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(54) **An engine and exhaust manifold assembly**

Motor- und Abgaskrümmeranordnung

Moteur et ensemble de tubulure d'échappement

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Description

[0001] The invention relates to internal combustion engines and in particular to an exhaust manifold for such an engine.

[0002] It is known to provide an assembly of an internal combustion engine and an exhaust manifold in which the engine includes a cylinder head or other engine component having a number of exhaust ports for the passage of hot gases from the engine and the exhaust manifold comprises a metal housing defining a number of exhaust passageways. The exhaust manifold is joined to the cylinder head so that each of the exhaust passageways corresponds to a respective one of a number of exhaust ports from the engine. The manifold is joined to the cylinder head by a flange on the manifold secured to the engine by threaded fasteners such as bolts or studs and nuts. A gasket is provided to seal between the cylinder head and the flange.

[0003] A disadvantage of this arrangement is that in use the exhaust manifold becomes very much hotter than the cylinder head and, if the threaded fasteners securing the manifold to the cylinder head are relatively tight, the thermal expansion of the exhaust manifold is restricted. While there is usually some slippage at the manifold to cylinder head face joint under the resulting compressive loading, the friction at this joint can remain quite considerable and at high temperatures, i.e. at very high engine loads, the material of the exhaust manifold can plastically deform or creep under compression. Then, when the engine and the exhaust manifold cool, there is then a tensile loading in the exhaust manifold and, over repeated engine cycles, the manifold can shrink considerably and the repeated stress cycles can cause cracking of the manifold or shearing of the threaded fasteners.

[0004] Although it is known to overcome by the use of special materials for the exhaust manifold, these are relatively expensive and so the problem remains.

[0005] Reducing the clamp load between the cylinder head and the exhaust manifold goes some way towards solving the problem, e.g. as shown in US6327854, as does reducing the friction and allowing radial clearance around the fastener as shown in US4214444. The problem of failure of the fasteners is addressed in US5566548 and JP7-310540A, each of these showing a fastener with a longer shank and a substantial radial clearance. Another approach to solving the problem is to provide slits in the manifold flange between adjacent exhaust ports. When the engine is run at high load the exhaust manifold is restrained by the fasteners from expanding freely and the material of the manifold undergoes plastic deformation by compression as explained above. However, when the manifold cools down, the slits close and prevent contraction at the flange. This puts a compressive force on the manifold at the flange which is balanced by tensile forces in other parts of the manifold, these tensile forces being absorbed by elastic strain of the manifold material. This approach is illustrated in Japanese Utility Model laid open No. 6-30424. However, the value of this approach is limited by the difficulty of producing the slits in manifolds made in quantities for mass-production. While slitting by laser, water jet or abrasive jet appears to be feasible, the requirement to cut through a considerable thickness of metal makes it likely that this method will require substantial development to ensure that the width of the slit is sufficiently small and is held to the required tolerance.

[0006] FR 2 575 788 discloses an exhaust manifold assembly according to the preamble of claim 1.

[0007] It is an object of the invention to provide an assembly of an internal combustion engine and an exhaust manifold in which the problems outlined above are alleviated and which can be manufactured economically.

[0008] According to a first aspect of the invention there is provided an internal combustion engine and exhaust manifold assembly, the assembly comprising an engine having a cylinder head, a cylinder block having at least two cylinders arranged in line and an exhaust port for each cylinder, an exhaust manifold having a mounting flange including a flange face for interfacing with a corresponding head face on the cylinder head and threaded fasteners attaching the manifold to the engine at the flange face, wherein the mounting flange is formed as a number of discrete flange sections, each flange section corresponding to a respective exhaust port of the engine and being separated from an adjacent flange section by a gap, characterised in that a respective spacer block is held in each gap by a respective one of the threaded fasteners (25), the arrangement being such that, in use, the exhaust manifold is restrained by the fasteners from thermal expansion at the mounting flange but thermal contraction causes one flange section to thrust on the adjacent flange section through the spacer block.

[0009] Each spacer block may be formed as part of a tubular spacer, each tubular spacer having a bore through which a corresponding one of the threaded fasteners extends.

[0010] Each spacer block may be formed integrally with a tubular spacer.

[0011] Each spacer block may be formed by sintering.

[0012] Each of the gaps between the flange sections may be a parallel sided gap.

[0013] According to a second aspect of the invention there is provided a method of manufacturing an internal combustion engine and exhaust manifold assembly comprising supplying an engine having a cylinder head, a cylinder block having at least two cylinders arranged in line and an exhaust port for each cylinder, supplying an exhaust manifold having a single mounting flange characterised in that the method comprises creating a number of gaps in the mounting flange each gap being at a position between adjacent exhaust ports so that the mounting flange has discrete flange sections and each flange section corresponds to a respective exhaust port, producing a spacer block for each gap, inserting the spacer blocks into the gaps so as to substantially fill the gaps

and attaching the manifold and the spacer blocks to the engine by means of a number of threaded fasteners.

[0014] The method may further comprise attaching each mounting flange to the engine by the use of two or more threaded fasteners.

[0015] The method may further comprise forming each spacer block as part of a tubular spacer having a bore through which in use a corresponding threaded fastener extends to secure the manifold to the cylinder head.

[0016] Each spacer block may be formed integrally with the tubular spacer.

[0017] The method may further comprise forming each spacer block by sintering.

[0018] Creating a number of gaps may comprise one of cutting and machining the manifold flange to form the gaps.

[0019] Each gap may be a parallel sided gap.

[0020] The invention will now be described by way of example with reference to the accompanying drawing of which:-

Fig.1 is a cross-section showing part of an internal combustion engine and exhaust manifold assembly according to the invention;

Fig.2 is a plan view of the exhaust manifold shown in Fig.1;

Fig.3 is a view in the direction of arrow A on Fig.2 showing a rear elevation of the exhaust manifold shown in Figs.1 and 2;

Fig.4 is a view in the direction of arrow B on Fig.2 showing a front elevation of the exhaust manifold shown in Figs.1 and 2;

Fig.5 is a cross-section through part of the engine and exhaust manifold assembly shown in Fig.1;

Fig.6 is a cross-section through a dual-function spacer shown in Fig.5; and

Fig.7 is perspective view of the dual-function spacer shown in Fig.6.

[0021] An internal combustion engine has a cylinder head 11 secured to a cylinder block 12 having four cylinders 21 arranged in line of which only one is shown. A piston is slideably restrained for reciprocating motion within each of the cylinders 21 as is well known in the art.

[0022] The cylinder head 11 incorporates an inlet port 13 and an exhaust port 14 for each cylinder 21, together with the usual inlet valves 15 and exhaust valves 16. While there are typically two inlet valves and two exhaust valves for each cylinder 21, the exhaust ports 14 are siamesed so that exhaust gas flow past the two exhaust valves flows out of the one exhaust port.

[0023] An exhaust manifold 17 is attached to the cylinder head 11 by a mounting flange 19 using threaded fasteners in the form of set bolts 25 and a gasket 22 is provided to seal between a head face 18 on the cylinder head 11 and a flange face 20 on the mounting flange 19.

[0024] As best seen in Figs. 2 to 4, the exhaust manifold 17 is machined from a casting, typically a high SiMo cast iron, this being a ductile cast iron with a relatively high silicon and molybdenum content. The exhaust manifold 17 ducts the exhaust gas displaced by a piston 23 slideable in each cylinder 21 past the exhaust valve 16 and out of the exhaust port 14. The cylinder head 11 is cooled by a water based coolant circulated through coolant passages 24. The gas from each exhaust port 14 is ducted by the exhaust manifold 17 through arcuate pipe sections 30 and an end pipe section 32 to an exhaust outlet port 27 where an exhaust pipe connector flange 28 is provided to allow the connection of an exhaust pipe or a close coupled catalyst assembly (not shown). A tapping 29 is provided for mounting a sensor, e.g. a lambda sensor.

[0025] There are eight of the set bolts 25 securing the exhaust manifold 17 to the cylinder head 11, two for each exhaust port 14, the set bolts 25 each having a cap head 26 and extend through holes 33 in the mounting flange 19 and into threaded holes 35 in the cylinder head 11. The threaded holes 35 may be initially formed as blind drillings and the threads may be formed during the first insertion of the set bolts 25, these being a thread forming type having a threaded portion 36 with a tri-lobular cross-section and a plain shank 38 adjacent the cap head 26. Such bolts are commercially available, e.g. as sold under the Taptite trade mark.

[0026] The mounting flange 19 is interrupted by three parallel sided gaps 31, one each between the exhaust ports 14 of adjacent cylinders 21, so that for each exhaust port 14 there is separate discrete flange section 19A, 19B, 19C or 19D. In the manufacture of the exhaust manifold 17 the mounting flange 19 is formed as one and the gaps 31 are formed by machining (e.g. milling).

[0027] Between each set bolt 25 and the respective flange section 19A, 19B, 19D, 19D there is a tubular spacer. Two types of spacer are used. The first type is a plain tubular spacer 37 (Fig.5) having a cylindrical outer surface and a stepped bore and the second type is a dual function spacer 39 which has a stepped bore 41 (Fig.6) similar to the stepped bore of the plain spacer 37, a part cylindrical outer surface 45 and an offset lug 43 which extends beyond an end face 46 which abuts the manifold mounting flange 19, the lug having parallel faces which are perpendicular to the end face 46.

[0028] Each stepped bore comprises a short small diameter portion 47 adjacent to an end face 42 opposite the eng face 46 where the cap head 26 of the set bolt 25 abuts and a longer large diameter portion 48 which provides a large clearance around the shank 38 of the set bolt 25. The manifold mounting flange 19 has a corresponding hole 33, most of which are of a similar diameter to give a corresponding large clearance. However, one

of the holes 33A between the middle two of the cylinders 21 is of a smaller diameter to provide a location for the manifold 17 on the cylinder head 11 while another of the holes 33B is oval to give an angular location but still allow for expansion and contraction of the manifold.

[0029] There is one dual function spacer 39 for each of the gaps 31 between the adjacent flange sections 19A, 19B, 19C, 19D, each dual function spacer 39 being arranged so that its lug 43 extends into the corresponding gap 31 to abut the adjacent sides of the flange sections 19A, 19B, 19C, 19D. The dual function spacers 39 are manufactured so that each lug 43 is an easy push fit into the respective gap 31.

[0030] The dual function spacers 39 are preferably made by sintering, e.g. using steel, while the mounting flange 19 can be machined by a milling cutter of the required width to produce the gaps 31.

[0031] In use of the engine the exhaust manifold 17 becomes very much hotter than the cylinder head 11, the head being cooled by the coolant in the coolant passages 24. This results in thermal expansion of the manifold 17 which is much greater than that of the cylinder head, even when the cylinder head is made of aluminium which has a higher coefficient of thermal expansion than cast iron. The set bolts 25 are tightened to an extent where the gasket 22 is effective to seal exhaust gases but where some slippage along the head face 18 and flange face 20 is allowed due to the thermal expansion of the manifold 17. This is helped by careful selection of the gasket material, e.g. molybdenum coated.

[0032] When the engine is first built, there is no stress on the exhaust manifold 17, apart from that arising from the tension of the set bolts 25. When the engine is run at high load there is sufficient restraint by the set bolts 25 to prevent the manifold 17 from expanding freely at the flange face 20. However, at the arcuate pipe sections 30 where the manifold 17 is hottest, the material of the manifold undergoes plastic deformation by compression so that a relatively small compressive stress is built up. When the engine cools, e.g. resumes moderate loading or is shut down or idled, the arcuate pipe sections 30 cool and contract. Each of the lugs 43 then acts as a spacer block so that the expansion of one flange section 19A, 19B, 19C, 19D thrusts on the adjacent flange section through the lugs and prevents or limits contraction at the flange face 20. The arcuate pipe sections 30 can deform elastically to balance the compressive loading at the flange sections 19A, 19B, 19C, 19D, the material of the manifold having regained its mechanical properties at the lower temperatures. When the engine is again run at a high load, the thermal expansion at the arcuate pipe sections 30 initially acts to reduce the elastic forces locked in when the manifold cooled so that the loading under thermal expansion is considerably reduced and further plastic deformation may not occur.

[0033] While the dual function spacer 39 is the preferred means of providing a spacer block to fill the gaps 31 between the flange sections 19A, 19B, 19D or 19D, other means may be employed. For example, the gaps 31 could be made quite narrow, e.g. as formed by a slitting saw or a laser and the gap filled by a down-turned tab of a tab washer inserted between one of the tubular spacers and the manifold or, particularly if the tubular spacers are omitted, under the head of the threaded fastener.

[0034] Alternatively, such a washer could have lugs which hold a separate solid spacer block in place in the gap.

[0035] Although the invention has been described in detail with respect to a engine having four cylinders, it will be appreciated by those skilled in the art that it is equally applicable to engines having two, three, five or more cylinders in line and to 'V' or horizontally opposed engines with banks of cylinders in line. Where there are several cylinders in a block or bank, the exhaust manifold may be manufactured so that in its "as cast" or otherwise initially manufactured condition there are two or more mounting flanges and the gaps in the mounting flanges are machined between adjacent pipe sections as previously described. Although described in relation to exhaust manifolds made by casting, the invention is also applicable to manifolds made by fabrication where pipe sections are attached to a flange plate, e.g. by welding.

Claims

1. An internal combustion engine and exhaust manifold assembly, the assembly comprising an engine having a cylinder head(11), a cylinder block (12) having at least two cylinders (21) arranged in line and an exhaust port (14) for each cylinder (21), an exhaust manifold (17) having a mounting flange (19) including a flange face (20) for interfacing with a corresponding head face (18) on the cylinder head (11) and threaded fasteners (25) attaching the manifold (17) to the engine at the flange face (20), wherein the mounting flange (19) is formed as a number of discrete flange sections (19A, 19B, 19C, 19D), each flange section (19A, 19B, 19C, 19D) corresponding to a respective exhaust port (14) of the engine and being separated from an adjacent flange section (19A, 19B, 19C, 19D) by a gap (31), **characterised in that** a respective spacer block (43) is held in each gap (31) by a respective one of the threaded fasteners (25), the arrangement being such that, in use, the exhaust manifold (17) is restrained by the fasteners (25) from thermal expansion at the mounting flange (19) but thermal contraction causes one flange section (19A, 19B, 19C, 19D) to thrust on the adjacent flange section (19A, 19B, 19C, 19D) through the spacer block (43).

2. An assembly as claimed in claim 1 wherein each spacer block (43) is formed as part of a tubular spacer (39), each tubular spacer (39) having a bore (47, 48) through which a corresponding one of the thread-

ed fasteners (25) extends.

3. An assembly as claimed in claim 2 wherein each spacer block (43) is formed integrally with a tubular spacer (39).

4. An assembly as claimed in claim 3 wherein each spacer block (43) is formed by sintering.

5. An assembly as claimed in any of claims 1 to 4 wherein each of the gaps (31) between the flange sections (19A, 19B, 19C, 19D) is a parallel sided gap.

6. A method of manufacturing an internal combustion engine and exhaust manifold assembly comprising supplying an engine having a cylinder head (11), a cylinder block (12) having at least two cylinders (21) arranged in line and an exhaust port (14) for each cylinder (21), supplying an exhaust manifold (17) having a single mounting flange (19) **characterised in that** the method comprises creating a number of gaps (31) in the mounting flange (19) each gap (31) being at a position between adjacent exhaust ports (14) so that the mounting flange (19) has discrete flange sections (19A, 19B, 19C, 19D) and each flange section (19A, 19B, 19C, 19D) corresponds to a respective exhaust port (14), producing a spacer block (43) for each gap (31), inserting the spacer blocks (43) into the gaps (31) so as to substantially fill the gaps (31) and attaching the manifold (17) and the spacer blocks (43) to the engine by means of a number of threaded fasteners.

7. A method as claimed in claim 6 wherein the method further comprises attaching each mounting flange (19A, 19B, 19C, 19D) to the engine by the use of two or more threaded fasteners (25).

8. A method as claimed in claim 6 or in claim 7 wherein the method further comprises forming each spacer block (43) as part of a tubular spacer (39) having a bore (47, 48) through which in use a corresponding threaded fastener (25) extends to secure the manifold (17) to the cylinder head (11).

9. A method according to claim 8 wherein each spacer block (43) is formed integrally with the tubular spacer (39).

10. A method according to claim 8 or in claim 9 wherein the method may further comprise forming each spacer block (43) by sintering.

11. A method as claimed in any of claims 6 to 10 wherein creating a number of gaps (31) comprises one of cutting and machining the manifold flange (19) to form the gaps (31).

12. A method as claimed in any of claims 6 to 11 wherein each gap (31) is a parallel sided gap.

Patentansprüche

1. Verbrennungsmotor- und Abgaskrümmeranordnung, wobei die Anordnung einen Motor mit einem Zylinderkopf (11), einem Zylinderblock (12), der mindestens zwei in Reihe angeordnete Zylinder (21) aufweist, und einem Auslasskanal (14) für jeden Zylinder (21), einen Abgaskrümmer (17) mit einem Montageflansch (19), der eine Flanschfläche (20) zum Zusammenwirken mit einer entsprechenden Kopffläche (18) am Zylinderkopf (11) enthält, und Gewindebefestigungselemente (25), die den Krümmer (17) an der Flanschfläche (20) am Motor befestigen, umfasst, wobei der Montageflansch (19) als mehrere separate Flanschabschnitte (19A, 19B, 19C, 19D) ausgebildet ist, wobei jeder Flanschabschnitt (19A, 19B, 19C, 19D) einem jeweiligen Auslasskanal (14) des Motors entspricht und durch einen Spalt (31) von einem benachbarten Flanschabschnitt (19A, 19B, 19C, 19D) getrennt ist, **dadurch gekennzeichnet, dass** ein jeweiliger Abstandsblock (43) durch ein jeweiliges der Gewindebefestigungselemente (25) in jedem Spalt (31) gehalten wird, wobei die Anordnung so ist, dass der Abgaskrümmer (17) im Gebrauch durch die Befestigungselemente (25) gegen Wärmeausdehnung am Montageflansch (19) festgehalten wird, aber Wärmekontraktion bewirkt, dass ein Flanschabschnitt (19A, 19B, 19C, 19D) durch den Abstandsblock (43) an den benachbarten Flanschabschnitt (19A, 19B, 19C, 19D) stößt.

2. Anordnung nach Anspruch 1, wobei jeder Abstandsblock (43) als Teil eines röhrenförmigen Abstandsstücks (39) mit einer Bohrung (47, 48), durch die sich ein entsprechendes der Gewindebefestigungselemente (25) erstreckt, ausgebildet ist.

3. Anordnung nach Anspruch 2, wobei jeder Abstandsblock (43) integral mit einem röhrenförmigen Abstandsstück (39) ausgebildet ist.

4. Anordnung nach Anspruch 3, wobei jeder Abstandsblock (43) durch Sintern hergestellt wird.

5. Anordnung nach einem der Ansprüche 1 bis 4, wobei jeder der Spalte (31) zwischen den Flanschabschnitten (19A, 19B, 19C, 19D) ein Spalt mit parallelen Seiten ist.

6. Verfahren zur Herstellung einer Verbrennungsmotor- und Abgaskrümmeranordnung, das Bereitstellen eines Motors mit einem Zylinderkopf (11), einem Zylinderblock (12), der mindestens zwei in Reihe angeordnete Zylinder (21) aufweist, und einem Auslas-

skanal (14) für jeden Zylinder (21), Bereitstellen eines Abgaskrümmers (17) mit einem einzigen Montageflansch (19) umfasst, **dadurch gekennzeichnet, dass** das Verfahren Herstellen mehrerer Spalte (31) in dem Montageflansch (19), wobei sich jeder Spalt (31) an einer Stelle zwischen benachbarten Auslasskanälen (14) befindet, so dass der Montageflansch (19) separate Flanschabschnitte (19A, 19B, 19C, 19D) aufweist und jeder Flanschabschnitt (19A, 19B, 19C, 19D) einem jeweiligen Auslasskanal (14) entspricht, Herstellen eines Abstandsblocks (43) für jeden Spalt (31), Einführen der Abstandsblöcke (43) in die Spalte (31), um die Spalte (31) im Wesentlichen zu füllen, und Befestigen des Krümmers (17) und der Abstandsblöcke (43) an dem Motor mittels mehrerer Gewindebefestigungselemente umfasst.

7. Verfahren nach Anspruch 6, wobei das Verfahren weiterhin Befestigen jedes Montageflansches (19A, 19B, 19C, 19D) an dem Motor durch Verwendung der zwei oder mehr Gewindebefestigungselemente (25) umfasst.

8. Verfahren nach Anspruch 6 oder 7, wobei das Verfahren weiterhin Ausbilden jedes Abstandsblocks (43) als Teil eines röhrenförmigen Abstandsblocks (39) mit einer Bohrung (47, 48), durch die sich im Gebrauch ein entsprechendes Gewindebefestigungselement (25) erstreckt, um den Krümmer (17) an dem Zylinderkopf (11) zu befestigen, umfasst.

9. Verfahren nach Anspruch 8, wobei jeder Abstandsblock (43) integral mit einem röhrenförmigen Abstandsblock (39) ausgebildet wird.

10. Verfahren nach Anspruch 8 oder 9, wobei das Verfahren weiterhin Herstellen jedes Abstandsblocks (43) durch Sintern umfassen kann.

11. Verfahren nach einem der Ansprüche 6 bis 10, wobei Herstellen mehrerer Spalte (31) Schneiden oder maschinelles Bearbeiten des Krümmerflansches (19) zur Bildung der Spalte (31) umfasst.

12. Verfahren nach einem der Ansprüche 6 bis 11, wobei jeder Spalt (31) ein Spalt mit parallelen Seiten ist.

Revendications

1. Ensemble de moteur à combustion interne et de collecteur d'échappement, l'ensemble comprenant un moteur ayant une culasse (11), un bloc-cylindres (12) ayant au moins deux cylindres (21) agencés en ligne et un orifice d'échappement (14) pour chaque cylindre (21), un collecteur d'échappement (17) ayant une bride de montage (19) incluant une face de bride (20) pour réaliser l'interface avec une face de culasse correspondante (18) sur la culasse (11), et des attaches filetées (25) fixant le collecteur (17) au moteur au niveau de la face de bride (20), la bride de montage (19) étant formée sous forme d'une pluralité de sections de bride discrètes (19A, 19B, 19C, 19D), chaque section de bride (19A, 19B, 19C, 19D) correspondant à un orifice d'échappement respectif (14) du moteur et étant séparée d'une section de bride adjacente (19A, 19B, 19C, 19D) par un espace (31), **caractérisé en ce qu'**un bloc d'espacement respectif (43) est retenu dans chaque espace (31) par l'une respective des attaches filetées (25), l'agencement étant tel que pendant l'utilisation, le collecteur d'échappement (17) soit retenu par les attaches (25) de manière à empêcher sa dilatation thermique au niveau de la bride de montage (19) mais que la contraction thermique presse une section de bride (19A, 19B, 19C, 19D) contre la section de bride adjacente (19A, 19B, 19C, 19D) par le biais du bloc d'espacement (43).

2. Ensemble selon la revendication 1, dans lequel chaque bloc d'espacement (43) est formé en tant que partie d'un élément d'espacement tubulaire (39), chaque élément d'espacement tubulaire (39) ayant un alésage (47, 48) à travers lequel s'étend une attache correspondante des attaches filetées (25).

3. Ensemble selon la revendication 2, dans lequel chaque bloc d'espacement (43) est formé intégralement avec un élément d'espacement tubulaire (39).

4. Ensemble selon la revendication 3, dans lequel chaque bloc d'espacement (43) est formé par frittage.

5. Ensemble selon l'une quelconque des revendications 1 à 4, dans lequel chacun des espaces (31) entre les sections de bride (19A, 19B, 19C, 19D) est un espace à côtés parallèles.

6. Procédé de fabrication d'un ensemble de moteur à combustion interne et de collecteur d'échappement, comprenant la fourniture d'un moteur ayant une culasse (11), un bloc-cylindres (12) ayant au moins deux cylindres (21) agencés en ligne et un orifice d'échappement (14) pour chaque cylindre (21), la fourniture d'un collecteur d'échappement (17) ayant une seule bride de montage (19), **caractérisé en ce que** le procédé comprend la création d'une pluralité d'espaces (31) dans la bride de montage (19), chaque espace (31) étant à une position entre des orifices d'échappement adjacents (14) de telle sorte que la bride de montage (19) ait des sections de bride discrètes (19A, 19B, 19C, 19D) et que chaque section de bride (19A, 19B, 19C, 19D) corresponde à un orifice d'échappement respectif (14), la production d'un bloc d'espacement (43) pour chaque espa-

ce (31), l'insertion des blocs d'espacement (43) dans les espaces (31) de manière à remplir substantiellement les espaces (31) et la fixation du collecteur (17) et des blocs d'espacement (43) au moteur au moyen d'une pluralité d'attaches filetées.

7. Procédé selon la revendication 6, dans lequel le procédé comprend en outre la fixation de chaque bride de montage (19A, 19B, 19C, 19D) sur le moteur en utilisant au moins deux attaches filetées (25).

8. Procédé selon la revendication 6 ou 7, dans lequel le procédé comprend en outre la formation de chaque bloc d'espacement (43) en tant que partie d'un élément d'espacement tubulaire (39) ayant un alésage (47, 48), à travers lequel, pendant l'utilisation, une attache filetée correspondante (25) s'étend de manière à fixer le collecteur (17) à la culasse (11).

9. Procédé selon la revendication 8, dans lequel chaque bloc d'espacement (43) est formé intégralement avec l'élément d'espacement tubulaire (39).

10. Procédé selon la revendication 8 ou 9, dans lequel le procédé peut en outre comprendre la formation de chaque bloc d'espacement (43) par frittage.

11. Procédé selon l'une quelconque des revendications 6 à 10, dans lequel la création d'une pluralité d'espaces (31) comprend une opération parmi le découpage et l'usinage de la bride de collecteur (19) pour former les espaces (31).

12. Procédé selon l'une quelconque des revendications 6 à 11, dans lequel chaque espace (31) est un espace à côtés parallèles.

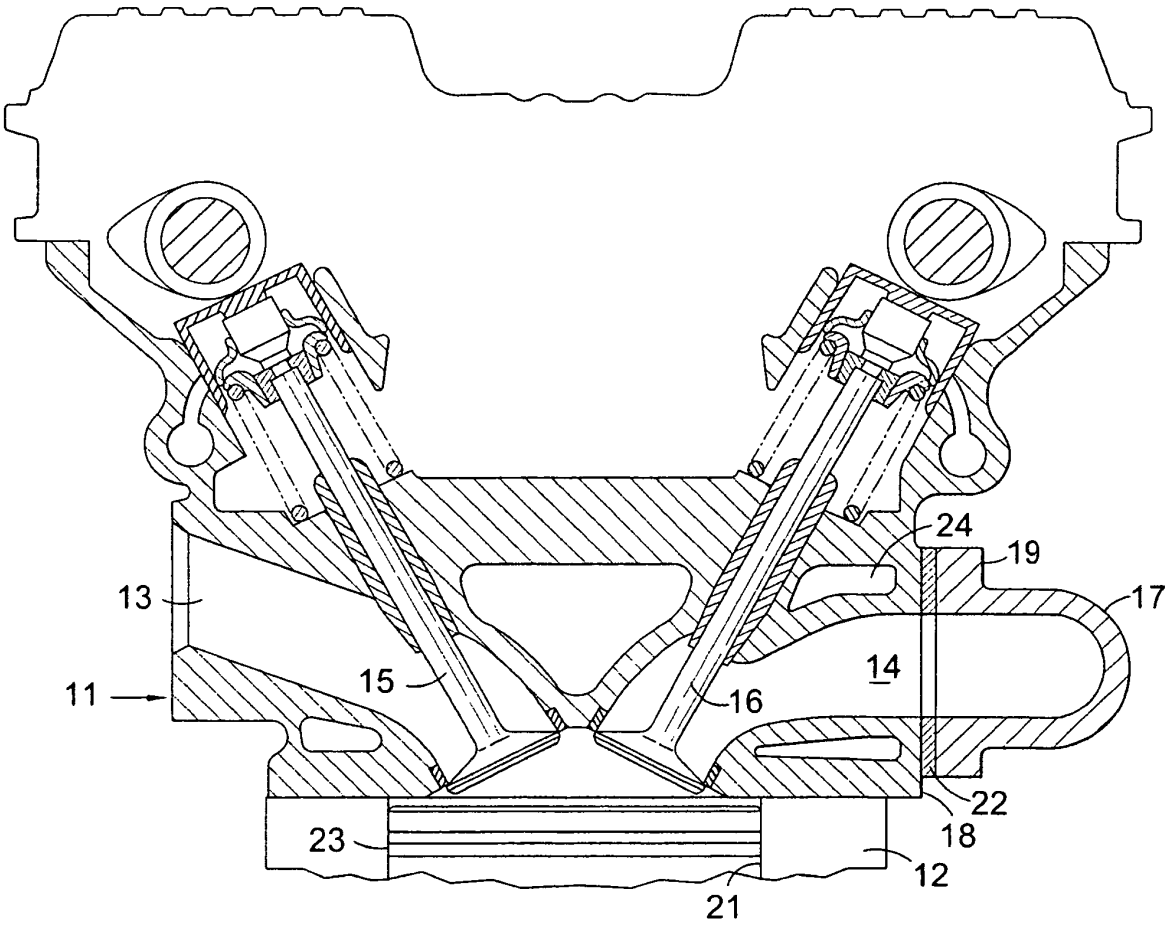


Fig.1

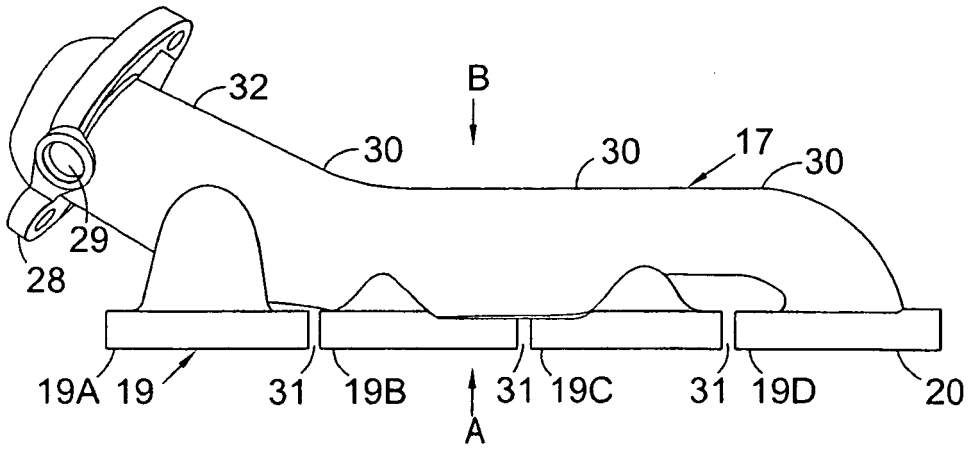


Fig.2

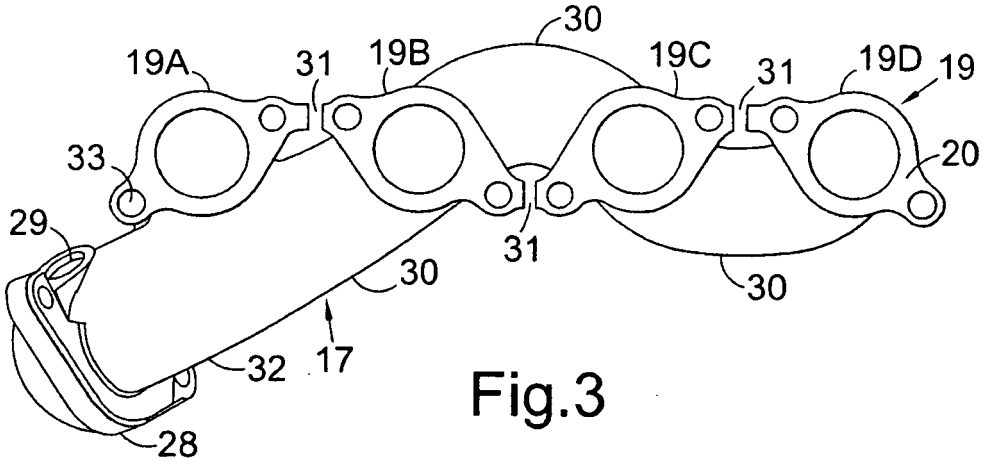


Fig.3

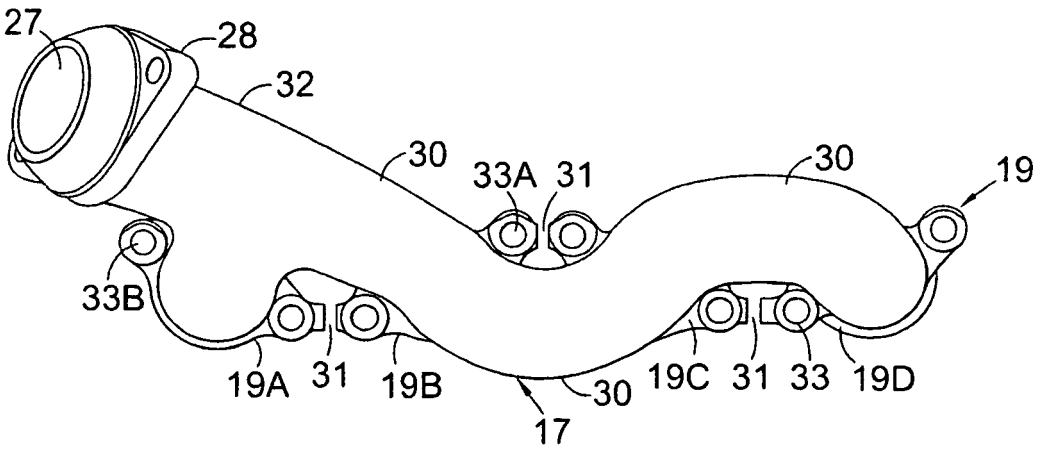


Fig.4

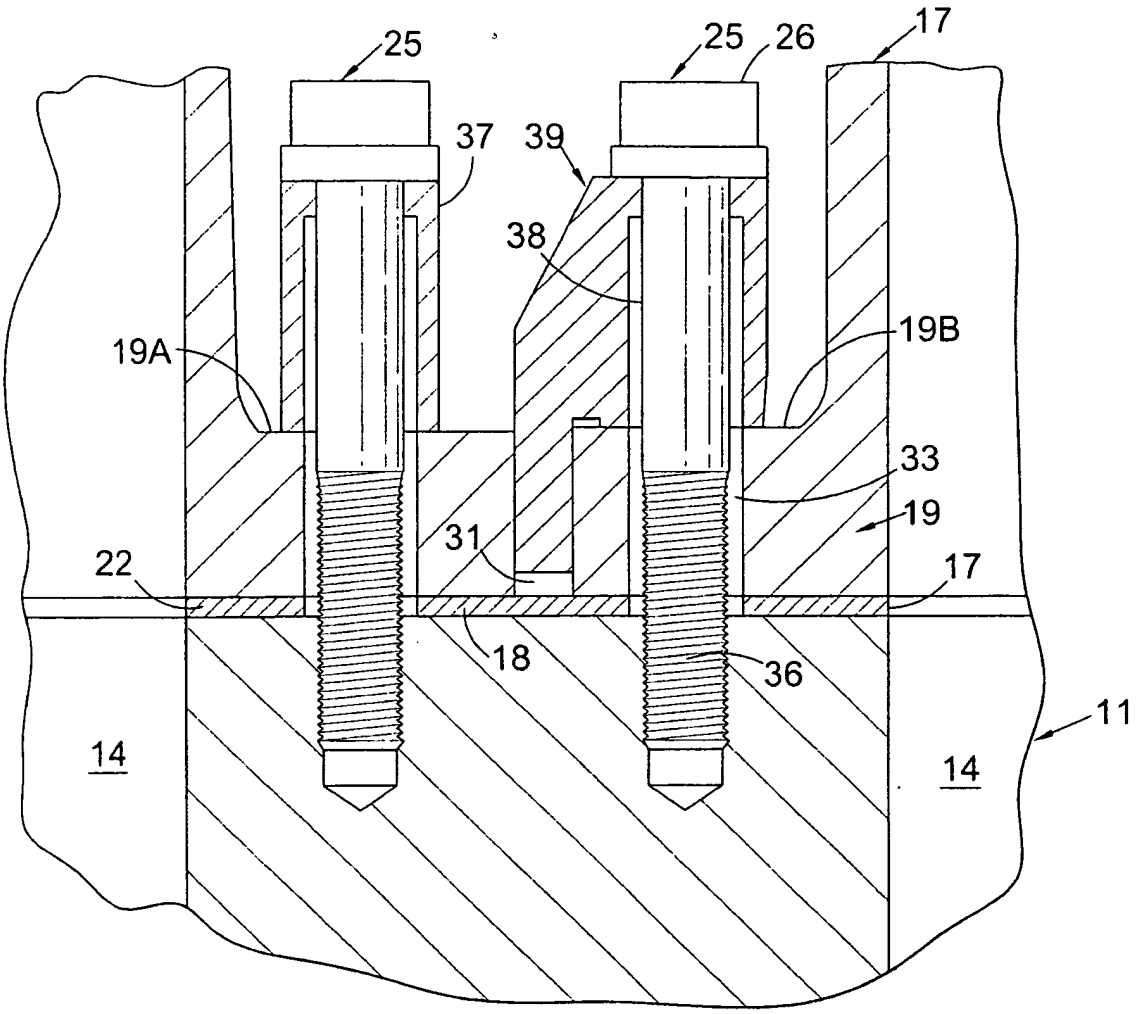


Fig.5

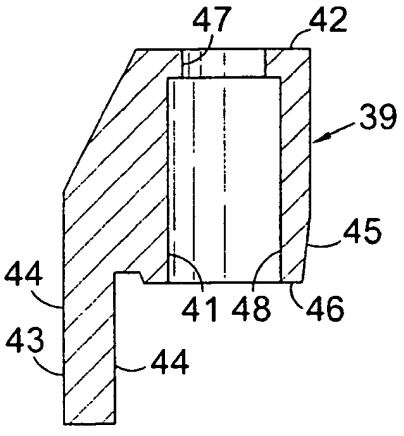


Fig.6

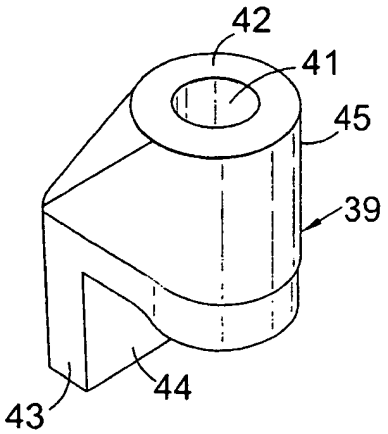


Fig.7

REFERENCES CITED IN THE DESCRIPTION

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