Dec. 27, 1960 K. FROEHLICH 2,966,145

PISTON OR CYLINDER HEAD STRUCTURE

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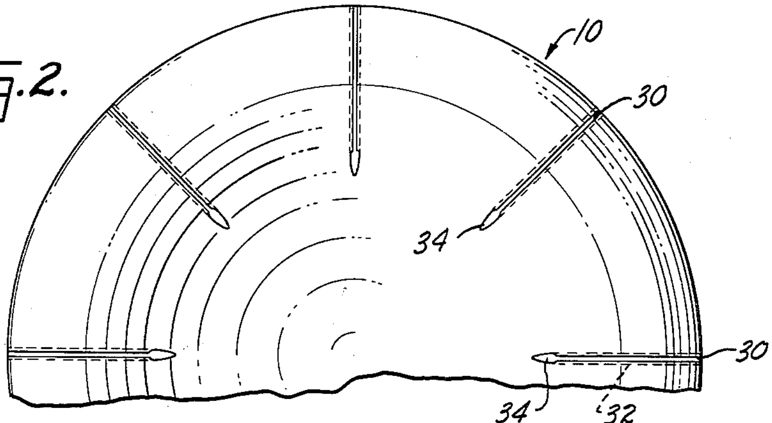
Fig. 2.



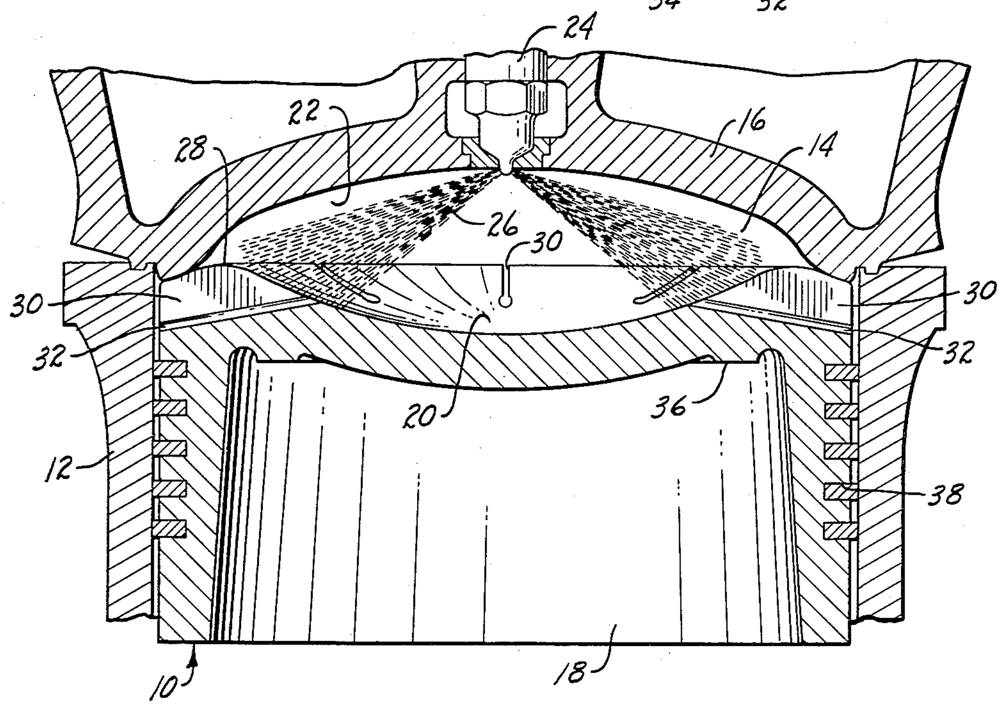


Fig. 1.

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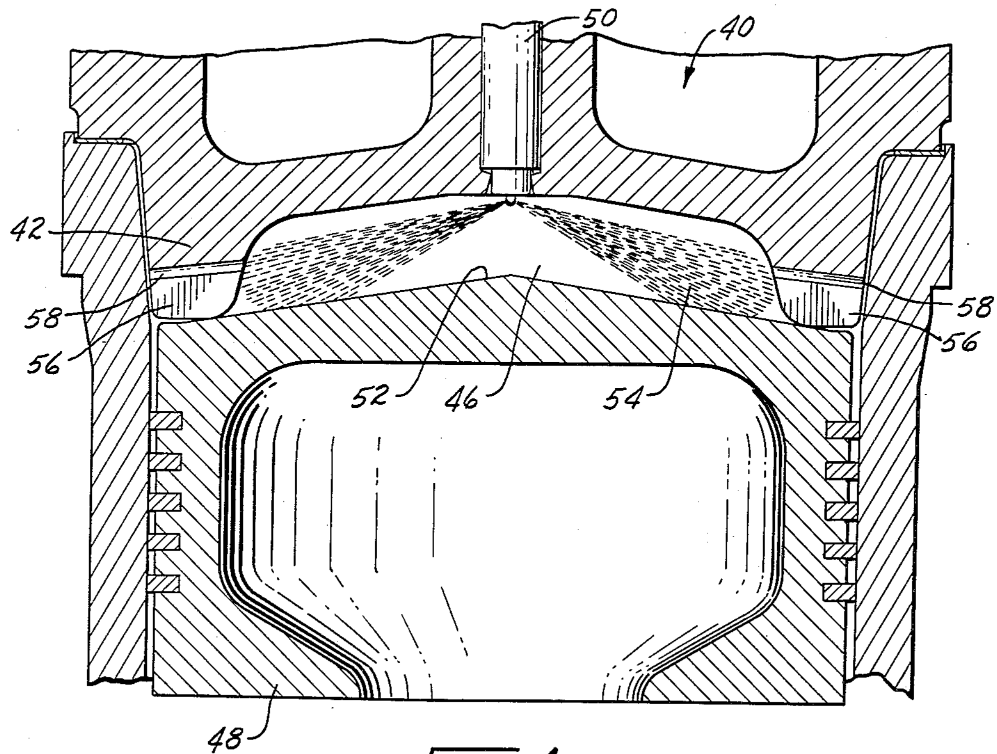

Fig. 4.

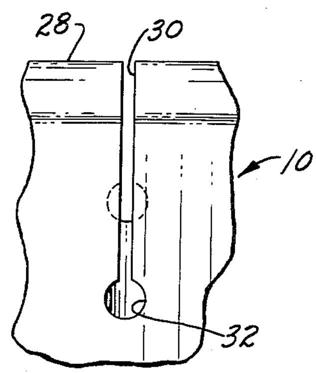

Fig. 3.

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PISTON OR CYLINDER HEAD STRUCTURE

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15 Claims. (Cl. 123—32)

This invention is in the field of internal combustion engines and is concerned with combustion chamber construction. The invention has to do with a temperature problem and is in the nature of an improvement that reduces the stresses in or around the structure of the combustion chamber caused by temperature differentials.

The parts that make up the combustion chamber of an engine, for example the cylinder head and piston, may be cracked or otherwise damaged due to excessive stresses. These stresses may be due either to the gas load or the heat load. In what I shall refer to as larger engines, the parts that make up or define the combustion chamber must be sufficiently heavy or thick to withstand the increased gas load. But this creates a heat problem since the thicker walls, sections, etc. will not transfer heat as rapidly. Since larger engines must necessarily have thicker walls around or defining the combustion chamber, the heat stresses become especially troublesome.

My invention is concerned with a combustion chamber primarily for larger engines which is constructed to handle the heat stresses.

The problem of heat stresses gets difficult when the outside of the piston and cylinder head surfaces which cooperate to form the combustion chamber are at a higher temperature than the interior. Such a situation is usually found in diesel engines, however, any heat engine might also have the problem. If the outside of the piston or cylinder head is at a higher temperature than the interior, the outside will expand more than the interior and the piston may pull itself apart. In operation, large radial cracks may develop in either the cylinder head or the piston from the uneven expansion. This, of course, makes the head or piston unsuitable for further use. In my invention I have placed a plurality of radial slots circumferentially around the piston or cylinder head to divide it into a series of segments. When the outside of the piston or cylinder head expande due to increased heat the total expansion will be divided among the segments and the slots will provide space into which the piston or cylinder head may expand without causing distortion or damage.

One purpose of the invention is a piston or cylinder head which will not crack or damage due to heat stresses formed therein.

Another purpose is a piston construction which will not cause the piston rings to scrape or rub unevenly against the cylinder walls.

Another purpose is an engine cylinder construction in which the piston or cylinder head have their opposing surfaces slotted to reduce heat stresses formed therein.

Another object is a combustion chamber that will slow down the fuel burning rate in gas engines and speed it up in oil or diesel engines.

Another object is a combustion chamber for large engines constructed for long life.

Another object is a combustion chamber of the above type which provides differential thermal expansion between the inner and outer parts thereof.

Another object is a formation for a combustion chamber which, while it relieves thermal stresses, is nevertheless inexpensive to manufacture.

Other purposes will appear in the ensuing specification and drawings and claims.

The invention is illustrated diagrammatically in the following drawings wherein:

Figure 1 is a vertical section through a cylinder, cylinder head and piston, with some parts in full;

Figure 2 is a partial top plan view of the piston of Figure 1;

Figure 3 is an enlarged elevation of a portion of the edge of the piston in Figure 1; and

Figure 4 is a vertical section, similar to Figure 1, of a variant form.

In Figure 1 a piston indicated generally at **10** reciprocates in the usual manner in a cylinder **12** and, at top dead center, defines a combustion chamber **14** with a cylinder head **16**. The interior of the piston, indicated generally at **18**, is preferably liquid cooled although it might be otherwise.

The upper surface of the piston is dished somewhat as at **20** while the lower surface of the cylinder head may be correspondingly domed as at **22**, so that together, they define a combustion space or chamber which is semi-elliptical or flattened in cross-section with the major axis or vertical dimension substantially less than its lateral dimension or diameter. The shape, design and makeup of combustion chambers has received considerable attention in the past and the factors that go to make up the contouring of a combustion chamber are not, in and of themselves, important to this invention.

A suitable fuel supplying device, shown in Figure 1, has an injector **24** for diesel fuel, sprays liquid fuel or oil into the combustion chamber from a generally centrally located position in a fan-shaped or diverging pattern, indicated generally at **26**. It will be noted that the spray or jets of fuel from the injector are directed more or less at what has reference to as an annular mass **28** which, in this case, is the upper, outer edge of the piston. Note in Figure 1 that the fuel pattern is directed toward and possibly impinges against the inner surface of this mass since the mass defines a portion of the exterior of the combustion chamber.

Because of the limited amount of cooling surface at the outside edges of the combustion chamber in relation to the heating surface, the wall temperatures around the combustion chamber are higher than in the center. In addition, the problem is further aggravated by the fuel pattern. For example, in diesel engines where the fuel is injected in a pattern something along the lines of that shown in Figure 1, the spray or jets come in contact with the surface of the combustion chamber toward the outside. This causes comparatively high localized temperatures at the points of contact, since the main combustion will start and take place close to the surface of the combustion chamber in the direction of the fuel spray. The exterior of the piston shown in Figure 1 will expand at a greater rate than the center, and stresses will be set up in the piston. These heat stresses may cause the piston to crack or to be otherwise damaged and so make the piston unsuitable for use. In order to alleviate the heat stresses, I have placed a plurality of radial slots **30** circumferentially around the piston thereby dividing the annular mass **28** into a number of separate circumferential segments. Each of the radial slots opens into and is aligned with a radial bore **32**. The bores **32** open into the general center of the piston as at **34**. The diameter of the radial bore **32** is greater than the width of the slots **30**, as shown in Figure 3. By placing the bore at the bottom of the slot I remove any stress concentration which would normally be present at the bottom.

As shown in the drawings there are eight such slots spaced around the piston, however, the exact number is not important. There may be any number of slots as will best fit the particular application. Additionally, the slots do not have to be evenly spaced. There may be situations where it is advantageous to have the slots unevenly spaced around the circumference. As shown in the drawings, the slots extend straight from the center toward the outside, however, the slots may be arcuate or curved or formed in any other manner. The important thing is that the slots divide the exterior of the combustion chamber into a series of segments. The segments divide the total expansion by the number of segments and further provide an area into which the piston may expand. The bottom of the slots should follow an isothermal temperature line as closely as possible. However, in no case should the depth of the slot be such that it will weaken the piston. If the circumferential mass or outer portion of the combustion chamber is too thin to permit sufficiently deep slots or divisions, I may nevertheless make the slots sufficiently deep to relieve the thermal stresses. Then the gas load or pressure stresses may be taken care of by reinforcing or thickening the piston along the inside under the slots, as at **36**.

The outside of the piston **10** may have a plurality of suitable piston ring grooves **38** formed therein. I have found that when the grooves **38** are placed near the top or combustion end of the piston when the outer portion of the piston expands the piston rings will be twisted in the piston ring grooves. The expansion of the combustion surface will cause the top of the piston to be canted outwardly toward the cylinder walls. This will cause the piston ring to unevenly rub or scrape the cylinder walls. This is an undesirable feature as it causes uneven wear on both the rings and cylinder walls and breakage of the rings.

In Figure 4, I have shown a variant form in which the cylinder head, indicated generally at **40**, has a downwardly disposed circumferential lip or shoulder or mass **42** which extends somewhat inside of the cylinder liner **44**. The cylinder head forms a combustion chamber **46** with the piston **48** and a suitable fuel supplying device, such as an injection nozzle **50** may be mounted in the cylinder head at or adjacent the center thereof.

It will be noted in this case that the upper surface **52** of the piston is truncated upwardly somewhat, instead of being dished or concave, as in Figure 1. But nevertheless the parts define what I shall refer to as a combustion chamber which is axially flattened somewhat and extending radially and circumferentially outwardly. In this case the mass or depending circumferential shoulder **42** forms the outer portion that defines the outside of the combustion chamber. It is in this area that the heat stresses will be set up since the spray pattern from the injector **50**, shown generally at **54**, will impinge or be aimed at the depending portion **42**.

I therefore place a plurality of slots **56**, each disposed radially, and spaced about the cylinder head to divide the mass into a plurality of separate or independent arcuate segments, each of which is free to independently expand and contract. But at the same time the segments combine to define a combustion chamber with the proper geometry. As before, the slots may end in an enlarged channel or opening **58** to avoid stress concentration in the bottom of the slots. As was also true in the piston the number and placement of the slots is not essential. However, in preferred form the slots will be evenly spaced around the circumference of the cylinder head.

My invention then comprises a piston and cylinder head either of which or both may have their opposing faces or combustion surfaces radially slotted to reduce heat stresses normally formed therein. In some applications it may be desirable to only slot the piston whereas in others it may be desirable to slot the cylinder head. There also might be applications wherein it was advantageous to slot both the cylinder head and piston.

The use, operation and function of my invention is as follows:

Shown and described herein is a means for reducing heat stresses normally formed in the combustion surfaces of cylinder members. The particular construction shown could be applicable to a diesel engine, however, there are numerous other types of engines to which the construction is equally applicable. In a diesel engine cylinder the interior of the piston and cylinder head combustion surfaces are at a lower temperature than the outside. This causes heat stresses to be formed in the cylinder head and piston which in turn may cause distortion or cracking of these members after short use. By slotting the opposed surfaces or combustion surfaces of the cylinder head and piston I have reduced the amount of expansion and have provided an area into which these members may expand.

When the piston has a depending skirt, such as shown in the drawings, the stresses in the top of the piston are similar to those of a clamped plate. There are high radial stresses and relatively minute tangential stresses. The radial slots of the invention provide all the advantages setforth herein on engines having a high gas load, but do not increase the radial stresses.

I have placed a radial bore in alignment with each slot at the bottom thereof to reduce the stress concentration which is normally formed at the bottom of a slot. The particular depth of the slot is not important, however generally the bottom should follow an isothermal temperature line. It should be understood that neither the piston nor cylinder head should be slotted to a depth which would materially reduce the strength of these members. It is important that the strength not be reduced below load requirement as by so doing any advantage secured by slotting these members would be lost.

Another cause of damage in cylinders is the uneven rubbing of the piston rings on the wall of the cylinder. This is caused by the fact that the rings closest to the combustion surface of the piston will be flexed or bent outward due to the expansion of the combustion surface. These rings then will rub on the cylinder wall more than the rings further away from the combustion surface. The uneven rubbing of the piston rings will damage both the cylinder wall and the piston rings. By reducing the expansion I have all but eliminated this problem.

In a sense my invention is a particular form of combustion chamber or the parts or elements that go to define or make up the combustion chamber. The outer portion of the combustion chamber, be it a part of the piston as in Figure 1 or in the cylinder head, as in Figure 4, is subjected to the highest temperature. If the outside of the piston, for example, is substantially hotter than the central portion, the piston may pull itself apart. I sub-divide or otherwise form the outer mass or outer formation into a plurality of segments, each being free to independently expand and contract, so the inner and outer portions of the piston are free to expand and contract on their own.

This arrangement has advantage in both a diesel or oil and a gas engine. For example, in a diesel engine it is well known that the rate of combustion or fuel burning is too slow, and engineers are always seeking ways and means to speed it up. In Figure 1, the annular mass **28** will be hotter than the jets or spray **26** while moving out toward it. Burning starts on the outside of the spray of fuel and works in toward the center. Heat will therefore flow from the annular mass **28** to the spray and will speed up the rate of combustion. But at the same time, the mass will not pull the piston apart since the load segments expand and contract on their own. The result is a combustion chamber that will speed up the rate of combustion but will not pull itself apart.

In a gas engine, the situation is somewhat reversed.

The mixture is ignited by a spark plug which normally is somewhat centrally located. The flame starts generally at center and works its way out. The annular mass, such as at **28** in Figure 1, will therefore be cooler than the mixture directly next to it. Heat will therefore flow from the mixture into the mass. The slots or divisions through the mass create more surface area and, accordingly, the rate of heat transfer from the mixture to the mass and through the walls of the combustion chamber will be increased. Therefore, the combustion chamber will reduce the tendency of an engine to detonate, since the rate of combustion will be slowed up.

The invention is not limited to the specific details of construction described and illustrated in the accompanying drawings, but covers all modifications coming within the scope of the following claims.

I claim:

1. An engine cylinder member having a combustion surface, said combustion surface having a raised outer edge and a generally recessed center area, said surface further having at least one radial slot formed therein.

2. An engine cylinder member having a combustion surface, said combustion surface having a plurality of radial slots formed therein, and a radial bore aligned with and forming the bottom of each of said radial slots.

3. An engine cylinder member having a combustion surface, said combustion surface having a plurality of evenly spaced radial slots formed therein, and a radial bore aligned with and forming the bottom of each of said radial slots.

4. A means for reducing heat stresses caused by uneven temperature distribution in the combustion surfaces of engine pistons including a plurality of radial slots formed in said combustion surface.

5. A means for reducing heat stresses caused by uneven temperature distribution in the combustion surface of engine pistons including a plurality of radial slots formed in said combustion surface, a radial bore aligned with and forming the bottom of each of said radial slots and having a diameter slightly greater than the width of said slots, said slots being evenly spaced around the circumference of said piston.

6. A piston including a combustion surface having a raised outer edge and a generally spherical center area, said surface having a plurality of radial slots spaced evenly therearound.

7. A piston including a combustion surface having a raised outer edge and a generally spherical center area, said surface having a plurality of radial slots, and a radial bore aligned with and forming the bottom of each of said radial slots.

8. The structure of claim 7 in which the diameter of the bore is greater than the width of the slot.

9. A cylinder head including a combustion surface having a raised outer edge and a generally recessed center area, said surface having a plurality of radial slots spaced evenly therearound.

10. A cylinder head including a combustion surface having a raised outer edge and a generally recessed center area, said surface having a plurality of radial slots, and a radial bore aligned with and forming the bottom of each of said radial slots.

11. The structure of claim 10 in which the diameter of the bore is greater than the width of the slot.

12. For use in an engine, a plurality of elements defining a combustion chamber and including a cylinder head and piston, the combustion chamber being somewhat flattened in an axial direction and extending circumferentially outwardly from the axis of the cylinder head and piston, at least one of the elements having an annular mass surrounding and defining an exterior portion of the combustion chamber, and a radial formation in the annular mass causing differential thermal expansion between the inner and outer portions of the said one element.

13. The structure of claim 12 further characterized in that the annular mass is divided circumferentially into a plurality of segments.

14. The structure of claim 13 in which all of the segments are approximately equal in circumferential extent.

15. For use in an engine, a plurality of elements defining a somewhat symmetrical combustion chamber which extends circumferentially outwardly from a central axis and is somewhat flattened in an axial direction, at least one of the elements having an annular, exterior mass surrounding and defining an exterior portion of the combustion chamber, the mass being divided into a plurality of circumferential segments.

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