No. 736,132. PATENTED AUG. 11, 1903.

H. H. MULHERIN.

GAS ENGINE.

APPLICATION FILED MAR. 2, 1901.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.

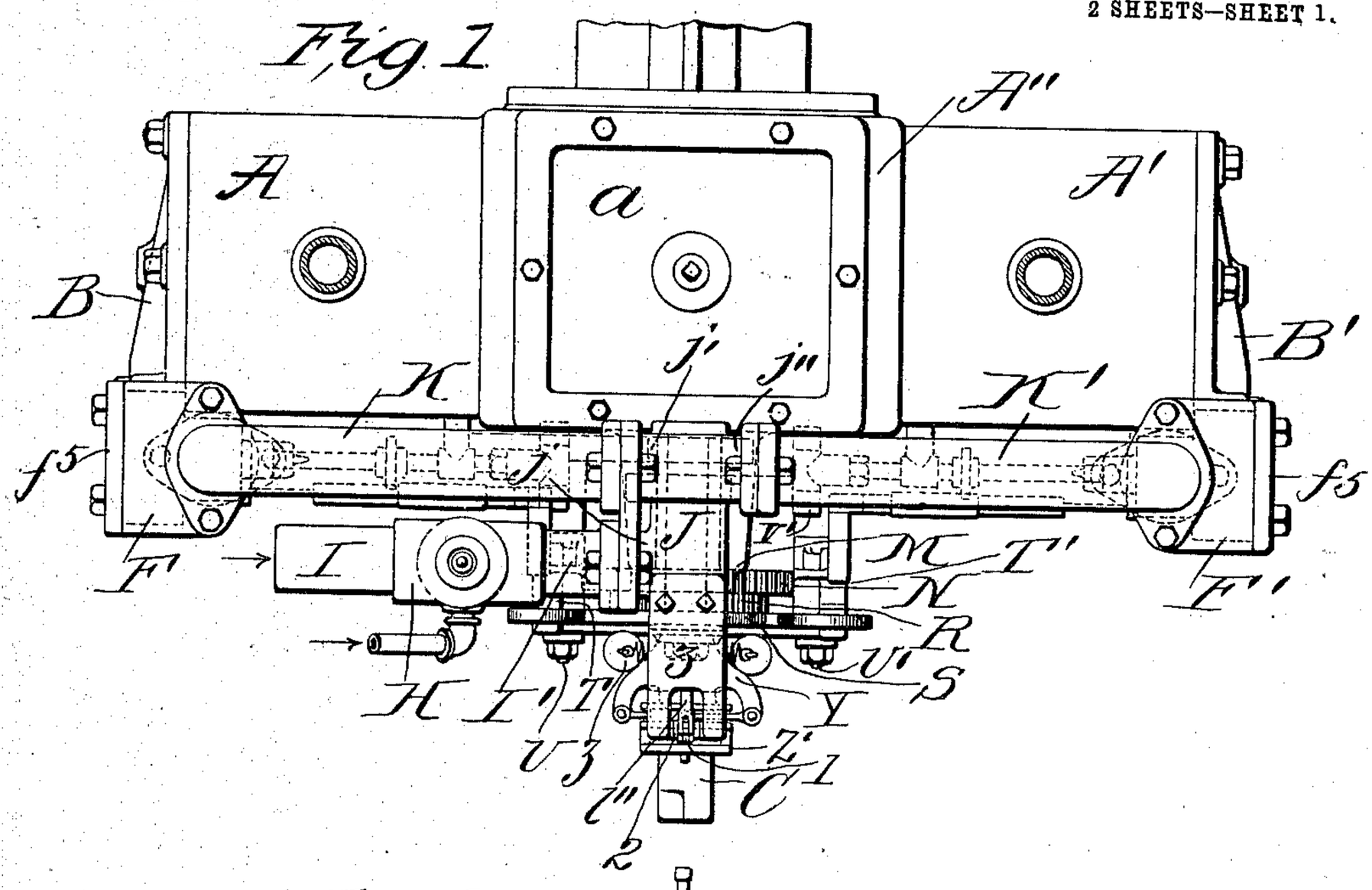
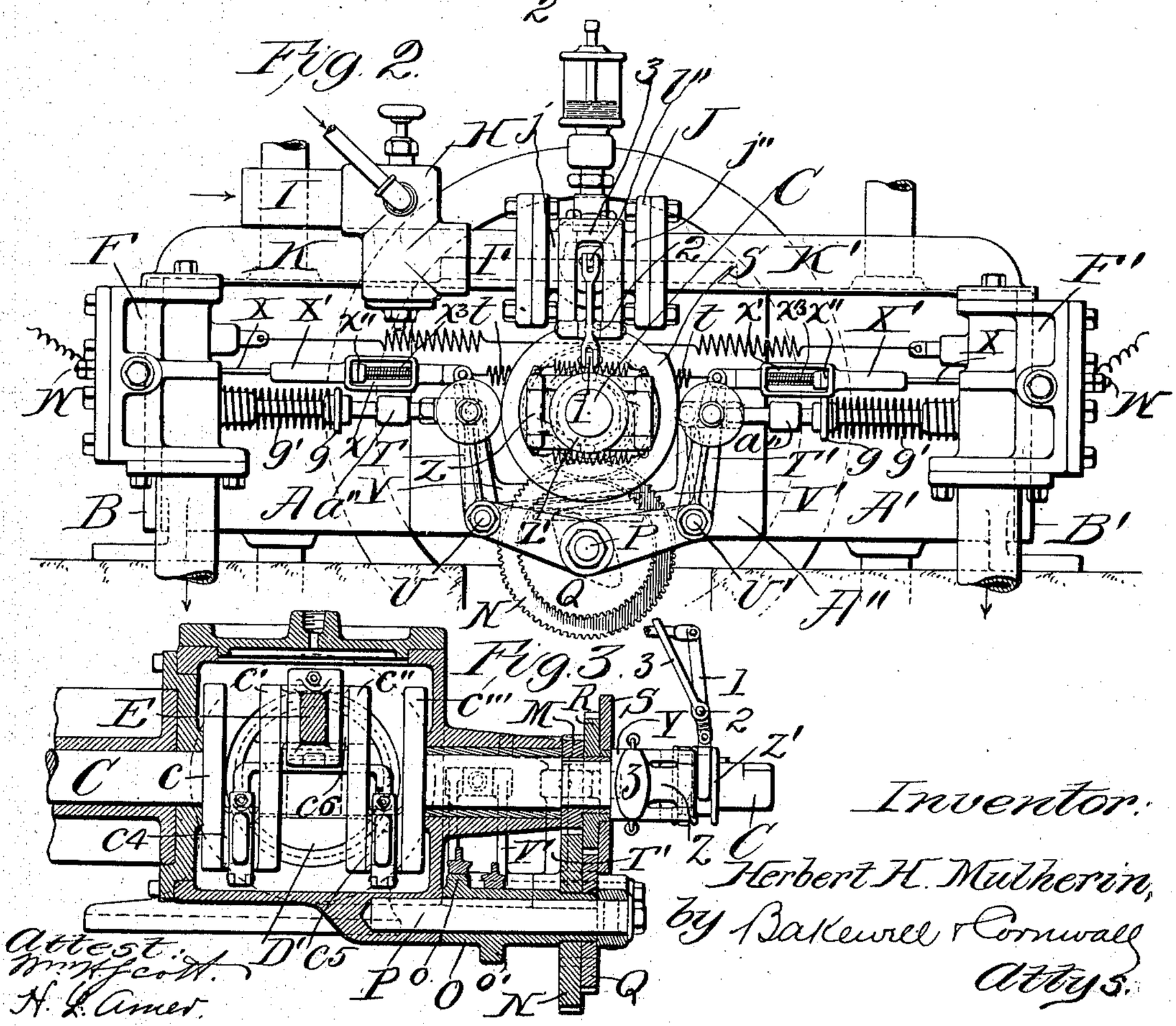


Fig. 2.



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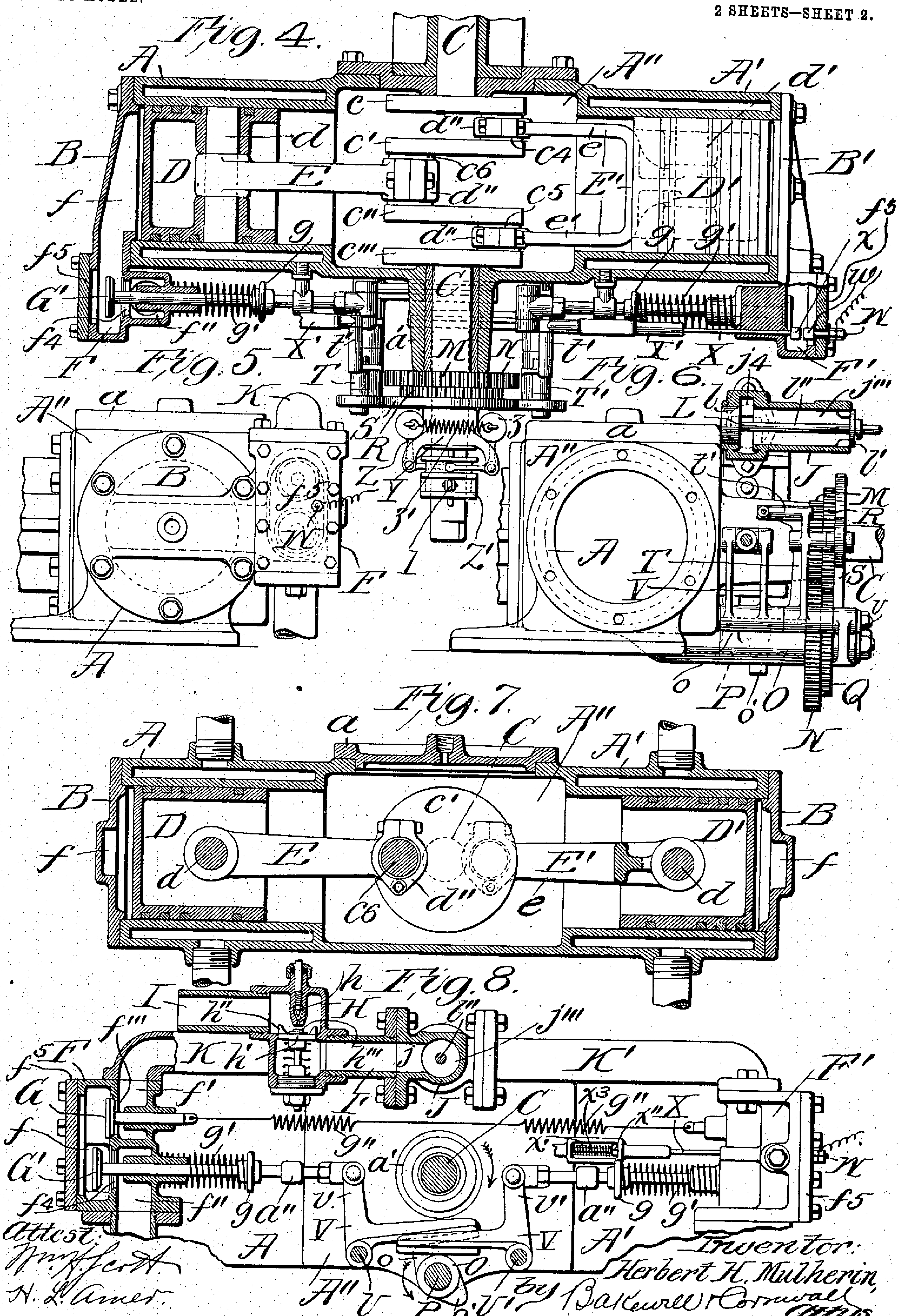

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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 736,132. Patented August 11, 1903.

UNITED STATES PATENT OFFICE.

HERBERT H. MULHERIN, OF ST. LOUIS, MISSOURI, ASSIGNOR TO INTERNATIONAL MOTOR COMPANY, OF ST. LOUIS, MISSOURI, A CORPORATION OF MISSOURI.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 736,132, dated August 11, 1903.

Application filed March 2, 1901. Serial No. 49,568. (No model.)

To all whom it may concern:

Be it known that I, HERBERT H. MULHERIN, a citizen of the United States, residing at the city of St. Louis, in the State of Missouri, have invented a certain new and useful Improvement in Gas-Engines, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a plan view of my improved gas-engine. Fig. 2 is a side elevational view of the same. Fig. 3 is a vertical transverse sectional view taken on line 3 3, Fig. 2. Fig. 4 is a horizontal longitudinal sectional view. Fig. 5 is an end elevational view. Fig. 6 is an end elevational view with the near cylinder-head removed, parts being shown in section. Fig. 7 is a vertical longitudinal sectional view; and Fig. 8 is a side elevational view, partly in vertical section.

This invention relates to a new and useful improvement in gas-engines; and it consists, generally stated, in the novel construction and arrangement of the cylinders and their contained pistons; in the novel construction and arrangement of the crank-shaft, the circuit maker and breaker, and the igniting devices; in the novel construction and arrangement of the inlet and exhaust valves and their means of actuation; in the novel construction and arrangement of the governor and its associate parts; and, finally, the invention consists in the construction, arrangement, and combination of the several parts, all as will hereinafter be described and afterward pointed out in the claims.

In the drawings the cylinder proper is composed of two cylindrical portions A A′, connected together by what I will term a "crank-housing" A″, which latter is preferably in the shape of a hollow cube having an opening in its upper face, through which access may be gained to the interior, the same being closed by a cap-piece *a*.

B and B′ indicate the cylinder-heads, which are secured to the outer faces of the cylindrical portions A A′, respectively.

C indicates the crank-shaft as an entirety, which is mounted in suitable bearings in the cylinder, the same being formed of four disks *c*, *c′*, *c″*, and *c‴*, the two former being connected by a journal c^4, the two latter connected by a journal c^5, and the two inner ones, *c′* and *c″*, connected by a journal c^6, the shaft proper extending outwardly from the outer faces of disks *c* and *c‴*. The journals c^4 and c^5 are arranged eccentrically on their respective disks, as is also the journal c^6, the latter, however, being arranged exactly diametrically opposite said journals c^4 and c^5, but is located at exactly the same distance from the centers of the disks. The shaft proper of the engine, as before mentioned, extends outwardly from the two outer disks, the same being in axial alinement therewith, as is clearly illustrated in Figs. 3, 4, and 7 of the drawings.

D D′ indicate pistons arranged within the cylindrical portions A and A′, respectively, said pistons being connected to the crank-shaft C by suitable pitmen E E′, the former having one end pivotally connected to a pin *d*, carried by piston D, and its other end pivotally connected to the journal c^6, while the latter is provided with a bifurcated inner end, whose members *e e′* are pivotally connected to the journals c^4 and c^5, respectively, of the crank-shaft, its outer end being pivotally connected to a pin *d′*, carried by the piston D′. In order to cause the inner ends of the pitmen to encircle the journals of the crank-shaft, I have formed on the ends of each a hinged cap-piece *d″*, which is clamped in position by suitable bolts, a bushing of soft metal being preferably interposed between said inner ends and the journals for obvious reasons.

F F′ indicate valve-casings, preferably formed integral with the cylinder-heads B B′, respectively, and as they are identical in construction except for the fact that they are "right" and "left" a detailed description of but one will be given. This valve-casing just referred to is provided with a passage-way *f*, which opens into the outer end of the cylinder, and two compartments *f′ f″*, each of which has an opening f^3 and f^4, respectively, which establish communication between the passage-way *f* and the compartments *f′* and *f″*,

said openings f^3 and f^4 being controlled, respectively, by outwardly-opening valves G G', the former being the supply-valve and the latter the exhaust.

H indicates a valve-casing in which are arranged two valves h and h', the former being a needle-valve which is manually operated for controlling the admission of the explosive fluid, while the latter is automatic and spring-actuated and controls the admission of both the explosive fluid and air, and consequently the gas resulting from the mixture, to the cylinders of the engine. Valve h', just referred to, is preferably cylindrical in shape and is designed to operate in a cylindrical bore formed in a centrally-located partition-wall arranged in casing H, said valve carrying guide-lugs h'' on its upper face and adjacent its periphery for alining the valve when the same is in its open position. This valve h' also carries upon its upper face a disk of leather or other suitable material h^3, the same being so arranged that when the valve is fully closed and in its uppermost position it will seat against and close the opening from the needle-valve h and prevent the explosive fluid from passing therethrough. Two pipes I and I' communicate with the interior of this valve-casing H, the former, which is the admission-pipe for air, being arranged above the valve h', while the latter, which is the pipe which conducts the vapor or gas from the valve-casing to the cylinders of the engine, is arranged below said valve, as illustrated in Fig. 8.

J indicates a combined elbow and T connection or fitting, whose member j is caused to communicate with the pipe T' and whose members j' and j'' communicate with pipes K and K', which in turn communicate with the compartments f' of the valve-casings F F', respectively, and conduct the explosive gas thereto. This fitting J is preferably arranged above and in vertical alinement with the crank-shaft of the engine, and its bore j^3, which is longitudinally disposed with relation to said crank-shaft, is provided with a governing-valve L, which consists of two cylindrical portions l and l', connected by a rod l''. (See Fig. 6.) Near the innermost end of this bore j^3 just described is an enlarged bore j^4, said bore j^4 being in alinement and in communication with the members of the fitting, to which the pipes K and K' are secured, and when the valve L is in the position shown in Fig. 6 of the drawings—that is, the cylindrical portion l being at the extreme inner edge of said bore j^4 and the portion l' within or at the edge of the outer end of said bore j^3—the gas which enters bore j^3 through pipe I' is free to pass to pipes K and K'; but when the valve L is moved outwardly the passage-way to the pipes K and K' is throttled or partially throttled by the portion l covering or partially covering the bore j', and at the same time the portion l' has moved out of or away from the end of the bore j and is permitting air to enter the passage-way, thereby diluting or reducing the percentage of combustible portion of the gas, as is obvious.

M indicates a pinion secured to the main shaft of the engine outside of the extended bearing a' of the cylinder, which pinion is in mesh with a gear N, secured to a cam-sleeve O, which is loosely mounted upon a stud-shaft P, secured to the cylinder. This gear N and sleeve O have conjoined to them a gear Q in mesh with a gear R, loosely mounted upon the main shaft of the engine, and secured to said gear R is a cam S, which coöperates with rollers mounted on the free end of levers T T', pivotally mounted upon the stud-shafts U U', which project outwardly from and are secured to the cylinder. These levers T T' are connected by a coil-spring t, whose tendency is to hold the same against the cam S for obvious reasons.

It will be observed from an inspection of the drawings that the pinion M and the gear N bear a relation of two to one, respectively—that is, the pinion M, which is the smaller, will make two revolutions while the gear N is making one, and as the gears Q and R are of the same diameter and the former is secured to gear N they both make two revolutions to one revolution of pinion M, and as the cam S is secured to gear R it consequently makes two revolutions to one of pinion M.

The cam-sleeve O, to which I have before referred, has formed thereon two projections o o', which are arranged diametrically opposite and out of vertical alinement with each other and coöperate with one member of bell-crank levers V V', which are, like the levers T T', pivotally mounted upon the stud-shafts U U', respectively. To the outer end of the members of the bell-crank levers V V', which I will designate as v v', respectively, are pivotally connected the valve-stems of the exhaust-valves G', said valve-stems being preferably guided in their movement by projections a'', which extend from the cylinder of the engine. Arranged on each of these valve-stems is a collar g, and interposed between said collar and the valve-casings F F', respectively, and surrounding said rods is arranged an expansible coil-spring g', the tendency of which spring is to seat the exhaust-valves G' when the position of the cams o o' and their coöperating bell-crank levers V V' permits them to do so.

The admission-valves G G are each provided with a short stem, which protrudes through their casing and are preferably both connected with a contractible coil-spring g'', whose tendency is to draw them to their seats, which it does, except when the engine is taking a charge of explosive fluid.

Each valve-casing F F' is preferably provided with a cap-piece f^5, and arranged on this cap-piece and insulated therefrom is an electric terminal in the form of a bolt W, preferably provided on its inner end—that is, the end within the casing—with an en-

larged head *w*. In vertical alinement with these bolts W and passing through the opposite side of the valve-casing is a rod X, whose inner end is preferably provided with an enlarged head *x*, similar to the head *w*. These rods X X telescope within hollow rods or sleeves X′ X′, which have one end pivotally connected to a projection *t*′, formed on the levers T T′, said hollow rods or sleeves being provided within their length with a slot *x*′, and upon the rods X X and within the slots *x*′ *x*′ is secured a collar or nut *x*″, and interposed between said collar or nut and that portion of the sleeve where one end of the slot *x*′ terminates and surrounding the rod X is an expansible coil-spring x^3. This construction just described produces a yielding connection between the rod X and the sleeve X′ when the levers T T′ are moved outwardly, and this insures a perfect contact of the head *x* with the head *w* to complete an electric circuit, it being understood that the entire engine is one terminal. When the levers T T′ move outwardly a certain distance, the heads *x* contact with the heads *w*, as just described, and arrest further movement of the rods X; but through the instrumentality of spring x^3 the levers T T′ and their sleeves X′ X′ are permitted to travel some little distance farther in the same direction, thus not only insuring a perfect contact of the heads *x* and *w*, but also obviating the necessity of having the cam which operates the levers T T′ of just exactly the proper proportion to effect this result and permitting the same to wear, as is obvious. When the levers T T′ move inwardly, the head *x* remains in contact with the head *w* for a certain length of time or until that portion of the sleeve at the outer end of the slot *x*′ contacts with the nut *x*″, after which the rod X is positively moved inwardly, and the heads *x* and *w* part, forming a spark.

Y indicates a collar which is secured to the main shaft of the engine, the same being located just to one side of cam S, said collar carrying projections to which are pivotally mounted two bell-crank levers Z, one member of which is provided with weights or balls *z*, which are connected by coil-springs *z*′, while the other member is caused to rest in a groove formed in a slidable collar Z′, keyed to the main shaft. This collar Z′ is provided with a second groove in which the bifurcated ends of lever 1 rest, said lever being fulcrumed at 2 to a bracket 3, preferably secured to the fitting J and having its upper end pivotally connected to the valve L.

The operation of the engine just described is as follows: Assuming the parts to be in the position shown in the drawings, wherein it will be observed that the pistons are at their extreme outward positions and the valve G′ of the casing F is open, the engine traveling in the direction of the arrow in Fig. 8 is just ready to explode a charge of compressed gas in the cylinder A′, as it will be observed that the cam S is just ready to actuate the sparker controlling that cylinder. It will also be observed that the cam *o* is moving away from the bell-crank lever V and permitting its spring to close the same. When the charge in the cylinder A′ has exploded and the pistons move inwardly, the exhaust-valve G′ in casing F being closed, a charge of air and gas will be drawn into the cylinder A through the valve G, and the exhaust-valve G′ of casing F′ will just start to open, the valve G remaining closed, due to the pressure inside of cylinder A′, and as the pistons move outward from this position, due to the momentum of the fly-wheel of the engine, cylinder A′ will exhaust its exploded charge and the charge in cylinder A will be compressed and ignited, as will be understood.

It will be observed from an inspection of the drawings that the cams *o* *o*′, as well as the cam S, make only one-half of a revolution to every complete revolution of the crank-shaft, the same being due to the difference in diameter of the pinion M and the gear N. Consequently the exhaust-valves G′ G′ are only opened once for every two revolutions of the crank-shaft, they being, however, alternate in their action—that is, when the exhaust-valve for one cylinder opens and closes at the next revolution of the crank-shaft this valve will remain closed and the exhaust-valve for the other cylinder of the valve will open. The reason for this is to allow one piston to compress its charge of air and gas in its cylinder while the other piston is exhausting its exploded charge from its cylinder.

Having now explained that the exhausting of one cylinder occurs simultaneously with the compression of the unexploded charge in the other cylinder, it is obvious that the ignition or sparking mechanism must be brought into action complementary therewith—that is, that the parting of the electric terminals *x* and *w* in one valve-casing must occur and form a spark immediately after an unexploded charge has been compressed in that cylinder with which said terminals *x* and *w* coöperate, the terminals *x* and *w* of the other valve-casing being at this time inoperative. To accomplish this end, the cam S, as before described, makes only one revolution to every two revolutions of the crank-shaft of the engine, and is so arranged relative thereto and to the rollers on the arms T T′ that only one arm, T or T′, as the case may be, will be acted upon and forced outwardly, causing the heads or terminals *x* and *w* to touch each other, completing the electric circuit, and subsequently part when the projection on cam S passes said roller, just after the piston of that cylinder with which said terminals *x* and *w* coöperate has compressed its unexploded charge.

The speed of the engine is regulated by the governing mechanism, which is composed of the valve L, its casing, the centrifugally-ac-

tuated weights or balls *z* and their associate parts, the slidable collar Z′, and the lever 1, their operation being as follows: When the engine has reached its maximum speed, the weights *z* will have been thrown outwardly by centrifugal force against the tension of their spring, and the other member of the bell-crank lever to that upon which said weights are on will have moved the collar Z′ inwardly and longitudinally, the shaft upon which said collar is keyed, and will have forced the upper end of lever 1 outwardly, which movement will have drawn the valve L outwardly and caused its cylindrical portion *l* to cover or partially cover the bore j^4 and cause a less volume of gas to enter the pipes K and K′ and at the same time cause the cylindrical portion *l′* of the valve to move away from the end of the fitting J and admit air, which, as before described, reduces the percentage of explosive properties in the mixture which is to be drawn into the engine, thereby decreasing the speed of the same.

One of the most essential features of this engine is the arrangement of the cylinders and their pistons in axial alinement and having the crank-shaft so constructed as to permit the pistons through the instrumentality of their pitmen to move toward and away from each other in their reciprocation, whereby an equal distribution of strain is attained in the bearings and shaft and renders the engine practically non-vibratory. In speaking of the equal distribution of strain, what is intended to be conveyed is that as the pistons move away from or approach each other upon completion of their half-stroke that inertia which tends to impel one piston outwardly after it has reached its predetermined limit of travel is counteracted by the inertia of the other piston, as said other piston upon reaching its predetermined limit of travel in either direction is exerting through its inertia a force in opposition to the force of the inertia of the first-mentioned piston.

I am aware that minor changes in the arrangement, construction, and combination of the several parts of my device can be made and substituted for those herein shown and described without in the least departing from the nature and principle of my invention.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a gas-engine, the combination with two cylinders, pistons therein, and a crank-shaft to which said pistons are connected, of admission and exhaust valves for said respective cylinders, a sparking device for each of said cylinders, a pinion secured to said crank-shaft, a gear in mesh with said pinion, mechanism operated by said gear for operating the exhaust-valves, a second gear conjoined to said first-mentioned gear, a third gear loosely mounted upon said crank-shaft and in mesh with said second gear, a cam conjoined to said third gear, and members connected to said respective sparking devices and in the path of movement of said cam; substantially as described.

2. In a gas-engine, the combination with two alining cylinders, their pistons, crank-shaft, pitmen, and cylinder-heads, of a valve-casing arranged on each of said cylinder-heads and having a passage-way which communicates with the interior of the cylinders, an admission and exhaust valve arranged in each of said valve-casings, a spring connected, and common to, both of said admission-valves for seating the same, a pinion arranged on said crank-shaft, a gear in mesh with said pinion and secured to a cam which is suitably mounted upon a stationary element, said cam being provided with two projections out of vertical alinement with each other, the said gear and pinion being so related that the former makes one revolution to every two revolutions of the latter, two bell-crank levers pivotally mounted on a stationary element and arranged in juxtaposition to said cam and having one of their members in coöperation with said cam and in vertical alinement with the projections thereon, and a rod secured to each of the exhaust-valves, and pivotally connected to the other end of said bell-crank lever; substantially as described.

3. In a gas-engine, the combination with two alining cylinders, their pistons, crank-shaft, pitmen, and cylinder-heads, of valve-casings arranged on said cylinder-heads, an admission and exhaust valve arranged in each of said casings, a sparking device arranged in said casing, a pinion secured to said crank-shaft, a gear in mesh with said pinion, mechanism operated by said gear for operating the exhaust-valves alternately, the relation between said gear and pinion being such that each exhaust-valve is operated at every second revolution of said crank-shaft, a second gear conjoined to said first-mentioned gear, a third gear loosely mounted on said crank-shaft and in mesh with said second-mentioned gear, a cam conjoined to said third-mentioned gear, levers pivotally mounted on some stationary element, rollers mounted on the free ends of said levers and in coöperation with said last-mentioned cam, means for holding said rollers against their coöperating cam, and means connected to the free ends of said levers and to one portion of the sparking device for the purpose specified, the relation of the parts being such that the said sparking devices are alternately operated, the operation of the exhaust-valve and sparking device alternating in each cylinder substantially as described.

In testimony whereof I hereunto affix my signature, in the presence of two witnesses, this 28th day of February, 1901.

HERBERT H. MULHERIN.

Witnesses:
WM. H. SCOTT,
A. S. GRAY.