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## (54) Fuel injector clamping means

(57) A clamping arrangement is disclosed for securing a plurality of fuel injectors (16A-D) to an engine assembly (10), preferably onto a cylinder head (112) thereof. The clamp (30A, 30B) comprises a longitudinally extending beam (32) having at each end thereof an injector clamping member (34) arranged in use to impart a clamping force onto a clamping portion (28) associated with an injector. The beam has defined therethrough and in between the clamping members at least one fixing hole (40) adapted to receive an associated mechanical fixing (36) for imparting the clamping force and the or each fixing hole and the clamping members are substantially in-line with each other. Each injector clamping member comprises a closed flange (34) that in use completely surrounds a portion (24) of its associated fuel injector (16A-D) and each closed flange is provided with at least one anti-rotation means (340) that is arranged in use to engage with an anti-rotation means (26A) of the fuel injector.

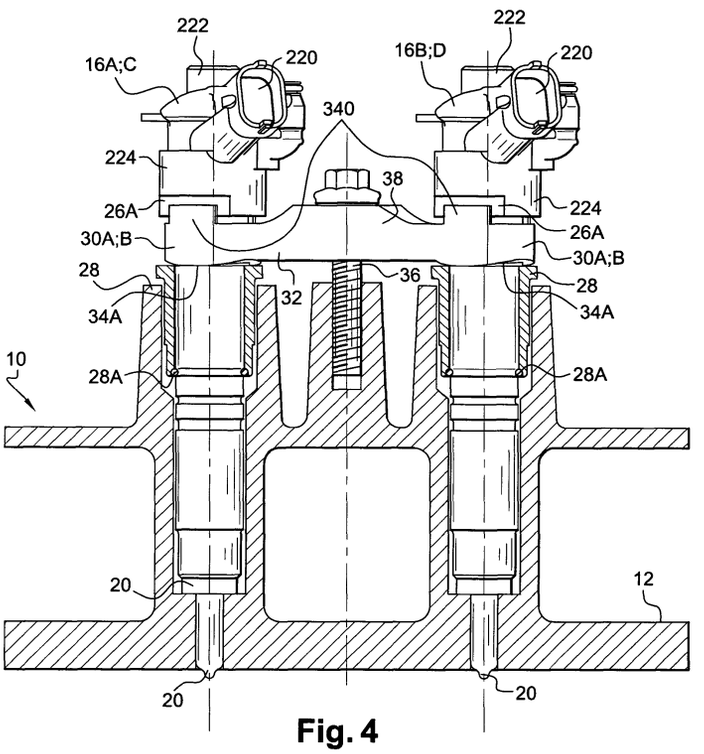


Fig. 4

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## Description

**[0001]** The present invention relates to engines and in particular to an arrangement for clamping fuel injectors in place on an engine assembly.

**[0002]** It is known to provide an engine with fuel injectors and to attach those fuel injectors to the engine using a clamp and a mechanical fastener. A common type of clamping arrangement that has been in use for many years is a simple open forked clamp used one per injector. Examples of such arrangements can be seen for example in US patents 2144861 and 6196194.

**[0003]** With the increasing use of multi-valve overhead camshaft engines, space constraints for injector clamping are becoming ever more restrictive. These problems are recognised in EP-0848158 and-EP-0751290 in which are proposed arrangements for clamping down a plurality of injectors using a single clamp. The clamp proposed in each case holds down its outer injectors using a forked end.

**[0004]** The downward force used to fix injector clamps in place tends to splay the fork ends outwards. In order to reduce this effect, such forked clamps have often been made from very thick material and, furthermore, the fingers of the forks tend to be quite wide. The thick material is also necessary to resist the ever higher in-cylinder pressures that try to unseat the injectors, in particular in diesel engine assemblies. Such use of thick and wide members can be inconvenient when trying to install injectors in tight places, such as for example between a pair of overhead camshafts in a multi-valve engine. There is therefore a continuing need to seek compact solutions to injector clamping arrangements.

**[0005]** It is an object of the present invention to provide an improved arrangement for engine fuel injector clamping.

**[0006]** Accordingly, the present invention provides a clamp for securing a plurality of fuel injectors to an engine assembly, preferably onto a cylinder head thereof, said clamp comprising a longitudinally extending beam having at each end thereof an injector clamping member arranged in use to impart a clamping force onto a clamping portion associated with a said injector, said beam having defined therethrough and in between said clamping members at least one fixing hole adapted to receive an associated mechanical fixing for imparting said clamping force and the or each said fixing hole and said clamping members being substantially in-line with each other, characterised in that each said injector clamping member comprises a closed flange that in use completely surrounds a portion of its associated said fuel injector and in that each said closed flange is provided with at least one anti-rotation means that is arranged in use to engage with an anti-rotation means of said fuel injector.

**[0007]** It is an advantage of the present invention that, because of the feature of the closed flange, the fuel injector hold-down clamp can be made lighter and narrower that some prior art arrangements. The additional characterising feature of the anti-rotation means helps ensure that the injectors are optimally orientated within the closed flange and therefore on the cylinder head.

**[0008]** Said anti-rotation means of said clamp may be formed integrally with said closed flange.

**[0009]** Said anti-rotation means of said clamp may comprise a plurality of lugs, preferably evenly disposed around said closed flange and more preferably comprising a pair of said lugs.

**[0010]** Said anti-rotation means of said clamp may define at least one anti-rotation surface that faces inwards and complements said anti-rotation means formed on said injector.

**[0011]** Said anti-rotation means of said clamp may comprise at least one pair of inwardly facing lugs, each of which pair or pairs of lugs comprises anti-rotation surfaces in the form of inwardly facing and substantially parallel flat surfaces.

**[0012]** Said anti-rotation means of said clamp may be upstanding from said closed flange.

**[0013]** Said closed flange may comprise a substantially cylindrical collar adapted to impart a clamping force to its associated said injector by axially directed contact between said collar and said clamping portion.

**[0014]** Said clamp may comprise a double clamp for securing only two neighbouring said injectors to said engine assembly, said clamp preferably being formed by a casting or moulding technique and said fixing hole being defined through a boss disposed substantially in-line and half-way in between two neighbouring said closed flanges.

**[0015]** An upper portion of said fixing hole may be defined in the form of an at least partially spherical or countersunk recess, preferably adapted to accommodate in use a corresponding part spherical or countersunk washer or a part spherical or countersunk head of a said mechanical fixing.

**[0016]** The present invention also provides a method of fixing a pair of neighbouring fuel injectors into an in-use position on an engine, preferably a direct injection diesel engine and more preferably in between a pair of overhead camshafts thereof, the method including clamping said pair of neighbouring injectors into said in-use position using a clamp according to the present invention.

**[0017]** The present invention also provides a fuel injector for use in co-operation with a clamp according to the invention, said fuel injector comprising a body portion that includes anti-rotation means adapted to co-operate with said anti-rotation means of said clamp and further comprising captive means to enable captive assembly of said injector into said clamp, said body portion preferably housing a fuel metering means of said injector and said anti-rotation surfaces comprising a pair of outwardly facing, substantially flat and parallel surfaces formed integrally with said body portion.

**[0018]** The present invention also provides a fuel in-

jection sub-assembly comprising a clamp according to the invention and having captured thereon, through each said closed flange thereof, first and second fuel injectors according to the invention.

**[0019]** The present invention also provides a method of producing a fuel injection sub-assembly according to the invention, the method including assembling said first and second fuel injectors into said closed flanges of said clamp and capturing each said injector onto said clamp by sliding onto each said injector a sleeve, preferably capturing each said sleeve onto its respective said injector using a captive member such as a snap or stop ring.

**[0020]** The present invention also provides an engine assembly including at least one clamp according to the present invention or at least one fuel injection sub-assembly according to the invention. Said engine assembly may comprise a row of cylinders having disposed therealong a pair of overhead camshafts, the or each said clamp or sub-assembly being disposed in use in between and preferably substantially in parallel with said camshafts, said engine assembly preferably comprising a compression ignition internal combustion engine such as a common rail direct injection diesel engine suitable for use in a road-going vehicle.

**[0021]** The present invention will now be described by way of example only and with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a fuel injector hold-down clamp;

Figure 2 is a perspective view of a fuel injector used in co-operation with the fuel injector hold-down clamp of Figure 1 to form a fuel injection sub-assembly;

Figure 3 is an end view of a fuel injection sub-assembly comprising the fuel injector of Figure 2 assembled into the fuel injector hold-down clamp of Figure 1;

Figure 4 is a side view in section of the fuel injection assembly of Figure 3, assembled into a cylinder head of an engine; and

Figure 5 is a side view in section of an engine assembly including fuel injection sub-assemblies according to Figures 3 and 4.

**[0022]** Referring to the drawings, an engine 10 will be considered as embodied in the non-limiting form of a compression ignition engine, preferably comprising a diesel engine suitable for use in a road-going vehicle such as a passenger car or light commercial vehicle. The engine 10 may comprise one or more banks having defined therein multiple cylinders disposed substantially in-line. For the current and exemplary but non-limiting embodiment, however, the engine 10 will be considered in the form of an in-line arrangement having four cylinders 1-4.

**[0023]** The engine 10 includes a cylinder head 12 having double overhead camshafts (DOHC) 14 arranged in parallel along that cylinder head 12. The engine 10 preferably comprises a common-rail direct injection diesel engine and has a series of fuel injectors 16A-D that are fitted into the cylinder head 12 for injecting fuel directly into the cylinders 1-4. The injectors 16A-D are disposed in between the DOHC 14 and substantially in-line and in parallel with those camshafts 14. The injectors 16A-D are preferably substantially identical in construction, so as to benefit from commonality between parts and processes.

**[0024]** Each injector 16A-D comprises a tubular body assembly 18 having a fuel inlet and control portion 22 in the region of one end and a fuel nozzle 20 in the region of the opposite end, considered for convenience as the top end 22 and bottom end 20 respectively of the injector 16A-D.

**[0025]** Looking for the moment in more detail at the fuel inlet and control portion 22, each fuel injector 16A-D includes at its top end an electrical connector 220 and a fuel inlet 222 both projecting away from a fuel metering body 224. The connector 220 is configured to connect to a wiring harness (not illustrated) via which harness and electrical connectors 220 fuel injection control signals are provided to control the flow of fuel through the fuel metering body 224. The fuel metering body 224 includes a first part of an anti-rotation means that is arranged in use to co-operate with a corresponding second part of the anti-rotation means formed as part of an associated injector hold-down clamp 30A;B. In this non-limiting embodiment, the part of the anti-rotation means formed on the injector 16A-D comprises a pair of flats 26A formed in opposite sides of the fuel metering body 224 and extending part way up the fuel metering body 220 from its lower end. The flats 26A are preferably substantially parallel, so as to optimise anti-rotation load sharing, and may comprise cut-outs from the fuel metering body 224 formed by a pair of chords cutting across it for at least part of its length.

**[0026]** At the lower end of the fuel metering body 224, each fuel injector 16A-D steps inwards to a body section 24 of narrowed diameter. The anti-rotation flats 26A may conveniently be substantially tangential to the diameter of this narrowed body section 24, which may help during assembly operations into the cylinder head 12. In the assembled condition, this narrow body section 24 is bounded by an upper flange and a lower flange. The upper flange comprises a lower face of the fuel metering portion 224 formed under the step downwards to the body portion 24 of narrowed diameter, the upper flange being less than fully round because of the cut-outs defined by the flats 26A.

**[0027]** The lower flange is formed by the top face of a clamping sleeve 28 that surrounds the narrowed injector body 24 and provides a circular and flat working surface at right angles to the injector centre line. This sleeve 28 and flange arrangement may be referred to for convenience as that fuel injector's clamping portion

and it is onto this lower flange that a clamping force is applied to clamp that injector 16A-D in place in the cylinder head 12. The sleeve 28 may conveniently be slid onto the injector16A-D during assembly and captured in place using a snap ring 28A or equivalent means that would stop axial movement of the sleeve 28 in at least one direction. That operation would normally take place after assembly of the injector into its hold-down clamp 30A;B. A clamping sleeve 28 that is moveable relative to the injector body 24 during assembly of the injector 16A-D into the cylinder head 14 prevents a rotation hindering interconnection or seizure between the sleeve 28 and the injector 16A-D during assembly or clamping.

**[0028]** The injectors 16A-D are clamped down into position and are retained there in use by fuel injector hold-down clamps 30A, 30B, briefly referred to above but now dealt with in greater detail. Each clamp 30A, 30B is adapted to clamp in place a pair of neighbouring injectors 16A-D. Thus a first clamp 30A clamps in place the injectors 16A, 16B for the first and second cylinders 1, 2 and a second clamp 30B clamps in place the injectors 16C, 16D for the third and fourth cylinders 3, 4.

**[0029]** Each clamp 30A, 30B comprises a longitudinally extending beam 32 having at the each end an injector clamping member 34. The injector clamping members 34 are each embodied in the form of a closed flange that in use completely surrounds a portion 24 of its associated injector 16A-D. The closed flange 34 preferably comprises a substantially cylindrical collar 34 that is adapted to impart a clamping force to its associated injector 16A-D by axially directed contact between the collar 34 and the sleeve 28 of the injector 16A-D. The clamping force would normally be expected to force the injector 16A-D towards the cylinder head 12.

**[0030]** The second part of the anti-rotation means is formed as part of the injector hold-down clamps 30A;B and, more particularly, this part is included as part of the closed flange 34. In the present embodiment, the second part of the anti-rotation means comprises a pair of lugs 340 that extend upwardly from each closed flange 34. The lugs 340 are preferably formed integrally with the closed flange 34 and, in the present embodiment, extend upwardly from it so as to compliment the configuration and disposition of the flats 26A forming the first part of the anti-rotation means. In the present case, the lugs 340 therefore comprise a pair of inward facing flats 26B that correspond to the flats 26A formed on the injector 16A-D. The flats 26B on the hold-down clamps 30A;B are preferably spaced apart sufficiently to allow easy fitting of the injector 16A-D into the hold-down clamp 30A;B but not so far as to allow excessive sloppiness in the fit that might vary injector orientation in the fitted position.

**[0031]** This means that in the present embodiment the flats 26B are substantially parallel and tangential to the injector hole defined through the clamp ring 34. The lugs 340 extend upwards so that their flats 26B at least partially overlap the flats 26A of the fuel metering portion 224, but preferably not so far up that they impinge on the fuel metering portion at the top of the cut out defined by the flats 26A of the fuel metering portion 224.

**[0032]** It will be appreciated that the relative orientation between the flats 26A on the injector 16A-D and the flats 26B of the lugs 340 on its clamping ring 34 dictates the orientation of the injector 16A-D when assembled into a subassembly with its hold-down clamp 30A;B and, more importantly, when that assembly 30A, 16A,B; 30B, 16C,D is assembled into the cylinder head 12. The orientation of the injector 16A-D may ultimately dictate the orientation of the spray pattern from its nozzle 20, which can have significant effects on the introduction of fuel into the cylinders 1-4 and therefore on combustion and exhaust gas emissions. Further more, the relative orientation between the two sets of flats 26A, 26B will also dictate the orientation of the connector 220 and also the approach angle of the fuel pipe, at least if the injector's fuel inlet 222 is angled away from the injector centreline. The relative positioning of the flats 26A, 26B can therefore be used to impart both variation between installations of different applications and consistency among installations in the same production run, e.g. for one or both of nozzle spray pattern and connector orientation.

**[0033]** The collars 34, plus their associated anti-rotation lugs 340, are preferably made with no great wall thickness with their outer circumference preferably not exceeding the maximum diameter of the injector 16A-D or more preferably its associated fuel metering body 224 and/or sleeve 28. This may be achieved because the collars 34 are closed and do not tend to splay open when the clamping load is applied. The clamping load is preferably transmitted from the clamp 30A, 30B into the injector 16A-D by a substantially localised contact surface, e.g. via point loading lobes or knuckles 34A disposed on opposing undersides of each of the collars 34. The closed flanges 34 preferably closely and completely encircle their respective injectors 16A-D, leaving a clearance only sufficient to avoid pinching or hindering the injector 16A-D during storage, fitting or operation and across its operating temperature range.

**[0034]** The beam 32 is preferably of a narrower width/thickness than the injectors 16A-D and/or narrower than the collars 34. The reduced width is possible because there is no longer any need to provide thick and wide fork legs for clamping purposes. This again provides improved packaging, in particular between the DOHC 14, and leads also to a light weight. The lugs 340 on the hold-down clamps 30A;B can therefore also be kept to a correspondingly small size, whilst still providing adequate anti-rotation properties for the loads they take directly.

**[0035]** The clamps 30A, 30B are each provided with means to introduce the clamping force into their respective pairs of injectors 16A,B; 16C,D. The clamping force may conveniently and cheaply be provided by a mechanical fixing such as a bolt or machine screw 36. Other mechanical fastening systems can be used, such as

a stud and nut arrangement. The mechanical fixing arrangement may also be captive on the clamp 30A, 30B so as to benefit from the possibility of sub-assembly, to keep down the parts count on the production line and to keep down the risk of a fitter dropping loose parts into a cam valley between the DOHC 14.

**[0036]** The clamps 30A, 30B, including their lugs 340, may be formed using a casting or moulding technique and preferably include a dimensionally enlarged portion adapted to co-operate with such a mechanical fixing 36. This may take the form of a boss 38 that both defines a hole 40 therethrough and is adapted to provide on an upper surface 42 thereof a region through which that mechanical fixing 36 can act. The boss 38 is preferably disposed substantially in-line and halfway in between two neighbouring collars 34. An upper portion of the fixing hole 40 is defined in the form of an at least partially spherical and/or countersunk recess 40A, preferably adapted to accommodate in use a part spherical or countersunk washer or a part spherical or countersunk head of the mechanical fixing 36.

**[0037]** The clamps 30A,B; 30C,D are fitted to their respective injector pairs 16A,B; 16C,D by sliding the injectors 16A,B; 16C,D through the collars 34 and then sliding the sleeves 28 onto the injector body below the clamp 30A, 30B and capturing the diverse parts 16A,D, 34, 28 together by fitting their respective snap/stop rings 28A. In sub-assembly and when such subassembly is fitted to the engine 10 therefore, the injector 16A-D is captured in the hold-down clamp 30A,B between, on one side, the upper end of the cut-outs defined by the flats 26A of the fuel metering portion and, on the other side, the top surface of the sleeve 28.

**[0038]** Among the further advantages of combined features in the present invention, the fact that the collars 34 completely encircle the injectors 30A, 30B couples with the feature by which each clamp 30A, 30B in the present embodiment is captured onto a plurality of injectors 16A-D, e.g. a pair thereof 16A,B; 16C,D. The interaction between these features means that there is a reduced likelihood of the mechanical fixing 36 from being worked loose by twist of the clamp 30A, 30B or by vibration coming up through the injectors 16A-D. Any turning moment of one injector 16A,C about the fixing 36 is blocked by the presence on the other end of the clamp 30A, 30B of the other injector 16B,D.

**[0039]** By fitting the injectors 16A-D to the clamps 30A, 30B in pairs 16A,B; 16C,D, the parts count at the side of the production line is reduced as they can be supplied already assembled as sub assemblies 30A, 16A,B; 30B, 16C,D. The parts counts being optionally still further reduced if a captive mechanical fixing 36 is employed. This allows a simpler method of clamping the injectors 16A-D in place on the engine 10, in particular between a pair of DOHC 14 and preferably substantially in parallel therewith, where the reduced width of the clamps 30A, 30B provides more handling room and lighter weight. For the same reasoning, servicing and parts exchange is also made easier. By using the fuel injection sub-assemblies 30A, 16A,B; 30B, 16C,D, there is also a reduced risk of encountering assembly problems such as those associated with dropping loose parts into camshaft valleys.

**[0040]** Configurations using the present invention are possible in which, depending on installation constraints or engine configuration, clamping arrangements may be used other than only the double clamps of the non-limiting embodiment described above. For example, in a three cylinder engine, a V-6 or indeed any engine having an odd number of cylinders in line, using only double injector clamp may prove inconvenient. It will be apparent to the skilled man that it is possible to extend the double clamp to form a triple, each collar having included with it the anti-rotation lugs. Such an arrangement would preferably include a boss and mechanical fixing between each pair of neighbouring injectors. As an alternative to a triple array of clamp and injectors, a single collar version can also be envisaged for use in co-operation with clamps having even numbers of collars, although such an arrangement might prove less resistant to twisting of the whole assembly than a multi-injector version..

**[0041]** The present invention can therefore be seen to reduce parts count line-side, reduce overall weight, reduce injector packaging problems and it simplifies assembly procedures. This therefore overcomes or at least alleviates certain problems with some known arrangements for clamping engine fuel injectors in place. In doing so and importantly, the anti-rotation arrangement 26A,B, 340 can be used to ensure consistent alignment of one or more of the injector spray pattern, connectors 220 and fuel inlets 222.

## Claims

1. A clamp for securing a plurality of fuel injectors (16A-D) to an engine assembly (10), preferably onto a cylinder head (12) thereof, said clamp (30A, 30B) comprising a longitudinally extending beam (32) having at each end thereof an injector clamping member (34) arranged in use to impart a clamping force onto a clamping portion (28) associated with a said injector, said beam having defined therethrough and in between said clamping members at least one fixing hole (40) adapted to receive an associated mechanical fixing (36) for imparting said clamping force and the or each said fixing hole and said clamping members being substantially in-line with each other, **characterised in that** each said injector clamping member comprises a closed flange (34) that in use completely surrounds a portion (24) of its associated said fuel injector (16A-D) and **in that** each said closed flange is provided with at least one anti-rotation means (340) that is arranged in use to engage with an anti-rotation means

(26A) of said fuel injector.

**2.** A clamp according to claim 1, wherein said anti-rotation means (340) of said clamp (30A,B) is formed integrally with said closed flange (34).

**3.** A clamp according to claim 1 or claim 2, wherein said anti-rotation means of said clamp (30A,B) comprises a plurality of lugs (340), preferably evenly disposed around said closed flange (34) and more preferably comprising a pair of said lugs.

**4.** A clamp according to any preceding claim, wherein said anti-rotation means (340) of said clamp (30A, B) defines at least one anti-rotation surface (26B) that faces inwards and complements said anti-rotation means (26A) formed on said injector (16A-D).

**5.** A clamp according to any preceding claim, wherein said anti-rotation means (340) of said clamp (30A, B) comprises at least one pair of inwardly facing lugs, each of which pair or pairs of lugs comprises anti-rotation surfaces (26B) in the form of inwardly facing and substantially parallel flat surfaces.

**6.** A clamp according to any preceding claim, wherein said anti-rotation means (340) of said clamp (30A, B) are upstanding from said closed flange (34).

**7.** A clamp according to any preceding claim, wherein each said closed flange (34) comprises a substantially cylindrical collar adapted to impart a clamping force to its associated said injector (16A-D) by axially directed contact between said collar and said clamping portion (28).

**8.** A clamp according to any preceding claim, wherein said clamp (30A, 30B) comprises a double clamp for securing only two neighbouring said injectors (16A,B; 16C,D) to said engine assembly (10), said clamp preferably being formed by a casting or moulding technique and said fixing hole (40) being defined through a boss (38) disposed substantially in-line and half-way in between two neighbouring said closed flanges (34).

**9.** A clamp according to any preceding claim, wherein an upper portion of said fixing hole (40) is defined in the form of an at least partially spherical or countersunk recess, preferably adapted to accommodate in use a corresponding part spherical or countersunk washer or a part spherical or countersunk head of a said mechanical fixing (36).

**10.** A method of fixing a pair of neighbouring fuel injectors (16A,B; 16C,D) into an in-use position on an engine (10), preferably a direct injection diesel engine and more preferably in between a pair of overhead camshafts (14) thereof, the method including clamping said pair of neighbouring injectors into said in-use position using a clamp (30A, 30B) according to any preceding claim.

**11.** A fuel injector for use in co-operation with a clamp (30A,B) according to any one of claims 1 to 9, said fuel injector (16A-D) comprising a body portion that includes anti-rotation means (26A) adapted to co-operate with said anti-rotation means (340) of said clamp and further comprising captive means (28) to enable captive assembly of said injector into said clamp, said body portion preferably housing a fuel metering means (224) of said injector and said anti-rotation surfaces preferably comprising a pair of outwardly facing, substantially flat and parallel surfaces.

**12.** A fuel injection sub-assembly comprising a clamp (30A, 30B) according to any one of claims 1 to 9 and having captured thereon, through each said closed flange (34) thereof, first and second fuel injectors (16A,B; 16C,D) according to Claim 11.

**13.** A method of producing a fuel injection sub-assembly according to claim 12, the method including assembling said first and second fuel injectors (16A, B; 16C,D) into said closed flanges (34) of said clamp (30A, 30B) and capturing each said injector onto said clamp by sliding onto each said injector a sleeve 28, preferably capturing each said sleeve onto its respective said injector using a captive member such as a snap or stop ring (28A).

**14.** An engine assembly including at least one clamp (30A, 30B) according to any one of claims 1 to 9 or at least one fuel injection sub-assembly (30A, 16A, B; 30B, 16C,D) according to claim 12.

**15.** An engine assembly according to claim 14, wherein said engine assembly (10) comprises a row of cylinders (1-4) having disposed therealong a pair of overhead camshafts (14), the or each said clamp (30A, 30B) or subassembly (30A, 30B, 16A,B; 16C, d) being disposed in use in between and preferably substantially in parallel with said camshafts, said engine assembly preferably comprising a compression ignition internal combustion engine such as a common rail direct injection diesel engine suitable for use in a road-going vehicle.

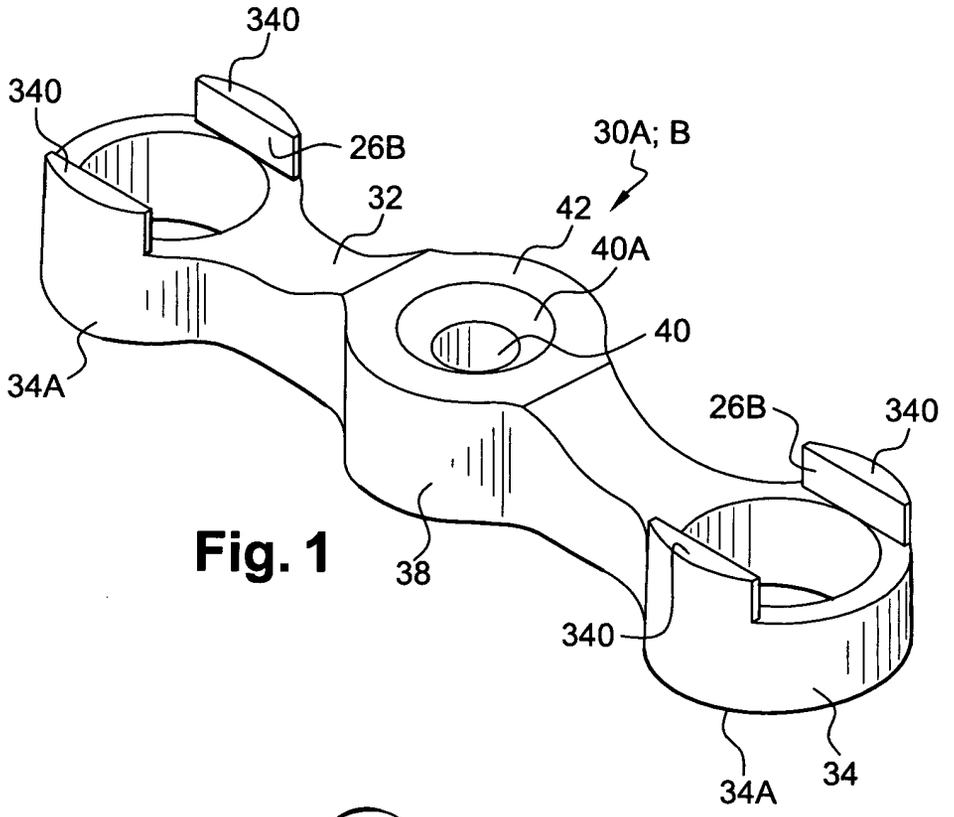

340
340
26B
30A; B
32
42
40A
40
34A
26B
340
38
340
34A
34

Fig. 1

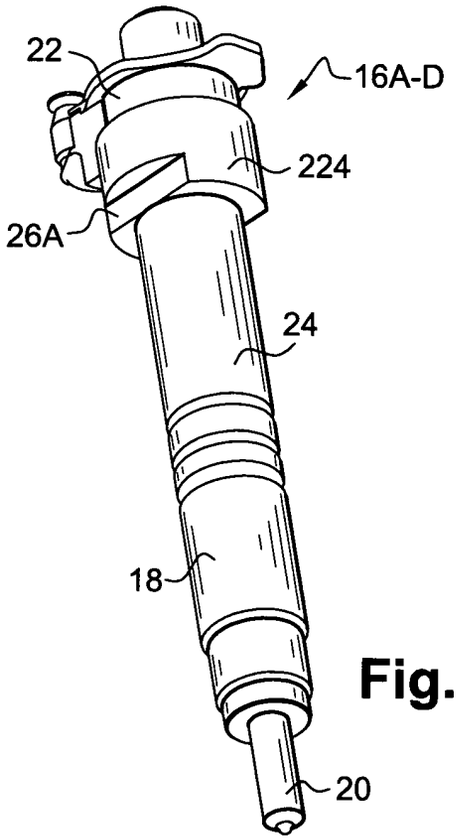

22
16A-D
224
26A
24
18
20

Fig. 2

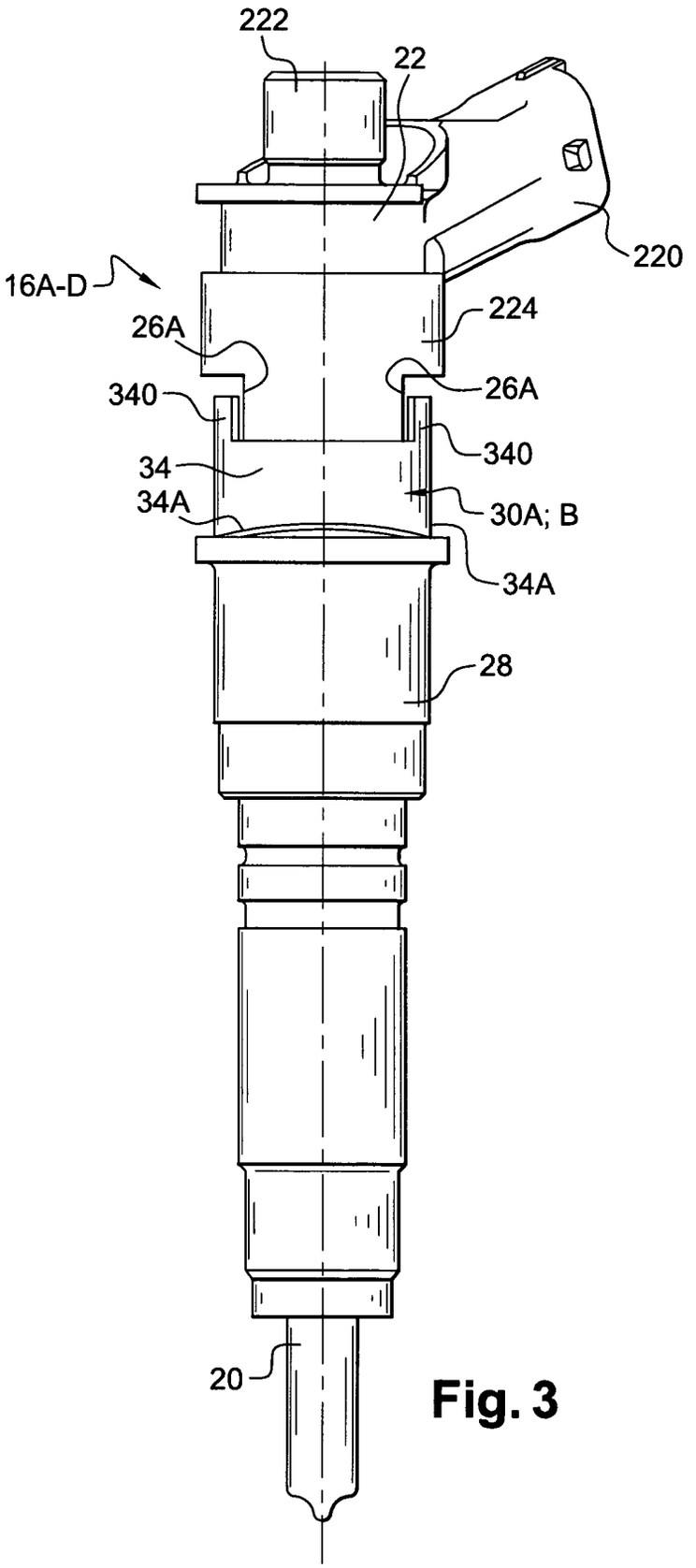



Fig. 3

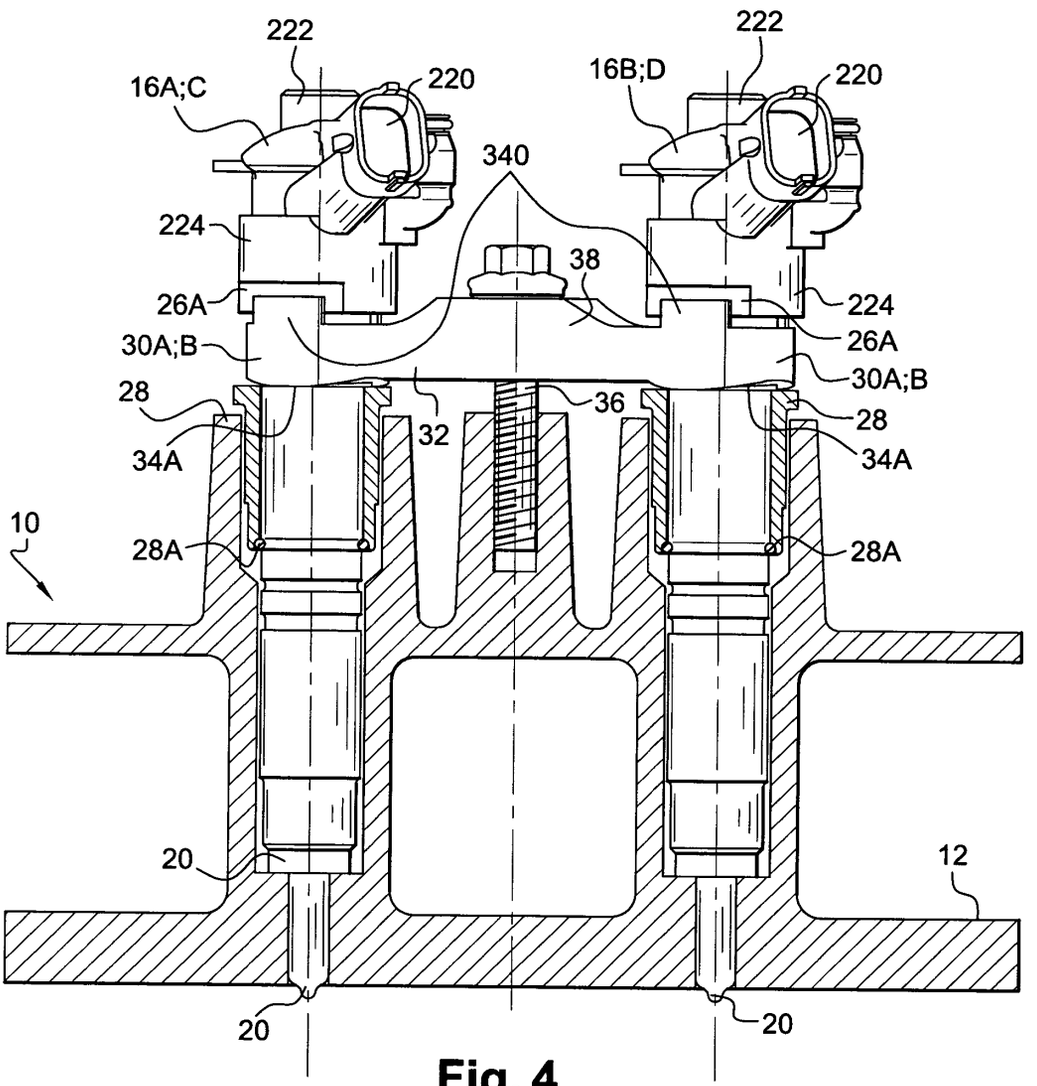
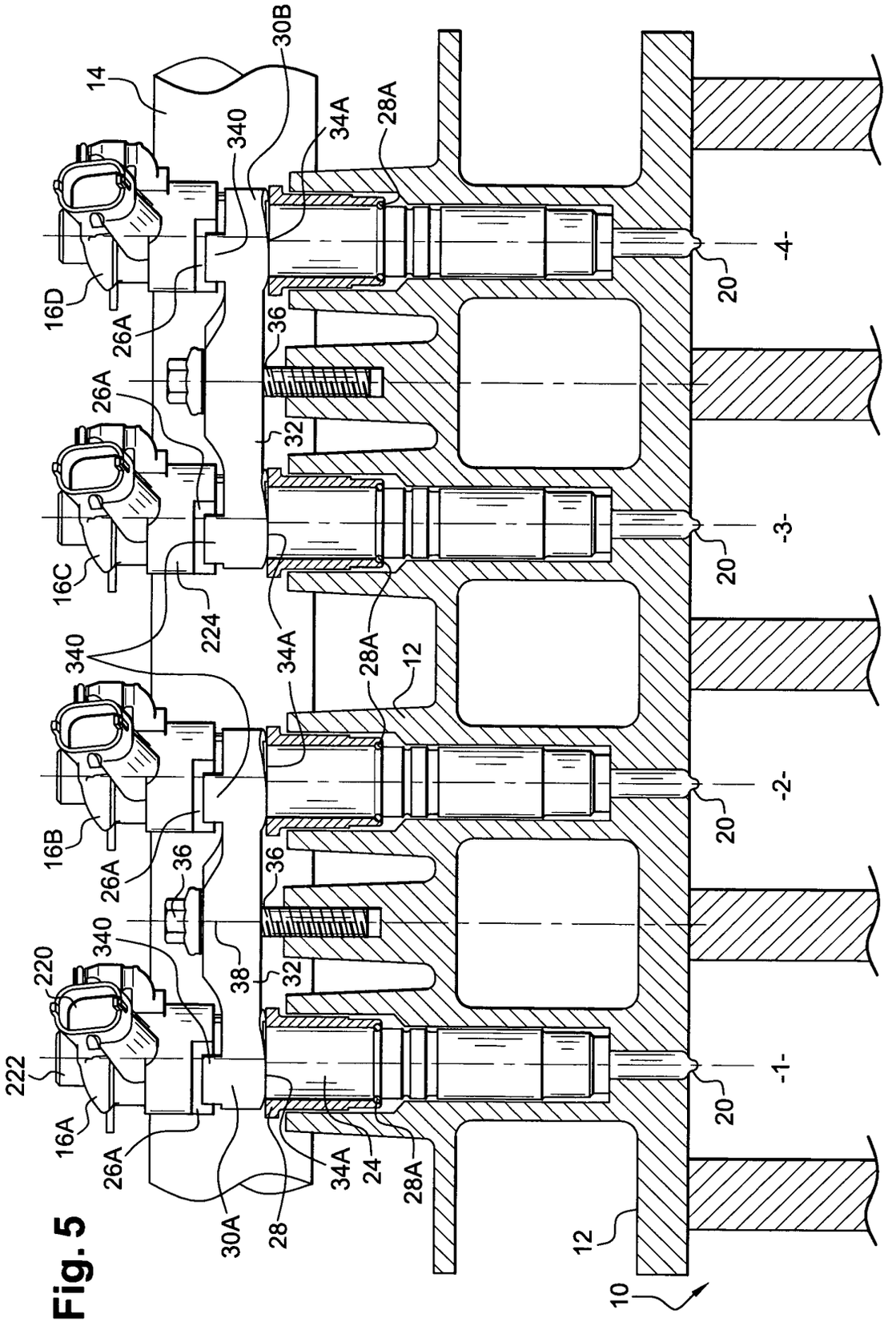

222
222
16A;C
16B;D
220
220
340
224
38
26A
224
26A
30A;B
30A;B
28
36
28
32
34A
34A
10
28A
28A
20
12
20
20

Fig. 4


14
30B
340
34A
28A
16D
26A
36
26A
32
16C
224
340
34A
28A
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26A
36
36
340
38
32
220
222
16A
26A
34A
24
28A
30A
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-1-
20
20
20
20

Fig. 5

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 03 29 2784

## 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) |
|---|---|---|---|
| X,D | EP 0 751 290 A (ISUZU MOTORS LTD) 2 January 1997 (1997-01-02) * column 3, line 15 - column 4, line 13; figures 4,5,8 * | 1-15 | F02M61/14 F02M61/16 |
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