No. 888,374. PATENTED MAY 19, 1908.

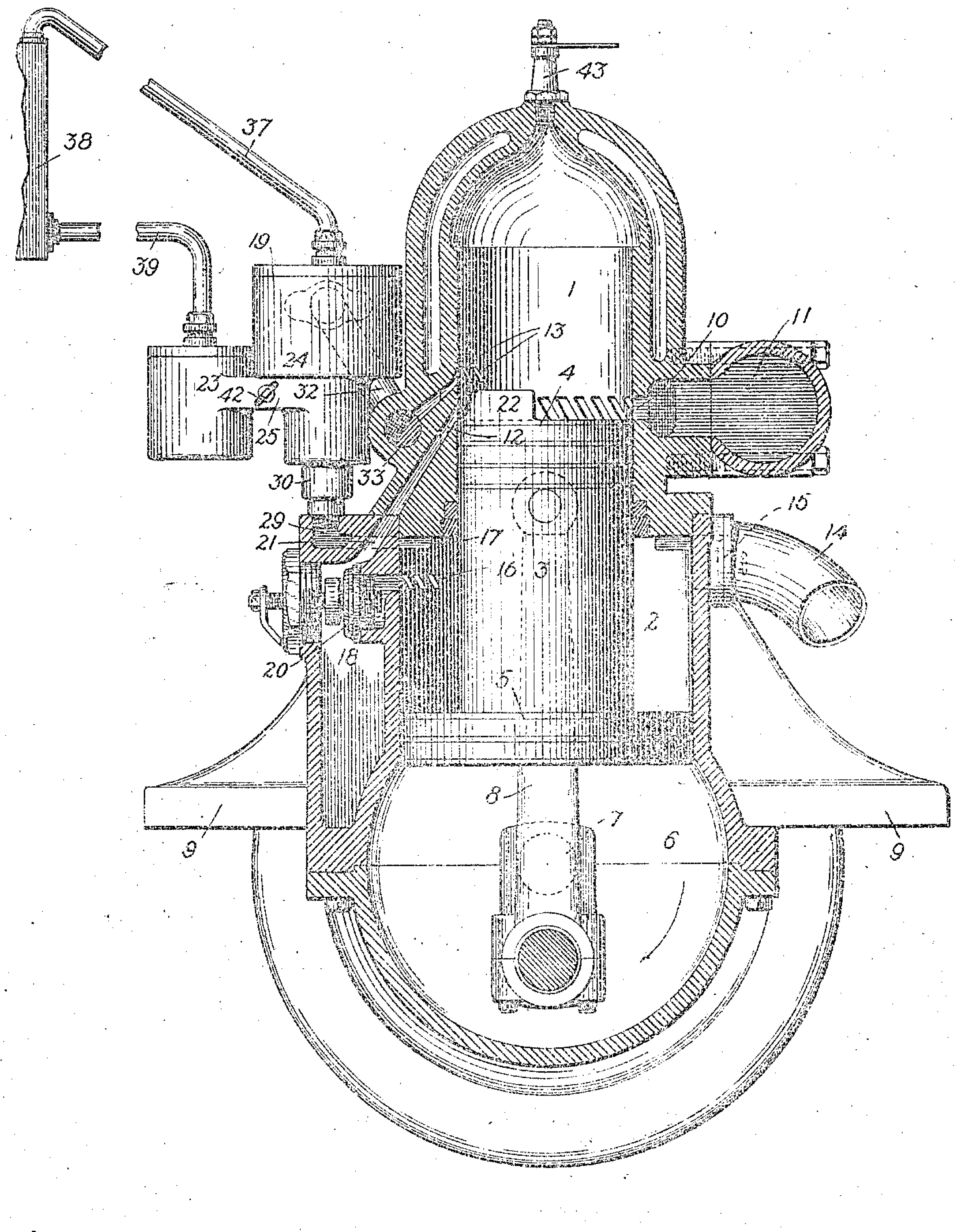
H. O. WESTENDARP.

EXPLOSIVE ENGINE.

APPLICATION FILED APR. 14, 1905.

6 SHEETS—SHEET 1.

Fig. 1.



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6 SHEETS—SHEET 2.

Fig-2-

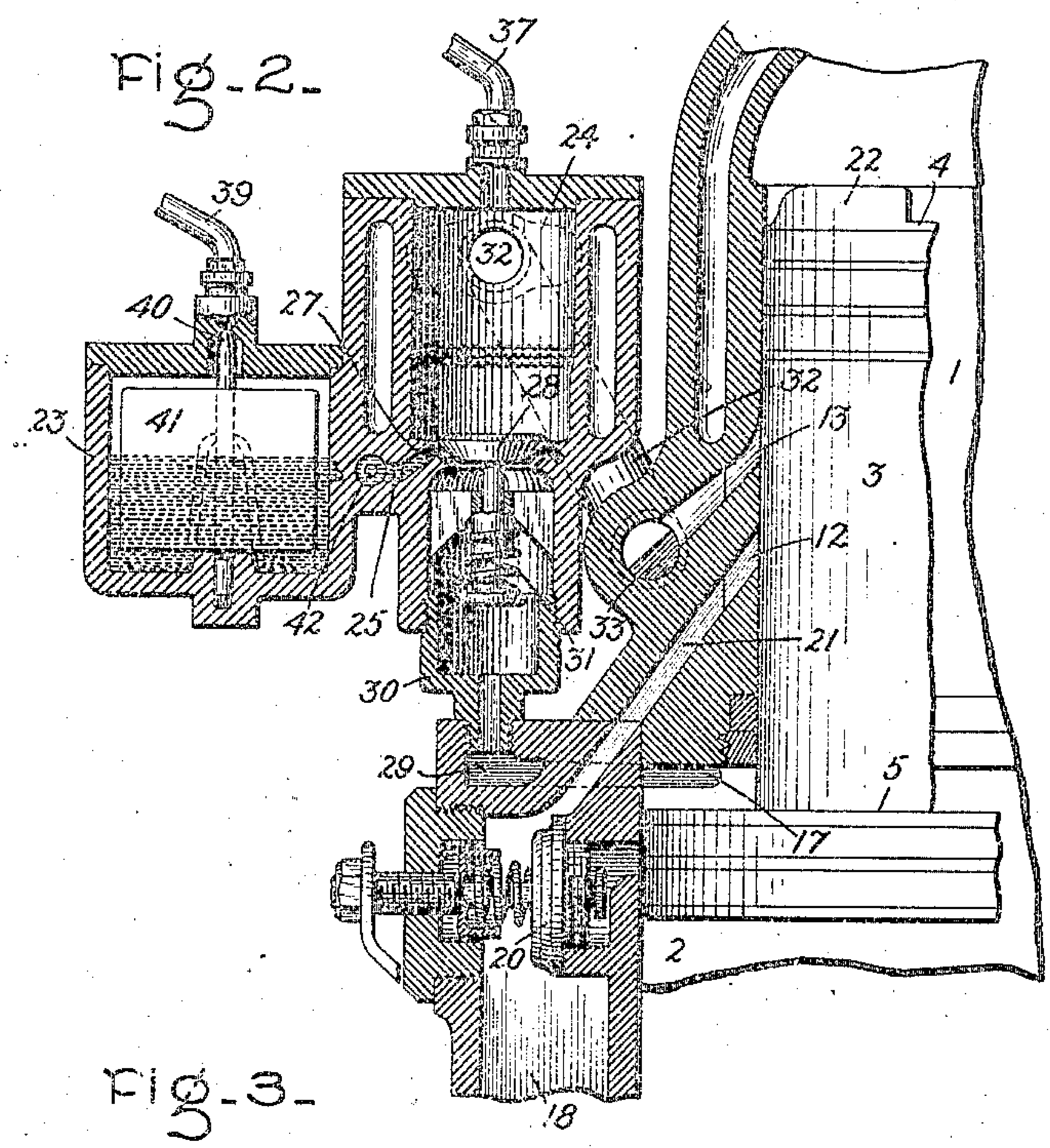
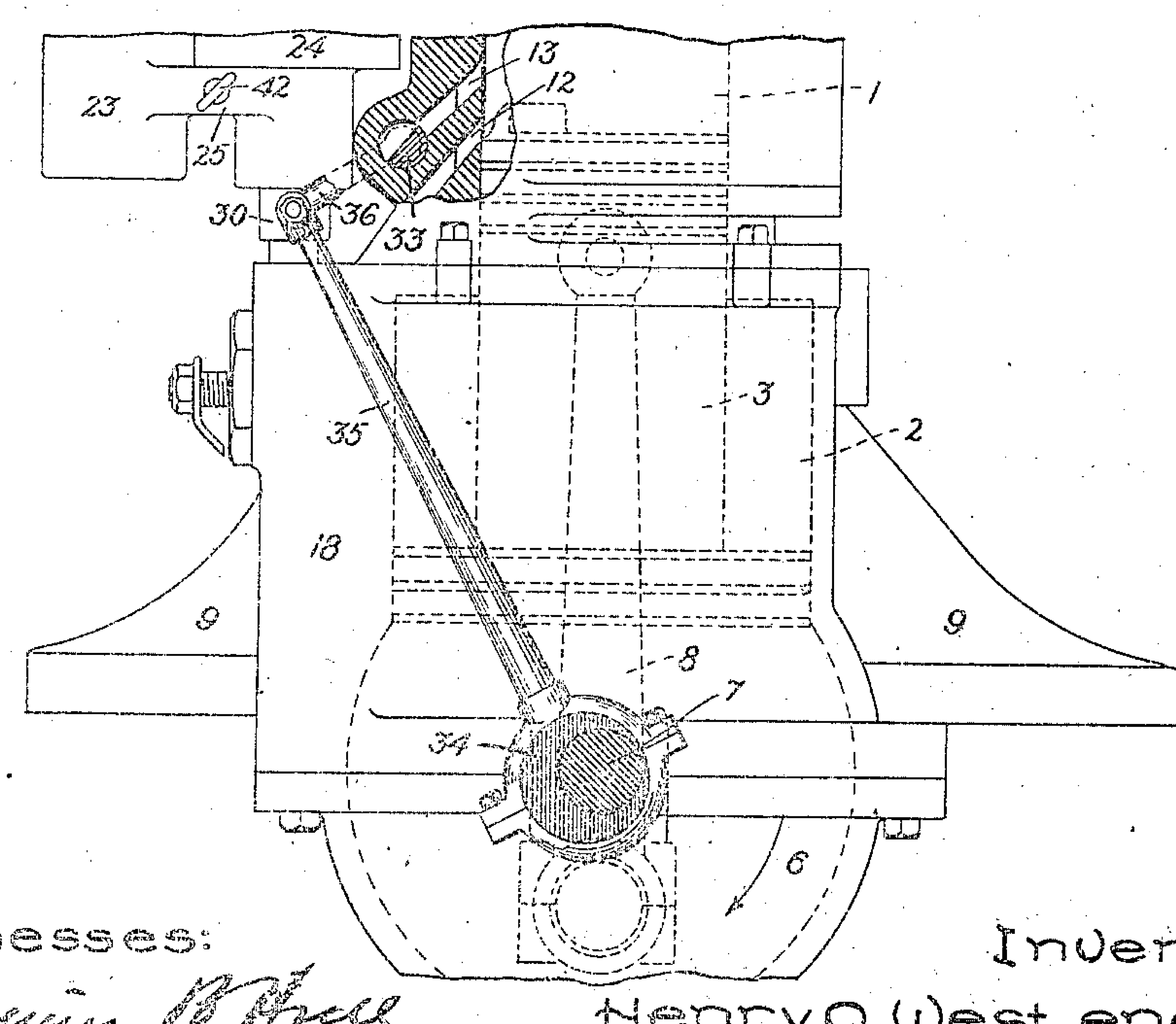


Fig-3-



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6 SHEETS—SHEET 3.

Fig. 5.

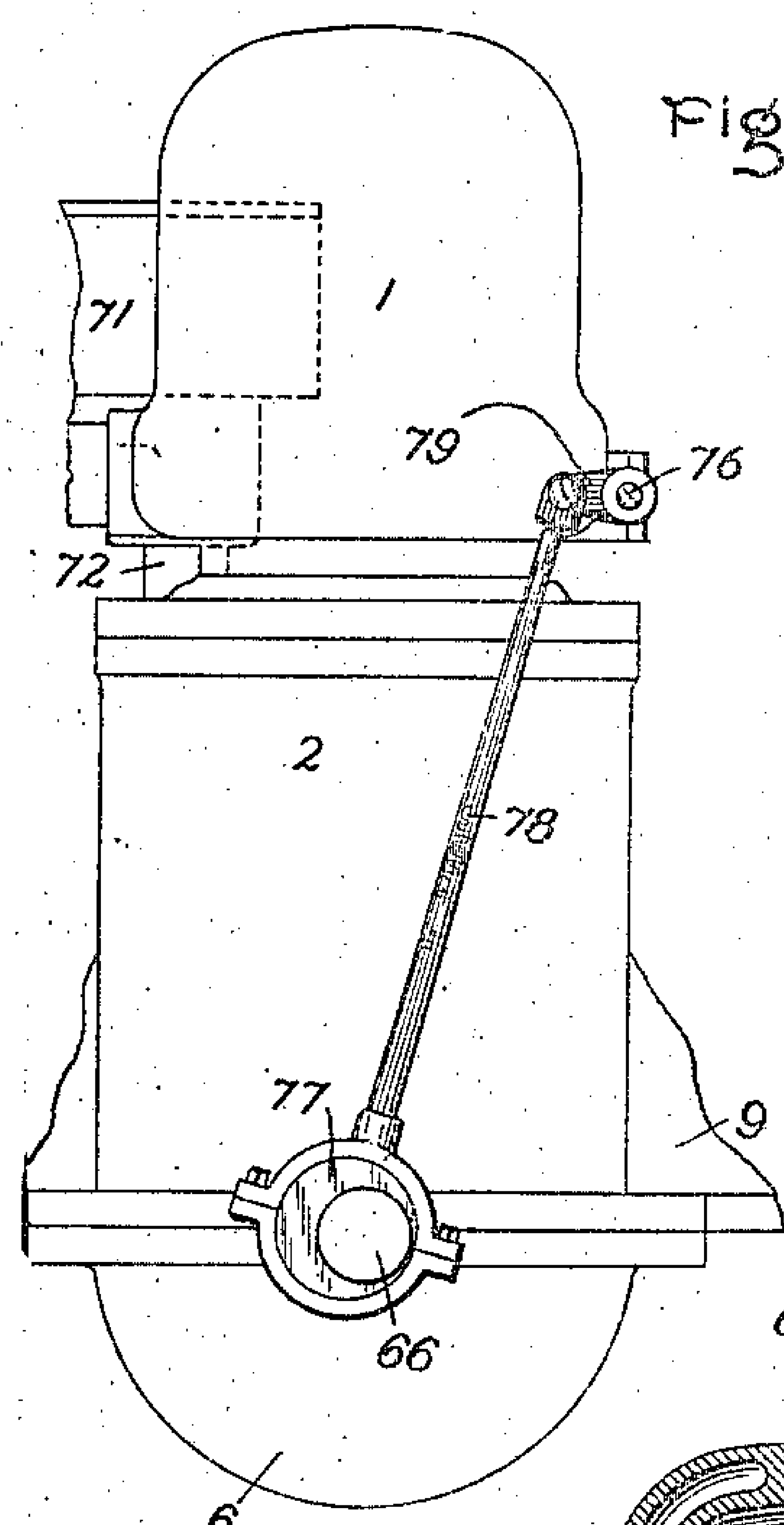


Fig. 6.

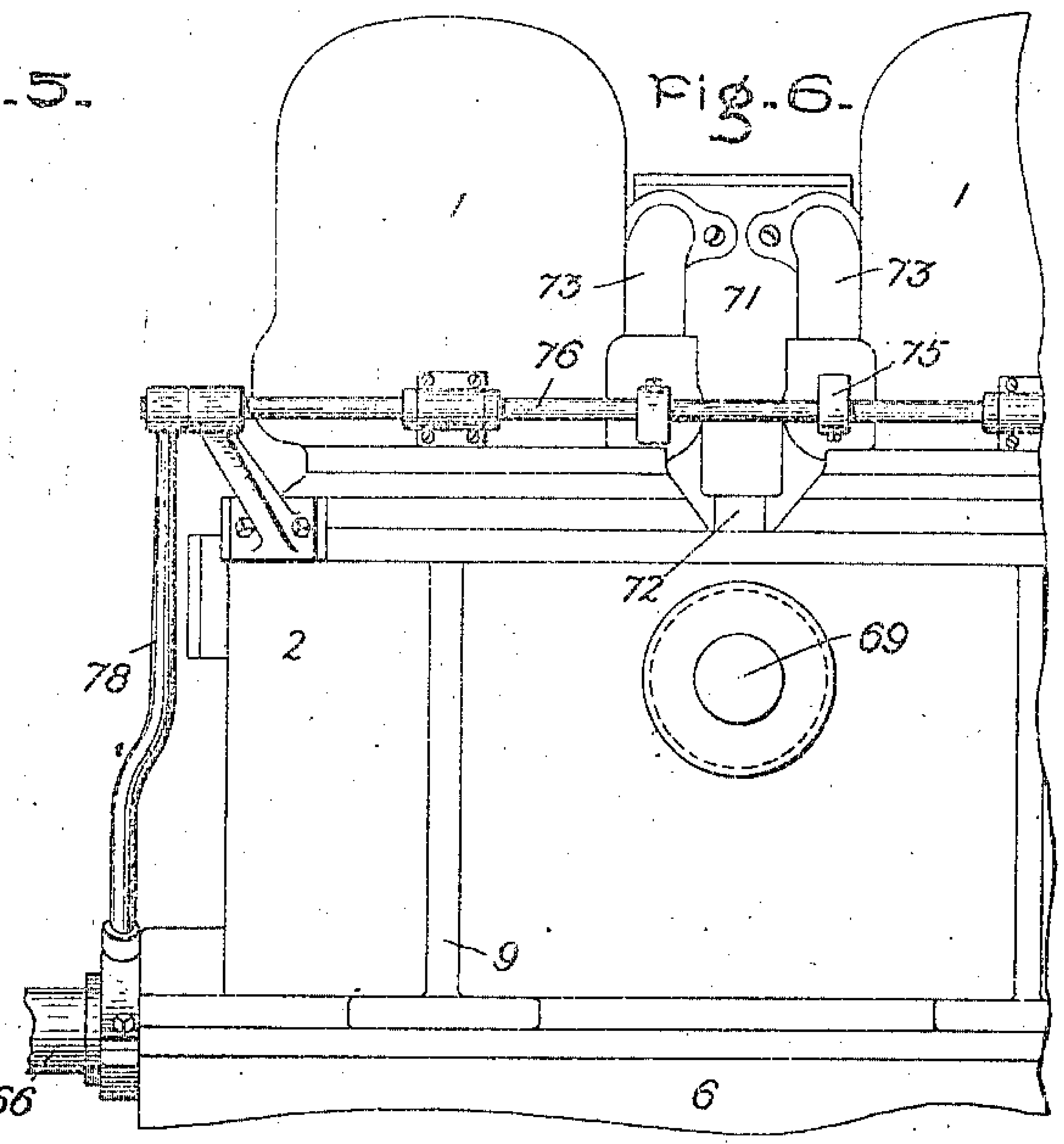
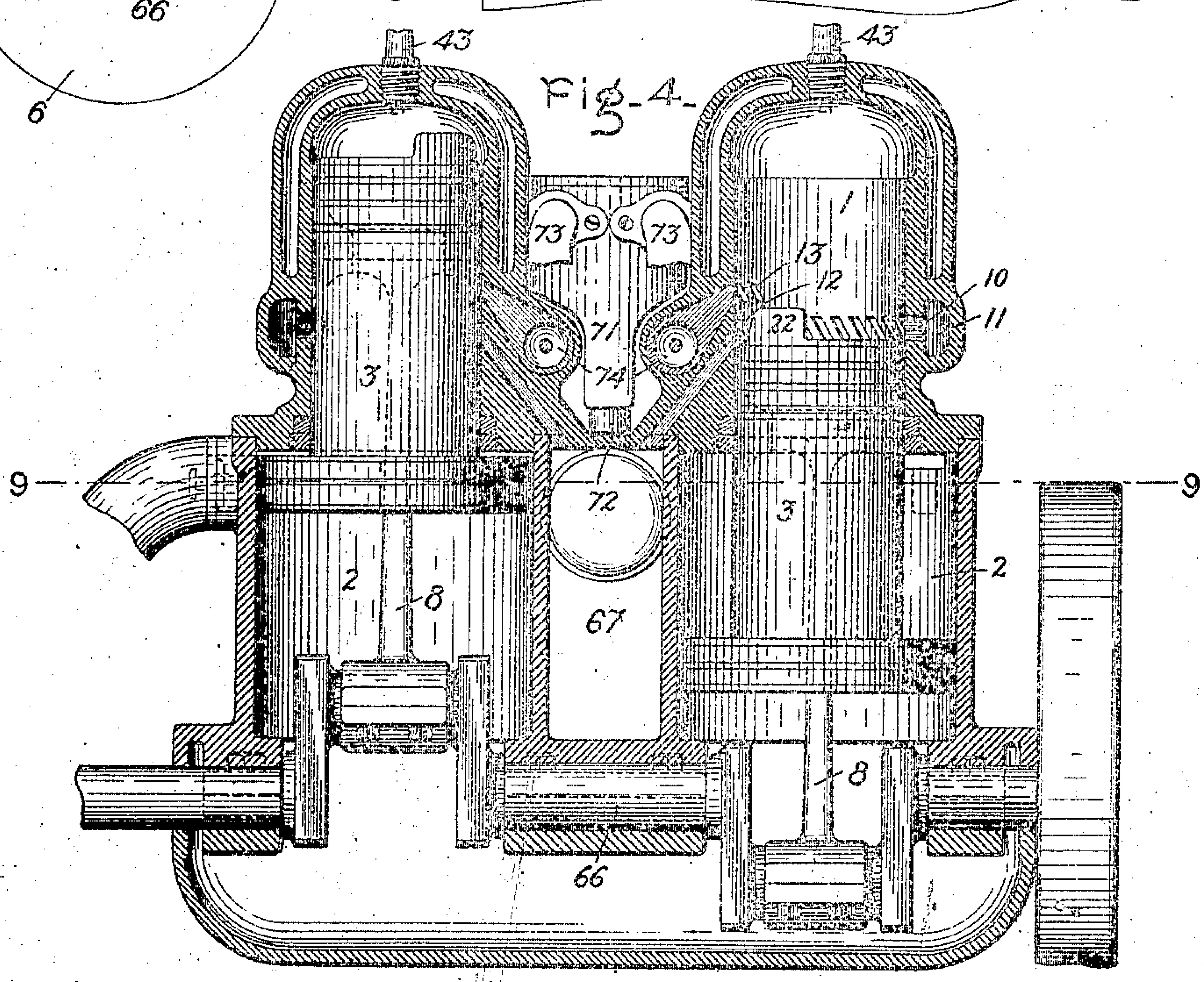


Fig. 4.



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6 SHEETS—SHEET 4.

Fig-7-

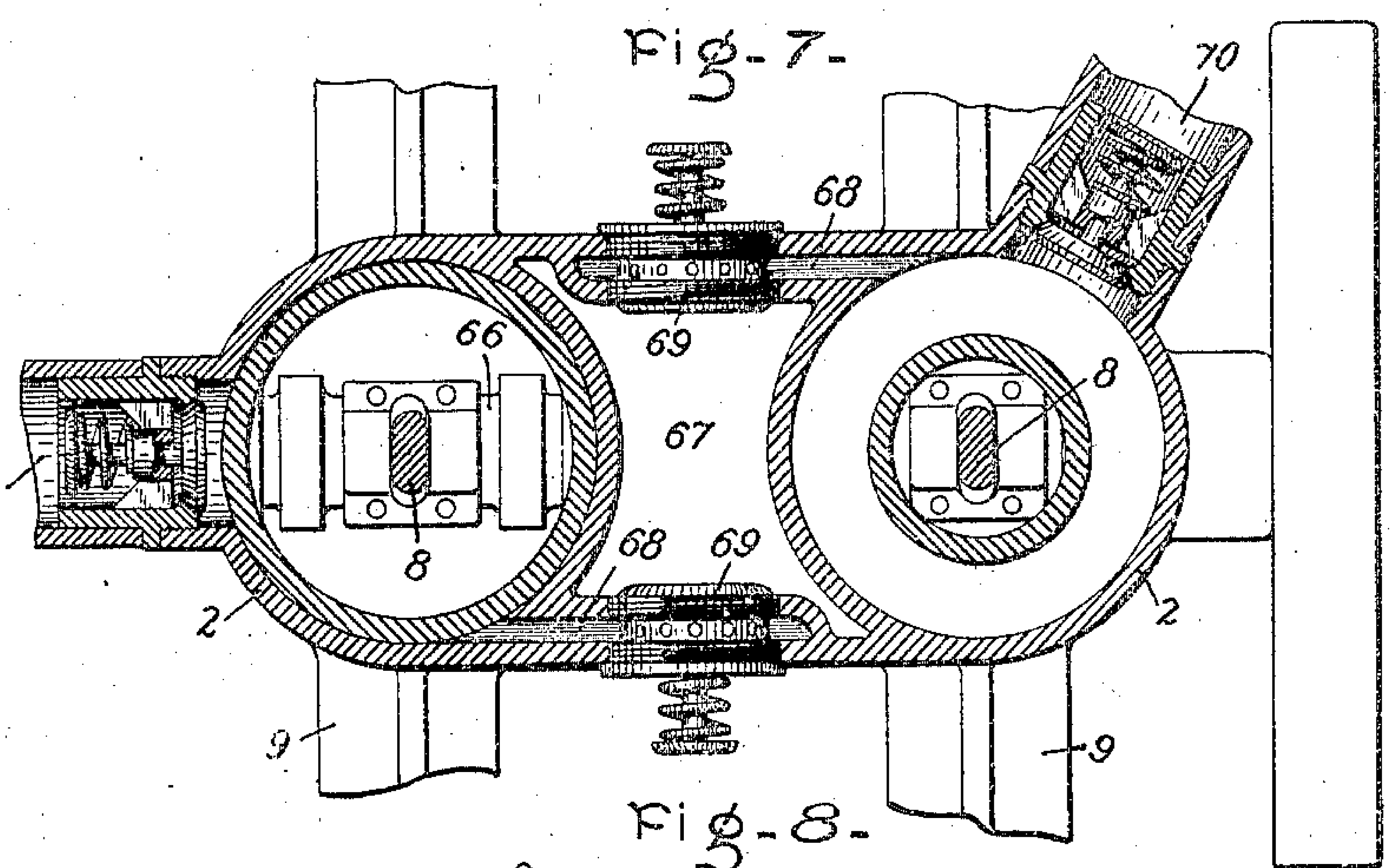
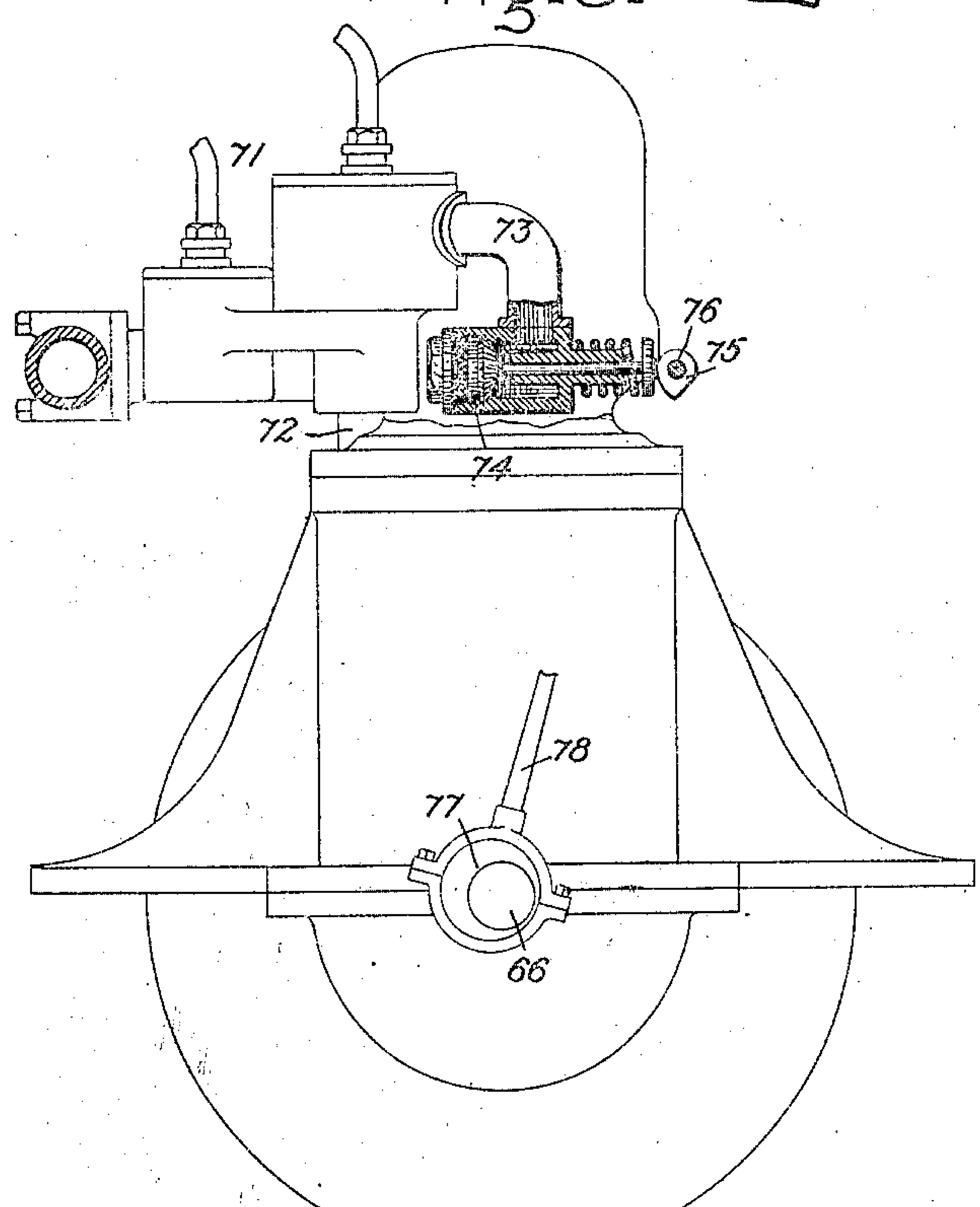


Fig-8-



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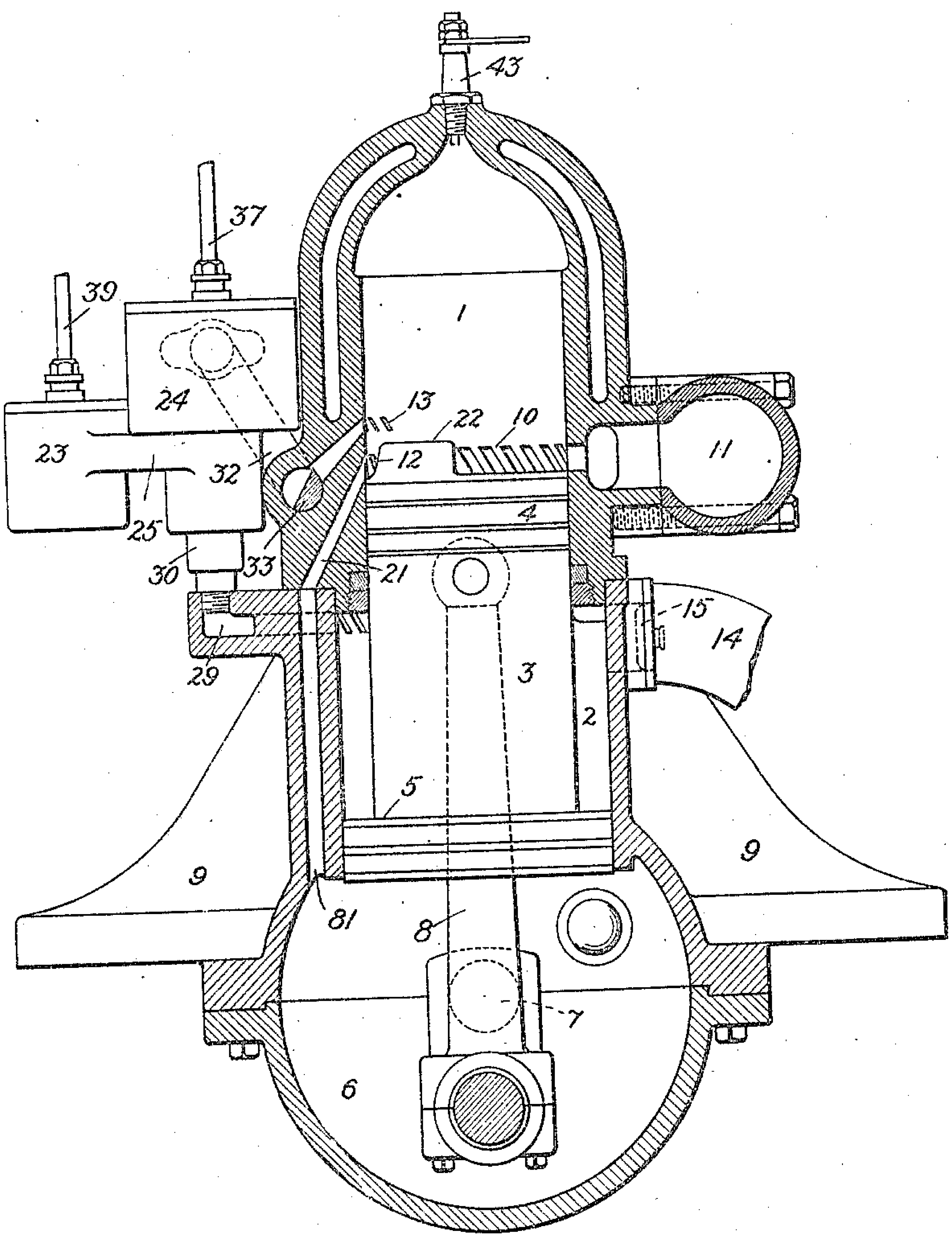
6 SHEETS—SHEET 5.

Fig. 9.



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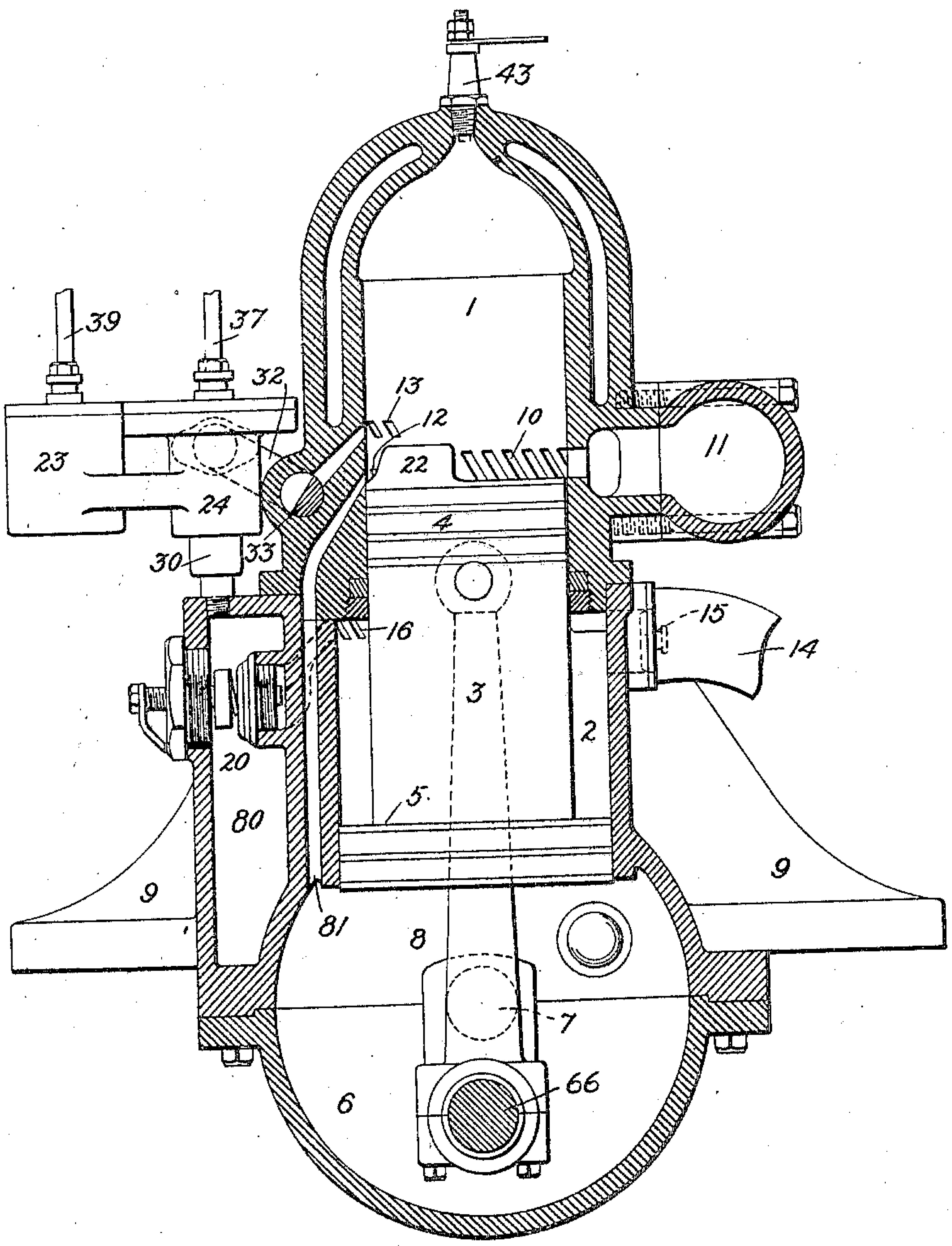
6 SHEETS—SHEET 6.

Fig. 10.



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UNITED STATES PATENT OFFICE.

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EXPLOSIVE-ENGINE.

No. 888,374. Specification of Letters Patent. Patented May 19, 1908.

Application filed April 14, 1905. Serial No. 255,510.

To all whom it may concern:

Be it known that I, HENRY O. WESTENDARP, a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Explosive-Engines, of which the following is a specification.

My invention relates to two-cycle explosive engines of that type in which the cylinder is scavenged at the end of the power stroke by a charge of air, and the fuel charge injected into the cylinder after the scavenging operation and closure of the exhaust ports.

It has for its object to provide simple and efficient means for scavenging the cylinder and supplying the fuel charges thereto.

In carrying out the invention, I employ a cylinder having suitable exhaust ports and separate fuel and air admission ports which are adapted to be closed and opened at suitable intervals with respect to the movements of the piston. The air for scavenging the cylinder may be derived from any suitable source, preferably an air-pump driven by the crank-shaft of the engine, and delivering to the air-admission ports. In order to supply the fuel with sufficient force to insure complete mixture with the residual air in the cylinder, it is injected at a pressure considerably above that of the air. One convenient method of doing this is to convey a charge of air at the desired pressure, or compression, through a suitable vaporizer, whereby the air picks up the required quantity of fuel to produce when mixed with the air in the cylinder a combustible mixture of the proper proportions. The fuel conveying air charges may be supplied by the scavenging pump or otherwise, and by means of a mechanically-actuated valve between the vaporizer and the fuel-admission ports, the fuel charges are injected at the proper period. The fuel is fed automatically, as by gravity, and for this purpose I employ a float feed carbureter. This is arranged so that the fuel-conveying air charge is passed through the same and thereby incorporates a quantity of fuel in passing. Between the vapor chamber of the carbureter or vaporizer and the fuel supply tank an equalizing conduit is provided so as to obviate differences of pressure between them which would cause irregularity in the feed of the fuel. When the lighter hydrocarbon fuels are used, such as gasolene, the fuel charges may be admitted to the explosion cylinder at ordinary temperature. In the case of the heavier fuels, such as kerosene or alcohol, the fuel with the conveying charge of air is preferably passed through a suitable heater before being injected into the explosion cylinder.

For a detail understanding of the invention, attention is directed to the following description, taken with the accompanying drawings, and to the claims appended thereto.

Referring to the drawings, which illustrate one embodiment of the invention, Figure 1 is a section of a single cylinder two cycle engine, with the carbureter and the fuel supply system applied thereto; Fig. 2 is a section of the carbureter and adjacent parts of the engine, showing the valve arrangements; Fig. 3 is a side elevation of the engine showing the actuating mechanism for the fuel-admission valve, portions of the engine being broken away; Fig. 4 is a central section of a two-cylinder engine embodying certain features of the invention; Figs. 5 and 6 are respectively a side and a front elevation of the two-cylinder engine, with portions broken away; Fig. 7 is a transverse section on line 9 9, Fig. 4; Fig. 8 is a side elevation, with one of the cylinders broken away to show the carbureter and the fuel-admission valve mechanism; and Figs. 9 and 10 are central sections of modified forms of the single cylinder engine.

I have elected to illustrate the invention in connection with a differential area piston and cylinder construction, in order to combine in a single structure the engine and air-pump. This arrangement, however, is not necessary to carry out the invention, as other constructions may be employed.

Referring to Figs. 1, 2 and 3, 1 represents the explosion cylinder, 2 the pump cylinder, and 3 the differential area piston working in the cylinders, which is of the trunk type and provided with heads 4 and 5 respectively in the cylinders 1 and 2. The pump cylinder 2 is shaped to form with the casing 6 a closed chamber for the crank-shaft 7. The shaft is mounted in suitable bearings and connected with the piston by a rod 8. Extending from the opposite sides of the pump cylinder are supporting brackets 9.

The explosion cylinder, which is shown of the water jacketed type, is provided at its forward end with three rows of ports, viz: exhaust ports 10 connected with an exhaust conduit 11, air-admission ports 12 and fuel-admission ports 13, which are covered and uncovered by the movement of the piston. The ports are arranged so that on the power-stroke the fuel-admission ports are first uncovered. These ports are controlled, however, so that fuel cannot be injected except at the proper period. The exhaust ports are next uncovered to permit the products of combustion to escape through the conduit 11 to the atmosphere. Slightly after the piston begins to uncover the exhaust the air-admission ports are uncovered to permit a scavenging charge of air to enter and drive out the products of combustion. This leaves the cylinder filled with substantially pure air into which the fuel charge is injected at the time the piston on its in-stroke has covered the exhaust ports.

The pump is arranged to supply the air for scavenging the cylinder and for conveying the fuel charges thereto. For this purpose the displacement of the piston is so proportioned as to provide air at the required pressure and quantity. The air charge is drawn in through an intake 14 which is controlled by a suction valve 15, shown in dotted lines, Fig. 1. Separate discharge ports 16 and 17 are provided; the first of which is arranged at a point corresponding to a definite part of the piston stroke, say about three-fourths, and the latter ports are arranged at the end of the pump cylinder. By this arrangement part of the air charge is delivered through the ports 16 to a receiver 18 during the first portion of the stroke, and the remaining part of the charge is delivered through the ports 17 to the vaporizer 19 during the last quarter of the stroke. The connection between the pump and the air receiver is controlled by a discharge valve 20 which can be adjusted so as to open at any desired pressure. The air-receiver is preferably cast integral with the pump cylinder 2 and is connected with the air-admission ports 12 by a conduit 21. This conduit is formed in the walls of the receiver and the cylinder 1 and is inclined toward the head of the latter so as to deliver the air in a direction to facilitate complete scavenging. A baffler 22 is provided on the head 4 of the piston to assist in directing the course of the entering air.

The vaporizer or carbureter 19 is preferably of the float feed type, comprising a float chamber 23 and a vapor chamber 24 connected therewith by a conduit 25 which conveys fuel to the latter chamber, Fig. 2. The outlet end of this conduit terminates in an annular port in the seat 27 of the inlet valve 28. This valve is adapted to open under the pressure of the air delivered by the pump, and the air in passing between the valve and its seat takes up the fuel from the annular port and incorporates the same. The air is supplied to the carbureter through a passage 29 cored out in the wall of the receiver and connected through a coupling 30, which is located between the vapor chamber 24 and the passage. The outer end of the passage is tapped and the coupling screws into the same, the latter also screws into the tapped lower end of the vapor chamber of the carbureter. The carbureter is thus supported close to the engine cylinder so as to be heated thereby. That portion of the wall of the vapor chamber on the discharge side of the inlet valve is jacketed so that exhaust gases may be passed through it if desired. The inlet valve is seated by a spring 31 whose tension is such as to yield under the pressure of the air delivered by the pump only during the last quarter of the stroke. In other words, its tension is greater than that of the spring of the discharge valve 20.

The vapor chamber 24 is connected with the fuel-admission ports by a pipe or other conduit 32, which is controlled by an admission valve 33 that is operated by an eccentric 34 through the rod 35 and lever 36, Fig. 3. The tubical contents of the vapor chamber and the conduit 32 bear such relation to the displacement of the pump piston over the last quarter of its stroke, that the air delivered to the vapor chamber will be under a compression to a considerable degree above atmosphere so that when the fuel-admission valve 33 is opened, the fuel charge is injected into the cylinder with sufficient force to insure complete commingling of the charge with the residual scavenging air in the cylinder. In order to insure a regular feed of fuel to the float chamber 23 an equalizing pipe 37 is provided between the vapor chamber and the fuel tank 38 (shown partly broken away in Fig. 1). The fuel feeds by gravity through a supply pipe 39 which terminates at its lower end in a valve port, Fig. 2, that is controlled by the valve 40 on the float 41. By this arrangement the float maintains a constant level of fuel in the carbureter. The quantity of fuel to be supplied to the annular port of the outlet valve 28, is regulated by a valve 42 located in the conduit 25. This valve is so adjusted that the requisite amount of fuel can be picked up by the air delivered by the pump to constitute the fuel charge.

The invention is not limited to the paticular carbureter illustrated because it is obvious that other forms of carbureters might be used.

Assuming the engine to be in operation the piston is passing its outer dead center, having finished the power stroke. The products of combustion are exhausting by virtue of the exhaust ports being uncovered and the air being injected into the cylinder through the uncovered air-admission ports for scavenging. At this time the pump cylinder is filled with air, and the vapor chamber of the carbureter contains the next fuel charge under pressure. As the piston moves inwardly it first covers the air-admission ports and the exhaust ports, and immediately following this the fuel-admission valve is opened by means of the eccentric or other mechanism. The fuel charge in the vapor chamber is thus released and injected into the explosion cylinder under its own pressure. The stream strikes upon the baffler on the piston and is forcibly deflected into the air in the cylinder, intimately mixing therewith. The piston proceeding on its in-stroke, compresses the mixture and at the proper time the same is ignited by the sparker 43, and the impulse from the explosion produces the power stroke. Simultaneously with the in-stroke the pump delivers first to the receiver, compressing the air therein, and then to the vapor chamber of the carbureter to produce the fuel charge. The fuel-admission valve, being in the meantime closed by the eccentric, holds the fuel charge under compression in the vapor chamber, while the piston itself retains the air in the receiver by reason of its covering the air-admission ports. On the power stroke the pump intakes a charge of air, and adjacent the end of the stroke the piston first uncovers the exhaust ports, thereby letting down the pressure by permitting exit of the gases of explosion, and then it uncovers the air-admission ports to permit the air in the receiver to enter the cylinder. This completes the scavenging and the piston then begins the in-stroke, repeating the cycle of operation.

The two-cylinder engine shown in Figs. 4 to 8 is substantially similar in construction to the single cylinder engine already described, as far as the explosion cylinder is concerned, hence further description thereof is unnecessary. The pistons 3 are connected to a two-throw crank-shaft 66, Fig. 4, so as to produce two impulses in one revolution. Between the pump cylinders 2 is an air receiver 67 common to both, the air being delivered thereto through discharge passages 68, Figs. 4 and 7, which are controlled by valves 69 that automatically open inwardly toward the receiver. The pumps draw in their charges through valve-controlled intakes 70. The air-admission ports 12 of the cylinder 1 are in open communication with the air receiver, so that the contents of the latter may pass freely to either explosion cylinder when its piston uncovers the ports. As the cranks are arranged 180 degrees apart, only one pump can deliver at a time to the receiver, so that the pressure therein is never greater than the maximum pressure of each charge delivered to the pumps. A single carbureter 71 is employed to supply the fuel. This is connected with the air receiver by a connection 72 and receives air directly therefrom. Between the carbureter and the fuel admission ports 13 are separate conduits 73 which are controlled by admission valves 74, Figs. 6 and 8. The valves are opened by cams 75 which are arranged 180 degrees apart on a rock-shaft 76 suitably mounted on the engine structure. The cam shaft 76 receives motion from the crank-shaft by means of an eccentric 77 on the latter which is connected with the cam shaft by the rod 78 and arm 79. Any other suitable means may be employed to open the valves at the proper periods.

Referring to Fig. 4, the operation is as follows: The left piston has just completed its compression stroke and the pump delivered its air-charge to the receiver 67 and compressed it therein. From the receiver a portion of the air passed to the carbureter 71 through the connection 72 and the inlet valve in the vapor chamber, thus producing, the fuel charge and holding it under compression in the said chamber. The right piston is at the end of its out-stroke, the exhaust and air-admission ports are open so that the air from the receiver is passing to the cylinder. The right pump cylinder is charged with air. Upon further movement of the crank-shaft, the right piston moves inwardly covering the exhaust and air-admission ports, and at this juncture the fuel admission valve 74 of the right cylinder opens to inject the fuel charge. The left piston is simultaneously moving outwardly on the power stroke and the pump draws in a charge. During the compression stroke of the right piston, the right pump delivers its charge of air to the receiver, wherein it is compressed and a portion passes to the carbureter. When the left piston uncovers its air-admission ports the air from the receiver is relieved or injected into the cylinder to scavenge the same. As soon as the left piston covers the exhaust ports and air-admission ports, the fuel charge is injected into the left cylinder from the carbureter and the contents of the cylinder is compressed by the compression stroke of the piston. The right piston at this interval is moving on its power stroke. The left pump delivers its charge to the receiver and carbureter in order to supply the air to the right cylinder and also the fuel charge at the proper interval. This completes the cycle of operation and the pistons are again in the position shown in Fig. 4.

The modifications shown in Figs. 9 and 10 are constructions which in some respects are similar to that shown in Fig. 1 and the corresponding parts are designated by corresponding reference characters. The modification resides in the pump which, in both Figs. 9 and 10, is double acting, the crank casing 6 being used for compressing the air for the scavenging charge, and the cylinder 2 being used for supplying the air for conveying the fuel from the carbureter to the explosion cylinder 1.

In Fig. 9 the pump supplies the air direct to the carbureter wherein it is held under compression until the fuel-admission valve 33 is opened, whereas in Fig. 10 the air is delivered to an intermediate receiver 80, as the vapor chamber of the carbureter is of comparatively small cubical contents. Hence with this arrangement, when the fuel-admission valve 33 is opened the air from the receiver sweeps through the inlet valve of the carbureter, and conveys the necessary fuel therewith to produce an explosive mixture when combined with the air in the explosion cylinder. The scavenging air charges are delivered to the cylinder from the crank casing through the connecting conduit 81.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative, and that the invention can be carried out by other means.

What I claim as new, and desire to secure by Letters Patent of the United States, is,—

1. In an explosive engine, the combination of a cylinder having exhaust ports and separate fuel and air admission ports at its forward end, a piston in the cylinder which moves over said ports to open and close them, a carbureter connected with the fuel admission ports, means for supplying compressed air through the air ports while the exhaust ports are open and also for supplying it to the carbureter to produce a fuel charge therein under pressure, and means which permits the fuel charge to pass from the carbureter to the cylinder after the exhaust ports are closed.

2. In an explosive engine, the combination of a cylinder having exhaust ports and separate fuel and air admission ports at its forward end, a piston in the cylinder which moves over said ports to open and close them, a carbureter connected with the fuel ports, a pump driven by the engine for supplying air to the cylinder for scavenging it and to the carbureter to produce a fuel charge under pressure, a valve in the connection between the carbureter and the fuel ports which holds the charge under pressure, and a means for opening the valve shortly after the exhaust ports are closed and the pressure in the cylinder is at a minimum.

3. In an explosive engine, the combination of an explosion cylinder having separate air, fuel and exhaust ports at its forward end, a pump cylinder, a carbureter, a differential area piston, the smaller portion of the piston working in the explosion cylinder and the larger portion in the pump cylinder, means for directing a portion of the compressed air from the pump to the air ports to scavenge the explosion cylinder and another portion to the carbureter to form a fuel charge therein under pressure, and means for admitting the fuel charge to the explosion cylinder after the exhaust and air ports have been opened by the outward movement of the piston and subsequently closed at the beginning of its return movement.

4. In an explosive engine, an explosion cylinder, an axally alined cylinder of larger diameter than the explosion cylinder, a trunk piston having two heads, one working in each cylinder and forming in the larger cylinder an annular pump chamber, exhaust ports and air ports adjacent the forward end of the explosion cylinder, which are opened and closed by the movement of the piston over them, separate fuel ports adjacent the air and exhaust ports but farther removed from the end of the cylinder, a carbureter receiving air from the pump to form a fuel charge under pressure, a connection between the carbureter and the fuel ports, a valve in said connection, and means for mechanically operating the valve to admit the fuel charge to the explosion cylinder after the piston on its inward movement has closed both the exhaust and the air ports.

5. In an explosive engine, the combination of differential area cylinders, the cylinders of smaller area having scavenging and exhaust ports, pistons working in the cylinders, the pistons and cylinders of larger area constituting air pumps, a receiver common to the pumps, connections between the receiver and the engine cylinders for supplying air to scavenge them, a carbureter, a connection between the receiver and the carbureter through which air passes to the latter to form fuel charges, connections between the carbureter and the engine cylinders, and means included in said connections which admit the fuel charges after the completion of the scavenging and the closure of the exhaust ports.

6. In an explosive engine, the combination of differential area cylinders, exhaust ports and separate air and fuel admission ports arranged at the forward end of each cylinder of smaller area, pistons in said smaller cylinders which move over the ports to open and close them, pistons coöperating with the cylinders of larger area to form air pumps, a double-throw crank shaft to which the engine pistons are connected, an air receiver which receives alternate charges from the pumps, separate connections between the receiver and the air admission ports through which scavenging charges pass when said ports are opened, a carbureter, a valved connection between the receiver and the carbureter to supply air to the latter to form fuel charges under

pressure, separate connections between the carbureter and the fuel admission ports, valves in said connections, and means which actuate said valves to admit the fuel charges after the exhaust and air ports have been closed by the pistons on their inward movement.

7. In a two-cycle engine, the combination of a crankshaft, an explosion cylinder having exhaust ports and separate scavenging and fuel ports near its outer end, an air pump cylinder, a double area piston having one portion working in the explosion cylinder and the other in the pump cylinder, the first portion opening and closing the ports as it moves over them, a connecting rod between the piston and the crankshaft, a carbureter, a connection between the air pump and the scavenging ports for delivering air to scavenge the cylinder, a connection between the air pump and the carbureter which delivers air into and through it to form a fuel charge, a conduit leading from the carbureter to the fuel ports, a valve in the conduit, and means for mechanically operating the valve to admit the fuel charge to the explosion cylinder after the exhaust has taken place and the cylinder has been scavenged.

In witness whereof I have hereunto set my hand this eleventh day of April, 1905.

HENRY O. WESTENDARP.

Witnesses:

JOHN A. MCMANUS, Jr.,

JOHN J. WALKER.