Oct. 22, 1957 J. WEISSENBACH 2,810,377

COMBUSTION CHAMBER

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Fig. 1.

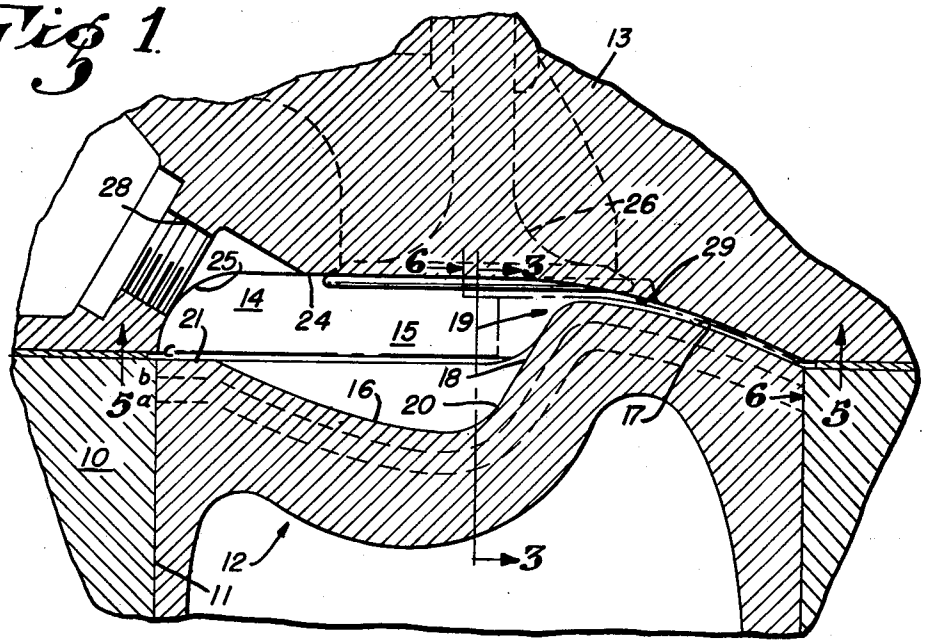
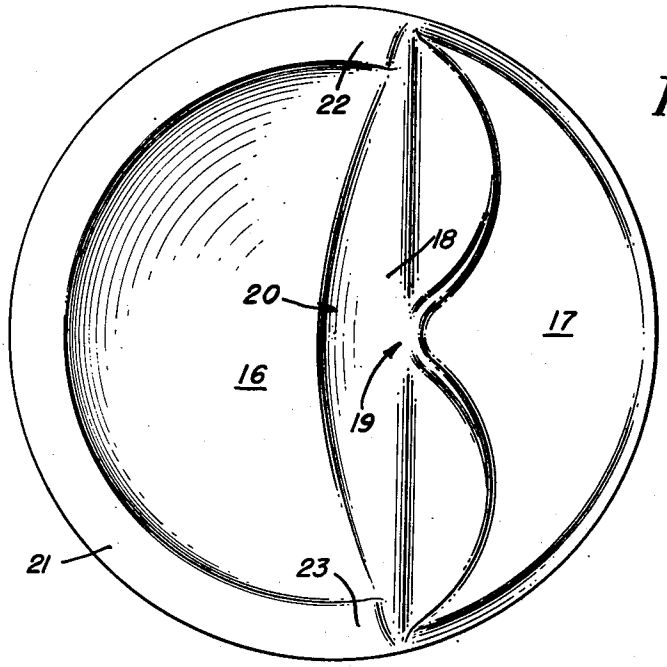


Fig. 2.



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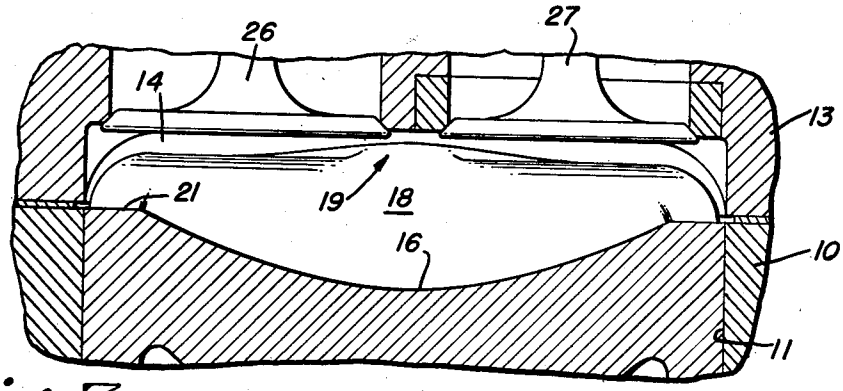


Fig. 3.

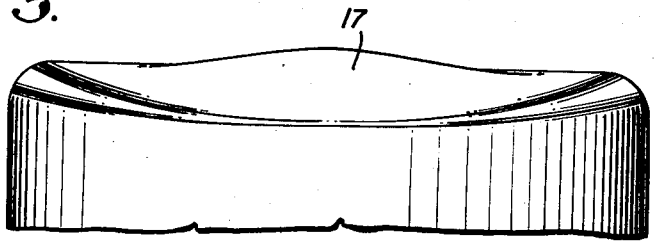
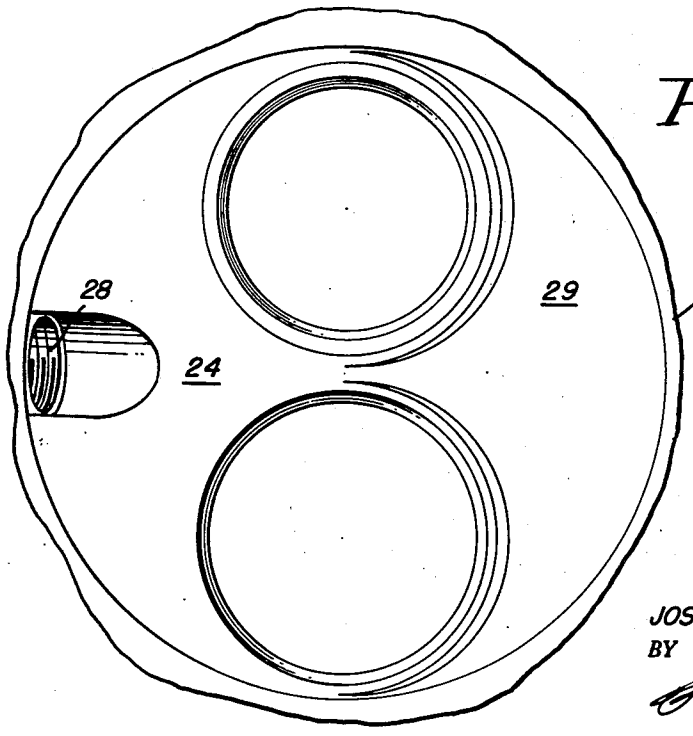


Fig. 4.

Fig. 5.



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Fig. 6.

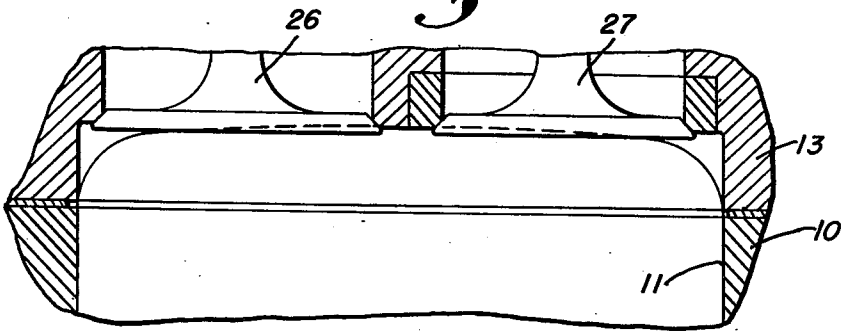
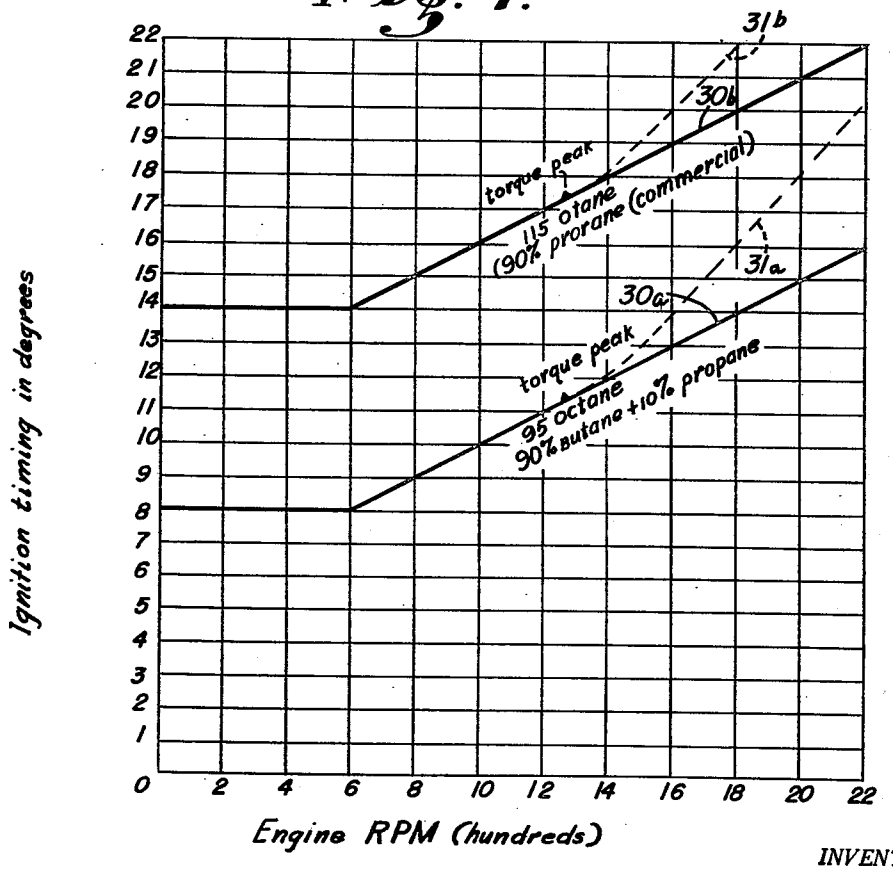


Fig. 7.



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COMBUSTION CHAMBER

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4 Claims. (Cl. 123—191)

The present invention relates generally to internal combustion engines, and is more particularly concerned with an improved combustion chamber construction for engines operating on the Otto-cycle, and by which the combustible mixture may be burned by a new and improved method.

One object of the herein described invention is to increase the compression ratio in engines of the Otto-cycle type, without producing a condition leading to detonation.

A further object is to provide an improved construction in which turbulence of the charge will be minimized immediately prior to ignition and during combustion, at elevated compression ratios, thereby conserving generated heat for useful purposes.

A further object is to provide an improved arrangement in which the dissipation of heat from the burning charge to the coolant medium will be minimized by an appreciable increase in the thickness of the wall materials of the combustion chamber, without producing detonation-prone characteristics when operating at elevated compression ratios.

A further object resides in a novel construction of the quench zone so that combustible gases therein will be displaced into the combustion zone at low velocity and with minimum turbulence, for cooling the gases ahead of the flame front in the combustion zone, thus preventing detonation at elevated compression ratios of operation.

A further object is to provide a quench zone in which curved, non-parallel wall surfaces extend from a point of minimum proximity with uniform increasing separation so as to effect movement of gases in a direction of progressive volumetric relief from said point with a minimum of velocity as the wall surfaces are relatively moved towards each other.

A still further object is to provide a quench zone which will be defined by surface areas of greater extent than is possible by the utilization of plane surfaces.

Another object is to provide a construction which will result in an appreciably lowered specific fuel consumption.

Still another object is to provide an internal combustion engine which will have a constant ignition advance rate throughout its entire operating speed range at wide open throttle.

It is also an object to provide improved apparatus which may be utilized for practicing an improved method of burning combustible mixture in internal combustion engines at elevated compression ratios, without causing pre-ignition or detonation.

Further objects of the invention will be brought out in the following part of the specification, wherein detailed description is for the purpose of fully disclosing the invention without placing limitations thereon.

Referring to the accompanying drawings, which are for illustrative purposes only:

Fig. 1 is a vertical section through a piston crown and

associated cylinder head constructed according to the present invention;

Fig. 2 is a top plan view of the piston;

Fig. 3 is a vertical section taken substantially on line 3—3 of Fig. 1;

Fig. 4 is a fragmentary elevational view of the upper end of the piston, looking in the direction of the arrow 4 of Fig. 2;

Fig. 5 is a sectional view, taken substantially on line 5—5 of Fig. 1;

Fig. 6 is a sectional view, taken substantially on line 6—6 of Fig. 1; and

Fig. 7 is a graph illustrating the constant spark or ignition advance rate throughout the entire operating range of an engine incorporating the herein described invention.

Referring generally to the drawings, for illustrative purposes there has been shown in Fig. 1 a piston-cylinder assemblage of an internal combustion engine arranged to operate on the Otto-cycle, this arrangement embodying the features of construction of the present invention.

More specifically, the arrangement comprises an engine block 10 which is fabricated to include a cylinder bore 11 within which there is positioned a reciprocable piston as generally indicated by numeral 12. The cylinder block is capped by a head block 13 which is provided with cavities 14 which are adapted to register with the uppermost ends of the cylinder bores and coact with the piston crown therein to cooperatively form a combustion chamber 15 within which a compressed combustible medium is burned to provide the operating power of the engine.

It has been determined that there are many factors which contribute to the attainment of the most desirable operating characteristics of the engine, which factors are under the control of the shaping of the combustible charge, burning rate and cooling thereof, and in the present invention the design of the combustion chamber takes into account these factors in order that the engine may be operated at considerably increased compression ratios for any given octane rating of fuel utilized, whether at high-speed or low-speed, without preignition or knock.

With more specific reference to the construction, the piston crown contour is constructed so as to have a recessed portion and a raised portion. The recessed portion is defined by a concave surface 16 which is preferably spheroidal.

The raised portion is defined by a convex surface 17 which is preferably spheroidal but may be cylindrical. The raised portion connects with the recessed portion by means of an inclined substantially diametrically extending barrier surface portion 18. It may be noted that the position of this barrier may be laterally shifted between the raised and recessed portions to compensate for different displacements as encountered in different engines. At its upper or elevated edge margin, the barrier surface 18 is carried into the surface 17 by means of a curved edge surface as generally indicated at 19, while at the lower edge margin, the barrier surface 18 is carried into the surface 16 by means of a curved surface 20. Moreover, the brim portion of the surface 16 connects with an annular extending transverse plane surface 21 having ends generally indicated at 22 and 23 which merge into the adjacent surface 18 at the ends of the barrier.

The surface 16 of the recessed portion subtends a substantially planer confronting surface 24 which is normal to the longitudinal axis of the cylinder and merges at its periphery through a curved surface 25 to form an edge wall for this portion of the head cavity 14. The recessed portion and the cavity 14 thereabove cooperate in this section of the chamber to form a combustion zone which is in communacation with a suitable inlet valve 26 and

and exhaust valve **27** for controlling associated ducts in the head block **13**. Also associated with the combustion zone is a threaded opening **28** which is positioned at a point normal to the barrier on a diameter on the opposite side of the piston crown from the raised portion. This opening is adapted to receive a suitable ignition device such as a spark plug which will ignite the combustible mixture at the shallow portion of the combustion zone, the flame front progressing towards the deeper portion of the combustion zone as it approaches the barrier surface **18**. Moreover, during this movement it will be appreciated that the cross-sectional area of the combustion zone progressively increases as the flame front moves towards the barrier.

Considering now the raised portion of the piston crown, it will be observed that the highest point of the raised portion is adjacent the barrier and that the surface is downwardly curved away from the barrier. This surface subtends a concave surface **29** in the cavity **14**, which extends from a line positioned generally above the barrier in a similar, but eccentric, curve to a point diametrically opposite the position of the axis of opening **28**. It will therefore be observed that if the surfaces **17** and **29** are spheroidal, these surfaces will have a gradually increasing spacing from the above mentioned point in two directions as the barrier is approached. On the other hand, if the surfaces **17** and **29** are cylindrical, this spacing will progressively increase in one direction only. In either construction, the surfaces **17** and **29** cooperate to form a quench zone on the opposite side of the barrier from the combustion zone. Moreover, as the piston travels towards the top of its movement, combustible medium which is in the quench zone will be moved towards the combustion zone and displaced thereinto with a minimum of velocity and turbulence so as to cool the combustible mixture and head of the flame front as it progresses towards the barrier. This action is in counterdistinction to the usual arrangement wherein the combustible mixture is injected from the quench zone at a high velocity, producing high turbulence.

It has been found that turbulent action is objectionable in that such action increases the transmission of heat energy into the surrounding wall medium and thus valuable heat is lost, whereas by utilizing low velocity and minimum turbulence, heat will be retained in the combustion zone of the chamber and thus contribute to the performance of useful work. Greater cooling of the combustible medium ahead of the flame front is likewise accomplished so that it is possible to avoid preignition and utilize higher compression ratios.

The transfer of heat to engine coolant is further inhibited in the present invention by providing wall structures of relatively greater thickness in the piston crown and cylinder head, as compared to the thin wall structures which are normally used. In the conventional constructions, the storage of heat would cause knock and preignition.

Further, in the present invention, by utilizing curved surfaces in the quench zone, instead of plane surfaces, it is possible to obtain an appreciably high proportion of cooling area to volume of conductively and pressure heated combustible medium, this ratio increasing as the piston reaches the top dead center of its movement. Also, in the event of mechanically induced aggravations of burning rate by hot spots, temporary excessive exhaust valve temperatures, etc., momentary pressure extremes are relatively cushioned. In the disclosure in Fig. 1, the position of the piston has been indicated in dotted lines at (*a*) which is the instant of ignition, and at (*b*) the mid-point of combustion, and in full lines at (*c*) which is the top dead center position of the piston.

In the operation of an engine constructed according to the present invention, it has been determined that regardless of the speed of piston travel, changes of end pressures and temperatures of the combustible mixture, the burning rate of the mixture remains relatively constant, in direct contrast to the variable burning rate of conventional combustion chambers as presently constructed. Tests conducted under compression ratios ranging from 10.0 to 1 upwards to 11.4 to 1 have revealed that the combustion chamber in the present invention remains free of detonation characteristics or indications, when utilizing fuel with octane ratings as low as 95 performance number, and while retaining constant spark or ignition advance rate throughout the entire operating range of the engine.

The constant spark or ignition advance rate is graphically illustrated in Fig. 7 wherein the ignition timing in degrees (crankshaft) before top dead center compression stroke is plotted against engine R. P. M. from test run on an engine having 5⅛" bore by 6" stroke at a compression ratio of 11.0 to 1, while utilizing 115 octane fuel (90% propane) commercial and 95 octane fuel (90% butane-10% propane). In the case of both of these fuels, it will be observed that the graph is a straight line **30***a* and **30***b* from the indicated torque peak point in each case and that artificial advance as shown in dotted lines **31***a* and **31***b* for conventional arrangements is obviated.

While the present invention has been described primarily with reference to an engine designed for operation on the Otto-cycle, the invention is susceptible of inclusion in kits for changing over the operation of Diesel engines for operation on commercially obtainable butane and propane fuels.

It is appreciated that various modifications may suggest themselves to those skilled in the art without departing from the spirit of my invention, and, hence, I do not wish to be restricted to the specific form shown or uses mentioned, except to the extent indicated in the appended claims.

I claim:

1. In an internal combustion engine: a cylinder; a piston movable in said cylinder; a cylinder head carried by said cylinder and adapted to mount an inlet valve and an exhaust valve, said cylinder head and said piston having confronting faces cooperating to define a chamber, the confronting face of said piston having a recessed portion and a raised portion interconnected by an inclined substantially diametrically extending barrier portion, said recessed portion having a curved surface subtending a substantially planar confronting surface portion of said cylinder head to form therewith a combustion zone, and said raised portion having a spheroidal convex surface subtending a spheroidal concave surface portion of said cylinder head in eccentric relation so as to form a quench zone in said chamber which is volumetrically relieved progressively from a peripheral point on a diameter normal to said barrier, towards said barrier, whereby turbulence is substantially reduced to a minimum, and means on the cylinder head for mounting an ignition device in the combustion zone diametrically opposite said peripheral point.

2. In an internal combustion engine: a cylinder; a piston movable in said cylinder; a cylinder head carried by said cylinder and adapted to mount an inlet valve and an exhaust valve, said cylinder head and said piston having confronting faces cooperating to define a chamber, the confronting face of said piston having a recessed portion and a raised portion interconnected by an inclined substantially diametrically extending barrier, said recessed portion having a curved surface area subtending a substantially planar confronting surface area of said cylinder head to form therewith a combustion zone, and said raised portion having a curved surface area subtending a curved surface area of said cylinder head to form therewith a quench zone in said chamber; and means for igniting a combustible medium in the combustion zone at a point such that a flame front will travel towards the quench zone, the surfaces of the quench zone being increasingly spaced toward the barrier so that as such surfaces are

moved towards each other gases will be displaced from the quench zone into the combustion zone at appreciably lower temperatures with low velocity and minimum turbulence to cool the gases ahead of the flame front and prevent detonation, when operating at elevated compression ratios.

3. In an internal combustion engine: a cylinder; a piston movable in said cylinder; a cylinder head carried by said cylinder and adapted to mount an inlet valve and an exhaust valve, said cylinder head and said piston having confronting faces cooperating upon movement towards each other to define a chamber having a combustion zone and a quench zone; means for mounting an ignition device in the combustion zone at a point spaced from the quench zone so that the flame front of an ignited combustible medium will travel towards the quench zone; and means for moving said medium in the quench zone towards the combustion zone with progressively relatively increasing volume, whereby the medium from the quench zone enters the combustion zone at appreciably lower temperatures and at low velocity and minimum turbulence for cooling the medium in the combustion zone ahead of the flame front therein so as to prevent preignition and detonation, when operating at elevated compression ratios.

4. An article of manufacture, comprising: an engine piston having an end face defining a recessed portion and a relatively raised portion positioned on opposite sides of an inclined barrier, said recessed portion having a concave spherical surface area terminating in a curved peripheral rim surface lying in a plane normal to the piston longitudinal axis and extending from one end of the barrier to the other, and said raised portion having a convex spherical surface area arranged with its highest point positioned substantially at the middle of an elevated edge of said barrier.

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