(No Model.)

J. C. BECKFELD & A. SCHMID.

GAS ENGINE.

No. 421,474. Patented Feb. 18, 1890.

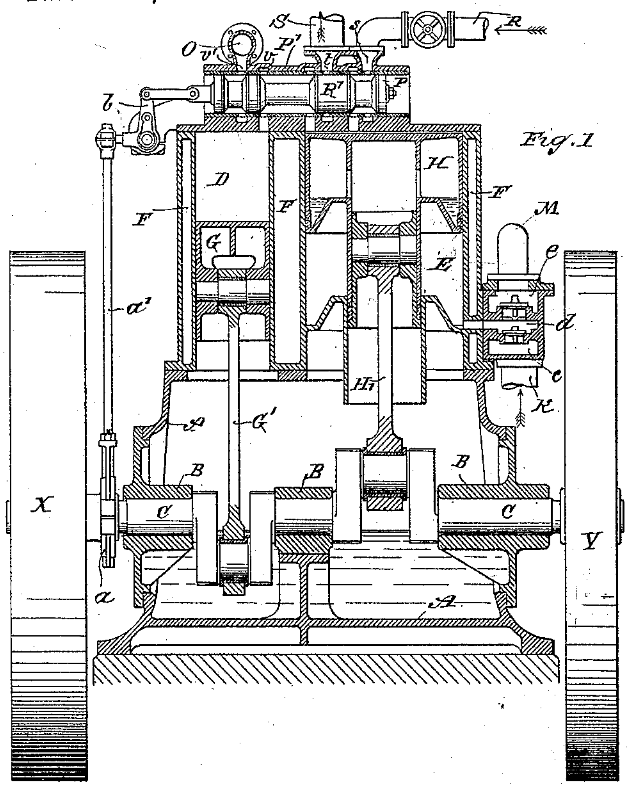

Fig. 1

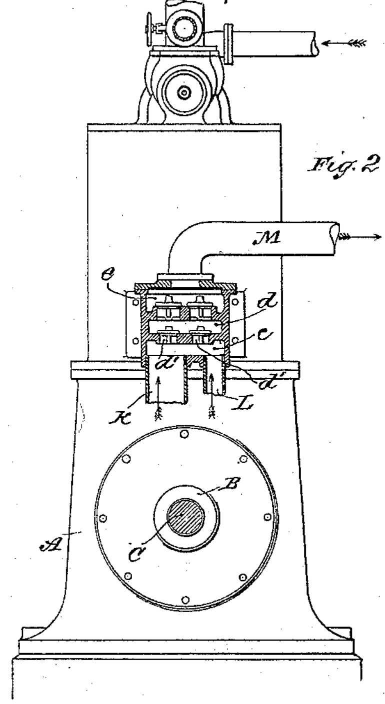

Fig. 2

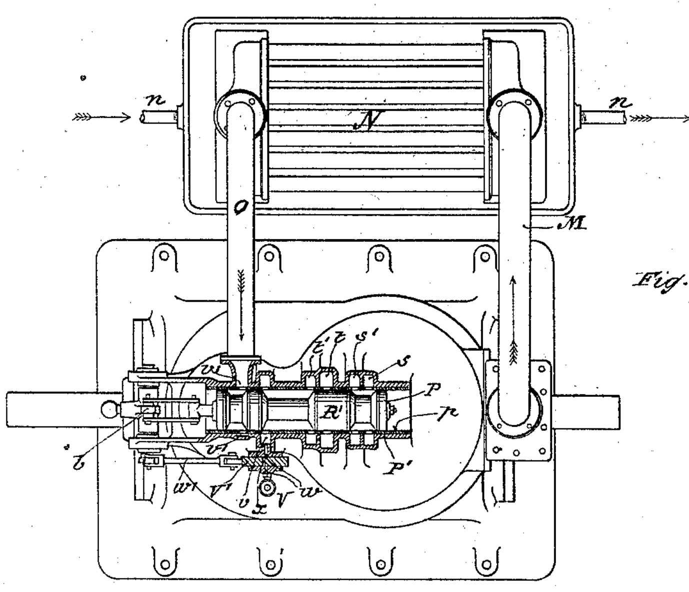

Fig. 3

Witnesses
Robt. F. Gaylord
Ernest Hopkinson

Inventors.
John Charles Beckfeld
and Albert Schmid
By their Attorneys
Duncan, Curtis & Page.

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

JOHN CHARLES BECKFELD AND ALBERT SCHMID, OF ALLEGHENY, PENNSYLVANIA.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 421,474, dated February 18, 1890.

Application filed July 12, 1889. Serial No. 317,277. (No model.)

To all whom it may concern:

Be it known that we, JOHN CHARLES BECKFELD, a citizen of the United States, and ALBERT SCHMID, a citizen of the Republic of Switzerland, residing at Allegheny, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification, reference being had to the drawings accompanying and forming a part of the same.

The invention, subject of this application, is an improved gas-engine, the construction and development of which were mainly the result of an endeavor to produce an economical and efficient gas-engine on a large scale.

The principal objects which we have had in view in carrying out our invention are to provide for a more uniform expenditure of driving-power than has heretofore been obtained and to secure economically a high rotative speed.

We will state generally the character of the engine as a whole, that the nature and scope of our improvements may be better understood.

The engine, constructed in accordance with the invention, contains two cylinders of unequal capacity, the smaller of which we designate the explosion-chamber, the other the power-cylinder, and direct communication between the two, back of pistons working therein, is controlled by suitable valve mechanism. The pistons are connected to the same crank-shaft in such relations that when one is at or near the end the other is at the beginning of its stroke. The movement of the engine as a whole is primarily produced by an independent source of power; but assuming the parts to be in movement, the piston of the explosion-chamber is primarily moved by an explosive gas or mixture of gases previously compressed by the other or power piston, and at or near the end of its movement or stroke and when direct communication is made, or about to be established, with the power-cylinder, the charge of gas is exploded. The force of the explosion drives forward the power-piston, which operates to return the smaller piston by its mechanical connection therewith, and at the same time stores a part of the energy of the explosion by compressing the next charge of explosive gas, which is to again drive forward the said smaller piston. It will be observed, therefore, that the power for driving the engine is not derived from a succession of sudden impulses, the force of which is exerted and expended through a part only of the revolution or revolutions of the crank-shaft; but a portion of the force of each explosion is applied through one part of the revolution, while another portion is stored to be applied during the remainder of the revolution. Our invention comprehends this feature broadly.

Other features of the invention reside in cooling the explosive mixture before it enters the explosion-chamber, in the special construction of various working-parts, and in specific details, the nature of which will be more fully hereinafter set forth.

In the drawings, Figure 1 is a central cross-section of our improved engine. Fig. 2 is a side elevation of the same with the air and gas valve mechanism in section, and Fig. 3 is a top plan view with the controlling-valve mechanism in section.

The engine as a whole is mounted on a suitable bed, the frame-work or main body being a hollow casing, of which the parts A form a receptacle for containing a mixture of oil and water.

B B are the supports and bearings for the main crank-shaft C.

The upper part of the mechanism includes an explosion chamber or cylinder D, a power-cylinder E, and a water-jacket F, surrounding both cylinders.

The controlling-valve mechanism is placed above the cylinders and is operated by an eccentric *a* on the main shaft through a connecting-rod *a'*, and a rock-shaft or pivoted bell-crank lever *b*.

G is the piston of the explosion-chamber, which is connected by the rod G' with a crank on the shaft C.

H is the power-piston, of greater area than the other, and it also is connected with a crank on the shaft C by the rod H'.

The crank-pins and piston-rods plunge into the oil and water in the receptacle A, and by splashing the mixture upon the pistons maintain a proper lubrication. We make the pistons with interior spaces into which the water is dashed with the result of cooling the pistons.

Both cylinders are open at the bottom. The opening in the larger or power cylinder is of smaller diameter than the cylinder itself, and through this opening a part of the body of the piston works, keeping it constantly closed. The head or end of said piston, however, is of larger diameter and fits the cylinder, as shown, so that it may be utilized on the upstroke to produce a partial vacuum in the lower part of the cylinder and thereby draw in an explosive mixture, and on the downstroke to compress the mixture for charging the explosion-chamber, as hereinafter described. The enlarged portion of the piston is hollow and communicates with the oil and water chamber beneath, so that it will be cooled by the water dashed up into it by the piston rods and cranks. A portion of the water may be retained in the piston by giving it the shape shown.

K represents a tube or pipe through which air is introduced into the engine. L is a similar pipe from a gas-main or other supply. These pipes conduct to a chamber *c*, communicating with a chamber *d* through check-valves *d′ d′*. The chamber *d* communicates directly with the lower part of the power-cylinder E, and also with a chamber *e*. From the last-named chamber *e* leads a pipe M to a receiver N, and from the latter leads a pipe O to the valve mechanism controlling the cylinder-ports. The receiver N is preferably inclosed by a water-jacket through which a circulation of water is maintained through pipes *n n* or other cooling device.

P is a cylindrical valve arranged to slide in a bushing *p*, and controlled, as above stated, by the eccentric and connecting-rod *a′*. The outer casing P′ of the valve contains annular chambers surrounding openings in the bushing *p*, the location and purpose of which will be described in detail in the following statement of the operation of the engine.

To start the engine, steam, gas, or air under pressure is admitted through a pipe R by opening the valve shown therein. This steam entering the annular chamber *s* from the pipe R passes through the valve and an annular chamber *s′* into the power-cylinder E, forcing down the piston H. The explosive mixture of air and gas under the piston H is thereby forced through pipe M into the receiver N, and at the same time the piston G is moved up or back into the explosion-chamber. This movement of the engine cuts off the steam from the cylinder E and opens the exhaust through annular chamber *t* and *t′* and pipe S. The charge of compressed air or air and gas in the receiver N then operates through pipe O and valve-chambers *v v′* to drive down the piston G. When the latter has reached or nearly reached the end of its stroke, the gaseous mixture above it is ignited and exploded. At or nearly at this time communication is established between the cylinders D and E through the chambers *v* and *t′*; hence the piston H is again driven downward.

It will be observed that while the exploded gases are acting upon the piston H, as described, the steam-supply is also open to the cylinder E; hence the piston will be moved by their combined pressure, or if the gas-pressure is greater than that of the steam no undesirable consequences result, as the excess of pressure is simply thrown back into the boiler. On the other hand, if there be no explosion, or if the steam-pressure exceeds that of the gas or air, the piston H will still be driven forward, owing to its relatively greater area. When by this means the engine is fairly started, the steam is shut off, and the engine continues to operate by the force due to the explosion, the piston H being impelled forward by the direct force of the explosion, and the piston G being driven forward by the energy stored in the gas compressed in the receiver N on the downstroke of the piston H. The difference between the force of the exploded charge of gas and the work of compressing the next charge represents the work done by the engine.

The means for exploding the gaseous mixture may be of any desired character, and we have shown in Fig. 3 a simple device for this purpose.

V is a device for producing or maintaining a flame and directing it into an opening or passage *w* in the annular chamber *v*. This passage is controlled by a slide V′, operated by an arm *w′* on the shaft of the lever *b*. The slide V′ contains an opening *x*, which by the proper adjustment of the slide is made to register with the passage *w* at the moment when the explosion is to occur. To this general plan of construction we have added the features of interior cooling and means for lubrication, to which allusion has before been made.

It is well known that the practical speed of engines of this general character is limited by the temperature imparted to the interior walls of the cylinder or cylinders. If it were possible to very materially reduce the thickness of the said walls and cool entirely from the outside, the speed-limit could be correspondingly raised; but this is only practicable to a comparatively limited degree; hence we have adopted two means of interior cooling—first, by use of a water-jacket or any other cooling device, in connection with the receiver N, we reduce the temperature of each successive explosive charge before it enters the explosion-chamber; second, we make the pistons hollow, so that the water from below may be splashed up into them, and in some cases we make them in such manner that they will retain a portion of the water, as above described.

Another useful feature of this engine is in its capability of positively and mechanically expelling the products of the combustion of the gaseous mixture at each stroke. The valve, it will be seen, is so constructed that during a portion of the up or return stroke of the piston G the cylinder D is open to the cylinder E, and the products of combustion are effectually driven out before a fresh charge is admitted. A like expulsion of the waste gases from cylinder E to the atmosphere is effected by the return-stroke of the piston H.

We have shown on this engine a driving or pulley wheel X and a fly-wheel Y; but from the nature of the operation of the engine it is evident that a much smaller or lighter fly-wheel would be required than in most gas-engines.

We do not limit our invention to the specific construction which we have herein shown, and which we claim as being the best and most practicable of which we are now aware for carrying out the invention; but we regard as within our invention any other devices which by their co-operation will produce the same result in a similar manner. For example, the explosion-chamber D may be of any other character and located in many other positions relatively to the power-cylinder, and in lieu of the special piston working therein, which we have herein shown, we may, at least for some purposes of the invention, use other forms of moving bodies which will be capable of withstanding the force of the explosions and afterward expel the products of combustion.

What we now claim is—

1. In a gas-engine, the combination of a power-cylinder, an explosion-cylinder communicating therewith, a valve for controlling such communication, a crank-shaft, and pistons or bodies movable in said cylinders and connected to diametrically-opposite cranks on the shaft, as set forth.

2. In a gas-engine, the combination with the crank-shaft, of a power cylinder and piston, an explosion-chamber with valve-controlled passages of communication between the same and the power-cylinder, and a piston in said explosion-chamber mechanically connected with the power-piston through the crank-shaft and dependent for its operation upon movement imparted to it by the power-piston, as set forth.

3. The combination, with the power cylinder and piston, of an explosion-cylinder and a piston therein connected with and adapted to be moved by the power-piston, and an intermediate receiver and valve-controlled passages of communication between the two cylinders and through said receiver, as and for the purpose set forth.

4. The combination, with the explosion and power cylinders and pistons working therein, of an intermediate receiver for containing the explosive charges compressed therein by the main or power piston, valve-controlled passages of communication between the two cylinders and through the receiver, and means for cooling said charges in the receiver and before passing therefrom to the explosion-chamber, as set forth.

5. In a gas-engine, the combination, with an explosion-chamber and a power cylinder and piston constructed and adapted to operate also as a pump for forcing an explosive gas into said explosion-chamber, of a cooling device in connection with the intermediate devices for conducting such gas for reducing the temperature of the charges before entering the explosion-chamber, as set forth.

6. The combination, in a gas engine, of an explosion-chamber and piston, a power cylinder and piston, a combined air and gas supply leading to the explosion-chamber and communicating with the power-cylinder forward of the piston therein, whereby the air and gas are forced by the movement of the said piston into the explosion-chamber, passages of communication between the explosion and power cylinders, and a valve adapted to establish communication between the same at or near the end of the stroke or limit of outward movement of the piston in the explosion-chamber, as herein set forth.

7. The combination of the explosion-chamber D, power-cylinder E, the pistons working therein, means for forcing an explosive mixture into the chamber D, and an ignitor controlled by the movement of the pistons and adapted to explode the mixture at or near the end of the stroke or limit of outward movement of the piston in the explosion-chamber D, as set forth.

8. The combination of the power cylinder and piston, the explosion-chamber and piston mechanically connected with the power-piston, an ignitor controlled by the movement of the engine to ignite the gaseous mixture in the explosion-chamber at or near the end of the stroke or limit of outward movement of the piston therein, whereby on the return of the said piston by the power-piston the products of combustion will be expelled from the explosion-chamber, as set forth.

9. In a gas-engine, the combination of an explosion-cylinder, a power-cylinder, a receiver for compressed gases intermediate of the two cylinders, valve mechanism for admitting compressed gases to the explosion-cylinder during the outward movement of the piston therein, and an ignitor operated by the movement of the engine at or near the limit of forward movement of the piston in the explosion-cylinder, as set forth.

JOHN CHARLES BECKFELD.
ALBERT SCHMID.

Witnesses:
J. M. TATE, Jr.,
W. D. UPTEGRAFF.