No. 736,224. PATENTED AUG. 11, 1903.

E. B. & L. S. CUSHMAN.

GAS ENGINE.

APPLICATION FILED MAY 6, 1902.

NO MODEL. 3 SHEETS—SHEET 1.

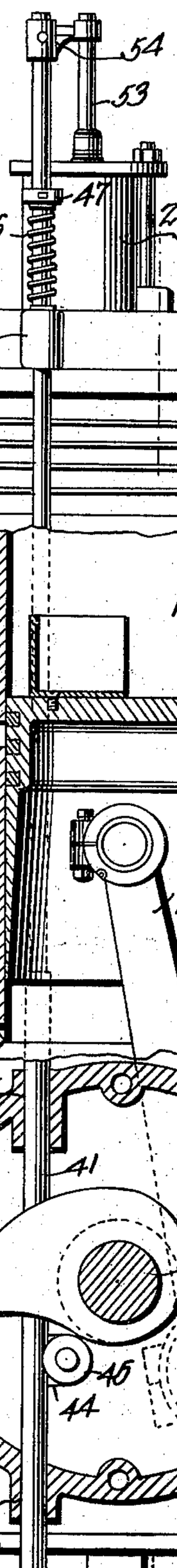

Fig. 1.

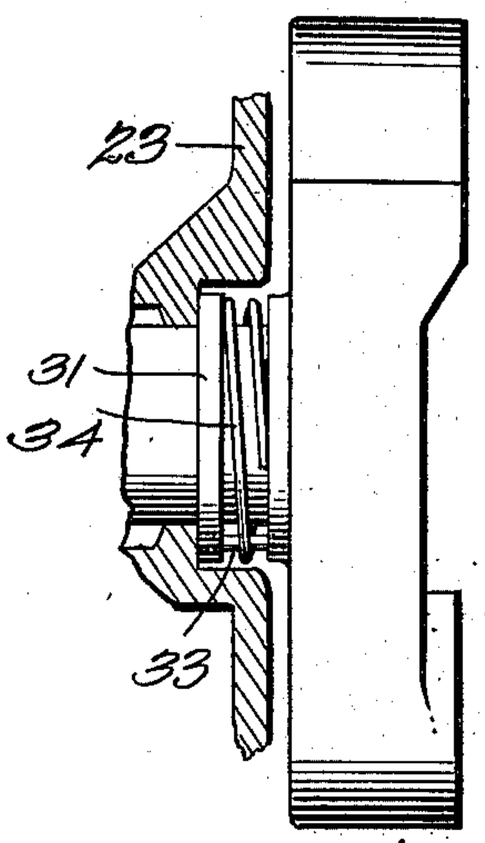

Fig. 7.

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NO MODEL.

3 SHEETS—SHEET 2.

Fig. 6.

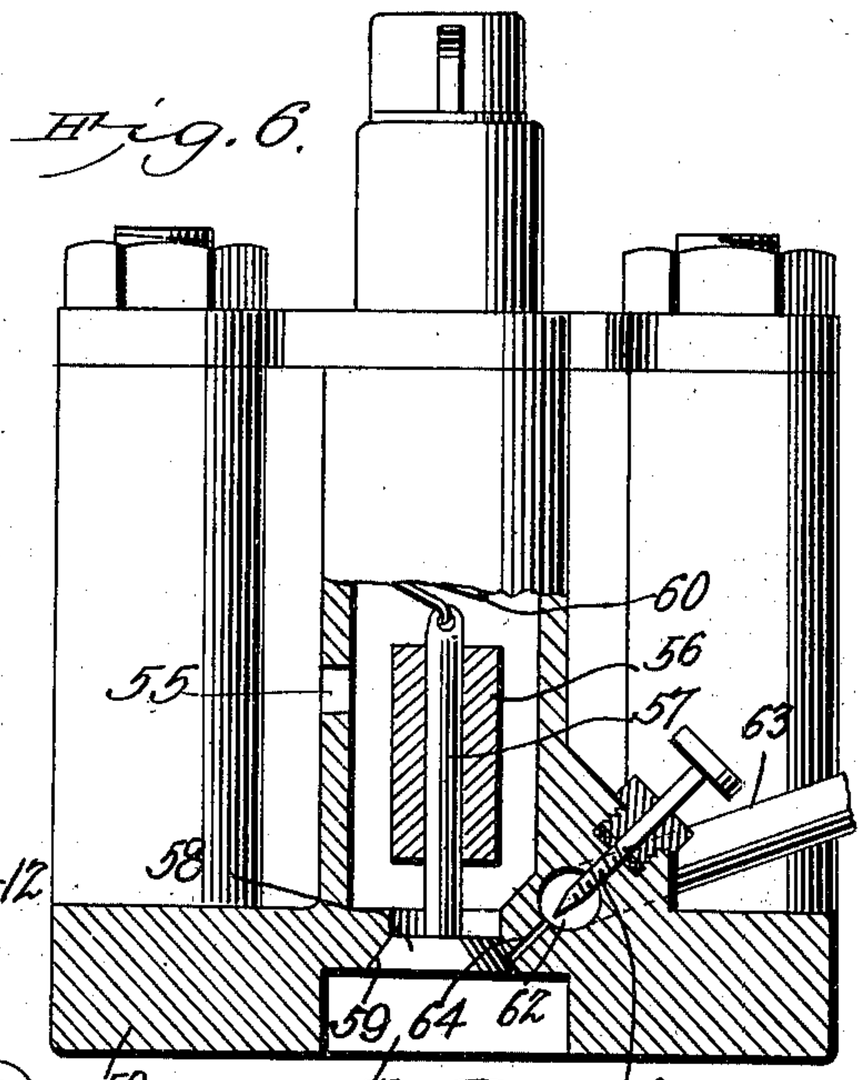


Fig. 1.

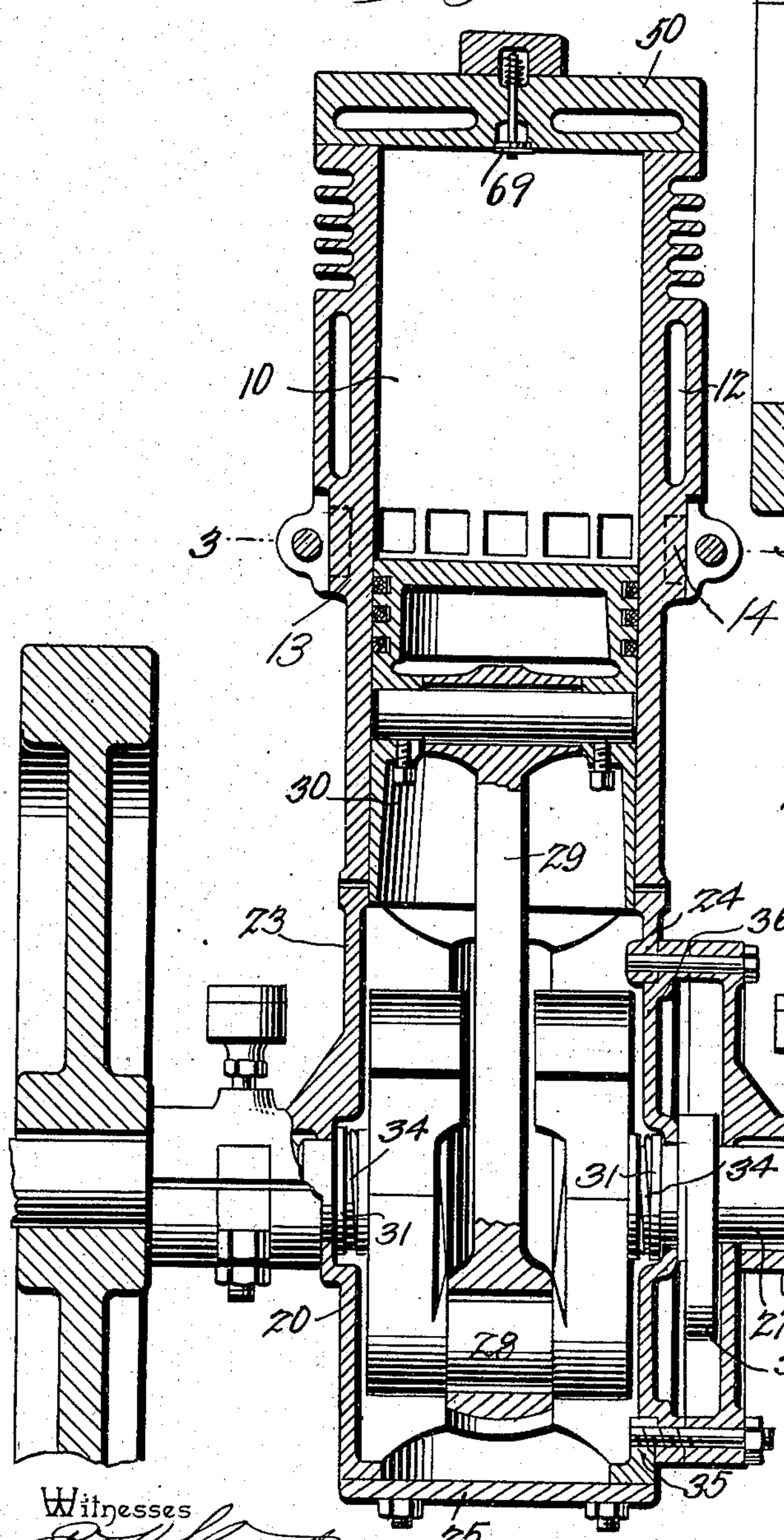
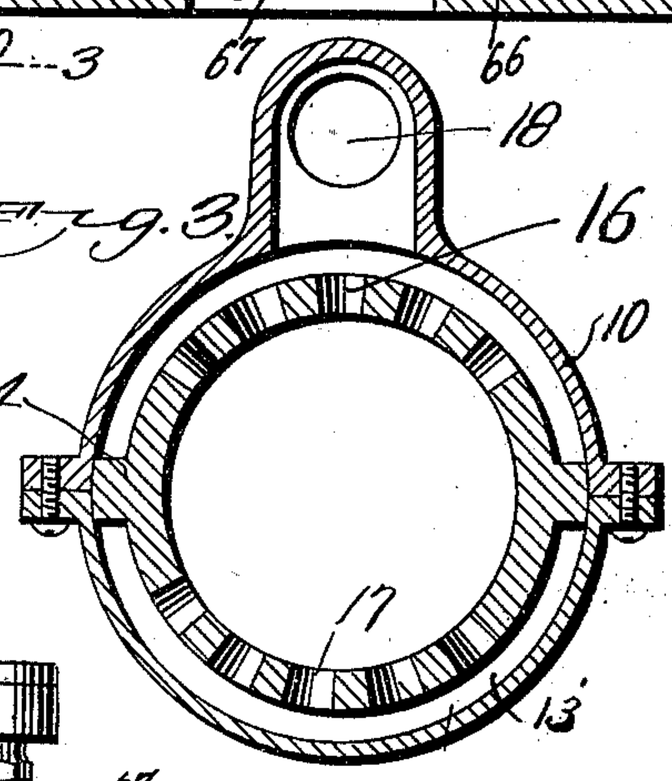


Fig. 3.



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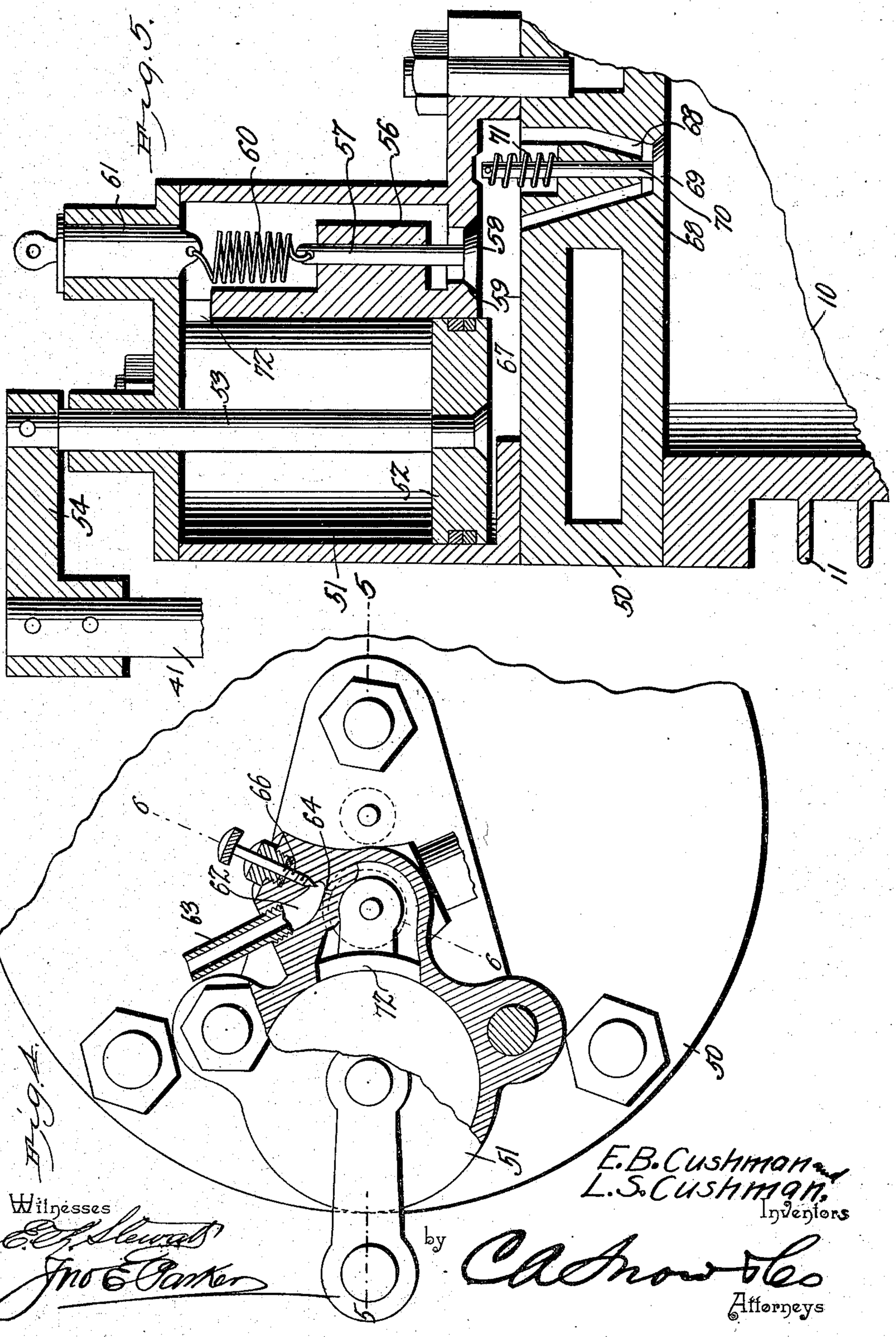
GAS ENGINE.

APPLICATION FILED MAY 6, 1902.

NO MODEL. 3 SHEETS—SHEET 3.

Fig. 5.



No. 736,224. Patented August 11, 1903.

UNITED STATES PATENT OFFICE.

EVERETT B. CUSHMAN AND LESLIE S. CUSHMAN, OF LINCOLN, NEBRASKA, ASSIGNORS TO CUSHMAN MOTOR CO., INCORPORATED, OF LINCOLN, NEBRASKA, A CORPORATION OF NEBRASKA.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 736,224, dated August 11, 1903.

Application filed May 6, 1902. Serial No. 106,185. (No model.)

To all whom it may concern:

Be it known that we, EVERETT B. CUSHMAN and LESLIE S. CUSHMAN, citizens of the United States, residing at Lincoln, in the county of Lancaster and State of Nebraska, have invented a new and useful Gas-Engine, of which the following is a specification.

The present invention relates to certain improvements in the construction and operation of two-cycle gas-engines, and has for its principal object to avoid the waste of explosive mixture which ordinarily occurs in engines of this type where a fresh charge enters at one side of the cylinder while the exploded charge is being exhausted through a port or ports at the opposite side of the cylinder. In ordinary practice a portion of the fresh charge passes directly to the exhaust and is wasted while the exploded charge is not in all cases completely expelled from the cylinder, a portion remaining to mingle with and dilute the fresh charge. This method of operating the engine makes it much more expensive to operate a two-cycle engine than a four-cycle engine, where the exploded charge is expelled from the cylinder on the back stroke of the piston.

In carrying out our invention the exploded gases are driven from the engine by admitting into the cylinder a quantity of air under pressure, the air sweeping through the cylinder and entirely expelling the products of combustion previous to the entrance of a fresh charge of explosive mixture and at the same time serves to cool the cylinder. The air remaining in the cylinder is then compressed on the back stroke of the piston, and before the latter reaches the full back position a supply of richly-carbureted air is forced into the upper portion of the cylinder, there to mingle with the compressed air and form an explosive mixture, to be ignited in any desired manner.

A further object of the invention is to improve, simplify, and cheapen the construction of engines of this type, as more fully described hereinafter.

In the accompanying drawings, Figure 1 is an elevation of a gas-engine constructed in accordance with our invention, a portion of the cylinder and piston being shown in section. Fig. 2 is a sectional elevation of the engine on the line 2 2 of Fig. 1. Fig. 3 is a sectional plan view of the engine on the line 3 3 of Fig. 2. Fig. 4 is a plan view, partially in section, of the top of the cylinder-head, illustrating the construction of the pumping device for forcing carbureted air or gasolene into the cylinder. Fig. 5 is a transverse sectional elevation of the same, on a somewhat larger scale, on the line 5 5 of Fig. 4. Fig. 6 is a similar view on the line 6 6 of Fig. 4. Fig. 7 is a detail sectional view of a portion of the crank-shaft and its packing-ring.

The cylinder 10 is provided with the usual heat-radiating ribs 11 and a water-jacket 12, which may be connected in the usual manner to water-supply pipes. On the exterior of the cylinder are a pair of annular ribs 13, connected by vertical partitions 14 and forming, in connection with a two-part ring 15, a pair of chambers which communicate with the cylinder through ports 16 and 17, respectively, the piston acting as a valve for opening and closing said ports and the port 16 at one side of the piston serving to admit a quantity of fresh air at the completion of the outstroke of the piston, while the port 17 at the opposite side of the cylinder is an exhaust-port, through which the exploded charge is driven by the entering air. One of the sections of the ring 15 is formed integral with a valve-chamber 18, in which is a spring-closed suction-valve 19, which is opened on the upstroke of the piston to admit a quantity of atmospheric air. To the lower portion of the cylinder is bolted an inclosed crank-casing 20, forming a compression-chamber for the air entering past the valve 19, the crank-casing communicating with the valve-chamber 18 through a pipe 21. The crank-casing is provided with one integral head 23 and a removable head 24, which may be taken off for convenience when it becomes necessary to remove the crank-shaft or any of its connected parts, and at the bottom of the casing is an opening normally covered by a removable plate 25. In the two heads of the crank-casing are formed bearings for the reception of the crank-shaft 27, and on said shaft are two counterweighted cranks, connected by a

crank-pin 28, to which is attached one end of the connecting-rod 29, the opposite end of which is pivoted in the usual manner to the trunk-piston 30. In order to prevent leakage of compressed air between the shaft and its bearings, rings 31 are placed on the shaft between the inner portion of the heads of the crank-casing and the adjacent faces of the crank. The rings are held from rotative movement by suitable pins 33, passing through alining openings in the rings and cranks. Between the cranks and rings are helical compression-springs 34, which serve to hold the rings snugly against the inner face of the crank-casing and prevent the escape of air during the downward or compression stroke of the piston.

The removable head 24 of the crank-casing is provided with an outwardly-projecting annular flange 35, to which is bolted a similarly-flanged cover-plate 36, carrying one of the shaft-bearings 37. The flanged faces of the head and cover-plate form a chamber for the reception of a cam 38, adapted to actuate the pumping mechanism for forcing carbureted air or hydrocarbon into the cylinder during the upstroke of the piston, the cam and pump being connected by a rod 41, the lower end of which is guided in suitable openings 42 on the casing of the cam-chamber and the upper end of said rod passing through a guiding-opening in a lug or boss 43 on the cylinder-head. The rod 41 is provided with a laterally-projecting pin or a stud 44, on which is mounted an antifriction-roller 45, the latter being maintained in constant contact with the lower face of the cam by a coiled compression-spring 46, surrounding the upper portion of the rod and held between the upper face of the boss 43 and an adjustable collar 47 on said rod.

In the operation of the mechanism thus far described the downstroke of the piston will compress air previously drawn into the crank-casing past the suction-valve 19, and when the piston reaches the full limit of downstroke the cylinder ports 16 and 17 will be uncovered. The compressed air in the crank-casing will then pass through the pipe 21 and port 16 into the cylinder, driving out all of the exploded charge through the port 17 and at the same time partly cooling the cylinder. The flow of air is continued until the crank is slightly past the center, and the piston on the starting of its upstroke closes the ports 16 and 17 and starts to compress the air remaining in the cylinder. Immediately on the closing of the ports, or in some cases slightly before the exhaust-port has been fully closed, the cam 38 starts to act on the antifriction-roller 45 and depresses the rod 41, this resulting in the forcing into the upper portion of the cylinder of a quantity of gasolene or richly-carbureted air to combine with the air already in the cylinder. The cam is so shaped as to complete its work and permit the rod to start on the ascending movement about the time the piston has completed about three-fourths of its upstroke, leaving about a fourth of a stroke for the gas and air to intermingle and be properly compressed before the explosion occurs.

On the top of the cylinder-head 50 is secured a vertically-disposed pump-cylinder 51, the lower head of which may be formed by the cylinder-head of the engine. In this pump-cylinder is a piston 52, having a rod 53 connected at its upper end by an arm 54 to the cam-actuated rod 41. On one side of the pump-cylinder is a valve-chest having an air-inlet opening 55 and provided with a perforated boss 56 for the reception of the stem 57 of an air-inlet valve 58. The valve 58 is normally held against the seat 59 by a tension-spring 60, the upper end of which is connected to an adjustable plug 61, which may be raised or lowered to alter the tension of the spring and increase or decrease the resistance to the opening movement of the valve. In one side of the casting which forms the cylinder and valve chamber is a port or passage 62, communicating through a tube 63 with a supply of gasolene or other suitable hydrocarbon. The lower portion of the port or passage communicates through an opening 64 with the inclined face of the valve-seat 59, the valve 58 controlling the supply of air and of gasolene, while a needle-valve 66 is employed to govern the quantity of gasolene admitted through the passage 64 at each opening movement of the valve 58. The valve 58 opens into a port or passage 67, opening at one end into the lower portion of the pump-cylinder and at the opposite end being provided with one or more ports or passages 68, leading to the engine-cylinder. The port 68 is normally closed by a valve 69, having a guided stem 70, surrounded by a compression-spring 71, the valve opening on the downstroke of the pump-piston to permit the passage of air and gasolene to the explosion-chamber. On the upstroke of the pump-piston the valve 69 will be held closed and the value 58 will be opened, permitting mingled currents of gasolene and air to enter the pump-cylinder below the piston, while a free outlet for any air between the piston and the upper head of the pump-cylinder is provided by a small port 72 between the cylinder and the valve-chest. On the downstroke of the pump-piston, which occurs during the upstroke of the main piston in the explosion-chamber, the mixed air and gas in the pump-cylinder will be forced through the ports 67 and 68 into the upper portion of the explosion-chamber and there mingled with partially-compressed air in the explosion-chamber. Before the piston reaches the upper limit of movement in the explosion-chamber the downstroke of the pump-piston has been completed, so that the valve 69 may close in advance of the completion of the upstroke of the main piston and afford an opportunity for the richly-carbureted air to mingle and be compressed with the atmospheric air already in the explosion-chamber.

While the construction herein described, and illustrated in the accompanying drawings, is the preferred form of the device, it is obvious that various changes in the form, proportions, size, and minor details of the structure may be made without departing from the spirit or sacrificing any of the advantages of our invention.

Having thus described our invention, what we claim is—

1. The combination in a two-cycle gas-engine, of a cylinder, means for the admission of air under pressure and means for the escape of the exploded mixture, a pump-cylinder at the outer end of the main cylinder, a ported cylinder-head forming the end of both cylinders, a valve normally closing the port and having opposite surfaces of different area of which the smaller is exposed to pressure from the pump-cylinder and the larger to pressure from the main-cylinder, a spring tending to maintain the valve in closed position, inlets for the elements of the explosive mixture, a suction inlet-valve normally closing said inlets, and means driven by the engine for imparting to the pump-piston a pumping stroke at a speed greater than that at which the piston of the engine travels during the return stroke.

2. The combination in a two-cycle gas-engine, of a cylinder, a piston therein, a crank-shaft connected to the piston, air-inlet and gas-exhaust ports for the cylinder, a pump-cylinder, a piston in said pump-cylinder, a valved passage between the two cylinders, inlets for the elements of the explosive mixture, a suction inlet-valve normally closing said inlet, and a cam operatively connected to the pump-piston and so formed as to accelerate the movement of the piston toward the end of the ejecting stroke of said piston.

3. The combination in a two-cycle gas-engine, of the cylinder having a gas-inlet port, a pump for forcing an explosive charge through said port, a crank-casing secured to the cylinder and forming an air-compression chamber, said casing having the flanged head, a flanged cover-plate secured to said flanged head and forming a cam-chamber, a shaft extending through the crank-casing and cam-chamber and adapted to bearings therein, a cam mounted on said shaft, and a pump-actuating rod adapted to guiding-openings in the cam-chamber and having an antifriction-roller for contact with the cam.

In testimony that we claim the foregoing as our own we have hereto affixed our signatures in the presence of two witnesses.

EVERETT B. CUSHMAN.
LESLIE S. CUSHMAN.

Witnesses:
J. M. GUILE,
A. D. GUILE.