April 5, 1966 W. STEIDLER 3,244,158

COMPRESSION-IGNITION ENGINES

Filed Aug. 6, 1963 2 Sheets-Sheet 1

Fig 1

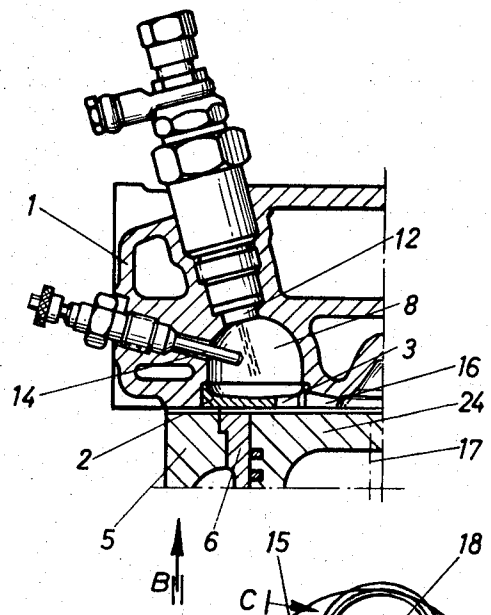
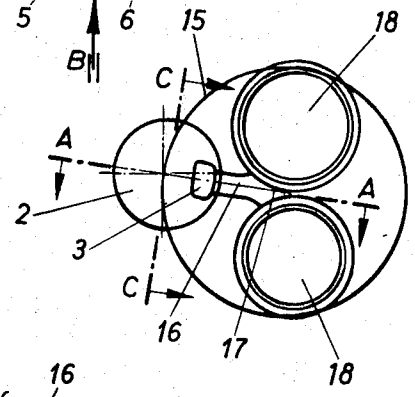


Fig 2



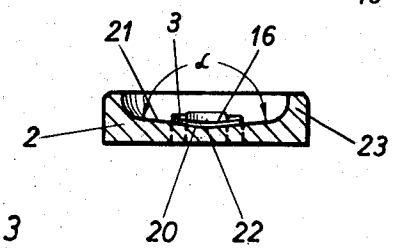


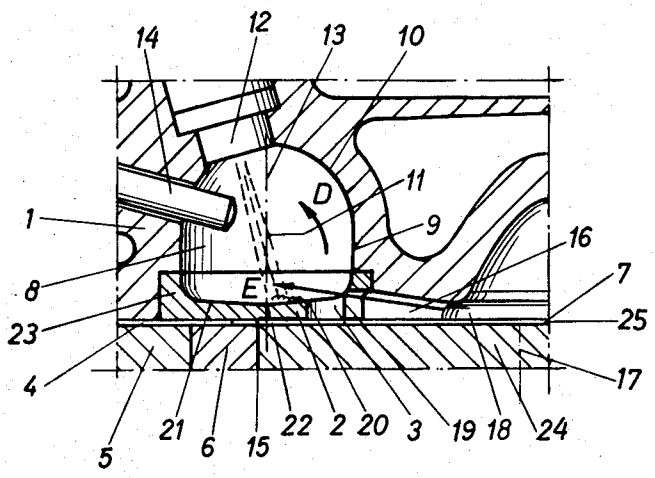
Fig 3

April 5, 1966 W. STEIDLER 3,244,158

COMPRESSION-IGNITION ENGINES

Filed Aug. 6, 1963 2 Sheets-Sheet 2

Fig 4



United States Patent Office 3,244,158 Patented Apr. 5, 1966

3,244,158

COMPRESSION-IGNITION ENGINES

Walter Steidler, Ilvesheim, Germany, assignor to Motoren-Werke Mannheim A.G. vorm Benz Abt. Stat. Motorenbau, Mannheim, Germany, a Germany company

Filed Aug. 6, 1963, Ser. No. 300,329
Claims priority, application Germany, Aug. 18, 1962, M 53,940
5 Claims. (Cl. 123—32)

This invention relates to a compression-ignition internal combustion engine having an auxiliary chamber accommodated laterally in a cylinder head with a duct opening into the cylinder space situated in the vicinity of the cylinder periphery in a bottom plate of small wall-thickness fitted into the cylinder head and situated in the surface of separation between the cylinder head and the cylinder block, an injection nozzle opening into the auxiliary chamber, the fuel jet of which nozzle is directed through the auxiliary chamber onto the bottom plate, while at least one recess in the cylinder-head undersurface, the depth of which recess in the vicinity of the duct is greater than the wall thickness of the bottom plate, extends substantially from the center of the cylinder-head undersurface to the duct and opens into the latter.

An object of the invention is to provide improvement of the gas-fuel mixture for the purpose of obtaining lower fuel consumption, higher mean effective pressure and reduced exhaust gas smoke.

According to the invention, in an internal combustion engine of the kind hereinbefore described, this object is achieved by the fact that the intersection edge situated opposite the recess and formed by the duct and the upper side of the bottom plate, facing the centre of the auxiliary chamber, is situated farther from the surface of separation than the center part of the upper side of the bottom plate, so that the air displaced at the end of the compression stroke from the space between the cylinder-head undersurface and the substantially flat piston crown through the recess into the auxiliary chamber is given a swirling motion on its path along the upper side of the bottom plate with flow-separation at the intersection edge, and mixes with the fuel impinging on the upper side of said bottom plate.

It becomes relatively simple to manufacture the bottom plate as a result of the shape of the upper side of the base plate which has the form of the surface of a shallow cone, the apex of which lies at the centre of the bottom plate, and the periphery of which is adjoined by a low rim.

To maintain the bottom plate temperature at a level suitable for the intended vaporization of the fuel on the bottom plate, the latter is arranged at a certain distance from the cylinder centre axis which is the hottest point of the cylinder head, for the purpose of furnishing the bottom plate with the desired correct temperature. A position of the bottom plate adapted for this purpose is obtained by the intersection edge being displaced towards the cylinder axis relative to the inner wall of the cylinder substantially by the amount of the radial width of the duct, measured in the radial direction from the intersection edge to the internal diameter of the cylindrical part of the rim of the bottom plate.

A constructional example of the subject of the invention is illustrated in the drawings, wherein:

FIG. 1 shows a section through the auxiliary chamber along the line A—A in FIG. 2,

FIG. 2 shows a view of the cylinder-head undersurface in the direction of the arrow B in FIG. 1,

FIG. 3 shows a section through the bottom plate along the line C—C in FIG. 2,

FIG. 4 shows a view of the auxiliary chamber according to FIG. 1 on a larger scale.

Set into the cylinder-head 1 is a bottom plate 2, in which is situated a duct 3. As shown in FIG. 2, the duct 3 may be made with straight inner and side edges and curved outer edge and with rounded corners. The duct 3 may have a round or oval cross-section which may be symmetrical or unsymmetrical. The bottom plate 2 is mounted with tight fit in the cylinder head, but it is secured in addition by resting on the cylinder head gasket 4, which is pressed by the cylinder block 5 and cylinder linear 6 against the flat cylinder-head undersurface 7. The auxiliary chamber 8 is machined in the cylinder head 1. It is bounded by a cylindrical lower wall part 9 and an upper wall part 10, the latter having the form of a spherical segment with a center at 11. In the present assembly, the point 11 is regarded as the center of the auxiliary chamber. The injection nozzle 12, which is inclined with respect to the axis 13 of the wall part 9, opens into the auxiliary chamber 8 through an opening in the wall part 10. The glow plug 14, which in the example shown is a bar-type glow plug, projects into the auxiliary chamber 8. The wall parts 9 and 10 are in direct contact with cooling water. Since the bottom plate 2 has only a relatively small surface of contact with the cylinder head, in which heat transmission is made difficult by the material separation existing there, the plate 2 assumes a temperature at which the fuel impinging on it is vaporized. In the embodiment shown, the walls of the duct 3 are parallel to the axis 13 and to the cylinder wall 15. They may, however, be slightly inclined with respect to said axis and wall. A recess 16 is machined in the cylinder-head undersurface 7, said recess extending from the valve chambers 18, situated in the vicinity of the cylinder axis 17, to the bottom plate 2, while becoming gradually deeper, said recess intersecting said bottom plate and opening into the duct 3 at the location 19. The depth of recess 16 at location 19 is greater than the wall thickness of the bottom plate 2 at the edge 20 of the duct 3 furthest from the axis 17, that is, an imaginary line drawn as an extension of the upper wall of the recess 16 passes over the edge 20 into the auxiliary chamber 8. The width of the recess 16 is less than the width of the duct 3. The cross sectional areas of the duct 3 is about 1/60 of that of the piston crown surface, but this value may differ considerably upwardly and downwardly. The edge 20 is formed as a sharp intersection edge of the duct 3 with the upper side 21 of the plate 2, the latter having a cavity constituted by shallow conical surface portion, the apex 22 of which lies on the axis of the bottom plate 2. The edge 20 is spaced a greater distance as compared to apex 22 from the surface of separation formed by the cylinder head gasket 4. The cone angle α, in the embodiment shown, is 170°. The shallow conical surface portion merges at its periphery with the inner peripheral surface of a low rim 23. The inner periphery of the rim 23 registers with the cylindrical wall part 9. It may, however, be of a diameter somewhat larger than the internal diameter of the wall part 9. The edge 20 is displaced towards the cylinder axis 17 relative to the inner wall of the cylinder 6 substantially by the amount of the radial width of the duct 3, measured in a radial direction from the edge 20 to the internal diameter of the cylindrical part of the rim 23 of the bottom plate 2.

The mode of operation of the described auxiliary chamber arrangement may be described as follows:

On the ascent of the piston 24, there is first produced a displacement of air into the auxiliary chamber 8, which results in a counter-clockwise circling air movement about the center 11 in the direction of the arrow D as shown

in FIG. 4. When the flat crown 25 of the piston 24 has approached the cylinder-head undersurface 7 to a distance of within a few millimetres, the displacement of the air enclosed between the piston end and the cylinder-head undersurface through the recess 16 into the auxiliary chamber 8, produces a very powerful compression flow in the direction of the arrow E, which is separated turbulently at the edge 20 and effects intimate mixing of the fuel impinging on the hot bottom plate and vaporizing from the latter again. The formation of the compression flow and the commencement of the fuel injection substantially coincide in time, so that the processes described occur in the initiation period of auto-ignition, which is of decisive importance for the course of further combustion. The fuel is injected in a compactly closed jet (having as small a spraying angle as possible) into the region between the edge 20 and the cone apex 22 on to the bottom plate where the turbulence on the upper side 21 of the bottom plate 2 is particularly intensive. The temperature of the bottom plate at this location is more than 350° C. This temperature is obtained by the fact that the edge 20 is displaced towards the center of the hot cylinder, so that only a small quantity of heat can flow away from the bottom plate. The auxiliary chamber 8, with the given size of duct 3, holds about 60% of the combustion air when the piston is at the upper dead center.

I claim:

1. A compression-ignition engine comprising a cylinder having an axis, a piston slidable in said cylinder and having a flat crown, a cylinder head having an undersurface defining together with said piston and said cylinder a main combustion space, said cylinder head having an auxiliary chamber opening into the undersurface of the cylinder head, a bottom plate of relatively small height fitted into said cylinder head and closing said auxiliary chamber, said bottom plate having a lower and an upper surface, said lower surface substantially coinciding with the undersurface of said cylinder head, said bottom plate having a duct by which said chamber is in communication with said main combustion space, said duct being arranged at a side of said bottom plate lying nearest to the axis of said cylinder, said bottom plate bounding said duct with a peripheral wall surface substantially parallel to said cylinder axis, a fuel injection nozzle in said cylinder head opening into said chamber, said nozzle being disposed opposite said bottom plate to inject a jet of fuel into said chamber at the end of the compression stroke of said piston, said fuel being directed onto said bottom plate and impinging thereon substantially at a central location of said bottom plate at a position more remote from said cylinder axis than said duct, said cylinder head having in the undersurface thereof a wedge shaped recess leading from a point in the vicinity of said axis of the cylinder to said duct, said cylinder head having an upper wall bounding said recess which is inclined such that the height of said recess is greater near said duct than near said axis of the cylinder, said bottom plate having a cavity in the upper surface thereof adapted for retaining fuel, the peripheral wall surface of the bottom plate which

bounds said duct forming a sharp intersecting edge with said upper surface of the bottom plate, said intersecting edge being proximate the location of fuel impingement and at a greater distance from said lower surface of the bottom plate than is a center portion of said upper surface in said cavity, said height of the recess at a location proximate the duct being greater than said distance of said intersecting edge from said lower surface of the bottom plate, said distances, said recess height, said inclination of the upper wall of said recess, said location of fuel impingement and intersecting edge being arranged such that air displaced by the action of the piston through said recess shortly before reaching the top dead center position in said chamber generates flow over said intersecting edge to generate air turbulence in the chamber in the vicinity of the upper surface of the bottom plate at the location of fuel impingement thereon for carrying away fuel vapors and droplets from said location and into said chamber whereby the vapors and droplets are intimately mixed with the air and burned at least partly therewith.

2. A compression-ignition engine according to claim 1, wherein said duct has an elongated shape when viewed perpendicularly onto said undersurface, the smallest dimension of said shape extending substantially in a radial direction with respect to said axis of the cylinder.

3. A compression-ignition engine according to claim 1, wherein said cavity in the upper surface of the bottom plate is a cone of small height.

4. A compression-ignition engine according to claim 1, wherein the bottom plate includes a rim encircling said cavity, the sharp intersecting edge being located closer towards said axis of the cylinder as compared to the inside wall of said cylinder, the radial distance between said inside wall of the cylinder and said edge being substantially the same as a radial dimension of said duct measured in a radial direction from said edge to the inside diameter of the cylindrical rim of said bottom plate.

5. A compression-ignition engine according to claim 1, wherein said cylinder head has two valves, said valves forming circular recess in said undersurface of said cylinder head together with their respective seats, said wedge shapes recess communicating with said circular recesses.

References Cited by the Examiner

UNITED STATES PATENTS

2,120,768	6/1938	Ricardo	123—32.9
2,513,874	7/1950	Howard	123—32.9
2,795,215	6/1957	Holt	123—32.9

FOREIGN PATENTS

1,211,196	10/1959	France.
904,339	8/1962	Great Britain.

MARG NEWMAN, *Primary Examiner.*

RICHARD B. WILKINSON, *Examiner.*

L. M. GOODRIDGE, *Assistant Examiner.*