2 Sheets—Sheet 1.

D. CLERK.

Gas Motor Engines.

No. 230,470. **Patented July 27, 1880.**

Fig. 1.

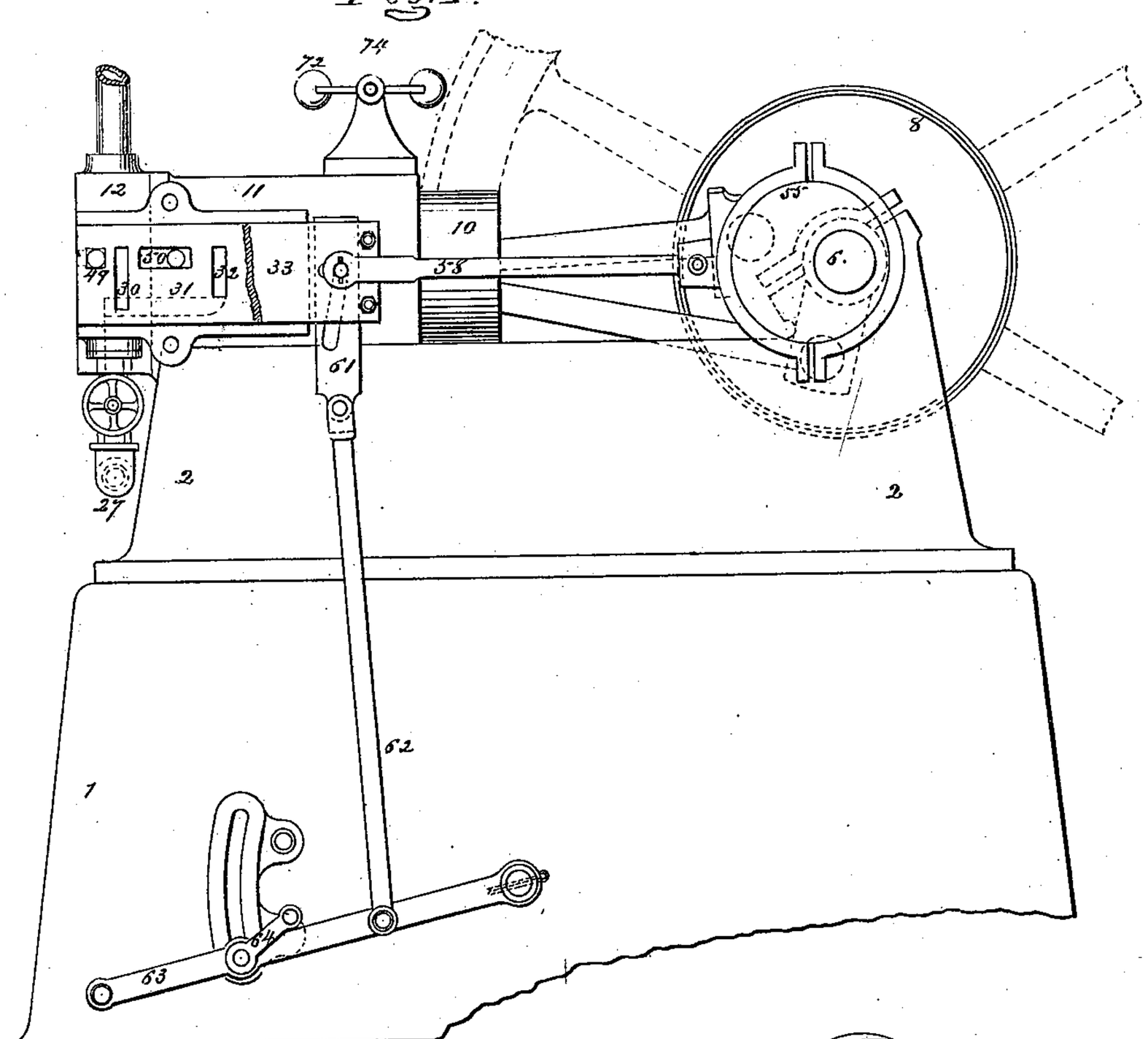
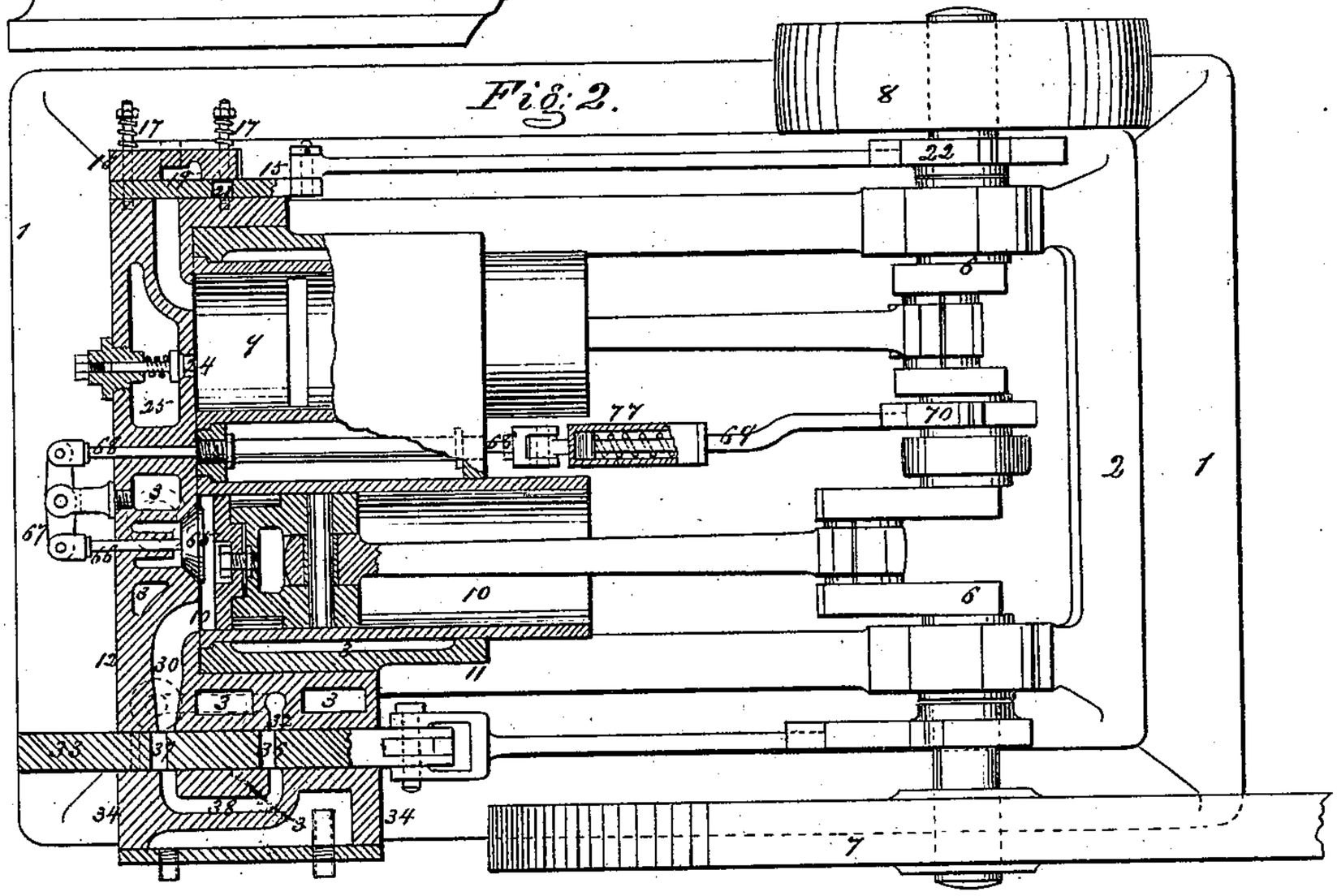


Fig. 2.



Witnesses:
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Jacob Feibel

Inventor:
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By atty. J. N. MacKenzie

2 Sheets—Sheet 2.

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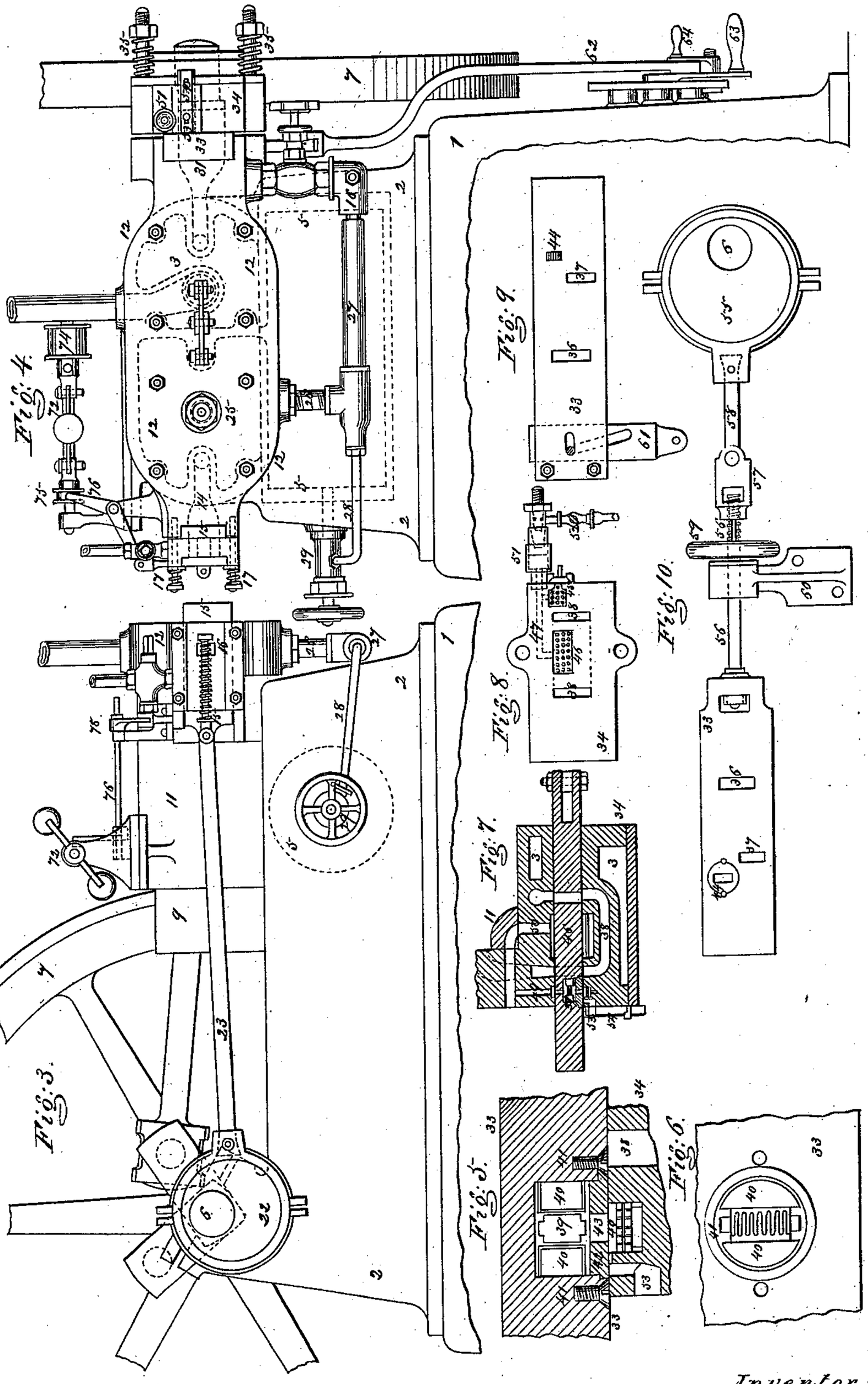

Fig. 4.

Fig. 9.

Fig. 8.

Fig. 10.

Fig. 7.

Fig. 6.

Fig. 5.

Fig. 11.

Fig. 3.

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UNITED STATES PATENT OFFICE.

DUGALD CLERK, OF GLASGOW, NORTH BRITAIN.

GAS-MOTOR ENGINE.

SPECIFICATION forming part of Letters Patent No. 230,470, dated July 27, 1880.

Application filed February 18, 1880. Patented in England August 1, 1878.

To all whom it may concern:

Be it known that I, DUGALD CLERK, of Glasgow, in the county of Lanark, North Britain, have invented certain Improvements in Gas-Motor Engines; and I do hereby declare that the following is a full and exact description thereof, reference being had to the accompanying drawings, making part of this specification.

My invention has for its main object to improve the construction and action of motor-engines in which a combustible gas is employed as the source of power, such gas being combined with a suitable proportion of air, and ignited within the engine, so as to operate by its expansive force.

In a simple modification of gas-motor engines embodying my improvements the power is developed in one single-acting cylinder having combined with it a second cylinder which is used as a compressing-pump, the two pistons being connected by rods to cranks on a first-motion shaft, which also carries eccentrics for working the valves.

The air and gas are admitted to the pump in suitable proportions by a valve sliding between two faces, and are forced by the pump-piston through a lift-valve into an intermediate chamber or reservoir, which consists, by preference, of a small compartment conveniently formed at the back end of the pump, and of a larger compartment communicating with the former by a comparatively small passage and formed beneath the pump and power cylinders.

The mixture of air and gas is admitted to the power-cylinder by means of a valve which is in the form of a plate, and slides between a port-face and a cover, the peculiarities of the valve and passages and other parts in connection therewith being hereinafter minutely described. The connecting-rod which works this valve is made with a screw-coupling or equivalent adjustable connection, so that the rod can be lengthened or shortened for the purpose of controlling the action of the engine, and, more particularly, for facilitating the starting of the engine by arranging the valve-action in a manner to make the engine act with a small compression of the air and gas.

When working at full power the engine operates with the air and gas in a state of considerable compression, and is on that account more economical than many existing gas-motor engines.

The power-cylinder is provided with a separate exhaust-valve, which is worked by an eccentric, the rod of which is in two parts, connected together with a spring arranged to allow of a part of the stroke of the eccentric being performed after the valve is closed.

A small centrifugal governor is fitted to the engine to act on a regulator-valve on the gas-supply pipe; but the parts are so arranged that if the regulator-valve is closed it cannot open except at the commencement of a stroke, and thereby are avoided inconveniences arising from the valve reopening at other times.

To enable those skilled in the art to make and use my improved gas-motor engine, I will now proceed to more particularly explain its construction and operation, referring by reference-figures to the accompanying drawings, in which—

Figure 1 is a side elevation of my improved gas-motor engine, showing the valve-cover and part of the admission-valve of the power-cylinder removed. Fig. 2 is a sectional plan view of the same. Fig 3 is a side elevation, showing the side of the machine opposite to that seen at Fig. 1. Fig. 4 is a back-end elevation, partially in section. The remaining figures (from 5 to 10 inclusive) are detail views, which will be explained and referred to during the following description.

The parts of the engine are carried upon a kind of double base, 1 2, consisting of a lower part, 1, used as a tank to contain water, which is made to circulate through various spaces 3 about the power-cylinder 10 and its valves, to prevent the parts from becoming inconveniently heated.

The circulation may be effected by means of a centrifugal pump (not shown in the drawings) or in any other convenient way.

The upper part, 2, of the base is partly occupied by a wrought-iron receiver, (indicated by dotted lines at 5 in Figs. 3 and 4,) and forming the larger compartment, hereinbefore referred to, for holding the compressed mixture of air and gas.

The base 1 2 is of an oblong rectangular

orm in plan, and the first-motion or crank haft 6 is placed horizontally in suitable bearngs across one end of the base, the shaft aving a fly-wheel, 7, on one end, and on the ther end a pulley, 8, for a belt for transmiting the power from the machine.

The compressing-cylinder or pump 9 and he power-cylinder 10, which are both single cting, are placed horizontally side by side at he end of the base opposite to that at which he crank-shaft 6 is situated, and their admission valves are at their outer sides.

The cylinders 9 10 are simple cylindrical shells held in a jacket or external casting, 11, and between it and an outer end casting, 12, which latter has formed in and on it the passages and port-faces, and also other parts, hereinafter referred to.

This construction admits of the cylinders being renewed, when requisite, at very small cost.

The admission-passage 13 of the pump has its outer end or port in a vertical port-face, 14, and the valve is a plate, 15, working horizontally between the face and a cover, 16, which cover is carried on studs or bolts and is pressed against the valve by springs 17, adjustable on the bolts by screw-nuts.

The gas-supply pipe 18 communicates, through a regulating-valve, 73, hereinafter described, with a cavity, 19, in the valve-cover 16, while the air has access by ports 20, formed through the cover above and below a part of the cavity 19.

The valve 15 is made with a single port, 21, through it, and when the eccentric 22, to which the valve 15 is connected by a rod, 23, moves the valve 15 so as to place its port 21 between the ports 19 and 20 and the passage 13, air and gas pass into the pump 9, the piston of which is then moving toward the crank-shaft. When the piston of the pump 9 returns the valve 15 is in its closed position, and the mixture of air and gas is compressed and is forced through a simple spring-lift valve, 24, into the intermediate chamber or reservoir, 25, formed in the end casting 12. The compressed gaseous mixture passes from the reservoir 25 by a pipe, 26, which communicates with a pipe, 27, leading to the admission-valve of the power-cylinder 10, and also with a small pipe, 28, leading through a stop-valve, 29, into the reservoir 5, within the upper part, 2, of the base.

While the division of the space for the compressed gaseous mixture into two compartments, 25 and 5, with the communication 28 between them comparatively small is of advantage in causing any action of the governor to be immediately effective, the larger compartment 5 can also be utilized for retaining or storing a quantity of compressed gaseous mixture when the action of the engine is stopped, to be availed of on afterward restarting the engine. For this purpose the stop-valve 29 must be closed whenever the engine is stopped. The gaseous mixture enters the power-cylinder 10 by an admission-passage, 30, formed in the end casting, 12, and having its outer end or port in a vertical port-face, 31. (Seen as for the most part uncovered in Fig. 1.) A passage formed also in casting 12 and having a port, 32, in the port-face 31, leads the gaseous mixture from the pipe 27 to the valve 33. This admission-valve 33 is a vertical plate working horizontally between the port-face 31 and the inside vertical face of a plate or cover, 34, held with a suitable pressure against the valve 33 by springs 35 on bolts or studs, such springs being adjustable by screw-nuts on the bolts.

The valve 33 and the adjacent parts are shown as in horizontal section at different levels in Figs. 2 and 7, and Figs. 8 and 9 are inner side elevations of the cover 34 and valve 33, respectively. There are two ports, 36 and 37, through the valve 33, and when the valve is in a certain position the gaseous mixture has access from the port 32 by one port, 36, into a passage, 38, formed in the cover 34, then through that passage 38 and the other port, 37, in the valve into the admission-passage 30, and thence into the cylinder 10.

The admission of the gaseous mixture into the cylinder 10 takes place while the valve 33 is moving toward the crank-shaft, and the combination of that movement first cuts off the supply of gaseous mixture, and immediately afterward brings between the passages 38 and 30 a bundle of incandescent platinum, 39, contained in a port formed through the valve. At this time the piston of the cylinder 10 is also moving toward the crank-shaft, which causes a slight expansion of the gaseous mixture in it, and the gaseous mixture remaining in the passage 38 has in consequence a slight excess of pressure, which is sufficient to make it expand to the platinum bundle, so as to become ignited. There being no outlet for the ignited gaseous mixture, it perforce expands into the cylinder 10 in a strong jet, which ignites the contents of the cylinder in a very complete manner. The platinum 39 and the part of the valve 33 containing it, and also part of the cover 34, are shown enlarged and in horizontal section in Fig. 5, while Fig. 6 is a corresponding face view of part of the valve 33.

The platinum 39, in the form of a thin sheet, is bent from side to side to form a bundle, with thin spaces for the passage of the gaseous mixture between its folds, and it is held between pieces 40, of porcelain or other suitable refractory material, being secured by small flaps formed on it and bent outward upon the pieces 40, while these pieces are protected by coverings of thin platinum.

The platinum 39 and its holding-pieces 40 are packed with asbestus into a cylindrical cavity, 41, formed for them in the valve 33, such cavity being fitted with a cover, 42, having a rectangular opening, 43, in it for the passage of the gaseous mixture, while a similar opening, 44, from the bottom of the cavity 41 to the other side of the valve, allows the gaseous mixture to pass onward.

The incandescence of the platinum 39 is

maintained partly by the combustion of the gaseous mixture passing through it from the passage 38 at the time of igniting the charge in the power-cylinder 10, and partly by the combustion of small quantities of gaseous mixture which are led through it by special passages at times when it is not in the position between the passages 38 and 30.

The valve-cover 34 has formed on its inner face two ports or cavities, 45 46, one on each side of the after port of the passage 38, and both these cavities are provided with pieces of wire-gauze held between perforated metal plates to prevent the flame from passing into a passage, 47, which supplies both cavities with gaseous mixture. The passage 47, which is indicated by dotted lines in Fig. 8, receives the gaseous mixture from a branch pipe connected to the main pipe 27 at any convenient point, as 48, Fig. 4, but not shown in that figure to avoid complexity.

In Figs. 5 and 7 the platinum 39 is shown as opposite one, 45, of the two cavities in the cover, and the gaseous mixture passes through the platinum and through a passage, 49, in the cylinder port-face 14. When the valve 33 is in the position with the platinum 39 opposite the other cavity, 46, the gaseous mixture, after passing through the platinum, enters a passage, 50, in the port-face 14. The two passages 49 50 unite and lead the products of combustion either immediately into the atmosphere or into the main exhaust-pipe.

The pressure of the gaseous mixture from the receivers 5 25 is greater than is necessary either for maintaining the incandescence of the platinum 39 in the manner just explained, or for heating up the platinum to the necessary temperature when starting the engine, and the pressure is economized and utilized by means of an injector, 51, fitted at the inlet into the passage 47 in a manner to make a very small quantity of the compressed gaseous mixture effect what is required. This injector 51 is formed with holes to take in air, and has connected to it a small branch pipe, 52, to admit combustible gas to mix with the air taken by the inductive action of the small jet of compressed gaseous mixture, so as to form a suitable gaseous mixture of the whole.

The outermost cavity, 45, is made to communicate by means of a small passage (seen in section in Fig. 5) with a port, 53, in the outer end of the valve-cover 34, and a small slide, 54, which ordinarily covers this port 53, is withdrawn, when about to start the engine, for the purpose of igniting the gaseous mixture and heating up the platinum 39.

The gas being turned on at the branch pipe 52, and also the jet of compressed gaseous mixture, the mixture issues at the port 53, and is there ignited, after which, the appearance of the flame being a guide, the stop-cocks are adjusted, and the cover 54 is then closed. The ignited gaseous mixture then passes through the platinum 39 and heats it up, the valve 33 being, of course, placed in a suitable position—that is, with the platinum 39 opposite the cavity 45, as shown in Fig. 5.

An important object I have had in view in the construction of my improved gas-motor engine, and more particularly in proportioning and arranging the passages and ports and the valve mechanism, is the working of the engine with the gaseous mixture in a state of considerable compression, whereby the power developed from the gas employed is greatly increased as compared with that obtained in gas-motor engines working with a low compression. The parts are at the same time such as to admit of the degree of compression being easily controlled and varied, and in particular to allow of the engine being conveniently started with the gaseous mixture of the low pressure.

If during the working of the engine the admission of gas and air to the pump continues the same, an alteration of the admission-valve 33 to the power-cylinder 10, such as will make it cut off earlier in the stroke, will not diminish the power developed by the engine. Each stroke of the pump will force a certain quantity of gaseous mixture into the reservoirs 5 25, and if an equal quantity does not pass into the power-cylinder at each stroke the pressure in the reservoirs must necessarily increase, and it will increase until the earlier cut-off the same quantity but of greater pressure, is admitted as with the later cut-off. This equal quantity admitted with the earlier cut-off, but at the increased pressure, must necessarily develope increased power, so that the making of the cut-off earlier increases the power developed from a given quantity of gaseous mixture.

For the purpose of varying the cut-off action of the admission-valve 33 of the power-cylinder 10 in a simple and convenient manner, I connect it to the strap of the eccentric 55, which works it, so that the length of the rod can be altered, the ports and passages being proportioned so as to be quite sufficient with any adjustment of the valve 33 relatively to the eccentric 55 that may be adopted in practice.

In one arrangement (shown in Fig 10) a rod, 56, connected to the valve 33 so as to be free to turn, has its outer end screwed into a coupling-piece, 57, which is jointed to the eccentric rod 58. The rod 56 has a longitudinal groove formed in it, and in this groove there engages a key in the tubular boss of a hand-wheel, 59, which is held by a bracket, 60. The rod 56 can move longitudinally through the center of the hand-wheel 59, while it can be turned by that hand-wheel independently of its longitudinal motion, and when it is thus turned it, by screwing into or out of the coupling-piece 57, adjusts the valve nearer to or farther from the eccentric.

Another simple arrangement for adjusting the valve 33 relatively to the eccentric 55 is

shown in Figs. 1, 2, 4, and 9, and in it the eccentric rod 58 is forked and connected to the valve 33 by a pin which passes through short horizontal slots in the valve and through an inclined slot in a bar, 61, which is movable vertically through a vertical slot in the valve. The bar 61 is connected by a long link, 62, to a hand-lever, 63, the link 62 accommodating itself to the reciprocation of the valve and the hand-lever 63 being fixed in any desired position by a handled pinching-screw, 64.

The effect of adjusting the valve 33 nearer to the eccentric 55 is to make the cut-off earlier, and vice versa.

The power-cylinder 10 is fitted with an exhaust-valve, 65, separate from the admission-valve 33, such exhaust-valve being by preference a simple disk-valve, 65, opening into the cylinder 10 and worked by a rod, 66, which is connected by a lever, 67, to a rod, 68. The rod 68 is connected to the rod 69 of the eccentric 70, which works it by a spring-coupling, 71, arranged so as to allow of a part of the stroke of the eccentric being performed after the valve is closed, in order that there may be a suitable interval between its closing and reopening.

A small centrifugal governor, 72, is fitted to the engines for regulating the speed by acting on a valve, 73, fitted in connection with the gas-supply pipe 18. The governor 72 is on a horizontal shaft driven by means of a pulley, 74, and a belt from the crank-shaft 6, and the governor-sleeve 75 acts on a lever on a rocking shaft, 76, which has on it a second lever, 77, connected to the spindle of the valve 73. The rocking shaft 76 has also on it a small boss, 78, on which there bears the end of a lever, 79, acting as a brake, and pressed against the boss 78 by a spring, and the lever 79 has made in the same piece with it an elbow, 80, the end of which projects down slightly in the way of the top of the valve 15 when the lever 79 presses on the boss 78.

The pressure of the lever 79 prevents any movement of the regulating-valve 73; but at the commencement of each movement of the pump-piston toward the crank-shaft the admission-valve 15, by acting on the elbow 80, relieves the pressure on the boss, and then allows the governor to act on the regulating-valve 73 if the speed has given it any tendency to do so.

Some of my improvements, hereinbefore described, are advantageously applicable to existing gas-motor engines.

Having thus particularly described my said invention and the manner of performing the same, I have to state that I do not restrict myself to the precise details herein described or delineated; but that

What I believe to be novel and original, and claim as the invention secured to me by and in terms of the hereinbefore in part recited Letters Patent, is—

1. The combination of the cylinders 9 and 10 with the embracing jacket or casting 11 and the end casting, 12, the whole constructed and arranged for operation substantially as set forth.

2. The combination, with the valve controlling the supply of combustible gas and the parts which prevent movement of the valve except at the taking-in movement of the pump-piston, of the speed-governor, all constructed and arranged substantially as described.

3. A power-cylinder having the admission-valve and the ports and passages in connection therewith constructed, arranged, and operating in the manner shown and specified, for the purposes hereinbefore described.

4. The valve 33, having a passage, 38, and having an action, as specified, such that a portion of the gaseous mixture led through the passage 38 is retained therein to assist in igniting the charge in the cylinder in the manner described.

5. In combination with the power-cylinder, for the purpose of igniting the charges therein, of platinum, the latter being rendered incandescent by the combustion of a portion of the gaseous mixture, as hereinbefore described.

6. The arrangement of the platinum igniter and the passages and parts for heating it and maintaining its incandescence, as hereinbefore described.

7. The adjustable connection arranged between the admission-valve of the power-cylinder and the eccentric which works it, substantially as and for the purpose described.

8. The combination, with the pump 9, operating to force a given quantity of gas and air at each stroke into the reservoir, of a power-cylinder the admission-valve of which may be adjusted to cut off earlier or later in the stroke, whereby the gaseous mixture may be caused to operate with the higher initial pressure by adjusting the cut-off to occur earlier, as hereinbefore described.

Witness my hand and seal this 28th day of January, 1880.

DUGALD CLERK. [L. S.]

In presence of—

JOHN SMITH,
Crown Iron Works, Glasgow.

DAVID LEWSLEY,
Crown Iron Works, Glasgow.