2 Sheets—Sheet 1.

R. D. BRADLEY.

GAS-ENGINE.

No. 187,092. Patented Feb. 6, 1877.

Fig. 1

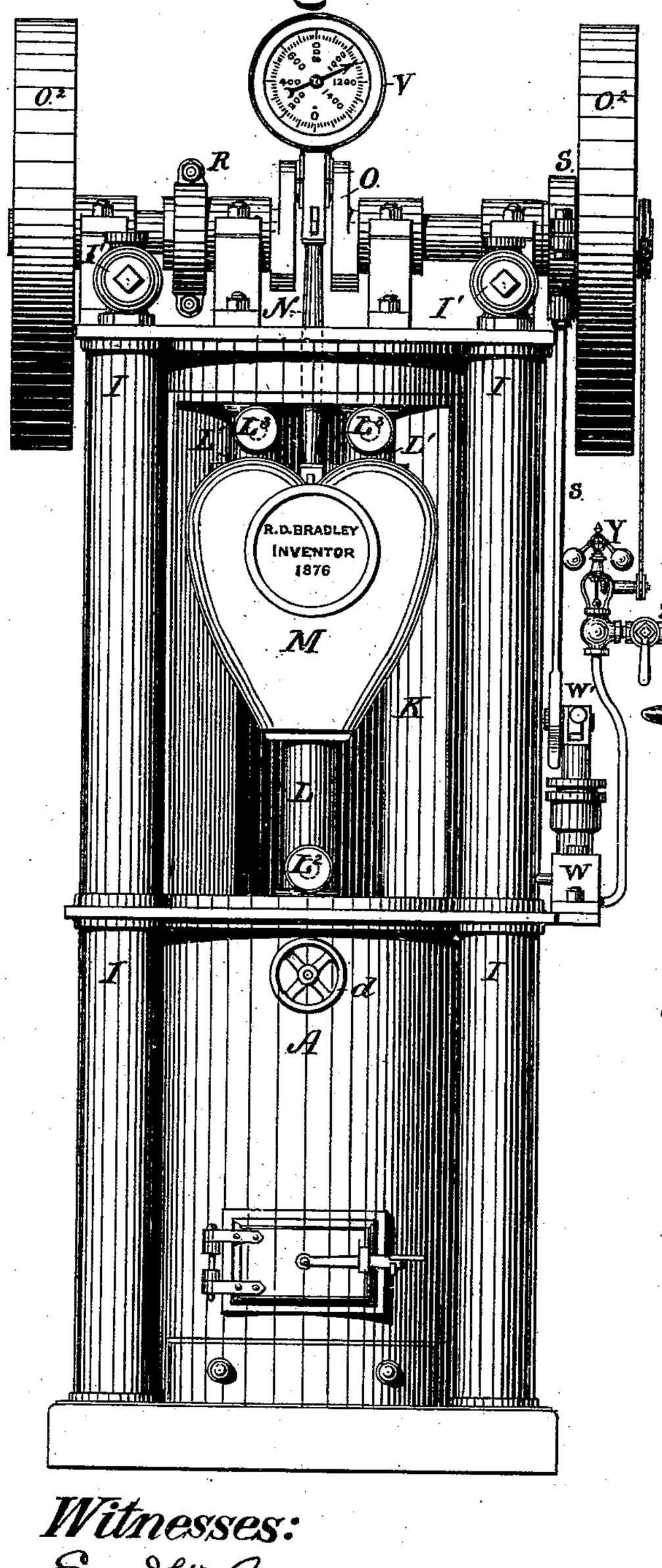
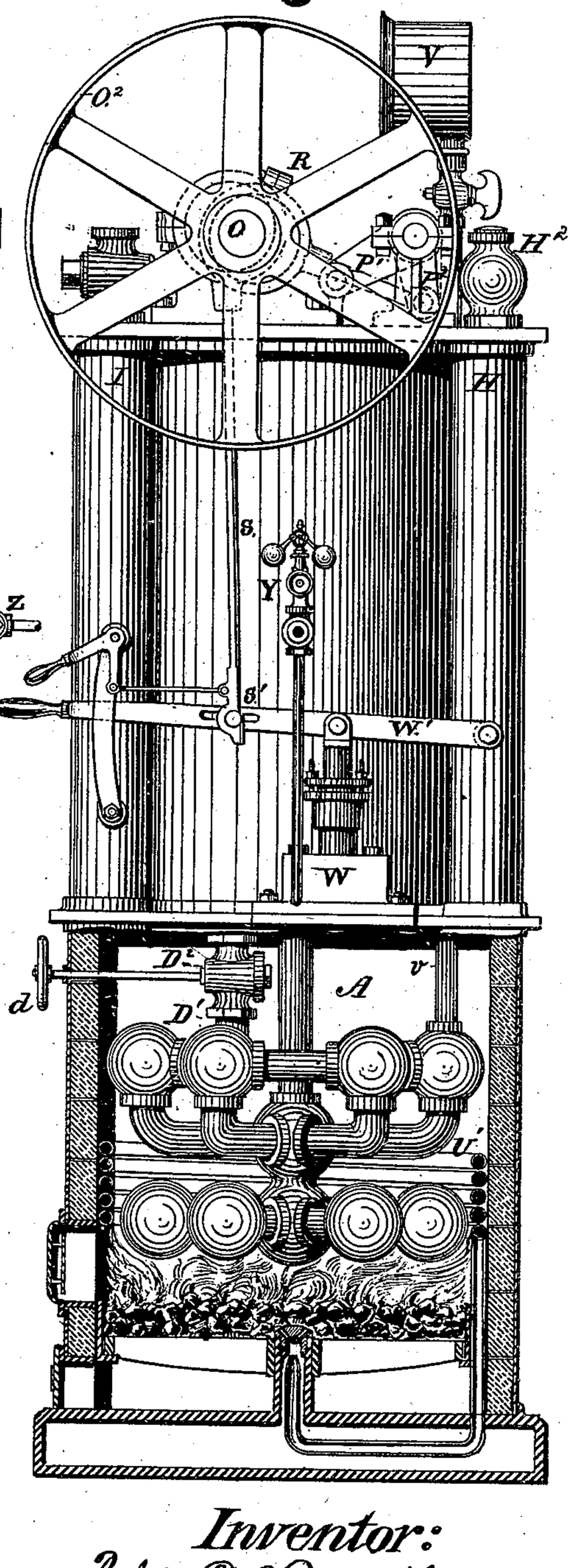


Fig. 2



Witnesses:

Edwd. W. Byrne.

J. Kenrow

Inventor:

Robt. D. Bradley

By Munn & Co

Attorneys

2 Sheets—Sheet 2.

R. D. BRADLEY.

GAS-ENGINE.

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Fig: 3

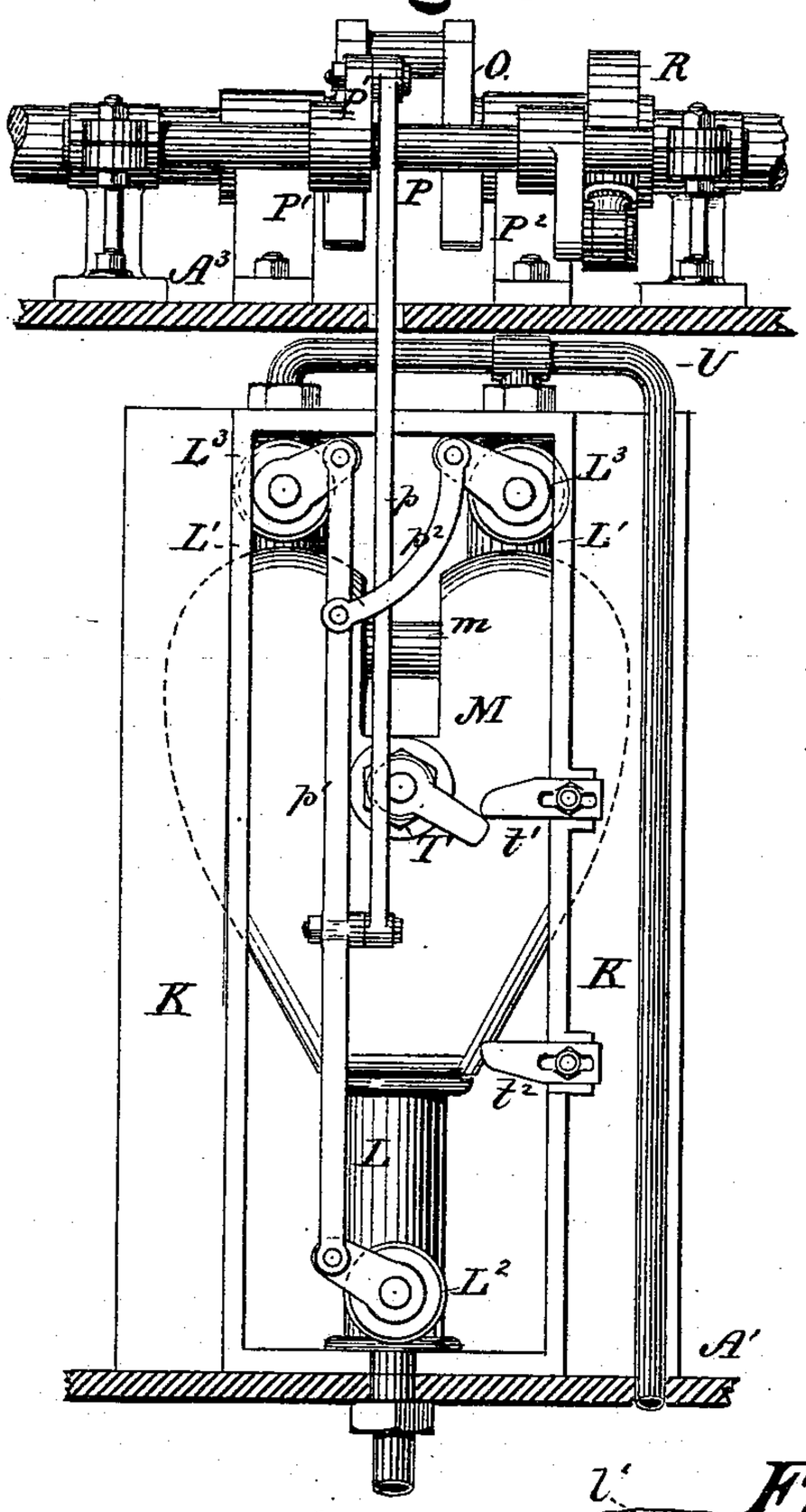


Fig: 4

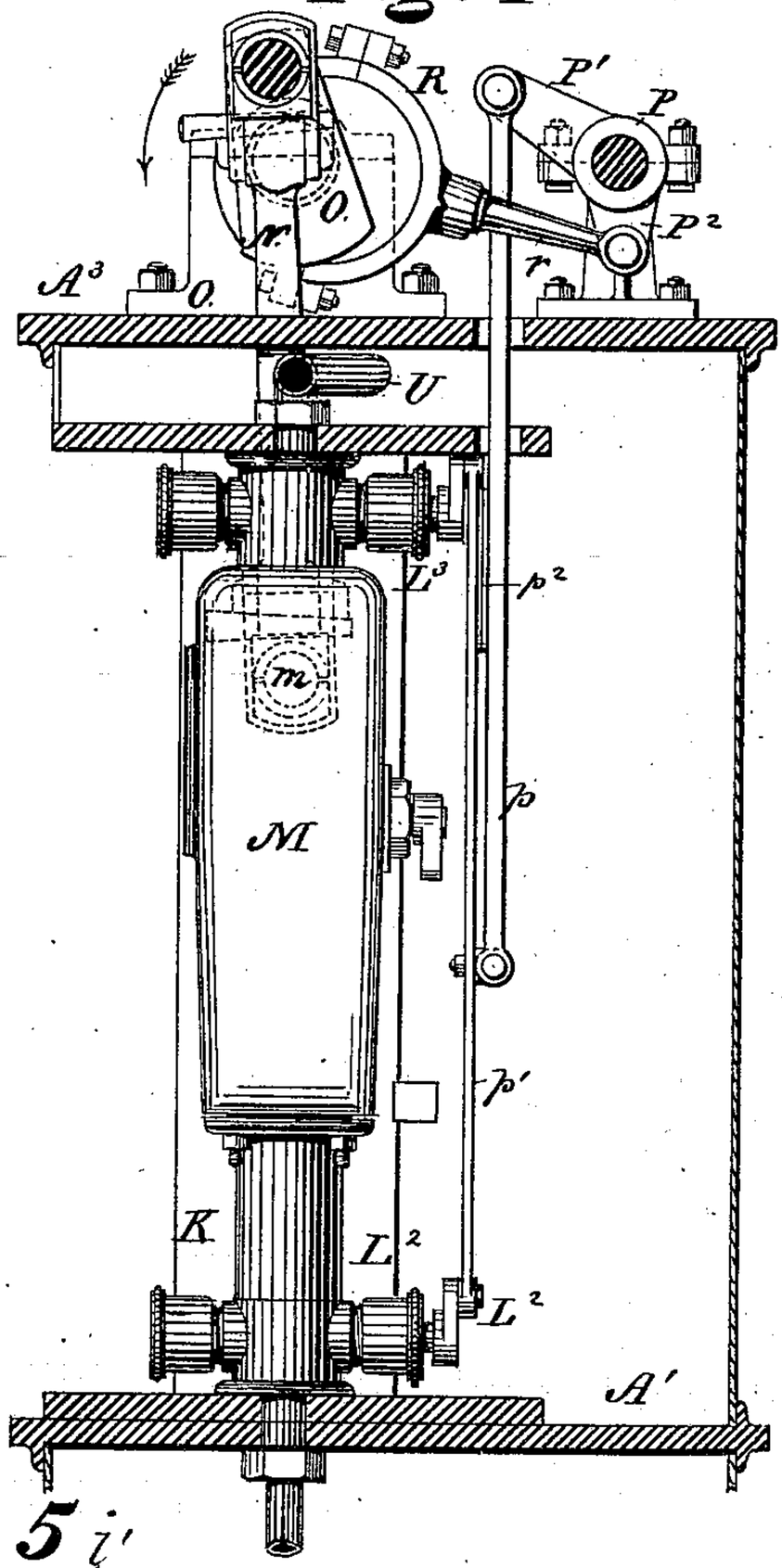
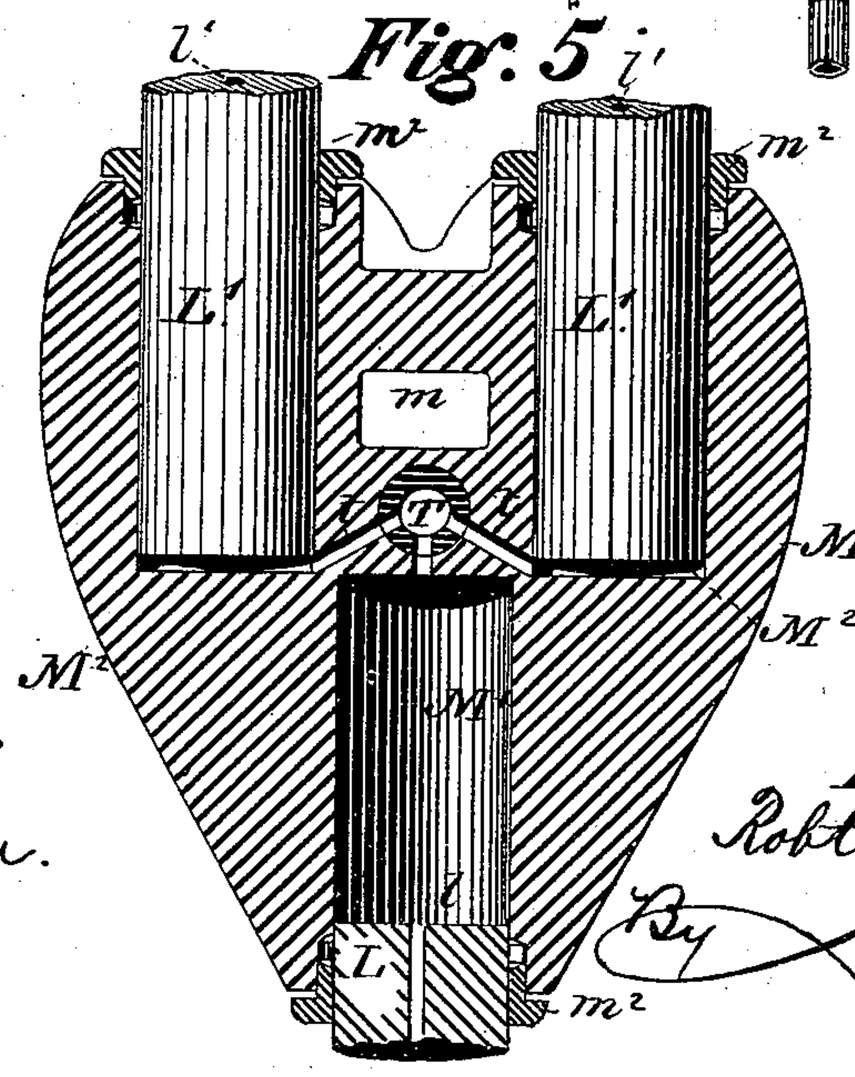


Fig: 5



Witnesses:

Edwd. W. Byrn.

J. C. Kennon

Inventor:

Robt. D. Bradley

By Munn & Co.

Attorneys.

UNITED STATES PATENT OFFICE.

ROBERT D. BRADLEY, OF PRESTON, MARYLAND.

IMPROVEMENT IN GAS-ENGINES.

Specification forming part of Letters Patent No. **187,092**, dated February 6, 1877; application filed July 11, 1876.

CASE B.

To all whom it may concern:

Be it known that I, ROBERT D. BRADLEY, of Preston, in the county of Caroline and State of Maryland, have invented a new and Improved Engine for Utilizing a New Motive-Gas Obtained from Water; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawing, forming part of this specification.

The object of my invention is to provide an engine or motor of very simple construction, to be operated by a gas of great expansive force developed from water, and to be used in combination with an apparatus for generating this gas, which I have fully described in my application for Letters Patent of this date, marked "Case A." To this end my invention consists, mainly, in the construction and arrangement of a number of permanent pistons attached to a rigid frame, and a heart-shaped block having cylindrical chamber, and receiving a reciprocating motion upon these pistons, a crank-shaft being connected by a pitman with the heart-shaped block, whereby its reciprocating motion is converted into rotary motion, which crank-shaft provides the necessary means for supplying the required quantity of water to the generator, and operates the valves for the induction and escape of the gas from the cylinders, all as hereinafter more fully described.

In the accompanying drawings, Figure 1, Sheet 1, is a front view of my new motor or engine; Fig. 2, a side view of the same, showing the lower part or generator in section. Fig. 3, Sheet 2, is a detached view, on a larger scale, of the mechanism for operating the induction, escape, and communicating valve; Fig. 4, a side view of the same; and Fig. 5, an enlarged vertical section through the heart-shaped sliding block, with part of the permanent pistons in view.

Upon the top plate A^1 of the generator A is mounted a rigid frame, K, to which are secured three stationary pistons. The piston L is firmly bolted through the bottom of the frame K to the plate A^1, and communicates directly with the pipe for the transmission of the gas from the generator. The pistons L^1 L^1 are secured to the top of the frame K, leaving a space between a little larger than the diameter of the piston, so that their center lines are in the same plane, and parallel with the center line of the piston L.

These pistons, instead of being made in the form of a disk, with the usual rod, are made solid, and of equal transverse diameter throughout their length, so as to secure a greater amount of strength to resist the tension of the motive fluid, and for the purpose also of forming guides.

The heart-shaped block M contains three cylinders, corresponding with the position and size of the pistons, so as to move freely thereon, and has attached or secured to the same a pin, *m*, commonly called "cross-head pin," to receive one end of a connecting-rod, H, whereby motion is imparted to the crank-shaft O, of the ordinary construction.

The induction-passage *l* extends through the piston L, and is governed by a plug-valve, L^2. Similar passages *l' l'* and regulating-valves L^3 L^3 are provided for the pistons L^1 L^1, by which the gas is permitted to escape from the upper cylinders.

A rock-shaft, P, secured to the top plate A^3, in suitable bearings or pillow-blocks, receives motion from an eccentric, R, upon the crank-shaft O, which is connected by a rod, *r*, to a small rock-arm, P^2, upon the rock-shaft P. Another rock-arm, P^1, transmits the motion to the rod p^1 by means of the rod *p*. The rod p^1 connects with levers secured to the plugs of the valves L^2, and one of the valves L^3, the other valve, L^3, being operated by the link p^2, which is connected with the rod p^1.

It will be seen that all the valves are operated simultaneously—that is to say, when the valve L^2 is open to allow the gas to enter into the single cylinder, the valves L^3 L^3 are also open to permit the escape of the gas from the two upper cylinders, and, vice versa, when the valve L^2 is shut, the valves L^3 L^3 will also be shut. A three-way cock or valve, T, controls small communicating passages *t t t* between the cylinder M^1 and the cylinders M^2 M^2, and is automatic in its action, a short arm secured to the plug striking, in the reciprocation of the heart-shaped block, alternately the adjustable tappets or projections t^1 t^2, secured to the frame K, and correspondingly controlling

the position of the valve T with respect to the ports *t t t*.

The escape or exhaust pipe U connects the openings in the pistons L^1 L^1 in such a manner as to leave sufficient clearance for the vibrations of the connecting-rod, and conducts the escaping gas, through the coil U′ in the furnace A, into the chamber of the bed-plate A^1, and is introduced as a jet to combine with the heated air and smoke, and, when required, with a fresh supply of atmospheric air to produce perfect combustion. Weighted valves H^2 H^2 are provided for the draft-connection to prevent a back pressure into the furnace, and permit the escape of carbonic-acid gas. The cocks I′ I′ regulate the supply of atmospheric air to promote combustion. The valve D^2 is for the purpose of regulating the supply of gas from the generator to the motor, and is provided with a hand-wheel, *d*. V is a pressure-gage, which communicates with the generator by means of the pipe *v*. The crank-shaft O is mounted upon the plate A^3, in suitable bearings or pillow-blocks, and is provided with fly-wheels or band-wheels O^2 O^2. A single-acting pump or injector, W, supplies the required quantity of water to the generator from a tank or other convenient receptacle. This pump must needs be single-acting, and not double-acting, on account of the peculiar construction of the engine, a single pulsation of the pump and injection of water effecting the two movements of the heart-shaped block by means of a single breath of the produced gas. The governor Y regulates the supply of water, and receives motion from a pulley upon the crank-shaft O, similarly to other engine-governors now in use. The cock Z is for the purpose of shutting off the supply of water entirely. A hand-lever, W′, is used on starting the motor, and then the eccentric rod S is thrown in gear with the pin S′, and the injector is worked by the motor.

The amount of water injected by each stroke of the pump may be regulated by the pin *s′*, which may be adjusted in the slot of lever W′, to produce a longer or a shorter stroke.

The operation of my engine or motor is as follows: After fire has been started in the furnace, and the generator becomes sufficiently heated, water is injected by means of the hand-lever W′, when almost instantaneously the gas is generated. The valve D^2 is opened, and the gas enters the cylinder M^1 through the passage *l*, and forces the heart-shaped block M upwardly away from the piston L. When it arrives at the limit of its throw or stroke the arm attached to the communicating valve T comes in contact with the tappet t^1, and the cock is opened, establishing a communication between the cylinder M^1 and the cylinders M^2 M^2 by the passages *t t t*, and the valves L^2 and L^3 L^3 are shut off simultaneously. The gas passes into the cylinders M^2 M^2, and forces the heart M in the opposite direction. This is the case by reason of the difference in the areas of pressure between the upper cylinders and lower one, there being two areas of downward pressure to one of upward pressure, the gas operating concussively in the lower cylinder for the upward movement of the heart-shaped block, and expansively in the two upper cylinders for the downward movement of the same. The moment the heart-shaped block arrives at the extremity of the return or downward stroke, the communicating valve T is shut off by the tappet t^2, and the piston-valves are opened simultaneously—the valve L^2 to furnish a new supply of gas from the generator to the cylinder M^1, and the valves L^3 L^3 to permit the escape or exhaust of the gas from the cylinders M^2 M^2. As soon as the motor has been started the eccentric rod *s* is thrown in to connect with the pin *s′* of the pump-lever W′, and the injector is worked by means of the eccentric rod S. By the reciprocating movement of the heart M a corresponding rotary movement is imparted to the crank-shaft O by means of the connecting-rod N.

It will be seen that the full pressure of the gas is exerted in the cylinder M to nearly the end of the stroke, and that the gas is then permitted to expand within all the cylinders, and so exerts an equal pressure in all directions. Notwithstanding, however, the triple arrangement of the cylinders, the holding capacity of the same cannot, by reason of the arrangement of the pistons, ever exceed the volume of two of the cylinders, and while the upward movement of the heart is effected concussively from a single cylinder, the downward movement is effected by the same gas expansively from two cylinders.

The arrangement of the heart-shaped block with respect to its stationary pistons secures also other important advantages in addition to those already described, in that in both the upward and downward movement of the same the resultant line of draft or strain is coincident with the central line of the heart. The stationary pistons also enable me to dispense with guides, and I have thus constructed a simple, novel, and effective engine, admirably adapted to the special uses for which it was designed.

I contemplate using the arrangement of cylinders, as presented in the heart-shaped block, with steam as a motive fluid, if I find it desirable; and when so used it may not be necessary to preserve the heart shape, but only the arrangement of the cylinders contained therein.

When used, however, with a gas possessing the intense energy of that which my motor is more particularly intended to utilize, it will be found that the arrangement of the three cylinders, together with the addition of sufficient metal to re-enforce and strengthen them where they most need it, will always produce the heart shape.

In relation to the peculiar construction of my motor, as hereinbefore described, I would

here state that in its organization I have endeavored to secure, as far as possible, that same economy in mechanics which characterizes the vital functions of the human body; and this result I have aimed at by imitating, in both construction and function, as closely as the nature of inanimate materials will permit, the vital organs of the human body and their physiological principles.

Considering the device herein described in connection with Case A, it will be seen that there is no smoke-stack and no waste-steam pipe, as in ordinary boilers and engines, the successive steps of generating power being conducted inside an air-tight casement, which is to be compared to the skin. The food of the machine is the fuel consumed. The ashes represent the solid waste products of the body, and the carbonic acid which escapes at the valves is the carbonic acid of respiration. The generating-cells, with their glands and minute perforations, as more fully described in Case A, correspond to the lungs, and the expansion of the intermittent injections of water into a motive gas represents the breath. The heart-shaped block, reciprocating twice to every expansion of gas, represents the pulsating heart, beating twice to every breath, while the cylinders in the heart-block correspond to the auricles and ventricles of the human heart. Instead of contracting and expanding, however, its rigid mechanical construction and different function (transmitting motion) requires that it shall move integrally.

The construction and operation of the various parts, as thus analogically described, are of a necessity not identical with that of the human body, but they nevertheless possess an analogy which secures important mechanical advantages, and enhances the economy of the machine.

In defining the limits of my invention, I would have it understood that I do not confine myself to the precise details shown, as they may be varied in some particulars without departing from my invention. Neither do I confine myself to the sole use of my motor with the gas for which it was more particularly designed, as the engine portion—*i. e.*, the arrangement of cylinders and valves in the heart-shaped block—may be, with slight modification, well adapted to utilize the expansive power of steam or other motive fluid. Neither do I confine myself, strictly, to the triple arrangement of pistons and cylinders shown; as a series of the same, bearing the same odd and even relation, may be employed—as, for instance, five cylinders, arranged with two at the bottom and three at the top. Three, however, is the least number that could be employed that would operate according to the principle of my invention, and utilize the pistons for guides.

Having thus described my invention, what I claim as new is—

1. A reciprocating case containing an odd and even number of cylinders, arranged as described, combined with, and adapted to move upon, stationary pistons as upon guides.

2. The case M, containing two cylinders in one end, and one in the other, and re-enforced with metal at its weak points, so as to form a heart shape, to operate in combination with the pistons, for the purpose described.

3. The combination, with a set of pistons, of a case or block containing cylinders arranged with an odd and even relation, as described, and connected by valves and ports, so as to allow the motive fluid to operate concussively in the one and expansively in the other, for the purpose described.

4. The combination, with a set of stationary pistons, arranged as described, and having ports for the induction and discharge of the motive fluid, of a reciprocating case containing cylinders corresponding to the pistons, arranged for different areas of pressure for the different strokes, and connected by a valve and ports, substantially as and for the purpose described.

5. The stationary pistons L^1, having discharge-ports l', and the stationary piston L, having the induction-port l, in combination with the heart-shaped block M, having cylinders M^1 M^2, arranged as described, and connected by valve T through ports t, as and for the purpose specified.

6. The reciprocating case, containing three or more cylinders, arranged as described, with different areas of pressure for the different movements, and connected by ports, in combination with the plug-valve T, having a projecting arm, and the stationary tappets t^1 t^2, for the purpose of effecting communication between the cylinders, substantially as described.

7. The reciprocating case M, carrying the cylinders, and the stationary pistons L L, having the induction and discharge ports, in combination with the valves L^2 L^3 and the connecting-rods p p^1 p^2, receiving motion from a rock-shaft and eccentric, or other suitable mechanism, for imparting reciprocating motion, for the purpose described.

8. The combination, with the crank-shaft O and a pitman, N, of the reciprocating heart-shaped block M, moving upon its stationary pistons as guides, and having a cross-head pin, m, substantially as and for the purpose described.

9. The solid stationary pistons, of equal diameters throughout their length, and having central ports, in combination with the case M, having valve T, as and for the purpose described.

The above specification of my invention signed by me this 8th day of July, 1876.

ROBERT D. BRADLEY.

Witnesses:

EDWD. W. BYRN,

SOLON C. KEMON.