(No Model.) 8 Sheets—Sheet 1.

E. QUACK.

GAS ENGINE.

No. 441,582. Patented Nov. 25, 1890.

Fig. 1.

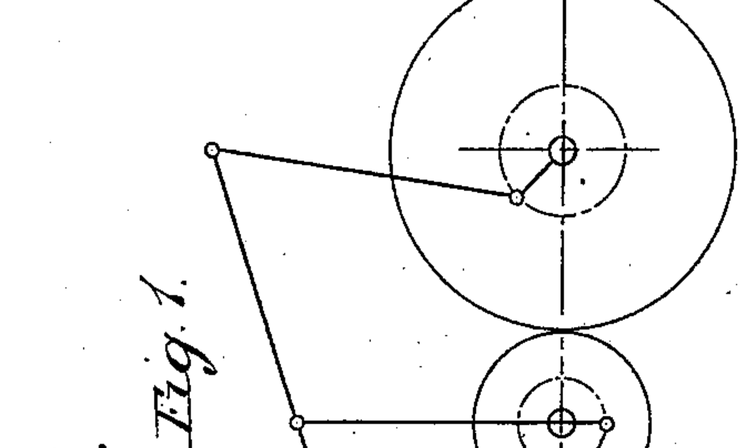


Fig. 2.

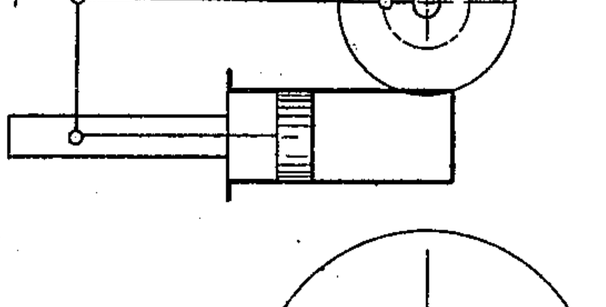
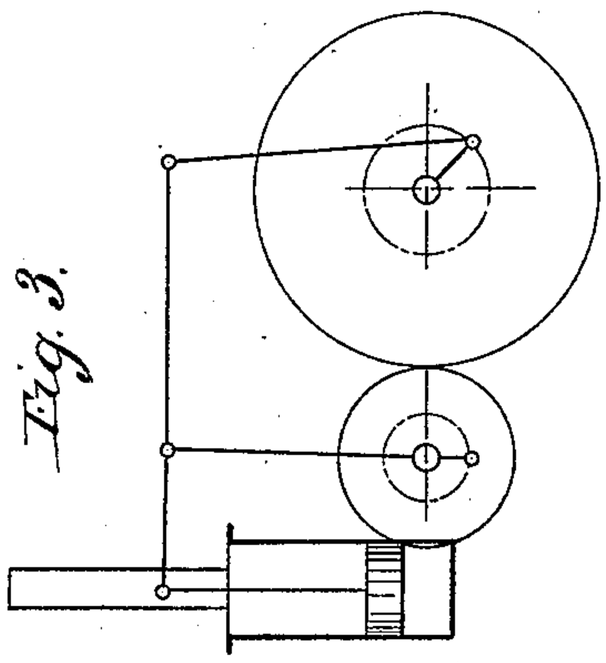


Fig. 3.



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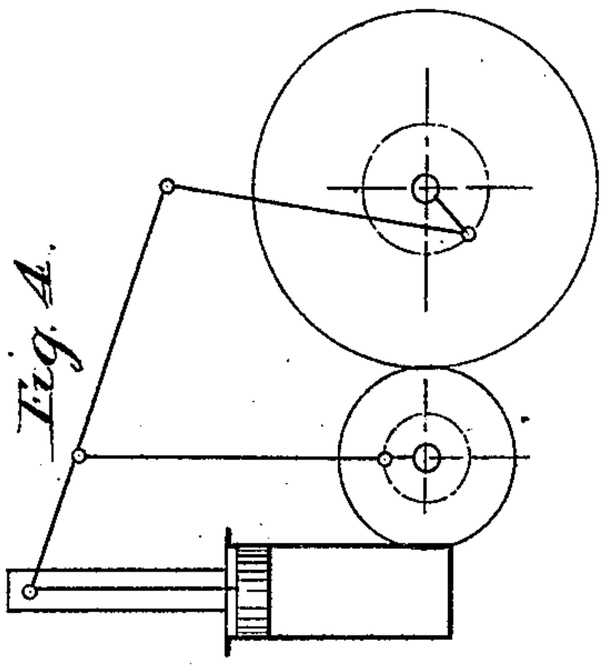


Fig. 5.

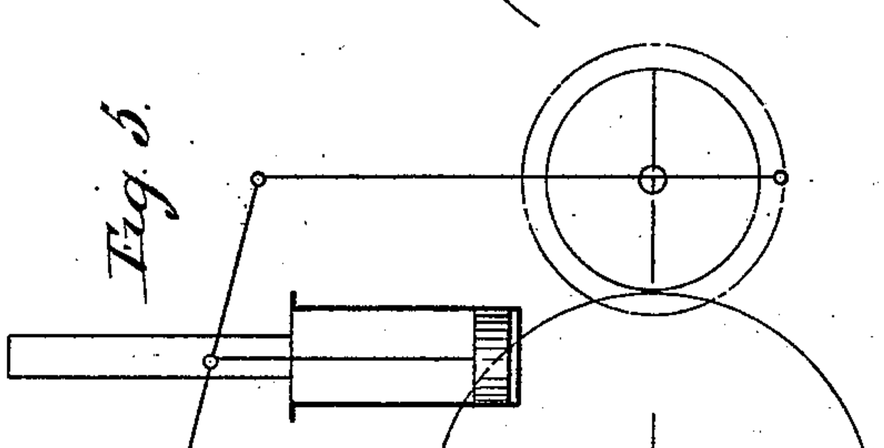
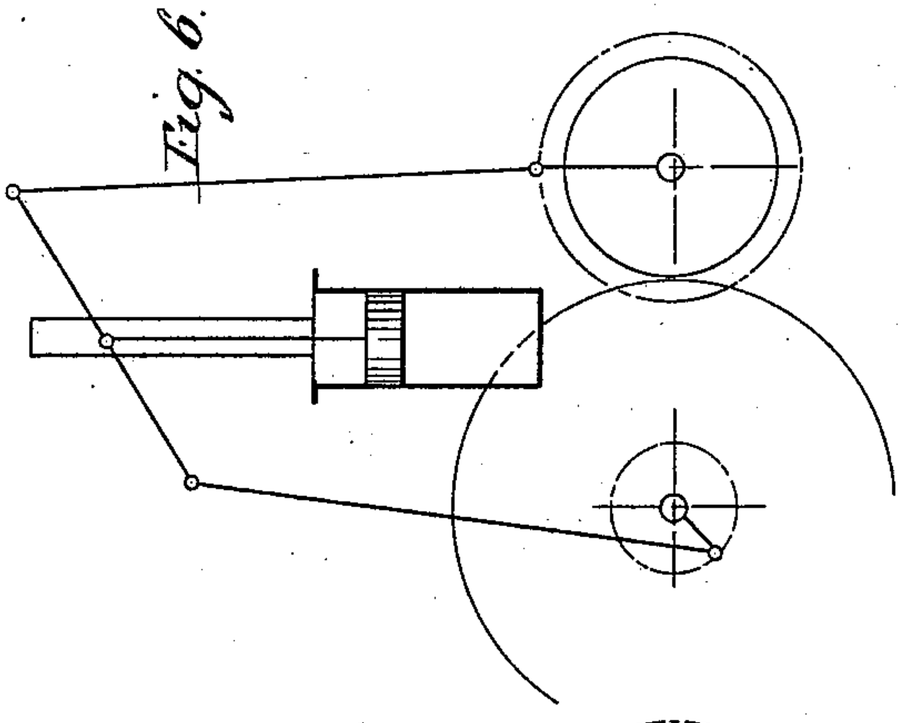


Fig. 6.



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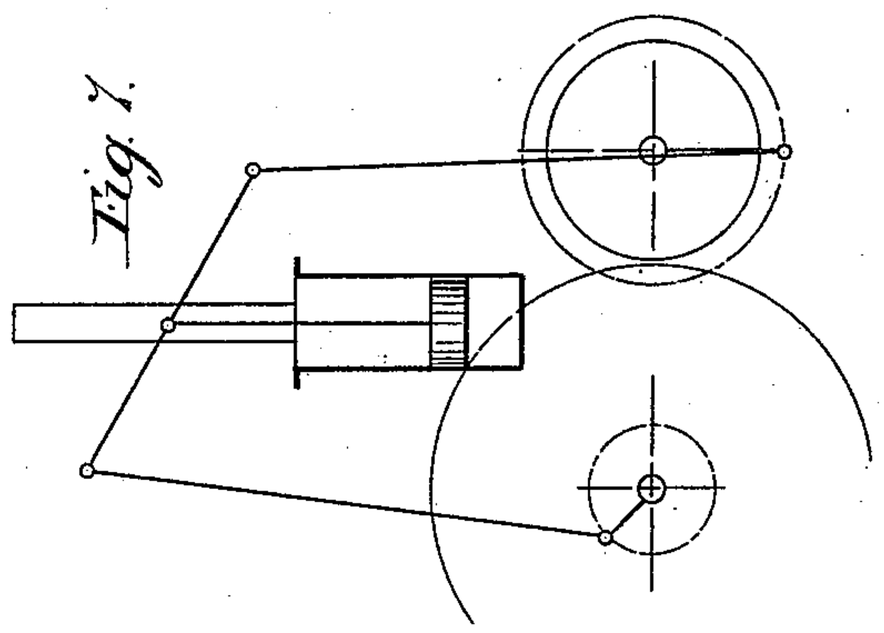

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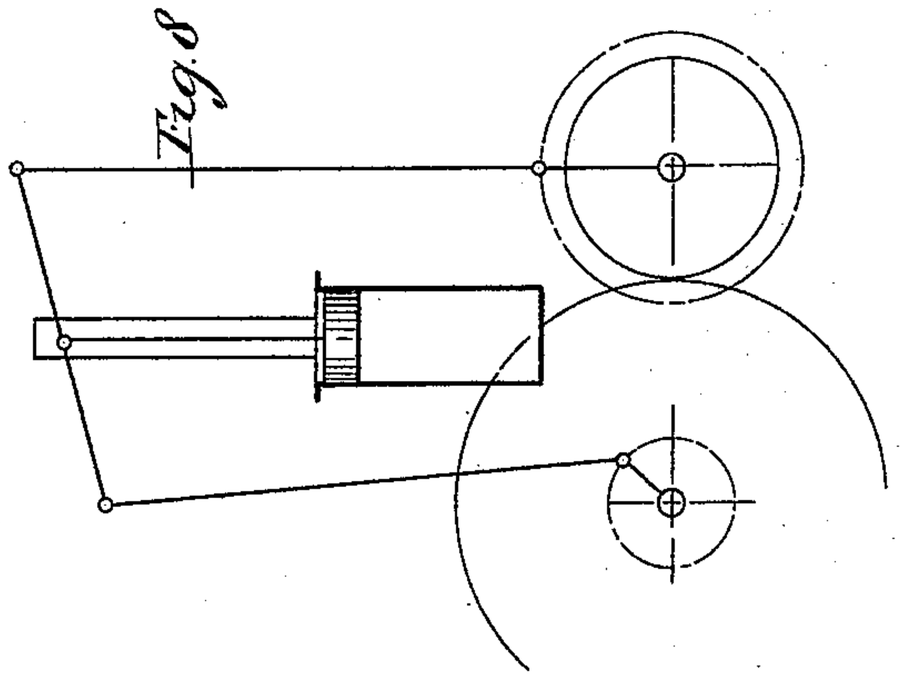

Witnesses.
H. R. McCready
Robert Everett

Inventor.
Edward Quack.
By James La Norris Atty.

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(No Model.) 8 Sheets—Sheet 2.

E. QUACK.

GAS ENGINE.

No. 441,582. Patented Nov. 25, 1890.

Fig. 12.

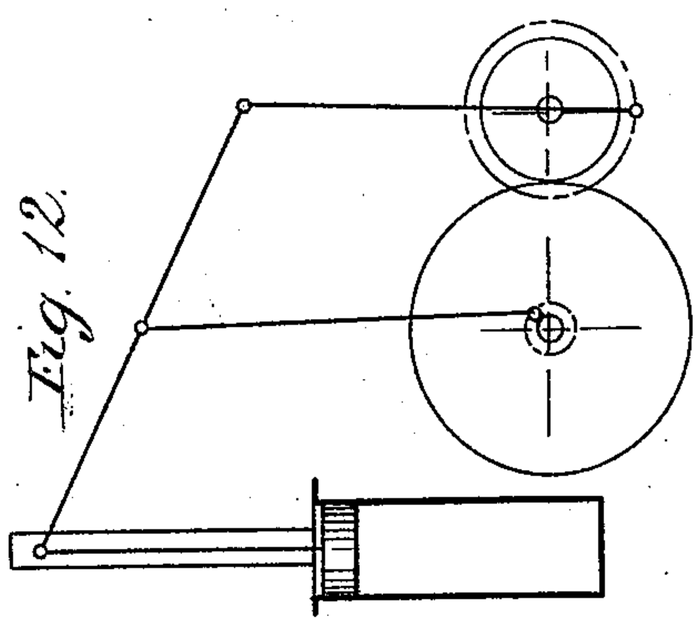


Fig. 16.

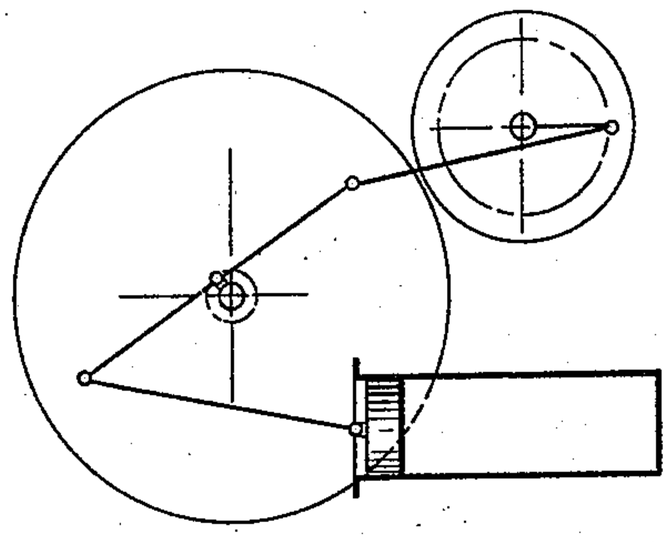


Fig. 11.

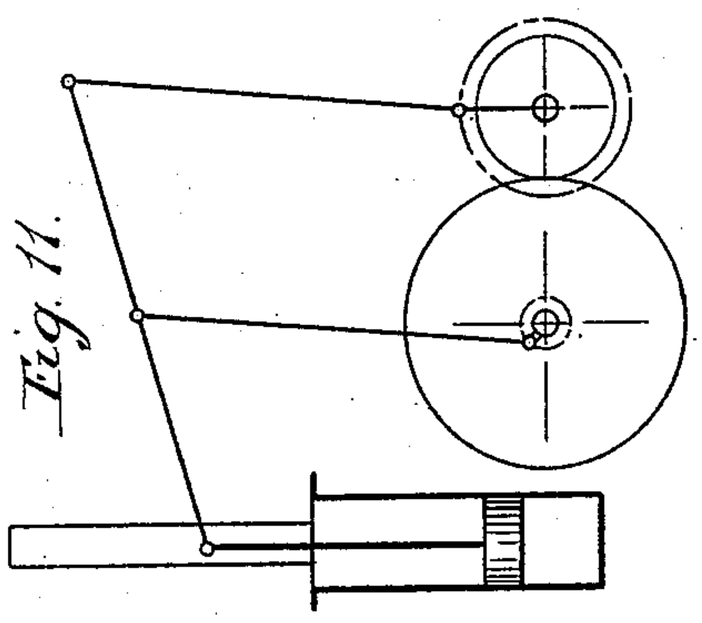


Fig. 15.

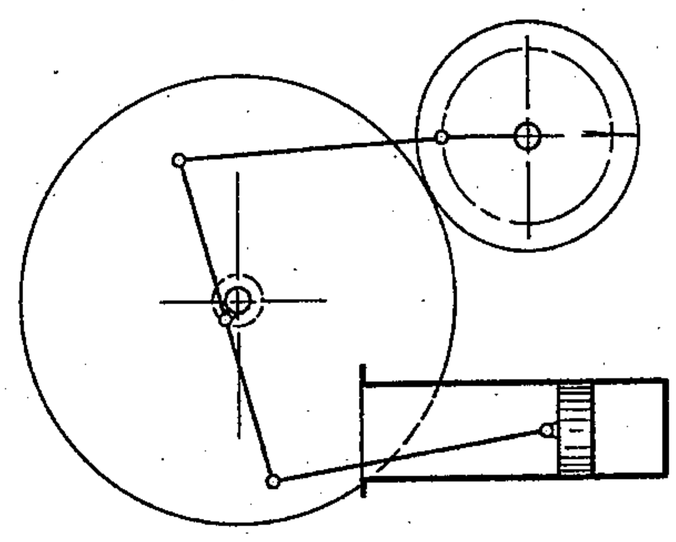
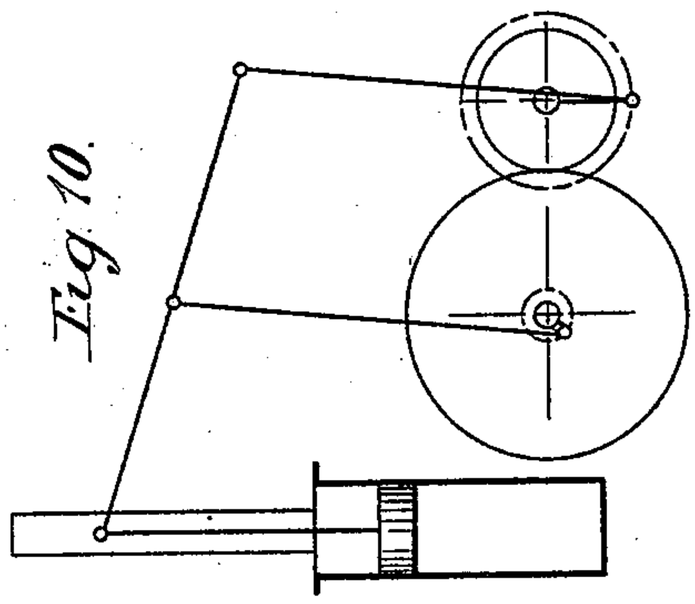


Fig. 10.



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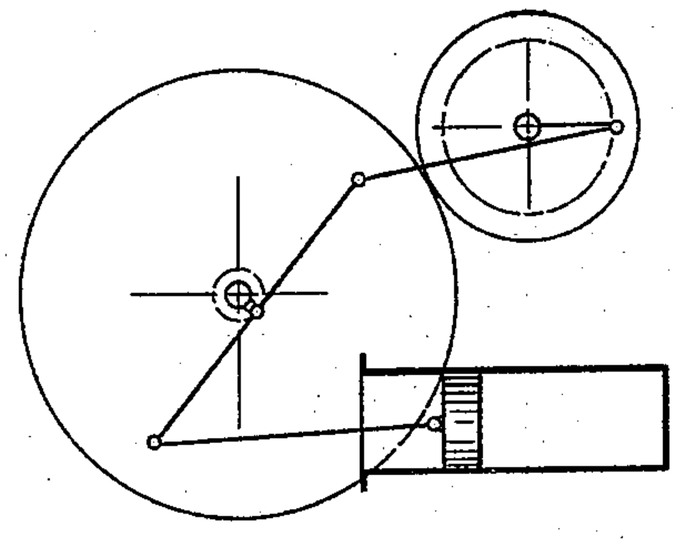


Fig. 9.

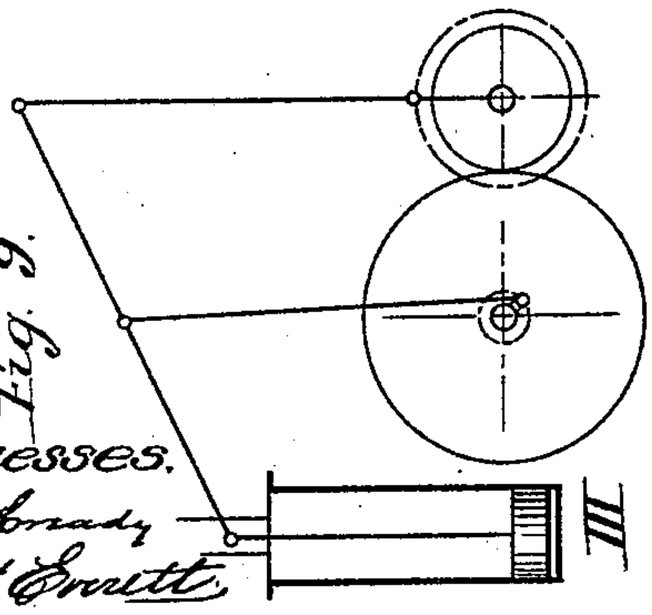
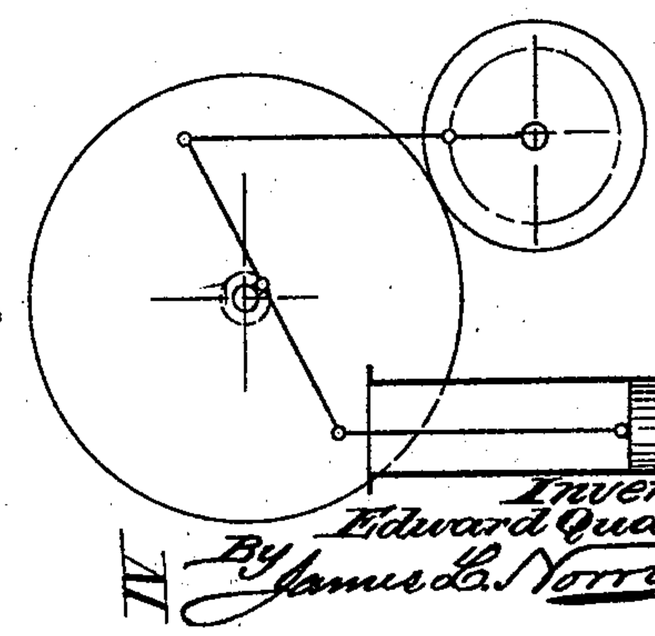


Fig. 13.



Witnesses.
N. R. McBrady
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By James La. Norris.
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(No Model.) 8 Sheets—Sheet 3.

E. QUACK.

GAS ENGINE.

No. 441,582. Patented Nov. 25, 1890.

Fig. 20.

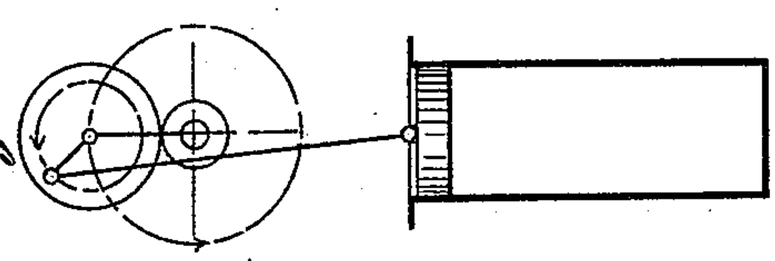
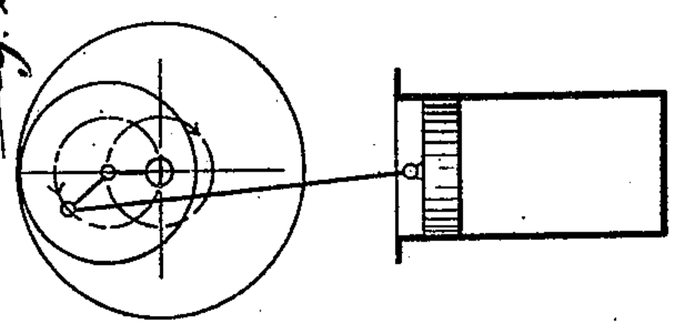


Fig. 24.



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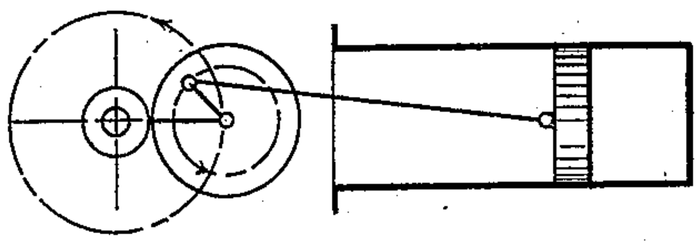


Fig. 23.

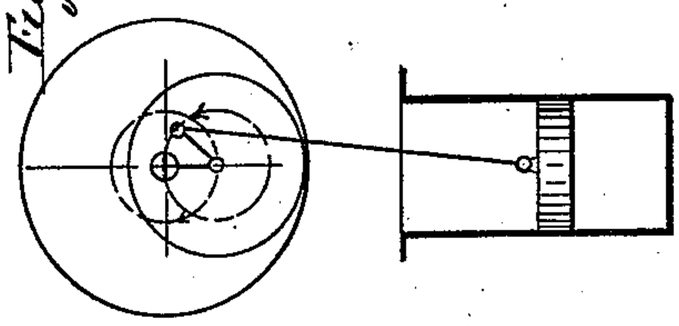
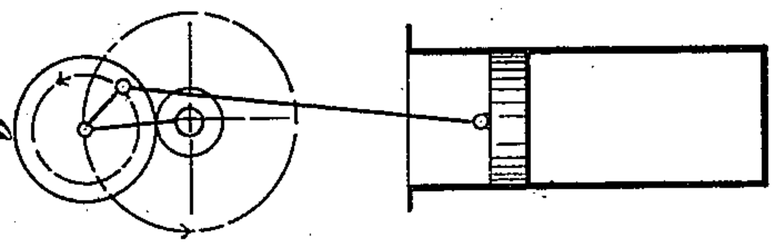


Fig. 18.



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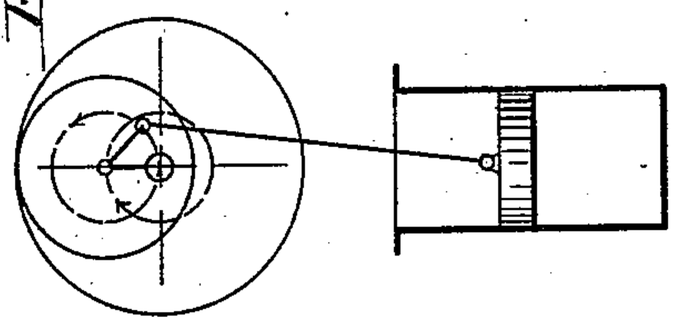


Fig. 17.

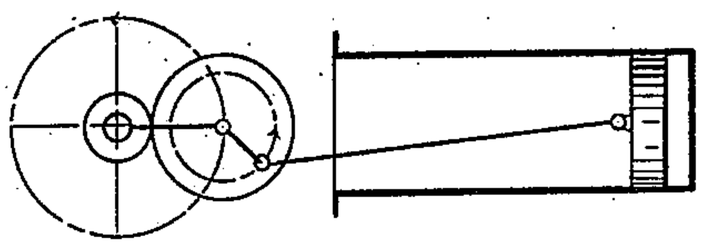
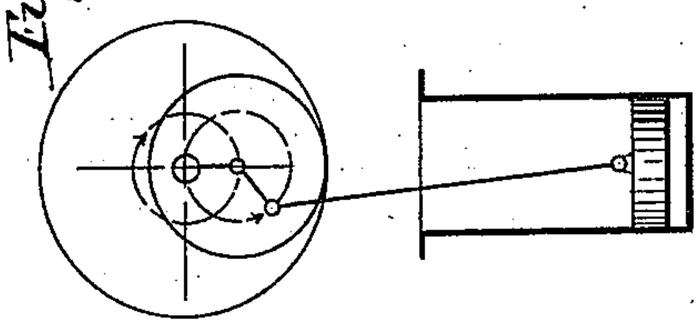


Fig. 21.



Witnesses

H. R. McCready

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(No Model.) 8 Sheets—Sheet 4.

E. QUACK.

GAS ENGINE.

No. 441,582. Patented Nov. 25, 1890.

Fig. 25.

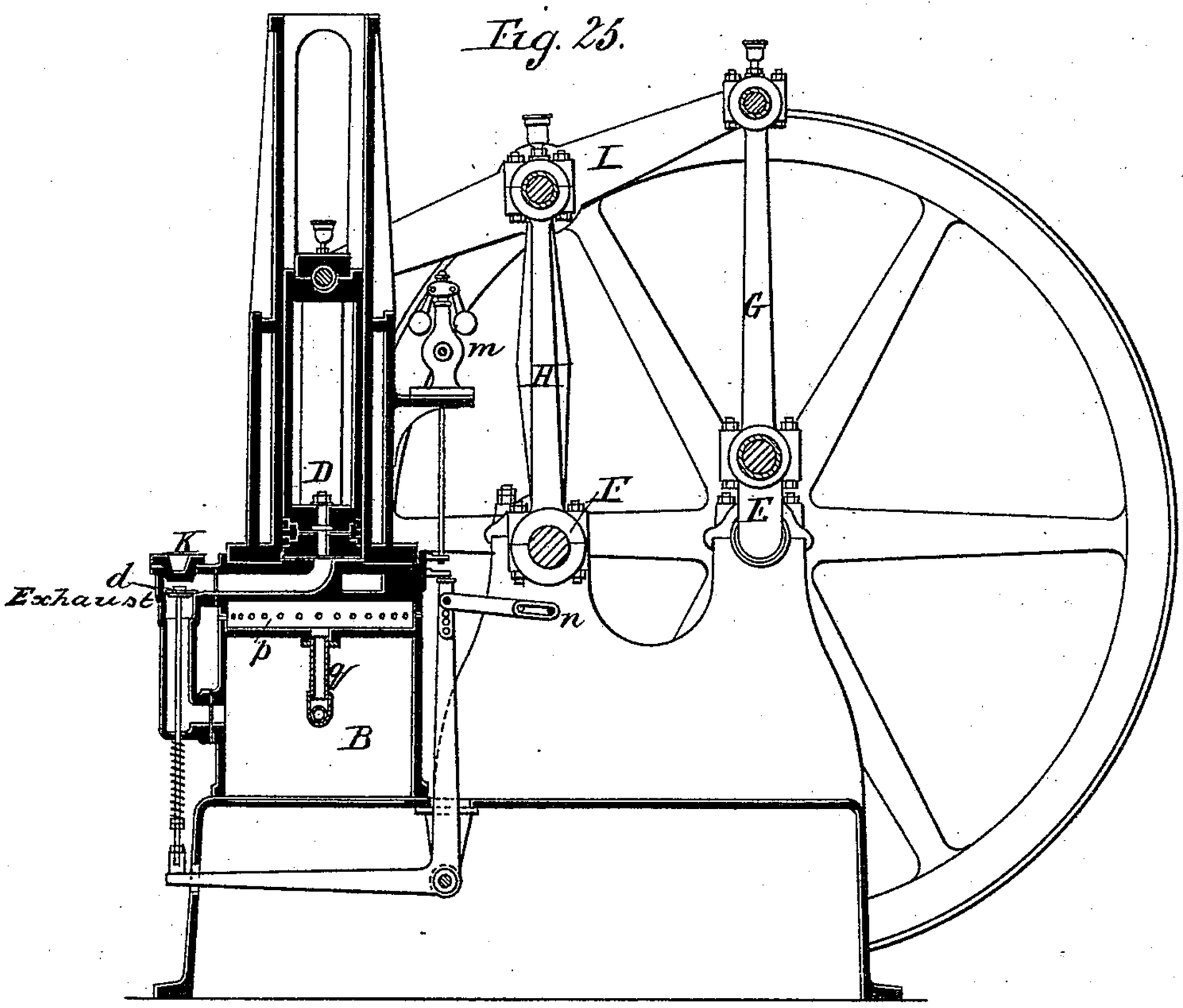
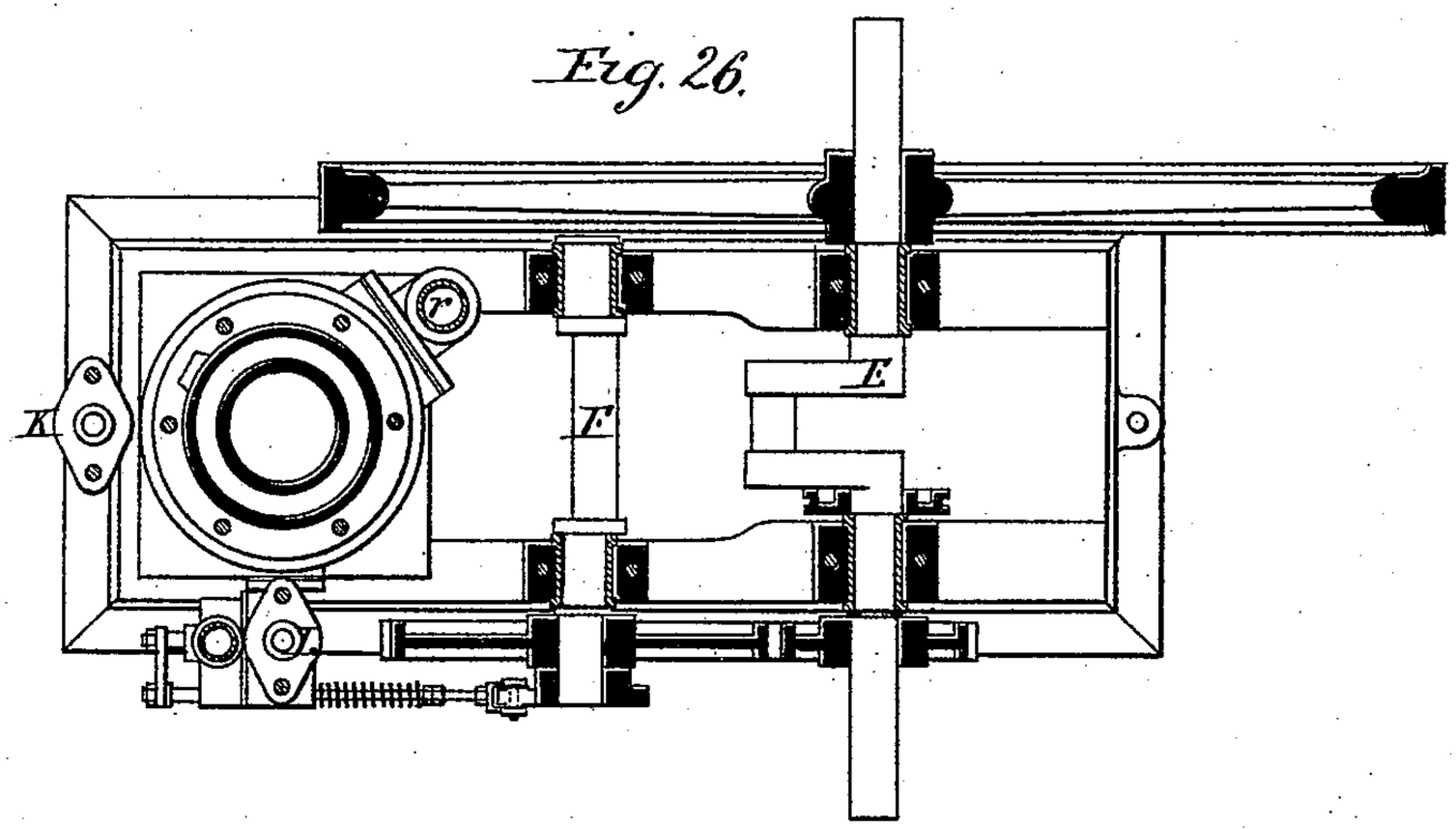


Fig. 26.



Witnesses.

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(No Model.) 8 Sheets—Sheet 5.

E. QUACK.

GAS ENGINE.

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Fig. 27.

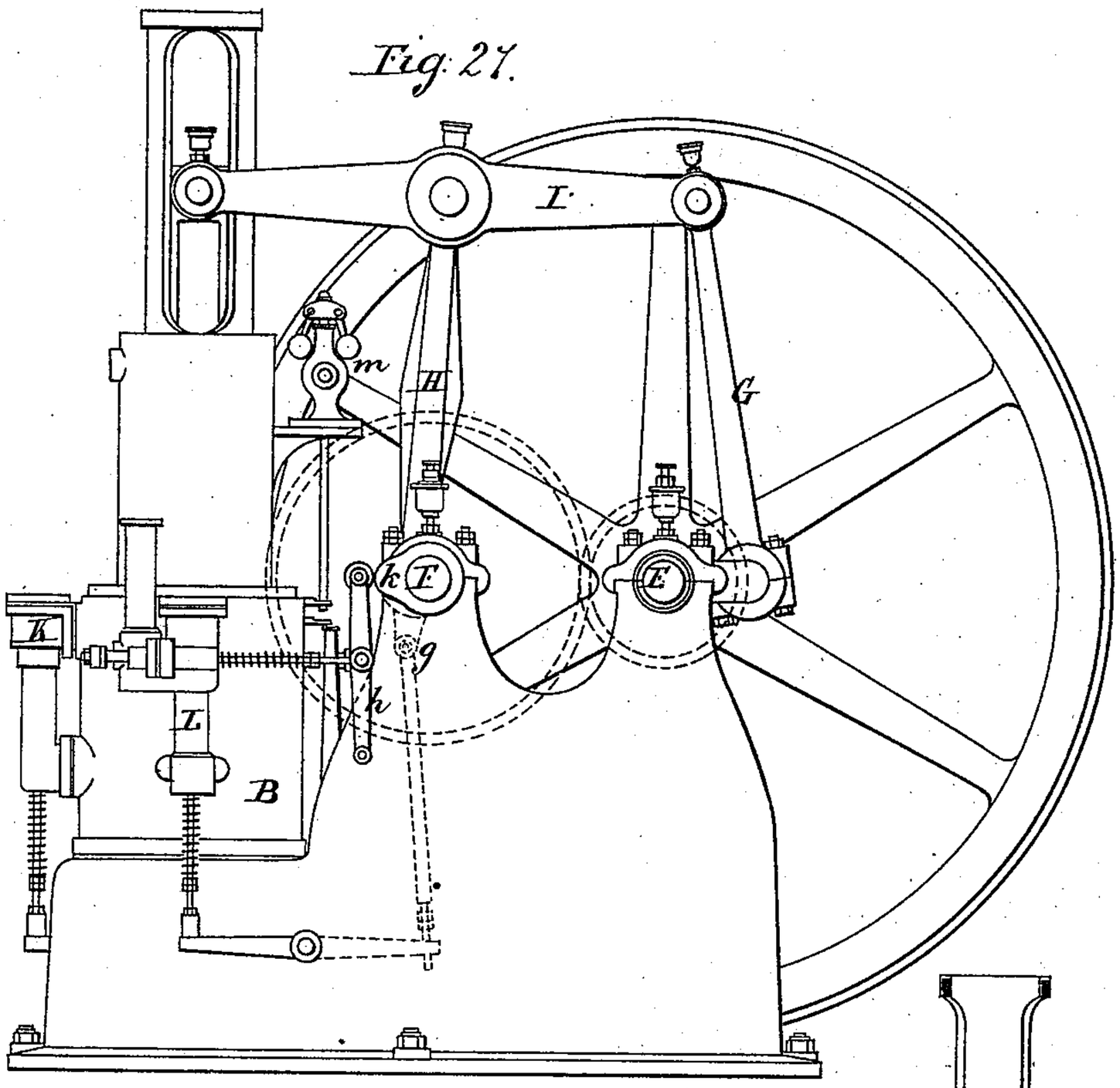


Fig. 37.

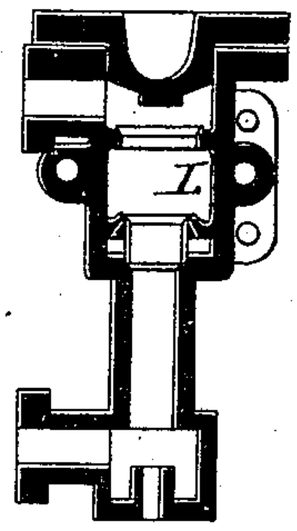


Fig. 38.

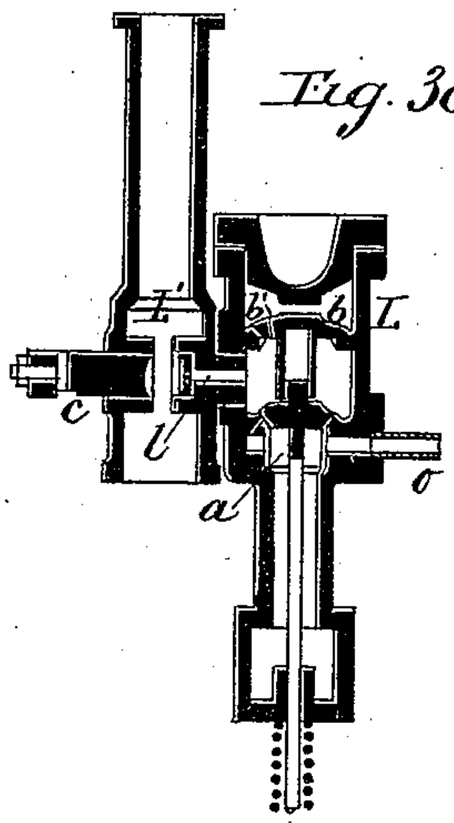


Fig. 39

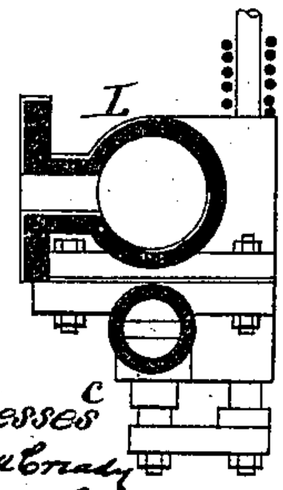
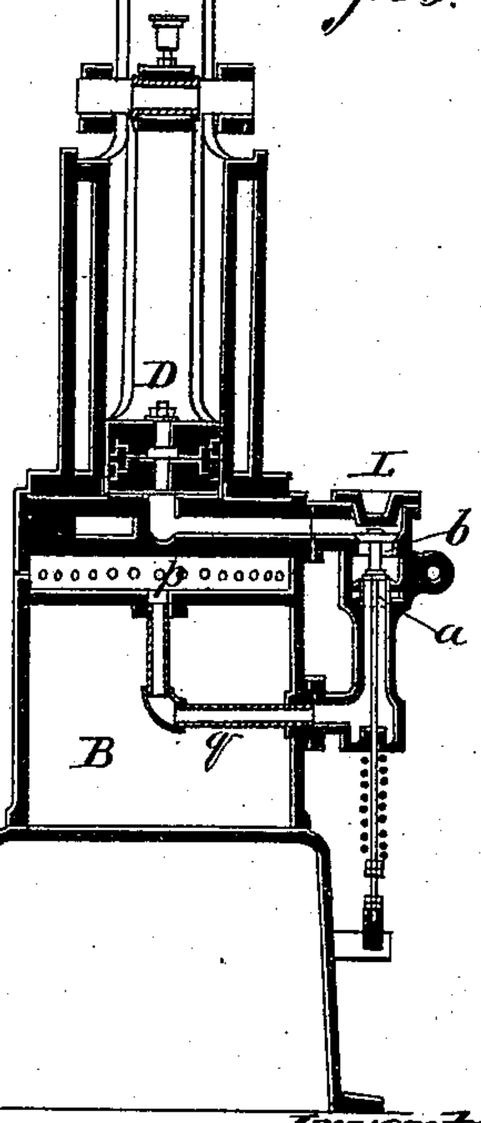


Fig. 33.



Witnesses
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(No Model.) 8 Sheets—Sheet 6.

E. QUACK.

GAS ENGINE.

No. 441,582. Patented Nov. 25, 1890.

Fig. 28.

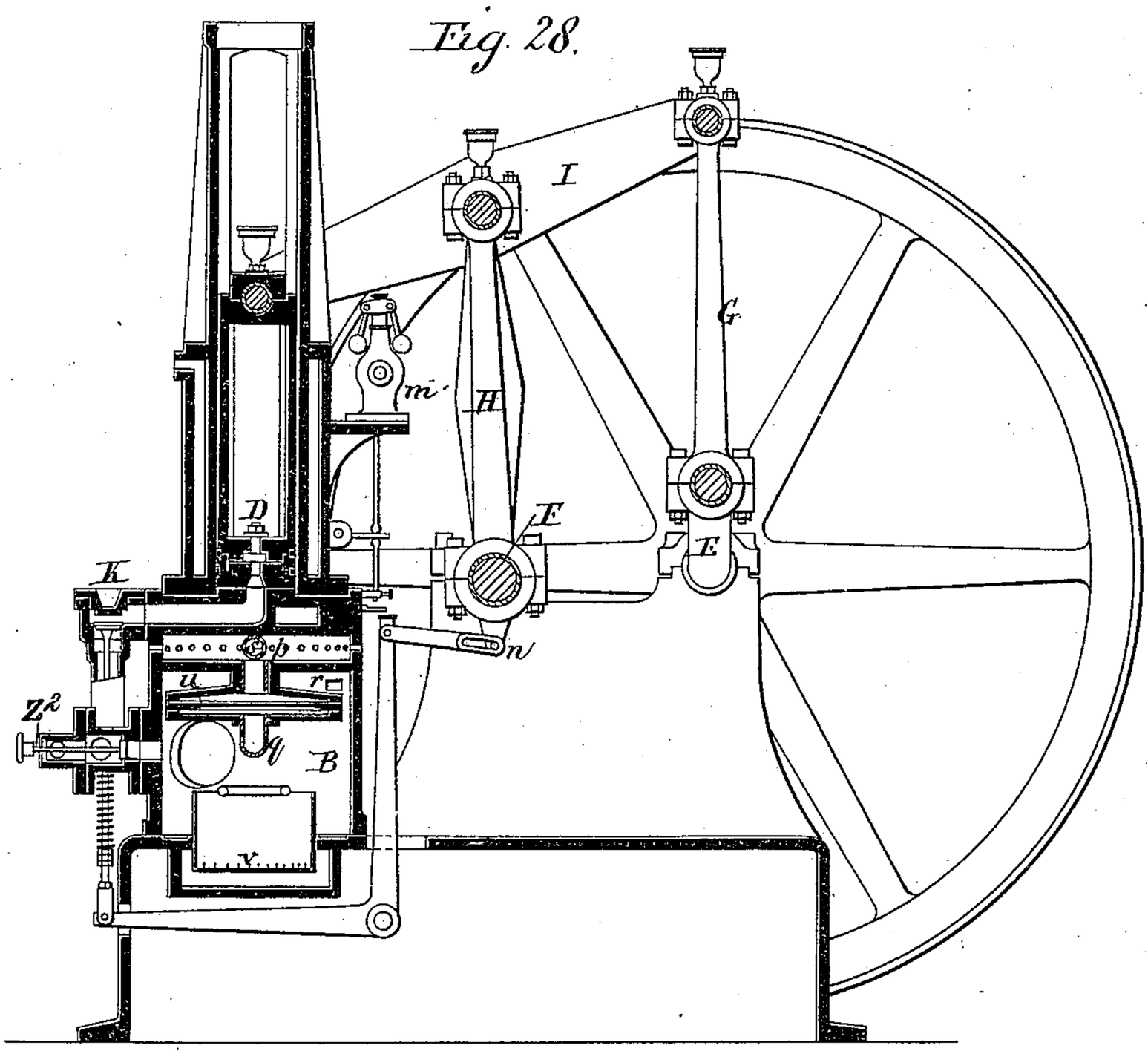
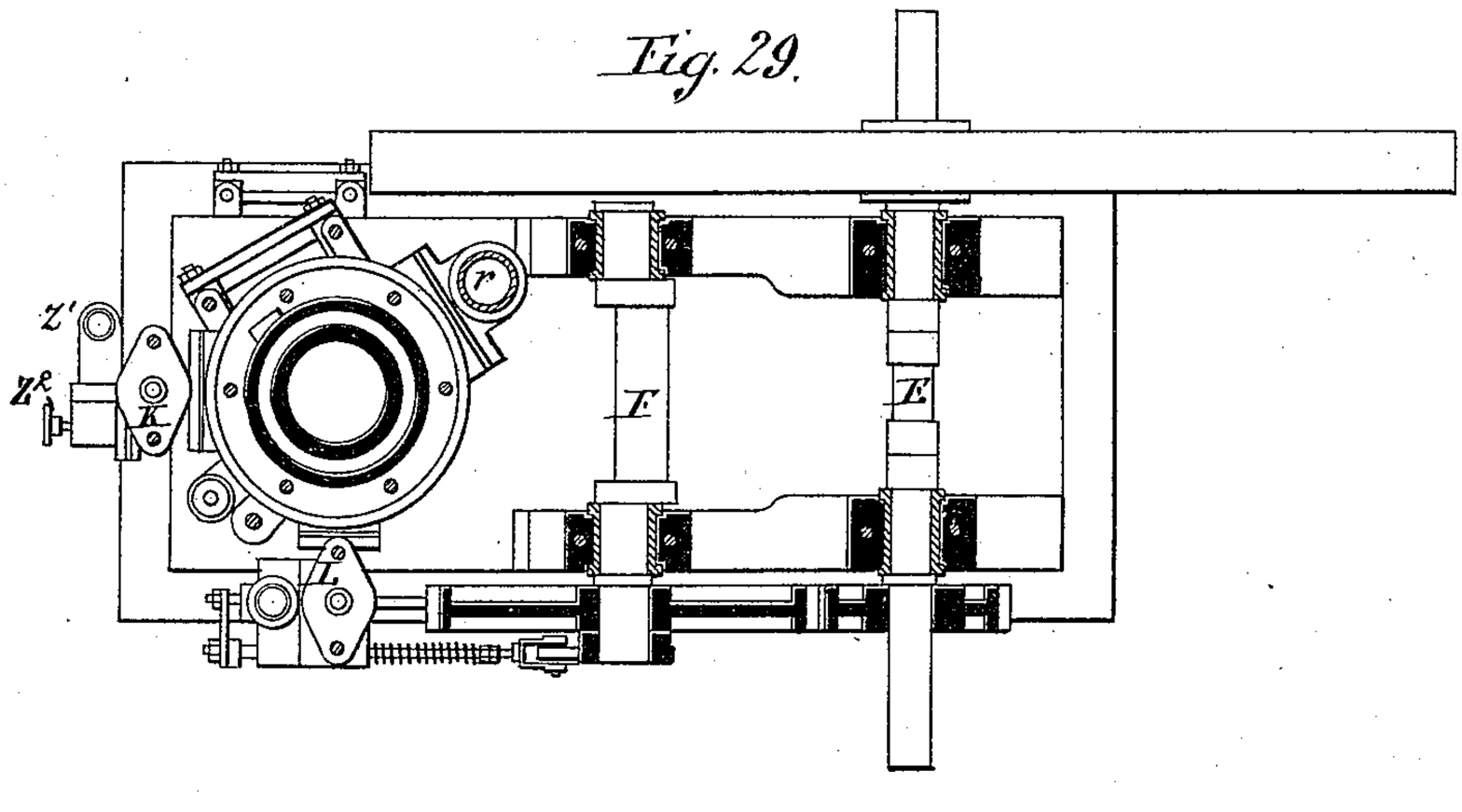


Fig. 29.



Witnesses

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(No Model.) 8 Sheets—Sheet 7.

E. QUACK.

GAS ENGINE.

No. 441,582. Patented Nov. 25, 1890.

Fig. 30.

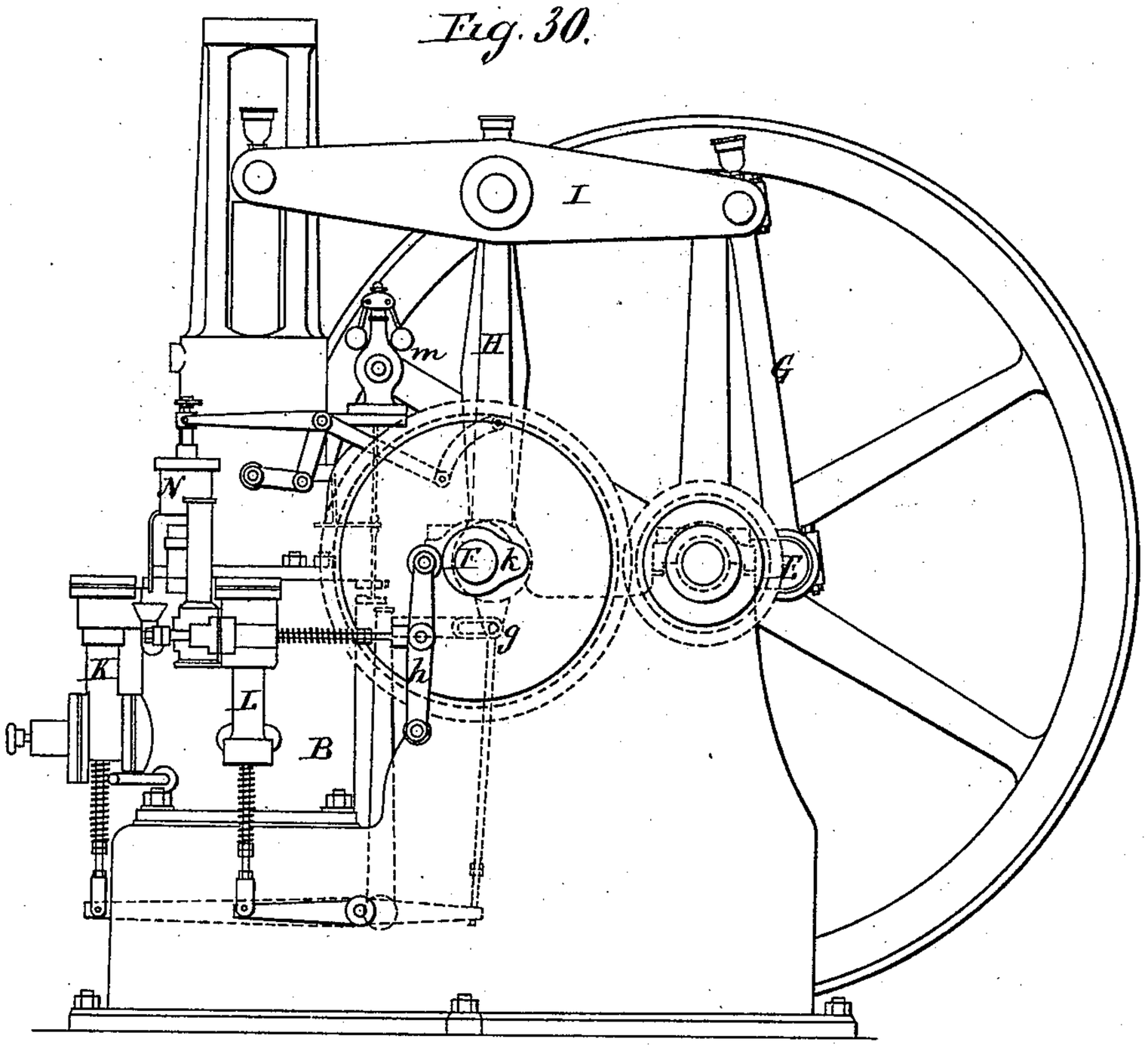
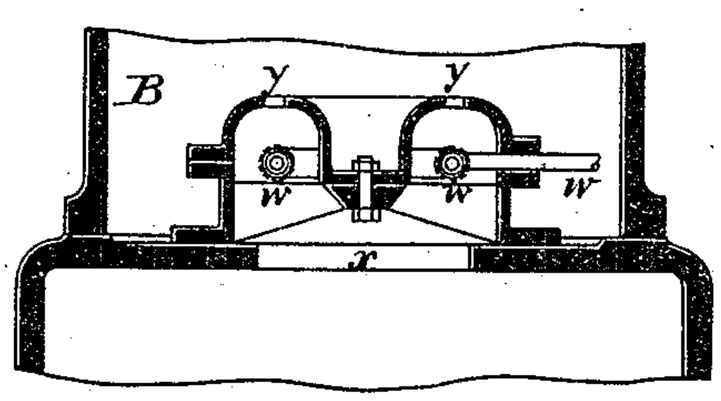


Fig. 35.



Witnesses.
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Robert Garrett.

Inventor.
Edward Quack.
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(No Model.)

8 Sheets—Sheet 8.

E. QUACK.

GAS ENGINE.

No. 441,582. Patented Nov. 25, 1890.

Fig. 31.

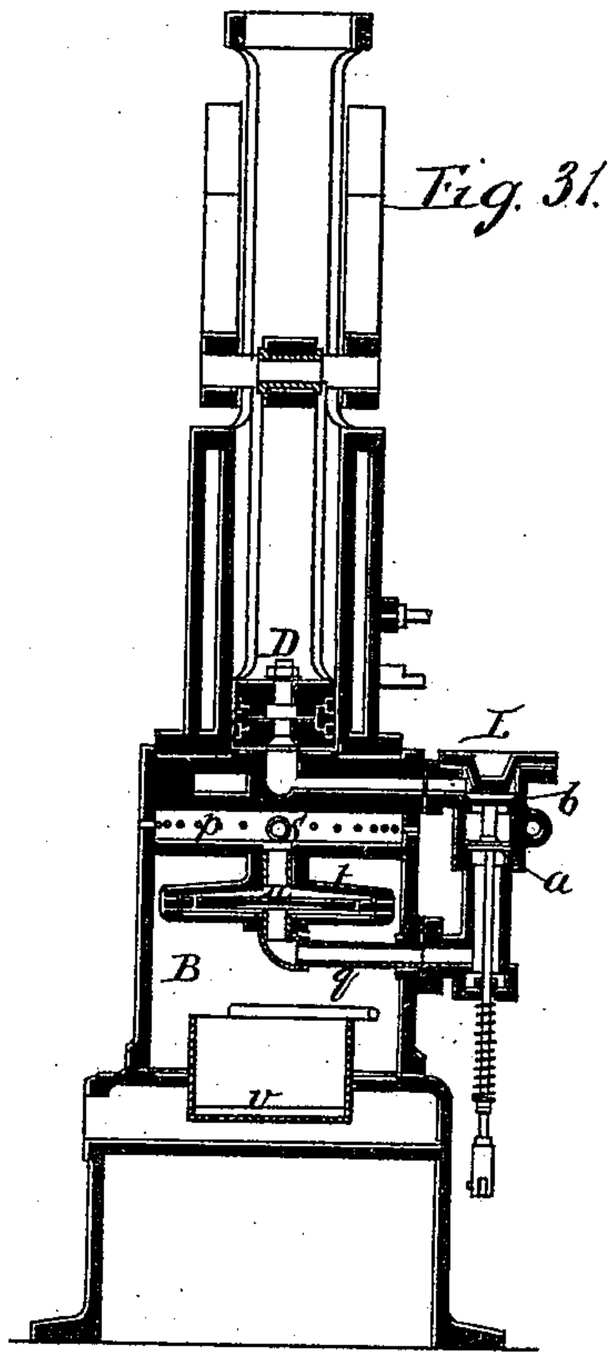


Fig. 32.

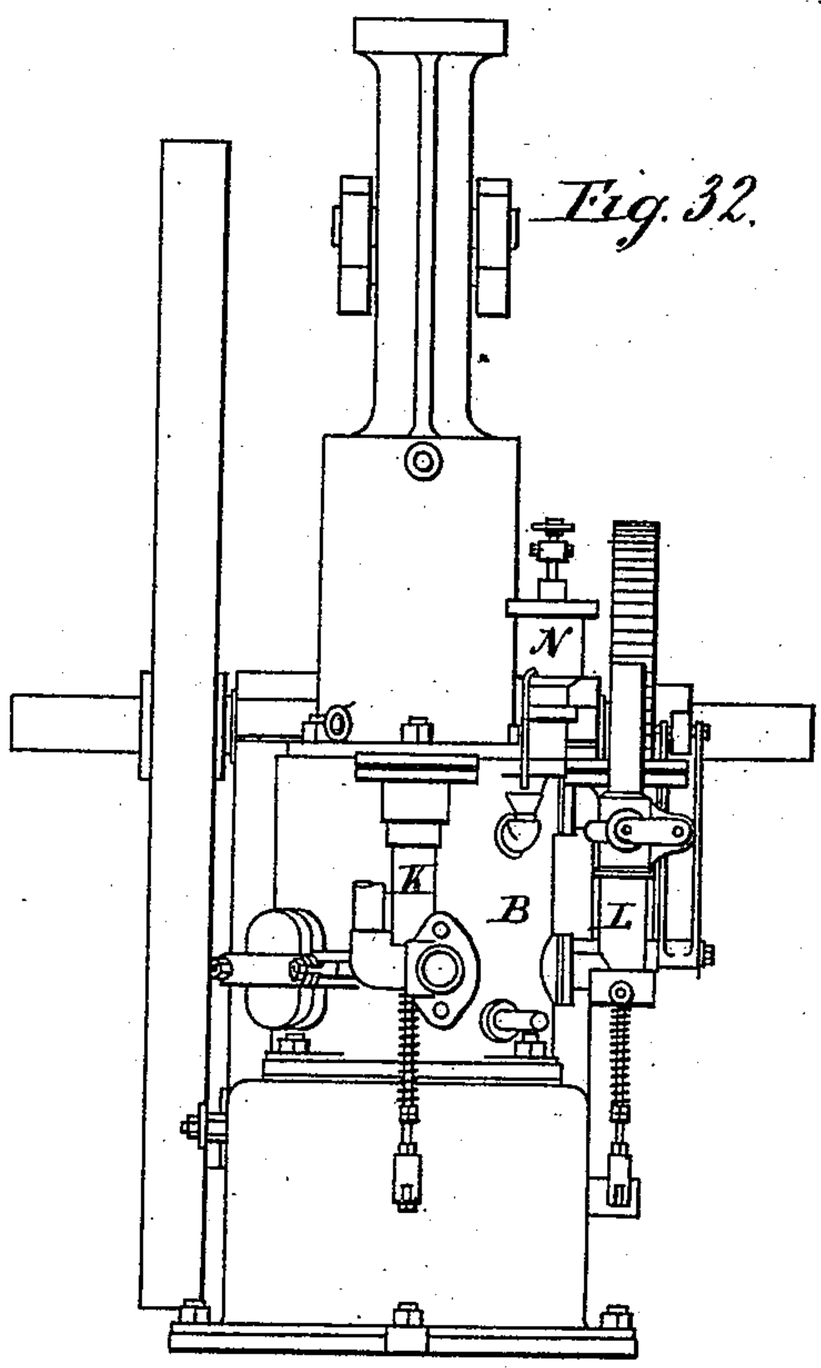


Fig. 34.

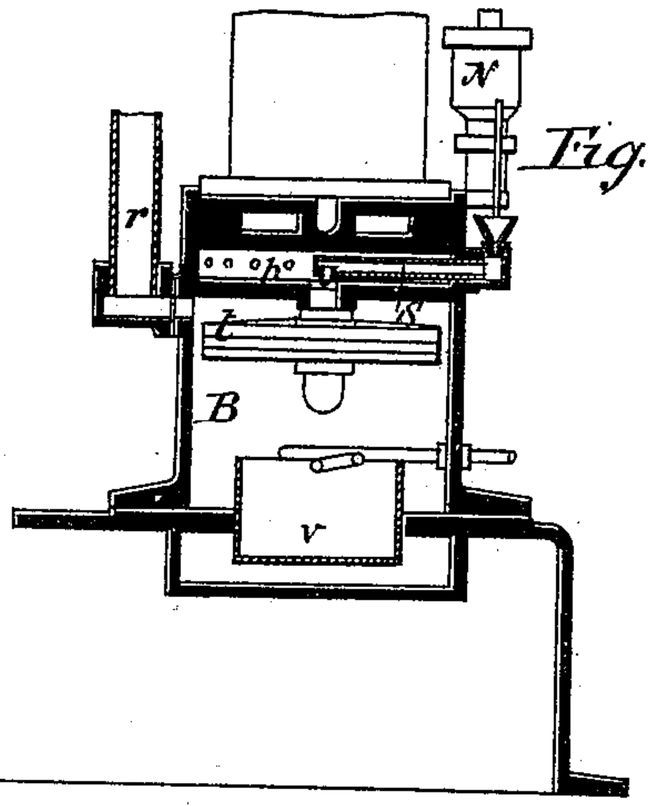
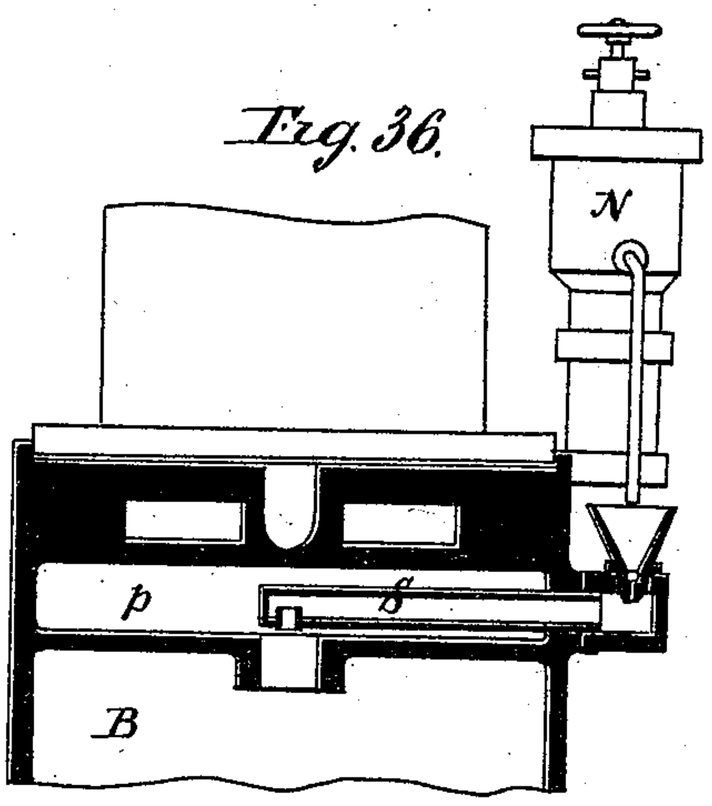


Fig. 36.



Witnesses.

N. R. McCready

Robt Burnett.

Inventor.

Edward Quack.

By James L. Norris.

Atty.

UNITED STATES PATENT OFFICE.

EDWARD QUACK, OF COLOGNE, ASSIGNOR TO C. W. HASENCLEVER SÖHNE, OF DUSSELDORF, GERMANY.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 441,582, dated November 25, 1890.

Application filed March 22, 1888. Serial No. 268,108. (No model.) Patented in Germany December 7, 1887, No. 44,273, and in England February 18, 1888, No. 2,466.

To all whom it may concern:

Be it known that I, EDWARD QUACK, engineer, a subject of the King of Prussia, residing at Cologne, Germany, have invented certain new and useful Improvements in Motor-Engines worked by combustible gas or vapor and air, (for which I have obtained Letters Patent in Great Britain, No. 2,466, dated February 18, 1888, and in Germany, No. 44,273, dated December 7, 1887,) of which the following is a specification.

My invention relates to that class of gas-motor engines in which the piston works with a cycle of four strokes—namely, drawing in the combustible charge, compressing the same, firing and working stroke, and expelling the products of combustion. According to my present invention I so construct such engines that the working-piston is made, at the end of the expelling-stroke and before commencing the suction-stroke, to approach so nearly to the end of the cylinder that the formation of a dead-space is avoided, while at the end of the compressing-stroke the piston remains sufficiently far away from the end of the cylinder to form the necessary chamber containing the compressed charge, so that on performing the working-stroke the highest or most forward position of the piston is above or in advance of that which it occupies at the end of the suction-stroke.

I will proceed to more particularly describe the arrangements which I employ for carrying my invention into practice, for which purpose I will refer to the accompanying drawings, in which—

Figures 1, 2, 3, and 4 are diagrams illustrating the invention and showing the piston in different positions. Figs. 5, 6, 7, and 8 are diagrams showing a modification of the invention with the piston in different positions. Figs. 9, 10, 11, and 12 are diagrams showing another modified arrangement with the piston in different positions. Figs. 13, 14, 15, and 16 are diagrams showing another modification with the piston in different positions. Figs. 17, 18, 19, and 20 are diagrams showing another modification with the piston in different positions. Figs. 21, 22, 23, and 24 are diagrams showing a further modification with the piston in different positions. Figs. 25, 26, and 27 show, respectively, a longitudinal section, a sectional plan, and a side view of a construction of the engine for working with ordinary combustible gas. Figs. 28, 29, 30, 31, and 32 show, respectively, a longitudinal section, a sectional plan, a side elevation, a vertical cross-section, and an end view of the same construction of engine as is shown by Figs. 25, 26, and 27; Fig. 33, a vertical cross-section through the engine-cylinder and valve apparatus; Fig. 34, a section of a vaporizing apparatus for the engine; Fig. 35, a modification of the same; Fig. 36, a view similar to Fig. 34 on a larger scale; Figs. 37 and 38, vertical sections on a larger scale, at right angles to each other, of the inlet and igniting valves and their casing; Fig. 39, a sectional plan view of the inlet and igniting valves and their casing.

In the various arrangements the shifting of the piston's stroke, as before described, is effected by not connecting the piston directly by a connecting-rod to the crank-shaft, but by interposing between them an intermediate mechanism, which consists of an auxiliary crank, that is connected to the crank-shaft by toothed or other gearing having such proportions that the said crank rotates at half the speed of the crank-shaft, the connection of the several parts being such that the positions of the piston during the first double stroke of the cycle are made to differ from those during the second double stroke by means of the varying positions which the said auxiliary crank occupies during such strokes relatively to the crank of the crank-shaft. Thus, taking the arrangement No. III, (shown at Figs. 9 to 12, and of which a practical construction is shown at Figs. 25, 26, and 27 of the drawings,) the crank F is connected by toothed gear having the proportion of two to one to the crank-shaft E of the engine. The crank F is connected to a rod H, the upper end of which constitutes the fulcrum of a beam I, to one end of which is connected the piston D, while its other end is connected by the rod G to the crank-shaft E. Thus it will be seen that during the two

revolutions of the crank-shaft that form the cycle of the engine the fulcrum of the beam I will be shifted vertically through a distance equal to the double throw of the crank F, thereby causing the second double stroke of the piston to be shifted to a corresponding extent relatively to the first. Figs. 9, 10, 11, and 12 show, respectively, each of the four relative positions which the two cranks occupy at the end of each of the four strokes of the cycle.

It will be readily understood that the mode of arranging the secondary crank in combination with the crank-shaft may be greatly varied for carrying out this mode of working. Thus in the arrangement No. I, Figs. 1 to 4, the crank-shaft is situated between the cylinder and the auxiliary crank, which in this case is consequently connected to the end of the beam serving as the fulcrum. At No. II, Figs. 5 to 8, the cylinder is in the middle between the crank-shaft and the auxiliary crank. At No. III the auxiliary crank is between the cylinder and crank-shaft, as first described. At No. IV the auxiliary crank is connected directly to the center of the beam. At No. V the beam is dispensed with and the auxiliary crank is connected directly to the piston-rod and is carried by the crank of the crank-shaft, the two being geared together by external toothed wheels. At No. VI the parts are arranged in the same way as at No. V, but the cranks are geared together by internal toothed wheels instead of by external gearing.

It will be readily understood that in the above-described arrangements the main crank-shaft and auxiliary crank may change places—that is to say, the frame may be the one that revolves at the slower speed; also, in place of gearing the cranks together by toothed wheels, any other system of transmission may be used. When employing a beam, the three points of connection may be made to assume any angle with each other instead of being in a straight line. The various arrangements may also be modified to suit horizontal single engines and horizontal or vertical twin engines.

The action of the gas-motor engine constructed according to this invention is as follows, referring to Figs. 25, 26, 27, and Figs. 37, 38, and 39:

The combustible gas enters the valve-casing L through the pipe *o*, Fig. 38, into an annular channel, from which it issues through a number of small openings in the seat of the inlet-valve *a*. At the same time the air passes from the chamber *p* in the base B of the cylinder (into which it enters through a row of small holes) through pipe *q* and also passes under the inlet-valve *a*. On opening the valves *a* and *b* at the same time that the piston D is made to perform its suction-stroke, air and gas enter the cylinder under the piston, becoming mixed as they enter. On the return-stroke, the valves *a* and *b* being closed, the piston compresses this charge, and at the same time forces a small quantity thereof through a very small hole *f'*, Fig. 38, in the inlet-valve *b* into the space between the valves, and thence through the igniting-passage *l* to the igniting-flame in the chamber L'. At the moment when the piston has arrived at its lowest position the ignition-valve *c*, which is actuated by a cam, is closed against the passage *l*, and the flame of the ignited mixture is thus made to strike back into the chamber L', whence it is transmitted through the hole in valve *h* to the cylinder charge. The working-stroke of the piston now takes place, during which it rises to its extreme position. On the commencement of the following expelling-stroke the expulsion-valve *d* in the chamber K, Fig. 25, which till then was held closed, is opened, in order to let the gases escape into the base B, from which they pass into the atmosphere through the exhaust-pipe *r*, Fig. 26. The cycle is then repeated.

The inlet-valves *a b* and the exhaust-valve *d* are not actuated by cams, but directly by the auxiliary crank F by means of two pins *g* and *n* on an arm formed on the eye of the rod H, Figs. 28 and 30, which pins act on levers that operate the valve-stems, as shown. The valve *b* is not connected rigidly to the valve *a*, but has a hollow stem fitting loose over a projection on valve *a*, so that on valve *a* being lifted it also raises valve *b;* but *b* can rise and fall independently of *a*. For regulating the speed a governor *m* is provided, which acts in the known manner upon the gas-admission valve. The ignition-valve *c*, Fig. 38, is actuated by a cam *k* on the axis of the auxiliary crank and by the lever *h*, pivoted to the engine-frame.

By the addition of some special apparatus this gas-motor engine is rendered equally applicable for working with liquid combustibles which are vaporized either in the hot or in the cold state. Among others the light and heavy petroleum-oils may be used, and at Figs. 28, 29, 30, 31, and 32 is shown a construction of motor which is more particularly adapted for the use of light petroleum-oils.

This motor-engine is generally of the same construction as previously described. It has only added to it:

First. A measuring apparatus N, Fig. 30, which measures the quantity of liquid to be taken in for each cylinder charge.

Second. The transport-channel S, Figs. 34 and 36, for conveying the measured quantity of liquid to the vaporizing apparatus, the said channel having an inwardly-raised discharge-opening, so that it always remains charged to a certain extent, as shown more clearly at Fig. 36.

Third. The vaporizing apparatus, Figs. 28 and 31, consisting of a casing *t* in the base B, in which casing is a plate *u*, onto which the liquid drips from the channel *s*, and where it mixes with the air entering from the air-chamber *p* through the central opening of the casing, whence it flows in a thin film over the

upper surface of the plate *u* and round the edge thereof to the under side, and thence to the inlet-valve through pipe *q*, the vaporization and mixing being facilitated by suitably restricting the area in the casing at the circumference of the plate *u*, which, as also the casing, is heated by the exhaust-gases from the engine. From this apparatus the gaseous mixture passes through the channel *q* under the inlet-valve, the further operation being the same as previously described.

Fourth. Heating apparatus for heating the cold vaporizing apparatus on starting the engine by means of petroleum, consisting in a burner *v*, placed in the base B under the vaporizing apparatus. This burner can be constructed in various ways. At Figs. 28, 31, and 34 it is shown consisting of a vessel with perforated or grid-shaped bottom filled with porous refractory material, onto which the petroleum drips from a perforated coiled pipe and where it enters into combustion with the air passing up through the grid-bottom. In the modification shown at Fig. 35 the petroleum-supply pipe *w* is of annular form, and is surrounded by a woven covering of asbestus or other refractory material, the ring being inclosed in a casing having an annular slit *y*. Air enters the casing through the opening *x*, and in coming in contact with the petroleum with which the porous covering *w* is saturated vaporizes the same, the resulting gaseous mixture being burned on issuing from *y*.

Fifth. The hand-operated valve Z^2, with double cone for two seatings, Fig. 28, so arranged as to allow the exhaust-gases of the engine to pass directly into the atmosphere through pipe Z′, Fig. 29, so long as the burner *v* is in action. On reversing the position of this valve after starting, the exhaust-gases are afterward made to pass into the base B for heating the vaporizing apparatus, and then to escape through pipe *r*, Figs. 29 and 34, as with the gas-motor engine.

Having thus described the nature of my invention and the best means I know for carrying the same into practical effect, I claim—

1. In a gas-motor engine working with a four-stroke cycle, the combination, with two cranks on separate axes coupled together by gearing, whereby one is made to revolve twice as fast as the other, and the piston, of a beam connected directly with the piston and with the two cranks, substantially as described.

2. In a gas-motor engine, the combination of two admission-valves for the combustible charge, having a space between them for containing a firing charge of the combustible mixture, the valve nearest the cylinder being raised by the other valve, but being also free to rise and fall independently thereof, and having a small hole for the passage of a portion of the compressed cylinder charge into the space between the two valves, substantially as herein set forth.

3. In a gas-motor engine working with a cycle of four strokes, whose piston is connected to two cranks, of which one revolves at half the speed of the other, and in which the combustible charge is admitted to the cylinder through two inlet-valves having a space between them, the combination of an apparatus for vaporizing combustible liquid, consisting of a plate on which the liquid is made to drip and which is inclosed in a casing through which air is made to pass, so as to volatilize the liquid and mix with the vapors thereof, a conduit for supplying the liquid to the vaporizing apparatus, having a discharge-opening raised above the bottom of the conduit, so that the latter always contains a layer of the liquid, an apparatus for heating the vaporizer, consisting of a perforated conduit from which combustible liquid issues onto a woven covering of refractory fiber or wire, and an escape-pipe for the products of combustion from the cylinder, containing a double-seated valve moved by hand, so as in one position to cause the products to escape into the atmosphere and in the other position to cause them to pass in contact with the vaporizing apparatus, substantially as herein described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 25th day of February, A. D. 1888.

EDWARD QUACK.

Witnesses:

FRIEDRICK ALBERT HASENSTERN,

D. J. PARTELLO.