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# F. DIECKMANN.

## GAS-ENGINES.

No. 195,585. Patented Sept. 25, 1877.

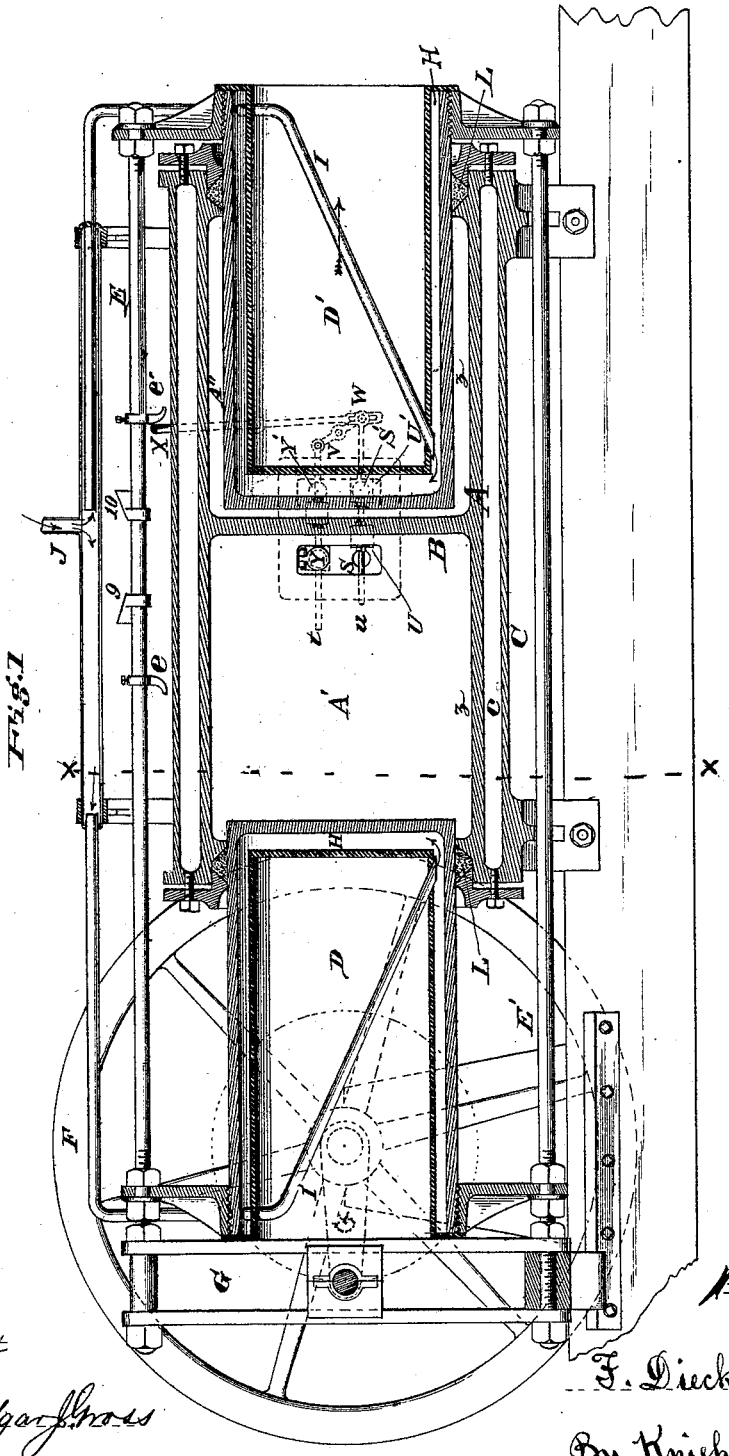

Fig. 1.

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Fig. 2

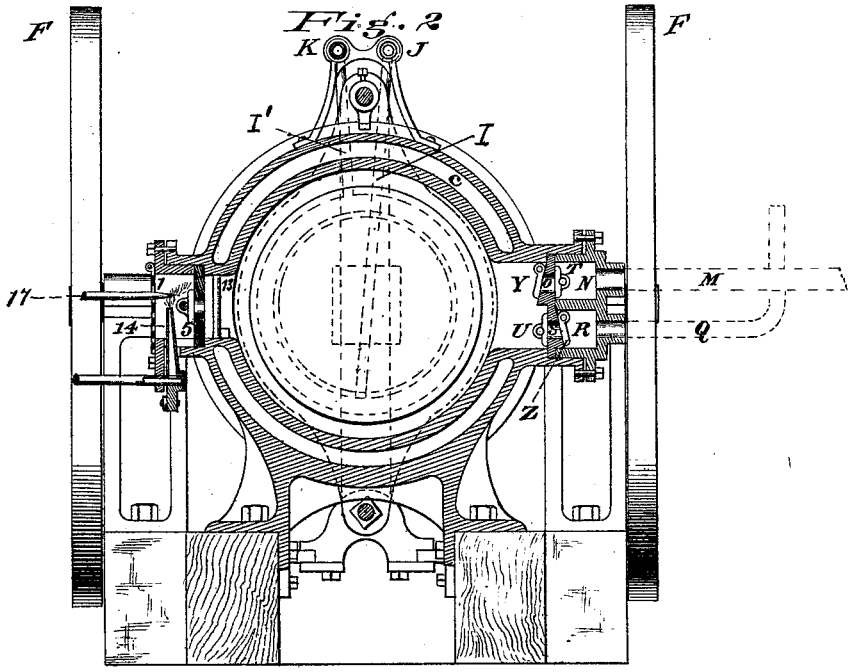


Fig. 3

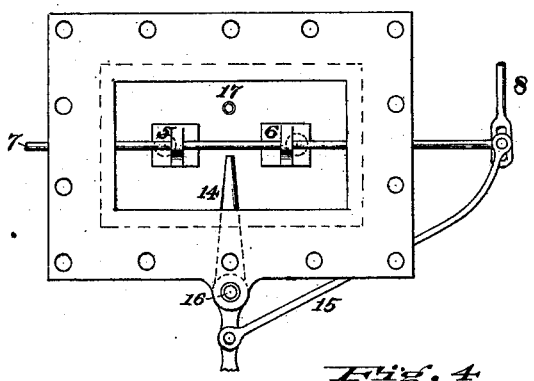


Fig. 4

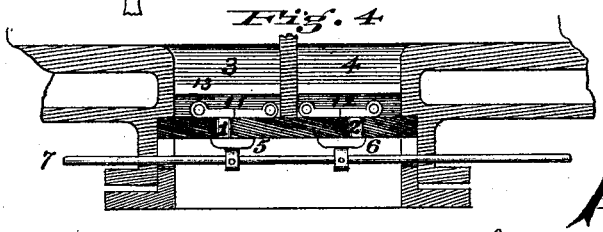


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Fig. 8

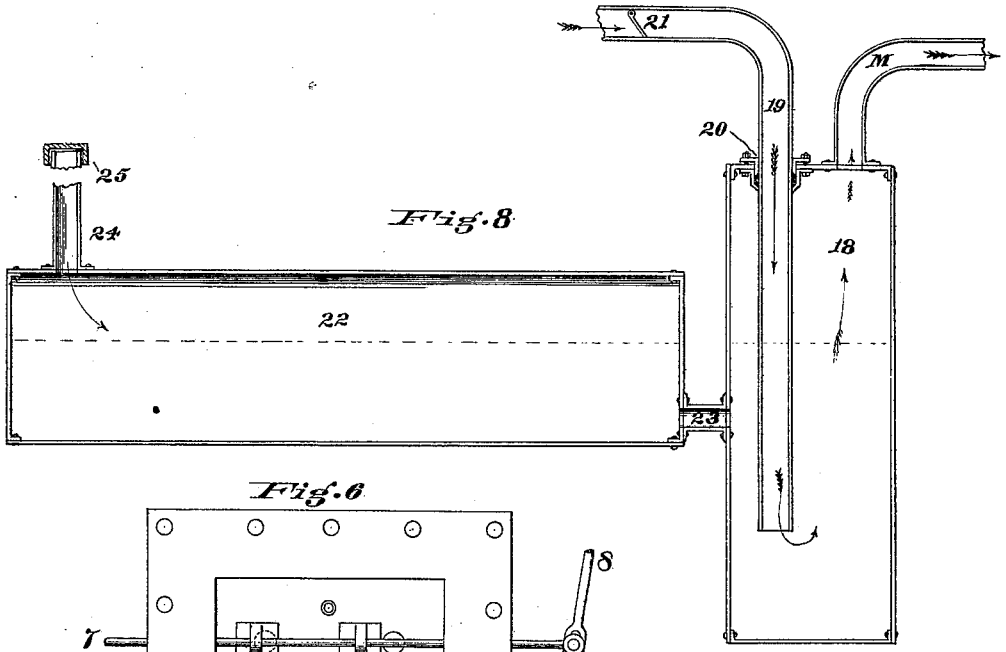


Fig. 6

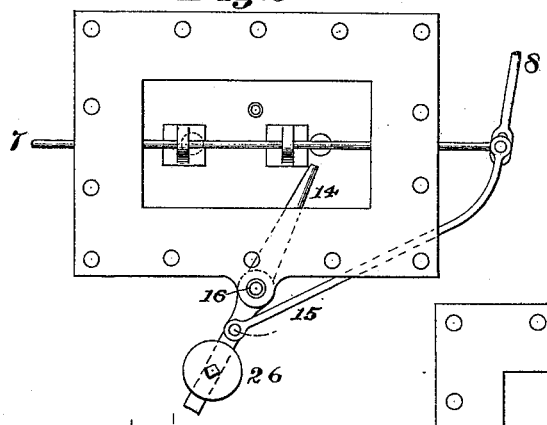


Fig. 5

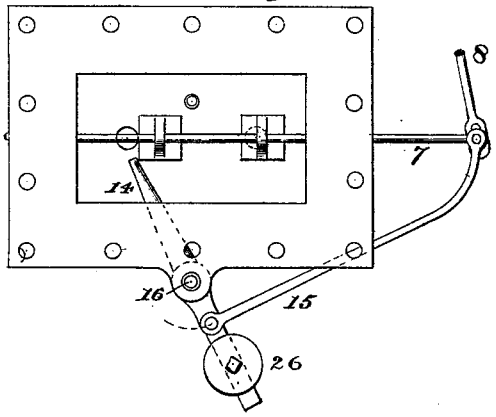


Fig. 7

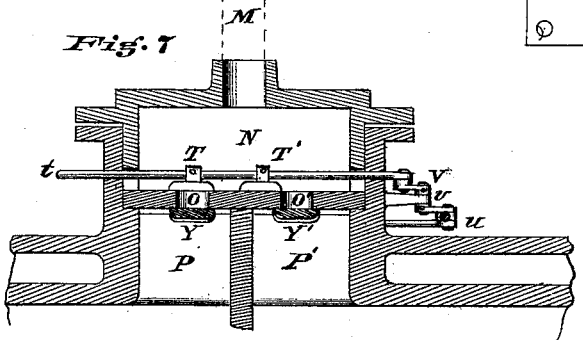


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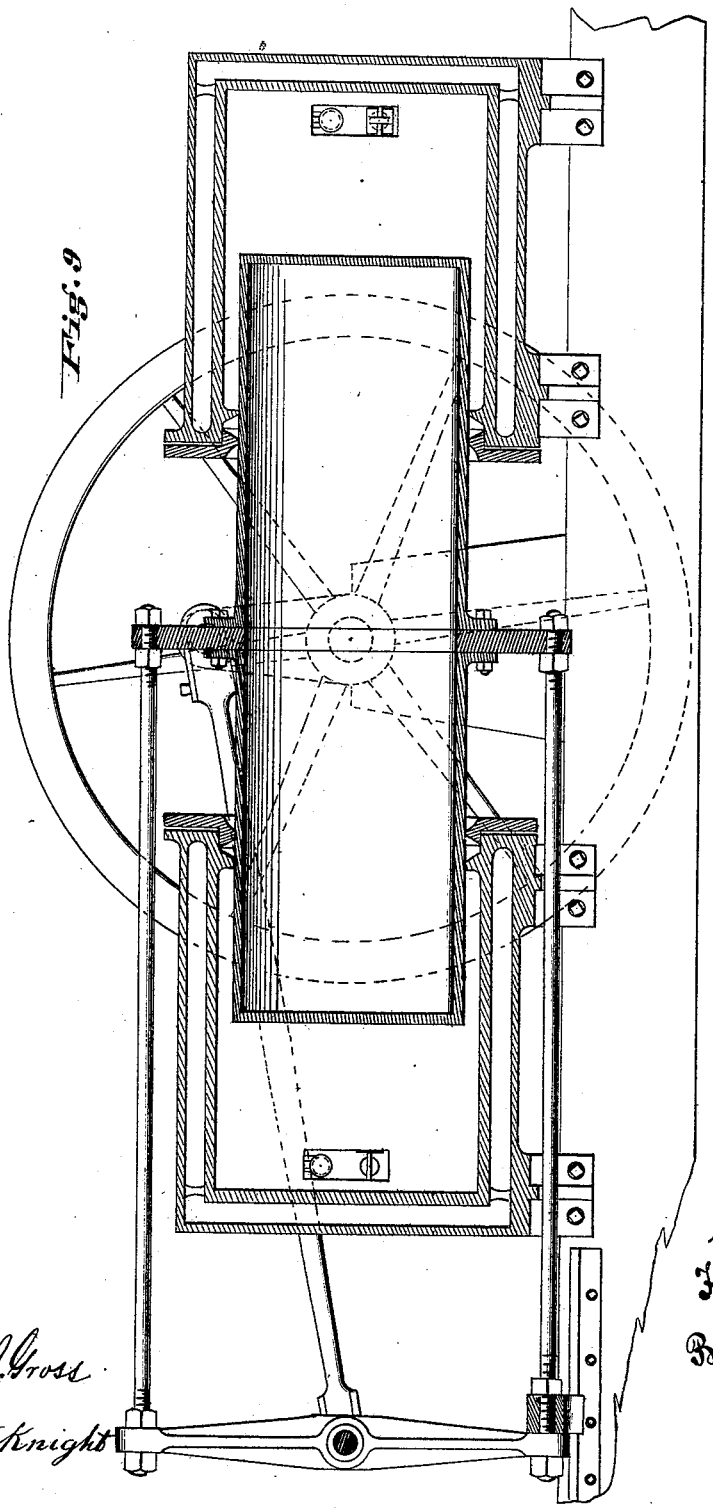
Fig. 9



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# UNITED STATES PATENT OFFICE.

FERDINAND DIECKMANN, OF CINCINNATI, OHIO.

## IMPROVEMENT IN GAS-ENGINES.

Specification forming part of Letters Patent No. **195,585**, dated September 25, 1877; application filed July 16, 1877.

*To all whom it may concern:*

Be it known that I, FERDINAND DIECKMANN, of Cincinnati, Hamilton county, Ohio, have invented a new and useful Gas-Engine, of which the following is a specification:

My invention relates to a dynamic engine or motor wherein the pressure resulting from the explosion of aerated petroleum vapor, or like gaseous compound, acts directly upon one side of a piston or plunger from whose other side pressure has been, for the instant, removed by condensation of the previous charge; and my invention, in its most complete form, comprises, first, a pair of rigidly-connected cylinders whose mouths or open ends are packed to receive a pair of rigidly-connected hollow plungers, of smaller diameter than the cylinder-bore—a construction which combines the advantages of extensive cooling-surface, remoteness of the packing from the heat-source, room for the deposition of soot out of contact with the plungers, and the non-necessity of imparting a smooth finish to any portion of the cylinders, which may, in fact, be simply rough castings; secondly, in connection with the above, a system of water-cooled passages, both in cylinders and plungers; thirdly, the provision, at the remote extremities of each supply and each exhaust passage, of two valves, of which one is positive and the other automatic, and of which both close toward the passage; fourthly, an automatically-shifted torch or burner for igniting the charge; fifthly, a flame-inlet, guarded externally by a positively-actuated valve, which closes inwardly, and which opens simultaneously with the effective shift of the igniting-torch, said inlet being guarded internally by a valve actuated by the alternately ingoing and outgoing currents, and closing outwardly.

The term "pot-formed," as hereinafter applied to my preferred form of plunger, is intended to designate a hollow cylindrical body closed at that end of it which is directed to the interior of the cylinder proper.

The term "positive" is applied to a valve which is opened and shut at specific periods of the stroke by mechanical connection with the machinery, in contradistinction from a valve which opens and closes at varying periods, dependent on the vicissitudes of pressure, and which I call an "automatic" valve.

Such automatic valves in my device are of two kinds, namely: first, such as, while opened and closed by the alternating fluid-pressures only, have a slight preponderating tendency to remain shut, and which I call "clack" valves; and, secondly, those so delicately hung on vertical pintles as to yield to the slightest current in either direction, and which I call "passive" or "door" valves.

The word "suction" I employ in its popular sense, to wit, a motion of fluid in the direction of least resistance.

In the accompanying drawings, Figure 1 represents a longitudinal section of an engine embodying my invention. Fig. 2 is a transverse section of the same on the line *x x*. Fig. 3 is a front view of my fire-inlet in its normal or inactive condition. Fig. 4 is a horizontal section of the same, the torch being omitted. Figs. 5 and 6 are front views of said valve in the two effective positions of the torch. Fig. 7 is a horizontal section of my supply-passage. Fig. 8 is a vertical section of my reservoir. Fig. 9 illustrates a modification of my invention.

I employ, in the preferred form of my invention, two rigidly-connected cylinders, A′ A″, produced by transverse partition B in a tube A. This tube is surrounded by a casing, C, inclosing a water-jacket, *c*.

D D′ are two precisely similar pot-formed plungers, held to true alignment and proper relative separation by rods E E′. These rods may terminate in cross-heads, of which one, G, being slotted, may communicate with fly-wheels F on the engine-shaft by any proper or customary transmitters, G′.

Each plunger has, preferably, a water-lining, H, which communicates, by means of sleeved pipes I I′, with customary cold-water circuit J K. Of these pipes the pipes I convey cold water to the lower part of water-space H, while the pipes I′ conduct off the heated water from the upper parts of said spaces.

The plungers should, of course, have smooth cylindrical peripheries; but the cylinders may be in the rough throughout.

The diameter of the plungers is considerably less than the bore of their containing-cylinders, so as to leave an annular interstice, which is of great practical importance. This

interstice is, at the extreme margin or mouth of each cylinder, filled by any suitable packed projection or flange, L.

The aerated petroleum or other explodent enters the respective cylinders alternately by simple suction, and is afterward expelled by the appropriate plunger in its retrograde stroke. For this purpose the supply-pipe M enters a chamber, N, having two passages, O O′, which communicate alternately with chambers P P′, of which each conducts to its proper cylinder A′ A″ at or near the extreme inner end thereof.

Similarly, the exhaust-pipe Q enters a chamber, R, having two passages, S S′, that communicate alternately with the chambers P P′. T T′ are two slide-valves, attached to valve-rod *t* at such relative distance as to alternately permit the entrance of the desired measure of explodent through the supply-passage O or O′ to its respective cylinder. With this object in view said valves are located at the outer extremities of said passages.

Similarly, the exhaust-passages S S′ are alternately opened for the expulsion of the spent fluids by two slide-valves, U U′, attached to rod *u*. For this purpose the said valves are located at the inner extremities of said passages. The size relatively to their ports and the distance of the slide-valves T T′ are such that the closure of one port is instantly accompanied by the opening of the other port, and in like manner the size and distance of the slide-valves U U′ relatively to their ports are such as always to open one port just as the other is being closed, and vice versa.

For the purpose of working these valves, any customary or appropriate mechanism may be employed. For example, the two valve-rods *t* and *u* may be hinged to the remote extremities of a lever, V, fulcrumed at *v*, and having link-connection W with lever X, which is shifted alternately to the right and to the left, at or near the termination of each piston-stroke, by means of tappets *e e′* properly located on rod E.

To insure the automatic closure of the supply-passages O O′ at the precise instant following the explosion—at whatever part of the stroke that may occur—I provide at the inner ends of said passages clack-valves Y Y′, hinged by their upper edges and resting upon slightly inclined seats, as shown.

Similarly, to insure the closure of the exhaust passages at the precise juncture when the internal pressure falls below that of the atmosphere, I provide, at the outer ends of said passages, similar clack-valves Z, (and Z′, not shown,) resting on like slightly-inclined seats. The slight inclination of the clack-valve seats utilizes the weight of the valves for prompt and effective closure, which it is desirable should always precede that of the fire-valve, to be presently described.

It will be seen that each inlet-passage, each outlet-passage, and each fire-passage is doubly valve-guarded—that is to say, each is furnished at one extremity with a valve, opened and closed periodically, and permitting for a brief period, and always in the same direction, the passage of fluid, and each has at its other extremity a valve which, by closing automatically in the opposite direction, absolutely prohibits the slightest refluent current through either passage. By this means each passage is, in its appointed turn and for a brief period, traversed by its proper current of flame, or of "live" or of spent explodent, and always in one and the same direction. This action is of absolute and vital necessity in my arrangement.

The proper ignition of the explodents within each cylinder alternately is effected by the following means: 1 and 2 represent two passages, which communicate, respectively, with the several cylinders, at or near their innermost ends, through chambers 3 and 4. These passages communicate, at their outer ends, with the external air, and are provided with a pair of slide valves, 5 and 6, upon a common valve-rod, 7, reciprocated by means of suitable connection 8 with tappets 9 and 10 upon rod E. The location of these valves upon their rod and their size are such as, at the extreme positions of the rod, to open one or other passage, the other passage meanwhile remaining closed, and in their middle position to close both passages.

The interior end of each fire-passage is furnished with one or a pair of clack-valves, 11 12, hung on vertical hinges or pintles, in order that their weight shall have no influence on their motions. These valves I have, for distinction, named "door-valves." The opening of my said door-valves is wholly inward, and is limited by a stop or bar, 13. When double, as shown, but one leaf or member covers the passage, the office of the other being to insure the closure of the first.

Moved simultaneously with the said slide-valves is an oscillating torch, 14, which, at the proper instant in each stroke, is momentarily deflected to one or other effective position. (Shown in Figs. 5 and 6, respectively.) This deflection is brought about by connection of said torch with valve-rod 7 by means of rod 15.

The torch 14, with its journal 16, may be hollow for the transmission of any combustible fluid, and, when in its normal or inactive position, (see Fig. 4,) is immediately under a stationary burner, 17, which serves to reignite the torch should it become extinguished by the force of the explosion or other cause.

That the torch 14 and the attached and the simultaneously-shifting fire-valves 5 and 6 may, of themselves, promptly resume their normal position, following each explosion, a counter-balance, 26, is provided upon that part of the torch 14 which extends below its fulcrum.

The above-described engine is intended to be placed in connection with a simple reser-

voir charged with gasoline or other hydrocarbon liquid. A suitable form for such reservoir is shown in Fig. 8, in which 18 is an upright tank partially filled with the combustible liquid, and having an open pipe, 19, which, being introduced through a packed orifice, 20, is submerged more or less at discretion of the operator.

Evaporation of gasoline vapor may be prevented by a valve, 21.

From the top of said tank the supply-pipe M conducts the aerated gasoline vapor to the engine, as hereinbefore stated.

In order to maintain for a lengthened period an adequate body of gasoline for the percolation and enrichment of the air, one or more horizontal tanks, 22, may be provided, having communication 23 with tank 18.

24 represents a charging-neck having an air-tight cap, 25.

The contents of the above-described reservoir not being subjected to artificial heat or pressure, and air entering only when the tank-pressure falls below that of the atmosphere, the accumulation of any dangerous volume of explodent is rendered impossible. Such reservoir may be located any distance from the engine.

The operation of said reservoir is as follows: Pressure within the reservoir falling below that of the atmosphere, consequent on the creation of a partial vacuum within the engine, which may be effected by a slight movement of the fly-wheel, the liquid contents of pipe 19 descend, and are replaced by air from without, which, bubbling up through the gasoline, becomes carbureted to a sufficient degree to constitute the well-known explosive compound, in which state it passes to the engine. Either an insufficient or a redundant impregnation of the entering air may be rectified by a downward or an upward adjustment of tube 19.

The operation of the above-described gas-engine is as follows: The plungers D and D′ being supposed in position shown in Fig. 1, then, the fly-wheel being rotated so as to move the plunger D′ in direction of arrow, a suction will be created in cylinder A″, which will draw in the explosive material through the now open passage O′ until the plunger has reached the desired point of cut-off, (which may be at any described period of the stroke.) At this juncture the tappet 10, operating lever 8, simultaneously opens valve 6 and brings torch 14 in front of passage 2. At the same time the atmospheric pressure, opening door-valve 12, drives in the flame, which, in turn, ignites the charge of explodent. The force of explosion then closes both the fire-valve 12 and the supply-valve Y′, and drives the plunger D′ to the end of the stroke. While these actions are taking place the rod 8, escaping from its tappet 10, permits the torch 14 to resume its vertical position and to reclose valve 6. On reaching the end of its stroke, as aforesaid, the tappet *e*, striking the lever X, reverses slide-valves T T′ and U U′, thus closing the outer end of the supply-passage O′ and opening at its inner end the exhaust-passage S′ of cylinder A″, at the same instant opening the supply-passage O and opening the exhaust-passage S of cylinder A′.

By this time the products of explosion in cylinder A″, by loss of heat incident to rarification and conduction, become condensed, forming a partial vacuum, which enables the atmospheric pressure to impel the plunger D′ in the reverse direction, carrying with it the plunger D, and, in turn, creating a partial vacuum in cylinder A′, accompanied by an in-rush of explodent through the already open passage O.

The plunger D′ having, on its return stroke, reached the point where the pressure of the contents of cylinder A″ equals that of the atmosphere, and said plunger being caused to continue its stroke by the explosion in cylinder A′ acting on plunger D, aided by the momentum of the moving mass, the valve Z′ flies open, and thus permits the contents of cylinder A′ to be expelled by said plunger D′.

When the plunger D′ reaches its innermost position the tappet *e*′, striking rod X, again reverses the supply and exhaust valves, and, the various moving members having reached the point of departure, the operation is repeated.

My said motor is believed to embody several useful features not heretofore effectively combined in such engines. For example, the original impulse of the explodent is utilized directly, or at first hand, upon the driving-member.

Only aerated gasoline at or below atmospheric pressure being employed, to which air is admitted by simple suction alone, there is never any dangerous accumulation of explodent.

My engine is wholly devoid of pumps or other forcing apparatus for introduction of the operated fluids, such introduction being effective by simple atmospheric pressure, aided by the vacuums generated in the operation.

My packing L, being attached to the cylinder, and consequently stationary, and at all times remote from the source of explosion, with its heat and débris, maintains its efficiency for a long period.

The annular interstice *z* between the cylinder and the plunger, by affording space for collection of the débris of combustion out of contact with the plunger, enables the engine to work for a protracted period unimpeded by such obstructions, and said interstice, by exposing the ignited fluid to contact with the cooled peripheries of both cylinder and plunger, insures a prompt and effective vacuum. This interstice also permits the entire interior surface of the cylinder to be left in the rough.

It will be seen that each inlet and each outlet passage has at its respective ends a valve actuated by the machinery and closing the passage in one direction, and a valve actuated

by the fluid-pressure and closing the passage in the other direction.

The office of the the first-named valves is to admit at the proper point of the stroke the passage of the fluid, and that of the second named is to prevent any passage in the reverse direction, and to protect the first named against counter-pressures. Thus, in the fire-inlet, the office of the valves 5 and 6 is to determine when the flame shall enter the cylinder, and subsequently to preserve the vacuum, while the office of the door-valves 11 and 12 is to withstand the shock of the explosion, and also to insure the prompt and effectual closure of the orifices 1 and 2 against refluent action.

In the supply-passages O O′ the check-valves Y Y′ serve to close said passages at the instant of explosion, at whatever point of the stroke that may take place, and the slide-valves T T′, by closing the passages at their receiving ends at the conclusion of each stroke, prevent the inrush of air when a vacuum is created within their respective cylinders A′ and A″.

In a similar manner, in the exhaust-passages S and S′ the clack-valves Z and Z′, after the slide-valves U and U′ have been opened, preserve the vacuums alternately created in the respective cylinders down to the point of atmospheric equilibrium, but instantly open to any pressure tending outward, and the closure of the slide-valves U U′ before the explosion takes place prevents the loss of explosive force through said passages.

Without the clack-valves the operation would not be automatic, nor would the slide-valves endure the shock of explosion, while without the supply slide-valves the admission of the fluids could not be restricted to the proper points of the stroke, and without the exhaust slide-valves the force of explosion could not be retained within the cylinder. This arrangement of valves constitutes a vital feature in my invention.

The automatically-shifted torch or kindler, by always encountering the stationary burner, secures its reignition in case it should become extinguished either by force of the explosion or other causes, and being out of contact with the valves, except at the instant of ignition, the said valves do not become overheated or otherwise injured by the flame. Moreover, such torch can also be used for starting the engine, and for that purpose may be operated from a distant point, if desired.

Having described what I conceive to be the best form of apparatus for direct utilization of the explosive force in a dynamic engine, I reserve the right to vary the specific devices. For example, the engine, instead of the duplex form represented, may comprise but a single plunger in a single open cylinder; or the cylinders may be separated and the plungers united, as shown in modification, Fig. 9.

The positive valves may be of "faucet," and the automatic valves of "ball," "puppet," or other form.

A simple oscillating lamp or taper may be employed instead of the tubular torch 14.

The packing L may be of the well-known "cup" or other suitable form.

A spring may be employed instead of the weight 26.

I claim as new and of my invention—

1. In a gas-engine, (hydrocarbon motor,) a cylinder having a closed end, at or near which explodents are admitted or discharged by means of the doubly valve-guarded ports or passages O O′ P P′, and an open end, provided at its mouth with inwardly-projecting packing, which encircles a pot-formed plunger of less diameter than the cylinder-bore, substantially as and for the purpose set forth.

2. In a gas-engine, a pair of aligned and rigidly-connected cylinders, A′ A″, having two opposing closed ends, at which the explodent is admitted and discharged by means of the doubly valve-guarded ports or passages O O′ P P′, and two open ends, which inclose, by suitable packing L, a pair of rigidly-connected pot-formed plungers, D D′, of less diameter than their cylinder-bores, substantially as set forth.

3. In a gas-engine, a cylinder having one closed end, at which the gases are admitted and discharged by means of the doubly valve-guarded ports or passages O O′ P P′, and an interiorly-projecting marginal packing for a pot-formed plunger of less diameter than said cylinder-bore, when said cylinder and plunger are provided with water-linings C H, substantially as set forth.

4. In a gas-engine, the combination, with the doubly valve-guarded inlet and outlet ports O O′ P P′ and the doubly valve-guarded fire-inlets 1 and 2, of a cylindrical tube, A, separated by fixed partition B into a pair of cylindrical open-ended compartments, A′ A″, having marginal packings L surrounding a pair of pot-formed plungers D D′, of less diameter, and rigidly connected by means of rods E.

5. In a gas-engine, the two rigidly-connected plungers D D′, working in rigidly-connected and suitably-ported cylinders A′ and A″, in combination with the doubly valve-guarded inlet and outlet ports O O′ P P′ and the doubly valve-guarded fire-inlets 1 and 2, whereby the force of explosion in one cylinder is made to coact with the pressure of the atmosphere made available by a partial vacuum in the other cylinder, substantially as set forth.

6. The positive valve, arranged at the outer end of each supply-passage, and closing and opening periodically to arrest and permit the entrance of the explodent, in combination with a valve at the inner end closing automatically against escape-currents, substantially as set forth.

7. The positive valve, arranged at the inner end of each exhaust-passage, and closing and opening periodically to arrest and permit the exit of the imprisoned fluids, in combination with a valve at the outer end closing auto-

matically against atmospheric access, substantially as set forth.

8. In combination with the inlet-passages O O′ and the outlet-passages S S′ and slide-valves T T′ 5 6, the four clack-valves Y Y′ Z Z′, hinged by their upper edges and resting on slightly-inclined seats, as and for the purpose set forth.

9. In a gas-engine, the fire-inlets 1 2, closed periodically against ingoing currents by the positive valves 5 and 6 at their outer ends, and provided at their inner ends with door-valves 11 and 12, which open automatically to all ingoing currents, and which close automatically against all outgoing currents, substantially as set forth.

10. The intermittingly-oscillated torch or burner 14, for alternate ignition of the gases in the respective cylinders A′ and A″, in combination with the valve-rod 7 and rod 15, substantially as set forth.

11. The combination of the oscillating torch or match 14 and the stationary burner 17, for reignition of said torch, in the manner set forth.

12. In the described combination, the oscillatory torch 14 and the fire-valves 5 and 6, shifted simultaneously with said torch by suitable connection with the tappets 9 and 10 upon rod E, said valves and torch being restored to their normal position by spring or counter-weight 26.

13. The combination, with a pair of conjoined cylinders, A′ A″, and fire-inlets 1 and 2, of the stationary jet 17, and of the torch 14 and fire-valves 5 and 6, operated from the tappets 9 and 10, or other moving members, in manner substantially as set forth.

14. The combination and arrangement, in a gas-engine, of the congeries of compound valves Y T, Y′ T′, U Z, U′ Z′, 11 5, and 12 6, adapted to operate in the manner and for the purpose set forth.

In testimony of which invention I hereunto set my hand.

FERDINAND DIECKMANN.

Attest:
WALTER KNIGHT,
L. H. BOND.