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S. MEURER

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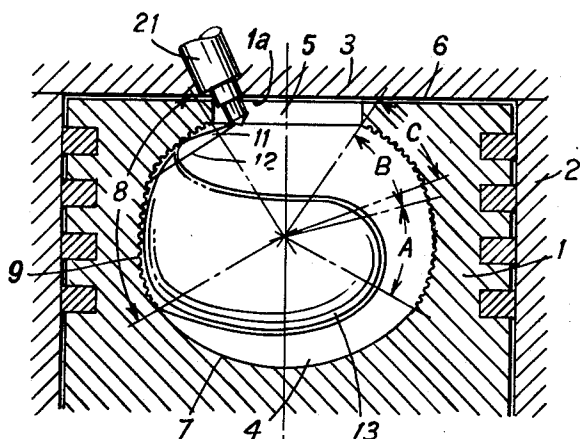


Fig. 1

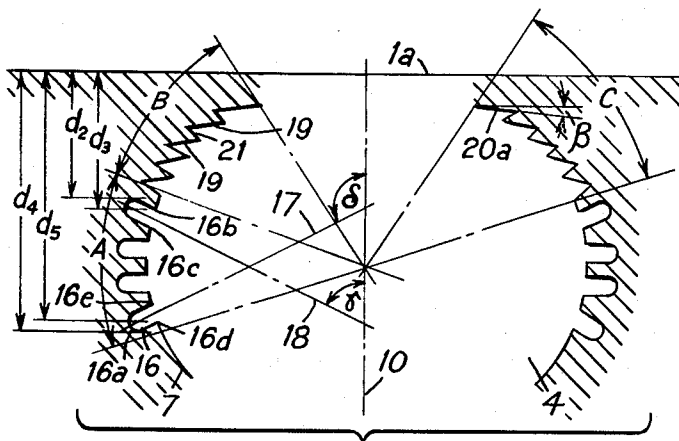


Fig. 3

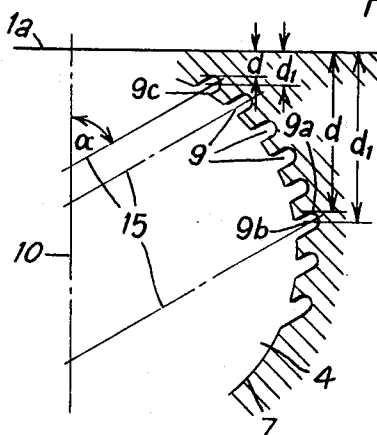


Fig. 2

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9 Claims. (Cl. 123—32)

This invention relates to a piston and in particular to the construction of a combustion chamber in the piston.

The piston of this invention is for a self-ignition internal combustion engine in which the combustion chamber is located in the piston and functions generally according to the engine disclosed in the patent to Meurer et al., No. 2,907,308, dated 6 October 1959.

The object of this invention is to improve the shape of the combustion chamber so that the fuel film deposited on the wall of the combustion chamber is not materially affected by the mass acceleration and inertia forces created by the piston movement.

In internal combustion engines according to this invention, the liquid fuel is applied directly onto the wall of the combustion chamber just prior to the end of the compression stroke and during the beginning of the expansion stroke. The wall of the combustion chamber is below the thermal decomposition temperature of the fuel but still in the boiling range thereof. The fuel is applied to the chamber wall without scattering so that the largest possible wall surface is wetted by the fuel sticking on the wall. This film of fuel is then removed as vapor by means of air rotating about the cylinder or combustion chamber axis and passing over the surface of the film of fuel. The operating principle is in that the major portion of the injected fuel, but not more than 98% thereof, is applied as the film on the chamber wall while the remaining 2% of fuel, which is at least 2% and at the most such that the engine makes a just noticeable ignition noise, is injected in atomized form in the combustion air. The cylinder has a compression ratio so that this small portion of atomized fuel is self-ignited, whereas the fuel on the wall of the chamber is not self-ignited.

According to said Patent No. 2,907,308, the fuel applied to the chamber wall extends evenly and with approximately the same thickness. In practice, this is, for the most part, accomplished. However, some unevenness of the fuel distribution occurs because the acceleration and inertia forces of the piston movement affect the fuel applied to the chamber wall. For example, as the piston moves downwardly from the top dead center, the fuel on the chamber wall will tend, because of inertia, to flow toward the opening of the chamber, and in some instances flow out of the opening. Consequently, an undesirable ignition delay occurs, especially in the cases where the fuel injection is continued from before to after the piston top dead center. Such undesirable effects are avoided by the instant invention by forming grooves in the combustion chamber wall over the areas which are to be covered with the fuel, with the grooves forming a roughened surface. These grooves function to catch the fuel and hold it against movement by reason of the acceleration and inertia forces produced by the piston movement.

Another feature of the invention lies in that the grooves cut into the chamber wall are concentric with the cylinder and are combustion chamber axes, and these grooves

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can either be individually endless or formed as a spiral.

In order to catch and hold the fuel, the shape of the grooves can differ. For example, if the grooves are to hold the fuel against downward piston movement, the grooves are given a curved bottom in the form of a semi-circle or oval. Such grooves are positioned so that part of its surface, for instance the deepest point of the groove bottom, is at a less distance from the surface of the piston head or opening of the combustion chamber than the top edge of the groove in the wall of the combustion chamber. Preferably these grooves are located in the chamber wall close to the combustion chamber opening.

If a reversed holding effect is desired so as to be effective during upward piston movement, grooves are provided which have curved bottoms and are positioned so that part of their surface, for instance the deepest point at the bottom of the groove, is lying at a greater distance from the combustion chamber opening than the lower edge of the groove opening into the chamber wall. Consequently, these grooves are preferably located adjacent the bottom of the combustion chamber. The invention also provides for the forming of the saw-tooth grooves. Such grooves are always shaped so that the side of the groove closest to the upper surface of the piston is either parallel to that surface or at a small angle with respect thereto. When an angle surface is used, the side of the groove is sloped towards the combustion chamber opening.

According to the invention, the various shaped grooves with their particular fuel holding action can be placed in different zones or heights of the combustion chamber with the form of the groove corresponding to the particular function desired thereof. Furthermore, the various shaped grooves can be used in combustion chambers having different shapes of a body of rotation as, for example, spherical, ellipsoidal or toroidal.

The grooved combustion chambers of the invention are not to be confused with heretofore known combustion chambers which have grooves or recesses in the chamber wall in connection with engine cylinders in which the fuel is injected and atomized according to the conventional diesel practice. In such engines, the grooves are for the purpose of producing secondary air turbulences for preventing the fuel from being deposited on the wall of the chamber. In another type of combustion chamber, the wall is given a wavy surface which may also be rippled between the waves. This again is for a piston in which the air is atomized as it is injected into the combustion chamber so as to be mixed with the combustion air. The wavy surface of the chamber wall is for increasing the heating surface for vaporizing the fuel while at the same time the fuel is more finely atomized because of being deflected from the wavy surface.

The means by which the objects of the invention are obtained are described more fully with reference to the accompanying drawings, in which:

Figure 1 is a cross-sectional view through an engine cylinder and the portion of the piston having the combustion chamber therein;

Figure 2 is an enlarged detailed cross-sectional view of a portion of the combustion chamber wall of Figure 1; and

Figure 3 is a similar view of a modified form of wall construction on wall portions A, B and C of Figure 1.

As shown in Figure 1, piston 1 having piston head surface 1a is contained in cylinder 2 having a cylinder head 3. A combustion chamber 4 formed as a body of rotation is in the piston head and has an opening 5 communicating with the cylinder space 6.

As shown in Figures 1 and 2, the combustion chamber wall 7 has, at least over the range 8 of the wall area to which the film of fuel is applied, a plurality of grooves 9.

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These grooves are cut in wall 7 either as a plurality of annular endless slots, or as a spiral groove. Each groove 9 has a curved bottom, as seen in the transverse sectional view, the curvature of which may be semi-circular or oval. However, other shapes may also be used.

Grooves 9, as seen in Figure 1, are positioned so as to function as holding devices for the film of fuel deposited on wall 7, especially when the piston moves downwardly and thus produces inertia forces toward the opening 5. The grooves of Figure 2 are shown in greatly exaggerated size for purposes of clarity, and the grooves are actually very small in depth and closely spaced so as to resemble the fine grooves in a phonograph record so that they appear as a surface of greater roughness and a coherent film of fuel is maintained over the range 8 as indicated in Figure 1. The fuel is deposited from injection nozzle 11 in the form of two or more jets 12 and 13 directly substantially tangentially to the surface 7 of the combustion chamber. Thus the length of each jet is very short and the fuel is deposited without deflection onto the wall 7 where it is spread out over a large surface area 14 in the form of a thin film.

The fuel holding function of the grooves 9 against the downward movement of the piston is further achieved by having the deepest portion 9a of the bottom of the groove at a distance d from the piston head surface 1a smaller than the distance d_1 from the upper edge 9b of the opening of the groove into wall 7. Edge 9b is closer to surface 1a than the lower edge 9c of the groove. The axis 15 through the center of the groove is always at an acute angle α to the vertical axis 10 of the cylinder so that each groove is inclined downwardly toward the bottom of the combustion chamber. Consequently, each groove 9 holds the fuel deposited on wall 7 against upward movement when the piston moves downwardly. By means of these grooves, a fuel film of substantially uniform thickness is constantly maintained on wall 7. Other forms of grooves are shown in Figure 3, also in exaggerated scale. These grooves are arranged over different area portions of wall 7, as shown by portions A, B and C, respectively. In section A, each groove 16 has a bottom 16a having essentially the form of grooves 9 in Figure 1 and differs in that the holding effect is for piston movement in the opposite direction. This is accomplished by positioning the deepest point of the groove bottom 16a with a different distance from surface 1a with respect to the edges of the groove. The axis through the center of the groove thus has a different inclination angle α , δ , respectively to cylinder axis 10. For example, the topmost groove 16 in section A, which is the closest to surface 1a, has its bottom positioned at a distance d_2 less than the distance d_3 of edge 16b from surface 1a. Edge 16b is, of course, closer to surface 1a than edge 16c. The central axis 18 of this groove therefore extends downwardly through chamber 4. The holding effect of the groove is exactly the same as that of groove 9 during downward movement of the piston.

On the other hand, in the lowest portion of section A, the groove 16 has its bottom 16a positioned at a distance d_4 from surface 1a greater than the distance d_5 of edge 16d from surface 1a. Consequently, edge 16d is further from surface 1a than edge 16e. Groove axis 17 then is upwardly inclined toward opening 5. The holding effect of this groove occurs during upward movement of the piston. The groove intermediate the uppermost and

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lowest groove of section A have their inclination set according to the holding effect required of them. This is done by the correct location of the bottom of the groove with respect to the edges of the groove. Therefore, the holding effect in the wall section is accomplished as desired and serves to prevent an undesired flow of fuel in either direction of the piston movement.

In wall sections B and C of Figure 3, the grooves 19 have the form of saw teeth. The sides 20 and 21 of each groove are straight and are connected at a pre-determined angle. Side 20, as shown in section B, is parallel to surface 1a, or as shown in section C by the side 20a, is at a slight angle β to plane 1a so that side 20a is slightly inclined toward chamber opening 5.

The forms of grooves shown in Figures 2 and 3 are selected and combined according to the type of roughness required on wall 7 to hold the fuel and different shapes of grooves can be used in different heights of wall 7. The forms and combinations of grooves shown in Figure 3 are examples only and can be varied to achieve the best possible results with the type of fuel used and other operating conditions.

Having now described the means by which the objects of the invention are obtained,

I claim:

1. In a piston having a combustion chamber for receiving a film of fuel injected upon the wall of the chamber, said fuel being then vaporized, released by a rotating air flow and burned, the improvement comprising a plurality of fine and closely spaced grooves formed in said wall at least over the wall area covered by the fuel film and forming a roughened wall surface, and said grooves being shaped to hold the fuel film against displacement by the acceleration forces created by piston movement.
2. In a piston as in claim 1, said grooves extending concentrically with the axis of said chamber.
3. In a piston as in claim 2, said grooves extending endlessly around said wall.
4. In a piston as in claim 2, said grooves being formed as a spiral.
5. In a piston as in claim 1, each groove having a curved bottom located with part of its surface at a less distance from the piston head surface than the edge of the groove opening in said wall.
6. A piston as in claim 5, said grooves being positioned adjacent the combustion chamber opening into said piston head surface.
7. In a piston as in claim 1, each groove having a curved bottom located with part of its surface at a greater distance from the piston head surface than the edge of the groove opening in said wall.
8. A piston as in claim 7, said grooves being located adjacent the bottom of said combustion chamber.
9. A piston as in claim 1, said grooves each having a saw-tooth shape with one side of each groove being slightly inclined toward the opening of the combustion chamber into said piston head surface.

References Cited in the file of this patent

UNITED STATES PATENTS

2,762,348	Meurer	Sept. 11, 1956
2,832,325	Liebel	Apr. 29, 1958

FOREIGN PATENTS

767,288	Great Britain	Jan. 30, 1957
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