Sept. 17, 1929. A. D. SNYDER 1,728,514

INTERNAL COMBUSTION ENGINE AND CYLINDER AND PISTON CONSTRUCTION

Filed Feb. 5, 1925 2 Sheets-Sheet 1

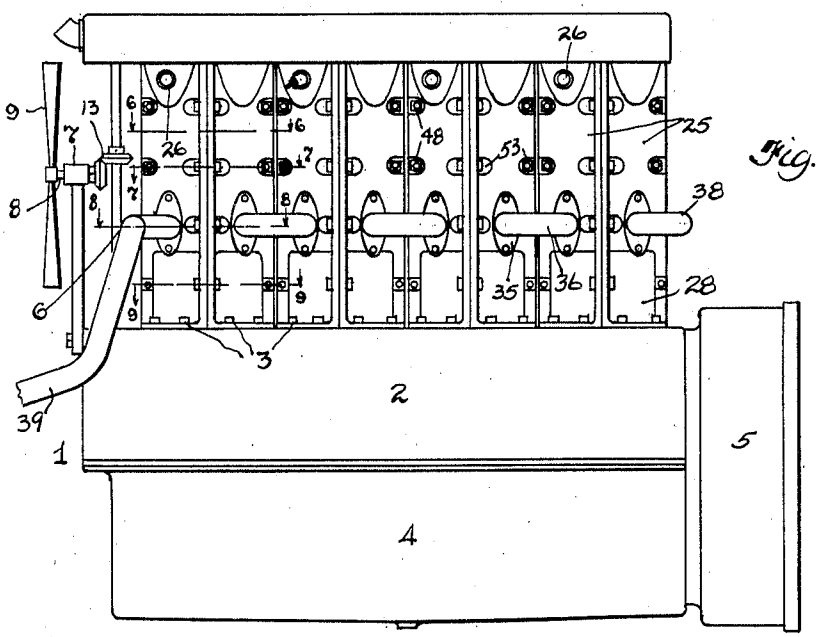


Fig. 1

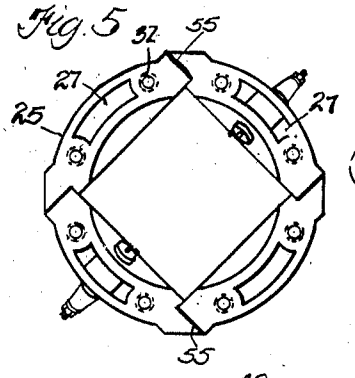


Fig. 5

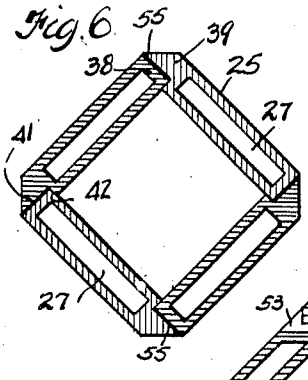


Fig. 6

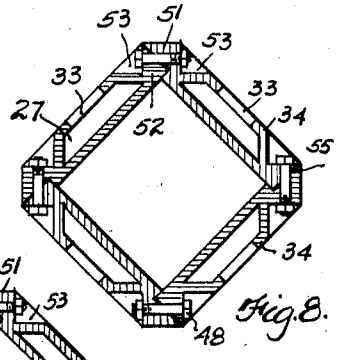


Fig. 8.

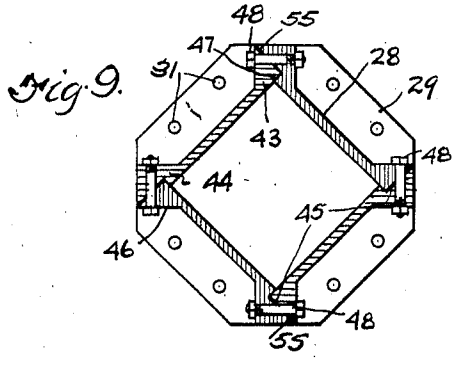


Fig. 9.

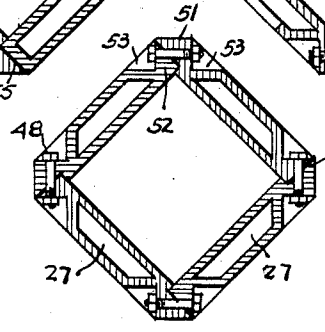


Fig. 7

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INTERNAL COMBUSTION ENGINE AND CYLINDER AND PISTON CONSTRUCTION

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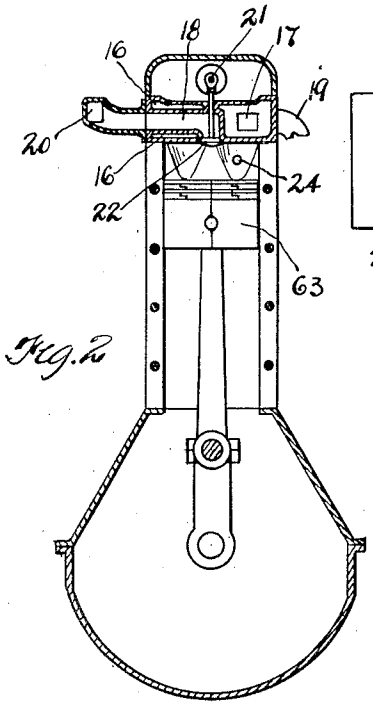


Fig. 2.

Fig. 3

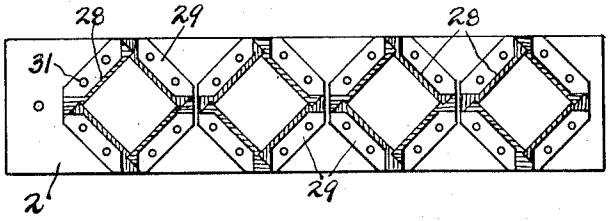
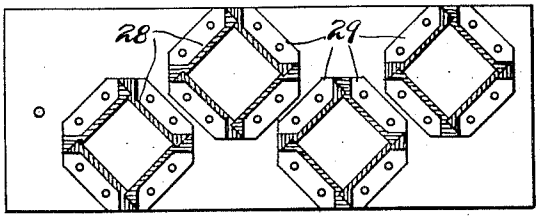


Fig. 4.



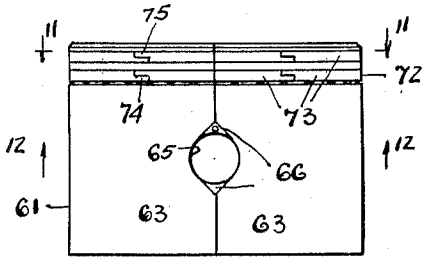


Fig. 10

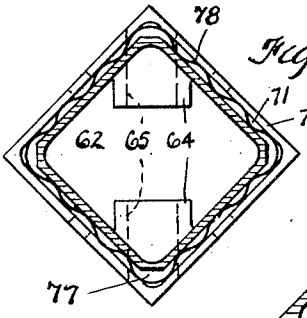


Fig. 11

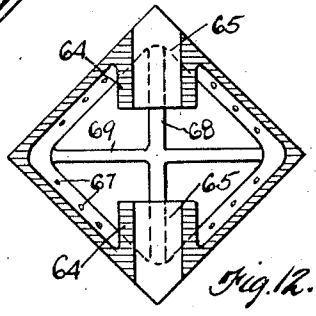


Fig. 12.

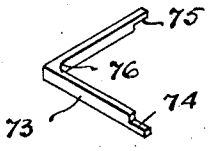


Fig. 13

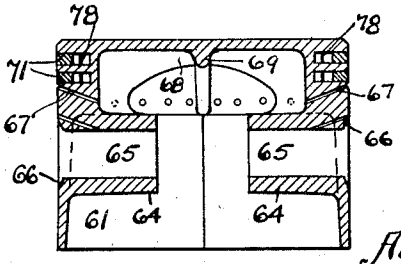


Fig. 14

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INTERNAL-COMBUSTION ENGINE AND CYLINDER AND PISTON CONSTRUCTION

Application filed February 5, 1925. Serial No. 6,956.

This invention, as indicated, relates to an internal combustion engine embodying improved features of construction, particularly with relation to the cylinder and piston structure.

Gas engines manufactured in accordance with standard practice are provided with cylindrical cylinders and pistons and carry compression rings of circular outline. In such engines, when used for automobiles, it is the usual practice to form said cylinders in a block of cast metal or to unite a series of individual cylinder castings in alignment over the crank shaft. The individual cylinders in each instance are formed as unit structures and when through continued use the fit of the pistons within said cylinders is not adequate to produce the required compression, it is the practice to fit pistons of larger diameter therein or to rebore the cylinders and fit new pistons of proper size. This operation is one involving considerable labor and expense and an engine is frequently permitted to operate under conditions below average efficiency because of the loss and expense which would be involved in making the necessary repairs.

The principal object of the present invention is to provide an internal combustion engine having an improved cylinder and piston construction which will obviate the difficulties above referred to and permit of ready inspection of the interior walls of a cylinder, as well as ready access to the piston and its associated parts, so that inspection and necessary adjustment or replacement may be made with a minimum of effort and expense. Another object of the invention is to provide a cylinder formed of a plurality of vertical sections which may be assembled in gas tight relation and form a combustion chamber of any desired cross section, which may vary from substantially circular to various polygonal forms of cross sectional outline. It is a further object of the invention to provide a cylinder and piston construction which may have a plane or two-plane contact with the cylinder walls prior to the bringing of the temperature of the engine to a point wherein a predetermined running fit of the piston with the cylinder shall have been reached, as distinguished from a line contact as in present practice. Another object of the invention is to provide a cylinder formed of a plurality of sections which may have on their inner sides and provide, when assembled, a cylinder of polygonal and preferably square cross section. Another object of the invention is to provide a piston of a cross section to correspond with the cross section of a sectional cylinder of the type above mentioned, with improved details of construction to co-operate with said cylinder. A further object of the invention is to provide a multi-cylinder engine of somewhat less than the usual length by positioning the adjacent cylinders in staggered relation with respect to each other. Other objects of the invention will appear in the course of the following description. The particular embodiment of the invention illustrated in the drawing comprises a cylinder and piston construction of square cross section but such illustration of one specific form is not to be taken to exclude the application of the principle of the invention to various other forms within the scope of the claims, certain of which cover constructional features applicable with equal advantage to cylinders of substantially true cylindrical shape and co-operate with cylindrical pistons in universal use. Likewise it is possible that a cylinder and piston of triangular cross section may be found advantageous for certain purposes. To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims. The annexed drawing and the following description set forth in detail certain mechanism embodying the invention, such disclosed means constituting, however, but one of various mechanical forms in which the principle of the invention may be used. In said annexed drawing:—

Fig. 1 is a side elevation of an engine embodying the principles of my invention; Fig. 2 is a transverse vertical sectional view taken through an engine of the type shown in Fig. 1; Fig. 3 is a top plan view of an internal combustion engine with the cylinder head removed, the cylinders being placed in lon-

gitudinal alignment with each other; Fig. 4 is a top plan view of an internal combustion engine with the cylinder head removed, showing the pistons arranged alternately on opposite sides of a line drawn parallel with the position of the crank shaft centrally of the top of the crank case; Fig. 5 is a top plan view of one of the sectional cylinders at its point of junction with the cylinder head; Figs. 6, 7, 8 and 9 are transverse sectional views, respectively, of one of the sectional cylinders taken at the lines 6—6, 7—7, 8—8 and 9—9, shown in Fig. 1, looking in the direction of the arrows; Fig. 10 is a side elevation of a piston embodying the principles of my invention; Figs. 11 and 12 are transverse sectional views taken along the lines 11—11 and 12—12, shown in Fig. 10, looking in the direction of the arrows; Fig. 13 is a perspective view of an angular piston groove engaging element corresponding with the usual piston ring; and Fig. 14 is a central vertical section taken through the wrist pin bosses.

As is shown in Fig. 1 of the drawing, the crank case 1 comprises an upper crank case and engine bed 2 to which the sectional cylinders are adapted to be secured by bolts 3, and a lower crank case 4, which is connected to the upper crank case by bolts as in standard practice. A fly wheel housing 5 is shown at the rearward end of the crank case. A standard 6 is bolted at its lower end to the forward end of the crank case and at its upper end carries a roller bearing 7 in which the fan spindle 8 is rotatably supported. At the forward end of said spindle the fan blades 9 are secured and at the rearward end a bevel gear 11 is mounted. A vertical shaft 12, driven from the crank shaft, extends through the upper crank case and into the cylinder head and carries at an intermediate position a bevel gear 13 which engages the bevel gear 11 on the fan spindle.

The sectional compression and explosion chamber members, although of square interior cross section as is shown in Fig. 3 of the drawing, in accordance with usual terminology, will be designated "cylinders" in this specification because of their function. At their lower ends the cylinders are provided with angularly disposed flanges 14 provided with a plurality of bolt holes by means of which they are secured by the bolts 3 to the top of the upper crank case. The cylinders in the form shown in Fig. 3 are four in number and are arranged in longitudinal alignment, with the diagonal corners of adjacent cylinders abutting, and with the side sections of each cylinder disposed diagonally with respect to a vertical plane through the central axis of the crank case. The upper face of the crank case will be suitably apertured, as shown in Fig. 2, to register with the openings in the cylinders.

In place of the cylinder arrangement shown in Figs. 1, 2 and 3, cylinders embodying the principles of my construction may be arranged in offset relation to a vertical plane extending through the central axis of the crank case, as is shown in Fig. 4 of the drawing. In such construction the cylinders may have their diagonal axes offset alternately upon the opposite sides of a central line. An offsetting of three-fourths of an inch in either direction from the central line will permit the cylinders to be brought quite close to each other, with their base flanges in close juxtaposition, and this will permit a shortening of the motor length with a slight increase in the width of the motor. The openings in the top plate of the crank case will be provided to register with those of the respective cylinders.

The modified cylinder arrangement just described causes the power impulses of the motor to be applied in different planes, and in consequence, periodic vibrations will be broken up and the smooth running of the motor will be thus insured. Four cylinder motors are particularly subject to periodic vibrations and the offsetting of the moving parts will be particularly effective in improving the operation of a motor of this type.

The upper ends of the cylinders are engaged in the usual manner with the bottom face of the detachable cylinder head 15, which is secured thereto by bolts engaging bolt-holes in the cylinder sections, as will presently be described.

The cylinder head carries the usual water passageways 16 and inlet and exhaust passageways 17, 18, with which the inlet and exhaust manifolds 19, 20, are connected.

An overhead cam shaft 21 operates a series of poppet valves 22 in the usual manner, the cam shaft being operatively connected with the vertical drive shaft 23 heretofore described.

The spark plugs 24 are set into one of the side plates of each cylinder at a point immediately below the water jacketed head, the adjacent inner faces of the side plates being preferably concave to provide an enlarged combustion chamber.

Each cylinder, as is clearly shown in the drawing, is formed of four side plates. Each plate 25 may be formed of a size and shape identical with its companion plates, having a water circulation connection at its lower ends. Likewise a spark plug aperture 26 may be formed in each plate. It has been found desirable to use two spark plugs for each cylinder and the spark plug apertures in the remaining plates may be plugged with a suitable closure.

Each individual cylinder plate will preferably be provided with a water jacket 27 extending over approximately three-fourths of its entire length, the lower portion 28 having

a wall of single thickness and terminating in an outwardly turned flange 29, provided with a plurality of bolt-holes 31, by means of which it may be secured by bolts 3 to the upper face of the crank case and engine bed, as heretofore mentioned.

Adjacent the upper end of each plate the water jacket will be of restricted width and at each side thereof a bolt-hole 32, preferably internally threaded, will be provided to receive the bolts for securing the cylinder head to the respective cylinders in accordance with standard practice.

The under face of the cylinder head will be provided with openings registering with the water jacket openings 27 in the upper ends of the individual cylinder plates. Adjacent the lower portion of the water jacket of each individual plate an opening 33 is provided in the outer wall, about which a seat 34 is provided against which the terminal plates 35 of a tubular water connection 36 may be bolted. The end plates of the cylinders will have similar water connections 37, 38, with the adjacent plates of their own cylinder and the forward connection 37 will have a branch 39 for the radiator.

As is clearly shown in Figs. 5 to 9, inclusive, of the drawing, each cylinder plate is provided along one side of its upper water jacketed portion with an end wall 38 corresponding in thickness with the inner and outer walls of the water jacket, and at its opposite side is formed with a solid enlargement 39 which is cut away on its inner face to provide a seat 41 the width of the opposite end wall of the plate. A shoulder 42 is thus provided at one side of said seat, against which the marginal portion of the inner wall of a companion plate may be secured in gas tight engagement, as will presently be described.

Below the line of the water jacketed area of the individual plates, enlarged solid metal ribs 43, 44, are provided at the opposite sides of the plates which are shaped to provide an end wall 45 at one side and a seat 46 and a shoulder 47 at the other, which are continuations of those formed on the water jacketed upper portions. Bolt-holes are provided at an intermediate point through said enlarged ribs, and bolts 48 are engaged through the aligned bolt-holes of abutting plates to secure the same together.

At three vertically spaced points along the water jacketed portion of each individual plate, the area of the water jacket is somewhat restricted, so as to provide corner lugs 51, 52, and recesses 53 adjacent thereto. The lugs correspond in cross-section with those of the ribs at the lower end of the plate, and bolt-holes are formed therethrough. Bolts 48 are engaged through the aligned bolt-holes of abutting plates in like manner to those heretofore described.

Thus four plates, when securely bolted together, will provide a cylinder which will be gas tight at the meeting edges.

In order to provide for an exact fit of the cylinder walls to predetermined piston sizes, and also to compensate for wear on the cylinder and piston, laminated shims 55 are interposed between the seats and the end faces of the plates adjacent thereto. The shims are placed only between the faces of the side edges through which the bolts pass, and the adjacent faces of the plates come into direct contact to form the gas tight joint.

Thus the marginal edge of the inside surface of one plate contacts directly with the shoulder of the adjacent plate, and the shims between the adjacent faces merely control the area of such direct contact.

In Figs. 10 to 14, inclusive, of the drawing, the details of the piston construction are illustrated. The piston 61 comprises a metal casting having a head portion 62 of square outline and a depending skirt portion comprising four walls 63. The upper portions of the side walls are preferably formed of substantially greater thickness than the lower portions, in order to provide for the deep piston ring grooves, presently to be described. At diagonally opposite corners, inwardly directed bosses 64 are provided, said bosses being centrally apertured to form journals 65 for the ends of the wrist pin (not shown). The corners 66 at the outer edges of the piston adjacent the wrist pin journals are beveled to prevent injury to the inside surface of the cylinder, and to remove a shoulder upon which foreign matter or hardened oil might lodge. An oil duct 67 is formed through each upper beveled face with its lower end leading to a point centrally above the wrist pin journal. The under side of the piston head is reinforced by diagonal ribs 68, 69, which also reinforce the inside corners of the side walls. One of the reinforcing ribs 68 is extended inwardly above the wrist pin bosses and serves to reinforce the same, as is clearly shown in Fig. 14.

Each piston is preferably formed with a plurality of grooves 71 for receiving the usual compression elements, which, for convenience of expression will be designated piston rings 72, although said devices are necessarily of square outline and possibly would be more accurately described as "compression squares."

The piston grooves, as illustrated in Figs. 2 and 10 of the drawing, are two in number and are formed closely adjacent the top of the piston. Each piston ring 72 is preferably formed of four right angled bars 73 having their extreme ends provided with upwardly and downwardly facing steps 74, 75, respectively. Each piston ring section or corner bar is adapted to engage in a groove of the piston with the respective legs thereof in contact with adjacent side walls, and with the stepped end portions overlying or underlying

the steps of the adjacent ring sections. The inside corner of each ring section may be provided with a reinforcing fillet 76 and the corresponding corners 77 within each of the grooves may be cut away or beveled to provide adequate clearance.

The piston ring grooves on the piston are formed of a depth sufficient to accommodate a piston ring spring behind the asembled piston ring sections. This spring may be formed in sections, but as shown in Fig. 10 of the drawing, comprises a single spring 78 of square outline formed with horizontally extending corrugations which bear alternatively upon the under side of the ring sections and upon the bottom of the piston ring groove. The spring is open-ended so as to be readily engageable with the groove in the piston, and the meeting ends are preferably brought adjacent each other at a central point on one side. The spring is properly tempered to exert the necessary degree of pressure upon the compression ring sections to prevent loss of compression in the cylinder.

The many advantages of the construction just described have already been pointed out. It might be added, however, that whenever inspection of but a single cylinder is required or minor adjustments within the crank case, the removal of one or more side plates of a cylinder will afford ready access at the point desired.

It should also be noted that complete replacement of piston or cylinder parts may be made without disassembling the entire engine and the lower half of the crank case and cylinder head may remain undisturbed.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the mechanism herein disclosed, provided the means stated by any of the following claims or the equivalent of such stated means be employed.

I therefore particularly point out and distinctly claim as my invention:—

1. An apparatus of the character described, having in combination a crank case and a plurality of cylinders mounted thereon, said cylinders being of polygonal cross-section and formed of a plurality of plates provided with water-jackets.

2. An apparatus of the character described, having in combination a crank case, and a plurality of cylinders of rectangular cross-section mounted diagonally upon said crank case.

3. An apparatus of the character described, having in combination a crank case and a plurality of cylinders mounted thereon, each cylinder being formed of a plurality of side plates provided with water-jackets, and joined together at their lateral edges.

4. An apparatus of the character described, having in combination a crank case and a plurality of cylinders mounted thereon, each cylinder being formed of a plurality of side plates provided with water-jackets, and joined together at their lateral edges, and a detachable head for said cylinders.

5. An apparatus of the character described, having in combination a crank case, a plurality of cylinders mounted thereon, said cylinders being formed of a plurality of side plates provided with water-jackets, and being of rectangular cross-section, and a detachable head for said cylinders.

6. An apparatus of the character described, having in combination a crank case, a plurality of polygonal cylinders mounted thereon formed of a plurality of side plates provided with water-jackets and laterally adjustable with respect to each other, a plurality of polygonal pistons engaged in said cylinders, and operative connections with pistons.

7. An apparatus of the character described, having in combination a crank case, and a plurality of cylinders mounted thereon formed of a plurality of side plates provided with water-jackets and laterally adjustable with respect to each other, said cylinders being of polygonal cross-section and positioned alternately on opposite sides of the central longitudinal line of said crank case and in overlapping relation to adjacent cylinders.

8. An apparatus of the character described, having in combination a crank case, a plurality of vertical plates provided with water-jackets secured to said crank case to form cylinder walls, means for joining adjacent side plates in gas tight relation, and a head adapted to be secured to said assembled side walls.

9. An apparatus of the character described, having in combination a crank case, a plurality of vertical plates provided with water-jackets secured to said crank case to form cylinder walls, means for joining adjacent side plates in gas tight relation, means for adjusting the cross-sectional area of the cylinder formed by said side plates, and a head adapted to be secured to said assembled side walls.

10. An apparatus of the character described, having in combination a crank case, a plurality of vertical plates secured to said crank case to form cylinder walls, water-jackets formed in said vertical plates, means for joining adjacent side plates in gas tight relation, means for connecting the water jackets of adjacent plates to each other, and a head adapted to be secured to said assembled side walls.

11. An apparatus of the character described, having in combination a crank case, a plurality of vertical plates secured to said crank case to form cylinder walls, water-jackets formed in said vertical plates, means for joining adjacent side plates in gas tight relation, means for connecting the water

jackets of adjacent plates to each other, and a water jacketed head adapted to be secured to said assembled side walls.

12. A cylinder formed of a plurality of side plates provided with water-jackets, and means at the lateral edges of said side plates for joining the same in gas tight relation.

13. A cylinder formed of a plurality of side plates, means at the margins of said side plates for joining adjacent side plates to each other, a plurality of contact faces in different planes upon each side edge of said side plate, a plurality of shims adapted to be interposed between companion faces upon adjacent side plates, and water jackets formed in each of said side plates.

14. A cylinder formed of a plurality of side plates, means at the margins of said side plates for joining adjacent side plates to each other, a plurality of contact faces in different planes upon each side edge of said side plate, a plurality of shims adapted to be interposed between companion faces upon adjacent side plates, and spark plug housings formed in said side plates.

15. A cylinder formed of a plurality of side plates, means at the margins of said side plates for joining adjacent side plates to each other, a plurality of contact faces in different planes upon each side edge of said side plate, a plurality of shims adapted to be interposed between companion faces upon adjacent side plates, water jackets formed in each of said side plates, and spark plug housings formed through said water jackets.

16. An apparatus of the character described, having in combination a crank case, a polygonal cylinder mounted thereon, a piston of polygonal cross-section, and compression rings associated therewith, said cylinder having means adapting the same for adjustment for piston wear.

17. An apparatus of the character described, having in combination a crank case, a polygonal cylinder mounted thereon, a piston of polygonal cross-section, and sectional compression rings associated therewith, said cylinder having means adapting the same for adjustment for piston wear.

18. An apparatus of the character described, having in combination a crank case, a polygonal cylinder mounted diagonally thereon, a piston of polygonal cross-section, and associated with said cylinder diagonally in said crank case.

19. An apparatus of the character described, having in combination a crank case, a polygonal cylinder mounted thereon, a piston of rectangular cross-section, comprising a head section and a skirt section, and diagonal ribs formed internally thereof and reinforcing said sections.

Signed by me, this 17th day of January, 1925.

AULDEN D. SNYDER.