No. 621,525. Patented Mar. 21, 1899.

J. H. HAMILTON.

GAS VAPOR MOTOR ENGINE.

(Application filed Dec. 28, 1897.)

(No Model.) 2 Sheets—Sheet 1.

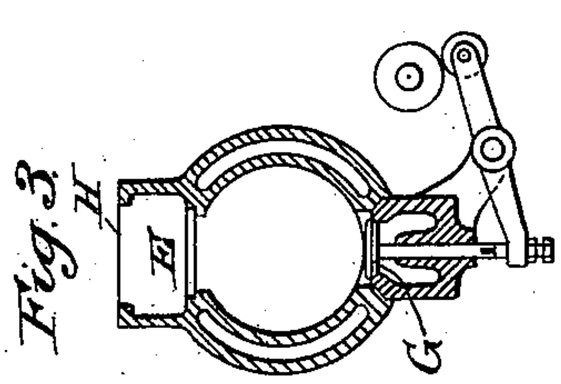

Fig. 3.

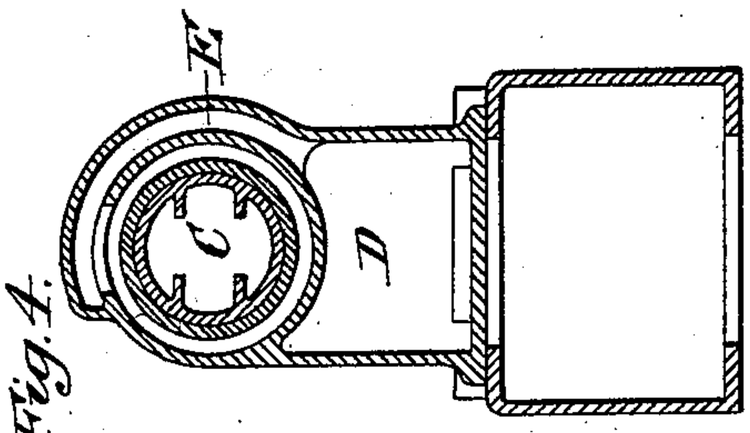

Fig. 4.

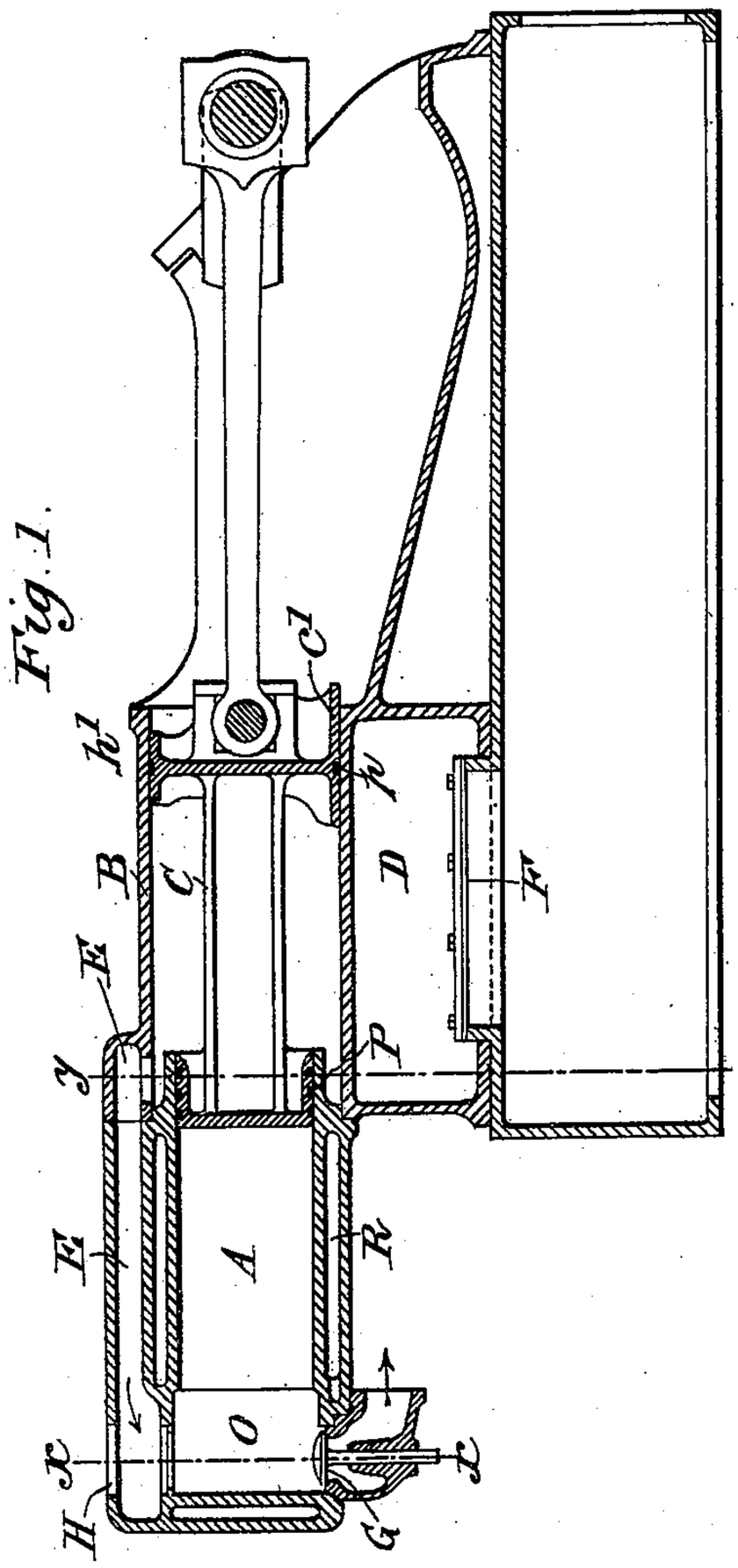

Fig. 1.

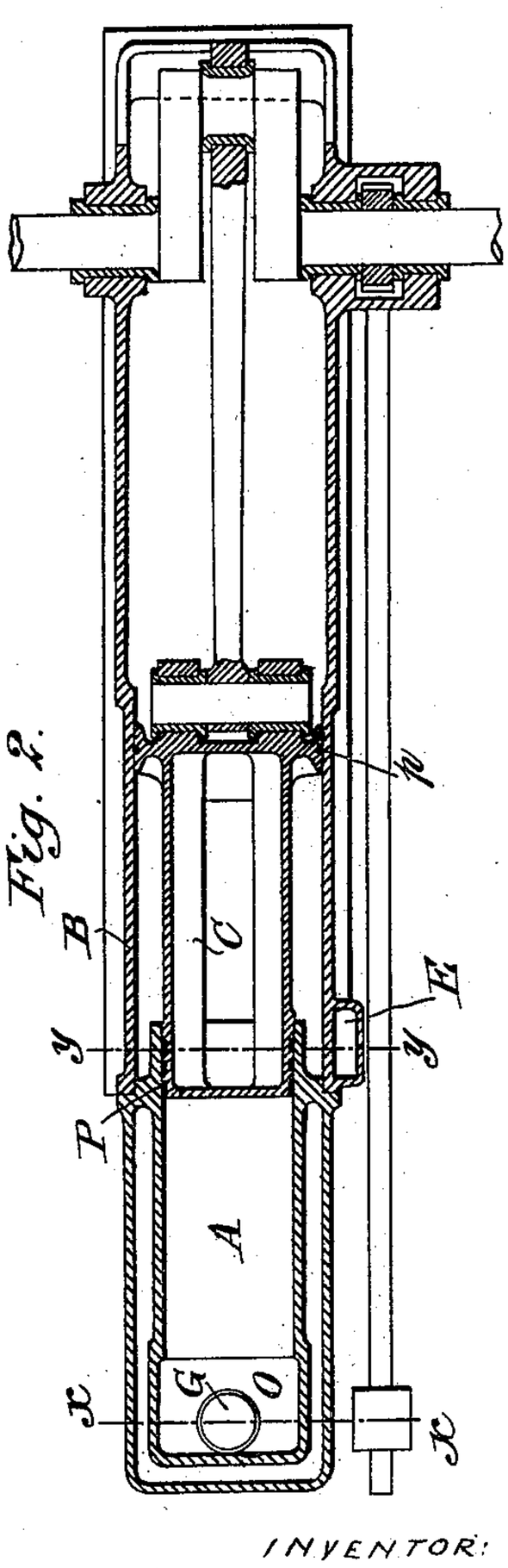

Fig. 2.

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Fig. 9.

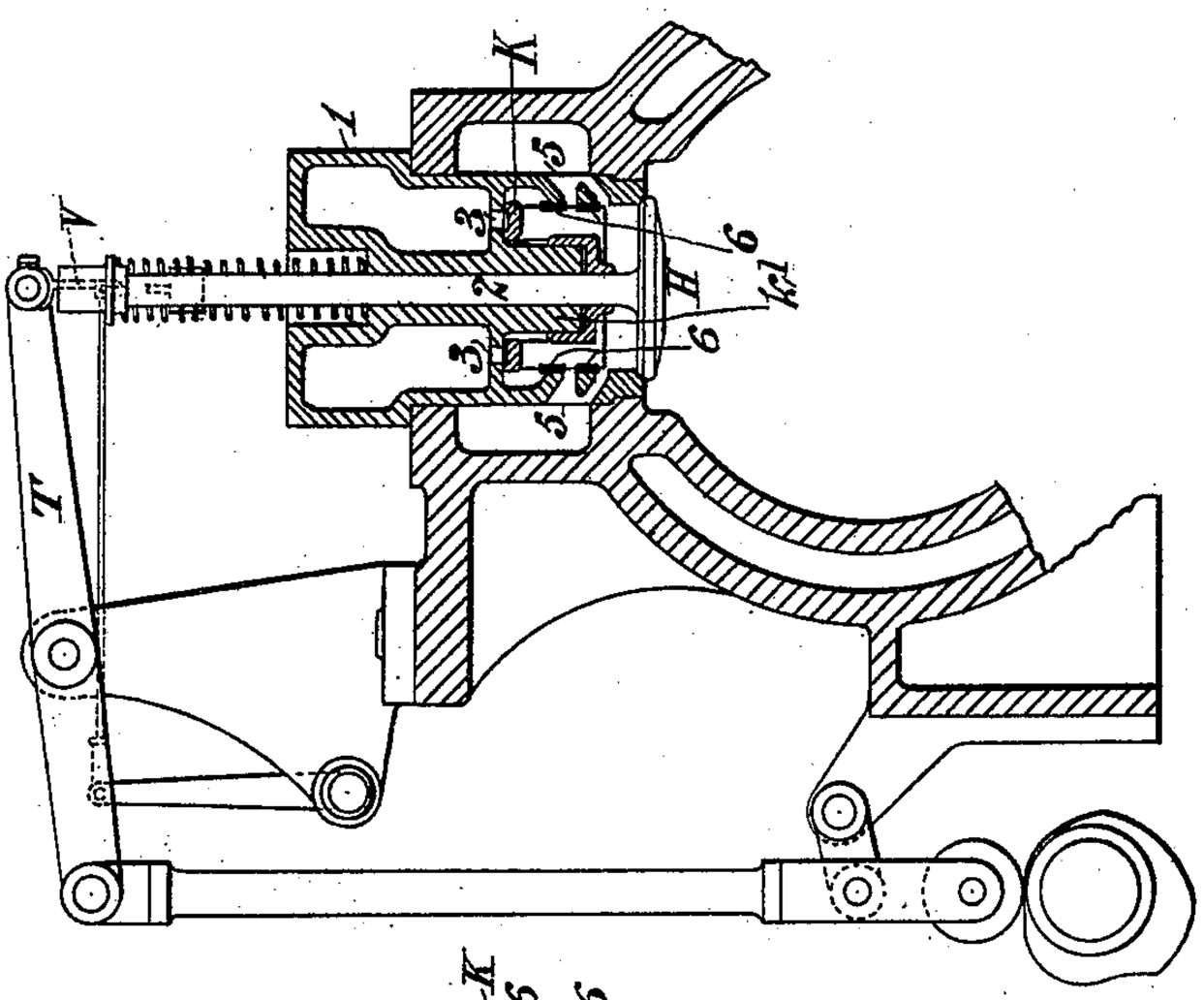


Fig. 8.

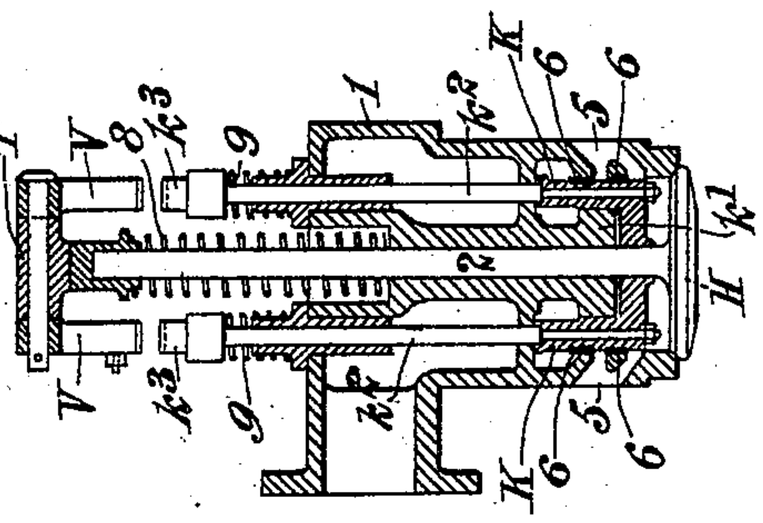


Fig. 7.

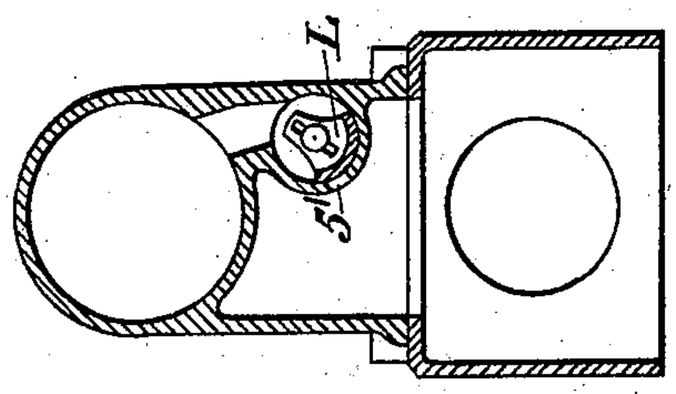


Fig. 6.

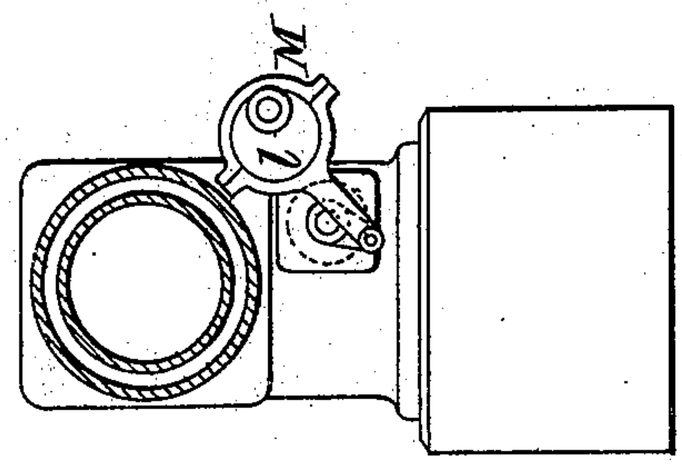
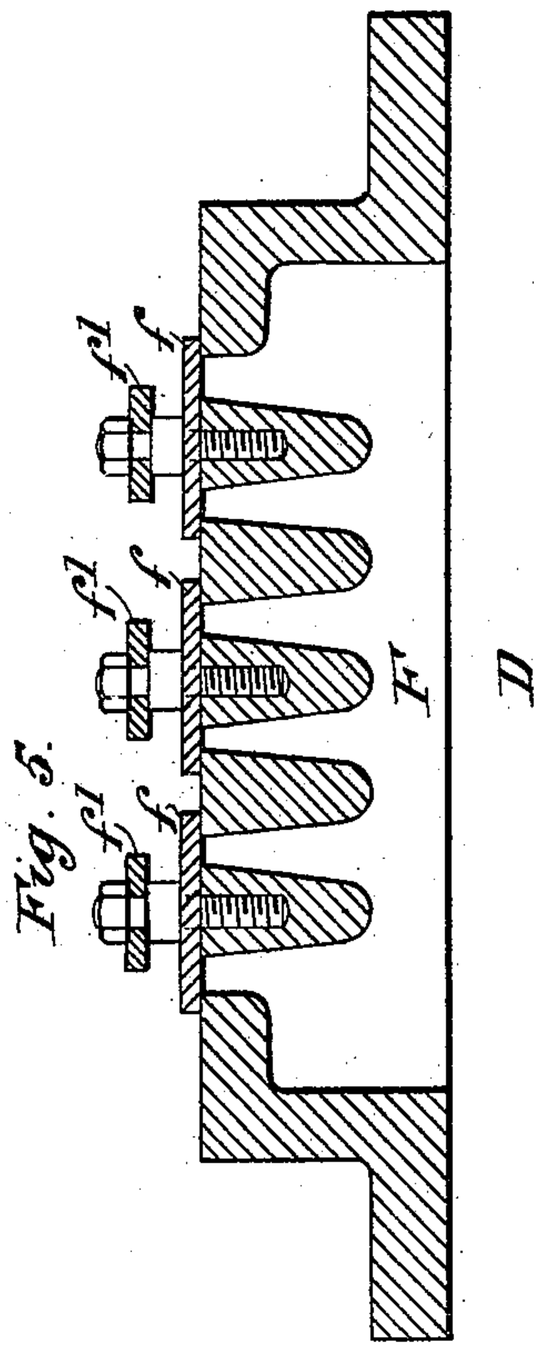


Fig. 5.



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UNITED STATES PATENT OFFICE.

JOHN HENRY HAMILTON, OF SANDIACRE, ENGLAND.

GAS-VAPOR MOTOR-ENGINE.

SPECIFICATION forming part of Letters Patent No. 621,525, dated March 21, 1899.

Application filed December 28, 1897. Serial No. 663,841. (No model.)

To all whom it may concern:

Be it known that I, JOHN HENRY HAMILTON, a subject of the Queen of Great Britain and Ireland, and a resident of Sandiacre, in the county of Derby, England, have invented certain new and useful Improvements in Gas or Combustible Vapor Motor-Engines, (for which I have obtained patents in Great Britain, No. 6,015, dated April 21, 1890, and No. 4,189, dated March 3, 1892,) of which the following is a specification.

In the ordinary type of gas or vapor engines in which the motor-piston makes one effective stroke in two revolutions when working at full power it is usual to allow some of the products of combustion to remain in the cylinder and mix with the incoming charge.

The object of this invention is the construction of an engine in which these products of combustion shall be replaced by air, and I now proceed to describe, with the aid of the accompanying drawings, how I effect this object.

In the drawings, Figure 1 is a sectional elevation, and Fig. 2 a sectional plan, of my improved engine. Fig. 3 is a transverse section on the center line *x x*, Figs. 1 and 2, of the admission and exhaust valves; and Fig. 4, a transverse section on line *y y*, Figs. 1 and 2. Fig. 5 is a section of the air-inlet valve F, Fig. 1. Figs. 6 and 7 are transverse sections showing an alternative form of inlet-valve, and Figs. 8 and 9 represent enlarged sections of my improved arrangement of admission and gas valves.

In the figures, A is the motor-cylinder, having a combustion-chamber O, as usual, and provided with an admission-valve at H and an exhaust-valve G. It is surrounded by a water-jacket R and provided with any suitable ignition apparatus, which is not shown; but it may consist of any of the usual types, such as a hot tube, sparking points, or the like. The cylinder A is secured to another larger one B, which need not have a water-jacket and which is concentric with A.

A differential piston C reciprocates in the cylinders A and B, being connected to the crank by a connecting-rod in the usual manner. The large end of this piston is preferably provided with a shoe *c'* for increasing the bearing-surface which takes the lateral thrust of the connecting-rod. The small end of the piston is provided with rings P in the usual manner and the large end may have a light ring *p* to prevent the escape of low-pressure air in the cylinder B.

The cylinder B communicates on the one hand with a large clearance-space or chamber D, as shown in Fig. 4, by a large permanently-open passage E, and on the other hand with the back of the admission-valve H of the motor-cylinder by means of an extension of the same passage E. An air-inlet valve F with a large area of opening allows a free passage of atmospheric air to the space D, thence to cylinders B and A by the passages E, mentioned above. A gas-valve K admits gas behind the admission-valve H. This valve is shown enlarged in Figs. 8 and 9 and consists of an annular valve K, with a central guide *k'* and operated by two spindles k^2, provided with blades k^3, which engage with other blades V V, pivoted to the lever T, Fig. 9, when a charge of gas is to be taken into the motor-cylinder A. The valve K is further provided with rings 6, which partially block the air-passages 5 when the gas-valve opens, but leave these passages free when the gas-valve is closed.

I shall now describe the action of the engine and shall suppose the piston to be commencing the suction or charging stroke. At the commencement of this stroke the air which has been compressed in cylinder B and clearance-spaces, as described below, is still flowing through the combustion-chamber O of the motor-cylinder; but at an early point of this stroke the exhaust-valve G is closed, and the gas-valve K is opened, and during the remainder of the stroke air is drawn through the valve F and passes thence to the cylinders B and A by the passages E, described above. Gas also passes to the cylinder A, the rings 6 on the gas-valve K partially blocking the air-passages 5 in the valve-casing 1 and thus preventing too free an access of air. On the next return stroke the explosive mixture is compressed in the space O, and the air in the cylinder B and clearance-spaces in free connection therewith are compressed also, but to a much smaller ex-

tent, the clearance-spaces being of large capacity. At the beginning of the next forward stroke the charge in chamber O is ignited and expands, and the air in the larger cylinder B and clearance-spaces reëxpands, giving back the work expended in compressing it. Toward the end of this stroke the exhaust-valve G is opened and remains open during the whole of the following return stroke. During the first portion of this stroke the air in cylinder B and clearance-spaces is recompressed, and when the pressure therein has risen to about two pounds per square inch above atmospheric pressure the valve H is opened and air flows through it and through the combustion-chamber D, clearing out the products of combustion therefrom, which pass out by the exhaust-valve G, mixed with and followed by a portion of the air, which enters by the valve at H. The exhaust-valve G is kept open till after the crank has passed the dead-center to allow time for all the air to be discharged and for the pressure to fall to atmospheric pressure. The exhaust-valve G is then closed and the gas-valve K opened by a further movement of the lever T, which operates it and the valve H, and the cycle begins again.

The volume of air which passes into the space D may be three or four times (or even more) the capacity of this space, so that when the gas-valve opens this space is practically filled with pure and comparatively cool air instead of products of combustion.

When the engine is working below full load, gas charges are omitted by the governor moving the blades V aside and so preventing the gas-valve being opened. In this case the air-passages 5 are left free and there is no undue resistance.

For the purpose of reducing the resistance to the entrance of air at the valve F, I make the latter of large area, and as the maximum pressure in the chamber D is low (generally not exceeding five pounds per square inch atmospheric pressure) the valves *f f f* may be made of leather or similar material. A suitable valve for this purpose is shown at Fig. 5, which represents a cross-section. This valve consists of a casting with slits, which are covered by leather strips *f*, prevented from lifting too high by metal bars *f'*.

In some cases it may not be convenient to have clearance-spaces of sufficient capacity to keep the air-pressure in the cylinder B and chamber D low enough, and in such case I may use a mechanically-operated valve to take the place of the valve F and operated so as to allow the air drawn into the cylinder B on the motor-piston suction-stroke to be expelled on the compression-stroke. A convenient form of valve for this purpose is shown in Figs. 6 and 7, which represent at L a Corliss valve operated by an eccentric *l* from the side shaft of the engine, which runs at half the speed of the crank-shaft, as is usual in four-stroke engines. This valve L is opened on the suction-stroke and remains open during the two following strokes—that is, the compression and explosion strokes—and may be closed early on the exhaust-stroke. The air-ports 5', leading to this valve, are made of large area, so that the air-resistance shall be minimized. The action of the engine when working with this valve is as follows: On the motor-piston suction-stroke the whole of the air enters through the ports 5' and the Corliss valve L, part going on to the cylinder A by passage E and the valve at H, Fig. 1, and part to the cylinder B. On the next stroke the charge is compressed in the cylinder A, and the air drawn into the cylinder B is expelled again into the atmosphere through the valve L. On the next stroke the charge is ignited in the cylinder A and air drawn again into the cylinder B through the valve L, which is still open. On the next stroke the exhaust-gases are expelled from the cylinder A and the valve L is closed, and air is first compressed in the cylinder B and then discharged through the valve H into the combustion-chamber O, sweeping out and replacing the products of combustion.

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

1. In a four-stroke or combustible-vapor engine, the combination with a working or motor cylinder having in front thereof an enlarged concentric cylinder, and a differential piston arranged to work in both cylinders, and admission and exhaust valves and means for operating same, of a large clearance-space, as above described, in free and permanent communication with the larger cylinder and with the back of the admission-valve to the motor-cylinder by the passage specified, and a non-return air-inlet valve opening into said large clearance-space for admitting air thereto, substantially as and for the purposes above described.

2. In a four-stroke-cycle gas or combustible vapor engine, a working cylinder having admission and exhaust valves and means for operating same, in combination with a larger cylinder, in line and concentric with said working cylinder at the front end thereof, a differential piston working in both cylinders, and means for reciprocating said piston, a valve and means for operating the latter to permit free access of air to or from the large cylinder and clearance-spaces during the suction compression and explosion strokes of the engine, but remaining closed during a part of the exhaust-stroke, and a passage leading from said large cylinder to back of said admission-valve, substantially as and for the purposes described.

3. In a four-stroke or combustible-vapor engine, the combination with a working cylinder, an enlarged concentric cylinder, and a differential piston arranged to work in both cylinders, an exhaust-valve, means for operating the latter, and a large clearance-space

communicating between said cylinders, of a gas and air admission valve controlling communication between said space and said working cylinder, and consisting of a casing 1, a gas and air inlet valve H, air-ports 5 in said casing 1 leading to back of said valve H, an annular gas-valve K, a ring 6 fitted to said valve K and adapted to partially close said air-ports, rods k^2 for operating said valve K, springs 8 and 9 adapted to normally keep said valves H and K to their seats, and said ring 6 clear of said ports 5, and means for operating said admission-valve, all substantially as and for the purposes described.

4. In a four-stroke-cycle gas or combustible vapor engine a working cylinder A, exhaust-valve G and means for operating same in combination with a large cylinder B, differential piston C and means for reciprocating it, clearance-space D, valve F and passage E, an admission-valve comprising a casing 1, gas and air valve H, spindle 2 air-ports 5, gas-valve K covering gas-ports 3, rings 6, rods k^2, springs 8 and 9, and means for operating said valves and rings substantially as and for the purposes described.

5. In a four-stroke-cycle gas or combustible vapor engine, a working cylinder A, exhaust-valve G and means for operating it, in combination with a large cylinder B, differential piston C and means for reciprocating same, an air-valve L for operating same opening to admit air to or from cylinder B during the suction, compression and explosion strokes, but closed during exhaust-stroke or a part thereof, and passage E, an admission-valve comprising a casing 1, gas and air valve H, spindle 2, air-ports 5, gas-valve K covering gas-ports 3, rings 6, rods k^2 springs 8 and 9 and means for operating said valves and rings all substantially as and for the purposes described.

In witness whereof I have hereunto set my hand in presence of two witnesses.

JOHN HENRY HAMILTON.

Witnesses:

HAROLD G. NIGHTINGALE,

THOS. HEATH.