(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 628 702 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number : **94303932.1**

(51) Int. Cl.[5] : **F01L 3/22**

(22) Date of filing : **01.06.94**

(30) Priority : **02.06.93 GB 9311384**

(43) Date of publication of application :
14.12.94 Bulletin 94/50

(84) Designated Contracting States :
DE FR

(71) Applicant : **MANGANESE BRONZE COMPONENTS LIMITED**
Elton Park Works,
Hadleigh Road
Ipswich, Suffolk IP2 0HX (GB)

(72) Inventor : **Greetham, Geoffrey**
59 Dale Hall Lane
Ipswich, Suffolk IP1 4LH (GB)
Inventor : **Williams, Michael Glyn, Audley End Farmhouse**
Melford Road
Lawshall, Bury St. Edmunds, Suffolk (GB)

(74) Representative : **Laight, Martin Harvey**
W.H. Beck, Greener & Co.
7 Stone Buildings
Lincoln's Inn
London WC2A 3SZ (GB)

(54) Improvements in and relating to valve seat inserts.

(57) A valve seat assembly has a valve seat insert (11) positioned in a recess (12) in a cast iron cylinder head (13). The recess has a first outer portion (14) having a first diameter, and a second inner portion (15) having a second diameter which is smaller than the first diameter, and a circumferential groove (16) extending laterally into the cylinder head from the first outer portion (14) of the recess. The valve seat insert (11) has a main external diameter which is a sliding fit with the outer portion (14) of the recess, and is formed of material softer than the material defining the cylinder head recess. When the insert is forced into the recess beyond the outer portion (14) of the recess, material of the insert (11) is deformed into the groove (16) of the recess to lock the insert into the recess.

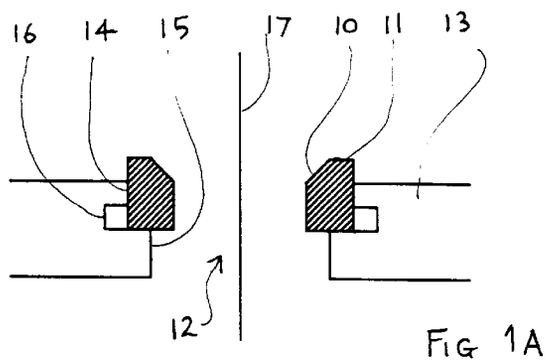

FIG 1A

EP 0 628 702 A1

The present invention relates to a valve seat insert for a cylinder head for an internal combustion engine; to a set of components to form a cylinder head assembly; and to a method of securing a valve seat insert in a cylinder head.

Conventional valve seat inserts are essentially simple cylindrical rings that are held in place in a cylindrical head by compressive stress generated in the head itself. This compressive stress is produced either by forcing a valve seat insert into a head with a positive interference between the valve seat insert and the cylinder head, or by contraction of the head and expansion of the valve seat inserts after the insert has been placed in the head at a temperature lower than that of the cylinder head. The latter is the so-called cryogenically fitted valve seat.

One method of removing the need to heat the seat and/or cool the insert is a mechanically locked device which can be used for aluminium heads only. In this system, the action of pushing the insert into the aluminium head causes aluminium to be mechanically moved into a circumferential groove in the insert, locking it in position. It is necessary that the insert material is stronger than the aluminium, as the insert has to be able to deform the aluminium into the groove without being distorted itself. This method is only useful therefore for aluminium cylinder heads and cannot be used with cast iron cylinder heads because the insert cannot deform the cast iron and therefore cannot fill the groove in the insert to provide a mechanical lock.

It is one object of the present invention to provide a method of locking a valve seat insert into a cast iron cylinder head whereby the insert is locked in position without the need for cryogenically fitting the insert.

According to the present invention in one aspect there is provided a set of components to form a cylinder head assembly, comprising a cylinder head for an internal combustion engine, and a valve seat insert for insertion into a recess in the cylinder head, in which the valve seat insert is formed at least in part of material which is softer than the material defining the cylinder head recess, and the recess has an opening extending laterally into the cylinder head from the recess, such that when the valve insert is forced into the recess, material of the valve seat insert is deformed into the lateral opening of the recess to lock the insert into the recess.

In one preferred form, the recess has a first, outer, portion having a first diameter, and a second, inner, portion having a second diameter which is smaller than the first diameter, the said lateral opening extending laterally into the cylinder head from the first, outer, portion of the recess, the valve seat insert having a main external diameter substantially equal to the diameter of the outer portion of the recess, and the arrangement being such that when the valve insert is forced into the recess beyond the outer portion of the recess, material of the valve seat insert is deformed into the lateral opening of the recess to lock the insert into the recess. Preferably the said lateral opening comprises a circumferential groove extending laterally into the cylinder head from the first, outer, portion of the recess.

In some forms it may be arranged that the insert has an inner, pilot, portion having an external diameter smaller than the said main external diameter and substantially equal to the said second diameter of the recess, to assist in centring the insert in the recess.

Preferably the dimensions of the opening and the insert are such that when the insert is pushed into the recess until the outer face of the insert is flush with the surrounding edge of the recess, the opening is completely filled with deformed material.

Conveniently the opening extends laterally from the outer portion of the recess in a plane at right angles to a central axis of the recess, but in other forms it may be arranged that the opening extends laterally from the recess in an inward direction inclined to a plane at right angles to the central axis of the recess.

Conveniently it may be arranged that the recess has a third, inner, portion having a third diameter which is smaller than the second diameter for providing a stop to prevent the insert from being pushed into the recess beyond a desired predetermined extent.

According to the invention in a preferred combination of features there is provided a set of components to form a cylinder head assembly, comprising: a cylinder head for an internal combustion engine, and a valve seat insert for insertion into a recess in the cylinder head, in which the recess has a first outer portion having a first diameter, and a second, inner, portion having a second diameter which is smaller than the first diameter, and a circumferential groove extending laterally into the cylinder head from the first outer portion of the recess, the valve seat insert having a main external diameter corresponding to the outer portion of the recess, and being formed at least in part of material which is softer than the material defining the cylinder head recess, such that when the valve insert is forced into the recess beyond the outer portion of the recess, material of the valve seat insert is deformed into the groove of the recess to lock the insert into the recess.

In order to reduce material costs, or to provide for particular performance requirements, it may be arranged that the insert is formed of at least two materials of different hardness, the valve seat being formed in a first region of the insert of a first material, and the insert including a second region of material softer than the first region, the softer material being positioned so as to be deformed into the opening when the valve seat insert is forced into the recess.

In accordance with the invention in another aspect, there may be provided a valve seat insert for a cylinder head of an internal combustion engine, com-

prising a ring shaped structure having a valve seat formed on a first region of the insert which includes an outer face of the insert relative to the intended direction of insertion of the insert into a recess in a cylinder head, the insert being formed at least at a second region of the insert which includes a periphery of the insert, of material suitable to be deformed into a laterally extending opening in a recess in a cylinder head made of material harder than the said material of the said second region.

Conveniently the said first and second regions are made of materials of different hardness, the material of the second region being made of material softer than the material of the first region.

In one form, the first region is an outer region of the insert relative to the intended direction of insertion of the insert, and the second region is an inner region of the insert relative to the same direction. In another form, the second region is an annular region surrounding the first region.

The material of the first region may conveniently be a hard, wear resistant material and can be ferrous based as in conventional practice for the valve seat. The material of the second region is made softer, for example a copper or copper based material, to provide the required deformable material.

In a further aspect of the present invention, there is provided a cylinder head assembly comprising a valve seat insert and a cylinder head as have been set out in any of the preceding paragraphs, after assembly of the insert and the cylinder head together, in which the material of the valve seat insert is deformed into the lateral opening of the recess to lock the valve seat insert into the recess.

In accordance with a yet further aspect of the invention there is provided a method of securing a valve seat insert to a cylinder head comprising forcing a valve seat insert into a recess in a cylinder head and deforming material of the valve seat insert into an opening extending laterally into the cylinder head from the recess so as to lock the valve seat insert into the cylinder head recess.

In a preferred arrangement there may be provided in accordance with the invention a method of securing a valve seat insert to a cylinder head comprising: inserting a valve seat insert into a recess in a cylinder head, advancing the valve seat insert into an outer portion of the recess which has a first diameter corresponding to the main external diameter of the valve seat insert, until the valve seat insert contacts an inner portion of the recess which has a second diameter which is smaller than the first diameter, and forcing the insert further into the recess to deform material of the valve seat insert into a circumferential groove extending laterally into the cylinder head from the first portion of the recess so as to lock the valve seat insert into the cylinder head recess.

In preferred forms the method made be used with any one or any combination of a valve seat insert and a cylinder head having the features set out in the preceding paragraphs.

The invention provides, at least in preferred forms, a number of advantages over previously known valve seat inserts for use with cast iron cylinder heads and the like. The method provides a means of locking a valve seat insert into a cast iron cylinder head giving low cost installation because no heating and cooling equipment is required. There can be provided low seat height, which therefore reduces material cost and gives the possibility of redesigning the head to give greater fuel efficiency. In use a cylinder head assembly according to the invention may provide high heat transfer due to materials used and method of insertion, leading to lower valve seat insert temperatures and subsequently lower valve temperatures.

A number of embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:-

Figure 1A is a diagrammatic cross-section through a valve seat and cylinder head embodying the invention, before final assembly, and Figure 1B is a diagrammatic plan view of the components of Figure 1A;

Figure 1C is a diagrammatic representation of one side of the cross-section of Figure 1A, before final assembly, and Figure 1D is one side of the cross-section of Figure 1A, after assembly of the components into a valve seat assembly;

Figure 2 shows one side of a cross-section through a valve seat insert and cylinder head, showing a modification of the embodiment of Figure 1A, including a pilot portion of the insert;

Figure 3 shows one side of a cross-section through a valve seat insert and cylinder head, showing an inclined circumferential groove in the cylinder head;

Figure 4 shows one side of a cross-section corresponding to that of Figure 3, but including a modification of a pilot portion of the valve seat insert;

Figures 5A and 5B show one side of a cross-section through a valve seat insert and cylinder head, showing a modification of the embodiment of Figure 1A, including a the provision of a stop portion at the base of the recess, Figure 5A showing the components before final assembly, and Figure 5B showing the components after final assembly;

Figure 6 shows one side of a cross-section corresponding to that of Figure 5A, but including a modification of a pilot portion of the valve seat insert;

Figures 7A and 7B show in each case one side of a cross section through a valve seat insert and cylinder head embodying the invention, including

a modification that the valve seat insert is formed of two materials of different hardness, Figure 7A showing the components before assembly, and Figure 7B showing the components after full assembly.

Figure 8 shows one side of a cross section through a valve seat insert and cylinder head embodying the invention showing a modification of the assembly of Figure 7B in that upper portion of the insert is of greater depth;

Figure 9 shows one side of a cross-section through a valve insert and cylinder head embodying the invention, showing a modification from the arrangement of Figure 7B in that material is deformed upwardly between the insert and the cylinder head; and

Figures 10A, and 11A and 11B, show in each case one side of a cross-section through a valve seat insert and cylinder head embodying the invention, showing modifications in which the valve insert is made of two materials of different hardness, the softer material being formed as an annular ring around the harder material.

Referring to Figure 1A, a valve seat insert 11 consists of a cylindrical ring of material which is inserted into a machined recess 12 in a cast iron cylinder head 13. The machined recess 12 has a first outer portion indicated at 14 which has a first diameter, and has a second inner portion 15 having a second diameter which is smaller than the first diameter. The recess 12 also has a circumferential groove 16 extending laterally into the cylinder head from the first outer portion 14 of the recess. For simplicity the groove 16 is shown as square, but in practice the groove 16 should not have sharp corners which might initiate cracks, and instead should be generously radiussed. In the example shown in Figure 1A, the groove 16 extends laterally in a plane perpendicular to a central axis 17 of the recess 12.

In Figures 1A and 1C, the valve insert 11 is shown after it has been pushed into the recess 12 until it reaches the bottom of the first portion 14 and meets the shoulder formed by the second portion 15. When the insert is pushed into the recess beyond the first portion 14, material of the insert is deformed into the groove 16 by the projecting shoulder of the second portion 15 of the recess 12. In order to achieve this it is necessary for the cast iron of the cylinder head to be stronger than the valve seat insert material. The dimensions of the groove 16 and the insert 11 are made to be such that when the insert 11 is pushed in flush with the cylinder head, the groove 16 is completely filled with insert material, as shown in Figure 1D. The valve seat insert 11 has a main external diameter corresponding to the first diameter of the first, outer, portion 14 of the recess 12, and conveniently is a sliding fit with the first portion of the recess.

In Figure 2 there is shown a modification of the insert shown in Figure 1C. In Figure 2 the insert 11 has an inner pilot portion 17 having an external diameter smaller than the main external diameter of the insert. The pilot portion 17 is used to assist in centring the insert.

Referring to Figure 3, the shape of the projecting shoulder formed by the second portion 15 of the recess may be altered to produce smaller insertion forces by inclining the groove. As shown in Figure 3, the groove 16 may be inclined to a plane perpendicular to the axis 17 (Figure 1A), the groove 16 be inclined inwardly relative to the direction of insertion of the valve insert. The projecting shoulder of the portion 15 acts as a cutting edge to shear material into the groove 16. Figure 4 shows a modification of the arrangement of Figure 3, by the provision of a pilot portion 17 of the insert 11, as shown previously in Figure 2.

Referring to Figures 5A and 5B, the recess may have a third, inner portion 18 having a third diameter which is smaller than the diameter of the second portion 15 of the recess. The shoulder formed by the third portion of the recess 18 provides a stop to prevent the insert from being pushed too far into the recess. As shown in Figure 5B, the insertion is halted when the bottom face of the insert 11 meets the shoulder formed by the third portion 18. Figure 6 shows a further modification in which a small pilot portion 17 is provided at the base of the insert.

To reduce materials costs, the insert may be made of two different materials, of different hardness, as is shown in Figures 7A to 11B. Referring to Figure 7A, the valve seat 10 has a first region 20 formed of a first material, and the insert includes a second region 21 of material softer than the first region 20. In the arrangement of Figure 7A, the first region 20 is an outer region of the insert relative to the direction of insertion, and the second region is an inner region. The material of the first region 20 is a hard, wear resistant material, and a ferrous based material may be used as in conventional practice for valve seats. The material of the second region 21 is softer, for example a copper or copper based material, to provide the deformable material to enter the groove 16, on insertion and to lock the insert in position. The deformation of the softer material of the region 21 is shown in Figure 7B.

Depending on the service required for the insert, it may be adequate to have remaining copper or copper based material above the second portion 15 of the recess (as shown in Figure 7B). If this is not acceptable, the geometry of the insert can be arranged to provide an insert such that the harder and stronger ferrous based material of the region 20 displaces most of the copper or copper based material of the region 21, and sits directly on the shoulder portion 15, as shown in Figure 8.

A further advantage of using an insert with two materials is that the softer material, after completely

filling the groove, can be made to extrude upwards as shown in Figure 9, to fill any gap 22, between the insert and the cast iron cylinder head 13. This improves heat transfer by removing any gap. By virtue of the high thermal conductivity of the copper or copper based material, which is greater than that of the cast iron and the ferrous valve seat insert material, the fitting of the insert can only become tighter when at the operating temperature of the engine, thus improving heat transfer.

In Figures 10 and 11A, there are shown two alternative configurations of an insert having two different materials. The first region 20 consists of an inner region of relatively hard material, and the second region 21 consists of an annular region of softer material, surrounding the harder material 20. In Figure 11A there is shown a modification in which a pilot portion 17 is provided, formed of the hard material of the region 20. Figure 11B shows that during the pressing operation the softer material 21 is deformed into the groove 16 providing the locking mechanism, and the seat is inserted until the harder material 17 meets the smaller diameter shoulder 18.

The softer copper or copper based material used can also be of the age-hardenable variety such that at the operating temperature the hardness of the material increases with time providing firm fixing of the insert and good wear resistance.

In all cases the valve seat inserts are simple cylindrical rings of one or two diameters and hence are simple to manufacture. Tolerances can be relaxed due to the extrusion of the copper or copper based material to fill any gap between seat and insert. Cast iron cylinder heads have to have a recess machined for conventional seats and the provision of a slightly more complex recess will not bring a significant cost penalty.

Claims

1. A set of components to form a cylinder head assembly, comprising:

   a cylinder head (13) for an internal combustion engine, and

   a valve seat insert (11) for insertion into a recess (12) in the cylinder head,

   characterised in that the valve seat insert (11) is formed at least in part of material which is softer than the material defining the cylinder head recess (12), and the recess has an opening (16) extending laterally into the cylinder head (13) from the recess, such that when the valve insert is forced into the recess, material of the valve seat insert is deformed into the lateral opening (16) of the recess to lock the insert into the recess.

2. A set according to claim 1 in which the recess has a first, outer, portion (14) having a first diameter, and a second, inner, portion (15) having a second diameter which is smaller than the first diameter, the said lateral opening (16) extending laterally into the cylinder head (13) from the first, outer, portion of the recess, the valve seat insert (11) having a main external diameter substantially equal to the diameter of the outer portion (14) of the recess, and the arrangement being such that when the valve insert is forced into the recess beyond the outer portion of the recess, material of the valve seat insert is deformed into the lateral opening (16) of the recess (12) to lock the insert into the recess.

3. A set according to claim 2 in which the said lateral opening comprises a circumferential groove (16) extending laterally into the cylinder head (13) from the first, outer, portion (14) of the recess.

4. A set according to claim 2 or 3 in which the insert has an inner, pilot, portion (17) having an external diameter smaller than the said main external diameter and substantially equal to the said second diameter of the recess, to assist in centring the insert in the recess.

5. A set according to claims 2, 3 or 4 in which the recess has a third, inner, portion (18) having a third diameter which is smaller than the second diameter for providing a stop to prevent the insert (11) from being pushed into the recess beyond a desired predetermined extent.

6. A set according to any preceding claim in which the insert is formed of at least two materials of different hardness, the valve seat being formed in a first region (20) of the insert (11) of a first material, and the insert including a second region (21) of material softer than the first region, the softer material being positioned so as to be deformed into the opening (16) when the valve seat insert is forced into the recess.

7. A valve seat insert for a cylinder head of an internal combustion engine, comprising a ring shaped structure (11) having a valve seat (10) formed on a first region (20) of the insert which includes an outer face of the insert relative to the intended direction of insertion of the insert (11) into a recess (12) in a cylinder head, characterised in that the insert is formed at least at a second region (21) of the insert which includes a periphery of the insert, of material suitable to be deformed into a laterally extending opening (16) in a recess (12) in a cylinder head made of material harder than the said material of the said second region (21).

8. A valve seat insert according to claim 7 in which the said first and second regions (20,21) are made of materials of different hardness, the material of the second region (21) being made of material softer than the material of the first region (20).

9. A cylinder head assembly comprising a valve seat insert (11) and a cylinder head (13) as set out in any one or any combination of the preceding claims, after assembly of the components, in which the material of the valve seat insert (11) is deformed into the lateral opening (16) of the recess (12) to lock the valve seat insert into the recess.

10. A method of securing a valve seat insert to a cylinder head characterised by the steps of forcing a valve seat insert (11) into a recess (12) in a cylinder head (13) and deforming material of the valve seat insert into an opening (16) extending laterally into the cylinder head (13) from the recess so as to lock the valve seat (11) insert into the cylinder head recess (12).

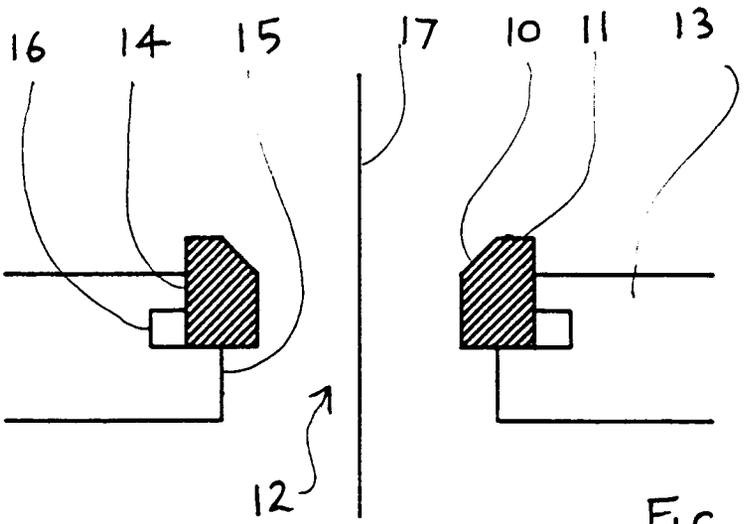

FIG 1A

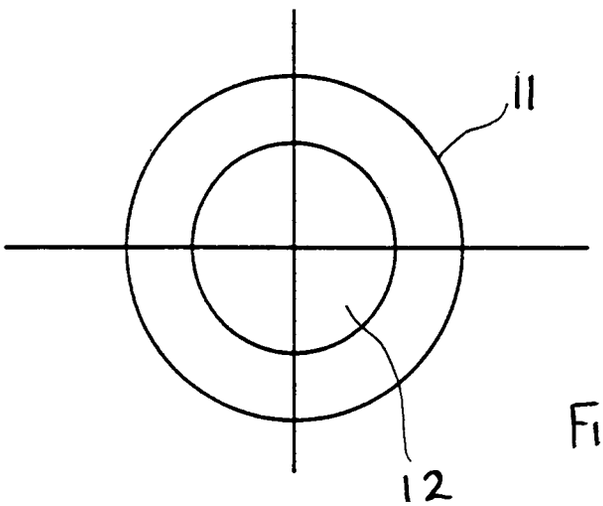

FIG 1B

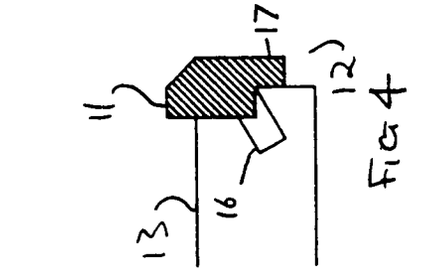

FIG 4

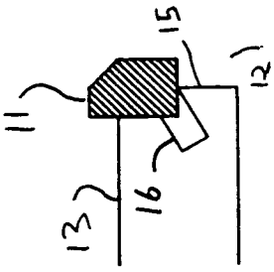

FIG 3

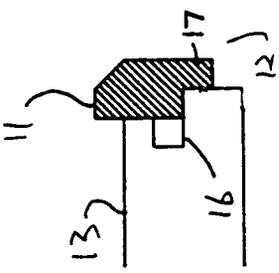

FIG 2

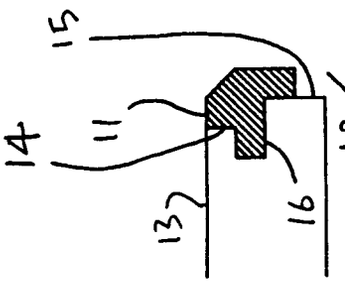

FIG 1D

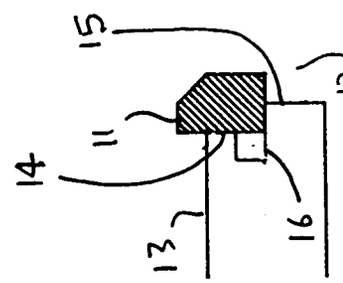

FIG 1C

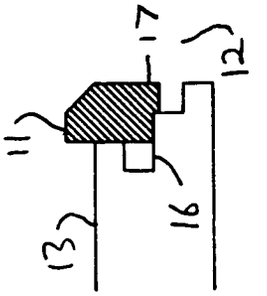

FIG 6

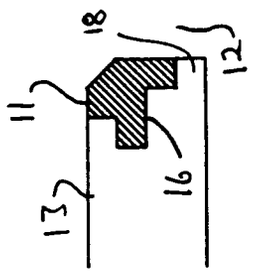

FIG 5B

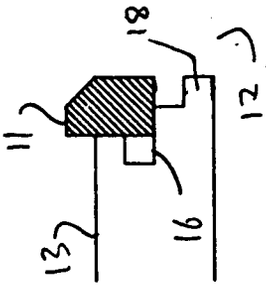

FIG 5A

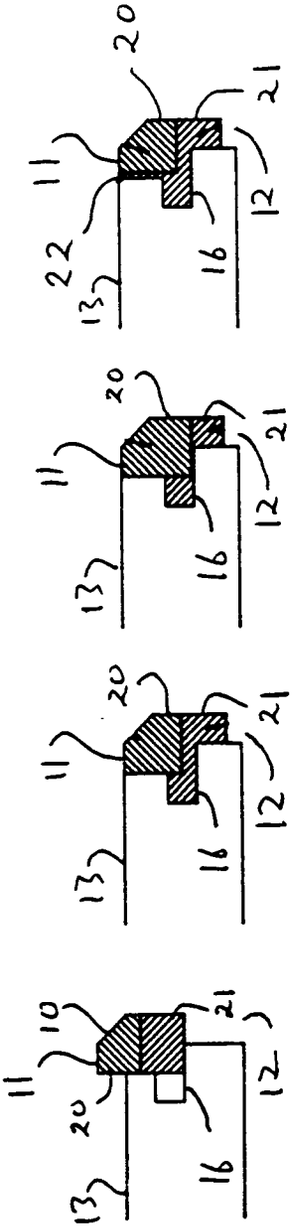

FIG 7A

FIG 7B

FIG 8

FIG 9

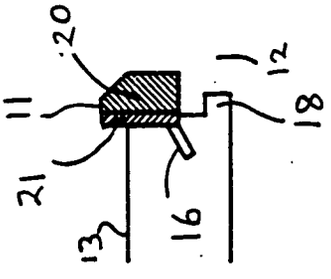

FIG 10

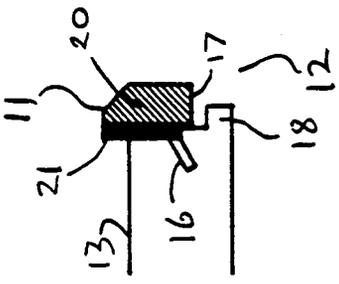

FIG 11A

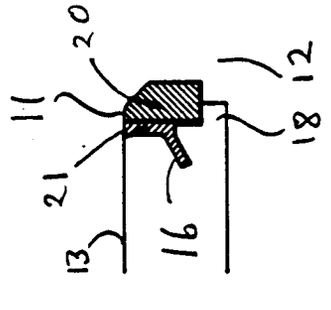

FIG 11B

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 3932

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.5)
X	GB-A-367 429 (WAKE) * page 4, line 59 - line 64 * * page 5, line 20 - line 74 * * figures 5,6 *	1-10	F01L3/22
X	US-A-2 035 165 (JARDINE) * page 2, line 7 - line 32 * * figures 8-11 *	1-4,7,9,10	
X	US-A-2 007 543 (MEEKER) * column 1, line 29 - line 39 * * figures 1-3 *	1-3,6-10	
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			F01L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	6 September 1994	Lefebvre, L

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)