No. 810,495. PATENTED JAN. 23, 1906.

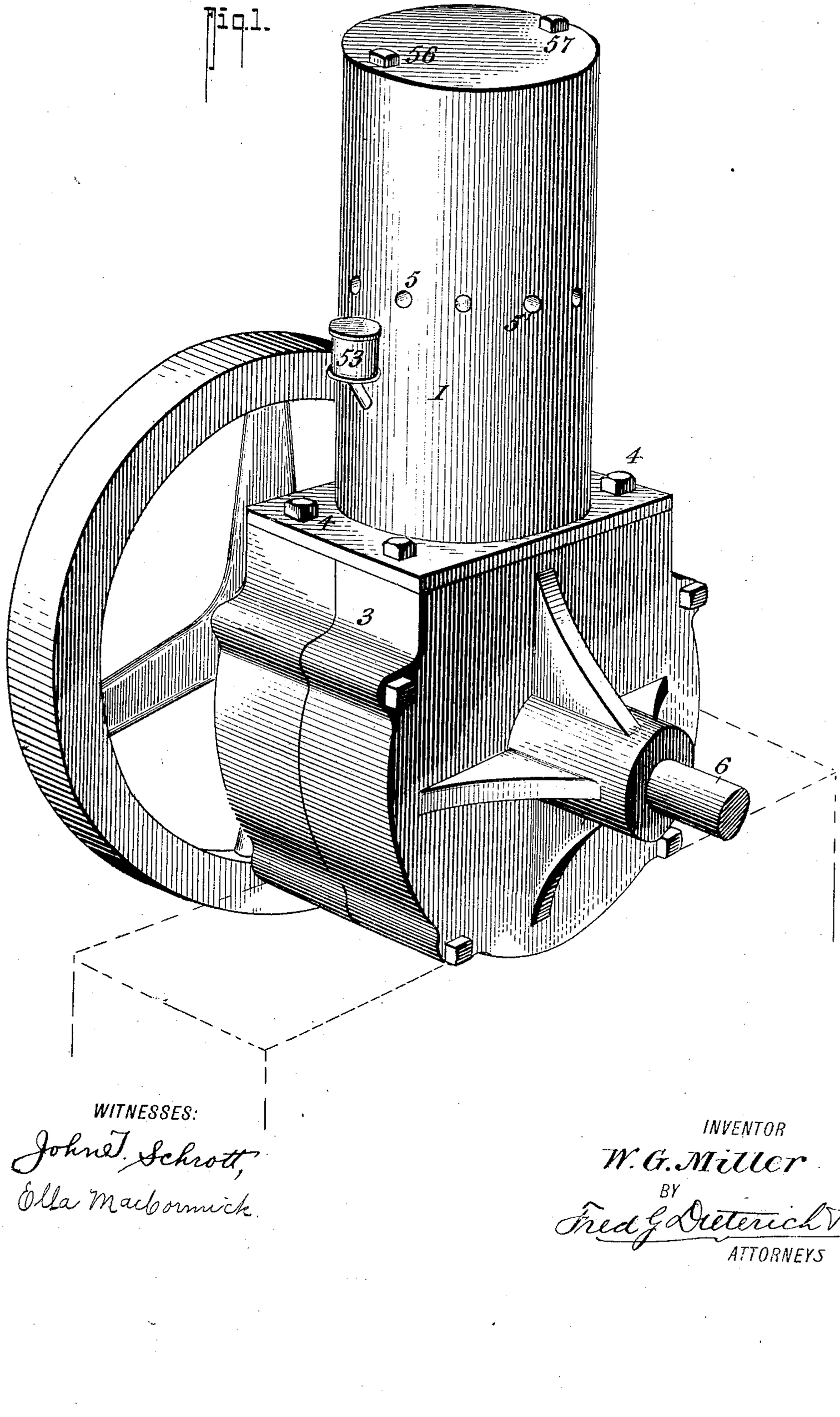
W. G. MILLER.

GAS ENGINE.

APPLICATION FILED MAR. 30, 1905.

4 SHEETS—SHEET 1.

Fig. 1.



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4 SHEETS—SHEET 2.

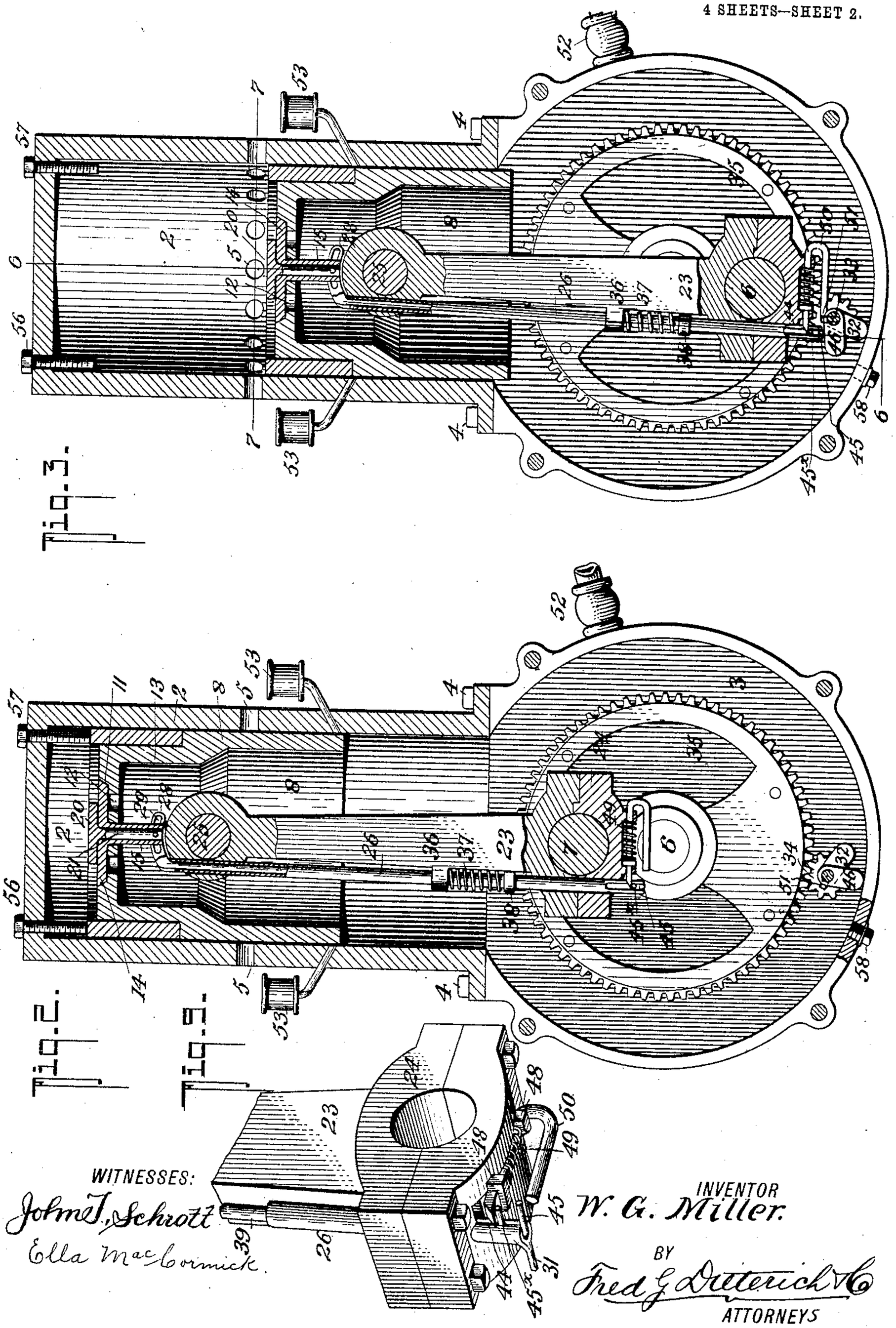

Fig. 3.

Fig. 2.

Fig. 5.

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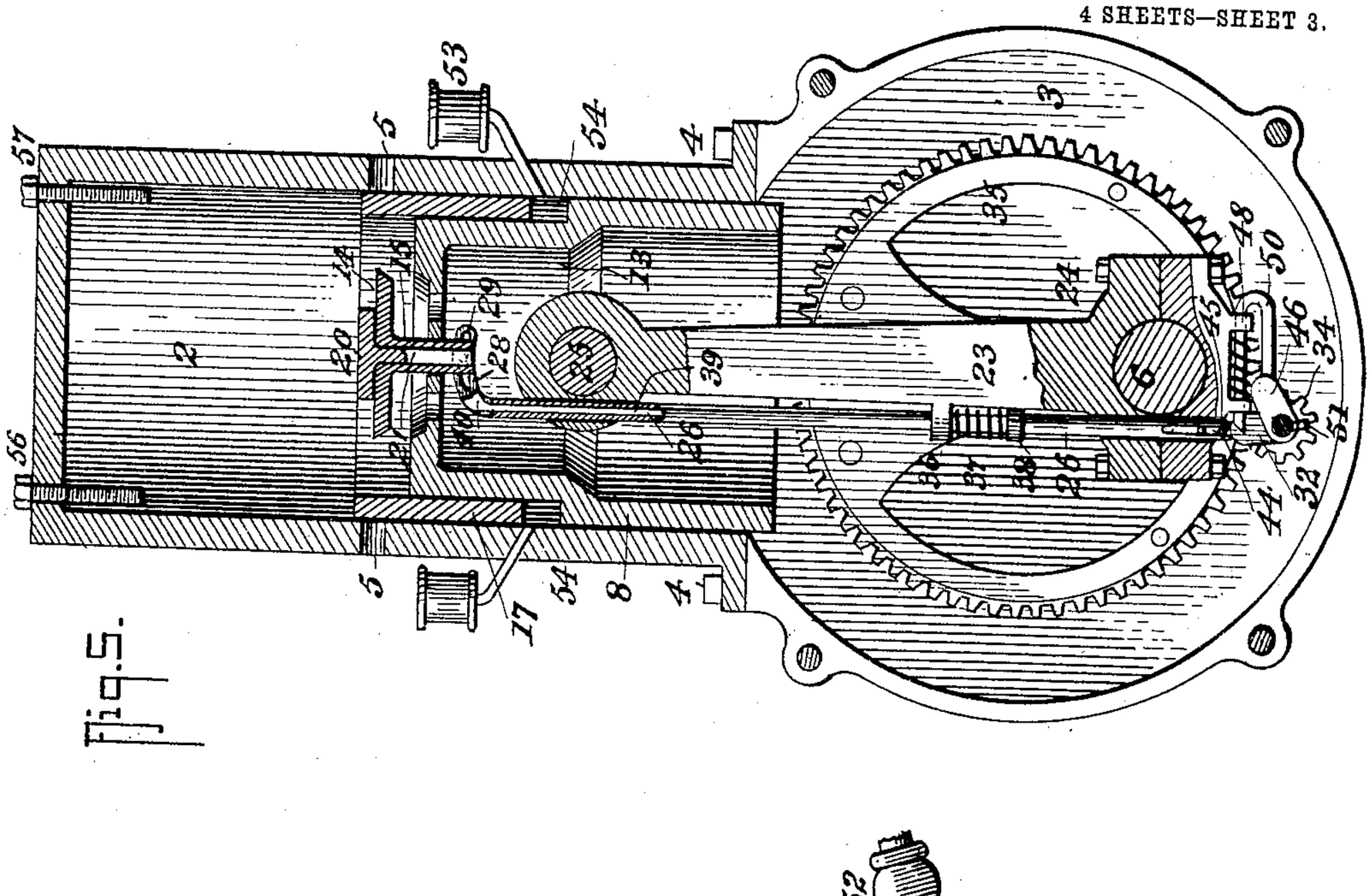


Fig. 5.

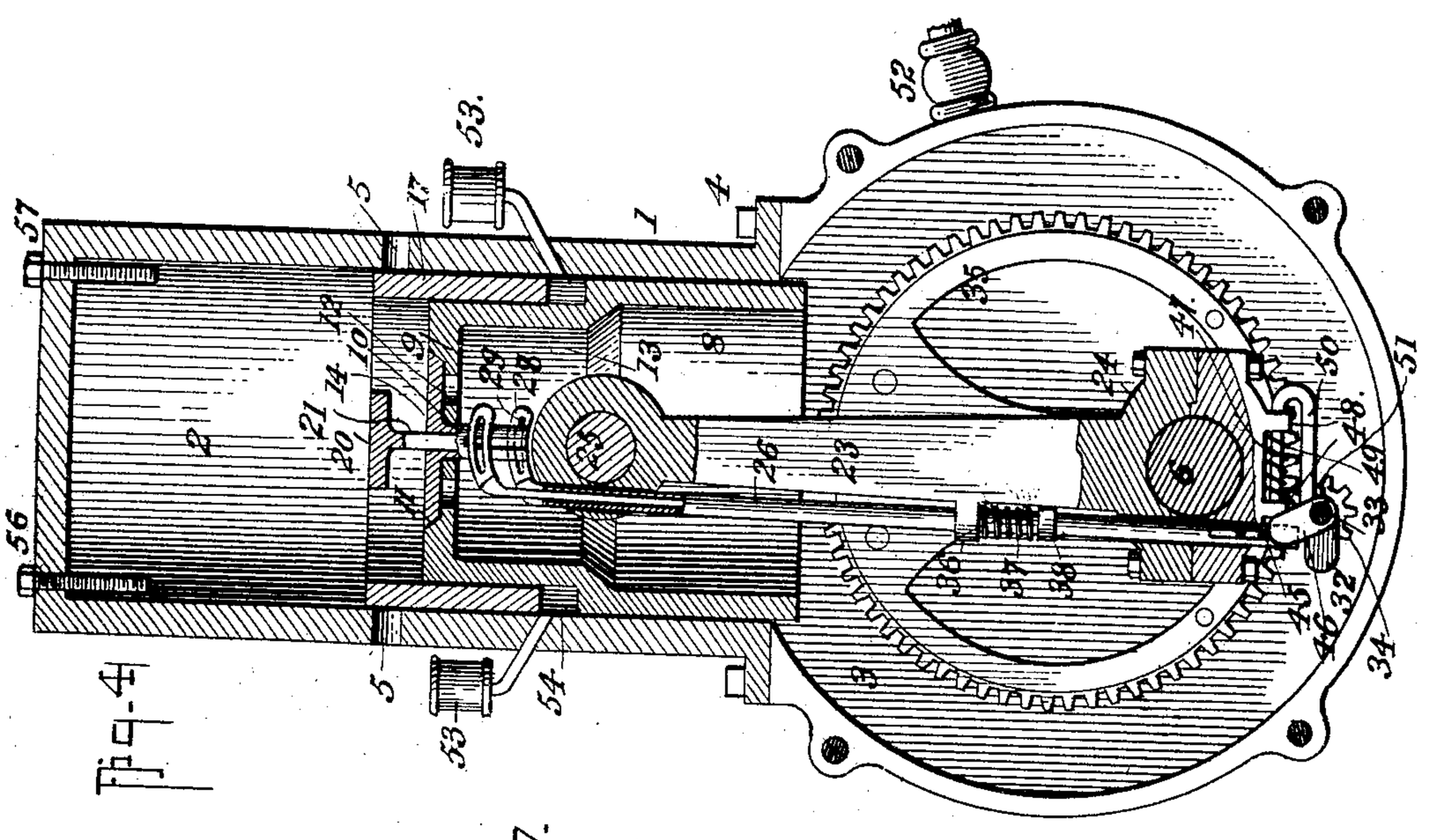
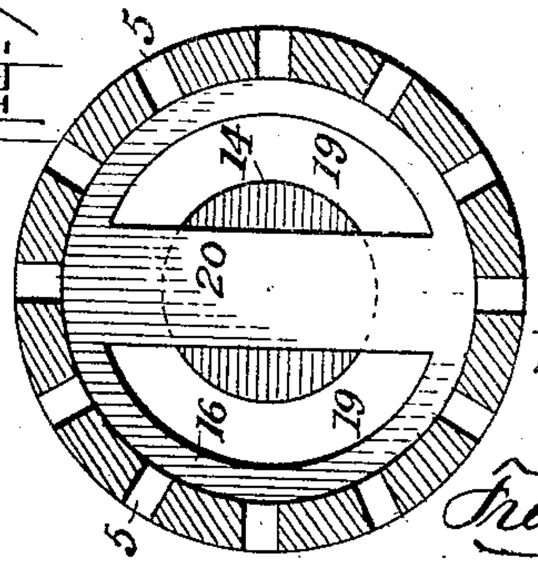


Fig. 4.

Fig. 7.



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4 SHEETS—SHEET 4.

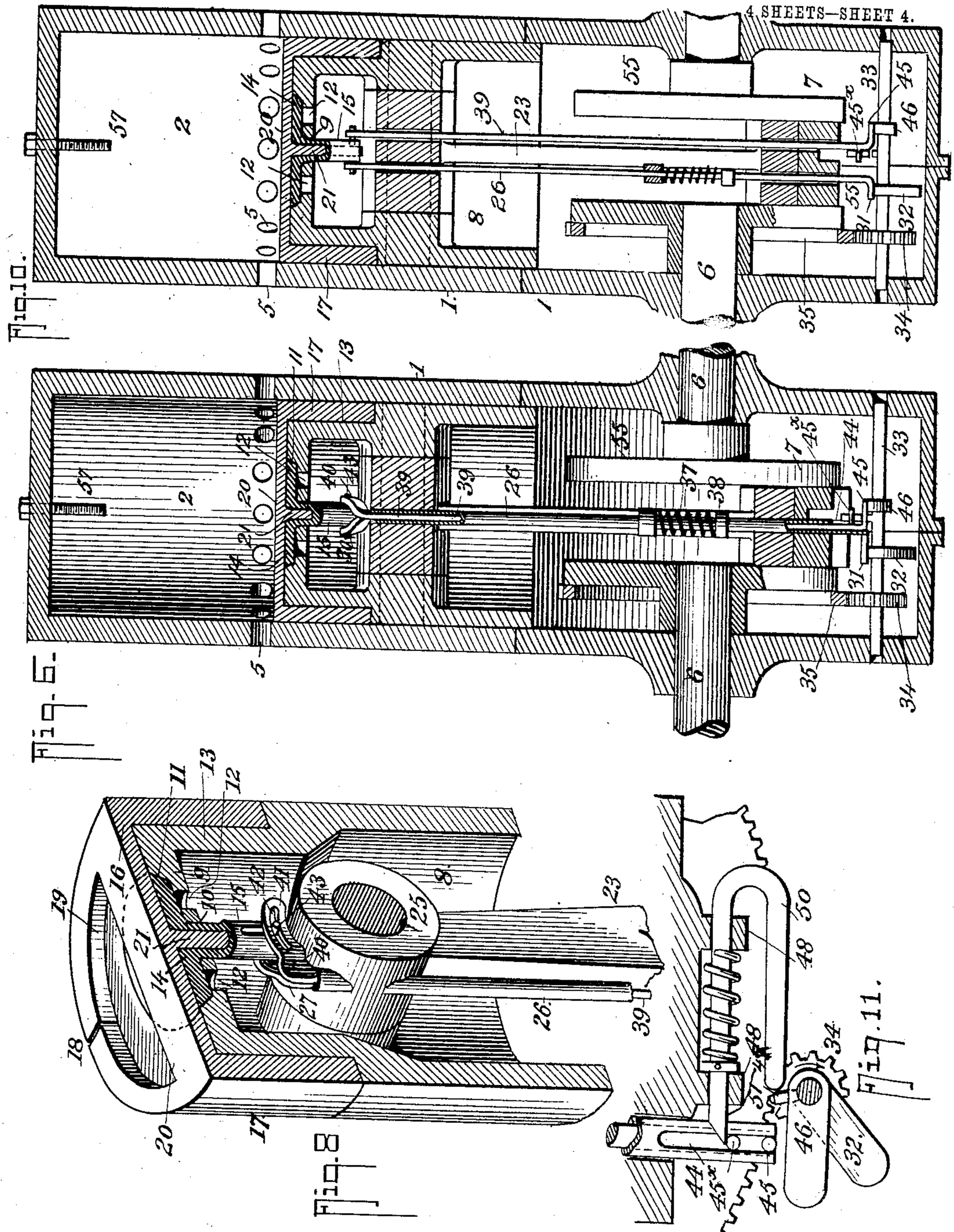

FIG. 10.

FIG. 6.

FIG. 8.

FIG. 11.

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UNITED STATES PATENT OFFICE.

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GAS-ENGINE.

No. 810,495. Specification of Letters Patent: Patented Jan. 23, 1906.

Application filed March 30, 1905. Serial No. 252,937.

To all whom it may concern:

Be it known that I, WILLIAM GEORGE MILLER, residing at West Medway, in the county of Norfolk and State of Massachusetts, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification.

My invention relates to certain new and useful improvements in gas-engines of the two-cycle type; and it primarily seeks to provide an engine of this character of a very simple and economical construction which will readily and effectively serve its intended purposes and in which all of the working parts of the engine are located within the engine-casing.

The invention also seeks to provide an engine in which the inlet and exhaust ports to the explosion-chamber are controlled by the piston and in which independent means are provided for closing the exhaust-ports before the new charge of working agent passes into the explosion-chamber and just after the exploded mixture has passed out of said chamber, thereby preventing any new charge passing out of the exhaust-ports with the exploded mixture.

In its more subordinate nature my invention includes special means for positively operating the independent exhaust-port-closing means and also the working-agent-inlet valve for the explosion-chamber.

Another object of my invention is to provide means for automatically drawing a supply of oil into the casing to thoroughly lubricate the moving parts.

Generically my improved engine comprises a casing including a crank-chamber portion and a piston-chamber portion, a piston reciprocally movable in the piston-chamber, a crank in the crank-chamber, a piston-rod connecting the piston with the crank, an inlet-valve carried by the piston for passing the working agent into the explosion-chamber of the casing, a supplemental valve carried by the piston for closing the explosion-chamber exhaust-ports, means mounted within the casing for operating both piston-valves automatically, means for locking the exhaust-port-closng valve at times, and means for drawing oil into the casing to oil or lubricate the moving parts.

With other objects in view than have heretofore been enumerated and which will hereinafter be made apparent, the invention also includes certain novel combination and arrangement of parts, all of which will be first described in detail and then specifically pointed out in the appended claims, reference being had to the accompanying drawings, in which—

Figure 1 is a perspective view of my invention. Fig. 2 is a longitudinal section thereof, showing the position of the parts when the engine is operating under an exploded charge. Fig. 3 is a similar view showing the position of the parts just after the exhaust-ports have been uncovered. Fig. 4 is a similar view showing the position of the parts immediately after the exhaust-ports have been covered up by the supplemental piston-valve. Fig. 5 is a similar view showing the position assumed by the parts when the inlet-valve of the piston has been opened. Fig. 6 is a vertical cross-section on the line 6 6 of Fig. 3. Fig. 7 is a cross-section on the line 7 7 of Fig. 3. Fig. 8 is a perspective view, partly in section, of the piston and its coöperating valve members. Fig. 9 is a detail view of the locking devices for holding the supplemental piston-valve to its locked position. Fig. 10 is a detail view hereinafter specifically referred to. Fig. 11 is a detail view of the cam and latch devices hereinafter referred to.

Referring now to the accompanying drawings, in which like numerals of reference indicate like parts in all of the figures, my improved engine comprises a casing 1, consisting of a working cylinder 2 and a crank-casing 3, as shown. The working cylinder 2 and the casing 3 are secured together by bolts 4 or otherwise in any approved manner, and in order to permit the ready assembling of the parts the casing portion 3 is also made in sections, as clearly shown in Fig. 1. Mounted in suitable bearings on the crank-casing 3 is a crank or drive shaft 6, whose crank portion 7 rotates within the casing 3.

Reciprocally mounted in the cylinder 2 is a piston 8 of tubular form, having one end closed by a diaphragm 9, which diaphragm 9 is centrally apertured, as at 10, to permit passage of the stem 15 of the valve 14. The diaphragm 9 is also provided on its outer face with a valve-seat 11 and is apertured, as at 12, to permit passage of the working agent therethrough when the valve 14 is off its seat in a manner presently more fully explained.

The piston 8 toward its closed end or head is provided with a portion 13 of reduced diameter to receive the ring or rim 17 of the supplemental valve 16, which ring or rim 17 is split, as at 18, to permit proper expansion or contraction thereof, due to the heat within the working cylinder.

The valve 16 is open at the top, as at 19 19, on each side of a transverse web 20, which carries a central stem 21, which passes through the stem 15 of the valve 14, the valve-stem 15 being made tubular to receive the stem 21, as clearly shown in Fig. 8.

The external diameter of the ring 17 of the valve 16 and that of the portion 22 of the piston 8 are the same and made to fit within the cylinder 2.

23 designates a piston-rod having a bearing 24, by which it is connected to the crank 7, and the said piston-rod 23 is connected with the piston 8 by a short stub-shaft 25, held in bearings in the piston-wall.

26 designates a tubular rod having an angle-arm 27 at its outer end, which is provided with a segmental portion 28, bent at right angles to the arm 27, which segmental portion 28 is slotted, as at 29, to receive the pin 30 on the tubular stem 15 of the valve 14. The rod 27 passes through a bearing 36 on the piston-rod 23 and is provided with a collar 38, between which and the bearings 36 a coil-spring 37 is placed to force the rod 26 normally downward. At its lower end the rod 26 is provided with a heel 31, projected at right angles thereto, which is adapted to be engaged at predetermined times by a cam 32 on a shaft 33, mounted in the walls of the casing 3, which shaft 33 is provided with a pinion 34, which meshes with a gear 35 on the crank-shaft 6.

Mounted within the rod 26 for independent longitudinal movement therein is a second rod 39, which is provided with an angled arm 40, having a segmental portion 41 at right angles to the arm 40 and parallel to the portion 28 of the rod 26, which segmental portion 41 is provided with a slot 42 to receive the stud or pin 43, carried by the stem 21 of the valve 16. At its lower end the rod 39 is provided with a right-angled heel 45, similar to the one 31 of the rod 26, which heel 45 is adapted to coöperate with a second cam 46 on the shaft 33 in a manner presently more fully explained. The tubular shaft 26 is provided with a slot 44 at its lower end to permit the rod 39 being forced upwardly within the rod 26 to operate the valve 16.

47 designates a latch mounted on the bearing portion 24 of the piston-rod, which is adapted to engage the lug $45^{\times}$ when the valve 16 is in its normal position to hold the said valve 16 in its normal position on the piston 8. The latch 47 is slidably mounted in bearings 48 and spring-pressed to its locking position by a spring 49.

50 designates an arm carried by the latch 47, which projects in the path of a supplemental cam portion 51 on the shaft 34, so that the latch 47 will be disengaged from the lug $45^{\times}$ just prior to the time when the cam 46 engages the stud 45 to raise the rod 39 in a manner presently more fully explained.

52 designates the intake-valve for the casing 3, through which the working agent is admitted to the casing 3 from the source of supply, the said intake-valve being a one-way valve and adapted to open inwardly to admit the working agent to the casing 3, while it will close to prevent the exit of the working agent from the casing 3.

53 53 designate oil-cups which communicate with the interior of the cylinder 2 at such point that when the valve 16 operates the oil will be drawn into the pockets 54, formed in the piston when the valve 16 operates to close the exhaust-ports 5 of the cylinder 2.

A counterweight 55 on the crank-shaft is provided to counterbalance the weight of the piston, the piston-rod, and their carried parts.

Operation: Assume the parts to be in the position shown in Fig. 2, the casing 3 being filled with working agent and the explosion-chamber of the cylinder 2 being filled with a charge of exploded mixture, the piston moving in the direction of the arrow, the valve 14 being closed, and the valve 16 being seated in its normal position on the piston and locked by the latch 47. As shown in Fig. 2, the piston is moving downwardly under the exploded charge of the working cylinder. At this time the new working agent within the chamber 3 is being compressed. As soon as the parts reach the position shown in Fig. 3, wherein the piston 8 has just uncovered the exhaust-ports 5, the exploded mixture will exhaust itself through the said exhaust-ports 5. As soon as the exploded mixture has passed out of the exhaust-ports 5 the cam 46 engages the stud 45 of the rod 39 and raises the said rod, thereby projecting the valve 16 beyond the end of the piston 8 and covering up the exhaust-ports 5, it being understood that just prior to the time the cam 46 engages the stud 45 the supplemental cam portion 51 will release the latch 47, as before explained. The parts are now in the position shown in Fig. 4. As soon as the valve 16 has closed the exhaust-ports 5 the cam 32 engages the stud or heel 31 of the rod 26, raising the rod 26, and thereby opening the valve 14 to allow the compressed working agent from the casing 3 to enter the explosion-chamber, and the parts are now in the position shown in Fig. 5. As soon as the working cylinder has its explosion-chamber filled with a new charge the heel 31 passes out of the sphere of action of the cam 32 and the spring 37 returns the valve 14 to its closed position, it being understood that the cam 46 has moved out of engagement with the heel 45 by this time. When the cam 46 engages the heel 45 and operates the rod 39 to project the valve 16 beyond the piston end, a chamber 54, surrounding the piston, is produced, and the vacuum created therein by the movement of the valve 16 draws in oil from the oil holders or cups 53 to fill the chamber 54. As the piston starts on its upstroke the new charge of working agent in

the explosion-chamber will be compressed, and as the piston reaches the limit of its stroke upwardly the ring 16 will again be seated in its normal position on the piston 8, as shown in Fig. 2, while the latch 47 will engage the stud 45 and lock the valve 16 in such position, the oil from the chamber 54 being forced out of the chamber 54 through the slits between the ends of the split ring 17. To aid in returning the valve 16 to its normal position on the piston 8, I provide adjustable stops 56 57 in the end of the working cylinder 2, which are adapted to be engaged by the valve 16 as the piston moves upwardly. As soon as the piston has reached the limit of its stroke in the upward direction the compressed charge in the explosion-chamber is exploded to force the piston downwardly and repeat the operations just explained. The oil from the oil-cups 53 when it is drawn in by the movement of the valve 16 serves to lubricate the interior of the working cylinder, the oil gradually gravitating downwardly into the crank-casing 3, in which a sufficient amount of oil is allowed to accumulate, so that the shaft 33, together with its cams 32 46 and its pinion 34, will run in oil and so that the bearing 24 and the crank 7 will pass through the oil during a portion of its stroke, so as to automatically lubricate such parts. The oil forced out of the pockets 54 when the valve 16 is returned to its normal position (shown in Fig. 1) passes through the split portion 18 of the ring 17 into the explosion-chamber, collects on the top of the piston 8 and in the spaces 19 19, and serves to lubricate the stem 21, as well as to lubricate the stem 15 and valve 14, the oil dripping down onto the stud-shaft 25, and the coöperating bearing of the piston-rod 23 serves to automatically lubricate the said bearing of the piston-rod. It will be therefore seen that all the parts of my improved engine are automatically lubricated by oil from the oil-cups 53. A draw-off cock 58 may be provided for drawing off the excess oil from the casing 3, if desired.

From the foregoing description, taken in connection with the accompanying drawings, it will be seen that I have provided a very simple and effectively-operating engine in which the exhaust-ports are positively closed before the new charge enters the explosion-chamber and also in which means are provided for automatically lubricating the various operative parts of the engine. It is also thought that from the foregoing the complete operation, construction, and many advantages of my invention will be readily understood by those skilled in the art to which it appertains, and while I have shown and described the respective rods 39 and 26 the one within the other yet the said rods may be made without engagement with each other and simply disposed parallelly to one another, as shown diagrammatically in Fig. 10. The arc upon which the slots 29 and 42, respectively, are formed are concentric with the axis of the stub-shaft 25 to allow for the lateral movement of the piston-rod 23 during the operation of the engine.

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

1. An engine comprising a casing, a piston reciprocally movable therein and dividing the casing into two compartments, one of said compartments forming the explosion-chamber, an inlet-valve to the other compartment, said piston adapted to draw the working agent into the said other compartment during one portion of its stroke, said casing having piston-controlled exhaust-ports for the explosion-chamber, means carried by the piston for passing the working agent into the explosion-chamber from the other chamber, and means carried by the piston for closing the exhaust-ports in advance of the admission of said working agent, substantially as shown and described.

2. An engine comprising a casing, a piston reciprocally movable therein and dividing the casing into two compartments, one of said compartments forming the explosion-chamber, an inlet-valve to the other compartment, said piston adapted to draw the working agent into the said other compartment during one portion of its stroke, said casing having piston-controlled exhaust-ports for the explosion-chamber, means carried by the piston for passing working agent into the explosion-chamber from the other chamber, means carried by the piston for closing the exhaust-port in advance of the admission of said working agent, and means mounted within the casing for automatically operating said first-mentioned piston-carried means.

3. An engine comprising a casing, a piston reciprocally movable therein, and dividing the casing into two compartments, one of said compartments forming the explosion-chamber, an inlet-valve to the other compartment, said piston adapted to draw the working agent into the said other compartment during one portion of its stroke, said casing having piston-controlled exhaust-ports for the explosion-chamber, means carried by the piston for passing working agent into the explosion-chamber from the other chamber, means carried by the piston for closing the exhaust-port in advance of the admission of said working agent, and means mounted within the casing for automatically operating said second-mentioned piston-carried means.

4. An engine comprising a casing, a piston reciprocally movable therein and dividing the casing into two compartments, one of said compartments forming the explosion-chamber, an inlet-valve to the other compartment, said piston adapted to draw the working agent into the said other compartment during one

portion of its stroke, said casing having piston-controlled exhaust-ports for the explosion-chamber, means carried by the piston for passing the working agent into the explosion-chamber from the other chamber, means carried by the piston for closing the exhaust-ports in advance of the admission of said working agent, and means mounted within the casing for automatically operating both of said piston-carried means.

5. In an engine of the character stated, a working cylinder and a crank-casing in communication with each other, a piston operatable in the working cylinder, a crank-shaft rotatably mounted in the crank-casing, a piston-rod connecting said crank-shaft with said piston, an intake-valve for said crank-casing, said piston arranged to draw working agent into said crank-casing when moving in one direction and to compress the working agent in the crank-casing when moving in the opposite direction, an inlet-valve in the piston-head for passing the working agent from the crank-casing into the explosion-chamber of the cylinder, said cylinder having exhaust-ports adapted to normally be closed by said piston and opened when the piston is at the limit of its stroke in one direction, and valve-controlling means carried by the piston, all being arranged substantially as shown and described.

6. In an engine of the character stated, a working cylinder and a crank-casing in communication with each other, a piston operatable in the working cylinder, a crank-shaft rotatably mounted in the crank-casing, a piston-rod connecting said crank-shaft with said piston, an intake-valve for said crank-casing, said piston arranged to draw working agent into said crank-casing when moving in one direction and to compress the agent in the crank-casing when moving in the opposite direction, an inlet-valve in the piston-head for passing the working agent from the crank-casing into the explosion-chamber of the cylinder, said cylinder having exhaust-ports adapted to be closed by said piston and opened when the piston is at the limit of its stroke in one direction, an exhaust-valve carried by the piston, means for automatically opening said inlet piston-valve, and means for automatically moving said exhaust-controlling valve to close the said exhaust-ports in advance of the opening of the inlet-valve.

7. In an engine of the character stated, a working cylinder and a crank-casing in communication with each other, a piston operatable in the working cylinder, a crank-shaft rotatably mounted in the crank-casing, a piston-rod connecting said crank-shaft with said piston, an intake-valve for said crank-casing, said piston arranged to draw working agent into said crank-casing when moving in one direction and to compress the working agent in the crank-casing when moving in its opposite direction, an inlet-valve in the piston-head for passing the working agent from the crank-casing into the explosion-chamber of the cylinder, said cylinder having exhaust-ports to be normally closed by said piston and opened when the piston is at the limit of its stroke in one direction, an exhaust-valve carried by the piston, means for automatically opening said inlet piston-valve, means for automatically moving said exhaust-controlling valve to close the exhaust-ports in advance of the opening of inlet-valve, and means for returning said inlet-valve to its seat.

8. In an engine of the character stated, a working cylinder and a crank-casing in communication with each other, a piston operatable in the working cylinder, a crank-shaft rotatably mounted in the crank-casing, a piston-rod connecting said crank-shaft with said piston, an intake-valve for said crank-casing, said piston arranged to draw working-agent into said crank-casing when moving in one direction and to compress the agent in the crank-casing when moving in the opposite direction, an inlet-valve in the piston-head for passing the working agent from the crank-casing into the explosion-chamber of the cylinder, said cylinder having exhaust-ports adapted to be normally closed by said piston and opened when the piston is at the limit of its stroke in one direction, an exhaust-valve carried by the piston, means for automatically opening said inlet piston-valve, and means for automatically moving said exhaust-controlling valve to close the said exhaust-ports in advance of the opening of the inlet-valve, and means for returning said exhaust-controlling valve to its seat.

9. In an engine of the character stated, a working cylinder and a crank-casing in communication with each other, a piston operatable in the working cylinder, a crank-shaft rotatably mounted in the crank-casing, a piston-rod connecting said crank-shaft with said piston, an intake-valve for said crank-casing, said piston arranged to draw working agent into said crank-casing when moving in one direction and to compress the agent in the crank-casing when moving in the opposite direction, an inlet-valve in the piston-head for passing the working agent from the crank-casing into the explosion-chamber of the cylinder, said cylinder having exhaust-ports adapted to be closed by said piston and opened when the piston is at the limit of its stroke in one direction, an exhaust-valve carried by the piston, means for automatically opening said inlet piston-valve, means for automatically moving said exhaust-controlling valve to close the exhaust-ports in advance of the opening of the inlet-valve, and means for locking said exhaust-valve to its seat at times.

10. In an engine of the character stated, a working cylinder and a crank-casing in com-

munication with each other, a piston operatable in the working cylinder, a crank-shaft rotatably mounted in the crank-casing, a piston-rod connecting said crank-shaft with said piston, an intake-valve for said crank-casing, said piston arranged to draw working agent into said crank-casing when moving in one direction and to compress the agent in the crank-casing when moving in the opposite direction, an inlet-valve in the piston-head for passing the working agent from the crank-casing into the explosion-chamber of the cylinder, said cylinder having exhaust-ports adapted to be closed by said piston and opened when the piston is at the limit of its stroke in one direction, an exhaust-valve carried by the piston, means for automatically opening said inlet piston-valve, and means for automatically moving said exhaust-controlling valve to close the said exhaust-ports in advance of the opening of the intake-valve, means for locking said exhaust-valve to its seat at times, and means for automatically releasing said locking means at times.

11. An engine comprising a working cylinder, a piston reciprocally mounted therein, said piston adapted to draw working agent into one end of said cylinder during one portion of its stroke and to compress said working agent on the return portion of its stroke, an inlet-valve in the piston-head adapted to open at predetermined times to admit said compressed working agent into the explosion-chamber of the cylinder, said cylinder having piston-controlled exhaust-ports substantially as shown and described.

12. An engine comprising a working cylinder, a piston reciprocally mounted therein, said piston adapted to draw working agent into one end of said cylinder during one portion of its stroke and to compress said working agent on the return of its stroke, an inlet-valve in the piston-head adapted to open at predetermined times to admit said compressed working agent into the explosion-chamber of the cylinder, said cylinder having piston-controlled exhaust-ports, and supplemental means carried by the piston for closing said exhaust-ports after the exploded mixture has escaped therethrough and before the opening of the piston inlet-valve.

13. In an engine of the class described, a working cylinder and a piston operatable therein, and an automatically-operated means carried by the piston for drawing oil into the cylinder to lubricate the moving parts, and an oil-containing vessel in communication with said cylinder substantially as shown and described.

14. In an engine of the class described, a working cylinder and a crank-casing, a piston reciprocally mounted in the working cylinder, a crank-shaft mounted in the crank-casing, a piston-rod connecting the crank-shaft to the piston, said piston having its head apertured and provided with a valve-seat, an inlet-valve carried by said piston with its stem passing through the piston-head, a valve-operating rod for said inlet-valve connected to its stem and held in bearings on the piston-rod, cam devices within the crank-casing for engaging said rod at times to open the valve, said cylinder having piston-controlled exhaust-ports, substantially as shown and described.

15. In an engine of the class described, a working cylinder and a crank-casing, a piston reciprocally mounted in the working cylinder, a crank-shaft mounted in the crank-casing, a piston-rod connecting the crank-shaft to the piston, said piston having its head apertured and provided with a valve-seat, an inlet-valve carried by said piston with its stem passing through the piston-head, a valve-operating rod for said inlet-valve connected to its stem and held in bearings on the piston-rod, cam devices within the crank-casing for engaging said rod at times to open the valve, said cylinder having piston-controlled exhaust-ports, and a supplemental valve carried by the piston for closing said exhaust-ports at times.

16. In an engine of the class described, a working cylinder and a crank-casing, a piston reciprocally mounted in the working cylinder, a crank-shaft mounted in the crank-casing, a piston-rod connecting the crank-shaft to the piston, said piston having its head apertured and provided with a valve-seat, an inlet-valve carried by said piston with its stem passing through the piston-head, a valve-operating rod for said inlet-valve connected to its stem and held in bearings on the piston-rod, cam devices within the crank-casing for engaging said rod at times to open the valve, said cylinder having piston-controlled exhaust-ports, and a supplemental valve carried by the piston for closing said exhaust-ports at times, and cam-controlled devices within the cylinder and crank-casing for positively operating said supplemental valve.

17. In an engine of the class described, a working cylinder and a crank-casing, a piston reciprocally mounted in the working cylinder, a crank-shaft mounted in the crank-casing, a piston-rod connecting the crank-shaft to the piston, said piston having its head apertured and provided with a valve-seat, an inlet-valve carried by said piston with its stem passing through the piston-head, a valve-operating rod for said inlet-valve connected to its stem and held in bearings on the piston-rod, cam devices witnin the crank-casing for engaging said rod at times to open the valve, said cylinder having piston-controlled exhaust-ports, a supplemental valve carried by the piston for closing said exhaust-ports at times, and cam-controlled devices within the

cylinder and crank-casing for positively operating said supplemental valve in advance of the opening of the piston inlet-valve.

18. In an engine of the class described, a working cylinder and a crank-casing, a piston reciprocally mounted in the working cylinder, a crank-shaft mounted in the crank-casing, a piston-rod connecting the crank-shaft to the piston, said piston having its head apertured and provided with a valve-seat, an inlet-valve carried by said piston with its stem passing through the piston-head, a valve-operating rod for said inlet-valve connected to its stem and held in bearings on the rod, cam devices within the crank-casing for engaging said rod at times to open the valve, said cylinder having piston-controlled exhaust-ports, a supplemental valve carried by the piston for closing said exhaust-ports at times, cam-controlled devices within the cylinder and crank-casing for positively operating said supplemental valve in advance of the opening of the piston inlet-valve, means for locking said supplemental valve to its normal position and supplemental cam devices within the crank-casing for releasing said locking means at times.

19. In an engine of the character stated, a working cylinder, a crank-casing connected to one end thereof, a hollow piston, closed at one end, reciprocally mounted within the working cylinder, said working cylinder having exhaust-ports adapted to be closed at times by said piston, a crank-shaft mounted in said crank-casing, a piston-rod connecting said crank-shaft to said piston, said piston having its closed end formed of reduced diameter to provide an annular seat, said piston having its closed end provided with apertures and a valve-seat, an inlet-valve having a hollow stem projected through said piston-head and adapted to normally seat on said valve-seat in the piston-head, a tubular rod mounted in bearings on the piston-rod and having one end in engagement with said tubular stem of the piston-head valve, said tubular rod having a cam-engaging foot at its free end, a supplemental valve having an annular ring adapted to seat in said annular seat of the piston and having a stem passing through the hollow stem of the first-mentioned piston-valve, a second rod held within said first-mentioned rod and having one end connected to said stem of the supplemental valve and having its free end provided with a cam-engaging heel, cams mounted within said crank-casing for coöperating with the heels of said rods, a gear mounted on said crank-shaft, a pinion connected with said cams and said gear whereby the motion of the crank-shaft is imparted to the cams, said cams being so arranged as to operate said supplemental valve in advance of said first-mentioned piston-valve to close the exhaust-ports of the working cylinder in advance of the admission of a new charge of working agent into the explosion-chamber, and oil-containing vessels communicating with the interior of said working cylinder at a point in alinement with the juncture between the large and reduced portions of the piston so that when the supplemental valve is operated the same will draw in a supply of oil from the oil-containers to lubricate the moving parts within the working cylinder and crank-casing, all being arranged substantially as shown and for the purposes described.

20. In an engine of the character stated, a working cylinder, a crank-casing connected to one end thereof, a hollow piston open at one end reciprocally mounted within the working cylinder, said working cylinder having exhaust-ports adapted to be closed at times by said piston, a crank-shaft mounted in said crank-casing, a piston-rod connecting said crank-shaft to said piston, said piston having its closed end formed of reduced diameter to provide an annular seat, said piston having its closed end provided with apertures and a valve-seat, an inlet-valve having a hollow stem projected through said piston-head and adapted to normally seat on said valve-seat in the piston-head, a tubular rod mounted in bearings on the piston-rod and having one end in engagement with the tubular stem of the piston-head valve, said tubular rod having a cam-engaging foot at its free end, a supplemental valve having an annular ring adapted to seat in said annular seat of the piston and having a stem passing through the hollow stem of the first-mentioned piston-valve, a second rod within said tubular rod, having one end connected to said stem of the supplemental valve and having its free end provided with a cam-engaging heel, cams mounted within said crank-casing for coöperating with the heels of said rods, a gear mounted in said crank-shaft, a pinion connected with said cams and said gear whereby the motion of the crank-shaft is imparted to the cams, said cams being so arranged as to operate said supplemental valve in advance of said first-mentioned piston-valve to close the exhaust-ports of the working cylinder in advance of the admission of a new charge of working agent into the explosion-chamber oil-containing vessels communicating with the interior of said working cylinder at a point in alinement with the juncture between the large and reduced portions of the piston so that when the supplemental valve is operated the same will draw in a supply of oil from the oil-containers to lubricate the moving parts within the working cylinder and crank-casing, a latch for cooperating with the first-mentioned tubular rod to hold the first-mentioned piston-valve to its seat, and a supplemental cam member for tripping said latch at times to release said

latch from operative connection with the first-mentioned tubular rod, all being arranged substantially as shown and described.

21. An engine comprising a casing including a crank and a piston-chamber, a piston reciprocally movable in the piston-chamber, a crank-shaft mounted in bearings in the casing, a piston-rod connecting the piston with the crank-shaft, inlet-valves carried by the piston for passing the working agent into the explosion-chamber of the casing, a supplemental valve carried by the piston for closing the explosion-chamber exhaust-ports, means mounted within the casing for operating both piston-valves automatically, means for locking the exhaust-port-closing valve at times, and means for drawing oil into the casing to lubricate the moving parts.

WILLIAM GEORGE MILLER.

Witnesses:

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CHARLES A. DILLON.