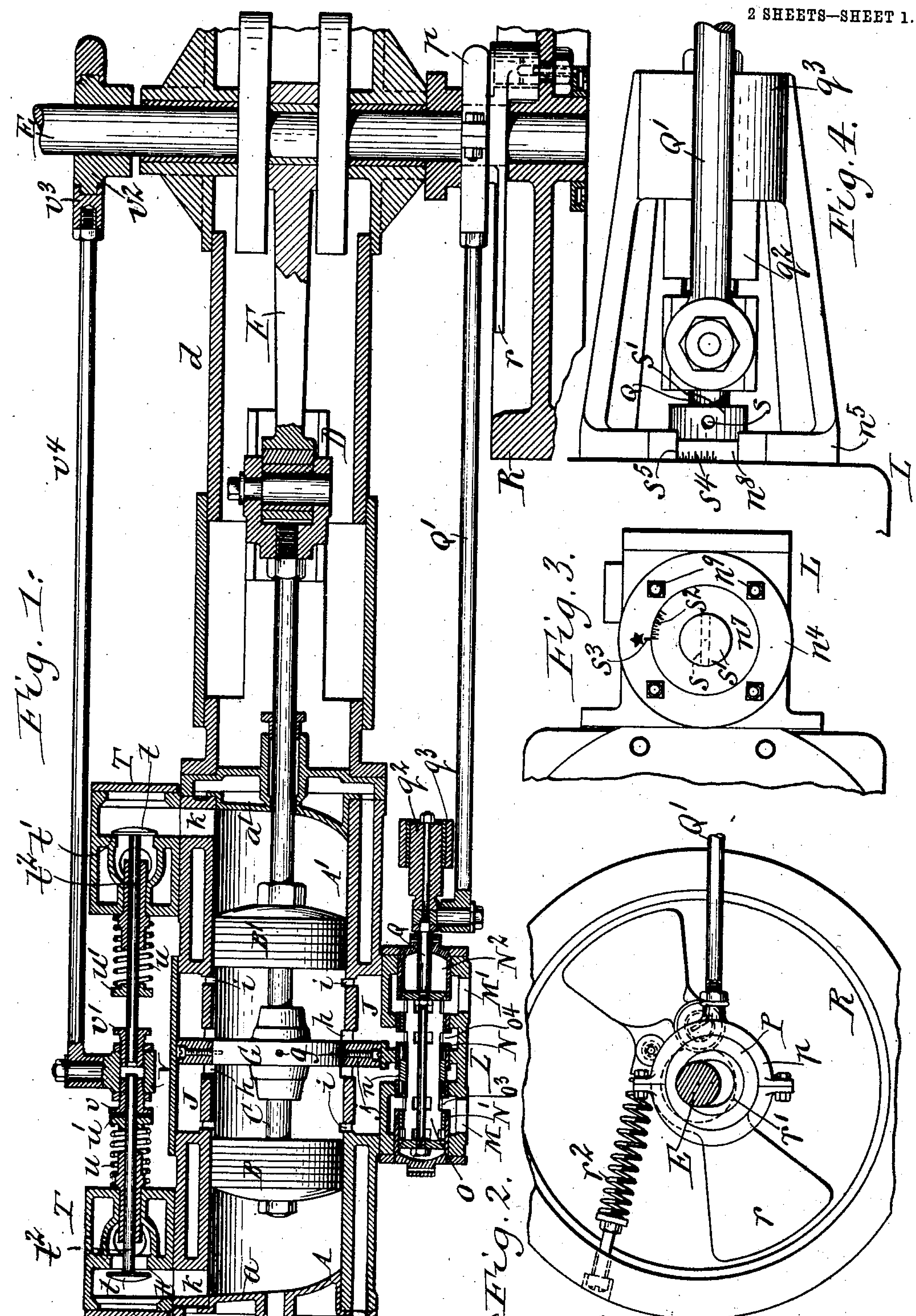
No. 832,089. PATENTED OCT. 2, 1906.

H. J. SMITH.

FUEL MIXING AND REGULATING DEVICE FOR GAS ENGINES.

APPLICATION FILED APR. 19, 1905.

2 SHEETS—SHEET 1.



Louis W. Gratz
May E. McArthur } Witnesses.

Harry J. Smith Inventor
by Geyer & Popp
Attorneys.

No. 832,089. PATENTED OCT. 2, 1906.

H. J. SMITH.

FUEL MIXING AND REGULATING DEVICE FOR GAS ENGINES.

APPLICATION FILED APR. 19, 1905.

2 SHEETS—SHEET 2.

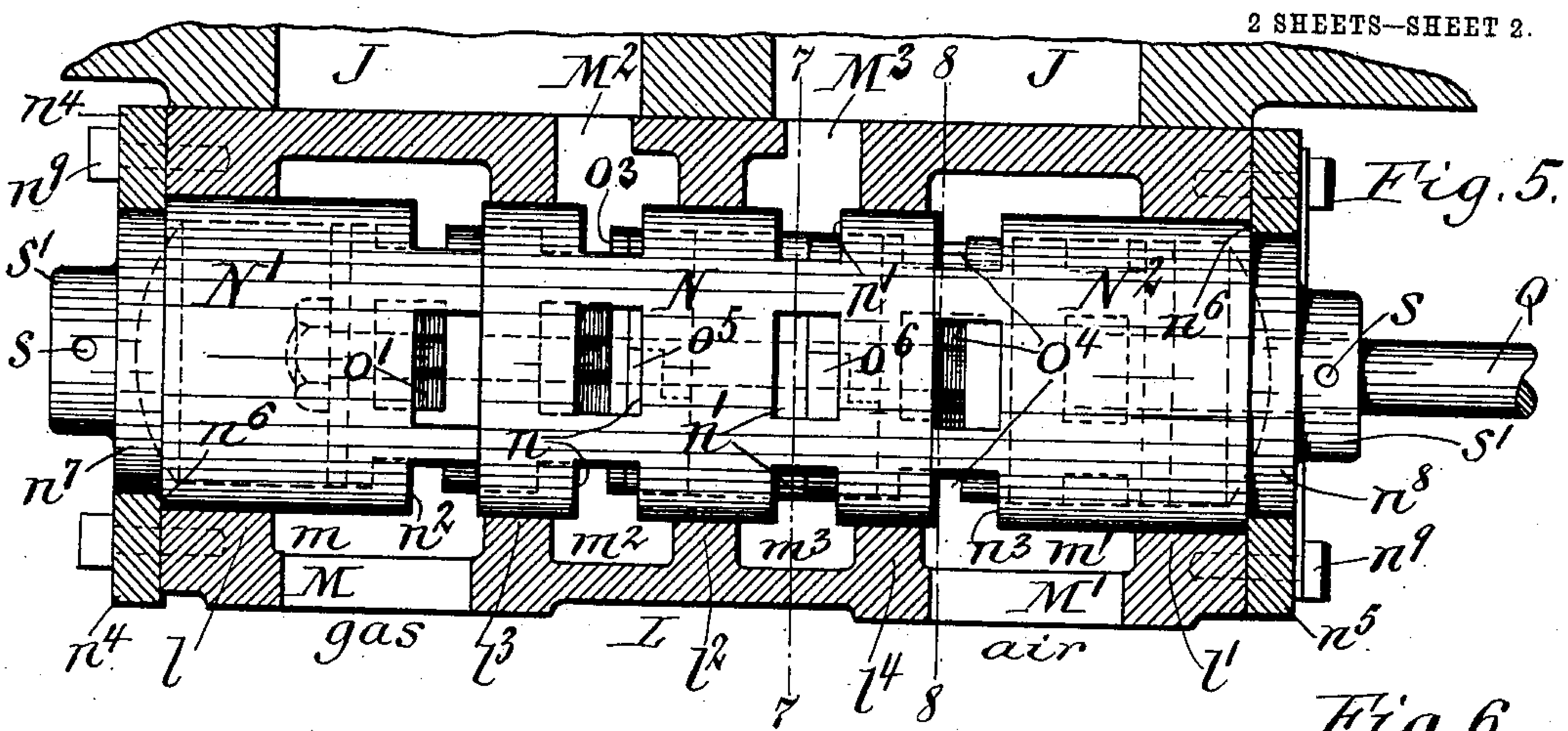


Fig. 5.

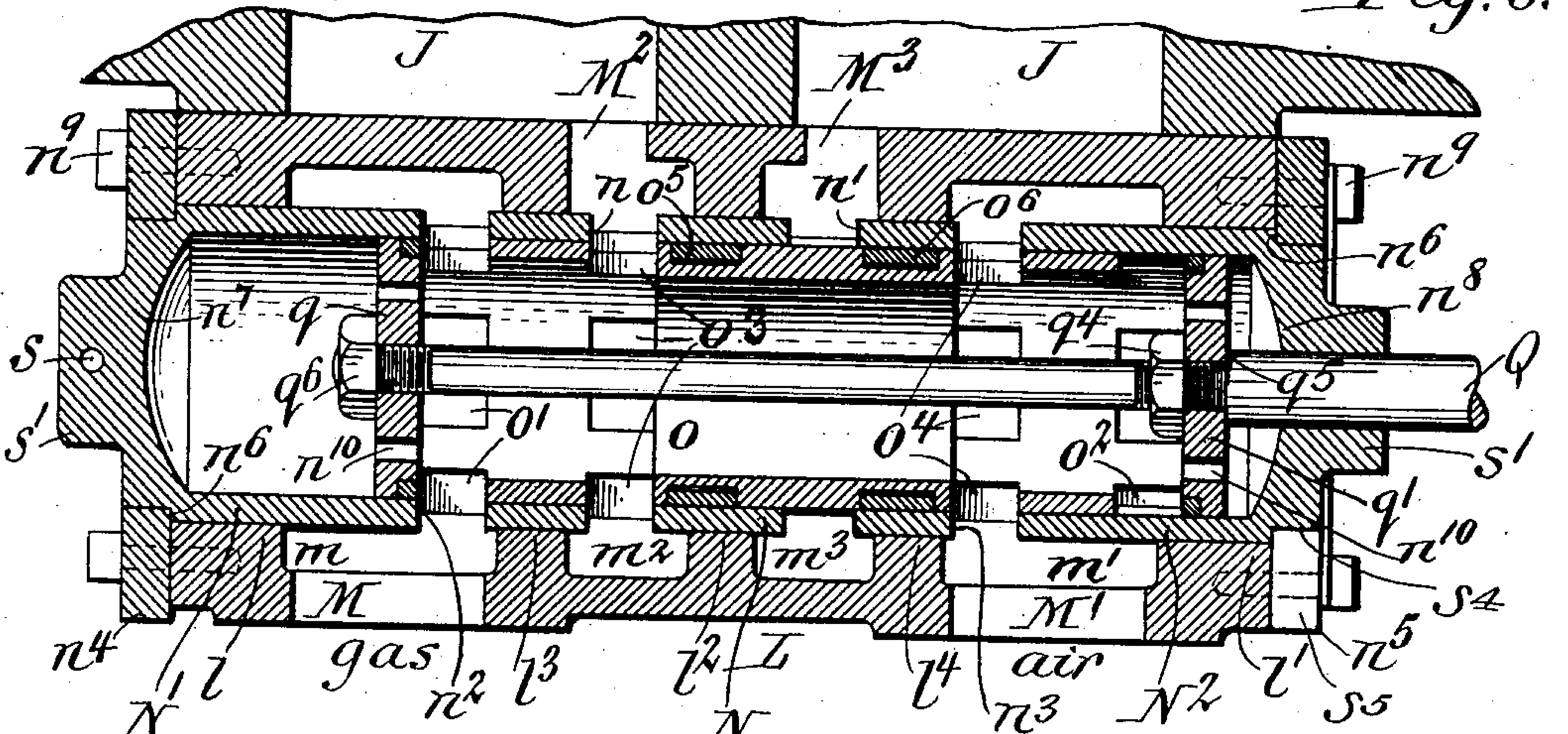


Fig. 6.

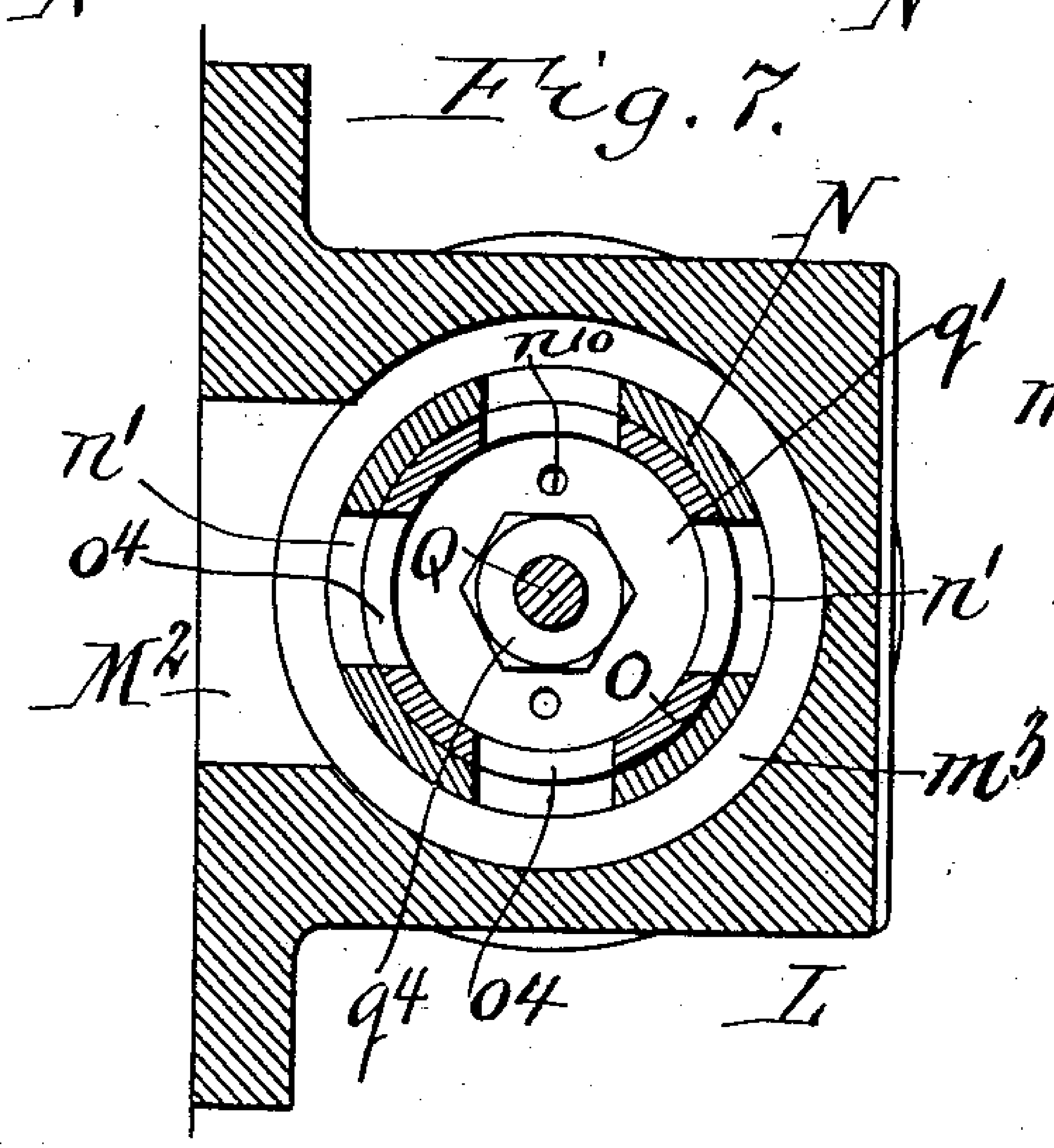


Fig. 7.

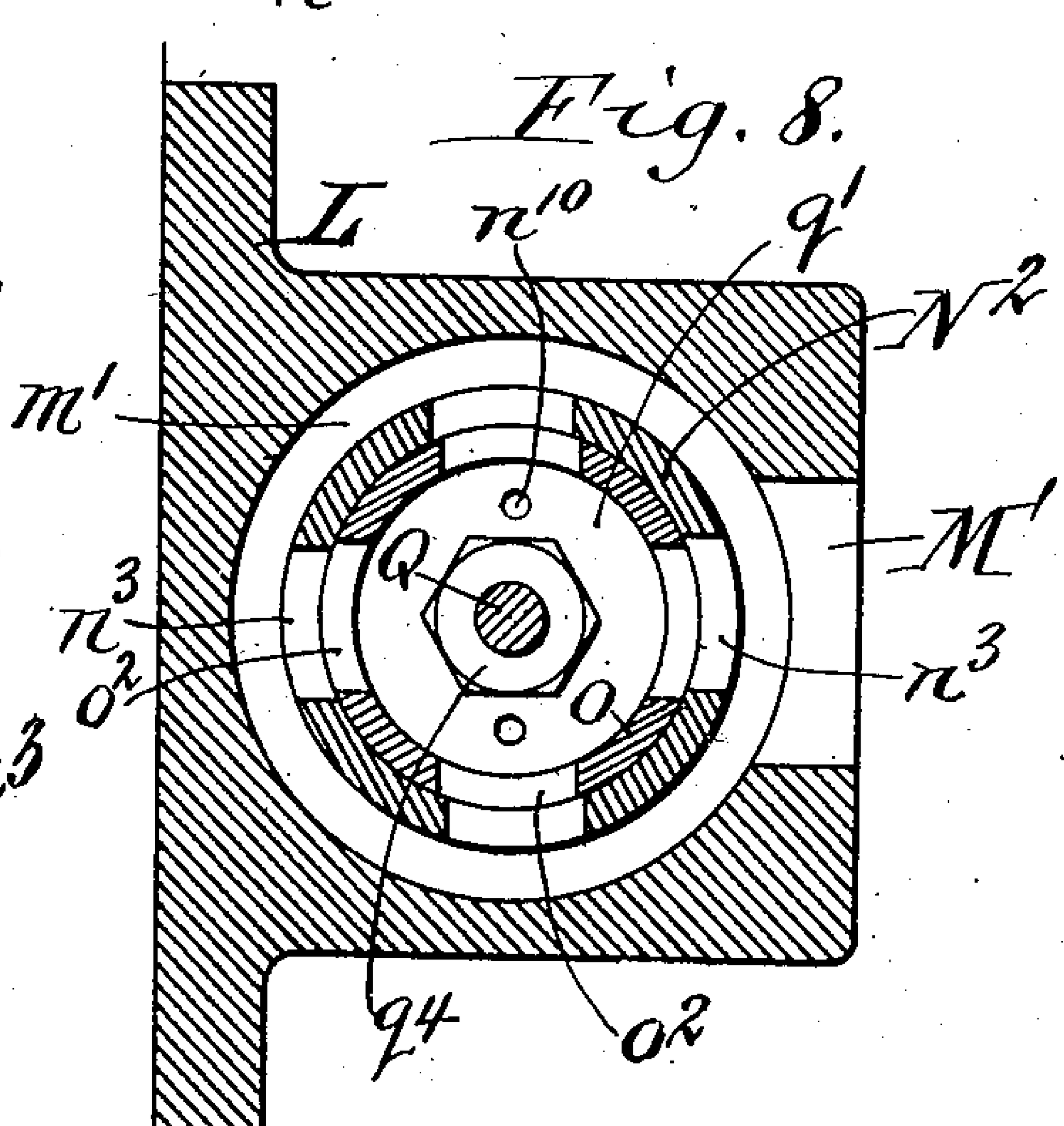


Fig. 8.

Louis W. Gratz
May E. McArthur. } Witnesses.

Harry J. Smith Inventor
by Geyer & Popp Attorneys

UNITED STATES PATENT OFFICE.

HARRY J. SMITH, OF BUFFALO, NEW YORK.

FUEL MIXING AND REGULATING DEVICE FOR GAS-ENGINES.

No. 832,089. Specification of Letters Patent. Patented Oct. 2, 1906.

Application filed April 19, 1905. Serial No. 256,513.

To all whom it may concern:

Be it known that I, HARRY J. SMITH, 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 Fuel Mixing and Regulating Devices for Gas-Engines, of which the following is a specification.

The object of this invention is to provide a simple, compact, and reliable mixing and regulating valve for gas-engines, whereby the proportion of gas and air to make a combustible mixture may be varied at will and which permits the amount of combustible passing into the cylinder to be controlled by a governor.

While this valve may be used in connection with engines of various types and having one or more cylinders, the same is especially applicable to an engine which has not less than one working stroke in each revolution, and more particularly to a two-cycle engine having two cylinders arranged end to end.

In the accompanying drawings, consisting of two sheets, Figure 1 is a horizontal section of a gas-engine equipped with my improved fuel mixing and regulating device. Fig. 2 is a sectional elevation of the governor which controls the mixing and regulating device. Fig. 3 is an elevation of one end of the valve-chest and adjacent parts. Fig. 4 is a side elevation of the opposite end of the valve-chest and adjacent parts. Fig. 5 is a horizontal section of the valve mechanism on an enlarged scale and showing the exterior of the valve casing or bushing. Fig. 6 is a similar view taken centrally through the valve. Figs. 7 and 8 are cross-sections taken approximately in lines 7 7 and 8 8, Fig. 5, respectively.

Similar letters of reference indicate corresponding parts throughout the several views.

A A′ represent two horizontal working cylinders arranged one behind the other; B B′, two pistons reciprocating in the cylinders, respectively; C, a rod connecting the pistons; D, a cross-head sliding on longitudinal ways of the engine-frame *d* and connected with the front end of the piston-rod C; E, a crank-shaft journaled in bearings on the frame, and F a pitman connecting the crank of the shaft with the cross-head. The two cylinders are cast in one continuous tubular shell or barrel which is closed at its front and rear ends by heads *a a′* and is divided centrally by a transverse disk or circular partition G, forming the two working cylinders A A′.

The partition is to be held in place within the barrel by pins or screws *g*, which extend radially through the barrel from the outer side thereof and enter the periphery of the partition, as shown in Fig. 1.

The outer end of each cylinder constitutes the firing-space in which the charge of explosive-fuel is ignited by an igniter of any suitable construction, and the piston therein is driven inwardly with a working stroke, while the pumping-space at the inner end of each cylinder, together with the piston, serves as a pump for delivering the fuel under pressure into the firing-space.

Each of the cylinders is provided at its inner end with one or more fuel-pumping ports *h*, which extend through the cylinder adjacent to the partition and also with one or more fuel-transferring ports *i*, which extends through the cylinder between the pumping-ports and the outer end of the cylinder. The distance between the fuel-ports *h i* is so determined that when a piston is in its innermost position in a cylinder the fuel-ports are located adjacent to the inner and outer sides of the piston and the latter does not cover either set of these ports. The two sets of fuel-ports of each cylinder are connected by a peripheral transfer or connecting passage J, surrounding the inner end of the cylinder. The transfer-passages of both cylinders are arranged side by side and are separated by a partition *j*, which consists of an external annular flange or rim formed centrally on the cylinder-barrel.

Each of the cylinders is provided at its outer end with an exhaust port or passage *k*, through which the products of the spent fuel are discharged. During the first part of the outward stroke of each piston gaseous fuel is drawn from the respective transfer-passage J through the pumping-ports *h* into the inner end of the cylinder, and when the piston has passed outwardly beyond the transferring-ports *i* fuel is also drawn from the transfer passage through the latter ports into the same end of the cylinder until the piston reaches the end of its outward or suction stroke. Assuming that an explosion now occurs of a charge of fuel which has previously been delivered into the outer end of the cylinder, the piston as the result will be forced inwardly with a working stroke.

During this inward movement of the piston the charge of fuel in the inner end of the cylinder and in the transfer-passage J, connected therewith, is compressed. When the piston has nearly reached the end of its working stroke the exhaust-valve is opened, permitting the spent gases to escape from the cylinder at the outer end thereof. Immediately after the exhaust-valve has opened the piston passes inwardly beyond the fuel-transferring ports i and uncovers the same. This permits the compressed charge of new fuel to escape from the inner end or pumping space of the cylinder through the pumping-ports h into the transfer-passage J and then pass, together with the gas in the latter, through the transferring-ports i into the outer end or firing space of the cylinder. The gas enters this end of the cylinder adjacent to the outer side of the piston and moves outwardly in the same, whereby the spent gases are driven through the exhaust at the outer end of the cylinder. After the piston covers the fuel-transferring ports i during the subsequent outward movement of the same the exhaust-valve is closed, which causes the piston to compress the charge of fresh fuel confined in the firing-space and at the same time draw another charge of fuel into the pumping-space of the cylinder. When the piston is at or near the end of its outward movement, the compressed charge of new gas mixture is ignited, whereby the piston is again driven inwardly and the cycle of operations is repeated, as before described.

When an engine having duplex cylinders, as shown, is fully in operation, the exploding mixture in the firing-space of one cylinder moves the piston therein inwardly and the piston in the other cylinder outwardly, which causes the piston under fire to compress a charge on the inner side of the same while the other piston is drawing a charge of mixture into the inner end of its cylinder and compressing a charge of mixture in the outer end of the same preparatory to igniting the last-mentioned charge and driving the corresponding piston inward with a working stroke. The two pistons are thus alternately acted upon by an exploding mixture, and both pistons are positively moved inwardly and outwardly in the cylinders, thereby giving an impulse during every stroke, as in a steam-engine.

The construction and operation of the engine thus far described is the same as that disclosed in an application for Letters Patent of the United States filed by myself February 2, 1903, No. 141,408.

The valve mechanism for controlling the fuel-supply is constructed as follows: L represents a valve-chest which extends across the transfer passages or chambers on one side thereof and which is provided with two end heads l l', a central partition l^2, and two partitions l^3 l^4 on opposite sides of its center, whereby the chest is divided into two outer supply or inlet chambers m m' and two inner mixture or outlet chambers m^2 m^3. One of the end chambers, say m, is connected with a gas or gasolene supply passage M, the other end chamber m' is connected with an air-supply passage M', and the two inner chambers m^2 m^3 are connected, respectively, by passages M^2 M^3 with the transfer-passages J J, leading to the two cylinders, respectively. N N' N^2 are the intermediate and two end sections, respectively, of a divided tubular bushing which forms the casing of the supply-valve. The central section N fits tightly in circular openings formed in the central and side partitions l^2 l^3 l^4 and has two annular series of mixture-outlet ports n n', which are arranged lengthwise side by side and open into the mixture-chambers m^2 m^3, respectively. The outer casing-sections fit in circular openings formed in the end heads l l' of the valve-chest and are provided with annular series of inlet-ports n^2 n^3, which open into the gas and air supply chambers m m', respectively. The ports of the end bushing-sections are preferably formed by notching the inner edges of these sections, which notches are closed by the opposing ends of the inner bushing-section to complete these ports, as shown in Figs. 5 and 6. The end bushing-sections are held in place by clamping plates or covers n^4 n^5, which have central openings through which the end bushing-sections project and which engage with outwardly-facing shoulders n^6 on the heads n^7 n^8 at the outer ends of the end bushing-sections. The clamping-plates are connected with the valve-chest by bolts or screws n^9.

O represents a tubular supply-valve which reciprocates axially within the valve-casing and is provided with two outer annular series of gas and air inlet ports o' o^2, arranged at opposite ends thereof, and two inner annular series of alternative ports o^3 o^4, arranged lengthwise side by side in the central part of the valve, the distance between each outer and inner series of ports of the valve being the same as the distance between the corresponding outer and inner series of ports of the casing. The ports o' of the supply-valve conduct gas only, its ports o^2 conduct air only, its ports o^3 conduct gas or a mixture of gas and air alternatly, and its ports o^4 conduct air or a mixture of air and gas alternately.

A longitudinally-reciprocating movement is imparted to the valve from the crank-shaft by an intermediate connecting mechanism consisting, essentially, of an eccentric P, rotating with the shaft and provided with a surrounding strap p, a valve-rod Q, connected with the valve, and a pitman Q', connecting the valve-rod with the eccentric-strap. The valve-rod extends centrally through heads q q', applied to opposite ends of the valve, and slides in a central opening formed in the rear head n^5 of the bushing-section N^2. At its outer end the valve-rod is secured to a slide or carriage q^2, which is guided in a bracket q^3, formed on the rear clamping-plate n^5 and which is pivotally connected with the pitman Q'. The heads of the valve are secured to the valve-rod and drawn against the ends of the valve by a screw-nut and shoulder q^4 q^5, arranged on the valve-rod and bearing against the inner and outer sides of the rear head q', and a screw-nut q^6, arranged on the rod and bearing against the outer side of the front head q.

In the position of the parts shown in Fig. 1 the engine-pistons are in the middle of the stroke toward the right and the fuel-valve has been moved by the eccentric P to the end of its stroke toward the left. While the parts are in this position the mixture-outlets port n are closed by the solid part of the fuel-valve between the alternative ports o^3 o^4 thereof, causing the left piston B to compress the fuel charge in the inner end of the left cylinder A while said alternative ports o^3 o^4 register, respectively, with the gas-supply ports n^2 and the right mixture-ports n' and the air-inlet ports o^2 register with the air-supply ports n^3, causing gas and air to be drawn into the inner end of the right cylinder by the right piston moving outwardly therein. By the time the pistons reach the end of their movement toward the right the eccentric P has moved the fuel-valve half a stroke from left to right, causing the solid part of the supply-valve between its gas-ports o' and alternative ports o^3 to close the gas-ports n of the casing, the solid part behind the two sets of alternating ports o^3 o^4 to close both sets of mixture-outlet ports, and the solid part between the air-inlet ports o^2 and alternating ports o^4 to close the air-inlet ports n^3 of the casing. While the ports of the valves are thus closed, the new charge of fuel in the left cylinder is transferred from the inner to the outer end of this cylinder and the compressed charge of fuel in the outer end of the right cylinder is ignited, causing the pistons to move with a working stroke from right to left. While the pistons are effecting the first half of the stroke in this direction, the supply-valve completes its movement toward the right, as shown in Fig. 6, and causes the gas-ports o' of the valve to register with the gas-inlet ports n^2 of the casing, the left alternating ports o^3 to register with the left mixture-outlets port n^3, the right alternating ports o^4 to register with the air-supply ports n^3, and the solid part of the valve between its alternating ports to still close the right mixture-outlet ports n', thereby causing a new charge of fuel to be drawn into the inner end of the left cylinder by its piston and the charge of fuel previously admitted to the inner end of the right cylinder to be compressed by its piston. While the pistons are effecting the second half of their stroke from right to left, the supply-valve effects the first half of its stroke in the same direction, thereby cutting off the fuel-supply from the left cylinder and also preventing the escape of the charge being compressed in the inner end of the right cylinder.

The compressed charge of fuel in the outer end of the left cylinder is now ignited, causing the pistons to move from left to right in the cylinder. While the pistons are effecting the first half of their movement from left to right, the supply-valve completes its movement from right to left, whereby the inner end of the right cylinder is placed in communication with the fuel-supply; but the mixture-ports leading to the left cylinder are still closed, as shown in Fig. 1, so that the charge previously drawn into the left cylinder will be transferred from the inner to the outer end of this cylinder. This cycle of operations is repeated for each rotation of the crank-shaft or every two strokes of the pistons on the principle of a two-stroke cycle engine. The basic form of this valve comprises a sliding member having ports for the separate admission of air and gas and exit of the mixture, these ports being so constructed and arranged relatively to the corresponding ports of the coöperating valve member that they open at the same time and in a like degree.

The solid part of the supply-valve between its alternative ports is of such length that it closes either of the mixture-ports after a charge of fuel has been drawn into the respective cylinder by its piston during the outward movement thereof and until this charge has been transferred from the inner end to the outer end of this cylinder by the piston during the last portion of its inward stroke. Inasmuch as this portion of the fuel-valve closes the mixture-outlet ports while a charge of fuel is being compressed in the inner end of the cylinder the same is provided with packing-rings o^5 o^6 in its periphery between its alternative ports. These rings are so disposed that they are arranged on opposite sides of the mixture-ports leading to the cylinder in which compression is taking place, as shown in Figs. 1 and 6, thereby effectually preventing backward leakage from the cylinder past the valve at this time. By employing the packing-rings o^5 o^6 on the valve on opposite sides of the mixture-ports n n' of the casing and between the alternative ports of the valve the use of separate inwardly-opening check-valves in the conduits leading to the cylinders is avoided.

It will be noted that when the fuel-valve is at either extreme of its movement its gas or air inlet ports o' o^2 are closed by the solid part of the casing-sections beyond the gas and air inlet ports thereof.

For the purpose of avoiding the formation of an air-cushion in the valve-casing between the heads thereof and the heads of the valve each of the latter is provided with vent-openings n^{10}, extending transversely through the same, as shown in Figs. 5, 7, and 8. These openings permit the air or gas to pass freely into and out of the spaces in the casing behind the valve without interfering with the operation of the same.

For the purpose of enabling the speed of the engine to be controlled automatically, according to the load on the same, means are provided for varying the extent of movement of the valve, so as to vary the point at which the fuel is cut off. The preferred means for this purpose shown in the drawings consist of a rotary support or wheel R, secured to the crank-shaft, a weighted governor arm or lever r, pivoted eccentrically on said wheel and having a bearing r', on which said eccentric is journaled, and a spring r, connecting said governor-lever and wheel and operating constantly to move the lever in the direction for carrying the center of the eccentric outwardly away from the axis of rotation.

When the engine is running under a heavy load, the eccentric is held by the spring r^2 in a position in which the fuel-valve opens the fuel-ports fully, so as to admit the maximum charges of fuel. When the speed of the engine increases while running on a light load, the governor-lever is shifted in the direction for bringing the center of the eccentric nearer to the center of the crank-shaft, thereby reducing the stroke of the fuel-valve and the extent of opening of the fuel-passages accordingly, whereby the size of the charge of fuel and the output of the engine is reduced in the same measure.

Inasmuch as the quality or richness of gas varies it is necessary to vary the proportion of gas and air in the mixture to suit the requirements of the engine. This is preferably effected by a rotary adjustment of the end sections or sleeves of the valve-casing, whereby the ports in these sections may be moved more or less out of line or register with the supply-ports of the valve.

When the gas is very poor or lean, the end section N' of the valve-casing is turned so that its ports register fully with those of the valve-casing and admit the maximum amount of gas for the mixture. When the gas is richer, the casing-section N' is turned so that its gas-inlet ports are more or less out of line or register with the gas-ports of the valve, thereby reducing the proportion of gas relatively to the air in the mixture.

By making both the gas-section and the air-section of the valve-casing adjustable circumferentially the total volume of fuel may be throttled at the same time that the relative proportion of gas and air is regulated, thereby enabling charges of fuel mixture which are less than a cylinder full to be drawn into the cylinder and then expanded by ignition to a cylinder full, whereby economy in the consumption of fuel is effected without any reduction in efficiency.

The adjustment of the proportioning sections or sleeves of the valve-casing allows of fixing the maximum limit of volume of combustible that can pass into the combustion-chambers of the cylinders. This is an especially valuable feature when less than a cylinder-volume of combustible is to be expanded through combustion to a low terminal pressure, as only the manipulation of the end sections of the casing or bushing is required and without any change in the stroke of the valve.

The rotary adjustment of the end sections of the valve-casing is preferably effected by means of a handle or pin which is inserted into openings s, formed in the sides of bosses s', arranged on the outer sides of the heads of said sections. In order to permit of readily adjusting the end sections of the casing to a predetermined position, indicating means are provided showing the relation of these end sections of the casing and the fuel-valve. For this purpose the front head of the valve-casing is provided with a segmental scale s^2, which coöperates with a mark s^3 on the front clamping-plate n^4, as shown in Fig. 3, and the rear head of the valve-casing is provided with a scale s^4 on its periphery, which coöperates with the edge s^5 of a notch in the rear clamping-plate n^5, as shown in Fig. 4.

The preferred form of valve mechanism for controlling the exhaust from the cylinder is constructed as follows: T T represent exhaust-valve chests, each of which contains an exhaust port or passage forming a continuation of the exhaust port or passage k at the outer end of one of the cylinders. t t represent exhaust-valves which control said exhaust-ports and each of which when moved outward or in the direction of the exhaust bears against a seat t' around its exhaust-port and closes the same, while upon moving the valve inwardly away from its seat the exhaust-port is opened. Each of the exhaust-valves is mounted on a guide rod or stem t^2, which is arranged lengthwise and guided in the inner part of its valve-chest. The exhaust-valves are yieldingly held in a closed position by springs u, bearing at opposite ends against the valve-chests and collars or shoulders u' on the valve-rods. The rods of both exhaust-valves project toward each other and are arranged lengthwise in line. V represents a longitudinally-reciprocating head provided with tappets v v', which are adapted to engage alternately with the collars t' of the rods carrying the exhaust-valves for opening the latter. Upon moving the latter lengthwise in either direction the tappet on its advancing side engages the collar of the companion valve-rod and opens the respective exhaust-valve. The tappet-head is actuated by means of an eccentric v^2, mounted on the crank-shaft and having its surrounding strap v^3 connected with the tappet-head by a pitman v^4.

I claim as my invention—

1. A fuel mixing and regulating device for gas-engines comprising a casing having a gas-inlet port at one end, an air-inlet port at the other end, and two intermediate mixture-outlet ports between the gas and air inlet ports, and a hollow valve coöperating therewith and having a port at each end so located as to act one as a gas-inlet, the other as an air-inlet, and two intermediate ports between the ends, adapted to alternately register one with one outlet-port and the other with the other outlet-port, substantially as set forth.

2. A fuel mixing and regulating device for gas-engines comprising a casing having a gas-inlet port at one end, an air-inlet port at the other end, and two intermediate mixture-outlet ports between the gas and air inlet ports, a hollow valve coöperating therewith and having a port at each end so located as to act one as a gas-inlet, the other as an air-inlet, and two intermediate ports between the ends, adapted to alternately register one with one outlet-port and the other with the other outlet-port, and packing-rings arranged on the valve between the intermediate ports, substantially as set forth.

3. A fuel mixing and regulating device for gas-engines comprising a casing having a gas-inlet port at one end, an air-inlet port at the other end and two intermediate mixture-outlet ports between the gas and air inlet ports, a hollow valve coöperating therewith and having a port at each end so located as to act one as a gas-inlet, the other as an air-inlet, and two intermediate ports between the ends adapted to alternately register one with one outlet-port and the other with the other outlet-port, the respective distances between the inlet-ports and the adjacent intermediate ports being the same, substantially as set forth.

4. A fuel mixing and regulating device for gas-engines comprising a casing having a gas-inlet port at one end, an air-inlet port at the other end and two intermediate mixture-outlet ports between the gas and air inlet ports, a hollow valve coöperating therewith and having a port at each end so located as to act one as a gas-inlet, the other as an air-inlet, and two intermediate ports between the ends, adapted to alternately register one with one outlet-port and the other with the other outlet-port, and a governor for controlling the movement of said valve relatively to the casing, substantially as set forth.

5. A fuel mixing and regulating device for gas-engines comprising a casing having a gas-inlet port at one end, an air-inlet port at the other end, and two intermediate mixture-outlet ports between the gas and air inlet ports, a hollow valve coöperating therewith and having a port at each end so located as to act one as a gas-inlet, the other as an air-inlet, and two intermediate ports between the ends adapted to alternately register one with one outlet-port and the other with the other outlet-port, said valve having a continuous longitudinal reciprocating movement for opening and closing said ports, and said casing being capable of circumferential adjustment for bringing the ports of the valve and casing more or less out of line and varying the proportion of gas and air in the mixture accordingly, substantially as set forth.

6. A fuel mixing and regulating device for gas-engines comprising a tubular casing composed of two circumferentially-adjustable end sections, one having a gas-inlet port and the other an air-inlet port, and a central fixed section having two intermediate mixture-outlet ports, and a tubular valve coöperating therewith and having a port at each end so located as to act one as a gas-inlet, the other as an air-inlet, and two intermediate ports between the ends, adapted to alternately register one with one outlet-port and the other with the other outlet-port, substantially as set forth.

7. A fuel mixing and regulating device for gas-engines comprising a tubular casing composed of two circumferentially-adjustable end sections, one having a gas-inlet port and the other an air-inlet port, and a central fixed section having two intermediate mixture-outlet ports, a tubular valve coöperating therewith and having a port at each end so located as to act one as a gas-inlet, the other as an air-inlet, and two intermediate ports between the ends, adapted to alternately register one with one outlet-port and the other with the other outlet-port, and a governor controlling the movement of said valve, substantially as set forth.

8. A fuel mixing and regulating device for gas-engines comprising a chest having a gas-inlet chamber at one end, an air-inlet chamber at the other end and between its ends with intermediate mixture-outlet chambers, a tubular casing arranged in the chest and having a gas-inlet port at one end opening into said gas-inlet chamber, an air-inlet port at its opposite end opening into said air-inlet chamber, and between its ends with two intermediate mixture-outlet ports which open into the outlet-chambers, and a tubular valve reciprocating in the casing and having a port at each end so located as to act one as a gas-inlet, the other as an air-inlet, and two intermediate ports between the ends adapted to alternately register one with one outlet-

port and the other with the other outlet-port, substantially as set forth.

9. A fuel mixing and regulating device for gas-engines comprising a chest having a gas-inlet chamber at one end, an air-inlet chamber at the other end and between its ends with intermediate mixture-outlet chambers, a tubular casing arranged in the chest and having a gas-inlet port at one end opening into said gas-inlet chamber, an air-inlet port at its opposite end opening into said air-inlet chamber and between its ends with two intermediate mixture-outlet ports which open into the outlet-chambers, a tubular valve reciprocating in the casing and having a port at each end so located as to act one as a gas-inlet, the other as an air-inlet, and two intermediate ports between the ends adapted to alternately register one with one outlet-port and the other with the other outlet-port, and packing-rings arranged on the periphery of the valve between its intermediate ports, substantially as set forth.

10. A fuel mixing and regulating device for gas-engines comprising a chest having a gas-inlet chamber at one end, an air-inlet chamber at the other end and between its ends with two intermediate mixture-outlet chambers, a tubular casing composed of two circumferentially-adjustable end sections, one having a gas-inlet port opening into the gas-inlet chamber and the other having an air-inlet port opening into the air-inlet chamber, and between the ends with a fixed central section having two mixture-outlet ports opening into the mixture-outlet chambers, and a tubular valve coöperating therewith and having a port at each end so located as to act one as a gas-inlet, the other as an air-let, and two intermediate ports between the ends adapted to alternately register one with one outlet-port and the other with the other outlet-port, substantially as set forth.

11. A fuel mixing and regulating device for gas-engines comprising a chest having a gas-inlet chamber at one end, an air-inlet chamber at the other end and between its ends with two intermediate mixture-outlet chambers, a tubular casing composed of two circumferentially-adjustable end sections, one having a gas-inlet port opening into the gas-inlet chamber and the other having an air-inlet port opening into the air-inlet chamber and each end section having an annular shoulder at its outer end, and between the ends with a fixed central section having two mixture-outlet ports opening into the mixture-outlet chambers, a tubular valve coöperating therewith and having a port at each end so located as to act one as a gas-inlet, the other as an air-inlet, and two intermediate ports between the ends adapted to alternately register one with one outlet-port and the other with the other outlet-port, and clamping-plates bearing against said shoulders and connected with said chest, substantially as set forth.

12. A fuel mixing and regulating device for gas-engines comprising a chest having a gas-inlet chamber at one end, an air-inlet chamber at the other end and between its ends with two intermediate mixture-outlet chambers, a tubular casing composed of two circumferentially-adjustable end sections, one having a gas-inlet port opening into the gas-inlet chamber and the other having an air-inlet port opening into the air-inlet chamber, and between the ends with a fixed central section having two mixture-outlet ports opening into the mixture-outlet chambers, a tubular valve coöperating therewith and having a port at each end so located as to act one as a gas-inlet, the other as an air-inlet, and two intermediate ports between the ends, adapted to alternately register one with one outlet-port and the other with the other outlet-port, heads applied to the end sections of the valve, a valve-rod extending through said heads and having a shoulder and a screw-nut bearing against opposite sides of one head, and a screw-nut arranged on the valve-rod and bearing against the other head, substantially as set forth.

Witness my hand this 12th day of April, 1905.

HARRY J. SMITH.

Witnesses:
THEO. L. POPP,
E. M. GRAHAM.