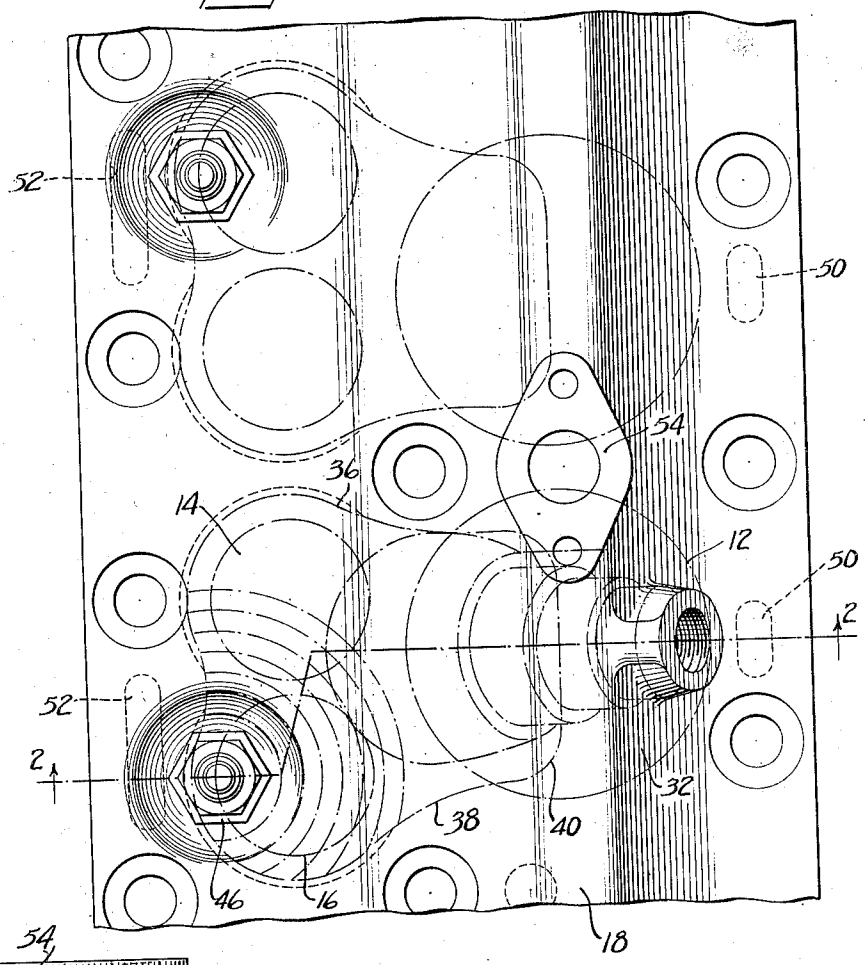
June 6, 1933. A. MOORE 1,913,310

COMBUSTION CHAMBER CONSTRUCTION

Filed June 3, 1931 2 Sheets-Sheet 1

FIG. 1.



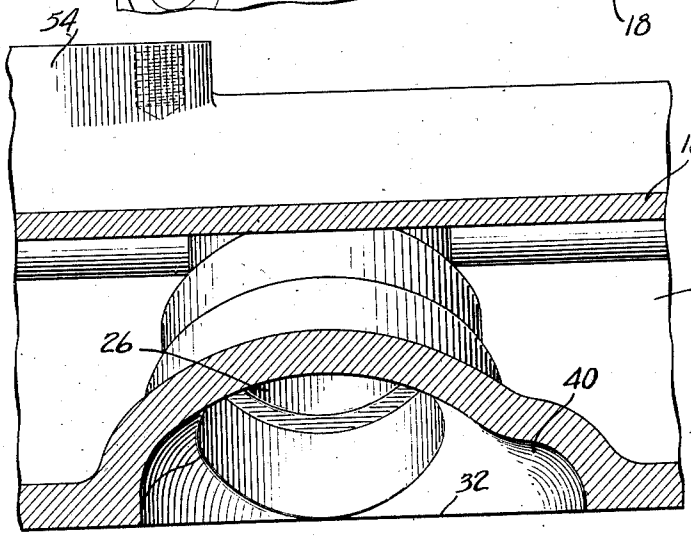


FIG. 3.

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COMBUSTION CHAMBER CONSTRUCTION

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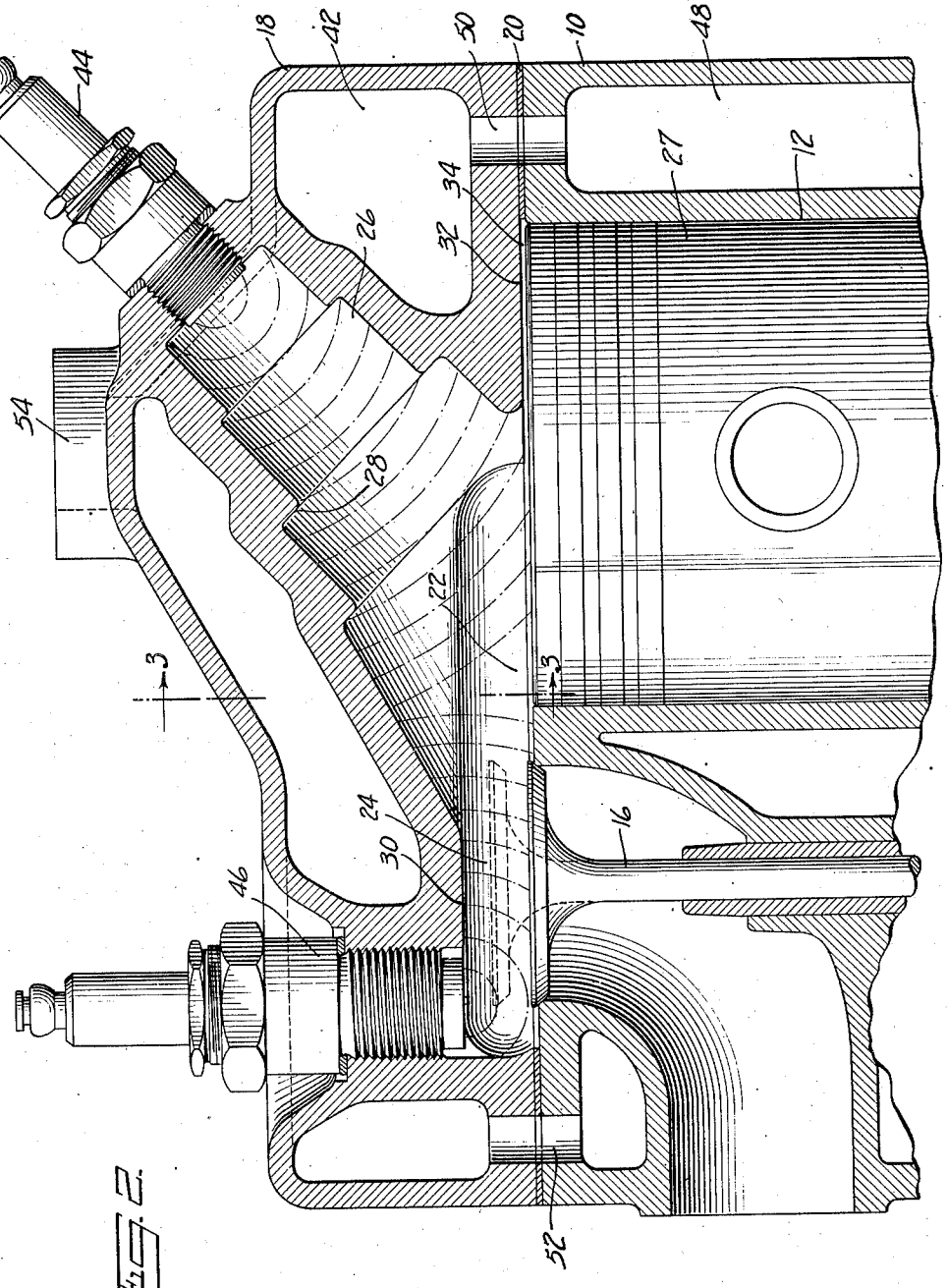


FIG. 2.

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UNITED STATES PATENT OFFICE

ARLINGTON MOORE, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO MAXMOOR CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

COMBUSTION CHAMBER CONSTRUCTION

Application filed June 3, 1931. Serial No. 541,785.

My invention relates to combustion chamber constructions for internal combustion engines, and particularly for engines having the valves in offset relation to the cylinders, such as, for example, L-head engines, and the same has for its object to provide a construction which is conducive to smooth engine operation, and which serves to reduce detonation.

Another object of the invention is to provide a construction of the character specified in which the combustion chamber is formed or shaped to control the flame propagation therein so as to prevent or retard the development of auto-ignition temperatures and pressures liable to cause detonation or roughness of engine operation.

Another object of the invention is to provide a construction of the character specified in which the combustion chamber is so formed and the ignition means so disposed therein that the flame wave propagated therein is subject to volume control and is directional relative to zones at different temperatures.

Another object of the invention is to provide a construction of the character specified in which the combustion chamber is formed so that the inflammation is initiated in a portion of the charge having a higher percentage of inert constituents or unscavenaged exhaust gases therein than other portions of the charge to retard the rate of burning and prevent undue rise of pressure and temperature.

Another object of the invention is to provide a construction of the character specified in which the combustion chamber is so formed and the ignition means so located therein that the inflammation progresses through a space increasing in cross-section.

Another object of the invention is to provide a construction of the character specified in which the combustion chamber portions are so arranged and the ignition means is so disposed therein as to cause relatively slow initial burning of one portion of the charge without undue pressure and temperature rise therein and to cause thereafter positive firing of the hottest portion of the charge before this hottest portion is unduly compressed and heated to auto-ignition temperatures by the effects of the initial flame wave.

Another object of the invention is to provide a construction of the character specified in which the combustion chamber and ignition means therein are arranged so that the portion of the charge first ignited burns relatively slowly to prevent undue initial temperature and pressure rises, so that the hottest portion of the charge is positively ignited before auto-ignition thereof by the flame wave first propagated, and so that the portion of the charge last to burn is the coolest.

Other objects will in part be obvious and in part be pointed out hereinafter.

In the accompanying drawings:

Fig. 1 is a plan of one form of combustion chamber constructed according to and embodying my said invention;

Fig. 2 is an enlarged section thereof on the line 2—2 of Fig. 1; and

Fig. 3 is a cross-section on the line 3—3 of Fig. 2.

Referring to the drawings, the cylinder block 10 is illustrated as of the standard L-head form, with the cylinder bores 12, and inlet valve 14 and exhaust valve 16 disposed laterally of each cylinder bore, and arranged in a right line so as to be operated from the usual cam shaft located low down in the engine alongside of the crank shaft and driven directly therefrom.

The hollow water containing cylinder head 18 is disposed upon the cylinder block with the usual gasket 20 therebetween, the cylinder block and cylinder head forming a combustion chamber 22 therebetween of predetermined compression ratio or clearance volume.

The fixed portion 24 of the combustion chamber overlying the valves is of reduced uniform depth, preferably of a depth which is minimum for allowing full opening movement of the valves, and the volume of such portion or part 24 is the minimum required to receive both valves and allow the opening thereof, the cross-sectional area thereof in the direction of charge flow approximating as far as practical the cross-section of

the passage at the outside of the intake valve 14.

The reduction in volume of the part 24 of the combustion chamber above the valves is compensated for to provide a predetermined clearance volume or compression ratio by enlarging the portion or part 26 of the combustion chamber above the piston 27, the enlargement being provided in the cylinder head 18. As illustrated, the enlargement 26 is formed as a conical recess or canyon, preferably of step formation, as indicated at 28, and increasing in cross-sectional area from the upper end thereof towards the piston. The axis of the cone or canyon is preferably tilted from the vertical about 45° and forms an obtuse angle with the portion 24 of the combustion chamber.

The part 24 of the combustion chamber is preferably formed as a recessed portion 30 in the cylinder head 18 extending over a portion of the piston contiguous to the valves, the canyon 26 merging with said recessed portion 30. Beyond the portion 30 the cylinder head 18 is formed as a flat portion 32 of reduced elevation lying substantially at the plane of the gasket 20 and extending over the remaining and major portion of the piston 27 and forming with the piston in the top dead center thereof a highly constricted combustion chamber space 34. The charge portion in this space 34 is coolest because of the relatively large surface exposed to water circulation compared to the volume.

As shown more clearly at Fig. 1 the vertical wall 36 at the outer side of the intake valve 14 has a stream line contour serving to facilitate flow of the charge into the cylinder, and the vertical wall 38 at the outer side of the exhaust valve 16 has a streamline contour for facilitating the flow of the exhaust gas in the opposite direction towards said exhaust valve. The vertical water-backed wall 40 of the recess 30 laterally of the canyon 26 above the entrance to the portion 34 is preferably vertical and flat so that the portion of the charge entering the restricted space 34 is subjected to a greater cooling effect by impact with such straight wall, a scrubbing action probably being produced thereby which promotes absorption of heat by the water backed wall.

The water cooling or circulating system of the construction embodying my invention is also productive of improved results in assisting to reduce detonation and to insure smoothness of engine operation. As shown, the water containing space 42 in the cylinder head 18 entirely surrounds the canyon 26, the stepped formation also increasing the heat absorbing surface relative to the volume thereof. A spark plug or ignition means 44, amply air cooled, is located at the apex of the cone 26.

A second spark plug 46 is located, as hereinafter described, contiguous to the exhaust valve 16 where the charge is hottest. The inner end of the plug 46 is likewise surrounded by the water containing space 42. Passage of water from the water containing space 48 in the cylinder block to the cylinder head space 42 is allowed through the openings 50 and 52, the opening 50 being located close to the chamber portion 34 and the cone 26, and the opening 52 being located close to the exhaust valve 16 and the spark plug 46, whereby to render the cooling more effective by passage of the water from the cylinder block to the space 42 in the region of the portions it is desired to particularly cool. The water passing through the passages 50 and 52 into the space 42 is preferably vented at the top through multiple outlets 54, one outlet being preferably associated with each pair of cylinders and being located centrally relative to the passages 50 and 52 associated with said cylinders. The water about each cone 26 tends to pass out through the contiguous outlet 54 instead of passing through the entire cylinder head to the radiator. The several outlets 54 may be connected to a common manifold for passage to the radiator. By this arrangement the several combustion chambers are more evenly cooled, and the formation of steam pockets is prevented.

The spark plug 44 is arranged to fire slightly before the spark plug 46 fires. The rate of initial burning is controlled by placing the spark plug 44 in the most constricted portion of the chamber portion 26. The percentage of residual gases contained therein is greater than elsewhere in the combustion chamber, so that the rate of burning is slower here. The canyon 26 also increases in cross-section, preferably abruptly or in steps, so as to physically control the flame propagation by expansion of the flame front, thereby decreasing the tendency to detonate. The extensive water backed wall surface of the cone by keeping the temperature lower also tends to reduce detonation.

Towards the exit of the canyon 26 the volume increases substantially, this intermediate portion of the combustion chamber having the maximum volume. As the flame wave reaches this point the secondary plug 46 fires the charge in the chamber portion 24, inflammation due thereto beginning at the exhaust valve 16 which is the hottest portion of the combustion chamber containing the hottest and driest portion of the charge.

The spark plug 46 is located intermediate the exhaust valve 16 and the contiguous vertical wall portion as close to the exhaust valve as possible. With the plug 46 in this position the charge is fired thereby at the most remote point from the portion of maximum volume, thereby preventing adiabatic compression of the charge in the hot pocket

at this point, and also insuring that the hottest portion of the charge is fired before the coolest portion in the combustion chamber portion 34 burns. By firing the charge portion in part 24 by means of the plug 46 before the inflammation from plug 44 reaches the same, undue compression of this charge portion by the flame wave from plug 44 is prevented, thereby reducing the tendency to auto-ignition. The use of two plugs at spaced points is advantageous also, irrespective of their firing order, because the flame is thus propagated to the entire charge in about one half the time.

By initiating the inflammation at the plug 44 the burning and flame wave acceleration are retarded, and excessive initial temperature and pressure rises are prevented, reducing the tendency of remote portions of the charge to be adiabatically compressed to cause auto-ignition and detonation. The prevention of detonation is also promoted by causing the plug 46 to fire the charge in the relatively constricted space of the chamber portion 24, the inflammation from both plugs progressing into an intermediate enlarged space, and the cool portion of the charge in the remote restricted space 34 being made the last to burn.

The spark plugs 44 and 46 are operated by the usual distributor with the breakers thereof adjusted in width of gap to cause a difference in timing.

The residual gases contained in the flame canyon 26 are adequately cooled by the liberal surface contact provided compared to the volume of the canyon. When the inflammation begins therein the presence of these inert gases exert an influence in retarding the flame wave acceleration. Because of the flame retarding effect of the inert gases the ignition timing of the plug 44 can be slightly advanced, if so desired, over that for ordinary combustion chamber constructions.

During engine idling and low fractional load operation the percentage of residual gases present in the combustion chamber is greater, and the plug 46 is principally relied on to fire the charge should the primary plug 44 be unduly blanketed or insulated by the inert gases and fail to fire. The same would also apply at high speeds when the pressure reduction in the intake manifold is high.

The angular disposition of the flame canyon 26 allows the formation of a cylinder head of not undue depth capable of supporting the common water manifold, and the distributor and ignition arrangements, and insuring proper cooling and water circulation. With the canyon 26 disposed at an angle to the cylinder the inflow of the charge and the outflow of the exhaust gases is more or less tangential to the space 26 thus minimizing turbulent effects, the inclined arrangement being particularly advantageous on the exhaust stroke to prevent such turbulent action which is liable to cause the exhaust gas to unduly heat the parts.

The spark plugs as located are less liable to have the points thereof become incandescent and deteriorate. Inasmuch as the plug 46 is particularly relied on at idling, the timing thereof is preferably adjusted for efficient operation at idling, while the timing of the plug 44 is preferably adjusted for efficient operation at the higher powers, the two timings, of course, being maintained so related that the plugs fire in sequence as above described.

In operation, the charge mixture in a homogeneous state is admitted into the combustion chamber upon the intake stroke, and travels at high velocity through the relatively highly constricted portion 24 to the cylinder, thereby preventing expansion of the charge and such cooling thereof as to render the mixture unduly heterogeneous because of fuel precipitation and more likely to cause detonation. The exhaust gases for the same reason pass out at high velocity upon the exhaust stroke. As the charge enters the cylinder the same mixes with the residual exhaust gases, the portion of the charge in the cone 26, according to my theory of operation, having a higher percentage of exhaust gases therein than the remaining portion of the charge.

Upon ignition, by plug 44, with the piston approaching top dead center position, the burning is relatively slow, and the flame wave is expanded as it progresses through the cone portion 26, thereby preventing undue initial pressure and temperature rises liable to cause detonation. Before the flame wave from plug 44 reaches the hottest portion of the charge in the chamber portion 24 the plug 46 fires so as to prevent auto-ignition of the charge portion in part 24 due to the compressing effect of the first flame wave, and to insure that this hottest portion of the charge burns before the charge portion in chamber part 34 burns, which last charge portion is the coolest and is the last to burn.

In my invention, the space 24 between the valves and the cylinder head is confined in depth to that for proper valve opening irrespective of the total clearance volume (or compression ratio) of the combustion chamber, the remaining space necessary for obtaining a given clearance volume being formed above the piston. That is to say, for a given clearance volume, in the absence of the cone 26, the depth of the portion 24 would have to be greater. By my invention, therefore, the desired clearance volume is obtained, while providing a non-compact form of combustion chamber for the volume control of the flame propagation to reduce detonation.

The invention enables the use of small clearance volumes or high compression ra-

tios, even when fuels less volatile than gasoline and more liable to detonate are used, while effectively reducing detonation. This is effected by insuring that the charge entering the cylinder is homogeneous and is maintained homogeneous, by differentially controlling the cooling of the charge, without too much cooling, by forming the combustion chamber non-compactly for volume control so that the inflammation is initiated in relatively restricted portions of the combustion chamber and is allowed to expand through enlarging intermediate portions thereof, by retarding the inflammation to cause relatively slow initial burning and pressure rise, as by initiating the inflammation in a cooler portion of the charge containing a higher percentage of inert constituents, by separately firing the hottest portion of the charge in chamber part 24 before the initial flame wave compresses such charge portion to cause auto-ignition thereof, and by causing the coolest portion of the charge in chamber part 34 to burn last, the several effects mutually cooperating to produce smooth engine operation and prevent detonation.

Having thus described my invention what I claim and desire to secure by Letters Patent is:

1. In an internal combustion engine, portions forming a combustion chamber of the offset head type, the ceiling of said combustion having a recess therein increasing in cross-section towards the piston and having the axis thereof disposed at an inclination.

2. In an internal combustion engine, portions forming a combustion chamber of the offset head type, said combustion chamber including a part in offset relation to the piston, and a part increasing in cross-section towards the piston and having the axis thereof inclined downwardly towards the offset part of the combustion chamber.

3. In an internal combustion engine, portions forming a combustion chamber of the offset head type including a recess in the ceiling thereof increasing in cross-section towards the piston and having the axis thereof disposed at an inclination, and ignition means disposed in said recess contiguous to the apex thereof.

4. In an internal combustion engine, portions forming a combustion chamber including a part in offset relation to the piston, and a part at an angle to the offset part, and ignition means disposed in each of said parts.

5. In an internal combustion engine, portions forming a combustion chamber including a part in offset relation to the piston, and a part at an angle to the offset part, and ignition means disposed in each of said parts, said ignition means being arranged to fire in succession.

6. In an internal combustion engine, portions forming a combustion chamber including a part of reduced depth in offset relation to the piston and a conical part having the axis thereof disposed at an inclination relative to said reduced part.

7. In an internal combustion engine, portions forming a combustion chamber of the offset head type including a part disposed in offset relation to the piston and containing the exhaust valve, and a part forming a pocket for residual exhaust gases, a spark plug disposed in said offset part, and a spark plug disposed in said pocket.

8. In an internal combustion engine, portions forming a combustion chamber of the offset head type including a part disposed in offset relation to the piston and containing the exhaust valve, and a part forming a pocket for residual exhaust gases, a spark plug disposed in said pocket, a spark plug in said offset part, the spark plug in said pocket being arranged to fire before the other spark plug fires.

9. In an internal combustion engine, portions forming a combustion chamber of the offset head type including a part contiguous to the valve forming a shallow pocket, a more constricted part at the opposite side of the combustion chamber over the piston, and an enlarged intermediate part, and ignition means in said intermediate part at the remote end thereof.

10. In an internal combustion engine, portions forming a combustion chamber of the offset head type including a part of reduced depth contiguous to the valves, a more constricted part at the opposite side of the combustion chamber over the piston and an enlarged intermediate part, and spark plugs in said reduced and intermediate parts.

11. In an internal combustion engine, portions forming a combustion chamber of the offset head type including a valvular part having a volume approaching the minimum required for allowing full valve opening movement and serving to maintain high velocity of charge flow, and a part disposed at an angle to said first named part and increasing in cross-section towards the same.

12. In an internal combustion engine, portions forming a combustion chamber of the offset head type including a valvular part forming a shallow pocket, a highly constricted part at the opposite side of the combustion chamber over the piston, and an intermediate part disposed at an angle to said first named parts and increasing in cross-section towards the same.

13. In an internal combustion engine, portions forming a combustion chamber of the offset head type including a valvular part forming a shallow pocket, a highly constricted part at the opposite side of the combustion chamber over the piston, and an inter-

mediate part disposed at an angle to said first named parts and increasing in cross-section towards the same, and ignition means in said valvular part and said intermediate part.

14. In an internal combustion engine, portions forming a combustion chamber of the offset head type including a part contiguous to the exhaust valve forming a shallow pocket, a more constricted part at the opposite side of the combustion chamber having a relatively large surface compared to the volume thereof for rendering the portion of the charge therein the coolest in the combustion chamber, and an intermediate part forming an angle with the first named parts and increasing in cross-section towards the same, said intermediate part forming a pocket for residual gases, a spark plug in said shallow pocket contiguous to the exhaust valve, and a spark plug at the apex of said intermediate part.

15. In an internal combustion engine, portions forming a combustion chamber of the offset head type, the ceiling of said combustion chamber having a recess of step formation therein increasing in cross-section toward the cylinder block and having the axis thereof disposed at an inclination.

16. In an internal combustion engine, portions forming a combustion chamber of the offset head type, the ceiling of said combustion chamber having a conical recess therein, having the axis thereof inclined substantially 45° from the vertical.

17. In an internal combustion engine, portions forming a combustion chamber of the offset head type, the ceiling of said combustion chamber having a conical recess therein, having the axis thereof inclined substantially 45° from the vertical, said conical recess forming an obtuse angle with the part of the combustion chamber contiguous to the valves.

In testimony whereof, I have signed my name hereto.

ARLINGTON MOORE.