No. 680,616. Patented Aug. 13, 1901.

W. J. PUGH.

MULTIPLE CYLINDER EXPLOSIVE ENGINE.

(Application filed Aug. 1, 1900.)

(No Model.) 3 Sheets—Sheet 1.

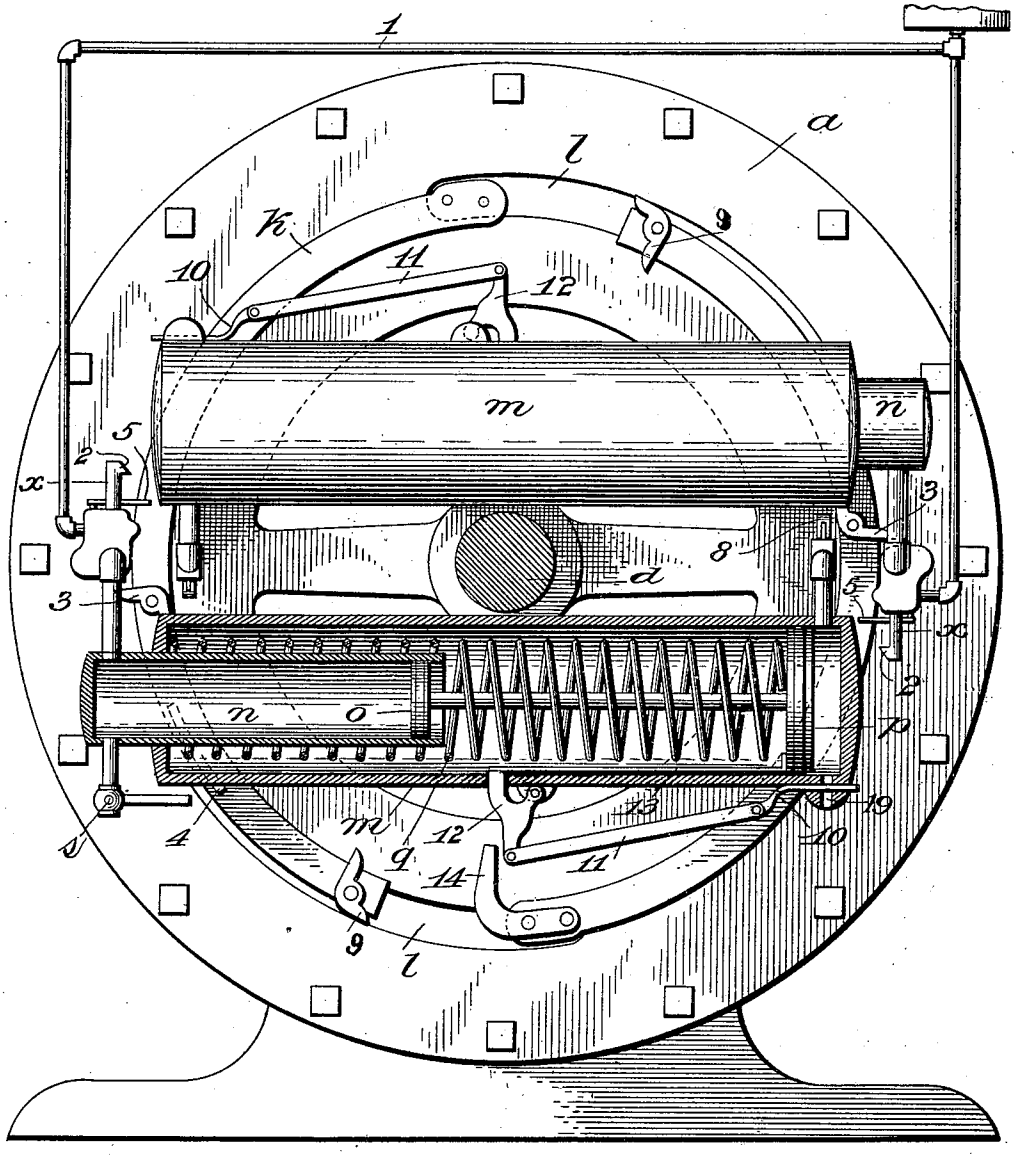


Fig. 1.

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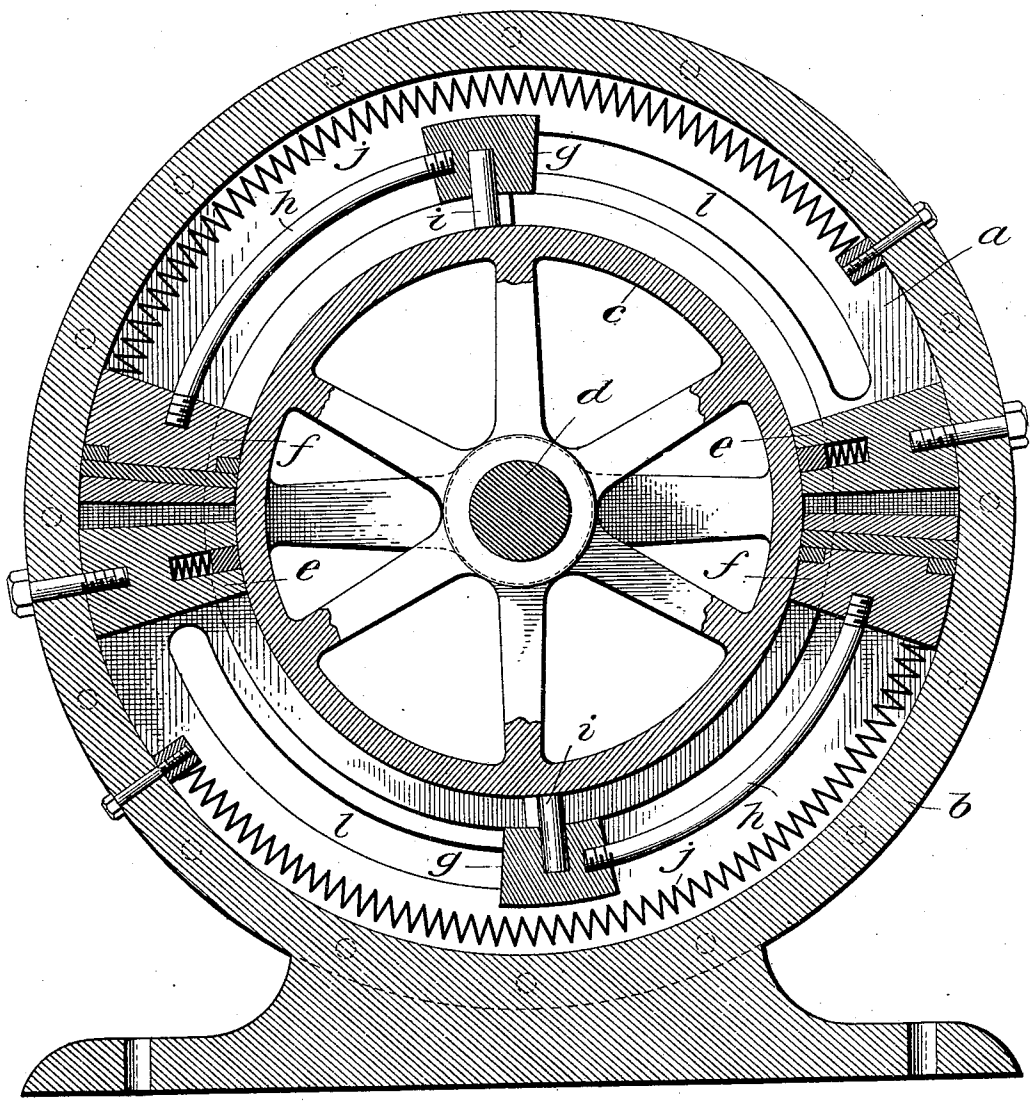
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Fig. 2.



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Fig. 3.

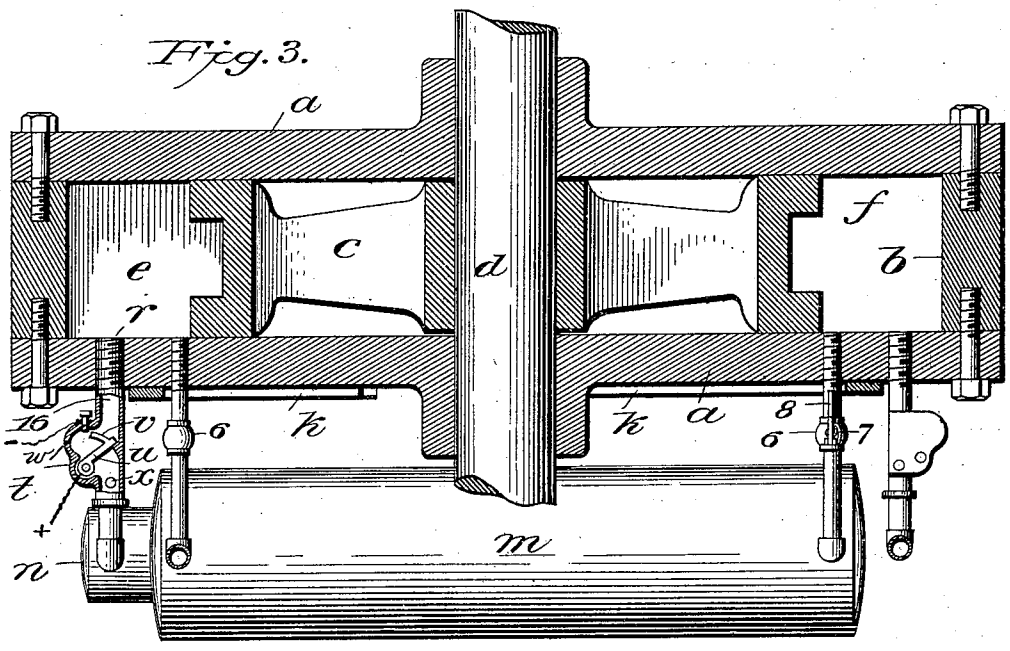


Fig. 4.

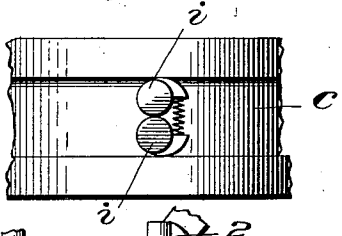
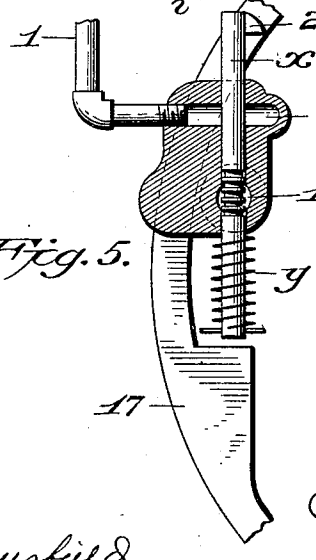


Fig. 5.



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UNITED STATES PATENT OFFICE.

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MULTIPLE-CYLINDER EXPLOSIVE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 680,616, dated August 13, 1901.

Application filed August 1, 1900. Serial No. 25,525. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM J. PUGH, of Davenport, in the county of Scott and State of Iowa, have invented certain new and useful Improvements in Explosive-Engines; and I hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, which form part of this specification.

This invention is an improvement in explosive-engines particularly designed for oil or gasolene; and one object is to produce a very compact duplex engine and to utilize the burned or exhaust gases from one explosion to compress air for use in the succeeding explosion.

Other minor objects of the invention will be hereinafter explained; and the invention consists in the novel construction and combination of parts hereinafter claimed, and illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation of the complete engine, one of the air-compressing cylinders being shown, partly in section. Fig. 2 is a longitudinal section through the engine. Fig. 3 is a transverse section. Figs. 4 and 5 are details.

The casing of the engine is preferably circular and consists of two side plates *a*, inclosing an outer annular ring *b*, and within the ring and fitted between the plate is a grooved wheel *c*, which rotates within the casing and is fixedly secured to the shaft *d*, which may be journaled in the side plates of the casing, as shown, and supported thereon, or the casing may be supported upon the shaft, according to the location and use of the engine. The annular chamber within the casing is divided into two semicircular explosion and working chambers by means of the diametrically opposite fixed heads *e e*, and within these semicircular chambers are fitted the movable pistons *f*, which are connected to cross-heads or guides *g* by means of the rods *h*, as shown. The pistons *f* are suitably packed on all sides, so that the explosive gases will be confined between the pistons *e* and *f*. The inner faces of the heads *e* may also be packed, so as to maintain a close steam or gas tight joint with the inner periphery of the pulley *c*. The parts *f g* of course move as one; but those in the opposite working chambers are adapted to operate alternately. The cross-heads *g* are provided with clutches *i*, which work in the groove of the pulley *c* and are adapted to lock the pistons to the pulley when the pistons move in one direction and release the pulley when the pistons move in the opposite direction. The clutches are so arranged that although the pistons work alternately in opposite directions they will impart continuous rotary movement to the pulley *c* and shaft *d* in one direction, the clutches *i* engaging the pulley when the pistons *f* are moved by the expansive force of the gases and the clutches disengaging the pulley as the pistons move back to original position. As shown, springs *j* are arranged in the working chambers between the pistons *f* and suitable stops on the casing to return the pistons to normal position when the exhaust is opened. Exterior segments *k* are connected to the cross-heads *g* through curved slots *l* in the casing, as shown, and these segments are vibrated back and forth with the pistons and are utilized to operate the valves, as hereinafter explained.

To that side of the casing where the segments *k* are arranged are attached two cylinders *m*, within each of which is a smaller cylinder *n*, having a piston *o*, connected by a rod to a larger piston *p* within the cylinder *m*. The piston *p* is normally thrown outward by means of a coiled spring *q*. Each cylinder *n* respectively communicates with the inlet-port *r* of the opposite exploding-chamber and with the air through a suitable port *s*, provided with a check-valve to admit air freely into the cylinder *n* when the piston *o* is moved inward.

Interposed in the passage 16 between the cylinder *n* and the port *r* is a valve-chamber *t*, within which is a valve *u*, provided with a tongue *v*, adapted to contact with a terminal point *w* when the valve is opened, and when the valve closes the contact is broken and a spark is made which causes the explosion, the valve and the contact-point *w* being connected to opposite terminals of a suitable electrical battery or other electrical supply which will produce a spark when the valve closes.

In this passage 16, between the valve *u* and the cylinder *n*, is a valve *x*, which is provided with a series of annular grooves and is normally held closed by a spring *y*. This valve intersects a passage *z* in the valve-casing, which passage is connected by a pipe 1 with a gasolene or oil supply. The valve *x* is provided with a lug 2, which is adapted to be engaged by a trip 3, pivotally mounted on the adjoining segment *k*, so that as the latter is oscillated at the proper time trip 3 will engage the lug 2 and pull the valve *x* inward, so that some of the annular channels therein will be filled with oil from the passage *z*. As soon as the trip 3 disengages the valve, spring *y* throws it backward, thereby bringing the oil-filled channels into communication with the passage 16, leading from cylinder *n*, so that the air expelled from this cylinder will in its passage to the exploding-chamber open valve *u* and carry a supply of oil or fuel into the exploding-chamber along with the air, the oil being sprayed therein much as in the well-known atomizer method and the explosion occurring upon the closing of valve *u*. The valve *u* may be operated by means of a trip 4, carried by arm *k*, which is adapted to engage with an arm 5 on the stem of the valve *u*, so as to positively close the latter at the proper time—to wit, at the time of the explosion. The exploded gases escape from either exploding-chamber through an outlet-port 6 into the respective adjoining cylinder *m* and are utilized in said cylinder to compress the air for use in the opposite exploding-chamber. The ports 6 are controlled by the valves 7, which are provided with rock-arms 8, adapted to be operated by a trip 9 on the adjoining arm *k*. (See Fig. 3.) After the exploded gases have actuated the piston *p* in cylinder *m*, thereby compressing air in the cylinder *n*, the exhaust-gases are permitted to escape from the cylinder *m* through a port 19, closed by a slide-valve 10 and operated by a link 11, attached to the pivoted arm 12, which has a tooth projecting through a bend in the side of the cylinder adapted to engage a rod 13, attached to the piston *p*, so as to lock this piston in open position. The exhaust-gases are expelled from cylinder *m* by the action of the spring *q*, and the valve 10 will be opened by means of a lug 14 on the end of the adjoining segment *k*.

The operation is as follows, it being understood that the pistons act alternately: The engine may be started in any suitable manner until a charge is exploded in one of the chambers—say the right-hand exploding-chamber. This propels the lower piston to the left, and thereby imparts rotary movement to the pulley *c* through the clutches *i*. When the piston has made its full stroke, the movement of the bar *k*, which is attached to the head *i* through the described connections, opens the exhaust-valve 6, whereupon the exhaust escapes into the lower cylinder *m*, driving the pistons *p* and *o* to the right and compressing a charge of air in cylinder *n*, and simultaneously the valve *t* is opened and the compressed air rushes forward, carrying with it a charge of oil into the left-hand exploding-chamber. As soon as the charge has entered into the left-hand exploding-chamber the valve *u* is closed, thereby igniting the charge and giving a power impulse to the upper left-hand piston. Meanwhile the valve 9 of the lower cylinder is opened and the exhaust-gases escape into the atmosphere. When the upper left-hand piston has made its stroke, the exhaust-gases therefrom are admitted into upper cylinder *m* in a manner similar to that already described and are utilized so as to compress a charge of air for and into the right-hand exploding-chamber. These operations are repeated continuously during the operation of the engine, the exhaust-gases for each explosion in one chamber being utilized to compress air for the explosive charge in the other exploding-chamber, the compressed air entering said exploding-chamber, carrying therein the charge of oil to produce the explosive mixture. The amount of oil introduced into the chamber can be varied according to the number of grooves in the valve *x*, which are permitted to register with the supply passage *z* and the air-passage 16, and this may be regulated by means of the adjustable controller-plate 17, which can be shifted so as to regulate the amount of return movement of the valve *x* by the spring *y*.

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

1. The combination of a pair of explosion-chambers, an air-compressor having an air-cylinder communicating with one explosion-chamber, and a motor-cylinder communicating with the exhaust of the other explosion-chamber, for the purpose and substantially as described.

2. In a gas-engine, the combination of a pair of explosion-chambers, and an air-compressing device having a motor-cylinder communicating with the exhaust of one explosion-chamber and an air-cylinder communicating with the inlet of the other explosion-chamber, said air-compressing device being operated by the exhaust-gases, substantially as described.

3. The combination of a pair of explosion-chambers and an air-compressor, with means for conducting the exhaust-gases alternately from the explosion-chambers into the compressor to operate the latter, and means for conducting air from the compressor into the explosion-chambers alternately, for the purpose and substantially as described.

4. The combination of a pair of explosion-chambers, an air-compressor, means whereby the exhaust-gases from the explosion-chamber alternately are conducted to the compressor, and means for conducting air from the air-compressor alternately to the explosion-chambers and an oil-supply communi-

cating with the air-inlets to the explosion-chambers.

5. In a gas-engine, the combination of a pair of exploding-chambers, an air-compressing device having its motor-cylinder communicating with the exhaust of one exploding-chamber and its air-cylinder communicating with the inlet of the other exploding-chamber and adapted to be operated by the exhaust-gases, with an oil-supply communicating with the outlet of the air-compressor whereby the compressed air carries a supply of oil into the exploding-chamber as it enters the latter.

6. The combination of a pair of exploding-chambers, a pair of air-compressing cylinders respectively communicating with the exploding-chambers, means for admitting the exhaust-gases from the exploding-chambers into the motor-cylinder of the respective air-compressor, and means for conducting the compressed air from the air-cylinder of the compressor into the other exploding-chamber, substantially as described.

7. The combination of a pair of exploding-chambers, a pair of air-compressing cylinders, and means whereby exhaust-gases from each exploding-chamber are utilized to compress air to supply the explosive mixture to the other exploding-chamber, for the purpose and substantially as described.

8. The combination of a pair of exploding-chambers, a pair of air-compressing cylinders, means whereby exhaust-gases from each exploding-chamber are utilized to compress air to supply the explosive mixture to the other exploding-chamber, and an oil-supply interposed between the air-compressing chamber and the exploding-chamber.

9. The combination of a pair of exploding-chambers, the pistons therein, a pair of air-compressors respectively communicating with the exhaust of one exploding-chamber at one end and the inlet of the opposite exploding-chamber at the other end whereby the exhaust-gases of one exploding-chamber are utilized to compress air into the other exploding-chamber, substantially as described.

10. In a gas-engine, the combination of a pair of exploding-chambers, an air-compressing device communicating with the exhaust of one exploding-chamber and with the inlet of the other exploding-chamber and adapted to be operated by the exhaust-gases, and means for permitting the escape of the exhaust-gases from the cylinder after it has effectively compressed the air.

11. The combination of a pair of exploding-chambers, the pistons therein, a pair of air-compressors respectively communicating with the exhausts of opposite exploding-chambers at one end and the inlet of the opposite exploding-chambers at the other end whereby the exhaust-gases of one exploding-chamber are utilized to compress air into the other exploding-chamber; with means for admitting the exhaust-gases alternately into the air-compressors, and means for permitting the exhaust-gases to escape from said compressors after they have effected the compression therein, substantially as described.

12. The combination of the exploding-chamber, its inlet and exhaust ports, the cylinder communicating with the exhaust-port, a smaller cylinder within the former cylinder, the pistons in said cylinders, and means for admitting the exhaust-gases from the exploding-chamber into said larger chamber to actuate the pistons therein to compress air in the smaller cylinder, and means for allowing the exhaust-gases to escape from said larger cylinder after they have effected the compression of the air.

In testimony that I claim the foregoing as my own I affix my signature in presence of two witnesses.

WILLIAM J. PUGH.

Witnesses:
MORTIMER CROUCH,
MAGULER BUTLER.