The invention relates generally to cylinder blocks and liners therefor, and more particularly to a cylinder block for an internal combustion engine having a so-called "wet" liner.

In internal combustion engines of the type where each cylinder is formed directly in the block, the metal of the entire block must be of proper type metallurgically to provide the desired wearing quality for the cylinder bore. In water-cooled engines, the block must also be carefully cast in order to provide coral water passages about the cylinder bore, with the proper wall thickness between the passages and the bore. These two factors increase the manufacturing cost of the cylinder block, and in addition there is another factor in such a block that affects the use thereof. Thus, when excessive wear of the cylinder bore occurs, the block must be rebored to permit the engine to operate properly, and such reboring requires replacement of the pistons and piston rings with pistons and rings that are oversized. Furthermore, the reboring reduces the thickness of the wall between the bore and the water passages, and in some instances where the casting is not too carefully made, poackets or cracks in the wall develop, which permit leakage.

With a wet liner, that is, one which provides the wall between the cylinder and the water passages, only the liner need be of such metallurgical structure as to provide the desired wearing quality of the cylinder. The block itself may therefore be cast of metal that is more readily machinable, resulting in a finished structure of lower cost. Moreover, in the rough casting, the water passages open into the cylinder so that in making the casting the cores to form such passages may be better supported in the mold than in the old form where the water passages are separated from the bore. In the old form, the difficulty of making and supporting the intricate water jacket cores usually caused considerable variation in cylinder wall thickness resulting in uneven cylinder cooling. By using liners, they may be machined separately which permits accurate control of cylinder wall thickness and assures uniform cylinder cooling. In operation, the liner is the only part which receives wear, and when excessive wear occurs, the liner may be replaced, permitting use after such replacement of standard size pistons and rings rather than over size.

Wet liners, as heretofore generally constructed, have been supported at their upper ends in the cylinder block. Thus, an outwardly extending flange is provided at the upper end of the liner, and the upper face of the block is counterbored to receive the flange. Providing space for the flanges on the liners for adjacent cylinders increases the distance between the axes of the cylinders and hence increases the overall dimension of the block. The flange also increases the cost of the liner casting because of the increased material, the difficulty in making such a casting, and the increased machining cost. Furthermore, the upper end of the liner is subjected to the greatest temperature changes during operation of the engine since it forms part of the combustion chamber and, because the liner is supported by the block at that point, distortional difficulties are encountered.

The general object of the invention is to provide a cylinder block and liner construction in which the necessity for the flange at the top of the liner is eliminated and the maximum diameter of the liner need not be greater than it is throughout the major portion of its length and particularly the portion intermediate its ends.

Another object is to provide a cylinder block and liner construction having novel sealing means for preventing leakage between the liner and block from the water passages.

A still further object is to provide a novel method of assembling a liner in a block.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawing, in which:

Fig. 1 is a longitudinal sectional view of a fragment of a cylinder block having mounted therein a liner, the block and liner embodying the features of the invention;

Fig. 2 is an enlarged fragmentary view of the right-hand portion of Fig. 1; and

Fig. 3 is a view similar to Fig. 2 but showing a modified form of construction.

The invention herein disclosed, relating to a so-called "wet" liner for a cylinder of an internal combustion engine, contemplates a liner that is supported in the cylinder block at its lower end, rather than being hung from its upper end. By such manner of support it is possible to make a liner in which the usual supporting flange at the upper end is eliminated and the liner may be made in a form which can be machined from a straight cylindrical casting of substantially uniform outside diameter. With such a form, the casting may be manufactured at substantially less cost and also lends itself to ease in manufacture by the centrifugal casting method. Moreover, the machining of such a casting is substantially less than that required for the old form having a supporting flange at its upper end.

To illustrate the invention, I have shown one embodiment is Figs. 1 and 2 in which 10 indicates a cylinder block having a cylinder bore 11 therein. The block is provided with a passage or cavity 12 for coolant, ordinarily water, and in the casting, the cavity 12 opens into the bore 11. With a casting of this type, the cores to form the cavity 12 and the passages connecting with such cavity may be readily supported from the core which forms the cylinder bore, thus insuring that the cavity 12 is properly placed within the casting relative to the bore 11.

Within the cylinder bore 11 is mounted the liner, indicated at 13, which is adapted to be supported at its lower end, thus eliminating the necessity of a flange at its upper end. The liner therefore may be formed from a substantially straight cylindrical casting. To support the liner in the manner stated, the lower end of the cylinder bore 11 is provided with an upwardly facing shoulder 14, and a correspondingly downwardly facing surface is formed on the lower end portion of the liner 13 for support by the shoulder 14. In the present instance, the downwardly facing surface on the liner is the lower end face thereof.

In prior constructions the cylinder liner does not become a rigid portion of the engine structure until the cylinder head is assembled to the block. Likewise the
This face of course facilitates both the casting and machining of the liner and materially reduces the cost thereof. In Fig. 3 the casting for the liner in the block and providing a seal therebetween is not effected until the head has been assembled.

With the present invention the assembly means employed assures a coolant seal at the bottom of the coolant jacket in all cases and a seal may be effected at the top of the water jacket but in any event the liner becomes a rigid portion of the block without depending upon the assurance of the cylinder head provided for in this patent. In the event that it is desired to finish machine the liner after it is installed in the block this construction will allow such machining.

The invention also includes means for rigidly holding the liner within the bore and for providing seals both above and below the coolant cavity to prevent leakage of coolant therefrom. In the present instance such holding and sealing means comprises an adhesive. It has been found that an epoxy resin has the desired characteristics for an adhesive in this particular use, since it is capable of withstanding relatively high temperatures and has strong adhesive properties for metal. The adhesive in this instance is preferably placed between the lower end surface of the liner and the shoulder and rigidly holds the liner in place in the block and provides a water-tight seal to prevent leakage from the coolant cavity.

The liner is also secured in the bore at its upper end above the cavity by means which also effects a seal at this point. The outside diameter of the liner and the diameter of the bore are such that a slight radial clearance is provided therebetween. Thus, by applying a ring of adhesive to the upper portion on the outer periphery of the liner prior to insertion of the latter into the bore, or to the lower portion of the bore, such ring of adhesive will fill the clearance between the liner and bore above the cavity to assist in holding the liner in place in the block and to provide a seal therebetween above the cavity.

To assemble the parts, a relatively thick layer of the epoxy resin is applied to the lower end surface of the liner or to the shoulder portion of the block, and a ring of adhesive is placed around the upper end of the liner or to the interior surface of the bore above the cavity, and the liner is then lowered into place in the bore. The epoxy resin can be obtained in a form which has substantial viscosity and therefore will remain in place when applied.

After it is preferable to apply pressure to the top of the liner to compress the layer of adhesive between the lower end of the liner and the shoulder. Such compression is preferably to an extent sufficient to force some of the adhesive upwardly into the clearance between the periphery of the liner and the bore immediately above the shoulder. At the upper end, the adhesive placed either on the liner or on the interior of the bore holds the upper end of the liner rigidly positioned within the bore and also provides a seal above the cavity.

With the foregoing construction, a seal is provided between the liner and the block both above and below the cavity and the liner is held rigidly positioned within the block. The seal at the lower end is highly effective since the adhesive is compressed between the end surface of the liner and the shoulder. At the upper end of the liner, while there may be some tendency to wipe off the adhesive as the liner is being inserted, it is generally found that a highly effective seal is also obtained at this point. However, such sealing effect by the adhesive is not entirely necessary at the upper end of the liner since passage of water upwardly between the liner and block is prevented by the usual gasket, indicated at 15 in Fig. 2, which is clamped tightly to the upper surface of the block and liner by the cylinder head.

By securing the liner and the block in the foregoing manner, it will be evident from an inspection of Fig. 1 that the liner may be made in the form of a perfectly straight cylinder of uniform wall thickness throughout its length.
between said shoulder and said surface with some of the adhesive forced upwardly therefrom into said clearance for securing the liner in the block and providing a seal therebetween.

3. The combination of a cylinder block for an internal combustion engine, said block having a cylinder bore therein and a coolant cavity opening into said bore, said bore having an upwardly facing shoulder adjacent its lower end and below said cavity, a liner having a slight radial clearance in the bore and having a downwardly facing surface on its lower end portion supported by said shoulder, a layer of adhesive compressed between said shoulder and said surface with some of the adhesive forced upwardly therefrom into said clearance for securing the liner in the block and providing a seal therebetween, and a ring of adhesive in the clearance between the block and the liner above said cavity to form a seal therebetween.

4. The combination of a cylinder block for an internal combustion engine, said block having a cylinder bore therein and a coolant cavity opening into said bore, said bore having an upwardly facing shoulder adjacent its lower end and below said cavity, a liner of substantially uniform outside diameter throughout its length and having a slight radial clearance in the bore and having its lower end surface supported by said shoulder, a layer of adhesive compressed between said shoulder and said said surface, and a ring of adhesive in the clearance between the block and the liner above said cavity, said layer and said ring of adhesive securing the liner in the block and providing seals therebetween above and below said cavity.

5. The combination of a cylinder block for an internal combustion engine, said block having a cylinder bore therein and a coolant cavity opening into said bore, said bore having an upwardly facing shoulder adjacent its lower end and below said cavity, a liner having its lower end of reduced diameter to form a downwardly facing shoulder, and a layer of adhesive compressed between said shoulders for securing the liner in the block and providing a seal therebetween.

6. The combination of a cylinder block for an internal combustion engine, said block having a cylinder bore therein and a coolant cavity opening into said bore, said bore having an upwardly facing shoulder adjacent its lower end and below said cavity, a liner having a slight clearance in the bore both above and below said shoulders, and a layer of adhesive compressed between said shoulders with some of the adhesive forced upwardly and downwardly therefrom into said clearance for securing the liner in the block and providing a seal therebetween.

7. The combination of a cylinder block for an internal combustion engine, said block having a cylinder bore therein and a coolant cavity opening into said bore, a liner in said cylinder bore axially supported at its lower end portion by the block, and adhesive rigidly securing the liner to the block in annular areas about the liner above and below the coolant cavity.

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