No. 687,924. Patented Dec. 3, 1901.

H. M. McCALL.

GAS ENGINE.

(Application filed Jan. 26, 1900.)

(No Model.)

Fig. 3

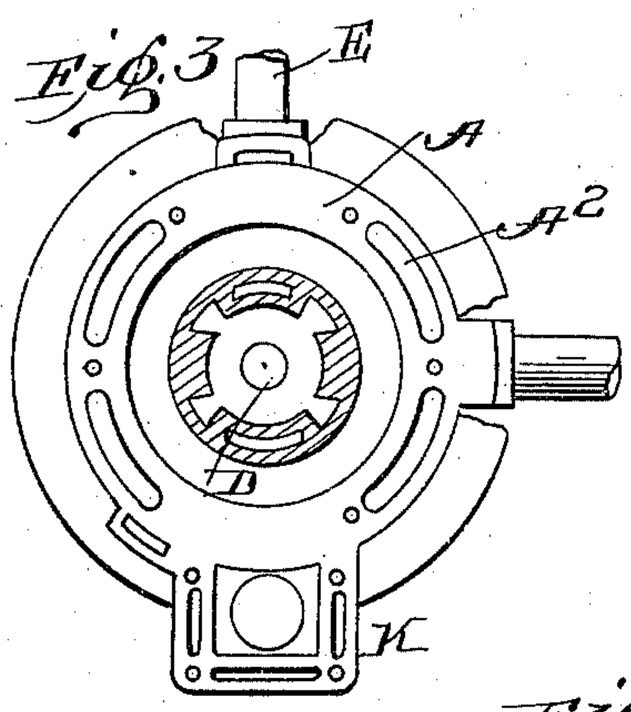


Fig. 4

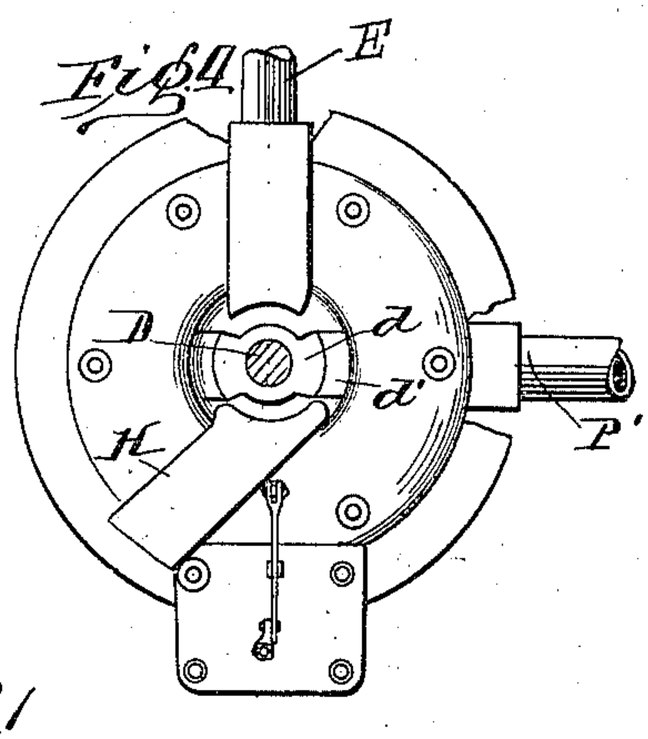


Fig. 1

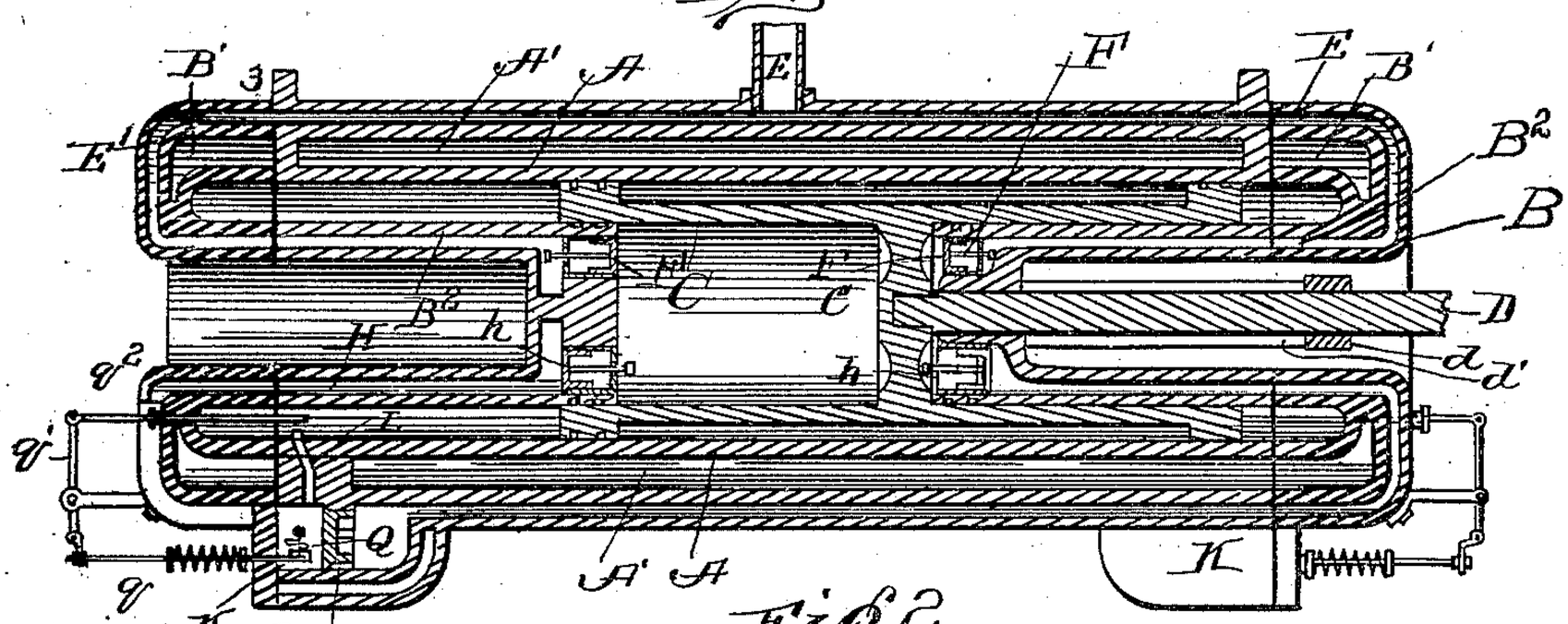


Fig. 2

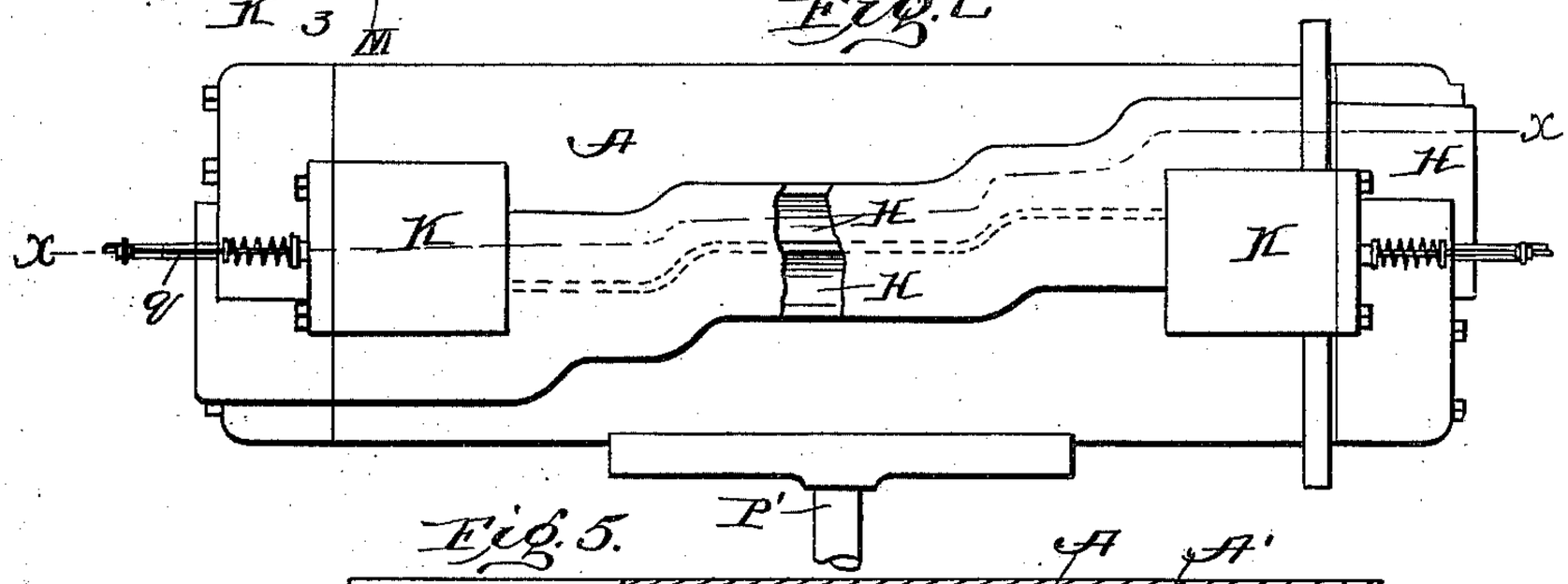
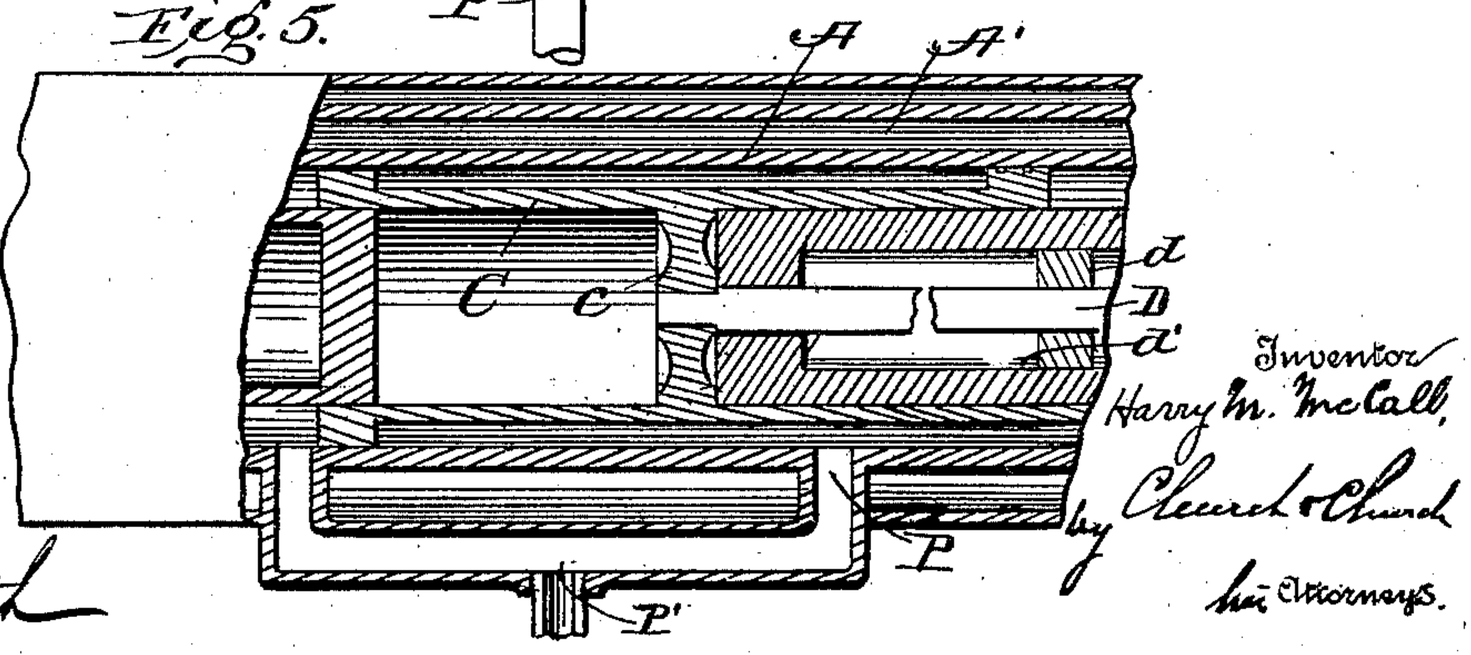


Fig. 5.



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UNITED STATES PATENT OFFICE.

HARRY M. McCALL, OF ALLEGHENY, PENNSYLVANIA.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 687,924, dated December 3, 1901.

Application filed January 26, 1900. Serial No. 2,904. (No model.)

To all whom it may concern:

Be it known that I, HARRY M. McCALL, a citizen of the United States, residing at Allegheny, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Gas-Engines; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming a part of this specification, and to the letters of reference marked thereon.

This invention relates to improvements in engines of the explosive type, such as are ordinarily designated as "gas-engines," and has for its object to provide an improved structure wherein charges of explosive mixture may be exploded for moving the piston in each direction, and under normal conditions of work two impulses may be imparted during each rotation of the crank-shaft, or, in other words, the piston receives two impulses during each complete excursion, the explosive mixture being delivered to the cylinder at a pressure above atmospheric pressure and compressed by the piston during its movement toward the end of the cylinder, ready for ignition as the piston begins its retreat from the end of the cylinder, the arrangement being duplicated at each end of the cylinder and piston, as will be hereinafter more clearly described.

A further object of the invention is to provide a simple and improved arrangement, whereby in a double-acting engine, as just designated, the explosive mixture may be drawn in through the supply-passages by the movement of the piston itself during the impulse period at one end and forced into the explosion-chamber at the opposite end of the piston during the return movement of the piston.

The invention consists in certain novel details of construction and combinations and arrangements of parts, all as will be now described, and the particular features of novelty pointed out in the appended claims.

Referring to the accompanying drawings, Figure 1 is a sectional view taken longitudinally of an engine cylinder and piston embodying my present improvements, the section being taken on the line X X, Fig. 4. Fig. 2 is a bottom plan view of the structure illustrated in Fig. 1. Fig. 3 is an end elevation of the body of the cylinder with the outer portion of the head removed and showing the inwardly-extending portion in section. Fig. 4 is an end elevation of the complete cylinder, and Fig. 5 is a horizontal section through the central portion of the cylinder and piston, showing the exhaust passage and ports.

Referring to said drawings, the letter A indicates the cylinder, which in itself is similar to other cylinders adapted for double-acting engines, and it is preferably provided in its walls with water-chambers A′, through which water may be circulated for reducing the temperature of the cylinder, as is well understood in this type of engine. In each end of the cylinder A there is fitted a head B, also preferably having water-chambers B′, which when the parts are assembled, as shown in Fig. 1, communicate with the chambers A′ through openings A^2, (shown clearly in Fig. 3,) the chambers thus constituting a complete water-jacket for the whole cylinder. The heads B are provided with inwardly-extending projections B^2, having their outer surfaces concentric with the inner circumference of the cylinder, the spaces between the projections B^2 and the inner surface of the said cylinder constituting the explosion-chambers for the engine.

A working space is provided between the ends of the projections B^2 of the cylinder-heads, and in this space is mounted the central diaphragm *c* of the piston, such piston being formed by annular projections C, extending into the spaces between the walls of the projections B^2 and inner surface of the cylinder and constituting the working faces of the piston. The piston-rod D extends through one of the heads B at the inner end of the projection B^2 and is connected centrally with the central portion *c* of the piston, while on the exterior the said piston-rod D is supported in a cross-head *d*, Fig. 4, working in guides *d′*, formed in or attached to the outer face of the head B, but lying within the recess formed in the projection B^2. Thus the said piston and its piston-rod are entirely supported and guided within the length of the cylinder proper, and the outer end of the piston-rod

may be connected through any suitable form of connection, such as a connecting-rod, directly with the crank-shaft of the engine.

The chambers formed in the internal annular spaces in the piston which accommodate the inwardly-extending projections B^2 of the heads are utilized for drawing in the charge of explosive mixture and forcing the same into the explosion-chambers, and in order to accomplish this result the explosive mixture is supplied through a pipe E, with which two passages E′ communicate, and extending around the wall of the cylinder and heads terminate in ports opening into the spaces in the piston at the inner ends of the projections B^2, the said ports or passages E′ being controlled by back-pressure valves F, which will open to permit the explosive mixture to enter the chambers in the piston, but will close and prevent the egress of mixture therethrough. Thus as the piston moves in one direction or the other the vacuum created in the chamber in the piston will draw in explosive mixture, and in order to force said mixture into the explosion-chambers of the engine to give the desired impulses to the piston passages are provided for opening communication between the chamber in the piston at one end of the cylinder and the explosion-chamber at the opposite end of the cylinder. Such passages are shown in the accompanying drawings as being formed in the walls of the cylinder and are lettered H, and at their inner ends valves *h* are provided which will permit the explosive mixture to enter said passages H as the piston advances, but will prevent any return of said mixture to the piston-chambers. The passages H are arranged at the ends of the cylinders, preferably somewhat diagonally, as shown in Fig. 4, in order to pass around the ignition-chambers K. Thus, if reference be had to Fig. 2, it will be seen that said passages H extend past the ignition-chamber at the inner end of the cylinder and pass thence to the piston or farther end of the cylinder, where they open into the ignition-chambers through back-pressure valves M. The ignition-chambers K communicate with the explosion chambers or cylinders through passages L. Pressure in the explosion-chambers and the waste products from previous explosions are allowed to escape from said chambers through exhaust-ports P, Fig. 5, extending through the wall of the cylinder and so located as to be uncovered when the piston reaches its extreme advance movement, but to be immediately covered and closed thereby when the piston commences to again move toward the end of the cylinder. The exhaust-ports P open into an exhaust-pipe P′, which may lead to any suitable point at which it is desired that the exhaust be permitted to escape into the open air.

In operation now, assuming that the engine is in motion, as the piston moves in one direction or the other explosive mixture is drawn into one or the other of the piston-chambers, and as the piston moves in the opposite direction such explosive mixture is discharged from the piston-chamber through the passage H and into the opposite explosion-chamber, and being under pressure somewhat greater than atmospheric pressure it sweeps out said explosion-chamber and causes any residual products of the previous explosion to pass off through the exhaust. On the return movement of the piston the explosive mixture thus forced into the explosion-chamber is compressed, and simultaneously the gas from the opposite piston-chamber is forced into the explosion-chamber at the opposite end of the cylinder. As the piston commences to advance the explosive mixture is ignited in the explosion-chamber, giving the desired impulse to the piston. This sequence of action takes place at opposite ends of the piston alternatively, and the arrangement is such that a charge of explosive may be ignited in the explosion-chamber each time the piston begins its advance movement in each direction. Thus not only is the engine a double-acting engine, but it is a double-acting explosive-engine with a single cycle of action.

The proportions between the capacities of the cylinder or explosive chamber and the piston or compression chamber are preferably such that the explosive mixture is maintained in said chambers at a pressure greater than atmospheric pressure. Thus not only is the explosive mixture preliminarily compressed, but such preliminary compression is utilized for sweeping out the explosion-chambers immediately after the explosion, thereby preventing accumulation of products in the explosion-chambers.

In the construction of the engine it will be noted that all of the parts may be fitted by turning operations, inasmuch as they are concentric, this being true even of the ways *d′* for the cross-head of the piston-rod, which ways may have the wearing-faces dressed by a boring or turning tool passed into the heads from the outer side.

Obviously any usual or preferred form of igniting mechanism may be employed; but I prefer to employ an electric igniter which depends for its action upon the movements of the piston itself, such an igniter being embodied in a contemporaneous application filed by me, Serial No. 2,905, and consisting, essentially, of a pair of contacts Q, located in the ignition-chamber at each end of the cylinder and having a spring-pressed rod *q*, connected therewith at one end and at its opposite end with a pivoted lever *q′*. The end of the lever *q′* is in turn connected with a push-rod q^2, extending into the end of the explosion-chamber and adapted to be moved outwardly by the piston as it reaches the extreme of its movement in that direction. The contacts are arranged to spark and ignite the charge as the rod *q* moves outwardly and the rod q^2 moves inwardly. Thus the spark is formed

as the piston begins its advance movement, thereby igniting the charge only after the crank has passed the dead-center and avoiding any danger of reversal or shock due to premature ignition.

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

1. In a double-acting explosive-engine, the combination with a cylinder, cylinder-heads having inwardly-extending projections concentric with the cylinder, ducts arranged in the walls of said cylinder and heads and extending from a supply-pipe to the inner ends of the projections on the heads and independent ducts extending from the inner ends of the projections to the opposite ends of the cylinder, of a piston having oppositely-arranged chambers for the reception of the inwardly-extending projections, check-valves for preventing the backflow of explosive mixture through the ducts, and igniting mechanisms for igniting the explosive charges in the ends of the cylinders; substantially as described.

2. In a double-acting explosive-engine, the combination with the cylinder, cylinder-heads having centrally-arranged inwardly-extending projections, concentric with the cylinder, ignition-chambers at opposite ends of the cylinder, ducts connecting said ignition-chambers and ends of the cylinder, ducts for supplying explosive mixture at the inner ends of the projections and ducts leading within the walls of the cylinder and heads from the inner ends of the projections to the ignition-chamber at the opposite end of the cylinder, of a piston working in said cylinder and having centrally-arranged chambers for the reception of the inwardly-extending projections on the heads, a piston-rod connected with said piston and working through one of the projections, check-valves for preventing backflow of the explosive mixture and igniting mechanisms for igniting the explosive charges in the ignition-chambers and ends of the cylinder; substantially as described.

3. In an explosive-engine, the combination with a cylinder, a head thereon, having an inwardly-extending concentric projection, and slideways formed in said projection, of a piston working in the cylinder and having a chamber for the reception of the said projection, a piston-rod connected with said piston and a cross-head for said rod mounted in the slideways in the projections; substantially as described.

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