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(71) Applicants:
- **IVECO FIAT S.p.A.**
  10156 Torino (IT)
- **Iveco Motorenforschung AG**
  CH-9320 Arbon (CH)

(72) Inventors:
- **Dellora, Giancarlo**
  10036 Settimo Torinese (IT)
- **Ellensohn, Rudolf**
  9434 AU (CH)

(74) Representative: **Gervasi, Gemma, Dr.**
Notarbartolo & Gervasi S.p.A.,
Corso di Porta Vittoria, 9
20122 Milano (IT)

(54) A cylinder liner for an internal-combustion engine, its method of production and an engine comprising such a liner

(57) A liner (8) for a cylinder (7) of an internal-combustion engine (5) comprising a cylindrical side wall (9) and an upper collar (10) adapted to be accommodated in a seating (17) of the engine block (6) coaxial to the cylinder (7). The side wall (9) is formed by a cylindrical tube, preferably made of steel, and the collar (10) is in the form of an annular body separate from the side wall (9) and rigidly connected thereto.

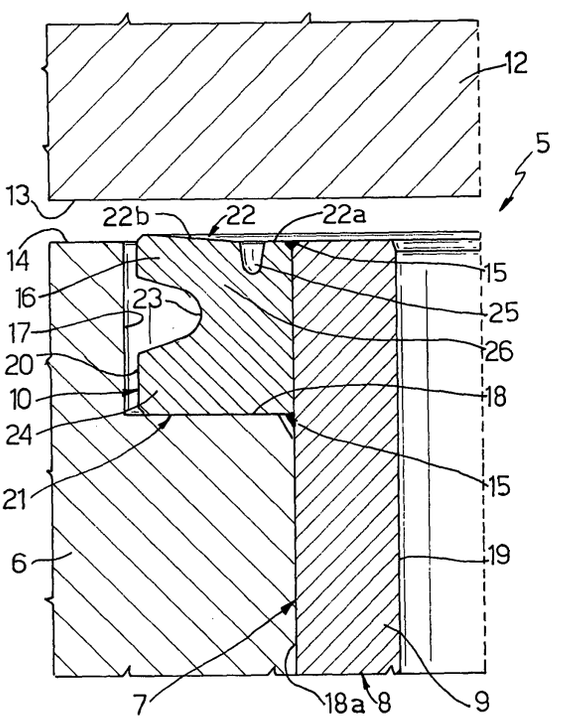

Fig.1

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Description

[0001] The present invention relates to a cylinder liner for an internal-combustion engine, to a method for producing said liner and to an engine comprising such a liner.

[0002] Internal-combustion engines comprise an engine block made of cast iron or an aluminium alloy formed by casting and defining a plurality of cylinders, and a cylinder head which is mounted fluidtightly on the engine block with the interposition of a gasket.

[0003] The cylinders are lined internally with respective sleeves or liners which are made from a material (generally special high-alloy cast iron) designed to resist the mechanical, thermal and chemical stresses to which they are subjected by the gases resulting from combustion; the liners have to undergo high precision machining operations so as to guide properly the reciprocating motion of the associated piston.

[0004] Furthermore, the liners are normally provided with an upper outer collar which is designed to be accommodated in an annular recess of the engine block surrounding the respective cylinder and to co-operate with the head gasket so as to provide a seal for the combustion gases.

[0005] The known liners are produced in one piece, firstly by forming a blank by casting and then machining this blank with machine tools so as to remove any swarf. Generally, a centrifugal casting process is used with a view to obtaining the desired metallurgical properties of the material.

[0006] The known liners have a certain number of disadvantages.

[0007] Firstly, the production process is expensive and involves long and difficult machining operations, as well as substantial waste of material.

[0008] The known production processes involve the use of a cast material which can be easily machined; therefore, for technological reasons, it is not possible to use materials, in particular certain steels, which possess optimum mechanical strength properties. As a result of this, in order to withstand the stresses to which they are subjected, the liners have to have a relatively large wall thickness, thereby reducing the effective cylinder capacity which can be obtained from a predetermined radial dimension of the cylinder.

[0009] It is the object of the present invention to devise a liner for the cylinder of an internal-combustion engine, which makes it possible to eliminate the drawbacks associated with the above-mentioned known liners.

[0010] According to the present invention, this object is achieved by a liner for a cylinder of an internal-combustion engine comprising a cylindrical side wall and at least one collar adapted to be accommodated in a seating of said engine coaxial to said cylinder, characterised in that said side wall is formed by a cylindrical tube and in that said collar is formed by an annular body separate from said side wall and rigidly connected thereto.

[0011] The present invention also relates to a method of producing a cylinder liner for an internal-combustion engine, said liner comprising a cylindrical side wall and at least one collar adapted to be accommodated in a seating of said engine coaxial to said cylinder, the method being characterised by comprising the stages of producing said side wall in the form of a cylindrical tube, producing said collar in the form of an annular body separate from said side wall and connecting said collar and said side wall rigidly together.

[0012] With a view to a better understanding of the invention a preferred form of embodiment will be described by way of example below, with reference to the accompanying drawings, in which:

Figure 1 is a partial section of an internal-combustion engine with the cylinder head and the engine block separated from one another, and

Figure 2 is a section analogous to that in Figure 1, with the cylinder head mounted on the engine block.

[0013] Referring now to Figures 1 and 2, the reference numeral 5 generally denotes an internal-combustion engine comprising an engine block 6 provided with a plurality of cylinders 7, only one of which is partly illustrated. The engine 5 further comprises a cylinder head 12, partly illustrated, which is adapted to be fastened to the engine block 6 by means of screws (not shown); the cylinder head 12 defines the combustion chambers (not shown for simplicity) and accommodates in known manner the inlet and exhaust valves of the cylinders, which are also not shown. The cylinder head 12 is bounded at the bottom by a lower flat surface 13 adapted to be connected with a corresponding upper flat surface 14 of the engine block 6.

[0014] The cylinder 7 is lined internally with a liner 8.

[0015] The liner 8 comprises a cylindrical side wall 9 and a collar 10 which is externally fastened to an upper end of the side wall 9. The collar 10 is accommodated in an annular seating 17 of the engine block 6, which is coaxial to the cylinder 7 and which is defined by a recess in the upper surface 14 surrounding the cylinder 7, and it abuts against a shoulder 18 downwardly delimiting the seating 17.

[0016] According to the present invention, the side wall 9 is formed by a cylindrical tube and the collar 10 is formed by an annular body separate from the side wall 9 and rigidly connected thereto. The side wall 9 is preferably made of a high strength steel; in this way the thickness of the side wall 9 can be kept to a minimum.

[0017] In particular, the side wall 9 has an outer cylindrical surface 18a and an inner surface 19. The collar 10 is bounded externally by a lateral surface 20 and axially by a lower surface 21 co-operating with a shoulder 18, and by an upper free surface 22.

[0018] The connection between the collar 10 and the wall 9 can be effected using any known technique. In

the form of embodiment illustrated the connection is effected by welding; two welds 15 are shown in the drawings along the lines of contact of the outer surface 18a of the side wall 9 respectively with the surface 21 and with the free surface 22 of the collar 10. Alternatively, the connection can be effected using any other known technique, for example by means of an interference fit and/or with an adhesive.

[0019] According to a preferred embodiment of the invention, the collar 10 defines integrally an elastic annular element 16 adapted to be deformed elastically when the cylinder head 12 is installed on the engine block 6 and to co-operate fluidtightly with the lower surface 13 of the cylinder head 12 as a result of the elastic reaction caused by this deformation. In this way, it is possible to eliminate the head gasket.

[0020] The element 16 is formed by a deformable upper outer portion of the collar 10 bounded at the bottom by an annular groove 23 provided in the lateral surface 20 of the collar 10 and which separates from a lower portion 24 of the substantially rigid collar 10 co-operating with the shoulder 18 of the engine block 6. Optionally, a second groove 25 provided in the free surface 22 of the collar 10 delimits radially inwards the annular elastic element 16 so as to form with the groove 23 a preferential deflection zone 26 and thus reduce the stress caused by the installation of the cylinder head 12 on the connection between the collar 10 and the side wall 9 of the liner 8. The groove 25 divides the free surface 22 of the collar 10 into an inner portion 22a adjacent the side wall 9 and into an outer portion 22b upwardly delimiting the elastic element 16.

[0021] According to the preferred embodiment illustrated, the elastic element 16 projects upwards by an amount h with respect to the upper flat surface 14 of the engine block 6 when the cylinder head 12 is detached from the engine block 6 as in Figure 1, and the elastic element 16 is in an undeformed condition. In particular, the outer portion 22b of the free surface 22 of the collar, which upwardly delimits the elastic element 16, is formed with a slight countersinking so as to exhibit, in section, a profile increasing from the inside (where it is substantially level with the upper surface 14 of the engine block 6) to the outside, where it projects with respect to the surface 14.

[0022] The portion 22b of the free surface 22 is disposed level with the surface 14 of the engine block 6 following the elastic deformation caused by the fastening of the cylinder head 12 on the engine block 6, as indicated in Figure 2. In this way the elastic element 16 exerts against the flat surface 13 of the cylinder head 12 an elastic force so as to ensure a perfect gas-tight seal of the liner 8 of the cylinder 7, at the maximum pressure provided for the operation of the engine 5.

[0023] Optionally, to ensure a seal between the engine block 6 and the cylinder head 12 around the ducts for the coolant and the lubricating oil, which are less critical, it is possible to use an adhesive or simple sealing rings of the type known as O-rings.

[0024] It is evident from the foregoing that the method for producing the liner 8 comprises the following stages:

- producing said side wall 9 of the liner 8 starting from a cylindrical tube;
- producing the collar 10 in the form of an annular element separately from the side wall 9, and
- rigidly connecting the collar 10 to the side wall 9.

[0025] Moreover, the advantages of the cylinder liner 8 according to the invention with respect to the state of the art are evident. Firstly, the casting of the blank for the liner 8 is eliminated and the machining of the components by means of machine tools is simplified. Additionally, it is possible for the liner 8 and, in particular, the side wall 9 to be made of a high strength material, such as steel, the use of which and the machining of which by means of machine tools were inconceivable for a one-piece liner.

[0026] Finally, this high-strength material makes it possible to produce the side wall 9 with reduced thickness and, therefore, to design engines with smaller dimensions for the same cylinder capacity or with increased cylinder capacity for the same dimensions with respect to the state of the art.

[0027] It is evident that the cylinder liner described can be subject to modifications and improvements without departing from the scope of the claims. For example, the collar 10 can be arranged at a certain distance from the edge of the side wall. Moreover, the collar 10 can be of different section to that described, for example rectangular, inverted L-shape, T-shaped, etc. The shoulder 21 may also be carried by a second collar which is separate from that of the elastic element 16. Finally, the cylinder liner 8 described can be applied to the cylinders of various types of internal-combustion engine, diesel or controlled ignition, including air-cooled engines and two-stroke engines.

Claims

1. A liner (8) for a cylinder (7) of an internal-combustion engine (5) comprising a cylindrical side wall (9) and at least one collar (10) adapted to be accommodated in a seating of said engine (5) coaxial to said cylinder (7), **characterised in that** said side wall (9) is formed by a cylindrical tube and **in that** said collar (10) is formed by an annular body separate from said side wall (9) and rigidly connected thereto.

2. A liner according to claim 1, **characterised in that** said side wall (9) is made of steel.

3. A liner according to claim 1 or 2, **characterised in that** said collar (10) is connected to said side wall

(9) by means of at least one weld (15).

4. A liner according to claim 1 or 2, **characterised in that** said collar (10) is an interference fit with an outer surface (18a) of said side wall (9).

5. A liner according to any one of the preceding claims, **characterised in that** said collar (10) comprises an annular element (16) which is elastically deformable to co-operate fluidtightly with a flat surface (13) of a cylinder head (12) of the engine.

6. A liner according to claim 5, **characterised in that** said elastically deformable annular element (16) is bounded axially towards the bottom by a first annular groove (23) provided in a lateral surface (20) of said collar (10).

7. A cylinder liner according to claim 5 or 6, **characterised in that** said elastically deformable elastic element (16) is bounded internally by a second annular groove (25) provided in an upper free surface (22) of said collar (10) and upwardly by an annular portion (22b) of said free surface outside said groove (23).

8. A cylinder liner according to claim 7, **characterised in that** said first and second grooves (23,25) define between them a preferential deflection zone (26) of said annular element (16).

9. A cylinder liner according to claim 7 or 8, **characterised in that** at least said outer portion (22b) of said free surface (22) of said collar (10) is formed with a slight countersinking with a profile increasing from the inside to the outside.

10. A method of producing a liner (8) for a cylinder (7) of an internal-combustion engine (5), said liner (8) comprising a cylindrical side wall (9) and at least one collar (10) adapted to be accommodated in a seating (17) of said engine (5) coaxial to said cylinder (7), the method being **characterised by** comprising the stages of producing said side wall (9) in the form of a cylindrical tube, producing said collar (10) in the form of an annular body separate from said side wall (9) and connecting said collar (10) and said side wall (9) rigidly together.

11. An internal-combustion engine (5) comprising a engine block (6) provided with at least one cylinder (7) and having an upper surface (14), a cylinder liner (8) fitted in said cylinder (7), a cylinder head (12) mounted on said engine block (6) and sealing means (16) interposed between said engine block (6) and said cylinder head (12) for effecting a gastight connection around said cylinder (7), said liner (8) comprising a cylindrical side wall (9) and at least one collar (10) accommodated in a seating of said engine block (6) coaxial to said cylinder (7); said engine (5) being **characterised in that** said side wall (9) of said liner (8) is formed by a cylindrical tube and that said collar (10) of said liner (8) is formed by an annular body separate from said side wall (9) and rigidly connected thereto.

12. An engine according to claim 11, **characterised in that** said collar (10) integrally comprises an elastically deformable annular element (16) co-operating with said cylinder head (12) and defining said sealing means.

13. An engine according to claim 12, **characterised in that** said annular element (16) is bounded upwardly by a free surface (22) projecting with respect to said upper surface of said engine block (6) when said elastic element (16) is not deformed, said free surface (22) co-operating by an interference fit with said cylinder head following the mounting of said cylinder head (12) on said engine block (6).

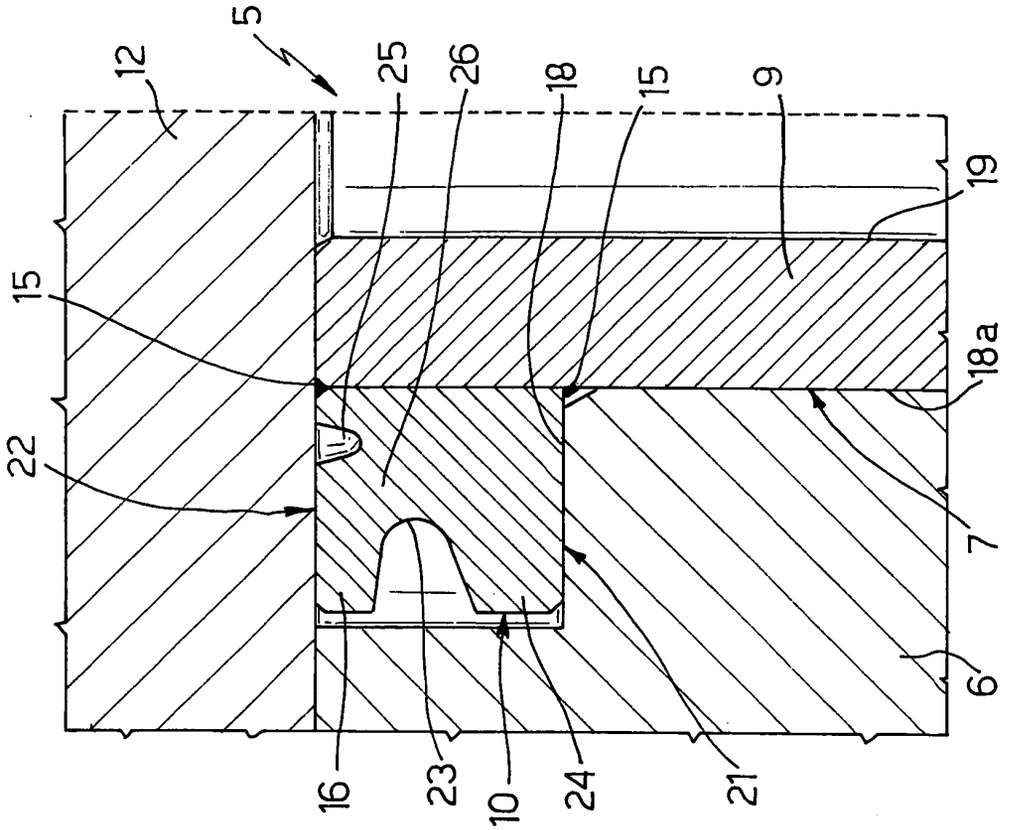
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Fig.2

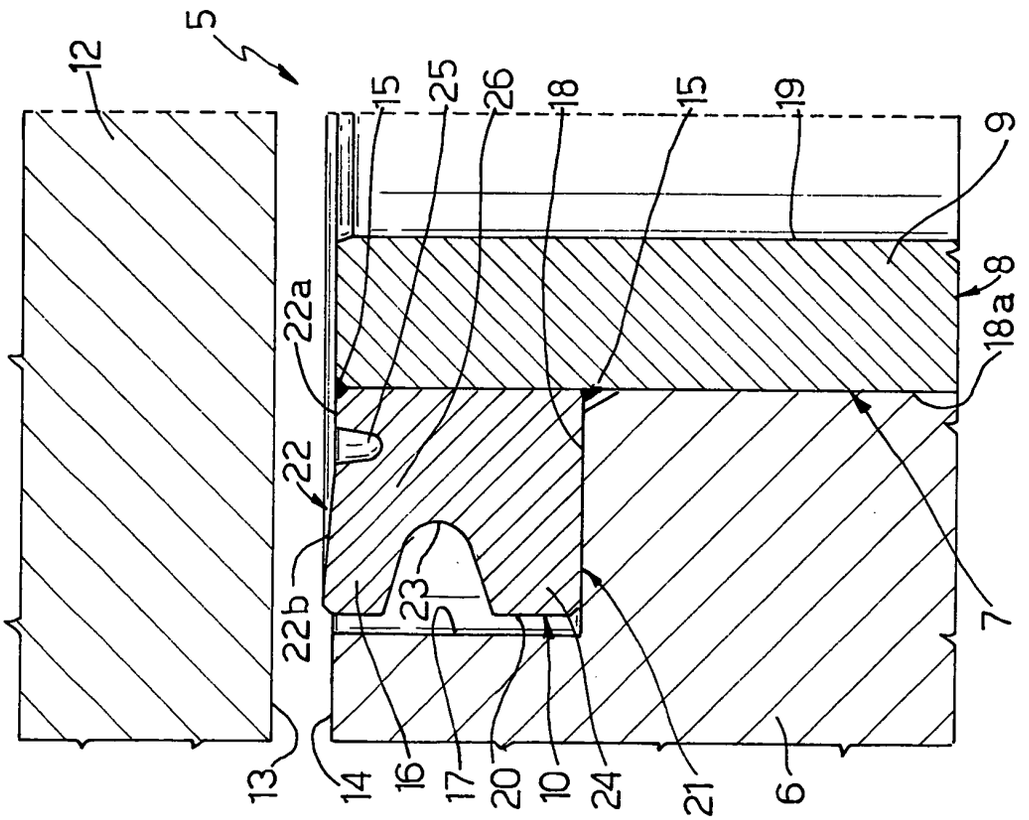
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Fig.1

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EUROPEAN SEARCH REPORT

Application Number
EP 03 01 7194

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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A	DE 24 42 352 A (DAIMLER BENZ AG) 18 March 1976 (1976-03-18) * figure 1 * * claims 1-4 *	5,6, 10-13	TECHNICAL FIELDS SEARCHED (Int.Cl.7) F02F F16J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22 August 2003	Wassenaar, G

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