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APPARATUS FOR SUPPLYING EXPLOSIVE GAS TO INTERNAL COMBUSTION ENGINES.

APPLICATION FILED OCT. 16, 1918.

1,344,793. **Patented June 29, 1920.**

3 SHEETS—SHEET 1.

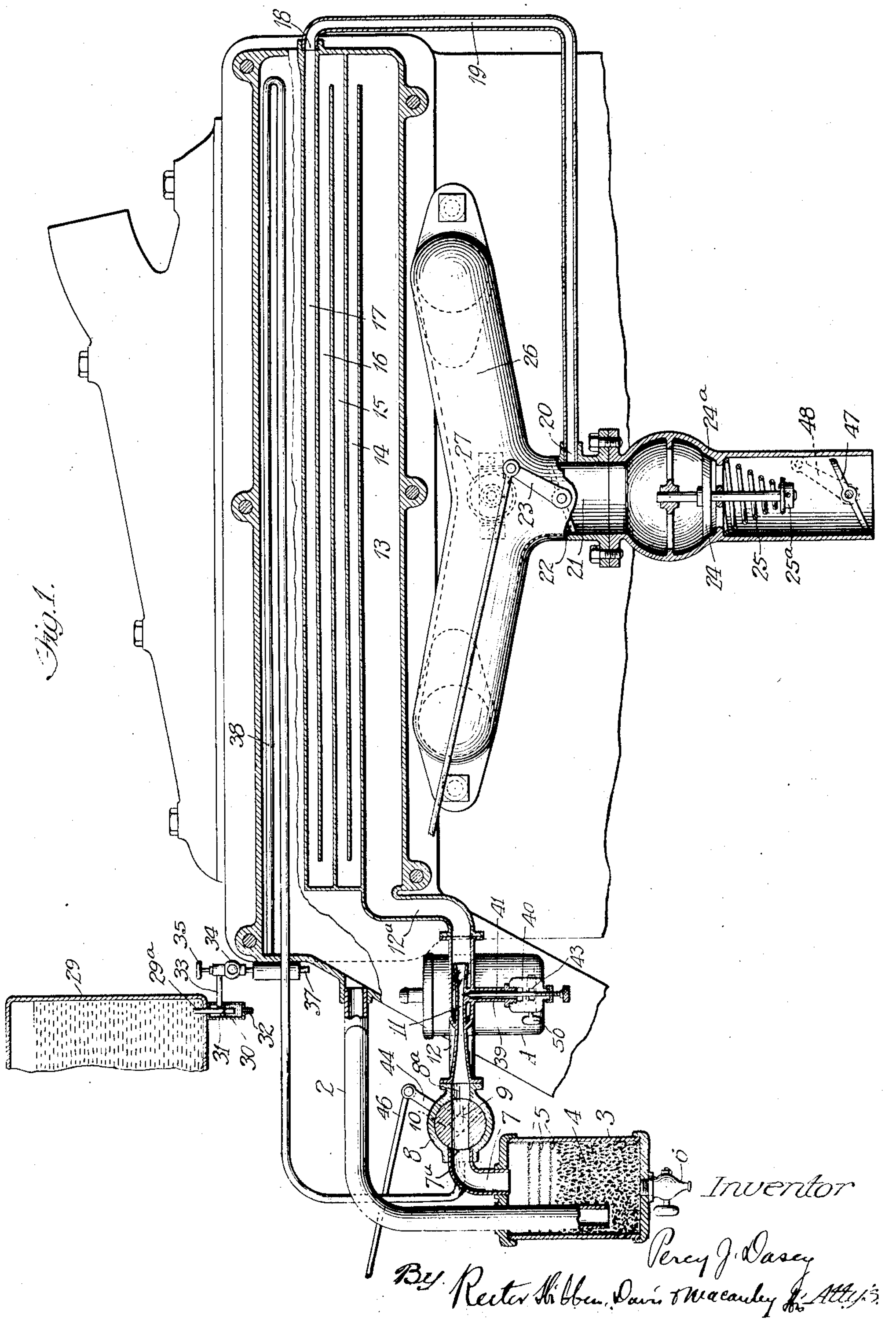

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Fig. 2.

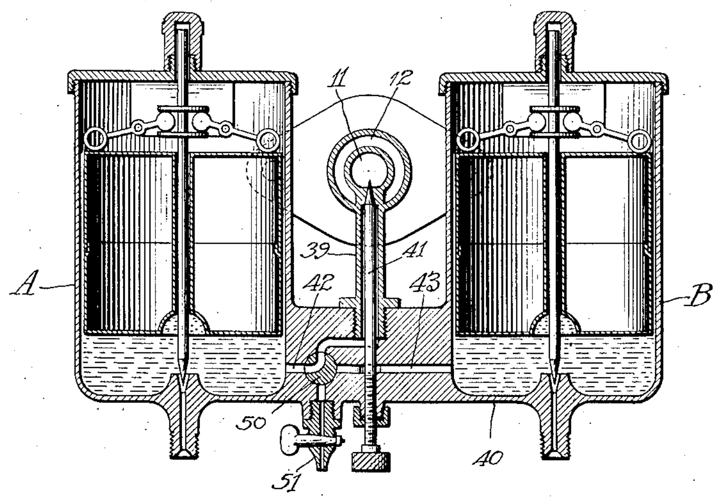

Fig. 3.

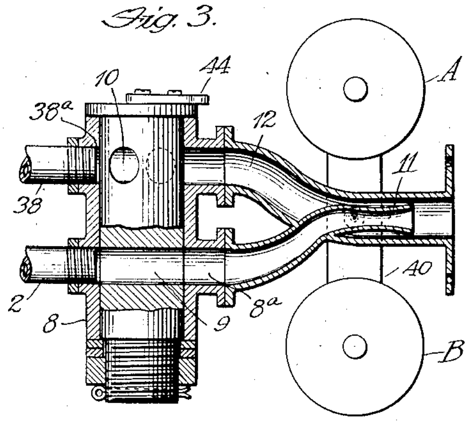

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Fig. 4.

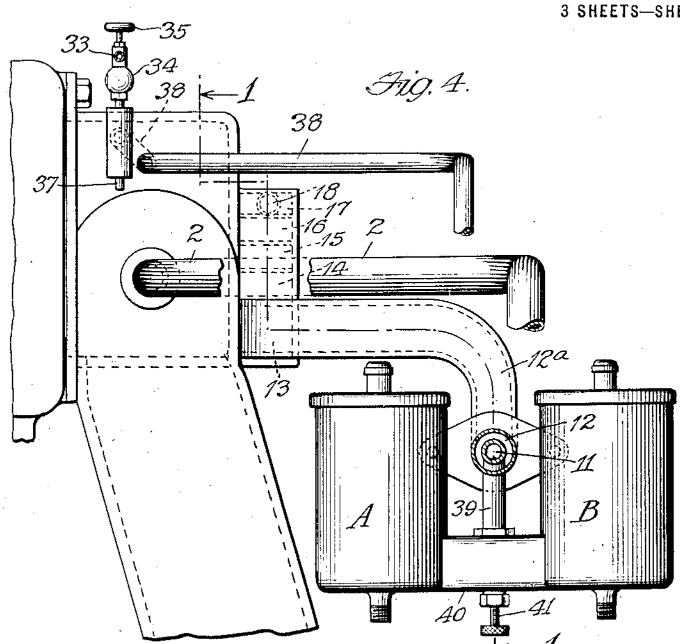


Fig. 5.

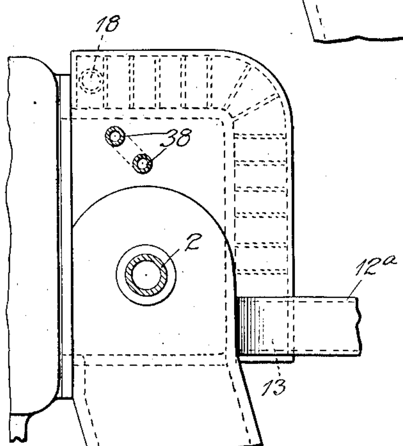


Fig. 6.

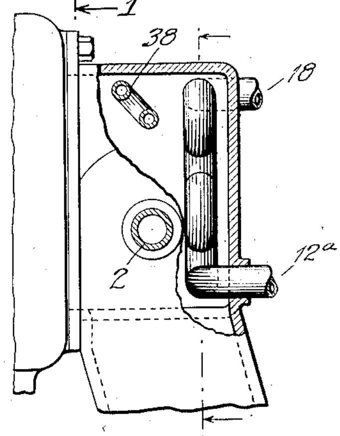
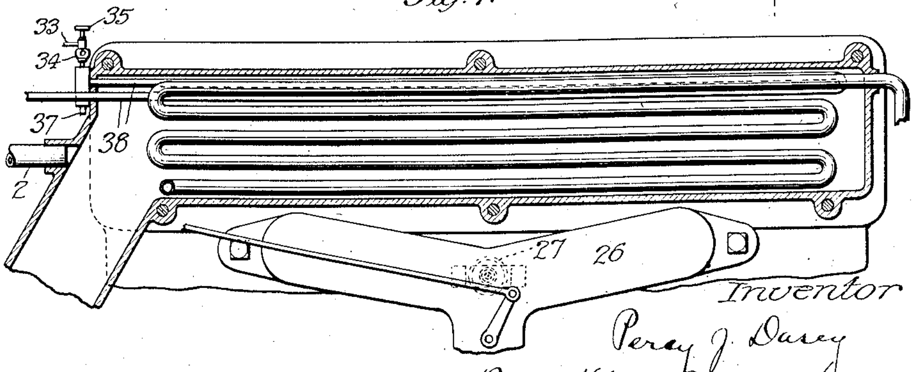


Fig. 7.



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UNITED STATES PATENT OFFICE.

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APPARATUS FOR SUPPLYING EXPLOSIVE GAS TO INTERNAL-COMBUSTION ENGINES.

1,344,793. Specification of Letters Patent. Patented June 29, 1920.

Application filed October 16, 1918. Serial No. 258,337.

To all whom it may concern:

Be it known that I, PERCY J. DASEY, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Apparatus for Supplying Explosive Gas to Internal-Combustion Engines, of which the following is a specification.

My invention relates to internal combustion engines in which a liquid hydrocarbon, vaporized and mixed with other gases furnishing a supply of oxygen is used as the explosive mixture. It is well known that the heavier hydrocarbons, such as kerosene, afford when burned more heat units, measure for measure, than the lighter and more volatile members of the hydrocarbon series, such as gasolene and naphtha. Since the heavier hydrocarbons contain more carbon than the lighter, however, it is more difficult to vaporize and burn them without liberating free carbon particles which are wasted and which are injurious to the cylinders and pistons of the engine. The object of my present invention is the provision of a novel and effective apparatus designed to overcome these difficulties when burning a relatively heavy hydrocarbon, such as kerosene, in which apparatus the fuel is vaporized by a portion of the heated exhaust gases of the engine; the carbureted vapor mixed with a proper proportion of superheated steam; the mixed gases then conducted through a passage in which they are highly heated, and such gases finally mixed with a suitable proportion of air to form the explosive charges which are supplied to the engine cylinders. My invention resides in the novel organization, arrangement and coöperative relation of the elements of the apparatus I have invented and designed for the purpose of mixing and treating the various components of the explosive mixture, as more particularly pointed out in the appended claims. It will be understood, however, that various modifications of my invention may be made without departing from the scope of the claims and the spirit of my invention.

In the drawings, Figure 1 is a side view, partly in elevation and partly in vertical section on the broken line 1—1 of Fig. 4, of a preferred form of a novel apparatus embodying my invention; Fig. 2 is a central vertical section of the double carbureter of the apparatus; Fig. 3 is a detail plan view of the proportioning valve and primary vaporizing and mixing tube; Fig. 4 is an end elevation of the apparatus, parts lying in front of the carbureter being broken away; Fig. 5 is an end elevation of a modified arrangement of the heating passages for the mixed vaporized fuel and steam; and Figs. 6 and 7 show respectively an end view and a side view of a different modification of the same parts.

The same reference characters indicate the same parts in all the figures of the drawing.

Describing first the mechanical construction and arrangement of my novel apparatus, the upper or inner part of the exhaust manifold of the engine is connected by a pipe 2 with the bottom part of a filtering or cleaning chamber 3 which is partially filled with a finely divided or fibrous non-combustible material such as a mass of steel chips 4 for the purpose of arresting particles of carbon or burned oil which may be present in the exhaust gases. Preferably a screen, or a series of screens 5, is provided above the steel chips 4 to assist in filtering the gases. A drain cock 6 is provided for use in washing out and cleaning the cleaning chamber. The upper end of the cleaning chamber is connected by a pipe 7 with a port 7^a in the casing of a cylindrical proportioning valve 8. This proportioning valve is formed with a passage 9 which is arranged to place the port 7^a in communication with a port 8^a connected to a Venturi tube 11, into which tube projects the nozzle of a double carbureter to be hereinafter described.

Superheated steam is supplied to the carbureted exhaust vapor issuing from the outlet of the Venturi tube through the following parts. A water tank 29 supported a suitable distance above the connections intermediate it and the exhaust manifold of the engine is in communication through a pipe 29^a with a sediment trap 30, the water passing through a screen 31 out of the trap through a pipe 33. A drain plug 32 is provided for the removal of accumulated sediment in the trap. The pipe 33 leads to the casing 34 of a needle valve 35 of ordinary construction, the casing being provided with a sight opening through which the drops of water passing through the valve may be observed for the purpose of determining the adjustment of the needle. The water passing drop by drop through the needle valve is conducted to an evaporating and alkali-depositing chamber which is arranged adjacent and in heat-conductive relation to the exhaust manifold. A plug 37 is provided at the lower part of the chamber to enable it to be cleaned out when necessary. Under normal running conditions, as will be hereinafter more fully explained, water passing through the needle valve is evaporated and converted into steam in the evaporating chamber, the larger part of the alkali being deposited and remaining there and the steam is conducted through a coil of piping 38 leading into and through the exhaust manifold of the engine where it is superheated. The outer end of the pipe 38 conducts the superheated steam to a port 38^a in the casing of the proportioning valve 8 before mentioned. This proportioning valve is provided with a passage 10 arranged to place the port 38^a in communication with a pipe or passage 12 which concentrically surrounds the Venturi tube 11, the inner end of the tube or pipe leading from the port 8^a which coöperates with the proportioning valve passing from without to the inside of the passage 12. The proportions of the parts and the angular arrangement of the valve passages 9 and 10 of the proportioning valve 8 are such that exhaust vapor only, or any desired proportions of exhaust vapor and steam, may be admitted through such valve. A valve lever 44 actuated by a rod 46 which may be operated by means of connections not necessary to describe is provided for adjusting the position of the valve.

From the mouth of the Venturi tube, where the carbureted exhaust gases and the superheated steam mingle, the mixed gases are conducted through a continuation 12^a of the passage 12 to and through a series of heating passages 13, 14, 15, 16 and 17 formed by alternately arranged partitions which are secured to the two end walls of a casing integral with the outer wall of the exhaust manifold and which extend toward each other in overlapping relation and constitute a heating coil. This casing is arranged directly in line with the exhaust openings from the cylinders, so that the burned and strongly heated exhaust gases impinge upon the heating coil as they are exhausted from the cylinders. From the outlet 18 of the passage 17 the heated gases are conducted through a pipe 19, cooling somewhat in their passage, to the inlet 20 of a mixing chamber 21, where they are mixed with air to form the explosive mixture, the usual throttle valve 22 operated through a lever 23 by means of an operating rod and hand-operated connections (not shown) being provided for controlling the amount of explosive mixture admitted to the intake manifold 26 and cylinders, and hence the speed of the engine.

Air is admitted to the mixing chamber 21 by an automatic spring-pressed puppet valve 24 coöperating with a valve seat formed in a valve casing or body 24^a, the stem of which valve is slidingly mounted in a spider within the casing, the tension of the spring 25 being regulated by adjusting nuts 25^a on the lower end of the valve stem. A butterfly damper valve 47 is arranged at the inlet side of the valve casing, and through a lever 48 and connections coöperating therewith (not shown) the position of the damper may be adjusted as desired. Preferably I provide an auxiliary automatic valve 27 opening into the intake manifold and tensioned to open under a higher degree of suction than the valve 24, to provide for the admission of an additional amount of air when the engine is running at high speed.

The carbureter of my novel apparatus is adapted to supply alternatively either kerosene or gasolene and the body 40 therefore includes two float chambers A and B of any suitable or ordinary construction, connected respectively to kerosene and gasolene supply tanks, not shown. By means of a four way valve 50 either the passage 42 leading from the kerosene chamber A or the passage 43 leading from the gasolene chamber B may be placed in communication with the fuel passage of the needle valve 41, or either of said chambers may be placed in communication with a drain cock 51. As before stated the nozzle 39 of the carbureter opens into the Venturi tube 11.

The manner in which the above described apparatus is operated and the functions and mode of operation of the various parts will now be described. The sight feed water valve,—which is left closed when the engine is not running,—remains closed during the starting and warming up of the engine. The four-way valve 50 of the carbureter is turned to admit gasolene to the vaporizing nozzle in the Venturi tube 11 when engine suction begins. The damper valve 47 is closed, or set to admit only a small amount of air, and the throttle valve 22 is opened slightly. The proportioning valve 8 is adjusted to partially open the passage 9, establishing communication between the exhaust manifold of the engine and the mixing chamber 21. When the engine is turned over a vacuum is created in the cylinders which draws in air from the exhaust manifold port past the vaporizing nozzle in the Venturi tube, where it is charged with gasolene vapor, and also draws in air through the automatic valve 24 (if the damper has been opened slightly and the suction is sufficiently great) into the intake manifold, and thence into the cylinders where the explosive charges are burned, the burnt gases escaping into the exhaust manifold 1 in the usual manner. As soon as the engine is started a portion of the hot exhaust gases begins to flow through the passages leading to and through the Venturi tube and continues to vaporize the gasolene fuel, but since these burnt gases contain no oxygen the damper valve 47 is opened slightly (if not already slightly open) to admit sufficient oxygen to form an explosive mixture. The flow of hot exhaust gases through the pipe 2 and connected passages is due in part to pressure in the exhaust manifold, and in part to engine suction, and the amount permitted to pass through the Venturi tube is regulated by the proportioning valve 8 and no more permitted to pass than is necessary to force the carbureted vapor through the heating passages into the mixing chamber 21.

The engine continues running in this manner until it has become thoroughly heated and the exhaust manifold and heating passages normally hot, when the needle-valve 31 controlling the water supply is opened to a proper extent, determined by the number of drops per minute or other unit of time. The alkali depositing chamber having been heated by the exhaust manifold, with which it is in heat-conductive relation, the water is immediately vaporized and forced by its own expansion into and through the superheating coil 38. The proportioning valve 8 is immediately manipulated to connect the coil 38 with the pipe or passage 12 through the passage 10 of the valve, and the four-way valve of the carbureter manipulated to shut off the gasolene and connect the kerosene float chamber with the vaporizing nozzle, and the damper valve is opened to admit a larger supply of air. The suction of the engine, and the pressure of the exhaust gases creating an injector effect at the mouth of the Venturi tube, now draws the mixture of exhaust gases and vaporized kerosene and superheated steam into the heating passages 13, 14, 15, 16, and 17 where the intense heat causes them to combine and become more or less fixed, the resultant mixture of gases that are thus formed containing a smaller proportion of carbon than vaporized kerosene alone, and including the hydrogen and oxygen which formed the constituents of the steam. The adjustment of the proportioning valve 8 should be such as to admit as little of the hot exhaust gases as will suffice to vaporize the fuel properly, and as large a proportion of steam as will pass into combination with the fuel in the heating passages and cylinder, since the exhaust gases are entirely inert whereas the constituents of water, when properly proportioned and combined with the vaporized fuel, take part actively in the process of combustion. Passing into the mixing chamber 21, the heated gases together with an admixture of air drawn in through the automatic air valve 24 and any which may be drawn in through the auxiliary air valve 27 are drawn into the engine cylinders by the suction of the pistons in the usual manner.

By the addition of water vapor to the vaporized fuel I am able to diminish or prevent the deposition of carbon, either in the heating passages before being delivered to the engine cylinders or in such cylinders and attain a much more complete combustion of the fuel. As is well known when the relatively heavy hydrocarbon molecules of kerosene are subjected to sufficient heat they break down or "crack" releasing more or less free carbon and producing a mixture of gases containing a considerable percentage of unsaturated molecules. The highly heated gaseous constituents of the steam, oxygen and hydrogen, during the passage of the mixed gases through the heating passages and during the time they are under compression in the cylinders, supply the necessary elements to combine with the carbon and unsaturated or incomplete molecules to complete their structure and form a mixture of gases which burn much more readily and completely than if uncombined, and release a much smaller percentage of free carbon. The cracking or decomposition of the fuel would be particularly apt to occur in engines running at or above moderate loads and speeds if the exhaust valves were set open early, say at 40° to 45° ahead of lower dead center, under which conditions the charge would be exhausted while still burning and the manifold temperature would be extremely high. The use of water vapor in the manner hereinbefore described, however, permits the use of heavy fuels and conducting the vaporized fuel through heating passages arranged in the exhaust, even when the exhaust valves are arranged to open early and burning gases are discharged into the exhaust.

In Fig. 5 I have shown a modified arrangement of the passages for heating the mixture of exhaust gases, vaporized fuel and steam in which the casing in which the heating passages are formed extends over the top of the exhaust manifold, the partitions (shown in dotted lines) being alternately arranged in a manner similar to the arrangement before described.

In Figs. 6 and 7 I have shown another modified arrangement of the heating passages in which the heating coil consists of piping connected by return bends in a well-known manner and arranged within the exhaust manifold of the engine. A carbureter having but a single float chamber which may be connected at will either to a supply of gasolene or a supply of kerosene may also be employed, but in such case the engine must be operated with gasolene a sufficient length of time before stopping it to fill the float chamber with gasolene, in order that it may be started again after being stopped.

It will be understood that fuel oils may be supplied to the fuel outlet in the Venturi tube not only by means of the constant level carbureting device illustrated and described, but also by equivalent means, such as pump injection or gravity feed when conditions are such that the engine on which it is used maintains practically a constant speed.

It will also be understood that my apparatus may be used with the parts for supplying water vapor shut off or without such parts, but for reasons sufficiently explained above, the results obtained will not be so satisfactory.

I claim:

1. In apparatus for supplying explosive gas to an internal combustion engine, a passage in communication with the exhaust passages of the engine, a vaporizing nozzle in said passage for supplying liquid fuel to exhaust gases passing therethrough, heating passages continuous with said first mentioned passage for heating the gaseous mixture to a high temperature, an air supply means for mixing the heated gaseous mixture with cold air to form an explosive charge.

2. In apparatus for supplying explosive gas to an internal combustion engine, a passage in communication with the exhaust passages of the engine, a vaporizing nozzle in said passage for supplying liquid fuel to exhaust gases passing therethrough, means for connecting said nozzle with either light or relatively heavy liquid fuel, heating passages for heating the gaseous mixture to a high temperature, and air supply means for mixing the heated gaseous mixture with cold air to form an explosive charge.

3. In an apparatus for supplying explosive gas to an internal combustion engine, a passage in communication with the exhaust passages of the engine, a vaporizing nozzle in said passage for supplying liquid fuel, means for supplying water vapor to the mixture of exhaust gases and vaporized fuel, heating passages for heating the resultant gaseous mixture, and air supply means for mixing the heated gaseous mixture with air to form an explosive charge.

4. In apparatus for supplying explosive gas to an internal combustion engine, a passage in communication with the exhaust passages of the engine, a vaporizing nozzle in said passage for supplying liquid fuel, means for supplying superheated steam to the mixture of exhaust gases and vaporizing fuel, heating passages for heating the resultant gaseous mixture, and air supply means for mixing the heated gaseous mixture with air to form an explosive charge.

5. In apparatus for supplying explosive gas to an internal combustion engine, a passage in communication with the exhaust passages of the engine, a vaporizing nozzle in said passage for supplying liquid fuel to exhaust gases passing therethrough, a heating coil continuous with said passage and in heat-conductive relation to the exhaust passage of the engine adjacent the engine cylinders for heating the gaseous mixture to a high temperature, and air supply means for mixing the heated gaseous mixture with cold air between the heating coil and engine cylinders to form an explosive charge.

6. In apparatus for supplying explosive gas to an internal combustion engine, a passage in communication with the exhaust passages of the engine, a vaporizing nozzle in said passage for supplying liquid fuel, means including a heating coil in heat-conductive relation to the exhaust passage of the engine for supplying steam to the vaporized mixture, a heating coil in heat-conductive relation to the exhaust passage of the engine for heating the gaseous mixture, and air supply means for mixing the heated gaseous mixture with air to form an explosive charge.

7. In apparatus for supplying explosive gas to an internal combustion engine, a passage in communication with the exhaust passages of the engine, a vaporizing nozzle in said passage for supplying liquid fuel, a water reservoir, an evaporating chamber having restricted communication with said reservoir, a heating coil in communication with said evaporating chamber and arranged adjacent the exhaust passage of the engine for supplying steam to the vaporized mixture, a heating coil in heat-conductive relation to the exhaust passage of the engine for heating the resultant gaseous mixture, and air supply means for mixing the heated gaseous mixture with air to form an explosive charge.

8. An apparatus for supplying gas to an internal combustion engine, according to claim 2 in which the means for supplying fuel to the vaporizing nozzle includes a carbureter having two chambers and also having a common drain passage, and a four-way valve arranged to connect either chamber with the nozzle or with the drain passage.

9. An apparatus for supplying gas to an internal combustion engine, according to claim 1 and including also a filtering chamber containing finely divided incombustible material interposed in the passage connecting the exhaust passage of the engine and the vaporizing nozzle.

10. An apparatus for supplying gas to an

internal combustion engine, according to claim 3 in which the water vapor is conducted through a pipe continuous with the heating passage and the exhaust gases are conducted through a pipe arranged concentrically within said first mentioned pipe and terminating in a Venturi tube.

11. In apparatus for supplying explosive gas to an internal combustion engine, a passage in communication with the exhaust passages of the engine, a vaporizing nozzle in said passage for supplying liquid fuel, means for supplying water vapor to the mixture of exhaust gases and vaporized fuel, means for varying the proportions of water vapor and said vaporized mixture, heating passages for heating the resultant gaseous mixture, and air supply means for mixing the heated gaseous mixture with air to form an explosive charge.

12. In apparatus for supplying explosive gas to an internal combustion engine, a pipe connected with a source supplying steam, a pipe connected with the exhaust passage of the engine, said pipes merging into a common intake passage, a common proportioning valve having separate ports and outlet passages respectively governing the passage of steam through said first mentioned pipe at a point intermediate the source of steam and intake passage and the passage of exhaust gases through said second mentioned pipe at a point intermediate said exhaust passage of the engine and said intake pipe, and a vaporizing nozzle in the portion of said second-mentioned pipe between said proportioning valve and intake pipe.

13. In apparatus for supplying gas to an internal combustion engine, a pipe connected with the exhaust passage of the engine, a pipe connection with a source supplying steam, a valve casing having two ports communicating respectively with said pipes, a valve in said casing having two passages coöperating with said ports and arranged to vary the proportion of exhaust gases and steam admitted through such ports, a pipe 12 communicating with a port in said casing coöperating with the valve passage admitting steam and communicating also with the intake passage of the engine, a pipe or tube 11 communicating with a port in said casing coöperating with the passage admitting exhaust gas, the end portion of said pipe 11 being arranged within and inclosed by said pipe 12, and a vaporizing nozzle opening into said pipe 11.

14. An apparatus for supplying gas to a multi-cylinder internal combustion engine according to claim 6 in which the coil for heating the gaseous mixture is arranged directly across the path of the exhaust gases entering the exhaust manifold of the engine.

15. An apparatus for supplying gas to a multi-cylinder internal combustion engine according to claim 6 in which the coil for heating the gaseous mixture includes a casing arranged directly opposite the ports for the exit of burned gases into the engine manifold and divided by alternately arranged over-lapping partitions spaced apart from each other and extending from two opposite walls.

16. In apparatus for supplying explosive gas to an internal combustion engine, a pipe connected with the exhaust passages of the engine, a pipe connected with a source supplying steam, said first-mentioned pipe having a terminal portion arranged concentrically within said second-mentioned pipe, a vaporizing nozzle arranged within the terminal portion of said first mentioned pipe, an intake pipe communicating with said first and second mentioned pipes, and means for supplying air to said intake pipe.

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