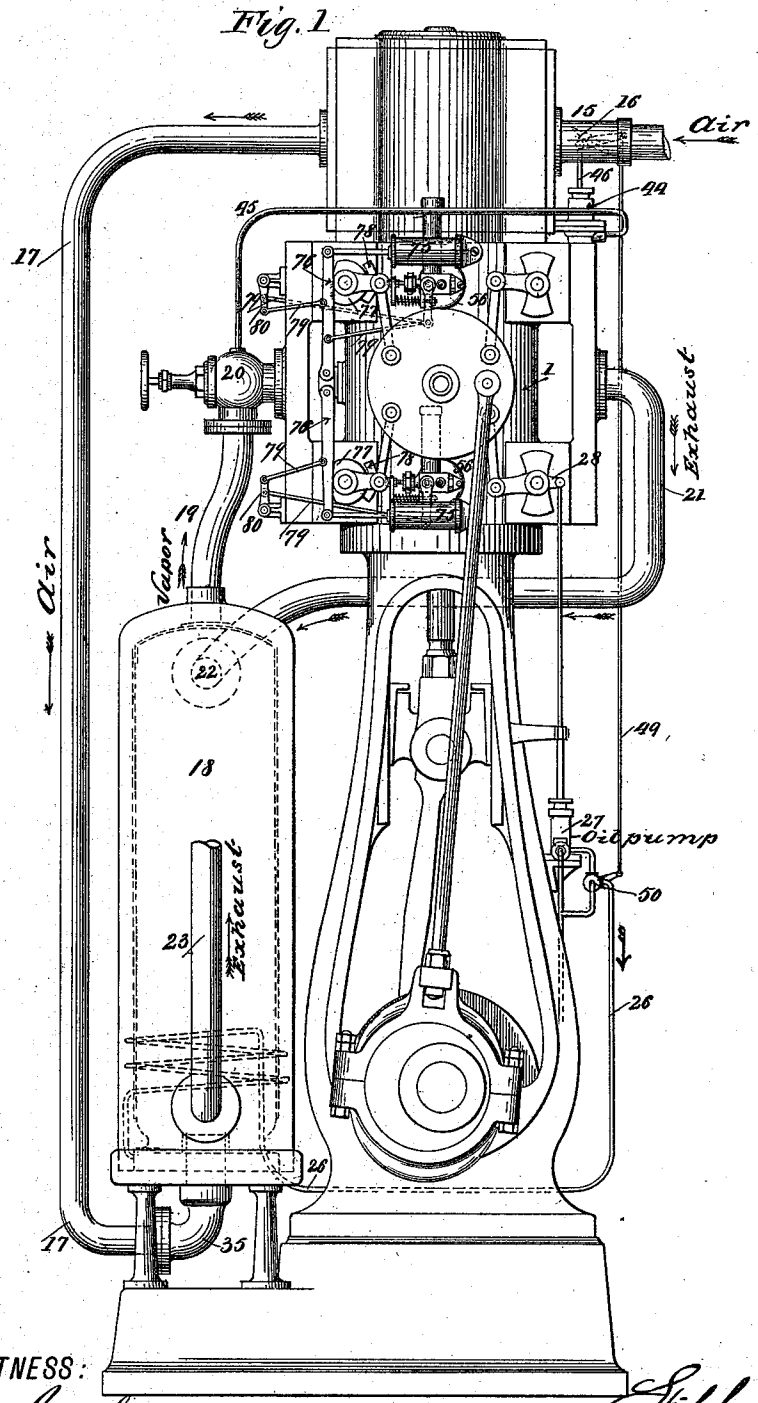
(No Model.) 4 Sheets—Sheet 1.

S. WILCOX.

GAS OR AIR ENGINE.

No. 402,549. Patented Apr. 30, 1889.

Fig. 1



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(No Model.) 4 Sheets—Sheet 2.

S. WILCOX.

GAS OR AIR ENGINE.

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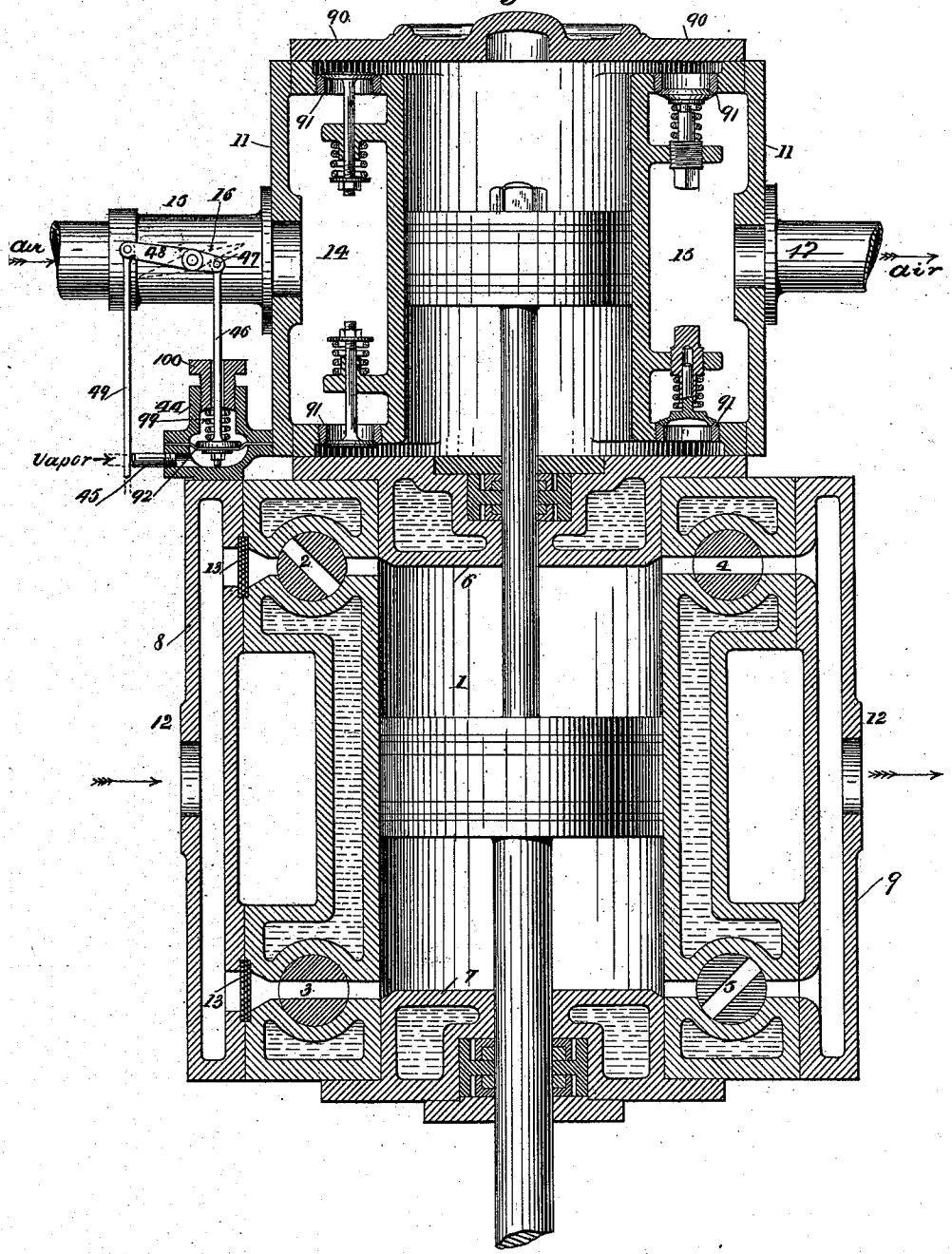
Fig. 2.



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GAS OR AIR ENGINE

No. 402,549. Patented Apr. 30, 1889.

Fig. 3.

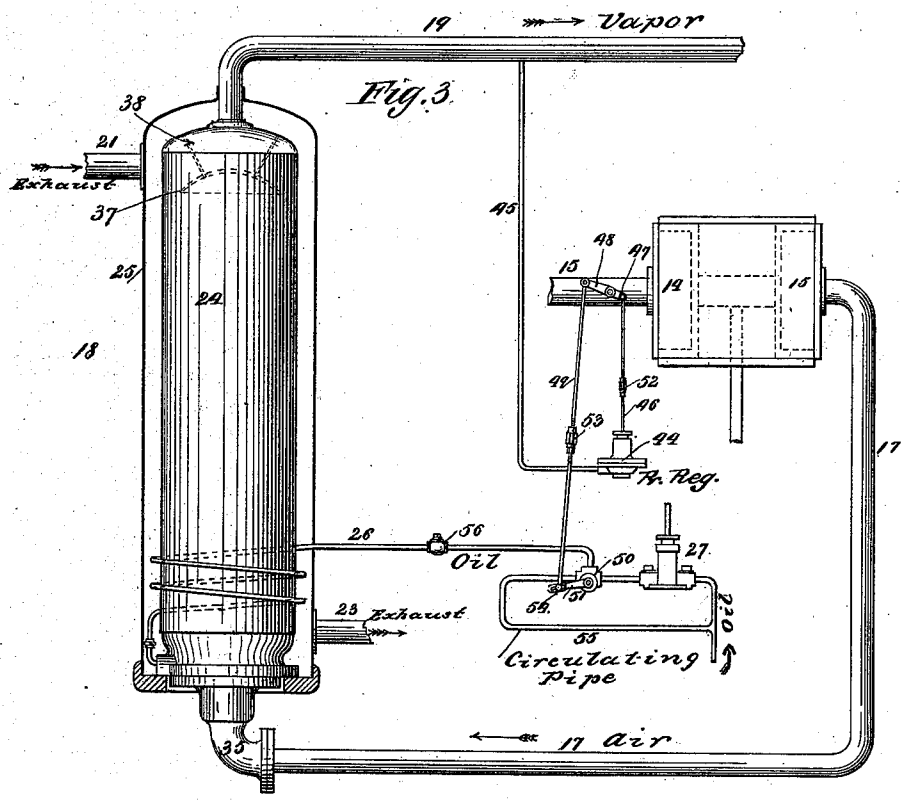


Fig. 4.

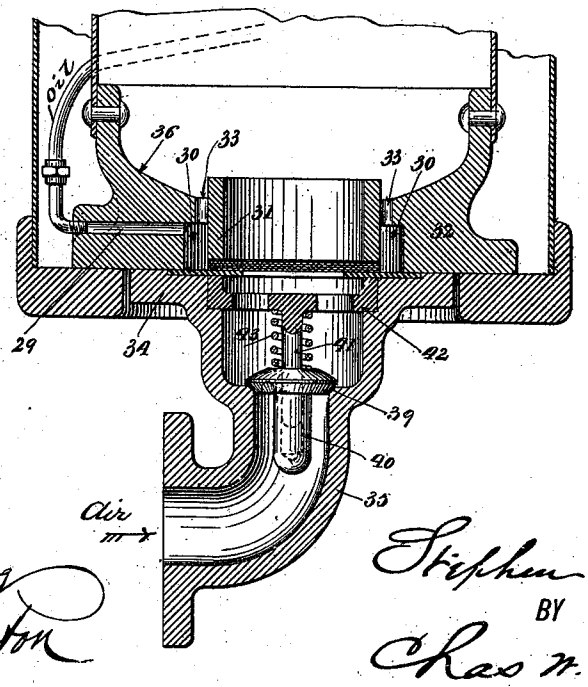


Fig. 5.

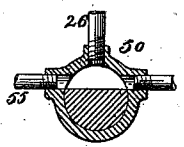
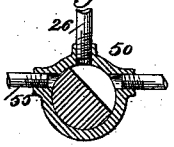


Fig. 6.



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(No Model.) 4 Sheets—Sheet 4.

S. WILCOX.

GAS OR AIR ENGINE.

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Fig. 7.

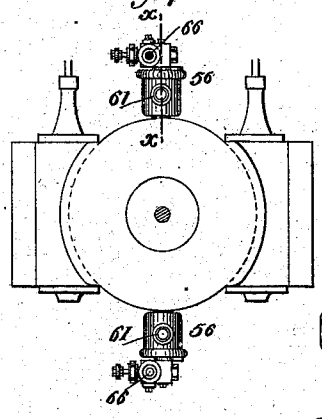


Fig. 8.

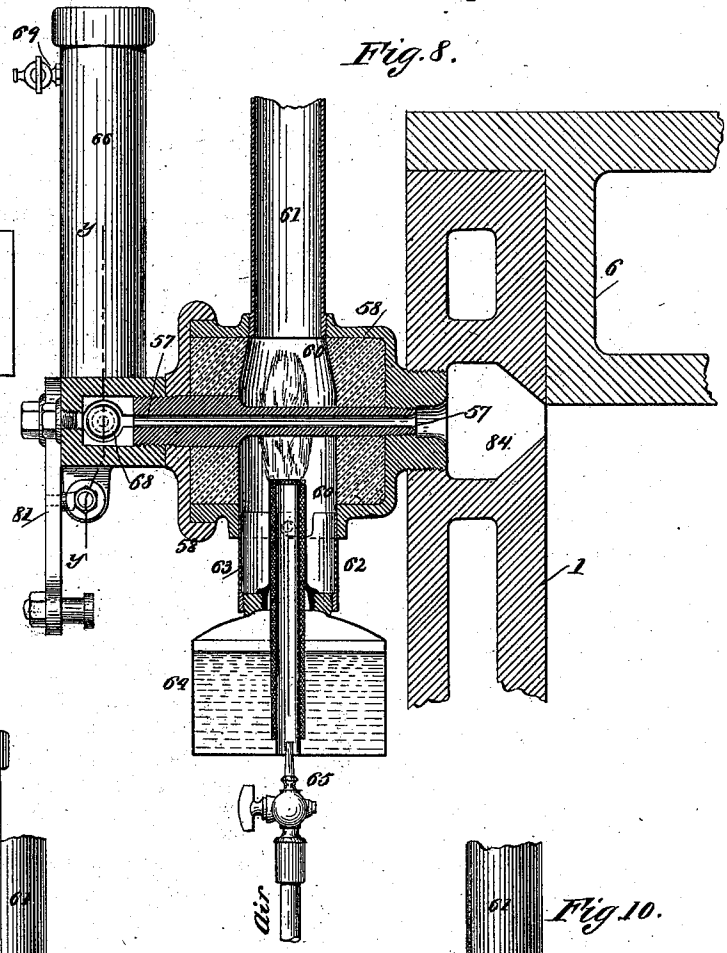


Fig. 9.

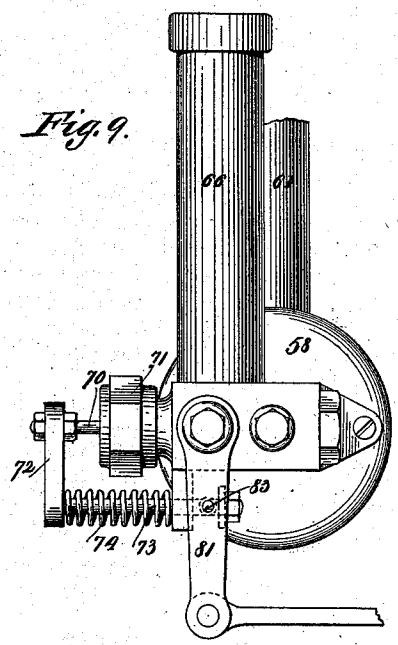
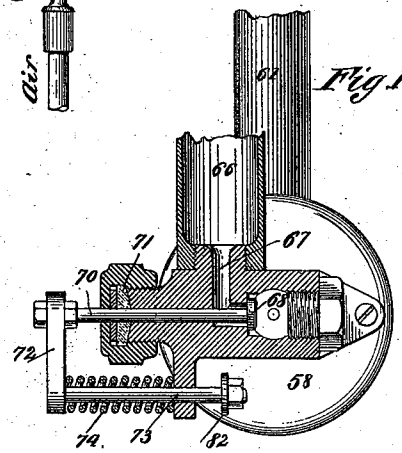


Fig. 10.



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UNITED STATES PATENT OFFICE.

STEPHEN WILCOX, OF BROOKLYN, NEW YORK.

GAS OR AIR ENGINE.

SPECIFICATION forming part of Letters Patent No. 402,549, dated April 30, 1889.

Application filed March 21, 1887. Renewed February 7, 1889. Serial No. 299,087. (No model.)

To all whom it may concern:

Be it known that I, STEPHEN WILCOX, a citizen of the United States, residing at Brooklyn, county of Kings, and State of New York, have invented certain new and useful Improvements in Air or Gas Engines, of which the following is a specification, reference being had to the accompanying drawings.

This invention relates to the class of engines in which compressed air charged with a combustible fluid forming an explosive compound is fired in the working-cylinder.

The invention consists in combining the inflammable fluid with the air prior to its admission to the working-cylinder and permeating the air with the said fluid by a repeated pulverizing action of the air upon the liquid by mechanical force, so that any portion of the fuel not effectually combined will be returned and subjected to repeated action; in heating the air and fluid during their combining action, so as to prevent as far as possible the condensation of the latter; in certain improved devices for igniting the cylinder-charge by transmitted heat simultaneously with the cut-off action of the cylinder induction-valves, and in a certain novel controlling device for regulating the effective capacity of the air-pump and the proportionate fuel-supply, according to the rate of consumption by the engine.

In order to enable others to understand and use my invention, I will describe the application of its several features to an upright inverted-cylinder engine, shown by the accompanying drawings, the same embodying one of various forms of construction of the several devices by which the respective methods of the invention may be carried into practice.

In the drawings, Sheet 1: Figure 1 is a general elevation of the machine, including the working-cylinder, air-pump, and receiver or pressure reservoir, and showing a general view of the variable cut-off mechanism, similar in action to the well-known Corliss type, the variable tripping-cams for the induction-valves and the governor being omitted, although preferably employed in connection with the present apparatus.

Sheet 2: Fig. 2 is an enlarged vertical central section showing the interior organization of the working-cylinder, the air-pump, and the several adjacent valves.

Sheet 3: Fig. 3 is a detail view of the receiver, the exterior shell being shown in section, the interior one in elevation, and the controlling device for regulating the air and fuel supply located relatively thereto, the latter with its connecting-pipes being diagrammatically shown; Fig. 4, an enlarged vertical central section showing the portion of the receiver at which the fuel is mechanically combined with the air-charge, and Figs. 5 and 6 detail views of the fuel-controlling valve.

Sheet 4: Fig. 7 is a plan view of the working-cylinder and ignitors; Fig. 8, an enlarged vertical section of one of the ignitors and a portion of the cylinder, taken on the line x x, Fig. 7; Fig. 9, a front elevation; and Fig. 10, a transverse vertical section on the line y y, Fig. 8.

Like numbers of reference indicate corresponding parts throughout the several views.

The double-acting working-cylinder 1, Fig. 2, and its valve-seats and heads containing the piston-rod stuffing-boxes are provided with water-jacket spaces, through which water is circulated by suitable pipe-connections, in the manner usual to engines of the present class, to prevent overheating of the working parts in frictional contact.

The induction-valves 2 3 and exhaust-valves 4 and 5 are constructed in cylindrical form, having their ports made directly through them, and having a circumferential bearing-surface upon their seats, so as to resist pressure in either direction, which in the instance of the induction-valves occurs from the receiver toward the cylinder during the exhaust-stroke and from the cylinder toward the receiver during a portion of the pressure-stroke.

To the outer facings of the valve-casings are bolted the air-chests 8 and 9, to which the induction and eduction pipes 19 21 are bolted at 12. Between the facings of the valve-casings and the chest on the induction side are interposed the perforated screens 13, which, in event of the premature ignition of the cylinder-charge, will prevent the inflamed fluid extending back into the receiver. The said

screens 13, being located back of the induction-valves, are protected from the heat of the cylinder, and so placed are rarely brought into action.

The cylinder-head 6 constitutes also the lower head of the air-pump cylinder, being bolted in its interposed position, securing the two cylinders together. This construction obviates the employment of an additional stuffing-box for the air-pump, gives solidity to the general structure, and, furthermore, furnishes a water-jacket which cools both cylinder and pump and the intervening stuffing-box.

The arrangement of the suction-valve chest 14 and discharge-valve chest 15 and valves of the air-pump will be apparent from an inspection of Fig. 2. The chests 14 and 15 are rendered easily accessible by the removal of the covers 11, whereby the examination or renewal of the valves is facilitated. The openings at the ends of the pump-cylinder opposite the valves are covered by the cylinder-head at the bottom and by extensions of the pump-head at the top, at 90, which permit the convenient fitting or replacing of all the valve-seats 91, which consist of separate bushings screwed in position.

In Fig. 1 the suction side of the pump is shown on the reverse side to that as shown in Fig. 2, and is provided in the adjacent section of the suction-pipe 15 with a regulating throttle-valve, 16, to control the admission of air and determine the effective working capacity of the pump, the said regulating-valve being actuated by means of an automatic controlling mechanism, hereinafter fully described.

The discharge-pipe 17 of the air-pump is carried to the lower end of the receiver 18, entering the inner shell of the same through the connection shown more fully in Fig. 4. The top of the interior receiver-shell is connected by the pipe 19 to the induction side of the working-cylinder, and is provided with a throttle-valve, 20.

The exhaust-pipe 21 of the working-cylinder is connected to the intervening space between the exterior and interior shell of the receiver at the point 22, and to the opposite or lower end of the exterior shell is connected the discharge-pipe 23, passing to the atmosphere.

The receiver and connections (more fully shown in Sheet 3) are composed of a double shell, 24 and 25, between which the hot products of combustion from the working-cylinder impart heat to the contents of the inner shell and also to the fuel-pipe 26, which is passed in coils through the heated space, as shown. The fuel is delivered in regulated quantities through said pipe 26 by the pump 27, located in any convenient position on the machine, as shown by Fig. 1, so as to be connected and operated, preferably, by the rock-arm 28 of one of the cylinder exhaust-valves. The liquid fuel is thus forced through the port 29, Fig. 4, and falls by gravity to the bottom of the annular chamber 30 around the rim 31, the latter being fixed and integral with the casting 32, the apertures 33 being in the form of perforations. The flange 34 of the elbow 35 is bolted to the casting 32, and between the said flange and casting are interposed several layers of perforated plates or wire-gauze, forming a screen, between the spaces or meshes of which the liquid fuel will permeate and be blown into a fine spray by the air-blast from the air-pump delivery-pipe 17.

The apertures 33 are provided for the purpose of returning any portion of the fuel failing to be sufficiently pulverized or being condensed to the annular chamber 30, the said condensed portion being returned by gravity to the inclined surface 36 at the bottom of the receiver. At the bottom of the annular chamber 30 a suitable cock may be connected through the flange 34 of the elbow for the purpose of draining off any thick portions of oil that may accumulate in said chamber. At the top of the receiver a deflector, 37, is suspended by rods 38, for the purpose of receiving the force of the air-current and preventing as far as possible the passage of any unpulverized portions of the fuel.

In the elbow 35 of the air-pipe 17 a check-valve, 39, is provided for the purpose of preventing the return of air or entrance of fuel to the said pipe by back-pressure between the periods of the pump-stroke. The check-valve 39 has a hollow sleeve, 40, formed upon it, which slides on the guiding stationary stem 41, projecting downward from the perforated plate 42, secured in the aperture of the elbow. A spring, 43, tends to retain the valve on its seat.

The controlling devices for regulating the supply of air and fuel (shown diagrammatically in Fig. 3) are actuated by means of a pressure-diaphragm of the well-known construction in the casing 44, the said construction being more fully represented in Fig. 2. The diaphragm 92 is subjected to the pressure from the receiver air-pipe 19 and the tube 45, being connected thereto, as shown in Fig. 3, or to the throttle-valve casing, as shown in Fig. 1, on the pressure side thereof. The diaphragm 92 is operatively connected by the rod 46 to the rock-arm 47 of the suction air-pipe valve 16, so as to diminish the opening of the latter when the pressure of the compressed air from the air-pump increases, and vice versa. The diaphragm 92 is provided with a regulating-spring, 99, and adjusting-sleeve 100, for counteracting the actuating-pressure on the diaphragm to the requisite degree. By means of suitable connections, as a rock-arm extension, 48, and connecting-rod 49, a circulating or three-way cock, 50, is operated by its rock-arm 51, so as to direct a greater or less portion of the fuel from the pump 27 through the fuel-pipe 26 by the aforesaid action of the diaphragm. The connecting-rods 46 and 49 are provided with turnbuckles 52 and 53, and one or more of the

rock-arms may be slotted, as at 54, so as to permit a radial adjustment of the rod-heads, the purpose being to obtain a ready and accurate adjustment of the proportionate movements of both regulating-valves.

The fuel-regulating cock 50 is more fully shown in Figs. 5 and 6, the former showing it in a position by which the fuel is circulated in rotation through the return-tube 55 to the suction side of the fuel-pump and the latter in a position by which the said fuel is forced entirely through the feed-pipe 26 to the chamber 30 of the receiver, the latter pipe having a check-valve, 56, to prevent the return of the fuel when the cock 50 is in the position of Fig. 5. The effect of the pressure-regulator thus connected is to maintain a uniform pressure of the inflammable fluid of maximum efficiency within the receiver during the fluctuations of the variable cut-off and consequent variation of consumption as controlled by a speed-regulator under different loads upon the engine.

The several ignitors 56 (shown more fully in detail by Figs. 7 to 10, inclusive) are each composed of a tube, 57, placed in a casing, 58, the whole being inserted into an aperture, 84, in the side of the cylinder at suitable points adjacent to the cylinder-heads.

A portion of the tube 57 is exposed within the vertical cavity 60 of the casing 58 to a constant oil or gas flame. This exposed portion of the tube 57 is preferably composed of nickel, platinum, or other efficient heat-conducting material which will resist the oxidizing action of intense heat. The casing 58 is filled with fire-brick or other heat-resisting substance surrounding the cavity 60. The opening at the top of the cavity is furnished with a chimney or draft-tube, 61. The lower end of said cavity is provided with a removable sleeve, 62, having draft-perforations 63 and carrying at its extremity the oil-lamp 64. The oil-lamp has preferably a circular wick, through the interior wick-tube of which a jet of air and inflammable fluid may be forced from the jet 65, connected to the receiver 18, or other source, for the purpose of intensifying the heat of the flame if necessary, especially in starting the engine.

Upon the outer extremity of the igniter is attached a chamber, 66, communicating with the ignitor-tube 57 by means of a port, 67, and an interposed valve, 68, by which latter the moment of action of the ignitor is determined.

The stem 70 of the valve 68, extending through a packing-gland, 71, has upon its outer end an offset-arm, 72, guide-rod 73, and a spring, 74, which tends to move the said valve to its closed position. The guide-rod 73, having at its extremity a collar, 82, is operated by a rock-arm, 81, bearing a stud, 83, which engages with said collar.

The valve 68 is actuated preferably by a connection with the cylinder-valve cut-off mechanism, so as to act coincident with or slightly in advance of the cut-off and in a manner which will be obvious by an inspection of Fig. 1, the said cut-off mechanism being of a construction which I have described in a separate application, filed simultaneously herewith, and which will therefore not require specific description here further than to state that the boxes 75 contain springs, which move the levers 76 in the direction of the arrows to the normal position shown, thereby performing the act of closing or cutting off the cylinder induction-valves when the cams 77 are released by tripping the pawls 78. This movement of the levers 76, the same having connection by rods 79 and rock-arms 80 to the rock-arms 81 of each ignitor-valve, will cause the latter to be held normally open by virtue of the preponderating springs in the boxes 75 acting in opposition to the springs 74, as when moved to the position of Fig. 1. The opening movement of a cylinder induction-valve by the means illustrated will therefore close the ignitor-valve 68 and cause the products of combustion from the preceding discharge in the cylinder to be detained in the ignitor-tube 57 and its enlargement or chamber 84, preventing the entrance of the explosive cylinder-charge into said tube until the event of cut off. At the latter event, the ignitor-valve, being thrown open, permits the pressure of the explosive cylinder-charge to drive the aforesaid products of combustion into the chamber 66, and the inflammable charge, following into the hot tube, becomes ignited. Upon the return-stroke of the piston the exhaustion within the cylinder will allow the compressed gases in the chamber 66 to be released through the port 67 preparatory to a repetition of the operation.

It will be observed that the enlargement 84, between the ignitor-tube and the cylinder, is provided for the purpose of insuring a sufficient bulk of burned gases to fill the tube and prevent premature explosion.

The chamber 66 is provided with an escape-cock, 69, for the purpose of discharging its contents and permitting the explosive gases to enter the ignitor-tube, when, especially in starting the engine, the pressure in the receiver is not sufficient to effect the necessary compression in said chamber of the burned gases.

The employment of more than one ignitor at each end of the cylinder insures against failure of ignition, and promotes rapidity of inflammation, especially in cylinders of large diameter.

Inasmuch as the initial pressure of the compressed explosive cylinder-charge will rapidly decrease during any interval that may occur between the moment of induction cut off and the act of explosion, it is of importance that the whole charge should be ignited instantaneously and coincident with (or slightly in advance of) the moment of cut off. To this end an important function of the enlargement or chamber 84 is to provide a partially-separated volume of the inflammable fluid that will

receive first ignition, and by its early explosion force the flame through the cylinder aperture in the form of a jet, which will traverse the cylinder and ignite the whole charge with energy and increased rapidity.

In the operation of the engine the inflammable fluid is first supplied to the annular chamber 30, around the porous diaphragm of wire-gauze in the bottom of the receiver, by means of a suitable hand-pump, or by disconnecting the pump 27 and operating it independently, and the fluid permeates the said gauze preparatory to being diffused into the receiver by the compressed-air charge from the pipe 17. The first air-charge is necessarily furnished from an exterior source, which may be of any appropriate construction—as an independent compressed-air reservoir. The ignitors being heated they will operate in the manner described upon admitting the explosive mixture to the working-cylinder. The explosive mixture is admitted during the early part of the piston's stroke, (say one-fourth of the latter,) at the termination of which event the induction-valve cut-off movement and simultaneous action of the igniter produces the succeeding event of explosion, the increased pressure of the latter being entirely apart from the pressure within the receiver.

The heat developed by combustion and conveyed through the jacket surrounding the receiver, as well as that developed by compression from the air-pump, renders the fluid limpid and facilitates to a great degree the thorough pulverizing and mingling of the fuel with the air and materially reducing its condensation. The liquid fuel, being thrown in a minute spray upward through the central portion of the receiver, fills the same, and such portions as may be condensed or not effectually pulverized falling back upon the sides of the shell are returned to the annular chamber and repassed through the gauze, so that a constant rotation is maintained, the finely-diffused particles alone being conveyed in suspension to the cylinder.

If crude petroleum is used as fuel, the volatile portions are readily absorbed by the entering air, already heated by compression in the air-pump, but pulverization must be depended upon to take up the heavier portions.

Special provisions are required to perfectly pulverize and thoroughly mix the inflammable fluid with the air in the receiver to secure instant and perfect combustion in the working-cylinder at the point of ignition, and to secure the best results the receiver should hold at least twenty charges, and each charge will then receive twenty blasts before passing out of the receiver, whereas if the receiver contained only one charge the first blast would sweep it into the cylinder, and even if perfect combustion ensued it would be so late in the stroke before completion that much of the effect would be lost and only manifested by a red-hot exhaust-pipe.

While it is preferable to introduce the fuel at the bottom of the receiver in order that gravity may return the condensed portions to the pulverizer, it is manifest that the latter may be located elsewhere than at the bottom and the air-current utilized or a pump employed to perform the returning or rotating function.

Heretofore others have charged air with various inflammables by means of evaporators and sprayers of various kinds, and the heat of the exhaust has been used to assist in evaporating the fluids employed; but my apparatus differs in using the compressed air as it is delivered by the air-pump into the receiver to pulverize the liquid fuel by its blasting action, and in maintaining a reservoir of compressed inflammable air, whether the fuel employed will evaporate or not, and in insuring the action by subjecting any portion too heavy to float off with the air-current to a repeated blast automatically.

Having thus fully described my invention, it is to be understood that I do not confine myself to the specific construction of the devices herein shown, the same being capable of a considerable scope of modification in carrying into practice the methods which I have described; hence

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The combination, with a gas-engine receiver having its induction-port at the bottom and eduction-port at the top, of a pulverizer, through which the induction passes thereto, and a deflector, around which the eduction escapes therefrom, as set forth.

2. A gas-engine receiver having a surrounding jacket enveloping a heating-coil, one end of said coil connecting with the oil-pump and its opposite end with the pulverizer, as set forth.

3. In a gas-engine having a compressed-air receiver and air and fuel pumps, a pressure-regulator for controlling the effective capacity of both the air and fuel pumps to determine the amount each shall furnish to maintain a uniform pressure and to supply the cylinder with charges of maximum efficiency.

4. In a receiver for air or gas engines, the combination, with a compressed-air-inlet pipe entering said receiver and provided with a porous diaphragm intercepting its aperture, of an inflammable fluid-chamber surrounding the margins of said diaphragm and so located that the portions of the inflammable fluid not effectually pulverized by the action of the air in the manner described shall be returned by gravity to said chamber and repulverized.

5. In an air or gas engine in which combustible gases are fired in the working-cylinder, the combination of a heat-transmitting ignitor-tube, the same being exposed to an exterior flame and communicating at its inner end with the working-cylinder, at its outer end with an exterior chamber, with an inter-

posed controlling-valve between the ignitor-tube and the exterior chamber, whereby the explosive mixture within said cylinder is admitted to said tube and fired at the moment of opening said controlling-valve, substantially as described.

6. In air or gas engines in which combustible gases are fired in the working-cylinder, the combination of a heat-transmitting ignitor-tube and exterior chamber, substantially as shown, with an interposed controlling-valve between the firing-tube and the exterior chamber, the same being actuated simultaneously with the variable cut-off movement of the cylinder induction-valve, so as to fire the cylinder-charge at the moment of cut off.

7. In an air or gas engine, an air-pump cylinder constructed with valve-boxes, substantially as described, covered by the working-cylinder head and opposite extended pump-cylinder head and side bonnets, whereby the valve-seats are made accessible and the examination and removal of the valves facilitated.

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