May 14, 1957 G. C. TREVARTHEN 2,791,996

COMBUSTION CHAMBER

Filed Jan. 16, 1953

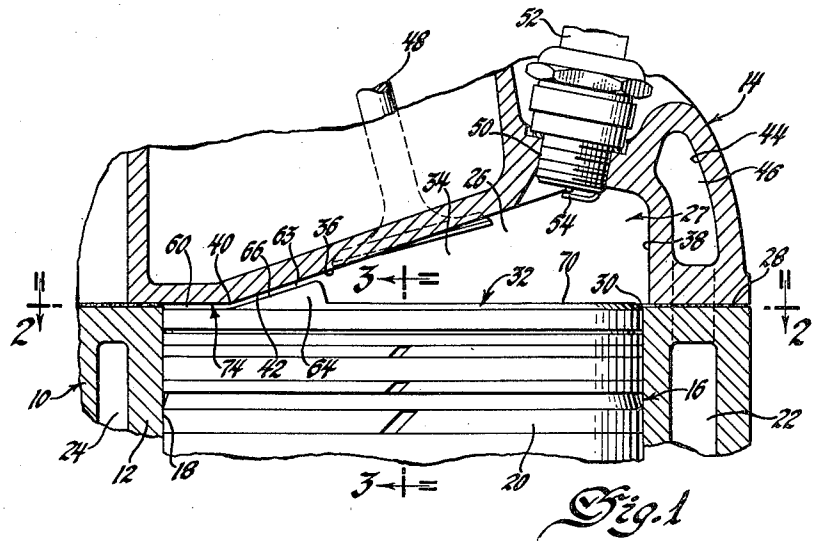


Fig. 1

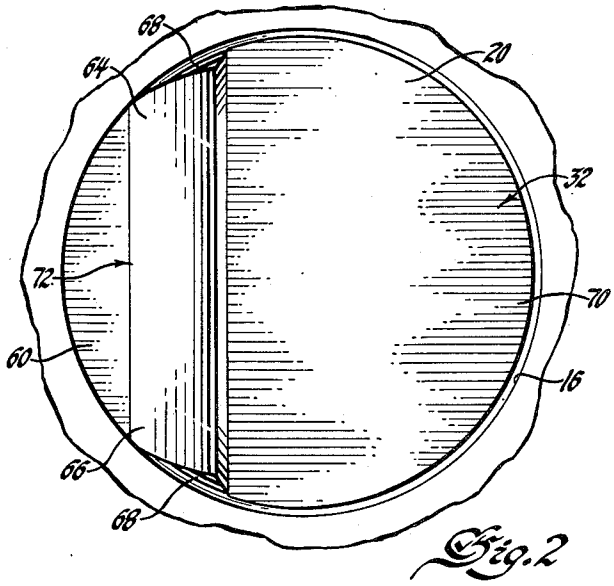


Fig. 2

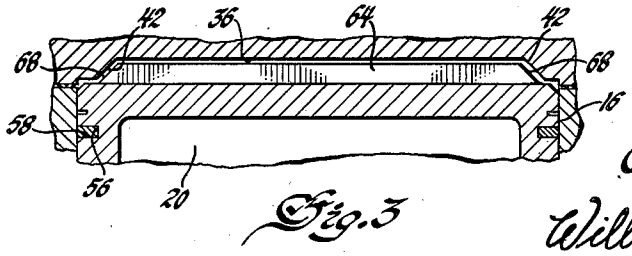


Fig. 3

INVENTOR

George C. Trevarthen

BY

Williston, Helwig & Baillio

ATTORNEYS

United States Patent Office 2,791,996 Patented May 14, 1957

2,791,996

COMBUSTION CHAMBER

George C. Trevarthen, Detroit, Mich., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Application January 16, 1953, Serial No. 331,681

15 Claims. (Cl. 123—191)

The present invention relates to combustion chambers for engines and has particular relation to combustion chambers especially applicable to spark ignited, valve in-head, high compression engines for automotive and other uses.

It has been a common practice in the past to employ the so-called wedge shaped combustion chamber in automotive engines. This type of chamber includes a cavity that is formed in the engine head by an obliquely disposed and planar wall surface intersecting one side of the cylinder and being connected to the remote edges of the cylinder by generally conical or cylindrical surfaces extending generally normal to the obliquely disposed planar surface. Although this form of combustion chamber performs satisfactorily under certain operating conditions as is inherent with all combustion chambers, its efficiency and usefulness is limited by a critical compression ratio. When the compression ratio exceeds the critical value, detonation occurs. As the burning gases in the combustion chamber expand, the remaining unburned gases are compressed causing their temperatures to rise. Unless precautionary measures are taken, under heavy loads the temperatures of these gases will rise sufficiently close to the kindling point for spontaneous combustion to occur which results in detonation.

It is now proposed to increase the critical compression ratio of a combustion chamber by employing a piston having a projection on the top thereof that extends into the combustion chamber. Although the present invention may be employed in any form of combustion chamber, the present embodiment is particularly adapted to th so-called wedge type of combustion chamber. The projection has a shape similar to that of the planar portion of the firing chamber and when the piston is at top dead center a substantially uniform amount of clearance is provided between the projection and the planar portion of the firing chamber. When the igniting spark plug is placed in the vicinity of the intersection of the planar and conical surfaces, the wedge will be placed on the remote side of the chamber from the initial point of ignition. This will result in concentrating the mass center of the combustion charge very close to the spark gap thereby effectively reducing the flame travel. Also a relatively large volume of the unburned gases will be confined in a space having a large ratio of quench area to volume. Thus even when the initial charge of the fuel mixture is burned very rapidly, no detonation will occur as the remaining unburned gases will be effectively cooled by the large quench area. By maintaining the temperatures of the unburned gases below the critical temperature at which detonation occurs, a fuel having a lower octane rating may be used in the combustion chamber without detonation occuring.

It is further proposed to place the valves and spark gap in substantial alignment with the mechanical clearance space between the projection and the walls of the firing chamber. By employing a wedged projection on the

piston having an inclined surface substantially parallel to the walls of the firing chamber, the squish area will cause the gases to flow along the upper surfaces of the combustion chamber. Thus it will now be possible to direct the gaseous flow into intimate contact with the valves and spark gap. Due to the scrubbing action created by such a flow, there will be a strong tendency to maintain the combustion chamber clean and reduce fouling of the valves and spark gap. Thus it will be possible to reduce or entirely to eliminate hot points that might cause detonation.

In the drawings:

Figure 1 is a cross-sectional view of a portion of an engine embodying the present invention.

Figure 2 is a cross-sectional view taken substantially along the plane of line 2—2 of Figure 1.

Figure 3 is a cross-sectional view taken substantially along the plane of line 3—3 of Figure 1 and showing the projection on the end of the piston.

Referring to the drawings in more detail, an engine 10 embodying the present invention includes a block 12 having a head 14 secured to the top thereof. The block 12 may have one or more cylinders 16 that extend therethrough. The cylinders 16 may be disposed as in a V, in-line, or other form of engine. The cylinders 16 are formed by arcuate walls 18 and have a reciprocating piston 20 slidably disposed therein. In order to prevent excessive temperatures causing damage to the engine 10, a water jacket 22 may be provided in the block 12. The jacket 22 comprises passages 24 which extend through the engine block 12 and conduct the cooling waters into heat exchanging relation with the cylinder walls 18.

The head 14 may be secured to the block 12 by any suitable means. The head 14 has cavities 26 formed in the bottom surface 28 thereof to register with the openings 30 formed by the ends of the cylinders 16. The cavities 26 form firing chambers 27 which cooperate with the top surfaces 32 of the pistons 20 and the cylinder walls 18 to form combustion chambers 34. The firing chambers 27 may be formed by a plurality of concave surfaces of any desired shape. In the present instance, the chamber 27 includes a surface of translation which has a substantially planar portion 36 and a surface of revolution which has substantially curved end walls 38. The planar portion 36 is inclined so as to be obliquely disposed to the axis of the cylinder 16 and positioned to intersect the plane of the top of the block along a chord 40 extending across one end of the cylinder 16. The lower surface 28 of the head 14 adjacent the chord 40 is disposed across the open end of the cylinder 16. End walls 42 are provided along the opposite sides of the planar surface 36 so as to intersect the cylinder walls 18. The curved end walls 38 are formed in the head 14 to be in substantial alignment with the cylinder walls 18 and to intersect the planar surface 36. To cool the head 14 a water jacket 44 may be formed to include water passages 46 that extend through the head 14 in heat exchanging relation with the surfaces comprising the firing chambers 27. If desired the water passages 46 through the head 14 may communicate with those 24 in the block 12.

Induction and exhaust means are provided for charging and exhausting the combustion chambers 34. The means include inlet and exhaust valves 48, which are preferably disposed in the planar surface 36, and separate passages formed in the head 14 to communicate with each of the valves 48. A threaded opening 50 adapted to receive a spark plug 52 having electrodes 54 projecting therefrom is provided through the head to communicate with each of the firing cavities. When the spark plug 52 is in position, the electrodes 54 will extend into the combustion chamber 34 and when properly actuated will

create an electrical discharge for igniting the gaseous charge in the combustion chamber **34**.

A piston **20** is slidably disposed in the cylinder **16** for reciprocating movement therein during operation of the engine **10**. A plurality of annular grooves **56** extending around the circumference thereof of the piston to receive piston rings **58**. The rings **58** are resilient so as to expand into wiping contact with the cylinder walls **18** thereby maintaining good compression in the engine **10**.

When the piston **20** is at top dead center, a segment **60** of the surface **30** on the upper end of the piston **20** will be adjacent and directly opposed to the bottom surface **28** of the head **14** bounded by the chord **40** and cylinder walls **18**. Mechanical clearance **63** is provided between these two surfaces to provide a space of relatively small volume. A member **64** which may be cast integral with the piston **20** projects upwardly therefrom to extend above the upper surface of the block **12**. This member is preferably disposed on the opposite side of the firing chamber **27** from the spark plug **52** and has a shape corresponding to the shape of the adjacent surface of the firing chamber **27**. Since this is the planar surface **36**, the projecting member **64** is substantially wedge shaped. The upper surface **66** of the wedge **64** is inclined at the same angle as the planar surface **36** and is positioned to provide a mechanical clearance **63** equal to that adjacent the segment **60** on the end of the piston **20**. The ends of the wedge **68** are shaped to conform as close as possible to end walls **42** of the planar portions **36** thus providing a mechanical clearance approximately equal to that around the rest of the wedge **64**. The remaining surface **70** of the piston **20** is flat and is disposed so as to provide a combustion chamber **34** of the desired shape and volume.

The space created by the limited clearance will be bound on one side by the quench and squish area **72** on the piston **20** and on the other side by the quench and squish area **74** on the firing chamber **27**. The quench and squish area **72** on the piston **20** includes the upper surface **66** of the wedge **64** and the segment **60** on the end of the piston **20**. The quench and squish area **74** on firing chamber **27** includes the bottom surface **28** on the head **14** and the lower end of the planar surface **36** that directly opposes the quench and squish area **72** on the piston **20**. It may be observed that the space **63** defined by the opposing quench areas **72** and **74** has a large area to volume ratio. Therefore any gases confined in this space **63** will be maintained relatively cool as a result of the large amount of metal in contact with these gases. Therefore the gases in the main portion of the combustion chamber **34** may burn rapidly when ignited by a spark between the electrodes **54**. As this burning progresses the unburned gases will be compressed into the space **63** between the quench areas **72** and **74**. As this compression continues, the unburned gases will be heated. However, due to the large quench areas contacting the gases they will be maintained below the kindling point. Therefore detonation will not occur.

The volume **63** between the squish areas **72** and **74** is substantially planar and the valves **48** and electrodes **54** are disposed substantially in this plane and diametrically opposed thereto. Thus as the gases are compressed between the squish areas **72** and **74** by the ascending piston **20**, they will flow outwardly in this plane. This flow will be along the planar surface **36** into intimate contact with the valves **48** and electrodes **54**. This flow of gases will cause a scrubbing action on the walls of the firing chamber **27**, the valves **48**, and electrodes **54**. Thus fouling deposits will be greatly reduced thereby decreasing the number of hot spots that might cause detonation.

While but one embodiment of the present invention has been shown and described, it will be apparent to those skilled in the art that various changes and modifications may be made without departing from the invention. It is, therefore, to be understood that the foregoing description is to be considered as illustrative only and in no way restrictive, reference being had to the appended claims to determine the scope of the invention.

What is claimed is:

1. A combustion chamber comprising a block having a cylinder extending therethrough, a piston reciprocably disposed in said cylinder, a head secured to said block and having a cavity positioned therein to register with said cylinder, one end of said cavity having a surface obliquely disposed to the axis of said cylinder, a portion of one end of said piston having a surface inclined to the axis of said cylinder so that to mate with said oblique surface, said surfaces being positinoned to provide a mechanical clearance space therebetween which extends substantially the entire width of said end of said cavity to direct a blast of gases along said oblique surface, and a spark plug mounted in said head and having the electrodes thereof being disposed substantially in said oblique surface and being positioned in said cavity in substantial alignment with the mechanical clearance space between said surfaces and being disposed directly in said blast of gases.

2. A combustion chamber comprising a block having a cylinder extending therethrough, a piston reciprocably disposed in said cylinder, a head secured to said block and having a cavity positioned therein to register with said cylinder, one end of said cavity having a surface obliquely disposed to the axis of said cylinder, a portion of one end of said piston having a surface inclined to the axis of said cylinder so as to mate with said oblique surface, said surfaces being positioned to provide mechanical clearance space therebetween extending substantially the full width of said end of said cavity, at least a portion of said space being a plane substantially parallel to said oblique surface, a spark plug mounted in said head and having electrode means projecting into said cavity, and valve means disposed in said oblique surface on said head and being removed from said portion for communicating with the center of said combustion chamber, said means being disposed in said plane in substantial alignment with said mechanical clearance space.

3. A combustion chamber having a cylinder extending therethrough, a piston reciprocably disposed in said cylinder, a head secured to said block and having a cavity positioned therein to register with said cylinder, one end of said cavity being defined by a surface obliquely disposed to the axis of said cylinder, a member projecting from the end of said piston and extending substantially across said end of said cavity, said member having a surface shaped similar to said obliquely disposed surface and being disposed in spaced relation thereto to form a comparatively thin clearance space at least the portion of said space adjacent the edge of said member comprising a plane, and a spark plug mounted in said head and having the electrodes thereof extending into said cavity and being disposed in said plane in substantial alignment with the space between said surfaces.

4. A combustion chamber having a cylinder extending therethrough, a piston reciprocably disposed in said cylinder, a head secured to said block and having a cavity positioned therein to register with said cylinder, one end of said cavity being defined by a surface obliquely disposed to the axis of said cylinder, a member projecting from one end of said piston, said member having a surface thereon substantially similar to a portion of said first surface, said surfaces being disposed in parallel spaced relation to form a mechanical clearance space therebetween having a substantially uniform thickness and extending substantially the full width of said end of said cavity, and a spark plug secured in said head and having the electrodes thereof projecting into said cavity and being positioned remote from the mating portions of said surfaces but in said obliqely disposed surface.

5. A combustion chamber having a cylinder extending therethrough, a piston reciprocably disposed in said cylin-

der, a head secured to said block and having a cavity positioned therein to register with said cylinder, one end of said cavity being defined by a surface obliquely disposed to the axis of said cylinder, a member projecting from one end of said piston, said member having a surface adapted to mate with only a portion of said obliquely disposed surface and being disposed in spaced relation thereto, a spark plug mounted in said head and having the electrode means projecting into said cavity through said obliquely disposed surface, and valve means mounted in said head and communicating with said cavity only through said obliquely disposed surface, said spark plug electrodes and said valve means being positioned in substantial alignment with said space between said surfaces.

6. A combustion chamber comprising a block having a cylinder extending therethrough, a piston reciprocably disposed in said cylinder, a head secured to said block and having a cavity positioned therein to register with said cylinder, one end of said cavity having a planar surface obliquely disposed to the axis of said cylinder, a wedge projecting from one end of said piston and having a planar surface thereon extending substantially entirely across said end of said cavity and being adapted to cooperate with said first planar surface to provide a plane mechanical clearance space therebetween, and a spark plug mounted in said head and having electrodes projecting into said cavity remote from said mechanical clearance space and being disposed substantially in the plane thereof.

7. A combustion chamber comprising a block having a cylinder extending therethrough, a piston reciprocably disposed in said cylinder, a head secured to said block and having a cavity positioned therein to register with said cylinder, one end of said cavity being defined by a planar surface obliquely disposed to the axis of said cylinder, a wedge projecting from one end of said piston and having a surface thereon extending substantially entirely across said end of said cavity and being adapted to cooperate with said planar surface, said wedge surface being positioned to provide a mechanical clearance between said planar surface and said wedge surface, and a spark plug mounted in said head and having electrodes thereon projecting into said cavity substantially in the plane of said mechanical clearance space.

8. A combustion chamber comprising a block having a cylinder extending therethrough from one side of said block, a head secured to said block and having a flat area thereon abutting said side of said block, said head having a cavity formed in said flat area, said cavity and a section of the flat area adjacent thereto being positioned to register with said cylinder, said cavity having one wall thereof obliquely disposed to the axis of said cylinder so as to intersect said section, a piston reciprocably disposed in said cylinder, one end of said piston having a segment the surface of which is directly opposed to said section, and a member projecting from said end and having a surface thereon angularly disposed with respect to and intersecting the surface of said segment, the surfaces of said segment and said member and the surfaces of said section and said wall of said cavity being positioned to provide a mechanical clearance space therebetween communicating with a chamber defined by the remaining walls of said cavity and said piston, said chamber having a larger volume-to-surface ratio than said clearance space.

9. A combustion chamber comprising a block having a cylinder extending therethrough from one side of said block, a head secured to said block and having a flat area thereon abutting said side of said block, said head having a cavity formed in said flat area, said cavity and a section of the flat area adjacent thereto being positioned to register with said cylinder, said cavity having one wall thereof obliquely disposed to the axis of said cylinder so as to intersect said section, a piston reciprocably disposed in said cylinder, one end of said piston having a segment the surface of which is directly opposed to said section, a member projecting from said end and having a surface thereon angularly disposed with respect to the surface of said segment, the surfaces of said segment and said member being shaped to mate with the surfaces of said section and only a limited portion of said wall of said cavity to provide a mechanical clearance space therebetween, a chamber disposed between said piston and the remaining portion of said wall of said chamber with the volume-to-surface ratio being larger than for said clearance space, and electrodes being disposed in said cavity remote from said member.

10. A combustion chamber comprising a block having a cylinder extending therethrough from one side of said block, a head secured to said block and having a flat area thereon abutting said side of said block, said head having a cavity formed in said flat area, said cavity and a section of the flat area adjacent thereto being positioned to register with said cylinder, a piston reciprocably disposed in said cylinder, one end of said piston having a segment the surface of which is directly opposed to said section, a member projecting from said end and having a surface thereon angularly disposed with respect to the surface of said segment, the surfaces of said segment and said member being shaped to mate with the surfaces of said section and said portion of said cavity adjacent said section and being positioned to provide a relatively thin mechanical clearance space therebetween, electrode means mounted in said head and projecting into said cavity, and valve means mounted in said head to communicate with said cavity, said means being disposed in substantial alignment with said space and being disposed within said blast.

11. A combustion chamber comprising a block having a planar surface with a cylinder extending therethrough, a head secured to said block with a flat area thereon abutting said planar surface on said block, said head having a cavity formed in said flat area, said cavity and a portion of said flat area being positioned to register with said cylinder, the end of said cavity adjacent said portion having a surface of translation obliquely disposed to said flat area, a piston reciprocably disposed in said cylinder with a segment thereof positioned to mate with said portion of said flat area to form a mechanical clearance space therebetween, and a wedge member projecting from one end of said member adjacent said segment to mate with only a portion of said surface of translation to form a mechanical clearance space therebetween contiguous with said first mechanical clearance space.

12. A combustion chamber comprising a block having a planar surface with a cylinder extending therethrough to form a circular opening in said surface, a head secured to said block with a flat area thereon abutting said planar surface on said block, said head having a cavity formed in said flat area to register with said cylinder, one end of said cavity having a surface of translation obliquely disposed to said flat area, the opposite end of said cavity having a surface angularly disposed with respect to said surface of translation and intersecting said flat area along a line coincident with a portion of said circle, a piston reciprocably disposed in said cylinder and having a member projecting from one end thereof to register with only a portion of said surface of translation, said member and said surface being positioned to provide a mechanical clearance space therebetween and a chamber formed between said piston, said angularly disposed opposite end of said cavity and the remaining portion of said surface of translation, the volume-to-surface ratio of said chamber being larger than for said clearance space.

13. A combustion chamber comprising a block having a planar surface with a cylinder extending therethrough to form a circular opening in said surface, a head secured to said block with a flat area thereon abutting said planar surface on said block, said head having a cavity formed in said flat area to register with said cylinder,

one end of said cavity having a surface of translation obliquely disposed to said flat area, the opposite end of said cavity having a surface angularly disposed with respect to said surface of translation and intersecting said flat area along a line coincident with a portion of said circle, a piston reciprocably disposed in said cylinder, and a wedge projecting from one end of said piston and having a planar surface thereon adapted to cooperate with only a portion of said surface of translation, said wedge being positioned to provide a mechanical clearance between said planar surface and said surface of translation of substantially uniform thickness and a chamber formed between said piston, said angularly disposed opposite end of said cavity and the remaining portion of said surface of translation, the volume-to-surface ratio of said chamber being larger than for said clearance space.

14. A combustion chamber comprising a block having a planar surface with a cylinder extending therethrough to form a circular opening in said surface, a head secured to said block with a flat area thereon abutting said planar surface on said block, said head having a cavity formed in said flat area, said cavity and a portion of said flat area being positioned to register with said cylinder, the end of said cavity adjacent said portion having a surface of translation obliquely disposed to said flat area, the opposite end of said cavity having a surface of revolution angularly disposed with respect to said surface of translation and intersecting said flat area along a line coincident with a portion of said circle, a piston reciprocably disposed in said cylinder with a segment thereof positioned to mate with said portion of said flat area to form a mechanical clearance space therebetween, and a wedge member projecting from one end of said piston adjacent said segment to mate with only a portion of said surface of translation to form a mechanical clearance space therebetween contiguous with said first mechanical clearance

space and a chamber formed between said piston, said angularly disposed opposite end of said cavity and the remaining portion of said surface of translation, the volume-to-surface ratio of said chamber being larger than for said clearance space.

15. A combustion chamber comprising a block having a cylinder extending therethrough from one side of said block, a head secured to said block and having a flat area thereon abutting said side of said block, said head having a cavity formed in said flat area to register with said cylinder, said cavity having a surface of translation obliquely disposed with respect to said flat area, said surface of translation including a planar center portion and angularly disposed edge portions, a piston reciprocably disposed in said cylinder with a member projecting from one end thereof to register with only a portion of said surface of translation, said member having a planar surface disposed parallel to said center portion and extending the full width thereof between said edge portions to form a mechanical clearance space therebetween and a chamber formed between said piston, said angularly disposed opposite end of said cavity and the remaining portion of said surface of translation, the volume-to-surface ratio of said chamber being larger than for said clearance space.

References Cited in the file of this patent

UNITED STATES PATENTS

2,016,734	Wittenberg et al.	Oct. 8, 1935
2,058,242	Lee	Oct. 20, 1936
2,428,886	MacPherson	Oct. 14, 1947
2,580,951	Pescara	Jan. 1, 1952

FOREIGN PATENTS

274,522	Italy	Mar. 23, 1930
348,938	Great Britain	May 21, 1931
264,714	Switzerland	Oct. 31, 1949