(No Model.) 3 Sheets—Sheet 1.

J. NOBLE.

GAS ENGINE.

No. 379,807. Patented Mar. 20, 1888.

Fig. 1.

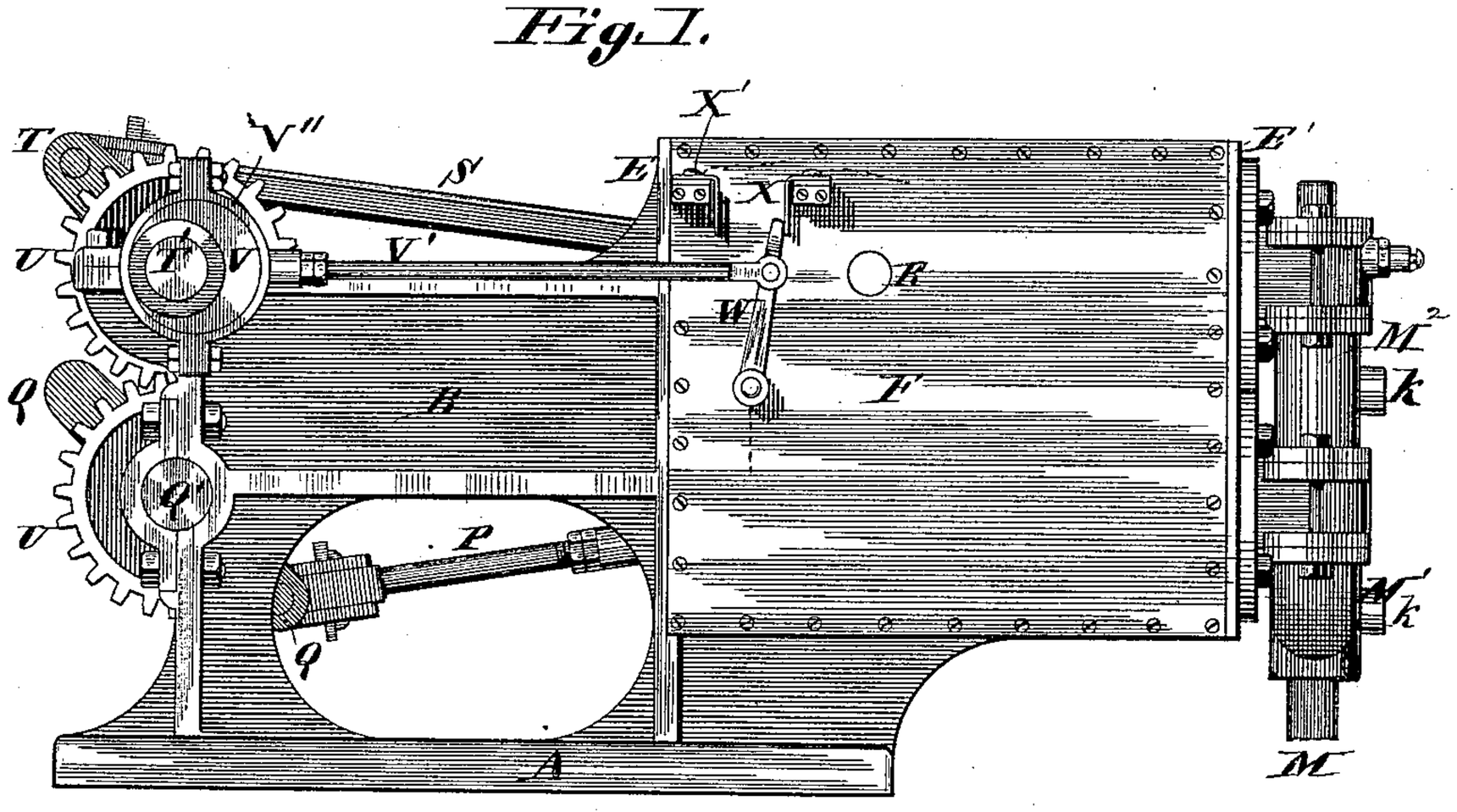


Fig. 2.

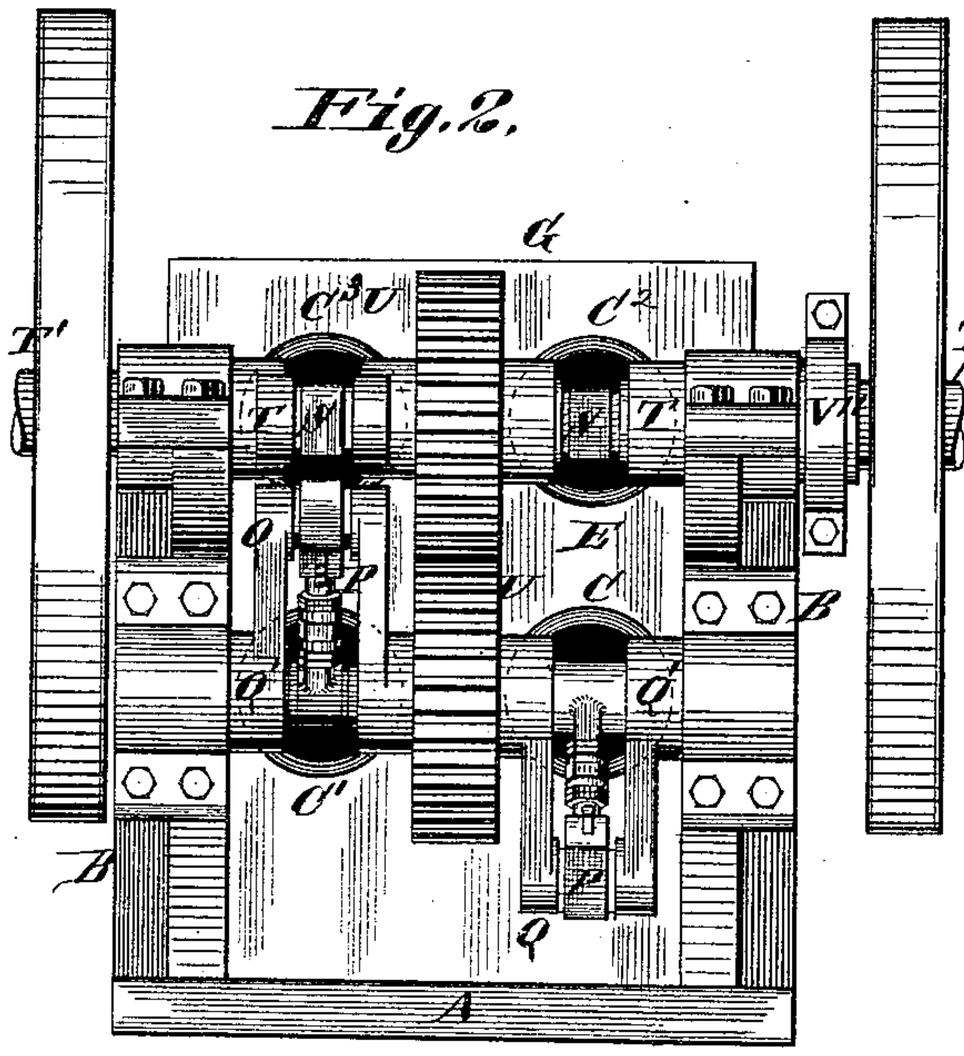
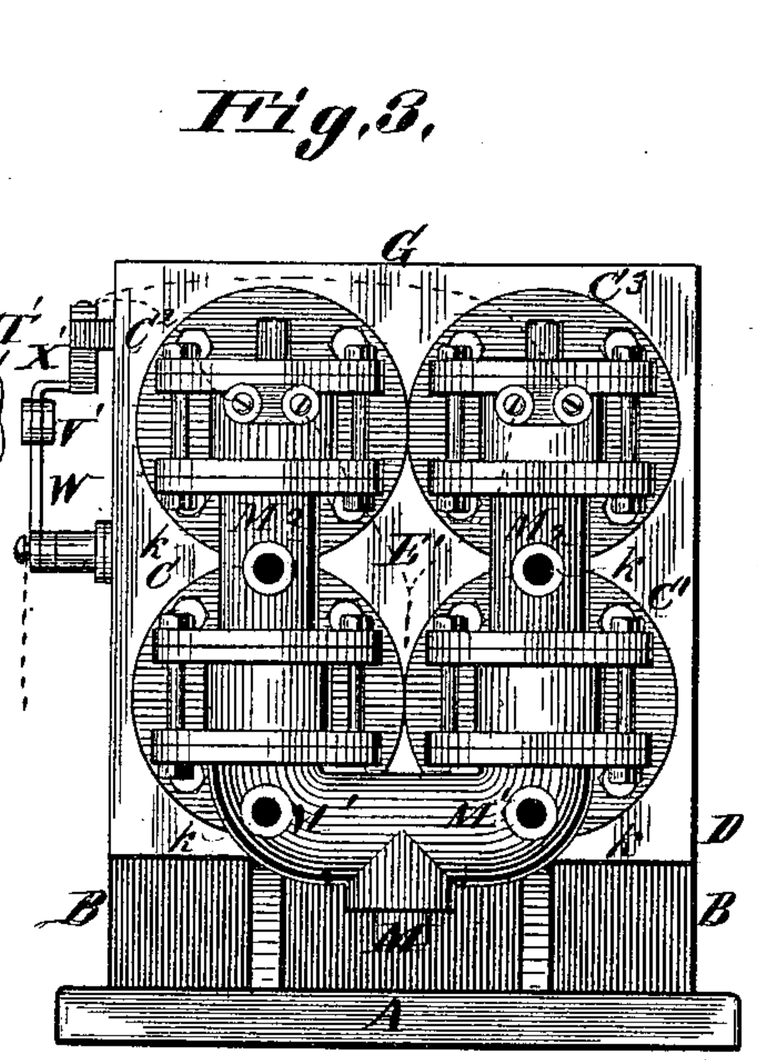


Fig. 3.



Attest:
Charles Pickles.
F. A. Hopkins

Inventor:
Jay Noble.
By Knight Bros.
Attys.

(No Model.)

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J. NOBLE.

GAS ENGINE.

No. 379,807. Patented Mar. 20, 1888.

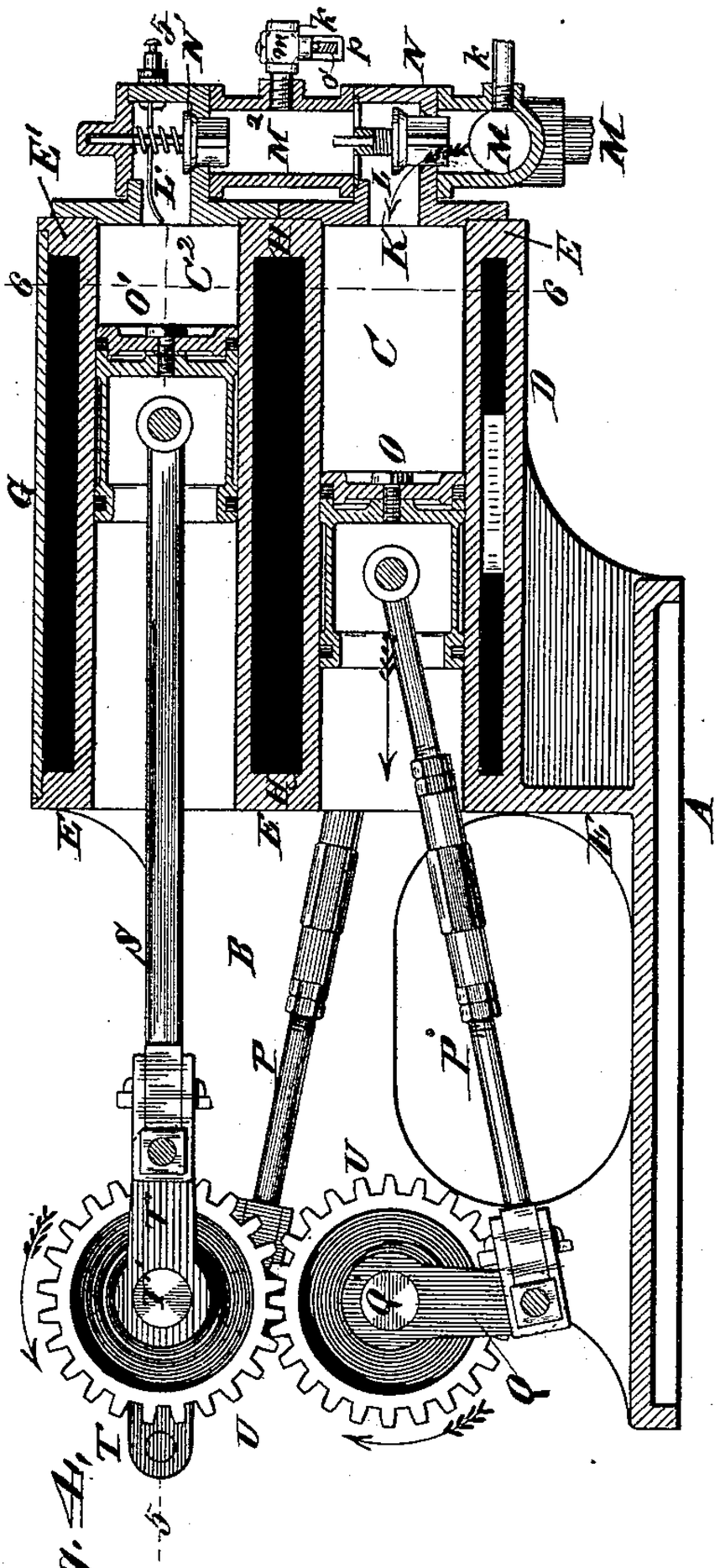

Fig. 4.

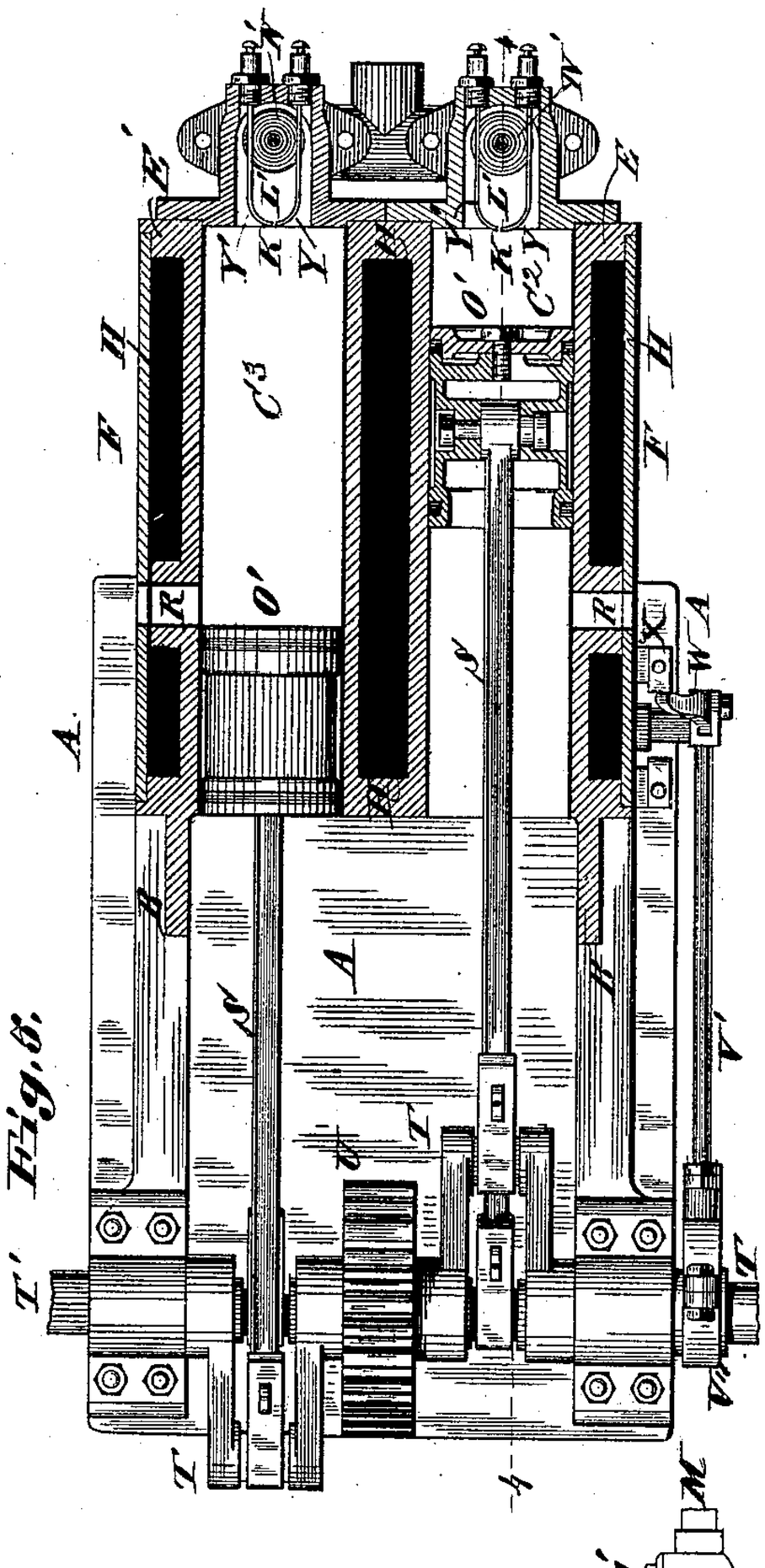

Fig. 3.

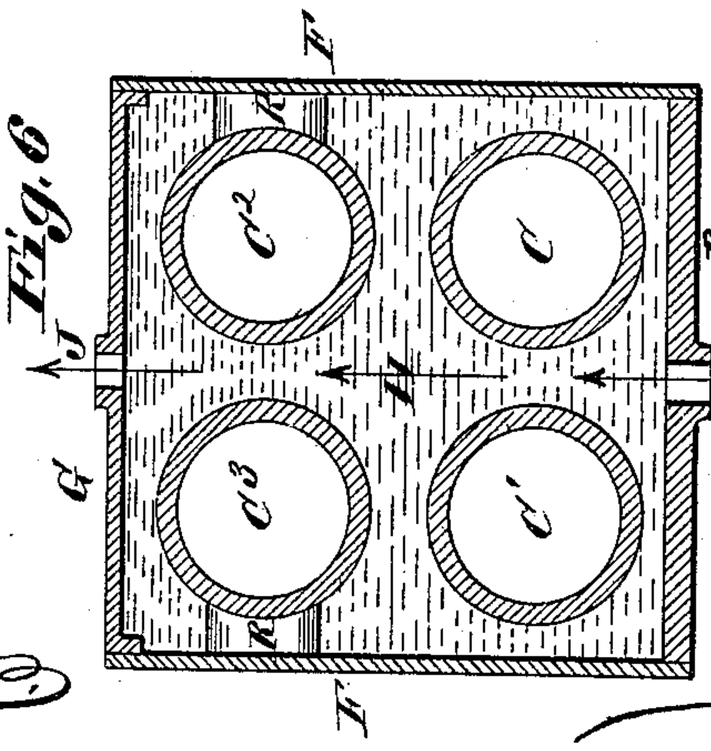

Fig. 6.

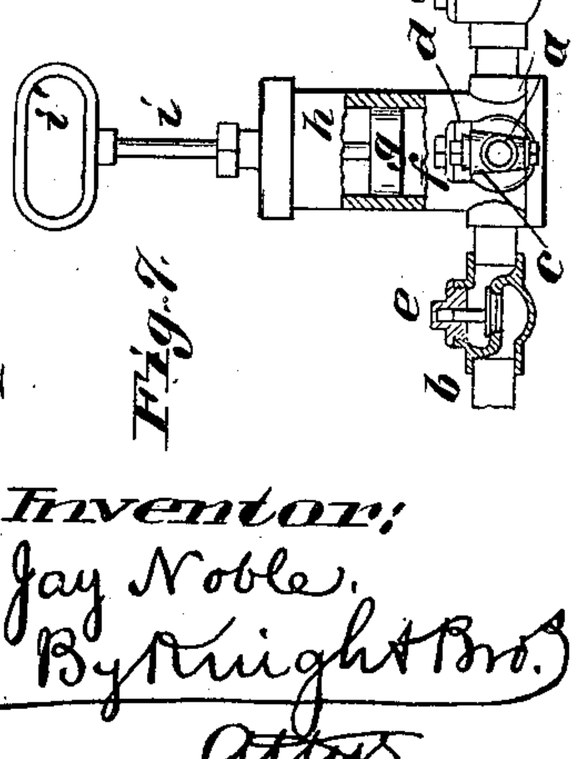

Fig. 5.

Attest:
Charles Pickles
F. A. Hopkins.

Inventor:
Jay Noble.
By Knight Bros.
Attys.

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J. NOBLE.

GAS ENGINE.

No. 379,807. Patented Mar. 20, 1888.

Fig. 8.

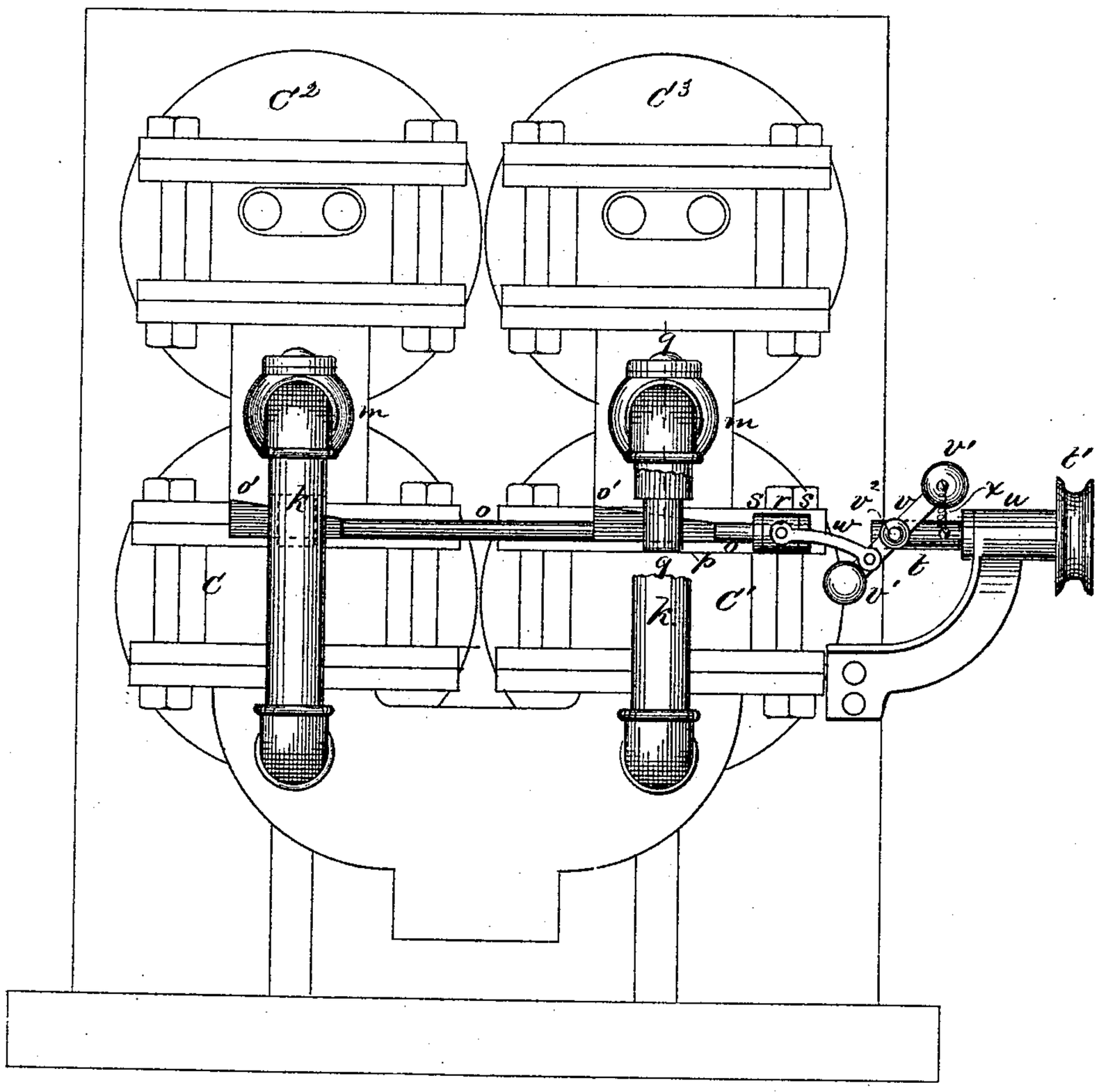


Fig. 9.

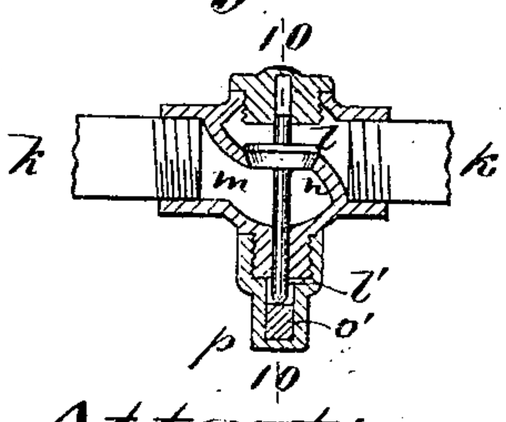
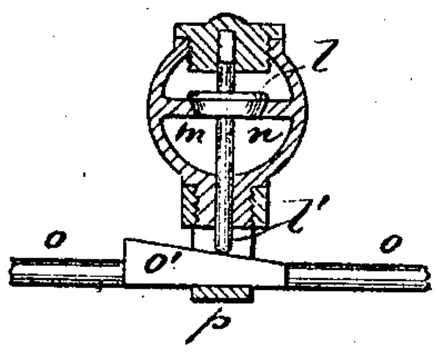


Fig. 10.



Attest:

F. A. Hopkins.

Emma Arthur.

Inventor:

Jay Noble.

By Knight Bros

Attys.

UNITED STATES PATENT OFFICE.

JAY NOBLE, OF ST. LOUIS, MISSOURI.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 379,807, dated March 20, 1888.

Application filed April 7, 1887. Serial No. 234,036. (No model.)

To all whom it may concern:

Be it known that I, JAY NOBLE, of the city of St. Louis, in the State of Missouri, have invented a certain new and useful Improvement in Gas-Engines, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, and in which—

Figure 1 is a side view of the engine. Figs. 2 and 3 are views of the opposite ends. Fig. 4 is a longitudinal section at 4 4, Fig. 5. Fig. 5 is a horizontal section at 5 5, Fig. 4. Fig. 6 is a transverse section at 6 6, Fig. 4. Fig. 7 is an elevation of the starting-pump, part in section. Fig. 8 is an end view with part broken away, showing a governor applied to the engine. Fig. 9 is a detail vertical section at 9 9, Fig. 8. Fig. 10 is a vertical section at 10 10, Fig. 9.

The bed-plate A, frame B, cylinders C C′ C^2 C^3, bottom plate, D, and end plates, E E′, are cast, preferably, in one piece. The side plates, F, and top plates, G, are attached to the bottom and end plates by water-tight joints. Surrounding the cylinders and within the bottom, top, side, and end plates is a chamber, H, through which water passes to keep the cylinders cool. The induction-opening is shown at I and the eduction-opening at J. The course of the water through the chamber H may, however, be in any direction. The cylinders are open at one end and at the other end have induction gas-ports K, leading from the valve-chambers L L′.

M is the supply-pipe, (through which explosive gases enter,) having branches M′, leading to the valves N of the chambers L. The chambers L communicate with the ports of the valves N′ in chambers L′ through passages M^2.

O O′ are the pistons. The pistons O of the two lower cylinders are connected with the cranks Q of the shaft Q′ by rods P, with an extension-joint to allow the pistons to be adjusted in position in the cylinders to cause a greater or less degree of condensation in the gas, for the sole purpose of the piston O is to condense the gas to a certain degree, which then passes into the cylinders C^2 C^3, where it is still further condensed prior to being ignited.

At R are shown exhaust-ports for the escape of the products of explosion. These ports are in connection with the cylinders C^2 and C^3. The cylinders C and C′ have no such exhaust-ports, as the mingled gas and air is simply compressed in these cylinders and passes out through the induction-ports K. The connecting-rods S of the upper pistons may be made with an extension-joint in the same manner as the rods P, if desired, but are not shown with this construction. They connect with the cranks T of the shaft T′. The shafts T′ and Q′ carry spur-wheels U, which are made fast to the shafts by keys or set-screws. At least one of these wheels I prefer to secure in such a manner upon the shaft that it may be slipped along the shaft out of engagement with the other wheel, if desired, and turned the distance of one or more teeth before re-engagement, so that the cranks Q upon shaft Q′ may be adjusted in position relatively to the cranks T upon shaft T′, so as to give the lower pair of pistons more or less lead (if desired) over the upper pair of pistons. I prefer to have the two cranks which are upon the same shaft project in opposite directions from the shaft, so that when one is at one extreme position the other shall be at the other extreme. On the other hand, the relative positions of the cranks Q relatively to the cranks T is such that the gas-chamber in the upper cylinders shall be filled with the partly-compressed gas while the piston in the upper cylinder is in its rear position or nearly so. As soon as the pressure of the gas in either of the cylinders C C′ exceeds the pressure in the supply-pipe M, the valve N closes, and on the pressure in cylinders C and C′ exceeding the pressure in cylinders C or C^3 the valve N′ between such cylinders opens and the gas passes through into the upper cylinders C^2 or C^3. Then, on the gas in the upper cylinder attaining a pressure greater than the pressure in the lower cylinder, with which it is in connection, the valve N′ between them closes. The gas, on attaining its extreme condensation in the upper cylinder, is ignited by an electric spark by the following device:

V is an eccentric on the shaft T′, which is surrounded by a yoke, V″, secured to one end of a rod, V′, whose other end is connected to a pivoted insulated arm, W, the latter being in electrical connection with one pole of a battery.

X is an insulated conductor connected with a conducting-rod, Y, whose point is within the cylinder C^2 or C^3.

Y′ is another rod within the cylinder, whose point is in close proximity to that of the rod Y, so that the electric spark is formed by an electric current between them. The rod Y′ is in communication with the other pole of the battery to that with which the arm W. is connected, so that when the arm W touches the plate X an electric spark is produced in the upper cylinder and the gas exploded. The explosion takes place in the other one of the upper cylinders by similar means, the insulated plate X′ being in communication with one of the conducting-rods in the latter cylinder and the other rod, Y, being in communication with the pole of the electric battery opposite to that connected with the arm W. After the engine is started, the ordinary pressure of the hydrocarbon gas and atmospheric air will carry it into the engine to fill the partial vacuum caused by the explosions within the cylinders C^2 and C^3; but to start the engine some outside force must be applied. For this purpose I provide an air-pump having one branch, *a*, in communication with atmospheric air and another branch, *b*, in communication with a supply of hydrocarbon gas. The air-branch has a cock, *c*, to regulate the amount of air entering.

d is a check-valve in the air-supply pipe, and *e* is a similar check-valve in the pipe by which the hydrocarbon gas enters the air-pump chamber *f*.

g is a piston working in a cylinder, *h*.

i is the piston-rod, having upon it a handle, *i′*, or other means by which the piston may be worked.

j is a check-valve in the supply-pipe M. On the ascent of the piston *g* the hydrocarbon gas and air enter through the pipes *b* and *a*, the check-valves *e* and *d* opening. On the descent of the piston the check-valves *e* and *d* close and the valve *j* opens, and the mingled gases enter the cylinders C, C′, C^2, and C^3, in the latter two of which they are exploded.

I will now describe the construction of the governor. The principle upon which the governor acts is the allowing of the return of a limited quantity of the gaseous mixture from the upper cylinders, C^2 C^3, back to the pump when the speed exceeds a given point, the quantity so returning being proportioned to the speed.

k k are pipes leading from the chamber M^2 to the branch pipes M′, which supply the pumps. At the top of each pipe *k* is a valve, *l*, working in a chamber, *m*. These valves, when on their seats *n*, prevent the return of any of the explosive mixture from the chambers M^2; but when the valves are raised from their seats a quantity of the mixture will return before the explosion takes place, leaving enough of the mixture in the cylinder C^2 or C^3 to give the required pressure upon the piston O′. In order to lift these valves *l* to the required height, the lower ends of the stems *l′* rest upon wedge-formed parts *o′* of the rod *o*. These wedges *o′* work in bearings *p*.

r is a ring or sleeve on the rod, bearing against collars *s*, so that it turns freely on the rod.

t′ is the governor-pulley upon a shaft, *t*, turning in a bearing, *u*, in which it has no endwise movement.

v is the governor-arm, having end balls, *v′*, and pivoted at its middle to the shaft *t* by a pin, v^2.

w is a link connecting the arm *v* with the sleeve *r*.

x is a spring extending from the shaft *t* to one of the balls, the spring tending to hold the ball near to the shaft, and thus to push the wedge-rod *o* to the left and allow the valves *l* to close. When, however, the increased rotary speed of the governor throws the balls outward, the wedges *o′* are drawn to the right and the valves *l* raised to allow more or less of the explosive mixture to return from the cylinder C^2 or C^3 to the branch pipes M′, which are in direct communication with and supply the pump by which the mixed gas and air is forced into the cylinders C and C′.

I claim as my invention—

1. The combination, in a gas-engine, of four pistons working in four cylinders connected together, substantially as and for the purpose set forth, two shafts, each having crank-connection with two of the pistons, and spur-wheels upon the crank-shafts, one of which is made adjustable, for the purpose set forth.

2. In a gas-engine, a pair of explosion-cylinders, a piston situated in each of said cylinders, a pitman connected to each of said pistons, a shaft, and cranks projecting in opposite directions therefrom, to which said pitmen are connected, in combination with a pair of compression-cylinders, a piston situated in each, a pitman connected to each of said pistons, a shaft, a pair of cranks projecting in opposite directions therefrom, to which said pitmen are connected, and intermeshing pinions secured to both of said crank-shafts, whereby they are caused to rotate in unison, the cranks on one of said shafts being placed at an angle to those on the other, so that the compression-piston shall lead the working-piston, substantially as set forth.

3. In a gas-engine, the combination, with the explosion-cylinder, a piston fitted therein, a pump, a passage connecting said pump with the explosive cylinder, and a pipe for supplying said pump with gas, of a pipe for placing the passage which forms communication between the pump and explosive cylinder in communication with the pipe which supplies the pump with gas, a valve in said pipe, and a speed-governor having connection with said valve, whereby it is lifted from its seat to permit more or less of the gas coming from the pump to return to the supply-pipe, substantially as set forth.

4. In a gas-engine, the combination of the

explosion-cylinder C^2, a piston, O′, situated therein, the compression-cylinder C, a piston, O, situated therein, the supply-pipe M, communicating with the port L of cylinder C, the passage M^2, communicating with the port L′ of cylinder C^2, the valve N′, situated between port L and passage M^2, the escape-pipe *k*, communicating with the passage M^2 and with the supply-pipe M, the valve *l*, for controlling the passage through said pipe *k*, and a speed-governor for controlling the position of said valve, substantially as and for the purposes set forth.

5. The combination, in a gas-engine, of a cylinder in which the gases are exploded, a pipe for conveying the gases thereto, a return-passage communicating with said supply-pipe, a valve in the supply-pipe situated between the cylinder and the return-passage, a valve in said return-passage, a rod having a wedge-shaped portion upon which the stem of said valve bears, and a speed-governor having connection with said rod, substantially as set forth.

JAY NOBLE.

In presence of—
SAML. KNIGHT,
BENJN. A. KNIGHT.