Feb. 7, 1928. 1,658,463

S. W. RUSHMORE

INTERNAL COMBUSTION ENGINE

Filed April 19, 1927

Fig. 1.

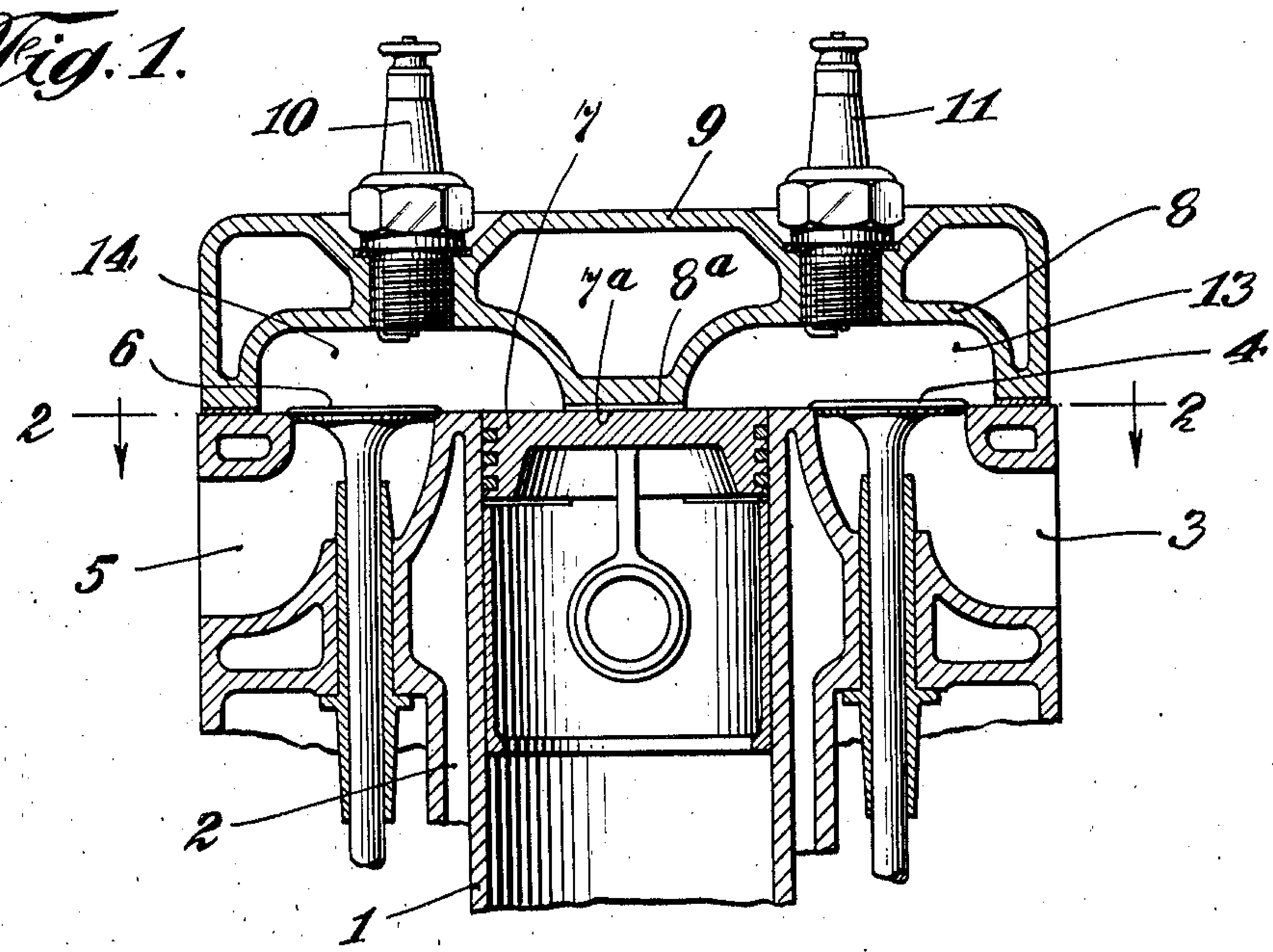
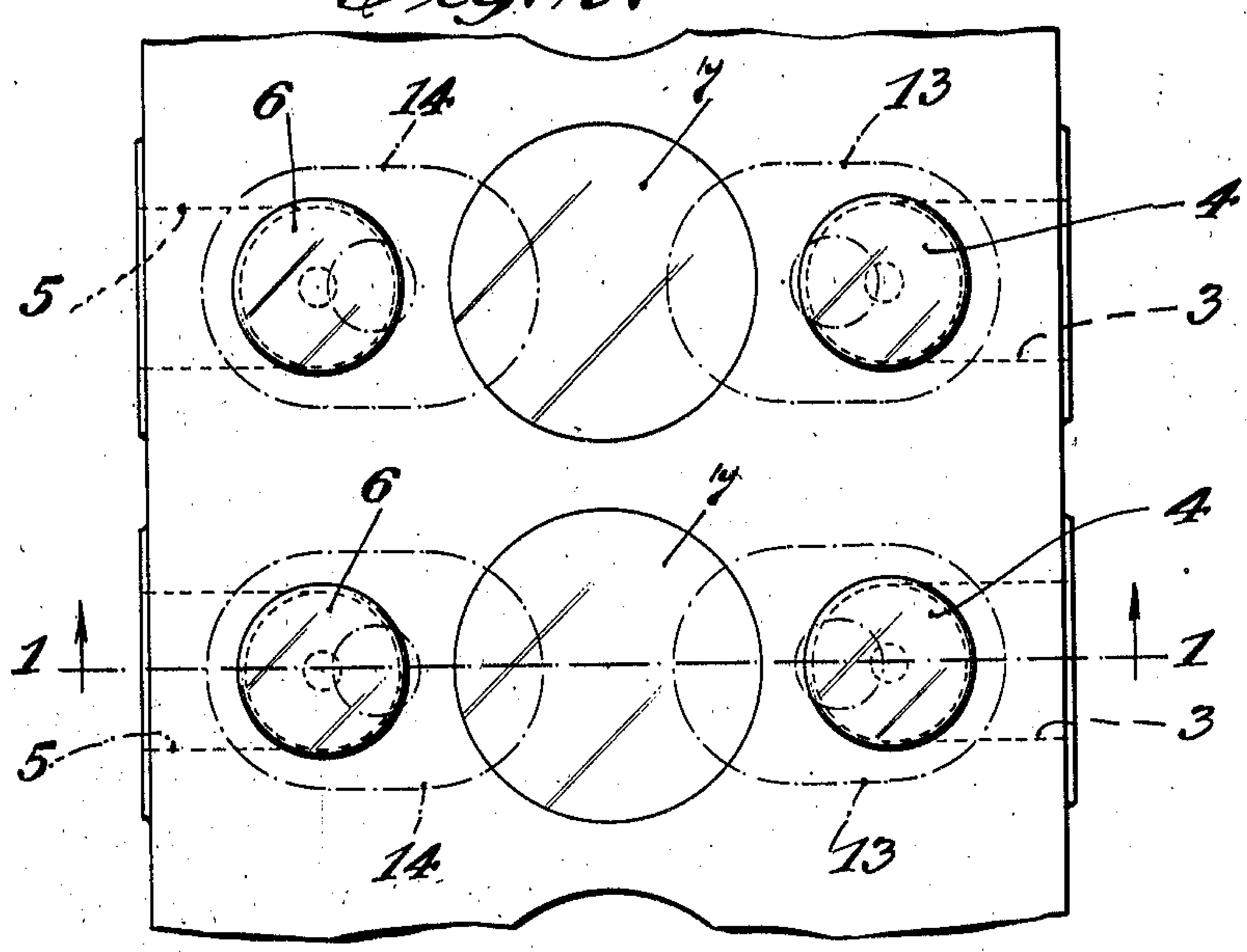



Fig. 2.




INVENTOR

Samuel W. Rushmore

BY

his ATTORNEY

Patented Feb. 7, 1928. 1,658,463

# UNITED STATES PATENT OFFICE.

SAMUEL W. RUSHMORE, OF PLAINFIELD, NEW JERSEY.

## INTERNAL-COMBUSTION ENGINE.

Application filed April 19, 1927. Serial No. 184,878.

My present invention concerns particularly internal combustion engines of the type wherein high compression is highly desirable for efficiency and economy of fuel consumption, and wherein the nature of the combustible fuel and the conditions of its burning within the engine are such that the desired high compression is substantially limited by reason of tendency of the combustible mixture to detonate instead of burning in an orderly manner. While ordinary automobile and motor boat engines burning gasoline as fuel present this problem and I have illustrated my invention as applied to engines of this type, it will be evident that the novel principles involved may be applied to other internal combustion engines for other purposes.

As is well known, rapid, uniform, complete burning of the combustible mixture constitutes a highly desirable type of "explosion", because the pressure generated is of moderate initial violence and is relatively well sustained throughout the expansion stroke of the piston, whereas detonation involves explosion of an entirely different order, more nearly instantaneous, violent and concussive in its effects. This is undesirable, because of the destructive effects on the engine and also because the explosive effort is exerted in too short a time to permit application of the explosive effort in producing useful expansive movement of the piston in response to the explosive effort.

The theory is that under certain conditions, the initial burning or explosion of part of the mixture starts an explosive wave that piles up excessive instantaneous pressures, particularly in the region of the exhaust valve, which is usually red hot under normal conditions of full load operation, and that under such condition the heat due to compression of the gas and excessive heat from the valve results in the above described violent type of explosion called detonation. The theory that detonation is largely due to piling up pressure is supported by experience which shows that the shorter the distance afforded for travel of flame in the compression space, the higher the compression may be carried, a notable illustration being the case of engines with cylinders of very small diameter, which experience shows can be run with very high compression without danger from detonation.

From the above, it will be evident that while small cylinder engines may now or hereafter be designed so as to develop conditions where detonation becomes a factor setting a limit of high compression so that my present invention would be applicable, it will be evident that it applies more particularly to engines having cylinders of relatively large diameter, wherein detonation already figures as the limiting factor preventing higher compression efficiencies.

A further specifically important application of my invention is to engines of the so-called T-head type, wherein the intake manifold and valves are on one side of the engine and the exhaust manifold and valves on the other side of the engine. While this type of engine is highly desirable because it permits the use of very large valves and for other reasons, it has been found to afford conditions particularly favorable for detonation and hence least favorable for high compression.

For application to the above and analogous conditions, my invention contemplates splitting up the compression space of each cylinder into a plurality of chambers that are virtually separated at the instant of ignition, preferably employing two spark plugs for each cylinder, one in each of its compression chambers. Preferably, the separate chambers are located symmetrically on opposite sides of the cylinder, each overlapping a relatively small area of the piston, on opposite sides thereof. With this arrangement and with the explosion substantially simultaneous in each chamber, the pressures initially applied to the head of the piston will be approximately equal on opposite sides of the line of thrust.

As detonation is caused and completed only at the instant the piston is at the top of its stroke, no moving parts other than the piston are necessary for separating the compression space into two chambers. In the present case, this is accomplished by bringing the cylinder head down to a position of approximate parallelism with the head of the piston over all the central part of the piston head area, and this may be as much as two-thirds of the total area, leaving, say, 1/6 or less of the piston area in direct exposed relation to the compression spaces and the explosive pressures generated therein.

It will be evident that in a T-head engine constructed in accordance with my present invention, the exhaust stroke leaves a volume of completely burned-out gas in the exhaust compression space which is entirely unaffected by the intake stroke, although said intake stroke completely scavenges the intake compression space. The following compression stroke leaves the charge in the intake compression space as rich as ever. In the exhaust compression space it crowds the burned out gases against the exhaust valve, blanketing it from contact by the explosive parts of the new charge; the final result at the end of the compression stroke is that the charge in the intake chamber is of normal richness and easily ignited, whereas that in the exhaust chamber is relatively poor. Hence the only part of the charge anywhere near the hot exhaust valve is too poor for preignition and, in fact, is so difficult to ignite that a separate spark plug for the exhaust compression space is highly desirable. With the separate charges fired simultaneously by the two plugs, the pressures from the two compression spaces are applied simultaneously and symmetrically on the piston head as above described.

The above and other features of my invention will be more fully understood from the following description in connection with the accompanying drawings, in which

Fig. 1 is a vertical axial section transversely of an internal combustion engine of the T-head type, having our invention embodied therein, the section being on the line 1—1, Fig. 2; and

Fig. 2 is a top plan view of the cylinders and valves with the cylinder head removed.

In these drawings, the parts of the engine necessary to an understanding of our present invention are shown as comprising the cylinder, 1, provided with a water-jacket, 2, formed with an intake, 3, controlled by intake valve, 4, an exhaust 5 controlled by an exhaust valve 6, a piston 7 in the cylinder and, in inoperative relation to the above parts, a cylinder head 8, provided with a water-jacket 9 and having mounted therein spark plugs 10, 11.

As shown in Fig. 1, the position of the piston 7 on dead center at the upper end of the compression stroke has all the central area of its upper face $7^a$ closely confronted by a broad lower surface $8^a$ of the cylinder head 8. The clearance between $7^a$ and $8^a$ is reduced to approximately the minimum practically permissible by conditions of ordinary operation. Thus, the compression space is divided between two chambers, 13 and 14, which are preferably of equal volume so that half of the charge is compressed into each of them.

As indicated in dot and dash lines, Fig. 2, the chambers 13 and 14 constitute the valve chamber space for lift of the valve, extended toward each other so as to partially overlap the head of the piston 7, equally on opposite sides thereof. As shown in Fig. 2, the area of the overlap of each chamber is less than one-third of the diameter and less than one-sixth of the area of the piston head.

It will be evident to those skilled in the art, particularly those having experience with sleeve valve internal combustion engines, that in my engine the clearance between the parallel surfaces may be reduced to a very few hundredths or even thousandths of an inch without danger that the carbon deposits will cause the piston head to pound the cylinder head. As is well known, the so-called carbon is initially a soft gummy deposit, consisting mainly of silica from the road dust with some carbon and oil. The deposit being very gradual, and initially soft, is simply squeezed along and ejected, only the unsqueezed remnant remaining in place long enough to form a solid. Consequently, any carbon deposit that may form will merely serve the useful purpose of a self gauging spacer between the parallel surfaces. In any event, it will be evident from the drawings that the area of the small clearance zone between the chambers is enormously wide as compared with the clearance space and as this zone is water-cooled, flame initiated in the inlet compression space will become chilled and incapable of penetrating through the clearance space zone, to permit passage of the detonating wave, through to the exhaust valve.

It results from the above relation of parts that the two chambers 13, 14, constitute a single compression space in so far as concerns distribution, density and degree of compression of the explosive charge during the compression stroke, but so far as concerns burning of the charge and particularly as concerns propagation of a detonating wave, they are effectively separated from each other by the piston when at the upper limit of its stroke. Incidentally, the separation is such that separate spark plugs are desirable for causing synchronized sparks in the two chambers to initiate combustion in both parts of the charge simultaneously.

By my above described invention, I am enabled to so increase the compression that with the larger valves permitted by the T-type construction, the cost of the desirable T-head design, for a given rate horse power, may be considerably lower than that of the cheaper L-head design while there may also be an appreciable saving in weight.

I claim:

1. An internal combustion engine, of the high-compression, T-head type, having a valved inlet passage for intake of an unignited charge located on one side of said head and a valved exhaust outlet chamber located in the opposite side; said engine in-

cluding also a cylinder piston and cylinder head arranged to afford a plurality of approximately equal compression chambers, separated by areas of minimum clearance between the cylinder head and the piston when the latter is at the upper end of its compression stroke, said separating areas of minimum clearance being of great width as compared with said clearance, one of said compression chambers including the inlet and having a spark plug therein and the other including the exhaust outlet.

2. An internal combustion engine, including cylinder, piston and cylinder head arranged to afford a plurality of compression chambers, separated by areas of minimum clearance between the cylinder head and the piston when the latter is at the upper end of its compression stroke, in combination with separate spark plugs for each of said chambers.

3. An internal combustion engine, of the high-compression, T-head type, having a valved inlet passage for intake of an unignited charge located on one side of said head and a valved exhaust outlet chamber located in the opposite side; said engine including also a cylinder, piston and cylinder head arranged to afford a plurality of compression chambers, separated by areas of minimum clearance extending in a wide central zone entirely across and between the cylinder head and the piston when the latter is at the upper end of the compression stroke, one of said compression chambers including the inlet and having a spark plug therein and the other including the exhaust outlet.

4. An internal combustion engine, including cylinder, piston and cylinder head arranged to afford a plurality of compression chambers, separated by areas of minimum clearance extending in a wide central zone entirely across and between the cylinder head and the piston when the latter is at the upper end of the compression stroke, in combination with separate spark plugs for each of said chambers.

5. An internal combustion engine, of the high-compression, T-head type, having a valved inlet passage for intake of an unignited charge located on one side of said head and a valved exhaust outlet chamber located in the opposite side; said engine including also a cylinder, piston and cylinder head arranged to afford a plurality of compression chambers, separated by areas of minimum clearance extending in a wide diametric zone entirely across and between the cylinder head and the piston when the latter is at the upper end of its compression stroke, one of said compression chambers including the inlet and having a spark plug therein and the other including the exhaust outlet, said chambers overlapping the piston less than one-third the diameter of said piston.

6. An internal combustion engine, including cylinder, piston and cylinder head arranged to afford a plurality of compression chambers, separated by areas of minimum clearance extending in a wide diametric zone entirely across and between the cylinder head and the piston when the latter is at the upper end of its compression stroke, said chambers overlapping the piston less than one-third the diameter of said piston, in combination with separate spark plugs for each of said chambers.

7. An internal combustion engine of the T-head type, including cylinder, piston and cylinder head formed with separate valve chambers on opposite sides of the cylinder both upwardly concave and having similar convex curve margins toward each other to overlap the piston, but separated from each other by areas of small clearance between cylinder head and piston when the latter is at the end of its compression stroke the overlap of the piston by each of said chambers being less than one-third the diameter of said piston, in combination with separate spark plugs for each of said chambers.

8. An internal combustion engine of the T-head type, including cylinder, piston and cylinder head formed with separate valve chambers on opposite sides of the cylinder both upwardly concave and having similar convex curve margins toward each other to overlap the piston, but separated from each other by areas of small clearance between cylinder head and piston when the latter is at the end of its compression stroke, in combination with separate spark plugs for each of said chambers.

9. An internal combustion engine of the T-head type, including cylinder, head and piston of diameter, stroke and clearance affording high compression, and having inlet and exhaust valves in separate inlet and exhaust chambers respectively located on opposite sides of the cylinder, whereby the exhaust valve is remote from and is not cooled by the inlet; said valve chambers being extended towards each other over the piston head adapted to afford two compression chambers that are separated from each other by an area of minimum working clearance between the cylinder head and the piston, when the latter completes its compression stroke, said separating areas of minimum clearance being of great width as compared with said clearance.

10. An internal combustion engine of the T-head type, including cylinder, head and piston of diameter, stroke and clearance affording high compression and having inlet and exhaust valves in separate inlet and exhaust chambers respectively located on opposite sides of the cylinder, whereby the ex-

haust valve is remote from and is not cooled by the inlet; said valve chambers being extended towards each other over the piston head adapted to afford two compression chambers that are separated from each other by an area of minimum working clearance between the cylinder head and the piston, when the latter completes its compression stroke; in combination with separate spark plugs for each of said chambers.

11. An internal combustion engine of the T-head type, including cylinder, head and piston of diameter, stroke and clearance affording relatively high compression and having inlet and exhaust valves in separate inlet and exhaust chambers respectively located on opposite sides of the cylinder, whereby the exhaust valve is remote from and is not cooled by the inlet; said valve chambers being extended symmetrically towards each other adapted to afford two compression chambers that are separated from each other by a relatively large central area having minimum working clearance between the cylinder head and the piston, when the latter completes its compression stroke.

12. An internal combustion engine of the T-head type, including cylinder, head and piston of diameter, stroke and clearance affording relatively high compression and having inlet and exhaust valves in separate inlet and exhaust chambers respectively located on opposite sides of the cylinder, whereby the exhaust valve is remote from and is not cooled by the inlet; said valve chambers being extended symmetrically towards each other adapted to afford two compression chambers that are separated from each other by a relatively large central area having minimum working clearance between the cylinder head and the piston, when the latter completes its compression stroke; in combination with separate spark plugs for each of said chambers.

13. An internal combustion engine of the T-head type, including cylinder, head and piston of diameter, stroke and clearance affording relatively high compression, and having inlet and exhaust valves in separate inlet and exhaust chambers respectively located on opposite sides of the cylinder, whereby the exhaust valve is remote from and is not cooled by the inlet: said valve chambers being extended over the piston head to form two similar compression chambers separated from each other by an area of minimum working clearance between the cylinder head and the piston when the latter completes its compression stroke, said separating areas of minimum clearance being of great width as compared with said clearance.

14. An internal combustion engine of the T-head type, including cylinder, head and piston of diameter, stroke and clearance affording relatively high compression, and having inlet and exhaust valves in separate inlet and exhaust chambers respectively located on opposite sides of the cylinder, whereby the exhaust valve is remote from and is not cooled by the inlet; said valve chambers being extended over the piston head to form two similar compression chambers separated from each other by an area of minimum working clearance between the cylinder head and the piston when the latter completes its compression stroke; said compression chambers being each upwardly concave with margins symmetrically convexing toward each other so that said separating area is a central zone extending entirely across the piston head, and of greater width adjacent the periphery of the piston than at the center.

15. An internal combustion engine of the T-head type, including cylinder, head and piston of diameter, stroke and clearance affording relatively high compression, and having inlet and exhaust valves in separate inlet and exhaust chambers respectively located on opposite sides of the cylinder, whereby the exhaust valve is remote from and is not cooled by the inlet; said valve chambers being extended over the piston head to form two similar compression chambers separated from each other by an area of minimum working clearance between the cylinder head and the piston when the latter completes its compression stroke; in combination with separate spark plugs for each of said chambers.

16. An internal combustion engine of the T-head type, including cylinder, head and piston of diameter, stroke and clearance affording relatively high compression, and having inlet and exhaust valves in separate inlet and exhaust chambers respectively located on opposite sides of the cylinder, whereby the exhaust valve is remote from and is not cooled by the inlet; said valve chambers being extended over the piston head to form two similar compression chambers separated from each other by an area of minimum working clearance between the cylinder head and the piston when the latter completes its compression stroke; said compression chambers being each upwardly concave with margins symmetrically convexing toward each other so that said separating area is a central zone extending entirely across the piston head, and of greater width adjacent the periphery of the piston than at the center; in combination with separate spark plugs for each of said chambers.

17. An internal combustion engine of the T-head type, including cylinder, head and piston of diameter, stroke and clearance affording high compression, and having inlet and exhaust valves in separate inlet and exhaust chambers respectively located on op-

posite sides of the cylinder, whereby the exhaust valve is remote from and is not cooled by the inlet; said valve chambers being extended towards each other over the piston head adapted to afford two compression spaces that are separated from each other by an area of minimum working clearance between the cylinder head and the piston, when the latter completes its compression stroke, said separating areas of minimum clearance being of great width compared with said clearance and including the entire area of the piston head except only opposite zone areas of minor circumferential extent that are necessary for and are swept by the flow of gases between the inlet valve chamber and the cylinder during the intake and compression strokes and from said cylinder to the exhaust valve chamber during the compression and exhaust strokes.

Signed at New York city, in the county of New York and State of New York, this 18th day of April A. D. 1927.

SAMUEL W. RUSHMORE.