No. 705,058. Patented July 22, 1902.

J. B. FENNER.

OPERATING MECHANISM FOR GAS ENGINE VALVES, &c.

(Application filed Mar. 21, 1900.)

(No Model.) 3 Sheets—Sheet 1.

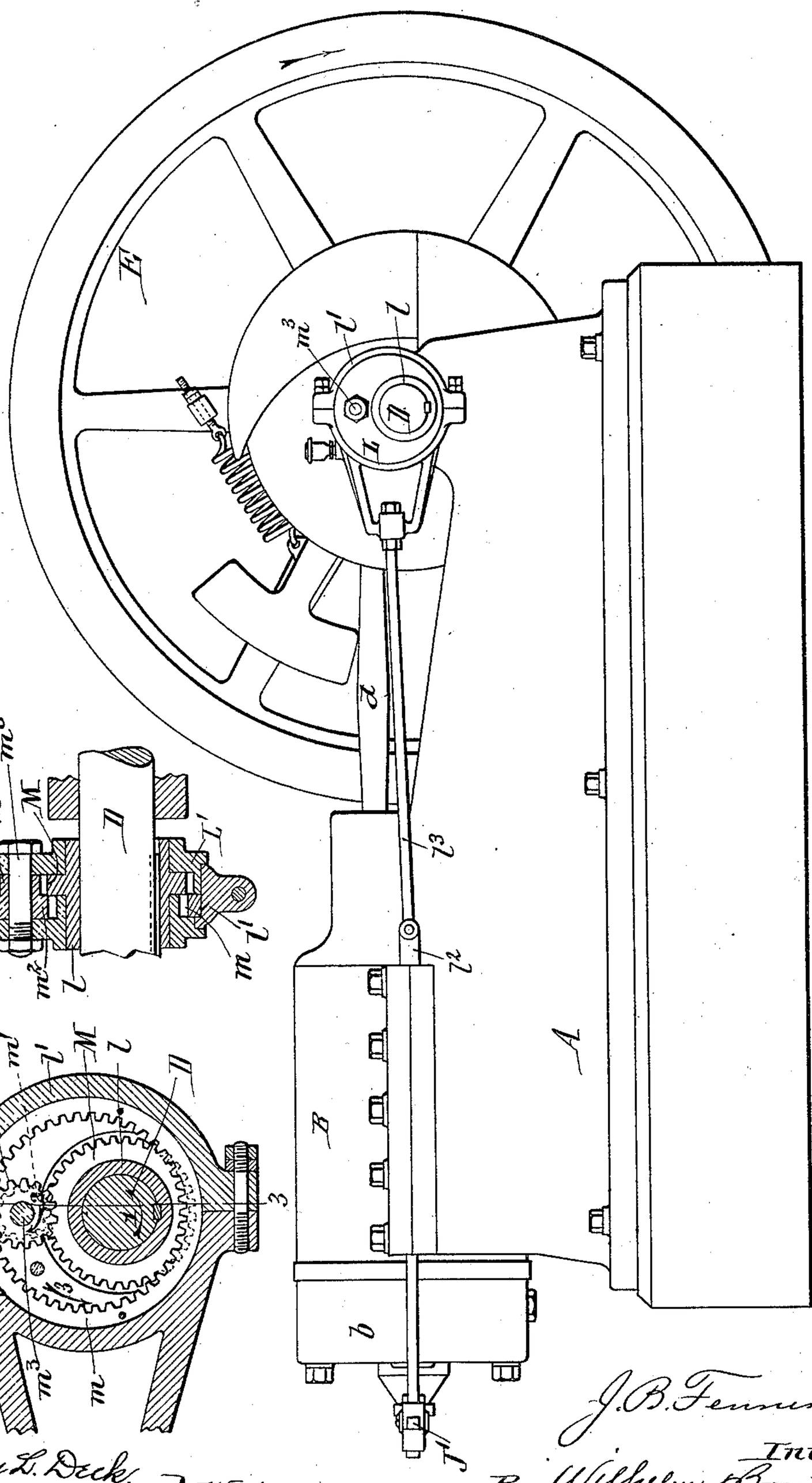

Fig. 1.

Fig. 3.

Fig. 2.

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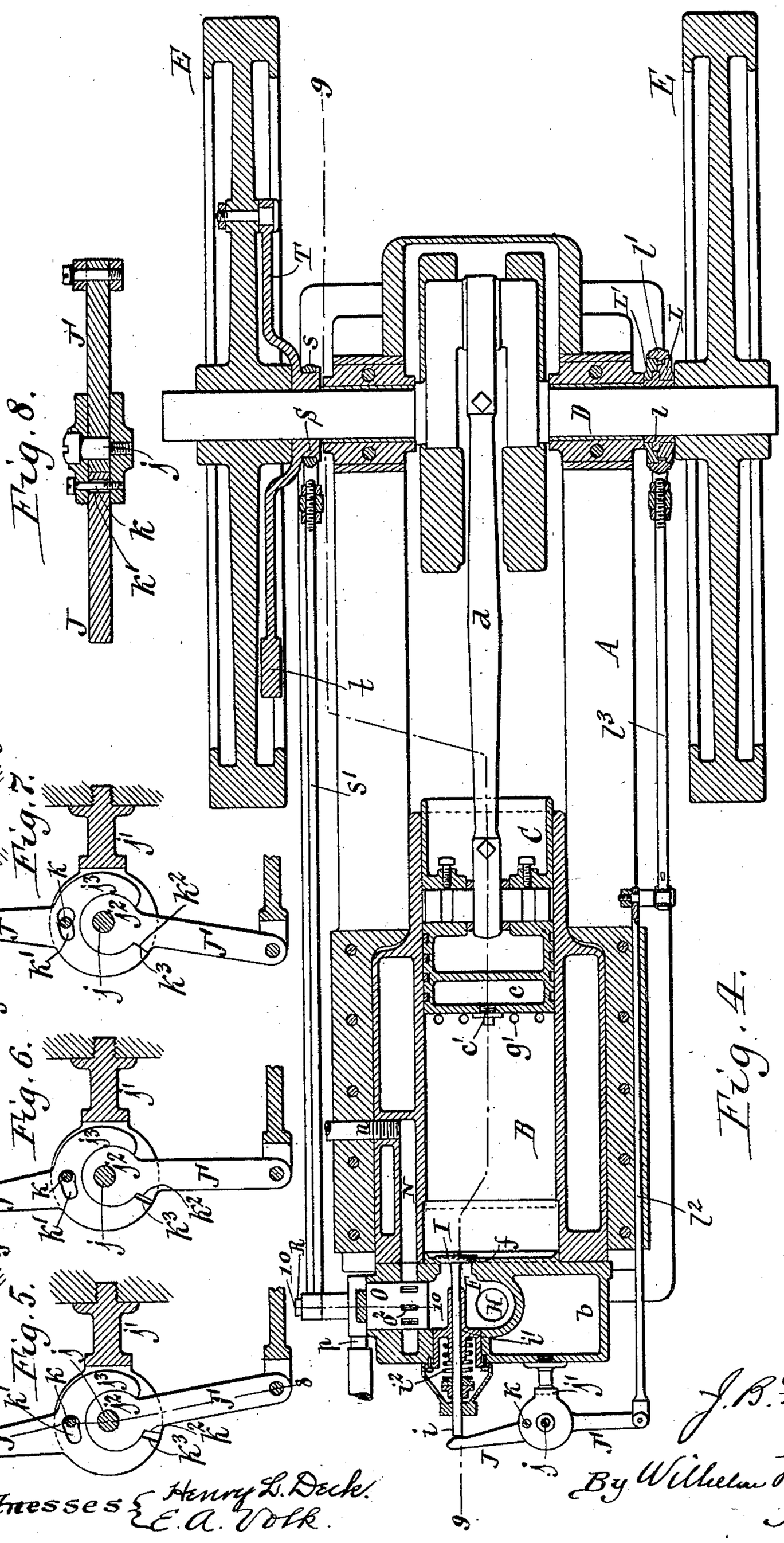

Fig. 8.

Fig. 7.

Fig. 6.

Fig. 5.

Fig. 4.

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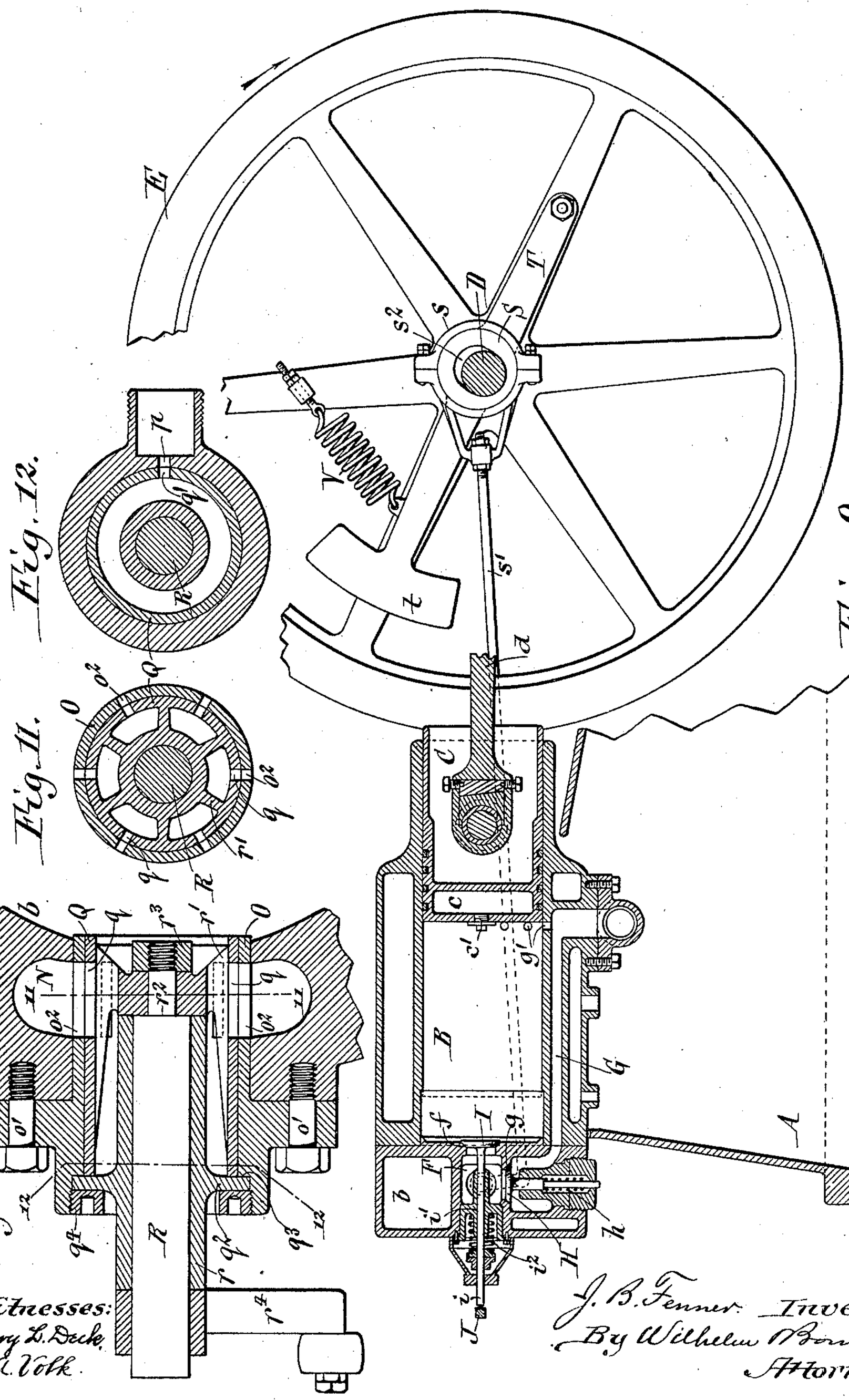

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UNITED STATES PATENT OFFICE.

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OPERATING MECHANISM FOR GAS-ENGINE VALVES, &c.

SPECIFICATION forming part of Letters Patent No. 705,058, dated July 22, 1902.

Application filed March 21, 1900. Serial No. 9,536. (No model.)

To all whom it may concern:

Be it known that I, JESS B. FENNER, a citizen of the United States, residing at Buffalo, in the county of Erie and State of New York, have invented new and useful Improvements in Operating Mechanism for Gas-Engine Valves, &c., of which the following is a specification.

This invention relates to an operating mechanism for gas-engine valves, &c., and has the object to provide improved means for operating a valve without undue noise or wear.

In the accompanying drawings, consisting of three sheets, Figure 1 is a side elevation of a gas-engine embodying my improvements. Fig. 2 is a fragmentary section, on an enlarged scale, of the gearing whereby the main or cylinder valve is operated. Fig. 3 is a vertical section of the same in line 3 3, Fig. 2. Fig. 4 is a horizontal section of the engine. Fig. 5 is a fragmentary horizontal section, on an enlarged scale, of the lever whereby the cylinder-valve is operated, showing the position of this lever when the valve is closed and the piston is beginning its working stroke. Figs. 6 and 7 are similar views showing different positions of this lever and valve. Fig. 8 is a vertical transverse section in line 8 8, Fig. 5. Fig. 9 is a vertical longitudinal section in line 9 9, Fig. 4. Fig. 10 is a fragmentary transverse section, on an enlarged scale, in line 10 10, Fig. 4. Figs. 11 and 12 are vertical sections in lines 11 11 and 12 12, Fig. 10, respectively.

Like letters of reference refer to like parts in the several figures.

A represents the base of the engine; B, the cylinder, which is open at its rear end and which is closed at its front end by a valve head or chest *b;* C, the piston, arranged in the cylinder; D, the crank-shaft, journaled in bearings on the base; *d*, the pitman, connecting the piston with the crank of said shaft, and E the balance-wheels, mounted on opposite ends of the crank-shaft.

In gas-engines as ordinarily constructed the piston becomes very hot by reason of the successive explosions of gas in the cylinder, which causes the oil in the piston-packing and in the pivotal connection between the piston and pitman to burn and smoke. To overcome this objection, the front or inner end of the piston, which faces the firing-space, of the cylinder is provided with a chamber *c*, in which a body of air is confined and forms an air cushion or jacket, whereby the transmission of heat to the packing and other oiled parts of the piston is checked, thereby preventing the oil from burning and smoking. This air-chamber is preferably formed by coring the front end of the piston, so that the chamber is cast in one piece with the piston. The core after casting the piston is removed through an opening in the air-chamber, which opening is closed by a plug *c'* when the piston is in use.

F represents a valve-chamber which is formed in the valve-chest and which communicates on its inner side with the front end of the cylinder by a main port or opening *f* and on its lower side with an exhaust-chamber G by a main exhaust port or opening *g*.

g' represents a number of auxiliary exhaust-ports which connect the rear end of the cylinder with the exhaust-chamber and which are uncovered by the piston at the end of the forward stroke of the piston.

H represents an outwardly-opening exhaust-valve which is held by a spring *h* against a seat formed around the outer end of the main exhaust-port *g*.

I represents a main or cylinder valve which moves toward and from a seat around the inner end of the main port and whereby the admission of fuel into the cylinder and the exhaust from the cylinder are controlled. This valve is provided with a valve-stem *i*, which projects forwardly through a guide *i'* in the valve-chest and which is moved outwardly against its seat by a spring i^2, bearing with its ends against shoulders on said guide and valve-stem.

J J' represent the inner and outer arms of a horizontal rock-lever, whereby the main valve is opened and which is connected with its outer arm to an actuating mechanism, while its inner arm is adapted to engage with the outer end of the stem *i* of the main valve I. The outer arm J' of this rock-lever is pivoted by a vertical pin *j* between the members of a bifurcated bracket *j'*, which is ar-

ranged on the front end of the valve-chest and is provided around its pivot with an eccentric j^2, which is arranged with its salient portion on the same side of the pivot j from which the outer arm projects. The inner arm J of the rock-lever is also arranged between the members of the bifurcated bracket j' and is provided at its outer end with an eccentric-jaw j^3, which embraces the eccentric of the outer arm of the rock-lever, as shown in Figs. 5 to 7.

k represents a pin or stop secured to the members of the bracket j' and extending through a segmental slot k', which is formed in the inner arm of the rock-lever.

k^2 k^3 represent two opposing shoulders which are formed on the outer side of the outer arm J′ and the outer end of the jaw of the inner arm J, respectively.

Upon moving the outer lever J′ into its extreme outward position its shoulder k^2 engages with the shoulder k^3 of the inner arm J, and the latter is moved to its extreme inner position, as shown in Fig. 7, whereby the main valve is opened to its fullest extent. During the first part of the subsequent inward movement of the outer arm of the rock-lever its inner arm moves outward quickly in the same measure and fulcrums on the pin j, this movement of the inner arm being effected by the spring i^2, which moves the main valve toward its seat during this movement of the rock-arms. When the inner rock-arm has nearly completed the first half of its outward stroke, it bears with the inner end of its slot k' against the pin or stop k, as shown in Fig. 6. During the balance of the inward movement of the outer rock-arm its shoulder k^2 leaves the shoulder k^3 of the inner arm and its eccentric works against the inner side of the jaw of the inner rock-arm and moves said jaw slowly inward, whereby the inner rock-arm is turned on the pin k as a pivot and its inner engaging end is caused to move outwardly slowly to the end of its stroke. The outward movement of the inner rock-arm J is slowed down just before the main valve bears against its seat, whereby this valve is caused to seat itself slowly, and then the inner arm moves away from the valve-stem to the end of this stroke. While the inner rock-arm is thus shifted outwardly by the eccentric of the outer arm, the inner arm moves slightly laterally while adapting itself to the eccentric of the outer arm, this lateral movement being permitted by reason of the slight enlargement of the inner end of its slot k', as shown in Figs. 5 to 7. During the first part of the subsequent outward stroke of the outer rock-arm its eccentric works against the outer part of the eccentric-jaw, thereby turning the inner arm J on the pin k as a pivot and moving its inner end slowly inward until the same engages with the outer end of the main-valve stem, thereby bringing the inner rock-arm and valve-stem together slowly. Just after the inner rock-arm J engages the stem of the main valve the outer rock-arm J′ during its continued outward movement engages its shoulder k^2 with that of the inner rock-arm, whereby the inner rock-arm is now compelled to move inwardly quickly to the end of its stroke in the same measure as the outer rock-arm moves outwardly. The inner rock-arm turns with the outer rock-arm on the pin j while completing the inward movement of the main valve. It will thus be seen that the two arms are practically one piece and turn about the same pivot for moving the main valve quickly part of the time and the inner rock-arm turns about a separate pivot and slower during the beginning of the opening and the last part of the closing movement of the main valve. The rock-lever is so timed that the main valve is moved toward its seat and closed during about the first half of the backward movement of the rock-lever, remains closed during about the second half of the backward movement and the first half of the subsequent forward movement of the rock-lever, and is moved away from its seat and opened during about the second half of the forward movement of the rock-lever. By this construction of rock-lever for operating the main valve the inner arm of the lever comes slowly into engagement with the stem of the valve, then moves quickly inward and moves the valve away from its seat and quickly outward until the valve has nearly reached its seat, and then completes its outward movement slowly while seating the valve, whereby the valve is opened and closed quickly; but the starting of its opening movement and the stopping of its closing movement are effected easily, thereby avoiding undue wear and noise in operating this valve. The rock-lever J J′ may be operated from the main shaft by any well-known or suitable mechanism, so as to move the rock-lever back and forth once during every two rotations of the main shaft, and thereby open and close the main valve I once during each complete cycle of operations of the engine. The preferred mechanism for this purpose is shown in Figs. 1, 2, 3, and 4 of the drawings and is constructed as follows:

L L′ represent two eccentric disks arranged axially in line and turning on a sleeve l, which is keyed to the main shaft.

l' represents an eccentric-strap which fits around the eccentric surface of both disks.

l^2 represents a longitudinal reciprocating rod which is guided in the base and which is connected at its rear end with the eccentric-strap by a connecting-rod l^3, while its front end is loosely connected with the outer arm J′ of the rock-lever.

M represents a gear-wheel arranged between the eccentric disks and formed on the sleeve l, so as to turn with the main shaft.

m represents an internal gear-rim arranged between the eccentric disks on one side of the gear-wheel M and secured to the inner side of the eccentric-strap.

m' m^2 represent a small gear-pinion and a large gear-pinion, respectively, which are arranged axially in line and connected. These pinions are journaled upon a transverse bolt or stud m^3, which connects the eccentric disks, so that the pinions are carried by said disks. The small gear-pinion meshes with the gear-wheel M on the main shaft, and the large gear-pinion meshes with the internal gear-rim m on the eccentric-strap. Upon turning the shaft in the direction of the arrow 1, Fig. 2, the gear-wheel mounted thereon turns the small gear-pinion m' and the large gear-pinion m^2, connected therewith, in the direction of the arrow 2. This turning movement of the pinions about their own axis is retarded by the engagement of the large pinion with the gear-rim, which causes the large gear-pinion to roll on the gear-rim m, and thereby carry both pinions bodily in the direction of the arrow 3 about the axis of the main shaft. This bodily movement of the pinions around the gear-rim causes the eccentric disks, which carry the pinions, to also be turned in the direction of the arrow 3 about the shaft, whereby the eccentric-strap is shifted transversely to the axis of the shaft for opening and closing the main valve connected therewith. The relative size of the gear-wheel, rim, and pinions is such that two revolutions of the main shaft produces a forward-and-backward movement of the main valve during every alternate rotation of the main shaft.

The mechanism whereby fuel is supplied to the cylinder is best shown in Figs. 4, 9 to 12 and is constructed as follows:

N represents an air-chamber which is formed partly in the valve-chest and partly in the side of the cylinder and which is connected with an air inlet or pipe n.

O represents the case of a fuel-valve, whereby the admission of air and gas into the cylinder is controlled. This case is of cylindrical form and arranged in a cylindrical opening which is formed transversely in the side of the valve-chest and which extends from the outer side of the valve-chest into the valve-chamber, whereby the valve-case extends across the air-chamber. The valve-case is secured to the chest by screws o', passing through ears on the outer end of the valve-case, and the latter is provided with a circumferential row of openings o^3 in its side, which register with the surrounding air-chamber.

p represents a gas-inlet which extends laterally through the outer part of the valve-case, as shown in Figs. 4 and 12, and which is connected with a supply of gas, gasolene, or similar motive agent.

Q represents a cylindrical rock-valve fitting in the fuel-valve case and provided with a circumferential row of air-ports q, which are adapted to register with the air-inlet openings o^2 of the valve-casing, and a fuel-port q', which is adapted to register with the gas-inlet p of the valve-casing. The inner end of the rock-valve opens into the valve-chamber.

q^2 is a disk or head which bears against the outer end of the rock-valve and closes the same and also against a shoulder q^3 on the valve-case. The head is held in place by a clamping-ring q^4, bearing against the outer side of the head and having an external screw-thread which engages with an internal thread on the outer end of the valve-case.

R represents a rock-shaft or spindle which is arranged axially in the cylindrical fuel-valve and journaled in a bearing r, formed centrally on the head q^2. The fuel-valve is provided with an internal open hub or spider r', which is mounted on the inner end of the rock-shaft R and which is firmly secured between a shoulder r^2 and a screw-nut r^3 on this shaft. The outer end of the valve rock-shaft R is provided with a depending rock-arm r^4.

In the operation of the engine the rocking movement of the fuel-valve alternately places the valve-chamber in communication with the gas and air supply and cuts the same off from the gas and air supply.

S represents an eccentric provided with a surrounding eccentric-strap s, which is connected by a rod s' with the rock-arm r^4. The eccentric is arranged on the inner side of the hub of one of the balance-wheels and is provided with a slot s^2, through which the main shaft passes.

T represents a governor-arm which is arranged substantially diametrically on the inner side of said balance-wheel and pivoted at one end to the same on one side of the main shaft, while its other free end is provided on the opposite side of the main shaft with a weight t. The eccentric S is formed integrally with the central part of the governor-arm, as shown in Fig. 4, or the eccentric may be made separate and secured to said arm.

V represents a spring which connects the governor-arm with the adjacent balance-wheel and which constantly tends to move said arm so as to move the eccentric away from the center of the main shaft, this movement of the lever being limited by the inner end of the slot in the eccentric. During the normal operation of the engine the balance-wheel turns in the direction of the arrow and the governor-arm by reason of its weight lags behind, thereby straining the spring somewhat and moving the eccentric inwardly from its outermost position. The governor mechanism is so adjusted that when the engine runs at a normal speed the eccentric rocks the fuel-valve during each rotation of the main shaft and opens and closes the gas and air ports, so as to admit a normal quantity of fuel. When the speed of the engine rises above the normal, the governor-arm lags behind a greater extent, and the eccentric is moved nearer to the center of the axis of rotation, whereby the rocking movement which is imparted by the eccentric to the fuel-valve is reduced and the air and gas ports

thereof are opened to a less extent during each rocking movement of the valve, thereby reducing the charge of fuel which is admitted to the cylinder and reducing the speed of the engine. When the speed of the engine drops below the normal, the governor-arm lags behind less than under normal conditions and the eccentric is moved farther outwardly from the center of rotation, whereby the throw of the fuel-valve is increased and its gas and air ports are opened wider, thereby increasing the charges of fuel to the cylinder. By this means of regulating the supply of fuel a charge of fuel is delivered to the engine during each suction-stroke of the piston, but the quantity of fuel in each charge is varied automatically, according to the speed of the engine, whereby the engine is caused to run more uniformly and with less vibration than engines in which the cylinder receives either a full charge of fuel or no charge of fuel.

The operation of the engine, briefly stated, is as follows: Assuming that the engine is running normally and that a charge of fuel has been drawn into the cylinder, the piston will be at the end of its forward suction-stroke, as shown in Figs. 4 and 9, and the main, exhaust, and fuel valves will be closed. During the subsequent backward stroke of the piston and after the piston covers the auxiliary exhaust-ports the charge of fuel in the cylinder is compressed. At the end of the compression-stroke the fuel is ignited by an igniter of any suitable construction, whereby the piston is driven forward with a working stroke by the expansion of the exploding gas. During the last part of the forward working stroke of the piston the latter uncovers the auxiliary exhaust-ports, whereby a part of the spent gas is permitted to escape from the cylinder into the exhaust-chamber. While the fuel is being thus compressed and exploded during the compression and working strokes of the piston, the inner arm of the valve rock-lever moves away from and toward the stem of the main valve, and the latter remains closed during these two strokes of the piston. At the beginning of the subsequent backward or exhaust stroke of the piston the main valve begins to open and completes its opening movement when the piston reaches the end of its backward or exhaust stroke, whereby the products of combustion are expelled from the cylinder through the main port and through the exhaust-port into the exhaust-chamber. The exhaust-valve is opened at this time by the pressure of the escaping gases, which overcomes the pressure of its spring, and the fuel-valve at this time is turned by the eccentric S so as to close the air and gas inlet ports and prevent the spent gases from entering the air and gas supply passages. At the beginning of the next forward stroke of the piston the main valve begins to close and the fuel-valve is opened, whereby a charge of gas or air is drawn past the fuel and main valves into the cylinder during this forward suction-stroke of the piston. After the piston, during its subsequent backward stroke, has covered the auxiliary exhaust-ports the main valve completes its closing movement, and during the continued forward movement of the piston the charge of fuel is compressed in the cylinder. This charge is now ignited, and the piston is driven forward with another working stroke, and the cycle is completed, as before described. The fuel-valve is closed while the piston is effecting its compression stroke and is again opened and closed during the following working and exhaust strokes of the piston; but no gas and air are drawn into the valve-chamber during the working stroke of the piston, because the main valve is closed at this time, thereby permitting of simplifying the means for operating the fuel-valve.

By drawing the charge of fuel into the cylinder past the same valve which controls the exhaust the incoming fuel is heated by contact with the valve, and the latter at the same time is cooled, thereby preventing the same from burning out or wearing rapidly and also promoting the efficiency of the engine.

Although I have shown my improved valve-operating mechanism applied to a gas-engine, it is obviously applicable to other purposes where an actuating rock-lever is brought intermittently into engagement with the actuated part. I do not wish to claim in this application the construction of the fuel-valve and its actuating mechanism, as this feature has been divided out of this case and forms the subject of a separate application for patent which was filed October 26, 1901, Serial No. 80,034.

I claim as my invention—

1. The combination with a valve or other part to be actuated, of a rock-lever having an actuated section which is adapted to be connected with an actuating mechanism and a shifting section adapted to operate said valve, means whereby said sections are caused to move in unison while the shifting section is disengaged from the valve, and a stop device which causes the shifting section to move slower than the actuated section while the shifting section is in engagement with the valve, substantially as set forth.

2. In a gas-engine, the combination with the cylinder, the piston and the crank-shaft connected with the piston, of a valve which controls a port of the cylinder, an outer rock-arm which is actuated from the crank-shaft, an inner rock-arm which operates said valve and which is coupled with the outer arm, so as to move in unison with the same when free, and a stationary stop which is engaged by the inner arm and which causes the same to move slower than the outer arm, substantially as set forth.

3. In a gas-engine, the combination with the cylinder, the piston, and the crank-shaft connected with the piston, of a valve which controls a port of the cylinder, an outer rock-arm

which is actuated from the crank-shaft and which is provided with an eccentric, an inner rock-arm which operates said valve and which embraces said eccentric, and a stationary stop which is engaged by the inner arm and whereby the same is caused to move slower than the outer arm, substantially as set forth.

4. In a gas-engine, the combination with the cylinder the piston and the crank-shaft connected with the piston, of a valve which controls a port of the cylinder, an outer rock-arm which is actuated from the crank-shaft and provided with an eccentric, an inner rock-arm which operates said valve and which is provided with an eccentric-jaw embracing said eccentric, a stationary stop arranged in a slot in the inner arm, and coöperating shoulders arranged on the outer arm and the eccentric-jaw, substantially as set forth.

Witness my hand this 17th day of March, 1900.

JESS B. FENNER.

Witnesses:
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