W. J. WRIGHT.

EXPLOSIVE ENGINE.

APPLICATION FILED FEB. 7, 1906. RENEWED FEB. 27, 1911.

1,006,166. Patented Oct. 17, 1911.

4 SHEETS—SHEET 1.

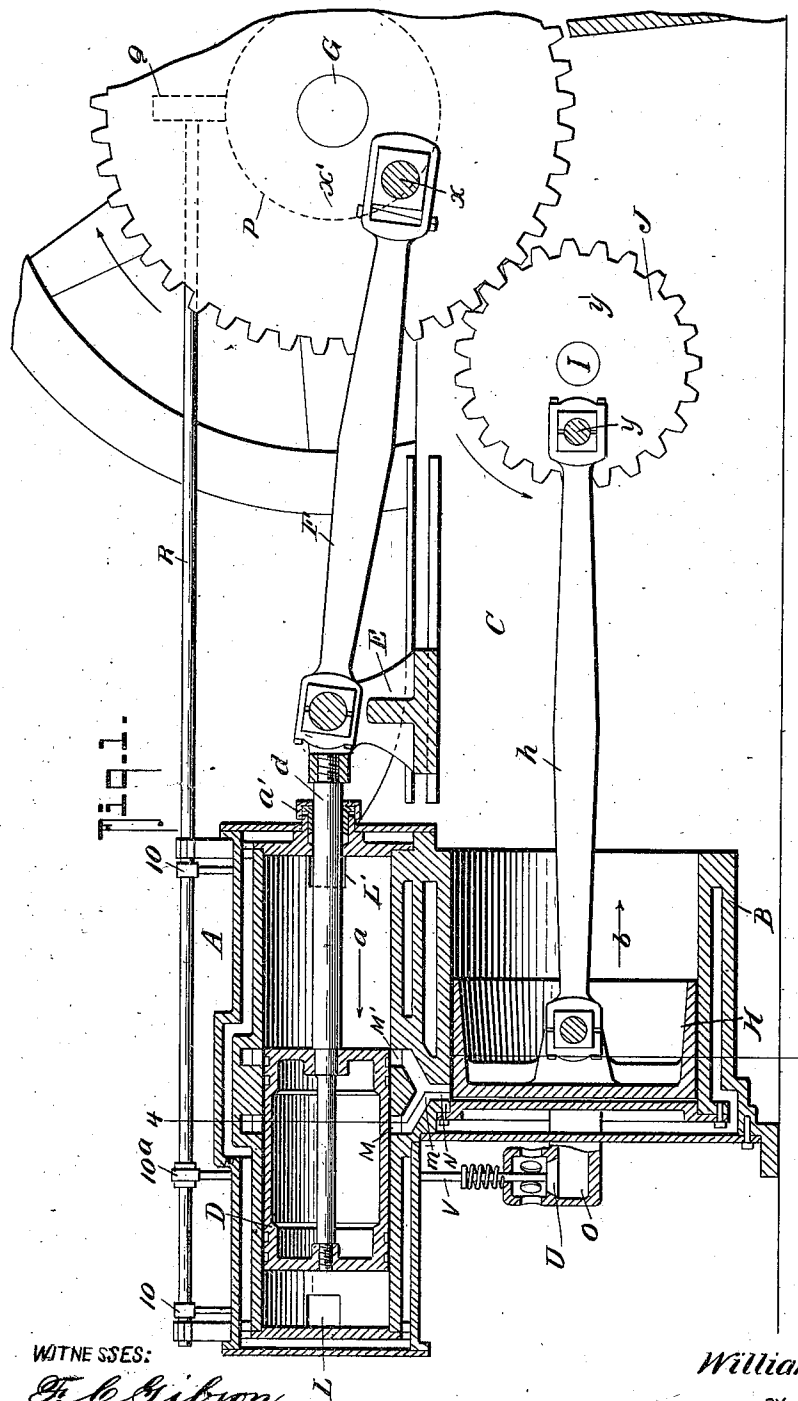

Fig. 1.

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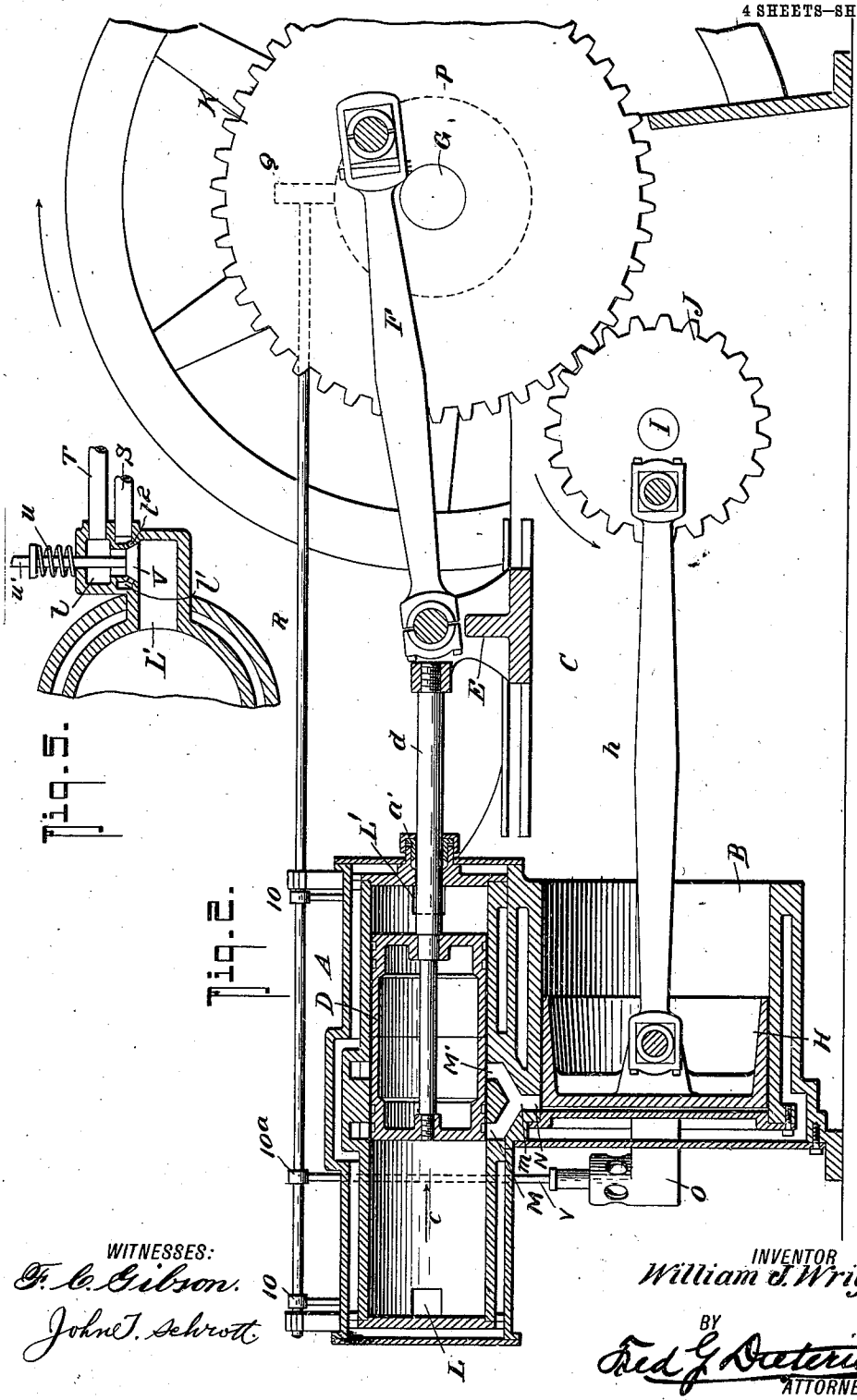

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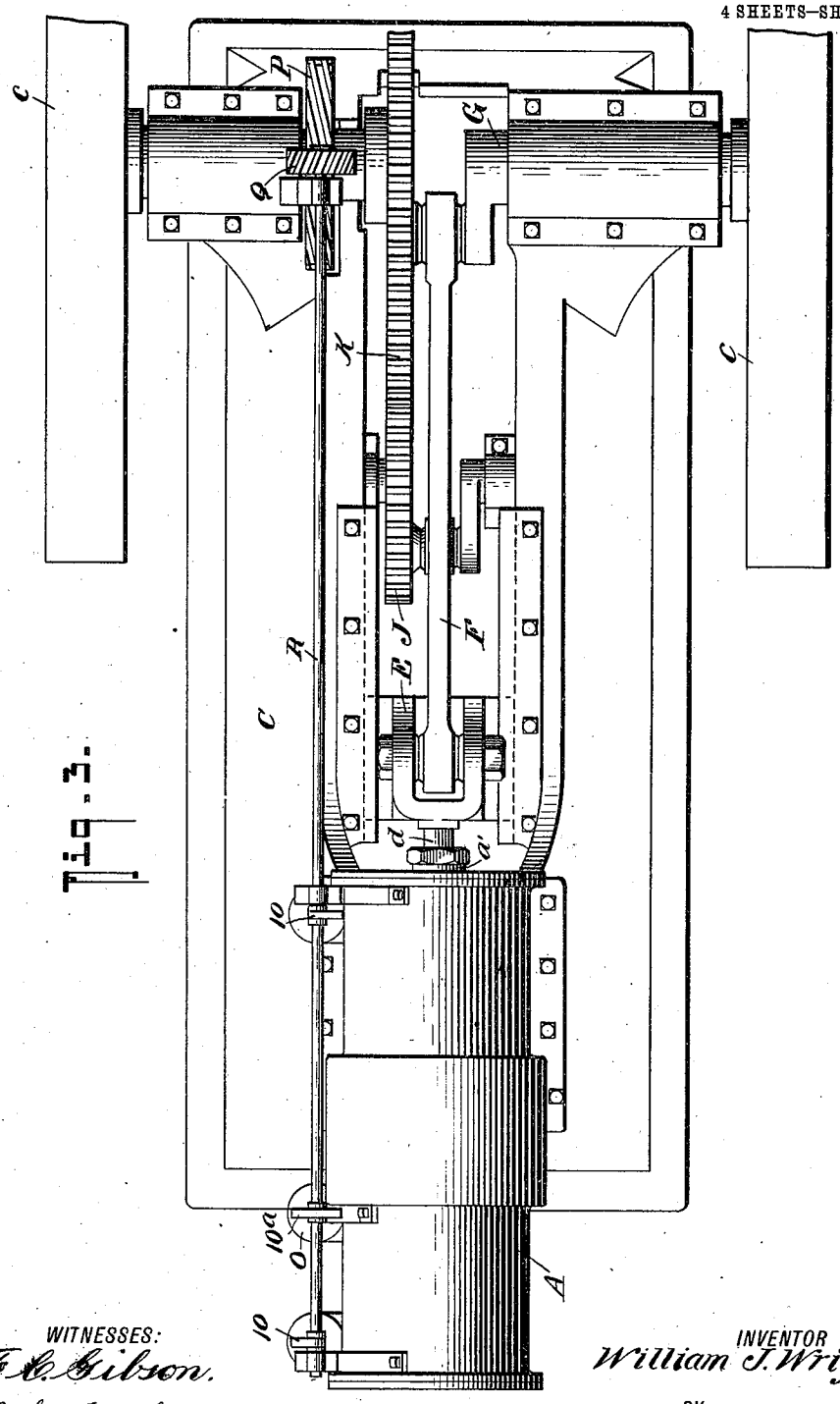

Fig. 3.

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4 SHEETS—SHEET 4.

Fig. 4.

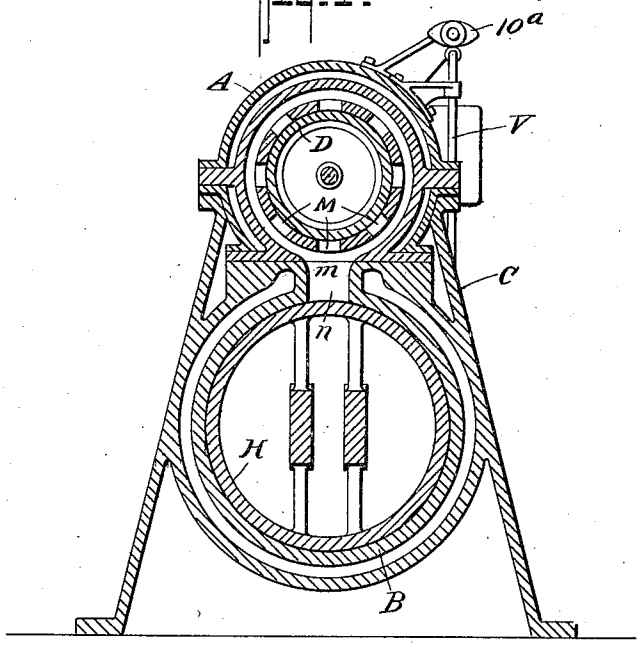
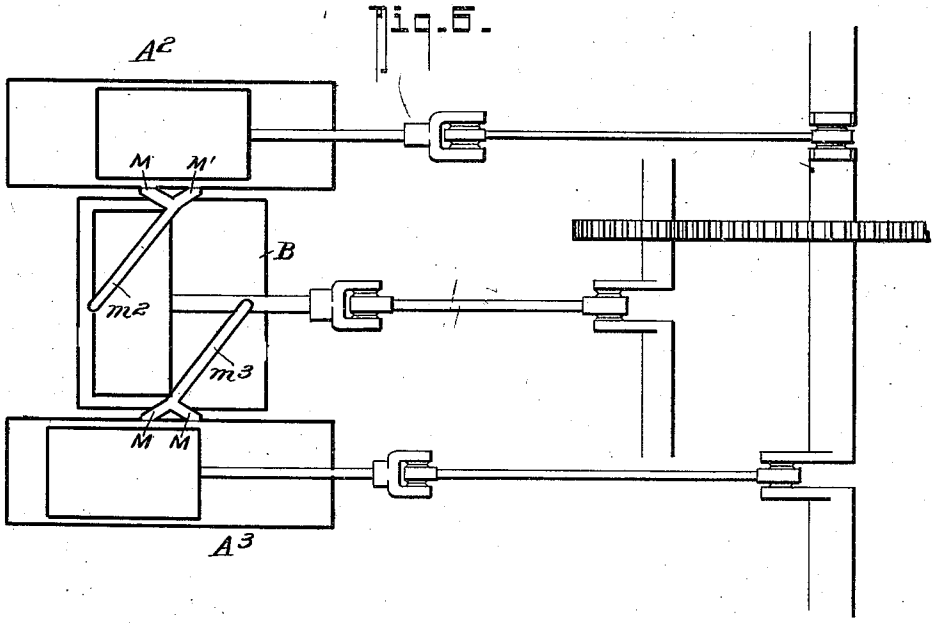


Fig. 5.



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UNITED STATES PATENT OFFICE.

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EXPLOSIVE-ENGINE.

1,006,166. Specification of Letters Patent. **Patented Oct. 17, 1911.**

Application filed February 7, 1906, Serial No. 299,893. Renewed February 27, 1911. Serial No. 611,232.

To all whom it may concern:

Be it known that I, WILLIAM J. WRIGHT, residing at Franklin, in the county of Venango and State of Pennsylvania, have invented a new and Improved Explosive-Engine, of which the following is a specification.

My present invention has for its purpose to provide an improved construction of gas engine capable of being economically built, and the several parts so designed and cooperatively combined so that a maximum power is obtained from the energy employed and in which the operation of running is easily controlled, with little or no loss of the energy utilized for actuating the same.

My present invention, in its general nature, comprises a peculiar relative arrangement of a pump mechanism in the nature of a low pressure cylinder having a single inlet, a single exhaust and a single piston operating therein, the working cylinder provided with an exhaust joined with the single inlet in the other cylinder, a single piston operating therein, the said two cylinders having a predetermined relative internal area or fluid receiving space, for example, the low pressure pump cylinder has approximately four times the area of the working cylinder; special means being also provided actuated by the crank shaft, for imparting differential motions to the pump and working pistons, two movements of the pump piston to one of the working piston, whereby the operation of drawing off the exploded charge from the working cylinder and drawing in the new charge is effected during that portion of the stroke of the crank which actuates the working piston to finish the last eighth of its movement in one cycle and passes over the first eighth of its movement in the next cycle, the parts being also so timed with respect to each other in their movement that the pressure of the exploded mixture in the working cylinder is utilized in assisting or driving the pump piston under gradually diminishing flow pressure, back, during that movement thereof in which the entire burnt mixture is passing out of the working cylinder and a vacuum created in that end of the cylinder from which the mixture is drawn off whereby to facilitate the entrance therein of a new charge while the working piston closes the exhaust of the working cylinder.

My present invention also embodies an improved construction of actuating mechanism controlled by the crank shaft for turning the charges of the working agent into the opposite ends of the working cylinder, and in its more specific nature it consists in certain details of construction and peculiar combination of parts, all of which will be hereinafter fully described and claimed and also illustrated in the accompanying drawings, in which:—

Figure 1, is a longitudinal section of an explosive engine constructed in accordance with my invention and which illustrates the working piston on the last eighth portion of its stroke in the direction indicated by the arrow *a* and the pump piston in position to begin its stroke in the opposite direction as indicated by the arrow *b*. Fig. 2, is a similar view illustrating the working piston in position of finishing its stroke in the direction indicated by the arrow *c*, the pump piston being back in position to exhaust the burnt mixture from and create a vacuum in the other end of the working cylinder. Fig. 3, is a plan view of my engine, the parts being in the position shown in Fig. 1. Fig. 4, is a transverse section thereof taken on the line 4—4 of Fig. 1. Fig. 5, is a detail sectional view which illustrates one of the air and gas intakes of the working cylinder, a valve device therefor, and a mechanical means for actuating said valve device at predetermined times. Fig. 6, illustrates a plan view of a slightly modified form of my invention which will hereinafter be explained.

In the practical application of my present invention and in its preferred form as best illustrated in Figs. 1, 2, 3 and 4, the same comprises generally, a double acting working cylinder A and a single combined low pressure and pump cylinder B, and these two cylinders are coöperatively connected and mounted on a suitable bed frame C and may have the usual water jacketed construction, as shown.

D designates a single piston within the working cylinder A, and whose rod *d* projects through the stuffing box *a'* in one end of the cylinder A and connects with the cross head E, slidably mounted in the usual manner on the bed frame and to which connects the pitman F that joins with the crank shaft G, mounted on one end of the bed

frame C, and provided with a balance wheel *c* at each end, see Fig. 3.

H designates an open or trunk piston within the cylinder B whose rod or pitman *h* pivotally connects with a supplemental crank shaft I from which it receives motion and for reasons hereinafter explained, it has a gear J that meshes with a gear K on the crank shaft G which has such diameter with respect to gear J that a "two to one" motion is imparted to the pistons H and D.

The working or power piston D is double acting, it compressing the working charges drawn in advance of it at each stroke, and it is of such length as to coöperate with the specially arranged inlet ports L—L′, located one at each extreme end of the cylinder A and to which the working agent, air and gas, is fed at predetermined times by valve mechanisms actuated by automatic devices controlled by the rotation of the crank shaft G, for reasons hereinafter explained, said piston D being also of such length and its stroke so regulated to properly coact with a pair of centrally disposed exhausts M—M′ that connect with a single exhaust port *m* that discharges through a single inlet N in the extreme front end of the cylinder B as clearly shown in Figs. 1 and 2.

As before stated, the cylinders A and B are of a predetermined correlative area, with the cylinder B the larger. The differential area of the two cylinders A and B in the practical application of my invention is such, that the expansive force of the exploded mixture can be positively and effectively utilized to assist in carrying the crank shaft G over the dead center by reason of its flowing against the piston H on the beginning of its forward movement, whereby during the forward movements of the piston H the cylinder B acts as a low pressure cylinder, since the entire expansive force of the exploded mixture, after it has carried the piston D forward to the limit of its stroke (impelled by the exploded charge) enters against the piston H under its maximum force, say for example, 50 pounds down to a minimum (atmospheric) pressure, during the forward travel of the piston H which occurs during the time the piston D is reciprocatingly moved under a one-fourth rotation of the crank shaft G to uncover and cover either one of the exhausts M or M′. The cylinder B has a single exhaust O usually held closed by suitable valve devices, which are mechanically opened at predetermined times by trip mechanism actuated from the crank shaft G.

The mechanism for actuating the several valve devices that control the feed inlets L and L′ to the cylinder A, and the exhaust from cylinder B, in practice is so arranged that the valves for the working agent L—L′ are alternately actuated to let in the charge into the opposite ends of the cylinder A, as the piston D makes its alternate strokes and the valve for the exhaust O actuated on each return stroke of the piston H.

To illustrate my way of effecting the required predetermined action of the several valve devices referred to, I have shown a worm gear P, see Fig. 3, mounted on the crank shaft G which meshes with a worm wheel Q on a shaft R, suitably journaled in supports on the bed frame C, and having such connection with the gear P that a single revolution thereof is produced at each complete revolution of the shaft G. Each inlet L—L′ communicates with a valve casing *l*, one of which is shown in detail in Fig. 5, by reference to which it will be seen that the casing has a chamber *l′* into which discharges an air feed pipe S and a gas feed pipe T and which has a port l^2 normally closed from the inlet L′ by a valve V normally held to its closed position by a stout spring *u* mounted on the stem *u′*.

While I have not shown it in the drawing, in the practical construction of my machine, means are provided for leading the air into the casing *l* in advance of the gas, but this is not essential for the working of my present form of engine, since the air and gas may be led into the casing through separate pipes as shown, or fed into said casing in a previously mixed condition.

The valve V for the exhaust O is of a construction similar to the valves U and has its stem *v* projected in the same direction that the stems *u* of valves U are directed and the several stems *u* and *v* are arranged to be engaged at predetermined intervals by the cams 10—10 and 10^a on the shaft R.

My engine constructed in the manner explained and illustrated, operates as follows:—Assuming the space behind the piston D, Fig. 1, to be filled with an exploded charge of the combustible mixture or working agent and the piston D just about to uncover the exhaust port M′, the crank on shaft G will now be at the point marked *x*, Fig. 1, and just beginning to finish the last eighth of its stroke, ending at the point indicated *x′*. At this time the piston in the combined compound and pump cylinder will be in the position of having finished its forward stroke and about to return, the shafts G and I moving in the direction indicated by arrows, the several valves V—V and U at this time closing the ports L—L′ and O. A charge in front of piston D has now been compressed to near its limit, since the said piston D during the next quarter of revolution of the shaft G, moves forward only enough to uncover the exhaust M′ and back again far enough on its reverse stroke to cover the said exhaust M′, the other exhaust M being at this time held closed by the piston D. While the shaft G is thus mak

ing the quarter revolution referred to, the shaft I is making a half revolution which brings the crank from Y to Y′, see Fig. 1, thus making a complete movement of the piston H in the direction indicated by the arrow *b*. The relative movements of the pistons D and B being understood, it is manifest, that so soon as the piston D begins to uncover port M′ the still expansive force of the working agent D will now go out under a full head against the piston H and impel it under a low exploded charge pressure, which pressure gradually diminishes as the piston H moves back until it reaches the minimum or atmospheric pressure, which, when the parts are as shown, is reached when the piston H has gone back about two-thirds of its back stroke and after the crank of the shaft G has just passed the point *x*′ and the piston D just begins its back stroke to recover port M′, it being understood that the piston D is now being impelled by the explosion of the charge back of it. At the time the piston D begins its back stroke to cover the port M′ and the piston H is finishing its back stroke a cam on shaft R actuates the valve V and opens the feed of the working agent, air and then gas, or a previously mixed air and gas charge to inlet L′, which, by reason of the vacuum now created in the cylinder B and that end of cylinder A in front of piston D, by reason of the piston H on the finish of its back stroke now acting as a pump, is quickly drawn into the cylinder A while the port M′ is yet open, the feed charge being cut off, by reason of the disengagement of the cam on shaft R from valve V the instant the port M′ is closed.

By reason of the operation just referred to the crank shaft is carried over the dead center by the impulse given it from the piston H, and moved forward under the compound action of the engine, that is, the impulse of the exploded charge first under high pressure against the piston D and then under low pressure against the cylinder H. The piston H now being at its extreme back stroke, a new charge drawn into the working cylinder back of its piston D, and both exhausts M and M′ being now closed and the expanded prior charge in the cylinder B in front of piston H, further movement of the shafts G and I causes the piston H to move forward and the piston D in the direction of arrow *c* on Fig. 2 to compress the new charge in front of it. As soon as the piston H begins to move forward the valve U for exhaust is mechanically opened, by reason of the cam on shaft R engaging the stem *v* which allows the piston H to quickly force out the exhaust or residuum of the last charge through the port O and when the piston H reaches the limit of its complete forward stroke, under a one-half rotation of shaft 1, the piston D will have nearly completed its compression of the charge in front of it and its back end just reached the port M, when the cycle of operation begins as before. Any suitable means, not shown, may be used for igniting the compressed charge.

From the foregoing, taken in connection with the drawings, the complete operation and the advantages of my engine will be readily apparent.

It will be noticed that the full expansive force of the working charge is used from the maximum down to atmospheric pressure and hence none of such force lost by reason of blowing through the exhaust, and the forming of a vacuum or pumping in a new charge is done while the working cylinder is emptying its burnt residuum in advance thereof.

While I prefer to use but a single working cylinder with a single combined compound and pumping cylinder, I desire it understood that my invention is not restricted to such arrangement since a single compound and pump cylinder may be used with a pair of working cylinders as shown diagrammatically in Fig. 6. In this modified form, the cylinder B is made closed at both ends and has an inlet and an exhaust at each end, and the cylinder A^2 at one side has its exhaust port M—M′ arranged to discharge into the inlet m^2 at one end of cylinder B and the exhaust ports M—M′ for the other cylinder A^3 discharge into the inlets m^3 at the other end of the cylinder B. When thus arranged the several pitmen or rods for the piston in the working cylinders are set in quarters to obtain the desired alternate actions on the cylinders A^2—A^3.

The arrangement of the parts shown in the drawings have been presented to illustrate in a concise and clear manner the structural arrangement of my improved engine, but I desire it understood that the several details of construction may be readily modified without departing from the scope of my invention.

What I claim is:—

1. In a gas engine, a double acting high pressure cylinder, means for feeding a working agent thereto at predetermined times, the said cylinder having an exhaust port, a working piston therein, said piston controlling the said exhaust port, a second or low pressure cylinder having an inlet port in communication with the exhaust port of the main or high pressure cylinder and having an exhaust port, a valve that controls the said exhaust port, automatically operated at predetermined times, a single acting piston in the low pressure cylinder moved under a part of its out stroke by the expansion of the exhaust from the working or main cylinder and operable on the finish of

its stroke for drawing off the exhaust from the last explosion end of the working cylinder, as set forth.

2. In a gas engine, a double acting working cylinder having a valve controlled working agent inlet at each end and an exhaust common to both ends, a working piston that controls the exhaust, a second cylinder having an inlet and an exhaust, the inlet being in open communication with the exhaust from the working cylinder, a single acting piston in the second cylinder, the crank shaft, and connections that join the two pistons with the crank shaft for imparting the different movements thereto, automatic means for opening the valves for the working agent inlets to the main cylinder and the exhaust for the second cylinder at predetermined times, the two cylinders, their pistons and the valve actuating mechanism having such coöperative relation as to discharge the burnt mixture under a low pressure against the piston in the aforesaid second cylinder and to form a vacuum in the working cylinder to draw in a new charge as the said piston is moving forward under the impulse of the low pressure exhaust.

3. In a gas engine, a primary double acting cylinder and a power piston therein, a second single acting cylinder and piston, the two cylinders being in communication, the power piston in its movement opening and closing said communication, means actuated from the crank shaft for imparting differential movement to the two pistons, the movement of the second cylinder being relatively such with respect to the discharge of the exploded force in the primary cylinder as to receive said force against the piston in the second cylinder during a part of its outstroke, for the purposes described.

4. A gas engine having a valve for controlling the working agent inlet to the working cylinder, and devices actuated from the crank shaft for opening said valve at predetermined times, in combination with a second single acting cylinder communicating with the working cylinder and having a piston adapted on the beginning of its stroke to receive the impact force of the exhausting charge that passes from the working cylinder, the said piston as it reaches the end of its stroke acting to create a vacuum in the working cylinder in front of the piston therein as the valve for the infeed opens, as set forth.

5. A gas engine having a high pressure double acting working cylinder provided with an inlet for the explosive charge, and a second single acting cylinder in communication with the primary cylinder, each cylinder having a piston, the second cylinder piston being partially impelled by the partially spent gases as they pass from the main cylinder during t' first portion of its stroke and acting as a pump for drawing a new charge into the front end of the working cylinders substantially as shown and for the purposes described.

6. A gas engine having a double acting working cylinder provided with a calve closed inlet for the explosive mixture, and a second single acting cylinder having an inlet in communication with the working cylinder, said cylinders each having a piston, and the second cylinder having a valve closed exhaust port, automatic means for imparting differential movement to the two pistons, the piston of the second cylinder during part of its out stroke receiving the final expansion of the partially spent gases that exhaust from the working cylinder and during the remainder of its stroke acting as a pump to form a vacuum in the working cylinder, automatic means for opening the valved closed mixture inlet to the working cylinder when the piston in the second cylinder acts as a pump, and automatic means for opening the valve of the exhaust for the second cylinder as the pump piston makes a return stroke.

7. In a gas engine of the character described, a double acting working cylinder having a valved fuel intake port mechanically opened at predetermined intervals, an exhaust, and a piston whose reciprocatory movements control the opening and closing of the said exhaust, in combination with a second single acting cylinder having an inlet in communication with the working cylinder exhaust and having a mechanically opened valved exhaust port, a piston in said second cylinder adapted during a part of its out stroke to receive the gradually reduced force of the partially spent exploded charge from the working cylinder and on the finish of its out stroke to act as a pump for drawing in a new charge to the working cylinder while its intake port is open, and on its return stroke to force the spent exploded charge through the exhaust port in the said second cylinder, as set forth.

8. In a gas engine comprising a double acting working cylinder, means for feeding an explosive charge thereto at predetermined times, a piston operating therein, and a single acting means coöperatively connected with the working cylinder adapted to receive the final expansive force of the partially spent exploded mixture and as it is thereby actuated to form a pump for sucking in a new charge to the working cylinder and then expel the previous exploded charge to atmosphere, as set forth.

9. A gas engine comprising a double acting working cylinder having a valved intake mechanically opened at predetermined times by a crank shaft action, and having an exhaust and a piston coupled with the crank shaft which opens and closes the said exhaust in its passage; of a crank shaft, a

second single acting cylinder having an inlet and a valved exhaust in one end, the latter being mechanically controlled by the rotation of the crank shaft, said cylinder inlet communicating with the working cylinder exhaust, a piston in the second cylinder coupled with the crank shaft to make two movements to one of the working piston, said piston being arranged to be partially impelled in one direction by the final expansion of the spent charge in the working cylinder, and when it reaches the end of the charge impelled stroke to act as a pump and when it returns to act as a plunger to force the burnt charge out through the exhaust in the second cylinder, as specified.

10. In a gas engine, the combination with a double acting working cylinder having a valved fuel intake in each end automatically opened alternately at predetermined times, and a pair of centrally disposed exhausts, and a second single acting cylinder having an inlet in one end in communication with the two exhausts from the working cylinder and a valved exhaust in the same end automatically opened after the fuel intakes to the working cylinder have been opened and closed, a piston for each of said cylinders, the crank shaft, means for connecting the two pistons with the crank shaft to cause a two to one movement to the second cylinder piston and the power piston, the said pistons, the ports that communicate with the two cylinders and the crank connections being such that the second cylinder piston makes a complete stroke outward during that movement of the working piston for uncovering and covering the exhaust explosive port of the working cylinder and on its return movement to expel the last exploded charge as the working piston is still moving forward to compress a new charge, as set forth.

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