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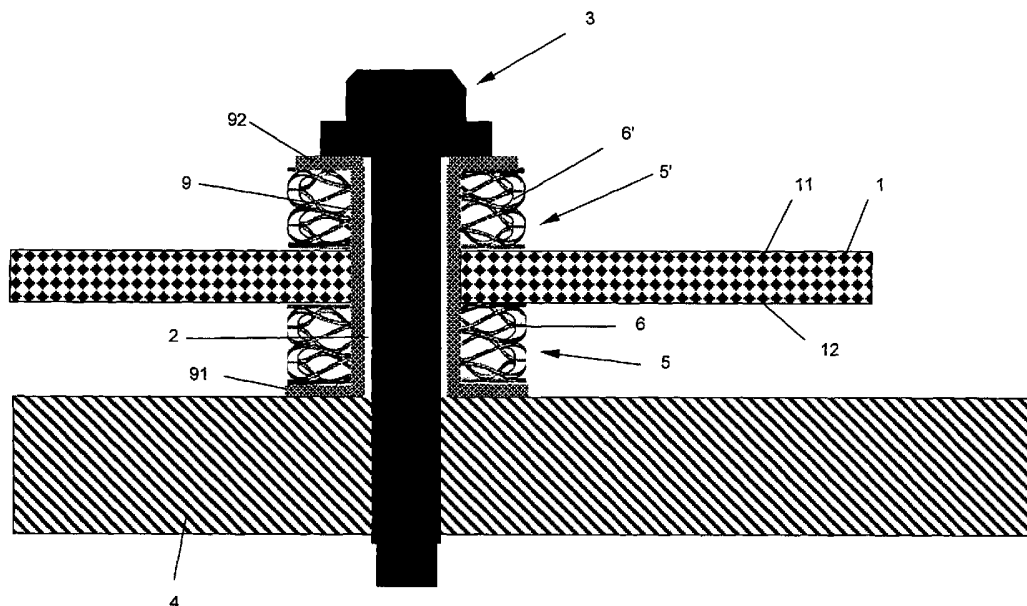
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(54) Title: HEAT SHIELD



(57) Abstract: The invention relates to a heat shield, comprising at least one fastening opening for receiving a fastening means, with which the heat shield and a component can be joined to each other. A decoupling element which comprises a wave spring is arranged between the heat shield and the component in the region around the fastening opening.

HEAT SHIELD

[0001] The invention relates to a heat shield, comprising at least one fastening opening for receiving a fastening means, with which the heat shield and a component can be joined to each other. A decoupling element is arranged between the heat shield and the component in the region around the fastening opening.

[0002] Heat shields are used as protection from sound and/or heat for other components. Heat shields are used in engine compartments of motor vehicles for example, especially in the area of the exhaust system in order to protect adjacent temperature-sensitive components and units from heating. Heat shields are often also used as sound protection devices. Conventional screwed connections are usually used for fastening the heat shield in the area of the exhaust system, e.g. on the exhaust manifold. In order to prevent any damage to the heat shield, the fastening torques of the screws must not be chosen too high. This leads to the risk however that the screwed connections will loosen under the influence of the vibrations acting on the same. The heat shield itself may also be damaged by the vibrations. In order to avoid this it is known from the state of the art to attach a decoupling element between the heat shield and the component to which the heat shield will be fastened, which decoupling element absorbs the vibrations. Decoupling elements are described in the state of the art as hollow cylinders made of a wire knit, through the openings of which the screws are guided. Heat shields with decoupling elements made of wire knit are disclosed for example in DE 19716733 A1 and DE 10021575 A1.

[0003] The disadvantageous aspect in the known decoupling elements made of wire knit is on the one hand their relatively complex and expensive production. Furthermore, the dimensions of the wire-knit pressed parts are difficult to control in their production and are subject to relatively high production tolerances. Also, wires tend to project beyond the outside contour of the pressed part, are the source of disturbances in mounting and can damage other parts. It is further disadvantageous that the damping properties of the wire-knit pressed parts can be set only with difficulty and an ad-

justment to the present vibration effects is only possible in a very adverse manner. In order to have the required damping properties, the wire-knit pressed parts must finally have a relatively high density, leading to the consequence that the total weight rises in an undesirable manner.

[0004] It is the object of the present invention to provide a heat shield which does not have the above disadvantages. A heat shield with a decoupling element shall be provided especially which can be set in a purposeful manner for damping certain vibrations, can be produced in a cost-effective way and has the lowest possible weight at small dimensions.

[0005] This object is achieved by a heat shield in accordance with claim 1. Preferred embodiments are disclosed in the sub-claims.

[0006] The invention therefore relates to a heat shield with at least one fastening opening for receiving a fastening means, with which the heat shield and a component can be joined to each other. A decoupling means is arranged between the heat shield and the component in the region around the fastening opening. In accordance with the invention, said decoupling element comprises a wave spring. Preferably, said wave spring encloses the fastening opening in a ring-shaped manner, especially in an annular manner. The wave spring need not necessarily be closed in an annular manner, although this is preferable. It is also possible that the wave spring is open at one position of the ring.

[0007] Wave springs are principally known from the state of the art, but were used previously for another purpose, namely as compression springs, e.g. in spring and damping systems in motor vehicles. Wave springs can be provided with a single layer or multiple layers. The common aspect is that they are formed from a strip-like or wire-like material in which successive waves are formed with crests and valleys.

[0008] The decoupling element in accordance with the invention can principally be configured according to the known wave springs and comprise single-layer as well as multi-layer wave springs. For the configuration of single-layer wave springs, reference is hereby made in an exemplary manner to EP 1477701 A2, DE 1696283 U and US 6,254,071 B1.

[0009] Decoupling elements in the manner of a multi-layer wave spring are preferable within the scope of the invention. The waves can be arranged above one another in such a way that wave crest comes to lie on wave crest, thus with contact points at which the wave crests of two adjacent layers

get in touch and a variable distance between the adjacent layers at other regions. In the following, this arrangement is referred to as crest-to-crest. In a preferred embodiment, the turns belonging to the different layers can be arranged in such a manner that they do not show any shift in their phases, so that adjacent layers at least almost touch each other all around. This arrangement in the following is referred to as crest-in-crest. The multi-layer wave spring can be made up of several superimposed separate layers or alternatively of a wire- or strip-like starting material which is wound several times about the central opening of the wave spring. Such wave springs are principally also known from the state of the art and have been described for example in DE 10324344 B4, US 4,901,987 A and US 6,758,465 B1.

[0010] In order to obtain the most even damping properties in the circumferential direction about the fastening opening, the wave spring of the decoupling element in accordance with the invention comprises at least three successive waves per layer in the circumferential direction, each comprising a valley and crest (this applies both for single-layer as well as multi-layer wave springs). Preferably, the number of waves per layer is between 3 and 6.

[0011] In order to ensure an even bearing surface and the most distortion-free loading in the circumferential direction in the case of a multi-layer wave spring – either crest-to-crest or crest-in-crest - it may be appropriate that the wave spring comprises a planar end section on at least one of its face sides, as is described for example in US 4,901,987 A and US 6,758,465 B1.

[0012] The wave spring as a decoupling element in accordance with the invention or as a part of the same can be made of a wire-like or strip-like material, as has already been mentioned above. The wire preferably has a round and especially a circular cross section. All previously used materials employed for wave springs are considered as starting materials, i.e. suitable polymer materials for example. Metallic materials are preferable in accordance with the invention however, especially suitable temperature-resistant metal alloys.

[0013] The advantage of the wave springs as described above as decoupling elements in accordance with the invention as compared with previously used wire knits is on the one hand the high production precision, the small dimensions and the low weight of the wave springs as compared with wire knits, and the reduced costs. A special advantage is also that the damping properties of the wave spring can be adjusted in a purposeful manner to the vibrations to be expected. This occurs on the one hand by the selection of the starting material as well as by shaping the wave spring. The damping

properties are influenced by the number of the layers of the wave spring, by the number of the waves and the contact points on which the wave crests come to lie on wave crests in the wave spring. Moreover, wave length and/or amplitude (height difference between wave crest and valley of a wave) can be adjusted in a purposeful manner to the excitation frequency acting upon the heat shield in order to thus achieve the best possible damping. Both the wave length as well as the amplitude can be varied in a purposeful manner in the circumferential direction about the wave spring and/or from layer to layer. If desired, asymmetrical damping properties in the circumferential direction can be set in this way. It is further possible to realize different spring constants with a single wave spring, as is described in DE 10324344 B4.

[0014] In case of a single-layer wave spring, either open or closed, it is preferable for the wave spring to have an outer diameter of 8 to 100 mm, preferably 10 to 40 mm and especially preferably 12 to 30 mm. The inner diameter is suitably set in a range of from 5 to 90 mm, especially 6 to 35 mm and preferably 8 to 25 mm. The spring force is advantageously between 30 and 500 N and preferably from 50 to 150 N. It is also preferred to fix the spring constant in a range of from 30 to 300 N/mm, especially from 200 to 300 N/mm. The spring travel, i.e., the distance in an axial direction between the outermost end of the wave spring in a compressed state and the same end in an uncompressed state, suitably lies between 0.2 to 6 mm, preferably 0.5 to 1.5 mm. In an unloaded state, the wave spring advantageously has a height between 1 and 15 mm, especially 2 to 6 mm.

[0015] In case of a multi-layer wave spring, either multiply wound from a single wire or strip or made of superimposed wave springs, the wave spring preferably has the same outer and inner diameters as the single-layer wave spring described before, irrespective of crest-to-crest or crest-in-crest arrangement.

[0016] In case of a crest-in-crest arrangement, the spring force as well as the spring constant result from a serial connection of single-layer wave springs, which is superposed by a slight increase of these values by a reciprocal restraint of the layers. Thus, spring force and spring constant are slightly larger than n times the corresponding values for the single layers, n being the number of layers, which is generally between two and eight, typically between three and five. The spring force can vary from 60 N for a two-layer to 4050 N for an eight-layer crest-in-crest spring. Considering this range of layers, it preferably ranges between 105 and 1250 N. For a typical three-layer crest-in-crest spring, the spring force is advantageously between 95 and 1600 N and preferably from 160 to 500 N. The spring constant can vary from 60 N/mm for a two-layer to 2500 N/mm for an eight-layer crest-in-

crest spring. Preferred spring constants for crest-in-crest springs range from 410 to 2500 N/mm when considering two- to eight-layer springs. The spring constant for a typical three-layer crest-in-crest spring is in the range of from 95 to 1000 N/mm, preferably from 600 to 1000 N/mm. The spring travel corresponds to the one of the single-layer wave spring, thus it is suitably chosen between 0.2 to 6 mm, preferably 0.5 to 1.5 mm. The height of the multi-layer crest-in-crest wave spring is somewhat larger than for the one-layer wave spring. With a typical material thickness of 0.2 to 0.6 mm, which is typical for rectangular cross-sections, the wave height may vary from 1.2 mm for a two-layer to 20 mm for an eight-layer crest-in-crest wave with a preferred range of 2.2 to 10.5 mm for this range of layers. The wave height for a typical three-layer crest-in-crest wave spring with rectangular cross-section ranges between 1.4 and 16.5 mm, preferably between 2.5 and 7.5 mm. For quadratic and circular cross-sections, the material thickness may be about twice as large, resulting in somewhat larger wave heights. The friction area depends on the number of layers, namely on the number of layers in contact with each other, thus $n-1$ with n the number of layers. Both in the loaded and the unloaded state of the crest-in-crest spring it ranges from 20 to 800 mm², preferably from 100 to 200 mm² for each of the $n-1$ contact "planes" between the layers. Thus, for a typical three-layer crest-in-crest spring, the friction area is between 60 to 2400 mm², preferably between 300 and 600 mm².

[0017] The crest-to-crest arrangement of the spring-wave is especially suitable in case larger spring travels and/or a higher material thickness, typically between 0.5 and 1 mm, are preferred. The spring travel suitably lies between 0.5 and 10 mm, preferably 0.5 to 5 mm. The spring force is advantageously between 30 and 500 N and preferably from 50 to 150 N. It is also preferred to fix the spring constant in a range of from 30 to 300 N/mm, especially from 200 to 300 N/mm. The wave spring advantageously has a height in the uncompressed state between 4 and 50 mm, especially 5 to 20 mm. The number of contact points between the superimposed layers distributed on a turn of 360 ° is preferably chosen between three and 15, especially three to six. The number of springs or layers, respectively, will generally be in the range from two to eight, preferably two to six and especially preferably three to five. In the unloaded state the friction area may vary from 0.6 to 140 mm², preferably 0.6 to 47 mm², for the range from two to eight layers. The corresponding values for the loaded state range from 1.2 to 470 mm² and preferably from 2 to 140 mm². The friction area for a typical four-layer crest-to-crest spring is suitably adjusted to 1 to 60 mm² and preferably 1 to 20 mm² in the unloaded state and to 2 to 200 mm², preferably to 3 to 60 mm², in the loaded state.

[0018] Variation of the damping properties is further possible by setting the shape of wave. Sinusoid wave shapes are preferable, but it is also possible to realize shapes of waves extending in a trapezoid

manner. The latter have the advantage of larger contact surfaces when wave crest comes to lie on wave crest, thus especially in the crest-to-crest embodiment. It is understood that it is also possible to combine sinusoid and trapezoid shapes of waves with one another within one wave spring. Other shapes of wave are principally possible, but preferred less by the invention.

[0019] The surfaces of the spring waves may be smooth. In order to increase their frictional behavior, they may also be structured or profiled. Typical profiles can be derived from tire profiles. In order to tailor the frictional behavior, the profiles may however change around a turn of a wave and may also be different between the various turns of a multi-layer spring. The effect of profiling or structuring the surfaces of the spring waves shows a larger influence in crest-in-crest springs than in crest-to-crest springs, due to the generally different contact behavior between the layers.

[0020] The use of a wave spring as a decoupling element in accordance with the invention allows a plurality of possibilities for variation and setting without making the production of the decoupling element expensive or complicated. It is especially advantageous that wave springs of different sizes and different damping properties can be produced from one and the same semi-finished goods, e.g. a wire- or strip-like starting material.

[0021] The decoupling element in accordance with the invention can be used with all known heat shields, e.g. with the known heat shields composed of several layers. The fastening means used previously can be used, especially screws. The number, layer and configuration of the fastening opening can also correspond to the state of the art. The heat shield differs principally from conventional heat shields only in the type of the decoupling element. The component from which the heat shield is decoupled by means of the decoupling element can be a component in the region of the exhaust system of a motor vehicle, especially an exhaust manifold. It can also concern another component which is fastened to the heat shield after the same has already been mounted for example in the region of the exhaust system. The decoupling element can be used not only for decoupling during the fastening of the heat shield itself, but also for decoupling when fastening other components to the heat shield.

[0022] In addition to the decoupling element which is arranged between heat shield and component, a further decoupling element can be provided on the side of the heat shield which is averted from the component. This appropriately concerns a wave spring as described above. Such decoupling elements on both sides are described for example in the initially mentioned DE 19716733 A1

and DE 10021575 A1. In the context of the decoupling element according to the present invention, for more resilient heat shields, it is preferred to use a pair of decoupling elements with either a planar surface directing at least versus the heat shield or crest-in-crest arrangement with a phase shift of the wave spring on one side of the heat shield relative to the phase of the wave spring on the other side of the heat shield ranging between 120 to 240 °, preferably 160 to 200 °, so that the decoupling elements on both sides of the heat shield touch the heat shield in the same areas.

[0023] The decoupling element can be formed alone by a wave spring or additionally comprise one or several other decoupling elements, which for the purpose of better distinguishing them from the wave spring decoupling elements in the context of this invention are also designated as damping elements. It is possible for example to arrange a damping element concentric relative to at least one of the decoupling elements. This damping element is appropriately arranged in the central opening of the wave spring. Said additional damping element can consist of a wire knit or interlaced metallic yarns, as has already been described in the state of the art as a damping element. The damping element appropriately has the shape of a hollow cylinder, with the fastening means being guided through the axial hollow space of the hollow cylinder.

[0024] For centering and for securely receiving the decoupling element and optionally the damping element, a groove can be present in at least one of the surfaces of the heat shield, in which one of the face sides of the wave spring and optionally also one of the face sides of the damping element can be received. In the case of a heat shield made of composite material, this groove can be embossed into the surface of the heat shield.

[0025] For facilitating the mounting and for reducing the number of individual parts, the decoupling element in accordance with the invention and optionally the damping can be pre-mounted on the heat shield or – and this is more common - on a sleeve, which is later on fixed on the heat shield. This sleeve is then present in the fastening opening for receiving the fastening means, as is described for example in DE 10021575 A1 or DE 10114295 A1. Said sleeve can also be used for pre-mounting the decoupling element and optionally also the damping element. The sleeve is preferably used for providing a defined stop for the fastening means based on a predefined height. A predefined pre-pressing is set over the sleeve length in order to prevent that an excessive pressing force will act upon the heat shield, which might damage the same. Direct pre-mounting on the heat-shield typically occurs by welding, soldering, riveting or gluing.

[0026] For the purpose of secure fastening and favorable power transmission, the sleeve appropriately comprises a flange on one of its face sides and in the tightened state preferably on both of its face sides, which in the tightened state of the fastening means rests on the decoupling element with tension. The sleeve consists especially preferably of two sleeve parts which are mutually displaceable in the axial direction and engage into each other, as is described for example in DE 10021575 A1 or DE 10114295 A1. Alternatively, the sleeve may include a one-piece shaft. The flanges of the sleeve(s) may be driven from the shaft of the sleeve or may be separate part(s) which are fixed by welding, soldering etc.

[0027] The invention will be explained below in closer detail by reference to the drawings. The drawings are merely of an exemplary nature and are used exclusively for illustrating preferred embodiments of the invention without the invention being limited to such examples. The drawings show schematically:

Fig. 1 a heat shield in accordance with the invention which is fastened by means of a fastening means to an exhaust manifold, in a cross-section through the fastening means;

Fig. 2 the decoupling element in a crest-to-crest embodiment, as is used in the heat shield in accordance with Fig. 1;

Fig. 3 an alternative decoupling element, again in a crest-to-crest embodiment;

Fig. 4 the wave spring according to Fig. 2 with inserted damping element in a perspective view, in a sectional view in the axial direction of the fastening opening,

Fig. 5 the decoupling element according to Fig. 4 in a top view in the direction of arrow A

Fig. 6 a heat shield fastening assembly comparable to Fig. 1 with the decoupling element in a crest-in-crest embodiment; and

Fig. 7 a heat shield fastening assembly comparable to Fig. 1 with the decoupling element in a single-layer embodiment.

[0028] Fig. 1 shows a heat shield 1 in accordance with the invention in a cross-sectional view through the fastening opening 2. The heat shield is fastened with a fastening means to a component, which in this case is an exhaust manifold 4, which fastening means is a screw 3 guided through the fastening opening 2. In order to prevent that vibrations are transferred from the exhaust manifold 4 to the heat shield 1, two similar decoupling elements 5 and 5' are arranged in the region about the fastening opening 2. The decoupling element 5 is located on the side of the surface 12 of the heat shield 1 between the latter and the exhaust manifold 4. The decoupling element 5' is arranged on the other side 11 of the heat shield 1. Both decoupling elements 5 and 5' are arranged as multi-layer wave springs 6 and 6' in a crest-to-crest embodiment, and substantially have the shape of a hollow cylinder. Screw 3 is guided through their central openings.

[0029] A portion of the screw shaft is received in a sleeve 9 which is guided through the fastening opening 2 and the central openings of the decoupling elements. Sleeve 9 comprises a flange 91 on its side facing the exhaust manifold, with which the sleeve rests on the exhaust manifold. The bottom face side of the decoupling element 5 rests on flange 91. The upper side of sleeve 9 is also flush with a flange 92, which rests on one face side of the decoupling element 5'. The flange 92 can be formed in one variant in such a way for example that an upper end region of the sleeve shaft is cut in the axial direction and the strips thus obtained are bent to the outside after the assembly of the decoupling elements 5, 5' and the heat shield 1 on the sleeve. Decoupling elements and heat shield are thus fixed on the sleeve 9. In the case of suitable material, the upper sleeve end can optionally be bent to the outside even without cuts thus forming the flange 92. It is understood that the flange 91 can be produced in addition to or instead of flange 92, as described. As an alternative, the flange 92 can also be formed by a disk element or an enlarged screw head.

[0030] Fig. 1 shows the state with tightened screw 3. For the purpose of fastening heat shield 1 to exhaust manifold 4, the screw 3 is inserted through sleeve 9 and tightened on a matching thread in the exhaust manifold. When an enlarged screw head or a disk element is used for the flange 92, they will press together the upper wave spring 6' in the direction towards the heat shield 1 when screw 3 is tightened and the heat shield 1 on its part compresses the lower wave spring 6. Screw 3 can only be tightened in such cases until the disk element 92 (or the screw head) rests on the upper edge of sleeve 9. Screw pressing is thus limited. The screw can only be tightened for a flange 92 integrated in the sleeve until it rests on the flange 92. After screw 3 has been tightened, the two decoupling elements 5 and 5' rest with predetermined tension on the heat shield 1. They receive vibrations of component 4 and prevent that the same are transmitted directly onto the heat shield 1.

[0031] The wave springs 6 and 6' which are used in Fig. 1 as decoupling elements 5 and 5' are shown in detail in Fig. 2. Wave spring 6' corresponds to wave spring 6. Wave spring 6 is made of a strip-like metallic material which was wound several times around the central opening 7. The first circular winding on the face side 65 was carried out with a smooth coil-like material in order to provide a planar end section 67. Waves are formed in the strip material only in the course of the second circular winding whose amplitude increases gradually. Amplitude shall be understood here as the difference in height between a crest 63 and an adjacent valley 62. A crest 63 and a valley 62 each form a wave 61. In a middle axial region of the wave spring 6 the amplitude will remain constant, whereas it decreases gradually towards the opposite face side 66 and is guided back to zero again in the end region of the strip-like material, thus also leading to a planar end section 68 at the second face side 66. In the wavy region in between, the waves are formed in such a way that crest always comes to lie on crest in the contact zones B. In fact, the planar end sections would also be formed from a separate ring.

[0032] Fig. 3 shows an alternative embodiment of a wave spring 6 as a decoupling element 5. This wave spring is not made of a single metal strip, but of several separate strip-like rings 64 which are placed above one another. Each of the said strip-like rings 64 comprises three waves, each with a wave crest 63 and a valley 62. The rings are arranged above one another in such a way that in the contact zones B a wave crest comes to lie on wave crest, so that a crest-to-crest embodiment results.

[0033] Fig. 4 shows a further alternative embodiment of a decoupling element 5. This decoupling element comprises a wave spring 6 which principally corresponds to that of Fig. 2. The figure shows a perspective cross-sectional view through the central axis of the wave spring. A damping element 8 is arranged within the central opening 7 of the wave spring 6. Said damping element 8 consists of a hollow cylinder made of a wire knit. It can principally be configured like the wire-knit damping elements of the state of the art. Its central opening corresponds with the fastening opening 2 and receives the fastening means 3 and optionally a sleeve 9. Fig. 5 shows the arrangement according to Fig. 4 in a top view of one of its face sides, e.g. in the viewing direction of arrow A.

[0034] Fig. 6 shows a further alternative embodiment of a decoupling element 5, integrated in a fastened heat shield assembly. The decoupling element 5 consists of a four-layer crest-in-crest wave spring 6'', which can either be wound as a one-piece spring or be composed from several, typically two or four springs. The decoupling element 5 shows no planar end sections. In the crest-in-crest

embodiment, the orientation of wave crests 63 and wave valleys 62 is the same in all layers of the wave spring. While in the crest-to-crest embodiment, the layers of the wave spring only touch in the contact zones B, in the present case, the layers – at least in the loaded state of the spring – touch all round so that a serial connection between the layers is formed which leads to an increase in the spring force. The decoupling elements 5, 5' facing the two surfaces 11, 12 of the heat shield 1 are oriented in such a way that the wave springs 6'', 6''' show a phase shift of about 180 ° causing the wave springs to touch the heat shield 1 from its upper and lower surface 11,12 in the same areas, which enables a better fastening of the heat shield. While the embodiment of Fig. 1 showed a single-piece sleeve arrangement, the sleeve arrangement here consists of a sleeve 9' and two disks 91' and 92'. The sleeve 9' may consist of a single shaft or of two shafts one within the other.

[0035] Fig. 7 finally shows an embodiment with two single-layer spring waves 6''', 6'''' as decoupling elements 5, 5'. The spring waves 6''', 6'''' on the upper and lower surface 11,12 of the heat shield 1 are arranged in such a way that they show almost no phase shift.

CLAIMS

1. A heat shield (1), comprising at least one fastening opening (2) for receiving a fastening means (3) with which the heat shield (1) and a component (4) can be joined to each other with a decoupling element (5) being arranged between the heat shield (1) and the component (4) in the region around the fastening opening (2),
characterized in that
the decoupling element (5) comprises a wave spring (6).
2. A heat shield according to claim 1, characterized in that the wave spring (6) encloses the fastening opening (2) in a ring-shaped manner, especially annular manner, and preferably in an annular closed manner.
3. A heat shield according to claim 2, characterized in that the wave spring (6) is a single-layer wave spring having at least one of the following properties:
 - an outer diameter of 8 to 100 mm, preferably 10 to 40 mm and especially preferably 12 to 30 mm,
 - an inner diameter in a range of from 5 to 90 mm, especially 6 to 35 mm and preferably 8 to 25 mm,
 - a spring force between 30 and 500 N and preferably from 50 to 150 N,
 - a spring constant in a range of from 30 to 300 N/mm, especially from 200 to 300 N/mm,
 - a spring travel in an axial direction between 0.2 to 6 mm, preferably 0.5 to 1.5 mm, and a height in an unloaded state between 1 and 15 mm, especially 2 to 6 mm.

4. A heat shield according to claim 1 or 2, characterized in that the wave spring (6) comprises several layers of superimposed waves (61) with a valley (62) and wave crest (63) each, with the superimposed waves being arranged with respect to each other with wave crest on wave crest.
5. A heat shield according to claim 4, characterized in that the wave spring (6,6') has at least one of the following properties:
 - an outer diameter of 8 to 100 mm, preferably 10 to 40 mm and especially preferably 12 to 30 mm,
 - an inner diameter in a range of from 5 to 90 mm, especially 6 to 35 mm and preferably 8 to 25 mm,
 - a spring force is between 3 and 500 N and preferably from 50 to 150 N,
 - a spring constant in a range of from 30 to 300 N/mm, especially from 200 to 300 N/mm,
 - a spring travel between 0.5 to 10 mm, preferably 0.5 to 5 mm,
 - a height in an uncompressed state between 4 and 50 mm, especially 5 to 20 mm,
 - a number of contact points between two neighboring layers distributed on a turn of 360 ° between 3 and 15, especially 3 to 6,
 - a number of rings or layers in the range from 2 to 8, preferably 2 to 6 and especially preferably 3 to 5,
 - a friction area per contact plane between two layers of 0.33 to 20 mm² and preferably 0.33 to 7 mm² in an uncompressed state,
 - a material thickness of 0.5 to 1 mm.
6. A heat shield according to claim 1 or 2, characterized in that the wave spring (6'',6''') comprises several layers of superimposed waves (61) with a valley (62) and a wave crest (63) each, with the superimposed waves being arranged with respect to each other in such a way that the superimposed waves show a phase shift of less than 10 °, preferably less than 5 °.
7. A heat shield according to claim 6, characterized in that the wave spring (6'', 6''') has at least one of the following properties:
 - an outer diameter of 8 to 100 mm, preferably 10 to 40 mm and especially preferably 12 to 30 mm,
 - an inner diameter in a range of from 5 to 90 mm, especially 6 to 35 mm and preferably 8 to 25 mm,

- a spring force between 60 and 4050 N and preferably from 105 to 1250 N,
 - a spring constant in a range of from 60 to 2500 N/mm, especially from 410 to 2500 N/mm,
 - a spring travel between 0.2 to 6 mm, preferably 0.5 to 1.5 mm,
 - a height in an uncompressed state between 1.2 and 22 mm, especially 2.2 to 12 mm,
 - a number of rings or layers in a range of from 2 to 8, preferably 3 to 5,
 - a friction area per contact plane between two layers of 20 to 800 mm² and preferably 100 to 200 mm²,
 - a material thickness of 0.2 to 1.2 mm.
8. A heat shield according to one of the claims 1 to 7, characterized in that the wave spring (6-6''') comprises at least three successive waves (61), preferably 3 to 6 waves, per layer (64).
9. A heat shield according to one of the preceding claims, characterized in that the wave spring (6-6''') is made of a wire with a round, especially circular cross section, or of a strip-like material.
10. A heat shield according to one of the claims 4 to 9, characterized in that the wave spring (6-6'') is composed of several superimposed separate layers (64).
11. A heat shield according to one of the claims 4 to 9, characterized in that the wave spring (6-6'') is made of a wire- or strip-like starting material which is wound several times about the central opening (7) of the wave spring (6-6'').
12. A heat shield according to one of the claims 3 to 11, characterized in that at least one of the face sides (65, 66) of the wave spring (6-6''') comprises a planar end section (67, 68).
13. A heat shield according to one of the claims 3 to 12, characterized in that the wave length and/or amplitude of the waves is adjusted to the excitation frequency acting upon the heat shield (1) in order to achieve the best possible damping.
14. A heat shield according to one of the claims 3 to 13, characterized in that a further decoupling element (5'), especially a wave spring (6-6''') according to one of the claims 1 to 9, is arranged on the side of the heat shield (1) averted from the component (4).

15. A heat shield according to claim 14, characterized in that the decoupling elements (5, 5') on the opposite surfaces of the heat shield (11, 12) are arranged in such a way that the two wave springs (6-6''') show a phase shift between 120 and 240 °, preferably between 160 and 200 °.
16. A heat shield according to claim 14, characterized in that the decoupling elements (5, 5') on the opposite surfaces of the heat shield (11, 12) are arranged in such a way that the two wave springs (6-6''') show a phase shift less than 20 °, preferably less than 10 ° and most preferably less than 5 °.
17. A heat shield according to one of the claims 2 to 16, characterized in that the decoupling element (5, 5') comprises a damping element (8), preferably concentric relative to the wave spring (6-6''').
18. A heat shield according to claim 17, characterized in that the damping element (8) is arranged in the central opening (7) of the wave spring (6-6''').
19. A heat shield according to claim 17 or 18, characterized in that the damping element (8) consists of wire knit or interlaced wire and especially has the shape of a hollow cylinder.
20. A heat shield according to one of the claims 1 to 17, characterized in that it comprises in at least one of its surfaces (11, 12) a groove for receiving a face side of a wave spring (6-6''').
21. A heat shield according to one of the preceding claims, characterized in that at least one surface of a wave spring (6-6''') has a surface which is at least partially structured or profiled.
22. A heat shield according to one of the preceding claims, characterized in that a sleeve (9) is present in the fastening opening (2) for receiving the fastening means (3).
23. A heat shield according to claim 22, characterized in that the sleeve (9) comprises a flange (91, 92) on at least one of its face sides, which flange rests on the decoupling element (5, 5') with tension in the tightened state of the fastening means (3).
24. A heat shield according to claim 22 or 23, characterized in that the sleeve (9) consists of two sleeve parts which are mutually displaceable in the axial direction.

25. A heat shield according to one of the preceding claims, characterized in that the component (4) is a component in the region of the exhaust system of a motor vehicle and especially an exhaust manifold.

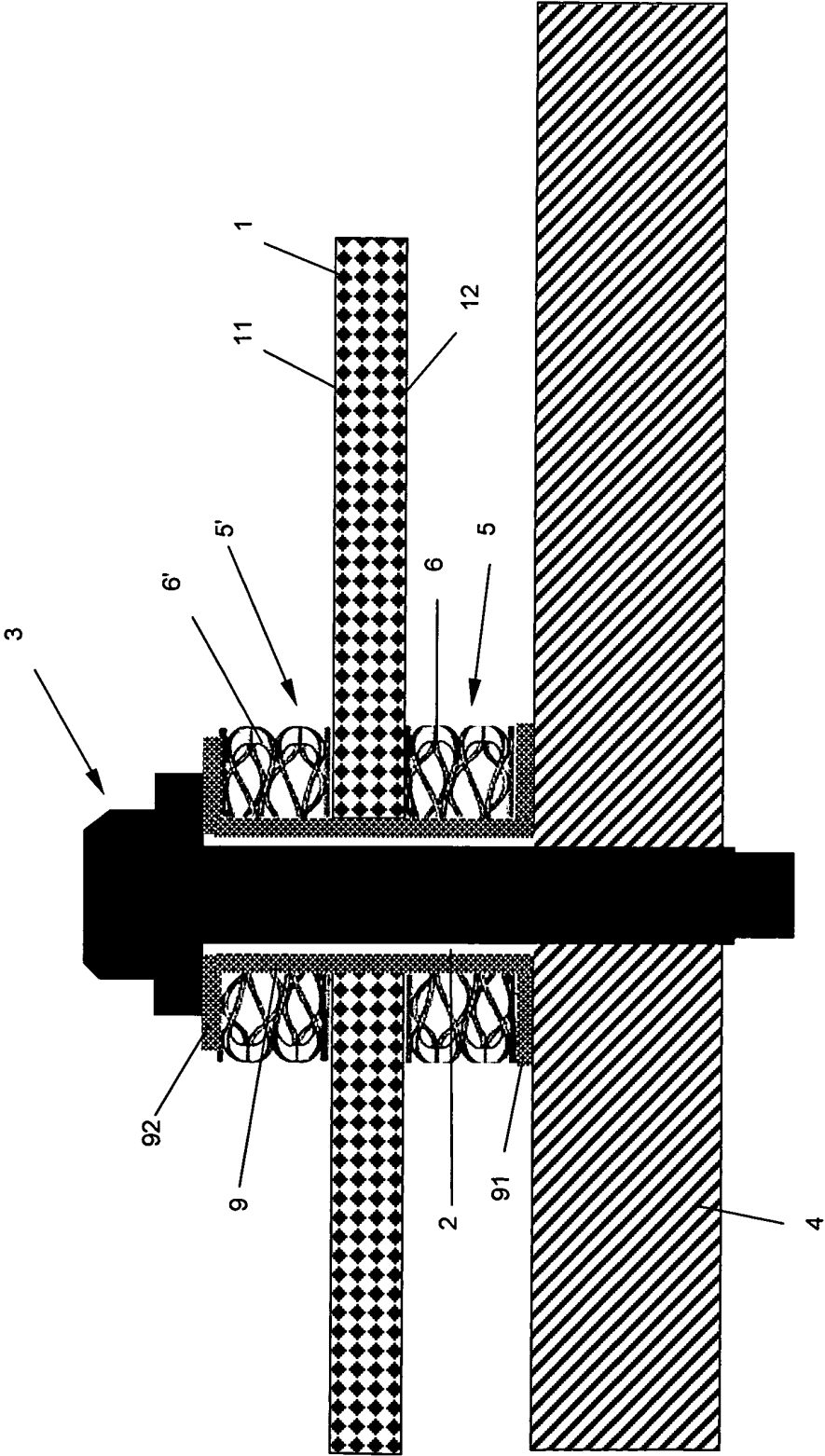
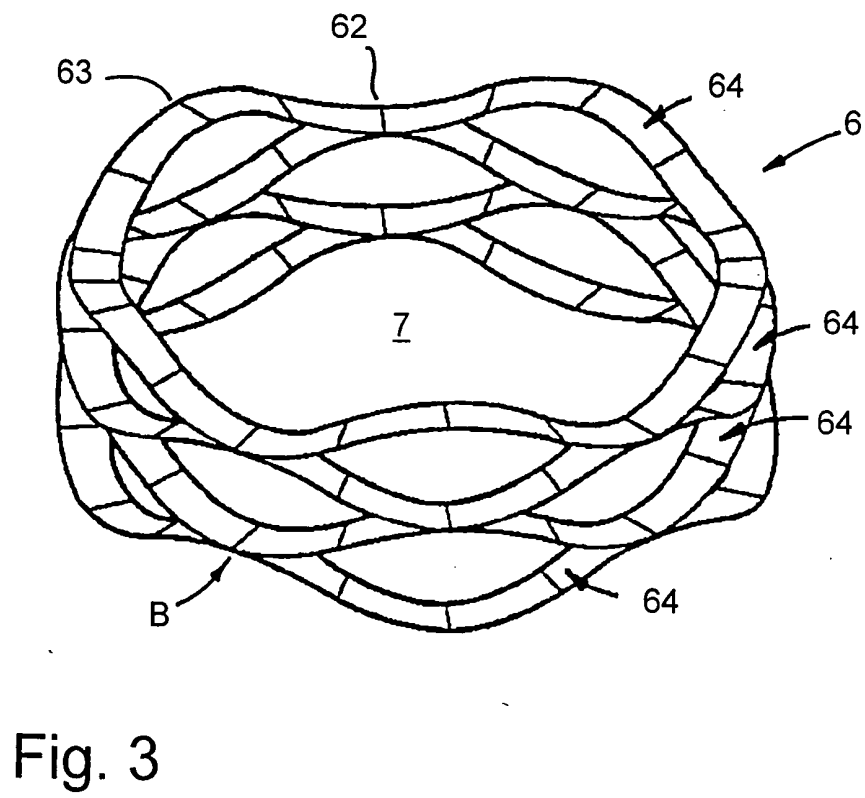
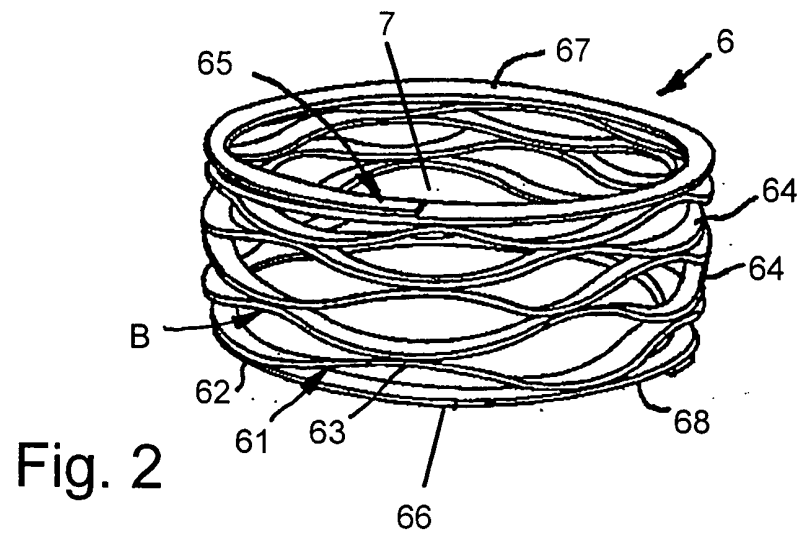


Fig. 1

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3/4

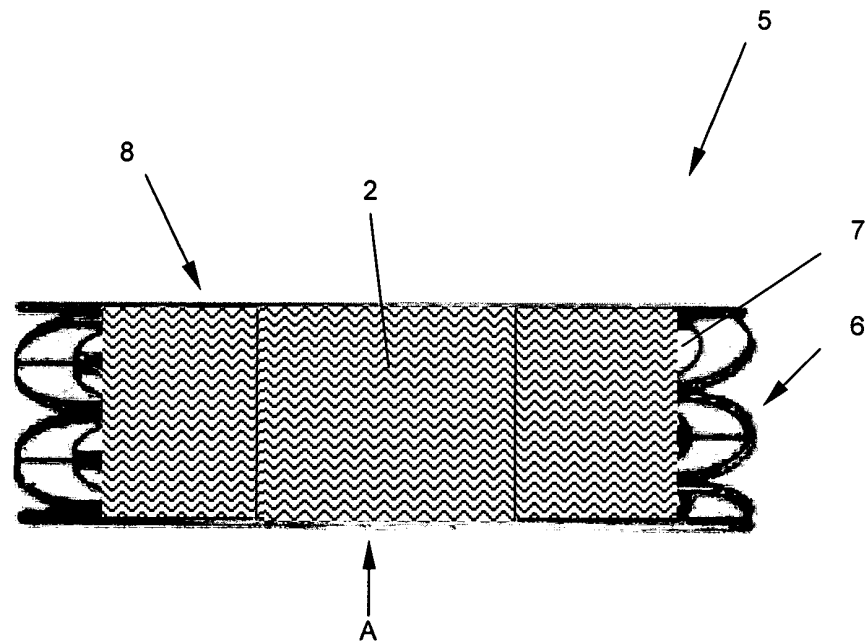


Fig. 4

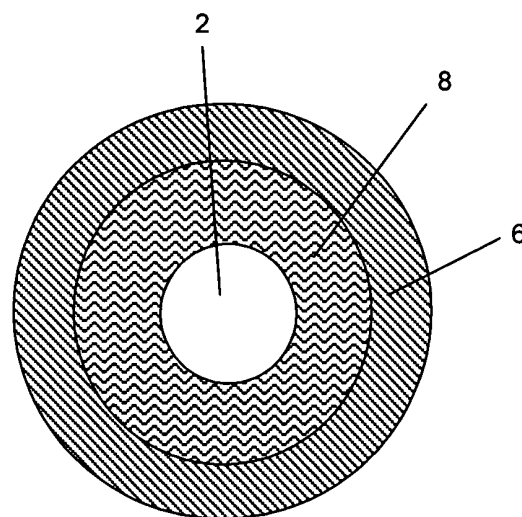


Fig. 5

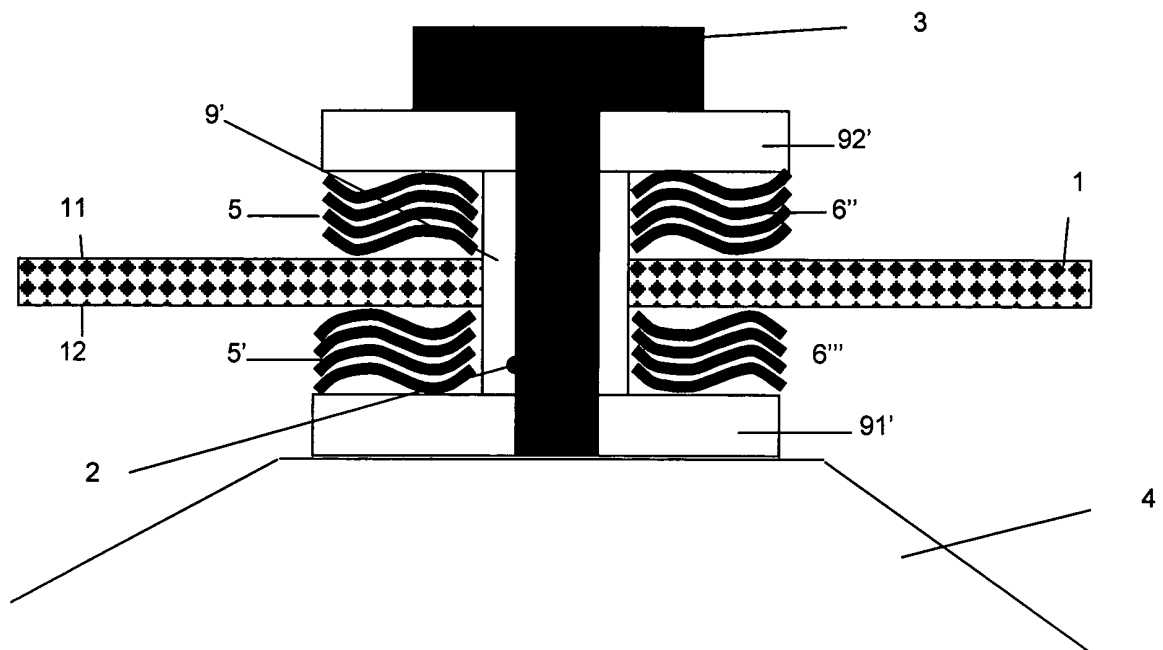


Fig. 6

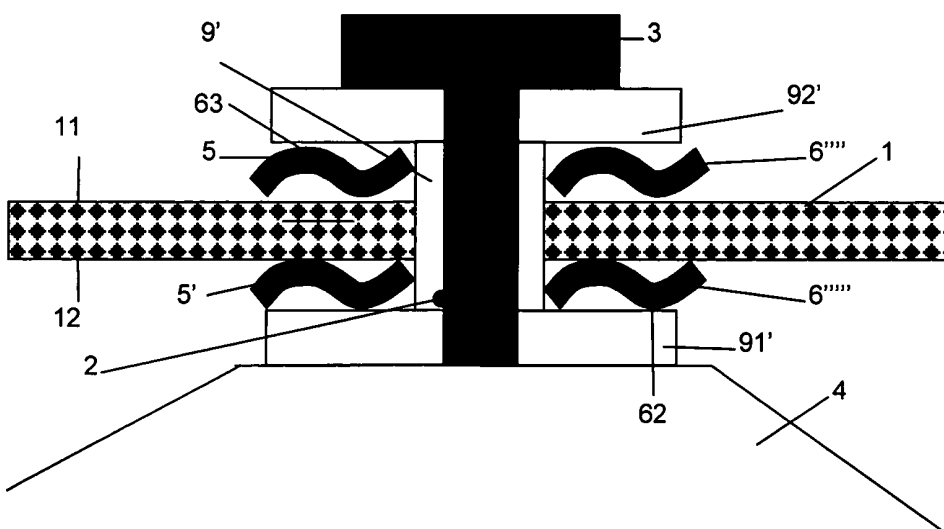


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2006/005155

A. CLASSIFICATION OF SUBJECT MATTER

INV. F01N7/10 F01N7/14 F16F15/06 F16F1/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F16F F16B F01N F16L B60R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 11 050842 A (MITSUBISHI MOTORS CORP) 23 February 1999 (1999-02-23)	1-3, 8, 9, 13, 14, 17-19, 21-25
Y	the whole document	4-7, 10-12, 15, 16, 20
Y	US 6 758 465 B1 (GREENHILL MARK [US] ET AL) 6 July 2004 (2004-07-06) cited in the application the whole document	4-7, 11, 12, 20
Y	DE 103 24 344 A1 (VISTEON GLOBAL TECH INC [US]) 18 December 2003 (2003-12-18) cited in the application the whole document	10
-/--		

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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- *Z* document member of the same patent family

Date of the actual completion of the international search

11 October 2006

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2006/005155

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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Information on patent family members

International application No

PCT/EP2006/005155

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