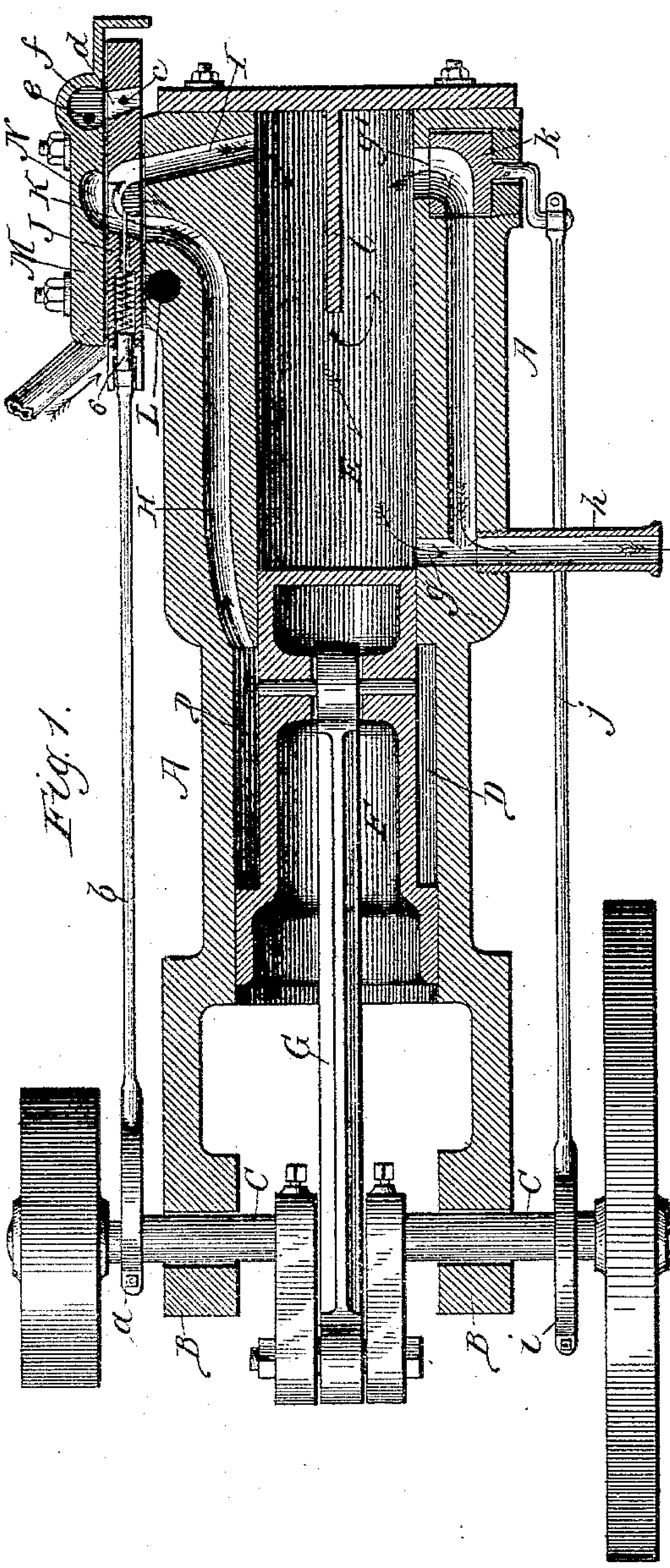
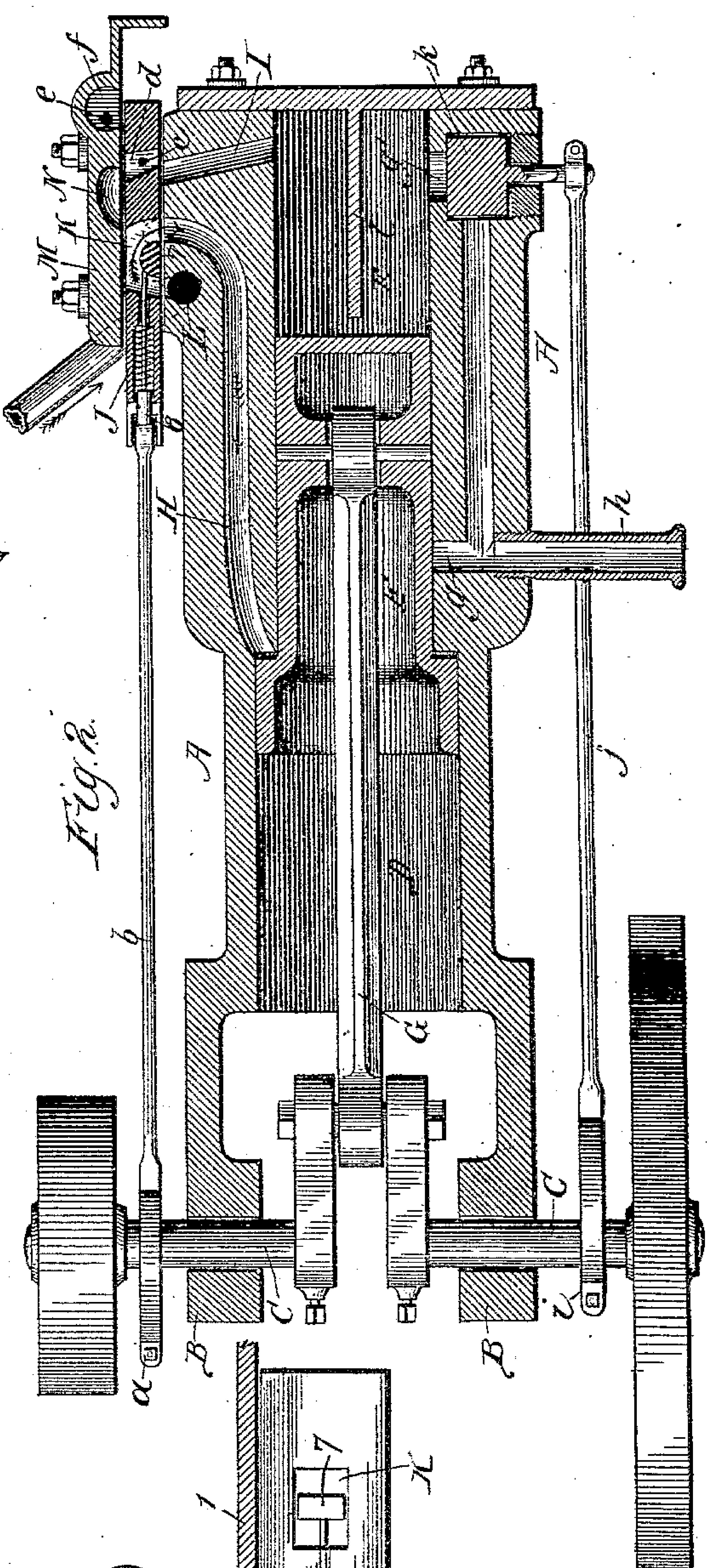
(No Model.)

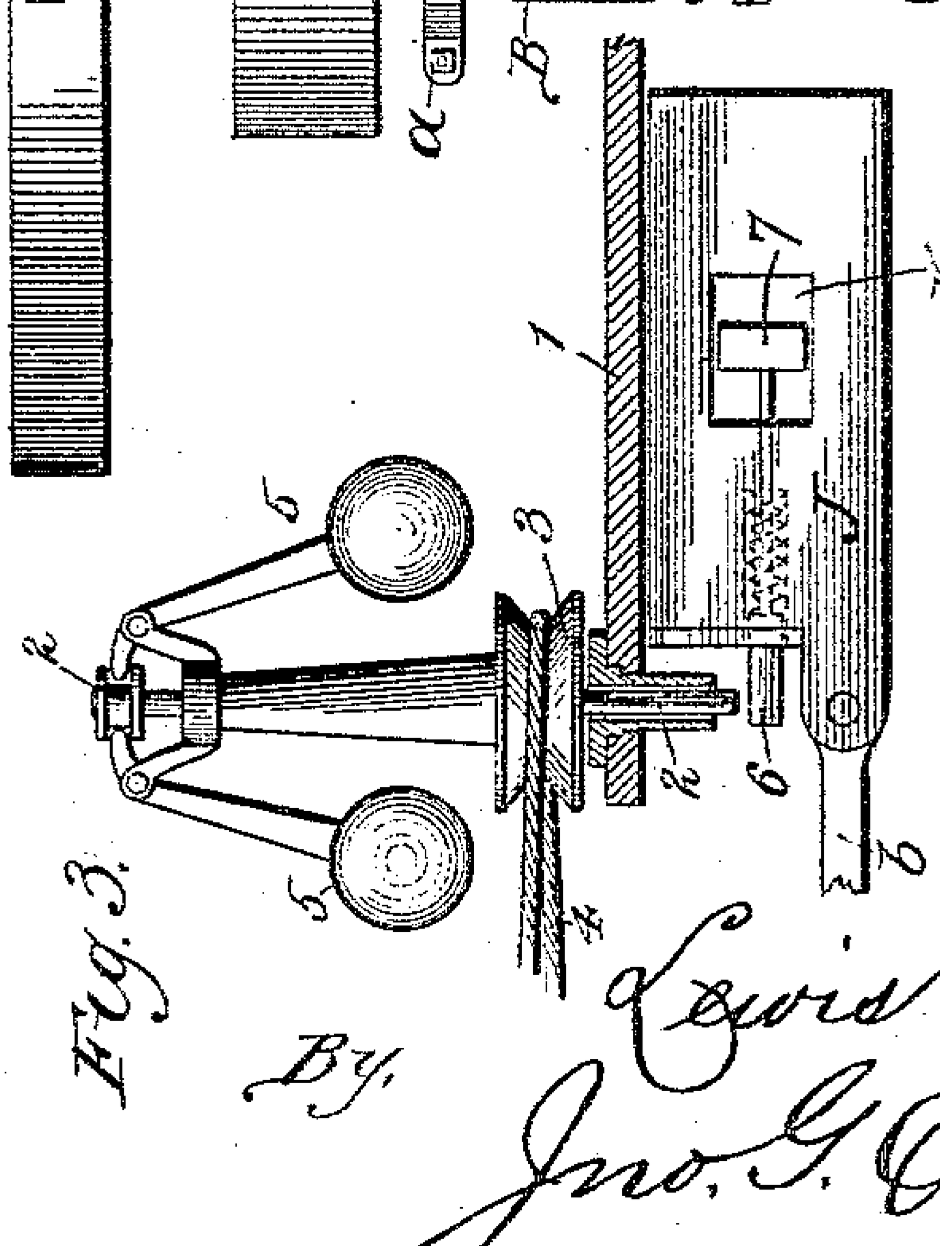
L. T. CORNELL.

GAS ENGINE.

No. 359,920. Patented Mar. 22, 1887.







Witnesses.
Will R. Omohundro
W. W. Elliott

Inventor.
Lewis T. Cornell
By Jno. G. Elliott. Atty.

UNITED STATES PATENT OFFICE.

LEWIS T. CORNELL, OF CHICAGO, ILLINOIS.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 359,920, dated March 22, 1887.

Application filed January 5, 1886. Serial No. 187,659. (No model.)

To all whom it may concern:

Be it known that I, LEWIS T. CORNELL, a citizen of the United States, residing in Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification.

This invention relates to improvements in gas-engines in which an explosive mixture of illuminating-gas and atmospheric air is confined within a chamber and exploded under compression in order to utilize to the fullest extent the explosive power of such a mixture against a piston-head.

The prime object of this invention is to combine with the exploding-chamber of a gas-engine a pocket constituting a primary exploding-chamber and communicating with the explosion-chamber of the engine in such a manner and at such times that the primary explosion shall insure an explosion in the main chamber at regular and determined intervals.

Another object of this invention is to produce a gas-engine in which the explosive mixture shall be compressed during the forward or in stroke and by the action of the piston in the exploding-chamber and without the employment of any auxiliary compressor or pump.

A further object is to expel the products of combustion or the exploded gas from and refill with and compress within the exploding-chamber the explosive mixture by and during a single forward or in stroke of the piston.

Further objects are to provide a piston having a double diameter, one of which parts plays in a suitable cylinder and constitutes a working-piston for supplying the explosive mixture to the compressing-cylinder or exploding-chamber, and the other part works in the compressing-cylinder and constitutes a compressing-piston adapted to first expel the products of combustion or exploded gas and then compress the said explosive mixture, whereby all of these operations may be produced by and during the forward or in stroke of said piston; to provide a valve having a connecting-chamber automatically operated to connect the inlet-port with a passage leading to the working-cylinder during the backward or out stroke of the piston, and to shift and connect said passage with the induction-port of the compressing-cylinder during the forward or in stroke of the piston, whereby the said piston during each stroke thereof will draw in a supply of the explosive mixture from the inlet-pipe or reservoir and forcibly inject the same into the compressing-cylinder, and to provide a keeping-plate for said valve having a constantly-burning flame-jet for relighting the valve-jet, and a pocket, constituting an auxiliary or primary exploding-chamber, adapted to register with the connecting-passage in said valve when said passage registers with the induction-port, in order to receive a supply of the explosive mixture simultaneously with the compressing-cylinder or exploding-chamber and to receive the valve-jet when said valve is at the limit of its stroke, and register with a passage through the valve leading to the induction-port, whereby an explosion first takes place in said pocket and thence reverberates through said passage and the induction-port to the exploding-chamber, where it produces a second explosion, which acts upon the piston-head and operates the engine; also, to provide a pair of eduction-ports, one of which is closed by the piston during its forward stroke and the other automatically just prior to the completion of the forward stroke of the piston, whereby the products of combustion may be entirely expelled from the exploding or compressing chamber, and these outlets from the said chamber closed during the operation of compressing and exploding the gas; to provide a division-plate for the compressing-cylinder intermediate the induction and eduction ports, whereby the action of the in-rushing gas or explosive mixture will effectually expel the products of combustion or exploded gas and without materially intermingling and escaping therewith; and, finally, to provide a governor for such an engine, whereby the speed of said engine may be automatically regulated and controlled. I attain these objects by devices illustrated in the accompanying drawings, in which—

Figure 1 represents a horizontal section through an engine embodying my invention, with the piston at the limit of its backward stroke and the valve connecting the working-cylinder with the induction-port of the compressing-cylinder or exploding-chamber; Fig. 2, a similar view, showing the piston at the limit of its forward stroke and the valve connecting the inlet-port with the working-cylinder through the medium of a passage leading thereto, located in the walls of the main frame or shell; Fig. 3, a detail view of the governor and valve operated thereby.

Referring by letter to the accompanying drawings, A indicates the main frame or casting of my engine, having brackets or arms B B extending rearwardly therefrom to form bearings for the drive crank-shaft C, carrying upon its outer ends, respectively, the usual fly and belt wheels. This shaft is cranked centrally of its length and midway between the brackets B B, at which point is connected the piston-rod, as will hereinafter be more fully described.

The main casting or shell A has, preferably, the contour of a cylinder, supported on a suitable base, and has formed axially and longitudinally therein two chambers of differing diameters extending, respectively, about one-half the entire length of the shell A and constituting a working and a compressing cylinder or chambers. I prefer to employ the cylinder having the larger diameter and located in the rear half of the shell as the working-cylinder D, and the smaller one, E, as the compressing-cylinder, which latter also subserves the purpose of an exploding-chamber, as will be explained farther on. Working in these cylinders is a piston, F, also having a double diameter to correspond with the differing diameters of the cylinders D and E, the larger diameter, of course, operating in the working-cylinder and the smaller in the compressing-chamber; and I may here add that this smaller portion subserves the double purpose of a compressor or plunger and the piston-head, against which the explosive force of the gas is exerted.

Pivotally connected to this piston at a suitable point and to the crank-shaft C, as before described, is the piston-rod G, by means of which the reciprocating movement of the piston is converted into a rotary motion in the crank-shaft, as is usual in engines of this class.

In general, the operation of this engine is to draw or suck into the working-chamber behind the piston, and during the outward stroke thereof, the supply of gas or explosive mixture, and on the in or forward stroke of the piston to forcibly inject this supply into the compressing-cylinder, where it first displaces the exploded gas or product of combustion, and is then compressed in the forward end of the compressing-cylinder and exploded about the instant the piston completes its forward stroke, and thus exerts its explosive power upon the head of said piston, forcing it to return to its outer position, during which outstroke it sucks in a fresh supply of the explosive mixture, to be in turn forced into the compressing-cylinder and exploded, as just described.

The operation of filling the working-cylinder with the explosive mixture occurs during the outstroke of the piston, but the transfer of the said mixture from the working to the compressing cylinder, the displacing and expulsion by it of the products of combustion or exploded gas in the latter cylinder, the compression of this new supply within the compressing-cylinder and the explosion of the gas or mixture while under compression all take place by and during the forward or in stroke of the said piston, and it is obvious that an explosion will take place at each complete stroke of the piston.

In detail, in order to accomplish the results just enumerated, the wall of the shell has provided therein a passage, H, and induction-port I, connecting the working-cylinder D with the compressing-cylinder E; but this passage and port do not have a direct communication with each other—that is to say, the passage does not lead directly to the induction-port, but across the ends of said passage and induction-port works an automatic slide-valve, J, provided with a chamber, K, which latter serves at proper intervals to connect the passage with the induction-port. It also serves at alternating intervals to connect the passage H with the inlet-port L, thus permitting the piston to draw in through the passage to the working-cylinder a supply of new gas and air.

The slide-valve J is rendered automatic and reciprocating by means of an ordinary eccentric, *a*, secured upon and rotating with the crank-shaft C, and a connecting-rod, *b*, connecting said eccentric with the valve, and it is held in position by means of a keeping-plate, M, secured to the shell A.

It will be observed by reference to the drawings that the connecting-chamber K in the slide-valve extends entirely through said valve, being virtually a slot or hole therein. This construction of the valve enters as an important element in my invention, for in connection with an exploding-pocket, N, now to be described, it constitutes a vital element in the construction and operation of my engine, and these parts are equally applicable to all gas-engines in which the explosion takes place under compression.

The pocket N just mentioned is formed in the inner face of the keeping-plate M next the slide-valve, and is located just opposite and extends approximately across the openings of the passage H and induction-port I, and by means of the connecting-chamber K it receives a supply of the explosive mixture simultaneously with the filling of the compressing-chamber; hence the importance of the connecting-chamber extending entirely through the slide-valve, for without such a pocket there would be no necessity for the chamber to extend entirely through the valve, as an oblong pocket in the face of the valve would serve the same purpose.

As previously described, the pocket N in the keeping-plate is an exploding-chamber, in which the primary explosion takes place just before the secondary explosion in the main compressing-cylinder occurs, and which is designed to be a result of the primary explosion, and positively insured by said explosion at each stroke of the piston. To produce this explosion at each stroke of the piston, the slide-valve J is provided near its rear end with a flame-jet, c, supplied with gas from any convenient point and opening into a small transverse slot or hole, d, in said valve, the forward wall of this slot being formed at an oblique angle to the valve, with the end on the side next the pocket N extending forwardly in such manner that the slot d, although designed to form a connecting-passage between the pocket and the induction-port, will communicate first with the pocket, as clearly illustrated in Fig. 2, when the flame-jet c, coming in contact with the gas in the pocket, will produce an explosion therein.

The continued forward travel of the valve carries forward the slot d, and almost immediately establishes communication between the pocket and induction-port, thereby permitting the explosion which has occurred in the pocket to reverberate through the induction-port into the exploding-cylinder, where it produces a secondary explosion. The violence of the explosion in passing across the flame-jet of course blows the jet out at each explosion, and in order to relight this jet after each explosion a constant-flame jet, e, is provided in the keeping-plate M, burning in a suitable recess in said plate and having an opening in the side of the chimney extending from said recess registering with the slot d at each instroke of the valve, so that the flame from the jet e will immediately ignite the jet c, to which latter a constant supply of gas is furnished during the entire operation of the engine.

I may here state that I consider the pocket N as the most important element in my invention, in that, although the other parts would perform their functions without it, at the same time the explosions would be so irregular and uncertain as to render the practical operation of the engine almost impossible, for its stroke would be so jerky as to be injurious to any machinery driven by the engine and to entirely preclude the performance of heavy work by the engine. So, also, would a great waste of the explosive mixture and danger of explosions be incurred in consequence of the excess of pressure which would occur should explosion not take place at the proper time. These disastrous results are more or less promoted by the method of exploding the compressed mixture as at present in vogue, which consists in bringing the valve-jet directly or in first contact with the compressed explosive mixture; but, instead of producing an explosion, the light is put out by the action of the compressed gas, and this may occur several times before an explosion takes place, resulting in the jerky motion before described and promoting the liability to a disastrous explosion, destroying the engine.

By the employment of my exploding-pocket all these difficulties are overcome, for the explosion of the gas contained in the pocket has not sufficient volume or expansive force to blow out the valve-jet before the explosion takes place in said pocket, and by the time the explosion does take place communication is established between the pocket and exploding-chamber proper, into which the explosion in the pocket reverberates, carrying with it the valve flame-jet producing the secondary explosion before described, which occurs in the compressing or exploding chamber, and acts upon the piston-head, forcing it backward to its outer position, from whence the momentum of the fly-wheel returns it to compress the next chamber full of gas.

To permit the escape of the exploded gas and products of combustion from the exploding-chamber, two eduction-ports, g g', are provided in the shell or casing A, located, respectively, near the front and rear end of the said chamber and connected by suitable passages with a single exhaust-pipe, h. The port g near the front end of the chamber will be closed first by the piston during its instroke; but the port g' is designed to remain open until the piston has nearly completed its instroke, when it will be automatically closed by means of an eccentric, i, corresponding to the eccentric a on the opposite side of the crank-shaft, which eccentric is connected by a rod, j, with an ordinary rotary valve, k, designed to cut off and open communication between the port g' and the exhaust-pipe h at the proper moment. The closing of these ports at different times is done for the purpose of thoroughly exhausting the exploded gas from the compressing-cylinder, the peculiar means employed for expelling the said exploded gas almost necessitating the employment of these two valves; but the valve g might be dispensed with without materially interfering with the operation of the engine. The action of these ports and the results obtained by their use will be more clearly understood when the means employed for expelling the gas has been described.

It will be remembered that when the piston is in the position shown in Fig. 1 the working-cylinder D is filled with a new supply of gas and air, while the exploding-chamber or compressing-cylinder is filled with exploded gas as the result of a previous explosion. Now, the instant the piston starts to move forward, the fresh gas will be forced through the passage H and induction-port I into the compressing-cylinder, whereupon the exploded gas will be displaced and expelled, first through the eduction-port g, and, when this is closed by the forward movement of the piston, then through the port g'. In order to more easily accomplish this result and prevent the fresh supply from flowing directly across the chamber and out through the port g', I have provided the compressing-cylinder with a vertical division-plate, l, which acts as a deflector for the new gas and air and forces it to travel around the walls of the said cylinder before reaching the eduction-port, thus causing it to force along before it the exploded gas already contained in the chamber, all as clearly illustrated by the arrows in Fig. 1.

The closing of the port g' by the valve k before the piston has completed its instroke not only serves to prevent the escape of the fresh gas and air which may now have mingled with the exploded gas, but also serves to convert the rest of the instroke of the piston into a compressing force by closing all the escape-orifices from the compressing-cylinder. When the piston has completed its instroke, the valve J will have traveled to approximately the position shown in Fig. 2, and produced an explosion in the cylinder, as before described, when the gas is under the greatest compression. The force of the explosion acting upon the head of the piston forces the piston back to its outer position.

With the valve in the position just described, the connecting-chamber therein establishes communication between the inlet-port and passage H, and the action of the piston on its outward stroke is to draw through the passage into the working-chamber a fresh supply of gas and air, as indicated by arrows in Fig. 2. To regulate the speed of the engine it is not only necessary to provide an automatic governor, as obtains in all engines, but also one which may be employed in connection with the foregoing construction and shall have as its principle the lessening of the supply of explosive to limit the speed of the engine. To this end I have provided the device more clearly illustrated in Fig. 3, in which is shown an extension, 1, of the shell A above the valve, and forming a loose bearing for an upright shaft, 2, having a sheave or pulley, 3, loosely sleeved thereon and connected by a belt, 4, in any well-known and convenient manner with the crank-shaft C. Extending upwardly from the sheave 3, and preferably cast therewith, is a sleeve having formed thereon at the top two arms, forming pivots for the arms or levers of the balls 5. The upper and inner ends of the ball-levers project in an annular groove in an enlargement or collar rigid upon the upper end of shaft 2, whereby said shaft is elevated and depressed by the action of the governor-balls, which action is common to all ball-governors. When depressed, the lower end of the shaft projects in the path of an arm, 6, extending from a small spring-actuated slide-valve, 7, located in the connecting-chamber K of the slide-valve J, and it is obvious that as this occurs only when the valve J is near the limit of its forward stroke, as shown in Fig. 2, the valve 7 would be moved from its seat in the position shown in said figure to project over the mouth of the passage H, and thus prevent the entrance therein of the supply of fresh gas and air, and this operation will be repeated until the momentum of the governor, and consequently the speed of the engine, is reduced.

In the construction of my engine the keeping-plate for the valve may be cast with the cylinder A; but in practice I prefer to form this plate separately and spring-seat it against the valve, as promoting the best mechanical results.

In conclusion, I may add that a water-jacket may be provided, cast in the cylinder or frame A and partly or entirely surrounding the explosion-chamber; but as this feature is not new in gas-engines, I did not deem it necessary to illustrate it in the drawings.

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

1. In a gas-engine, the working-cylinder, the compressing-cylinder, an inlet-port, and a passage and induction-port connecting said cylinders, in combination with an automatic valve having a connecting-chamber alternately connecting said inlet-port and passage and the passage and induction-port, substantially as described.

2. In a gas-engine, the working-cylinder, the compressing-cylinder, an induction-port for the compressing-cylinder, and an inlet-port, in combination with a double piston working in said cylinders and an automatic slide-valve adapted to connect, first, the inlet-port with the passage, and then the passage with the induction-port, whereby said piston during the outstroke will draw in through the passage into the working-cylinder a fresh supply of the explosive mixture and during the instroke will transfer and forcibly inject the same into the compressing or exploding cylinder, substantially as described.

3. In a gas-engine, the working-cylinder, the compressing-cylinder, and a passage and induction-port connecting said cylinders, in combination with a valve intermediate said passage and induction-port, having a connecting-chamber extending transversely through said valve, and a pocket registering with said chamber when connecting said passage and induction-port, whereby said pocket may receive a charge of the explosive mixture, substantially as described.

4. In a gas-engine, the working-cylinder, the compressing-cylinder, an inlet-port, and a passage and induction-port connecting said cylinders, in combination with an automatic slide-valve having a connecting-chamber intermediate said inlet-port and passage or induction-port and passage, a double piston working in said cylinders, a keeping-plate for said valve, and a pocket in said keeping-plate registering with the connecting-chamber in said valve when connecting the passage and induction-ports, substantially as described.

5. In a gas-engine, the working-cylinder, the compressing-cylinder, and the passage and

induction-port connecting said cylinder, in combination with the double piston working in said cylinders, the pocket, and the automatic slide-valve having the connecting-chamber and flame-jet located in a transverse slot, substantially as described.

6. In a gas-engine, the compressing-cylinder or exploding-chamber, and the induction and eduction ports on either side thereof, in combination with a longitudinal division-plate or deflector in said cylinder interposed between said induction and eduction ports, substantially as described.

7. In a gas-engine, the compressing or exploding cylinder, the piston thereof, and the induction and the eduction ports on either side of said cylinder beyond the limit of the forward or in stroke of said piston, in combination with a longitudinal division-plate or deflector in said cylinder intermediate the induction and eduction ports, substantially as described.

8. In a gas-engine, the working-cylinder, the piston thereof, and the passage leading to the compressing-cylinder, in combination with the compressing-cylinder, the piston thereof, the induction and eduction ports on either side of said cylinder, and the longitudinal division-plate or deflector intermediate said ports, substantially as described.

9. In a gas-engine, the compressing-cylinder, the piston thereof, the induction-port, and the valve for opening and closing said port, in combination with the deflector or division-plate and eduction-ports, all of which are adapted to be automatically closed just prior to the completion of the instroke of the piston, whereby the gas contained in said cylinder will be compressed during the rest of the stroke, substantially as described.

10. In a gas-engine, the compressing-cylinder, the piston thereof, and the induction-port located forward of the instroke of said piston, in combination with the deflector or division-plate and one or more eduction-ports, all except one of which are located within and closed by the stroke of the piston, which latter is automatically closed just prior to the completion of the stroke of the piston, whereby a supply of fresh gas will enter the exploding-chamber through the induction-port, be deflected forward and along the walls of said chamber, and hence force the exploded gas first out through the eduction-ports closed by the piston and then through the automatically-closing eduction-port until this latter port is closed, after which the induction-port will be closed and the remainder of the stroke serve to compress the gas in the cylinder, substantially as described.

11. In a gas-engine, the combination of the cylinders D and E, piston F, passage H, induction-port I, valve J, having connecting-chamber K, jet *c*, and slot *d*, pocket N, deflector *i*, and eduction-ports *g* and *g'*, substantially as described.

12. In a gas-engine, the working-cylinder, the compressing-cylinder, a combined gas and air inlet port, a passage and induction-port connecting said cylinders, and an automatic slide-valve having a connecting-chamber alternately connecting said inlet-port and passage, and the passage and induction-port, in combination with a spring-actuated slide-valve carried by and working in the chamber of said automatic valve, a valve-rod secured to the spring-actuated slide-valve and projecting beyond the automatic valve, and a governor-rod adapted to be depressed by the speed of the governor to project in the path of travel of said valve-rod, whereby the spring-actuated slide-valve will project over and seal the mouth of the passage at each stroke of the automatic slide-valve, substantially as described.

LEWIS T. CORNELL.

Witnesses:
WILL R. OMOHUNDRO,
W. W. ELLIOTT.