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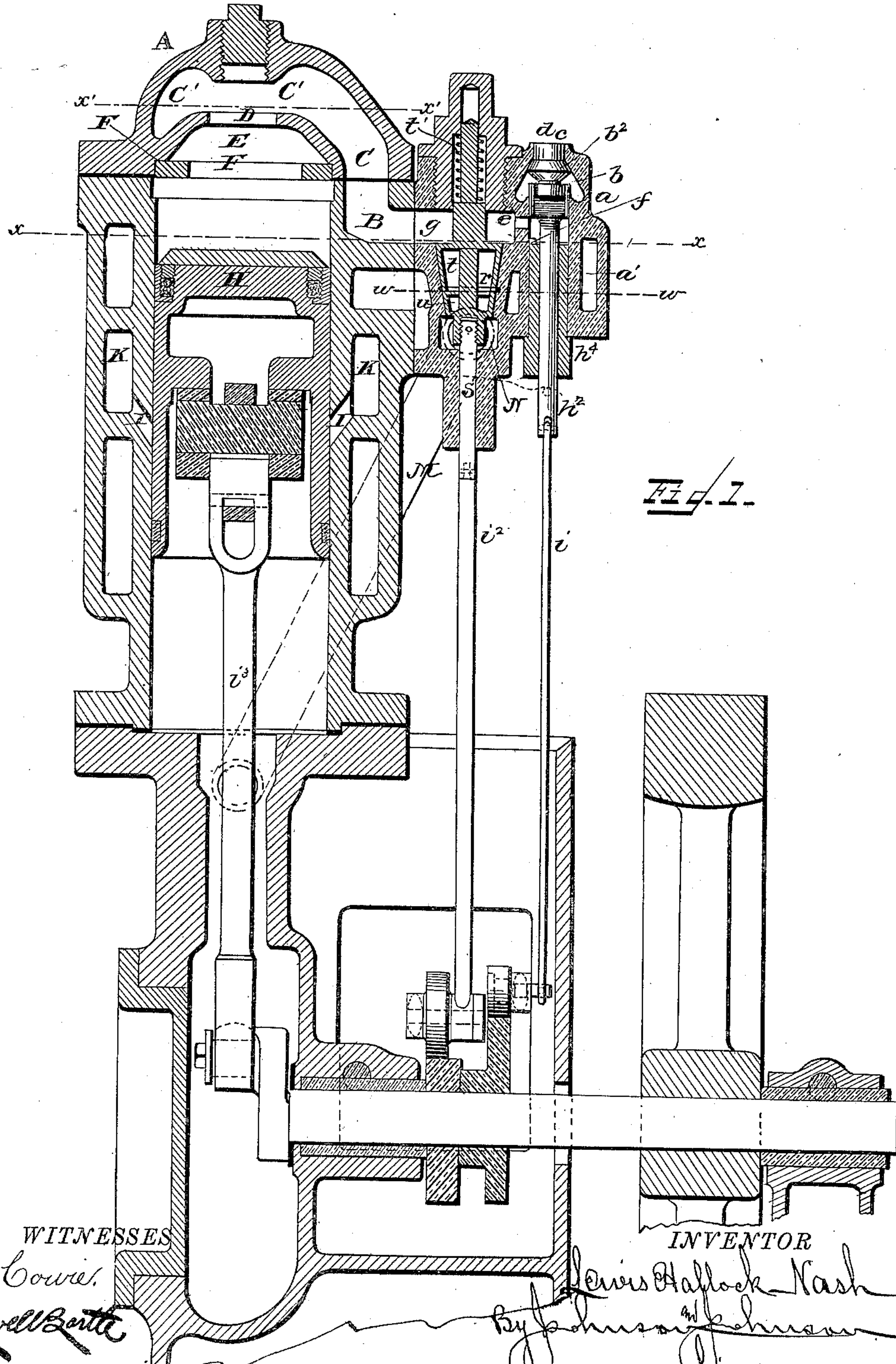
L. H. NASH.

GAS ENGINE.

No. 418,417. Patented Dec. 31, 1889.



WITNESSES
F. S. Cowie.
Howell Bartle

INVENTOR
Lewis Hallock Nash
By Johnson and Johnson
his Attorneys.

N. PETERS. Photo-Lithographer, Washington, D. C.

(No Model.) 4 Sheets—Sheet 2.

L. H. NASH.

GAS ENGINE.

No. 418,417. Patented Dec. 31, 1889.

Fig. 2.

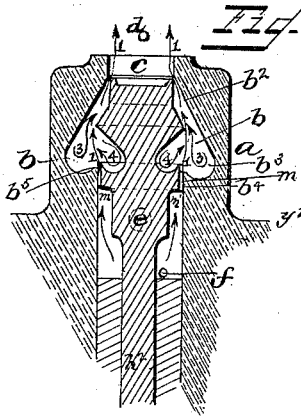


Fig. 3.

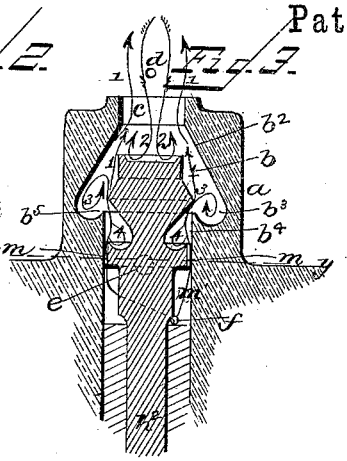


Fig. 4.

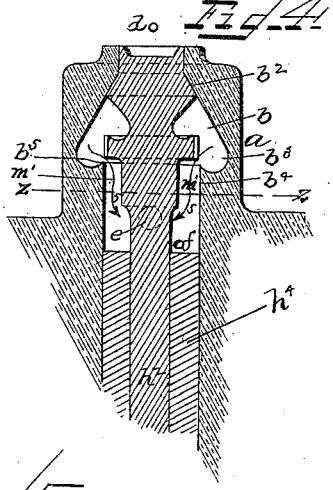


Fig. 6.

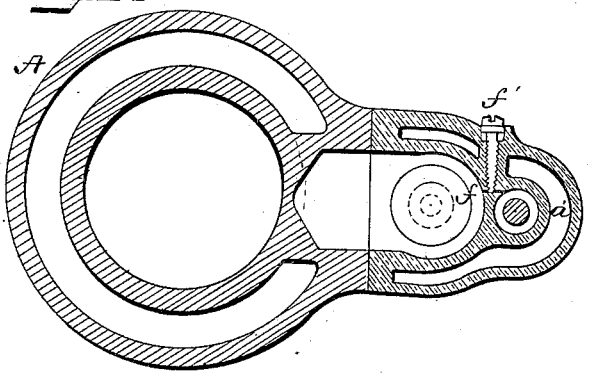


Fig. 5.

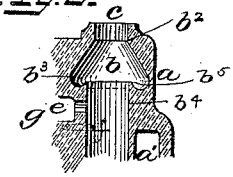


Fig. 7.

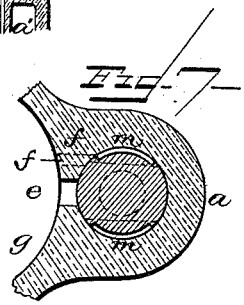


Fig. 8.

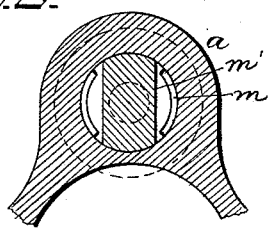


Fig. 10.

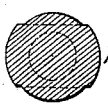
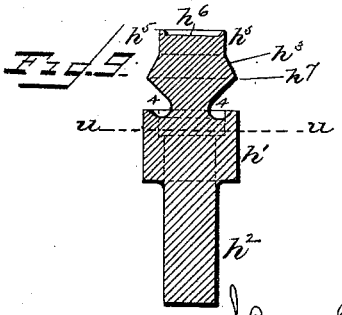


Fig. 9.



WITNESSES

F. D. Coure.

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(No Model.)

4 Sheets—Sheet 3.

L. H. NASH.

GAS ENGINE.

No. 418,417. Patented Dec. 31, 1889.

Fig 11

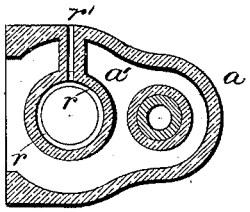


Fig 12

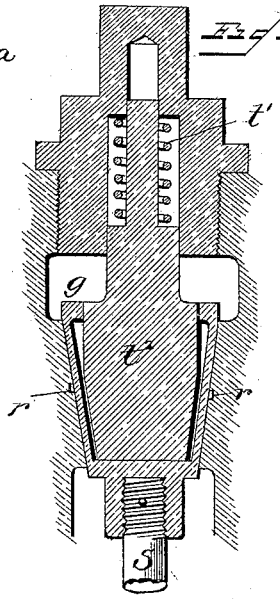


Fig 13

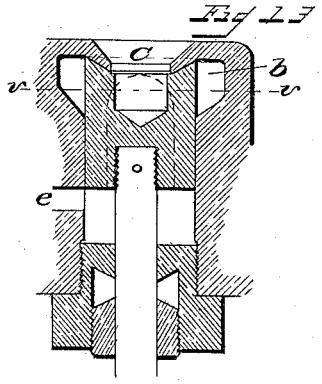


Fig 16

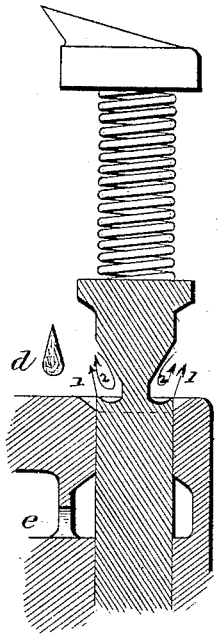


Fig 14

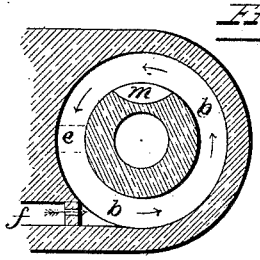
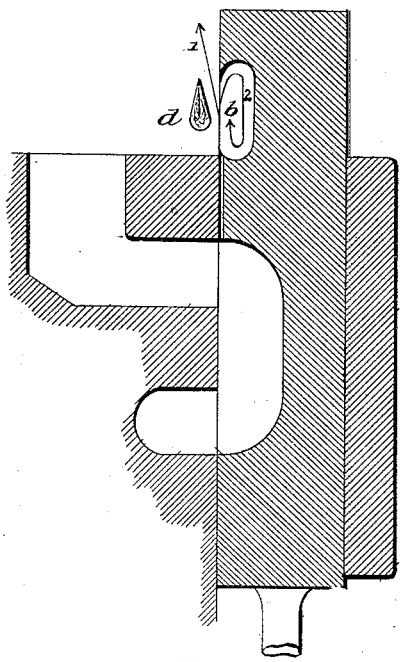


Fig 15



WITNESSES

F. B. Coura,

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his Attorneys.

(No Model.) 4 Sheets—Sheet 4.

L. H. NASH.

GAS ENGINE.

No. 418,417. Patented Dec. 31, 1889.

Fig. 19.

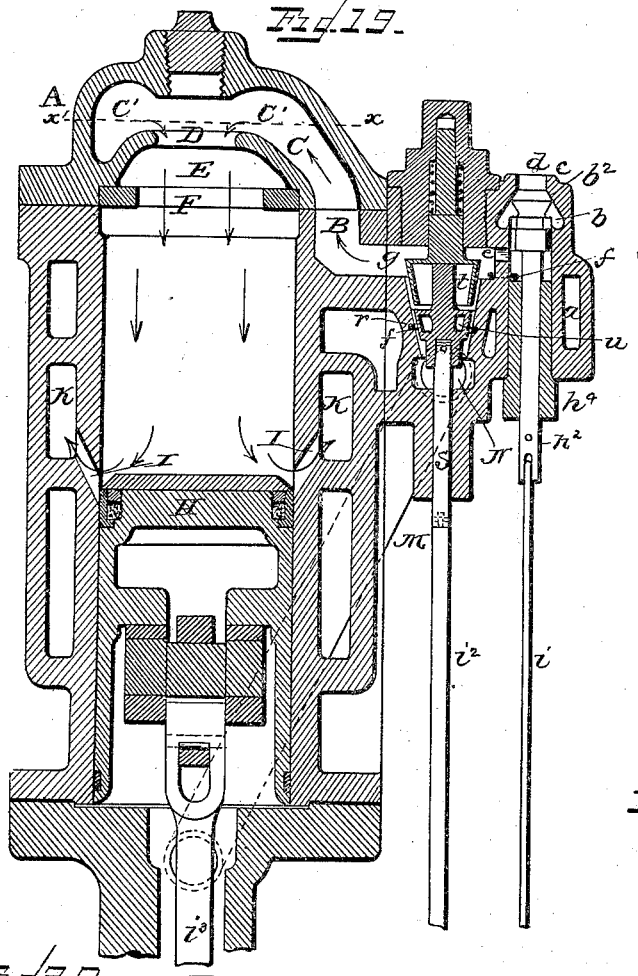


Fig. 21.

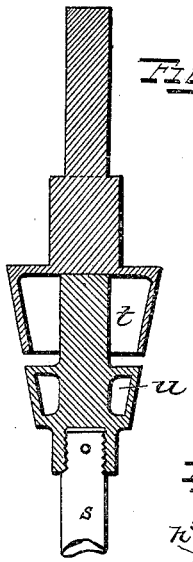


Fig. 22.

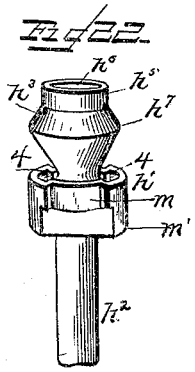


Fig. 18.

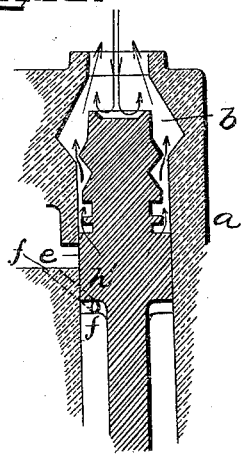


Fig. 20.

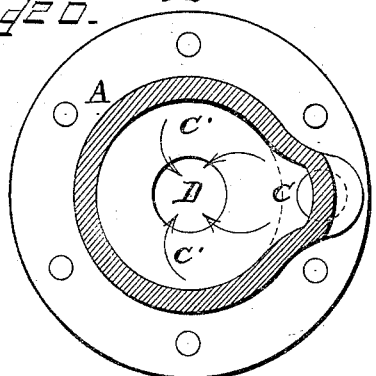
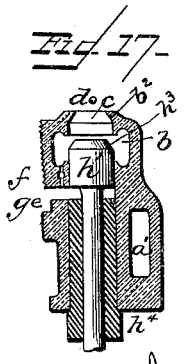


Fig. 17.



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UNITED STATES PATENT OFFICE.

LEWIS HALLOCK NASH, OF SOUTH NORWALK, CONNECTICUT, ASSIGNOR TO THE NATIONAL METER COMPANY, OF NEW YORK, N. Y.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 418,417, dated December 31, 1889.

Application filed January 24, 1888. Serial No. 261,728. (No model.)

To all whom it may concern:

Be it known that I, LEWIS HALLOCK NASH, a citizen of the United States, residing at South Norwalk, Fairfield county, and State of Connecticut, have invented new and useful Improvements in Gas-Engines, of which the following is a specification.

My invention relates to gas-engines; and it consists of certain novel parts and combination of parts, which will be separately pointed out in the claims concluding this specification, wherein will be designated the several novel features of my invention, which I desire to have protected by these Letters Patent.

The following is a description of the machine and the several devices illustrated in the accompanying drawings, which machine embraces the several features of my invention in total combination. These several features are not, however, necessarily dependent on each other, except as indicated in the claims, and they may therefore be employed severally in machines differing largely from that which I have shown in the drawings.

Figure 1 represents in vertical section a gas-engine embracing my invention, the ignition-valve and the admission-valve being shown as closed. Fig. 2 shows in vertical detail section a portion of the ignitor-valve and its ignition-chamber-forming case, the valve being in position to close the charge-igniting port *e* and the lighter-port *c*. Fig. 3 shows the same parts, the valve being in position to close the charge-igniting port *e* and to open the lighter-port *c*. Fig. 4 shows the same parts, the valve being in position to close the lighter-port *c* and open the charge-igniting port *e*. Fig. 5 shows in detail sectional view the ignition-chamber-forming case and its jet-supply passage *f*. Fig. 6 is a horizontal section taken through the ignitor device and the engine on the line *x x* of Fig. 1, showing the jet-supply passage *f* and its controlling-plug *f'*. Fig. 7 is a horizontal detail section taken on the line *y y* of Fig. 3, showing the surface-channels *m* in the ignitor-valve port *h'*, and their relation to the jet-supply passage *f*. Fig. 8 is a horizontal detail section of the ignitor-valve and its case, taken on the line *z z* of Fig. 4 and looking upward; and Fig. 9 is a vertical section of the ignitor-valve, and Fig. 10 is a cross-section thereof on the line *u u* of Fig. 9. Fig. 11 is a horizontal detail section of the ignitor and admission-valve on the line *w w* of Fig. 1, showing the passages *r r'* for the escape of leakage from the admission-valve. Fig. 12 shows in vertical section a modification of the charge-admission valve. Fig. 13 shows in vertical section a modification of the ignitor-valve and its ignition-chamber-forming case, and Fig. 14 is a horizontal section of the same on the line *v v* of Fig. 13. Fig. 15 shows in vertical section another modification of the ignitor-valve. Fig. 16 is still another modification of such valve. Fig. 17 shows another modification of the ignitor-valve, and Fig. 18 is still another modification of said valve. Fig. 19 represents in vertical section the power-cylinder and igniting device, the piston being shown at the limit of its forward stroke, the admission-valve open, and the ignition-valve closed; and Fig. 20 is a horizontal section taken through the entrance-passage C of the power-cylinder on the line *x' x'* of Fig. 19, illustrating the gas-flow into the power-cylinder. Fig. 21 represents the admission-valve in vertical section enlarged, and Fig. 22 shows the ignitor-valve in perspective.

Referring to my improved ignitor device, I have shown in Figs. 9 and 22 a puppet-valve for controlling the several ports of said device arranged within an ignition-chamber *b* of the case *a*, so as to open endwise inward, because in the construction shown said chamber opens at *c* at the top of the case *a*, and the external lighter *d* is placed immediately above said opening, while the valve has such construction as to close endwise against the chamber-wall by an outward movement. The valve for this purpose has a form adapted to receive an outward pressure when the charge is ignited, and thereby keep it closed upon its seat. The ignition-chamber is preferably formed in the valve-case, since it relieves the valve of much heat; but the form of said chamber may be varied, as shown in the several modifications in the drawings, or otherwise. Referring to this valve as having the

form and construction particularly shown in Figs. 1 to 10, inclusive, and shown in the perspective detail view, Fig. 22, it consists of a stem h^2, reciprocating in a guide-bushing or bearing-bushing h^4, hereinafter referred to, and having near its upper end a cylindrical portion h', formed at opposite sides with shallow and wide longitudinal grooves or recesses m, the lower portions of which are formed into deeper recesses m', cut into the cylindrical portion of the valve, to allow the flame to pass along the side of the valve to the port e in a certain position of the valve. The upper end of the cylindrical portion of this valve has a conical portion h^3 and a recess 4 cut into the top surface of the cylindrical portion h', as clearly shown in Fig. 22 and in the vertical sectional views of the valve, and has a cylindrical upper end h^5, formed with a concavity or recess h^6 in its top. The ignition-chamber b has the central top opening c, into which the cylindrical upper end h^5 of the valve may fit loosely, so as to leave a narrow annular passage around it, and below this opening the chamber is widened, forming an inclined seat b^2 for the conical face h^3 of the valve, as seen in Fig. 2. This widening seat, forming parts, extends below the valve-seat and terminates in a rounded recess b^3 and forming the widest part of the ignition-chamber, and is thereupon again contracted to form a cylindrical portion b^4, having the outlet-passage e in its side near the upper end, said passage communicating with the combustion-chamber of the power-cylinder, and also having a smaller jet-supply passage f. The cylindrical portion of the valve fits freely in the cylindrical portion of the ignition-chamber, the long cylindrical portions h' controlling the ignition port or passage e, opening the same when the valve is entirely raised, while the short recessed portions m and the deep recesses m' leave a permanent connection between the ignition-chamber and the jet-supply passage f. That part which operates the lighter-port c has the beveled joint forming face h^3, adapted to close without sliding friction upon the correspondingly-formed seat b^2 within the ignition-chamber around the walls of its central opening c, so as to close the communication of said chamber with the external lighter d. The ignition-chamber communicates with the combustion-chamber of the power-cylinder, through a passage e, at a point below the bottom of said ignition-chamber, and this passage is also controlled by the puppet-valve, which control is best effected by a cylindrical valve part h', adapted to close such communication at the time when the lighter-port is freely open. By this construction the puppet-valve has also the function of a plunger-valve, also acting without sliding friction, because it is not necessary to make a close fit of this valve part with its case, since at the time this part of the valve is acting the cylinder-pressure is low, and the gases that may leak by said valve part will be from the charge. The said leakage may be utilized as a portion of the supply to the ignition-chamber to sustain the torch-flame therein.

In the operation of the ignitor-valve there is a time when the communication between the ignition-chamber and the inner-wall passage of the valve-case is opening, while the valve is not yet seated, as seen in Fig. 2; and to avoid a great loss of gas, which would escape at this time through the lighter-port, I provide for temporarily closing this port by forming the outer end of the valve into the part h^5, preferably adapted to enter but not closely fit the lighter-port c. This loose fitting of the valve part h^5 into the lighter-port has the advantage of affording a leakage of gas from the ignition-chamber during this movement of the valve in order to sustain the torch-flame in said chamber. When the valve part h^3 closes upon its seat b^2, a perfect joint is effected, and at this moment the ignition of the charge takes place through the passage m' and e, and the pressure at this moment in the ignition-chamber acts to press the valve-face upon its seat.

While the valve having the inclined and cylindrical seat parts h' and h^3 is preferred, yet their function may be performed by a single valve part, as shown in Fig. 17, wherein the ignition-chamber is formed so as to be closed off on both sides by the valve part h', the end of which has the inclined face fitting the seat in the lighter-port.

In the operation of the ignitor-valve it is necessary to provide a torch-bearing flame within the ignition-chamber, which will burn while the ignitor-valve part is closing, and which will ignite the charge with certainty, and for this purpose I have shown various forms of ignition-chambers. Since, however, this matter will be made the subject of separate and distinct applications for patents by me, it is deemed only necessary to particularly describe herein one form of such form in connection with my combined valve, it being understood that my puppet-valve is not limited to any particular form of ignition device.

Referring to Figs. 1 to 12 as illustrating that part of my present invention which relates to the production of a torch-bearing flame by means of eddy currents, e is the ignitor-port, by which the ignition-chamber has communication with the cylinder-charge. f is a jet-supply passage formed in the valve-case wall, so as to open into the ignition-chamber, and communicate with the cylinder-charge and be controlled by a screw-plug f', accessible from the outside, as shown in Figs. 2 and 6. As shown in Fig. 6, this jet-supply passage is formed in the wall having the ignitor-passage. When the valve is in the position shown in Fig. 3, its plunger part h' closes the ignition-port e, and the combustible mixture passes through the passage f, under the valve, and up along the side of

its plunger part, as indicated by the arrows 1. To permit this upward free current passage, the plunger-valve part is preferably formed with surface-channels *m* and *m'*, as shown in Figs. 7 and 22. As these currents pass over the edge of the recess 4, formed around the sides of the valve just above its plunger part, they will cause eddy currents within said recesses between the walls of the valve and its case-walls. Continuing to rise, these currents will pass from these valve-recesses up into the ignition-chamber, over its bottom edges, and under the puppet-valve part, producing the eddy currents 3 within said chamber. Then still rising, these currents 1 will pass over the puppet end of the valve and produce a series of eddy currents 2 within the chamber to its lighter-port. Having now reached the external lighter, the flame will flash back along the eddy currents 2 into the ignition-chamber to the eddy currents 3 and 4, which will burn with a steady torch-flame during the movement and closed position of the valve. (Shown in Fig. 4.) At this moment the lighter-port is closed and the ignition-port *e* is open, so that the flame is communicated to the charge in the passage *g*, leading to the combustion-chamber of the engine, through the recesses of channels *m m'*.

By referring to Fig. 4 of the drawings the special functions and advantages of the channels and recesses *m'* in the opposite sides of the cylindrical valve portion will be clearly seen and understood. The ignitor-gas in the ignition-chamber will require a freer passage to the ignition-port *e* than the shallow grooves or channels *m* in the cylindrical valve portion can afford, and this freer passage is afforded by the valve being raised sufficiently high to bring the shoulders between the channels *m* and the recesses *m'* above the edge b^5 of the recessed portion of the ignition-chamber, so that the flame, which is indicated by the arrows 5 5, may pass freely between the said shoulders and the said edge into the recesses *m'*, and through them down to the space below the cylindrical portion *h'* and into the ignition-port *e*.

In order to increase the effect of the outward currents 1 in producing the reverse currents 2, I prefer to form the recess h^6 in the end of the valve, the effect of which causes a greater suction action over the edge of the valve extension h^5 and gives a greater effect to the action of the currents 1 in causing the currents 2.

As before stated, the plunger-valve part *h'* need not make a contact-joint fitting over the ignition-port *e*, for the gases that leak from there help to supply the torch-flame, and if this leakage were great enough it would not be necessary to supply any gas through the passage *f*; but in order to have this torch-supplying gas under control I prefer the plunger-valve part should operate to substantially close this port *e*, so that the jet-supply will come principally from the passage *f*.

I have described and shown a puppet-valve as co-operating to produce the eddy jet-currents for the torch-bearing flame of the ignitor, but my invention in this particular is not confined to such form of valve. For producing such eddy jet-currents I may use a plug and puppet-valve, as shown in Fig. 16, adapted to close from the outside of the ignition-chamber; or I may form the ignitor-chamber *b* in a slide-valve, as shown in Fig. 15, wherein the action of the primary gas-jet (indicated by the upward-standing arrow 1,) will cause an eddy jet in the valve-chamber *b*, in a manner substantially as indicated in Fig. 3. I may also use other forms of torch-jets in connection with the combined ignitor-valve—as, for instance, a whirling jet, as shown in Fig. 14; or I may use an expanding retarding-passage of ordinary form for supplying the ignitor-jet in connection with my combined valve.

One advantage in the use of my improved puppet-valve is the fact that it controls all the ports, and may be operated rapidly, consisting, as it does, of a single moving part having a positive motion.

The valve for controlling the admission of the charge to the power-cylinder is also of the puppet form, and the matters of improvement embodied in it are a construction which tends to remove foreign substance which may collect upon its faces, a construction by which it is made capable of yielding in body to accommodate it to changes which may occur in the case-seat, a provision for such valve or valves for permitting the escape of leakage, which may be due to their imperfect form, and to a provision whereby the valve is free to take up its own joint-forming position without restraint from its operating-connection.

The gas-supply pipe M enters a chamber N below the seat for the charge-admission valve, the upper end of said seat opening into the passage *g*, communicating with the combustion-chamber, as shown in Figs. 1 and 19.

I prefer to make the charge-admission valve in two independent parts, each forming a separate valve, one placed above the other, and controlling the same passage, and as they perform the office of a single valve I prefer to treat them as such in this specification. The advantage of making this valve in two independent parts is that each part is thus free to make its own joint independent of the other. Such independent action is of special advantage in case any foreign substance should lodge upon the seat of one valve part, so as to cause leakage of such part. Then the other part will form a joint and sustain the pressure of the charge. The upper part *t* of this valve preferably has its stem fitted in an upper case-guide, and is preferably controlled by a spring *t'*, while the lower valve part *u* is preferably controlled by the stem *s*, fitted in a lower case-guide, and which stem I prefer to connect loosely to the lower end of a short

stem upon which this lower valve part u is mounted.

The stem-connection, as shown, is made by a loosely-fitting screw-thread; but however made, such joining should allow ample freedom of motion to permit the valve to seat itself without restraint and without interference with its joint-forming function. The short stem of this lower valve part extends upward into the upper valve part t to lift it, so that the two valve parts operate together in controlling the admission of the charge. Both parts are preferably made hollow to form thin yielding walls, so that as the valve wedges downward upon its tapering seat these thin walls will yield so as to fit accurately upon the seat, even if the latter shall have been distorted from any cause, and thus a tight joint will be insured.

In the seat of the valve-case I prefer to form a groove r, so as to divide the seat into two sections, and this groove may be connected by a wall passage r', opening to the air at the side of the case, as seen in Fig. 11. The object of thus separating the two valve-seats by the groove is to collect any gas that may leak by the joint-forming faces of one of the valve parts and allow it to pass out, instead of being forced past the joint-forming face of the other valve part. This escape provision renders it impossible for any leakage of gas to pass the combined valves. When the valve parts are raised together to admit the charge, there would be a free escape of the gas through the aforesaid valve-seat groove, and in engines using a compressed charge this loss of gas would be considerable. In such cases I would omit the passage r' and form a leakage storage-chamber between the valves, as shown in Figs. 1, 19, and 21, wherein such storage-chamber is formed by the upper hollow valve, and for this purpose the valve parts are slightly separated. With such provision for the storage of leakage, suppose the upper valve part to make imperfect seating, the gases leaking by it would collect within the valve-chamber, gradually filling it, but some time would be consumed in so doing; hence the lower valve part would only have to resist the pressure of the gases contained in the said leakage storage-chamber, which pressure would be much less than that of the charge, and in rapidly-running engines the piston would advance so quickly as to lower the pressure of the cylinder-gases before the pressure in the storage-chamber would accumulate to any great extent, and the said chamber hence will act to hold the leakage gases only momentarily. Then as soon as the valve opens to admit a fresh charge to the cylinder the stored gas instantly escapes ahead of the fresh incoming gases and all pass into the cylinder together as the charge. This leakage storage-chamber may be formed in the case as well as in the valves, and for this purpose the groove r can be made large enough, or the valve parts can be placed far enough apart, to serve the purpose.

In Fig. 12 I have shown an admission puppet-valve of one part only, which, in connection with the seat-dividing groove, operates in substantially the same manner as the two-part separate valves. When the valve shown in this figure is made hollow, I prefer to partially fill the interior of the valve by a loose plug t^2, which acts as a shield to protect the thin valve-walls from the direct contact of the hot gases of the charge.

In an application for a patent filed by me December 30, 1886, under Serial No. 222,990, I have shown and described a gas-engine in which the waste gases are driven out by the incoming charge, and in which the gases are prevented from mixing by means of one or more perforated plates placed in the entrance-passage, so as to divide it into a series of chambers. My present invention contemplates the use of such entrance-chambers, but with separating-plates having central openings of less diameter than said chambers, whereby to prevent the mixing of the gases, and I have shown such improvement in Figs. 1, 19 and 20. Referring to these figures, I prefer to form the main supply-passage for the engine in a separate cap or hood A, placed directly over the cylinder and forming the end chamber of the series. The charge enters from the admission-valve through the passage B from the valve-chamber passage g, and passes through the cap-passage C into the cap-chamber C', from which it passes through a central opening D in an inner cap-plate into a chamber E, which opens into the cylinder proper by a central opening formed in a plate F, the upper central opening D being of less diameter than the chamber C', while the central opening of the inner plate F is of greater diameter than the opening D.

In Fig. 19 the piston is shown in its lowest position uncovering the exhaust-ports I, which open into the exhaust-passage K, so that as the combustible mixture flows into the cylinder through the entrance-openings of different diameters the waste gases are thereby forced out through the exhaust-ports.

The action of the entrance-passages is as follows: The charge entering in currents through the passage C, as indicated by the arrows, flows into the chamber C' under a high velocity, and these currents naturally circulate around in and in contact with the walls of said chamber, during which time they gradually lose their velocity by mutual interference before they reach the center opening D. They are now ready to flow through the said opening in a solid stream, without eddy currents and with a greatly reduced velocity of flow, into the next chamber E, from which chamber they expel the waste gases of the previous charge, and then pass through the center opening in the plate F in a solid column, carrying the old charge ahead of the column without eddy currents

and without mixing therewith. I may use a series of chambers, and in large engines more than two would be desirable to perfectly control the entering charge.

In Fig. 1 I have shown the operating connections of the crank-shaft with the ignitor puppet-valve by the rod i, with the admission-valve by the rod i^2, and with the piston by the rod i^3, and the strokes of these parts are adjusted for the proper operation of the engine.

It will of course be understood that my invention is not limited to the precise devices and combinations of devices herein described and illustrated, as many modifications in each and all of them may obviously be made without affecting the principle or exceeding the scope of my invention.

I claim—

1. In an ignition device, the combination of an ignition-chamber and suitable devices for causing therein a primary jet-current, and a secondary eddy current induced in said chamber by the action of said primary current, substantially as described.

2. In an ignition device, the combination of an ignition-chamber and suitable devices for causing therein a primary jet-current, and a secondary eddy current induced in said chamber by the action of said primary current, with a valve controlling communication between said chamber and an external lighter and the charge, substantially as described.

3. The combination, in an ignition device, of an ignition-chamber, and a positively-moving puppet-valve closing with the pressure in said chamber at the instant of the explosion of the charge, substantially as described.

4. The combination, in an ignitor device, of an ignition-chamber, ports communicating between said chamber and an external lighter and between said chamber and the charge, with a positively-moving puppet-valve controlling said ports and closing with the pressure in said chamber at the instant of the explosion of the charge, substantially as described.

5. The combination, with a gas-engine, of a double puppet-valve and its case-seat, having separate joint-forming faces closing the same passage at the same time, substantially as described.

6. An ignition-valve having three port-operating faces, the middle one of which is inclined to the line of its movement, in combination with an ignition-chamber, substantially as described.

7. An ignition-valve having three port-operating faces, the middle one of which is inclined to the line of its movement, in combination with an ignitor-chamber having a lighter-port, an inner-wall passage, and an intermediate valve-seat corresponding to the inclined face of the valve, substantially as set forth.

8. The combination, with a gas-engine, of a double puppet-valve and its case-seat, having separate joint-forming faces having a leakage storage-chamber formed between the said joint-forming faces, substantially as described.

9. The combination, with a gas-engine, of a double-seated puppet-valve, a case-seat therefor, and a passage dividing said seats and connecting with a waste-passage, whereby to prevent the fouling of the charge, substantially as described.

10. The combination, in an ignitor device, of an ignition-chamber having an end lighter-port c at its top, lateral recesses at its bottom, and intermediate inclined seat-forming walls, with a puppet-valve having inclined joint-forming faces, and side recesses beneath said faces, whereby to produce eddies or secondary currents in the gas entering the ignition-chamber, substantially as described.

11. In combination with a gas-engine cylinder, an entrance-passage into the end of the same having partitions formed with central apertures increasing in diameter toward the end of the cylinder, substantially as described.

12. In a gas-engine, a cylinder having chambers formed at its inlet end communicating with each other and with the cylinder through central apertures of increasing diameter toward the end of the cylinder, substantially as described.

13. In combination with a gas-engine cylinder, two chambers communicating with each other through a central aperture and with the cylinder through a central aperture of a larger diameter than the concentric aperture between the chambers, substantially as described.

14. In combination with a gas-engine cylinder having an upper open end, a cap over the said open end having the gas-entrance passage opening in it and formed with a chamber having a central aperture in its upwardly-bulged bottom, and a plate over the open end of the cylinder having a central aperture of a greater diameter than the registering aperture in the bottom of cap and forming a chamber between it and the said bulged bottom, substantially as described.

15. The combination, with a conical inlet-valve seat for a gas-engine having an annular channel or groove in its seat-forming face, of two co-operating but loosely-connected conical valve portions fitting in the seat and having a chamber formed in the upper valve open at the bottom and having the space between the meeting ends of the valve portions registering with the chamber in the seat, substantially as described.

16. The combination, with a conical inlet-valve seat for a gas-engine, of an upper valve portion fitting in the upper part of the seat playing freely in the same and having means for seating it, and a lower valve portion fitting in the lower part of the seat and having

means for reciprocating it and bearing with its upper portion against the upper valve portion, substantially as described.

17. The combination, with a conical inlet-valve seat for a gas-engine, of an upper valve portion fitting in the upper part of the seat playing freely in the same and having a spring forcing it to its seat, and a lower valve portion fitting in the lower part of the seat and provided with a reciprocating and loosely-attached rod, and with an upwardly-projecting stem bearing into a recess in the upper valve portion, substantially as described.

18. The combination, with a conical inlet-valve seat for a gas-engine having an annular groove or channel, of an upper valve portion fitting in the upper portion of the seat above the channel and having means for seating it, and having a recess or chamber formed in it open at the lower end, and a lower valve portion fitting in the seat below the channel and provided with means for reciprocating it, and with a stem projecting upward into the chamber of the upper valve portion supporting the same, substantially as described.

19. The combination, with the conical inlet-valve seat for a gas-engine having the annular channel or groove r, of the upper valve portion t, having the spring t', forcing it to its seat above the channel and having the chamber formed within it open at the lower end, and the lower valve portion u, having its reciprocating stem s secured movably in a socket at its lower end and having the upwardly-projecting stem supporting the upper valve, substantially as described.

20. The combination, with the conical inlet-valve seat O, formed with the channel r, and having chamber N below it receiving the supply-pipe M and gas-passage g above it, of the upper valve portion t, having spring t', the lower portion u, having the upwardly-projecting stem and the downwardly-extending socket, and the stem s, loosely secured in the socket and having means for reciprocating it, substantially as described.

21. In a gas-engine, the combination of the ignition-chamber b, having a cylindrical outlet c and conical valve-seat b^2, and formed with the recess b^3, having upwardly-curved edge b^5, and the cylindrical extension b^4, with the reciprocating valve A^2, having the cylindrical upper end h^5 and the conical face h^3, and formed with the recess 4 and cylindrical portion h', and channels m and recesses m', as shown, and for the purpose specified.

22. The combination of the ignition-chamber having the upper seat formed with the recess b^3, forming edge b^5, and the cylindrical extension b^4, having inlet-passage f and outlet-passage e, with the valve having the upper seating portion and formed with the cylindrical portions h', and with the channels m and recesses m', as shown, and for the purpose specified.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

LEWIS HALLOCK NASH.

Witnesses:
JNO. H. NORRIS,
PERCY MACCALLUM.