(No Model.)

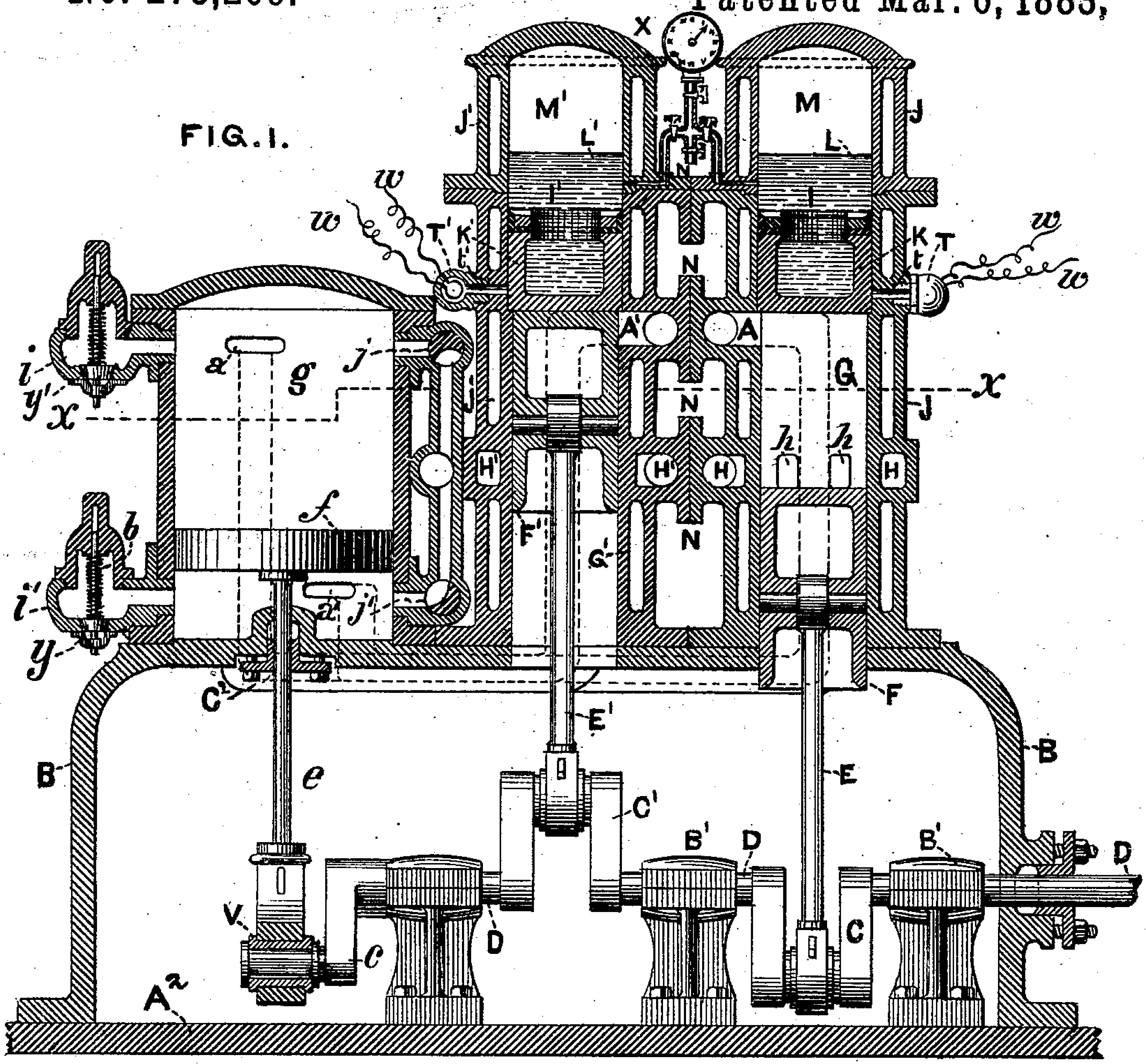
2 Sheets—Sheet 1.

E. J. FROST.

GAS ENGINE.

No. 273,269. Patented Mar. 6, 1883.

FIG. 1.



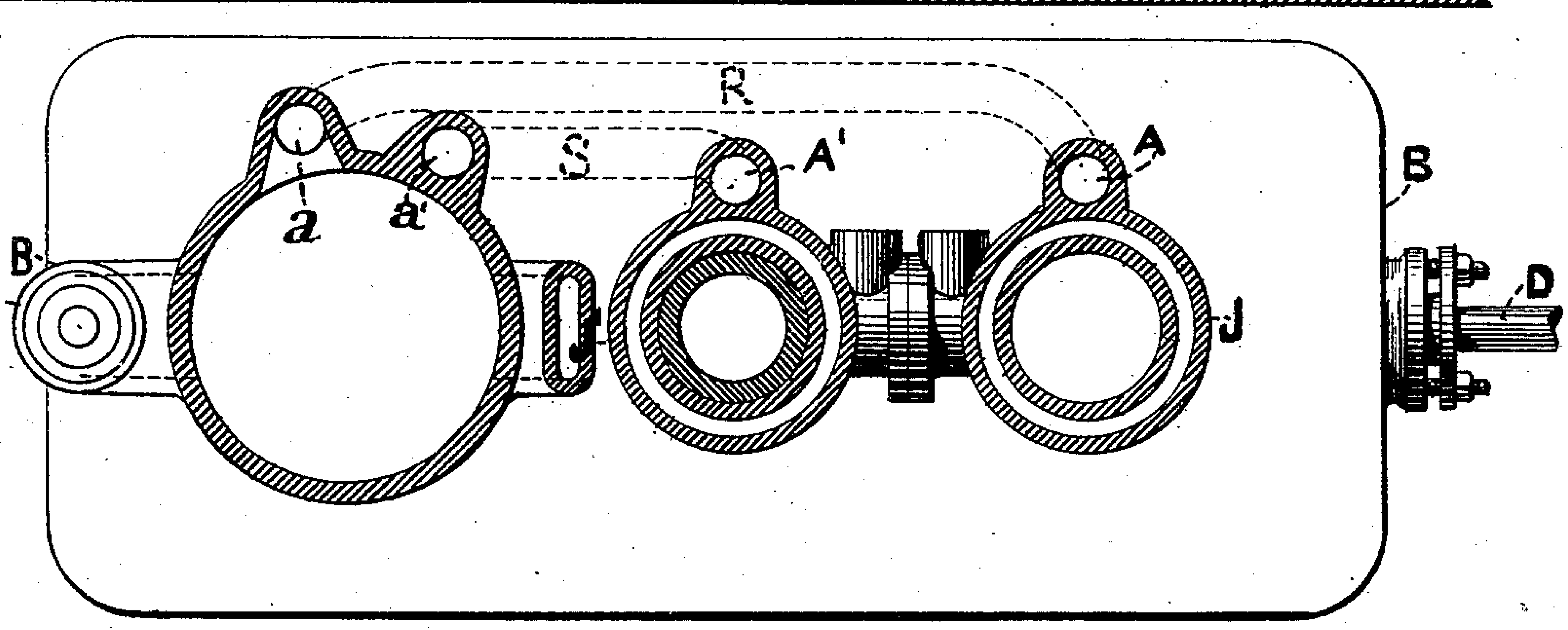


FIG. 2.

WITNESSES

J. Walter Douglass.

William W. Farr Jr.

INVENTOR

Edward J. Frost

By Jno. C. Fraley

Attorney

N. PETERS. Photo-Lithographer, Washington, D. C.

(No Model.) 2 Sheets—Sheet 2.

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FIG. 3.

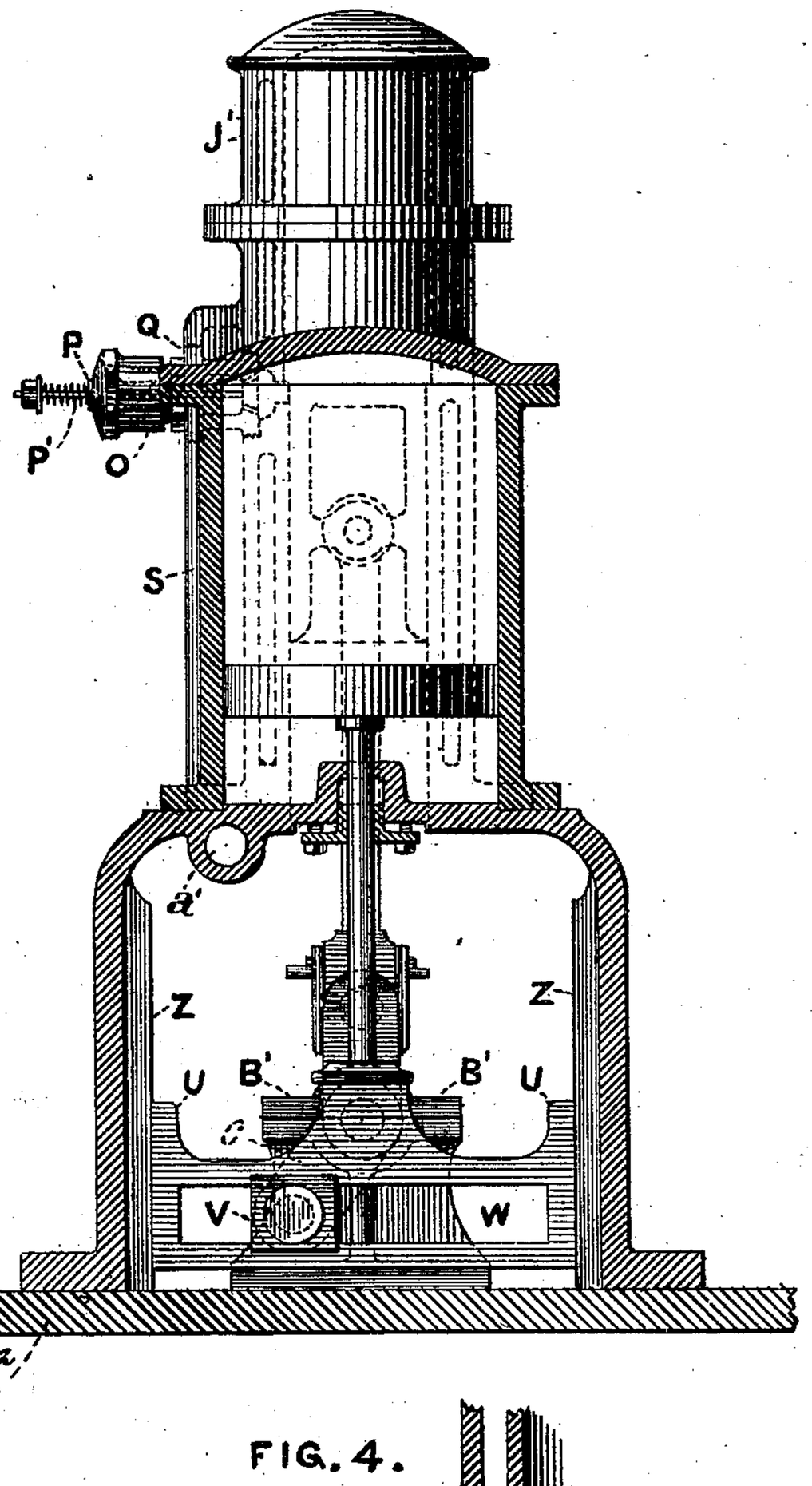
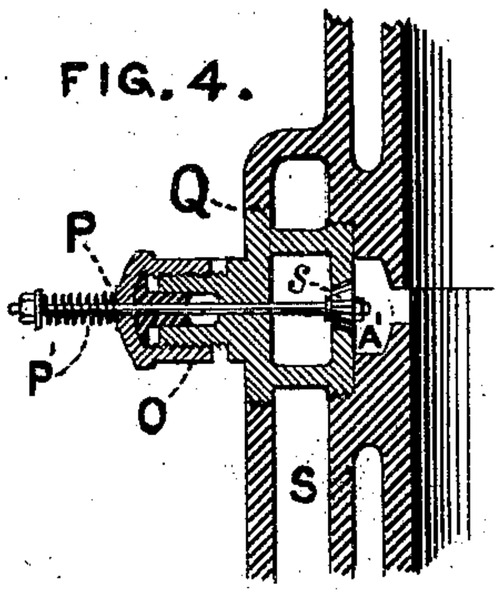


FIG. 4.



WITNESSES

J. Walter Douglass

William W. Farr Jr.

INVENTOR

Edward J. Frost

By J. L. Ralby

attorney

UNITED STATES PATENT OFFICE.

EDWARD J. FROST, OF PHILADELPHIA, PENNSYLVANIA.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 273,269, dated March 6, 1883.

Application filed July 26, 1882. (No model.)

To all whom it may concern:

Be it known that I, EDWARD J. FROST, of the city and county of Philadelphia, in the State of Pennsylvania, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification of my improvements, reference being had to the accompanying drawings, wherein—

Figure 1 is a vertical longitudinal section through the center of the apparatus, or on a line parallel to the driving-shaft. Fig. 2 is a top or plan view thereof. Fig. 3 is a vertical section, in a direction at right angles to that of Fig. 1, through the center of the gas-supply cylinder, showing also partly in perspective and partly in section one of the power-cylinders and its adjacent valve mechanism. Fig. 4 is a vertical section, on an enlarged scale, through the check-valve which controls the inlet of the power-cylinder.

It is the primary object of my invention to permit the use of a highly-explosive mixture of gas and air in the cylinder of the engine—a mode of operation which has heretofore been attended with difficulty, owing to the suddenness of the explosion and the consequent waste of power from the inability of the piston to move with sufficient rapidity.

To that end my invention consists in combining with what may be called the "power-piston" a secondary piston, which acts immediately upon the explosion to compress a quantity of air or other elastic fluid tightly contained in an adjacent cylinder, the force of the explosion (which takes place between these two pistons) being first exerted directly upon the power-piston, and being followed by the reactionary pressure of the secondary piston, due to the resilience of the air compressed by such secondary piston.

Various auxiliary features of improvement are employed to facilitate the action of these main features, and some of such auxiliary devices can be advantageously used in connection with engines of other types.

In the drawings, A^2 represents the bed-plate of the engine, which supports the pillow-blocks B'. A tight rectangular shell or box, B, incloses the bearings of the main shaft D, cranks C C' *c*, and is adapted to be filled with oil, so that these working-parts may be constantly lubricated.

Upon the box B are mounted, preferably on either side of the center-line, the power-cylinders G G', formed with jackets J J', respectively, to permit the exterior cooling of the cylinders by water in the usual way, and provided with ears or flanges N N N, which afford a convenient means of bolting the pair together. The cylinders G G' contain, respectively, pistons F F' of the usual form, which communicate by means of rods E E', respectively, with the cranks C C'. The cylinder G has an entrance-port, A, and exhaust-ports *h h*, the latter communicating with the exhaust-passages H H, cast in the cylinder-shells. In the cylinder G' the entrance-port is indicated by A' and the exhaust-passage by H', the exhaust-ports being covered by the piston in the position there shown. Above the extreme upward stroke of the pistons the cylinders are slightly enlarged, as shown, forming air-spaces M M'. The secondary pistons K K' respectively work in these enlarged portions of the cylinders, and are provided with cup-packings I I', respectively, above which, as well as in the interior of the secondary pistons K K', is a quantity of water or other liquid, serving both to insure a tight packing against the escape of air from the chambers M M' and to cool the pistons K K'.

Adjacent to that portion of the cylinders to which the charge is admitted are small passages *t t'* respectively leading to igniting-chambers T T', and within these igniting-chambers are platinum wires communicating through wires *w w* with electrical apparatus, by means of which said platinum wires may be maintained at a heat sufficient to ignite the gas in the chambers T T'. I contemplate the use of a small dynamo-electric machine run by the engine itself for the production of the necessary electrical current; but obviously other sources of electricity or other igniting devices of well-known forms may be used.

The gas-supply cylinder *g* is also mounted upon the box B, and contains the pumping-piston *f*. At each end of the cylinder *g* are gas-inlets *j j'* and air-inlets *i i'*, respectively. The former are controlled by cut-off valves, which are worked by any suitable governing device, and cut off the inflow of gas very considerably before the completion of the stroke of the piston *f*. The air-inlets *i i'* are provided

with check-valves *y y'*, held on their seats by springs *b b'*, so that while the gas-inlets are open no air enters; but after the cut off of the gas the continuing movement of the piston *f* causes an exhaust sufficient to raise the valves *y y'* and admit air during the remainder of the stroke, and as the air is drawn in last it will be the first portion of the charge to enter the power-cylinder on the return-stroke of the piston. An outlet, *a*, in the upper portion of the cylinder *g* leads by pipe R to the inlet A of the cylinder G, and a corresponding outlet, *a'*, in the lower part of the cylinder *g* leads by a similar pipe, S, to the inlet A' of the cylinder G'.

To prevent the back passage of the flame into the pipes R and S, I employ at each of the inlets A and A' check-valves *s*, which, with their spindles P, stuffing-boxes O, and pressure-springs, P' are mounted upon the sides of the power-cylinders G G' by means of bushings Q.

The rod *e* of the displacement-piston passes through a stuffing-box, C^2, to a cross-head, U, and a box, V, upon the crank *c* plays freely in a slot, W, in the cross-head, so as to cause the vertical reciprocation of the cross-head in the guides Z Z. The crank *c* is arranged so as to be somewhat in advance of the crank C, preferably by about one-eighth of a revolution.

The operation of my improved engine is as follows: The fly-wheel is first started by any secondary motive power and turned until the parts assume the positions shown in Fig. 1, when the upward movement of the piston *f* forces the charge of gas and air (previously mixed in any desired proportions) into the cylinder G. As soon as the piston *f* completes its upstroke the valve *s* is closed by the spring P', and as the piston F rises the charge is compressed in the upper portion of the cylinder G and between the pistons F and K. As the upstroke of the piston F is completed the compression of the gas is sufficient to raise the piston K somewhat, thus uncovering the passage *t* and establishing a communication with the igniting-chamber T. The gas ignites and explodes the charge in the cylinder G, giving a direct impact upon the piston F, and also upon the secondary piston K. The former is driven downward and the latter upward until the force of the explosion is balanced by the compression of the air in the chamber M, when the piston K rebounds downward, driving the expanded products of combustion and the piston F before it until the exhaust-ports *h h* are uncovered, when the spent charge passes out. Meanwhile the crank *c* has revolved and drawn in a second charge of gas and air at the other or lower end of the cylinder *g*, which charge, by a similar sequence of operations, is driven into the other power-cylinder, G', there to be similarly compressed, exploded, and discharged, and as the crank *c* is set ahead of the crank C the position of the charge which has been last indrawn, and which consists of air, is drawn first into the upper portion of the cylinders G G, while the exhaust-ports are still open, so as to drive before it the spent charge and wash out the cylinder.

A pressure-gage, X, may be connected with the compressing-chambers M M', so as to indicate the pressure yielded by the explosion. As has been before stated, the employment of these air-chambers permits the use of a highly-explosive mixture without loss of any efficient power, and they not only require no washing out after the explosion, being closed against the entrance of the products of combustion, but aid in cleansing out the cylinder itself on their downward stroke. Furthermore, the construction of the working parts, when arranged as above set forth, also adapts the engine specially for use under severe strain, and the arrangement of the cylinders out of line with and on opposite sides of the driving-shaft avoids the dead-points. As the most highly explosive mixtures of gas and air contain a very small percentage of the former, the economy due to their use is obvious.

Having thus described the nature and objects of my invention, what I claim herein as new, and desire to secure by Letters Patent, is—

1. In a gas-engine, the combination, with the cylinder and its driving-piston, of the compression-chamber and secondary piston, substantially as and for the purposes set forth.

2. The combination of a cylinder having entrance and exhaust ports at its opposite ends, a driving-piston whose downstroke uncovers the exhaust-port, and a compression-chamber adjacent to the cylinder, and provided with a secondary piston, whose downstroke terminates immediately above the entrance-port, whereby the charge is permitted to expand on both sides of the entrance-port, but after expansion is driven below the said extrance-port by the return of the secondary piston, and is finally expelled by the entering charge.

3. In a gas-engine, the combination, with the cylinder, of a power-piston, a secondary piston, and igniting-chamber, said igniting-chamber being alternately covered and uncovered by the movement of said secondary piston, substantially as set forth.

4. In a gas-engine, the combination, with the lubricating-box B, of the driving-shaft D and cranks C C' *c*, working therein, the power-cylinders G G', and gas-supply cylinder *g*, mounted upon said box and above the driving-shaft, substantially as set forth.

5. The combination of the compression-chamber M with the secondary piston and its hydraulic packing, substantially as and for the purposes set forth.

EDWARD J. FROST.

Witnesses:
J. WALTER DOUGLASS,
CHARLES F. ZIEGLER.