



(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
08.03.2006 Bulletin 2006/10

(51) Int Cl.:
F02M 35/10^(2006.01) F02M 69/46^(2006.01)
F02M 35/04^(2006.01)

(21) Application number: 04255352.9

(22) Date of filing: 03.09.2004

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IT LI LU MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL HR LT LV MK

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(54) Crash protection barrier for a fuel rail system of an internal combustion engine

(57) The present invention relates to a crash protection barrier for a fuel rail system of an internal combustion engine, and in particular to an engine component such as an inlet manifold having a crash protection barrier facing a fuel rail. The engine (101) comprises an elongate moulded plastic material fuel rail (106), the fuel rail having an elongate side (126) extending along the length of the fuel rail (106) and at least one fuel inlet (110), and at least one fuel outlet (122) for supplying fuel to a combustion chamber. The engine (101) comprises additionally at least one component (104) spaced apart from and sep-

arate from the fuel rail (106), said component having a side (120) that faces towards the elongate side (126) of the fuel rail (106) across a gap (127) between the fuel rail and said component (104). A moulded plastic barrier (113) is joined to and extends across the side (120) of the component (104) facing the elongate side (126) of the fuel rail (106). The barrier (113) has at least one bar (116) spaced laterally from said side of the component, the or each bar (116) being joined to said component by at least two webs (118) of moulded plastic material that extend diagonally between the component (104) and the or each bar (116).

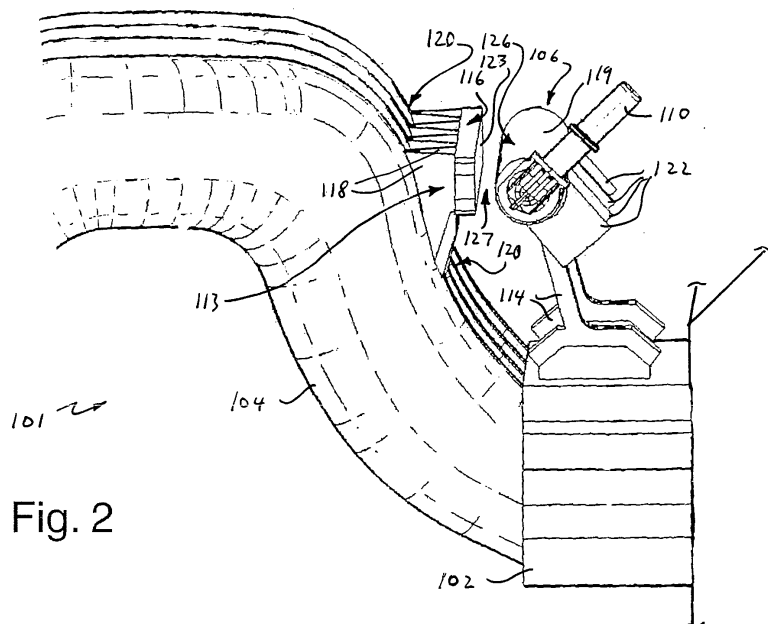


Fig. 2

Description

[0001] The present invention relates to a crash protection barrier for a fuel rail system of an internal combustion engine, and in particular to an engine component such as an inlet manifold having a crash protection barrier facing a fuel rail.

[0002] In recent years in the automotive industry, there has been an increasing use of fuel rails made of plastic materials, rather than metal. Fuel, such as gasoline or diesel, is supplied to the engine through a channel in the plastic material, and so the material must be able to withstand prolonged contact with the fuel. One common choice of plastic material is polyamide.

[0003] Although plastic material fuel rails are less expensive to manufacture than those formed from metal, plastic materials generally are not as robust as metal materials against impact damage. One way to improve the robustness of a plastic material is to use a composite glass-filled plastic material.

[0004] Fuel rails normally have to be situated in close proximity with a cylinder head or engine block. (For convenience, the term "engine block" shall be used hereinafter to denote a cylinder head or engine block, either individually or in combination.) This is particularly the case in automotive applications, where there may be little free space in an engine compartment. The proximity of the fuel rail to the engine block, and other components within the engine compartment, in particular an air inlet manifold, means that in the event of a collision the fuel rail may be impacted or pressed upon by such components. In one standard crash test (Legal Test ref. EC96/79), a fuel rail is deemed to pass if the volume of any egress of fuel is less than 30 g in one minute.

[0005] Therefore, care has to be taken over the placement of nearby components, such as an air inlet manifold or an electronic throttle assembly, as these may come into contact with or strike the fuel rail in the event of a collision. Even where an engine and vehicle design is optimized to minimise the possibility of fuel loss from a fuel rail in the event of a collision, it may not be possible to use the same fuel rail on a different vehicle application for this reason. There also remains the possibility that a change to another component in the engine compartment, seemingly unconnected with the fuel rail, may inadvertently increase the risk of fuel loss after a collision.

[0006] One known way of protecting a fuel rail from collision damage is to mount a protective metal shield around the fuel rail. This however, adds to materials and production costs and tends to obviate some, if not all, of the advantages provided by the use of plastic materials for the fuel rail.

[0007] It is an object of the present invention to provide a more convenient fuel rail system for an internal combustion engine.

[0008] According to the invention, there is provided an internal combustion engine, comprising an elongate moulded plastic material fuel rail, the fuel rail having an

elongate side extending along the length of the fuel rail and at least one fuel inlet, and at least one fuel outlet for supplying fuel to a combustion chamber, the engine comprising additionally at least one component spaced apart from and separate from the fuel rail, said component having a side that faces towards the elongate side of the fuel rail across a gap between the fuel rail and said component, wherein a moulded plastic barrier is joined to and extends across the side of the component facing the elongate side of the fuel rail, said barrier having at least one bar spaced laterally from said side of the component, the or each bar being joined to said component by at least two webs of moulded plastic material that extend diagonally between the component and the or each bar.

[0009] The component may be any engine component that is not a fuel rail.

[0010] The join between the barrier and the component may be by means of moulding the barrier integrally with the component, or by means of clips, screws, adhesives or any other suitable means of forming the barrier with the component or of affixing the barrier to the component.

[0011] Optionally, particularly if the component is positioned between two fuel rails, the engine may comprise additionally a second moulded plastic barrier, the second barrier protecting extending along the component on an opposite side from the first barrier, and each barrier being spaced apart from a corresponding fuel rail. The second barrier may then have at least one bar spaced laterally from the fuel rail, the or each of said bars being joined to the component by at least two webs of moulded plastic material that extend diagonally between the component and the or each of said bars. This arrangement may therefore absorb impacts or stresses from opposite directions. This may be useful if, in a collision, the component could be pinched between two opposing objects at least one of which is a fuel rail, for example an electronic throttle assembly on the one hand and a fuel rail on the other hand.

[0012] In the following description, the invention will be described in terms of a single barrier, however, it will be understood that if the fuel rail system has two such barriers arranged on opposite sides of the component, the features described for one barrier may be present on both barriers.

[0013] The bar may therefore be arranged to bear an impact from a fuel rail or onto a fuel rail. The stresses from the impact are then transferred between the component and the bar along the webs. Because the bar is essentially separated from the component by the webs, cracking or deformation of the bar will not affect the integrity of the component, and will hence help to protect the fuel integrity of the fuel rail. In addition, the webs may be made sufficiently thin that these may bend or otherwise deform. Any movement of the bar may therefore be at least partially accommodated by the deformation of the webs. This movement will also help to dissipate the energy of the impact, so that this is borne by the component and/or fuel rail over a longer time, and this has the

effect of lowering the maximum forces on the bar.

[0014] Although the barrier may be formed separately from the component, for example being fitted to or around the component, it is preferred if the barrier is integrally formed with the component, for example being a unitary moulding.

[0015] In a preferred embodiment of the invention, the component is moulded from a first plastic material, and the barrier is moulded from a second plastic material.

[0016] The barrier may be comprised of discontinuous or discrete sections, but is preferably a unitary elongate barrier, and continuous along the length of the component where this could otherwise impact the fuel rail.

[0017] The webs and/or component may be designed to help spread the load of any impact along the component and/or fuel rail, thereby reducing the chance of failure of the fuel rail at any one point. For example, the component may be reinforced along its length between points at which the webs of moulded plastic material join the component.

[0018] If there are at least three webs of moulded plastic material joining the bar and the component, these webs may be arranged in a zigzag pattern between the component and the bar (that is, arranged head-to-tail alternately from the bar to the component, and from the component to the bar). This has two benefits in the event of an impact on the barrier. First, any local movement of the bar will tend to cause a lateral deformation of the adjacent webs, thus absorbing impact energy. Second, the stresses will then be transferred in opposite lateral directions away from the localised impact, thereby spreading the forces on the component and so minimising the possibility of any significant damage to the component.

[0019] The zigzag arrangement permits adjacent webs, together with the component and/or the bar, to define one or more triangular voids in the barrier. In this arrangement, each web may be joined to at least one other web at a vertex on the bar or on the component.

[0020] Preferably, the or each bar is square or rectangular in cross-section. Opposite flat faces of the bar may then be arranged to face respectively directly towards the component and directly away from the component. The face that faces away from the component will therefore be arranged to face towards a possible impact against the fuel rail, which will help to spread loads across this face. In addition, this arrangement means that there will not be any corners between such surfaces directed at the fuel rail, which could cause damage in the event of an impact.

[0021] In preferred embodiments of the invention, the fuel rail extends along a first axis, the or each bar extends along a second axis that is parallel with the first axis, and the webs each have a planar structure which extends in a plane that is transverse to a plane containing both the first axis and the second axis.

[0022] The webs may define, with the bar and/or the component, a plurality of voids, in which case the ar-

angement may comprise additionally at least one strip of resilient material. This strip or strips may then have projections that are seated in corresponding voids. For ease of assembly, it is preferred if there is just one such strip for one barrier, and also if the projections fill the voids.

[0023] The invention will now be further described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is partial perspective view of a conventional internal combustion engine for a motor vehicle, having an engine block, an elongate plastic moulded fuel rail mounted to the engine block and separated by a gap from various components that face towards an unprotected elongate side of the fuel rail;

Figures 2 and 3 are perspective views of a portion of an internal combustion engine for a motor vehicle according to a first embodiment of the invention, having a moulded plastic barrier on a surface of an air inlet manifold that faces towards the elongate side of the fuel rail, the barrier comprising a straight bar supported by a collapsible lattice structure formed from four pairs of oppositely diagonal webs;

Figures 4 and 5 are, respectively horizontal and vertical cross-sectional views of a portion of an internal combustion engine with an air inlet manifold having a moulded plastic barrier according to a second embodiment of the invention similar to the first embodiment but having diagonal webs of unequal length;

Figure 6 is a perspective view of a portion of a protection barrier for use in an internal combustion engine according to a third embodiment of the invention, which is similar to the second embodiment of Figures 3 and 4, but having also a strip of resilient material which has projections that are seated in corresponding voids in the barrier;

Figure 7 is a perspective view of a portion of an internal combustion engine according to a fourth embodiment of the invention with a component having a clip-on moulded plastic barrier with a collapsible lattice structure formed from a regular zigzag array of diagonal webs;

Figure 8 is a perspective view of a portion of an internal combustion engine according to a fifth embodiment of the invention with a component having a clip-on moulded plastic barrier similar to the fourth embodiment, but having a pair of integrally moulded oppositely directed collapsible lattice structures each being formed from zigzag pairs of diagonal webs;

Figure 9 is a partial perspective view of a portion of

an internal combustion engine according to a sixth embodiment of the invention with a component having a moulded plastic barrier with an integrally moulded protective barrier having a curved elongate bar;

Figure 10 is a partial perspective view of a portion of an internal combustion engine according to a seventh embodiment of the invention with a component having an integrally moulded protective barrier having two parallel bars, each of which is supported by a collapsible lattice structure having at least two diagonal webs of moulded plastic material; and

Figure 11 is a partial perspective view of a portion of an internal combustion engine according to an eighth embodiment of the invention, which combines features of the sixth and seventh embodiments, having an integrally moulded protective barrier having two bars, an inner one of which is straight and an outer one of which is curved.

[0024] Figure 1 shows a partial view of a conventional reciprocating piston internal combustion engine 1, having an engine block 2, an inlet manifold 4 and a fuel rail 6 for delivering fuel to a number of cylinders (not shown) inside the engine block 2. In Figure 1, the fuel rail 6 is shown end-on in the direction of an axis 8 defined by the centre of a hollow cylindrical fuel inlet 10 to the fuel rail. The fuel rail 6 is fixed to the engine block 2 by means of a mounting bracket 14 and bolts (not shown). Not shown, for clarity, is a fuel inlet pipe that would be connected to the inlet 10. The fuel rail 6 extends along the direction of the axis 8 in order to conveniently supply fuel to the cylinders, for example by means of fuel injectors (not shown), in a manner that is well known to those skilled in the art.

[0025] As can be seen from Figure 1, a fuel rail 6 is positioned generally between the inlet manifold 4 and the engine block 2. The inlet manifold 4 may include or be associated with other components, for example an electronic throttle control assembly 12. Components such as the throttle assembly 12 or the inlet manifold itself may, in the event a vehicle collision, be thrust against the fuel rail 6, leading to the possibility of damage to the fuel rail and consequent escape of fuel. As a result, it may be preferable to manufacture the fuel rail 6 in a metal material, for example aluminium, rather than less expensive moulded plastic materials. If a plastic material is used, then the fuel rail 6 may have to be protected by a half-cylindrical metallic shield (not shown) affixed to and extending along the length of the fuel rail 6 between the fuel rail and the inlet manifold 4 and throttle assembly 12.

[0026] Figures 2 and 3 are perspective views of a portion of an internal combustion engine 101 for a motor vehicle according to a first embodiment of the invention. The engine has an air inlet manifold 104 that is connected to an engine block 102, only a portion of which is illustrated in the drawings. A moulded plastic material elongate fuel rail 106 is mounted by means of a pair of feet

114 to the engine block 102. A fuel inlet 110 is provided at one end of the fuel rail 106 by which fuel is supplied along a fuel rail axis 108 to four injection ports 122 along the length of a tubular body 119 of the fuel rail 106. Not shown for clarity are a fuel pipe that would be connected to the fuel inlet 110, and fuel injectors that would be fitted to each of the injection ports 122.

[0027] The air inlet manifold has a surface, indicated generally by reference number 120, which faces towards an elongate outwardly exposed surface 126 of the fuel rail body 119. The opposed air inlet and fuel rail surfaces 120, 126 are essentially parallel such that a gap 127 extends between these surfaces 120, 126.

[0028] An elongate moulded plastic barrier 113 is provided on the surface 120 of the air inlet manifold 104. The barrier 113 is arranged to project partially across the gap 127 between the air inlet manifold 104 and the fuel rail 106.

[0029] The barrier 113 is directly opposite and has an axis 109 parallel with the elongate fuel rail body 119 and axis 108. A front rectangular cross-section bar 116 presents a front surface 123 which is sufficiently long so that it extends at least as far as the ends of the elongate fuel rail body 119.

[0030] The barrier 113 has nearest the fuel rail 106 an elongate bar 116 that is spaced laterally from the air inlet manifold surface 120. The bar 116 is joined to the air inlet manifold 104 by a number of webs 118 of moulded plastic material that extend diagonally between the manifold and the bar 116. In the example of Figures 2 and 3, both the barrier 113 and the air inlet manifold 104 are formed in a unitary moulding, from a glass-filled polyamide material. The webs 118 and bar 116 therefore form a unitary impact barrier 113, which is integrally moulded with the air inlet manifold 104.

[0031] A second embodiment of the invention is illustrated in Figures 4 and 5 which show, respectively, horizontal and vertical cross-sectional views of a portion of an internal combustion engine 201. Features which correspond with those of the first embodiment 101 are indicated by reference numerals incremented by 100. Not shown for clarity in this and further drawings is the fuel rail 106, which is positioned with the same orientation with respect to the moulded plastic barrier as with the first embodiment 101.

[0032] The protective moulded plastic barrier 213 differs from that 113 of the first embodiment 101 in having diagonal webs 218 of unequal length. This provides greater flexibility in concentrating the webs 218 where the barrier 213 will be exposed to the greatest stresses in the event of a collision.

[0033] As can be seen most clearly in Figure 4, the bar 216 is rectangular in cross-section, with one flat face 221 facing towards the air inlet manifold 204, and the opposite flat face 223 of the front bar 216 facing directly towards fuel rail 106. Both the bar 216 and webs 218 have common upper and lower surfaces 224, 225 that extend, preferably at right angles, to the length of the barrier 213.

The webs 218 are preferably thinner than the thickness of the bar 216, and most preferably are between 10% and 50% of the thickness of the bar 216. In the example of Figures 4 and 5, the webs 218 are 20% the thickness of the bar 216. As a result, the webs 218 are considerably less rigid than the bar 216.

[0034] The webs 218 are also arranged in a zigzag pattern between the manifold 204 and bar 216. Therefore, if a force (F) as indicated by arrow 230 is exerted against the outer face 223 of the bar 216 during an impact of the protective barrier 213 against the fuel rail 106, then one or more of the webs 218 may deform as the bar 216 moves towards the manifold 204. The deformation may take the form of bending or cracking through. As can be seen in Figure 4 each web 218 splays outwards, and is therefore reinforced where this meets the air inlet manifold 204, and this together with the diagonal arrangement of the webs 218 tends to spread the force 230 laterally along the extent of the air inlet manifold 204.

[0035] In use, the second embodiment of the invention 201 functions in a similar manner to the first embodiment 101. A force (F) 230 caused by an impact with the fuel rail 106 on the front surface 223 of the bar 216 may cause local damage to the bar 216 and deformation of the webs 218, however this deformation and the diagonal arrangement of the webs 218 will help to dissipate and spread the force 230 laterally over the component to which the barrier 213 is attached and also over the fuel rail 106 against which the barrier 213 impacts.

[0036] Figure 6 is a perspective view of a protection barrier for use in internal combustion engine according to a third embodiment of the invention 301. Features similar to those of the second embodiment 201 are indicated by reference numerals incremented by 100. The third embodiment 301 has a protective moulded plastic barrier 313 which is similar to that of the second embodiment 201 in having diagonally transverse webs 318 of differing lengths extending rearwardly from a front bar 316, and differs in having a rear bar 326 parallel with the front bar 316. The bars 316, 326 are spaced apart by the diagonal webs 318. The rear bar 326 also has a flange 334 which may be provided with screw holes or other means by which the barrier 313 may be affixed to an engine component (not shown) in proximity with but separate from the fuel rail 106.

[0037] The third embodiment 301 also differs from the second embodiment 201 in having a strip of resilient material 340 which has projections 304 that are seated in corresponding voids 302 in the barrier 316.

[0038] The strip of resilient material 340 is made from a unitary moulding and acts to provide additional energy absorbing ability to the barrier 313. The zigzag arrangement of the webs 318 creates a series of laterally adjacent recesses or voids 302. Each recess 302 has a triangular cross-section in planes parallel to the top and bottom surfaces 324, 325 that extend across the front bar 316, webs 318 and rear bar 326. Each of the webs 318 is joined head to tail with at least one neighbouring web

318, so that each of the triangular recesses 302 is defined one two sides by two adjacent webs 318 which meet at an intervening vertex 328, and on the third side by either the rear surface 321 of the front bar 316 or a front surface 332 of the rear bar 326.

[0039] The resilient strip 340 has a series of laterally adjacent protrusions 304 each of which has a similar triangular cross-section shape so that these can partially or completely fill the corresponding triangular recesses 302. The strip 340 is separately moulded from an elastomeric material, for example a natural rubber or nitrile material. The strip 340 has a planar backing or flange 306 from one side of which the projections 304 extend. The flange 306 also has the same rectangular outer profile as the barrier 313 and rear bar 326. In the event of a collision, the resilient strip 340 will provide additional energy absorbing capability, as well as helping to maintain the structural integrity of the barrier 316.

[0040] Figures 7 and 8 show, respectively, a fourth and a fifth embodiment of the invention 401, 501. In the fourth embodiment 401 features similar to those of the first embodiment 101 are indicated by reference numerals incremented by 300 from those of the first embodiment 101. In the fifth embodiment 501 features similar to those of the first embodiment 101 are indicated by reference numerals incremented by 400 from those of the first embodiment 101. Again, for clarity the fuel rail 106 is not illustrated, but would extend in close proximity with and spaced parallel from front bars 416, 516 of the barriers 413, 513.

[0041] The fourth embodiment 401 differs from the first embodiment 101 in having a moulded plastic protective barrier 413 in being a clip-on barrier that is manufactured separately from the engine component 404. The barrier 413 has a sleeve 434 with a channel 436 that runs the length of the sleeve and which has an internal profile which matches the external profile of the component 404 from which the fuel rail 106 requires protection. The sleeve 434 therefore is removably attached by clipping to the component 404.

[0042] Optionally, the barrier 413 may, as illustrated be formed in more than one segment 438, 440, each segment being separately clipped to the component 404.

[0043] The fifth embodiment 501 illustrated in Figure 8 is similar to the fourth embodiment 401 in providing a clip-on barrier 513, 513' but has a pair of integrally moulded oppositely directed collapsible lattice structures each being formed from zigzag pairs of diagonal webs 518, 518'. Thus, there are two protective barriers 513, 513' on opposite sides of a central channel 536. Unless the barriers 513, 513' are positioned in a component between two similar fuel rails 106, only one of the barriers 513 will provide protection between a component 504 and the fuel rail 106.

[0044] The barriers 513, 513' are integrally moulded in a plastic material. Each barrier 513, 513' has diagonal webs 518, 518' extending between the central sleeve 534 and a pair of elongate bars 516, 516', the arrange-

ment being such that each web 518, 518' attaches each bar 516, 516' to the sleeve 534 directly opposite a corresponding web on the other barrier. This provides the benefit in that in the event of an impact on one barrier 513, 513' which causes compression of the opposite barrier, any forces transmitted by each web 518, 518' are transmitted directly through the sleeve 534 to an opposite web, thereby minimising the possibility of damage to the barriers 513, 513' and hence to the fuel rail 106.

[0045] Other ways of attaching a moulded plastic barrier to a component include using screws, bolts, ties, ultrasonic or heat welding, and adhesives. Such means may also be used in conjunction with a clip-on barrier 413, 513 to further secure the barrier to the fuel rail 106.

[0046] Figure 9 shows a sixth embodiment of the invention 601 having with a component 604 with an integrally moulded plastic barrier 613 having a curved elongate bar 616. In the sixth embodiment 601 features similar to those of the first embodiment 101 are indicated by reference numerals incremented by 500 from those of the first embodiment 101.

[0047] The sixth embodiment 601 differs from the first embodiment 101 in that the integrally moulded protective barrier 613 has a reinforcing rear bar 626 up against the component 604, and in that the front bar 616 is a non-parallel curved bar. Diagonal webs 618 of varying lengths span varying distances between the front bar 616 and rear bar 626 the barrier 613. Such an arrangement is useful if the protective barrier 616 needs to be shaped to allow for components that project from a fuel rail, for example a fuel filter (not shown), or which are interposed partially between the component 604 and the fuel rail 106.

[0048] Figure 10 shows a seventh embodiment of the invention 701. In the seventh embodiment 701 features similar to those of the first embodiment 101 are indicated by reference numerals incremented by 600 from those of the first embodiment 101.

[0049] The seventh embodiment 701 differs from the first embodiment 101 in that the integrally moulded barrier 713 is a compound barrier having two parallel bars, namely an outer bar 716 and an intermediate bar 744 each of which is spaced from the component 704. The front 716 bar is joined to the middle bar 744 and the middle bar 744 is joined to the component 704 by at least two diagonal webs 718 of moulded plastic material. Specifically, the outer bar 716 is joined to the intermediate bar 744 by an outer set of diagonal webs 746, and the intermediate bar 744 is joined to the fuel rail by an inner set of diagonal webs 748. The advantage of this system is that in the event of an impact causing the barrier 713 to strike the fuel rail 106, one set of diagonal bars 746, 748 can be designed to collapse in advance of the other set of bars, thereby provides a more controllable progressive collapse and hence energy absorption by the barrier structure 713.

[0050] Figure 11 shows an eighth embodiment of the invention 801. In the eighth embodiment 801 features similar to those of the first embodiment 101 are indicated

by reference numerals incremented by 700 from those of the first embodiment 101.

[0051] The eighth embodiment 801 combines features of the sixth and seventh embodiments 601, 701, having a moulded plastic barrier 813 with a straight intermediate bar 844 parallel with a generally straight component 804, and an outer bar 816 which is curved.

[0052] Like the seventh embodiment 701, the eighth embodiment 801 therefore provides a compound barrier 813 having two parallel bars, namely an outer bar 816 and an intermediate bar 844 each of which is joined to the component 804 by at least two diagonal webs 818 of moulded plastic material. Specifically, the outer bar 816 is joined to the intermediate bar 844 by an outer set of diagonal webs 846, and the intermediate bar 844 is joined to the component 804 by an inner set of diagonal webs 848.

[0053] As with the sixth embodiment 601, the outer bar 816 is a non-parallel curved bar, with diagonal webs 818 spanning varying distances between the outer bar 816 and the intermediate bar 844.

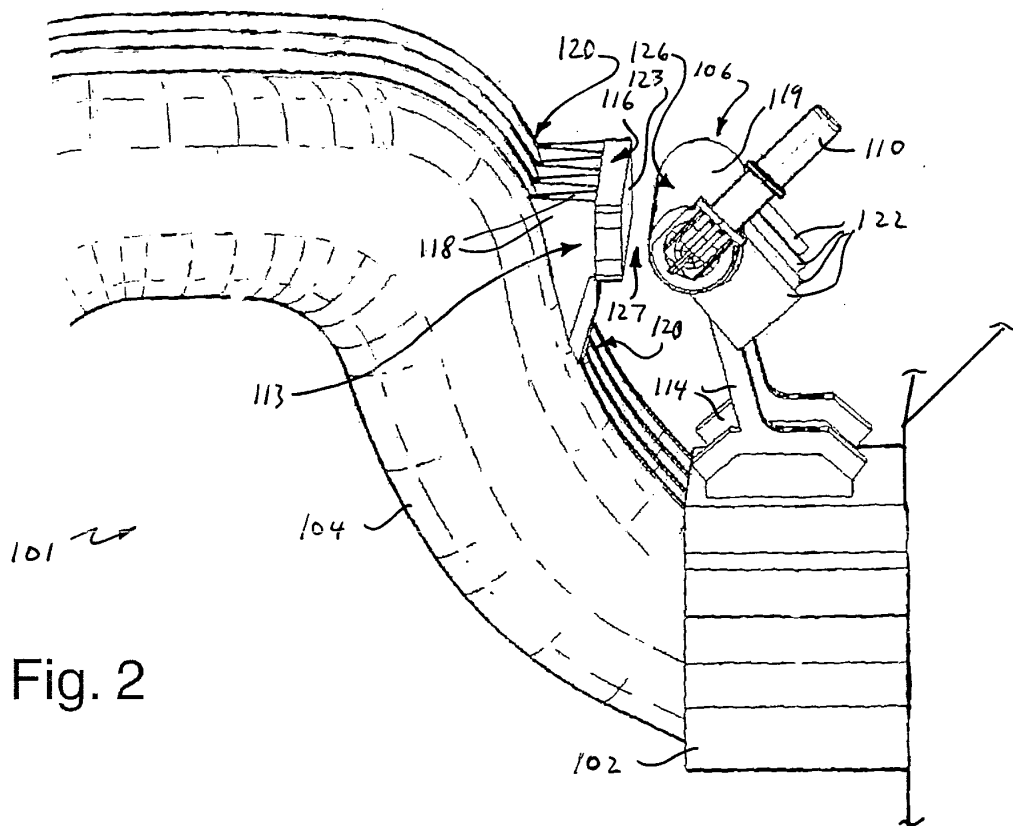
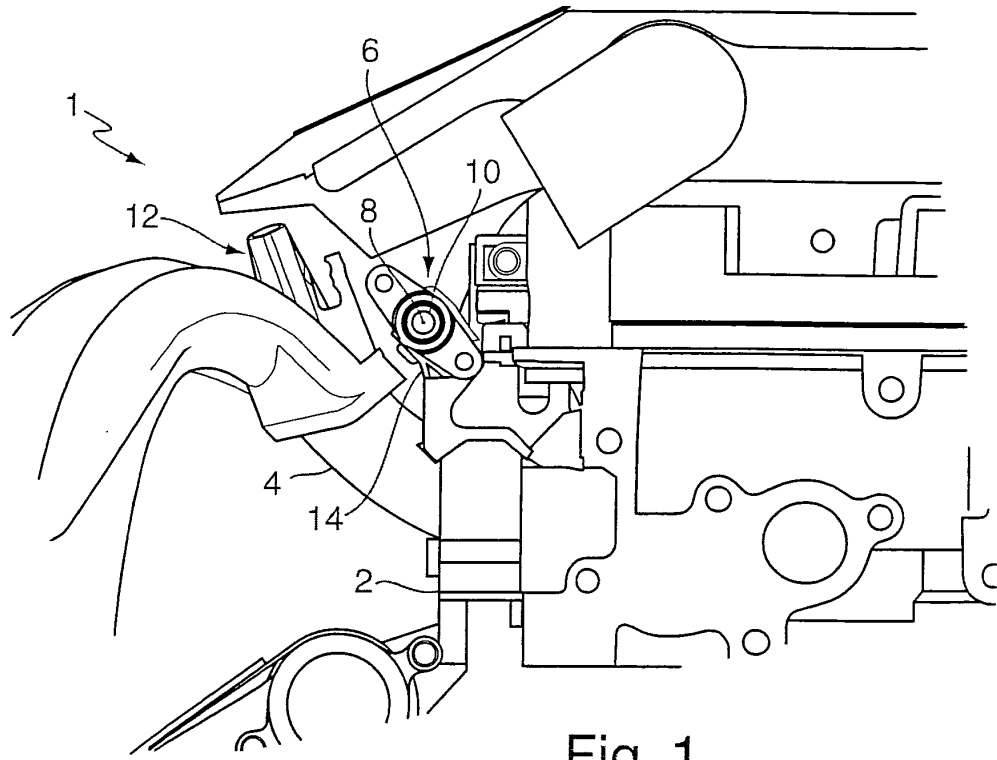
[0054] In any of the embodiments described above, the barrier 113, 213, 313, 413, 513, 613, 713, 813 may be integrally moulded in a two-stage moulding process using a first plastic material for rear portions of the barrier (e.g. the rear bar 326 illustrated in Figure 6) for example using a glass-filled polyamide, and a second more compliant and resilient plastics material for the webs 118, 218, 318, 418, 518, 618, 718, 818 and front bar 116, 216, 316, 416, 516, 616, 716, 816 for example using polypropylene. Such a two-stage moulding process may be accomplished by using a moulding tool (not shown) which has a thin retractable gate that forms initially a barrier between, on the one hand, the webs and front bar of the barrier and, on the other hand, the rear bar or, if the barrier is integrally moulded with the component, the component itself. When the moulding tool is nearly filled with both plastic materials, the barrier is withdrawn, thereby allowing the first and second plastic materials to come together at a boundary between in order to form a unitary moulded structure.

[0055] The various embodiments of the invention 101, 201, 301, 401, 501, 601, 701, 801 therefore provide an economical and convenient internal combustion engine having a plastic moulded barrier to protect a fuel rail from damage by a separate component during a collision.

[0056] It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention which are, for brevity, described in the context of a single embodiment, may also be provided separately, or in any suitable combination within the scope of the appended claims.

Claims

1. An internal combustion engine (101), comprising an elongate moulded plastic material fuel rail (106), the fuel rail having an elongate side (126) extending along the length of the fuel rail (106) and at least one fuel inlet (110), and at least one fuel outlet (122) for supplying fuel to a combustion chamber, the engine (101) comprising additionally at least one component (104) spaced apart from and separate from the fuel rail (106), said component having a side (120) that faces towards the elongate side (126) of the fuel rail (106) across a gap (127) between the fuel rail and said component (104), wherein a moulded plastic barrier (113) is joined to and extends across the side (120) of the component (104) facing the elongate side (126) of the fuel rail (106), said barrier (113) having at least one bar (116) spaced laterally from said side of the component, the or each bar (116) being joined to said component by at least two webs (118) of moulded plastic material that extend diagonally between the component (104) and the or each bar (116).
2. An internal combustion engine (101) as claimed in Claim 1, in which the component (104) is integrally moulded with the barrier (113).
3. An internal combustion engine (101) as claimed in Claim 2, in which the component (104) is moulded from a first plastic material, and the barrier (113) is moulded from a second plastic material.
4. An internal combustion engine (101) as claimed in any preceding claim, in which the component (104) is reinforced along its length between points at which the webs (118) of moulded plastic material join the component (104).
5. An internal combustion engine (101) as claimed in any preceding claim, in which there are at least three webs (118) of moulded plastic material joining the bar (116) and the component (104), said webs (118) being arranged in a zigzag pattern between the component (104) and the bar (116).
6. An internal combustion engine (301) as claimed in Claim 5, in which adjacent webs (318) form together with the component (104) and/or the bar (316) a triangular void (302) in the barrier (313).
7. An internal combustion engine (301) as claimed in any preceding claim, in which each web (318) is joined to at least one other web (318) at a vertex (328) on the bar (116) or on the component (104).
8. An internal combustion engine (101) as claimed in any preceding claim, in which the or each bar (116) is square or rectangular in cross-section.
9. An internal combustion engine (101) as claimed in any preceding claim, in which the fuel rail (106) extends along a first axis (108), and the or each bar (116) extends along a second axis (109) that is parallel with the first axis (108), wherein the webs (118) each have a planar structure which extends in a plane that is transverse to a plane containing both the first axis (108) and the second axis (109).
10. An internal combustion engine (301) as claimed in any preceding claim, in which the webs (318) define with the bar (316) and/or the fuel rail (306), a plurality of voids (302), the barrier (313) comprising additionally at least one strip of resilient material (340), the or each strip having projections (304) that are seated in corresponding voids (302).
11. An internal combustion engine (301) as claimed in Claim 10, in which said projections (304) fill the voids (302).
12. An internal combustion engine (301) as claimed in Claim 10 or Claim 11, in which the strip (340) has a planar backing (306) from one side of which the projections (304) extend.
13. An internal combustion engine (301) as claimed in any of Claims 10 to 12, in which the strip (340) is a unitary moulding.
14. An internal combustion engine (401,501) as claimed in any preceding claim, in which the barrier (413,513) is clipped on to the component (404,504).
15. An internal combustion engine (501,701) as claimed in any preceding claim, in which the barrier comprises an outer barrier (516,716) which faces the fuel rail (106) and an intermediate barrier (544,744) spaced apart from both the outer barrier (516,716) and component (504,704), in which the intermediate barrier (544,744) is joined to both the outer barrier (516,716) and the component (504,704) by diagonal webs of material (518,718).



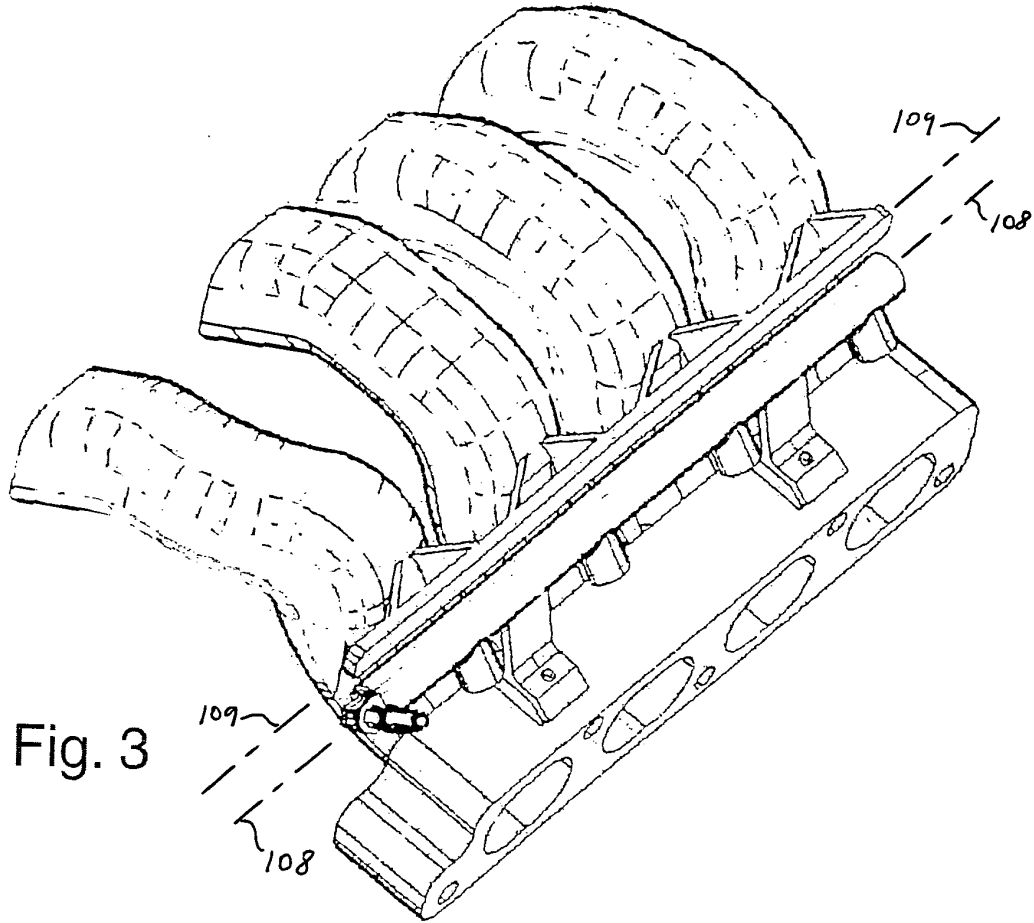


Fig. 3

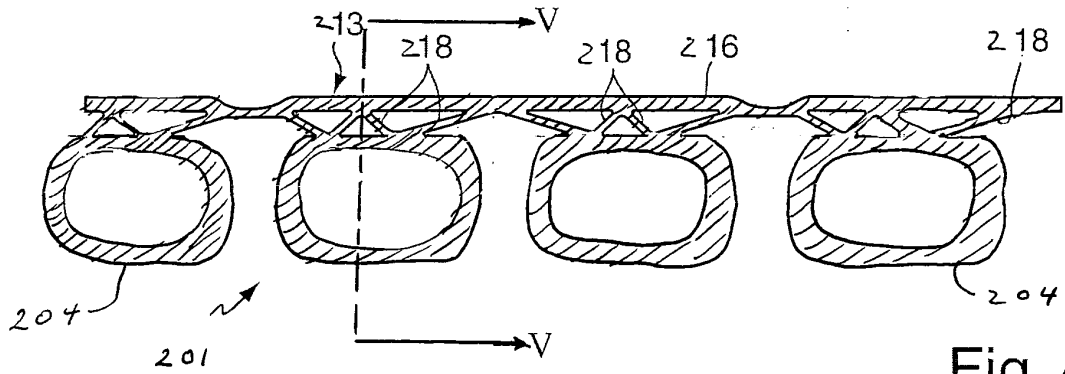


Fig. 4

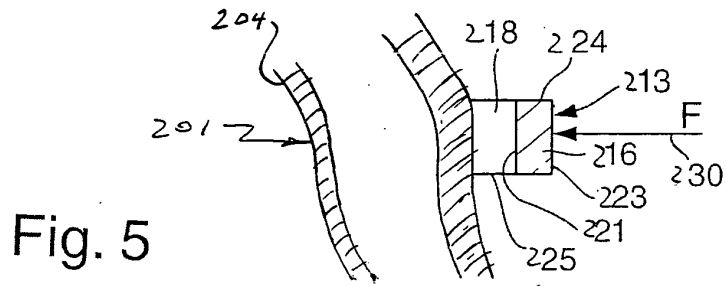


Fig. 5

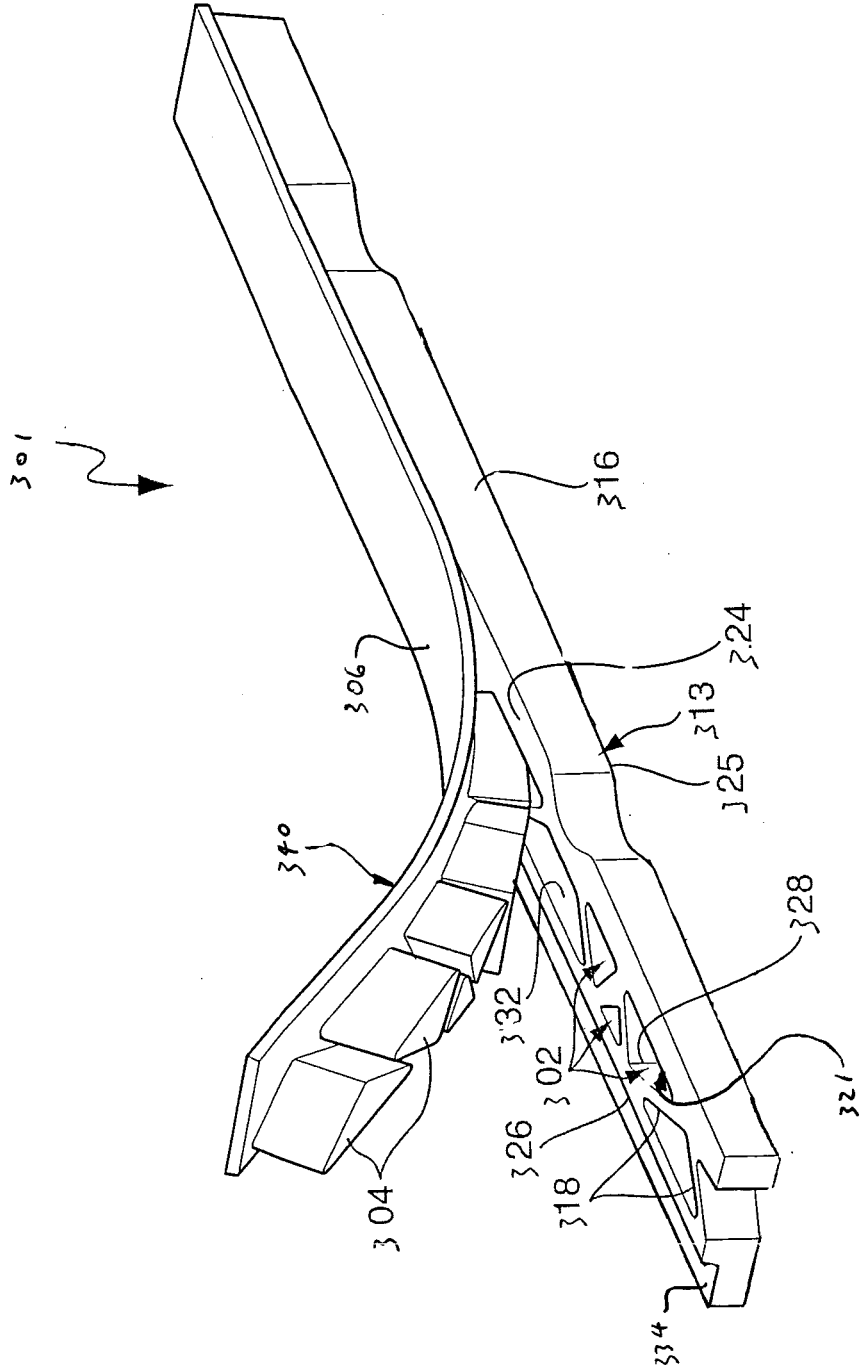
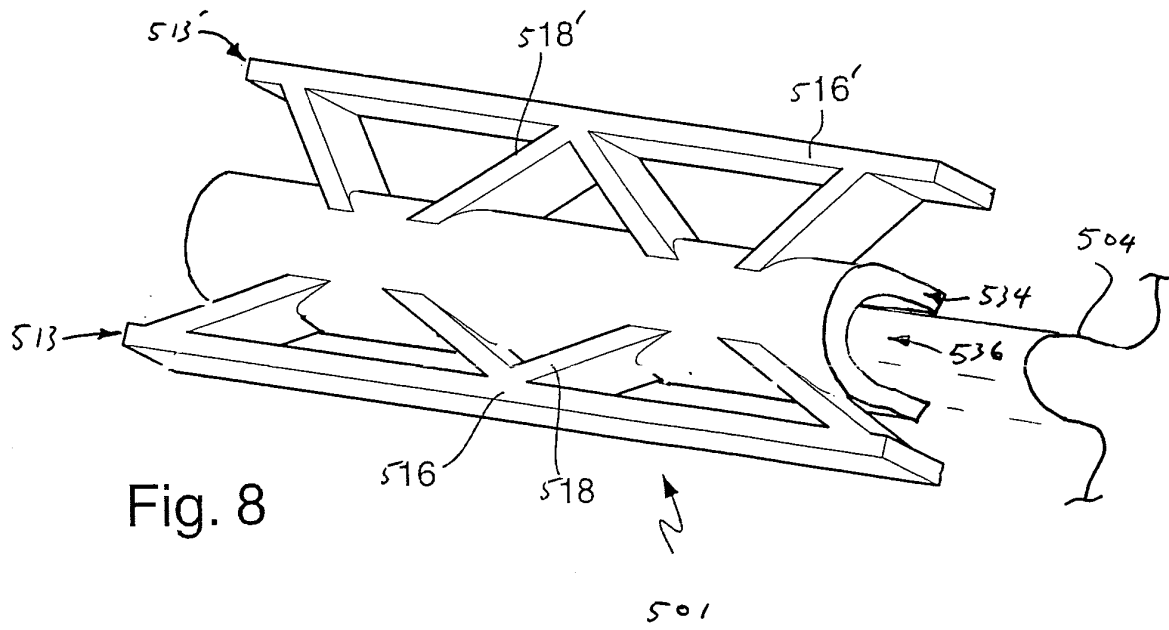
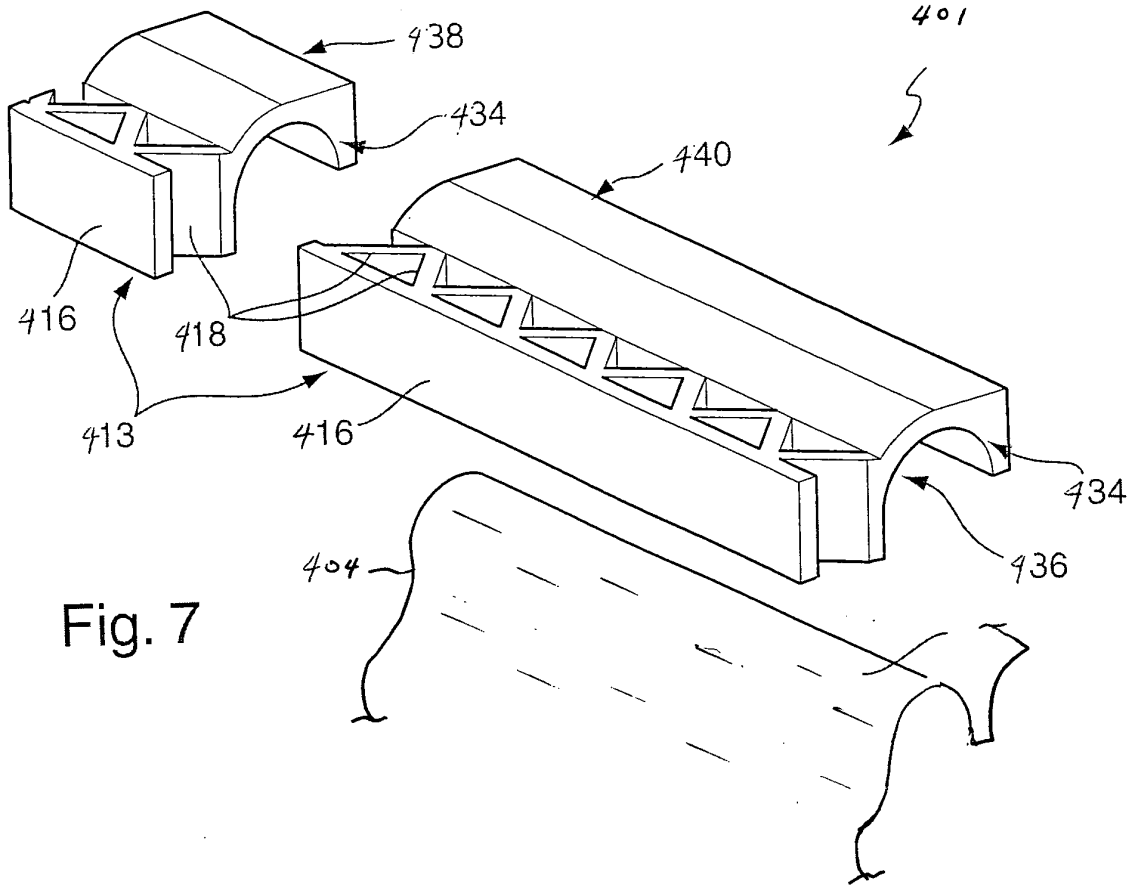


Fig. 6



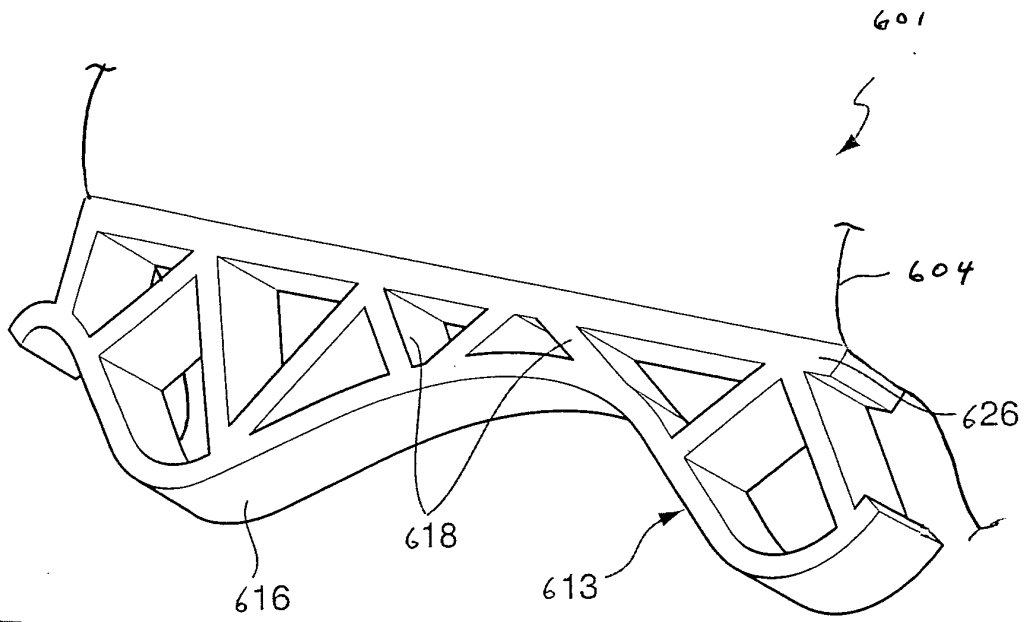


Fig. 9

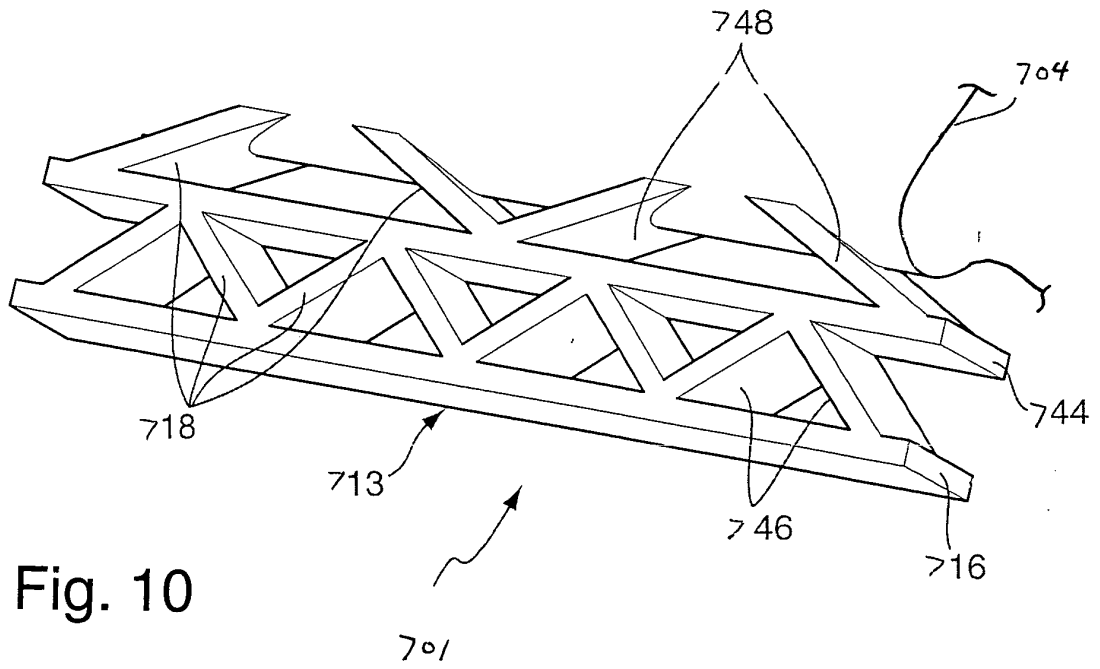
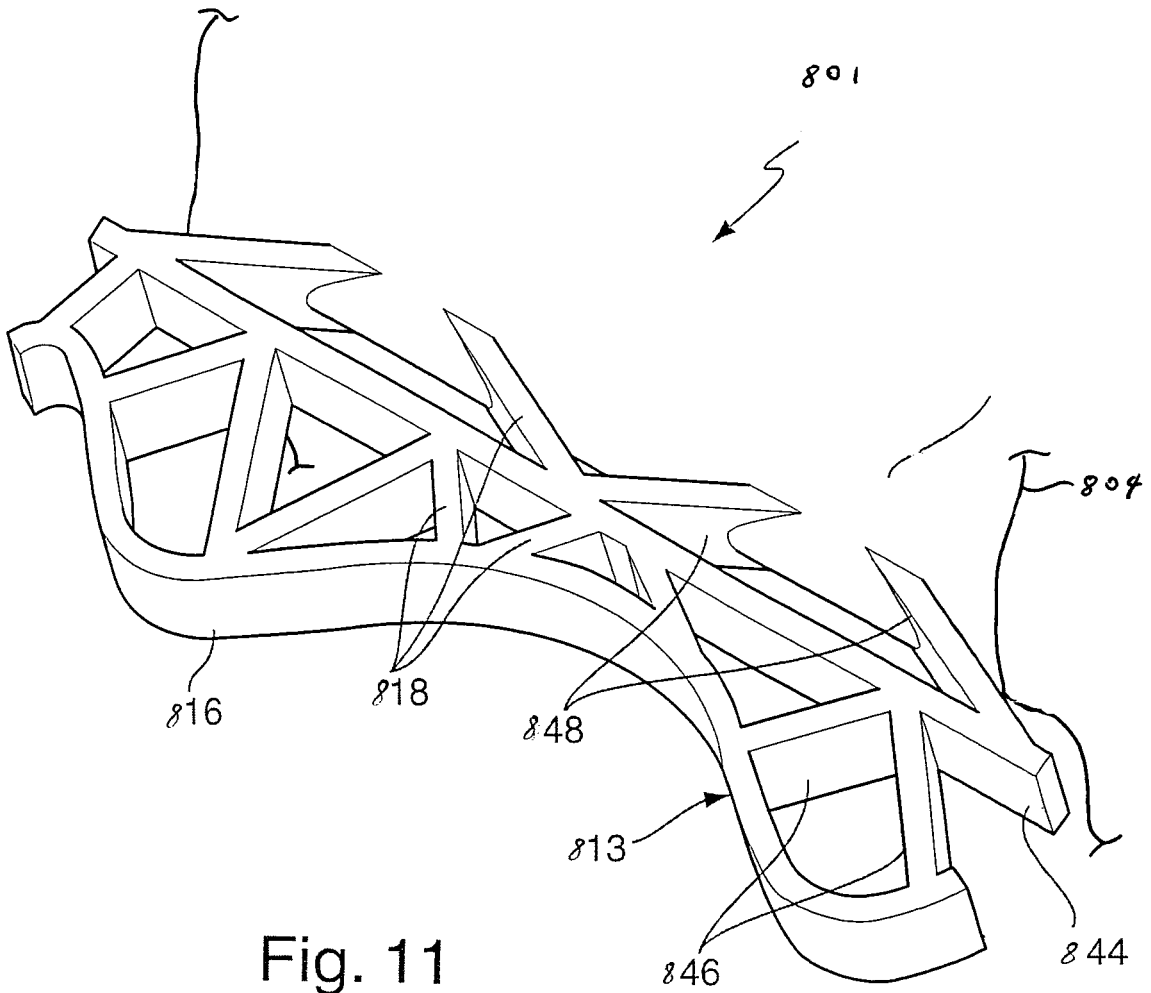


Fig. 10





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	GB 2 333 324 A (DAIMLERCHRYSLER AG) 21 July 1999 (1999-07-21) * page 2 * * page 4; figures 1,3 * -----	1-4,8,9, 14	F02M35/10 F02M69/46 F02M35/04
A	EP 1 304 473 A (NISSAN MOTOR COMPANY, LIMITED) 23 April 2003 (2003-04-23) * paragraph [0020] - paragraph [0024]; figures 3,5,7 * -----	1-15	
A	US 5 465 699 A (VOIGT ET AL) 14 November 1995 (1995-11-14) * column 1, line 53 - line 60; figure 2 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			F02M
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 2 February 2005	Examiner Schmitter, T
<p>CATEGORY OF CITED DOCUMENTS</p> <p>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</p> <p>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</p>			

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EPC FORM 1503 03 82 (P04/C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 04 25 5352

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

02-02-2005

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
GB 2333324	A	21-07-1999	DE 19801171 C1	15-04-1999
			FR 2773592 A1	16-07-1999
			IT RM990012 A1	11-07-2000
			US 6076505 A	20-06-2000

EP 1304473	A	23-04-2003	JP 2003120467 A	23-04-2003
			EP 1304473 A2	23-04-2003
			US 2003075135 A1	24-04-2003

US 5465699	A	14-11-1995	DE 4418001 A1	08-12-1994
			FR 2705997 A1	09-12-1994
			JP 7054724 A	28-02-1995
