June 24, 1947. L. N. MILLER 2,423,039

DIFFERENTIAL CONVERTIBLE GASOLINE-DIESEL ENGINE

Original Filed March 31, 1938 2 Sheets-Sheet 1

FIG. 3

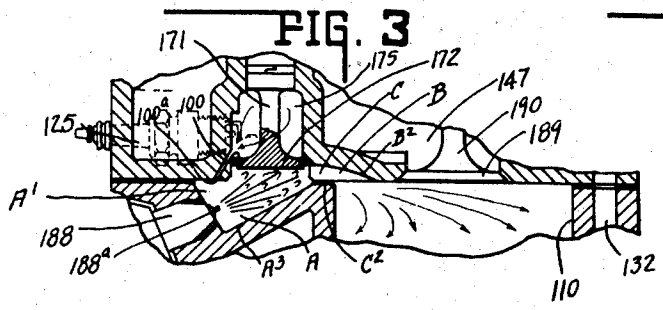



FIG. 4

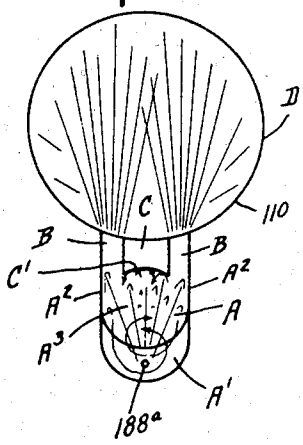



FIG. 2

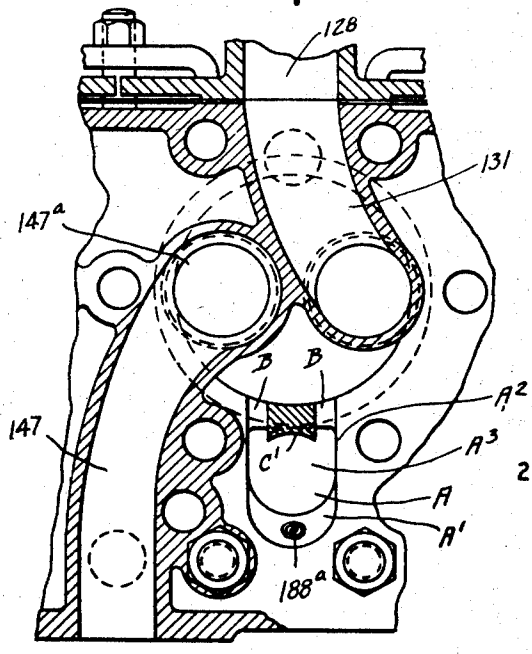
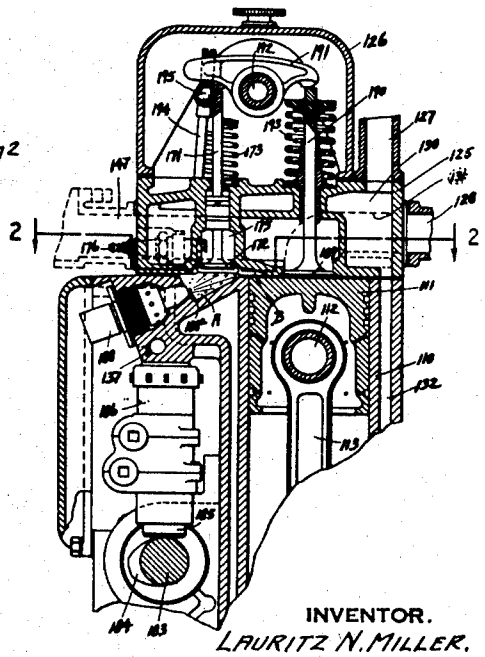



FIG. 1




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FIG. 5

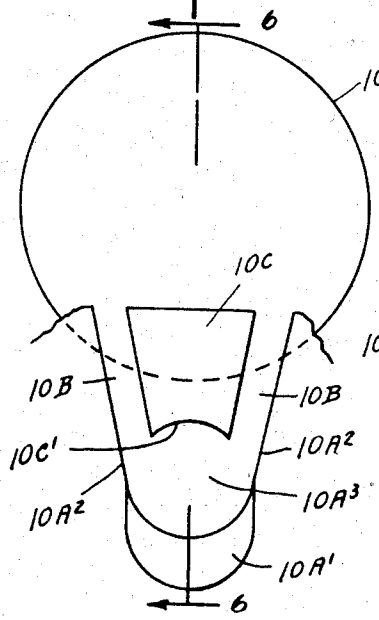



FIG. 6

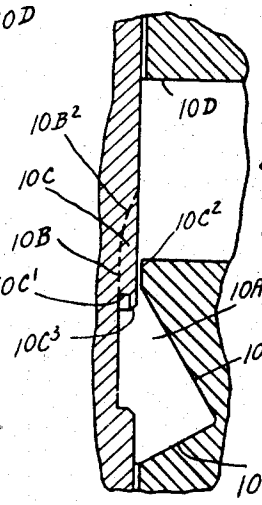



FIG. 7

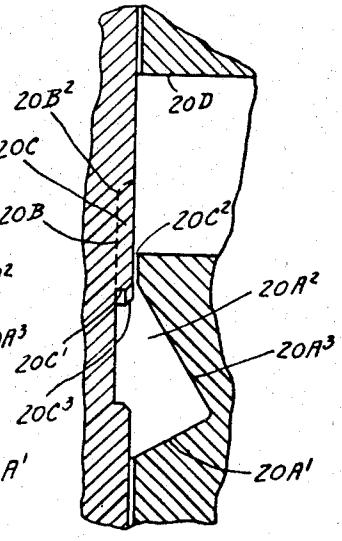



FIG. 9

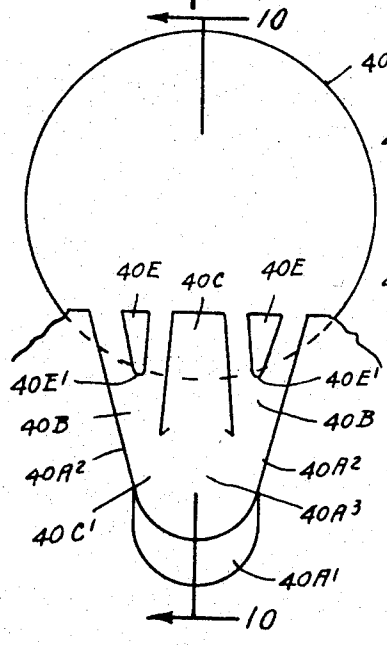



FIG. 10

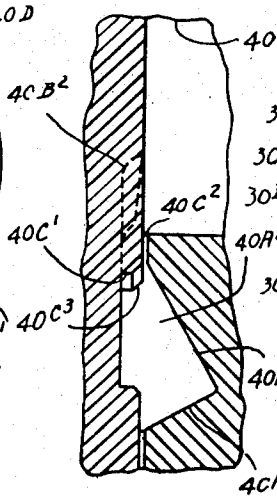
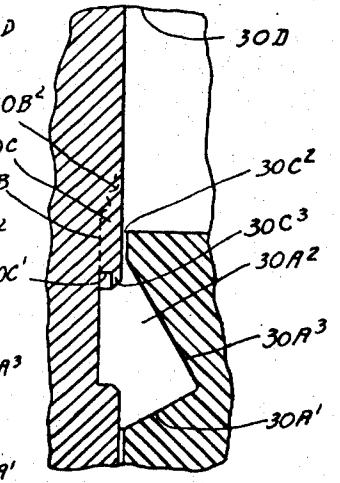



FIG. 8




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# UNITED STATES PATENT OFFICE

2,423,039

## DIFFERENTIAL CONVERTIBLE GASOLINE-DIESEL ENGINE

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Original application March 31, 1938, Serial No. 199,210. Divided and this application March 21, 1942, Serial No. 435,730

2 Claims. (Cl. 123—32)

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This invention relates to internal combustion engines and of multi-cylinder character, if desired, and wherein the advantages of a gasoline engine and a Diesel engine are included without the inherent disadvantages incident to the operation of either. These two types of engines have certain recognized advantages well known in the industry. They likewise have certain recognized disadvantages.

An object of this invention is to produce an engine which will include a maximum number of advantages of both engines and a minimum number of the disadvantages thereof.

Another object of the invention is to arrange certain parts of the engine so that the fuel supplied to the combustion chamber when operating as a Diesel engine is completely burned, thereby insuring cleanliness of the fuel nozzle.

One feature of the invention for the accomplishment of the foregoing object, consists in arranging the mechanism incident to the engine operation so that all or a part of the fuel supplied when operating as a Diesel is bypassed.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims:

In the drawings,

Fig. 1 is a vertical sectional view through a combination gasoline-Diesel engine embodying the invention.

Fig. 2 is a transverse sectional view of the intake, exhaust and fuel passages, and is taken approximately in the plane of the line 2—2 of Fig. 1 and in the direction of the arrows.

Fig. 3 is an enlarged vertical sectional view taken in a central plane to illustrate the injector scavenging and cleaning mechanism and is of the form of the invention shown in Figs. 1 and 2.

Fig. 4 is a diagrammatic plan view of the combustion chamber and corresponds to a section parallel to that shown in Fig. 2 but closer to the cylinder bore.

Fig. 5 is a view similar to that shown in Fig. 4 but is enlarged and is of a modified form of the invention.

Fig. 6 is a vertical sectional view taken approximtaely in the plane of 6—6 of Fig. 5 and in the direction of the arrows but illustrates a modified form of combustion chamber.

Fig. 7 is a view similar to Fig. 6 and of a still further modified form of combustion chamber.

Fig. 8 is a view similar to Figs. 6 and 7 and of a still further modified form of the invention.

Fig. 9 is a view similar to Fig. 5 and of a modified form of the invention.

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Fig. 10 is a view similar to Figs. 6, 7 and 8 and of the form of the invention shown in Fig. 9 and is taken approximately in the line 10—10 of Fig. 9 and in the direction of the arrows.

In Fig. 1 of the drawings 110 indicates a conventional cylinder structure of an engine embodying the invention. Mounted therein for reciprocation is a piston structure 111 of any desired character connected by a wrist pin 112 to a connecting rod 113 connected to a crankshaft or the like of the engine—see Fig. 1 of Patent No. 2,277,130 dated March 24, 1942.

Reference is had more particularly to said patent for a general disclosure of the engine including the present invention.

Herein the engine includes the cylinder head 125 in turn supporting a suitable cap structure 126. To the head structure may be suitably secured an exhaust manifold 128. 127 indicates a water manifold for cooling fluid. Water cooling passage 130 in the head encircles exhaust passage 131 from the cylinder and head. The cylinder block 110 is provided with head communicating water cooling passage 132.

Fig. 1 of said patent illustrates in the upper left hand portion a gasoline fuel supply and the fuel mixture is supplied to intake passage 47 therein which herein in Fig. 1 is indicated by the numeral 147. A valve member 172 has stem 171 suitably actuated as described in said patent. A spring 173 normally constrains said valve and stem upwardly into closed valve position. This is to seal off, as it were, auxiliary chamber 175 from direct connection with chamber A as shown, and this is provided for Diesel operation. Spark plug 176 constitutes the gasoline ignition source.

The purpose of this auxiliary chamber 175 is multi-fold. One conventional purpose is to insure ignition of the gaseous mixture when the engine is operating as a gasoline engine and, therefore, since it confines the ignition initially to the gaseous mixture trapped in this chamber 175, the problem of knocking of the engine is materially reduced. Therefore, this engine can operate on a very low grade so-called gasoline.

When the engine is operating as a Diesel engine, the cam shaft 183—see Fig. 1—having the cam 184 thereon, is adapted to engage plunger 185 of an injector structure 186 connected to nozzle structure 188 by means, not shown, in Fig. 1. Plunger 185 is cam actuated in opposition to spring constraint to supply Diesel fuel under pressure to the nozzle structure which discharges to chamber A at 188a.

The exhaust valve—see Fig. 1—is indicated by

numeral 189 and the stem 190 thereof is engaged by rocker arm 191 pivotally supported at 192. Spring 193 normally constrains exhaust valve 189 to closed position. Arm 191 is actuated by rod 194 through the adjustable connection 195 and said rod is actuated in proper timed relation by means associated with cam shaft 183 and not shown herein.

The zero volume chamber, designated A and B, includes the auxiliary or preliminary ignition chamber 175 before mentioned. By zero volume it is intended to include that volume at the head of cylinder and in the head when the piston has advanced its maximum distance toward the head of the cylinder and when the intake and exhaust valves are both closed. Intake valve 172 has stem 171 of piston character. Note that the spark plug fires the gasoline fuel mixture within the ignition chamber 175.

By referring to Fig. 2 it will be noted the air is supplied to the intake passage 147 and the port 147a is arranged for suitable intake valve control, the said intake valve being positioned in longitudinal alignment with the exhaust valve.

Attention is specifically directed to the chamber portion designated A in the middle of Fig. 1 as well as the chamber portion designated B therein and immediately to the right thereof. This chamber arrangement is similarly designated in Fig. 2 and further reference will be had thereto. It is to be understood that air or the fuel mixture when operating as a gas engine is supplied by the passage 147 to the cylinder and is compressed by the piston 111 and forced into the zero volume chamber, to-wit, chamber portions A and B, as well as the auxiliary chamber 175.

At the proper interval if the engine be operating as a gasoline engine, the ignition is supplied to the spark plug 176 and while the engine is operating as a gasoline engine, the valve 172 remains in the lowered or open position. Thus the initial combustion of the combustible mixture occurs in this auxiliary chamber 175 and gradually feeds out around the valve and spreads into chamber A and B and as the gases expand, the power piston 111 is moved and combustion becomes complete. This eliminates to a considerable degree the detonating effect obtained when utilizing relatively low octane gasoline type fuels.

When the device operates on a Diesel principle the valve 172 remains closed during the entire period of operation.

Reference will now be had to Fig. 3 and this figure illustrates substantially that which is illustrated in Fig. 1 and, therefore, like numerals and letters employed in Figure 1 are herein employed. This figure illustrates the addition of a relief port 100 providing restricted communication between the auxiliary chamber 175 and the chamber portion A. When the device is operating on the Diesel principle, the air, supplied on the intake stroke through passage 147, the valve 189 being then open, thereafter is compressed, the valve 189 being then closed and the piston returning on the compression stroke, is forced into the chamber portions B and A and through the restricted passage 100 into the chamber 175. When the change from gasoline to Diesel operation is effected, piston 111—see Fig. 1—is close to the valve 189 when the latter is seated and, therefore, the air supplied to the cylinder is under a relatively high compression and a portion thereof is stored in the chamber 175.

At the proper interval through cam 184 the injector 186 is operated to supply fuel to the nozzle 188 and this nozzle through the tip 188a discharges the fuel into the chamber A, where it mixes with the highly compressed air and ignites due to the high compression. The fuel, of course, is supplied under the desired pressure as is well understood in Diesel practice. Upon ignition taking place, the air and fuel burn forming expanding gases which force the power piston downwardly, this being the power stroke. As the piston moves downwardly, the pressure is released. At the proper time, of course, the fuel discharge is discontinued. However, as the piston travels further and further on its power stroke, the highly compressed air in the auxiliary chamber 175 is discharged through the restricted passage 100 into chamber A and swirls about the discharge tip 188a and insures complete burning of the last drop of oil on that tip, thereby insuring the maintenance of a clean fuel nozzle at all times when the engine is operating on the Diesel principle.

The arrows in Fig. 3 do not show this last supplementary air discharge in the chamber A although the arrows in the chamber 175 do show that it is discharging. The fuel pressure naturally is higher than the air pressure. The fuel nozzle also is shown directed angularly with reference to the discharge end 100a of the discharge passage 100 so that the raw fuel is not discharged thereto so that accidental filling of this opening with fuel is prevented.

Reference will now be had to Fig. 4 wherein the same numerals employed in Figs. 1, 2 and 3 are again employed. This figure is a diagrammatic plan view taken approximately in the plane of the auxiliary chamber control valve and seat shown in Fig. 3. It is also shown in Fig. 2. As shown in these several figures and more especially Fig. 4, numeral 110 indicates the cylinder chamber. A indicates a recess of the depressed type in the cylinder block and having an aperture in which is mounted the nozzle 188—see Fig. 3—and into which chamber A projects the tip 188a of the nozzle. The rear wall into which extends the nozzle is partially cylindrical and this is indicated by A1 in Fig. 4. The sides thereof merge into the straight side walls A2. The floor of the chamber A is indicated by A3. The chamber A communicates with the cylinder chamber 110 by means of the passages B formed in the head.

In the present form of the invention these passages form an island C and the wall of the chamber A formed by this island C is indicated by C1 in Fig. 4 and is of partial circular form for swirling. Each passage B is tapered downwardly as indicated at B2 in Fig. 3. The result of this multiple chamber construction is that there is created a certain turbulence which is in the direction shown by the several arrows in Figs. 3 and 4. This is in addition to the turbulence previously mentioned and described with reference to the supplementary discharge of compressed air from the chamber 175 through the restricted passage 100. Figs. 2, 3 and 4, therefore, represent one convenient form of the chamber arrangement.

As shown clearly in these figures, it will be noted that the air and fuel discharged upwardly and to the right in chamber A by reason of fuel injection, impinge on the curved wall C1 and the same is deflected to the right and left, respectively, prior to escaping laterally and to the right

through the passages B. That which escapes through the passages B, as shown clearly in Fig. 3, is deflected downwardly onto the adjacent power piston and across the cylinder into the remote corner thereof.

It will be noted also between the head 125 and the block of the engine and beneath the island, there is no gasket, leaving a space C2. This provides a relatively thin but wide, restricted passage from chamber A to the cylinder and between the main passages B. This insures discharge directly across the top of the cylinder and that insures distribution of the combustible mixture toward the upper right hand portion of the cylinder, as shown by the topmost arrow in that cylinder in Fig. 3. This eliminates the possibility of a "dead spot" in the top of the cylinder.

Reference will now be had to Fig. 5 which is another diagrammatic representation of the chamber arrangement previously described. In Figs. 5 and 6 the same letters employed in Fig. 4 are employed but are increased by ten. Thus, the cylinder is indicated by 10D corresponding to the cylinder D in Fig. 4. The rear of the energy chamber wall is indicated by 10A1. The two side walls are herein indicated by 10A2 and these as shown, are of diverging character instead of being parallel, as illustrated in Fig. 4. The curved deflecting wall of the island 10C is indicated by 10C1. The channels are indicated by 10B. The chamber bottom is indicated by 10A3.

Referring to Fig. 6 it will be noted the island 10C provides the gasketless passage 10C2 between the head and the block. For convenience the representation of the intake and exhaust valves is omitted. If desired, the curved edge 10C1 may be chamfered as at 10C3. In this form of the invention the top wall 10B2 of the passage 10B is curved downwardly toward the cylinder chamber 10D, as shown in Fig. 6. This curvature is of relatively great radius.

In Fig. 7 letters and numbers similar to those employed in Fig. 6 but increased by ten indicate like or equivalent parts. This form of the invention differs mainly in that the slope of curvature of the top of the passage 20B is of relatively short radius curvature, as indicated at 20B2, whereas that illustrated in Fig. 6 is of relatively large radius curvature, as indicated at 10B2.

In Fig. 8 letters and numbers similar to those heretofore utilized, indicate like or similar parts but the letters again are increased by ten and this form of the invention is similar to those previously described, with this exception, that in place of the deflecting wall portion of passage 30B being of curved formation as indicated at 10B2—see Fig. 6—the same is of corrugated character as indicated at 30B2 in Fig. 8.

Reference will now be had to Figs. 9 and 10, and more especially Fig. 9. Herein the side walls 40A2 are of diverging character similar to those as indicated at 10A2 in Fig. 5 and as distinguished from the straight or parallel walls A2 of Fig. 4. Herein also the channels 40B are of gradually increasing width instead of being of constant width, as shown at 10B in Fig. 5 and as shown at B in Fig. 4.

The island 40C, therefore, in the present instance has two side walls that are directed toward each other in the direction of the cylinder 40D as distinguished from the two side walls being parallel as shown in Fig. 4 or of diverging character, as shown in Fig. 5. Herein additional islands are provided, these being of lesser area and the same are indicated by 40E. These form



in the passages 40B obstructions having the curved or forward division portions 40E1 and which divide the fuel through 40B previous to its discharge into the cylinder. It is observed, however, the space C2 is continuous from one side wall 40A2 to the opposite wall 40A2 so that the directional discharge to prevent "dead spots" at the head of the cylinder is provided. While the discharge ends of the passage 40B2 are shown of the character illustrated at 20B2 in Fig. 7, these may be modified as shown at 10B2 in Fig. 6 or 30B2 in Fig. 8, or in any other suitable manner as desired.

It is obvious from the foregoing that all of these forms of zero volume chambers do insure the production of turbulence in Diesel or gasoline operation and so highly desirable in an internal combustion engine and do insure the elimination of so-called "dead spots." The forms of the invention herein disclosed are substantially free from so-called "hot spots." For different fuels, one form will have advantages over the other. While the supplementary island arrangement is shown herein associated with the diverging channel disclosure, it is to be understood the supplementary island arrangement may be incorporated in the so-called parallel channel form of the invention without departing from this disclosure.

The nozzle 188, see Fig. 5 of Patent No. 2,277,130, dated March 24, 1942, preferably is of two-part character, see also Fig. 6 of the copending application Serial No. 435,729, filed March 21, 1942, wherein the nozzle tip 188*a* is normally constrained to extend inwardly into chamber A as shown in Fig. 1. Upon the compression stroke, air under compression is stored in nozzle 188 as set forth in said application and following fuel injection, this compressed, stored air is released and serves to clean and cool the tip 188*a*.

It is also to be noted that Diesel fuel is bypassed continuously in the injector 188 as long as the engine operates as a gasoline engine and is bypassed proportionately for Diesel operation fuel control as set forth more particularly in said copending application.

The engine is gasoline started and whenever desired, changed over to Diesel operation as described in said patent.

This application is a division of application Serial No. 199,210, filed March 31, 1938, now Patent No. 2,277,130, dated March 24, 1942, and said application is made a part hereof for so much as is briefly described and claimed herein.

While the invention has been illustrated and described in great detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character.

The several modifications described herein as well as others which will readily suggest themselves to persons skilled in this art, all are considered to be within the broad scope of the invention, reference being had to the appended claims.

The invention claimed is:

1. In a Diesel engine having a cylinder bore with a piston therein, a fuel receiving chamber adjacent thereto, passage means therebetween, island means in said passage means, and fuel injection means in the chamber, the chamber having a face inclined away from the bore and passage means, and another face angular to the first face, the fuel injection means being in the second mentioned face and discharging toward the

passage means and island means, the fuel injection means having a longitudinal axis substantially parallel to the first mentioned face and located in the lower portion of the second mentioned face of the chamber.

2. In a Diesel engine as defined by claim 1, a second chamber having restricted communication with the first chamber at all times and near the upper end of the second face, the relative angularity between the axis of the fuel injection means and the restricted communication being such that the fuel is not discharged directly toward the last mentioned communication but the latter discharges directly toward the fuel injection means.

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