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HEAVY FUEL ENGINE

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Fig. 1.

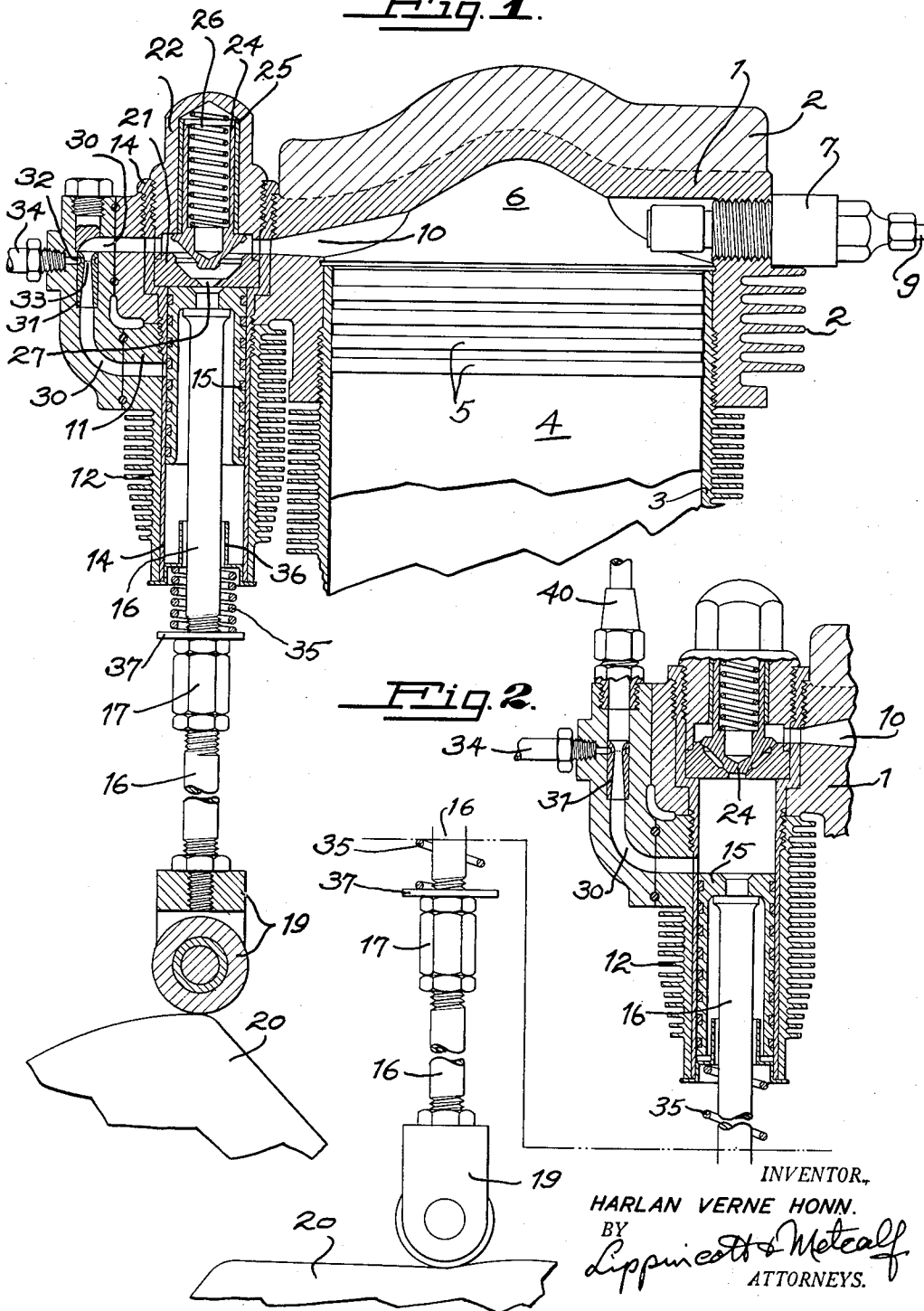


Fig. 2.

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HEAVY FUEL ENGINE

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8 Claims. (Cl. 123—143A)

My invention relates to heavy fuel engines, and more particularly to engines wherein a charge is ignited before being projected into a work cylinder. This application is a continuation in part of my co-pending application, Serial No. 745,573, filed September 26, 1934.

In my co-pending application referred to above, I have described and claimed an internal combustion engine wherein two separate cylinders are utilized, these cylinders being of different sizes. The smaller cylinder I term an igniter cylinder, and in that cylinder I compress and fire by compression an extremely rich charge of fuel. The burning charge is then by-passed into the larger work cylinder where it mixes with an air charge and completes its combustion with the proper fuel-air mixture.

The present invention concerns a similar engine, differing, however, in a number of features from that described in my prior application, although the general theory of operation is similar. In my prior application, for example, I utilize the compressed air in the work cylinder to carry fuel through a fuel valve into the igniter cylinder, and I supply no additional fuel to the work cylinder. My present invention, however, allows additional fuel to be injected into the work cylinder, and in addition provides specifically for an entirely different means and method of supplying a fuel charge to the igniter cylinder. Consequently, the main object of my present invention is to provide an internal combustion engine wherein all or part of the charge is ignited before entering a work cylinder, to the end that the igniter cylinder only need be of high compression.

Among other objects of my invention are: To provide an engine utilizing heavy fuel; to provide a heavy oil engine having a relatively low compression in the work cylinder; to provide a means and method of supplying an igniting charge to a low pressure work cylinder; to provide a means and method of supplying fuel to an igniter cylinder; and to provide an improved means and method of firing a heavy oil engine having a relatively low working pressure.

My invention possesses numerous other objects and features of advantage, some of which, together with the foregoing, will be set forth in the following description of specific apparatus embodying and utilizing my novel method. It is therefore to be understood that my method is applicable to other apparatus, and that I do not limit myself, in any way, to the apparatus of the present application, as I may adopt various other

apparatus embodiments, utilizing the method, within the scope of the appended claims.

In the drawing:

Figure 1 is a longitudinal sectional view of a portion of a cylinder head and igniter cylinder embodying my invention.

Figure 2 is a similar view showing another modification utilizing a different fuel supply to the igniter cylinder.

In the following description it is to be distinctly understood that while I have shown and illustrated my invention as applied to a single air cooled cylinder, it is applicable to any type of engine having single or multiple cylinders, and it is also applicable to internal combustion engines operating with any of the known cycle relationships. For that reason I have not shown connecting rods, crank shafts, cam shafts, or other appurtenances of the engine not related to the present invention, as such arrangements are well known to those skilled in the art.

My invention may be more fully understood by direct reference to the drawing.

In Figure 1 a cast cylinder head 1 is provided with air cooling fins 2 and preferably a hardened cylinder liner 3. The customary air intake and exhaust valves utilized for Diesel operation of an internal combustion engine have not been shown as there are many modifications of such devices and they are no part of the present invention. Bearing on the cylinder liner 3 is a piston 4 provided with the usual rings 5, there being the usual combustion chamber 6 above the top of the piston.

The structure just described, comprising the head 1, liner 3, and piston 4, will be termed hereafter the work cylinder. The piston 4 is connected to the crank shaft of the engine in the usual manner.

Inasmuch as I intend to describe my engine as operating with part of the fuel injected into the work cylinder, I provide the cylinder head 1 with a fuel injection nozzle 7, supplied with fuel oil from a source at the proper time in the cycle through fuel pipe 8. The cylinder head 1 is also provided with an igniter channel 10 leading laterally through an igniter assembly attached to the side of the cylinder head. This igniter assembly comprises an igniter casting 11 carrying an igniter cylinder body 12 provided with an igniter cylinder liner 14. The igniter cylinder is much smaller than the work cylinder. In the igniter cylinder is a high pressure piston 15 reciprocated in the cylinder through the medium of a divided piston rod 16 joined by an adjusting nut assem-

bly 17. The piston rod 16 terminates in a cam roller assembly 19, the cam roller bearing on a cam 20 driven in synchronism with the work cylinder piston 4 through the usual crank shaft and driving means.

Immediately above the igniter piston 15 is inserted a valve seat 21, held down by a valve cage 22, the latter being screwed to the upper end of the cylinder liner 14. The valve cage carries a surge valve 24 operating in a valve sleeve 25, and forced against the seat 21 by valve spring 26. Valve 24 opens into igniter channel 10 and the valve seat 21 is provided with an ignition aperture 27 opening beneath the valve so that the contents of the igniter cylinder may be discharged into the igniter channel 10, and from thence into the work cylinder.

In the modification shown in Figure 1, however, igniter channel 10 extends past the surge valve 24, and is continued as a fuel pressure channel 30, making a one hundred eighty degree bend, and opening into the igniter cylinder below the high point of the igniter piston travel as determined by cam 20. In the fuel pressure channel 30 I position a Venturi block 31 provided with an annular fuel channel 32 opening through multiple apertures 33 into the narrowest portion of the venturi thus formed. A fuel pipe 34 feeds the annular fuel channel 32.

Inasmuch as it is not important whether the igniter piston 15 is positively driven or roller driven, as shown, I may prefer to utilize an igniter piston return spring 35 bearing against the lower end of the cylinder liner through the medium of a cylinder spring retainer 36, and maintained in place by the usual spring retaining disc 37.

I prefer to operate my engine on the four-stroke cycle system, and as one complete up-and-down stroke of the piston is a scavenging movement I prefer to start my operational description at the beginning of the charging stroke, after all scavenging has been completed. At some time after the firing stroke (the time being at any portion of the complete cycle when no great pressure exists in the work cylinder chamber 6, and therefore in the fuel channel 30), I deposit, by any convenient supply means, an ignition charge of fuel in the annular fuel channel 32 through igniter fuel supply pipe 34. It may be held there in any convenient manner, such as by a check valve in the fuel pipe. At the same time air is being admitted through the usual air intake valve into the work cylinder, and as the piston 4 starts to rise in the work cylinder the igniter piston 15 is dropping, due to the contour of cam 20. The suction produced immediately closes the surge valve 24, and a slight negative pressure is produced in the igniter cylinder at the same time that pressure is being built up in the work cylinder. As soon as the descent of the igniter piston uncovers the closed end of fuel channel 30 there is a surge of air from the work cylinder through the fuel channel 30, and through the venturi, thereby withdrawing the ignition fuel in the annular channel 32 through apertures 33 into the fuel channel and thereafter into the igniter cylinder. The igniter piston then starts to rise faster than the work cylinder piston and to compress the fuel charge in the igniter cylinder against the surge valve 24. I prefer to so adjust the tension of the igniter valve spring and the area of the surge valve face exposed to the work cylinder pressure with relation to the surge valve face exposed to the igniter cylinder pres-

sure, that the igniter cylinder pressure may rise to a point where the igniter fuel charge is ignited by pressure. This pressure will vary, according to the type of oil used, from eighteen hundred to thirty-five hundred pounds per square inch. After ignition the pressure will still rise until the pressure developed snaps open the surge valve, and the ignited charge will surge into the main combustion chamber. The work cylinder, in the meantime, has had the intake air compressed to a relatively low pressure, for example, to three hundred fifty pounds per square inch. At the same time, or slightly before the ignited charge reaches the work cylinder, I prefer to inject additional fuel through igniter nozzle 7. Both the burning fuel and the injected fuel mix with the air, and flame propagation is continued in the work cylinder, the ignition being accomplished by the burning injected fuel.

It is obvious that the ignition of the charge in the igniter cylinder and the subsequent surge valve opening can be timed to place the ignited fuel into the main combustion chamber at exactly the proper time to meet the auxiliary injected fuel for maximum effect on the work piston 4, usually arriving three or four degrees before the main piston starts down on the power stroke. At the proper time in the power stroke the exhaust valve opens and the main combustion chamber is scavenged on the next two strokes as is usual in this type of engine, and the power stroke is repeated.

In the modification shown in Figure 2 the ignition channel 10 does not extend through into fuel channel 30, and I utilize a separate source of air entering above the Venturi block 31 through an auxiliary air pipe 40. Air may be supplied through this pipe under constant pressure inasmuch as no air will move through the fuel channel 30 except when the igniter piston is in its lowest position as shown in this figure. When the end of the igniter channel 30 becomes uncovered air can rush in carrying with it the fuel from the annular fuel ring in the Venturi block. After the piston rises air passage through the channel is automatically shut off by the piston, and the ignition in the igniter cylinder proceeds as described above.

It is obvious that if desired the entire charge may be injected into the work cylinder from the igniter piston, and in this case I completely eliminate fuel injection nozzle 7. Both methods of operation are satisfactory, and in either case the operation of the igniter assembly is the same, the only difference being the amount of fuel supplied to the annular ring 32 and the manner in which the device is throttled.

For example, when using an auxiliary injector nozzle 7 the amount of fuel supplied to the ignition venturi may be maintained constant, just sufficient to ignite the charge in the cylinder chamber 6. If, however, no auxiliary fuel is supplied, then the charge deposited in the Venturi block must be varied in accordance with the power demand required from the main work cylinder. It is also possible to adjust the air passages and pressures in such a manner that when the complete charge passes through the igniter assembly very incomplete combustion is obtained therein, whereas, if a firing charge only is desired a more perfect combustion can be produced in the igniter cylinder.

My invention has numerous advantages. Pre-ignition of the fuel reduces ignition lag in the work cylinder practically to zero, and a pre-

determined cycle can be followed. The maximum speed developed by the engine is much greater than that obtained in the usual type of Diesel engine, and the whole cycle of the igniter assembly can be timed to any advance or retard in respect to the work cylinder piston movement by changing the advance or retard of the cam with respect to the crank shaft of the engine. Another important feature is that since the fuel enters the work cylinder already ignited, any desired compression ratio may be used in the power cylinder, inasmuch as there is no necessity for ignition pressures to be developed by the work cylinder piston.

15 I claim:

1. In an internal combustion engine having a main combustion chamber containing a piston operating to produce a compression therein, an ignition device comprising an auxiliary combustion chamber, a venturi opening into said auxiliary combustion chamber, a fuel reservoir opening into the throat of said venturi, means for depositing fuel in said reservoir, means for cyclically supplying compressed air through said venturi to carry said fuel into said auxiliary chamber, means for compressing said fuel and air mixture to cause ignition thereof in said auxiliary combustion chamber by heat of compression, automatic means for releasing the ignited fuel into said main combustion chamber, and means for timing the deposition of fuel in said reservoir during the static portion of the air supply cycle.

2. In an internal combustion engine having a main combustion chamber containing a piston operating to produce a compression therein, an ignition device comprising an auxiliary combustion chamber, a venturi opening into said auxiliary combustion chamber, a fuel reservoir opening into the throat of said venturi, means for depositing fuel in said reservoir, means for cyclically supplying compressed air through said venturi to carry said fuel into said auxiliary chamber, means for compressing said fuel and air mixture to cause ignition thereof in said auxiliary combustion chamber by heat of compression, automatic means for releasing the ignited fuel into said main combustion chamber when the pressure of the burning fuel reaches a predetermined figure, and means for timing the deposition of fuel in said reservoir during the static portion of the air supply cycle.

3. In an internal combustion engine having a main combustion chamber having a timed fuel supply and containing a piston operating to produce a compression therein, an ignition device comprising an auxiliary combustion chamber, a venturi opening into said auxiliary combustion chamber, a fuel reservoir opening into the throat of said venturi, means for depositing fuel in said reservoir, means for cyclically supplying compressed air through said venturi to carry said fuel into said auxiliary chamber, means for compressing said fuel and air mixture to cause ignition thereof in said auxiliary combustion chamber by heat of compression, automatic means for releasing the ignited fuel into said main combustion chamber, to ignite the timed fuel supply.

4. In an internal combustion engine having a main combustion chamber containing a piston operating to produce a compression therein, an ignition device comprising an auxiliary combustion chamber, a venturi opening into said auxiliary combustion chamber, a fuel reservoir opening

into the throat of said venturi, means for depositing fuel in said reservoir, means for passing an air charge through said venturi to carry said fuel into said auxiliary chamber, means for compressing said fuel and air mixture to cause ignition thereof in said auxiliary combustion chamber by heat of compression, and automatic means for releasing the ignited fuel into said main combustion chamber.

5. In an internal combustion engine having a main combustion chamber containing a piston operating to produce a compression therein, an ignition device comprising an auxiliary combustion chamber, a venturi opening into said auxiliary combustion chamber, a fuel reservoir opening into the throat of said venturi, means for depositing fuel in said reservoir, means for passing an air charge through said venturi to carry said fuel into said auxiliary chamber, means for compressing said fuel and air mixture to cause ignition thereof in said auxiliary combustion chamber by heat of compression, and automatic means for releasing the ignited fuel into said main combustion chamber when the pressure of the burning fuel reaches a predetermined figure.

6. In an internal combustion engine having a main combustion chamber having a timed fuel supply and containing a piston operating to produce a compression therein, an ignition device comprising an auxiliary combustion chamber, a venturi opening into said auxiliary combustion chamber, a fuel reservoir opening into the throat of said venturi, means for depositing fuel in said reservoir, means for passing an air charge through said venturi to carry said fuel into said auxiliary chamber, means for compressing said fuel and air mixture to cause ignition thereof in said auxiliary combustion chamber by heat of compression, automatic means for releasing the ignited fuel into said main combustion chamber, to ignite the timed fuel supply.

7. In combination with an engine having a main combustion chamber and an auxiliary combustion chamber containing a piston and an inlet port opening below the top level of the piston travel, a conduit connected to said inlet port, a source of compressed air connected to said conduit, a venturi in said conduit, said venturi having an annular fuel ring around the throat of said venturi, said ring having multiple small openings into said throat, means for depositing fuel into said ring, said fuel being carried into said auxiliary combustion chamber solely by the rush of air through said venturi when said piston uncovers said port, and means for creating a static condition in said venturi during fuel deposition.

8. In combination with an engine having a main combustion chamber and an auxiliary combustion chamber containing a piston and an inlet port opening below the top level of the piston travel, a conduit connected to said inlet port, said conduit being connected to said main combustion chamber, a venturi in said conduit, said venturi having an annular fuel ring around the throat of said venturi, said ring having multiple small openings into said throat, and means for depositing fuel into said ring, said fuel being carried into said auxiliary combustion chamber solely by the rush of air from said main combustion chamber through said venturi when said piston uncovers said port, said fuel being deposited in said ring only when said port is covered.

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