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C. WHITE & A. R. MIDDLETON.

GAS ENGINE.

No. 438,209. Patented Oct. 14, 1890.

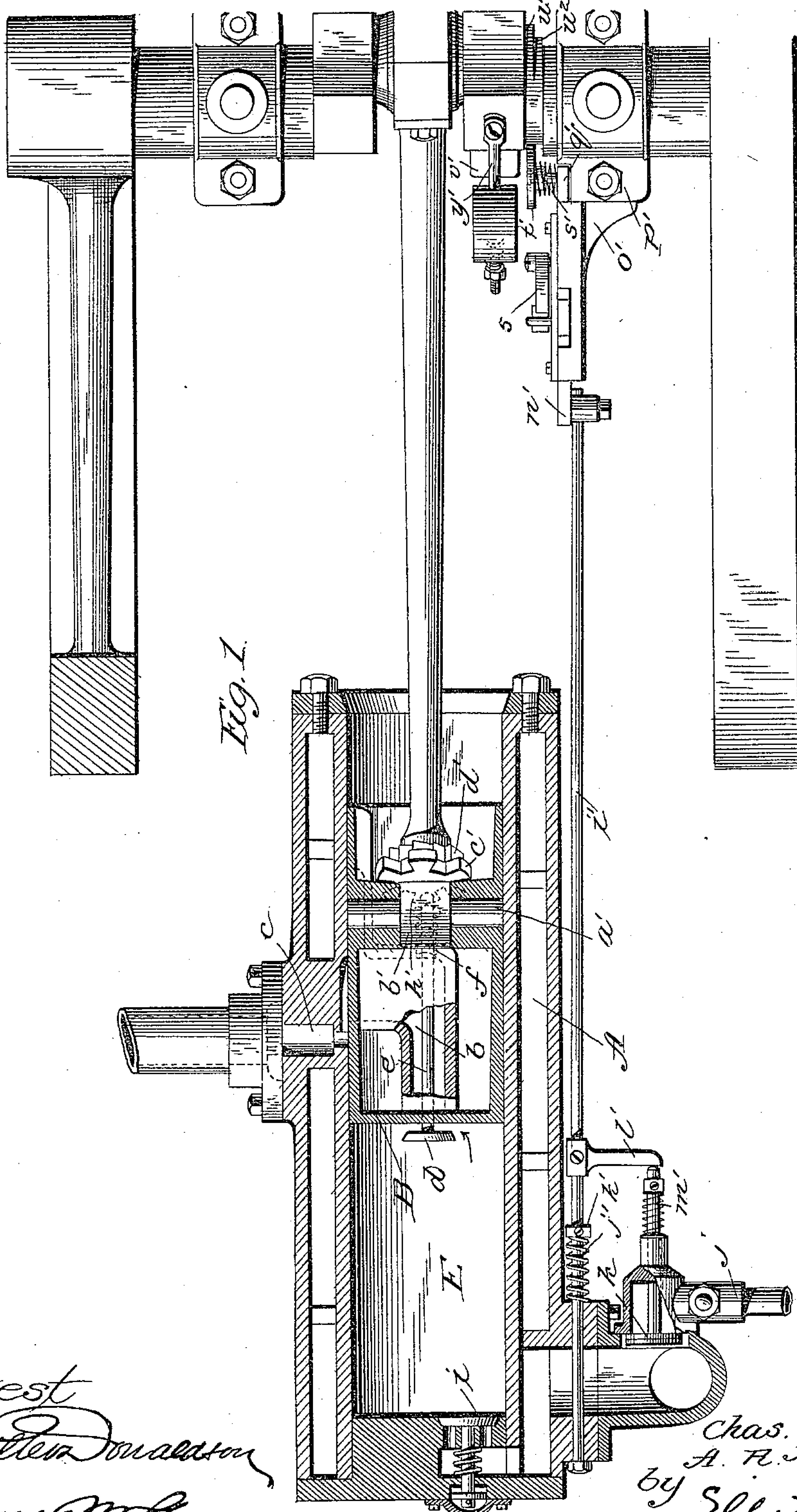

Fig. 1

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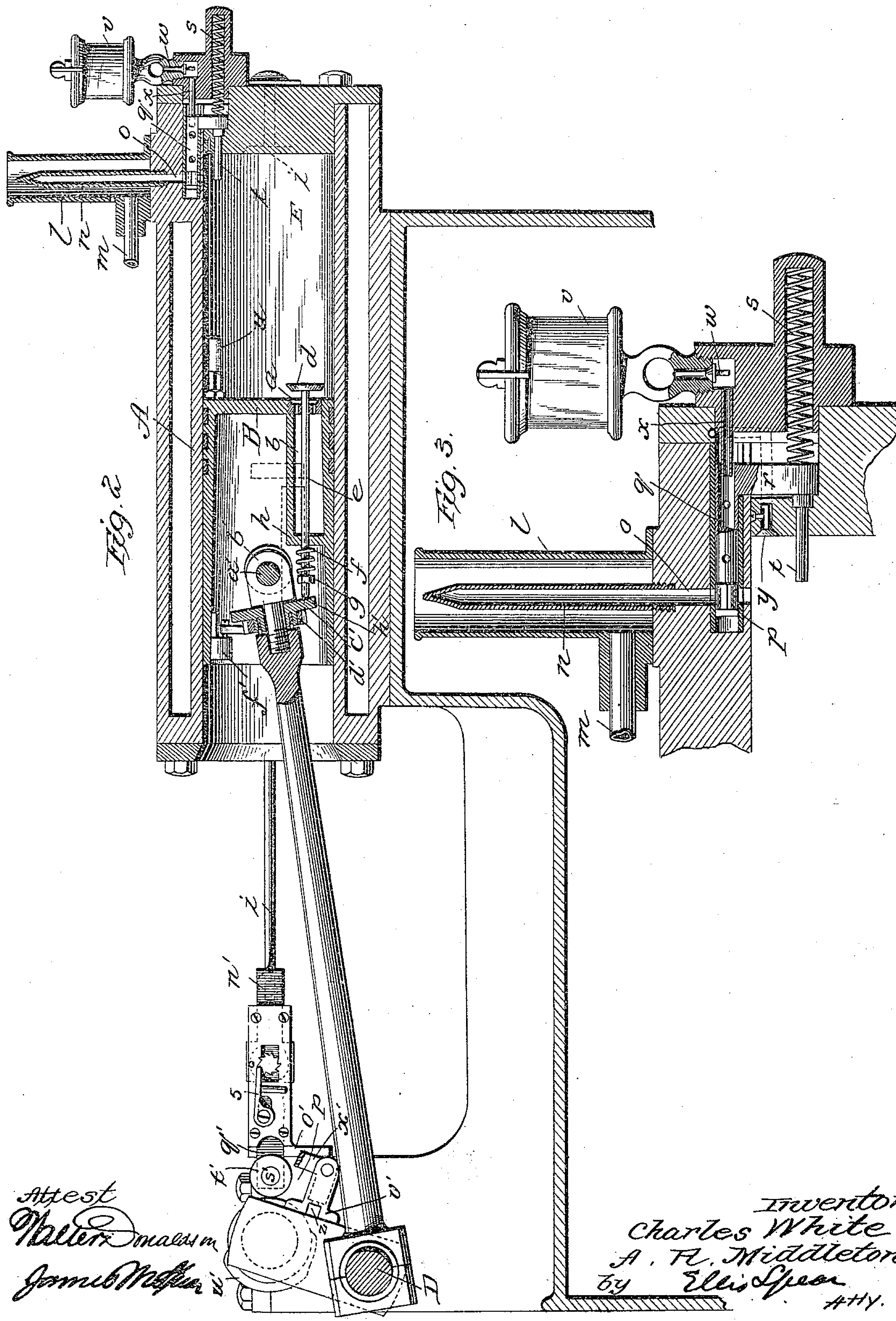

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Fig. 5.

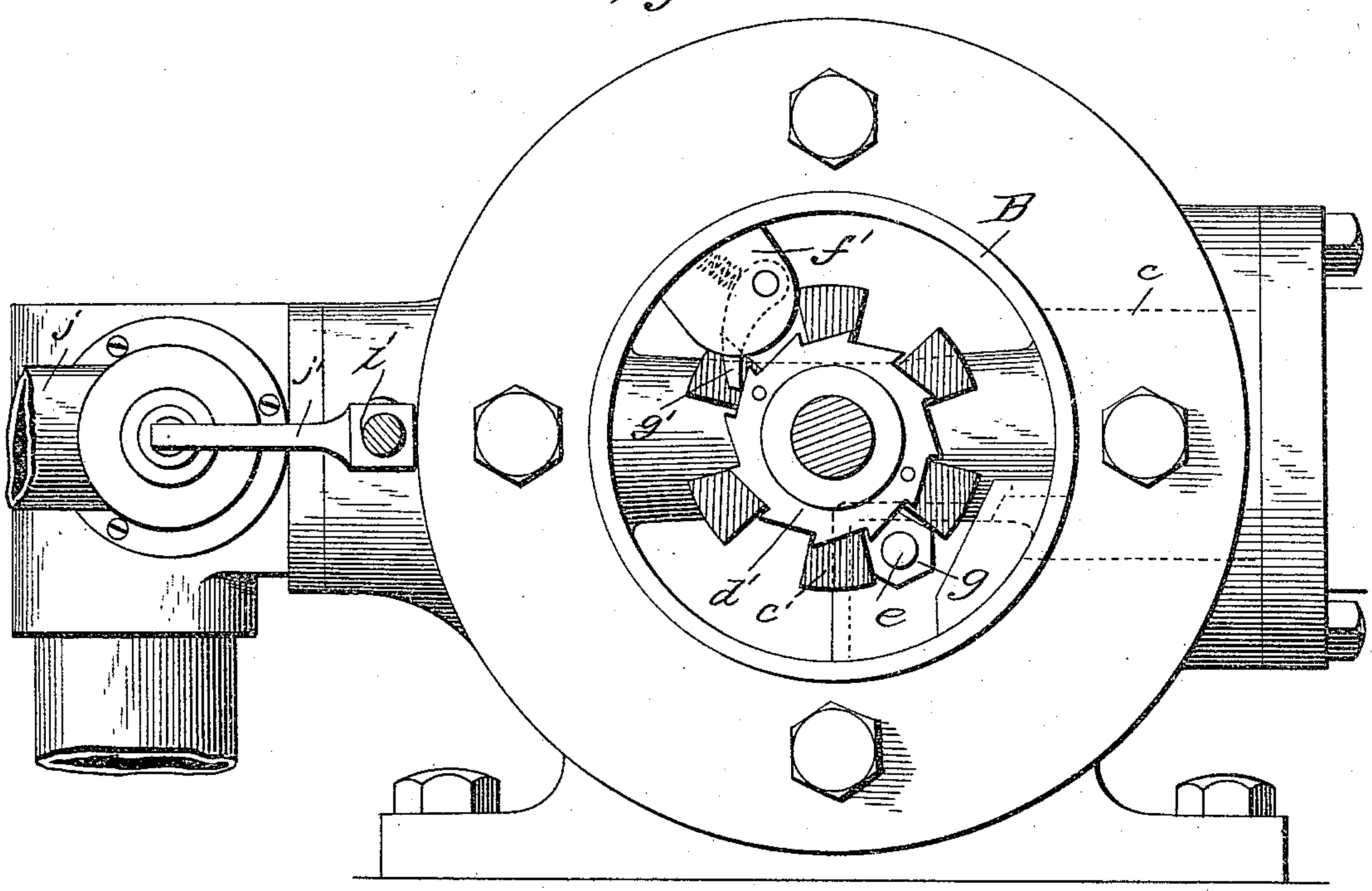
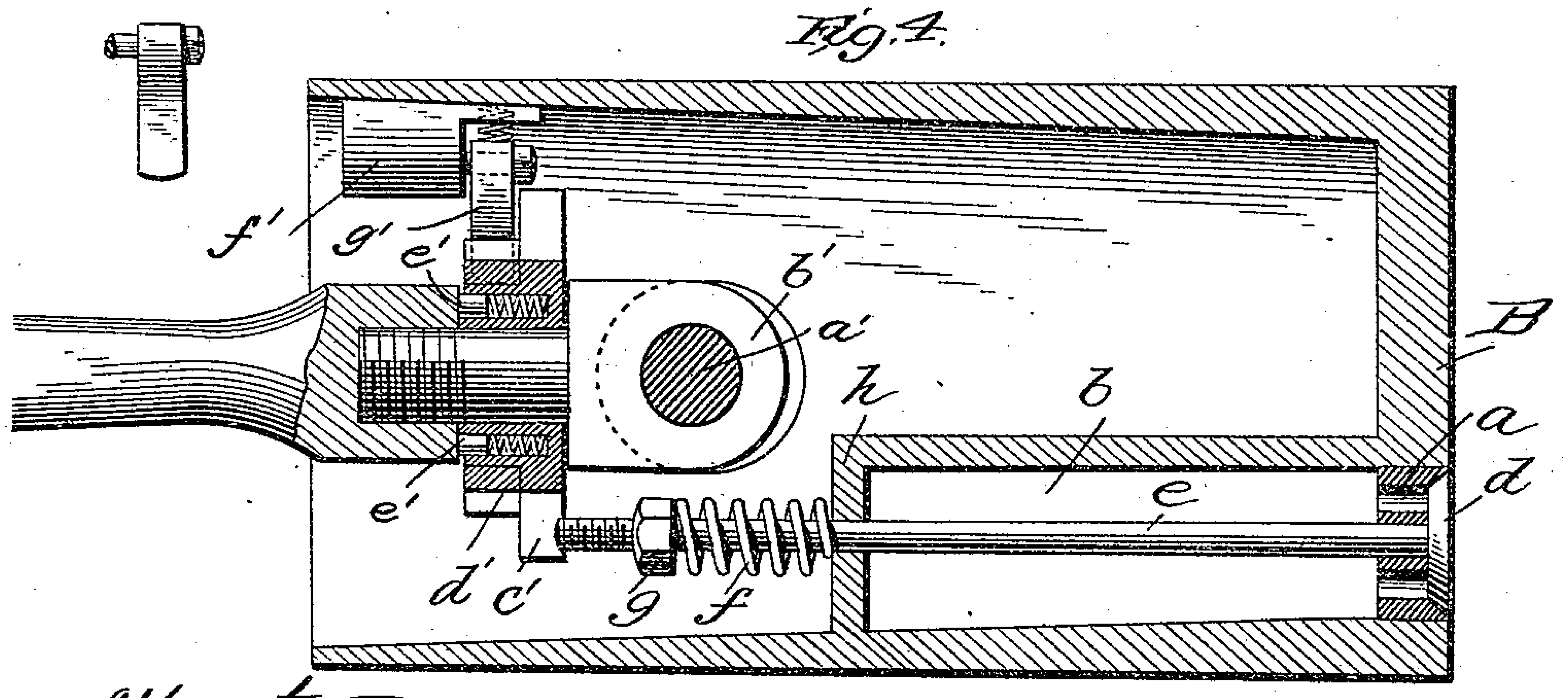


Fig. 4.



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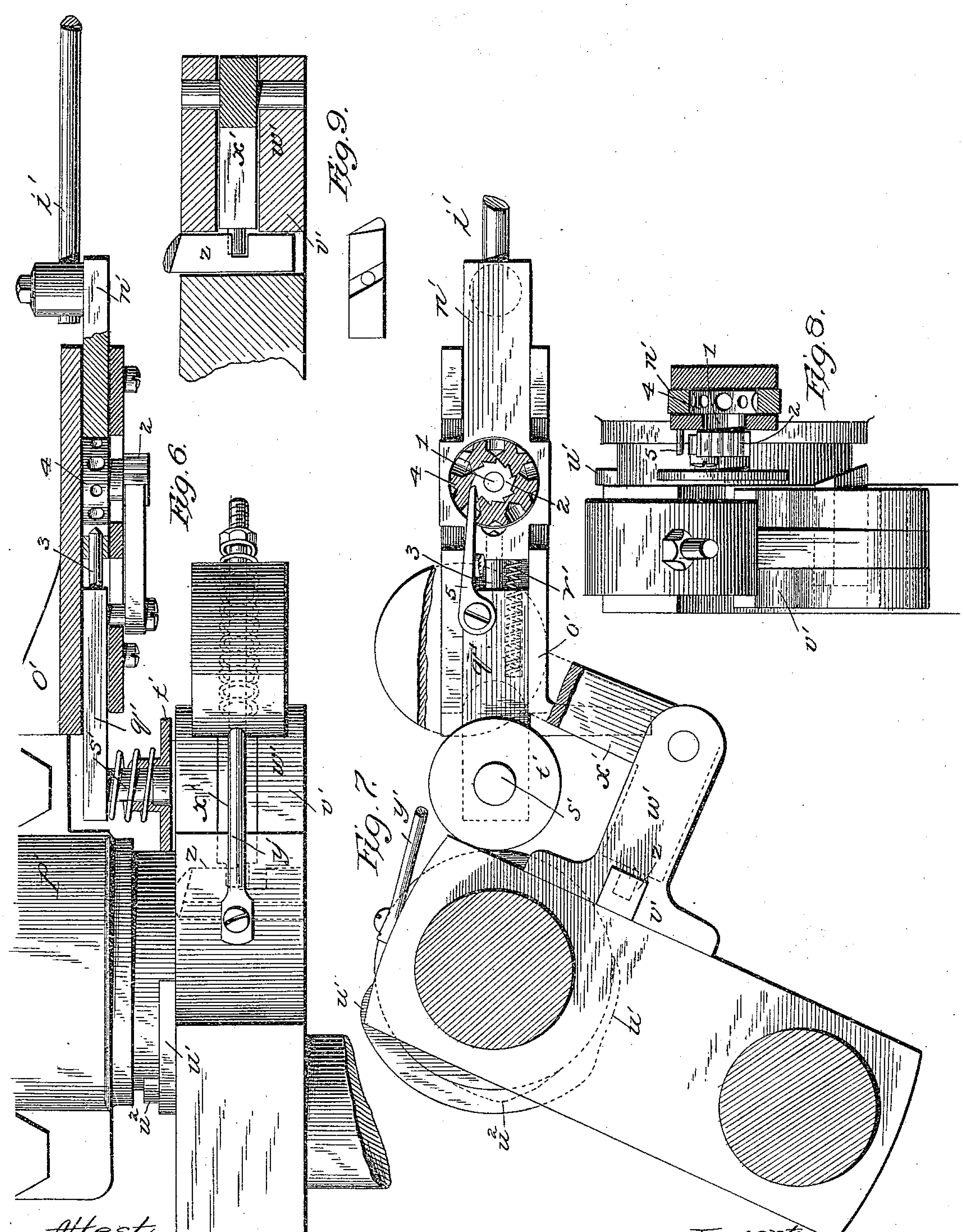

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UNITED STATES PATENT OFFICE.

CHARLES WHITE AND ARTHUR R. MIDDLETON, OF BALTIMORE, MARYLAND.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 438,209, dated October 14, 1890.

Application filed April 4, 1890. Serial No. 346,521. (No model.)

To all whom it may concern:

Be it known that we, CHARLES WHITE and ARTHUR R. MIDDLETON, citizens of the United States of America, residing at Baltimore city, State of Maryland, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification, reference being had therein to the accompanying drawings.

In devising a gas-engine designed to be run at a high rate of speed, and in which an explosion takes place after every other reciprocation of the piston or less frequently, we have aimed to bring the number of parts down to the minimum and to materially lessen those parts which add to the cost of manufacture, thus simplifying the construction not only as to the number but the character of its parts, and thereby lessening its cost to a material degree. Further, we have kept in mind the item of fuel, and have endeavored to diminish in our improved construction the cost of running the engine and to secure a maximum amount of power with a minimum consumption of the propelling-mixture. Further, we have considered the value of space and the lack of it in many situations where a source of power is needed, and we have accordingly produced a structure of an exceedingly compact form without in any way depreciating its power or durability. Further, on account of the expense attendant upon the employment of skilled labor we have taken great pains to arrange the parts of our engine in such a manner that no sensitive or weak parts are exposed to the concussive action of the explosion, and no important valves to the clogging and consequent injurious action of the residuum left by the explosions, and hence an unskilled person can with perfect safety be given the care of the engine, as it requires no attention save the turning on or off of the cocks controlling the passage of the cooling medium to the jacket of the cylinder, and the fuel-supply and the heating medium to the igniting-tube, the machine being automatic in all other respects, and capable, as hereinafter explained, of governing its communicated power to the requirements of the work. The means whereby these various objects are accomplished we will particularly describe, the preferred form and the best known to us being represented in the accompanying drawings, in which—

Figure 1 is a sectional view of the cylinder and piston of the engine, while the crank-shaft, with the governor, is shown in plan. Fig. 2 illustrates the engine in side elevation, the cylinder, piston, and igniting devices being in section. Fig. 3 is an enlarged sectional view of the igniting devices. Fig. 4 is a detail sectional view of the piston enlarged, showing the valve therein closed. Fig. 5 is a front elevation of the cylinder and piston, showing particularly the connection between the star-wheel carried on the piston-rod and the pawl carried by the piston. Fig. 6 is a detail view of the governor mechanism, this being shown partly in plan and partly in section. Fig. 7 is a side elevation of the governor devices. Fig. 8 is an end elevation of the same, partly in section; and Fig. 9 is a detail view of the slide operated by the governor to interrupt the regular explosion.

Our engine comprises a jacketed cylinder, as at A, of a size as to length and diameter as may be required by the work for which it is intended, a cooling medium—such as air or water—being introduced within the space between the walls. The piston B moves within the cylinder, being fitted thereto and properly packed in any well-known manner to make a gas-tight connection with the cylinder-walls. A piston-rod extends between the piston and the crank-shaft D of the engine. The piston is propelled by the explosion of a mixture of gas and air admitted to a chamber in rear of the piston, the arrangement being such as to allow of an explosion after every other reciprocation of the piston, or of less frequency, if the work does not require alternate explosions, the frequency of the explosions being automatically controlled, so as to prevent any undue waste or unnecessary speed under the changing conditions of the work. The explosion-chamber is in rear of the piston, as at E, and this space also serves as a compression-chamber for the mixture preparatory to its ignition. The piston is of tubular form, with its rear end closed, except where a part *a* is made leading from the explosion-chamber to the channel *b*, which channel passes through the piston for about half its length, opening through an elongated port to the exhaust-pipe *c*. The port in the end of the piston is provided with a valve *d*, which is hereinafter described, closes the passage to the exhaust under certain conditions, and is operated to open it under other conditions. The valve *d* is carried upon a stem *e*, which is guided in its movement by the walls of the openings through which it passes in the front and rear walls of the passage or channel *b*, and the front end of this stem carries a spring *f*, held between the nut *g* on the threaded end of the stem and the wall *h*. The tension of the spring may be regulated as required.

After an explosion has taken place the piston is driven to the front until its rear edge reaches the exhaust-port, when the exploded mixture flashes out and the force of the charge is then spent. In this forward movement the valve *d* is tightly closed upon its seat, which is made dish-shaped, so as to bring the outer face of the valve flush with the rear face of the piston; but as the backward movement of the piston takes place the valve is moved forcibly from its seat, as hereinafter described, and an exit is thus opened through the channel *b* to the exhaust for the escape of the foul mixture. This frees the space in rear of the piston from the exploded compound, and thus the next charge admitted is practically entirely fresh, and a minimum amount of the old mixture remains, thus enabling us to gain largely in power by the explosion of a fresh charge over a charge largely composed of spent mixture ordinarily remaining in the explosion-chamber. In such cases where the chamber is heavily charged with the exploded mixture not only does it prevent the admission of a proper amount of the fresh mixture, but by the detrimental adulteration materially diminishes the estimated force ordinarily derived from the explosion of a determined charge. We entirely avoid this serious objection by expelling the exploded mixture down to one atmosphere in the return-stroke of the piston succeeding an explosion.

The gas or vapor is admitted to the explosion-chamber through the ports covered by the valve *i*, (shown in Fig. 1,) this valve being normally closed by a spring, but opened to admit a charge by the suction of the piston as it moves forward after the chamber has been emptied of the exploded mixture. The gas or vapor is admitted to the space in rear of the explosion-chamber through the pipe *j*, which may be in connection with any suitable source of supply; but the flow of the gas is interrupted by a valve *k*, as in Fig. 1, this valve being automatically controlled by a governor mechanism, hereinafter to be described, which, by thus allowing or preventing the flow of gas to the chamber, controls the number of explosions, the governor operating to admit the gas according to the requirements of the work.

The igniting devices are arranged at the end of the piston, as shown particularly in Figs. 2 and 3. The chimney *l* is mounted on the cylinder and is in connection with a gas-pipe *m* or other source of heat, and in the center of the chimney is the igniting-tube *n*, the interior of which is a continuation of the opening passing through the cylinder to the interior thereof. The tube *n* becomes heated under the action of the flame and the charge is ignited through the opening *o*. The opening *o* is normally closed by a valve consisting of a spring-ring *p*, mounted on a sliding tube *q*, fitting a socket or recess extending longitudinally of the cylinder and intersecting the passage. The spring-ring, by its elasticity, forms a perfect valve and prevents absolutely all danger of leakage, and consequently premature explosions. The tube *q* is carried by a block *r*, which is kept normally forward by a coiled spring *s*, and this block has a stem *t* projecting through the head of the cylinder, as shown in Figs. 2 and 3, where it is the path of a like stem secured to the rear face of the piston, as at *u*. In order to lubricate the sliding tube *q* and the other parts within the recess or space in the cylinder-head, we provide an oil-cup *v*, provided with a valve *w*, which is kept closed by the back-pressure; but when the piston moves forward the pressure is relieved, the valve drops, and the oil is drawn out and diffused. A valve *x* conducts the oil to the sliding tube *q*, extending partly into the same, and this tube *q* is provided with an opening or openings at its forward end, through which the oil passes to the bearing-surface. A valve *y*, opening into the explosion-chamber, opens as the piston moves forward, but on the back movement closes and prevents the blowing out of the oil in the cup. This valve works in a passage, which, as shown in dotted lines in Fig. 3, extends to the rear and thence upwardly, so that its upper open end is above the line of the oil-delivery tube and tube *q*, thus preventing the oil from being sucked out in the forward movement of the piston. The suction of the piston is utilized without danger of emptying the recess accompanied by the ignitor and its operating parts from the oil contained therein. Thus those parts are always thoroughly lubricated.

We have referred to the alternate opening and closing of the valve in the piston so as to permit the discharge of the exploded mixture in the rear movement of the piston and to prevent the escape of the fresh charge or the force of the explosion in the forward movement by the closing of the valve, and we will now describe a preferred means of effecting the result automatically by the oscillation of the piston-rod, though we do not limit ourselves in this respect, as the means shown may be greatly modified and changed without departing from the spirit of this part of our invention.

The piston-rod is provided with a screw-threaded socket in its end, adapted to receive the threaded shank of the eye *b′*, which is pivoted to a bar or rod a', crossing between the walls of the piston. Between the shoulders of the eye and the end of the piston-rod is supported a star-wheel c', having an elongated hub, which in turn supports a ratchet-wheel d'. The star-wheel is freely mounted on the shank of the eye b'; but frictional contact is secured sufficient to prevent accidental slipping of the plugs e', pressed outward by springs bearing against the end face of the piston-rod proper. A supporting projection f from the interior periphery of the piston carries a spring-pawl g', adapted to engage with the teeth of the ratchet d' in the up-and-down movement of the piston-rod, this movement bringing the teeth of the ratchet into engagement with the pawl, which causes the ratchet to revolve, carrying with it the star-wheel. This wheel has a series of projections alternating with spaces, and the wheel and stem of the valve d are so arranged relatively to each other that the stem is in the path of the wheel, and when a space is opposite the stem the spring thereof keeps the valve closed; but when a projection, as h' in Figs. 1 and 2, comes in line it engages the end of the stem as the piston moves down and forces open the valve.

We will now particularly describe the governor which has been heretofore referred to. This is designed to automatically control the explosions as required by the work by operating the valve in the pipe supplying the gas or explosive mixture.

A rod i' extends between the engine and the governing devices, the rear end finding bearings in openings passing through a part of the cylinder. A spring j', bearing against a stop k', keeps the rod pressed constantly toward the front and the arm l' thereon away from the stem of the valve in the gas-supply pipe, this valve being normally closed by a spring m'. The front end of the rod i' is connected to a slide n', which moves in ways formed for it in a bracket o', extending from the bearing p'. Between the slide and the operating-cam on the crank-shaft is a second slide q', with a spring r' interposed between the two slides to take up the shock and allow the action of the one upon the other to be gradual. The slide q' carries upon its forward end a pin s', carrying a disk t', freely mounted thereon and pressed outward by a spring, and this disk is adapted to engage and ride over a cam u', (shown fully in Figs. 6 and 7,) arranged closely against the angular part of the crank-shaft. The action of the cam is to advance the slide q' and through the second slide n' operate the rod i', and thus open the valve in the gas-pipe to admit a charge to the explosion-chamber through the arm l', coming in contact with the stem of said valve. The cam u' is made with a slight rise, which gradually increases, as shown in Fig. 7, to avoid any great shock and consequent wear, and while the disk is being operated by this part of the cam but little power is required, as the slide q' is simply being moved toward the slide n', and by the time power is required to move the slide n' and its rod the high part of the cam has reached the position of the disk. The cam u' is so arranged as to provide for an explosion after every alternate reciprocation of the piston; but as it often occurs that the work does not require explosions as frequent we have provided an automatic regulator to govern the frequency of the explosions by controlling the movement of the rod actuating the valve in the gas-pipe. To the angular part of the crank-shaft, as at v', we secure a bracket having a bifurcated projecting partition w', supporting a pin, which serves as a pivot for a bell-crank lever x', having one end weighted. In addition to the weight, to still further add to the tension of the bell-crank, a stem y' is secured to the angular part of the crank-shaft, passing through the weight with a nut on its projecting end, and a spring interposed between the nut and the wall of the cavity in the weight occupied by the spring. The opposite end of the bell-crank is reduced, as shown in Fig. 9, and this fits an inclined slot in a shifting-block z, which has lateral movement in a passage formed through the base of the bracket v'. This block has its end made inclined, and as soon as the speed of the engine begins to increase beyond the requirements of the work the centrifugal action on the weighted end of the bell-crank moves the inner end and operates through the inclined slot to shift the block laterally, which thus brings its inclined end into the path of the shifting disk, thus forcing it to one side and out of the path of the cam, thus causing the engine to miss its regular explosion, and this is done as often as the governor is operated under the varying condition of the work. As the intermittent movement of the star-wheel is uniform, presenting a space and then a projection in the path of the stem of the valve d, it will be seen that the rod for operating the valve in the gas-pipe must be moved by the governor with regard to the movement of the star-wheel or else in the missing of an explosion the order of movement would be changed and a charge admitted on the wrong stroke of the piston. In order to cause the movement of the rod only at the proper time in relation to the position of the star-wheel, we provide the slide n' with a disk 4, having recesses or pockets in its periphery, this wheel being secured to one end of a short spindle 1, which has its bearings in the face-plate covering the slide n'. A ratchet-wheel 2 is carried on the other end of the spindle, and the teeth of this wheel are engaged by a long pawl 5, carried on the slide q'. The slide q' also carries a pin 3, having a conical end, which is guided in its movement through an opening in the slide n'. The recesses or pockets in the disk are of different depth, a shallow one alternating with a deeper one.

In the ordinary action of the mechanism

operating the rod controlling the valve in the gas-pipe the slide q' is advanced by the cam on the crank-shaft, as before described, until the pin 3 engages with one of the recesses in the disk 4, and if this is one of the shallow recesses the amount of movement is sufficient to move the slide n' and its rod, and thus open the valve to admit a charge. In the same movement of the slide q' its pawl turns the ratchet-wheel, which brings a deep recess or pocket in line with the pin, and in the next movement of the slide q' the pin enters the deep recess, and as the depth is sufficient to take up all the movement of the pin the slide n' is not operated and no charge admitted to the engine; but the pawl operates the ratchet to bring the next recess, a shallow one, around for the next action of the pin, thus providing for an explosion under normal conditions on every other movement of the slide q', thus timing the explosions to accord with the movement of the piston and the position of its valve as controlled by the star-wheel, the relation being such that when a projection of the star-wheel is in contact with the stem of the piston-valve a deep notch is in line with the pin 3, and when a space of the star-wheel is opposite the valve-stem a shallow recess is opposite the pin and the valve in the gas-pipe operated. We provide, however, for the less frequent operation of the valve in the gas-pipe than in the alternate order stated without interrupting the relative movements of the star-wheel and slide n' by arranging alongside the cam u' a second cam u^2, and thus when the disk f' is shifted by the block z out of the path of the cam u' it engages the cam u^2, which is of less height than its companion cam, and the movement imparted to the slide q' is of such limited extent as to render ineffectual the action of the slide q' on the slide n', though a shallow recess be opposite the pin 3. The action, however, is sufficient to move the ratchet-wheel to turn the recessed disk, and thus the relative positions of the star-wheel and disk are maintained.

A pin 5 limits the upward movement of the pawl of the slide q'.

While we have described the mixture used as being gas and air, it will be understood that any suitable fuel may be substituted therefor.

We claim as our invention—

1. In a gas-engine, a cylinder having a main exhaust, a piston therein, a supplemental exhaust-passage from the explosion-chamber, and means for opening the supplemental valve on every alternate reciprocation only of the piston to discharge the exploded contents under the action of the piston, substantially as described.

2. In a gas-engine, a cylinder having a main exhaust, a piston therein, a supplemental valved exhaust-passage from the explosion-chamber, and automatic means for opening said supplemental valve on every alternate reciprocation only of the piston to discharge the exploded mixture, substantially as described.

3. In a gas-engine, a cylinder, a piston therein, having a passage through its head to the exhaust, a valve controlling said passage, and means for operating the valve on every alternate reciprocation of the piston, substantially as described.

4. In a gas-engine, a cylinder, a piston having a passage through the same leading to the exhaust, a valve controlling said passage, and automatic means for opening said valve on every alternate reciprocation of the piston, substantially as described.

5. In a gas-engine, a cylinder, a piston having a valved passage through the same, a spring for operating said valve in one direction on every alternate reciprocation of the piston, and positive means for operating it in the other direction, substantially as described.

6. In a gas-engine, a cylinder, a piston having a valved passage and spring for keeping the valve in one position, and means for operating the valve positively and only on every alternate reciprocation of the piston, substantially as described.

7. In a gas-engine, a cylinder, a piston having a valved passage, and a star-wheel operated by the movement of the piston-rod to alternately present its projections and spaces in the path of the valve-stem, substantially as described.

8. In a gas-engine, a cylinder, a piston having a valved opening leading to the exhaust, a piston-rod, a star-wheel, a ratchet-wheel in connection therewith, and a pawl, these parts being carried by the piston and rod, and the pawl engaging the ratchet to move the same under the oscillations of the piston-rod, substantially as described.

9. In a gas-engine, a cylinder, a piston having a valved opening, a piston-rod, a star-wheel carried on an extension of the rod, a ratchet-wheel connected therewith, and a pawl carried by the piston for engaging the ratchet and moving the same with the star-wheel under the oscillations of the piston-rod, the said valve having a stem in the path of movement of the star-wheel, substantially as described.

10. In a gas-engine, an igniting-opening, a valve therefor, a recess in the cylinder-head to receive the parts of the ignitor, an oil-cup, and a valved passage between the oil-cup and the recess, substantially as described.

11. In combination with a gas-engine, an igniting-opening, a slide-valve covering the same, said valve and the operating parts connected therewith being located in a recess in the end of the cylinder-head, an oil-cup in connection with said recess having a valve, and a valve located in a recess in the inner face of the cylinder-head, substantially as described.

12. In a gas-engine, a cylinder, a piston, a gas-supply pipe, a valve therein and controlling means therefor, operated by a cam on the

crank-shaft, a weighted governor-lever, a laterally-movable disk adapted to be acted upon by the cam on the crank-shaft under ordinary conditions, and a laterally-movable block operated by the governor to deflect the laterally-movable disk, and thus miss an explosion, substantially as described.

13. In a gas-engine, a cylinder, a piston therein, a gas-pipe and valve, a rod for operating said valve, a two-part slide with yielding means between, a cam on the crank-shaft, and a shifting disk carried by one of the slides, with means for shifting the same, substantially as described.

14. In a gas-engine, a cylinder, a piston, a gas-pipe and valve, a cam on the crank-shaft, an operating-connection between said shaft and valve, a shifting disk forming part of said connection, and means for shifting the same under the action of a governor-weight, substantially as described.

15. In combination with a gas-engine, a gas-pipe and valve, a rod having an arm adapted to engage with said valve, a slide connected to said rod, a second slide with an interposed spring between the two slides, a shifting disk on the end of the slide q', a cam on the shaft, a sliding block, and a governor-lever for moving said block laterally to shift the disk, said block having an inclined end, substantially as described.

16. In combination with a valve in the explosion-chamber of a gas-engine, and with means for opening said valve during every alternate reciprocation of the piston, a gas-pipe and valve and means for controlling the inlet of the gas, consisting of an operating-rod, a slide connected thereto, a recessed disk carried by the slide and having a ratchet-wheel on one end, the recesses being of different depth alternating in position, a second slide with a spring interposed between the two, a pin for engaging the recesses of the disk, a pawl carried by the second slide and engaging the ratchet of the first, and means for controlling the second slide, substantially as described.

17. In combination with the alternately-operated valve in the explosion-chamber of the cylinder, means for controlling the valve in the gas-pipe, consisting of an operating-rod, a slide connected therewith carrying a recessed disk and ratchet-wheel, a second slide with a spring interposed between the two, said slide having a pin and pawl, a laterally-movable disk on the end of the slide q', a cam u' for operating said disk, a shifting-block for moving the disk laterally, and a second cam u^2, for operating the disk in its shifted position, substantially as described.

18. In a gas-engine, an igniting-opening, a valve therefor carried by a sliding tube, an oil-cup, and a tube, as x, for directing oil to the sliding tube, said sliding tube having an opening or openings through its walls, substantially as described.

19. In a gas-engine, an igniting-opening, a valve therefor carried by a sliding tube, an oil-cup, a passage extending through the cylinder-head, and a valve v therein, said passage opening into the recess in the cylinder-head above the line of the sliding tube, substantially as described.

In testimony whereof we affix our signatures in presence of two witnesses.

CHAS. WHITE.
ARTHUR R. MIDDLETON.

Witnesses:
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JNO. T. MADDOX.