

[54] GLOW PLATE FOR INTERNAL COMBUSTION ENGINE

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[58] Field of Search..... 123/193 CP, 193 P; 92/176, 92/216, 224; 29/156.5

[56]

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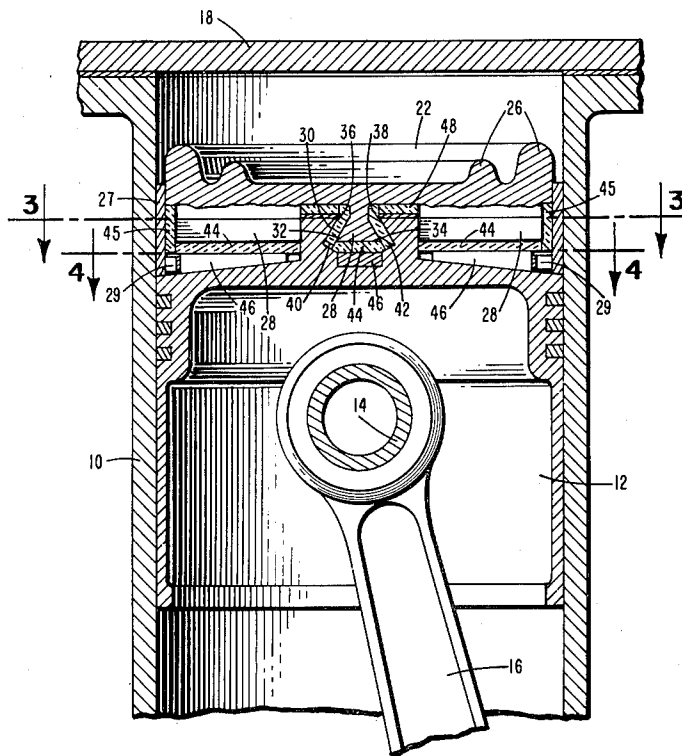
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[57]

ABSTRACT

A high thermal capacity plate and means for mounting the plate in the combustion chamber of an internal combustion engine. The mounting means maintains the plate in spaced and insulated relationship from the cooled surfaces so it will maintain a higher temperature to better vaporize fuel in the chamber.

10 Claims, 8 Drawing Figures



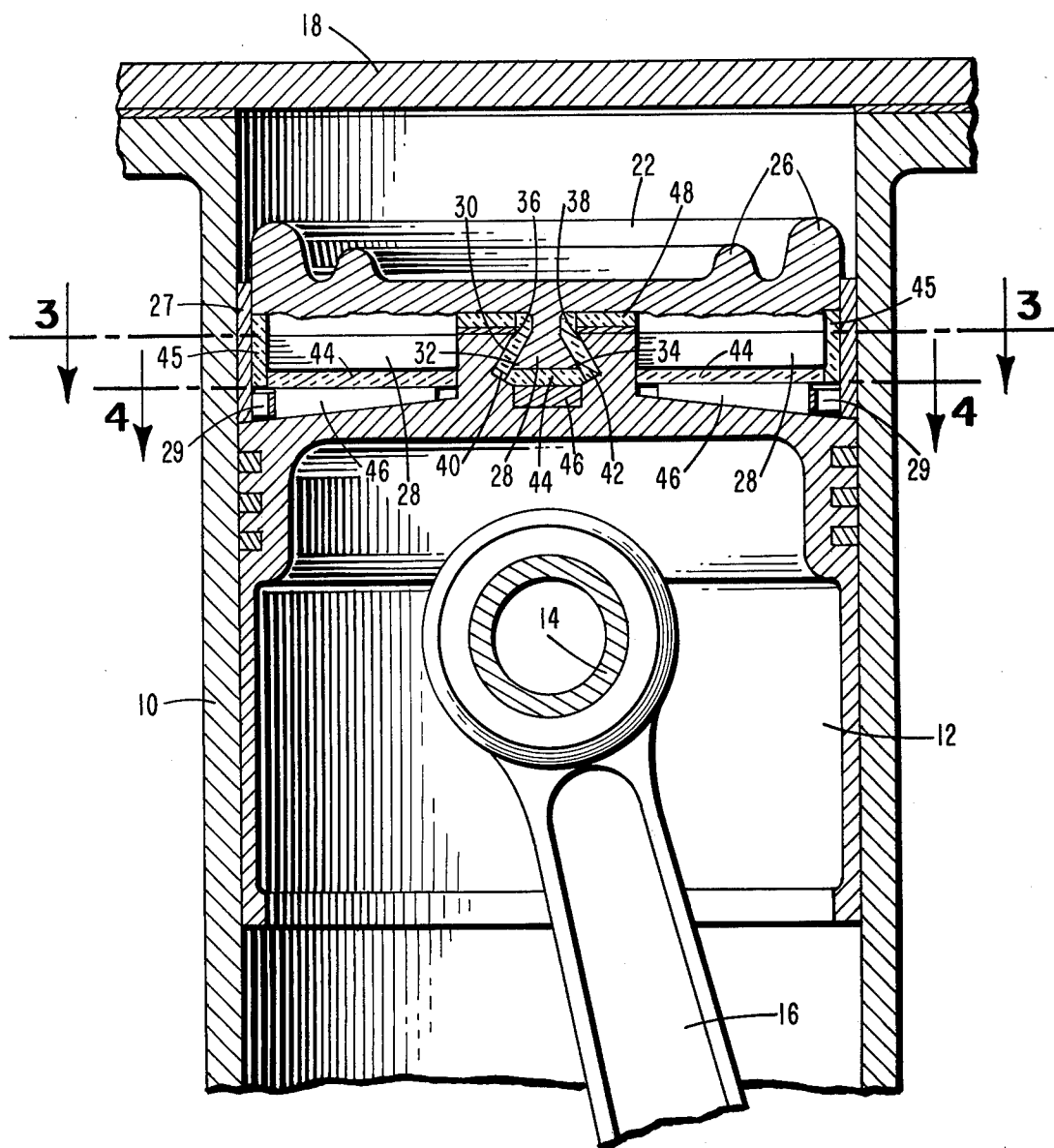


FIG. 1

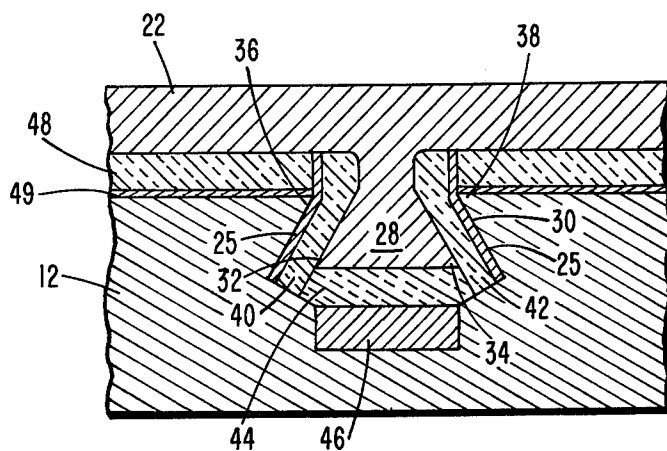


FIG. 2

FIG. 3

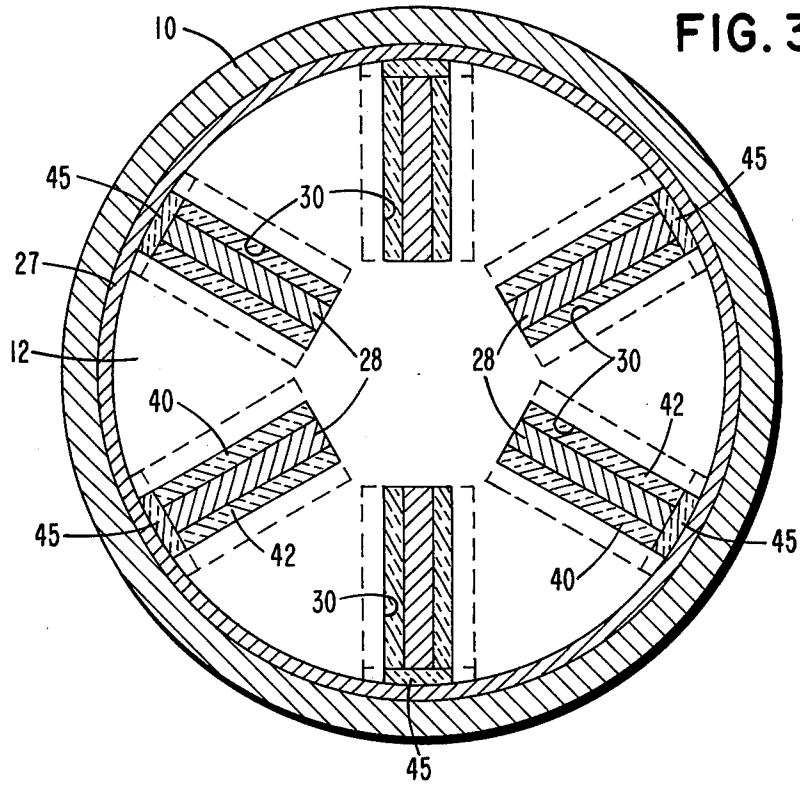
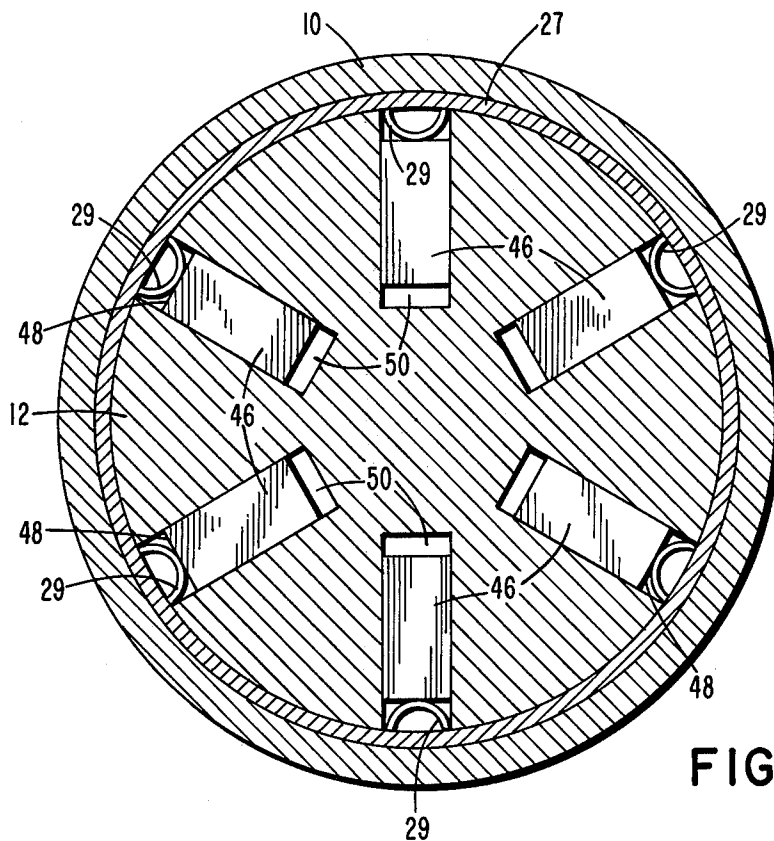
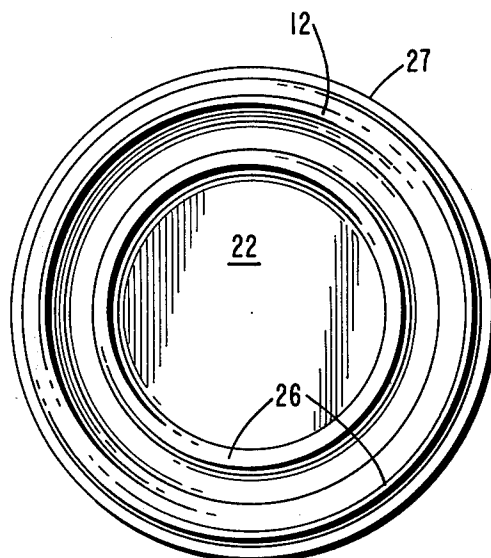
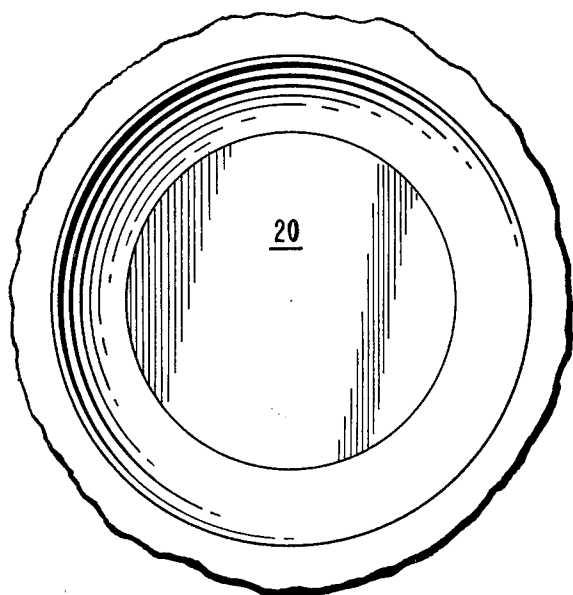
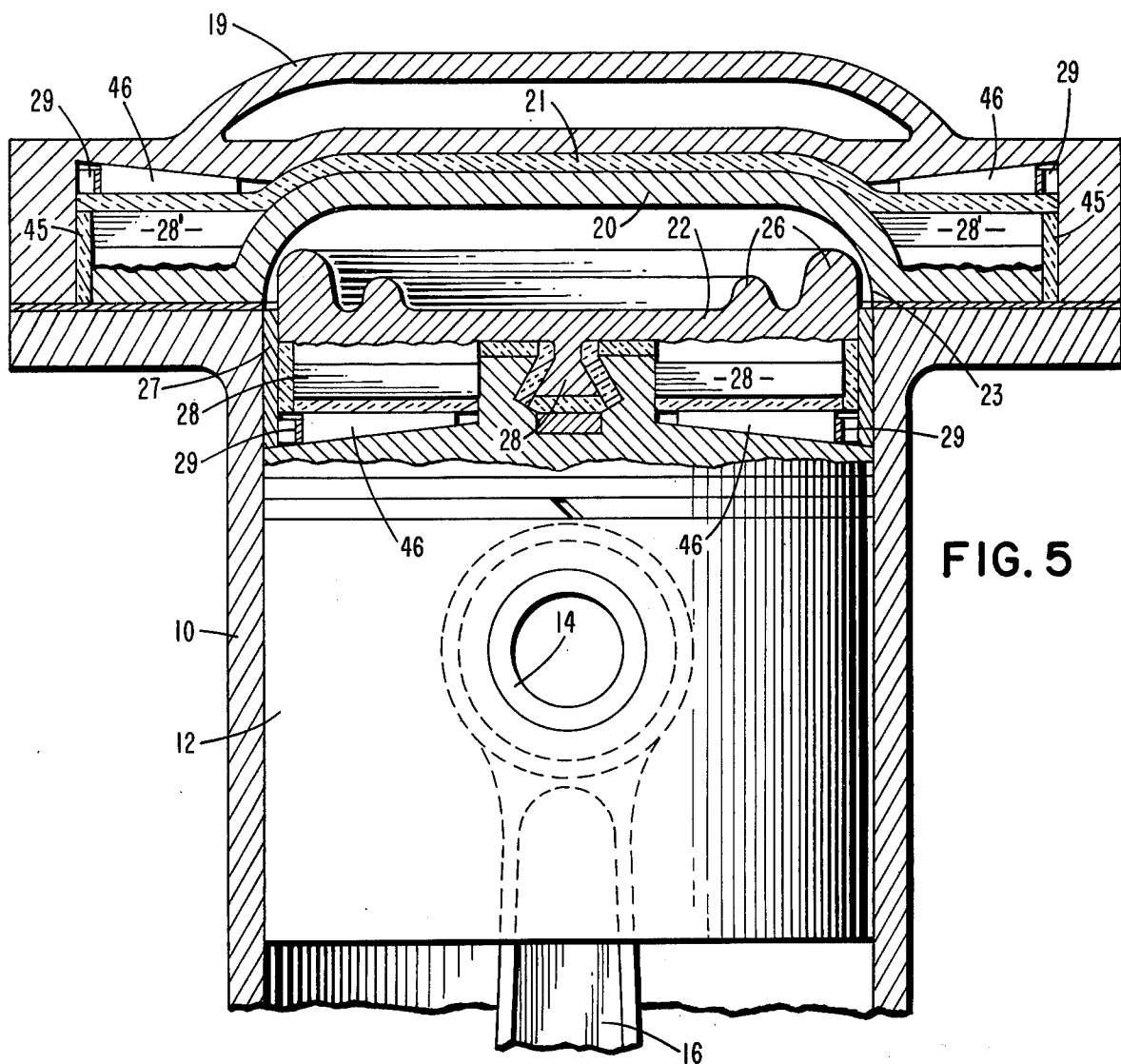


FIG. 4





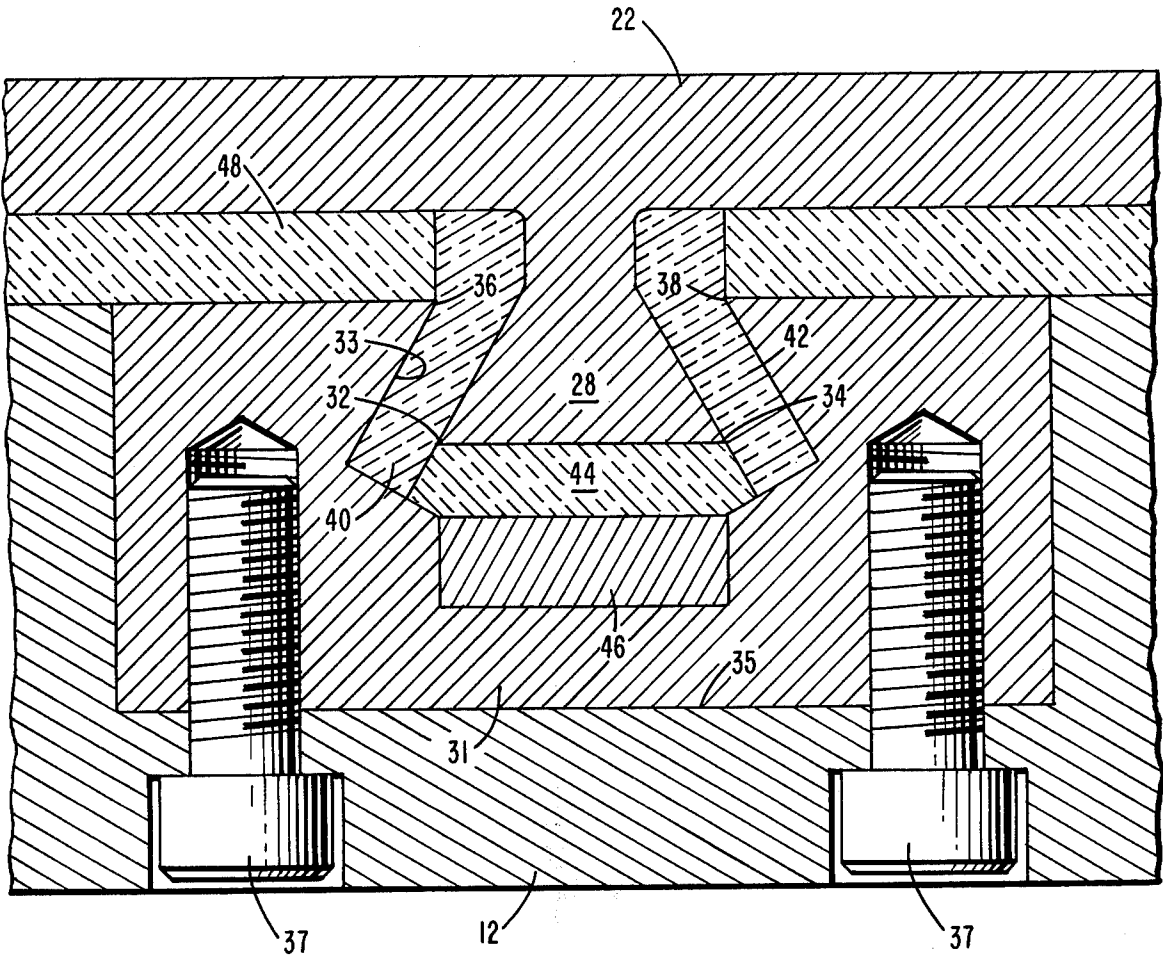


FIG. 8

GLOW PLATE FOR INTERNAL COMBUSTION ENGINE

BACKGROUND OF THE INVENTION

This invention relates to internal combustion engines and more particularly to means for increasing the efficiency and decreasing the pollution output of such engines by maintaining the combustion chamber temperature at a higher level. The invention is especially useful in diesel engines but it is contemplated to be applicable to any types of internal combustion engines in which fuel is injected and burned by heat such as a conventional reciprocating diesel engine or a rotary engine such as the Wankel Engine.

It is well known in the art that high surface temperatures within the combustion chamber are desirable to promote better fuel vaporization, decrease carbon accumulation and decrease the emission of pollutants in the exhaust gases since the higher temperatures will result in a much higher percentage of hydrocarbons being completely oxidized. This produces higher engine efficiency, reduces fuel consumption and avoids the problems of attempting to decrease hydrocarbon exhaust content after the gases have left the engine. Despite the recognition of the desirability of high surface temperatures within the combustion chamber the prior art has experienced considerable difficulty in obtaining this goal.

RELATED PRIOR ART

To accomplish the above results there must be some sort of insulation between the combustion chamber or parts thereof and the remainder of the engine. In the past various types of coating materials have been applied to the combustion chamber wall surfaces such as in U.S. Pat. No. 3,552,370 of Jan. 5, 1971 to Briggs. Other attempts have included particulate insulating material imbedded in the top of the piston such as in U.S. Pat. No. 3,149,409 of Sept. 22, 1964 to Maruhn or the securing of an insulating layer to the piston and combustion chamber walls such as in U.S. Pat. No. 3,408,995 of Nov. 5, 1968 to Johnson.

The main difficulty with prior art attempts has been to produce a durable effective insulating liner which will remain adhered to the combustion chamber walls and withstand the thermal expansion and the stresses of the combustion cycle.

PROBLEMS IN THE ART

The problem of maintaining a high combustion chamber temperature is especially acute in diesel engines since a heavy liquid fuel is injected into the cylinder against the peak of internal compression. Since the fuel is incompletely vaporized much of the burning takes place on the suspended fuel globules. Some fuel survives burning and strikes the lubricated cylinder walls and degrades the lubricant to some extent. It is thus desirable to have a metal plate attached to the top of the diesel piston and insulated from it so that it will remain at a higher temperature. Similarly the cylinder top can be lined with a thermally conductive shell, insulated from the water cooled structure above. It is also advantageous that the piston stroke is markedly oversquare, that is, the stroke is shorter than the piston diameter so that less cylinder wall will be exposed (and subsequently delubricated) in operation. Both a piston plate and a head liner will then become glowing hot as

the engine is run. Any heat which flows past the piston plate insulation will be dissipated by the piston skirt against the water cooled cylinder wall and also by the lubricating oil. Heat lost by the head liner is carried away by the water cooled structure above.

THE PRESENT INVENTION

The purpose of this invention is to provide a thermally insulated lining for the firing chamber of a diesel engine. The stress problems of differential expansion, the looseness and flaking encountered in prior art attempts, are avoided.

A high thermal capacity material lining, preferably a metal, insulated from the surrounding structure is attached to the piston top and preferably also to the cylinder head. The linings can be fairly massive plates of metal, having high thermal conductivity and capacity. In the course of operation the plates reach glowing temperature. They may be called glow plates. A number of advantages follow from the cylinder insulation, some of which have long been recognized. This invention provides a practical solution to the problem of insulating the glow plates and accommodating their expansion.

The underlying concept of this invention is to mount each glow plate on insulated ways which lie along lines of expansion. By this means the glow plate is held with no play on a cooled piston top or cylinder head, but it can expand freely as it is heated. The concept will become clearer by examining some basic properties of uniform expansion.

SOME PROPERTIES OF UNIFORM EXPANSION

A Disc

Let the center of a disc be held stationary with respect to a supporting plane. The disc alone is then uniformly heated. The movement of any mark on the disc due to expansion will be along a line through the mark and the center.

If another point, such as one on the periphery of the disc is held stationary, the movement of a mark on the disc will be along a line through the stationary point and the mark.

Sliding ways, which permit only one direction of relative motion, are attached between the disc and supporting plane. They lie along the radial expansion lines from the fixed point. Then the disc can expand freely, but it cannot be raised, moved off center, or rotated. The fixed point need not be attached. The convergence of the ways determines it. In principle, only two sliding ways determine the fixed point. The ways need not extend across the width of the disc.

A Curved Lining

The preceding is obviously applicable to the case of a glow plate covering the top of a diesel piston, with the center of the plate held fast. The glowing lining for the cylinder head will not in general be flat, circular or even symmetrical, due to the placement of valves and injectors. On a homogeneous uniformly heated shell, curved in three dimensions, the motion of a given point lies along a line from the selected stationary point through the given point. In general the expansion lines for different points will lie in different planes, and so must the ways.

The convergence point of the expansion lines may lie outside the expanding object. This case may be treated

as if the object material had been extended to that point.

If the shell is neither uniformly heated nor homogeneous, the stationary point is selected, and the ways placed along the measured lines of expansion.

According to this invention it is more desirable to provide a surface within the combustion chamber which can be maintained at a higher temperature than it is to merely insulate the walls of the chamber. This invention pertains to plates which, under operating conditions, will be glowing hot; thus the term "glow plate" as previously mentioned, will be used in the description herein.

In view of the above discussed problem, principal objects of the present invention are to provide an internal combustion engine, particularly a diesel engine, which will operate at a higher combustion chamber temperature leading to more efficient use of the fuel and fewer polluting exhaust products.

Another object of this invention is to provide glow plate surfaces within the combustion chamber which will be hot enough to better vaporize the fuel and promote spattering and more complete combustion of it.

A further object of this invention is to provide means for mounting such glow plates which will not only insulate them from the surrounding engine structure but also compensate for thermal expansion thereof.

DESCRIPTION OF A PREFERRED EMBODIMENT

Other objects and advantages of this invention will become apparent from a review of the attached drawings which are furnished by way of example only and not of limitation in order to illustrate a preferred embodiment in which:

FIG. 1 is a sectional view through a cylinder head and piston of an internal combustion engine, the piston having a glow plate and securing means of the present invention;

FIG. 2 is a detailed cross section showing a modified means for securing the glow plate to the top of the piston;

FIG. 3 is a sectional view along line 3—3 of FIG. 1;

FIG. 4 is a sectional view along line 4—4 of FIG. 1;

FIG. 5 is a sectional view through a cylinder head and piston of an internal combustion engine, both the head and the piston having a glow plate according to the present invention attached thereto;

FIG. 6 is a plan view of the interior of the cylinder head;

FIG. 7 is a plan view of the top of the piston;

FIG. 8 is a cross section similar to FIG. 2 but of an alternative embodiment.

Turning now to the drawings in greater detail, FIG. 1 shows a cylinder 10 having a piston 12 mounted therein for reciprocal movement with a wrist pin 14 securing it to a connecting rod 16 in a conventional manner. The cylinder 10 has a cylinder head 18 secured thereto also in conventional manner. A piston glow plate 22 is secured to the top of the piston by the means of this invention as will be explained later in detail. Piston glow plate 22 preferably has an irregular surface 26 to increase its surface area and promote better fuel vaporization and also to impede the flow of liquid fuel to the cylinder wall.

In the embodiment of FIG. 1 the glow plate 22 is secured to the top of the piston 12 by means of a downwardly projecting inverted V shaped portions 28 which

fit into complimentary shaped sectors 30 formed in the top of the piston. The widest part of the portion 28 is defined by corners 32 and 34 and the distance between these corners is just slightly less than the distance between edges 36 and 38 of sector 30.

FIG. 3 shows that there are a plurality of inverted V-shaped portions 28 around the circumference of the glow plate and the piston top; in this particular instance six are shown for purposes of illustration although the number may be varied as needed. To install the glow plate on the piston the glow plate is moved vertically into place so that corners 32 and 34 will fit between edges 36 and 38 of the sector. Pieces of insulation 40, 42 and 44 are then slid radially into place from the periphery of the piston so as to surround the portion 28 and hold it in spaced and insulated relationship from the piston top. A wedge 46 is then slid radially into place under insulation block of 44 so as to compress that block against the under side of portion 28 which is in turn pushed against insulation pieces 40 and 42 so as to form a secure seating against the insulation, holding the glow plate rigidly in place. It is to be understood that the remaining portions around the periphery of the piston are similarly secured. The remaining space between the underside of the glow plate and the top of the piston is filled with a similar insulation material 48, a compound sold under the name of "Fibrefrax" (Al_2O_3 51.7%, SiO_2 47.6%) (a registered trademark of Owens Corning) being found to be quite satisfactory although any insulation material which is relatively incompressible, such as a ceramic material, could also be used. If necessary, the insulation 48 may be cemented to the top of piston 12 by suitable cement 49 as seen in FIG. 2.

The wedges 44 are held in place by U-shaped springs 29 (see FIG. 4) which bear against the end of 48 of the wedge 46 to hold the wedge firmly in place. The wedge is not as long as the opening or way in the sector 30, thus defining a space of 50 (see FIG. 4) between the distal end of the wedge and the end of the way. Thus, if any later compression of any of the insulation pieces 40, 42 or 44 takes place, the wedge will be forced farther along the way by the spring 29 and pick up the additional space so that a rail portion 28 is still held firmly in place.

Pieces of insulation 45 fill the space between the outer ends of rails 28 and insulation pieces 40, 42 and 44 and band 27.

The U-shaped springs 29 are held in place by a suitable end covering over the sectors 30; in the embodiment shown in FIGS. 1, 3 and 4 it is held by a band 27 which is heat-shrunk over the piston to surround the end of the springs 29 to hold them securely in place.

FIG. 2 discloses a modified embodiment of the securing means shown in FIG. 1 in which the insulation pieces 40 and 42 have outer metal facings 25 which are thick enough to make the upward stress on the insulation largely compressive. Simultaneous compression perpendicular to the direction of shear, strengthens the insulation in shear.

In the alternative arrangement of FIG. 8, the sector 31 which holds the rail 28 has an entrance slot defined by edges 36 and 38 which is narrower than the widest part of the rail 28. In this arrangement the sector 31 is a rectangular block with a V-shaped slot 33 which must be slid radially in from the end of the rail along with the insulation and the spring loaded wedge. Sector 31 may

be secured in the piston in a suitable slot or trough 35 with the aid of screws 37. It can be applied when the end of the channel is not accessible for sliding in the end of the insulation. The open end of each channel must of course be closed and this can be done with an appropriate cross piece such as the band 27 previously described. As previously indicated, any other space between the glow plate and the piston top is preferably also filled with insulation 48. The insulation for the ways may be cut transversely, inserted in pieces as required. Transverse cuts without gaps cause practically no weakening since the insulation is contained by the channel and is stressed in compression and transverse shear.

The preceding is obviously applicable to the case of the cylinder head liner 20 (see FIG. 5) which also acts as a glow plate covering the top of the combustion chamber. This liner will in general not be circular or even symmetrical due to the placement of valves and injectors. On a homogeneous uniformly heated shell secured in three dimensions, the motion of a point on the shell away from the stationary point will lie along a line between the two points. The ways along such lines will not, in general, lie in the same plane. As in the case of the piston, the dead space between the liner and the cooled cylinder head 19 should be minimized by filling it with insulation 21 adhering to the cylinder head. If the shell is neither uniformly heated nor homogeneous, the stationary point should be selected and the insulated ways placed along the measured lines of expansion.

Rails 28 securing liner 20 to cylinder head 19 would preferably be of the cross-sectional shape of rail 28 shown in FIG. 2, but inverted. That is, with a flat upper surface and inclined sides sloping downwardly and inwardly to the vertical web. This avoids the stress concentration of a rectangular head. This sloping transition also fixes the rail laterally when wedge pressure is applied even if the insulation is somewhat loose before pressure. The rail is no longer in contact area than that required by strength. The temperature of the glow plate is of course continual rather than intermittent during the cycle and thus the insulation must be of the highest quality such as an adhesive refractory insulation similar to Fibrefrax (Al_2O_3 51.7%, SiO_2 47.6%) tamping mix.

Although it would be ideal to have all surfaces of the combustion chamber covered by the glow plates of the present invention, it is realized that practical considerations such as complex shapes of the combustion chamber may make this difficult. It is contemplated that a glow plate may be placed in only one part of the combustion chamber such as on the head of the piston. In such case it would be desirable for the glow plate to have sufficient mass to store enough heat to maintain a proper temperature despite the possibility of heat loss through the uncovered surface areas of the combustion chamber.

In an embodiment such as shown in FIG. 5 where a head liner is used, the liner glow plate 20 is held in place by rails 28 and wedges 46 which are similar in cross section to the rail 28 of FIGS. 1 and 2. A plurality of these rails are spaced around the periphery of the liner in a manner similar to that shown in FIGS. 3 and

4, that is the rails (and their ways) do not extend to the center of the liner. The ways may be cut into the head to receive the corresponding rails and insulation is placed between the rails and ways, as in the manner previously described with suitable sealing of the grooves afterwards.

It should be noted that the lower edge 23 of the head liner 20 extends down to overlap the raised rim 26 of the piston glow plate so that any fuel globules spattered and vaporized against a glow plate surface rather than against a cooled lubricated surface. The contour of the glow plate surfaces shown has been chosen to cause fuel particles or globules to bounce from one to the other and especially to lead them away from the periphery of the piston to prevent unburned fuel from descending along the cylinder walls.

The above description is given by way of example only and is not considered to be a limitation of the scope of the invention which is defined by the following claims.

What is claimed is:

1. A device for increasing the efficiency of an internal combustion engine having a cylinder and a moveable member therein comprising:

a. a thermally conductive plate carried by the moveable member said plate and member having surfaces facing each other;

b. means between the plate and member to hold the plate in spaced apart relation from the member while permitting thermal expansion of the plate comprising a plurality of discrete rail means projecting from one of said surfaces along lines of thermal expansion of the plate, the other surface having complementary rail retaining means receiving said rail means.

2. The device of claim 1 in which the plate has sufficient mass to store heat to vaporize fuel on contact therewith.

3. The device of claim 1 in which the outer surface of the plate is non-planar to increase its surface area.

4. The device of claim 3 in which the non-planar surface has ridges to direct fuel and vapor axially in the cylinder.

5. The device of claim 1 including biasing means between the rail means and the retaining means.

6. The device of claim 5 in which the biasing means is a wedge with a spring to maintain it in place.

7. The device of claim 1 including insulation means between the rail means and the retaining means.

8. The device of claim 7 in which the insulation means comprises blocks of a hard non-compressible material having a metal sheath on at least one side to facilitate insertion along the rail.

9. The device of claim 1 in which the rail means has a triangular cross section with one side of the triangle facing toward the rail retaining means, the retaining means being a similar triangular shaped groove having a mouth slightly wider than said one side of the rail.

10. The device of claim 9 in which the cross sectional area of the triangular shaped groove is greater than the cross sectional area of the rail means with the space between them being filled with insulation.

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