F. W. BRADY.

INTERNAL COMBUSTION ENGINE.

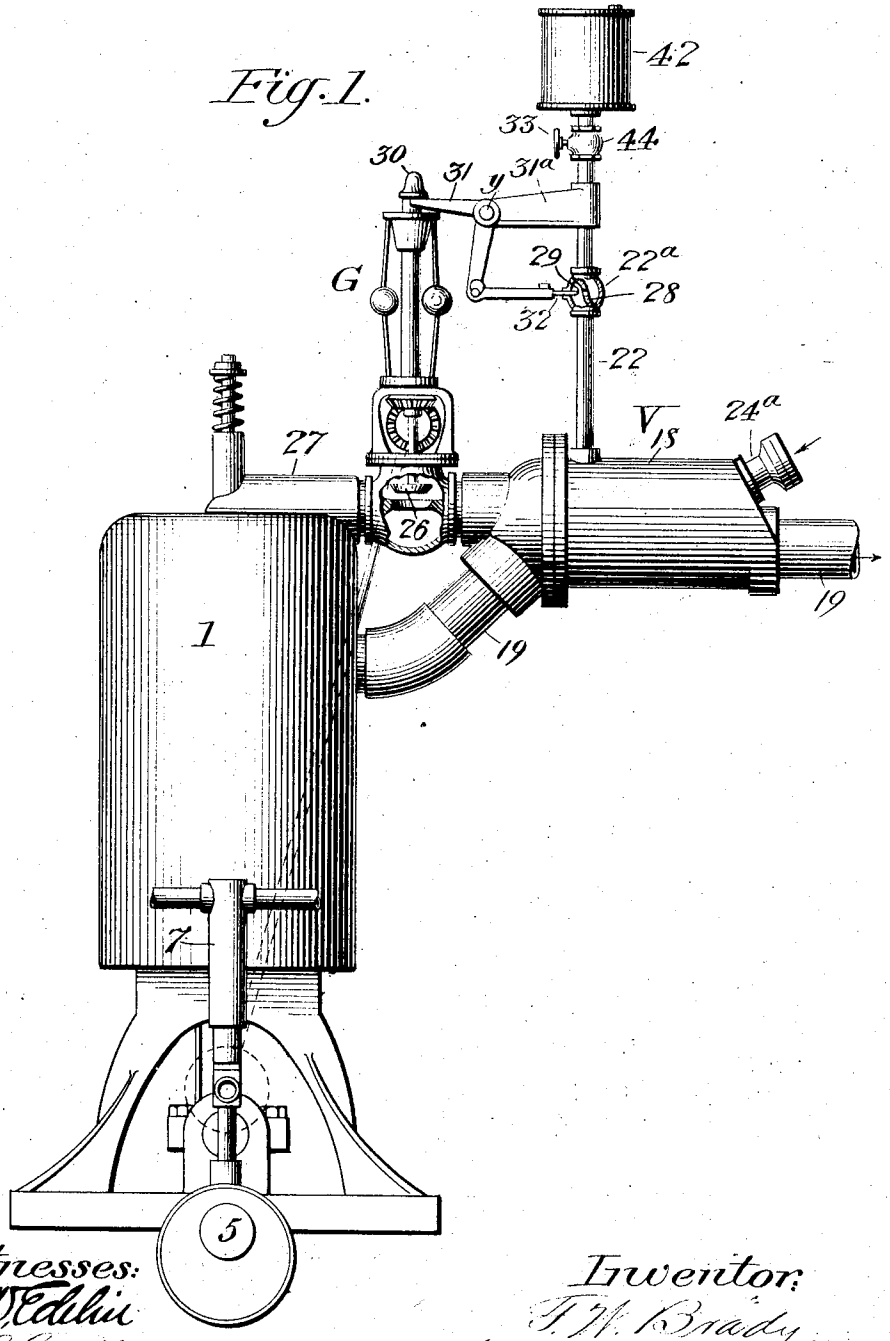
APPLICATION FILED APR. 23, 1906.

947,633.

Patented Jan. 25, 1910.

3 SHEETS—SHEET 1.

Fig. 1.



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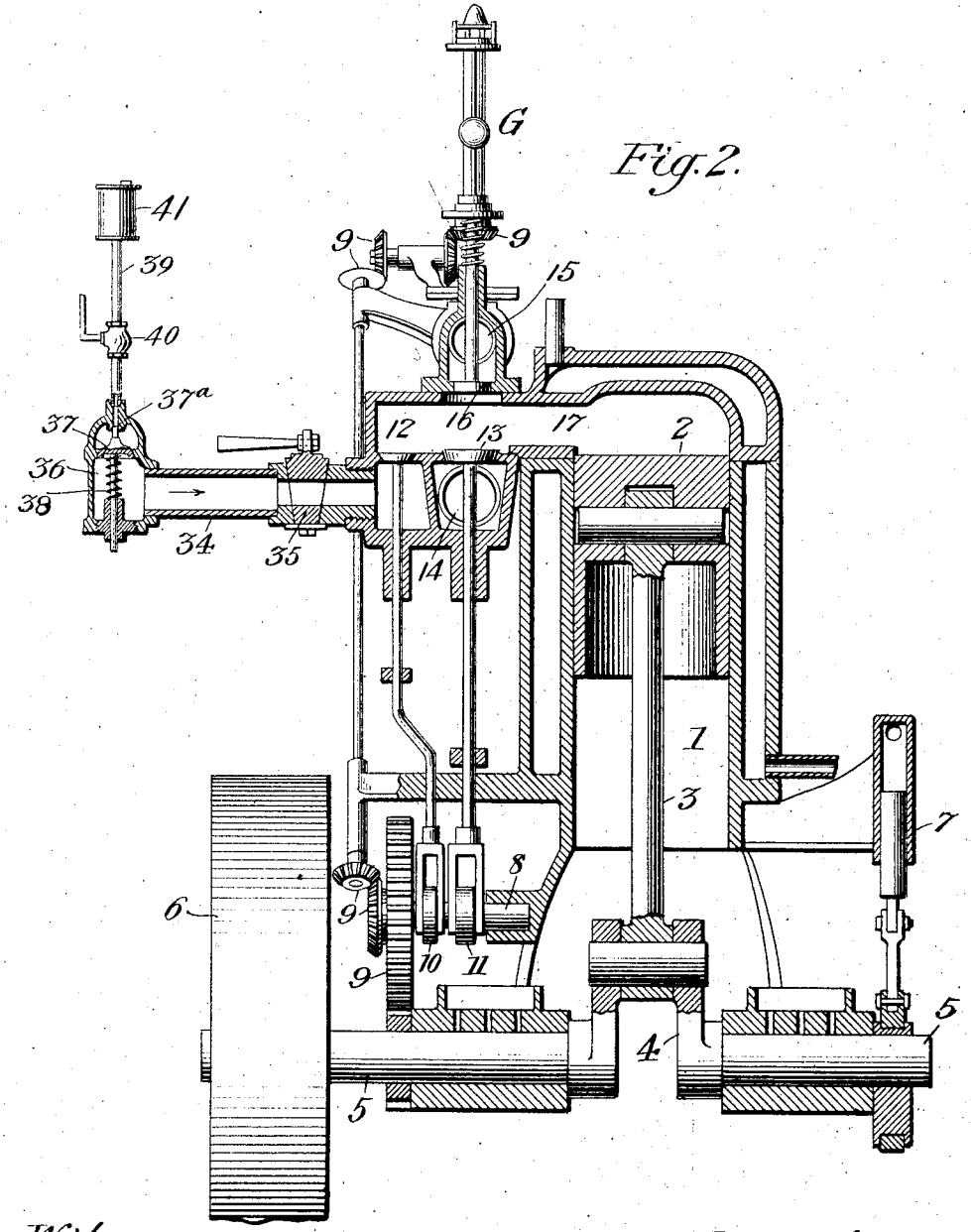
3 SHEETS—SHEET 2.

Fig. 2.



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3 SHEETS—SHEET 3.

Fig. 3.

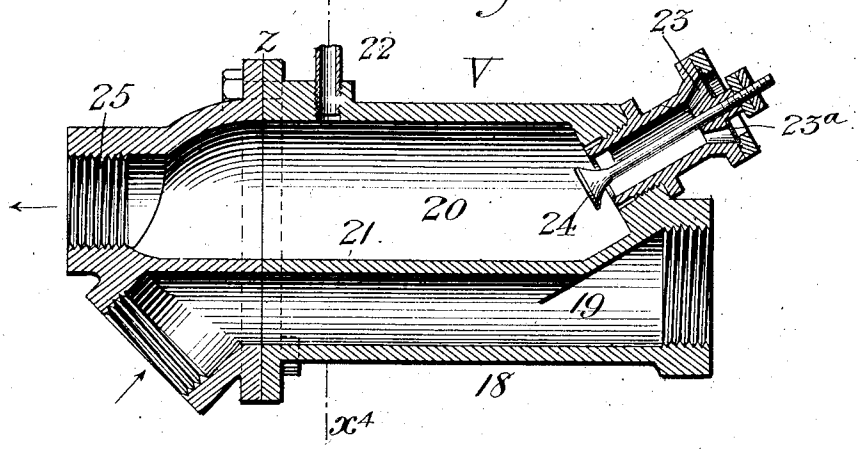


Fig. 4.

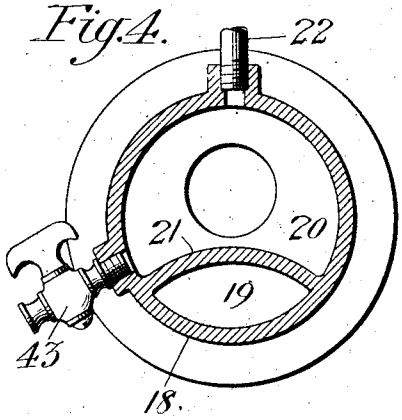


Fig. 5.

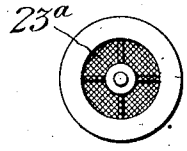


Fig. 6.

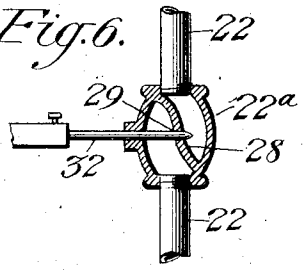
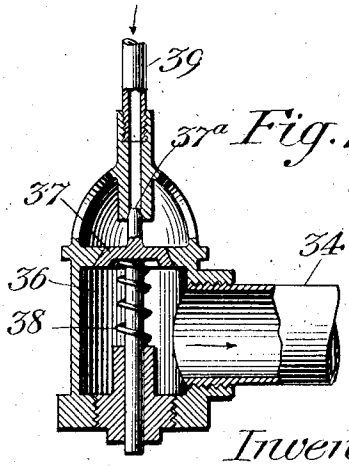


Fig. 7.



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UNITED STATES PATENT OFFICE.

FRANCIS W. BRADY, OF ENGLEWOOD, NEW JERSEY.

INTERNAL-COMBUSTION ENGINE.

947,633. Specification of Letters Patent. Patented Jan. 25, 1910.

Original application filed September 29, 1903, Serial No. 175,087. Divided and this application filed April 23, 1906. Serial No. 313,180.

To all whom it may concern:

Be it known that I, FRANCIS W. BRADY, a citizen of the United States, residing at Englewood, county of Bergen, State of New Jersey, have invented certain new and useful Improvements in Internal-Combustion Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to the class of internal combustion engines wherein a liquid hydrocarbon is vaporized for producing the hydrocarbon element of the explosion charge.

The present application is a division of my application, Serial Number 175,087, filed September 29, 1903, and the object of the division is to secure protection for certain inventions described in my earlier application.

The invention for which I seek protection in this divisional application has for its object to provide means for supplying to the combustion chamber of the engine a charge of vaporized hydrocarbon or carbureted air, which in itself is not explosive, and adding to this non-explosive charge in the combustion chamber a sufficient quantity of air to form an explosive mixture. The vaporized hydrocarbon or carbureted air may be supplied from any suitable source, but I prefer to employ carbureted air produced by vaporizing a liquid hydrocarbon of such specific gravity as to require artificial heat to vaporize it, and supplying to the hydrocarbon so vaporized a sufficient quantity of air to form a saturated vapor, before it is admitted into the combustion chamber of the engine. This mixture of vapor and air should contain so large a proportion of the heavy hydrocarbon vapor that it is not explosive, and its specific gravity will ordinarily be greater than that of atmospheric air.

In order that my invention may be clearly understood, I shall proceed to describe the form in which I prefer to embody it. This description should be considered in connection with the accompanying drawings, in which—

Figure 1 is a side elevation of an internal combustion engine embodying my invention and Fig. 2 is a sectional elevation of the same, the plane of the section being taken at right angles to the plane of Fig. 1 and along the axis of the engine shaft. Figs. 3, 4 and 5 are detail views on a larger scale, illustrating the construction of the vaporizer which I prefer to use. Fig. 3 is a longitudinal axial section; Fig. 4 is a cross section on the line X—4 of Fig. 3, and Fig. 5 is an end view of the air inlet valve for the vaporizer; Fig. 6 is an enlarged view of a needle valve in the fuel feed pipe, and Fig. 7 is an enlarged view of a fuel feed valve for starting the engine.

Referring primarily to Figs. 1 and 2, 1 designates the jacketed cylinder of the engine, in which the piston 2 reciprocates. The piston rod 3 is connected to the crank 4 on the main shaft 5. The main shaft carries a pulley and fly wheel 6 and an eccentric for driving the pump 7, which circulates water through the cylinder jacket. A counter-shaft 8 is driven from the main shaft by gears 9 and carries eccentrics 10 and 11, the former operating the air inlet valve 12 and the latter the exhaust valve 13. This counter-shaft also drives, by appropriate gearing, the centrifugal governor G.

A vaporizer V is mounted at one side of the engine cylinder and communicates therewith through the vapor feed pipe 27. The exhaust from the engine is led through this vaporizer for the purpose of heating the same by means of the pipe 19. This vaporizer is adapted to vaporize a heavy hydrocarbon oil and to mix the vapor so produced with a certain quantity of air in a manner which will be understood by reference to Figs. 3, 4 and 5, from which it will be seen that the vaporizer consists of a casing 18 having within it a chamber forming a continuation of the exhaust pipe 19 and through which the hot exhaust gases from the engine pass. Above this chamber is a second chamber 20, the bottom plate 21 of which is located in the path of the exhaust gases. This chamber 20 is provided with an air inlet 23 controlled by a valve 24, which has a screw-threaded stem, by means of which the extent of opening of the valve may be adjusted. The heavy hydro-carbon oil enters the upper portion of this chamber through the pipe 22 and drips onto the plate 21, which is heated by the exhaust gases and serves to vaporize the oil.

25 is an outlet from the vaporizer communicating with the pipe 27, through which the mixture of air and hydrocarbon vapor is

drawn from the vaporizer into the engine. This vaporizer is made in two sections, bolted together at *z* in Fig. 3, and the valve 24 is provided with a screen 23^a to keep out foreign particles floating in the air. A drainage cock 43 (Fig. 4) should be provided for draining the vaporizer V. In the pipe 27 there is a valve 26, which is controlled by the governor G, and this governor also actuates an elbow lever 31 fulcrumed at *y* in a supporting bracket 31^a and carrying a needle 32, which controls the flow of liquid from the tank 42 through the aperture 29 in the diaphragm 28 of the valve 22^a. By this arrangement the governor G regulates simultaneously and proportionately the feed of liquid hydro-carbon to the vaporizer V and the feed of vapor from the vaporizer to the engine, thus controlling the speed of the engine and preventing an undue accumulation of the hydro-carbon in the vaporizer.

Inasmuch as the engine herein described is particularly constructed for use with heavy hydro-carbons vaporized by the heat of the exhaust gases, it is desirable to supply means for starting the engine. These means comprise a tank 41 for containing alcohol or other highly volatile liquid, and this tank is connected through a pipe 39 and a stop cock 40 to a port opening into the air inlet pipe of the engine, and which is so constructed as to be closed when the air inlet pipe is closed. The particular construction of this valve is shown in Fig. 7, in which 34 is the air inlet pipe which communicates with the atmosphere through the valve 37 and ports in a dome on the top of the valve casing 36, as shown. Through the center of this dome the feed pipe 39 is tapped. The delivery outlet of this pipe 39 is adapted to be closed by the plug 37^a on the valve 37 when the valve is held to its seat by the spring 38.

Referring now to Fig. 2, it will be seen that the air inlet pipe 34 communicates through a stop-cock 35 and the air inlet valve 12 with the combustion chamber 17. The vaporizer communicates with this chamber through the inlet 15 and the vapor valve 16. 14 is the exhaust outlet, and 13 is the exhaust valve. The vapor valve 16 is operated by suction, and the valves 12 and 13 are operated by the eccentrics 10 and 11 at such times as to coöperate properly in the following cycle of operations. At starting, the stop-cock 40, controlling communication with the alcohol tank 41, is opened and with the parts in the position shown in Fig. 2 a rotation of the main shaft of the engine starts the piston on its suction stroke. At the same time the air valve 12 is opened by the eccentric 10 and the suction caused by the outward movement of the piston opens the valve 37 and draws in air and the vapor from the tank 41, filling the cylinder with an explosive mixture. The valve 12 is then closed, and on the compression stroke of the piston, this mixture is compressed in the combustion chamber and ignited by any suitable ignition mechanism. The explosion stroke which then occurs is followed by the exhaust stroke, during which the exhaust valve 13 is opened by the eccentric 11. The operation is continued by means of the vapor from the tank 41 until the parts have become sufficiently heated to vaporize the heavy hydro-carbon in the vaporizer V. The hydro-carbon is then admitted to the vaporizer V by opening the stop-cock in the pipe 22, and the stop-cock 40 is closed, shutting off the supply from the auxiliary tank 41. The next suction stroke of the piston 2 will draw in uncharged air through the valve 37 and the valve 12, which is held open by the eccentric 10 during the major portion of the suction stroke. During the last portion of the suction stroke, however, the valve 12 is closed and the suction created by the outward movement of the piston draws down the valve 16 and sucks in the carbureted air from the vaporizer. On the compression stroke of the piston the carbureted air and the uncharged air are mixed and compressed, and the explosive mixture thus formed is ignited at the proper instant, driving the piston 2 outward. During the exhaust stroke of the piston, the valve 13 is opened by the eccentric 11 and the valves 12 and 16 remain closed. Where a heavy hydro-carbon is used so that the carbureted air drawn from the vaporizer V is heavier than atmospheric air, it is preferable to open the valve 12 at the beginning of the suction stroke and hold it open during the major portion of that stroke, when it is closed, allowing the suction to open the valve 16 and admitting the carbureted air above the uncharged air in the cylinder. By this arrangement the greater specific gravity of the carbureted air causes it to sink through the uncharged air, thus insuring a complete mixture. It is obvious, however, that if a vaporized hydro-carbon of less specific gravity than the uncharged air is used, the eccentric 10 may be arranged to open the valve 12 at the latter portion of the stroke. In such an arrangement, the lighter hydro-carbon will be admitted first and will tend to rise through the uncharged air. Furthermore, if for any reason it is desirable to do so, the vaporized hydro-carbon may be admitted at any other portion of the suction stroke by so constructing the eccentric 10 that the valve 12 will be opened at the desired point. In any case, I secure an internal combustion engine in which uncharged air and carbureted air, both of which are non-explosive, are separately drawn into the combustion chamber and there formed into an explosive mixture.

By this arrangement I prevent premature explosion and am enabled to secure good regulation, and efficient combustion of heavy hydro-carbon oils.

By so constructing the carbureted air valve that it is normally closed by a spring and is opened by the unbalanced pressure due to the outward movement of the piston when the air valve is closed, I provide for the automatic opening of the carbureted air valve whenever the air valve is closed during the suction stroke. With this arrangement it is only necessary to adjust the mechanism for opening the air valve in order to vary the order of feed of the air and carbureted air in any desired manner.

Though I have described above and illustrated in detail the form in which I prefer to embody my invention, it will be understood that my improvements may be embodied in other forms without departing from the spirit of my invention.

What I claim is:—

1. In an internal combustion engine, a combustion chamber, a vaporizer adapted to produce a non-explosive hydro-carbon vapor, a connecting conduit between the vaporizer and combustion chamber, a valve controlling said conduit, and an air inlet to the combustion chamber, in combination with means for opening the valve controlling the vapor conduit during a part only of the suction stroke to thereby allow a stratum of the non-explosive hydro-carbon vapor to be drawn into the combustion chamber, and means for opening the air inlet during that portion of the suction stroke when the valve controlling the vapor conduit is closed, to thereby allow a stratum of air to be drawn into the combustion chamber, whereby the air and vapor are admitted in separate non-explosive strata during the suction stroke and are intimately mixed during the compression stroke; substantially as described.

2. In an internal combustion engine, a vaporizer for heavy hydro-carbon oils, means for mixing the vaporized hydro-carbon with air in said vaporizer to produce non-explosive carbureted air having a greater specific gravity than atmospheric air, a combustion chamber, an air inlet to said chamber, a port at the upper portion of the combustion chamber for admitting the carbureted air, means for opening the air inlet during the first part of the suction stroke, and means for opening the carbureted air port during the last part of the suction stroke, whereby the carbureted air is fed above the atmospheric air in the combustion chamber.

3. An internal combustion engine, having a combustion chamber, and having means for admitting air into said combustion chamber during the first part of the suction stroke and then discontinuing the admission of air, and means for subsequently admitting into the upper part of said combustion chamber a hydro-carbon having a greater specific gravity than air.

4. In an internal combustion engine, a combustion chamber having an air inlet and a vapor inlet, means for opening the air inlet during part only of the suction stroke, and means for opening the vapor inlet during that part of the suction stroke when the air inlet is closed.

5. In an internal combustion engine, a combustion chamber having an air inlet and a vapor inlet, means for opening the air inlet during the first part of the suction stroke, means for closing said air inlet before the end of the suction stroke, and means for opening the vapor inlet after the air inlet is closed.

6. In an internal combustion engine, a combustion chamber having an air inlet valve and a vapor inlet valve, the said valves being so constructed and arranged that the vapor inlet valve will open whenever the air inlet valve is closed during the suction stroke.

7. In an internal combustion engine, a combustion chamber having an air inlet valve, and a vapor inlet valve, so constructed and arranged as to be opened by the suction created by the engine piston when the air inlet valve is closed during the suction stroke.

8. In an internal combustion engine, a combustion chamber having an air inlet and a vapor inlet, means for opening the air inlet during the first part of the suction stroke, and for closing it before the end of the suction stroke, and means actuated by the closure of the air inlet to open the vapor inlet during the remainder of the suction stroke.

9. In an internal combustion engine, a vaporizer, for heavy hydro-carbon oils, a combustion chamber, a port in the upper part of the combustion chamber communicating with the vaporizer, an air inlet for said combustion chamber, means for opening the air inlet during the first part of the suction stroke and then discontinuing the admission of air, and means for subsequently opening the port communicating with the vaporizer, whereby the heavy hydro-carbon vapor is fed above the air in the combustion chamber.

In testimony whereof I affix my signature, in presence of two witnesses.

FRANCIS W. BRADY.

Witnesses:
BURGESS A. CURDEN,
WILLIAM H. DAVIS.