1 is a vertical sectional view of the engine. Fig. 2 is a similar view taken at right angles to Fig. 1. Fig. 3 is a plan view. Fig. 4 is a cross-section. Fig. 5 is a detail view.

A represents the main cylinder-casting; B, the compression-chamber, which is made somewhat larger than the main cylinder A; C, the engine-bed, and C′ C^2 castings located between the lower end of the compression-chamber and the engine-bed, and between said castings C′ C^2 is the crank-pit C^3.

A jacket D surrounds the cylinder A and is adapted to produce an air-space 1, which extends around and above said cylinder, said jacket D either being bolted to the cylinder A, as shown in the drawings, or made integral therewith, as desired.

In proximity to the base of the cylinder A an annular air-chamber 2 is made in the casting and communicates through small ducts 3 with the air-space 1. Another annular air-chamber 4 is located above the chamber 2 and communicates with a valve-chamber 5, having a check-valve 6 therein. The annular air-chamber 2 also communicates with the valve-chamber 5, as shown in Fig. 1. Thus it will be seen that air in the chamber 1 can pass through the ducts 3 into the air-chamber 2, from thence to the valve-chamber 5, and thence into the annular chamber 4, from which chamber the air will pass through inclined ducts 7, which communicate at the lower ends with the interior of the cylinder A in proximity to the lower end thereof. The upper end of the compression-chamber is somewhat enlarged, as shown at *a*, and produces an annular shoulder *b*, on which a ring *c* is located, said ring being adapted to project inwardly a distance commensurate with the difference in diameter of the compression-chamber and the main cylinder, for a purpose which will hereinafter appear. Within the enlarged portion *a*, at the upper end of the compression-chamber, two sets of packing-rings H are located, and between said sets of packing-rings a spring or springs *f* are inserted, these springs being designed for the purpose of obtaining a close bearing of the rings at their outer edges, so that any wear at these points may be continually taken up, thereby preventing any leakage of water. The enlarged portion *a* also forms a chamber *g*, which extends between the sets of packing-rings and is adapted to receive water, which enters at *h* and has its exit at *h′*, the water in said chamber being adapted to come into contact with a piston E, which is made to reciprocate in the cylinder A and compression-chamber B in a manner presently explained, the packing-rings above described being also adapted to bear on said piston. In the interior face of the compression-chamber, somewhat below the center thereof, recesses *i* are made for the reception of water.

The piston E is made hollow and on its top is provided with a cap *j*, preferably very slightly larger in diameter than the piston, so that should the piston from any cause be liable to touch the cylinder when working the cap *j* will touch the cylinder and prevent the piston from becoming scored or its smooth wearing-face from being injured by coming into contact with anything other than the packing-rings. The main purpose of the cap *j* is to prevent the hot gases from coming into direct contact with the cold piston, and the space within the cap is filled with asbestos or other suitable material.

To the lower end of the main barrel-piston E a larger hollow piston E′ is secured, (by means of a bolt *k*,) which fits neatly within the compression-chamber B, said piston E′ being provided with a recess *l*, in which packing-rings *l′* are inserted. When the pistons are at the lower extremity of their stroke, an annular chamber 8 will be formed between the barrel-piston E and the interior wall of the compression-cylinder B, with which chamber a suitable pipe communicates at *m* for the admission of gas. A pipe 9, having an interposed check-valve 9^a, also communicates with the chamber 8 at one end and at its other end is adapted to discharge gas into the upper end of the cylinder A, the small outlet at the discharge end of said pipe being so made as to cause the discharge of gas downwardly. The air-chamber 1, surrounding the cylinder A, communicates with a valve-chamber 11, in which a check-valve 12 is located. A pipe 13 also communicates with said valve-chamber at one end and at the other end with the lower end of the compression chamber or cylinder B. With the pipe 13 an air-inlet pipe 14, having a check-valve 15, communicates. A valve-chamber 16 is located to one side of the cylinder A and is provided with a valve 17. With the valve-chamber 16 one end of a duct 18 communicates, the other end of said duct communicating with the upper end of the cylinder A, said duct being adapted to convey the exhausted gas to the valve-chamber 16, from which it escapes through an exhaust-pipe 19.

Mounted in a pedestal *n*, projecting from the base or bed C of the engine, and in the casting C′, is the engine-shaft F, which terminates at the crank-pit C^3, where it is provided with a disk wheel *n′*, carrying a crank-pin *o*. The crank-pin *o* is connected with lugs *o′*, projecting from the bolt *k*, by means of a pitman

F′. The shaft F also carries a balance-wheel F^2, and in proximity to said balance-wheel a cam-wheel *p* is secured to the shaft. The stem 20 of the valve 17 passes downwardly through a suitable packing-box secured to the casing of the valve-chamber 16 and through a dash-pot 21, carried by a bracket 22, secured to the casting C′, and at its lower end said valve-rod is provided with a roller 23, adapted to bear on the cam-wheel *p*. The plunger 24 of the dash-pot is carried by the valve-stem 20, whereby to cause the exhaust-valve 17 to be seated lightly. A spring 25 encircles the valve-stem, whereby to cause the exhaust-valve to be closed quickly, the tension of said spring being regulated by means of a collar 26, adjustably secured to the valve-stem.

Assume now that the pistons E and E′ are in the positions shown in Fig. 1 and a charge has been compressed in the space *q* at the upper end of the cylinder A, (this condition can be obtained by turning the engine by hand, or by a hand-pump if the engine is large,) which may be ignited in the usual way by a flame or by an electric spark, when the piston will be forced down to the end of the stroke into the position shown in Fig. 2. When the upper edge of the cap *j* reaches the upper edge of the openings 7 in the cylinder A, the exhaust-valve is opened by the cam *p* on the shaft F through the medium of the stem 20, and the remaining pressure of the expanded gases in the cylinder A is allowed to escape to the atmosphere. The cylinder A will still remain filled with burned gases at atmospheric pressure, which gases are expelled in the following manner: When the piston E′ was in the position shown in Fig. 1, the space in the compression-chamber under it, as well as the space in the crank-pit, was filled with air, which on the downstroke of piston E′ was compressed to, say, four pounds pressure above the atmosphere. This compressed air will pass up pipe 13 and through the check-valve 12 into the air-space 1, but will not do so freely until the exhaust-valve 17 is opened, when it will be perfectly free to pass into the air-space 1, while the heated air will pass down through the holes 3 into the enlarged annular chamber 2, thence through the check-valve 6 into the annular chamber 4 and into the cylinder A through the passages or ducts 7. As these openings are inclined at an angle of twenty-four degrees downwardly, the air will strike upon the face of the casting or cap *j*, where they will meet, and, rising in a solid body, will force the hot and burned gases out through the exhaust-duct, and thence to the atmosphere through the valve 17 and exhaust-pipe 19. The compression cylinder or chamber B is supposed to be one-seventh larger than the interior diameter of the cylinder A, (more or less,) and as the air in its travel around the hot casting or cylinder A (when the engine is fully in operation) will be highly heated and rarefied it will drive out all of the burned gases in the cylinder A by the time the upper edge of the casting or cap *j* reaches the upper edge of the openings 7. Then the exhaust-valve will close and the piston-barrel E will begin to compress the inclosed air in main cylinder A.

On the downstroke gas was being admitted to the space or chamber 8 through the inlet *m*, at which point any suitable valve may be located. By the closing of this valve the gas in the chamber 8 will be prevented from returning when the piston E′ on its return stroke compresses the gas and forces it through the small pipe 9, past the check-valve 9^a, into the upper end of the cylinder A, there mingling with the fresh charge being compressed. When the piston-barrel E reaches the position shown in Fig. 1, the charge will be again ignited and the preceding operations repeated. It will be noticed that the point of exit of the gas from the pipe 9 is pointed and smaller than the balance of the pipe, the object being to introduce the gas in a fine and forcible jet, that it may penetrate and agitate the air and thoroughly mix the two gases.

On the upward stroke the retraction of the piston E′ will draw in fresh air through the check-valve 15 in the pipe 14, which when closed on the return stroke will prevent the escape of air when being compressed.

In all engines the piston slides along the surface of the inside diameter of the cylinder, and in gas-engines, as before stated, to make this possible or practicable it is necessary to keep the cylinder cool, which causes a loss of one-half the energy of the heated gases. I have in my improvement greatly reduced this loss by reversing this method in a way. The piston is a light hollow barrel sliding along the packing-rings H, and, being of slightly less diameter than the surrounding cylinder-casting A, it therefore does not touch it.

The packing-rings H are in pairs or sets, having a space between them, into which the steel springs *f* are inserted, and having sufficient tension to keep the rings bearing hard upon their outside edges against the adjacent surface. Into the space or chamber *g* water will be introduced through the inlet *h* in sufficient quantity to keep the rings and the springs and the surface of the piston-barrel E at all times cool and at the same time lubricate their wearing-faces. Any water which may escape into the upper chamber or cylinder A will be a very small quantity, if any, as by the pressure of the gases in the cylinder A it will be forced down; so it may be expected that the only water which will enter the cylinder A will be what will remain on the surface of the piston-barrel E. What water may escape into the gas-chamber 8 will be removed by the recesses *i* in the following manner: When the piston E reaches the lower end of its stroke, any water that may be on its upper edge will run into these recesses, where it will remain as the piston moves up on its return stroke, when, having reached the end of its upward motion, the recesses are uncovered by the piston E′ and the water will run out. There will be no loss of gas by these recesses, for the reason that they will be filled with air when the piston opens them into the gas-chamber 8, which will remain unless driven out by water, which will prevent any gas from entering them. However, should any gas escape into the lower air-chamber it will eventually be carried into the cylinder A. It is intended to keep a proper amount of water and oil in the crank-pit at all times to lubricate the parts, the splashing of which will reach the upper end of the connecting-rod and lubricate it also, and any excess will be drawn off in a suitable trap.

By the form and construction of the castings C′ C^2 it will be observed that the space in the crank-pit is greatly contracted, and by increasing or diminishing the depth of the casting C^2 the pressure of the air can be regulated as desired, within certain limits. This, of course, can only be done by having different covers or castings C^2. Where an engine is only doing light work constantly, a very light pressure would be required in the air-chamber B. Not so much air would be required to keep the cylinder A cool as when the engine is working to the full limit of its power a great part of the time.

As I have stated, the greatest loss in gas-engines accrues from the cooling of the cylinder by the water circulating around it. In my improvements the cylinder A occupies the position of the cylinder in other engines, and as there is no wearing-surface upon it it may be kept at a great heat compared with water-cooled cylinders. The air-space 1 being supplied at each revolution with cool fresh air, the radiating heat of the cylinder A will be taken up by this air and at the proper time will be injected into the cylinder A and there compressed and supplied with the proper amount of gas to make it an explosive mixture.

In explosive-gas engines in which the cylinder is cooled by water the explosive charge when compression is complete and just before ignition takes place is never of a much higher temperature than the atmosphere from which the air is taken. In my improvement by taking the air from the space 1, which has been used to cool the walls and end of the cylinder, and compressing it in the cylinder, which is very hot, a great amount of heat is absorbed by the charge from the cylinder. Thus the charge is given a very high temperature before ignition, and therefore will require just so much less gas in the charge to produce the temperature in the exploded charge necessary to create the corresponding pressure. Heat or energy that passes through the cylinder-walls and into the water is lost entirely; but heat or energy that passes through hot cylinder-walls into the air that is used in the following explosion is not lost, but is carried back from where it came, requiring just so much less of the valuable element of the combination producing heat or energy to keep the same up to the efficiency required.

The object of the check-valve 12 in the pipe 14 is that when the cool air has entered the space 1 and the valve 6 is held down by the pressure of gases in the cylinder A (this pressure being communicated to the top of this valve through the small space between the piston-barrel E and the cylinder A) it will become heated and its pressure increased by radiated heat from the cylinder A. It will not then be able to return down the pipe 13; but the instant the exhaust-valve opens, thereby relieving the pressure on the top of the valve 6, it will rush into the cylinder A with sufficient violence and force to expel the spent gases from said cylinder, and the latter will then be filled with an almost pure and highly-heated air. When the heated air left in the space 1 and the pressure became sufficiently reduced, the air from the lower end of the cylinder or chamber B ascended and took the place of the air that entered the cylinder A and forced all the heated air out of said cylinder. The air-space 1 should be of the same cubical capacity as the space within the cylinder A, to the end that the space 1 may be filled at each revolution with cold air and also that none of the cold air may enter the cylinder A when the spent gases are expelled, but will all remain in the space 1 to cool the cylinder A and in turn to be heated by it. If some cooling did not take place in the cylinder A, it would, from the constant explosions, become too hot to stand the pressure put upon it.

While I in no way save any of the heat of the exhausted gases, I do save that heat in a great measure that passes into the walls of the cold cylinders at present used, and by the addition of another jacket D′ and interposed asbestos D^3, which will be done, I can further increase the heat of the air in the space 1.

As the explosion will take place in a cylinder that will be highly heated, there will be no deposit of carbon on the walls of the space in which the explosion takes place.

A small space between the sides of the piston-barrel E and the walls of the cylinder-casting A when the piston is at any considerable point above the lowest point of its stroke will always be filled with non-circulating gases, that will act to prevent much heat being transferred to the piston, and consequently not much loss will occur at this point.

The continual passing of the piston-barrel through the water surrounding it between the packing-rings H will at all times keep it cool and well lubricated.

The expansion of the exploded gases, taking place in a hot-walled cylinder, in which no water is used to cool it, will be as perfect as possible—that is, the decrease in the pressure will be due very nearly to expansion alone and not be intensified by the cooling effect of the water surrounding the cylinder-walls. This being the case, it is possible for me to use a very much smaller charge of air and gas, and, compressing it to the ordinary pressure before igniting it in a small explosion-chamber and obtaining the usual initial pressure and suffering slight loss from cold walls, expand it to the end of the stroke, thereby effecting great economy in the consumption of gas, the original volume being expanded several times more than it is in engines at present in use, and yet have in the cylinder at the time of the exhaust a pressure nearly as great, by reason of the expansion being due alone to the movement of the piston.

The engine above described is simple in construction, comparatively cheap to manufacture, and is effectual in every respect in the performance of its functions.

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

1. In a gas engine, the combination with a cylinder, and a piston, of an air chamber surrounding said cylinder, an annular air chamber communicating with said first-mentioned air chamber, a second annular air chamber communicating with the first mentioned annular air chamber, and ducts leading from said second annular air chamber to the interior of the cylinder, substantially as set forth.

2. In a gas engine, the combination with a cylinder, and a piston, of an air chamber or space surrounding said cylinder, an annular air chamber communicating with the air space, a second annular air chamber adapted to communicate with the first mentioned annular air chamber, and inclined ducts leading from said second annular air chamber to the interior of the cylinder in proximity to the lower end thereof, substantially as set forth.

3. In a gas engine, the combination with a cylinder, and a piston, of an air space surrounding said cylinder, an annular air chamber adapted to communicate with said air space, a second annular air chamber, a valve chamber with which both of said annular air chambers communicate, a check valve in said valve chamber, and ducts leading from said second annular air chamber into said cylinder, substantially as set forth.

4. In an explosive gas engine, an explosion cylinder, surrounded by an air space which communicates with the cylinder, said air space adapted to receive a supply of fresh air to keep the explosion cylinder cool, said air space adapted to empty into the cylinder wherein it expands to flush and clear the cylinder of exhausted gases and the heat which it has absorbed from the explosion cylinder so prepares it that the supply of gas required to be added to form an explosive mixture is reduced to a minimum, substantially as set forth.

5. In an explosive gas engine, the combination with a main explosion cylinder, and a compression chamber, of an air space surrounding the main cylinder, said air space in communication with the cylinder and the compression chamber whereby fresh air is received from the compression chamber into the air space where it is utilized to cool the cylinder and then allowed to discharge into the cylinder to flush the latter and remove the exhausted gas and an exhaust port through which this exhausted gas is discharged, substantially as set forth.

6. In a gas engine, the combination with a main cylinder, a compression chamber in communication therewith, and an exhaust port, of a gas chamber, a piston operating therein, a pipe leading from the gas chamber to the cylinder, said gas pipe having a check valve therein adapted to be kept closed by the partial vacuum formed in the compression chamber and by the expanding air in the cylinder while flushing the latter, substantially as set forth.

7. In a gas engine, the combination with a cylinder and a compression chamber, of a piston adapted to operate in the main cylinder and compression chamber and produce a gas chamber between it and the wall of the compression chamber, and a pipe leading from said gas chamber to the upper end of the main cylinder, and adapted at its free end to discharge gas into the cylinder downwardly and in a fine jet, substantially as set forth.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

JOHN R. BRIDGES.

Witnesses:
H. WALTER DOTY,
MARY A. BRIDGES.