Nov. 13, 1956 E. HAIGH ET AL 2,770,227

COMBUSTION CHAMBER

Filed Nov. 28, 1952 2 Sheets-Sheet 1

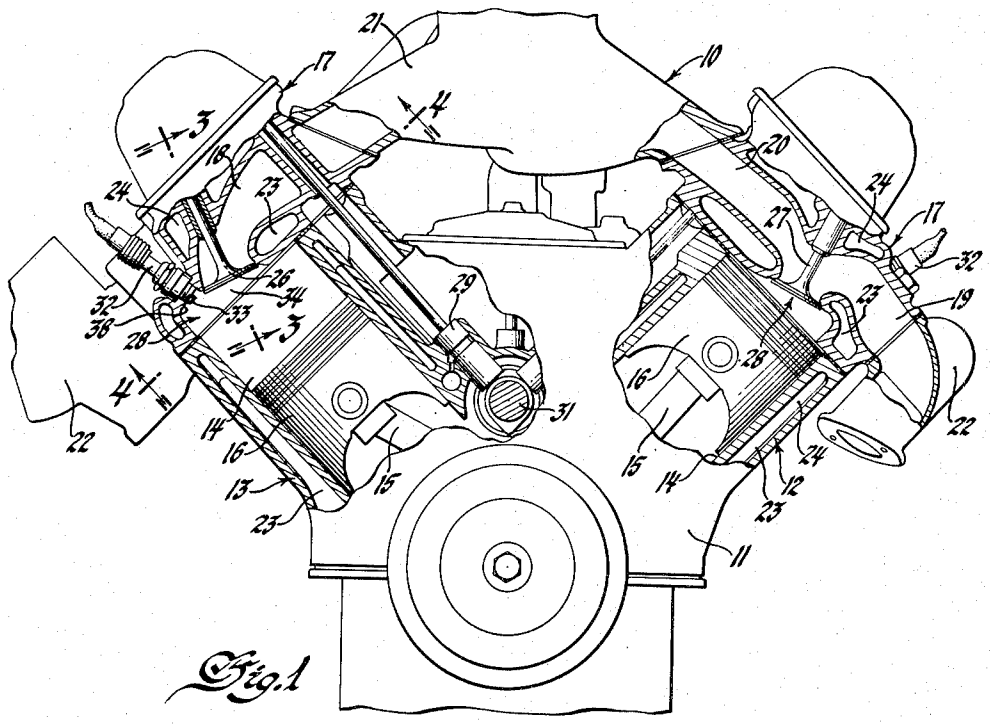


Fig. 1

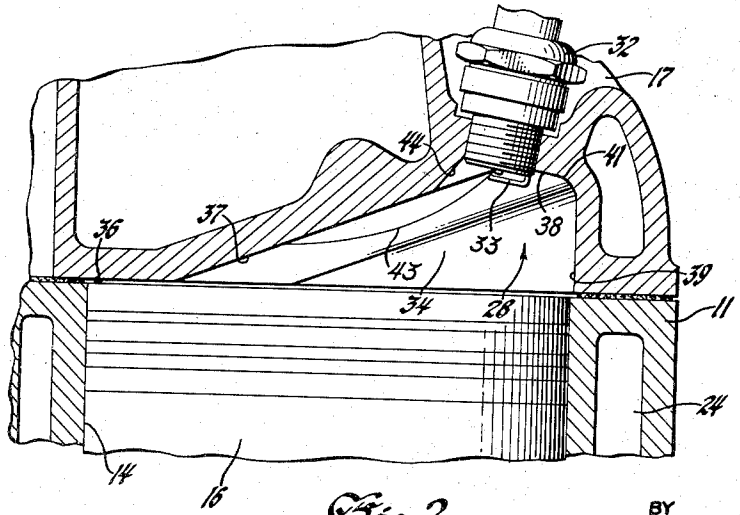


Fig. 2

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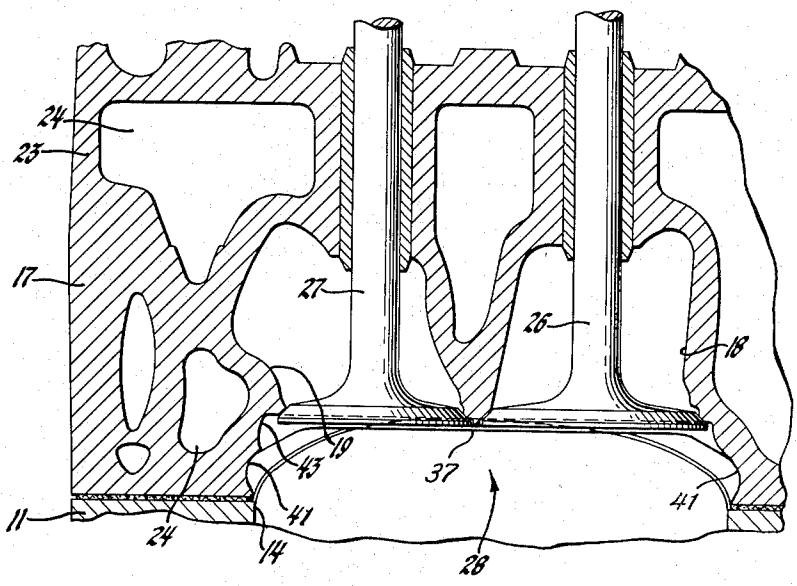


Fig. 3

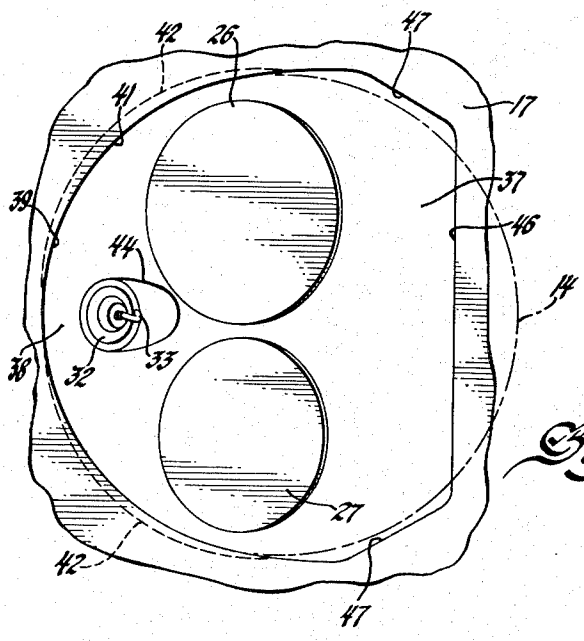


Fig. 4

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COMBUSTION CHAMBER

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Application November 28, 1952, Serial No. 322,926

7 Claims. (Cl. 123—191)

This invention relates to combustion chambers for engines and has particular relation to combustion chambers especially applicable for spark ignited, valve-in-head, V-type, 8-cylinder, internal combustion engines for automotive and other uses.

It has been customary heretofore to form combustion chambers in the heads of internal combustion engines by providing obliquely disposed and plane outer end wall surfaces intersecting the edges of the cylinders on one side of the cylinders and connected to the remote edges by cylindrical surfaces extending normally to the obliquely disposed and plane surfaces. When aligned valves are positioned in the heads of rows of such cylinders and opening into the firing chambers thereof through the plane surfaces forming the outer ends of the firing chambers it has been necessary to position the spark plugs very near the relatively cold walls of the firing chambers and practically at the intersections of the plane and cylindrical surfaces referred to. In such a combustion chamber almost all of the charge is at one side of the spark plug in the firing chamber and it is necessary to burn almost all of the charge by a flame moving across the firing chamber in one direction. With a spark plug located at the intersection between the plane and cylindrical surfaces of the firing chamber the ignition terminals are very close to and more or less pocketed within wall surfaces that limit the volume of the charge available to initiate burning in the chamber and tend to cause a slow initial burning of the charge in the vicinity of the spark plug. The excessive distance of the spark plug from a large part of the charge at the opposite end of the combustion chamber and the masking of the spark plug referred to tends to increase the time required for burning the charge in the firing chamber and tends to increase the tendency to detonate and pre-ignite at high compression ratios and with relatively low octane fuels.

It is now proposed to decrease the height of such firing chambers by bringing the ends of the pistons and the end walls of the firing chambers closer together, thereby decreasing the volume of the charge at each end of the chamber. This decrease in volume at each end of the firing chambers will greatly increase the ratio between the volume of charge and the surface area in the smaller ends of the chambers whereas it will not materially affect this ratio in the larger ends of the chambers. It is also proposed to enlarge the larger ends of the chambers by making the side wall surface elements immediately adjacent the larger ends form substantially a continuation of the cylindrical surfaces at the adjacent sides of the cylinders. Hence, it will be seen that without moving the spark plugs or the valves transversely of the cylinders it is possible to greatly increase the volume of charge immediately adjacent the spark plugs and to decrease the volume of charge in regions remote from the spark plug. With such construction it is possible to burn a very large part of the charge in a combustion chamber in the immediate vicinity of the spark plug and to burn the remaining parts of the charge in the smaller end of the

combustion chamber where the volume decreases as the surface area increases. Under such circumstances it is possible to increase the compression ratio and to burn fuel more efficiently and without objectionable detonation and pre-ignition.

In the drawing:

Figure 1 is a transverse sectional view of a V-type engine employing combustion chambers embracing the principles of the invention.

Figure 2 is a transverse sectional view of one of the cylinders of the engine illustrated by Figure 1. Figure 2 is taken substantially diametrically across one of the cylinders, through the spark plug and between the valves of the cylinder.

Figure 3 is a longitudinal sectional view through one of the combustion chambers and in the plane of the valve stems for the cylinder. Figure 3 is taken substantially in the plane of line 3—3 on Figure 1 looking in the direction of the arrows thereon.

Figure 4 is a plan view of the lower side of the head for one of the cylinders of the engine. Figure 4 is taken substantially in the plane of line 4—4 on Figure 1 looking in the direction of the arrows thereon.

In the structure disclosed by Figure 1 the engine **10** comprises an engine block **11** having obliquely disposed rows or banks **12** and **13** of cylinders **14** formed therein. The cylinders **14** are adapted to receive reciprocating pistons **16** which are connected to the crankshaft of the engine by connecting rods **15**. The banks of cylinders **12** and **13** have cylinder heads **17** in which are formed inlet passages **18** and exhaust passages **19**. The inlet passages **18** receive charges of combustible mixture from an inlet manifold **21**. The exhaust passages **19** communicate with exhaust manifolds **22** and have by-pass passages **20** leading to heating passages in the manifold **21**. The by-pass passages **20** supply exhaust gas for heating the inlet manifold **21** when the engine heat control valve restricts the flow of exhaust gas from one of the engine exhaust manifolds. The cylinder banks **12** and **13** and the head **17** may be provided with jackets **23** providing cooling liquid cavities **24** for cooling the cylinders **14**. The cylinders **14** in each bank of cylinders are provided with aligned inlet and exhaust valves **26** and **27** for controlling the inlet passages **18** and exhaust passages **19** respectively. The inlet and exhaust valves **26** and **27** open into combustion chambers **28** which are formed in the ends of cylinders **14** between the pistons **16** and the heads **17**. The valves **26** and **27** are operated by valve actuating mechanisms **29** which are driven by the camshaft **31** of the engine **10**. The combustion chambers **28** in each bank of the cylinders **14** are provided with aligned spark plugs **32**, the ignition terminals **33** of which extend into the combustion chambers **28**, substantially on diameters of the cylinders **14** extending between the valves **26** and **27**. The spark plug **32** in each cylinder is positioned between the valves **26** and **27** and as near as possible to the valves.

The combustion chamber **28** for each of the cylinders **14** comprises a firing chamber **34** and a mechanical clearance space **36**. The mechanical clearance space may be formed at the inner edge of each cylinder **14** in the rows or banks **12** and **13**. In addition to providing a clearance space between the piston and the head for each cylinder the clearance space **36** provides a squish area for creating turbulence and a quench area where the ratio between the surface area and the volume of charge is high. The firing chamber **34** for each cylinder is constructed as a surface of revolution and translation which may be formed in any suitable manner. The surfaces of revolution and translation in each firing chamber **34** consist of obliquely disposed plane surfaces **37**, frusto coni-

cal surfaces 38, frusto conical surfaces 39 and arcuate surfaces 41. The surfaces 38, 39 and 41 extend only for 180° around the larger ends of the firing chambers but continue in the smaller ends as parallel surfaces of the same slope with respect to the plane surfaces 37. In each chamber 34 the larger ends of the frusto conical surfaces 38 and 39 merge to form the curved surfaces 41. The smaller ends of the frusto conical surfaces 38 intersect the plane surfaces 37 while the smaller ends of the frusto conical surfaces 39 substantially coincide with the peripheral edges of the cylinders 14 around the larger ends of the firing chambers 34. In planes perpendicular to the plane surfaces 37 and through the axes of the valves 26 the surfaces 38, 39 and 41 will appear as receding surfaces which are indicated at 42 in Figure 3 and which enlarge the sides of the combustion chambers to provide clearances at the opposite ends of the valves 26 and 27. The plane surfaces 37 may be further extended at the opposite ends of the valves 27 and 28 and across the width of the combustion chambers 28 as is indicated by the depressions 43 which extend into the frusto conical surfaces 38 at the sides of the combustion chambers 28.

The firing chambers 34 may be machined in the heads 17 by employing a rotating tool the end cutting surface of which forms the plane surfaces 37. The tool may rotate about an axis normal to the plane surfaces 37. The side cutting surfaces of the tool may be formed to conform to the configuration of the frusto conical surfaces 38 and 39 and the arcuate surfaces 41. The tool may be moved into the work in the plane of a diameter extending across each of the cylinders 14 and with the end of the tool moving in parallel relation to the plane surfaces 37. However, the firing chambers 34 may be cast without machining and in the form of the surfaces of rotation and translation described, if this is preferable.

The rows of spark plugs 32 for each bank of cylinders may be secured in the head 17 in threaded openings which open into the firing chambers 34 and the axes of which are obliquely disposed with respect to the axes of each row of cylinders 14. It is considered preferable to have the axes of each row of the spark plugs 32 intersect the inner surfaces of the firing chambers 34 at about the places where the frusto conical surfaces 38 intersect the outer extremities of the plane surfaces 37. It is also considered preferable to have the axes of the spark plugs 32 disposed in planes normal and tangent to the frusto conical surfaces 38 at the outer and larger extremities of the firing chambers 34. In order to provide an ample supply of combustible mixture around the spark plug terminals 33 and to prevent the surfaces of the firing chambers 34 from too closely approaching the spark plug terminals 33 it is proposed to relieve the plane surfaces 37 by providing frusto conical surfaces extending from the spark plug openings outwardly as is indicated at 44.

In order to decrease the tendency for detonation of the last part of the charge to burn in the combustion chambers 28 and to provide sufficient turbulence in the combustion chambers 28 so that a good quality of mixture will be provided adjacent the spark plug terminals 33 it is proposed to decrease the clearance space 36 in each of the cylinders to a minimum value. The clearance spaces 36 are the relatively shallow spaces outside the firing chambers 34 and between the ends of the pistons 16 and the adjacent surfaces of the head 17. It is preferable to have the plane surfaces 37 intersect the cylinders 14 somewhat within the inner edges of each of the cylinders 14 and at cords in each of the cylinders extending across the inner sides of each of the cylinders. A cord representing the inner extremity of the clearance space 36 in the structure illustrated by Figure 4 is indicated at 46. While shallow pockets 47 may be formed outside of the cylinders 14 at the smaller ends of the firing chambers 34 the depth of the pockets will be so little and the ratio of surface area to volume so large that the pockets will not result in detonation of the last part of the charge to burn.

It will be noted that the terminals 33 of the spark plugs 32 are in the middle of the larger ends of each of the combustion chambers 28 where the greatest volume of the charge is located. Upon ignition it will be apparent that the greater part of the charge will burn very rapidly in all directions from the terminals 33 and will burn before detonation may occur. Thereafter as the charge burns toward the smaller end of the combustion chamber the ratio between the surface area and the volume will increase very rapidly, thereby preventing the temperature of the charge from increasing at a rate as great as might otherwise occur. After the charge is burned across the smaller end of the firing chamber in each cylinder it will be apparent that the last part of the charge to burn will be in the clearance space 36 where the ratio between the surface area and volume is so great that the burning of the charge may be completed at a rate and temperature which is not excessive.

It will be apparent that the combustion chamber design is simple and inexpensive to construct, that complicated mechanisms are not required to operate the valves and that combustible charges may be burned under conditions that will permit relatively high compression ratios with relatively low octane fuels.

We claim:

1. A combustion chamber for engines comprising an engine cylinder having a piston therein and a head for said cylinder, said head being formed to provide a firing chamber for said combustion chamber in directly opposed relation to said cylinder, said firing chamber being formed to provide a plane surface and a pair of adjacent but oppositely disposed frusto conical surfaces, said plane and frusto conical surfaces being surfaces of revolution and translation with the axis of rotation thereof being normal to said plane surface and the plane of translation thereof being a plane through said axis and parallel to said plane surface, said frusto conical surfaces being formed on the cylinder side of said plane surface with the adjacent and outer edges thereof merging in a curved surface and being disposed with the apex of one of said frusto conical surfaces on one side of said plane surface and the apex of the other of said frusto conical surfaces on the opposite side of said plane surface, said frusto conical surfaces also being formed with the inner edge of one of said surfaces merging with said plane surface and the inner edge of the other of said surfaces merging with a peripheral edge of said cylinder, and a spark plug opening extending into said cavity on an axis substantially normal to one of said frusto conical surfaces.

2. A combustion chamber for engines comprising an engine cylinder having a piston therein and a head for said cylinder, said head being formed to provide a cavity forming a firing chamber for said combustion chamber, said cavity being formed to provide surfaces of revolution including a plane surface and a pair of oppositely disposed frusto conical surfaces, said plane and frusto conical surfaces being formed about an axis of rotation normal to said plane surface, said frusto conical surfaces being formed on the cylinder side of said plane surface with the adjacent and outer edges thereof merging in a curved surface and being disposed with the apex of one of said frusto conical surfaces on one side of said plane surface and the apex of the other of said frusto conical surfaces being disposed on the opposite side of said plane surface, said frusto conical surfaces also being formed with the inner edge of one of said surfaces merging with said plane surface and the inner edge of the other of said surfaces merging with a peripheral edge of said cylinder, and means for supplying combustible mixture to and exhausting products of combustion from said combustion chamber.

3. A combustion chamber for engines comprising an

engine cylinder having a piston therein and a head for said cylinder, said head being formed to provide a cavity therein in directly opposed relation to said cylinder and providing a firing chamber for said combustion chamber, said cavity being formed to provide surfaces of revolution including a plane surface and a pair of oppositely disposed frusto conical surfaces and with the common axis of rotation of said surfaces being normal to said plane surface, said pair of frusto conical surfaces being formed on the cylinder side of said plane surface with the adjacent and outer edges thereon merging and being disposed with the apex of one of said frusto conical surfaces on one side of said plane surface and the apex of the other of said frusto conical surfaces on the opposite side of said plane surface, said frusto conical surfaces also being formed with the inner edge of one of said surfaces merging with said plane surface and the inner edge of the other of said surfaces merging with a peripheral edge of said cylinder, said plane surface being disposed obliquely with respect to the axis of said cylinder and intersecting said cylinder on a cord at one side of said cylinder, and means for successively igniting combustible charges in said firing chamber.

4. A combustion chamber for engines comprising an engine cylinder having a piston therein and a head for said cylinder, said head being formed to provide a cavity therein in directly opposed relation to said cylinder, said cavity being formed to provide an obliquely disposed plane surface intersecting said cylinder on a cord at one side of said cylinder, inlet and exhaust valves disposed in said head and opening into said cavity through said plane surface, a spark plug disposed in said head and having the ignition terminals thereof projecting into said cavity between said valves, and an end surface formed in said head and disposed at the end of said cavity opposite said cord, said end surface being formed to provide substantially a continuation in said head of the adjacent surface of said cylinder.

5. A combustion chamber for engines comprising an engine cylinder having a piston therein and a head for said cylinder, said head being formed to provide a cavity forming a firing chamber in directly opposed relation to said cylinder, said cavity being formed to provide an obliquely disposed plane surface intersecting the end of said cylinder on a cord at one side of said cylinder, inlet and exhaust valves disposed in said head and opening into said firing chamber through said plane surface, said valves being disposed with the axes thereof extending substantially normally to said plane surface and in a plane extending in substantially parallel relation to said cord, a spark plug disposed in said head and having the ignition terminals thereof projecting into said firing chamber on the side of said valves opposite said cord and between said valves, and an arcuate surface formed in said

head and forming the end of said cavity in opposed relation to said cord and having a curved surface forming within said head substantially in continuation of the adjacent arcuate surfaces at the end of said cylinder.

6. A combustion chamber for engines comprising an engine cylinder having a piston therein and a head for said cylinder, said head being formed to provide a cavity forming a firing chamber for said combustion chamber, said cavity being formed in said head to provide an obliquely disposed plane surface intersecting said cylinder on a cord at one side of said cylinder, inlet and exhaust valves in said head and opening into said plane surface with the axes thereof disposed in substantially parallel relation to said cord, a spark plug disposed in said head with the axis thereof in obliquely disposed relation to the axis of said cylinder and through an obliquely disposed surface of said cavity intersecting said plane surface beyond said valves, and an arcuate surface forming the end of said cavity opposite said cord and forming substantially a continuation in said head of the adjacent end of said cylinder.

7. A combustion chamber for engines comprising an engine cylinder having a piston therein and a head for said cylinder, said head being formed to provide a cavity forming a firing chamber for said combustion chamber, said firing chamber being formed to provide an obliquely disposed plane surface intersecting the axis of said cylinder and an arcuate surface extending around the larger end of said firing chamber and intersecting said plane surface, a spark plug opening extending into the intersection between said surfaces and having the axis thereof normal to one of said surfaces, said firing chamber being formed adjacent said spark plug opening to provide a frusto conical surface formed in the other of said intersecting surfaces and diverging from said spark plug opening and into said firing chamber through said other of said surfaces, a spark plug in said spark plug opening with the ignition terminals thereof disposed within said firing chamber, and inlet and exhaust valves in said head and opening into said obliquely disposed plane surface.

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