(No Model.) 3 Sheets—Sheet 1.

T. SHAW.

COMBINED GAS AND OIL ENGINE.

No. 367,937. Patented Aug. 9, 1887.

Fig. 1.

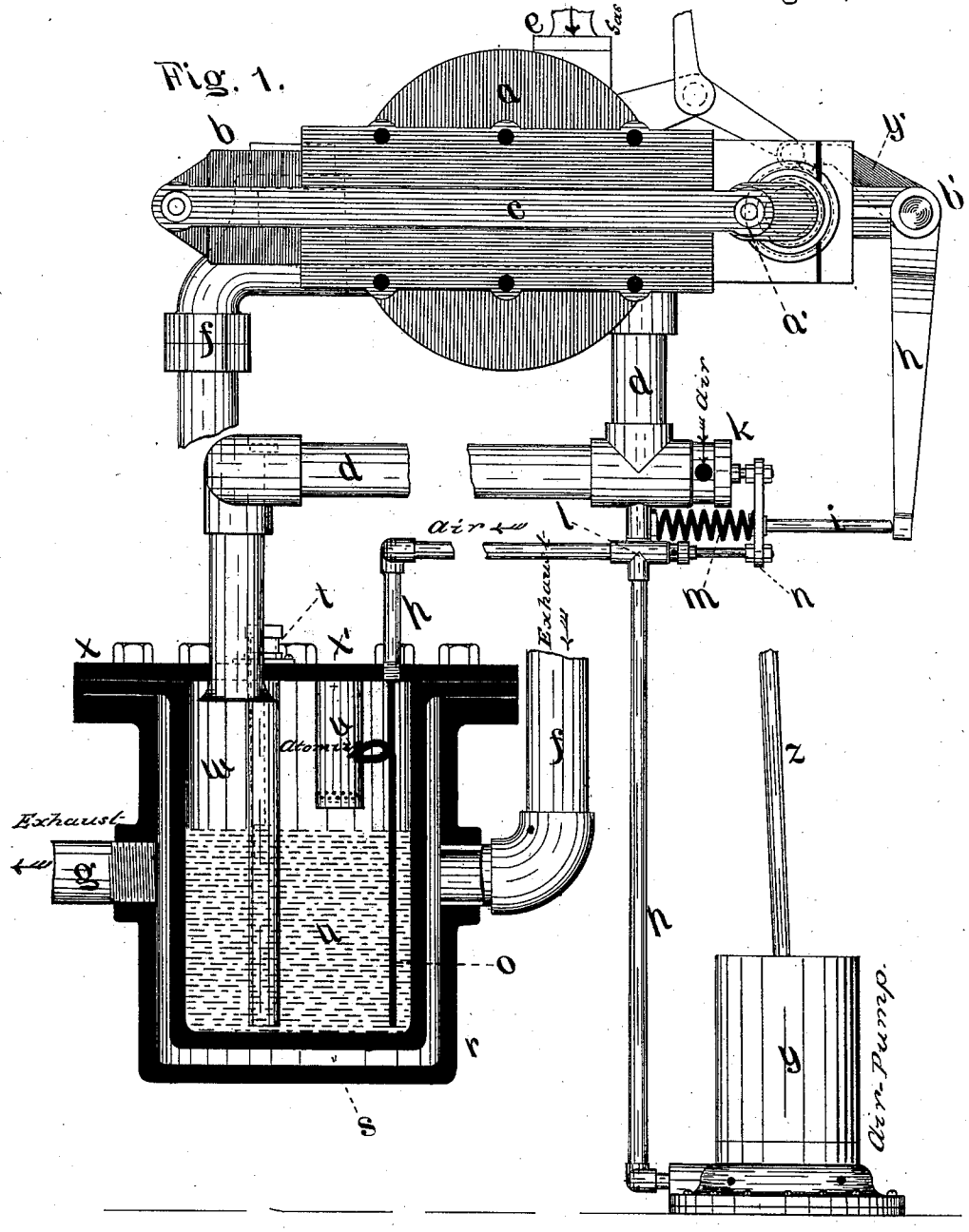

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Fig. 2.

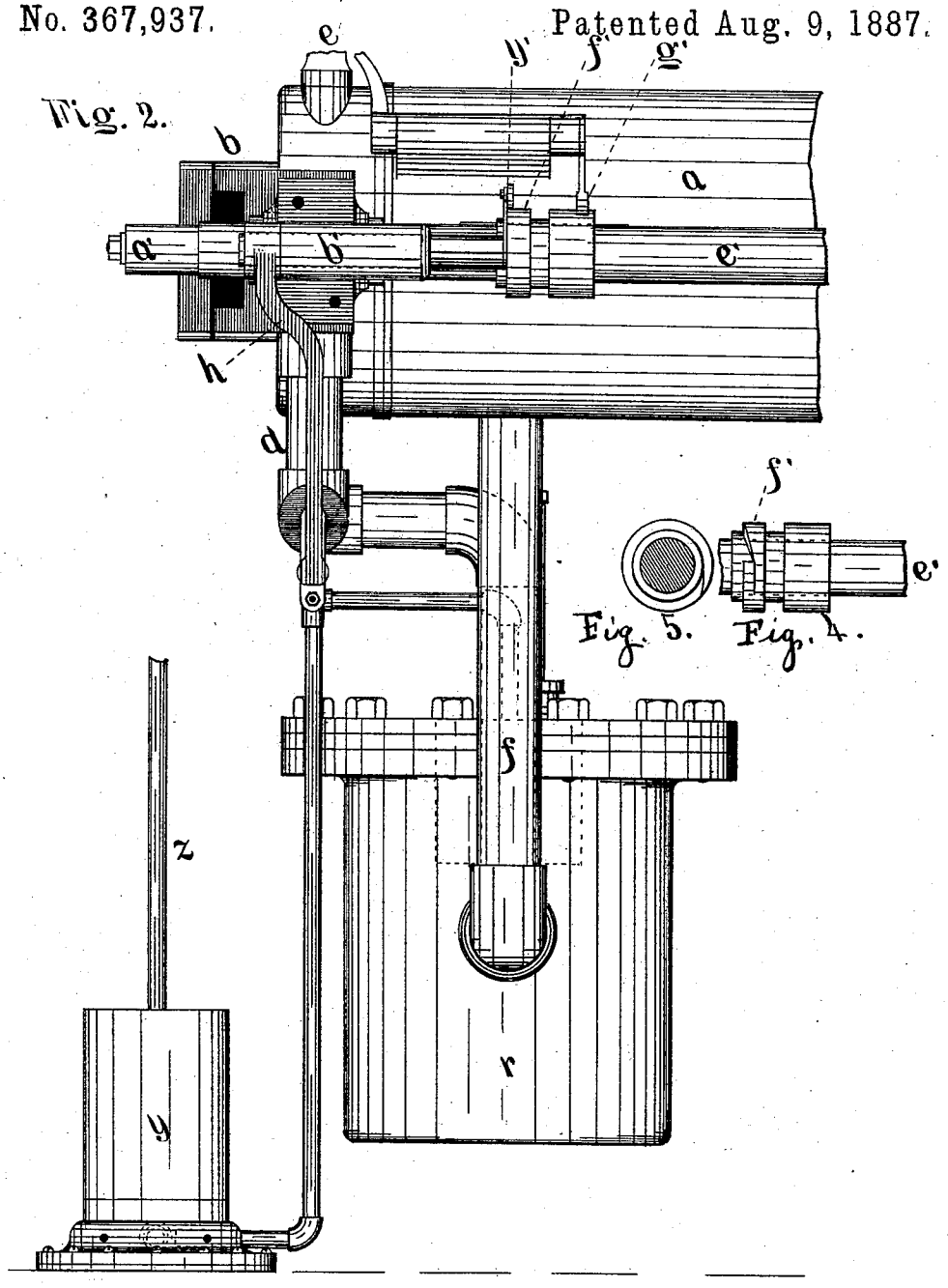

Fig. 5. Fig. 4.

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(No Model.) 3 Sheets—Sheet 3.

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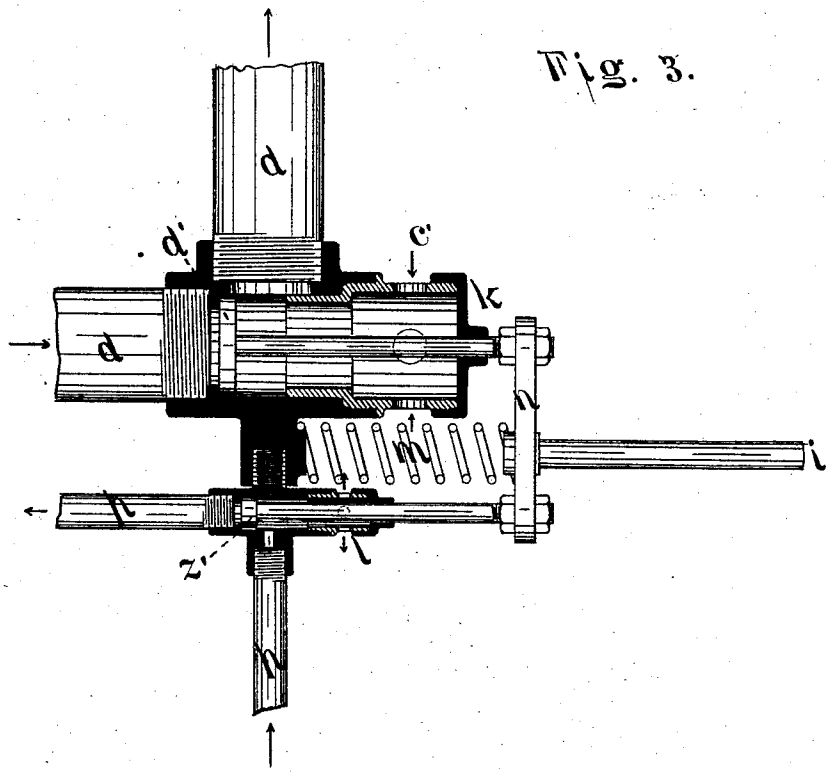
Fig. 3.



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UNITED STATES PATENT OFFICE.

THOMAS SHAW, OF PHILADELPHIA, PENNSYLVANIA.

COMBINED GAS AND OIL ENGINE.

SPECIFICATION forming part of Letters Patent No. 367,937, dated August 9, 1887.

Application filed March 18, 1887. Serial No. 231,365. (No model.)

To all whom it may concern:

Be it known that I, THOMAS SHAW, of the city and county of Philadelphia, Pennsylvania, have invented a new and Improved Combination of Gas and Oil Engines; and I hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

My invention consists in the within-described apparatus for supplying heavy hydrocarbon fluids to the air-passage of gas-engines.

The object of the invention is to cheapen the running cost of gas-engines by the use of hydrocarbon fluids supplied to the air-passage in the manner hereinafter explained, enabling the use of heavy or unrefined fluids acceptable to insurance companies, and which can be procured at low cost.

In order to enable others to use and practice my invention, I will proceed to describe its construction and operation.

On reference to the accompanying drawings, which form part of the specification, Figure 1 represents an end view, in part section, of the apparatus as operated in connection with the Otto gas-engine, and Fig. 2 a side view of the same; Fig. 3, a vertical section through center of air-valves, and Figs. 4 and 5 a side and end view of changes in cam-sleeve of the Otto gas-engine.

Similar letters refer to similar parts, of which *a*, Fig. 1, is the rear end of gas-engine cylinder of the said Otto class provided with the usual sliding valve, *b*, actuated by pitman-arm *c* from crank-pin *a'* of rotating valve-axle *e'*. The said Otto gas-engine is shown in part section, sufficient for the description of the new combined apparatus, which is connected directly with the exhaust-pipe *f* and the air-feed pipe *d*, as shown in Fig. 2. The exhaust-pipe *f*, Fig. 1, enters one side of a cast-iron cylinder, *r*, which contains an inner cylinder, *s*, of dimensions small enough to permit an annular passage-way for the exhaust (shown between said cylinders) to the exit-pipe *g*, causing the exhaust to impart heat to the cylinder *s* and contents. The said cylinders *r* and *s* are provided with flanges on the upper end and a metal cap-plate, *x*, all firmly bolted together by bolts. (Shown.) The air-feed pipe *d* of engine receives its air from within the chamber *s* at *w* and from the inlet-passage *c'*, Fig. 3, controlled in the manner hereinafter explained.

The chamber *s* is filled with hydrocarbon fluid, *u*, in portion shown by dotted lines, and is provided with an atomizer, *v*, the fluid-tube *o* of which extends to bottom portion of fluid *u*, and the air-pressure tube *p*, which actuates the atomizer, receives its impulse of air from a single-acting air-pump, *y*. Said pump consists of an ordinary single-acting air-pressure pump provided with ordinary valves. The pump is secured to the floor in line beneath crank-pin *a'* of valve-axle *e'*, and the pitman-rod *z* (shown in section) is connected at its upper end by ordinary journal with crank-pin *a'*, and at its lower end is pivoted by ordinary ball-joint with plunger in pump *y*. The regular rotative motion of crank-pin *a'* is thus caused to operate the air-pump *y*, which supplies regular impulses of air to the said atomizer *v*, all for the purpose hereinafter explained.

Fig. 3 represents a combined safety or regulating valve to prevent the engine from running off when all the gas-supply is cut off from the engine. The said valves consist of a plain flat valve, *d'*, (shown in position of closing the passage *d*,) through which vapor is led from chamber *w*, and opening to passages *c'* of the outer air, while a similar valve, *z'*, connected with the air-pipe *p*, closes the passage against entrance to said atomizer and opens in apertures *l* to the outer air. The valve-stems of said valves are connected to cross-head *n* in the manner shown, and is provided with spring *m*, to cause said valves to assume the normal or outward position, for the purpose hereinafter explained.

The cross-head *n* is provided with a projecting pin, *i*, to be actuated by lever *h*, which lever swings on a short axle in journal *b'*. The inner end of said axle is provided with a lever, *y'*, that has a small friction-wheel on its outer end to cause it to ride up the cam-groove *f'*, Figs. 4 and 5, and thus cause lever *h* to compress and close the said air-valves *d'* and *z'* to the position before described, for the purpose hereinafter explained. The said cam-groove *f'* is provided on the rear portion of the regular cam-sleeve of the Otto gas-engine *g'*, which is controlled by the regular gov-

ernor in the usual manner, and it is only when at the extreme of its stroke, actuated by highest speed of engine, when said crank-groove f' is caused to act as before described.

An ordinary tube, t, secured to top plate, x, and open at its bottom end, enables the application of a cork float in said tube, with projecting wire to show depth of contained fluid u. Ordinary tubes, x', of diameter sufficient to equal area of tube d, are secured to plate x, with open tops, permitting a downward current of air in chamber w. Said tubes x are closed at the bottom end and provided with numerous apertures on the sides of said tube, to equal area of tube, and the air entering said chamber w is diffused through the said apparatus, for the purpose hereinafter explained.

The engine is operated with the improved apparatus in this wise: Gas is fed to the engine in the regular way to the entrance-valve located at e. The heavy hydrocarbon fluid u is placed, as shown, in cylinder s, through ordinary plugged aperture in cap x. When the engine is cold at starting, it will for a few strokes receive its power almost entirely from the gas in the ordinary way; but as soon as the parts get warmed up and the pump y run to the regular speed, the impulses of air cause the atomizer to fill the chamber w with hydrocarbon fluid in atomized condition at the proper moment when engine is taking air, causing the inrushing air to become mechanically saturated with the contained oils, thus feeding the said air with nearly the requisite amount of hydrocarbons for explosive effect, requiring the minimum of gas to insure the same. The heat utilized from the described exhaust-passages prevents refrigeration and enables the use of high fire-test oils. When atomizer is working in best condition and the oils are heated to the highest point that exhaust is capable of heating, the engine will run entirely from oils without any gas whatever, and the gas is entirely cut off by the regular governor of the Otto engine, and any further increase of speed of engine is checked by the said governor causing the described cam f' to come into play and elevate the lever y', which, through lever h on the same axle, depresses the pin i in opposition to spring m, and thus shuts off the atomizer by closing valve z' and shuts off the hydrocarbon-saturated air by closing-off valve d' to position shown in Fig. 3, causing pure air to enter ports c', thus preventing explosive charges, and a decease of speed as a consequence. This provision causes the engine-governor to control the engine at both the gas and the air inlet passage-ways.

When the apparatus is freshly charged with oil and heated to the maximum temperature of exhaust, the inrushing air fed to the engine is largely saturated with the vapors of the oil without the operation of the atomizer until the lighter qualities of the oil have passed off in vapor, in which condition good results have been obtained with atomizer detached by detaching the described air-pump from the crank pin A'.

It will be evident that said device can be modified to suit the various classes of gas-engines without any alteration in the result. I therefore do not wish to confine myself to the exact configuration here shown.

I do not in this case claim anything claimed in my application Serial No. 231,239, filed by me March 17, 1887, wherein is shown a construction in some respects similar to that herein shown and described.

What I claim, and desire to secure by Letters Patent, is—

1. The combination, with a gas-engine and a gas-supply pipe, e, of a chamber containing a hydrocarbon, a vapor-passage leading from said chamber to the explosion-cylinder, and a passage-way, described, for feeding air into said chamber, where it is charged with vaporized hydrocarbon, and thence by said passage into the explosion-cylinder of the engine, whereby the engine is supplied with both gas and air charged with a vaporized hydrocarbon oil, substantially as described.

2. The combination, with a gas-engine and a gas-supply pipe, e, of a chamber containing a hydrocarbon oil, a passage leading from the chamber to the explosion-cylinder of the engine, mechanism for forcing air through said chamber, whereby it becomes charged with hydrocarbon vapor, and thence into the explosion-cylinder, and a governor which automatically cuts off the gas-supply as the speed of the engine increases, the latter being fed by the vaporized hydrocarbon, substantially as described.

3. The combination, with a gas-engine and a gas-supply pipe, e, of a chamber containing a hydrocarbon oil, a passage-way leading from the chamber to the explosion-cylinder of the engine, mechanism for forcing air through said chamber and into the explosion-cylinder, a cut-off in the gas-supply pipe operated as the engine attains a determined speed, and another cut-off, which shuts off the hydrocarbon-charged air as the engine attains a greater determined speed, substantially as described.

4. The combination, with a gas-engine and a gas-supply pipe, e, of a chamber containing a hydrocarbon oil, a conductor for leading the exhaust products from the explosion-cylinder to heat said oil, a passage-way leading from the chamber to the explosion-cylinder, mechanism for forcing air through said chamber, where it is charged with vaporized hydrocarbon and thence into the explosion-cylinder, and a governor which automatically cuts off the gas as the oil becomes heated, substantially as described.

5. The combination, with a gas-engine, of a chamber containing a hydrocarbon oil, an air-forcing mechanism which discharges a current of air into said chamber, whereby it becomes charged with hydrocarbon vapor, a passage for conducting such hydrocarbon-charged air to

the explosion-cylinder, and cut-off mechanisms operated by the engine, when it attains a determined speed, for simultaneously restricting the passage from the chamber to the explosion-cylinder, and the admission-air passage to the chamber, substantially as described.

6. The combination, with a gas-engine, of a chamber wherein air is mixed with a hydrocarbon vapor, a pipe, *d*, leading therefrom to the explosion-cylinder of the engine, an air-forcing mechanism, a pipe, *p*, leading therefrom to said chamber, valves *d'* and *z'*, operated by the engine to respectively close pipes *d* and *p* on their sides toward said chamber, and apertures *c'* and *t* in pipes *d* and *p*, respectively, and opened by valves *d'* and *z'* when they are moved to close said pipes to the chamber, substantially as and for the purpose described.

7. The combination, with a gas-engine having a valve-stem, *e'*, provided with a cam, *f'*, of mechanism, substantially as described, for delivering hydrocarbon-charged air to the explosion-cylinder of the engine, a valve for regulating the delivery of such vapor-charged air, a spring for maintaining the valve in an open position, and a lever, *h*, operated upon by said cam *f'* for closing said valve, substantially as described.

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