No. 683,080. Patented Sept. 24, 1901.

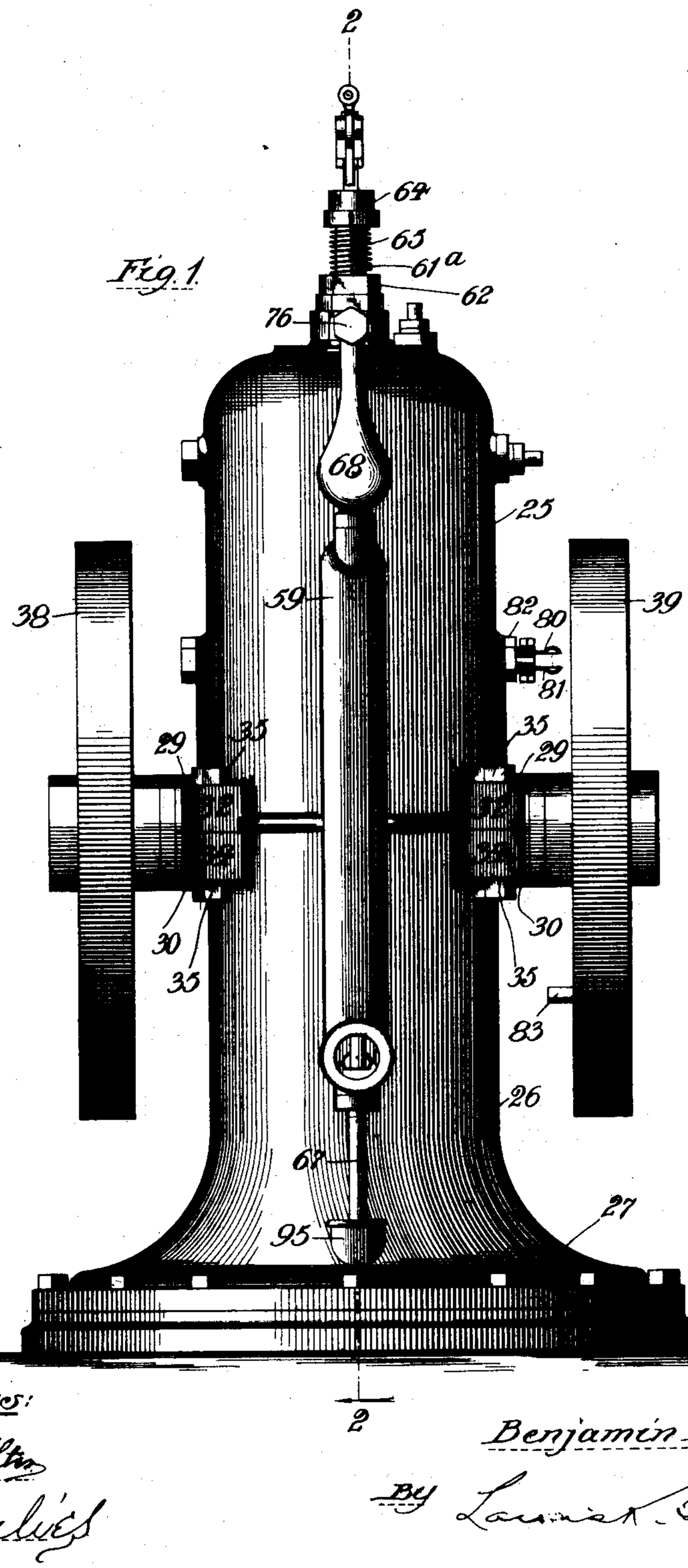
# B. F. STEWART.

## GAS ENGINE.

(Application filed Sept. 20, 1900.)

(No Model.) 6 Sheets—Sheet 1.

Fig. 1.

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## GAS ENGINE.

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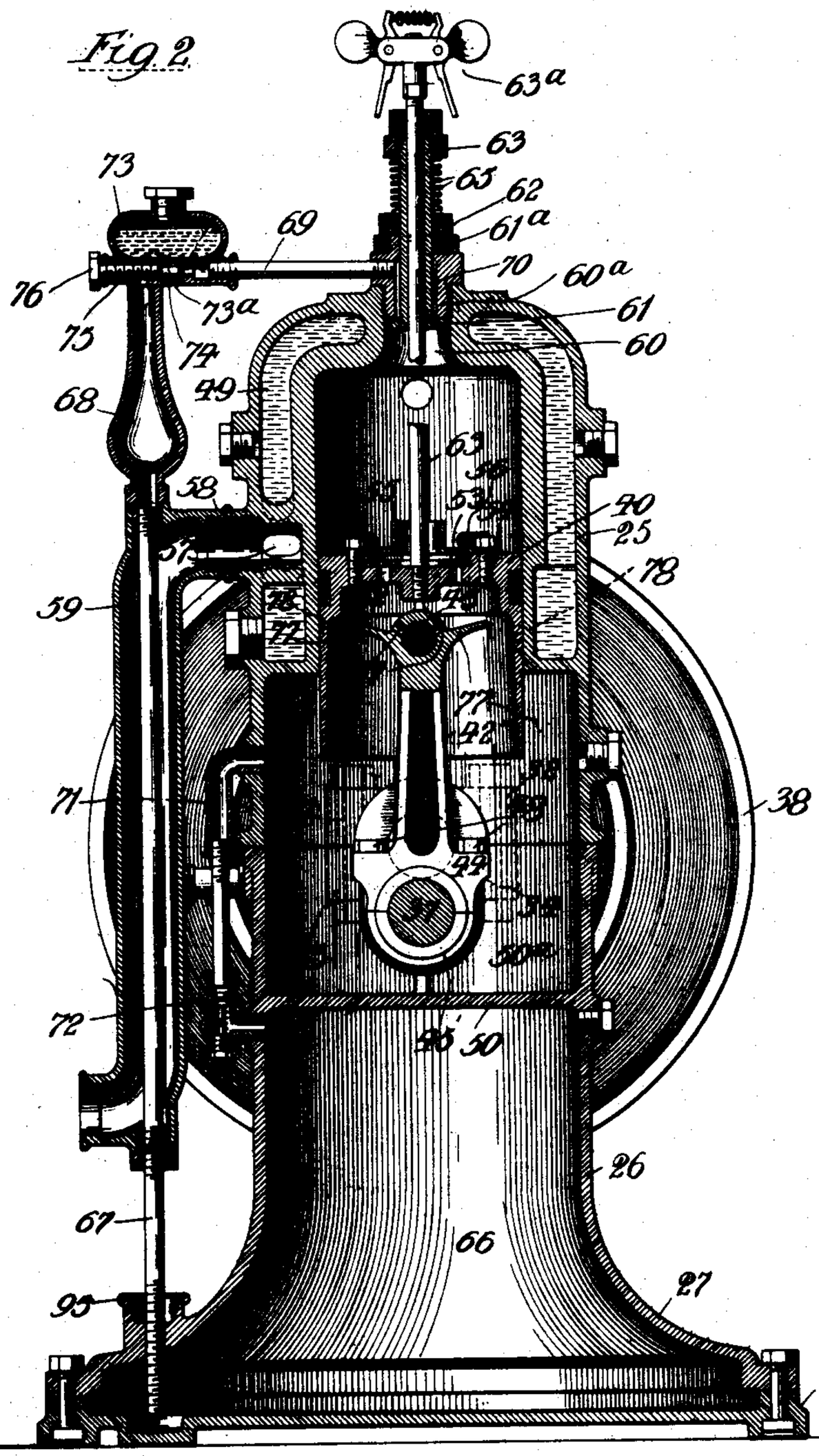
(No Model.) 6 Sheets—Sheet 2.

Fig. 2.

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## GAS ENGINE.

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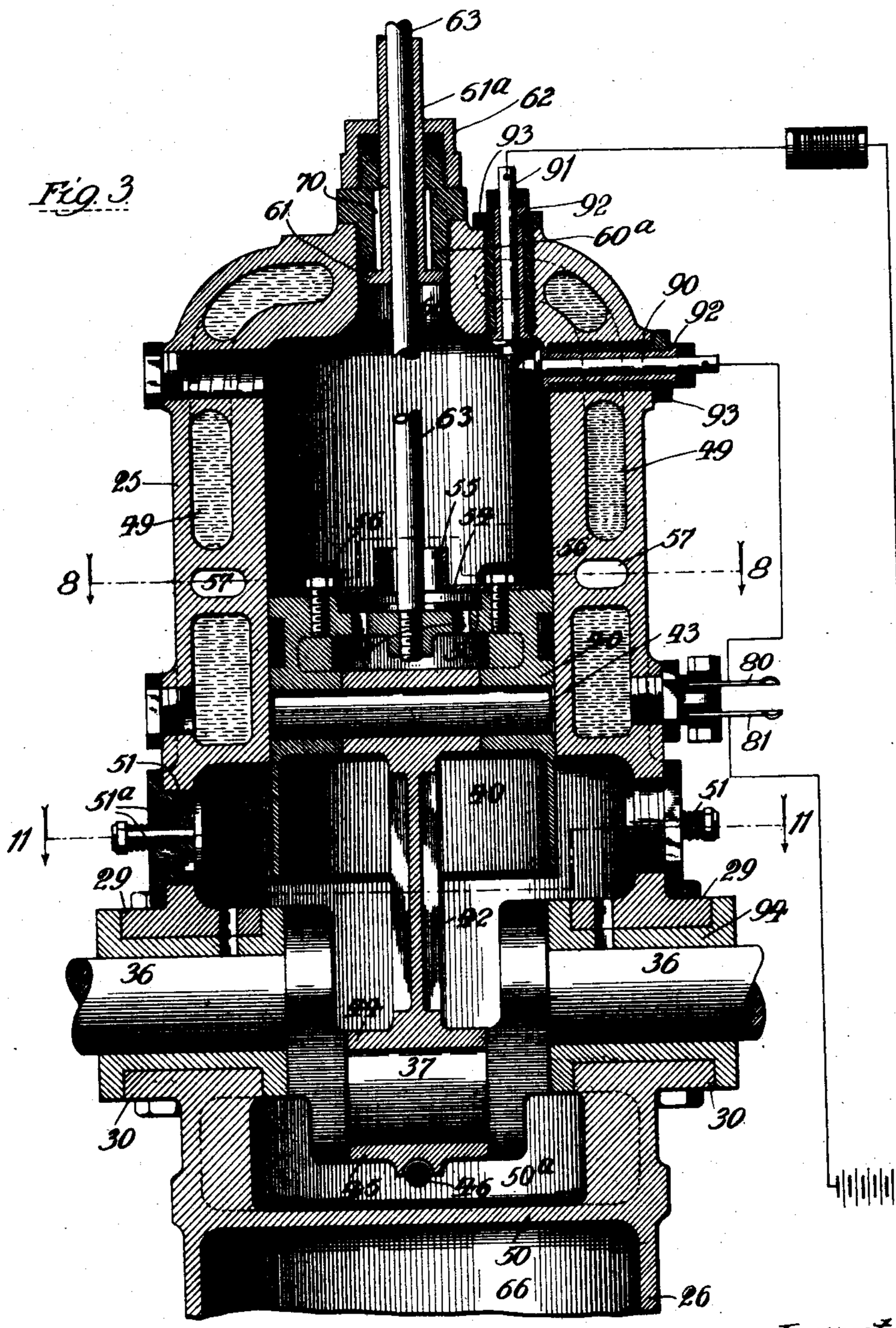
(No Model.) 6 Sheets—Sheet 3.

Fig. 3

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(No Model.) 6 Sheets—Sheet 4.

Fig. 4.

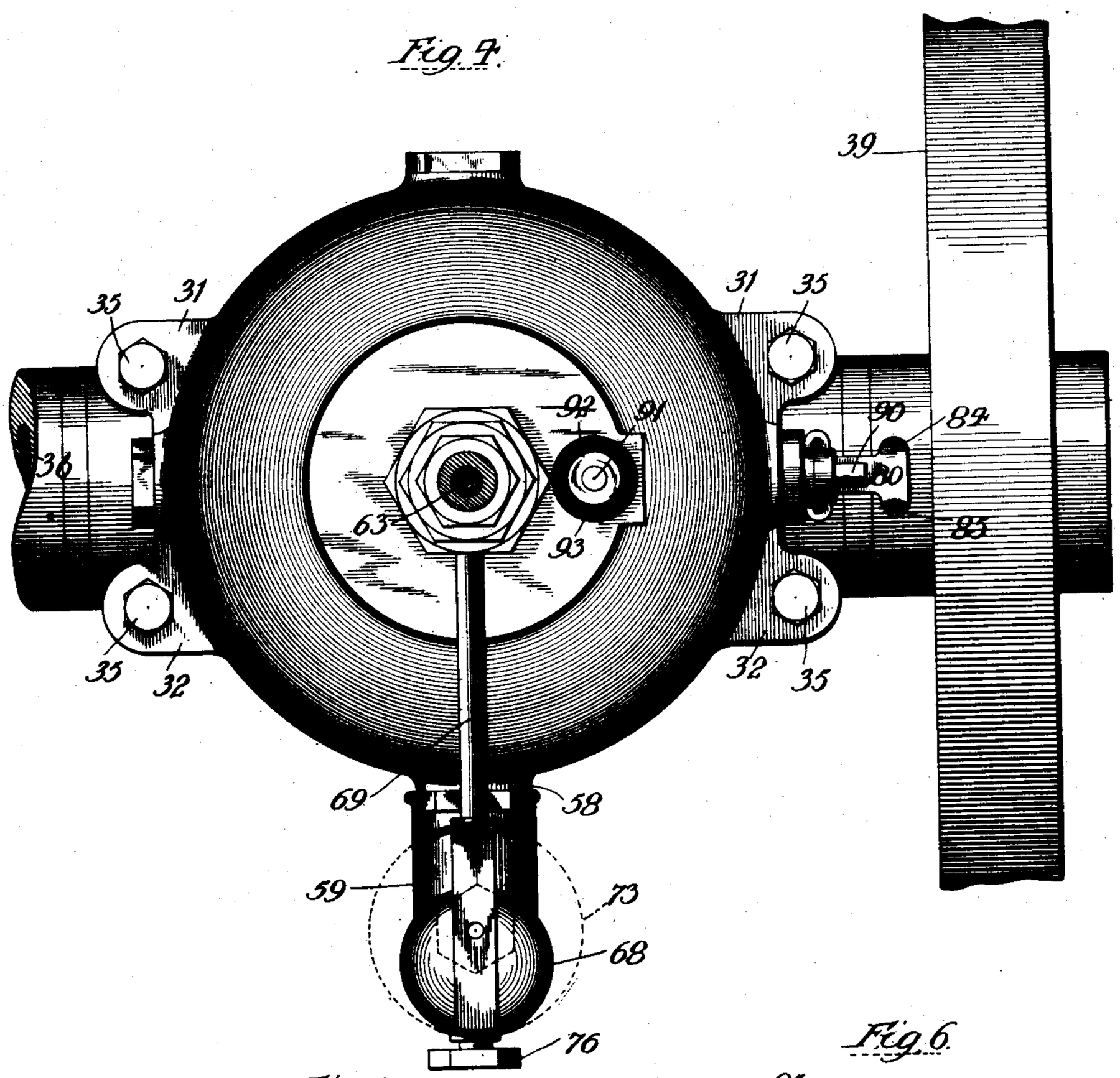



Fig. 5.

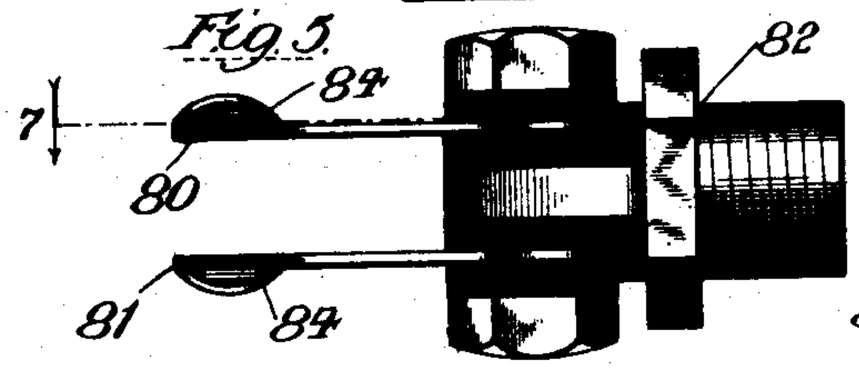



Fig. 6.

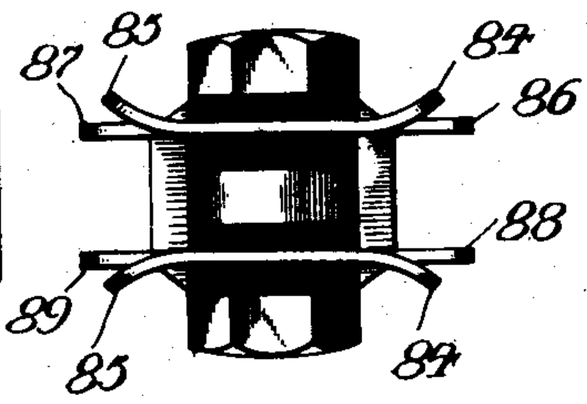
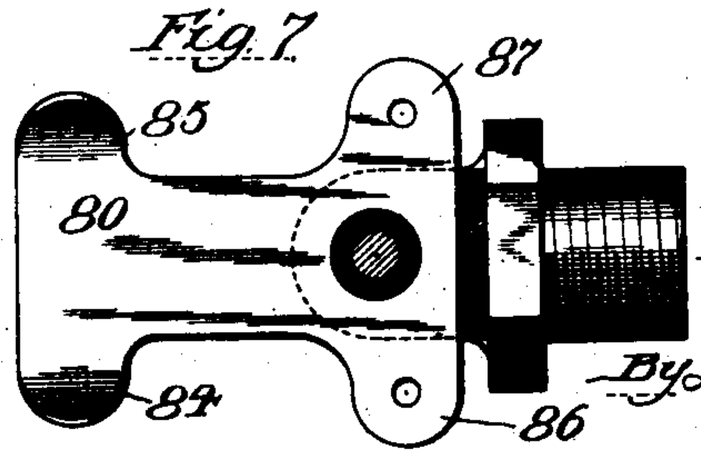



Fig. 7.

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## GAS ENGINE.

(Application filed Sept. 20, 1900.)

(No Model.) 6 Sheets—Sheet 5.

Fig. 8.

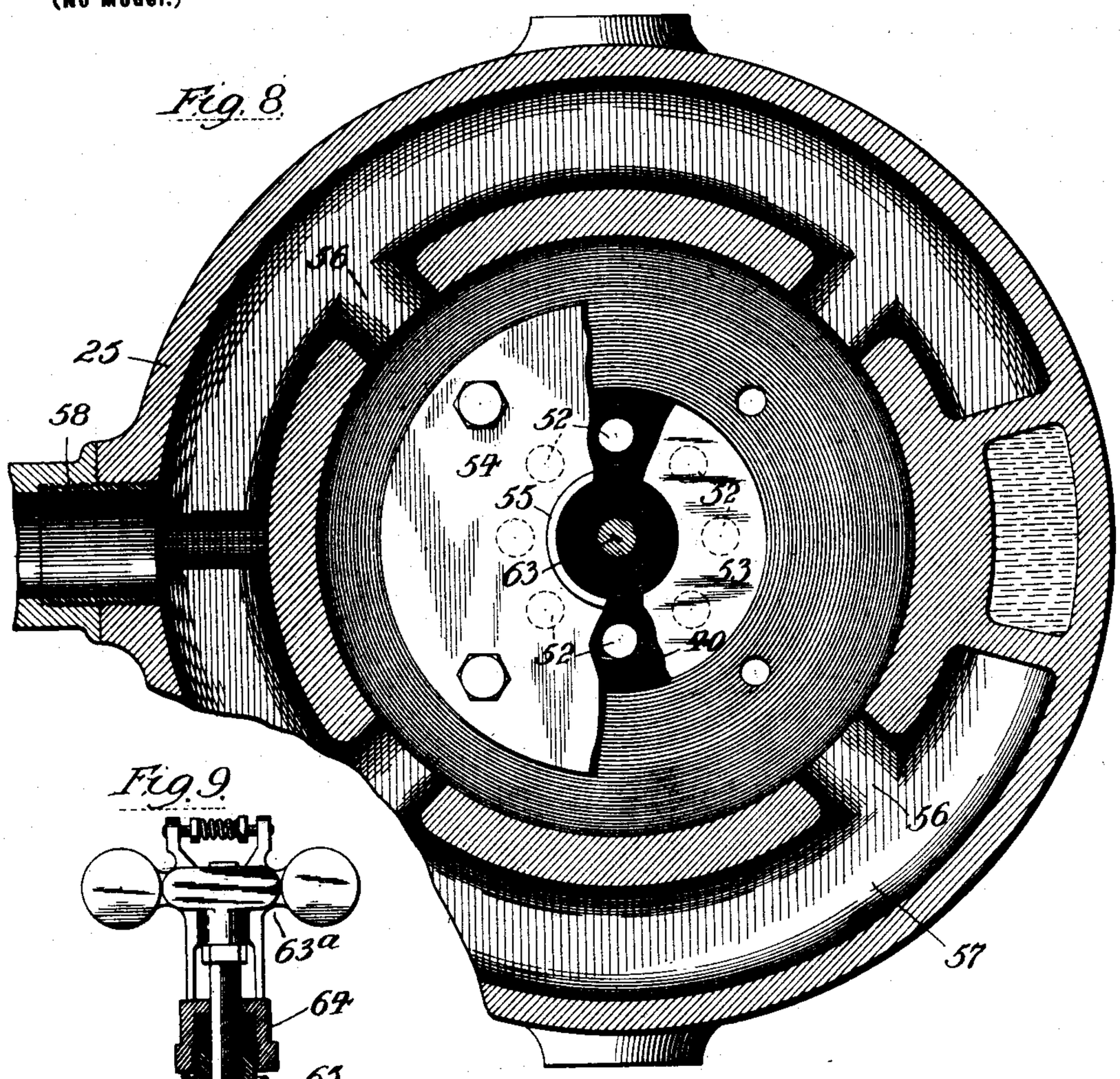



Fig. 9.

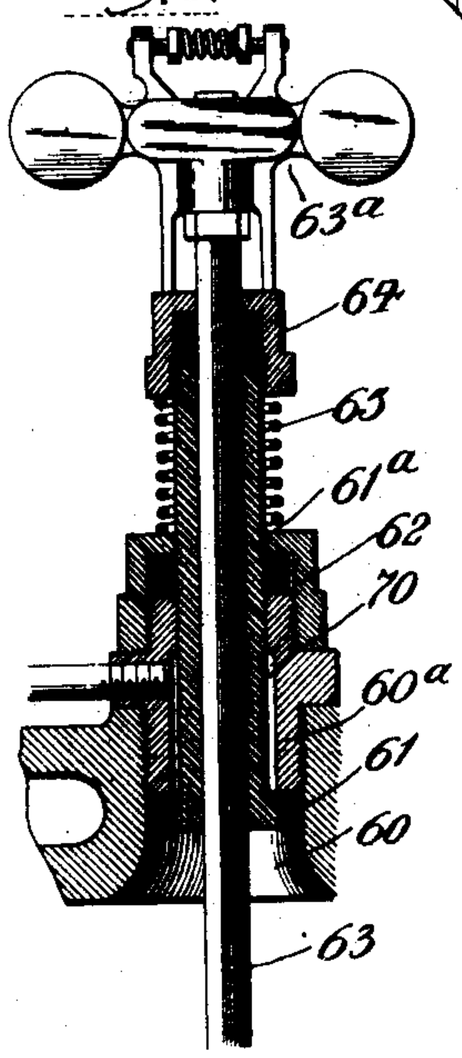
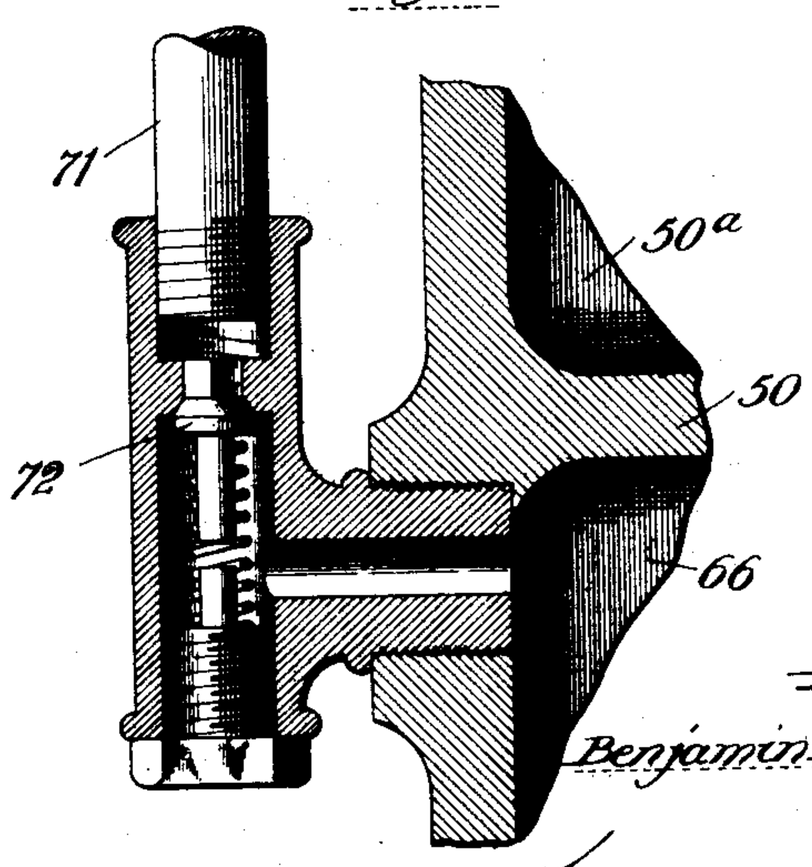



Fig. 10.

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No. 683,080. Patented Sept. 24, 1901.

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## GAS ENGINE.

(Application filed Sept. 20, 1900.)

(No Model.) 6 Sheets—Sheet 6.

Fig. 11.

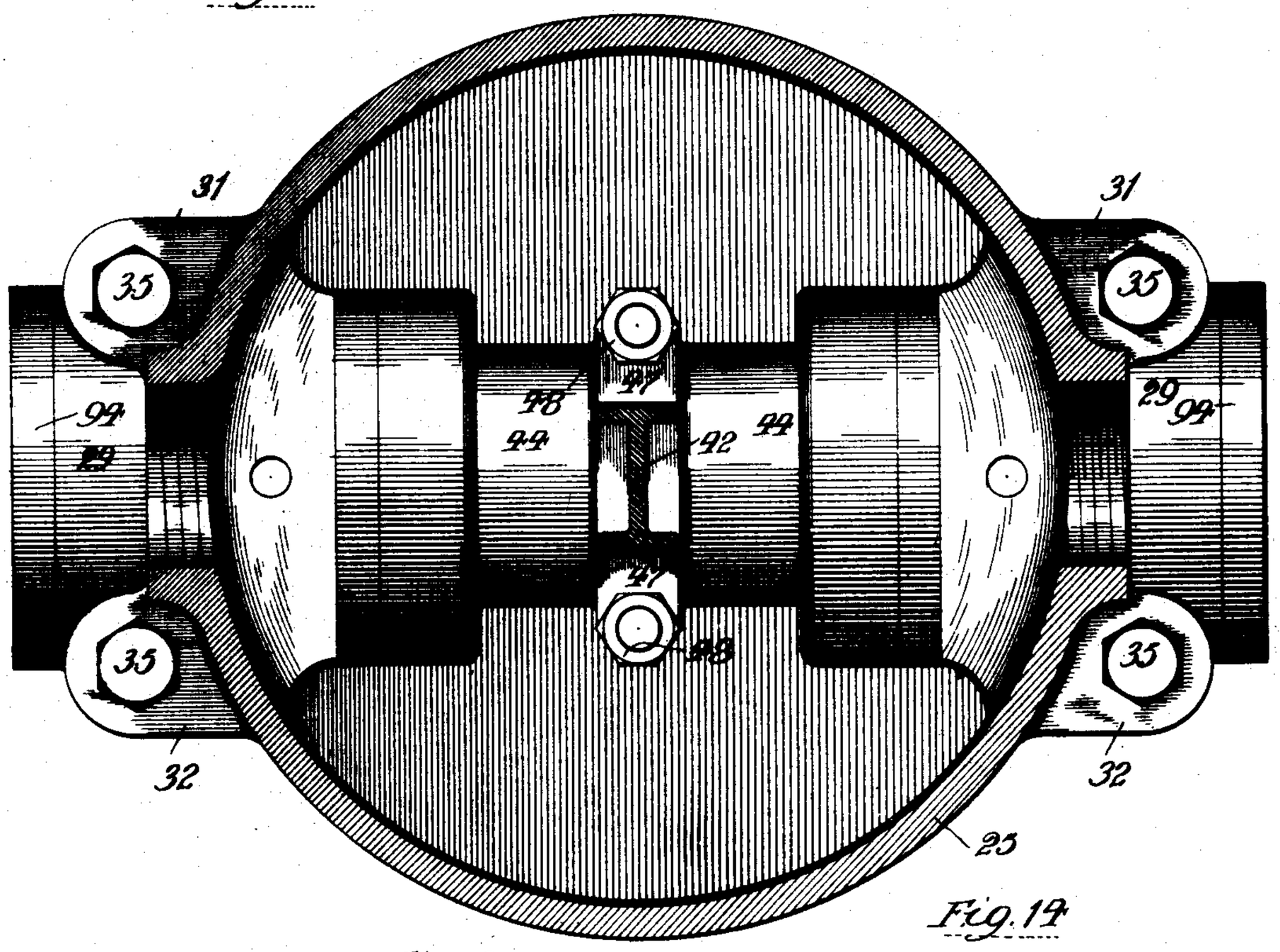



Fig. 14.

Fig. 12.

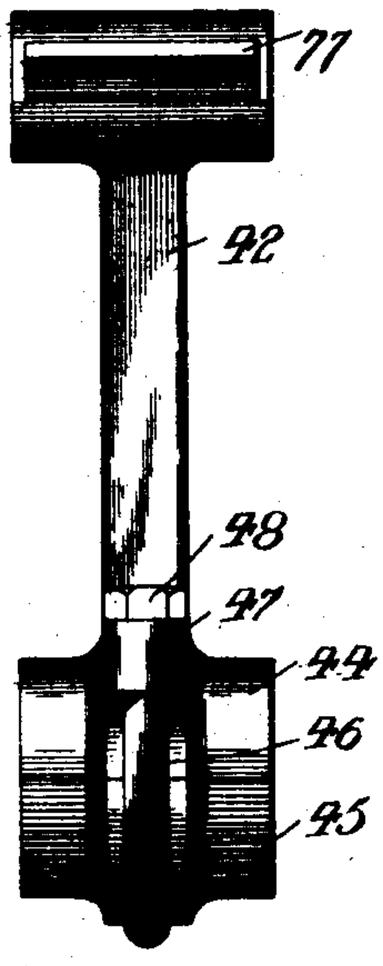
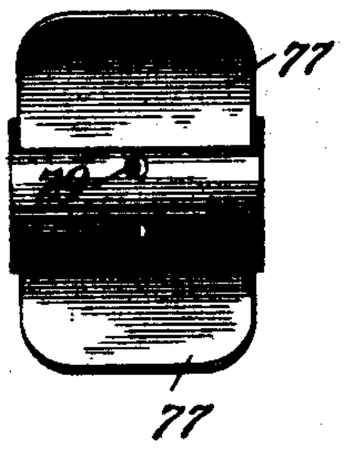



Fig. 13.



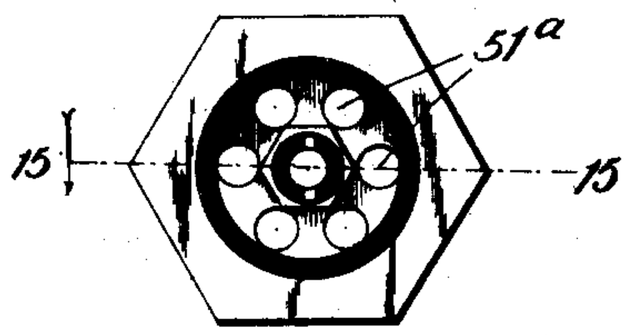
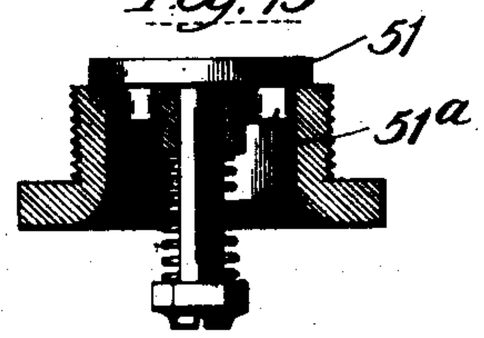




Fig. 15.

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# UNITED STATES PATENT OFFICE.

BENJAMIN F. STEWART, OF CHICAGO, ILLINOIS.

## GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 683,080, dated September 24, 1901.

Application filed September 20, 1900. Serial No. 30,537. (No model.)

*To all whom it may concern:*

Be it known that I, BENJAMIN F. STEWART, a citizen of the United States, and a resident of Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification and which are illustrated in the accompanying drawings, forming a part thereof.

This invention relates to that type of gas-engines in which power is generated by the explosion of a charge of gas and air, and more particularly to that type of reciprocating engines of this class which are known as "two-cycle" engines, in which an explosion occurs at each revolution of the shaft.

The objects of the invention are to simplify the construction and increase the efficiency of engines of this type; and the invention consists in the parts and arrangement of parts, as hereinafter fully described and as illustrated in the accompanying drawings, in which—

Figure 1 is an elevation of the engine. Fig. 2 is a vertical section on the line 2 2 of Fig. 1. Fig. 3 is a detail vertical central section in the plane of the crank-shaft. Fig. 4 is a detail plan section of the engine. Figs. 5, 6, and 7 are details of the circuit-breaker of the electric igniter, Fig. 7 being taken on the line 7 7 of Fig. 5. Fig. 8 is a sectional view on the line 8 8 of Fig. 3, some of the parts being broken away. Fig. 9 is a detail of the induction-valve. Fig. 10 is a sectional detail of one of the parts of the engine. Fig. 11 is a transverse section on the line 11 11 of Fig. 3. Figs. 12 and 13 are details of the pitman; and Figs. 14 and 15 are details of the air-induction valve, Fig. 15 being taken on the line 15 15 of Fig. 14.

The engine is shown as being vertical in form, and its trunk comprises a cylinder 25 and a base 26, the former superimposed upon the latter, the two being joined in the plane of the center of the crank-shaft. The base 26 flares or spreads at the bottom, as shown at 27, and rests upon a floor-plate 28, to which it is securely bolted. The journal-boxes for the crank-shaft comprise the two parts 29 and 30, the former being cast integrally with the cylinder 25 and the latter with the base 26. The upper members or caps 29 of the journal-boxes are provided with lugs 31 32, and the lower members 30 of these boxes are provided with corresponding lugs 33 34. These lugs provide means for not only securing the two members of the journal-boxes together by means of the bolts 35, but also for binding together the two members 25 and 26 of the trunk. The crank-shaft is shown at 36 and its wrist-pin at 37. A pair of fly-wheels 38 and 39 are shown as being mounted upon the two ends of the crank-shaft. The piston is shown at 40 and is of the trunk type and is connected with the crank-shaft by means of a pitman 42. The pitman is pivotally secured within the body of the piston by means of a pin 43 and is secured to the crank-shaft by means of boxing, consisting of the member 44, cast integrally with the pitman, and a cap 45, completing the circle of the wrist-pin 37 and secured by means of a U-strap 46, the ends of which pass through lugs 47 on the pitman and to which are applied the nuts 48. The walls of the upper part of the cylinder—that is to say, of the cylinder proper—are chambered, as shown at 49, so as to constitute the usual water-jacket. An imperforate septum or partition 50 is formed across the base 26, near its top, thereby, with the upper portion of the side walls of the base 26 and the lower portion of the side walls of the cylinder 25, inclosing a commodious chamber $50^a$, within which the crank turns and within which air is compressed by the outstroke of the piston, as hereinafter more fully described. The side walls of this chamber are provided with inwardly-opening spring-closed valves 51, covering air-ports $51^a$, so that at the instroke of the piston air is drawn into the compression-chamber. The head of the piston 40 is perforated, as shown at 52, so as to permit air compressed below the piston to pass upwardly into the cylinder or combustion-chamber. The ports 52 are annularly arranged and are covered by an annular valve 53, which fits loosely within a recess in the face of the piston, so that it may freely move transversely to its plane. The recess within which the valve 53 is housed is covered by an annular plate 54, secured to the face of the piston by suitable screws and having around its aperture an upstanding flange 55. A plurality of eduction or exhaust ports 56 open through the side walls of the

cylinder and are so located as to be uncovered during the last portion of the outstroke of the piston. These ports 56 lead to a duct 57, formed in the wall of the cylinder 25 and almost encircling it, and a port 58 leads from this duct to the exhaust-pipe 59. The induction-port 60 is through the head of the cylinder and central with reference thereto. Within this port there is fitted a valve-casing $60^a$, the inner end of which forms the seat for a valve 61, having an outwardly-projecting stem $61^a$, which passes through a stuffing-box 62, applied to the outer end of the casing $60^a$. The valve-stem $61^a$ is tubular, and the governor-rod 63, which is fixed in the piston, passes therethrough, a suitable stuffing-box 64 being provided at the outer end of the valve-stem. The governor $63^a$, applied to the outer end of the rod 63, may be of any form of that type which is controlled by the inertia of a weighted lever. The governor herein shown is not fully described, for the reason that it forms the subject of a concurrently-pending application. A spiral spring 65, wound about the outer end of the valve-stem $61^a$, reacts between the cap of the stuffing-box 62 and the cap of the stuffing-box 64 to hold the valve 61 normally closed. The supply of fuel is contained within a commodious chamber 66 in the base 26 of the engine. From the chamber 66 there rises a pipe 67, passing through a portion of the exhaust-pipe 59, so that a liquid-hydrocarbon fuel may be used, and as it rises in this pipe will be vaporized by the heat derived from the exhaust, and the vapor thus generated will accumulate in the reservoir 68 at the top of the pipe 67 and pass from thence through a tube 69 to an annular chamber 70, around the valve-stem $61^a$, and within the casing $60^a$, entering the explosion-chamber of the engine from this chamber as the valve 61 is unseated. A duct 71 leads from the upper portion of the pressure-chamber $50^a$ to the chamber 66, being provided with a suitable check-valve 72, so that there is at all times a sufficient pressure within the chamber 66 to cause the fuel to rise in the pipe 67. A closed cup 73 is provided at the upper end of the gas-reservoir 68, within which a small supply of fuel may be placed for use in starting the engine. A port $73^a$ leads through the bottom of the cup 73, and a needle-valve 74 is provided for controlling the entry of the fuel from this cup into the pipe 69. The needle-valve is formed at the end of the valve 75, controlled by a handpiece 76, which cuts off communication between the gas-reservoir 68 and the tube 69. The lubricant for the engine is placed within the chamber $50^a$, so that the crank of the engine will dip into it and thoroughly agitate it. At the upper end of the pitman 42 there are placed a pair of deflecting-wings 77, which serve the double purpose of preventing the lubricant from being splashed up into the ports 52 and of guiding the air-currents to the walls of the piston for cooling purposes. Ports 78 are formed within the piston-walls to permit the lubricant to pass to the cylinder-walls, and ports 79 in the end of the pitman provide for the lubrication of its bearing upon the pin 43, sufficient lubricant finding its way past the guide-wings 77 to accomplish this purpose. An electric igniting device is shown and comprises a pair of contact-plates 80 81, rigidly secured in parallel planes to but insulated, as shown, from a plug 82, adapted to be screwed into the outer wall of the cylinder 25. A wiping-pin 83, fixed in one of the balance-wheels, as 39, passes between the contact-plates 80 81 and closes the circuit between them. To facilitate this action, each of the plates is provided with lateral backwardly-turned guide-lugs, as shown at 84 85. At the base of each of the contact-plates there are laterally-projecting apertured lugs 86, 87, 88, and 89, whereby one plate may be connected by means of wires, as shown, with one of the poles of an electric generator and the other with one of the electrodes or sparking-points. The electrodes are shown at 90 and 91, and each consists of a carbon pencil incased within a suitable insulating-bushing 92, set within a tubular plug 93, passing through the walls of the cylinder 25, the two electrodes being so disposed that their points are sufficiently close to each other so that when the electric circuit is closed by the contact of the brush-pin 83 with the contact-plates a spark will pass from one to the other.

The operation of the engine is as follows: A suitable electric generator having been connected with one of the contact-plates 80 81, the lubricant having been placed within the chamber $50^a$ a supply of liquid hydrocarbon in the chamber 66, and the cup 73 having been supplied with similar hydrocarbon, the needle-valve 74 is retracted, allowing a small quantity of the fuel in the cup to find its way into the chamber 70, and the crank-shaft having been rotated, by hand or other means, a single turn the valve 61 is opened by the contact of the governing device with the outer end of its stem, allowing the fuel to enter the combustion-chamber, and there is at the same time an inward rush of air from the chamber $50^a$ through the piston-ports and against the valve 61, vaporizing a sufficient quantity of the fuel to provide an explosive mixture, and as the piston reaches the end of its instroke a spark crosses from one electrode to the other, causing an explosion, which is sufficiently strong to cause a complete stroke of the piston and set the engine in motion. By the time the liquid has been exhausted from the cup 73 the vaporization of the fuel within the pipe 67 will be sufficiently rapid to provide for the continuous operation of the engine. At each instroke of the piston air is drawn into the chamber $50^a$ through the ports $51^a$, and at each outstroke the air in this chamber is somewhat compressed, and by means of the passage 71

an equal pressure is maintained within the chamber 66, insuring the presence of liquid hydrocarbon in that section of the tube 67 which is inclosed within the exhaust-pipe 59. As the piston approaches the end of its outstroke the exhaust-ports 56 are uncovered, allowing the escape of the gases within the combustion-chamber and reducing the pressure therein sufficiently so that the compressed air within the chamber $50^a$ will raise the valve 53 and pass into the combustion-chamber with great velocity. The upstanding flange 55 of the plate 54 directs this current of air upwardly toward the induction-port, which is opened as the piston reaches the end of its outstroke. The inrushing air expels the residue of the burned gases, so that by the time the piston has advanced on its instroke so as to cover the ports 56 there remains within the combustion-chamber only the new charge of air and hydrocarbon vapor, and by reason of the direction taken by the air-current as it enters this chamber these two have become thoroughly intermixed. As the piston continnes to advance on its instroke the contents of the combustion-chamber are compressed, and both the valve 53 and the valve 61 are thereby seated, the spring 65 coöperating to close the induction-port. The brush 83 is so located upon the wheel 38 that the electric circuit is closed at the end of the instroke of the piston, and an explosion is thereby caused, and the engine commences a new cycle. The deflecting-wings 77 upon the pitman cause the air as it passes from the chamber $50^a$ to the combustion-chamber to sweep the walls of the piston, thereby sufficiently cooling the latter, so that there is no tendency to premature explosions. By the use of fixed electrodes the spark may be developed close to the cylinder-walls, and as the electrodes project but a short distance beyond these walls they are sufficiently cooled by the water within the jacket. I prefer to use round carbons and to point them, so that if they become incrusted they may be easily pushed inwardly until their beveled faces come into contact and then being rotated will abrade and clean each other. Leakage about the crank-shaft is guarded against by the use of linings 94 for the journal-boxes in spool form, which not only are so constructed as to fit snugly within the boxes and around the crank-shaft, but the inner ends of which form bearings for the radial faces of the crank. The pressure developed within the chamber $50^a$ is not such as to render it necessary to provide a stuffing-box, and the construction described not only enables me to obtain close-fitting joints without an excess of friction, but the joints, which might form a passage for the escape of air, are very long, and the presence of the lubricant within the chamber provides a packing for them.

I have not deemed it necessary to show water connections for the cooling-jacket, as this feature of the engine is the same as is almost universally practiced.

If desired, a cup 95 may be located at the lower end of the pipe 67, within which there may be placed a combustible fluid which upon being ignited will heat the tube and vaporize some of the fuel for service in starting the engine.

The diameter of the piston exceeds the length of its stroke. As a result a great area of piston-face is exposed to the pressure developed within the cylinder, while the area of cylinder-wall surface exposed to the heat of the burning vapors is correspondingly reduced.

I claim as my invention—

1. In a reciprocating gas-engine, in combination, a trunk having at one end a power-cylinder, at its opposite end a fuel-reservoir and an intermediate compression-chamber, a piston adapted to reciprocate within the cylinder, having a passage connecting the compression-chamber with the cylinder, a valve for the passage, a plate for retaining the valve in place having a tubular extension, a valve-governed induction-port arranged axially with the tubular extension, a valve-closed passage connecting the compression-chamber with the reservoir, and a connection between the reservoir and the cylinder.

2. In a reciprocating gas-engine, in combination, a trunk having at one end a power-cylinder, at its opposite end a fuel-reservoir and an intermediate compression-chamber, a piston adapted to reciprocate within the cylinder, a valve-closed passage connecting the compression-chamber with the reservoir, an exhaust-tube, an oil-pipe leading from the reservoir through the exhaust-tube, and a vapor-reservoir communicating with the oil-pipe and the cylinder.

3. In a gas-engine, in combination, a cylinder having a valve-closed fuel-induction port, a compression-chamber inclosing the engine-crank and having an induction-port, a piston reciprocating in the cylinder and having a passage opening from the compression-chamber to the cylinder, a valve carried by the piston, and a tube arranged axially to the fuel-induction port forming a continuation of the said passage.

4. In a gas-engine, a cylinder having an induction-port in its head, a compression-chamber inclosing the engine-crank and having an induction-port, a piston reciprocating in the cylinder and having a check-valve-closed passage opening from the compression-chamber to the cylinder, and a plate secured to the piston for retaining the check-valve in place and having a tubular flange forming a continuation of such passage for directing air-currents passing therethrough against the head of the cylinder.

5. In a gas-engine, in combination, a cylinder having a valve-closed fuel-induction port, a compression-chamber inclosing the engine-

crank and having an induction-port, a piston reciprocating in the cylinder and having a passage opening from the compression-chamber to the cylinder, a valve carried by the piston, and a plate secured to the piston for retaining the valve in place and having a tubular flange arranged axially to the fuel-induction port and forming a continuation of the said passage.

6. In a gas-engine, a cylinder, a compression-chamber inclosing the engine-crank and having an induction-port, a piston reciprocating in the cylinder and having a check-valve-closed passage opening from the compression-chamber to the cylinder, a pitman pivotally secured to the piston within its body, and lateral deflecting-wings near the piston end of the pitman.

7. In a gas-engine, in combination, a cylinder, a piston reciprocating therein, a compression-chamber at the end of the cylinder and having an induction-port, the piston having an annular series of ports through its head, an annular valve for covering such ports and opening toward the cylinder, and a retaining-plate for the valve having a tubular flange forming a continuation of the passage.

8. In a gas-engine, in combination, a cylinder having a fuel-induction port in its head, an inwardly-opening valve for such port having a tubular stem, a reciprocating piston, a rod fixed to the piston and extending through the valve-stem and being provided with means for engaging such stem to open the valve as the piston approaches the limit of its outstroke.

9. In a gas-engine, in combination, a cylinder having a fuel-induction port in its head, an inwardly-opening valve for such port having a tubular stem, a stuffing-box fitted to such stem, a reciprocating piston, a rod fixed to the piston and extending through the valve-stem and being provided with means for engaging such stem to open the valve as the piston approaches the limit of its outstroke.

10. In a gas-engine, in combination, a cylinder, a tubular valve-casing set through the head thereof and having a lateral induction-port and constituting the induction-port of the cylinder, a stuffing-box applied to the outer end of such casing, an inwardly-opening valve applied to the inner end of the casing and having a tubular stem passing through the stuffing-box, a stuffing-box at the outer end of the valve-stem, a reciprocating piston, a rod fixed thereto and passing through the valve-stem, and means at the outer end of the rod for bearing upon the outer end of the stem to unseat the valve.

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