

Dec. 6, 1938.

M. J. MURPHY

2,139,170

ENGINE

Filed Dec. 13, 1935

5 Sheets-Sheet 1

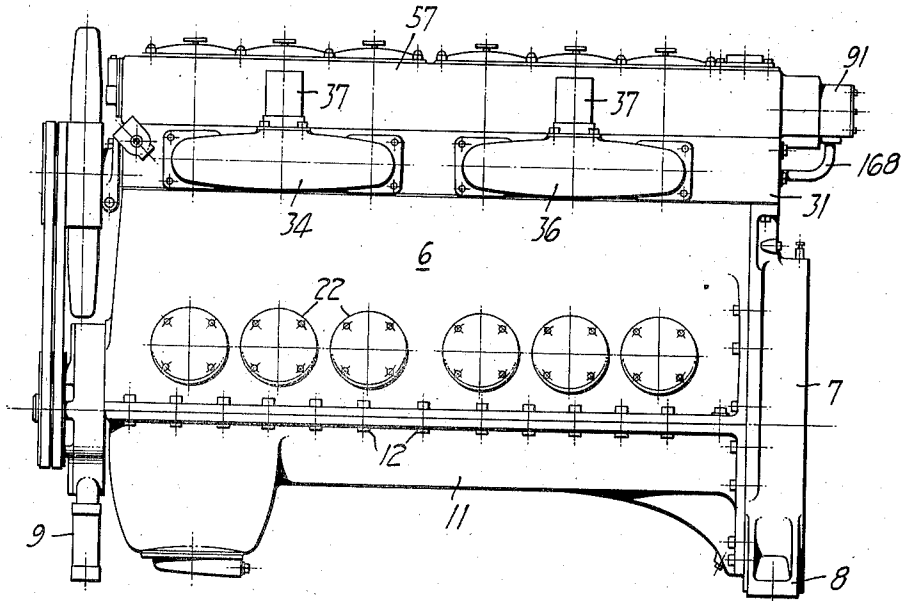


FIG. 1

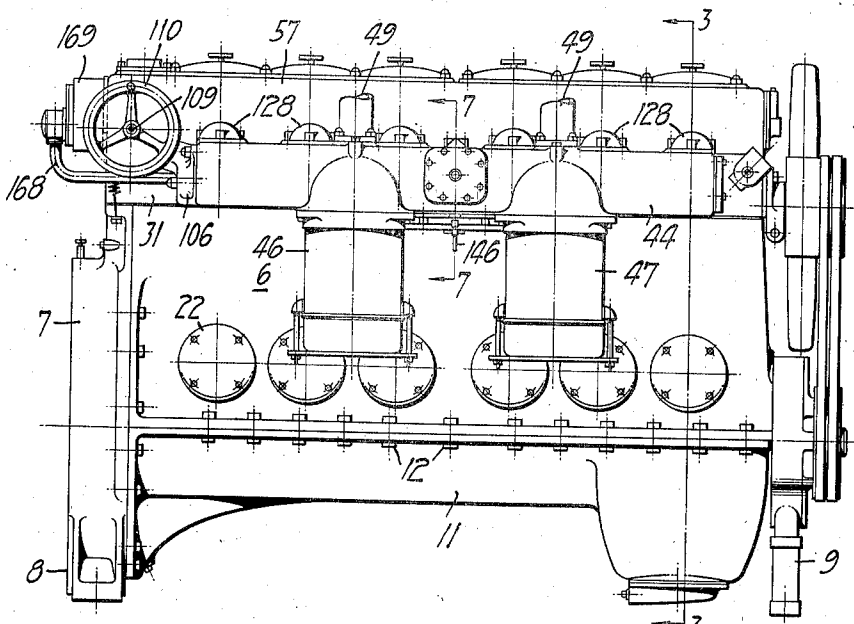


FIG. 2

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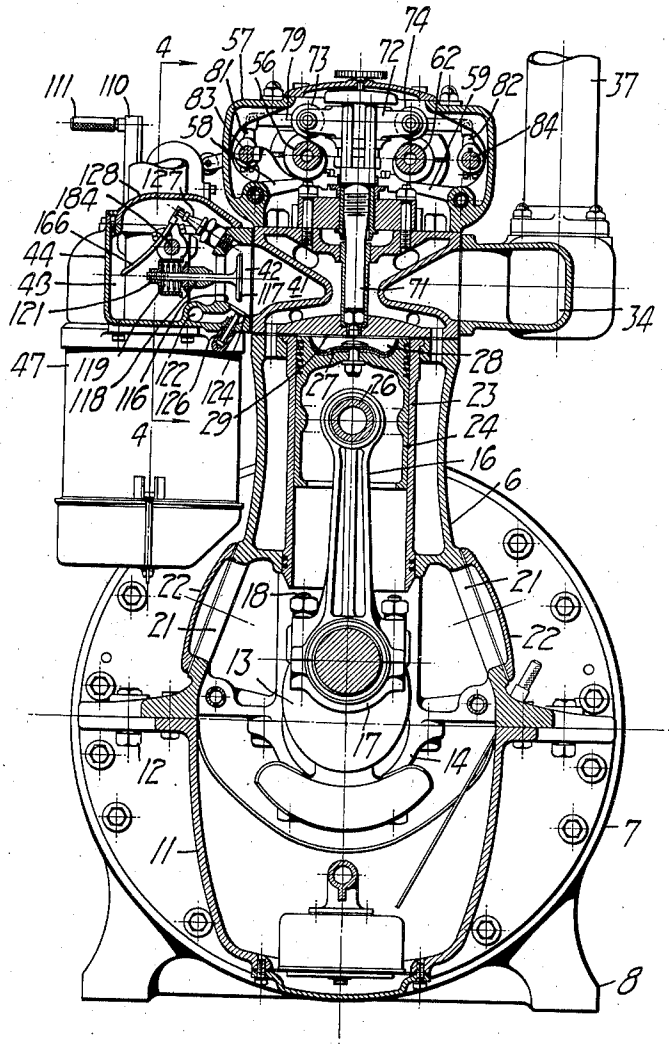


FIG. 3

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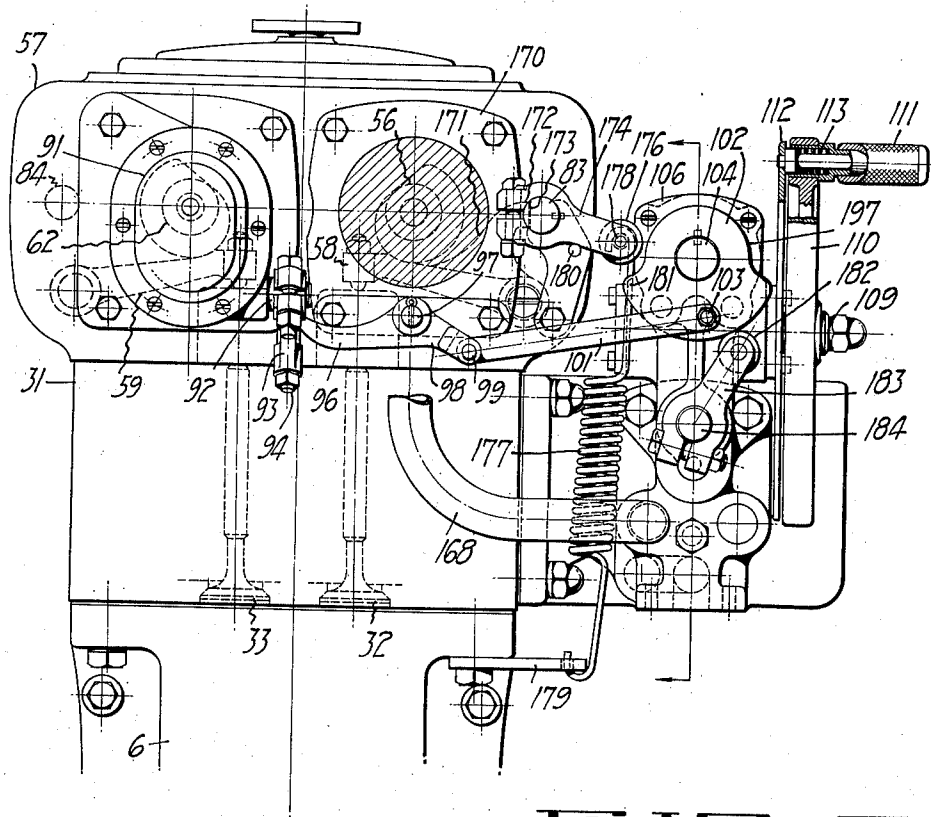


FIG. 5

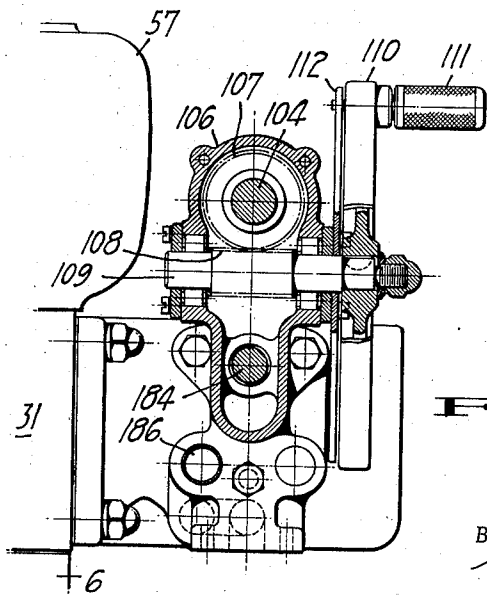


FIG. 6

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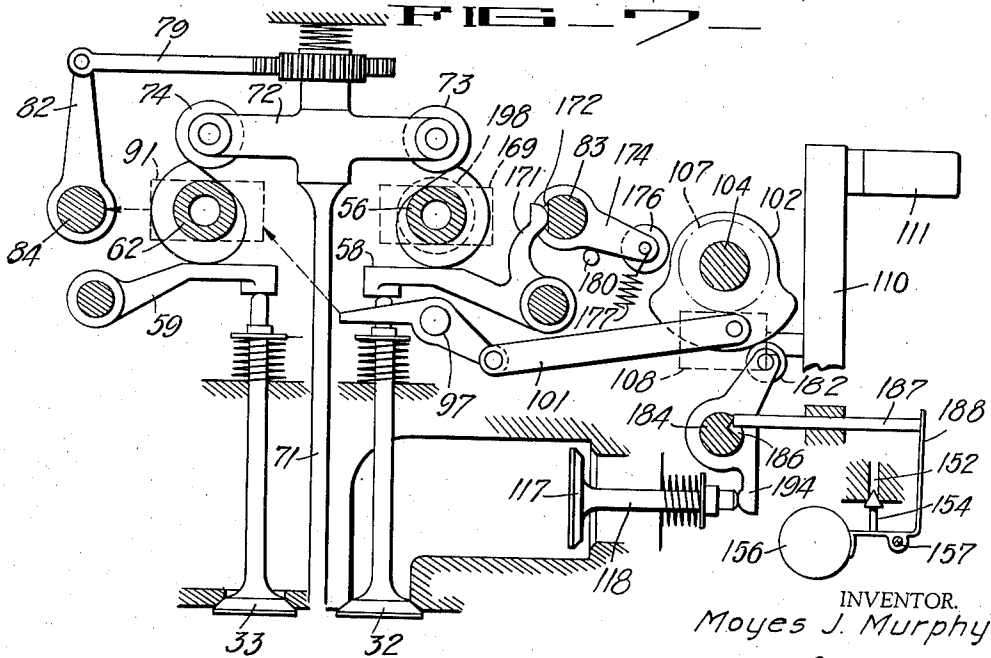
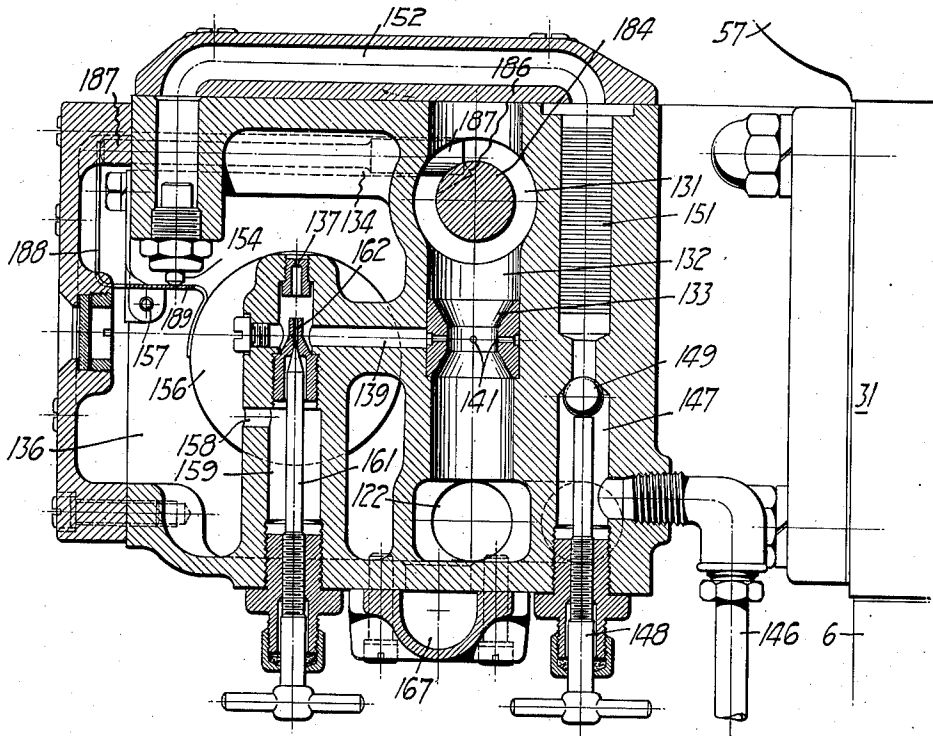
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5 Sheets-Sheet 5



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# UNITED STATES PATENT OFFICE

2,139,170

ENGINE

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Application December 13, 1935, Serial No. 54,270

8 Claims. (Cl. 123—180)

My invention relates to engines intended to operate usually on the Diesel cycle but convertible by a simple manipulation of the controlling mechanism to operate in accordance with the Otto cycle. A typical engine of this character is disclosed in my copending application entitled "Engine," filed October 20, 1931, with Serial No. 569,907.

In my copending application there is shown an engine in which the relatively small combustion chamber for use during operation on the Diesel cycle is augmented by an additional, auxiliary combustion chamber when the engine operates on the Otto cycle. Suitable poppet valves are utilized to control the events of the operating cycle, and additional valves are utilized to convert the auxiliary combustion chamber to an operative or an inoperative state. In many installations, the operation of the engine according to the Otto cycle is useful primarily for starting the engine from cold, and where an engine must be started often from a cold condition it is advantageous to have such Otto cycle mechanism incorporated with the Diesel engine. On the other hand, in certain circumstances the engine is started but seldom and sometimes is permanently connected to a suitable starter, such as an electric generator. In the latter case it may not be desirable to have the Otto cycle starting mechanism incorporated in the engine.

It is therefore an object of my invention to provide an engine in which the Otto cycle mechanism is almost entirely contained in a separate, detachable unit.

Another object of my invention is in general to improve Diesel engines which are capable of operating according to the Otto cycle when desired.

A further object of my invention is to provide an improved internal combustion engine.

An additional object of my invention is to provide an engine which can be operated either on gasoline or on fuel oil, and in which there is an abrupt change-over from one fuel to the other with no intermediate operation on a mixture of two fuels.

A still further object of my invention is to provide a simple control means for an engine as described.

The foregoing and other objects are attained in the embodiment of the invention shown in the drawings, in which—

Fig. 1 is an exhaust side elevation of an engine constructed in accordance with my invention.

Fig. 2 is an intake side elevation of the engine of Fig. 1.

Fig. 3 is a cross-section, the plane of section being indicated by the line 3—3 of Fig. 2.

Fig. 4 is for the most part a cross-section the plane of which is indicated by the line 4—4 of Fig. 3 but which in part is broken away to show the interior arrangement of the cam shaft and injector mechanism.

Fig. 5 is an end elevation of the upper portion of the engine of my invention.

Fig. 6 is a fragmentary cross-section, the plane of section being indicated by the line 6—6 of Fig. 4.

Fig. 7 is a cross-section through the carburetor, the plane of section being indicated by the line 7—7 of Fig. 2.

Fig. 8 is a schematic diagram showing the operative relationship of the engine parts, particularly the controlling devices.

In its preferred form, the engine of my invention incorporates a cylinder assembly having a main combustion chamber and an auxiliary combustion chamber, the latter of which is partly contained in a detachable body. The mechanism includes an inlet valve between the auxiliary combustion chamber and the main combustion chamber, and a valve between an air manifold and the auxiliary combustion chamber. Means are provided for operating the inlet valve in time with the operation of the engine and for disabling the inlet valve and the valve under the control of a single control means which likewise is effective to control the supply of fuel to the combustion chamber.

While an engine in accordance with my invention can be embodied in a large number of variant forms, it has been constructed successfully as shown in the drawings herein. In this exemplary modification the engine includes a block casting 6, in the present instance designed for the accommodation of six cylinders in line. The casting 6 at one end merges with a fly-wheel housing 7 having supporting feet 8 thereon, and at the other end is carried on a pedestal support 9. The bottom portion of the casting 6 is closed by an oil pan 11 secured to the casting by suitable fastenings 12 and forming therewith a crank-case. Disposed within the crank-case so formed is a crank-shaft 13, held in place by main bearings 14. Journaled on the crank-shaft are connecting rods 16, each including a removable cap 17 held on by studs 18 and nuts 19. Access to the interior of the crank-case is attained

through handholes 21, normally closed by covers 22.

The working cylinders are formed by suitable liners 23 introduced into the block casting 6 and receiving reciprocable pistons 24 to which the connecting rods 16 are articulated by wrist pins 26. The piston 24 is provided with a depressed head within which a heat insulator 27 is disposed, to provide a partially insulated main combustion chamber 28. The combustion chamber is likewise bounded by the lower planar face 29 of a cylinder head 31 which is held in place on the cylinder block 6. Operating in each cylinder, and disposed in the cylinder head 31, is a pair of inlet valves 32 and a pair of exhaust valves 33. The exhaust valves control communication between the combustion chamber 28 and a pair of exhaust manifolds 34 and 36 to which exhaust stacks 37 are connected. The inlet valves 32 control communication between the combustion chamber 28 and an inlet passage 41 formed in the cylinder head 31.

The passage 41 communicates with an air duct 42 merging with an intake manifold 43 formed as a separate body 44 secured to the side of the head 31 opposite to the manifolds 34 and 36. Clean air is admitted to the air manifold 43 from air cleaners 46 and 47, each of which contains baffling material 48 for filtering dirt and oil entrained by air entering from the atmosphere through an entrance tube 49 and passing in contact with a pool of oil 51 in the removable bottom of each air cleaner. The inlet valves 32 are operated by an intake cam shaft 56 journaled in a cam shaft block 57 disposed on the cylinder head 31.

Rocker arms 58 are interposed between each cam and its respective valve stem of the intake valves 32, and, similarly, rocker arms 59 are interposed between the stems of the exhaust valves 33 and the cams on an exhaust cam shaft 62 likewise journaled in the cam shaft block 57. The two cam shafts 56 and 62 are preferably driven in synchronism but in opposite directions of rotation, by a suitable drive mechanism (not shown) connected to the crank-shaft adjacent the fly-wheel. The valves are operated in time with the operation of the engine, so that the engine performs in accordance with the customary four-stroke cycle.

In order to provide the cylinders with fuel for operation on the Diesel cycle, each cylinder is provided with a solid injector 71 generally disposed in the cylinder head 31, including, in addition to the customary casing, a reciprocable plunger connected to a crosshead 72. The crosshead at opposite extremities carries roller followers 73 and 74 bearing respectively on the intake cam shaft 56 and the exhaust cam shaft 62. Identical cams on each of these shafts produce a rectilinear translation of the crosshead 72 in time with the operation of the engine, in order to inject fuel at the correct time.

The amount of fuel injected by each injector and, correspondingly, the speed and load-carrying capabilities of the engine are controlled by a regulating crank 75 (Fig. 4) which is rotatable on a stud 76. The crank 75 is provided with an arm 77 which is connected by a manually releasable pin 78 to a cross-link 79. This link is mounted for approximately parallel motion transversely of the engine by being pivoted at opposite ends to levers 81 and 82 surrounding longitudinal shafts 83 and 84. The lever 81 is freely rotatable on the shaft 83, but the lever 82 is fast on the shaft 84. Thus, rotation of the shaft 84 produces

a translation of the link 79 and, through the arm 77, controls the operation of the injector. Since each injector is so connected to the shaft 84, rotation of the shaft 84 governs all of the cylinders simultaneously.

In order that the shaft 84 may be appropriately controlled to vary the speed of the engine, it extends to a governor 91, preferably located at one end of the cam-shaft block 57 and driven by the exhaust cam-shaft 62. The governor is of any convenient kind, but preferably is of the hydraulic type interconnected with the lubricating oil system of the engine so that in the event of failure of the lubricating oil supply the engine will be shut down. The governor is capable of rotating the shaft 84 in order to maintain the speed of the engine at any set value.

In order to vary the speed of the engine by varying the set speed of the governor, the governor is provided with a control shaft 92 (Fig. 5) to which a lever 93 is secured. This lever projects forwardly and at its extremity is provided with an adjustable tappet 94 adapted to bear against one arm 96 of a lever pivoted at 97 to the cam shaft block 57. The other arm 98 of the lever is bifurcated to receive a pivot pin 99 connecting the lever to a link 101 extending to a cam disc 102. A pin 103 secures the link 101 to the disc 102. The cam disc is fast on one extremity of a gear shaft 104 suitably journaled in a gear housing 106 secured to the manifold body 44. Within the housing 106 the shaft 104 carries a worm wheel 107 with which meshes a worm 108. This worm is on a main control shaft 109 likewise journaled in the housing 106 and at its end carrying a control wheel 110 equipped with an axially movable handle 111. A peripherally perforated plate 112, secured to the housing 106, provides a backing for the wheel 110 and provides locking stops for the axially movable handle 111 which is normally pressed by a spring 113 into engagement with one of the apertures to hold the control wheel 110 in any selected position.

When the handle 111 is retracted against the urgency of the spring 113 to release the wheel 110 from the plate 112, the wheel 110 can be rotated, thereby rotating the shaft 109 and the worm 108. Rotation of the worm 108 produces a corresponding rotation of the worm wheel 107 and of the shaft 102. This causes the link 101 to rock the lever 98, thus, through the tappet 94, moving the lever 93 and the shaft 92. Such movement either opposes the action of the governor tending to shut down the engine, or permits such slowing-down action of the governor to be effective in order to reduce the engine speed. The governor manipulates the shaft 84 and directly governs the injectors. Thus, by setting the wheel 110 in any selected position the operator can predetermine any desired governed speed for the engine or, by suitably manipulating the wheel, can at random accelerate the engine or permit it to slow down.

In accordance with my invention, means are provided for preventing operation of the engine on the Diesel cycle and for alternatively operating the engine on the Otto cycle. This last type of operation is especially desirable for starting the engine from cold and for warming up the engine, at the conclusion of which operation a rapid change-over to functioning on the Diesel cycle can be effected.

The combustion chamber volume requisite for Diesel cycle operation is that provided by the depressed head of the piston; namely, the combus-

tion chamber 28. Operation in accordance with the Otto cycle requires a considerably augmented volume of combustion chamber, and I consequently provide means for utilizing a portion of the intake passage 41 for this purpose. Furthermore, in accordance with my present invention I dispose most of the mechanism for effecting operation on the Otto cycle in the manifold body 44, so that when such body is removed from the engine the engine is virtually a standard Diesel cycle engine without possibility of operating in accordance with the Otto cycle, and so that in those installations where gasoline starting and operation is not requisite the engine can be utilized as a straight Diesel engine and its construction is in no wise, or at least very little, affected by its adaptability.

To this end I provide means for segregating or isolating, when desired, part of the air intake passage 41 and air duct 42 so that they can be combined with the combustion chamber 28 to provide an augmented combustion chamber. The body 44 is provided, at the junction of the air intake manifold 43 with the air duct 42, with a seat 116 for a poppet valve 117 the stem of which is carried in a boss 118 in the manifold body 44 and which valve is normally urged to seat by a coil spring 119 held in place by a flanged cap 121. To supply the auxiliary combustion chamber 41 with a combustible gasoline-air mixture, I provide a mixture manifold 122 which is preferably cast integrally with the manifold body 44 and communicates with the auxiliary combustion chamber under the control of an automatic poppet valve 124 normally urged onto its seat by a light coil spring 126 surrounding its stem. Ignition of mixture within the auxiliary combustion chamber is afforded by an ignition device such as a spark plug 127 which is seated in the body 44 and is removable when a closure cap 128 is removed.

In order that the mixture manifold 122 may be suitably supplied with fuel there is located in the manifold body 44 a carburetor such as shown in Fig. 7. Air flows into the carburetor body from the manifold 43 through passages 131 leading to a down draft passage 132. Situated in this passage is a venturi 133 through which the air flows on its way to discharge into the mixture manifold 122. Some of the air entering the carburetor flows from the passage 131, through passages 134, into a float chamber 136. From the float chamber air passes through a metering nozzle 137 into a mixing chamber 138 from whence it discharges as mixture through a passage 139 and through orifices 141 in the venturi 133 to join the main stream of air.

Gasoline is brought to the carburetor through a supply pipe 146 which leads into an entrance chamber 147. A manually operable needle valve 148 is effective to force a ball 149 onto its seat, if desired, in order to provide a positive shut-off for the gasoline. Normally, however, the valve is open to permit gasoline to flow past the ball-check 149. The gasoline then flows through a filter 151 and passes through a jumper passage 152 in a separate cap held onto the manifold body, and from thence passes into the float chamber 136. Flow into this chamber is controlled by a needle valve 154 actuated by a pair of floats 156, one of which is disposed on each side of the center of the carburetor. The floats are joined to pivot on a pin 157 and rise and fall with the level of gasoline in the float chamber 136. A constant level is thus maintained in the float chamber.

From the chamber 136 gasoline flows through a suitable orifice 158 into a needle valve chamber 159. Within this chamber is located a needle valve 161 which is manually adjustable to govern the size of passage through an orifice 162 leading to the mixing chamber 138. Since the quantity of air is fixed by the size of the orifice in the metering nozzle 137, and the quantity of gasoline can be regulated by the needle valve 161, a suitably rich mixture is maintained in the passage 139. This mixture, when mixed with the air flowing through the passage 132, provides a combustible mixture in the manifold 122.

The spark plugs 127 are supplied with ignition current through leads 166 passing through the air manifold 43 which thereby serves also as a suitable high tension duct and protector. The high tension leads are preferably carried along the bottom of the intake manifold and pass under the carburetor body through a jumper 167, finally being carried through a tube 168 at the rear of the manifold body to a magneto 169 situated at the rear of the intake cam shaft 56 and disposed to abut a pad 170 (Fig. 5).

In accordance with my invention I preferably provide that all of the described instrumentalities are under the control of the single control wheel 110. There has already been described the mode of operation of such wheel in governing the speed of the engine when operating on the Diesel cycle. Since, when the engine is converted from operation on the Diesel cycle to operation on the Otto cycle, the combustion chamber must be augmented, I preferably effect this by lifting all of the inlet valves 32 and holding them in lifted or inoperative position. To this end each of the rockers 81 for the inlet valves is provided with an upstanding lug 171 ending in a cam face 172. The cam face abuts a flat 173 provided at a suitable location on the shaft 83. This shaft projects from the rearward end of the cam shaft block 57 and at its extremity is provided with a lever 174 carrying a roller follower 176. A coil spring 177 engages the pivot pin 178 of the roller 176 and likewise is hooked into a bracket 179 fastened to the cylinder block 6. The spring 177 normally tends to hold the lever 174 in its lower position, as seen in Fig. 5, against a stop pin 180. This holds the shaft 83 in such a position that the cam faces 172 do not contact the flats 173.

When the engine is conditioned for gasoline operation the hand wheel 110 is rotated in such a way that the link 101 permits the governor to cut off the supply of fuel to the injectors. Such rotation of the wheel 110 entails a corresponding rotation of the cam disc 102. A shoulder 181 on the disc 102 contacts the roller follower 176 and lifts the lever 174 from the stop pin 180 against which it has been held by the spring 177. The lever 174, in lifting, correspondingly rotates the shaft 83, so that the flat portions 173 of the shaft act against the cam faces 172, thereby moving the rockers 83 about their pivots and forcing the stems of the inlet valves 32 downwardly into open position wherein they are held as long as the shoulder 181 of the disc 102 rides underneath the roller 176.

Also in contact with the disc 102 is a roller follower 182 at the extremity of a lever 183 secured on a through-shaft 184 passing through the manifold body 44. The shaft 184 where it passes through the carburetor is provided with notches 186 with which pins 187 engage. These pins fit loosely in the passages 134 and extend to projections 188 on the lever 189 of the float mecha-

nism. During operation of the engine on the Diesel cycle the shaft 184 is in such a position that the pins 187 are forced against the projections 188 to lift the floats 156 and simultaneously to seat the float valve 154 so that no gasoline can flow into the float chamber. When the shaft 184 is rotated from Diesel cycle position to Otto cycle position, the notches 186 free the pins 187 which then no longer bear against the projections 188, and the floats 156 seek their normal level. Since the float valves 154 are thus freed to operate to admit gasoline, the carburetor, which is normally held out of action during operation of the engine on the Diesel cycle, is released for operation of the engine on the Otto cycle.

The shaft 184, in addition to controlling the carburetor as described, is at suitable intervals provided with drop arms 194 and 196 which straddle the cap 121 surrounding each of the springs 118. When the engine is operating on the Diesel cycle the springs 119 are held compressed, since the arms 194 and 196 press against the encompassing caps and are held in such location by the position of the shaft 184. This shaft is prevented from rotating since the follower 182 bears against the enlarged portion of the disc 102. When the engine is changed over to operation on the Otto cycle, however, the follower 182 is free to drop into the smaller diameter 197 of the disc 102, and the springs 119 are thereupon effective to rotate the shaft 184 so that the valves 117 can seat. This precludes communication between the air manifold 43 and the auxiliary combustion chamber 41, thereby ensuring a suction within the auxiliary combustion chamber of sufficient value or effect to operate the automatic valves 124 in suitable time with the operation of the engine. These valves normally are inoperative, since when the valves 117 are held open during operation of the engine on the Diesel cycle there is not sufficient suction upon the auxiliary valve heads to cause them to open automatically against the urgency of their springs 126.

The magneto 169 is not in the present instance directly under the control of the operating wheel 110 but is preferably connected to its driving cam shaft 56 through a clutch 198 which is completely ineffective above a predetermined number of revolutions per minute but which cuts the magneto into operation automatically as soon as the engine speed drops to a predetermined value. This automatically governs the speed of the engine when operating on the Otto cycle, since above the predetermined speed the magneto is thrown out of operation and there is no spark ignition.

I claim:

1. An engine comprising a structural assembly defining a combustion chamber and an inlet passage leading to said combustion chamber, an inlet valve for said chamber operating in time with the operation of said engine, means in a body detachable from said structural assembly for augmenting said combustion chamber, spark ignition means on said body and communicating with said augmenting means and means for preventing the operation of said inlet valve in time with the operation of said engine.

2. An engine comprising a structural assembly defining a combustion chamber and an inlet passage leading to said combustion chamber, an inlet valve between said passage and said chamber, an air duct communicating with said passage, a valve in said air duct, a mixture manifold opening into said duct between said valves, means

for controlling flow through said mixture manifold, and ignition means in said duct between said valves.

3. An engine comprising a structural assembly defining a combustion chamber, means forming an auxiliary combustion chamber in communication with said combustion chamber, an inlet valve for controlling communication between said combustion chamber and said auxiliary combustion chamber, means for conducting air to said auxiliary combustion chamber, a valve for controlling communication between said air conducting means and said auxiliary combustion chamber, means for conducting a combustible mixture to said auxiliary combustion chamber, a valve for controlling communication between said combustible mixture conducting means and said auxiliary combustion chamber, and ignition means in said auxiliary combustion chamber.

4. An engine comprising a structural assembly defining a combustion chamber, means forming an auxiliary combustion chamber in communication with said combustion chamber, an inlet valve for controlling communication between said combustion chamber and said auxiliary combustion chamber, means for operating said inlet valve in time with the operation of said engine, means for conducting air to said auxiliary combustion chamber, a valve for controlling communication between said air conducting means and said auxiliary combustion chamber, means for holding said valve open, means for conducting a combustible mixture to said auxiliary combustion chamber, an automatic, suction-responsive valve for controlling communication between said combustible mixture conducting means and said auxiliary combustion chamber, and ignition means in said auxiliary combustion chamber.

5. An engine comprising a structural assembly defining a combustion chamber, means forming an auxiliary combustion chamber in communication with said combustion chamber, an inlet valve for controlling communication between said combustion chamber and said auxiliary combustion chamber, means for operating said valve in time with the operation of said engine, means for supplying said combustion chamber with fuel, means for controlling said fuel supplying means, means for conducting air to said auxiliary combustion chamber, a valve for controlling communication between said air conducting means and said auxiliary combustion chamber, means for holding said valve open, means for holding said inlet valve open, and a single control means for alternatively actuating either said inlet valve holding means or said other valve holding means and said fuel controlling means to supply fuel.

6. An engine comprising a structural assembly defining a combustion chamber and also an inlet passage leading to said combustion chamber, an inlet valve between said passage and said chamber, a manifold body detachably secured to said structural assembly, said body defining an air duct communicating with said passage, a valve for isolating a portion of said duct which together with said passage forms an auxiliary combustion chamber, a mixture manifold communicating with said auxiliary combustion chamber, and means on said body for alternatively preventing the cyclic operation of said inlet valve or of said valve.

7. An engine comprising a structural assembly defining a combustion chamber for operation by compression ignition, an inlet valve for said chamber, means in a body detachable from said

5 structural assembly for augmenting said combustion chamber for operation by spark ignition, spark ignition means in said body, means for holding said valve open, and means on said body for operating said valve-holding means.

8. An engine comprising a structural assembly defining a combustion chamber, means forming an auxiliary combustion chamber in communication with said combustion chamber, an inlet valve for controlling communication between said 10 combustion chamber and said auxiliary combus-

tion chamber, means for operating said valve in time with the operation of said engine, means for conducting air to said auxiliary combustion chamber, a valve for controlling communication between said air conducting means and said auxiliary combustion chamber, means for holding said valve open, means for holding said inlet valve open, and a single control means for alternatively actuating either of said holding means. 5

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