Oct. 1, 1968 D. E. VALENTINE ET AL 3,403,661

ENGINE CYLINDER BLOCK AND LINER SEAL CONSTRUCTION

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Fig. 2.

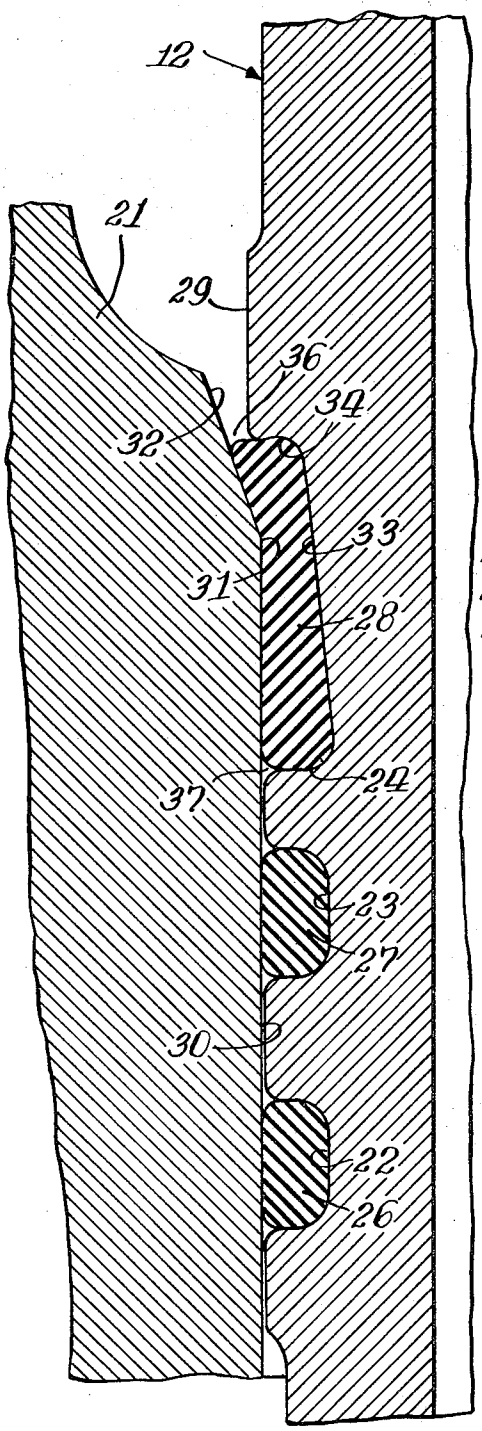
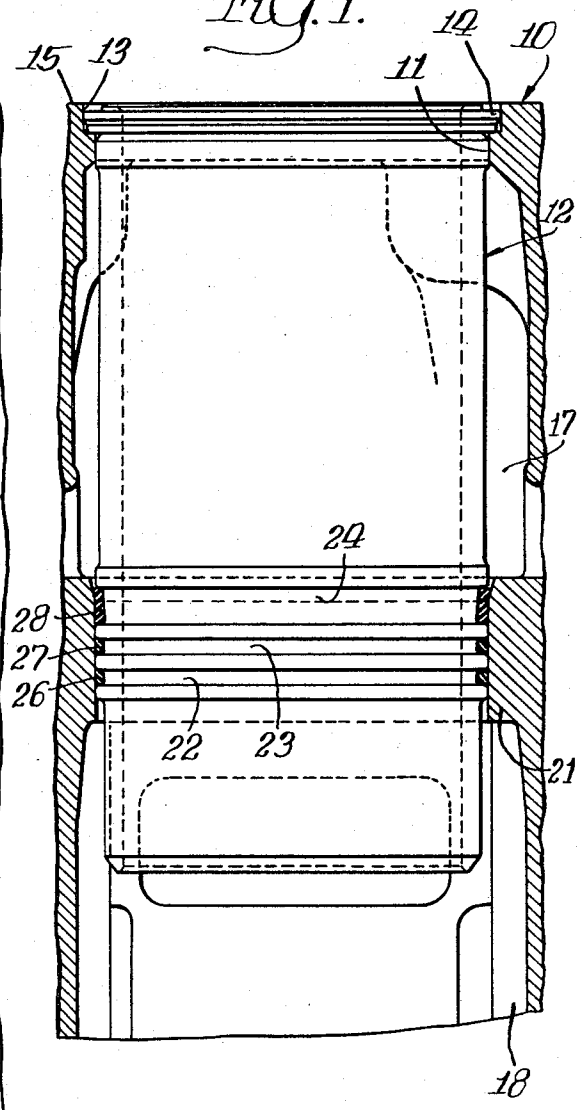


Fig. 1.



Inventors:-
Donald E. Valentine,
Glenn W. St. Clair,
By Hibben, Noyes & Bicknell,
Attys.

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Fig. 3.

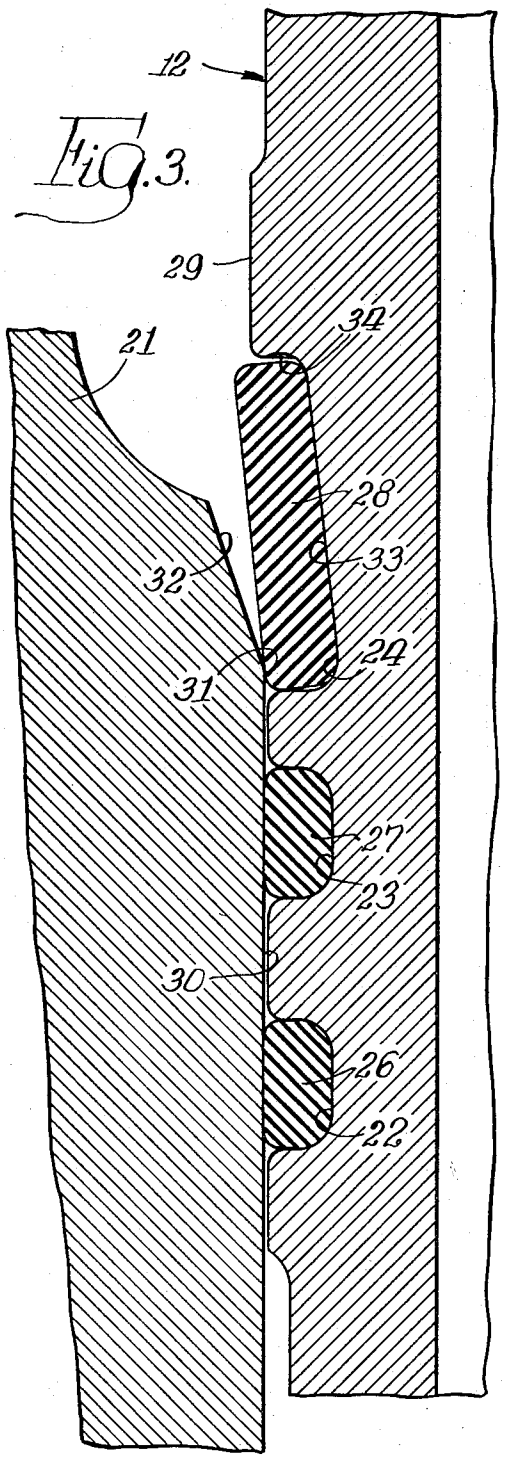
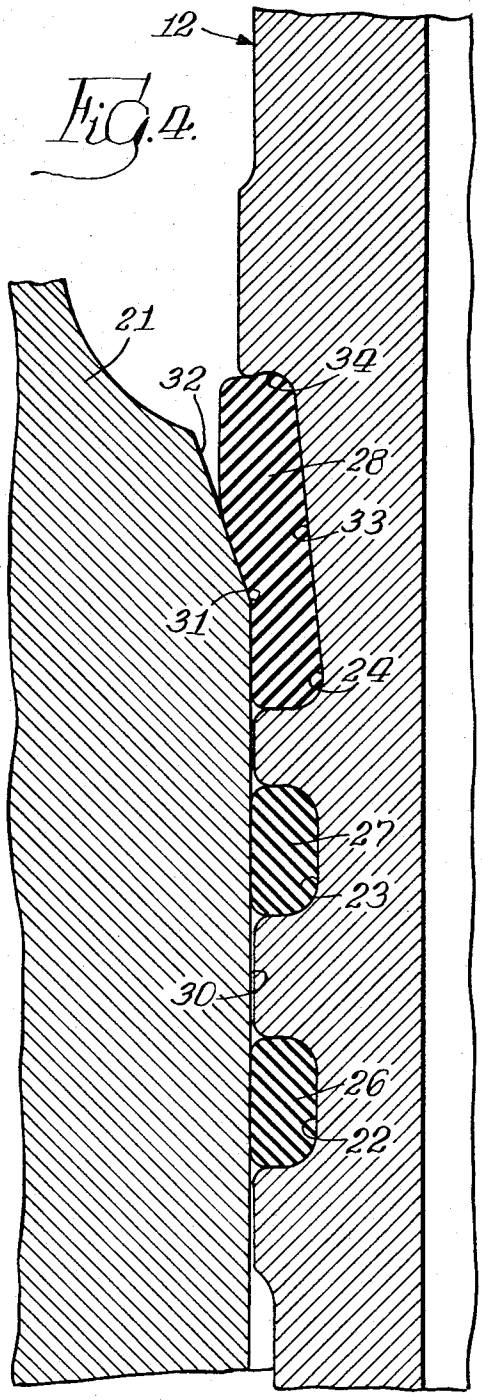


Fig. 4.



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ENGINE CYLINDER BLOCK AND LINER SEAL CONSTRUCTION

Donald E. Valentine, Columbus, and Glenn W. St. Clair, Bartholomew County, Ind., assignors to Cummins Engine Company, Inc., Columbus, Ind., a corporation of Indiana

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8 Claims. (Cl. 123—41.84)

ABSTRACT OF THE DISCLOSURE

A liner seal for an internal combustion engine having a block and one or more cylinder liners mounted in the block. Each liner is positioned in a bore formed in the block, one end being secured to the block and the other end being relatively unsupported. Adjacent the unsupported end of the liner, a resilient, annular axially elongated seal is compressed between the liner and the block to form a liquid seal and to damp vibrations of the liner. Compression on the seal is greatest along a line intermediate its ends and compression decreases gradually in both directions from the line.

When wet cylinder liners are provided in an internal combustion engine, each liner is positioned in a bore extending through a cylinder block, and one end portion of the liner is rigidly secured to the block adjacent an exterior surface thereof. The remainder of the liner is relatively unsupported and extends through the block to a crankcase cavity, the liner closing a coolant cavity in the block intermediate the ends of the liner. To prevent the coolant, usually water, and solid particles carried by the coolant from leaking from the coolant cavity, into the crankcase cavity, a seal is provided between the exterior of the liner and the block at a position where it separates the coolant and crankcase cavities.

Considerable difficulty has been encountered in the past in providing a seal which is effective at this location. One source of the difficulty is the fact that, to render the seal effective, a predetermined amount of pressure must be exerted on the seal and such pressure must be obtained when the liner is moved axially to its assembled position in the cylinder block. Another source of difficulty is the fact that the unsupported portion of the liner vibrates during operation of the engine, and such vibration tends to permit solid particles in the coolant to work into the areas between the seal and either the liner or the block. A solid particle in this seal area tends to destroy the effectiveness of the seal.

Consequently, it is an object of this invention to provide a novel engine construction having a seal between the cylinder liner and the cylinder block of the engine which is rendered effective upon axial movement of the liner to its assembled position in the cylinder block.

It is another object to provide an engine construction of the foregoing character, with a seal which is effective in spite of dirt particles in the coolant.

Still another object is to provide an engine construction of the foregoing character, with a seal which tends to damp vibrations of the unsupported portion of the liner.

Other objects and advantages of the invention will become apparent from the following description taken in conjunction with the accompanying figures of the drawings, in which:

FIG. 1 is a fragmentary view of an engine construction comprising a cylinder block and a cylinder liner, with a seal therebetween, in accordance with the invention;

FIG. 2 is an enlarged fragmentary view of a portion

of the structure shown in FIG. 1, showing the parts of the engine construction in assembled relation;

FIG. 3 is a view similar to FIG. 2 but showing the parts at one stage during assembly thereof; and

FIG. 4 is a view similar to FIGS. 2 and 3 but showing the parts at another stage during assembly thereof.

In general, an engine in accordance with the invention includes a cylinder block, a cylinder liner and a seal between the outer periphery of the cylinder liner and a portion of the cylinder block, to separate a coolant cavity in the block from a crankcase cavity therein. A bore is formed in the cylinder block, the bore extending from one exterior surface thereof through the block to the crankcase cavity. The liner is positioned in the bore with one end of the liner rigidly secured to the cylinder block adjacent said exterior surface, and the remainder of the liner being relatively unsupported. The liner extends through the block to the crankcase cavity and closes the coolant cavity. The block within the bore, has a ledge between the coolant and crankcase cavities, the ledge extending adjacent the outer periphery of the liner at a position intermediate the ends of the liner, and a seal is interposed between the ledge and the outer periphery of the liner.

The seal is axially elongated and is between the liner and the ledge, and the liner and the ledge include surfaces designed to engage the seal and apply a relatively high compressive load on a portion of the seal intermediate its ends and relatively small compressive loads on the end portions of the seal. Further, the surfaces are slanted and shaped such that they automatically engage and apply such compressive loads on the seal when the liner is moved axially to its assembled position in the cylinder block.

In greater detail, the structure shown in FIG. 1 includes a cylinder block **10** of an internal combustion engine, having a bore **11** formed therethrough and a cylinder liner **12** positioned in the bore **11**. The cylinder block **10** may include a plurality of bores **11**, each of which has a cylinder liner **12** disposed therein, but since all of the bores **11** and all of the liners **12** are substantially identical, only one bore **11** and liner **12** are shown. The upper end of the bore **11** is preferably counterbored as at **13**, and the upper end portion of the cylinder liner **12** includes a radially outwardly extending flange **14** which seats in the counterbore **13** and is rigidly secured thereto. The remainder of the cylinder liner is relatively unsupported. The engine also includes a cylinder head (not shown) which fits over the upper surface **15** of the cylinder block **10** and the liner **12**, and a gasket (not shown) which is positioned between the cylinder block and the head.

The engine further includes a piston which reciprocates within the liner **12**, at the end of a connecting rod, and a crankshaft which is rotated upon reciprocation of the piston. Since the piston, the connecting rod and the crankshaft are conventional, they are not shown in the drawings. To cool the upper portion of the liner, which forms the combustion chamber, coolant cavities and passageways are formed within the cylinder block, one coolant cavity being shown at **17** in the drawing. A coolant, such as water, normally flows through the coolant passageways and cavities and the cavity **17**. On the lower side of the cylinder block **10**, a crankcase cavity **18** is formed, the crankcase cavity cooperating with a pan (not shown) to receive oil for lubrication of the engine.

To prevent the coolant and any solid particles carried by the coolant from entering the crankcase cavity **18**, means is provided between the outer periphery of the liner **12** and the inner periphery of a ledge **21** formed within the interior of the cylinder block **10** within the bore **11** to separate the cavities **17** and **18**. With reference to FIG. 2, a lower annular groove **22**, an intermediate annular

groove 23, and an axially elongated upper annular groove 24 are formed in the outer periphery of the liner 12. O-rings 26 and 27 are positioned in the grooves 22 and 23, respectively, and an axially elongated upper seal 28 is positioned in the upper groove 24. While the O-rings 26 and 27 are circular in cross section, the seal 28 is generally rectangular in cross section. The outer diameter of the portions of the liner 12 below the upper groove 24 is less than the minimum inner diameter of the ledge 21, while the outer diameter of a portion 29 of the liner 12 just above the upper groove 24 is preferably slightly greater than the inner diameter of the ledge 21. As shown in FIGS. 2 to 4, the ledge 21 includes an axially extending lower surface portion 30 and a slanting upper surface portion 32, the portions 30 and 32 meeting at a line 31. From the line 31, the surface 32 slants radially outwardly and axially upwardly as seen in FIGS. 2 to 4. The surface 30 overlies the grooves 22 and 23 and a lower part of the upper groove 24.

The thickness of the O-rings 26 and 27 and the radial width of the grooves 22 and 23 are such that the O-rings 26 and 27 are compressed between the bottoms of the grooves 22 and 23 of the liner, and the surface 30 of the ledge. To compress the upper seal 28, the bottom 33 of the upper groove 24 is slanted radially outwardly and axially upwardly as seen in FIG. 2, the slant of the bottom 33 however being less than the slant of the surface 32. The groove 24 is constructed such that the lower portion thereof has a radial dimension which is substantially the same as the thickness of the seal 28, while, due to the slant of the bottom 33, the radial dimension at the upper portion of the groove 24 is less than the thickness of the seal 28 when in its uncompressed state (FIG. 3). Further, it is preferred that the upper and inner corner of the groove 24 be undercut or recessed slightly as indicated at 34.

Before assembly of the liner with the cylinder block 10, the two O-rings 26 and 27 are positioned in the grooves 22 and 23 and the seal 28 is positioned in the groove 24. The lower end of the liner 12 is then inserted into the upper end of the bore 11 and the liner 12 is moved axially downwardly relative to the cylinder block. When the O-rings 26 and 27 engage the slanted surface 32, they are cammed radially inwardly, and movement of the O-rings 26 and 27 past the line 31 causes the O-rings 26 and 27 to be compressed and substantially fill their respective grooves. Further on movement of the liner 12 downwardly relative to the cylinder block 10, the lower outer corner of the seal 28 passes the line 31 without engagement and the slant of the seal 28 causes the line 31 to engage the seal member 28 a short distance above the lower corner of the seal (FIG. 3). This eliminates the possibility of the ledge wiping the seal 28 upwardly and possibly tearing it. Continued downward movement of the liner 12 and the seal 28 causes the ledge to exert increasing pressure on the seal (FIG. 4) and causes the area of maximum compression, which area is adjacent the line 31, to gradually move upwardly in the seal 28. When the liner 12 is moved to its final position, as shown in FIGS. 1 and 2 with its flange 14 seated in the counterbore 13, the area of maximum compression formed by the line 31 is located intermediate the upper and lower ends of the seal 28 somewhat above the midpoint.

The seal 28 is sized relative to the depth of the groove 24 such that, when the parts are in their full assembled relation shown in FIGS. 1 and 2, maximum compression on the seal 28 occurs adjacent the line 31 which in this position of the parts is located intermediate the ends of the seal. The amount of compression in the seal 28 gradually reduces with distance from the line 31. The amount of squeeze, or reduction in width of the seal 28, at the line 31 may be between 18% and 26% of the thickness of the seal when free, and the upper limit of this squeeze is preferably 30%. Both ends of the seal 28 are substantially free from compression, and the upper and lower ends of the member 28 are free to expand into unfilled openings 36 and 37 between the ledge and the liner at the respective ends of the seal. Due to the fact that there is little or no compression on the lower end portion of the seal member 28 during assembly of the parts and after assembly thereof, the parts may be easily assembled without danger of tearing the seal 28. If the lower end of the seal 28 were compressed when it engaged the line 31 during assembly of the parts, the relatively long axial movement of the seal 28 and the build-up of pressure on the seal 28 would tend to tear the seal 28. In the present construction, however, the lower end of the seal 28 is able easily to move past the line 31 and then the pressure on the seal 28 gradually builds up, with the result that there is no tendency for the seal 28 to tear.

As stated above, as the liner and the cylinder block are being assembled, downward movement of the seal 28 relative to the line 31 causes the seal 28 to be squeezed upwardly in the groove 24 and to completely fill the recess 34 at the upper side of the groove 24. The provision of the recess 34 is advantageous because it tends to hold the seal 28 against the liner 12 and to prevent the seal 28 from bulging outwardly into the opening 36 between the liner 12 and ledge 21 any more than necessary to accommodate the seal material.

The use of the seal 28 produces still another advantage in that it tends to damp vibrations of the liner 12. As previously stated, the flange 13 of the liner is secured to the block 10, and there is a slight clearance between the liner and the ledge 21. Consequently, the unsupported lower portion of the liner would tend to vibrate during operation of the engine. Vibrations of the liner tends to permit solid particles to work downwardly between the seal 28 and the ledge 21. Such downward working particles are disadvantageous first because the particles might reach the crankcase cavity and be carried along with the oil to engine bearings, and secondly because particles between the seal 28 and the ledge 21 might result in leakage of the coolant particularly if the material forming the seal 28 had hardened somewhat due to aging. Since the pressure in the coolant cavity is usually around 30 p.s.i. while the pressure in the crankcase cavity is usually around 1 to 2 p.s.i., a small leak could cause considerable flow of coolant. The solid particles referred to above may, for example, be rust deposits or sand and shot remaining in the cast cylinder block 10 after the casting and cleaning operations.

The relatively large area of the seal 28 and the snug fit between the seal 28 and the ledge 21 tend to damp such vibration so that the difficulties to a great extent are avoided.

As a specific example of the materials used for the two O-rings 26 and 27 and the seal 28, the O-ring 26 may be made of silicone, the O-ring 27 may be made of buna-N and the seal 28 may be made of neoprene. The use of neoprene for the seal 28 is advantageous because it is more pliable and resistant to temperature and water than other materials such as buna-N. Buna-N and silicone are used in the respective O-rings because neoprene with a cross section such as the O-rings would tend to take a permanent set. However, neoprene is satisfactory for the seal 28 because with its size the neoprene has less tendency to take a permanent set.

We claim:

1. In an internal combustion engine, the improvement comprising a cylinder block having at least one bore extending through the block, said block having a coolant cavity opening into said bore intermediate the ends of said bore, a tubular liner positioned in said bore and closing said coolant cavity, said liner being rigidly secured to said block in sealing relation therewith at one end of said coolant cavity, said block including a ledge located at the other end of said coolant cavity and extending adjacent the outer periphery of said liner at a position intermediate the ends of said liner, and means located

between said ledge and said liner for sealing said other end of said cavity, said sealing means comprising an annular seal positioned between said outer periphery of said liner and the inner periphery of said ledge, said seal being elongated in a direction generally parallel to the axis of said liner, said liner and said ledge engaging said seal, and said liner, said ledge and said seal being shaped to apply a relatively high compressive load on said seal at a line intermediate the ends of said seal with the compressive load on said seal gradually decreasing from said line towards the respective ends of the seal.

2. Apparatus as in claim 1, wherein the outer periphery of said liner has a groove formed therein and said seal is positioned in said groove, said seal when in its free state having a substantially uniform thickness, and the bottom surface of said groove being slanted such as to force said seal outwardly into engagement with said ledge.

3. Apparatus as in claim 2, wherein the space between said bottom surface of said groove and said ledge at the end of the seal which is remote from said coolant cavity is slightly greater than said thickness of said seal in its free state, whereby on inserting said liner into said bore from said one end of said cavity the advancing end of seal passes by said ledge and said ledge contacts said seal above said advancing end.

4. In an internal combustion engine, the improvement comprising a cylinder block having at least one bore extending through the block, said block having a coolant cavity opening into said bore intermediate the ends of said bore, a tubular liner positioned in said bore and closing said coolant cavity, said liner being rigidly secured to said block in sealing relation therewith at one end of said coolant cavity, said block including a ledge located at the other end of said coolant cavity and extending adjacent the outer periphery of said liner at a position intermediate the ends of said liner, and means located between said ledge and said liner for sealing said other end of said cavity, said sealing means comprising an annular seal positioned between said outer periphery of said liner and the inner periphery of said ledge, said seal being elongated in a direction generally parallel to the axis of said liner, said liner and said ledge engaging said seal, and said liner, said ledge and said seal being shaped to apply a relatively high compressive load on said seal at a line intermediate the ends of said seal with the compressive load on said seal decreasing towards the respective ends of the seal, the outer periphery of said liner having a groove formed therein and said seal being positioned in said groove, and the inner corner of said groove at the end of said groove which is adjacent said coolant cavity being recessed.

5. Apparatus as in claim 1, wherein said liner is secured at one end thereof to said block, the remainder of said liner being relatively unsupported by said block, and said elongated form of said seal and the snug fit between said liner, said seal and said block damping vibrations of said liner during operation of said engine.

6. Apparatus as in claim 1, wherein said sealing means further includes a pair of axially spaced O-rings located at spaced locations from said seal and on the side of said seal which is remote from said cavity, said seal being made of neoprene, said O-ring adjacent said seal being made of buna-N, and the other O-ring being made of silicone.

7. In an internal combustion engine, the improvement comprising a cylinder block having at least one bore extending from one exterior surface of the block through the block, said block having a coolant cavity opening into said bore intermediate the ends of the bore and a crankcase cavity in the exterior surface of the block opposite said one surface, a tubular liner positioned in said bore and extending to said crankcase cavity and closing said coolant cavity, one end portion of said liner being rigidly secured to said block at the margin of said bore adjacent said one surface and the remainder of said liner being relatively unsupported, said block including a ledge located between said coolant and crankcase cavities and extending adjacent the outer periphery of said liner at a position intermediate the ends of said liner and means located between said liner for sealing said coolant cavity from said crankcase cavity, said sealing means comprising an annular seal positioned between said outer periphery of said liner and the inner periphery of said ledge, said seal being elongated in a direction generally parallel to the axis of said liner, and said liner and said ledge engaging said seal and cooperating to apply a relatively high compressive load on a portion of said seal intermediate its ends and relatively small compressive loads on the end portions of said seal, the compression load on said seal gradually decreasing in both directions from said intermediate portion toward said end portions.

8. Apparatus as in claim 7, wherein said seal has a generally rectangular cross sectional configuration when in its uncompressed state.

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AL LAWRENCE SMITH, *Primary Examiner.*