Jan. 8, 1952 L. D. THOMPSON 2,581,458

METHOD AND APPARATUS FOR OPERATING INTERNAL-COMBUSTION ENGINES ON COMPOSITE MIXTURES OF DIESEL FUEL OIL AND GASOLINE

Filed Jan. 22, 1946 2 SHEETS—SHEET 1

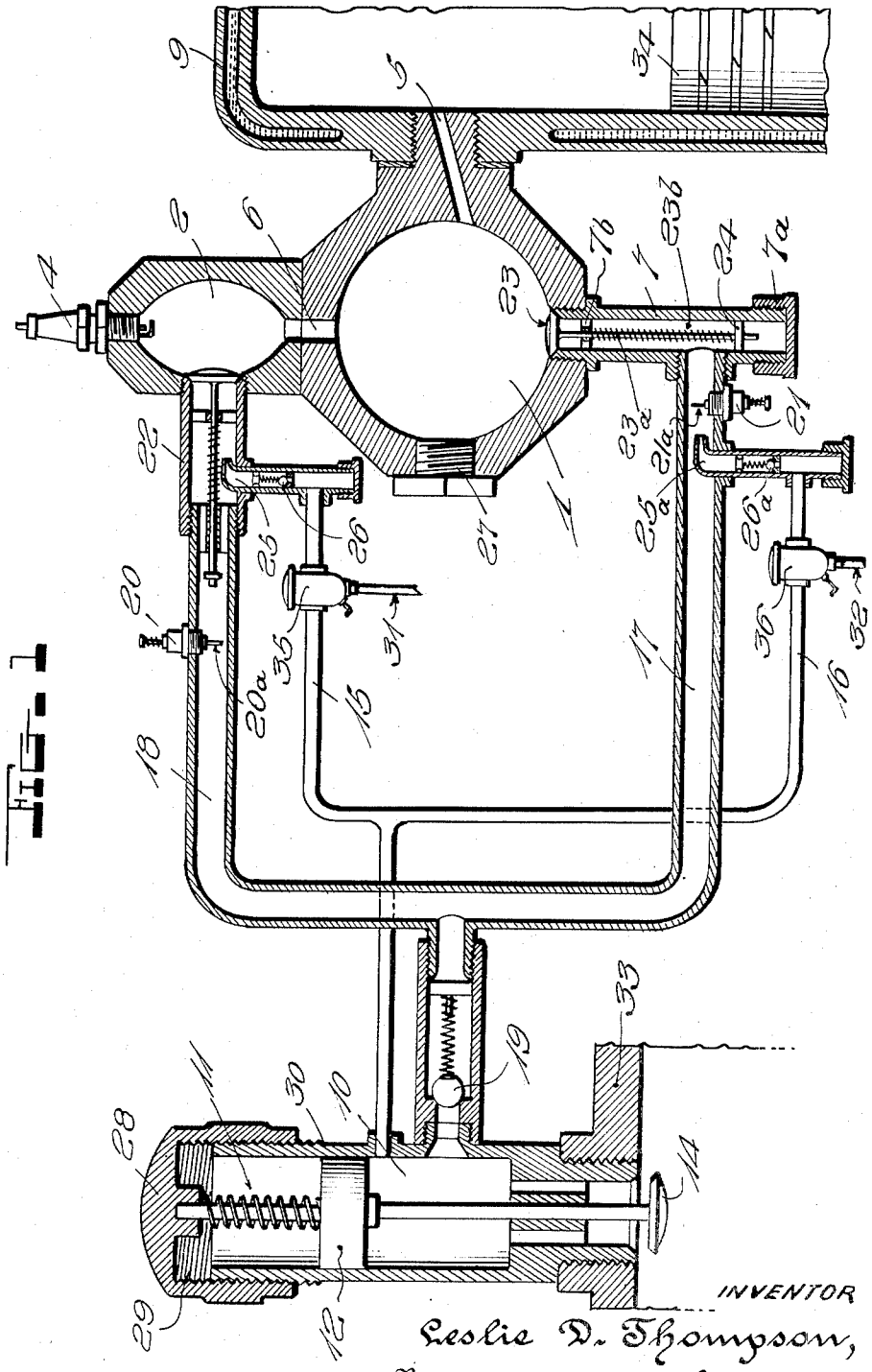


Fig. 1

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Filed Jan. 22, 1946 2 SHEETS--SHEET 2

FIG. 2

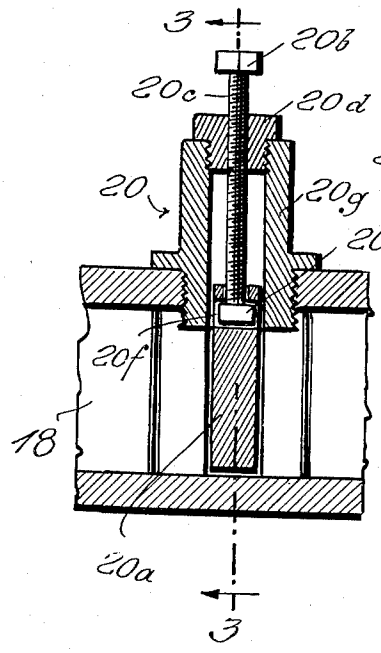


FIG. 3

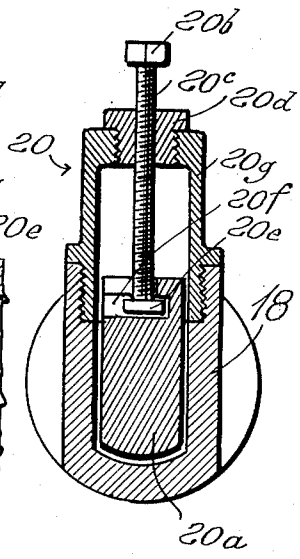


FIG. 4

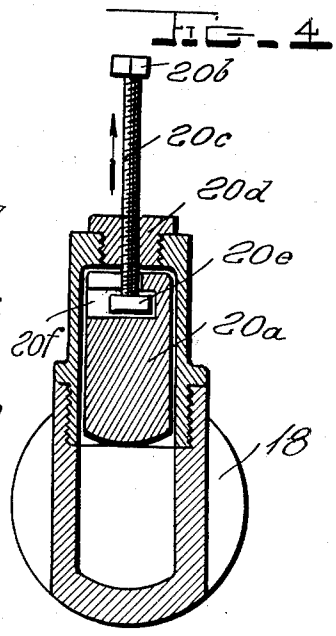


FIG. 5

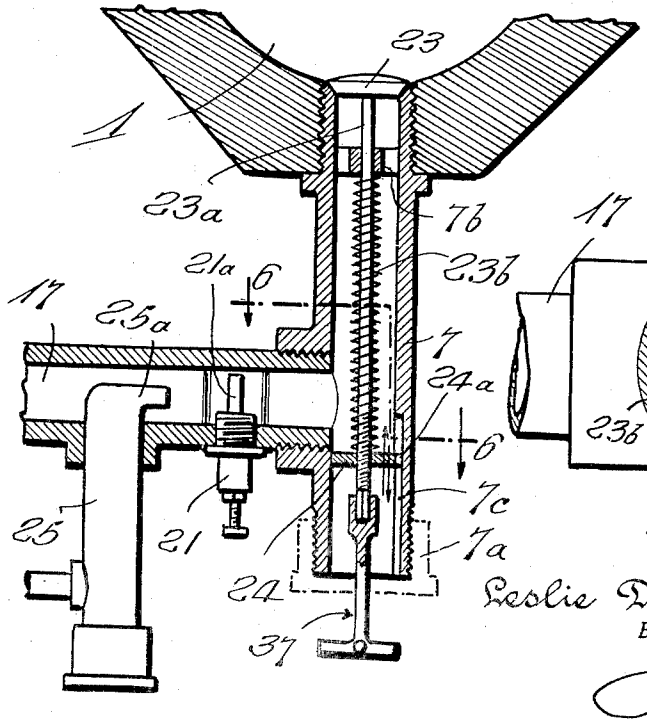
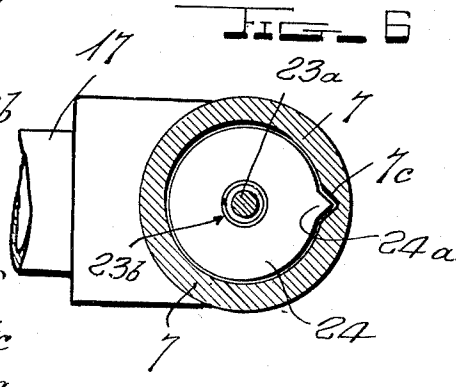


FIG. 6



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Patented Jan. 8, 1952

2,581,458

UNITED STATES PATENT OFFICE

2,581,458

METHOD AND APPARATUS FOR OPERATING INTERNAL-COMBUSTION ENGINES ON COMPOSITE MIXTURES OF DIESEL FUEL OIL AND GASOLINE

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Application January 22, 1946, Serial No. 642,626

6 Claims. (Cl. 123—33)

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My invention relates broadly to engines, and more particularly to mechanism for utilizing diesel fuel oil in combination with gasoline as a driving media for internal combustion engines.

One of the objects of my invention is to provide an arrangement of a fuel feeding mechanism for internal combustion engines by which the consumption of gasoline may be economized by employing a fuel mixture in which more readily available, and cheaper diesel fuel oil is used.

Another object of my invention is to provide a construction of pre-combustion chambers for internal combustion engines for utilizing composite diesel, or other heavy fuel oil with gasoline as a fuel mixture for driving internal combustion engines.

Still another object of my invention is to provide a construction of pre-combustion chambers which may be connected through the spark plug aperture of an internal combustion engine cylinder, where the pre-combustion chamber is constituted by two sections, into one of which vaporized gasoline is introduced and into the other of which vaporized, or heavy diesel fuel oil is introduced for composite operation as a driving media for internal combustion engines.

Still another object of my invention is to provide a construction of pre-combustion chamber connectable with an internal combustion engine cylinder for utilizing as a combustable mixture combined gasoline and diesel or heavy fuel oil in proportions in which the diesel or heavy fuel oil predominates for forming a driving mixture for operating the internal combustion engine.

Other and further objects of my invention reside in the combustion of gasoline and diesel, or heavy fuel oil feeding, vaporizing and mixing chambers associated with an internal combustion engine for the economical operation of the engine as set forth more fully in the specification hereinafter following by reference to the accompanying drawings which show the system and mechanism of my invention, and in which:

Figure 1 is a schematic layout of the system of my invention showing the application of the combination gasoline and heavy fuel oil feeding system to an engine in accordance with my invention; Fig. 2 is a fragmentary longitudinal sectional view of one of the metering valves showing the valve moved to one of its extreme limits closing the airpipe; Fig. 3 is a vertical sectional view taken substantially on line 3—3 of Fig. 2; Fig. 4 is a view corresponding to Fig. 3 and illustrating the metering valve adjusted to its opposite extreme position for opening the airpipe to the

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maximum exent; Fig. 5 is an enlarged fragmentary vertical sectional view through the intake valve for the heavy fuel oil leading to the pre-combustion chamber with certain of the parts shown in elevation; and, Fig. 6 is a transverse sectional view taken substantially on line 6—6 of Fig. 5.

My invention requires the use of two fuel tanks to supply the pre-combustion chambers on an engine in accordance with my invention, one for gasoline and one for diesel fuel oil or other heavy fuel oil. The gasoline supply for the system illustrated is connected at 31 while the diesel fuel supply is connected at 32 for providing respectively the gasoline fuel feed and the diesel fuel feed for the engine. The intake manifold of the engine is detached from the carburetor and thus supplies pure air to the cylinders. A charge of gasoline flows by gravity, or is pumped, and forced and drawn from the tank connected to pipe 31 through pressure valve 35 and through a pipe line into section 2 of the pre-combustion chamber through a nozzle 25, check valve 26, passing intake valve 22 where carburetion takes place. A charge of diesel fuel oil flows by gravity, or is pumped, and forced and drawn through pipe 32 from another tank into section 1 of the pre-combustion chamber through diesel fuel feed chamber 36, check valve 26a, and nozzle 25a through intake spring valve 23 regulated by stem 23a, or some other similar device.

In the form shown the stem 23a is screw threaded through plate number 24 keyed by lateral projection 24a to slide along the inner walls of the intake pressure valve housing 7 in keyway 7c. The stem 23a may be adjusted by removing cap 7a from housing 7 and revolving stem 23a with a tool 37 which increases or decreases the effective pressure of spring 23b as the distance between the plate member 24 and the guide 7b for the stem 23a is varied.

The gasoline vapor in section 2 is exploded by the regular ignition of the gasoline engine. The spark plug for this purpose is inserted into section 2 in the position 4. The pressure of the ignited charge forces the charge through port opening 6 into section 1 igniting the diesel fuel oil and vapor therein. The vapor is caused by the heat of the pre-combustion chamber after the engine has been warmed up and by the spray action in 25a. The resultant pressure forces the burning charge through port 5 into the combustion chamber or cylinder of engine designated at 9 where the combustion is completed thus generating power which has a slow even impulse like a diesel engine. The

explosion is not instantaneous as when gasoline alone is used in an ordinary gasoline engine consequently most of the knocks common in gasoline engines in slow hard pulls are eliminated.

The pre-combustion chamber can be built into the combustion section of internal combustion engines during initial production. The construction, however, is particularly applicable as an attachment for existing internal combustion engines and will be referred to herein in that application without limiting my invention thereto.

The pre-combustion chamber is made of steel, iron, aluminum or similar material. It may vary as to shape and size and may be attached to the engine cylinder horizontally, vertically or at an angle. This is usually determined by the position of spark plug opening as the pre-combustion chamber is usually attached by removing the spark plug from cylinder and substituting the pre-combustion chamber which is screwed into the opening as hereinbefore mentioned. The proportion of gasoline and diesel fuel oil may vary so long as enough gasoline is employed to fire the charges in sections 2 and 1. A typical size for warm climate is about 50% larger than represented in the drawing, in which section 1 is about 1/20 as large as the combustion section of the associated engine cylinder, and section 2 is approximately 1/5 the size of section 1. 5% gasoline and 95% diesel fuel oil works satisfactorily in the tropics but this can vary widely. In some engines now in use gasoline is employed in starting and after the engine has become heated the gasoline is cut off and diesel fuel oil or other heavy fuel oil is turned on. Gasoline is used continuously with the pre-combustion chamber of my invention and the diesel fuel oil does not come in contact with the spark plugs which keeps them clean and accounts for much of the success of the device of my invention. That is to say, the gases immediately around the spark plug are gasoline vapors while the diesel oil vapors are removed from immediate proximity with the spark plug. The explosive sequence is accordingly established first through the gasoline vapor ignition which fires the heavier oil vapors which in turn effect the explosive drive force.

The mechanism of my invention includes a pressure valve connected to the combustion section of the engine cylinder which fires just before the one to which the pre-combustion chamber is attached. The connection may be made by screwing pressure valve into an opening through wall of cylinder 33. The pressure valve is set to close just before the ignition of cylinder from which the pressure is taken. The pressure valve plunger or piston 12 is forced up and closes intake valve 14 until the pressure is released after the ignition and power cycle, the valve closing before the firing thus preventing burned gases entering into pressure valve chamber 10. The piston 12 is adjusted under control of the coil spring 11 by means of valve cap 28 which is screw threaded at 29 to variably engage the screw threaded housing 30 of the valve structure. As the pressure has increased in air pipes 15 and 16 to the pressure in 10, air pipes 17 and 18 also have a like pressure but differ from the pressure in air pipes 15 and 16 as the pressure is locked in by air pressure check valve 19 and a portion of the compression is only relieved through passing obstruction or metering valves 20 and 21 controlling the rate of flow of air.

The obstruction or metering valves 20 and 21 are individually adjustable to allow the vanes 20*a* and 21*a* to extend wholly or partially into the air pipes 17 and 18 or to be selectively positioned at an angle to the axis thereof to regulate the effective size of the passage through which the air may flow. Figs. 2–4 show the details of construction of each of the metering valves which for purposes of illustration have been exemplified by metering valve 20 in which adjustable vane 20*a* slides transversely in valve housing 20*g* under control of the adjustment head 20*b* attached to screw threaded stem 20*c*. The screw threaded stem 20*c* is adjustable through the screw threaded bushing 20*d* which is mounted in valve housing 20*g*. The vane 20*a* is slotted at 20*f* for the passage of the end of screw threaded stem 20*c* which is provided with transverse head 20*e* thereon engaged within the slot 20*f* so that the head 20*e* may freely revolve in slot 20*f* as the vane is advanced or retracted with respect to airpipe 18 for controlling the effective cross sectional area of airpipe 18. Metering valve 21 is constructed in a similar manner. The air under pressure then passes through valves 22 and 23, each of which is spring biased to closed position but free to open on the pressure in pipes 17 and 18 when the pressure increases to the proper point for the continued operation of the engine. The flow of air in pipes 17 and 18 into sections 1 and 2 is controlled by obstruction or metering valves 20 and 21 in order to maintain an even pressure in combustion chamber 9 and sections 1 and 2 until the completion of compression cycle of piston 34.

As the air in air pipe 18 passes nozzle 25 it is sprayed with gasoline vapor through an appropriate atomizing orifice. Under these conditions the gasoline vapor now collects in section 2 under a pressure controlled by the adjustable obstruction or metering valve 20 and equal to pressure in section 1. As the air in pipe 17 passes check valve 26*a* it is sprayed along with diesel fuel oil through the open nozzle or atomizing device 25*a*. The diesel oil sprayed compressed air in air pipe 17 that has passed nozzle 25*a* passes through the obstruction or metering valve 21 into section 1 of the pre-combustion chamber at a pressure controlled by the obstruction or metering valve 21 as near cylinder compression in the engine as it is practicable to adjust, preventing its flowing through port 5. Both of the obstruction or metering valves 20 and 21 are individually adjustable to control the size of the orifice through which the air in one instance, and the mixture of diesel fuel oil and air in the other instance is supplied to the pre-combustion chambers.

It will be observed that the obstruction or metering valve 20 determines only the quantity of air supplied to section 2 while obstruction or metering valve 21 determines the quantity of both air and diesel fuel mixture that is supplied to section 1 of the pre-combustion chamber, as in the first instance the obstruction or metering valve 20 is located in advance of the gasoline feed nozzle 25 while in the second instance the obstruction or metering valve 21 is located after the diesel fuel feed nozzle 25*a* in the feed path to the section 1.

During the rotative cycle within the progressive range of 20 to 45°, before dead center and adjustably controlled by spark advance, gasoline vapor is fired in section 2 of the pre-combustion chamber creating a pressure which forces the charge into section 1, igniting the diesel fuel oil and vapor therein which then passes through port 5 into the combustion section of cylinder 9 of the engine where combustion is completed and power generated. The flow of partially combusted fuel

from section 1 into engine cylinder 9 is regulated by the size of port 5 to meet the revolutions per minute of the engine. After the power stroke of the piston the usual scavenger cycle of the engine expels the burned gases. This operation takes place sequentially from engine cylinder to engine cylinder in their regular firing order and applies to an engine with two or more cylinders.

Both ports 5 and 6 may be varied in size, shape and direction and the pre-combustion chamber should be large enough and so constructed that an ordinary spark plug can be inserted into section 2 as shown at 4. Section 1 may be cleaned out from time to time by removal of cleaning plug 27. At times, particularly in cold weather, it may be desirable to heat the air by the engine exhaust before it is drawn into the cylinder.

The combustible mixture which is supplied to the engine cylinder through port 5 is obtained by a collision effect between the gasoline vapor injected into section 1 of the pre-combustion chamber and the diesel fuel oil vapor injected from the diametrically opposite position in the wall of the pre-combustion chamber 1 through valve 23. These two pressure flow paths meet in the center of section 1 of the pre-combustion chamber and the impact further aids the vaporization and commingling of the mixtures which are supplied through port 5 to the engine cylinder. The diametrically opposite location of the two separate injection means 6 and 23 with respect to the pre-combustion chamber is an important feature of my invention.

A slow speed internal combustion engine, one making say 1000 or less revolutions per minute, may be successfully operated with the pre-combustion chamber of my invention without the use of the pressure valve and connections for regulating pressure in sections 1 and 2 other than hereinafter mentioned. This is done by utilizing the suction of the engine cylinder to which the pre-combustion chamber is attached. The pre-combustion chamber is attached as shown in accompanying drawing, one to each cylinder of the engine, except that sections 1 and 2 are placed in a horizontal position. As described above two fuel tanks are required and the intake manifold of the engine is detached from the carburetor and thus supplies pure air to the cylinders. The gasoline supply is connected to an ordinary carburetor, or similar device, to which it is pumped or flows by gravity. The diesel fuel oil, or other heavy fuel oil, supply is connected to diesel fuel feed chamber 36, or similar device, to which it is pumped or flows by gravity. Vaporized gasoline and air is drawn from the carburetor, or similar device, by the suction stroke of the piston of cylinder to which the pre-combustion chamber is attached through a pipe and intake valve 22, which is preferably placed at 4, into sections 2 and 1. A slight depression or well large enough to hold a charge of diesel fuel oil is made at the bottom of section 1 in relation to its new position. The same piston suction draws a charge of diesel fuel oil, or other heavy fuel oil, from diesel fuel feed chamber 36, or similar device, through a pipe and intake spring valve 23 into section 1. Most of the diesel fuel oil, or other heavy fuel oil, in section 1 at the beginning of the compression stroke of the piston of cylinder to which the pre-combustion chamber is attached is in liquid form. Said compression stroke forces air through port 5, which is preferably slanted towards port 6, compressing and forcing most of the gasoline and vapor then in section 1 through port 6 into section 2. Port

6 being preferably funnel shaped with the smaller opening of funnel in section 1 and slanted so the explosive force from section 2 strikes the slight depression or well at bottom of section 1. In relation to the new position of the pre-combustion chamber the spark plug opening is preferably made in the top of section 2 and the opening for intake spring valve 23 is preferably made in the slight depression or well at the bottom of section 1.

The gasoline vapor in section 2 is exploded by the regular ignition of the gasoline engine and the order of ignition, explosion and power generation is the same as hereinabove described, that is, the pressure of the ignited charge in section 2 forces the charge through the port opening 6 in section 1 igniting the diesel fuel oil, or other heavy fuel oil, and vapor therein. The resultant pressure forces the burning charge through port 5 into the combustion chamber of the cylinder where the combustion is completed thus generating power. The usual scavenger stroke of the piston expels burned gases. A slow speed internal combustion engine with one or more cylinders may be operated by this method.

In the methods of operation described above the gasoline feed, which is preferably permanently fixed, is regulated by the adjustment of pressure valve 35 or carburetor and the diesel fuel oil, or other heavy fuel oil, feed is regulated by a throttle connected with the diesel fuel oil, or other heavy fuel oil, feed pipe.

While I have described some of the preferred embodiments of my invention I realize that modifications may be made and I intend no limitations upon my invention other than may be imposed by the scope of the appended claims.

What I claim and desire to secure by Letters Patent of the United States is as follows:

1. An internal combustion engine comprising an engine cylinder and co-acting piston therein, a pair of fuel feed lines, one of which delivers gasoline and the other of which delivers a heavier oil fuel, a pre-combustion chamber including a gasoline combustion section and an interconnected heavier fuel oil combustion section, means interconnecting said heavier oil combustion section with said engine cylinder, a connection from the gasoline fuel feed line with said first mentioned section, a connection between said heavier oil fuel feed line and said second mentioned section, said last mentioned connection and the interconnection between the gasoline combustion section and the heavier oil combustion section being diametrically aligned on opposite sides of said heavier oil combustion section, means for igniting gasoline fuel in said first mentioned section for sequentially firing the heavier oil fuel in said second mentioned section for conjointly establishing a pressure force in said engine cylinder, means for establishing an air flow through each of said sections for facilitating the charging of said engine cylinder and means for regulating the pressure of said air flow independently of cyclic engine cylinder compression.

2. An internal combustion engine comprising an engine cylinder and co-acting piston therein, a pair of fuel feed lines, one of which delivers gasoline and the other of which delivers heavier oil fuel, a pre-combustion chamber including a gasoline combustion section and an interconnected heavier fuel oil combustion section, means interconnecting said heavier oil combustion section with said engine cylinder, a connection from the gasoline fuel feed line with said first men-

tioned section, a connection between said heavier oil fuel feed line and said second mentioned section, said last mentioned connection and the interconnection between the gasoline combustion section and the heavier oil combustion section being diametrically aligned on opposite sides of said heavier oil combustion section, means for igniting gasoline fuel in said first mentioned section for sequentially firing the heavier oil fuel in said second mentioned section for conjointly establishing a pressure force in said engine cylinder, compression means for establishing a flow of air through each of said sections at a predetermined velocity for facilitating the charging of said engine cylinder and means for regulating the pressure of said air flow independently of cyclic engine cylinder compression.

3. An internal combustion engine comprising an engine cylinder and co-acting piston therein, a pair of fuel feed lines, one of which delivers gasoline and the other of which delivers heavier oil fuel, a pre-combustion chamber including a gasoline combustion section and an interconnected heavier fuel oil combustion section, means interconnecting said heavier oil combustion section with said engine cylinder, a connection from the gasoline fuel feed line with said first mentioned section, a connection between said heavier oil fuel feed line and said second mentioned section, said last mentioned connection and the interconnection between the gasoline combustion section and the heavier oil combustion section being diametrically aligned on opposite sides of said heavier oil combustion section and independently adjustable means for developing a flow of air through each of said connections, adjustable means for introducing atomized gasoline in said first mentioned connection, adjustable means for introducing atomized heavier oil fuel in said second mentioned connection, and means for igniting gasoline fuel in said first mentioned section for sequentially firing the heavier oil fuel in said second mentioned section for conjointly establishing a composite pressure force in said engine cylinder.

4. An internal combustion engine comprising an engine cylinder and co-acting piston therein, a pair of fuel feed lines, one of which delivers gasoline and the other of which delivers heavier oil fuel, a pre-combustion chamber including a gasoline combustion section and an interconnected heavier fuel oil combustion section, means interconnecting said heavier oil combustion section with said engine cylinder, a connection from the gasoline fuel feed line with said first mentioned section, a connection between said heavier oil fuel feed line and said second mentioned section, said last mentioned connection and the interconnection between the gasoline combustion section and the heavier oil combustion section being diametrically aligned on opposite sides of said heavier oil combustion section, an atomizing nozzle for supplying atomized gasoline through said first mentioned connection, a separate atomizing nozzle for supplying heavier oil fuel through said second mentioned connection, compression means for establishing a flow of air through said connections, a metering device disposed in said first mentioned connection in advance of said atomizing nozzle on the compression side of said connection, a metering device disposed in said second mentioned connection intermediate the atomized nozzle therein and said second mentioned section remote from the compression side of said connection and means for igniting the gasoline fuel in said first mentioned section and producing a collision between the flow of the heavier oil fuel and the ignited gasoline gases in alignment with the connection between said heavier oil combustion section and said engine cylinder for sequentially firing the heavier oil fuel in said second mentioned section for conjointly establishing a composite pressure force in said engine cylinder.

5. An internal combustion engine comprising an engine cylinder and co-acting piston therein, a pair of fuel feed lines, one of which delivers gasoline and the other of which delivers heavier oil fuel, a pre-combustion chamber including a gasoline combustion section and an interconnected heavier fuel oil combustion section, means interconnecting said heavier oil combustion section with said engine cylinder, a connection from the gasoline fuel feed line with said first mentioned section, a connection between said heavier oil fuel feed line and said second mentioned section, independently adjustable means for developing a flow of air through each of said connections, adjustable spring biased valve means for admitting a flow of atomized gasoline from said first mentioned connection to said first mentioned section, independently adjustable spring biased valve means for admitting the flow of atomized heavier oil fuel from said second mentioned connection into said second mentioned section, said spring biased valve means operating under control of said last mentioned flow above a predetermined engine operating speed for charging said sections, and means for igniting atomized gasoline fuel in said first mentioned section for sequentially firing the heavier oil fuel in said second mentioned section for conjointly establishing a composite pressure force in said engine cylinder.

6. An internal combustion engine comprising an engine cylinder and co-acting piston therein, a pair of fuel feed lines, one of which delivers gasoline and the other of which delivers heavier oil fuel, a pre-combustion chamber including a gasoline combustion section and an interconnected heavier fuel oil combustion section, means interconnecting said heavier oil combustion section with said engine cylinder, a removable and replaceable clean out plug disposed in the side of said heavier oil combustion section on the side remote from said engine cylinder and in alignment with the connection of said heavier oil combustion section with said engine cylinder, a connection from the gasoline fuel feed line with said first mentioned section, a connection between said heavier oil fuel feed line and said second mentioned section, said last mentioned connection and the interconnection between the gasoline combustion section and the heavier oil combustion section being diametrically aligned on opposite sides of said heavier oil combustion section, an atomizing nozzle for supplying atomized gasoline through said first mentioned connection, a separate atomizing nozzle for supplying heavier oil fuel through said second mentioned connection, compression means for establishing a flow of air through said connections, a metering device disposed in said first mentioned connection in advance of said atomizing nozzle on the compression side of said connection, a metering device disposed in said second mentioned connection intermediate the atomized nozzle therein and said second mentioned section remote from the compression side of said connection and means for igniting the gasoline fuel in said first mentioned section and producing a collision between the flow of the heavier oil fuel

and the ignited gasoline gases in alignment with the connection between said heavier oil combustion section and said engine cylinder for sequentially firing the heavier oil fuel in said second mentioned section for conjointly establishing a composite pressure force in said engine cylinder.

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