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(54) Method of forming a chamber in a workpiece

(57) A method of forming a chamber (13) in a workpiece (10) comprises the steps of forming a blind bore (12) in the workpiece (10) and inserting an insert member (20) into the blind end of the bore (12) such that the insert member (20) and the bore (12) together define the chamber (13). The invention also relates to a workpiece formed using such a method.

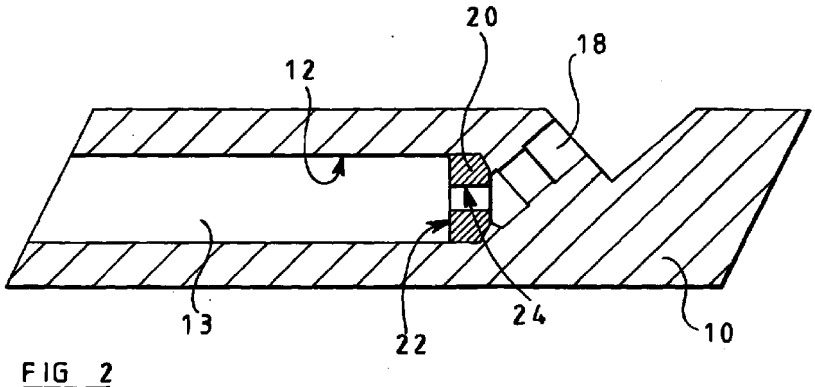

FIG 2

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Description

[0001] The invention relates to a method of forming a chamber in a workpiece. In particular, but not exclusively, the invention relates to a method of forming a chamber in a fuel injector suitable for use in delivering fuel to a combustion space of an internal combustion engine. The invention also relates to a workpiece formed using the method.

[0002] Referring to Figure 1, there is shown a part of a conventional fuel injector including a nozzle body 10 which is provided with a blind bore 12 defining a chamber 13. The chamber 13 is formed by means of a conventional process which includes the initial step of drilling the blind bore 12 in the nozzle body 10.

[0003] When the fuel injector is in use, the chamber 13 houses a compression spring (not shown), one side of spring being seated against a seating 14 defined by the blind end of the bore 12 and the other side of the spring being in abutment with a surface associated with the valve needle of the fuel injector to urge the valve needle towards a seating. As the blind end of the bore 12 provides a seating surface 14 for the spring, it is important that it is substantially free from irregularities. However, the initial step of drilling the bore 12 in the nozzle body 10 results in the blind end of the bore 12 being formed with an irregular surface such that the depth of the chamber 13 varies across the diameter of the bore 12. Thus, following drilling of the bore 12, it is necessary to machine the blind end of the bore so as to form a substantially flat seating surface 14 for the spring. Figure 1 shows the fuel injector following this stage of the manufacturing process.

[0004] Following machining of the blind end of the bore 12, a drilling 16 is formed in the nozzle body 10, the drilling 16 communicating with a further drilling 18. The drilling 18 communicates with a low pressure drain or fuel reservoir such that, in use, fuel within the chamber 13 is able to escape to low pressure.

[0005] A disadvantage of the conventional method of forming the chamber in the nozzle body is that it is a relatively complex process, involving several drilling and machining stages, and is costly to carry out.

[0006] It is an object of the present invention to provide a method of forming a chamber in a workpiece which alleviates this disadvantage.

[0007] According to a first aspect of the present invention, a method of forming a chamber in a workpiece comprises the steps of;

forming a blind bore in the workpiece; and

inserting an insert member into the blind end of the bore such that the insert member and the bore together define the chamber.

[0008] As the chamber is defined, in part, by the insert member, rather than by the blind end of the bore, the method of forming the chamber has a reduced number of processing steps. In particular, the need for machining the blind end of the bore is removed. The method can therefore be carried out with reduced cost and provides a significant manufacturing advantage over the conventional method.

[0009] The method may be used to form a chamber in a part of a fuel injector, for example in fuel injector nozzle body. The method may comprise the further step of inserting a compression spring into the chamber such that one end of the spring abuts a surface of the insert member, the surface of the insert member thereby providing a seating for the spring.

[0010] The method may further comprise the step of providing the nozzle body with a drilling which communicates with the bore, the insert member being provided with a bore which permits communication between the chamber and the drilling.

[0011] According to a second aspect of the invention, a workpiece having a chamber formed using the method described herein comprises a blind bore, an insert member being received within the blind end of the bore, the insert member and the bore together defining the chamber.

[0012] The workpiece may form part of a fuel injector, for example a fuel injector nozzle body. Conveniently, the chamber may house a compression spring for urging a valve needle of the fuel injector against a seating when the fuel injector is in use, a surface of the insert member providing a seating for the spring.

[0013] Preferably, the nozzle body may also be provided with a drilling and the insert member may be provided with a bore which permits communication between the chamber and the drilling.

[0014] The drilling provided in the nozzle body may define, at least in part, a flow passage for fuel which communicates with a low pressure drain or fuel reservoir, in use.

[0015] The invention will now be described, by way of example only, with reference to the accompanying drawings in which:-

Figure 1 shows a part of a conventional fuel injector having a nozzle body provided with a spring chamber; and

Figure 2 shows a part of a fuel injector in accordance with an embodiment of the present invention.

[0016] With reference to Figure 2, there is shown a nozzle body 10 forming part of a fuel injector for use in delivering fuel to a combustion space of an internal combustion engine. The nozzle body 10 is provided with a blind bore 12 and a drilling 18 which communicates with a low pressure drain or fuel reservoir (not shown). An insert member 20 is received within the blind end of the bore 12, one surface of the insert member being in abutment with the blind end of the bore and another sur-

face of the insert member 20 defining, together with a part of the bore 12, a chamber 13 for housing a compression spring (not shown).

[0017] The insert member 20 is provided with a bore 24 extending along the axis of the insert member 20, the bore 24 defining a flow passage for fuel between the chamber 13 and the drilling 18 such that, when the fuel injector is in use, fuel within the chamber 13 is able to flow to the low pressure drain. The insert member may form an interference fit within the bore 12. In use, the compression spring is received within the chamber 13 such that one end of the compression spring is in abutment with a seating 22 defined by a surface of the insert member 20 and the other end of the compression spring is in abutment with a surface associated with a valve needle of the fuel injector, the spring thereby serving to urge the valve needle towards a valve needle seating.

[0018] The chamber 13 is formed by initially carrying out the step of drilling the blind bore 12 in the nozzle body 10 using a conventional drilling technique. Subsequently, the drilling 18 is formed in the nozzle body 10 such that one end of the drilling 18 communicates with the bore 12 at its blind end. The insert member 20 is then inserted into the blind end of the bore 12. If required, any irregularities in the surface of the blind end of the bore 12 following drilling can be compensated for by appropriately shaping the surface of the insert member 20 which abuts the blind end of the bore, prior to insertion thereof into the bore 12.

[0019] As shown in Figure 1, in a conventional fuel injector the compression spring abuts a seating 14 which is defined by the blind end of the bore 12 and it is therefore necessary to carry out a machining process to ensure the blind end of the bore 12 is substantially flat over the region of the seating 14. It is also necessary to provide an additional drilling 16 in the nozzle body 10 to provide communication between the chamber 13 and the low pressure drain. The manufacturing process is therefore relatively complex, as it requires several drilling stages and a machining process, and is costly to carry out. The present invention provides the advantage that, as the insert member 20 is formed prior to being received within the bore 12, the surface of the insert member 20 which defines the seating 22 for the spring can be shaped relatively easily and the need to machine the blind end of the bore following drilling is removed. Furthermore, the drilling 16 in Figure 1 is not required as the insert member 20 is provided with a bore which permits communication between the chamber 13 and the low pressure drain. The method of the present invention therefore requires fewer processing steps and provides an advantage in terms of manufacturing cost.

[0020] For some applications, the drilling 18 may be formed in the nozzle body 10 such that it does not communicate directly with the flow passage defined by the bore 24 in the insert member 20. In this case, it is necessary to provide a further drilling in the nozzle body 10, one end of which communicates with the bore 24 and the other end of which communicates with the drilling 18. This requires the additional method step of providing a further drilling at the blind end of the bore 12. Typically, the further drilling will have a diameter which is substantially the same as the diameter of the bore 24 in the insert member 20. Although this method requires an additional drilling stage, the need to machine the blind end of the bore to reduce surface irregularities is still removed.

[0021] It will be appreciated that the bore 12, the bore 24 and the drilling 18 may be formed with different dimensions to those described hereinbefore. Furthermore, it will be appreciated that the chamber 13 may house any spring, or any other component, in use, and need not house a spring which acts on the valve needle. Additionally, it will be appreciated that the method of the present invention is not limited to use in forming a chamber in a fuel injector but may be used to form a chamber in any workpiece.

Claims

1. A method of forming a chamber (13) in a workpiece (10) comprising the steps of;

   forming a blind bore (12) in the workpiece (10); and

   inserting an insert member (20) into the blind end of the bore (12) such that the insert member (20) and the bore (12) together define the chamber (13).

2. The method as claimed in Claim 1, wherein the workpiece is a nozzle body (10) forming part of a fuel injector.

3. The method as claimed in Claim 1 or Claim 2, comprising the further step of inserting a compression spring into the chamber (13) such that one end of the spring abuts a surface of the insert member (20), the surface of the insert member (20) thereby providing a seating for the spring.

4. The method as claimed in any of Claims 1 to 3, comprising the further step of providing the workpiece (10) with a drilling (18) which communicates with the bore (12), the insert member (20) being provided with a further bore (24) which permits communication between the chamber (13) and the drilling (18).

5. A workpiece (10) having a chamber (13) formed using the method as claimed in any of Claims 1 to 4.

6. The workpiece as claimed in Claim 5, wherein the

workpiece is a nozzle body (10) forming part of a fuel injector.

7. The workpiece as claimed in Claim 6, wherein the chamber (13) houses a compression spring for urging a valve needle of the fuel injector against a seating when the fuel injector is in use, a surface of the insert member (20) providing a seating for the spring.

8. The workpiece as claimed in Claim 7, wherein the nozzle body (10) is provided with a drilling (18) and the insert member (20) is provided with a further bore (24) which permits communication between the chamber (13) and the drilling (18).

9. The workpiece as claimed in Claim 8, wherein the drilling provided in the nozzle body (10) defines, at least in part, a flow passage for fuel which communicates with a low pressure drain or fuel reservoir, in use.

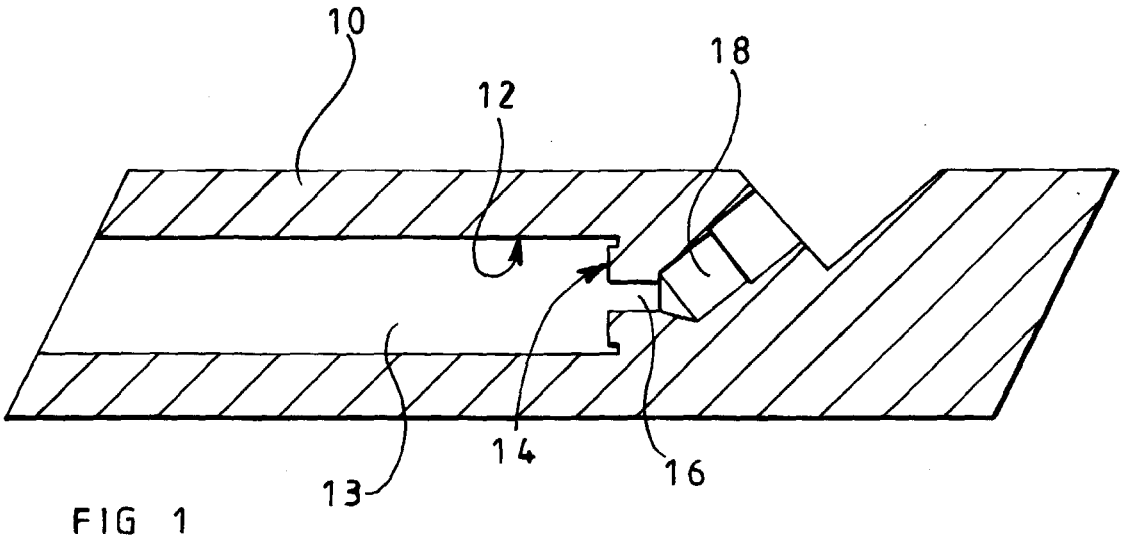

FIG 1
(Prior art)

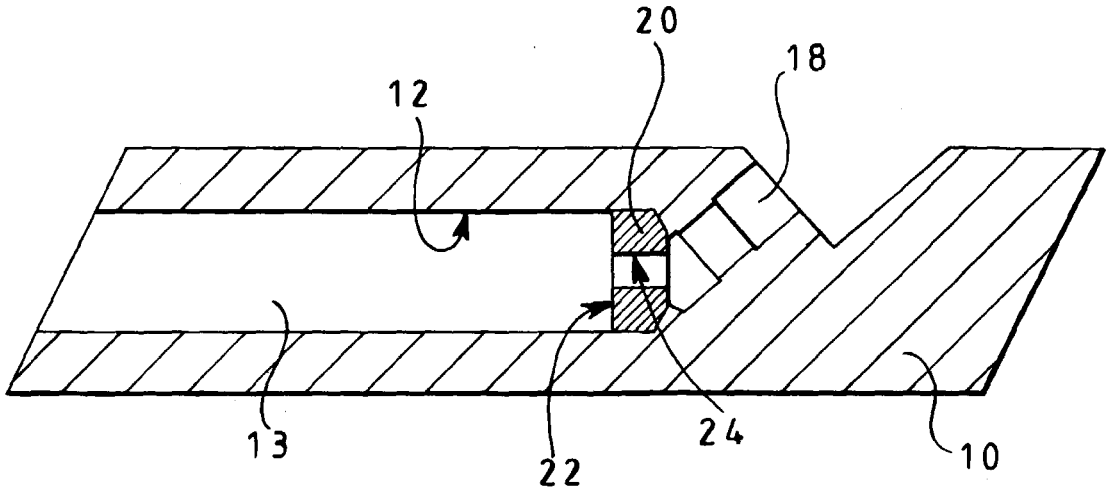

FIG 2