(No Model.) 4 Sheets—Sheet 1.

L. H. WATTLES.

GAS ENGINE.

No. 577,567. Patented Feb. 23, 1897.

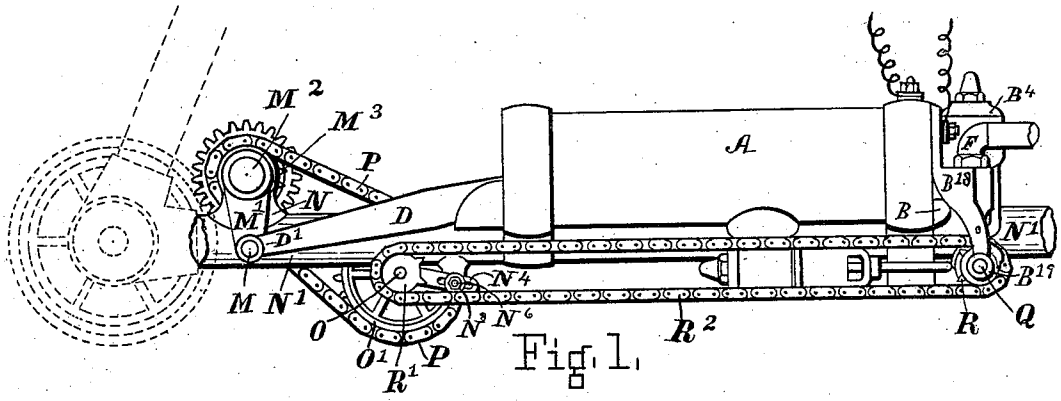

Fig. 1.

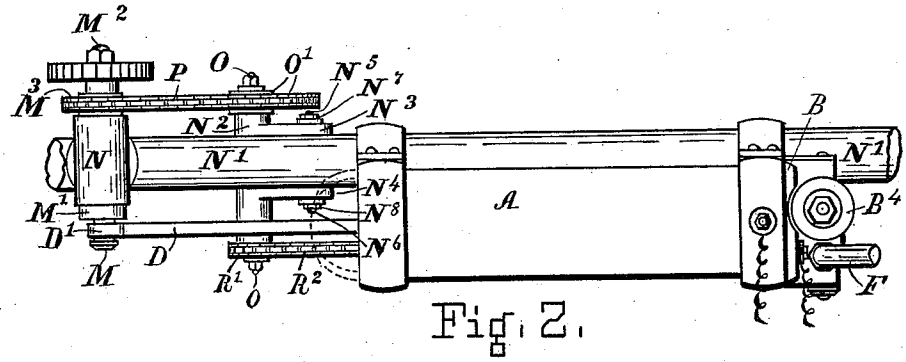

Fig. 2.

WITNESSES:

James A. McGain

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(No Model.) 4 Sheets—Sheet 2.

L. H. WATTLES.

GAS ENGINE.

No. 577,567. Patented Feb. 23, 1897.

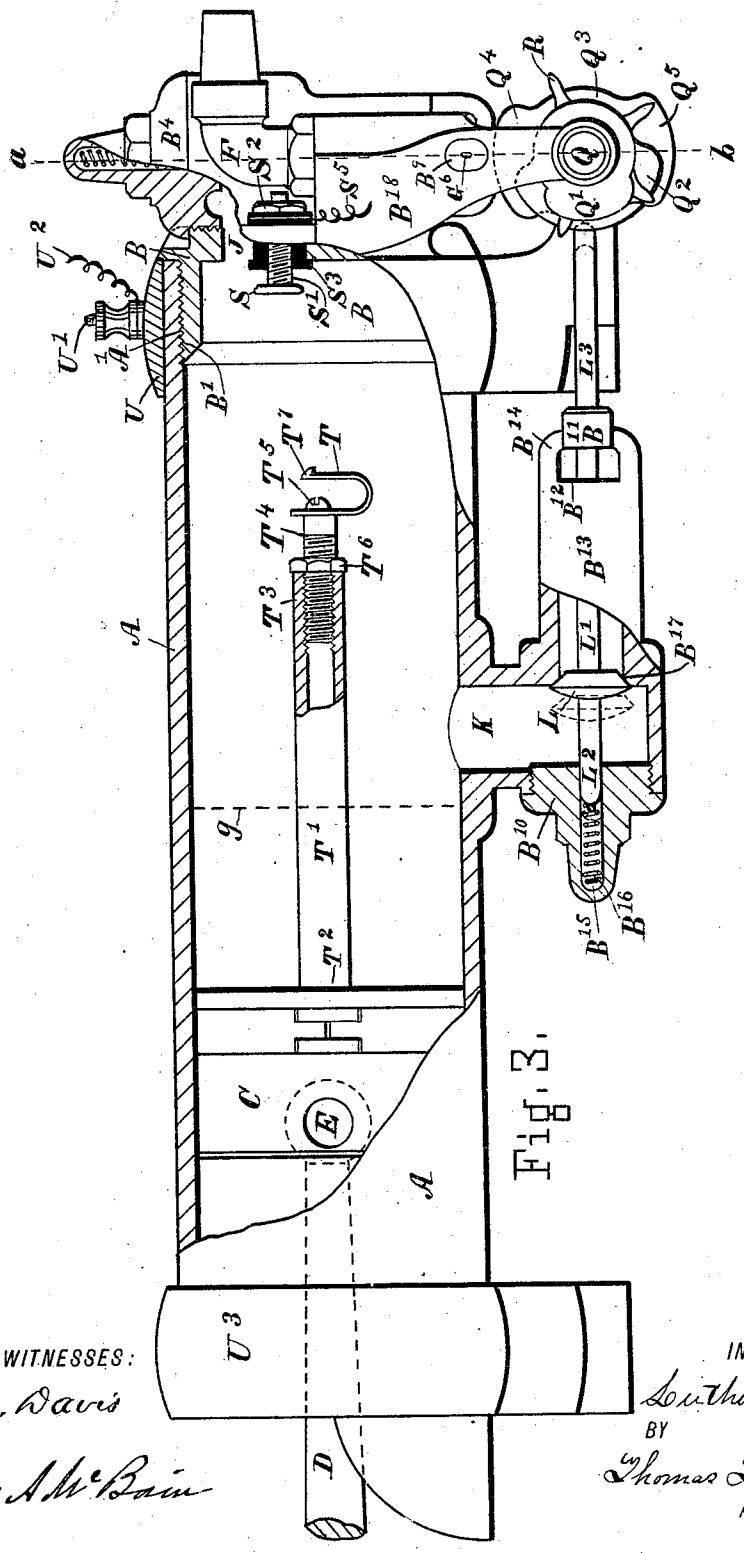

Fig. 3.

WITNESSES:

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(No Model.) 4 Sheets—Sheet 3.

L. H. WATTLES.

GAS ENGINE.

No. 577,567. Patented Feb. 23, 1897.

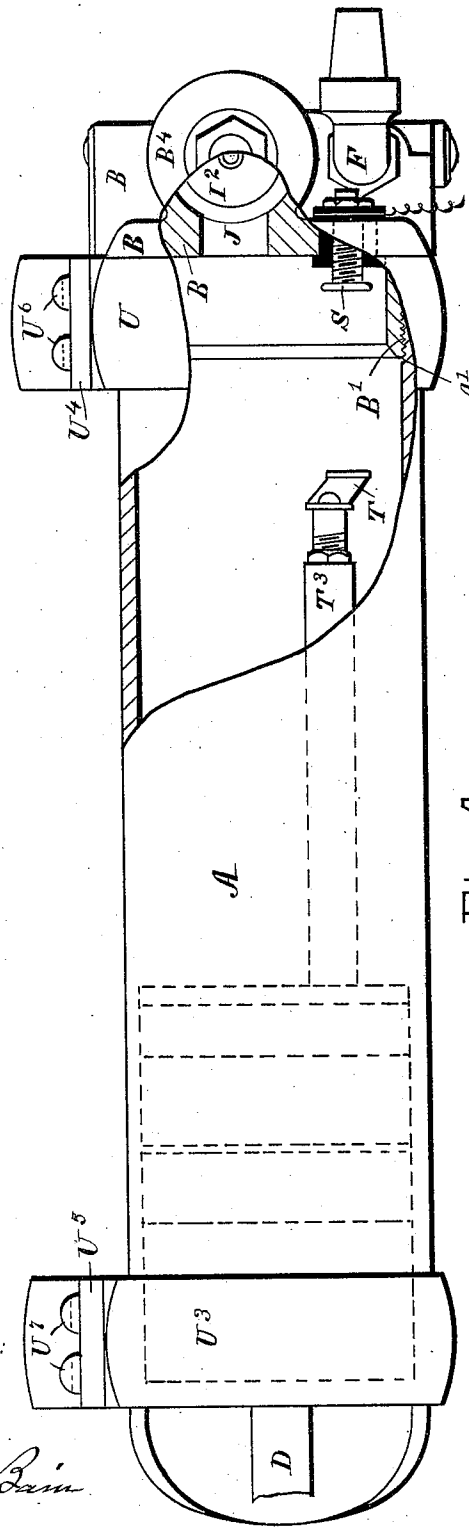

Fig. 4.

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(No Model.) 4 Sheets—Sheet 4

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GAS ENGINE.

No. 577,567. Patented Feb. 23, 1897.

Fig. 5.

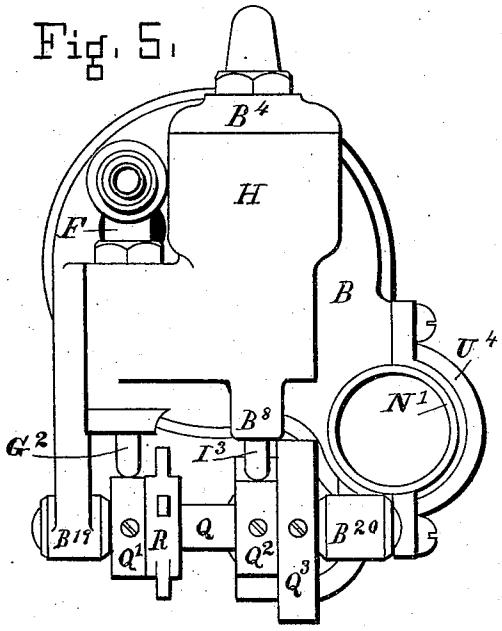


Fig. 6.

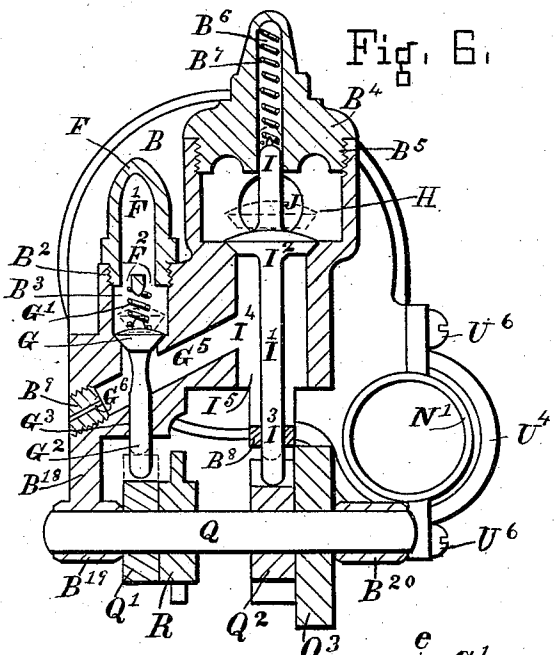
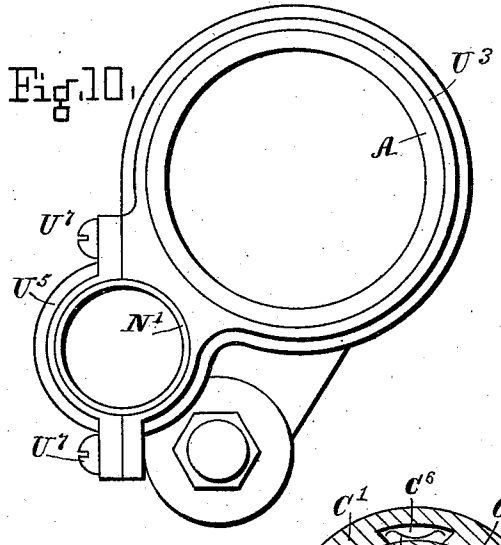


Fig. 10.



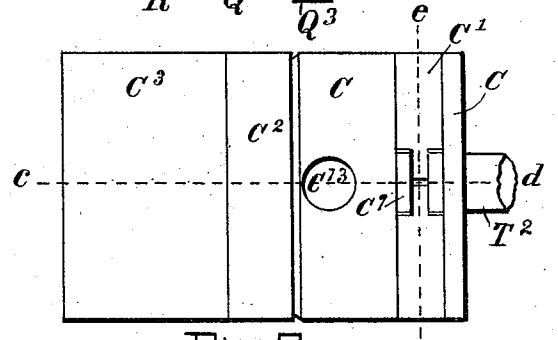


Fig. 7.

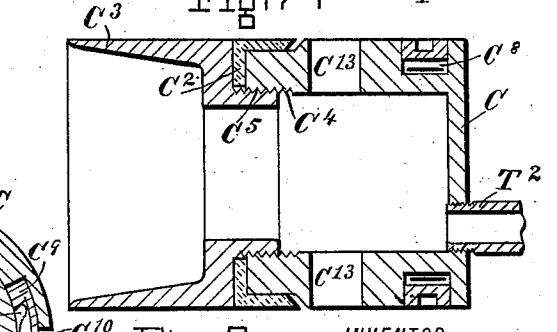


Fig. 8.

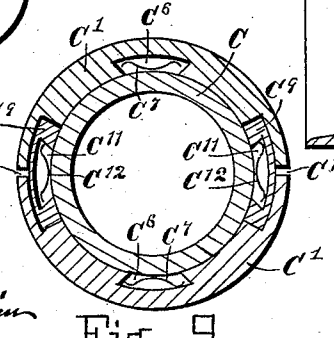


Fig. 9.

WITNESSES:

B. C. Davis

James A. McBain

INVENTOR

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BY

Thomas L. Raynor.

ATTORNEY.

UNITED STATES PATENT OFFICE.

LUTHER H. WATTLES, OF PROVIDENCE, RHODE ISLAND, ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, OF THREE-FOURTHS TO WILLIAM B. SHERMAN, OF SAME PLACE, AND BYRON C. DAVIS, OF BROOKLYN, NEW YORK.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 577,567, dated February 23, 1897.

Application filed December 7, 1895. Serial No. 571,337. (No model.)

To all whom it may concern:

Be it known that I, LUTHER H. WATTLES, a citizen of the United States, and a resident of Providence, in the county of Providence and State of Rhode Island, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification.

My invention relates to improvements in gas-engines; and it consists in a novel construction and arrangement of the igniting mechanism therefor, as will be more fully described hereinafter and especially pointed out in the claim.

The object of my invention is to produce a simple and inexpensive engine in which gas or vapors adaptable to use in motors of this character can be used successfully and economically, and especially applicable to the propulsion of cycles, motocycles, carriages, cars, boats, and other applications where small units of power are required.

The character of my invention will be more fully understood by reference to the accompanying drawings, forming part of this specification, in which—

Figure 1 represents a front view of the engine, which is shown as being mounted upon and connected with a part of the frame of a cycle and near the pedal-shaft mechanism of the latter. Fig. 2 represents a top view or plan of Fig. 1. Fig. 3 represents an enlarged side elevation of the cylinder and valve mechanism and is shown partly in section, that the exhaust-valve mechanism and the gas-igniting devices may be more clearly seen. Fig. 4 is a top view of Fig. 3, also partly showing in section the admission-port and igniting mechanism. Fig. 5 is an end view of Fig. 3 and shows the cam mechanism which actuates the valves. It also shows the means by which the engine is secured to the frame of the cycle seen in Figs. 1 and 2. Fig. 6 is a vertical section on the line *a b* in Fig. 3. Fig. 7 is a side elevation of the piston mechanism. Fig. 8 is a section of Fig. 7 on the line *c d*. Fig. 9 is a section on the line *e f* in Fig. 7. Fig. 10 is a rear end view of Fig. 3.

Similar letters refer to similar parts throughout the several views.

In the drawings, A represents the cylinder of the engine, to which the head B is fitted by means of the internal thread A′, which is cut therein, and the threaded section B′ of the head B, and by means of which a tight joint between the two is obtained.

The piston C is fitted to the cylinder in the usual manner and is provided with the divided packing-ring C′ and an additional packing or lubricating ring C^2, which may be of leather or other suitable material for such purposes. The piston is divided into two sections C C^3, which are secured together by means of the internal thread C^4 within the former and to which the external threaded portion C^5 of the latter is fitted. This arrangement of the parts admits of adjusting the lubricating-ring C^2 in its proper position without dividing it, and securing it effectively to the piston. Recesses C^6 C^6 are provided in the ring C′, in which springs C^7 C^7 are placed, which bear outwardly against the ring C′ and cause it to make the proper contact and fit against the internal surface of the cylinder.

An annular groove C^8 is provided in the piston, into which the ring C′ is fitted loosely, and blocks C^9 C^9 are likewise fitted therein to close the joints C^{10} C^{10} between the sections of the ring C′. These blocks have internal recesses or cavities C^{11} C^{11}, in which the springs C^{12} C^{12} are placed for the purpose of producing the proper bearing of the ring C′ at its joints against the internal wall of the cylinder.

The connecting-rod D is connected with the piston C by the wrist-pin E, which is fitted to the piston C in the holes C^{13} C^{13} in its walls in the usual manner of such connections.

The head B is of such construction as to provide for bearings and seats for the gas-valve and air-valve mechanism, a mixing-chamber, and duct leading from the gas-valve to the air-valve, and also provide bearings for the shaft which rotates the cams actuating the valves. The head B is consequently provided with the gas-pipe connection F, which is screwed into the upper portion B^2 of the gas-chamber B^3, so as to make a tight joint therewith, while admitting of the insertion of the gas-valve G and its spring G′ when necessary.

The valve-stem G^2 has a bearing G^3 in the head B in the same axis with that of the gas-chamber and gas-valve.

The mixing-chamber H is internally threaded at its upper end, and to it the cap B^4 is fitted by a correspondingly-threaded portion B^5. The cap B^4 has a spring-cavity B^6, which serves to retain the air-valve spring B^7 and also give a bearing for the upper portion I of the stem I′ of the air-valve I^2. This form of construction, as in the case of the gas-valve mechanism, admits of access to the spring B^7 and air-valve I^2. The lower portion I^3 of the valve-stem I′ has a bearing at B^8, which is in a common axis with the cavity B^6 and the valve I^2, and all of which are of cylindrical form.

The chambers and openings and connecting-passages between the same will now be described. The opening F′ in the gas-pipe F communicates through passages F^2 with the gas-chamber B^3. When the valve G is elevated, a passage is opened from the gas-chamber B^3 to a duct G^5, leading to an air-chamber I^4. The air-chamber I^4 is open at I^5 for the admission of the air into the mixing-chamber H at the proper time when the air-valve I^2 is elevated for this purpose. An opening or admission-port J communicates between the mixing-chamber H and the interior of the cylinder A, through which the mixed gas and air enters the cylinder, by a suction of the piston C, with every alternate outward stroke of the latter, as will be more fully described hereinafter. When the gas-valve G is elevated, the gas passes under it into the duct G^5 and into the air-chamber I^4, where it becomes mixed with the incoming air and is then drawn with it into the mixing-chamber H, where it becomes more thoroughly commingled with the latter for its subsequent combustion in the cylinder. A small orifice G^6 at the bottom of the duct G^5 in the screw-plug B^9 forms an air-passage for the suction of the gas remaining in the duct after the valve G is closed.

An exhaust-port K is provided at the lower part of the cylinder A for the escape of the products of the combustion of the gas, provided with the exhaust-valve L, having the stem L′, which has a bearing at its inner end L^2 in the cap B^{10}, which is fitted to the cylinder A by the threaded form of construction shown and described in connection with the mixing-chamber H and cap B^4. The outer portion L^3 of the stem L′ has its bearing at B^{11} beyond the end B^{12} of the exhaust-pipe B^{13} and connected with it by the bridge B^{14}. This form of construction is similar to that provided for the bearing of the air-valve stem I′ at I^3 and B^8 and provides an exit for the escape of the burned gas similar to the inlet I^5, as seen in Fig. 6. Cap B^{10} has a spring-cavity B^{15}, in which the spring B^{16} is secured, which presses the valve L against its seat B^{17}.

The valve-actuating mechanism will now be explained. The connecting-rod D has its outer end D′ directly attached to the crank-pin M of the crank M′ of the crank-shaft M^2, and upon which the sprocket-wheel M^3 is mounted. The shaft M^2 has its bearing in a pillow-block N, which is secured to the frame N′ or may be integral therewith. The frame N′ has also another bearing N^2 secured to it, and in which an intermediate sprocket-wheel shaft O is journaled and upon which the sprocket-wheel O′ is mounted, and of a diameter equal to twice that of the crank-shaft sprocket-wheel M^3. The sprocket-wheels M^3 and O′ are connected by an endless chain P, by means of which motion may be imparted to the shaft O, which of course makes but one revolution for every two made by the crank-shaft on account of the respective proportions of the sprocket-wheels, as described. The connection between the frame N′ and the bearing N^2 is an adjustable one, and to provide for this the bearing N^2 has a pair of arms N^3 N^4, through which the studs N^5 N^6 are fitted, and by means of nuts N^7 N^8 the position of the bearing N^2 may be secured in any degree necessary to give the sprocket-wheel chain mechanism the requisite tension on the sprocket-wheels.

Extending from the head B and integral with it is a hanger or bracket B^{18}, the lower end of which forms a bearing B^{19} for a cam-shaft Q, and which also has another bearing B^{20}, likewise integral with the head B. Mounted upon the shaft Q is a sprocket-wheel R, which is connected with another sprocket-wheel R′ and of similar dimensions, which is mounted on the shaft O, by means of the endless chain R^2, and through which rotary motion is communicated from the shaft O to the shaft Q and of the same ratio.

It can be seen that the shaft Q makes but one revolution for every two made by the crank-shaft M^2 and consequently every four strokes of the piston C. This being understood, the control of the movements of the valves by the cams will now be described. Secured to the shaft Q are the gas-valve-actuating cam Q′, the air-valve cam Q^2, and the exhaust-valve cam Q^3, by means of which the movements of the gas-valve G, the air-valve I^2, and the exhaust-valve L are controlled, respectively. The cams Q′ Q^2 are single-acting—that is, they have each but a single projection thereon—and thereby make their respective valves move up and down but once during each revolution of the shaft Q—that is, so as to admit gas and air into the mixing-chamber H and cylinder A with every alternate outward stroke of the piston C. The cam Q^3, however, is double-acting—that is, it has two projections Q^4 Q^5, which cause the exhaust-valve L to open with each return stroke of the piston C. The object of this arrangement of the exhaust-valve mechanism is to provide against non-compression of air and gas within the cylinder, as will be explained more fully hereinafter.

The shape of the cams is determined and arranged so as to produce the proper movements of the valves with the requisite accu-

racy and precision, as can be understood without further explanation.

Secured in a hole through the head B of the engine is an electrode or terminal S, provided with a thread S′ and nut S^2 and an insulating-bushing S^3, by means of which the electrode may be adjusted in its position within the cylinder, an electric conductor S^5 be connected therewith, and the electrode be insulated from the head B of the engine. Another electrode T is connected with the piston C by means of a tube T′, which is threaded therein at its outer end T^2, and its inner end T^3 being internally threaded, so as to receive the adjusting-screw T^4, to which the electrode T is secured by the screw T^5. The adjusting-screw T^4 is secured more effectively to the tube T′ by means of a check-nut T^6. The end T^7 makes contact with the electrode S with each return stroke of the piston C and of course breaks contact therewith at the beginning of each outward stroke of the piston, thereby producing an electric spark to ignite the gas mixture within the cylinder at the time and produce the explosion or expansive power which actuates the piston. The electrode T is in circuit through the screw T^4, tube T′, piston C, wall of the cylinder A, and a standard or support U and binding-post or terminal U′, to which the other wire or conductor U^2 is connected. The conductors U^2 and S^5 are in circuit with an electric generator and apparatus capable of producing an arc or spark whenever contact is broken between the electrodes S and T, and an electric circuit is established between them at the time.

U U^3 represent standards or supports which are securely attached to the cylinder A, and are also shaped and constructed so as to fit over the frame N′, upon which the whole mechanism is mounted and to which it is rigidly connected by means of the straps or caps U^4 U^5 and screws U^6 U^6 U^7 U^7, respectively.

The operation of the invention will now be described. The valves being all in the closed positions, as shown in Figs. 3 and 6, and the piston being at its extreme inward position, as indicated by the dotted line *g* in Fig. 3, and the electrodes S and T being in contact with each other, at the beginning of the outward stroke of the piston C the cam-shaft Q rotates, carrying the cams with it, which lift the gas-valve G and air-valve I^2, allowing the gas from the pipe F to flow into the air-chamber I^4 simultaneously with the requisite volume of air, which enters through the opening I^5, and both the gas and air being drawn into the mixing-chamber H and through the admission-port J into the cylinder. During this operation the gas and air become thoroughly commingled and in the proper proportions for the complete combustion following the explosion caused by their ignition by the electric spark at the beginning of the next outward stroke of the piston. The outward movement of the piston continues to suck into the cylinder the gas mixture to the end of its stroke, but in the meantime the cams have each performed their functions of actuating the gas and air valves, and the latter are closed down on their seats by their respective springs G′ B^7, so that no more gas or air will enter the cylinder until the second next outward stroke of the piston on account of the single-acting construction of the cams Q′ Q^2 and the fact that the cam-shaft Q rotates only half as fast as the crank-shaft M^2. The condition of the mechanism, therefore, at the end of the first outward stroke is that the maximum space between the piston C and the head B in the cylinder is filled with the mixture of gas and air drawn in, as already described, but still unexploded. The mixture of gas and air in the cylinder at this time is more or less completely effected and rarefied according to the respective quantities of air and gas admitted and the time of their cut off, and which is regulated by the shape of the cams Q′ Q^2 and their positions upon the shaft Q. By this arrangement the following condition can be attained, namely: The gas, by reason of its extreme buoyancy or specific lightness, will collect in the upper portion of the cylinder, while the air or partially-mixed air will take the lower portion in the cylinder on account of its greater specific gravity than that of the gas. The piston C now commences its return stroke, and at the same time the exhaust-valve L opens by the action of the cam Q^3 thereon and allows the piston C to return again without compression of the confined gas mixture in the cylinder, and if any of the mixture is forced out of the cylinder it is only that in the lower portion thereof, which is only air or that containing a low percentage of the gas. If the cut-off mechanism of the gas-valve and air-valve be properly constructed and adjusted, a partial vacuum or at least a degree of rarefaction of the gas mixture can be attained, so that little of the mixture will be expelled by the piston in its return stroke, and which end can be facilitated by the proper timing of the movements of the exhaust-valve L through its actuating-cam Q^3. The object sought for and attained by this arrangement of the parts is the non-compression of the gas mixture with its consequent heating effects upon the mechanism and the economical application of the gas and the prevention of the noise incidental to the exhaust of compression-engines.

When the piston C reaches the end of its first return stroke, the gas and air valves, as well as the exhaust-valve, are closed, the electrodes S and T are in contact, and the gas mixture is ready to be ignited when the electrodes break contact and produce a spark necessary for igniting the mixture. The gas being thus ignited immediately explodes, expanding with great force and propelling the piston forward again, and thus making its first live or working stroke in the cycle of its

movements. All the valves remain closed during this live outstroke of the piston to the end, after which the piston C makes its second return stroke, and at the same time the exhaust-valve L again opens and allows the products of combustion within the cylinder to escape through the exhaust-port K and the exhaust-pipe B^{13} into the atmosphere. At the end of this second return stroke the whole cycle of movements of the parts is again repeated as already described, and so on indefinitely during the working of the engine.

It will be observed that by means of the sprocket-wheel and chain mechanism by which the movements of the cam-shaft Q are controlled from the crank-shaft M^2 and the intermediate shaft O, with its means for adjustment of the tension of the chains connecting the two shafts together, a very simple, complete, and effective mechanism is provided for the operation of the valve devices.

The engine is shown as being mounted upon a part of a frame of a cycle for which it is especially applicable. The details and advantages of such an application can be more fully seen and understood by reference to another application for Letters Patent for an improvement in motocycles which I have made on December 7, 1895, Serial No. 571,338, and which is now pending before the Office.

My invention is also peculiarly well adapted for the use of hydrogen gas or hydrogen gas and electricity generated in a generator of these forces, and of which a description may be obtained by reference to another application for Letters Patent which I have made on December 7, 1895, Serial No. 571,336, for an improvement in systems of generating and using hydrogen gas and electricity, and which is now pending before the Office.

My invention is also well suited as a motor for all kinds of devices for propulsion of vehicles, cars, boats, launches, and other apparatus for transportation or the like. It is also applicable in stationary engines, where small or large power installations are needed, and gas or vapors of a combustible character can be used as the fuel or generator of the power in the form of expansion by combustion within a cylinder mechanism.

Any gas, vapor, or mixture of the same that can be used in other gas, gasolene, or petroleum motors or the like may be used in connection with this engine and as a fuel therefor.

This device has been referred to as a "non-compression" engine, but it can of course be understood and seen that by dispensing with one of the projections Q^4 Q^5 upon the cam Q^3, which actuates the exhaust-valve L, a single movement of the latter will be made during the working cycle of strokes of the piston C, the same as made by the gas and air valves, and consequently that a regular compression of the gas mixture could be obtained, the same as in any other four-cycle compression gas-engine.

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

The combination of a cylinder, a piston provided with an electrode connected therewith by means of an adjusting-screw and a tube having a threaded connection with the adjusting-screw, and a cylinder-head secured to the cylinder, and through which, an insulated electrode is fitted and with which, the piston-electrode is adapted to make and break contact, during its movements, substantially as specified.

Signed at Brooklyn, in the county of Kings and State of New York, this 5th day of December, A. D. 1895.

LUTHER H. WATTLES.

Witnesses:
G. W. IRWIN,
JAMES A. MCBAIN.