No. 631,003. Patented Aug. 15, 1899.

C. P. BLAKE.

GAS ENGINE.

(Application filed July 18, 1898.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

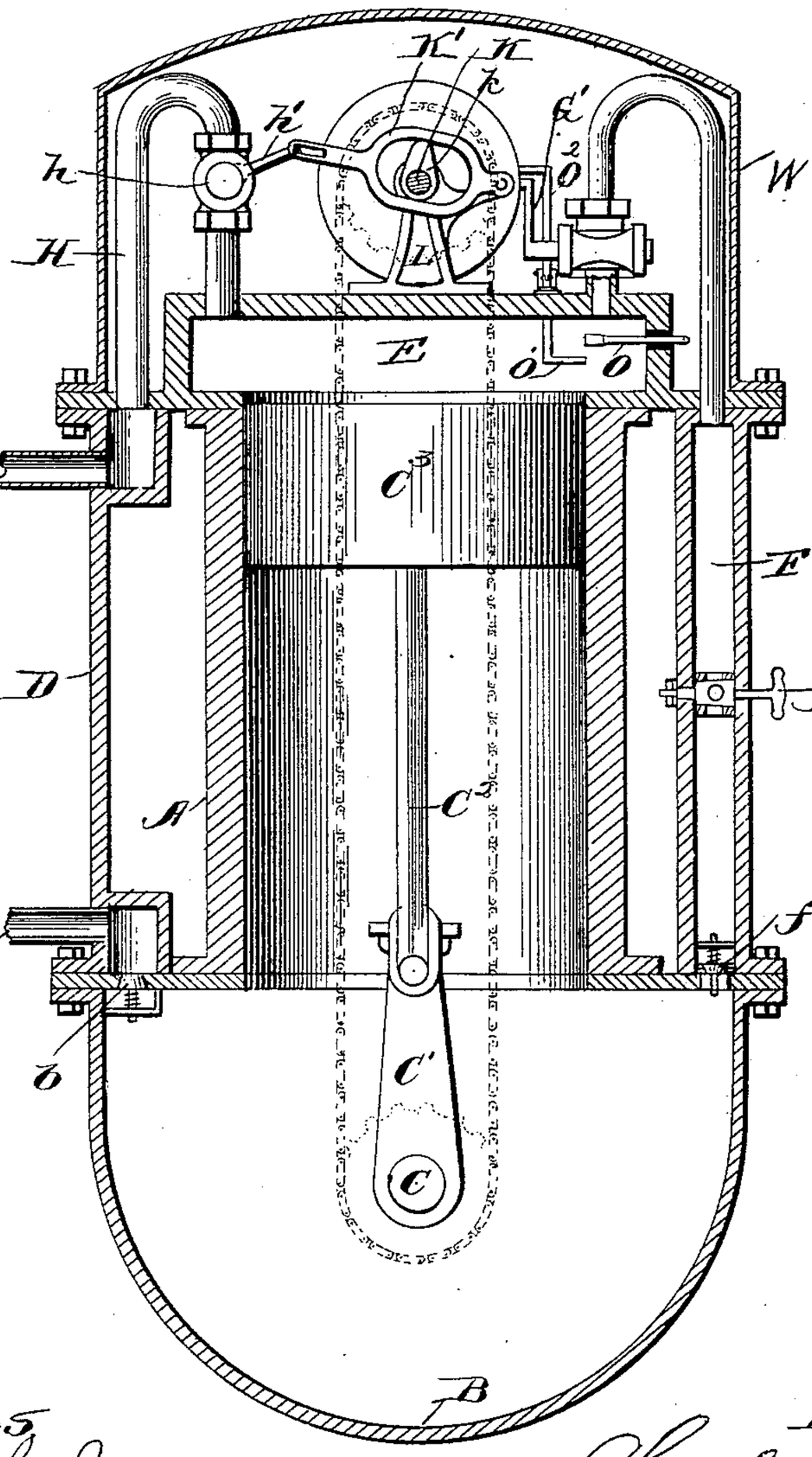

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Fig. 7.

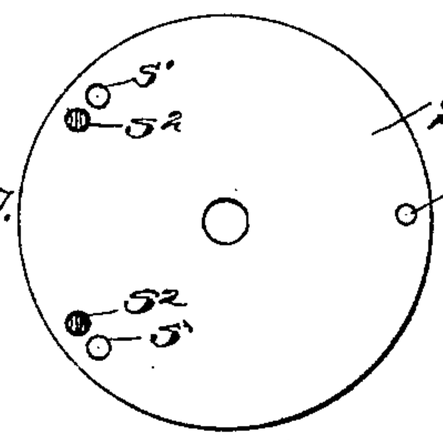


Fig. 8.

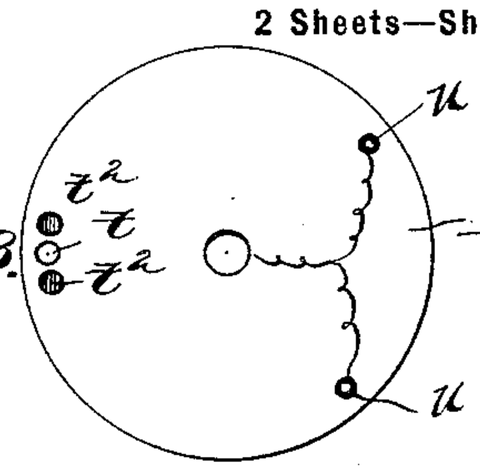


Fig. 9.

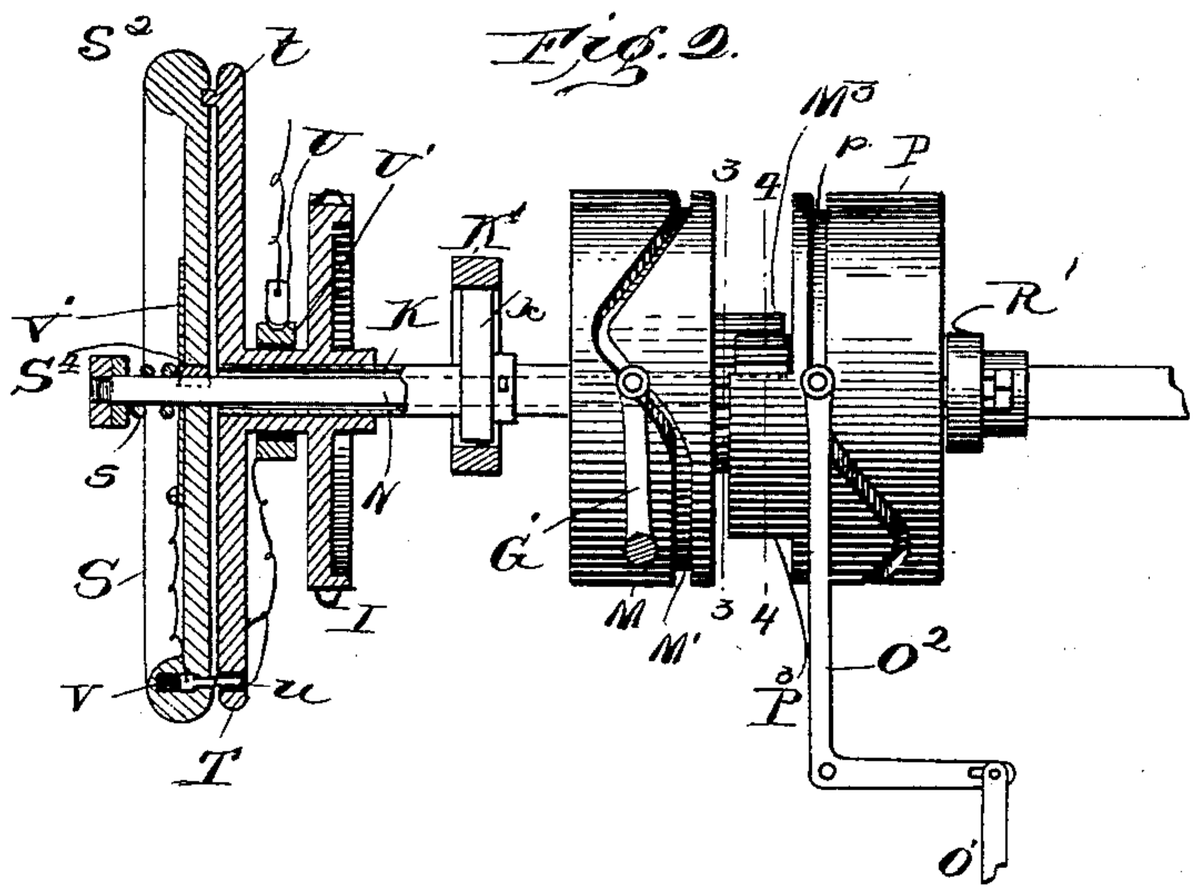


Fig. 3.

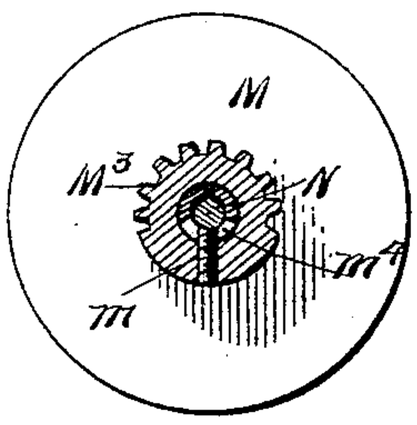


Fig. 4.

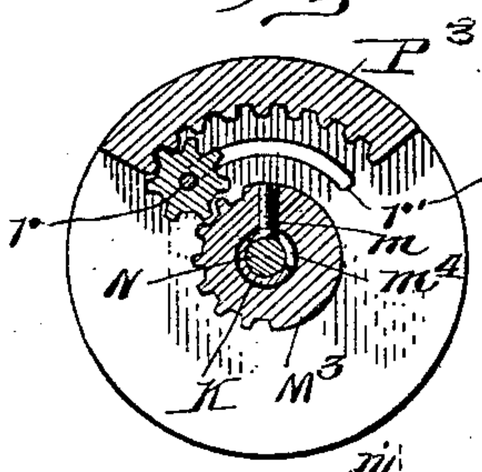
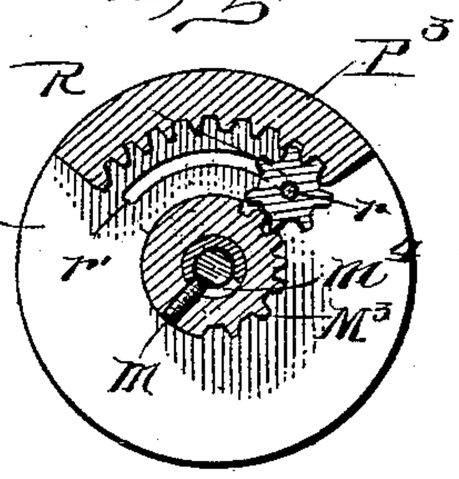


Fig. 5.



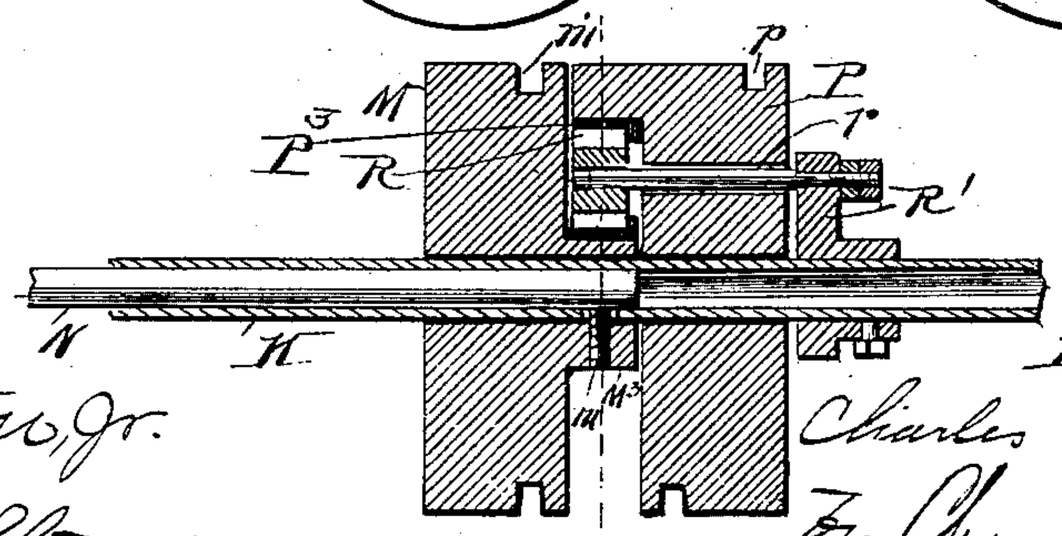


Fig. 6.

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UNITED STATES PATENT OFFICE.

CHARLES P. BLAKE, OF CHESTER, PENNSYLVANIA.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 631,003, dated August 15, 1899.

Application filed July 18, 1898. Serial No. 686,267. (No model.)

To all whom it may concern:

Be it known that I, CHARLES P. BLAKE, a citizen of the United States, residing at Chester, in the county of Delaware and State of Pennsylvania, have invented certain new and useful Improvements in Gas-Engines; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming a part of this specification, and to the letters of reference marked thereon.

This invention relates to improvements in engines, more particularly of the explosive type, designed for operation by the explosion of a gaseous mixture, although features of the invention are applicable to other types of engines, as will be at once appreciated by those skilled in the art.

The objects of the invention are to provide a simple and cheap structure which may be run by comparatively unskilled persons.

A further object of the invention is to provide a convenient and effective reversing mechanism which will enable the engine to be run in either direction at will and which will enable the reversing operation to be performed without bringing the engine to a standstill.

The invention consists in certain novel details of construction and combinations and arrangements of parts, all as will be now described, and pointed out particularly in the appended claims.

Referring to the accompanying drawings, Figure 1 is a vertical section taken through the cylinder of a gas-engine of the explosive type embodying my present invention. Fig. 2 is a detail elevation, partly in section, of the reversing-gear. Fig. 3 is a section on the line 3 3, Fig. 2. Figs. 4 and 5 are sections on the line 4 4, Fig. 2, showing the reversing-gear in opposite positions of adjustment or for running in opposite directions. Fig. 6 is a detail longitudinal section through the cams of the reversing-gear and the intermediate pinion. Figs. 7 and 8 are views of the adjacent faces of the locking and hand wheels for controlling the reversing-gear.

Like letters of reference in the several figures indicate the same parts.

Referring to Fig. 1, the letter A indicates the cylinder of the engine, which is preferably mounted on a base B, shown diagrammatically as a closed casing, and adapted to operate as a chamber for compressing the gas preliminarily to its introduction into the cylinder above the piston, for which purpose the lower end of the cylinder is open to the casing.

C indicates the crank-shaft; C′, the crank; C^2, the connecting-rod, and C^3 the piston working in the cylinder A.

The cylinder A is preferably surrounded by a water-jacket D, as is usual in this class of engines. Above the cylinder I preferably arrange an explosion-chamber E, with a suitable duct or conduit F leading from the casing B into the explosion-chamber E, the passage of gas through said duct or conduit being controlled, preferably, first, by a check-valve *f;* secondly, by a hand-valve *f′*, and, thirdly, by a valve G, which is adapted to be operated in the running of the engine to admit the gas at the proper moment into the explosion-chamber E and upper portion of the cylinder, such admission usually taking place as the piston is nearing the upper portion of its stroke and the communication being cut off just as the piston reaches the upper extreme of its movement. For admitting gas to the casing B an entrance-pipe B′ is provided, having a check-valve *b* for preventing the return of the gas and securing its compression and passage into the conduit F and explosion-chamber E when the piston C^3 descends. The exhaust from above the piston takes place through an exhaust-pipe H, having a suitable exhaust-valve *h* therein, adapted to be controlled from the crank-shaft in the manner to be now described.

The crank-shaft is provided with a gear-wheel or sprocket-wheel, as preferred, which is in mesh with a corresponding wheel I on a valve-shaft K, so that said valve-shaft K will rotate in unison with the crank-shaft, or where the explosion is adapted to take place once in every two revolutions of the crank-shaft the gearing will be such that the valve-shaft will rotate once in every two revolutions, as is well understood in this art.

On the valve-shaft K is a cam or eccentric *k*, which coöperates with a valve-operating lever K′, preferably pivoted to one of the bearings L, in which the valve-shaft is journaled, and at its free end engaging with the arm *h′*

of the valve *h*, the arrangement being such that the exhaust-valve *h* is opened as the piston approaches the lower extreme of its movement and remains open until the piston has moved upwardly on its upward stroke a corresponding distance. Thus the exhaust-valve is opened uniformly regardless of the particular direction in which the engine is run. The admission-valve G for admitting gas under pressure to the explosion-chamber E is controlled by a cam M, journaled loosely on the valve-shaft K, but connected rigidly, preferably by a set-screw *m*, with a central controlling-shaft passing longitudinally through the valve-shaft and lettered N in the accompanying drawings. The screw *m* passes through a slot m^4 in the shaft K. The cam M is preferably provided with a cam-groove M′, in which a crank end G′ of the valve-stem is adapted to work, and the shape of the cam-groove is such as to move the valve so as to open and close the same as the piston approaches the upward extreme of its movement, the final closing taking place preferably just as the piston reaches such extreme, and obviously the admission must take place at a different instant with respect to the position of the crank-shaft, depending upon which direction the shaft is rotating, and I have in the present instance provided a mechanism which will without stopping the engine permit this cam to be shifted so as to secure the desired object, and at the same time said mechanism will correspondingly shift the igniting mechanism, so as to insure the ignition of the explosive charge when the piston has commenced its downward movement. The shifting of these two mechanisms is accomplished simultaneously and without stopping the engine, as before stated, and consequently it is obvious that by simply changing the moment when the gas is admitted to the explosion-chamber and the moment when the ignition of the charge takes place with relation to the movement of the crank-shaft the engine may be reversed at will. In other words, assuming that the engine is running in one direction, if it be desired to reverse it is only necessary that the valve and igniting mechanism be so manipulated that a charge will be ignited as the piston approaches the uppermost limit of its movement, so as to drive the piston reversely or check its upward movement and cause it to move downwardly in the reverse direction.

The igniter in the present instance is illustrated as an electric sparking device having contact O, fixed in the wall of the explosion-chamber, but insulated therefrom, and contact O′, movably mounted in the wall of the explosion-chamber, is adapted to be operated by a lever O^2, coöperating with a cam or eccentric P, which is also loosely journaled on the valve-shaft K in proximity to the cam or eccentric M. A cam-groove *p* in the cam P is formed to move the lever O^2 in such manner as to bring the contacts together and separate the same to cause the spark, and, as before explained, this operation takes place immediately after the admission-valve has been closed. The cam P, as shown, is provided with an internally-toothed sector P^3, and the cam M is provided with a toothed sector M^3, and connecting or meshing with both of these sectors is an intermediate idler-pinion R, carried by an arm or projection R′ on the valve-shaft, and a shaft *r*, extending from said arm through a segmental slot *r′* in the cam P. With such an arrangement, now, assuming that the engine is rotating in one direction, the operative portion of the cam M will lead the operative portion of the cam P a distance which will insure the closing of the admission-valve and the initiation of the downward movement of the piston before the spark is formed to ignite the explosive charge, and if it is desired to reverse the controlling-shaft N is retarded in its movement, the result being that the arm R′, rotating with the valve-shaft, will continue to move, and the pinion meshing with the sectors on the cams P and M will give the cam P a forward movement with relation to the cam M a distance which may be limited by suitable stops, as by the shaft *r* striking the end of the segmental slot and corresponding to the desired lead for the operative portion of the cam M, and in this new position of adjustment the spark or ignition of the charge will take place when the crank-shaft and piston are approaching the upward extremes of their movements instead of when they are receding therefrom, and at most the engine can make but a single ineffective stroke in the direction in which it was formerly running.

As a convenient means for manipulating the controlling-shaft I provide a hand-wheel S on its outer end, which is capable of being moved longitudinally thereon, but is connected by a key S^4 or otherwise to rotate in unison therewith. This hand-wheel is adapted to coöperate with a locking wheel or disk T, mounted rigidly on the end of the valve-shaft K, and is held in contact therewith by a spring *s*, which spring is, however, of such strength that it may be readily compressed when the engineer grasps the hand-wheel and draws it outwardly and away from the locking-disk. The adjacent faces of the hand-wheel and locking-disk are provided with stop pins or projections *t* and *s′*, two projections *s′* being shown, between which the projection *t* plays, and the amount of play between these projections corresponds to the relative movements of the cams necessary in reversing the engine, and in order to lock the cams in their positions of adjustment recesses t^2 and s^2 are provided, into which the corresponding projections *t* and *s′* will fit when the hand-wheel and locking-disk are in their proper relative adjustments for running the engine in either direction. With such an arrangement, now, it is obvious that the hand-wheel may be grasped and the motion of the

shaft N retarded, and the momentum of the engine, if it be running, will effect the reversing or adjustment of the cams to insure a running in the reverse direction, and if the engine be stationary the hand-wheel itself may be drawn out and turned to secure the desired adjustment.

In order to guard against any possibility of a spark being made or an ignition of the charge taking place except when the parts are in such proper relative positions that the piston will be forced downwardly and the crank-shaft turned in the direction desired, or, in other words, to prevent any possibility of an ignition of the charge when the piston and crank-shaft are on the dead-center, the circuit which is completed by the contacts O O′ also passes through the hand-wheel and locking-disk and is broken at this latter point at all times, except when the two parts are locked in their proper positions and the cams have been moved completely over into their proper positions of adjustment. As a convenient means for accomplishing this end the circuit from the battery leads in through a brush U and an insulated commutator-ring U′, and from thence the circuit is led by a wire to a contact-pin *u* in the locking-disk T. A corresponding or preferably spring-pressed contact-pin V is mounted in the hand-wheel S and connected with a plate V′ at the center of the said hand-wheel and in position to insure electrical contact with the shaft or frame of the machine either through the shaft itself or through the spring *s*. From the frame of the machine the circuit passes to the contact O′, and from the contact O′ to the insulated contact O, and thence back to the battery or sparking coil. Two pins *n* are preferably provided in electrical connection with each other, as shown in Fig. 8, one for contacting with the pin V when the hand-wheel and locking-disk are in one position of adjustment and the other for contacting with said pin when said parts are in the other position of adjustment. This arrangement insures a breaking of the circuit whenever the hand-wheel is drawn outwardly, and the circuit cannot be completed until the projections *s′* and *t* again seat in their recesses, and hence during the time that the cams are being adjusted no explosion can by any possibility take place.

In the preferred construction the entire valve mechanism, together with the reversing gear, with the exception of the hand-wheel and parts immediately adjacent thereto, are inclosed by a casing or housing W, which may be attached to the cylinder-casing in any well-known manner or, as shown, by bolts, and, if desired, water may be circulated through this casing to keep the parts cool and in operative condition.

While I have described herein specifically cams or eccentrics of specific construction, it is obvious that other forms of cams might be employed and other forms of valves operated thereby, and it is also obvious that while a sparking or electrical igniter is illustrated as operated by one of the cams any other well-known form of igniter may be operated thereby without departing from the spirit of my invention.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent of the United States of America, is—

1. In a gas-engine, the combination with the cylinder, piston, crank-shaft driven thereby and valve-shaft driven by the crank-shaft, of igniter and admission-valve controlling cams loosely mounted on the valve-shaft, gear-segments on said cams, an idler connecting said gear-segments carried by the valve-shaft and means for moving said cams independently of the valve-shaft; substantially as described.

2. In a gas-engine, the combination with the cylinder, piston, crank-shaft and valve-shaft, of the independent admission and igniter cams loosely mounted on said valve-shaft, a gearing interposed between said cams for causing their simultaneous movement in opposite directions, a controlling mechanism for adjusting said cams with relation to each other and a lock for locking said controlling mechanism and valve-shaft for simultaneous rotation; substantially as described.

3. In a gas-engine, the combination with the cylinder, piston, crank-shaft and valve-shaft driven by the crank-shaft, of the independent valve and igniter cams loosely mounted on said shaft, gear-sectors carried by said cams and an intermediate idler connecting said sectors carried by the valve-shaft, with means for retarding the valve-cam to reverse the lead of the same; substantially as described.

4. In a gas-engine, the combination with the cylinder, piston, crank-shaft and valve-shaft driven by the crank-shaft, of the independent valve and igniter cams mounted loosely on the valve-shaft, gear-sectors carried by said valve and igniter cams, an arm carried by the valve-shaft, an idler-pinion arranged intermediate said gear-sectors and mounted on said arm and a lock for holding the cams in their relative positions of adjustment; substantially as described.

5. In a gas-engine, the combination with the cylinder, piston, crank-shaft and valve-shaft driven by the crank-shaft, of valve and igniter cams loosely mounted on the valve-shaft, an idler arranged intermediate said valve and igniter cams and carried by the valve-shaft, means for rotating one of said cams independently of the valve-shaft and a lock for locking said cam in its adjusted position with relation to the valve-shaft; substantially as described.

6. In a gas-engine, the combination with the cylinder, piston, crank-shaft and valve-shaft driven by the crank-shaft, of the valve and igniter cams, a reversing-gear interposed between said valve and igniter cams for caus-

ing their simultaneous movement in opposite relative directions, a controlling-shaft connected with one of said cams, a hand-wheel carried by said controller-shaft and movable longitudinally thereon, a locking-disk carried by the valve-shaft and coöperating projections on the locking-disk and hand-wheel for holding the controlling-shaft and valve-shaft in their proper relative positions of adjustment; substantially as described.

7. In a gas-engine, the combination with the cylinder, piston, crank-shaft and sparking-electrodes, of an igniter-cam for controlling the creation of a spark, a valve-cam controlling the admission of gas to the cylinder, a reversing-gear controlling the relative positions of said cams and movable contacts interposed in said reversing-gear and included in the circuit with the electrodes whereby when the reversing-gear is being operated said circuit will be broken to prevent the creation of a spark; substantially as described.

8. In a gas-engine, the combination with the cylinder, piston, crank-shaft and valve-shaft driven by the crank-shaft, of the valve and igniter cams mounted loosely on said valve-shaft, a reversing-gear interposed between said cams for reversing their relative positions, a hand-wheel controlling the valve-cam, a contact moved by said hand-wheel and through which the circuit for the igniter is completed and a lock for holding said hand-wheel and valve-shaft in their relative positions of adjustment; substantially as described.

9. In a gas-engine, the combination with the cylinder, piston, crank-shaft, valve-shaft driven by the crank-shaft, and electrodes between which the igniting-spark is formed, of the valve and igniter cams loosely mounted on the valve-shaft, gear-sectors carried by said cams, an intermediate idler carried by the valve-shaft, controlling-shaft connected with the valve-cam, a hand-wheel mounted to rotate in unison with but longitudinally movable on said controller-shaft, the locking-disk on the valve-shaft, the locking projections on the adjacent faces of said hand-wheel and locking-disk, the spring for holding said hand-wheel in engagement with the locking-disk and the contacts in said hand-wheel and locking-disk respectively, included in the circuit with said electrodes, whereby when the hand-wheel and locking-disks are separated for the readjustment of the cams, the circuit will be broken and no spark can be formed; substantially as described.

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