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S. W. RUSHMORE INTERNAL COMBUSTION ENGINE

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INTERNAL-COMBUSTION ENGINE.

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My present invention concerns particu- while small cylinder engines may now or larly internal combustion engines of the hereafter be designed so as to develop conditype wherein high compression is highly de- tions where detonation becomes a factor setsirable for efficiency and economy of fuel ting a limit of high compression so that my 60 5 consumption, and wherein the nature of the present invention would be applicable, it combustible fuel and the conditions of its will be evident that it applies more particuburning within the engine are such that the larly to engines having cylinders of relativedesired high compression is substantially ly large diameter, wherein detonation allimited by reason of tendency of the com- ready figures as the limiting factor pre- 66 10 bustible mixture to detonate instead of burn- venting higher compression efficiencies. ing in an orderly manner. While ordinary A further specifically important applicaautomobile and motor boat engines burning tion of my invention is to engines of the sogasoline as fuel present this problem and I called T-head type, wherein the intake manihave illustrated my invention as applied to fold and valves are on one side of the en- 70 15 engines of this type, it will be evident that gine and the exhaust manifold and valves the novel principles involved may be applied on the other side of the engine. While this to other internal combustion engines for type of engine is highly desirable because it other purposes. permits the use of very large valves and for As is well known, rapid, uniform, com- other reasons, it has been found to afford 75 20 plete burning of the combustible mixture conditions particularly favorable for detonaconstitutes a highly desirable type of "ex- tion and hence least favorable for high complosion", because the pressure generated is pression. of moderate initial violence and is relative- For application to the above and ly well sustained throughout the expansion analogous conditions, my invention contem- 80 25 stroke of the piston, whereas detonation in- plates splitting up the compression space of

- volves explosion of an entirely different each cylinder into a plurality of chambers order, more nearly instantaneous, violent that are virtually separated at the instant and concussive in its effects. This is unde- of ignition, preferably employing two spark 30 the engine and also because the explosive ef- compression chambers. Preferably, the fort is exerted in too short a time to permit separate chambers are located symmetricalapplication of the explosive effort in produc- ly on opposite sides of the cylinder, each ing useful expansive movement of the piston overlapping a relatively small area of the 35 The theory is that under certain condi-arrangement and with the explosion subtions, the initial burning or explosion of stantially simultaneous in each chamber, the part of the mixture starts an explosive wave pressures initially applied to the head of the that piles up excessive instantaneous pres- piston will be approximately equal on opsures, particularly in the region of the ex- posite sides of the line of thrust. 40 haust valve, which is usually red hot under As detonation is caused and completed normal conditions of full load operation, only at the instant the piston is at the top of and that under such condition the heat due its stroke, no moving parts other than the to compression of the gas and excessive heat piston are necessary for separating the com-45 violent type of explosion called detonation. present case, this is accomplished by bring-
- sirable, because of the destructive effects on plugs for each cylinder, one in each of its 85 in response to the explosive effort. piston, on opposite sides thereof. With this so from the valve results in the above described pression space into two chambers. In the 100

The theory that defonation is largely due to ing the cylinder head down to a position of piling up pressure is supported by experi- approximate parallelism with the head of ence which shows that the shorter the dis- the piston over all the central part of the tance afforded for travel of flame in the com- piston head area, and this may be as much as 105 pression space, the higher the compression two-thirds of the total area, leaving, say, 1/6 may be carried, a notable illustration being or less of the piston area in direct exposed the case of engines with cylinders of very relation to the compression spaces and the small diameter, which experience shows can explosive pressures generated therein. be run with very high compression without It will be evident that in a T-head engine IC danger from detonation. constructed in accordance with my pres-From the above, it will be evident that ent invention, the exhaust stroke leaves

exhaust compression space which is entirely the area of the overlap of each chamber is unaffected by the intake stroke, although less than one-third of the diameter and less said intake stroke completely scavenges the than one-sixth of the area of the piston • intake compression space. The following head. compression stroke leaves the charge in the It will be evident to those skilled in the 15 in the exhaust chamber is relatively poor. Hence the only part of the charge anywhere simultaneously and symmetrically on the 25 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

volume of completely burned-out gas in the opposite sides thereof. As shown in Fig. 2, 70

intake compression space as rich as ever. In art, particularly those having experience the exhaust compression space it crowds the with sleeve valve internal combustion enburned out gases against the exhaust valve, gines, that in my engine the clearance be-10 blanketing it from contact by the explosive tween the parallel surfaces may be reduced 75 parts of the new charge; the final result to a very few hundredths or even thouat the end of the compression stroke is that sandths of an inch without danger that the the charge in the intake chamber is of nor- carbon deposits will cause the piston head mal richness and easily ignited, whereas that to pound the cylinder head. As is well known, the so-called carbon is initially a so soft gummy deposit, consisting mainly of near the hot exhaust value is too poor for silica from the road dust with some carbon preignition and, in fact, is so difficult to ig- and oil. The deposit being very gradual, nite that a separate spark plug for the ex- and initially soft, is simply squeezed along 20 haust compression space is highly desirable. and ejected, only the unsqueezed remnant 85 With the separate charges fired simultane- remaining in place long enough to form a ously by the two plugs, the pressures from solid. Consequently, any carbon deposit the two compression spaces are applied that may form will merely serve the useful purpose of a self gauging spacer between the parallel surfaces. In any event, it will 90 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 95 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

Fig. 1 is a vertical axial section trans-30 versely 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 35 and values 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 40 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 value 6, a piston 7 in the cylinder and, in inoperative relation to the above 45 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 desirable for causing synchronized sparks in piston 7 on dead center at the upper end of the two chambers to initiate combustion in 50 the compression stroke has all the central both parts of the charge simultaneously. area of its upper face 7^a closely confronted By my above described invention, I am by a broad lower surface 8^a of the cylinder enabled to so increase the compression that head 8. The clearance between 7^a and 8^a with the larger valves permitted by the is reduced to opproximately the minimum T-type construction, the cost of the desirable 55 practically permissible by conditions of or- T-head design, for a given rate horse power, 120 dinary operation. Thus, the compression may be considerably lower than that of the cheaper L-head design while there may also space is divided between two chambers, 13 and 14, which are preferably of equal vol- be an appreciable saving in weight. ume so that half of the charge is compressed I claim: 1. An internal combustion engine, of the 125 60 into each of them.

valve.

100 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 105 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 110 limit of its stroke. Incidentally, the separation is such that separate spark plugs are 115

As indicated in dot and dash lines, Fig. 2, high-compression, T-head type, having a the chambers 13 and 14 constitute the valve valved inlet passage for intake of an unigchamber space for lift of the valve, ex- nited charge located on one side of said tended toward each other so as to partially head and a valved exhaust outlet chamber overlap the head of the piston 7, equally on located in the opposite side; said engine in- 130

cluding also a cylinder piston and cylinder piston less than one-third the diameter of head arranged to afford a plurality of ap- said piston. proximately equal compression chambers, 6. An internal combustion engine, includcluding cylinder, piston and cylinder head for each of said chambers. upper end of its compression stroke, in com- both upwardly concave and having similar 20 bination with separate spark plugs for each convex curve margins toward each other to 85 of said chambers. high-compression, T-head type, having a cylinder head and piston when the latter is valved inlet passage for intake of an un- at the end of its compression stroke the over-25 ignited charge located on one side of said lap of the piston by each of said chambers 90 cluding also a cylinder, piston and cylinder spark plugs for each of said chambers. head arranged to afford a plurality of com- 8. An internal combustion engine of the 30 pression chambers, separated by areas of T-head type, including cylinder, piston and 95 minimum clearance extending in a wide cen- cylinder head formed with separate valve tral zone entirely across and between the chambers on opposite sides of the cylinder

separated by areas of minimum clearance ing cylinder, piston and cylinder head ar-5 between the cylinder head and the piston ranged to afford a plurality of compression 70 when the latter is at the upper end of its chambers, separated by areas of minimum compression stroke, said separating areas of clearance extending in a wide diametric zone minimum clearance being of great width as entirely across and between the cylinder compared with said clearance, one of said head and the piston when the latter is at 10 compression chambers including the inlet the upper end of its compression stroke, 75 and having a spark plug therein and the said chambers overlapping the piston less other including the exhaust outlet. than one-third the diameter of said piston, 2. An internal combustion engine, in- in combination with separate spark plugs 15 arranged to afford a plurality of compres- 7. An internal combustion engine of the 80 sion chambers, separated by areas of mini- T-head type, including cylinder, piston and mum clearance between the cylinder head cylinder head formed with separate valve and the piston when the latter is at the chambers on opposite sides of the cylinder overlap the piston, but separated from each 3. An internal combustion engine, of the other by areas of small clearance between head and a valved exhaust outlet chamber being less than one-third the diameter of located in the opposite side; said engine en- said piston, in combination with separate cylinder head and the piston when the lat- both upwardly concave and having similar ter is at the upper end of the compression convex curve margins toward each other to ³⁵ stroke, one of said compression chambers overlap the piston, but separated from each 100 including the inlet and having a spark plug other by areas of small clearance between therein and the other including the exhaust cylinder head and piston when the latter is at the end of its compression stroke, in com-4. An internal combustion engine, includ- bination with separate spark plugs for each 105 ranged to afford a plurality of compression 9. An internal combustion engine of the ⁴⁵ head and the piston when the latter is at and exhaust valves in separate inlet and ex- 110 each of said chambers. [haust valve is remote from and is not cooled]

outlet.

ing cylinder, piston and cylinder head ar- of said chambers. chambers, separated by areas of minimum T-head type, including cylinder, head and clearance extending in a wide central zone piston of diameter, stroke and clearance afentirely across and between the cylinder fording high compression, and having inlet the upper end of the compression stroke, in haust chambers respectively located on oppocombination with separate spark plugs for site sides of the cylinder, whereby the ex-

5. An internal combustion engine, of the by the inlet; said valve chambers being ex-⁵⁰ high-compression, T-head type, having a tended towards each other over the piston 115 valved inlet passage for intake of an un- head adapted to afford two compression ignited charge located on one side of said chambers that are separated from each other head and a valved exhaust outlet chamber by an area of minimum working clearance located in the opposite side; said engine in- between the cylinder head and the piston, cluding also a cylinder, piston and cylinder when the latter completes its compression 120 head arranged to afford a plurality of com- stroke, said separating areas of minimum pression chambers, separated by areas of clearance being of great width as compared minimum clearance extending in a wide dia-, with said clearance. metric zone entirely across and between the 10. An internal combustion engine of the 60 cylinder head and the piston when the lat- T-head type, including cylinder, head and 125 ter is at the upper end of its compression piston of diameter, stroke and clearance afstroke, one of said compression chambers fording high compression and having inlet including the inlet and having a spark and exhaust valves in separate inlet and explug therein and the other including the ex- haust chambers respectively located on oppo-haust outlet, said chambers overlapping the site sides of the cylinder, whereby the ex- 130 65

when the latter completes its compression to form two similar compression chambers

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haust valve is remote from and is not cooled fording relatively high compression, and by the inlet; said value chambers being ex- having inlet and exhaust values in separate tended towards each other over the piston inlet and exhaust chambers respectively lohead adapted to afford two compression cated on opposite sides of the cylinder, 5 chambers that are separated from each other whereby the exhaust valve is remote from 70 by an area of minimum working clearance and is not cooled by the inlet; said valve between the cylinder head and the piston, chambers being extended over the piston head stroke; in combination with separate spark separated from each other by an area of 10 plugs for each of said chambers. minimum working clearance between the 75 11. An internal combustion engine of the cylinder head and the piston when the latter T-head type, including cylinder, head and completes its compression stroke; said compression chambers being each upwardly concave with margins symmetrically convexing toward each other so that said separating 80 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 85 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 lo- 90 cated 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 cham- 95 bers separated from each other by an area of minimum working clearance between the cated on opposite sides of the cylinder, cylinder head and the piston when the latwhereby the exhaust valve is remote from ter completes its compression stroke; in combination with separate spark plugs for 100 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 105 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 45 13. An internal combustion engine of the and is not cooled by the inlet; said valve 110 cylinder head and the piston when the lat- 115 piston of diameter, stroke and clearance af-

piston of diameter, stroke and clearance affording relatively high compression and hav-15 ing 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 20 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 25 the cylinder head and the piston, when the latter completes its compréssion stroke.

12. An internal combustion engine of the T-head type, including cylinder, head and piston of diameter, stroke and clearance af-30 fording relatively high compression and having inlet and exhaust valves in separate inlet and exhaust chambers respectively lo-35 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 40 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.

T-head type, including cylinder, head and chambers being extended over the piston piston of diameter, stroke and clearance af- head to form two similar compression chamfording relatively high compression, and bers separated from each other by an area having inlet and exhaust valves in separate of minimum working clearance between the 50 inlet and exhaust chambers respectively located on opposite sides of the cylinder, ter completes its compression stroke; said whereby the exhaust valve is remote from compression chambers being each upwardly and is not cooled by the inlet; said valve concave with margins symmetrically convexchambers being extended over the piston ing toward each other so that said separat-55 head to form two similar compression cham- ing area is a central zone extending entirely 120 bers separated from each other by an area across the piston head, and of greater width of minimum working clearance between the adjacent the periphery of the piston than at cylinder head and the piston when the lat- the center; in combination with separate ter completes its compression stroke, said spark plugs for each of said chambers. separating areas of minimum clearance being 77. An internal combustion engine of the 125 of great width as compared with said clear- T-head type, including cylinder, head and ance.

14. An internal combustion engine of the fording high compression, and having inlet T-head type, including cylinder, head and and exhaust values in separate inlet and ex-65 piston of diameter, stroke and clearance af- haust chambers respectively located on op- 130

haust valve is remote from and is not cooled site zone areas of minor circumferential exby the inlet; said valve chambers being ex- tent that are necessary for and are swept 15 tended towards each other over the piston by the flow of gases between the inlet valve 5 head adapted to afford two compression chamber and the cylinder during the intake spaces that are separated from each other and compression strokes and from said cylby an area of minimum working clearance inder to the exhaust valve chamber during between the cylinder head and the piston, the compression and exhaust strokes. when the latter completes its compression Signed at New York city, in the county of 10 stroke, said separating areas of minimum New York and State of New York, this 18th clearance being of great width compared day of April A. D. 1927. with said clearance and including the entire

posite sides of the cylinder, whereby the ex- area of the piston head except only oppo-- SAMUEL W. RUSHMORE.

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