March 17, 1964 F. M. STANSFIELD ETAL 3,125,082

INTERNAL COMBUSTION ENGINE CYLINDER HEADS

Filed Feb. 20, 1962 2 Sheets-Sheet 1

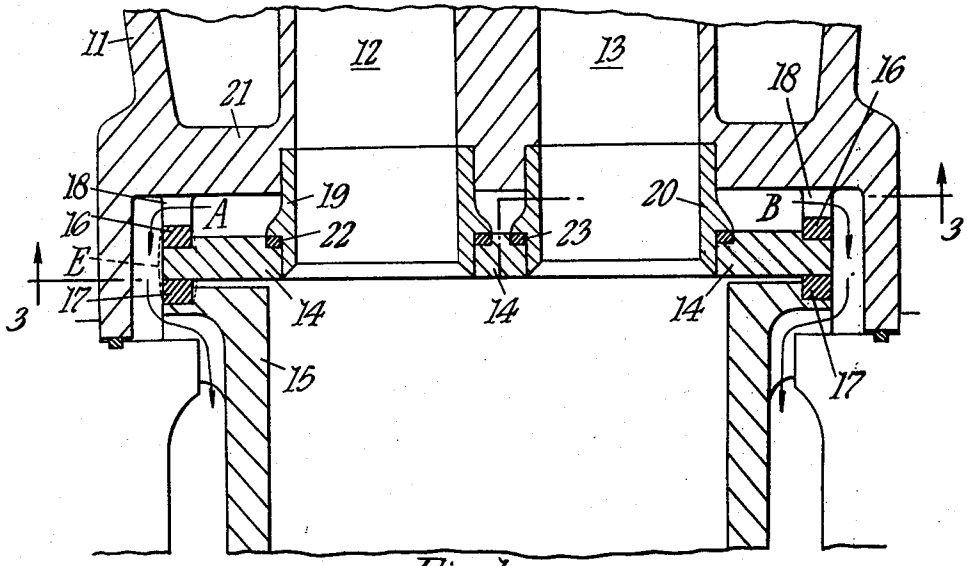


Fig. 1.

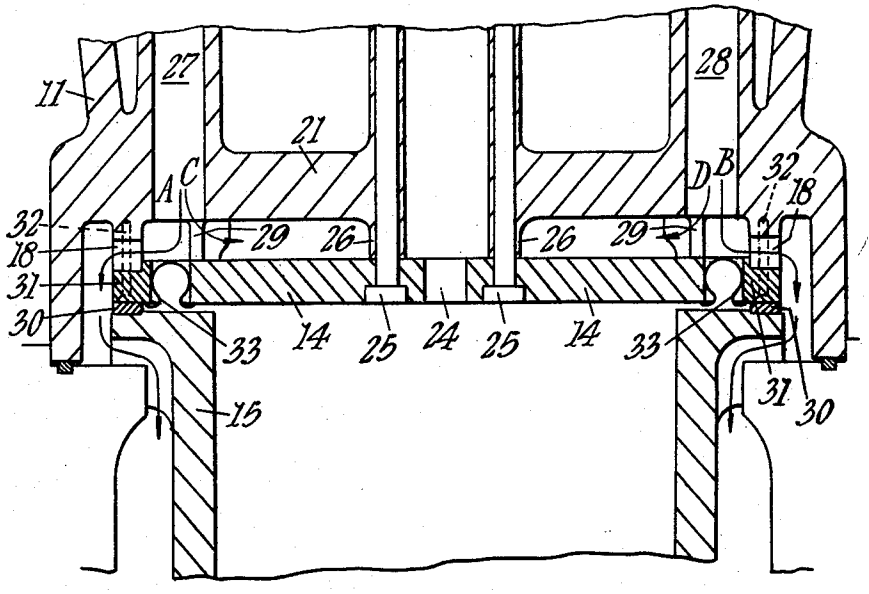


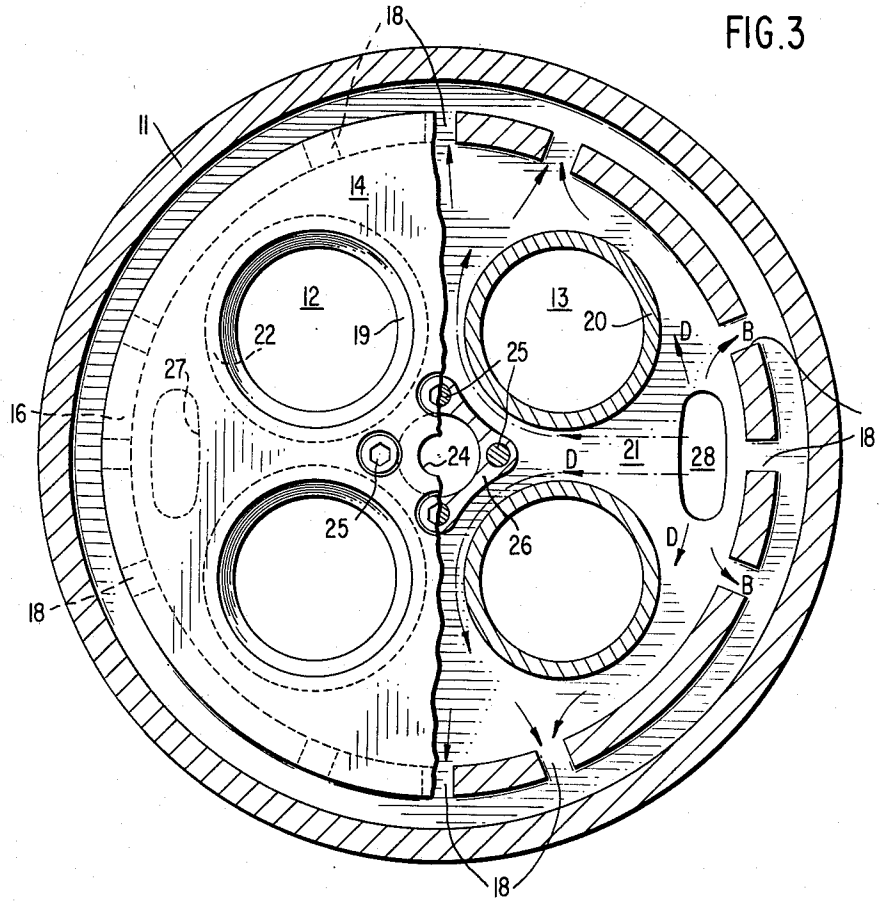
Fig. 2.

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FIG.3



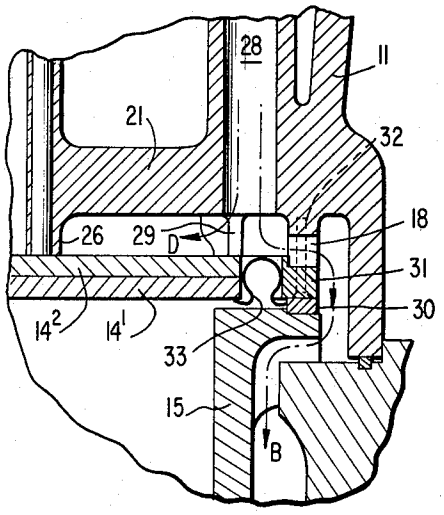


FIG.4

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INTERNAL COMBUSTION ENGINE CYLINDER HEADS

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This invention relates to improvements in the design and construction of cylinder heads for internal combustion engines, particularly but not exclusively for compression-ignition, overhead valve engines, and the object of the invention is to provide a method of and means for counteracting distortion and cracking of thermally stressed parts.

The raising of the specific power of internal combustion engines by increasing power ratings has resulted in the parts bounding the combustion space being subjected to severe thermal expansion and contraction, giving rise to many effects such as "crazy" cracking and corrosion of the surface skin, thermal distortion and displacement of parts, cylinder head gasket failures, and cracking in parts of unequal thickness. The worst effects are encountered in the hot wall or deck of the cylinder head separating the head from the combustion space, wherein inlet and exhaust valve ports and seats; injector or sparking plug holes; air starter holes and the like involve unequal thicknesses and openings in the material of the said deck, the resulting temperature distribution leading to high thermal stresses.

The invention alleviates these effects by providing a separate, removeable, and replaceable fire plate as a combustion space wall or deck of a cylinder head, a small area only of the said fire plate, preferably a substantially central area, being rigidly secured to a comparatively cool part of the cylinder head, the remaining area being substantially free to expand, contract, and to assume a degree of curvature or dishing, thus avoiding the development of high stresses associated with rigid restraints: movement of the fire plate due to thermal distortion being accommodated at its periphery by non-rigid or kinematic connection thereof with cylinder head sealing means.

The invention also includes a method of rigidily securing a part of each contiguous component such as valve seat inserts to a comparatively cool part of the cylinder head, other parts of such components being a clearance fit in the said fire plate, so that distortion in the said fire plate should not substantially distort the said components.

The invention also includes a coolant flow arranged around the central circumferences of the valve seat inserts between the part of such inserts rigidly connected with a cool part of the cylinder head and the part of such inserts being a clearance fit in the fire plate, the said coolant flowing over substantially the whole area of the cool side of the fire plate not occupied by valves, injector, or the like associated parts. The coolant flow may also be directed past the periphery of the sealing means between the cylinder head and its associated cylinder or liner.

In the following description and the drawings accompanying the provisional specification, the invention is applied by way of example only to a water-cooled compression-ignition overhead valve engine, with two air inlet and two exhaust valves symmetrically disposed around a central injector coaxial with the piston.

FIGURE 1 is a sectional view in a vertical plane of part of a cylinder head and liner sectioned through two of four valve ports, showing a form of peripheral support for the fire plate which provides freedom to expand and contract and to assume a limited amount of curvature;

FIGURE 2 is a centrally sectioned elevation of the cylinder head, showing an alternative method of peripheral support for the fire plate which provides freedom to expand and contract and to assume a considerable degree of curvature;

FIGURE 3 is a section on the lines 3—3 of FIGURE 1, and

FIGURE 4 is a view similar to FIGURE 2 but including a portion thereof to show a modified form of the fire plate 14.

Referring to FIGURE 1, a cylinder head 11 having four valve ports, of which two, 12, 13, are shown, is fitted with a flat, circular, removeable fire plate 14 acting as the combustion space deck of the cylinder head. The periphery of fire plate 14 extends radially over liner 15, and is coaxial therewith. Gas and coolant sealing means include an upper seal 16 and lower seal 17. The cylinder head sealing load is transmitted through seals 16, 17, and the periphery of fire plate 14. A downwardly projecting ring on the cylinder head engaging with upper seal 16 may have a plurality of gaps 18 therein to allow passage of coolant to flow from cylinder head 11 to the exterior of liner 15 in the direction of arrows A, B. Seals 16, 17, may be rectangular in section and made from a material such as copper, or a combination of materials having sufficient elasticity to yield with any radial distortion of the fire plate 14. A comparatively small central area of the fire plate is rigidly secured to the cylinder head as described below in connection with FIGURE 2. The principle of seals 16, 17, is to afford an adequate seal plus a small degree of freedom of radial movement for the periphery of plate 14 while preserving its sealing and load transmitting contact with associated parts. Dotted lines E indicate the possible radial expansion and contraction of plate 14 and the accommodation thereof by seals 16, 17. A limited amount of fire plate curvature in the unsupported portion of the plate 14 is possible with this form of seal.

Also shown in FIGURE 1 is the method of valve seat insert support. The upper circumferences of inserts 19, 20, are shrunk into, or otherwise rigidly secured to intermediate deck 21, which, being remote from the combustion space is comparatively cool and positionally stable. The lower circumferences of inserts 19, 20, are a clearance fit in fire plate 14, and the central circumferences thereof are exposed to the coolant circulating in and around the space between intermediate deck 21 and substantially the whole area of the cool side of fire plate 14 and inserts 19, 20, which may be flanged to hold seals 22, 23, in position. The clearance fit between fire plate 14 and the lower circumferences of valve seat inserts 19, 20, ensures that any thermal distortion of plate 14 has a minimal effect on the inserts 19, 20, and the direct cooling of the central circumferences thereof further reduces any tendency to loosen or distort the said inserts. Other associated parts, for instance, an injector, may be secured and sealed and cooled in a similar manner, or in any other suitable way.

Referring to FIGURE 2, a central injector hole 24 is surrounded by four equi-spaced bolts 25 (of which two are not visible in this section) rigidly securing fire plate 14 through a boss 26 and intermediate deck 21 to a top deck (not shown). The boss 26 spaces the intermediate deck 21 from the fire plate 14 and allows coolant to circulate from ducts 27, 28, in the direction of arrows C, D, to cool all the above-mentioned parts and the valve seat inserts 19, 20 (FIGURE 1), issuing through the plurality of peripheral gaps 18 in the direction of arrows A, B, as described for FIGURE 1. Fire plate 14 is rigidly secured only in the comparatively small central

area around the injector hole 24. The periphery of the fire plate is shown as supported by an alternative method to that shown in FIGURE 1, being simply supported in one direction only by a number of projections 29 on the cylinder head disposed around the periphery of the fire plate, the area of the fire plate apart from the centrally secured area being substantially free to expand and contract, and, in this case, to assume a considerable degree of curvature. This freedom may be achieved in several ways: as shown by way of example in FIGURE 2, gas and coolant sealing load connection between cylinder head 11, fire plate 14, and liner 15 is achieved by means of a gasket 30 and an annular ring 31 preferably of the same cross-section as fire plate 14, being positioned coplanar with and extending coaxially around fire plate 14 leaving an annular gap therebetween. Screws 32 may secure ring 31 to cylinder head 11. A stainless steel spring ring 33 seals the annular gap between fire plate 14 and ring 31 from the combustion space on one side and the coolant space on the other side. The cylinder head gasket sealing load is transmitted through gasket 30 and ring 31, and it will be realised that although plate 14 and particularly the periphery thereof, may expand, contract, or bow in either direction, it cannot distort or displace ring 31 and cause failure of gasket 30 since it is not rigidly connected therewith, and in any case, distortion in plate 14 will not be excessive because of the cooling system. In some applications the cooling effect, allied with the fact that there are no unequal thicknesses in the fire plate, may reduce distortion to a level such as to allow valve seat inserts to be an integral part of the fire plate.

Referring now to FIGURE 3 which is a section on the lines 3—3 of FIGURE 1, this figure serves to show further the relationship between the valve seat inserts 19 and 20 and the coolant passage ways 18. The ducts 27 and 28 for the passage of coolant are also indicated in this figure in proper relation to the remaining parts of the structure.

Referring now to FIGURE 4 of the attached drawings, this is merely a portion removed from FIGURE 2 and showing a fire plate comprising a pair of superimposed plates 14^1 and 14^2. The lower layer, namely 14^1 may be steel or cast iron and the upper layer 14^2 may be aluminum or sintered alumina bonded to the upper or coolant side. Other alternatives would be steel or cast iron plate with sprayed ceramic on the combustion space side.

It will be understood that the examples given for the sealing and support of the fire plate periphery are capable of many variations without departing from the scope of the invention, and that the invention could be applied to types of cylinder head and combustion chamber other than that shown in the drawings.

The invention is not confined to any of the suggested materials, but it can be shown that where curvature of the plate is restrained by semi-rigid peripheral fixing as in FIGURE 1, a plate constructed of aluminium alloy on the coolant side and cast iron on the combustion space side, the thickness of the cast iron layer being 30 to 40 percent of the total thickness (excluding the height of cooling fins), shows a reduction of maximum stress to half of that in a wholly cast iron plate. For a given temperature difference between the hot gases and the coolant, the hot side metal temperature is very considerably less with this bimetal combination. These results are in comparison with a plate of the same total thickness constructed of cast iron alone.

Where, however, the plate is substantially free peripherally as in FIGURE 2, a plate constructed of a single material shows negligible thermal stress.

The invention simplifies cylinder head construction: the removeable nature of the fire plate allows easy access to the interior of the cylinder head for inspection or the fixing of instruments or indicators such as strain or temperature gauges; and replacement of the fire plate, if necessary, may save the replacement of the whole cylinder head.

What we claim is:

1. An internal combustion engine structure including a cylinder and a cylinder head therefor, a separate removeable, and replaceable fire plate interposed between said cylinder and said cylinder head and forming a combustion space wall or deck, said fire plate being a substantially flat plate, means rigidly but releasably securing a small area of the center of said fire plate to a comparatively cool part of the cylinder head, the remaining area of said plate being substantially free to expand and contract in its own plane, said cylinder head providing a coolant space above the top surface of said plate, and sealing means at the periphery of said plate providing a coolant seal between said plate and said cylinder and a gas seal between said plate and said cylinder, said sealing means permitting radial expansion of the periphery of said plate.

2. An engine structure according to claim 1 wherein said sealing means comprises rings of sealing material carried on opposite faces of the peripheral portion of said plate and having sealing engagement with ring areas of said cylinder head and cylinder, respectively.

3. An engine structure according to claim 1 wherein said sealing means comprises a separate ring surrounding the peripheral edge of said plate in spaced relation thereto and being sealed to said cylinder head and said cylinder, respectively, and a hollow metallic spring ring sealed within the annular space between the peripheral edge of said plate and said ring.

4. An engine structure according to claim 1 wherein said fire plate is constructed of one material on the face thereof which closes said combustion space, and is formed of a different material on the face thereof which closes said coolant space.

5. An engine structure according to claim 1 and including at least one valve seat insert passing transversely through said coolant space and having an upper end portion rigidly connected with a cool part of the cylinder head, the other end portion of said insert extending with clearance fit into an aperture in said fire plate, and sealing means engaging said insert to establish a seal between said insert and said coolant space and combustion space.

6. An engine structure according to claim 1 wherein said cylinder head is provided with passages communicating with said coolant space for directing said coolant past the periphery of said sealing means.

7. A cylinder head according to claim 5 in which a coolant flow is arranged around the central circumferences of the said valve seat inserts between their rigid connection with a cool part of the cylinder head and their clearance fit in the fire plate; the said coolant flowing over substantially the whole area of the cool side of the fire plate not occupied by valves, injector, or the like associated parts.

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