

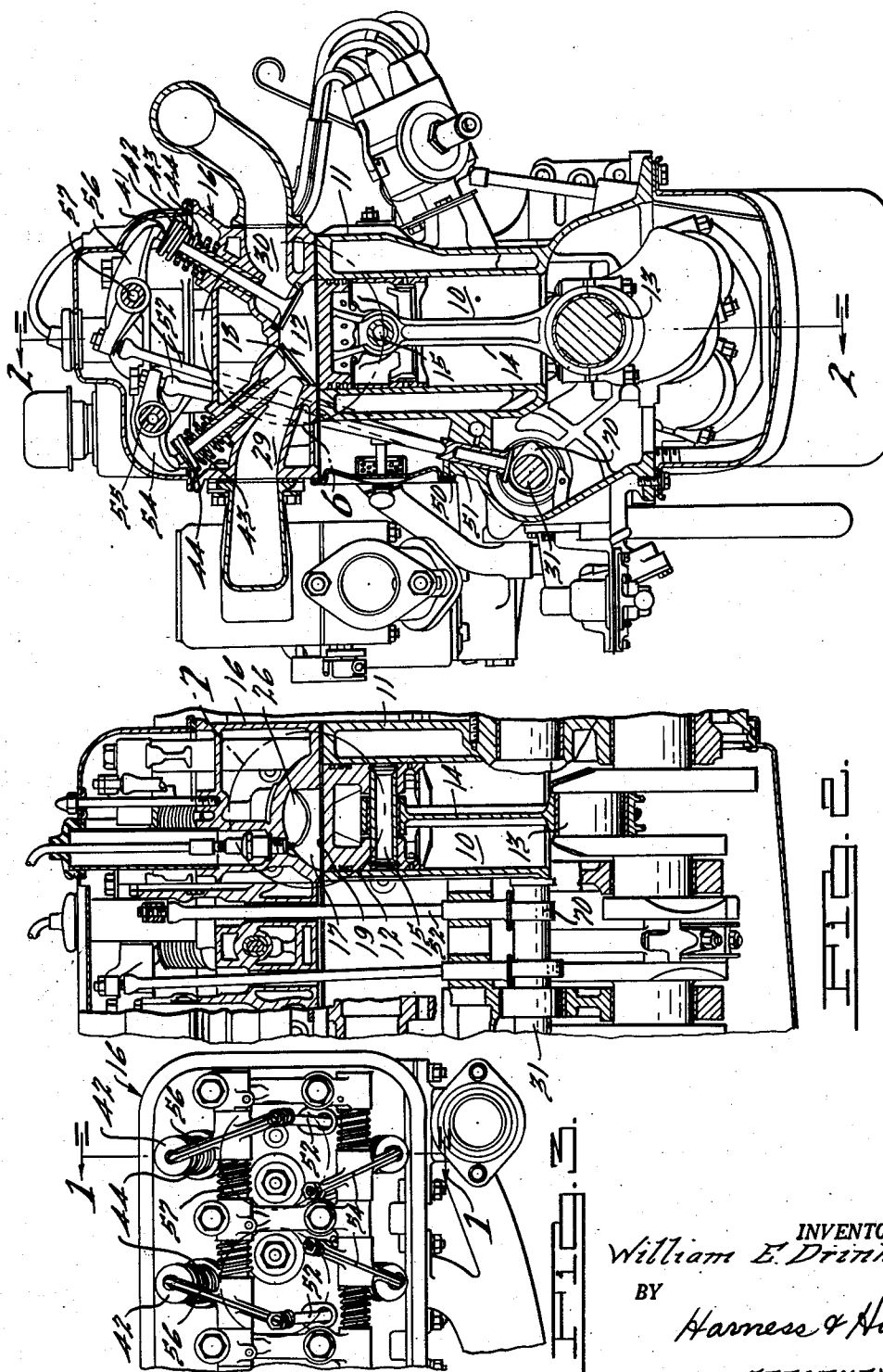
Feb. 16, 1954

W. E. DRINKARD
OVERHEAD VALVE ENGINE

2,669,227

Filed April 15, 1950

4 Sheets-Sheet 1



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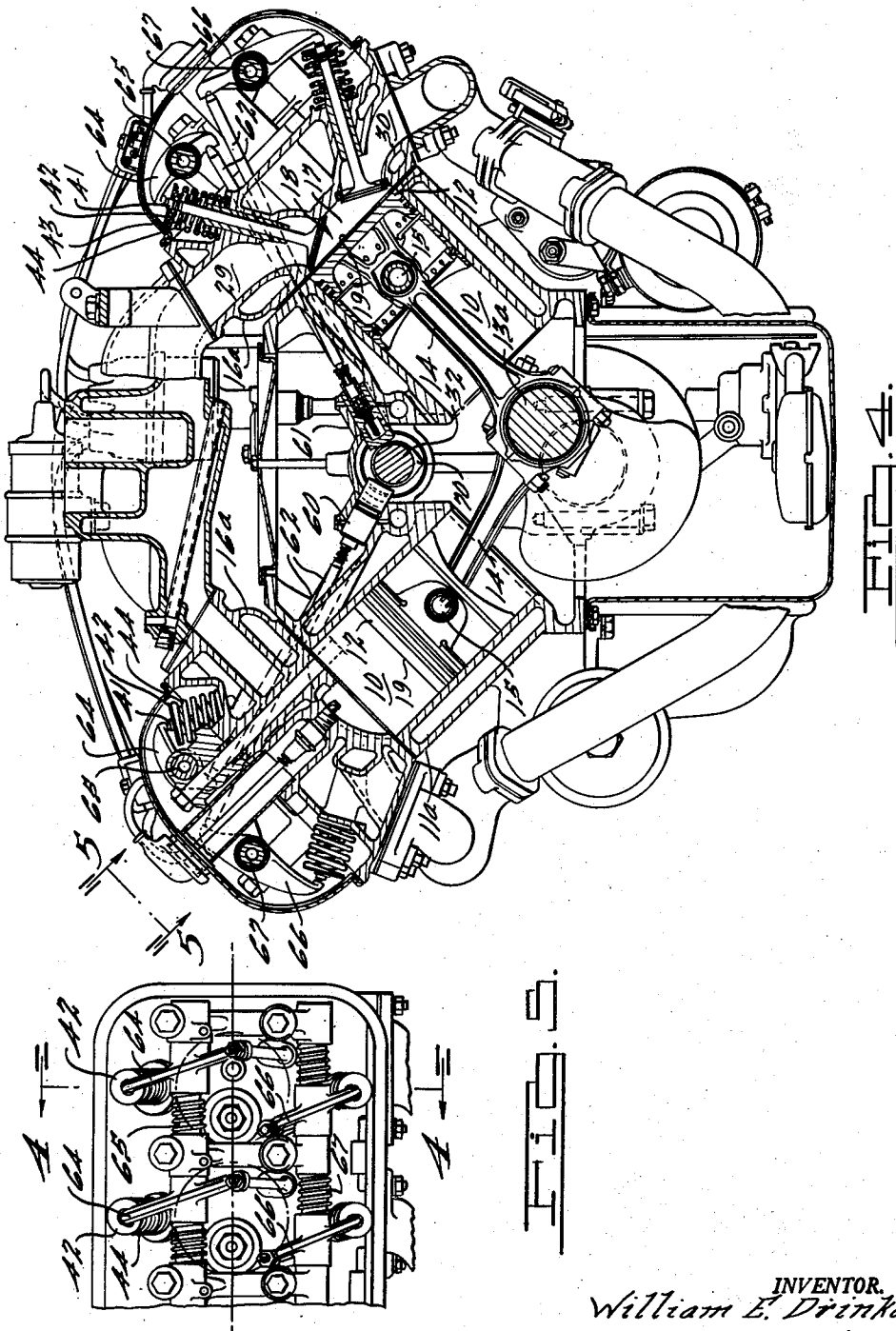
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OVERHEAD VALVE ENGINE

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4 Sheets-Sheet 2



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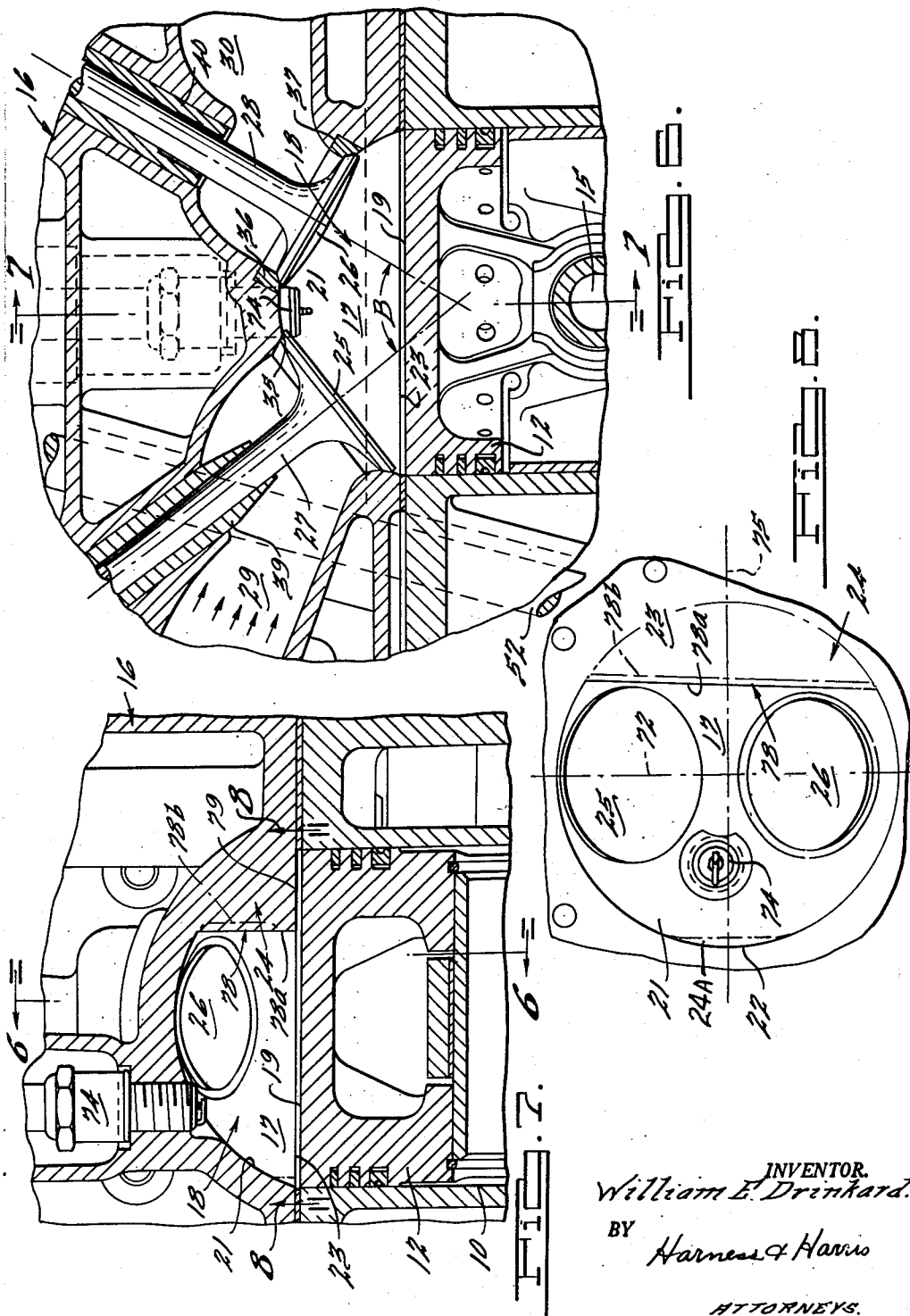
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4 Sheets-Sheet 3



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4 Sheets-Sheet 4

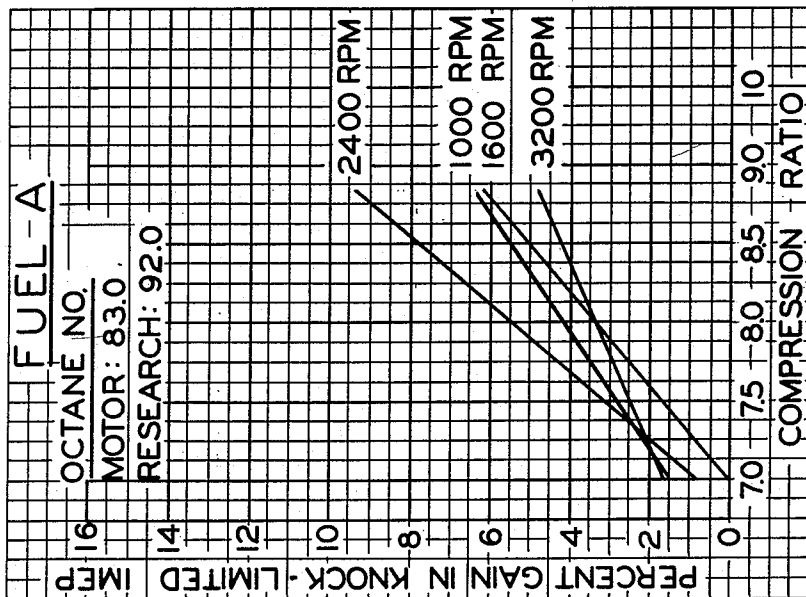


FIG. 10.

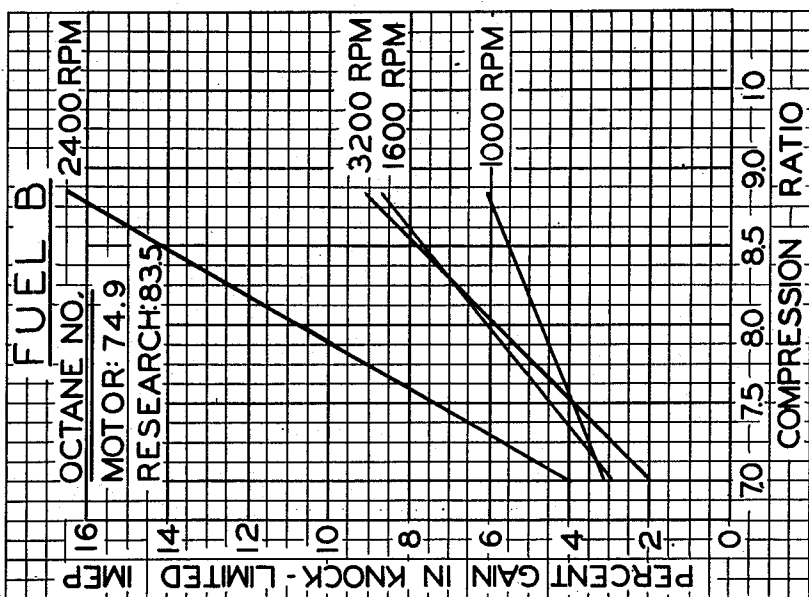


FIG. 11.

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UNITED STATES PATENT OFFICE

2,669,227

OVERHEAD VALVE ENGINE

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Application April 15, 1950, Serial No. 156,215

11 Claims. (Cl. 123—55)

1

This invention relates to internal combustion engines. More specifically the invention concerns improvements in engines of the so-called "overhead" valve type.

It is known that the power of overhead valve engines depends upon many factors such as the thermal and volumetric efficiency of the engine. Moreover, that the maximum compression given the gaseous fuel mixture short of detonation or pre-ignition has a decided effect upon the first of these factors. Numerous attempts have been made to increase the compression ratio of the engine in order to improve the efficiency. However, detonation problems are encountered in these attempts and unless solved, limit the possible improvement. In this connection the general procedure heretofore followed for detonation control is the use of special fuels of high octane rating. The reason for this procedure possibly is best explained by the belief that other steps thought useful for controlling detonation, for example, spark retarding and combustion space shaping, have more often than not been directly responsible for power losses or have contributed largely thereto in the particular engine structures wherein they were employed.

Although the above procedure using fuels of high octane number to combat detonation have met with considerable success, the use of these more costly fuels adversely affects operating costs. Moreover, experience, it is believed, has shown that manufacturers inevitably push the compression ratios beyond the limit of the octane number of available commercial fuels and hence as fuels of still higher octane number are developed, detonation may still be expected to be a problem.

I have discovered that to obtain maximum knock-limited output with a given fuel the highest thermal and volumetric efficiencies are desirable. One essential in this regard is to get the maximum amount of air into the combustion chamber. I have found that an engine provided with a cylinder head which I will hereinafter refer to as a penthouse cylinder head, that is to say a head whose combustion cavity is of the shape of a spherical segment of a single base and which head has a single angularly disposed inlet valve and a single angularly disposed exhaust valve forming a substantial angle i. e., a wide angle to each other, particularly lends itself to satisfying this requirement.

Accordingly, it is an object of my invention to improve the maximum knock limited output of an overhead valve engine by the use of a penthouse cylinder head.

2

I have further found that by modifying the combustion space of such a penthouse head in a particular manner and preferably within certain limits, which I will hereinafter set forth as a guide, it is possible to substantially satisfy knock problems arising and secure a higher knock-limited output on a given fuel, especially a low octane fuel, than has heretofore been possible. As a result of this discovery I have been able to utilize so-called knocking fuels at compression ratios heretofore believed to require a non-knocking or high octane numbered fuel, and I have also been able to operate the engine with such knocking fuels at a minimum of ignition retard with resulting improvement in power and efficiency.

Thus if the combustion cavity of the penthouse head be provided with the ignition means at one side of a plane containing the valve axes and the spherical cavity be modified to provide a detonation control portion or area in the form of a single contraction or overhang adjacent the farthest portion of the flame travel or stated otherwise, at the far side of the cavity from the ignition means, and which preferably comprises a side induction turbulence control face and a bottom quench face, the knock characteristics of the engine may be improved to an extent permitting the use of knocking type commercial fuels coupled with a minimum spark retard, and providing a higher knock-limited performance on such fuels than that provided by a similar engine having an unmodified cavity. I have found that where improvement in power and economy is desired, care must be taken to limit the quench area to an amount that will not reduce the volumetric efficiency of the engine significantly below that of an unmodified head. Moreover, the extent to which knock limited power will improve is believed to depend upon the stroke-bore ratio of the engine. Satisfactory results are believed possible with stroke-bore ratios of about 0.85 and greater but test operations indicate that best results may be expected when this value is about 1.0 and greater. Hence stroke-bore ratios of about 1.0 and greater are preferred.

It is therefore, another object of my invention to provide a suitable engine structure including means for minimizing the octane number requirement for a given compression ratio.

A further object is to provide an engine structure giving equal or improved knock-limited power output as compared to engines of the same and even greater compression ratios and by the use of a fuel of lower octane number.

An additional object is to provide in an overhead valve engine a cylinder head construction of modified penthouse form permitting the use of lower octane numbered fuels at higher compression ratios than thought normally possible and with resulting gain in power and economy.

Another factor contributing to maximum efficiency is the relationship of the aforesaid lateral or side turbulence face of the penthouse head cavity to the edge of the valve openings especially around the intake valve. This is somewhat critical in relation to volumetric efficiency and induction turbulence. In order to obtain as large a quench area as possible without interfering with volumetric efficiency and breathing, it has been found desirable in general to employ a detonation control portion, the lateral face or plane of which, especially in the area immediately adjacent the quench face, approaches a plane tangent to the periphery of the two valves. Preferably the lower edge of the face should be brought as close as possible to the tangent plane of the valves. For best results a distance of $\frac{1}{16}$ " or less is preferred. If this distance is greatly exceeded quench area and induction turbulence control is lost and knock limited performance is adversely effected.

It is therefore, another object of my invention to provide in an engine of the type described, the highest knock limited power output by utilizing a modified penthouse head and arranging the lateral face of the detonation control area thereof as close as possible to the intake and exhaust valves without substantial interference with the volumetric efficiency of the engine.

I have additionally observed that in my improved overhead valve penthouse head engine employing the above method of detonation control and a flat top piston, the distance to the top of the piston from the quench face at top dead-center, should preferably be in the order of .015" to .080" and that if this distance is greatly exceeded, the engine operation will then approach that of an open cylinder head with resulting detonation.

Hence it is still another object of my invention to provide in combination in an overhead valve engine having a penthouse cylinder head, a detonation control area, a flat-top piston, and close clearance between the top of the piston and the quench face of the detonation control area at top dead-center position of the piston.

I have also discovered that by employing an overhead valve engine with my penthouse head and arranging the valves transversely of a plane containing the axis of the cylinders, a single valve operating camshaft becomes feasible. Moreover, a higher volumetric efficiency is possible because the wide angle valve arrangement permits the use of larger valves and permits the valve stems to be arranged as near as possible to the direction of the manifolding to minimize turns and corners for the air-fuel mixture to follow. These latter features in combination with the detonation control feature mentioned above and the use of a flat-headed piston results in an engine having a high knock limited output.

Accordingly, it is an important object of my invention to provide a multi-cylinder modified penthouse overhead valve engine as aforesaid employing flat-headed pistons and wherein the valves are arranged transversely of a plane containing the cylinder axes.

Finally, it is a specific object of my invention to provide an engine employing all the above features in combination to secure maximum thermal

and volumetric efficiencies, maximum knock limited performance on a given fuel and a commercially feasible construction.

I have also discovered that it is possible to increase the compression ratio of an engine having a penthouse cylinder head by using a substantially flat top piston and reducing the clearance volume of the combustion chamber through filling in the head cavity by the above described detonation control means and/or by removing material from the bottom face of the head at the junction of the faces of the head and cylinder bore, all this being possible without a major tool change, extensive changes in operation parts, or impairment of thermal efficiency such as results where a crowned piston is employed to reduce the clearance volume.

It is therefore another object of my invention to provide a method of increasing the compression ratio of an engine without resort to extreme tool operations, changes in operating parts, or modification or basic change in the head structure and to provide a head structure making this method feasible.

Further objects and advantages of my invention will be more apparent as this specification progresses, reference being made to the accompanying drawings in which:

Figure 1 is an end elevational view partly in section of a 6-cylinder overhead valve-in-line engine embodying my invention, the cylinder head and bore showing being a section approximately taken on the line 4—4 of Figure 3;

Figure 2 is a fragmentary longitudinal elevational view, partly in section, of an end portion of the engine of Figure 1, the section through the cylinder head, bore and ignition wall being taken approximately on the line 2—2 of Figure 1;

Figure 3 is a fragmentary plan view of an end portion of the engine of Figure 1, the cylinder bores shown in phantom and the rocker mechanism cover being removed to show the rocker arm, valve, and ignition arrangement;

Figure 4 is an end elevational view partly in section of an 8-cylinder V-type overhead valve engine embodying my invention, the cylinder head and bore showing being a section approximately on the line 4—4 of Figure 5;

Figure 5 is a fragmentary plan view of the engine of Figure 4 taken in a direction of the arrows 5—5 of Figure 4 with the rocker mechanism cover removed to show the rocker arm, valve and ignition arrangement of a single bank of cylinders, the cylinder bores being shown in phantom.

Figure 6 is an enlarged typical showing of the construction of the cylinder head cavity, valve ports, and piston of the engine of Figures 1 and 4, this view being specifically an enlargement of that portion of Figure 1 within the dot and dash circle inscribed thereon and also being a section taken on the line 6—6 of Figure 7;

Figure 7 is a sectional elevational view taken on the line 7—7 of Figure 6 showing the arrangement of ignition means and detonation control structure in the cylinder head cavity, this view being also an enlargement of a portion of a cylinder and head of the engine of Figure 2 within the dot and dash circle inscribed thereon;

Figure 8 is a plan view of the cylinder head cavity of Figures 6 and 7 looking in the direction of the arrows 8—8 of Figure 7; and

Figures 9 and 10 are graphical presentations of data giving some indication of the improvements in performance possible by the use of my invention.

Referring now to the drawings wherein similar numerals are used to designate similar parts of the structure, I have for purposes of exemplification only, illustrated my invention as applied to either a V-type or line engine. Each engine has a plurality of side-by-side cylinder bores 10 formed in their respective cylinder blocks 11, Figures 1 and 2, and 11a, Figure 4. The engine of Figures 1, 2, and 3 comprises a line of 6 cylinders, of which only one is shown in section and that in Figures 4 and 5 comprises two angularly-arranged banks of four cylinders each. Each cylinder is provided with a reciprocating piston 12 for actuating a crankshaft 13, Figure 1, 13a, Figure 4, through a connecting rod 14 and a wrist-pin 15.

The engine of Figure 1 has a cylinder head 16 and that of Figure 4 a cylinder head 16a, each being in the form of a casting bolted to their respective cylinder blocks 11 and 11a, in the usual manner. Each head has a combustion cavity 17 directly opposite each cylinder bore and which forms a combustion chamber 18 with the upper face 19 of the piston 12, the latter being shown in top dead-center position in Figures 6 and 7.

The form of the combustion chamber 18 is an important feature of my invention. In this connection, I have found that the benefits of my invention are best obtained if the combustion chamber 18 of each cylinder be provided by an engine having a penthouse cylinder head and in which the fuel-air mixture is compressed by a piston which in the present invention preferably has its upper face 19 substantially flat.

Thus, I have provided, especially as shown in Figures 6, 7, and 8, a cylinder head combustion cavity 17 of dome-like character directly opposite the upper end of the cylinder bore 10 and defined by a substantially continuous spherical surface or wall 21 which rises from and returns to the generally circular perimeter 22 of the cavity lying in a plane containing the mounting face 23 of the cylinder head and which cavity 17, except for a detonation control portion generally designated by the numeral 24, which will hereinafter be more specifically adverted to, basically conforms substantially to the shape of a spherical segment of a single base having said mounting surface as its base and is substantially coincident with the cylinder bore 10.

Moreover, as shown, the combustion cavities 17 are each preferably provided with a single inlet valve 25 and a single exhaust valve 26 arranged transversely of the longitudinal axis of the cylinder head or bank of cylinders, that is to say, transversely of a plane containing the axes of a row or bank of cylinders and also preferably arranged at a substantially wide angle β to each other on a great arc of the spherical segment. This angle β will preferably be as large as possible consistent with adequate valve size and preferably not less than about 60°. A good range is between 60° to 100°. Thus the valves in Figures 1, 4, and 6 preferably lie in a plane containing the axes of the cylinder bore 10 and the cavity 17 formed by the spherical segment. Moreover, the valves in Figures 1 and 6 form an angle β of 69° for a stroke bore ratio of 1.15 whereas the valves of Figure 4 form an angle of 60° for a stroke of 0.91, the amount in excess of 60° generally depending upon and being increasable with the stroke bore ratio of the engine.

The aforesaid arrangement of the valve is particularly advantageous from the standpoint of volumetric efficiency in that it permits a maxi-

imum quantity of air to be admitted to the combustion chamber 18 and permits the shanks 27, 28 of the inlet and outlet valves, respectively, to be arranged more nearly to the direction of the manifold conduits 29, 30 than would otherwise be feasible. This is particularly important of the inlet valve 25 and it will be noted from Figure 6 that the stem 27 of the inlet valve 25 is arranged as closely as possible to the direction of flow of the fuel-air mixture in the inlet manifold conduit 29 to thereby avoid making the fuel-air mixture move around sharp or short bends.

The disclosed valve arrangement also facilitates the use of large valves. Moreover, it allows sufficient latitude in the positioning of the inlet and exhaust valve members to make possible operation of both valves from a single camshaft 31 in Figure 1, 32 in Figure 4, located as high as possible above the crankshaft 13, while at the same time permitting a practical drive connection (not shown) between the crankshaft and the camshaft, a suitable rocker arm design, and operating clearance between the push rods and cylinder walls with a minimum center distance between adjacent cylinders. In this connection it will be observed that in Figure 1 the exhaust valve 26 forms a slightly smaller angle with the vertical than does the inlet valve 25, such being preferable in this embodiment to avoid the use of exceedingly long rocker arms for operating the exhaust valves and to make feasible operation of both valves from a common camshaft.

The inlet valve 25 is served by the inlet manifold conduit 29 while the exhaust valve 26 is associated with the exhaust manifold conduit 30 which conducts exhaust gases from the combustion chamber. As seen in Figure 6, the inlet valve 25 operates directly against a seat or port 35 formed on the spherical surface 21 of the cylinder head at the outlet of the inlet manifold 29 whereas the exhaust valve 26 which incidentally is a smaller valve than the inlet valve 25 operates against a hardened heat resisting inserted seat or port 36 mounted in a shoulder 37 machined in the spherical surface 21 of the cylinder head at the entrance of the exhaust manifold 30.

The valve stems 27, 28, respectively, are slidably journaled in bushings 39, 40, respectively, mounted in the cylinder head. Fixed to the upper ends 41 of the valve stems as seen more clearly in Figures 1 and 4, are collars 42 beneath which are double concentric compression springs 43, 44 serving to normally maintain these valves in closed position.

The valves of each engine are operated by the camshafts 31, 32 thereof through suitable tappet and push rod arrangements, two forms of construction being here exemplified. Thus in the engine of Figure 1 there is associated with the camshaft 31 conventional tappets 50 which are slidably journaled in lateral bearing portions 51 integral with the cylinder casing 11. These tappets are operably connected through suitable push rods 52 with short inlet valve rocker arms 54 journaled on a rod 55 and long exhaust valve rocker arms 56 journaled on a rod 57. In the Figure 4 engine suitable hydraulic tappets 60 are slidably journaled in the hollow central portion 61 of the cylinder casing 11a and operably communicate through push rods 62 with short inlet valve rocker arms 64 journaled on a rod 65 and long exhaust valve rocker arms 66 journaled on a rod 67.

It will be observed that in each arrangement the push rods 52, 62 respectively, communicate with the short lever portions of the rocker arms

and at a position intermediate the rocker arm journal rods. Moreover, as seen in Figures 3 and 5, the valve rocker arms are angularly disposed to their journal rods and communicate with the push rods at points substantially within a circle the size of the engine cylinder. These relationships together with the ability to position the camshafts as high as possible above the crankshaft commensurate with a practical drive connection therewith makes possible the obtaining of short center distances between the rocker arm journal rods, the use of rocker arms of a practical size and the use of relatively short push rods. Moreover, these relationships permit the cylinders to be then brought as close as possible together within the limits dictated by good cooling practice.

Manifestly, the camshafts are provided with raised cam portions 70 operable upon the tappets which through their associated push rods push upwardly upon the short lever portions of the rocker arms and the latter in turn exert a downward force through their adjacent long lever portions against the valve stems and against the force of the compression springs 43, 44 to open the valves.

It will also be noted that in the V engine of Figure 5 the adjacent cylinders are arranged with their valve arms in the same relationship to the ignition means whereas those of the line engine of Figure 3 are arranged with the valve arms of adjacent cylinders in opposite relationship to one another and with those of alternate cylinders in the same relationship. The same advantages pointed out above are nevertheless obtained in each instance.

Referring now again to Figures 6, 7, and 8, it will be seen that I have modified or truncated the combustion cavity 17 of the penthouse cylinder head of each engine by filling in a portion of the spherical segment formed thereby, at one side only of the head adjacent the valves 25 and 26 to provide a detonation control structure, area, or portion 24 overhanging the perimeter of the cylinder 10 and located on the opposite side of a plane through the common axis 72 of the inlet and outlet valves from the ignition means, for example, a spark plug 74 which in the disclosed arrangement is disposed intermediate the valves 25 and 26 and on the inlet valve side of an axis 75 through the cavity 17 and normal to the axis 72 of the valves 25, 26.

By preference the ignition means will constitute a single spark plug position as near the uppermost point of the spherical dome of the cavity 17 as is physically possible. I have found that the advantages aforesaid of arranging the valves 25 and 26 on a great arc of the cavity outweigh the disadvantages of having the ignition means somewhat offset from the peak of the cavity dome and hence the ignition means in my invention is located as near as possible to the preferred position commensurate with mechanical adaptability.

The detonation control portion 24 as employed in my penthouse cylinder head is an important feature of my invention since as pointed out above, I have found that it will substantially satisfy knock problems arising in engines employing the same and permit a higher knock-limited output to be secured with a given fuel especially with a so-called commercial knocking fuel.

It is to be observed that the portion 24 is located only at one side of the cavity 17. This is

by preference. Experimentation has shown that although small filled-in areas 24A on the spark plug side of the valves may be desirable in certain instances as for increasing the compression ratio of the engine, these areas when of any extent, as is the portion 24, have the effect of reducing volumetric efficiency of the engine in proportion to their size and result in power loss. It is, therefore, desired to keep any filled area on the spark plug side of the valves to a minimum and preferably to avoid the same entirely. Even the single area 24 illustrated, increases the surface area to volume ratio somewhat, but its induction turbulence control of the air-fuel mixture and its cooling effect on the flame curtain among other advantages, facilitates control of detonation and surprisingly enables me to obtain a higher knock-limited power output with my penthouse head engine than would be expected without its presence, this being especially true when using a commercial knocking fuel or even a so-called non-knocking fuel at higher compression ratios beyond the limit of such fuel.

As seen in Figures 7 and 8, the portion 24 comprises a lateral face or wall 78 connecting with the inner margin of the spherical portion and the function of which among other things, is to control the flow of the air-fuel mixture and which face I have termed the induction turbulence control face, and a bottom face or wall 79, the inner margin of which connects with the said lateral wall whose function among other things, is to cool the last portion of the charge to burn and which I will term the quench control face. It is preferable that the face 78, especially the intersecting edge portion 78a thereof with the face 79 when projected vertically be located immediately adjacent the periphery of the valves 25 and 26 so as to obtain a maximum useful overhang of the face 79 and thereby provide a maximum quench control. For this reason, as shown in the disclosed embodiment in Figure 8, the face 78, especially the edge 78a thereof is preferably located parallel to a tangent plane to the valve 25 and to the valve 26 at the periphery of the seating ring 36. Experimentation has also shown that the position of the edge portion 78a of the lateral face 78 is somewhat critical from the standpoint of volumetric efficiency especially as regards its relationship on a projected basis to the inlet valve. For maximum knock limited power output it is therefore preferred that the edge 78a be brought as near as possible to the tangent plane especially at the inlet valve 25 without reducing the volumetric efficiency of the engine below that which would be attained with one having an unmodified penthouse head.

In general, a distance from the tangent plane to the face 78, especially the face edge 78a of between $\frac{1}{16}$ " to $\frac{3}{16}$ " will give best results. However, in certain instances it may be found that when the distance is as little as $\frac{1}{16}$ " or thereabouts, there may be some loss in volumetric efficiency. This loss may be compensated for by slightly undercutting the face 78 above the edge 78a in the area embraced by the dot and dash line 78b in Figures 7 and 8, especially adjacent the valve 25.

It will be understood that the face 78 need not be a continuous flat face, but may comprise a single or plurality of curved faces or a compound arrangement of curved and flat faces. For example, it may curve around the inlet valve 25. Moreover, it may also be curved transversely, for example, as when undercutting is desira-

ble. Moreover, in certain cases it may be desired to limit the detonation control structure to an area adjacent the inlet valve 25 only.

The location of the bottom quench face 78 of the portion 24 is also important from the standpoint of obtaining effective cooling of the last portion of the charge to burn. This face should preferably be immediately adjacent the top face 19 of the piston 12 at top dead center position of the engine crankshaft. Preferably the face 78 will coincide with the mounting face 23 and will provide a clearance relative to the top face of the piston at top dead-center of between .015" to .080". A clearance greatly in excess of this amount will reduce or completely destroy the detonation control effectiveness of the quench face and cause the engine to act the same as if an open cylinder head were used. Although preferably flat, the face 79 may also assume a curve or other surface formation.

It will also be understood that the cavity 17 itself may be slightly larger than the cylinder bore 10 in the plane of the face 23 without a perceptible loss of power or efficiency except some slight loss of thermal efficiency at low operating speeds of the engine. On the other hand, if the cavity be smaller than the cylinder bore, valve sizes will be restricted with loss of volumetric efficiency.

Another feature of my invention concerns the ability to increase the compression ratio of the engine without making a major change in construction or tooling. Thus by merely taking a series of cuts or grinding off the face 23 of the cylinder head so as to reduce the effective height of the cavity 17 I may effect a considerable reduction in the volume of the cavity and thereby increase the engine compression ratio while at the same time retaining the other benefits derived from my invention.

In order to give those skilled in this art some idea of the possible advantages of my invention, I have presented in Figures 9 and 10 data derived from tests made over a range of different compression ratios and at different engine R. P. M.'s with a single cylinder engine employing the featured modified penthouse cylinder structure of my invention, these tests being made using two different fuels of which fuel B in the graphs was a clear fuel having an ASTM or motor method rating of 74.9 and a research method rating of 83.5, while fuel A was the same as fuel B but had added thereto a small amount of tetra ethyl lead modifying its ASTM or motor method rating to 83.0 and its research method rating to 92.0.

In the graphs, compression ratios are plotted against the percent gain in knock limited IMEP for the foregoing fuels at different engine R. P. M. It will be observed that in each instance for any compression ratio of somewhat under 7.0 and greater there is a definite improvement in knock limited IMEP to be expected.

Thus, for example, if the engine of Figure 1 be operated at a compression ratio of 7.0 an improvement of between 2% to 4% in knock limited IMEP could be expected with fuel B, while an improvement between 0% and 2% could be expected with fuel A. By increasing the compression ratio of this engine, it will be obvious that further improvements in knock limited IMEP could be expected.

The construction of the engine of Figure 4 permits of greater compression ratios and assuming this engine is arranged to operate at a compression

ratio of 7.5 it will be apparent that with fuel B an improvement between 3¼% to 4½% could be expected in knock limited IMEP, whereas the improvement for fuel A would be between 1½% and 3¼%.

Thus it will be apparent that substantial improvements in performance may be expected with either the line-type engine or V-type engine utilizing the above described features of my invention over engines of similar character not employing these features.

From the foregoing description of my invention it will be apparent that I have provided a combination of structure capable of effecting novel improvements in the art relating to engines. Although the particular structure shown and described above is well adapted for carrying out the various objects of my invention set forth above, it will be clearly understood that various modifications, changes and substitutions may nevertheless be made in the disclosed embodiments of my invention by the exercise of mechanical skill without departing from the letter or spirit of my invention. The subject invention is therefore to be construed to include all such modifications, changes, and substitutions as may come within the scope of the appended claims.

What is claimed is:

1. The combination with an internal combustion engine cylinder, of a cylinder head provided with a dome-like combustion cavity directly opposite an end of said cylinder and substantially coaxial therewith, a major portion of said cavity being defined by a spherical wall conforming to a spherical segment of a single base having substantially the periphery of the bore of said cylinder as its base, said spherical wall extending from said periphery at one side of the cylinder and terminating in an inner margin short of said periphery at the other side of said cylinder, a single valved inlet port and a single valved outlet port in said spherical wall on an arc thereof each at an angle to the other and to the cylinder axis, and another portion of said chamber being defined by a bottom wall generally normal to the cylinder axis and having its inner margin extending in the same general direction as that in which a plane through said ports extends, and being further defined by a wall in juxtaposition to said ports connecting the said inner margin of said bottom wall and the said terminal inner margin of said spherical wall, and said spherical wall having an aperture on the opposite side of said valved ports from said juxtaposed wall for receiving an ignition means.

2. The combination with an internal combustion engine cylinder, of a cylinder head provided with a dome-like combustion cavity directly opposite an end of said cylinder and substantially coaxial therewith, a major portion of said cavity being defined by a spherical wall conforming to a spherical segment of a single base having substantially the periphery of the bore of said cylinder as its base, said spherical wall extending from said periphery at one side of the cylinder and terminating in an inner margin short of said periphery at the other side of said cylinder, a single valved inlet port and a single valved outlet port in said spherical wall on a great arc thereof each at an angle to the other and to the cylinder axis, a conduit in said head leading from each port and in a direction generally determined by a plane through said ports, and another portion of said chamber being defined by a bottom wall generally normal to the cylinder axis and

having its inner margin extending in the same general direction as that in which said conduits extend, and being further defined by a wall in juxtaposition to said ports connecting the said inner margin of said bottom wall and the said terminal inner margin of said spherical wall, and said spherical wall having an aperture on the opposite side of said valved ports from said juxtaposed wall for receiving an ignition means.

3. The combination with an internal combustion engine cylinder block of a cylinder head having a mounting surface in assembled relation to said block and provided with a dome-like combustion cavity directly opposite an end of a cylinder of said block and substantially coaxial with said cylinder therewith, a major portion of said cavity being defined by a spherical wall conforming to a spherical segment of a single base having substantially the periphery of the bore of said cylinder as its base, said spherical wall extending from said periphery at one side of the cylinder and terminating in an inner margin short of said periphery at the other side of said cylinder, a single valved inlet port and a single valved outlet port in said spherical wall on a great arc thereof each at an angle to the other and to the cylinder axis, a conduit in said head leading from each port and in a direction generally determined by a plane through said ports, and another portion of said chamber being defined by a substantially flat bottom wall overhanging the periphery of said cylinder and substantially contiguous with a plane containing said mounting surface, said bottom wall having an inner margin extending in the same general direction as that in which said conduits extend, and being further defined by a wall in juxtaposition to said ports connecting the said inner margin of said bottom wall and the said terminal inner margin of said spherical wall, and said spherical wall having an aperture on the opposite side of said valved ports from said juxtaposed wall for receiving an ignition means.

4. The combination with an internal combustion engine cylinder, of a cylinder head provided with a dome-like combustion cavity directly opposite an end of said cylinder and substantially coaxial therewith, a major portion of said cavity being defined by a spherical wall conforming to a spherical segment of a single base having substantially the periphery of the bore of said cylinder as its base, said spherical wall extending from said periphery at one side of the cylinder and terminating in an inner margin short of said periphery at the other side of said cylinder, a single valved inlet port and a single valved smaller outlet port in said spherical wall on a great arc thereof, each at an angle to each other and to the cylinder axis, a conduit in said head leading from each port and in a direction generally determined by a plane through said ports, and another portion of said chamber being defined by a bottom wall generally normal to the cylinder axis and having its inner margin extending in the same general direction as that in which said conduits extend, and being further defined by a wall in juxtaposition to said ports connecting the said inner margin of said bottom wall and the said terminal inner margin of said spherical wall, and a spark plug in said spherical wall spaced from each of said ports and on the opposite side of said ports from said juxtaposed wall but positioned nearer to said intake port than to said outlet port and having its axis generally paralleling the axis of said cylinder.

5. The combination with an internal combustion

engine cylinder block having a plurality of cylinder bores arranged with their axes in a common plane, of a cylinder head having a mounting surface in assembled relation to said block and provided with a dome-like combustion cavity over an end of each cylinder of said block and substantially coaxial with such cylinder, a major portion of each cavity being defined by a spherical wall conforming to a spherical segment of a single base having said mounting surface as its base, a single inlet port and a single exhaust port disposed in the spherical wall of each cavity on an arc thereof, the axes of said ports being disposed at an angle to each other and in a plane transversely related to said common plane of the cylinder bores, an air-fuel conduit extending from each inlet port in the general direction in which said transverse plane extends, and the remainder of each said cavity being defined by detonation control means on one side only of the said ports thereof, said control means comprising a turbulence control wall extending in a plane substantially paralleling a tangent to the periphery of said ports and a second wall in a plane substantially coincident with said mounting surface.

6. The combination with an internal combustion engine cylinder block having a plurality of cylinder bores arranged with their axes in a common plane, of a cylinder head having a mounting surface in assembled relation to said block and provided with a dome-like combustion cavity over an end of each cylinder of said block and substantially coaxial with such cylinder, a major portion of each cavity being defined by a spherical wall conforming to a spherical segment of a single base having said mounting surface as its base, a single inlet port and a single exhaust port disposed in the spherical wall of each cavity on an arc thereof, the axes of said ports being disposed at an angle of at least about 60° to each other and in a plane transversely related to said common plane of the cylinder bores, an air-fuel conduit extending from each inlet port in the general direction in which said transverse plane extends, and the remainder of each said cavity being defined by a detonation control means on one side only of the inlet port thereof, said control means comprising a turbulence control wall extending transversely of said common plane of the cylinder bores and extending the substantial depth of said cavity and in juxtaposition to said inlet port, and further comprising a second wall in a plane substantially coincident with said mounting surface and intersecting with said turbulence control wall.

7. The combination with an internal combustion engine cylinder block having a plurality of cylinder bores arranged with their axes in a common plane, of a cylinder head having a mounting surface in assembled relation to said block and provided with a dome-like combustion cavity over an end of each cylinder of said block and substantially coaxial with such cylinder, a major portion of each cavity being defined by a spherical wall conforming to a spherical segment of a single base having said mounting surface as its base, said spherical wall extending from substantially the periphery of the cylinder bore at one side of the cylinder and terminating in an inner margin short of said periphery at the opposite side of said cylinder, a single inlet port and a single smaller exhaust port disposed in the spherical wall on each cavity on an arc thereof at an angle to each other and to the cylinder axis and having their axes disposed in a

plane transversely related to said common plane of the cylinder bores, an air-fuel conduit extending from each inlet port in the general direction in which said transverse plane extends, and the remainder of each said cavity being defined by detonation control means on one side only of the inlet port thereof, said control means comprising a bottom wall generally normal to the common plane of the cylinder bores, which wall extends inwardly over the cylinder bore from the said periphery at the said opposite side of the cylinder and terminates in an inner margin at a distance between about $\frac{1}{16}$ " to about $\frac{1}{8}$ " from said inlet port and further comprising a turbulence control wall connecting the said inner margin of said bottom wall and the said terminal margin of said spherical wall.

8. The combination with an internal combustion engine cylinder block having a plurality of cylinder bores arranged with their axes in a common plane, of a cylinder head having a mounting surface in assembled relation to said block and provided with a dome-like combustion cavity over an end of each cylinder of said block and substantially coaxial with such cylinder, a major portion of each cavity being defined by a spherical wall conforming to a spherical segment of a single base having said mounting surface as its base, said spherical wall extending from substantially the periphery of the cylinder bore at one side of the cylinder and terminating in an inner margin short of said periphery at the opposite side of said cylinder, a single inlet port and a single smaller exhaust port disposed in the spherical wall on each cavity in an arc thereof at an angle to each other and to the cylinder axis and having their axes disposed in a plane transversely related to said common plane of the cylinder bores, an air-fuel conduit extending from each inlet port in the general direction in which said transverse plane extends, and the remainder of each said cavity being defined by detonation control means on one side only of the inlet port thereof, said control means comprising a bottom wall generally normal to the common plane of the cylinder bores, which wall extends inwardly over the cylinder bore from the said periphery at the said opposite side of the cylinder and terminates in an inner margin at a distance between about $\frac{1}{16}$ " to about $\frac{1}{8}$ " from said inlet port and further comprising a turbulence control wall connecting the said inner margin of said bottom wall and the said terminal margin of said spherical wall, said engine having a stroke-bore ratio of about 0.85 and greater.

9. The combination with an internal combustion engine cylinder block having a plurality of cylinder bores arranged with their axes in a common plane, of a cylinder head having a mounting surface in assembled relation to said block and provided with a dome-like combustion cavity over an end of each cylinder of said block and substantially coaxial with such cylinder, a major portion of each cavity being defined by a spherical wall conforming to a spherical segment of a single base having substantially the periphery of the cylinder bore at said mounting surface as its base, said spherical wall extending from said periphery at one side of the cylinder and terminating in an inner margin short of said periphery at the opposite side of the cylinder, a single inlet port and a single smaller exhaust port disposed in the spherical wall of each cavity at an angle of at least about 60° to each other and having their axes disposed on a great arc of

said spherical wall in a plane substantially normal to said common plane of the cylinder bores, the remainder of each said cavity being defined by detonation control means on one side only of said ports, said control means comprising a bottom wall generally normal to the common plane of the cylinder bores which wall extends inwardly over the cylinder bore from the said periphery at the said opposite side of the cylinder and terminates in an inner margin substantially paralleling a tangent to said ports and at a distance between about $\frac{1}{16}$ " to about $\frac{1}{8}$ " from said ports and further comprising a turbulence control wall connecting the said inner margin of said bottom wall and the said terminal margin of said spherical wall, an air-fuel conduit in said head extending from each inlet port in the same general direction in which said plane containing the axes of said ports extends, and said spherical wall having an aperture on the opposite side of said ports from said turbulence control wall and intermediate said ports for receiving an ignition means and said engine having a stroke-bore ratio of about 0.85 and greater.

10. In an internal combustion engine, in combination, a cylinder block having a plurality of cylinder bores arranged with their axes in a common plane, a cylinder head having a mounting surface in assembled relation to said block, said head having wall means rising from said mounting surface and defining a dome-like combustion cavity over each cylinder bore, a major portion of said wall means defining each cavity being spherical and conforming to the surface of a spherical segment of a single base having said mounting surface as its base, a single inlet valve and a single smaller exhaust valve disposed in each said spherical wall means on a great arc thereof and having their respective axes in a plane transversely related to said common plane, and at an angle of at least 60° to each other with the exhaust valve disposed at a smaller angle to said common plane than said inlet valve, and all the inlet valves being on one side of said common plane and all the exhaust valves on the opposite side of said common plane, a piston operably disposed in each cylinder bore, a crankshaft below said cylinder bores substantially in said common plane, piston rods connecting said pistons and crankshaft, a camshaft above said crankshaft and on the inlet valve side of said common plane of the cylinder bores and operably connected with said crankshaft, inlet and exhaust valve rocker arms respectively journaled on said head for actuating said valves, the axes of said shafts being substantially parallel to said common plane of the cylinder bores, each rocker arm being provided with a relatively long and a relatively short lever portion, the said portions of each rocker arm being substantially aligned with each other and angularly positioned relative to their journal axes, the overall length of the exhaust valve rocker arm being greater than that of the inlet valve rocker arm and the inlet and exhaust valve rocker arms for each cylinder lying substantially parallel to each other on opposite sides of the axis of the bore thereof, push rod means operably connecting the short lever portions of each rocker arm and said camshaft substantially on the same side of said common plane of the cylinder bores as said camshaft and the connections between said push rod means and the short lever portions of the rocker arms for each cylinder lying substantially within a

15

circle coincident with the cylinder bore of such cylinder.

11. The combination with an internal combustion engine cylinder block having a plurality of cylinder bores arranged with their axes in substantially a common plane, of a cylinder head having a mounting surface in assembled relation with said block and provided with a dome-like combustion cavity over an end of each cylinder of said block and substantially coaxial with such cylinder, a major portion of each cavity being defined by a spherical wall conforming substantially to a spherical segment of a single base having said mounting surface as its base, a single inlet port and a single exhaust port disposed in the spherical wall of each cavity on an arc thereof, the axes of said ports being disposed at an angle to each other and in a plane transversely related to said common plane of the cylinder bores, an intake conduit extending from each inlet port and in the general direction in which said transverse plane extends, and said cavity being further defined by a detonation control means on one side only of the said inlet port thereof, said control means comprising a turbulence control wall projecting downwardly from said spherical wall of said cavity and extending between points spaced transversely in the general direction in which said intake conduit extends and in juxtaposition to said inlet port, and said cavity having an aperture in said spherical wall

16

on the opposite side of said ports from said turbulence control wall for receiving an ignition means.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,526,678	Poppe	Feb. 17, 1925
1,792,867	Radford	Feb. 17, 1931
1,835,302	Horning	Dec. 8, 1931
1,910,558	Milbrath	May 23, 1933
2,380,066	Pescara	July 10, 1945
2,481,890	Toews	Sept. 13, 1949
2,515,347	Jameson	July 18, 1950
2,546,263	Jameson	Mar. 27, 1951

FOREIGN PATENTS

Number	Country	Date
466,677	Great Britain	June 2, 1937
475,860	Great Britain	Nov. 26, 1937
567,029	Great Britain	Jan. 24, 1945
591,157	Great Britain	Aug. 8, 1947
635,240	Great Britain	Mar. 28, 1947
968,120	France	Apr. 12, 1950

OTHER REFERENCES

- Air Service Information Circular, vol. V. #401, Feb. 15, 1923, p. 1.
Automotive Industries, Mar. 9, 1935, p. 354.