(No Model.) 6 Sheets—Sheet 1.

R. J. ROLFSON.

GAS ENGINE.

No. 570,649. Patented Nov. 3, 1896.

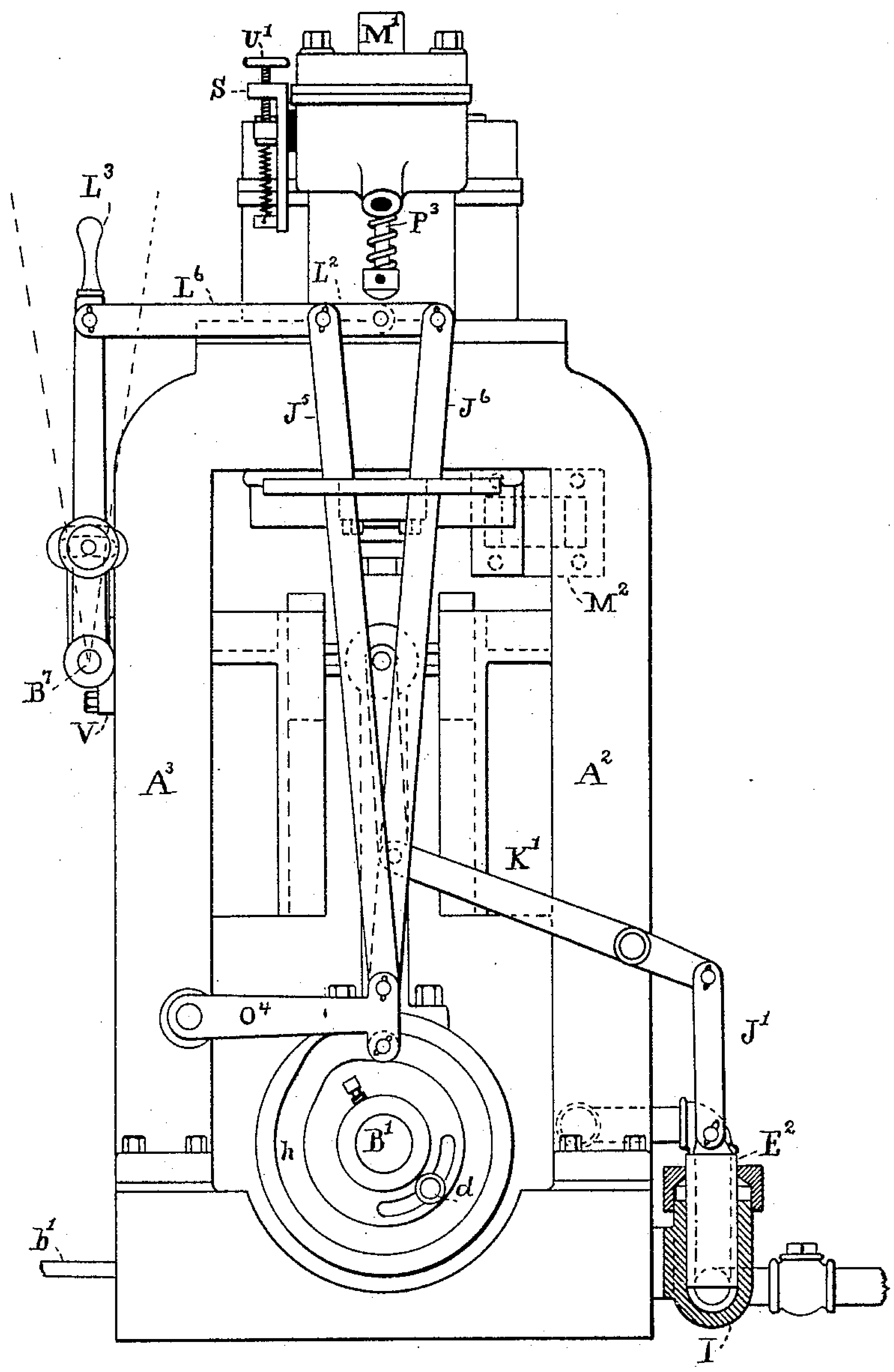

Fig. 1.

Witnesses:

Edw S. Cobb.

Wilson D. Bent, Jr.

Inventor:

Rolf J. Rolfson

By John Richards Atty

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(No Model.)

6 Sheets—Sheet 2.

R. J. ROLFSON.

GAS ENGINE.

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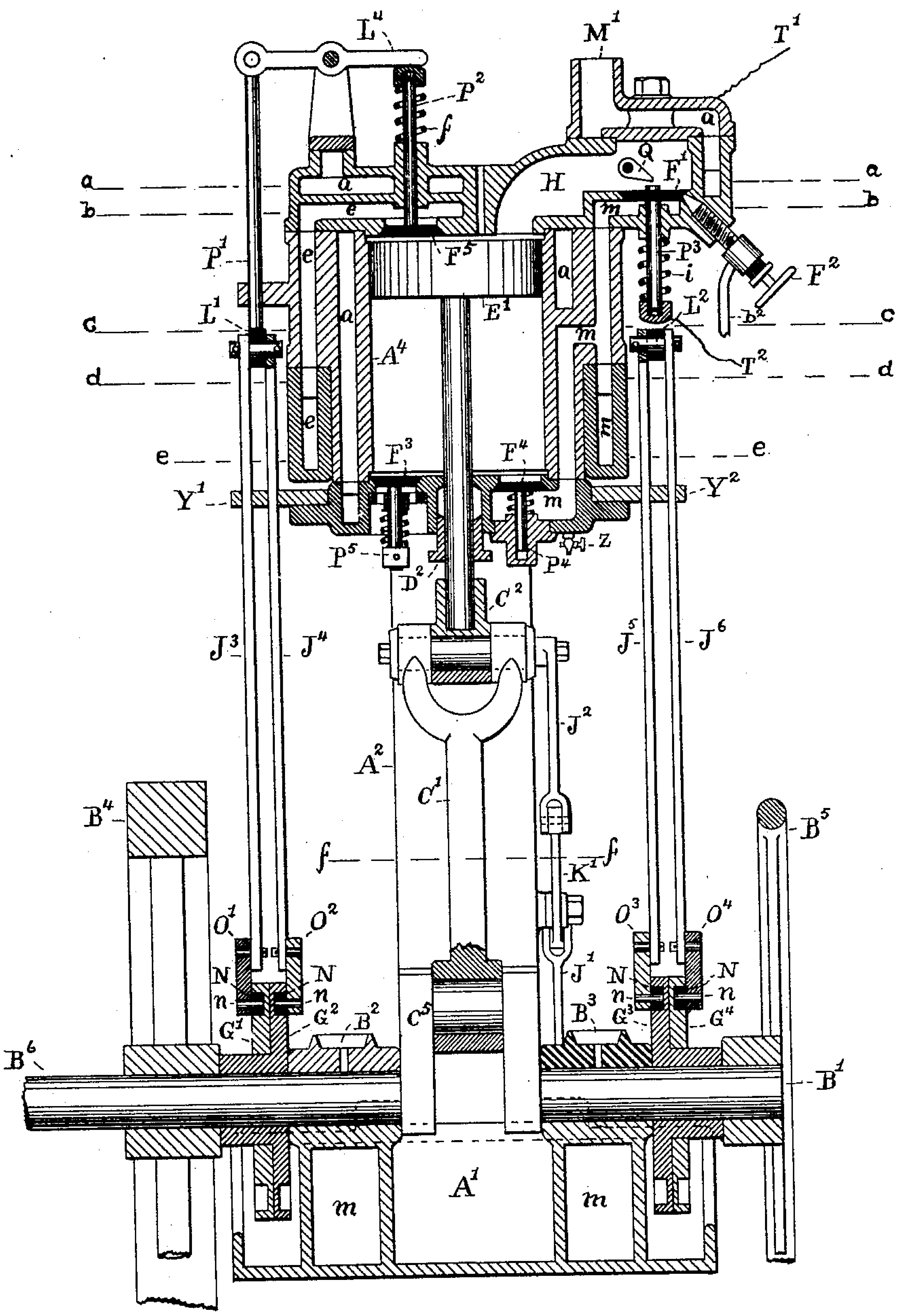

Witnesses:

Edw. S. Cobb.

Wilson D. Bent, Jr.

Fig. 2.

Inventor:

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By John Richards Atty

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(No Model.) 6 Sheets—Sheet 3.

R. J. ROLFSON.

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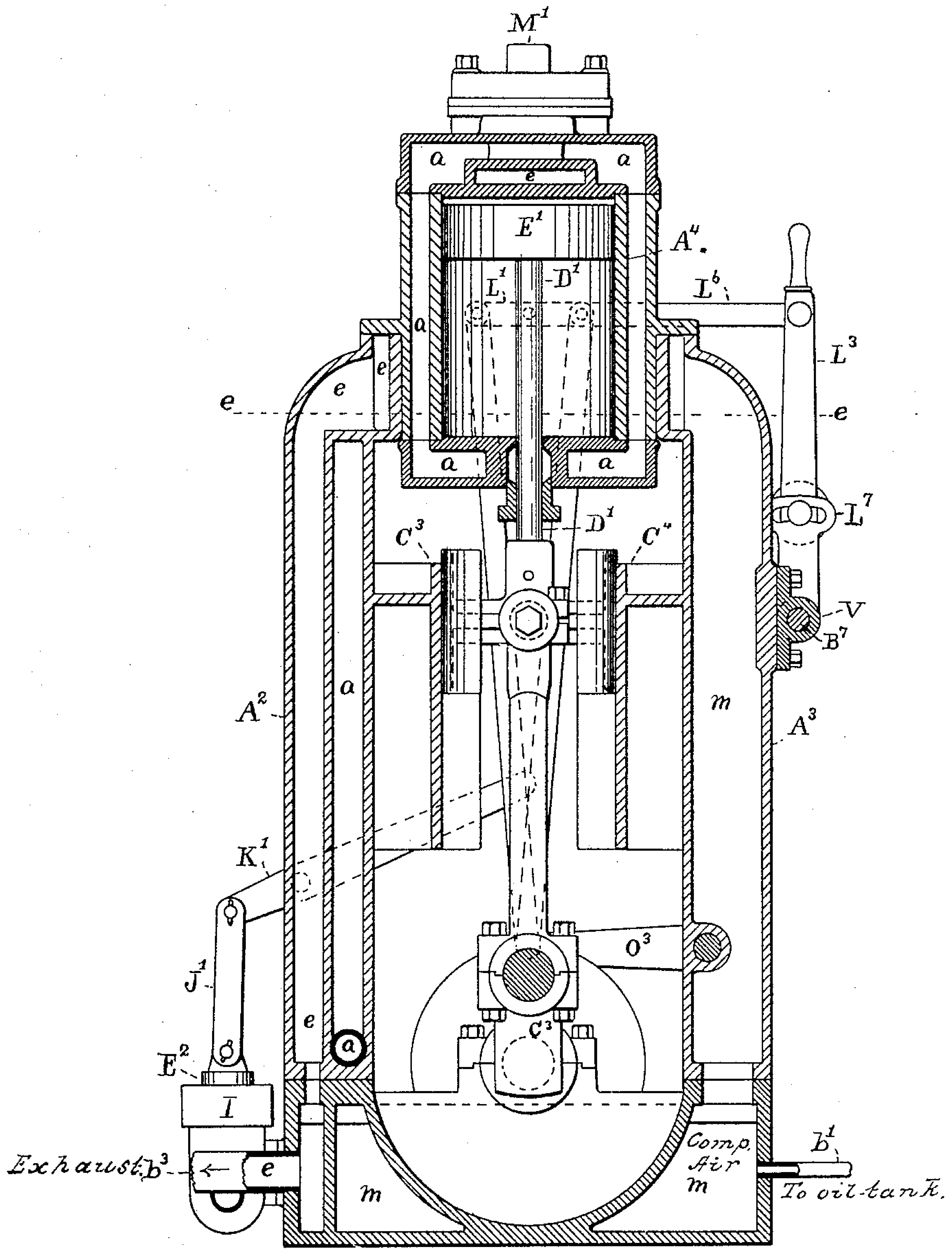

Fig. 3.

Witnesses:

Edw. S. Cobb.

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By John Richards Atty

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(No Model.)

6 Sheets—Sheet 4.

R. J. ROLFSON.

GAS ENGINE.

No. 570,649.

Patented Nov. 3, 1896.

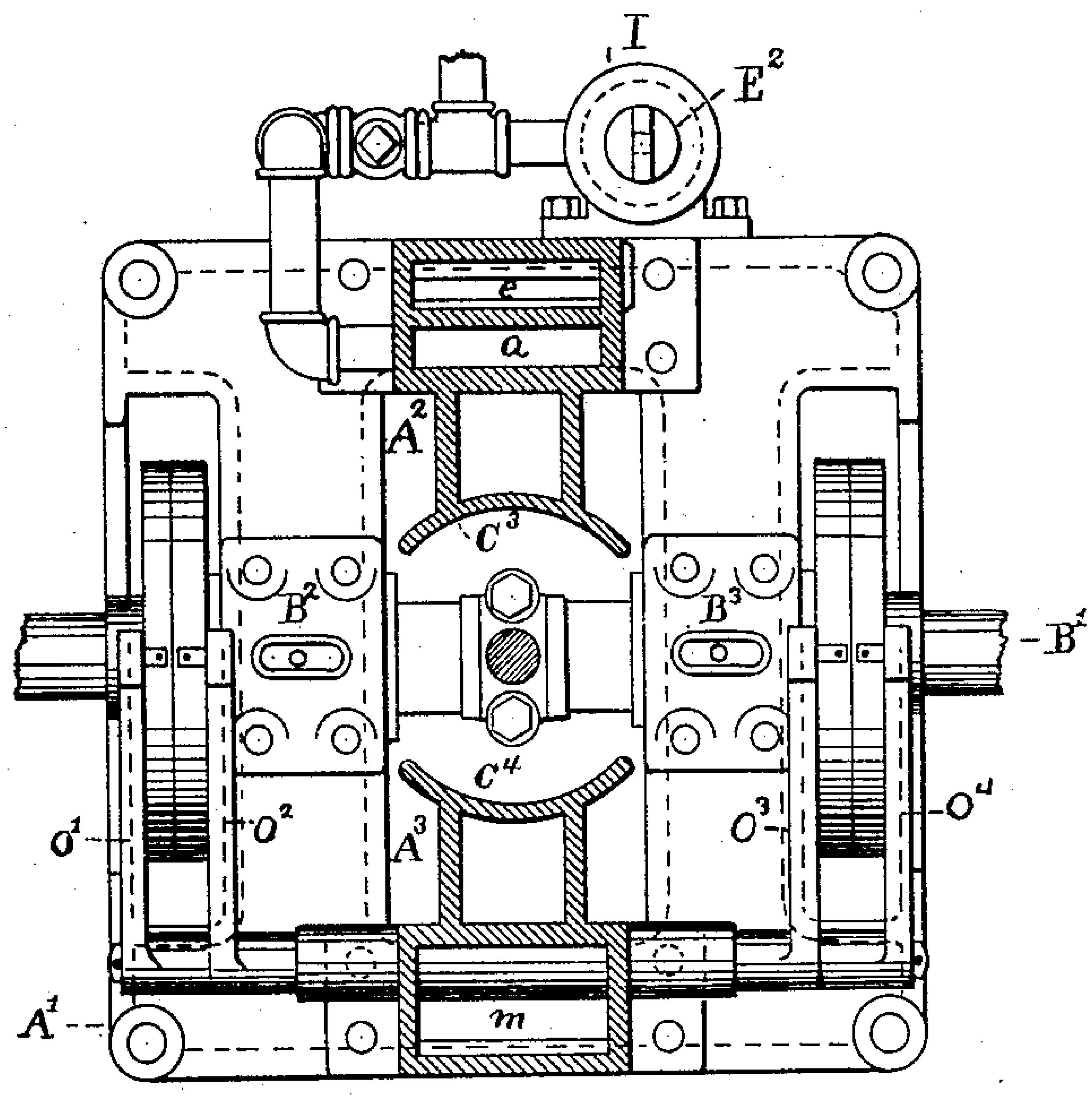

Fig. 4.

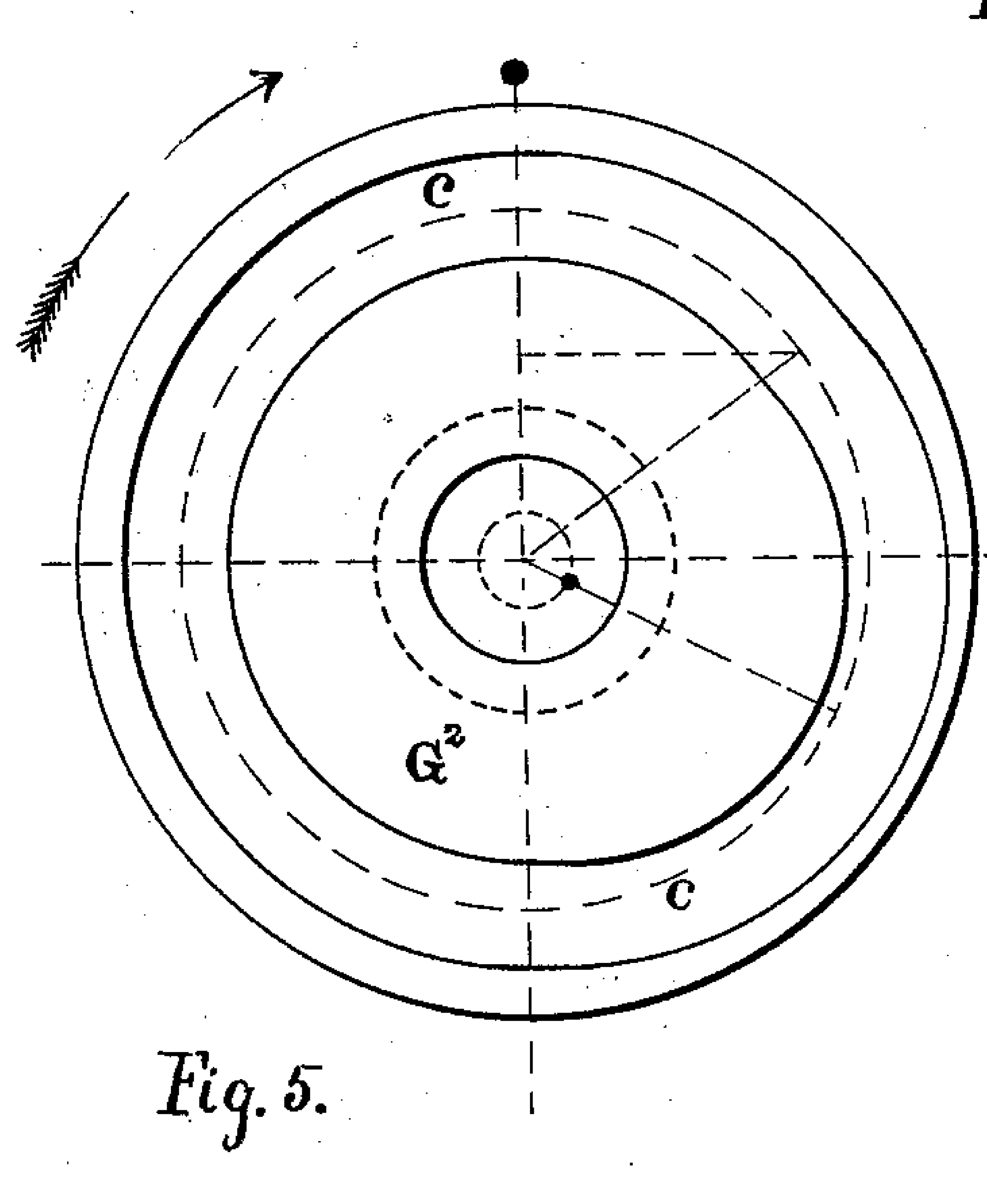

Fig. 5.

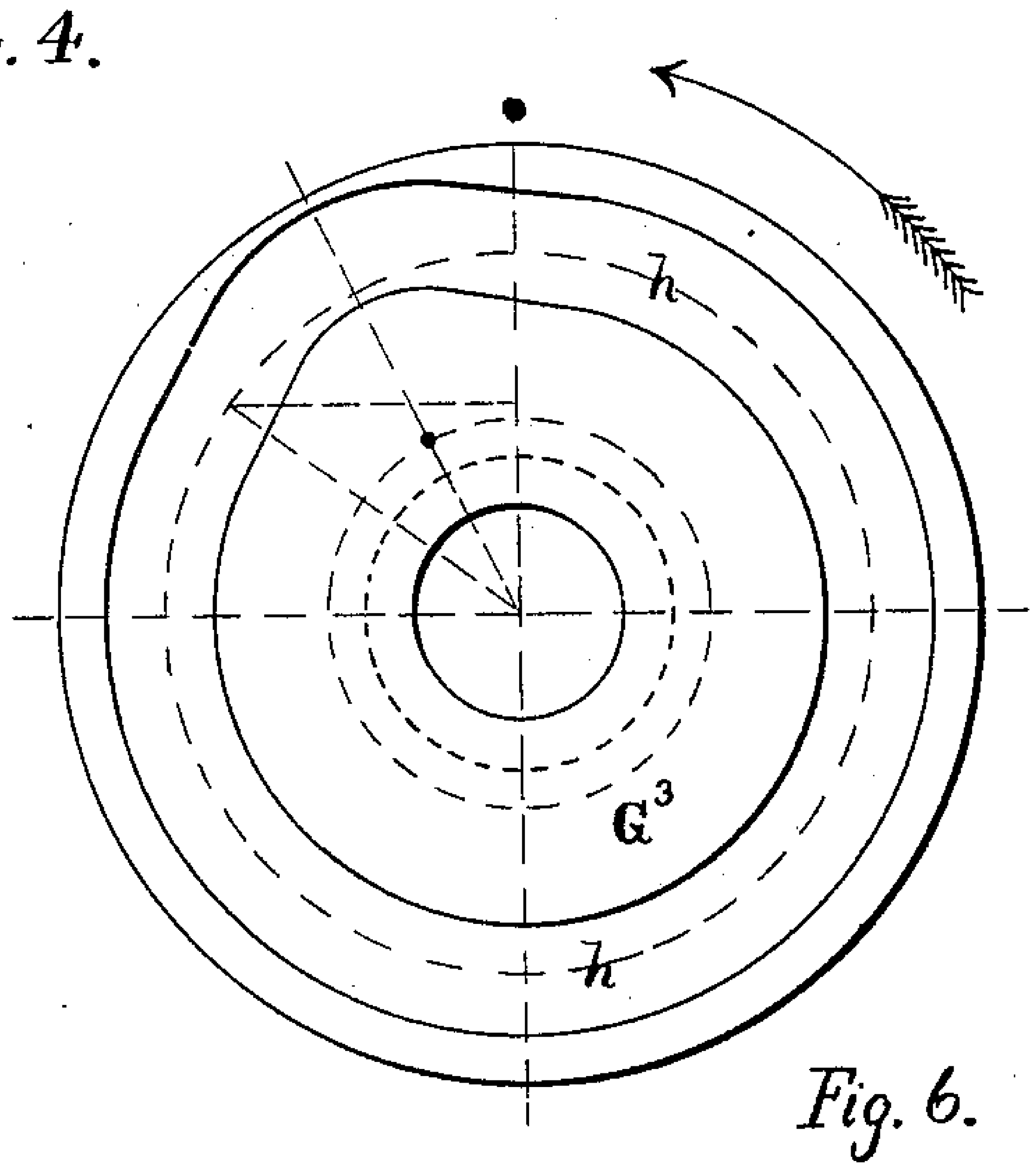

Fig. 6.

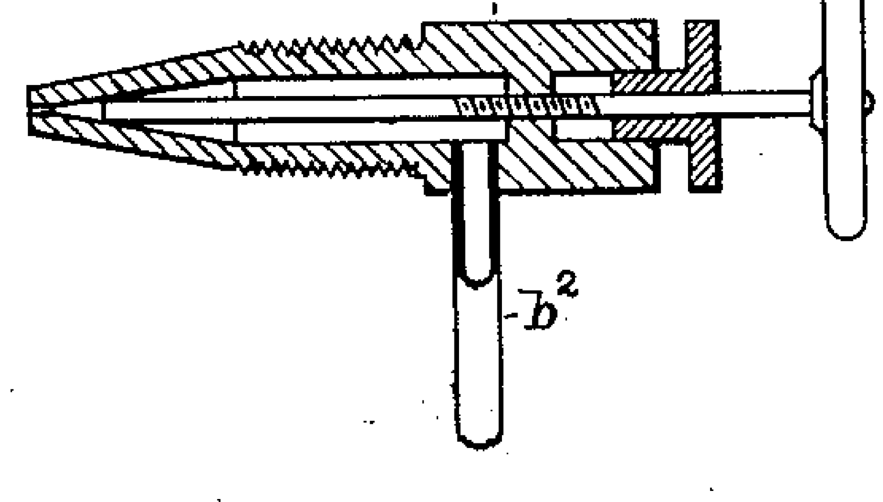

Fig. 7.

Witnesses:

Edw. S. Cobb.

Wilson D. Bent, Jr.

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By John Richards Atty.

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(No Model.) 6 Sheets—Sheet 5.

R. J. ROLFSON.

GAS ENGINE.

No. 570,649. Patented Nov. 3, 1896.

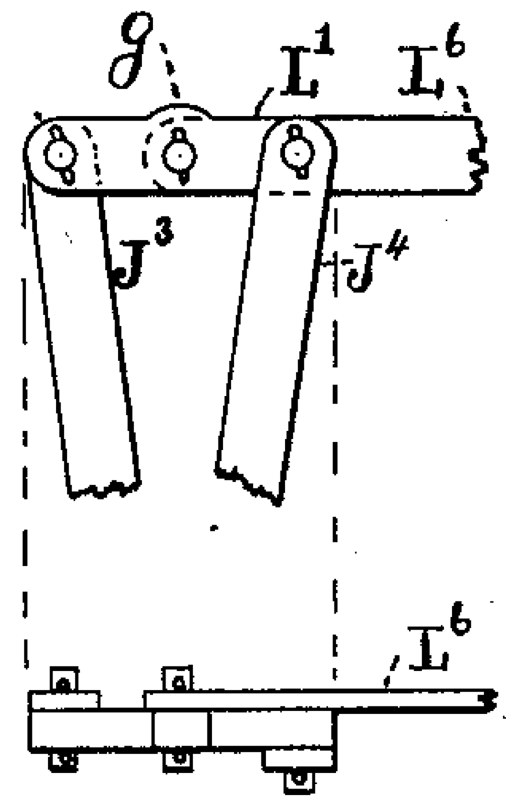
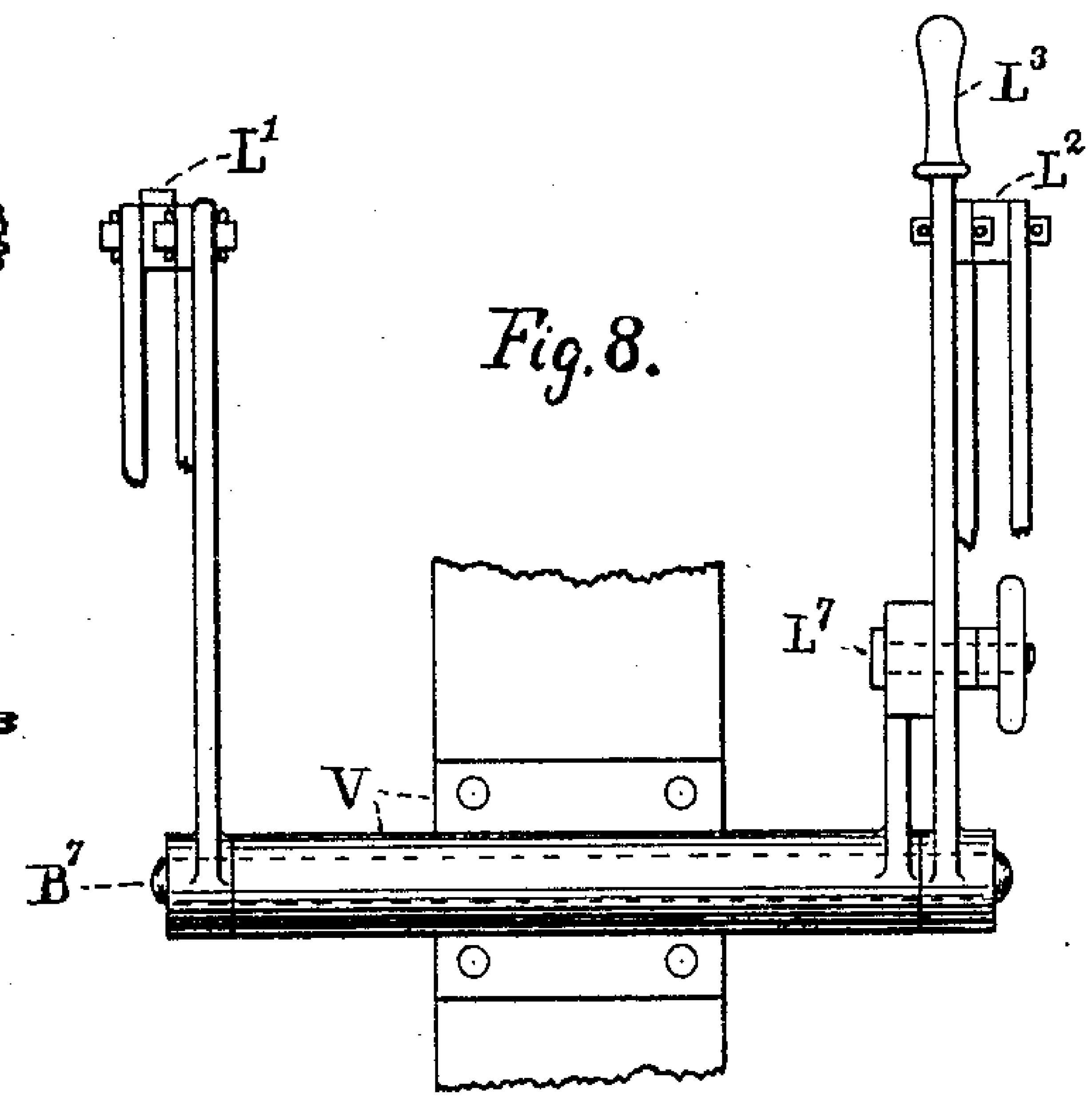


Fig. 9.

Fig. 8.



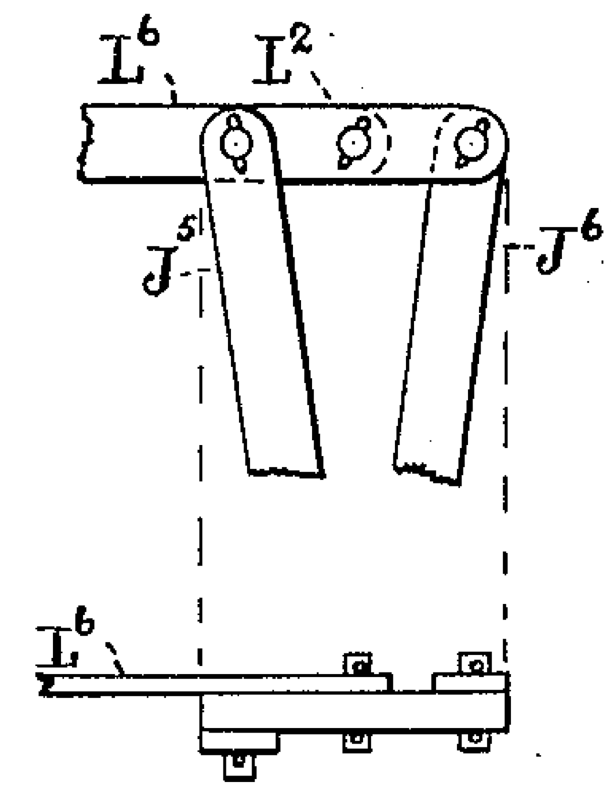


Fig. 10.

Fig. 11.

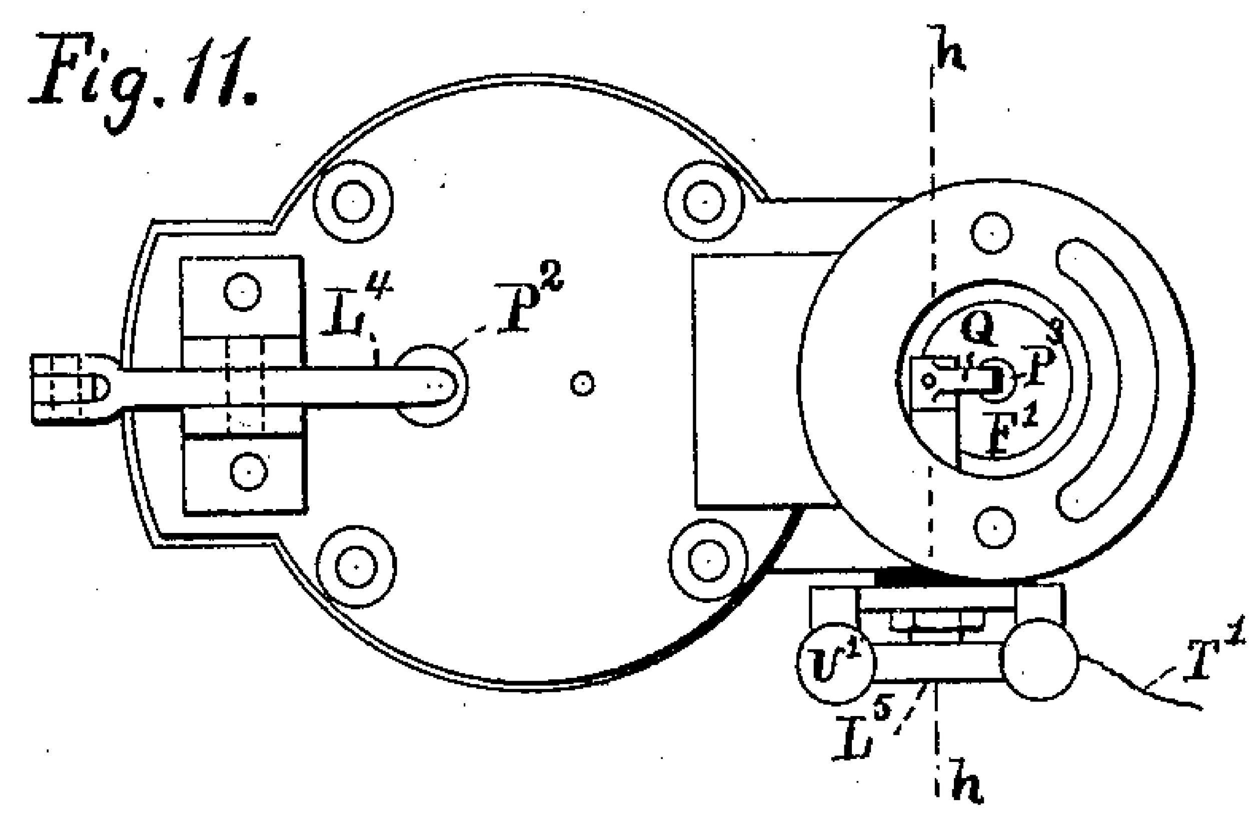
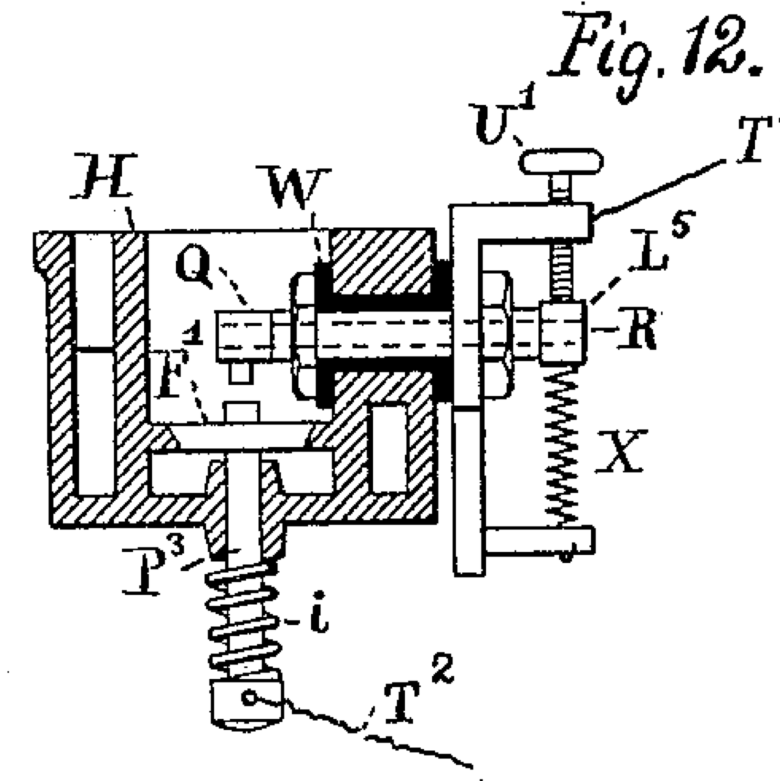


Fig. 12.



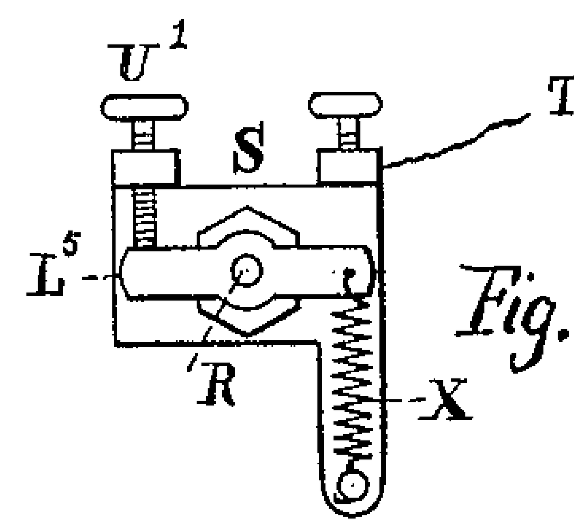
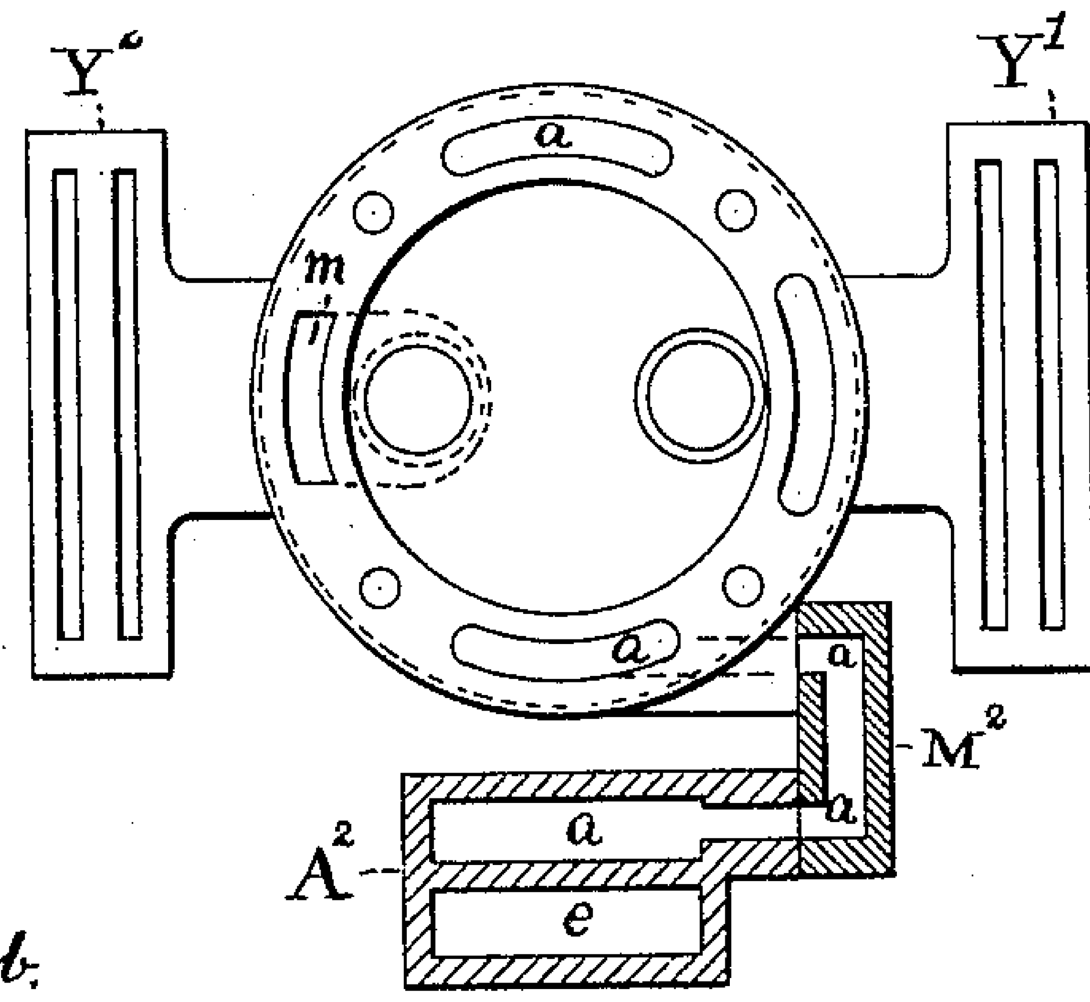


Fig. 13.

Fig. 14.



Witnesses:

Edw. S. Cobb.

Wilson D. Bent, Jr.

Inventor:

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(No Model.)

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R. J. ROLFSON.

GAS ENGINE.

No. 570,649.

Patented Nov. 3, 1896.

Fig. 15

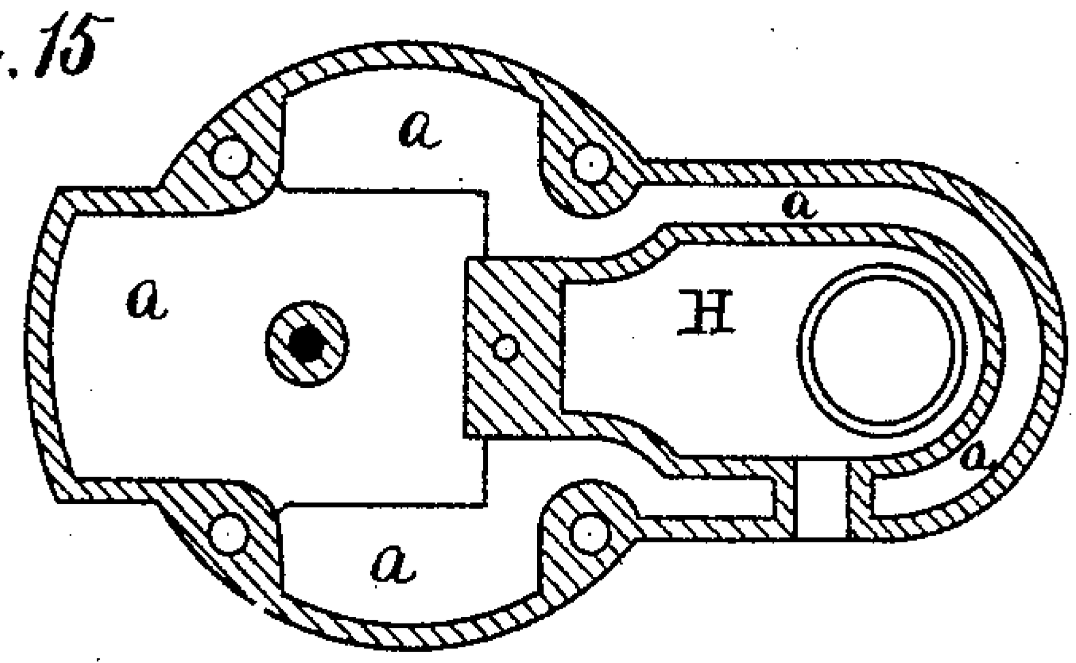


Fig. 17.

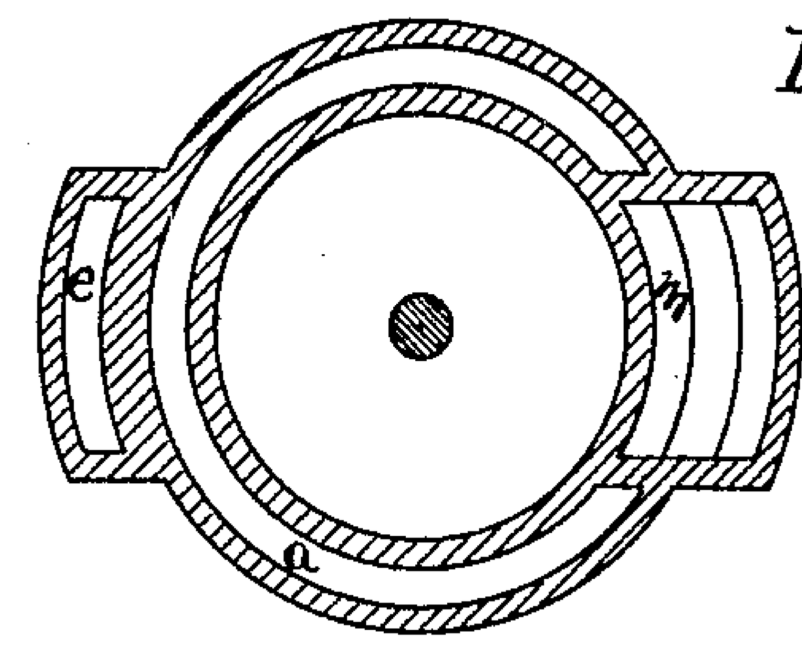


Fig. 16.

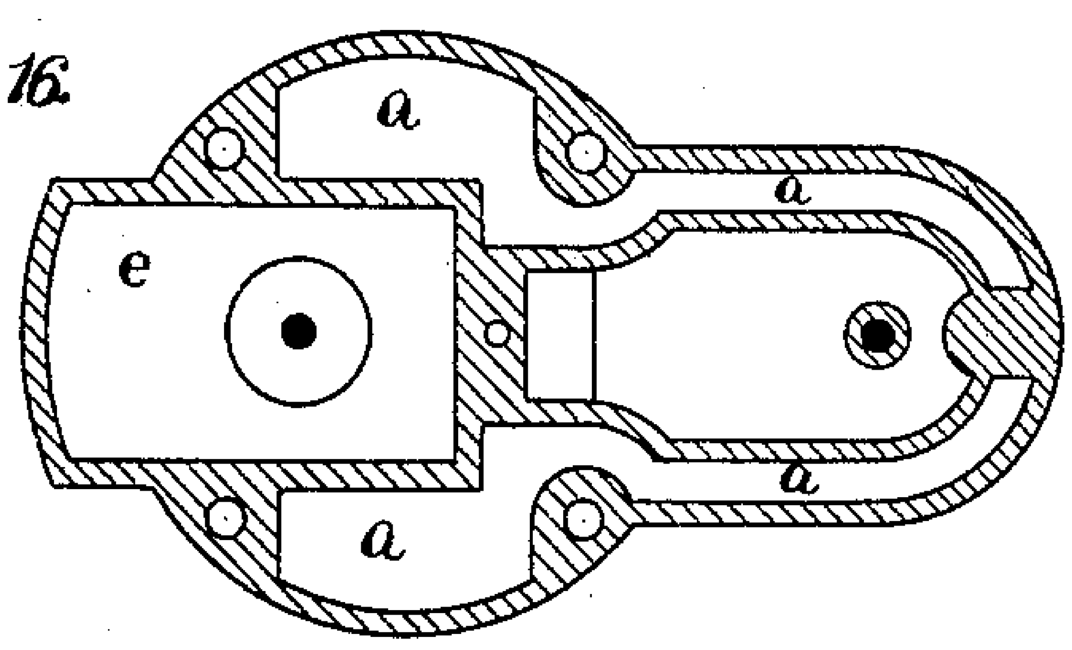
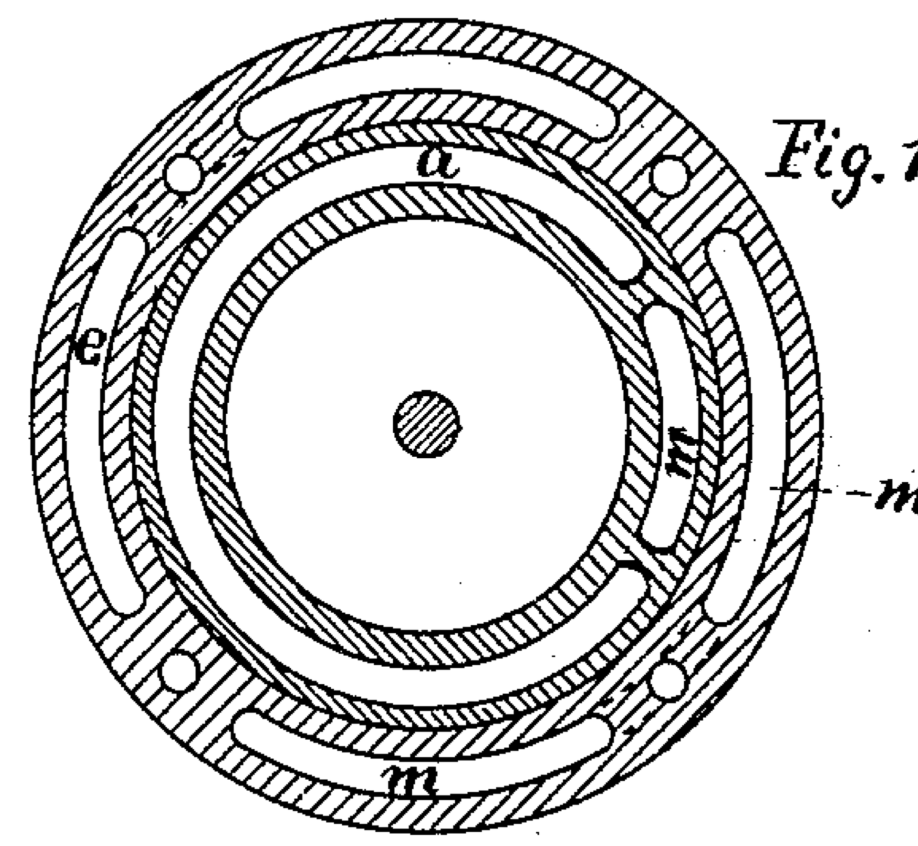


Fig. 18.



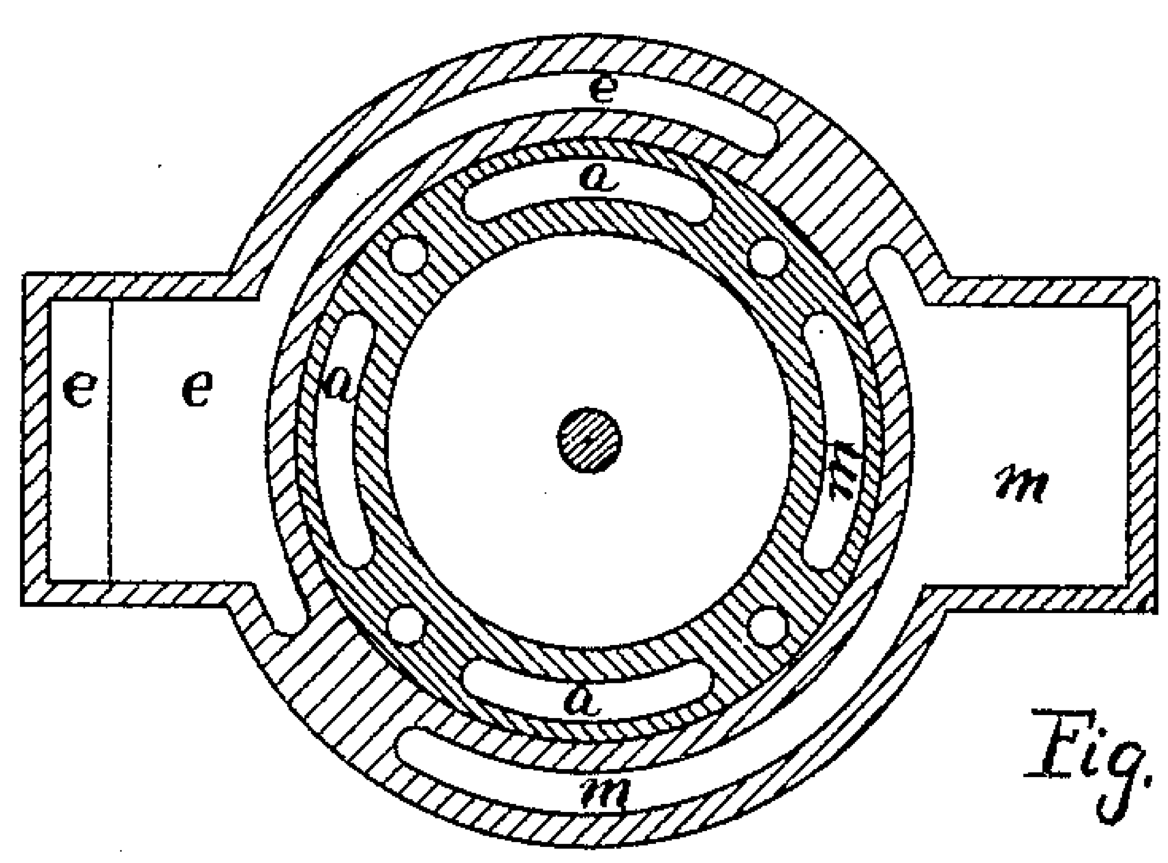


Fig. 19.

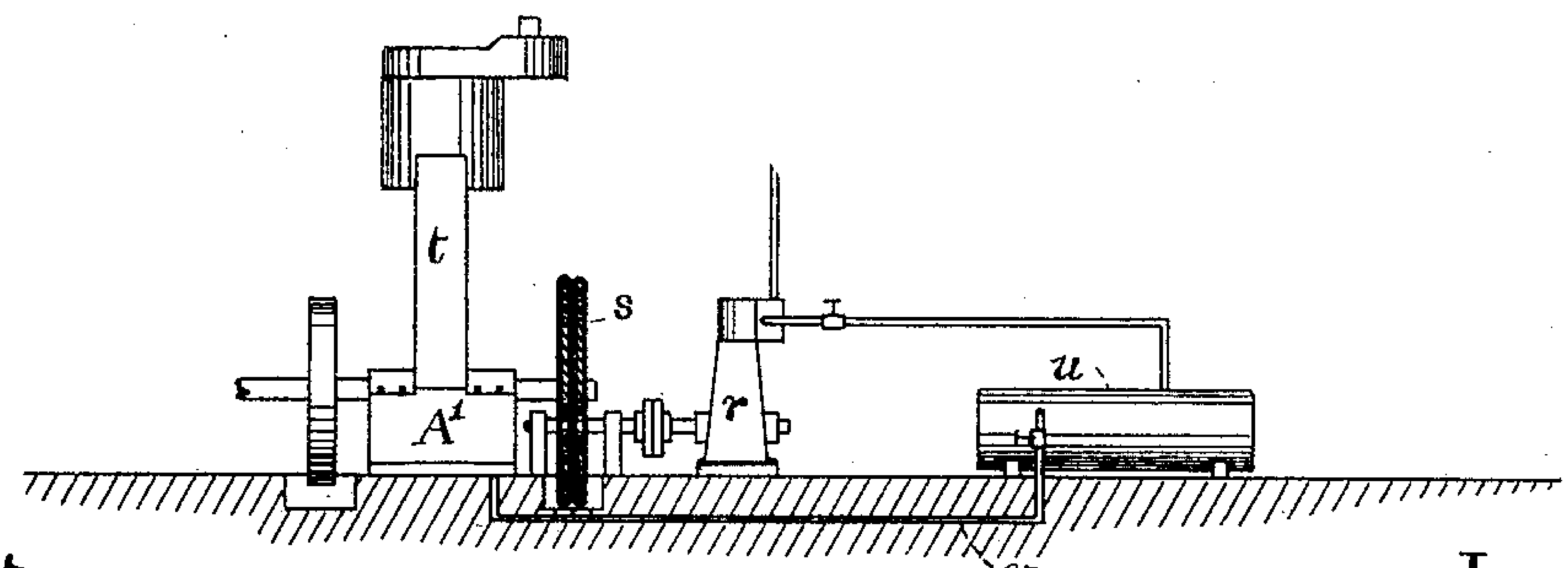


Fig. 20.

Witnesses:

Edw. S. Cobb.

Wilson D. Bent, Jr.

Inventor:

Rolf J. Rolfson

By John Richards Atty.

UNITED STATES PATENT OFFICE.

ROLF J. ROLFSON, OF SAN FRANCISCO, CALIFORNIA, ASSIGNOR OF ONE-HALF TO SAMUEL S. SIMRAK AND ALBERT R. HERMAN, OF SAME PLACE.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 570,649, dated November 3, 1896.

Application filed May 16, 1895. Serial No. 549,522. (No model.)

To all whom it may concern:

Be it known that I, ROLF J. ROLFSON, a citizen of the United States, residing in the city and county of San Francisco, State of California, have invented certain new and useful Improvements in Gas-Engines; and I hereby declare the following specification and the drawings therewith to be a complete description of my improvements, with the method of constructing and applying the same.

My invention relates to motive engines impelled by the expansive force of gas or vapor burned in the cylinder of the engine, and a combustion-chamber connecting therewith, and to the control of such engines for marine and like purposes, where their motion has to be reversed, and to methods of constructing and operating such engines in other respects.

My improvements consist in various features of arrangement, construction, and functions in such engines that will be pointed out in the drawings and set forth in the claims at the end of this specification.

Among the main objects to which my improvements are directed is to make such engines reversible and adapted to run in either direction by simple adjustment of the valves and other elements thereof, as in the case of steam-engines; to attain with one cylinder and piston an impulse of the gas or vapor at each alternate stroke of the engine or for each revolution of the crank-shaft; to compress continually and store up the air required for combustion, the pressure of which is automatically regulated by the action of the engine; to provide efficient methods of cooling parts of the engine subjected to high temperature; to provide by means of a single valve for the admission of air and oil or fuel, also by the same movement the ignition of charges admitted to the cylinder or combustion-chamber; to avoid pipes about the engine by providing the various ducts for air, oil, water, and gas integrally with the main cylinder and its supports; also other features of both an operative and constructive nature that will be pointed out in the specification and set forth in the claims at the end thereof.

Referring to the drawings herewith, Figure 1 is a side elevation of a gas-engine embodying my improvements. Fig. 2 is a central vertical section of the same engine parallel with the crank-shaft. Fig. 3 is a central vertical section of the same engine in a plane at right angles to Fig. 2. Fig. 4 is a plan view, partially in section, on the line *f f* in Fig. 2. Fig. 5 is an enlarged side view of the cam for operating the exhaust-valve of the engine. Fig. 6 is an enlarged side view of the cam for operating the admission-valve of the engine. Fig. 7 is a section through the axis of the adjustable valve for admitting oil or gasolene. Fig. 8 is a front elevation of the hand-gearing to operate the valve-actuating mechanism of the engine. Fig. 9 is a partial side view of the link for operating the exhaust-valve of the engine. Fig. 10 is a similar side view of the link to operate the admission-valve of the engine. Fig. 11 is a plan view on top of the cylinder-cover of the engine, showing some of the details of the igniting apparatus. Fig. 12 is a section through Fig. 11 on the line *h h*. Fig. 13 is a detail of the igniting apparatus shown in Figs. 11 and 12. Fig. 14 is a plan view of the plate on which the cylinder is bolted, forming the bottom cover thereof. Fig. 15 is a section through Fig. 2 on the line *a a*. Fig. 16 is a section through Fig. 2 on the line *b b*. Fig. 17 is a section through Fig. 2 on the line *c c*. Fig. 18 is a section through Fig. 2 on the line *d d*. Fig. 19 is a section through Figs. 2 and 3 on the line *e e*. Fig. 20 is a diagram indicating a method of starting an engine made according to my invention.

Similar letters of reference are employed to designate corresponding parts throughout the various figures of the drawings.

The main framing of the engine, consisting of the hollow base A' and vertical standards A^2 A^3 and main cylinder A^4, are in the present case shown in their most simple form as adapted for marine purposes to occupy a minimum amount of space and be accessible from all sides without the obstruction of pipes, and provided with interior passages and chambers for air, water, and oil or fuel.

The crank-shaft B' is of the usual form, mounted in bearings B^2 B^3 and provided, as in Fig. 2, with a fly-wheel B^4 at one end, and when required a hand starting-wheel B^5 on the other end, the extension B^6 being connected to a propeller or other machinery to be driven.

C′ is a common connecting link or rod attached to a cross-head C^2, that moves between the guides C^3 C^4 in the same manner as a common steam-engine.

D′ is the main piston-rod, attached to the cross-head C^2 and the piston E′, which moves in the cylinder A^4. A packing-gland D^2 forms a close joint around the piston-rod D′ in the usual manner of double-acting engines.

The piston E′ has two separate functions to perform. On the top it receives the impulse of the explosive gases, imparting the force thereof to the crank C^5 and crank-shaft B′, and on the bottom acts as an air-compressor, as will be hereinafter fully described.

Surrounding the cylinder A^4, the combustion-chamber H, and in other parts of the framing are passages for cooling-water, marked *a* throughout and traceable by this reference.

The cooling-water in the various passages and chambers marked *a* is supplied or circulated by a pump I, having a plunger or piston E^2, operated by a link J′, attached to a lever K′, and by a second link J^2, connected to the cross-head C^2, as seen in Figs. 2 and 3. This pump I discharges into the passages *a* in the main leg A^2 of the framing, as seen in Fig. 4, and thence passes into the various passages, marked *a* in Figs. 15 to 19 of the drawings, finally passing out at the nipple M′ at the top of the engine, and is discharged as waste water, or conducted to some suitable place for cooling and returned to the pump I to be again used. It will not be necessary to follow the course of this cooling-water throughout the whole of the passages, as these can be traced by their proper reference, except when the water is transferred from the standard A^2 to the passages around the cylinder A^4. This is illustrated in Fig. 14, where a pass-over chamber M^2 forms such connection, and it will be seen that this member M^2 is the only duct or connection of any kind, except inlet and outlet pipes, external to the main framing of the engine.

Returning now to the engine-cylinder and the combustion-chamber H connecting therewith, F′ is the inlet-valve for air and oil or fuel, the latter admitted or controlled by a needle-valve F^2. (Shown enlarged in Fig. 7.)

Describing first the air-compressing elements of the engine, the piston E′, as before explained, acts on its bottom side as an air-compressor, F^3 being the air-inlet valve and F^4 the discharge-valve therefor, the latter connecting directly with the fuel-inlet valve F′ and also with the various passages and chambers marked *m* in the different figures of the drawings.

The surplus air, or that required to produce a continued pressure, is stored in the chambers *m* in the base of the machine and in the standard or leg A^3 of the main framing, flowing thereto by the passages marked *m* in Figs. 14, 16, 18, and 19, all integral with and contained in the main frame of the engine.

From the chambers *m* in the base of the machine, or from any other convenient point, a pipe b′ leads to a tank or vessel containing the oil or liquid fuel, causing a pressure therein equal to that in the passages *m* and forcing the oil or fuel through the pipe b^2 to the controlling-valve F^2 and main inlet-valve F′, from where it enters the combustion-chamber H with the air from the passages and chambers *m*.

The needle-valve F^2 being of the common form to secure minute graduation of the oil or fuel admitted does not require description. It operates in conjunction with the main inlet-valve F′, being closed when that valve is seated, as will be seen in Fig. 2.

Referring next to the exhaust or waste gases of combustion, these pass out of the cylinder A^4 through the valve F^5 and into the passage *e*, as seen in Fig. 2, around the base of the cylinder A^4, outside the water-space, and into the supporting-standard A^2 and down through this to the exhaust waste-pipe b^3.

When the engine is employed for marine purposes, the exhaust-pipe is supposed to terminate below the water-line of the vessel in which the engine is working. The passages *e* are throughout cooled by adjacent passages *a*, containing cooling-water.

The exhaust-valve F^5 is opened by means of a bar L′, which has a vibratory motion produced by the links J^3 J^4, actuated by the cams G′ G^2, the form of which is shown in Fig. 5. These cams G′ G^2 are set opposite or at the proper angle of advance for running the engine either way and have grooves *c* in their faces, in which are rollers N, supported on the pins *n*, fastened in the vibrating levers O′ O^2, to which are attached the links J^3 J^4. The cams G′ G^2 are set relatively in respect to the eccentricity of the grooves *c*, and are adjustably attached together by a screw *d*, as seen in Fig. 1, the inner cam G^2 being keyed to the crank-shaft B′, and the other cam, G′, mounted thereon, as seen in the section, Fig. 2. These cams G′ G^2 produce an opposite vibrating motion of the levers O′ O^2, which is imparted by the links J^3 J^4 to the bar L′, that comes in contact with the stem P′, raising the exhaust-valve F^5 at each revolution of the crank-shaft B′ and each outward stroke of the piston E′.

The bars L′ L^2 at the two sides of the engine and operating the valves F′ F^5 are adjusted for the forward and backward motions of the engine by means of a rock-shaft B^7, supported in a bracket V, and the lever L^3 and links L^6, attached to the lever L^3 and to the bars L^2, as seen in Figs. 1 and 8. This lever L^3 is adjusted backward or forward, as indicated by dotted lines in Fig. 1, bringing either of the links in line with the stem P′ as the engine is to run backward or forward.

The bar L′ on the exhaust side of the engine, as seen in Fig. 2, raises the stem P′ and, acting on the lever L^4, depresses the stem P^2, opening the valve F^5, which is closed again by the spring f as soon as the stem P^2, lever L^4, and stem P' are released.

A sector and clamp screw L^7 is provided to hold this lever L^3 when set in either position, forward or backward, or at its central or neutral point, as seen in Fig. 1, when the engine is not in motion.

When the bar L' is in its central or neutral position, as indicated in Fig. 1, a ledge or projection g (seen in Fig. 9) comes in contact with the stem P', partially opening the exhaust-valve F^5 when the engine is not in motion, the purpose being to permit the circulation of air and a free movement of the piston E^2 upward or downward if the engine is turned by hand or by auxiliary power. Similar provision is made in respect to the bottom or air-compressing end of the cylinder A^4 by means of a cock Z, that can be opened to the atmosphere, or some mechanism is provided to open the air-inlet valve F^3, as may be most convenient in operating.

Referring next to the induction-valve F' for the admission of air and oil or fuel, the operating elements correspond throughout very nearly to those for actuating the exhaust-valve F^5, and as the various parts are marked with corresponding letters of reference it will not be necessary to follow through the movements of the cams, links, and other details for operating the admission-valve and reversing the engine on the induction side. (Seen in Fig. 1.)

The bar L^2, that operates the valve-stem P^3, is flat on the top, not requiring a ledge g, as seen in Fig. 9, and the cams G^3 G^4, as seen in Fig. 6, are of a different form from the exhaust-cams, Fig. 5, the groove h producing a more abrupt movement.

The inlet-valve F' when released closes by means of a coil-spring i strong enough to overcome the air-pressure in the passages m, and not only cuts off the inflow of air, but at the same time closes the inlet for oil or fuel passing through the needle-valve F^2, as seen in the section, Fig. 2, thus performing a double function usually accomplished by separate mechanism and securing thereby positively coincident action and supply of the combustible elements; also has a third function of operating as an electrode for igniting the charge in the combustion-chamber H in the following manner:

Referring to Figs. 2, 11, 12, and 13, a small oscillating spindle R passes through an insulating-bush W in the wall of the combustion-chamber H. On the inner end of this spindle R is attached the electrode Q, and on the outer end a cross-lever L^5, continually under a turning strain by means of a spring X, as seen in Figs. 12 and 13, and its range of movement regulated by the screw U'. Positive and negative electric wires T' T^2 connect one to the stem R and electrode Q and the other to the stem P^3, thus forming positive and negative poles or electrodes of the member Q and the valve F'. In this manner it will be seen that each time the valve F' is raised it comes in contact with the electrode Q, and when a charge is admitted and the valve has to descend to a certain distance a spark is given off, igniting the charge. By adjusting the screw U' up or down the range of the lever L^5 and of the electrode Q is changed, so the electric spark may occur at the instant the valve F' begins to close, or at any intermediate point of its range, thus determining by simple adjustment when the engine is in motion the point of igniting the charge with definite reference to the position of the piston E^2 and point of stroke and when the engine is running in either direction. This method of constructing the igniting apparatus admits of a wide range of adjustment. If, for example, a more instantaneous ignition is desired, the electrode Q can be made longer and its contact with the valve F' take place near the entrance of the oil or fuel from the valve F^2, where the combustible element has not been completely incorporated with the air. On the reverse this contact can be farther away from the valve F^2 or in any part of the chamber H. It will thus be seen that the admission of both air and oil or fuel and the position of ignition are all connected coincident and definite in relation, performed by one agent, so that derangement as to time and position is nearly impossible; that in this simple arrangement it is made possible to retain the correct relation between the time of firing the charges and the motion of the piston when the engine is reversed.

At the sides of the main frame are provided slotted flanges Y' Y^2 to support and guard the links J^3, J^4, J^5, and J^6, as seen in Fig. 14.

To start the engines when too large to be turned by hand, I employ, preferably, an auxiliary engine r, as shown in Fig. 20, connected by frictional gearing s to the main engine t and driven by compressed air stored in a tank or receiver u, the latter connected by a pipe v to the air-containing chambers m in the base A' of the main engine t. The receiver u is provided, so that a store of air can be accumulated while the main engine t is in motion.

I do not confine myself to this means of starting my improved engines. Any of the well-known means can be employed. The present one is shown to make the operative details complete in the description and drawings.

Having thus described the various constructive elements of a gas-engine made according to my invention, I will now proceed to explain briefly the method of its operation, first pointing out that all ducts for air, water, fuel, and spent gases are provided within the engine and its framing, thus utilizing the tubular sections for that purpose and avoiding external pipes and connections.

The compression of the air supplied for

combustion and its delivery to the combustion-chamber H at some predetermined pressure demands certain proportions between the volume displaced by the piston E' on its downward stroke and the cubic contents of the combustion-chamber H and clearances; otherwise the volume of air forced into the passages and chambers *m* would exceed the volume admitted to the chamber H, so that this chamber and the clearances connected therewith become a measure of the pressure at which the air can be maintained. If, for example, the air in the passages and chambers *m* is maintained at a pressure of four atmospheres, then the combustion-chamber H and clearances should have a cubic capacity of one-fourth the displacement of the piston E'. This proportion is not, however, absolute, but is self-regulating, because any increment of the amount of air forced into the chambers and passages *m* will be provided for by reduction of volume and consequent increase in the amount of air that passes into the chamber H.

In constructing an engine according to my invention it is necessary to provide cubic capacity in the combustion-chamber approximately in proportion to the air-pressure employed, that is, for a tension equal to two, three, four, or more atmospheres, as the case may be.

The charge of compressed air enters the chamber H at the same time with the charge of oil, the valve F' admitting both under the same pressure and in a manner to atomize and incorporate the fuel with the air. At the same motion the valve F' or its stem engages and lifts the electrode Q to a distance determined by adjustment of the screw *u'* and to a degree that determines the point of ignition by the release and resulting spark. This latter it will seem should not take place previous to the closing of the valve F', but in practice it is found that an appreciable period of time is required for ignition, and that when the valve F' is in rapid descent ignition can take place at almost any point of the valve's downward movement without the burning gases forcing their way back into the passages *m*.

Moving the lever L^3 forward or back, as indicated in Fig. 1, performs all the operations required in reversing the motion of the engine in respect to the induction, eduction, and ignition, as will be understood from explanations hereinbefore given.

What I claim is—

1. In a reversible gas-engine, a main cylinder and double-acting piston therein, a combustion-chamber and inlet-valve for compressed air and fuel, in the manner described, a hinged electrode engaged by the inlet-valve or its stem, and reversible valve-gearing that closes the valve and causes an igniting-spark at the end of the stroke when the engine is running in either direction, in the manner substantially as described.

2. In a gas-engine the combination with the main cylinder and piston therein, of a combustion-chamber connecting therewith, an inlet-valve for air and fuel operated by eccentrics on the main crank-shaft, a hinged or oscillating electrode coming in contact with and moved by the inlet-valve or its stem and forming poles for electrical ignition of the charge, and external mechanism provided with an adjusting-screw, by means of which the point of ignition may be regulated when the engine is running in either direction, substantially as set forth.

3. In a reversible gas-engine, the combination with the main cylinder having a piston therein, of the combustion-chamber connected therewith, a main inlet-valve for air and fuel, an exhaust-valve for spent gases, double cams on the crank-shaft to operate said valves, an oscillating electrode coming in contact with and moved by the inlet-valve or its stem and forming poles for electrical ignition of the charge, and external mechanism provided with a spring and adjusting-screw to regulate the range and time or point at which the inlet-valve will engage and release the oscillating electrode, in the manner substantially as described.

4. In a reversible gas-engine, a cylinder, piston and combustion-chamber connected therewith, in combination with an inlet-valve for air and fuel and forming a contact with a pivoted or oscillating electrode in the combustion-chamber, the latter supported on an insulated stem and connected with a conducting-wire, the insulated stem provided with a cross-lever, a spring and adjusting-screw outside the combustion-chamber to adjust the range, contact and point of release between the valve and hinged electrode, and a double cam on the crank-shaft having connection with a movable trip-bar to operate the inlet-valve.

5. In a reversible gas-engine, a cylinder and a piston therein, the latter acting for an air-compressor on its downward or outward stroke; an inlet-valve communicating with the external air, and an outlet-valve communicating with the engine inlet-valve for air and fuel and also with a passage formed in the main frame leading to cells in the bottom thereof, fuel inlet and exhaust valves and reversing-gearing to change the motion of the valves so a store of compressed air will be accumulated when the engine is running in either direction, substantially as described.

6. In a reversible gas-engine, a cylinder mounted on a double-leg frame, consisting of two tubular columns or supports set on and communicating with a hollow base, passages through the vertical columns or supports for air, cooling-water and also the exhaust-gases of the engine, in the manner substantially as described.

7. In a reversible gas-engine frame, a hollow base having chambers to contain compressed air, two vertical tubular columns

mounted thereon and connected to the engine-cyliner; a pump and ducts for cooling-water that passes into the hollow base, up one of the vertical columns and around the cylinder and combustion-chamber of the engine, such passages all within the contour of the engine-frame, in the manner substantially as described.

8. In a reversible gas-engine, a hollow frame, consisting of a base and two hollow columns thereon, the latter containing ducts or passages for air, water and waste gases, also having guides for the engine cross-head made integrally therewith, in the manner substantially as described.

9. In a reversible gas-engine, a cylinder and piston therein; an inlet-valve for air and fuel, and an exhaust-valve for spent gases, in the manner described; double cams on the crank-shaft, and double connections therefrom connecting to movable trip-bars L′, L^2, to operate the engine inlet and exhaust valves in the same relation to the piston when the engine is running in either direction, in the manner substantially as described.

10. In a reversible gas-engine, double eccentrics or cams on the crank-shaft at each side of the engine, the pairs of cams set oppositely or at coincident angles each way, connections from each cam to movable vibrating bars that open and release the inlet and exhaust valves of the engine by means of a lever L^3, so the engine may be reversed and run in either direction by shifting the vibrating bars or links L′, L^2, in the manner substantially as described.

11. In a gas-engine, a cylinder, piston, inlet and exhaust valves therefor, the latter operated by double eccentrics or cams on the crank-shaft, and a shifting trip-bar that will open the valve at the proper point to run the engine in either direction, and a ledge thereon that will hold the exhaust-valve open when the trip-bar is in its central or neutral position, in the manner substantially as described.

12. In a gas-engine, the combination of a cylinder, an impelling and air-compressing piston therein, and a combustion-chamber connecting therewith, the cubic contents of the cylinder and the combustion-chamber being in proportion to the respective volumes of the air when free and compressed, and a hollow base and two hollow columns thereon connecting with the main cylinder, and ducts for air, water and waste gases in said base, columns and cylinders, all in the manner substantially as described.

In testimony whereof I have hereunto affixed my signature in the presence of two witnesses.

ROLF J. ROLFSON.

Witnesses:

ALFRED A. ENQUIST,

WILSON D. BENT, Jr.